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Urban Ecosystem Participation in Extreme Landscapes

Hooimeijer, F.L.; Kothuis, B.L.M.; Recubenis Sanchis, I.; Meneses Di Gioia Ferreira, L.

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Urban Ecosystem Participation in Extreme Landscapes

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Unless you Will.
Paul Gaffney



from the series Inner Vision
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Colophon

Editorial Team
Fransje Hooimeijer
Baukje Kothuis
Isabel Recubenis
Lucas Meneses Di Gioia Ferreira

Tutors
Fransje Hooimeijer
Taneha Kuzniecow Bacchin
Francesca Rizzotto
Baukje Kothuis
Frits van Loon

Authors

URBANISM STUDENTS
Laura Conijn
Menno Aerts
Ilse van Milaan
Amber van der Voorn
Cas Goselink
Lucas Di Gioia
Ganesh Babu Ramaiah Perumalsamy
Hadrien Cassan
Jan Eggink
Menno de Roode
Stefan Vermeulen
Jurriënne Heijnen
Chengao
Baokun Wei
Asmita Puspasari
Noa te Duits
Janis Berzins
Jort van den Broek
Yujia Liu
Zhe Hou
Yixiang Huang
Ning Cai
Ying Hou
Johnathan Subendran
Zichuan Lu

LANDSCAPE ARCHITECTURE STUDENTS
Esmee van Eeden
Kuei-Tso Chen

TRANSPORT, INFRASTRUCTURE & LOGISTICS STUDENTS
Johan Krom
Richard Commandeur
Younes Douari
Leanne van Bentem

INNOVATION MANAGEMENT ENGINEERING
Jeffrey Huisman

CONSTRUCTION MANAGEMENT ENGINEERING
Suzan van Werkhoven

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Faculty of Architecture and Built Environment
TUDelft
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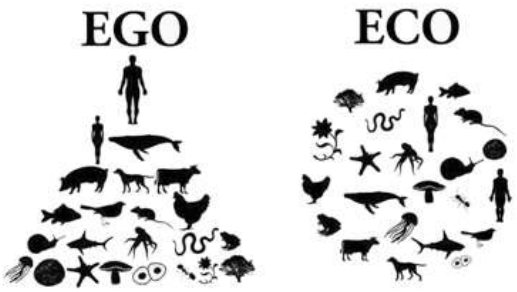
EGO
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Introduction

§ 1.1

The main research question, relevance, theoretical background

Environmental crisis

The environmental crisis is composed out of direct and indirect impact of human action on the ecosystem. The direct impact is: biodiversity loss, pollution, conservation, landscape use and exploitation of natural resources; with focus on terrestrial, freshwater and marine realms (Domingues, 2017). The indirect impact is the human impact on the climate inducing climate change that impacts the ecosystem in: timing of seasonal life-cycle events, range shifts of species territories, food web disruptions, buffers and threshold effects for wildfires, flooding and drought, spread of pathogens, parasites, and disease: shifts in ecological conditions could support the spread of pathogens, parasites, and diseases and plant and animal extinction risks (EPA, 2017)

With this urgent challenge to respond to the environmental crisis with strategies like climate adaptation, energy transition, and continued but sustainable urbanisation, the urgency of integrating planning and design with urban engineering increases. The implementation of new technological interventions and the utilisation of the natural system in urban development is hampered by the lack of an integrated approach incorporating urban planning and design decisions. This can be illustrated in decision making concerning changing to decentralized systems of water and energy. Meanwhile, urban and economic growth increasingly competes for infrastructure and environment, affecting the success or failure of the daily operating systems of cities and regions and thereby affecting urban competitiveness (Kresl & Ietri, 2014). In light of new technologies, the challenge is to fundamentally re-think the urban landscapes material and ecological practices. In this sense, the question is how to renew existing urbanized areas by integrating parameters of the natural system and technological innovations directly into urban development opportunities arising from spatial planning and design. The ecological, climate and urban crisis globally takes place in extreme landscapes, in this research understood as landscapes where climatic conditions are delivering the most pressing challenges in terms of extreme natural hazards like tsunami and hurricanes, or extreme floods and droughts due to climate change and/or extreme water pollution coming from extreme urbanization.

This book presents a selection of cases around the globe providing an overview of the different forms of critical relationship between nature (biotic/abiotic) and culture. By reading and mapping ongoing trends and projecting future change, the course engages with a main research question which has the purpose to turn the negative effects of extreme ecologies around:

> *How can ecosystem participation work as catalyst for healthy, climate proof extreme urban environments?*

The working hypothesis moves away from the notion of ecosystems as services to be deployed in a human-nature dichotomy, and instead, it acknowledges the fact that people and urban systems are part of the ecosystem and stipulates on the fact that we need to engage with nature as nature, thus participate. Furthermore, the notion of participation purposefully engages

with local sensitivities and culture, re-establishing a new harmonious relation between traditional/indigenous practices and technology. This is an important new perspective that not only gives natural systems a better position as a stakeholder in urban development, but it also acknowledges the fact that extreme landscapes are complex ecosystems that need to be contextually understood, demanding tailor made solutions. In this regard, terms like 'nature based solutions', 'building with nature', 'green blue infrastructure' or 'landscape infrastructure' are solutions that can be re-defined for each context.

Finally, the research investigates how ecosystem participation affects the living in the proposed extreme situations. By comparing them, a fundamental and methodological understanding of how this affects the field of urban design is generated. The cases for extreme landscapes are:

DESERT
Egypt – Cairo (drought and exploding growth)

WIND
The Bahamas – Baintown (hurricane and shrinkage)

WAVE
Japan – Otsuchi (tsunami and shrinkage)

ICE WATER
Norway - Lofoten and Hammerfest (accelerated climate change, temporal use)

SANE WATER
India – Bhuj (drought, flood, sanitation)

CONFLICTING WATER
Houston (hurricane, pluvial, fluvial and coastal flooding)

Theory

Human technologies and understanding of the natural systems have allowed humans to adapt, survive, and populate in dense areas. This understanding has, however, also created a culture and economy in approaching the natural system in a specific way. It has become a second nature and might even be called the Anthropocene lifestyle in which human actions relentlessly affect the environment and ecosystems without taking notice of the global consequences. Since the Enlightenment humans have placed themselves outside of the natural systems, by defining the notion of 'conscious' and 'non-conscious' creatures. The Enlightenment or the Age of Reason was an intellectual and philosophical movement that emerged around the 17th and 18th centuries as a result of a European intellectual and scholarly movement known as Renaissance humanism. During this period a series of humanists thinkers within a scientific

and philosophical perspective, become key enablers of this movement shaping what we define today as the Scientific Revolution and Enlightenment: the work of Francis Bacon (1561 – 1626), the philosophy of 'Cogito, ergo sum' ('I think, therefore I Am') by René Descartes (1637), and Isaac Newton's Principia Mathematica (1687) annotate a human centred movement, and the conviction of the possibility to control and predict nature.

Since the 1970s (Holling 1973, 1978) the negative impact of human control over complex and non-linear natural systems have been recognized (Holling and Meffe 1996). From this point, ecosystems are acknowledged as complex, dynamic, adaptive systems with nonlinear feedback and thresholds (Costanza 2008) tightly interlinked with human systems (Menzel and Teng 2010). The ecosystem services approach recognises the interactions of natural structures, processes, and services of an ecosystem across the landscape (Turner and Daily 2008, Fisher et al. 2009). Since many frameworks that give insight in the drivers, trade-offs, and synergies between services have been developed. However, there is still disjointed knowledge, and uncertainty about how different kinds of governance structures, levels of participation, and adaptive strategies affect ecosystems (Paavola and Hubacek, 2013). A downside of the ecosystem services approach is that there is much emphasis on the quantification of services, of which the development of environmental accounting and performance systems (Boyd and Banzhaf 2007), economic valuation for environmental decision making, planning and policy (Balmford et al. 2002, Turner et al. 2003) and attainment of multiple conservation objectives (Fisher et al. 2009), are examples. However, is necessary to understand and enhance the adaptability and resilience of social-ecological systems in the face of disturbances and associated fluctuation of ecosystem services, changing of societal preferences, changing needs of local communities and other stakeholders, and distributional impacts of different management options and governance regimes (Hubacek et al. 2009).

The application of the ecosystem participation approach implies a more critical focus on environmental governance and participation (Wesselink et al. 2011) in which humans participate within systems instead of making use of them. Empirical studies suggest that successful ecosystem change, resource management, and implementation of resilience/coping strategies can be achieved only when social and ecological systems are interlinked (Rechkemmer and von Falkenhayn 2009, Biggs et al. 2012). Menzel and Teng (2010) have emphasized that the human dimension has to be included early and explicitly in ecosystem service projects, for example, through the involvement of stakeholders in research. Therefore, the concept of ecosystem participation considers power and distributional issues, considering a broader participation, and reconceptualizing social-ecological systems so as to anticipate to undesired changes and take steps to either reduce their probability or minimize their impact once they occur.

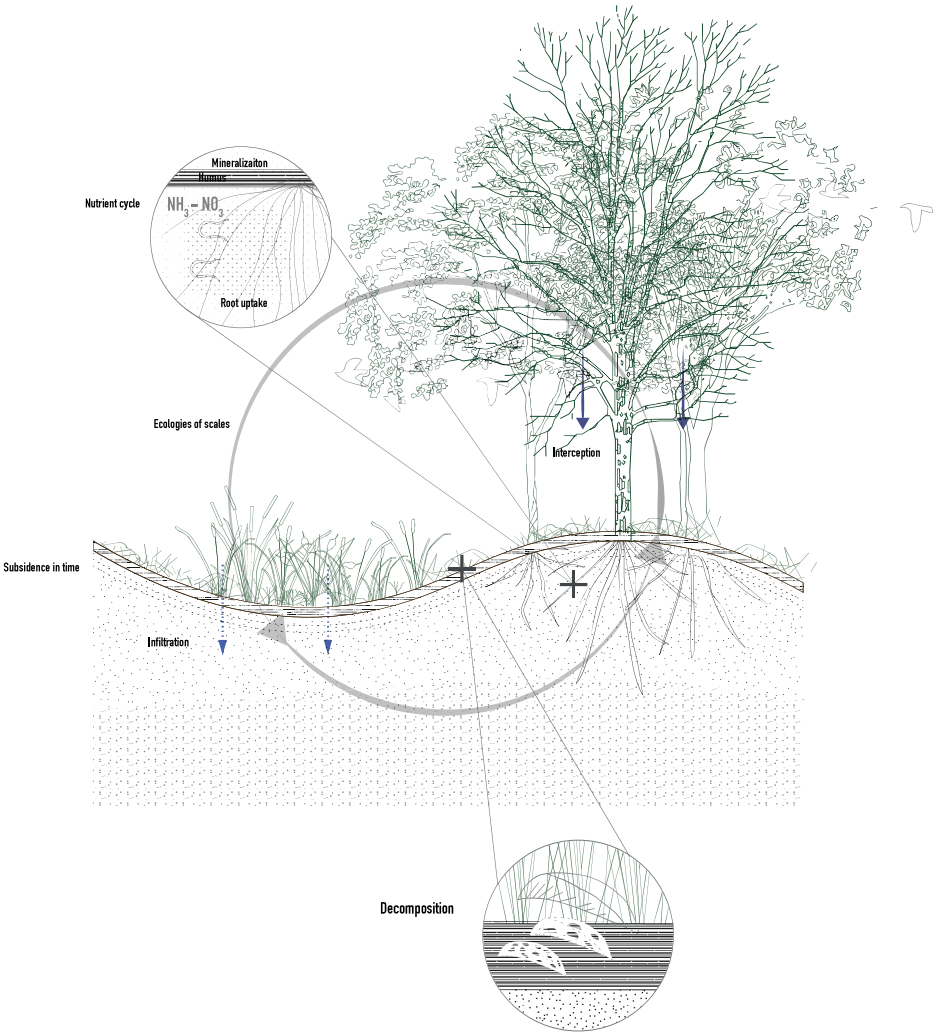
The term ecosystem participation as such in general, and specifically related to infrastructure and environment, is not yet underpinned by research, debate and design. The term is important to support a clear approach that is contextual with the inclusion of the natural system as an important stakeholder and not reaching out to applicable solutions from nature. The use of the concept ecosystem services supports a shift towards a more 'sustainable' lifestyle but does not create 'stewardship' in which understanding of their role and consequently actions as participant in the ecosystem acknowledged and executed.

Exemplary cases and concepts

As part of Africa's Great Green Wall program, the Sahel community needs where successfully combined with the selection of suitable native species for large-scale natural capital restoration. The restoration of degraded land and increase of plant diversity research went hand in hand with the analysis of 120 beneficiary village communities through the organization of diagnostic meetings. The community participation lead to the selection of 170 native plant species that were not only suitable for enriching and restoring those village lands, but they also provided with food, medicine, fodder, and fuel for the villagers Sahel (Sacande and Berrahmouni, 2016).

In that sense the ecosystem participation concept is the spatial design counterpart of the more sociology oriented approach of 'Civic ecology practices' (Krasny et al., 2014): community-based and environmental stewardship actions taken to enhance green infrastructure, ecosystem services, and human well-being in cities and other human-dominated landscapes. Examples include tree planting in post-Katrina New Orleans, oyster restoration in New York City, community gardening in Detroit, friends of parks groups in Seattle, and natural area restoration in Cape Flats, South Africa.

Capacity building is also an important tool in which ecosystem participation can be supported. The project 'Capacity Building to Strengthen Resilience of Coastal and Small Island Communities against Impacts of Hydro-Meteorological Hazards and Climate Change' by the Asia-Pacific Network for Global Change Research is facilitating cooperation among scientists and non-scientists in Indonesia, Japan, the Philippines and Timor Leste. Aim is to develop educational and awareness-raising materials on disaster risk reduction and climate change adaptation by integrating scientific knowledge with local and indigenous knowledge (UN, 2016).



Nano-scale - Corridor Segment
Subsurface-surface performative design
project/ drawings by Filippo LaFleur,
led by Fransje Hooimeijer

§ 1.2
The research methodology

The research methodological steps were designed to organise theory, information and ideas from the general question into ecosystem participation in extreme landscapes toward application to the specific cases.

The first step was the theoretical framing which is described in the former paragraph. This was important to bring focus into the research and to feed the second step of critical cartography. Each member of the case team took a perspective and cooperated with the team members of the other groups in this perspective. This was the analysis were tuned and cross learning took place.

The perspectives were:
Systems of systems (guided by Taneha Kuzniecow Bacchin)
Anthropology (guided by Baukje Kothuis)
Landscape morphology (guided by Frits van Loon)
Ecology (guided by Francesca Rizzetto)
Urban morphology (guided by Fransje Hooimeijer)
Mobility and Transport (guided by Fransje Hooimeijer)

The results of these analyses were brought together for the selected cases in a Systems description and synthesis. By applying four scenarios, boundaries and qualities were explored and ideas generated for the System intervention that followed later, in the case level as general guidelines and on the individual level in the design experiment.

Building the theoretical humous layer

The first step was the theoretical framing from the main research question and a sketchy environment which is described in the former paragraph. The main research question:

> How can ecosystem participation work as catalyst for healthy, climate proof extreme urban environments?

was divided in three domains: ecosystem participation, catalyst for health and climate proofing and extreme urban environments. The students needed to take one or two domains and formulate a sub-question to the main question. For that question they needed to perform a literature review by defining concept and their keywords that defined the direction of their search. This resulted in a collection of literature review papers describing literature to form the theoretical base for the research that continued.

The table on the next pages is the overview of the sub-questions, concepts (C) and keywords (KW). The review papers offer the base for the theoretical framework and group question per team.

How can ecosystem participation work as catalyst for healthy, climate-proof extreme urban environments?
Concepts (C), Keywords (KW)

ecosystem participation	catalyst for healthy, climate-proof	extreme urban environments
What are drivers for people to participate in nature? *Sociology of ecology* (C) => Biophillia, Gaianism, Biological attraction (KW); *Urban functionality* (C) => Green index, Leisure (KW) *Anthropological characteristics* (C) => Behaviour, Time, Space/location, Sociology, Age (KW) *Ecosystem participation* (C) => Human-nature participation, Human-nature connection (HNC), Human-nature relation (KW) *Jan Eggink*	What is the role of information systems in behaviour change for climate change mitigation? *Information systems* (C) => Social media, Internet, Apps, Mobile, ICT, Mapping, Data Visualisation (KW); *Behavioural Change* (C) => Behavioural change, Social change (KW); *Climate change mitigation* (C) => Car free, Active transportation, walking, cycling, Energy conservation, Domestic energy use, Water conservation, Domestic water use (KW) *Ganesh Babu R P*	What is the impact of extreme climate events on humans and ecosystems? Extreme Climate Events (C) => Climate change adaptation, Extreme events, Climate risks (KW) Natural system (C) => Ecosystem functions, Soil ecology (KW) Socioeconomic system(C) => Risks, Individual and group vulnerability, Human health (KW) *Laura Conijn*
How are human activities different in the landscape types of coast, desert and river? *Human activity* (C) => Socio-economic system, Outdoor, Productivity, Leisure, People (KW) *Landscape* (C) => Land use, Ecosystem service, Landscape typology (KW) *Landscape Type* (C) => River, Waterbody, Coastal, Desert (KW) *Asmita Puspasari*	What is the impact of the extreme climate condition on public health? *Extreme Climate change, extreme climate event* (C) => Heat wave, Drought, Flood, Temperature change (KW) *Public health* (C) => Physical health, Mental health (KW) *Chen Gao*	
To what extent is environmental equity taken into consideration in nature based solutions for climate mitigation? *Environmental Equity* (C) => Environmental equity, Social equity, Environmental justice (KW) *Nature Based Solutions* (C) => Nature Based Solutions, Urban Resilience, Ecosystem Services (KW) *Climate Mitigation* (C) => Climate Mitigation, Climate Change, Climate Crisis (KW) *Urbanized areas* (C) => Urbanized areas, Urban area, City area, urban region (KW) *Lucas di Gioia*	How to improve public health under the extreme climate and urbanization? *Public health* (C) => Public health science, climate monitoring, health monitoring, air sensing (KW) *Urban densification* (C) => Liveable city, Eco Friendly (KW) *Water safety* (C) => Water purification system, Sustainable city (KW) *Urban ecosystems* (C) =>Liiveable city, Eco-friendly (KW) *Kuei tso, Chen*	How to engage shrinking communities in ecosystem restoration to improve urban microclimate? *Engagement* (C) => Stakeholder engagement, Community building (KW) *Shrinking communities* (C) => Shrinking cities, Population decline (KW) *Ecosystem restoration* (C) => Ecological restoration, Ecosystem restoration, Biosiversity (KW) *Urban microclimate* (C) => Thermal comfort, Heat stress, Sunlight, Wind, Shade (KW) *Janis Berzins*
How can we adjust the infrastructure system to participate in the natural (animal) system instead of blocking it? Infrastructure design (C) => Infrastructure, Infrastructure design (KW) Natural system (C) => Ecosystem (KW) Environment (C) => Biodiversity, Ecological connectivity, Conservation, Habitat loss, Pollution, Land use (KW) Blocking (C) => Blocking, Hindrance, Barrier, Fragmentation (KW) *Leanne van Bentem*	How can mimicking ecosystem services help design sustainable urban environments? Mimicking ecosystem services (C) => Biomimetic, Biomimicry (KW) Sustainable (C) => Sustainable, Regenerative, Climate proof (KW) Urban environments (C) => Cities, Built environment (KW) *Ilse van Milaan*	How is human behaviour influenced by being exposed to risk and disaster due to living in a hazard scape? Hazard scape (C) => Hazard scape, Extreme environments, Natural hazard (KW) Human behaviour (C) => Human behaviour, Behaviour, Culture (KW) Risk (C) => Risk, Vulnerability, Exposure (KW) Disaster (C) => Disaster, Natural disaster, Hazard (KW) *Amber van der Voorn*

ecosystem participation

How can socially vulnerable groups benefit from ecosystem participation?
Social equity (C) => Tribes, Self-sufficient, Nomads, Africa, Slums, Favelas, Ghetto (KW)
Benefit (C) => Benefit (KW)
Ecosystem participation (C) => Agriculture, Local agriculture, Private agriculture, Natural disasters, Urban agriculture, Urban nature (KW)

Menno Aerts

What is the influence of public space design on human environmental behaviour?
Direct influence (C)=> top-down - traffic behaviour; walkability; safety, diversity (KW)
*Indirect influence (*C)=> bottom up - community, awareness, participation, responsibility (KW)

Jort van den Broek

How can community participation enhance social-ecological resilience in urban flooding areas?
Community participation (C) => Local actors, Community engagement, Bottom-up (KW)
Social-ecological resilience (C) => social-ecological sustainability, ziecosystem restoration, disaster planning (KW)
Urban flooding areas (C) => flood risk, stormwater, coastal (KW)

Zhe Hou

What is the role of the ecosystem in cultural urban environments to improve human interaction?
Ecosystem (C) => Ecosystem, Natural System, Ecosystem Functions, Ecosystem services (KW);
Cultural Urban Environments (C) => Cultural public space, Cultural urban environments, Cultural infrastructure (KW);
Human Interaction (C) => Interacted, Interacting, Interact, Activity, Activities (KW)
Li Yangzi

catalyst for healthy, climate-proof

Which urban ecosystems can mitigate the effects of urbanisation on ecosystem services?
Urban ecosystems (C) => Urban ecosystems, Urban biome, Urban ecology (KW)
Urbanisation (C) => Urbanisation, Urban areas, Cities, Population growth (KW)
Ecosystem services (C) => Ecosystem services, Ecology, Ecosystems, Biodiversity (KW)

Noa te Duits

How can ecosystem participation in coastal waters influence the way we observe this territory?
Coastal waters (C)=> Anthropocene, Geopolitics, Territorialism, Boundaries, Territorial waters, Coastal territory (KW)
Ecosystem participation (C)=> Aquatic ecosystem services, Sustainable, Environment, Ecological (KW)

Cas Goselink

What is the role of local knowledge to promote contextualized climate adaptation strategies in vulnerable areas?
Climate change (C) => Climate change, Disaster risk, (KW);
Climate adaptation (C) => Climate adaptation, resilient, adaptation (KW);
Vulnerability (C) => Vulnerable, Social, Economic, Environmental vulnerability, Accessibility, Inequality (KW)
Contextual (C) => Context specific, Local intelligence, local adaptation, participatory, local knowledge, indigenous knowledge (KW)

Johnathan Subendran

What is the role of building with nature in improving public health in coastal urban environments?
Public health (C) => healthy urbanism, healthy urban planning, healthy city (KW)
Building with nature (C) => nature-based solution (KW)
Coastal urban environment (C) => coastal, coastal ecosystem, coastal zone (KW)

Yixiang Huang

extreme urban environments

What are life world views on personal car usage in densely trafficked urban environments.
Life world (C) => Anthropology, human experience, life world (KW)
Car usage (C) => Mobility, Transportation, roads, automobile (KW)
Dense traffic (C) => Congestion, traffic jams, barrier effects (KW)
Urban (C) => Cities, Urban areas, Sprawl

Johan Krom

How can building with nature concepts be applied to the flood safety of urban floodplains?
Flood safety (C) => Flood safety, Flood protection, Risk management, Flood control, Resilience (KW)
Urban floodplain (C) => River delta, low lying city (KW)
Building with nature (C) => Sustainable engineering, Landscaping, Environmentally friendly (KW)
Suzan van Werkhoven

How can the relation between public infrastructure and private protection be balanced to anticipate hazards impacting extreme urban environments?
Public infrastructure (C) => Public infra-structure, Critical urban infrastructure (KW)
Private protection (C) => Private protection, (KW)
Hazard (C) =>Hazard, Flood, Drought, Climate change, (KW)
Extreme urban environment (C) => Extreme urban environment, Vulnerable urban environment (KW)

Zichuan Lu

ecosystem participation

How can (urban) logistic solutions cooperate with ecosystem participation?
Ecosystem participation (C) => Collaborative design, Stakeholders involvement, Consumer participation, Value co-creation (KW).
Urban ecosystem (C) => Environment; Sustainability, Liveability, Liveable cities, Healthy environment (KW)
(Urban) logistics (C) => JIT, Last-mile, City logistics, urban freight (KW)

Richard Commandeur

What is the role of community participation in nature based solutions in vulnerable water sensitive areas?
Community participation (C) => community gardens, raising awareness, local green-blue infrastructure (KW)
Nature based solutions (C) => sustainable management, resilience, biodiversity (KW)
Water sensitive area (C) => flooding risk, soil, subsidence, socio-environmental challenges, coastal area (KW)
Ying Hou

How can transport infrastructure be tuned with geomorphologic factors of river landscapes so that it does not disrupt ecosystems?
Transport infrastructure system (C) => Transport infrastructure, Urban infrastructure, Road, Railroad (KW)
Landscape (C) => Landscape, Geomorphology, Green infrastructure, Rivers, Delta, Floodplains (KW)
Ecological impact mitigation (C) => Ecological impact, Ecosystem, Disruption, Mitigating impact (KW)
Environmental hazards (C) => Increased flooding, Floods, Environmental danger(KW)

Jeffrey Huisman

catalyst for healthy, climate-proof

How can people transition towards participation instead of utilization of ecological infrastructure in planning and design?
Ecological infrastructure (C)=> green-blue infrastructure, urban resilience, ecological measures, ecological design, urban ecosystem design (KW)
Transitional Theory (C) => social-technical regimes, landscape, niche, development, multi-layer framework, transitional instruments (KW)
Adaptable cities (C)=> sponge city theory, eco-city theory, ecological planning, liveable city theory (KW)

Baokun Wei

How can nature-based solutions be integrated in regeneration approaches in a post-disaster environment ?
Nature Based Solution (C) => Nature based solution, Nature based measures, Regeneration approach, Nature infrastructure (KW)
Post-disaster area (C) => Flood, Hurricane, Flood defence, Climate change, Tsunami (KW)
Governance (C) => Governance, Socioecology, Public participation, Engagement (KW)

Ning Cai

How does resilience shape literature on planning support systems for cities that suffer from the consequences of climate change?
Climate change in cities (C) => Climate change in cities, climate change statistics, climate change in coastal areas (KW)
Resilience (C) => Resilience (KW)
Antifragile (C) => Antifragile planning (KW)
Climate resilient cities (C) => Resilient cities, Resilient planning, Climate Resilience in cities (KW)

Younes Douari

extreme urban environments

How to implement ecosystem restoration in extreme urban environments?
Extreme urban environment (C) => Climate change, Extreme environments, Urbanization (KW)
Ecosystem restoration (C) => Urban ecology, Ecology restoration, Restoration ecology (KW)

Jurriënne Heijnen

Are nature-based solutions able to mitigate flood risks in dense coastal regions?
Hybrid Infrastructure (C) => Hybrid infrastructure, Green-blue infrastructure, Nature-based solutions, Ecosystem-informed flood defense, Natural-flood defence, Flood defence (KW)
Water Hazards (C) => Flood risks, Sea-level rise, Climate change, Storm surge, Urban inundation (KW)
Coastal Regions (C) => Coastal Development, Water-adjacent Community, Densifying Coasts, Coastal landscapes (KW)

Hadrien Cassan

ecosystem participation

How can citizens participate in the ecosystem specifically to reach a water-sensitive urban environment?
Water-sensitive city (C) => Water sensitive city, Water sensitive urban environment, Water sensitive urban design, Resilience, Water sensitive design, Water policy, Water management (KW)
Citizen participation (C) => Citizen participation, Public participation, Sociological values, Community, Social network (KW)

Yujia Liu

How can mimicking ecosystem services help in creating liveable climate proof desert systems?
Mimicking ecosystem services (C) => Pastoralism, Agroforestry, Reforestation, Afforestation, nature-based solutions, Rehabilitating (KW)
Desert systems (C) => Dryland, Arid zone, Semi-arid zone, desert, Dru wasteland (KW)

Esmée van Eeden

catalyst for healthy, climate-proof

How can the concept of biophilia potentially influence urban form?
Biophilia (C) => Biophilia, Biophilic (KW)
Urban (C) => Urban, Urbanism, Built environment, Cities, City (KW)
Form (C) => Form, Typology, Shape, Pattern, Design, Performance, Function (KW)

Menno de Roode

extreme urban environments

What is the impact of extreme environments on ecosystems?
Extreme environments (C) => Floods, Droughts, Heat waves, Storms (KW)
Ecosystems (C) => Biodiversity, Ecosystems, Microclimate, Ecology (KW)
Urban (C) => Urban, City (KW)

Stefan Vermeulen

Critical cartography

The critical cartography started with formulation the base-line information by the case group identifying the answers to the following questions:

1. What is/are the environmental risk(s) to be tackled?
   - e.g. flood risk / flood and drought risk / accelerated climate change / hurricane / a combination of ...

2. How does the population of the case study experience the risk?
   - risk preparedness / response (planning) framework in place, system's robustness (and resilience) by design
   - non or little preparedness / response framework in place
   - based on individual responses /social resilience

3. What are the project scales and who are the actors to be involved at each scale:
- Macro-scale: Regional level
  What is the larger spatial (aggregative) unit at ecological/water processes level of importance? e.g. river catchment area / eco-region / etc.
  Who are the actors at this scale?
- Meso-scale: Urban level
  What is the urban scale (metropolitan area / entire city / portion of a city) to be considered?
  Who are the actors at this scale?
- Micro-scale: Urban fragment level
  What could be potentially the smaller spatial unit to be used as test site for a design experiment? e.g. neighbourhood / urban or ecological corridor / parcel (patch of land) / street / household level (plot)
  Who are the actors at this scale?

After defining the problem and the scales of action each group member of the case group took a perspective in the study and cooperated with the members of the other case groups with the same perspective in the investigation. This way the research was tuned between the different cases and the analysis could become comparable. Each perspective had clear goals and products.

<u>Systems of systems analysis</u>

This perspective considers relations in terms of boarders, power, assemblage and cycles. These are the dynamic layers of the social and physical layers studied in the other groups. The three steps in analysis were:
1 Relations of borders, power, assemblages (geo-political / cultural / economic / logistics frameworks and their abstract and concrete manifestation in space territorialisation) to identify/ delineate the interdependencies between systems in place: Are they conflicting (dissonances) or reciprocal (assemblages) relations?]
2 Scale continuity in the relational systems and cycles within the environment

(atmosphere, climate, energy) the description of a set of characteristic elements areas space and mass elements, both within the area and outside that show specific mutual influences and there infrastructural connections related to current and future policies. Circular systems and cycles (climate, water, energy, ecology regimes).

3 Extreme systems impact from Climate change, Energy transition and Closing loops. Creation of abstract flow schemes of the materials, goods, currents, etc. that have an impact on the designated design area and or vice versa. Description and mapping of elements, areas and or infrastructure systems of influence as they are now.

Due to the context of the landscapes the topics studied in this perspective are quite divers per case.

Anthropology analysis

The results of the study into anthropology for this research are insight in local time, cultural, and social systems to be able to map out an impression and overview of typical local human behavior in the diverse local extreme environments and local natural hazards.

1 Time systems:
How have people coexisted with their local extreme environment(s)/events?
Products:

- Linear and/or circular timelines, showing Time * Social Dynamics, including
  - General and local historically relevant events and changes
  - Local decisive events, disasters and changes concerning living in and coping with the extreme environment

By including imagery in the timeline(s) both cognitive and visual impressions are created. Additionally, this implies a more diverse contextual approach by the researcher and adds a broader frame of reference to the communication of time systems. Guiding principle is a quote from Donella Meadows's essay 'Dancing with Systems' (2001):

'In a strict systems sense, there is no long-term, short-term distinction. Phenomena at different time-scales are nested within each other. Actions taken now have some immediate effects and some that radiate out for decades to come. We experience now the consequences of actions set in motion yesterday and decades ago and centuries ago. The couplings between very fast processes and very slow ones are sometimes strong, sometimes weak. When the slow ones dominate, nothing seems to be happening; when the fast ones take over, things happen with breath-taking speed. Systems are always coupling and uncoupling the large and the small, the fast and the slow. When you're walking along a tricky, curving, unknown, surprising, obstacle-strewn path, you'd be a fool to keep your head down and look just at the next step in front of you. You'd be equally a fool just to peer far ahead and never notice what's immediately under your feet. You need to be watching both the short and the long term - the whole system.'

2 Human Cultural Perspectives:

How do people perceive their extreme environment(s)/events?

Products:

- A series of window-scapes including representations of typical local interior and exterior surroundings during 'normal' daily life and during life in the extreme environment and/or during the extreme natural event.
- Each window scape explained by 'perception of nature'-concepts based on the 'A Credible Biosphere' (Douglas, 1992), a well known and practicable anthropological perspective on how humans cope with nature and hereto related 'myths' (or 'the socialized perceptions'), using the following legend:

'Nature is Capricious' – This perception implies uncertainty for humans towards extreme environments and natural disasters; the ball can roll anywhere on a flat plane, we don't know what it will do next.

'Nature is Fragile' – This perception implies vulnerability for humans towards extreme environments and natural disasters; there is only one possibility of equilibrium, with the ball on top of the mound, every disturbance creates major changes.



'Nature is Robust' – This perception implies a resilient situation for humans towards extreme environments and natural disasters; there will be return to the original state no matter what the disturbance is.

'Nature is Robust within limits' – This perception implies a resilient situation for humans until the extreme environment or natural disasters reaches a tipping point, from where there is no return to the current safety; the ball will roll over the edge and never come back to the original state.



Taking human agency as a starting point, some of the following notions could be leading for research:

- How do people perceive the extreme natural hazard in the specific local environment and culture?
- Before, during, after extreme events?
- What conflicts/opportunities/actions have sprouted from these perspectives?
- Or could be developed based on these perspectives?

3 Extremes and vulnerabilities:

Which strategies for coping with the local hazards and which aspects relevant for developing local social resilience are in place or can be developed to deal with vulnerability in this extreme environment?

Product(s):

- Deep map/Heat map: showing structures, infrastructure, and other strategically aspects (potentially) relevant for coping with hazard and developing social resilience on the urban scale. Using images, layers, text, drawings, in overlapping layers to demonstrate aspects of (potential) mitigation (minimizing devastating impacts of hazard/extreme environment) and adaptation (adjusting circumstances to live with hazard/extreme environment).
- Mind-map: Communicating an array of connections related to 'resilience to vulnerability' that are hard to explain with a linear story. Make use of pictures, words, drawings, etc. 'Vulnerability is the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience'.

Taking the' formal and informal' as starting points for the anthropological perspective on extremes and vulnerability, some of the following notions can be leading

- How is vulnerability shared/distributed in the extreme environment?
- Who is formally responsible for coping with the extreme environment/ hazard and how is that responsibility enacted? (Think of policies, institutions, etc)
- Who takes responsibility for coping with the extreme environment/hazard informally and how is that responsibility enacted? (e.g.; local initiatives; objection against formal rules, etc)
- How do people individually prepare for extremes?

Landscape morphology analysis

This perspective aimed at analysis of the larger scale natural landscape and bringing it to the urban scale in three parts: Palimpsest, Perception and Extreme Landscape.

The first part of analysis is named Palimpsest, a term which originally describes the scraping of a manuscript page to be used again. In geology, a palimpsest is a geographical feature composed of superimposed structures created at different times. Palimpsest is beginning to be used by glaciologists to describe contradicting glacial flow indicators, usually consisting of smaller indicators overprinted upon larger features. The Palimpsest thus is the natural layer, the cultural layer and the urban layer connected through scales. The natural layer is the landscape typology like forest, desert, tropical forest, the geomorphology like topographic contour lines, elevation and landform and the soil type. The cultural layer are the settlements, settlement typologies and land use based on the possibilities of the natural layer with relatively small impact. The urban layer are on the larger scale the energy landscapes like windmill and solar parks, understanding of the larger scale of the landscape morphology and composition.

The second part of Perception is about the spatial experience of the location in describing the space and mass relation, mapping of all the identified mass elements and spaces blend into one space, orientation points and the creation of a Gordon Cullen sequence (#REF) with expressions of built elements, vegetations, light and darkness, texture and materials.
Two important remarks on perception

- The perception of space is not only static, space is also perceived through movement. Different speeds give different perceptions of space. Sequences can either be experienced by cars on a high way or at lower speed, or by public transport also with different speeds, by cyclists, pedestrians or of track, or people in boats with different speeds and different eyelevel perspective.
- Next to that, different users might have different perceptions because they

create or have different patterns of movement. You can think of people in different social classes, or locals versus tourists or …. it might even be other organisms, flora and or fauna.

The final part is to map the extreme in hazard prone areas, exposure and fragility.

Ecology analysis

The ecological analysis is aimed at detailing of natural context of the site by describing it in three levels: the analysis ecosystems' profiles and series, processes and extreme ecology.

The first level of ecosystems' profiles and series is about defining which systems (biomes) and how they relate (ecotone), their flora and fauna and soil conditions. The biomes and ecotones are first found in their larger scale positioning in the landscape of the site. An ecotone is a transition area between two biological communities or biomes. They are then described in their Flora, the natural (possible) vegetations and Fauna, the natural (possible) habitat and the present habitat of species. The soil typology is defined and seen for its life and fertility.

The Processes are pollution, climate and dynamics. The pollution is studied in the soil, air and noise on the urban scale. The climate is studied in the categories wind, direction and intensity, temperature, deviation and seasonal, and dynamics is studied in tidal sea, flash flood, erosion, fluvial and pluvial flooding.

The concluding part is extreme ecosystem in which the assessment of the habitat and quality of life is done.

Urban morphology analysis

The perspective of urban morphology is the base line study for the urban design field and for this research focussed on the two scales: urban and architecture. The constructions analysis is the connection between the scales.

The first part of urban morphology looks into the urban typology and vital infrastructure. The urban typology is taking the logic from building ensembles (year of construction, materialization), Public spaces (spaces of collective gathering), Green open spaces (parks / vegetated areas) and draws sections of the most characteristic typologies of spaces, and masses. The study of vital infrastructure is aimed at health and utilities.

The second part of architectural morphology is important to make the step to the human scale and continued with the vernacular architecture, building typology and construction and materials. This scale is clearly connected to the anthropology study that also entered the house with interior drawings like the window-scape. It also connected to the scale of ecology in studying the natural habitat.

The last part of extreme constructions investigates the relation between landscape alterations, hazard protection and draws the conclusion to extreme situation on the urban scale as a collection of buildings.

Mobility and Infrastructure in stress and shock

The Transport Infrastructure and Logistics (TIL) students took the additional general perspective from their disciplines which is presented in 1.3 named 'Mobility & transport in stress and shock'. Herein they developed a model how to understand the differences between a landscape in stress or a landscape in shock and what the impact is of stress and/or shock on the mobility and transport system.

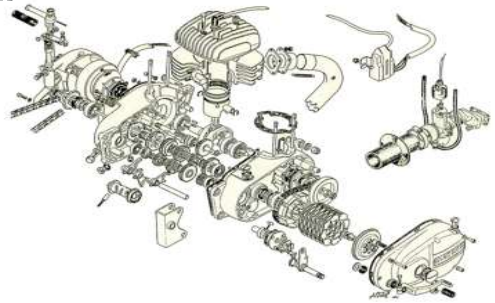
This model is applied to the cases Bahamas, Egypt, Norway and Houston.

Systems description and synthesis

After concluding the critical cartography per perspective, all perspectives are, coming from the problem statement, brought into one hybrid system drawing and problem analysis map. The representation of the case in its complex relations is done on the lowest scale of analysis to be able to connect to the human scale and design directly.

Inspiration for the hybrid system drawing was the exploded view of a machine. Among those involved in the Landscape Urbanism discourse, Gray (2011) states in relation to the concepts of 'the machine landscape mode' as defined by Mohsen Mostafavi (2003) and the 'field operations mode' as set out by James Corner (2006) 'In pairing landscape with urbanism, landscape urbanism seeks to reintroduce critical connections with natural and hidden systems and proposes the use of such systems as a flexible approach to the current concerns and problems of the urban condition.' The machine landscape mode considers landscape as a cybernetic universe with its own laws.

The method applies dynamic systems in mapping to the study of the fluxes and processes that are inherent to the constant time-space evolution of the landscape. It comprises the gathering of information, its decoding, synthesis and systematic processing towards a design that accommodates change and indeterminacy. This approach puts this knowledge in the centre to steer infrastructure and ecological systems as guiding mechanism in urban design, thus to make the step to intervention the decoding and problem analysis offer the base. This base is tested in the next step of scenario development and application.





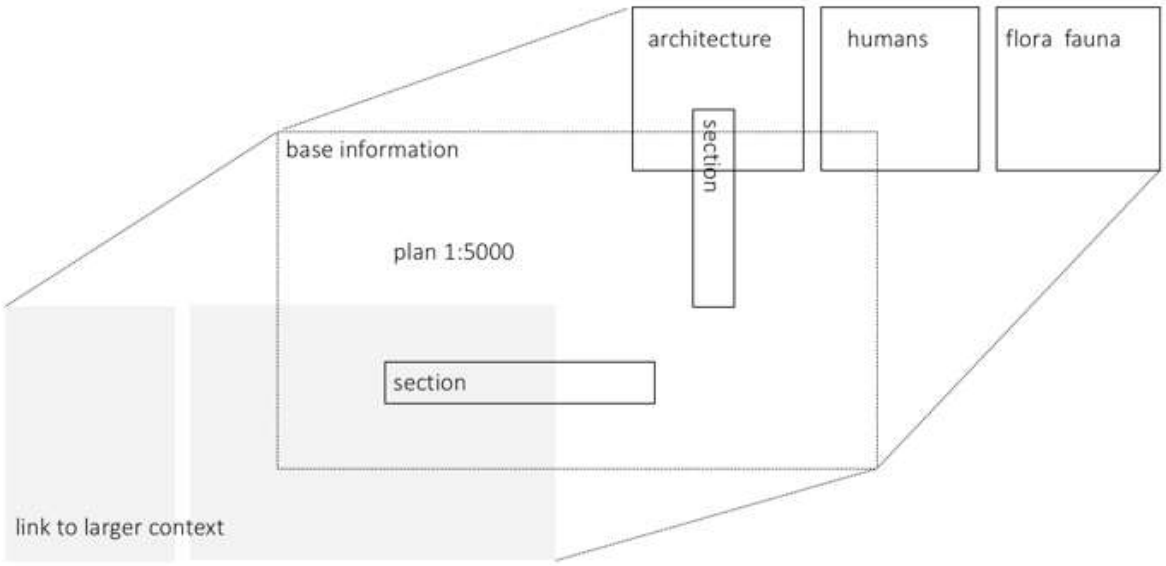
Scenario development and application

When the location was studied, described and analysed, the synthesis between spatial elements of the site understood, the next step of scenario application was done to test the potentials of the location. Four scenarios were proposed that the students developed further (see table on next pages):

Nature first: situation of no further urban development and nature is prioritized.
No technology: situation of growth in which technological solutions are avoided.
No humans:the location is left to nature.
Covid-19: the situation where there is no mobility and less environmental impact, social distance.

The base that was developed was used as a paper doll that could be dressed up with different outfits, the four different scenarios.

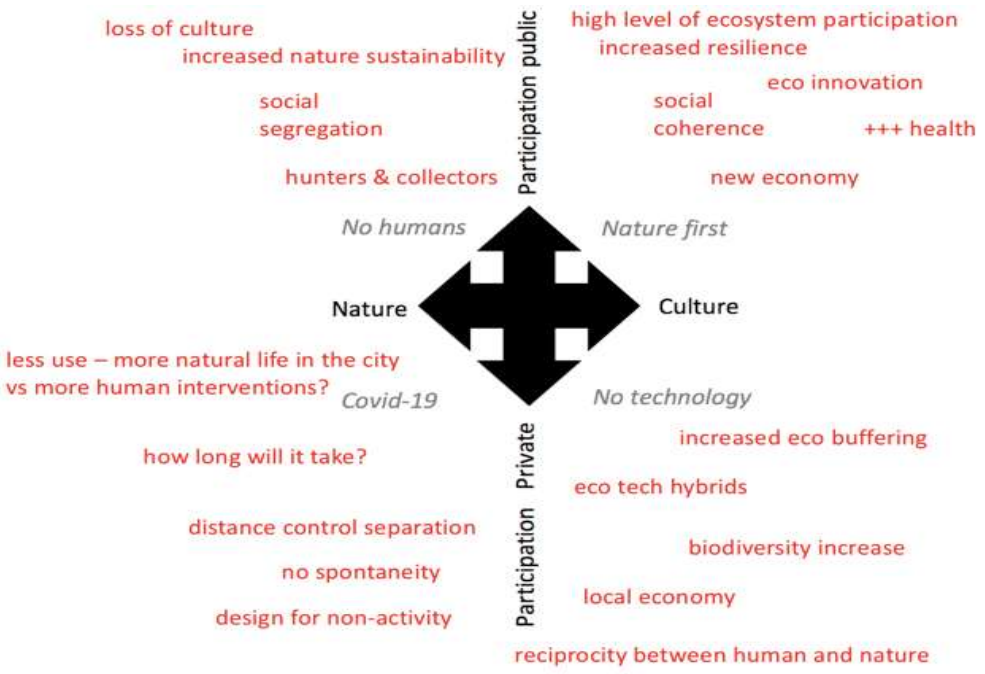
The image to the right shows the main conclusions and directions within the four scenarios.



System intervention – guidelines, manifesto and design experiment

The last part of the project was the system intervention, proposing guidelines for the case as a group and developing a manifesto and design experiment individually. Continuing on the conclusions of the research the group develops a vision for the future of the area and formulates Performance based urban design guidelines as a group. These guidelines are presented in a map and in a flow chart in which the relations between the vision, the goals and the proposed development rules become clear.

The final part is individually drawing up a manifesto which connects the urban design guidelines for the area to the personal fascination. This is tested in a design experiment on a smaller scale and more specific topic as an elaboration of the guidelines.



	No Humans	Nature first	No technology	Covid-19
	This scenario is part of a retreat strategy over a long time, where it is assumed that people will gradually leave the area, leaving nature to re-colonize the place.	*This scenario assumes a de-growth context where nature is put at the centre of the design decisions.*	*This scenario excludes heavy engineering and tech-based solutions from design. It integrates a radical design with nature or "deep ecology" approach to design.*	*This scenario is based in social distancing, reduction of mobility, coming back to the local scale.*
impact on stress or shock	In this scenario, stress decreases as less people put pressure on the system.	Land use change and land use intensity degrowth will allow for the regeneration of natural ecosystems, healthier flora and fauna, and increase in biodiversity. In this sense, putting nature first could potentially increase resilience of the natural systems by minimizing stresses on ecosystems such as mass-urbanization, intensive agriculture, and heavy industrialization.	Because Lo-TEK (local technologies and traditional ecological knowledge) relies on local and available resources, external stresses have no or little impact.. .	Environmental stresses decrease within this scenario as the intensity of use of the land, the amount of travels decrease. On the contrary, the reduction on social and economic activities poses a challenge on the current economic paradigm. The state of extreme uncertainty and social interaction as well cause psychological stress.
Mitigating or adaptive impact	This scenario enhances the mitigation of Climate change as people stop exerting a pressures on the environment. On the other side, there is no adaptation to the new condition, as the preferred solution is retreating from them.	The hypothesis of Nature first embraces the intrinsic ability of Gaia (living and non-living components of earth) to function as a single complex system, auto-regulating when conditions change. In this sense, this scenario is highly adaptive.	While technological solutions rely on the forecasting of events and deliver solutions focused on reacting; Lo-TEK techniques work with the conditions at stake, preventing or reducing the probability of problems from happening. In this sense, this scenario focuses on the mitigation through a constant re-adaptation and learning from changing conditions.	In this scenario, the mitigation (top down; short term) is embraced by measures like: regulated entrance of public in- and outdoor spaces. On the other side, adaptation (bottom up; long term) is embraced by relying on social behaviour, civic and collective responsibility.
Impact on resilience	As resilience is no longer defined by the resilience of people but the resilience of the environment, resilience will increase. Nature might change but will bounce back.	Natural resilience is increased as nature has more space to regenerate after a shock. On the other side, humans would be less affected by natural events (floods..) because nature would have greater capacities to suppress their effects on cities.	Resilience level will increase for two aspects: Firstly, a resilience technical framework will be built to make sure habitats can recover from the damage of hazards easily and fast. The content includes nature-based solutions, vernacular and infrastructural technologies, and traditional experience in living with hazards. Secondly, a resilient social agenda will be established to make sure daily life could go back to normal in a clear and stable way.	Resilience in the Covid-19 scenario is about the ability of re-starting life after periods of lockdown, with a possible recurrence in winter.
Impact on social life	Social life will naturally decrease. People will become more individualistic due to a decrease in social security and community feeling.	In the Nature First scenario social life is centred around green infrastructure in the city. The city gets a different, more green character, which attracts a different crowd. As nature is dominant in the city, people are more likely to have a connection with the natural environment. This would result in more knowledge about nature and more incentive to maintain it.	This scenario assumes a transition from individualistic to collective behaviours. Social life is driven by a collective behaviour where resources will be treated as a commons. The stability of the natural based systems is contingent on a productive dialogue between inhabitants to ensure equitable distribution of the common resources and aim to dismantle existing systemic injustices.	This scenario assumes more activities on the street and more local contact, but possibly less spontaneous contact due to social distancing. Social life related to movement is largely controlled by prescribed measures of one-way streets, crowd-control and reservations for the use of amenities in public places. Elderly people will get less assistance in their daily life from the community, this may lead to more physical and psychological problems. Finally, green space may become popular since it is not necessary to have contact with a safe social distance.

	No Humans	Nature first	No technology	Covid-19
Eco-life	Ecosystems will be balanced and not disturbed or influenced by human interaction. Nature will take over the abandoned urbanized areas gradually, first small vegetation and animals, then bigger ones. People will need to adapt to nature. Without human activity in the area, foreign species (seeds or bacteria from other parts of the world) are less likely to invade the local habitat. Therefore the food chain and ecosystem will be more balanced.	Human activities are disturbing both the structure and functions of ecosystems and altering native biodiversity. Such disturbances reduce the abundance of some organisms, cause population growth in others, modify the interactions among organisms, and alter the interactions between organisms and their physical and chemical environments. By putting nature first, the ecosystem gets the opportunity to recover. Eco life will be thriving.	The main goal in this scenario is to use eco or nature based solutions. This means that nature becomes more prominent and visible and gets more space. Besides more space there is also a big opportunity for creating more different habitats..	Eco-Life is getting closer or even back into the city again since people move less. The amount of small pieces of greenery in private yards will increase as people are spending more time in their own house.
Economy	The current economic model will gradually decline, and services will disappear. Instead, a self-sustaining economy, reliant on local goods, will ensure survival and continuity	Nature is a prerequisite for sustaining economic development. Economical activities are strongly connected to ecosystem functioning and related to the natural environment. As an example, services provided by animals, such as bees, doing the pollination work that underpins about one trillion dollars-worth of agricultural sales has been valued at $190 billion per year.	As the “deep ecology” technology is replacing the heavy engineering and tech based solutions the economy will be more local and nature based. Due to this approach will increase the resilience of local natural environment, the local economy will be more resilient too.	In this scenario, less tourism will lead to less economy income; a large part of consumed goods might be delivered from online stores instead of being bought in physical stores; employees of large industrial facilities might have to be quarantined before working on a rig/plant, causing them to be away for longer durations of time.
Infrastructure/mobility	Infrastructure is functioned as backbones for the needs of species within an ecosystem. The importance of the railroad and main road will be diminishing, private car usage will rise and the river will be more active again (water is the source of life of all species). Main road and rail road will have no prominent roles for mobility as all of the species have different infrastructure for maintaining their life-cycles. However, rivers will still become the main infrastructure, as water is a source of life. Transportation decreasing and from wholesale to small retailers and finally personal buying. Less public transportation services and an increasing demand for private cars. Hard for people who don’t own a car to move around.	Infrastructure and mobility corridors today have a strong negative impact on the natural environment and contribute to habitat loss and fragmentation. On top of that, our principle transportation modes are high consumers of non-renewable energy and emitters of greenhouse gas emissions. In a scenario where nature is dominating the agenda, mobility networks would seek to: 1. have as little influence as possible on surface and subsurface ecosystems: unpaved and pervious surfaces (to allow for water infiltration), possibly elevated (ie. some highways in Houston) 2. would allow for full porosity: easily crossable systems for fauna, no habitat fragmentation 3. would follow key landscape features (river as a road, follow topography). Modes of mobility would also have to adapt to this new system and instead of being powered by gas for exemple, would be powered by natural phenomenons such as water and wind currents and topography.	‘No technology’ recognises that human infrastructure usage is here to stay. Seeking to reducing such use as a goal in its own accord is unrealistic. Rather, it seeks to grow and adapt systems so that they become more in sync with the natural and social surroundings which infrastructure users pass through. Neighbourhood service infrastructures become more locally embedded by drawing on local resources and becoming community meeting places. Three shifts are envisioned three axes: 1. Reduce pollution, 2. Reduce the consumption of resources and space. 3. Enhance the societal role of infrastructures. Technologically, these transitions can be seen in e.g. moves from from scooters to bikes and from cars to transit, but also in shifts from shopping malls to neighbourhood grocerers and from anonymous online contact to interpersonal meetings. Remaining transport infrastructures are transformed from large-scale steel-and-concrete linear architectures which exclude people, to environments	1. Less commuters and less traffic, more local amenities. 2. Change of public transport 3. Large planes/busses/trains will become less used, focussing on small scale traffic over shorter distances. Communities located at a large distance from big cities might become isolated, leading to possible abandonment. .

	No Humans	Nature first	No technology	Covid-19
		In the scenario where nature-dominant cities function socially and economically at a more local level, small scale mobility networks would favor least disturbing modes of transport such as walking and non-motorized vehicles (bikes, sail boats…). Long-distance travel would become harder and rarer making local communities stronger and cultures unique.	that simulate human-level interactions. it seeks to grow and adapt infrastructural systems so that these stimulate users to interact with the natural and social surroundings which users pass through.	
Buildings	In short: Buildings will not have high importance to the ecosystem. Buildings with flexibility functions and biodegradable materials are more preferred to be adaptable in this scenario. Non-biodegradable buildings will be abandoned, except for some buildings that are suitable for some species living spaces. Buildings with vernacular materials that are nature-friendly and biodegradable will have high value in this scenario. More flexible buildings (e.g apartments for seasonal tourists, workers and researchers) and less commercial and some other types of public buildings.	. More focus on vernacular architecture as it works with nature to create a pleasant indoor climate. New, passive technologies could increase the effectiveness but still take nature into account. It uses as little material and energy as possible to maintain good living conditions which meet the standards of today. Energy positive buildings which produce energy by using the elements. Modular buildings which can easily be removed on replaced in case the landscape changes threat increases. Biophilic architecture is practiced, where natural elements are put forward during the design process. Buildings are designed not only to house humans, but also to house different species. In case of a very centralized city (to decrease the overall footprint of the city and give back the edges) buildings should house a bigger number of residents. This will result in higher structures. The other possibility is a more scattered city which allows nature to flow through the city. In this case, housing will be freestanding and have a patch of land around.	Vernacular construction with materials available locally. Ownership is collective to increase accountability and participation. Self sustaining units in terms of resource management with strategic overlaps in some sensitive and interdependent systems such as water. Houses are collective typological units with provisions for livestock management. Rural-urban hybridity. In terms of typology, cultural buildings will be more significant as civic infrastructure as society is more interdependent for existence. Revival of town halls and step wells. Building units are designed to engage with nature and not to keep nature out. Detailing would reflect that in how natural elements are engaged with. Tree and plant roots as reinforcement for walls. Water harvesting from roofs for drinking. A predictable housing unit, designed for profit maximization isn't sufficient due to independence from external systems.	Private buildings and ground are getting more attention out of boredom, public buildings often get an upgrade since they're less needed at the moment so the space and time is there. This mostly means that the small ecosystems close to the buildings are having a little bit of a harder time. However, for the buildings it's the ideal change to get upgraded towards a more environmentally resilient building. Private buildings will become larger due to the increased time spent inside. The private plots will also preferably become larger, leading to urban sprawl.
Public space	In this scenario, public space should be designed for biodiversity needs to maintain ecosystem balance. Most of the man-built public spaces would be given back to nature. Man-built public space will be abandoned as the designs are fully	Public space will be given back to nature where necessary. Based on opportunities for the increase of biodiversity and/or mitigating extreme climate consequences public space is given back to nature. Streets, tiles and other non-permeable materials will be replaced by natural materials, such as	The built environment blends with the natural systems and is adapted to it. Open drainage systems along the main streets and public spaces allow people to understand the natural processes. Natural elements provide specific conditions for urban microclimate to diminish the use of air conditioning or heating, i.e. more trees on the streets provide shade and shelter from wind. There will be more Green spaces	1. Empty and abandoned during periods of lockdown, initially crowded and chaotic when the lockdown is lifted. 2. Public space needs reforming to be able to contain many people and retain social distance Public space could become more walkable, green and safe, since less

No Humans	Nature first	No technology	Covid-19
with human needs and behaviour consideration. Then, public space should be designed for biodiversity needs to maintain ecosystem balance. As there is less income for the public sector, maintenance of public spaces is difficult. Most of them would be given back to nature. As young people and high-income families may leave first, then the low-income families. For a long time, the main users of public spaces are elderly people.	grass, trees, plants. By increasing the amount of greenery, flora and fauna will be more connected and form an unlimited flow, moving through the city. When this natural flow is connected to the biophilic architecture the public/private boundary will be more blurred and the line between indoor/outdoor will blur. Some public spaces could lose their identity due to the decrease of functions in/around the public space. Public space where nature is introduced could form the base for the more/other social groups, and could form a starting point for people to participate (more) in ecosystems. Public spaces with certain (leisure) functions would be more concentrated, with more green / recreational spaces in between. These recreational spaces would be open to all layers of the population, which will result in local social groups with different residents from different layers of the society.	in the city that are not only for recreation, but also provide specific services that would otherwise need the technology. These green spaces and solutions are closely linked with the local culture, environment and climate; therefore, the public space design is very local and specific to the place, emphasizing local flora and fauna and providing specific local identity of place for residents and users of the public space. No universal solutions can be applied. Very site-specific design. Solutions need to be designed according to local knowledge and include not only the design factor, but also the specific services these spaces will provide. The public space in the built environment becomes very dynamic, diverse and more natural. The public space is governed on a local scale, managing it to the specific local conditions. The public space design is strongly based on ecosystem services and participation to avoid or minimize use of technology and emphasize nature-based solutions. Local context is a crucial aspect, therefore the public spaces become more diverse, natural and provide different socio-cultural activities for diverse users.	cars are used in a local economy. More people walking on the street will lead to more social control and sense of safety and community. 3. The accessibility of public space has become more important since the mobility during Covid-19 has been restrained for instance, neighbourhood park.
The intervention in nature by humans is reduced, and the ecosystem gradually takes the leading role. But in this scenario, people can also systematically guide natural self-healing through ecosystem participation. At this time, due to the decrease of community, the community participation at the local level decreases, but on the other hand, the resistance from the community also decreases.	In this scenario, humans are really participating in an ecosystem that is not centred around people. The level of ecosystem participation is therefore high. Because all of the economy and a lot of social life is centred around natural places and processes, there is an incentive to maintain nature and its qualities. Knowledge about natural systems will increase, as it becomes a valuable asset. However, when nature is put first, cities are no longer ideal places for humans to reside. As the natural environment is not centred around human's needs. This means that	Without the opportunity to use enormous technological constructions to control nature, people have to go with the flow. This means that humans really need to work together with nature in order to prevent themselves from natural hazards. The level of ecosystem participation in this scenario is thus really high. In this scenario the designing part is still very important. Nature is (re)introduced in the city but it's not taking over. The goal is to aim for a clear balance between letting nature do its thing and let it work in the way that people want.	1. Ecosystems are more ignored since other problems are more important and the contact with the ecosystems are decreasing because of the reduction of going out. This makes the ecosystems get a free role in what they want to do without interference from people. This improved ecosystems could have positive influences after the crisis. 2. Citizens involvement in the planning process will become online, this will make it more efficient and time saving, but on the other hand, elderly will have some difficulties to join this process. 3. People will have more recreation activities in nature than urban

Level of ecosystem participation

	No Humans	Nature first	No technology	Covid-19
		people will also experience certain ecosystem disservices. Examples of disservices range from mosquitoes to the presence of dangerous animals, and the species that will consume a large part of 'our' cultivated food.		environments, this will lead to more chances of ecosystem participation. 4. Major companies who use nature as a source for their work are less able to work. These results in less activities which makes ecosystems can get back into these areas again, or can stay longer. People will feel more attached with their local area, since they will be at home much more often. That could lead to more awareness and responsibility on sustainability, climate change, resilience and ecosystem participation. Possible side effect: people are able to do eco participation practices at their own home since they've got more time compared with normal periods.
Influence on climate/climate change	On the one hand, factory shutdowns, and traffic reduces. Carbon emissions and pollution decrease. The impact of climate change will be partly mitigated. On the other hand, without positive human intervention, some restoration and environmental protection projects that require human participation will therefore cease. Positive human intervention examples: Reforestation, Plastic waste disposal, etc.	All the changes mentioned before will have a positive impact on mitigating climate change. The biobased economy in this scenario greatly reduces the carbon in the atmosphere, and the carbon footprint of people is also reduced because the local economy is emphasised. Goods and people will have to travel less distances. Online infrastructures replace conventional carbon exhausting transport modes and will further reduce the carbon output.		.These types of crises make people and companies become less functioning. This leads to the reduction of ongoing processes that pollute the climate. On a short and local scale a lot of effects are visible, but also on a longer scale effects could be there when the awareness is being raised and people see the positive effects. It could also turn negative while people notice less even though it should be a lot better.
Culture/Heritage	Without human activity, the continuation of local culture and identity is threatened, especially the intangible heritage such as language, ritual, local knowledge and technology, etc. Is it still necessary to preserve and maintain tangible and intangible cultural heritage in this case? The value of local cultural heritage should be reevaluated under different circumstances, and the strategies will differ as well.			.
Health		Ecosystem services are indispensable to the wellbeing of all people, everywhere in the world. They include provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other services. From the		

availability of adequate food and water, to disease regulation of vectors, pests, and pathogens, human health and well-being depends on these services and conditions from the natural environment.
Human well-being has a two-way interaction with ecosystem condition, mediated in the one direction through the services that ecosystems provide to people, and in the other by the largely unintended impacts of human activities on ecosystem functioning. If society fails to read the warning signs delivered by a decline in ecosystem services and does not adjust its activities accordingly, it ultimately fails. Harming nature harms humans while healing the environment restores both human and ecological health.

Summary for No technology scenario

Currently people have passed beyond using hard technological solutions to control nature and prepare for natural hazards. There is a transition going on towards a more preventive approach rather than a reactive approach to tackle climatic hazards. Hard technological designs always have the chance of breaking during an extreme event, and whén it breaks serious damage is the result. Infrastructural designs based on nature adapt and recover quicker during and after a hazard since they are constructed by the natural processes of nature. With more nature based solutions the reliance on hard infrastructural solutions is reduced. This creates space for more hybrid solutions between hard and soft infrastructure.
The environment and the nature of a place forms its original housing typology and traditions of that area. The connection of people and nature is deeply rooted, nature based solutions will therefore feel more comprehensible and tangible. People will feel more responsible to make it work. Nature based solutions have, in contrast to technological solutions, a more collective based management system. This would entail an equitable distribution of common resources through a range of unique collaborations amongst diverse socio-economic groups.
Nature based solutions enlarge the space reserved for nature in the city since they replace the technological structures. This will enhance the amount of room for ecological developments. Besides that, the different aspects of transforming technological structures into nature based solutions requires each a different way of nature. This will create many different microtopes and habitats which increases biodiversity. The deep ecological solutions that are used will increase the resiliency of the measures and become more circular and sustainable. This will enhance the local economic resiliency, especially on the local scale.
Having nature based solutions embedded into the infrastructure and mobility of people's daily lives increase heavily the amount of time people are exposed to nature. The mobility users interact more with nature and their social surroundings. Exposure to green on a daily basis increases mental health. The design of housing and public space is strongly based on ecosystem services and participation to avoid or minimize use of technology and to emphasize the use of nature based solutions. Local context is a crucial aspect, therefore the public spaces become more diverse, natural and provide different socio-cultural activities for diverse users.
Without the opportunity to use enormous technological constructions to control nature, people have to go with the flow. This means that humans really need to work together with nature in order to prevent themselves from natural hazards. The level of ecosystem participation in this scenario is thus really high.

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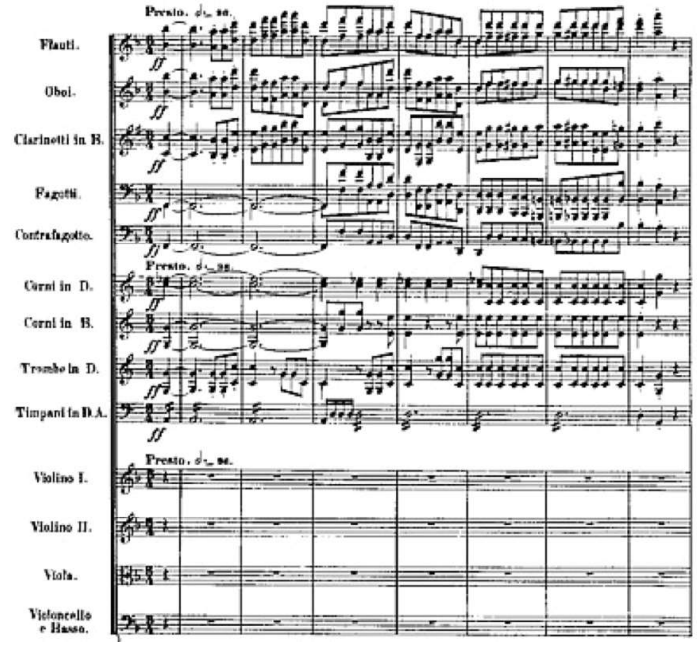


§ 1.3
Mobility & transport in stress and shock

How can ecosystem participation add to environmental health when developing transportation and mobility systems? The method to analyse is to systematically dissect certain areas and environments, identifying the main pillars of mobility and transportation flows and nodes, the potential shocks and stressors, and potential strategies from an ecosystem participation perspective that could mitigate the risks of those shocks and stressors.

In this first part the main four focus aspects of mobility and transport will be addressed. These are selected based on literature and are used to analyse stresses and shocks in mobility and transport systems in extreme landscapes. In assessing transport networks in an area multiple levels need to be analysed. It is important to get a total picture of the mobility and transport network in the area, which means how people and goods move in the area. Naturally, this is different for every area, this has to do with the prosperity of the region, the quality of the road network and public transport etc. In this part it will be addressed which aspects of the transport system need to be analysed for all case studies within this research. The identified four main aspects that are applicable to analyze the mobility and transport network are: connectivity, accessibility, reliability and vulnerability.

This methodology distinguishes between mobility of people and the logistics system for the transportation of goods. Networks can be described as a set of nodes and links that connect them. The nodes are places that represent something, a town, railway station, shopping mall or a where people meet. The links are connections of roads, railway or a path.

Connectivity & Accessibility

The set of nodes in mobility or transport networks can be very scattered in an area, but this does not mean they are is not connected well, the links provide connectivity and if there are well balanced the area can be very connected. Rietveld (1995) pointed out, 'the quality of transport networks does not only depend on the features of the links, but also on the way the links are connected.'

Next to connecting nodes with links, it is important that areas are accessible. In terms of accessibility the travel time and distance are considered traditionally (Xie & Levinson, 2007). But accessibility can also be described by the available modes of transport, the function of roads in the network and the interconnectivity between different modes in transport (Xie & Levinson, 2007).

In developing countries especially, connecting remote populations is hard. There are few roads and in case of disasters these populations are not easy to reach (Muriel-Villegas et al., 2016). In general, most countries have a difficulty with connecting and accessible transport. Peripheral areas are in most cases less connected and accessible than the urban areas (Rietveld, 1995). Thus, the complexity of connectivity and accessibility is generally applicable and that makes it interesting aspects for this perspective.

Reliability

To provide safe and efficient movement of people and goods, mobility and transportation system should be reliable. To be reliable, the network should perform in good condition and accommodate different levels of disruption for a certain time (Wakabayashi and Iida, 1992). Muriel-Villegas et al. (2016) state that the systems 'should perform within predefined standards of capacity and travel time'. The network should accommodate a given level of demand in order to prevent congestion.

Vulnerability

Vulnerability in mobility and transport systems in mobility and transport systems is mostly described as weak or critical spots in the system with possible hazards that could make the system less robust and can cause damage (Muriel-Villegas et al., 2016; Mattson and Jenelius, 2015). These spots form a threat to the system. Both the failure probability and the disruption consequences can be measured to determine its vulnerability.

The mobility and transport systems should be resilient instead. Hollagel (2011) defined resilience as "the intrinsic ability of a system to adjust its functioning prior to, during, or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions". This to be said, a resilient system should be able to absorb shocks without changing the qualitative behavior (Mattson and Jenelius, 2015). Some important aspects improving the resilience of the transport mobility and transport systems are; preparedness, response, recovery and adaptation.

Stress and Shock

Existent theory on urban resilience can serve as a basis to identify these pressures. 'Across the world, cities are challenged by acute and chronic problems. Acute problems include shocks such as earthquakes, floods, and disease outbreaks. Chronic problems are stresses that weaken the fabric of a city on a daily or cyclical basis. Examples include high unemployment, inefficient public transportation systems, unbalanced composition of the population, chronic food and water shortages, and endemic violence' (Spaans & Waterhout, 2017).

The concept of resiliency, initially coming from the field of ecology, was defined by whether a system could bounce back after shock and how much disturbance it could take. There is a 'belief in the existence of equilibrium in systems, be it a pre-existing one to which a resilient system bounces back (engineering) or a new one to which it bounces forth (ecological)' (Spaans & Waterhout, 2017). Urban planners realized however that, within a new context of climate change and rapid urban development, not only mitigation, but also flexibility and adaptability to stress and shock should be implemented in

decision-making. The systems performance should therefore be enhanced in the face of stresses and shocks rather than solely mitigating the loss of assets due to events causing its fallout (Spaans & Waterhout, 2017). When assessing the robustness and resiliency of the transport system and its role in the mobility of citizens within extreme urban environments, it is important to identify the kind of pressure that exists on the various transport infrastructure systems that affect the mobility of inhabitants.

Mobility, the transport system and shock

If mobility and transport infrastructure networks are not equipped for the impacts of climate extremes, increasingly frequent and intense, or other environmental disasters, these events can impact the durability of materials, the structural integrity, maintenance and operability of transport infrastructure assets (Hayes, 2019), in turn this will affect mobility.

The question can be posed whether certain infrastructure networks are equipped well enough to withstand these shocks. This is important to note, given the fact that transport infrastructure is characterized by its long life-span and capital investment cost. Establishing resilience to shocks like this should be seen as 'a dynamic and evolving characteristic of transport infrastructure, with key features of sustained adaptability, multi-functionality and real-time feedback loops. Opportunities are identified for research enquiry into transport infrastructure design, construction and operation, wherein design and engineering approaches are informed by resilience strategies and characteristics found in living systems' (Hayes, 2019).

This approach is important as the reconstruction costs associated with infrastructure failure is increasingly high. Changes can be seen however, as infrastructure investors are also increasingly incorporating vulnerability assessments of physical assets, in regards to predicted changes in climate and weather, into their investment decisions. Users' social vulnerabilities due to infrastructure failure remain underexposed (Hayes, 2019).

Mobility, the transport system and stress

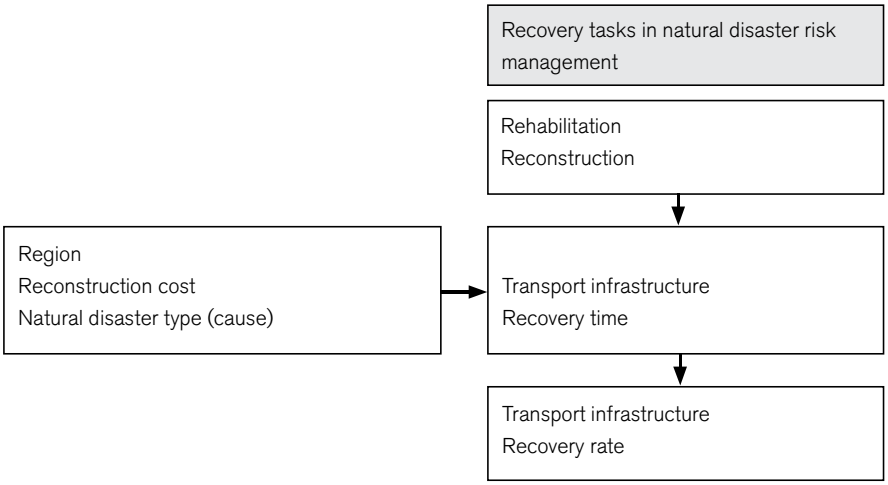
The transport system itself can suffer from endemic stresses, often the result of growing travel and transport demand that it can not properly accommodate. This can result in a loss of mobility for the users of the system and a downturn of accessibility. Often government policy is to reduce this stress on the system, mostly done through a strategy of investment in transport infrastructure. This usually entails the expansion of the Rail Transit or the expressway network (Song et al., 2019). This strategy encompasses a hopefulness that increasing the supply side of transport might influence travel demand. Travel demand is a key aspect of travel decisions and entail peoples travel need, purpose, destination and most importantly mode of travel. Responding to travel demand,

assuring greater mobility within communities, helps maintain their robustness and quality of life.

Travel demand and the built environment are interrelated, as trip rates tend to be higher in high density, mixed land use neighborhoods with easy access to public transport. The correlation between the built environment and travel demand is inconclusive however, as travel demand for specific modes of transport, whether this is by road or rail vehicle, appear mostly dependent on income rather than land use attributes. In other circumstances the opening of new rail transit lines did however result in a shift from private cars to rail transit. Urban planning policies can thus be less effective in controlling people's travel demand and reducing endemic stress than assumed. Infrastructure expansion to address the mobility of people must therefore often also be based on other factors inherent to these modes of transport (Song et al., 2019).

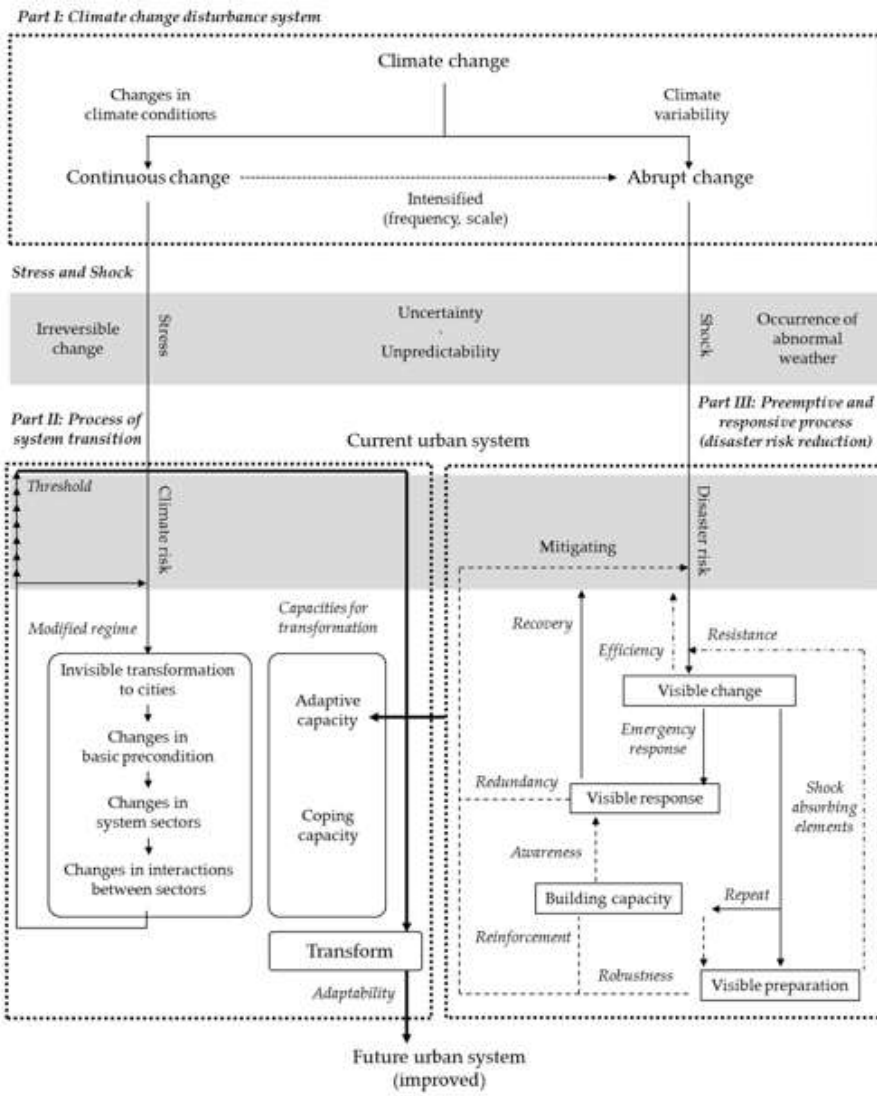
Transport infrastructure, mobility and 'bounce back' from shock

There exists the recognition that there is a need for built infrastructure to not only withstand threats posed by natural, human or technological hazards, but also to properly recover from them. Resilience is therefore also 'a function of the robustness of a system to resist the initial adverse impacts of a disruptive event and the speed with which that system is able to return to an appropriate level of functionality' (Mojtahedi et al., 2016).



Recovery tasks in natural disaster (Mojtahedi et al., 2016)

Infrastructure is characterized by its networked nature; failure in one location can have a disruptive effect on a far wider area of the network. Transport, mobility and associated infrastructure, like roads, railways, bridges, airports and ports, are at risk of extreme climate events. The impact of these shocks depends on the regional location, elevation and condition of the infrastructure, as well as the nature and frequency of the shock event. The recovery activity or 'bounce back' is an important part of the risk management involving natural disasters. These activities involve rehabilitation in the short term and



Climate change disturbance system and process of system transition (Kim & Lim, 2016).

reconstruction in the long term. Recovery involves the coordination of and the rebuilding of infrastructure itself. Post-disaster recovery planning grants governments the opportunity to mitigate future risk or increase adaptability. It is important to note that restoration and reconstruction often require experience and skill for effective management that local affected areas do not possess. This makes full recovery difficult and will escalate the cost of said recovery. Cost can be divided into recovery from actual contact (direct damage) and long-term disruption caused to the system (indirect damage), as well as intangible social damage (Mojtahedi et al., 2016).

Transport infrastructure, mobility and 'bounce back' from stress

Defining a clear framework for 'bounce back' from shock is rather difficult due to the nature of stress tending to be a slow buildup influenced by many factors. There is no clear direct impact, but rather a continuous change. In scientific literature, the recovery or mitigation process from stress on transportation infrastructure appears scarcely described. It is however possible to look at more general urban resilience frameworks in dealing with the impact of slow chronic stress factors caused by climate change. To deal with stress, on the one hand a cycle of slow smaller iterative changes must be made to the system and on the other hand opportunities and lessons from shocks must be used to adapt the system (Kim & Lim, 2016). When making policy o n urban design, a similar method of making changes to the system should be present, regardless of whether the stress is necessarily related to climate change.

Assessment

The developed methodology can be used to analyze mobility and logistics systems and their exposure to shocks and stressors. The method highlights the main aspects within the mobility and transportation domain (connectivity, accessibility, reliability and vulnerability) and allows researchers to apply different forms of risk exposure (shocks and stressors) to respective mobility & logistic flows per area.

The justification of the current choice of research fields (mobility and logistic flows and infrastructural nodes) is because of the importance of these elements within the transportation and mobility system as a whole. These elements also provide key insights in the socio-economic structure of regions, and their dependency on these systems.

The goal of this method is to identify potential environmental shocks and stressors within the transportation domain per case. Once identification on a certain area of region has been performed, the framework allows researchers to identify potential gaps that need (urgent) attention, and can recommend further research. Therefore, this method can be used as a guideline to validate stress and shock mitigation strategies in further research.

Application to the cases

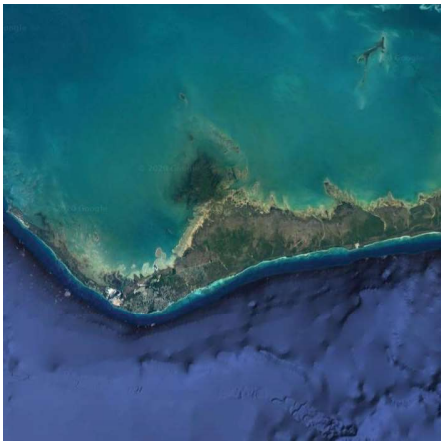
To validate this methodology, four case studies have been performed. The methodology is applicable to different types of cases and the interpretation can vary greatly per case. The respective cases have been analyzed using the methodology and have yielded interesting results per case of aspects that have been identified for further research.

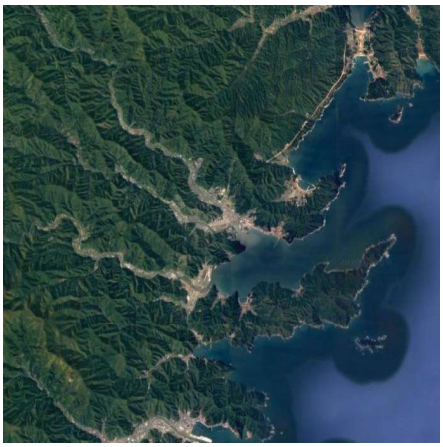
This methodology helped in finding shocks and stresses in the ecosystems of the analyzed areas, that contributed in providing insights in potential developments in ecosystem participation. In a lot of cases it becomes clear how the relation between logistics and mobility and shocks and stressors can have a great impact on respective communities. Furthermore, the designed framework can be applied to other case studies, since it is relatively simple but provides clear insights in the system.

TIL FRAMEWORK

	Shocks		Stress		
	Accessibility and connectivity	Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)	Accessibility and connectivity	Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)	Response
Mobility flows: PT/ road network					
Activity nodes: Critical facilities					
Logistics flows: Road/ waterway network					
Transfer nodes: Harbours/ airports					
Conclusion in relation to ecosystem participation					

1 

 2

3 

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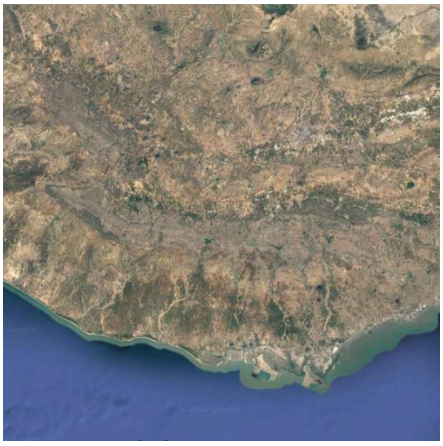
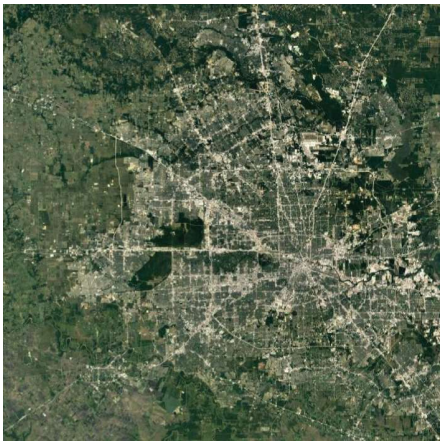
5 

 6

1. Desert, Egypt
2. Wind, The Bahamas
3. Wave, Japan
4. Ice Water, Norway
5. Sane Water, India
6. Conflicting Waters, USA

§ 1.4
The cases

In order to really test the concept of ecosystem participation it is applied to a set of different extreme landscapes. In order to have good access to data and cultural understanding of the context the cases are chosen based on the international network of academic partners:
German University of Cairo, University of the Bahama's, AHO The Oslo School of Architecture and Design, CEPT University India, Waseda University, Tohoku University and Texas A&M University.

DESERT - Egypt, Cairo (drought and explosive growth)

WIND - The Bahamas, Baintown (hurricane and shrinkage)

WAVE - Japan, Otsuchi (tsunami and shrinkage)

ICE WATER - Norwegian Artic, Lofoten and Hammerfest (accelerated climate change, temporal use)

SANE WATER – India, Bhuj (drought, flood, sanitation)

CONFLICTING WATER – United States, Houston (hurricane, pluvial, fluvial and coastal flooding)

DESERT - Egypt, Cairo (drought and explosive growth)

Wadis are often perceived as an obstacle when it comes to urban planning, rather than seeing them as an opportunity which can advance the quality of urban space. However, wadis are also recognized as a threat due to the occurrence of flash floods hazards. This project takes the hypothesis of perceiving wadis as opportunities for transforming the urban pattern with inclusion of agriculture water sensitive landscape infrastructure. Proposing an alternative model for the conventional Egyptian desert city model were wadis can be transformed into a productive landscape, leisure parks, green spaces, public spaces and last but not least as a major water resource.

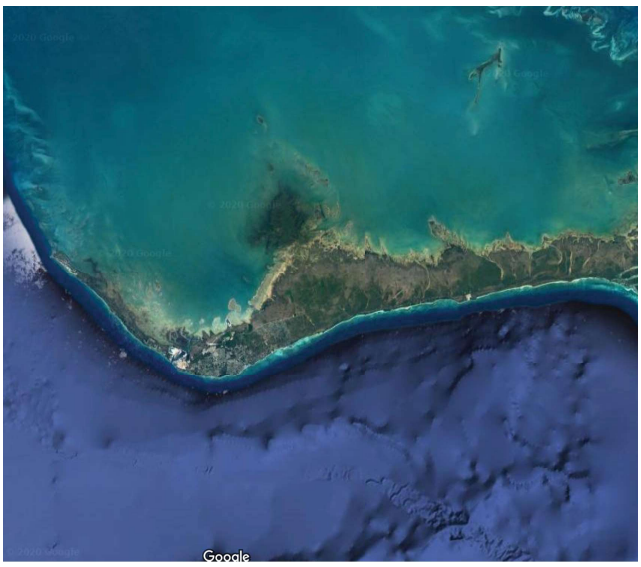


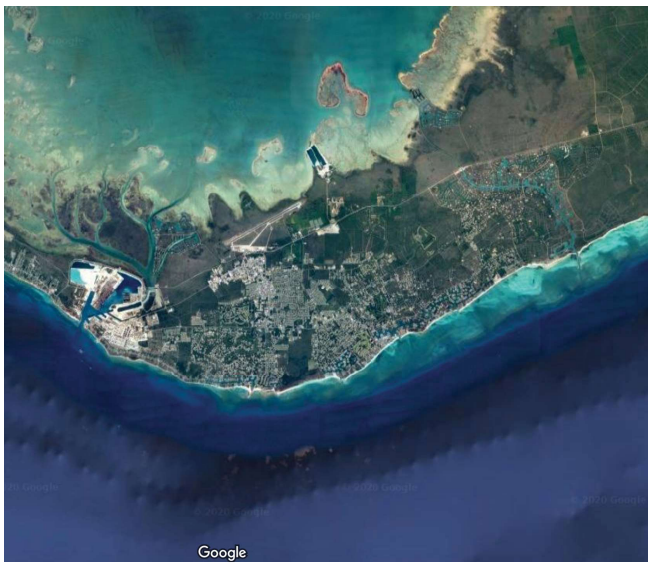


WIND - The Bahamas, Baintown (hurricane and shrinkage)

On September 1, 2019, Hurricane Dorian made landfall on the Abaco Islands as a Category 5. On September 2 it hit the island of Grand Bahama at the same strength and stalled there for another day, finally pulling away from the island on September 3. The windspeeds up to 295 km/h also impacted a storm tide of 6.1 to 7.6 m, covering a large part of the flat part of Grand Bahama with sea water. Dorian also dropped an estimated 0.91 m of rain over the Bahamas. Damage total in the Bahama's amounted to US$3.4 billion, there were at least 70 deaths in the country, of which 10 deaths on Grand Bahama, and another 282 people were left missing after the hurricane.

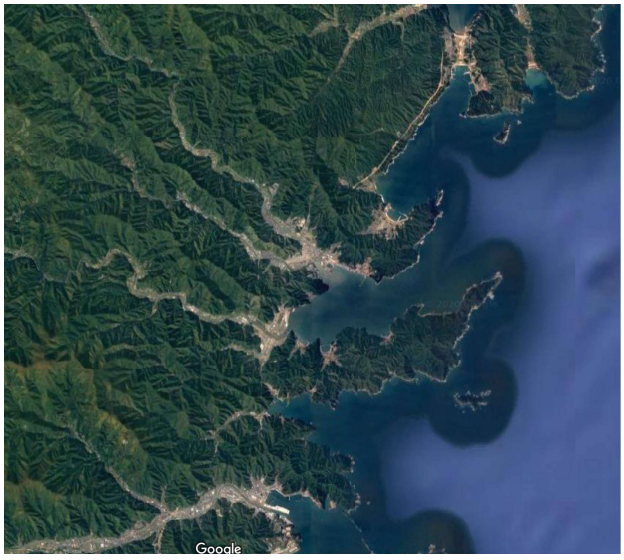
The Island Grand Bahama suffered from direct damage due to the wind and water. There was an island-wide power outage on Grand Bahama Island, and an oil refinery was damaged. About 300 homes on the island were destroyed or severely damaged, with the heaviest damage on the eastern side. At least 60% of Grand Bahama Island was left submerged as Dorian moved away on September 3.





WAVE - Japan, Otsuchi (tsunami and shrinkage)

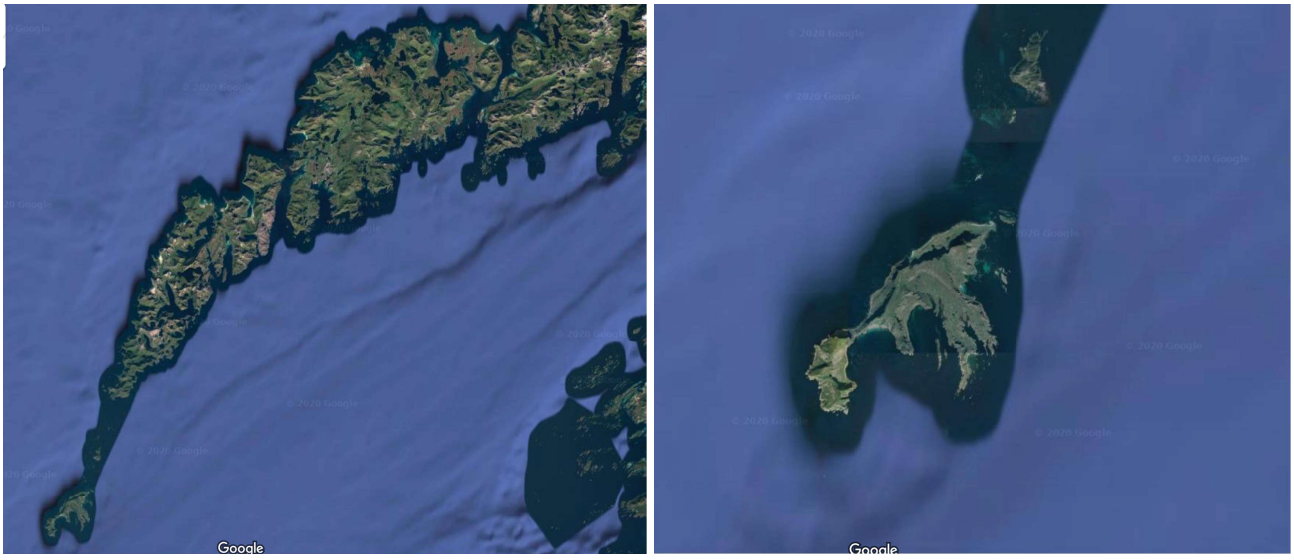
The 2011 Japan tsunami destroyed half of the town of Otsuchi, and over 1,200 residents lost their lives. Surrounded by steep mountains, Otsuchi is subject to landslides, river flood and tsunami hazards. The sea here hosts Japan's most productive fishing ground, but the coast is isolated from the more populous inland cities and, like many towns in the region, Otsuchi has been experiencing severe population aging and decline since the 1980's.
The reconstruction of Otsuchi after the 2011 tsunami serves as a proving ground to study what previous disaster countermeasures worked and what did not. Japan's national government's 250 billion Euro reconstruction project relies on construction of giant coastal embankments, gates, and seawalls, elevating residential land, and enacting land use controls to remove development from the tsunami hazard zone.





ICE WATER - Norwegian Artic, Lofoten and Hammerfest (accelerated climate change, temporal use)

The project focuses on past, present and future coastal infrastructure development in the Norwegian Arctic, where fishery and oil industries shaped its wealth and culture. A geo-political (territorial) project characterised by the power relation between man and nature - now evermore under pressure/ instability led by extreme climatic shifts and the consequent expected access to new resources and logistics routes.



SANE WATER – India, Bhuj (drought, flood, sanitation)

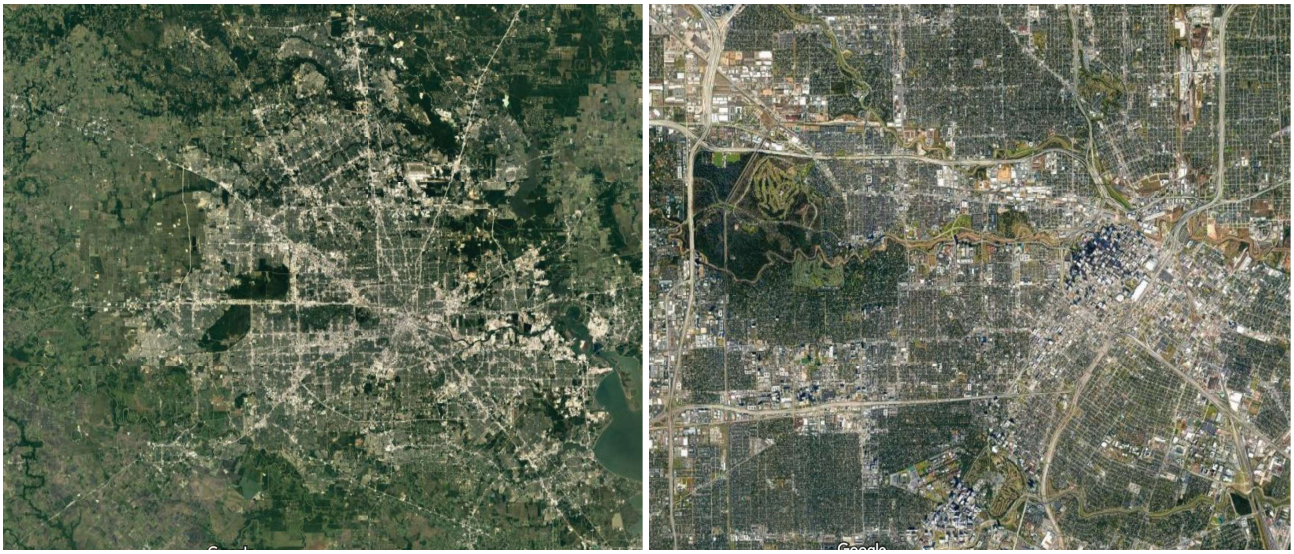
India is a country which is rapidly growing into urban agglomerations showing infrastructure deficits and adaptation gaps in relation to current and future climatic, societal and economic change. Water stress – pressure on the quantity and quality of water resources – throughout India results yearly in serious problems of water shortages, flooding, pollution and ecosystem damage.
In fast-growing secondary cities in India there is a wide variability of these impacts, showing the geographical and contextual reasons behind of potentially contaminated sites, as well as management of water resources. Additional challenges being faced by cities are rapid urbanisation, demands for climate adaptation, shift from a traditional linear organisation to co-production among different stakeholders and the need for experimentation/ open innovation fostering new economic models.





CONFLICTING WATER – United States, Houston (hurricane, pluvial, fluvial and coastal flooding)

The Houston metropolitan region is home to more than six million people and an economic hub for many different industries and has - next to large exposure to hurricanes – to deal with fluvial and pluvial flooding. Big flooding in 2017 disrupted large parts of the city, proving that accommodation of excess water needs to be incorporated in the cities' economy, population and built environment, all still rapidly expanding. Houston is infamous for its urban sprawl, car-dependency and lack of zoning laws, issues that need adaptation to the effects of climate change.



2.

Lofoten and Hammerfest, Norway

Extreme temporality

Amber van der Voorn
Cas Goselink
Janis Berzins
Yixiang Huang
Zhe Hou


US
Tlf. 78 40 73 00
www.hisas.no
Petroleum



Hammerfest - *Picture by Gioele Colombo & Santiago Palacio Villa*

1.

Introduction to Reine & Hammerfest

With the earth's climate changing, Norway is foreseeing economic growth. Warm ocean currents already allow Norway to hold the world's nothernmost port; Hammerfest port . In addition to this, as global temperatures keep rising, the reduction in the Arctic Sea ice extent offers the possibility of connecting this port with East Asia and establishing an continual intercontinental trade route. Furthermore, with glaziers and ice coverage retreating, previously inaccessible land is becoming available for resource extraction. Both these developments suggest that the focus of the Norwegian economy will be on the North for the coming decades.

Hammerfest, owing its origin to fishing, has enjoyed an economic boom and new optimism in recent years thanks to the construction of a large liquefied natural gas site on Melkøya, a nearby island. Its geographical location and well organized infrastructure have made it the focuspoint of the North, ensuring even more economic growth for Hammerfest in the future.

Meanwhile, in 2019, in contradiction to the developments in the North, the Norwegian government announced that it will withdraw support to oil explorations and drilling off the coasts of, amongst others, the Lofoten Archipelago.

The Lofoten Archipelago consists of distinctive fjords that create stunning landscapes and a unique ecosystem. It embodies the origin of the second economic driver of Norway, the fishing industry. Lofoten has a big contribution to Norway being Europe's number one exporter of fish. Over the last decade, in addition to fishing, the landscape and Nordic lifestyle that can be experienced in the archipelago have resulted in development of tourism in the region. As this industry grows every year, it puts a new kind of pressure on the existing fishing industry, ecosystem and infrastructure.

The dependence on both the ecology based industries (fishing and tourism), in combination with its extensive coastline and geographic location, make Norway extremely vulnerable to climate change. While the North profits from climate change and is even contributing to it by the extraction of fossil fuels, the rest of Norway is experiencing its stress. This polarization in dealing with the landscape asks for a comparison.

This research project explores the possible future of Northern Norway in light of the developments and foreseen challenges it faces. This is done by comparing cities from both of the contradictory areas on different scales. The research incorporates the environmental, spatial, social and industrial aspects of the case.

2.

Research Question and Theoretical Framework

Aims of the Project

As Norway has already been covered in research projects of this course before, the aim is to find a new focuspoint. The research will push to find an overarching theme which allows both cases to be assessed. To find a common ground, with a case specific conclusion.

Research Questions

Territorial Scale

How is the territory influenced by the contemporary geopolitical, economical and environmental changes in the Norwegian Arctic?

Urban Scale

How can the cities in the contradicting areas deal with the stress of an expanding industry while at the same time mitigate the effects of the environment, as well as on the environment?

Local Scale

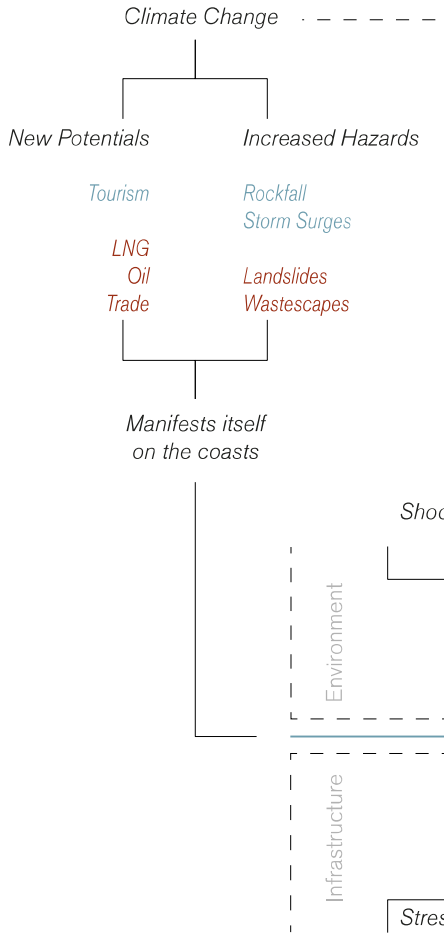
How can ecosystem participation in the coastal zone mitigate both the stress of the growing industries, and potential shock from natural hazards?

Methodology

The assignment and research question set for the project is:

"How can ecosystem participation work as catalyst for healthy, climate proof extreme urban environments" (Hooimeijer, 2020)[1]

With climate change, the conditions in Norway become more extreme, posing hazards but also enabling development of new opportunities. After identifying the specific characteristics of these extreme environments for both the Lofoten Islands and Hammerfest, it has become clear that all developments manifest itself on the coastal territories. A contextual analysis has been conducted for both coastal locations, from the perspectives of Systems of Systems, Anthropology, Landscape, Urbanism and Ecology (see chapter 2.3). Next to the detailed research into the specific environmental conditions, a theoretical framework supports underlying theories, scientific concepts and design solutions. Both approaches to the identified characteristics aim to answer the main research question of the course, related to the Norwegian cases. The individual design experiments (chapter 2.7) all share the question of temporality in economy, urban environment and natural environment, related to ecosystem participation.



[1] *Source originating from Brightspace TU Delft (not publicly accessible)*

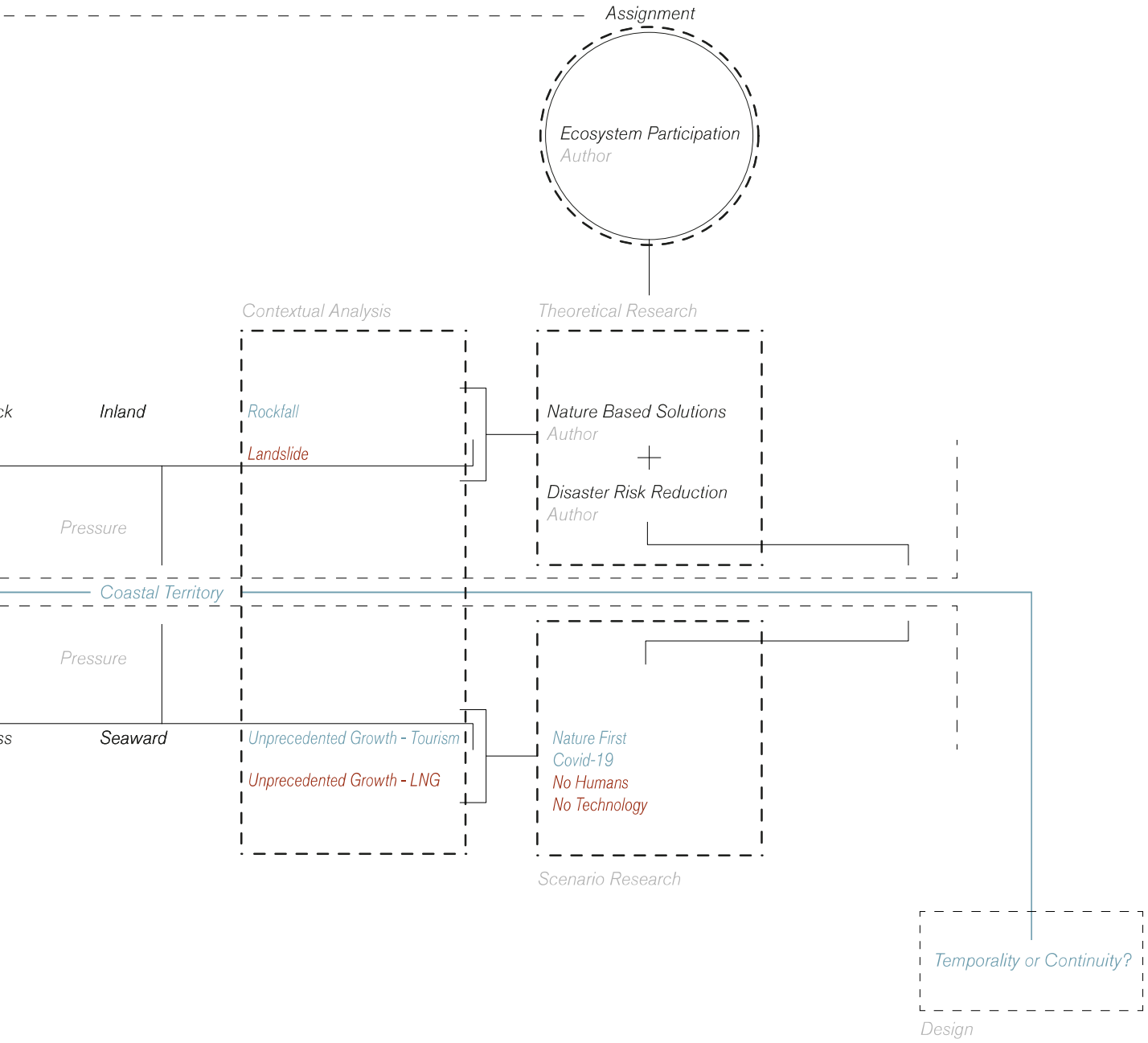


Figure by C. Goselink

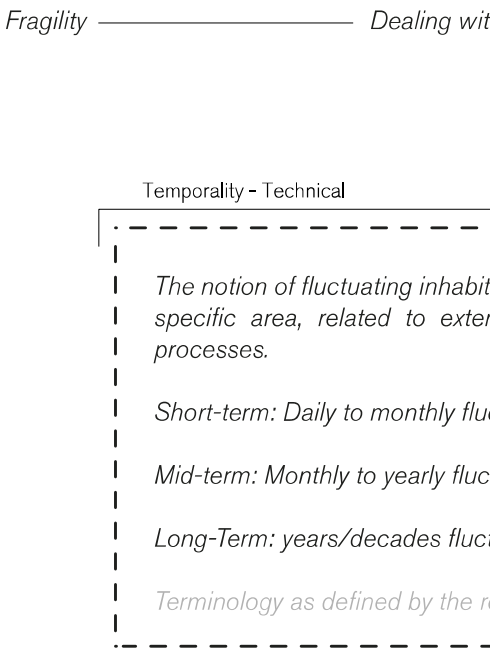
Theoretical framework

The fragility of the Norwegian cases is caused by two main problems; the temporality of inhabitation in relation to economy and geopolitics, and the stress and shocks posed by the landscape in relation to changing climatic conditions.

The temporality concept consists of two separate theories. On the one hand, we identified and carefully discussed our more technical terminology, based on the identified characteristics of the Norwegian cases. This terminology relates to the fluctuations of economy and inhabitation over several timescales. It identifies the urban layer as a temporal and ever changing space.

From the social temporality theory we can conclude that people tend to behave similarly in spaces over time, based on their earlier experience. The human factor of appropriation and continuity is inseparably connected with the territory. Sociological temporality is inherently related to behavior and participation of inhabitants, as they will base their thinking on 'what has been'. The technical temporality concept goes against their fundamental understanding of place and time. When the technical temporality is understood and accepted, this could open up new opportunities for growth of the people, and development of new ways, uses or economic prospects in the light of environmental participation.

The second main problem is caused by the extreme landscape and changing climatic conditions. To resolve the threats posed by the hazardous environment, nature based solutions are key. It relates closely to integrative, regenerative and participative strategies, all incorporating the ecosystem into the urban fabric. It does not only identify natural solutions as a form of infrastructure to provide services to the built environment, but also involves inhabitants and governance to provide suitable conditions for the natural environment in return.



The Nature based solution concepts strength lies in the integrative and systematic approach, preventing it from providing justification for the classic ecosystem services concept, in which 'green tools' exploit natural resources.

Nesshöver, C., Assmuth, T., Irvine, K. N., Rusch, G. M., Waylen, K. A., Delbaere, B., ... & Krauze, K. (2017). The science, policy and practice of nature-based solutions: An interdisciplinary perspective. Science of the Total Environment, 579, 1215-1227.

Nature Based Solutions [NBS]

Mountaineous terrain is inherently increasingly subjected to hazards and extreme events. Eb-DRR emphasizes conserving, restoring and sustainably managing the ecosystem.

Klein, J. A., Tucker, C. M., Steger, C. E., Nolin, A., Reid, R., Hopping, K. A., ... & Ghate, R. (2019). An integrated community and ecosystem-based approach to disaster risk reduction in mountain systems. Environmental science & policy, 94, 143-152.

Ecosystem based Disaster Risk Reduction [Eb-DRR]

h temporality ——— + ——— *Dealing with extreme environments*

Temporality - Sociological

ation or landuse over time in a rnal influences, systems and

ctuations

tuations

tuation

esearch group

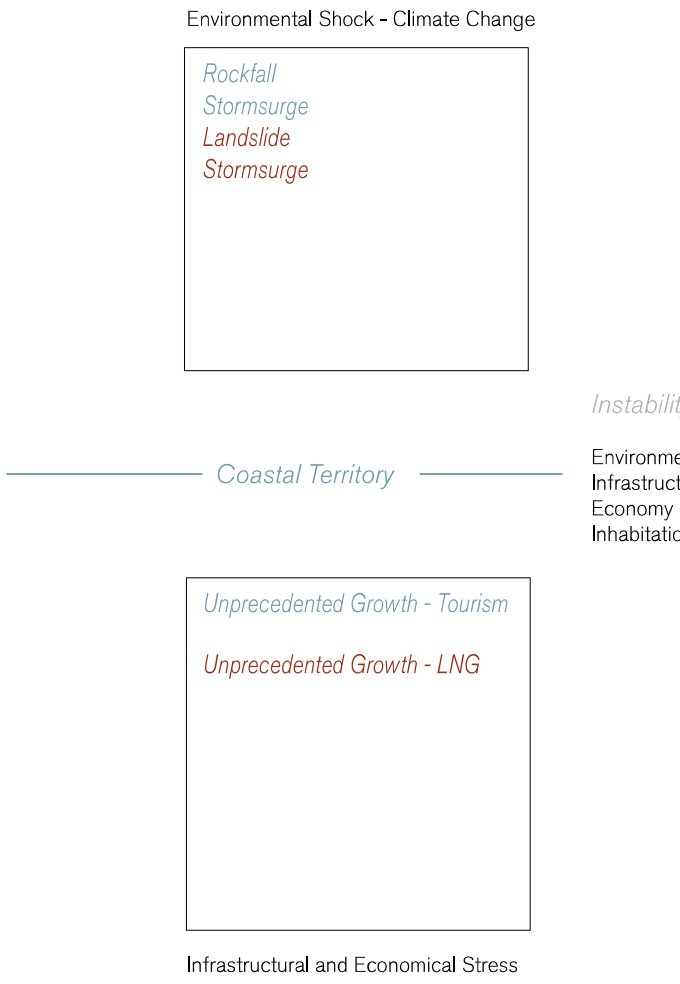
People connect with eachother through appropriating spaces, after which spaces are being re-used based on their apprehension and understanding.

Lotfata, A. (2018). Urban Mind. International Journal of Culture and History, 5(2).

Figure by C. Goselink

Conceptual framework

As mentioned, the coastal territory is undergoing large changes, both environmentally as infrastructural. The instability caused by environment, inhabitation, economy, infrastructure and geopolitics has a defining influence on the future sustainability of the locations. The problems caused by the extreme temporality in both Norwegian cases, can be addressed in different ways. Temporality benefitting both natural and built environments creates an 'and-and' situation, in which both natural and human space has to be able to function without preventing the other from doing the same. This can be reached by designing the environment as either human or natural, but include the other in a sensitive way into this environment. It has to be a mutually beneficial relationship in order to be sustainable in the long term. On the other end of the spectrum is the negative temporality, e.g. continuity. This situation can in principle be designed as a balanced landscape, but will in practice always lead towards an 'either-or' situation, as we can conclude from several perspectives on the Norwegian situation. If a balance has to be found that does not favor either of the environments, an equilibrium might possibly be reached through careful consideration of all aspects influencing both environments, and integrating needs and services. This seems to be the optimal outcome, although the research has pointed out that this task in the geopolitical scenario seems almost impossible, as the government has created a polarized policy system which deliberately and conclusively favors either human or natural environment. In this consideration, the challenge of the Norwegian cases lies.



Relation between Territory and Urbanization

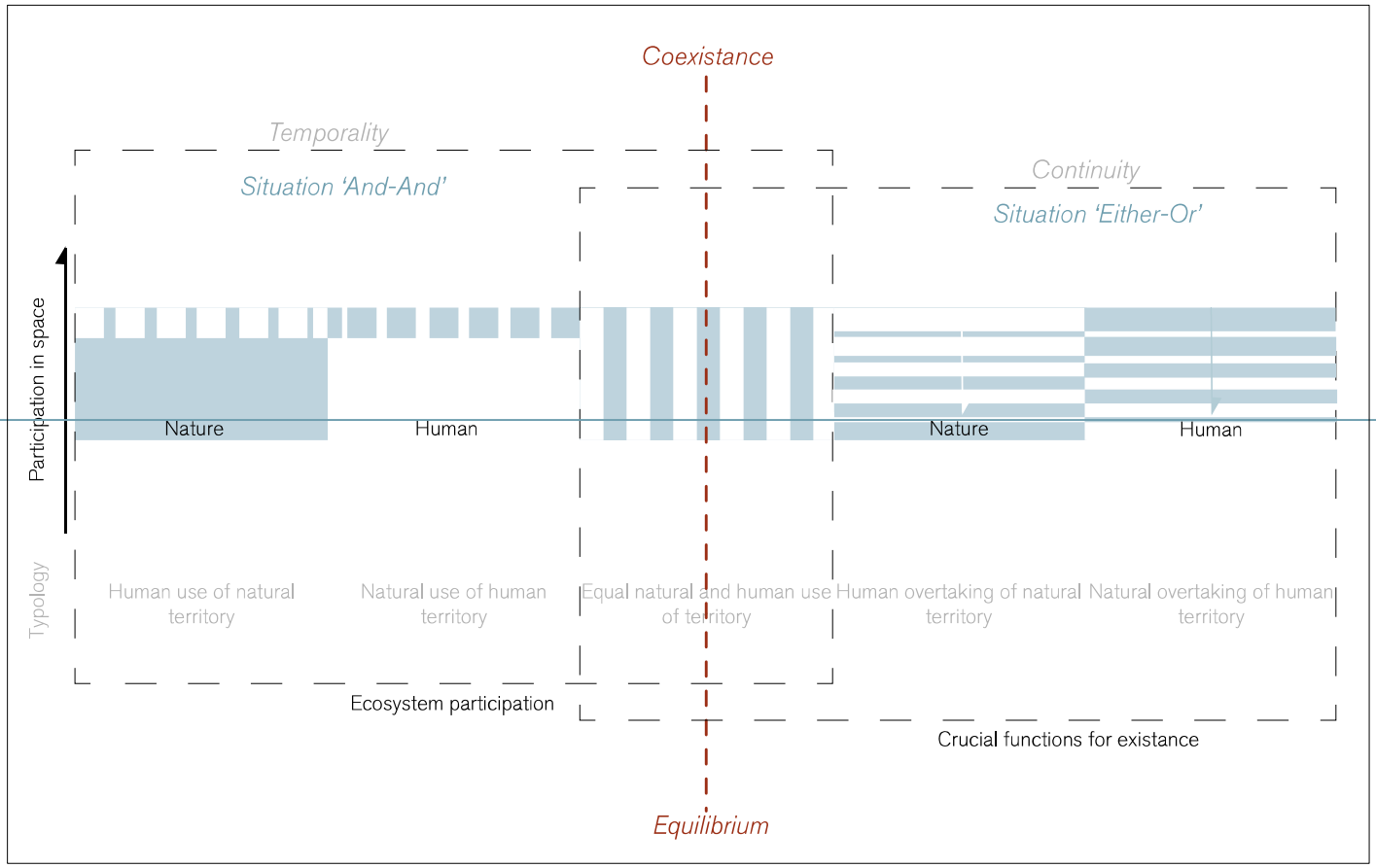


Figure by J. Berzins & C. Goselink

3.

Critical Cartography

3.1. Process of collecting data

Topics of climate change, fishery, mineral extraction, and cultural issues of Sami nation are on the foreground of discussion about processes that influence Norwegian Arctic, therefore there has been done extensive research on these topics. The data used for this group research project included information that was collected by student groups and graduate students in TU Delft from previous years, open-source GIS data, open-access data provided by the Norwegian government and local municipalities, as well as recent scientific literature on the related topics. This allowed access to a large amount of data that was carefully assessed to answer the research questions that were set for this specific project.

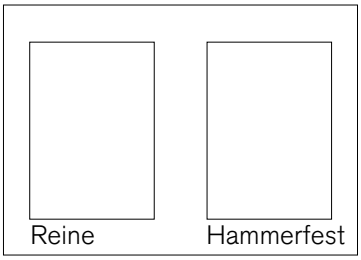
The process of collecting data included elaborative research on the specific topics and it was hard to scope the necessary information due to sometimes overwhelming amounts of data, therefore it was important to make the conclusions and narrow the research.

The data collection also included understanding of the site and territory. As the research was conducted during the COVID-19 pandemic, on-site visits and field studies were prohibited, therefore available information, including documentary videos and photos of the sites were used to understand the specific processes and environment of Hammerfest and Lofoten archipelago. Very important insight on the life and activities of people in Hammerfest were provided by graduate students of TU Delft Gioele Colombo and Santiago Palacio Villa, who had visited the city of Hammerfest in March 2020 and provided several pictures and stories about their on-site experience.

The data and experiences conducted online for the research allowed the group to focus on the objective information that was available, however, the results and conclusions of the research could vary if the on-site experience could have been included.

The data found is translated into maps, schemes and sections. The scales vary; 1:20.000.000, 1:5.000.000, 1:50.000, 1:20.000 and 1:5000.

As the report covers two different cases, the aim is to make a clear distinction between them. In order to achieve this, in the smallest three scales Reine will always be on the left, and Hammerfest always on the right side of the spread.



3.2. System of systems

The main research questions in system of system perspective are: what are the main systems and their compositions that have an impact on the territorialization of the two chosen cities? what are the conflicts and synergies among those different systems? To answer the questions, it requires us to jump between different scales and have an extensive collection about environmental, geo-political, economic and cultural aspects.

As Oil and LNG industry has a huge impact on the use of land and sea in Norwegian territory. The analysis starts from this industrial infrastructure system. Since the discovery of North Sea oil during the late 1960s, a large number of on-shore and off-shore facilities have been built in North sea and Barents sea, which are used for transport, storage and processing of oil and gas. In the national scale, the Norwegian exclusive economic zone, which is a 200 nautical miles stretch from the coast, is provided with large areas and special rights with extraction. In the regional scale, infrastructures in cities like Hammerfest are highly related to production and logistics activities.

Next part is the energy system, which focuses on the potentials of using renewable energy and the current situations of fossil fuels. Electricity generation in Norway is almost entirely from hydroelectric power plants. However, the emission of CO2 per capita is still high due to the extraction and logistics of fossil fuels in North sea and Barents Sea, which have put the most critical stress on ecosystem. There is a trend of using renewable energy in extraction activities. Winds and huge currents that come in from the Barents Sea carry flush green power and profits. The conditions along the coast of Finnmark are suitable for developing wind and tidal power.

After that, the conflicts between the environmental system and the industrial system are ellaborated. On the one hand, climate change will have a huge impact on infrastructure systems. On the other hand, the operation of the oil and gas industry will further accelerate the melting of frozen soil and rising water levels. The map shows how the sea ice area has shrunk in recent decades. The melting of sea ice and permafrost would increase the risk of landslide and storm surges. The conflicts and synergy map summarizes the above issues.

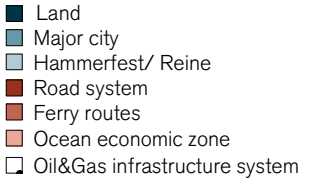
The last part is about flows. Together with the conflicts and synergies which as a context, the maps jump into an urban scale and focus on how the flows of different elements (materials, goods, people, etc.) impact on both cities.

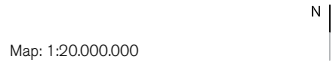
Territorial infrastructure/ National scale

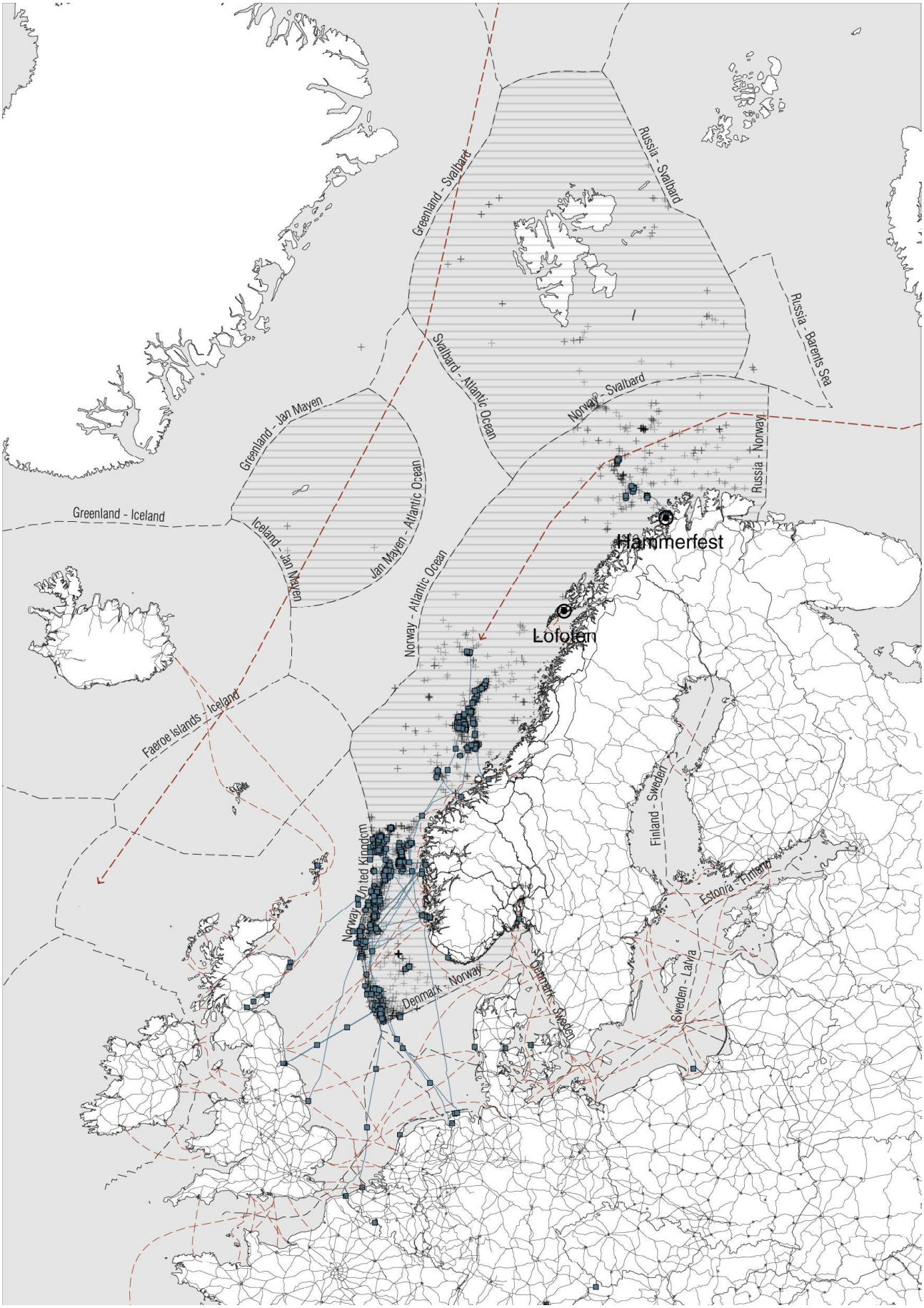
The Norwegian exclusive economic zone is a 200 nautical miles stretch from the coast where Norway is provided with special rights with extracting marine resources. Since the discovery of North Sea oil during the late 1960s, exports of oil and gas have become very important elements of the economy of Norway. A large number of on-shore and off-shore facilities were built in North sea and Barents sea, which are used for transport, storage and processing of oil and gas.

Additionally, mining and fishery are also major industry in some counties. The long coastline (2,650 km) and the high-density road network allows a large amount of export to other places.

Map sources: Arctic-nga.opendata.arcgis.com., Diva-gis.org., Geonorge.no.






Greenland - Svalbard
Russia - Svalbard
Russia - Barents Sea
Svalbard - Atlantic Ocean
Norway - Svalbard
Greenland - Jan Mayen
Jan Mayen - Atlantic Ocean
Russia - Norway
Greenland - Iceland
Iceland - Jan Mayen
Hammerfest
Norway - Atlantic Ocean
Lofoten
Faeroe Islands - Iceland
Finland - Sweden
Norway - United Kingdom
Estonia - Finland
Denmark - Norway
Denmark - Sweden
Sweden - Latvia

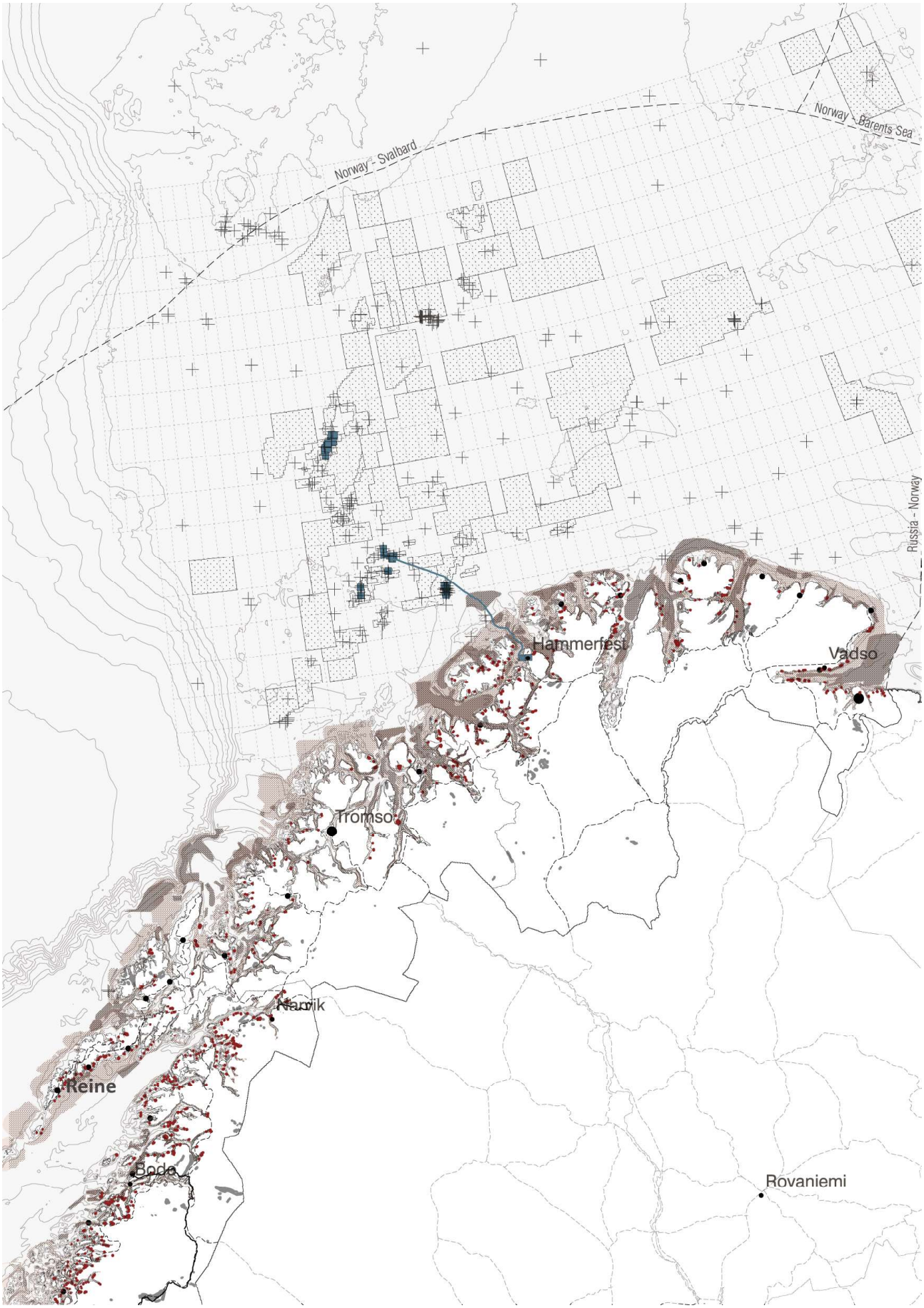
Territorial infrastructure/ Regional scale

Map sources: Arctic-nga.opendata.arcgis.com., Diva-gis.org., Geonorge.no.

- Water or highlight
- Rivers
- Sealevel rise
- Mountain

N

Map: 1:5.000.000


Norway - Svalbard
Norway - Barents Sea
Russia - Norway
Hammerfest
Vadso
Tromso
Narvik
Reine
Bodo
Rovaniemi

Energy system/ Renewable energy and fossil fuels

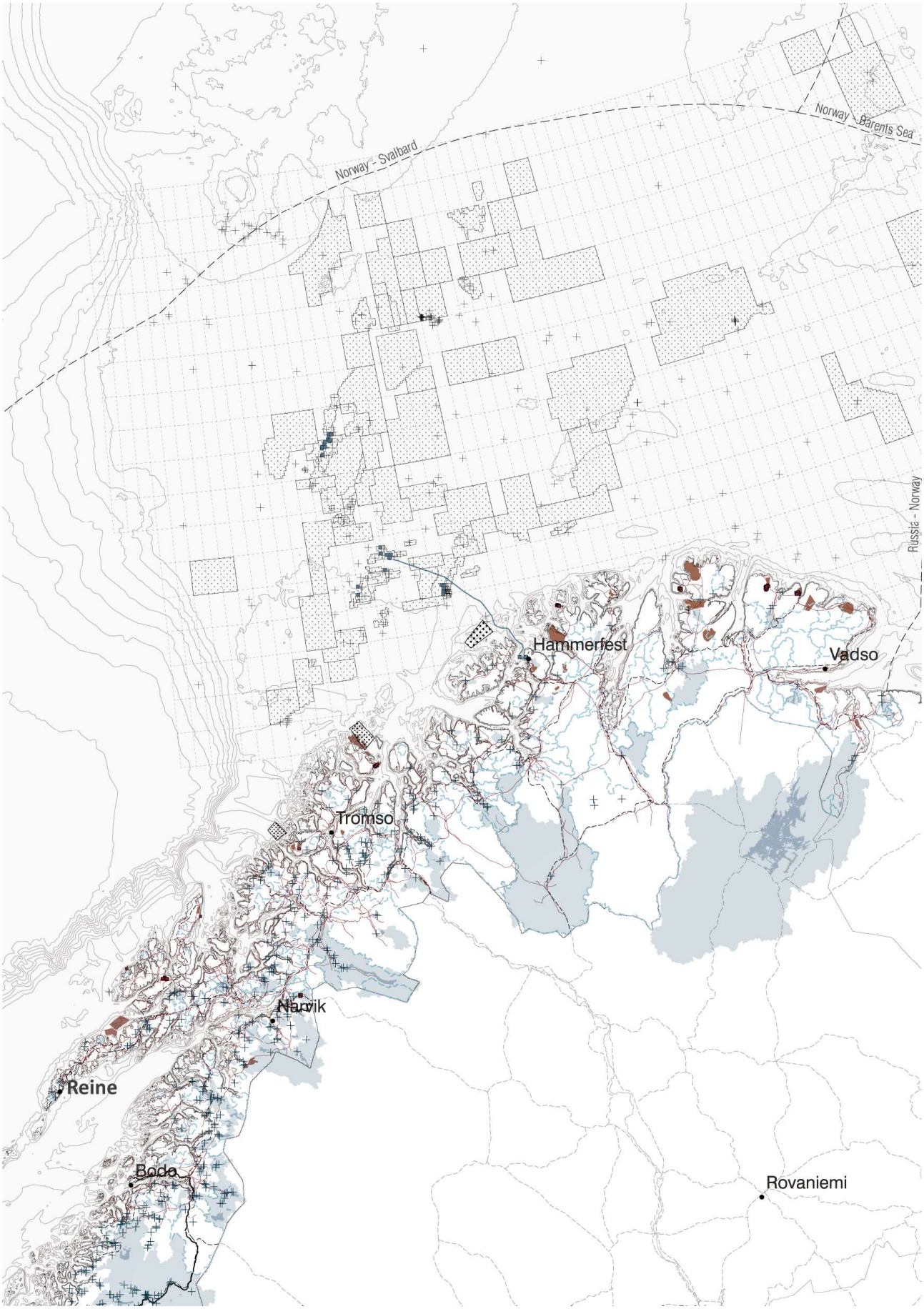
Electricity generation in Norway is almost entirely from hydroelectric power plants. However, the emission of CO2 per capita is still high due to the extraction and logistics of fossil fuels in North sea and Barents Sea, which have put the most critical stress on ecosystem.
There is a trend of using renewable energy in extraction activities. Winds and huge currents that come in from the Barents Sea carry flush green power and profits. The conditions along the coast of Finnmark are suitable for developing wind and tidal power.

Map sources: Arctic-nga.opendata.arcgis.com., Diva-gis.org., Geonorge.no.

- Water intake area
- Hydropower station
- Wind farms
- Wind turbine
- Power lines
- Oil&Gas platform
- Oil&Gas wellbore
- Pipelines
- Tidal turbine potential area

N

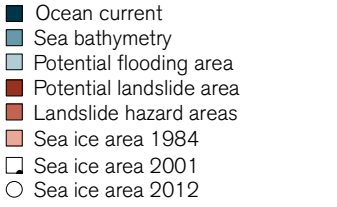
Map: 1:5.000.000


Norway - Svalbard
Norway - Barents Sea
Russie - Norway
Hammerfest
Vadso
Tromso
Narvik
Reine
Bodo
Rovaniemi

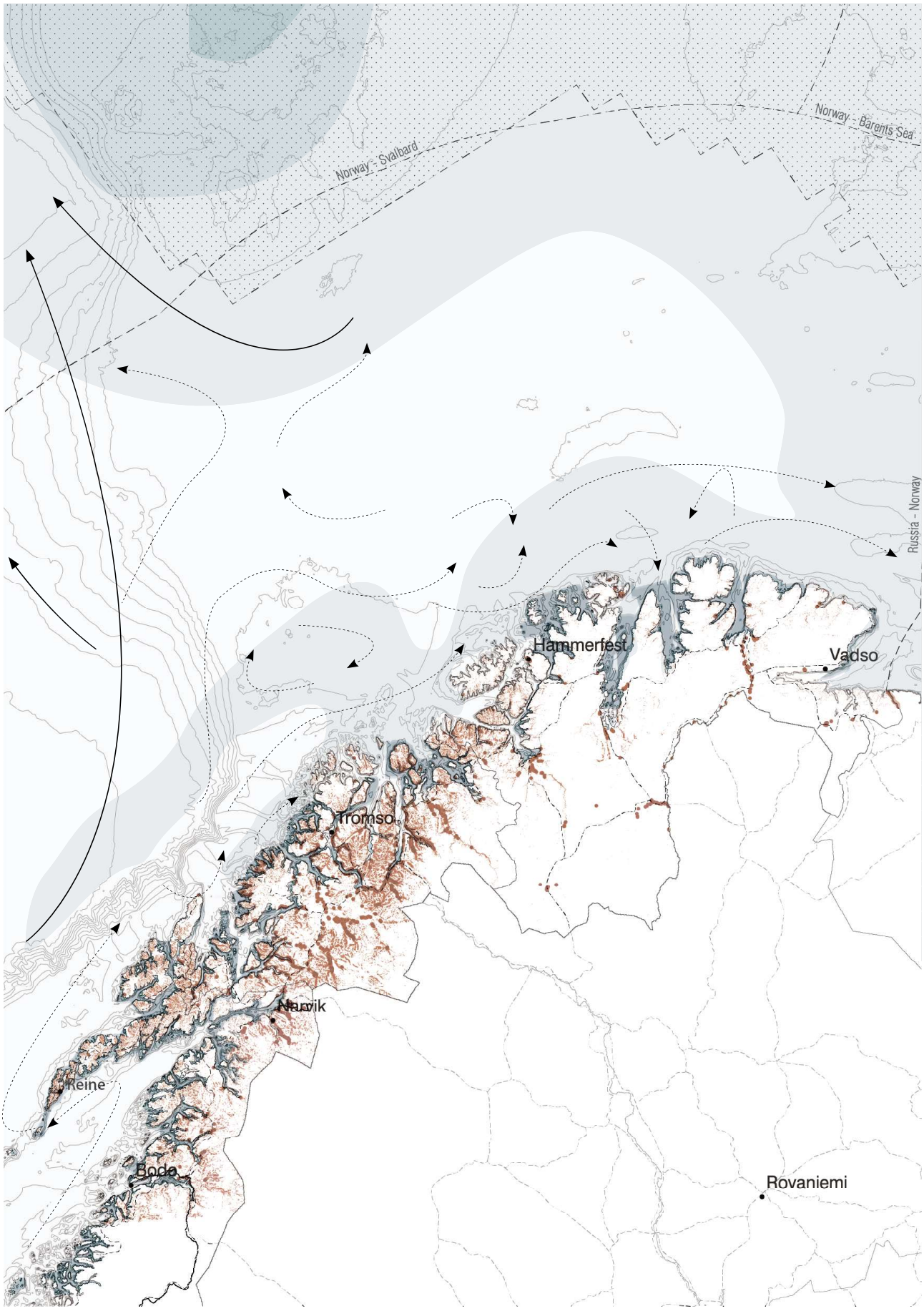
Climate change/ Risks on coastline

The map shows how the sea ice area has shrunk in recent decades. Additionally, base on speculation, most of the permafrost would melt by the end of the century(Hanssen-Bauer et al., 2017). The melting of sea ice and permafrost would increase the risk of landslide and storm surges.

Map sources: Arctic-nga.opendata.arcgis.com., Diva-gis.org., Geonorge.no.



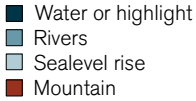



Norway - Svalbard
Norway - Barents Sea
Russia - Norway
Hammerfest
Vadso
Tromso
Narvik
Reine
Bodo
Rovaniemi

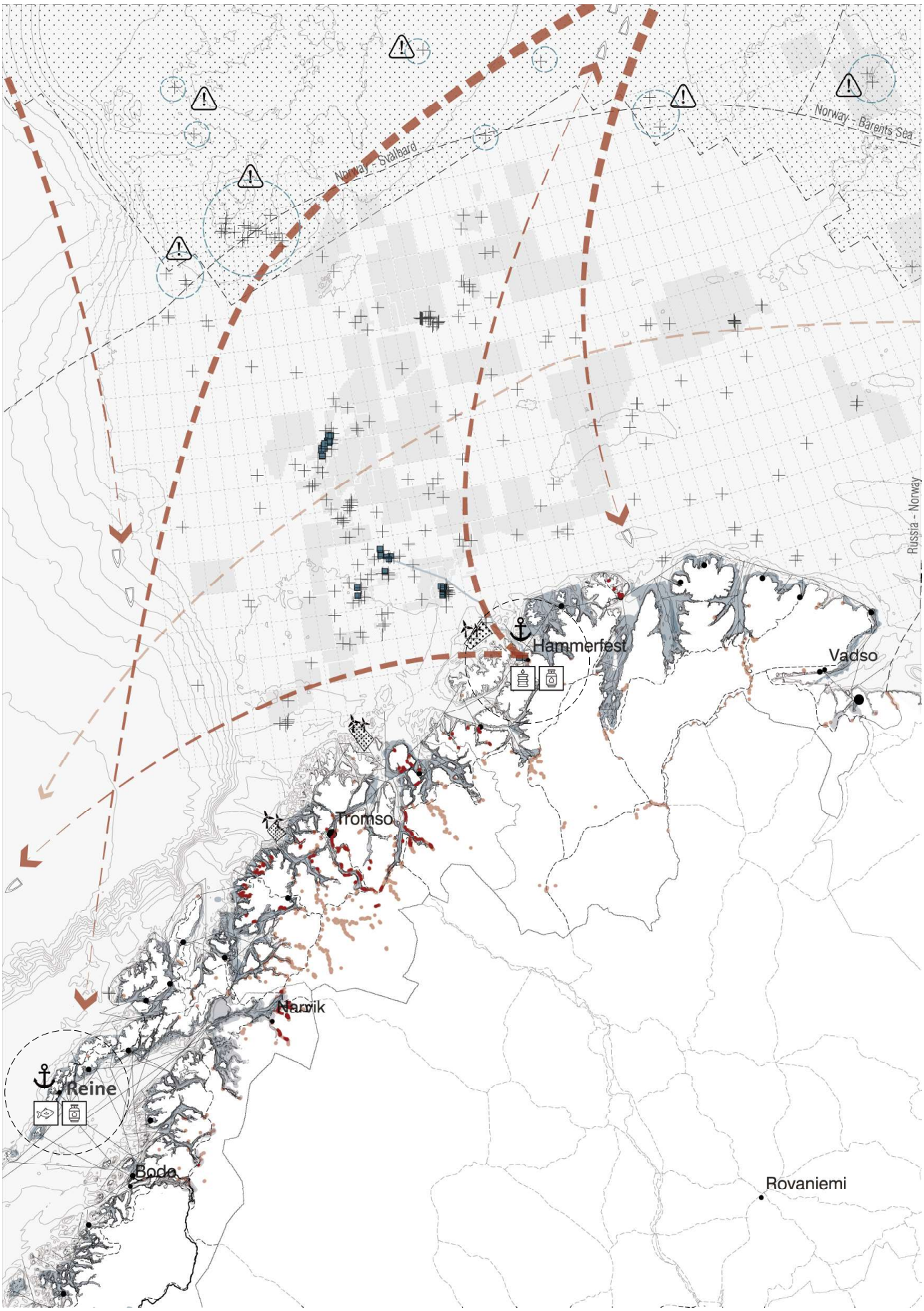
Conflicts and Synergy

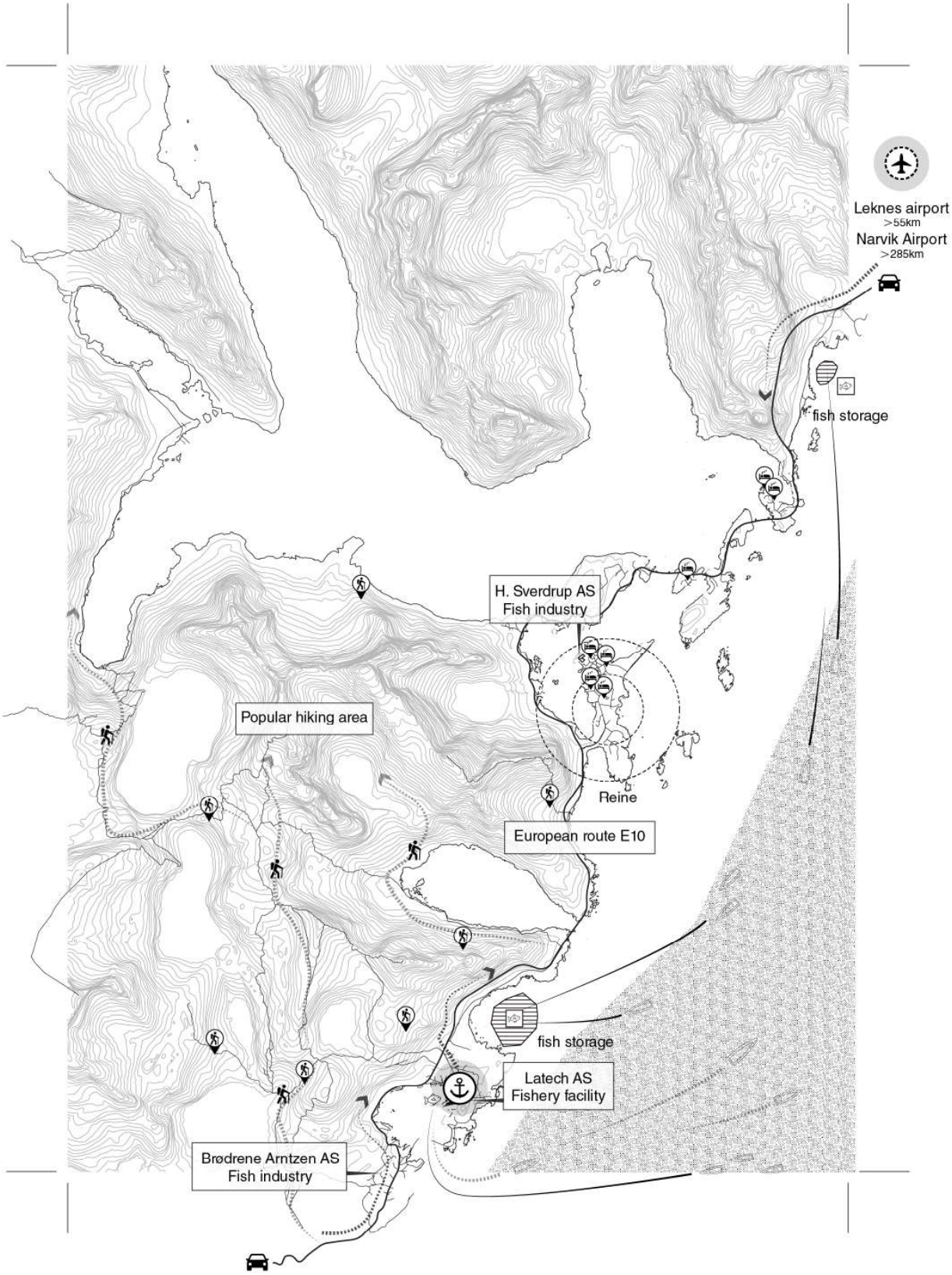
Due the sea ice decline, new trade corridors in the Arctic region will become possible, which would increase large shipping volume from Norway to Russian and East Asia. This will boost the profits of fishery and extraction industries along the Barents Sea. However, the increasing landslide and storm surge along the coast make it more difficult to build infrastructure and settle people.

Map sources: Arctic-nga.opendata.arcgis.com., Diva-gis.org., Geonorge.no.

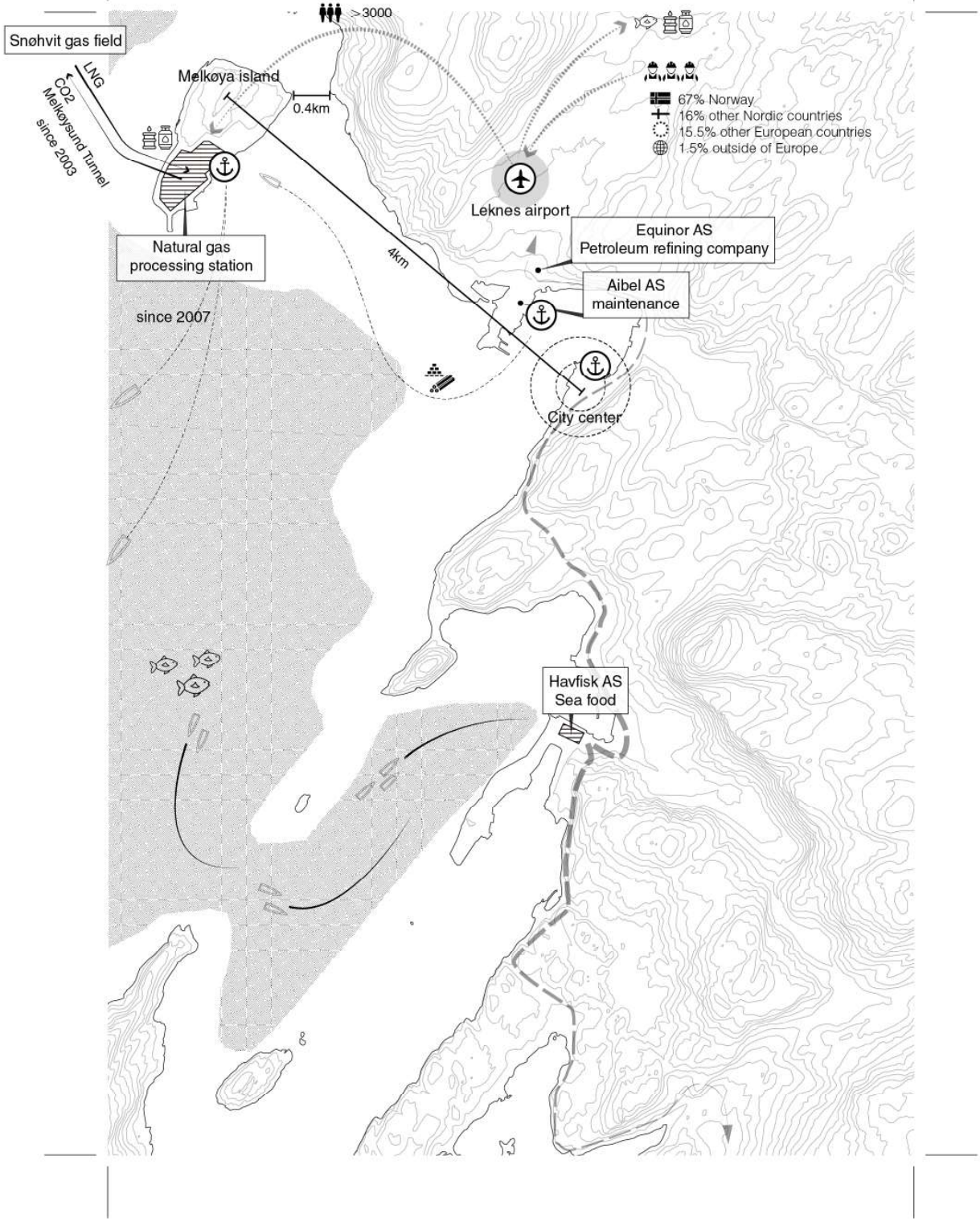





Norway - Svalbard
Norway - Barents Sea
Russia - Norway
Hammerfest
Vadso
Tromso
Harvik
Reine
Bodo
Rovaniemi



Flows in Reine/ Tourists and fishery



Flows in Hammerfest/ Fossil fuel and fishery

3.3. Anthropology

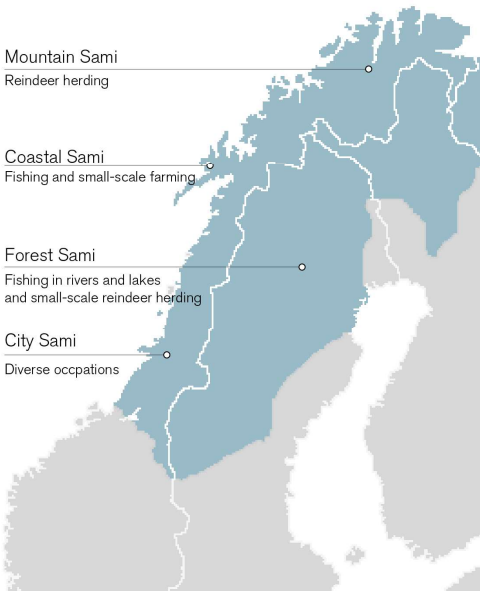
The perspective of anthropology focuses on the life of humans living in extreme environments through time and space. In the case study of Norway, the anthropology perspective researched the characteristic lifestyles of the local population that have been created since ancient times to adapt to extreme environment. In addition, this perspective also studied how the more extreme environment caused by natural and social factors challenges the lifestyle of the local population.

There are both similarities and differences in the ways in which people in Lofoten and Hammerfest coexist with extreme environments. The similarity lies in the fact that the inhabitants of both cities have developed seasonal lifestyles and culture adapted to extreme environments. But the current leading industries in both cities have a significant impact on the traditional lifestyle and culture of the indigenous populations. The difference is that the main industries in the two cities, tourism in Lofoten and liquefied natural gas (LNG) in Hammerfest, have different impacts on prospects for coexistence between humans and nature in time and space.

The content of this perspective includes the following three parts. The first part is general information and time system. General information includes maps of the in-digenous population, religious culture, and the relevant numbers of reindeer herding industry. The Time system includes historical perspective and seasonal perspective, that is the evolution of living with extreme environments from ancient times to the present and the perception of the extreme environment over four seasons.

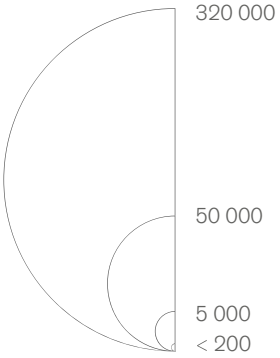
The second part is a human perspective analysis, which mainly discusses how the inhabitants coexist with extreme environments under the influence of natural and social factors such as climate change and industrial transformation. Using window scapes connected to a Venturi atlas and the analysis approach created by Michael Thompson and Mary Douglas, this part analyzed the threatens from the extreme environment and events in Lofoten and Hammerfest, as well as the natural and social re-silience under the circumstances.

The third part is the deep map of natural and social vulnerabilities. Hammerfest's vulnerability comes from the impact of landslides and the transformation of the LNG industry, while Lofoten's vulnerability is due to rockfall and the extreme seasonality of the dominant industries. For Hammerfest, what impact will the development of the Arctic route and the prospects of the LNG industry have on the natural environment, social structure and the construction of infrastructure funded by the oil company? In terms of Lofoten, how will the shrinking town cope with the seasonal flow of people from fishery and tourism? These are the questions preliminary studied from this perspective.



Sami Settleme nt

Total population in the settlement (2011)



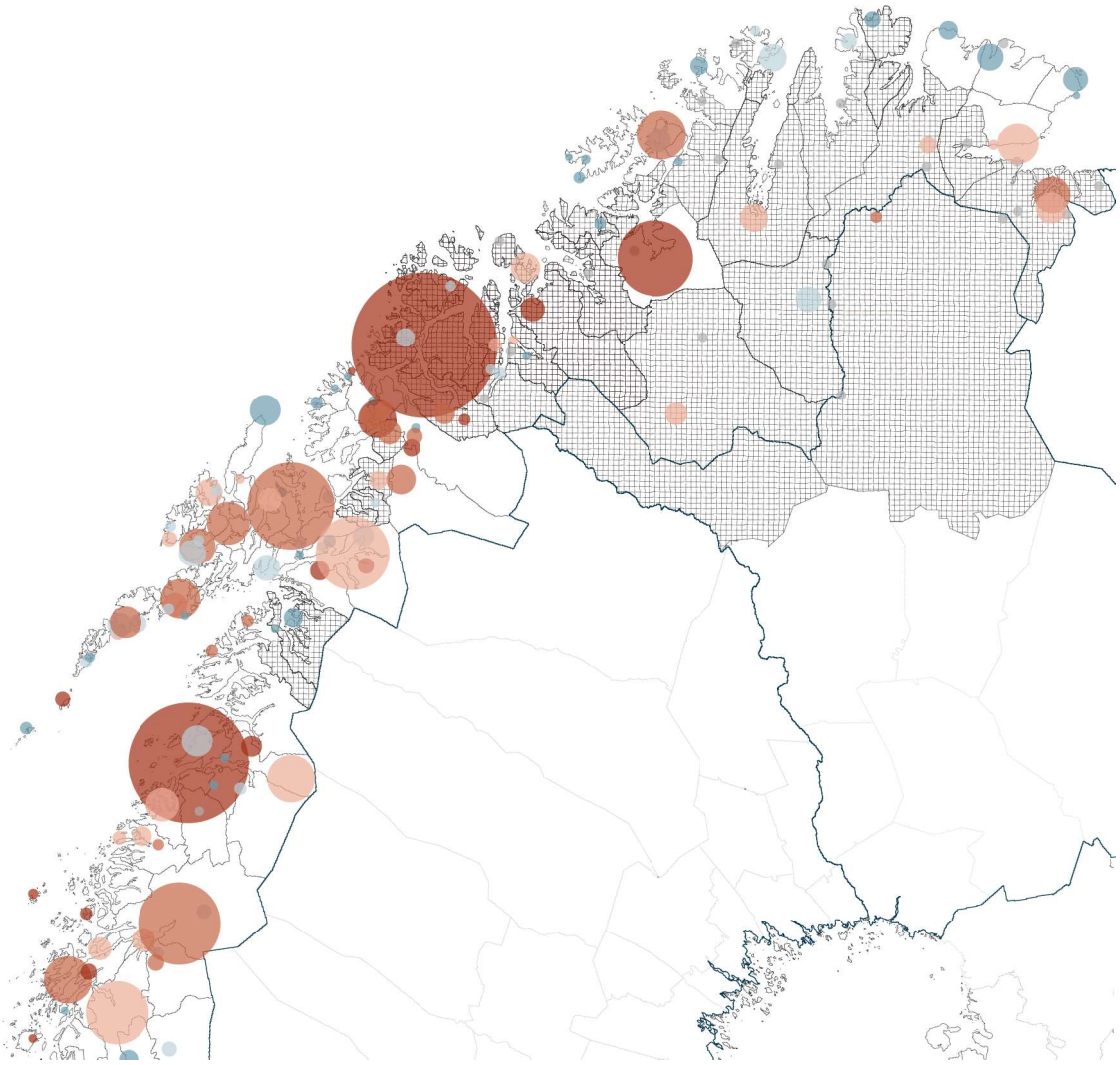
Annual average population change in the settlements in 2000-2010, in %

- < -1.0
- -1.0 — -0.1
- -0.1 — 0.1
- 0.1— 1.0
- > 1.0
- No change data
- STN Area
- National boundary

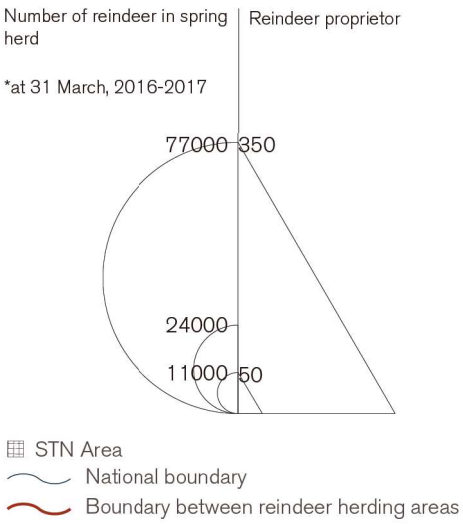
N

Map: 1:5.000.000

2019—2020
IED Infrastructure and Environment Design
Lofoten / Hammerfest Anthropology Perspective



Sami Reindeer Husbandry

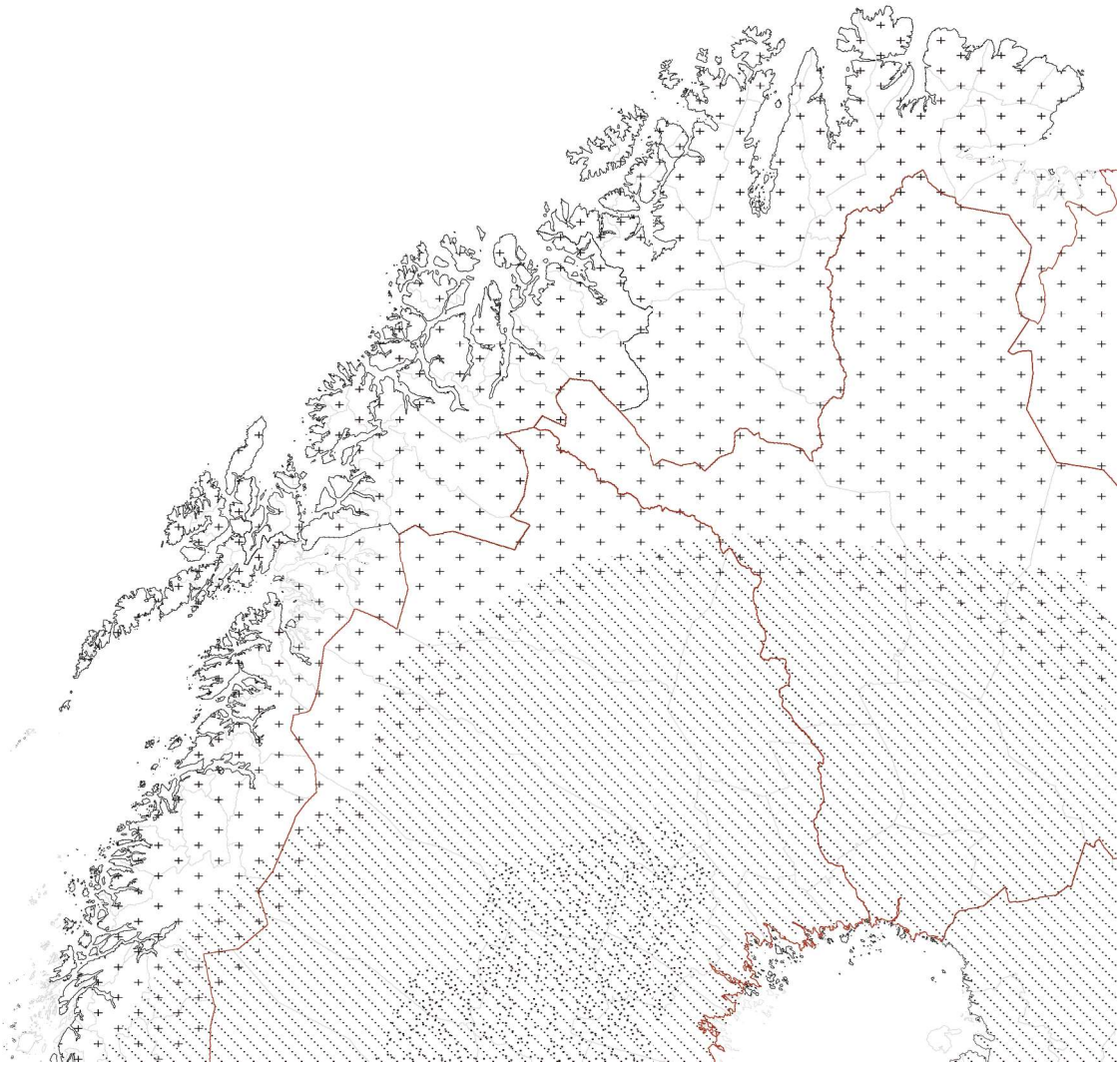




Map: 1:5.000.000

Sami Shamanistic and Animistic Cultures

- Areas of original ancient shamanism
- Areas of original ancient animism
- Areas of recreated modern animism of shamanism
- National boundary



Frequency of extreme climate events



Indigenous culture

Western culture

Christianization

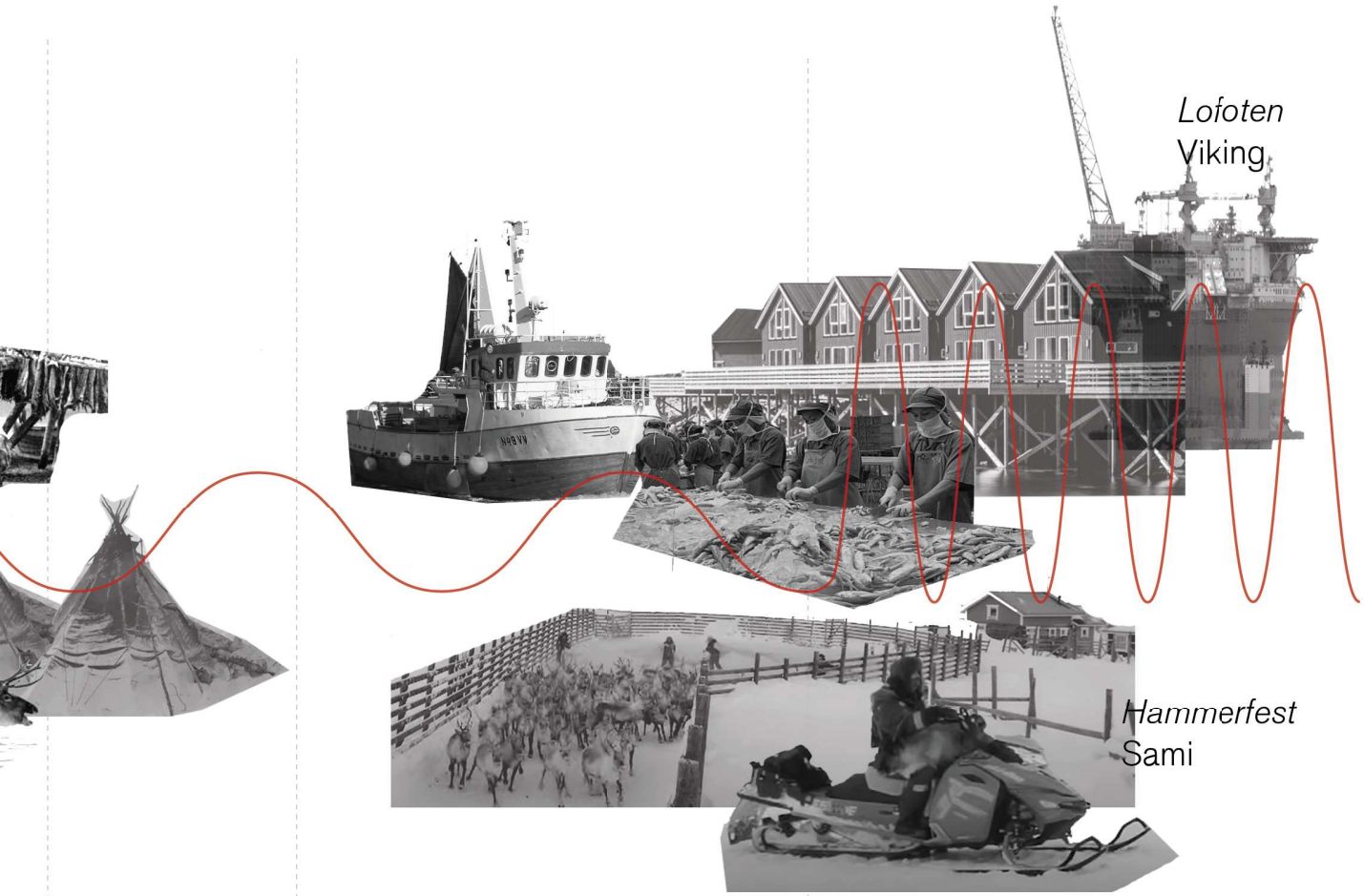
Cul

Indigenous social organization

“siidas” —— membership in a reindeer pastoralistic district

1600

W



Lofoten
Viking

Hammerfest
Sami

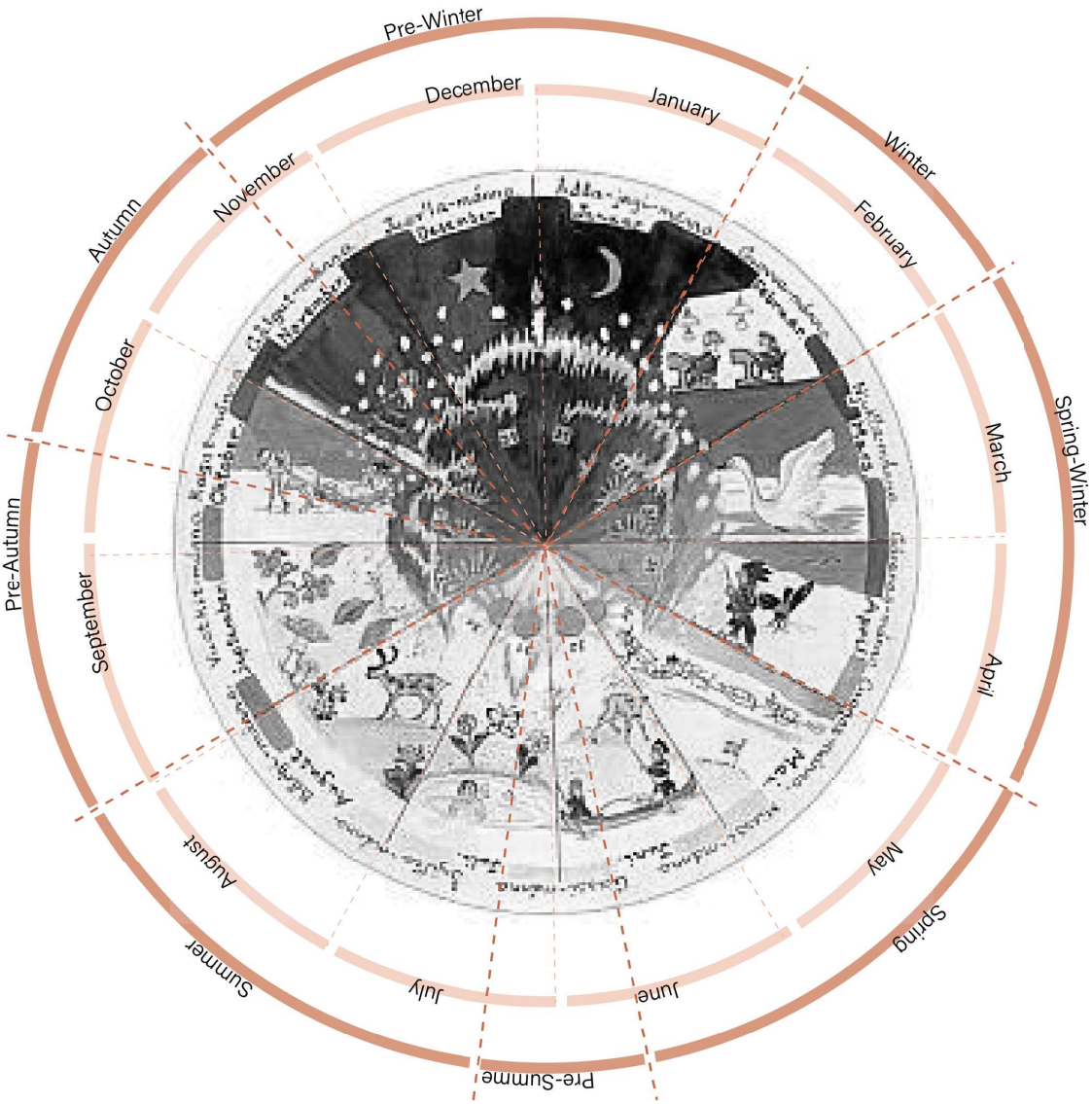
ture revival

the Sami Parliament

orld War II 1970 2000

The Sami Concept of Time

Sami time was based on the cycles of nature, particularly the yearly cycle of the reindeer. The eight seasons of this cycle are directly related to the annual behavioral patterns of the reindeer.



Western month
Sami season

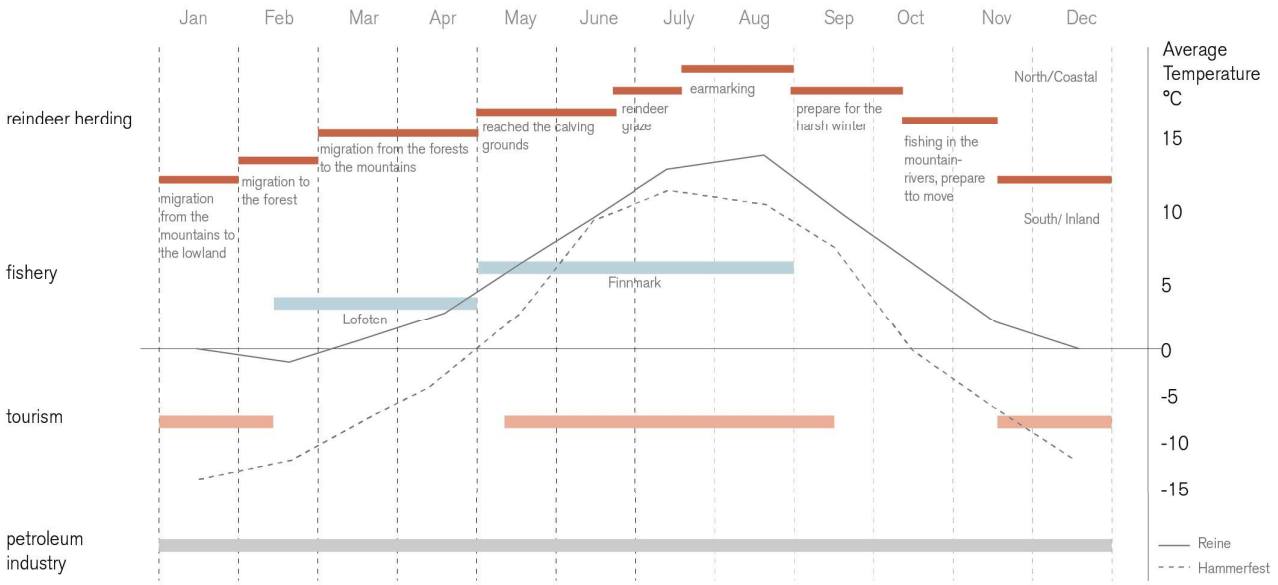
Seasonal Fishery & Reindeer Herding

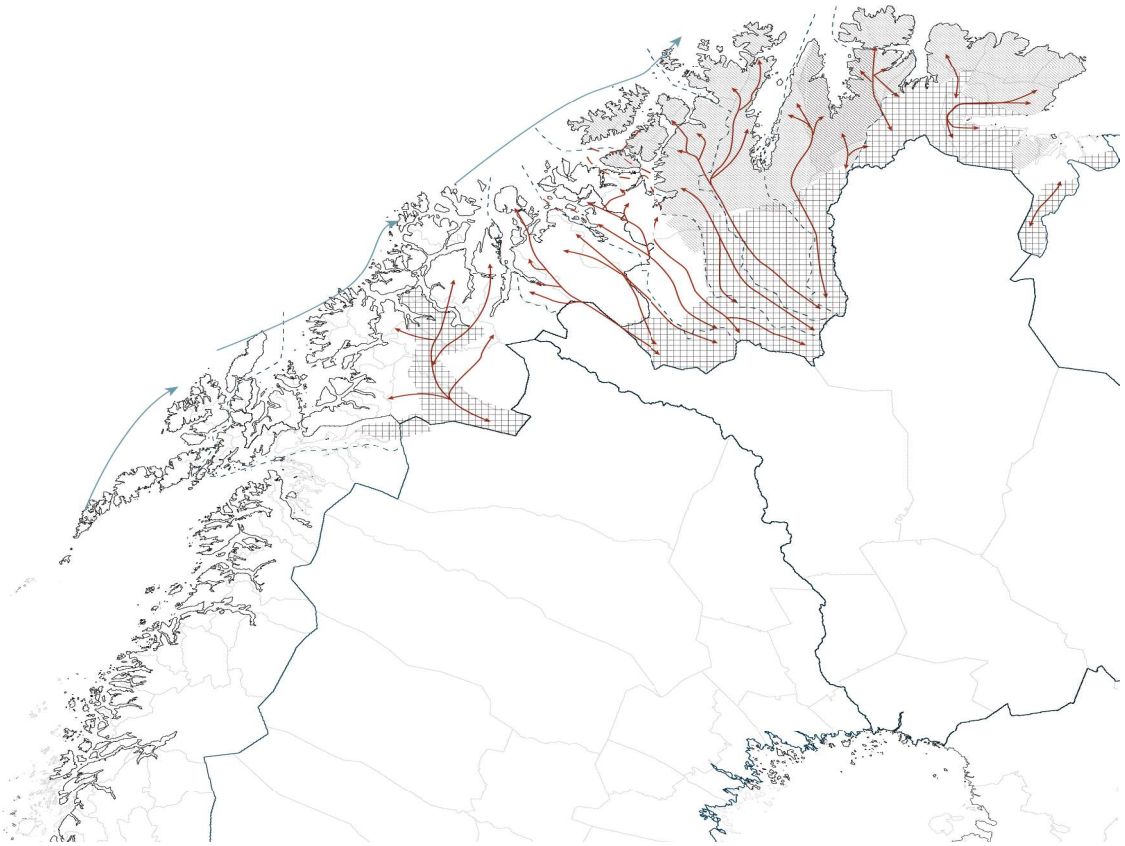
Summer pastures
Winter pastures

Boundary between reindeer herding areas
Reindeer migration routes
Fishery routes

N

Map: 1:5.000.000


Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec
reindeer herding
fishery
tourism
petroleum industry
migration from the mountains to the lowland
migration to the forest
migration from the forests to the mountains
reached the calving grounds
reindeer graze
earmarking
prepare for the harsh winter
fishing in the mountain-rivers, prepare tto move
North/Coastal
South/ Inland
Lofoten
Finnmark
Average Temperature °C
15
10
5
0
-5
-10
-15
Reine
Hammerfest

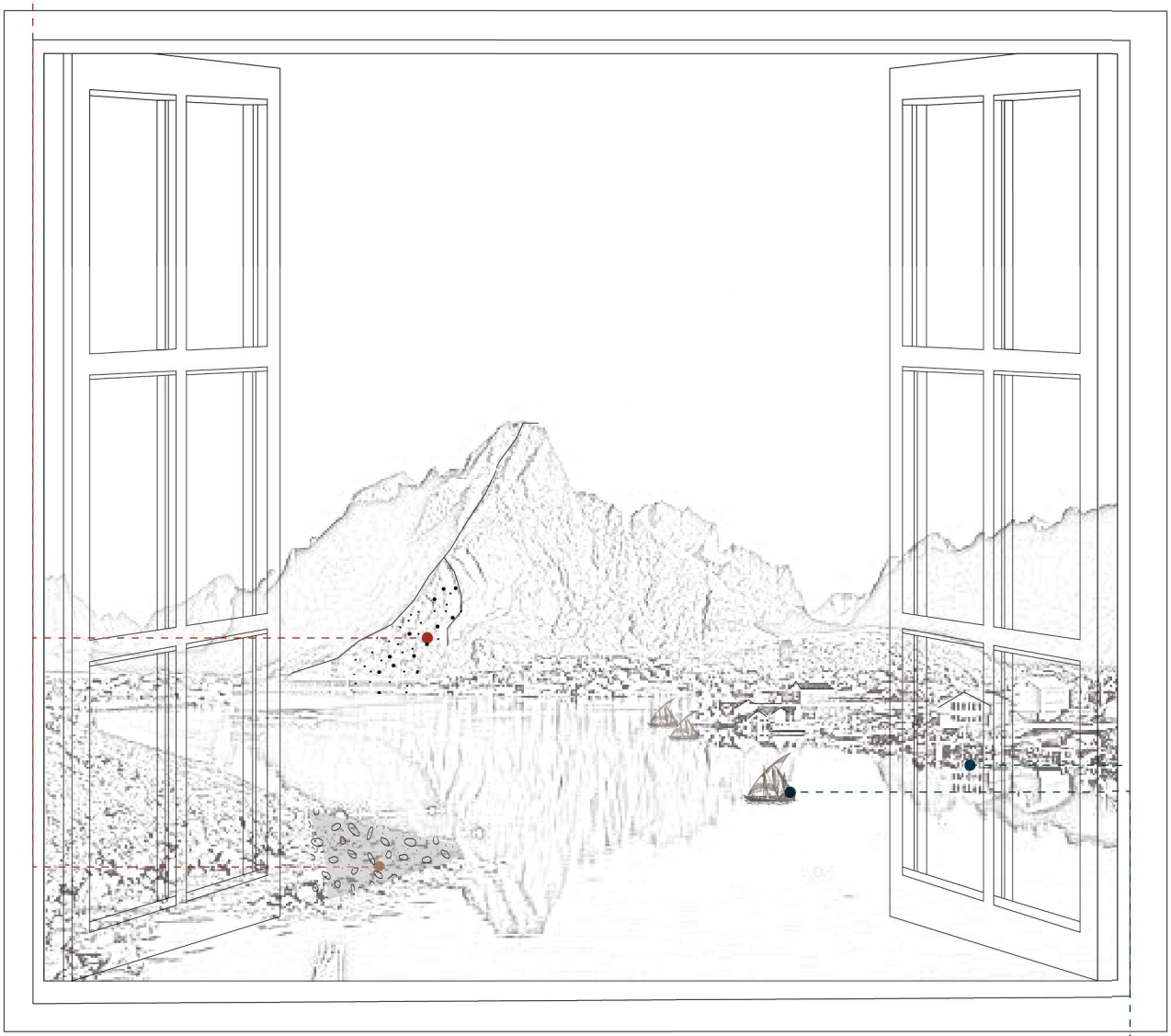


Rockfall

The topography of the islands is exceptionally steep and rugged, which means that landslides and rockfalls are common.

Garbage and Waste

“One weekend it was 8,000 liters of garbage,”that is the extent of the village’s control over the tourist invasion. It can’t send tourists away, even when there is barely room to walk, and locals can’t enjoy their own beach. The village can’t collect new fees at all, much less enough to ensure proper sanitation and safety.



Local residents are not likely to be present there for more than short periods in the most attractive seasons. This means that for long periods during the year, these rorbus will be empty. In cases where rorbus are dotted along the coastline, this renders large coastal areas “dead” for long periods of the year.

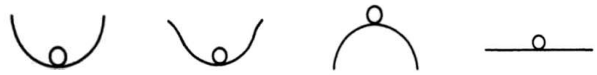
Absenteeism of local landlords

Tourists already have more space than fishermen. Tourism can’t replace the income from fishing because of the seasonality.

Confilcts between Fishery and Tourism

Reine

robust robust within limits fragile capricious



natural resilience social resilience





Garbage and Waste

natural resilience social resilience

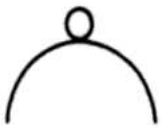




Rockfall

natural resilience social resilience



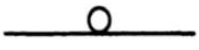




Absenteeism of Local Residents

natural resilience social resilience



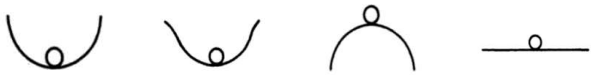




Oil Drilling (Stopped)

Hammerfest

robust | robust within limits | fragile | capricious



natural resilience | social resilience





Climate Change

natural resilience | social resilience





Landslide

natural resilience | social resilience





Petroleum Industry

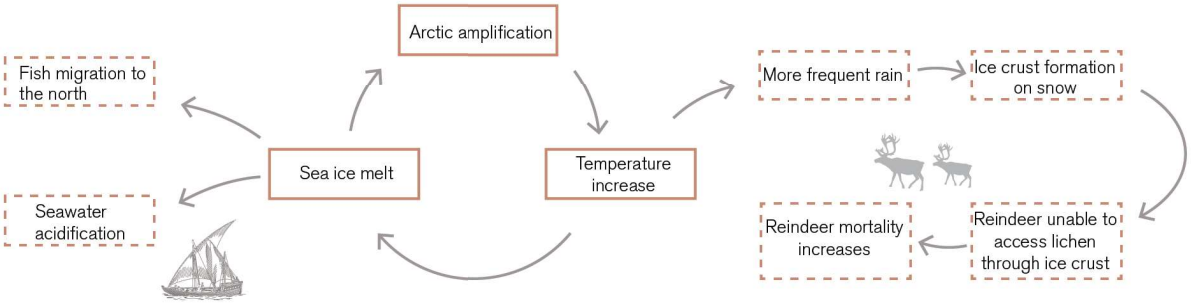
natural resilience | social resilience

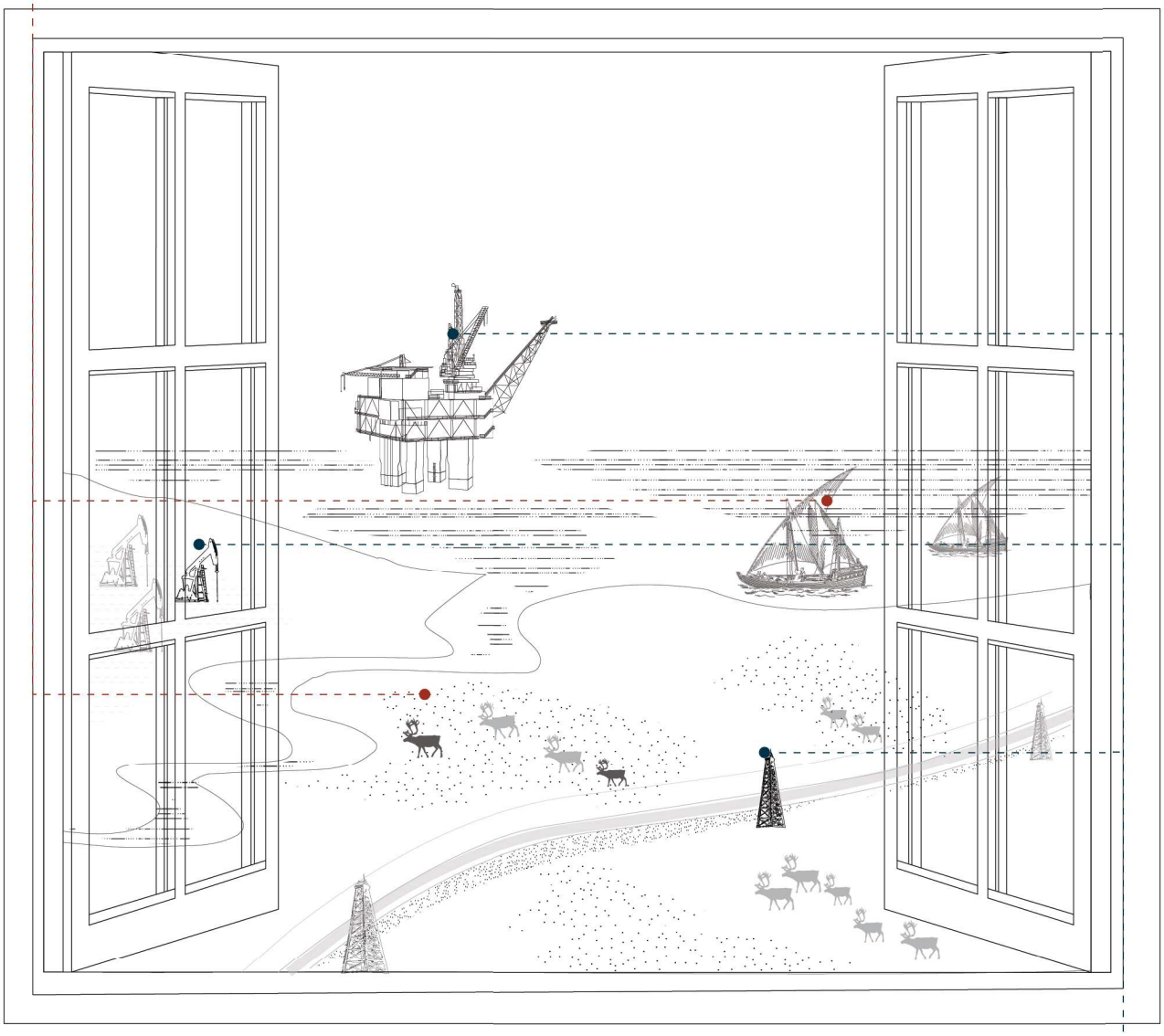


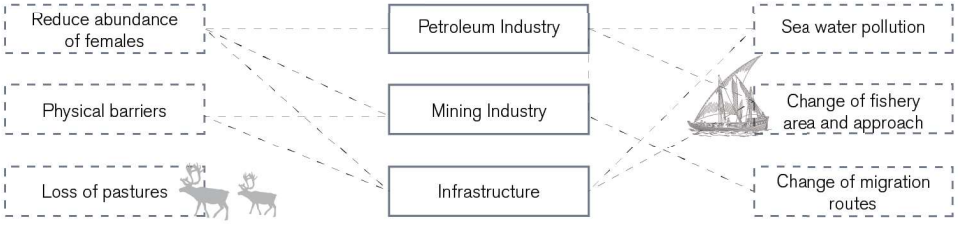


Urbanization

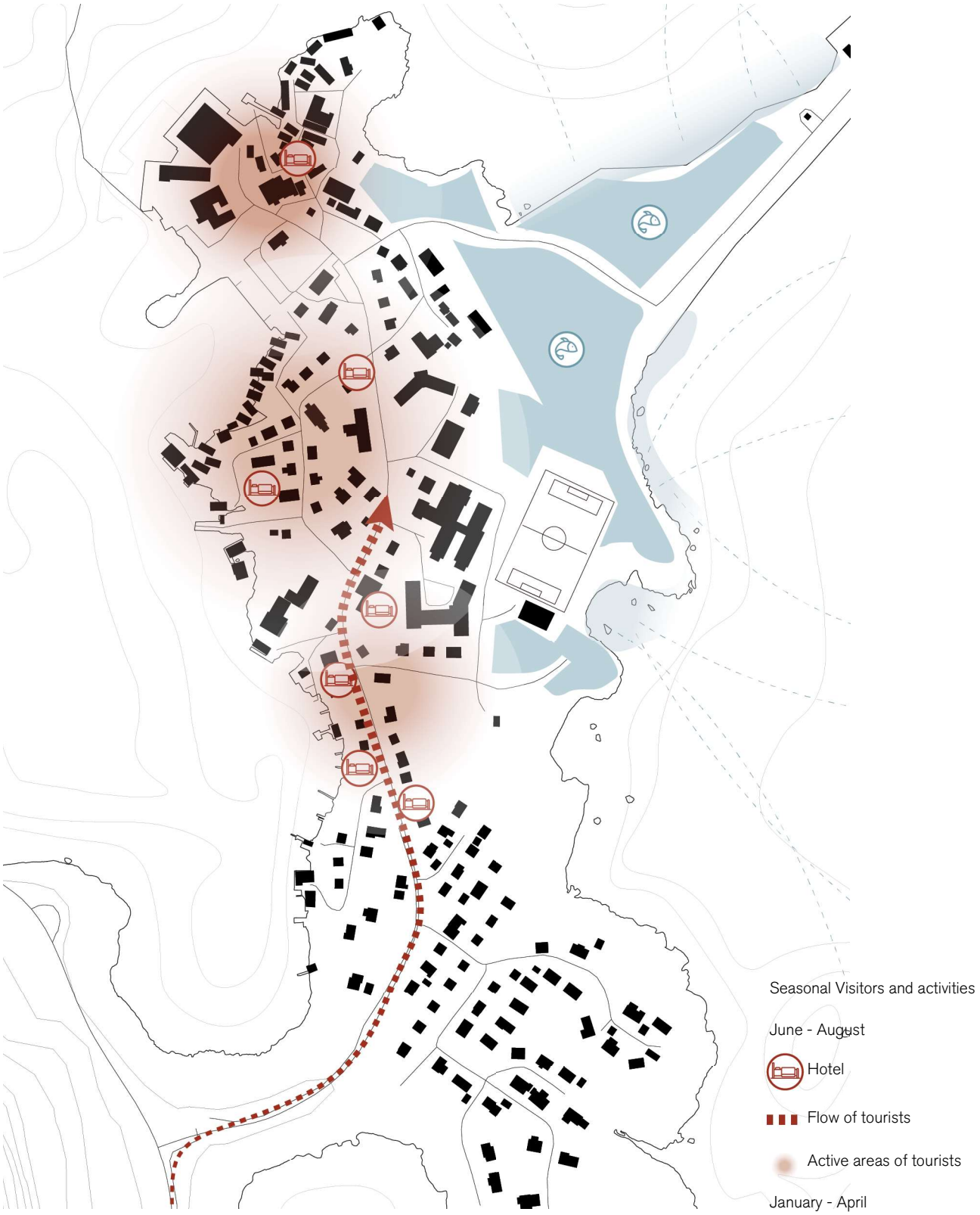
Impacts of Climate Change







Impacts of Development and Human Activities

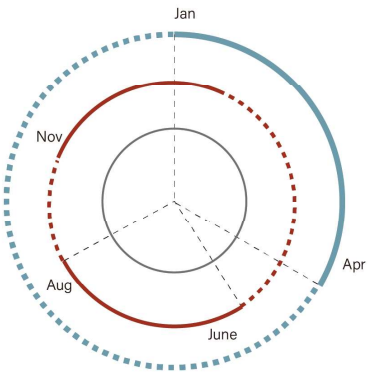

Seasonal Visitors and activities
June - August
Hotel
Flow of tourists
Active areas of tourists
January - April
Fishery ground
Flow of fishermen
Active areas of fishermen
N

Map: 1:5.000

Reine: Long History of Welcoming Seasonal Visitors

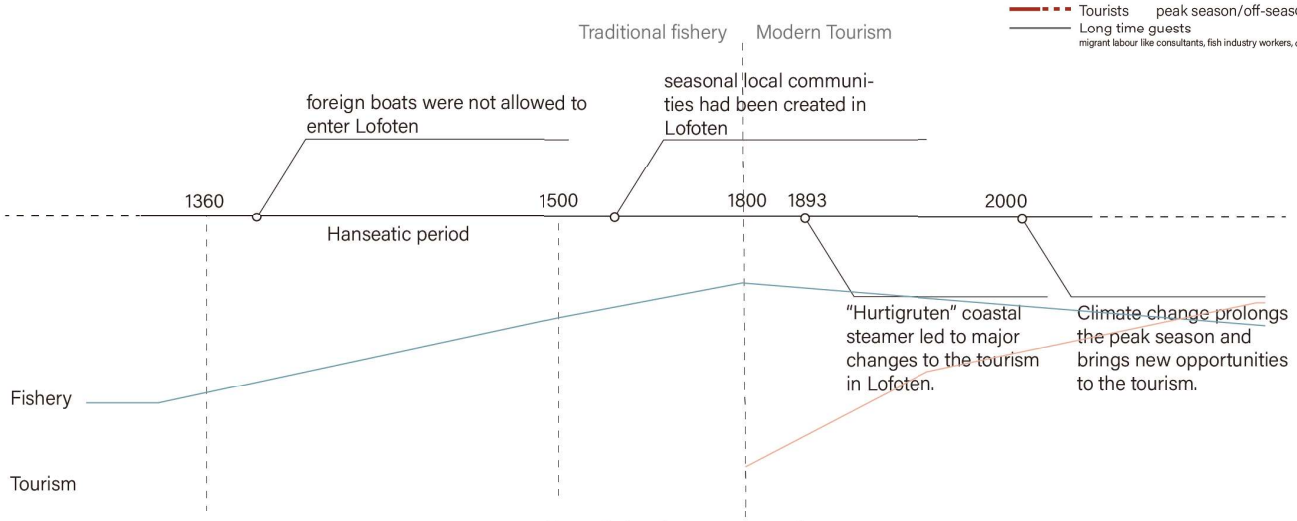
The image of Lofoten is often synonymous with the simple fisherman's chalet, the "rorbu". But the image of the simplicity of the "rorbu" does not only stem from its architecture and location at the waterfront. It is also because it is the carrier of the more than 1000 year tradition of the Lofoten fisheries. Fishers from all over Northern Norway and parts of West Coast north of Bergen migrated to Lofoten between New Year and Easter to participate in this massive fisheries. It is this capacity to receive thousands of fisher "visitors", developed through 1000 years, that in later years is transformed into today's even larger capacity to receive tourist "visitors".

Reine



Fishermen peak season/off-season
Tourists peak season/off-season
Long time guests
migrant labour like consultants, fish industry workers, carpenters

Reine



Upgraded and rent out to tourists

Original Rorbu for Fishermen

A harbour shack with sleeping, cloth washing and cooking facilities and fishery facilities.

Modern Rorbu for Tourists

Sanitary, infotainment and other technical amenities that modern living requires.



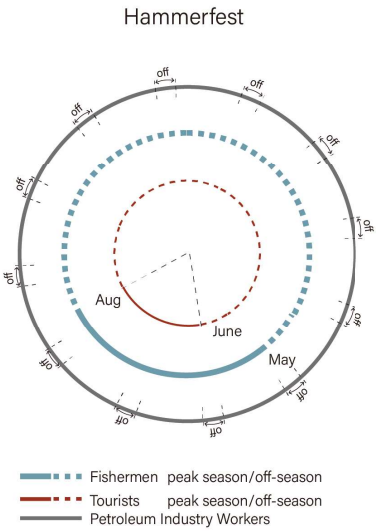
Storage space for drying nets and long-lines

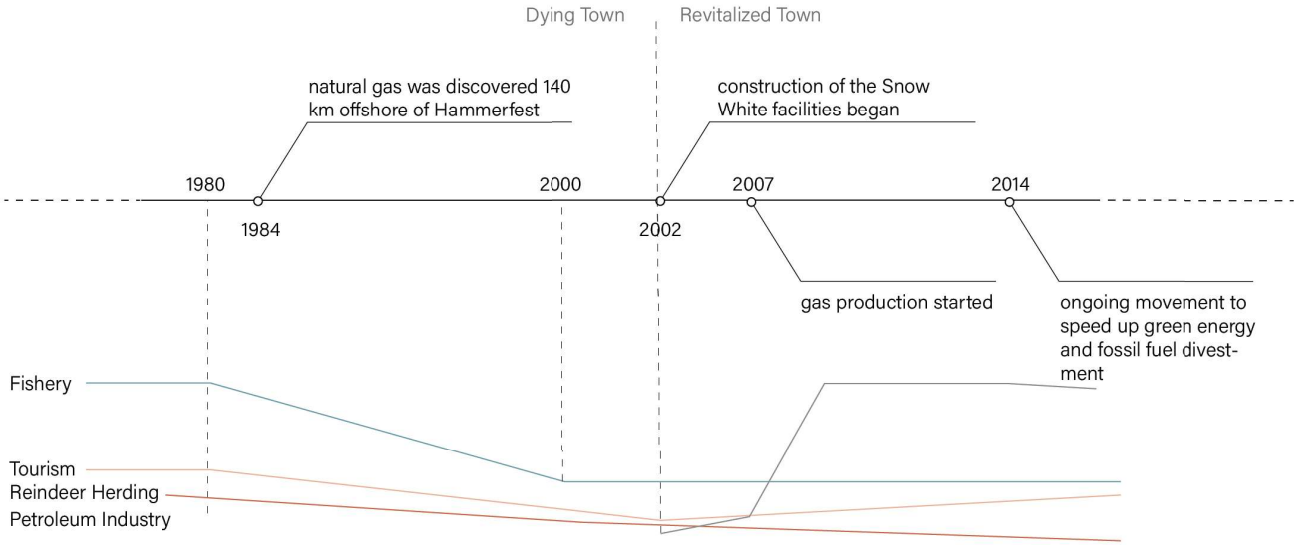
Leisure Space

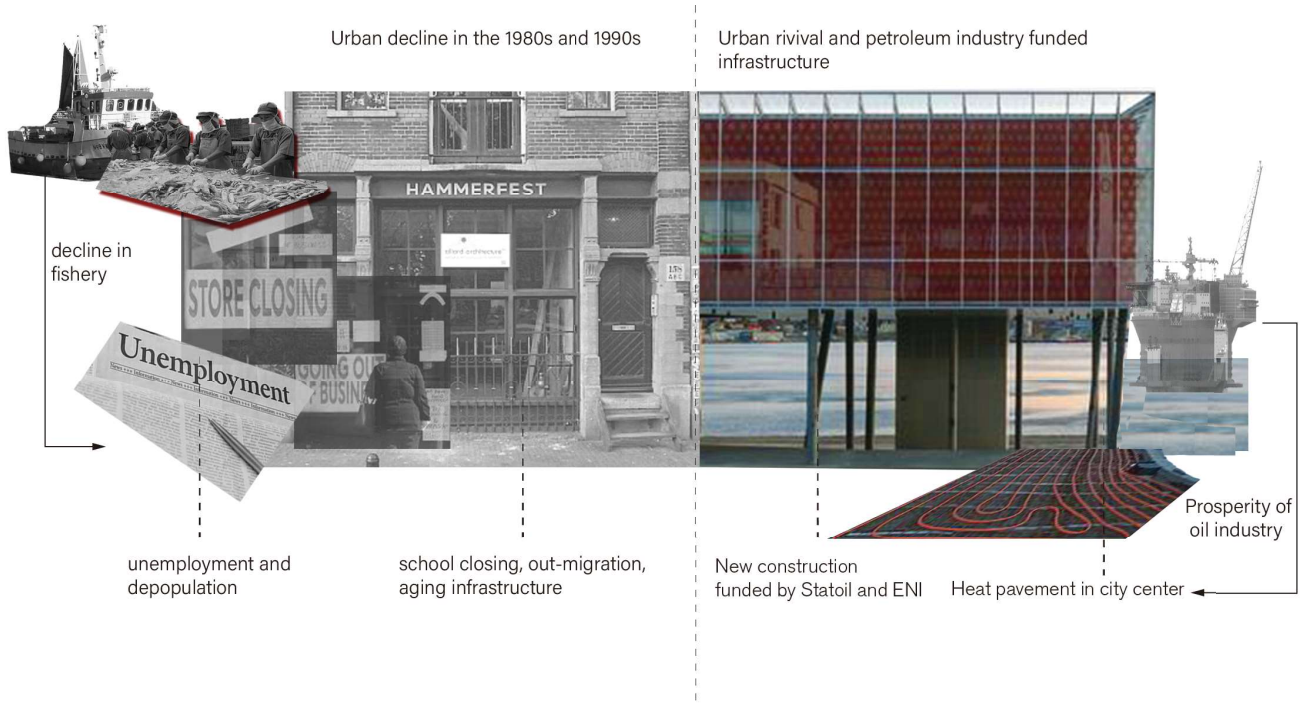
Seasonal occupancy for fishers and other employees is not affordable.

Hammerfest: Local Perceptions of Petroleum Developments

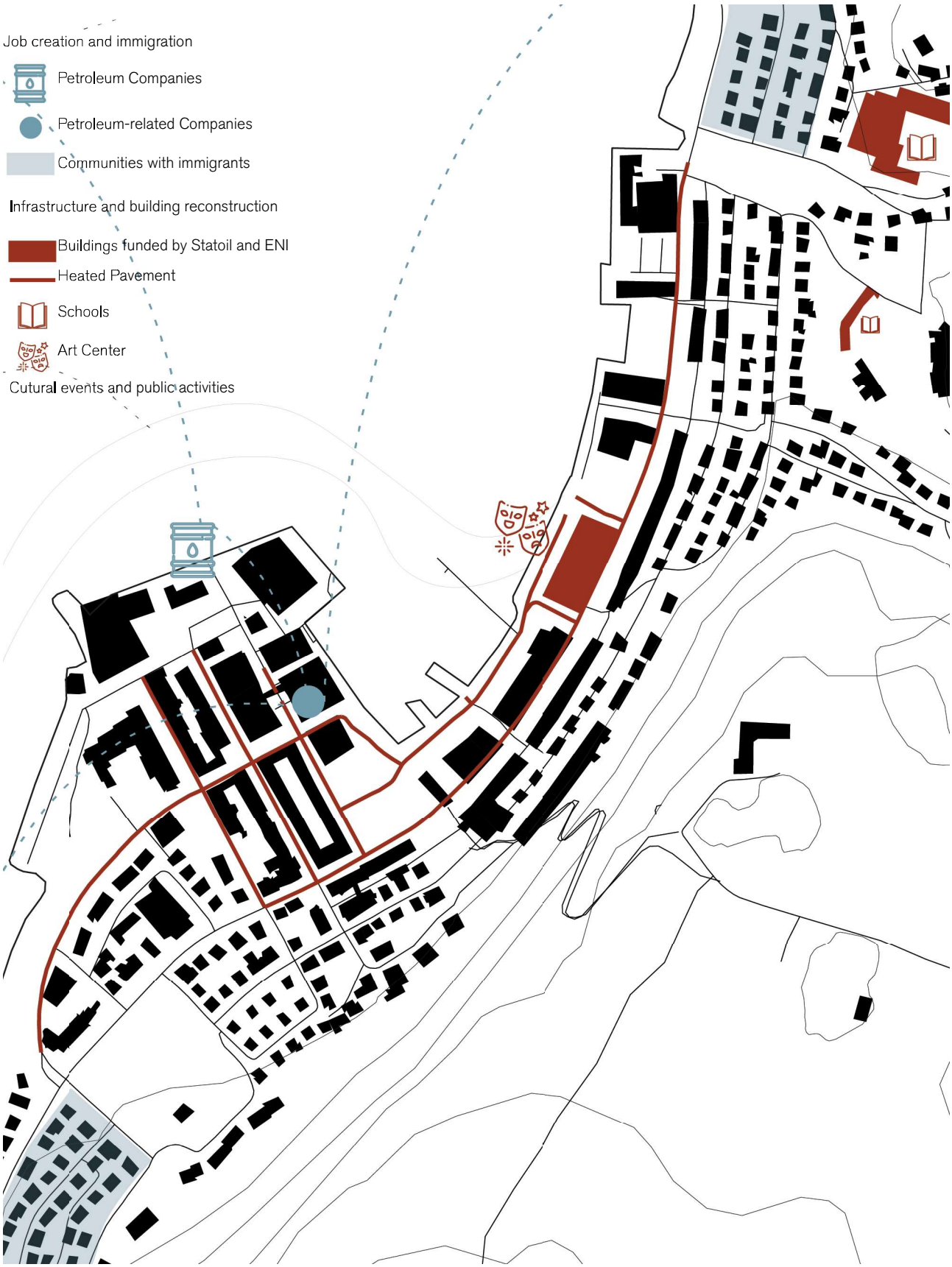
Hammerfest is a small town with approximately 10,500 inhabitants of which approximately 1200 work in the petroleum industry. Of them, 500 work directly with oil and gas, while other petroleum-related jobs, including the supplier industry, employ approximately 700 people.







Externalities of Petroleum Developments at Local Level



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Map: 1:5.000

3.4. Landscape

A critical view on the Norwegian landscape:

In order to understand the location of infrastructures and the built environment within their environmental setting, the landscape is key. The conditions, opportunities or threats posed by the surrounding landscape is defining in both historic settlement condition, as it is in the future of the areas. To be able to fully explain the relation between oceanic- and terrestrial territory and the built environment, three 'lenses' have been used.

The palimpsest lens on the landscape addresses the base principles of Lofoten and Hammerfest. The relation between landscape and settlement typology, territorial confinement, hydrology systems and local climate are explained through composition maps and mapped structures.

The lens of 'perception' on the landscape aims to provide a deeper understanding of the landscape, as it is not only a static environment in which settlements and processes can be placed, but a system of spaces and masses, defining spatial elements and orientation points. Infrastructural repetitive, continuous or linear elements, placed in relation to their natural surroundings. Next to fixed features, the most characteristic moving objects, in the cases of Lofoten and Hammerfest primarily ships, have been added to complete the scenery.

The last lens, on the extreme landscapes of Lofoten and Hammerfest, identifies them in detail, focusing on the largest natural hazard in both places. The physical and morphological processes leading to these disturbance events are explained. A technical perspective is used to be able to understand, explain and design with the unpredictable systems and complex structures that drive landscape change.

3.4.1. Palimpsest

The palimpsest view on the landscape addresses the base principles of Lofoten and Hammerfest. The relation between landscape and settlement typology, territorial confinement, hydrology systems and local climate are explained through composition maps and mapped structures. These visual representations have been combined with other visual means where possible, in order to provide a detailed and complete overview of the specific local components of the landscape.

3.4.2. Perception

The view of 'perception' on the landscape aims to provide a deeper understanding of the landscape, as it is not only a static environment in which settlements and processes can be placed, but rather a playing field of space and mass. Only through movement, the spatial features and sequences can be experienced, offering an insight in the behavioral patterns that have been created or have existed in the landscape. Characteristic spaces and masses, defining spatial elements and orientation points, are taken in careful consideration, adding tactile structural and systematic connections throughout the terrestrial and oceanic landscape.

The landscape does not only exist out of natural components, anthropogenic infrastructural elements can have a large influence on the perception of space. Repetitive, continuous or linear elements have been identified as 'spatially defining elements', and placed in relation to their natural surroundings. Next to fixed features, the most characteristic moving objects, in the cases of Lofoten and Hammerfest primarily ships, have been added to complete the scenery.

3.4.3. Extreme Landscape

The extreme landscapes of Lofoten and Hammerfest are identified in detail, focussing on the largest hazard in both places; rockfall and landslides. The physical and morphological processes leading to these disturbance events are explained. As there are no available sources on the actual soil conditions, layering of substrates and direct hazards, assumptions have been made based on knowledge from another TU Delft course, applied to photographic material of the sites.

After this, the conclusion on fragility and hazardeous environments is drawn by combining the most important identified features from the previous two chapters into conclusion maps.

3.4.1.

Palimpsest

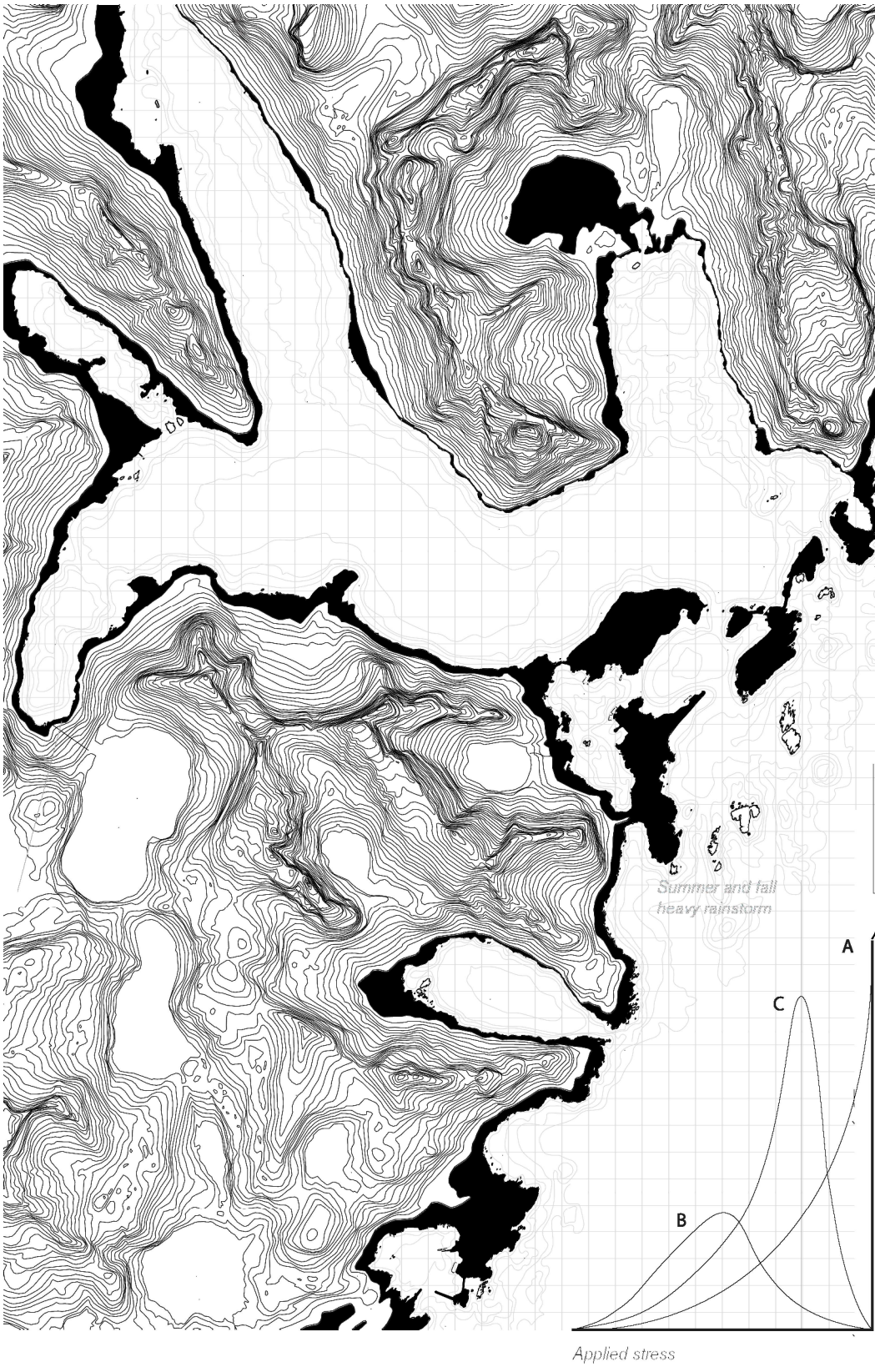
Landscape and settlement typology

Composition Map
Settlement conditions

The landscape of the Lofoten Islands is characterized by steep slopes, plunging into the fjords. Inhabitable space is only found on the border between terrestrial and oceanic territory. The original settlement typology relates directly to this unforgiving landscape, with houses built partially on poles on the colluvial shoreline. This ensures both an elevated flat platform to build on, and a direct accesspoint to the water.

The landscapes steep slopes are endangered by rockfall, caused by physical fractioning. The geomorphic 'work-done model' shows that most natural changes in the landscape take place when much stress is applied, during for example heavy spring- and fall storms, with a low frequency of occurrence.

- Inhabitable space
- Heightline
- Watersurface



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Map: 1:50.000 Section: 1:10.000

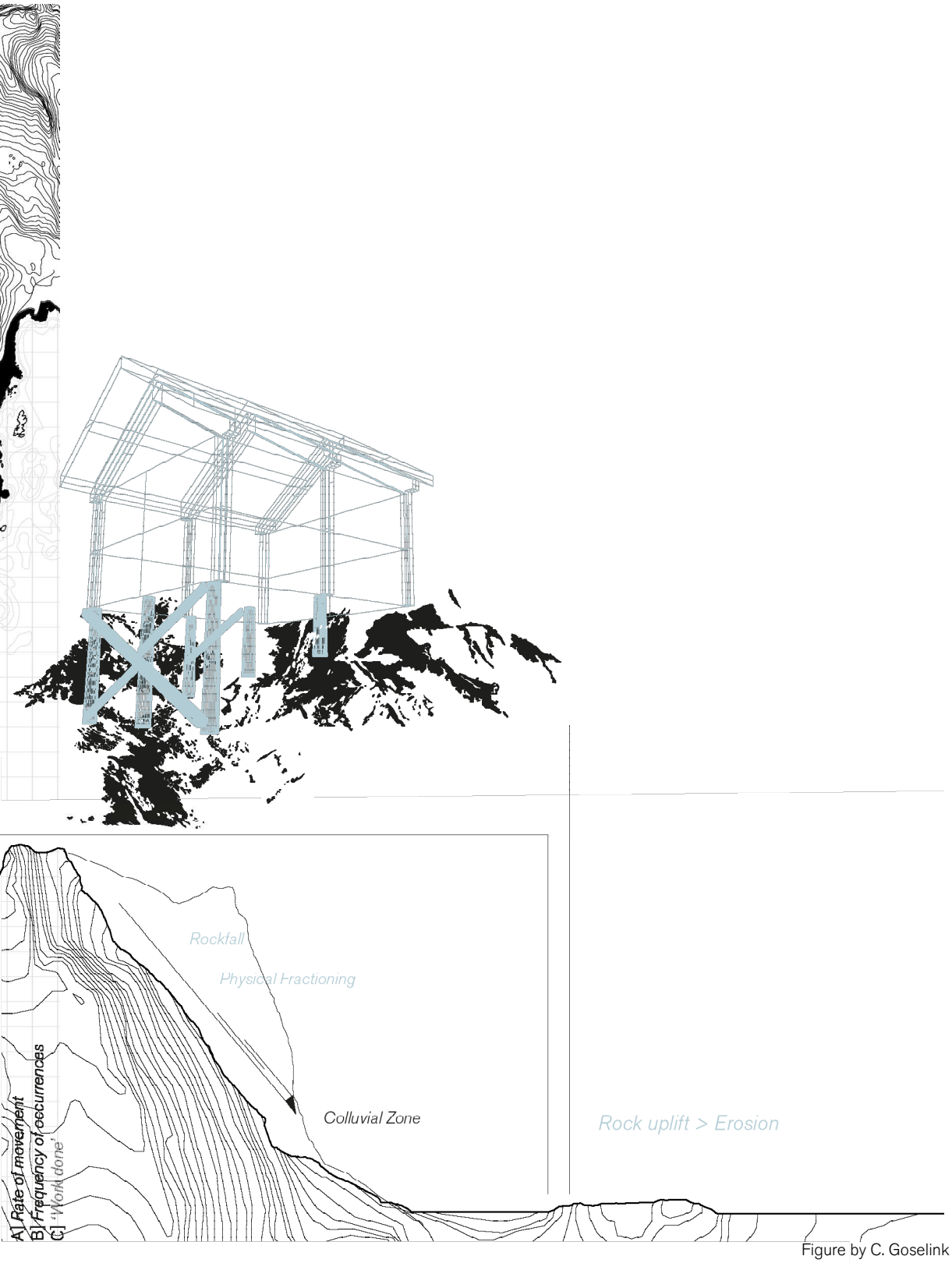


Figure by C. Goselink

3.4.1.

Palimpsest

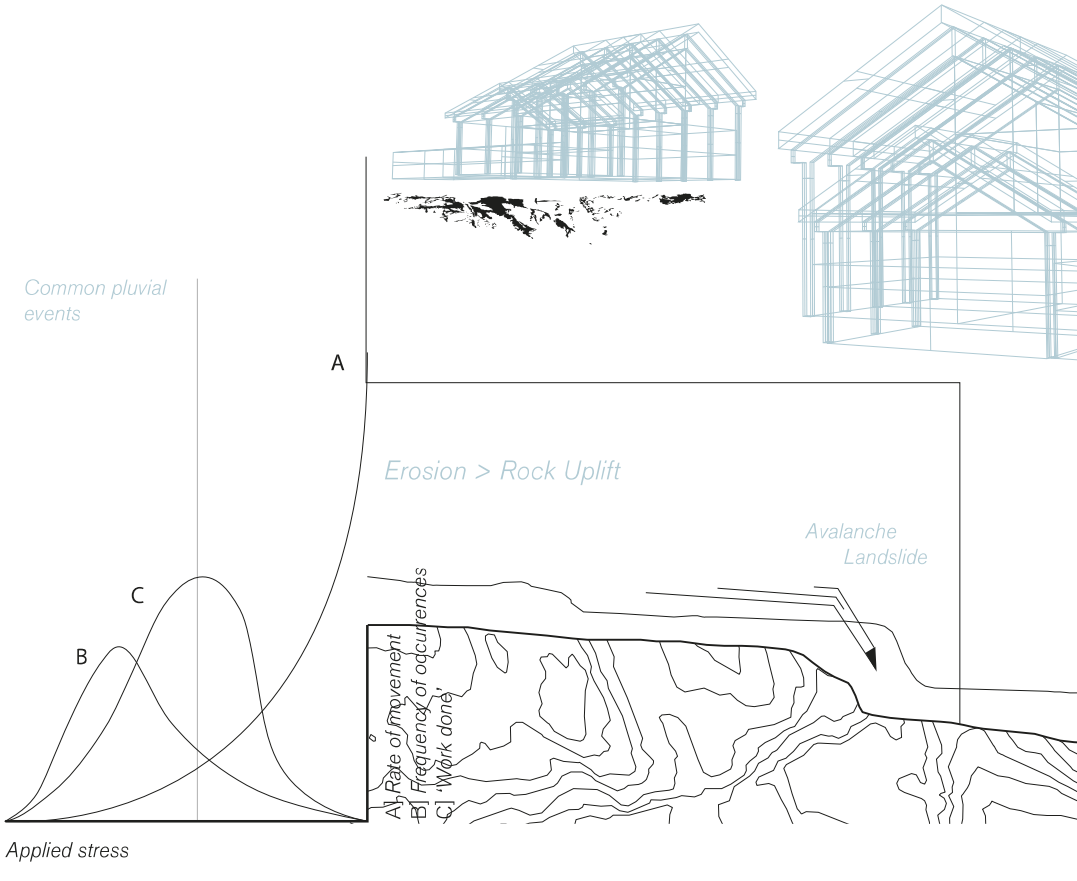
Landscape and settlement typology

Composition Map
Settlement conditions

The landscape of Hammerfest is characterized by eroded slopes and some rocky outcrops. Inhabitable space is mostly found on the shoreline, extending inland along sedimented flats. Settlements are built on terraces to overcome the height differences throughout the urban area.

As the landscape is already quite eroded, most danger to the settlements is posed by avalanches during spring, and landslide risk during summer and fall. The geomorphic 'work-done model' shows that most natural changes in the landscape happen during common pluvial events, when the surfaces are eroded and the sediment is carried downstream by ephemeral streams.

- Inhabitable space
- Heightline
- Watersurface



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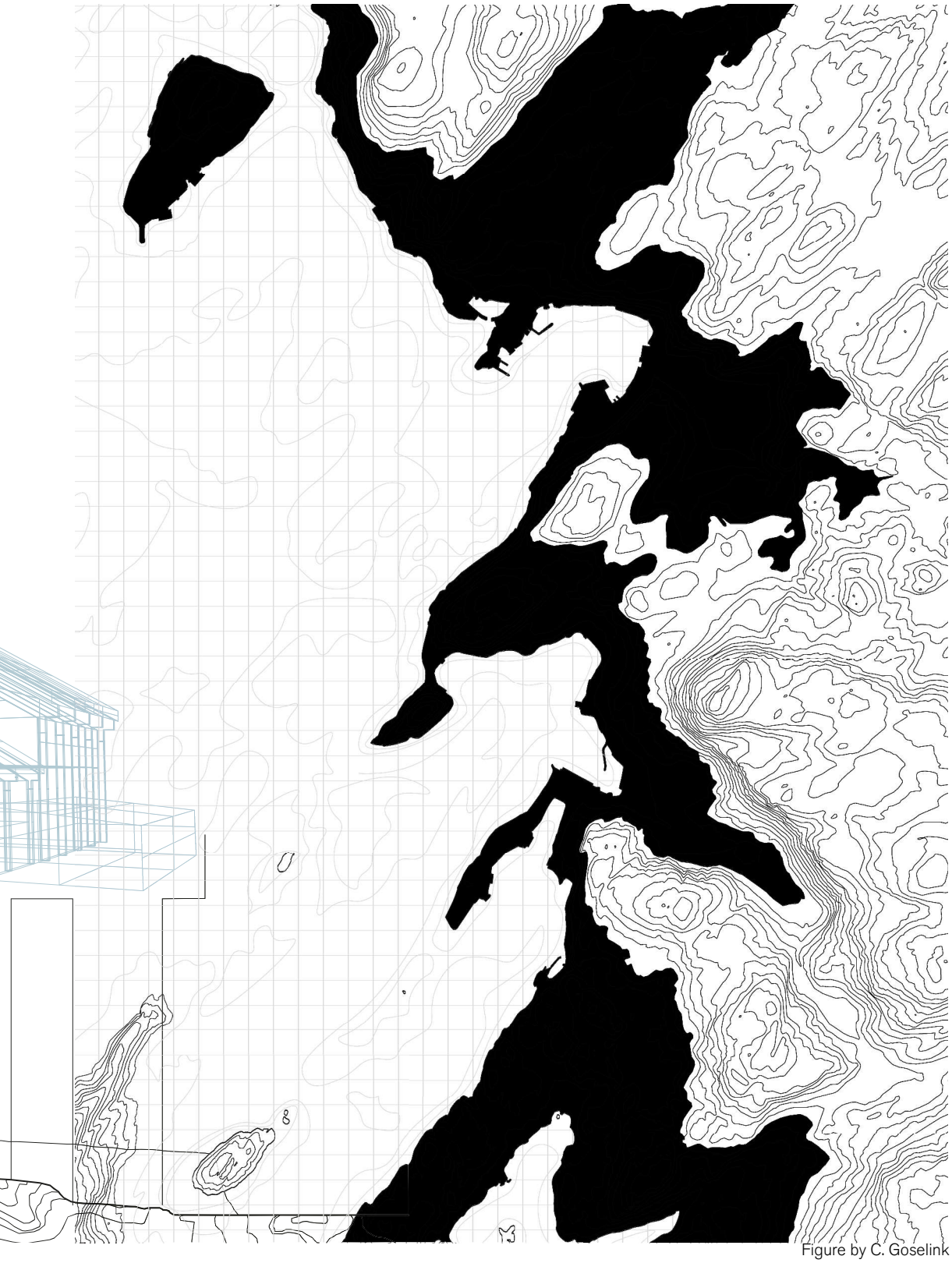


Figure by C. Goselink

3.4.1.

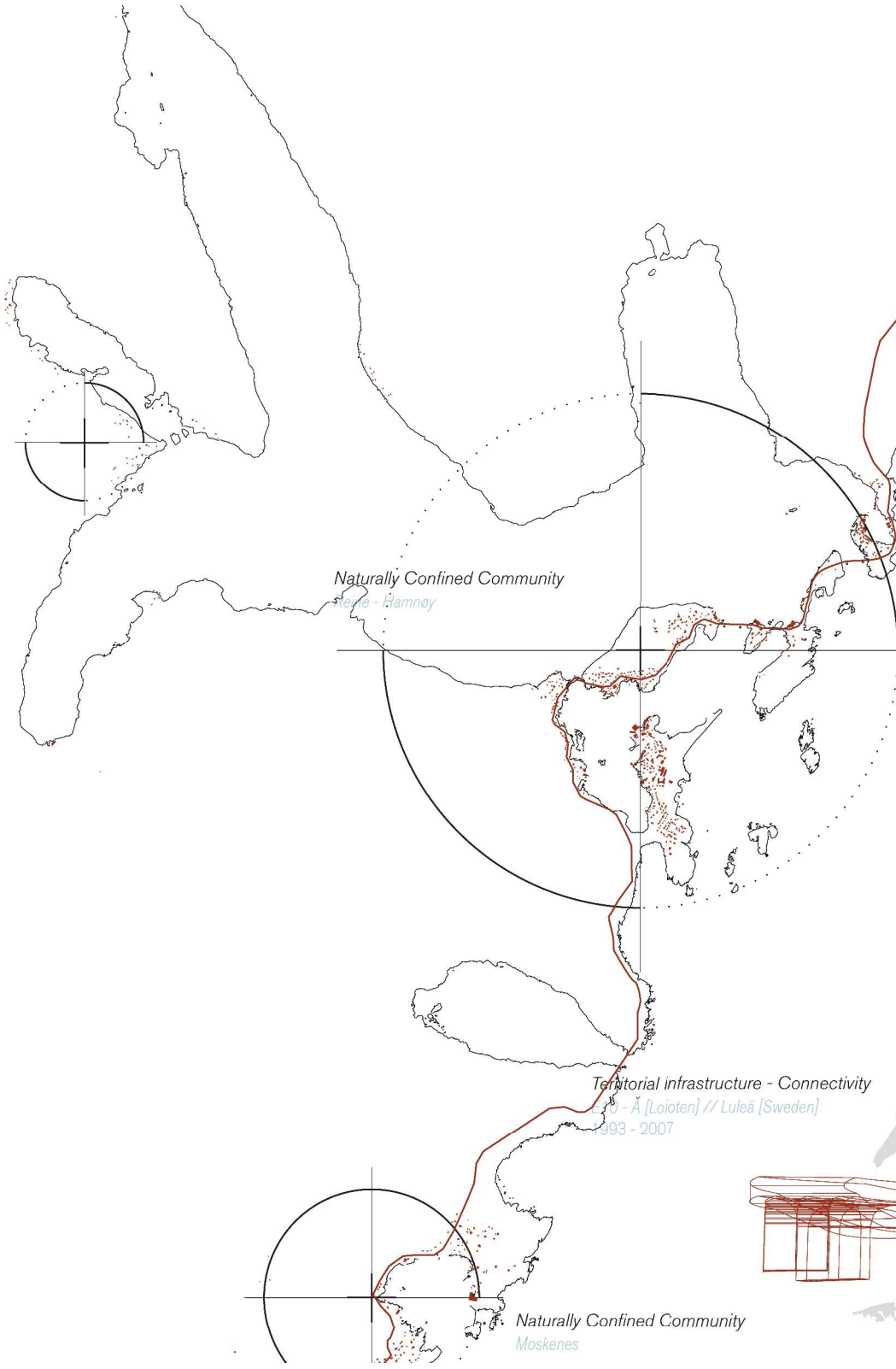
Palimpsest

Territorial confinement of settlement

Composition Map
Connecting infrastructure

As the landscape in Lofoten consists mostly of steep slopes, the urban areas are naturally confined. Originally, the only connection throughout the islands was the water, but recently the government has constructed a highway connecting Ä, at the southern most tip of the peninsula, to the mainland of Norway. This infrastructure now plays an important role in the daily connectivity throughout the area, pulling it away from the waterfront.

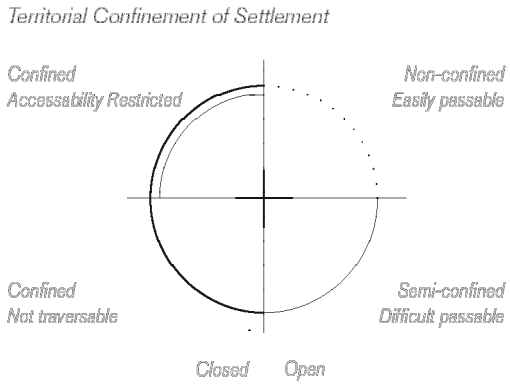
The E10 infrastructure consists of a series of bridges and tunnels, providing a diverse and scenic route for tourists.



Building
E10 Highway

N

Map: 1:50.000



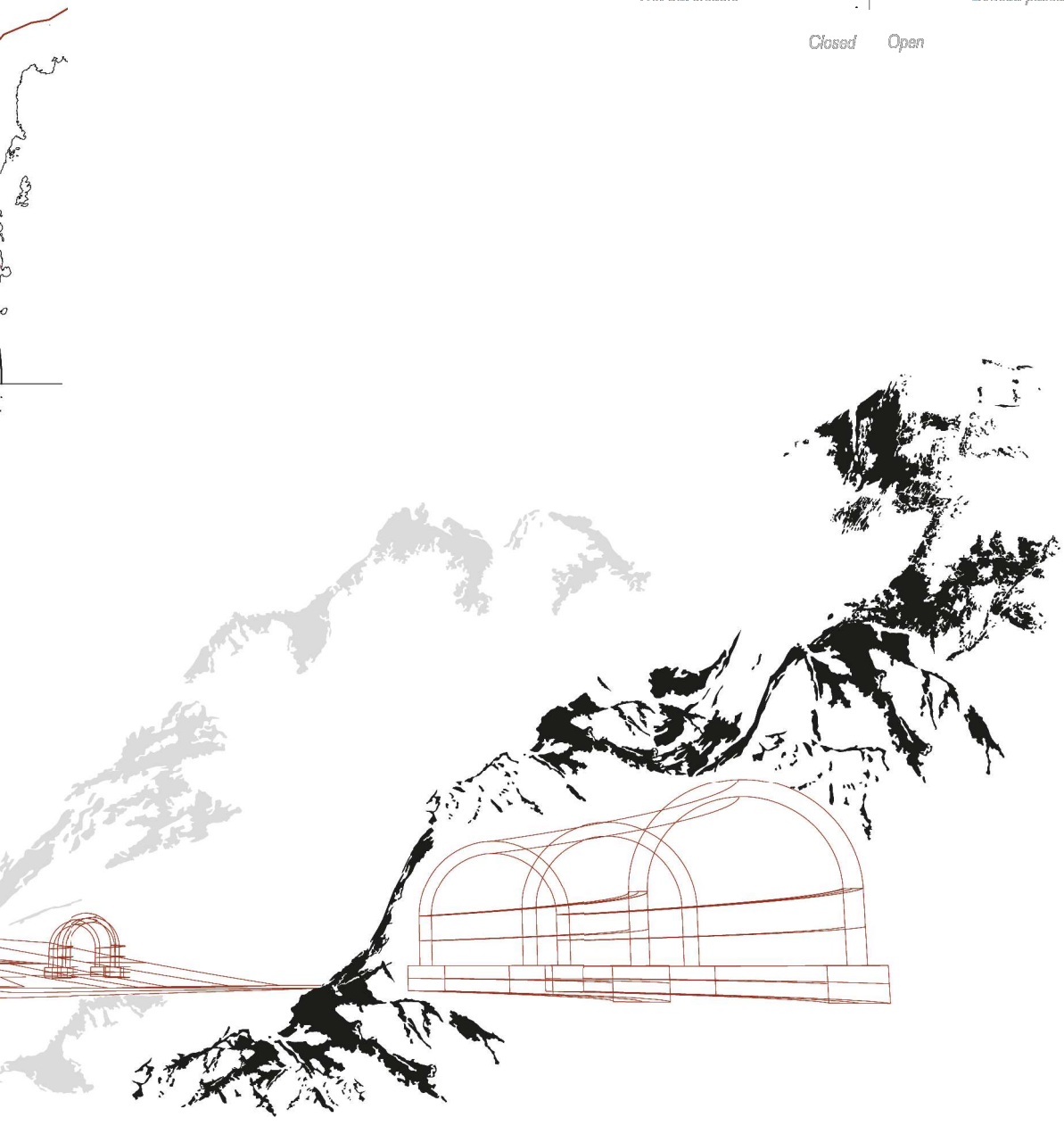
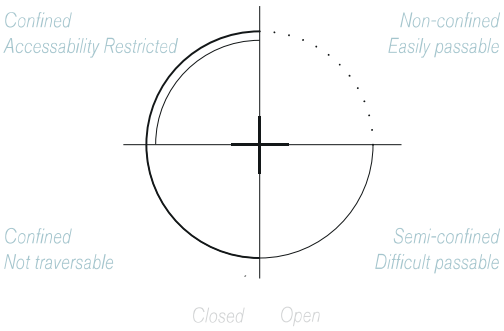


Figure by C. Goselink

Territorial Confinement of Settlement



3.4.1.

Palimpsest

Territorial confinement of settlement

Composition Map
Restricting infrastructure

The territory of Hammerfest has largely been focused on its maritime component, although the inland is (with some difficulty) passable. The territorial infrastructure here is not focused on connecting, but rather appropriation and restriction. The incoming oil and LNG industry, government owned Equinor AS, has placed boundaries on the landscape. Especially the harbor of Hammerfest has been restricted in its use, as a large part of the waters directly north and west of the port are prohibited from entry when LNG tankers are in the area.

On land, Equinor has appropriated a portion of the island as private territory, to house its workers in barracks and control entry of their private tunnel leading to the processing plant.

- Equinor AS private territory
- Submarine tunnel
- Shipping lane
- Submarine infrastructure



N

Map: 1:50.000 Section: 1:10.000

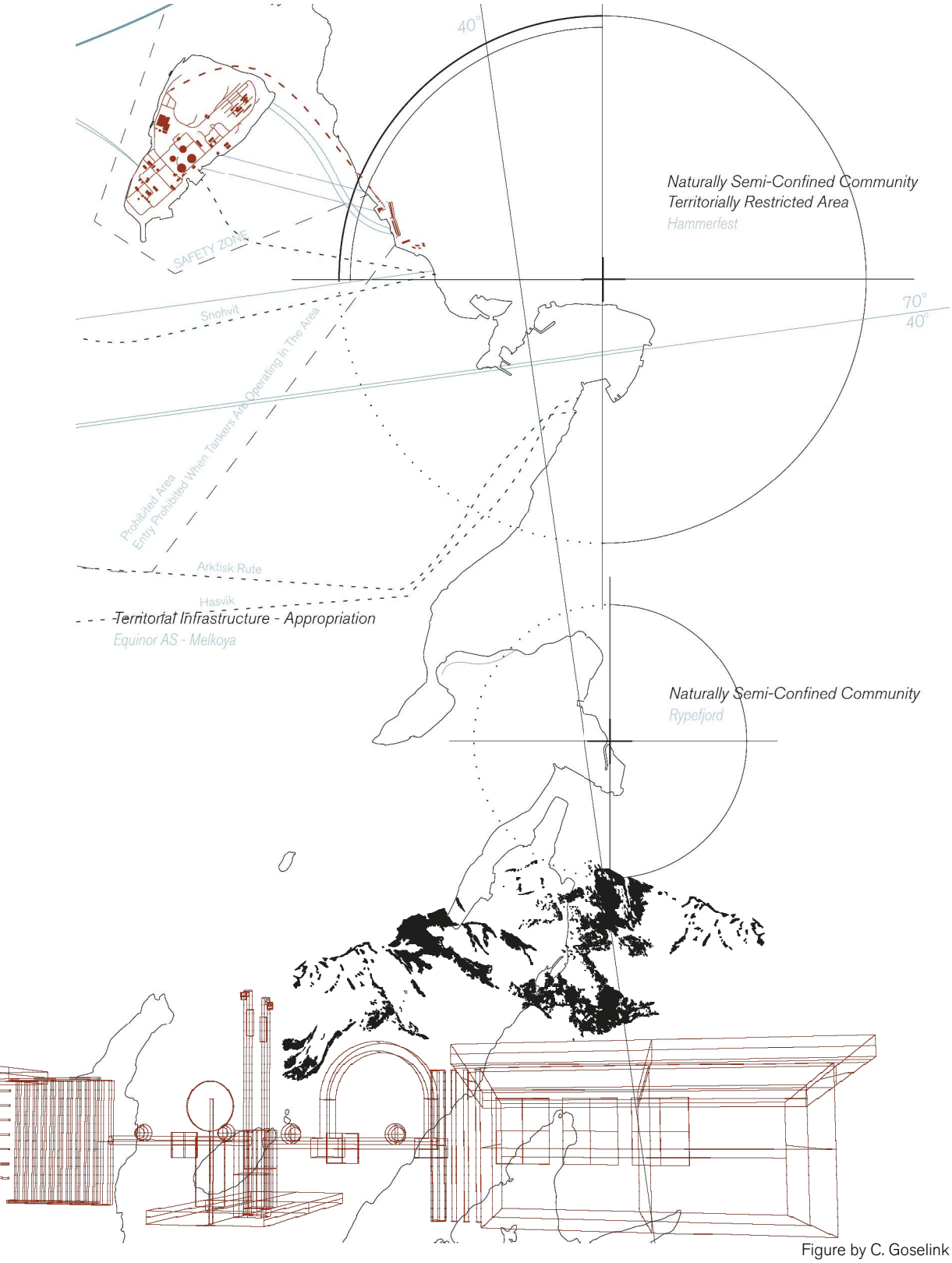


Figure by C. Goselink

3.4.1.

Palimpsest

Surface hydrology

Mapped structure
Hydro-spatial sequence

The hydrological system of Lofoten is defined by its mountain lakes, fed by snow melt and rain through ephemeral streams and falls. The system is hydrologically disconnected for large parts of the year.

The conceptual map on the right depicts the orientation and outline of the successive bodies of water, related to the height differences between them. Remarkable is the steepness of the landscape between the lakes, which can also be seen in the perspective drawing on the right.



N

Scheme: 1:50.000

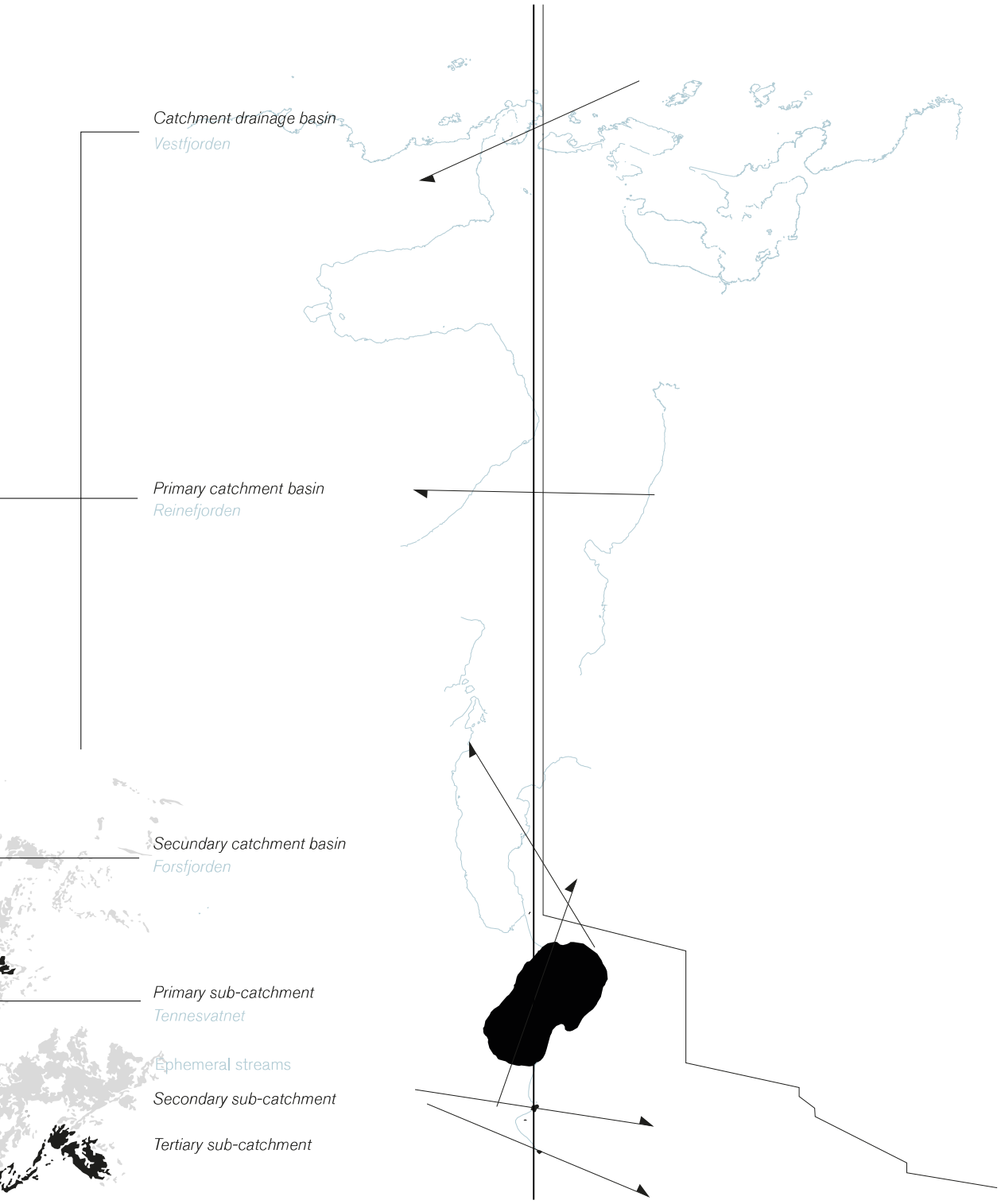


Figure by C. Goselink

3.4.1.

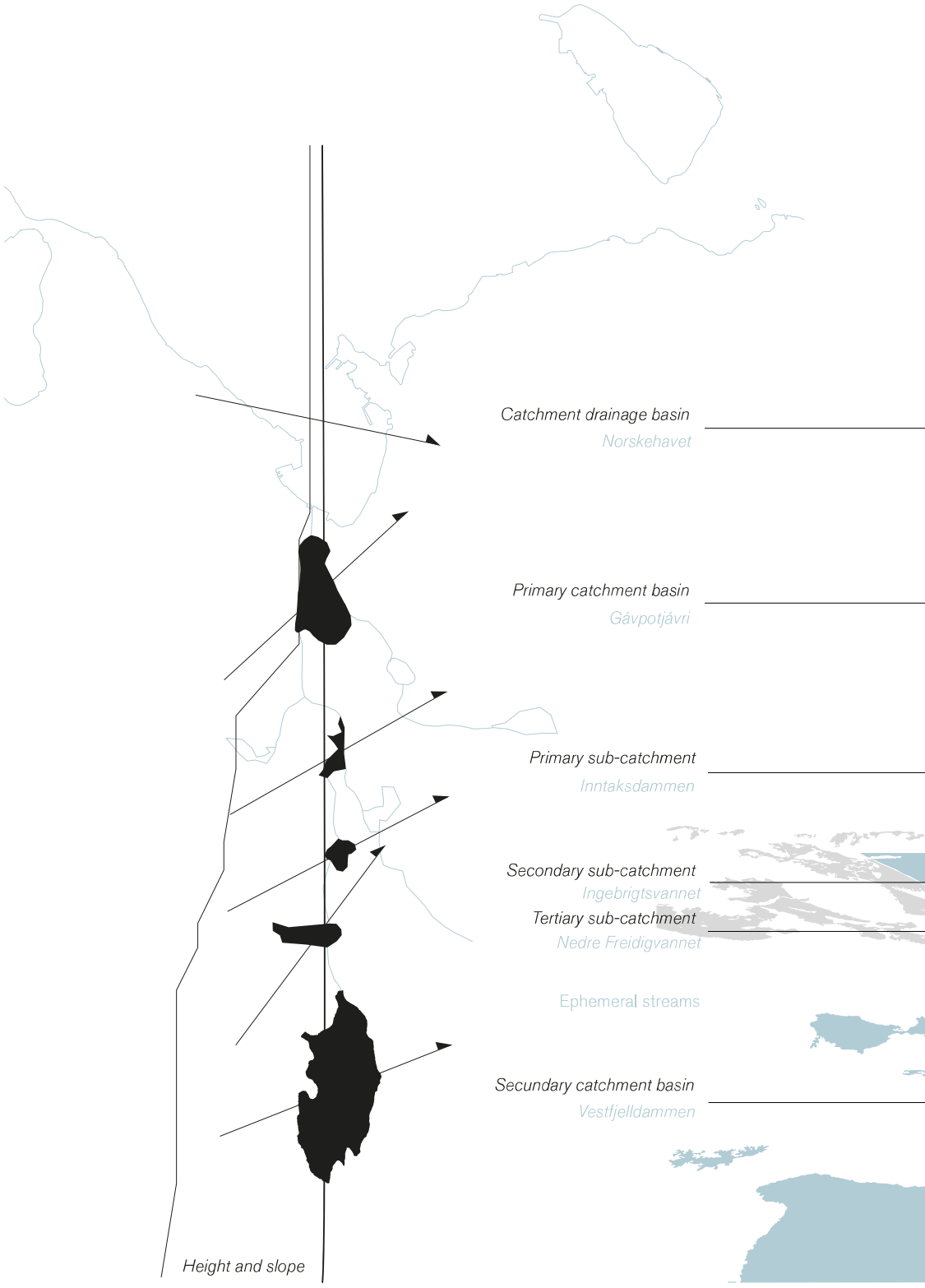
Palimpsest

Surface hydrology

Mapped structure
Hydro-spatial sequence

The hydrological system of Hammerfest consists mostly of lakes created by snow melt and rainwater, connected mainly by ephemeral streams. The landscape slopes down gradually, providing a spread of small lakes throughout the area.

The orientation of the lakes is roughly the same, indicating that the lowest parts of the landscape are possibly eroded faultlines, creating fairly straight successions of waterbodies.



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Scheme: 1:50.000

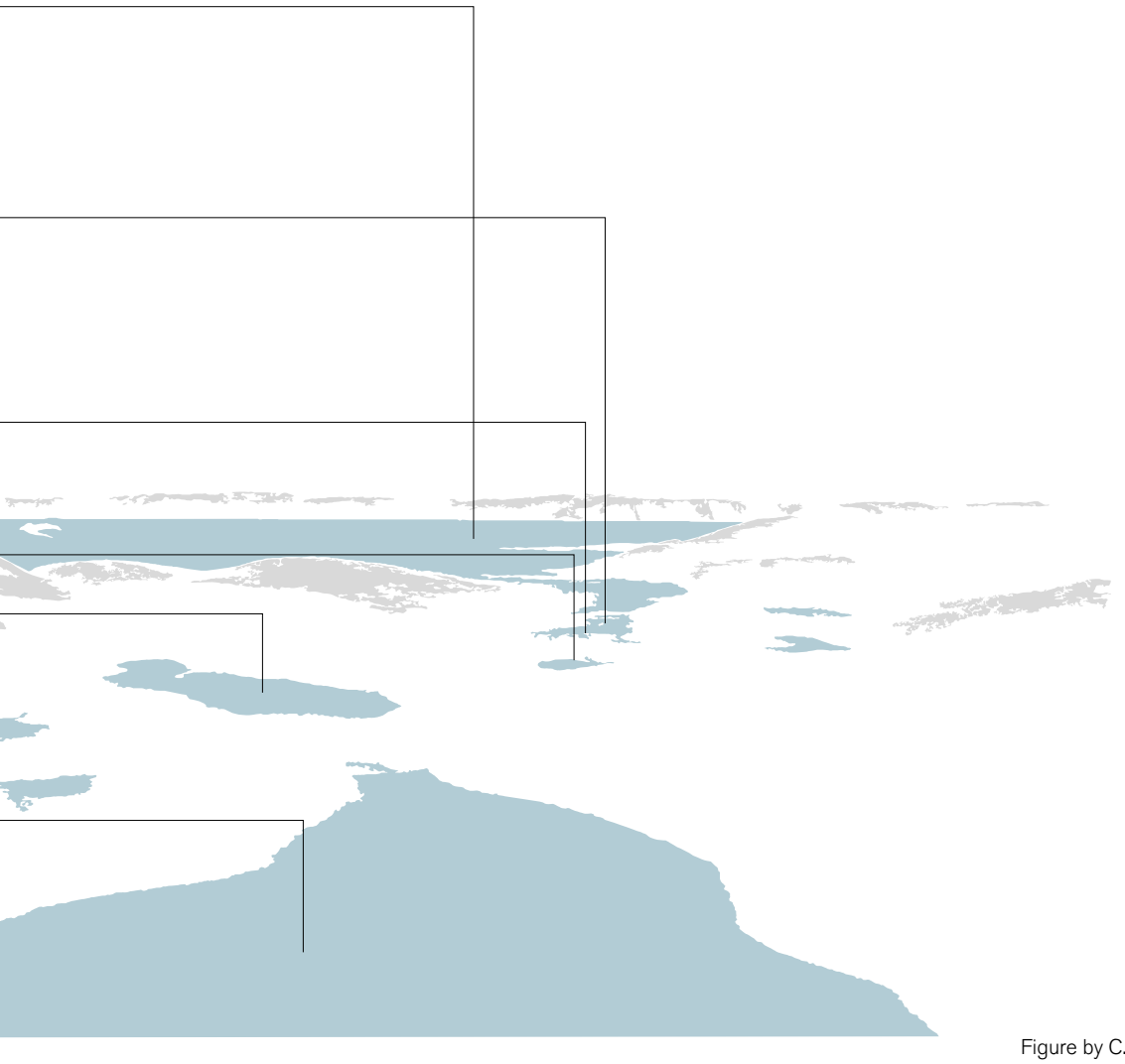


Figure by C. Goselink

3.4.1.

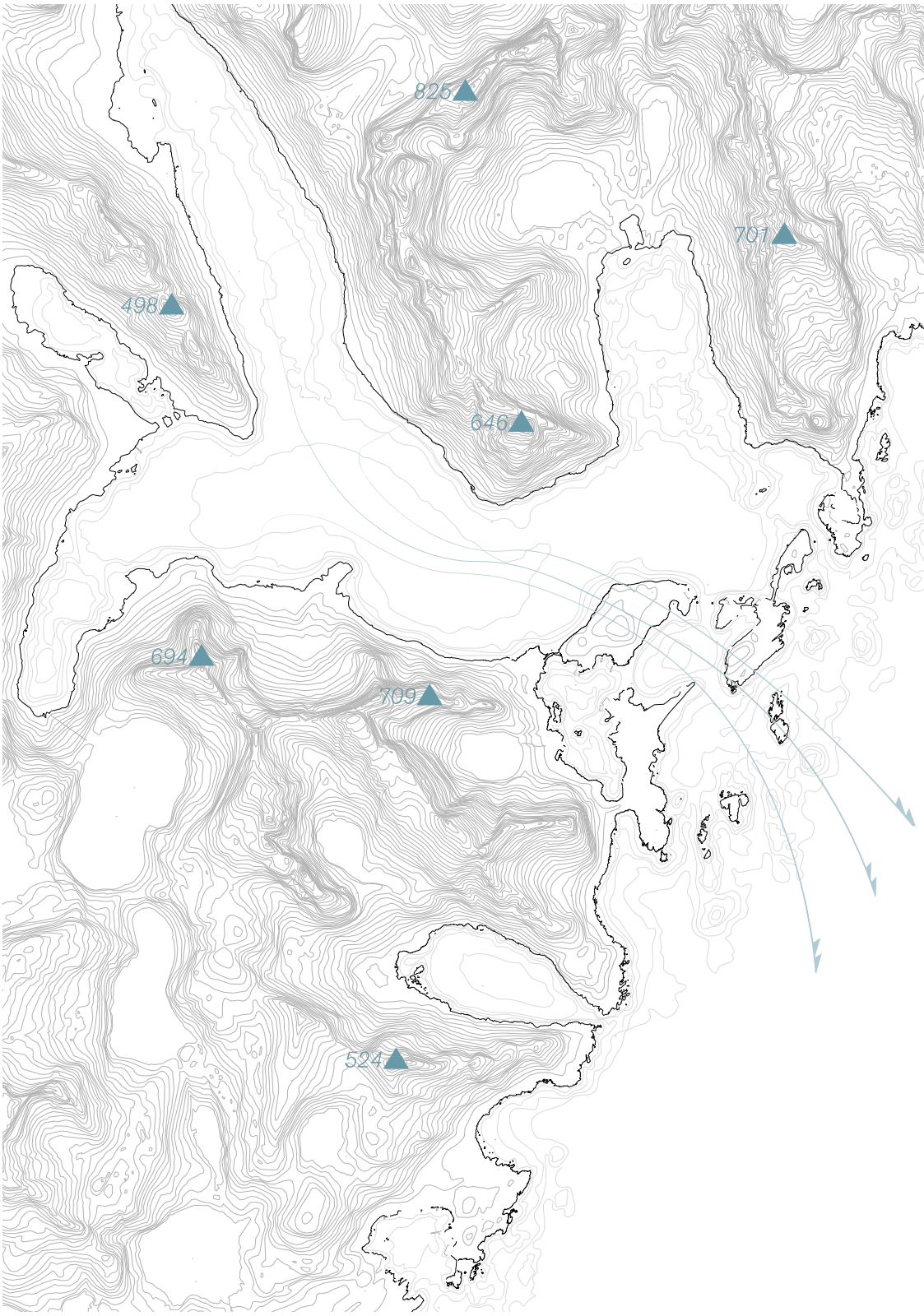
Palimpsest

Landscape and climate

Composition map
Geomorphic influence on local climate

The high peaks and steeps slopes of the Reinefjorden influence the local climate. Although the winds mostly come from either the SW or the ESE, the local weather conditions differ from this. Due to the geomorphological conditions of the site, the falling winds blow strongly and almost constantly out of the fjord.

The falling and turbulant winds also cause frequent heavy swells and rough water inside the fjord, making it hard to navigate. The rocky inlet is only navigationable with detailed local knowledge



▲ Summit
Wind

N

Map: 1:50.000

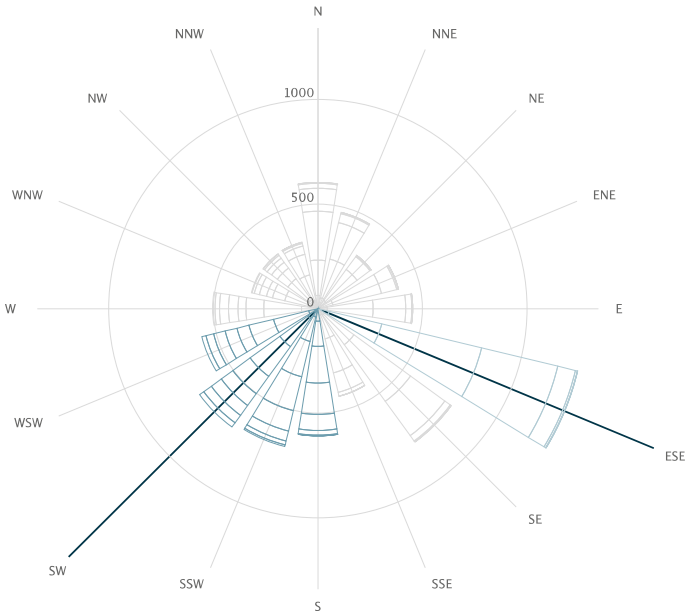
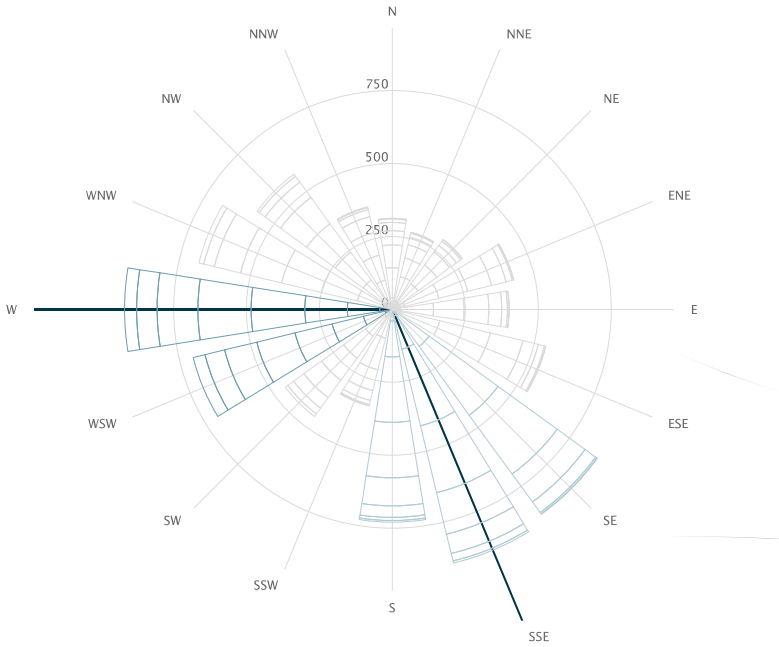


Figure by C. Goselink



3.4.1.

Palimpsest

Landscape and climate

Composition map
Geomorphic influence on local climate

The winds in Hammerfest, blowing in from the W and SSW, are funneled through the landscape. The location of Hammerfest a small bay, leads to possible danger of storm surges. The water flowing in from the south is susceptible for being pushed into the bay by strong western winds.

▲ Summit
Wind

N

Map: 1:50.000

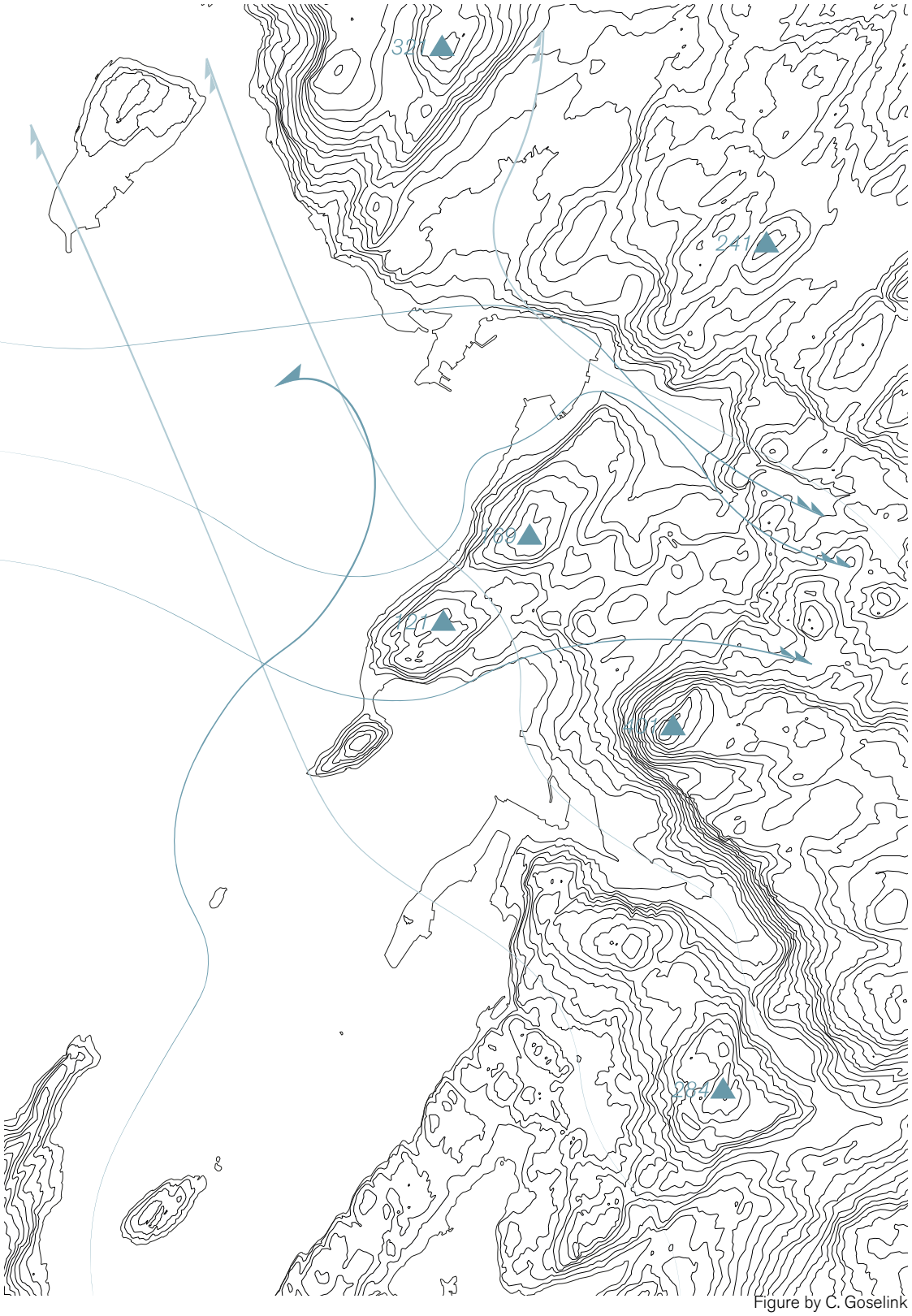


Figure by C. Goselink

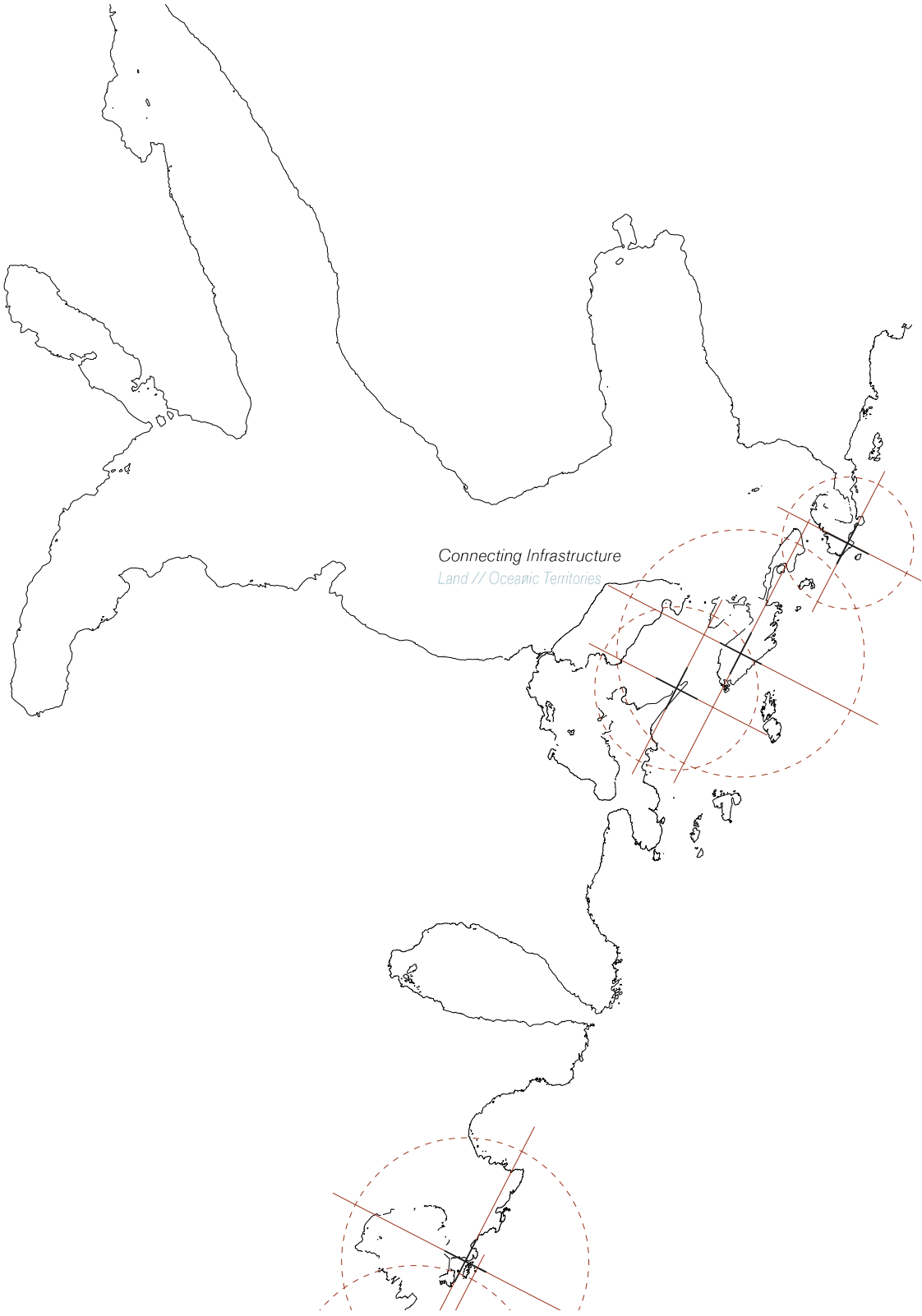
3.4.2.

Perception

Landscape and settlement typology

Components map
Repetative elements

Within the steep mountainous territory of the Lofoten Islands, the fjord inlets are marked by vertical linear components, supplying both an orientation point for vessels coming in, and connecting the islands to the mainland with internet, radio and television signals. Although no two components are exactly the same, they combine into a repetitive set of spatial features.



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Map: 1:25.000

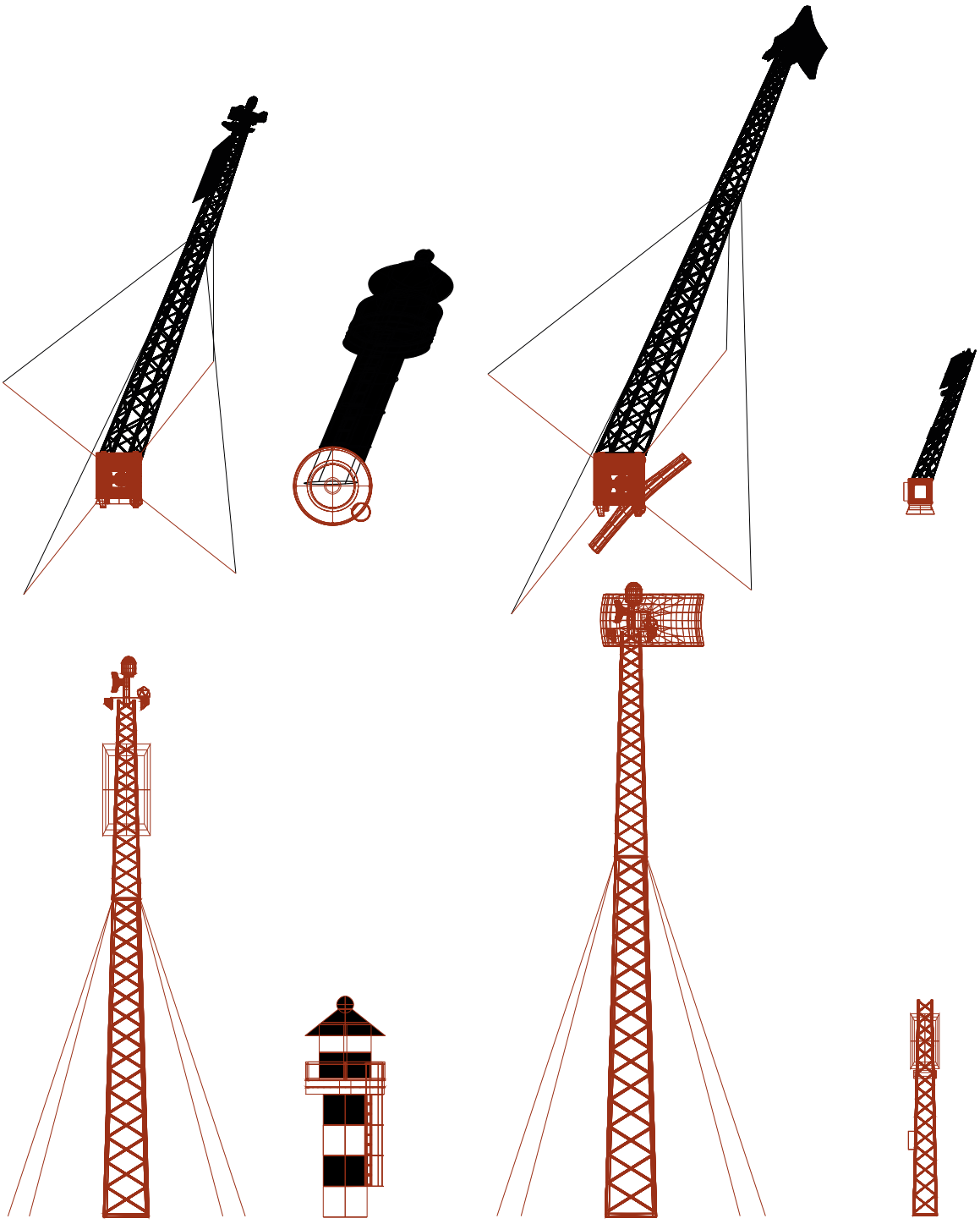

Figure by C. Goselink

3.4.2.

Perception

Landscape and settlement typology

Composition Map
Continuous elements

The flattened landscape surrounding Hammerfest is marked by the linear elements of the power lines, crossing the natural scenery over large distances. The power lines are constructed towards the inland, as the area is more flat here, and therefore it poses less risk of landslides and avalanches which could destroy the infrastructure. The elements are visible throughout the area.

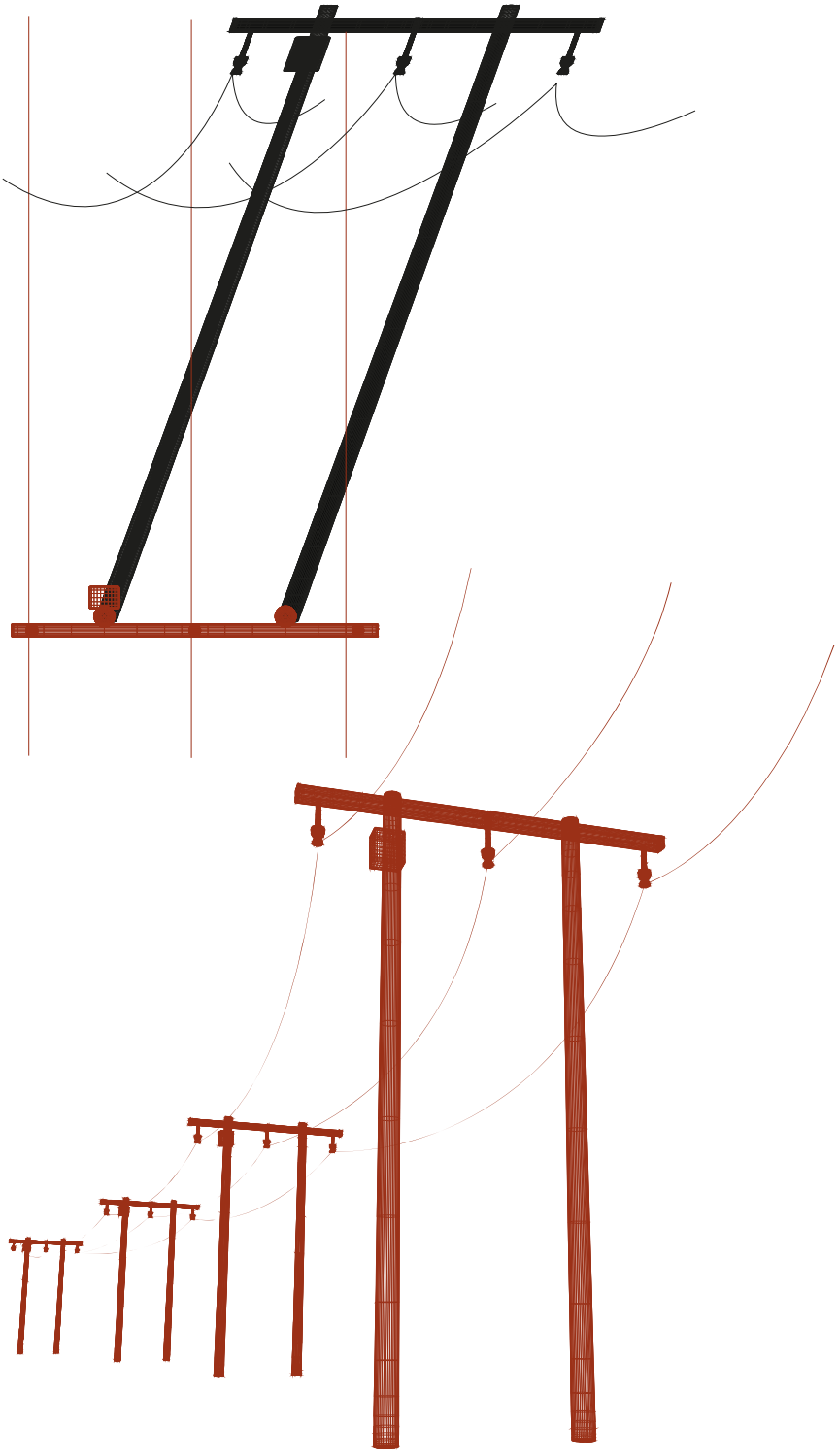

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Figure by C. Goselink

3.4.2.

Perception

Landscape and settlement typology

Mapped structure
View and orientation

The scenic route offers a constantly changing perspective on the surrounding landscape, in which most of the elements and geographical features are visible. The road offers a clear and layered overview of the surroundings, offering a scenic succession of viewpoints on various heights.

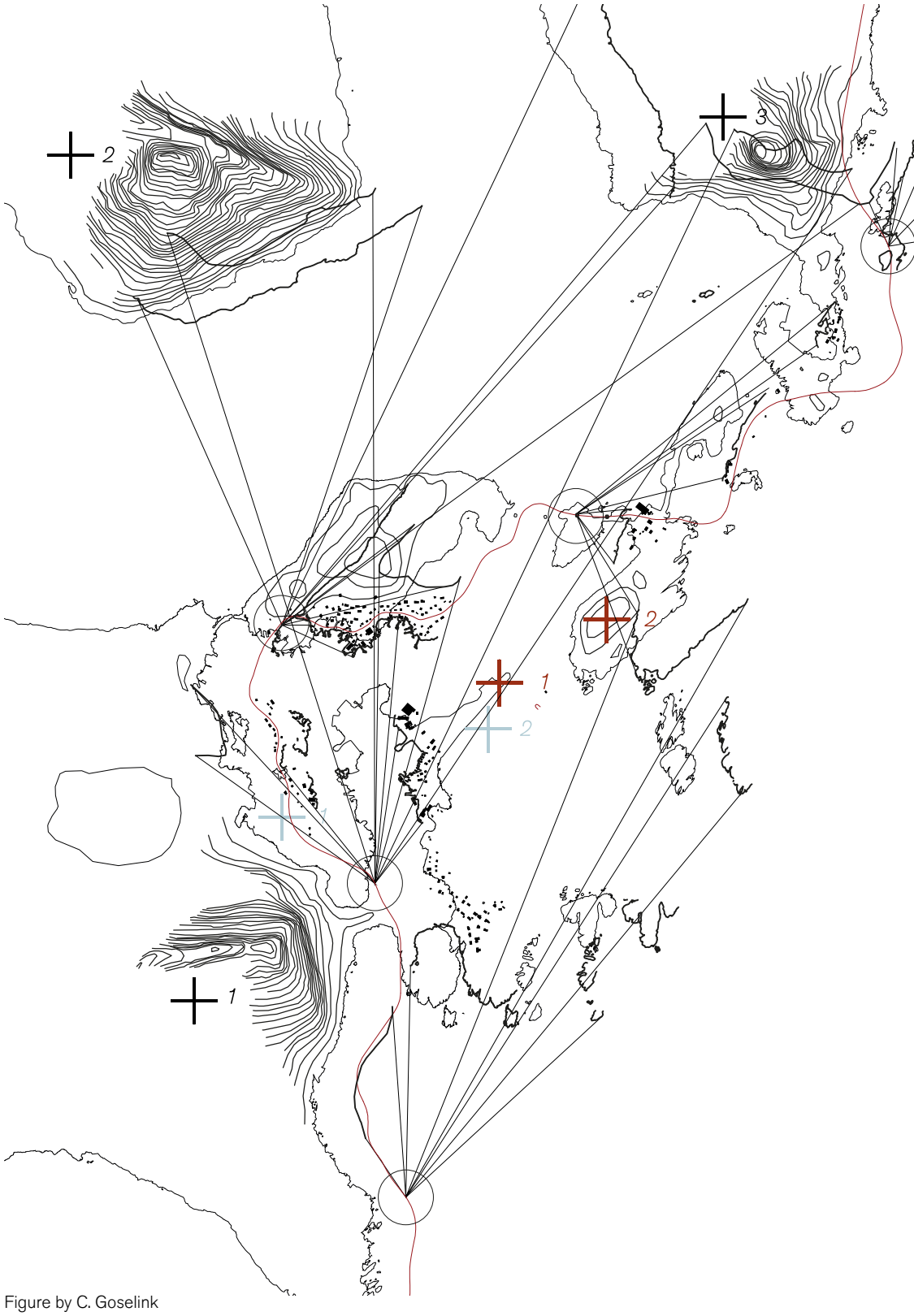
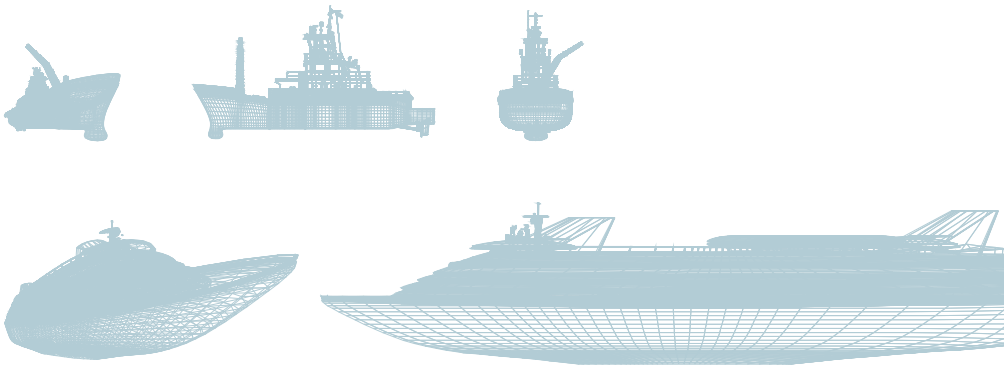


Figure by C. Goselink

Landmass
Infrastructure
Vessel

Map: 1:25.000





3.4.2.

Perception

Landscape and settlement typology

Defining elements
Nature and infrastructure

The steep and rigid mountain scenery is defining and visually confining the settlement area. Two infrastructural elements point out the inlet of the Reinefjorden, large vessels included serve commercial fishing and tourism, both temporal.



Landmass
Infrastructure
Vessel

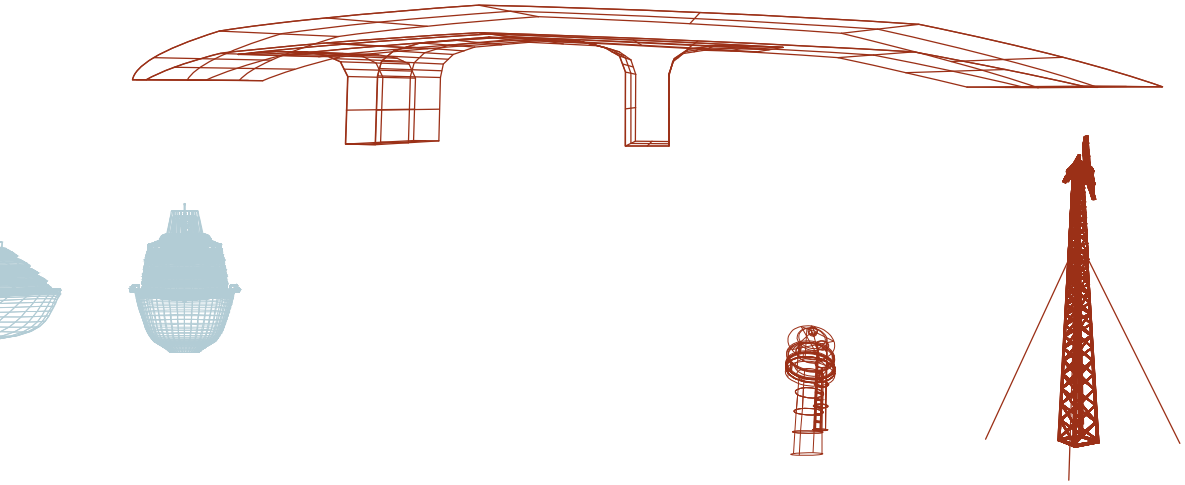


Figure by C. Goselink

3.4.2.

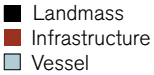
Perception

Landscape and settlement typology

Mapped structure
View and orientation

Views are sparse and far between, without providing a clear overview of the surrounding landscape. In winter, when the snow from the road is pushed up onto the banks, the views are even less. The construction and location of the road is purely practical.

In contrast to the quite local scale of the views, the most defining elements are located at large distances, and are of large scales.





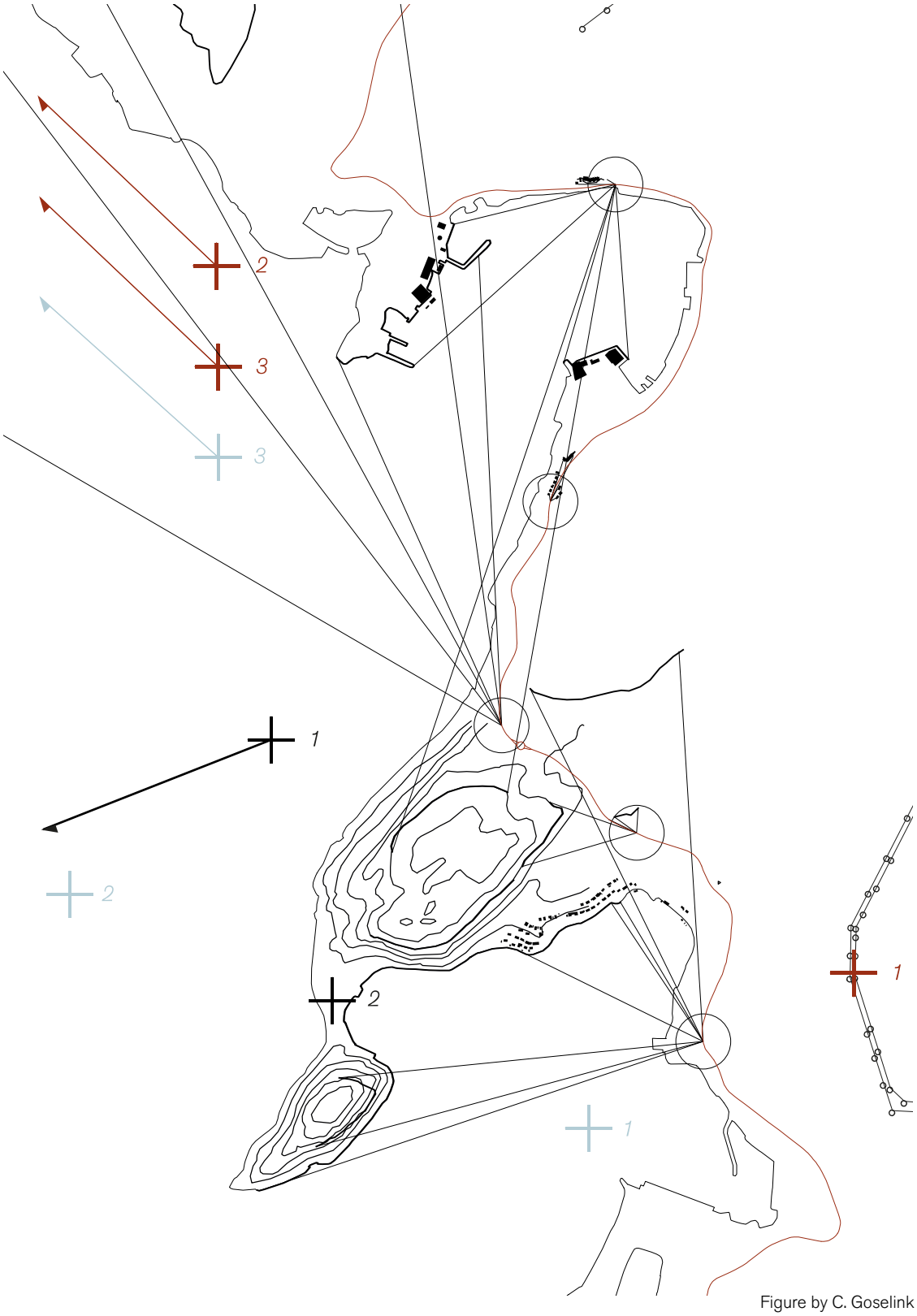
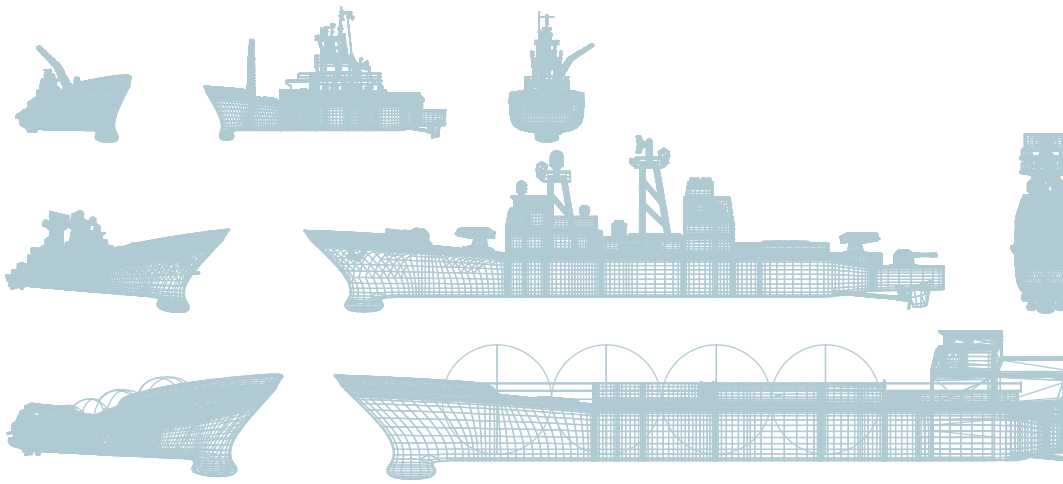


Figure by C. Goselink



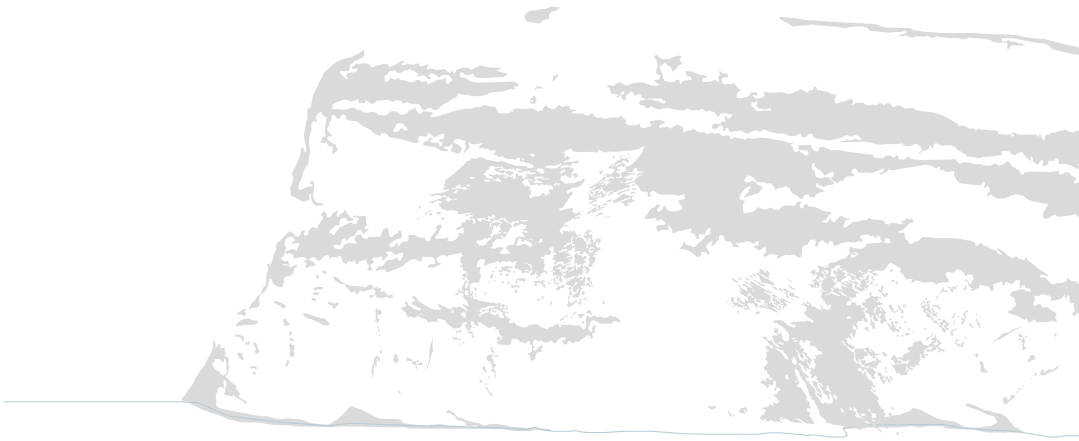
3.4.2.

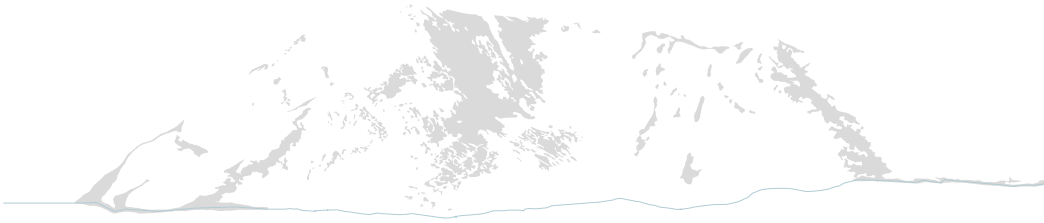
Perception

Landscape and settlement typology

Defining elements
Nature and infrastructure

As the mountainous landscape has flattened and eroded over time, the horizontal lines of the geomorphic surroundings make for a wide landscape, in which the large infrastructural elements and two scene defining landmasses influence their surroundings on a larger scale. Vessels that often (if not continuously) define the scenery, serve commercial fishing, LNG transport and the Norwegian Royal Navy.





Landmass
Infrastructure
Vessel

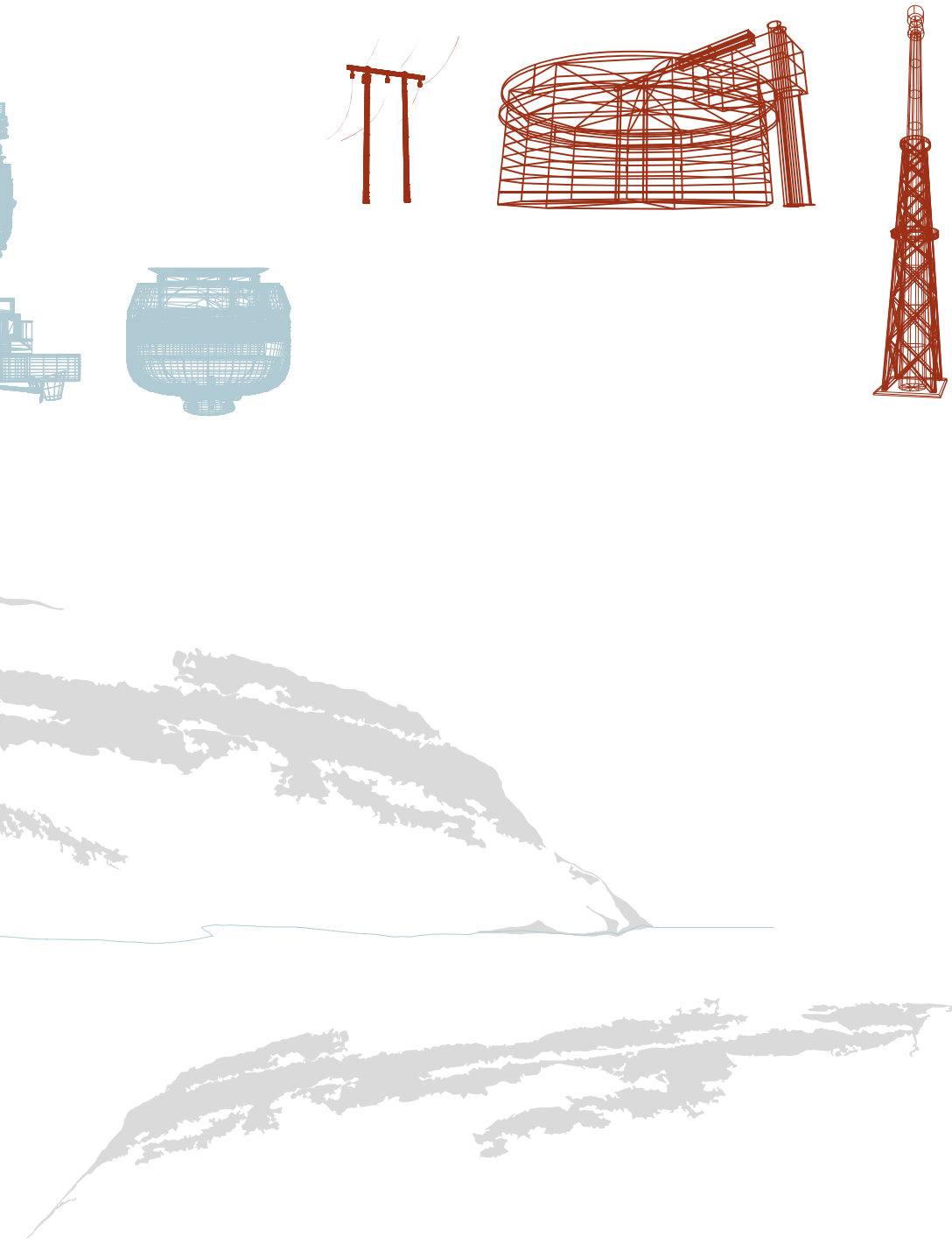


Figure by C. Goselink

3.4.3.

Extreme Landscape

Geomorphic Threats

Mapped structure
Local conditions

Rockfall endangers the coastal coastal zones of the Lofoten Islands. The connecting infrastructure (E10) is under constant threat, as are some houses built on the shorelines. However, most built environment is located at the small islands littering the inlet to Reinefjorden, and are therefore safe. The process of physical fractioning, during which water seeps into small cracks in the exposed bedrock, freezes up due to the cold climate and then pushes out parts of the rockface, is shown in the sections.

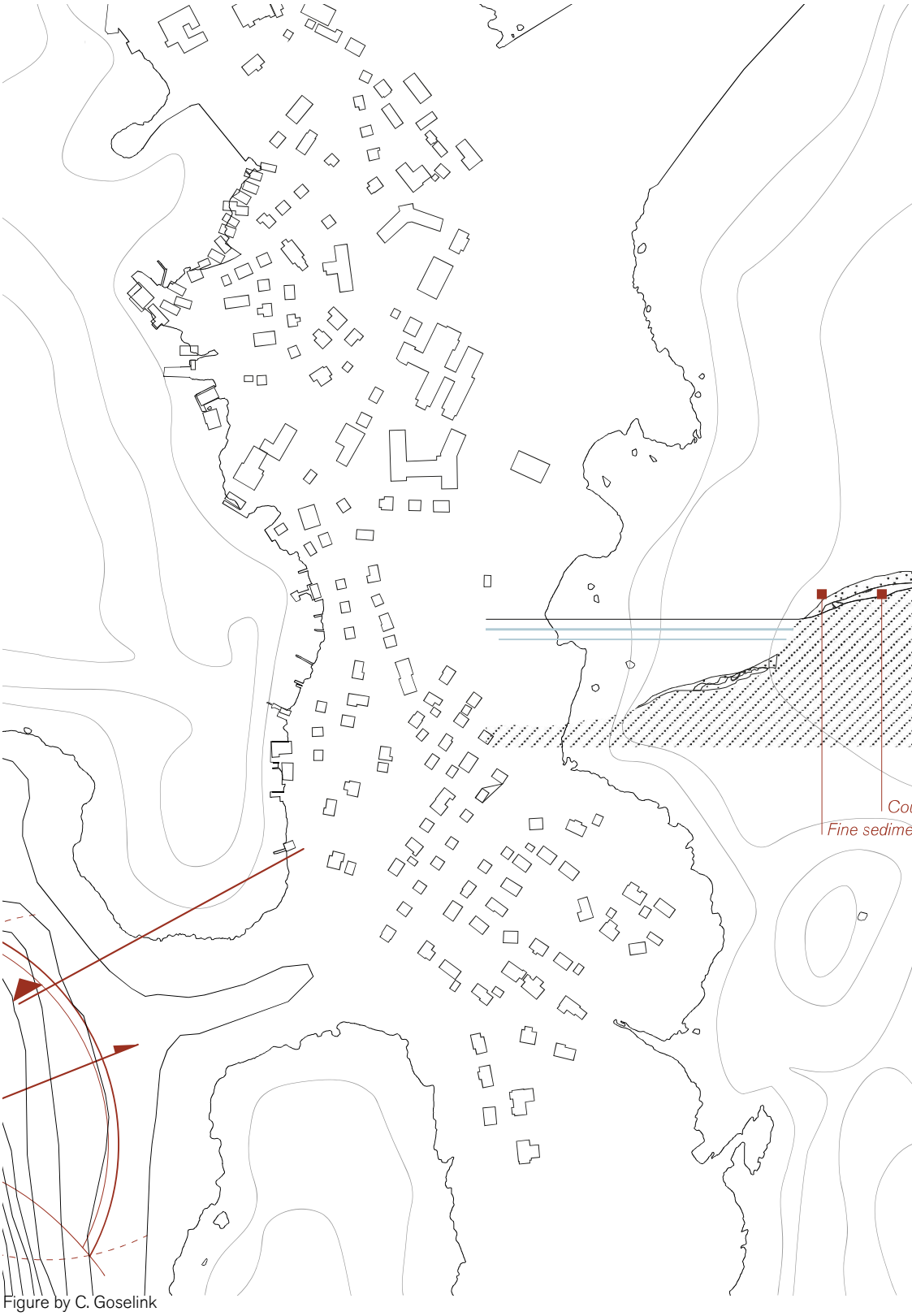
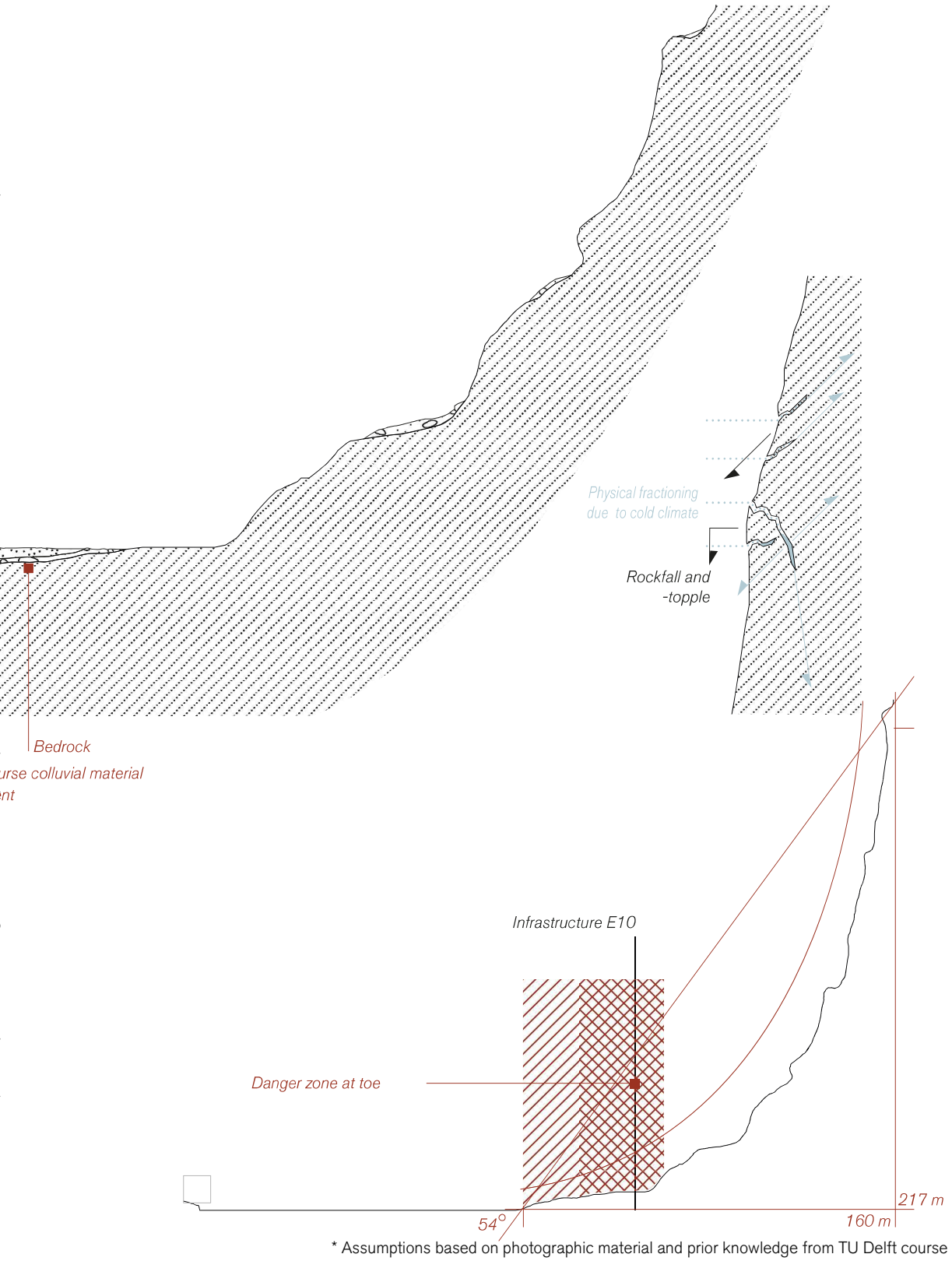


Figure by C. Goselink

N

Map: 1:5.000 Section: 1.2.5000 Detail: 1:1.000



* Assumptions based on photographic material and prior knowledge from TU Delft course CIE5581: Ecology and Morphodynamics in Catchments (2019/20 Q4)

3.4.3.

Extreme Landscape

Geomorphic Threats

Mapped structure
Local conditions

The largest threat on the built environment in Hammerfest is posed by landslide risk. In relation to climate change, which might lead to more intense rainfall events, the probability of a landslide endangering infrastructure and inhabitants increases. Shallow landslides are mostly triggered by short, high intensity rainfall events, causing pore pressure due to infiltration to rise, thereby decreasing the weight of the loose material on top. Deep rooted landslides are a looming danger during longer periods of rainfall, when overall causal pressure rises on the slipsurface between the bedrock and course material on top.

A secundary threat to the buildings along the coast is the possibility of stormsurges, pushed into the bay by western winds.

■ Endangered buildings

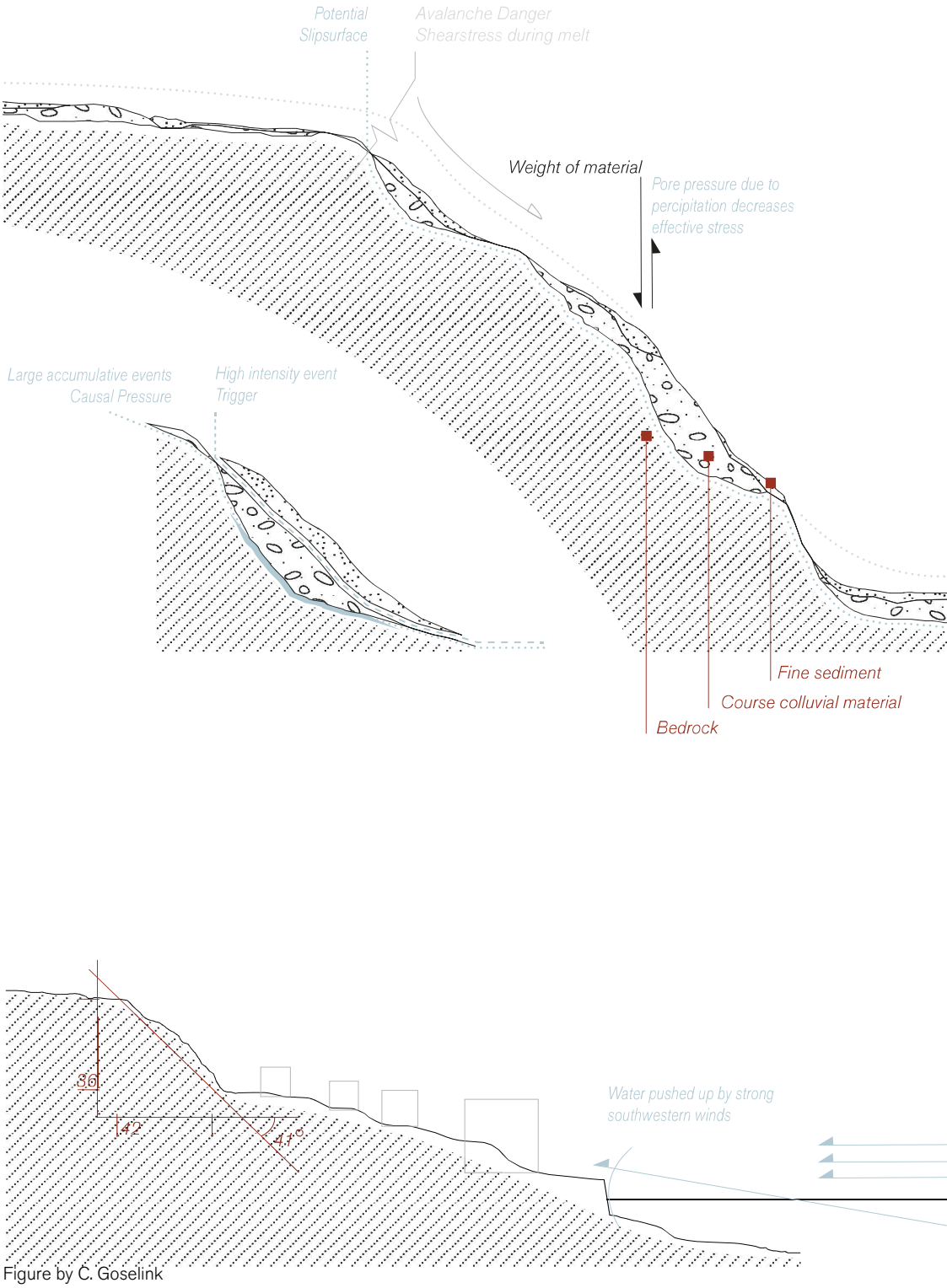


Figure by C. Goselink

N

Map: 1:5.000 Section: 1.2.5000 Detail: 1:1.000



* Assumptions based on photographic material and prior knowledge from TU Delft course CIE5581: Ecology and Morphodynamics in Catchments (2019/20 Q4)

3.4.3.

Extreme Landscape

Overseeing Lofoten

Mapped Form
Conclusion

The largest identified shocks are disturbance events like storm surges and rockfall, directly endangering the settlement nestled in the fjord inlet. Almost all inhabitable space is endangered by rising water, only the areas located at the main land are endangered by rockfall, closed in by these threats on both inland and seaward side. The territorial infrastructure is especially endangered by rockfall events, which could render this lifeline to the outside world useless in minutes, locking the inhabitants in place.

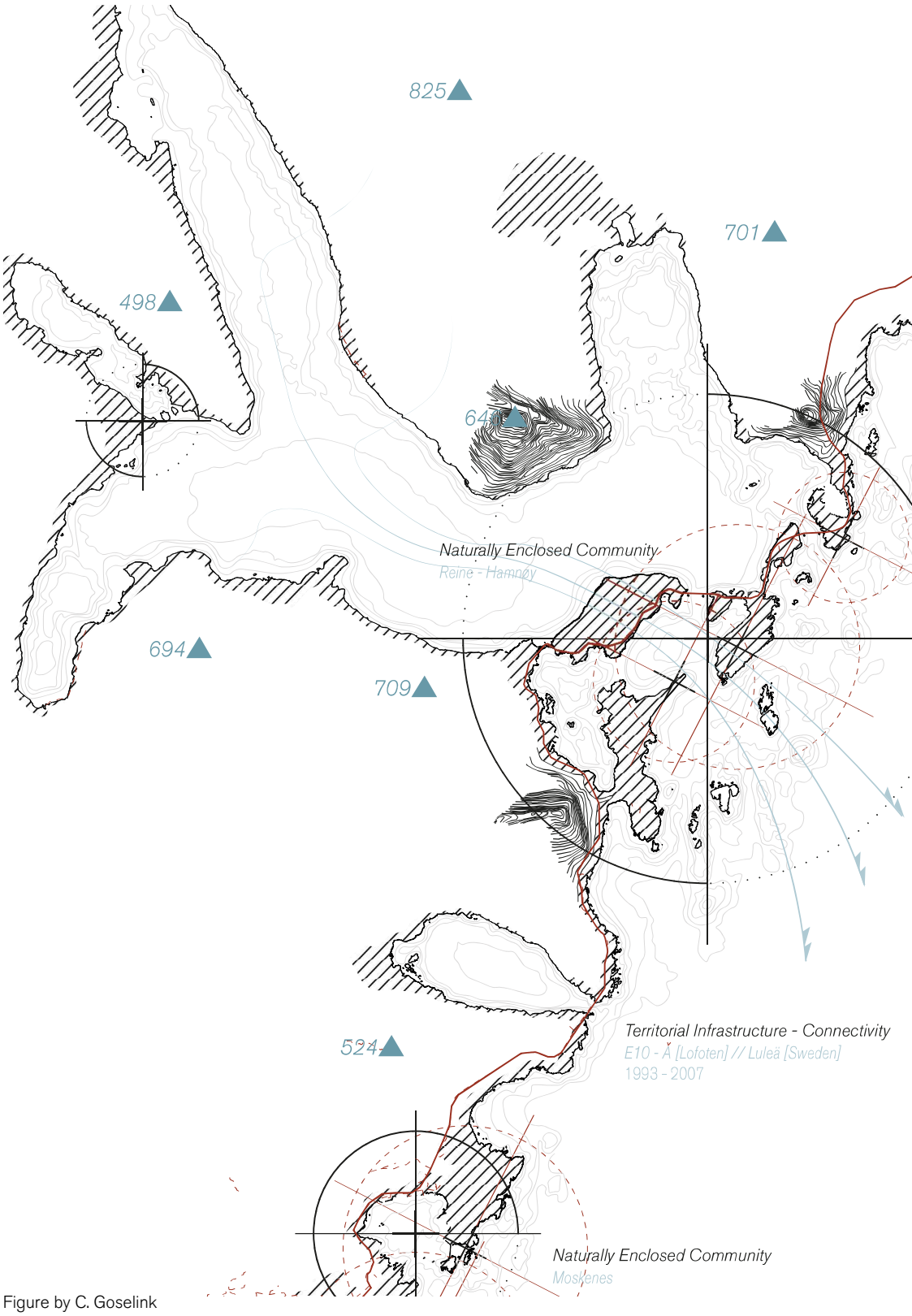


Figure by C. Goselink

2019—2020
IED Infrastructure and Environment Design
Lofoten / Hammerfest Landscape Perspective

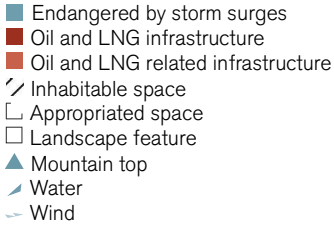
3.4.3.

Extreme Landscape

Overseeing Hammerfest

Mapped form
Conclusion

The identified shock events near Hammerfest are both landslides and storm surges, pushing up the water into the bay. This has especially been shown in relation to the oil related infrastructure, which could lead to a large scale disaster, destroying both infrastructure and natural habitat when oil or gas is spilled into the surrounding environment. The largest stress on the area is the territorial appropriation related to the oil industry, closing of terrestrial and oceanic territory from use by inhabitants. With climate change effect opening up the arctic for exploration and extraction, this influence is most likely to grow in the coming decades, until the western world really starts to make the transition towards renewable energy sources.



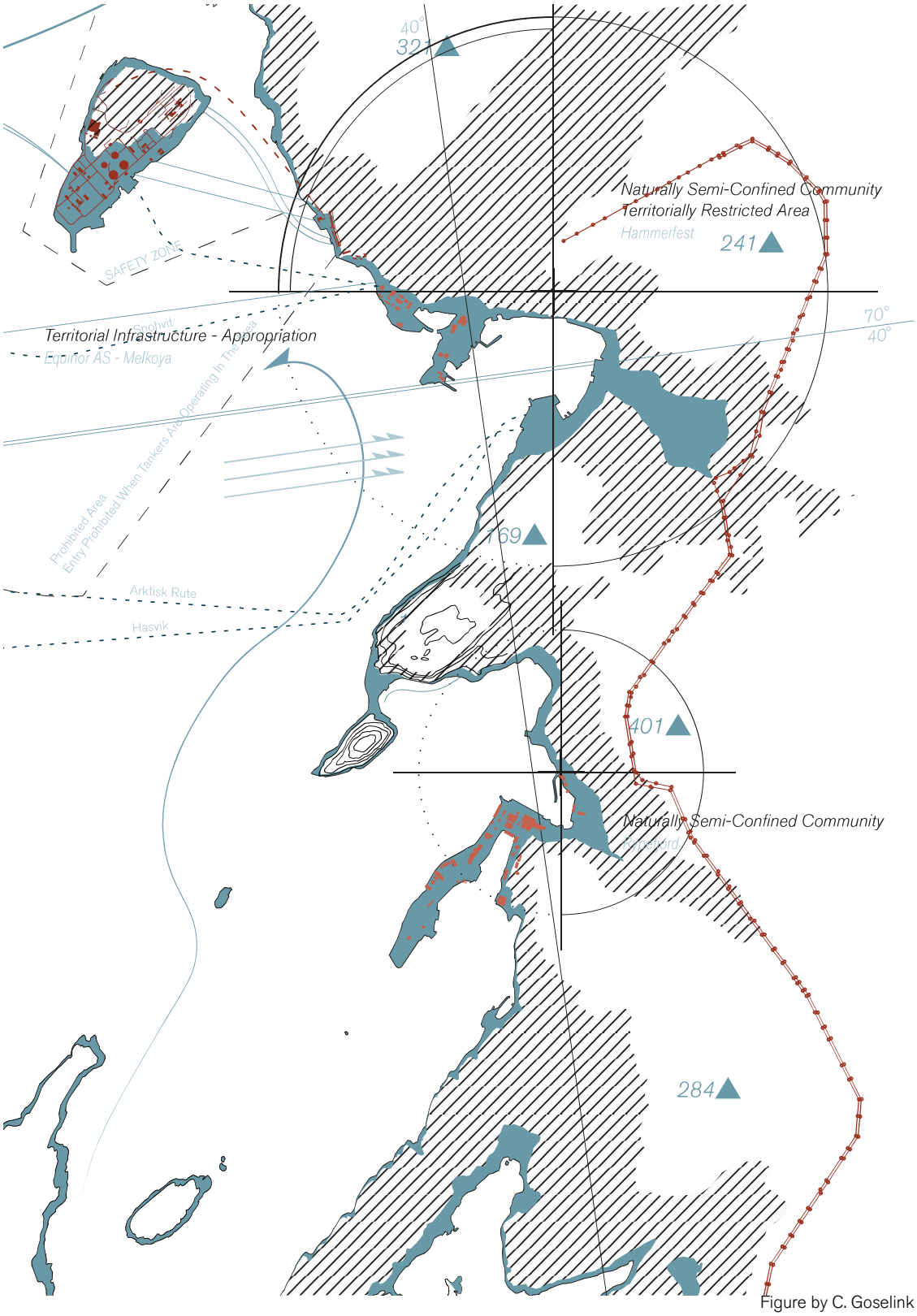
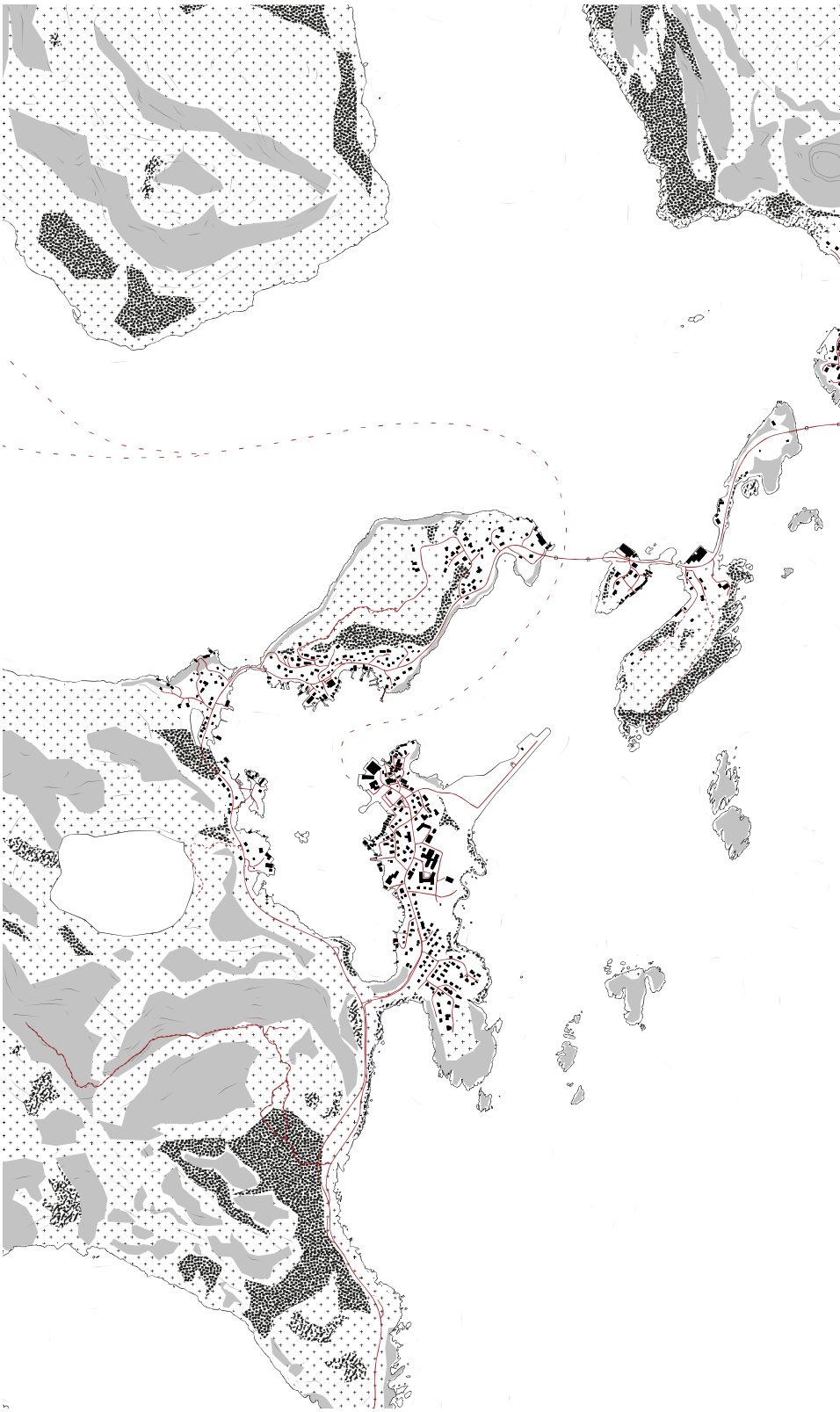


Figure by C. Goselink

3.5. Ecology

The research perspective of ecology focus on the common and different aspects of the local ecosystem of Hammerfest and Reine. As both cities are located above the Arctic circle, there are similar climatic and natural conditions of the ecosystem, however, they belong to different marine ecoregions and the distance between them are significant to have different flora and fauna species.

The extreme climatic conditions, landscape and climate change influence the ecosystems in both cities, therefore the research aims to understand the extremalities of the local ecosystems.



Biomes and ecotones

Hammerfest and Reine are located in subarctic ecozone, however, as Hammerfest is located in Northern part of Norway, the ecology of the city consist of elements of tundra.
Both cities are located on the North Eastern coast of the Atlantic ocean, therefore the climate, flora and fauna species habitats are influenced by the warm Gulf stream that makes the climate more mild in comparison to the inland and Northern territories of Norway.
The marine ecosystems differ in both cities. Reine is located on the coast of Norwegian Sea and is part of its ecoregion, on the other hand, Hammerfest is part of the Barents Sea ecoregion that has more arctic plant and animal habitats. (ICES, 2019, p. 2), (Kankaanpää & Program for the Conservation of Arctic Flora and Fauna, 2001, pp. 6-9)

Vegetation and ground cover

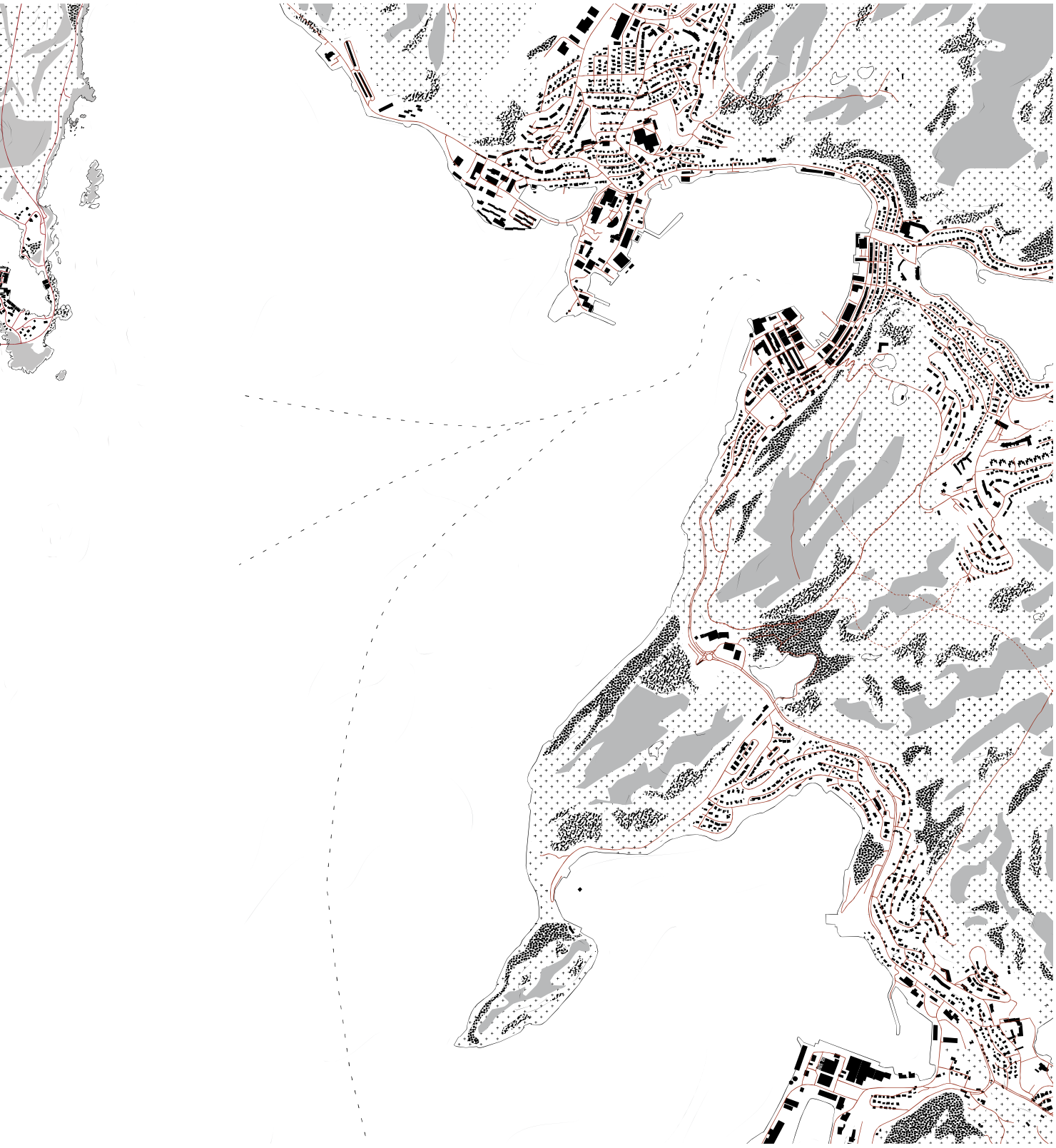
The maps show the main biomes in both cities that consist of alpine vegetation, low broad-leaf bushes and open bedrock.

- Bedrock
- Gravel
- Alpine vegetation
- Low bushes and forests

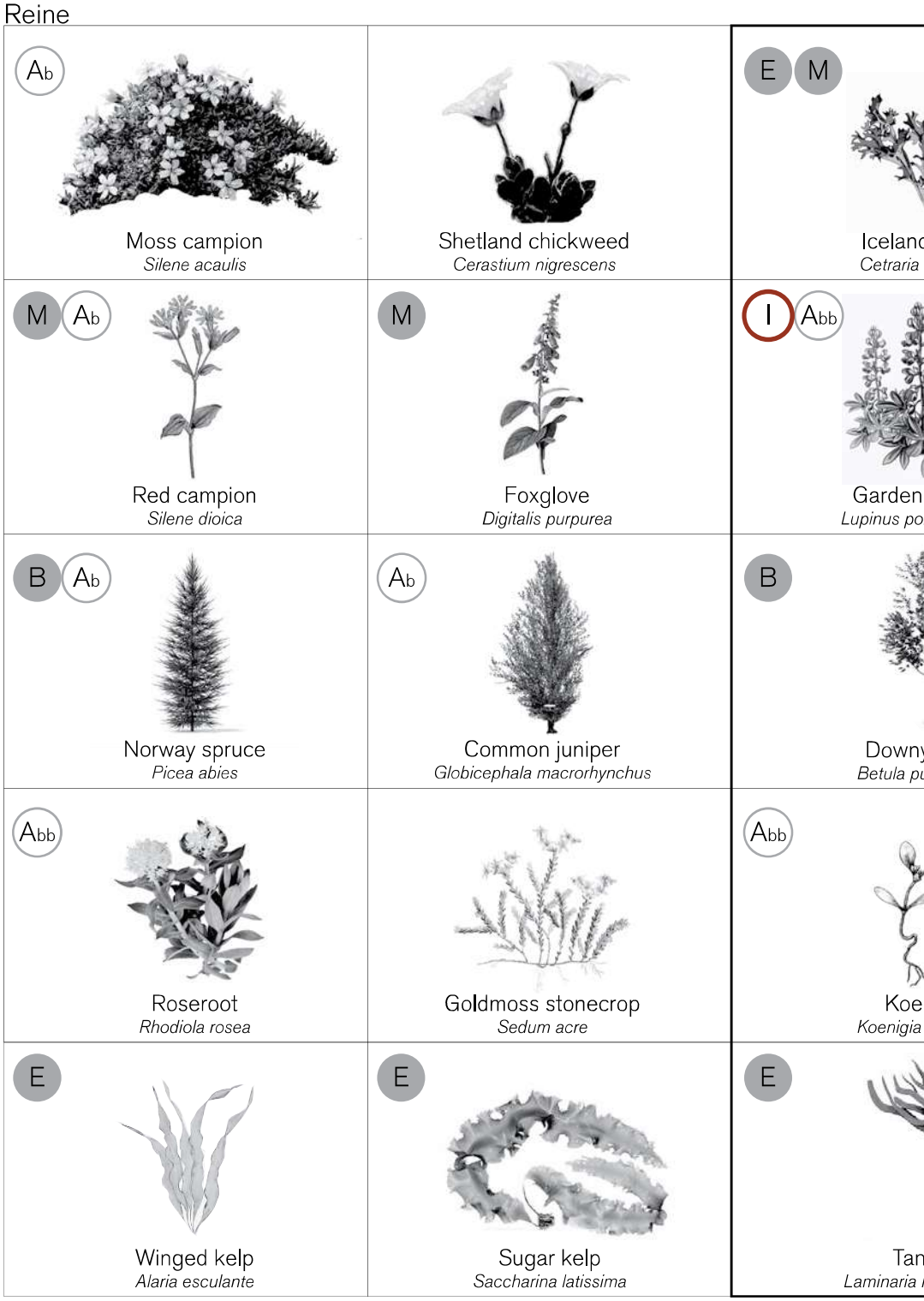
Map by J.Berzins
based on Google sattelite image

N

0 500 m



Reine



Flora in Reine and Hammerfest

The diagram describes some of the species that are living in Hammerfest and Reine.

These plants have different uses and characteristics that can be used by humans. The main difference between both cities are the forest biome. Lofoten archipelago has some boreal forest areas with larger conifer and broad leaf trees on the lower parts of the mountains. In Hammerfest, low broad-leave bushes dominate the lower parts of the mountain range. In both cities, in the mountain areas, the alpine biomes are found with alpine and arctic plants that have adapted to the harsh climatic conditions. (Araújo et al., 2016, p. 1344), (Martineau, n.d.) (Norwegian Lichen Database, n.d.) (Norsk Botanisk Forening, n.d.) (Short Seaweed Guide, n.d.), (Norwegian Environment Agency, 2017)

Both cities

Hammerfest

d moss *islandica*	Alpine azalea *Kalmia procumbens*	E Reindeer moss *Cladonia rangiferina*	Ab Alpine bearberry *Arctous alpina*
lupin *lyphyllus*	Cross leaved heath *Erica tetralix*	M Common cowslip *Primula veris*	Wolf's bane *Aconitum lycoctonum*
y birch *ubescens*	E Cloudberry *Rubus chamaemorus*	B Mountain willow *Salix arbuscula*	Ab Aspen *Populus tremula*
niga *islandica*	European searocket *Cakile maritima*	Abb Lapland poppy *Papaver lapponicum*	F Four-leaved Mare's tail *Hippuris tetraphylla*
gle *hyperborea*	Phytoplankton *Various species*	E Oarweed *Laminaria digitata*	Common eelgrass *Zostera marina*

water habitat

Abb Attracts bees and butterflies

Ab Attracts birds

I Endengered species

Figure by J.Berzins
Photos: A.Olsvik, (Olsvik, 2016) , (Olsvik, 2018a) ,(Olsvik, 2018b)
open internet sources

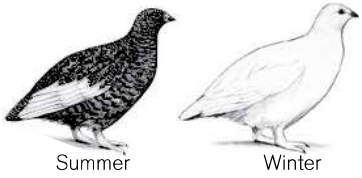
Reine

C !



Atlantic puffin
Fratercula arctica

I !



Willow ptarmigan
Lagopus lagopus

C I



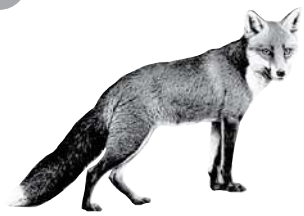
Kitti
Rissa tr

I



Moose
Alces alces

I



Arctic fox
Vulpes vulpes

I



Mountai
Lepus ti

S



Common minke whale
Balaenoptera acutorostrata

S



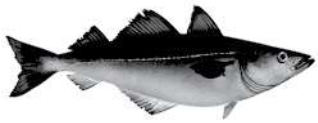
Short-finned pilot whale
Globicephala macrorhynchus

S !



Killer
Orcinu

S



Saithe
Pollachius virens

S F



Atlantic salmon
Salmo salar

S



Atlantic
Clupea h

C Coastal habitat

I Inland habitat

Fauna in Reine and Hammerfest

The diagram describes the main species that are living in Hammerfest and Reine and their characteristic properties.

The unique habitats of Northern Norway are home of many endangered species. They are affected by the climate change and are forced to relocate more North, because the climate is becoming too warm.
As the region has 4 distinct seasons through the year, some animals have adapted to this seasonality and change their fur accordingly. (Wildlife in Norway, n.d.), (Animal Life in Lofoten, n.d.), (Species of Fish in Lofoten, n.d.), (Havfisk - Fish Species, n.d.) (Norwegian Environment Agency, 2017)

Both cities

Hammerfest

C !



wake
idactyla



Eider
Somateria mollissima

C I



Common gull
Larus canus

C !



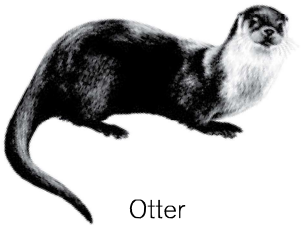
Theist
Cepphus grylle

C



Winter

n hare
midus



Otter
Lutra lutra

I



Reindeer
Rangifer tarandus

I !



Arctic fox
Vulpes lagopus



whale
s orca

S



Humpback whale
Megaptera novaeangliae

S !



Bearded seal
Erignathus barbatus

S !



Beluga whale
Delphinapterus leucas



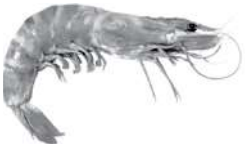
herring
harengus

S



Atlantic cod
Gadus morhua

S



Atlantic northern shrimp
Pandalus borealis

S



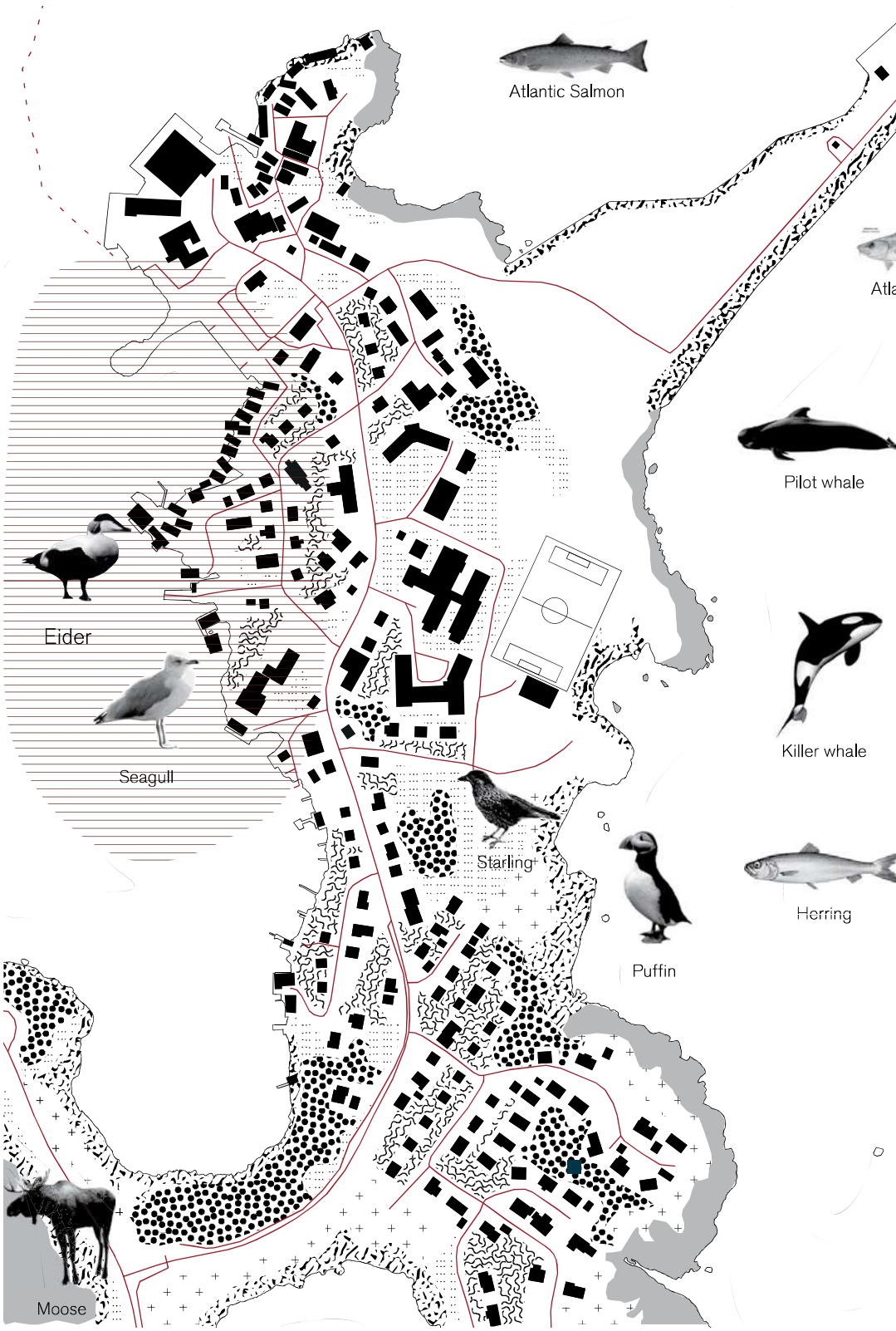
Atlantic redfish
Sebastes norvegicus

S Salt water habitat

F Fresh water habitat

! Endangered species

Figure by J.Berzins
Photos: open internet sources



Flora and fauna in Reine

The map shows the differen biomes and main animal species in the central part of Reine.

- Protection zone
- Alpine vegetation
- Broad-leaf bushes
- Urban gardens
- Grassland
- Gravel
- Bedrock

Figure by J.Berzins
based on envrionment.no

N

0 100 m



antic Cod

Alpine vegetation
Moss, shrubs, summer flowers, lichen



Low broad-leaf bushes
Mountain birch, dwarf birch, willows



Gardens
Garden conifers, broad-leaf bushes, summer flowers



Grass with wild flowers
Grass, weeds, herbs, summer flowers



Gravel
Moss, lichen



Bedrock
Moss



Photos: Google street view



Alpine vegetation
Moss, shrubs, summer flowers, lichen

Low broad-leaf bushes
Mountain birch, dwarf birch, willows

Gardens
Garden conifers, broad-leaf bushes, summer flowers

Grass with wild flowers
Grass, weeds, herbs, summer flowers

Gravel
Moss, lichen

Bedrock
Moss

Photos: Google street view

Flora and fauna in Hammerfest

The map shows the differen biomes and main animal species in the central part of Hammerfest.

- Alpine vegetation
- Broad-leaf bushes
- Urban gardens
- Grassland
- Gravel
- Bedrock

N

0 100 m

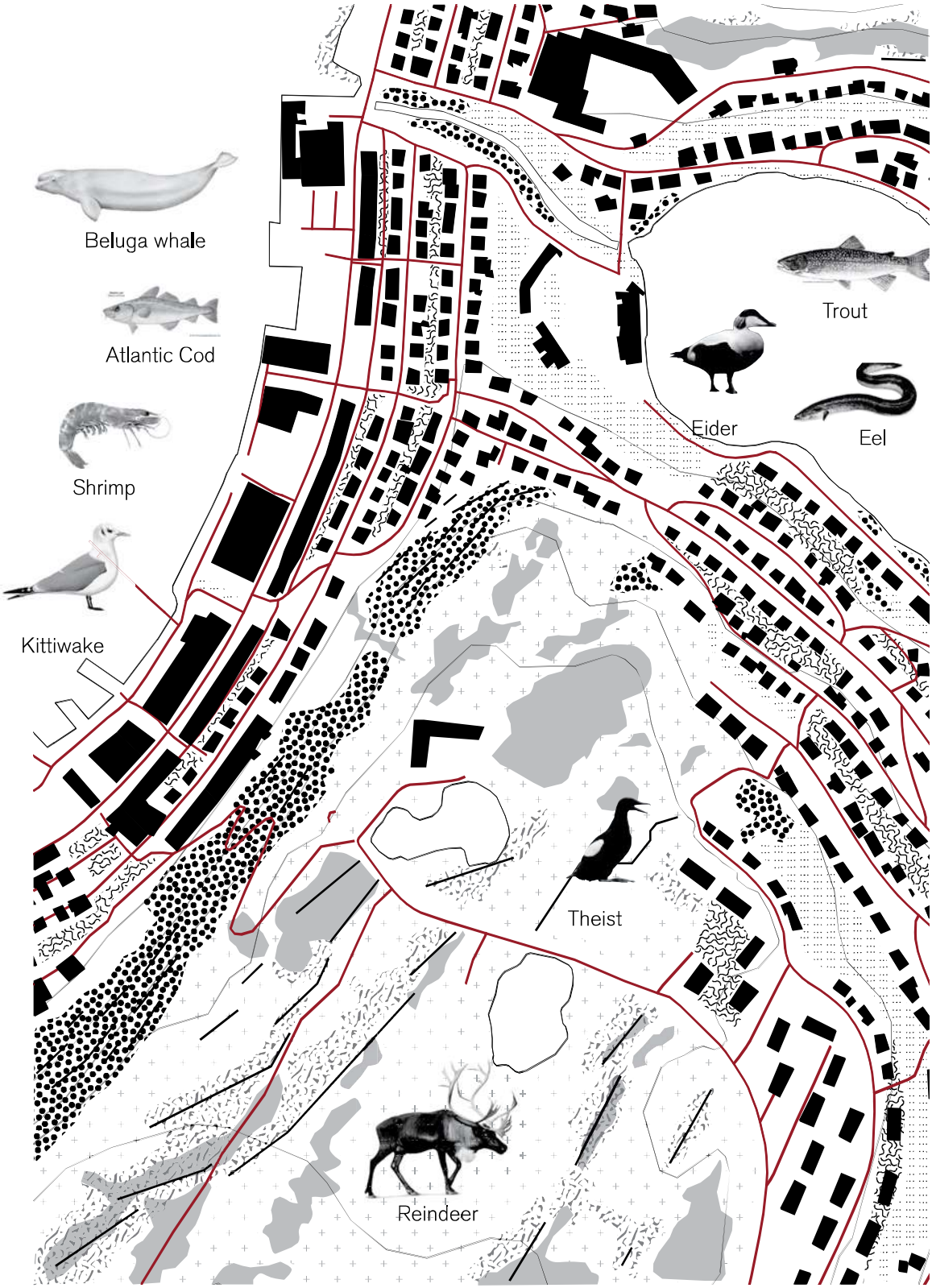


Figure by J.Berzins
based on environment.no

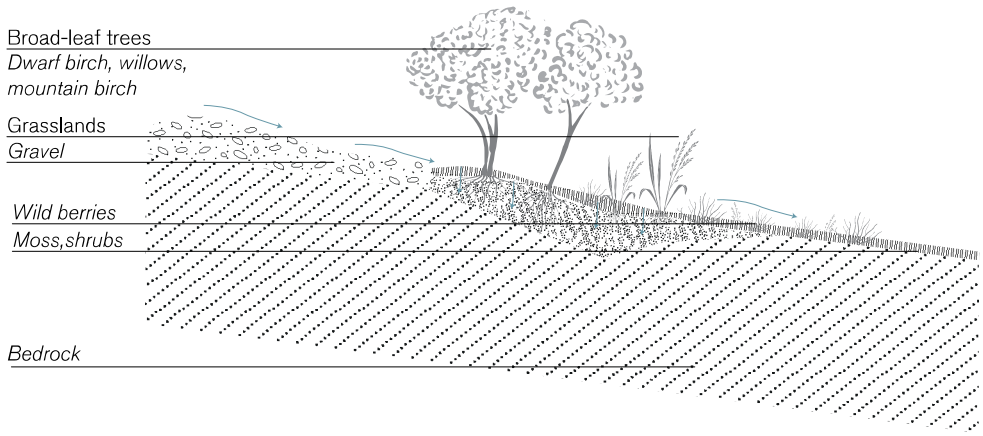
Soil life during seasons

Both cities Reine and Hammerfest are located on Leptosol soil type, which consist of open bedrock, gravel and few fertile soil sediments between the bedrock cracks and on top of it. (Jones et al., 2010), (Lag & Norges geografiske oppmaling, 1983),
The scematic sections describe how rainfall, snow and ice during winter influence plants and their productivity.

0 2 m

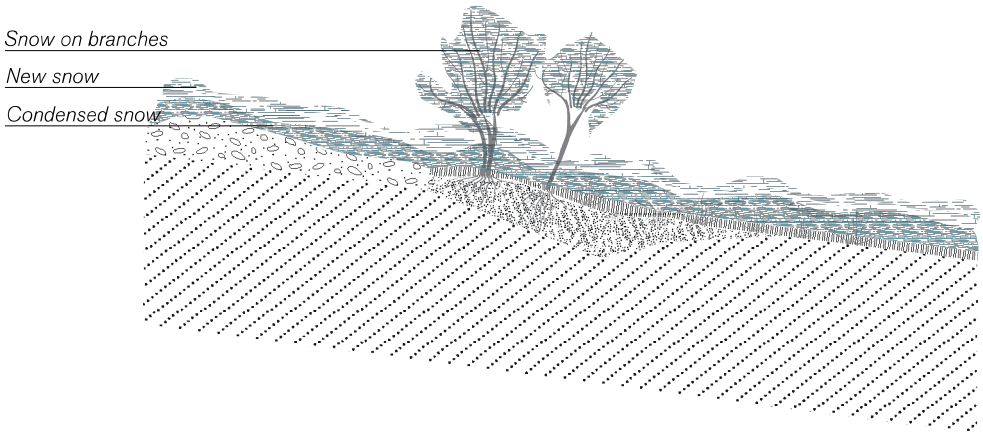
Summer

Rain water flows from the mountains and infiltrate the organic soil. The Discharge continue to flow over impermeable bedrock



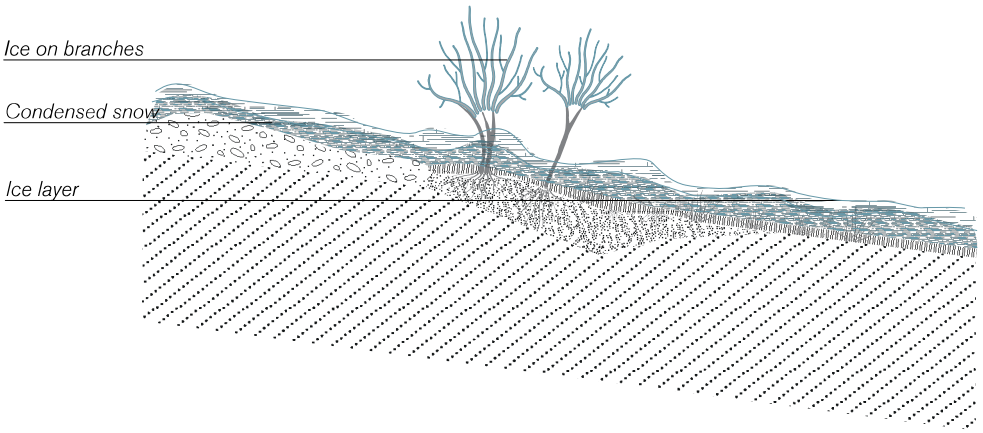
Winter

During winter, snow is formed in layers according to the age of the snow. Lower layers during time become more dense, putting pressure on organic soil and plants, creating compostation and new fertile soil elements.

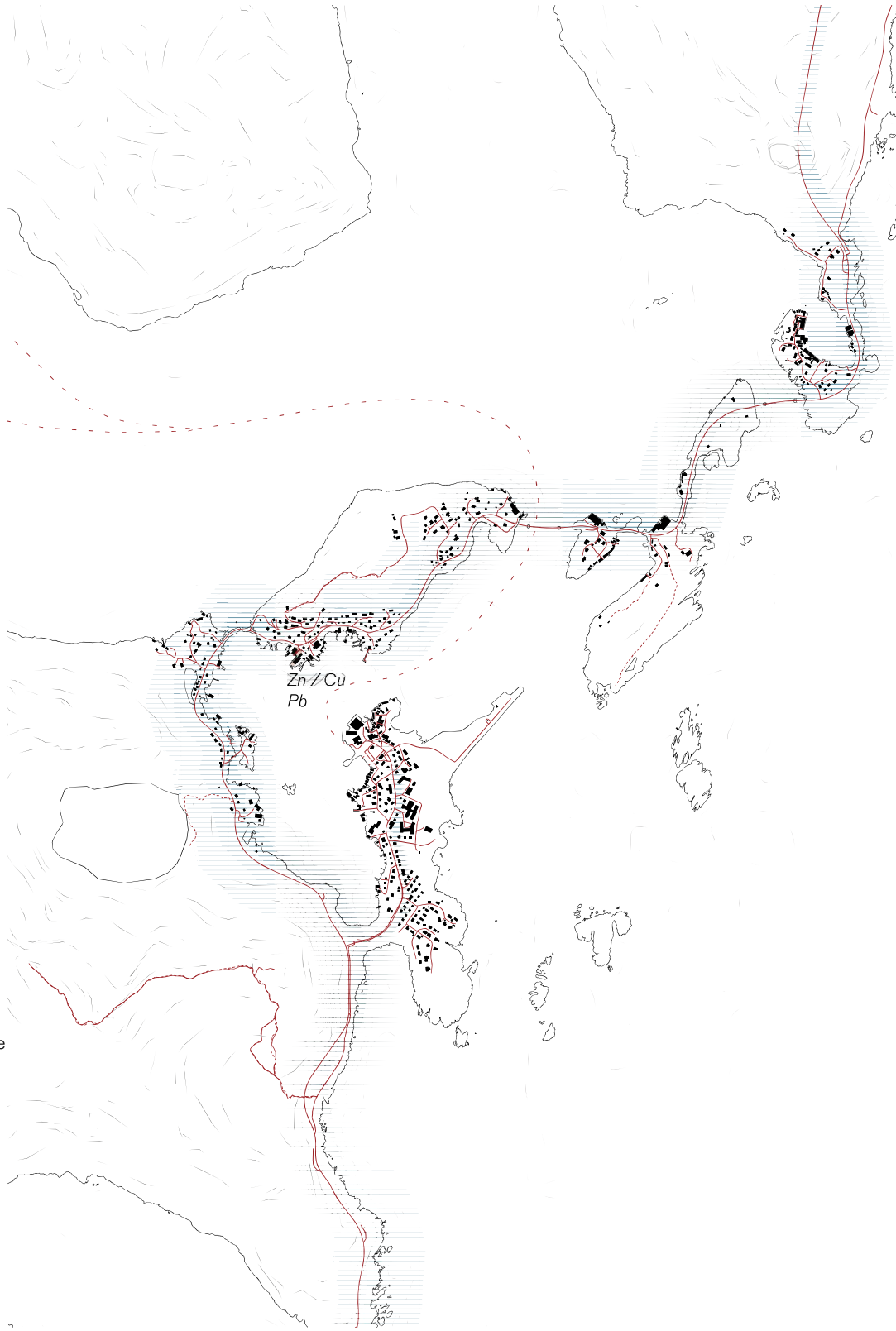


Spring / autumn
Thaws and sudden temperature change

Due to climate change, there are more thaws and sudden temperature changes happening. These processes create several ice layers on top of the snow eliminating possibilities for animals to feed from the plants below the soil and damaging the new blooms on trees and bushes.



Figures by J.Berzins



Pollution in Reine and Hammerfest

The main soil polution source in both cities are the heavy industry and fishery. In Hammerfest, the soil pollution with heavy metals and polycarbonates mainly are found in harbour and industrial areas; in Reine - around warehouses.
The sound pollution in both cities are caused by the main road that goes through residential areas, however, the noise level in Hammerfest is significantly influenced by the Hammerfest airport.

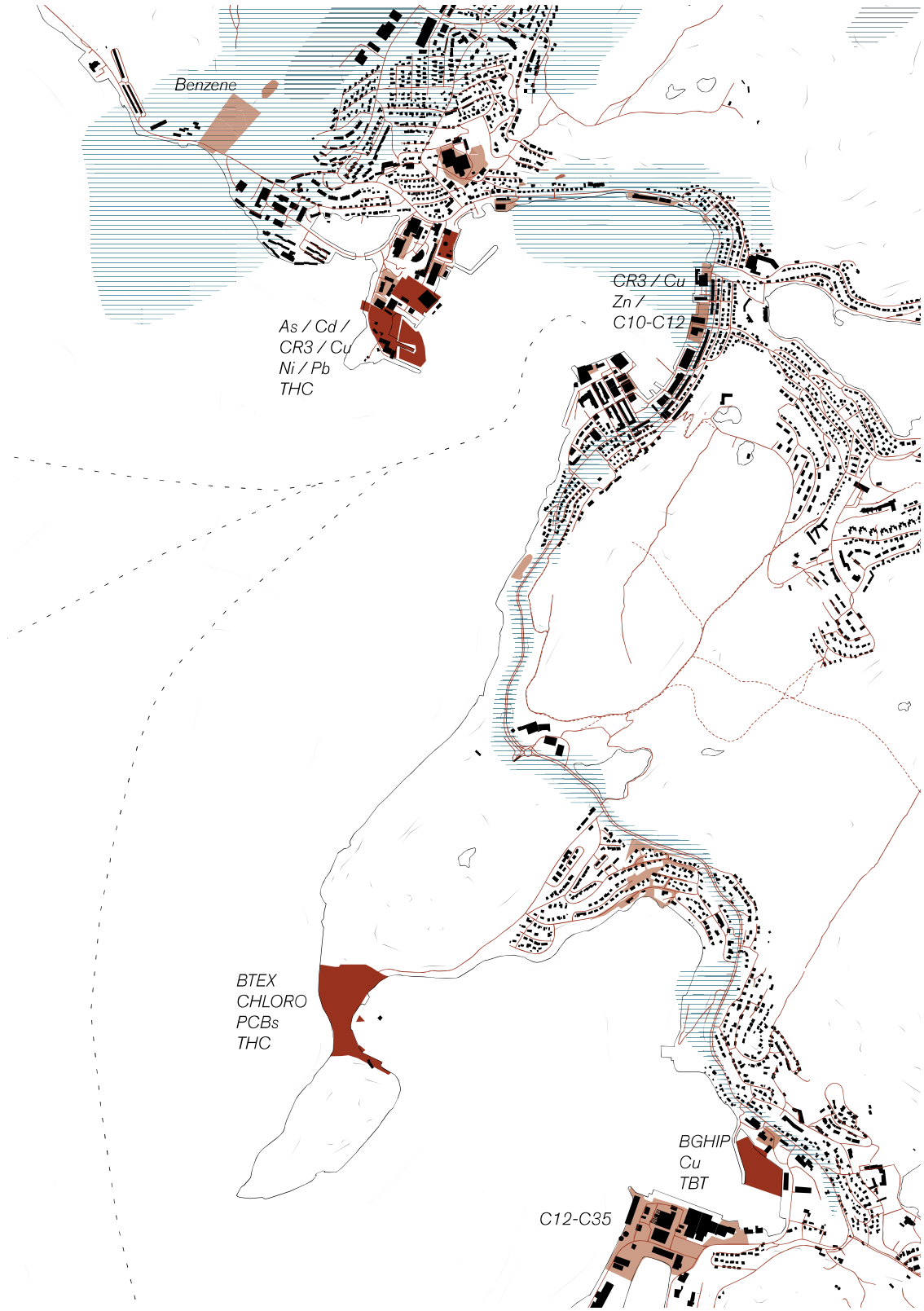
- Contamination suspected
- Restricted use
- Serious contamination

- >70 dB
- 50-70 dB
- <50 dB

Maps by J.Berzins
based on environment.no
(Global Noise Pollution - Reine, n.d.)

N

0 | 500 m


Benzene
As / Cd /
CR3 / Cu
Ni / Pb
THC
CR3 / Cu
Zn /
C10-C12
BTEX
CHLORO
PCBs
THC
BGHIP
Cu
TBT
C12-C35

Average water temperature

+12
+4

August
March

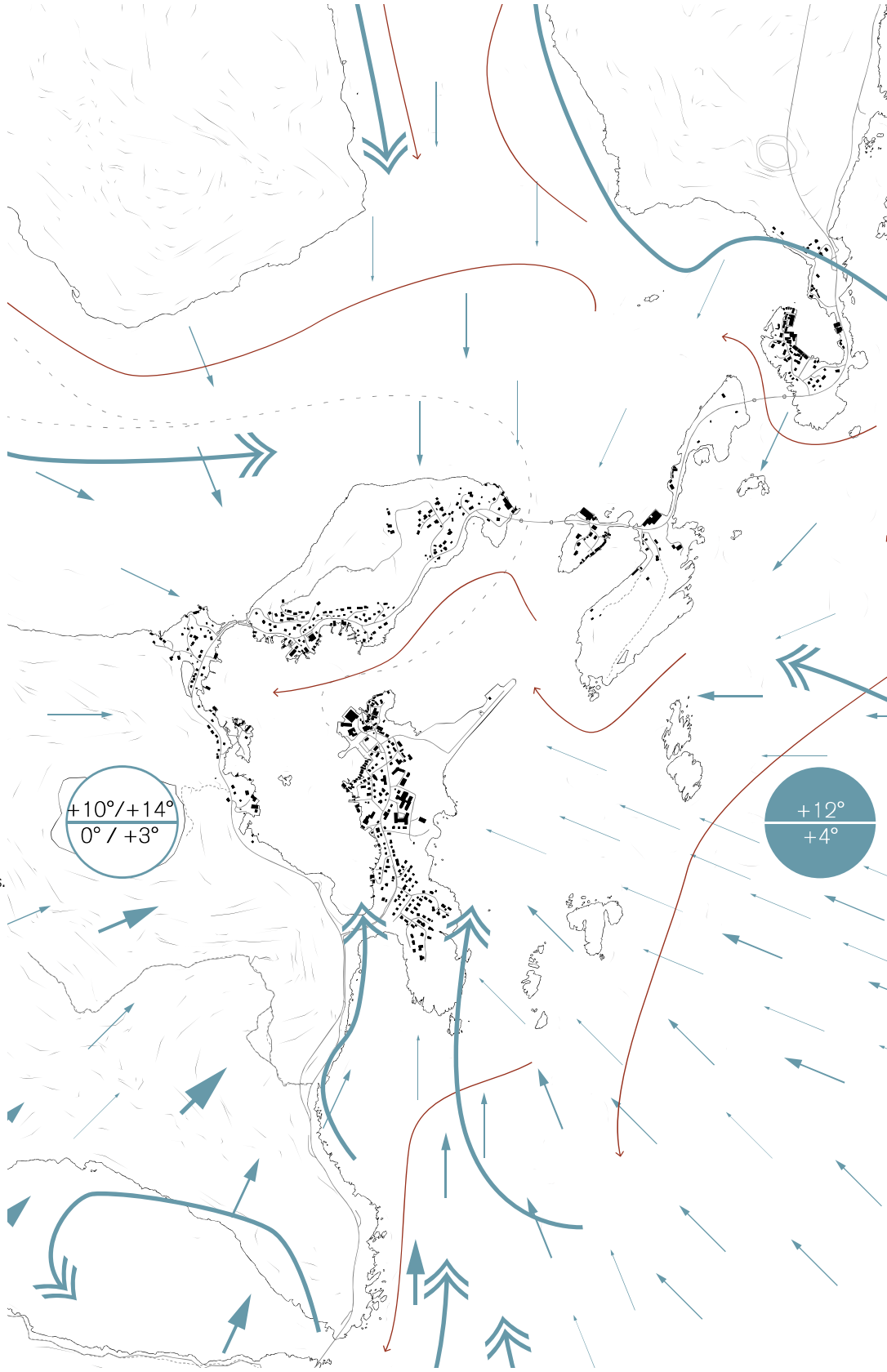
Average air temperature

+10/ +14
0 / +3

January
July

Climate map

Climatic conditions are influenced by the warm Gulf stream that brings warm ocean water all year round. In Hammerfest intensive wind gusts blow from two main directions: SE and W.
In Reine the climatic conditions area also influenced by the Gulf. Intensive wind gusts make it difficult to sail in the fjord.
In both cities the sea doesn't freeze during winter, therfore the climate at the coast is more mild, compared to the inland territories. (Average Weather in Reine, Norway Year Round, 2020), (Average Weather in Hammerfest, Norway Year Round, 2020).



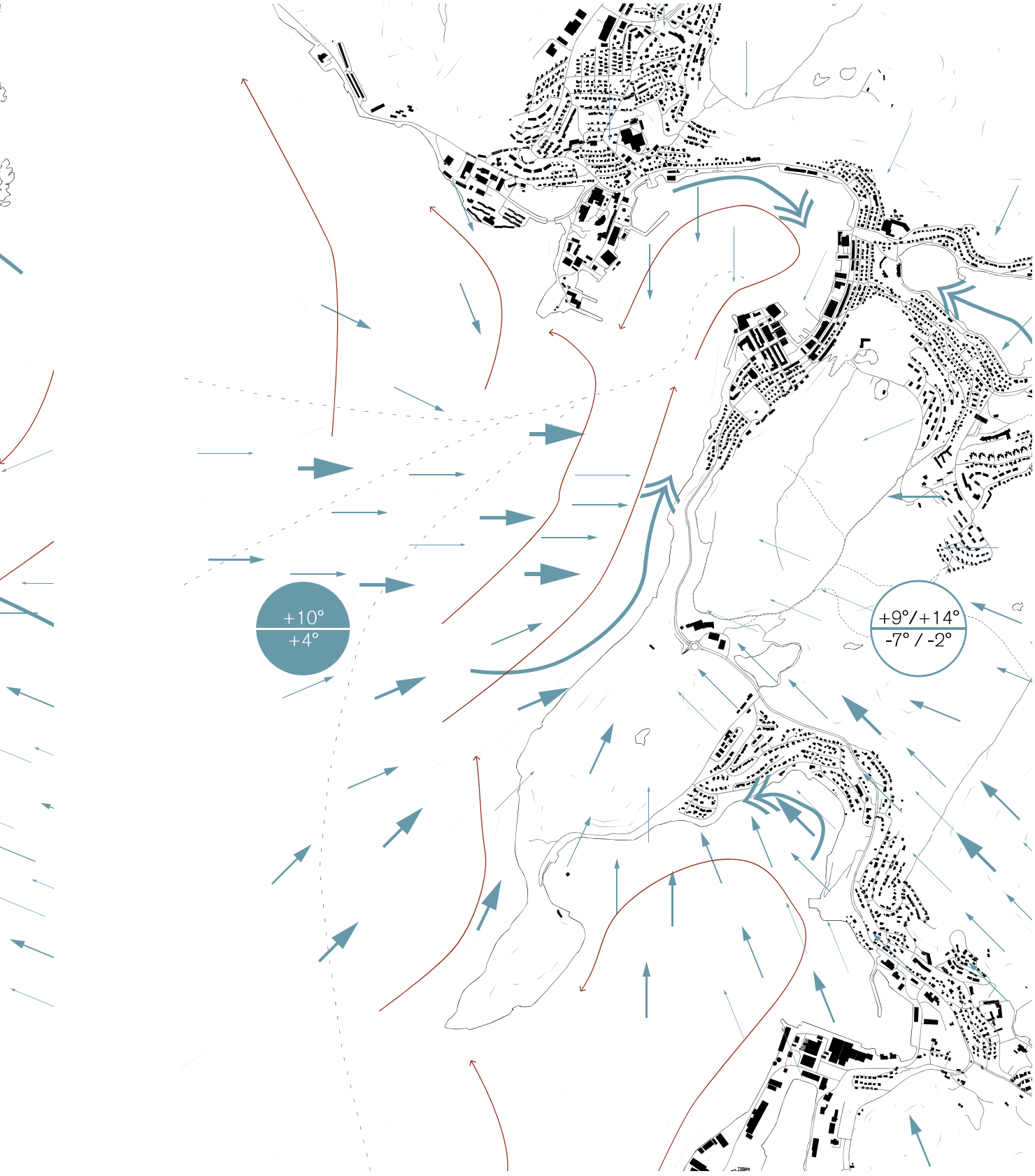
Ocean currents

Wind direction change
0-5 km/h
5-15 km/h
15-30 km/h
30-45 km/h
45 - 60 km/h
>61 km/h

Maps by J.Berzins
based (Climate Hammerfest, 2020)
and (Climate Reine, 2020)

N

0 500 m


+10°
+4°
+9°/+14°
-7° / -2°

Extreme ecology

The extreme conditions of the ecology on both cities are caused by the climate change and the effects of it. Warmer climatic conditions force various habitats to retreat to higher altitudes or move towards North where the temperatures are colder. This allows new, invasive species to develop along the coastal area.
The potential Arctic shipping route can cause significant danger to the marine ecology. Mre intensive cargo and cruise shipping increase the potential accidents of oil spills, as well as hazards from balast and sewage water discharge. With these ships, invasive marine animals and plants also can travel and establish new habitats, causing the native species to die out.
In Hammerfest, the reindeer habitat that surrounds the city have conflicts with the potential urban expansion of the city. These conflicts between local residents and reindeers that already occour, will only grow in the future, because the city is taking over the reindeer territory.

Invasive species

Garden lupine

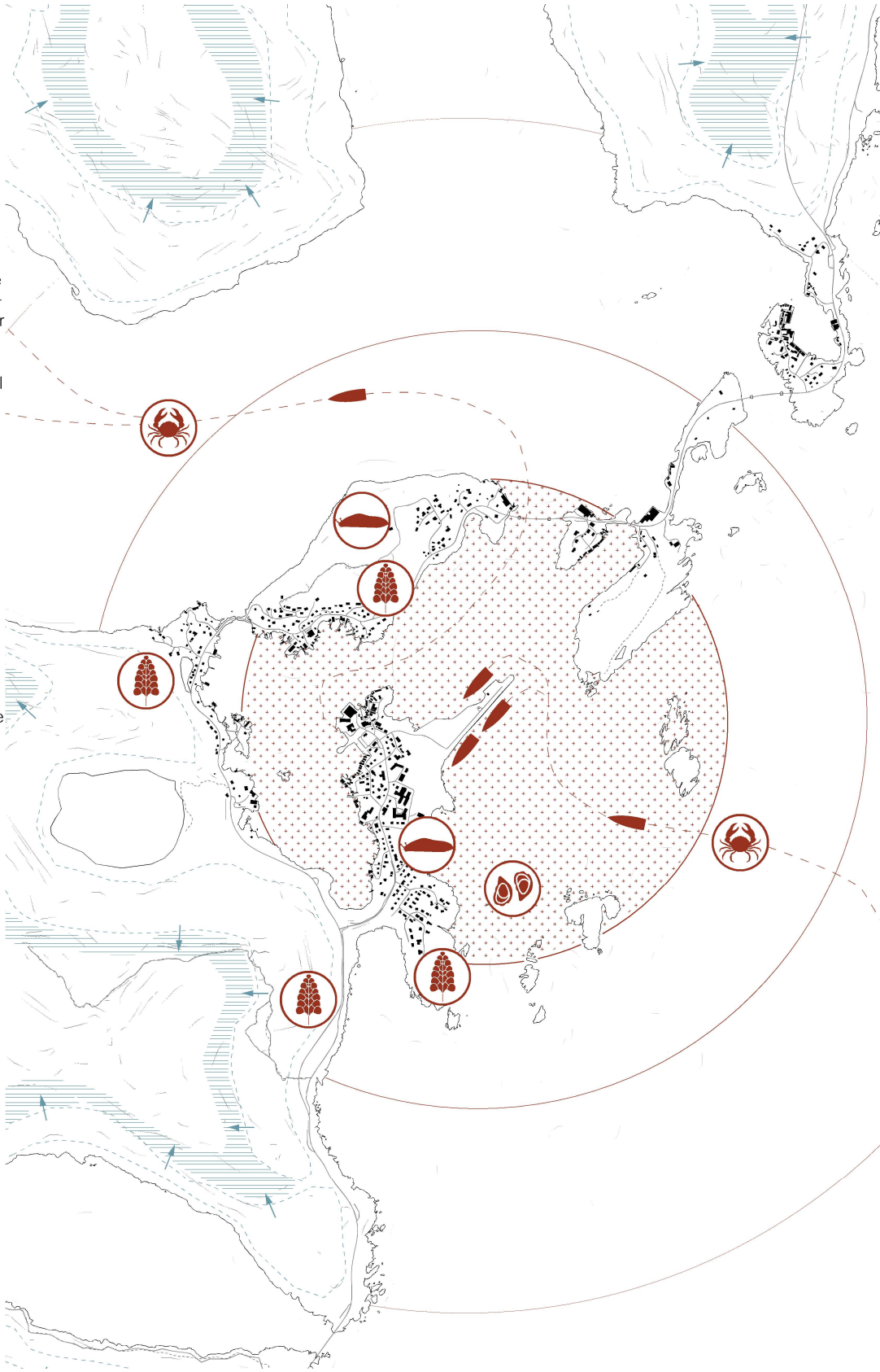
Spanish slug

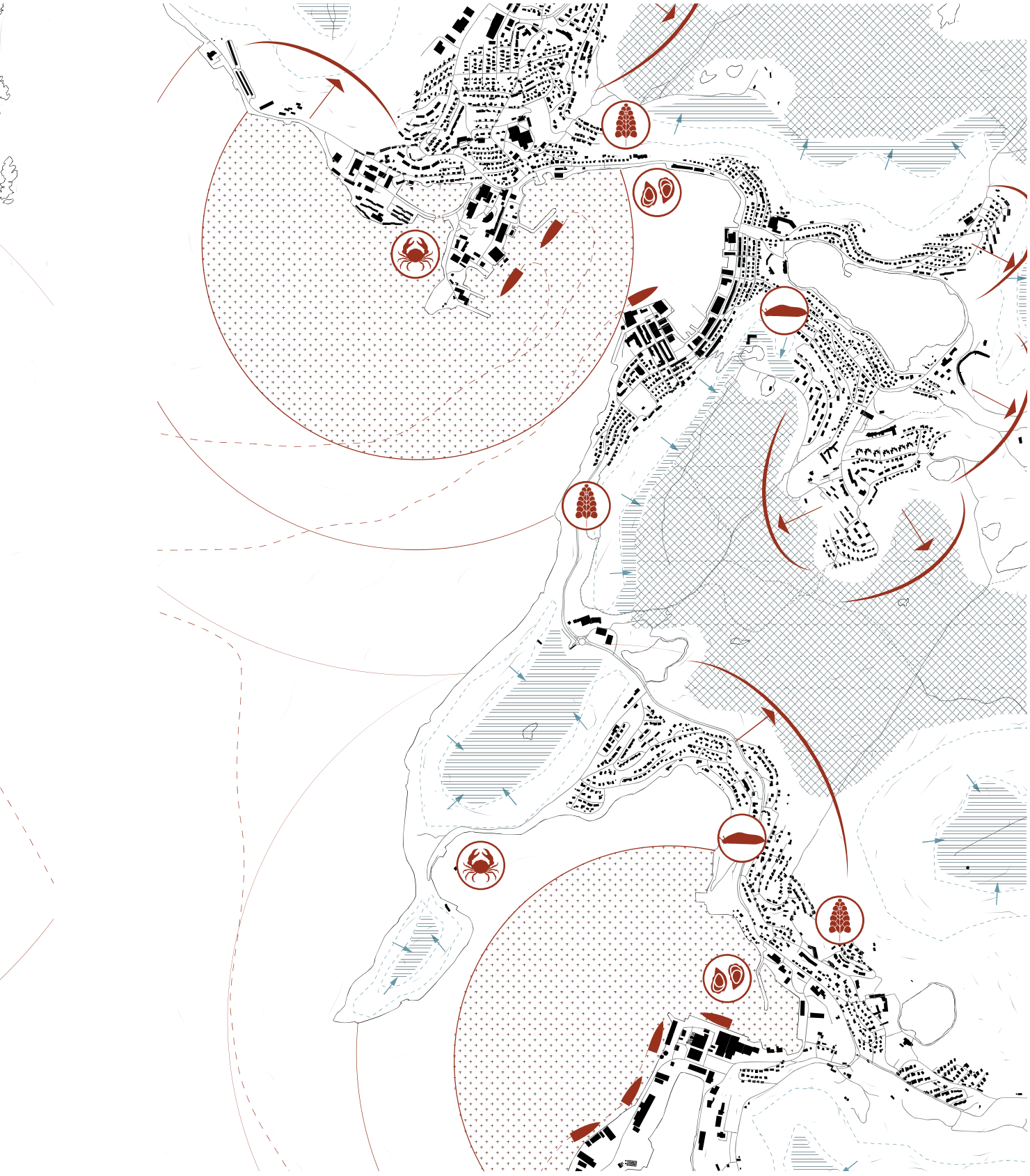
Red king crab

Pacific oyster

Habitat retreat to higher altitudes
Reindeer habitat
Urban expansion
Potential water pollution hazard
Cargo and cruise ships

Maps by J.Berzins





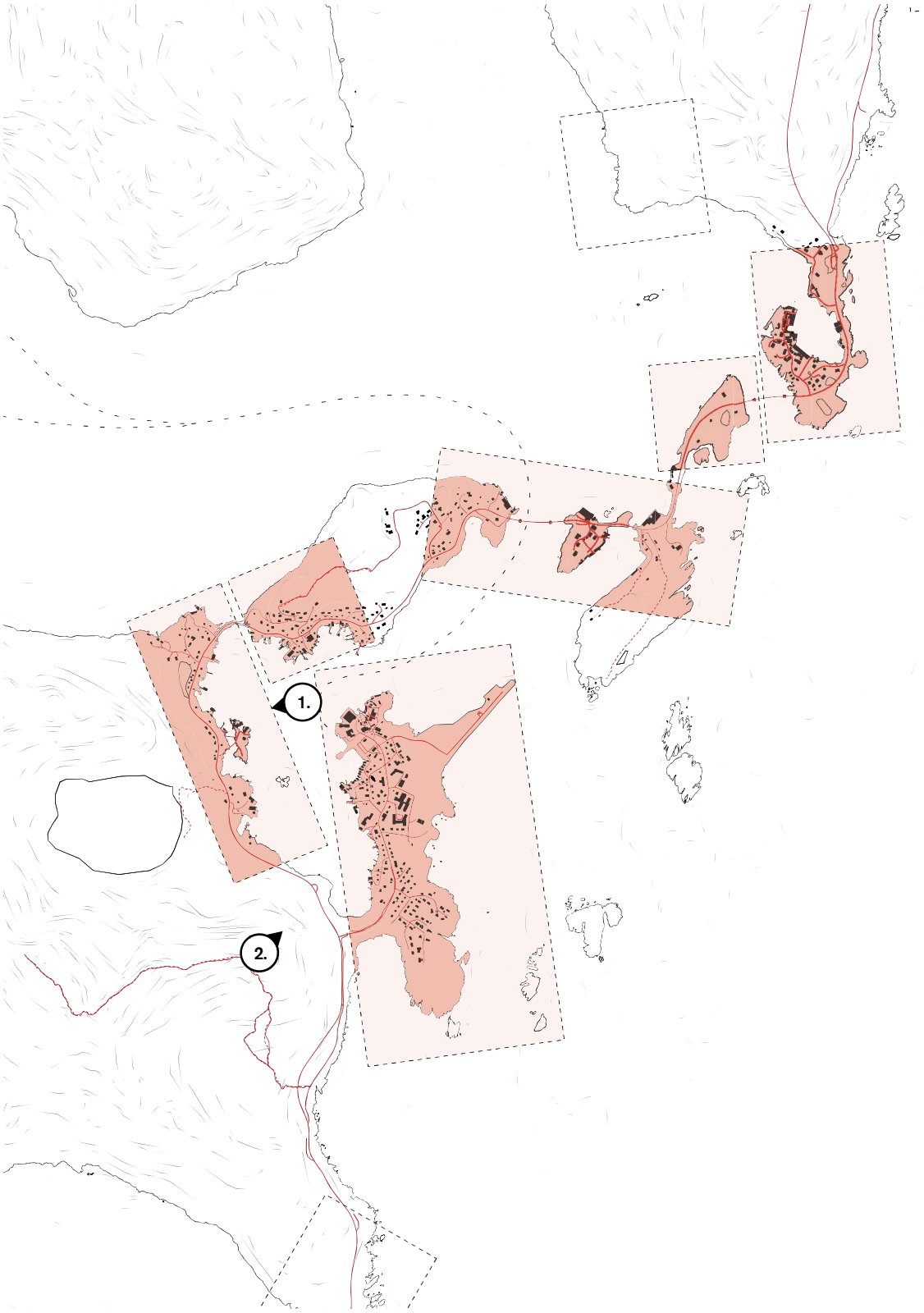
3.6. Urban Morphology

The Urban persepective will cover the smallest scale yet. Starting from the original settlement pattern, it seeks to understand the spatial structure and character of both areas. It will do so by identifying the different building ensembles, street patterns and public spaces.

In addition to this, the effect of the distinctive landscape is taken into account. A set of sections provides the right perception of scale when talking about the city in relation to its natural environment.

The architectural scale focusses namely on vernacular architecture and the changing function and social nature of the structures over time. It will aid the understanding of the changes Reine and Hammerfest have been going though on the larger scale.

The concluding maps, called extreme constructions, will capture the shock or stress on both Reine and Hammerfest as seen from the Urban Morphology persepective. These maps will be combined with the conclusions of the other perspectives in chapter 2.4; Systems description and synthesis.





1. Foot of the mountain prov
(fishing) and a reasonably fla

2. The Reine area is remarka
surrounding landscape. This,
open sea makes naturally be

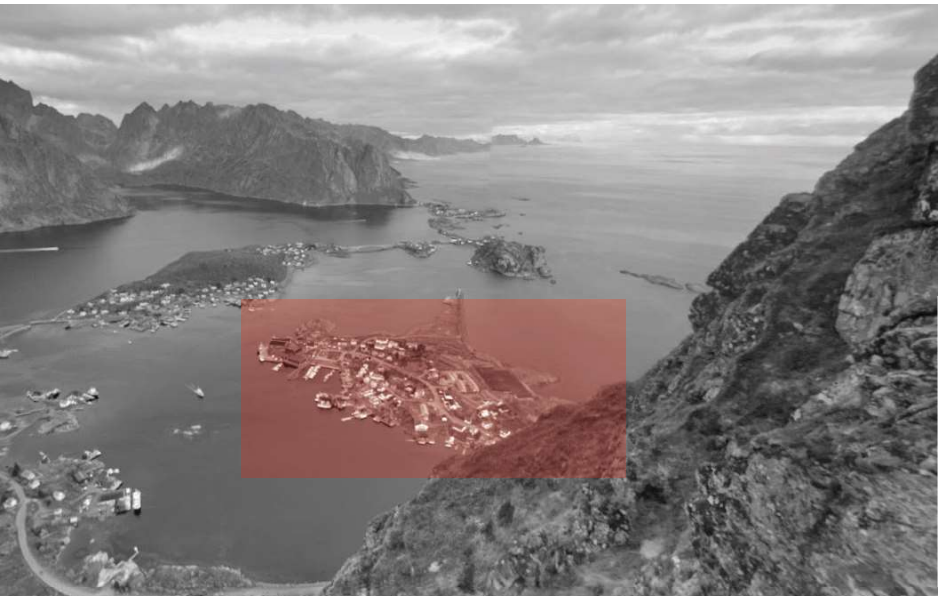




ides easy access to the coast
t surface to built on.



bly flat considering the
and the direct connection to the
nificial spot for settlements.



Urban morphology

Urban tissue
Settlement pattern

Settlement on the flat parts for safety.

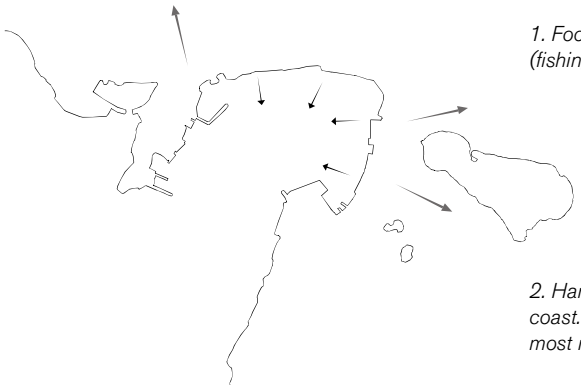
- Buildings
- Roads
- Settlement area

N

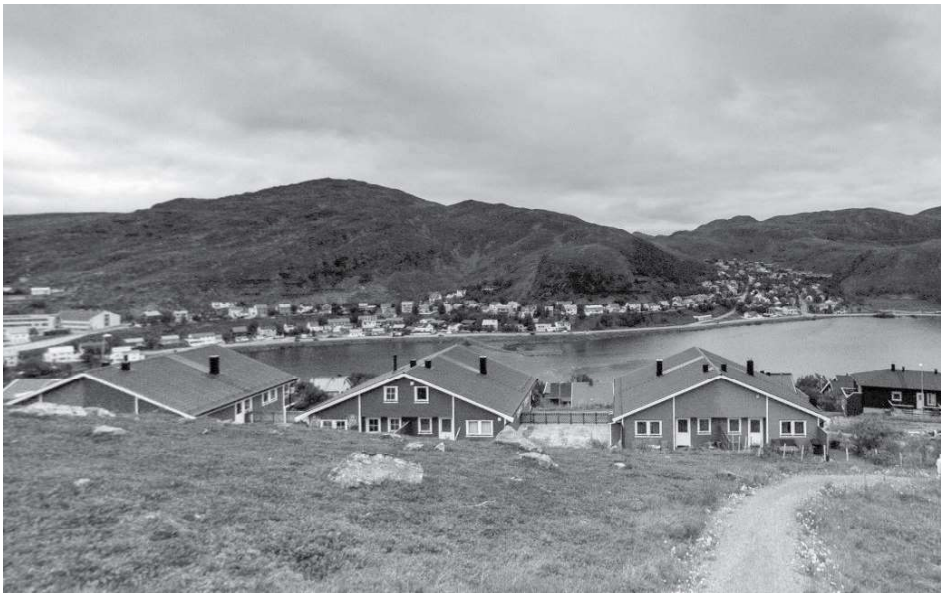
Map: 1:25.000



1. Foot of the mountain provides easy access to the coast (fishing) and a reasonably flat surface to built on.



2. Hammerfest has lower, more flat inlets that connect to the coast. They provide more protection from storm surges. The most recent expansions of the city were realized in these inlets.



Urban morphology

Urban tissue
Settlement pattern

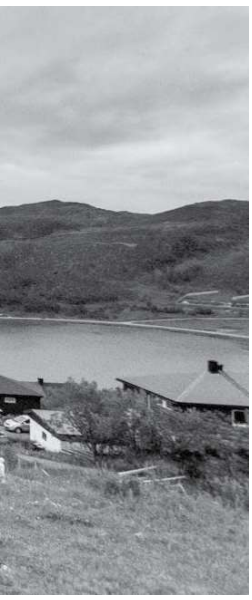
Settlement on the flat parts for safety and inside inlets for more protection from harsh weather and storm surges.

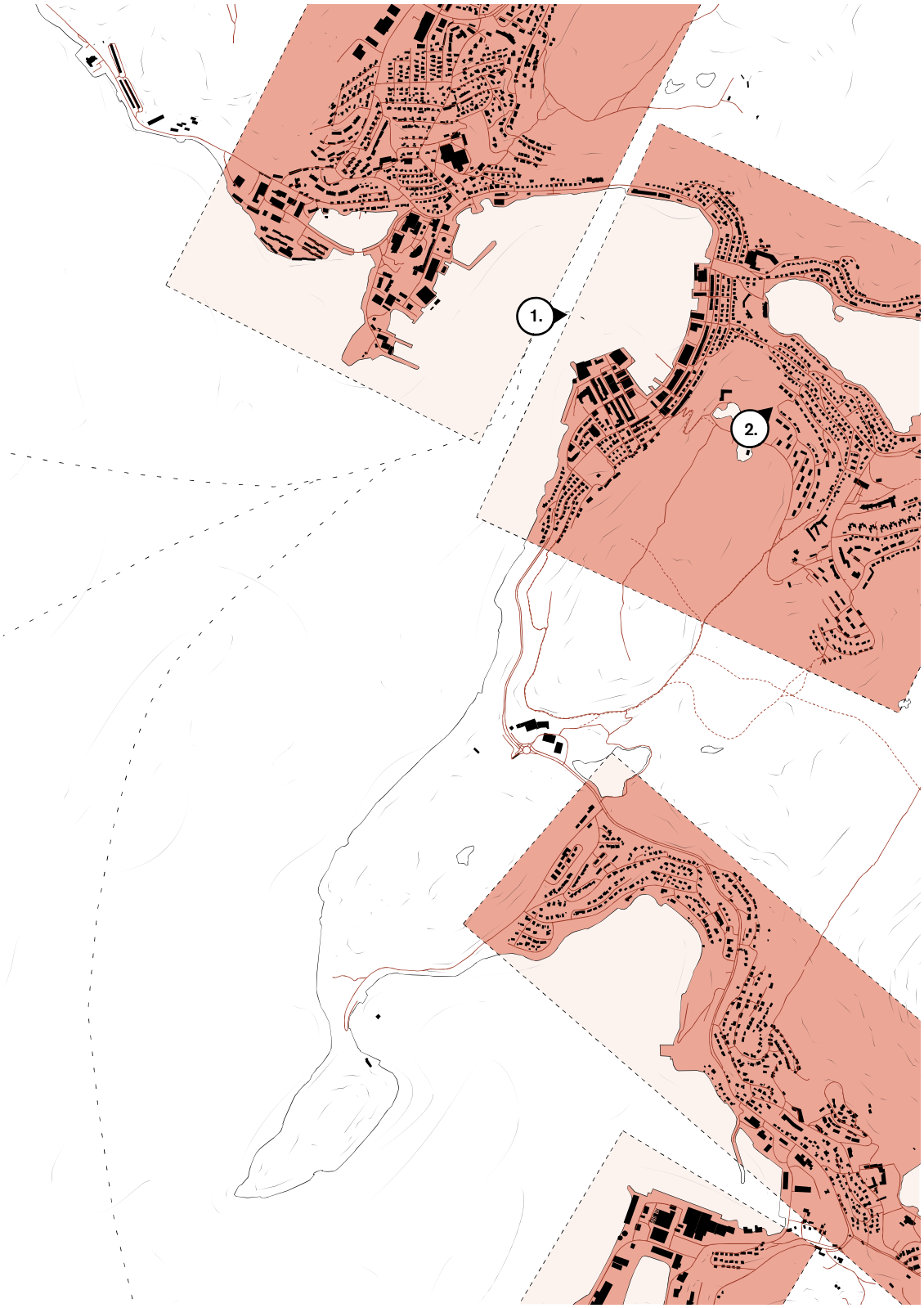
- Buildings
- Roads
- Settlement area

N

Map: 1:25.000



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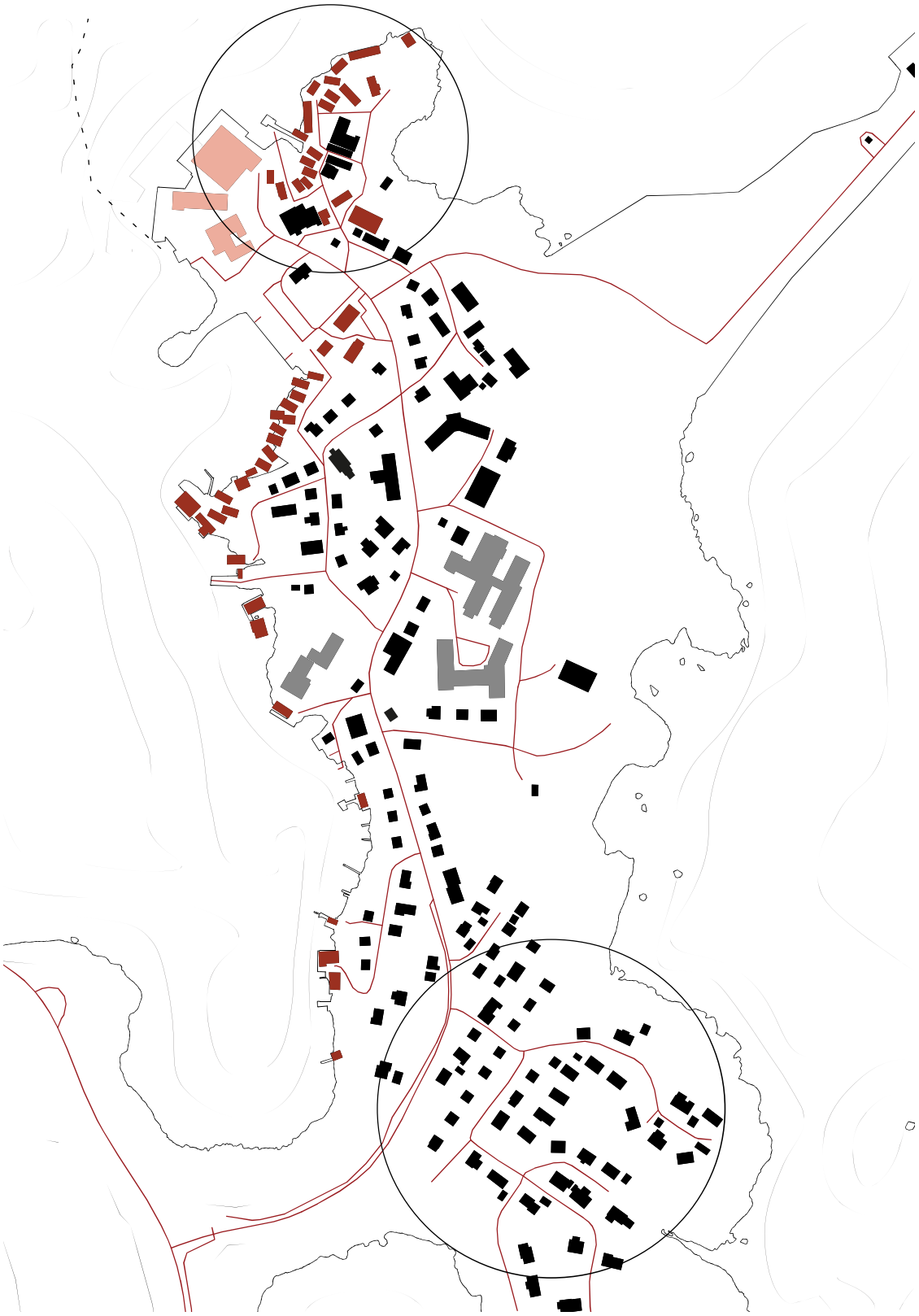




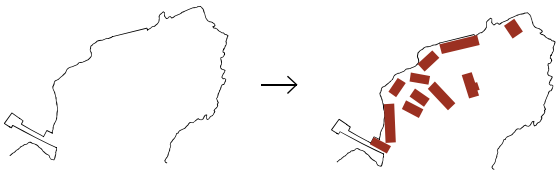
In the North, a dense collecti
the coast.

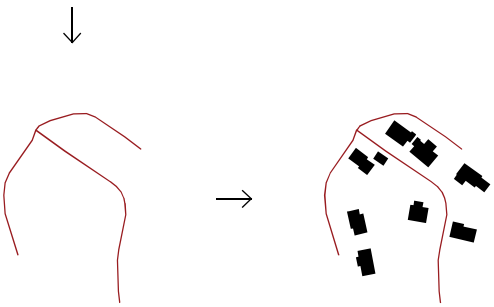
In the South, the later develo
infrastructure was developed





ion of fishing cottages following





ppements followed after
l.



Urban morphology

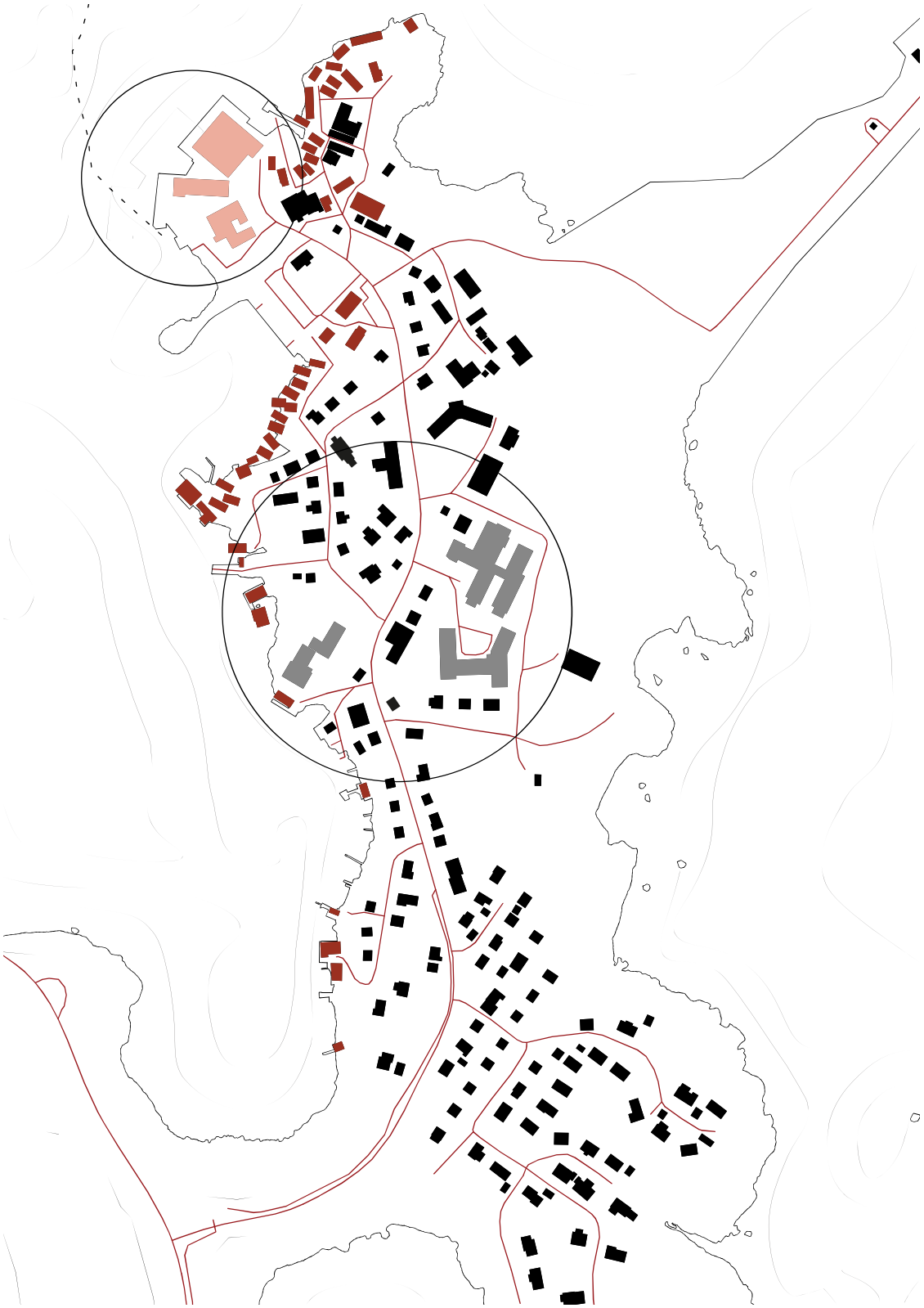
Urban typology
Building ensembles

Comparing the building ensembles of the North of Reine to the South shows a clear difference in how dealing with structure of the landscape changed over time

- Municipal buidlings
- Traditional (family) homes
- Renovated vernacular housing
- Fishing industry

N

Map: 1:5.000





The fish industry that is prese
upscaled traditional fishing h

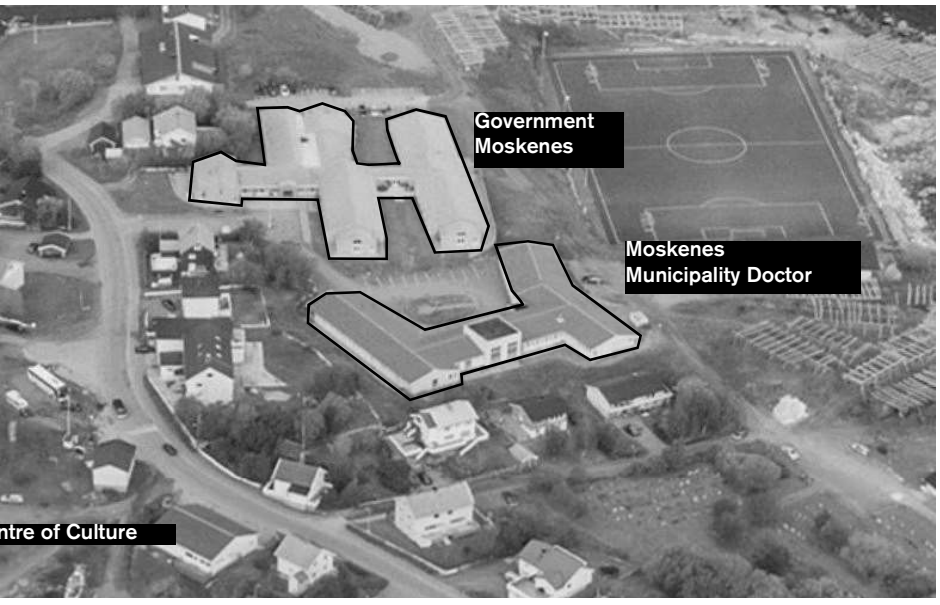
Bigger buildings with public
and seem te be extruded orig

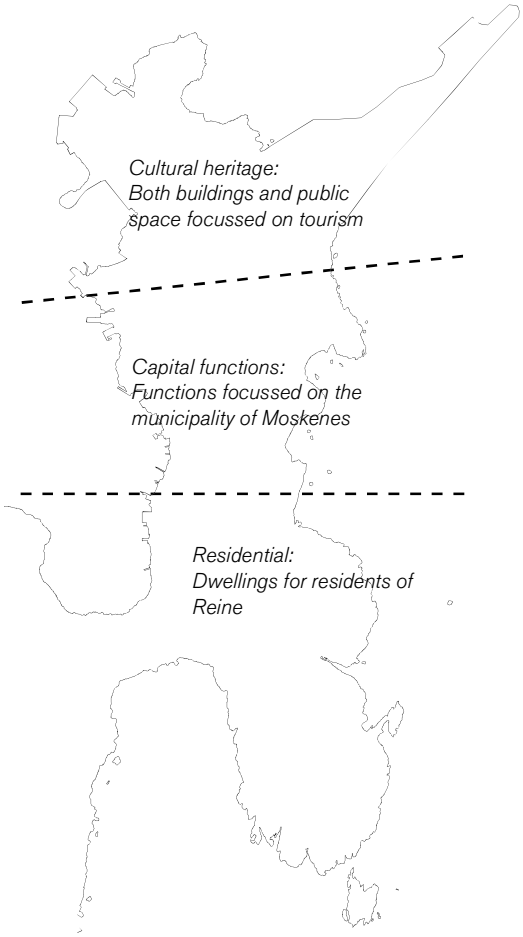




ent is has the features of an
ouse.

functions have the slanted roofs
ginal fishing houses.





Urban morphology

Urban typology
Building ensembles

- Municipal buidlings
- Traditional (family) homes
- Renovated vernacular housing
- Fishing industry

N

Map: 1:5.000



Most of the original urban tissue is made up of freestanding houses. The buildings follow the margins of the landscape; along the foot of the mountain. A soft grid of roads encloses them.

Planned building ensembles on the east and west side of Hammerfest. These are the most recent developments. The city originated along the coast and has had a radial development inland. Only the latest extensions are bigger, planned areas, funded by the oil companies.The housing is used to offer temporal residency to people working on the oil platforms off the coast of Hammerfest.

Urban morphology

Urban typology
Building ensembles

There is a high visibility of the petroleum companies' constributions to the region, seen through the spending of the generated wealth. Along the coast, but also more inland, new buildings are funded by the company. Refurbished facades, schools and daycare facilities are also part of the funding. In the city centre, heated pavement create the opportunity of walking and shopping, even during winter. All this due to new wealth generated using property taxes from the petroleum companies
(Soltvedt, Rottem, Hønneland; 2019)



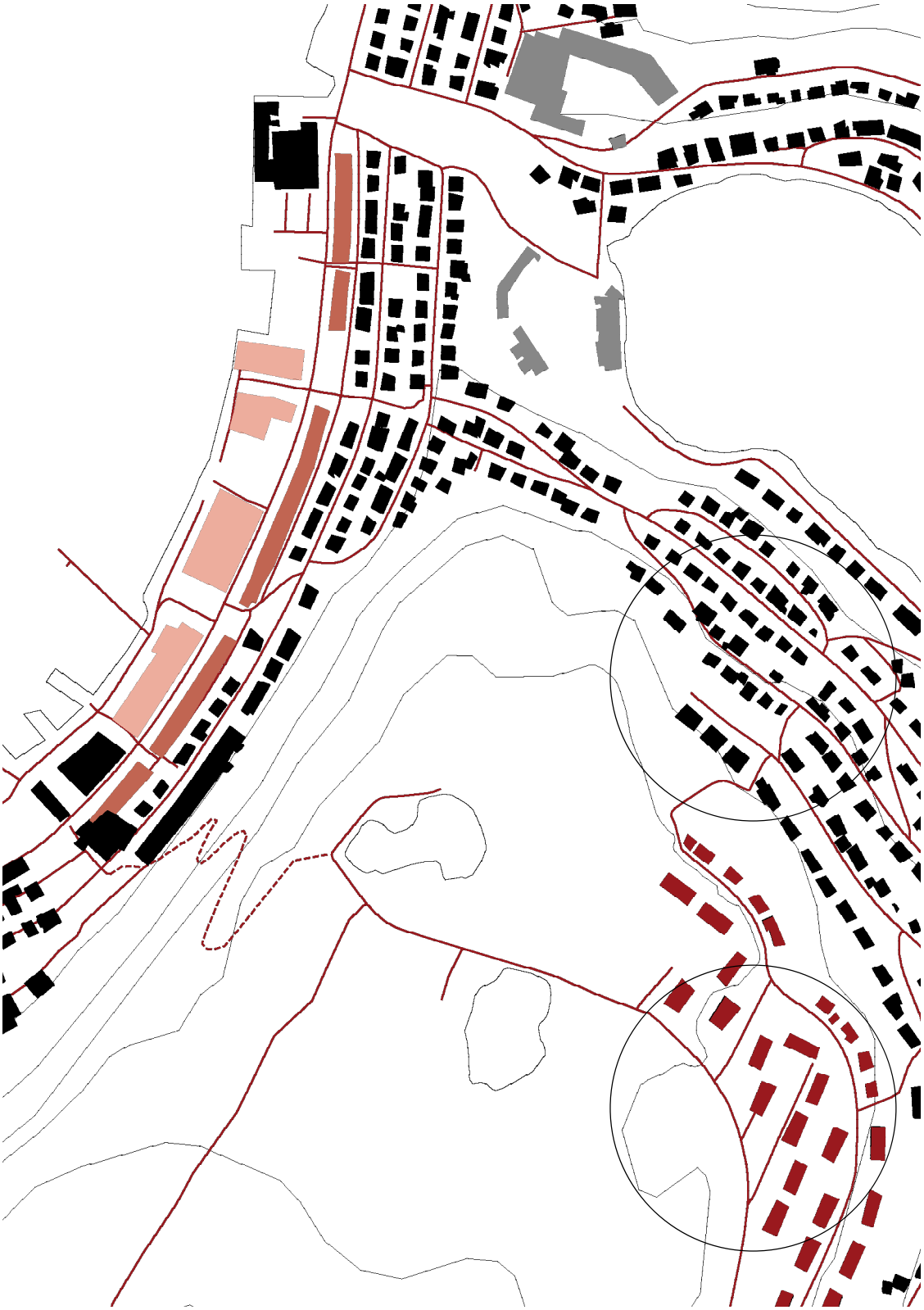
- Schools
- Traditional (family) homes
- Baracks
- Apartment buildings
- Large scale offices / public buildings

N

Map: 1:5.000



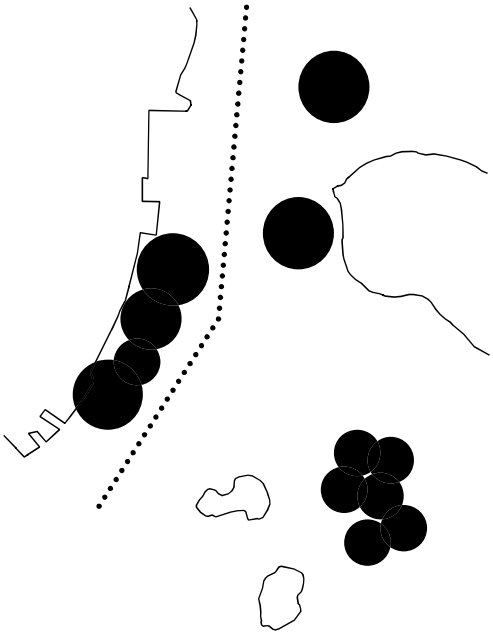






Along the main road stretching along the entire coast of Hammerfest, buildings have more than one level. The majority has functions in the plinth. Compared to the rest of Hammerfest, it is a very dense area and does have the same traditional atmosphere.

Buildings and infrastructure funded by the State-owned oil industry



Along the coast, new public buildings have been developed recently, consisting of a Culture centre, a Smarthotel and a bar with a terrace. In addition to this, the new head office of the oil industry has recently been finished. They are in strong contrast with the old buildings in the harbour, and the orginal housing building ensembles.



Urban morphology

Urban typology
Building ensembles

Growing influence of the oil industry through funding to public buildings and infrastructure.

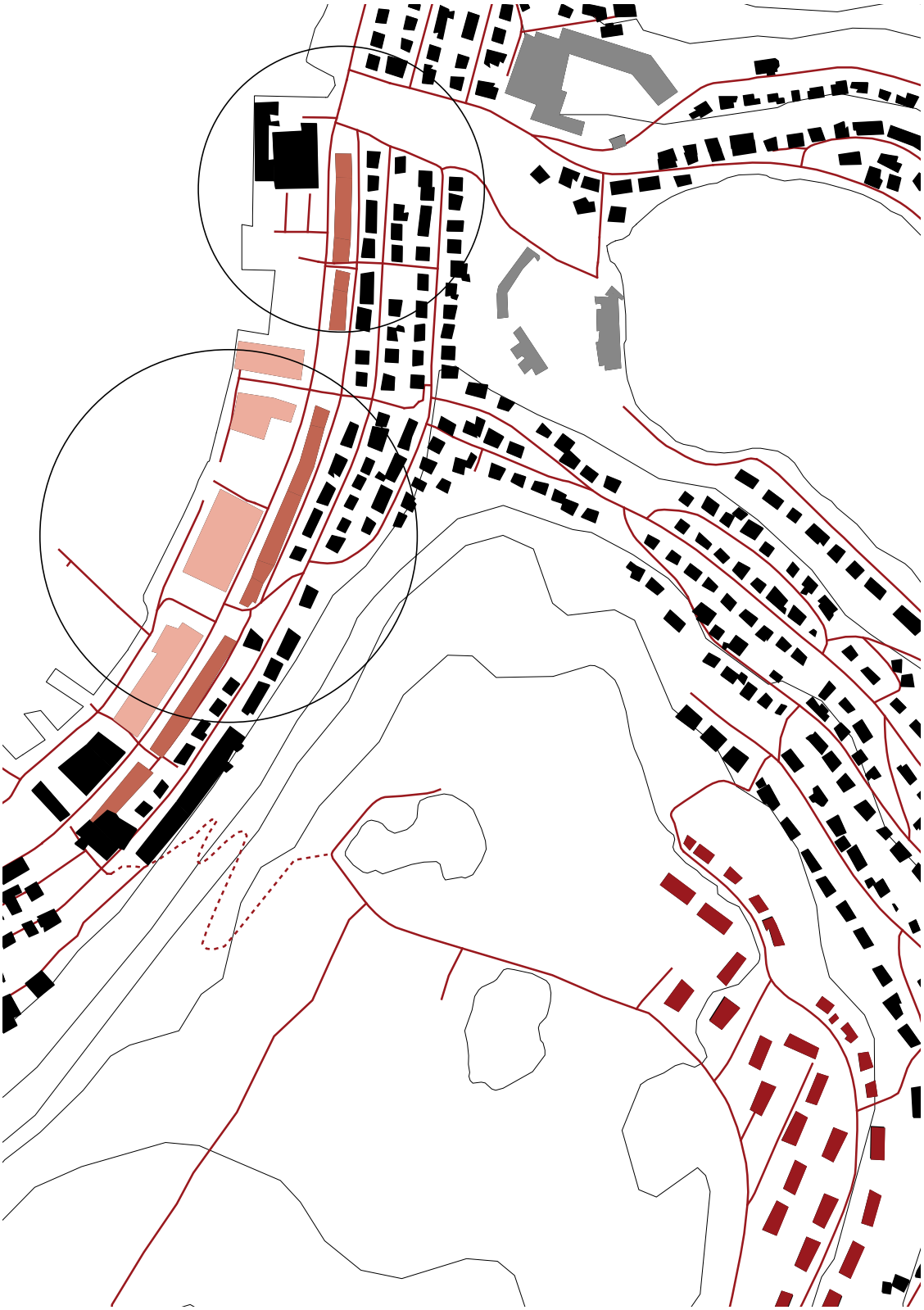
- Schools
- Traditional (family) homes
- Baracks
- Apartment buildings
- Large scale offices / public buildings

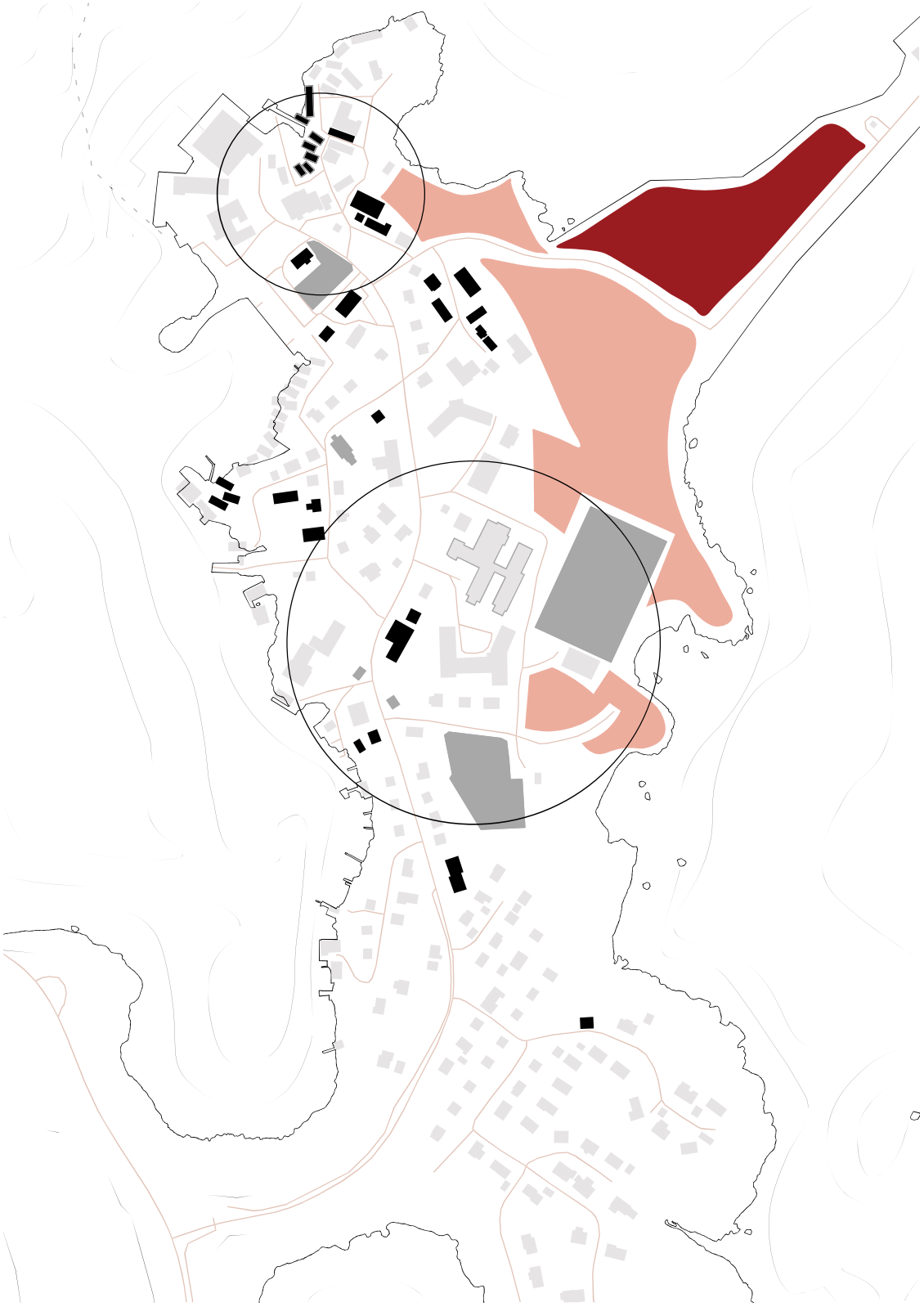
N

Map: 1:5.000











The Northern area of Reine c
moving through the distinctiv
Rorbu, creating a very scenic

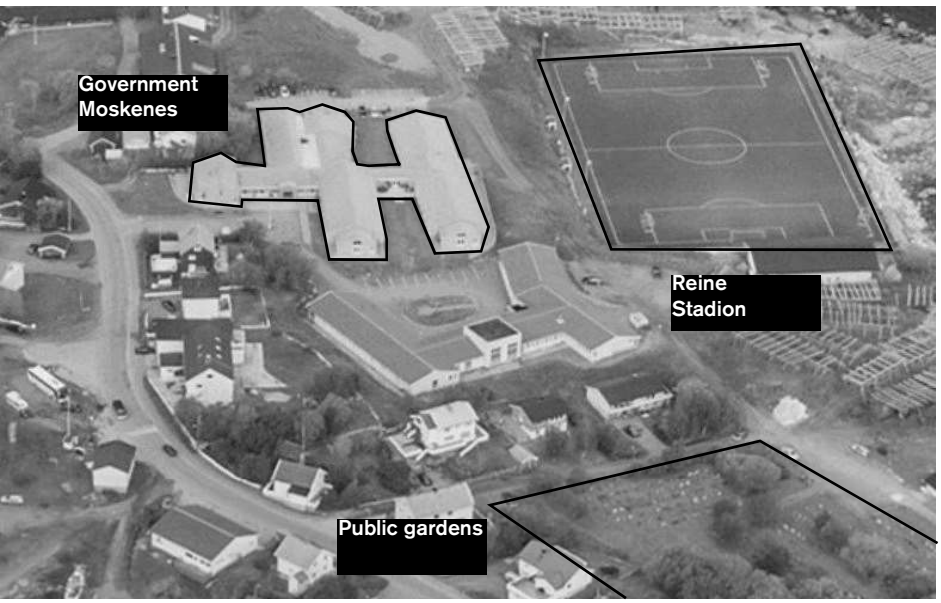
The central part of Reine has
the permanent community, ra





consists of small walkways
ve combination of Hjell and
c view ideal for tourism.

s public functions that serve
ather than the tourists.



Urban morphology

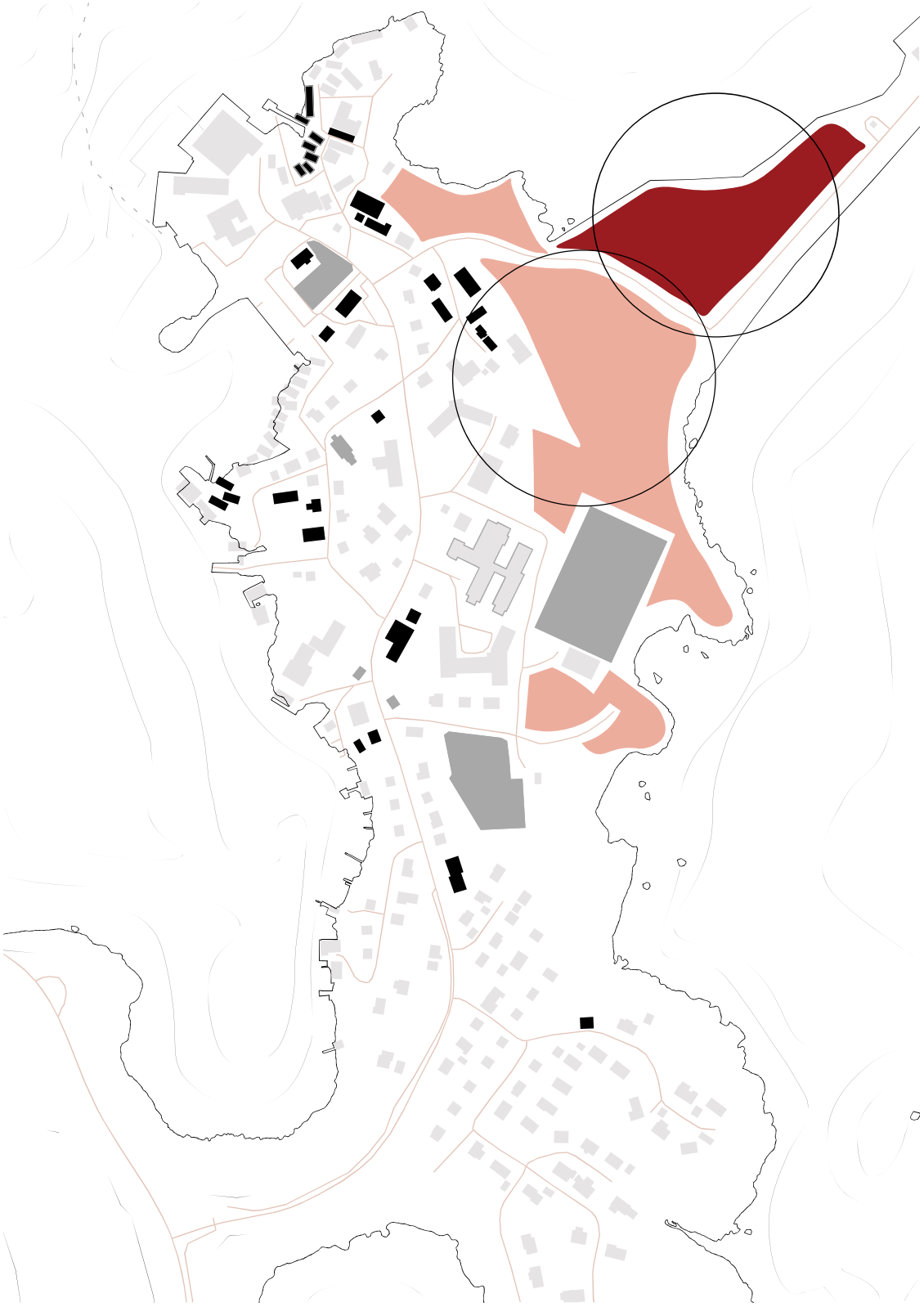
Urban typology
Public space

The tourism industry is taking up more and more of Reine.

- Public building
- Community space
- Building with touristic function
- Camp site
- Hjell

N

Map: 1:5.000





The pier serves as a place fo
during the night.

A large area is used for the c
winter. The structures are ca

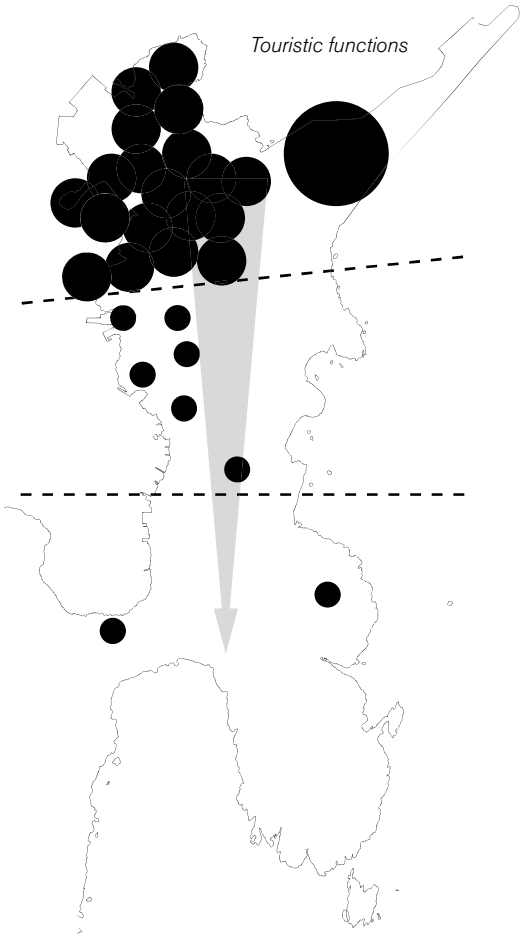




r campers to stay

od to be dried during
lled "Hjell".





Urban morphology

Urban typology
Public space

The tourism industry is taking up more and more of Reine.

- Public building
- Community space
- Building with touristic function
- Camp site
- Hjell

N

Map: 1:5.000



Both schools are important public buildings for the community. Recent renovations and expansions were funded by the petroleum companies. They enclose safe playgrounds for children and offer a place to come together.

Wooden stairs reach to the top of a mountain looking out over Hammerfest. The wooden fencing seen in the picture protects lower laying areas from landslides and avalanches during winter. Therefore, the function of public space changes drastically during this time.



Urban morphology

Urban typology
Public space

The amount of recreational public space is quite limited and its availability is greatly influenced by the weather.

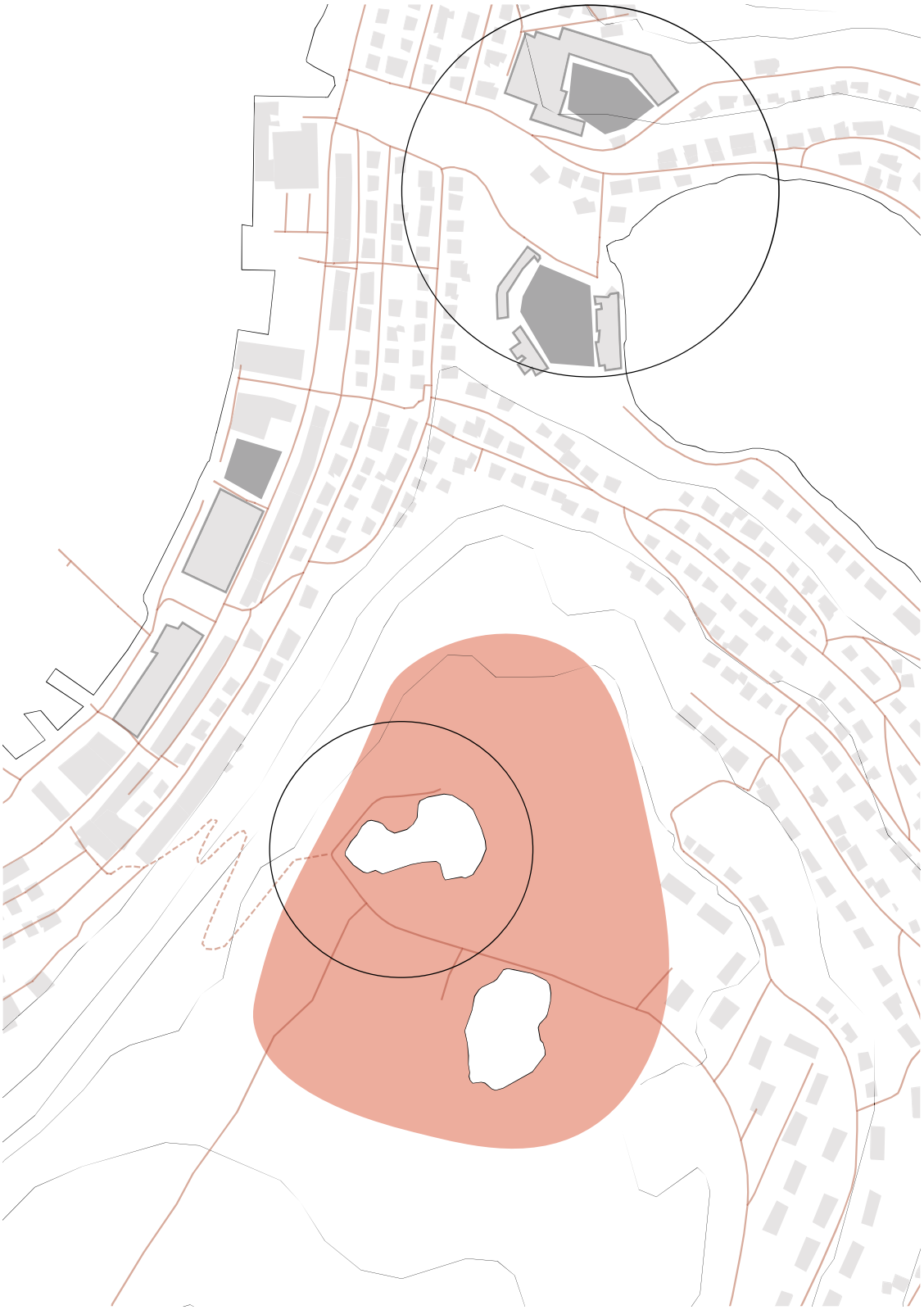
- Public building
- School playground
- Building with touristic function
- Look-out park

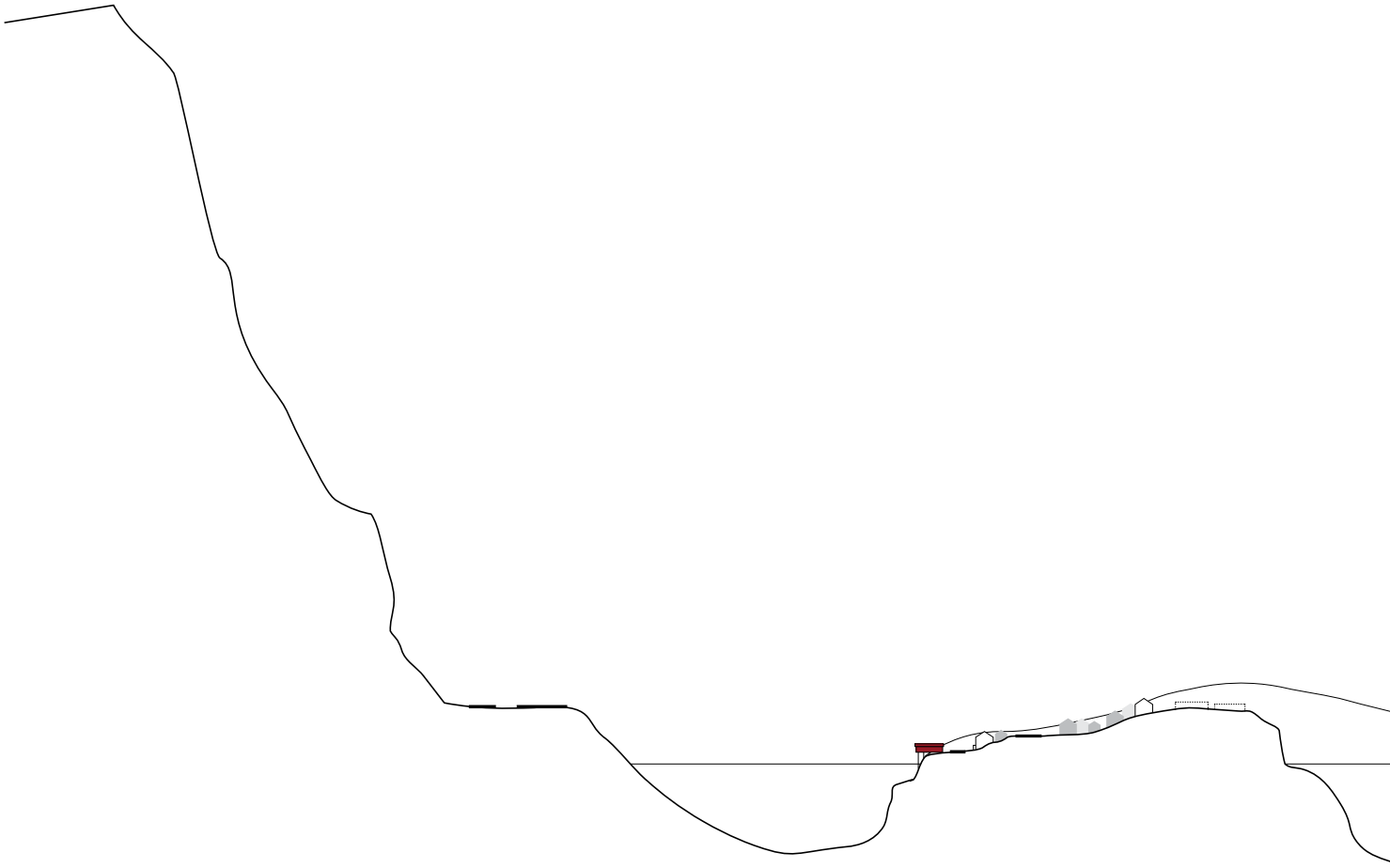
N

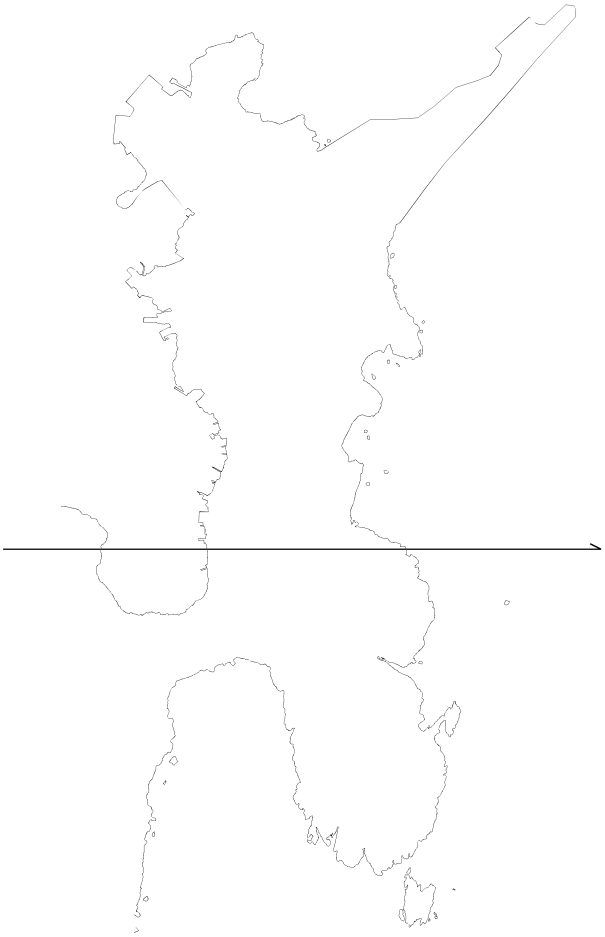
Map: 1:5.000

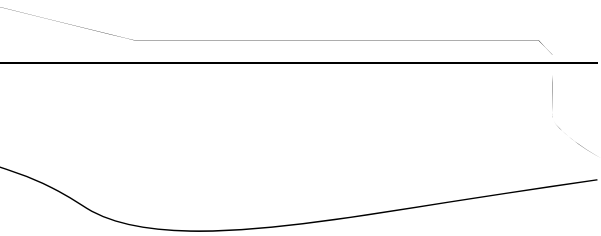












Urban morphology

Urban typology
Section

N

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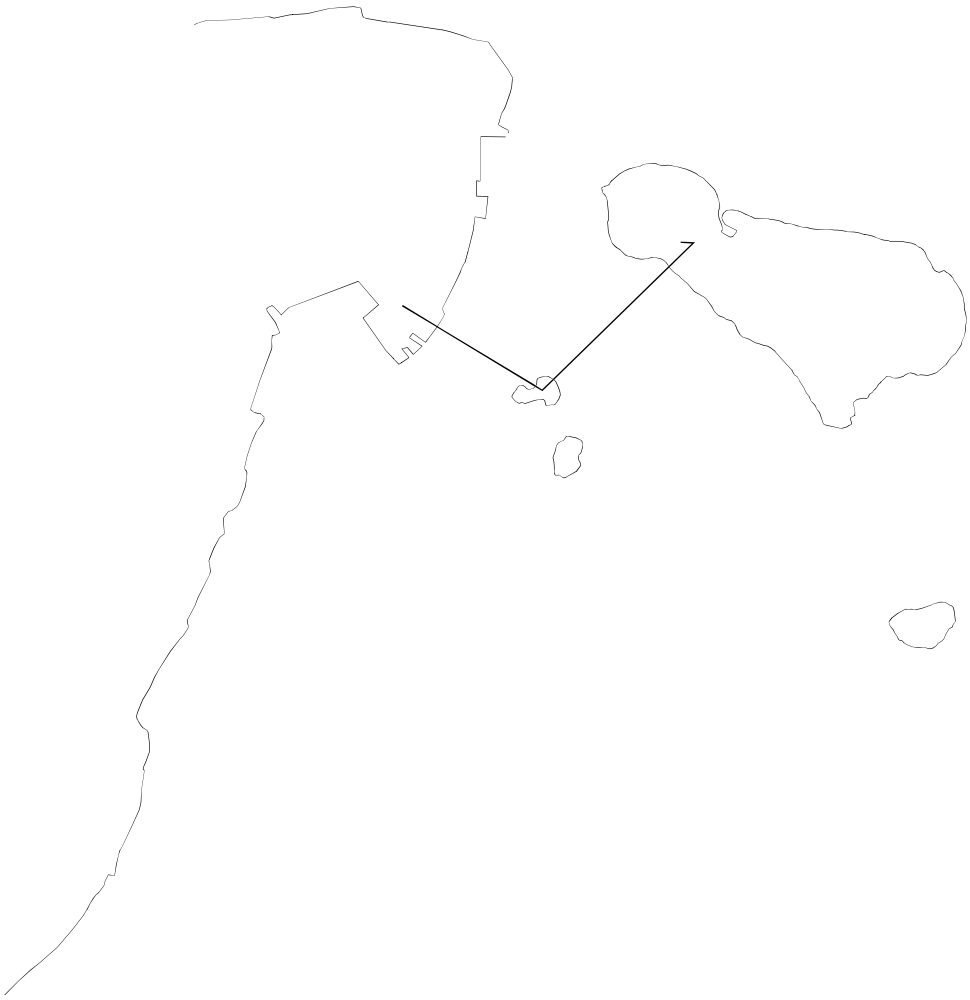

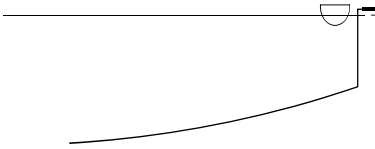

Urban morphology

Urban typology
Section

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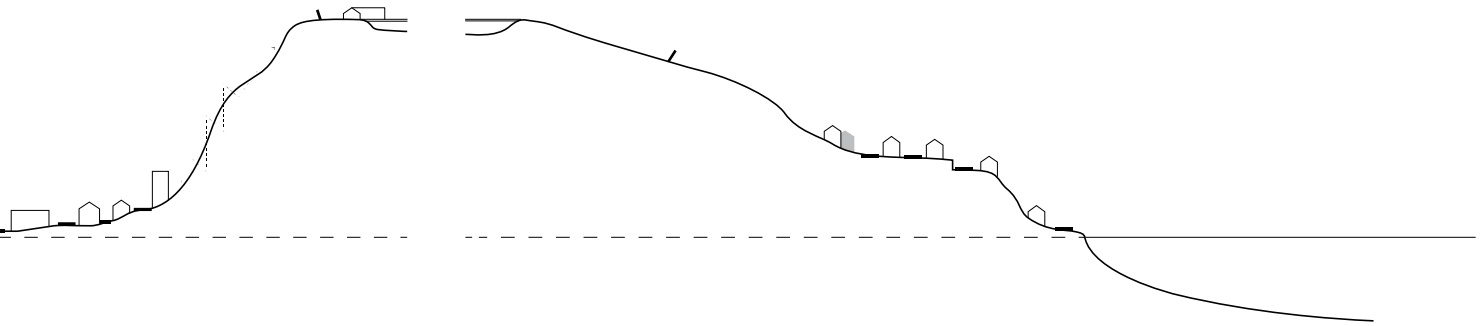
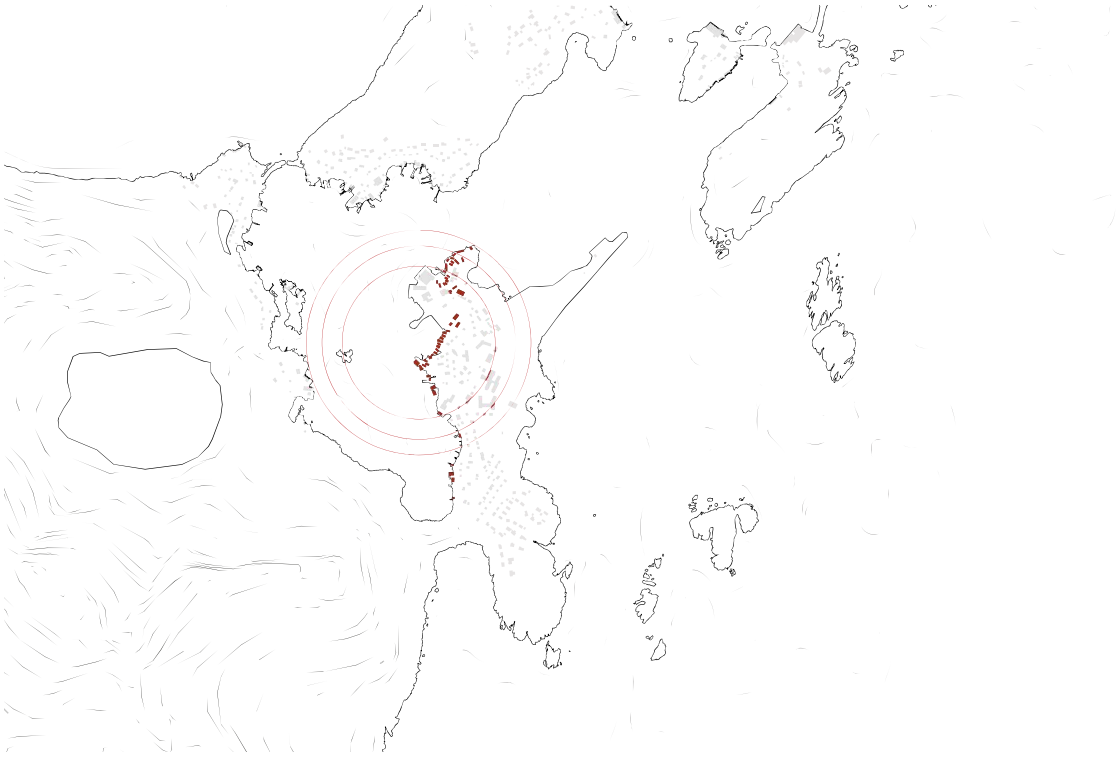


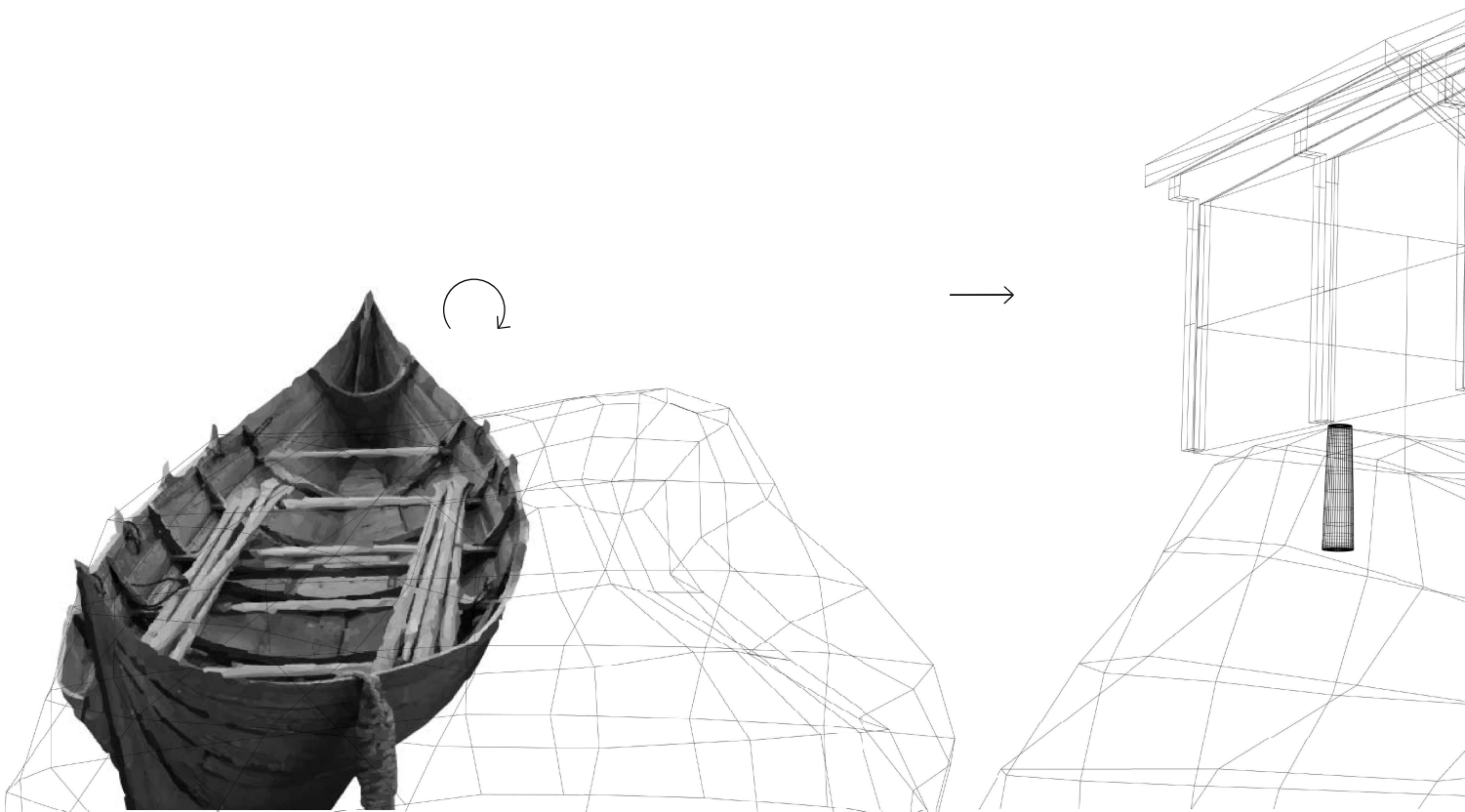




(Šmerkl, 2009)

History

Settlements started on the coast as a temporary resting place for fishermen. They would use their boats as shelter. Eventually, as boats grew bigger, the small cottages were built for the fishermen since they could no longer drag their boats on shore. Over time, these cottages lost their temporary identity.





Rorbu

Rorbu is a Norwegian traditional type of seasonal house used by fishermen, normally located in a fishing village. The buildings are constructed on land, but with the one end on poles in the water, allowing easy access to vessels. The style and term is used along the coast of Western Norway and Northern Norway, and is most common on Lofoten and northwards to eastern Finnmark. The use of rorbu for fishing has diminished and the style of housing is now largely used to rent out to tourists.

Slanted (sod) roof

Almost all buildings is Reine and Hammerfest have slanted roofs. The ones that do not, are appartment buildings. Some of the Rorbu buildings is Reine have sod roof. A sod roof is a traditional Scandinavian type of green roof covered with sod on top of several layers of birch bark on gently sloping wooden roof boards. Until the late 19th century, it was the most common roof on rural log houses in Norway and large parts of the rest of Scandinavia. The load of approximately 250 kg per m of a sod roof is an advantage because it helps to compress the logs and make the walls more draught-proof. In winter the total load may well increase to 400 or 500 kg per m because of snow. Sod is also a reasonably efficient insulator in a cold climate. The birch bark underneath ensures that the roof will be waterproof.

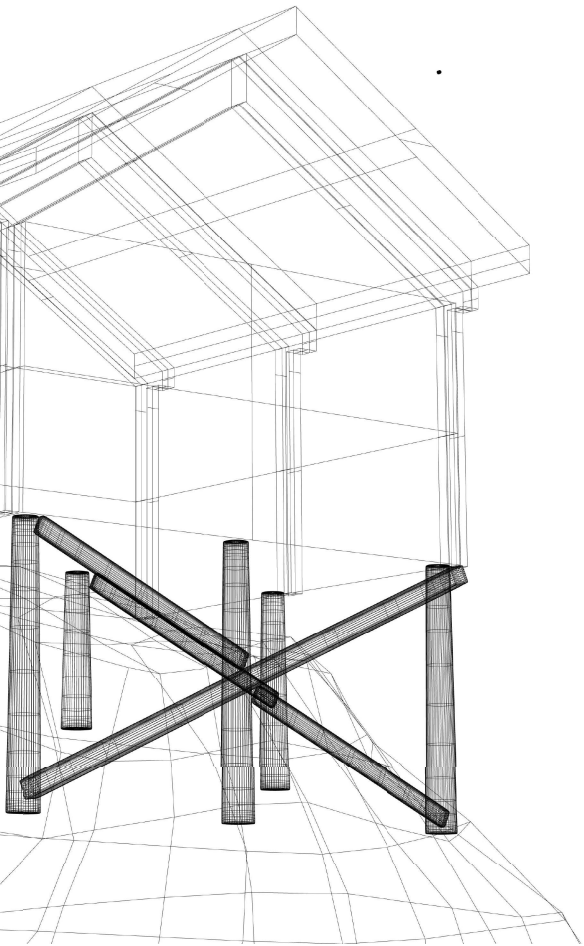
Norwegian wood

Building and art have always been executed in the same medium; wood.

The aspects that indentify the Norwegian vernacular architecture are:

- Refined techniques
- Native Materials
- Distinctive landscape (coastal / rural)
- Climatic conditions (harsh winters)

(Essays, 2018)



Architectural morphology

Architectural typology
Vernacular architecture

N

Map: 1:25.000

Heightened stone base

Base was historically made from stone slabs (or sometimes wooden poles) to:

- Level out the mostly slanted terrain.
- Keep access during heavy snow fall. The acces is above the base and can be reached be stairs.

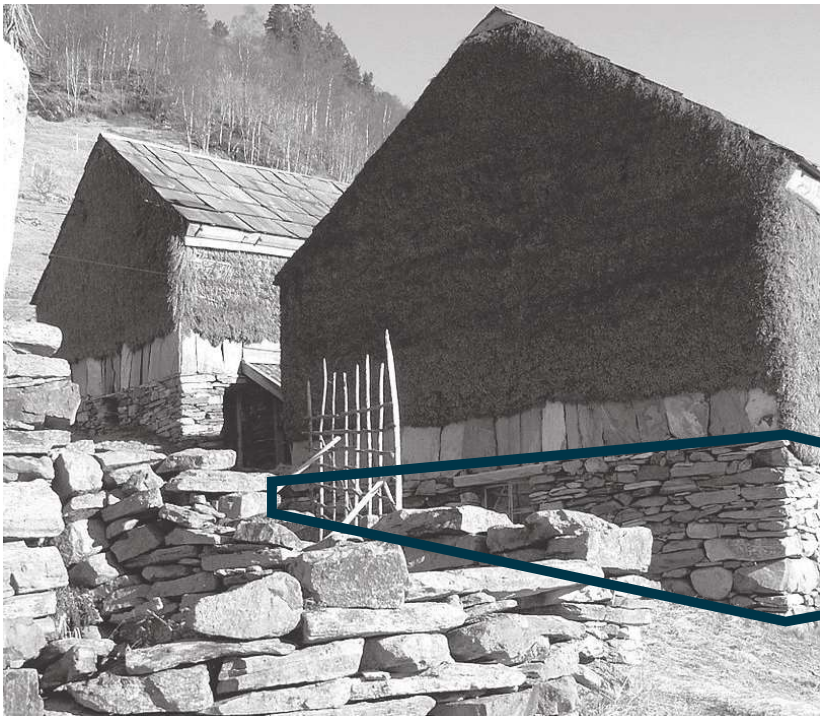
Nowadays the base is mostly made out of concrete.



Colourful weatherboards

Weatherboards are used to finish the facades. In towns and central country districts during the 18th century, log walls were increasingly covered by weatherboards, a fashion made possible by sawmill technology. These buildings were better insulated and better protected against the harsh climate. But the main reason for the rapid adoption of this custom was the more fashionable appearance of boarded walls.

The choice for colourful paint on the weatherboards is to make people remember the colours of summer during the long winters.



(Helland, 2006)

Architectural morphology

Architectural typology
Vernacular architecture

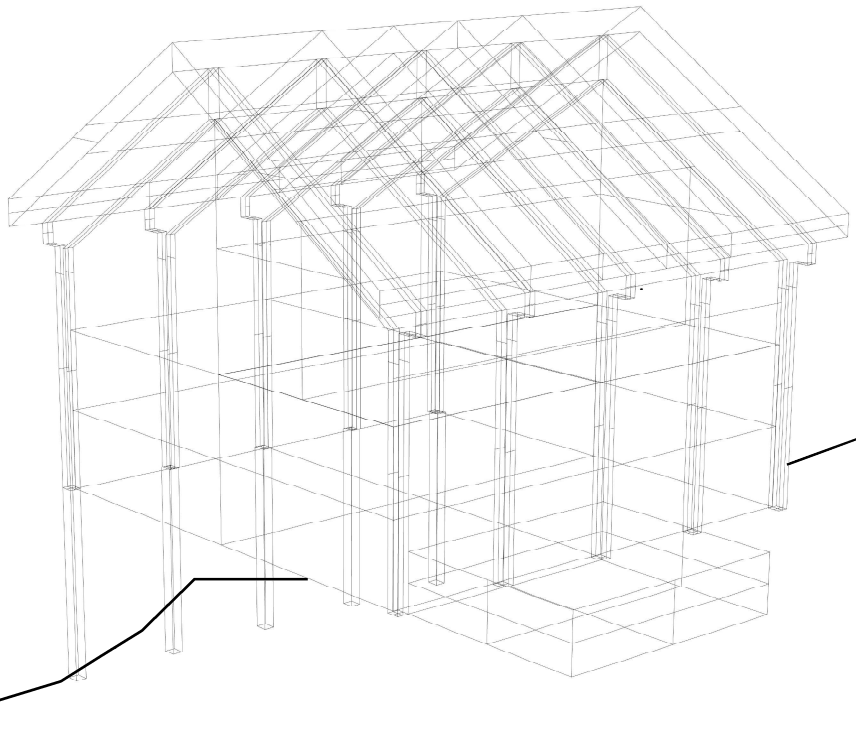
N

Map: 1:25.000









Extreme constructions Reine

Concluding map

The concluding map of the Urban perspective focusses on the increasing influence of the tourism industry on the area. Starting from the place of cultural heritage, the Rorbu, the touristic functions are slowly taking up buildings and public space.

As tourism is a seasonal event, this means that these parts of Reine serve a temporal crowd. This has an effect on the permanent residents, and how they experience their city.

- Increasing stress from tourism
- Buildings with touristic function
- Public space with touristic function

Extreme constructions Hammerfest

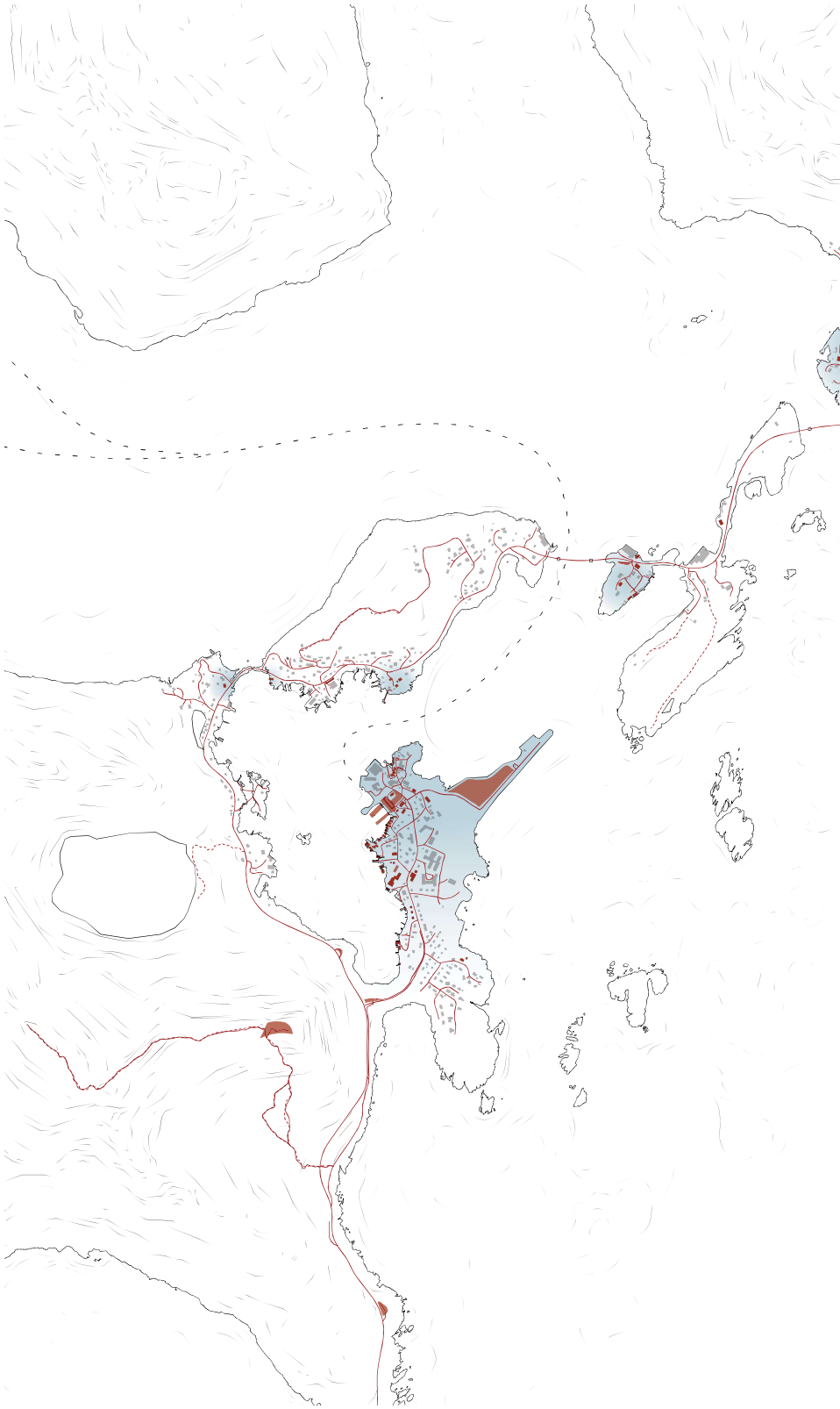
Concluding map

The concluding map of the Urban perspective focusses on the increasing influence of the petroleum industry on the area.

A big portion of the buildings that are funded with tax payed by the oil company are meant to house seasonal workers. These men and women work on the oil platforms off the coast of Hammerfest. In the periods they are not working, they either move directly to the airport to fly home, or they stay in the barracks untill their next shift starts.

This encourages quick expansion of the city, and changes the identity of the city creating a more temporal occupation pattern.

- Increasing influence of petroleum industry
- Buildings funded by petroleum industry
- Infrastructure maintained by petroleum industry



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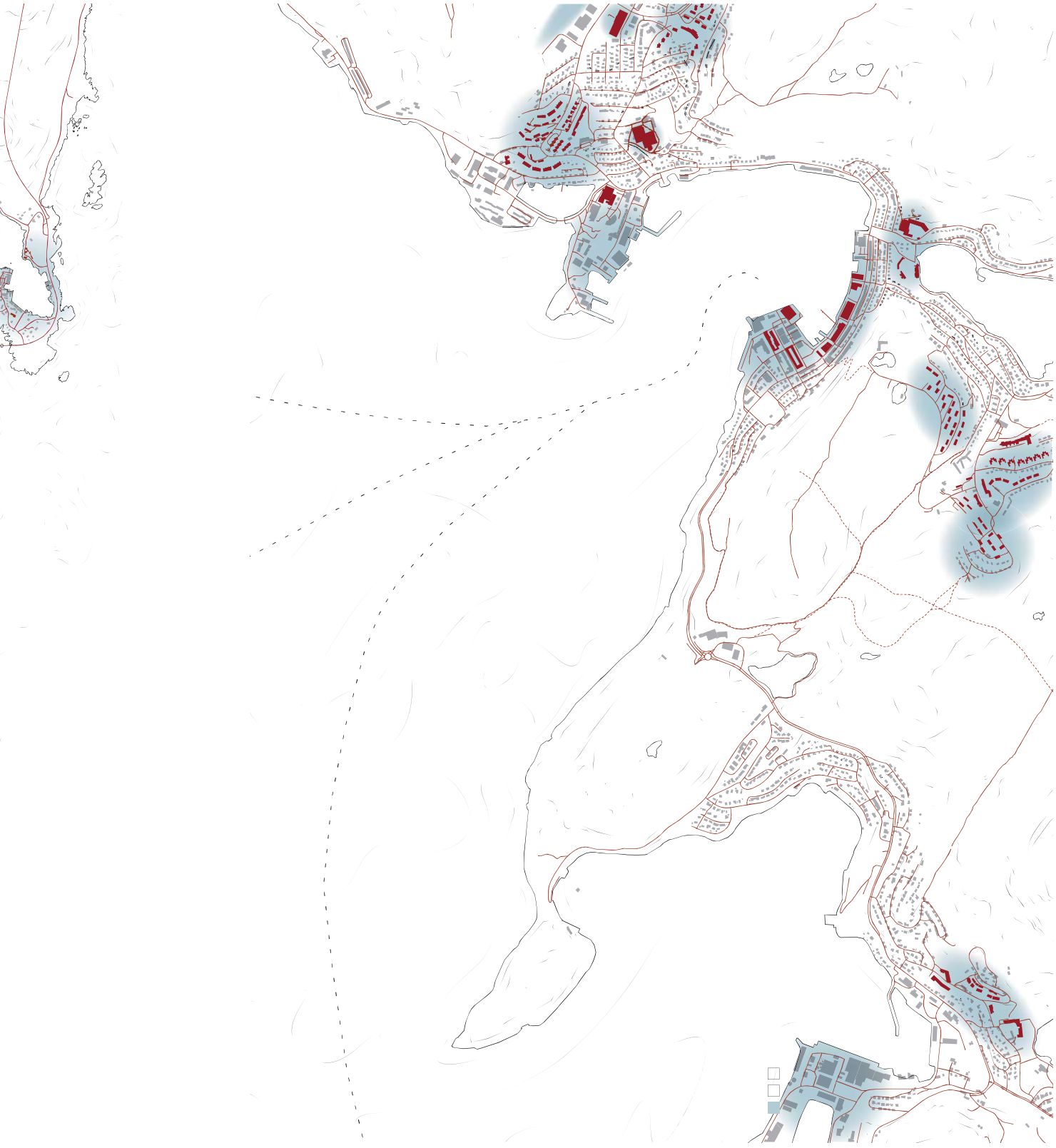
Map: 1:25.000



3.7. Mobility & Transport

How can environmental participation in Hammerfest and Lofoten add to ecosystem building from a transportation and mobility perspective? The method to analyse this theme and research field is to systematically dissect the two different areas, identifying the main pillars of transportation flows and nodes, the potential shocks and stressors, and potential strategies from an ecosystem participation perspective that could mitigate the risks of those shocks and stressors. As discussed in the TIL methodology section, 4 different aspects of transportation and mobility are identified: 1) (human) mobility flows, 2) flows good goods, 3) activity nodes and 4) transfer nodes. The scales and scope of research are bound to two different scales. For Lofoten it's: 1:5000 and 1:25000, and for Hammerfest, it's 1:25000 and 1:50000. The justification for these different geographical scopes is because of the nature of the environments, whereby the exclusion of the oil industry would lead to a significant decrease of quality on the analysis level.

	Shock: **Rockfall**		**Stress:** **increase of usage because of seasonal tourism flows**		
	Accessibility and connectivity	**Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)**	**Accessibility and connectivity**	**Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)**	**Response**
Mobility flows: PT/Car flows	Rockfalls can hurt the users of the road/waterway network at the time of impact		Increase of congestion could harm connectivity and accessibility of routes.		Increase adaptatio the events (sensor warning systems increasing resilienc another approach v be to live on higher ground (robust). investments in infrastructure or po better spread touris flows.
Activity nodes: Critical facilities	Rockfalls could seriously hurt operations and the integral infrastructure of both activity nodes as transfer nodes by varying levels of damage.	The social and economic vulnerability lies in the dependency of these activity nodes.		The increase could lead to a bigger stress on equipment because of increased use, resulting in wear and tear of equipment.	The nature of this s is fat tailed (very ra but is relevant enou let authorities place sensors to monitor rockfalls and predic them
Logistics flows: Road/waterway network	Rockfall can hurt the connectivity of the road/waterway network because of damage.	The nature of this shock is fat tailed (very rare) but is relevant enough to let authorities place sensors to monitor rockfalls and predict them	The increase could lead to a bigger stress on equipment because of increased use, resulting in wear and tear of equipment.		
Transfer nodes: harbours/airports	Rock falls could seriously hurt operations and the integral infrastructure of both activity nodes as transfer nodes by varying levels of damage.	The social and economic vulnerability lies in the dependency of these transfer nodes.			investments in infrastructure or po better spread touris flows
Conclusion	For Lofoten it becomes clear that the increase of tourism is the most human controlled stress, while fat tailed events like falls are shocks that are harder to control. To create better insights on how eco-system participation could play a role in mitigation of these processes, further research into the economic dependency of tourism and alternative ways to facilita tourism flows should be able to provide interesting insights.				

n to s ce), would r olicy to sm
shock are) ugh to e ct
olicy to sm
e rock n the ate

Lofoten

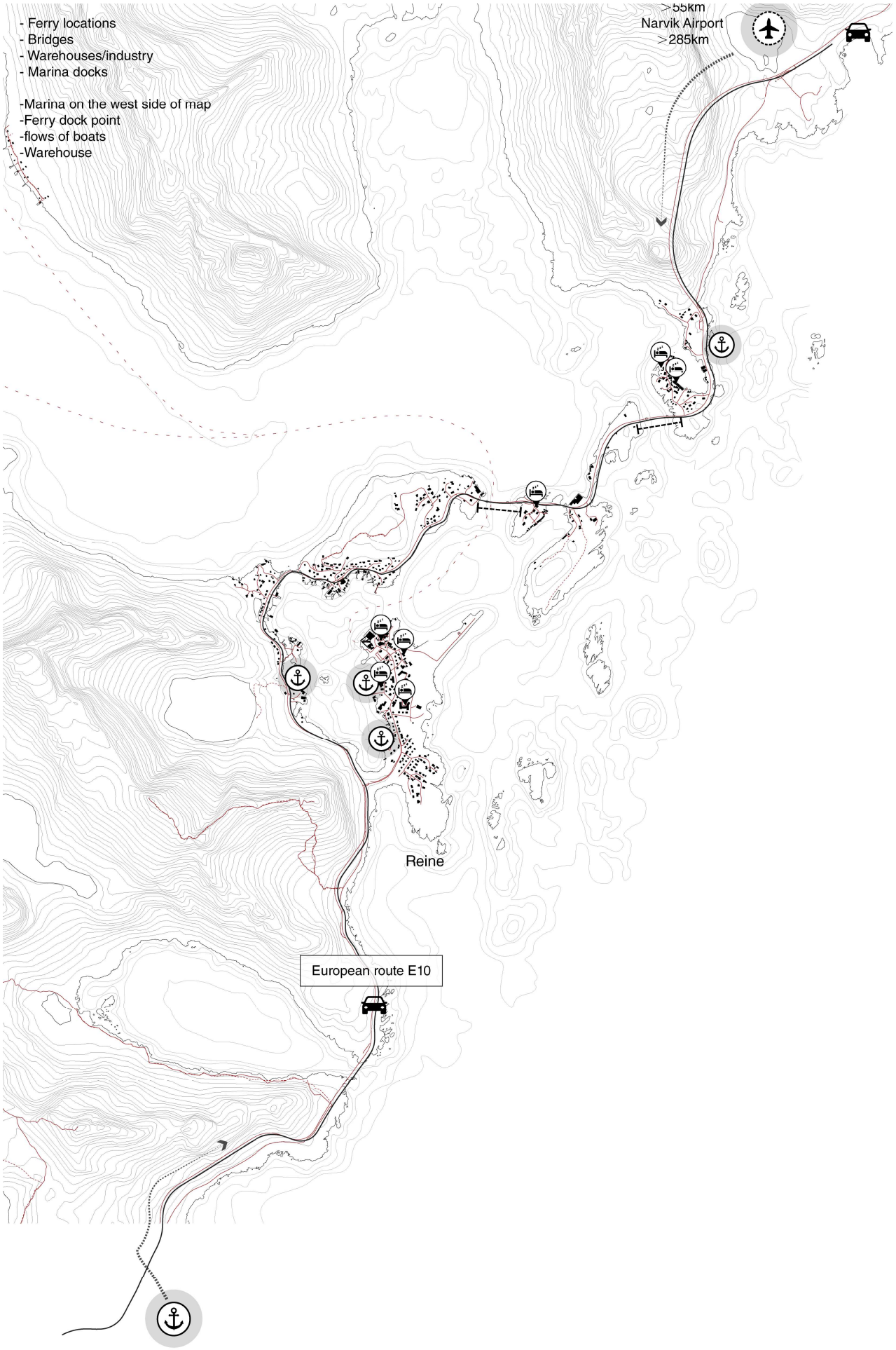
In Lofoten, the main aspects of transportation are portrayed in maps XX and XX in their respective scales. The most notable of these aspects is the centering of activities around the harbour of Reine. Both human mobility flows from tourist activities converge with logistical flows from fishery and transportation of goods. The closest airport is 55KM away, and the car dominated mobility flows on land are facilitated by the E10 road network, which can only exist because of critical infrastructure of the two bridges connecting two sides of the archipel. To assess in what way these nodes and mobility flows are prone to shocks and stressors. The potential shocks and stressors will be assessed on their potential impact on relevant indicators for assessing the overall state of transportation systems: connectivity, accessibility and reliability. Table XX includes the framework of these components.

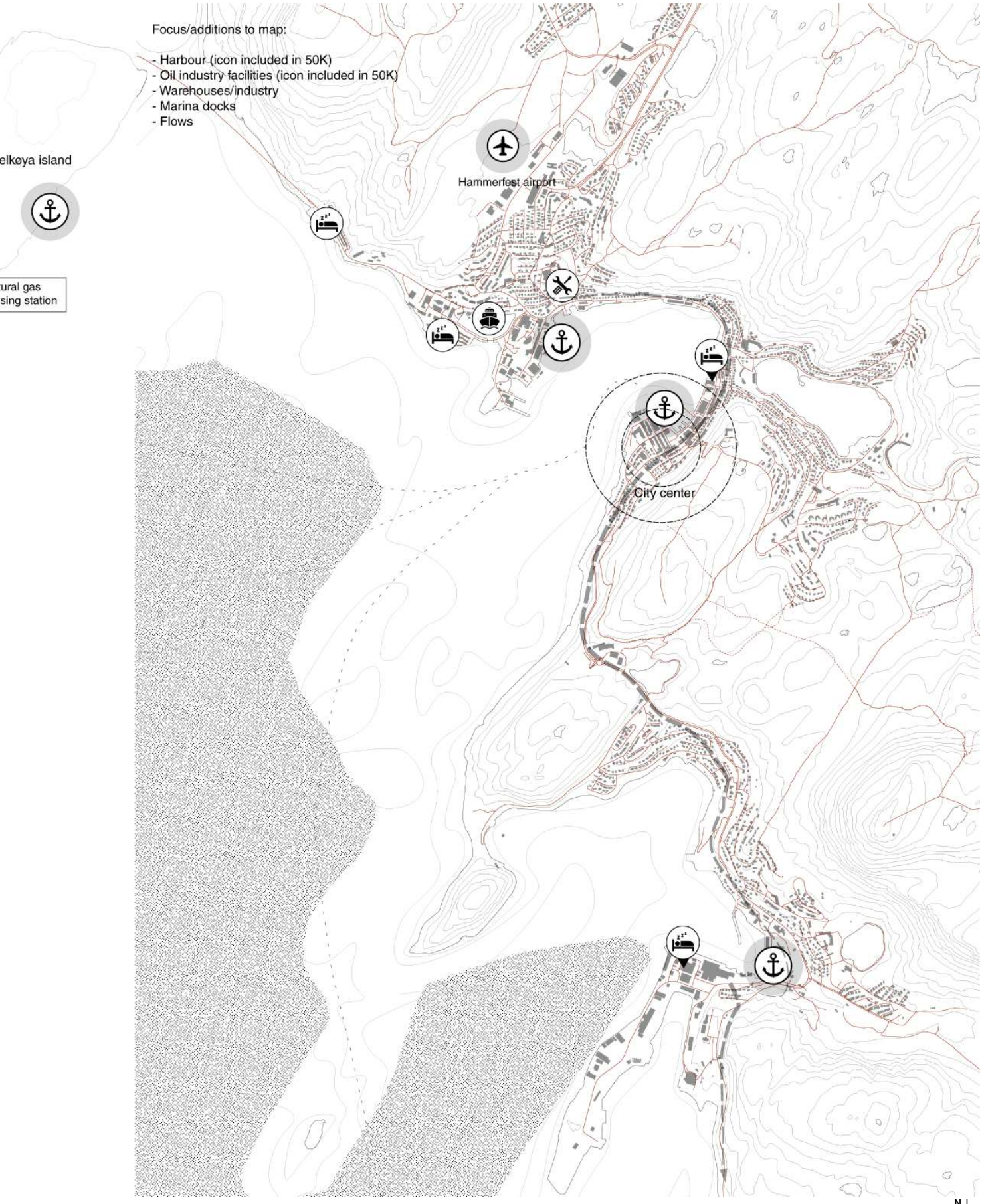
Hammerfest

Hammerfest's transportation and mobility flows around the activity and transfer nodes are mainly concentrated at it's harbour and the oil industry facilities displayed in maps XX and XX. The potential shocks and stresses of hammerfest concentrate on the stress that has facilitated much of this oil industry: climate change and the de-icing of the environment, and the potential shocks derived from oil drilling activities: oil spills. To put this framework in to more perspective.

Mobilit **flows:** PT car flow Commu Ferry
Activit **nodes:** Critical facilitie
Logisti **flows:** Road/ waterw networ
Transf **nodes:** Harbou
Conclu

	Shock: Oil Spills		**Stress: De-icing**		
	Accessibility and connectivity	**Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)**	**Accessibility and connectivity**	**Vulnerability (Physical and Social) & Reliability: (current mitigation or risk in place)**	**Response**
ty ws uter	Oil spills could harm commuter ferry operations, decreasing accessibility and connectivity of parts of the region.	All land processes would remain in place, but the reliability of human transport over sea is vulnerable to this shock.	De-icing actually increases accessibility and connectivity because it allows transport flows over sea to have less resistance in winter time.	Mobility flows over water are, in this case, antifragile.	The response that decreases risks would be better management of oil activities, but a better approach would be to abolish the industry from operating.
y s	Oils spills could harm operations at oil industry locations at sea, preventing ships to load/dock at the harbour.	Because of the positioning in the ocean, the vulnerability of these facilities is high. The social implications are huge though because of the great dependency of this industry to the local community.	De-icing increases accessibility and connectivity for the same reasons as above.	Activity nodes in the ocean are in this case, antifragile.	
ics ay k	On a higher level, it could harm logistic flows from and to Hammerfest, or even worse transnational routes if the oil spill is of large scale.	The vulnerable erability is high since there is a large dependency on logistical flows and the economic activities tied to these flows.	De-icing on logistical flows could mean the opening of the arctic route, increasing accessibility and connectivity, but >	it could harm environments because of the increase of traffic and pollution that comes with this traffic increase.	
er rs	Oil spills could harm harbour connectivity and accessibility.	Harbours are extremely vulnerable for these shocks.	De-icing increases the connectivity but can also create congestion in traffic, this is dependent on the level of infrastructure.	Transfer nodes like harbours, are in this case, antifragile.	
usion	For Hammerfest, it seems that the oil industry and the deicing process brings a new dynamic of stress and shocks in Hammerfest' transportation and mobility system. Because the oil industry is a national matter, it could be interesting to research how the local community values of Hammerfest are incorporated in these dynamics and what legal frameworks are needed to change to give this community a larger say to what's happening to the area they live and work in.				


- Ferry locations
- Bridges
- Warehouses/industry
- Marina docks
-Marina on the west side of map
-Ferry dock point
-flows of boats
-Warehouse
>55km
Narvik Airport
>285km
Reine
European route E10


Focus/additions to map:
- Harbour (icon included in 50K)
- Oil industry facilities (icon included in 50K)
- Warehouses/industry
- Marina docks
- Flows
elkøya island
ural gas
sing station
Hammerfest airport
City center
N
Map: 1:25.000

Discussion and a look towards the future

Using the TIL framework for the case of Lofoten and Hammerfest it becomes clear that both cases have their own respective transportation and mobility systems that are prone to case-dependent shocks and stresses. The individual conclusions of both cases have some touching points that might be interesting to discuss. For one, in Lofoten we are dealing with a bottom-up type of upcoming tourism industry that is fairly different from that of Hammerfest, where mainly top-down power plays have an influence on the spatial developments. The oil industry in Hammerfest is creating a dependency relationship with the local community by providing investments in infrastructure, jobs and other forms of social functions that are a direct or indirect consequence of their presence in the area. The local community becomes dependent on these developments, as their livelihood and economic flows are shaped around the presence of this industry.

A lot of questions arise on the developments within the two areas. These questions surround three different themes: sustainability, labour issues and local community ownership on a governance perspective. First, questions can be raised in what ways the tourism industry in Lofoten is scaling in a sustainable way. The same question can be raised for Hammerfest, that has to deal with an industry that can be made obsolete in the coming century with upcoming renewable energies. Researching possibilities to make the oil industry infrastructure adaptable for other functions (logistics, energy etc) could provide for valuable insights that could help the community prosper for a longer period beyond the time of the oil industry.

4.

Systems description and synthesis

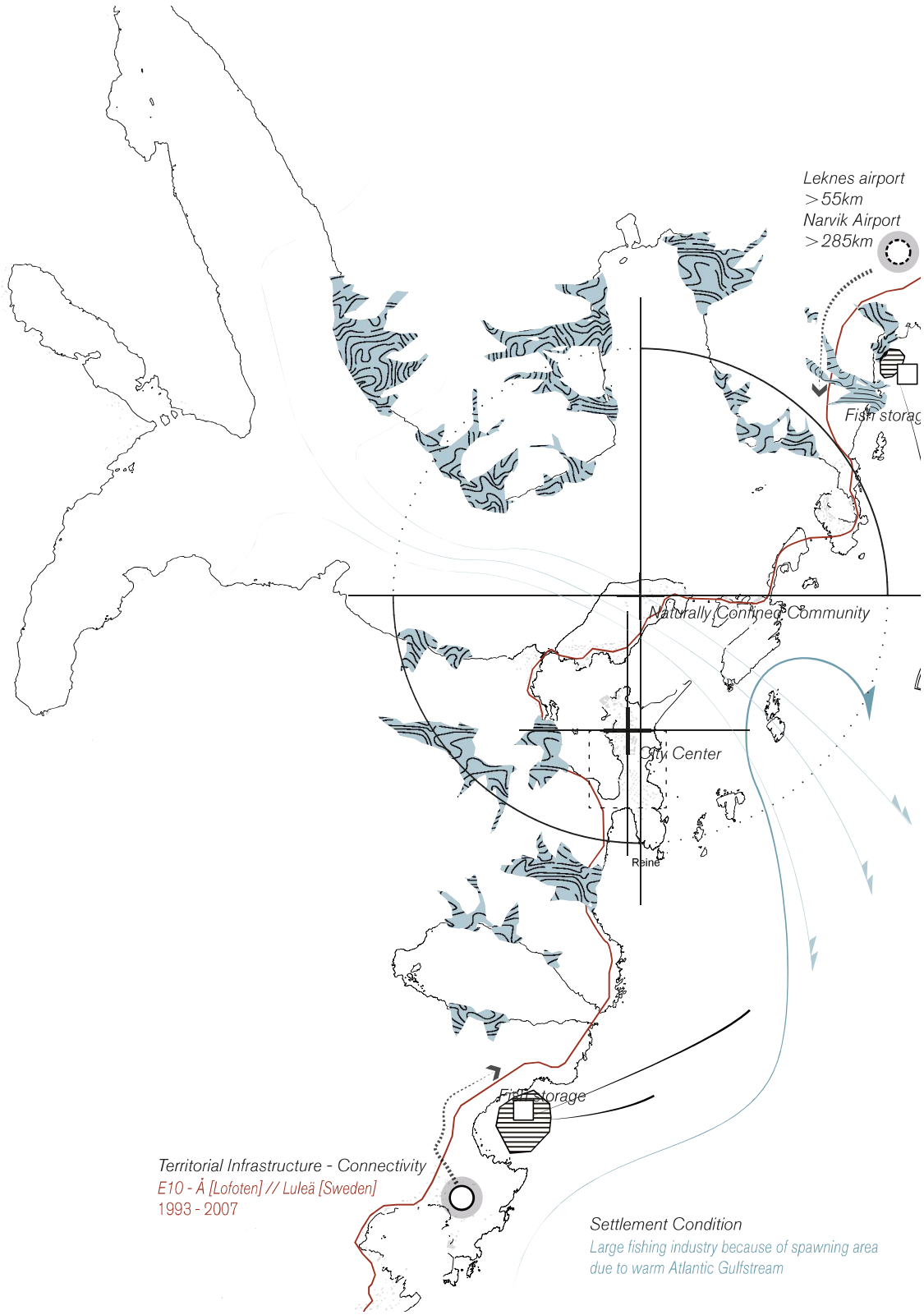
Hybrid system drawing

The maps describe the processes that influence urban settlements and their functionality. Both cities were established as temporary settlements for fishermen to stop and rest during the fishing season, therefore the warm Gulf stream has a significant influence in their development. However, natural hazards like landslides, avalanches and rockfall cause serious stress on the permanent infrastructure that has been developed in the cities throughout the time.

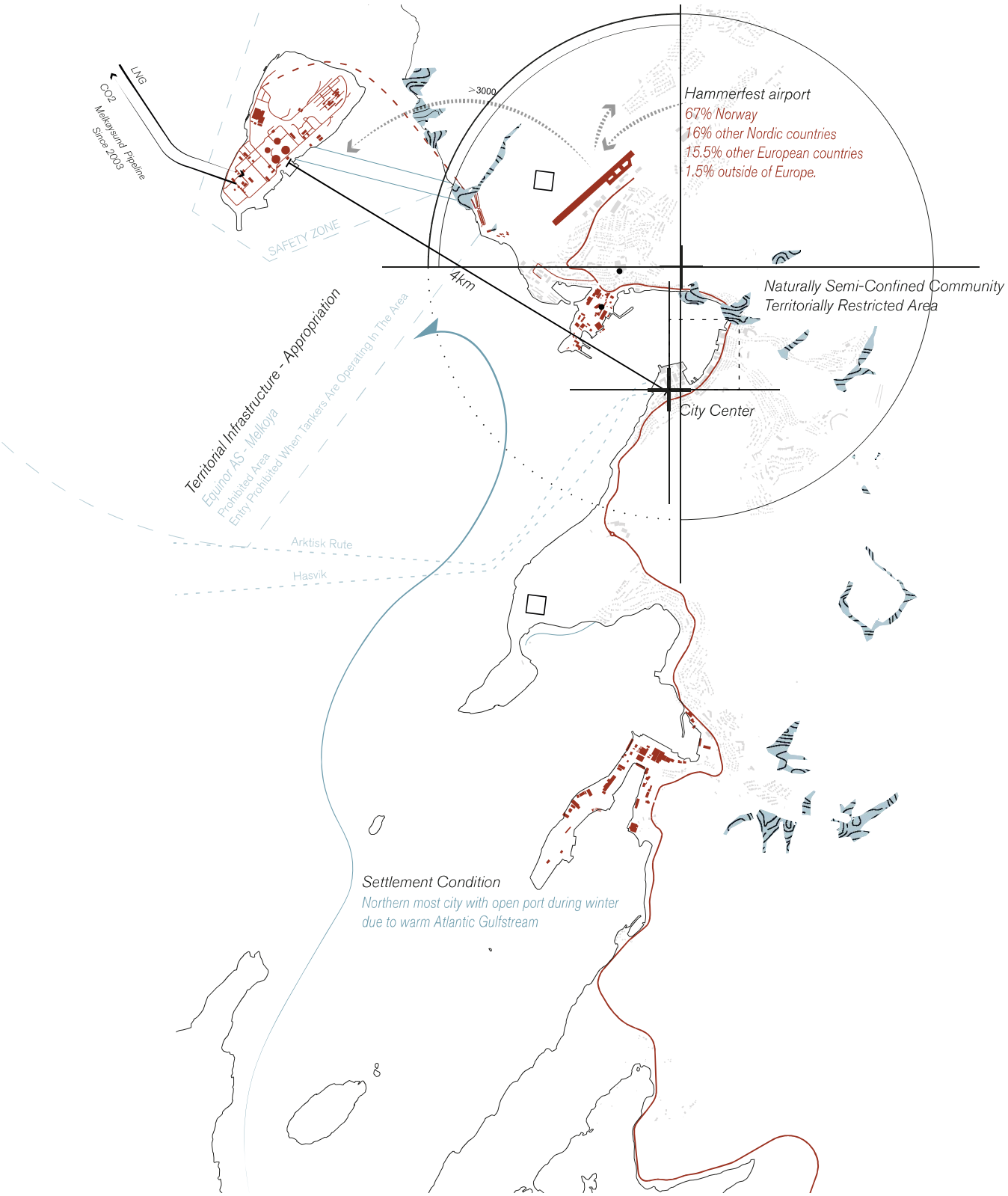
Nevertheless, the importance of the natural habitat in both locations has been in the foreground of the discussion. In Reine, oil drilling and mineral extraction was prohibited to save the natural marine ecosystems, on the other hand, city of Hammerfest is dealing with reindeer who, during the summer period, are coming in the city, thus this conflict due to the provisioned expansion of the city will only be more relevant.

Both cities face conditions that restrict their urban pattern to expand. In Reine, the steep mountainous landscape is inhabitable, therefore the urban settlements have been developed on the coastline where the landscape is more leveled and allow fishermen to dock their boats. In comparison, the urban pattern of Hammerfest has also been developed around the coastline, however, the growing demands of the oil and LNG industry has developed restricted zones around their terminals.

Reine and Hammerfest also face issues caused by the temporal and seasonal residents. In Reine, during the summer tourism season, there is a significant increase of temporary visitors. On the other hand, the national government subsidizes residents to live permanently in the city to preserve the picturesque landscape. In Hammerfest, the oil company employs temporary workers who are living in the city for a limited amount of time throughout the year in barracks.

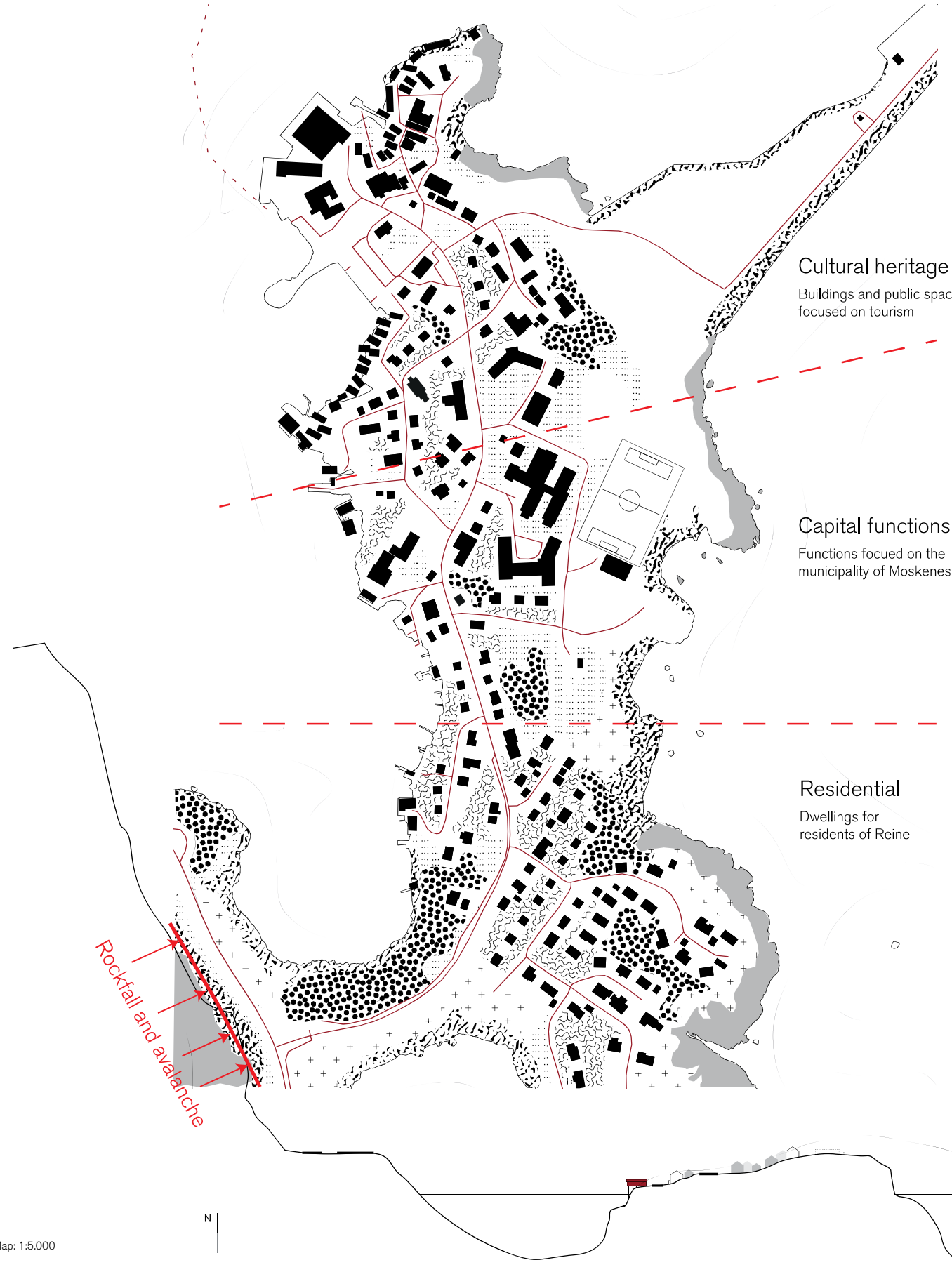

Leknes airport
>55km
Narvik Airport
>285km
Fish storag
Naturally Confined Community
City Center
Reine
Fish storage
Territorial Infrastructure - Connectivity
E10 - Å [Lofoten] // Luleä [Sweden]
1993 - 2007
Settlement Condition
Large fishing industry because of spawning area
due to warm Atlantic Gulfstream
N

Map: 1:50.000


LNG
CO2
Melkøysund Pipeline
Since 2003
>3000
Hammerfest airport
67% Norway
16% other Nordic countries
15.5% other European countries
1.5% outside of Europe.
SAFETY ZONE
4km
Naturally Semi-Confined Community
Territorially Restricted Area
City Center
Territorial Infrastructure - Appropriation
Equinor AS - Melkøya
Prohibited Area
Entry Prohibited When Tankers Are Operating In The Area
Arktisk Rute
Hasvik
Settlement Condition
Northern most city with open port during winter
due to warm Atlantic Gulfstream

N

Map: 1:50.000


Cultural heritage
Buildings and public space focused on tourism
Capital functions
Functions focued on the municipality of Moskenes
Residential
Dwellings for residents of Reine
Rockfall and avalanche
N

Map: 1:5.000

FLORA / FAUNA

Alpine vegetation
Moss, shrubs, summer flowers, lichen

Low broad-leaf bushes
Mountain birch, dwarf birch, willows,

Gardens
Garden conifers, broad-leaf bushes, summer flowers

Grass with wild flowers
Grass, weeds, herbs, summer flowers

Gravel
Moss, lichen

Bedrock
Moss

Fish
Atlantic Cod
Herring
Atlantic Salmon

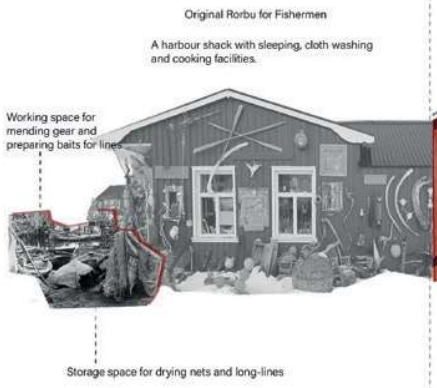
Water mamals
Killer whale
Pilot whale

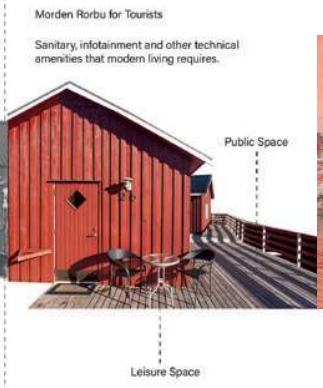
Birds
Puffin
Seagull

Mamals
Moose

ARCHITECTURE

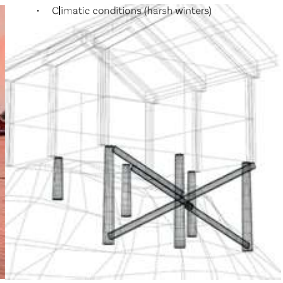
Tourist / fishermen house





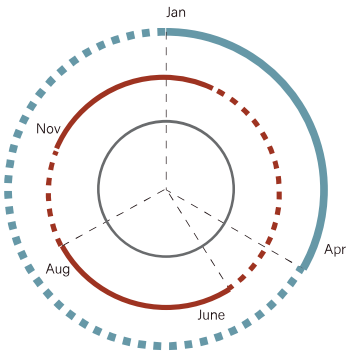
Building typology





HUMANS

Tourist / fishermen season calendar



Fishermen peak season off-season
Tourists peak season off-season
Long time guests
migrant labour like consultants, fish industry workers, carpenters

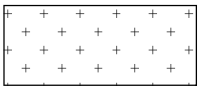
Problem description

Appearance	Utopia
Scope	Local (economy)
Shock	Rockfall
Stress	Tourism / fishing
Territory	Naturally bordered
Indiginous	Viking
Government	Protected areas
Seasonal residents	Tourist
Occupation of buildings	Increasing amount of buildings for tourists
Public space	Important for tourism
Originated from	Fishermen stop

- Harsh environment / difficult to move around in winter
- Logistics / Well connected with E10
- Seasonal changes / has big impact on public spaces
- Tourism is taking over, but Reine cannot live without it

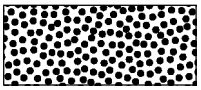
FLORA / FAUNA

Alpine vegetation



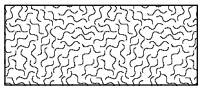
Moss, shrubs, summer flowers, lichen

Low broad-leaf bushes



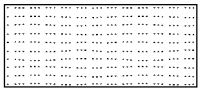
Mountain birch, dwarf birch, willows,

Gardens



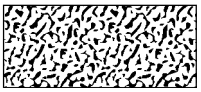
Garden conifers, broad-leaf bushes, summer flowers

Grass with wild flowers



Grass, weeds, herbs, summer flowers

Gravel



Moss, lichen

Bedrock



Moss

Fish



Atlantic Cod



Shrimp



Trout

Water mamals



Beluga whale

Birds



Eider



Theist



Kittiwake

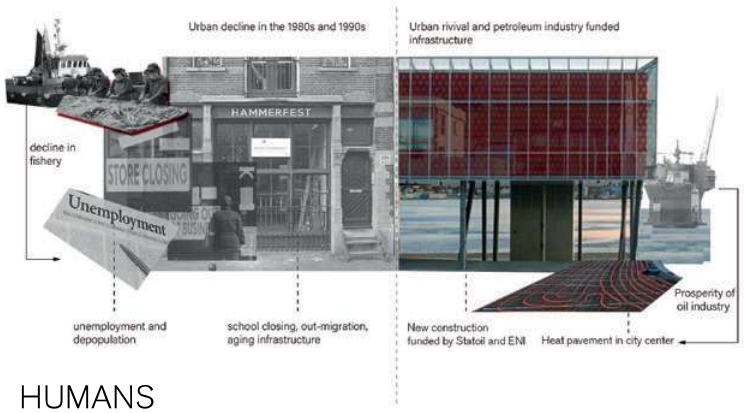
Mamals

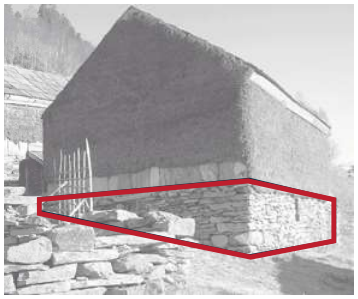


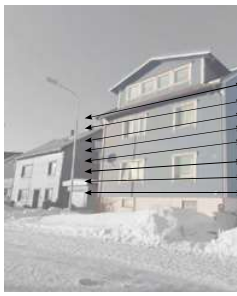
Reindeer

ARCHITECTURE

Local buildings / oil industry funded buildings



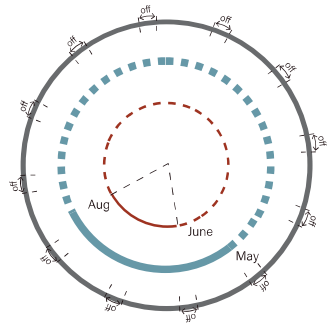




Building typo

HUMANS

Seasonal workers / fishermen season calendar



Fishermen peak season⊠off-season
Tourists peak season⊠off-season
Petroleum Industry Workers

Problem description

Appearance	Distopia
Scope	Global (economy)
Shock	Landslide
Stress	Extraction of materials
Territory	Borders by oil industry
Indiginous	Sami
Government	Permision to waste in
Seasonal residents	Seasonal workers
Occupation of buildings	Increasing amount of b funded by the oil comp
Public space	Less important
Originated from	Fishermen (easy to att

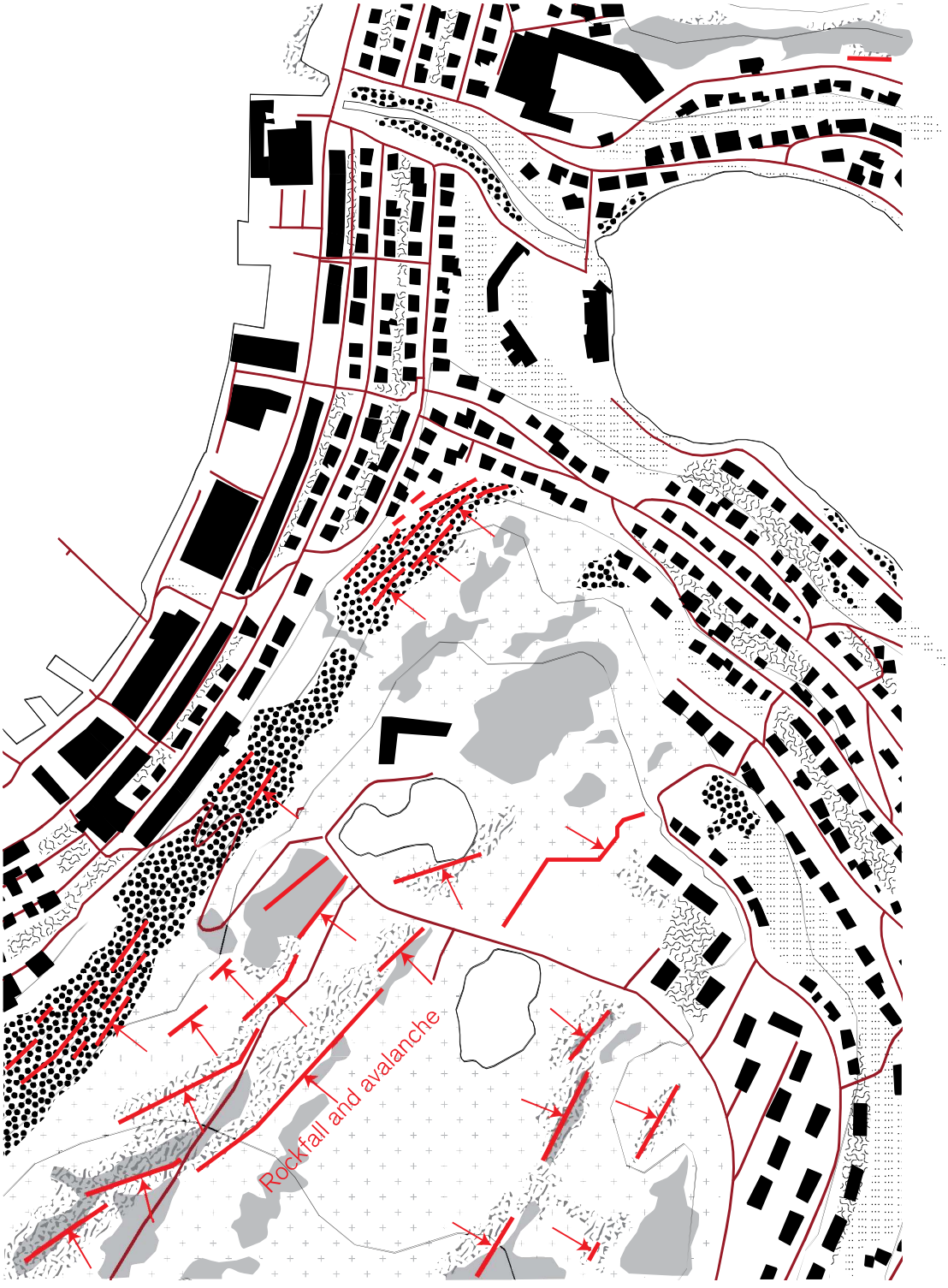
- Harsh environment / difficult to move around in winter
- Logistics / Harbor will double in size, most northern port without ice
- Seasonal changes / has big impact on public space
- Oil is taking over, but Hammerfest cannot live wi

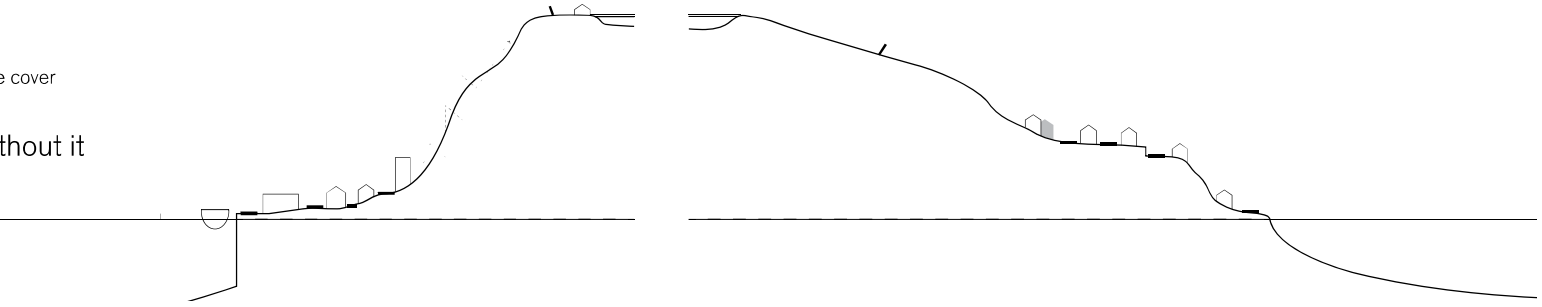
N

Map: 1:5.000






Rockfall and avalanche



5.

Scenario making

5.1. Nature First (Reine)

The Nature First scnenario focusses on the shrinking population of Reine. It returns focus on the areas of original settlement, reducing the footprint and therefore the impact on the environment. This includes reinventing the way the tourism industry can operate.

5.2. No technology (Hammerfest)

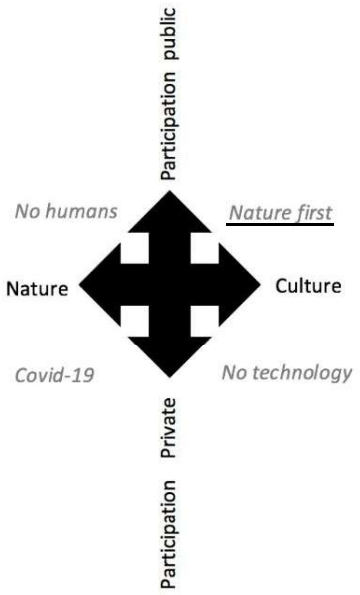
This scenario investigates the development possibilities and challenges that Hammerfest could face if technologies and infrastructure that is supported by the oil industry does not take place anymore. This scenario could lead to shrinkage, major changes in the local economy as well as more natural zones in the city.

5.3. No humans (Hammerfest)

As most of citizens are moving out, there are more flexible buildings and less commercial and some other types of public buildings in the city. Man-built public spaces would be given back to nature. Native flora and fauna would come back to be the host all year round.

5.4. COVID-19 (Reine)

As an island with tourism as its main industry, Reine's COVID-19 scenario mainly emphasizes how local tourism can cope with the impact of the global epidemic. The spatial interventions according to the new social normal of 1.5 meters on public and private spaces are the key elements of this scenario.


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Private
Participation

5.1. Nature First Scenario (Reine)

In case of Reine, Nature First would mean for people to have a closer connection with their natural environment. However, during winter, nature is already first. There is very little that can be done against the heavy snowfall and harsh winters the residents have to live with.

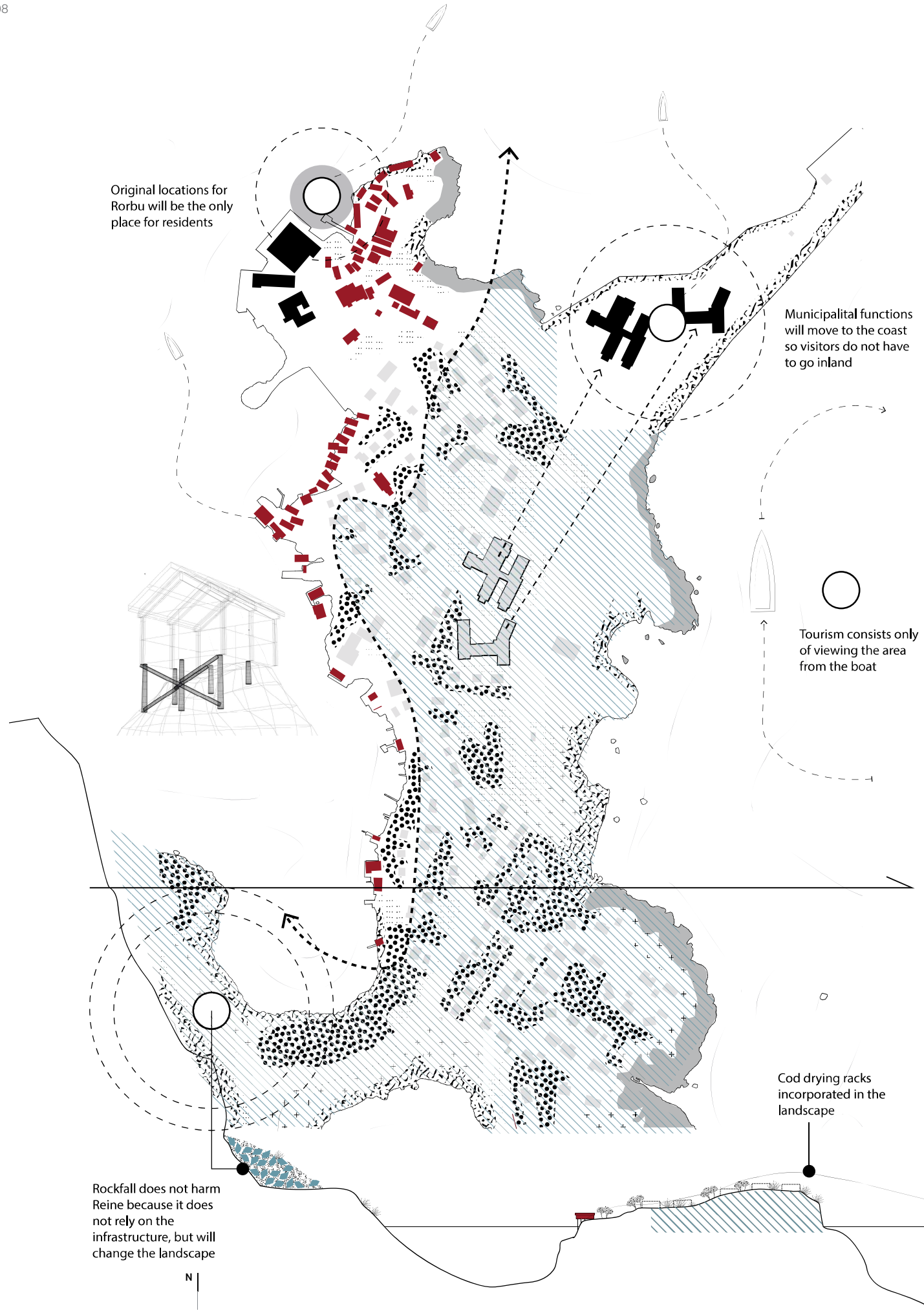
Currently, one can state that the economic advantages are now found in tourism activity. Therefore, elongating the tourism season (during summer) is beneficial. Infrastructure to support this system has also been improved, guarding it from potential rockfall. More than ever, this is a motivation to mitigate the effects of the harsh environment. This means more interference with the ecosystem than ever.

However, Reine itself started as a bunch of Rorbu for shermen to temporarily stay. These fishermen reached the peninsula by boat, hung their cod to dry and came back when this was done, limiting their effect on the surrounding environment. Going back to this would be the extreme scenario of nature first. Medium size boats would be the only means of transportation between the islands. The settlements on the foot of the mountains would be dissolved, as the area cannot be protected from rockfall. Only the areas where no human intervention to the landscape is needed will be inhabited.

Tourism will only consist of “looking”. A boat can pass by, but it cannot dock. Since boats are now the only means of transport between islands, and the touristic functions in Reine are no longer used, only people who can support themselves and have knowledge of fjord-nature will take residency in Reine.

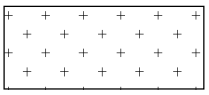
Scenario Scale 1:5000

Amber van der Voorn


Original locations for Rorbu will be the only place for residents
Municipalital functions will move to the coast so visitors do not have to go inland
Tourism consists only of viewing the area from the boat
Cod drying racks incorporated in the landscape
Rockfall does not harm Reine because it does not rely on the infrastructure, but will change the landscape
N

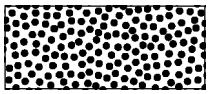
FLORA /FAUNA

Alpine vegetation



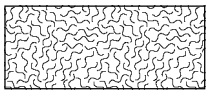
Moss, shrubs, summer **flowers, lichen**

Low broad-leaf bushes



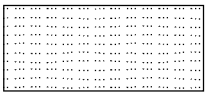
Mountain birch, dwarf birch, willows,

Gardens



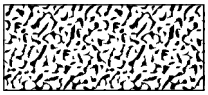
Garden conifers, broad-leaf bushes, **summer flowers**

Grass with **wild flowers**



Grass, weeds, herbs, **summer flowers**

Gravel



Moss, lichen

Bedrock



Moss

Fish



Atlantic Cod — Herring — Atlantic Salmon

Water mamals



Killer whale — Pilot whale

Birds



Puffin — Seagull

Mamals

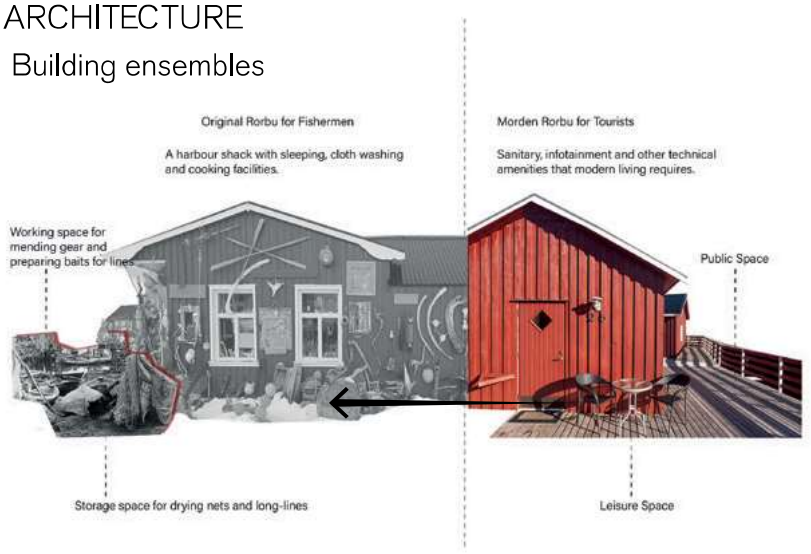


Moose

Less stress on the environment would result a thriving ecosystem. Even during summer the vegetation in large parts of Reine is undisturbed and able to grow. This provides food and shelter for animals.

ARCHITECTURE

Building ensembles



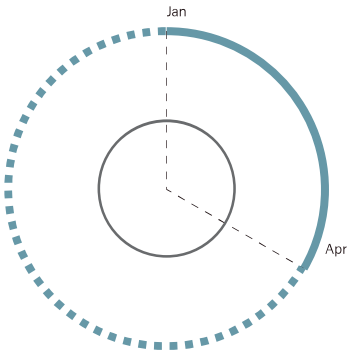
Housing should consist of enough space to accomodate equiptment needed to live in the harsh fjord landscape. This would mean the Rorbu now aimed at tourism would again house permanent residents, and therefore move towards its original appearance and function.

Natural landscape



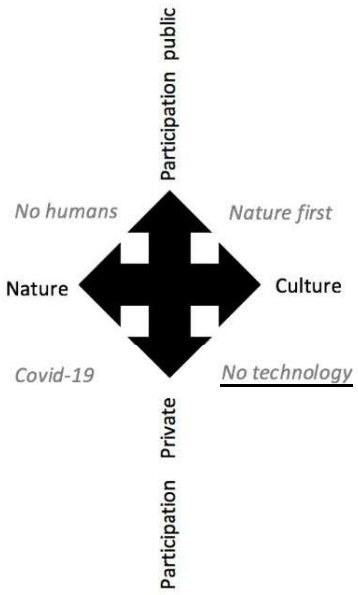
Cod drying embedded in the landscape

HUMANS



Fishermen peak season off-season

Long time guests
fish industry workers, carpenters


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Private
Participation

5.2. No Technology Scenario (Hammerfest)

In Hammerfest, the technologies of oil industry significantly influence the development of the city. If the oil industry leaves, the city must change their local economy. This change can lead to shrinkage, depopulation, decline of the infrastructure and lack of investment in the city. However, the local fishing industry still could function and expand, taking over the territories that used to be dedicated for the oil and LNG industry. The change of the economy minimizes the environmental hazards and pressure from the industries, allowing the city to develop and participate in the native Sami culture and reindeer herding.

In the context of this scenario, it involves eliminating hard technologic solutions for controlling natural processes. The built environment is influenced significantly. Due to possible shrinkage, some residential and public buildings could not be maintained properly and eventually would be demolished, creating new, empty plots. This also gives opportunity to expand green zones in the city and to eliminate the landslide barriers, allowing avalanches and landslides to occur naturally.

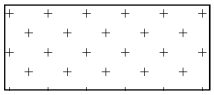
The ecosystems and nature around the city could thrive and become stronger, because the oil industry would not put pressure on the wildlife habitats, however, the expansion of the fishing industry could influence the amount of fish resources in the sea.

Scenario Scale 1:5000

Janis Berzins

FLORA / FAUNA

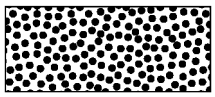
Alpine vegetation



Moss, shrubs, summer flowers, lichen

- Stable

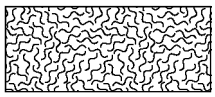
Low broad-leaf bushes



Mountain birch, dwarf birch, willows,

- Increase, taking over grasslands

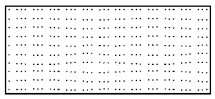
Gardens



Garden conifers, broad-leaf bushes, summer flowers

- Decrease

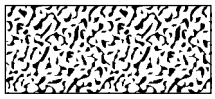
Grass with wild flowers



Grass, weeds, herbs, summer flowers

- Overtaking gardens

Gravel



Moss, lichen

- More in the city due to landslides

Bedrock



Moss

- More exposed



Atlantic Cod



Shrimp



Trout



Beluga whale



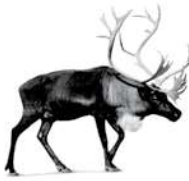
Eider



Theist



Kittiwake



Reindeer

Fish

- More fishing can cause damage to the existing population

Water mamals

- Undisturbed habitat

Birds

- Increase in population, more nesting places

Mamals

- More reindeer cl to the city

ARCHITECTURE

Local buildings / oil industry funded buildings

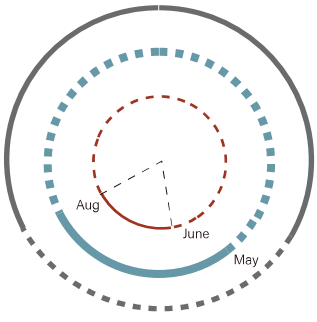
- No oil - empty industrial buildings
- Lack of state funding to maintain buildings
- Nature-based solutions in architecture
- Buildings are demolished in hazard zones, allowing natural proceses and landslides
- More low-vegetation zones and bushes in the urban area

Building typology

- More fishing ships and fishery buildings in harbour
- More local residents that live here all year

HUMANS

Seasonal workers / fishermen season calendar

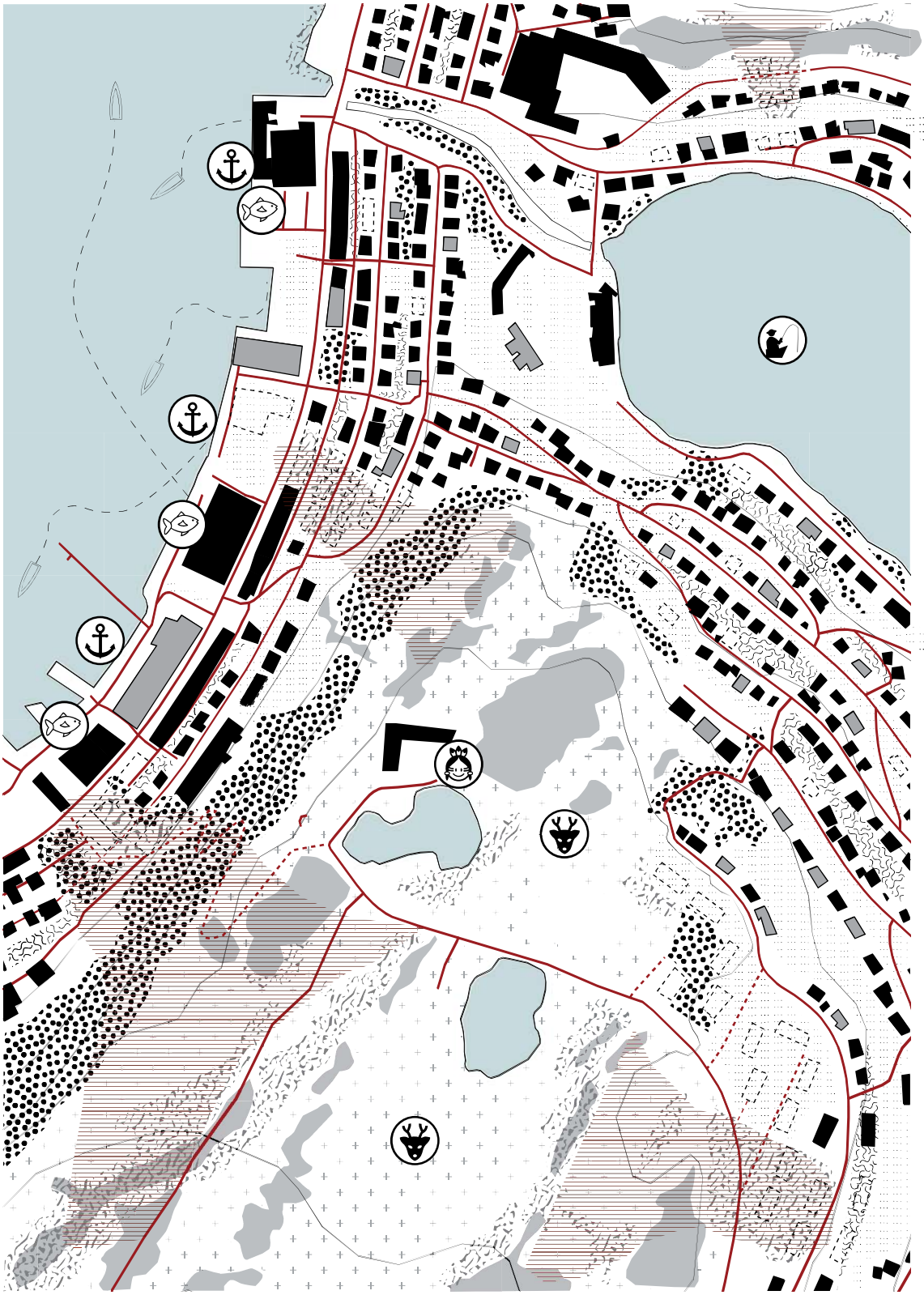


- No oil - no seasonal workers
- Local economy based on fishing and reindeer herding

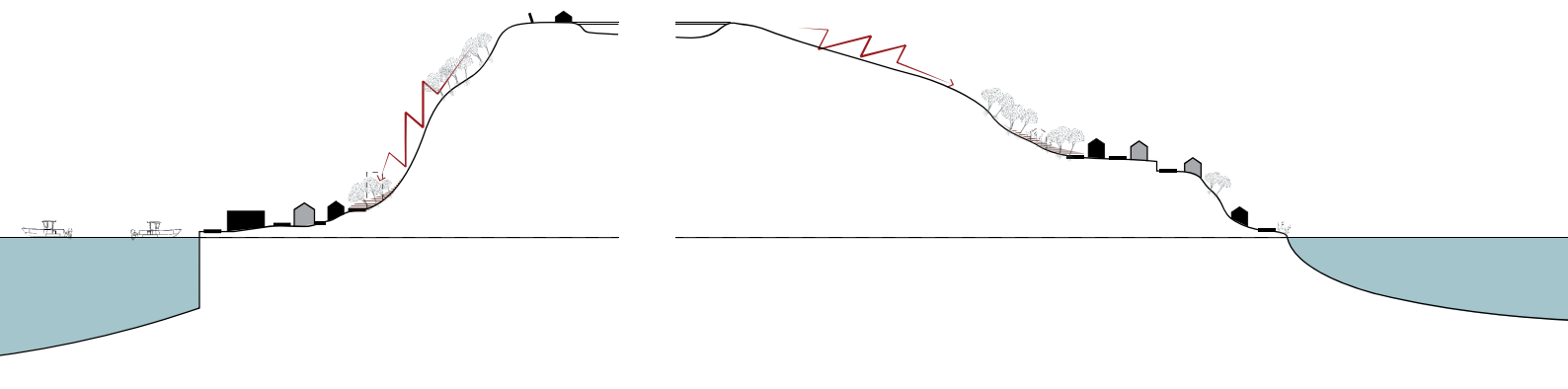
Fishermen peak season / off-season
Tourists peak season / off-season
Reindeer hersing

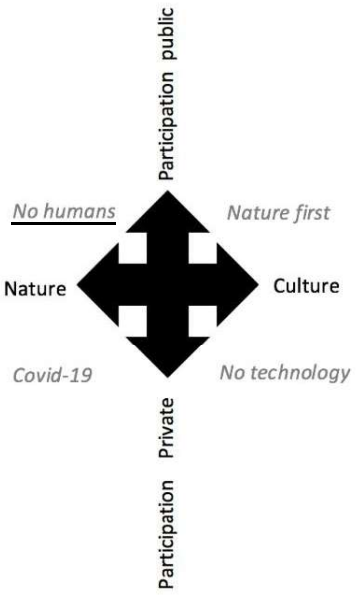
- **Harsh environment /**
  difficult to move around in winter
- **Logistics /**
  Harbor will shrink, emphasis on fishing
- **Seasonal changes /**
  Public space designed according to seasonal changes
- **Oil is gone but**
  Hammerfest can live without it

oser



Empty buildings
Demolished buildings
Demolished road
Avalanche zone




Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Private
Participation

5.3. No Humans Scenario (Hammerfest)

In the future, due to the increasing risk of landslides caused by global warming, people who live in the potential hazard areas would gradually move out. The global warming also causes the fishing zone moving towards north, as the sea fish need a lower temperature to live. Fishery shrink and local fishman move to other places. While at the same time, the shift to automation of oil & natural gas industry also leads to a decrease in the demand for seasonal workers, which result in a huge decrease in the number of local residents. Thus, in a long term, most of citizens would move out of Hammerfest. There are only a few people staying for the necessary maintenance of LNG industry and logistic.

In this scenario, nature would come back to be the host of the city. Buildings and other constructions in landslide areas would be demolished. Those residential areas would restore to natural habitats. The only man-built things that be kept are some commercial and public service buildings in city center, which would be maintained by oil companies. There would be a functional transformation in city center. More spaces are needed for: monitoring, maintenance of the automatic facilities and logistic infrastructure. City center still offers public services for workers, and indigenous who choose to stay, and for passerby from Norwegian national road 94. As for other areas in Hammerfest, most of the open spaces will be occupied by native flora and fauna. Coastline and river bank would become more ecological, biodiversity, suitable for animals to use. Man-built public spaces and parking area are all given back to nature/ natural habitat. Other critical infrastructure which provides necessary support for energy and service need to minimize the impact on the surrounding environment.

Scenario Scale 1:5000

Yixiang Huang

References:

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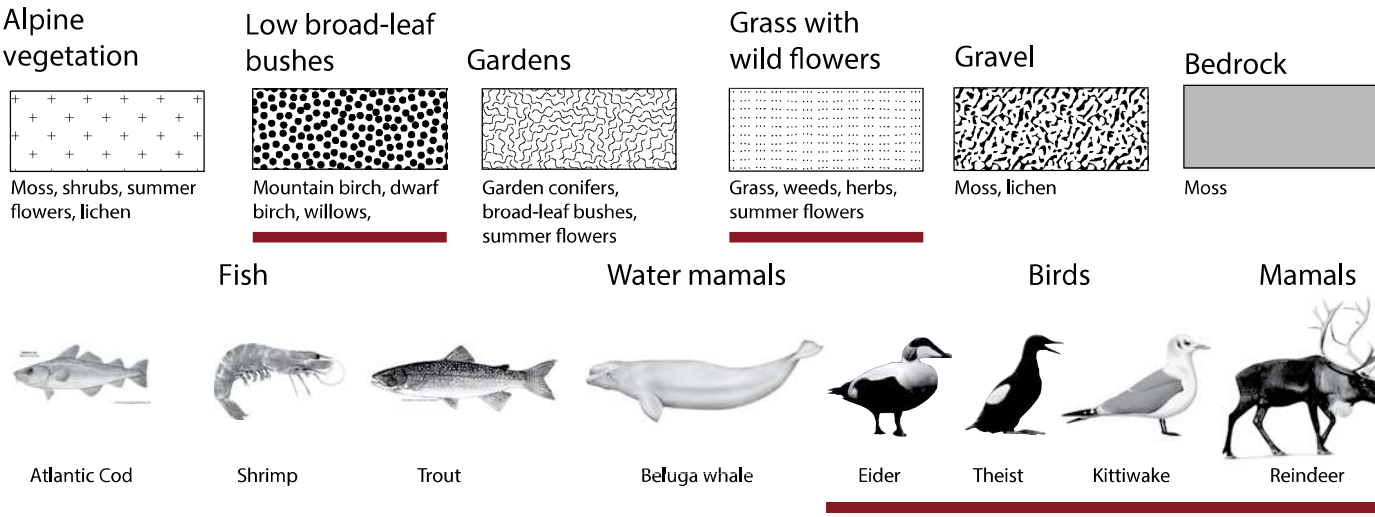
Felix Todd (05 Mar, 2019). What are the pros and cons of automation in the oil and gas industry? NS ENERGY. https://www.nsenergybusiness.com/features/oil-and-gas-automation/

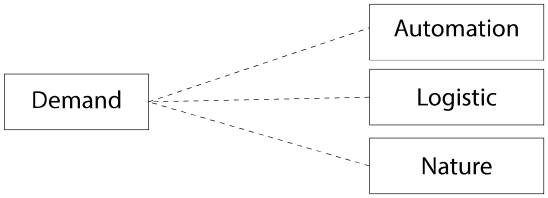
HAMMERFEST, NORWAY

FLORA / FAUNA



ARCHITECTURE





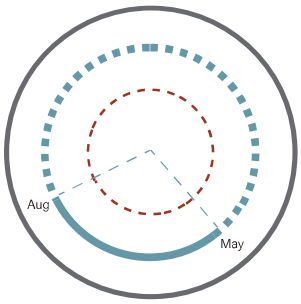
Buildings and other constructions in landslide areas would be demolished. Those residential areas would restore to natural habitats.

Some critical commercial and cultural areas in city center would be kept, and be maintained by oil companys:

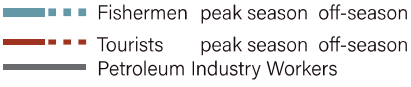
1) More spaces for: monitoring, maintenance --> for automation infrastructure; logistic --> for fishery, oil and gas.
2) city center still offers public services for workers, and indigenous who choose to stay.
3) offer supply for passerby from Norwegian national road 94.
4) keep the construction materials shops for the construction in Melkoya island.

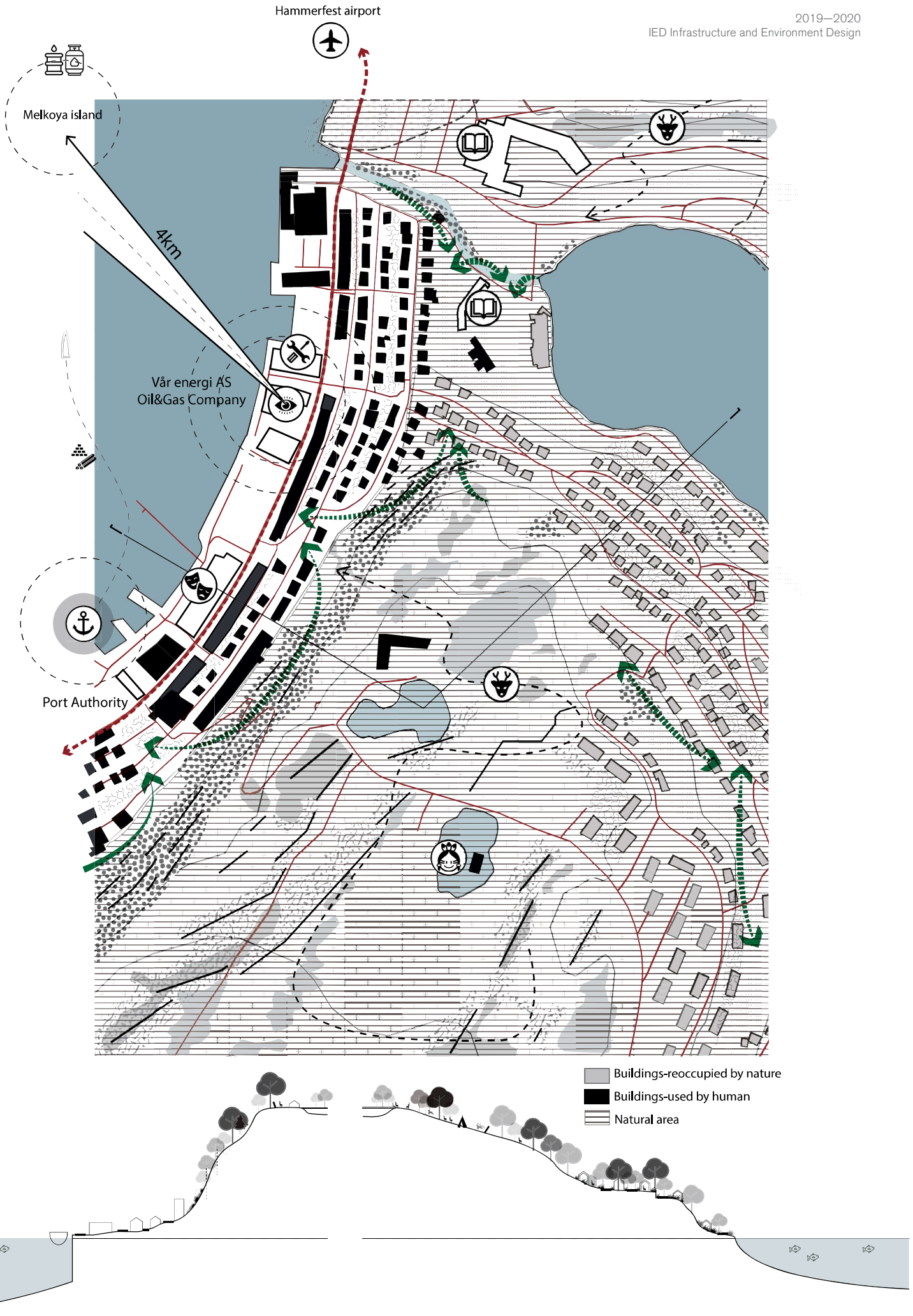
HUMANS

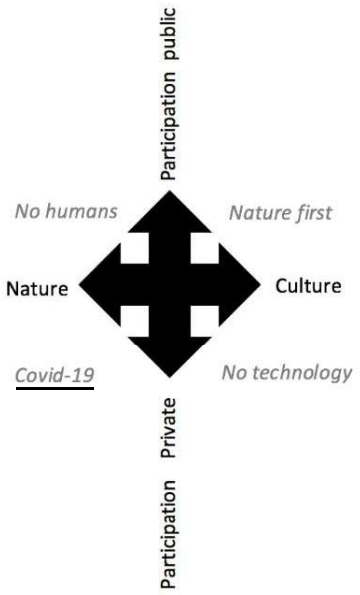
Workers / fishermen season calendar



In the future, due to the intensification of landslides caused by global warming, and at the same time the automation of oil & natural gas industry leading to a decease in the demand for workers, most of the residents would gradually move out of Hammerfest. Sami people and some fishermen may stay.




Hammerfest airport
Melkoya island
4km
Vår energi AS
Oil&Gas Company
Port Authority
Buildings-reoccupied by nature
Buildings-used by human
Natural area


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Private
Participation

5.4. COVID-19 Scenario (Reine)

The COVID-19 scenario for Reine is divided into a short-term scenario and a long-term scenario. In the short term, it is a mitigation scenario to mitigate the economic impact of bans on travel. In this scenario, there are some potentials for the online economy, such as virtual sightseeing via social media. In this case, the hotel keepers may become Youtubers and keep interaction with online tourists all over the world, which will increase income for them because of the commercial value. In the long term, it is an adaption scenario for tourism under the new normal of 1.5-meter society. The impact of this new normal includes capacity control for tourist attractions (maximum 50%-60%), space redesigning according to social distancing guidelines, etc.

In terms of interventions, first, soft boundaries will be set between three main areas to keep the flow of tourists within the two more public areas (Attraction Area and Capital Functions Area). Second, to improve the ability to evacuate tourists, more outdoor public spaces with social distancing measures will be provided along the west coast. Third, the conventional fishing houses, which are used as hotels, Air Bnbs, and summer houses, will be upgraded under the social distancing guidelines. For rorbu hotels that have public spaces and facilities, the routes of tourists will be redesigned to reduce the potential for cross-infection. For private rorbus, there will be more private green spaces, such as roof gardens, and community gardens shared by small groups, to provide recreational places for quarantine time. Moreover, the main streets will be redesigned to accommodate pedestrians over longer distances.

Scenario Scale 1:5000

Zhe Hou

References:

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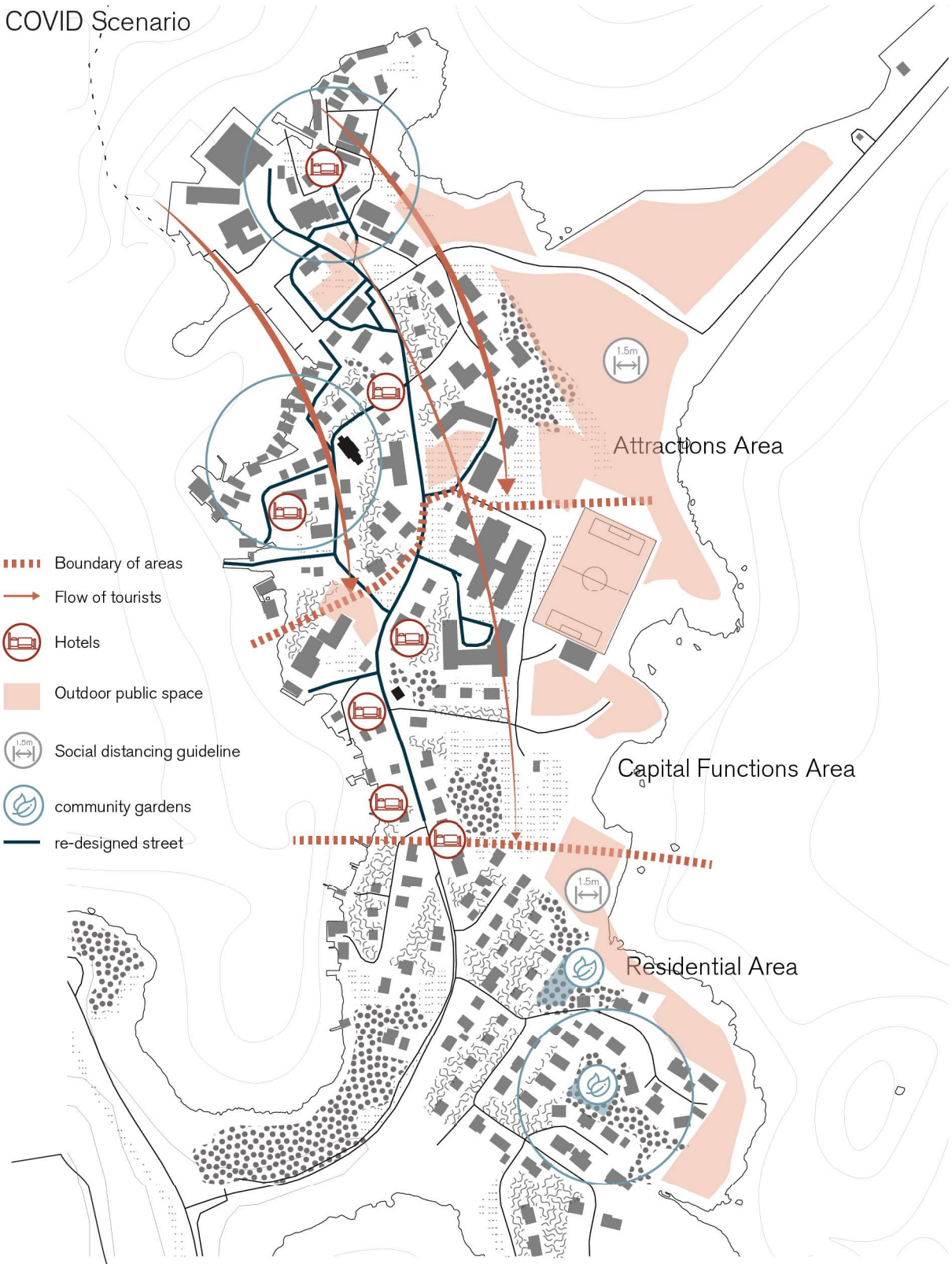
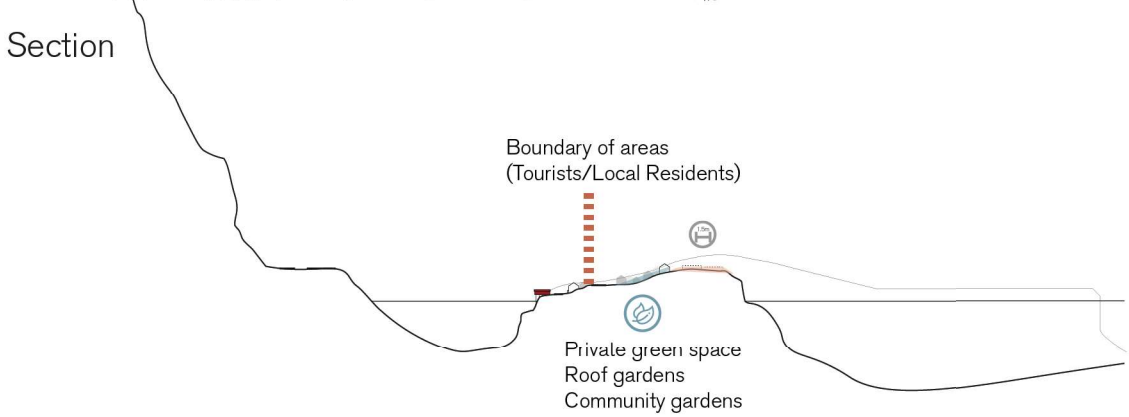
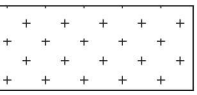
Three things visitor attractions should focus on during the Covid-19 pandemic | Cambridge Network. (2020). Retrieved 6 July 2020, from https://www.cambridgenetwork.co.uk/news/three-things-visitor-attractions-should-focus-during-covid-19-pandemic


COVID Scenario
Attractions Area
Capital Functions Area
Residential Area
1.5m
Boundary of areas
Flow of tourists
Hotels
Outdoor public space
Social distancing guideline
community gardens
re-designed street

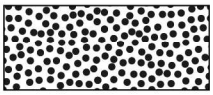

Section
Boundary of areas
(Tourists/Local Residents)
Private green space
Roof gardens
Community gardens

FLORA / FAUNA



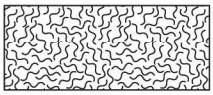
lpine
egetation

loss, shrubs, summer
owers, lichen



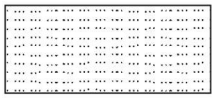
Low broad-leaf
bushes

Mountain birch, dwarf
birch, willows,



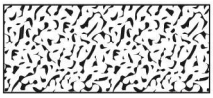
Gardens

Garden conifers,
broad-leaf bushes,



Grass with
wild flowers

Grass, weeds, herbs,
summer flowers



Gravel

Moss, lichen



Bedrock

Moss

Fish







Water mamals



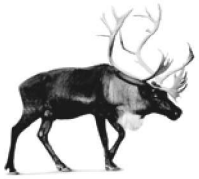
Birds







Mamals



tlantic Cod

Shrimp

Trout

Beluga whale

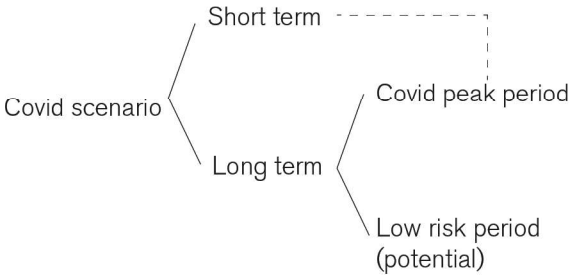
Eider

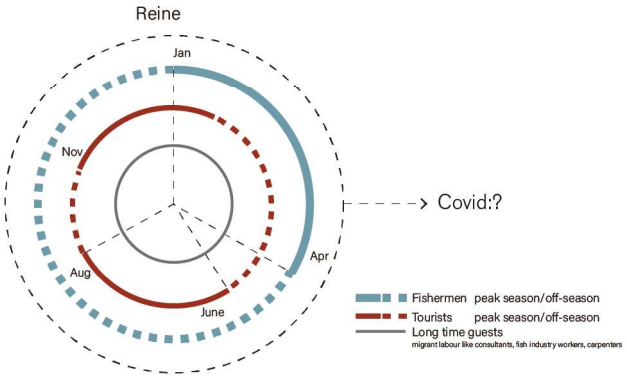
Theist

Kittiwake

Reindeer

HUMAN





Mitigation: Reduce the economic impact of the bans on travel
Adaption: Tourism under the new normal of 1.5 meter society

Short Term

Virtual sightseeing via social media
Hotel keepers >>> Youtubers





Long Term

Social distancing guidelines



- capacity control for tourist attractions (maximum 50%-60%)
- redesign the space according to social distancing guidelines
  examples: one-way route
- reservation for the use of amenities
- less contiguous services provided, more digital service and self-service
  examples: cruise, events and culture activities...

ARCHITECTURE



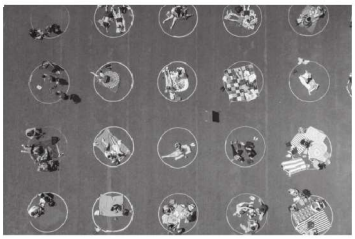
Rorbu hotels with public spaces

Social distancing



Private rorbus

More private/community green spaces



Outdoor public spaces

1.5 meter measures

6.

System Intervention

6.1. System Intervention (Reine)

The most crucial characteristic of Reine is the seasonality, which leads to temporary industry, visitors and occupation patterns. Therefore, the key point of the vision for Reine is to embrace the extreme temporality instead of fight against it. The challenge from temporality will be changed to opportunity, resulting in a more sustainable coexisting way of human and nature. In Reine, industries and nature go with the seasonal flow. Fishery, tourism and nature are coexisting but taking turns in different seasons.

Fishery and Tourism

Due to the impact of the epidemic on tourism, the declining fishery in Reine will face new opportunities for growth. To adapt to the expansion of fishery, more fishery production spaces and facilities will be built in the coastal areas, which will be shared with tourism as well. Tourism will emphasize on Viking fishery culture and water sports culture, through the tourism development of traditional production space and the thematic development of surrounding islands.

Hazard and Transport

To deal with the increasing rockfall risk because of global warming, first, the rockfall prone areas will be dissolved. The settlements will be relocated to other islands of low risk. The E10 highway, which is the main road connecting islands in Lofoten, will only be maintained during tourism seasons in summer. In winter it will be closed because of potential rockfall risk. Instead, water transportation will become the main way to Reine as it was first built in the 1800s. The surrounding islands will be upgraded with more docks and warehouses to improve the water transportation system.

Nature and Energy

In the future, there will be no permanent residents in Reine. During nature first season which is from September to December, Reine is watched by 5 rangers overlooking the area. Decreased human activity in this period provides nature with time for ecological restoration.

Fossil energy will be gradually replaced by clean energy such as wind and tidal energy. Windmills and tidal power generation facilities will be built on the surrounding islands. The electricity will be transmitted to Reine via cables and stored at the storage station. In the summer with plenty of sunshine, the buildings in Reine use solar panels to generate electricity as supplementary energy.

6.2. System Intervention (Hammerfest)

The project finds a way to deal with the huge change in economy, seasonality and also the population under the expanding pressure of the oil & LNG industry. The transition in local industry calls for spatial transformation, in which both continuity and temporality are needed. Also, tackle with the harsh weather and the increasing risk of landslides, the project proposes the co-existence and integration of biosphere and technosphere.

Land use & Zoning

The red zone in the map is continuous habitats for residential and industrial activities which happen all year round, while the blue part is for temporal living from May to August.

Economy & LNG industry

The LNG industry shifts towards a more automatic and sustainable mode. Inland industrial sites along the coast are transformed into automation hubs and logistics hubs. The renewable energy stations are settled for utilization of wind and tidal energy. The transition in local industry acts as a driving force for the circular economy in Hammerfest.

Transportation & logistics

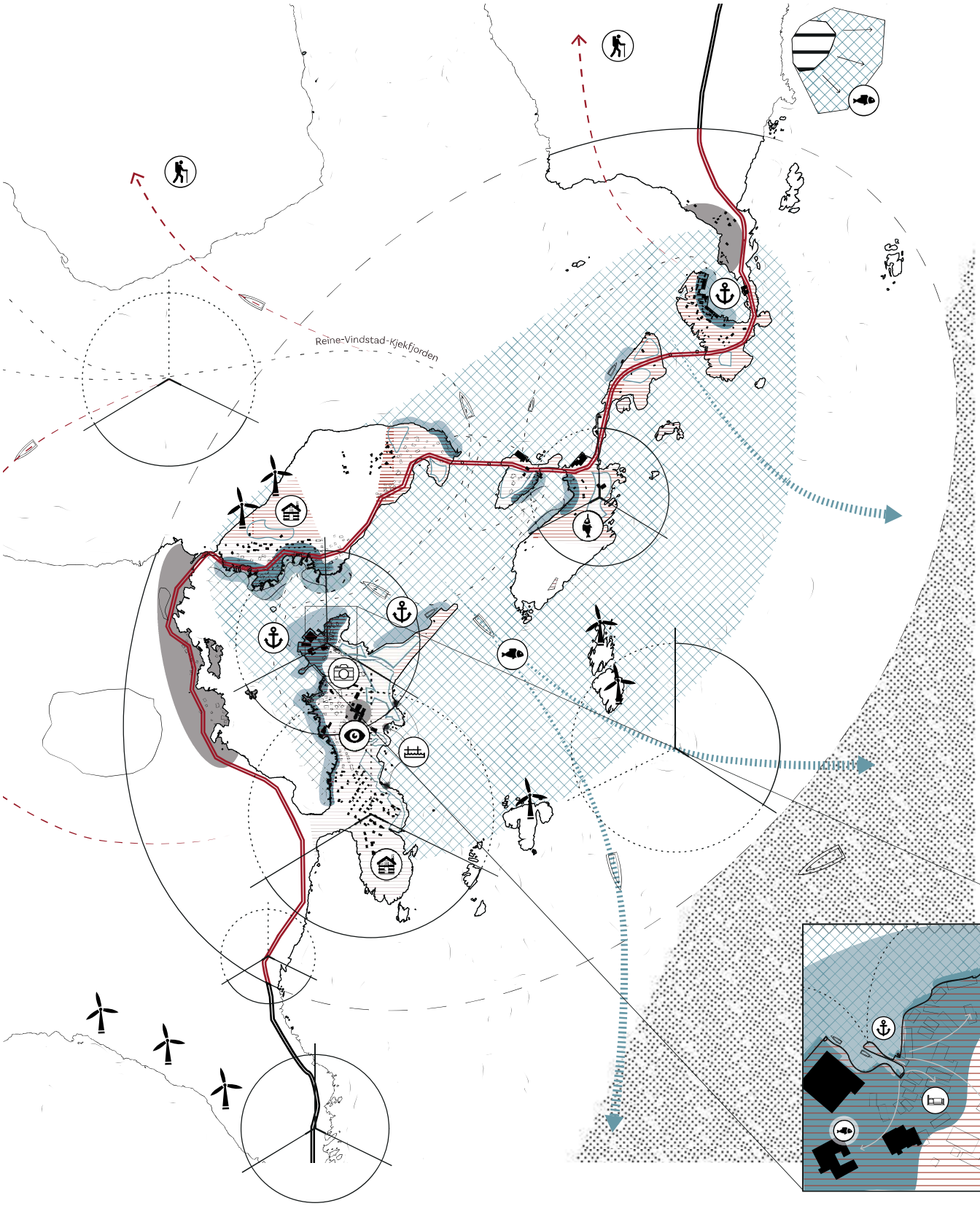
There are four types of harbor zones with port infrastructure (logistic, fishing, ships, concrete pier etc.) defined along the coast. New cargo terminal for the Arctic route is built in the harbor. More seasonal flows would come in from May to August. The cargo terminal would only open during summertime, while the Hammerfest port, which is for the LNG industry, would open all year round.

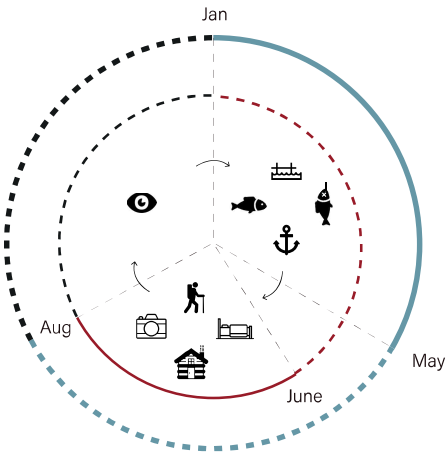
Workers & Urban life

Population and job opportunities increase due to the expansion in the LNG industry. More education and research institutions are located in automation hubs. Urban spaces are designed for seasonal activities. More public spaces are needed for winter activity.

Environment

Define the nature protection zones, which are for nature only. The green buffer zones between urban areas and nature-only areas are for hazard protection, such as avalanche and snowmelt flooding. There are also common zones, which are used as recreation areas in reindeer herding areas and other natural areas during summertime. And the native flora and fauna come in during winter. The coastal habitats zones are also defined as two types. One is the natural bedrock habitat, and the other is artificial and man-made coast.


Reine-Vindstad-Kjekfjorden



Urban area (temporal occupation pattern)

Fishing Jan-May
coastal zone reserved for fishing industry

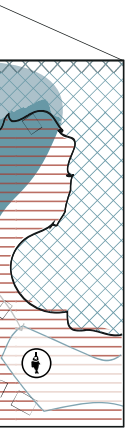
Tourism June-Aug
urban area reserved for tourism industry

Fishing + Tourism Jan-May + June-Aug
urban area where tourism and fishing take turns

Infrastructure

Main transportation by (own) boat
no need to travel inland

E10 (within protected borders)
only maintained during tourism season



Natural area

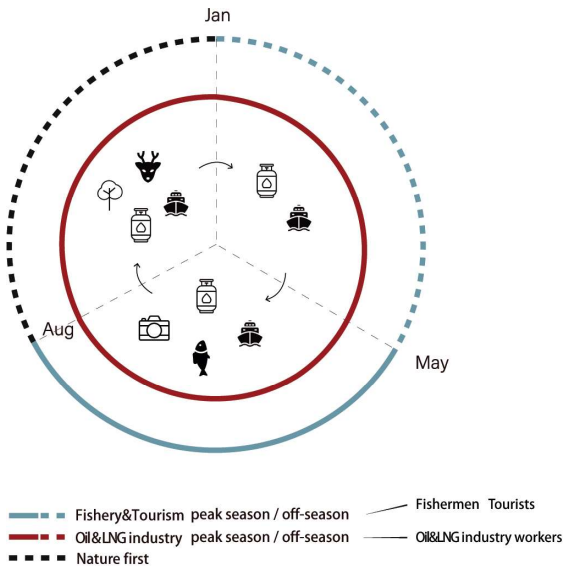
Nature first (protected area)
- Aug-Jan

Hazard areas
Rockfall

Public space

New Hjell fields
increase capacity of fishing industry, can be transformed to public space for tourism

Existing Hjell fields
adjusted to provide public space for tourism





Natural area

Nature first
Nature protection zone

Only nature - no humans
to prevent avalanche (trees, bushes)

Common zone (Humans + nature)
Humans are guests - recreational area - all year
People access reindeers and other animals

(Nature > Humans)
Humans are guests - recreational area - only summer
People access reindeers during summer, nature comes in human areas when they are gone

Hazard areas
Landslide

Urban area

Continuity
- all year

Temporality
- only summer

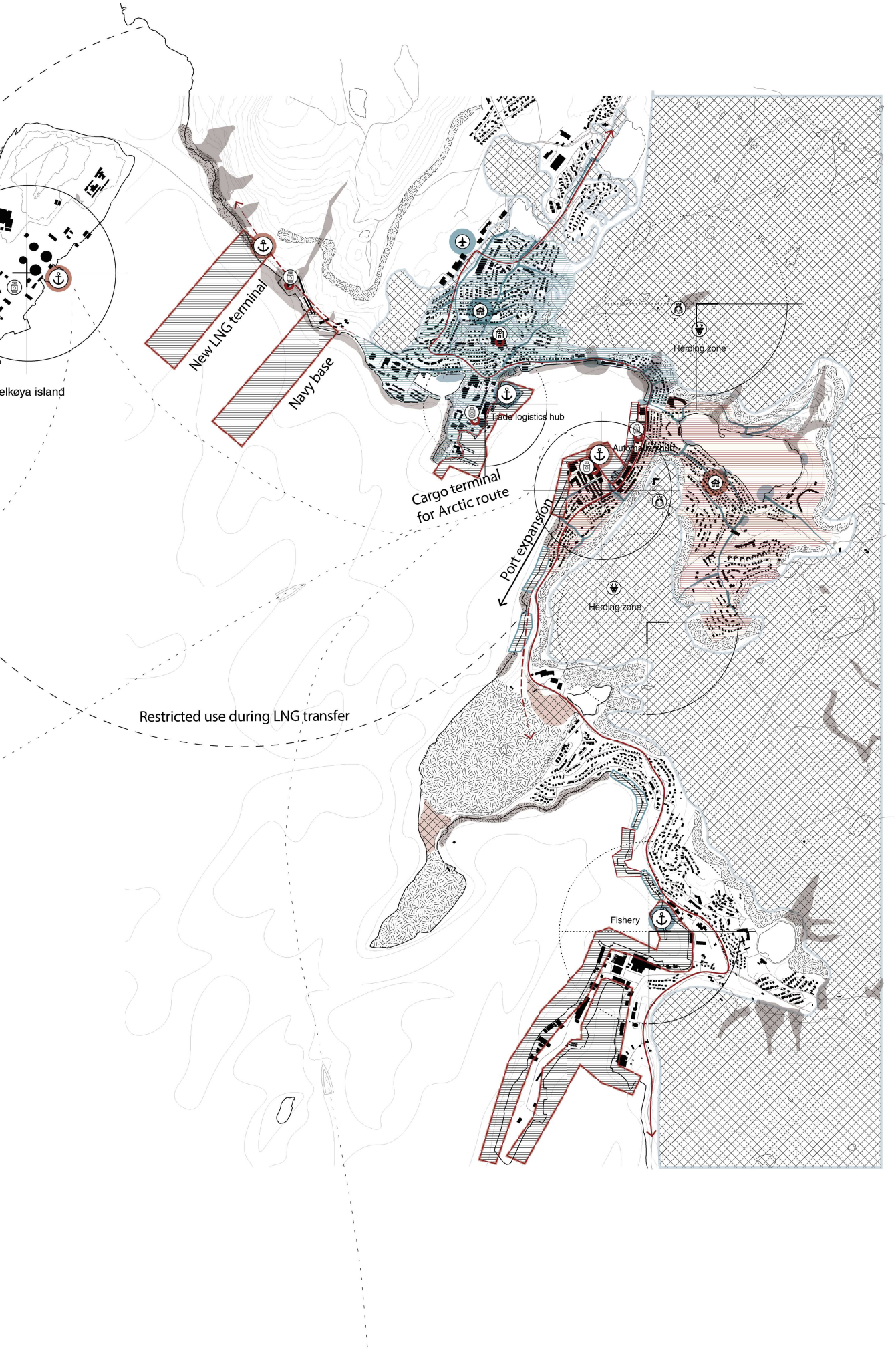
Coastal area

Coastal living
Fishermen cabins - temporal summer use / nomadic lifestyle, houses on piles

Natural coastal habitat
Rocky beach, seabirds, marine plants

Artificial coastal habitat
Floating islands, new rocks, gravel beach, habitat on concrete embankment

Harbour area
Concrete pier for docking ships and boats
Port infrastructure on the coast

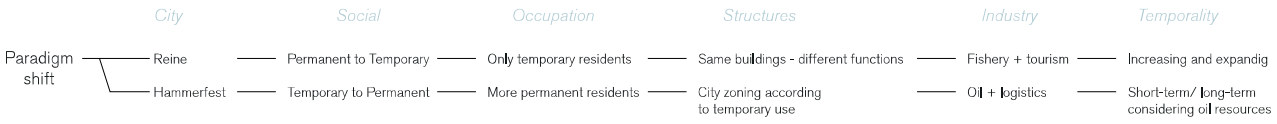

New LNG terminal
Navy base
Trade logistics hub
Cargo terminal
for Arctic route
Port expansion
Herding zone
Herding zone
Fishery
Restricted use during LNG transfer

6.3. System intervention - Temporality

Temporality is the overarching theme for both cities derived from the research conducted in the critical cartography paragraph. As the vision maps imply, both cities handle temporality in a different manner. The table aims to clarify the implications.

Finally, the diagram below offers a simplified, concluding version of the table.

Temporality	Reine	Hammerfest
Social	To sustainably develop the city in future, there is a need for a paradigm shift in how people are perceiving Reine. The shift, from permanent use of the city to temporary use during distinct seasons, will have a significant impact on the perception of the city and will take a few decades.	The technical process of oil industry and climatic conditions have resulted in perception of Hammerfest as a temporary living space. In the future, a paradigm shift will be necessary. A shift in the perception of the city as a suitable place for permanent living.
Occupation	Human residence in Reine becomes temporary, allowing the fisherman and tourists to use the city in different seasons. The local community will not be there anymore, because there will be no more permanent residents. Reine will be transformed back into a temporal settlement.	Automatization of the oil industry will allow Hammerfest to continue developing as a Northern industrial city, with even stronger importance in the future, due to the opening of the Arctic route. This could bring more permanent residents to the city, however, the logistics industry that will still function during the summer will bring in new temporary workers to the city. This means that there will be two different communities whose interests will have to be taken into consideration.
Structures	In order to embody the focus on extreme temporality in Reine, existing and new structures should be able to serve the different functions (nature, fishing and tourism). This is necessary to prevent vacancy during the active seasons.	The development pattern of Hammerfest calls to attention two different building typologies: buildings for permanent use throughout all year, and temporary buildings for workers and functions in summer season.
Industry	Climatic conditions force the fishery and tourism industries to work during distinct seasons. These industries will have seasonal temporality effects on the city.	The oil industry has a long-term temporary effect on the city, due to unknown amount of fossil resources in the area, however, the logistic industry that will become available due to climate change could have a strong short-term temporary effect on the city in the long-term development.
Overall	Enhancing	Short-term / long term, considering oil resources



6.4. Design Experiements

6.4.1.

Watchtower System: Embodying extreme temporality in Reine.

Amber van der Voorn

6.4.2.

Reine: Multifunctional FIshing Hub

Zhe Hou

6.4.3.

Hammerfest: Landscape, Seascape, Wastescape

Cas Goselink

6.4.4.

Hammerfest: The Nordic Possibilities

Janis Berzins

6.4.5.

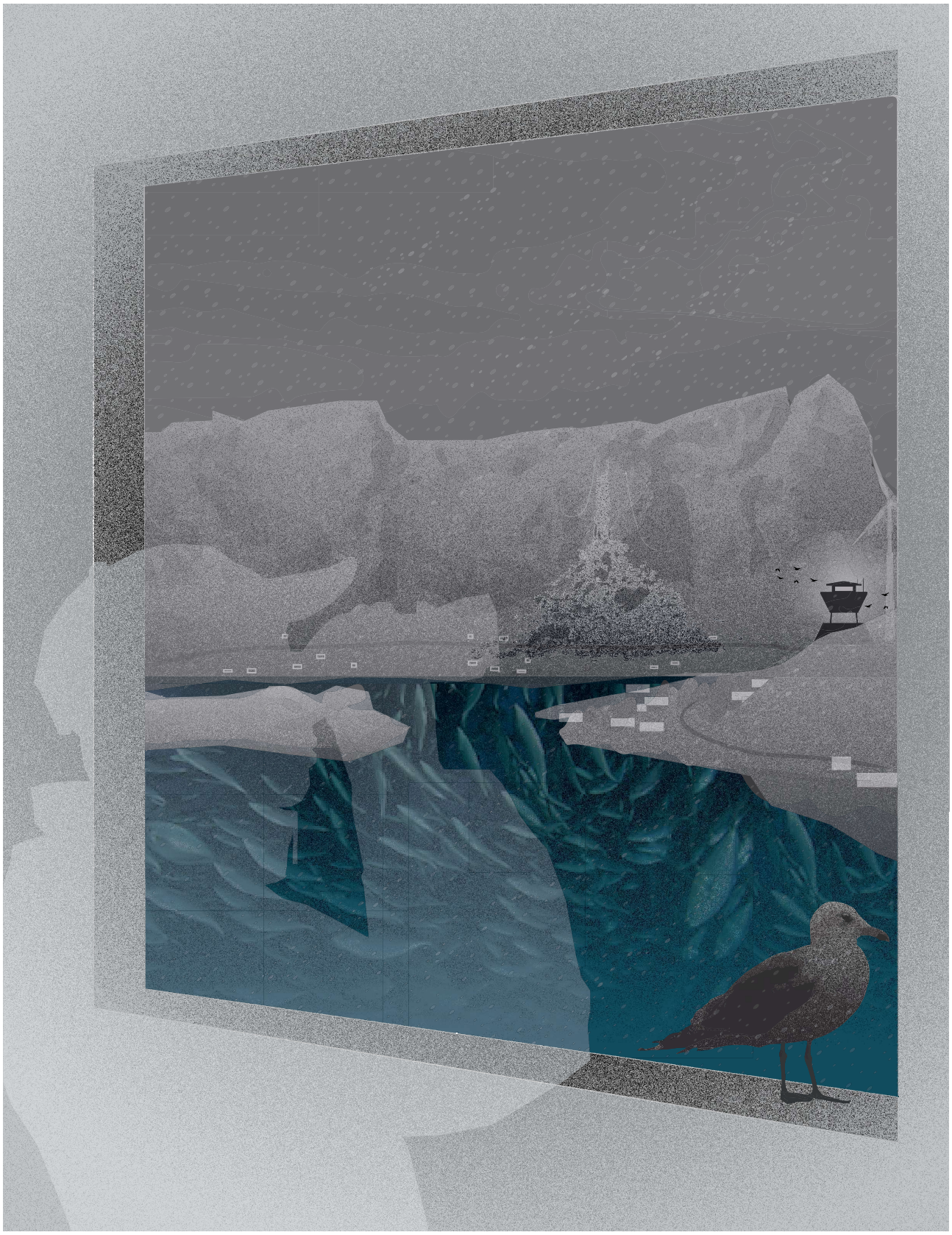
Hammerfest: Transitional Waterfront

Yixiang Huang

6.4.1.

Watchtower System: Embodying extreme temporality in Reine.

Amber van der Voorn



Manifesto

Reine owes its origin to fishermen using the rare flat surface as a safe haven. On land, the boats of the fishermen would function as a shelter, protecting them from extreme weather conditions. Eventually, Rorbu were built to offer more comfort during the temporal stay. These cabins were shared, and only occupied during fishing season.

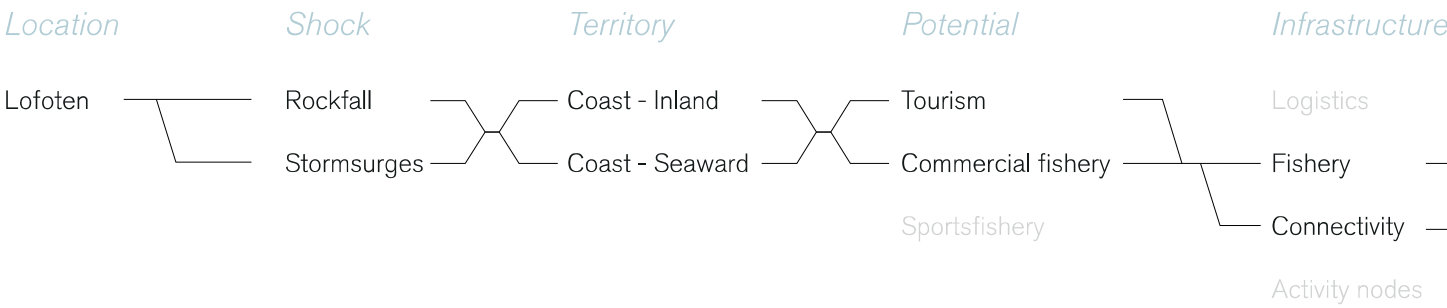
Now, Reine is not just a settlement for fishermen anymore. It has a shared economy, focussed on both fishing and tourism. As accessibility of the area has developed, the urban tissue has evolved to accommodate permanent stay. Fishing, as well as tourism put a pressure on the ecosystem. Having permanent residents means the ecosystem gets little chance to restore itself. As both industries rely on the extensive ecosystem of the Lofoten islands, one for its species and the other for its unique landscape features, it is of great importance to maintain that very ecosystem.

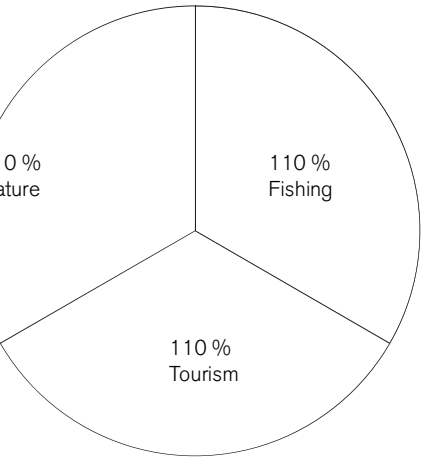
Furthermore, Reine, like other villages in Lofoten, is shrinking. The government of Norway is offering tax reduction in order to attract permanent residents. However, rather than fighting this trend, the shrinkage must be embraced. As living standards change, it will prove hard to find people who will settle for a winter with extreme weather conditions and no sunrise. Having no permanent inhabitants offers space to expand the existing industries. 1) There will be fixed seasons for fishing and tourism during which only people working in said industry can enter the Reine area. During the period where neither fishing nor tourism is a source of income, the area is given back to nature. During this season there will be no human interference, as no human is allowed on the Reine islands.

Reine is redeveloped according to its extreme seasonality and its associated temporal occupation patterns. This is how ecosystem participation is achieved. Reine aims to be an example for the rest of the Lofoten island system. Through its independence and self-sufficiency, it will show the potential of extreme temporality as the future for Lofoten.

The self-sufficiency of Reine has a second driver. As the oil industry of Norway is expanding, Reine, being part of the most characteristic fjord landscapes of Norway, is aimed to provide the alternative. 2) It will not be dependent on the oil industry and will therefore rely on its own production of renewable energy, thus portraying Norway as the Utopia it wants to be as a way to contradict the developments up north.

3) Potential rockfall, caused by the environmental impact of global warming, requires dissolving part of the coastal settlements of Reine. In these areas, the emphasis lies on how these settlements used to be safe, and what caused them not to be. This way, the changing climate and its effect will be made visual and be a way to speak out against the use of oil and the oil industry.


Location
Shock
Territory
Potential
Infrastructure
Lofoten
Rockfall
Stormsurges
Coast - Inland
Coast - Seaward
Tourism
Commercial fishery
Sportsfishery
Logistics
Fishery
Connectivity
Activity nodes



Design experiment

Reine is proving self sufficiency by enhancing (110%) the two industries:

Tourism & Fishing

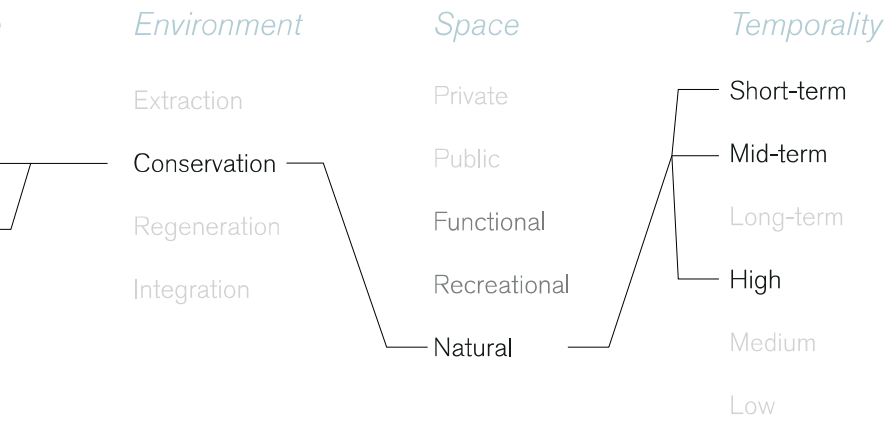
But, it is doing so in a manner that stress on the environment does not increase.

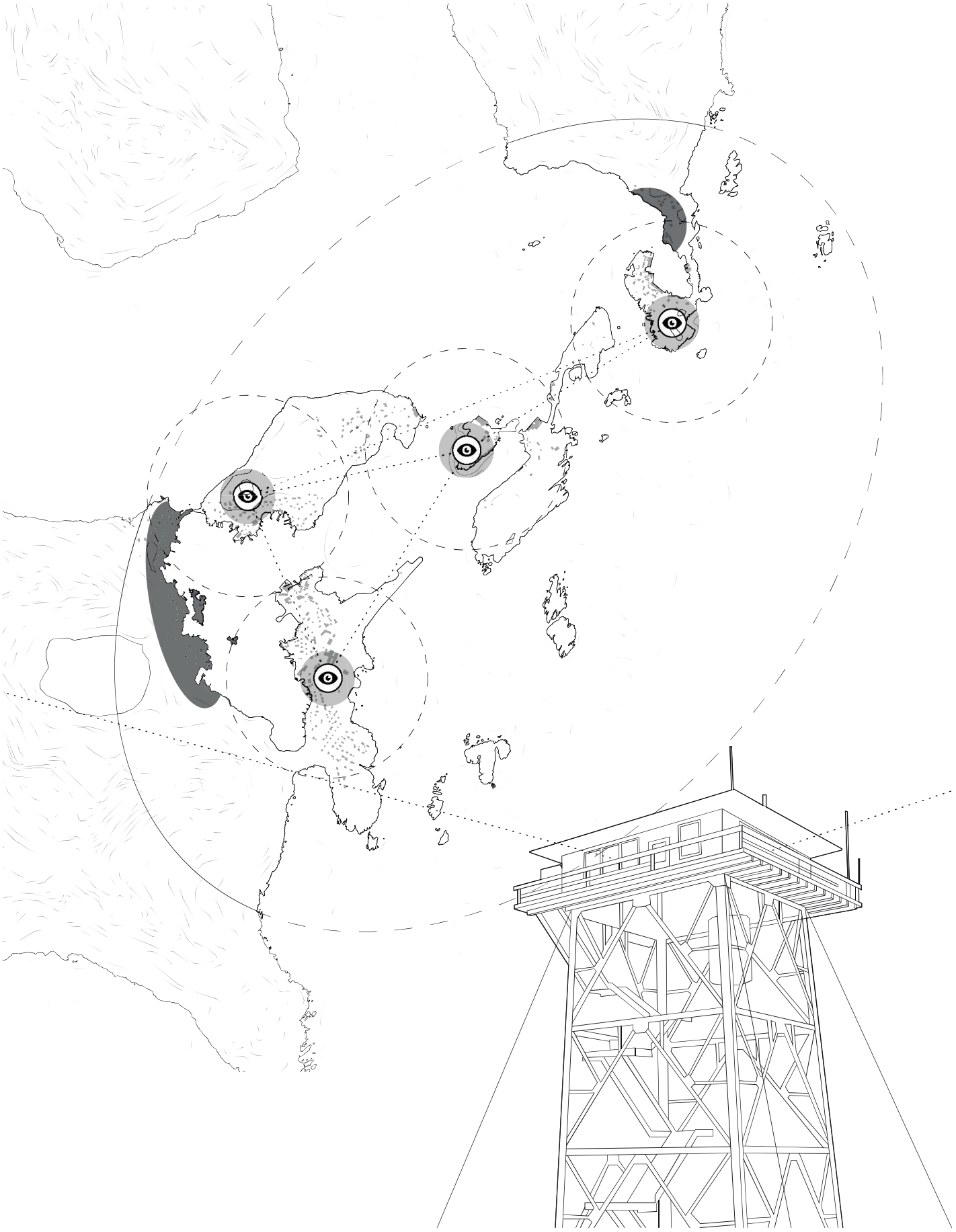
It is aiming to achieve this by introducing the following:

- Trying to limit land occupation in fishing season

- Creating more (designated) space for tourism, relieving stress on current hotspots

- Taking time to recover during Nature season





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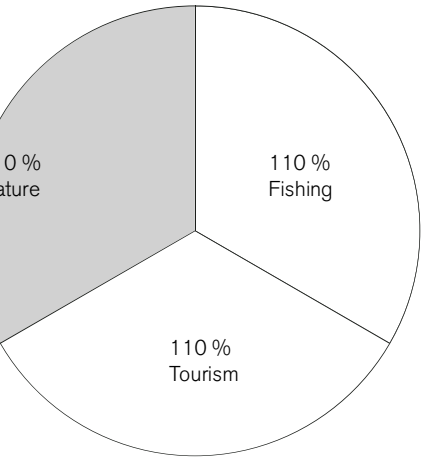


ng from Nature . . .

System of watchtowers

During the season of 110% Nature, no human is allowed on the Reine islands. To maintain this, the area is monitored by 4 rangers communicating through a system of watchtowers. The rangers have shifts of a week, and enter the area by boat.

Seasonality

As Reine is redeveloped according to its seasonality and extreme temporality, the new system of structures embodies this flexibility of space.

During Nature season, the watchtower provides protection of the harsh climate. At the same time it allows the ranger to have a clear view of their designated island, as well as the other towers in the system.

As Reine is trying to grow its fishing industry, there is a demand for more space to dry cod. During fishing season, the foot of the supporting structure of the watchtower is used for this. The structure incorporates the traditional wooden Hjell, but allows to reach larger heights for in order to increase the capacity.

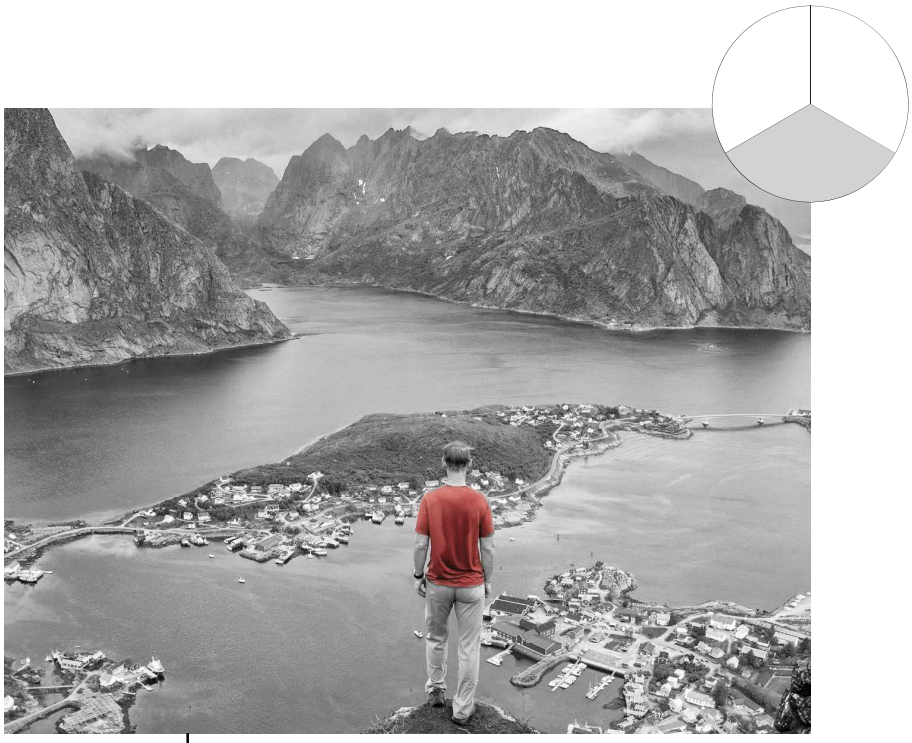
The growth of the tourism industry is asking for more distinctive locations within and outside of Reine. By creating these new viewing points, pressure on the most popular areas of Reine is deminished. At the same time, the traditional appearance of the Hjell surrounding the watchtowers make sure the sceneric landscape is not disturbed.

unctional watchtower as the embodiment
extreme temporality of Reine.
nly building that is occupied all year round.

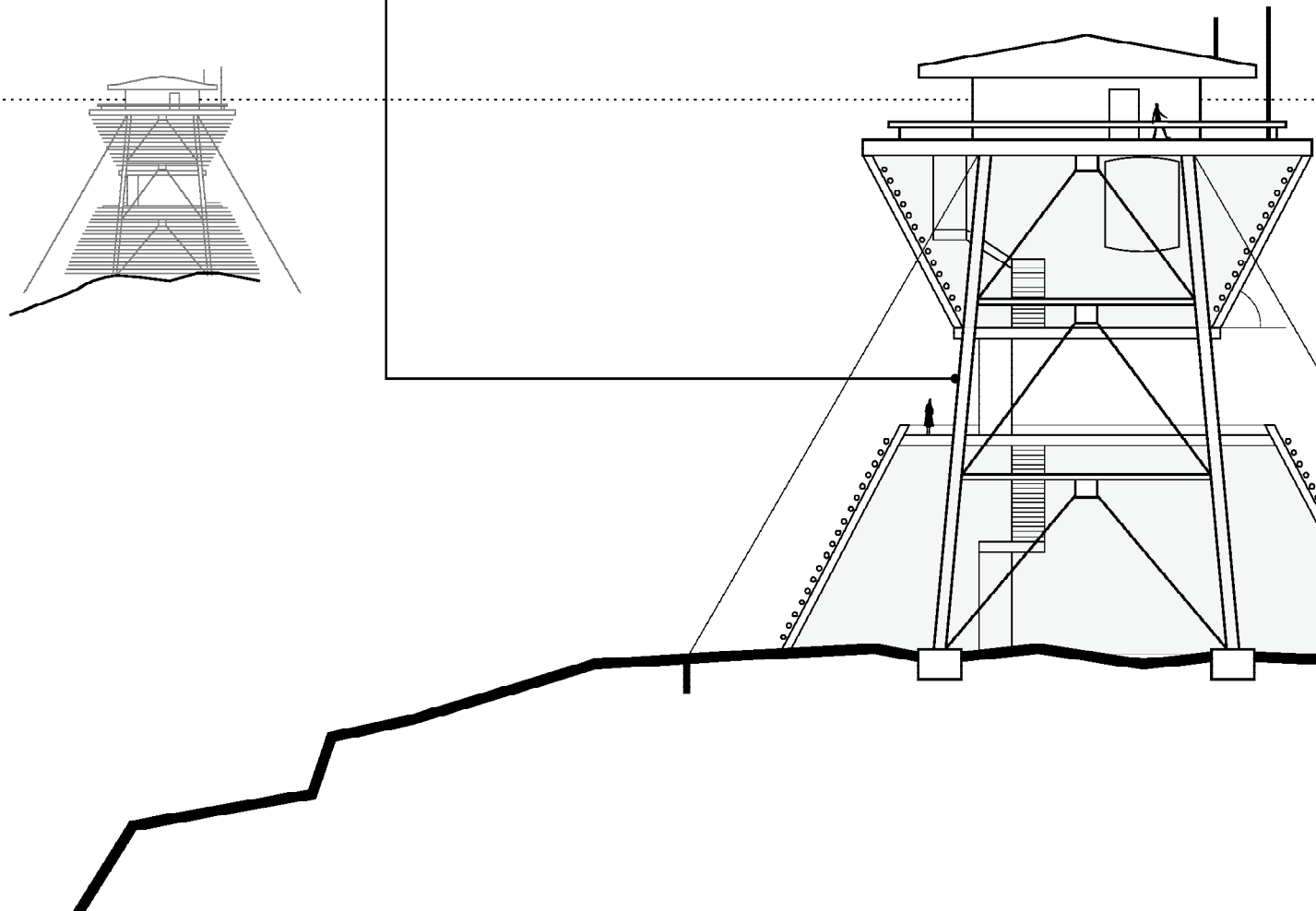
Public space directly affected by towers
Dissolved area

N

Map: 1:25.000

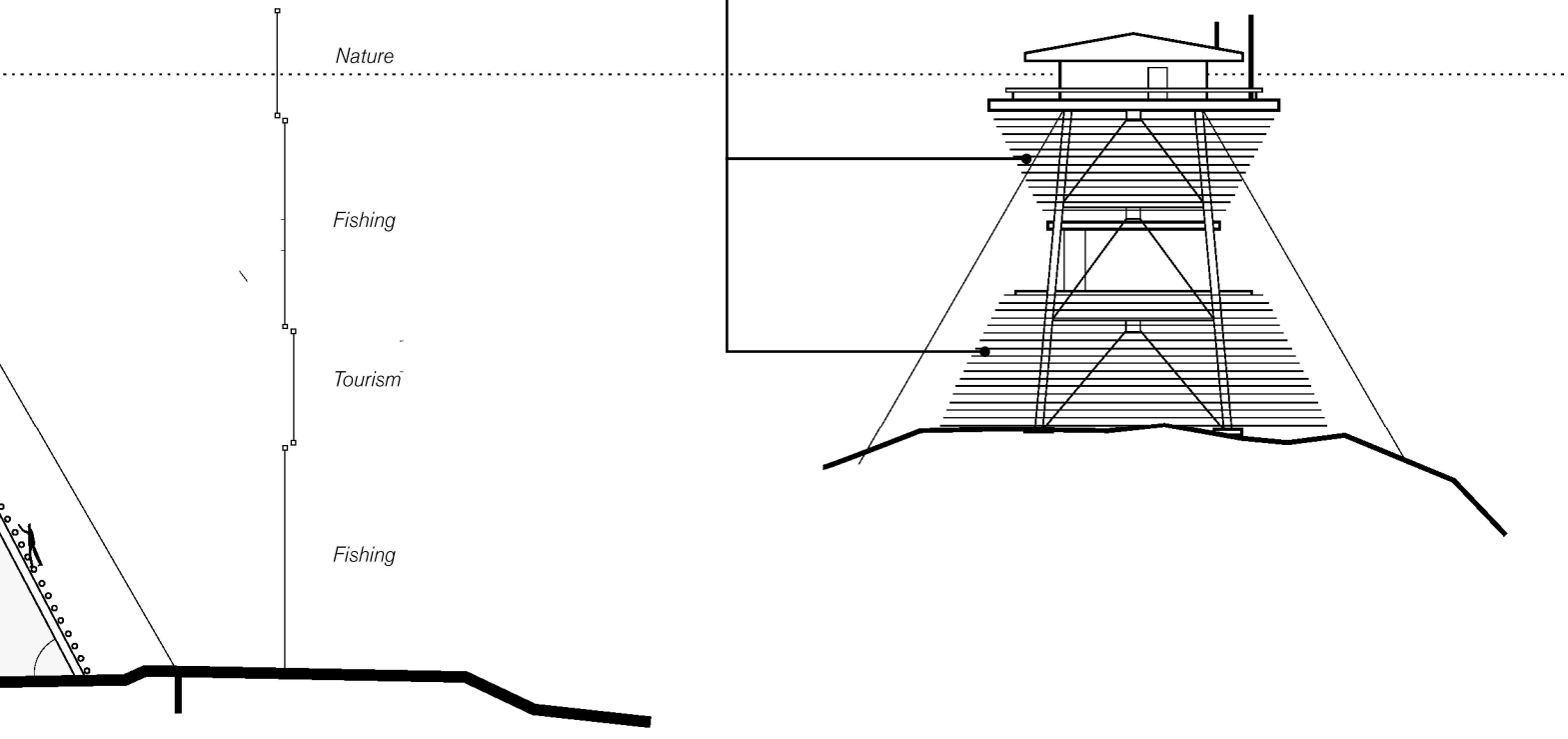


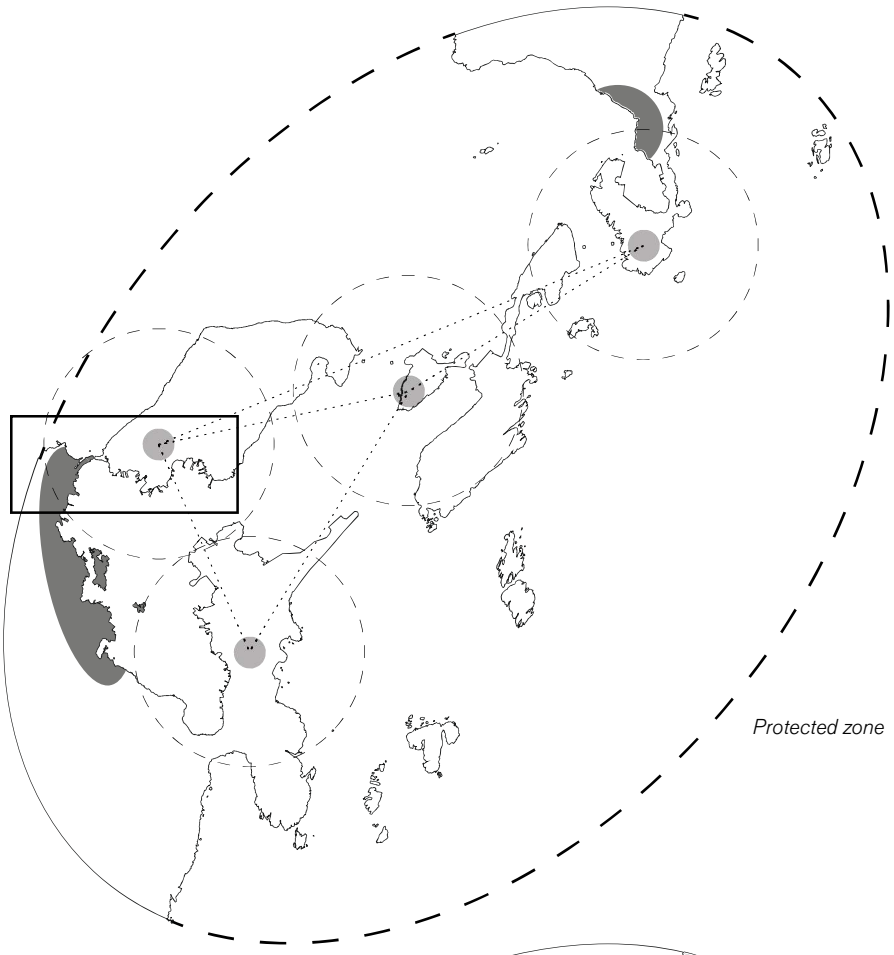
Platform create different viewing points on the Island system

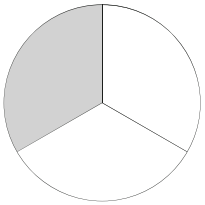




Incorporated traditional wooden Hjell.

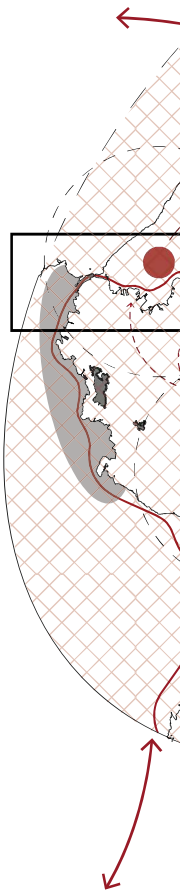


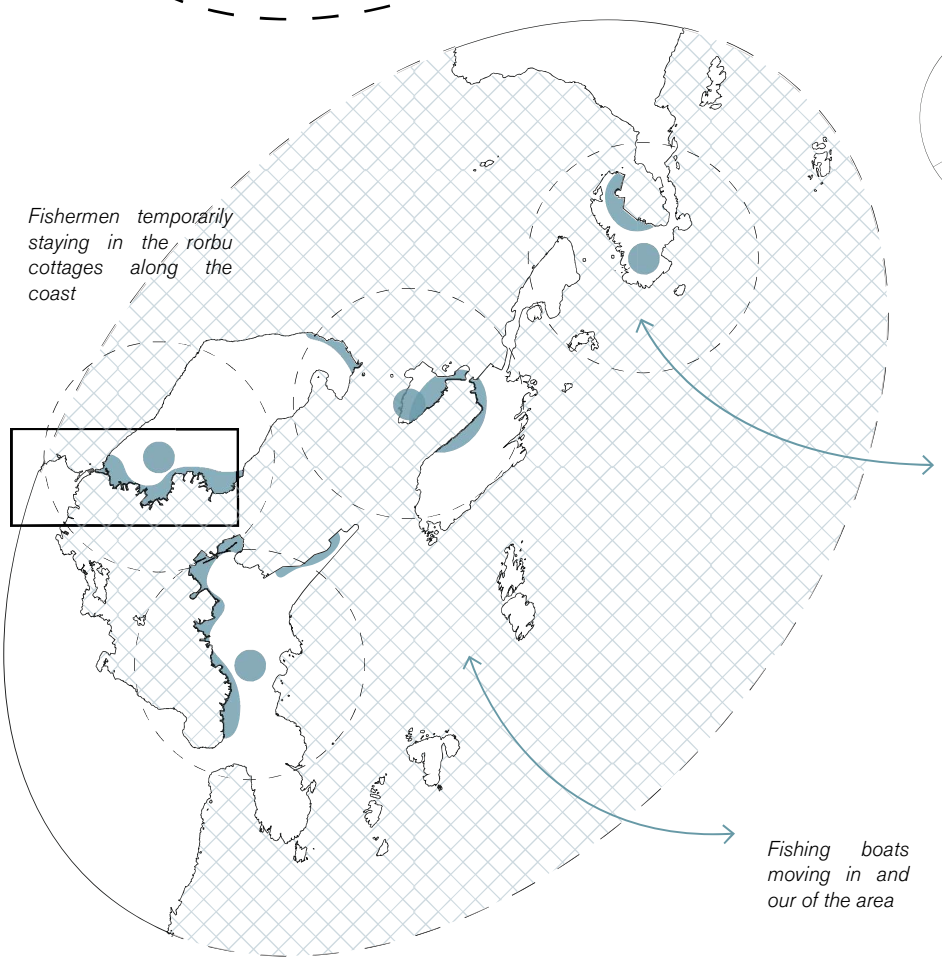


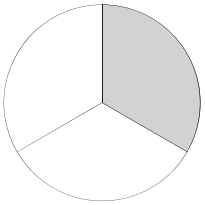


Protected zone

Tourists
for hiking tr
neighbouring
landscape

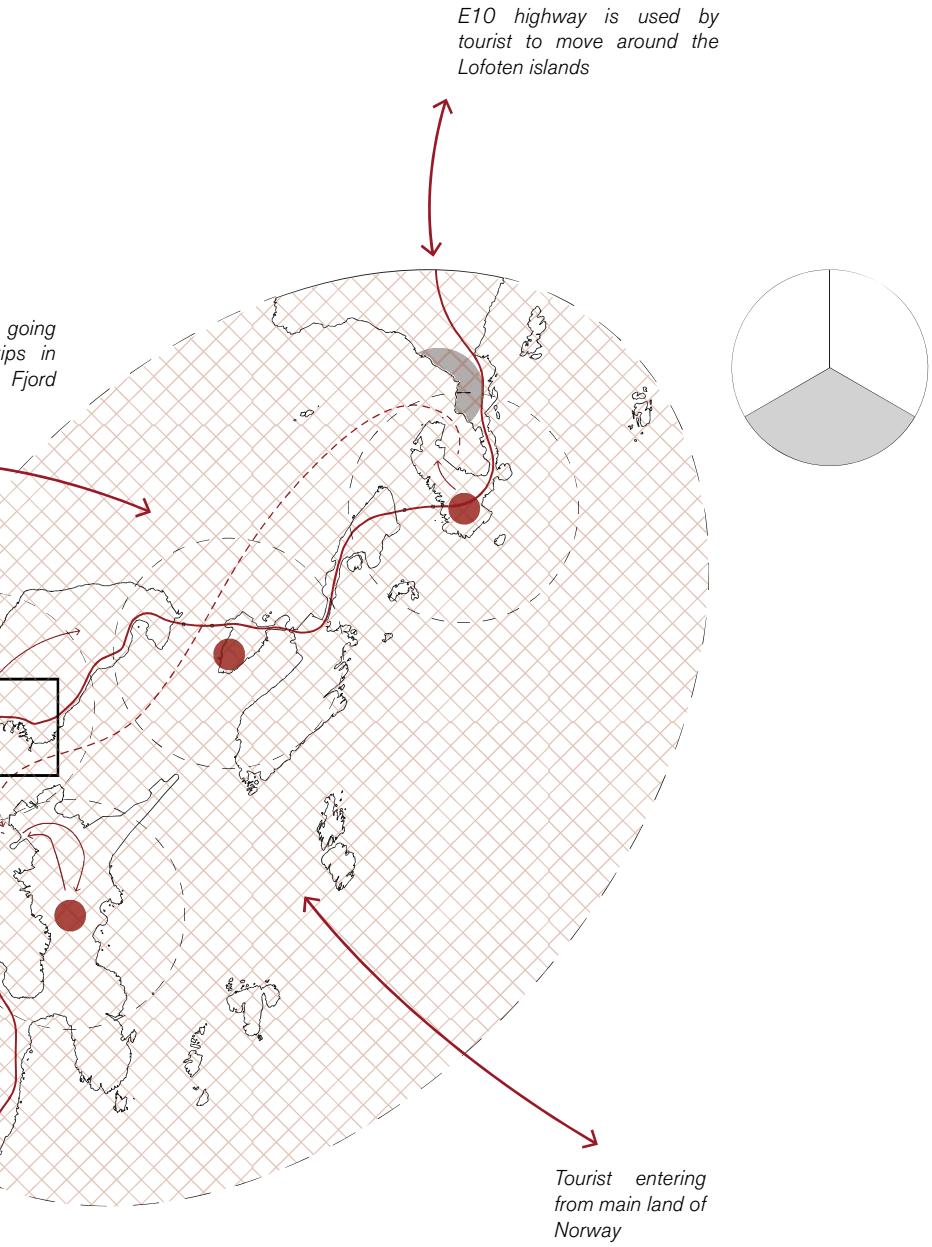






Fishermen temporarily staying in the rorbu cottages along the coast

Fishing boats moving in and our of the area



Occupation

As the vision map of Reine already showed, the occupation differs per season.

During Nature seaon, the land and ocean are left untouched. The only human movement will be that of a ranger traveling to and from the tower after a shift.

Fishing season occupies the coastal areas and the ocean. There is only movement towards the open sea, not inland.

Tourism season covers all the of the Reine island system. The main road is used again, and the area is well connected to other touristic activities in the fjords nearby.

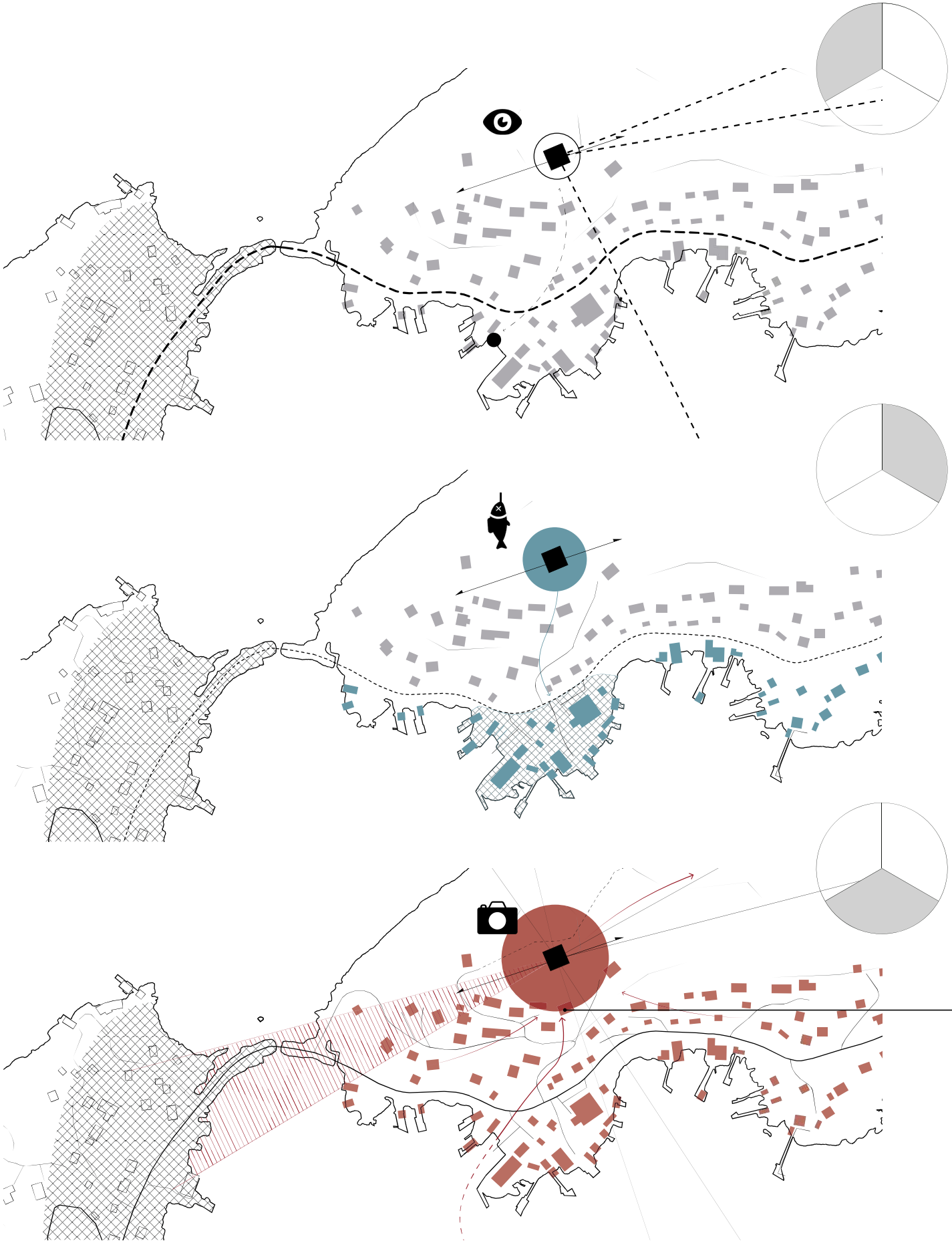
Location of watchtowers

The location of the towers is determined by its different functions.

The structure is on higher ground, allowing the overseeing rangers to be in visual contact with each other. Together, the towers are able to cover all of the Reine islands.

The structure can be accessed easily from the coastal zone. Considering the area is covered with snow during the period that the cod is dried, the landscape between the coast and the tower cannot be too steep. There is a connection between the tower and the nearest coastal area.

During tourism season, the combination of towers allows for an interesting route across the Reine island system, activating areas which are currently undevalued. With tourism growing, creating more areas suitable for tourist activities will relieve stress from the current focus points.



Public space

Seasonality and function have an impact on the public space that is taken up around the structure.

During Nature season, only the tower itself is in use.

When the cod is dried during fishing season, the area directly around the tower is used for this activity. Only the path directly connecting the coast with the towers are in use.

During tourism season, a new touristic epicentre is created, which encourages "ecotourism". The Reine Hiking Route connects all towers and offers different views and stories. It educates the public on the effects of global warming on the Lofoten Island system, and why Reine is choosing for extreme temporality.
In Norway, by law, everone has "The right to roam". It means that everyone in Norway enjoys the right of access to, and passage through, uncultivated land in the countryside. For Reine during tourism season, this creates the challenge of keeping people on the areas designated for tourism. This is achieved by creating these routes and new destinations.

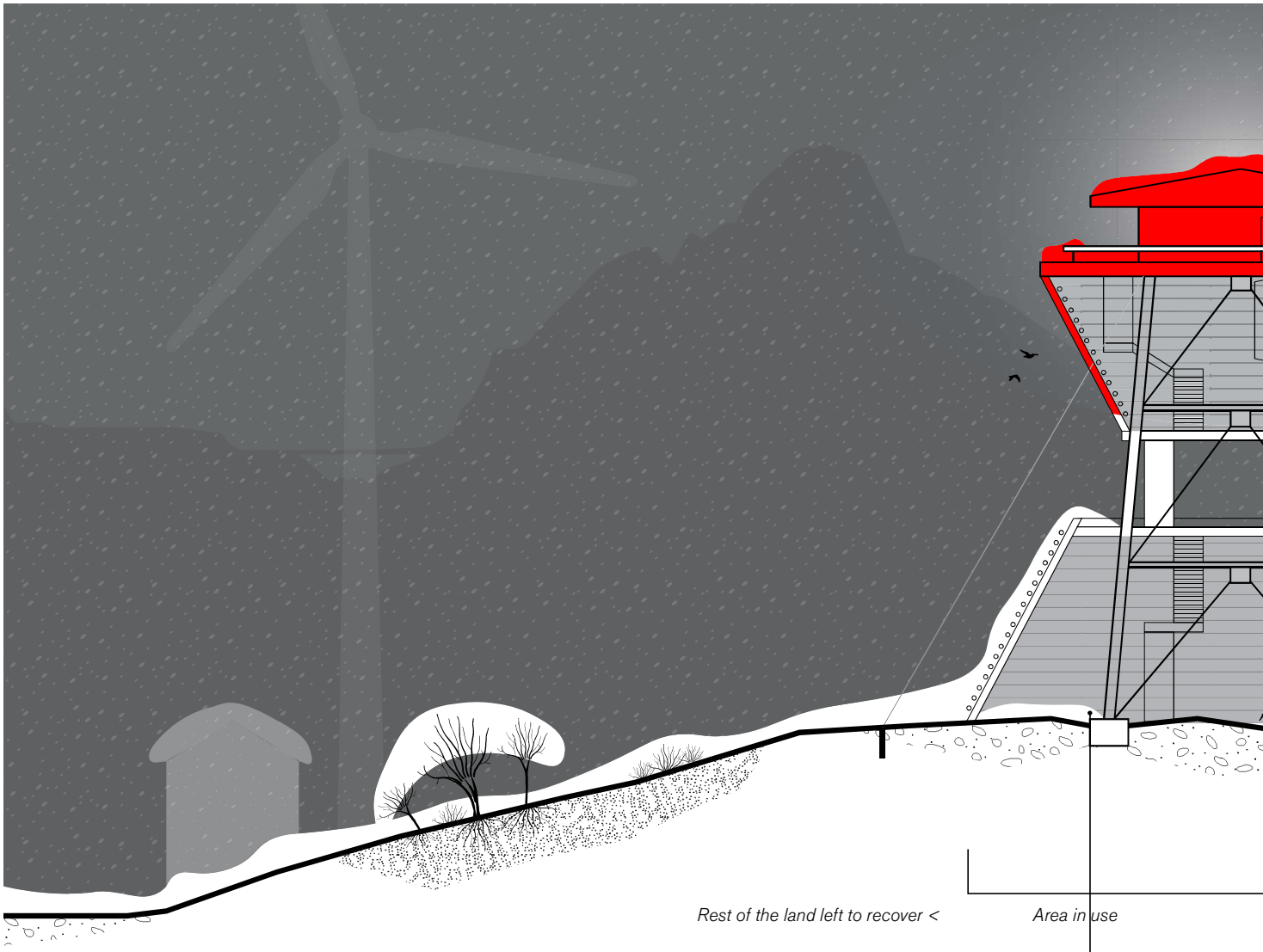
Surrouding buildings consist of tourist information and small restaurants.

Unoccupied buildings

Dissolved area

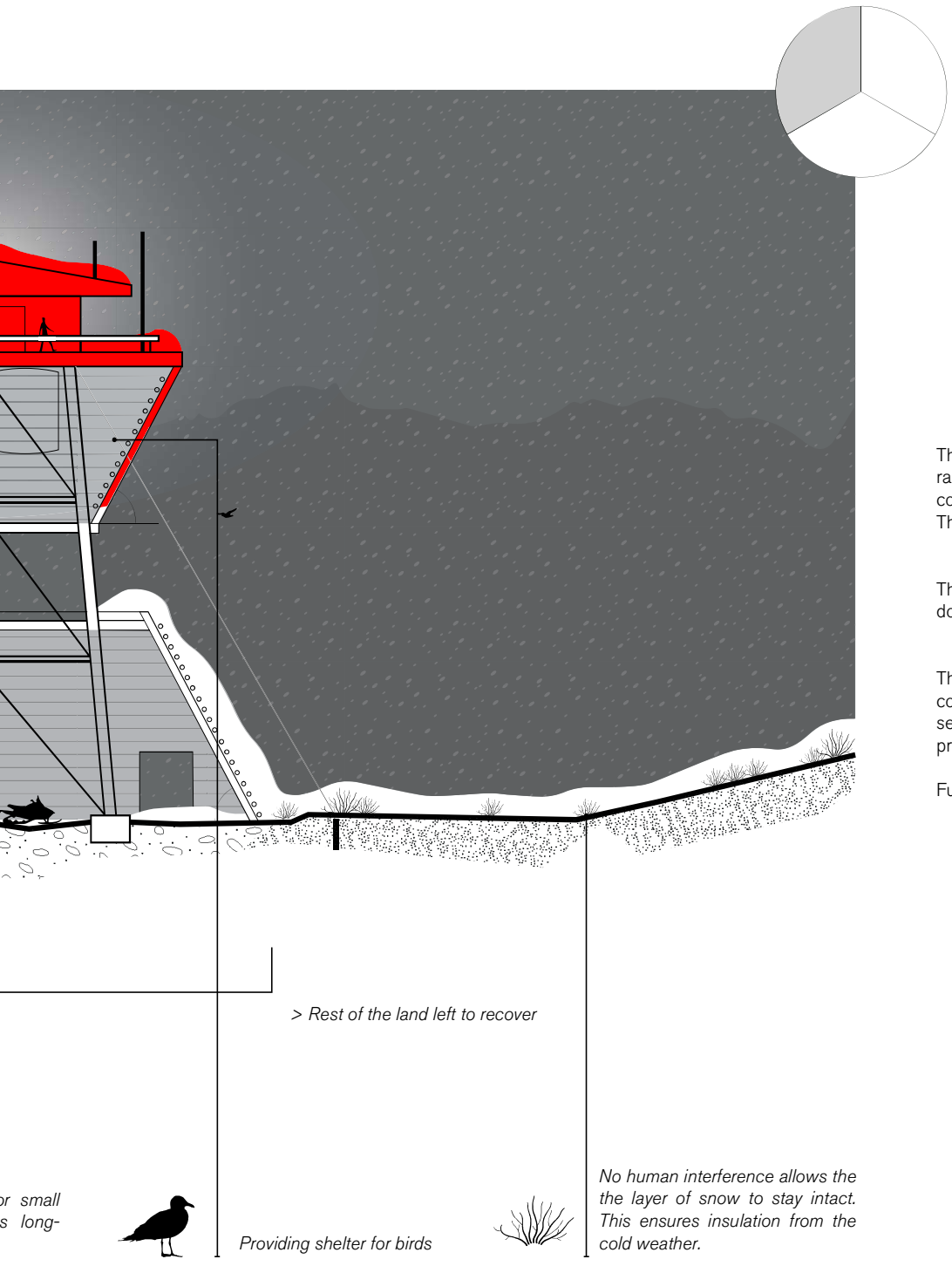
N

Map: 1:5.000



Nature

Providing shelter fo
mammals (such a
tailed weasels)



or small
s long-

> Rest of the land left to recover

Providing shelter for birds

No human interference allows the the layer of snow to stay intact. This ensures insulation from the cold weather.

Seasonality Imaging

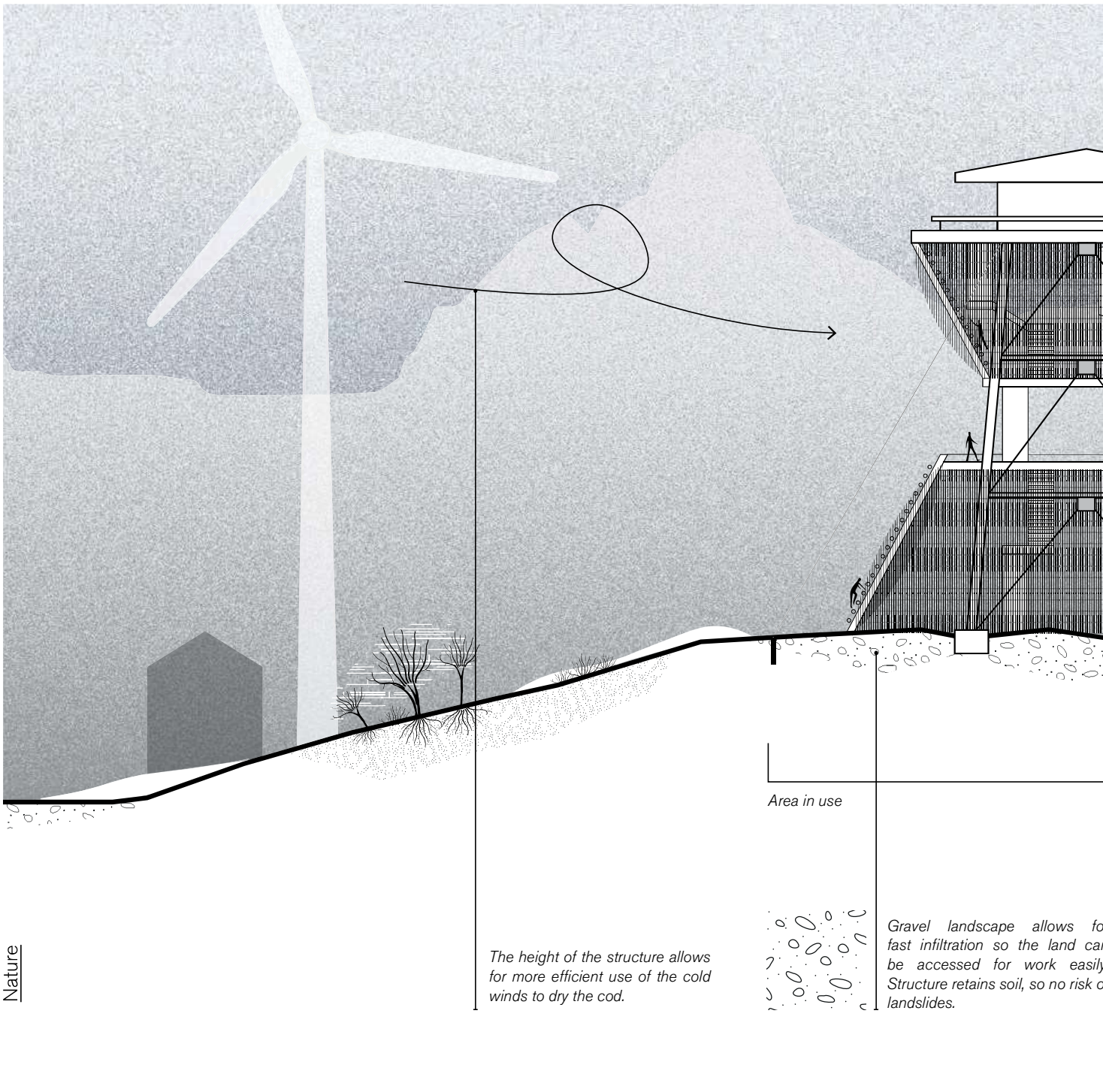
The cabin on the top of the tower allows the ranger to stay for a week. He will be in radio contact with the other rangers at all times. The electricity is provided by the wind turbine on the shore.

The functions per season in the wachtowers do not mean the rest of the tower serves no purpose during that period.

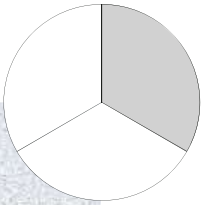
The wooden slats, designated for hanging cod, will get covered by snow during nature season. The accumulation of snow allows for protection from the harsh climate. Birds and small surface animals can use this space. Furthermore, the tools and transportation of the ranger can be stored underneath.

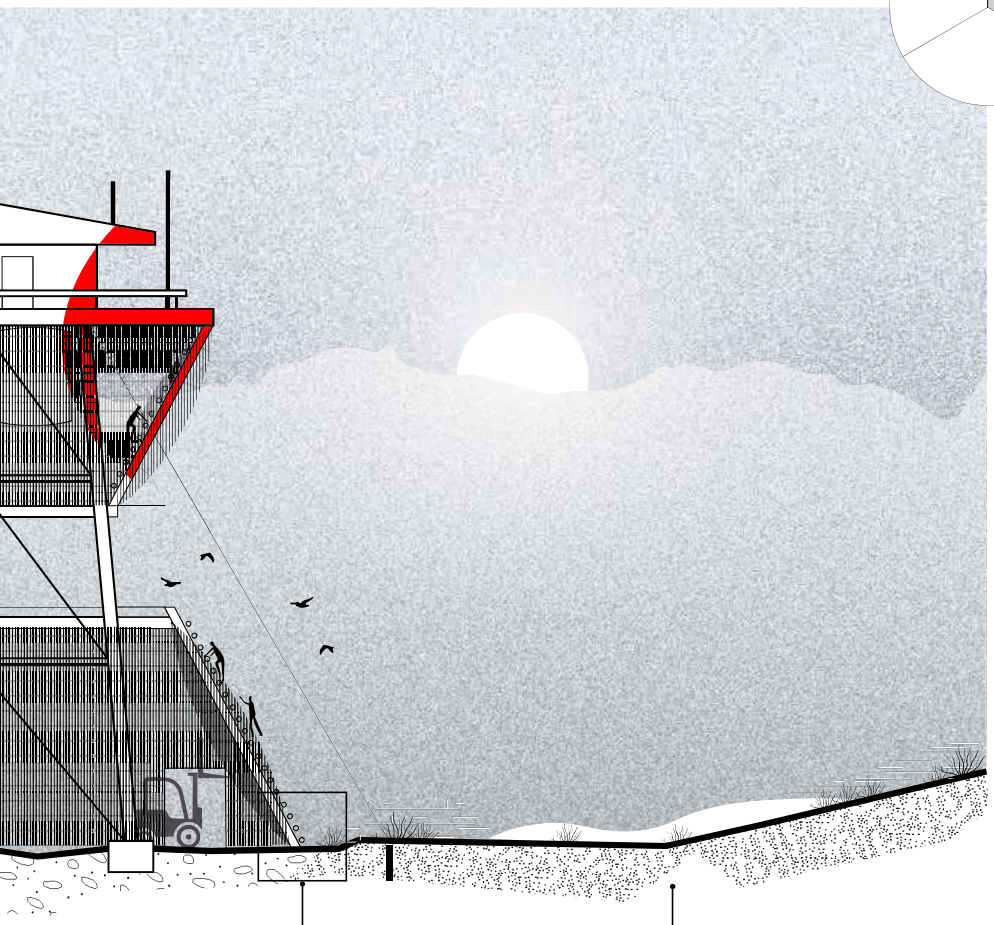
N

Section: 1:500


Area in use
The height of the structure allows for more efficient use of the cold winds to dry the cod.
Gravel landscape allows fo
fast infiltration so the land ca
be accessed for work easily
Structure retains soil, so no risk o
landslides.

Nature





Seasonality Imaging

To facilitate the growth of the fishing industry, the stacked Hjell provide a great amount of extra space. Eventhough the wooden slats surround the entire structure, openings allow for vehicles to go underneath the Hjell and aid the workers (as seen in the picture before). The middle platform ensures the workers do not have a risk of falling from too great heights.

.

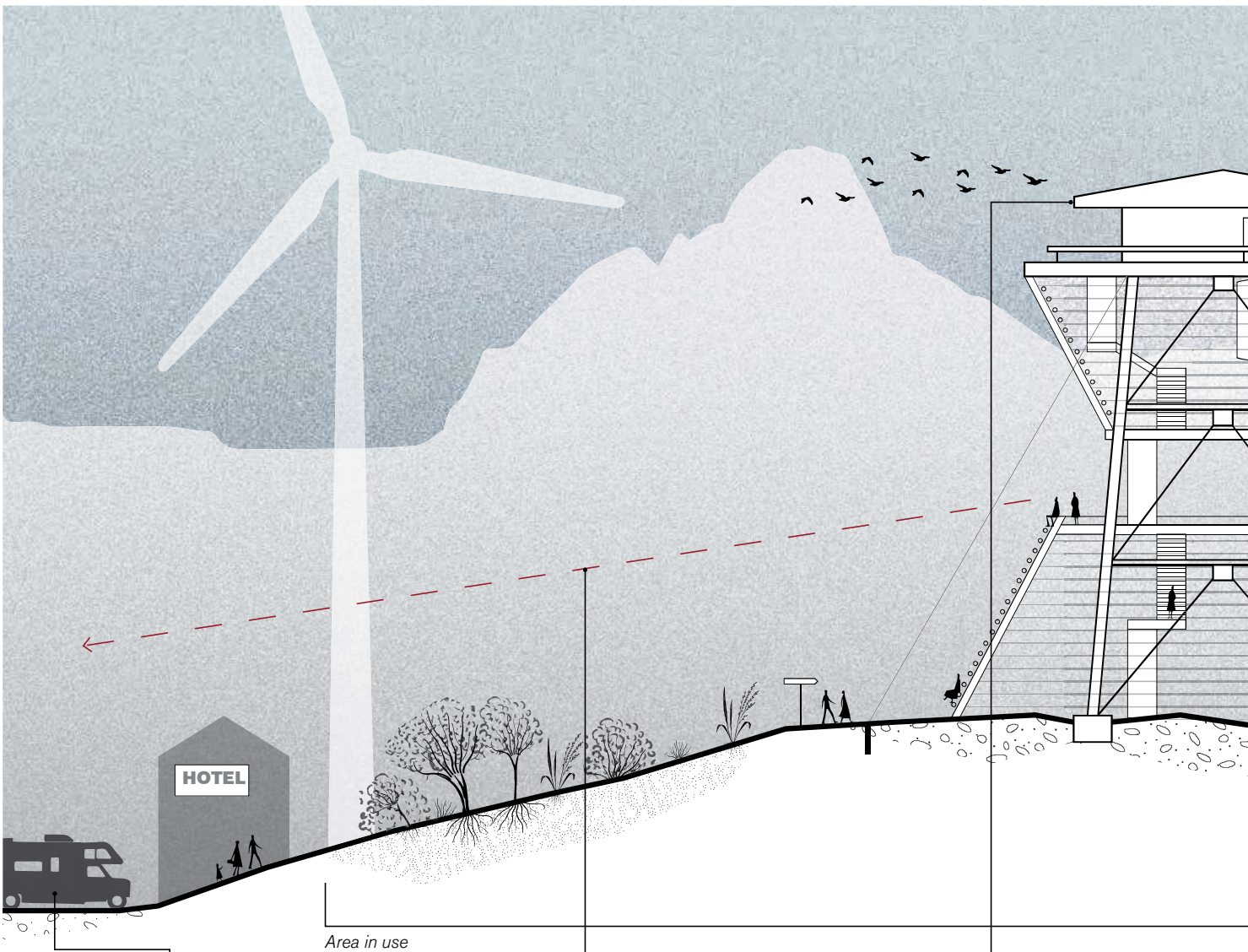
> Inland left to recover

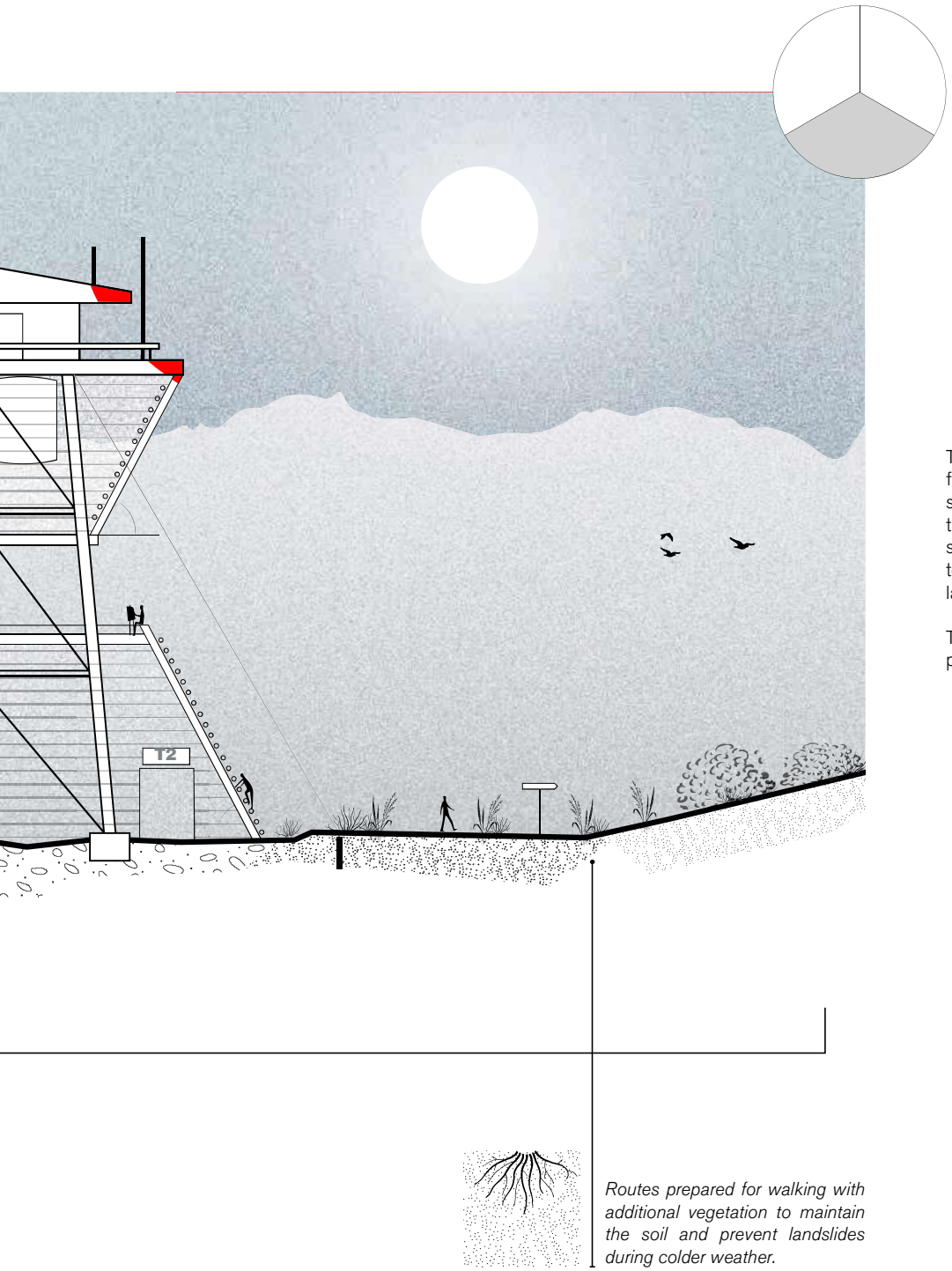
In case of a landslide, the structure protects lower lying buildings from damage

Rest of the land is untouched allowing time for the vegetation to regain strength after the melting snow and prepare for tourism season.

N

Section: 1:500


HOTEL
Area in use
Nature
Only during tourism season private car traffic is allowed to leave the E10 and use the smaller roads on Reine
Environmental awareness is increased through the visual connection with the dissolved area of Reine.
Ideal nesting place for birds



Seasonality Imaging

The structure aims to create more space for the growing tourist industry, but does so in a manner which limits impact on the environment. The tower activates the surrounding public space and attracts tourists to the areas that are prepared to handle larger numbers of people, hence mitigating the risk of landslides.
The platform looks out on the dissolved part of Reine and highlights the cause; the changing climate.

Routes prepared for walking with additional vegetation to maintain the soil and prevent landslides during colder weather.

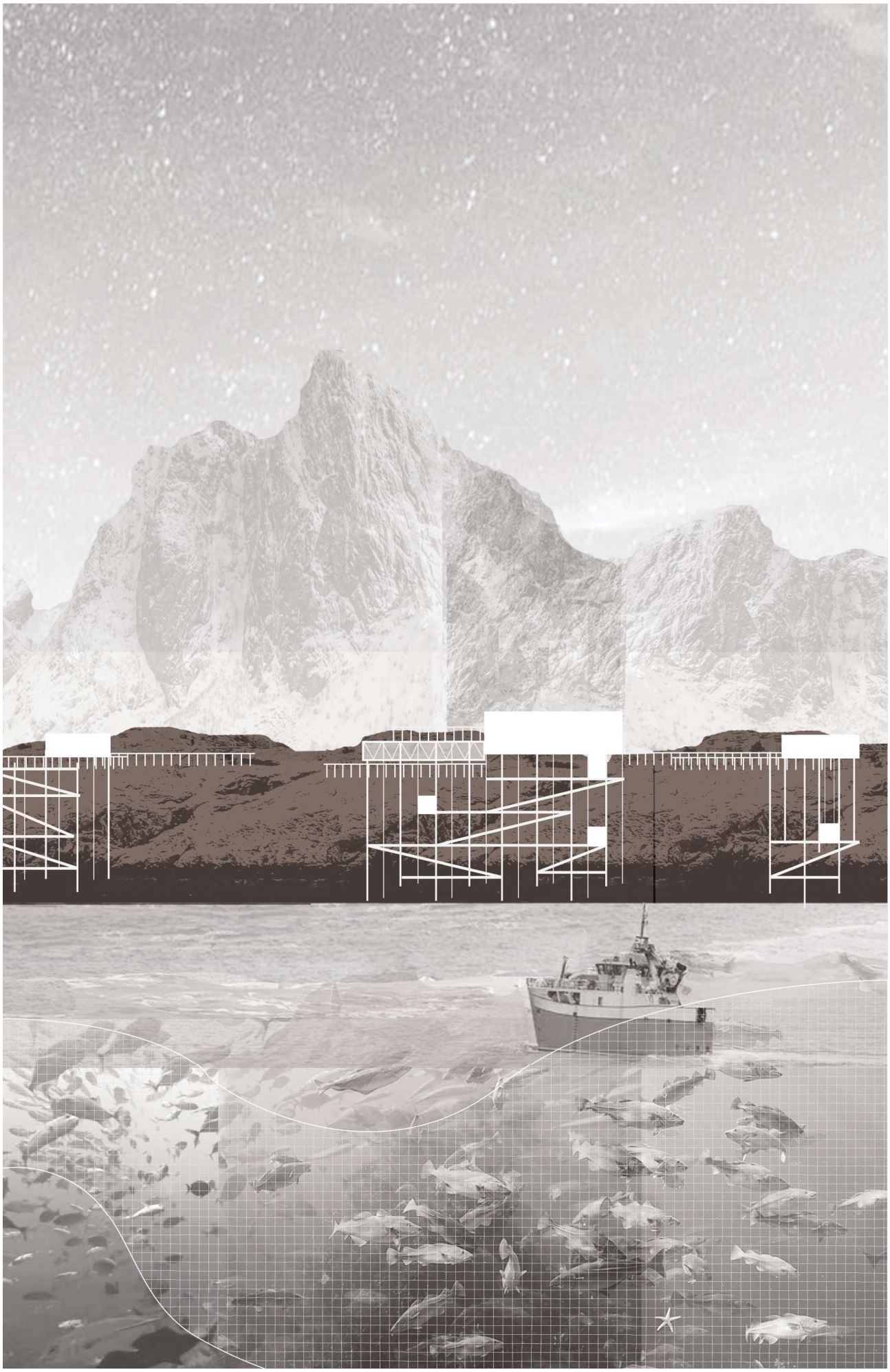
N

Section: 1:500

6.4.2.

Reine Multifunctional FIshing Hub

Zhe Hou



Reine's future is facing both opportunities and challenges. On the one hand, the global epidemic will keep impacting on tourism in the next few years. But it also brings new opportunities to the declining fishery. On the other hand, sea-level rise caused by climate change increases the risk of storm surge disasters in coastal areas. Therefore, Reine needs to enhance both natural and social resilience to adapt to more complex extreme situations. Fishery and tourism need to explore a mixed-use approach to make the temporary function of space can be shift more flexibly between seasons.

Fishery: TO Combine tradition and modernity

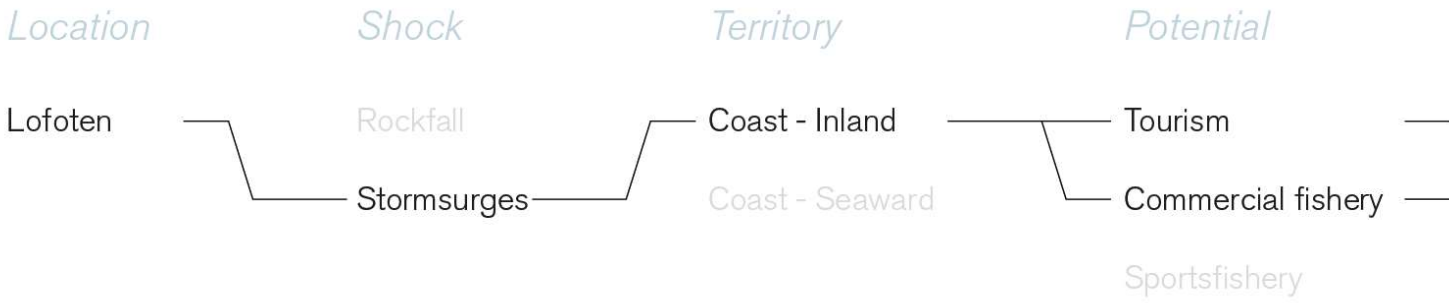
The expansion of fisheries has promoted the upgrading of the traditional living and production spaces of fishermen to adapt to modernity. First of all, in addition to the traditional temporary fishing houses, new docking areas and public facilities on the shore are added to adapt to a variety of temporary living modes. In terms of fishery production, modern technology is applied to traditional drying methods. The degree of automation driven by clean energy is improved in the production process to increase production efficiency. The hjells, as an important production space and cultural landscape, are preserved and expanded, and explore ways of mixed-use. Besides, The surrounding islands cooperate with the construction of warehouses and docks to upgrade the modern logistics and warehousing chain. Moreover, scattered living and production spaces will be integrated to optimize the activity flow of fishermen.

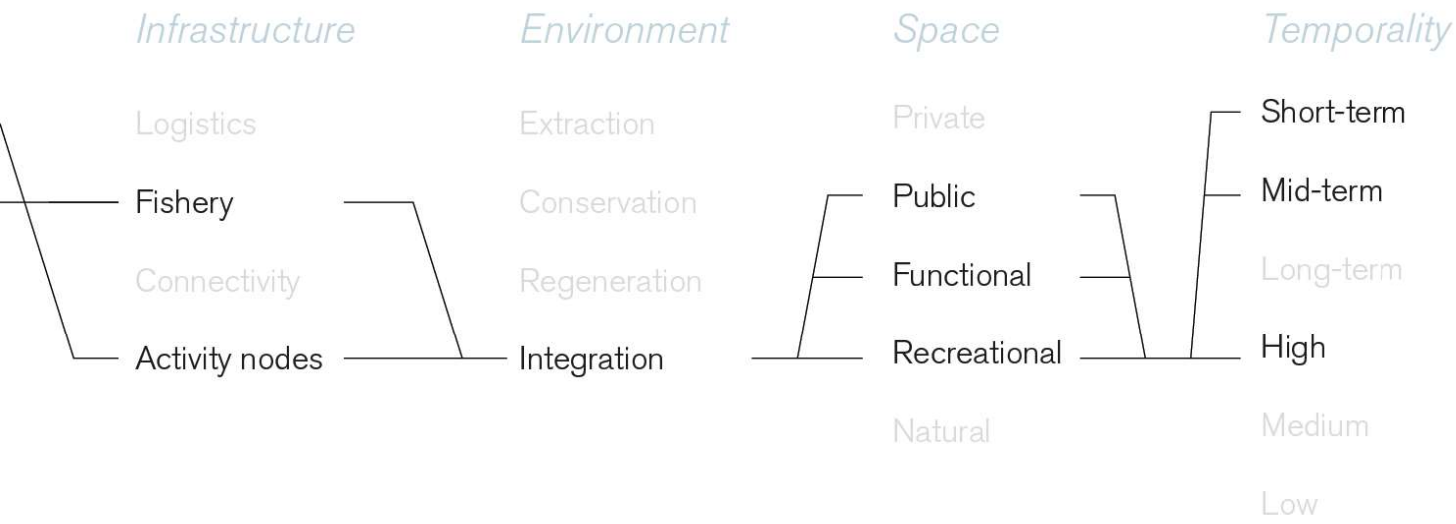
Tourism: TO Explore the transformation of fishery spaces

The local tourism industry affected by the epidemic needs to strengthen its fishery cultural identity in addition to the advantages of natural landscapes and diverse outdoor activities to enhance competitiveness. Service facilities and fishery production space in the fishing season are transformed into tourist service and cultural experience places during the tourist season to achieve the inter-seasonal mixed use. Besides, the tourism industry adapts to the new normal of social distance, such as use cod drying ground as outdoor public activity spaces to enhance the ability to evacuate tourists.

Enhance natural resilience with artificial intervention

For the west coastal line, which is more vulnerable to storm surge disasters, potential flooding areas are set by monitoring and analysis. The foundations of buildings in the area are refer to the traditional rorbu form. The ground floor of the building is elevated to give space for flooding, as well as providing space for vegetation to reduce soil erosion. Based on the topography and soil type, a drainage system is designed for the outdoor space in potential flooding areas, which enhances natural resilience by artificial interventions.


Location
Shock
Territory
Potential
Lofoten
Rockfall
Stormsurges
Coast - Inland
Coast - Seaward
Tourism
Commercial fishery
Sportsfishery



Design experiment

Multifunctional Fishing Hub

The design project aims to explore a mixed-use space that can be used for three temporary functions of fishery production, tourism and natural disaster management.

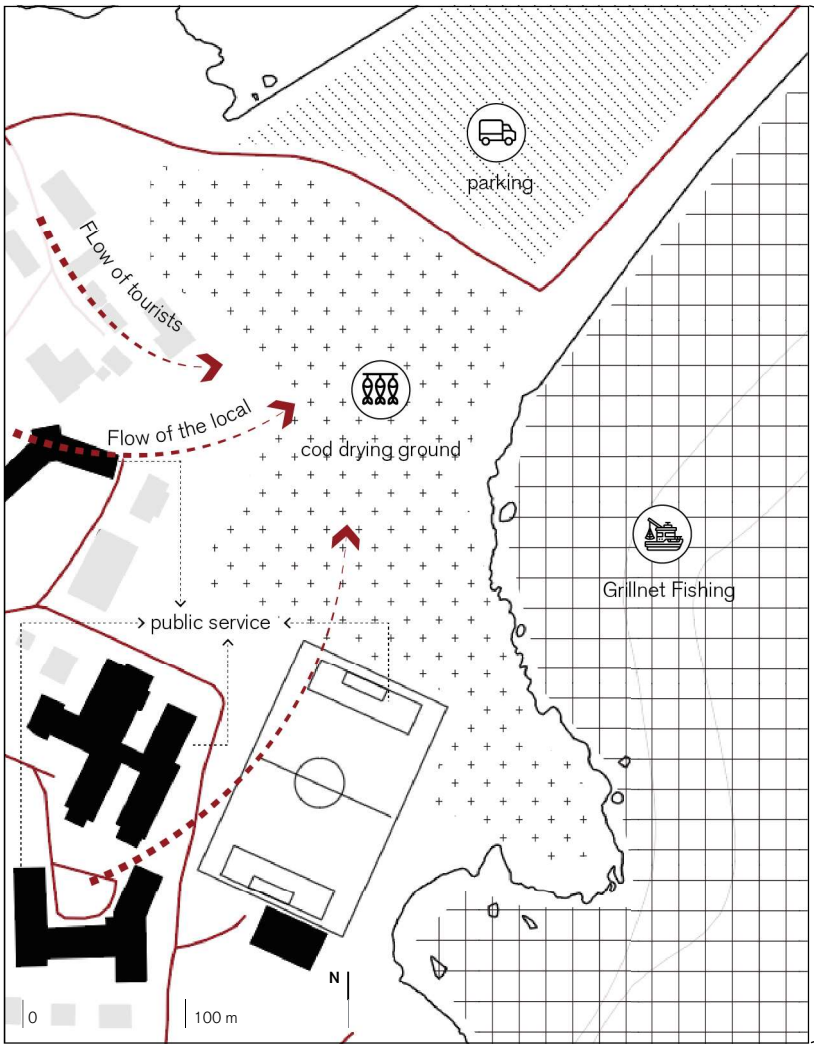
The project focuses on the west coast with more fishery activities, lower tourism development, and higher natural ecological vulnerability. Fishery production, tourism services, ecology restoration and disaster management all have specific requirements for space. The project of multifunctional fishing hub aims to explore an approach of function combination and transformation to enhance social-ecological resilience to extreme temporarity and seasonality.

Urban Scale

Zhe Hou

Location

The project is located on the west coast. The north side is the largest parking area on the island, providing potentials for convenient freight transportation. The west side is a group of public buildings and football field, which has a strong publicity and brings flow of both tourists and local residents. The east side is the main grillnet fishing area. At present, there is a large-scale drying ground on the site, but there is no area for docking and working. The fishermen's activity route needs to be optimized.



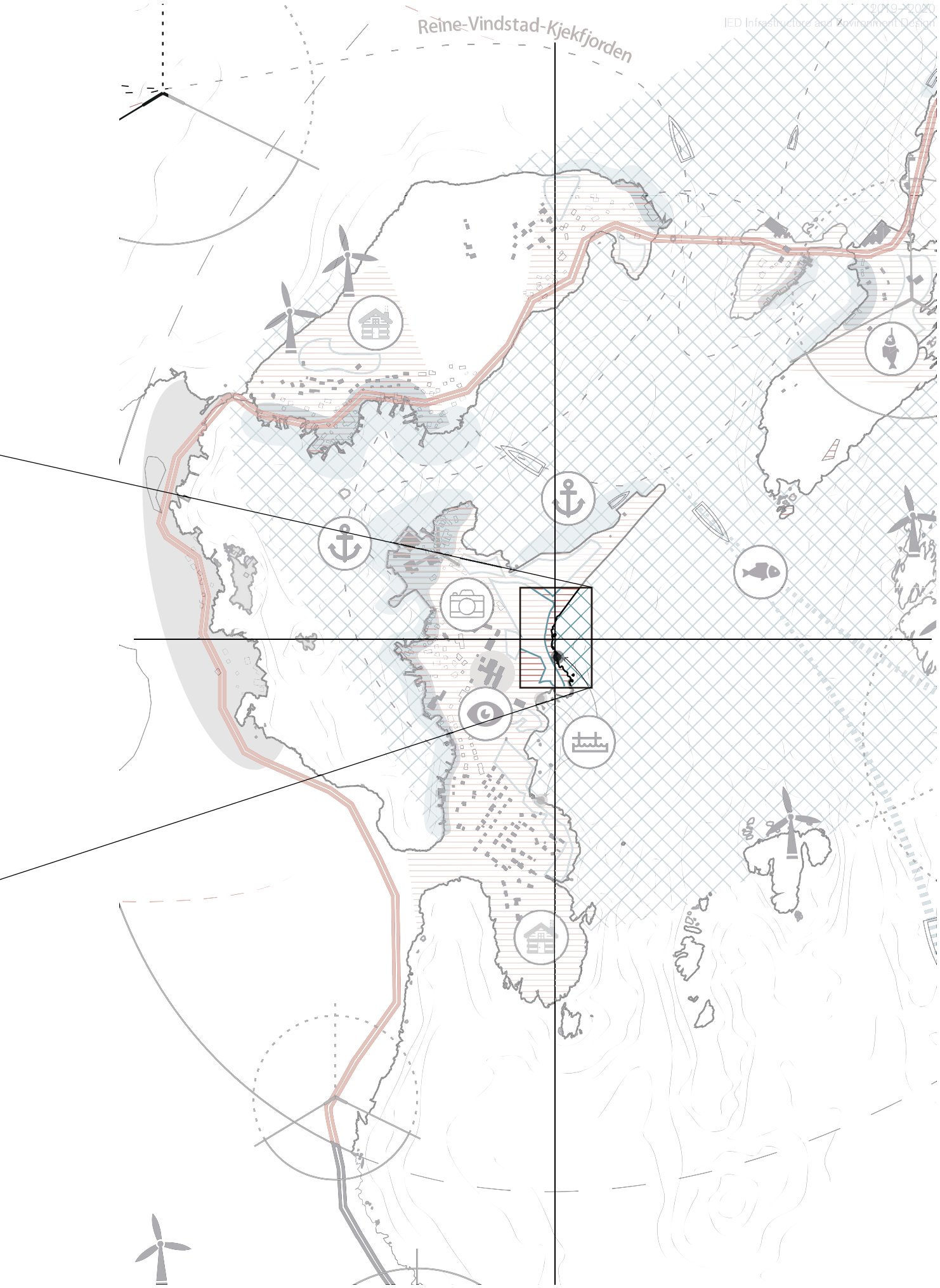
Fishing Jan-May
coastal zone reserved for fishing industry

Tourism June-Aug
urban area reserved for tourism industry

New Hjell fields
increase capacity of fishing industry, can be transformed to public space for tourism

Existing Hjell fields
adjusted to provide public space for tourism

N
0 30 m


Reine-Vindstad-Kjekfjorden

Plan

The projext consists of designs for architecture and open spaces. The new quick dock, working platform, multi-functional fishery hall and service center and the current fishing ground together form an integrated fishery hub, providing fishermen with comprehensive services for boat parking, work, rest and entertainment. The outdoor space is divided into cod drying ground, garden and plaza around the buildings. The new road system is connected to the existing roads to integrate the fishing hub into the public areas of Reine. Bush gardens are designed as a transition zone between the drying ground and the urban areas, which are public activity places shared by local residents, fishermen and tourists.



Cod Drying Ground



Water Buffer Gardens



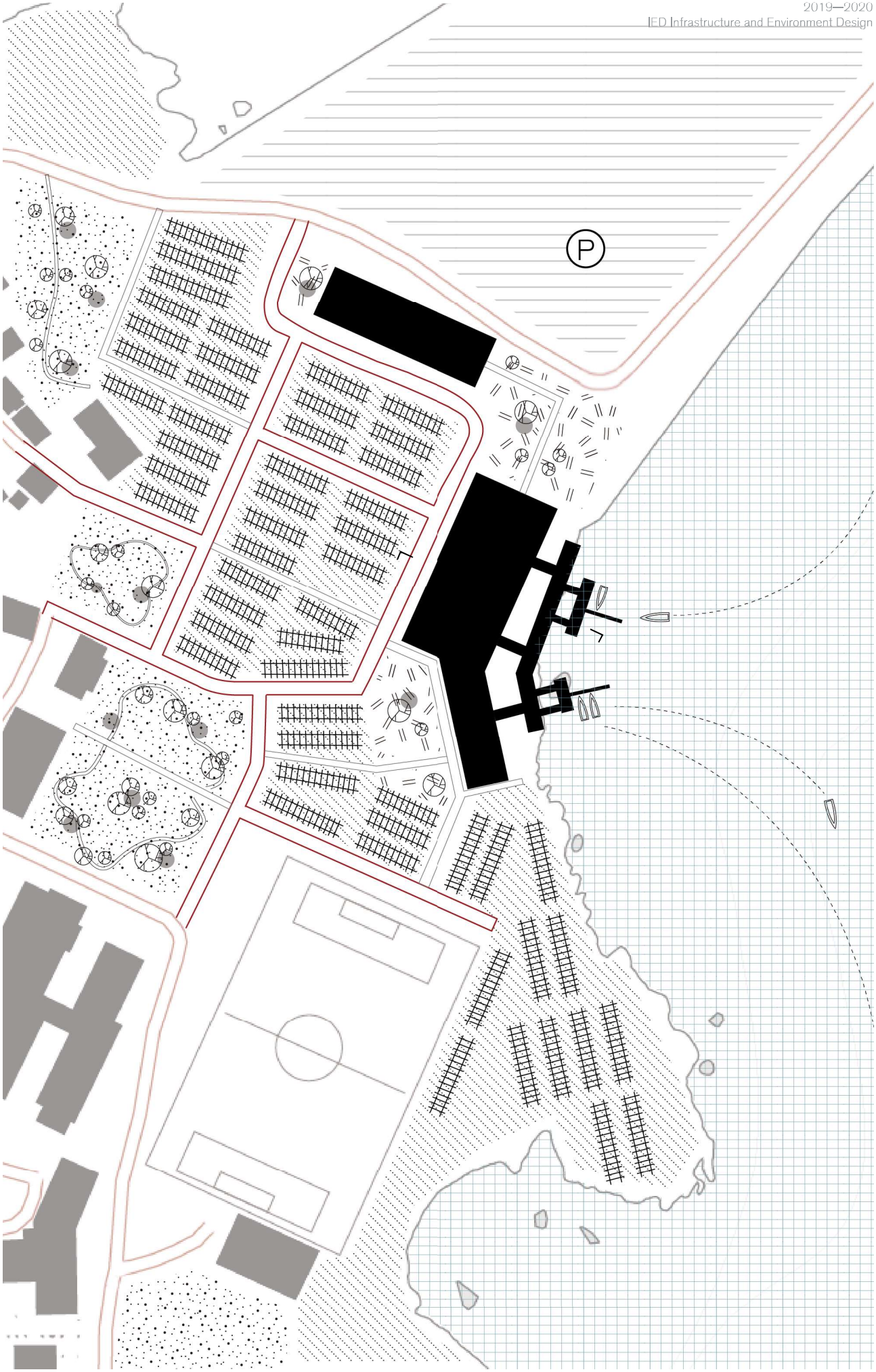
Open Spaces

Parking Ground



Fishing Area

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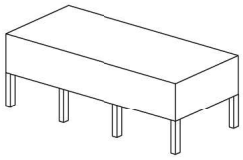
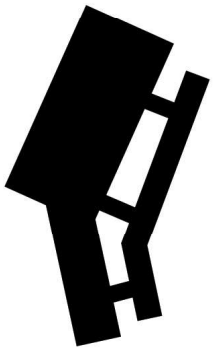
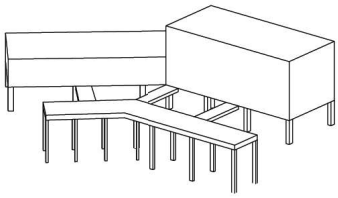
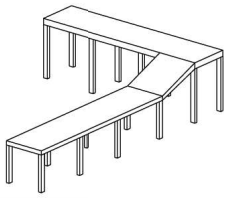
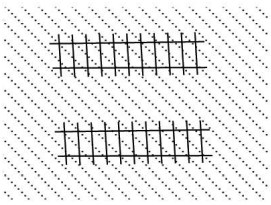
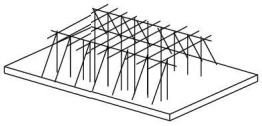
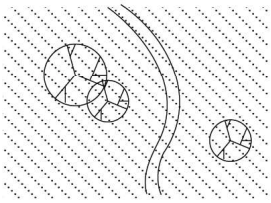
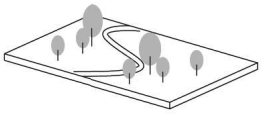
Plan	3D	Fis
		Fisher
		Wo She Pub
		Qui Fish
		Hjell (Woo Dryin
		Gard

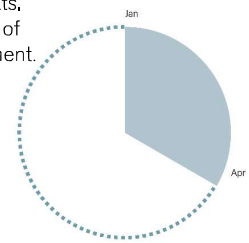
Function Transformation

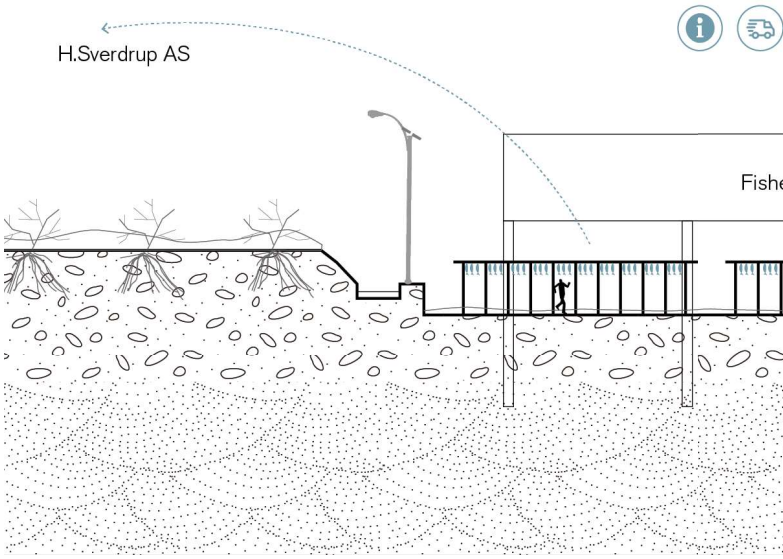
The functions of the buildings and open spaces can be transformed between the fishing season and the tourist season. During storm surge disasters, the cod drying grounds and bush gardens have the function of controling the flood water as a buffer area between coast and urban areas.

shing Season	Tourism Season	Nature First/ Stormsurge	
men Service Center	Tourists Service Center	Closed	
rking Platform elter/Cafe blic Space	Sightseeing Platform Exhibition/Gallery Place for Events	Closed	
ck Docks for hermen	Quick Docks for Tourists	Closed	
oden Racks for Cod ng)	Cutural Attractions Pavilion Campsite	Flood Buffer Zones	
en	Garden Activity Place	Flood Buffer Zones	

Fishing Season

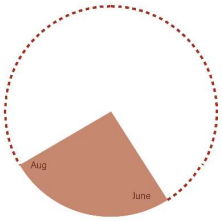
During the fishing season, the fishing hub provides fishermen with an efficient workplace, comfortable rest areas and convenient living services. A semi-automatic mechanical system driven by clean energy enhances the efficiency of cod transport, handling and drying. The second floor of the workplace is used as a cafe and lounge to provide fishermen with a place to rest and socialize. The information center provides logistics services and facilities for fishermen living on boats, The fishing hub can improve the quality of fishermen's working and living environment.

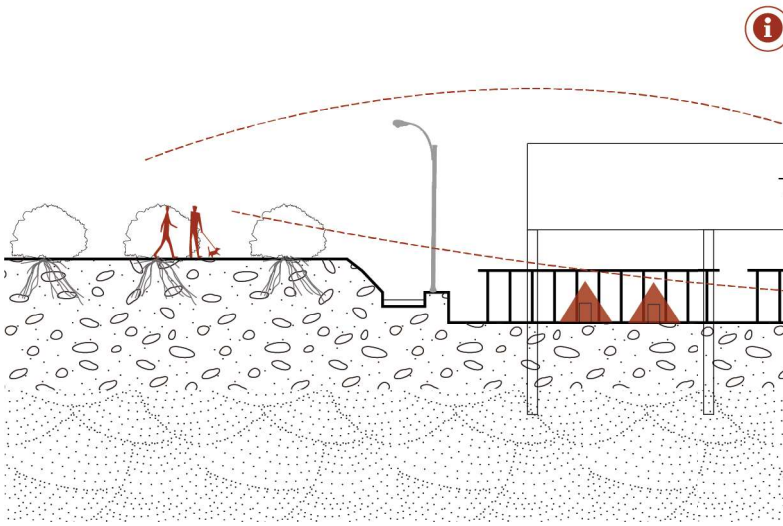




Tourism Season

During the tourist season, the fishing hub will be transfoemed to a tourist activity center with the theme of Viking fishery culture. The docks serve tourists for marine activities. The working spaces and automation facilities are used to hold exhibitions and events. As pavilions and campground, the hjells and drying grounds bring a unique experience. The Fishermen Information Center serves as a tourist information center and camping service center, providing convenient facilities and selling souvenirs. The bush gardens become a place for local residents and tourists to communicate.

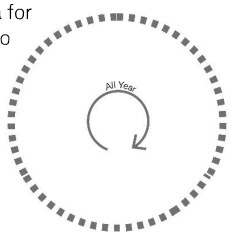


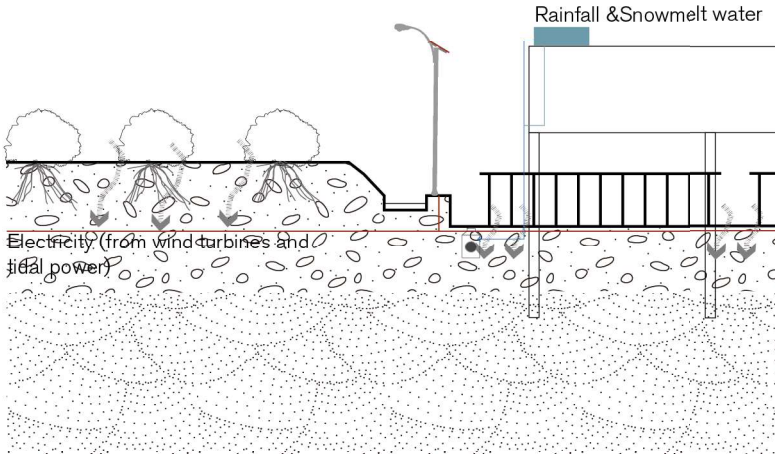


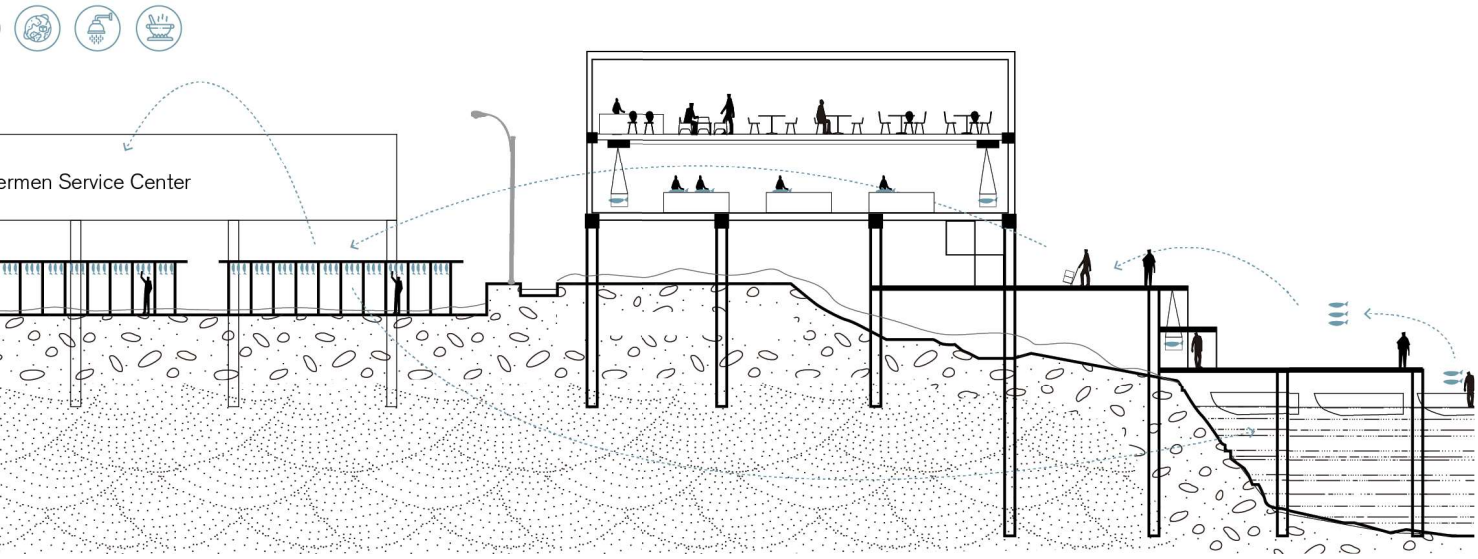
Energy & Flood Risk Management System

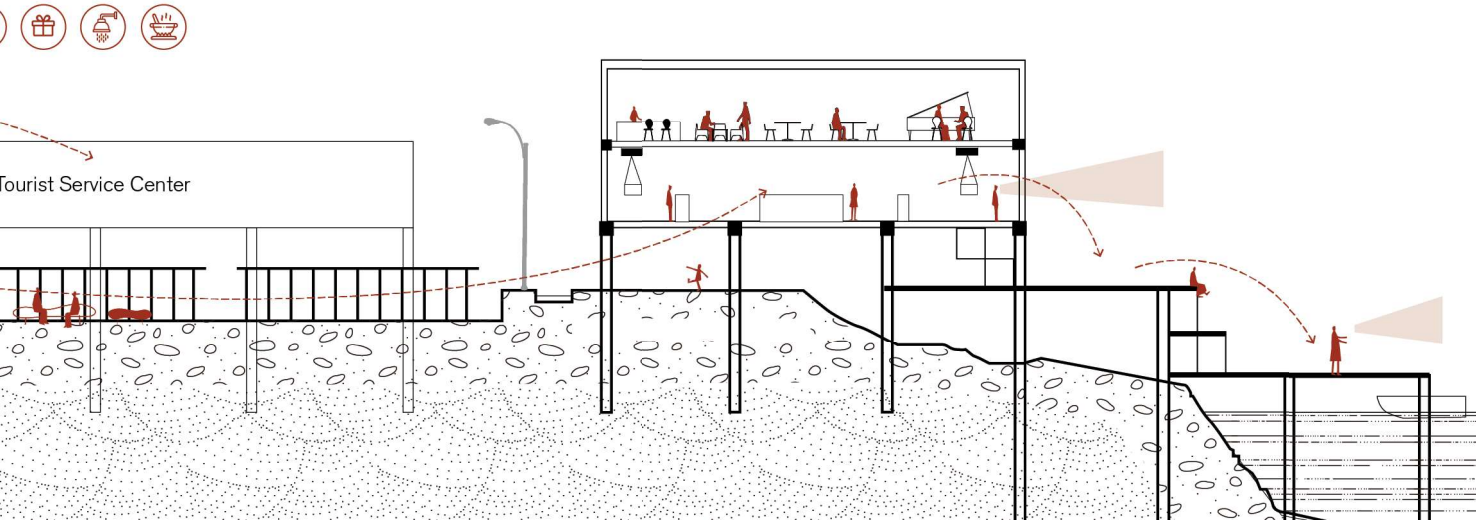
The electricity generated by wind and tides will be transmitted here and used by those public buildings. In the summer with plenty of sunshine, buildings and street lights also use solar panels to generate electricity.

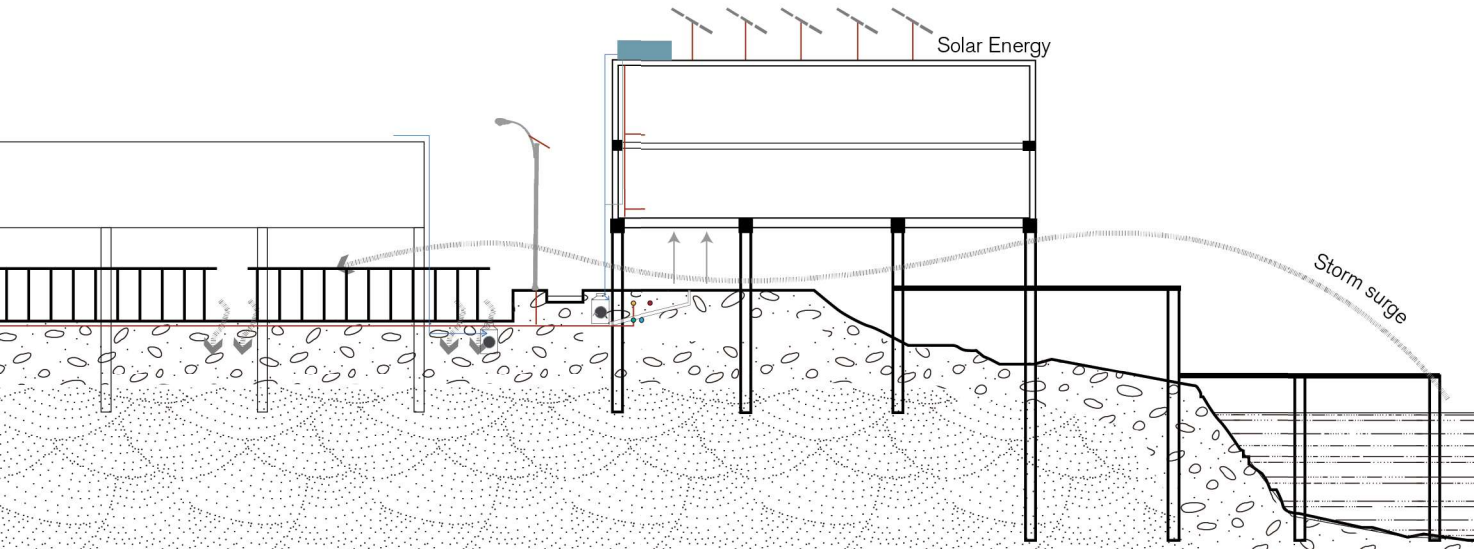
In terms of nature restoration and flood management, the ground floor of the buildings are elevated for vegetation growth and potential flood. The drying ground and gardens use a highly permeable paving and drainage system, which can be a water buffer area for the city. Rainwater and snow melt are also collected, stored and recycled.





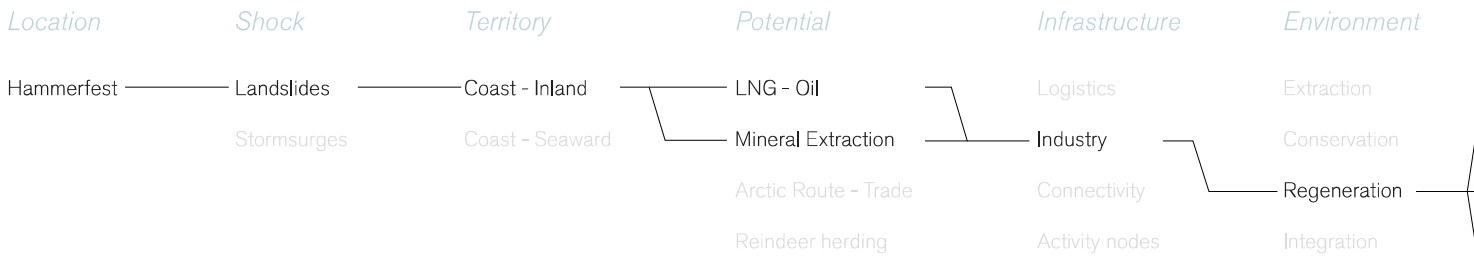

ermen Service Center


Tourist Service Center

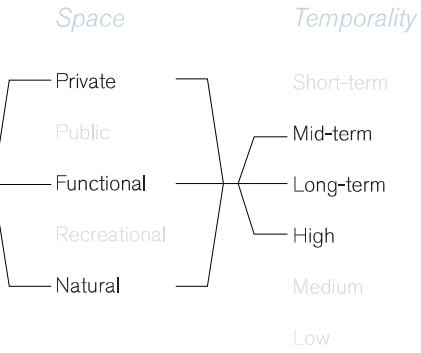

Solar Energy
Storm surge

6.4.3. Hammerfest: Landscape, Seascape, ~~Wastescape~~

Cas Goselink


Location
Shock
Territory
Potential
Infrastructure
Environment
Hammerfest
Landslides
Stormsurges
Coast - Inland
Coast - Seaward
LNG - Oil
Mineral Extraction
Arctic Route - Trade
Reindeer herding
Logistics
Industry
Connectivity
Activity nodes
Extraction
Conservation
Regeneration
Integration

Manifesto



Hammerfest, Norway. Known for LNG, oil and mineral extraction. The scale of private infrastructure constructed throughout the area, and the amount of marine and terrestrial territory claimed, lends validity to both the importance of the site and the power of the state operated oil Company over the territory and its inhabitants. This influence will only increase over the coming decades, but will inevitably decline when the shift towards renewable energy sources really sets in. This will lead to abandoned industrial wastescapes throughout the Norwegian Arctic, polluting and littering the surrounding pristine land- and seascape.

The development of industrial private property such as housing barracks, will have to be designed for abandonment now, in order to be able to prevent future wastescapes. The design has to take two phases into account, using nature based solutions during the period of human activity, ensuring safety and livability in this anthropocene era. Then, after the human retreat, nature has to be able to responsibly take over the former industrial sites, which will have to participate in the local ecosystem.

Phase 1: Temporal industrial site - Extractivism - Ecosystem services - Landslide risk reduction (2020 - 2045)

Nature based solutions and ecosystem based disaster risk reduction strategies deal with the landslide hazards. This has to be done without doing unregenratable harm to the natural environment, as this layer of built environment is of temporary existence.

Phase 2: Abandonment - Post-extractivism - Ecosystem participation - Landslide ecology (2048+)

The materials left behind have a specific purpose in the regeneration process, providing conditions for a diverse habitat. The foundations guide developing waterways and prevent deep-rooted landslides from scattering the material throughout the area, while allowing shallow landslides to constantly change and disturb the ecosystem, in order to ensure diversity and cross-connectivity.

The intrusion of industry and infrastructure is inevitable, however, we have the opportunity to leave behind a state that is more beneficial to the natural environment, which creates a more bio-diverse region, which creates and connects several habitats both longitudinal and lateral. Let nature take over former sites in a responsible way, designing with local geographical and morphodynamical features in mind, improving natural habitats in the Arctic post-extractivist era.

Cas Goselink
4463811

Manifesto Image

Improving habitat diversity in the post-extractivist Norwegian Arctic by designing for abandonment of oil-related infrastructure



Figure by C. Goselink

Design experiment

As this is a design experiment, and experiments should inherently be reproducible, the explanation is focused on the theoretical and technical aspects of the design that function as guidelines. The aim of the experiment is to investigate how the spatial implementation of these theoretical principles could work in the arctic environment, and how both landslide risk reduction ánd landslide ecology could successively be incorporated into the same project.

Phase 1

In order to create a safe environment for the temporal stay of the Equinor AS workers, forests are a viable nature based solution to decrease landslide risk. However, there are many specific characteristics to which this forest should comply, in order to decrease landslide risk. If not, it will invert the effect and increase the hazard.

The general principle is based on the reduction of pore water pressure, e.g. the decrease of suction stress, through interception and transpiration. The second element is to prevent the slipsurface from failing through basal and lateral root reinforcement and soil stiffening. Important is that the slope has to be less than 45 degrees, otherwise the downslope component of the tree weight would be larger than the normal force (Moos et al., 2018). Also, the root system has to penetrate the slipsurface (Schwarz et al., 2010). According to Stokes et al., (2008) and Bathurst et al., (2010) the penetrating roots have to be small in diameter and high in numbers, as smaller diameter roots offer a greater tensile strength, increasing root cohesion. Also, the tree length has to be proportionate to the rooting depth and soil stability (Stokes et al., 2008). Last, the tree species have to be diverse and native to the region, in order to promote biodiversity and ecosystem health (Kobayashi et al., 2017).

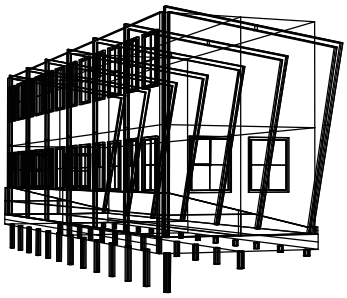
With the NBS preventing shallow landslides in the topsoil, the buildings themselves should be connected to the deeper subsurface layers and bedrock. This will prevent deep-rooted landslides, which might occur at a depth the trees cannot reach.

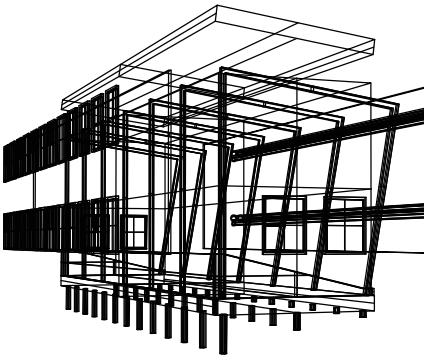
Phase 2

As the settlement is abandoned, the streambeds will start to expand their territory due to climate change (more precipitation). The trees, now not maintained, will grow out of proportion to their stabile soils, and combined with the buildings being reduced to structures, be toppled by heavy winds. This added weight will stop stabilizing the soil, but rather increase the risk (or opportunity) for landslides. The open soil allows for movement, thereby naturally incorporating the foundations into the ecosystem. The streambeds will inhabit the structures, leaving puddles of standing water when the beds dry up. This creates an excellent habitat for insects and small birds, which in turn will feed the larger species.

Architectural Scale

Cas Goselink





Ecosystem services

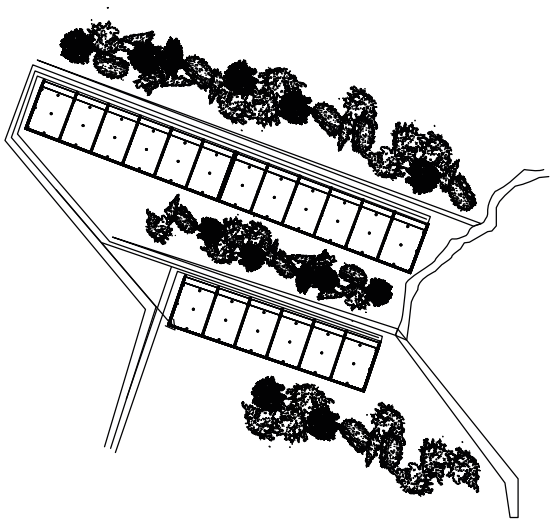
Natural components functioning as infrastructure, providing services

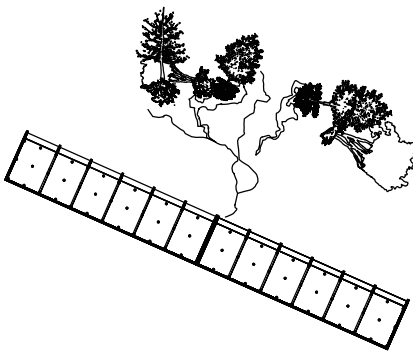
Territorial transition

Development timeline

Scenario diagram
Expected events
3.6.1

In addition to the scenario explained in the manifesto, this timeline shows the expected successive events from a geopolitical and economical view, related to the environmental influences and development of the design itself.





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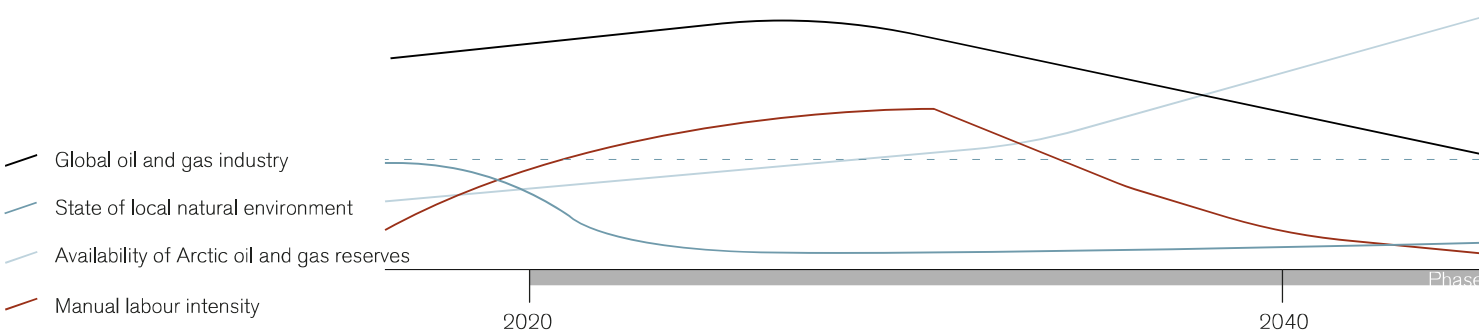
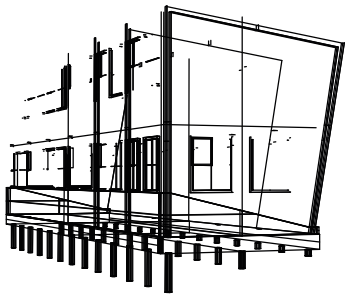
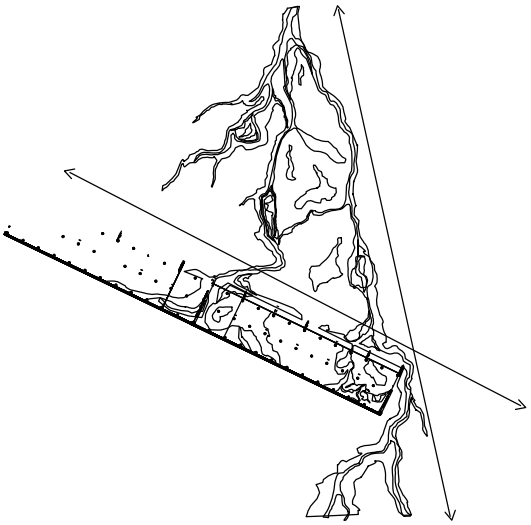






Ecosystem participation

Infrastructure deliberately functioning as natural component, designed to provide services back



Economical and Geo-political developments

1 By fortress conservation of specific marine and terrestrial territories (such as Lofoten), extraction in the arctic (Hammerfest) is 'justified'

2 Increasing need for labour
- exploration
- drilling and rigging
- maintenance

3 Technical advancements allow for automation and remote controlling of drilling operations

4 Due to climate change, more oil and gas reserves in the Arctic become available and accessible

5 Western world transitions towards green energy
- decreasing demand
- geopolitical and social pressure
- more attention to environment

6 Economic prospects for new oil infrastructure deminish

Design developments

1 Ecosystem-based disaster risk reduction strategies, using NBS to prevent landslides and provide a safe living environment

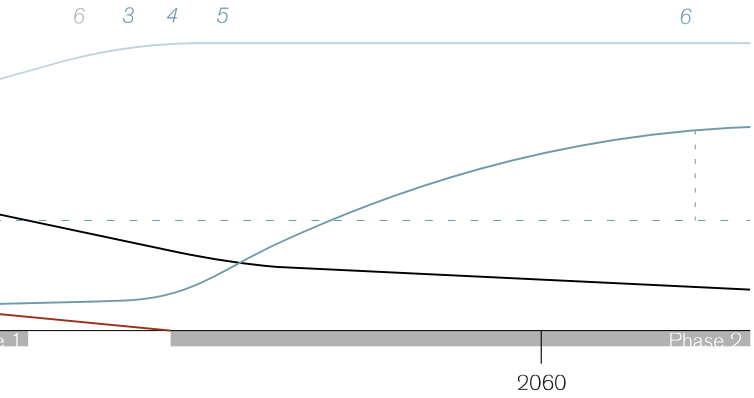
2 The change from the social temporality mindset towards the technical temporality theory has to be made

3 Economic collapse in Arctic cities that were 'fueled' by the oil and LNG economy.

4 Abandonment of infrastructure and settlements

5 Changes in maintenance regime combined with climate change effects transform the NBS in destabilizing factor, accellerating environmental regenration

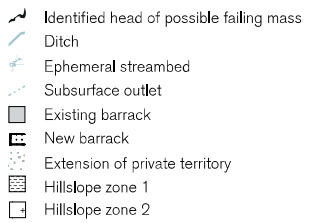
6 Baseline conditions for nature improved by infrastructure functioning as natural catchments and riffles



Experiment map

Mapped structure
Identified local conditions
3.6.1

In the landscape, several possible failing masses have been identified, indicated by their mass head. In order to prevent landslides, the addition of weight is guiding. The bottom third (zone 1) can be built. Zone two has the NBS forest, zone three has to remain barren. This way, the correct weight distribution stabilizes the subsoils.
Next to the landslide hazard, the local geographical conditions and streambeds are used to place the building blocks, to where they can be reclaimed by nature easily when human activity retreats. The center points of the circles will act as conversion point for the walkways leading up to the barracks, stimulating social interaction between the workers. With this sociological temporality in mind, the workers will still appropriate the space during their stay.





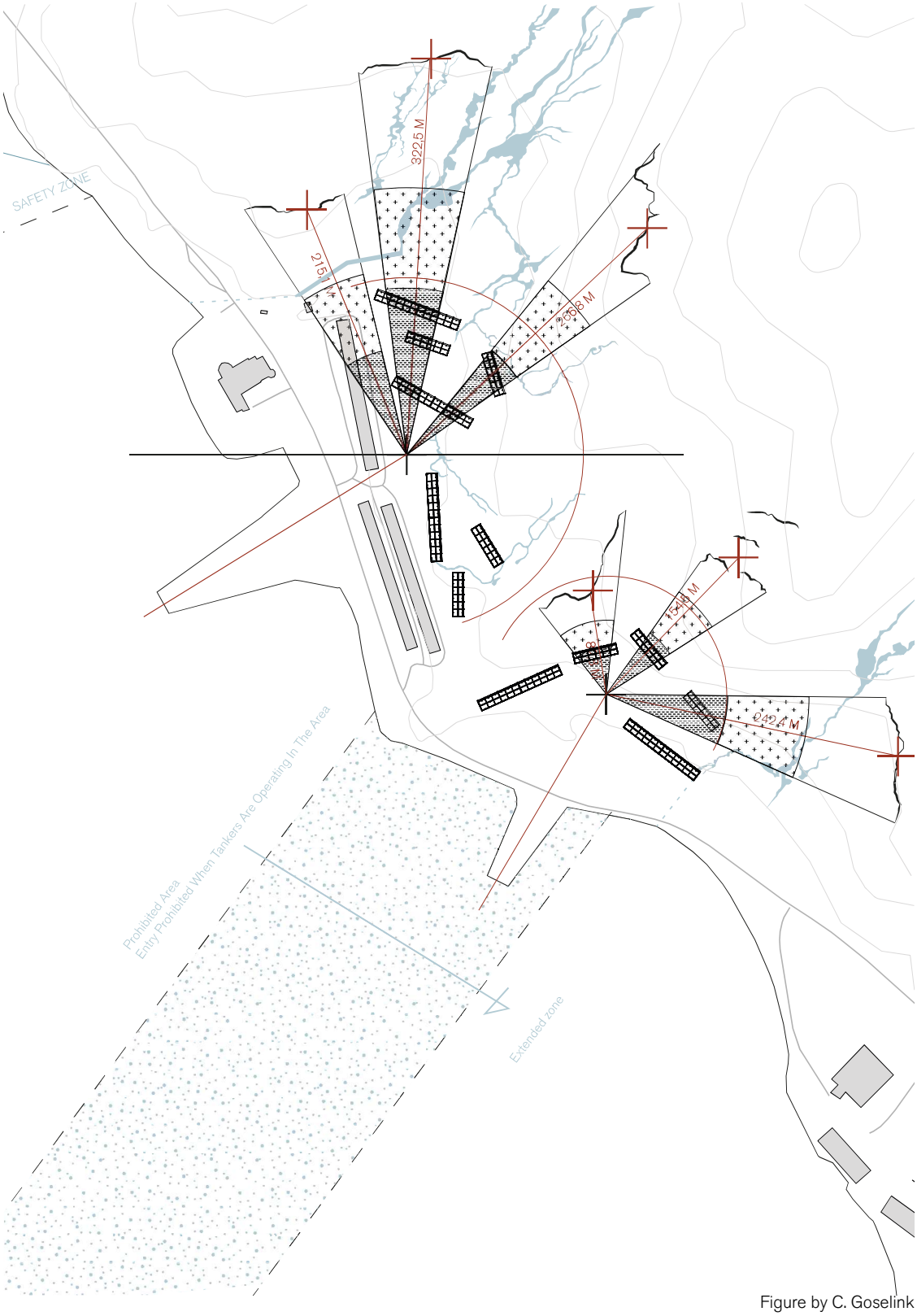


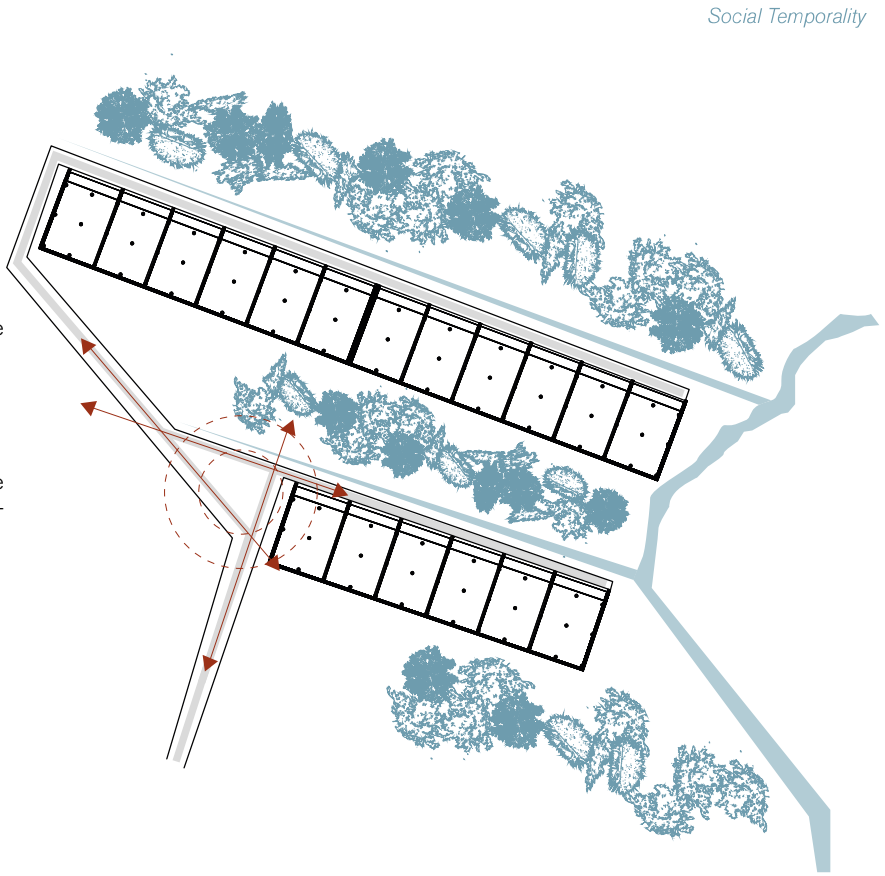
Figure by C. Goselink

Phase 1: Extractivism
Ecosystem services
Landslide risk reduction

Diagram Phase 1

Mapped structure
Identified local conditions
3.6.1

The forest provides an ecosystem service, therefore functioning as 'infrastructure' for the human system. Vegetation has to become smaller as it grows further uphill to distribute the weight correctly on the hillside. The red line shows the added weight, and the stabilizing effect it has. The public space is small, as it has no purpose than to connect the barracks. The walkways however are designed for meeting and appropriation by the temporal inhabitants.



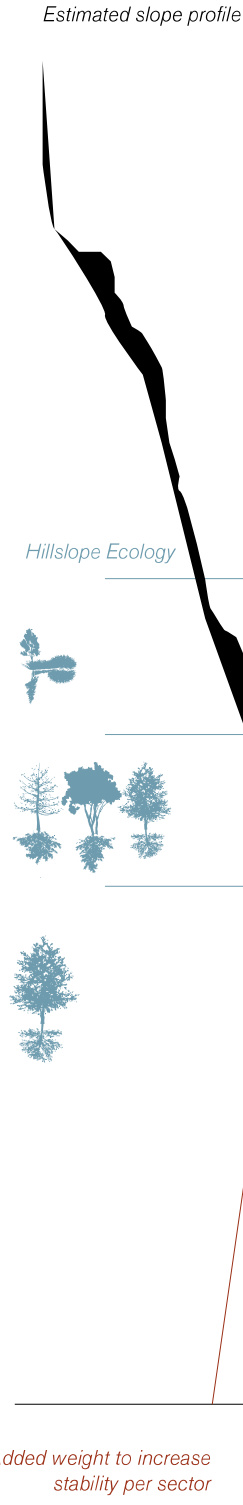


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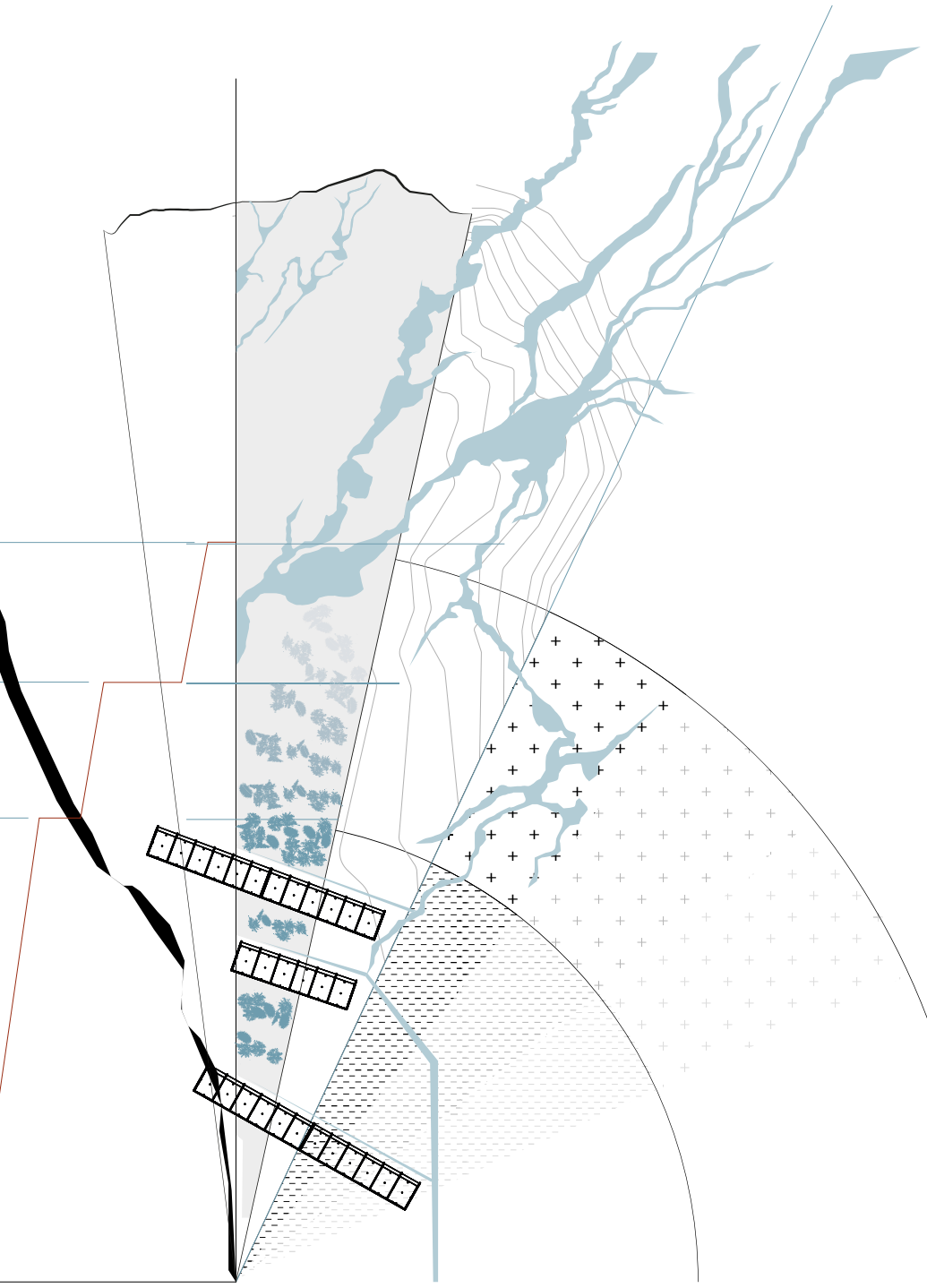
Diagram: 1:2000



Sector 1

Buildings
Infrastructure
Vegetation
Water channels

Sector 2

Vegetation
Ephemeral streambeds

Sector 3

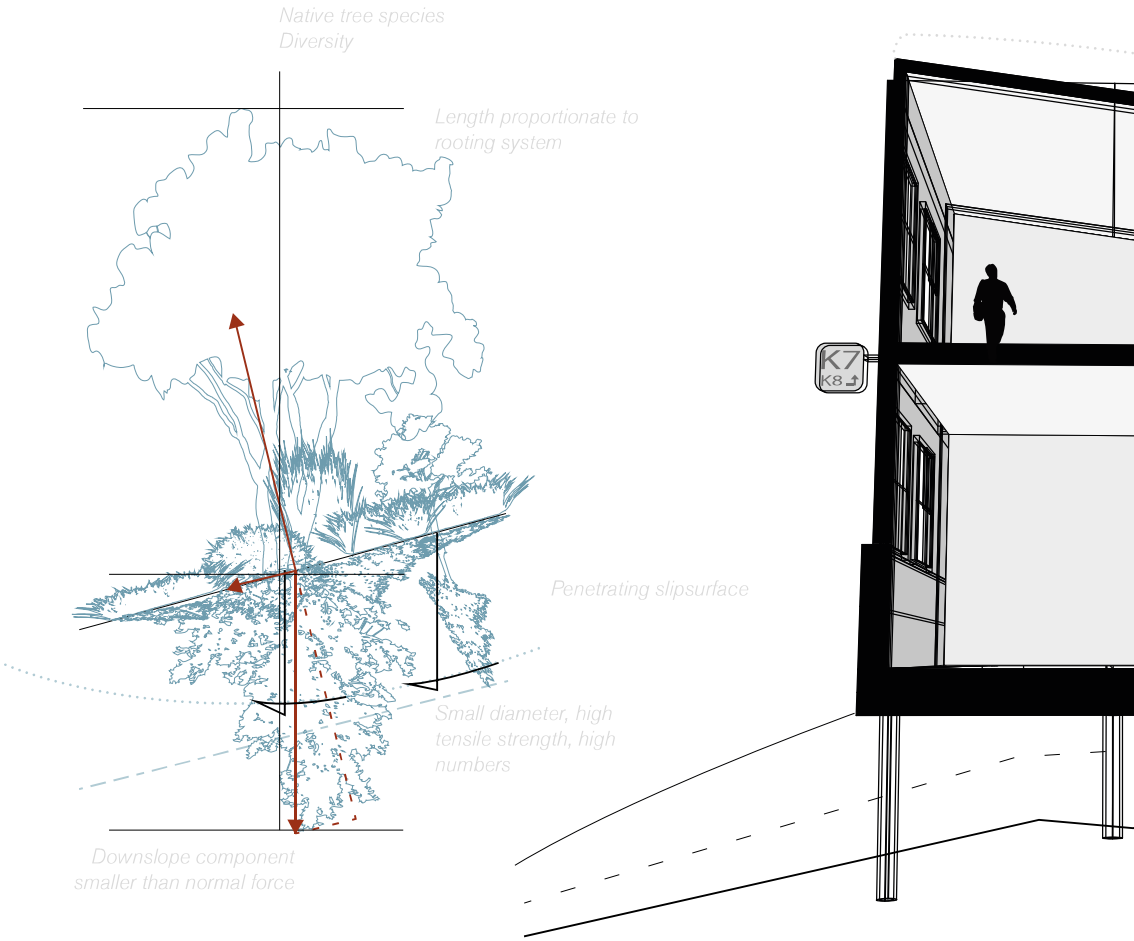
Ephemeral streambeds

Figure by C. Goselink

Section Phase 1

Technical section
Systems and concepts
3.6.1

The identified theoretical guidelines for effective landslide risk reduction by forests are brought into practice.



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Section: 1:150

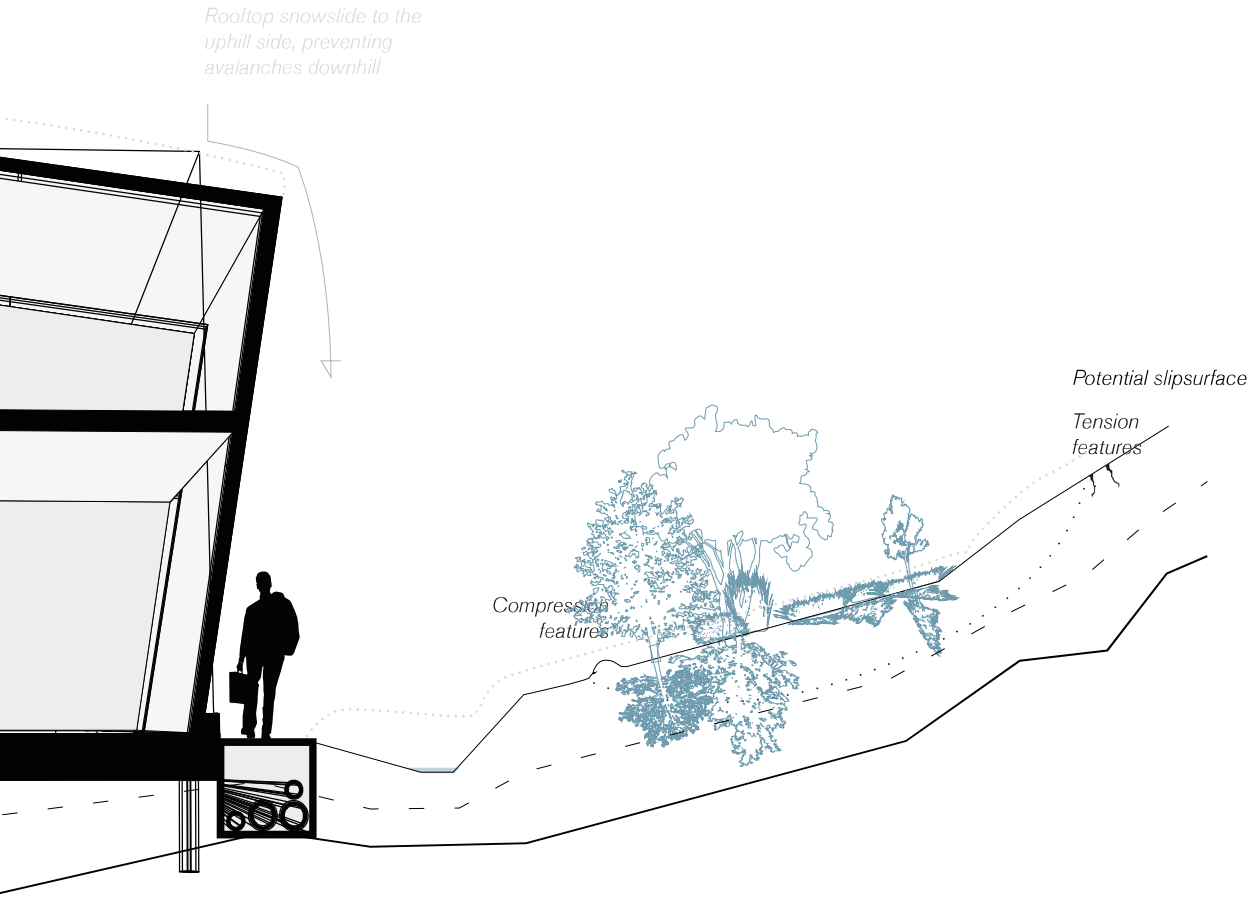

Figure by C. Goselink

Phase 2: Post-Extractivism
Ecosystem participation
Landslide ecology

Diagram Phase 2

Mapped structure
Identified local conditions
3.6.1

After the human retreat, the vegetation on the hillside is not maintained any more, causing it to grow out of proportion. This weight combined with the strong winds, which are no longer blocked by the buildings, cause the trees to topple, opening up the soil for shallow landslides.

The added weight of the toppled vegetation will start to counteract to its original purpose of stabilizing the slope, it will naturally decrease the stability over time, allowing for landslides.

The developing situation can be characterized as 'landslide ecology', an emerging field of research and design. The continuously changing landscape consists of different types of substrates, ecological succession regeneration phases and newly disturbed soil by successive deposition and erosion processes.

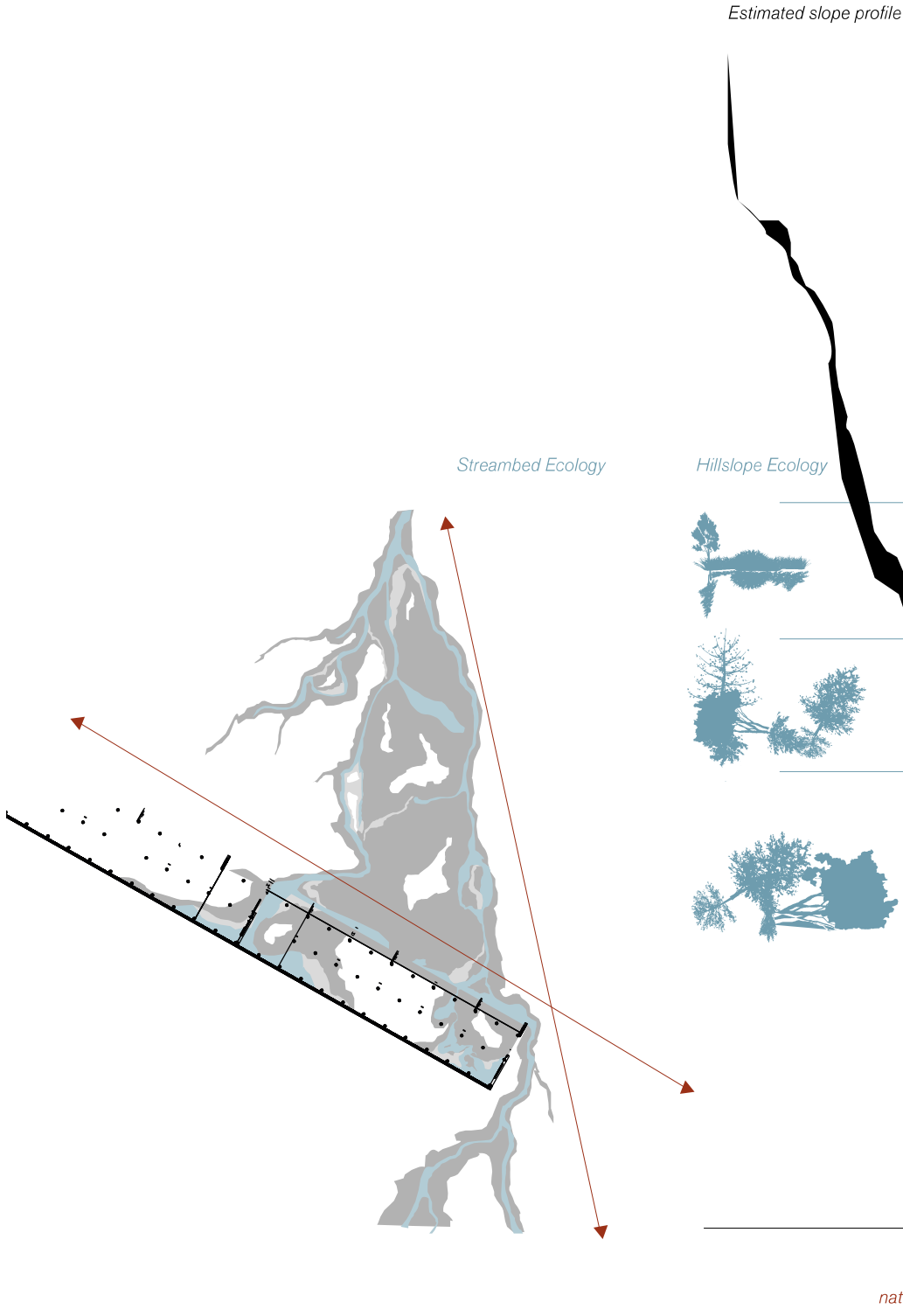

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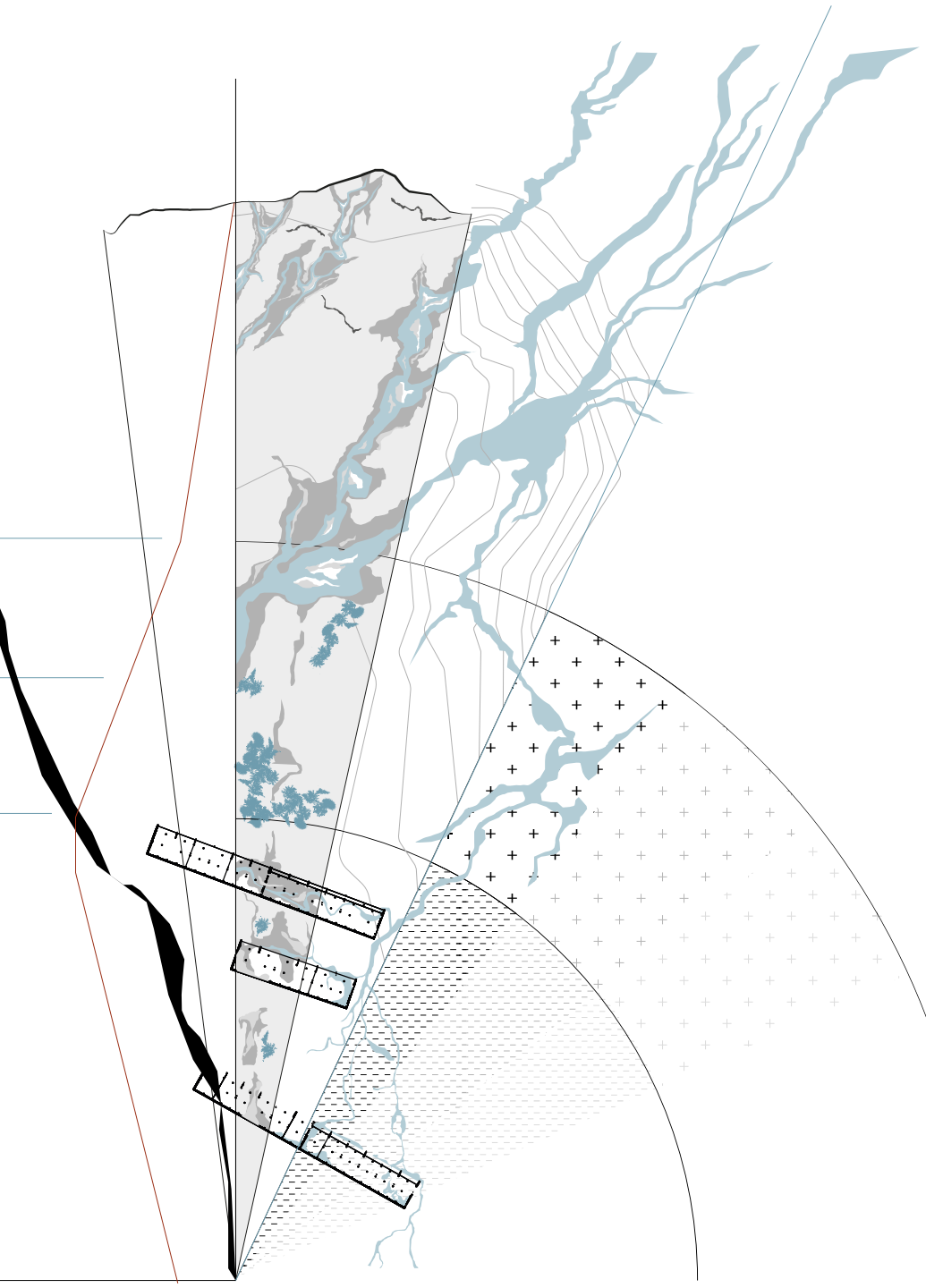
Diagram: 1:2000



Added weight will
urally decrease stability

Sector 1

Decaying material
Overgrowing vegetation
Ephemeral streambeds
Ponds

Sector 2

Overgrown vegetation
Ephemeral streambeds

Sector 3

Ephemeral streambeds

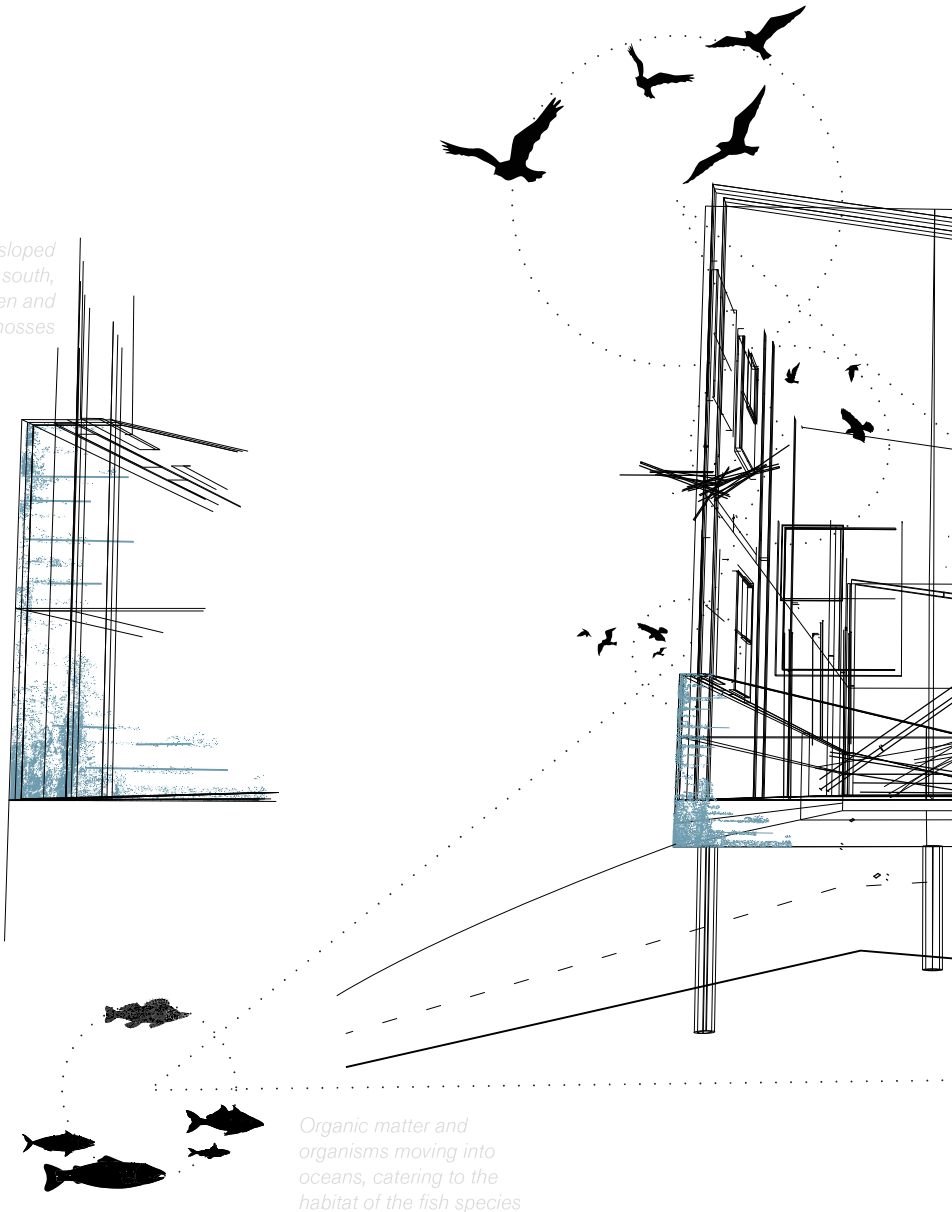
Figure by C. Goselink

Section Phase 2

Technical section
Systems and concepts
3.6.1

The habitat gets increasingly diverse, connected lateral and longitudinal, and offer possibilities for inhabitation by different species.

As in phase 1 the ecosystem was upgraded and maintained as it provided services, in phase 2 the man made structures provide a baseline for the regeneration of the natural environment. Now, the ecosystem does not function as infrastructure any more, but the infrastructure itself provides services back to nature. From ecosystem services, to ecosystem participation.



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Section: 1:150

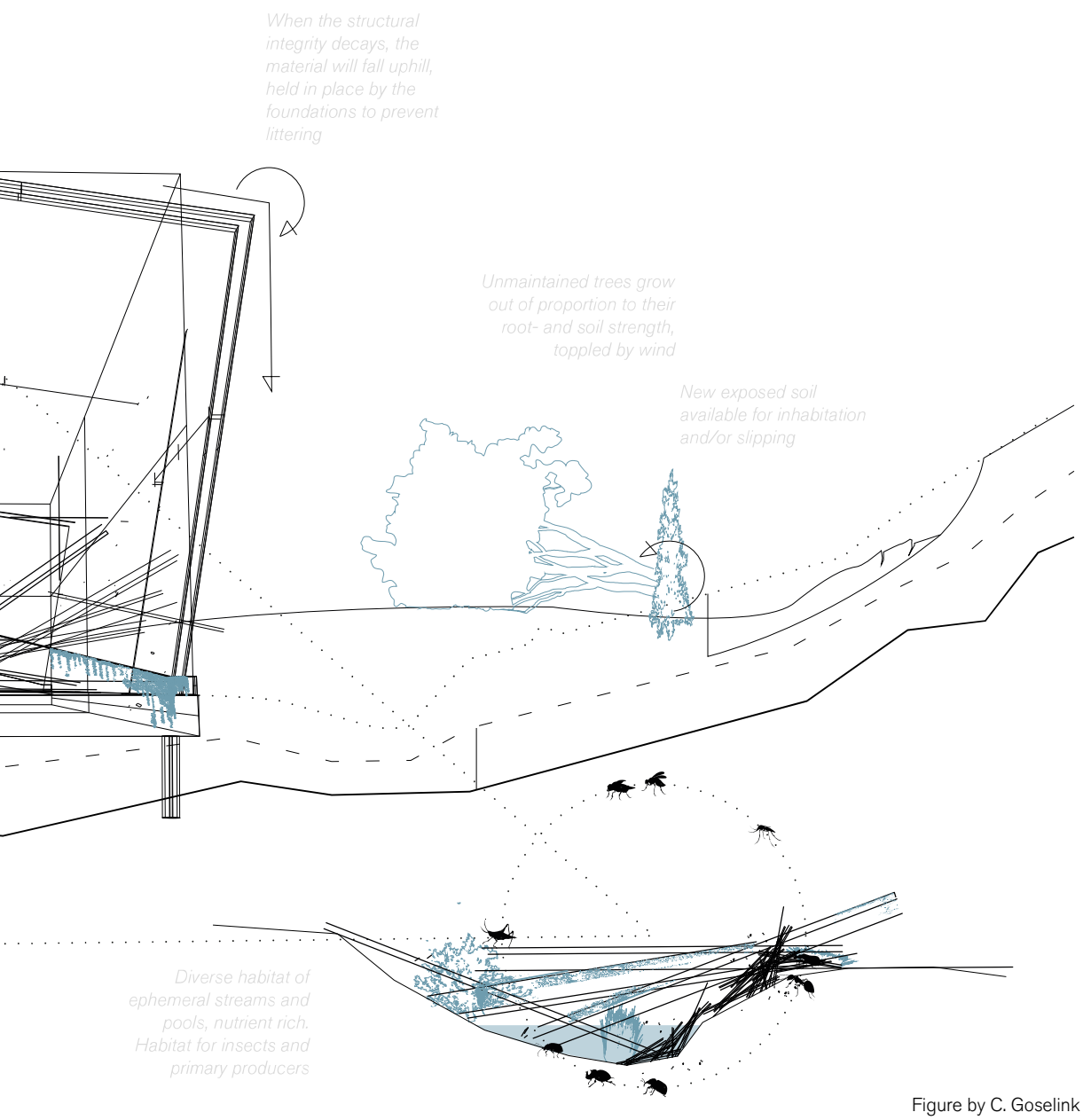
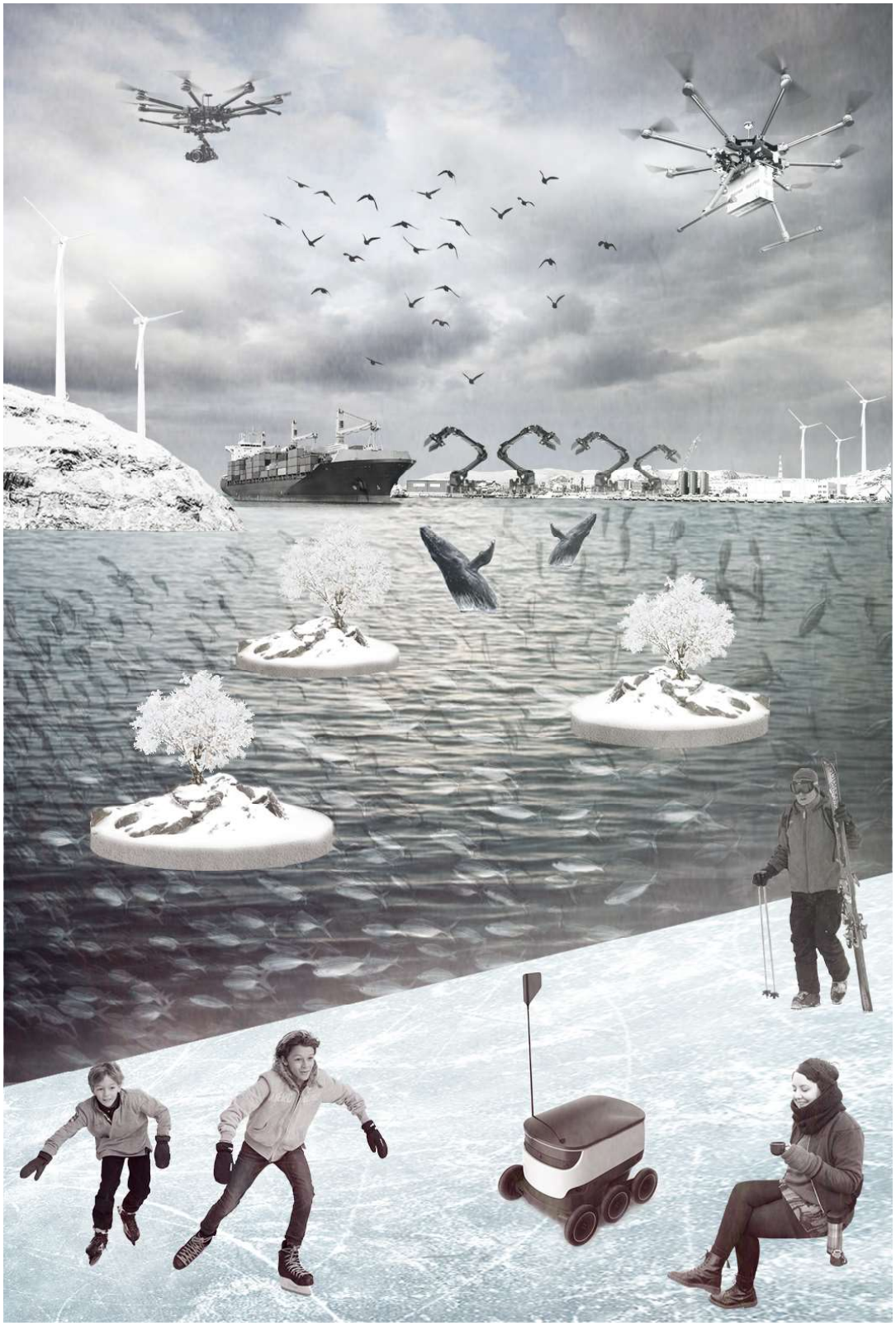


Figure by C. Goselink

6.4.4.

Hammerfest: The Nordic Possibilities

Janis Berzins



The Nordic automatization

Automatization in the far North brings more possibilites for local residents to participate in the natural ecosystem and develop unique, northern lifestyle that appreciate the nature surrounding them.

Manifesto

Hammerfest is the Nordic capital of automatization. Introduction of robotics in oil, gas, mineral extraction, and logistics have attracted highly skilled engineers, scientists and other professions to the city. The local economy is thriving, and new services have opened also to serve the military personnel.

Automated machines that can be managed from the distance limit the time that people must spend on the site. If necessary, workers can get to their desired location using self-driving moto bikes that can be turned into snowmobiles on wintertime. For shorter distances people can skate, on ice or road, to reach their necessary destination. Machine parts, as well as cargo from mineral extraction sites are now delivered by specific Nordic drones, therefore the city is less crowded with trucks and other cars. The money that is saved from road maintenance on winter is invested in green-blue solutions for the city.

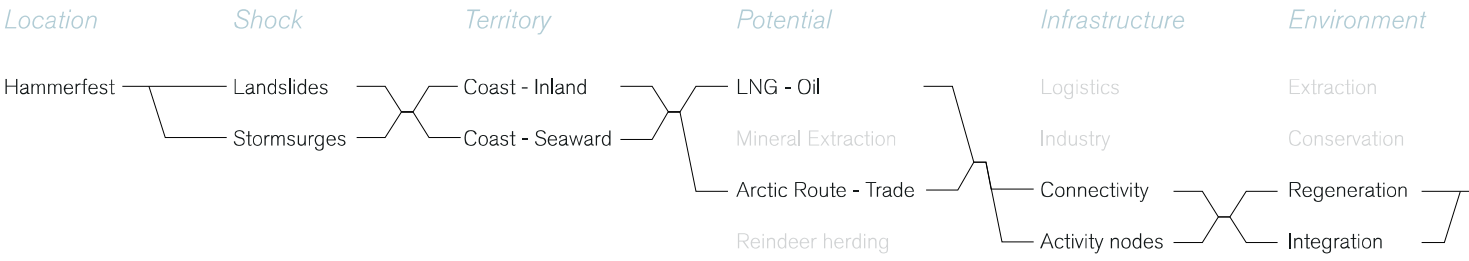
New windmills in the mountains can provide the necessary energy for the city and the machines, at the same time not disturbing the incredible Arctic landscape.

The seasonality is embraced and well-managed, allowing a part of the city to be used only on summer season to house people who are working on the logistics industry for the Arctic route. At the same time, the centre of the city is lively all year round, because people can spend more time in the city due to fact that the manual work is done by the machines.

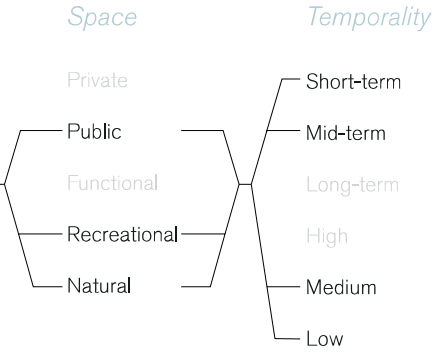
Locals now spend more time on outdoor activities, they are aware of the natural processes and enjoy living in the Northern climate, because they are not tired from the manual work on the oil and gas plants. The nature is very important for the residents of Hammerfest. By maintaining and not destroying the natural habitats around and within the city, local residents have discovered new possibilities for local food sources, such as seaweed and kelp. Fish and reindeer produce are now a significant part of the local, Nordic diet, as well as summer flowers, herbs and medicinal plants that grow in the gardens.

Due to automatization, the slower pace of life makes people appreciate the uniqueness of the surrounding habitats that cannot be found anywhere else. By embracing the Nordic lifestyle and diet, humans are participating in the local ecosystems and they have become stronger, at the same time providing the necessary elements for a unique way of living in a harsh climate and remote location.

TAXONOMETRY
Individual project
Hammerfest promenade



Design experiment - The waterfront in-between



Embracing temporality of residents, automatization of the industries and economic benefits of the climate change can bring new development possibilities for Hammerfest.

In this design experiment, waterfront between two parts of the city - temporary neighborhoods for summer workers and permanent neighborhoods for high-skilled workers who live here all year round - is designed to show the possibilities for public space design in the Nordic climatic conditions.

Automatization and new technologies in the industry and everyday life minimize the necessity for “hard“ infrastructure therefore it is possible to develop new “green-blue“ solutions to integrate the natural processes in the public space design. This approach also allows the residents to better understand natural processes and become a part of the local ecosystem.

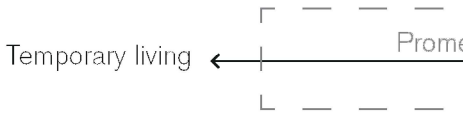
Several public functions are placed along the waterfront that can be used all-year and more intensively during the summer. The existing asphalt road is narrowed to place new water catchment systems along the road to minimize the impact of rainfall and melting snow water. New lane for the self-driving robots are placed along the road to connect both parts of the city and the logistics port. Along the water, new gravel embankment is designed to minimize the effect of storm surges, at the same time, allowing different coastal species to use this space for habitat. New skating lane is designed to be used for ice-skating in winter and skating or biking in the summertime.

Kelp farming zone along the waterfront, which could be managed as a Private-Public partnership, promote new possibilities for local food source. In combination with floating islands with low bushes and gravel, this zone strengthens the coastal habitat, providing living space for marine animals, fish and birds and recreation and economic possibilities for the local residents.

This design experiment shows that although climate change has a significant effect on the Arctic region and its ecosystems, there are possibilities how to deal with these changes in order to create sustainable habitat for nature and humans in which they exist side by side not destroying each other.



Concept schemes

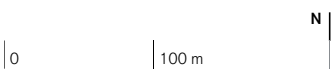


Hammerfest waterfront 1:5000

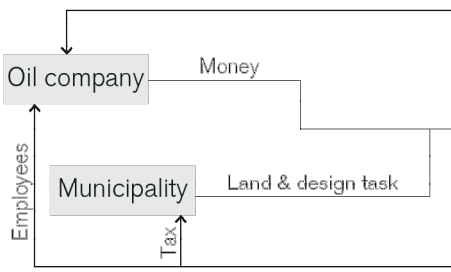
Here you can write a brief explanation.
Use as much text space as needed.

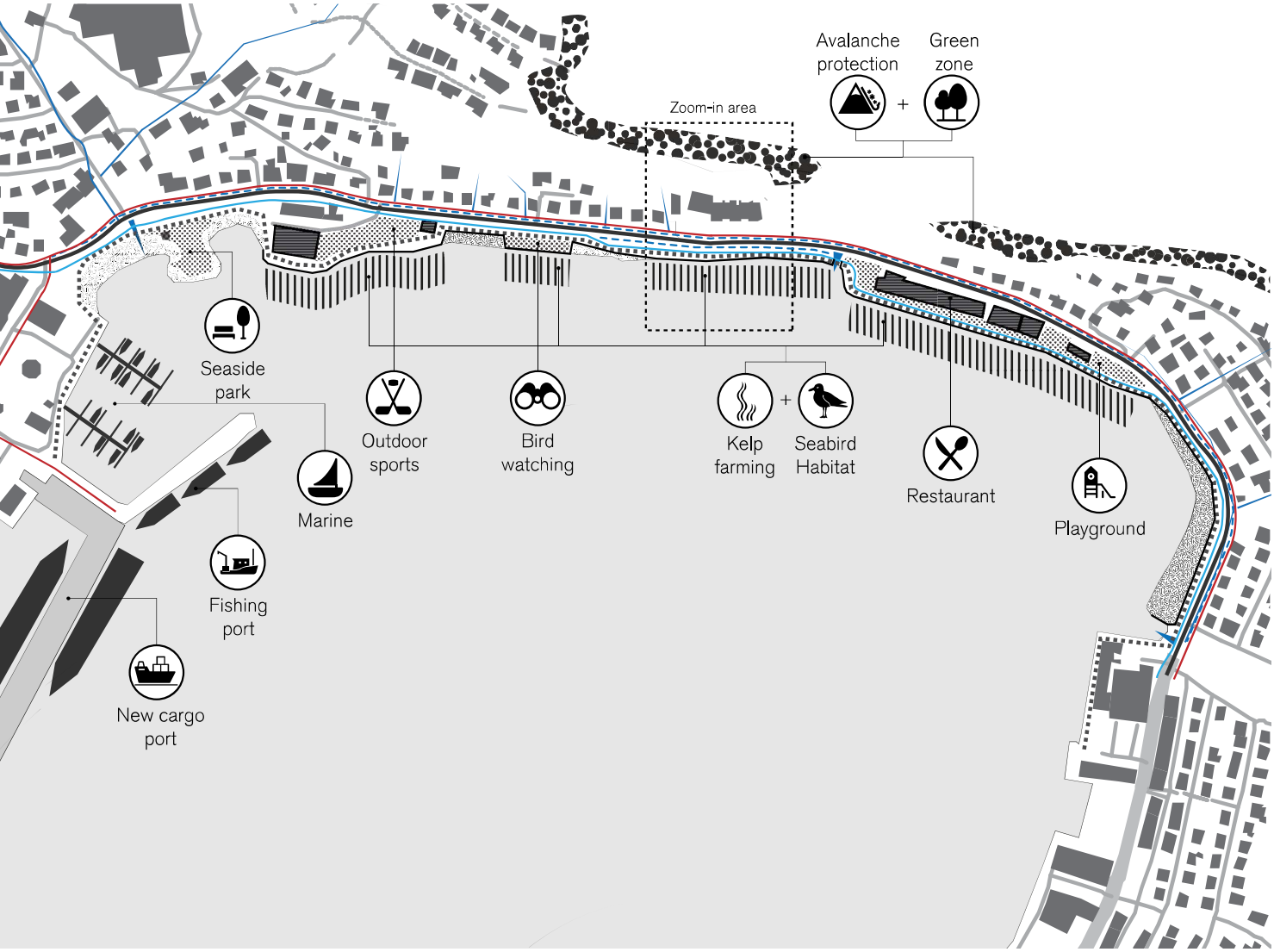
Legend

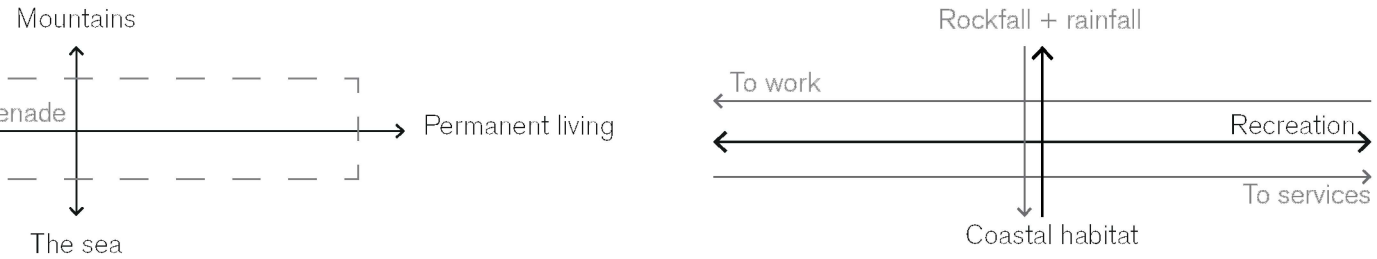
- Road for self-driving cars
- Lane for self-driving cargo robots
- Lane for skating
- Water catchment system
- Pedestrian promenade

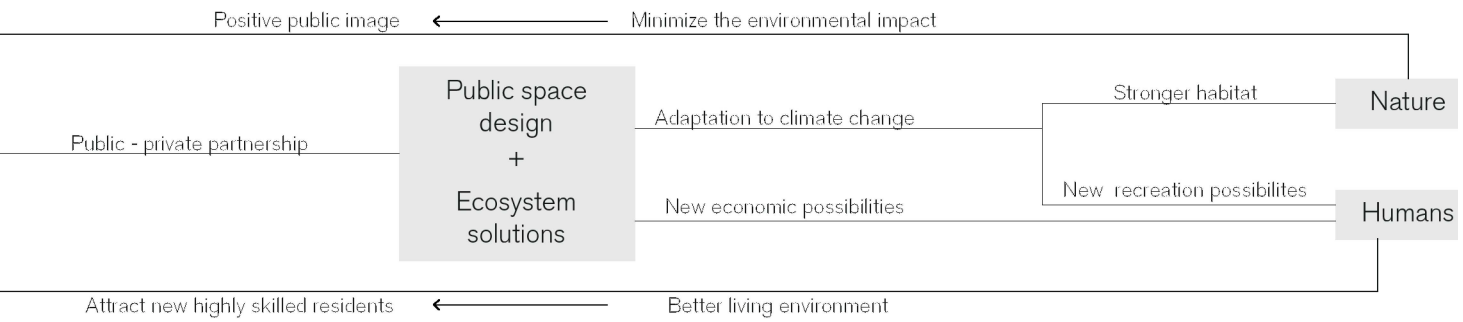


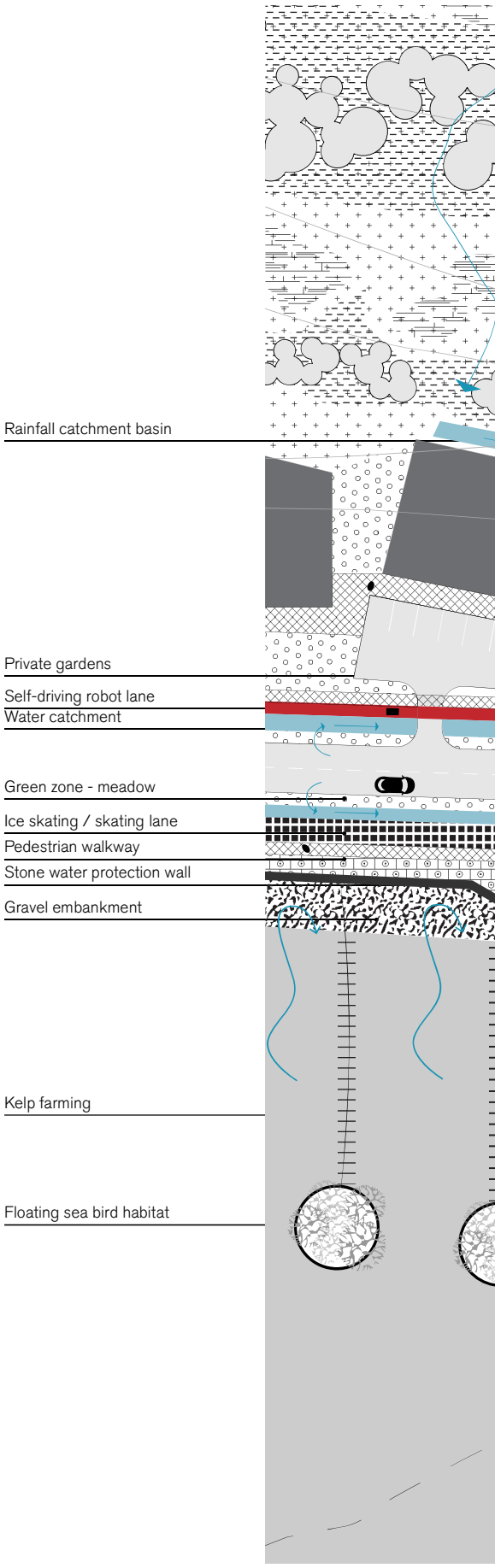
Participation diagram




Avalanche protection
+
Green zone
Zoom-in area
Seaside park
Outdoor sports
Bird watching
Kelp farming
+
Seabird Habitat
Restaurant
Playground
Marine
Fishing port
New cargo port


Mountains
enade
Permanent living
The sea
Rockfall + rainfall
To work
Recreation
To services
Coastal habitat


Positive public image
Minimize the environmental impact
Public space design
+
Ecosystem solutions
Public - private partnership
Adaptation to climate change
Stronger habitat
Nature
New economic possibilities
New recreation possibilites
Humans
Attract new highly skilled residents
Better living environment



Hammerfest waterfront 1:1000

This section of the waterfront shows the changes of the street, as well as new embankment with kelp farming platforms. The public life in this space is influenced by the natural processes and seasons. The space is used by people and nature.

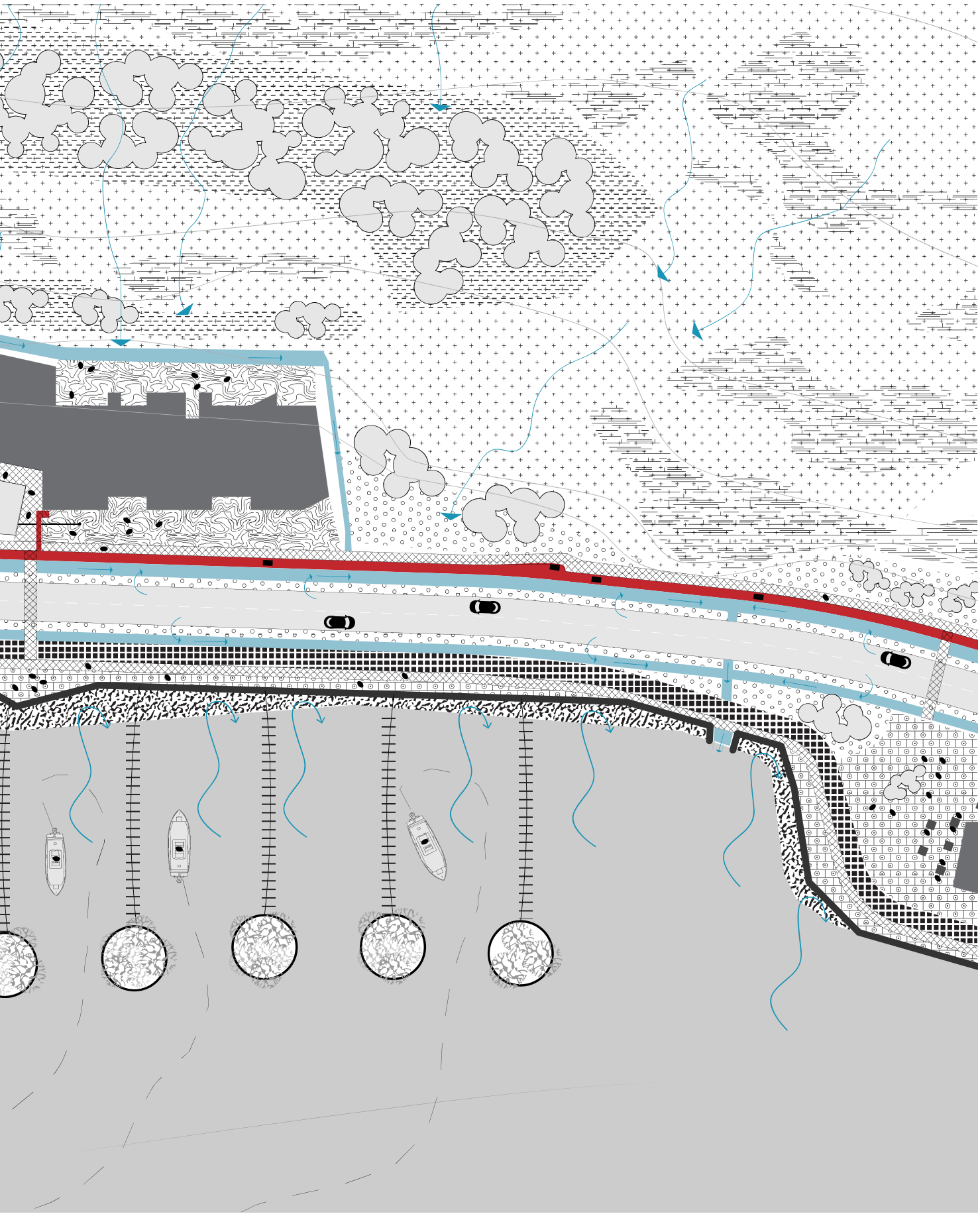
Legend

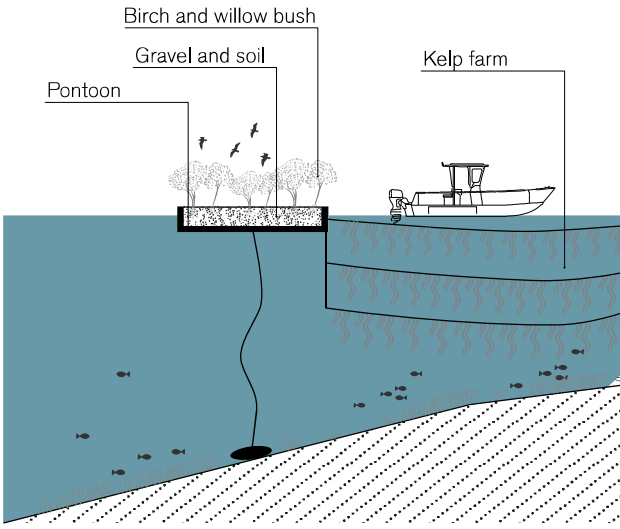
Sea waves and storm surges

Rainfall and melting snow water movement

N

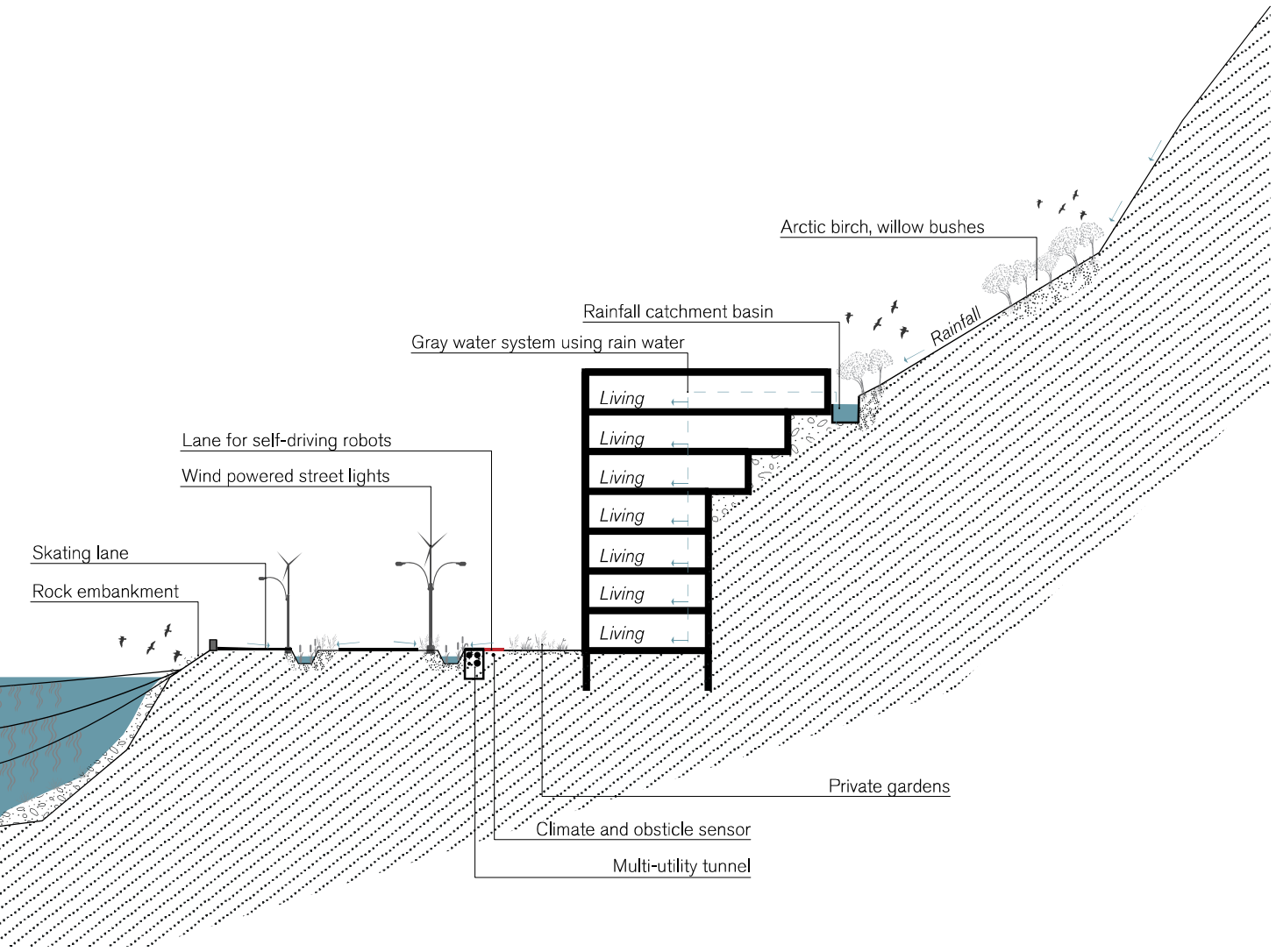
0 20 m

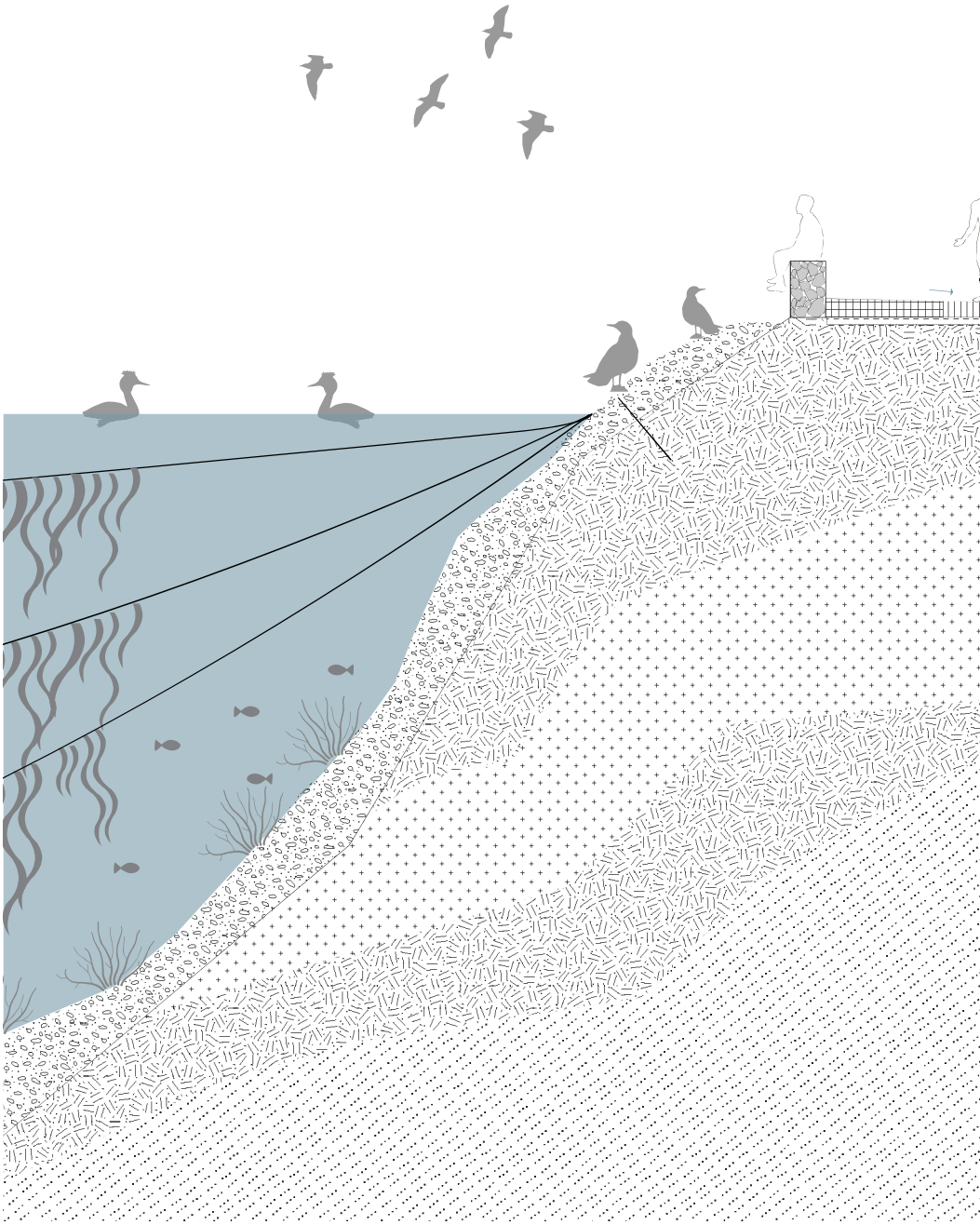




Section 1:500 Summer

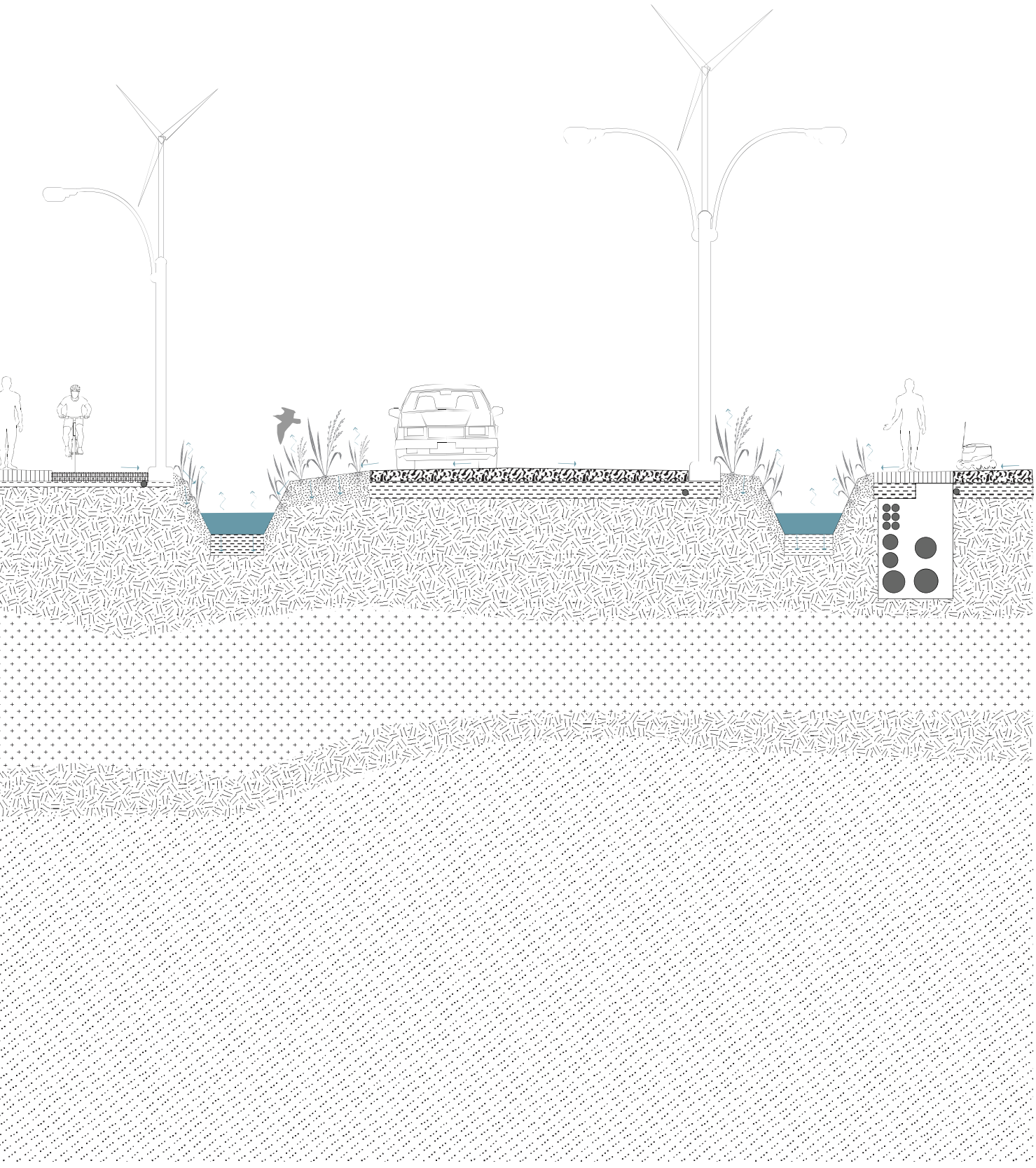
During the summer season, the waterfront is lively and are occupied by human and natural activities. The infrastructure is designed in context of increased rainfall in the future, due to climate change.
The natural habitats, both inland and on the floating structures, provide rich habitat possibilities for different species.
In this space, people not only can enjoy the nature, but also participate in kelp farming and fishing, as well as use the raifall from the mountains for grey-water systems.
Multi-utility tunnel systems are easier in maintenance and adaptation for automatization infratructure, such as possible new IT and electricity cables, especially considering the bedrock soil.

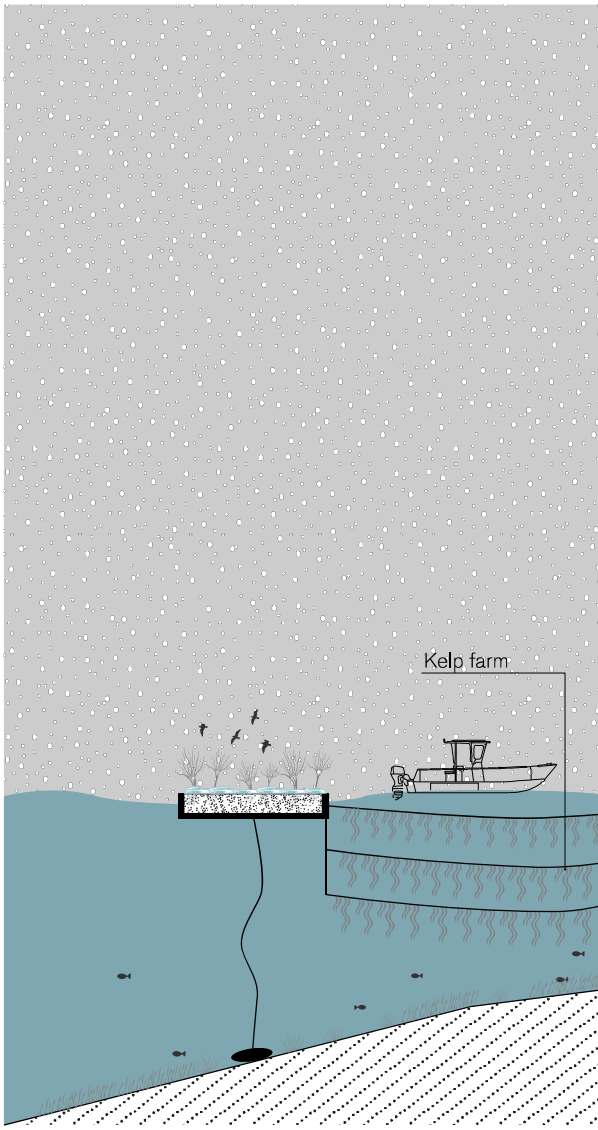

Arctic birch, willow bushes
Rainfall catchment basin
Rainfall
Gray water system using rain water
Living
Living
Living
Living
Living
Living
Living
Lane for self-driving robots
Wind powered street lights
Skating lane
Rock embankment
Private gardens
Climate and obsticle sensor
Multi-utility tunnel



Section 1:100 Summer

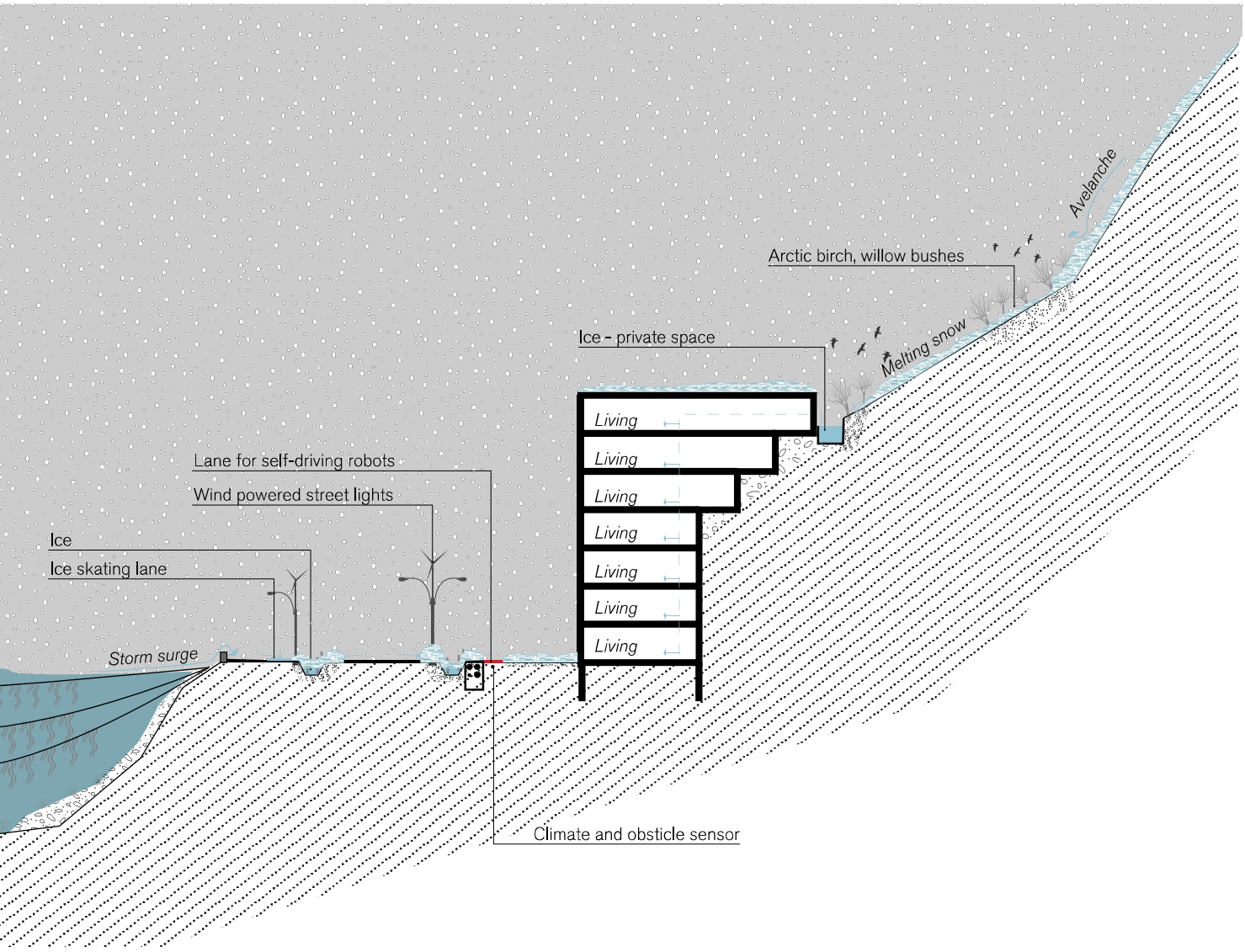
The section shows in detail how the water-front functions during the summer season. The rainfall is gathered in cathcment basins along the main road. These basins also work as a green zone with plants allowing evaporation.

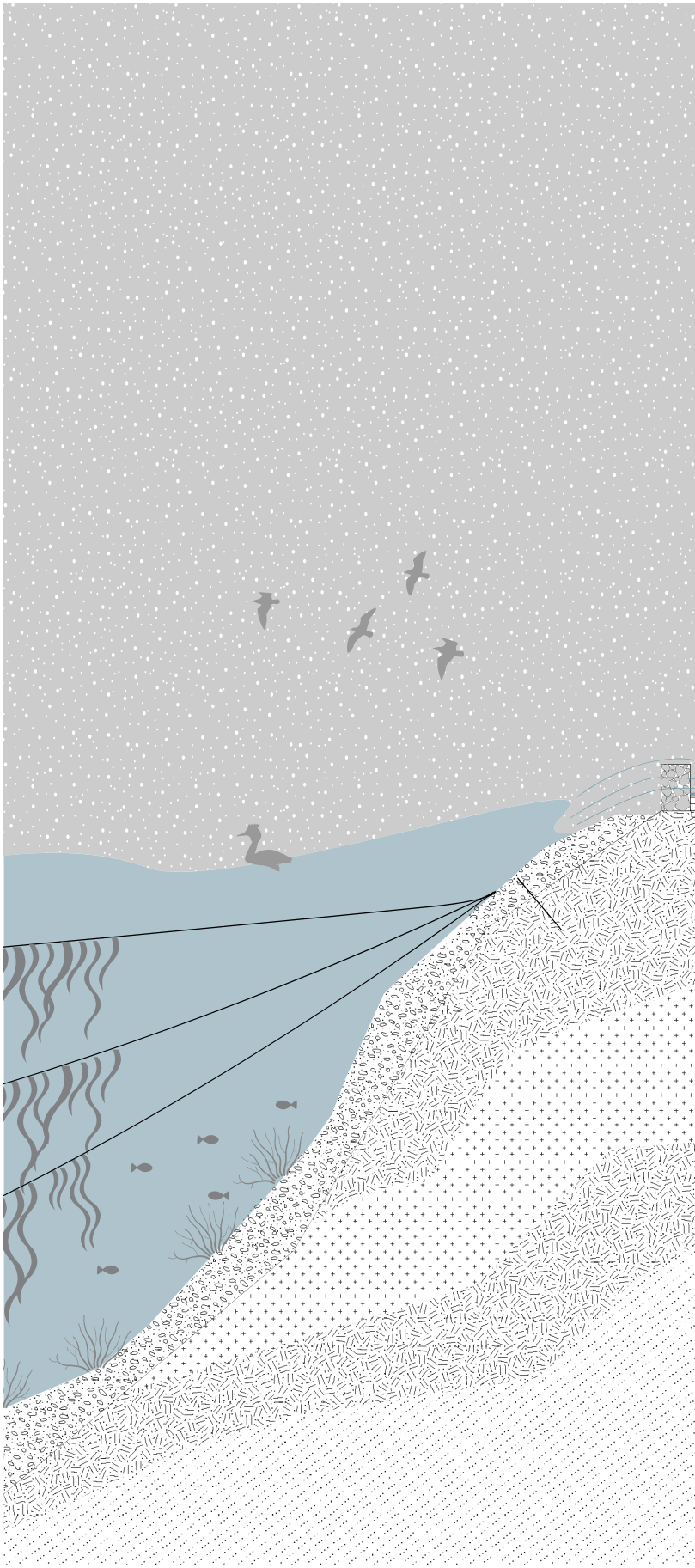




Section 1:500 Winter

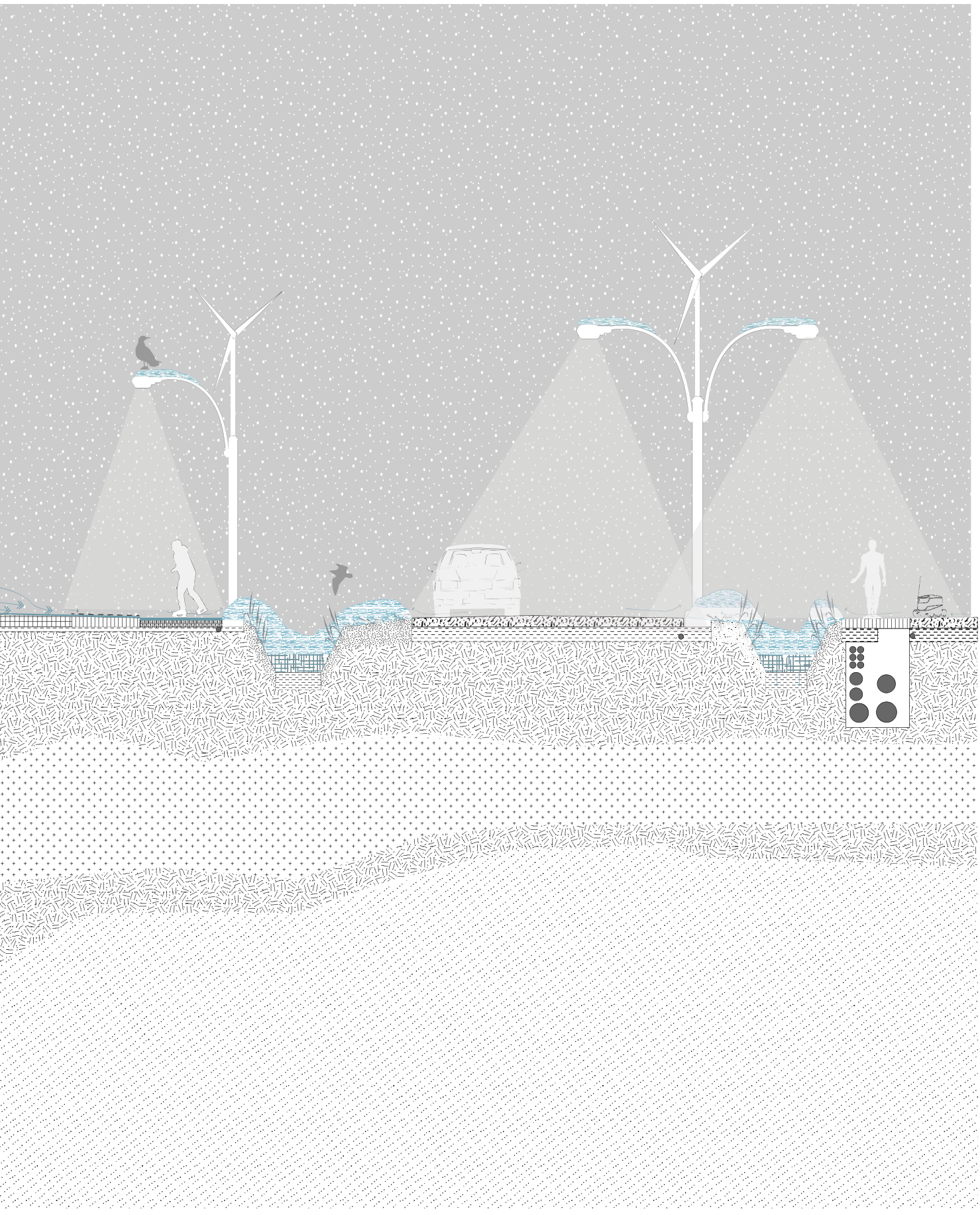
During winter season, the storm surges bring higher water level in the bay and bigger waves can get over the rock embankment. This allows layer of ice to form on the promenade, allowing ice-skating possibilities. The water-catchement system along the road works as a storage for snow from cleaning the road.
As the bay does not freeze during winter, it is possible to harvest kelp all-year round. It allows to form a habitat for fish which do not migrate during winter.
New extenive bush zone in the mountains can prevent and minize the avalanche risk, at the same time providing shelter for smaller birds. Rainfall catchement basin freezes during winter time, providing a possibility for outdoor space and winter activities.


Avalanche
Arctic birch, willow bushes
Ice - private space
Melting snow
Living
Living
Living
Living
Living
Living
Living
Lane for self-driving robots
Wind powered street lights
Ice
Ice skating lane
Storm surge
Climate and obsticle sensor



Section 1:100 Winter

The section shows in detail how the water-front functions during the winter season. The water catchment basin during winter season function as snow storage space. The sea water from storm surges are can go through rock embankment and form a layer of ice on the promenade that can be used for ice skating lane.



6.4.5.

Hammerfest: Transitional Waterfront

Yixiang Huang



Manifesto

Hammerfest has become one of the most important terminals for the Arctic Trade Route. Seasonal logistics and tourism bring huge flows of goods, tourists and workers, which boosts a prosperous urban life from May to August. Proceeding to automation and circularity, local industry continues to shift to a more sustainable mode. Circular economy becomes a new driving force for Hammerfest with innovations in carbon capture project and the utilization of tidal and wind energy system. However, at the meantime, the city is still facing the increasingly risks of climate issues and extreme events, such as sea level rising, landslides and storm surge. Citizens and the whole technosphere need to find a way to adapt to seasonal variation and co-exist with harsh weather.

Transformation in Industry - automatic, clean, and sustainable

1) LNG Industry: Manpower is mainly replaced by automatic facilities in producing processes. People are working on land instead of offshore platforms. Automation hubs are built along the coast to provide monitoring and maintenance. There are also education and research centers in city center, which providing expertise about sustainable energy and automatic technology for local industry. New logistic hub is also settled down near the Arctic Route terminal.

2) Seasonal fishery: Fishery is boost again by the Arctic Trade Route. The utilization of renewable energy supports the automation and expansion of fishery.

Urban environment - compressed, diverse, and green

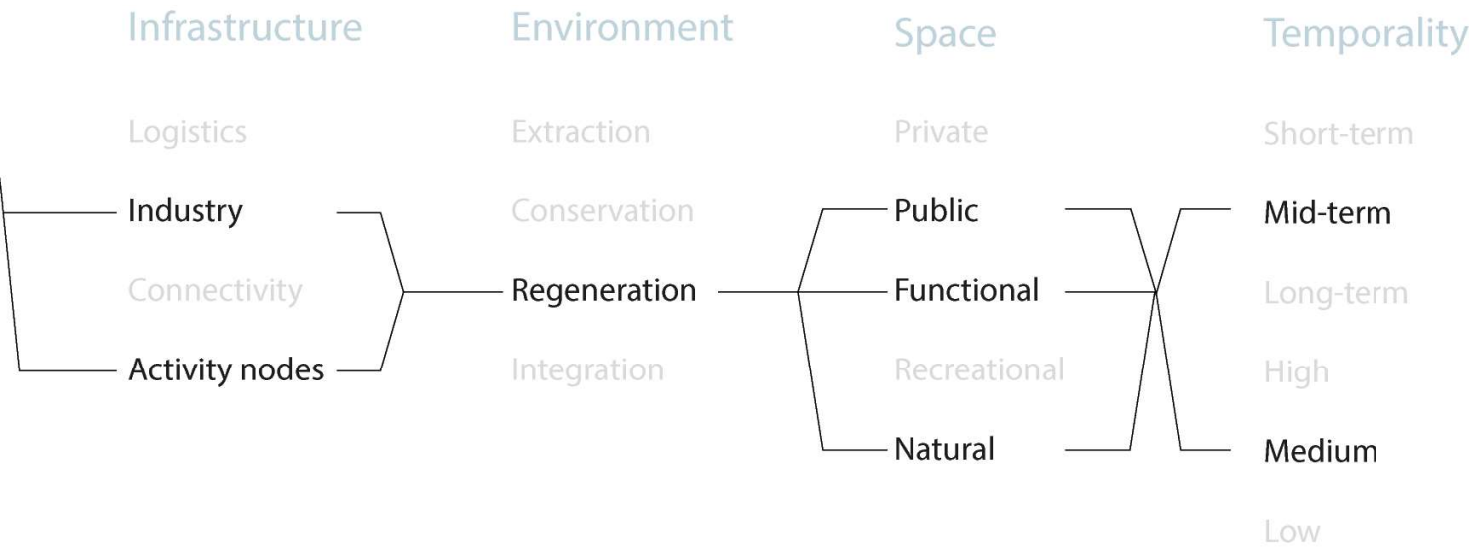
1) Densification + Greenification: A lot more people settle in Hammerfest than in the past, to work for the LNG Industry. The Arctic shipping route also brings tourists and traders during the summer time. Densification in city center help to meet the housing demand. More green spaces relieve the pressure of increasing population on nature.

2) Public spaces: Spaces for social activities are different in each season. During the summer time, there're more outdoor activities in street and squares, while in winter, people stay indoor to enjoy exhibitions, movies and parties. High quality public spaces for both indoor and outdoor activities are needed to ensure a good living experience all year round.

Bond with nature

Native flora and fauna reoccupy most of the urban area every autumn and spring. During that time, humans are guests in Hammerfest. Unused residential areas become habitats for birds and reindeers. Roads and man-built open spaces become corridors for seasonal migration for animals. New buildings and infrastructure are designed to mitigate extreme events and co-exist with biosphere better.

Location	Shock	Territory	Potential
Hammerfest	Landslides	Coast - Inland	LNG - Oil
	Stormsurges	Coast - Seaward	Mineral Extraction
			Arctic Route - Trade
			Reindeer herding



Design experiment

The new flows brought by arctic route and the transition in local industry calls for more spaces for housing, education, and management. To meet the demand, the oil and gas company need to transform the function and capacity of their inland territory in city center.

This design experiment takes a closer look into one of these transitional areas along the waterfront. It owns by the Vår energi AS company.

1. Transformation in functions: monitoring, research, education, housing

2. Public spaces for seasonal activities: outdoor (from spring to autumn) + indoor (winter)

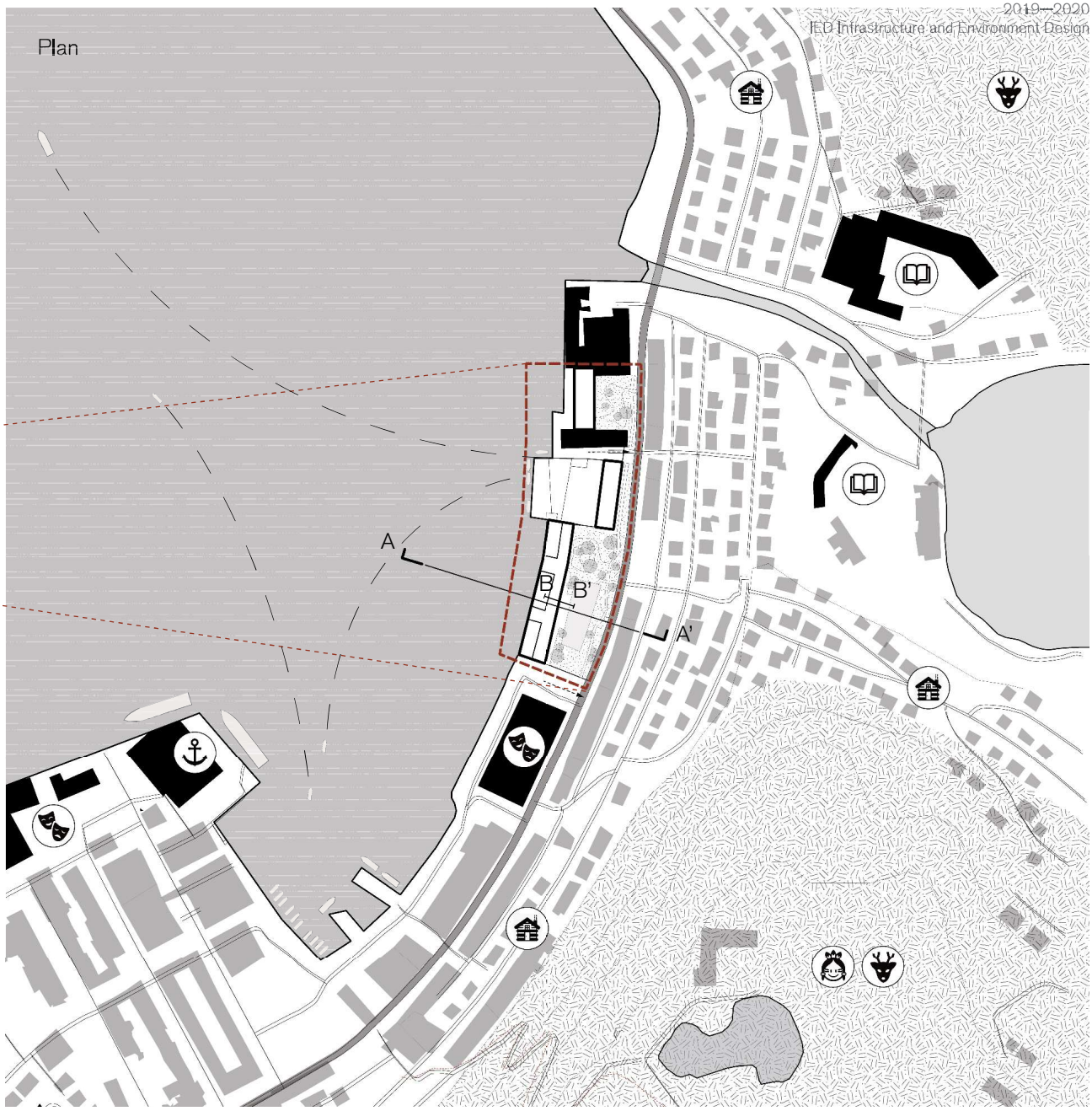
3. Adapt to environmental risks: defense for seasonal storm surges,

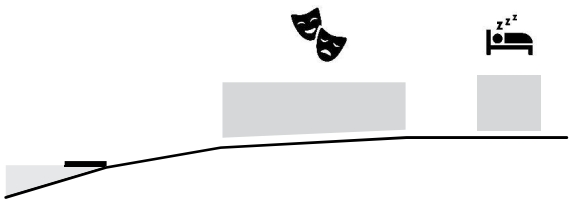
storage for snowmelt flooding.

Project location

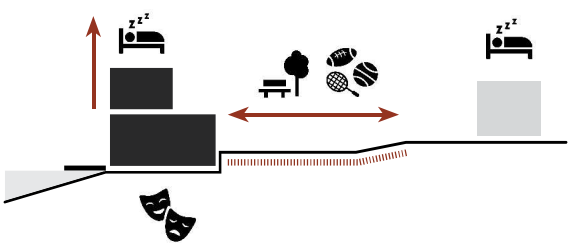


Plan





Present section



Proposed section

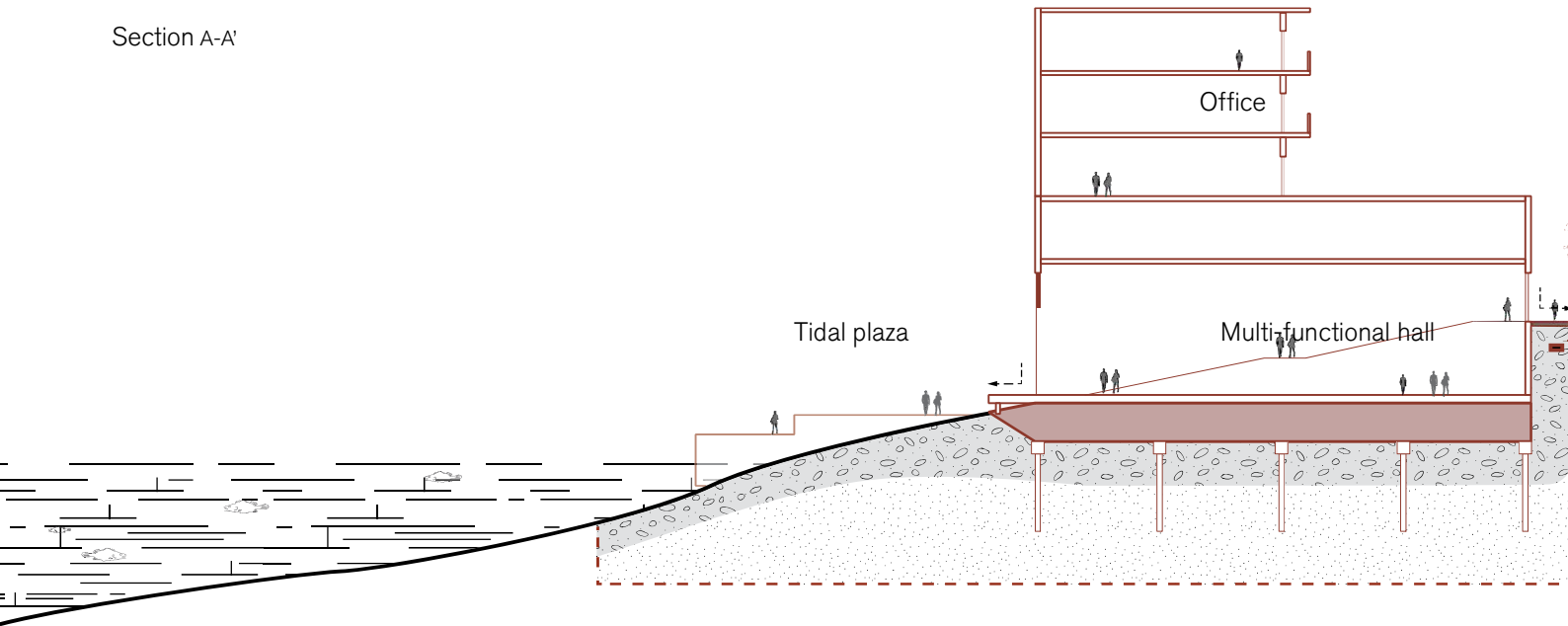
Stakeholder analysis

Scales	Stakeholders
Global	Investor
National	Ministry of Trade, Industry and Fisheries
	Ministry of Petroleum & Energy
	Ministry of Education & Research
Regional	Municipality
	Petroleum company
	Equinor AS
	Vår energi AS Hammerfest
	Transportation & Logistics company
Local	Community
	Worker
	Indigenous

Phase 1

Temporal, petroleum

Section A-A'



Project process

Outcome

Construction

Operation

Maintainance

Phasing

Sustainable extraction

Tourism

Economic growth

Social needs

Environmental risks

Job opportunity

Education & Training

Public activity

Storm surge

Snowmelt flood

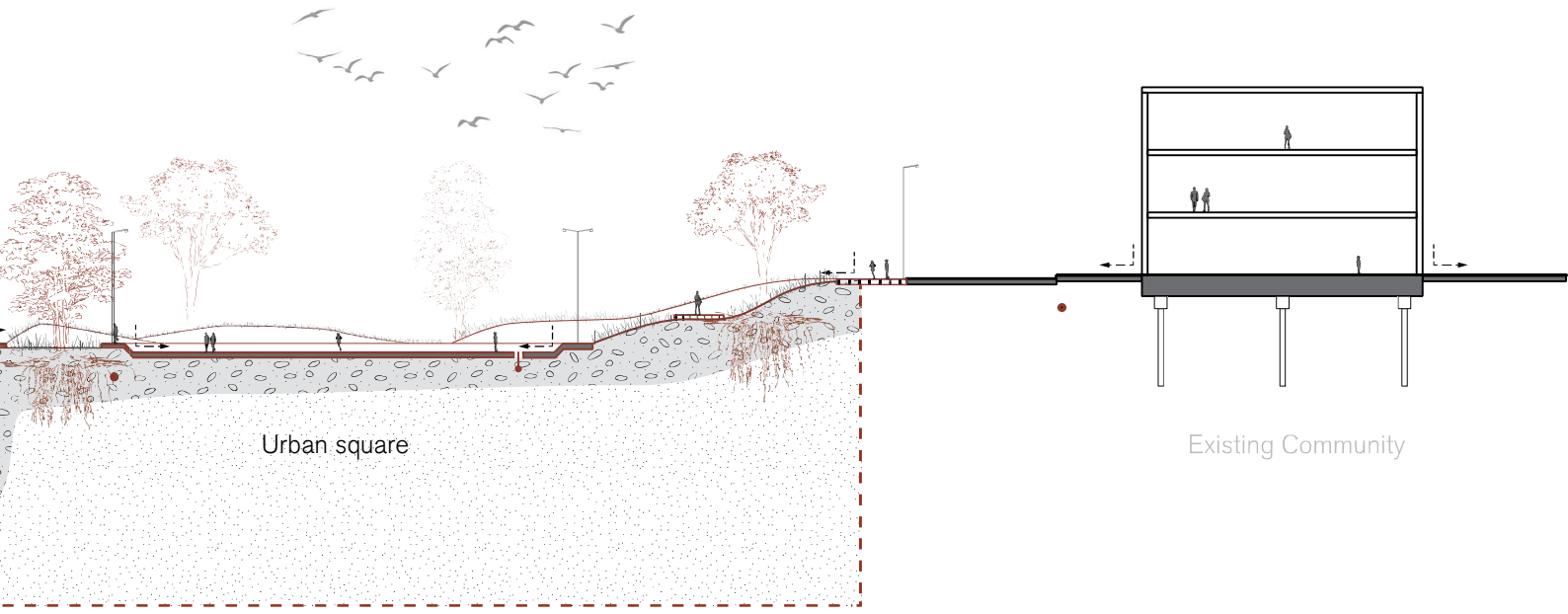
Phase 2

Phase 3

industry

Permanent, automation hub,
nature & human co-exist

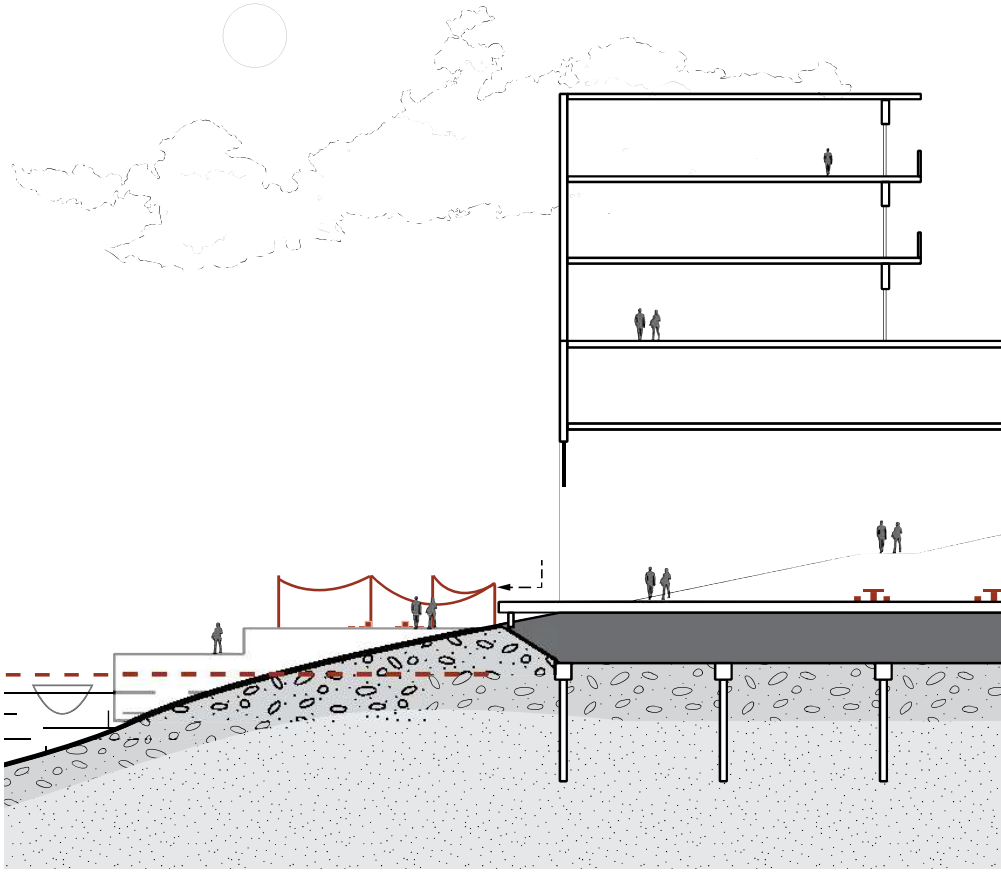
Adapt to future challenge,
new transition,
ecosystem participation



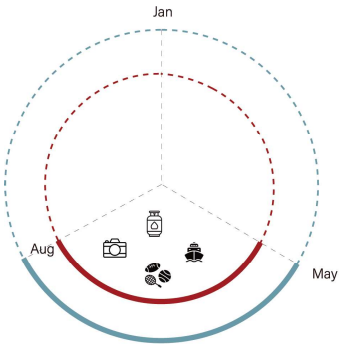
Phase 1

Temporal, petroleum industry

In the first stage, automation has not been fully realized yet. The building mainly provides office spaces in summer. In winter, only the multi-functional hall is open for indoor activities. The outdoor pablic space also occupied by animals.

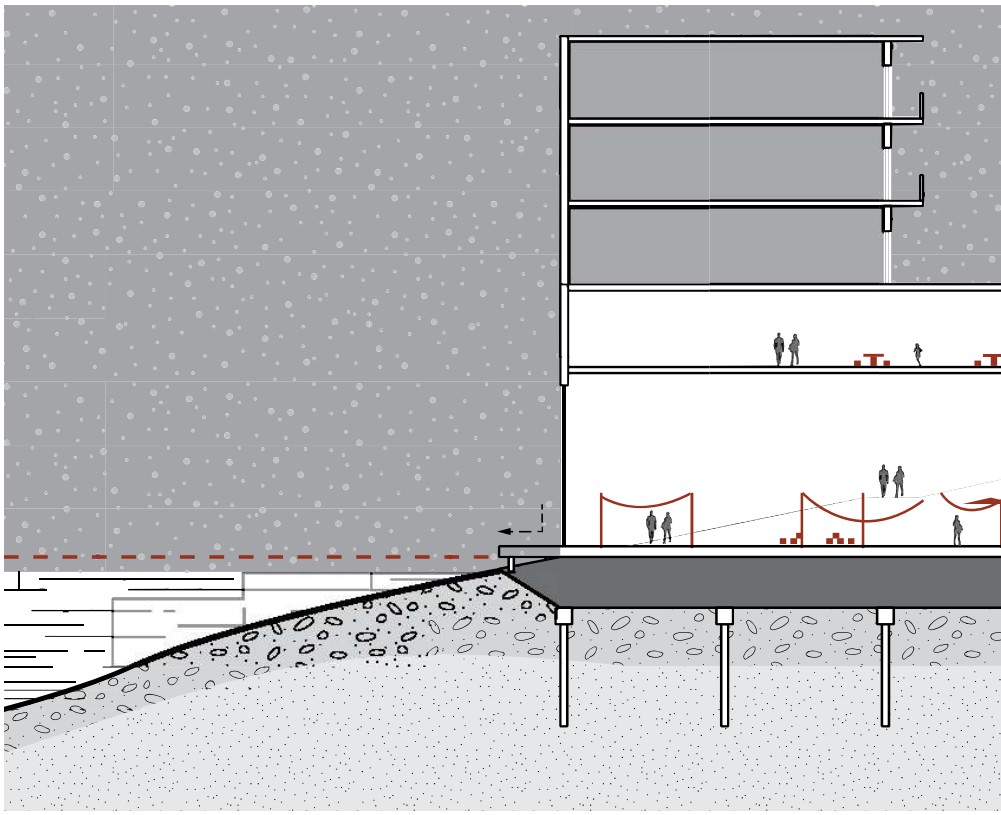


Activities in Summer

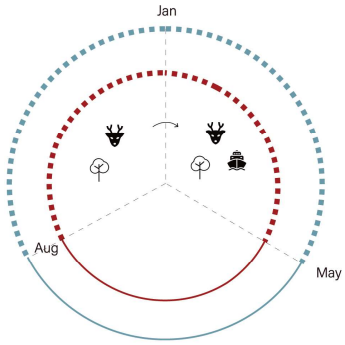


Fishery&Tourism peak season / off-season
Oil&LNG industry peak season / off-season

More spaces for outdoor activities:
tidal plaza, urban square and green land;
Opening up the multi-functional hall
and get closer to ocean.

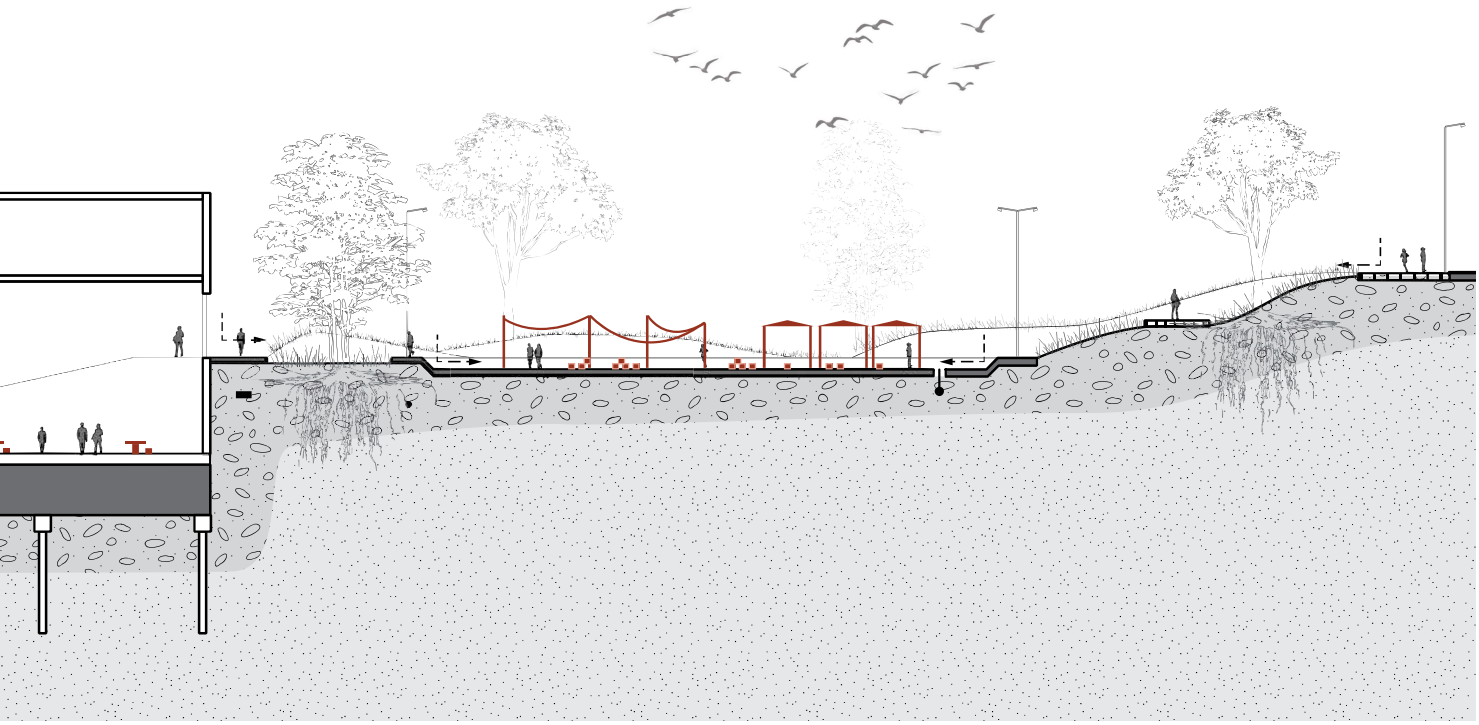


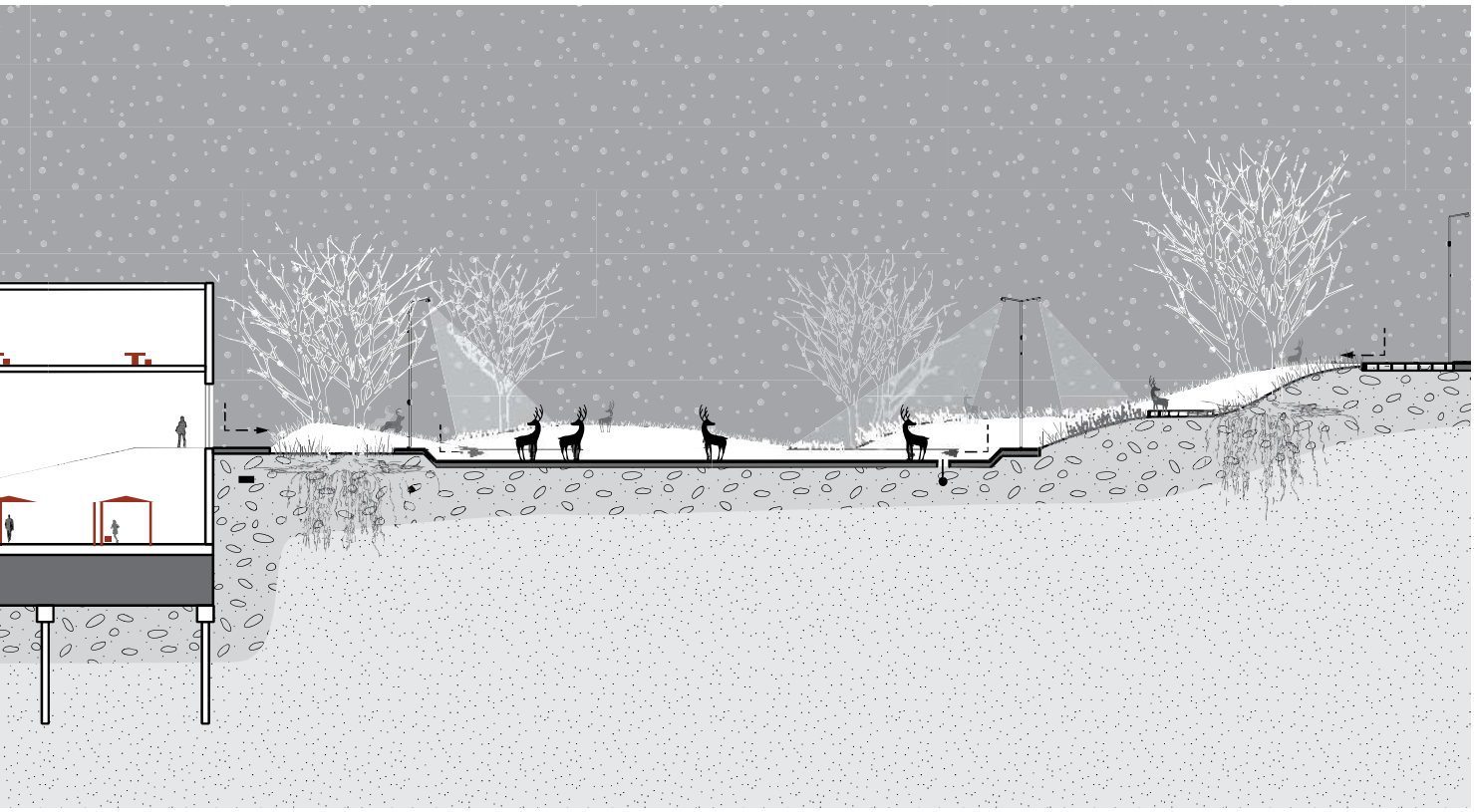
Activities in Winter



Fishery&Tourism peak season / off-season
Oil&LNG industry peak season / off-season

Multi-functional hall is used for public activities in harsh climates. The urban square and greeenland are used by native species and plants.



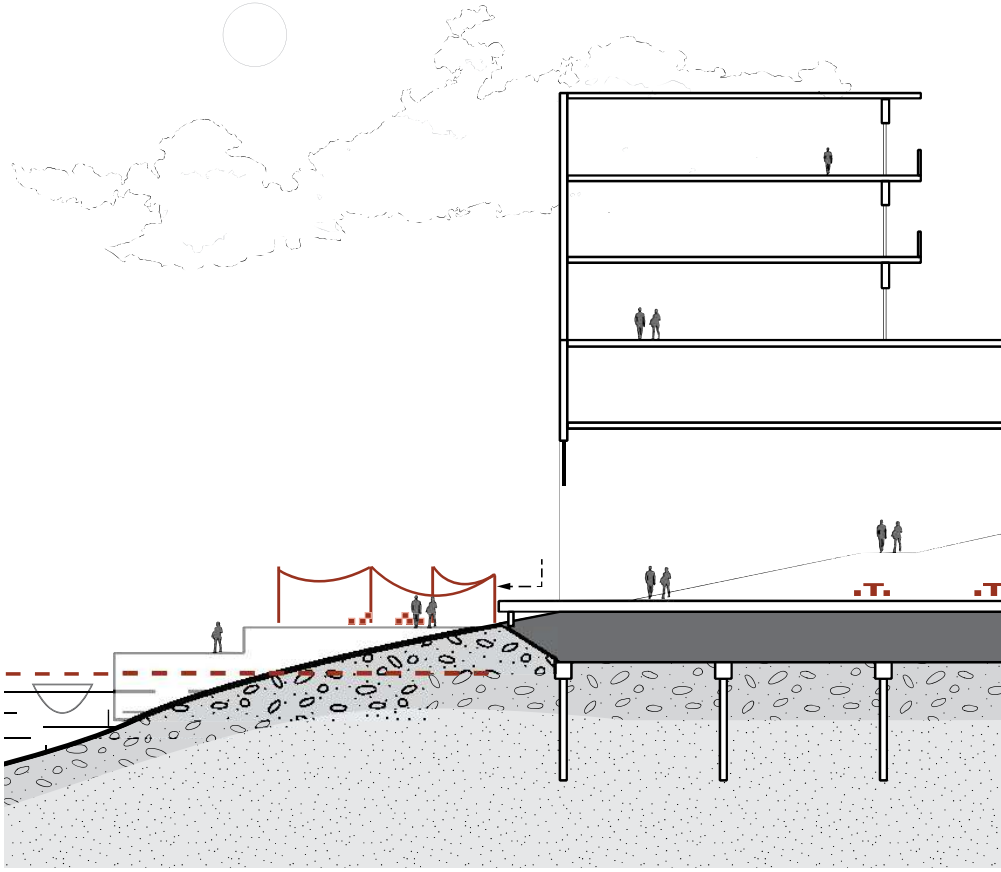


Phase 2

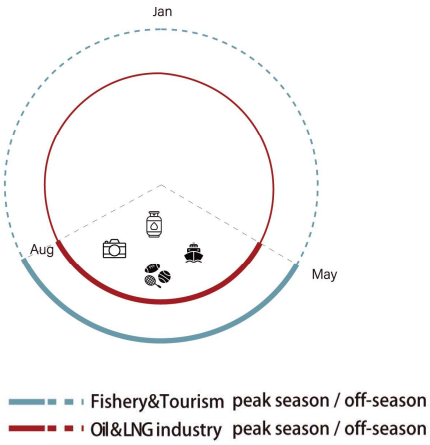
Permanent, automation hub, nature & human co-exist

Automation in industry is almost realized. The buildings are in use all year round, as the control room, research and training institutions are needed even in winter.

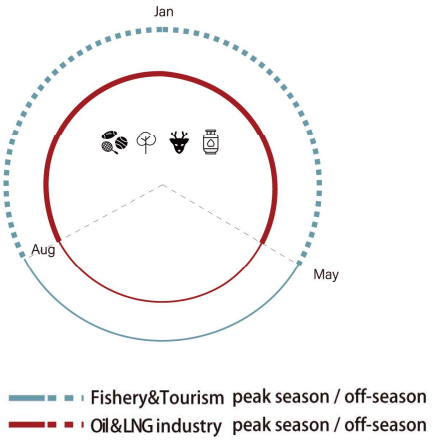
During winter, it not only provides living space for animals, but also serves as a place for hockey, ice skating and other winter sports for human.

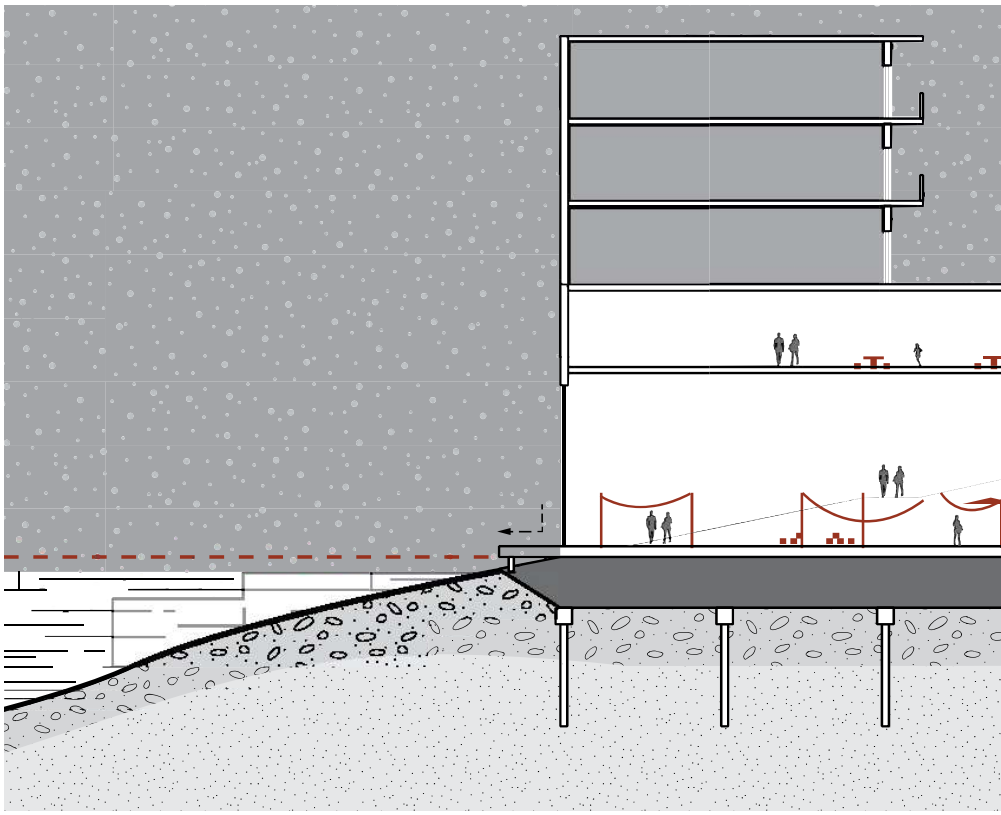


Activities in Summer

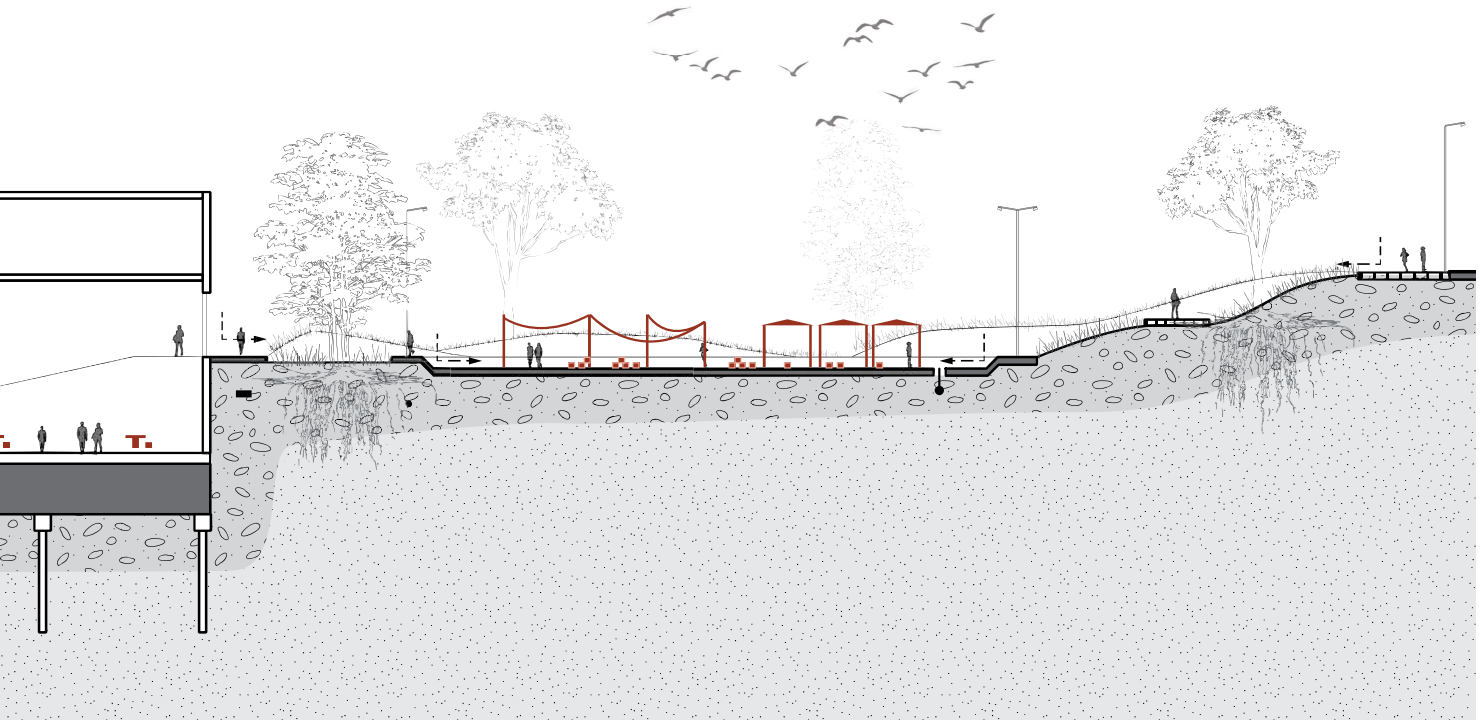


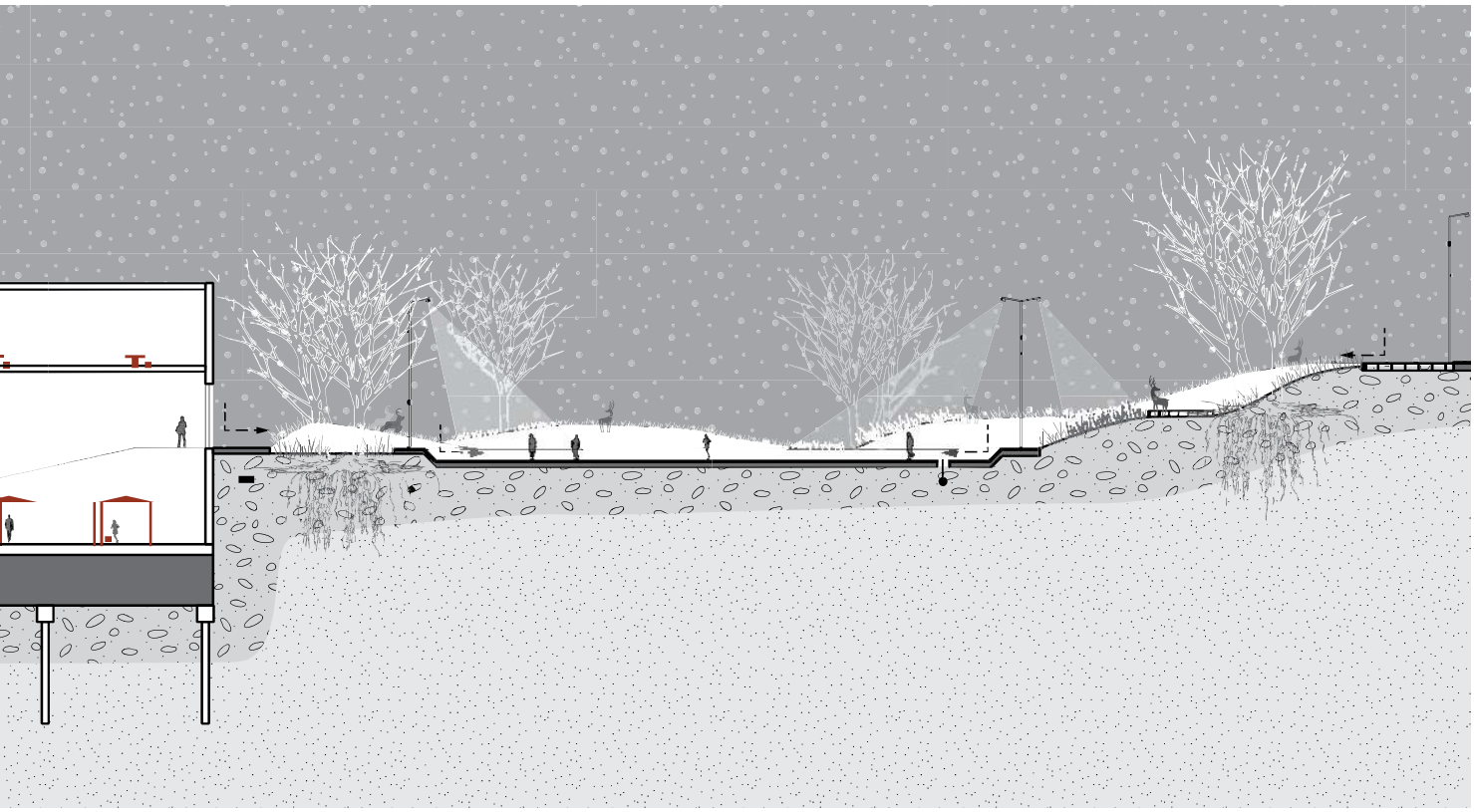
Activities in Winter





Multi-functional hall
for all kinds of cultural events
(indoor exhibitions, markets and celebrations
all year round.





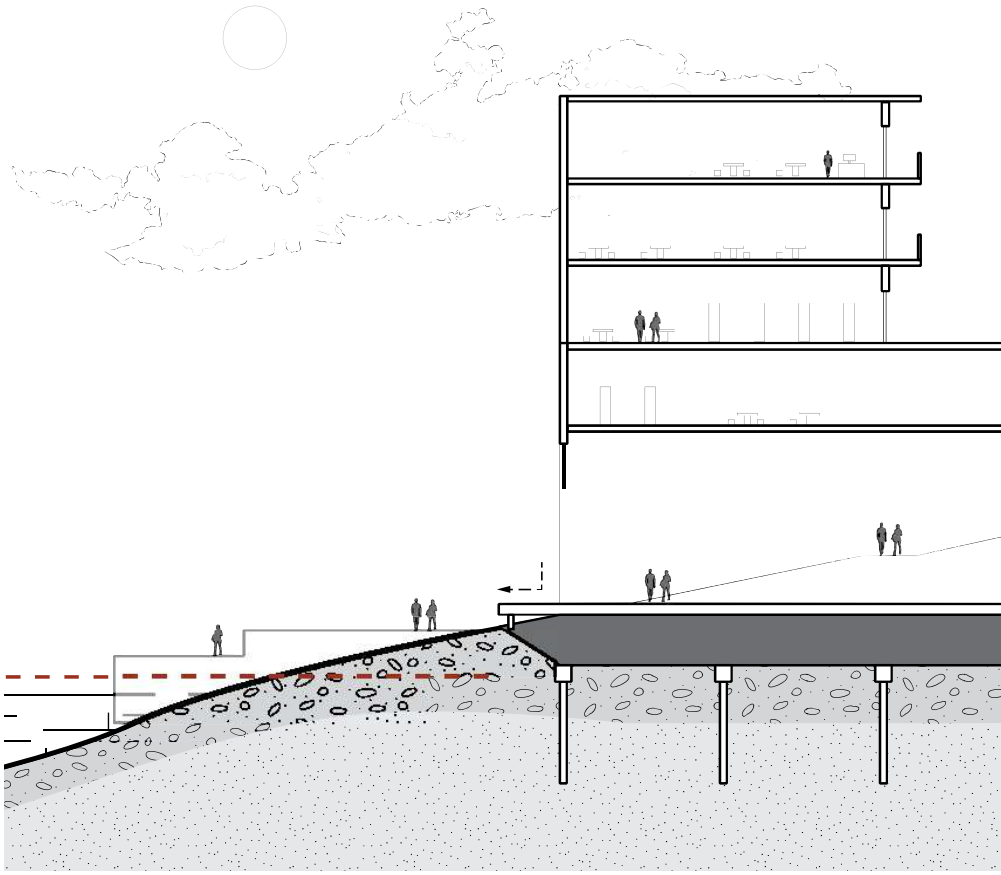
Phase 3

Adapt to future challenge, new transition and ecosystem participation

More innovative industries, logistic and tourism industry will settle in Hammerfest. The project not only serves as an innovation hub, but also as a public service for passengers.

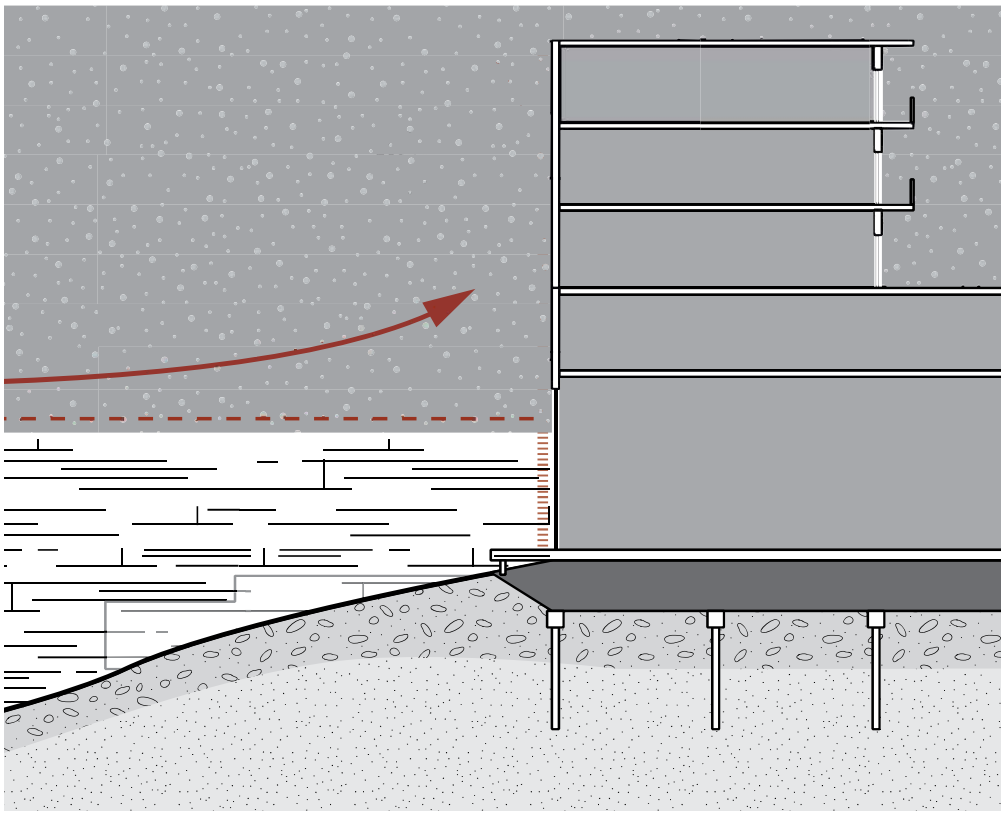
As there is less demand for industrial area inland, the green space will extend along the waterfront to replace those abandoned industrial sites. There're will be more in between open space for human and animals.

The entire waterfront is used as a defence for storm surge. Also the square would be a water square during the spring time to collect the snowmelt flooding.



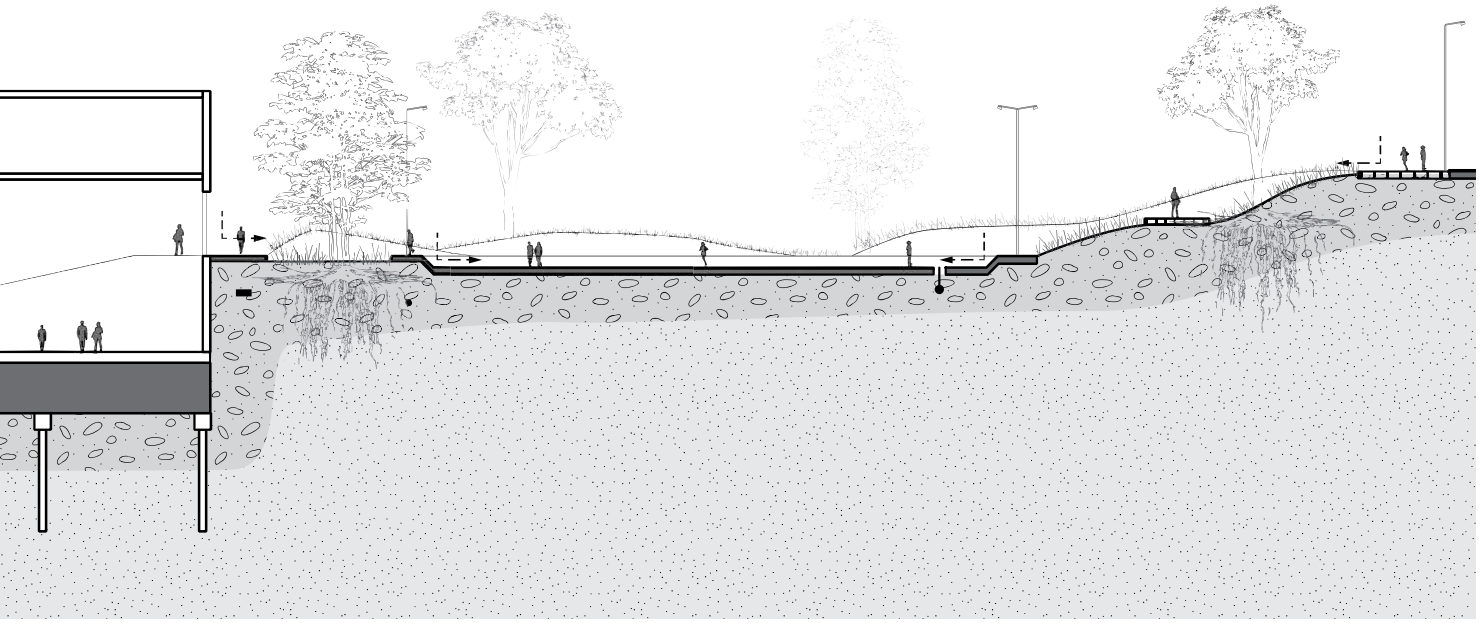
Spaces for new functions

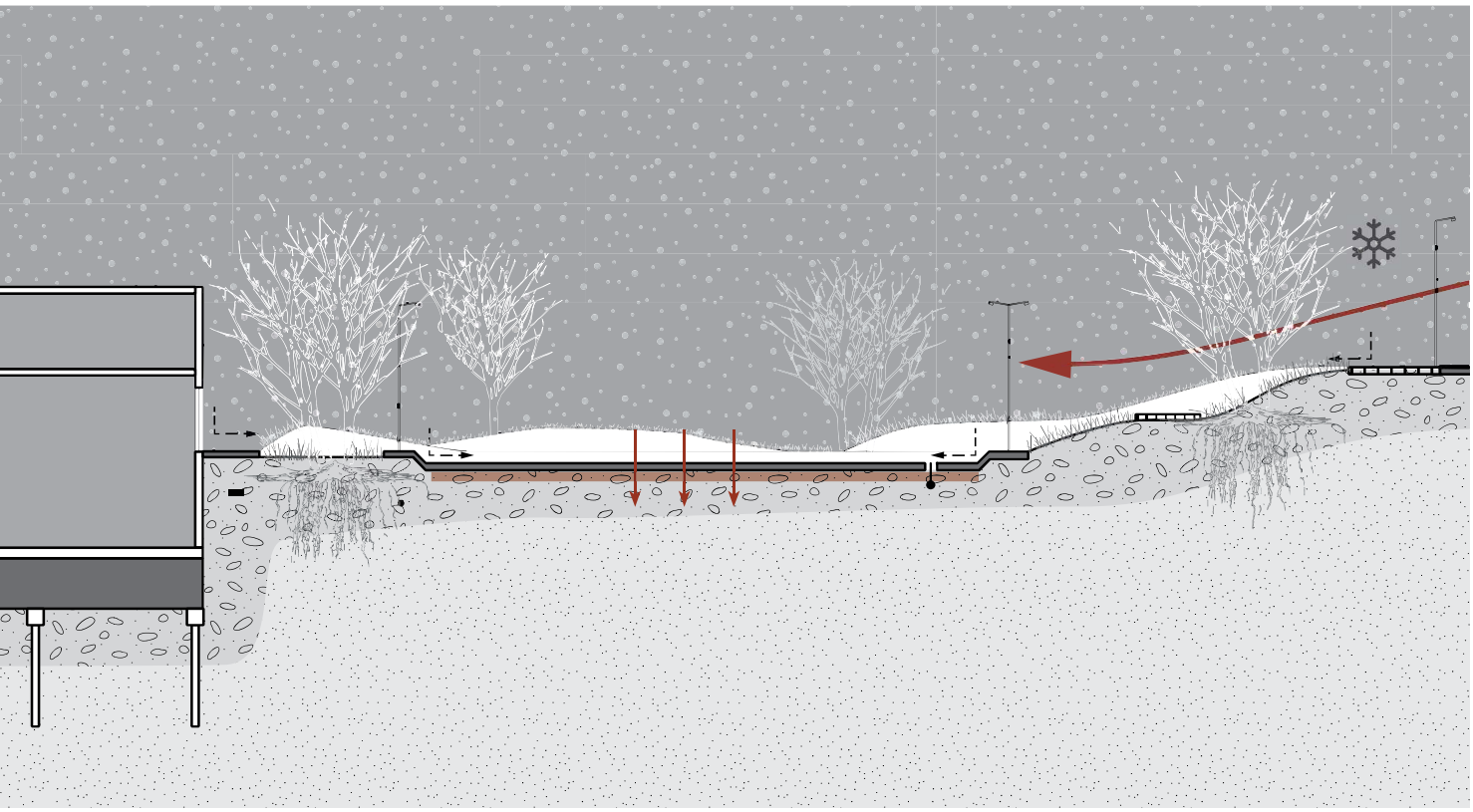
Office building: monitoring, research;
Education and training center;
Housing for workers.

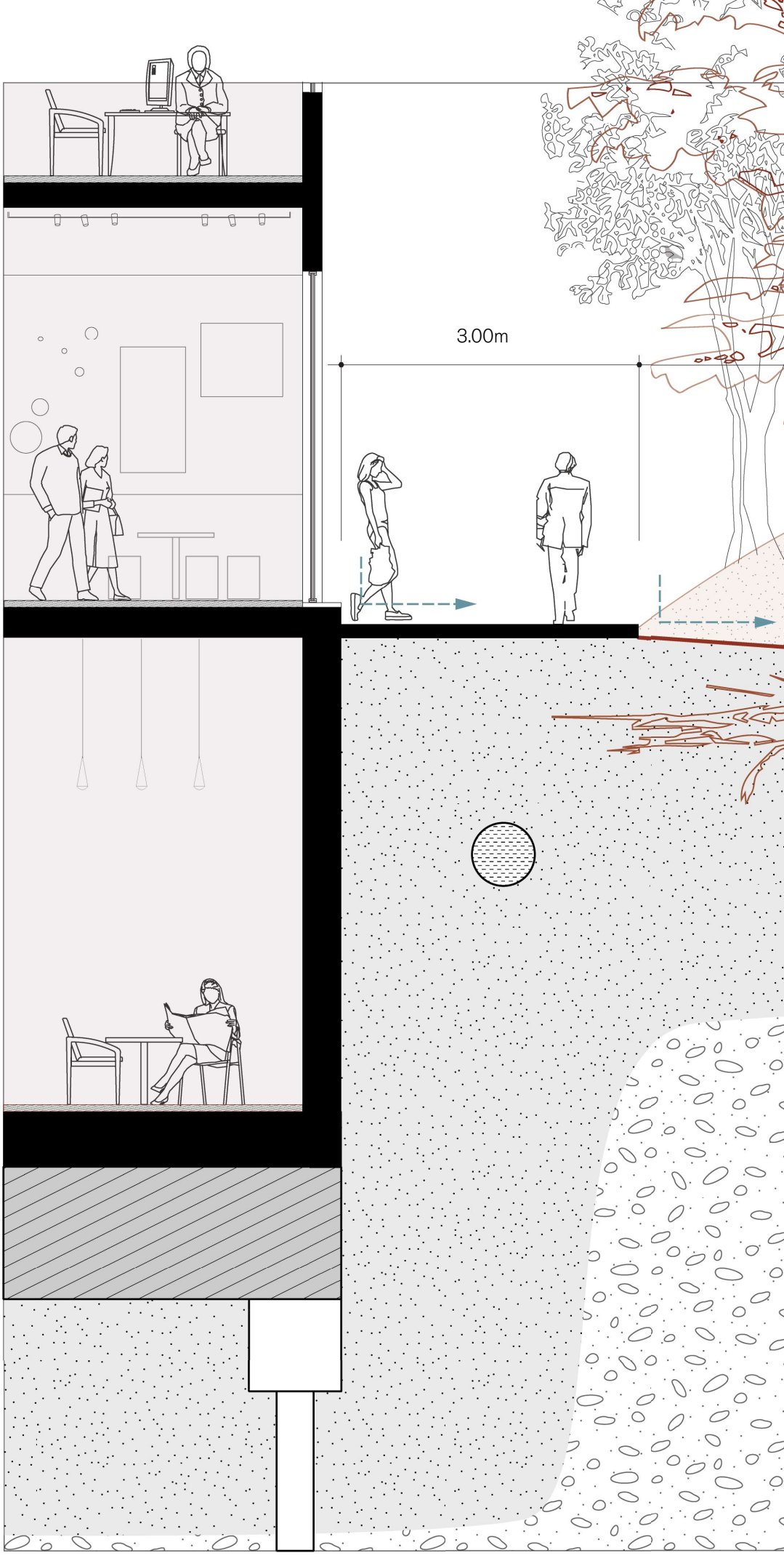


Adapt to environmental risks

defense for seasonal storm surges,
storage for snowmelt flooding.

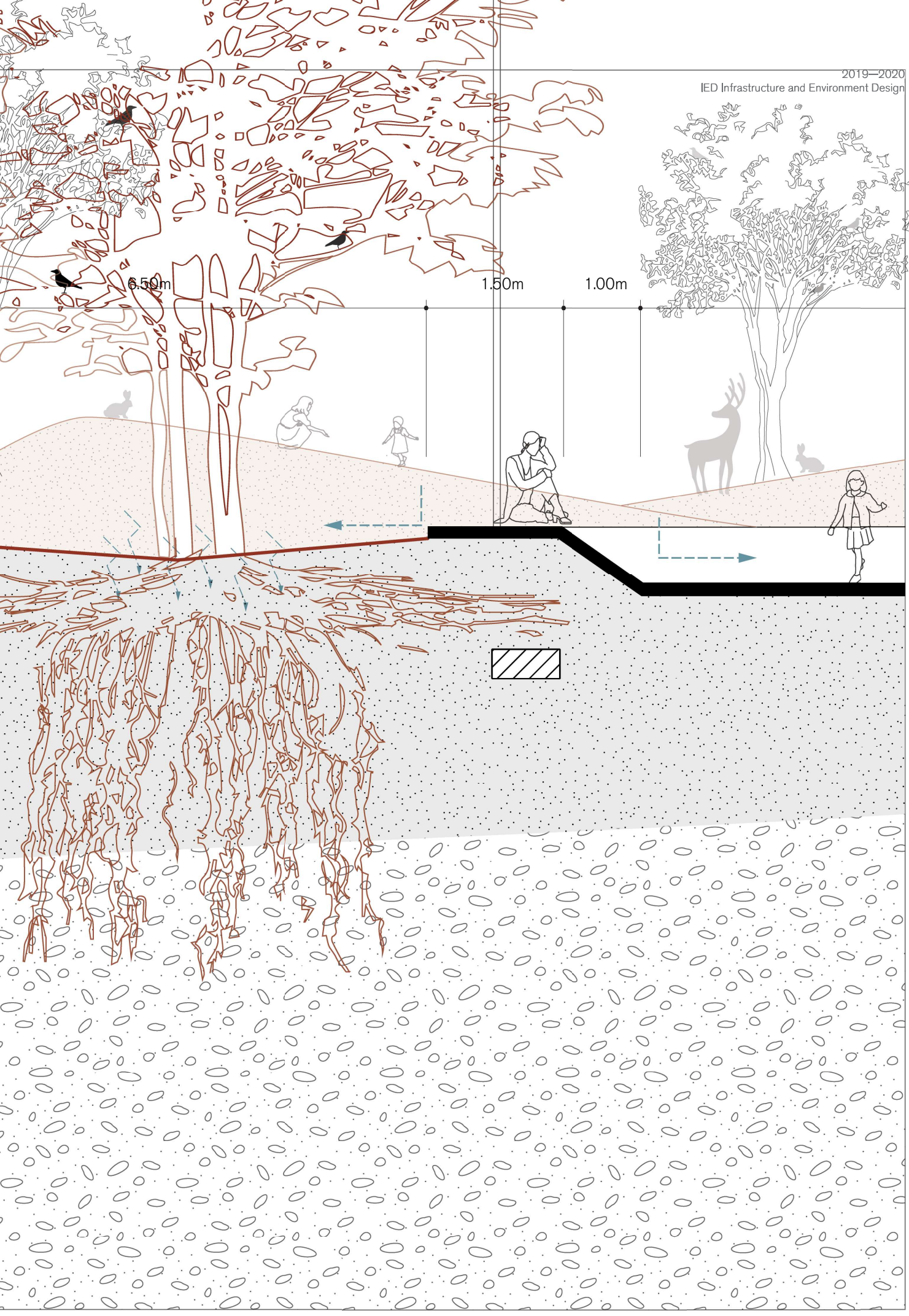






Detailed section B-B'

0 1 m


6.50m
1.50m
1.00m

Group Reflection

This research project about the extreme temporality in Norwegian Arctic has been quite demanding but very interesting. The topics that were discussed during the research have opened our minds to the complexity of planning and designing in this region. Lectures, workshops, group work and work in different perspectives allowed us to develop a deeper insight in ecosystem participation to understand the processes that influence urban development in extreme conditions.

The structure of the course and interactive methods allowed us to learn how to approach and comprise different interests and future scenarios. Although the research and design were conducted and made during the COVID-19 pandemic, in the online educational environment, we as a group were able to communicate our ideas and work together on a satisfactory level.

We want to thank all our tutors, in particular Francesca Rizzetto, for the support, inspiration and push outside our comfort zone. The pandemic demanded more flexibility and adaptability from the supporting staff, but we felt well guided and challenged. We also want to thank Gioele and Santiago, who, despite the graduation stress, found time to share their on-site experience and photos.





Hammerfest - *Picture by Gioele Colombo & Santiago Palacio Villa*

3.

Otsuchi, Japan

Ying Hou
Yujia Liu
Zichuan Lu
Kueitso Chen
Ning Cai





The devastated town of Minamisanriku, Miyagi, two days after the tsunami. Photograph, The Asahi Shimbun/Getty Images





The ‘miracle pine’, a tree said to symbolise hope and recovery after it survived the 2011 tsunami, stands next to a damaged building in front of a newly built sea wall in Rikuzentakata,
Mainichi Shimbun/Reuters

1.

Introduction to Otsuchi

Otsuchi, a coastal town in Japan, has been suffering from tsunamis in history. After the among which the one on 11th march of 2011 was the worst. A set of engineered protection actions, like land elevation and concrete sea walls, were taken to protect residents from disasters. However, these constructions are not only expensive and need much maintenance, but also disturb the ecological systems. Moreover, human interaction with water is blocked by these high sea walls. Except for the extreme environment, Otsuchi is also facing an aging society and mono-economy, which is leading to a decline in local development and loss of culture. The problems in this area are in multi fields, so the construction of the sea wall is far from enough to solve these interrelated problems.

In this project, we are dedicated to mitigating the adverse effect brought by the engineered constructions by restoring the ecosystem service and revitalizing the relationship with humans and the ecosystem. The ecosystem itself already has the ability to absorb and mitigate disturbance and disasters. We want to reinforce this ability and use more nature-based solutions to protect local residents from disasters. What's more, the ecosystem can also be seen as a catalyst to bring social cohesion and economic development. The perspective we adopted as a group is to put nature first and try to solve environmental, social, economic problems while guaranteeing safety by an integrated plan with respect to nature.

Challenges in this area come from different fields, the protection from disaster, economic development, and the revitalization of local communities. First of all, the construction of the sea wall is already ongoing, so how to evaluate the current construction and change it to a more nature-based and human-involving infrastructure is our main concern. Secondly, economic growth here mainly comes from marine-related industries, which are easily affected by tsunamis, so alternative economic activities that are stimulated by local characteristics, are needed. Here comes the second challenge on how to stimulate new economic sectors by using the unique landscape and cultural resources in Otsuchi and how to protect them from natural disasters. Lastly, outmigration, aging society, and disasters lead to a shrinking population, and social structure is disturbed by the relocation project, the local community is losing its vibrancy and traditional identity. The third challenge is to find solutions that can preserve the traditions and culture while enhancing the new development of local communities towards more sense of belonging and cohesion.

Environmental risk

Located on the Ring of Fire, earthquakes and the corresponding tsunami are common natural hazards in Japan due to the movement of fault lines along the coast, especially the east coast. The effect of each of these tsunamis is followed by a large scale loss of life. Therefore, as earthquake and tsunami-prone areas, most of the buildings take mitigations measurements into account during the planning process, as well as in the urban planning level. However, current measurements only have a limited effect when faced with serious natural disasters.

In March of 2011, the Great East Japan earthquake of 2011, a 9.0-9.1 magnitude earthquake which is the strongest ever recorded in Japan. hits the coastline with the epicenter situated at only a 70-km distance from the Oshika Peninsula of Tohoku. The tsunami occurring simultaneously was also historical as its run-up height reached over 39 m. (At Otsuchi Bay, the maximum height of tsunami inundation and run-up were 14.7 and 19.4 m above mean sea level, respectively. The maximum run-up distance from the coastline was 3.7 km.) It caused devastating damages to both infrastructures and, a total of 15,897 lives were lost. Almost all villages lost an average of 15% of their citizens to this tsunami. Furthermore, the tsunami also brings nuclear accidents, which sequentially affects the residence problem. Previous inhabitants either lived in temporary housing or relocate to other places, which are far away from their homes. Consequently, the damage faced by Japanese people can be seen as a giant composite disaster. Although Japan, and the northeast of Japan in particular, has over a long time period increased its preparedness against earthquakes and tsunamis, huge damage still occurred.

Human response to the risk

In Japan, after tsunami, the recovery planning can be divided into two kinds: hard measures and soft measures. Hard measures usually mean engineering solutions to withstand future tsunamis. First, breakwater, levee and second levee are built to protect lands from future tsunami. Second, if communities are willing to move, they will be relocated in higher land. If they don't want to move away, the land of original site will be raised and they can rebuild their houses there. Soft measures include tsunami warning system, tsunami alarm system, evacuation plan, tsunami shelters, and evacuation points.

Hard measures_Levee construction:

Concept on Level 1 and Level 2 tsunami has developed at the national level. Level 1 tsunami is defined as happens once every a hundred years or so. Level 2 tsunami happens once hundreds to a thousand years. The height of levee should higher than Level 1 tsunami. The heights of levees depend on the area location and need to be calculated and decided by prefecture governments and professionals. Local governments decided on land use according to the tsunami simulation. Local governments also have the responsibility to talk and negotiate with communities to choose the proper rebuilding programs.

Land use details:

Relocation:

·If the original site is near the ocean, the communities will be relocated close to continuous hills. So if Level 2 tsunami happens, they can always go higher in the mountainous area for safety.

Land raising:

·If the communities don't want to move away, the original land will be raised and the buildings will aggregate.

Land use policy:

·In case of Level 2 tsunami, the land use policy defined that the land behind levee should not be used as residential area. Instead, industries, parking lot or sport field can be set here.

·Therefore, because of the limited land, the residential area will always be denser after rebuild.

·Social infrastructure like hospitals and schools are built in higher space near hills and evacuation points.

Soft measures

Tsunami warning system / tsunami alarm system

Japan has the national tsunami warning system. If the Earthquake Early Warning system is issued, the tsunami warning system usually issue the warning minutes later.

Evacuation plan

Tsunami hazard maps are published by local governments. Residents can check evacuation route, temporary tsunami evacuation facilities and predicted post-earthquake flooding.

Tsunami shelters, evacuation point:

·Hills higher than terrain that are adjacent to the coast but continue to increase in elevation for a long distance. So people can always go higher and safer place when suffering from Level 2 tsunami.

·Robust buildings over 6 floors or hills over 20meters high. This kind of evacuation place has the risk of being isolated during tsunami.

·Robust buildings over 4 floors high. This kind of evacuation place has the risk of being overlapped during tsunami

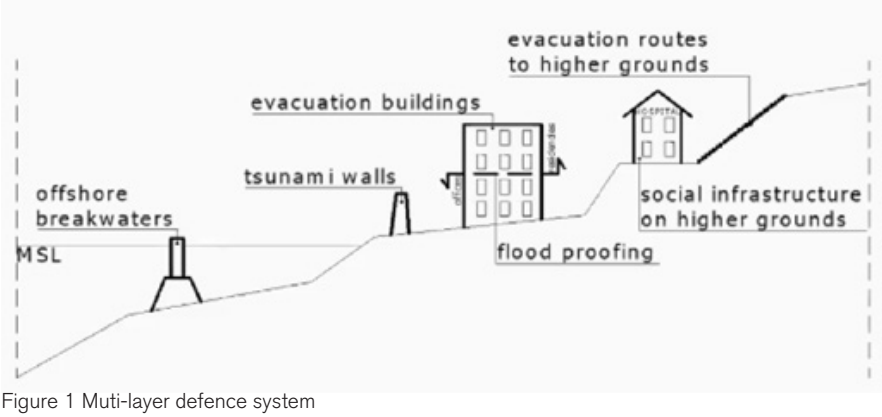


Figure 1 Muti-layer defence system

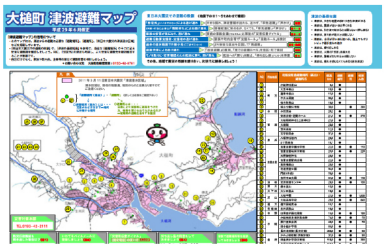


Figure 2 Tsunami hazard map



Figure 3 Tsunami sign

Problem field

Aging Society

The transportation between Otsuchi and Kamaishi is so convenient that the population of Otsuchi is closely related to the economic development of Kamaishi. A lot of large and medium-sized factories in Kamaishi were closed in 1980, and remain factories in Kamaishi gradually reduced in size. Since then the population of Otsuchi Town continued to decrease. After the earthquake and tsunami in 2011, the shrinking progress of the Otsuchi Town population obviously accelerated.

1. Decreasing population

According to the population change of Otsuma from 2010 to 2019 (Figure 1), the population has been steadily decreasing year by year. As of January 1, 2019, the population was 11,874, with a negative growth rate of 1.2%. The population is expected to drop to about 6,200 by 2045. By then, the average age in 2045 will increase from 51.6 in 2015 to 59.1, an increase of 7.5.

According to the population age distribution (Figure 2), the proportion of the elderly (over 65 years old) in 2019 is 36.7%, and the ratio of the elderly to the working-age population (15-64 years old) is 1:1.5, which means that every 1.5 workers need to support an elderly person. Besides, for young women focused on childbearing and raising, the population between the ages of 20 and 39 is 926, accounting for 7.8% of the total population, which is lower than the national average (10.4%).

2. Low birth rate

The Otsuchi Basic Resident Registration Form shows the change in the number of births per 1,000 people (Figure 3). The number of births per 1,000 people in 2018 was 5.86, and the birth rate in the past two decades has been far lower than the national average.

3. Proportion of family composition – elderly families

The types of households and their proportions in Otsuma-cho in 2015 (Figure 4) shows the total number of general households is 4769, of which 33.3% live alone, and 66.7% account for more than two family members. Among households with elderly members, the proportion of elderly single households (single households 65 years and older) and elderly couple households (husbands 65, wives 60 and older) (a couple) is 27.8%. The proportion of ordinary families of the elderly is 5.3 percent higher than the national average (22.5%).

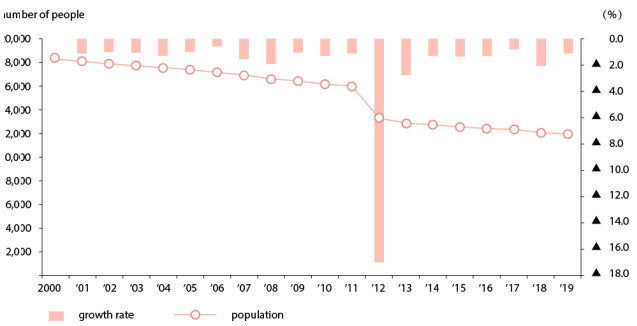


Figure 1Demographic statistics

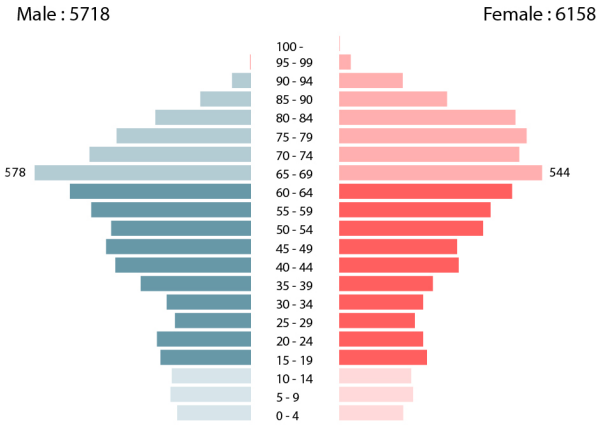


Figure 2 Population composition in 2019

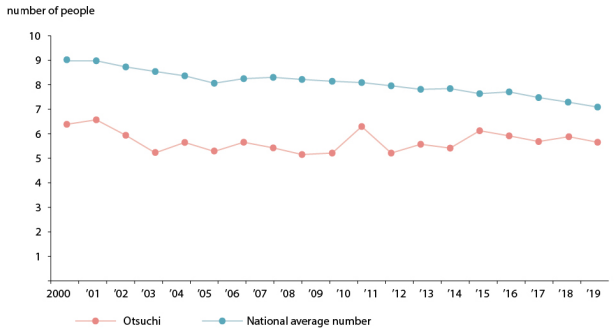


Figure 3 Births per thousand

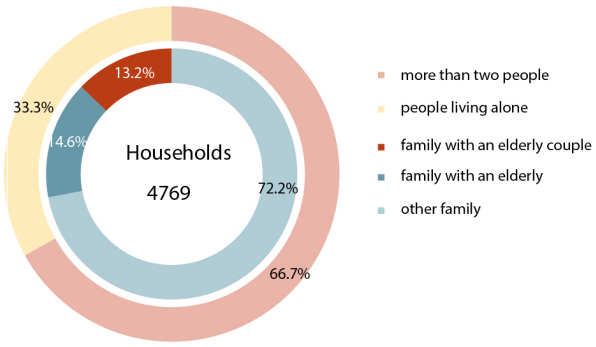


Figure 4 Household members in 2015

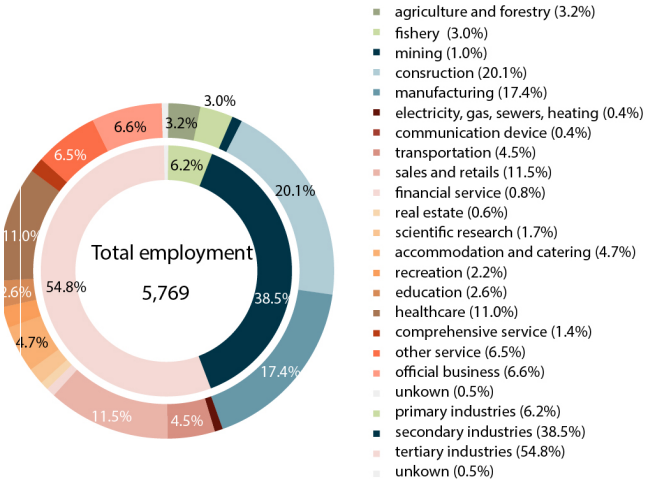


Figure 5 Employment distribution in 2015

Land area		Households	
Total	20,059 ha	Total	5,689
Cultivated area	399 ha	Agricultural management	195
Farming land	170 ha	Farming households	308
Arable land	229 ha	Self-contained farmers	117
Forestland area	17,798 ha	Commercial farmers	191
Population			
Total	15,279	Forestry management	92
Agricultural population	326	Fishery management	225
Fishery population	437		

Figure 6 Primary industry basic information statistics

Economy

In terms of industrial structure (Figure 5), tertiary industries accounts for 54.8%; the secondary industry accounts for 38.5%; sales and retails accounts for 11.5%, and the construction industry accounts for 20.1%. The earthquake lost the foundation of the local economy, but the regeneration of Otsuma-cho and the revitalization of wholesale and retail are indispensable. Besides, although the manufacturing sector is small in number, it has created more jobs. And as the main urban area faces Otsuchi bay, and another settlement, kirikiri, faces Funakoshi bay, salmon farming, aquaculture, and seaweed farming, and fish product processing also occupy an important part. There was also a good scallop production before the tsunami.

The industrial structure as a primary industry is shown below (Figure 6). Otsuchi farming area is 399ha. From the 20,059ha area of the town, it only accounts for 1.9%, showing that its agricultural advantage is almost zero. The area of woodland is 17,798 hectares, accounting for 89%. It can be seen that most of the area of Okuchi Town is woodland. In this sense, forestry revitalization is an industry with great potential for Otsuchi, and it is necessary to take some measures in the future.

Energy

Since the nuclear disaster at Fukushima, the government has not put forward a “non-nuclear society” claim. Japan’s electricity demand is large, and to meet these needs, three social forces must be considered simultaneously.

The first group of people hopes to have a clear plan to phase out all nuclear reactors by 2030. In the 2012 vote, it was found that 90% of people want to live in an environment without nuclear energy.

The second category is the Japanese public utility companies. They defend their monopoly status, pointing out that imported fuel is expensive and the source is unstable and should continue to use nuclear energy as a source.

People who promote the use of renewable energy form the third type of group. They believe that renewable energy can be called a viable alternative to Japan’s nuclear energy, and it will also create new business opportunities, create a large number of jobs, reduce import demand, and thus improve Japan’s terms of trade. It was proposed to build an East Japan solar belt to produce solar energy, wind energy, and geothermal energy on the base of the tsunami erosion.

Disaster

1. Earthquake & Tsunami

The coast of Sanriku, which includes Otsuchi Town, is a tsunami zone that has been hit by a large tsunami and earthquake once in the past few decades. At the same time, the earthquake also caused secondary disasters, such as fire, the effect of each of these disasters is followed by large scale loss of life. Since 1991, in Otsuchi there are already 1233 lives were lost due to the earthquake and 52 lives were lost due to secondary disasters.

The worst disaster in recent years is the 2011 Great East Japan earthquake, which cost a total of 15,897 lives were lost in Japan and almost all villages lost an average of 15% of their citizens to this tsunami. Otsuchi which lay closest to the epicenter of the earthquake was affected badly. Much of its urban districts on the coastline were wiped out. At the same time, the earthquake also caused serious secondary disaster, which is nuclear pollution. Since the Fukushima nuclear power plant was damaged during the earthquake, a large amount of radioactive material flowed into the sea, and many parts of Iwate Prefecture, including Otsuchi, were affected by the nuclear radiation.

The Otsuchi district consisted of 16,000 people before the tsunami. There were around 817 deaths, 416 missing people followed by around 3000 people leaving the town after the event. Currently the town is around 11000 people. There is a 25 % reduction in the population of the district. These are drastic numbers considering the population was already decline.

And the urban area of Otsuchi was almost destroyed by the tsunami, 4375 buildings were destroyed, including housings, public buildings, factories and etc. Which has a great impact on the local economy and has caused many people to lose their homes. Due to the great degree of damage to the city, otsuchi post-reconstruction project has not yet been completely completed nine years later.

2. Typhoon

Locating on the east coast of Japan, from June to September every year, Otsuchi will also be affected by the typhoon. Compare with earthquakes and tsunami, typhoons will not cause that high damage to Otsuchi, but it still will affect the local economy as the family fishery is the main industry of Otsuchi.

Problem Statement

The issues being faced by the tsunami-devastated regions following the Great East Japan Earthquake are the same issues being faced by all Japanese rural towns today. They all share similar planning challenges. Specifically, they all need to improve disaster resilience, and comprehensive spatial planning which adapts to population decline, and the aging population make it even more difficult to create unique and attractive communities. In this context, what makes it a more special intractable situation in Otsuchi.

Throughout history, Otsuchi has enjoyed the benefits of its proximity to the ocean and the mountains that straddle it, But it has suffered as a result too. Having the mountains so close to the sea means there is little flat land in the coastal region. Most of the coastal land lay at sea level. Even the town hall was slightly raised, are only 2 or 3 meters above it. At the same time, it is prone to natural disasters, such as a big earthquake, tsunami, fires and typhoons, and floods. This is one of the reasons why the loss of human life reached the extent that it did in the Tohoku tsunami.

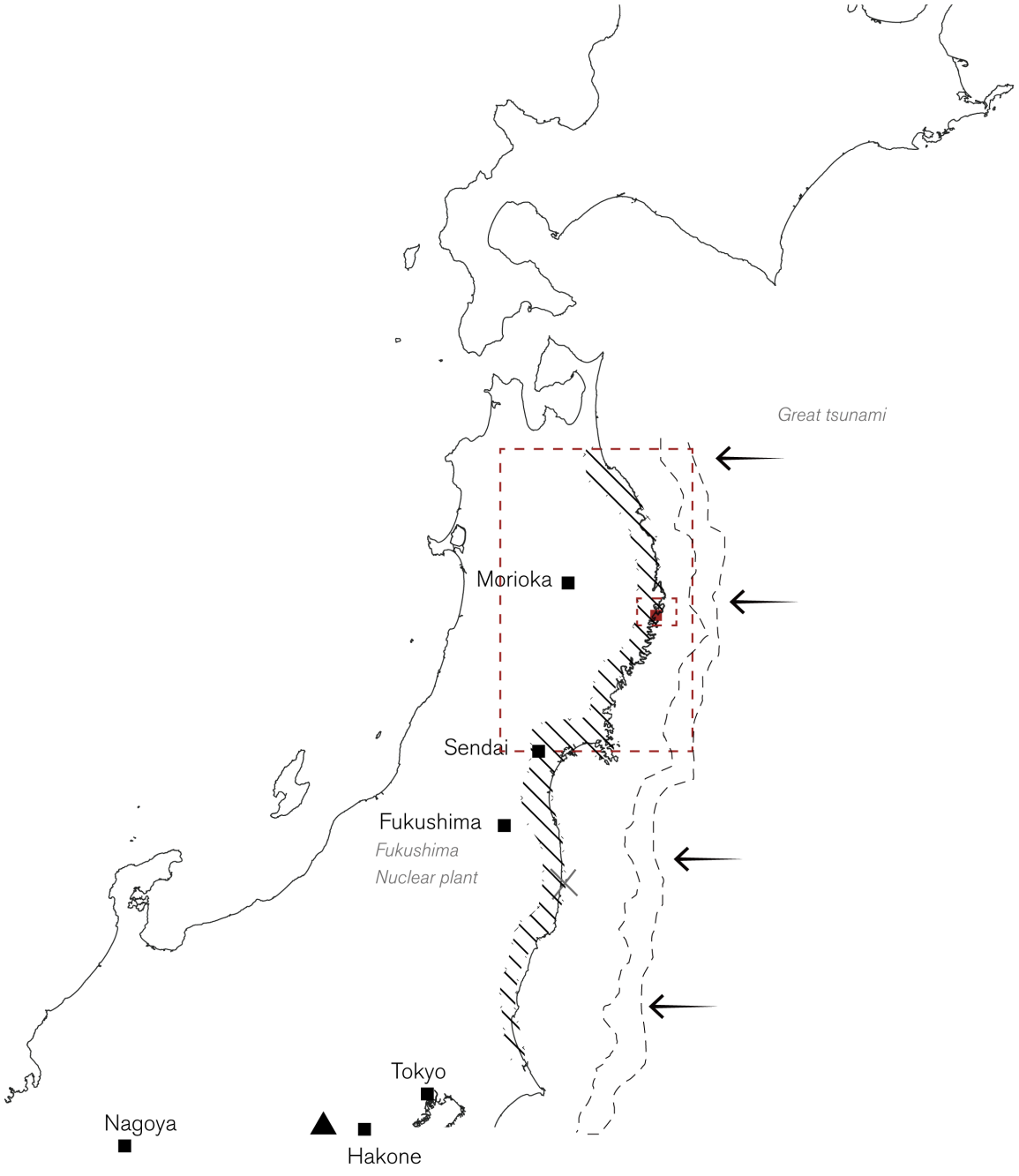
Since suffered the effects of a tremendous tsunami in 2011, civil engineering reconstruction work is now progressing rapidly, from constructing coastal protection facilities to constructing various kinds of infrastructure and public facilities, etc. However, Concern has arisen about the deterioration of the ecosystem caused by the construction of embankments, landfills, and floodgates, as well as the fact that the inland water has become disconnected from the sea due to the formation of the huge tidal breakwater. (Endo, A., & Oh, T. (Eds.). (2018).)There is a danger that any civil engineering reconstruction project might destroy the attractiveness of the region cause disruption to future town management. Furthermore, economically, The Tohoku earthquake and tsunami swept through the city, destroying all fishing boats and completely wiping out the town's sea farm industry, which makes the already shrinking fisheries even harder to sustain. Also because of the construction of a seawall, the accessibility to water and ocean will be limited, changing social and economic patterns to a certain degree.

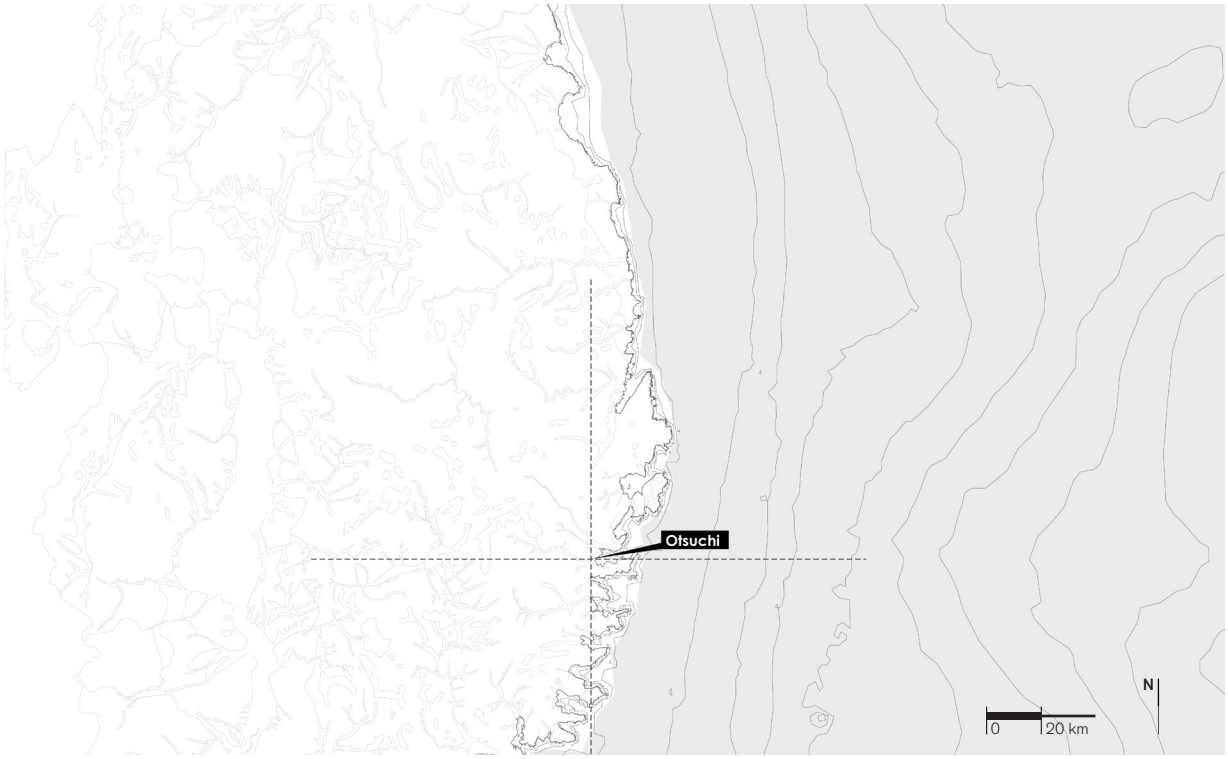
Location

Otsuchi (大槌町, Ōtsuchi-chō) is a town located in Kamihei District, Iwate Prefecture, in the Tōhoku region of northern Japan. As of 1 March 2020, the town had an estimated population of 11,572 and a population density of 58 persons per km² in 5308 households.[1] The total area of the town is 200.42 square kilometres (77.38 sq mi).Located along the mid-point of the coastline of Iwate Prefecture, Otsuchi is blessed with abundant nature. Gorgeous mountains, coastal inlet areas, numerous historic sites and ancient temples – the town is full of attractions.



Scale definition





Territorial Scale

1-50000



Meso Scale

1-5000



Urban Scale

1-25000



Local Scale

1-5000

Actors and Stakeholder involved

During the reconstruction process,stakeholder need to be involved,where the national and local government,communities,NGOs,and the private sector are all know their role.It is also important to understand the responsibilities of various institutions with respect to coastal structures. The national government has an authority to build the structures, while the prefectural government is given the responsibility of management. The municipal government has no authority to modify the structural design, while the environmental considerations and community participation are required.

The central Disaster Management Council prepared The Basic Disaster Management plan which is the master plan clarifies the duties of the central government, public corporations, and local governments in implementing measures.

Iwate prefectural governments designate the multifunctional facilities, allowing concerned organizations to initiate coordination under a new tsunami Disaster risk management.

civil engineering department of Iwate Prefecture provide the valuable information exchange on some reconstruction projects.

The municipal government plays a fundamental role in disaster ,it is responsible for establishing a local disaster management plan, emergency operations such as warning systems, issuing evacuation recommendations and orders, and flood fighting and relief activities.

Local governments also conducted countless negotiations and coordination with national and prefecture governments,as well as collaborated with numerous key actors in reconstruction,such as NGOs,universities , the private sector,and most importantly,their residents.

Local communities play a key role in preparing for disaster events,and are normally the first responders to take action.(Ranghieri,et al ,2014) .Nongovernmental organizations (NGOs) and nonprofit organizations (NPOs) are involved in disaster risk management activities at the community level.The role of communities in DRM is formally recognized and supported by local and national authorities through linkages with local institutions.

Organizations for disaster management and other public sector organizations should coordinate to ensure that their public works are multifunctional whenever possible , and cost-sharing mechanisms should be developed to ensure that the financial burden is shared equitably.(Ranghieri,et al ,2014)

The Private sector plays a major role in creating employment and supporting the local economy,thereby ensuring regional sustainability.In this case ,private sector including,transportation companies, fisheries, electricity companies, water supply companies, etc.

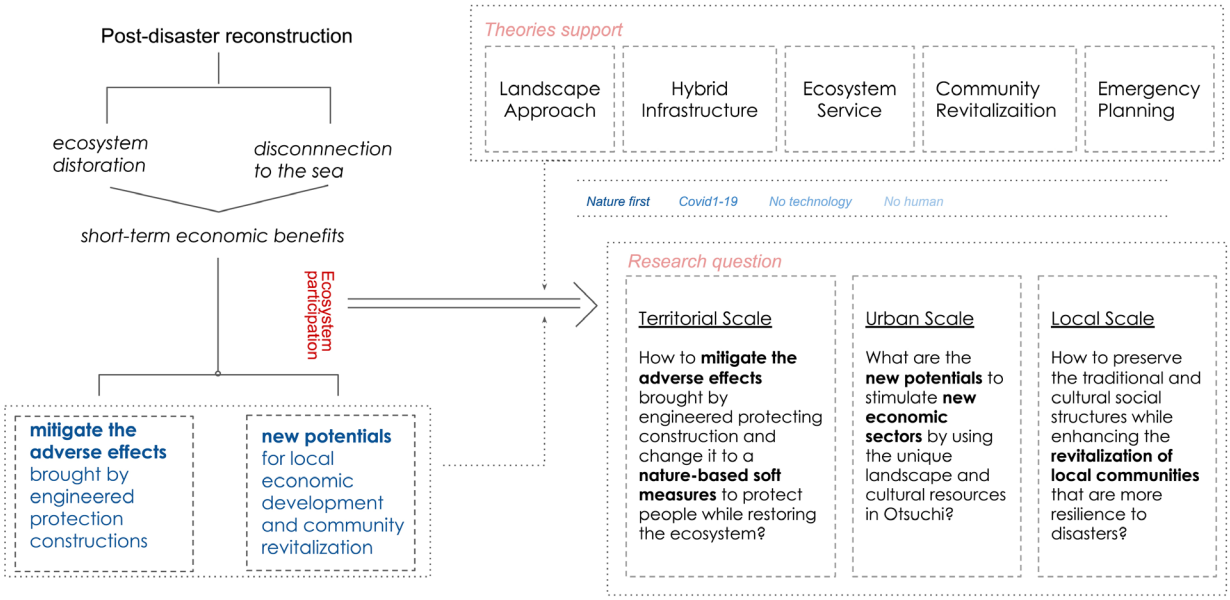


Fig.Planning organization of the basic reconstruction plan
Sourcee:Nakai, Y. (2013). Reconstruction plan of Otsuchi town, Kamihei county, Iwate prefecture. Journal of JSCE, 1(1), 242-250.

2.

Research Question & Theoretical framework

Conceptural framework



Aims of the Project

This project aims to gradually mitigate the adverse effects brought by engineered protection constructions both ecologically and socially by using more nature-based hybrid infrastructures to protect people from disasters while still keeping the function of the ecosystem, even adding more. A whole new landscape with a high level of diversity that integrates high-tech construction and natural processes will be created, and it will be robust to defend disasters and also eco-friendly. Apart from this, more values in the economic and social domain will be added to this new landscape.

The new add more identity and attraction to Otuschi town, and here lie the chances to develop new economy sectors, such as tourism featured with tsunami memory and nature-based infrastructures. What is more, with more protection and a more reasonable land use pattern, the fishing industry would be more resilient in the face of tsunamis. The ecosystem is not only existing in the coastal area as defense infrastructure but also can be little greenery scattered over the residential areas, such as backyards and community gardens. In this way, people can have more collective activities with their neighbors; older people can spend time with younger generations. With more interaction, people can build a relationship both with the community and the place they live. As a result, more sense of belonging and cohesion will occur.

Research Questions

Territorial Scale

How to mitigate the adverse effects brought by engineered protecting construction and change it to a nature-based and human-involving hybrid infrastructure?

Urban Scale

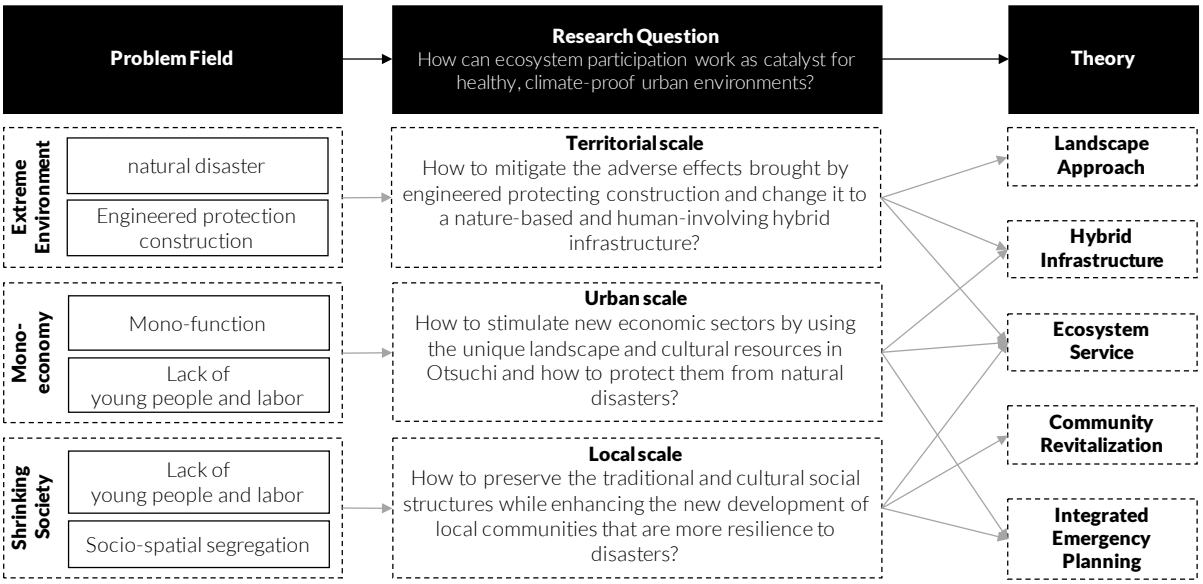
How to stimulate new economic sectors by using the unique landscape and cultural resources in Otsuchi and how to protect them from natural disasters?

Local Scale

How to preserve the traditional and cultural social structures while enhancing the new development of local communities that are more resilience to disasters?

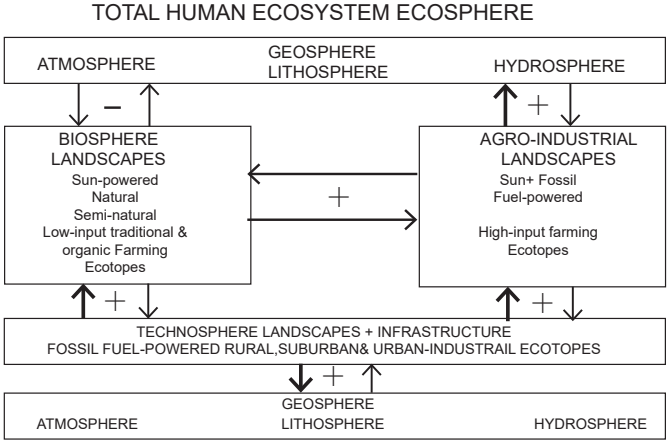
Theoretical framework

The theoretical framework is formulated based on the problem fields and research questions. From the problems in environmental, economic, and social domains and the perspective of ecosystem participation, five theories were chosen to answer the research questions and to form the guidelines.



Landscape Approach: Landscape is able to connect, city to landscape, district to district, since it is a place of meeting and interaction. Properly designed landscape can function as a healer and a source of inspiration for a sustainable way of life and a just and liveable city (Koh & Beck 2006;19). A Unique kind of landscape that can reposition itself as a complex, instrumental system of essential services, resources, and processes. (Hung & Aquino,2013). This kind of landscape underpins contemporary urban economies and acts as a performative hybrid infrastructure.
Landscape, as corner notes, 'has come to assume deeper roles of contextualization, heightening experiences, and embedding time and nature in the built world'(Corner 1999:16). A landscape approach, Koh states is that (Koh, 2008) accepts the evolution (rather than individual, egoistic, and willful invention) of the landscape as "ideas, cultural practices, and community". It is an integrative, dynamic, evolutionary approach that seeks field immersion for complete, aesthetic understanding and leads to emergent design.
A landscape approach centers on the (holistic) landscape. The holistic of the system state by a biologist (Weiss,1969,pp.10-11) as follows:"
The whole is more than the sum of its parts". Hence, the holistic landscape here is the whole system of nature, culture, processes, time, space, time, experience, and interaction. Designing with the landscape approach means that we recognize the landscape as a source of a method, as an operating method and practice, liberating design from the architectural approach.
Within the landscape approach, it is subordinate to landscape processes. Koh(2005:8) states it as; a landscape approach to form, in contrast to a focus on composition a typology,' seeks a morpho-genetic approach. It sees form as a result of an adaptation process and lets form emerge rather than imposing it.' Therefore it is an open-ended and adaptable process, during which it more 'responsive to evolutionary change, context and human culture, making it durable and resilient.'(Koh,2005:8)

When we see landscape as 'How' we design ,then the design process shift from statics,demarcation and final images to movement, change , dynamics, growth and evolution.It becomes design in transforming,creative and evoving .



Refference: Model of the total human eecosystem ecosphere (Naveh,2000)

Hybrid Infrastructure:

The way of mitigating nature hazard has changed form built infrastructures to hybrid infrastructures due to the theory and thought of ecosystem participation. For built infrastructure, the advantages are that it could effectively protect communities, but its effectiveness decline over time and can not adapt to the future change of climate and environment. Therefore, the natural ecosystem, including forests, wetlands, and mangroves, can help increase natural resilience and mitigate the effects of climate change (Executive Office of the President, 2013), there is significant potential for natural ecosystem to play an important role in reducing natural hazards such as storm and flooding (Sutton-Grier, et al, 2015). Thus, the hybrid infrastructure is to combine the built infrastructure and natural ecosystem to mitigate hazards from extreme environments and to restore the ecological environment.

This approach is recommended not only because it could combine the advantage of built infrastructure and natural ecosystem, but also because simultaneously it provides many valuable co-benefits to social, environmental, and economic objectives (Sutton-Grier, et al, 2015). Recently, the New York City and Boston have been aggressively researching options to protect the city by hybrid infrastructure, by “The Coastal Green Infrastructure Research Plan for NYC” (Zhao et al., 2014) and “Designing with Water”(Aiken et al., 2014).

In “The Coastal Green Infrastructure Research Plan for NYC” to provide protection and enhance resilience to hazards, while also providing a suite of co-benefits. This plan includes six approaches that combining built infrastructure and natural ecosystem. The six approaches include: constructed wetlands and maritime forests; constructed reefs; constructed breakwater islands; channel shallowing; ecologically enhanced bulkheads and revetments; and living shorelines (Zhao et al., 2014).

Social Resilience

A healthy (resilient) community provides not only sustainable energy, food, and good natural environment, but also the sufficient traditional culture atmosphere and social coherence (Japan Satoyama–Satoumi Assessment 2010). The biggest challenge of community revitalization is how to strengthen ecosystem capacity, in order to support the social and economic development in this area. The foundation of this strategy is traditional rural territorial and coastal landscape, which is the key element of the relationship between human and the surrounding area where they live. Those two kinds of landscape provide a series of ecosystem service for human society (Saito and Shibata 2012, p. 26).

In historical agriculture, fishery and forestry, a great number of related traditions and rituals emerged, and some of them still exist until today, which take a large part of human leisure. Therefore, build resilience should not only focus on resilience of local ecosystem, such as wildlife protection, biodiversity, and renewable energy. Revitalization of culture and build the identity of community is also of permanent importance.

Above all, some suggestions are proposed for community revitalization:

1. Transformation to sustainable agriculture, forestry, and fishery.

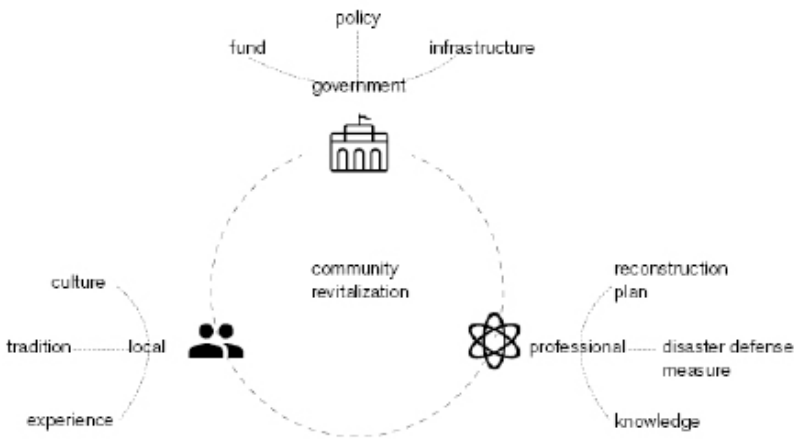
2. Linkage between traditional rural territorial and coastal landscape is helpful to strengthen the relationship between residents and the surrounding environment.

3. Decision maker from different level should use holistic approaches to achieve revitalization.

4. The voice from local level should be heard, because the locals are more familiar with the surrounding environment, and they are who will really live here.

5. Public participation should be considered not only for labour and economic benefits, but also for promoting social coherence and build up a sense of belonging (Kohsaka et al. 2013).

6. All measures should be carried out in the communication between various parties, and continuously optimized and improved according to the implementation effect (van



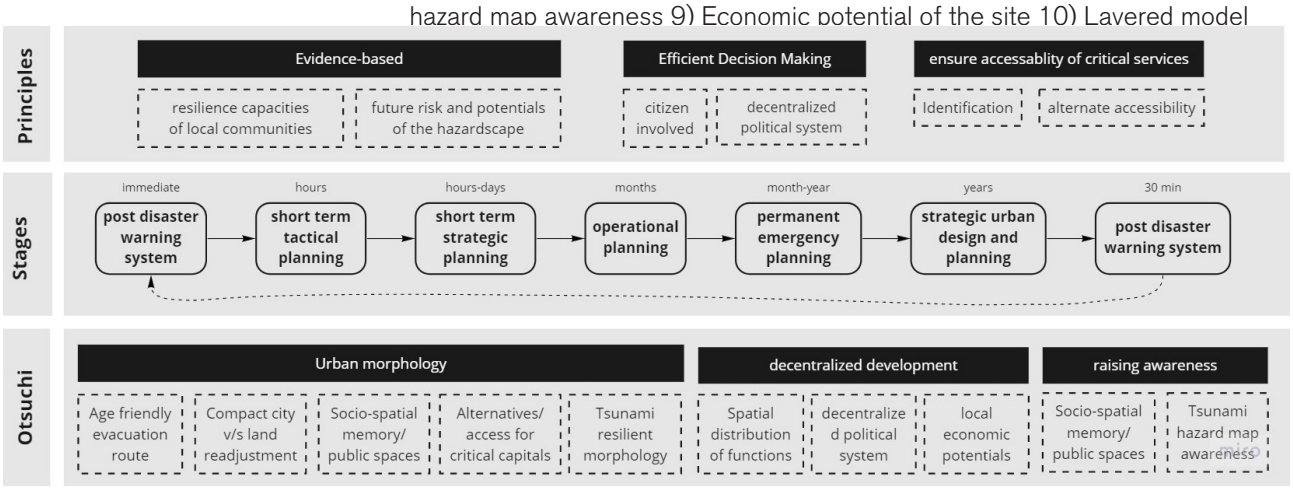
Intergreted Emergency Planning

Integrated emergency planning is needed in Otsuchi area to formulate an immediate and yet continual recovery process and strategy than can reduce the likelihood of lives and social capital in a disaster while planning for the post-disaster recovery activity (Mujumdar, 2019) By emergent it means the strategies that are specific to the hazard scape and which further in the planning stage can be strategically improvised(Wiechmann, 2007). in order to make the right decisions immediately and effectively, three kinds of background information are needed to make integrated and site-specific planning, the natural process of hazardscape, the resilience capacity of local communities, and the critical capita. (Mujumdar, 2019)

Several principles of integrated emergency planning are mentioned in the literature review, and here follows the list of them. Firstly, the identification of critical services and alternate accessibility is needed. Secondly, efficient decision making based on a decentralized and citizen involved political system is vital to take immediate action in the face of disasters. Also, these decisions should be evidence-based and rational, which calls for available data backups. Thirdly, the recovery and reconstruction plan ought to be built upon assessment of future risk and potentials of the hazardscape and resilience capacities of local communities. (Mujumdar, 2019)

Since the situation keeps changing, especially in hazardscape, emergency planning should be able to evolve over time. Long-term planning is supposed to be integrated with an immediate warning system. Several stages are defined in the literature review, the warning system right after a disaster, short term strategic planning, long-term permanent emergency planning, and pre-disaster warning system for future events. Proposing this planning in a long-term way creates decision clarity, resource maximization, risk analysis, contingency planning, and faster in reaching normalcy(Alexander, 2013). (Mujumdar, 2019)

Based on the specific conditions in Otsuchi, Mujumdar(2019) also gave principles that are particular to this area. (Mujumdar, 2019) 1) Age-friendly evacuation 2) Tsunami resilient morphology 3) Spatial distribution of functions 4) Transitional housing as a typology 5) Compact city v/s land readjustment 6) Multiutility transit systems 7) Socio-spatial memory/ public spaces 8) Tsunami hazard map awareness 9) Economic potential of the site 10) Layered model



3.

Critical Cartography

Process of collecting data

To form a scientific-based research project. Different phases of collecting data and information are used. We start to formulate an overview of knowledge from the lecture. And literature review in various topics covering the general part of how ecosystem participation works as a catalyst in an extreme urban environment. Which helps us targeting the main theme and theories valuable for our project. They reflect later on our guideline of the project area.

As group work, data was collected from the perspective of systems, landscape, ecology, anthropology, and urban to integrate into a comprehensive data collection. The data also be translated into maps diagrams or text interrelate into three scales:1:5000 covering the most are of Iwate prefecture,1:25000 covering the neighboring towns,1:5000 scale covering main part were affected by the tsunami.

As mapping is an important tool for an urbanist. We use several databases to grasp essential information and answer to per perspective. Gis data from the Geospatial Information Authority of Japan was used for context analysis. Furthermore, to have supportive information, Books, academic research, government reports, news reports, students' works, etc, were collected to develop science-based research.

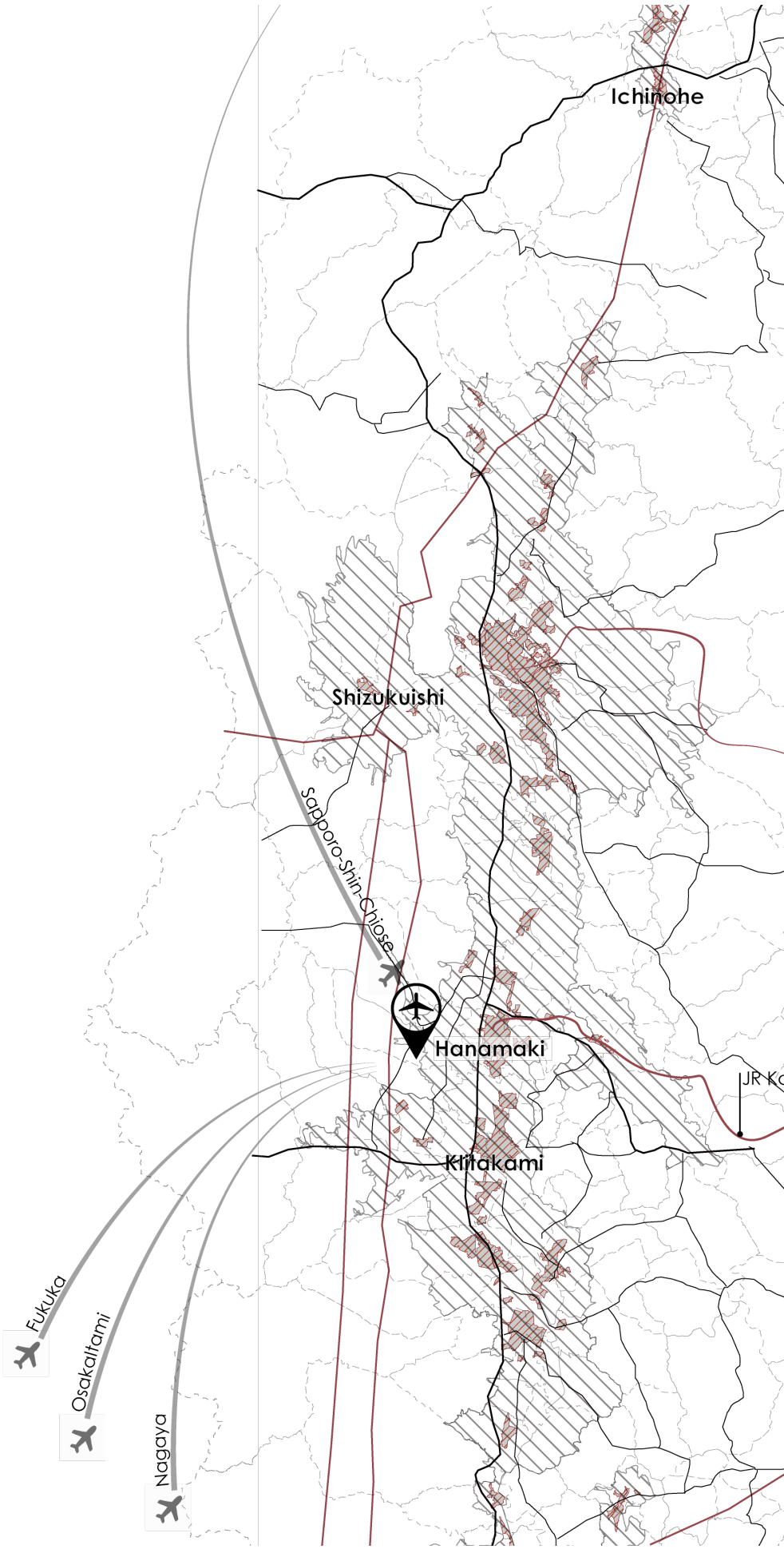
3.1.

Systems of Systems

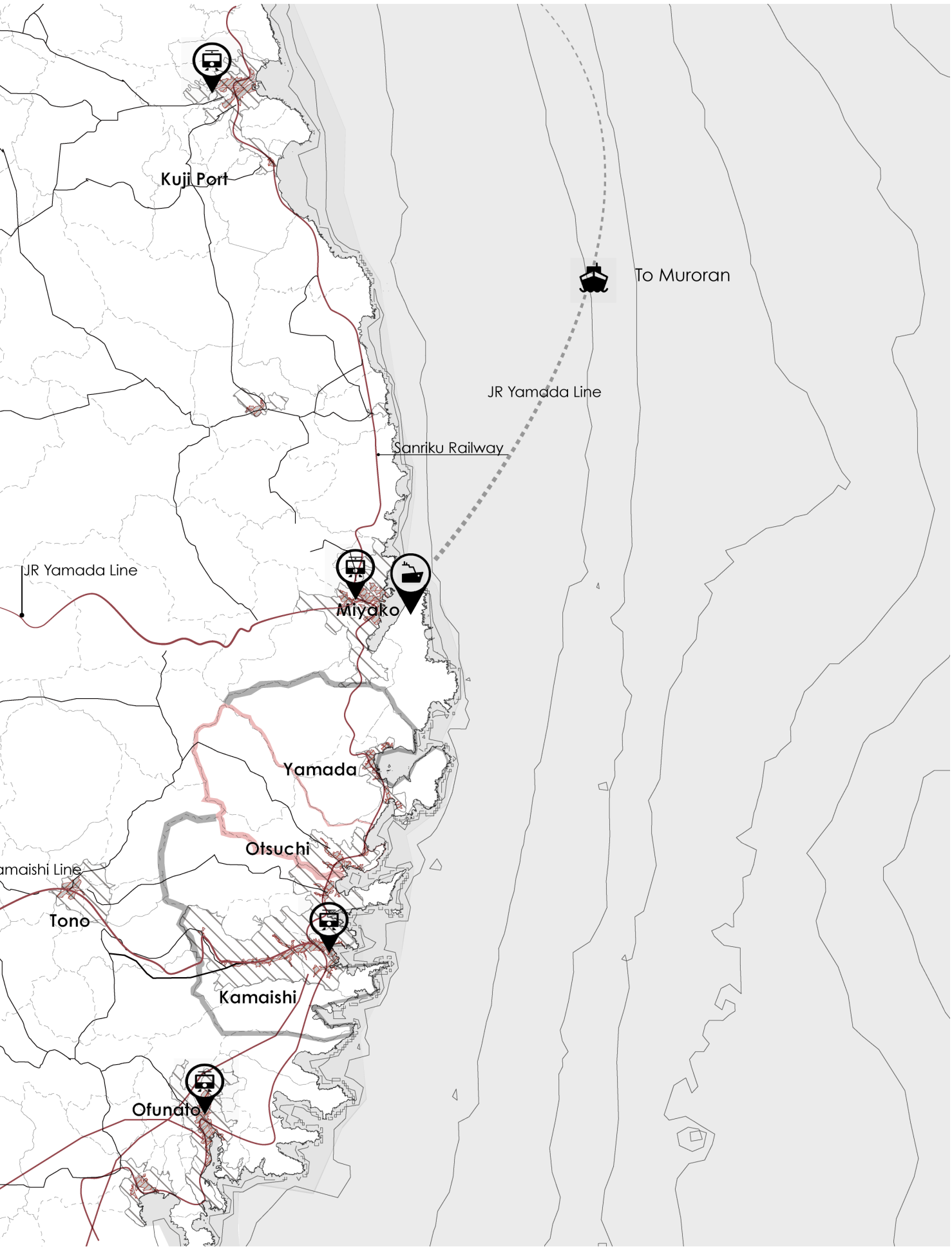
BOUNDARIES_/REGIONAL SCALE

Transport network & Administritive boundaries & Urban area

Otsuchi is located in Iwate prefecture.The prefecture is divided into three parts.The east part is made up mostly of seaside towns and cities that are heavily reliant on the fishing and marine products industries.



- Administritive boundaries
- Urban area
- Population densed area
- Rail way
- Expressed way
- High way



Data source:Geospatial information Authority of Japan,Gis data



SYSTEM OF SYSTEM

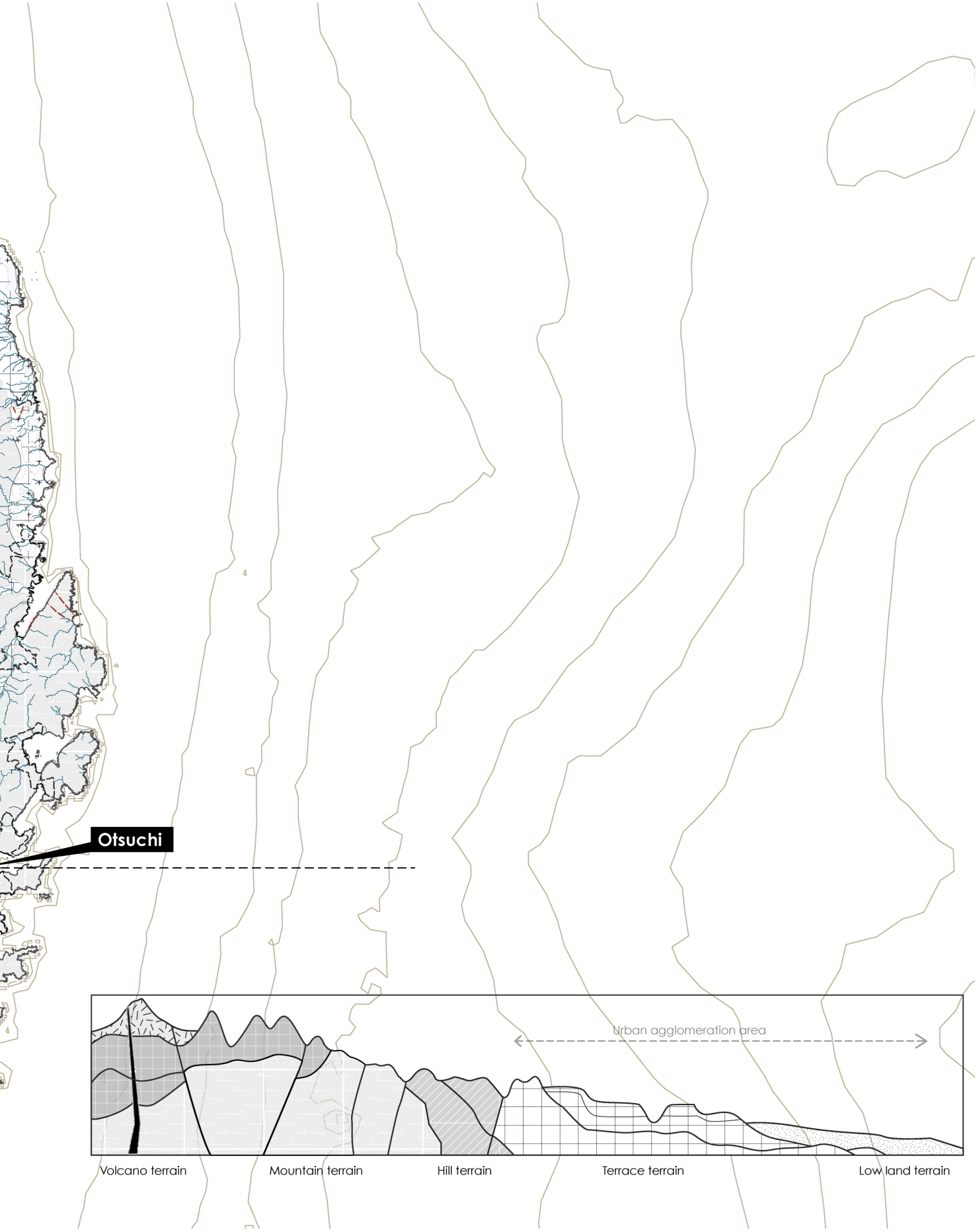
BOUNDARIES_

The most inland part of the prefectue encompasses both wide streches of farming land lying in the basin of the Kitakami River,and Iwate's major cities. Otsuchi town lies on relatively flat ground,wih mountain forests.On the other hand, This mountainous strip cuts off the coastal region from the prefectu-re's main citirs, adding large obstacle to the area's post-tsunami recovery.

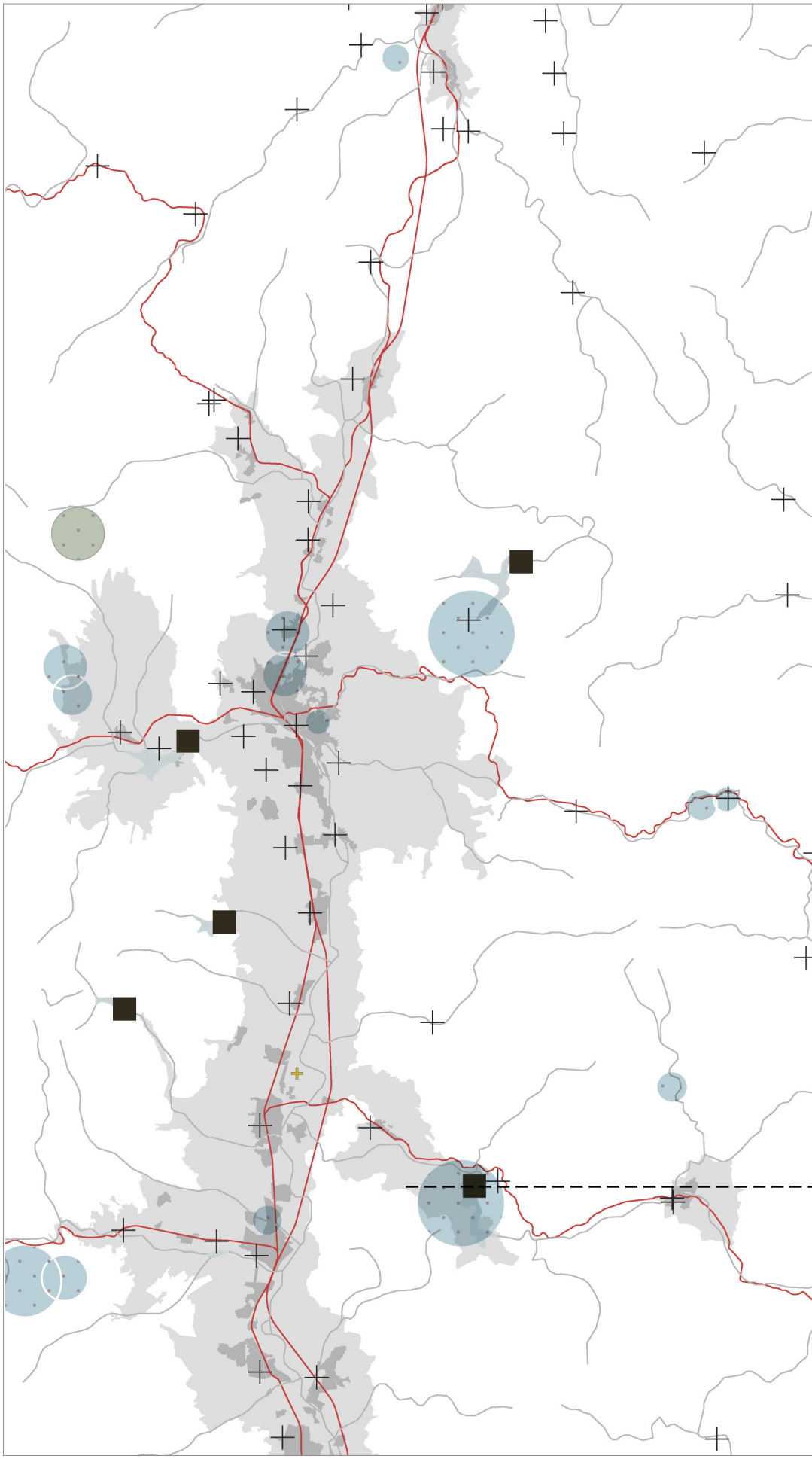
- High-relief mountains
- Moderate-relief mountains
- Small- relief mountains
- High undulating hills
- Terrace
- Volcanic land
- Low land
- Fault line scarp
- Urban area
- Stream

N

0 100 km



Data source:Geospatial information Authority of Japan,Gis data



SYSTEM OF SYSTEM

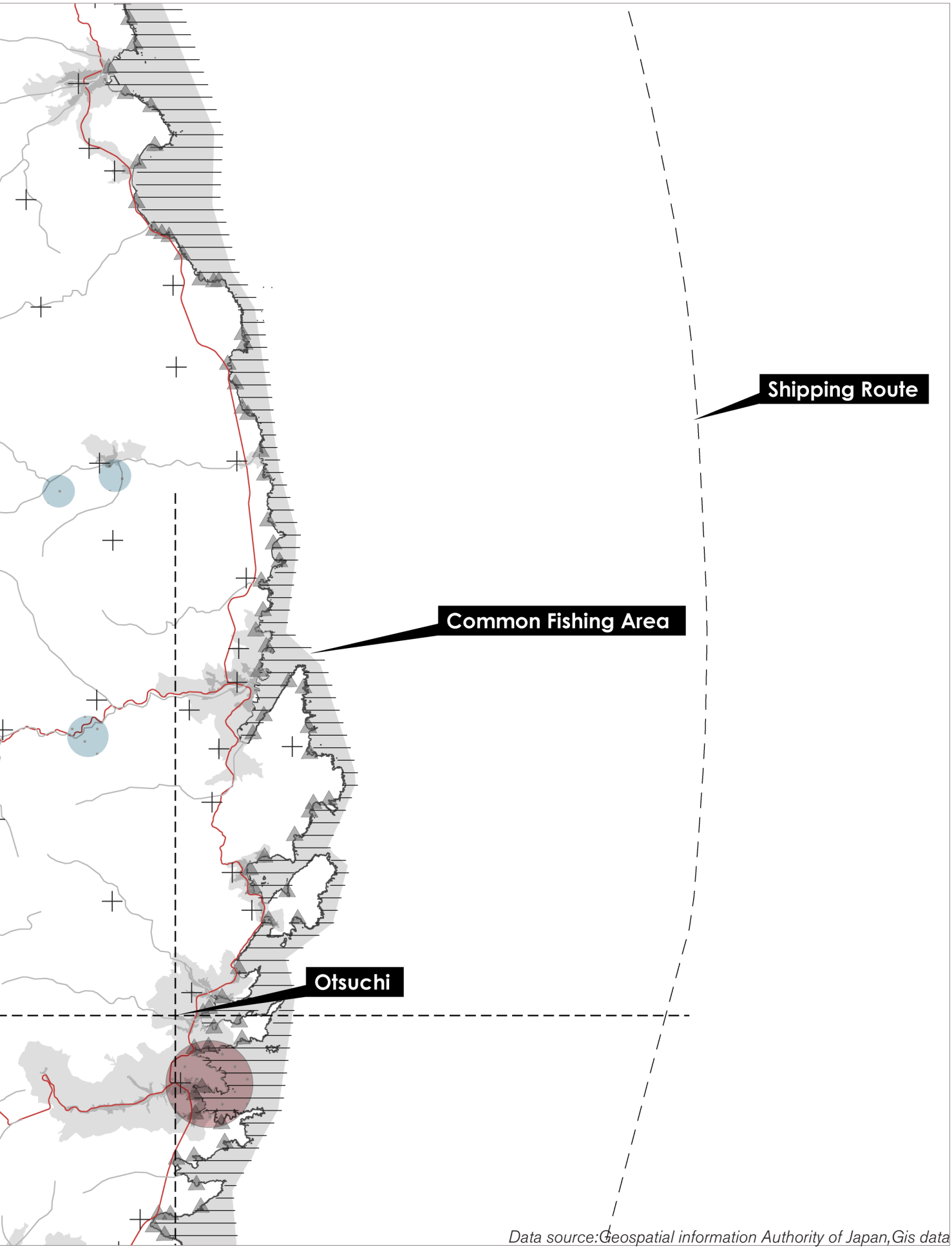
CRITICAL INFRASTRUCTURE

Landform Morphology & water network
& Urban area

- Local government location
- Fishing port
- Dam
- Railway
- Common fishing area
- Stream

N

0 100 km

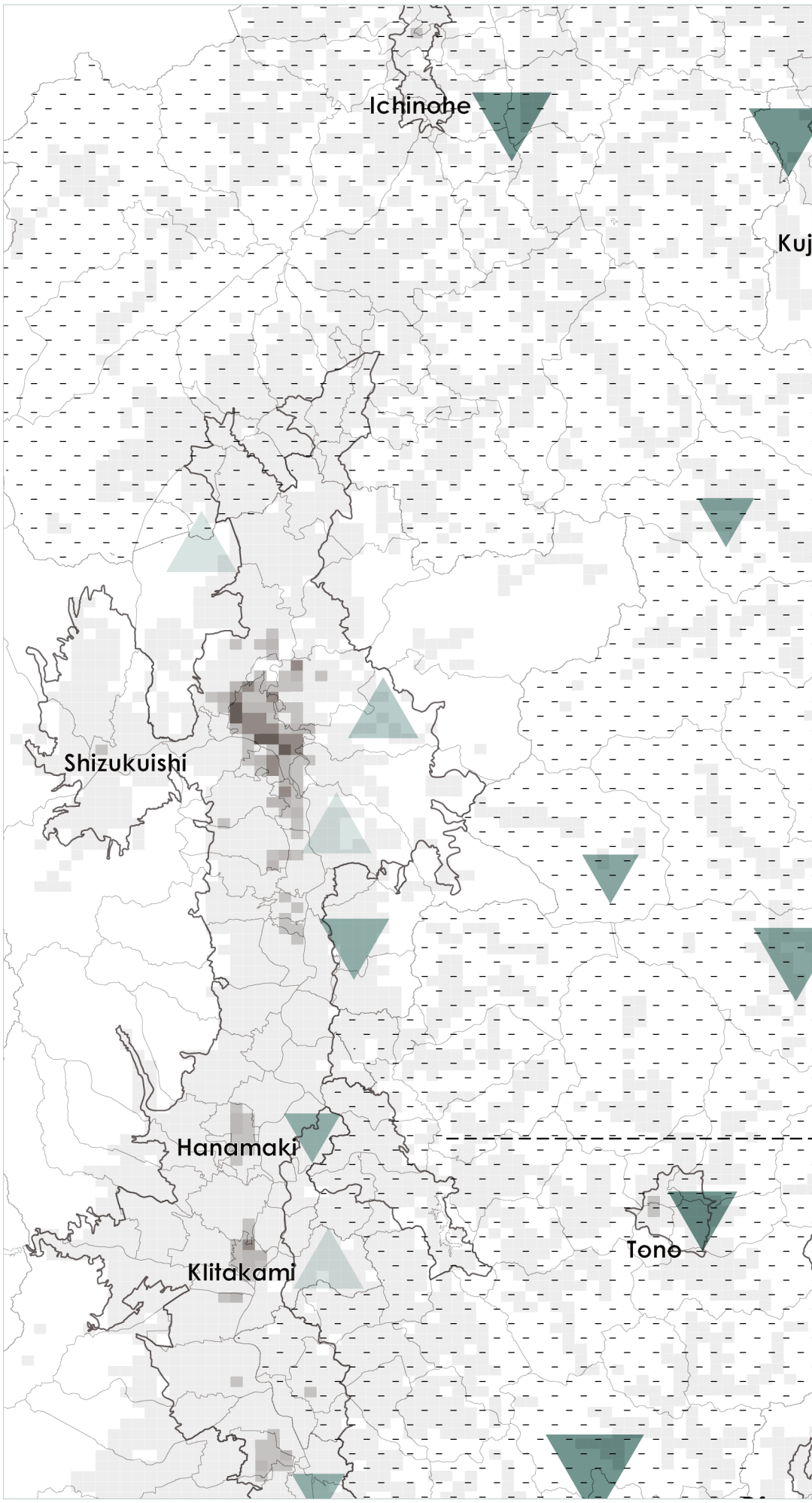


Data source:Geospatial information Authority of Japan,Gis data

SYSTEM OF SYSTEM

BOUNDARIES_

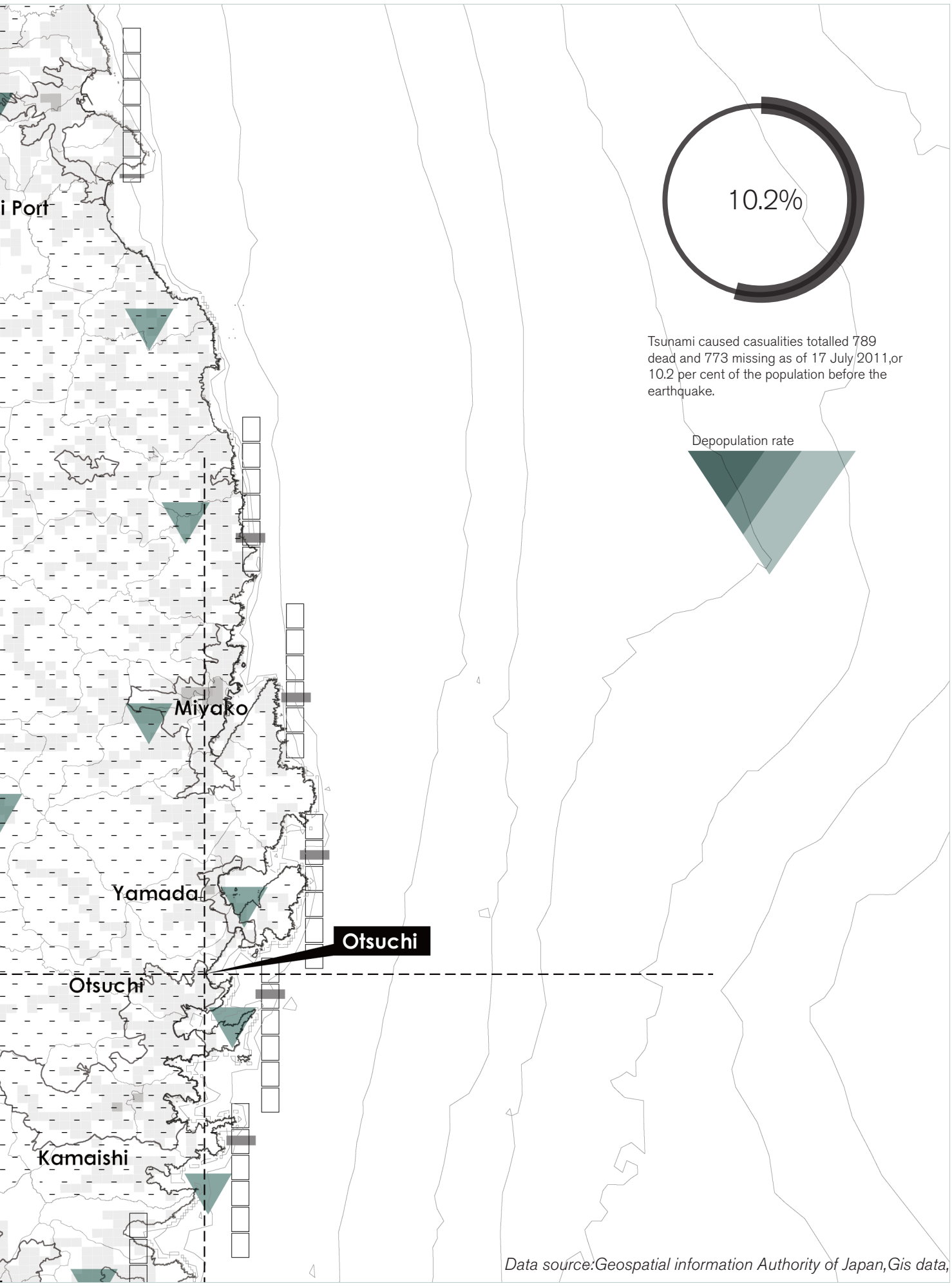
Demographic characteristic
Cities in Tohoku were shrinking rapidly much before the tsunami happened. The tsunami made it more evident.The number of missing and dead in Otsuchi totaled more than 1,200,or about 10% of the town's pre-quake population.

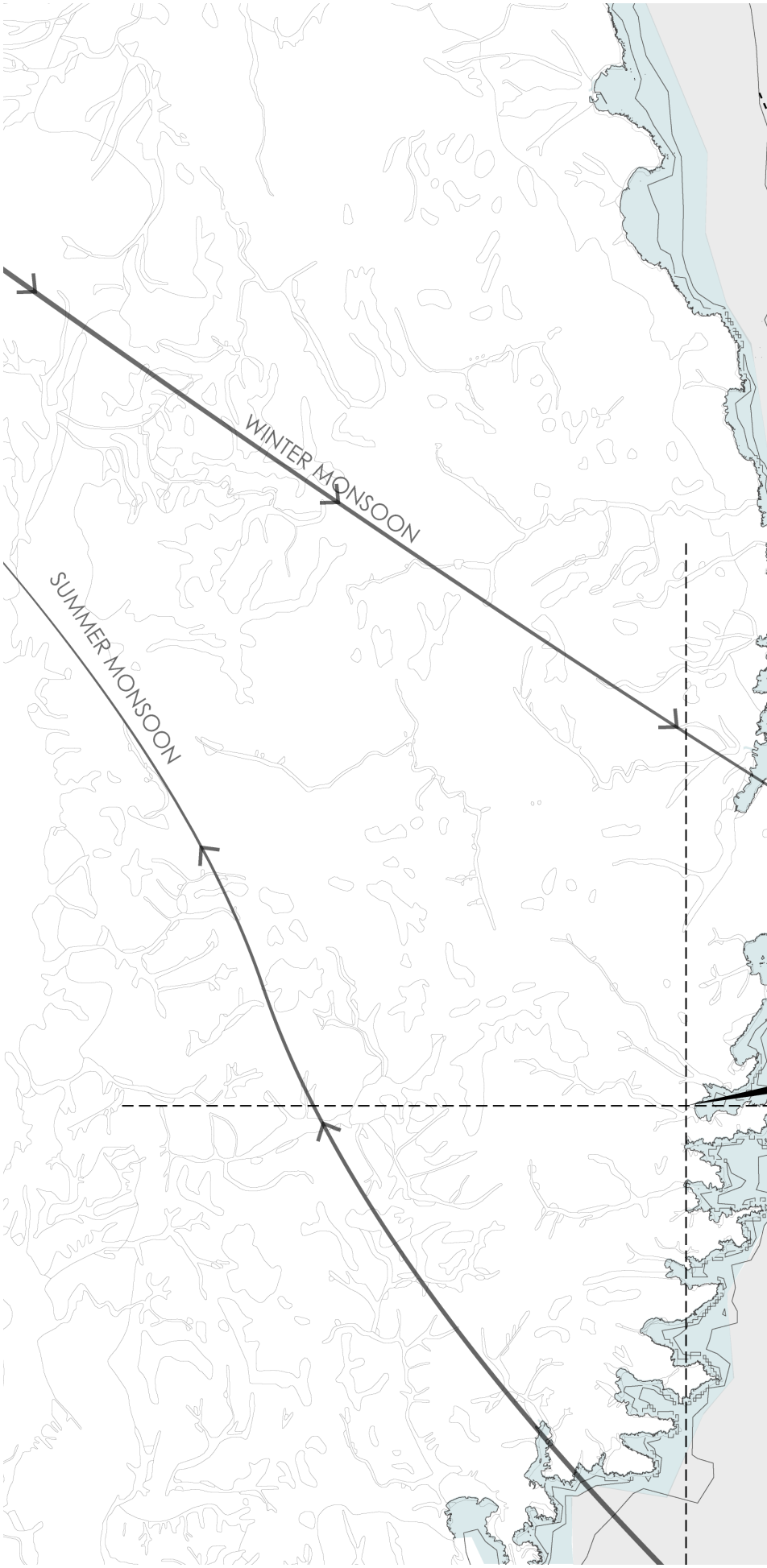


- Depopulation area
- Urban area
- Casualties (per block means 200)

N

0 100 km


i Port
Miyako
Yamada
Otsuchi
Otsuchi
Kamaishi
10.2%
Tsunami caused casualities totalled 789 dead and 773 missing as of 17 July 2011,or 10.2 per cent of the population before the earthquake.
Depopulation rate
Data source:Geospatial information Authority of Japan,Gis data,



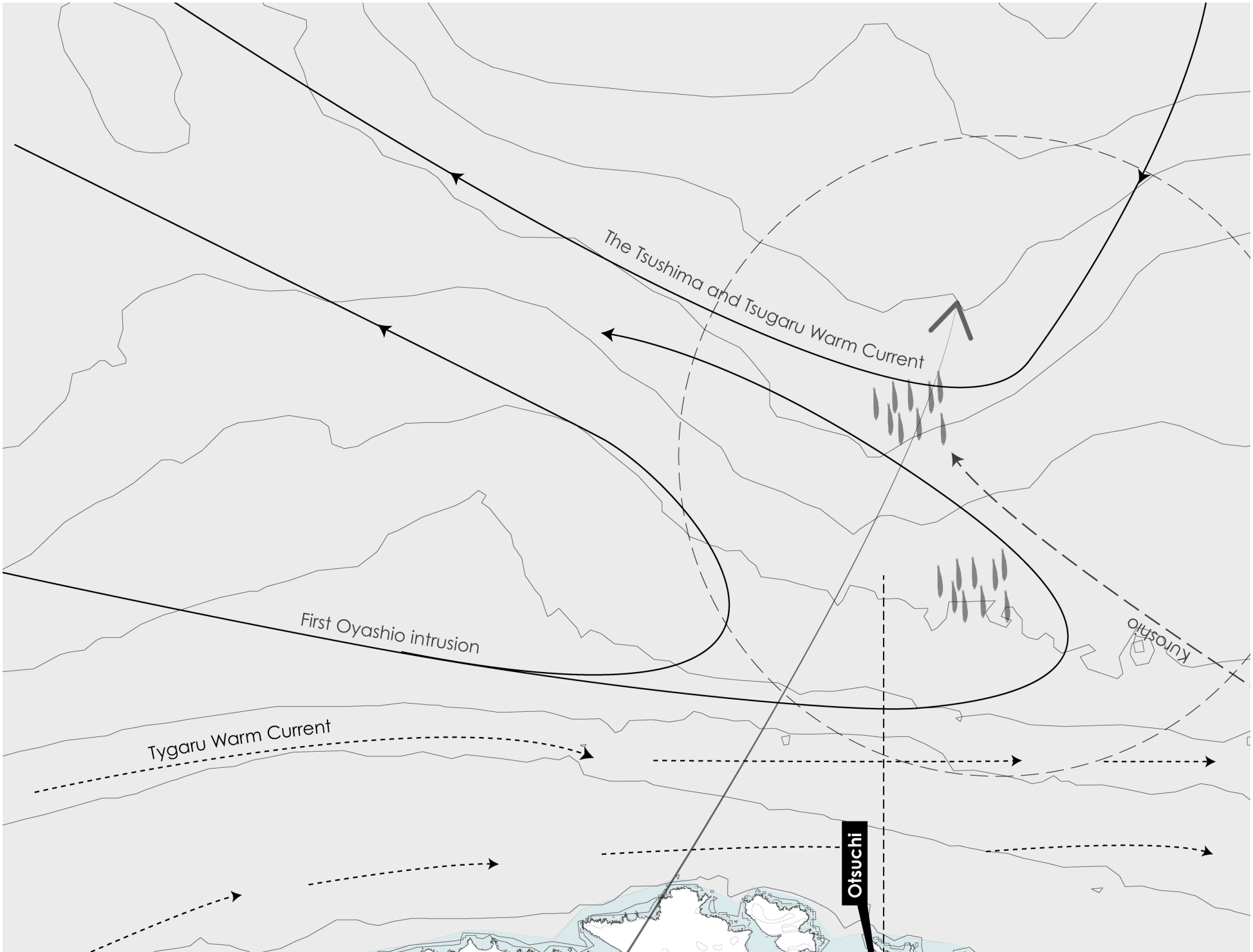
SYSTEM OF SYSTEM

Current & Wind direction_

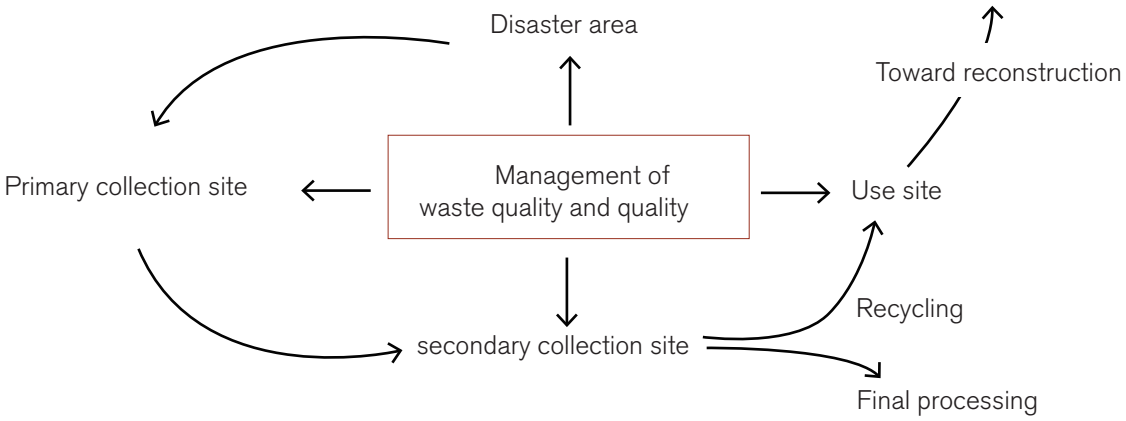
In this area, many currents intersect. There is the Kuroshio current from the south, the Oyashio current from the north, and the Tsugaru warm current that flows in from the Tsugaru Straight by the Sea of Japan. These junction lines provide a perfect breeding ground for plankton which feed a variety of fish that are also brought in from the currents。

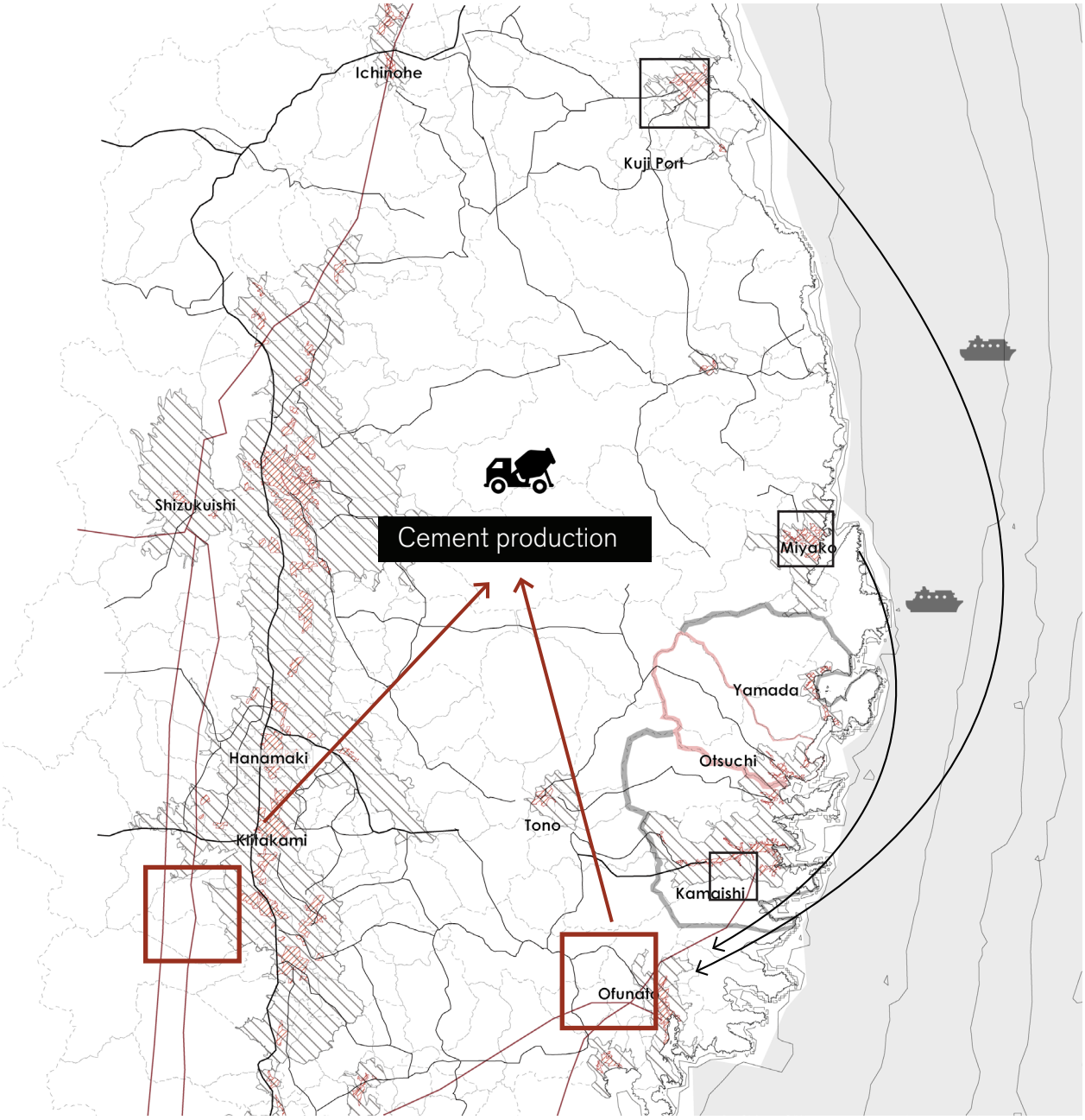
High-relief mountains
Moderate-relief mountains
Small- relief mountains
High undulating hills
Terrace
Volcanic land
Low land
Fault line scarp
Urban area
Stream

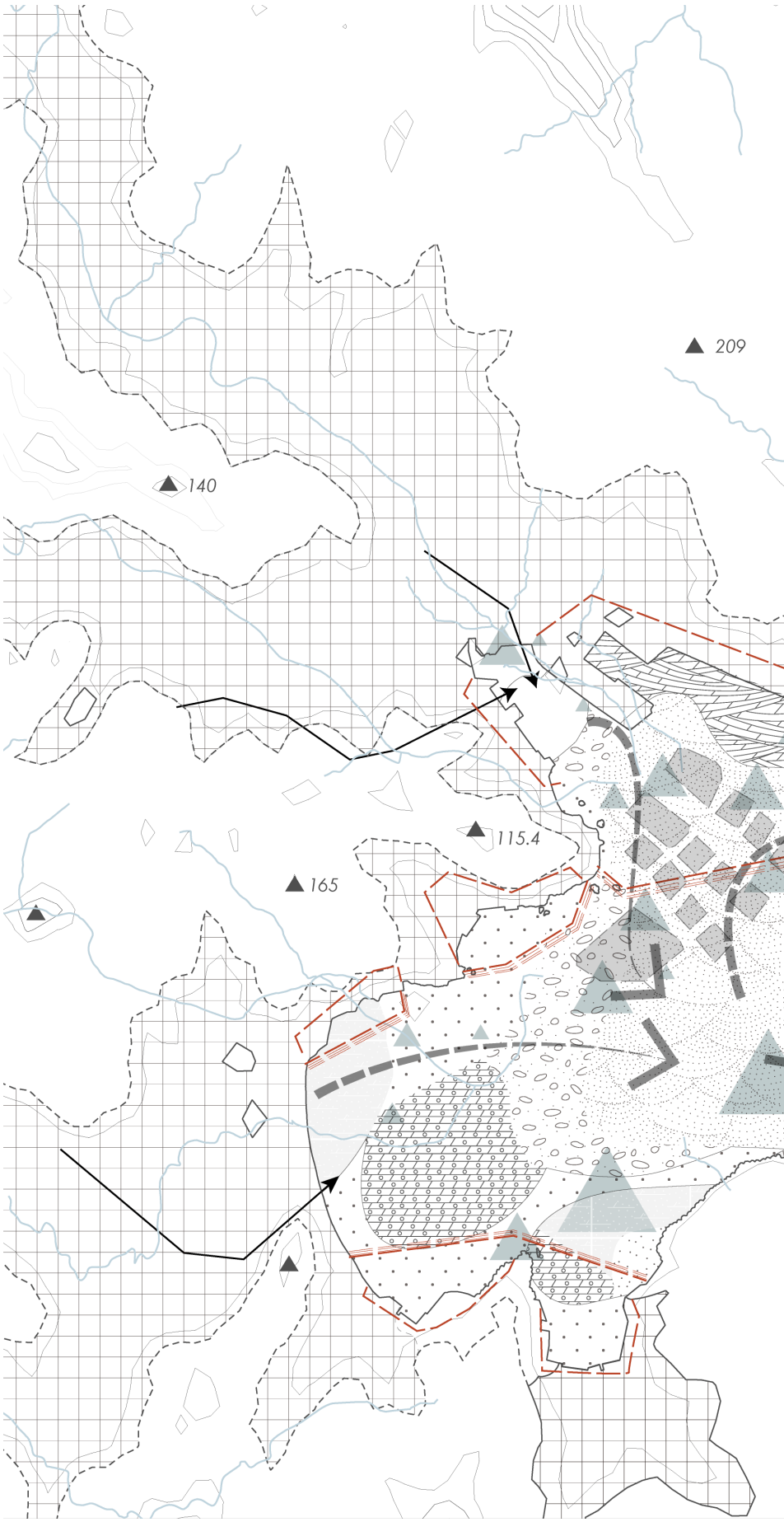
N


The Tsushima and Tsugaru Warm Current
First Oyashio intrusion
Kuroshio
Tygaru Warm Current
Otsuchi

Frame work for processing earthquake debris in Iwate prefecture







SYSTEM OF SYSTEM

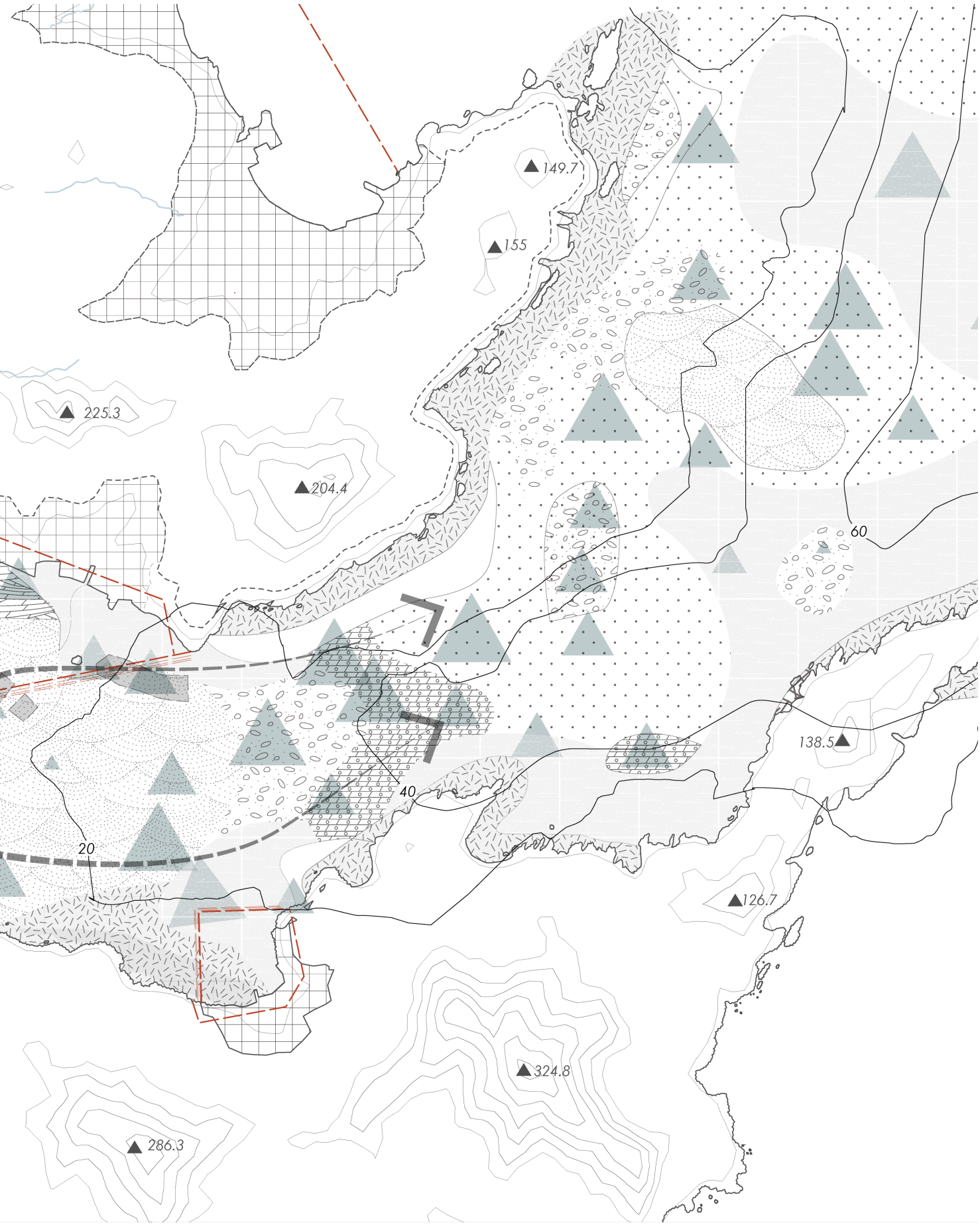
Marine environment & ecosystem

In Otsuchi Bay, the dynamic stste of the seawater inside and outside the bay was clarified.*(Santiago et al,2018)*
Iwate's coastal towns were renowned for their vibrant fishing industry, which resulted from the convergence of the Kuroshio Current from the south and the Oyashio and Tsugaru currents from the north. *Komatsu et al. (2015)* showed that sea-grass and seaweed beds in Otsuchi were variably affected; thus, for example, the former growing by the bay's mouth were completely destroyed. Addressing the importance of the potential impacts of seawalls which will affect the existing fauna and flora.

- Rock
- Gravel
- Shell Sand
- Medium-fine sand
- Sandy slit
- Species diversity indices
- Marine farms
- Water flow
- Marine work area

N

Data source:Ikeya, N. O. R. I. Y. U. K. I., Zhou, B. C., & Sakamoto, J. (1992). Model



rn ostracode fauna from Otsuchi Bay, the Pacific coast of northeastern Japan. Centenary of Japanese Micropaleontology. Terra Scientific Publishing Company, Tokyo, 339, 354.

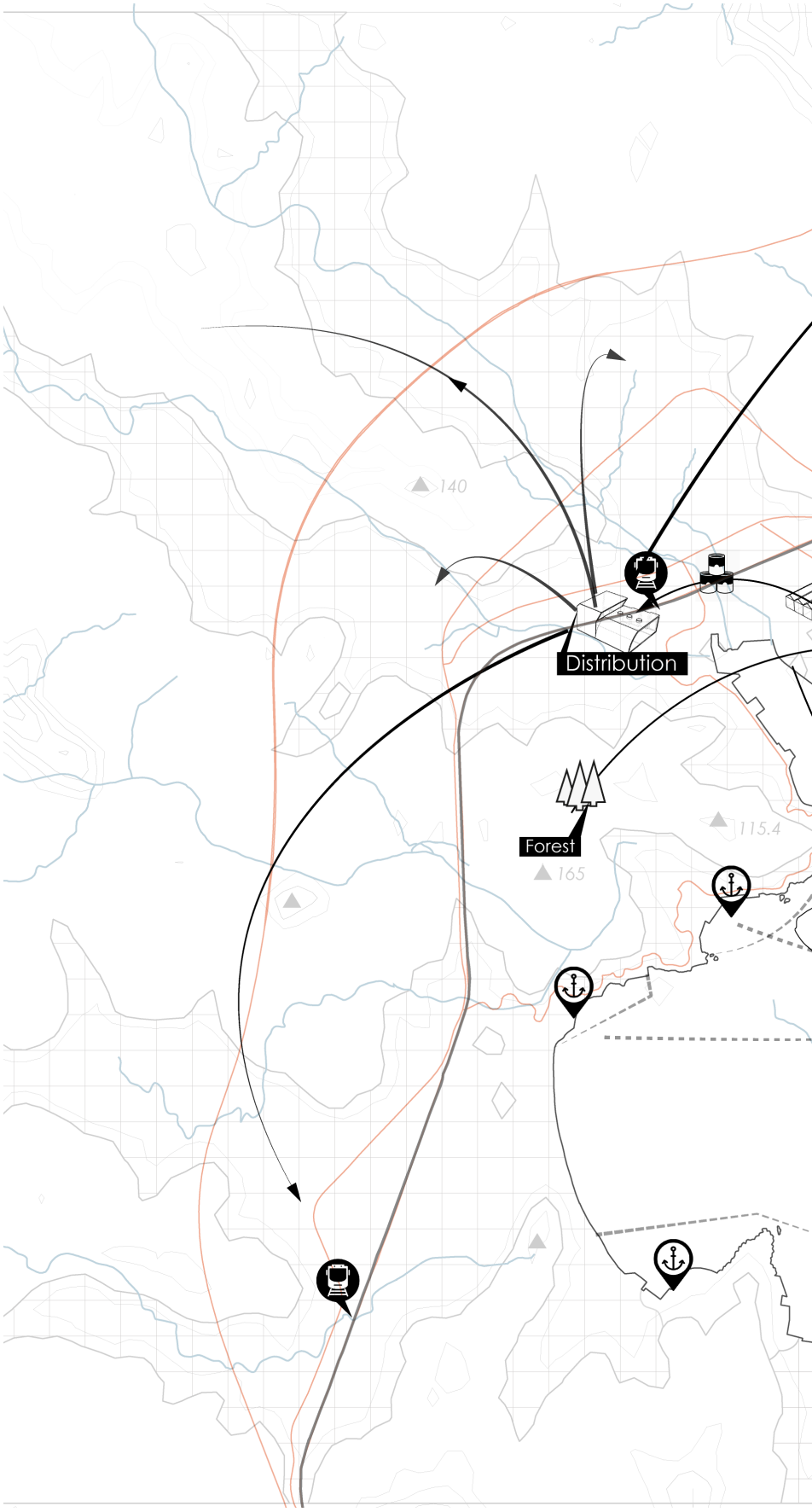
SYSTEM OF SYSTEM

Economic Flow of Otsuchi

The main industry is fisheries, with salmon being the most important target species.

The town is also famous as a habitat for three-spined stickleback(Gasterosteus aculeatus).The fishing industry of otsuhci,sonsists mainly of auaculture and fixed net fishing. In Iwate, the scale of each of aquaculture is relatively small,based around the family unit,and depends on nutritious elements that are carried into sea from the rivers.As the fishermen do not need to invest much for aquaculture,they could relatively easily recover from the loss of the fishing implements in the tsunami (Takezawa, 2016).

This coastal area of rural Iwate Prefecture has long lagged behind the rest of Japan. The average annual income in Otsuchi is 1.7 million yen, around $21,000, about 60 percent of the national average.In this fishing port, most of the work was either on fishing boats that worked local oyster, scallop and seaweed farms or in canneries and sea-food-processing plants along the wharfs. All were destroyed by the tsunami.



- High-relief mountains
- Moderate-relief mountains
- Small- relief mountains
- High undulating hills
- Terrace
- Volcanic land
- Low land
- Fault line scarp
- Urban area
- Stream

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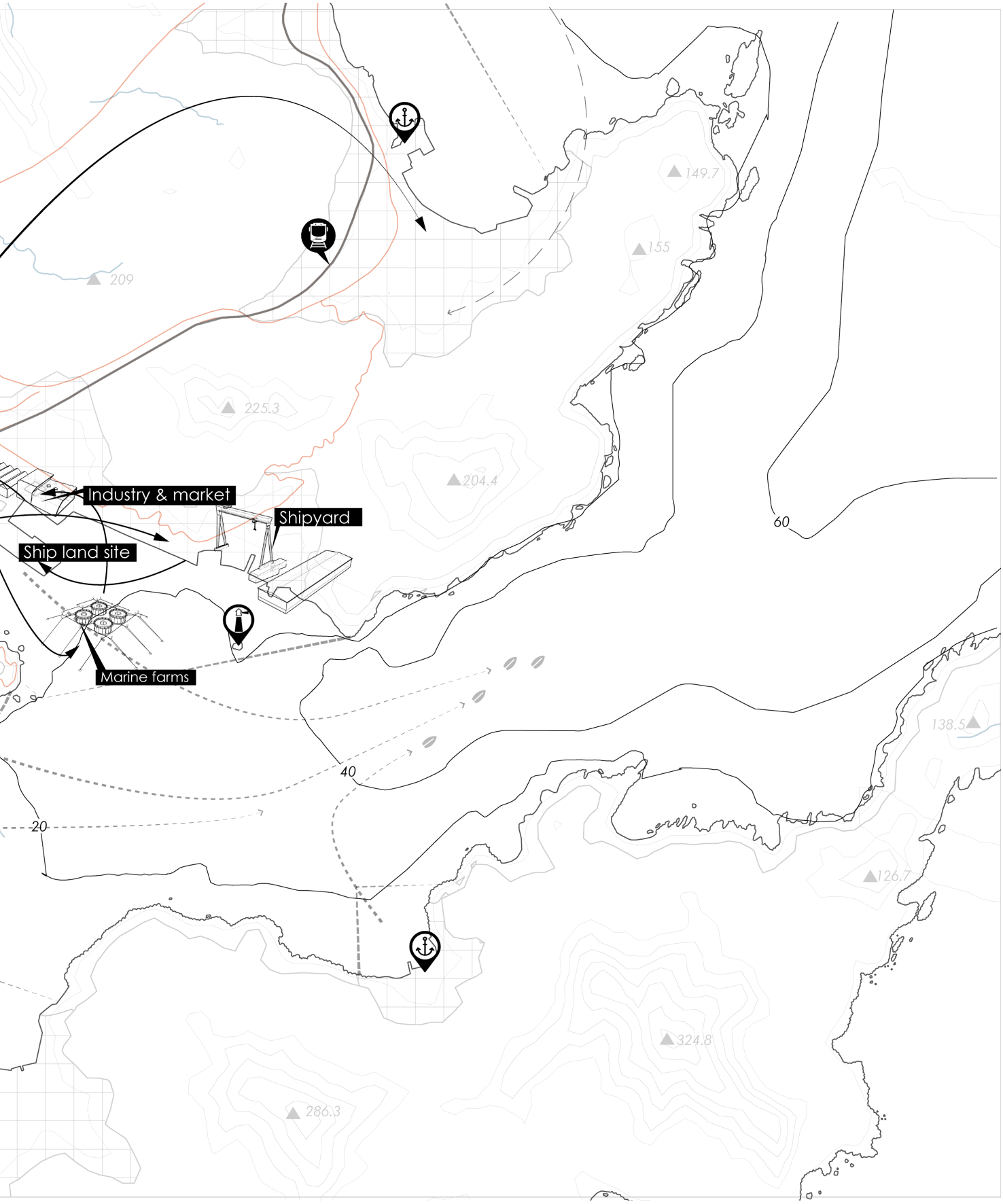
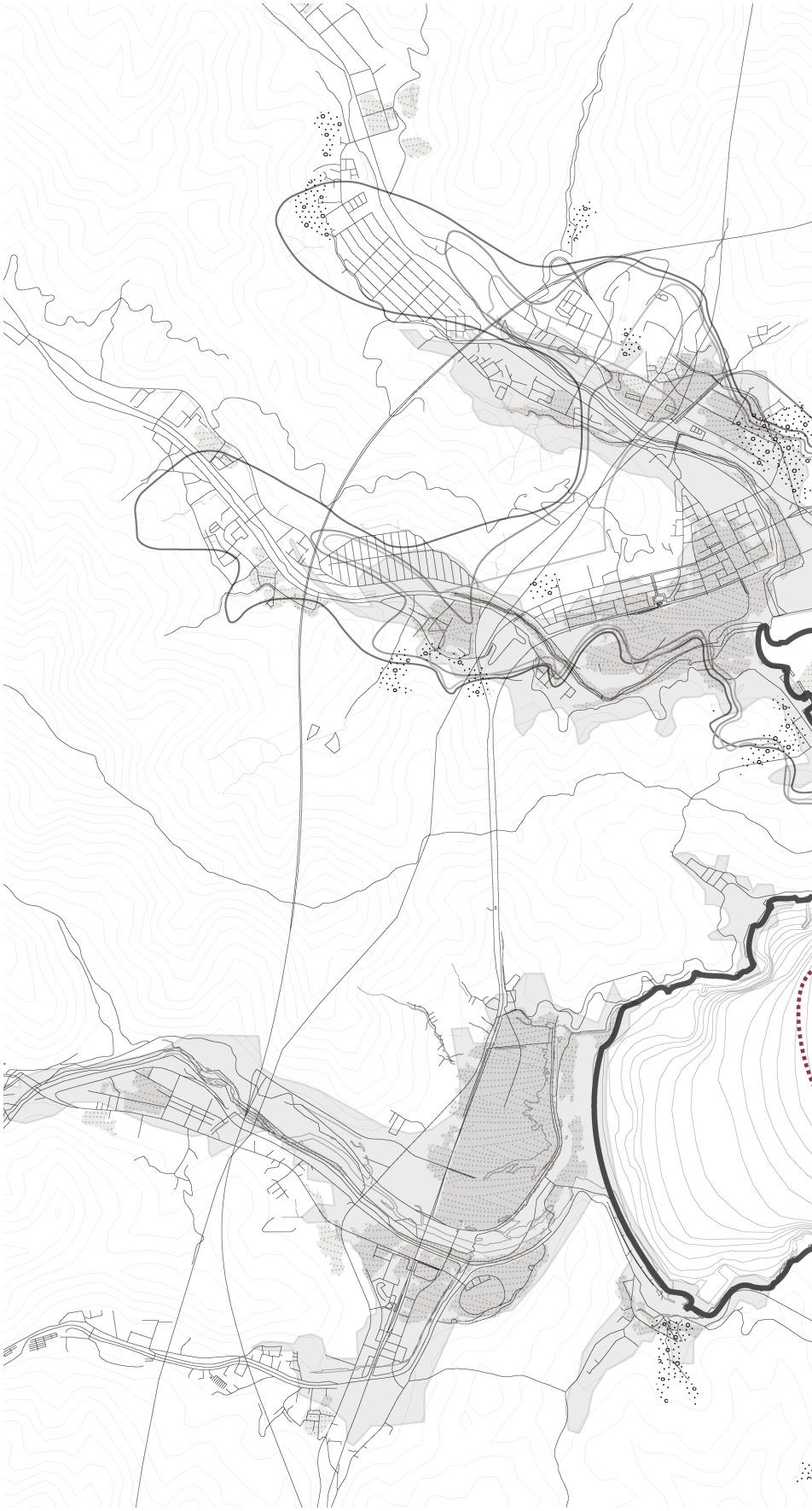

Industry & market
Shipyard
Ship land site
Marine farms
209
225.3
204.4
149.7
155
60
40
20
138.5
126.7
324.8
286.3

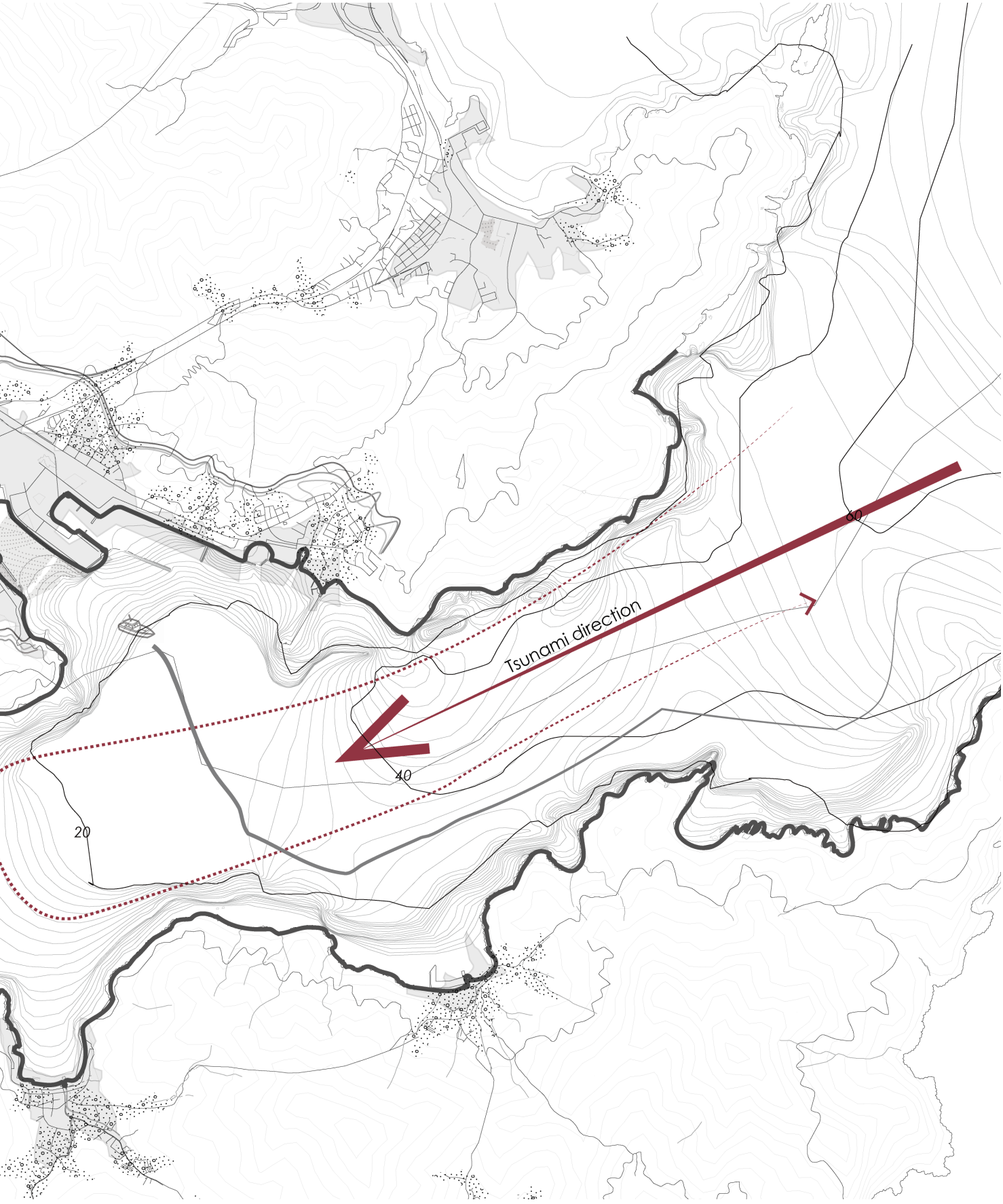


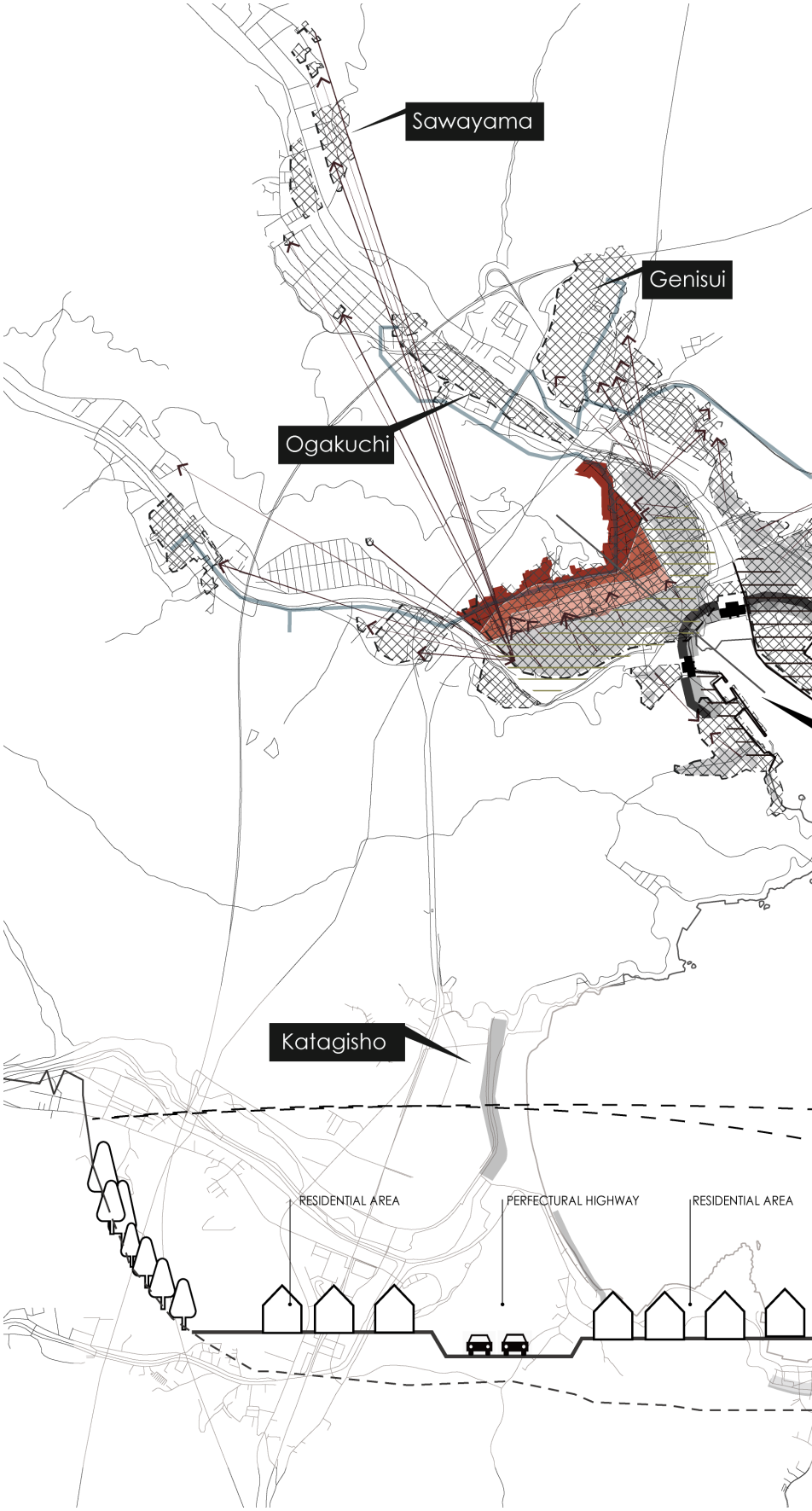
SYSTEM OF SYSTEM

Vulnerable area

The tsunami destroyed approximately 94 percent of the city's vessels, the fish market, and most of the wakame seaweed processing factories, refueling centers, and cranes. The number of missing and dead totaled more than 1200,or about 10% of the town's pre-quake population.

- Tsunami inundation extent field
- Land slide area
- Low elevation area
- Interpreted Tsunami inundation
- Land slide warning


Tsunami direction
60
40
20

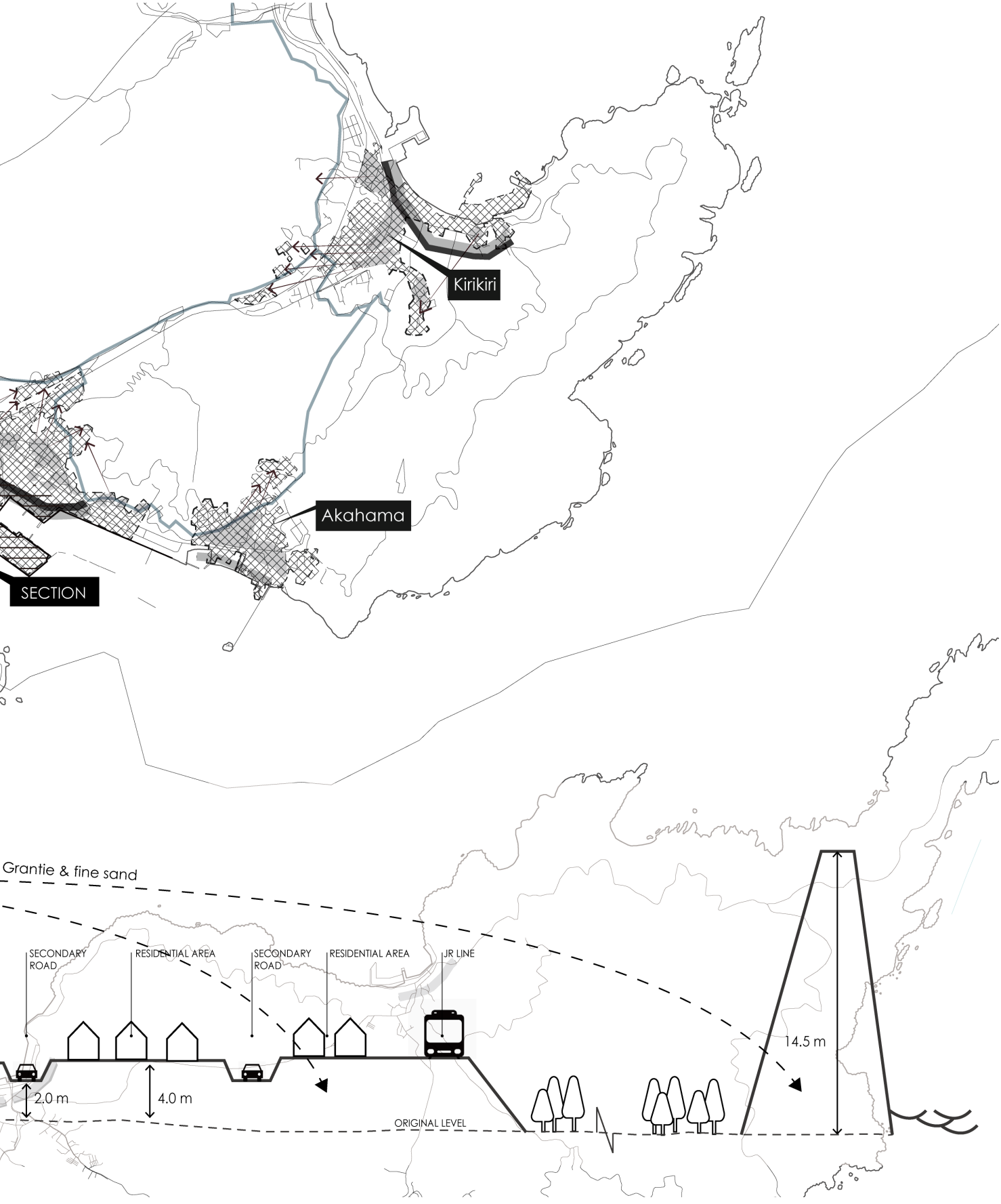


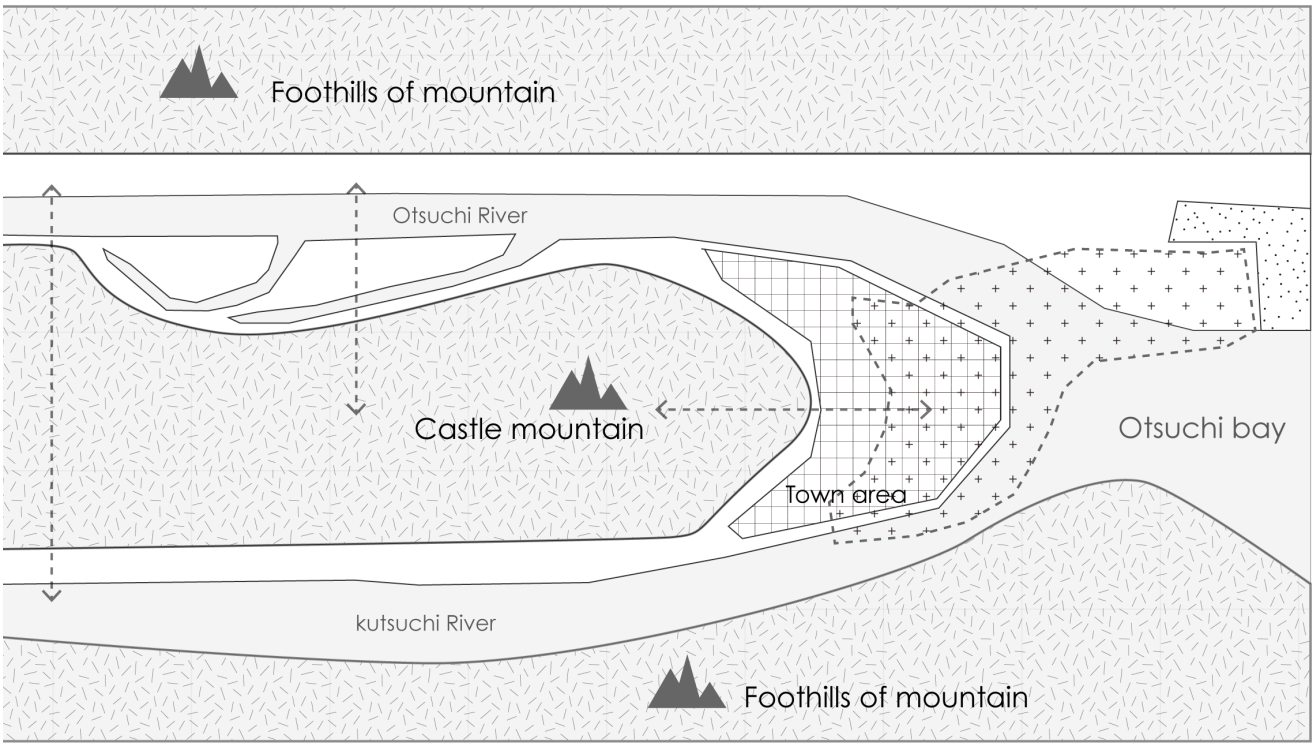
SYSTEM OF SYSTEM

Reconstruction project

These construction planseperatin ghuma-nactivities apart from the sea and relocate towns to higher ground.However,this may be only a desk theory.Looking bcak at Otsuchi history,Even if ppeople move inland,some of them will o down neer the sea 10-20 ears later,and schools,shops and companies will also return in 30 years.

→ Relocation plan
▬ Sea wall
■ Landrising


Kirikiri
Akahama
SECTION
Grantie & fine sand
SECONDARY ROAD
RESIDENTIAL AREA
SECONDARY ROAD
RESIDENTIAL AREA
JR LINE
2.0 m
4.0 m
ORIGINAL LEVEL
14.5 m



RIVERINE ECOSYSTEM

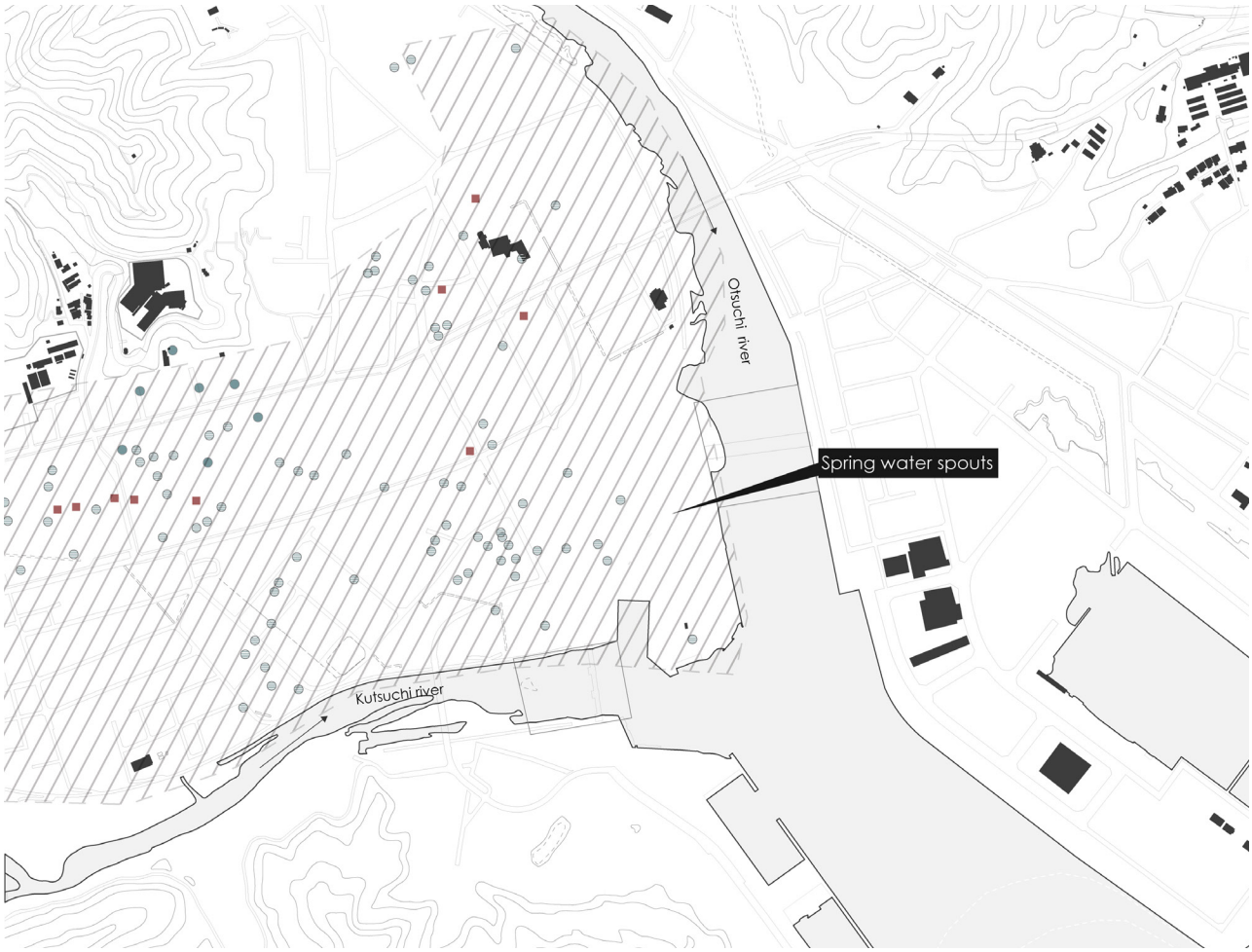
The town is famous for its riverine ecosystem,which includes important salmon fidheries and the endangered fish species , three-spined stickleback.

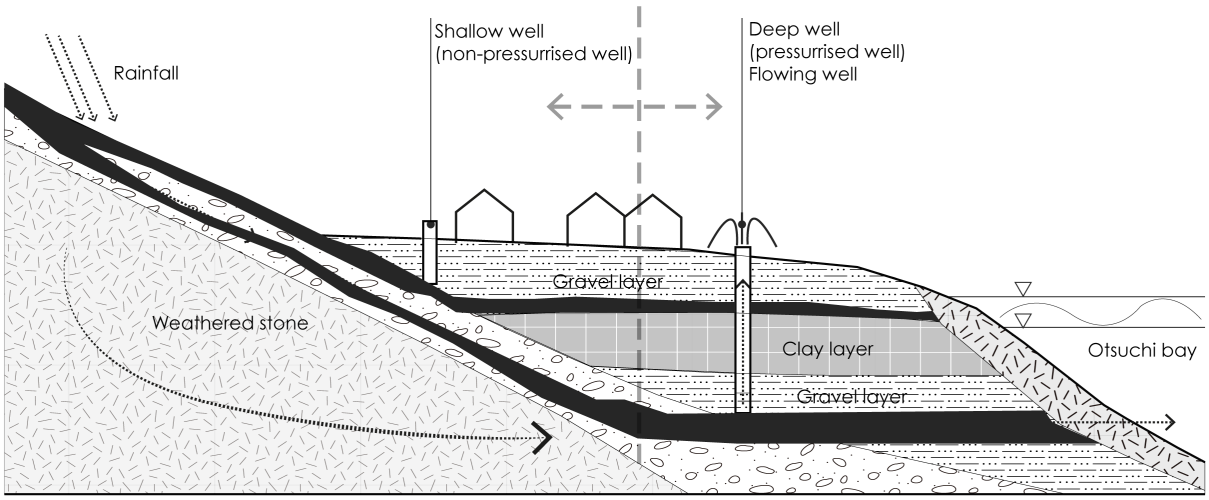
One of the major characteristics of the town is that it can be seen everywhere in the city,there is a well where the generated spring water spoutsIt is possible. Even in the basic plan for reconstruction, local history and nature The revitalization of a rich urban space utilizing the resources of The town development that makes use of spring water is mentioned. The Basic Plan for reconstruction also mentions town planning utilizes spring water to restore a rich urban space that makes use of local history and natural resources.

Self-flowing wells are used by many residents as water for daily life not only before the maintenance of the water supply (1960-70s) , but also after the maintenance, which is indispensable for conducting a livelihood such as marine product processing, brewing, and tofu making. Later, It is mainly used by setting up a water boat (Kits) in the outdoor space, and it is an important element that forms the scenery of the life of the town as well as the wells of each house, as well as the common well, and the common space of the residents. It is thought that it worked as well.

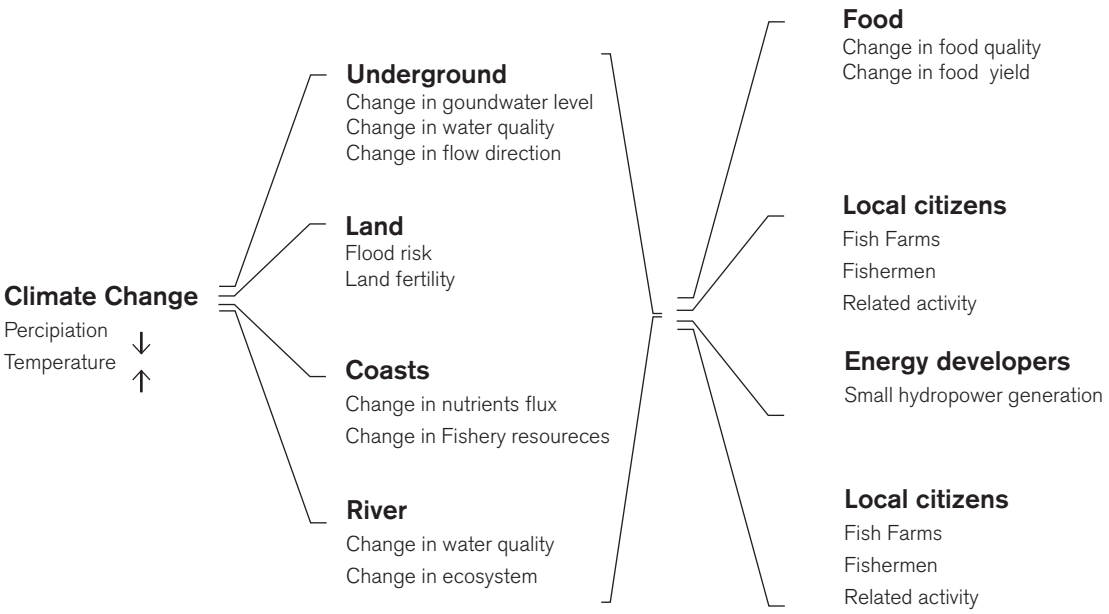
Spingwater & people & life & Cultural

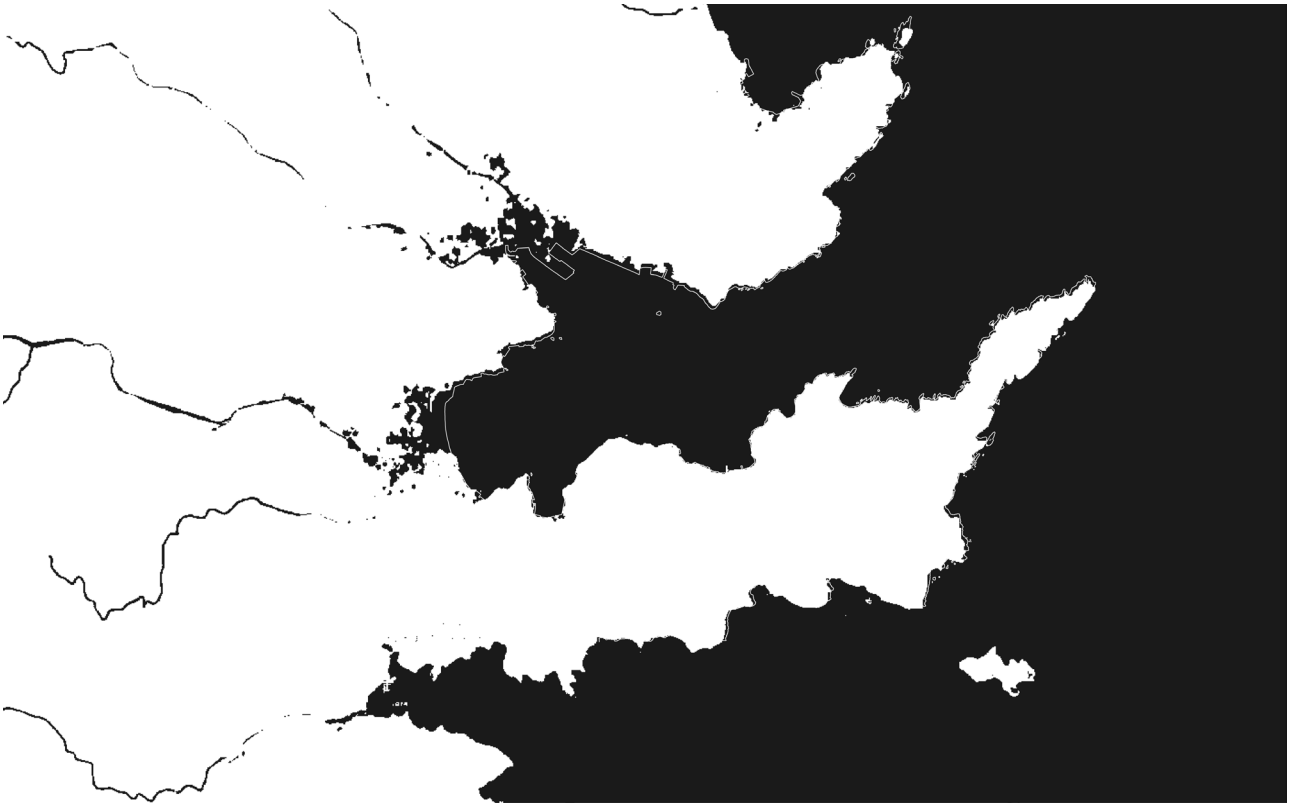
By raising homes two meters to protect against inundation, approximately200 groundwater springs will be lost.


Otsuchi river
Spring water spouts
Kutsuchi river

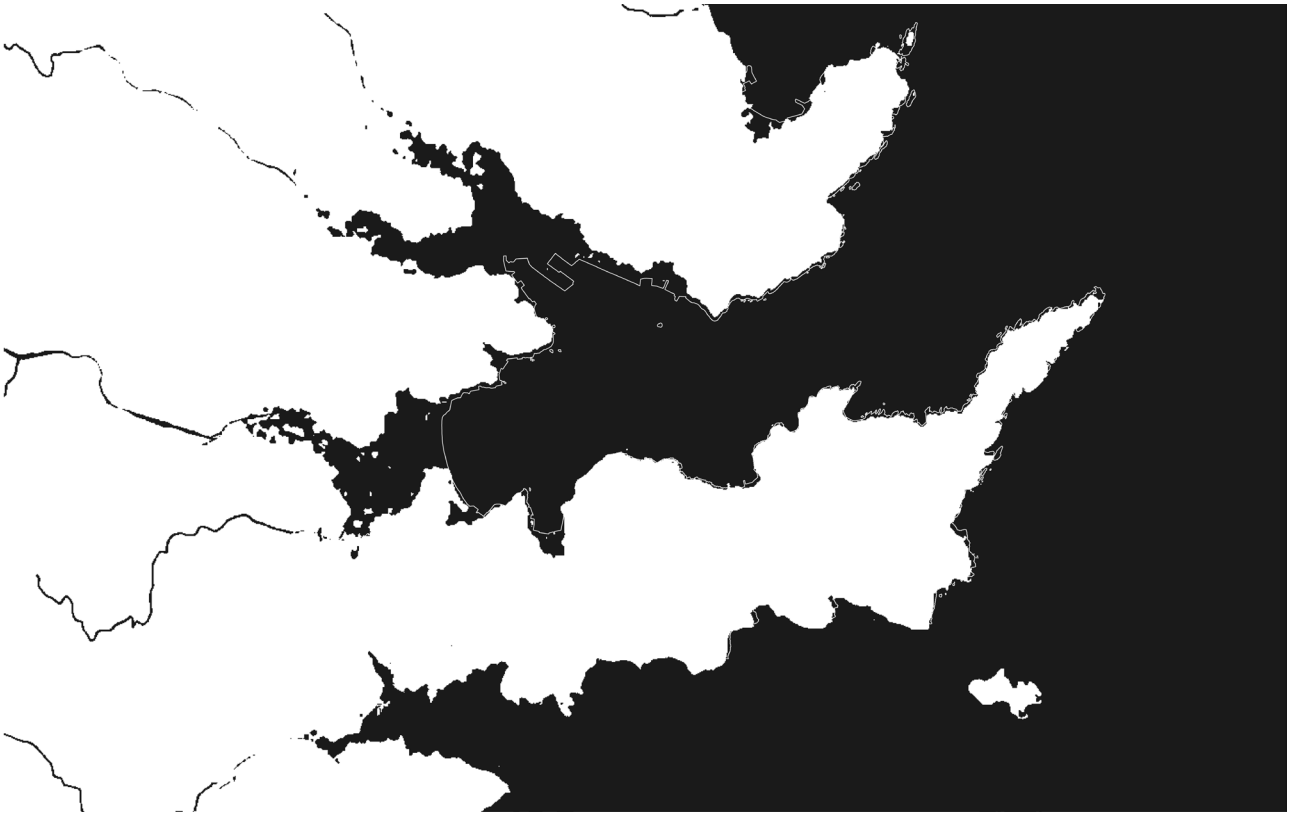

Rainfall
Shallow well
(non-pressurrised well)
Deep well
(pressurrised well)
Flowing well
Gravel layer
Weathered stone
Clay layer
Otsuchi bay
Gravel layer

Impacts of Climate change

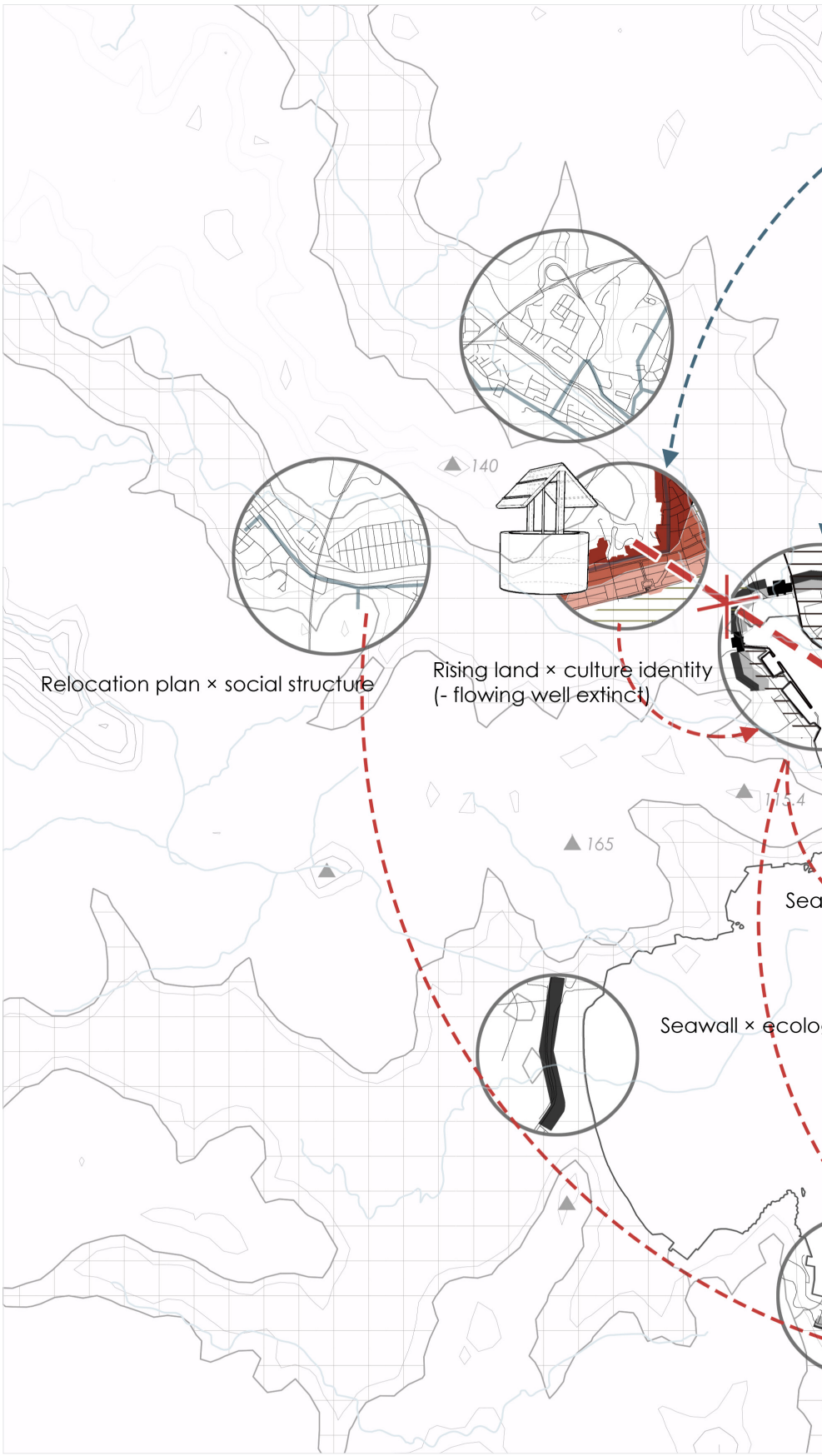




Sea level rise _1M

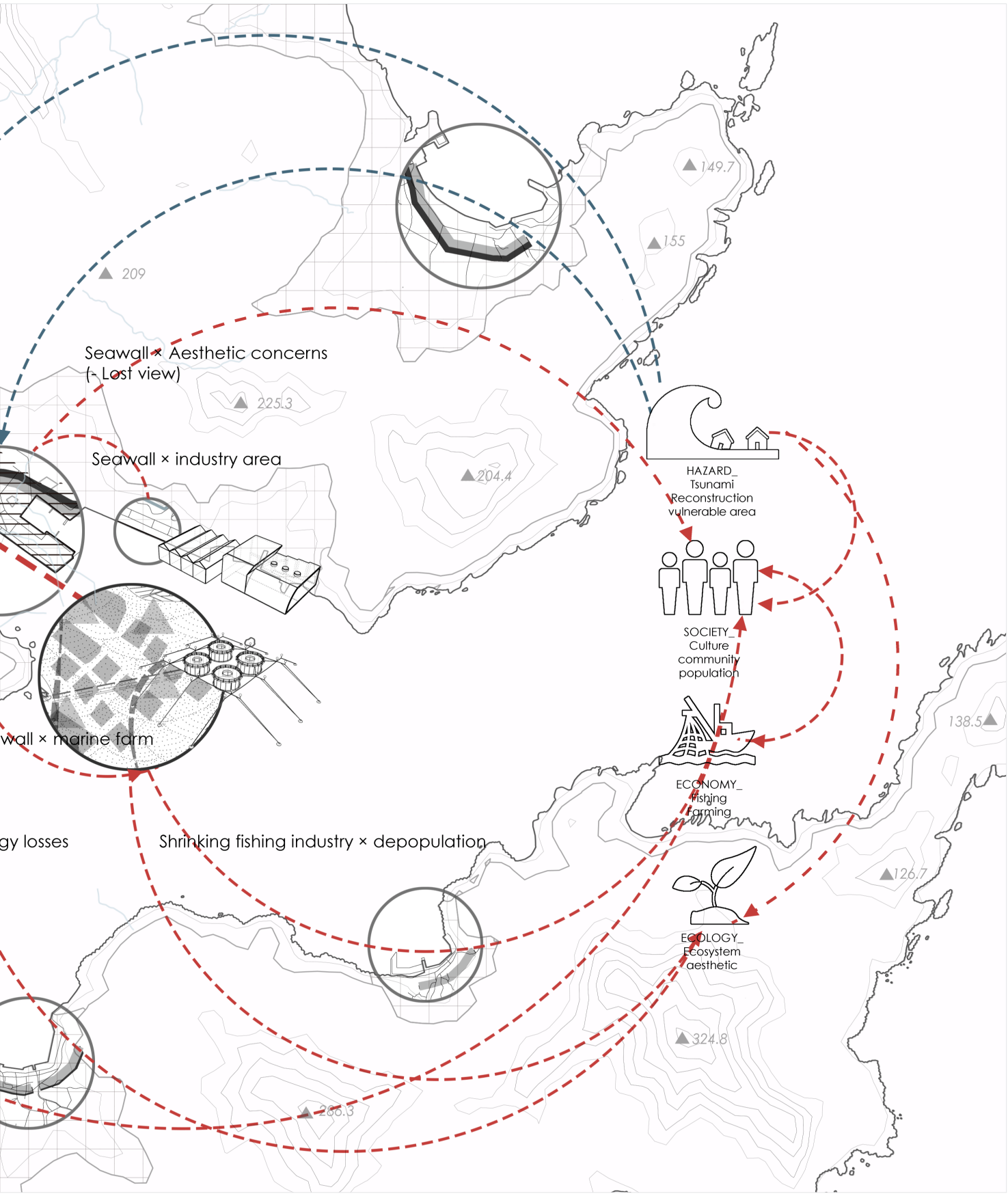


Sea level rise _5 M



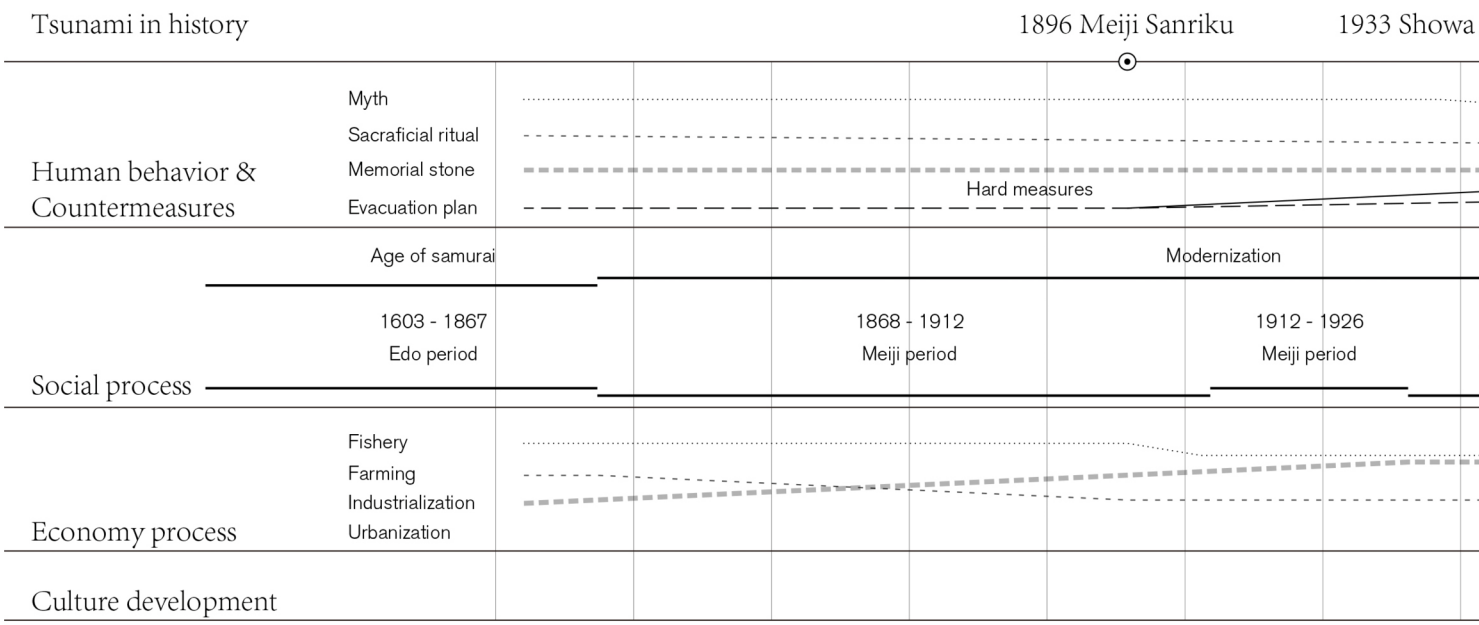
SYSTEM OF SYSTEM

Conclusion map


149.7
155
209
Seawall × Aesthetic concerns
(- Lost view)
225.3
Seawall × industry area
204.4
HAZARD_
Tsunami
Reconstruction
vulnerable area
SOCIETY_
Culture
community
population
ECONOMY_
Fishing
Farming
138.5
wall × marine farm
gy losses
Shrinking fishing industry × depopulation
126.7
ECOLOGY_
Ecosystem
aesthetic
324.8
266.3

3.2.

Anthropology





i. people fight with the catfish (earthquake)



ii. the god protect people from catfish (earthquake)



iii. business man and craftsman thanks catfish because of the rebuild project

大津絵

Otsue

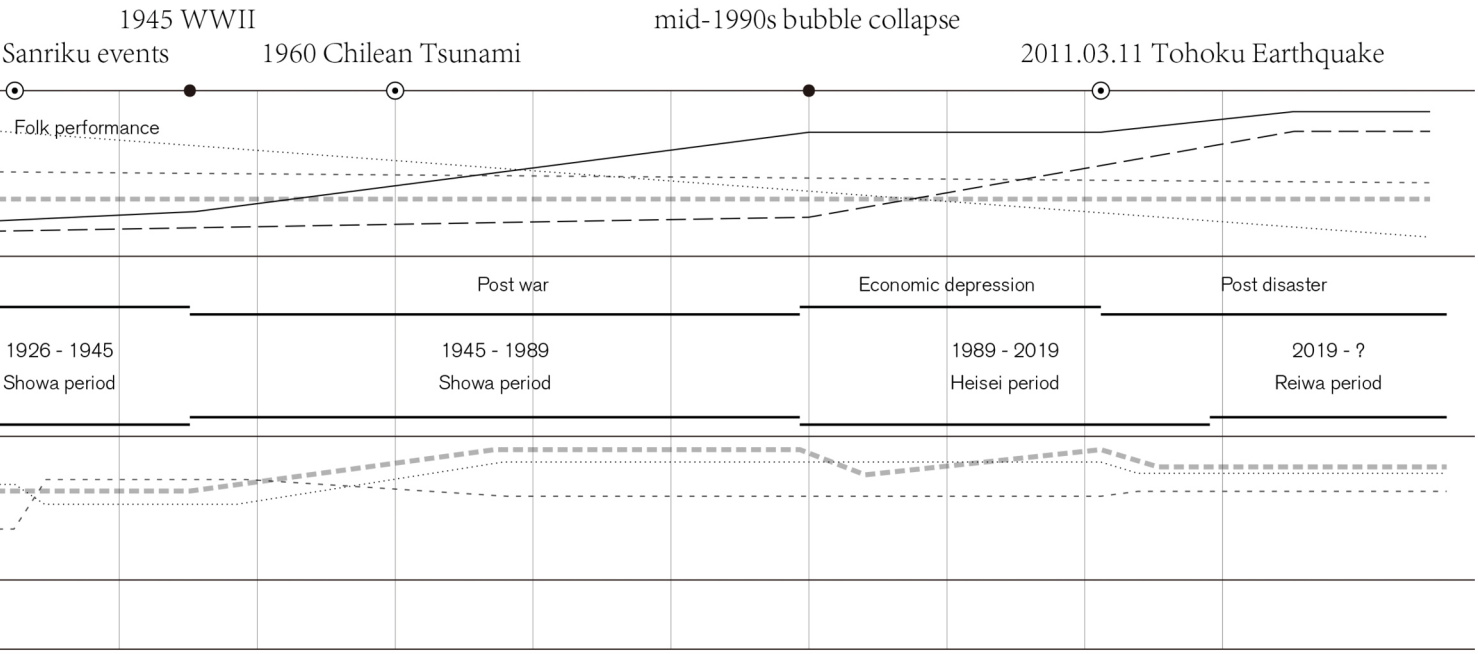
Otsue is a kind of folk painting in edo period. This Otsue shows a monkey is trying to press the gourd, which looks a tool to imprison the catfish. Gourd is an important element in Buddhism.



鯰絵

Namazue

Namuzue is a kind of traditional painting in Japan, emerging in late edo period. After xx tsunami in1855, people thought that the earthquake happens because of the catfish underground activities, so the Namuzue has been widely published as sets of paintings, eliminating people's anxiety or working as a protective charm.



石碑

Tsunami Stone

Earthquake and Tsunami Memorial Stones were built after every disaster. The stones are not only for commemorating the victims, but also for passing on experience and memory of the disasters. Usually they are located in the tsunami arrival point, which means you should not stay in the ground lower than this stone during the tsunami.



民俗学

Folk performance

Originating from traditional sacrificial rituals, folk performance became an essential part of people's life. It's not only a ritual of praying for safety, but also an important community activities to unite residents and to encourage them to live positively.



Before the Meiji Restoration, Japanese natural villages were formed around local shrines. Usually there is one shrine per natural village.

In 1906, the Meiji government launched the "Shrine Shrine Movement" and formulated the "One Village, One Shrine" system, stipulating that each administrative village has a shrine. The strong sense of identity generated on this basis promotes internal unity.

奉納

Dedication Rituals

Japanese traditional sacrificial activities are extremely cohesive. The shrine Taoism is the foundation of the existence of Shintoism, and the sacrificial ritual is the bond that maintains the faith.
The Japanese sacrificial ritual can be traced back to the Jomon era, and it is a way of communication between man and god.





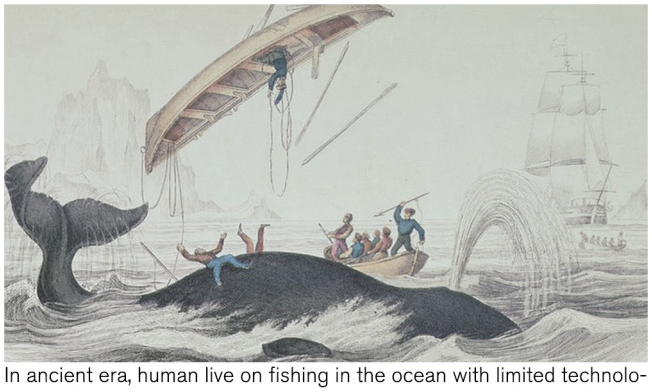
Later, the sacrificial activities were also used to commend the people who were committed to reconstruction after the tsunami, to express gratitude and raise people's awareness of disaster prevention.

Nature



People





In ancient era, human live on fishing in the ocean with limited technology.

Nature



People





When tsunami happens, it sweeps away almost everything in city.

Nature



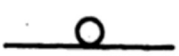
People





New technology and fishing plan are applied in fishery.

Nature

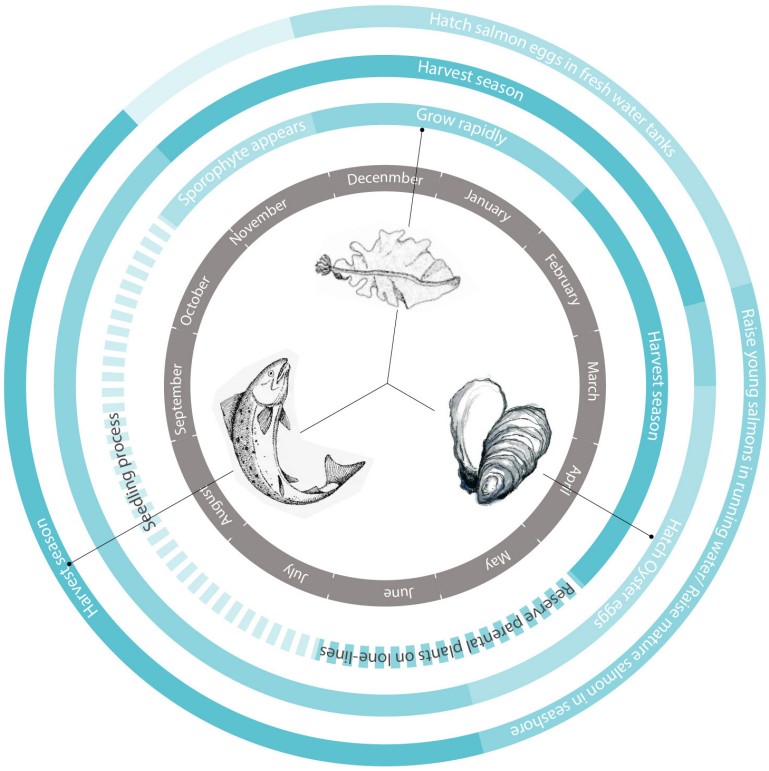


People



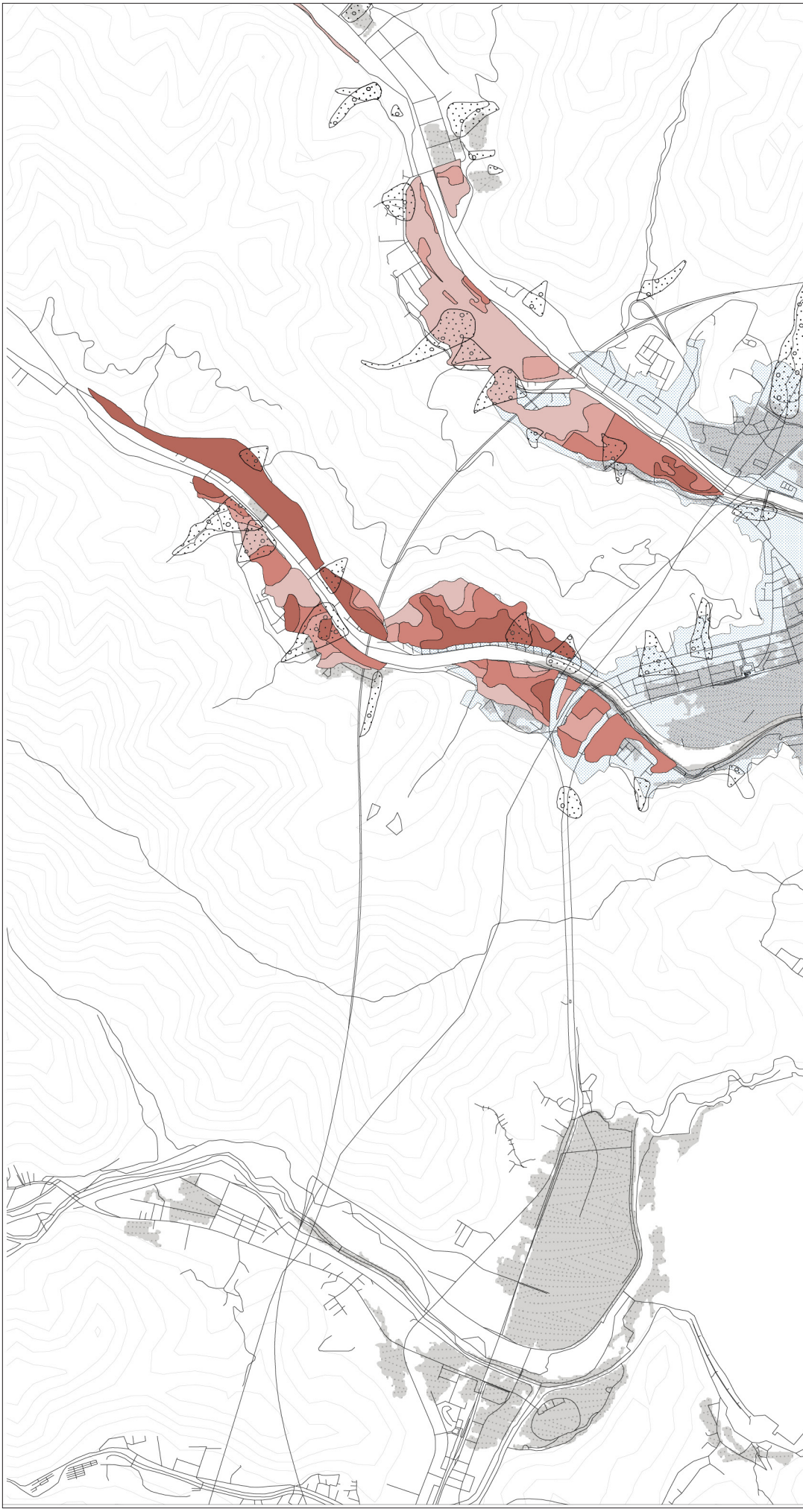


Dikes are built, and evacuation plans are made, in order to save more life if the tsunami happen in the future.



Living with the sea

Salmon, oyster, scallop and seaweed farming are the most important part of the local aquaculture farming. They have different culture-cycle, and the occupation of space can be adjusted according to the schedule.



Vulnerable Area

This map shows the vulnerable area may be suffered from tsunami, flooding, debris, and sedimentation, which means those areas are more suitable for industries, parking lot, greenland, and sportsfields rather than living. In addition, the evacuation route from those areas to shelter are very important.

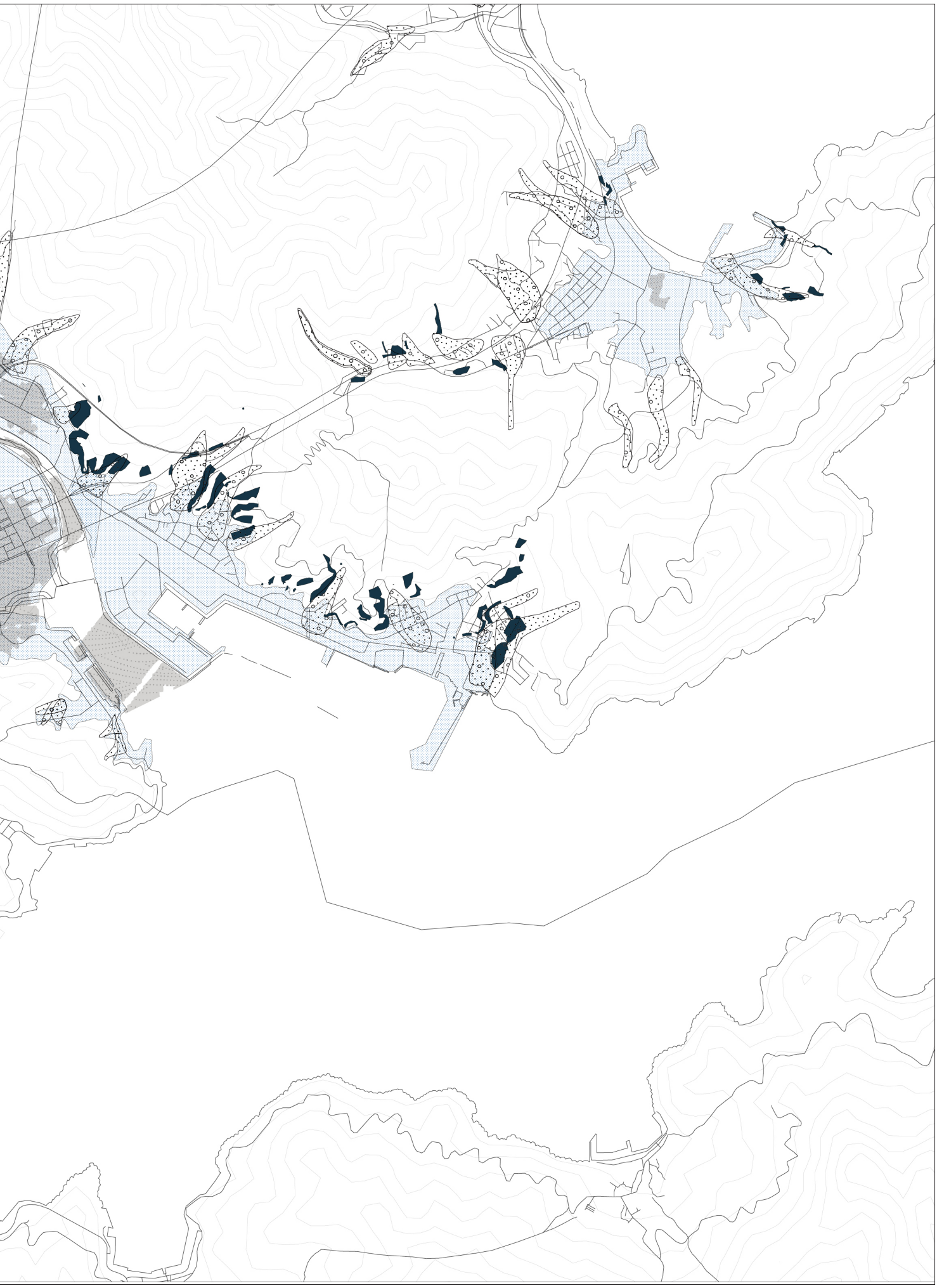
- flooded area in 2011
- low elevation area
- Sediment vulnerable area (steep slope)
- Debris flow vulnerable area

Flood disaster inundation expected area

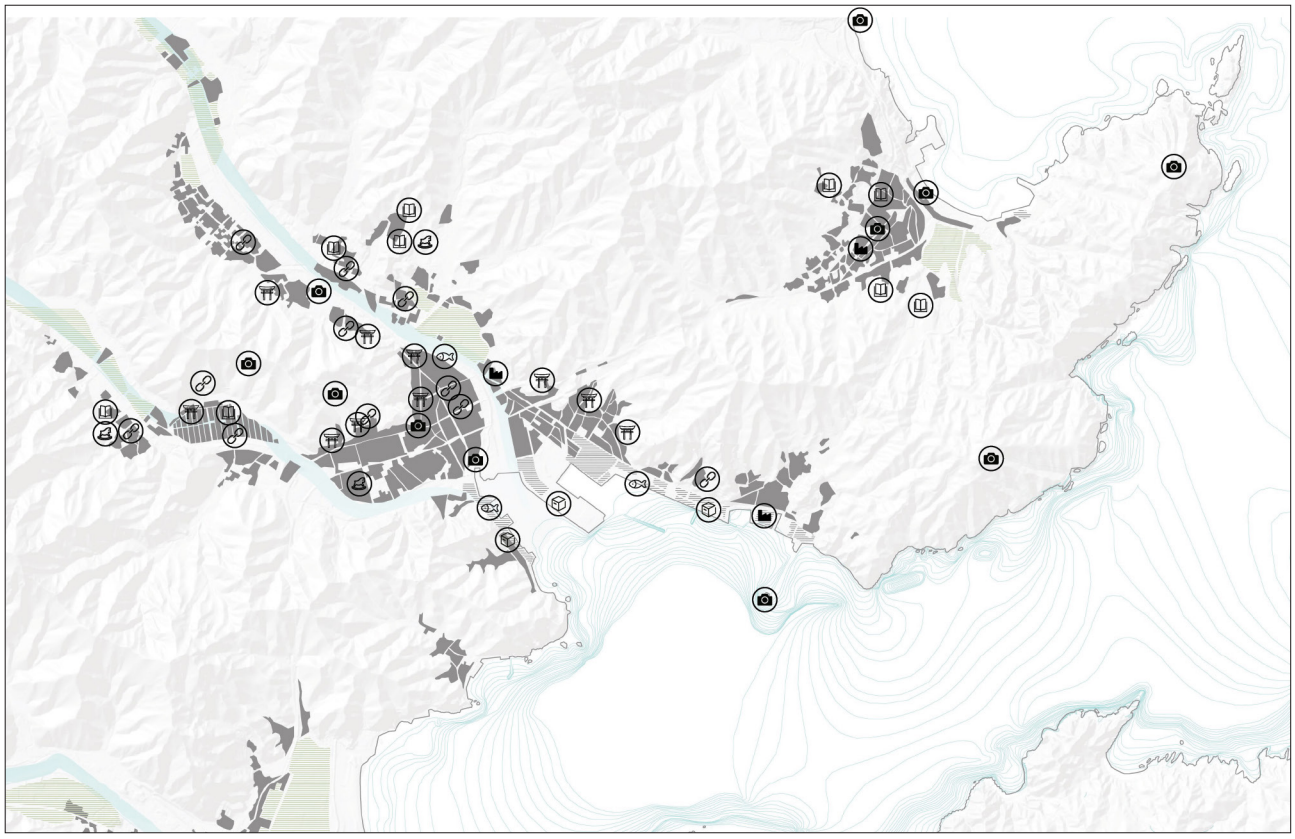
- 0 - 0.5m
- 0.5 - 1m
- 1 - 2m
- 2 - 5m

N

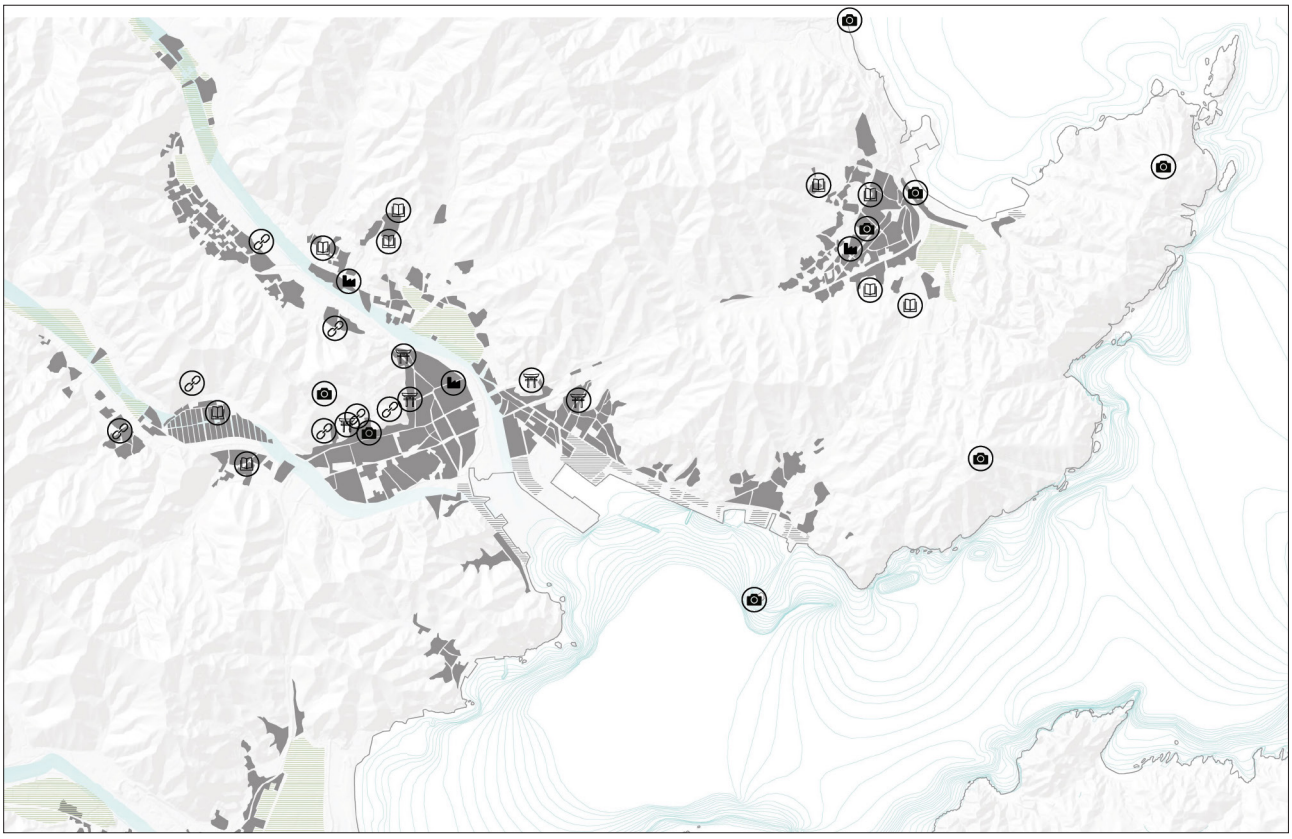
0 100 km



Public services before 2011



Public services after 2011



How do the residents experience tsunami ?

[Before tsunami]

Otsuchi was traditionally popular with tourists who came to appreciate the beautiful scenery of the Sanriku coastline and enjoy local food.

Salmon fishing, aquaculture of scallops and seaweed (wakame), and the fish processing industry were part of the main commercial sector. Scallop production is a famous local product, attracting tourists from other cities.

There was a well-known sandy beach that was busy during summer periods. Namiita beach was selected as one of the top 100 beaches in Japan, and it's a very good surfing destination.

For tsunami defence:

Layer 1 tsunami countermeasure had been developed along Otsuchi and the wider ria coastline. Layer 3 countermeasures (early warning and evacuation schemes) were well developed, with local residents and children frequently taking part in evacuation exercises.

However, those 'sufficient' countermeasures promote a bilnd faith amongst local people that the area were safe enough against a tsunami attack.

[During tsunami in 2011]

Some residents could not hear the warning systems, possibly due to power cuts. Firefighters and neighborhood association members patrolled the area right after the earthquake to warn residents about the tsunami. Some firefighters perished when trying to close the tsunami gates.

The time available for evacuation in some places was too short. Most evacuation centers were flooded. Some residents did not want to evacuate, and some did not believe the tsunami would reach the town given the existence of significant sea defenses. Fires broke out, making things worse.

Most high ranking municipal officials were perished, leading to the delay of the recovery process. Earthquakes contributed to the land subsidence and local beaches lost. People died of not only tsunami but also chronic illness (with the lack of medicine).

[After tsunami in 2011]

Temporary housing were built in high ground for local residents.

For the reconstruction plan, Municipality and Community Reconstruction Committees worked together to discuss and plan. 30% of the residents participated in in the local district forums. NPO also offerred help.

With the help of government and the group subsidies, 76.3% of the closed down industries has re-started in 2014. Post-disaster tourism emerged. Tour guides show visitors how the town used to be like before the tsunami, heightening awareness.

In addition to the building reconstruction programme, the post-disaster revitalization also includes community cultural renewal and mental health recovery. (Fig.x)

After tsunami

- revitalization in the long term, in a community that a local resident's tissue such as neighborhood associations showed the leadership.

Community Reconstruction

Prevention Propaganda
- World Tsunami Day
- New Prevention Manual
- pass on awareness
- Survivor Memoir

Survivor Participation

Disaster Prevention Publicity



Wooden Monument

A destination for the study of tsunami disaster prevention



- NPO Participation
- Volunteers Participation
- Public Housing
- Inheritance Of Folk Culture
- Labor Market

Tourism Planning





Conncection with nearby communities

supported by the foundation
- Collection of costumes, masks and props

Resume practice and performance
- New Performing Center

- Movie and Documentary



Pass on power

- High School Graduates
- Resource Matching
- Employment Benefits
- Encourage Housewives to Work
- Government Cooperates with Private Sector

Psychological Recovery

- Relationship Recovery
  - Shelter Council Activities
  - Survivor Revisit
  - Social Welfare Committee Cooperates with Business Organizations
- Lost and Found - Memory



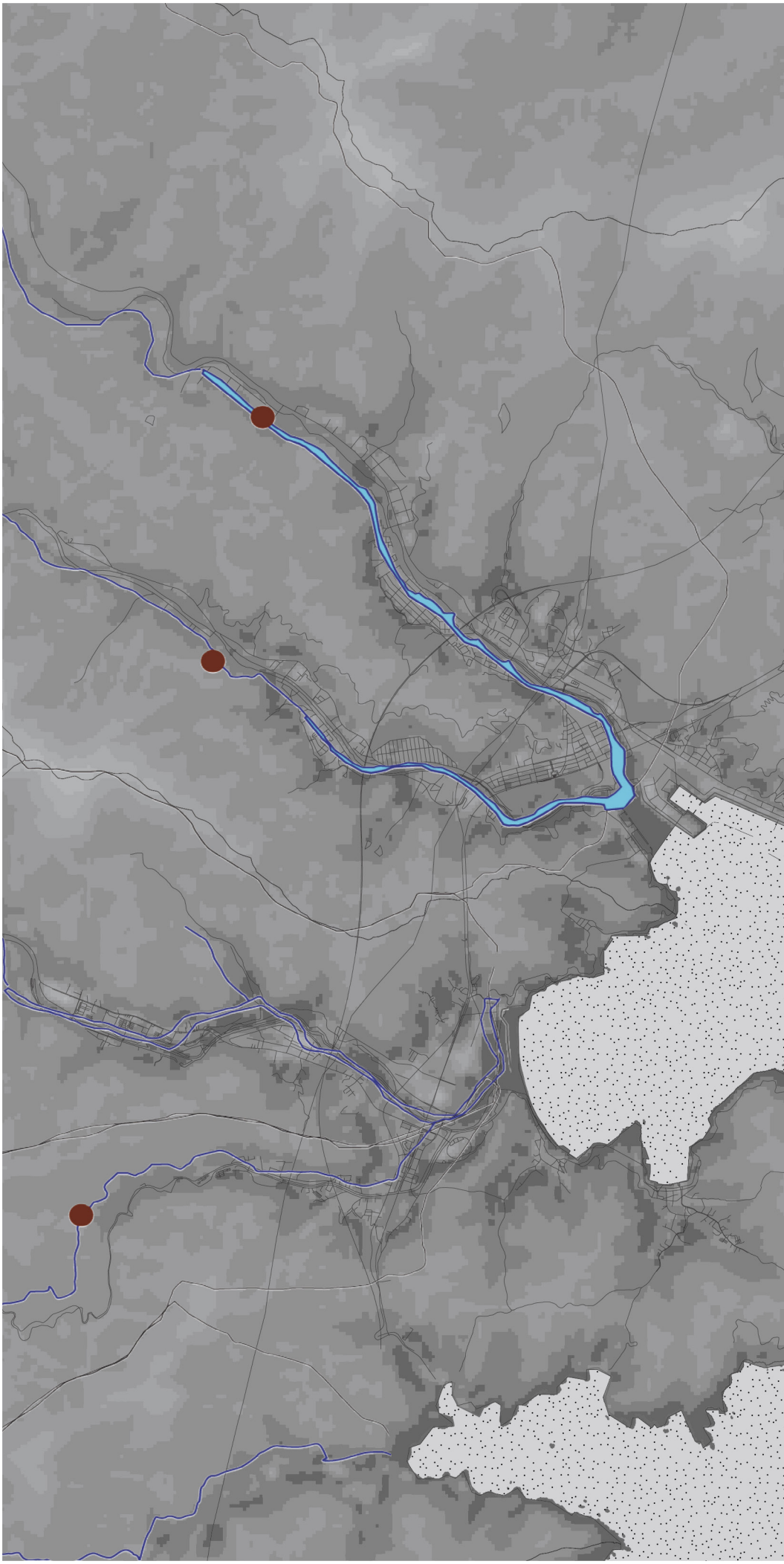
If even the foundation was swept away, what do you have left?

Survivor Salon. fit club



3.3.

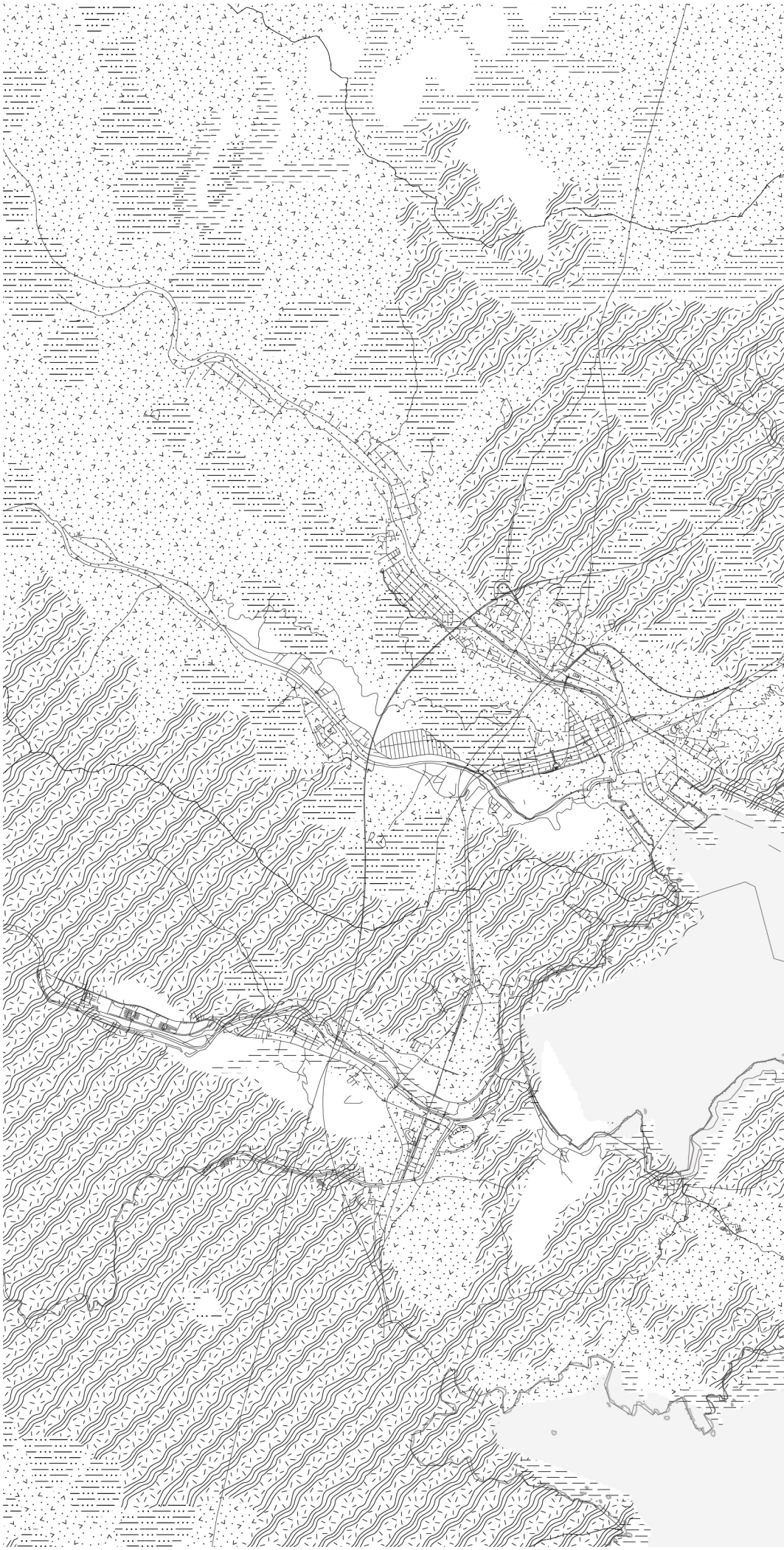
Landscape



Elevation map

This map shows the topography and the river system of otsuchi. Moreover the humans settlement and river have a close relationship.





Soil map

From the soil map, it can be seen that people choise “Allophane black soil” to settle down. And Allophane has been known to occur widely in volcanic ash soils in Japan. It is widely used as a field (ordinary field, meadow, orchard) in agricultural land.

Allophane

Brown forest soil

Weathered red-yellow soil

0.5 1 2 km

N





Land use
(Before Tsunami)

Resident area

Education/
public facility

Urban street
regeneration area

Industrial area

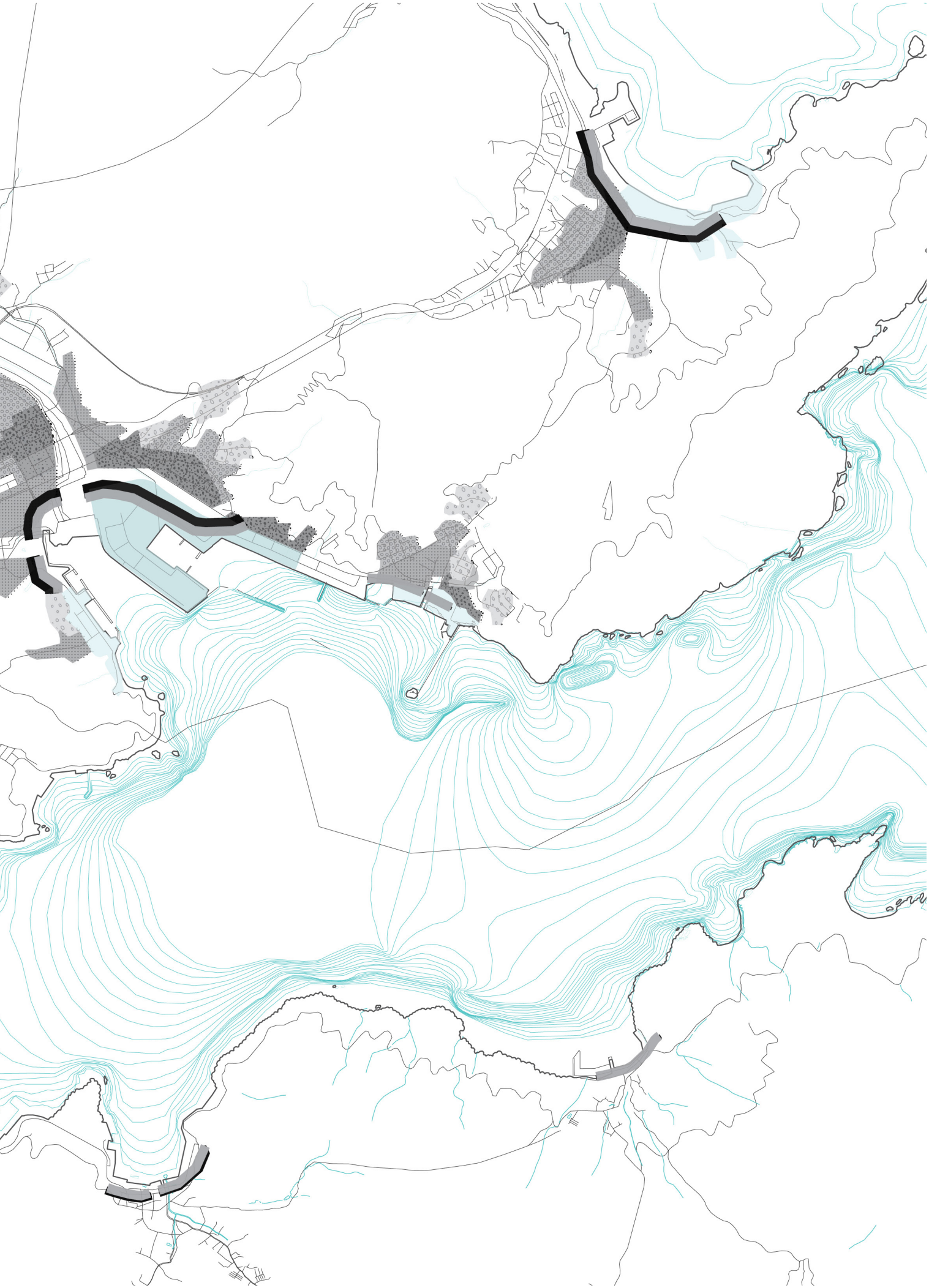
Green zone

Park

Fishing port facility

0.25 0.5 1 km

N





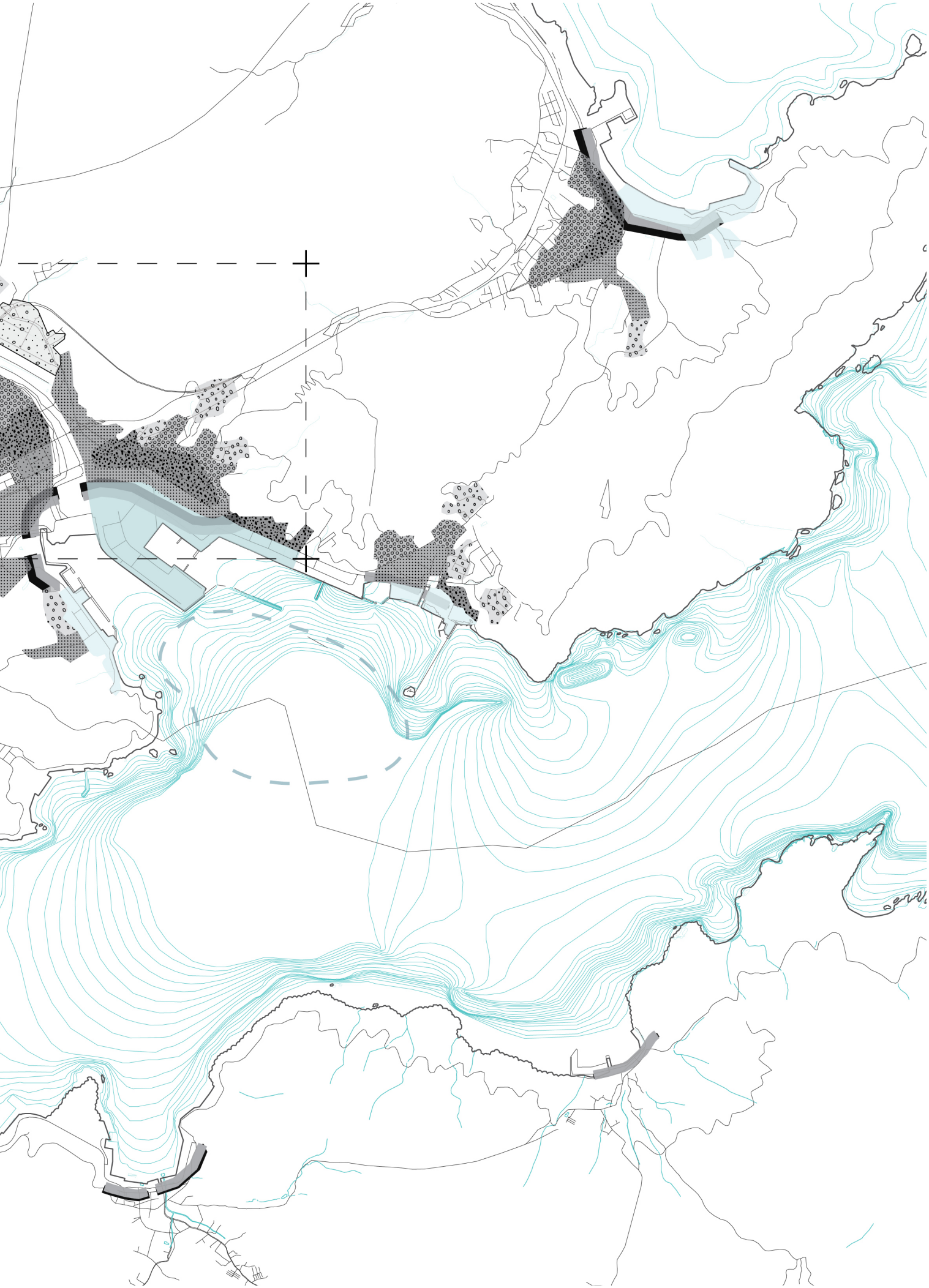
Land use
(After Tsunami)

Park and green zone are taking as buffer zone to mitigate the damage of tsunami. And resident area is far away from the sea.

- Resident area
- Education/ public facility
- Urban street regeneration area
- Industrial area
- Green zone
- Park
- Fishing port facility
- Farmland recovery area
- Marine farm

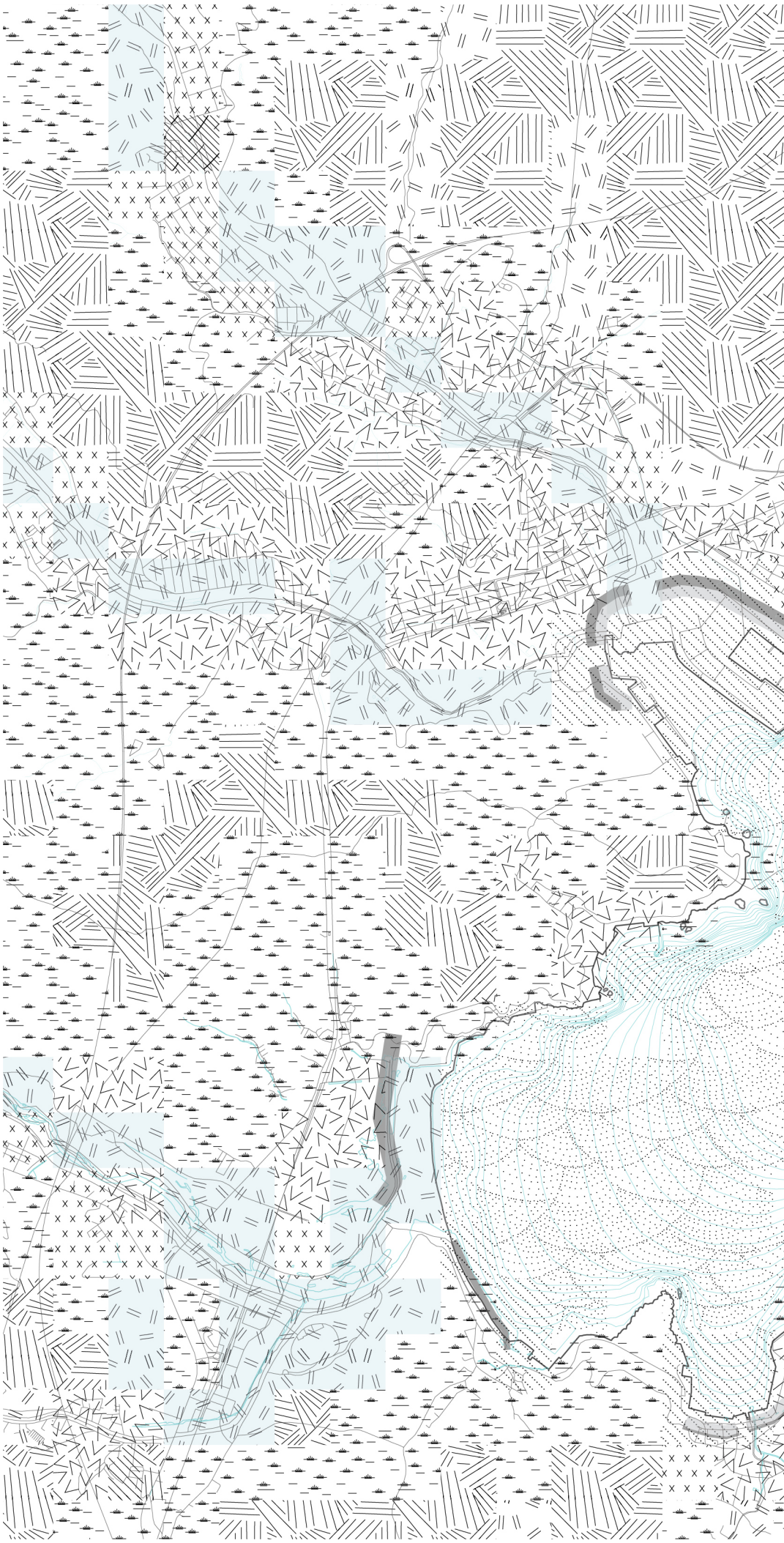
0.25 0.5 1 km

N



Landscape typology

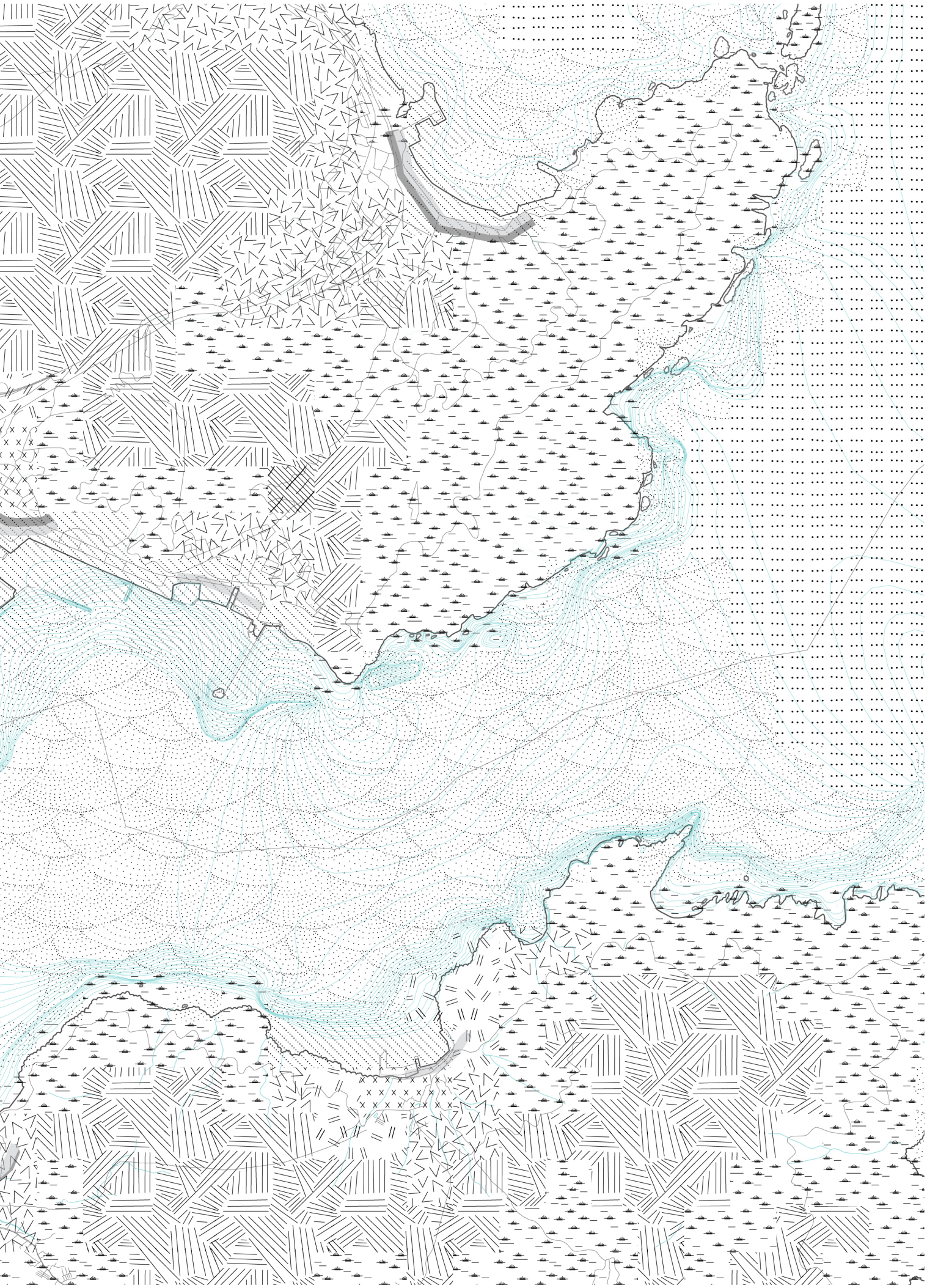
In Otsuchi, there are about eight different kinds of landscape can be perceived which is quite diverse and interesting. Moreover, people can experience the sea and mountain landscape in a short distance. However, because of the dyke the continuity of river and sea is blocked, so is the connection between humans and water.



River
Village
Farmland
Sea
Mountain
Continental sea
Hills/slopes
Port

0.25 0.5 1 km

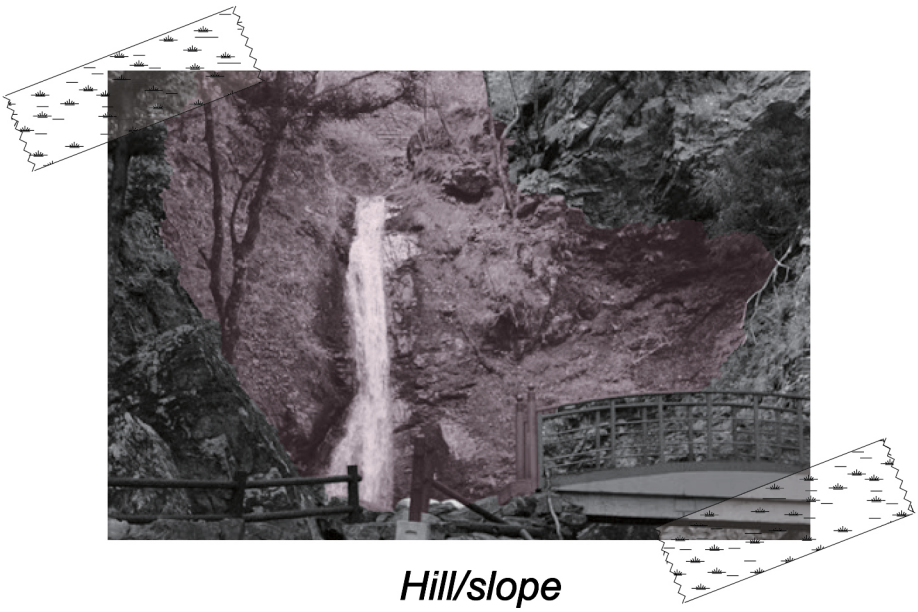
N



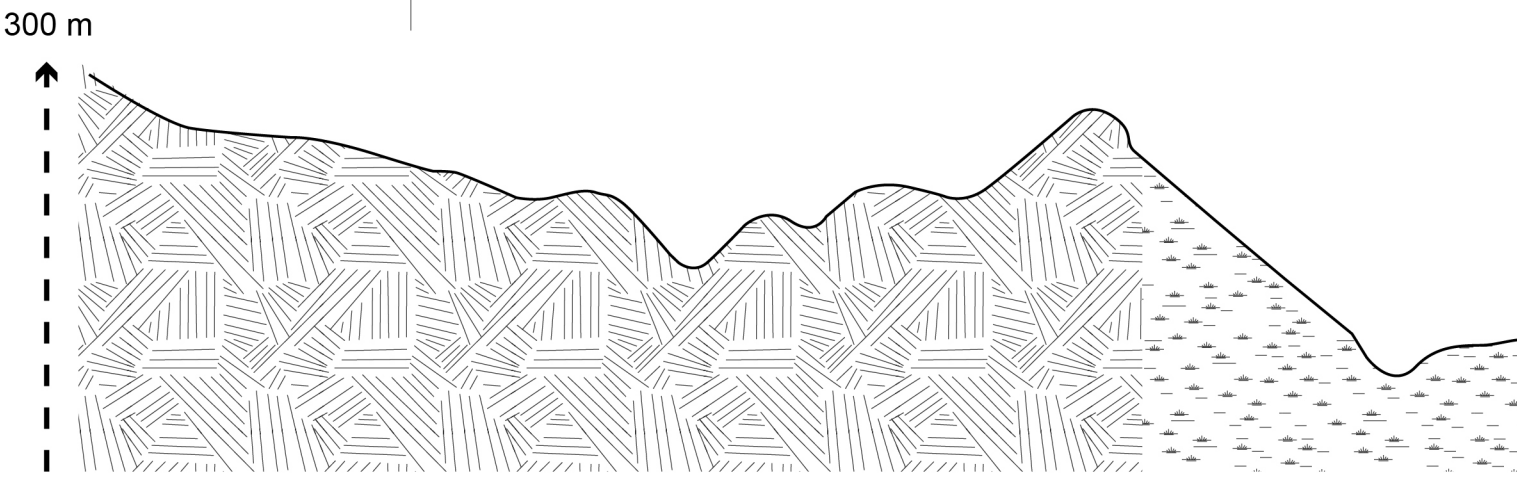


Mountain



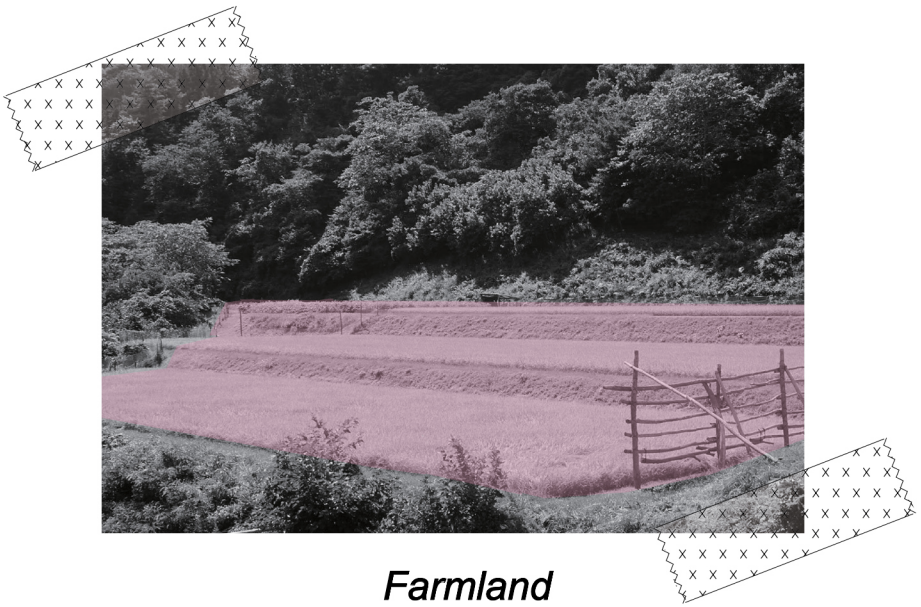


Hill/slope

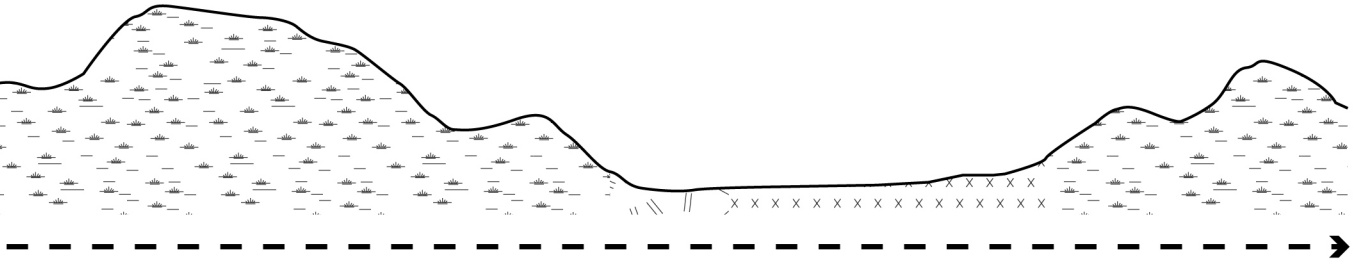




River

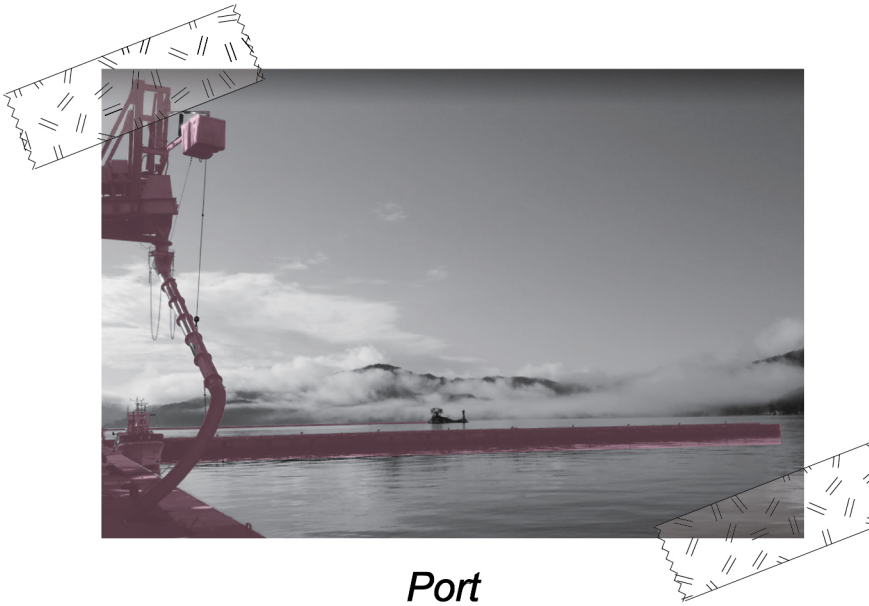


Farmland

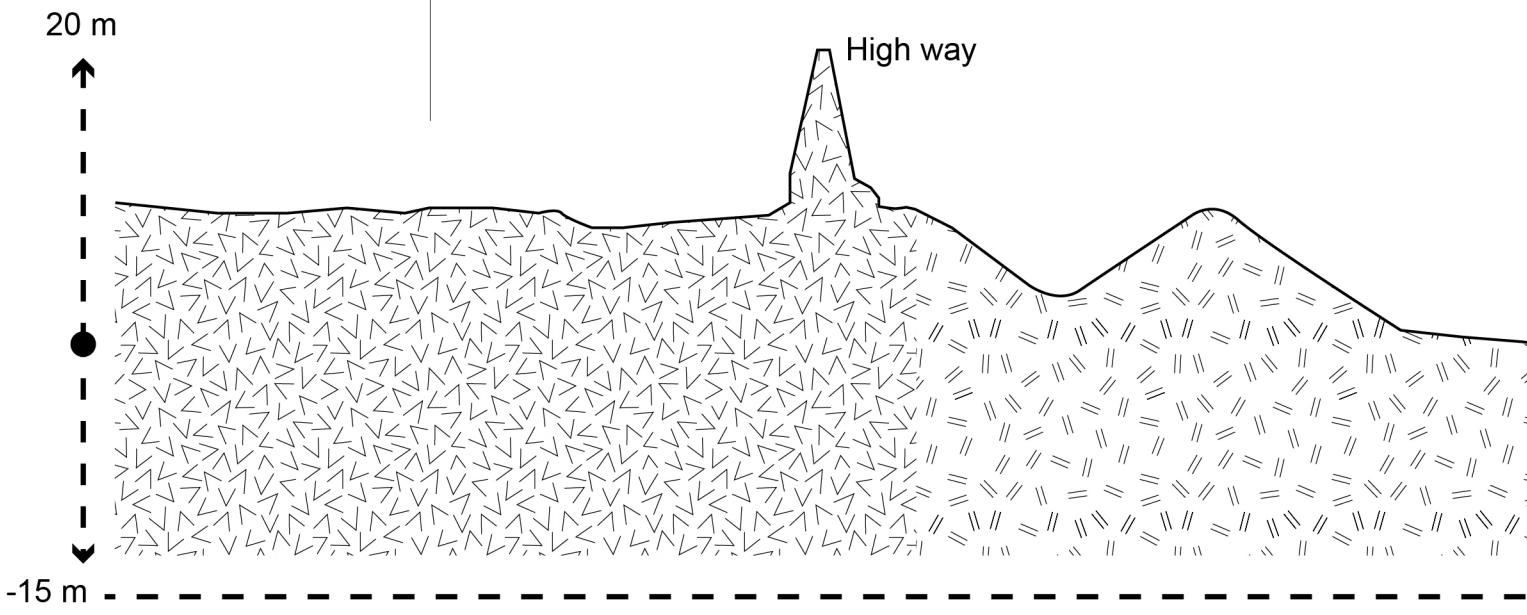




Village



Port





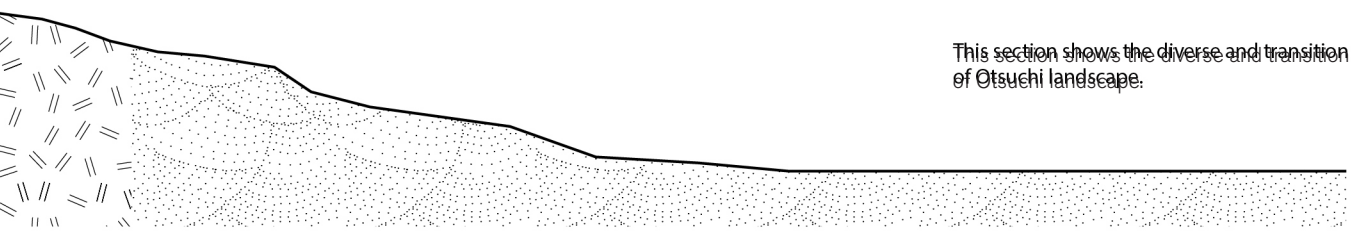
Continental sea



Sea

This section shows the diverse and transition of Otsuchi landscape.

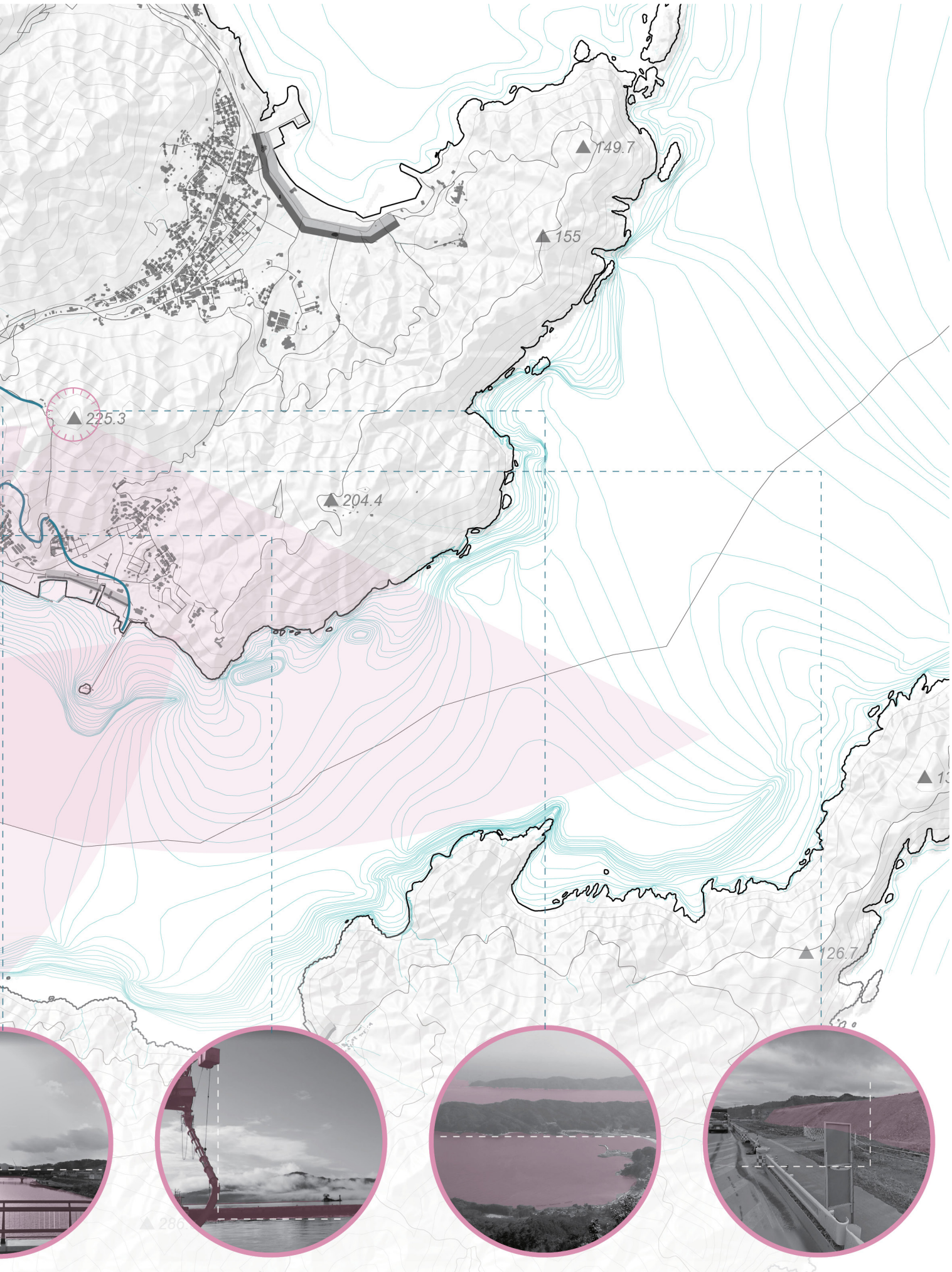
This section shows the diverse and transition of Otsuchi landscape.



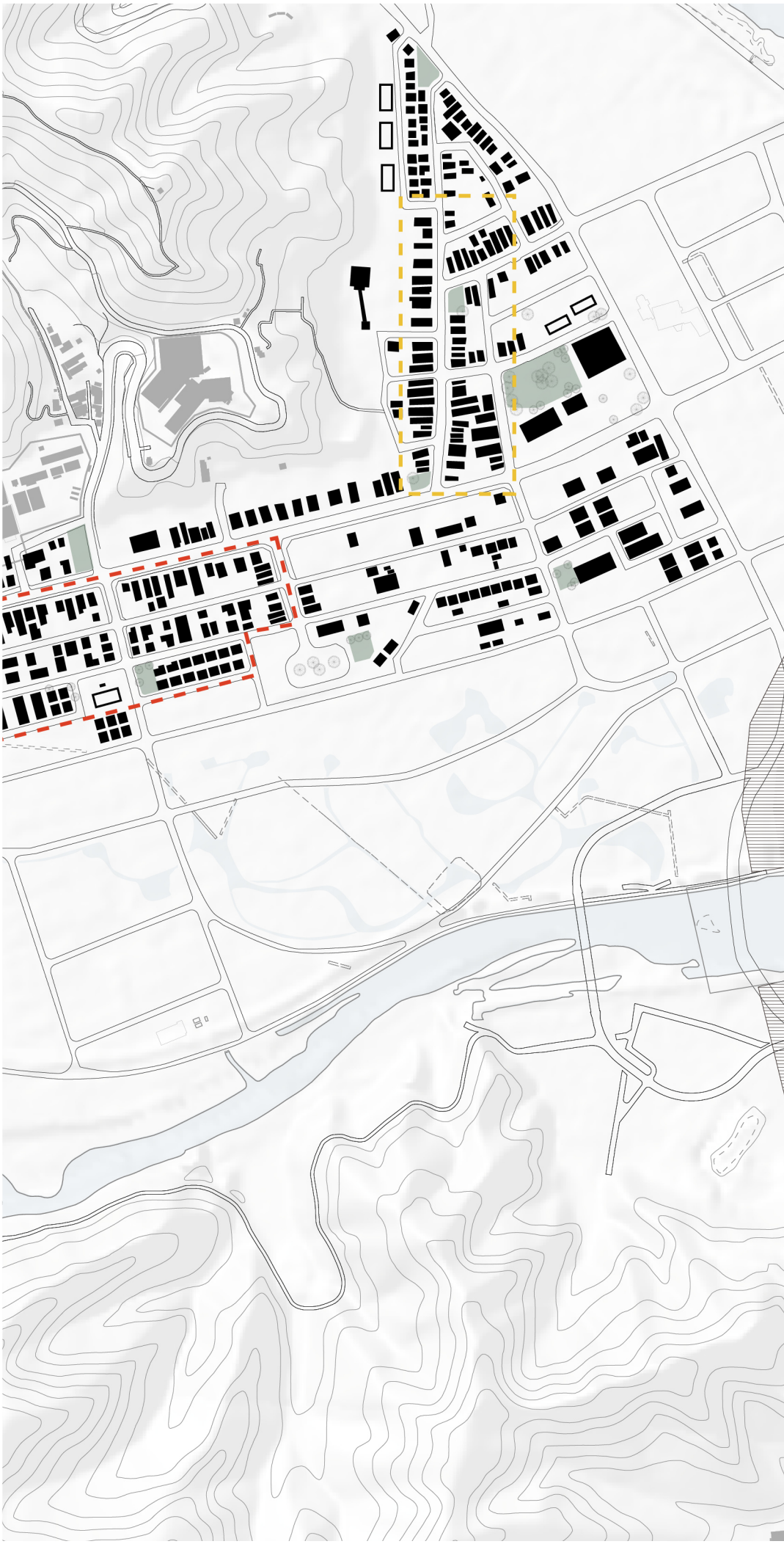
6.4 km



On the way to the hilltop, people would feel enclosed by the trees on both sides then the open view of the sea could be observed. (White dot line emphasizes the openness of spaces)



However, the dyke disconnects the relation between people and the sea.



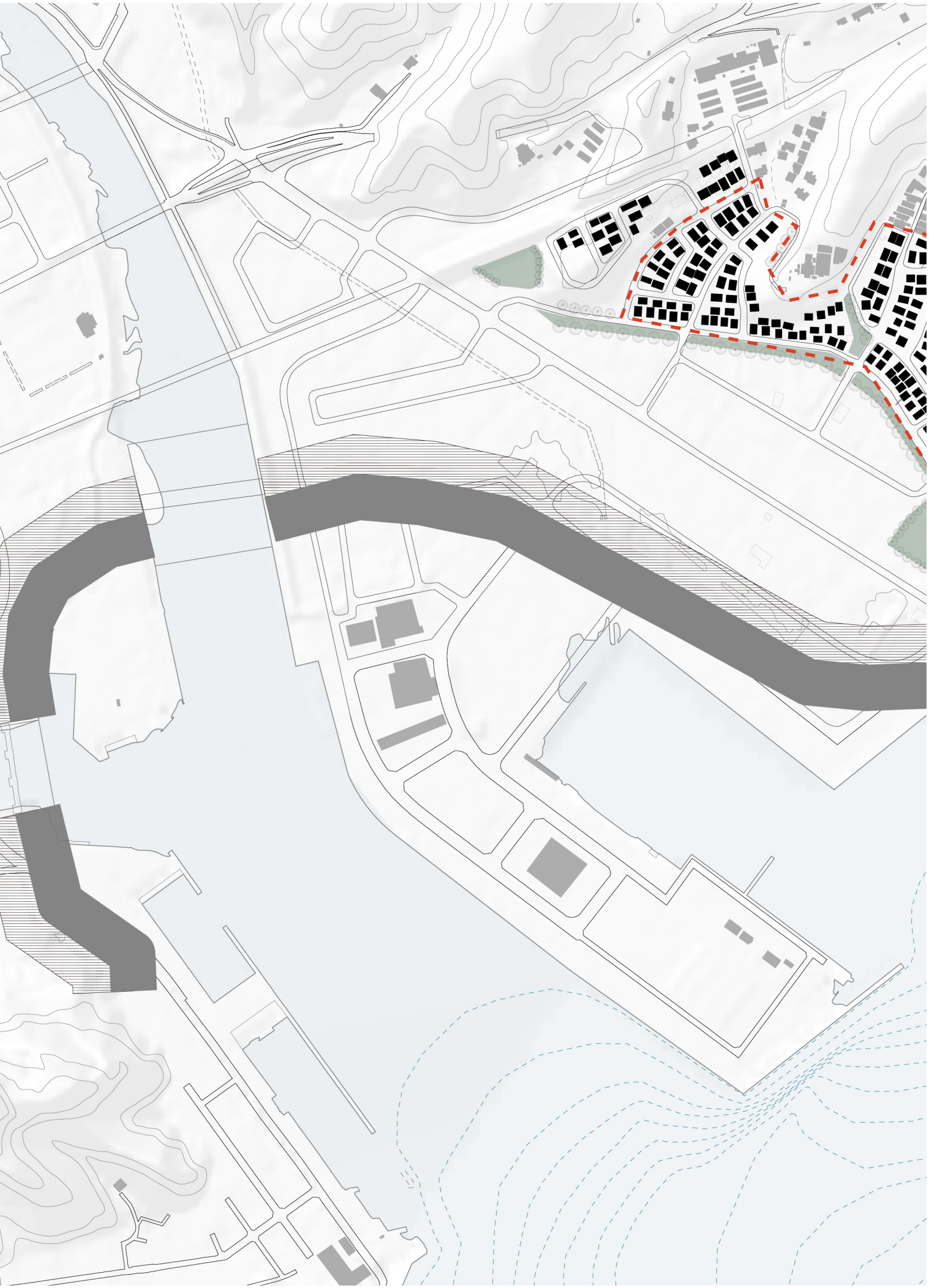
Block and building

Typology A

Typology B

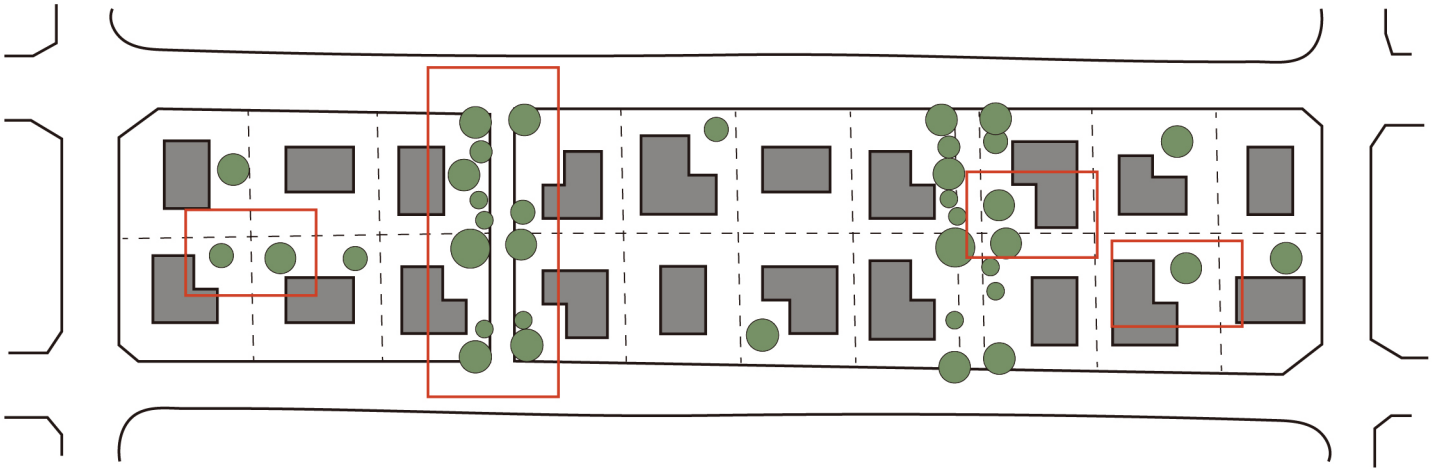
0.25 0.5 1 km

N

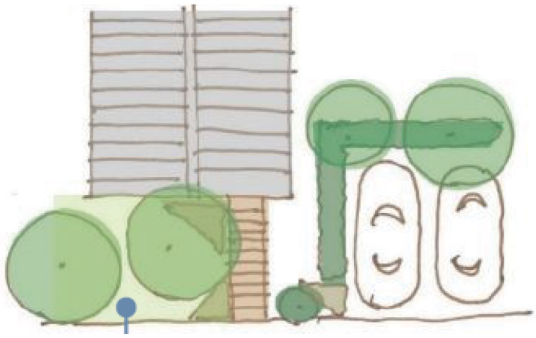


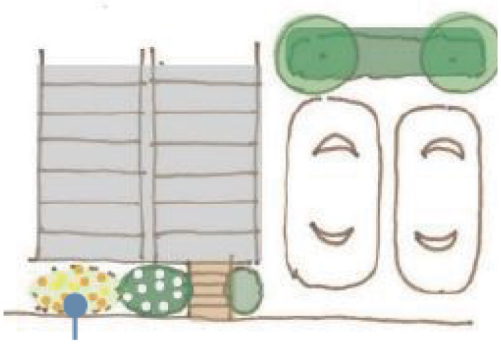


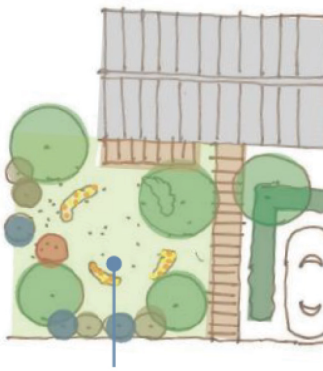




Local scale

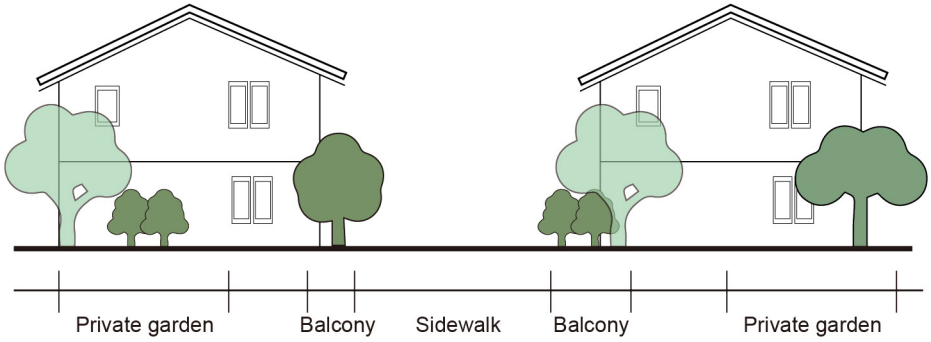




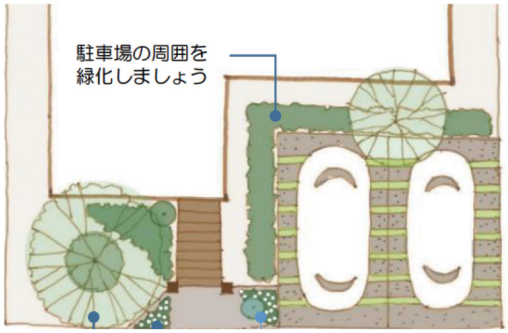


Plants can be seen in the small scale. Make the street like a park a town that m











ake people want to take a walk.





In this type, the building scale is larger and higher. And some government offices can be seen in this are.There are also some parks in the corner of block.





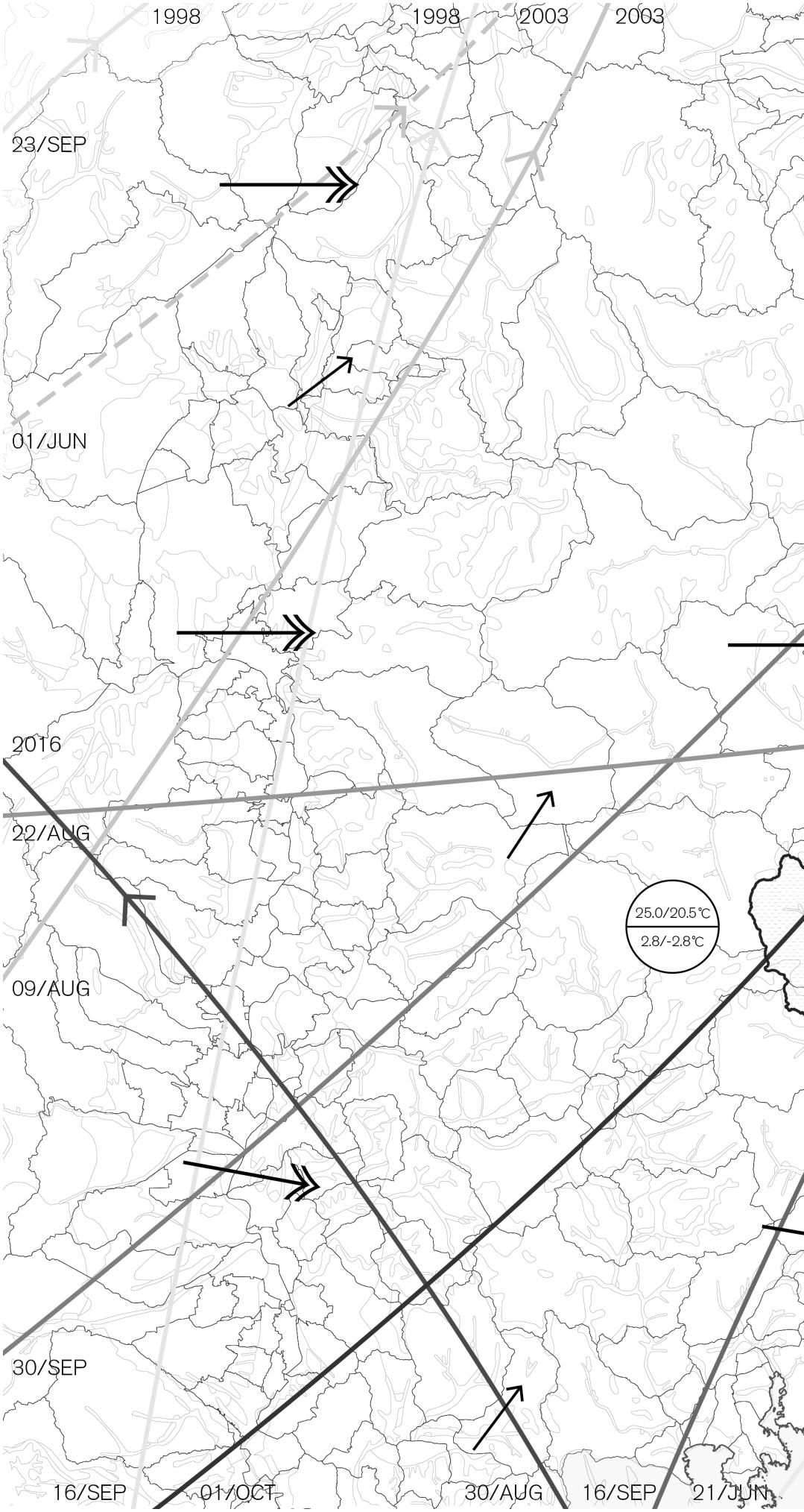
No.9 parks (御社地公園) have larger service area including visitors and all residents.

3.4.

Ecology

Cliamte & typhoon track

Otsuchi is located in the north-east part of Japan and suffered from natural hazards such as typhoons a lot. This map shows the typhoon tracks around Otshuchi in recent 25 years.



Average air temperature

25.0/20.5 AUG.
2.8/-2.8 JAN.

Average water temperature

18.8 AUG.
9.4 MAR.

Typhoon track

Tropical cyclone track

Average winter wind direction

Average summer wind direction

Cold current

Warm current

N

0 100 km


2001
2016
2018
2012
2013
2002
1997
Oyashio Current
2010
17.0km/h
18.8℃
9.4℃
OTSUCHI
Tsushima Warm Current
11.4km/h
Kuroshio Current
2009
2004
22/AUG
17/AUG
11/JUL
30/SEP
08/SEP

Biomes

In Otsuchi, a large amount of land is covered by nature, and most of it is forest. People in Otsuchi have strong connections with the forest. And the forest also provides habitats for different species of animals.



- Chestnut-quercus serrata forest
- Japanese red pine afforestation
- Cryptomeria,chamaecyparis,sawara plantation
- Town areas
- Greenery residential area
- Developed land
- Japanese larch afforestation
- Willow&shrub community
- Paddy field&weed community
- Carpinus tschonoskii-carpinus laxiflora community
- Chestnut-quercus crispula community
- Zelkova serrata community
- Japanese black pine afforestation
- Coastal cliff vegetation
- Iwakaku and coastal cliffs coniferous forest
- Field weed communit
- Machilus thunbergii community
- Roadside/open space weed communities
- Abandoned field weed community
- Miscanthus sinensis community
- Beech community-logging site
- Natural bare land
- Residual/planted trees
- Orchard
- Amorpha fruitcosa spraying ground
- Bamboo grove
- Factory zone
- Open water
- Pasture
- Abandoned paddy field weed community
- Golf course & lawn

N

0 100 km



Flora

Since ancient times, people in Otshuchi were already started making use of the forest, they mostly use the forest as resources for construction materials. The forest also provides food, medical, and protection to people.

Chestnut-quercus serrata forest

Castanea crenata



Useage: Food/timber/ medicinal

Quercus Serrata



Useage: Charcoal/ mushroom logs

Japanese red pine afforestation

Pinus densiflora (Japanese red pine)



Useage: Ornamental tree/ firewood/building materials/medicinal

Cryptomeria, Chamaecyparis, sawara plantation

Cryptomeria japonica



Useage: Parsnip tree/ building materials/ incense

Chamaecyparis obtusa



Useage: Building materials/ Essential oil

Chamaecyparis pisifera (Sawara Japanese)



Useage: Timber/ornamental tree

Japanese larch afforestation

Larix kaempferi (Japanese larch)



Useage: Forestry plantations/ construction work

Paddy field&weed community

Japanese rice



Useage: Food

Willow&shrub community

Phragmites australis (Reed)



Useage: Papermaking raw material/medicinal material/fertilizer/ fuel/instrument

Zizania latifolia (Manchurian wild rice)



Useage: Food/black pigment

Carex kobomugi (Japanese sedge)



Useage: Windproof and sand fixation

Chestnut-quercus serrata forest

Castanea crenata



Useage: Food/timber/ medicinal

Quercus crispula Blume



Useage: Shiitake mushroom cultivation/ furniture/building materials/wine barrels

Carpinus tschonoskii-Carpinus laxiflora community

Carpinus tschonoskii



Useage: Ornamental tree/ charcoal/boundary tree

Carpinus laxiflora



Useage: Ornamental tree

Coastal cliff vegetation

Peucedanum japonicum



Useage:
Herb/food

Lilium maculatum Thunb



Useage:
Gardening/
food

Dianthus japonicus



Castanea crenata



Iwakaku and coastal cliffs coniferous forest

Pinus densiflora (Japanese red pine)



Useage:
Ornamental tree/
firewood/building
materials/medicinal

Juniperus Rigida

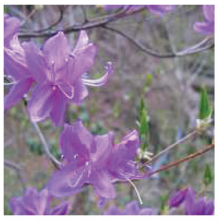


Useage:
Aroma oil/herb

Lespedeza buergeri



Rhododendron dilatatum



Enkianthus subsessilis



Machilus thunbergii community

Machilus



Miscanthus sinensis community

Maiden silvergrass



Useage:
Ornamental
plant/material for
thatched roofs/
food for livestock

Beech community-Logging site

Beech



Useage:
Firewood/furniture/
ornamental tree

Amorpha fruitcosa spraying ground

Amorpha fruticosa



Useage:
Nitrogen fixation/
ornamental plant

Bamboo grove

Bamboo



Useage:
Construction/
textiles/musical
instruments

Zelkova serrata community

Zelkova serrata



Useage:
Timber

Japanese black pine afforestation

Pinus thunbergii (Japanese black pine)



Useage:
Windbreak/tidal
forest/ornamental
tree/medicinal



Fauna

Because nature is well protected, the Otsuchi area has really good biodiversity. This map shows how those species are distributed in this area.

Some of them are like living near housing, fields, and city areas, and some are not.

Forest

N

0 100 km



Fauna

There are a large number of animal species living in the Otsuchi area, some are living with people, some are breeding in this area, and some have economic value.

■ Mammals

Crocidura dsinezumi



Habitat:
Watersides and forests, around farmlands, and houses.

Japanese shrew mole (Urotrichus talpoides)



Habitat:
Under the leaves of alpine forest and grasslands.

Small Japanese mole (Mogera Imaizumii)



Habitat:
Lowland grasslands and agricultural land, and prefers moist and deep plains.

Greater horseshoe bat (Rhinolophus ferrumequinum)



Habitat:
Forest, cave

Raccoon dog (Nyctereutes procyonoides)



Habitat:
Hardwood and coniferous forests around rivers, lakes and coasts

Japanese marten (Martes melampus)



Habitat:
Boreal forests

Red fox (Vulpes vulpes)



Habitat:
High mountains, plains, forests, grasslands

Japanese Weasel (Mustela itatsi)



Habitat:
waterfronts such as rivers, lakes, swamps, and swamps, forest areas

Japanese badger (Meles anakuma)



Habitat:
Mountains, forest areas

Japanese black bear (Ursus thibetanus)



Habitat:
Alpine region

Japanese squirrel (Sciurus lis)



Habitat:
Forest



Japanese giant flying squirrel (Petaurista leucogenys)

Habitat:
Forest

Sika deer (Cervus nippon)



Habitat:
Subtropical forests

■ Birds

Little grebe (Tachybaptus ruficollis)



Habitat:
Coast

Season:
Winter

Red-necked grebe (Podiceps grisegena)



Habitat:
Coastal and estuary areas

Season:
Winter

Streaked shearwater (Calonectris leucomelas)



Habitat:
Inshore waters, offshore islands

Breeding

Little grebe (Tachybaptus ruficollis)



Habitat:
The rock crevices

Breeding

Japanese cormorant (Phalacrocorax capillatus)



Habitat:
Rocky shores

Season:
Breeding/winter

Night heron (Nycticorax nycticorax)



Habitat:
Rivers, lakes, ponds, marshes, paddy fields, coasts, etc.

Season:
Winter

Little egret (Egretta garzetta)



Habitat:
Lake shores, paddy fields, river banks, beaches, mudflats and coastal streams

Season:
Winter

Black kite (Milvus migrans)



Habitat:
Nests on trees

Season:
Breeding/winter

Slaty-backed gull (Larus schistisagus)



Habitat:
Ocean, river mouths, tidal flats, and surrounding lakes and marshes

Season:
Breeding/winter

Black-tailed gull (Larus crassirostris)



Habitat:
Coastal areas, estuaries, and tidal flats

Season:
Breeding/winter

■ Freshwater fish

Japanese dace (Tribolodon hakonensis)



Habitat:
Upstream and downstream of the river

Pond loach (misgurnus anguillicaudatus)



Habitat:
Rivers, lakes, ponds and paddy fields

■ Migratory fish

Chum salmon (Oncorhynchus keta)



Habitat:
River/sea

Masu salmon (Oncorhynchus masou masou)



Habitat:
River/sea

Sweetfish (Plecoglossus altivelis altivelis)



Habitat:
Downstream of the river

■ Sea fish

Pufferfish (Takifugu rubripes)



Habitat:
Bay area

Fat greenling (Hexagrammos otakii)



Habitat:
Bottom layer

Sardine (Sardinops melanostictus)



Habitat:
Sea

Japanese serow (Capricornis crispus)

Habitat:
temperate deciduous forest, broad-leaved or subalpine coniferous forest made up of Japanese beech Japanese oak



■ Shellfish

Umbonium costatum



Habitat:
Seabed

Yoldia notabilis



Habitat:
Seabed

Japanese scallops (Mizuhopecten yessoensis)



Habitat:
Seabed

Mercenaria stimpsoni



Habitat:
Seabed

Sea potato (Mizuhopecten yessoensis)



Habitat:
Seabed

Scaphechinus mirabilis



Habitat:
Seabed



Soil type

- Rocky land
- Light allophane black soil
- Weathered red-yellow soil
- Lowland soil
- Gray lowland soil
- Brown forest soil

N

0 100 km



Soil type

By analyzing the humus and clay minerals and comparing different types of soil, a ranking of soil fertility can be implemented.

The rocky land has worest soil fertity as there are barely no vegetations grow on it, and the light allophane black soil has the best soil fertity, as it has rich accumulation of humus and clay minerals.

Light allophane black soil



The most commonly seen black soil. Soil characterized by the accumulation of humus and clay minerals (alofene, imogolite) with weak crystallinity produced by weathering under good drainage conditions, mainly from volcanic emissions.

Clay minerals generally produced from volcanic ash are mostly amorphous minerals such as allophane and imogolite. It has a characteristic that volcanic ash is carried by wind and piles up (wind piles), so it is distributed regardless of topography, except for new alluvial areas and steep slopes.

Weathered red-yellow soil



Weathered altered red-yellow soil is generally red or yellow soil with low organic saturation, low base saturation, and advanced weathering.

Weathered and altered red-yellow soil is widely used as paddy fields, ordinary fields, and orchards in agricultural fields.

Gray lowland soil



Alluvial soil in intermediate wetness. Typical soil of Japanese paddy fields. A porphyry layer showing wetness characteristics of groundwater developed by the saturation of seasonal groundwater appears within 50 cm below the surface.

The porphyry layer due to groundwater is characterized by the presence of tubular and membranous porphyrites along the pores and cracks, which is different from the graying layer of paddy fields caused by irrigation water that is graying along the pores. It is widely distributed on the coast / river plains, valley floors and fans, and the topography is almost flat.

Brown forest soil

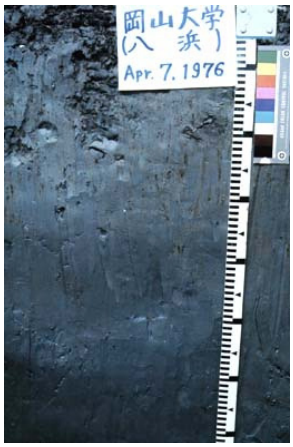


Soil with brown or tan "weathered alteration layer" distributed in mountains and hills that are less affected by volcanic ash.

"Weathered alteration layer": A layer that has changed its color due to weathering, has a large amount of clay, or has a massive structure

Brown forest soil has a dark surface layer rich in organic matter in forest areas, but in organic areas such as orchards and upland fields, organic matter content is generally small and the surface layer is thin. The next surface layer is uniformly brown or yellowish brown due to free iron oxide, and the migration and accumulation of clay and free iron from the surface layer to the next surface layer is not clear.

Lowland soil



The soil with the highest groundwater level in the lowland soil swarm, and the gly layer that is saturated with water throughout the year appears within 50 cm.

Widely distributed in floodplains, back marshes, deltas, and tidal plains. The groundwater level is high and drainage is generally poor. Most are used as paddy fields. In order to improve drainage for agricultural use, drainage from underdrain is often implemented.

Fertility

In Otsuchi the soil around the city area usually has butter soil fertility, which means this area is could support more agriculture activities.



High

Low

N

0

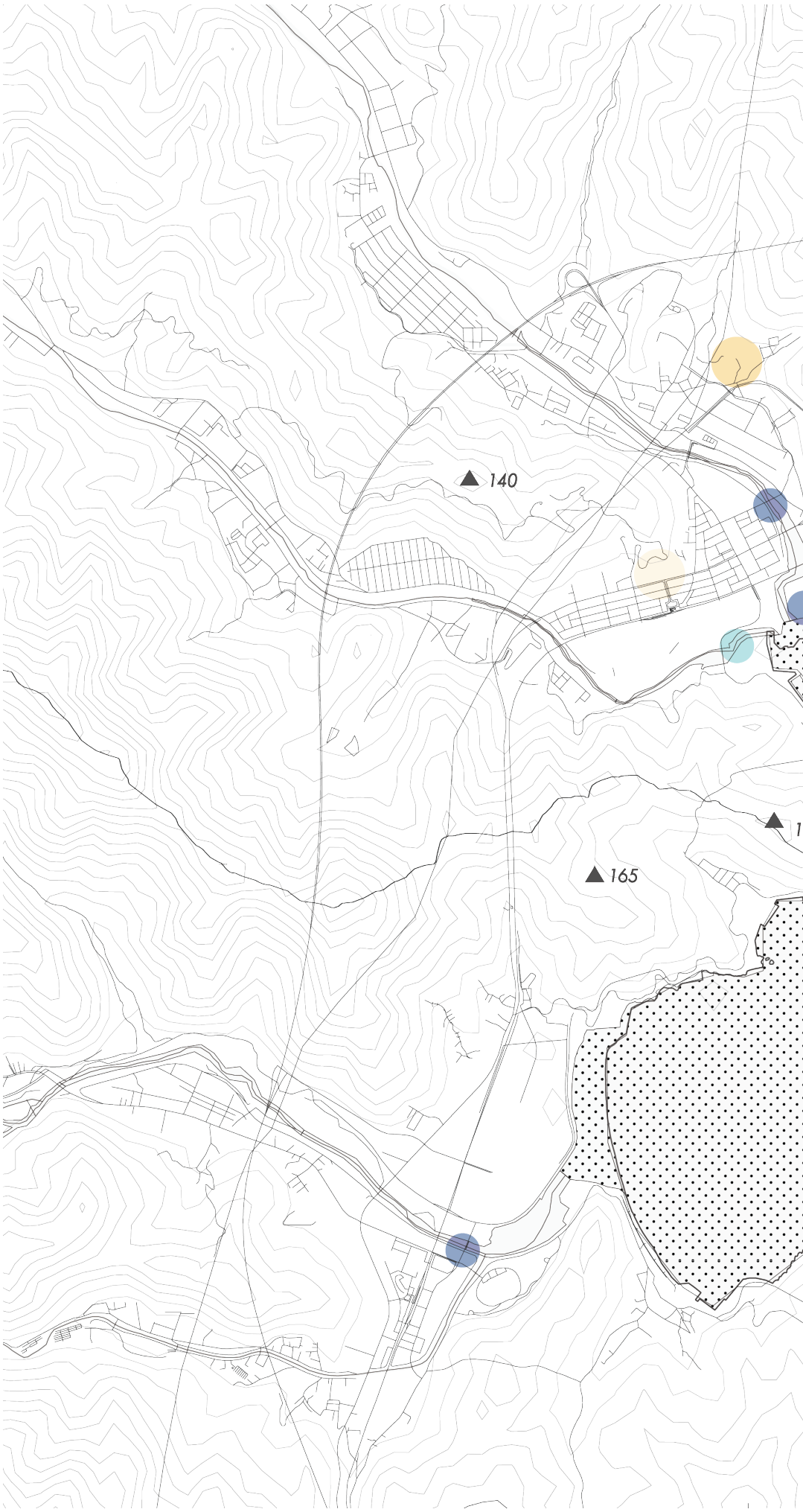
100 km

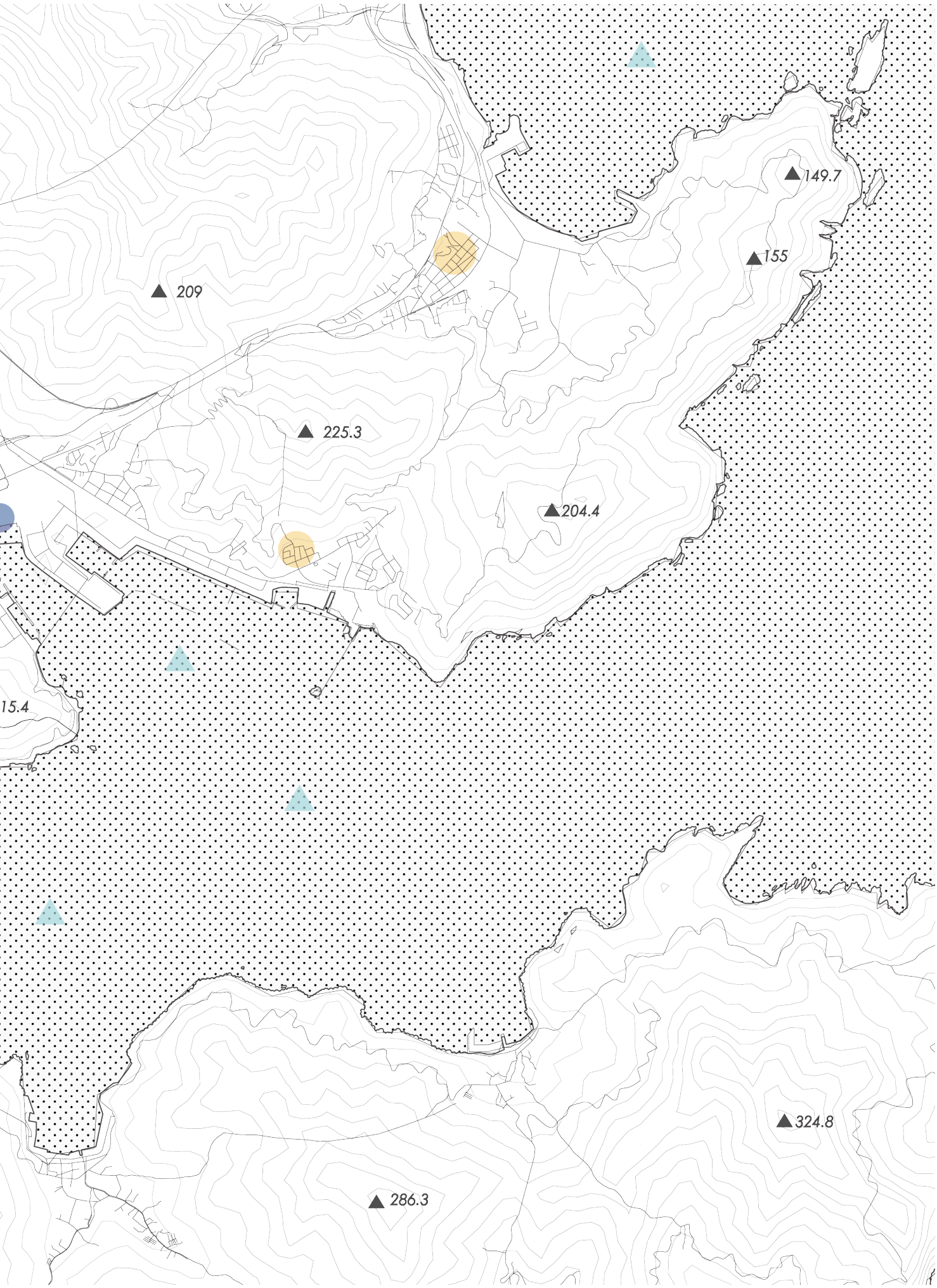


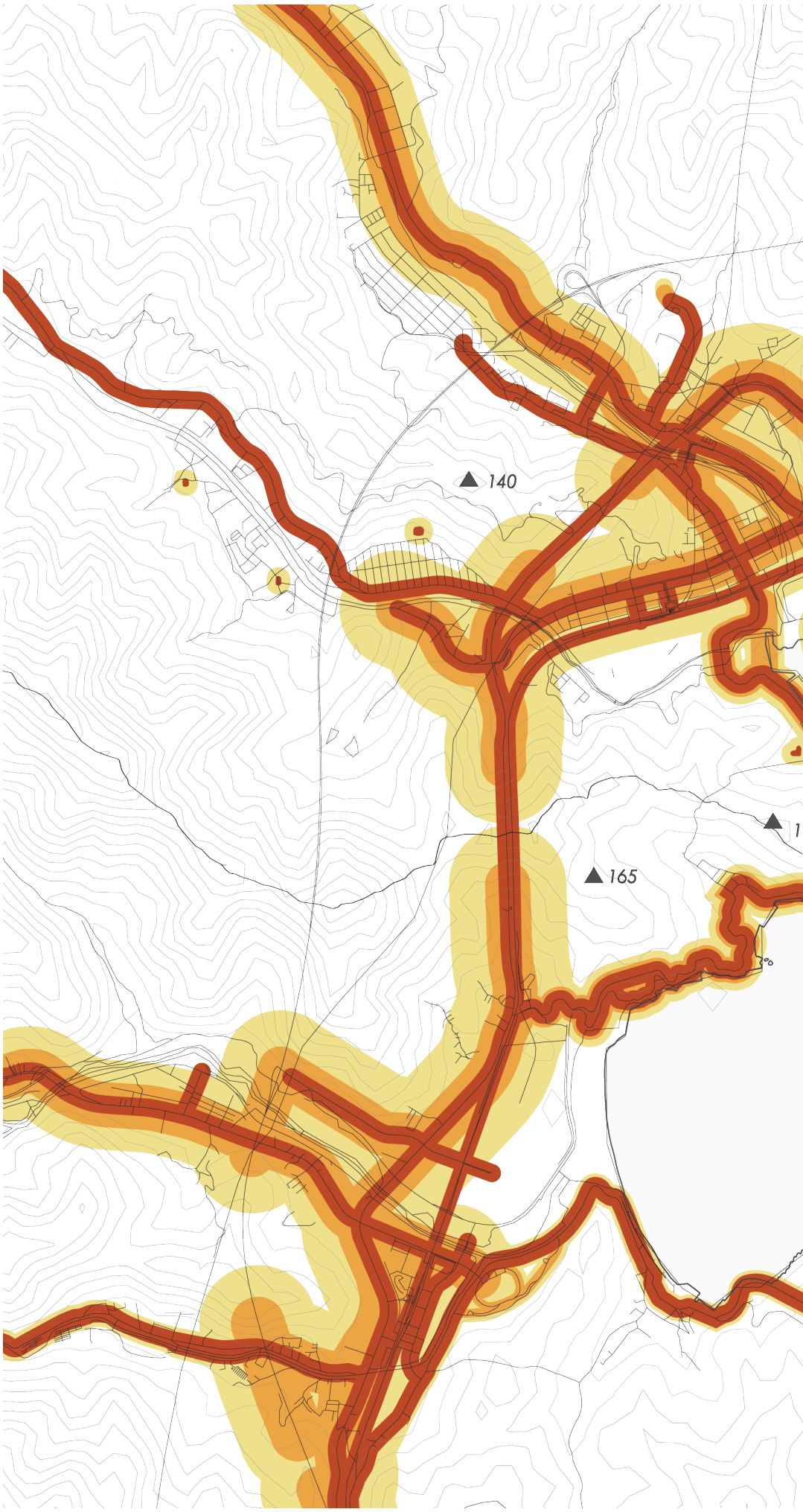
Water and nuclear pollution

The water system in Otsuchi does not have serious pollution issues, only little chemical oxygen demand and biochemical oxygen demand are tested in this area.

Another potential pollution is nuclear pollution from Fukushima, however, it is not a threatening for people anymore because it has now decayed to a very low level.




149.7
155
209
225.3
204.4
15.4
324.8
286.3



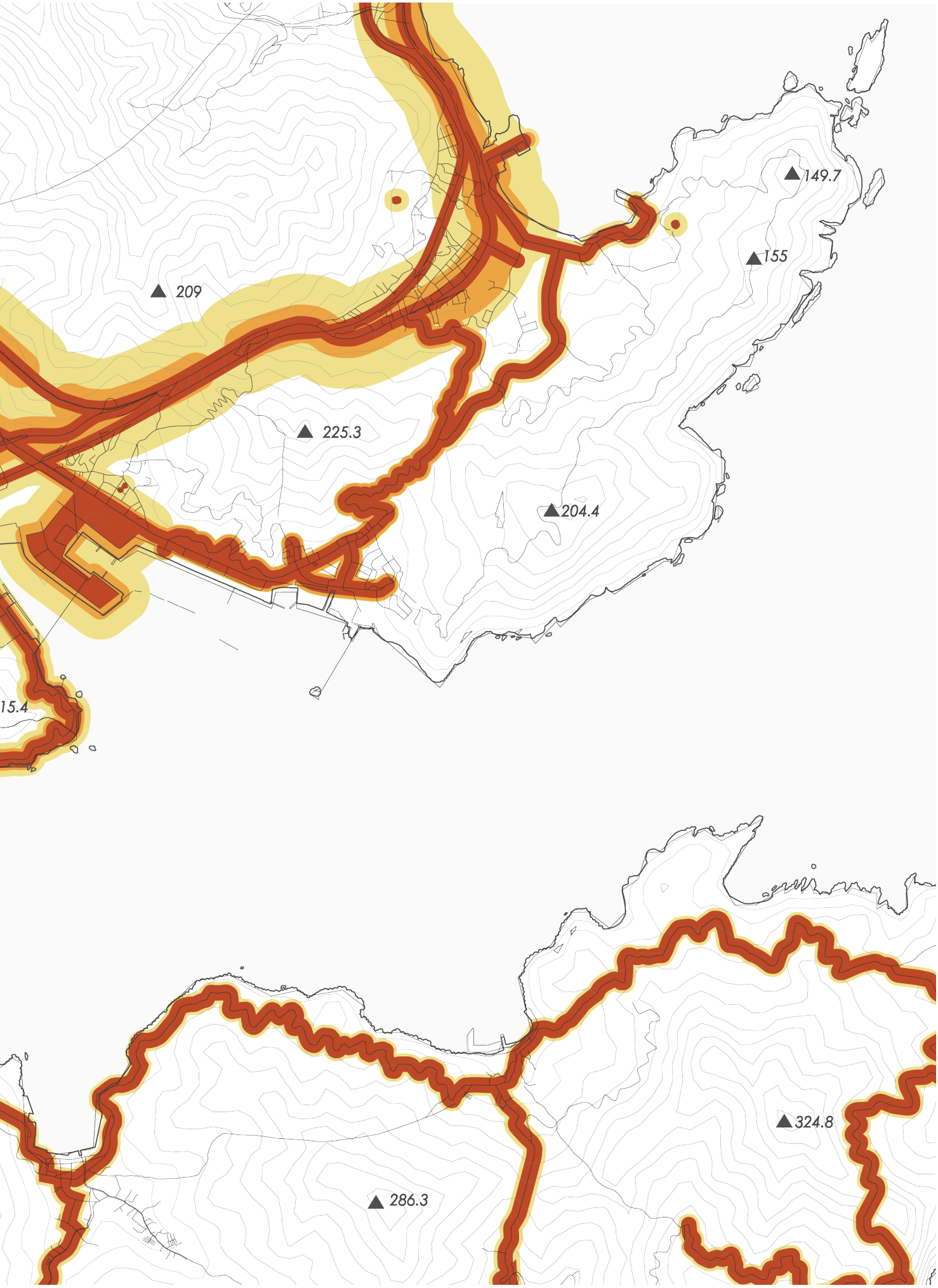
Noise pollution

The main noise pollution source in Reine is the highway, harbor, and industrial area. And in some areas, the noise is reduced by the forest.

- ≥ 65 dB
- 55 - 64.9 dB
- 45 - 54.9 dB

N

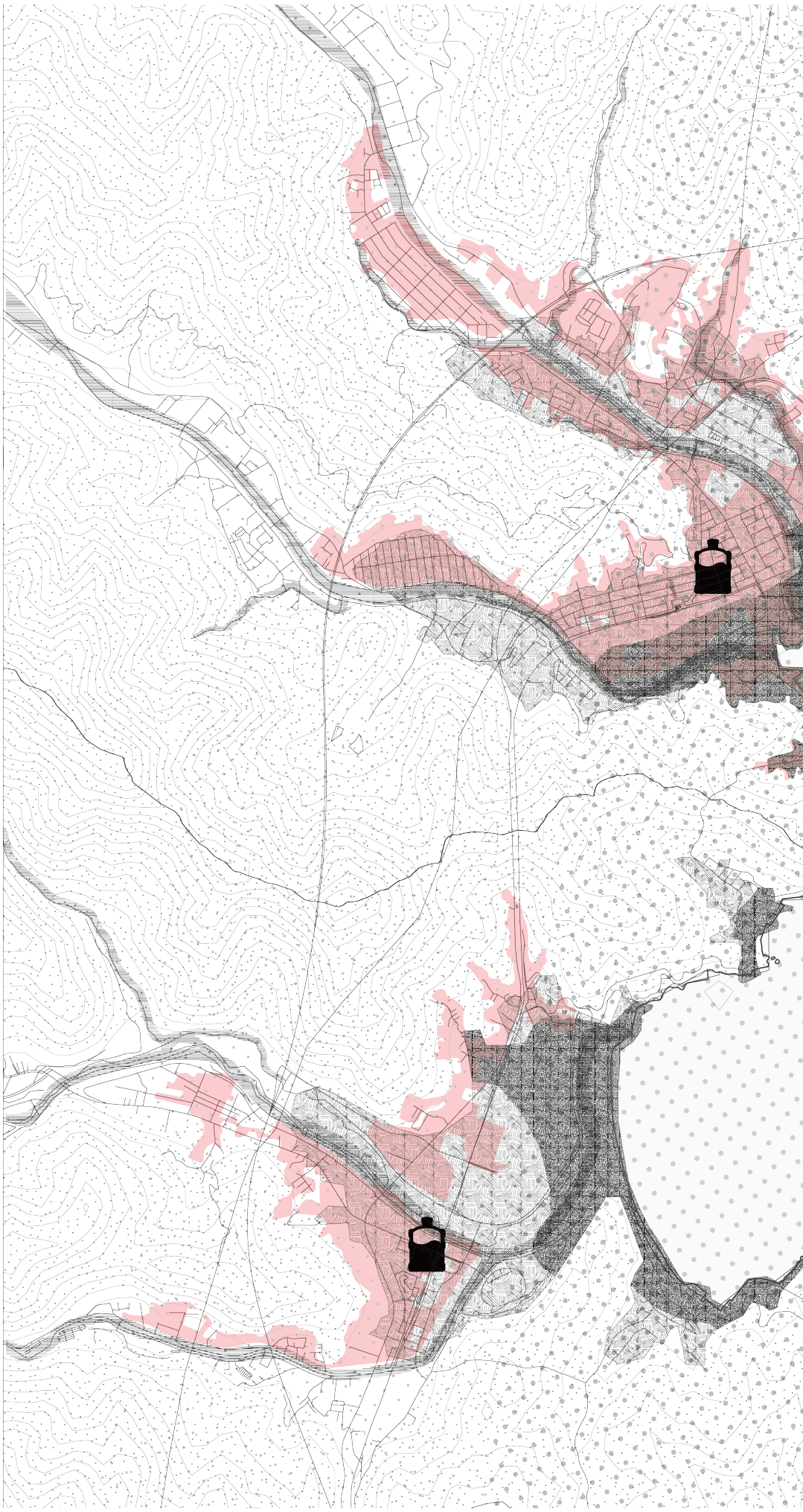
0 100 km

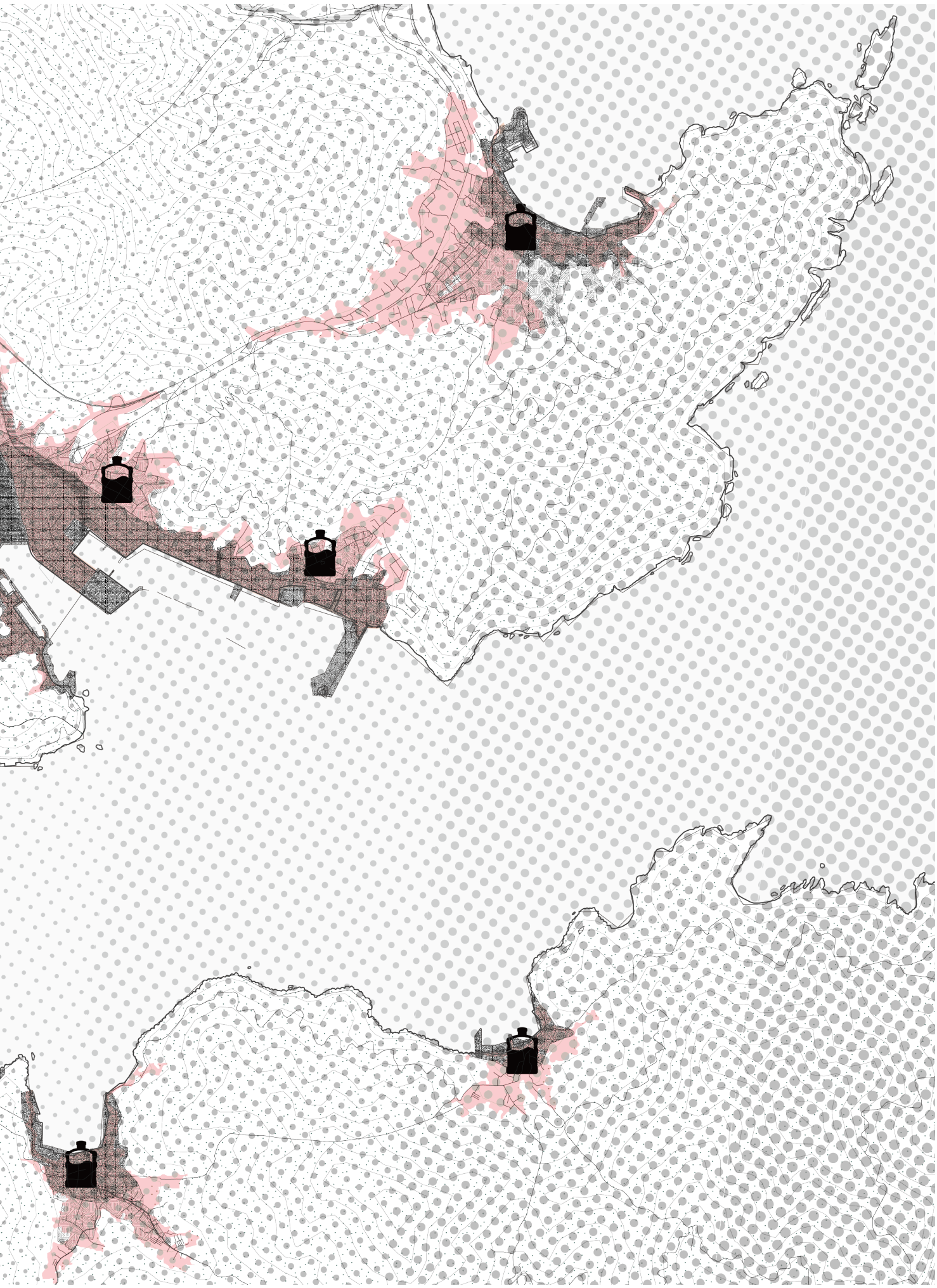

149.7
155
209
225.3
204.4
15.4
324.8
286.3

Extreme ecology

Otsuchi bay suffers from tsunami a lot, in the 2011 tsunami, almost all the buildings in this area were distorted. When emergencies come, there is no reliable freshwater supplement for local people.

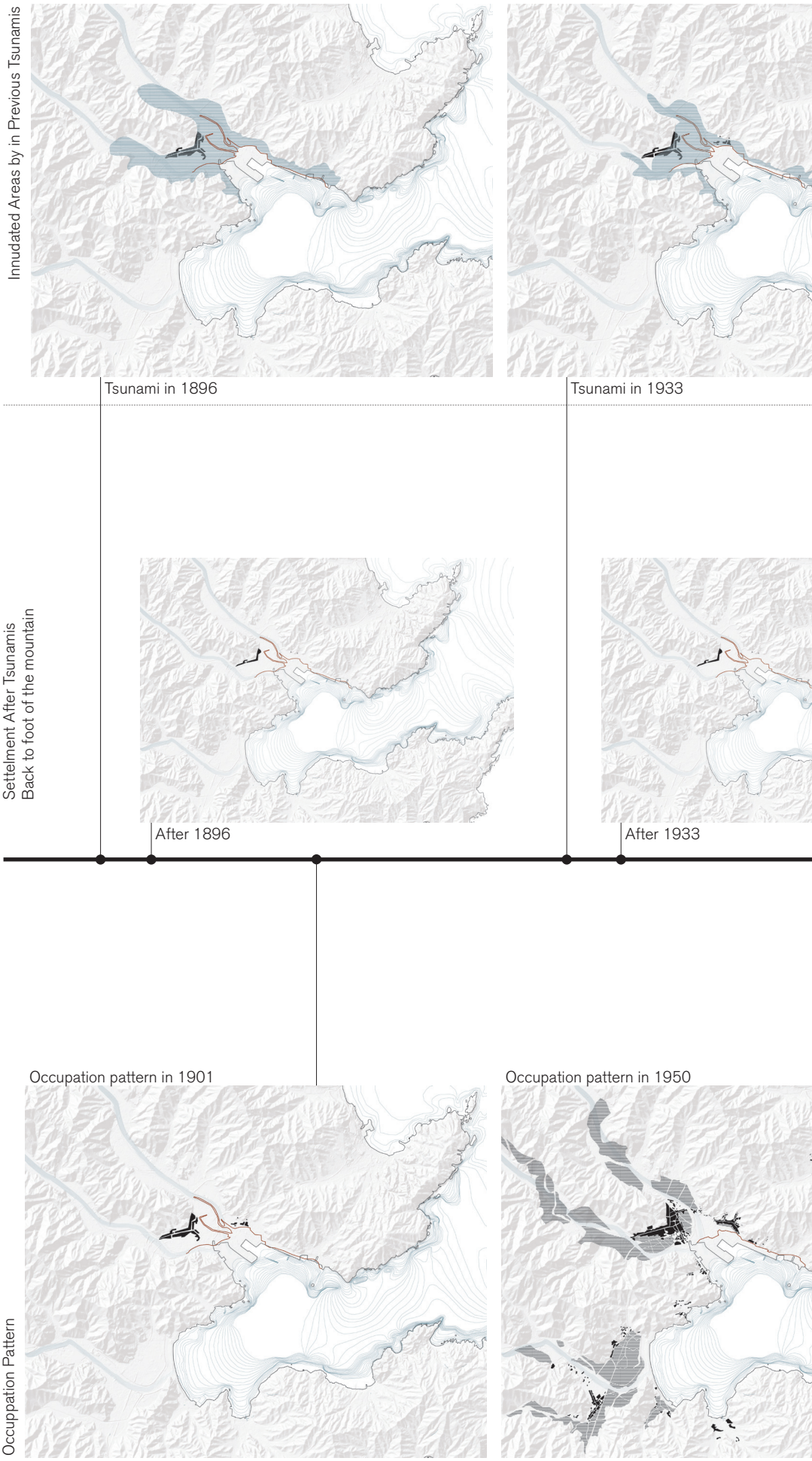
As Otsuchi is in the northeast of Japan, each year during Jun. to Sep. people also suffer typhoons, which could also cause flooding and other secondary disasters.





3.5.

Urban Morphology

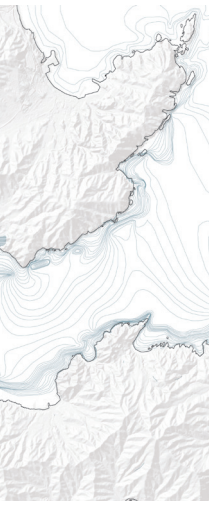


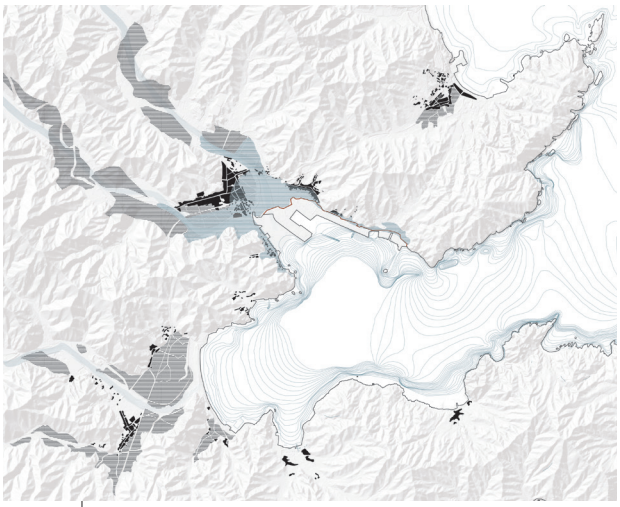
Settlement Chaning Process

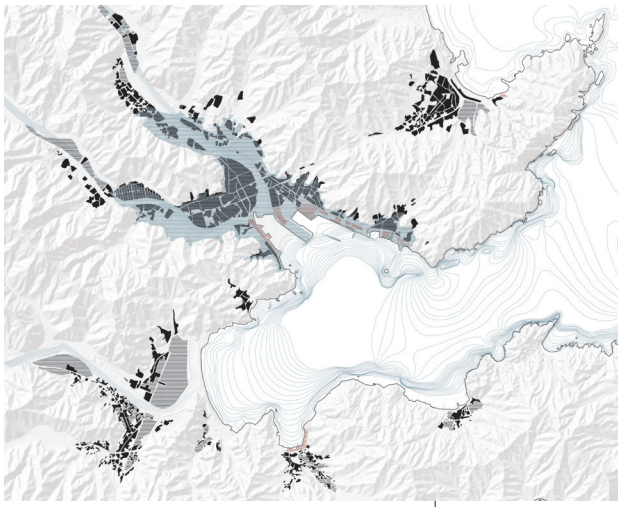
The settelment changing process is closely linked with the change in social, economic and natural backgrounds, which specificly reffers to tusnami, the port industry and a change in population in the case of Otsuchi.

- Residential area
- Farmland
- Industrial area
- Coastaline
- Innudated area

N

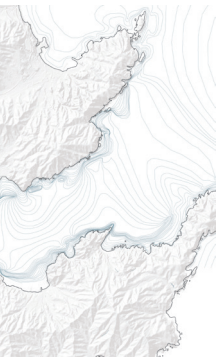






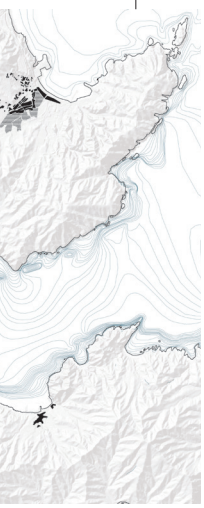
Tsunami in 1958

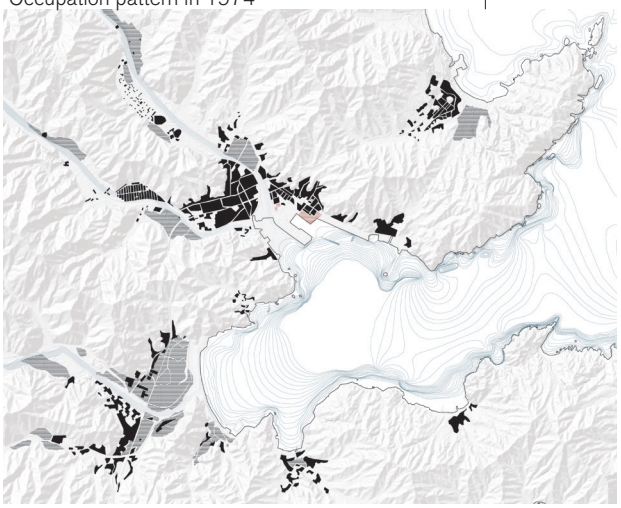
Tsunami in 2011

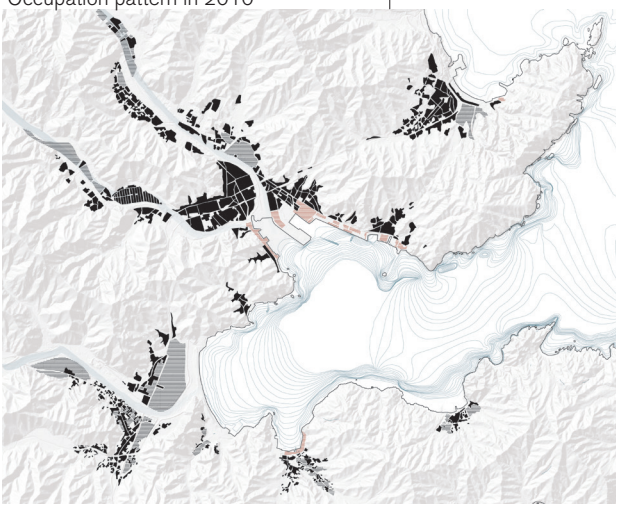


Occupation pattern in 1974

Occupation pattern in 2010







(Drawn by Author,2020 - Sourced from GIS data, Japan)

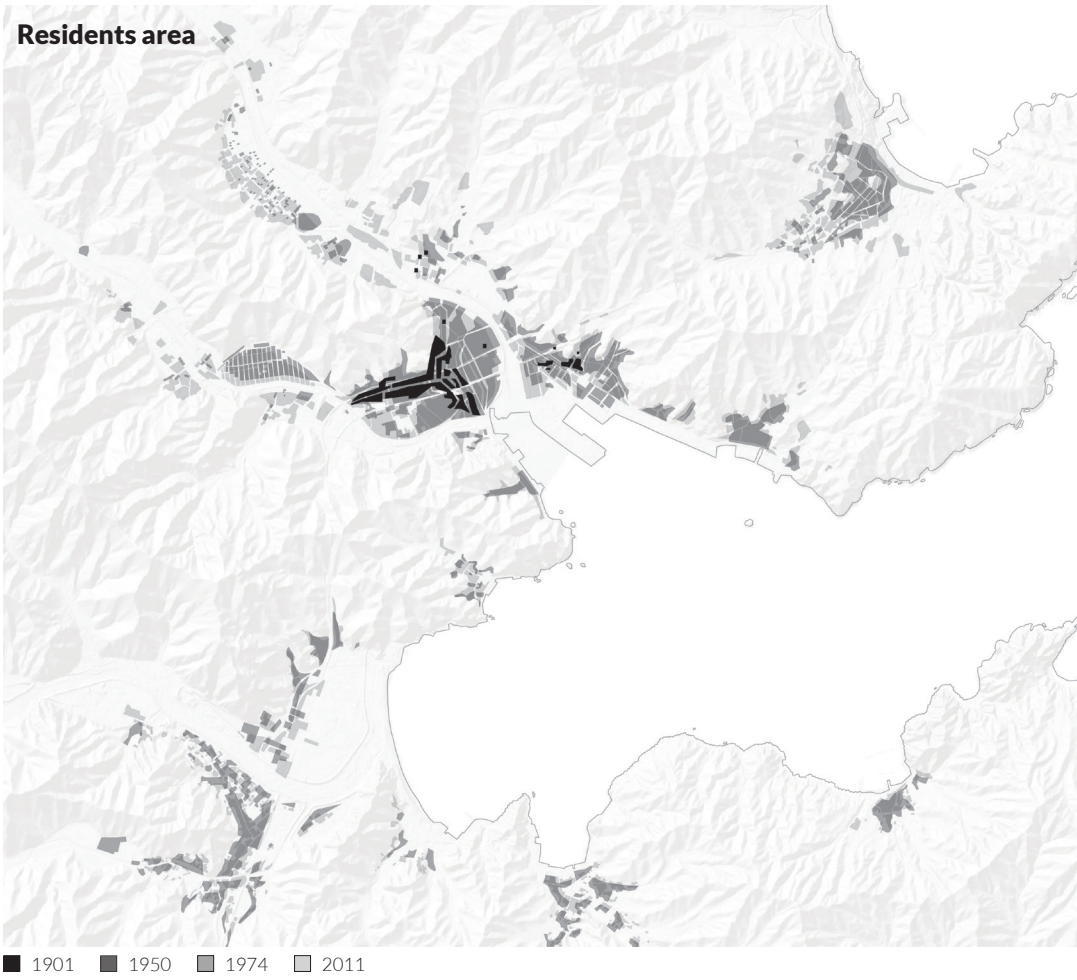
Changing Mechanism

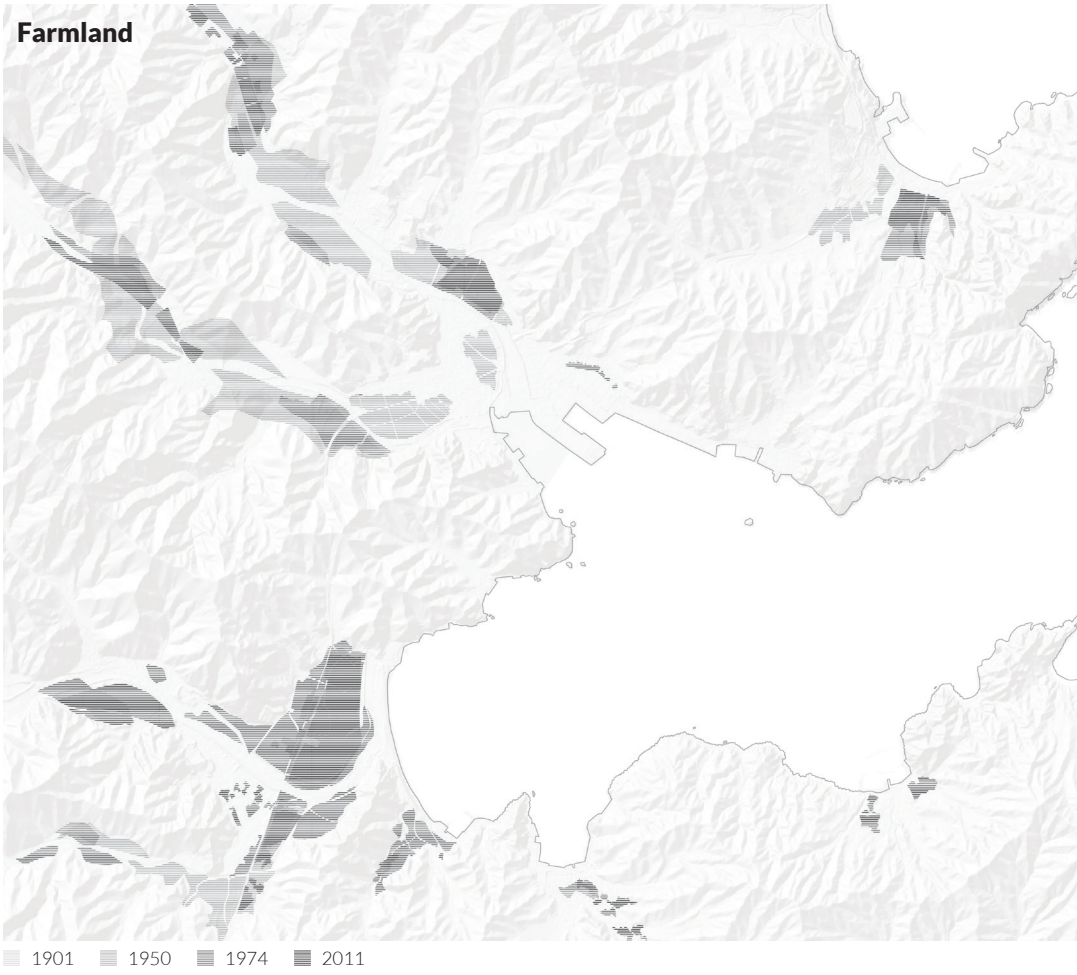
The images above show the changes chronologically, but I also find out there are some chaniging mechanisms behind each seperate elements, here I selected four catagories to show how they chang over time.

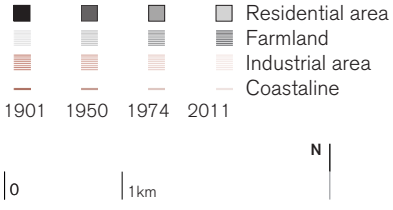
Historically the coastal communities are located near the mountain foot with distane to the sea, but with population growing and installation of hard-measure protections, people were gradually moving to the sea.

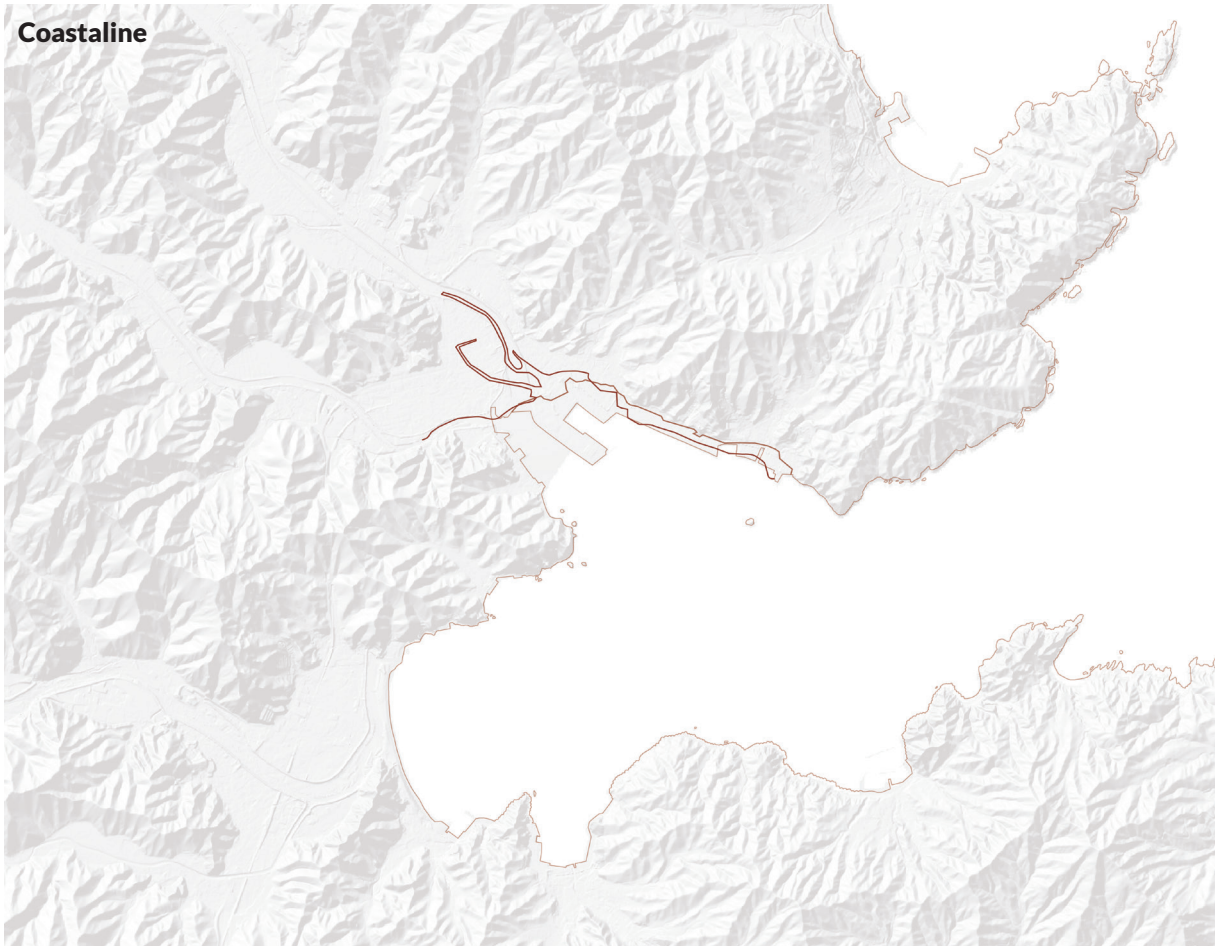
The coastal line was changed form a natural form to an artificial form as the land near the coast were reclaimed for port industry and fishing. This changing process is also shown in growing of industrial area.

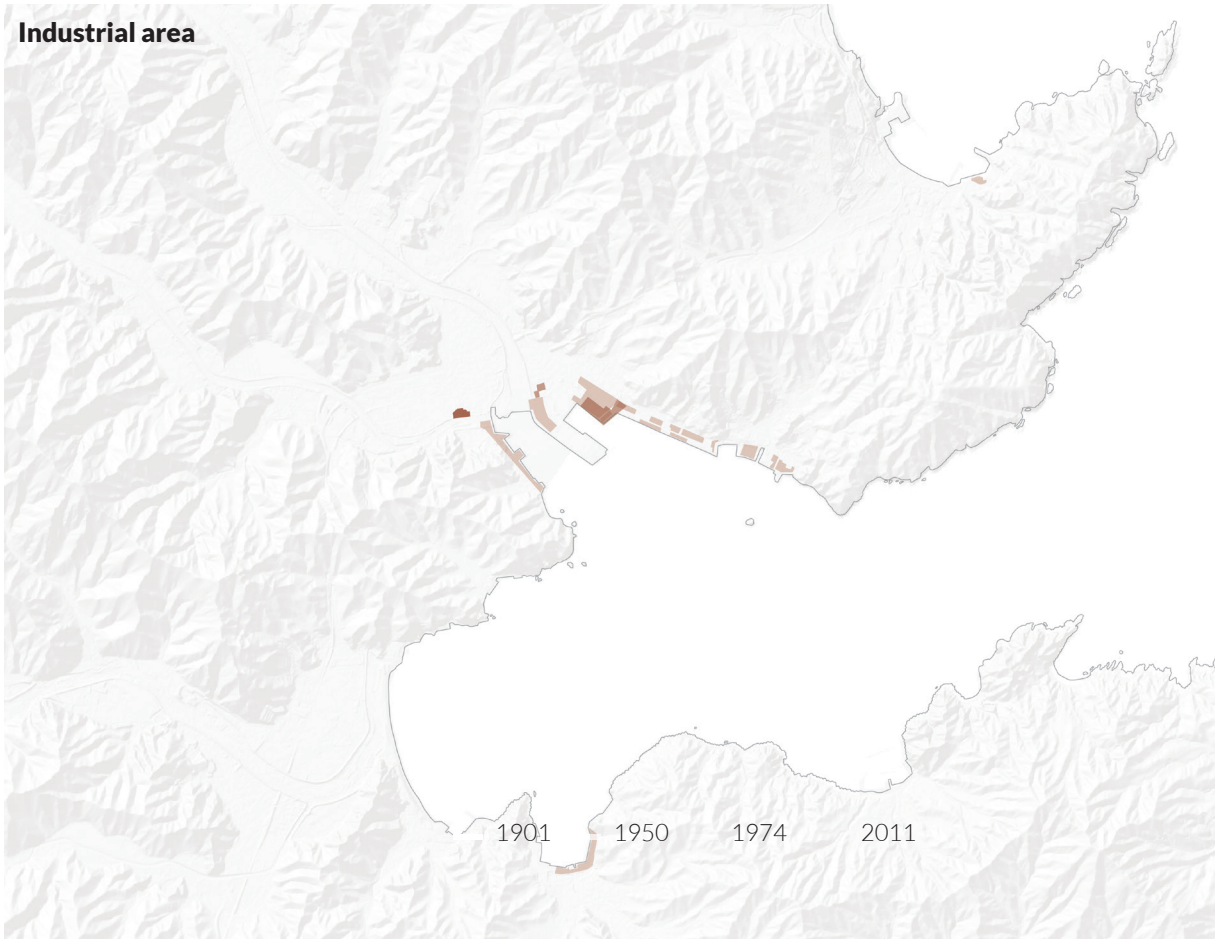
The farmland is growing rapidly after the world war two because of the rapid population growing. But after the development of fishing industry, more people are engaged in the marine-related job, so the farmland was shrinking after that.











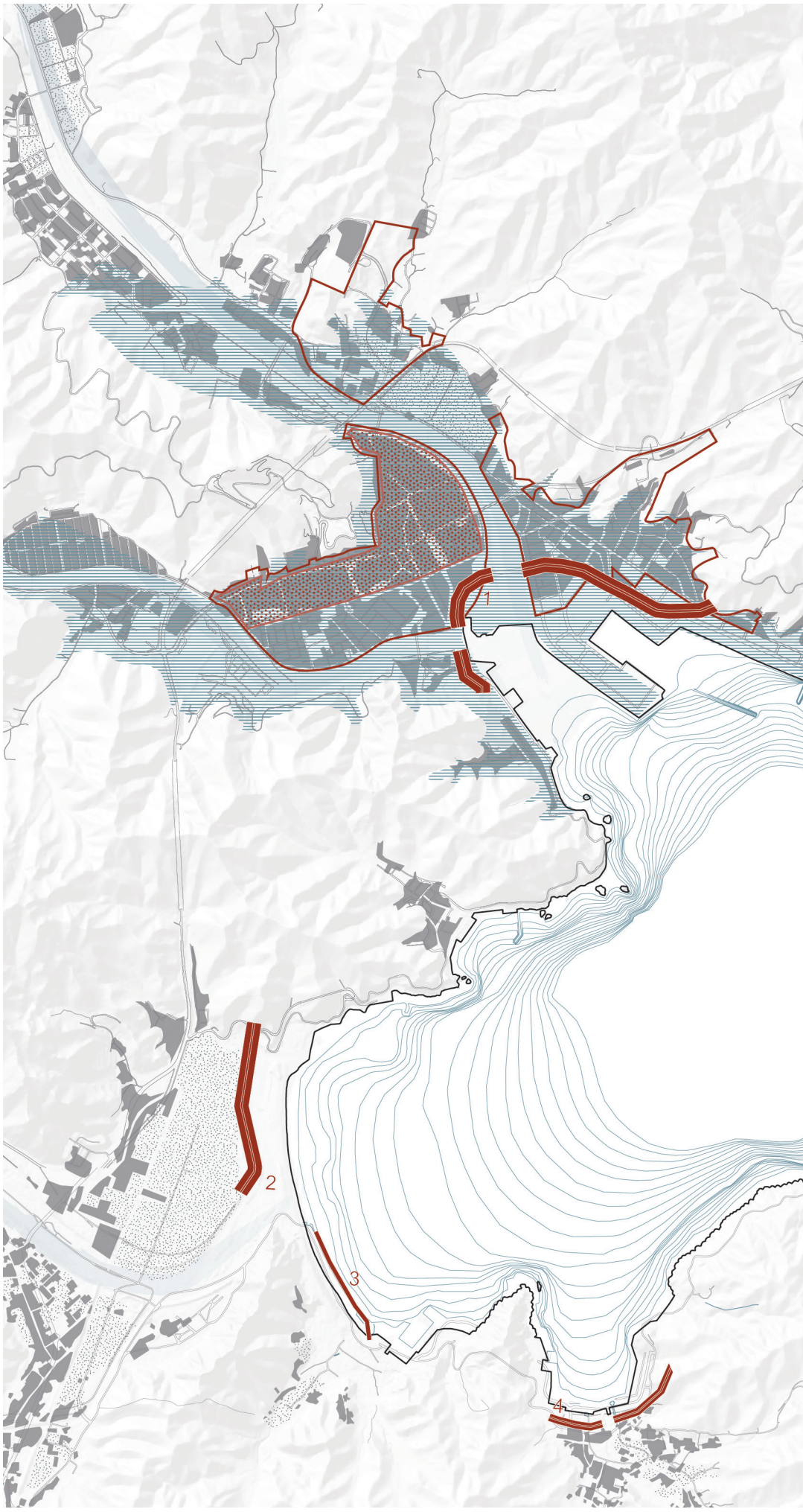
(Drawn by Author,2020 - Sourced from GIS data, Japan)

Extreme construction after 2011 tusnami

This map shows the innudated area in 2011 tsunami and the extreme constructions to protect this area from next disaster.

Alomst all the residenrial areas along the costal and rive is innudated. With this huge damage, extreme measures were taken to prepare this area for next disaster.

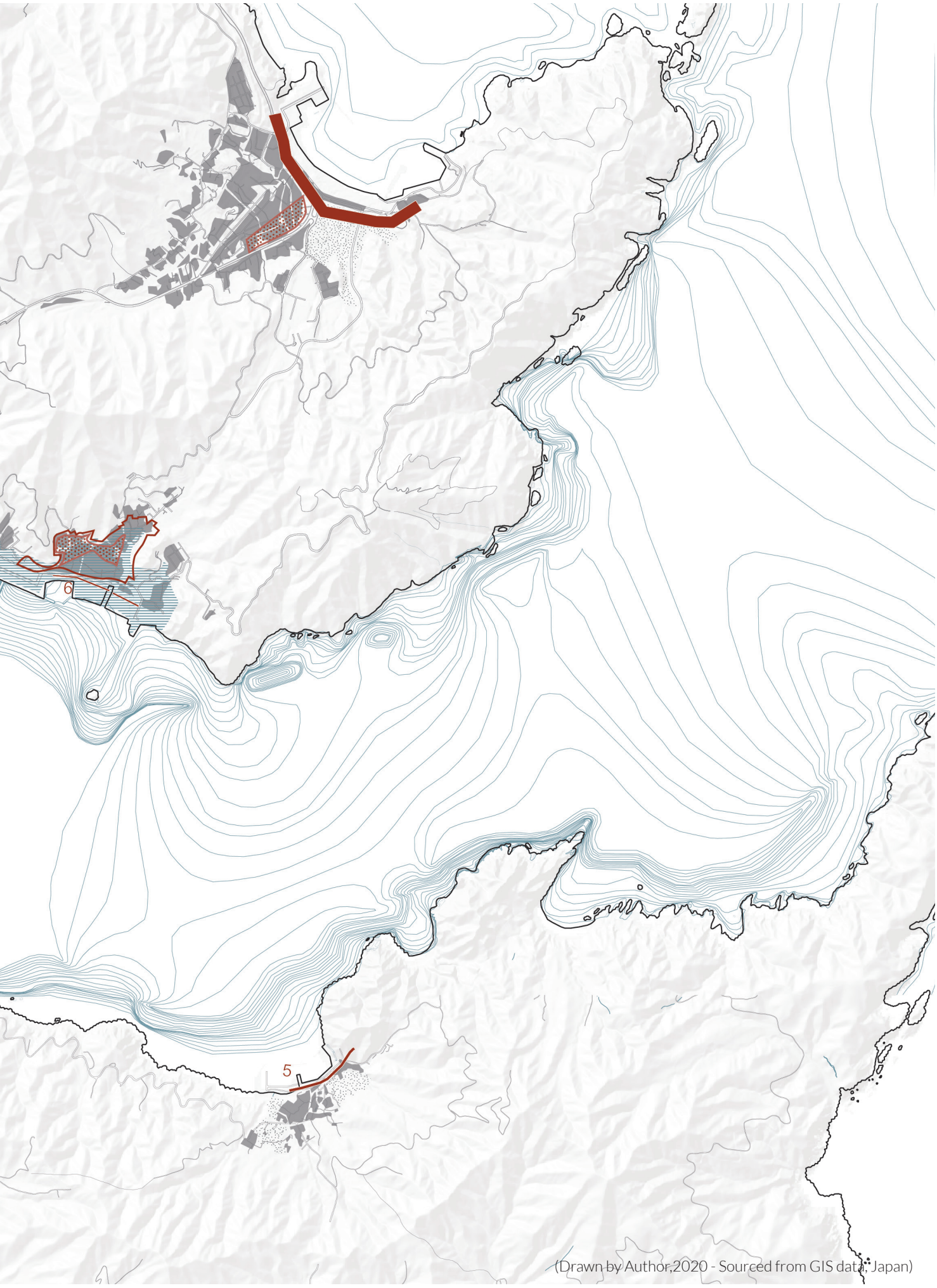
Main two kinds of extreme construction are conducted in this area, the sea dykes and land elevation.



- Residential area before 2011
- Farmland before 2011
- Seawall
- Land adjustment area
- Replanning area
- Innudated area

N

0 1km



(Drawn by Author,2020 - Sourced from GIS data, Japan)

Urban structure after 2011 tusnami

This map shows new urban structure after 2011 tsunami, the residential areas are moved to higher land, facilities and gathering palcesare located even higher. the lower land is used for recreation and industry. Dykes along the coastaline are built.



- Buildings before 2011tsunami
- Buildings after 2011tsunami
- Parks
- Gathering places
- Seawall
- Facilities

N

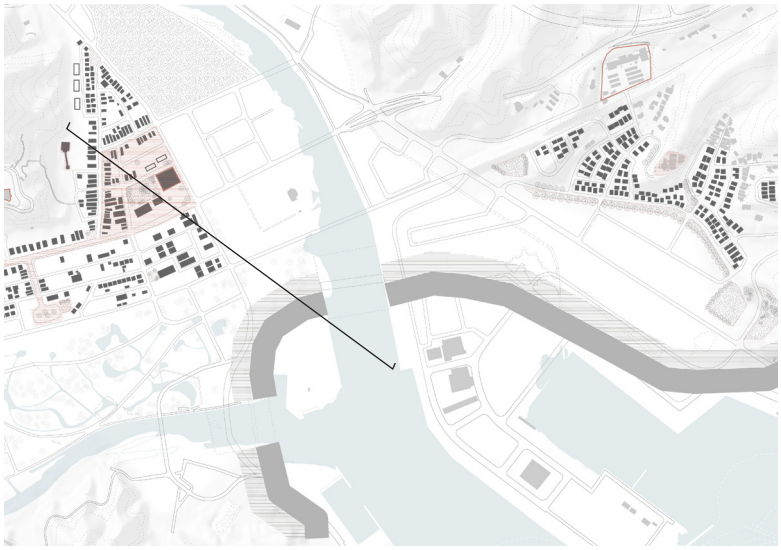
0 200m

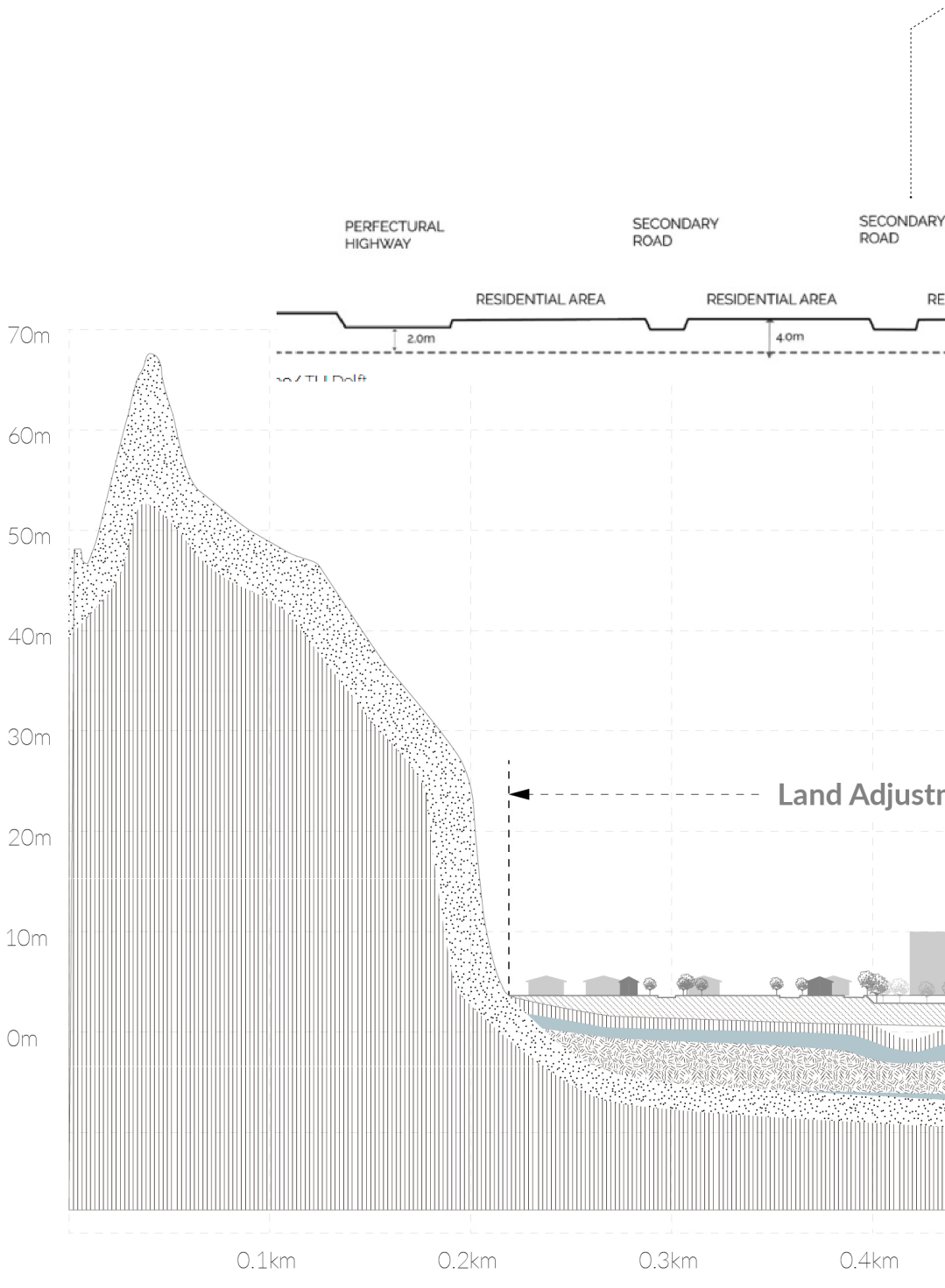


(Drawn by Author,2020 - Sourced from GIS data, Japan)

Extreme construction after 2011 tusnami

This section shows the situation from mountain to sea after the extreme construction to protecto people fome tsunami and the detail construction profile of land elevation and dyke.





Base Rock
Land Elevation
Sand
Marine Clay
Aquifer
Buildings

N

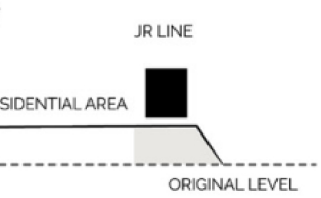
0 1km



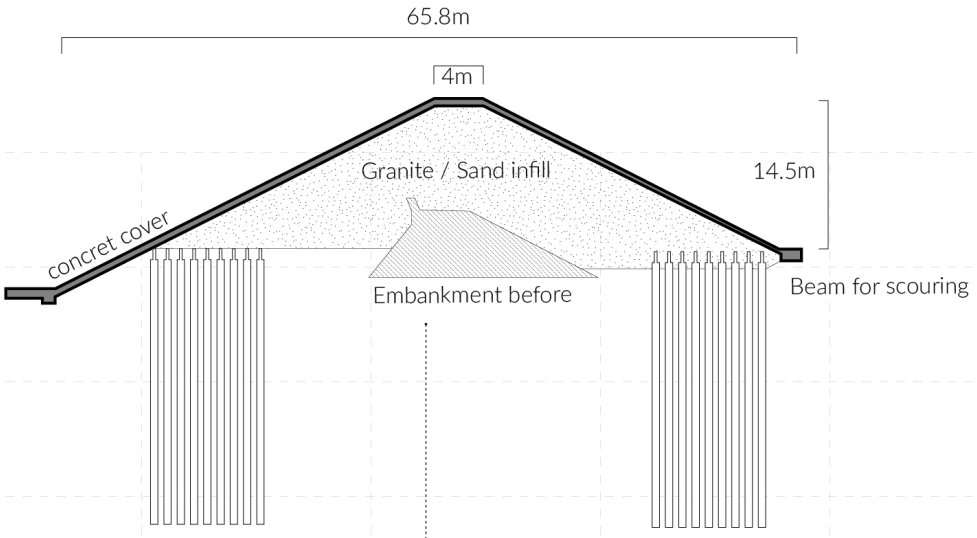
Picture of land elevation
(Source: https://www.google.nl/maps)



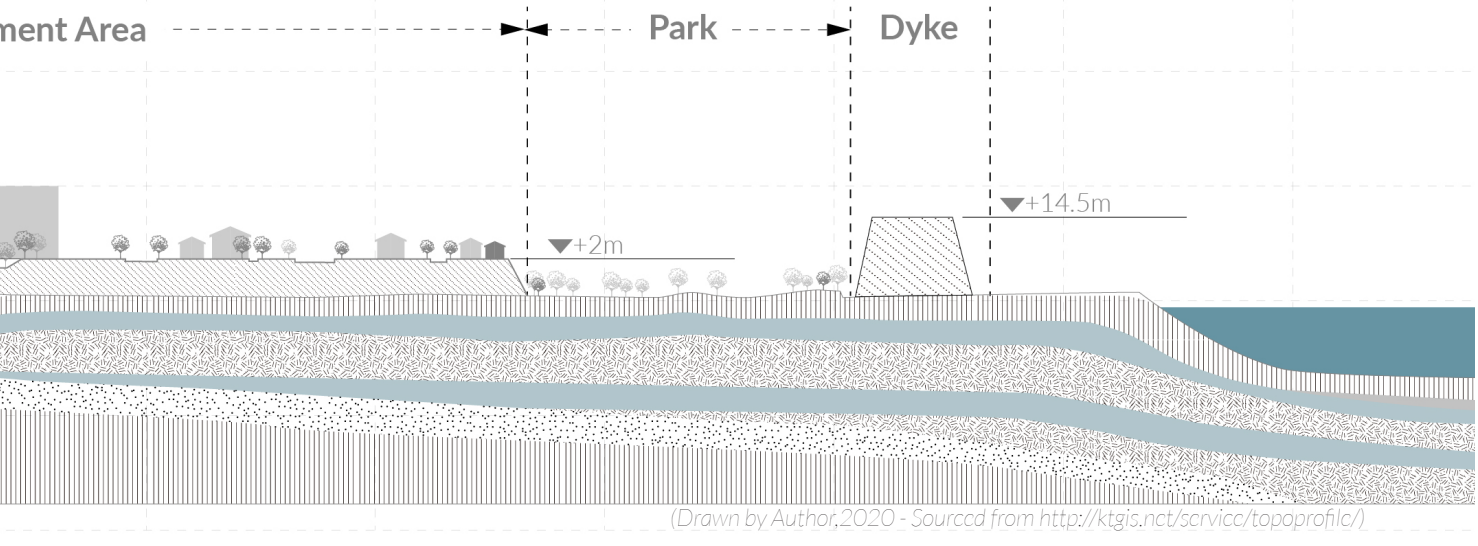
Picture of dyke
(Source: https://www.google.nl/maps)



(Source: Aditya, 2018)



(Source: Aditya, 2018)



(Drawn by Author,2020 - Sourced from http://ktgis.net/service/topoprofile/)

Architecture Morphology Traditional JapaneseHousing

The analysis of architecture morphology focused on the tipyicial local housing type and reconstruction housing type.



Shoji (sliding)

Sliding panel that
paper in a wooede
diffuse light throu
exterior walls



Architecture Morphology Housing type in reconstruction plan in Otsuchi

There are three kinds of housing types in reconstructino plan, the detached house, the row house and the apartment. In these housing types we can see that some features from traditional housing types are preserves, such as the washitsu, genkan and different kind of slidings. Also the tradiational material. wood, is partly preserved.

In otsuchi, the mostly used housing type in reconstruction is the detached house, of which wood is the main material. So the local forest can be used to offer construction materials.





is made of translucent
en frame, allowing
gh both interior and



Wooden engawa verandas

Outer corridor wraps around the house
Seperator between delicate shoji and outer storm shutter



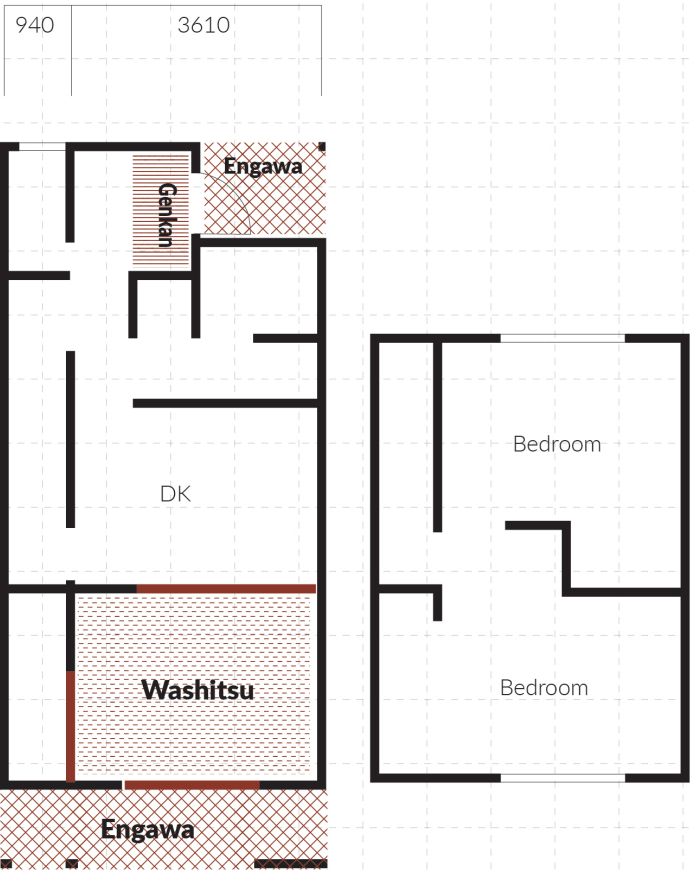
Genkan

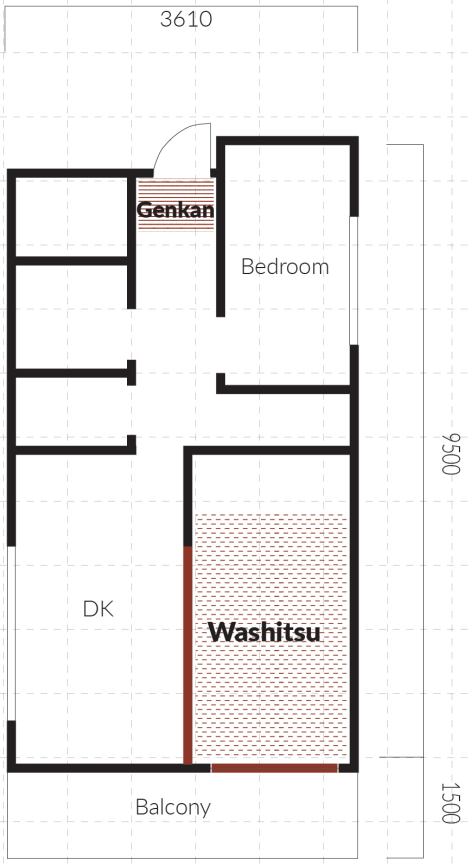
A small area, at the same level as the outside, where arriving people remove their shoes. At the same level as the outside, The rest of the residence is at the raised level of this floor.



Washitsu

Japanese styled room with tatami flooring, shoji rather than draperies covering the window, fusuma (opaque sliding vertical partitions) separating it from the other rooms.It might be unfurnished, and function as a family room during the day and a bedroom at night.







Row house
Wooden structure
(steel frame)



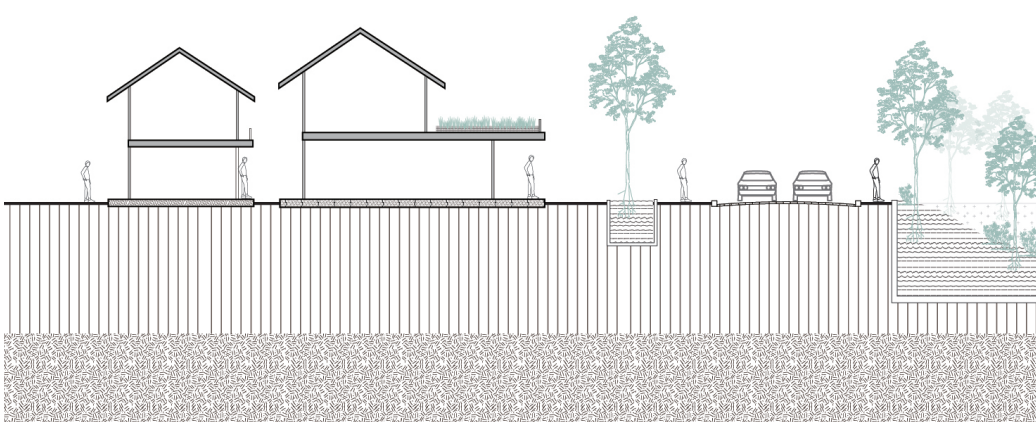
Apartment
Concrete
construction
(steel frame)

Block & Public Space

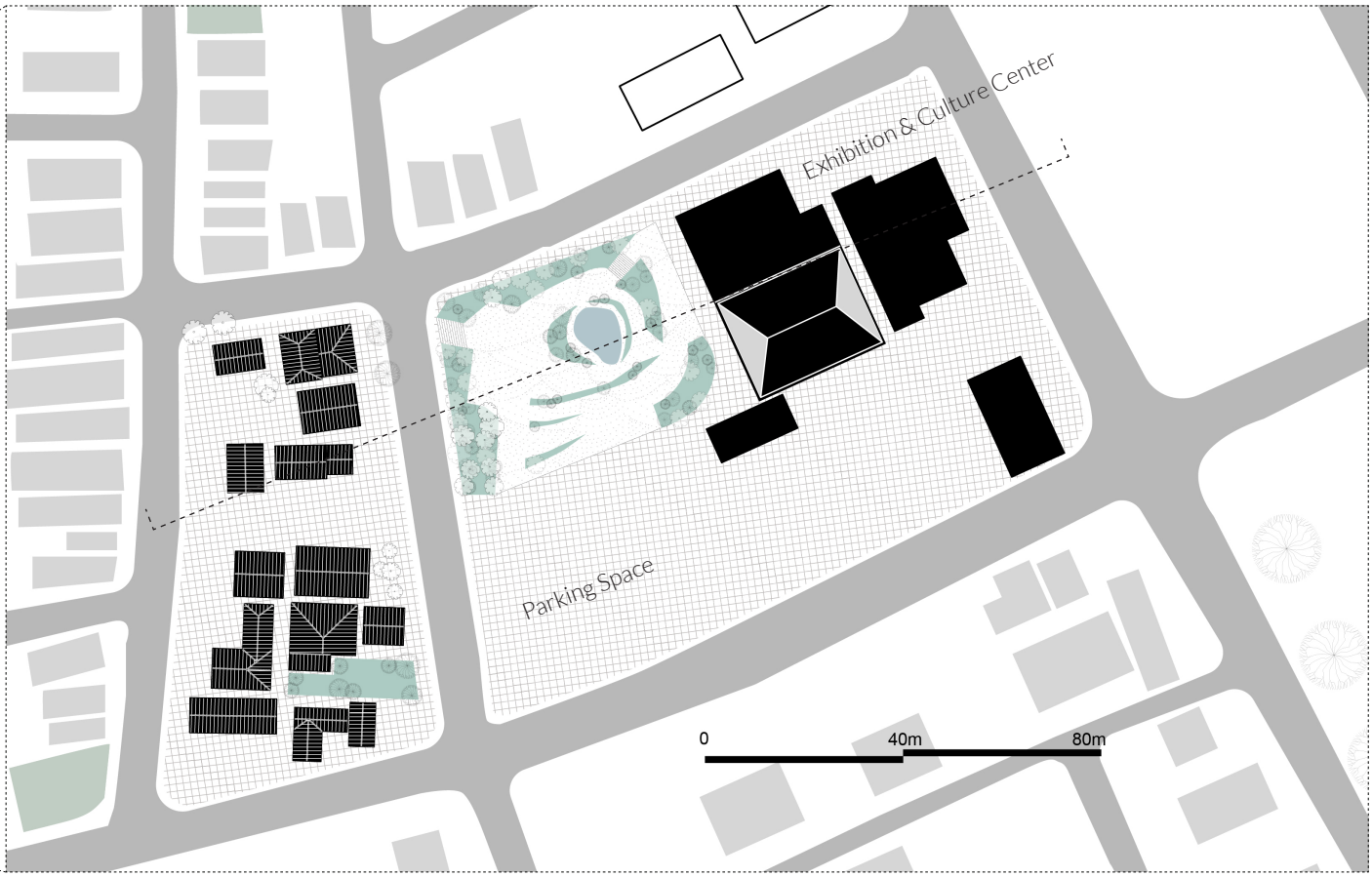
This page shows a zoomed-in view of the block scale to see the situation on streets and in public spaces. An area in the Machikata district is chosen as this is the historical and living center of Otsuchi, and here lies the culture and exhibition center.

In the center of the plaza in front of the new cultural center is a water pool formed from the spring well, which is a unique landscape element in Otsuchi. Around the public space, an area with a low-rise and high-density houses are built. Almost all the houses are detached house with some retail space on the ground floor facing the street. Because of the low rise typology, people can enjoy the vibrant daily life and the view of mountains behind on the street.





water
greenery
marine clay
concret
open soil
wood
Land elevation



(Drawn by Author,2020 - Sourccd from : https://www.googlc.nl/maps)



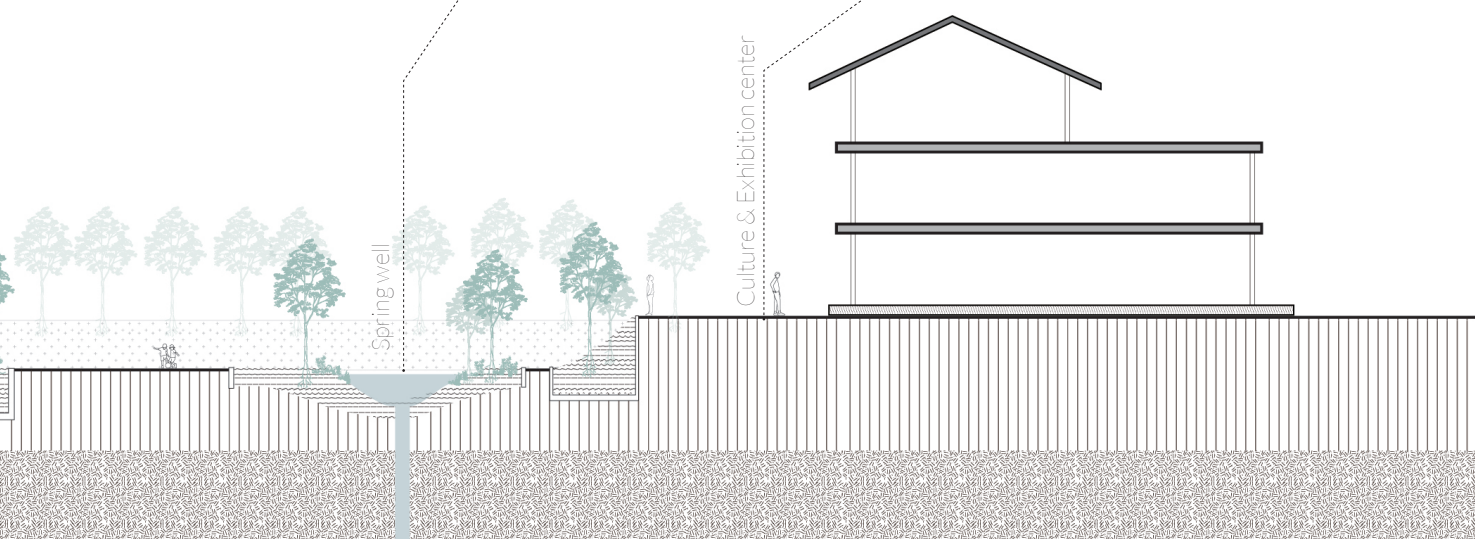
(Sourcc: https://www.googlc.nl/maps)



(Sourcc: Aditya, 2018)



(Sourcc: https://www.googlc.nl/maps)



(Drawn by Author,2020 - Sourccd from : http://www.toshikatsukiuchi.com/?pagc_id=1006)

4.

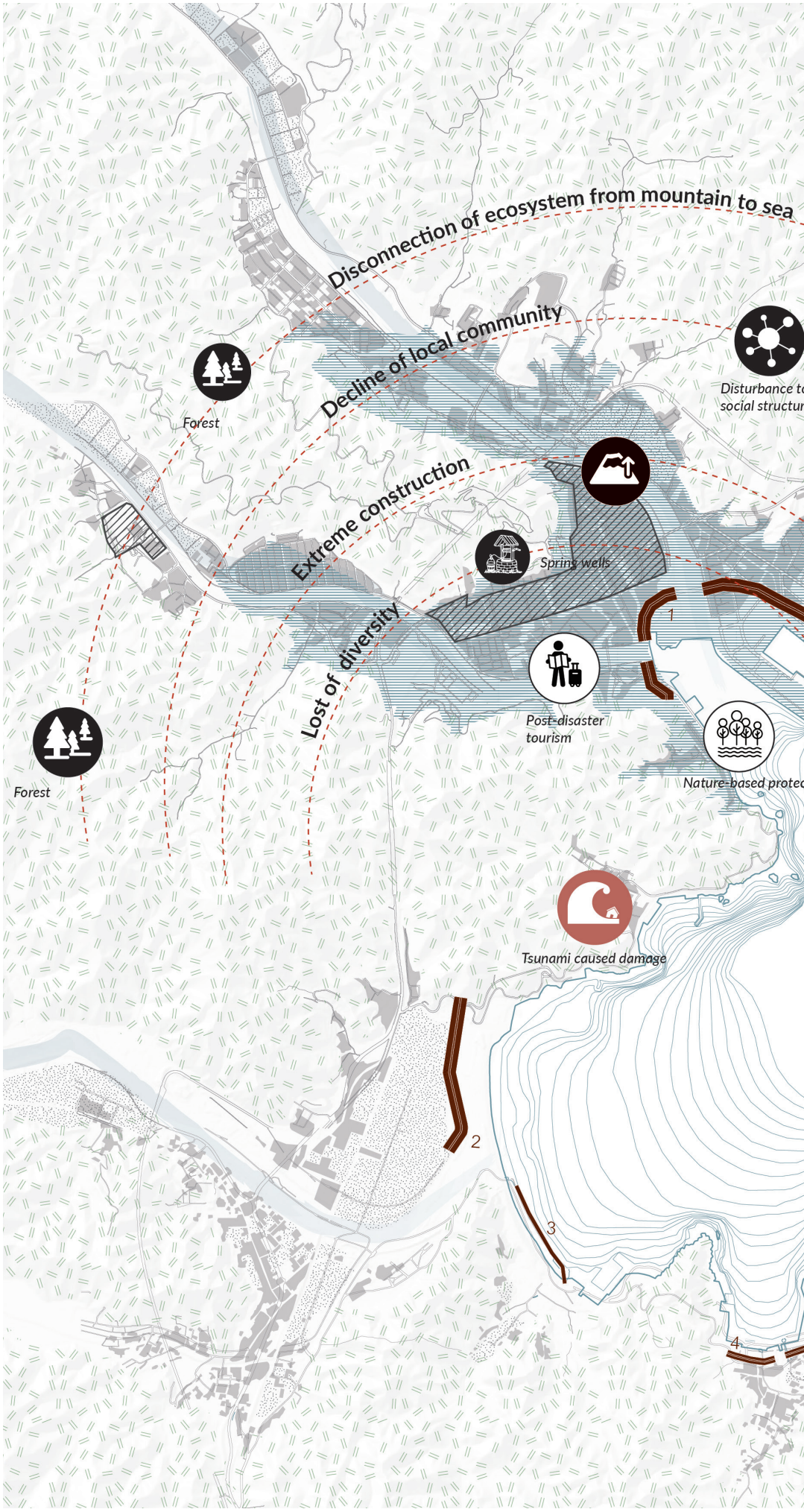
Systems Description and Synthesis

Hybrid system drawing

Otsuchi is a coastal mountainous town that lies close to the epicenter of the earthquake, which will cause severe tsunamis, thus end up with a series of problems in the ecological, social, and economic domain. After combining the different perspectives, the interrelation of these fields was found, and here we combine these relations in this hybrid map to show how things are related to each other. Some potentials we think can be used as catalysts to solve these problems in one goal.

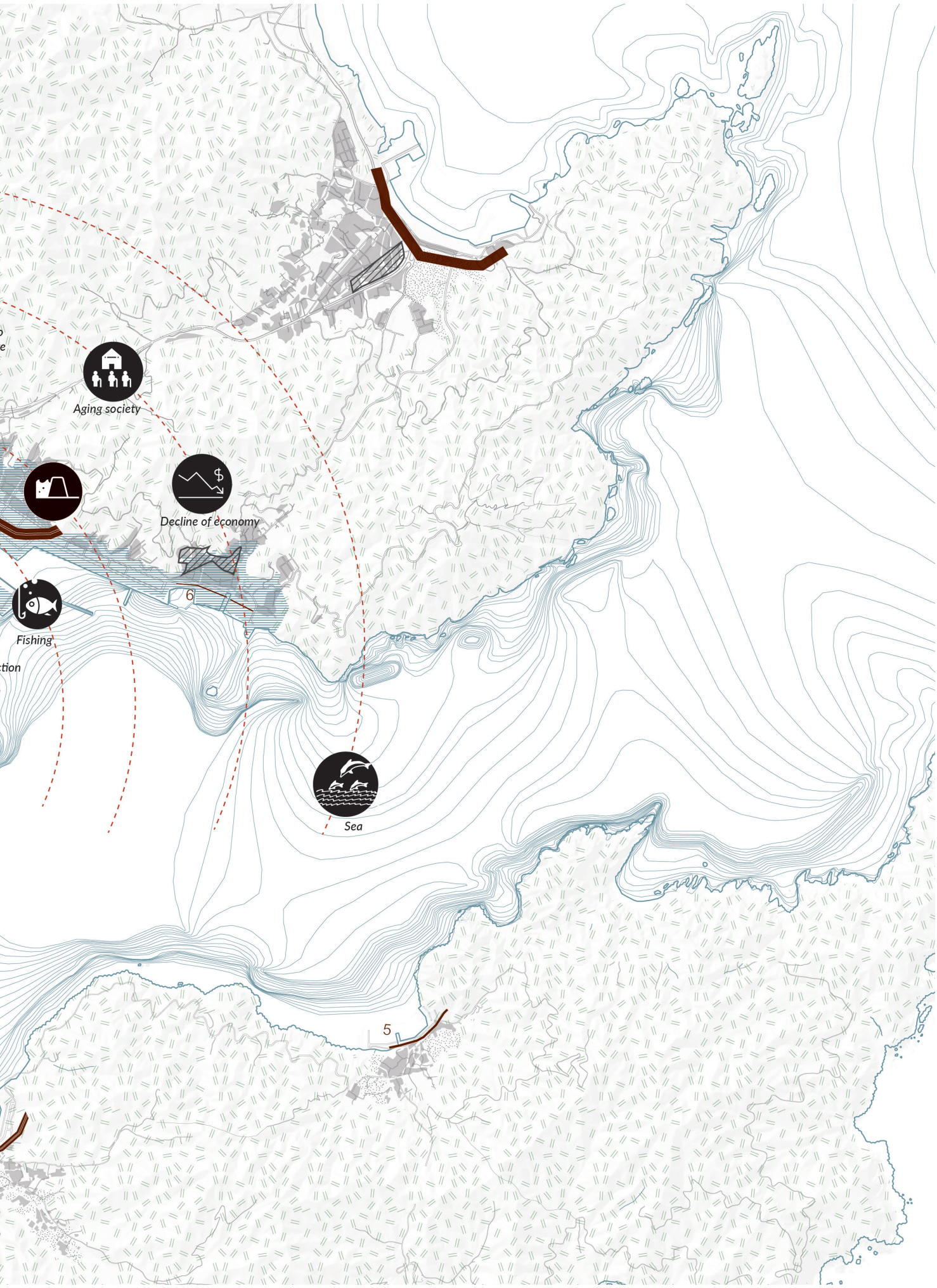
Natural disasters like tsunami caused by extreme landscapes are destroying the urban spaces. What is damaged is not only the physical environment but also the ecological habitats, the traditional cultural elements like spring wells, and the existing social structure. Engineering solutions like land elevation and sea dikes are taken, which will guarantee safety when a tsunami is under fourteen meters to prevent more future damage. However, these solutions are neglecting other problems that lie in the ecosystem and society. With this hard infrastructure, the ecological connection from mountain to sea is blocked. Soil and water dynamics are no longer existing, and habitats of various coastal vegetation and creature are taken. Moreover, the interaction from humans to the sea is blocked by sea walls, causing an unpleasant living environment. Puls with the risky of living here, more and more people are tending to move out, and the population here is shrinking and aging very fast.

With the awareness that all these problems are interrelated to each other, we want to make a synergy between them. Nature-based protection measures can be adopted to offer a safer and livable environment. These solutions can not only defense tsunami but also restore the ecosystem. With these new landscapes featured with post-disaster memory and natural protection, a new identity can be created, and post-disaster tourism is possible to make revitalization of the local economy and community.



Hybrid drwaing

This map shows the conclusion of critical cartography. By bringing together different perspectives, we realized all the problems are related, yet the essential ones are the natural disasters like tsunami and shrinking population. As a result, small interventions like nature-based defense and post-disaster tourism in one area can also have a series of outcomes.


Aging society
Decline of economy
6
Fishing
ction
Sea
5

5.

Scenario making

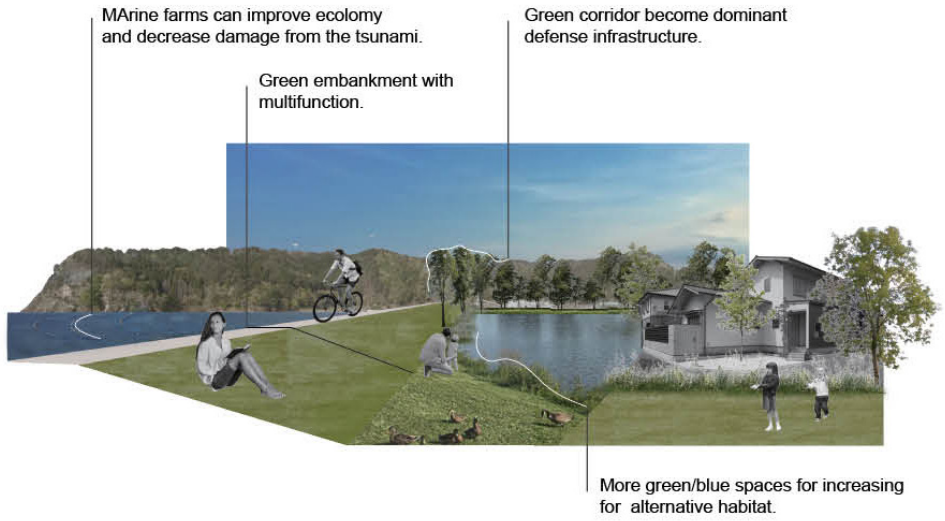
Scenarios

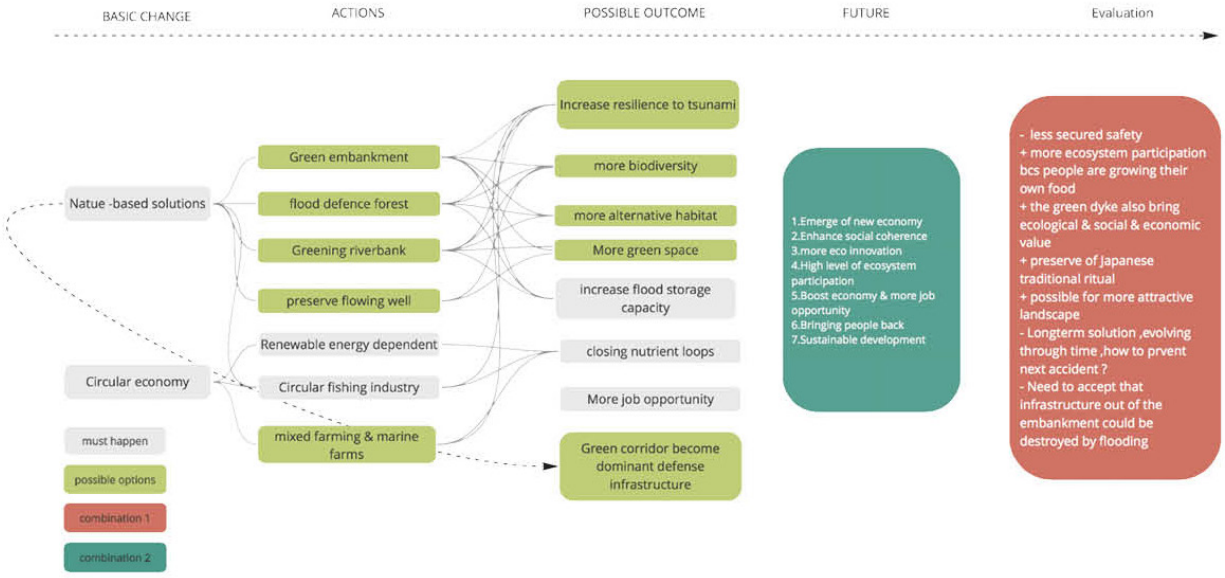
5.1. Nature First

5.2. No technology

5.3. No humans

5.4. COVID-19


MArine farms can improve ecolomy
and decrease damage from the tsunami.
Green embankment with
multifunction.
Green corridor become dominant
defense infrastructure.
More green/blue spaces for increasing
for alternative habitat.

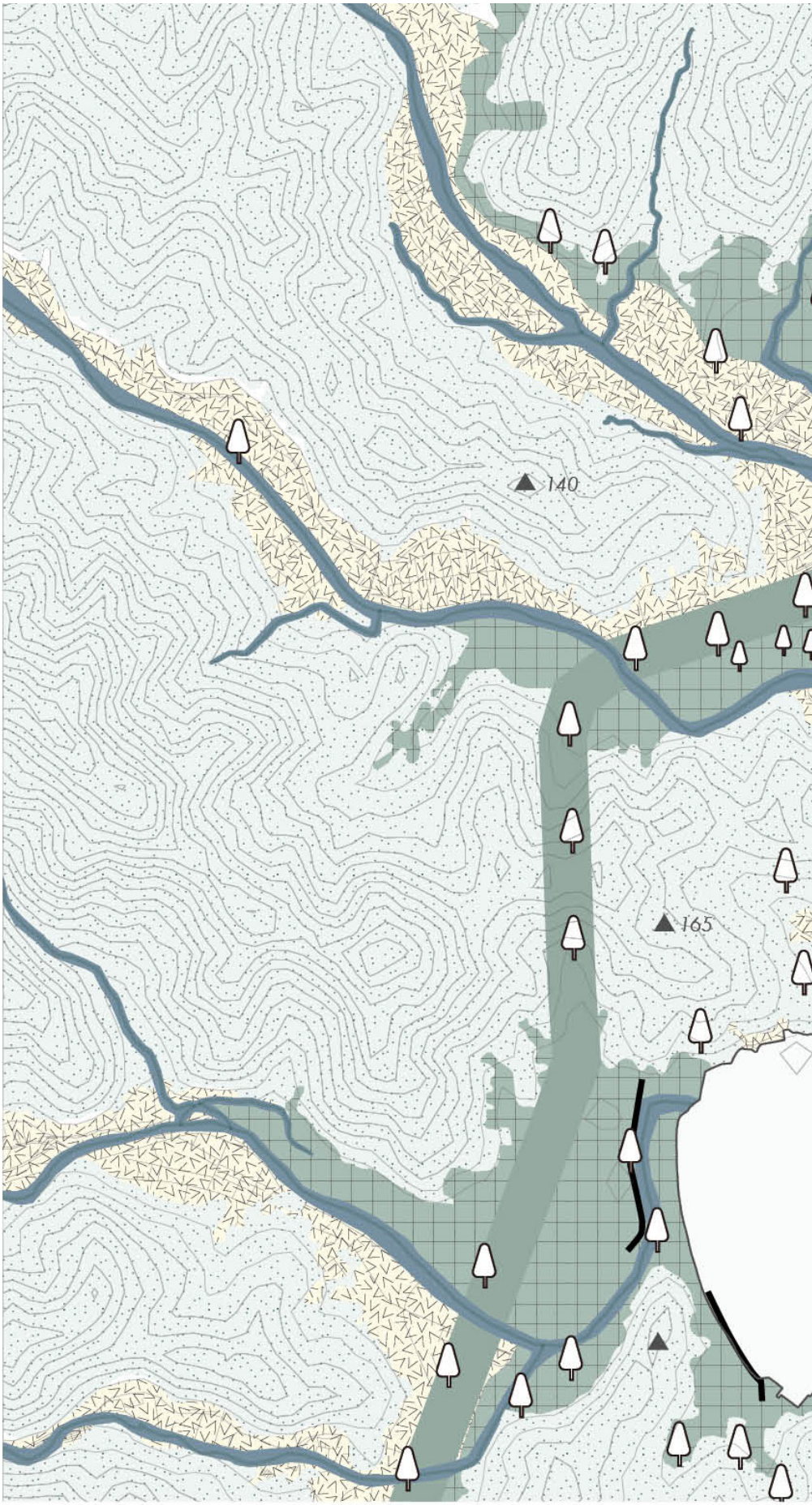

BASIC CHANGE
ACTIONS
POSSIBLE OUTCOME
FUTURE
Evaluation
Natue -based solutions
Circular economy
must happen
possible options
combination 1
combination 2
Green embankment
flood defence forest
Greening riverbank
preserve flowing well
Renewable energy dependent
Circular fishing industry
mixed farming & marine farms
Increase resilience to tsunami
more biodiversity
more alternative habitat
More green space
increase flood storage capacity
closing nutrient loops
More job opportunity
Green corridor become dominant defense infrastructure
1.Emerge of new economy
2.Enhance social coherence
3.more eco innovation
4.High level of ecosystem participation
5.Boost economy & more job opportunity
6.Bringing people back
7.Sustainable development
- less secured safety
+ more ecosystem participation bcs people are growing their own food
+ the green dyke also bring ecological & social & economic value
+ preserve of Japanese traditional ritual
+ possible for more attractive landscape
- Longterm solution ,evolving through time ,how to prvent next accident ?
- Need to accept that infrastructure out of the embankment could be destroyed by flooding

Scenario 1 . Nature First

In this scenario, it focuses on the nature-based solution and uses multiple ways to defense the tsunami. For example, green embankment and flood defense forest, which means the huge concrete dyke would not be seen in this scenario. The green corridor and barrier islands will be the dominant measure. Moreover, fishing and farming industries can improve the economy. Especially the aquaculture can also mitigate the tsunami. And the nature area will start to take over and extend so people have more connections with it.

By doing so, it can not only bring benefits for the residents but also for ecology. Growing flood defense forests and islands, more different habitats can be offered for diverse species, which can improve biodiversity.

For the residents, those measures can increase the resilience to the tsunami, have more green space and better living quality, and even create more job opportunities to improve the economy and attract people to go back to Otsuchi.



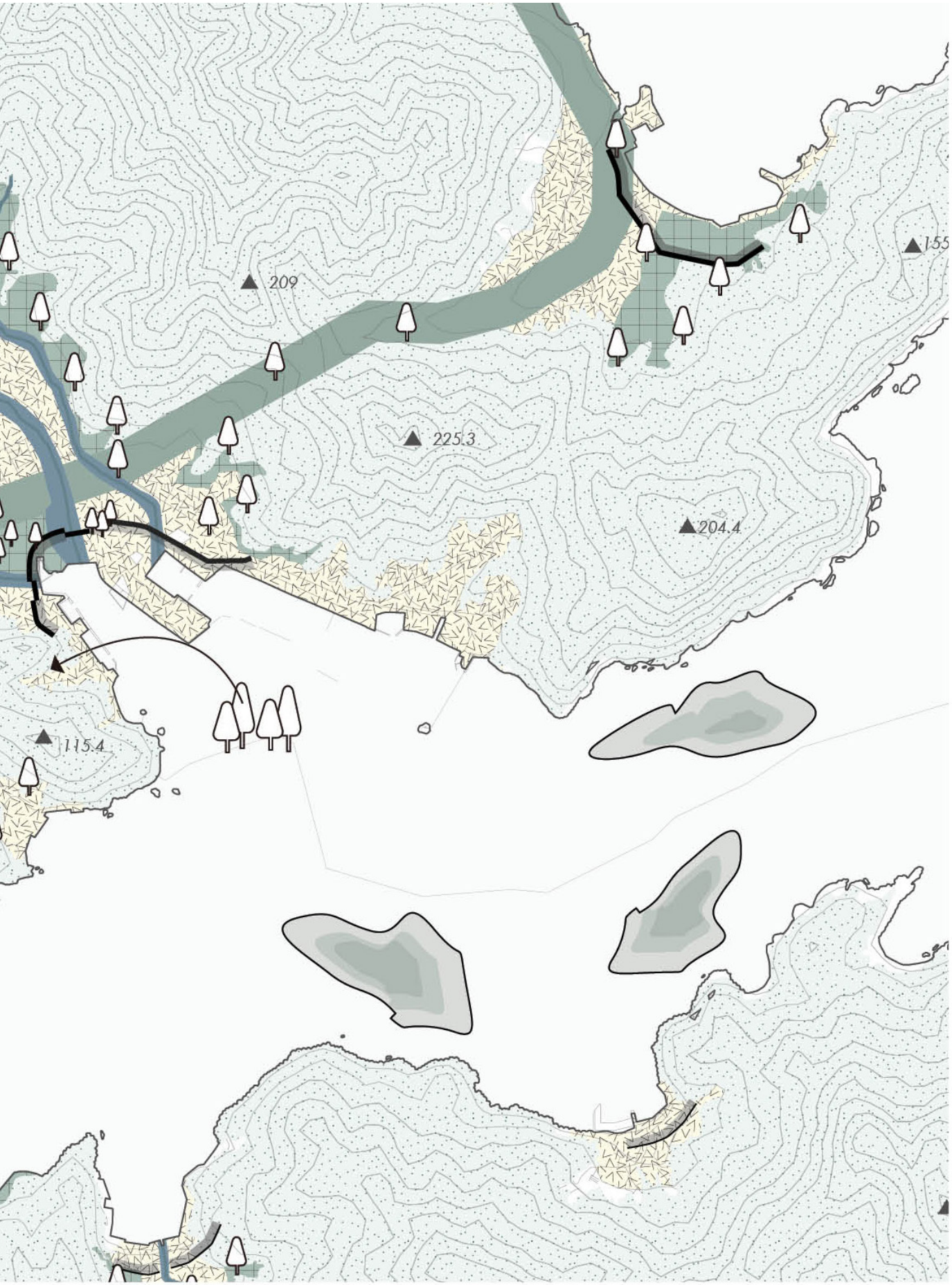
Nature first scenario

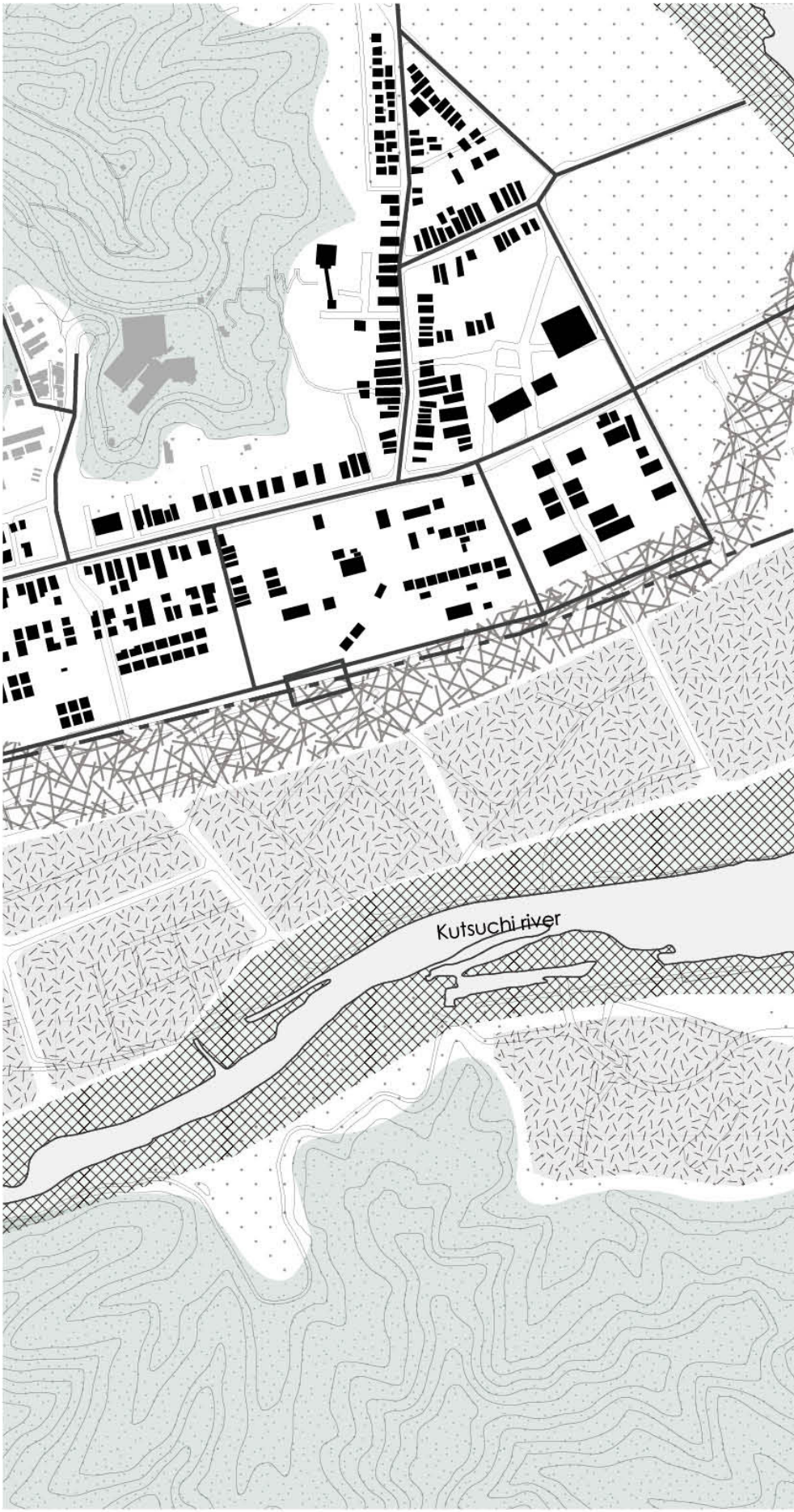
Barrier islands, flood defence forest and green dyke become layers system to mitigate the tsunami.

Original forest
Extended nature area
River erosion
Green corridor
Community
Stream

N

0 100 km


209
225.3
204.4
115.4



Nature first scenerio

This map shows how things will change in micro-scale. Nature will extend to some residential area and the more farmland can be seen in the flood-prone areas.

forest

industrial area

green embankment

green riverbank

farmland

grassland

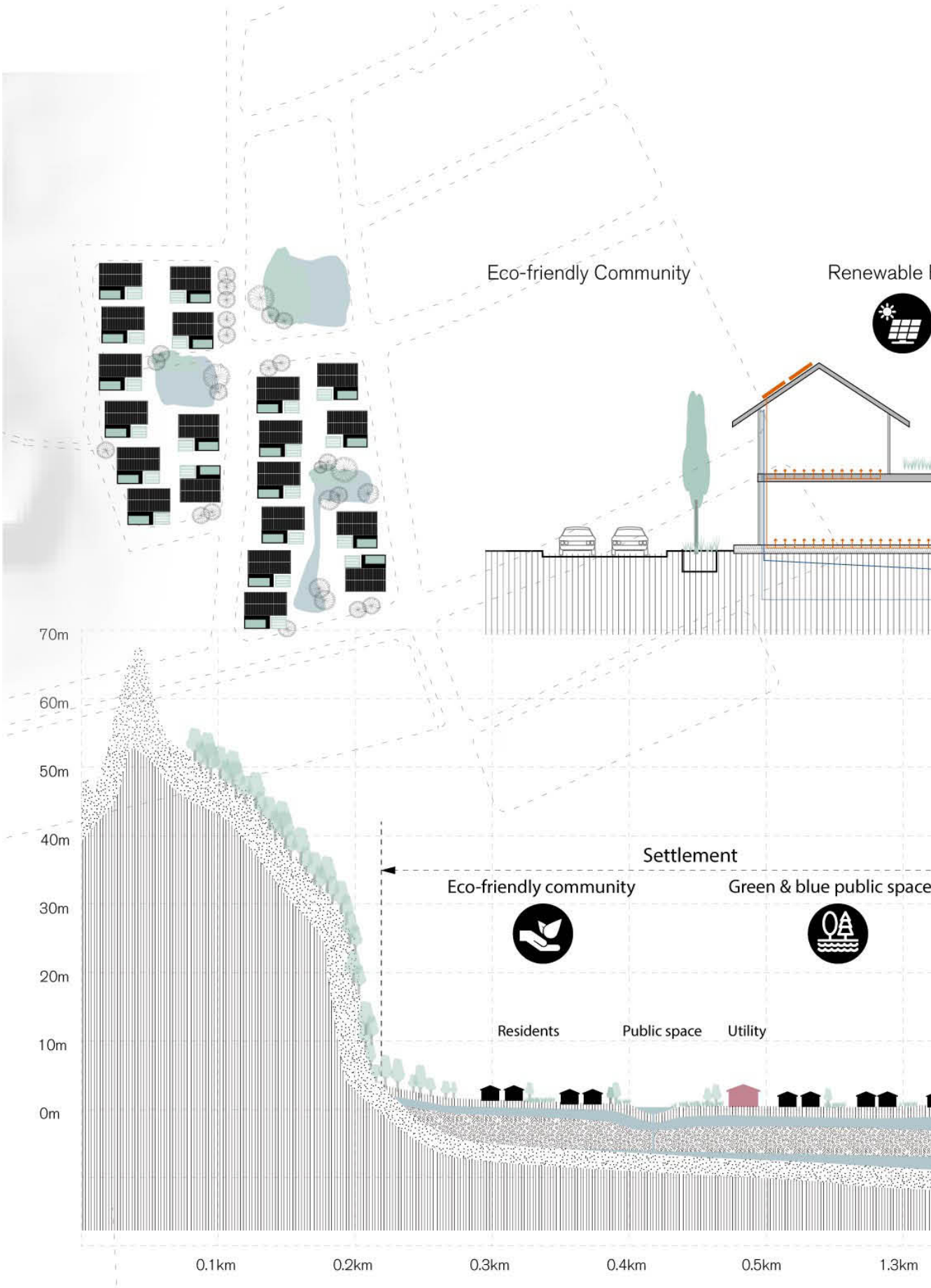
flood defence forest

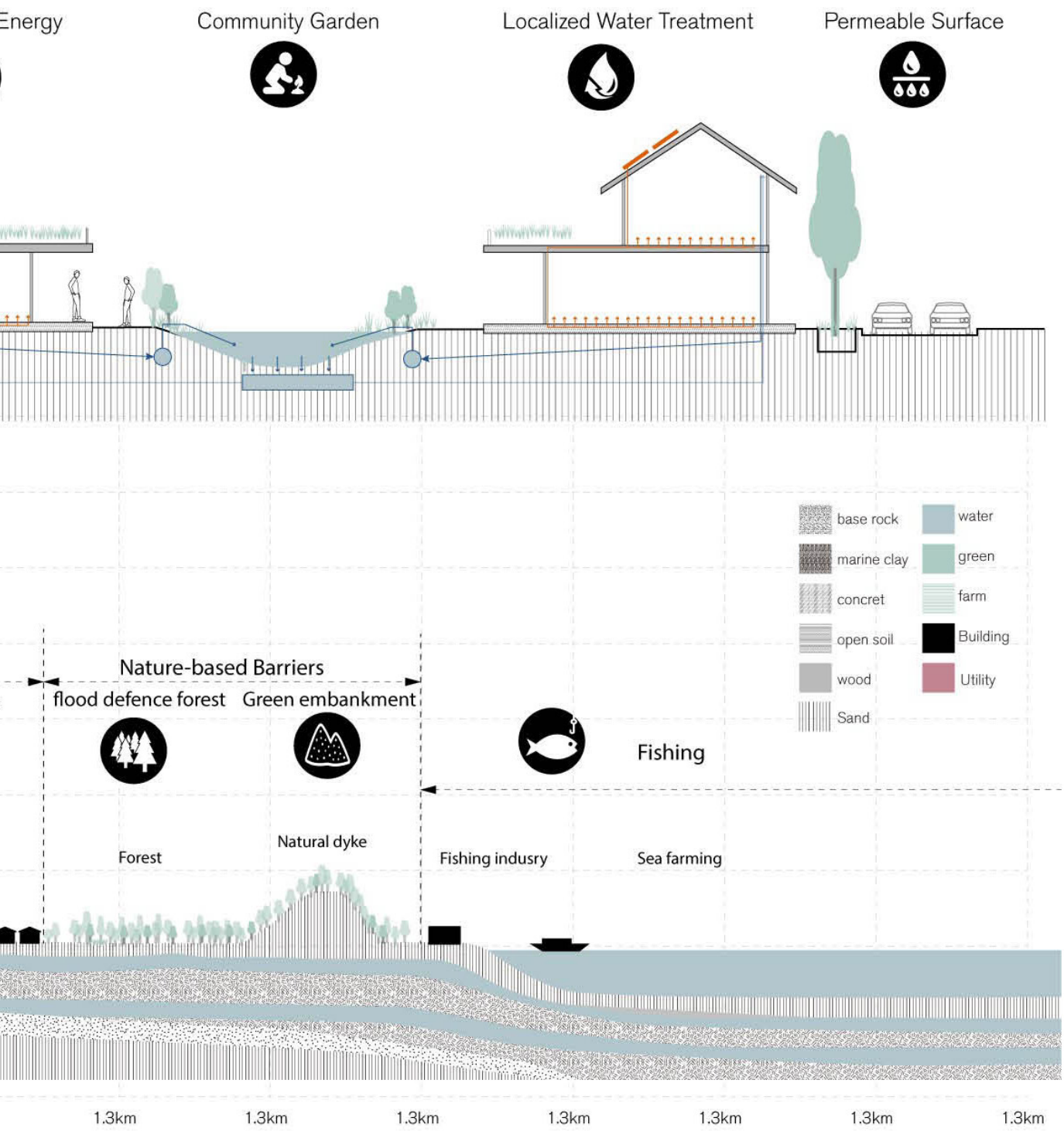
aquaculture

aquaculture

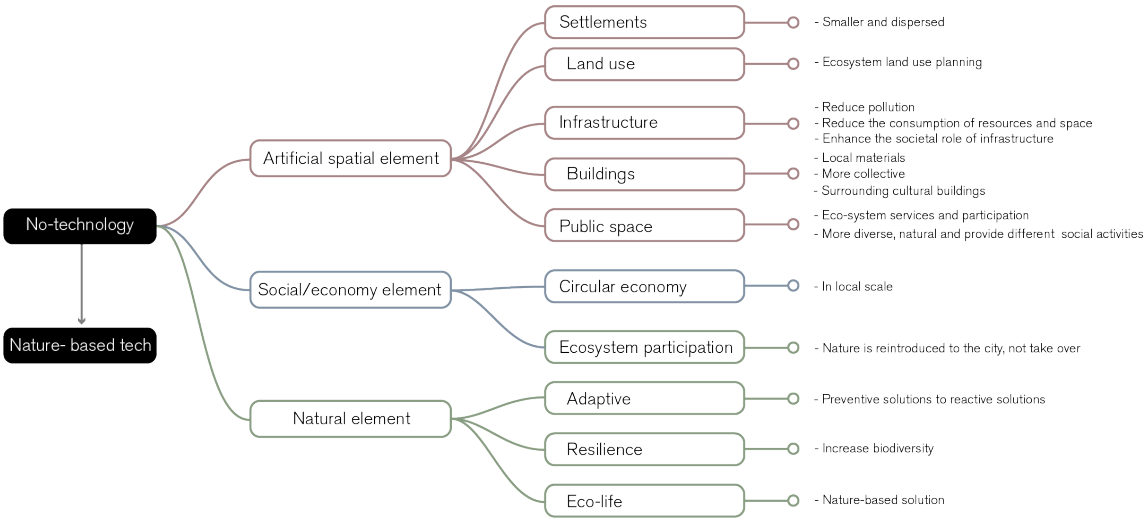
fishery


Otsuchi river


Eco-friendly Community
Renewable
70m
60m
50m
40m
30m
20m
10m
0m
Settlement
Eco-friendly community
Green & blue public space
Residents
Public space
Utility
0.1km
0.2km
0.3km
0.4km
0.5km
1.3km


Energy
Community Garden
Localized Water Treatment
Permeable Surface
base rock
marine clay
concret
open soil
wood
Sand
water
green
farm
Building
Utility
Nature-based Barriers
flood defence forest
Green embankment
Fishing
Forest
Natural dyke
Fishing indusry
Sea farming
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km


Aquaculture can improve ecolomy
and decrease damage from the tsunami.
Use nature-based technology to
decrease damage from the tsunami.
Community become smaller
and dispersed.
oyster bed
salt marsh
Dunes
More diverse, nature and provide
different social activities
Agriculture can also improve ecolomy
and provide food for community.


No-technology
Nature- based tech
Artificial spatial element
Social/economy element
Natural element
Settlements
Land use
Infrastructure
Buildings
Public space
Circular economy
Ecosystem participation
Adaptive
Resilience
Eco-life
- Smaller and dispersed
- Ecosystem land use planning
- Reduce pollution
- Reduce the consumption of resources and space
- Enhance the societal role of infrastructure
- Local materials
- More collective
- Surrounding cultural buildings
- Eco-system services and participation
- More diverse, natural and provide different social activities
- In local scale
- Nature is reintroduced to the city, not take over
- Preventive solutions to reactive solutions
- Increase biodiversity
- Nature-based solution

Scenario 2 . No technology

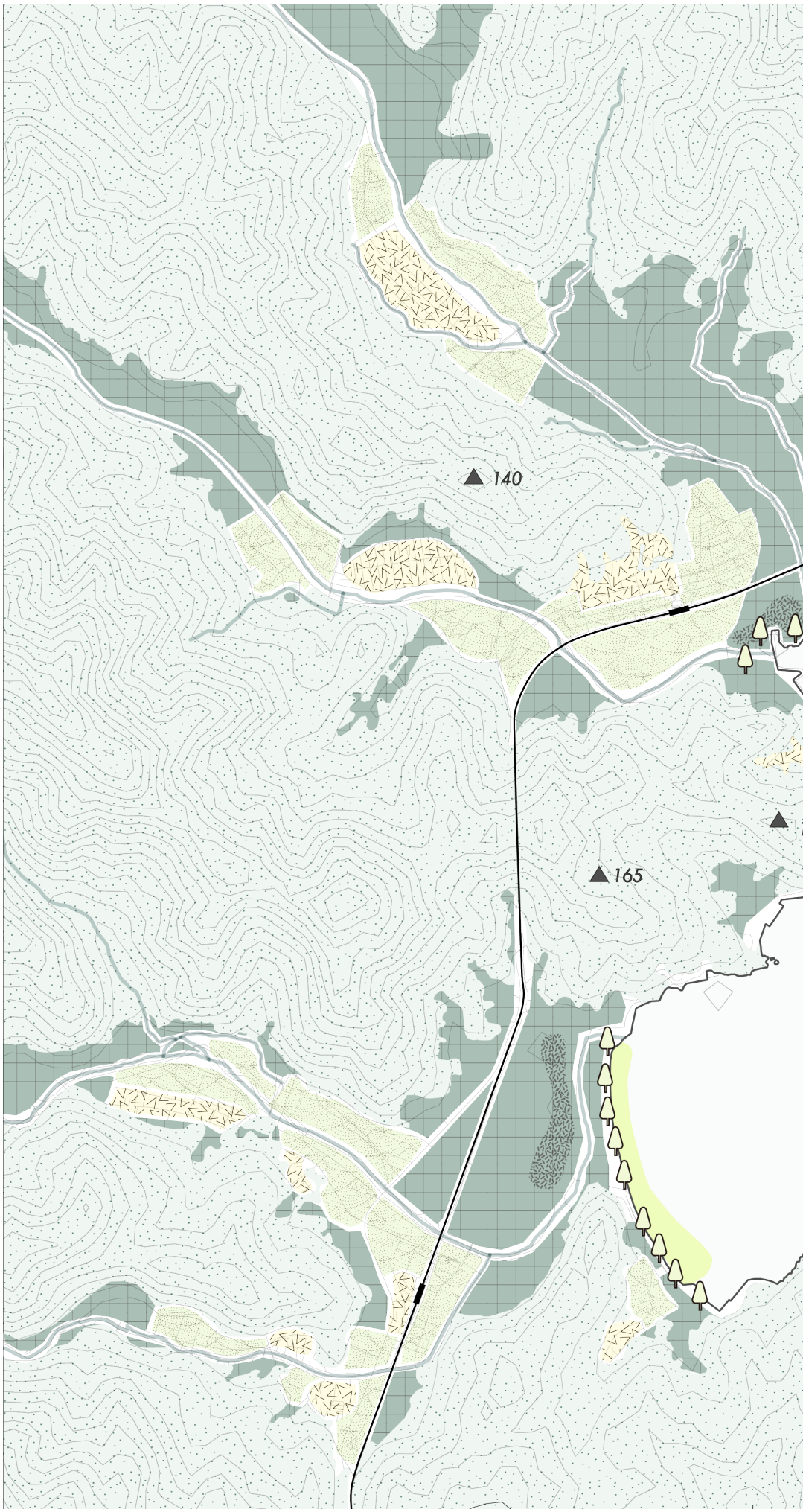
Currently, people have passed beyond using hard technological solutions to control nature and prepare for natural hazards. There is a transition going on towards a more preventive approach rather than a reactive approach to tackling climatic hazards. Hard technological designs always have the chance of breaking during an extreme event, and whén it breaks serious damage is the result. Infrastructural designs based on nature adapt and recover quicker during and after a hazard since they are constructed by the natural processes of nature. With more nature-based solutions the reliance on hard infrastructural solutions is reduced. This creates space for more hybrid solutions between hard and soft infrastructure.

The environment and the nature of a place forms its original housing typology and traditions of that area. The connection of people and nature is deeply rooted, nature-based solutions will therefore feel more comprehensible and tangible. People will feel more responsible to make it work. Nature-based solutions have, in contrast to technological solutions, a more collective based management system. This would entail an equitable distribution of common resources through a range of unique collaborations amongst diverse socio-economic groups.

Nature-based solutions enlarge the space reserved for nature in the city since they replace the technological structures. This will enhance the amount of room for ecological developments. Besides that, the different aspects of transforming technological structures into nature-based solutions require each a different way of nature. This will create many different microtopes and habitats which increases biodiversity. The deep ecological solutions that are used will increase the resiliency of the measures and become more circular and sustainable. This will enhance the local economic resiliency, especially on the local scale.

The design of housing and public space is strongly based on ecosystem services and participation to avoid or minimize use of technology and to emphasize the use of nature based solutions. Local context is a crucial aspect, therefore the public spaces become more diverse, natural and provide different socio-cultural activities for diverse users.

Without the opportunity to use enormous technological constructions to control nature, people have to go with the flow. This means that humans really need to work together with nature in order to prevent themselves from natural hazards. The level of ecosystem participation in this scenario is thus really high



No-technology Scenario_Meso Scale

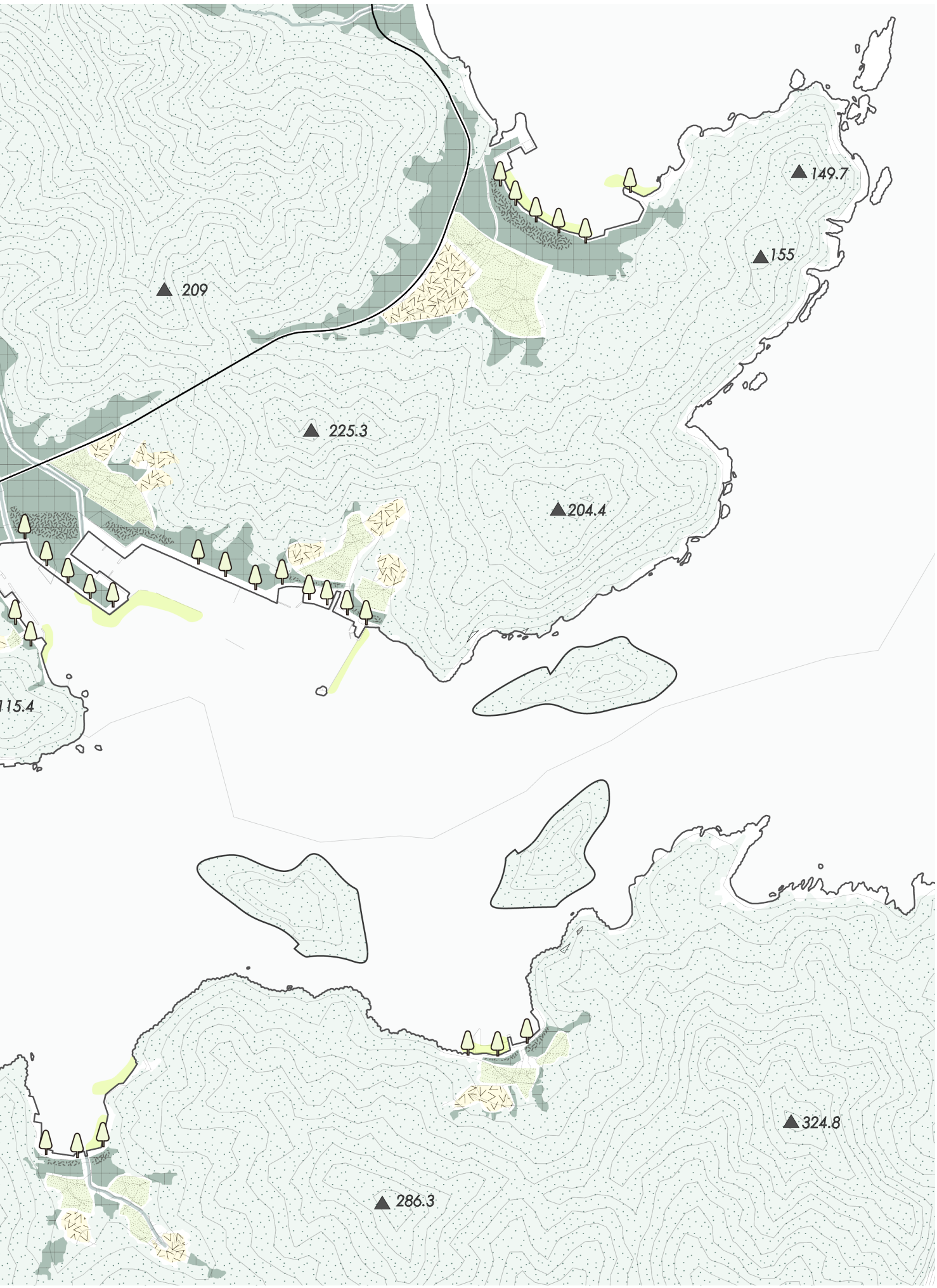
In the meso scale, the nature area will extend, and the people's settlements will become smaller and more dispersed, and more land use will change from urban to natural.

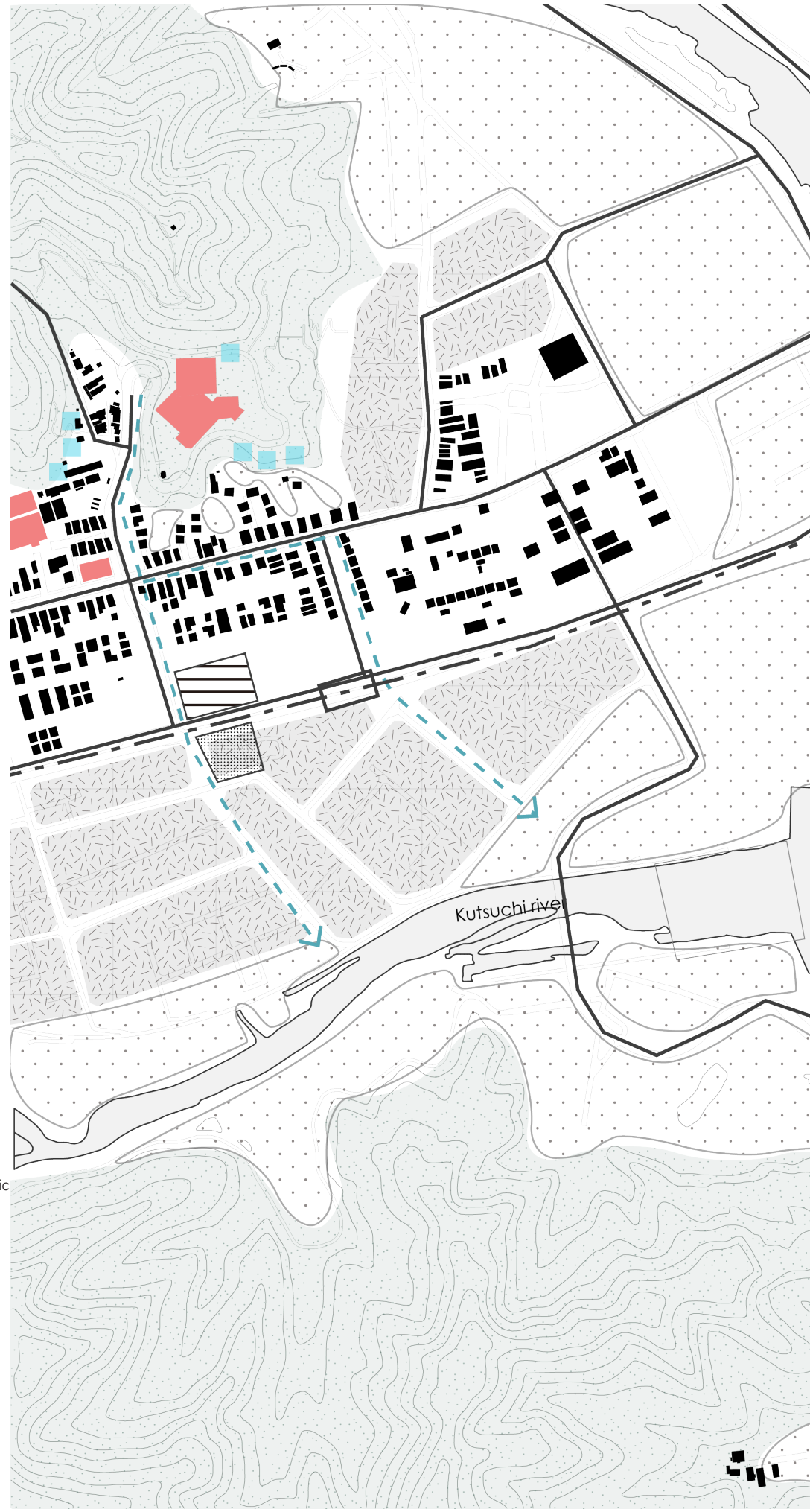
A more natural way, which is breakwater-salt marsh- dune system, is used to mitigate the nature hazard

- Original forest
- Community
- Farmland
- Extended nature area
- Oyster beds
- Dune
- Salt marsh
- Stream
- Rail way
- Rail station
- Road

N

0 100 km


149.7
155
209
225.3
204.4
115.4
324.8
286.3



No-technology Scenario_Micro Scale

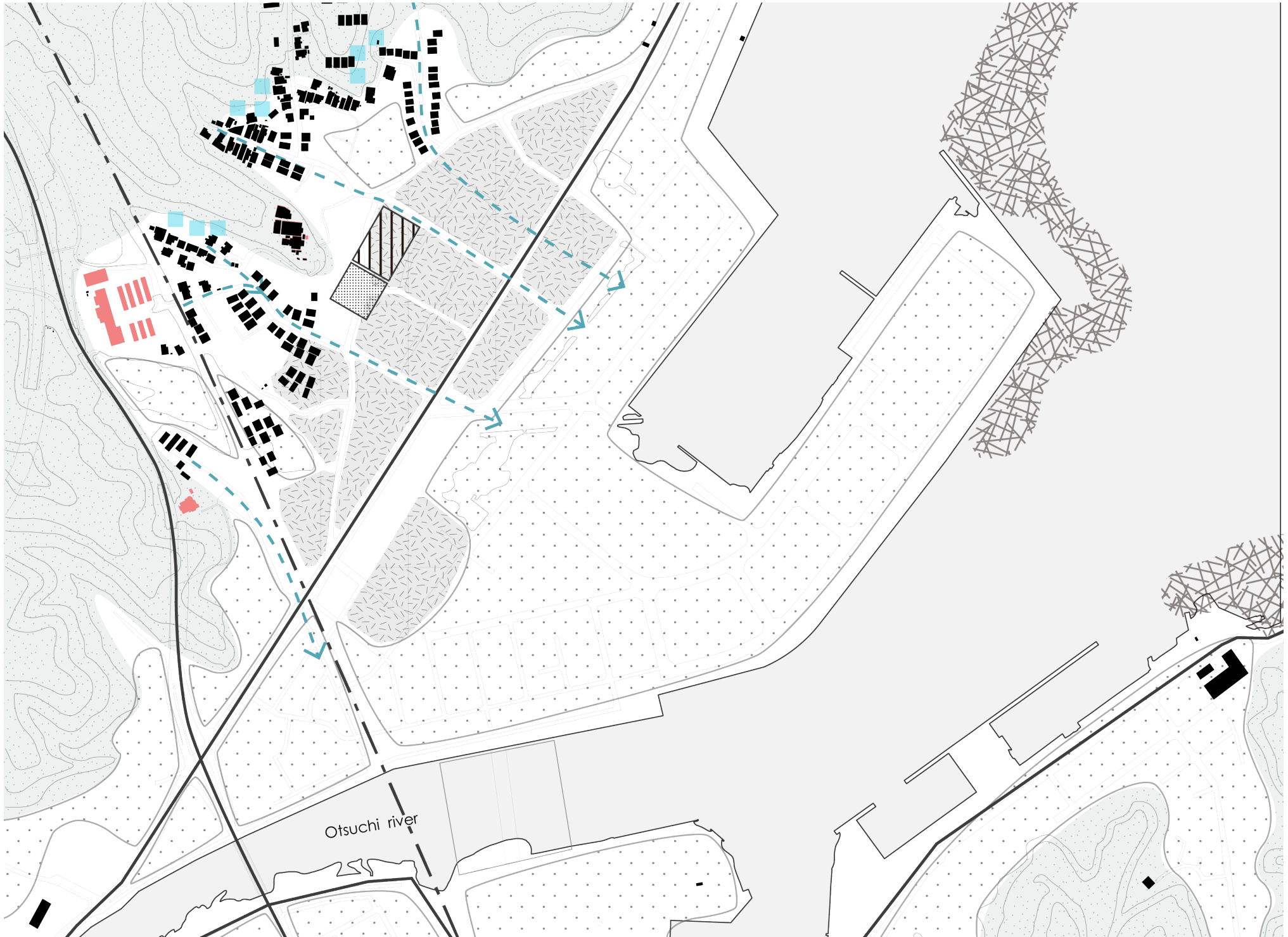
In micro scale, due to people's settlements become more collective and local, each settlement will be surrounding one public building. They will also implement facilities to produce their own power and freshwater, and also have their own sewage treatment system.

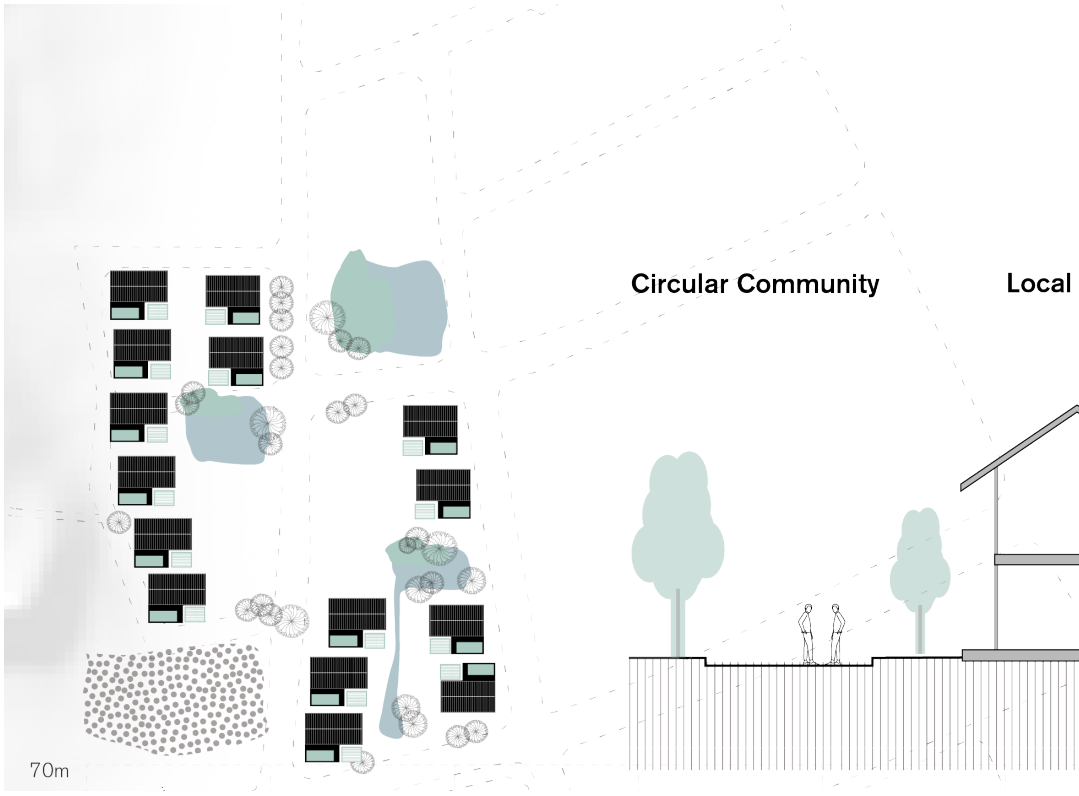
And bioswales along from mountains to the river could create more possibilities for public space in this area.

- Forest
- Farmland
- Grassland
- Oyster bed
- Barrier island
- Public building
- Water catchment
- Biomass energy generation
- Sewage treatment
- Bioswales

N

0 100 km


Otsuchi river

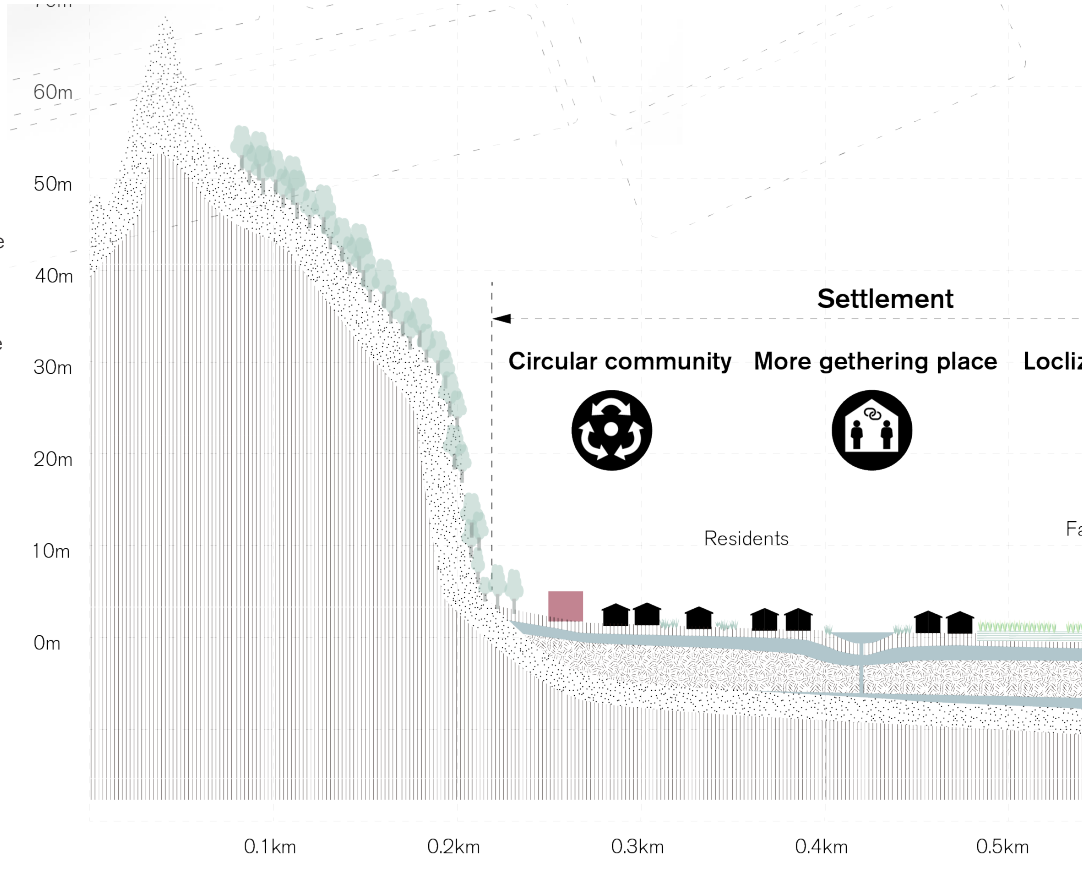


No-technology Scenario_Section

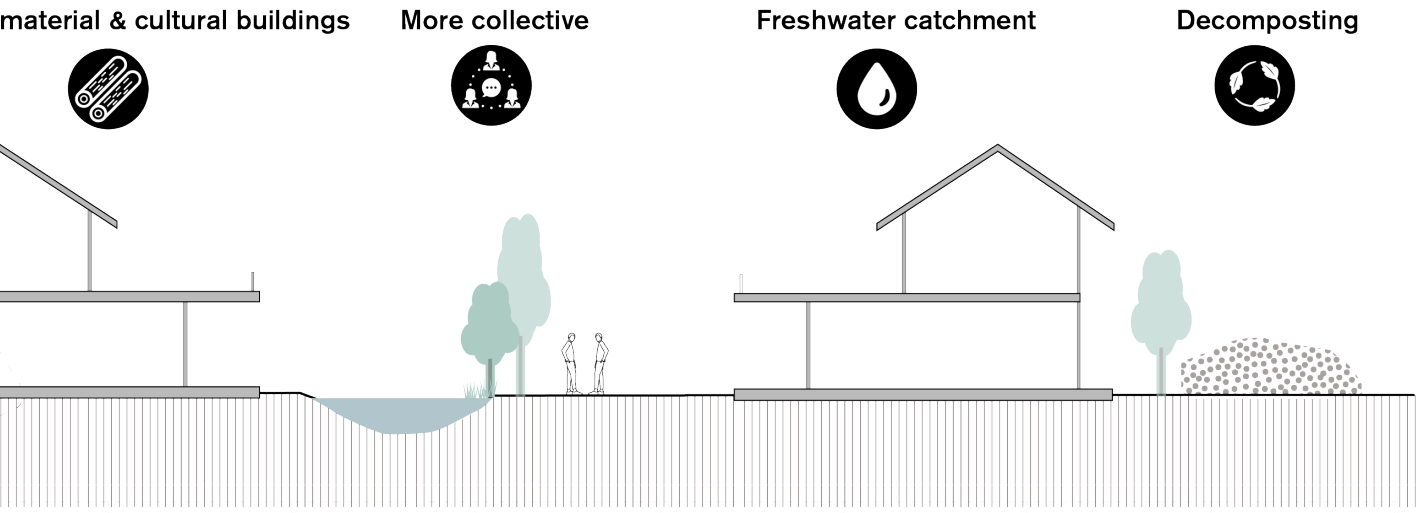
The buildings here will use more local materials, and local society will become more collective.

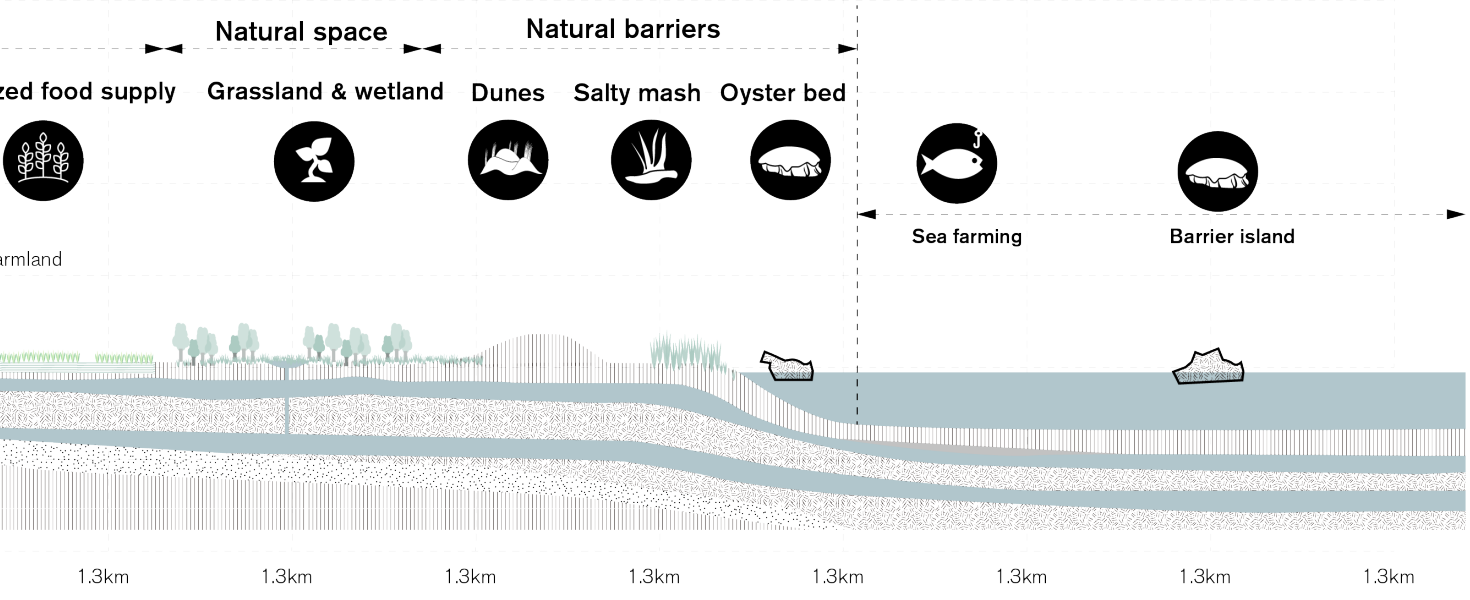
Meanwhile, the local economy will become more circular and more resilient, due to more business will happen on a local scale.

- Base rock
- Marine clay
- Concret
- Open soil
- Wood
- Sand
- Water
- Green
- Farm
- Building
- Utility
- Decomposting
- Lowland soil
- Gray lowland soil
- Brown forest soil






material & cultural buildings
More collective
Freshwater catchment
Decomposting

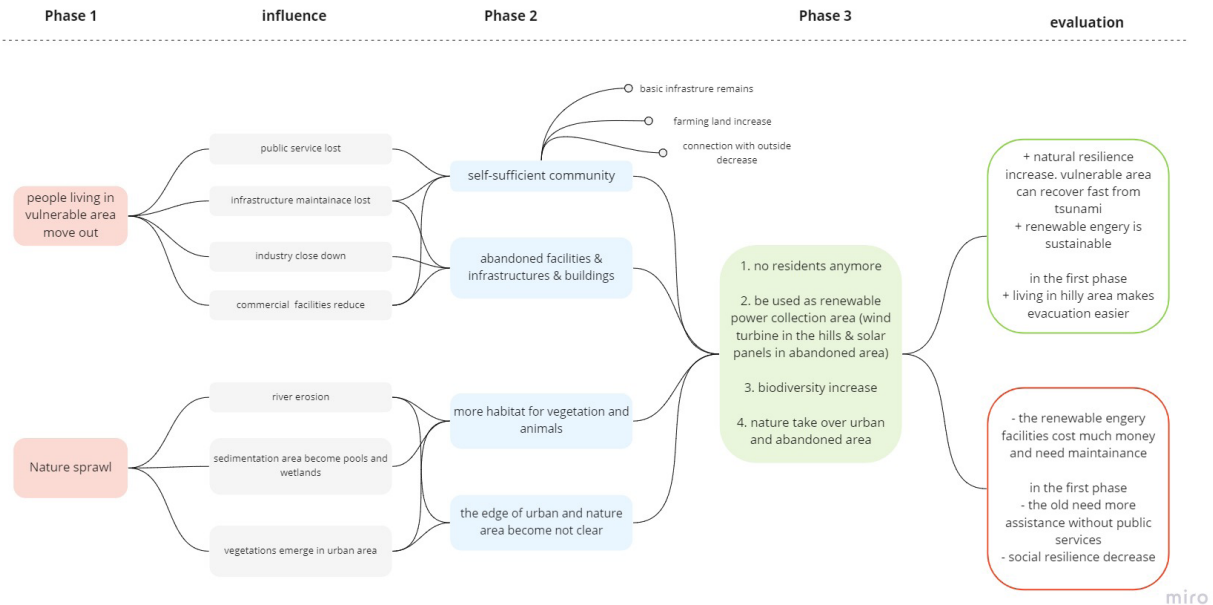

Natural space
Natural barriers
zed food supply
Grassland & wetland
Dunes
Salty mash
Oyster bed
Sea farming
Barrier island
armland
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km

Become a renewable energy base to provide electricity for the community nearby.



Riverbank becomes natural.

Nature starts to take over some places.

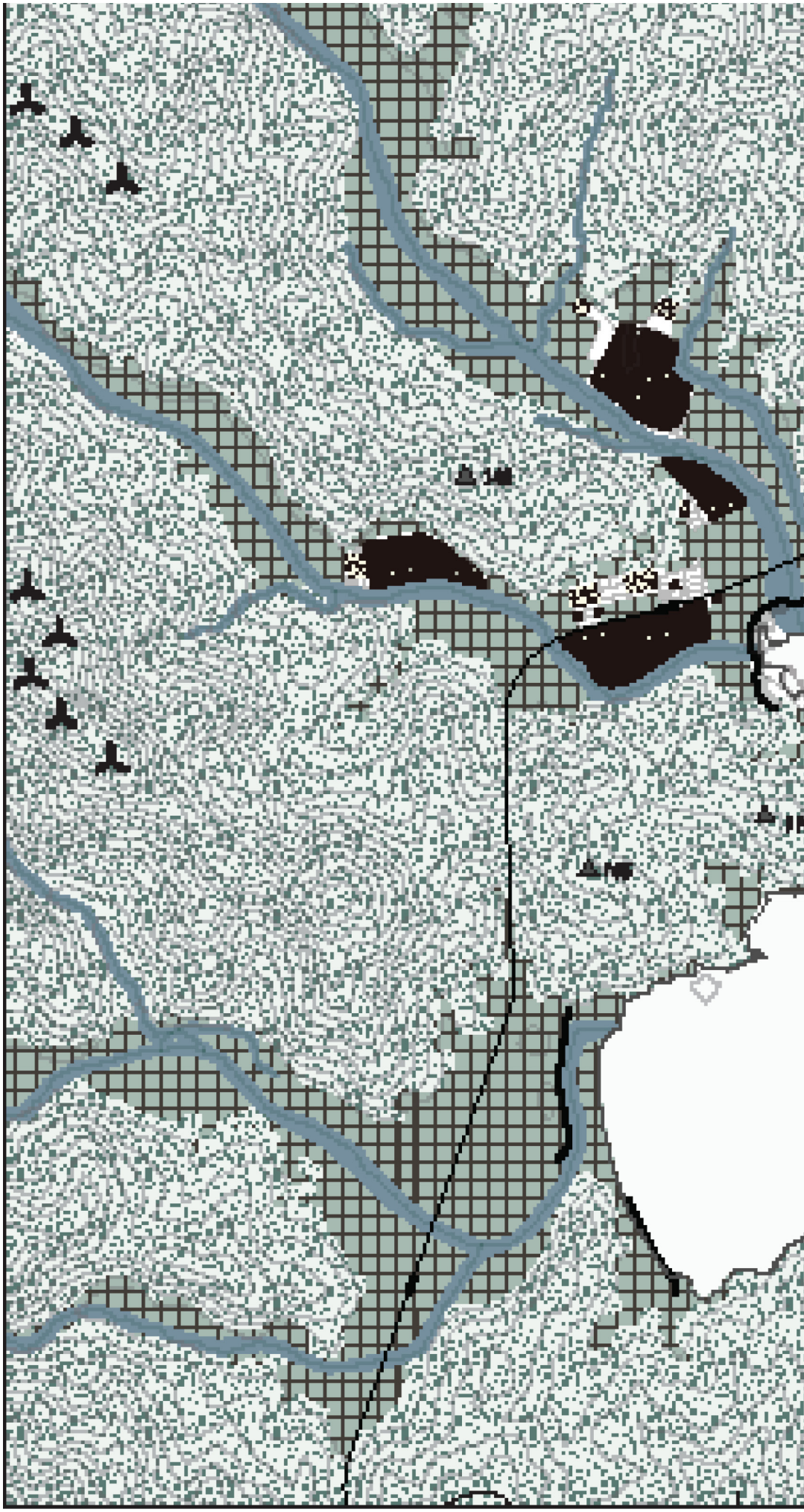


Scenario 3 . No human

There are three phases in this scenario. In the first phase, people who live in vulnerable areas will move out first, which means the public services and infrastructure maintenance will become lost. industries will close down and commercial facilities will reduce. At the same time, nature will begin to sprawl into the urban area.

In the second phase, the river will erode the embankment, and the sedimentation area will become pools and wetlands, which provide various habitats for vegetation and animals, and the edge of the urban and nature area will be not so clear as before. More and more people move out, then the who still live here will form up small self-sufficient communities. Basic infrastructure will remain, and the farming land will increase. The abandoned facilities, infrastructures and buildings will be covered by nature.

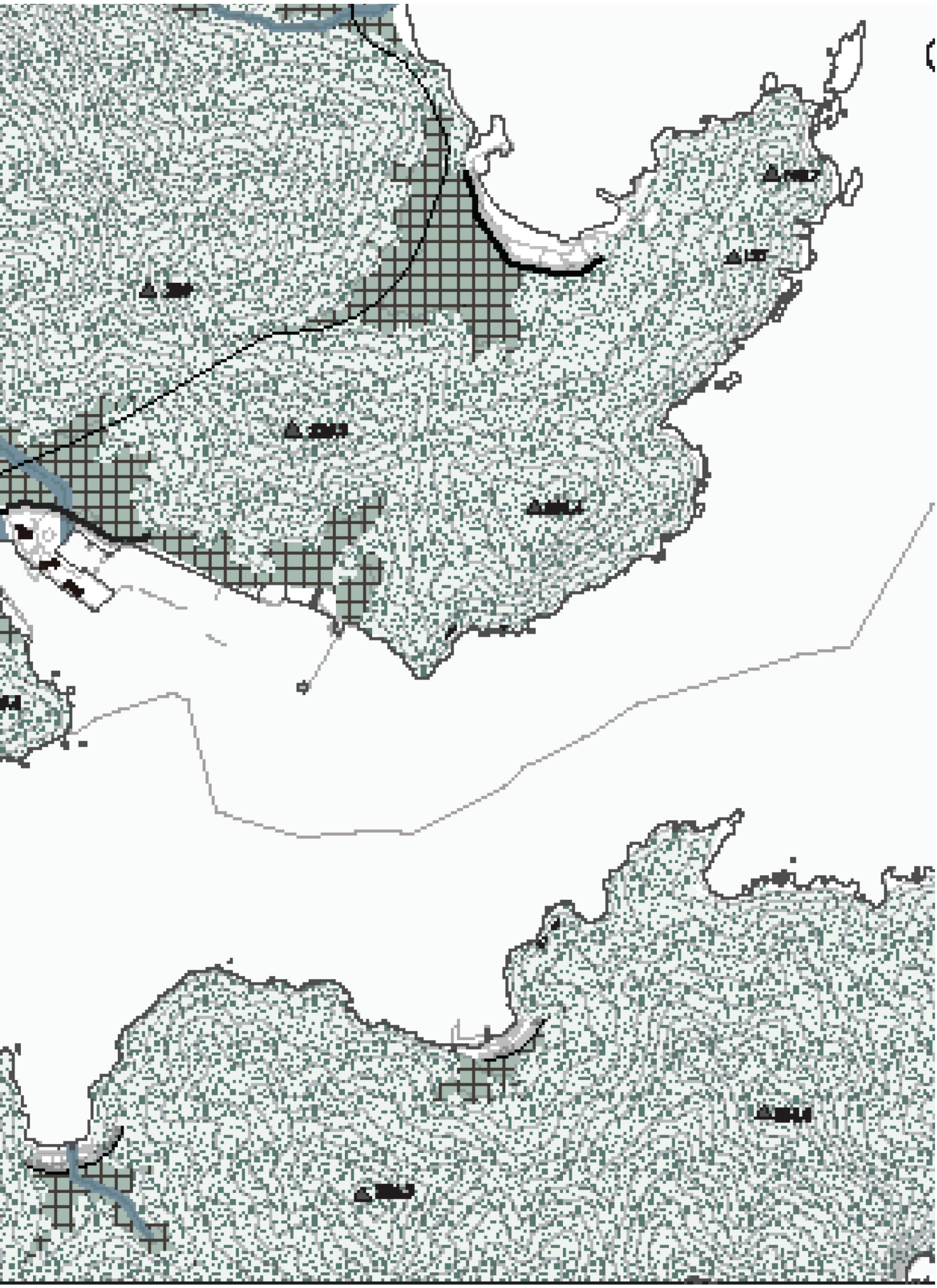
In the third phase, there will be no residents anymore. Otsuchi will be used as a renewable power collection area with the wind turbine in the mountains and the solar panels in the abandoned area. Biodiversity in this area will increase, and gradually nature will take over the urban and abandoned areas.



No human Scenario_Meso scale

The map shows how thing will change in large scale. Nature will extend into urban and abandoned area. Self- sufficient community will be formed up in high ground, surrounded by farmland. Wind turbines will be set in mountainous area, and the solar panels will be set in abandoned area.

- Original forest
- Community
- Farmland
- Extended nature area
- Wind turbines
- Dike
- Stream
- River erosion
- Solar panels
- Rail way
- Rail station
- Road



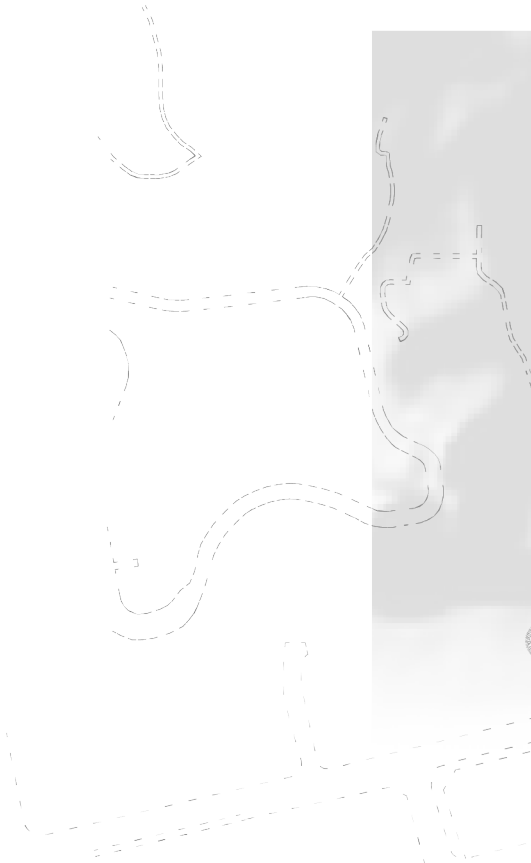


No human Scenario_Mirco scale

This map shows how thing will change in micro scale. Rivers will erode the embankment, and the sedimentation area will change into ponds and wetland, providing habitats for vegetations and animals. Solar panels offer the remaining communities energy.

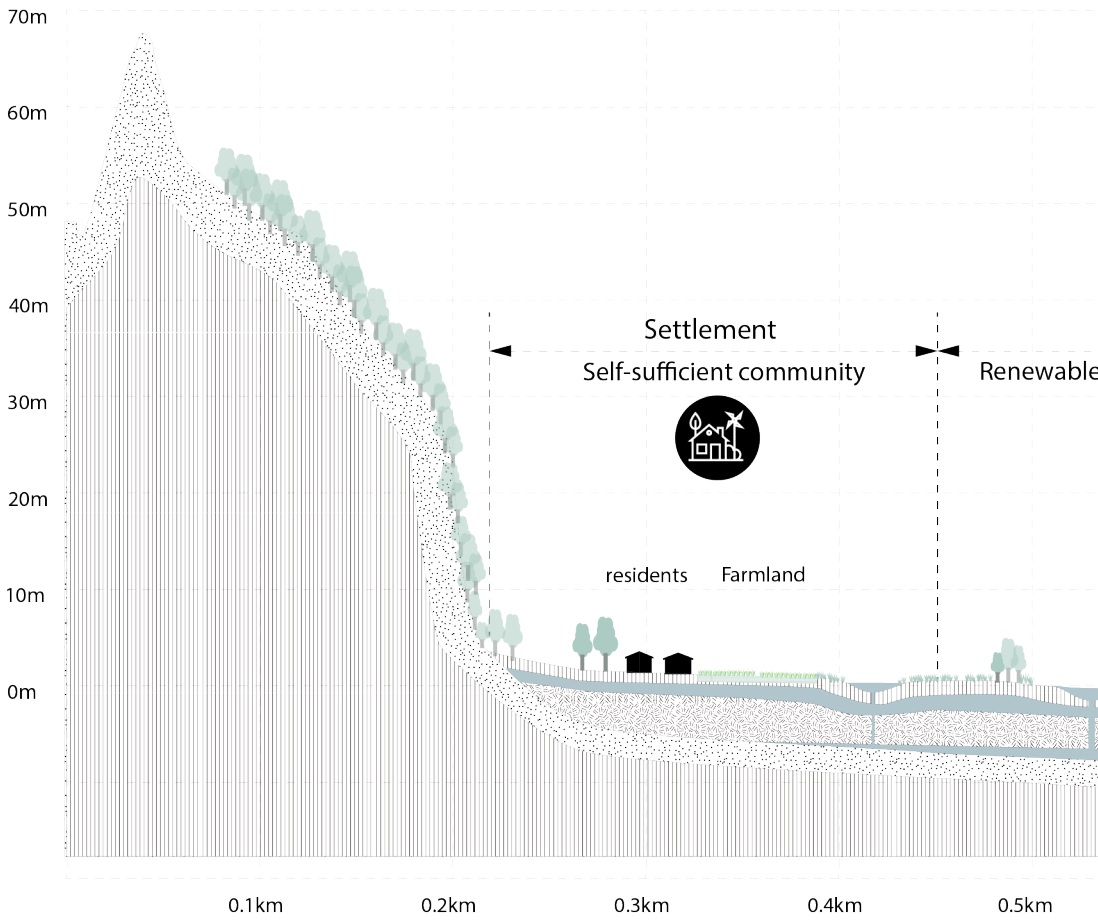
- forest
- original river
- river erosion area
- farmland
- grassland
- pools / wetland
- solar panel
- dike


Otsuchi river
0
200m

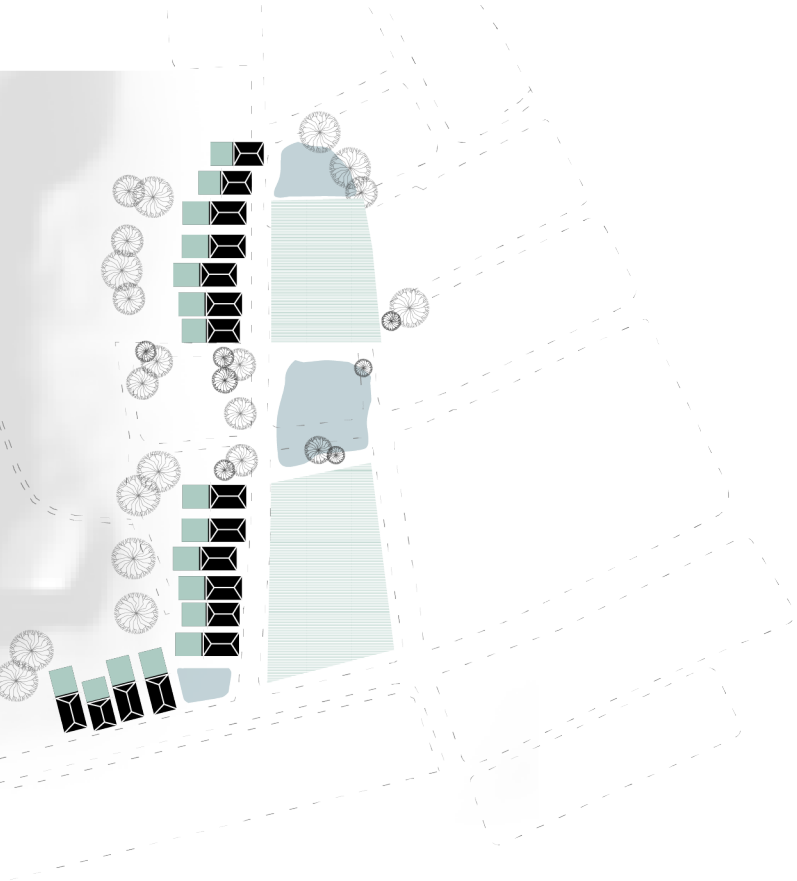


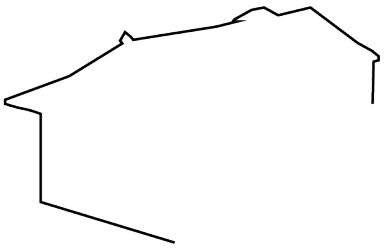
No human Scenario_Section

Communities will be located in high ground, with farmland nearby. Solar panles provide residents with renewable energy. The connection between Otsuchi and outside world will decrease.



base rock
marine clay
concret
open soil
wood
Sand
water
green
farm
Building
Utility





Tranditional housing type in Otsuchi
Local material: wood, clay
Easy built

Self-suficient community

Abandoned Area

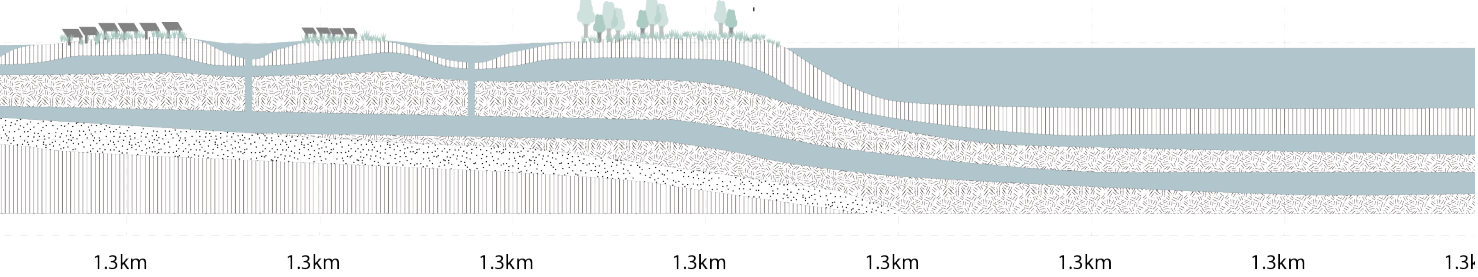
power collection area

Nature take over abandoned area

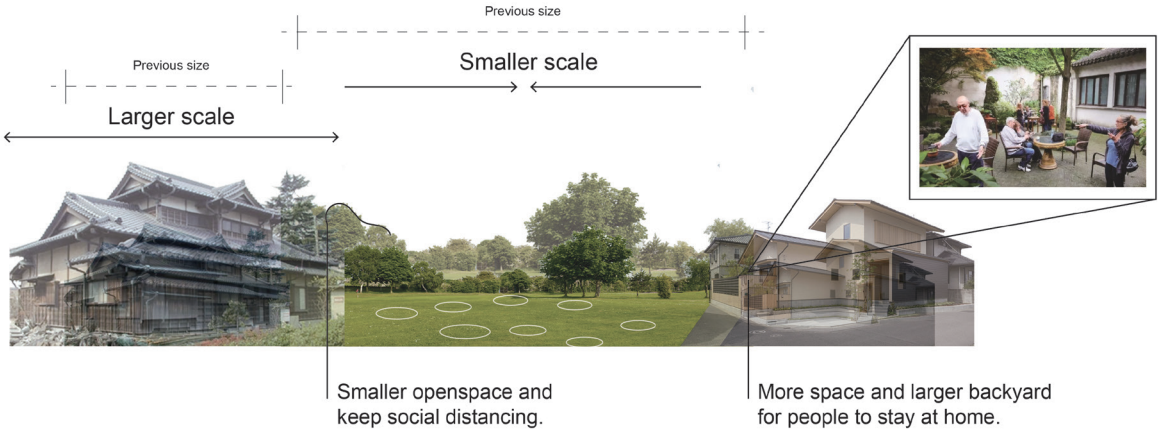
Solar panels

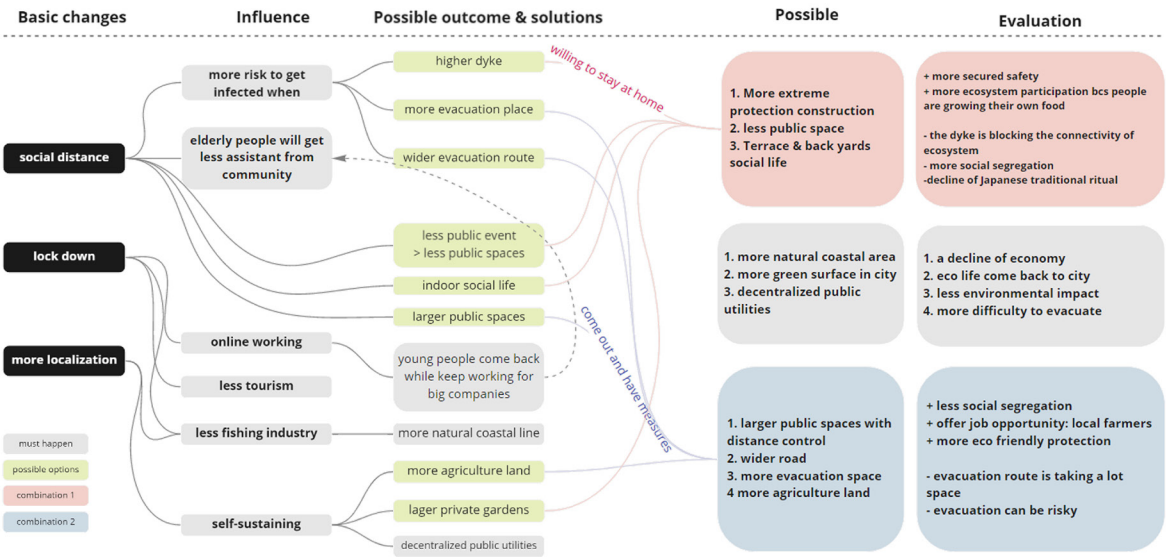
Spring well & Ponds

Vegetation



1.3km 1.3km 1.3km 1.3km 1.3km 1.3km 1.3km 1.3k


Previous size
Smaller scale
Previous size
Larger scale
Smaller openspace and
keep social distancing.
More space and larger backyard
for people to stay at home.

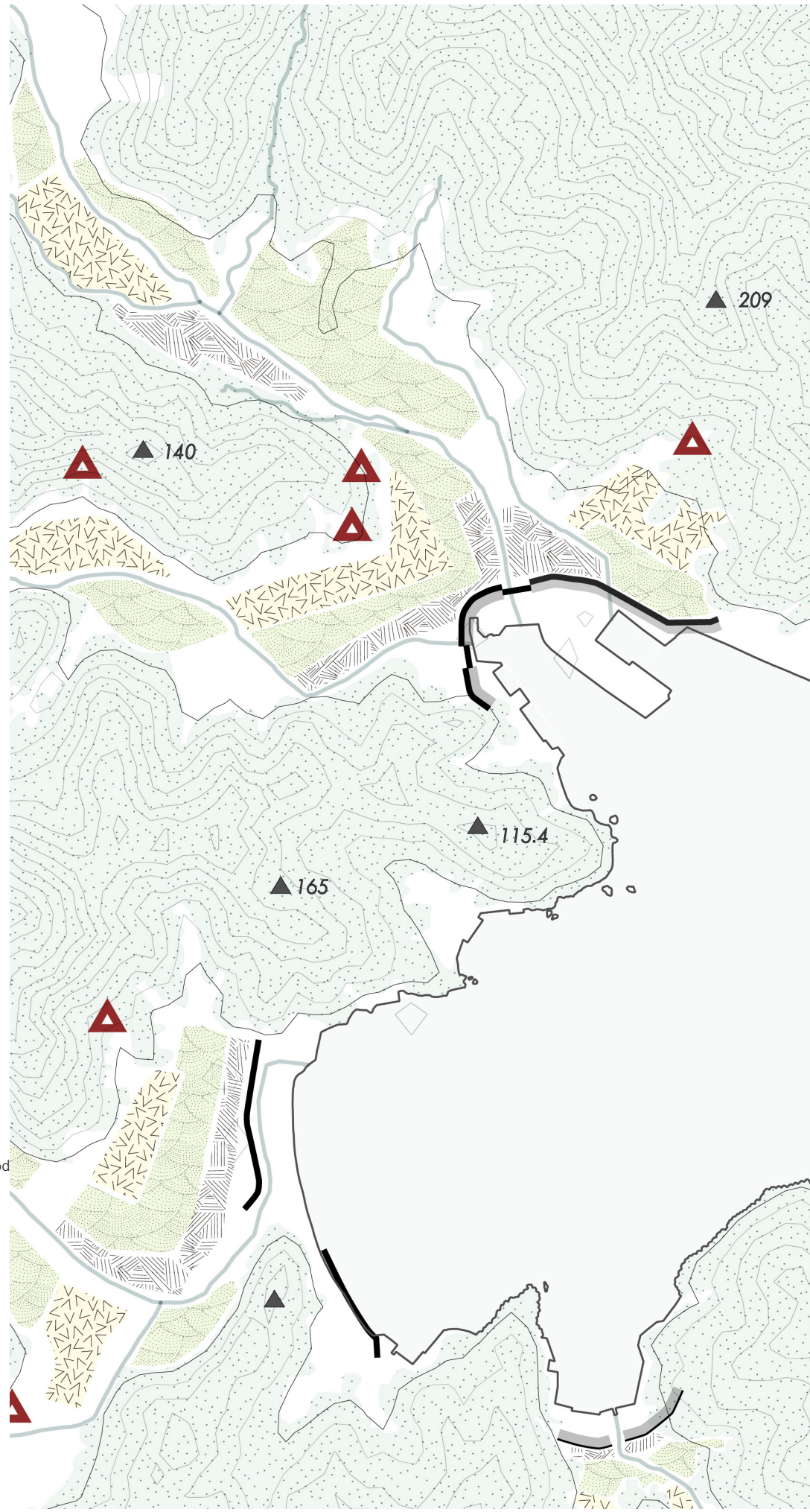

Basic changes
Influence
Possible outcome & solutions
Possible
Evaluation
social distance
lock down
more localization
more risk to get infected when
elderly people will get less assistant from community
online working
less tourism
less fishing industry
self-sustaining
higher dyke
more evacuation place
wider evacuation route
less public event > less public spaces
indoor social life
larger public spaces
young people come back while keep working for big companies
more natural coastal line
more agriculture land
lager private gardens
decentralized public utilities
willing to stay at home
come out and have measures
must happen
possible options
combination 1
combination 2
1. More extreme protection construction
2. less public space
3. Terrace & back yards social life
+ more secured safety
+ more ecosystem participation bcs people are growing their own food
- the dyke is blocking the connectivity of ecosystem
- more social segregation
-decline of Japanese traditional ritual
1. more natural coastal area
2. more green surface in city
3. decentralized public utilities
1. a decline of economy
2. eco life come back to city
3. less environmental impact
4. more difficulty to evacuate
1. larger public spaces with distance control
2. wider road
3. more evacuation space
4 more agriculture land
+ less social segregation
+ offer job opportunity: local farmers
+ more eco friendly protection
- evacuation route is taking a lot space
- evacuation can be risky

Scenario 4 . Covid-19

There are three fundamental changes in this scenario: keeping social distance, lockdown, and more localization. General influences generated by social distance are that evacuation will be riskier, and older people will get less assistant from the community. Lockdown will lead to online working, less tourism, and less fishing industry. More localization will lead to a more self-sustaining developing mode.

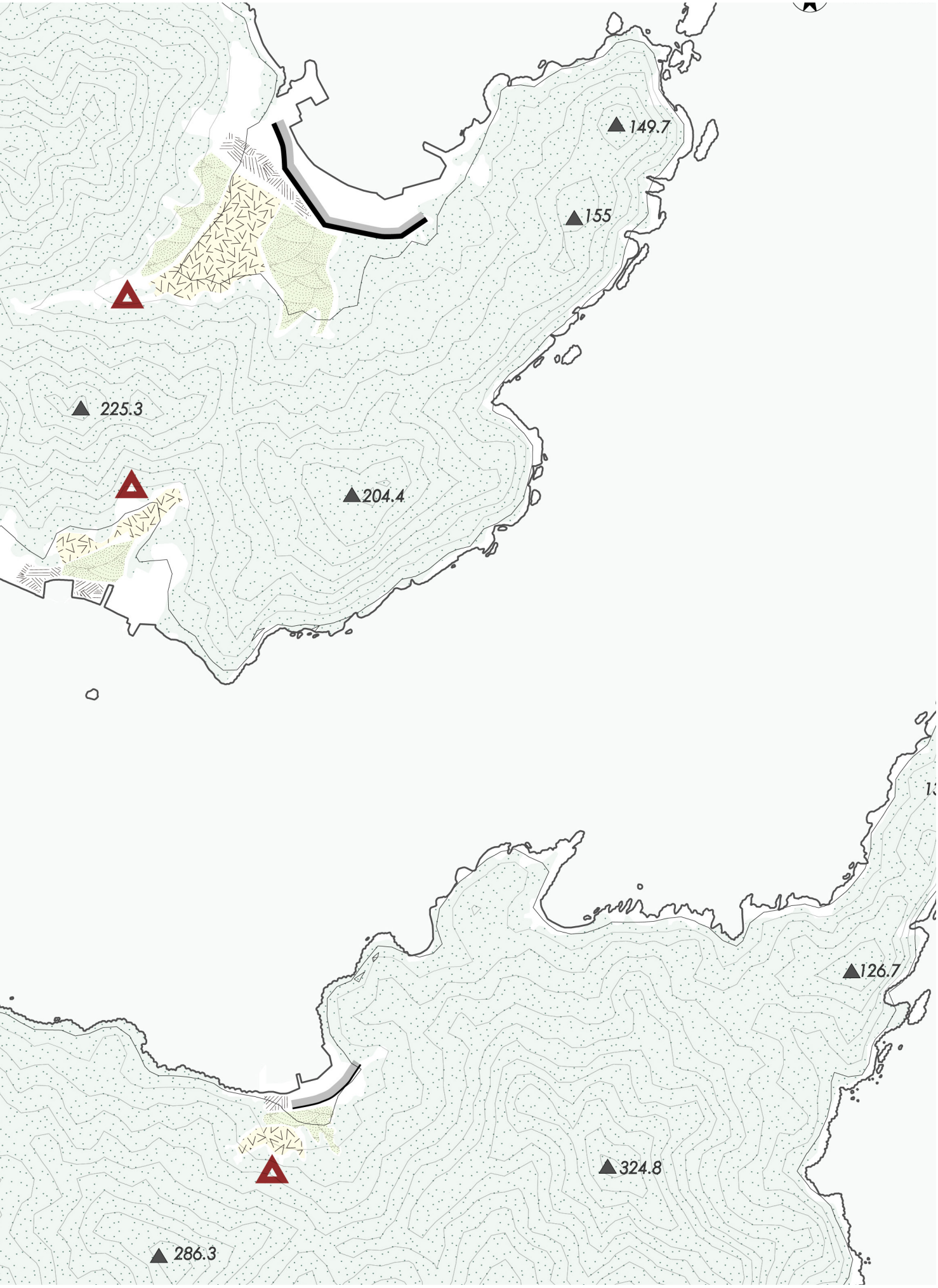
Base on these influences, there are two ways to deal with this situation. On the one hand, the government can be rigorous to keep people in their own houses. To doing so, higher dikes are needed to keep people safe and avoid chances when people need to evacuate. Moreover, because of staying at home, larger houses with backyards garden is on the call, and public spaces will be smaller than before. On the other hand, there is another perspective we can take. People can still go out to have collective activities with soft measures to keep themselves safe. In this circumstance, a new evacuation plan featured with larger evacuation places and wider evacuation routes are needed. Public spaces will be larger for people to keep social distance.

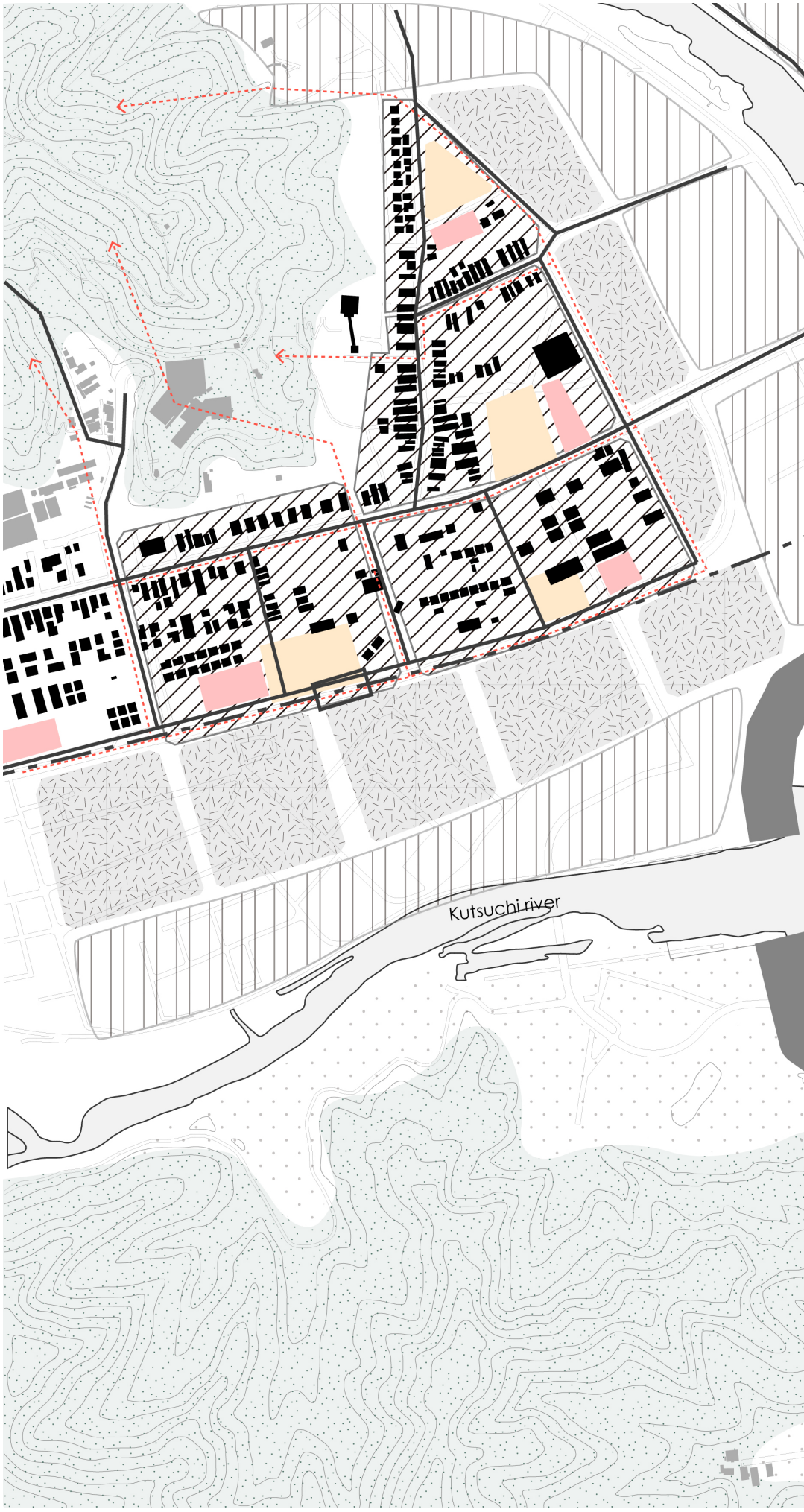
By evaluation the two options in safty, environmental and social dimension, we choose the second option as it has more respect to people's mental health and social life. We assume that when facing epedemics, people can still keep their normal life as much as possible with soft measures to guarantee their health.



Covid-19 Scenario_Meso Scale

This map shows how thing will change in large scale, the dyke is preserved and more evacuation places are added. Along the coastal area there is farm land to supply food to local communities.


149.7
155
225.3
204.4
126.7
324.8
286.3



Covid-19 Scenario_Micro Scale

This map shows how thing will change in micro scale In each community, there are larger public spaces and evacuation routes to the ligher land.

forest
community
large public space
farmland
grassland
community public space
utility
evacuation route
dike

N

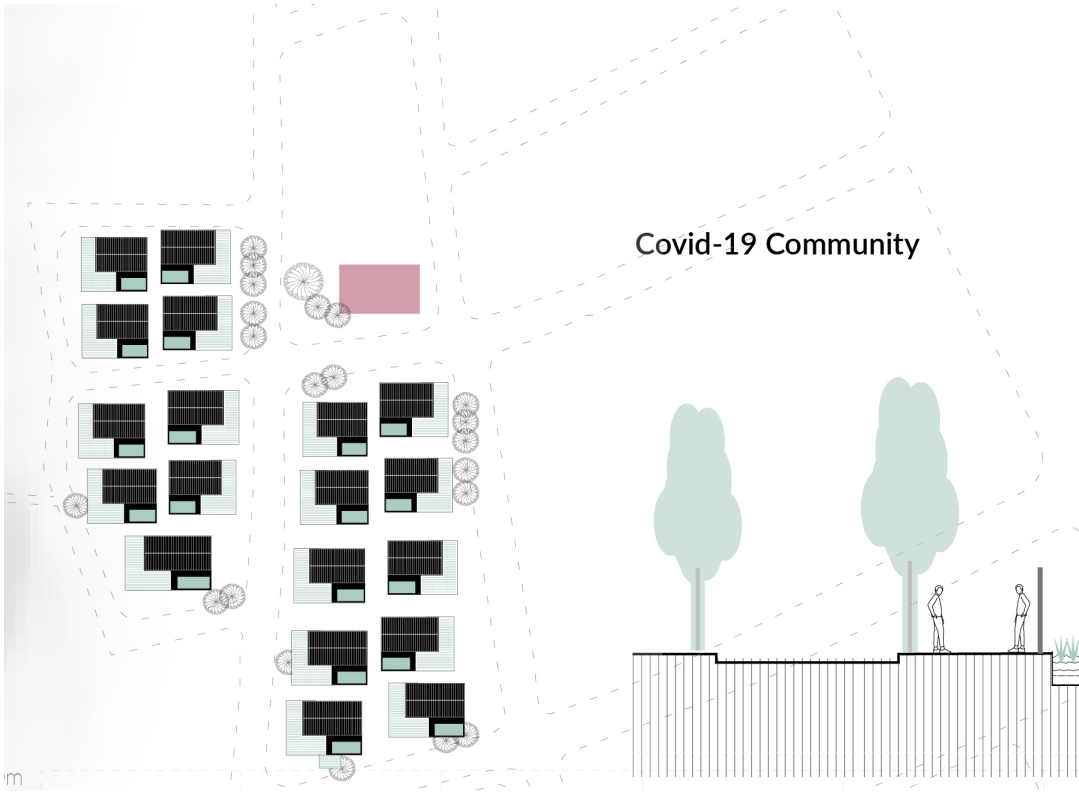
0 200m


Otsuchi river

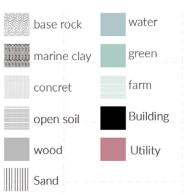
Covid-19 Scenario_Community

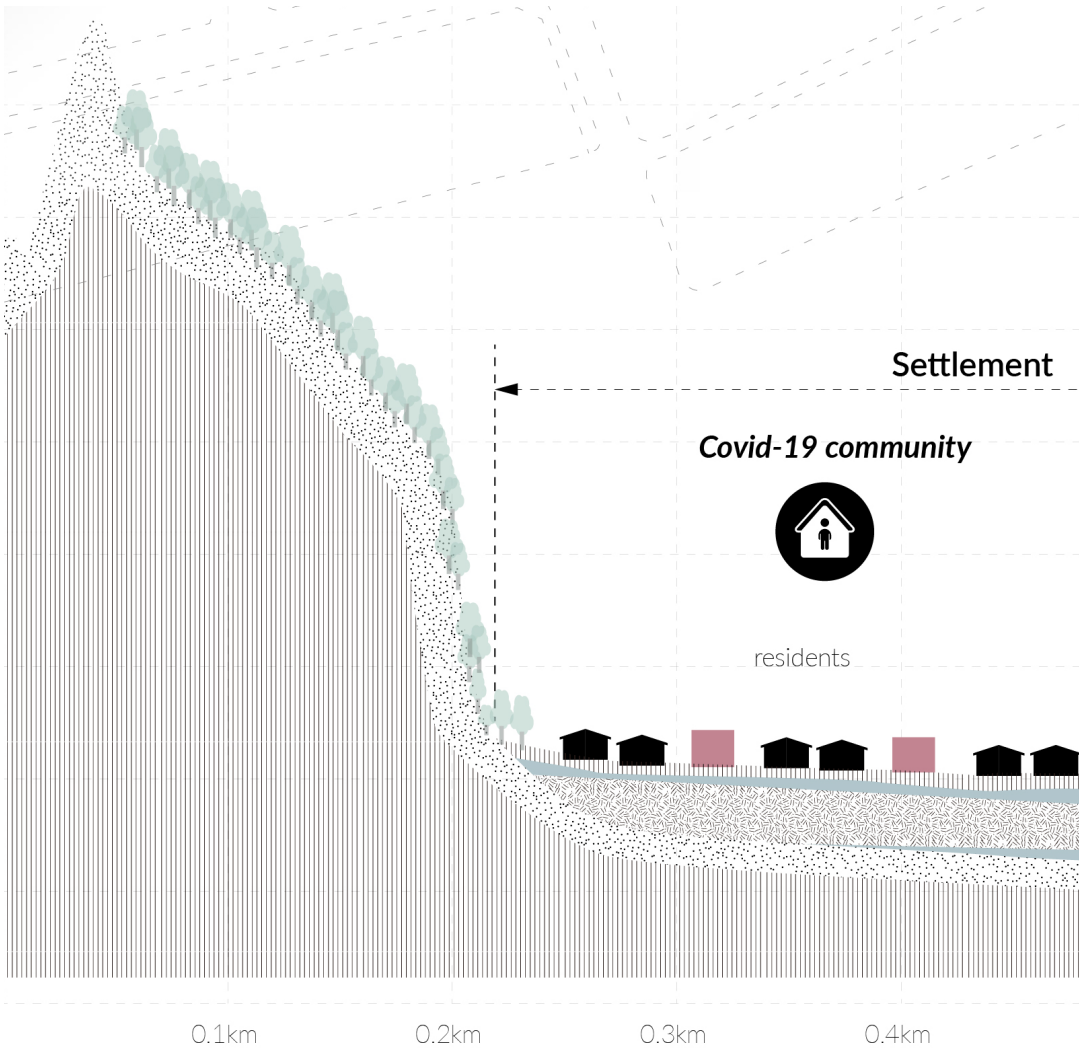
At community scale, new housing types with gardens and larger working spaces will appear, balconies are used to have indoor social life. Sidewalks will be wider for peopel to keep distance.

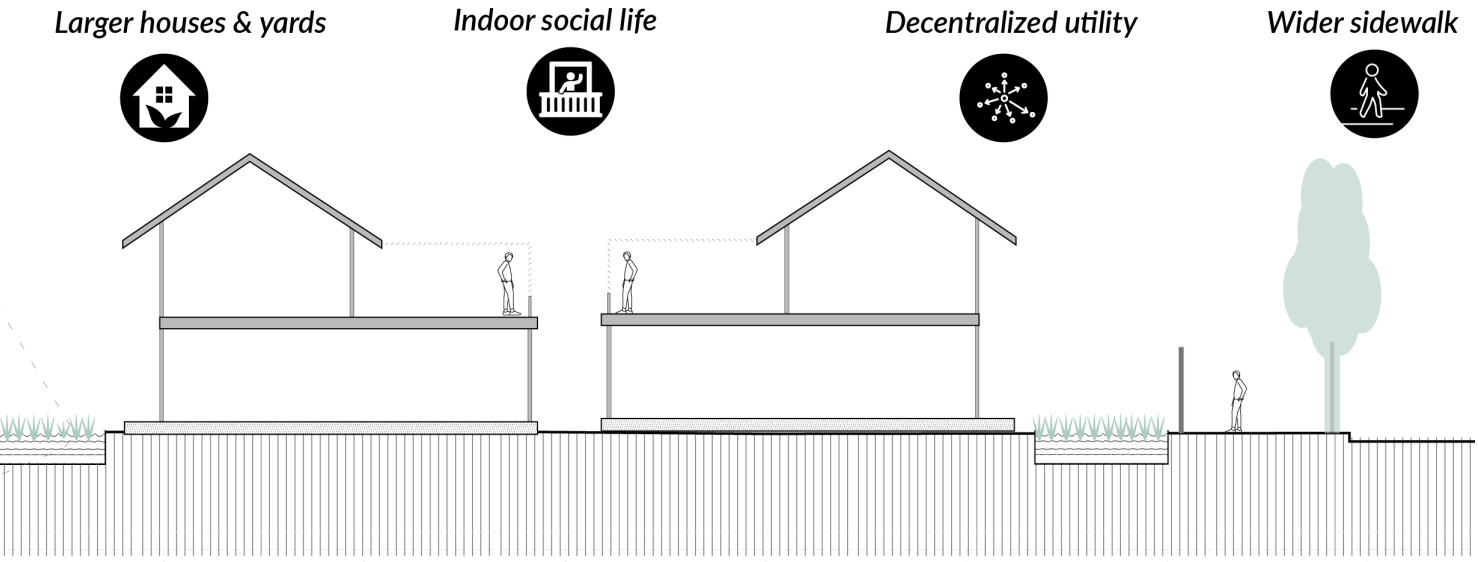


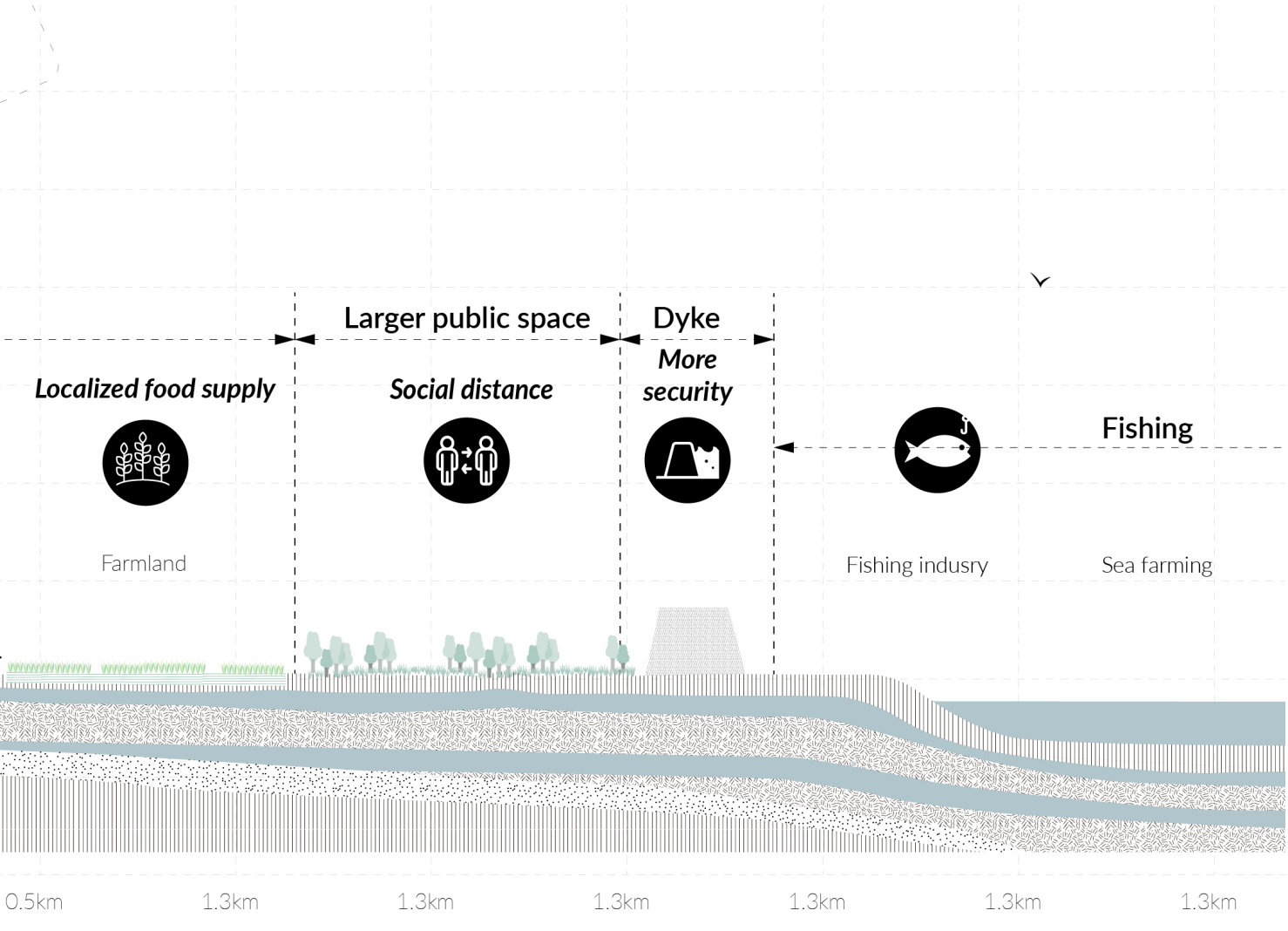


Covid-19 Scenario_Section






Larger houses & yards
Indoor social life
Decentralized utility
Wider sidewalk


Larger public space
Dyke
Localized food supply
Social distance
More security
Fishing
Farmland
Fishing indusry
Sea farming
0.5km
1.3km
1.3km
1.3km
1.3km
1.3km
1.3km

6.

System Intervention

6.1. System intervention

In the future we want to reconnect people with the water and the sea, by turning the hard measures to soft measures gradually, to mitigate the adverse effects. Moreover, by seeking what benefits can those nature-based measures bring to ecology, environment, and people., more integrated plan will be developed .

Instead of putting all protection stress on the engineered infrastructure, the nature-based solution will be applied at the regional level, working as a gradient buffer zone. This soft measure concept also creates a framework that connects the coast, riverine, and mainland.
It's not only fulfilling sustainable goals but also helps foster the economic and social opportunities that support an inclusive regional community. New activities such as post-disaster, eco-tourism, recovery education learning, and recreational fisheries can be embedded in the new system.

Within these projects, a new life circle is stretched, and more local people, groups, and parties can be part of for better post-disaster development. At the same time, The plan can also attract more people to go back to Otsuchi, which will deal with population decline and aging society.

6.2. Design Experiements

6.2.1.

Living with water

Floating communities of family-based fishing industry and experiencing tourism

Ying Hou

6.2.2.

Tsunami Park

Yujia Liu

6.2.3.

Turn Crisis into Chance

Ning Cai

6.2.4.

Living Shoreline:

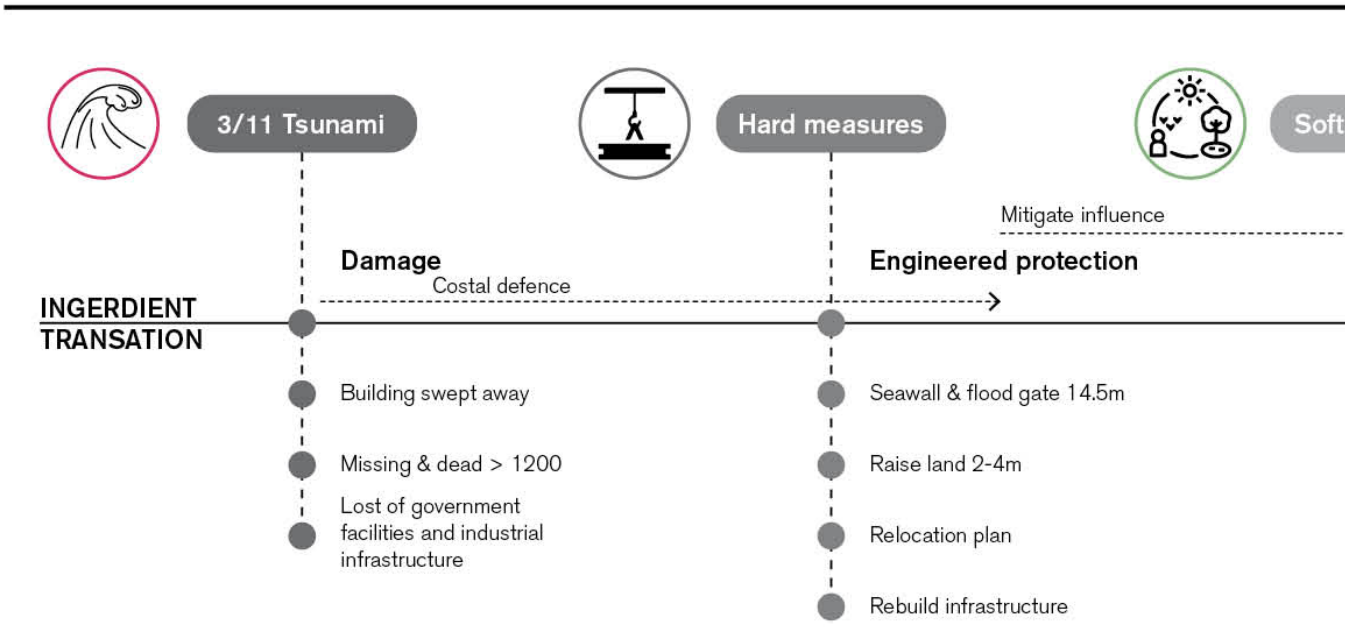
Fishery industral area peotection and coastal ecological restoration

Zichuan Lu

6.2.5.

Mountain / Water

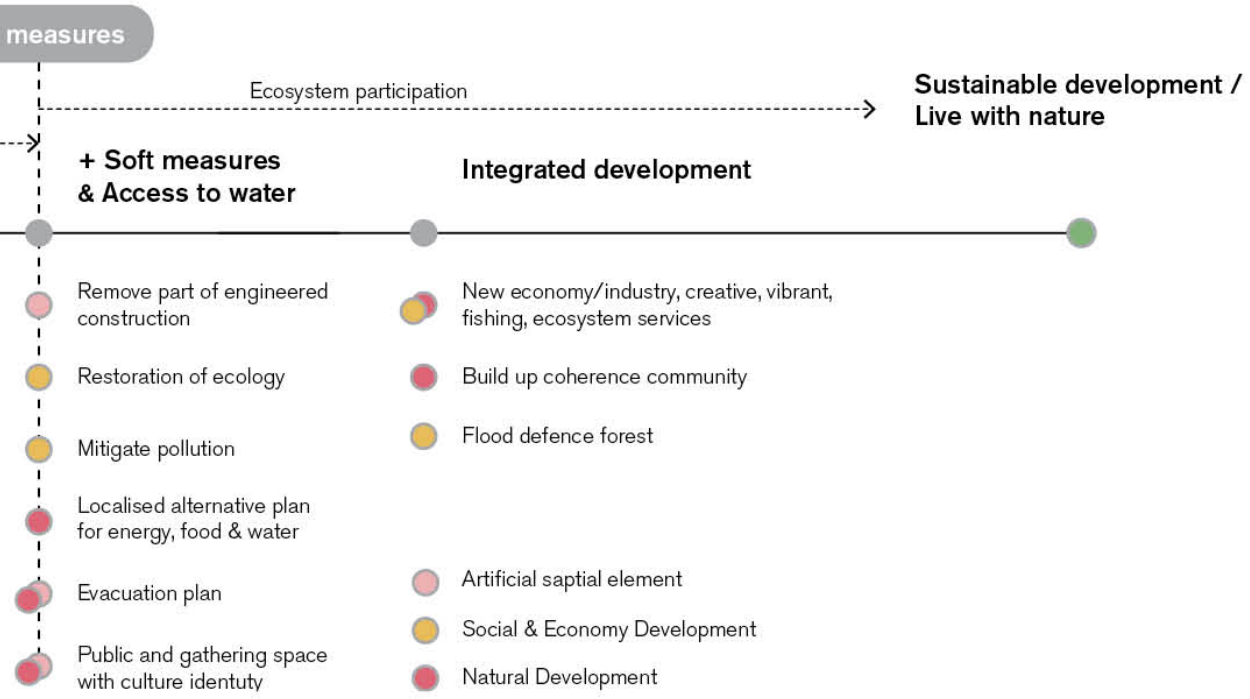
Kueitso Chen

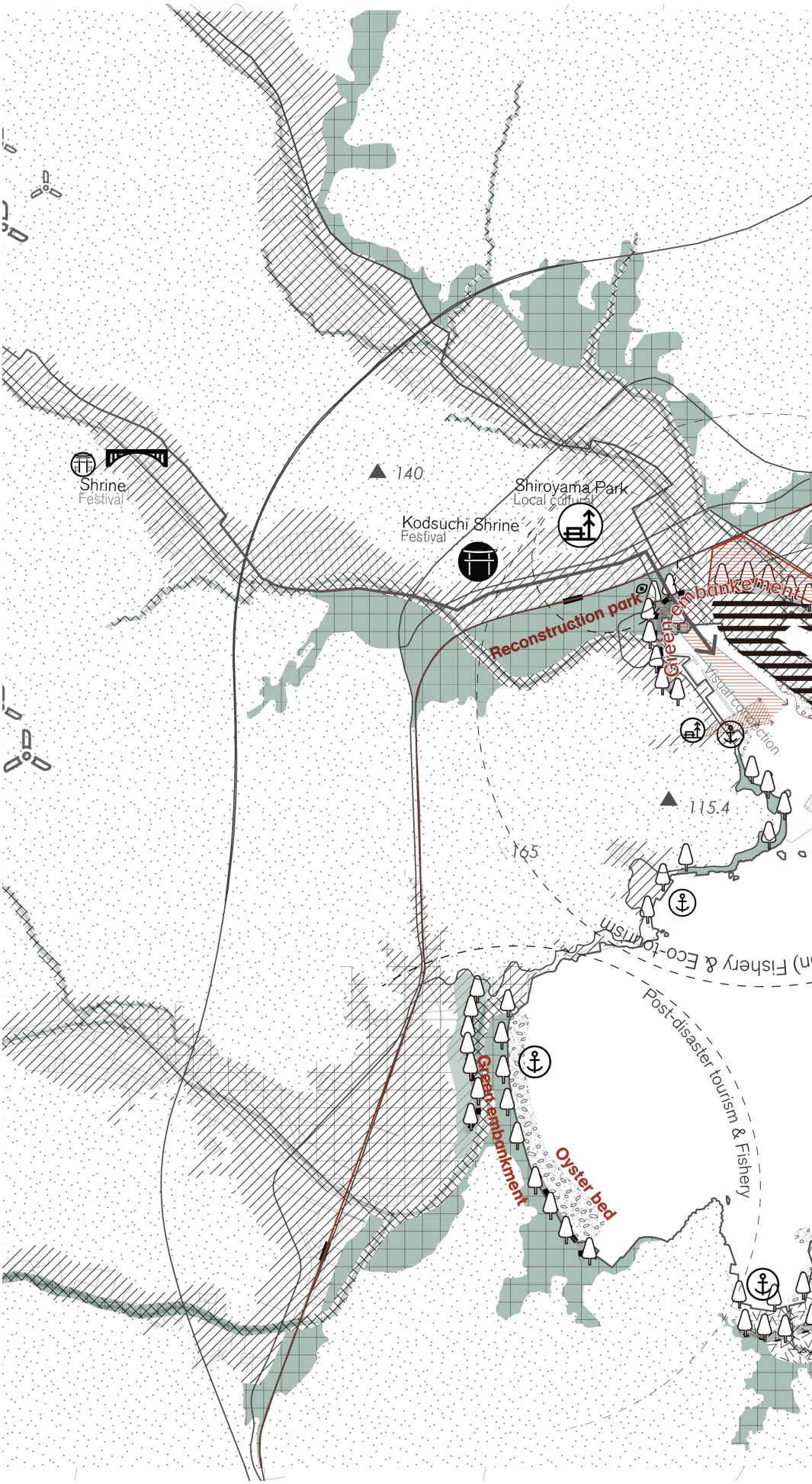

3/11 Tsunami
Hard measures
Soft
Mitigate influence
Damage
Costal defence
Engineered protection
INGERDIENT
TRANSATION
Building swept away
Missing & dead > 1200
Lost of government facilities and industrial infrastructure
Seawall & flood gate 14.5m
Raise land 2-4m
Relocation plan
Rebuild infrastructure

System intervention

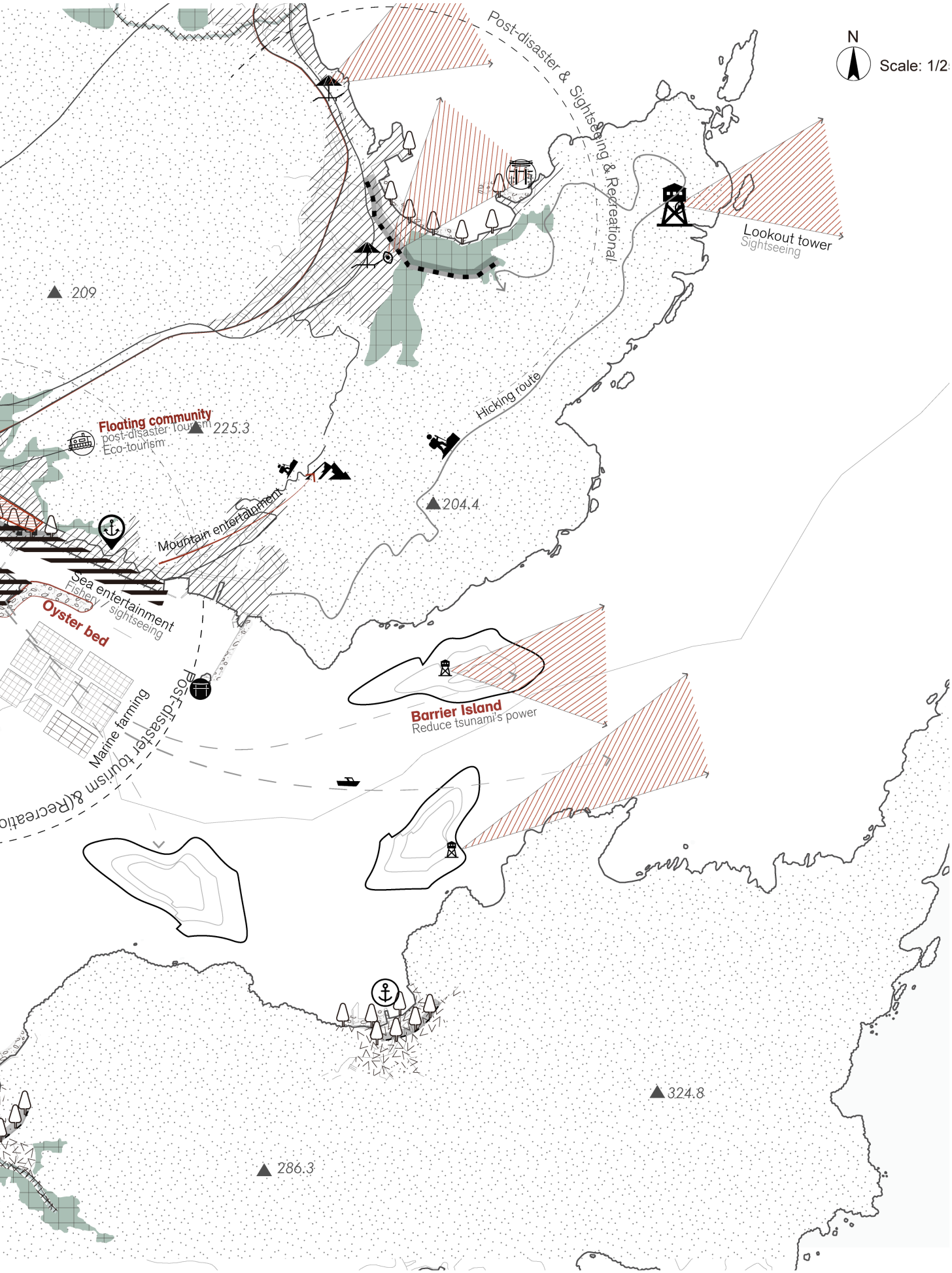
In current planning, it tends to use engineered and hard measures to deal with the disaster. However, from the analysis, it can be seen that these measures disconnected the relationship between water and residents which cause the almost different living experiences from the residents used to have.

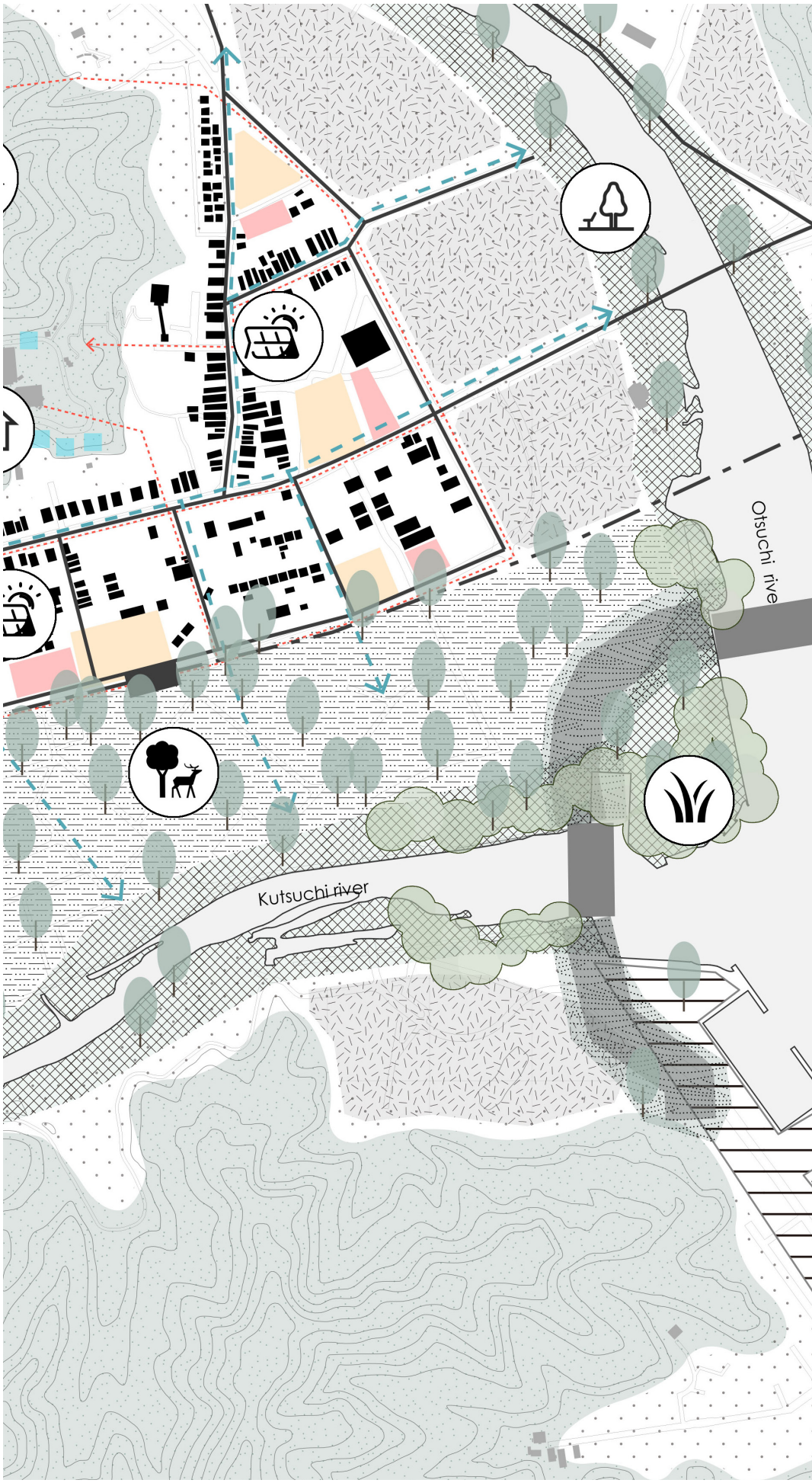
As a result, this project aims to gradually turn the adverse effects by engineered protection constructions both ecologically and socially and use more nature-based hybrid infrastructures to protect people from disasters while still keeping the function of the ecosystem, even adding more diverse habitats. Moreover, seeking what and how those nature-based measures can bring to ecology, environment, and people is also another critical subject. Blossom this area and develop new economy sectors, such as tourism featured with tsunami memory and nature-based infrastructures which can also attract more people to go back to Otsuchi to deal with population decline and aging society. By doing so, it can bring multiple benefits.





Vison map _1-25000


N
Scale: 1/2
Post-disaster & Sightseeing & Recreational
Lookout tower
Sightseeing
209
Floating community
post-disaster tourism
Eco-tourism
225.3
Hicking route
204.4
Mountain entertainment
Sea entertainment
Fishery sightseeing
Oyster bed
Post-disaster tourism &(Recreatio
Marine farming
Barrier Island
Reduce tsunami's power
324.8
286.3



Guideline map _ 1:5000

use nature-based protection solutions to defend tsunami while enhancing the existing fragile ecosystem, and then come up with a lifestyle that matches it.

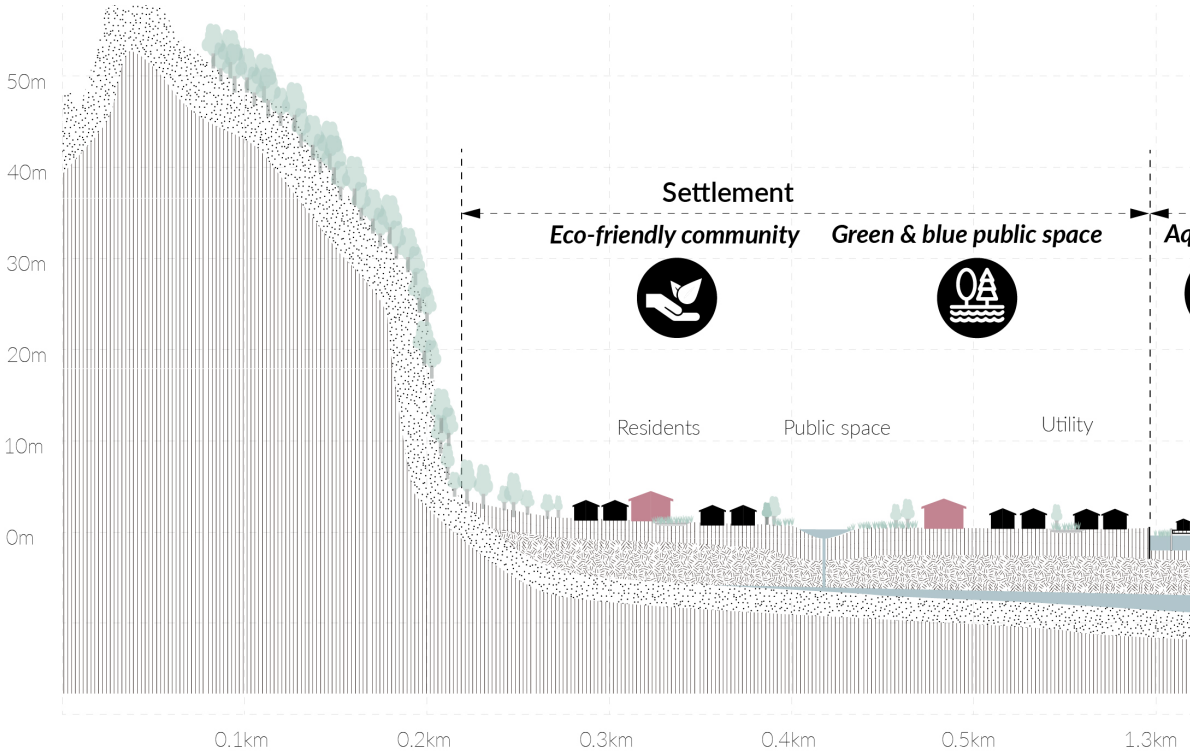
- Water or highlight
- Rivers
- Sealevel rise
- Mountain
- Etc
- Etc
- Etc
- Etc

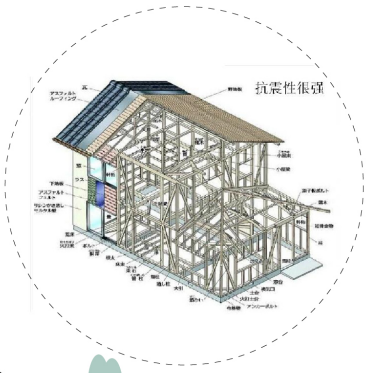
N

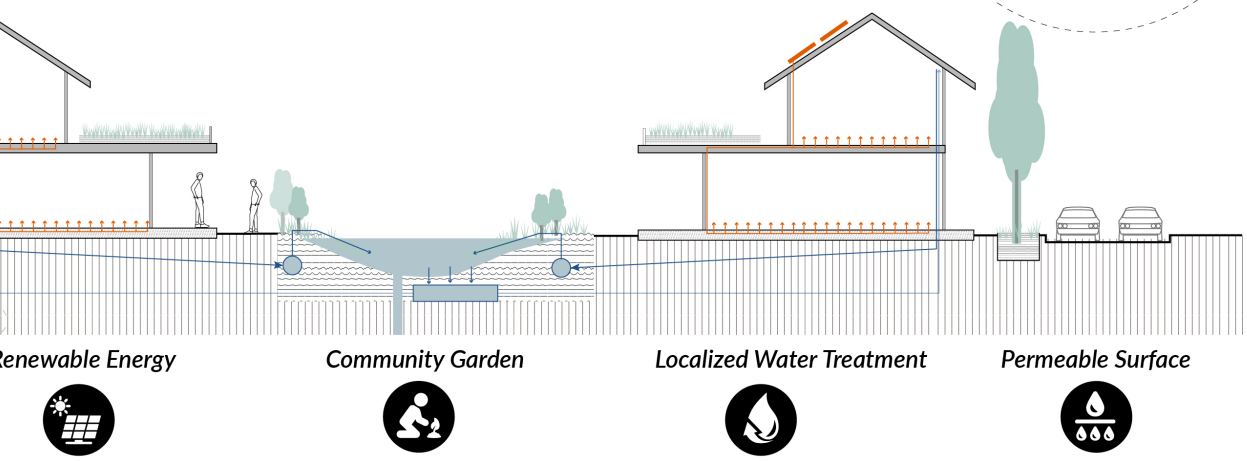
0 100 km

Guideline

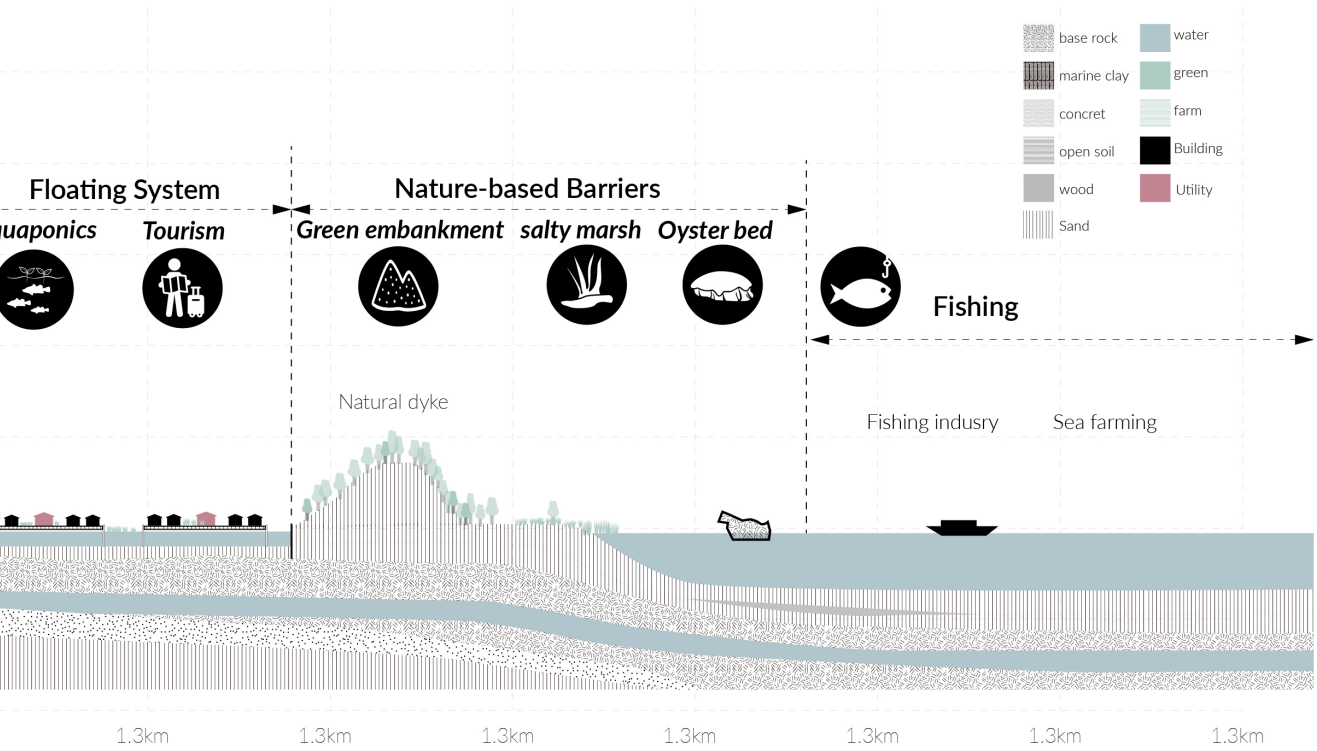

Eco-friendly Community


50m
40m
30m
20m
10m
0m
Settlement
Eco-friendly community
Green & blue public space
Residents
Public space
Utility
0.1km
0.2km
0.3km
0.4km
0.5km
1.3km





Renewable Energy *Community Garden* *Localized Water Treatment* *Permeable Surface*



Domain of guidelines	Category	Guideline
Emergency planning	Urban morphology	Age friendly evacuation route
		Compact city and land readjustment
		Public spaces to raise secio-spatial memory
		Alternative/ access for critial capitals
	Decentralized system	Spatial distribution of functions
		Decentralized political system
		Local economic potentials
	Raising awareness	Socio-spatial memory
		Tsunami hazard map awareness
Transitional coatal defence	Flood- prone area	Tsunami- defense measures become mult functionalized that ecosystem can get benefits from
		Restore the ecological environment and create diverse habitats
		Create continous landscape integrated with mixed function
		Transfer hard coastal defense to hybrid measure
Community resilience	Social identity and cohesion	Create public and gathering spaces with culture identity
		Community garden
		Build up the community for all ages
		Decentralized political system and functions
	Local economy development	Revitalization of fishing industry in floating communities
		Tourism development featured with tsunami memory, fishing experience
	Built environment	Traditional housing type with local materials
		Localized water cycle and energy supply
		Coherence & diversity community arrangement

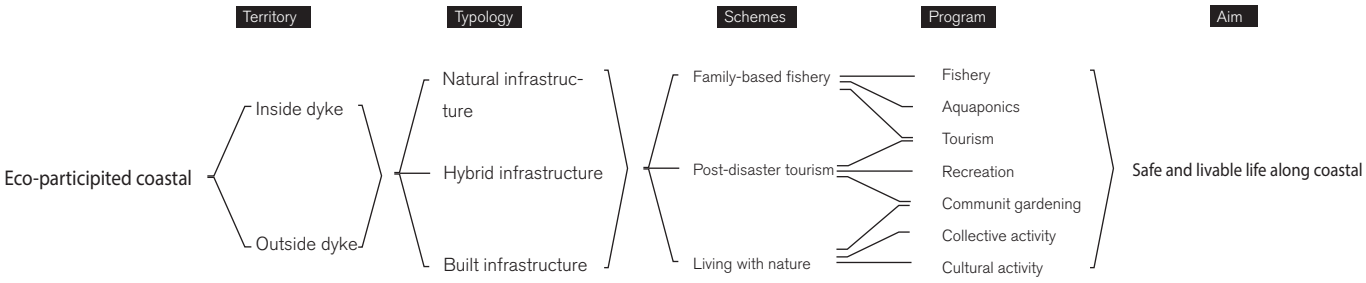
Guideline

To face the specific issues like improving disaster resilience, and comprehensive spatial planning which adapts to population decline, and the aging population, there are three dominant in guideline which is the main subject of this project.

In emergency planning, the strategy is mainly about how to react with the tsunami. For example, building up aged-friendly evacuation route, and decentralized the political system and raising awareness of tsunami with hazard map and monument.

For improving disaster resilience, there is a danger that any civil engineering reconstruction project might destroy the attractiveness of the region cause disruption to future town management. As a result, it is important to transfer hard coastal defense to hybrid measure and make those measures become multi-functionalized that ecosystem can get benefits from and create continuous landscape integrated with mixed function.

There are three categories which are focusing on social identity and cohesion, local economy and building environment to deal with the socio issue. And the main purpose is to activate the community by revitalizing of the fishing industry in floating communities, tourism development and build up coherence & diversity community arrangement.


Territory
Typology
Schemes
Program
Aim
Eco-participited coastal
Inside dyke
Outside dyke
Natural infrastruc-
ture
Hybrid infrastructure
Built infrastructure
Family-based fishery
Post-disaster tourism
Living with nature
Fishery
Aquaponics
Tourism
Recreation
Communit gardening
Collective activity
Cultural activity
Safe and livable life along coastal

Design expirement location



Living with water

Floating communities of family-based fishing industry and experiencing tourism

Ying Hou



Territory **typo**

Eco-participated coastal defence

- Inside dyke
- Outside dyke

- Natura
- Hybrid
- Built in



ology

l infrastructure

infrastructure

frastructure

Schemes

Family-based fishing

Post-disaster tourism

Living with nature

Programs

Fishing

Aquaponics

tourism

Recreation

Community gardenning

Collective activity

Cultural activity

Aim

Safe and livable living along coastal

miro



To deal with water-related disasters, as exemplified by floods, the answer lies not in massive structures like dams, dikes, and seawalls but rather in taking an indirect approach that tames the water's impact and minimizes the effect of water-related disasters more economically. (Nakajima & Umeyama, 2015, p. 21)



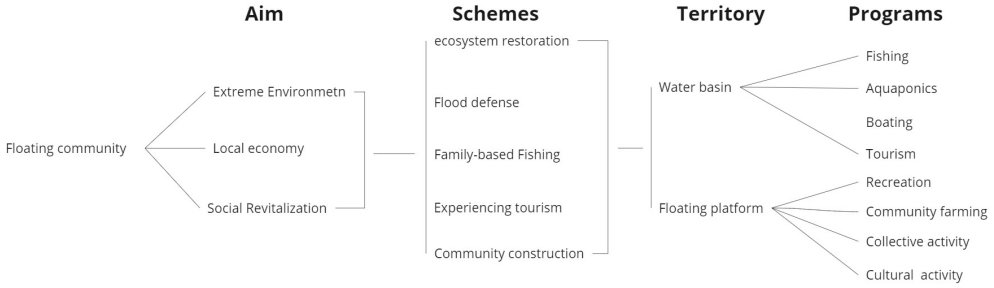
Manifesto

Right now, what people do to prepare for the next tsunami is to build sea walls and living away from the sea. However, here we assume a different way that can protect residents from while still keep the relation to the sea. The theme of our vision and guideline is to use eco-participated coastal defense measures to rebuild the connection from humans to water.

In the design of the floating community, the main goal is to create a new landscape and lifestyle for the family-based fishing industry and tourism. Here I envision that people are not scared away by water; on the contrary, they can live with water and take advantage of it to develop a family-based fishing industry and experiencing tourism.

Here I want to invite you to see an alternative way to live in Otsuchi. Imagine that those who used to earn their lives on the family-based fishing industry do not need to change their lifestyle but still keep their tradition but with a more safe living environment, both for themselves and their houses. Imagine that a wide range of species will not lose their habits due to the engineered sea walls. They can find places on the soil cover that on top of the hard measure. New species will be formed thanks to the water basin where salty water and fresh water can mix. Imagine that in the future, not only people with low skills are left here, but young people and tourists will also be attracted here. Young people will have job opportunities in the eco-tourism sector while enjoying a vibrant life with water. Tourists can come here to live in the traditional houses and experience the daily life of fishing man to boating in the water and capturing fishes.

This new landscape can offer not only diverse habits for species but also a new lifestyle for different human groups.



CURRENT SITUATION

Remove soil to build an artifical waterbase, and the soil can be used to make soil covers on the dyke and oyster beds.

FIRST STEP

Steel bargetype floates and buildings on it to bring water and people together.

SECOND STEP

There are piles understand each floater to suppot it in normal days. When tsunami comes, the guide piles on the side will lead the floaters to stay on top of water.

DEFENSING SYSTEM

Continuaty water process from mountain to sea

More habitats offered by soil cover and oyster bed

Brackish water mixed of salty water and fresh water will forster new species

ECOLOGICAL BENEFITS

Reconnection to the sea

More job opportunities to attract young people

More attractions for tourism

A mix of different groups will create a diverse and inclusive living environment

SOCIAL BENEFITS

Fishing industry

Tourism attracting

No need to build houses from scrach after disasters

ECONOMY BENEFITS

Construction Process of Floaters

This page shows how the construction of flooters are processed and how can these floaters defend flood. What's more, multi-benefits by this system are explained.

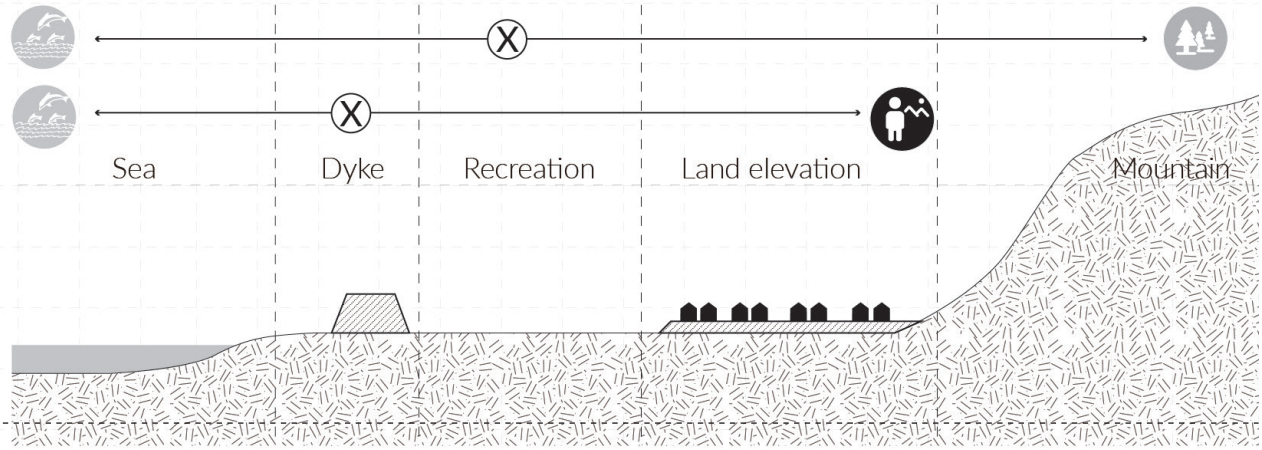
water

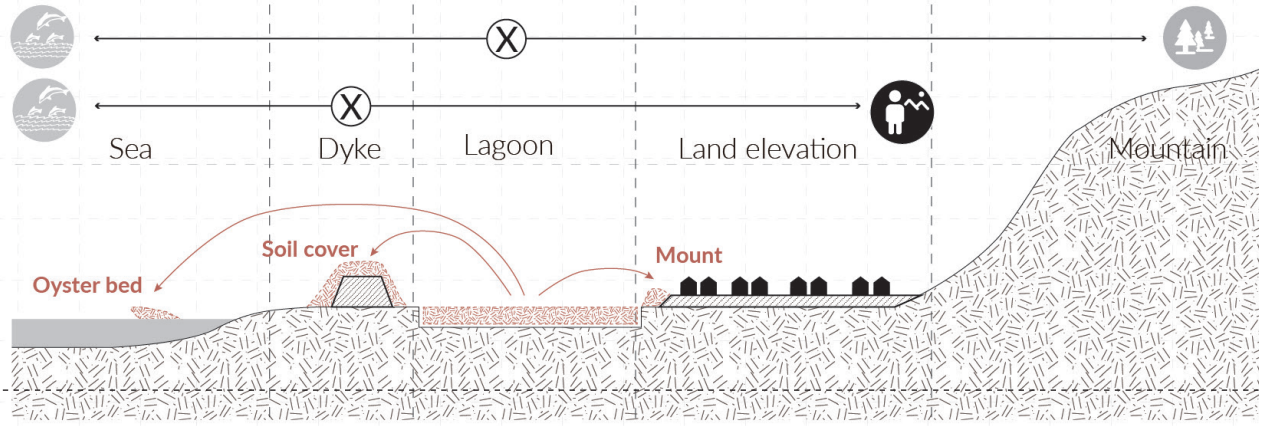
greenery

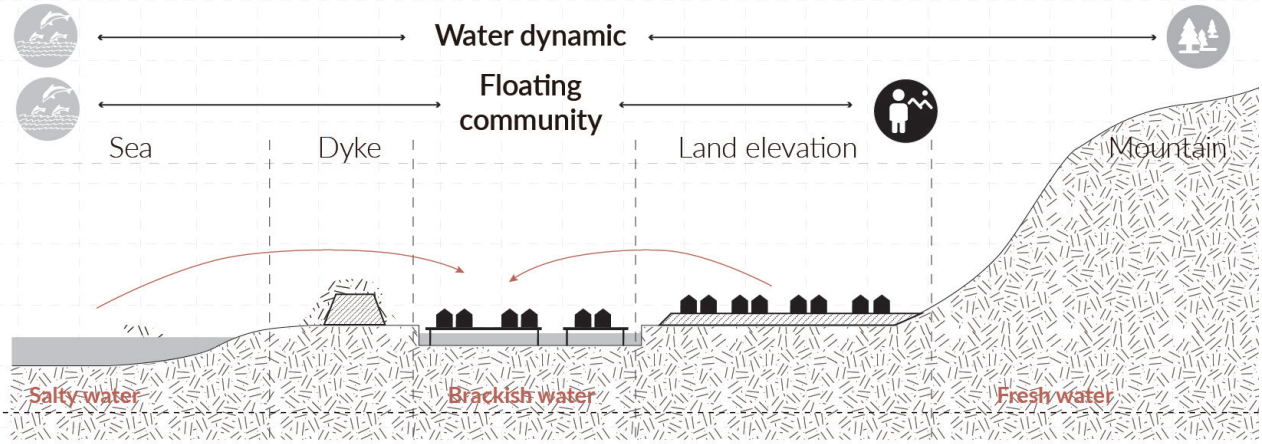
marine clay

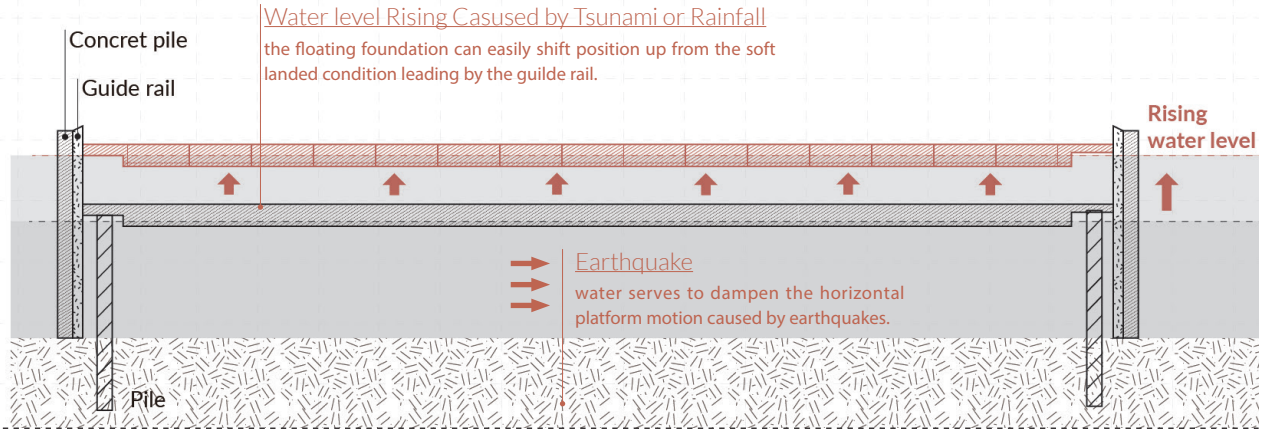
concret

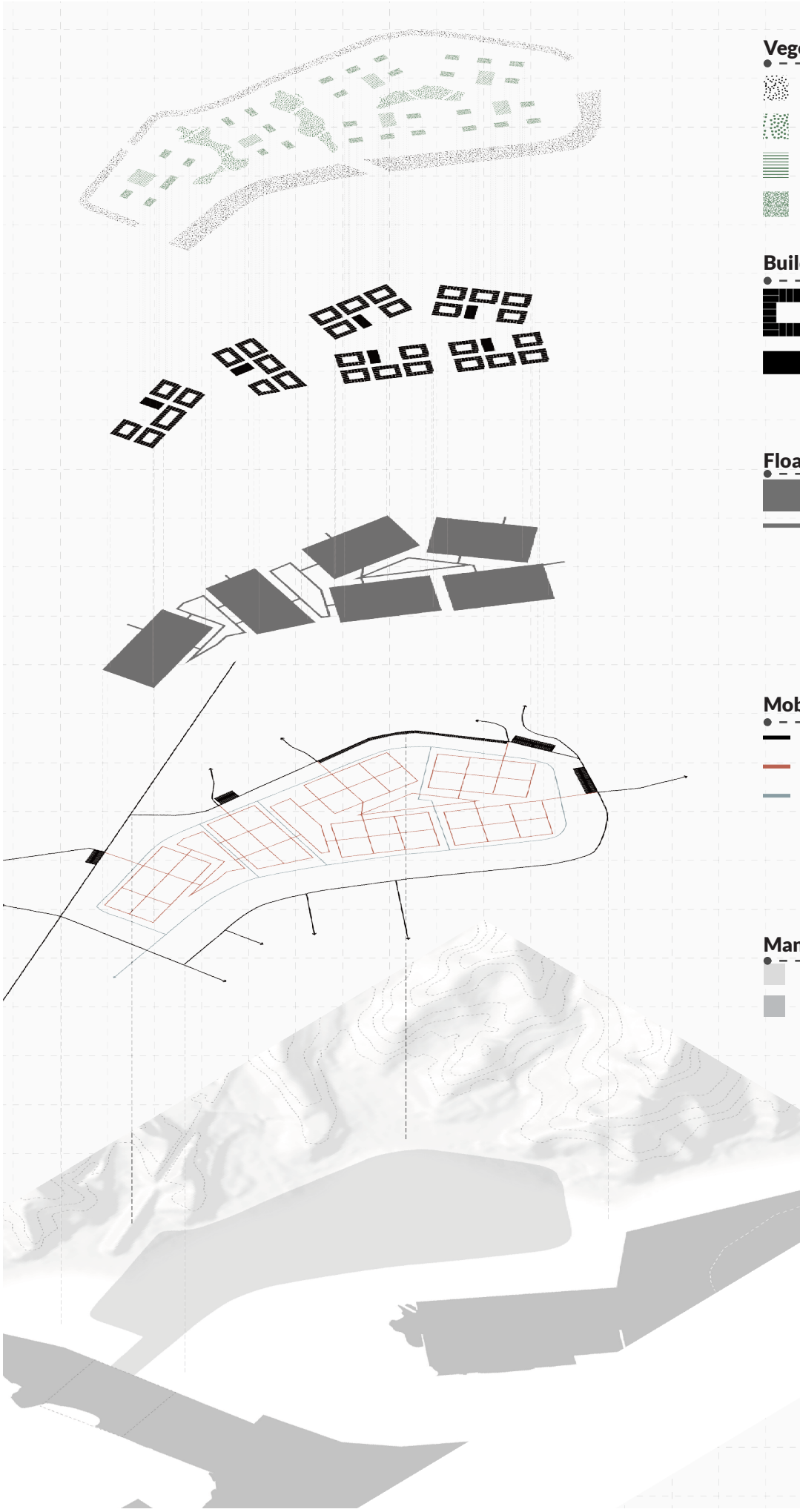
Engineered construction


Sea
Dyke
Recreation
Land elevation
Mountain


Sea
Dyke
Lagoon
Land elevation
Mountain
Soil cover
Oyster bed
Mount


Water dynamic
Floating community
Sea
Dyke
Land elevation
Mountain
Salty water
Brackish water
Fresh water


Water level Rising Casused by Tsunami or Rainfall
the floating foundation can easily shift position up from the soft landed condition leading by the guilde rail.
Concret pile
Guide rail
Rising water level
Earthquake
water serves to dampen the horizontal platform motion caused by earthquakes.
Pile



Design Experiments

This page shows different layers in the floating community. From the manmade lagoon to the vegetations.

With these different layers, a new landscape is created. And a new community is embeded in it. With the floaters and new mobility network, new block configuration, a safe living environment is created for local family based fishing industry and experiencing tourism.

etation

Flood defense forest

Aquaponics

Parks

Community farming

dings and Blocks

Block

Public utility

ting system

Floater

Floating roads

bility Network

Motor way

Pedestrian & cycling

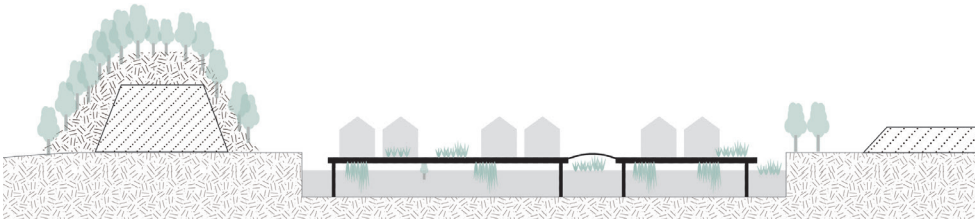
Boats

nmade Lake

Lagoon

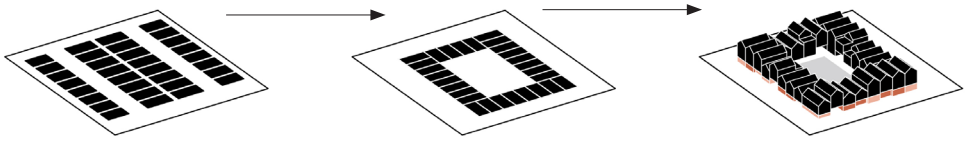
Rivers

Vegetation



Inside the floating community, different habitats for vegetions are created. Around the lake, there are forest on soil dyke. On floaters there are farming space and community garden. In between the floaters and beneath them, there are hydroponics for different species.

Buildings and Blocks



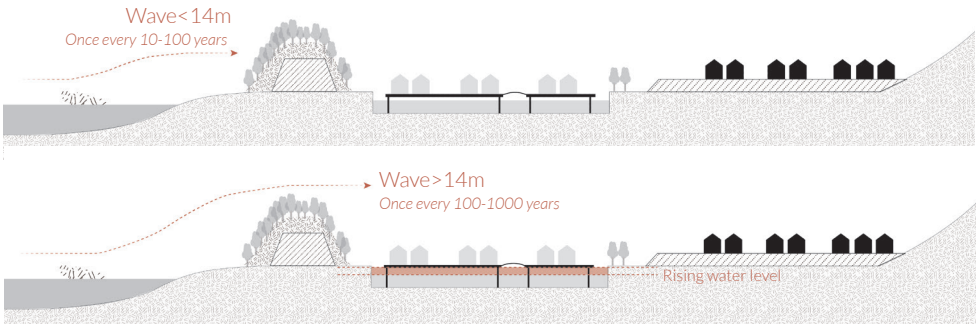
Traditional Blocks
raw house

Enclosed courtyards

High dense with low rise
Public function on ground floor

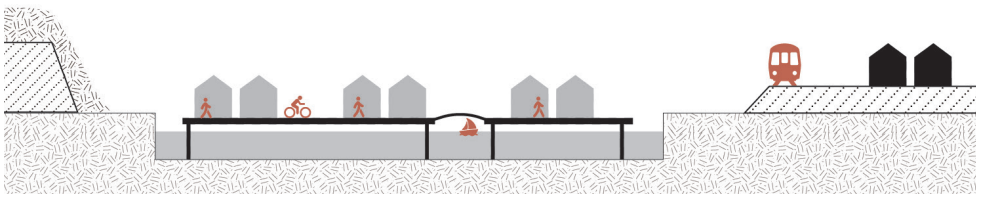
A new block type is introduced according to the principles in Soft City. An enclosed residential block with community gardens or other gathering space inside is more helpful to build community cohesion. This kind of block also contributes to a low-rise high density, which is needed to cover the cost and raise diversity. Besides, the ground floor should be active for people to make a connection with each other and with the place. (Sim, 2019)

Floaters and Flood Defense



Multi-defense solutions are used here. When the wave is under 14m, the flood defense forest will protect this area; when the wave is higher than 14m, water will come in to the lagoon, and the float will also rise to prevent flood.

Mobility Network



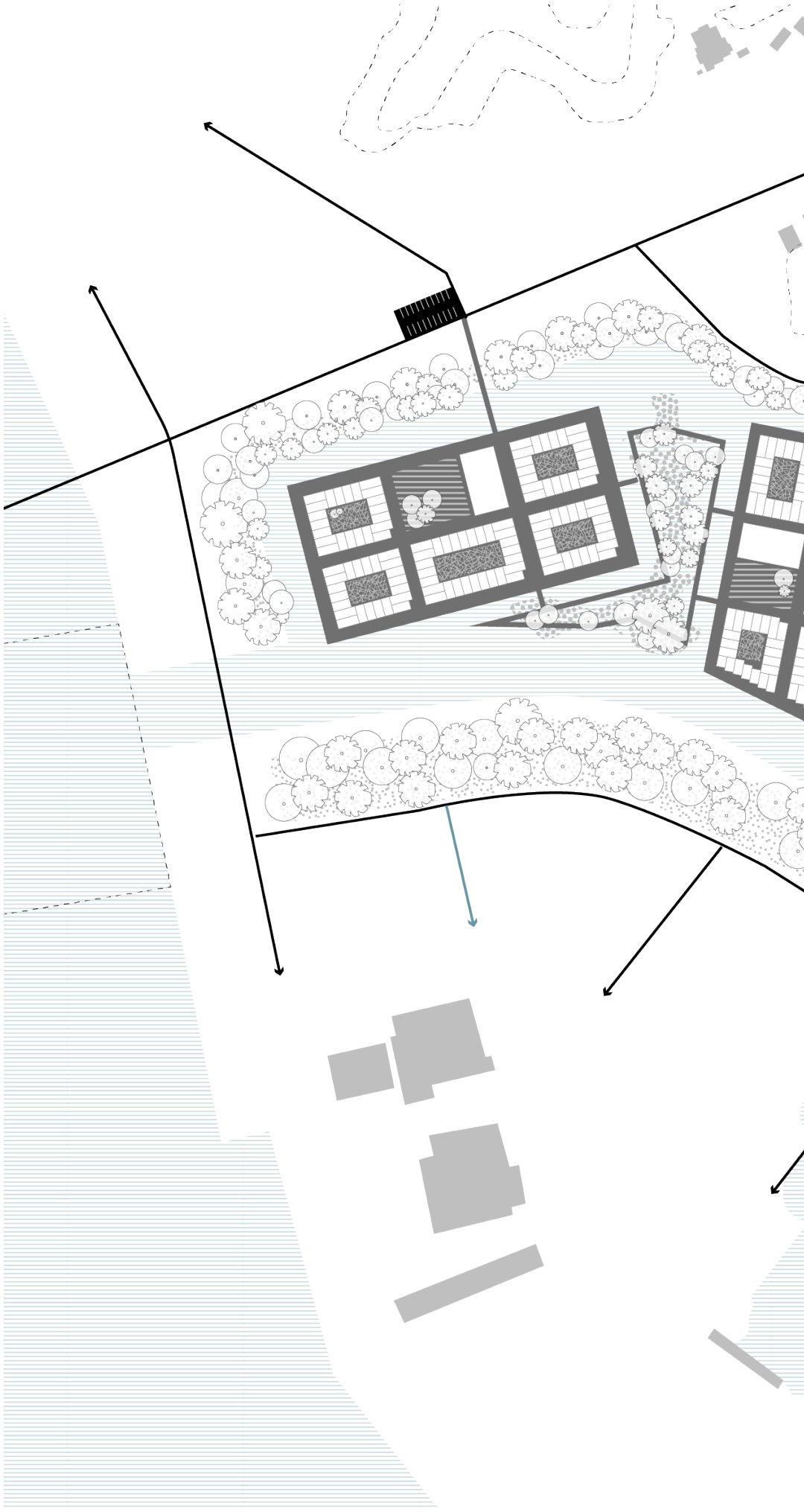
I want to create a new lifestyle in the floating community that is more eco-friendly and have its own feature. So only boating, walking, and cycling way are designed inside the lake. And a new railway station is put near the entrance to reduce car traveling.

Landscape

The humanmade water basin is connected with the river by a 30m wide channel used for water transportation. Freshwater from the river and salt water from the sea are mixed in the lagoon. This kind of brackish water can offer diverse habitats for more creatures. Around the lagoon, a structure made by rocks and stone is installed to keep the form which is permeable for water to go through.

Layout of floating community

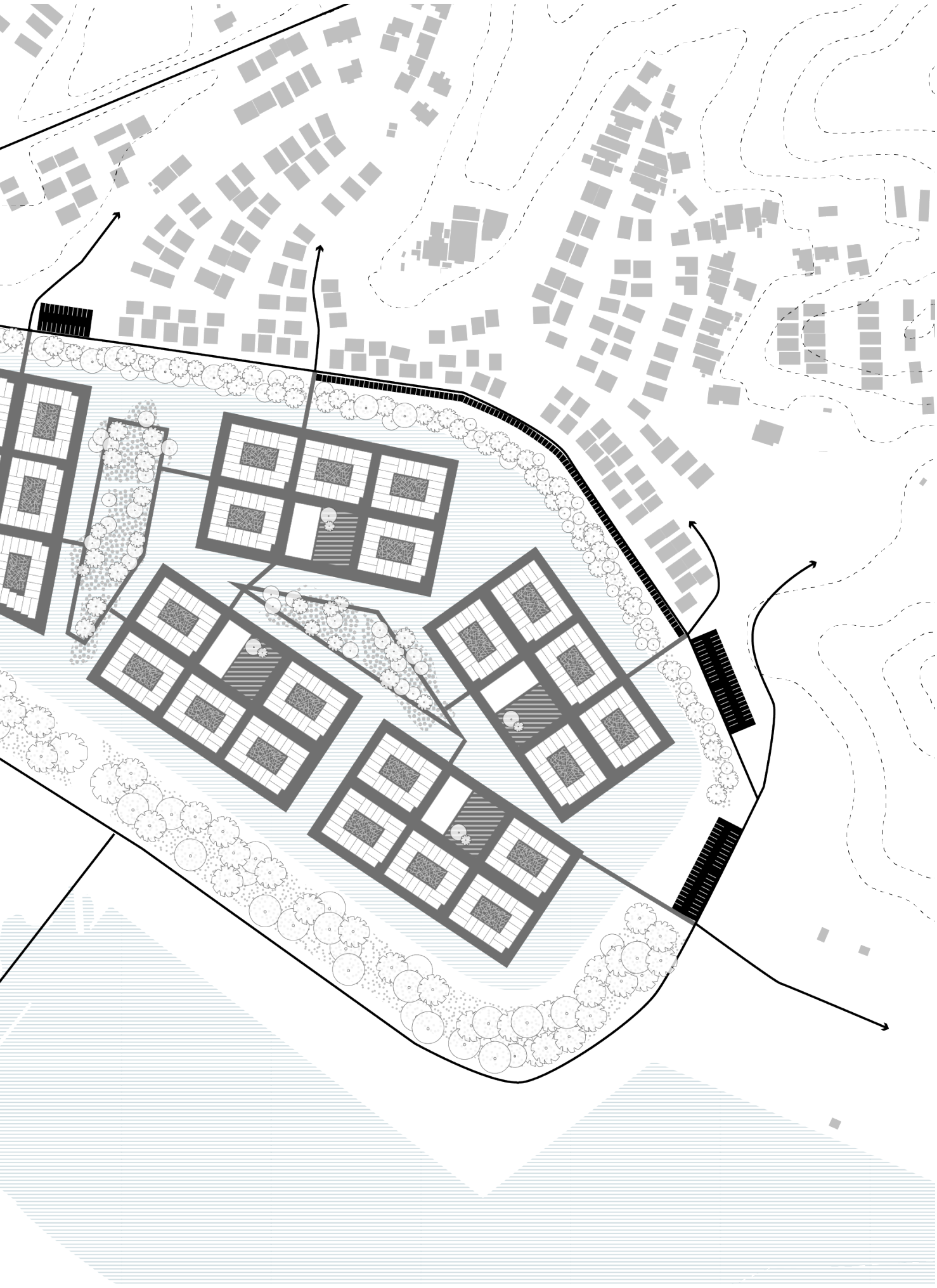
This map shows the layout of the floating community, assmebling all the layers on last page.



water
soil dyke
aquaponics
community farm
public space
floater
buildings
motor way

N

0 50m



Little egret (Egretta garzetta)



Habitat:
Lake shores, paddy fields, river banks, beaches, mudflats and coastal streams
Season: Winter

Night heron (Nycticorax nycticorax)



Habitat:
Rivers, lakes, ponds, marshes, paddy fields, coasts, etc.
Season: Winter

Slaty-backed gull (Larus schist



Habita
Ocean
mouth
lakes a
marshe

Season
Breedi
winter

Pinus thunbergii (Japanese black pine)



Useage:
Windbreak/tidal forest/ornamental tree/medicinal

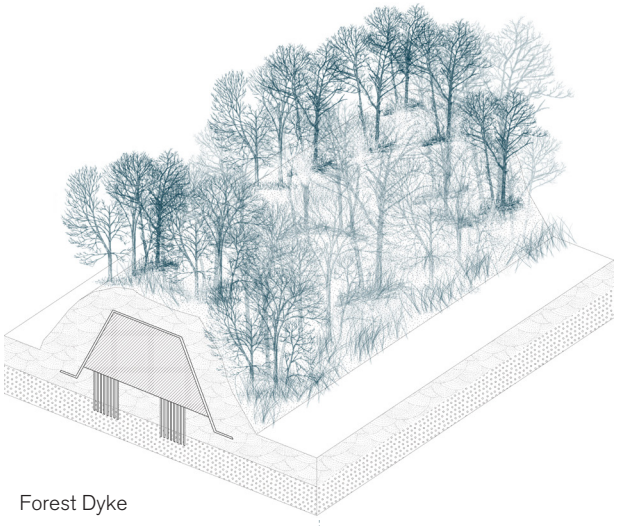
Oryza sativa



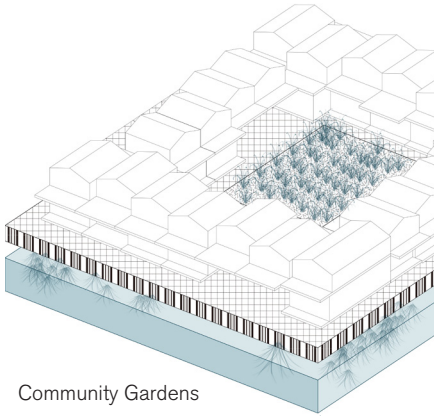
Seaweed

Mono





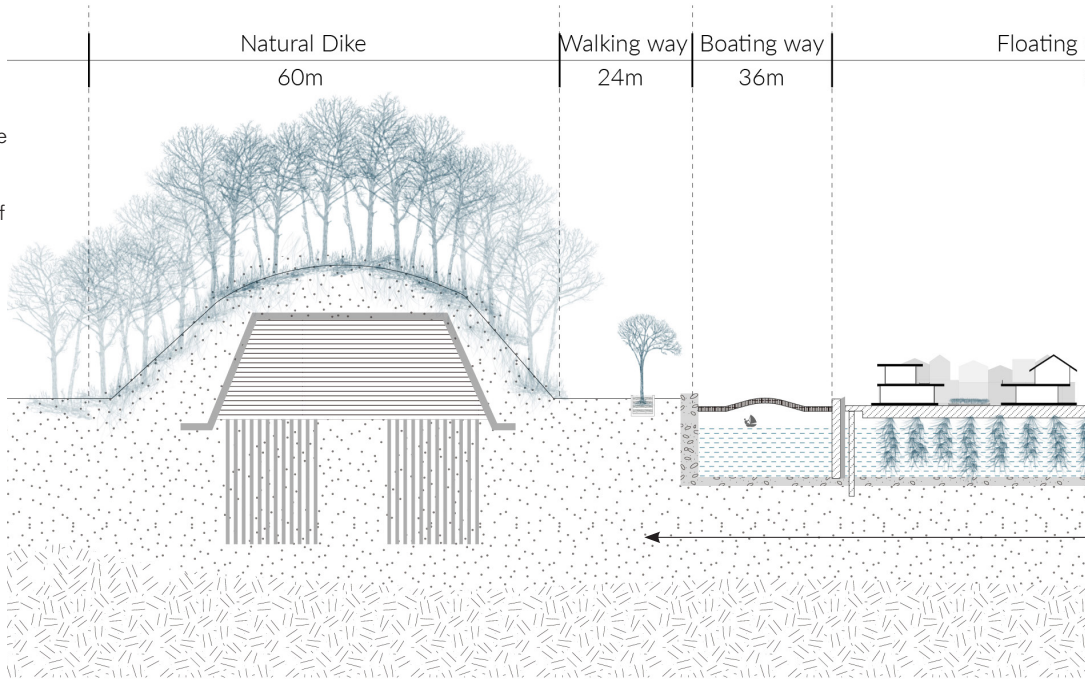
Forest Dyke



Community Gardens

New Landscape

With the man made lagoon, a new landscape is created. Different habitats for vegetations and creatures are embeded in this new landscape. This page shows the overvirew of different habitats and diverse environments.



Water
Soil
Marine Clay
Concrete
Open Soil
Stone Structure
Guide Rail

0 20m

tisagus)

t:
, river
s, tidal
nd
ding
and
es

n:
ng/

Masu salmon (Oncorhynchus masou masou)



Habitat:
River/sea

Sweetfish (Plecoglossus altivelis altivelis)



Habitat:
Downstream of
the river

Pufferfish (Takifugu rubripes)



Habitat:
Bay area

Migratory fish

Chum salmon (Oncorhynchus keta)



Habitat:
River/sea

Fat greenling (Hexagrammos otakii)



Habitat:
Bottom layer

---

ochoria korsakowii



Watercress



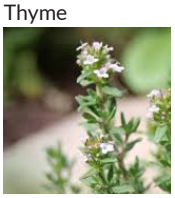
Basil



Rosemary

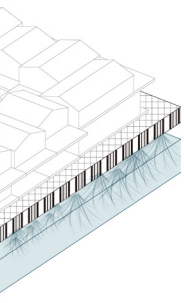


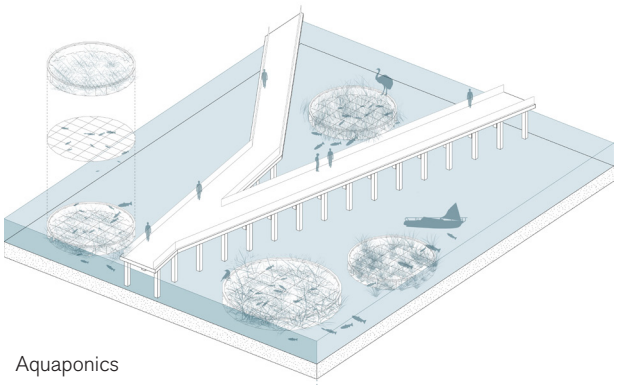
Thyme



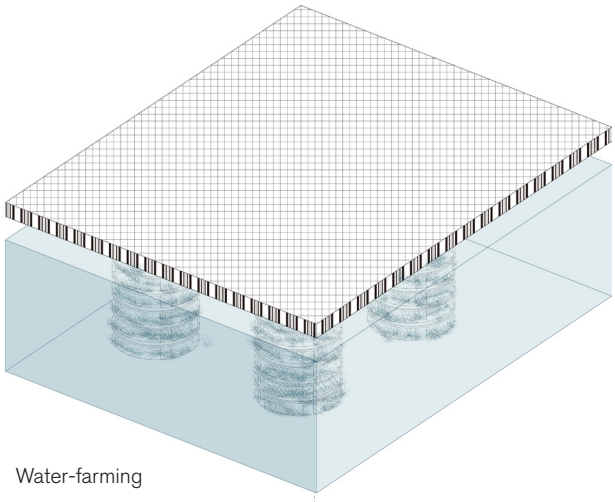
Peppers







Aquaponics



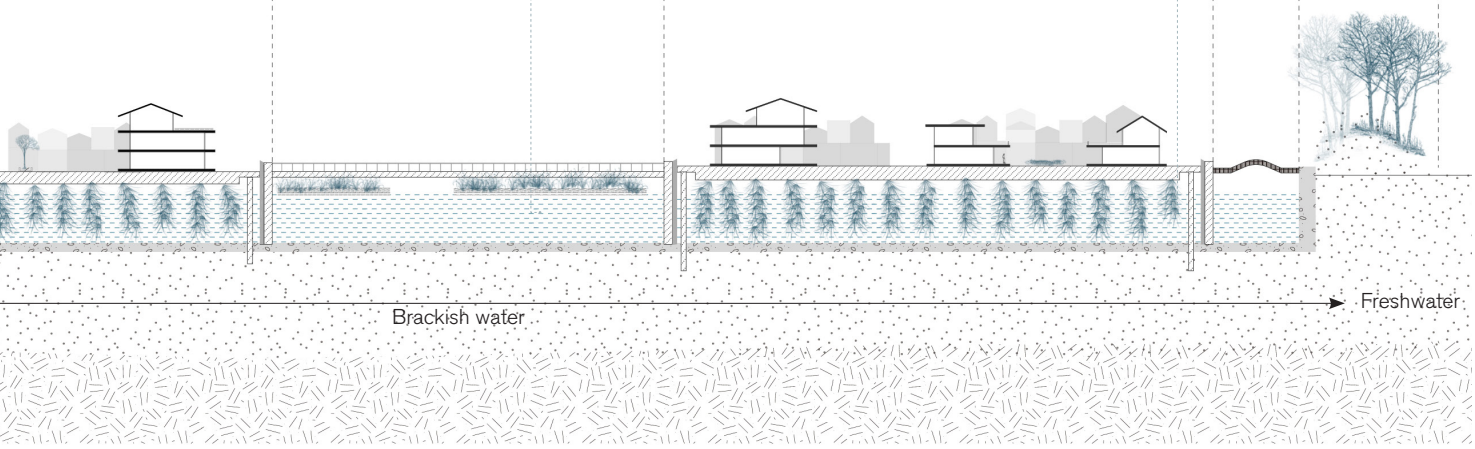
Water-farming

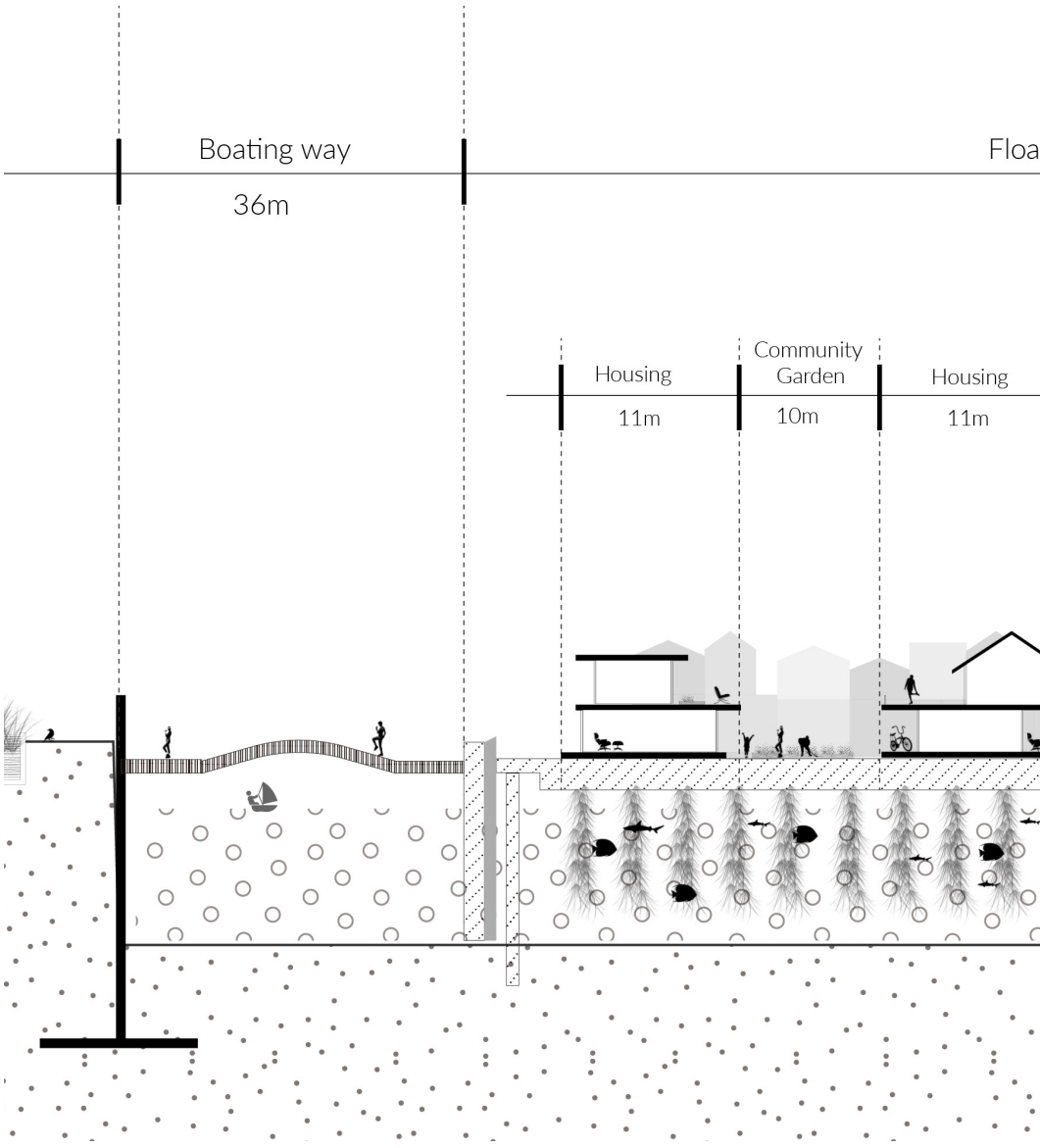
community
80m

Aquaponics
50m

Floating Community
80m

Boating
Way
10m



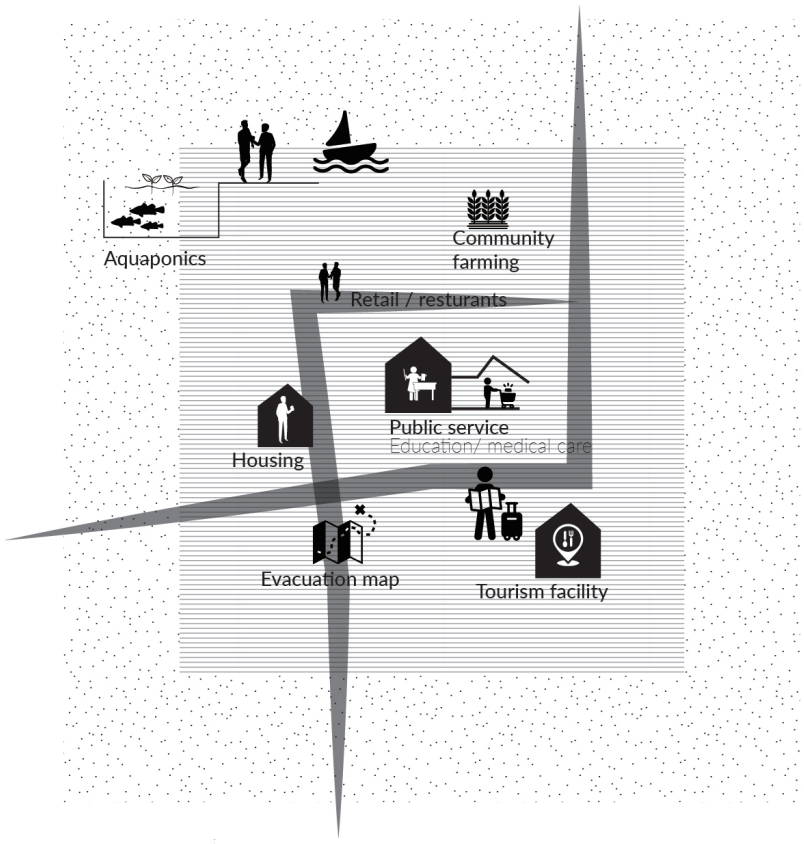


New Lifestyle

In the section of small section, what we can see is a new lifestyle living with nature.

A life circle within an island is created. Public services are provided in each island, tourism facilitates like restuarant and home-stay is offered too. People also have their job nearby, either working at the aquaponics or on the tourism industry. All these jobs and living activities have a close interaction with nature, informs of hydroponics in the water basin or community gardens on islands.

0 10m



ting community

80m

Aquaponics

50m

Street

4m

Open public space

20m

Facilities

18m

Community

Community Farming

Home stay

Roof Garden

Street

Retail

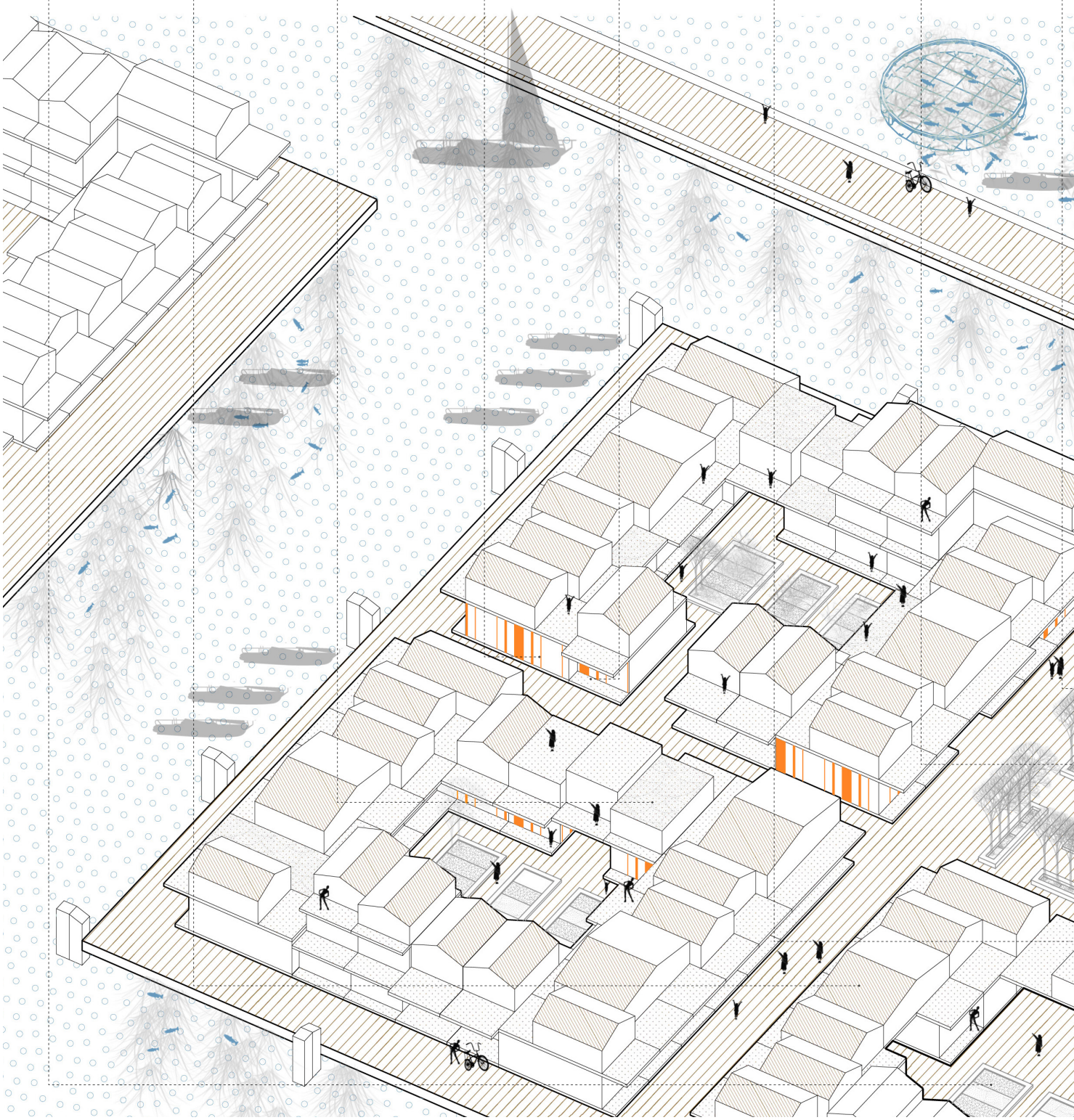
Restaurant

Recreation

Evacuation Map

Public

Educatio



Facility

on

Health Care

Sports Center

Meeting

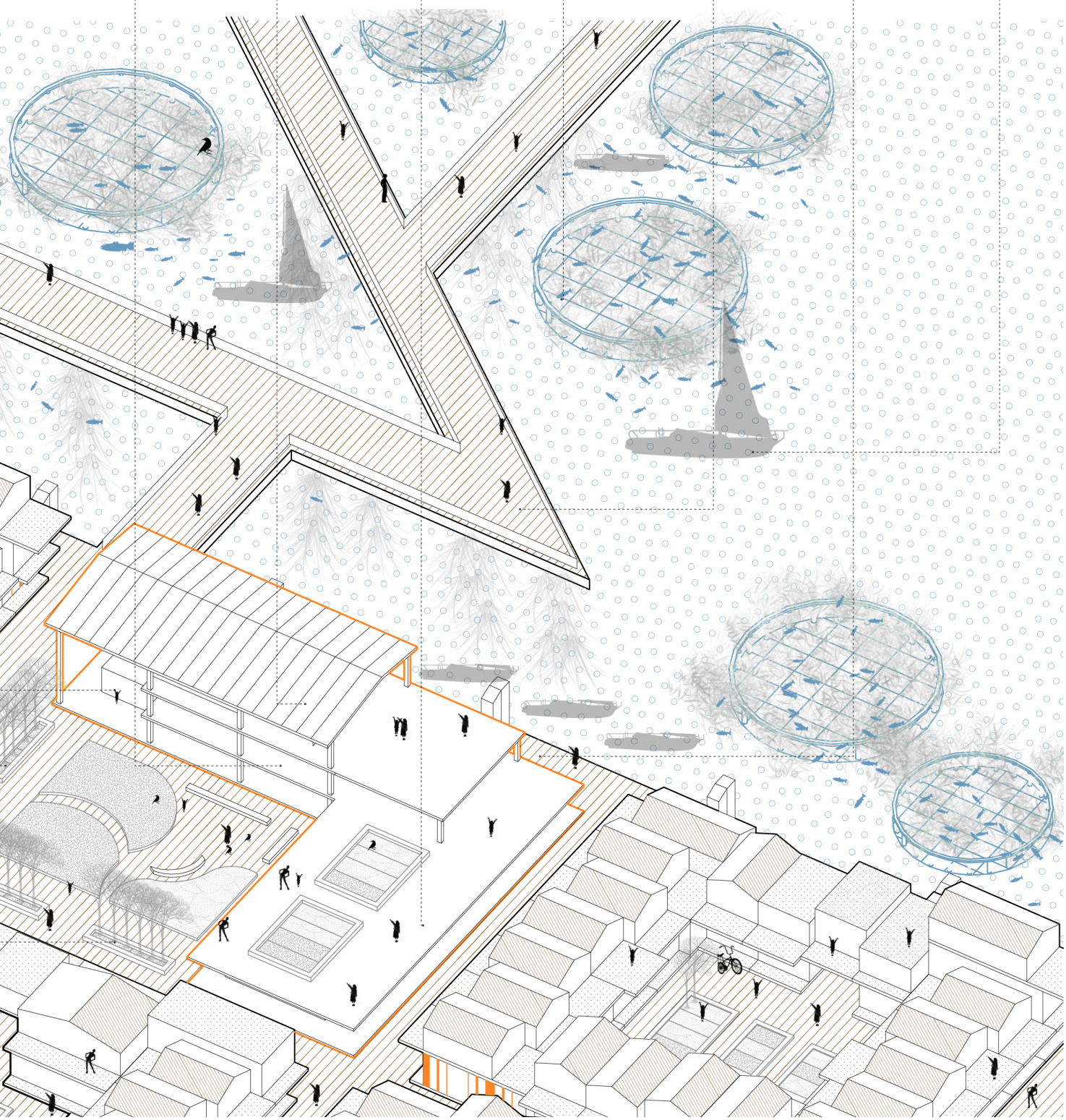
Aquaponics

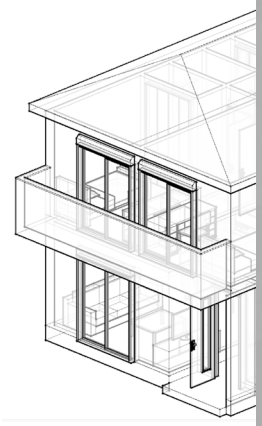
Fishing Industry

Recreation

Fishing tourism

Boating







New Lifestyle

A life circle within an island is created. Public services are provided in each island, tourism facilitates like restuarant and home-stay is offered too. People also have their job nearby, either working at the aquaponics or on the tourism industry. All these jobs and living activities have a close interaction with nature, informs of hydroponics in the water basin or community gardens on islands.


Wooden Panel
Factories Outside Dike
Wood From Forest

Tsunami Park

Yujia Liu



Water information center

Water information center is the only building in the tsunami park. The local and tourists can observe the phasing of the ecosystem recovery in the riverbank from here. They can also exchange knowledge and ideas of Otsuchi or any other thing. The water information keeps reminding people of the power of tsunami and the close relationship between human and nature.

Manifesto

After the tsunami in 2011, Otsuchi was damaged a lot. Lands were flooded, and more than 2000 people were killed. Some survivors left hometown and live in other cities, and some move to temporary houses, waiting for the reconstruction plan. Until 2021, the reconstruction will be completed, with the dyke of 14.5 meters high. What will the town look like in the future?

[Disaster defense]

The dyke transforms into a green dyke softly. Soil and sand are dug from inside of the dyke to form up the basin of the green dyke. Japanese black pine trees and other water-defense trees are planted on the dyke, setting as part of the multi-layered tsunami defense system. The water defense forest, which is in face of the Otsuchi train station, is planted with trees. Wetland is also located here, which means a good capacity of potential flooding water in the rainy season. River bank area is not suitable for living, so it turns into a continuous public space for social activities and ecosystem recovery. The old street area in Ando District transforms into a floating community, providing identified spaces for commercial and cultural activities. Evacuation routes from every site in the town to shelters are considered. Water basins are set on the foot of the hills for emergency use.

[Economy]

Fisheries and Fishing process industries start to boom again. The biggest fish market is located in the harbor of Ando district, near the road. Some people make a living from aquaculture, including salmon, seaweed, scallop, and oyster. The oyster bed, which can be called ‘the living breakwater’, becomes part of the tsunami defense system, and it also provides habitats for seabirds and other animals, increasing the biodiversity. The local seafood, the living breakwater, the green dyke and forest, and the memory of tsunami, can be the special characteristics of Otsuchi, which attracts a lot of tourists from all over the country, even the world.

[Culture]

The culture of Otsuchi has a deep relationship with the ocean and tsunami. The ruin of the city hall which is destroyed in 2011 is kept until today, for reminding locals and tourists of the power of nature. Memorial park is built for memorial ceremonies and other activities. Cultural performance and rituals take place regularly in community centers, temples, and shrines, which is not only for memorial and pray, but also a good chance to unite the residents together, forming up a sense of belonging to Otsuchi.

Design experiment

The riverbank area becomes a continuous public space for social activities and nature recovery after the tsunami. In this design, it will transform into a 'tsunami park', paying more attention on the ecosystem recovery after the tsunami and preparing itself for future tsunami as well.

Sand and soil are dug from the grassland to overlap the first and second dyke. Then grassland with trees and wetlands will become a buffer zone for future tsunami and flooding. Wetland, forest, grassland, and seaweed, offer more varied habitat for vegetation, birds, fishes and other animals. Aquatic plants on the riverside and the seagrass bed in the river provide food, habitat for other animals, purify the water. They can also mitigate the impact of the tsunami and flooding.

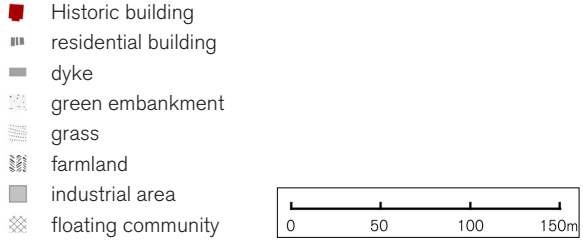
The water information center is the only building in the riverbank. It's a great place to observe the recovery phase in the riverbank area. It's also a public place for the exchange of knowledge between locals, tourists, professionals, etc. Students can take part in the outside course here, learning more about the tsunami and flooding. The water information center reminds the locals of the tsunami and the relation between human and nature.

The whole riverbank area between the two higher dykes is allowed to be flooded by a tsunami. The ground floor of the water information center is empty to reduce the impact of floods. After the flooding, the river bank will recover again, form grassland to bushes and wetland, then to the forest and a more biodiverse area, with the potential new species, brought here by the tsunami in the future.

The top of the building is connected to the green dyke, then connected to the memorial park and the ruin of the old city hall which was destroyed in 2011. Next to the old city hall is the community public space, then go along the street, people can easily access to the commercial district and the temple.



Plan







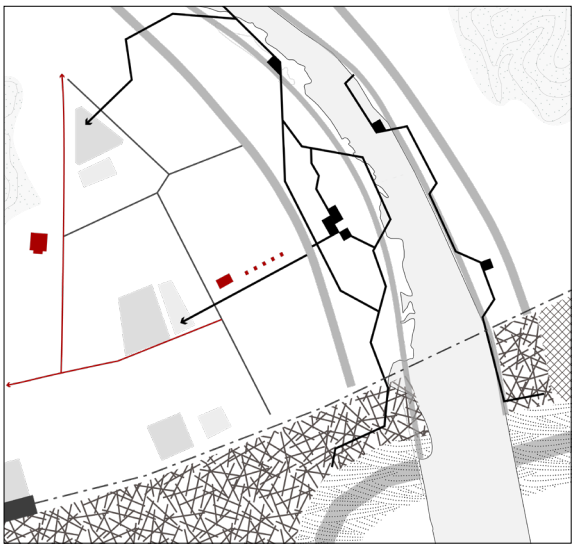
Continuous public realm

The tsunami park is connected to the neighborhood park, the memorial park, and the water defense forest. Those elements are combined to be a continuous public realm, providing more spaces and chances for the local's daily life.



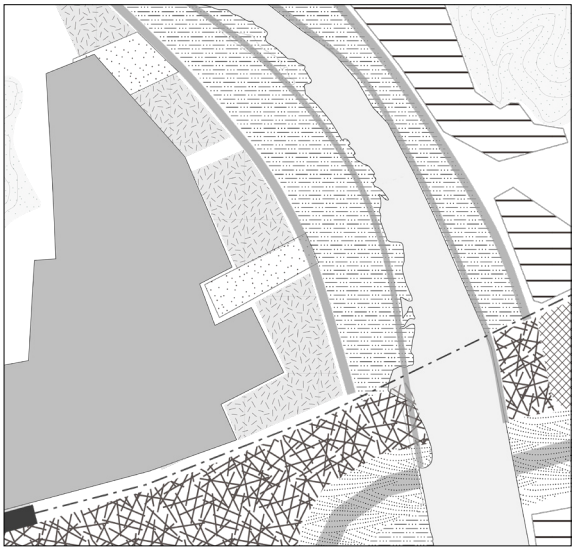
Connection between downtown and tsunami park

By the footpath in tsunami park, the neighborhood park, and the memorial park, the tsunami park is closely connected with the commercial street in the downtown area, where is also the most attractive place in Otsuchi.



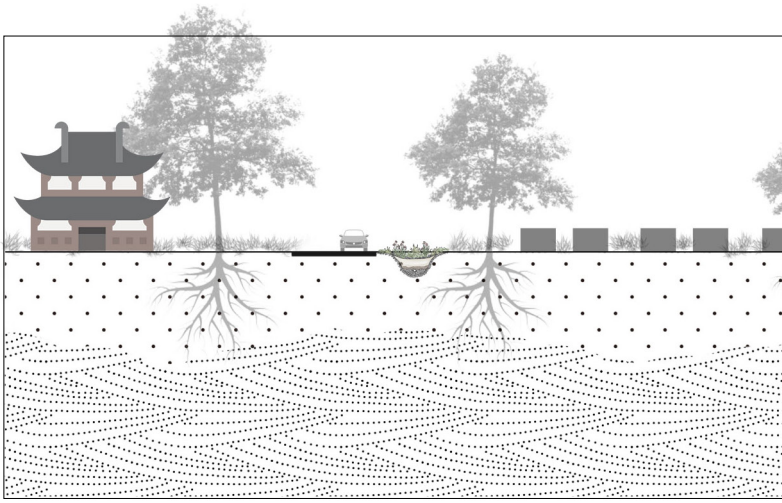
Urban, sub-urban, and nature area

The tsunami park will be one of the most natural area in Otsuchi. The neighborhood park and the memorial park among the farmland became the sub-urban area to lead people from urban area to get the access to nature.



Section A
Urban area > Memorial park

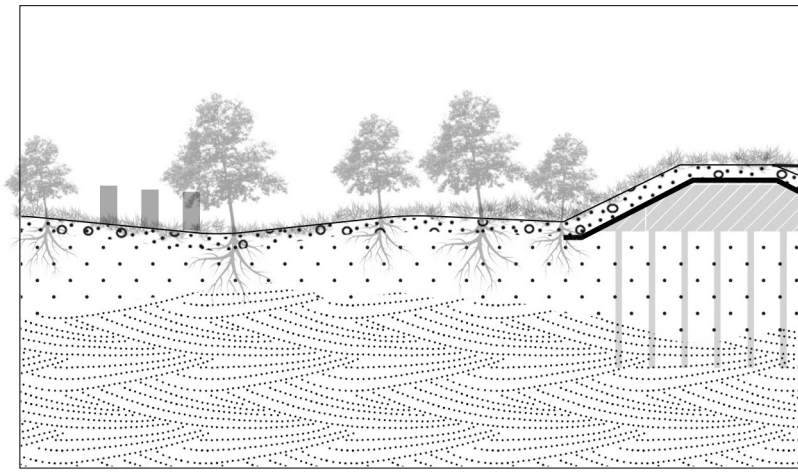
In the urban area, bioswales are set along the existing road, filtering runoff water and collecting extra rainwater. More permeable pavement is used in public space.



Section B
Memorial park > Tsunami park

Soil and sand are dug to cover the concrete dykes on both sides of the river. Grass, bushes, and trees grow up on dyke and the riverbank area. The sedimentation area transforms into mall ponds and wetlands, which have a good capacity of water.

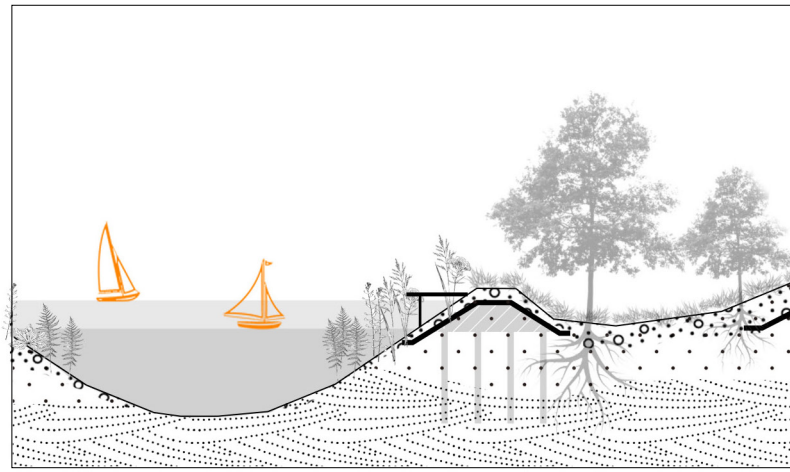
Aquatic plants grow up on the slope of river embankment, offering varied habitats and foods for animals. Biodiversity increases at the same time.

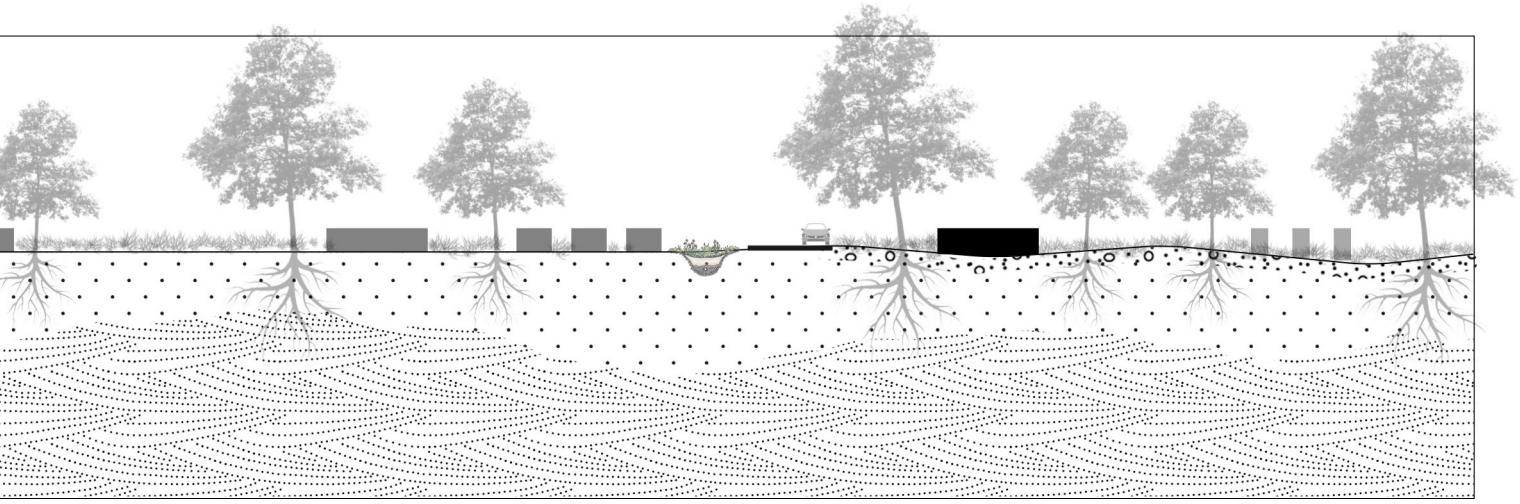


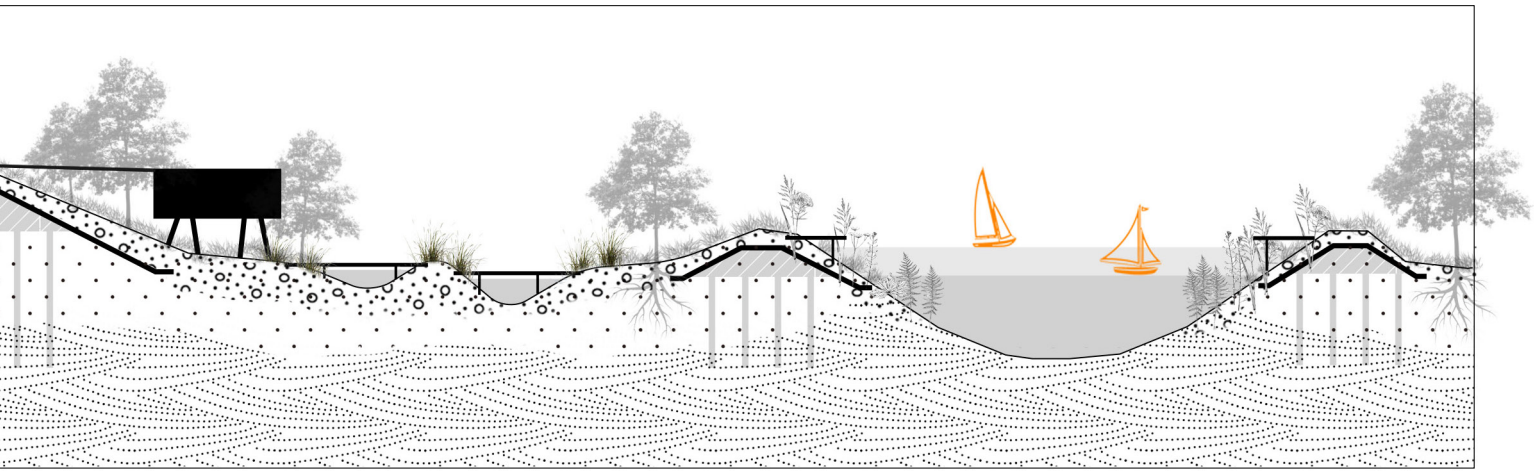
Section C
Tsunami park > Industrial area > Mountains

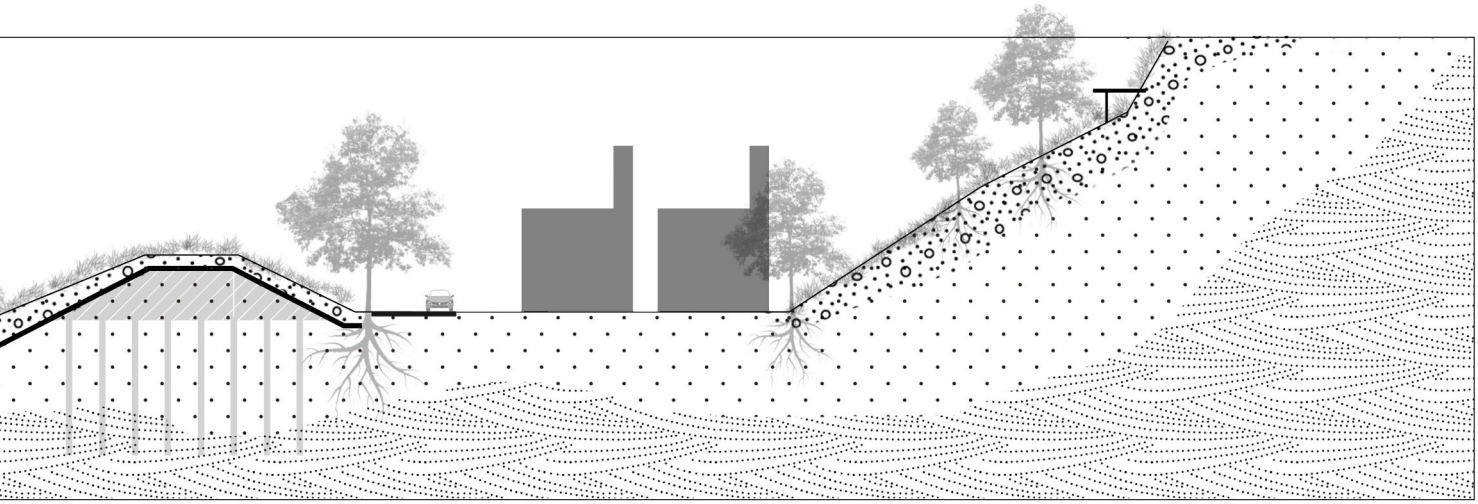
Industrial area is located on the foot of the hills, near the main road. Water basins are set here for collecting water from mountain in case of emergency use.

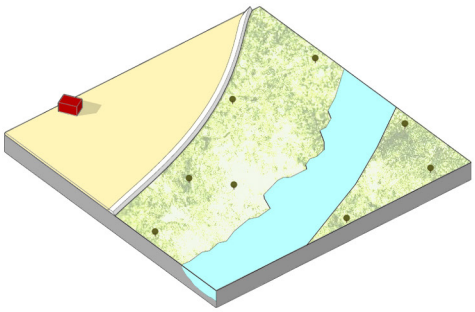
On mountains there are footpaths for hiking, which are also part of the evacuation routes leading to shelters on high ground.





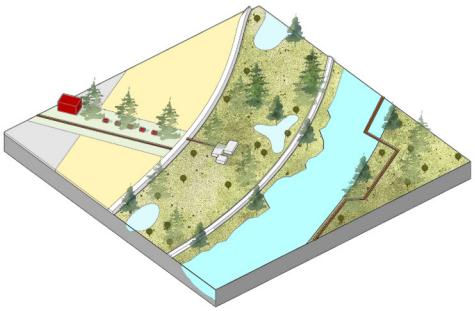






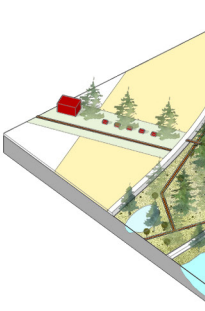
Recovery

Right after the tsunami, the land was flooded and all the constructions and plants are swept away. Concrete dykes were built for protecting the urban area. Grass and some bushes start to grow up by riverbank.



Develop

The memorial park is built next to the ruin of the old city hall, connecting to the dyke. The water information center is also built here, connected with the dyke, and the ground floor is empty so it will be more resilient to the flooding. Soil and sand are dug to cover the concrete dyke, providing habitat for vegetation, insects, and other animals. Ponds and wetlands emerge in the riverbank, with bushes and trees nearby.



Mature

When the ecosystem b
paths are built along th
cal and tourists to the
and the water. The wat
is still the only building



Japanese black pine tree



?



Mugil cephalus



sal



rice



Maccomo

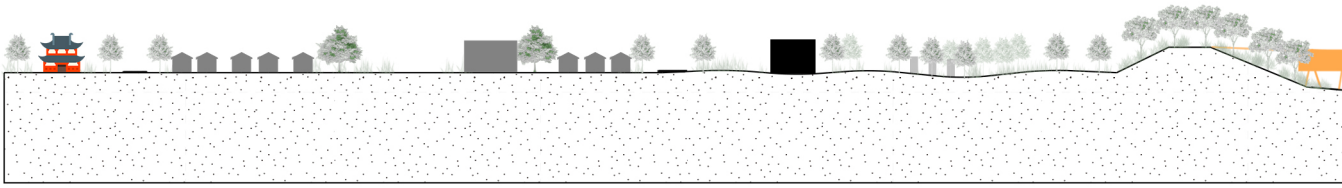


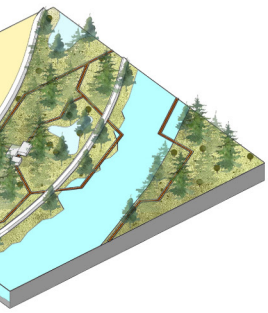
Monochoria korsakowii



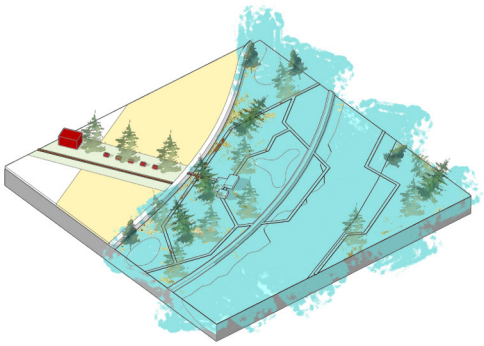


Water



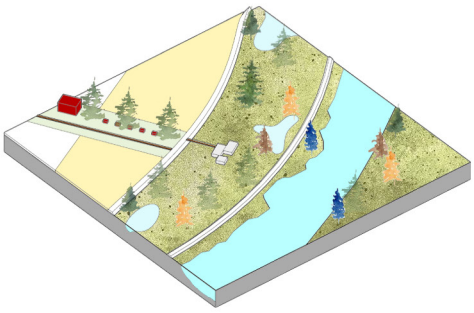


become mature, foot-
e river, leading the lo-
grassland, the woods,
ter information center
in the riverbank area.



Flooded

The whole riverbank area can be flooded in future tsunami. There is not many constructions here so the debris will not be too much. The ponds, wetlands, woods, and aquatic vegetation can mitigate the impact of tsunami.

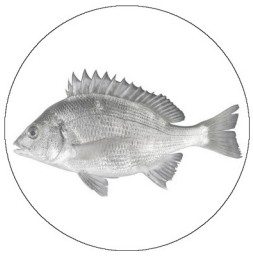


Recovery with new species

The tsunami brings seeds and small animals from other ecosystem, which will increase the biodiversity in this area. After the tsunami, the ecosystem in the riverbank will recover again with those new species. All the recovery phases can be observed from the water inforamtion center.



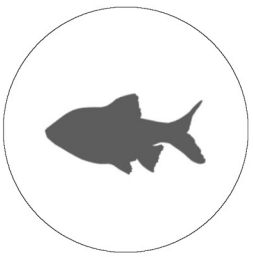
mon



Acanthopagrus schlegelii



scallop



?



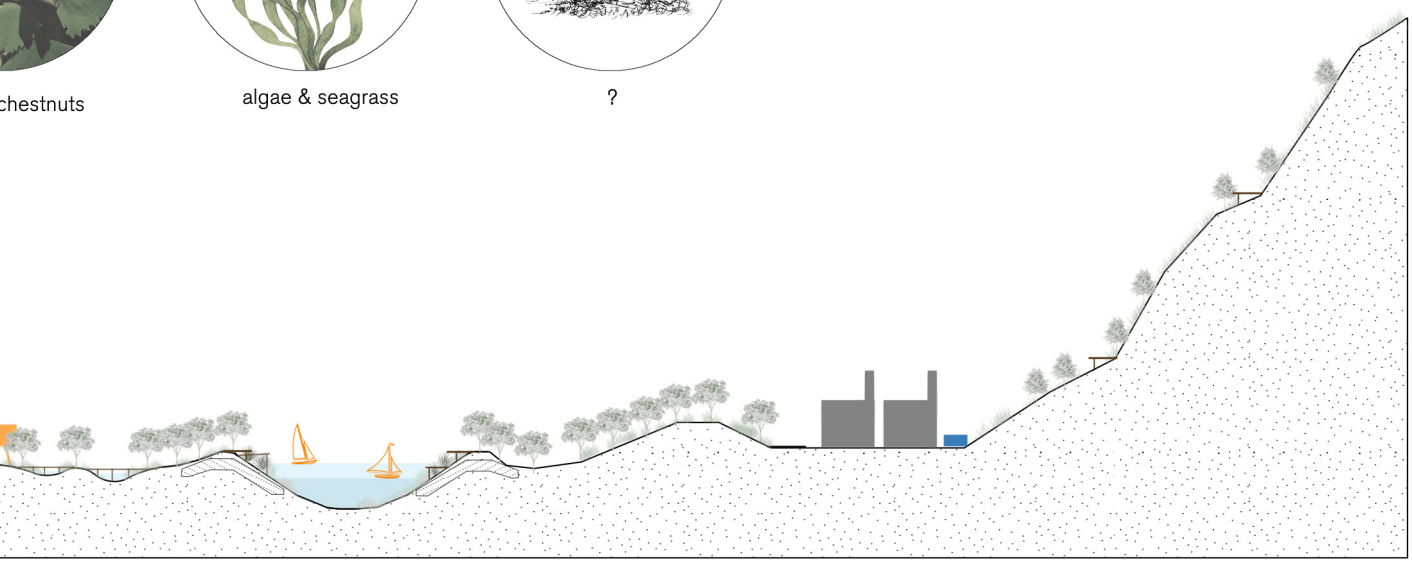
chestnuts



algae & seagrass



?



Turn Crisis into Chance

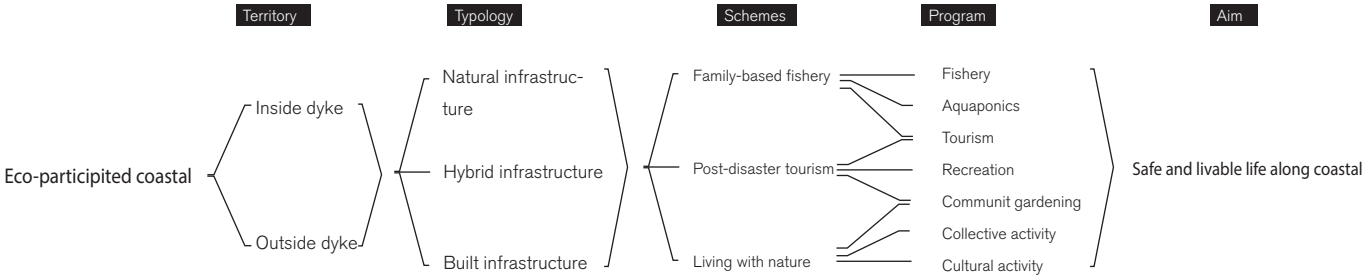
Ning Cai

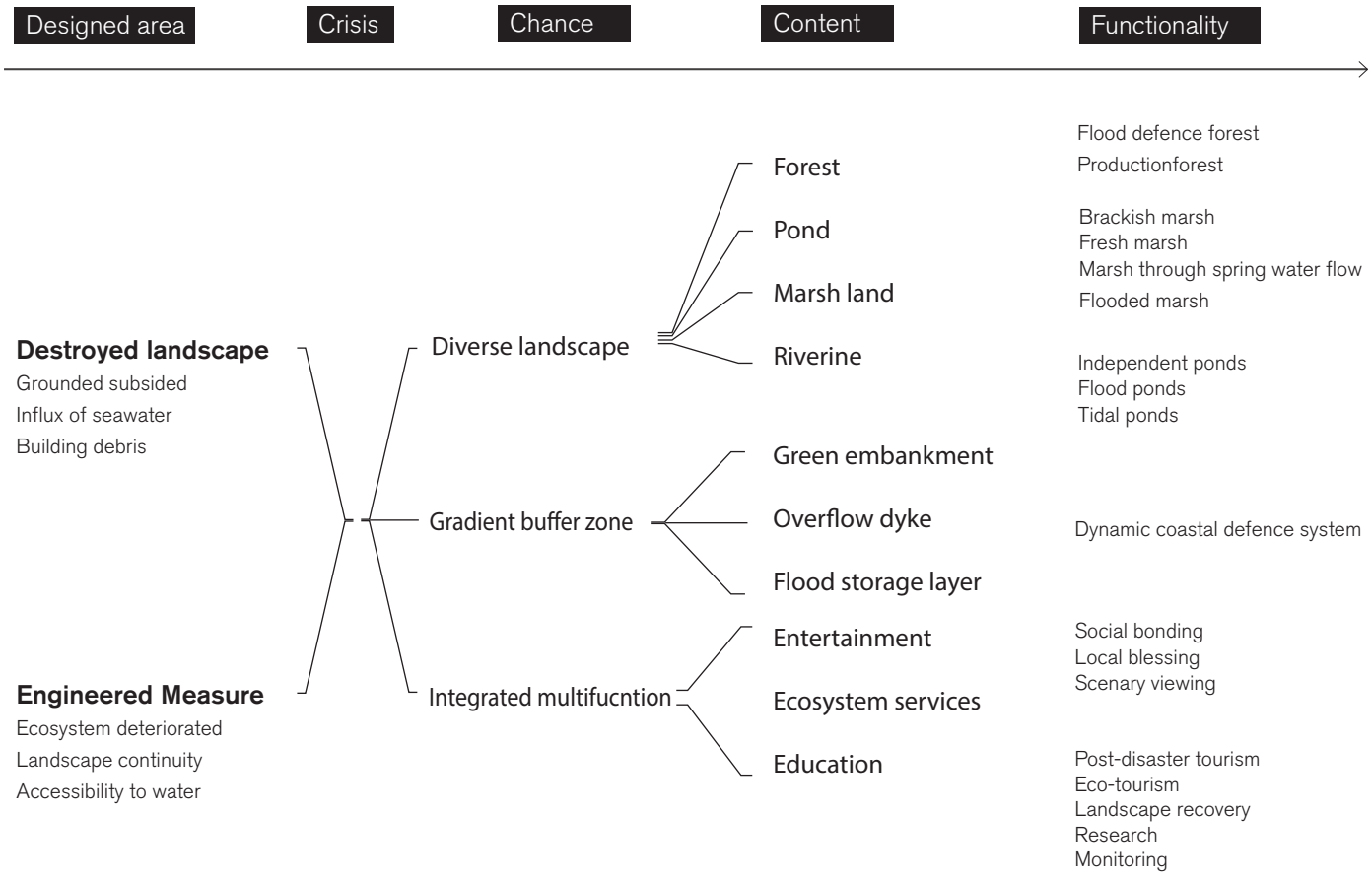
Manifesto

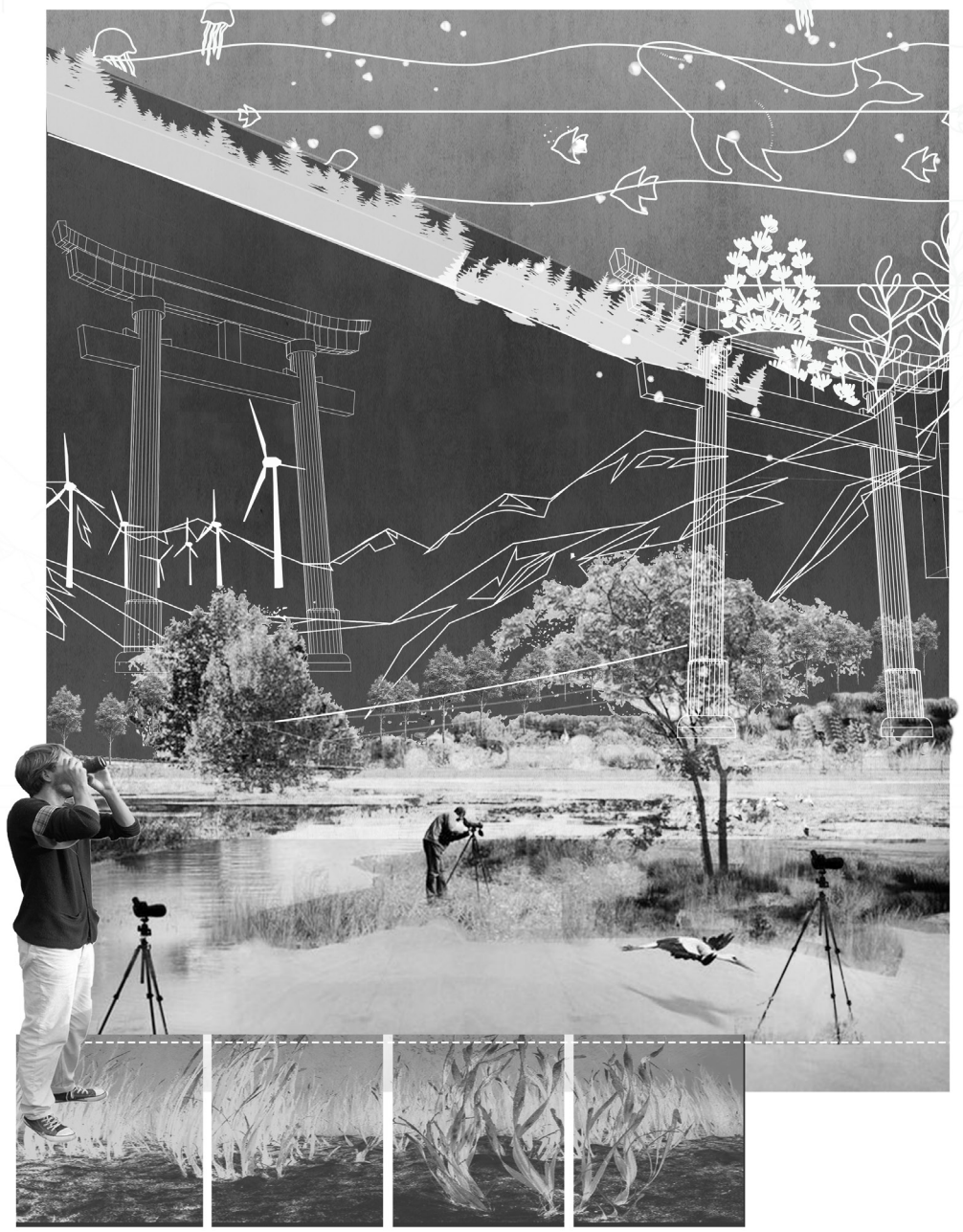
In the future transition, by applying nature-based solutions, the connection between the mountain and sea will become one continuous and holistic landscape. During the same time, the coastal defense system becomes a gradient buffer zone integrating multi-functions and dynamics seawater inside and outside the bay to mitigate nature hazard. The core design strategy is to enhance the existing fragile ecosystem and then come up with a lifestyle that matches it.

First of all, various environment which formed after the earthquake will be protected allowing a characteristic diversity of flora and fauna to inhabit the area. Secondly, by cutting inward-facing channels in the site to soften the terrain, this not only helps to promote the wetland ecosystem but also to be used as a retention area that allows stormwater to drain from nearby areas. The next step is about to transform the current sea wall to green infrastructure. The seawall under construction will be covered by the dune landscape in the short term, then evolve into flood defense forest in the future, which enhance the visual continuity and connection to the sea. The dune landscape is added together with native plant species, and people from various fields are asked for their cooperation by implementing this vegetation-ecological reforestation approach. (Miyawaki,2014)The soil will be created from disaster debris to minimize the reconstruction flow, help reduce CO2 emissions from incineration.

After Landscape transition and ecological restoration, a new lifestyle dependent on the newborn ecosystem is proposed. The dynamic coastal defense system replaced the hard, grey infrastructure as the ‘new engine’ for the entire life cycle. Otsuchi will become a model for post-disaster tourism. The increased publicity of the town after the tsunami has already been a key driving force in drawing visitors. While Otsuchi lost many during the disaster, people who survived and landscape, the ecosystem in the area are transitioning in a new direction. Projects like gradient coastal defense and floating community can provide disaster-recovery learning opportunities for visitors. The visitors will enjoy experiences such as tasting water from natural resources, learning about different ecosystems, and participating in cultural activities. Since the main attraction for the tourists would be the destroyed houses and landscapes. (Endo, & T. 2018)Some wrecked place will be preserved and be designed as a memorial park. Thus, tourism will become an important element of the town’s economy.


Territory
Typology
Schemes
Program
Aim
Eco-participited coastal
Inside dyke
Outside dyke
Natural infrastruc-ture
Hybrid infrastructure
Built infrastructure
Family-based fishery
Post-disaster tourism
Living with nature
Fishery
Aquaponics
Tourism
Recreation
Communit gardening
Collective activity
Cultural activity
Safe and livable life along coastal


Designed area
Crisis
Chance
Content
Functionality
Destroyed landscape
Grounded subsided
Influx of seawater
Building debris
Engineered Measure
Ecosystem deteriorated
Landscape continuity
Accessibility to water
Diverse landscape
Gradient buffer zone
Integrated multifucntion
Forest
Pond
Marsh land
Riverine
Green embankment
Overflow dyke
Flood storage layer
Entertainment
Ecosystem services
Education
Flood defence forest
Productionforest
Brackish marsh
Fresh marsh
Marsh through spring water flow
Flooded marsh
Independent ponds
Flood ponds
Tidal ponds
Dynamic coastal defence system
Social bonding
Local blessing
Scenary viewing
Post-disaster tourism
Eco-tourism
Landscape recovery
Research
Monitoring



Design experiment

Currently

- The ground is mostly lowland,less than 0.5m abover sea level. Some area facing the threat be submerged at high tide.Plant communities, such as Chima-dojotsunagi, a rare species in the brackish area, grow naturally.

- Diverse environment emerge after tsunami, like marshland and new spring water pond, allowing fauna and floral to inhabitat.

- The groundwater level became markely lower

- The new spring water ponds can be divided into three type:completely independent ponds; flood ponds; and tidal ponds (Otsuchi Town 2014).

Completely independent ponds: formed only by spring water. flood pond: influenced by saltwater run-up,flood during rainstorms and connects with a salt water pond. Tidal pond: Brackish pond,affected temporarily by saltwater run-up.

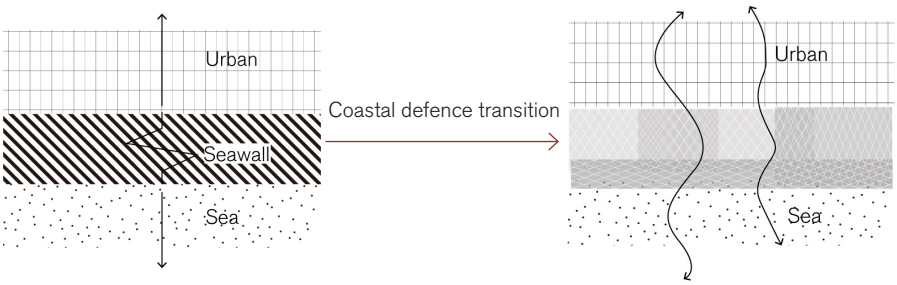
From the point of view of the natural environment and abundant springs, maintaining an environment where the ocean interacts with the river is the minimum required for guaranteeing Otsuchi Town's distinguishing characteristic.

The principle of designed area:

- Enhance connection with the sea

- Protect diverse environment & preserve dynamic wetland ecosystem

- Integrated wiith multi-functions



Phase 1 Landscape transition

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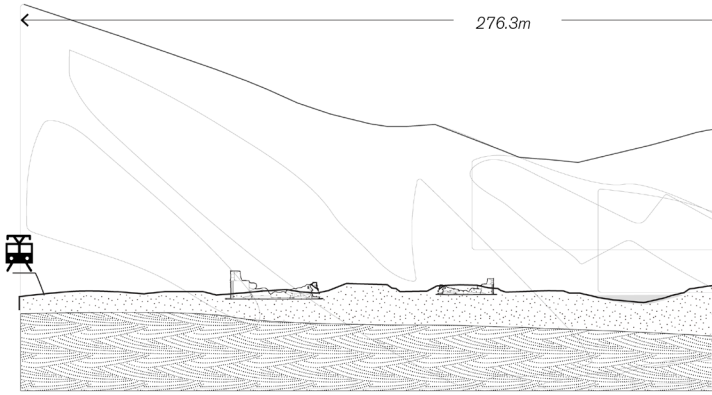
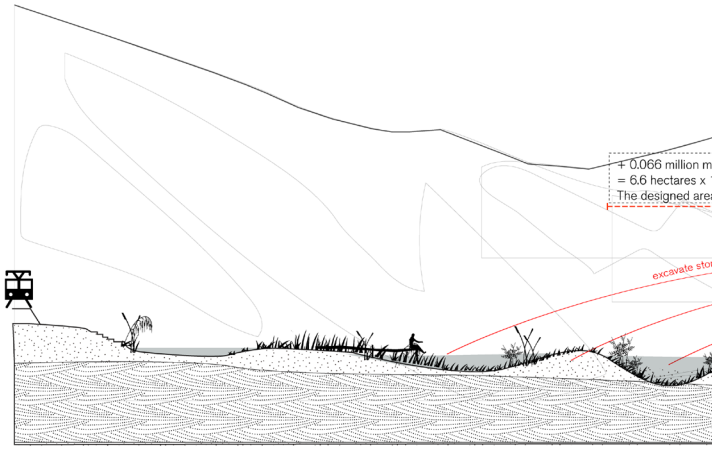
Current situation

Where seawall is built
Land covered with debris



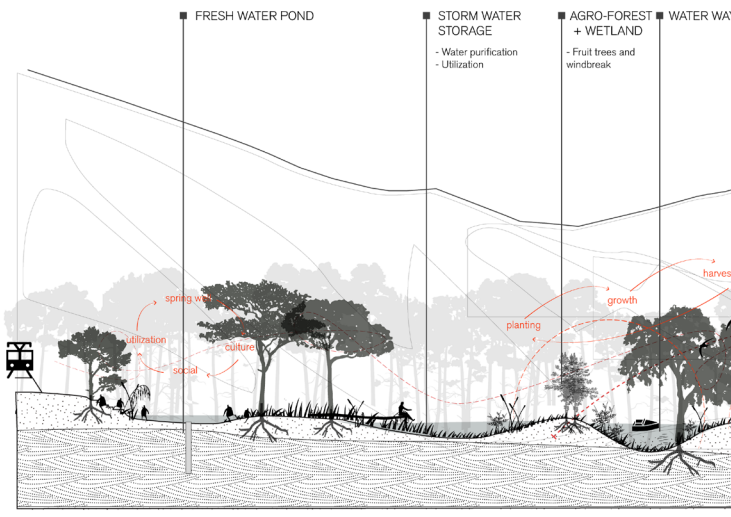
Short term

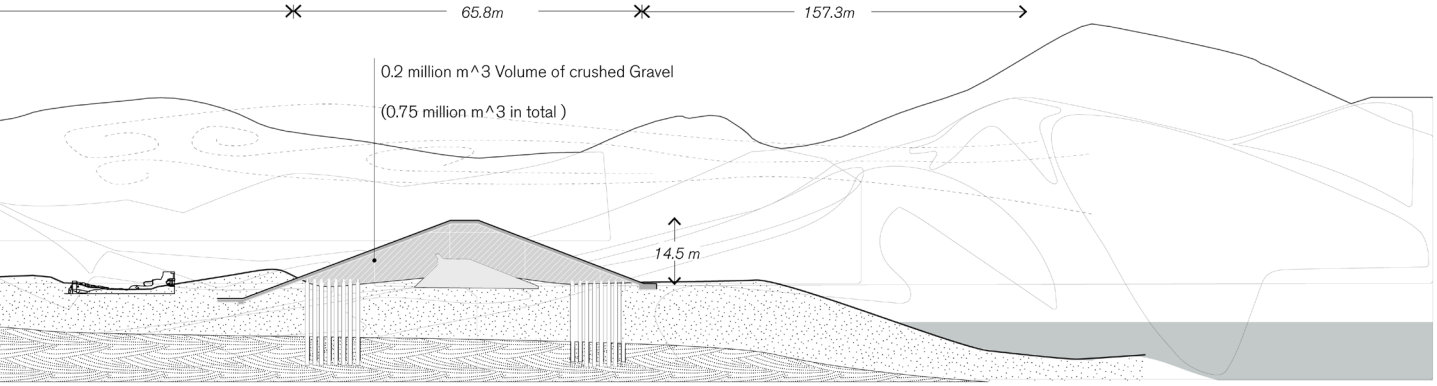
Seawall coverd by dune lanscape

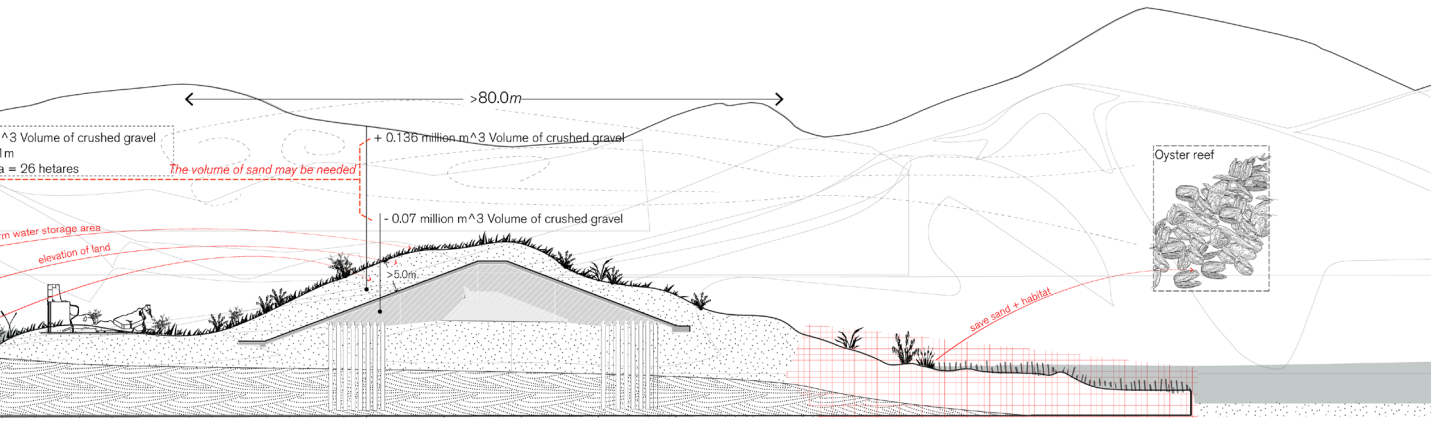


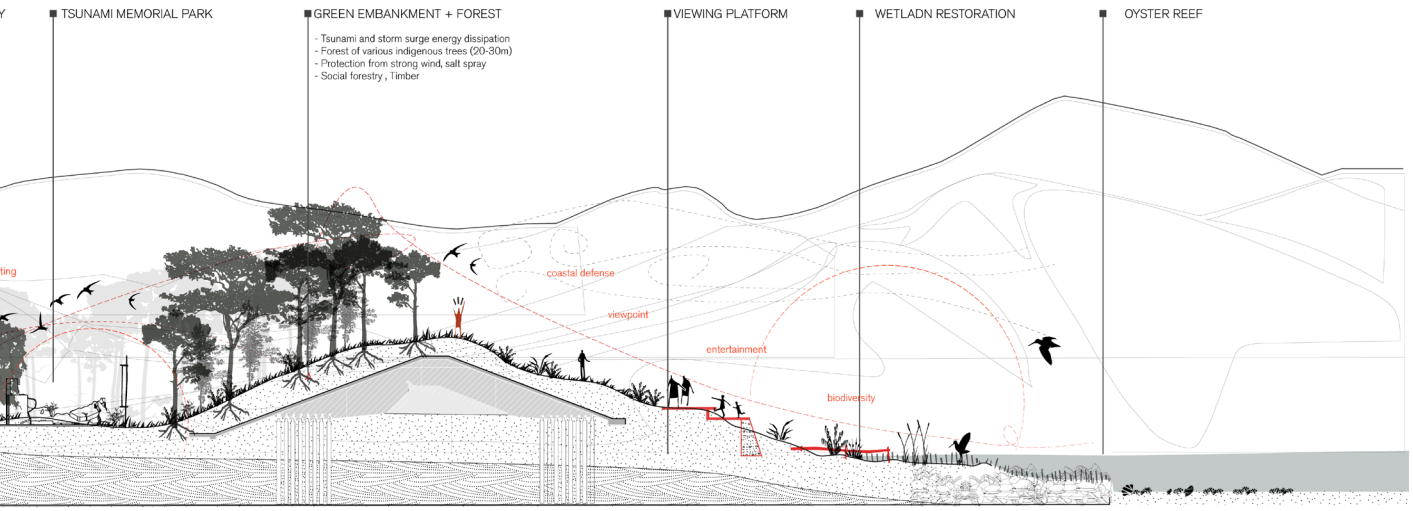
Long term

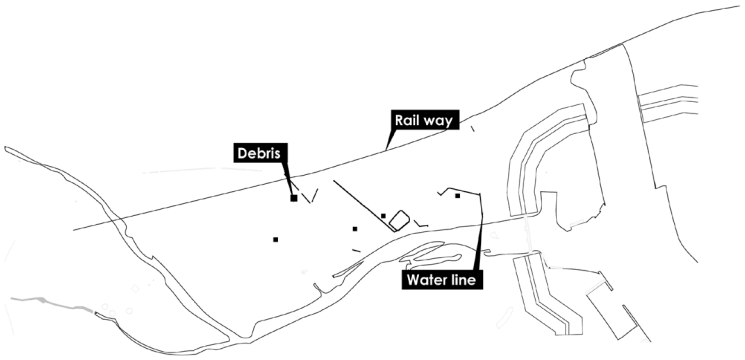
Trees strengthern the dune landscape
Viual connection
Gradient bufferzone




65.8m
157.3m
0.2 million m^3 Volume of crushed Gravel
(0.75 million m^3 in total)
14.5 m

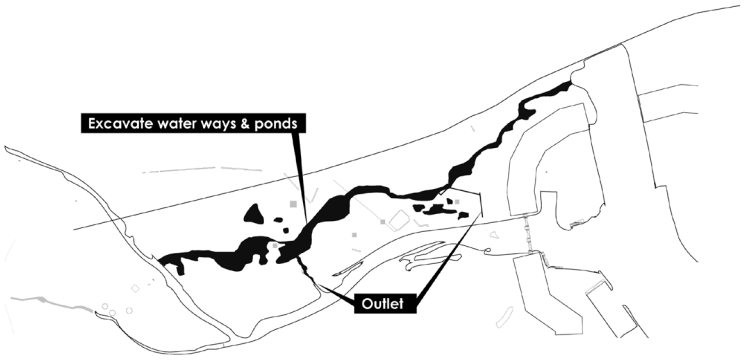

>80.0m
^3 Volume of crushed gravel
m
a = 26 hetares
The volume of sand may be needed
+ 0.136 million m^3 Volume of crushed gravel
- 0.07 million m^3 Volume of crushed gravel
m water storage area
elevation of land
>5.0m
Oyster reef
save sand + habitat


Y
TSUNAMI MEMORIAL PARK
GREEN EMBANKMENT + FOREST
- Tsunami and storm surge energy dissipation
- Forest of various indigenous trees (20-30m)
- Protection from strong wind, salt spray
- Social forestry , Timber
VIEWING PLATFORM
WETLADN RESTORATION
OYSTER REEF
ting
coastal defense
viewpoint
entertainment
biodiversity



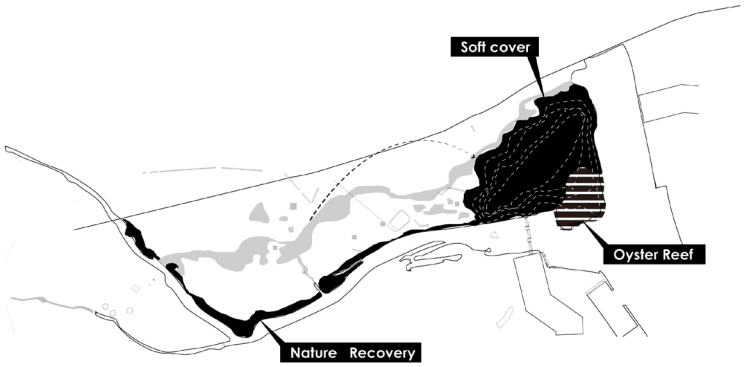
1_ After tsunami

After the tsunami disater and a huge amount of debris was remoed, flowing wells and spring ponds appeared.Diverse environments have been formed through change in the mixing of sprong water and saltwater at high tide,and flooding caused by rainfall.()



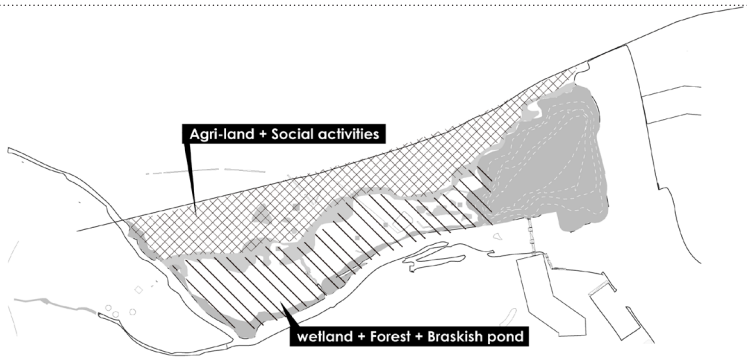
2_ Excavated sand

The waterway barrier can storage storm-water, also integrated various activities and eco-services value. The sand is Excavated will be used for soft land cover on the dike which minimizes the construction flow.



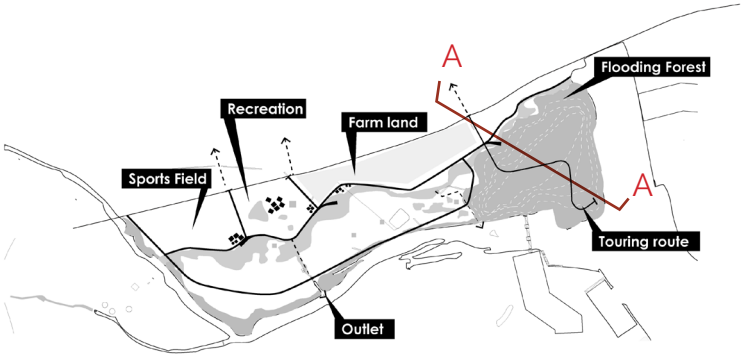
3_ Elevation of land

The sea wall will transform into the green embankment, which becomes a gradient buffer zone instead of hard engineered defense barrier. The designed area will become one continuous landscape mixing of various function and defense measures.



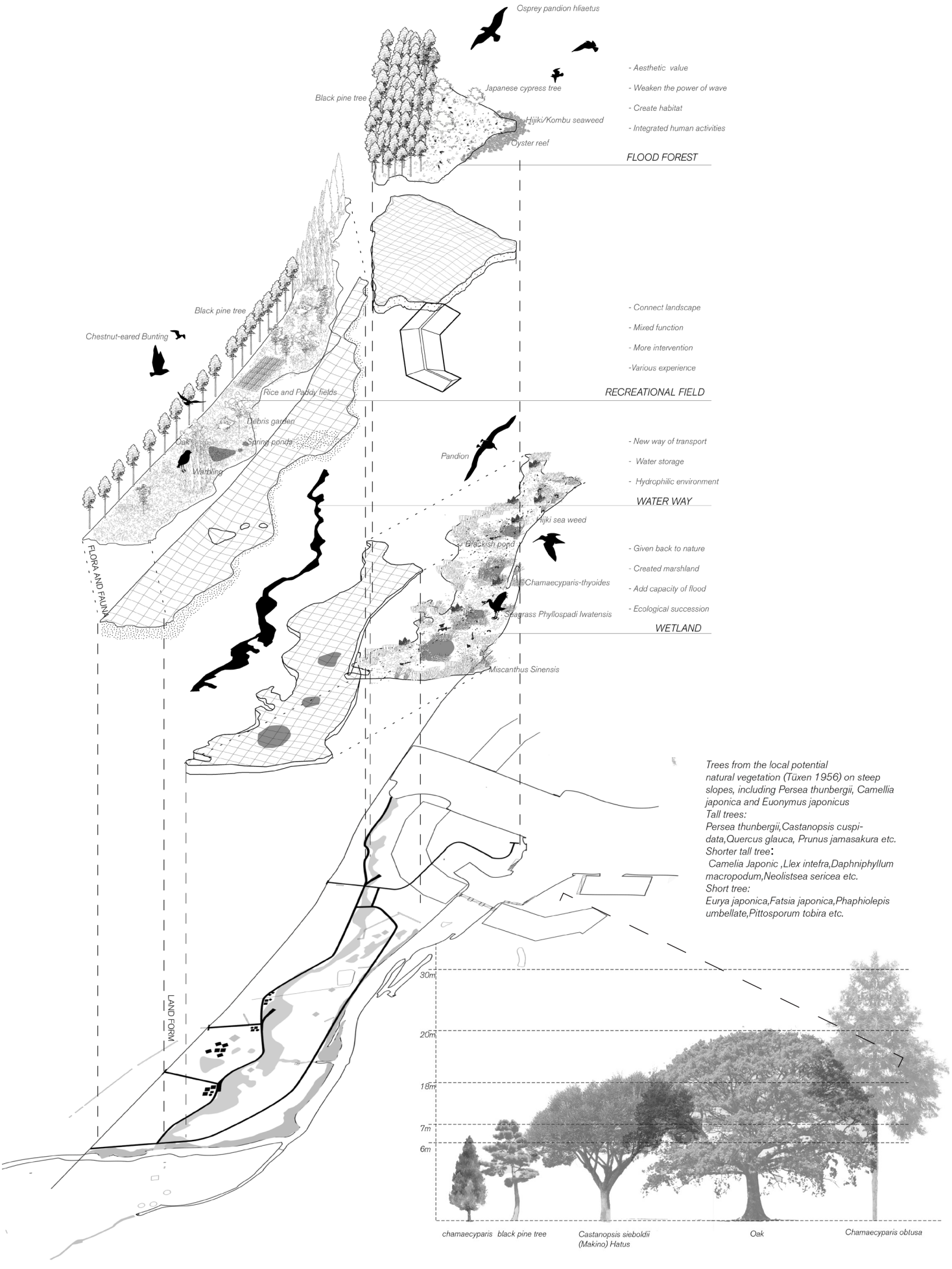
4_ Seperate zoning

After elevation of land, the designed ara could be seperated for variouos function



5_ Embeded infrastructure

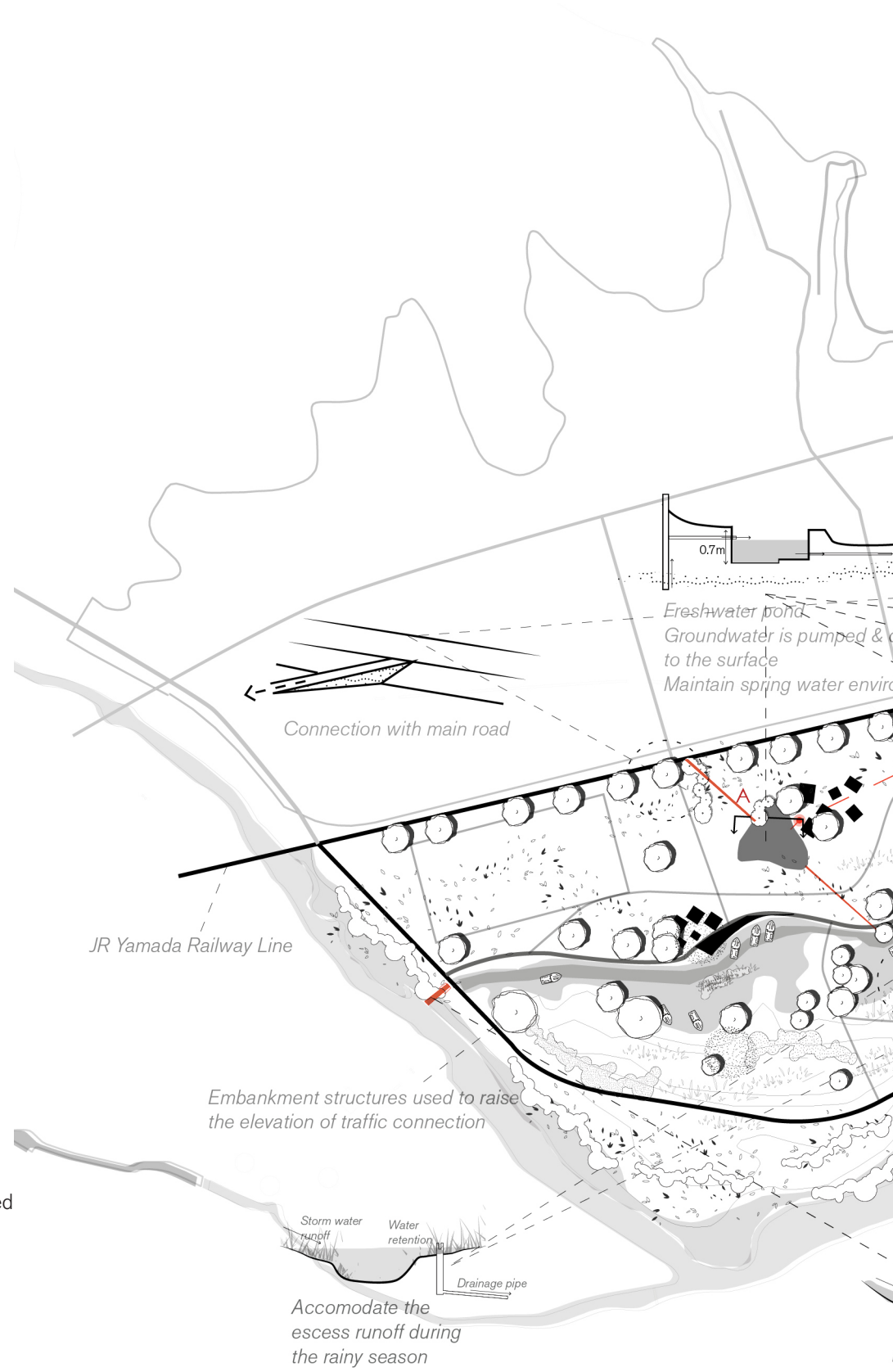
Local people could get involved in co-evolved landscape and fully the place by mebeding infrastructure by nature-based material


Osprey pandion hliaetus
Black pine tree
Japanese cypress tree
Hijiki/Kombu seaweed
Oyster reef
- Aesthetic value
- Weaken the power of wave
- Create habitat
- Integrated human activities
FLOOD FOREST
Black pine tree
Chestnut-eared Bunting
Rice and Paddy fields
Debris garden
Spring ponds
Oak
Warbling
- Connect landscape
- Mixed function
- More intervention
-Various experience
RECREATIONAL FIELD
Pandion
Hijki sea weed
Brackish pond
Chamaecyparis-thyoides
Seagrass Phyllospadi Iwatensis
- New way of transport
- Water storage
- Hydrophilic environment
WATER WAY
- Given back to nature
- Created marshland
- Add capacity of flood
- Ecological succession
WETLAND
Miscanthus Sinensis
FLORA AND FAUNA
LAND FORM
Trees from the local potential natural vegetation (Tüxen 1956) on steep slopes, including Persea thunbergii, Camellia japonica and Euonymus japonicus
Tall trees:
Persea thunbergii,Castanopsis cuspi-data,Quercus glauca, Prunus jamasakura etc.
Shorter tall tree:
Camelia Japonic ,Llex intefra,Daphniphyllum macropodum,Neolistsea sericea etc.
Short tree:
Eurya japonica,Fatsia japonica,Phaphiolepis umbellate,Pittosporum tobira etc.
30m
20m
18m
7m
6m
chamaecyparis
black pine tree
Castanopsis sieboldii (Makino) Hatus
Oak
Chamaecyparis obtusa

Phase 2 Ecological restoration

.

BASIC PLAN



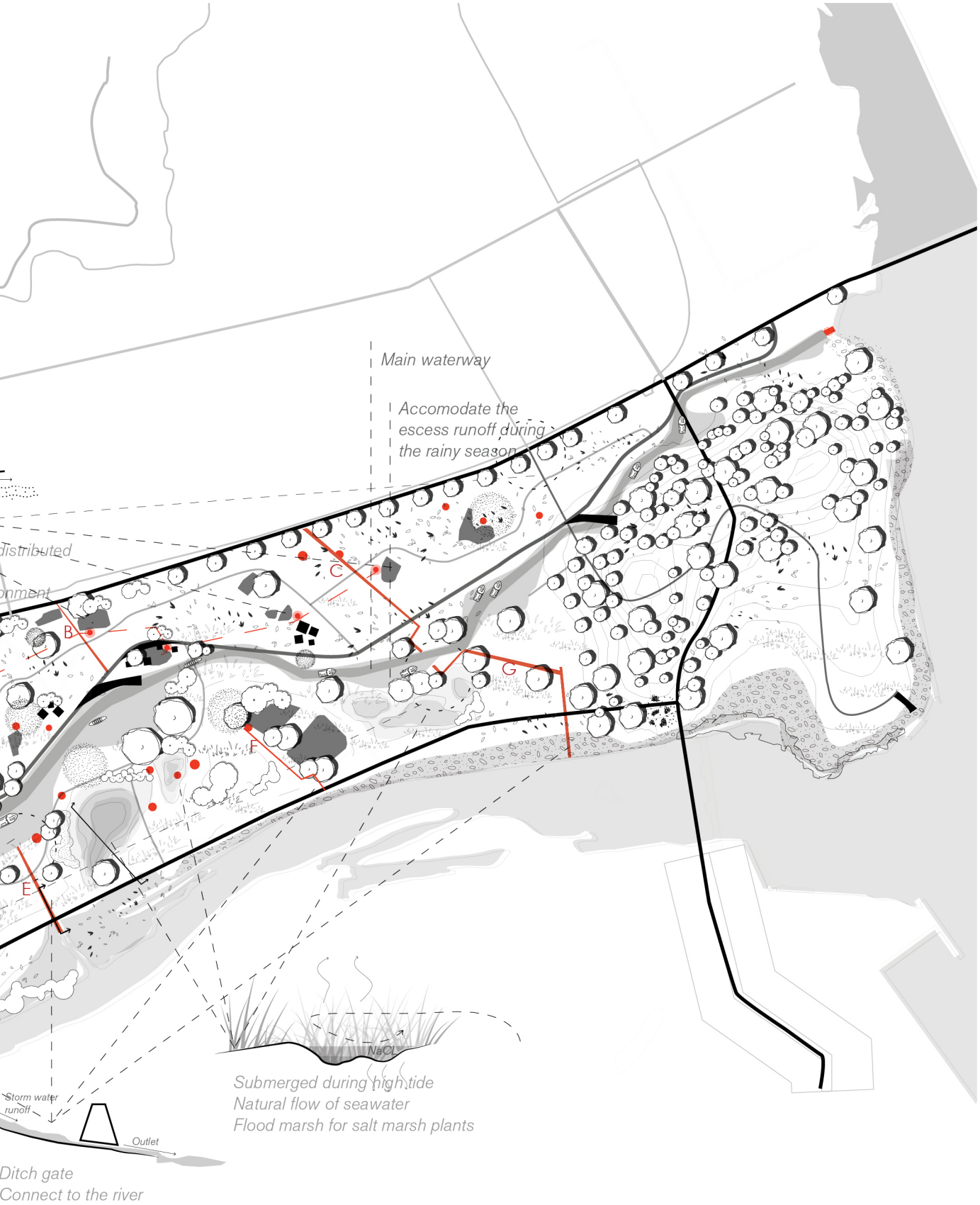
Watersystem

- water flow from the sea will be secured by utilizing current water-ways
- the freshwater area and brackish water area will be connected via a network
- Freshwaterponds will be preserved

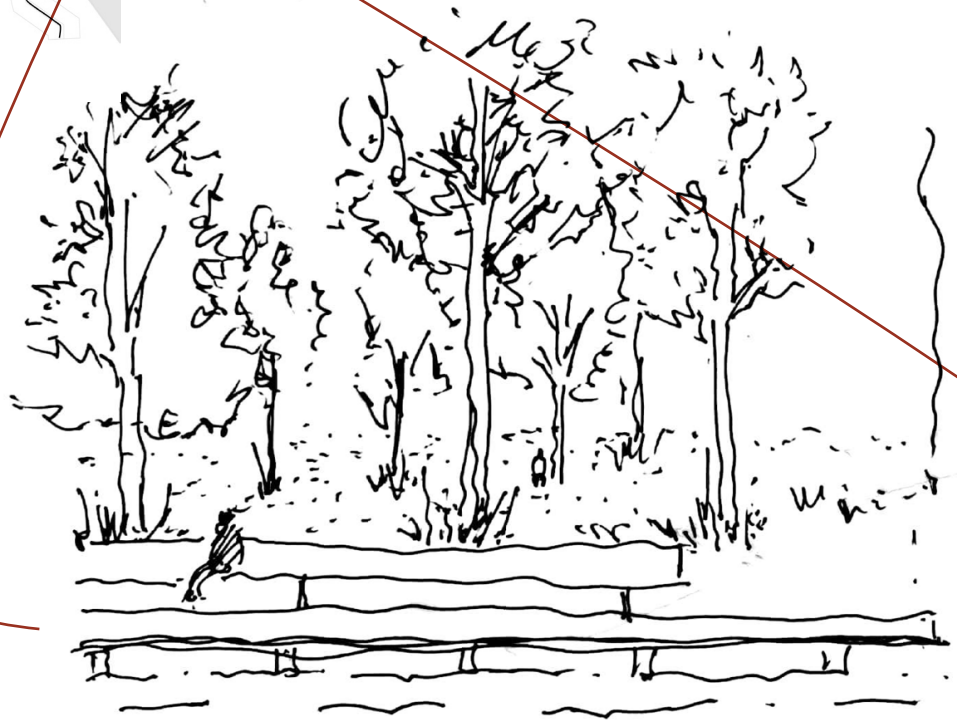
Water way
Pipeline
Alive spring well
Pump station
Traffic road
Pedestrain road
Fresh pond

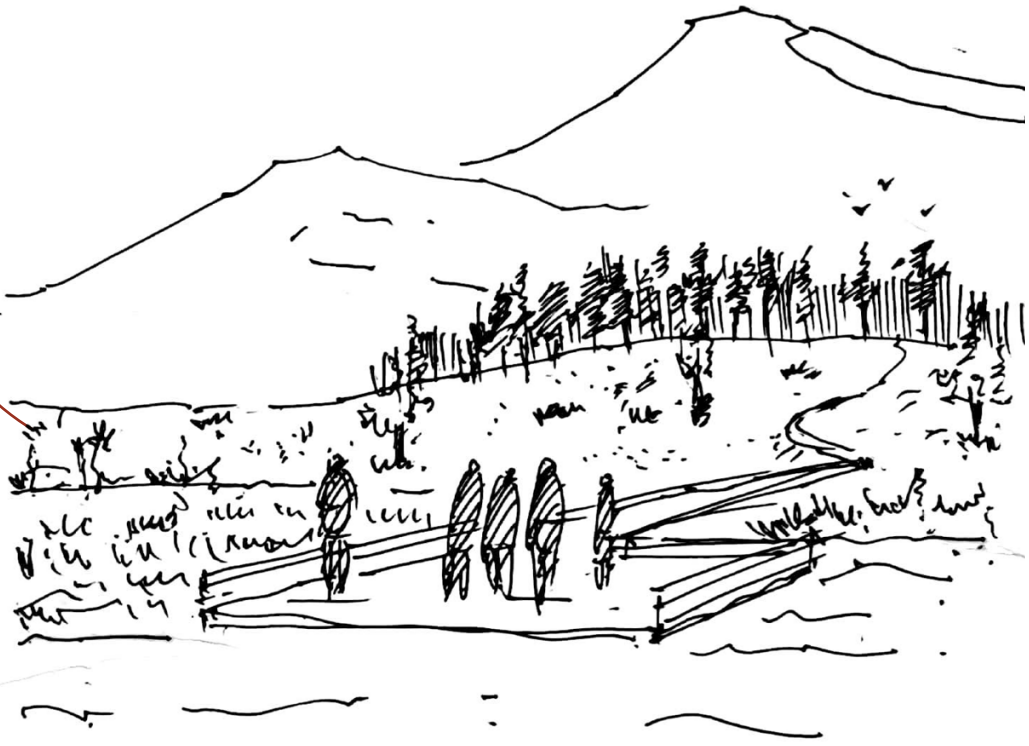
N

0 100 m

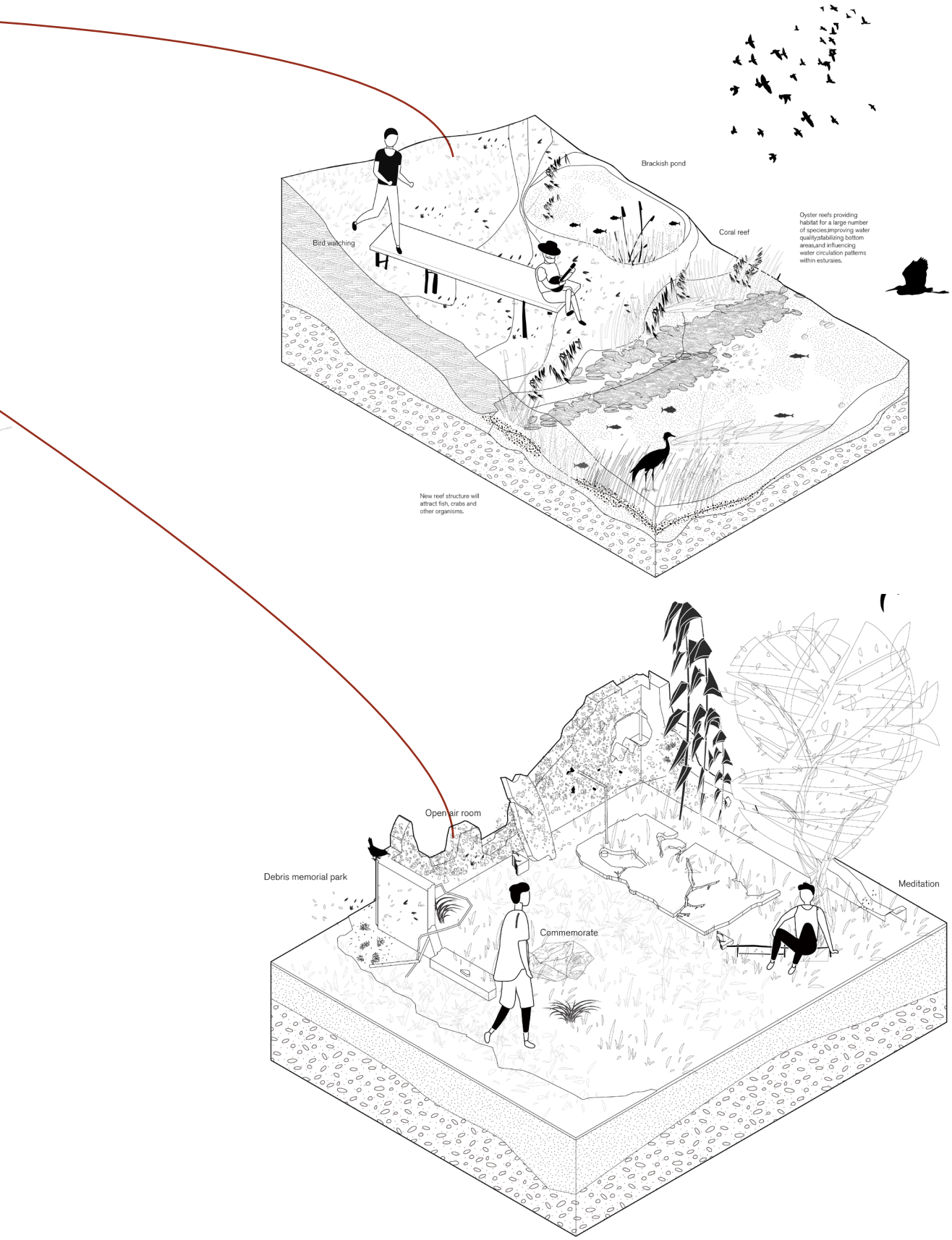

Main waterway
Accomodate the
escess runoff during
the rainy season
distributed
B
C
E
F
G
NaCL
Submerged during high tide
Natural flow of seawater
Flood marsh for salt marsh plants
Storm water
runoff
Outlet
Ditch gate
Connect to the river







Phase 3 Integrating activities


Brackish pond
Bird watching
Coral reef
Oyster reefs providing habitat for a large number of species,improving water quality,stabilizing bottom areas,and influencing water circulation patterns within esturaies.
New reef structure will attract fish, crabs and other organisms.
Open air room
Debris memorial park
Meditation
Commemorate

Living Shoreline:

Fishery industral area peotection and coastal ecological restoration

Zichuan Lu



Location

The design site is located on the bay area of Otsuchi, outside of the dike. The main land use of this area is fishery industry and harbor.


Oystahy river

Manifesto

After the 2011 tsunami, the gap between community and sea has became wider, people are afraid of the damage taken by the sea, and they built a sea wall to protect themselves from natural hazards. This built infrastructure cut the link between people and water not only physically but also psychologically. The sea wall is like a city wall, protecting the communities, but at the same time increasing the community's fear of the sea. From the ancient time, people in Otsuchi have lived with sea and have strong spiritual sustenance with nature, and this emotion should not be killed by the built infrastructure.

In the coastal area of Otsuchi, we want to bring these hundred-years-long emotions and spirit back to the post-disaster communities. Human activities should be highly intertwined with the sea and nature, and the hazard defense infrastructures should play a positive role in the middle, not the reverse. It should be emphasized that in this process the infrastructure still needs to have the ability of defense hazards and protect the local communities.

The family-based fishery is the main industry in Otsuchi, and we think that industry could also be the catalyst to reconnect the emotions between the local communities and the sea. The hazard defense infrastructure could play multi-role in this action, as protector, as producer, and as coordinator. And we also encourage local communities to participate in this action by providing a stable environment for the fishery industry, as well as by giving them more options for marine agriculture.

The sea and coastal areas should not only reconnect to local communities but also given back to nature. By the construction of the giant sea wall, the eco-corridors between forest area and coastal area are cut, and the built infrastructure also destroyed the natural habitat for a series of species. By transforming the hard infrastructure to hybrid infrastructure, more eco-functions will be implemented in the defense systems, which could give this area back to nature and function as habitat for animals.



Marine farming

Design experiment

The main goal of this design is to reconnect the community to the sea not only in physical but also in social and economy.

The first approach is to revitalize the local fishery industry.

As the location of most fishery factories in Otsuchi, the security of fishery factories should be considered, the industrial area should have the ability to defense nature hazards like floods and tsunami. So a hybrid flood defense infrastructure system should be implemented in the industrial area, to protect the industrial area in an eco-friendly way.

The second approach is to making opportunities for marine farming.

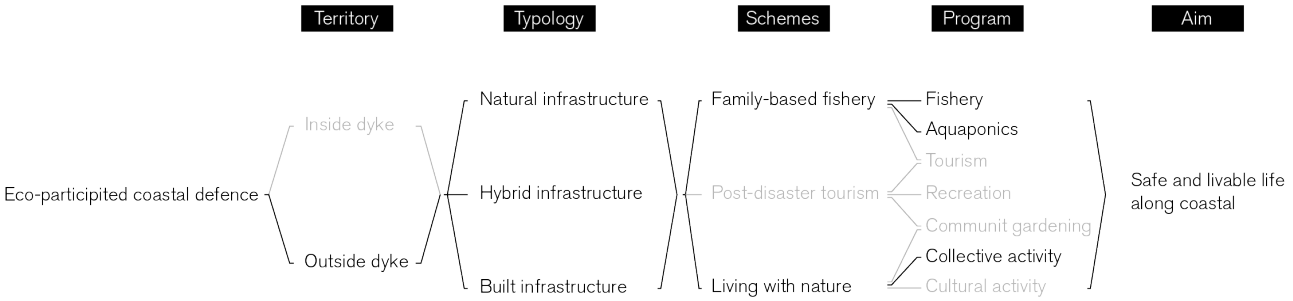
By implementing the breakwaters in the bay area, more seas will become calm waters which create the opportunities for marine farming. The marine framing could also increasing the local income at the same time enhance emotional connections between communities and sea. Also, the nutrition made by marine farming could also be the food of sea animals, thus marine farming will also helping to increase local animals.

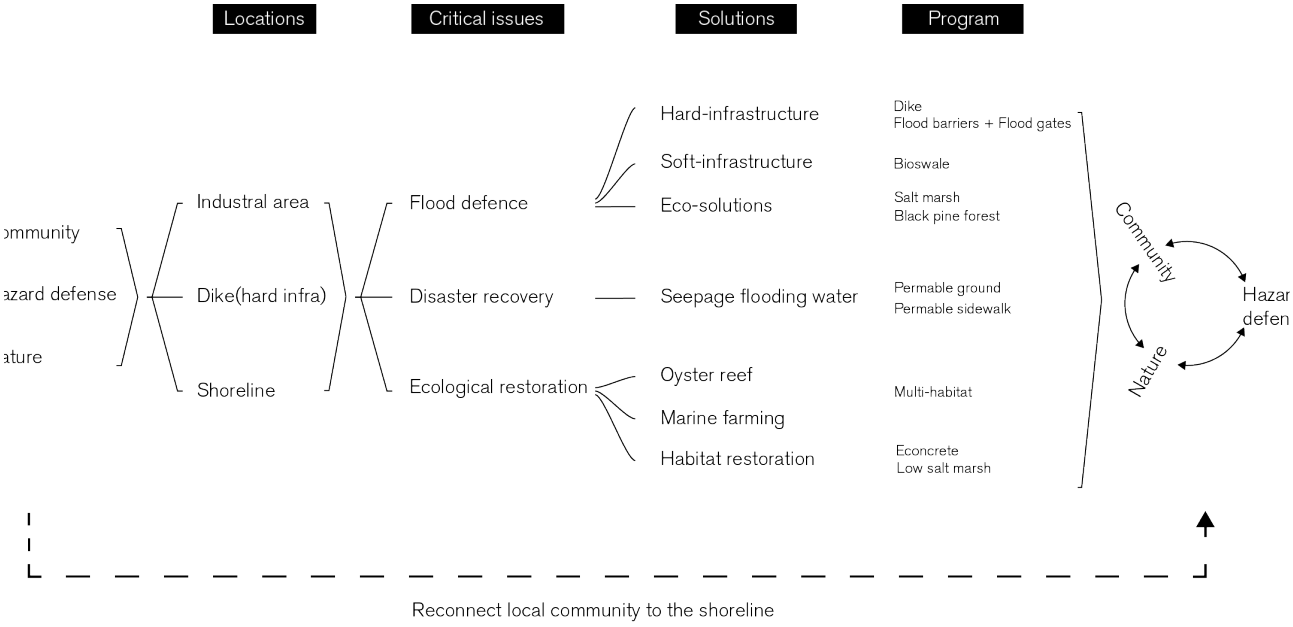
The third approach, which also a long-term approach is giving the land back to nature.

By transforming the built flood defense infrastructure (dike) to hybrid infrastructure, the land occupied by hard infrastructure could also function as natural habitat and breeding area for animals and increasing the biodiversity and natural resilience of Otsuchi.

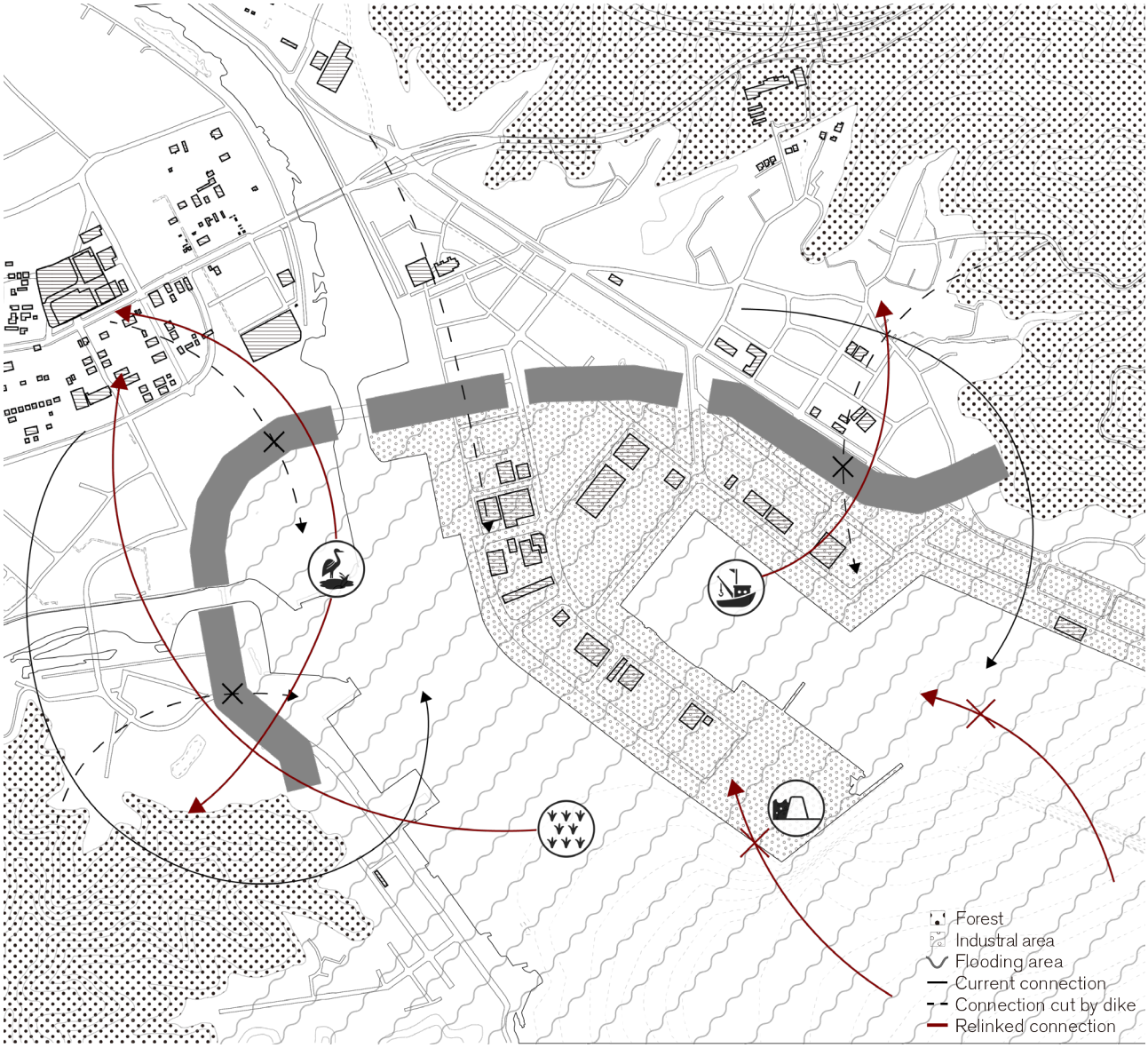


Guideline

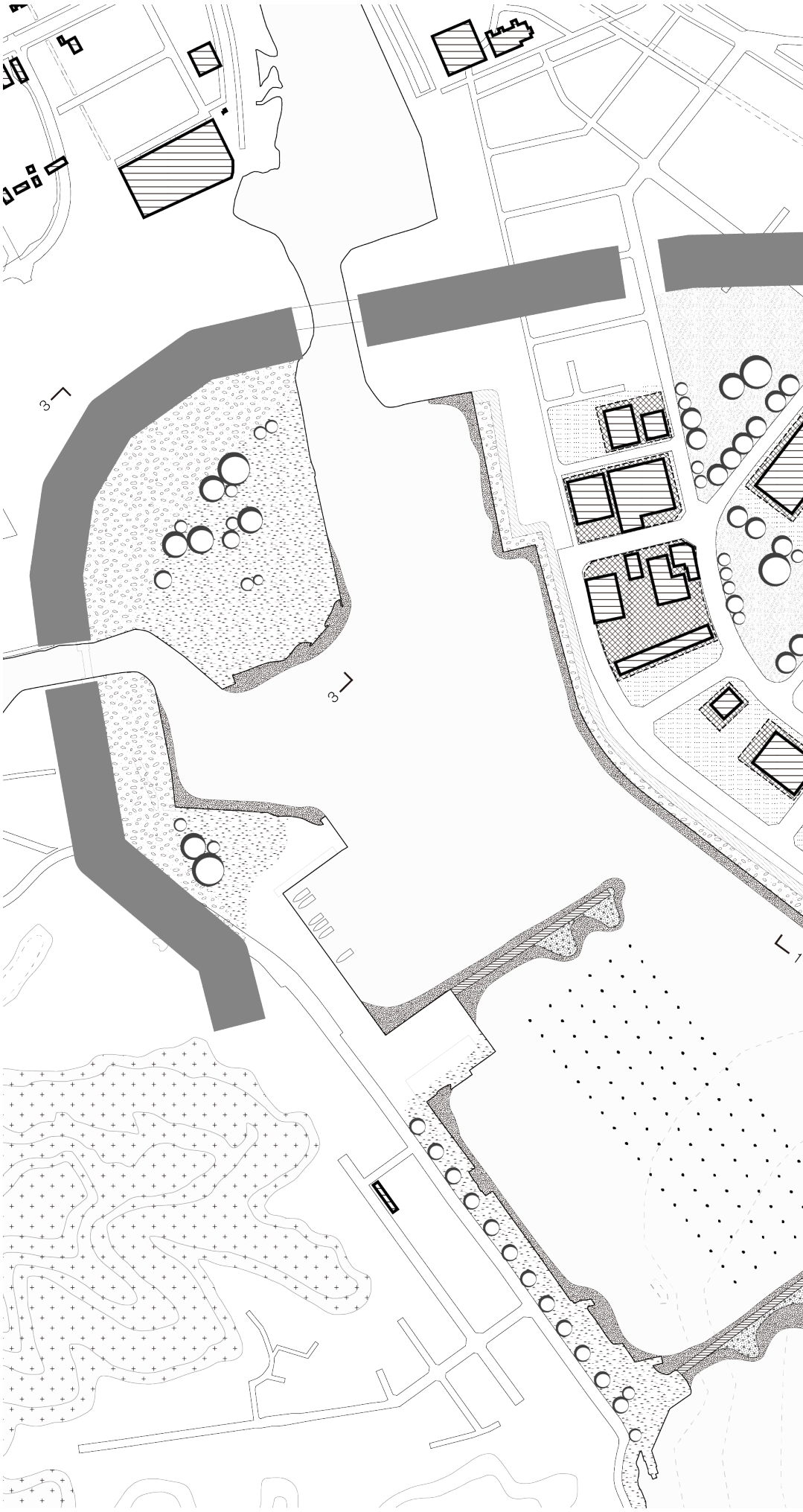

Territory
Typology
Schemes
Program
Aim
Eco-participited coastal defence
Inside dyke
Outside dyke
Natural infrastructure
Hybrid infrastructure
Built infrastructure
Family-based fishery
Post-disaster tourism
Living with nature
Fishery
Aquaponics
Tourism
Recreation
Communit gardening
Collective activity
Cultural activity
Safe and livable life
along coastal


Locations
Critical issues
Solutions
Program
ɔmmunity
ɜzard defense
ɜture
Industral area
Dike(hard infra)
Shoreline
Flood defence
Disaster recovery
Ecological restoration
Hard-infrastructure
Soft-infrastructure
Eco-solutions
Seepage flooding water
Oyster reef
Marine farming
Habitat restoration
Dike
Flood barriers + Flood gates
Bioswale
Salt marsh
Black pine forest
Permable ground
Permable sidewalk
Multi-habitat
Econcrete
Low salt marsh
Community
Nature
Hazar
defen
Reconnect local community to the shoreline

Reconnection



In the current situation, the connection between the local community is cut by the 14.5m high dike. The connection is not just accessibility, but also the ecosystem connection and the emotional connection. The carrier of reconnection will be flood defense, marine farming, and ecological restoration.

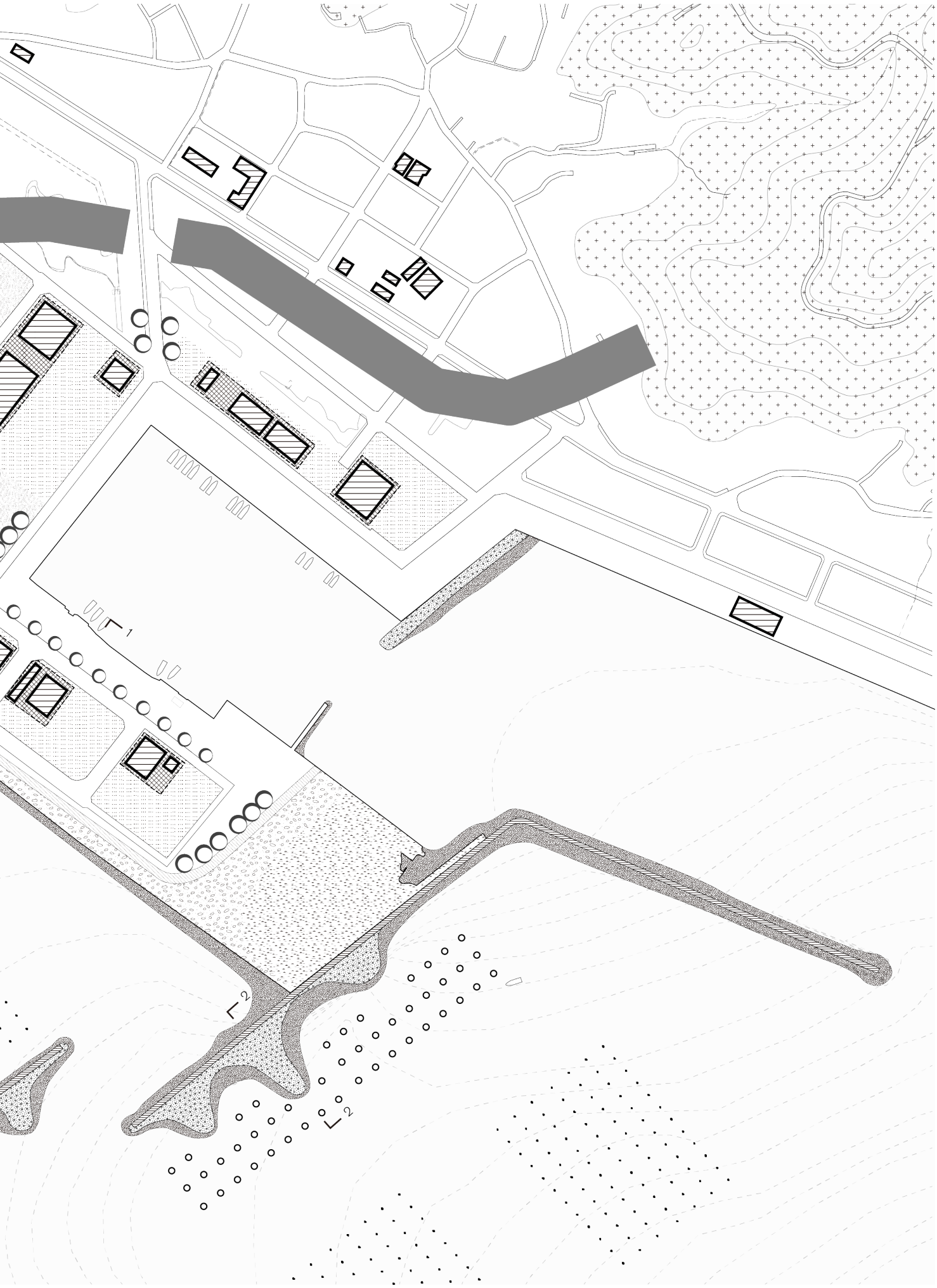


Plan

- Bioswales
- Rocky land
- Salt marsh
- Oyster beds
- Breakwater
- Permeable area
- Impermeable area
- Grassland
- Sea Mustard farming
- Oyster farming

N

0 100m 200m


L1
L2
L2

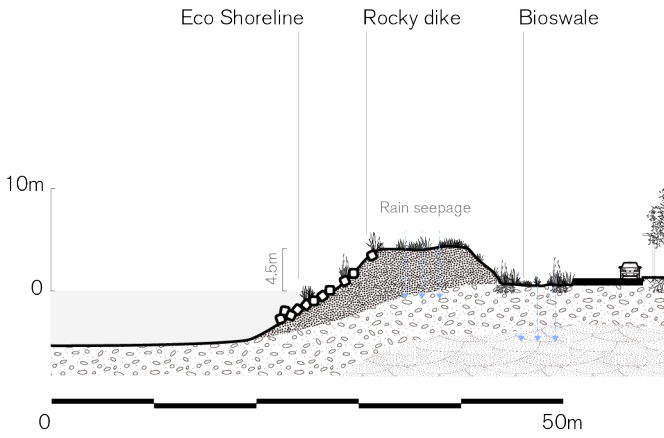
Flood defense

The hybrid flood defense system is including rocky dike, land elevation, and flood barrier.

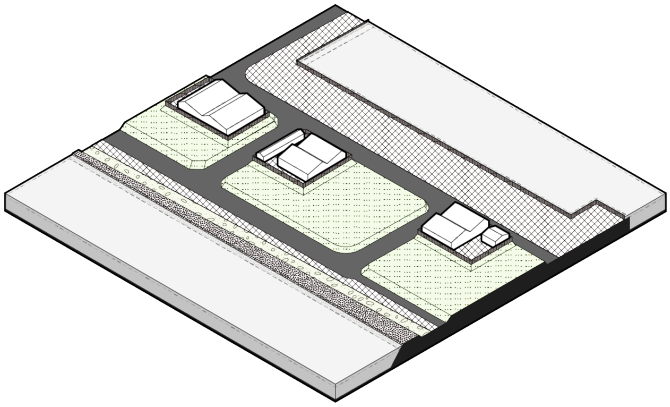
The eco shoreline is the rocky dike that implements e-concrete units which could be habitat for fishes and shellfishes, also the rocky dike itself could also be breeding area for some kinds of birds.

The plot with the industrial function will be elevated to protect the factories and facilities from flooding. And the flood barrier will be implemented around the factory building as the last line of flood defense.

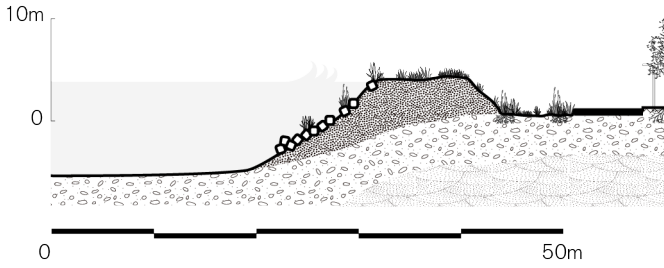
Permeable pavement is widely used in this area, after the tsunami, the floodwater could drainage to underground as soon as possible.



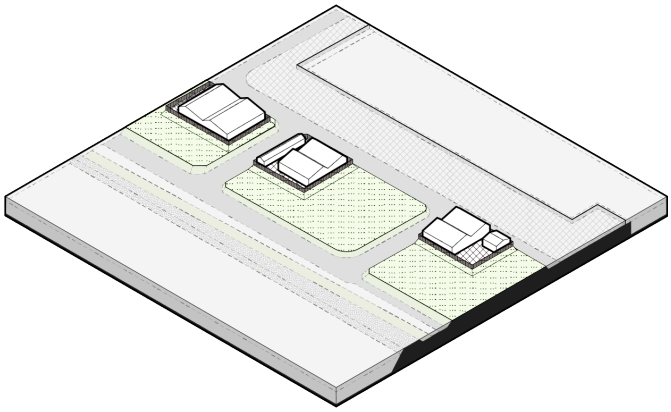
Low flood (<3m)



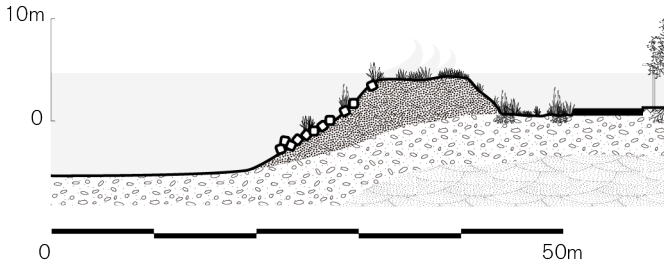
The rocky dike and green flood barrier could defend the tsunami.



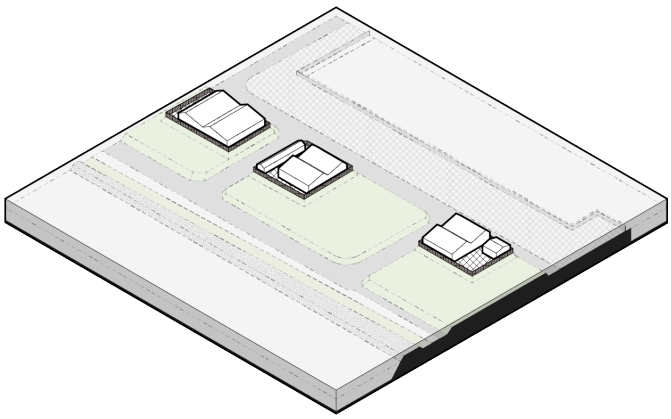
Medium flood (3<6m)



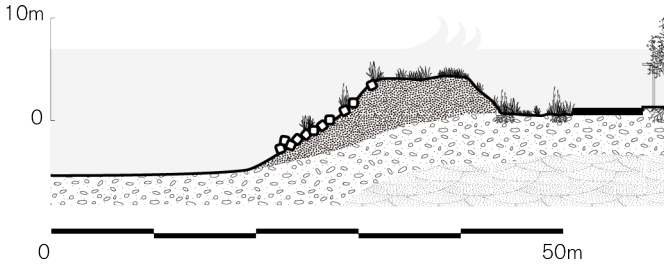
The land elevation could help industrial area out of tsunami.

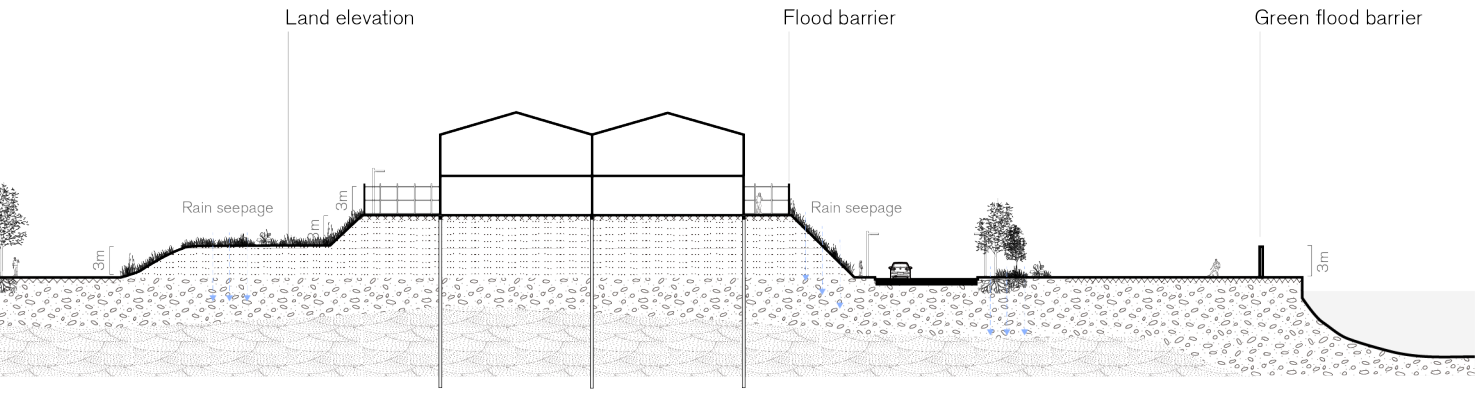


High flood (6<9m)

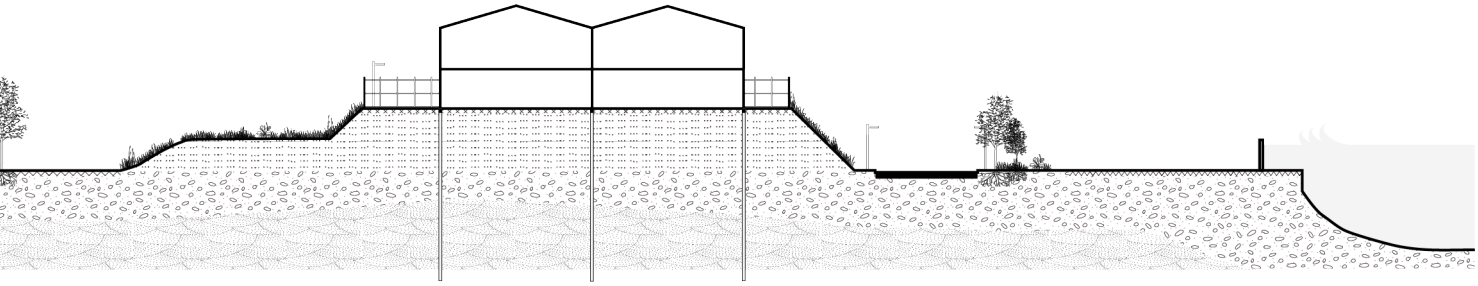


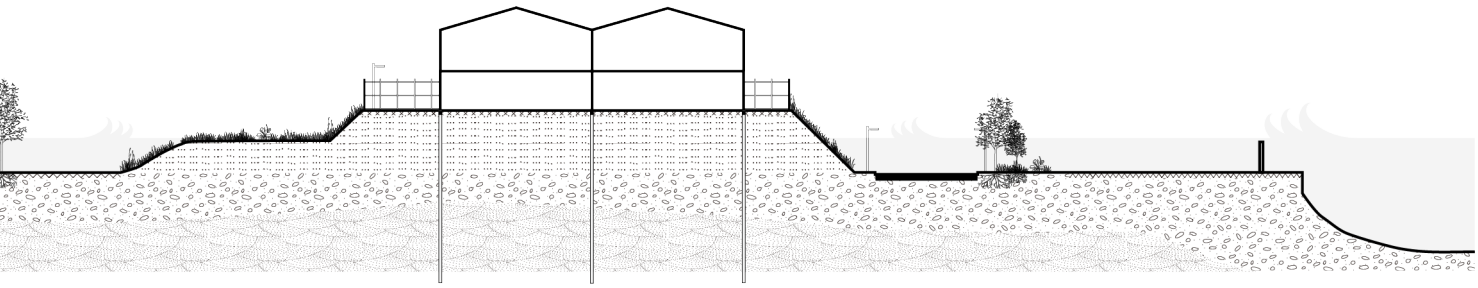
The flood barrier around factory buildings could defend the tsunami.

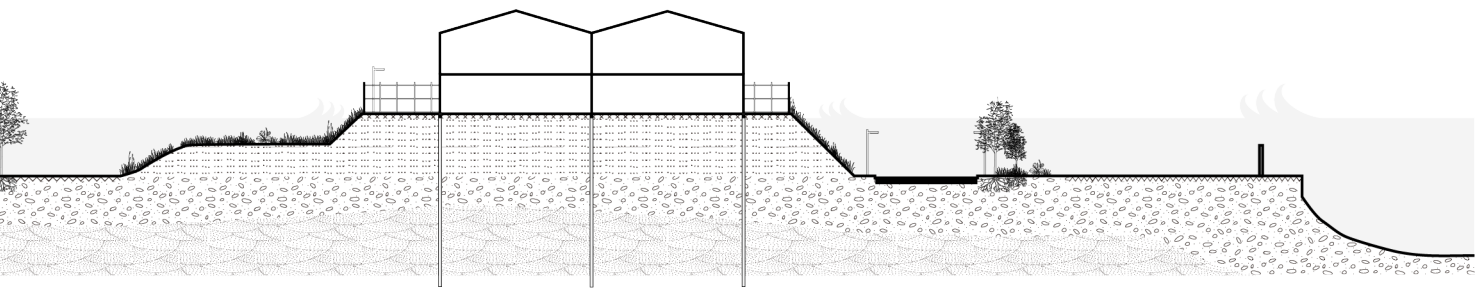



Land elevation
Flood barrier
Green flood barrier
Rain seepage
Rain seepage
3m
3m
3m
3m

Section 1-1

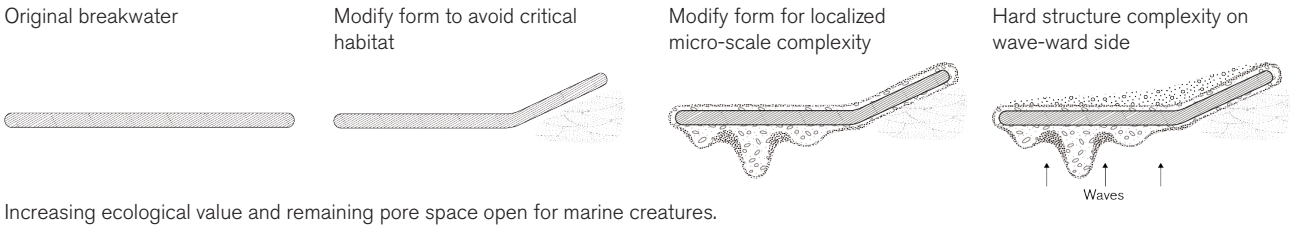






Marine farm & ecological restoration

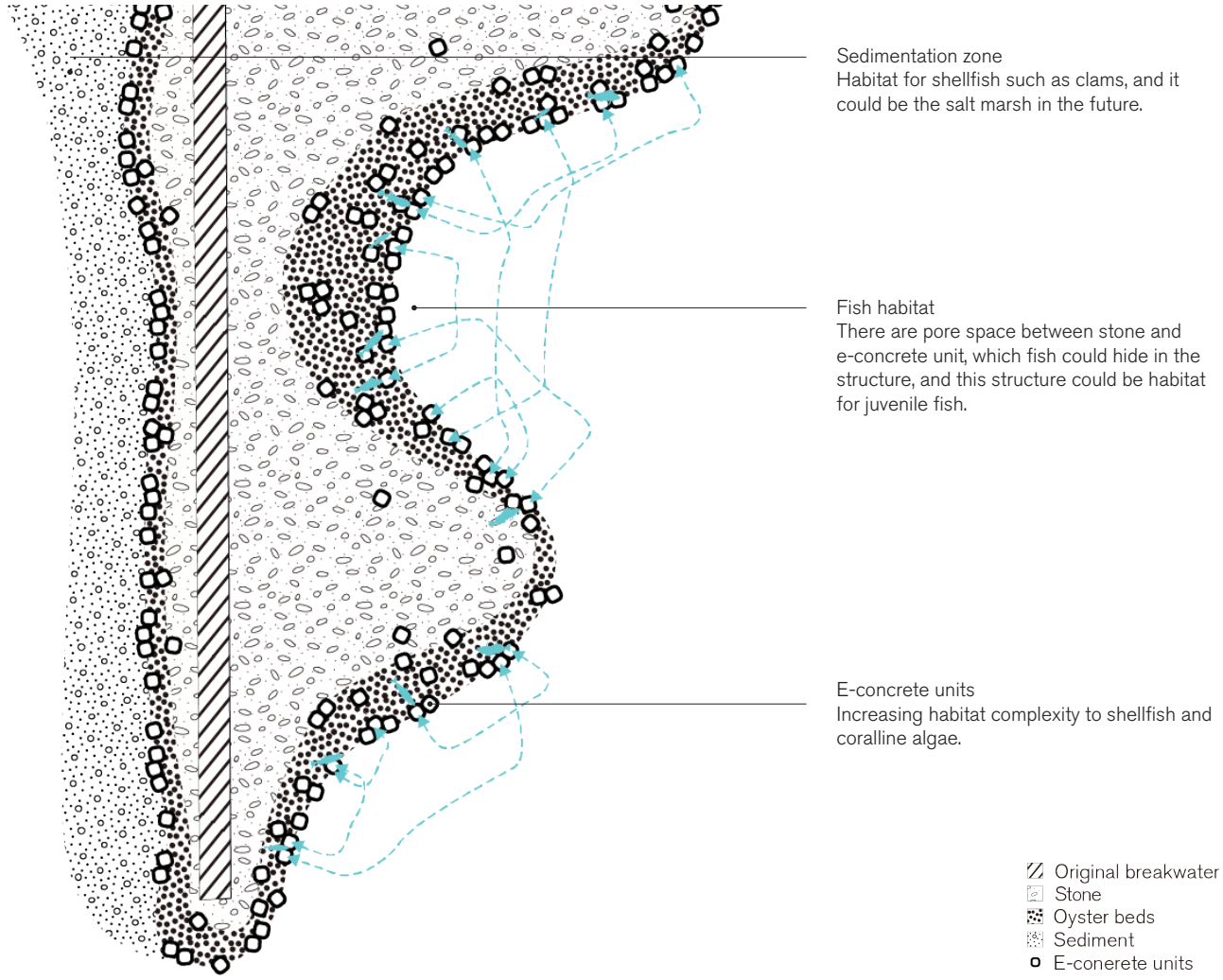
Living breakwaters

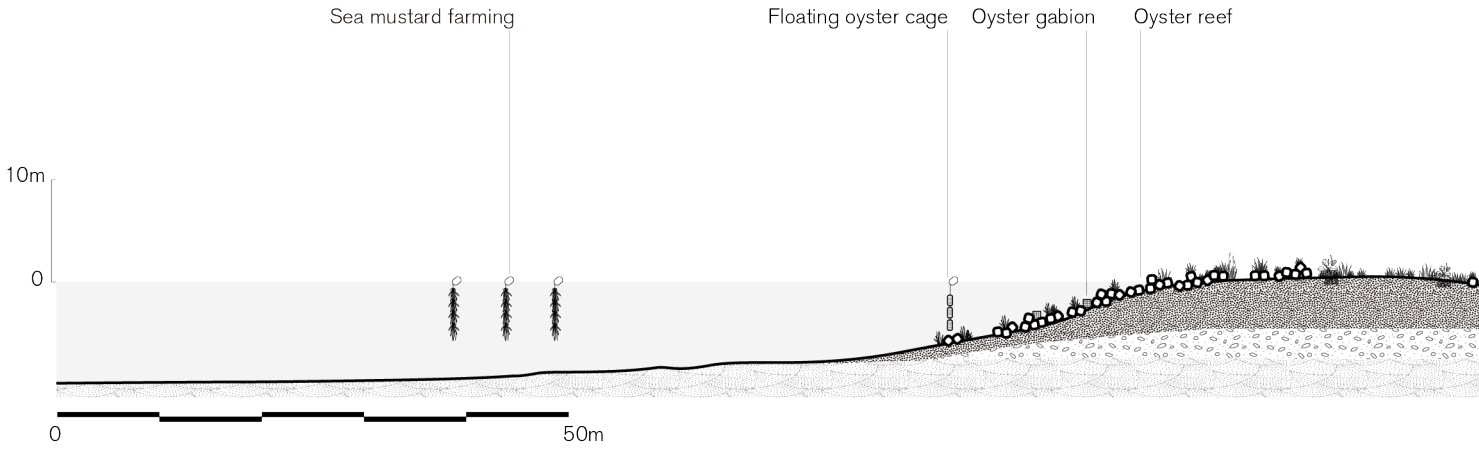


Increasing ecological value and remaining pore space open for marine creatures.

Reef habitat

A multi-habitat will be created in living breakwaters, which could help to increase the local biodiversity. This constructed habitat will attract fish of all ages, and in turn, fishermen looking for that perfect secret fishing hole.

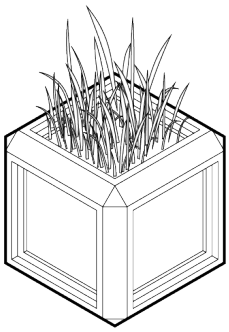




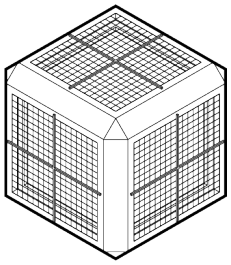
E-concrete units

By using certain material and increasing surface complexity, the eco-concrete unit could be the multi-habitat for various species, including oysters, sponges, sabellidae, serpulidae, tunicates, bryozoans and coralline algae. These communities contribute to water purification, increase habitat complexity, and attract a larger amount of native fish species.

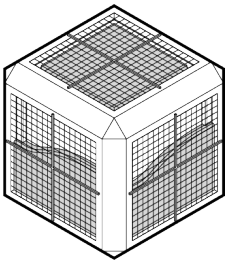
Tidal planter



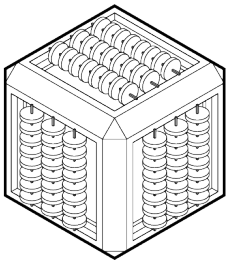
Fish hub



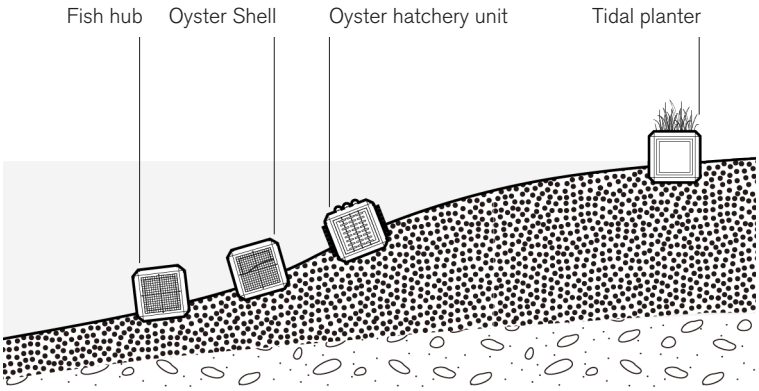
Oyster Shell



Oyster hatchery unit

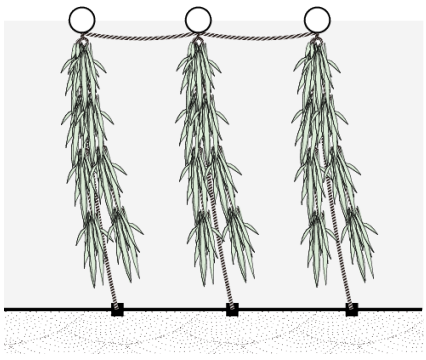


The eco-concrete unit was eco-engineered to accommodate different add-on elements for enhancement of target species for example oysters, fish, or vegetation. Eco-concrete units will be placed in the breakwater reef, to attract and create habitat for certain species of marine animals.



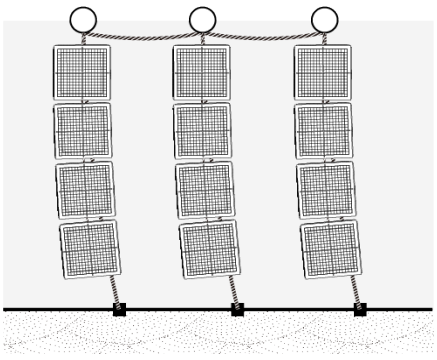
Marine farm

Sea mustard farming

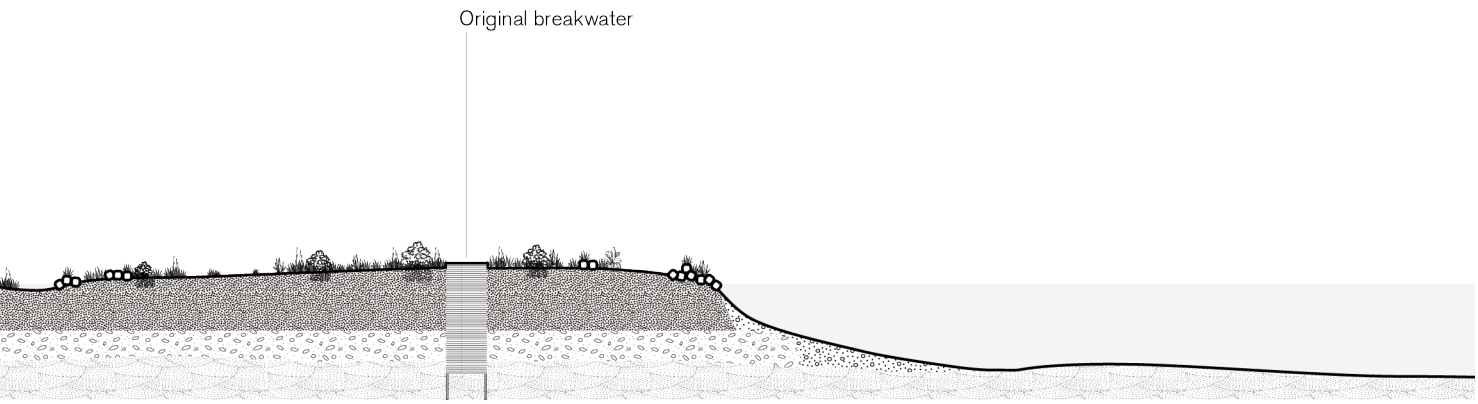


Sea mustard is the traditional food of Japan, so it will have a positive impact on local economy, and the sea mustard field could also be habitat for some local fishes.

Floating oyster cage



Oyster farming could increase the local income and the floating oyster cages also provide a safe nursery for commercially valuable species including shrimp, stone crab, flounder and etc.



Ecological restoration

The original dike will transfer to a hybrid dike covered by rocks, and the black pine forest will be planted as tidal forest, combing with salt marsh to increasing natural resilience of this area. The rocky dike and the forest will also be the shelter and habitat for species of local birds and mammals.

Habitat

Japanese shrew mole (Urotrichus talpoides)



Habitat:
Under the leaves of alpine forest and grasslands.

Japanese squirrel (Sciurus lis)



Habitat:
Forest

Streaked shearwater (Calon



Habita
nshor
slands

Breeding habitat

Little grebe (Tachybaptus ruficollis)



Habitat:
The rock crevices

Japanese cormorant (Phalacrocorax capillatus)



Habitat:
Rocky shores

Slaty-backed gull (Larus schistisagus)



Habitat:
Ocean, river mouths, tidal flats, and surrounding lakes and marshes

Black-ta



Vegetation

Maiden silvergrass



Useage:
Ornamental plant/material for thatched roofs/ food for livestock

Phragmites australis (Reed)



Useage:
Papermaking raw material/medicinal material/fertilizer/ fuel/instrument

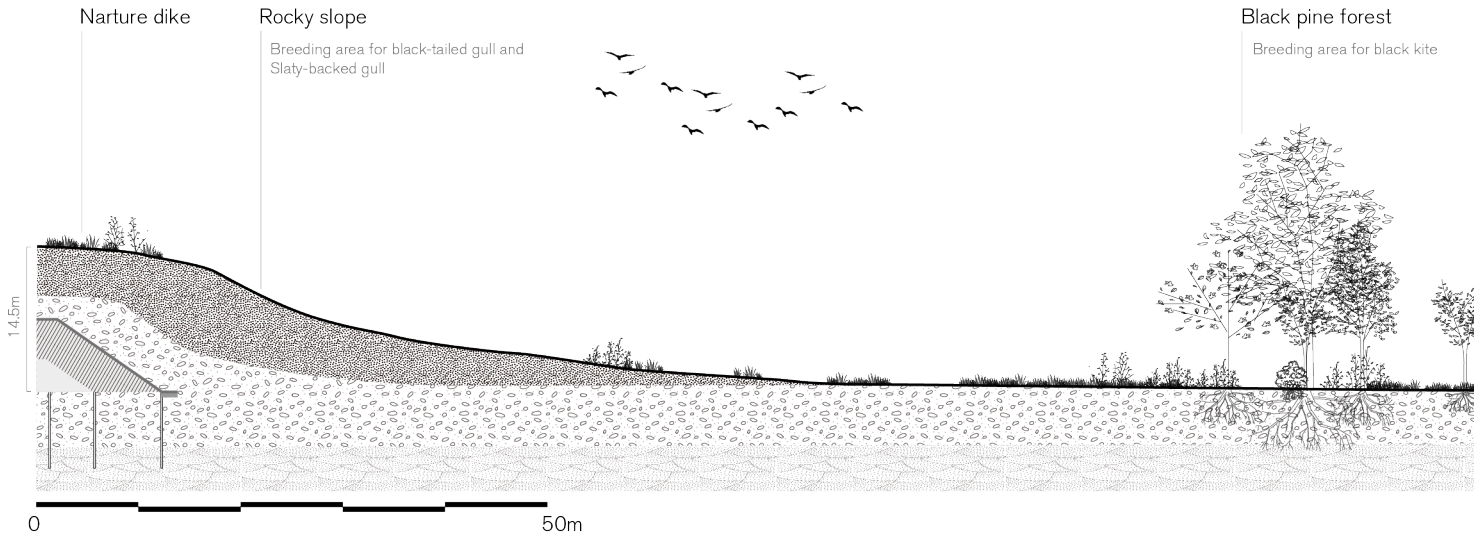
Amorpha fruticosa



Useage:
Nitrogen fixation/ ornamental plant

Pinus thu





Masu salmon (Oncorhynchus masou masou)



Habitat:
River/sea

Chum salmon (Oncorhynchus keta)



Habitat:
River/sea

ectris leucomelas)

t:
e waters, offshore

Little grebe (Tachybaptus ruficollis)



Habitat:
Coast

Red-necked grebe (Podiceps grisegena)



Habitat:
Coastal and estuary areas

iled gull (Larus crassirostris)



Habitat:
Coastal areas, estuaries, and tidal flats

Black kite (Milvus migrans)



Habitat:
Nests on trees

nbergii (Japanese black pine)

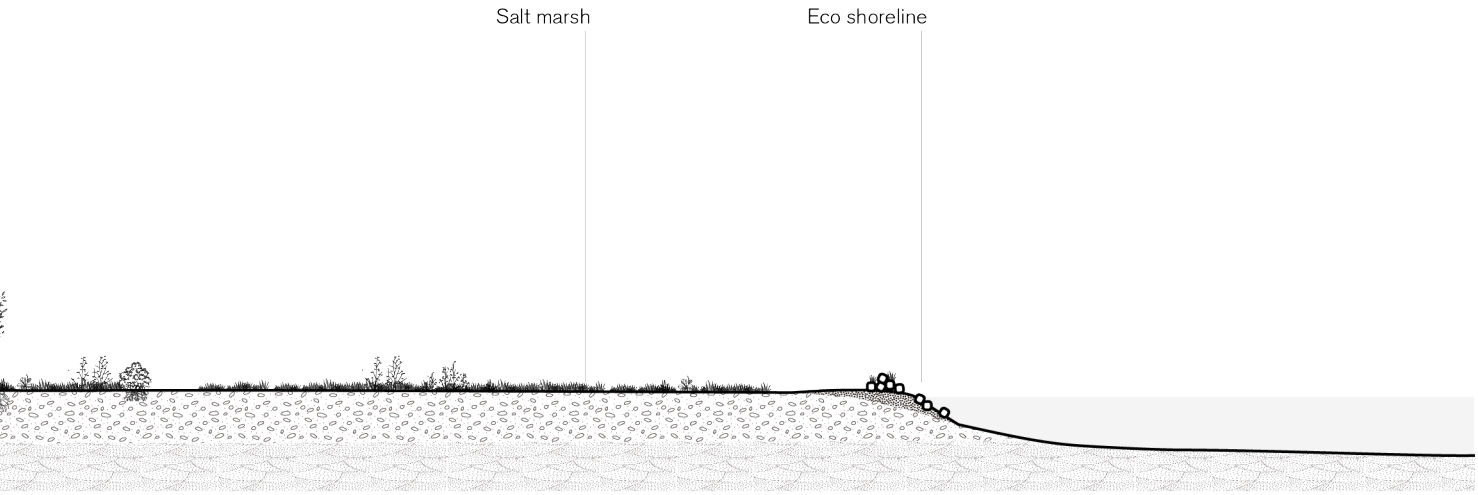


Useage:
Windbreak/tidal forest/ornamental tree/medicinal

Carex kobomugi (Japanese sedge)



Useage:
Windproof and sand fixation



Section 3-3

Mountain / Water

Kueitso Chen



Manifesto

In Otsuchi, there are various landscape and the transition from the mountain to the sea can be experienced. And people used to settle down in the foothill area and riverbank to grow some crops and then gradually moving to the sea. So we can say that residents here have a strong relationship with mountains and water. However, in order to defense the tsunami, people build up huge dyke. The relationship between people and water (river/sea) is disconnected

In the individual focusing area, the land is raised about 2 meters which are relatively safer but also lost the connection water. As a result, this design experience aims to use the water system as a catalyst and built up the continuous landscape which connected the mountain and water is the main goal of this design experience. Rebuild the connection between water and people and make the residents live in the foothill area can perceive the water combine with different functions, to see what can people do for nature and vice versa. Then, all those elements can be perceived when walking through Otsuchi.

Capture the surface water from mountain and storage then go through the community and drain to the river and wetland. By doing so, the ecology has more chances to get involved with people and become a green finger which also creates more habitats. The waterbody can be used as a residential, productive, and natural area. Create a living experience with nature.

Kuei-Tso, Chen

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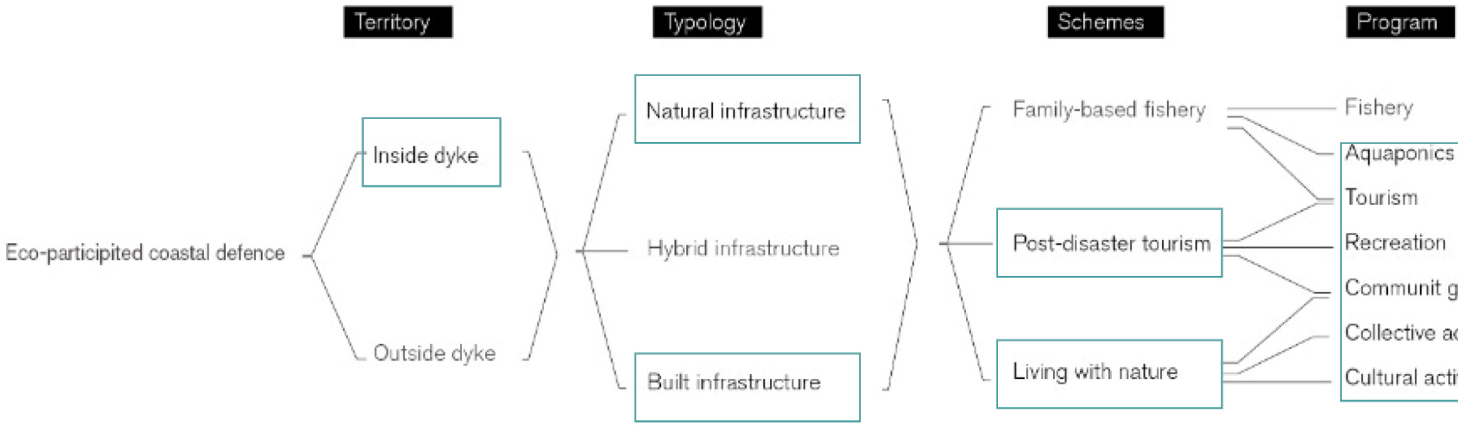
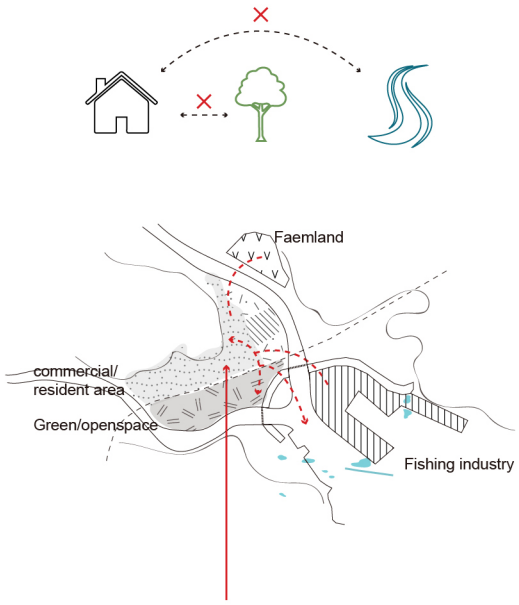




Add new element into resident area



Fresh water aquaculture/
Agriculture



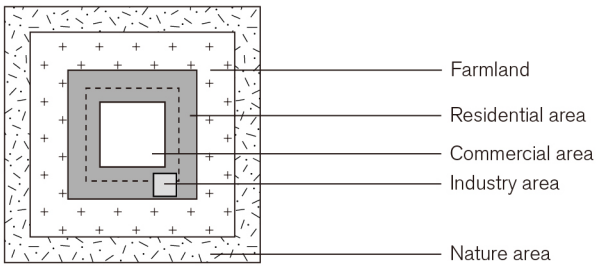
Blue element



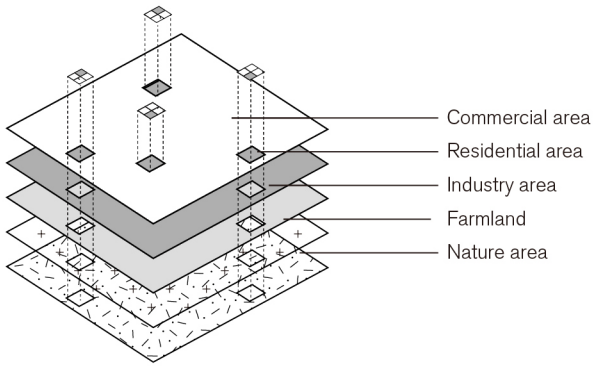
Green space

Currently, the plan is based on the different function and become separated which make this vulnerable. Moreover, it also disconnects the relationship between residents and varied landscapes.

Current situation

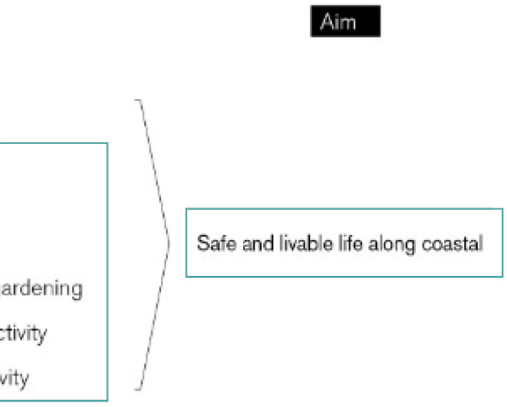


Fold up city



Decentralize and minimize the city adn become mix-used.
These small vacant lots in the city will have more possibilities for use and can perform their maximum functions. At the same time, unused vacant lands and empty houses will be "closed", which is "folding". However, after folding, when there is a possibility of use, it can be "opened again".

Reference: Shin Aiba (2020) 都市をたたむ：人口減少時代をデザインする都市計画



Design experiment

The new water flows as an intermediary to connect the people and nature create more habitats in an urban area, job possibilities for the residents, and recreation area.

This design experiment takes a closer look into how water can flow from foothill to residential are to river and explore the suitable location for water to go through and storage.

1. Understand the surface water from mountain

2. Find out the potential location to storage water and spring water distribution

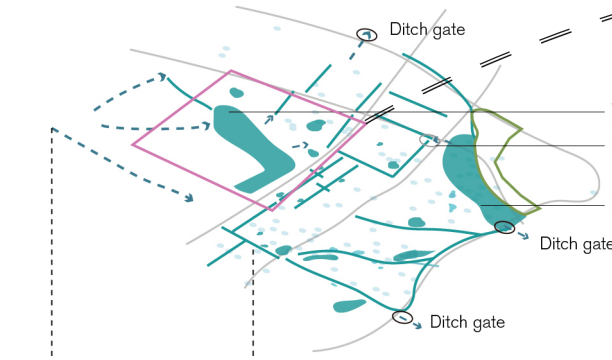
3. Face to the shrinking population in Otsuchi and design an adaptable urban planning

4. Calculate water storage and supply in the emergency situation

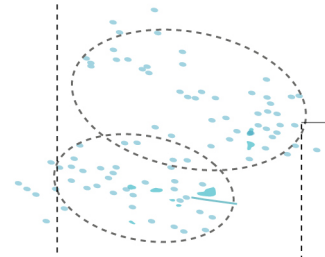
Landscape Scale

Kuei-Tso, Chen

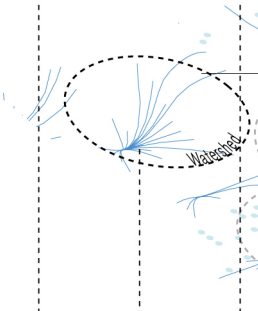
Water system



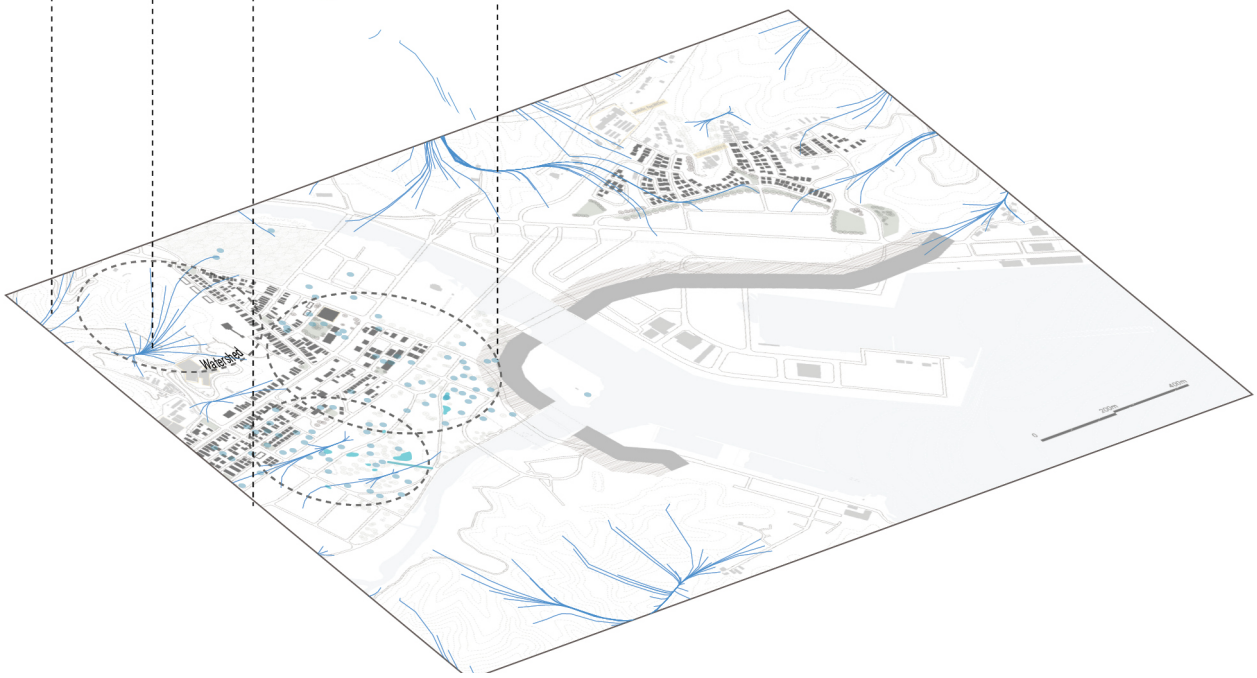
The pond can storage 71400m3
amount of water, asume that there are 4 members in a family and the water consumption average is 0.15m3
It can provide bout 11900 families for ten days

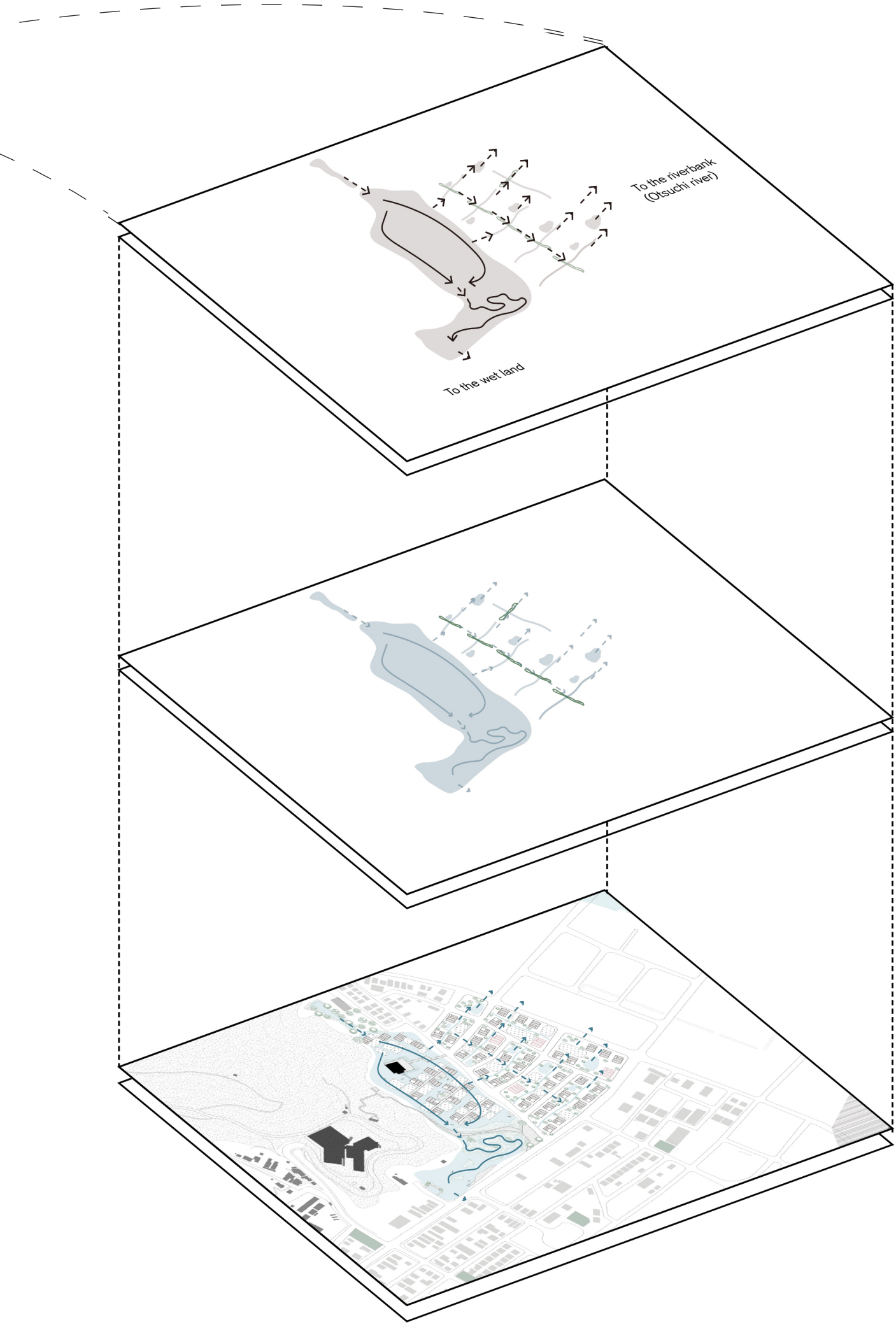


Most of the spring water can be seen in those areas which can be storaged for both daily use and after the disaster



Annual rainfal: 1392mm
Area: 84480 m2
84480*1.392=117596 m3




To the riverbank
(Otsuchi river)
To the wet land


A
Temple
Purification area
Floating Island
Floating farm
Platform
Farmland
Grass ditch
Island
Shelter
N
02
5
50
100
M


A‴
B‴
B‴

Normal sitaution

Floating community



Matsu



Quercus serrata



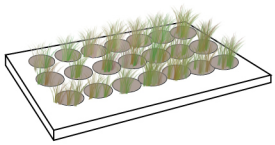
Chamaecyparis



Water bamboo



Nampyeong



Flo
eff
bio



Masu salmon



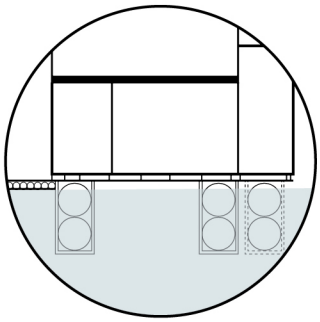
Sweetfish



sardin

Hiking trail

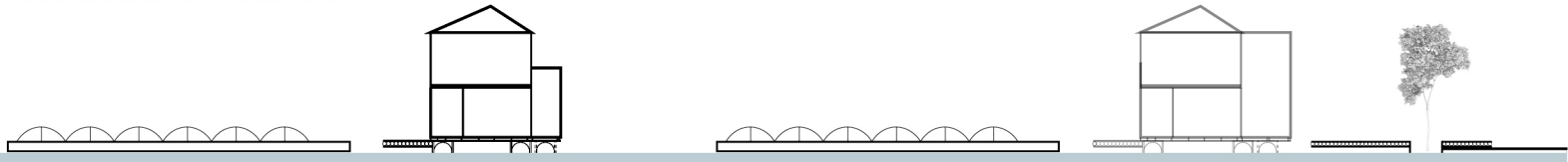
Float farming





Japanese black pine

oating rice-culture system assimilated nutrients
ectively. Nutrient- and organic compound-rich rice
omass can be a resource for animal feed.



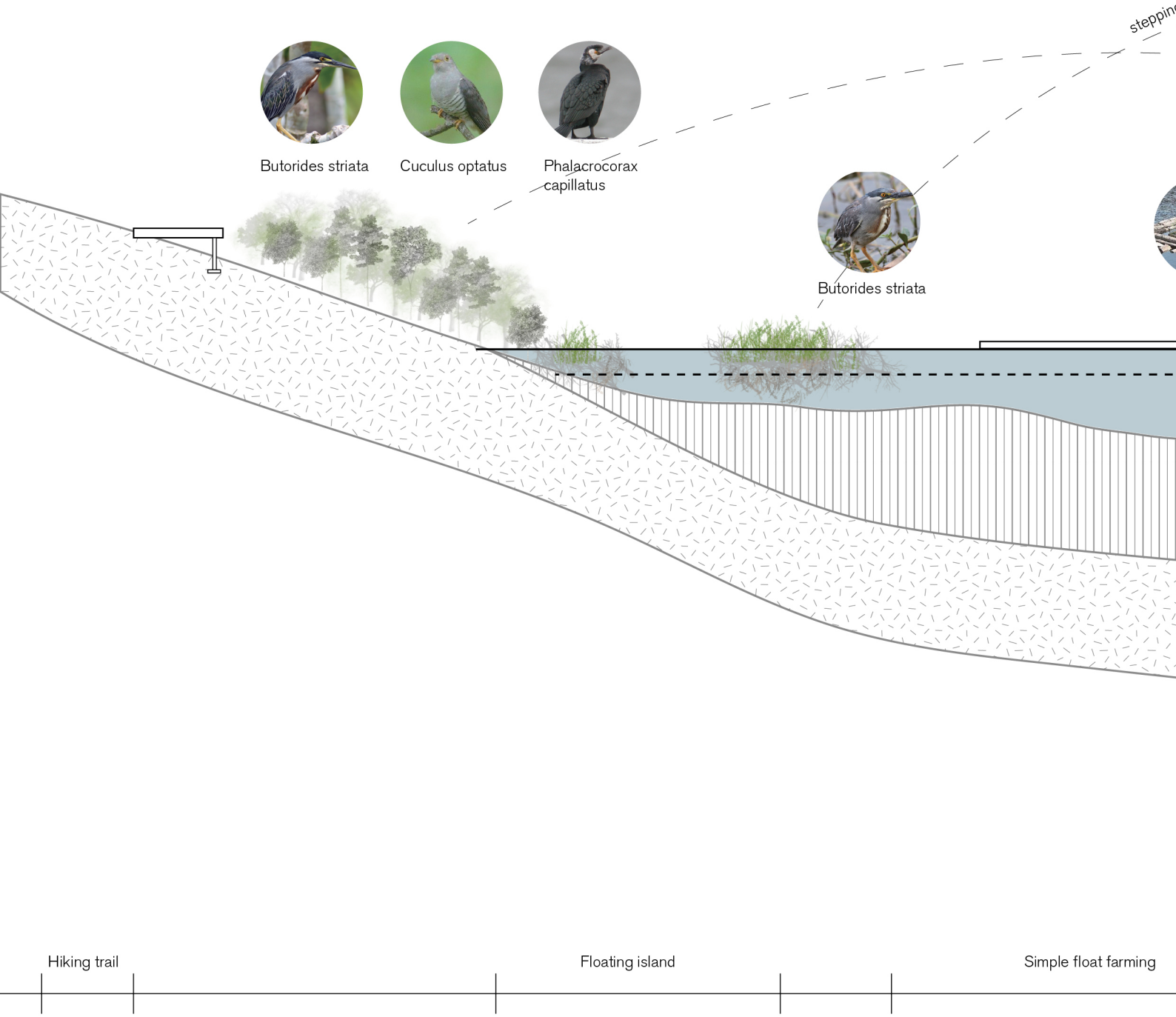


e

/ Aquaponics | Floating House | Floating farming | Floating platform

Section A-A" Scale: 1/500

If tsunami comes
Floating community



g stones into urban district then connect with riverbank and sea.



Simple floating made by trunk or bamboo
after the original structure were damaged

Some floating islands might be seen after the flood.
It could be formed by debris or tree trunk
And some new species might be brought into this area.
It can also become stepping stones into urban district
then connect with riverbank and sea.

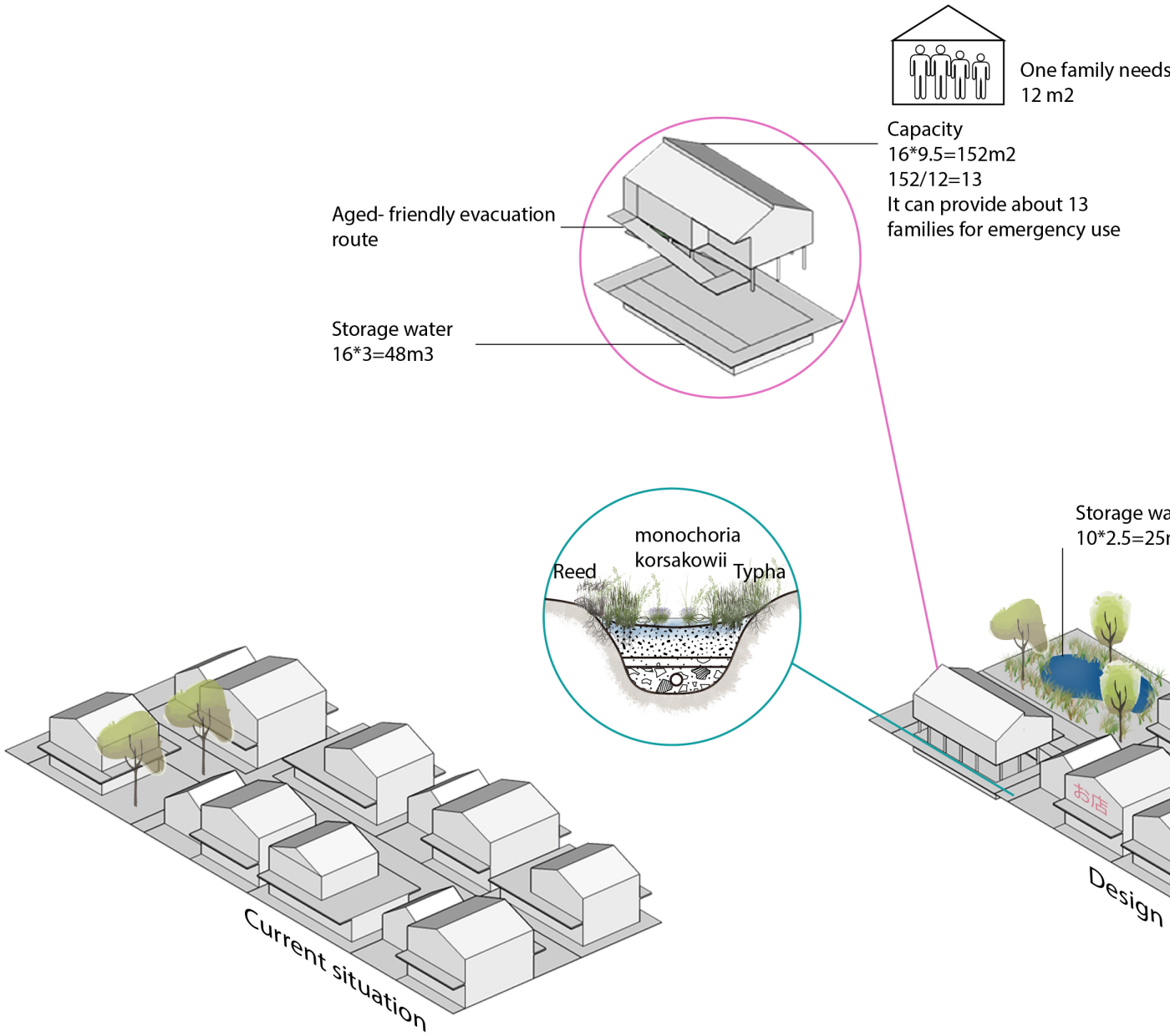
Raise about 2-3 m

Floating House | Floating island | Floating House

Section A-A" Scale: 1/500

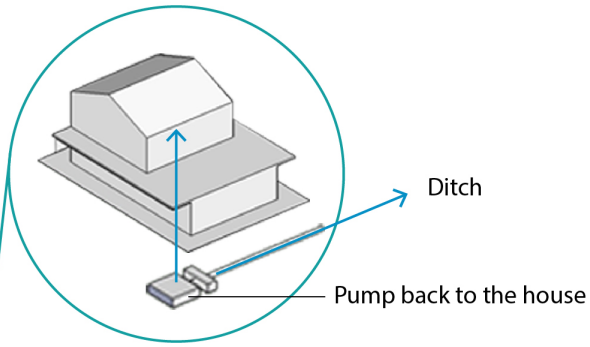
Block composition

Regular community



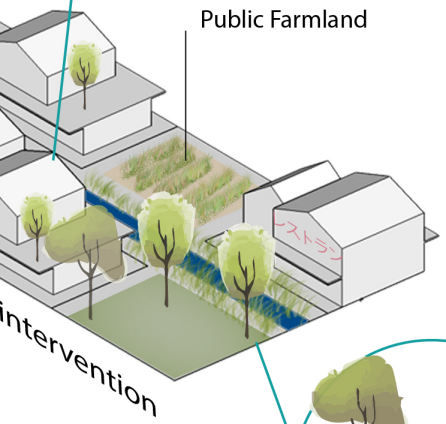
In the current situation, there is no chance for the ecosystem to get involved with human.

After the intervention, there is n
neighborhood to create habitat
for daily use so that people can

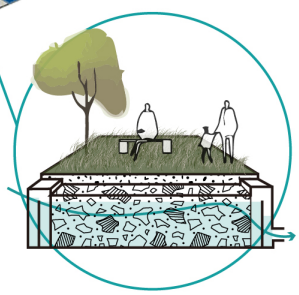


ter
m3

Public Farmland

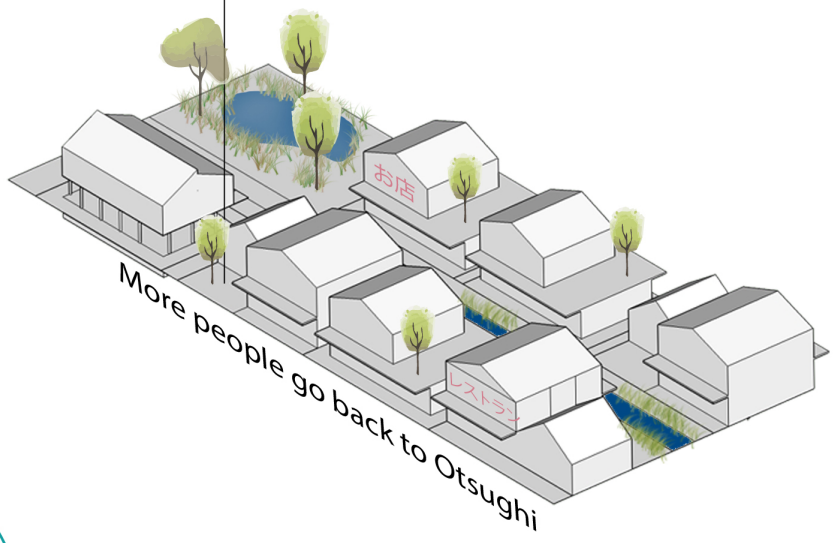


intervention



nore water in the
s and provide water
live with nature.

Personal garden



There might be some people go back to Otsuchi cause this town is gradusllly blooming. Some public spaces con become buildings again.(based on fold up city)



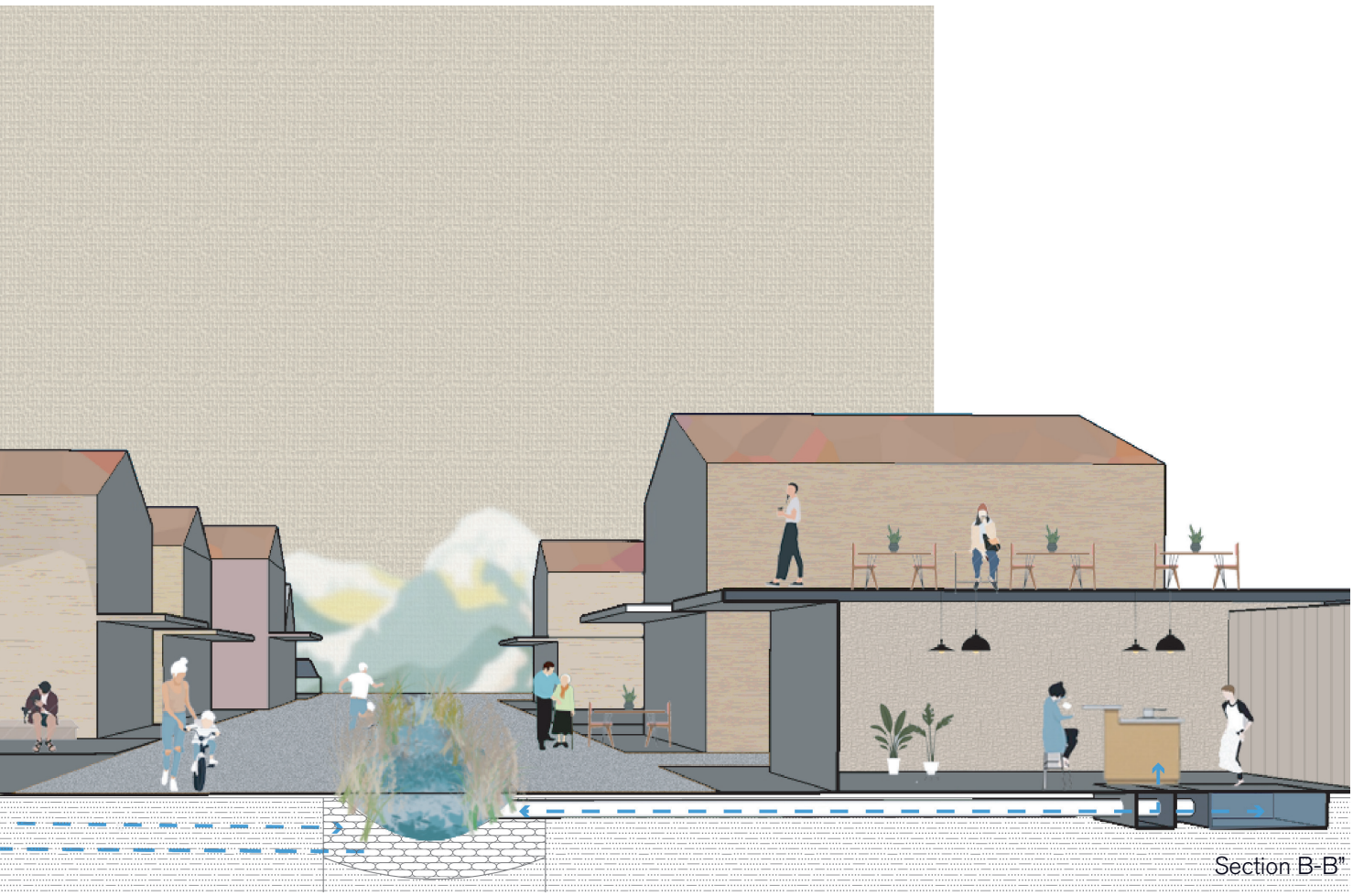


Regular community

Living in the regular community, people can still have srtong water and mountain. The end point will always face to the mountion. And in the community backyard, there is a community social farming garden in the block which can promote communication between different age groups.

Floating community

Even living at the foothill, the resident can still have strong connection with water which represents the Otsuchi bay landscape quality. So they will not feel life in prison anymore. Moreover, their own farmland is close to where they live. As time go by, some floating island will be seen on the waterbody so the landscape is changing with the time that might make the living experience more interesting.



Section B-B"

Mountain/

Water/

People



4.

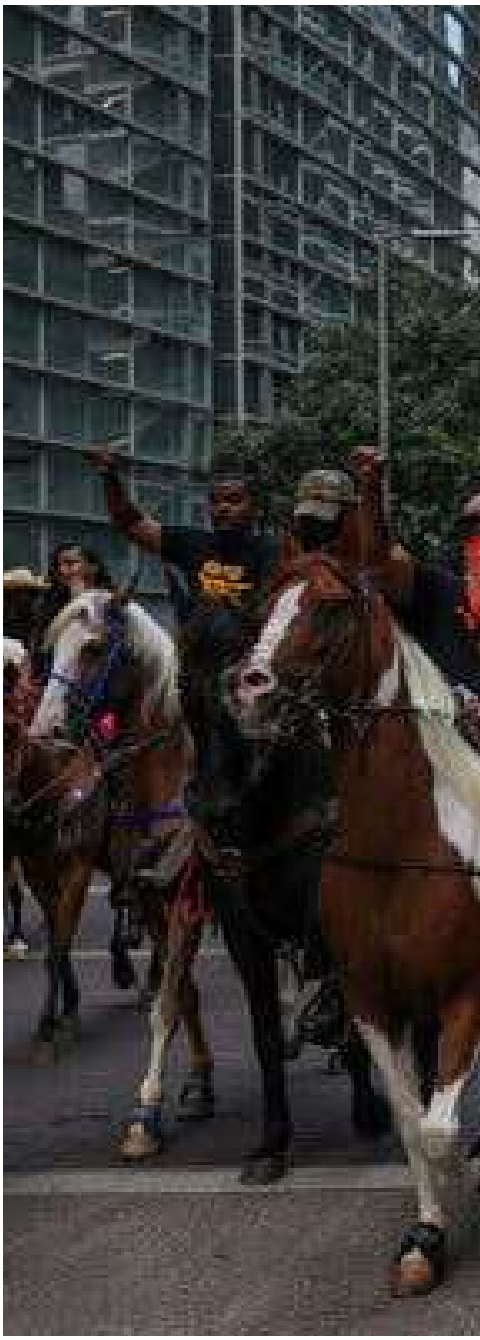
Houston, U.S.A.
Watch for high water

Resilient communities through regenerated ecosystems in the extreme urban environment of Harrisburg Manchester

Hadrien Cassan
Noa te Duits
Jurriënne Heijnen
Jeffrey Huisman
Stefan Vermeulen
Baokun Wei

2019—2020 IED
Infrastructure and Environment Design
July 2020





A warning sign warning for high water is half drouwned in the floodings of Hurricane Harvey.
Reprinted from The Chronicle, by M Ciaglo , 2017.



Black Lives Matter protesters on horseback in downtown Houston, protesting for social justice.
Reuters Reprinted from Reuters, by A. Latif, 2020.

1.

Introduction to Houston

The UEPEL research is aimed at renewing an urbanized area of the American city of Houston, Texas, by integrating parameters of the natural system as well as technological innovations into urban development opportunities arising from spatial planning and design. An integrated and multiscalar analysis of the East Houston's Magnolia Park and Harrisburg / Manchester area (at the confluence of the Brays and Buffalo Bayous) through the different perspectives of the urban, the landscape, the ecology, the systems, the infrastructure and the people, grasps the extreme environment that occurs and how it is experienced.

Different theory on ecosystem participation as a catalyst for healthy, climate-proof extreme urban environments provides an understanding of the relationship between human and nature and how this is affects the success or failure of urban [eco]systems. With the current increase in urgency of urban challenges and extremity of urban environments, four relevant scenarios are taken into account concerning the urban development. The analysis, literature review and exploration of four different scenarios, brought forth development guidelines to tackle the hazards that the extreme environment composes. They propose a vision for a balanced and less vulnerable urban area and aim to stimulate the synergy between design and engineering.

Amid the current global pandemic and [American] inequality issues, questions on the development of our urban social connections [to nature] and re-thinking our urban systems seem more relevant than ever.

Context and Problem Field

Houston is a large city of 2.3 million inhabitants (U.S. Census Bureau, 2018) in the Southeast of the state of Texas, U.S.A. and it is urbanizing at a rapid pace. The city, being located in the southern continental U.S., is situated closely to the gulf of Mexico, an area which faces several storms every year. Thunderstorms, hurricanes, tornadoes cause destructive winds and heavy rainfall, mostly during late spring until the end of the summer that lasts till november. The local climate can be defined as humid subtropical with monthly average temperatures between 35 and 24 degrees Celsius. (Weather-us, 2020).

The most prominent natural landscape features of the city include prairies and wetlands, as well as bayous slow moving brackish rivers and streams with a bidirectional flow. These watersheds, bayous and creeks all have their own floodplains. The adjacent coastal flat lowlands with clay and loam based underlying soil, make the surface unsuitable for quickly draining water into its soil (Kothuis, 2020).

The economy of Houston is moslty based on the oil-industry. Furthermore, the city is known for its medical hub, consisting of 61 medical institutes, the biomedical research and the aerospace sector. Amongst the leisure and hospitality sector, the two industries suffered a lot as 265.000 houstonians lost their jobs in the Covid-19 crisis (Bureau of Labour Statistics, 2020). Before the Covid-crisis, the Texas state is pressed by the political battle between democratic urbanised areas and republican hinterland in anticipation of the presidential elections of november this year (Houston Public Media, 2020).

At the confluence of two bayous, in proximity to the oil industy and the medical campus ly the Magnolia park neighborhoods. They are prone to flooding and pollution and are inhabited by socio-economic vulnerable Houstonians. The area therefore relates very much to current socio-economic issues and environmental challenges. Hence, here is a lot of opportunity in this area to improve the relationship and promote synergy between human and nature.

Problem Statement

Houston is dealing with extreme waters. Pressure of heavy rainfall, storm surge, subsidence and urban runoff as a result of saturated reservoirs lead to compound flooding. During the storm season, from June until November, extreme weather and storms cause several floodings each year and greatly impact communities and ecologies in the region. The main challenge to tackle in the Magnolia park neighborhoods is high risk and high vulnerability to the extreme environment of these floodings.

Urban flooding can result in the destruction of property with monetary or personal value, cause serious health consequences and even the loss of life (Slides, Baukje). In 2017 Harrison County was hit by hurricane Harvey and faced with a 70% flooding of the area and 36 deaths. (Denham & Baker). Houstonians all experience risk, as most live in very flood prone areas. Their vulnerability to this risk however, depends not only on location but on socio-economic status as well.

Destructive consequences of these extreme shock events cause long-term stress on Houston. For example through damaged transportation systems. There is the short term impact of the loss of emergency access and the access critical facilities such as hospitals. However there are also long term socio-economic impacts of the failure of the transportation network (Slides, Baukje).

Historically, the Harris County government has been most involved in flooding adaptation and mitigation policies. However, Texas state and U.S. federal governmental systems are all involved in flooding management to various degrees and the boundaries overlap.

Therefore, promoting ecosystem participation to reduce risk and vulnerability in the Magnolia park area is not only a case of local interventions but one of regional and national governance as well.

2.

Research question & Theoretical framework

Aims of the Project

The aim of the intervention is to promote ecosystem participation in the Magnolia Park neighborhoods of Houston. More ecosystem participation can be a catalyst to improving adaptation to, and mitigation of the extreme environment. Meaning, less risk and less vulnerability for the Houstonians living in the flood prone bayou areas close to the polluting oil-industry.

As current [eco]systems are failing under the shock and stress of extreme flooding, a comprehensive, multi scalar analysis can provide new insights. An accompanying visionary but specific proposal for a more integrated [technical and natural] and more collective development approach might inspire vigor?a

To understand the context and the circumstances, analysis has been done on different scales and throughout different perspectives.

Research Questions

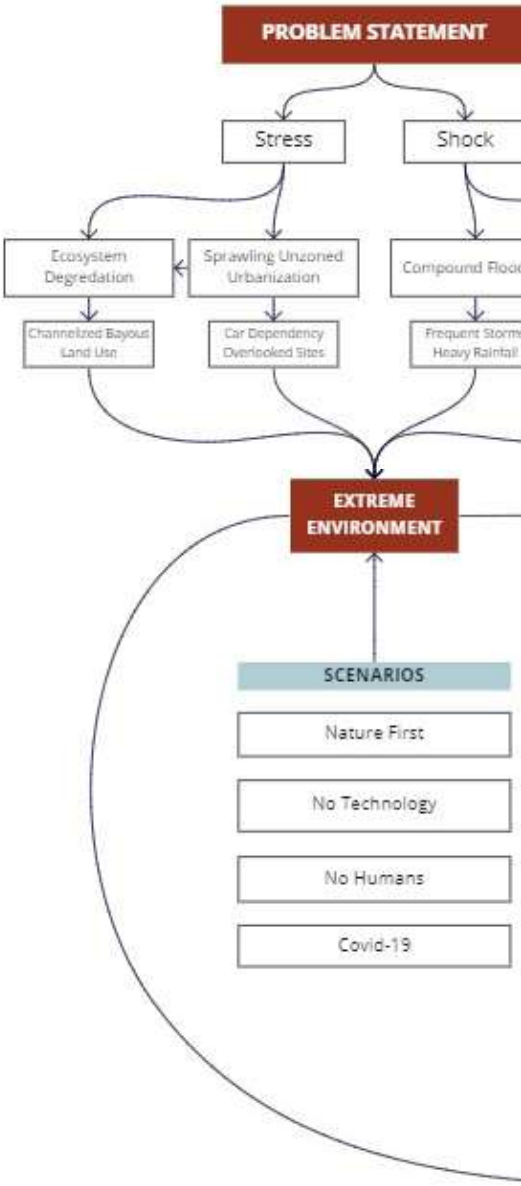
The main UEPEL research question “How can ecosystem participation work as a catalyst for healthy, climate-proof extreme urban environments?” is applied and specified to the Houston case. In the problem statement, context and problem field, the extreme environment is defined. Considering this extreme environment, the concept of ecosystem participation is in this case specified to participation on the societal level. Because this is an essential condition for participation in the environment in stress and shock circumstances. Therefore, the main question for the Houston case is as follows: “How can ecosystem participation (A) be used to bring synergy in dealing with socio-economic issues (B), ecosystem degradation and the natural hazard of flooding (C)?”.

A > B + C

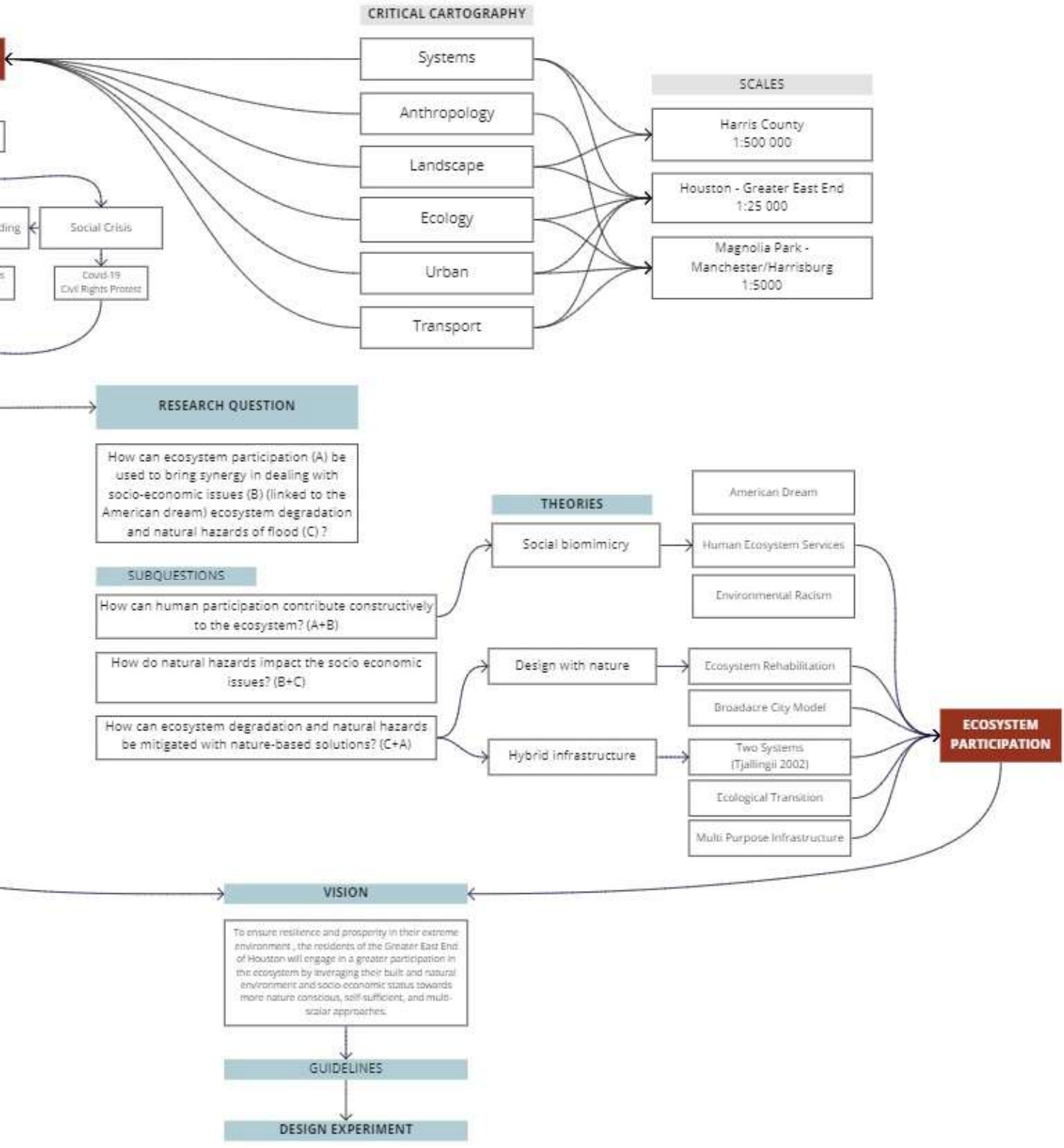
The spatial guidelines, manifestos and design experiments at the end of this chapter will propose interventions that promote ecosystem participation and synergy, in dealing with both socio-economic issues, ecosystem degradation and the natural hazard of flooding. To support the reasoning of the investigation the three theories of social biomimicry, ecological infrastructure and design with nature are adopted as the main theoretical framework.

The following sub-questions provide a structure for answering the main question through analysis and design:

- How can human participation constructively interact with the ecosystem? (A+B)
- How do the ecosystem and natural hazards impact the socio economic issues? (B+C)



Jurrienne


CRITICAL CARTOGRAPHY
Systems
Anthropology
Landscape
Ecology
Urban
Transport
SCALES
Harris County
1:500 000
Houston - Greater East End
1:25 000
Magnolia Park -
Manchester/Harrisburg
1:5000
Social Crisis
Covid-19
Civil Rights Protest
RESEARCH QUESTION
How can ecosystem participation (A) be used to bring synergy in dealing with socio-economic issues (B) (linked to the American dream) ecosystem degradation and natural hazards of flood (C) ?
SUBQUESTIONS
How can human participation contribute constructively to the ecosystem? (A+B)
How do natural hazards impact the socio economic issues? (B+C)
How can ecosystem degradation and natural hazards be mitigated with nature-based solutions? (C+A)
THEORIES
Social biomimicry
Design with nature
Hybrid infrastructure
American Dream
Human Ecosystem Services
Environmental Racism
Ecosystem Rehabilitation
Broadacre City Model
Two Systems
(Tjallingii 2002)
Ecological Transition
Multi Purpose Infrastructure
ECOSYSTEM
PARTICIPATION
VISION
To ensure resilience and prosperity in their extreme environment , the residents of the Greater East End of Houston will engage in a greater participation in the ecosystem by leveraging their built and natural environment and socio-economic status towards more nature conscious, self-sufficient, and multi-scalar approaches.
GUIDELINES
DESIGN EXPERIMENT
Stefan
Baokun
Noa
Hadrien

miro

- How can ecosystem degradation and natural hazards be mitigated with nature based solutions? (C+A)

A + B

The following theories provide insight in the concept of social biomimicry and how people can cooperate and organize themselves to be better integrated with the environment. As the principles of ecology are currently not manifested in the community of the urban and especially the local scale. A reconsideration of ecosystem services is in this respect very important, shift the paradigm from taking from nature towards exchanging with nature. The design should be focused on promoting the sense of stewardship within residents and visitors towards the environment.

Biomimicry is the search for design inspiration from the natural world (Benyus 1997; Passino 2005). We can learn a tremendous amount from the social insects about the organization of work, the mechanisms underlying collective behavior, and how to integrate from simple individual rules and local information exchange to the global construction of products, ideas and consensus. However, social insects and humans vary fundamentally in their consideration of the importance of the individual versus the group in decision making, and in answering the question of "what is effective colony function?" (Fewell, 2015). Nevertheless, we need to revitalise our communities – including our educational communities, business communities, and political communities – so the principles of ecology become manifest in them as principles of education, management, and politics. Communities should adopt such a pathway, and develop policies inclusive of all ecosystems, human and otherwise. We need to educate and ensure that policies address problems that affect all levels of the community, develop sustainable partnerships with industry, government and people. This also means involving school children, awaking in them a sense of 'stewardship' with their whole environment (French & Ahmed, 2011).

The ecosystem services that city residents depend on are found inside urban ecosystem as well as in ecosystem outside city boundaries (Alberti, 2015). To mitigate the effects, maximizing techniques for resources can be applied and nature based solutions are applied in city planning to restore the balance. (Elmqvist, Setälä, Handel, van der Ploeg, Aronson, Blignaut, de Groot, 2015) Mitigating effects through ecosystem based management helps to restore the balance between demand and supply of ecosystem services in urban ecosystems (De Valck, Beames, Liekens, Bettens, Seuntjens, & Broekx, 2019).

In his book, Design with Nature, Ian McHarg (1969) proposes integrated planning for ecology in the Landscape design practice. His emphasis on creating a rational, systematized design process expanded the fields of landscape architecture and

environmental planning, pulling practitioners out of gardens and small parks and into territorial-scale design. The book also provided a practical method for intervening in the land-use system - the layering of large, complex spatial data to make policy and design choices about a site's "fitness" or "suitability" for various types of development, conservation, and restoration plans (Yang & Huang, 2015). Ecosystem participation on the small local scale should be regarded within the larger system and vice versa.

B + C

The ways in which the ecosystem and natural hazards impact the socio economic issues are explored in the critical cartography. Theories on environmental racism and 'the american dream' ...

Many American cities are currently tackling 'sustainability planning,' a from of planning that aims to reduce greenhouse emissions. This is achieved by transforming urbanized areas from car- oriented spaces into more pedestrian friendly spaces, which results in increased density and more mixed- use development. For this to succeed policies are put into place that define urban – growth boundaries, for example through placement of greenbelts. Creating two forms of urban life in American cities 1) low rise and drivable suburban areas and 2) high density, walkable inner cities (O'Toole, 2013).

This second form of urban life is what Leinberger (2009) calls 'the Next American Dream'. The old one is geared toward drivable sub-urban areas, the new one toward the walkable urban development. Where the next American dream is seen as the sustainable and energy efficient alternative. He notes that although this might seem preferable, as it reduces chronic health conditions (for example asthma and obesity) and it provides a sense of community, it is prone to socio-economic segregation (Leinberger, 2009).

Another author that writes about social and environmental problems in relation to the principles of the American dream is Peter Calthorpe (1993). In his book, The Next American Metropolis, he focuses on environmental, social, housing, and traffic problems that characterize sprawl. He advocates for a change in the American Dream that is more guided by natural systems or humans needs. Right now most quality and placement of growth is dependent on cars, as it decides the scale of the city, streets and open spaces available. In his new American Dream, values as community, diversity, human scale and frugality are seen as the base principles of development within Metropolitan areas. In his book he provides concrete guidelines to achieve these principles (Calthorpe. 1993).

American cities have not only been shaped by changing approaches to urbanization

and modes of transport but also by racial and segregation policies which date back to as early as the post-slavery era and as late as the mid-20th Century with Jim Crow Laws, the practice of Redlining, and policies put forth by the Federal Housing Administration (Heathcott, 2015). These various urban development policies purposefully delineate neighborhoods which were considered less desirable (either flood prone or industry-adjacent) and especially to concentrate vulnerable socio-economic communities (mostly African-Americans and non-white immigrants) which were thought to bring blith to communities. These laws made it seemingly impossible for middle-class families to gain loans or insured mortgages for houses outside those sharply drawn lines, establishing generations of vulnerable communities in these less-habitable areas of the city, and unabling capital and equity accumulation.

Houston, although being coined as the largest “unzoned” city in the US was actually influenced by these racial planning practices in the early 20th Century. An old map of the city shows the concentration of african-american community (colored in the map legend) west of downtown where upstream flooding was more prone to occur. Similarly, areas to the East of Downtown along the Buffalo Bayou (now composed of large polluting industries) was also ‘reserved’ for these more vulnerable communities. These segregation practices are not only a social problem but and environmental one. Environmental racism, first coined with the 1987 United Church of Christ Commission for Racial Justice report “Toxic Wastes and Race in the United States”, refers to actions or policies by public or private actors that disproportionately harm persons of color or disadvantaged racial groups (Vanderheiden, 2011). Today, communities of color in Houston most often border large industrial complexes, which has had significant health consequences and has only been worsened during the Covid-19 pandemic (Harvey Wingfield, 2020).

C + A

The following theory provides insight in mitigation of ecosystem degradation and natural hazards through natural solutions and insight in the transition toward ecological infrastructure. The guidelines are based on these concepts and provide a (spatial) framework for the ecosystem-participation promoting proposals.

This transition is complex compared to traditional transitions for 3 reasons (Geels, 2011). Firstly, the sustainability transitions seems goal-centered instead of emergent. Secondly most of the sustainable transitions are not able to offer as much obvious benefits as than the current one. Thirdly, it has a relationship with practical domains. It is reasonable to apply a MLP (Multi-level Perspective) approach (Geels, 2011) to analyse the question with three key concepts which compose a non linear process: social technical regime, niche development and social technical landscape. In order to provide specific context for ecosystem participation, it is limited to the goal of transition as ecological infrastructure planning and design.

While Nature Based Solutions have significant potential to be a major influence in flood mitigation and the will for implementation exists, multidisciplinary work is necessary for implementation (Sutton-Grier et al., 2015). As the notion of NBS is still relatively recent, accurate quantifiable data is still lacking but the added benefits of such flood defence projects is clear: adaptable, regenerative, ecologically enhancing… (Gill, et al., 2007). Benefits of NBS have been properly qualified through the three systems looking precisely at ecosystem services, co-benefits, and suppressed trade-offs (of grey infrastructure) (Bush and Doyon, 2019 ; Sutton-Grier, et al., 2015 : Chelleri et al., 2015).

Broadacre City was a conceptual development scheme put forth by Frank Lloyd Wright in the first half of the 20th century, which looked at given American Families a one acre plot of land (0.40 hectares) for personal and productive use (Pimlott, 2011). The plan proposed an alternative to urban living influenced by the freedom of the automobile and the possibilities of private property. Houston loosely mirrors FLW's vision while disregarding key principles such as the self-sufficiency of each block and the decentralized productive area. By looking at the potential for Houston's residential block structure to incorporate more mixed programs - making neighborhoods as productive as they can be. Moreover, a consideration would have to be made to promote multi-mobility as oppose to a car-dependent vision FLW promoted.

According to Tjallingii (2002) the development of ecologic quality is connected to human participation with the water network, which carries the 'low dynamic' recreational activities. The water network provides in ecosystem services such as water quality and recreation. The 'high dynamic' economic activities are carried by the infrastructural network. The activity of living is the in-between and connecting activity. The synergy between living and the natural water systems is achieved through recreation and maintenance. He proposes the spatial clustering of high and low dynamic activity and separating systems by their functionality. By connecting and the separation of working (infrastructure), living and recreation (water), eco-system participation can be facilitated as a synergy between living and recreation can be achieved (Tjallingii, 2002).

Transport infrastructure systems have often become a large part of natural landscapes. They provide economic and spatial advantages but also have an impact on local ecosystems and its dynamics. It is therefore important to find a balance in these flowscapes, regard the landscape as infrastructure and infrastructure as landscape.

3.

Critical Cartography

Process of collecting data

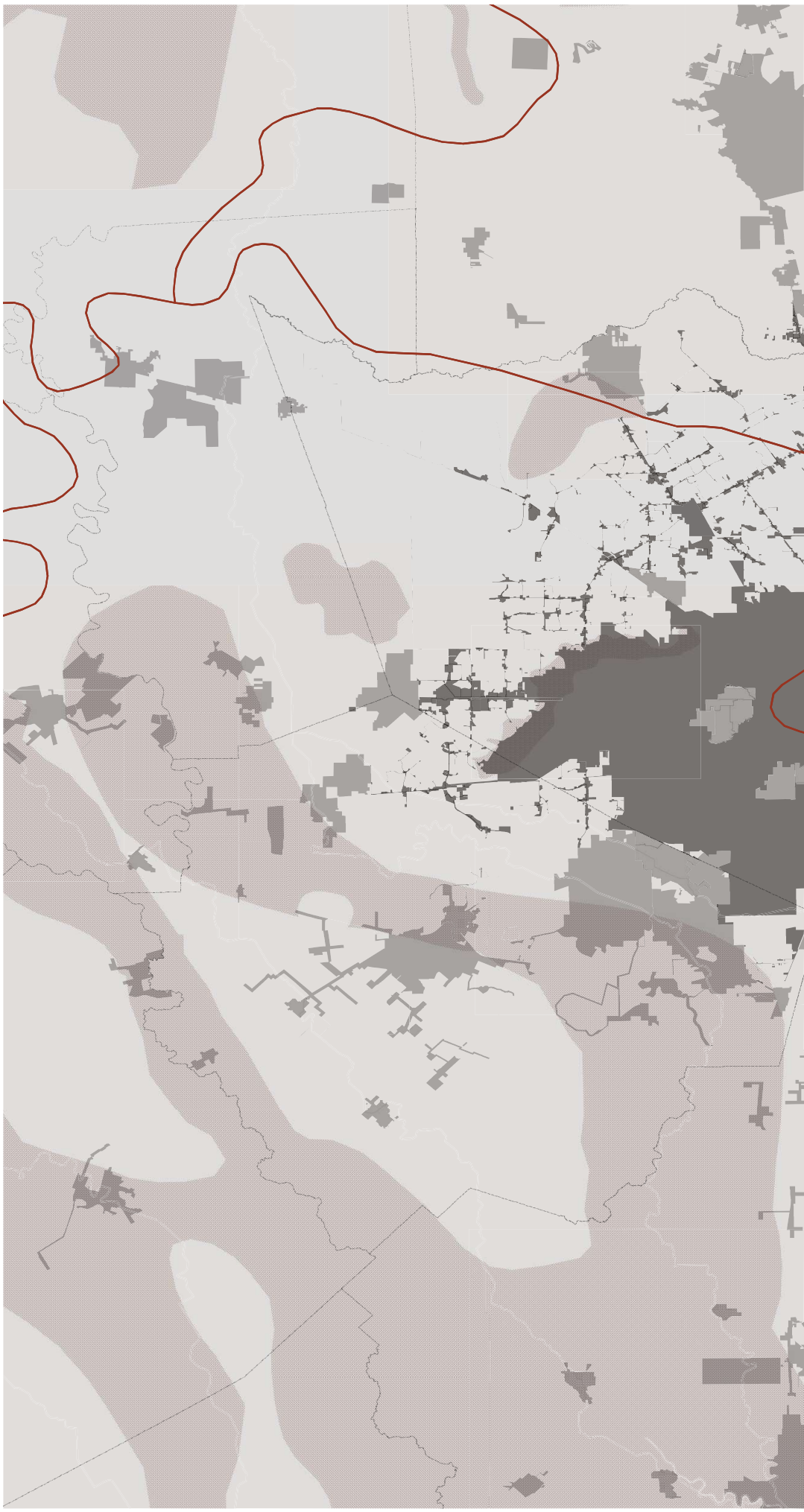
In order to form a solid scientific knowledge base for the design proposals, different methods of collecting data are used. Literature reviews of several topics concerning ecosystem participation form the theoretical framework. They elaborate on methods and theories proposing a better relationship between human and nature in extreme environments.

In order to consider these theories and concepts in the context of Houston, data was collected on the perspectives of landscape, ecology, systems, urban, anthropology and transport, infrastructure and logistics. This data was subdivided in three scales, the territorial, 1 : 500 000 covering the Harris County area, the urban, 1 : 25 000 covering the city of Houston, and the local scale, 1 : 5 000 covering the Magnolia Park and Harrisburg / Manchester neighborhoods.

A Multiple database collection approach was taken and in which GIS data was used by all perspectives in the context analysis. Furthermore, governmental reports, academic research, historical surveys, newspaper articles, and personal logs are used to comprehend the attributes, development, and experience of the extreme environment of Houston. This multi perspective data collection approach provided useful insights in the overall social and environmental systems of the extreme environment of Houston.

3.1.

Systems of Systems



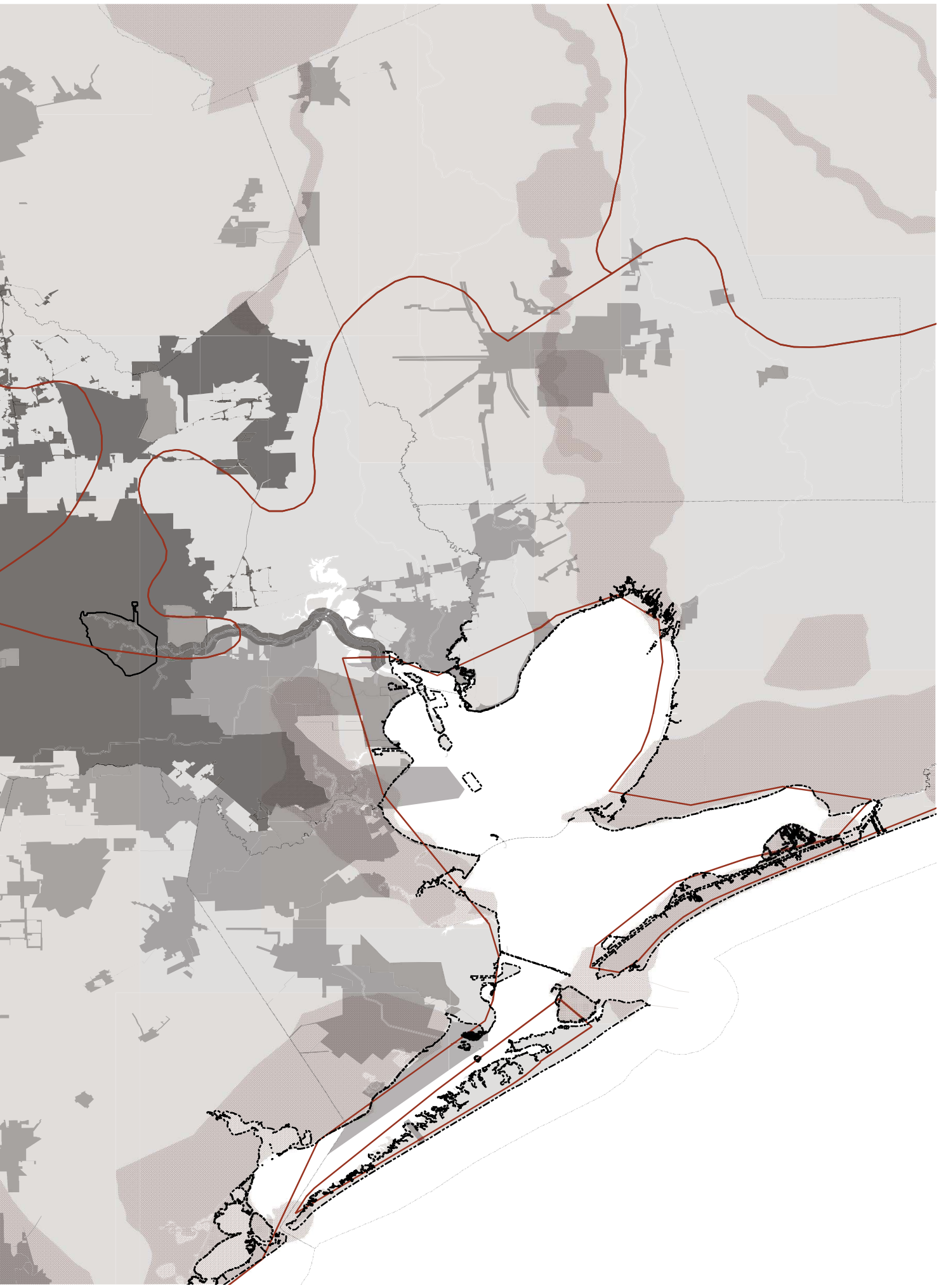
Political vs Ecological borders

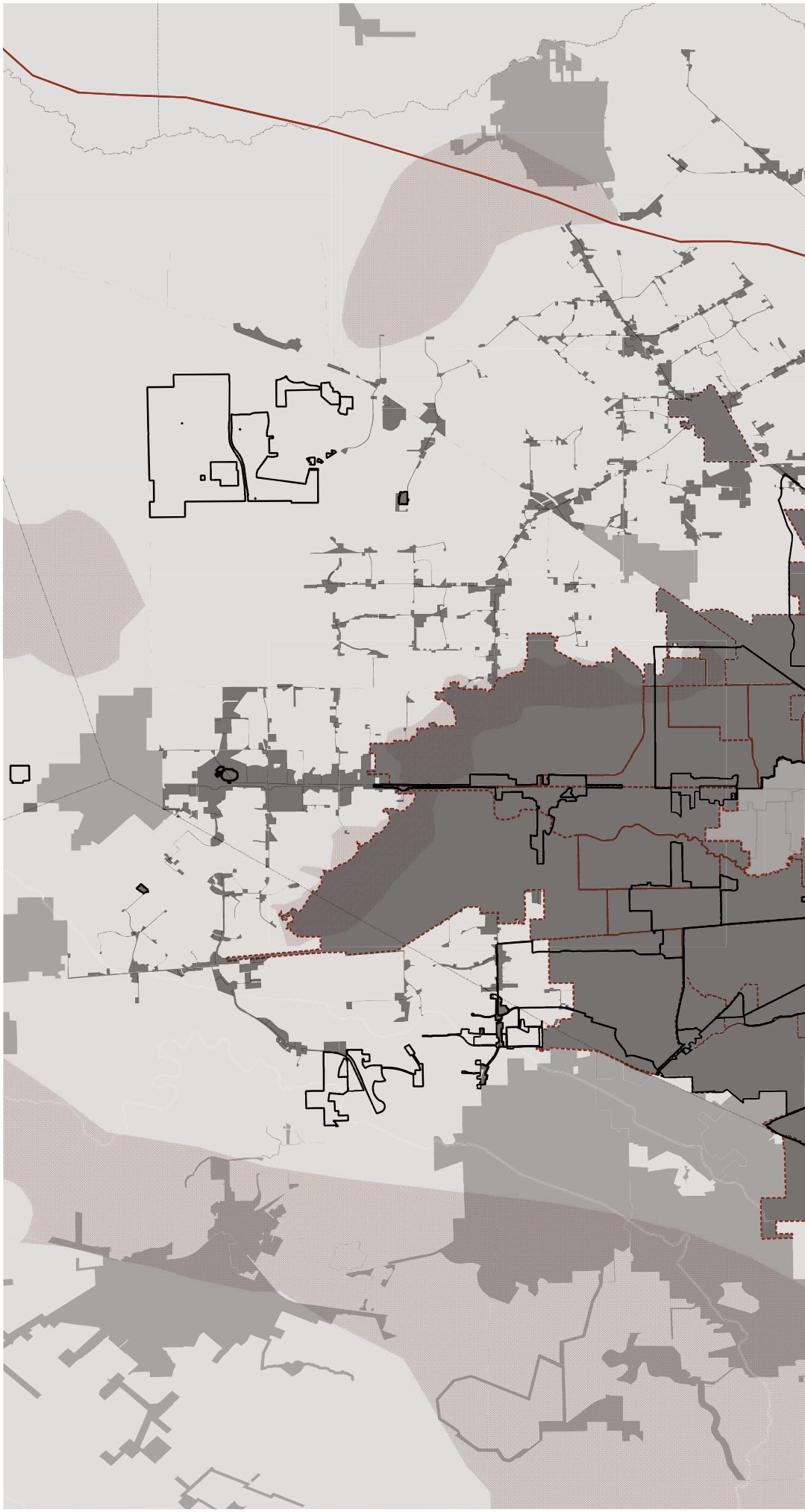
This map shows the potitical borders, the counties and cities, in relation to the Ecological borders, ecoregions and nature reserves.

- County border
- Great East End
- Coastline
- Ecoregions
- City of Houston
- Other cities
- Nature reserves

N

0 500 km





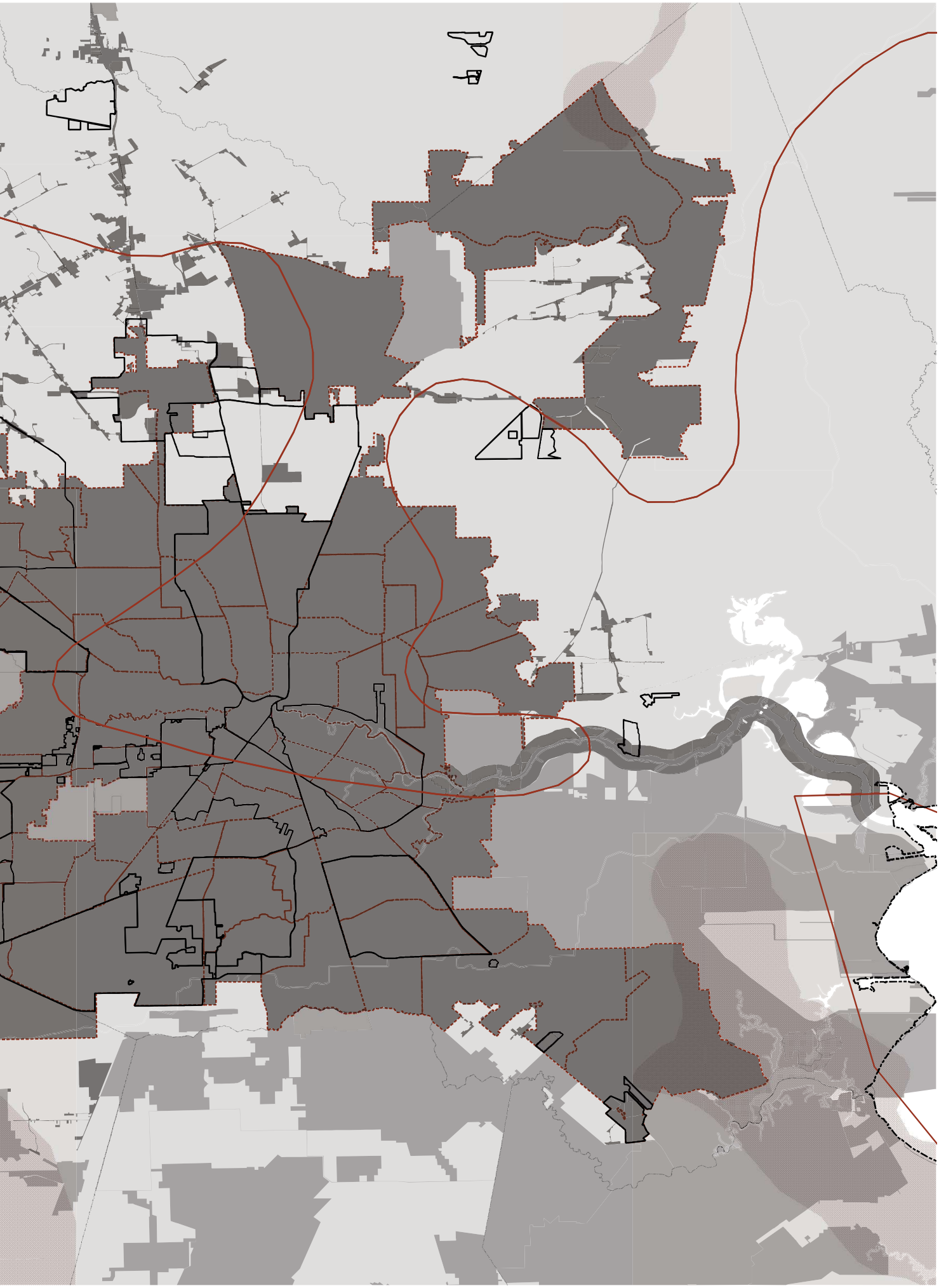
Political vs Ecological borders

This map shows the potitical borders in relation to the ecological borders on a city scale, it shows also the neighborhoods and district.

- County border
- Management districts
- Neighborhoods
- Ecoregions
- City of Houston
- Other cities
- Ecoregions

N

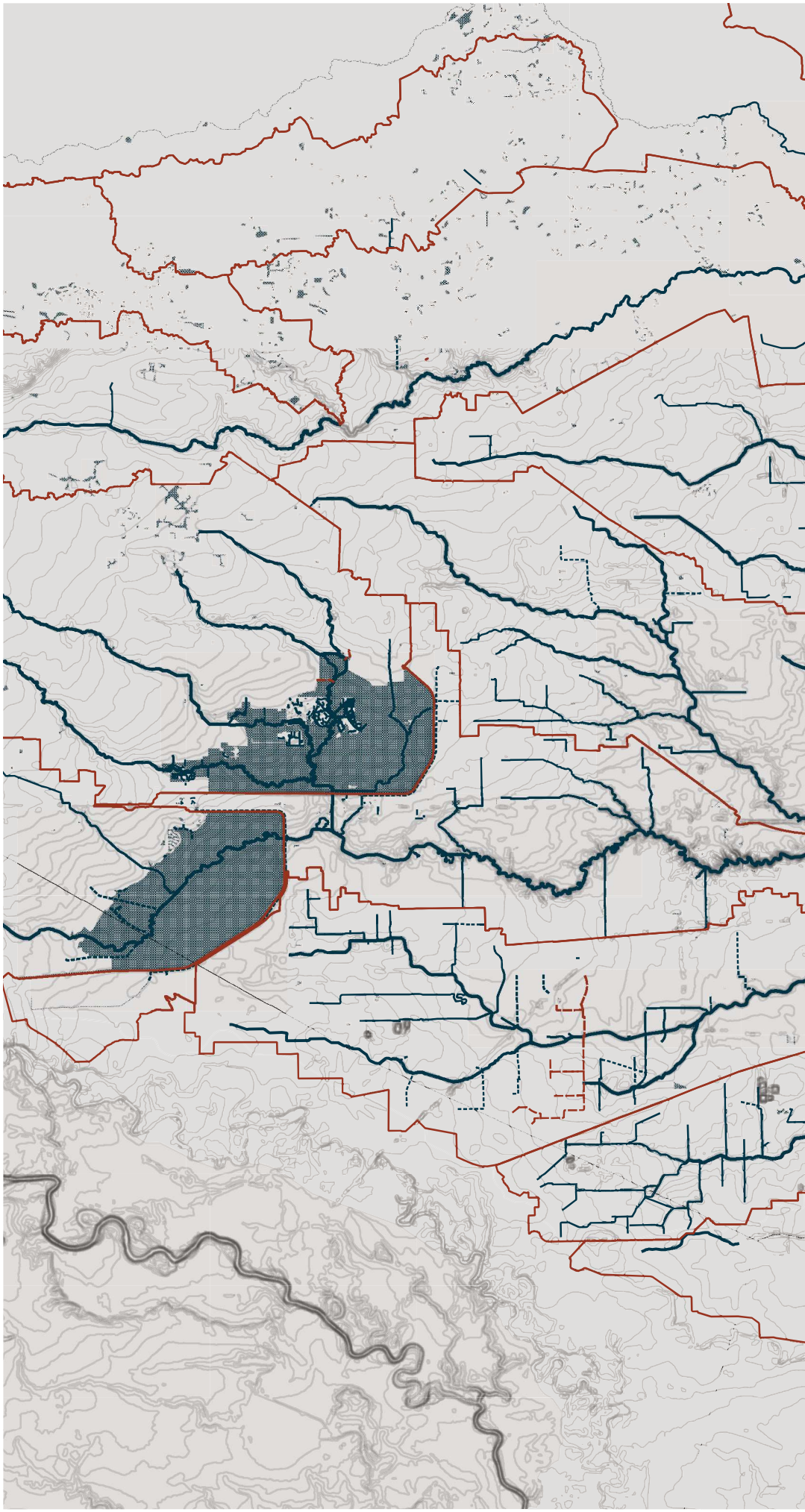
0 250 km



Political vs Ecological borders

The city of Houston is in the southeastern part of Texas. The city covers almost the whole Harris County, but Greater Houston extends also to Galveston County, Brazoria County and Fort Bent County. The city of Houston is the largest in the area, Sugar Land, Baytown and Pasadena are suburb cities to Houston. The city is divided into several management districts, which all consists of different neighborhoods. The Magnolia Park and Harrisburg/Manchester area is located in the district Greater East End.

The southeastern part of Texas could be divided into different ecoregions. NA0701: Gulf Coast Prairies and Marshes, reaches all over the coastal area. Houston is located on the border of this ecoregion, together with NA0522: Upper West Gulf Coastal Plain, which reaches into the city from the north. Nature reserves which surround the Houston area are the Columbia Bottomlands, Galveston Bay Prairie Complex and the Addicks-Barker Prairie Complex. More on this topic could be found in the critical cartography of the ecology perspective.



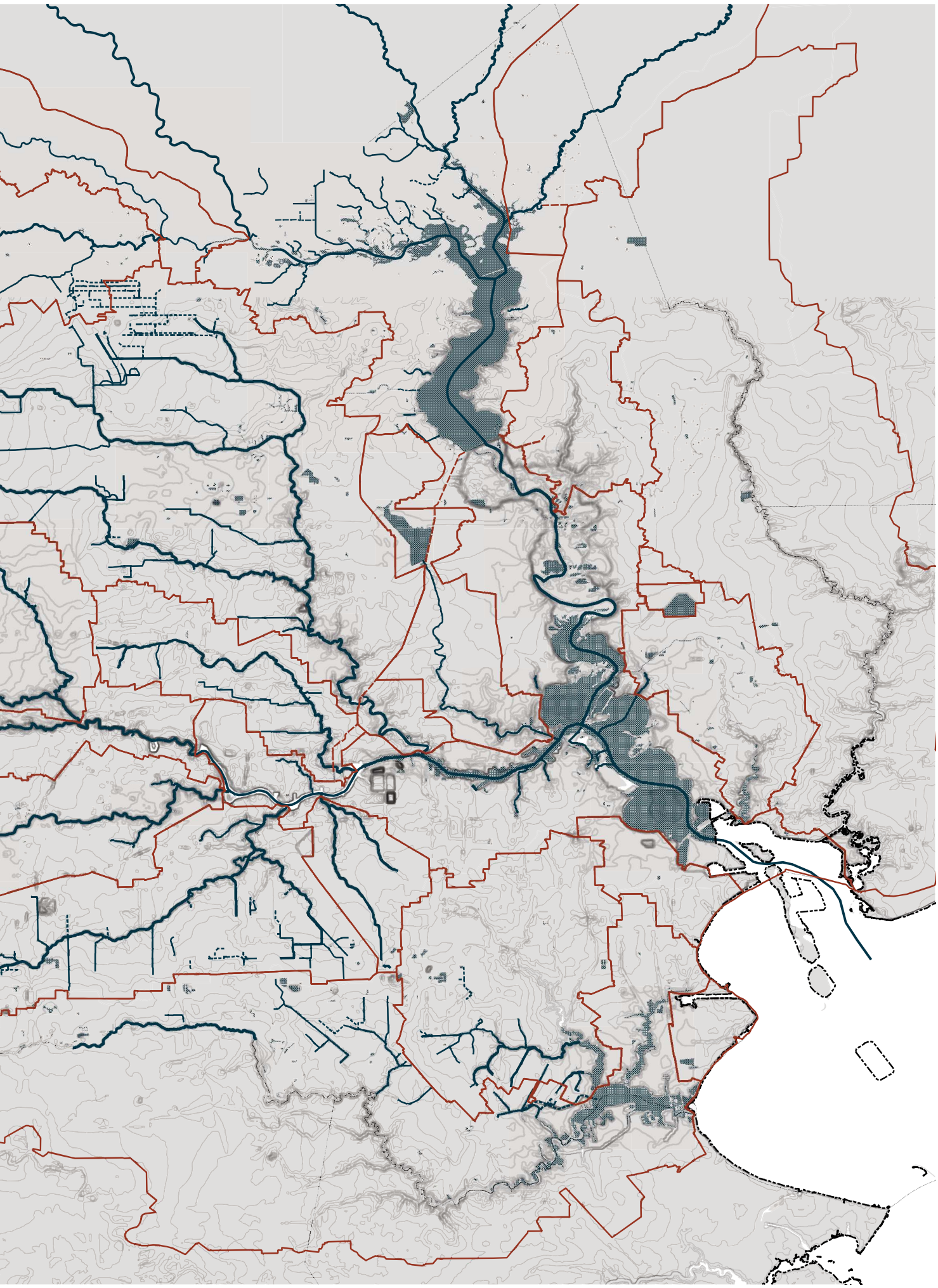
Natural System

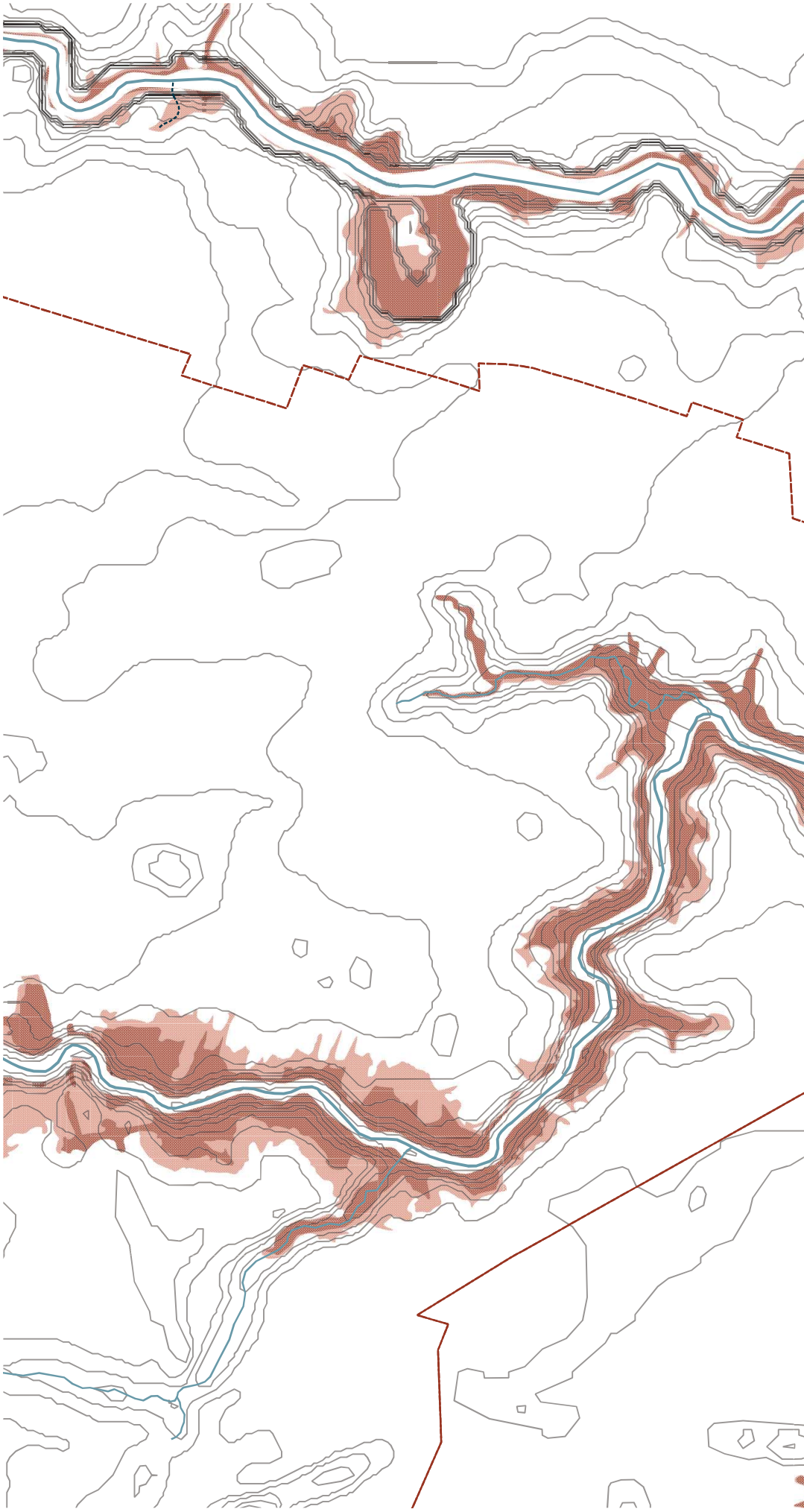
The Harris County consists of ditches, drains, streams leading into the bayous. The bayous eventually flow into the bays. The Two waterbodies in the eastern part of the city are the Addicks and Barker reservoir. The watersheds are also shown in this map

- Rivers/bayous
- Streams
- Drains
- Ditches
- Watersheds
- Heightlines
- Waterbodies

N

0 250 km





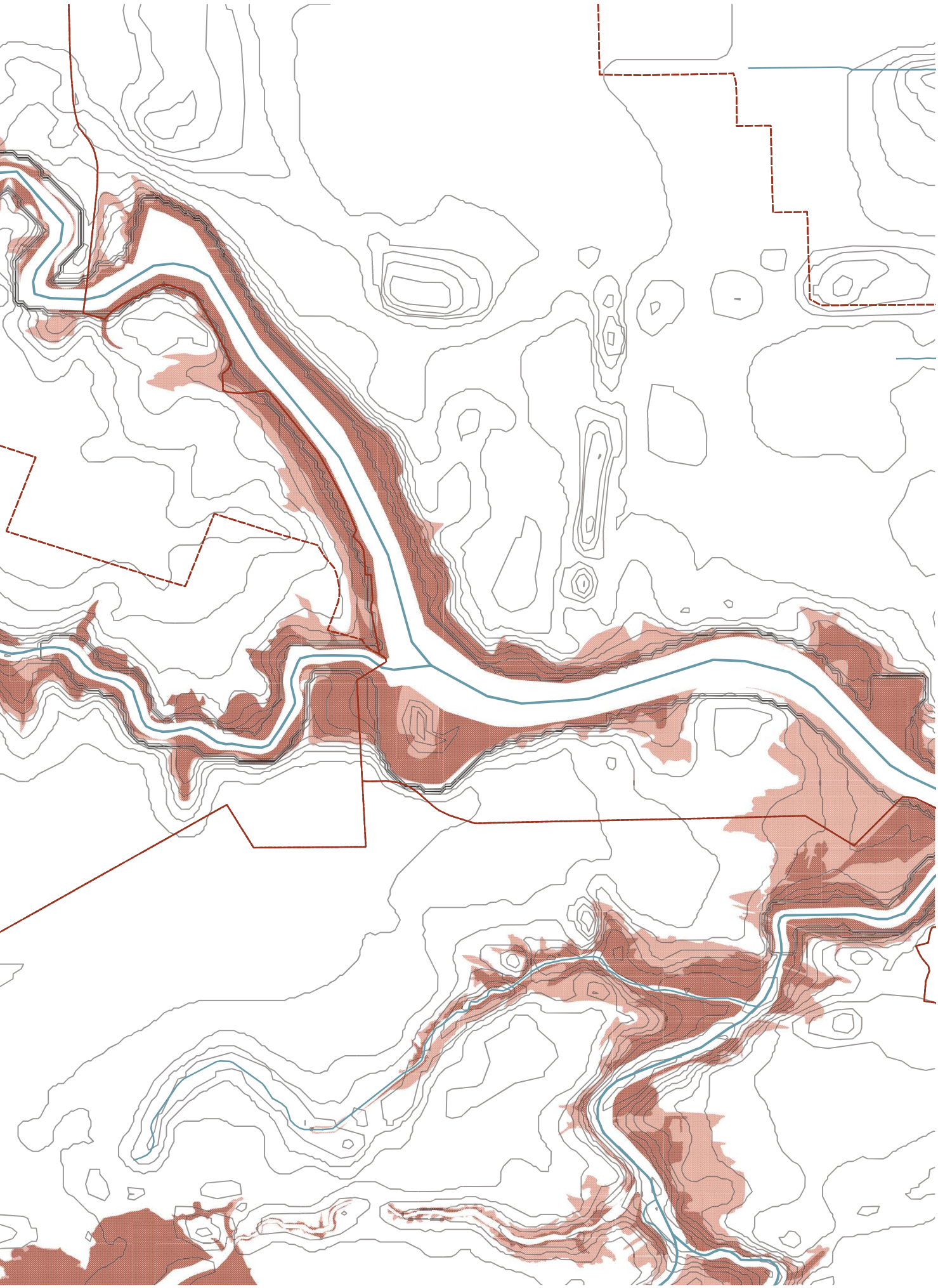
Natural System

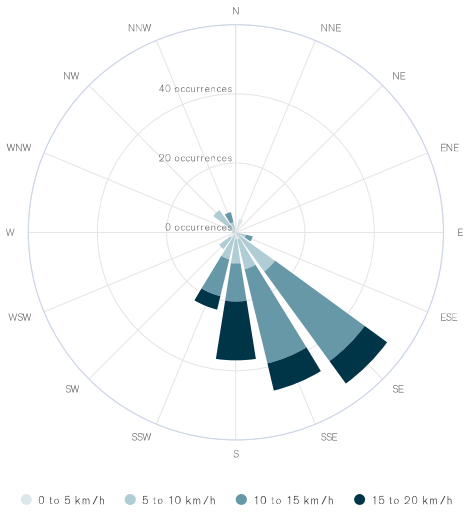
This map shows the Brays Bayou, the Buffalo Bayou and the Sims Bayou and their 100/500 year flood plain.

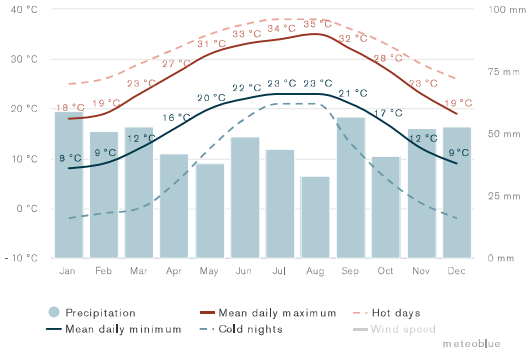
- Rivers/bayous
- Streams
- Watersheds
- Heightlines
- 100 year flood plain
- 500 year flood plain

N

0 100 km

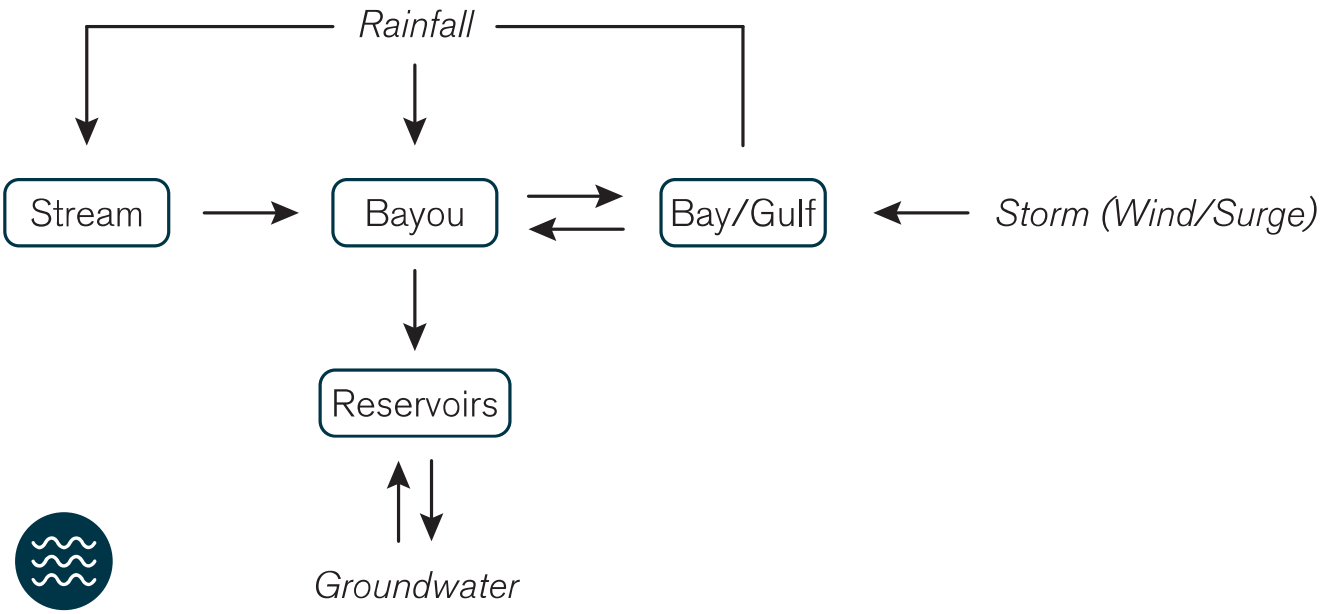






Climate schemes

Source: Meteoblue, redrawn by Vermeulen



Water flowscheme

Natural System

The flow schemes show the water and climate system in Houston, with water pressure from all sides on the Bayous. The pictures represent different parts of the system.



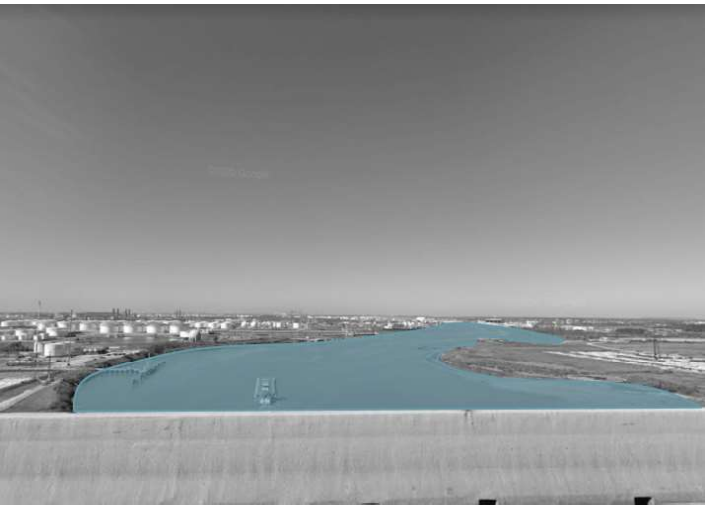
Water stream



Buffalo Bayou



Brays Bayou



Buffalo Bayou (downstream)



Tabbs Bay

Natural System

The city of Houston is located in an area of bayous. The Buffalo Bayou runs form the western to the eastern part of the city. The White Oak Bayou, the Brays Bayou and the Sims bayou merge into Buffalo Bayou which eventually flows into the Galveston Bay. The different Bayous are supplied by ditches, drains and streams witch flow through the whole city. In dry periods, these streams can stand dry, but during the rainy season there are of good drainage use. Houston has a Humid Subtropical Climate with hot humid summers and cold/mild winters.

The extreme weathers, like tornados, tropical cyclones, and hurricanes, which come with this climate are no exception in Houston. With an average southeastern wind direction water from the Galveston Bay is pushed into the bayous during severe storms. Together with the rainfalls and emerging groundwater this puts a lot of pressure on the bayous. In the eastern part of the city two reservoirs, the Addicks and Barker reservoir, are for floodwaters during such events. However, during the Harvey hurricane, the reservoirs where not able to storage all water and parts of the city still flooded.

The Magnolia Park and Harrisburg/Manchester area is located next to the confluence of the Buffalo and Brays Bayou. The Sims Bayou is located more south, but the borders of the three watersheds cross the area. The part near the confluence has a 100 year floodplain, because of the water pressure on the Bayous this area overflows a lot. Alongside all three bayous 100 year floodplains cover the area, and at some places even the 500 year floodplain.



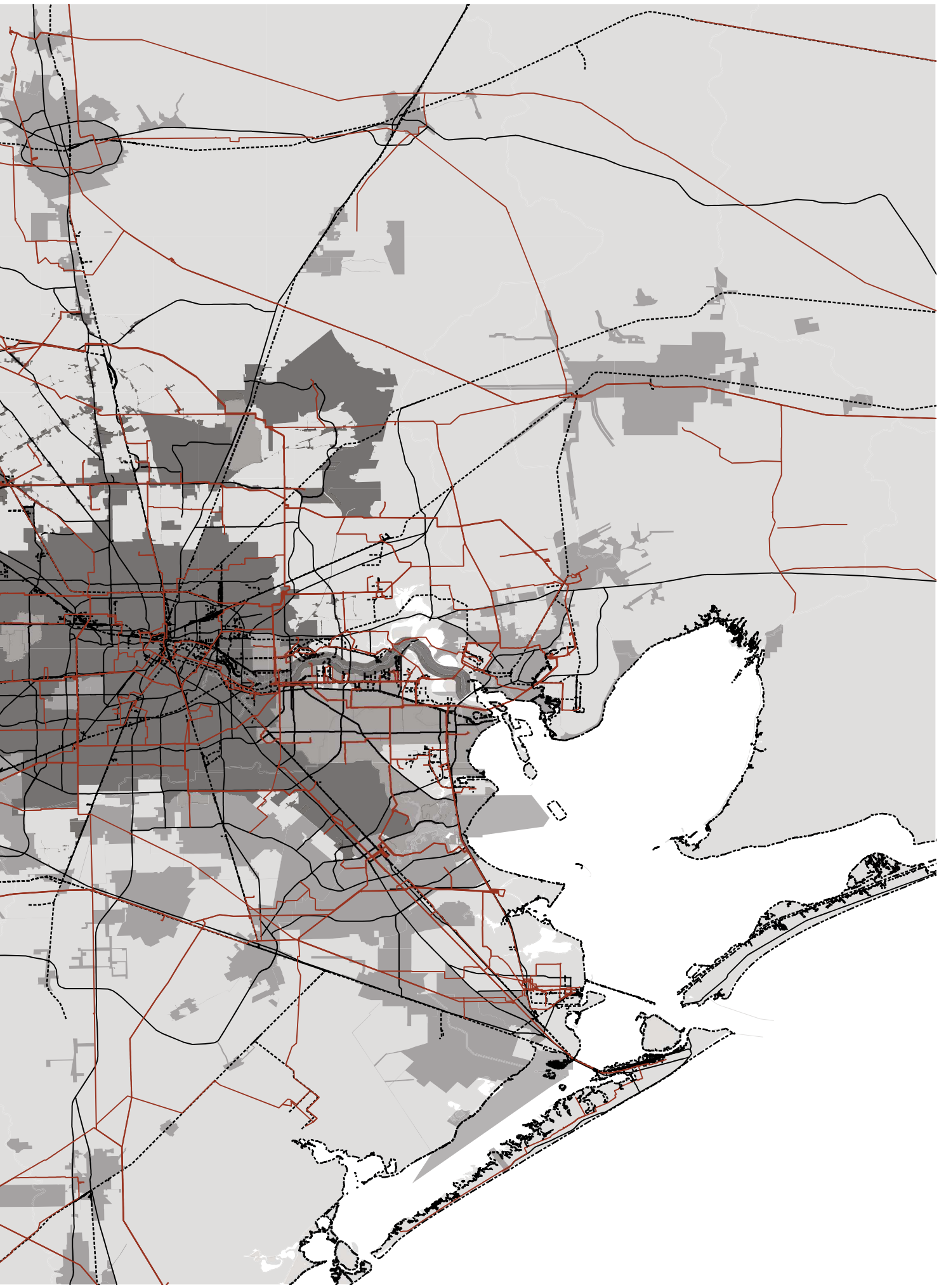
Networks

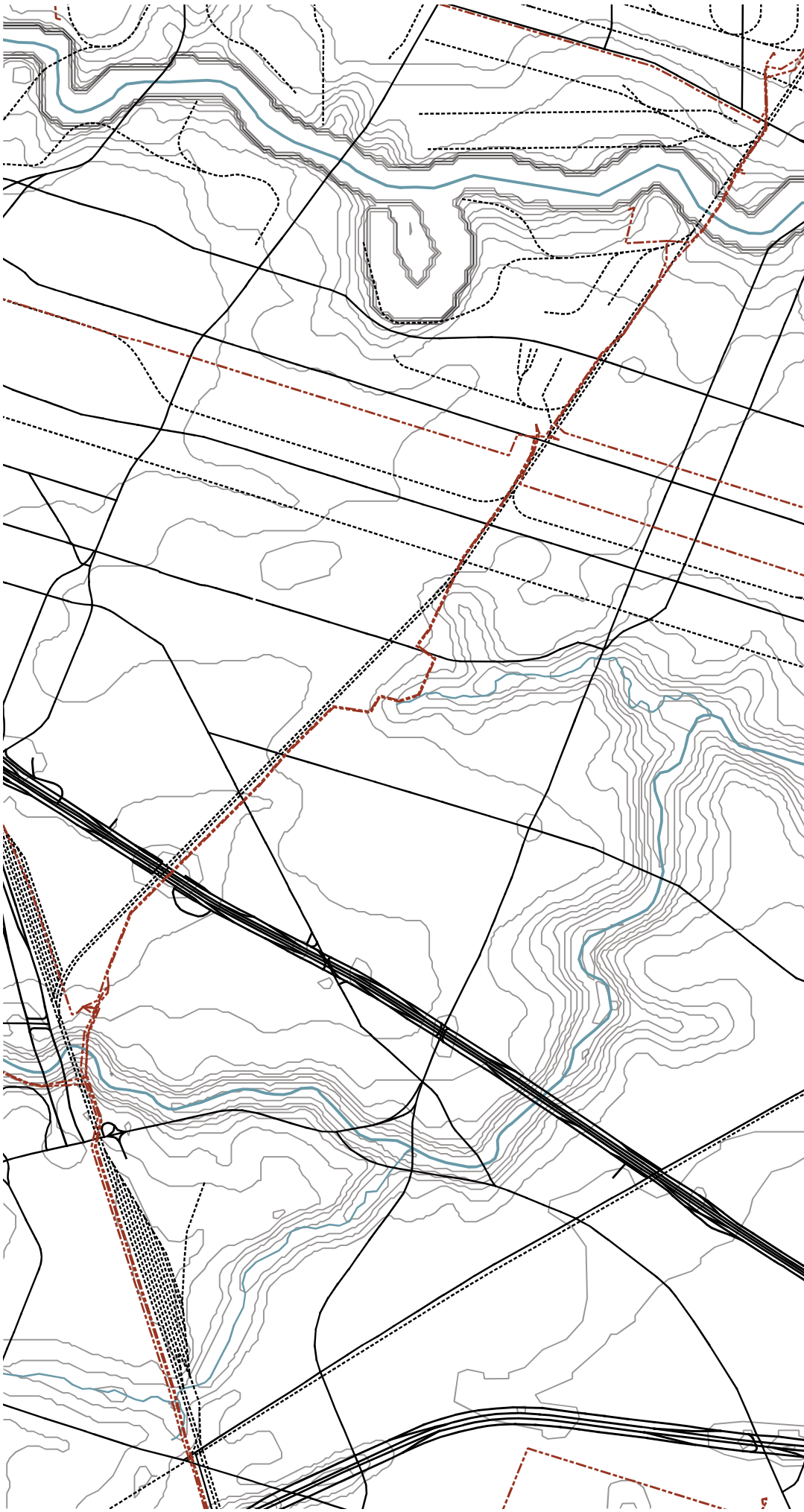
The city of Houston is connected to its surroundings by the networks of roads, rails, and power lines.

- Road network
- Rail network
- Energy network
- Coastline
- County border
- City of Houston
- Other cities

N

0 500 km





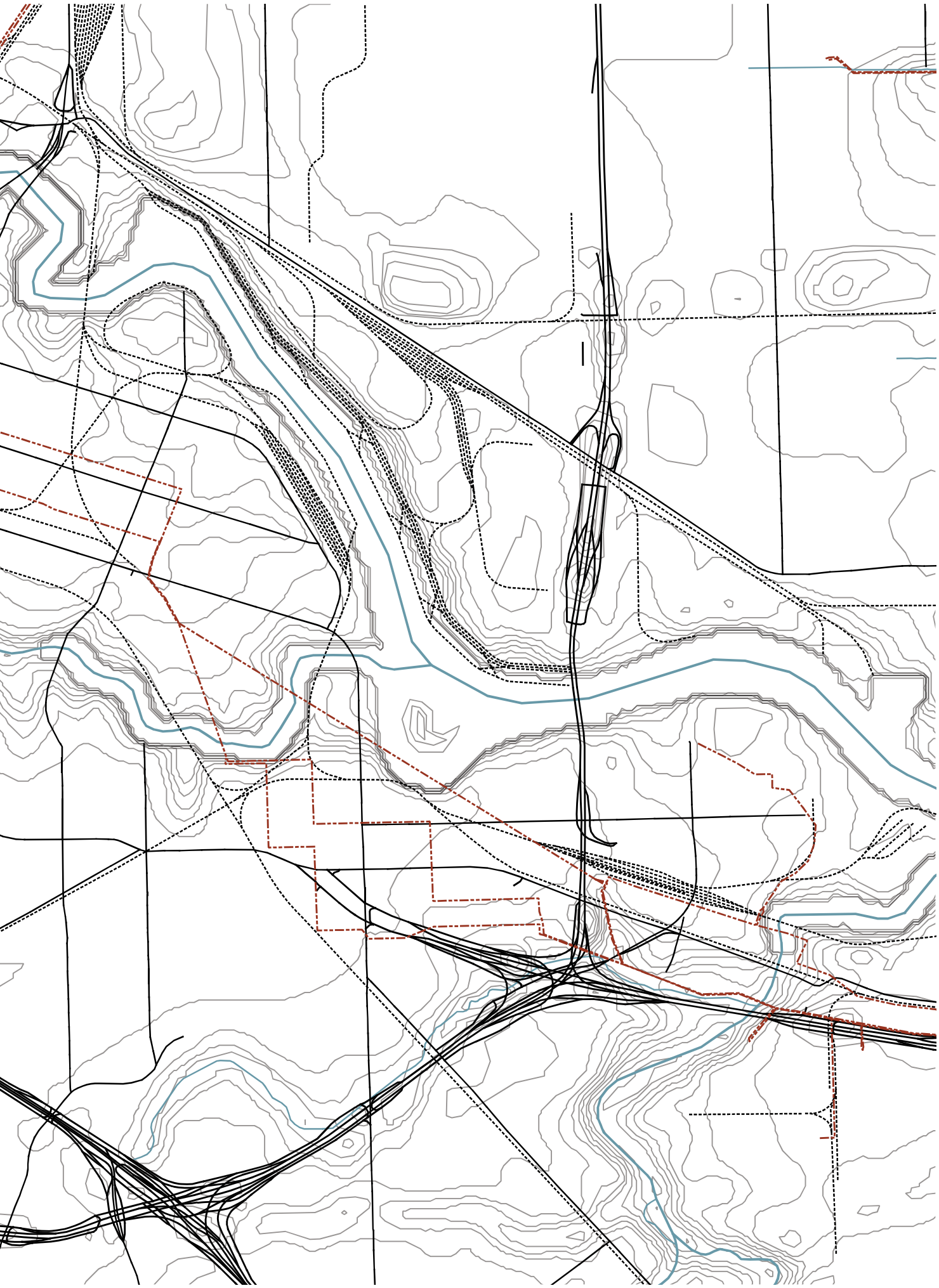
Networks

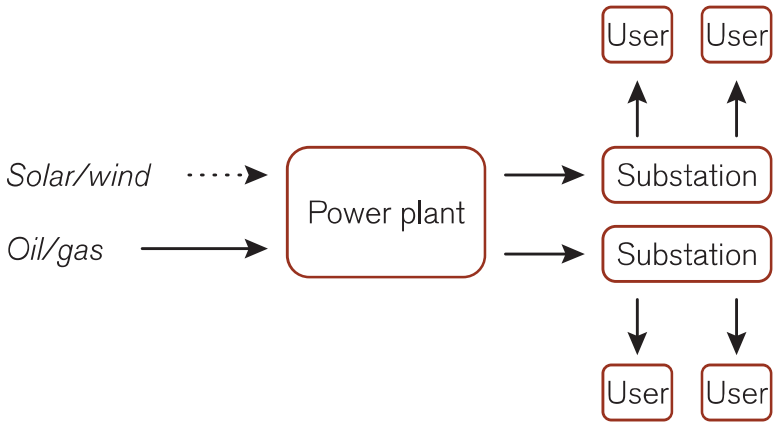
The area of Magnolia Park and Harrisberg/ Manchester is connected to its surroundings by the networks of roads, rails, and power lines.

- Road network
- Rail network
- Energy network
- Coastline
- County border
- Heightlines
- Rivers/bayous

N

0 25km





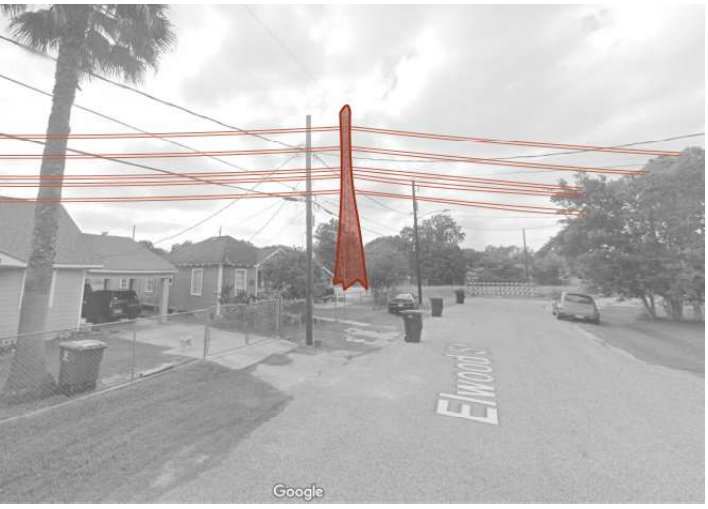
Energy flowscheme

Networks

The flow scheme shows the current energy system. Oil and gas is transformed into energy in the powerplant and distributed over the city.



Highway Network



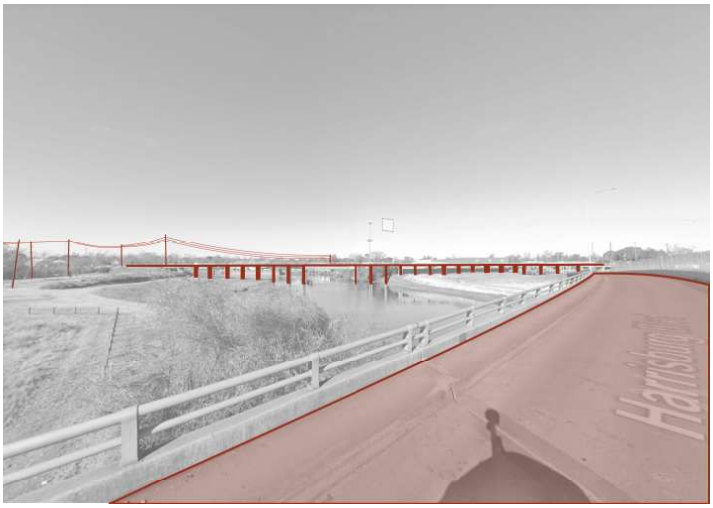
Energy Network



Energy Network (local)



Rail Network



Combined Networks

Networks

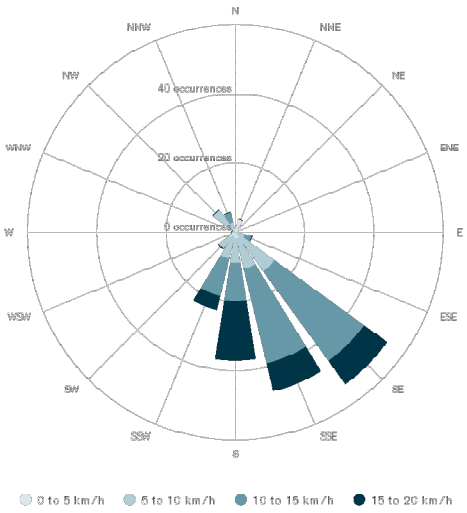
The city of Houston is connected by different networks. The highways are the primary use of transportation between cities, but as Houston has a large sprawl, the highways are also used for inner city connections. The highway system of Houston consists of a radial road network with some ring roads, some leading over seven lanes each direction. The hurricane evacuation planning has assigned which highways are used in case of a flood emergency. Not only the people in Houston, but also the smaller cities surrounding the Galveston Bay make use of these routes through Houston. The rail network of Houston is mostly used for cargo purposes, connected to the cities harbor. Cargo is imported by ships and in the harbor transferred onto trains to be transported inland. The energy network covering the city is used to supply all the buildings with power. The main energy resource in Houston used to be oil or gas, but the city is trying to change to natural resources for a more sustainable network. The network is connected to large solar farms in the upper parts of Texas, and with this shift Houston is becoming one of the leaders in renewable energy use.

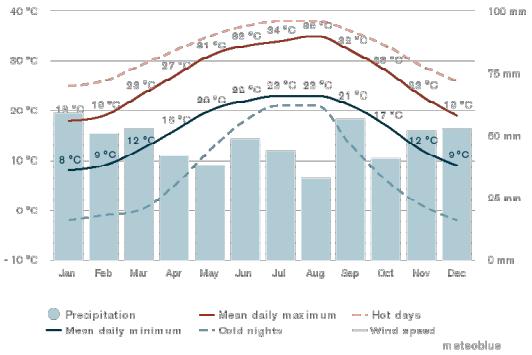
The Magnolia Park and Harrisburg/Manchester area is located near the interstate 610. This freeway provides accessibility to the area, but in a case of emergency also acts as the main evacuation route of these neighborhoods. The train tracks running through the neighbourhood are used by cargo trains, connected to the harbor activities. The powerlines, supplying the area of energy, are leading from the substations, which are connected to powerplants at the border of the city.

Climate, water and energy cycle

These adapted flow schemes show a way of closing/adapting the loops. In the water system designated overflow areas should be introduced to deal with the excessive water. The energy cycle is adapted with more local energy production through individual generation.

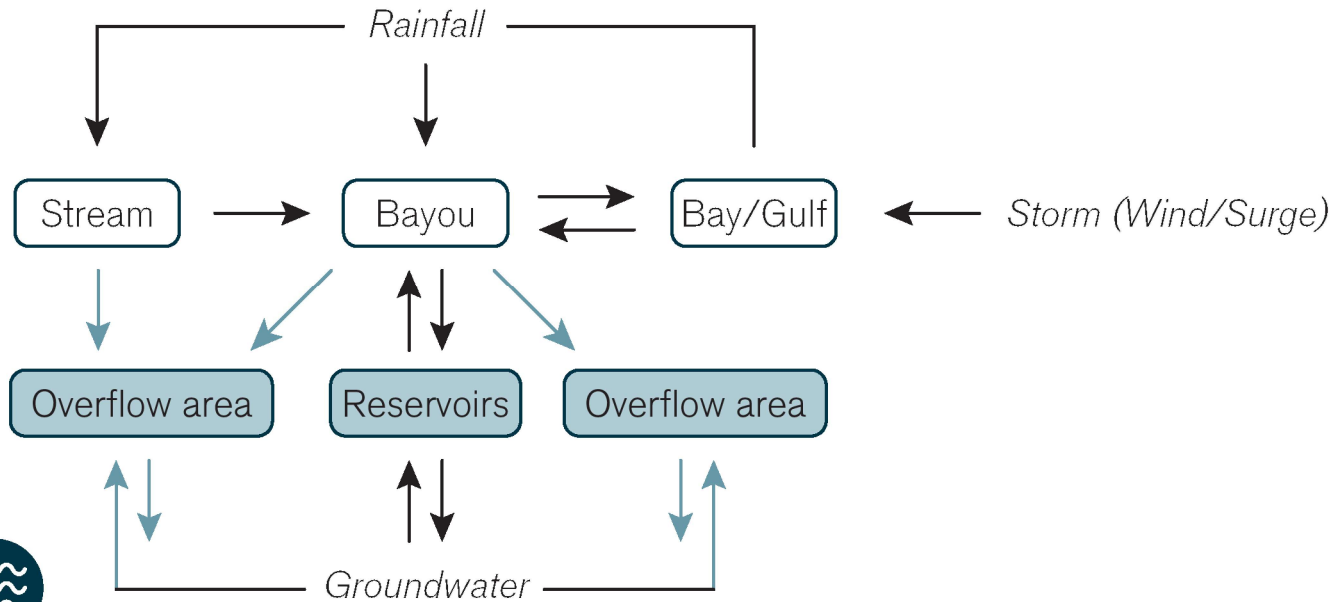
CLIMATE



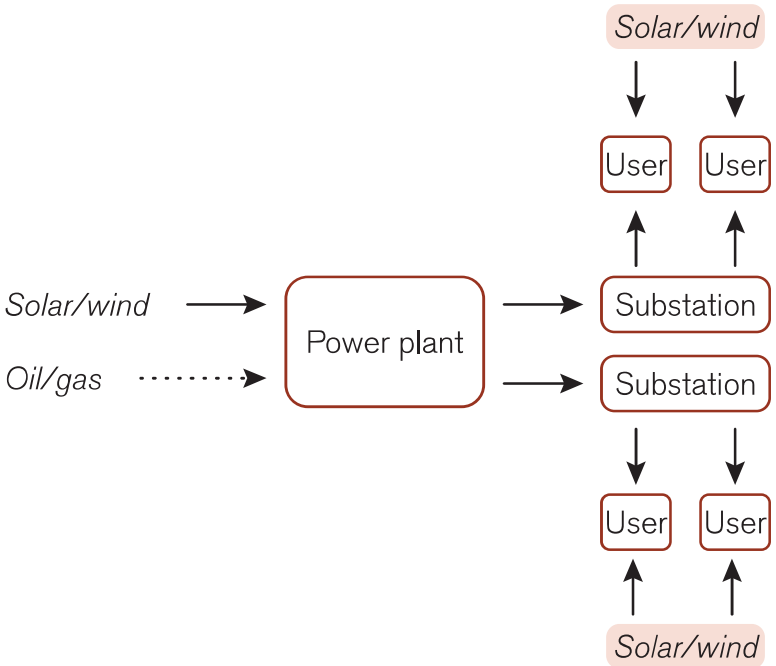


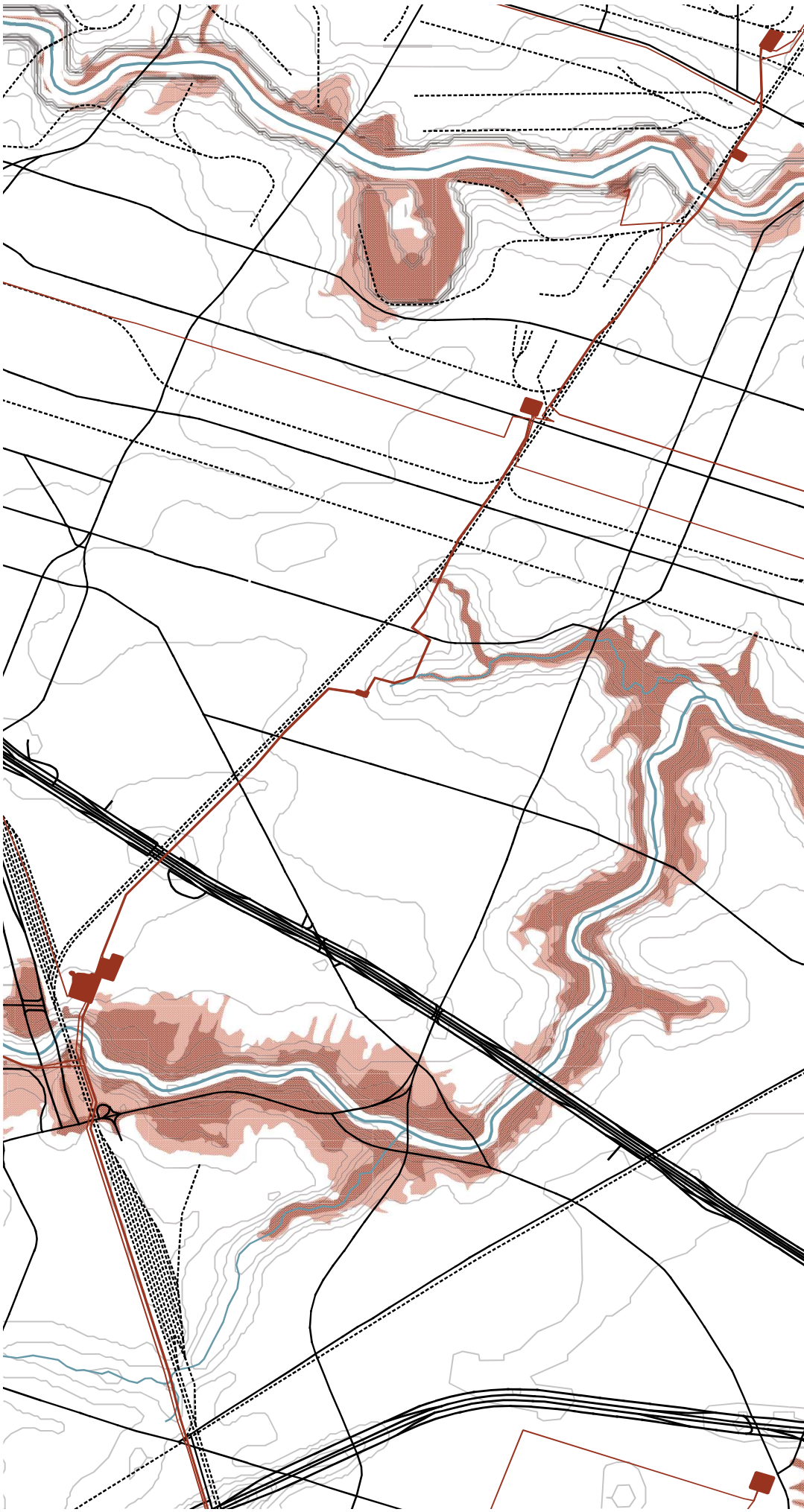
Source: Meteoblue, redrawn by Vermeulen

WATER



ENERGY





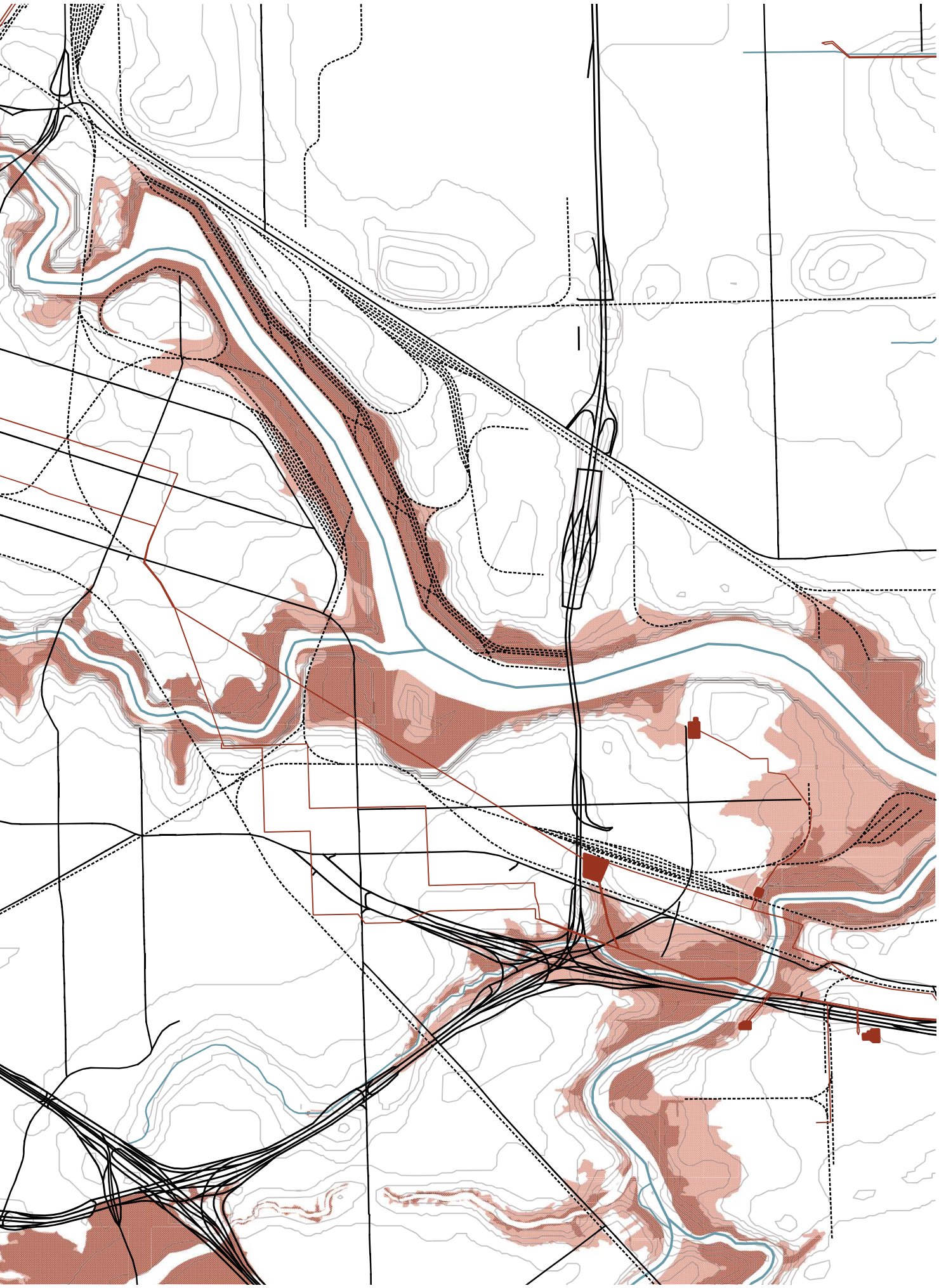
Networks and Floodplains

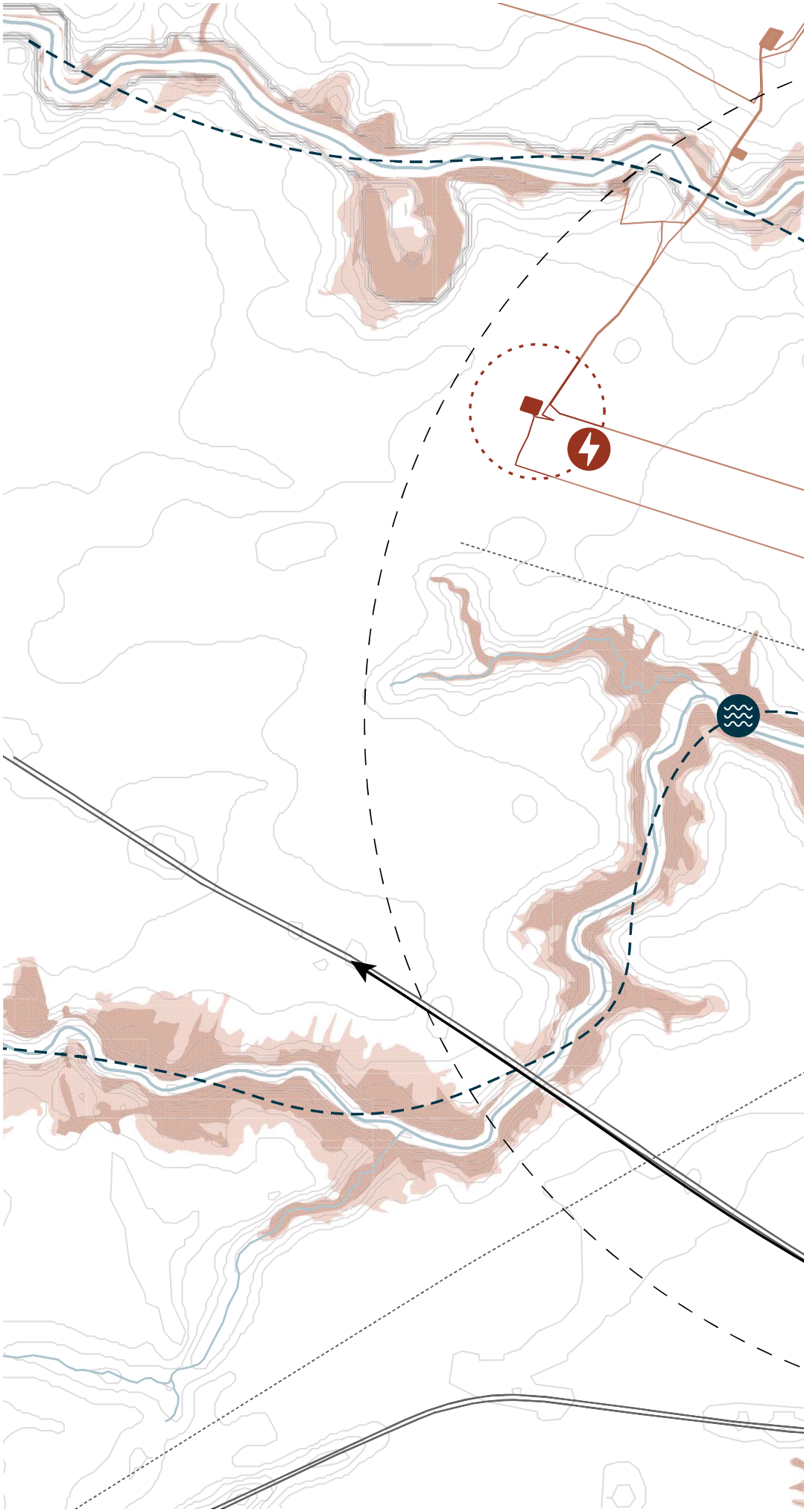
This map shows the floodplains in the area of Magnolia Park and Harrisburg/Manchester, in relation to the networks.

- Bayous
- Heightlines
- 100 year flood plain
- 500 year flood plain
- Road network
- Rail network
- Energy network
- Power substations
- Rivers/bayous

N

0 100 km





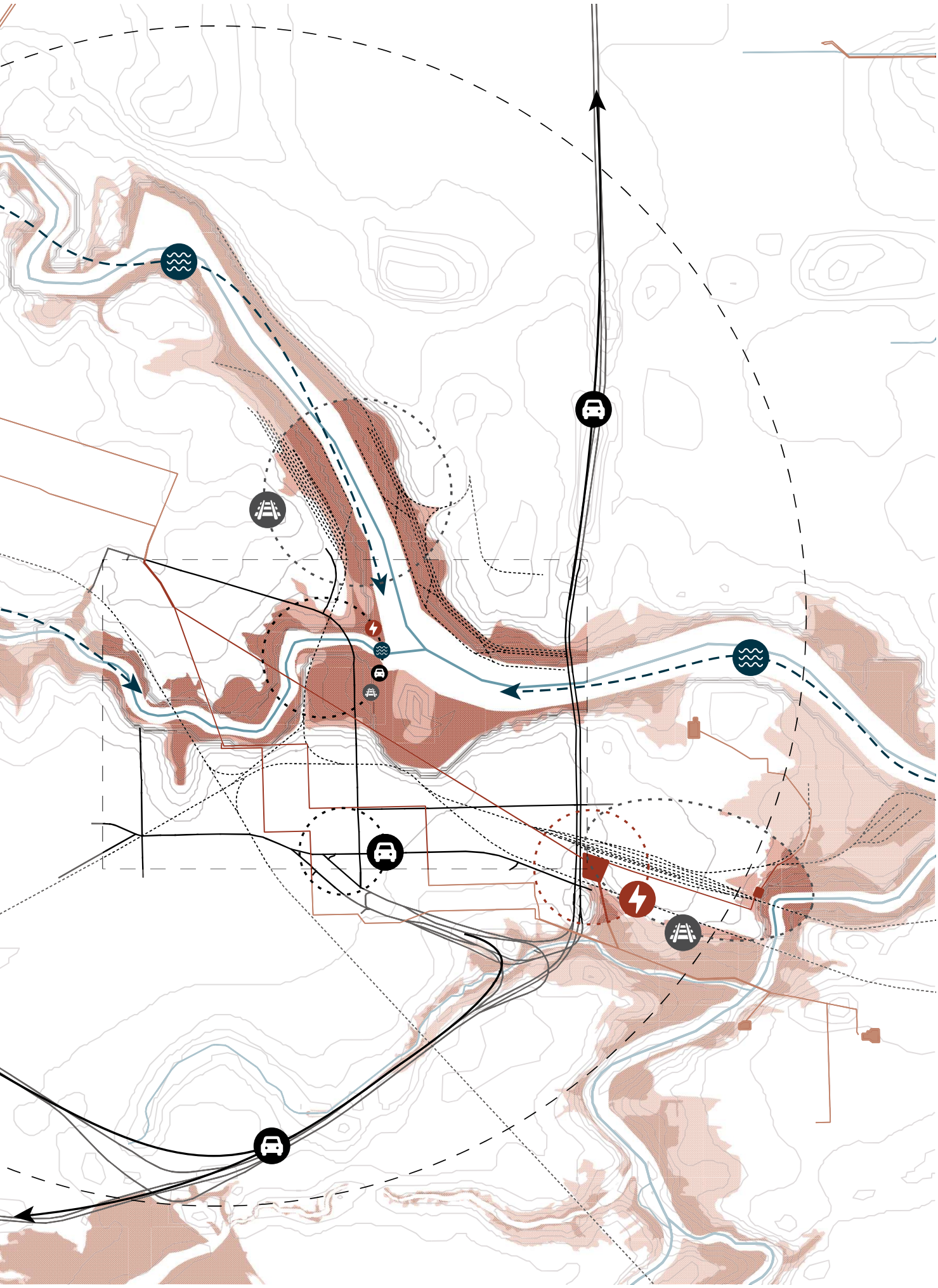
Extreme systems

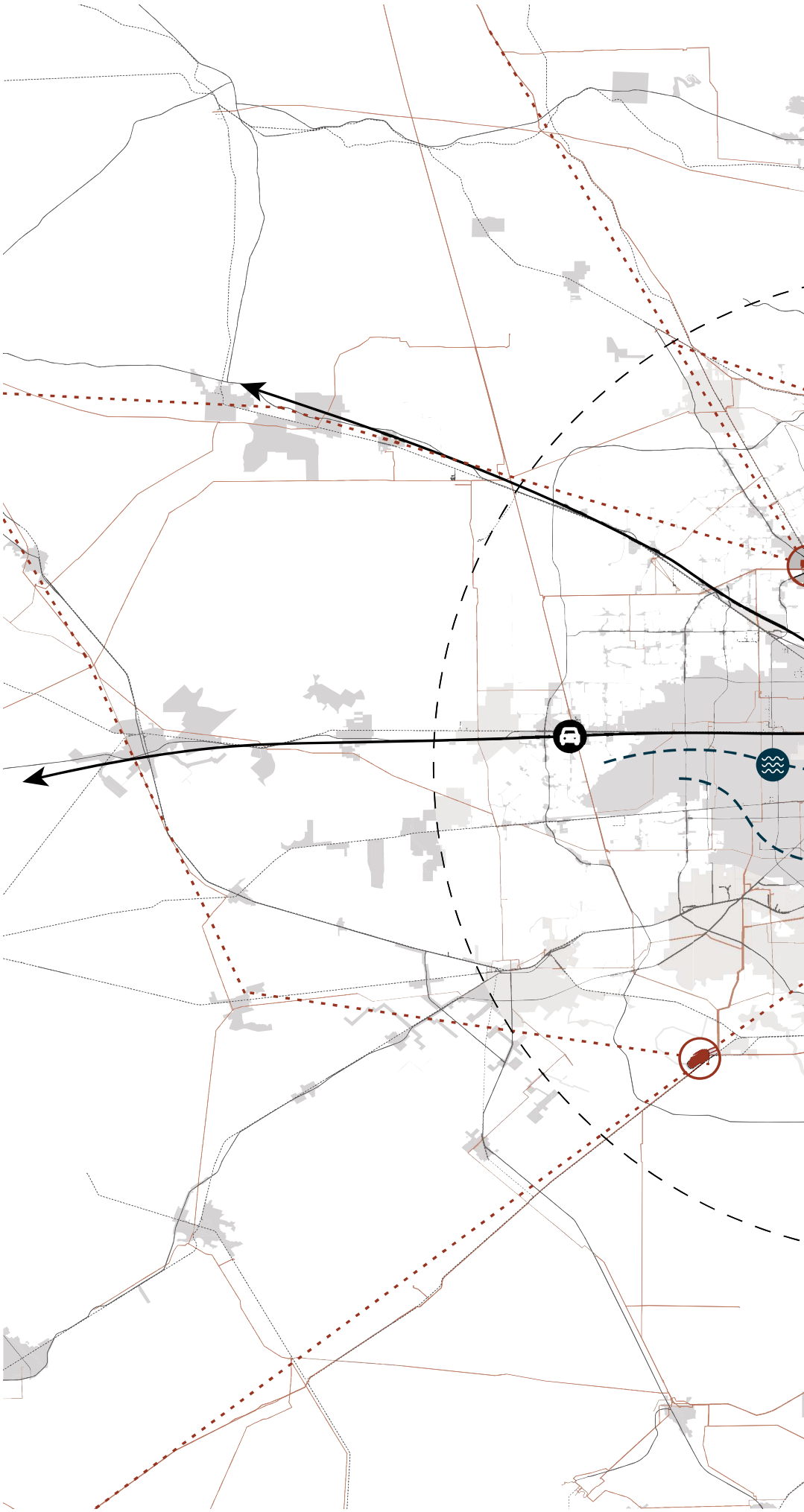
A conclusion map which contains the main areas, networks and flows at the meso scale.

- Rivers/bayous
- Streams
- Watersheds
- Hightlines
- 100 year flood plain
- 500 year flood plain
- Energy System/Flow
- Water System/Flow
- (Evacuation) road System/Flow
- Railway System/Flow

N

0 | 25 km





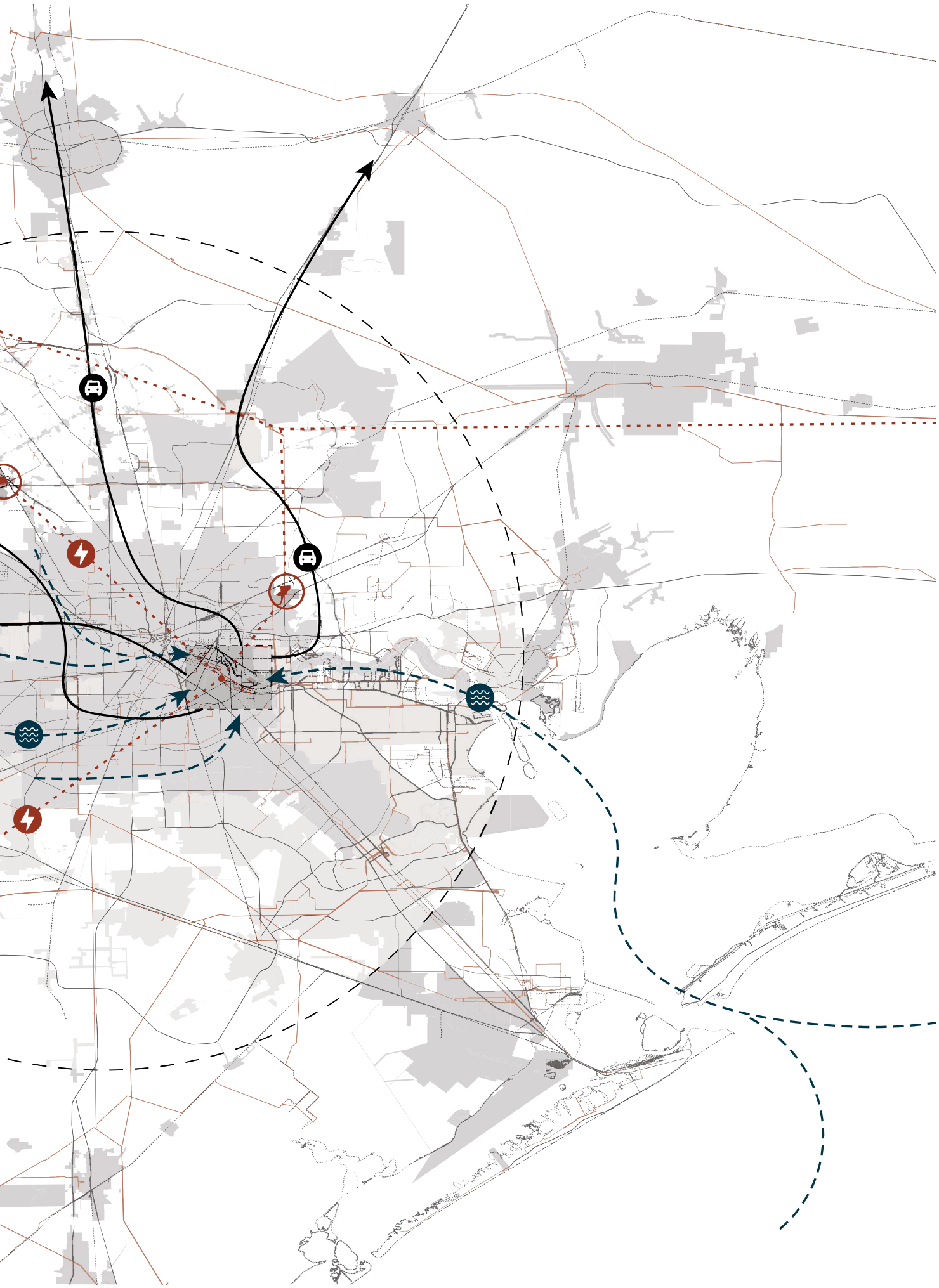
Extreme systems

A conclusion map which contains the main areas, networks and flows at the macro scale.

- Road network
- Rail network
- Energy network
- Energy System/Flow
- Water System/Flow
- (Evacuation) road System/Flow
- Railway System/Flow

N

0 500 km



Extreme Systems

The critical cartography in the systems perspective is focused on the flows of the different networks of water, roads, rails, and energy. The two maps show how each network is connected and influences the area of Magnolia Park and Harrisburg/Manchester.

The water system puts a lot of pressure on the bayous in Houston. The rainwater is collected in streams all over the city, flowing downstream into the Buffalo Bayou. With an average southeastern wind direction, storm water is pushed through the Galveston Bay into the Buffalo Bayou as well. With rainfalls and rising groundwater, the bayous are under pressure by conflicting waters. In the Magnolia Park and Harrisburg/Manchester area this results in floodplains around the Buffalo and Brays Bayou. These floodplains are buildup areas, so not allowed to be flooded, which affects different networks. To make this cycle closed designated overflow areas are needed to release pressure on the bayous in extreme conditions.

The road system connects the city of Houston to it surroundings. The importance of the highway systems becomes visible in case of a flooding. The highways act as an evacuation network for the whole Galveston Bay area, with routes leading in the north and west direction land inwards. The Magnolia Park and Harrisburg/Manchester area is connected by the interstate 610 which acts also as the main evacuation route for the area. Main roads connect the different parts to the highway. As Magnolia Park is separated from Harrisburg/ Manchester by the Brays Bayou the connection between the two neighborhoods is lost when the Brays Bayou overflows. This also means the direct evacuation route to the interstate 610 is lost for Magnolia park.

The rail system of Houston is mainly used for cargo purposes, as it connects the Harbor to the inlands. In the Magnolia Park and Harrisburg/ Manchester area this is also the case. The major railways leading trough the area are connected to huge marshalling yards. These yards are located near the bayou, as this is beneficial for the industrial activity. However, these yards are build in the low-lying floodplains of the Bayous. In case of a flood these areas will not be function again, shutting down the industrial activities.

The energy system of Houston consists of three major powerplants at the border of the city. The main energy resource in Houston used to be oil or gas, but the city is trying to change to natural resources for a more sustainable network. From the powerplants huge powerlines are running through the city connecting different substations. The energy in Magnolia Park and Harrisburg/Manchester is distributed form two substations laying central in the neighborhoods. From the powerlines running in between these substations, a local network is needed to supply the different buildings. Each building is individually connected to the overhead powerlines. The inhabitants are mostly dependent on the large system, as individual power generation through solar panels or other sustainable resources is not the case in this area yet.

The systems of roads, rails and energy leading to/through Magnolia

3.2.

Anthropology

Time Systems

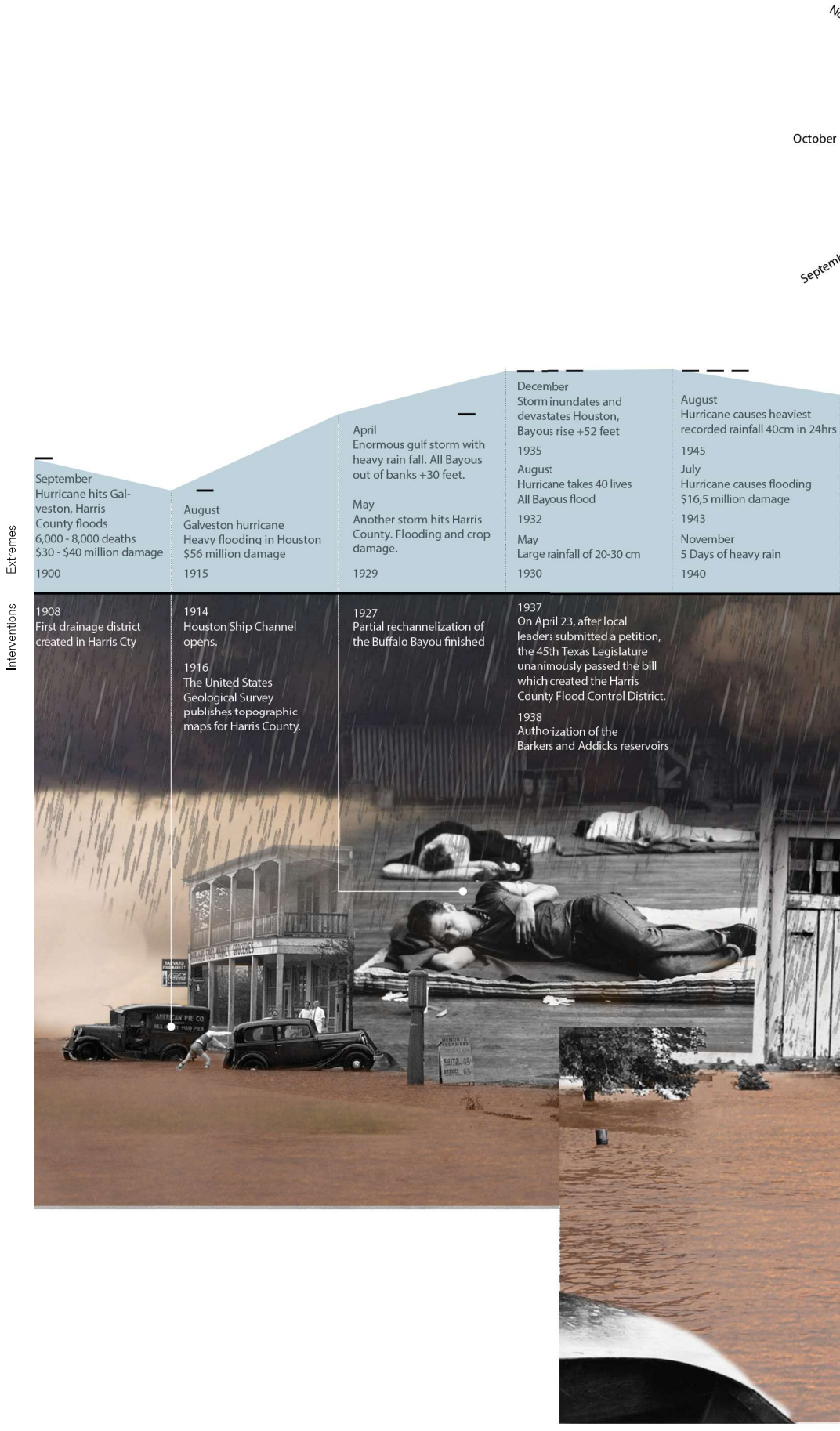
One life, one year and one extreme moment during a storm are captured.

The timeline represents all major extreme events that occured since 1900 and which human interventions they triggered.

The collage corresponds with the timeline and shows people experiencing and dealing with this extreme environment throughout different times of the past century.

The circular diagram shows the seasonal temporality of the extreme environment and one intense moment during hurrican Harvey in 2017.

- Extreme Flooding
- Flooding
- Normal / low water





1950 February- Thunderstorm Flooding of Greens Bayou and Baytown to flood

1955 May - Thunderstorm Flooding Harris County

1957 June - Hurricane Audrey Floods Harris County

1959 October - Thunderstorm Floods Houston Area

1960 June - Thunderstorm Floods Harris County 200 Families evacuate

1961 September - Hurricane Carla Heavy flooding causes 34 Lives lost

1969 June - Thunderstorm Floods Harris County

1972 March - Thunderstorm Floods Harris County 300 Families evacuate

1973 June - Major storm Heavy rains of 10 lives lost

1979 July - Tropical Storm Heavy rainfall $ 60 million damage

1983 May - Large Storm Floods Bayous $14 million damage

1983 August – Hurricane Alicia Heavy wind causes $1 billion damage

1983 September - Heavy rain floods Brays Bayou $38 million damage

1984 October - Thunderstorm floods Harris County $32 million damages

1992 March - Major storm floods Bayous and I-10

1998 October - Major storm floods North Harris County

1998 October - Major storm floods North Harris County

1998 September - Tropical storm floods Bayous

1949 October – Major storm floods Bayous

2001 June – Tropical Storm Floods Houston 22 Lives Lost

2006 June - Heavy Rainfall Floods Berry and Sims bayou

2008 September – Hurricane Ike Surge Floods Harris County 11 Lives lost, $28 Billion

2009 April - Heavy rainfall floods Bayous and highways 5 children lose their lives

2012 July – Heavy Rainfall Floods Houston

2014 August – Heavy rain floods Greens Bayou

2015 May - Heavy Rainfall Floods Buffalo & Brays Bayo

2016 April - Heavy rain Flood Harris County and Peak reservoir water levels

2016 May - Heavy Rainfall More than 40 Flood Harris County

2017 May - Hurricane Harvey Floods Harris County 68 Lives lost, $128 billion

1966
The Bayou Preservation Association prevent further channelization of the Buffalo Bayou

1989
May & June - Two separate storms result in two back-to-back presidential disaster declarations.



Time systems

The time systems are represented in several ways. Looking back at the history of extreme storms that plagued the city of Houston, it becomes apparent that the impact of the storms have become greater over time. Storms have become more frequent and more extreme. With the urbanization, the amount of financial and material damage has increased and more people are affected by the extreme weather and floodings (Harris County Flood Control District, 2018).

Interventions to adapt the environmnet and mitigate flood risk have been done since the beginning of this century. Bayous were channalized, drainage ditches were installed and in 1938 the Addicks and Barkers reservoirs were authorized. These mitigation efforts reduced the flood risk but over time climate change and urbanization overruled this. Currently,

After Hurricane Harvey, where 68 lives were lost, a coastal wide resiliency plan to reduce risk to viable coastal communities, habitats and industries (Texas General Land Office, 2019).

Bungalow

Brays Bayou - West Side

Fennel Street, Magnolia park

Nature is robust



Human is robust



Shotgun House

Brays Bayou - East Side

80th Street, Harrisburg / Manchester,

Human is fragile



Nature is robust

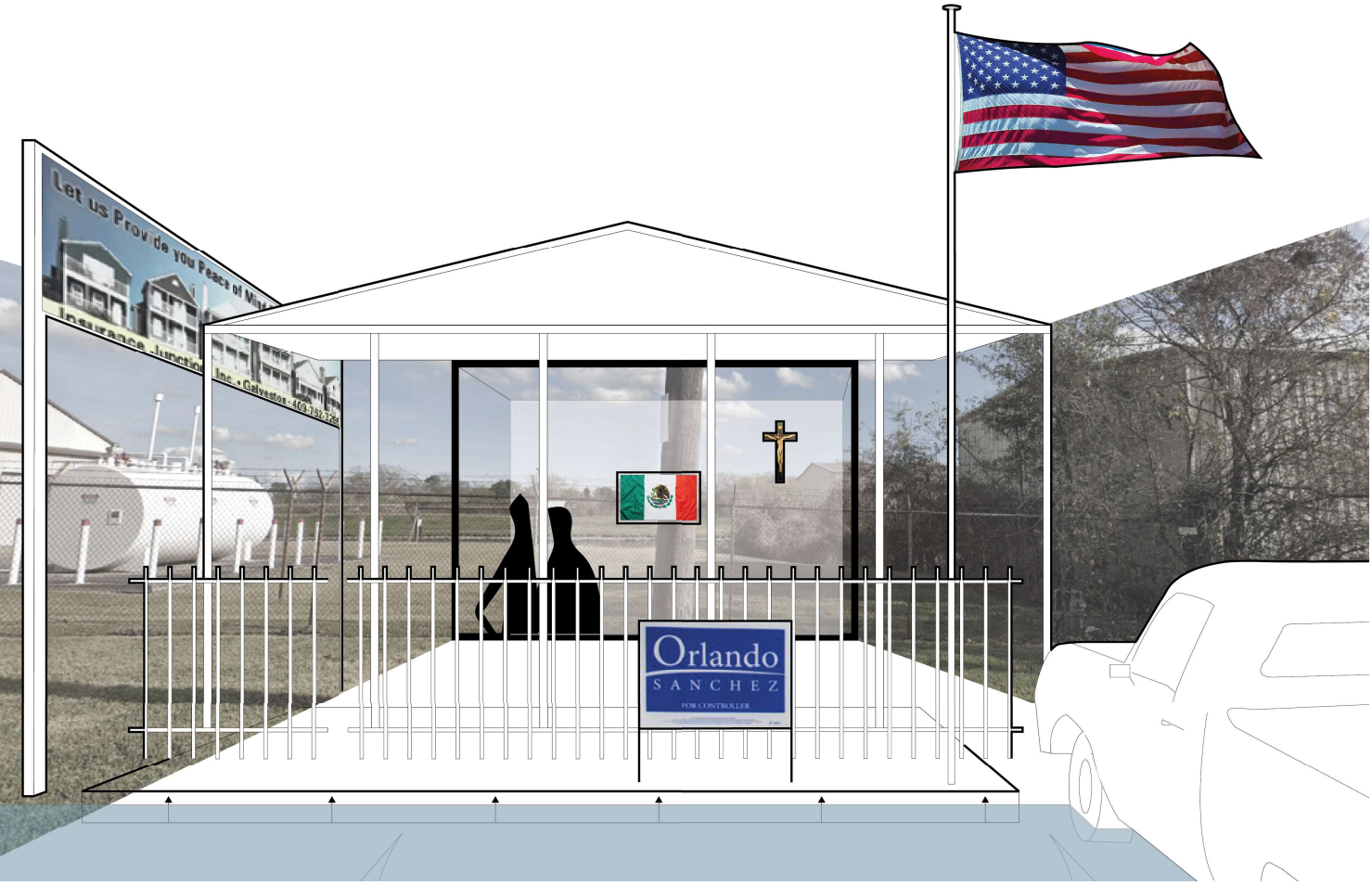


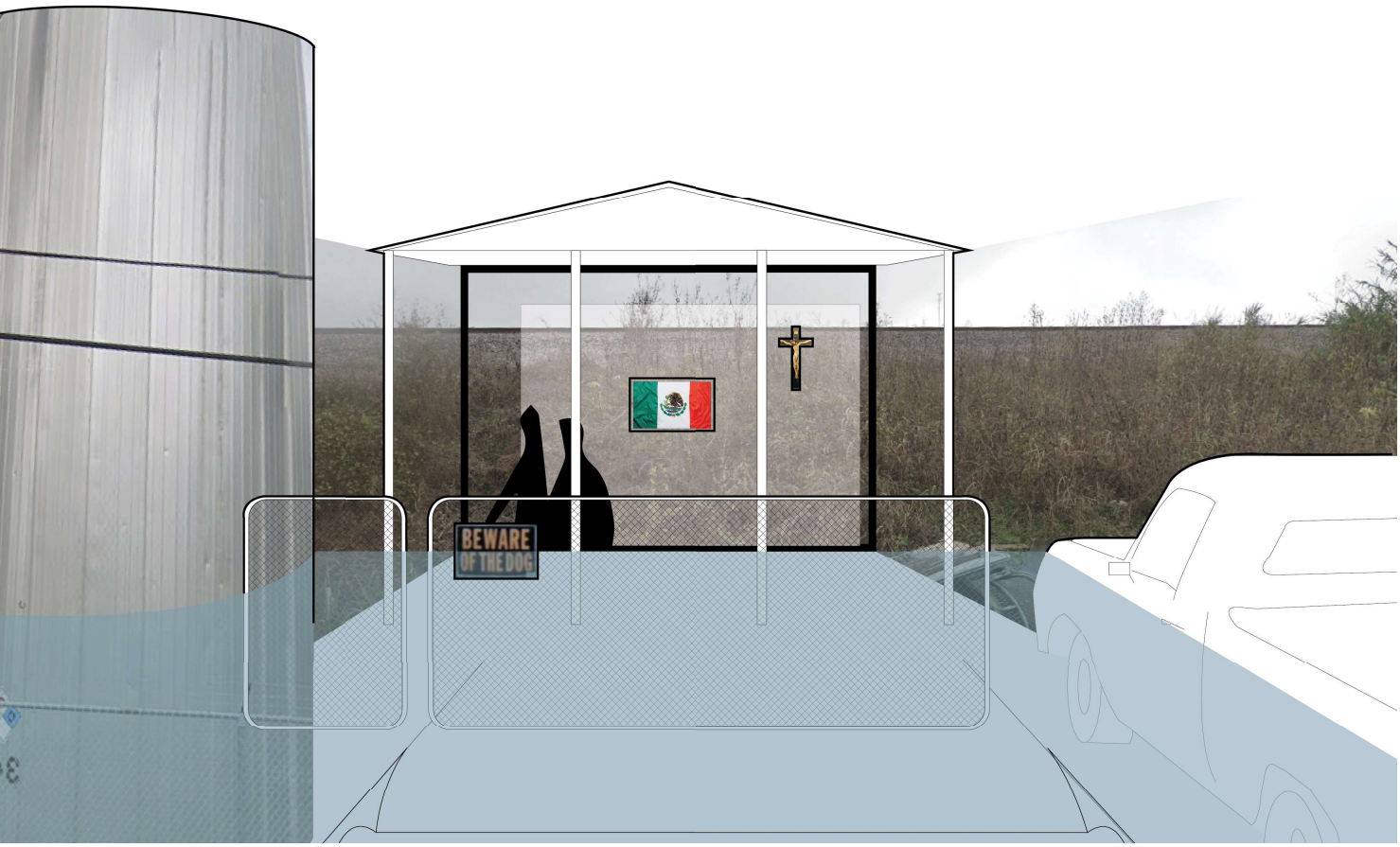
Human Perspectives & Cultural Systems

Two different human perspectives of the [extreme] environment and which artefects are representative of cultural systems of two neighbourhoods in Houston.

The Magnoliapark neighbourhood above and the Harrisburg / Manchester neighbourhood below are similar in many ways but their differences change the way in which residents percieve the extreme environment.

◀ View


Orlando
SANCHEZ
FOR CONTROLLER


BEWARE
OF THE DOG

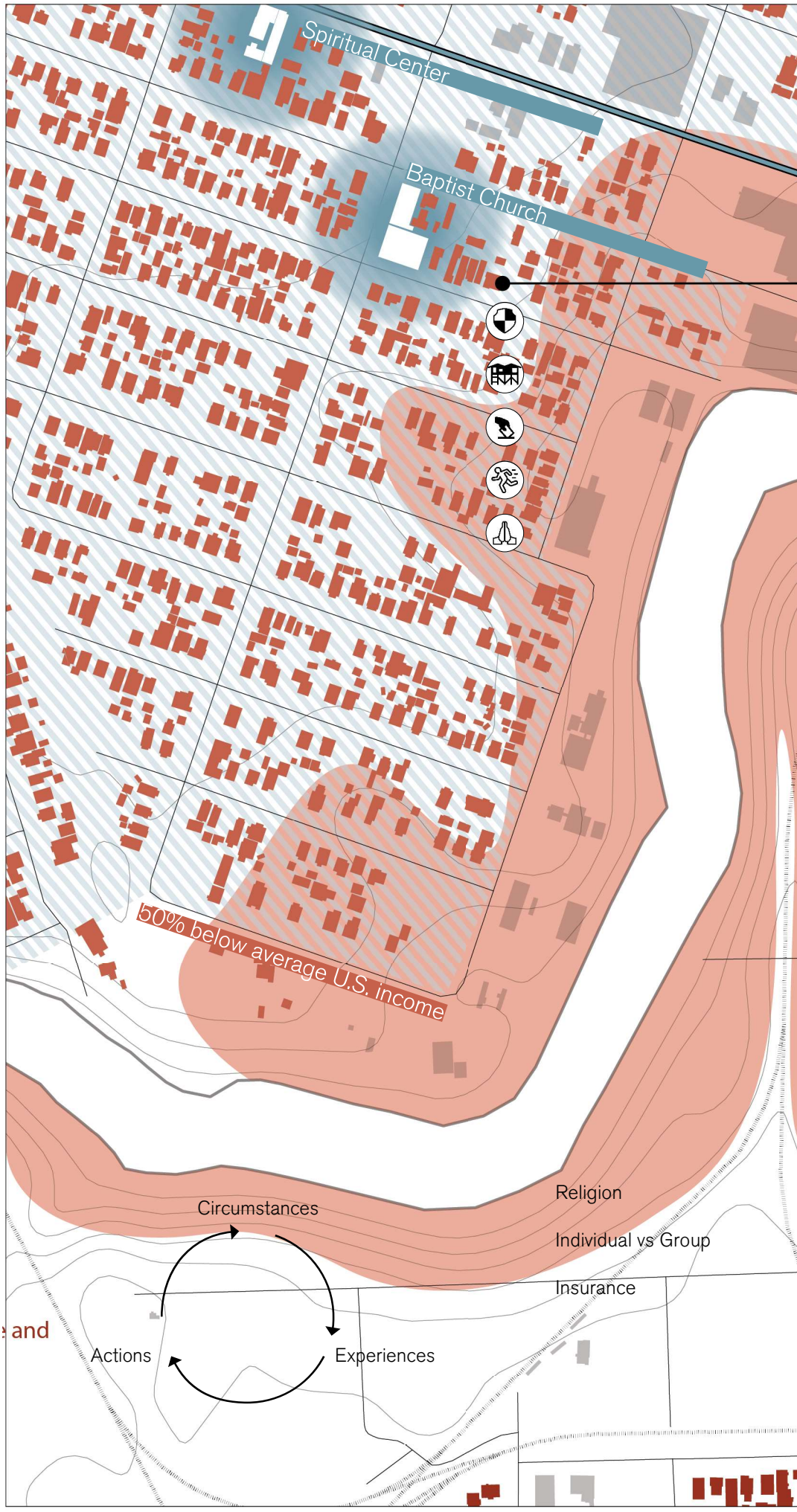
Human Perspectives & Cultural Systems

The Harrisburg Manchester neighbourhood is eighty percent Hispanic, fifteen percent Black and 15 percent White (Trovall, 2018). Ninety percent of those residents live within one mile of a refinery resulting in higher cancer risks, and extreme high respiratory hazard (TEJAS, 2016). On top of this health stress, extreme events such as storms and flooding cause even more acute pollution and acute health risks. Even though the Harrisburg Manchester residents experience these bad health due to polluting industries and extreme weather events, residents tend not to be aware of the risks or tend to normalize these risks. They frame them as coming from external forces and not because of the local polluting industries (Thomas et al, 2018).

The Magnoliapark neighbourhood has an average income which is fifty percent below the U.S. average income, the Harrisburg Manchester average income is even fifty-nine percent below average. The front lawns within the Magnoliapark neighbourhood are kept more tidy and have significantly more political voting signs. The amount of American flags is roughly the same in both neighbourhoods. Assuming, even though people in both neighbourhoods share the Hispanic / American culture, people in Magnoliapark are more inclined to participate in politics. Perhaps because of their slight income advantage, lots of houses in the neighbourhood have been elevated as well (Google Maps, 2020).

Within the neighbourhoods of 478 and 489 households, around 11 churches are located, most of them in the Harrisburg Manchester neighbourhood. Churches appear to be a central part of the daily life in the neighborhood as services are given many hours of the day in both hispanic and english (Google Maps, 2020).

In conclusion, it is hard to pinpoint the exact experience of the East-end Houstonians as it is stongly related to their circumstances such as income or level of education. Some appear more prepared, while others are unaware of the risks and choose to assign their suffering to external forces and have faith.



Deepmap of Extremes & Vulnerability

Showcasing the ability of the Magnoliapark and Harrisburg Manchester Houstonians to live and deal with the extreme environment and hazard threat of flooding and industrial (air)pollution.

- Church
- 50% below average income
- 59% below average income
- Flood plane

N

0 | 100 km


INSURANCE
Mind Before the Next Storm
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PLOT ELEVATION
POLITICAL ENGAGEMENT
Orlando SANCHEZ
FOR CONTROLLER
Carla Brailé
SYLVESTER TURNER
Elect Jerome PROVOST
Houston City Council
EVACUATING
HAVING FAITH
59% below average U.S. income
Methodist Church
Lighthouse Church
Church of Yaw-Hoo
Iglesia Bautista

Deepmap of Extremes and Vulnerability

Vulnerability is the extent of harm, which can be expected under certain conditions of exposure, susceptibility and resilience. Most residents of this local scale are exposed to health risks of industrial pollution and extreme weather that can cause flooding. The location of their house is the key factor in determining their risk to these hazards. Their susceptibility and resiliency to this risk depends on several factors such as age, income, education level, mobility and social network (Civis, 2020). Overall the area knows an average risk to the extreme environment of flooding. However, vulnerability is very high as lots of factors such as a low income, massively increase susceptibility and decrease the resiliency, the ability to respond to these risks.

Keck and Sakdapolrak (2013) define three capacities of social resilience. Coping capacities, adaptive capacities and transformative capacities. Currently the social resilience of the Houstonians in these neighbourhoods can be catagorised as coping capacities. Meaning that response to the risk is mostly after the fact, in the form of insurance or federal funds. The temporal scope of dealing with the hazard is short-term and the degree of change is low with the overall outcome that pre-hazard levels of well-being are restored but not improved.

As mentioned before, the Houstonians have different methods of preparing for extreme events, depending on their vulnerability. During shock situations such as storms, floodings or Covid-19, communities are strong and civil first-responders are essential to cooping with the hazards (Crowdsourcerescue, n.d.; Gray, 2020). However, long term recovery funds are insufficient most of the time and people have to depend on their self-reliency.

Preparing for extremes therefore differs per individual and can mean raising your plot above flood level, voting for better policies, insuring yourself, evacuating or having faith.

3.3.

Landscape

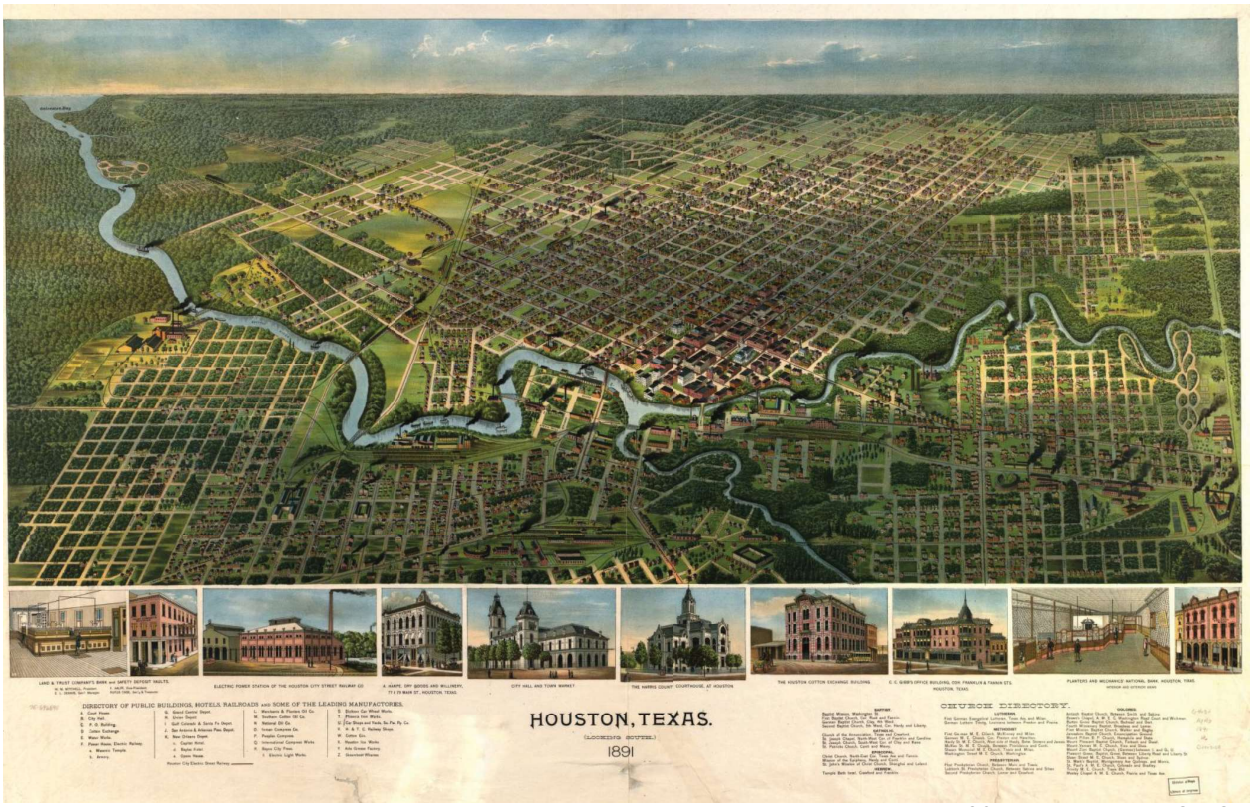
Historical-Critical Cartography

These two historic maps depicting Houston in its early days (19th Century) were the starting point for the landscape perspective analysis and critical cartography.

These drawings put side by side, depict two different versions of the same story. From these maps, you can clearly see the city growing out of the Buffalo Bayou, the birthplace (and later on the economic driver) of the Texan settlement. Additionally, the early 'land survey' grid is clearly outlined foreshadowing the possibility of seemingly endless urban sprawl on the flatlands of Eastern Texas. This grid, which supports the current road network of the city, allowed for modern-day Houston to extend as far as it does but was also a catalyst for the repeatedly overlooked spaces and vacant lots which are found in the city today.

However, the landscape which Houstonians are settling in seems drastically different - from a vegetated and lush green landscape to a hardier and dusty scape. This points out the extremeness of the environment studied in this research project and the drastic seasonal changes the landscape endures. If this same drawing was done today would the dominant color be the grey from the concrete and asphalt?

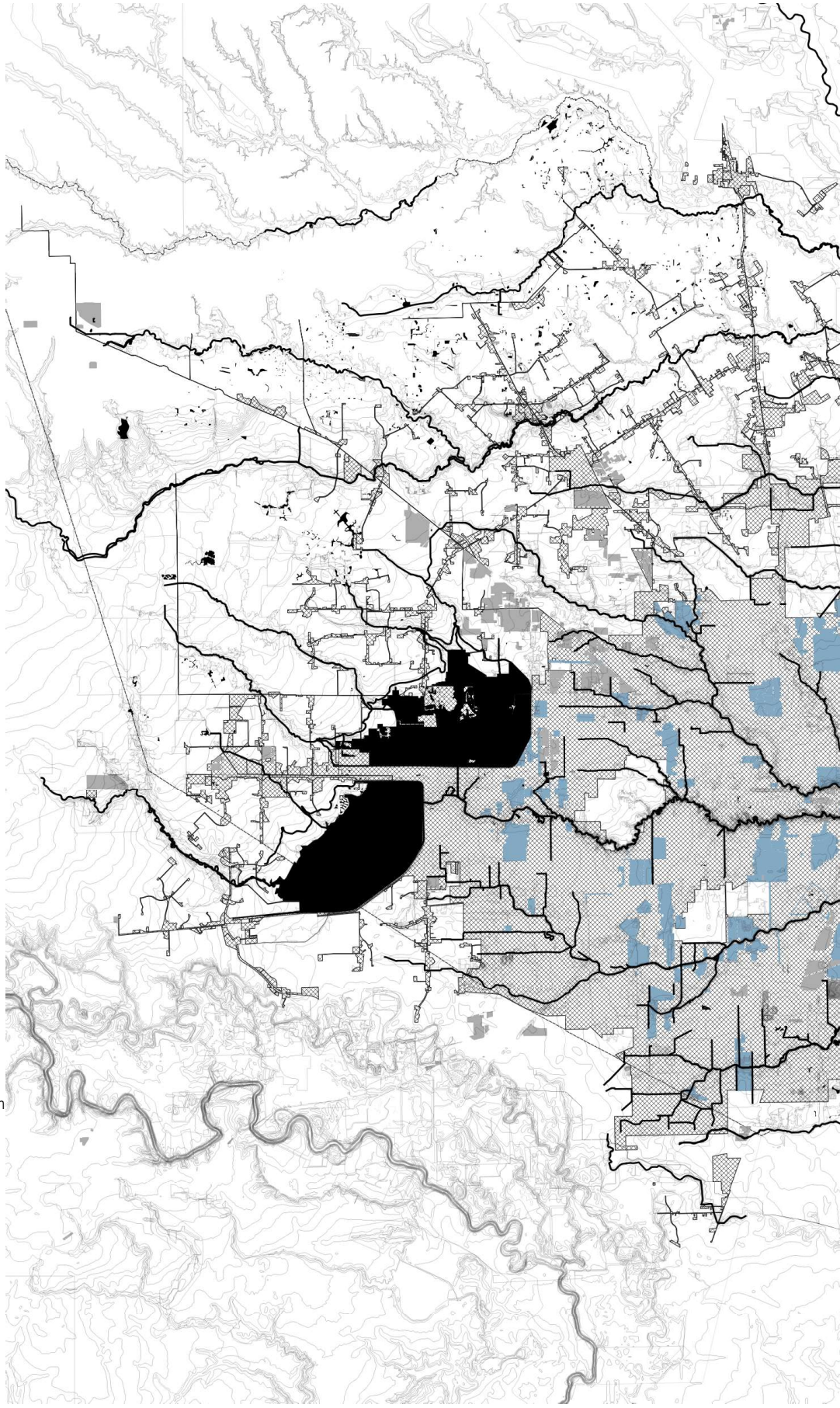
These two historical images introduce us to the notion of critical cartography as they purposely depict key elements of the landscape to sway opinions and tell a clear story of the area.



Bird's Eye View by A.L. Westyard, 1891, Restored by KNOWOL.



Bird's Eye View of the City of Houston, Augustus Koch, 1873.



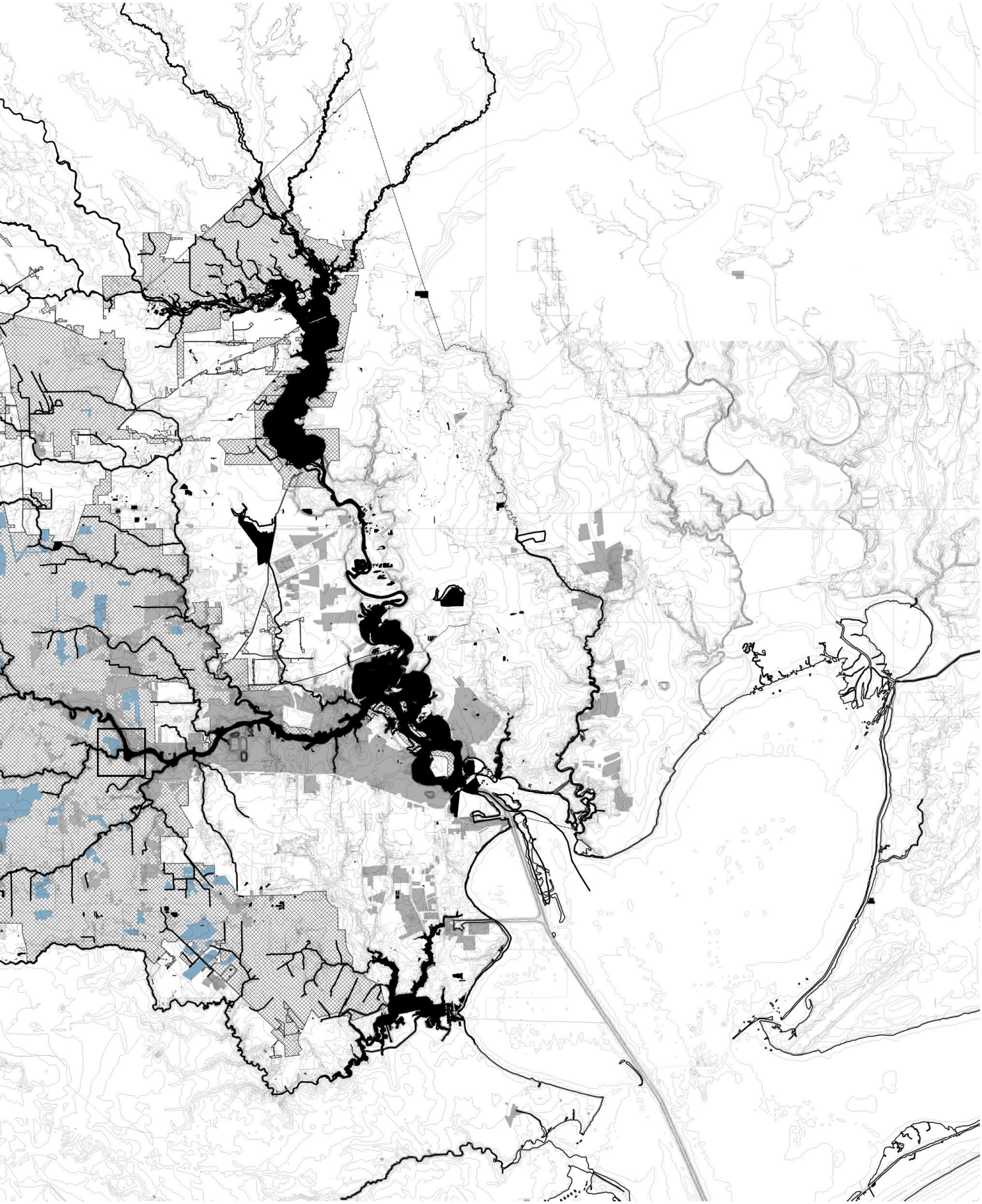
Harris County Hydrology Map

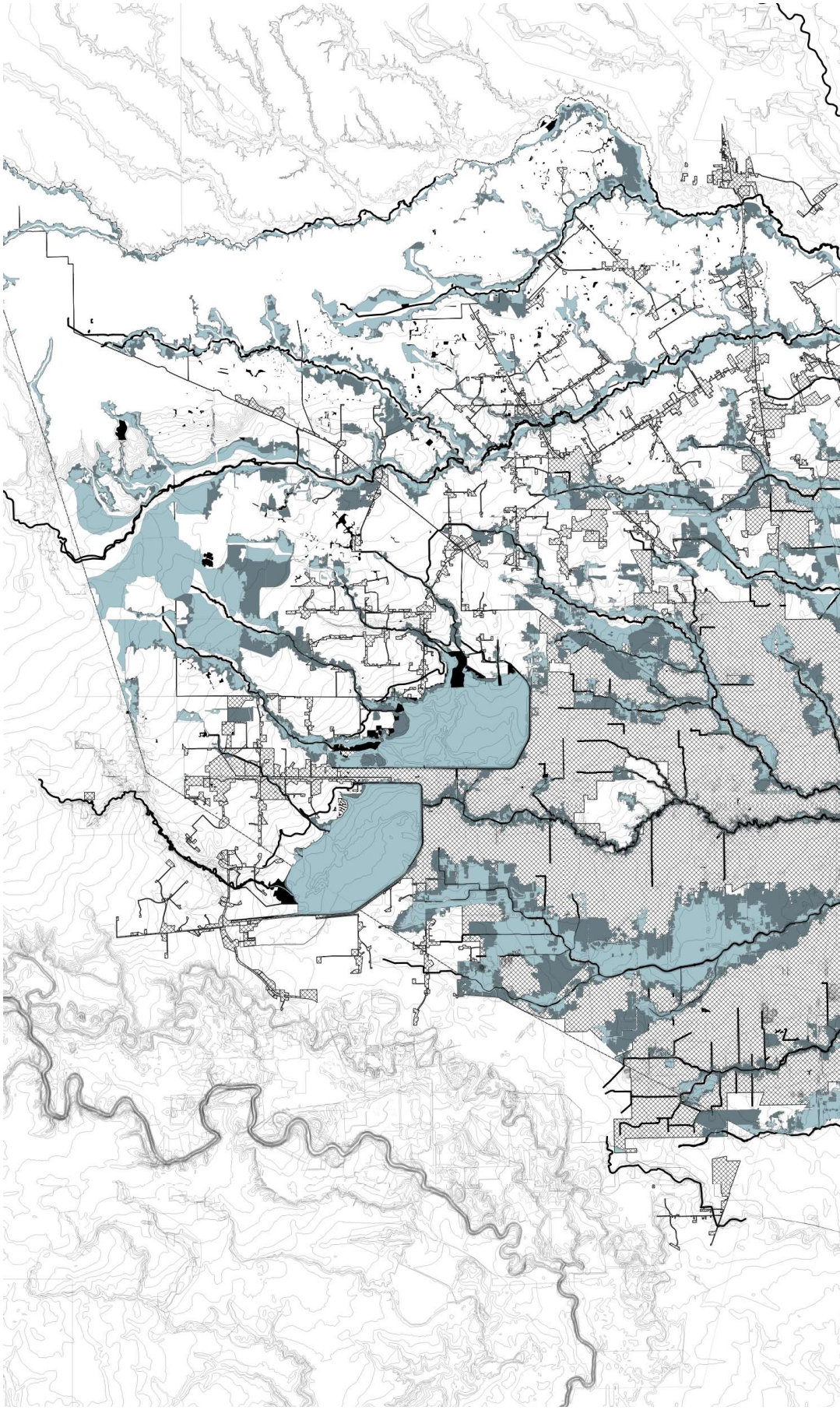
The larger Houston context shows the spread of urban development along with the intricate veins of the hydrology systems: from streams to bayous to larger bodies of water. The scale of the artificial retention basins (Barker and Addick Reservoir) in the West of the city hints at the volume of water this region has to deal with.

- Water features (streams, bayous, lakes, reservoirs)
- Industrial landuse
- Drainage zones
- Urbanized areas
- 1ft Topography
- Harris County
- Greater East End

N

0 10 km





Harris County Flood Map

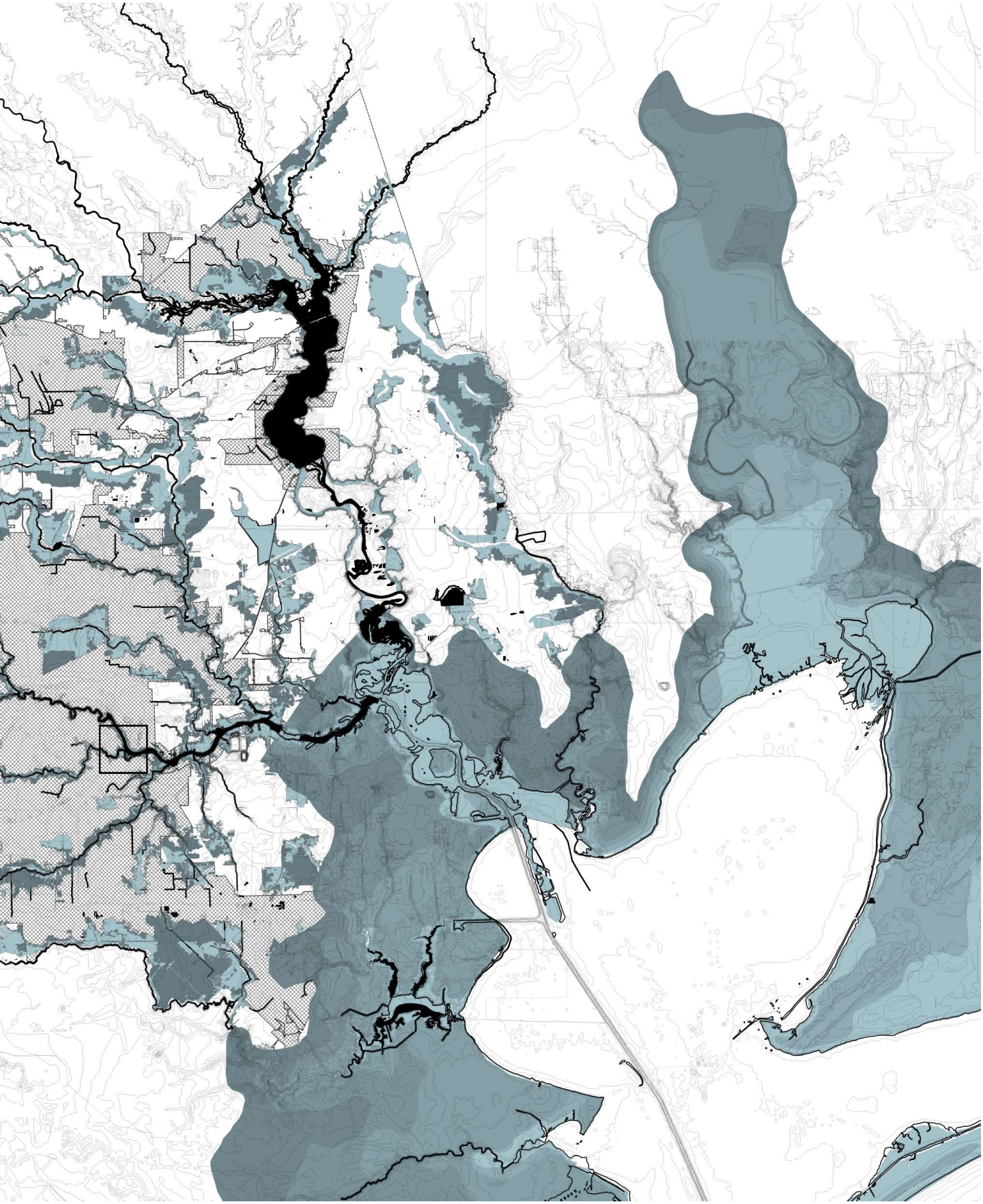
This map illustrates the extent of the region which is fragile and prone to flooding - whether that be fluvial flooding (around the bayou edges from rainfall and runoff) or coastal flooding (coming from storm surge in times of hurricanes).

Coastal Flooding
- Category 1 Hurricane
- Category 2 Hurricane
- Category 3 Hurricane
- Category 4 Hurricane
- Category 5 Hurricane

Fluvial Flooding
- 100 Year Flood
- 500 Year Flood

N

0 10 km

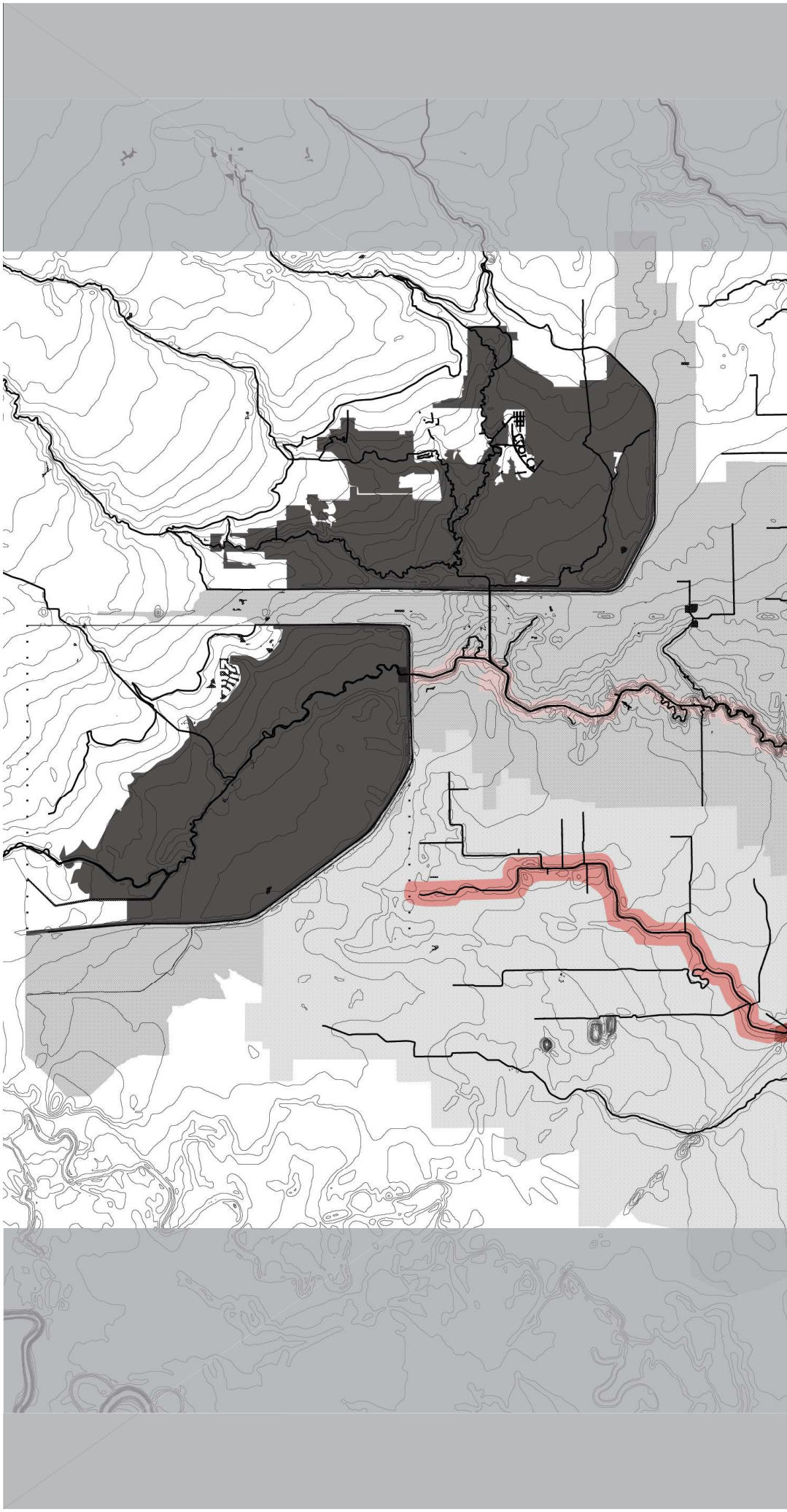


Harris County

Harris County - where the urban area of Houston is located - can be categorized as an extreme environment for multiple reasons. Historically, the city was established in the mid 19th Century at the confluence of the Buffalo and White Oak Bayou, where Downtown Houston now stands. The flatness of the landscape and the seeming abundance of space encouraged sprawling urbanization. The Buffalo Bayou - which was quickly converted into a ship channel - served as the main economic driver of the city in the early 20th Century which lead to rapid urbanization. With no zoning laws, the city expanded greatly in superficies putting the landscape under severe stress. The sensitized bayou network, which once relied on vegetation and topography to cope with seasonal changes in water volume was given little space to recharge or adapt to changing conditions over the years. The urbanization of these bayou channels has increased the exposure of the city to rain, fluvial, and coastal floodings which have caused severe damage to property over the decades. In 2017, Hurricane Harvey hit the Gulf Region particularly hard affecting Houston in unprecedented ways.



Tidwell at the East Sam Houston Tollway during Hurricane Harvey.
Melissa Phillip, Houston Chronicle, 2017



Brays Bayou and Buffalo Bayou

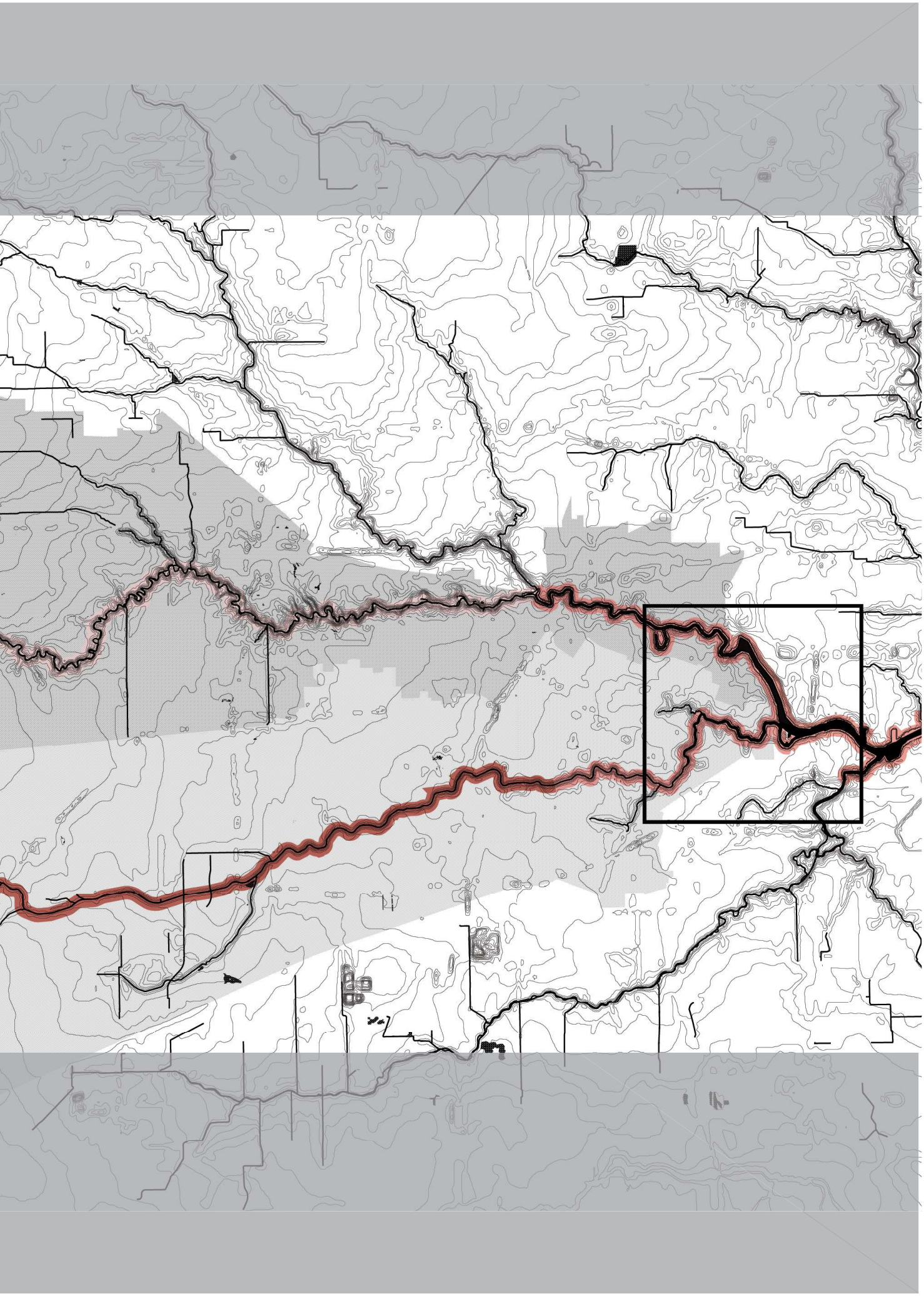
This map highlights the differences of riparian corridor conditions between the natural Buffalo Bayou and the artificially channelized Brays Bayou. This contrast in condition has proven critical in managing water discharge in times of heavy rainfalls.

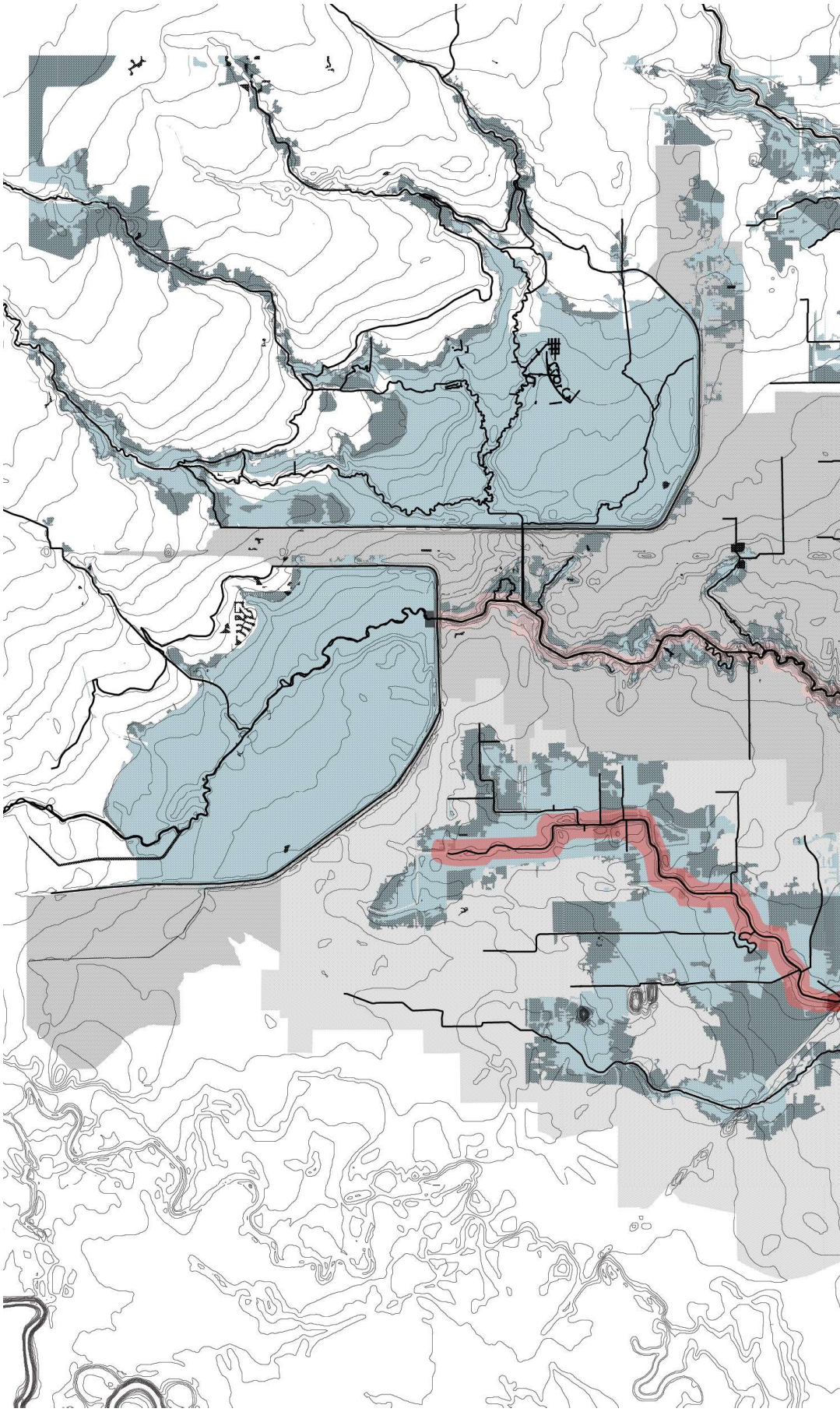
- Artificial Water Reservoirs
- Brays Bayou Watershed
- Buffalo Bayou Watershed

Quality of Bayou Edges
- Channelized
- Low Quality Natural Edges
- High Quality Natural Edges

N

0 5 km





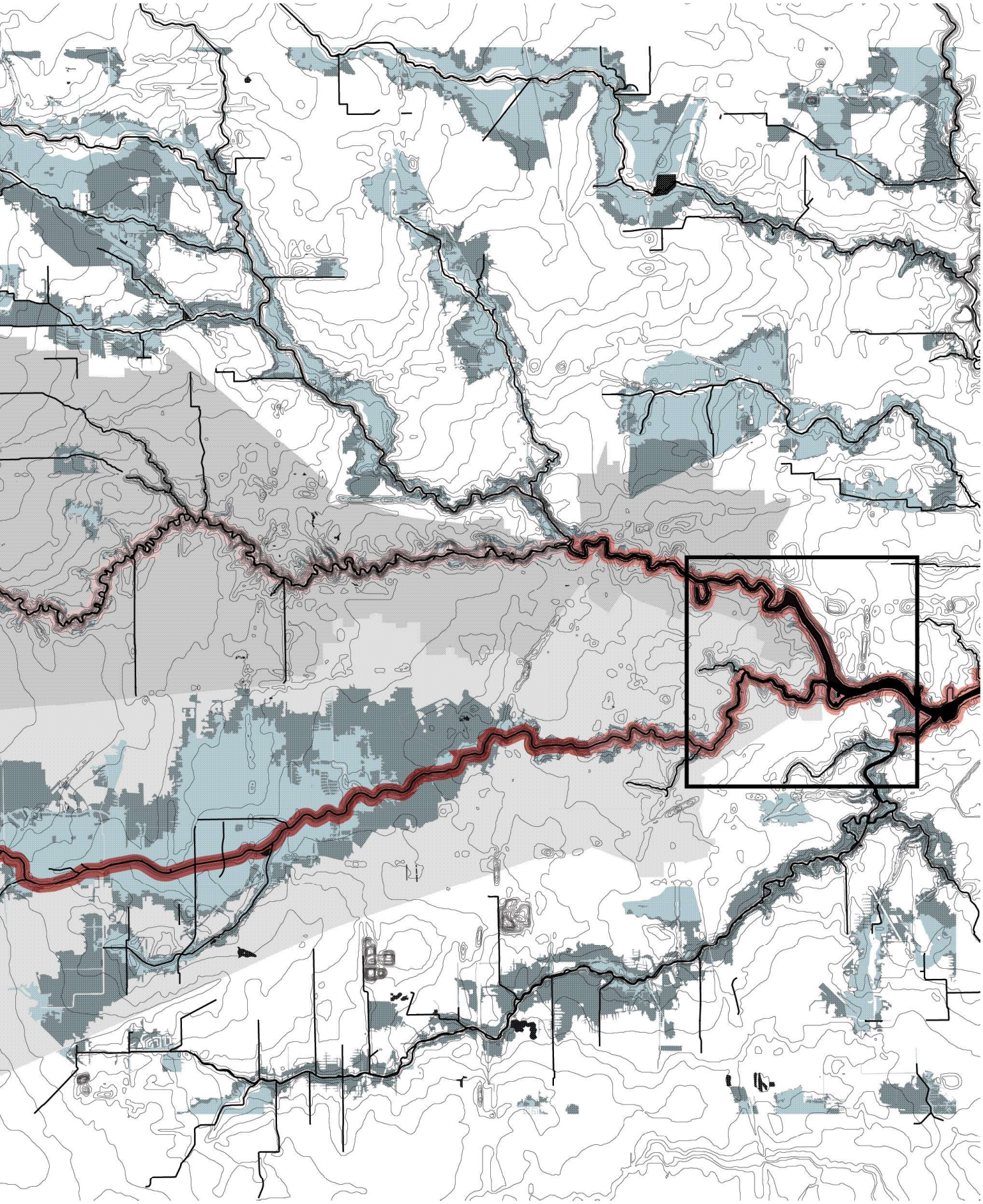
Brays Bayou and Buffalo Bayou Corridor Flood Zone

Based on the FEMA flood data release after Hurricane Harvey, this map highlights the magnitude of flooding which has or would occur notably around the channelized and grass-vegetated Brays Bayou. In contrast, neighborhoods along the heavily vegetated Buffalo Bayou seems to be almost spared.

100 Year Flood
500 Year Flood
Greater East End

N

0 5 km





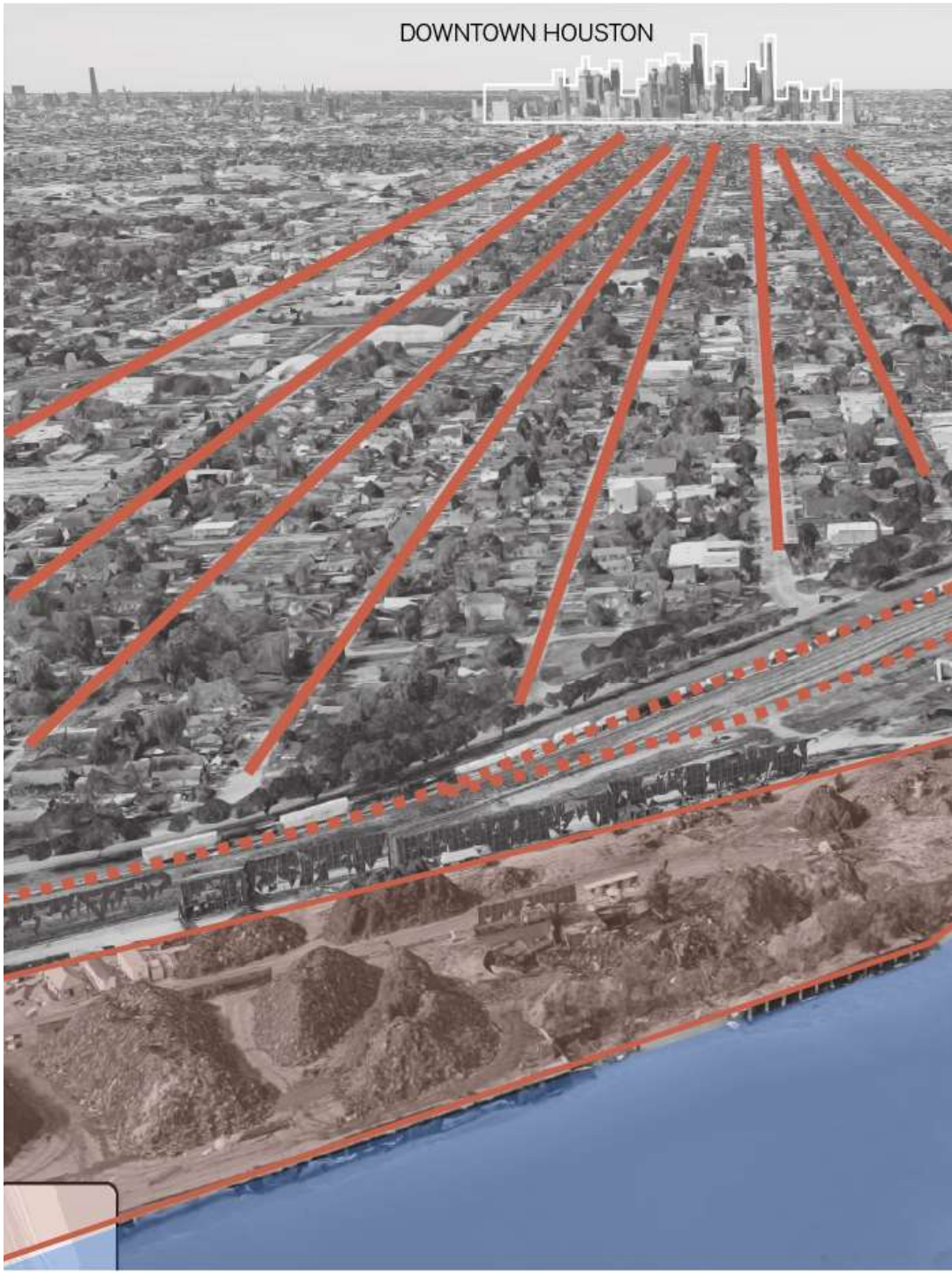
Brays Bayou Bird's Eye View

Looking westwards from the Greater East End, here is outlined the main edge conditions and markers in the landscape: residential areas and human-centric development.

- Brays Bayou
- Vegetated edges
- Industrial site
- Main transit infrastructure
- Main energy corridor



Google Maps. (2020). Retrieved June 2020.



Buffalo Bayou Bird's Eye View

The Buffalo Bayou - downstream of Downtown Houston - is heavily industrialized and was converted to a ship channel facilitating good and materials movement. A railroad system runs alongside the bayou feeding industries and loading ships.

- Brays Bayou
- Vegetated edges
- Industrial sites
- Main transit infrastructure



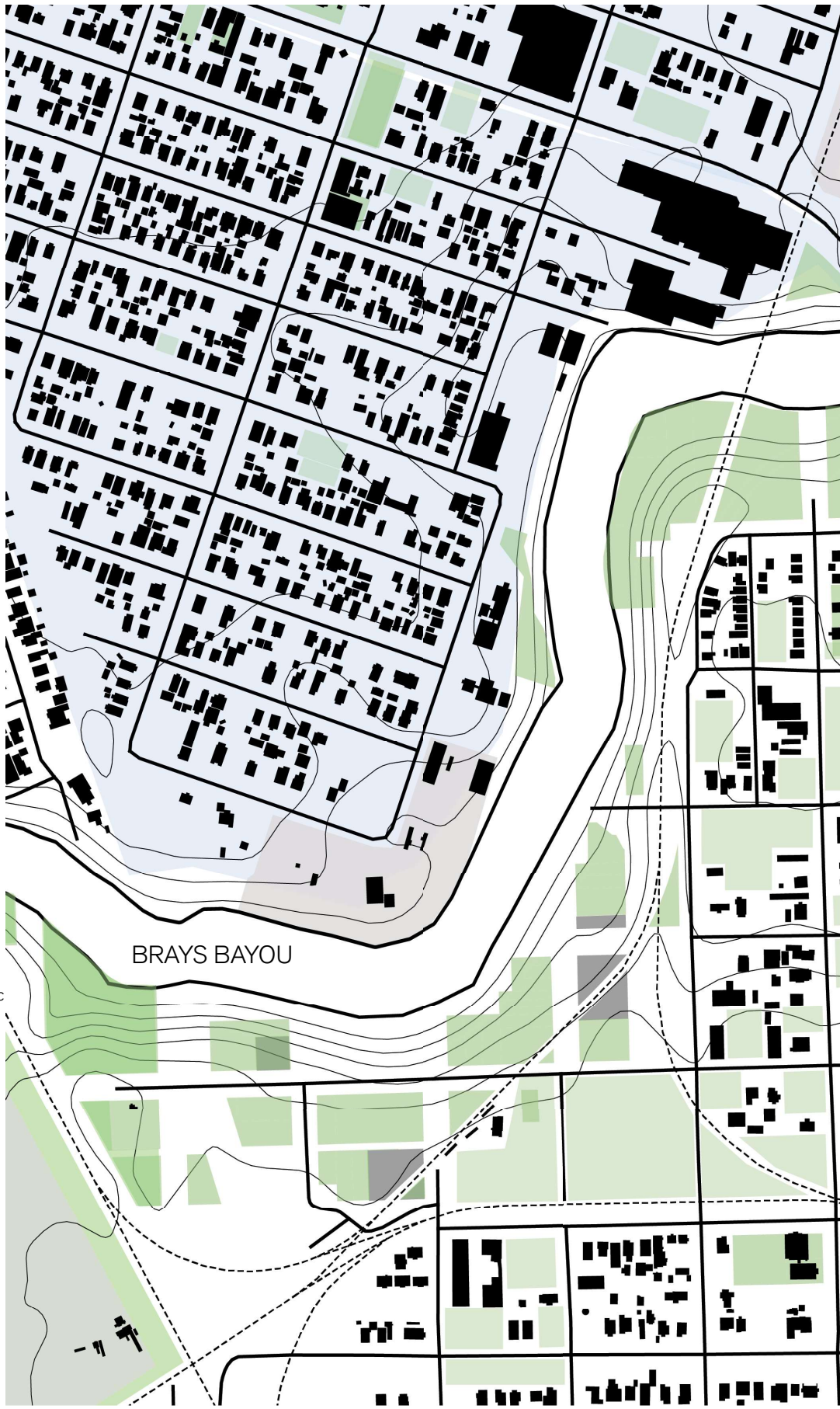
Google Maps. (2020). Retrieved June 2020.

Brays and Buffalo Bayou Corridor

To protect the City of Houston from upstream floodings, large artificial reservoirs were built in the mid 20th century by the Army Corps of Engineers to store and retain water in times of heavy rainfall. The Barker and the Addicks Reservoir are vast lightly-vegetated flat areas surrounded by built-up dams of more than 30m above the National Geodetic Vertical Datum. Combined, the reservoirs have a capacity to store an estimated 510 million cubic meters of water (Handbook of Texas Online, 2008). In the last decade, urbanization has gradually occurred in the Barker Reservoir putting the flood defense infrastructure under considerable stress. During Hurricane Harvey in 2017, the Barker Reservoir was on the brink of overflooding which forced the city to open the dam and release water into the bayou systems. This caused extreme floodings in the Western part of Houston most notably in neighborhoods surrounding the channelized Brays Bayou. An estimate of $125 billion in private property damage resulted from the floods according to the National Hurricane Center (Kimberly, 2019). The concrete channel of the Brays Bayou and it's artificial and grass-edges was not able to sustain such a discharge volume and overflooded - causing the adjacent upper-middle-class neighborhoods to flood. The stark difference between the response of the Brays and Buffalo Bayous shows how edge conditions significantly affect water management. Natural and heavily planted edges have a capacity of absorption and adaptability that was not mimicked in the artificial bayou. Hurricane Harvey exposed flaws in Houston's flood defense system which the city has been actively seeking to solve. As an increase in changing climates and more severe hurricane periods is expected, the City of Houston remains extremely vulnerable to water-related threats.



Barker Dam and Reservoir, Michael Stravato, The Texas Tribune, Sept. 19, 2017



Magnolia Park and Harrisburg/ Manchester Land Use Map

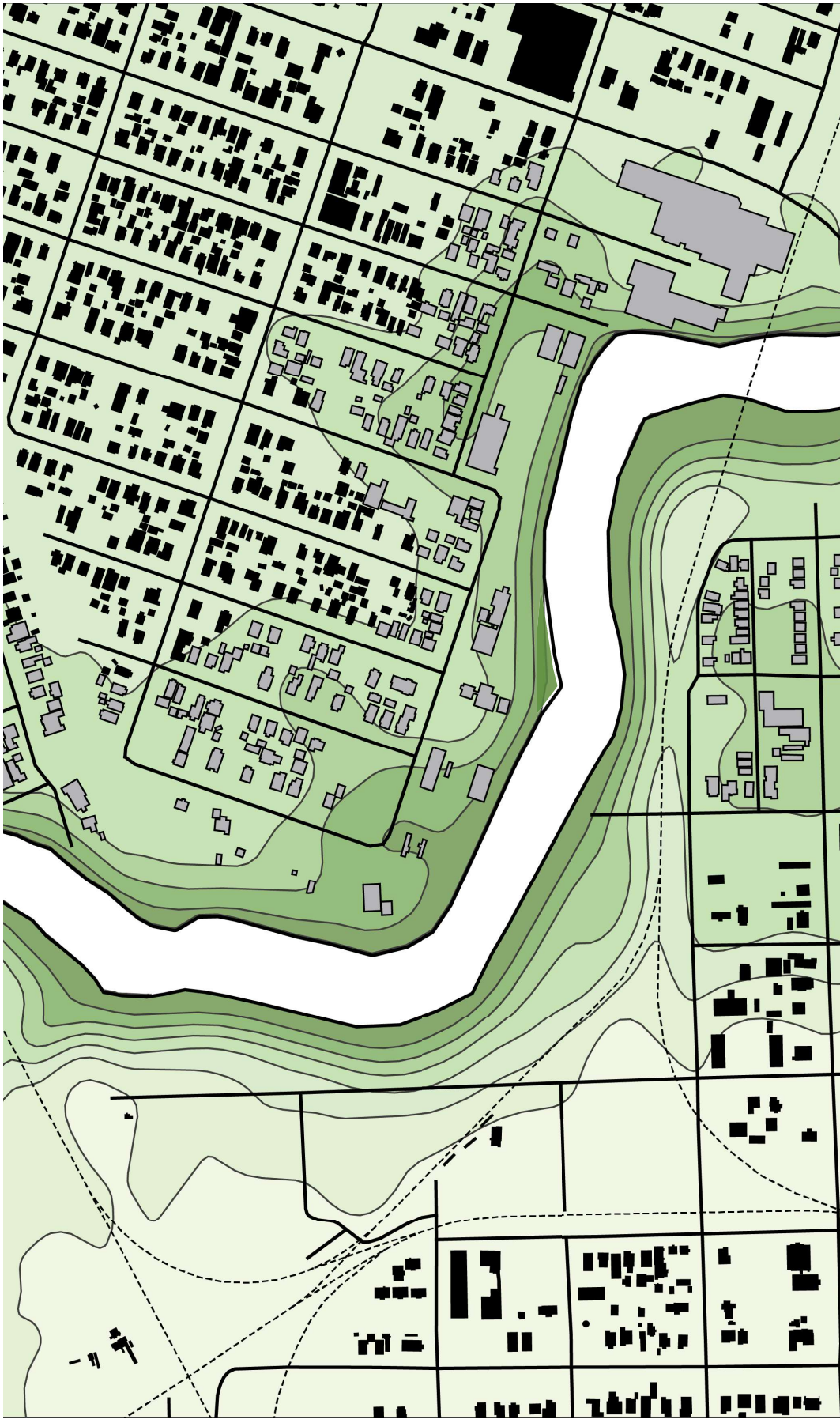
The zoomed-in study area reveals an eclectic landscape from low-density residential neighborhoods to vacant lots to large-scale industrial complexes. The Buffalo Bayou is highlighted as an industrial corridor supporting most export-oriented production and processing. In contrast, the Brays Bayou seem to scarcely benefit residents of adjacent communties.

- High Quality Green Space
- Low Quality Green Space
- Industrial Sites
- Drainage Basins
- Buildings
- 1ft Topography
- Roads
- Railroads

N

0 100 m


BUFFALO BAYOU



Topography Map

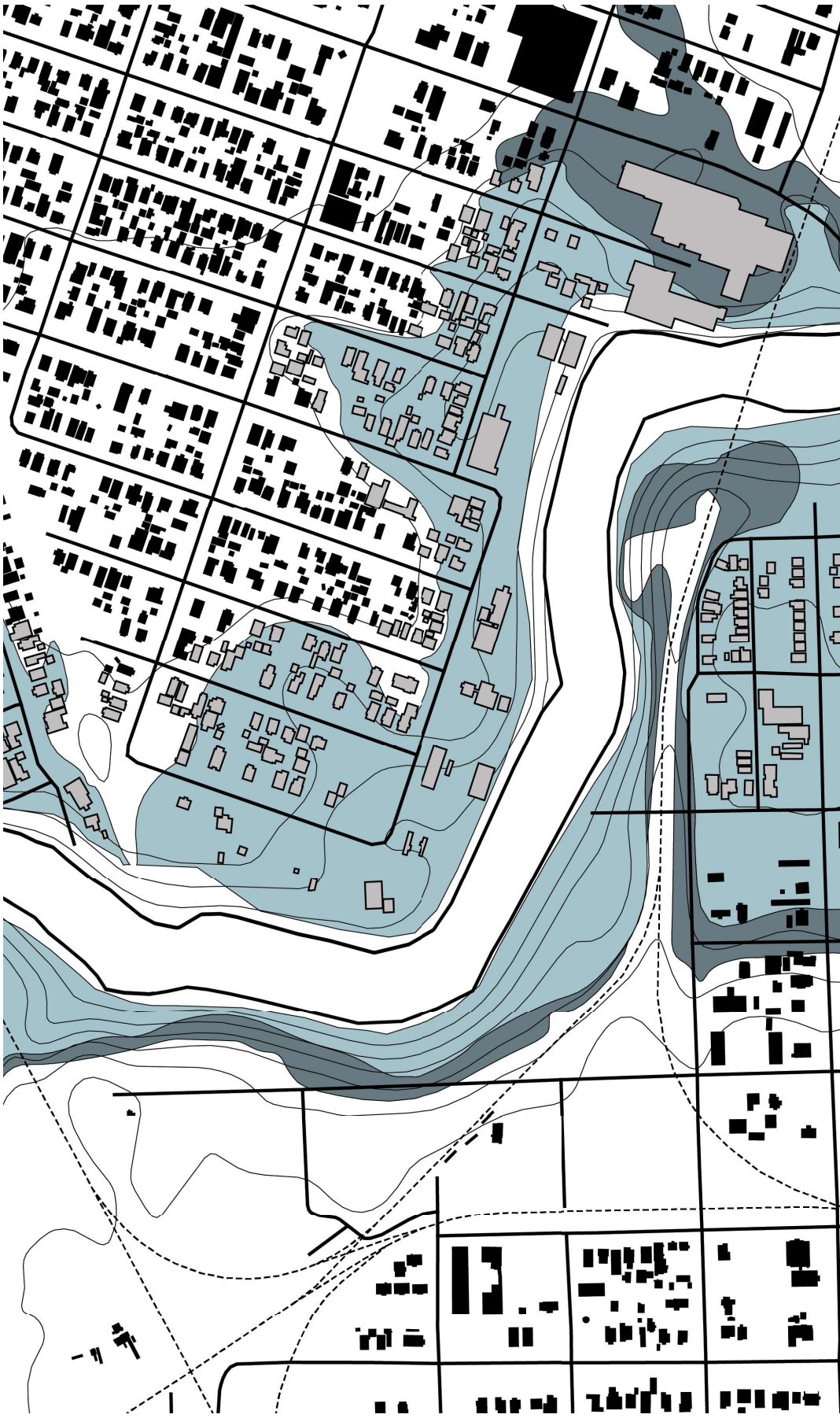
You can see in this map the steep natural bayou edges which allowed for natural flooding. Some of these floodplains have since been deteriorated and urbanized. Many low-income houses and small scale industries have been built on these natural flood-defense areas.

Flat Ground (out of floodplain)
Buildings in Natural Bayou Edges
1ft Topography

N

0 100 m





Flood Map

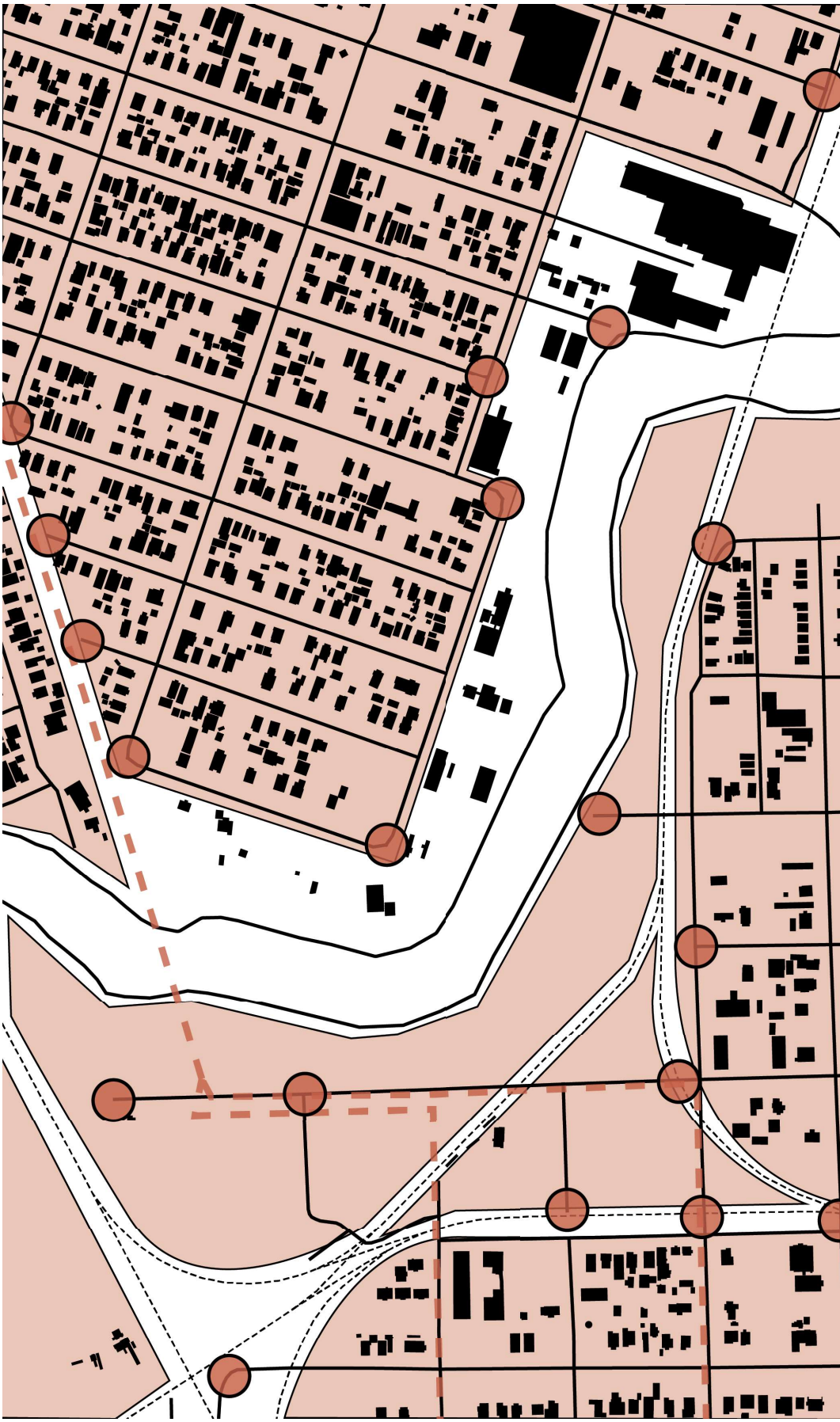
Based on FEMA flood data, this zoomed-in map reveals the extend of the neighborhood which is prone to large-scale floodings due to overflowing bayous. Notable to note is the exposure of the low-income ‘peninsula’, the elevated railroad line which could serve as a flood defense infrastructure, and the nearly untouched refineries to the East.

- 100 Year Flood
- 500 Year Flood
- Building in Floodplain

N

0 100 m





Fragmented Landscape Map

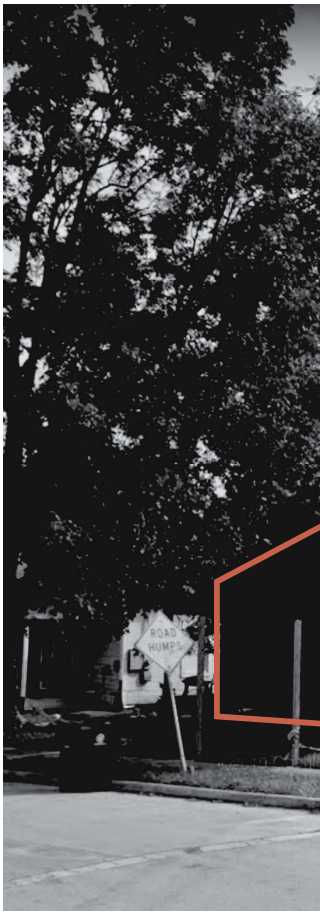
This map reveals the various fragmented areas of the neighborhood and the many disconnected and dead-end roads. This leads to spatial segregation whether due to program, transport infrastrucutre, or landscape features.

- Fragments
- Dead Ends
- Energy Corridor

N

0 100 m







Fragmented Landscape

The main urban networks contribute to neighborhood and landscape fragmentation. The two could however be leveraged to reconnect various layers of the landscape and support ecological corridors.



Google Street View. (2020). Retrieved June 2020.



Google Street View. (2020). Retrieved June 2020.



Industrial Landscape

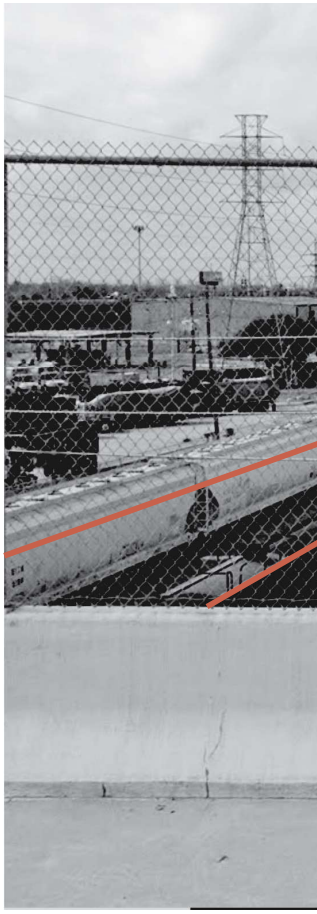
Harrisburg/Manchester is home to small and medium scale metal recycling plants and large petro-chemical refineries which are feed by an extensive *industrial-use-only* railway system which crosses and fragments the various layers of the landscape.

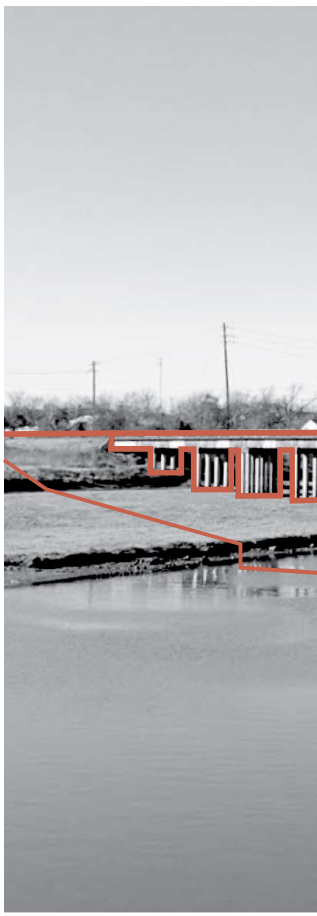
- Industrial Railroad
- Industrial Sites
- Brownfields

N

0 | 100 m







Industrial Infrastructures

These single-use large-scale infrastructures cross all elements of the landscape and could serve as connectors rather then dividers (as they do today).



Google Street View. (2020). Retrieved June 2020.



Google Street View. (2020). Retrieved June 2020.



Vacant Lot Map

This map highlights the various under-used and fully vacant spaces in the neighborhood. Either doted of a for lease or for sale sign, used as an abandoned car lot, or simply vacant and scarcely vegetated.

Vacant Private Lot
Vacant Public Lots

N

0 100 m







Vacant Lots

Illustrated here, two types of vacant lots in the Greater East End. These lots - either for sale, for lease, or seemingly abandoned - offer a great deal of possibilities to create small ecological reserves, productive community lands or striving social centers. Today, there are mostly underplanted and sometimes feature discarded furniture or cars.



Google Street View. (2019). Retrieved June 2020.



Google Street View. (2020). Retrieved June 2020.



Extreme Conclusion Map

This map summarizes the key landscape features of the Magnolia Park and Harrisburg/Manchester area. A large swatch of the land is prone to floods coming from the overflowing bayous, a vast amount of space remains vacant to this day offering multi-opportunities development (either built or natural) and finally the space is locally fragmented by large-scale industrial infrastructure which currently does not serve the community.

N

0 100 m



Magnolia Park and Harrisburg/Manchester

In conclusion, the landscape of this neighborhood was significantly modified by human-centric uses. On one hand, the industrial complex sprawling along the Buffalo Bayou intended for global exports has strongly impacted the local scale. The railway infrastructure serves as a divider in the community and large industrial sites border the bayou making these spaces inaccessible for leisure. The neighborhood is doted of multiple vacant lots which are either for sale, for lease, or simply abandoned. This practice derives from the City of Houston's lack of zoning, which not only allows for close proximity between industrial and residential neighborhoods but also incentivized sprawl over densification. This practice (or lack thereof) although free in nature, does not value communities, proximities, and adjacencies as much as investments and profits. The riparian corridors of both bayous have been significantly modified, either by urbanization (or industrialization) or by vegetation modification. These changes have exposed vulnerable residential areas to extreme floods. Although large fragmenting infrastructure and vacant lots can seem like a negative aspect of the current neighborhood's landscape, these offer immense opportunities for redevelopment and regeneration of weakened areas.

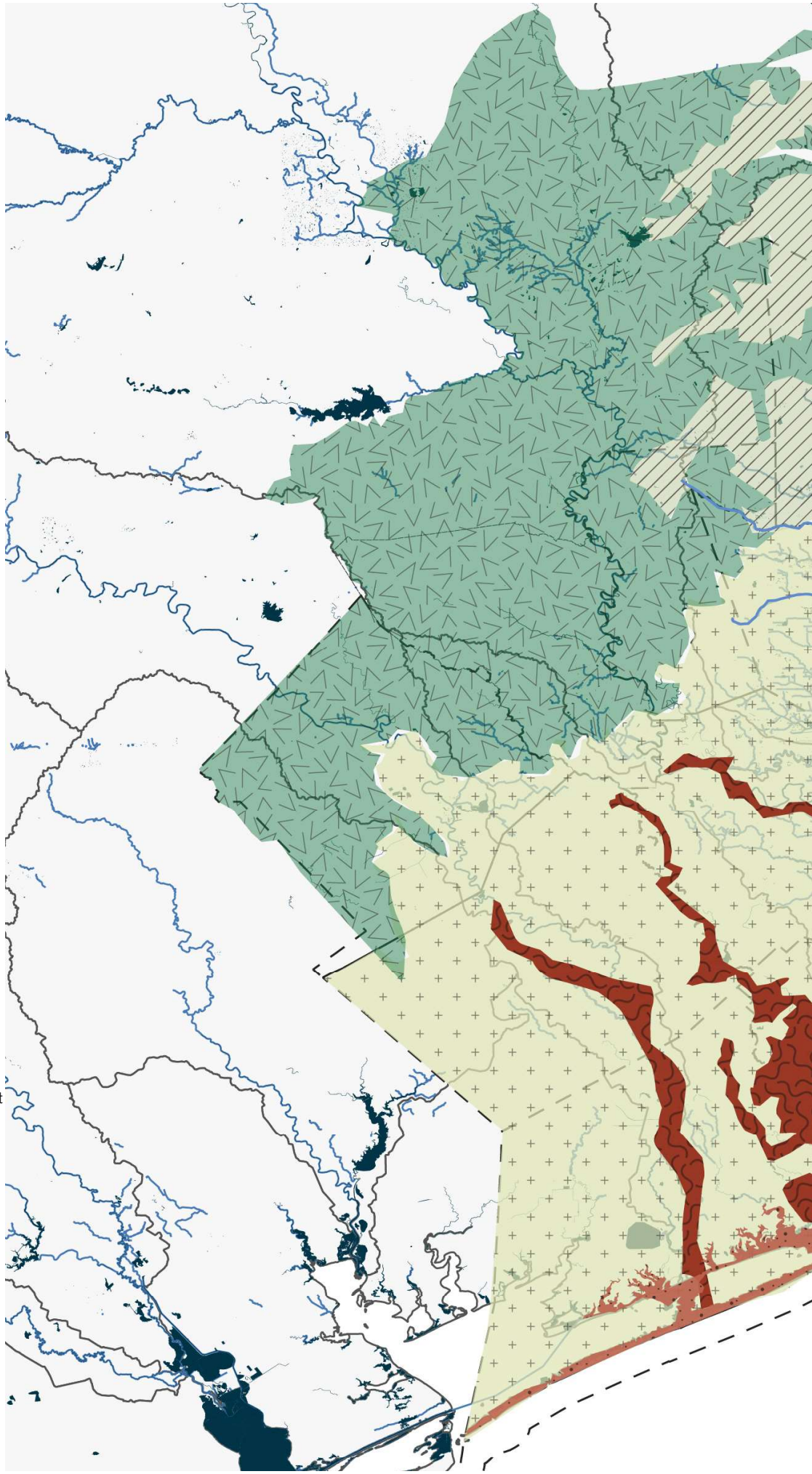


BUFFALO BAYOU IN MAGNOLIA PARK
An Unspoiled Bend which may be preserved as a Breathing-spot in the Industrial Region

University of Houston Digital Library, retrieved June 2020, from https://digital.lib.uh.edu/collection/p15195coll2

3.4.

Ecology

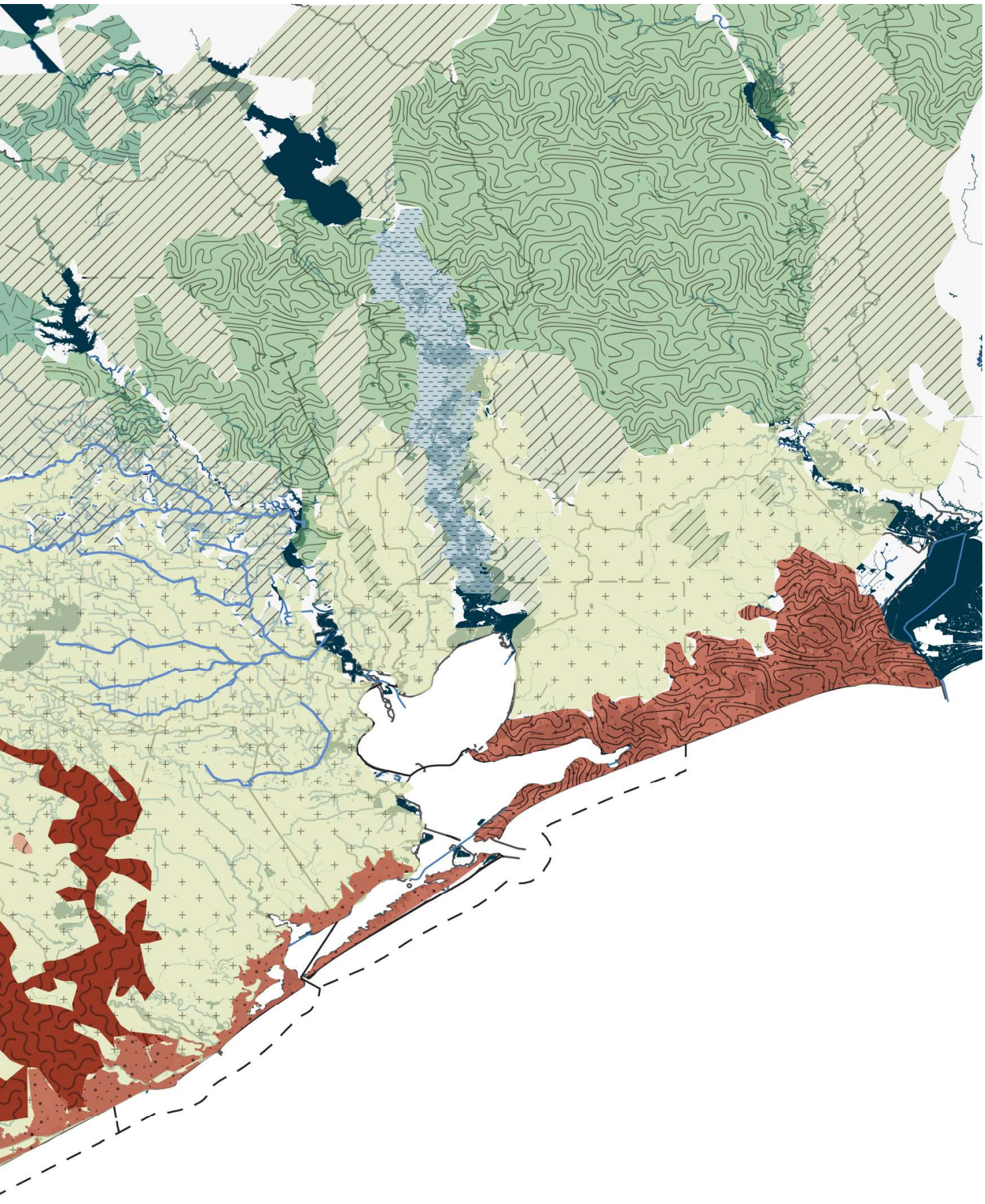


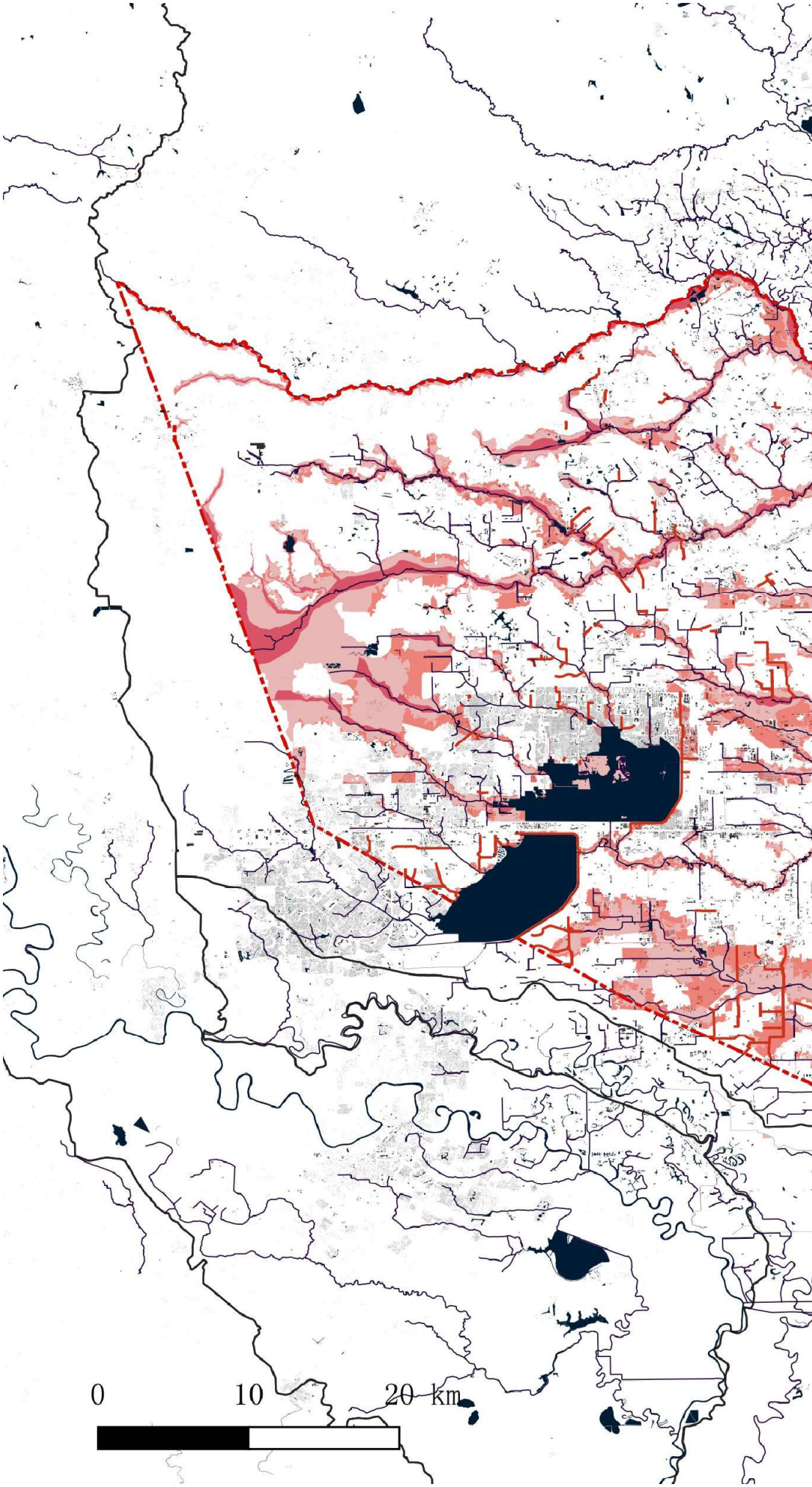
Eco-regions

The city of Houston is loacted in the most of ecological diverfied urban area in the US.There are ten kinds of eco-regions: seven land based and three water based.

- Water or highlight
- Sealevel rise
- Trinity Bottomland
- Coastal Marches
- Post-oak savannah
- Esturaies (flood river valley)
- Prairie System
- Piny Woods

0 100 km



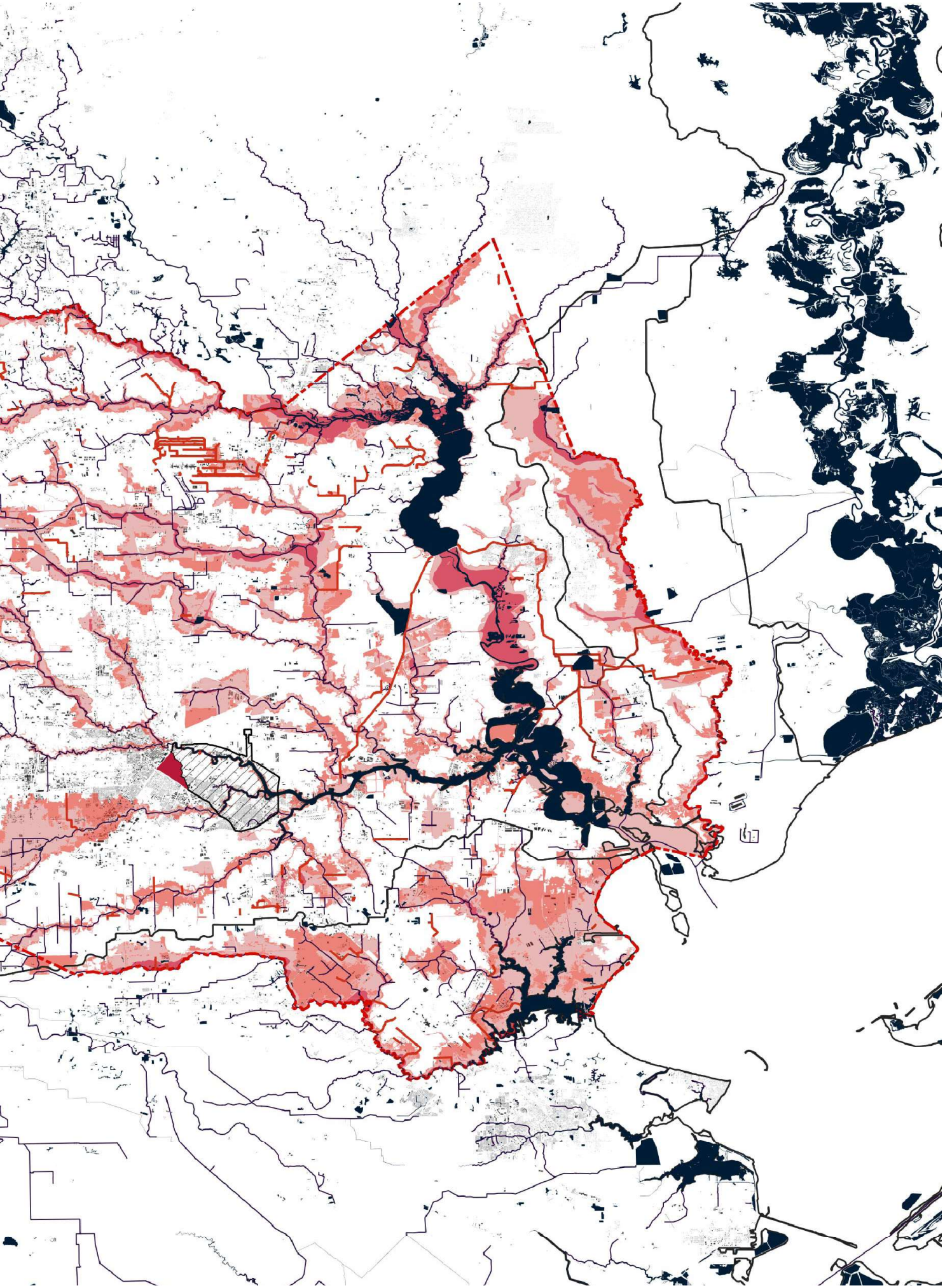


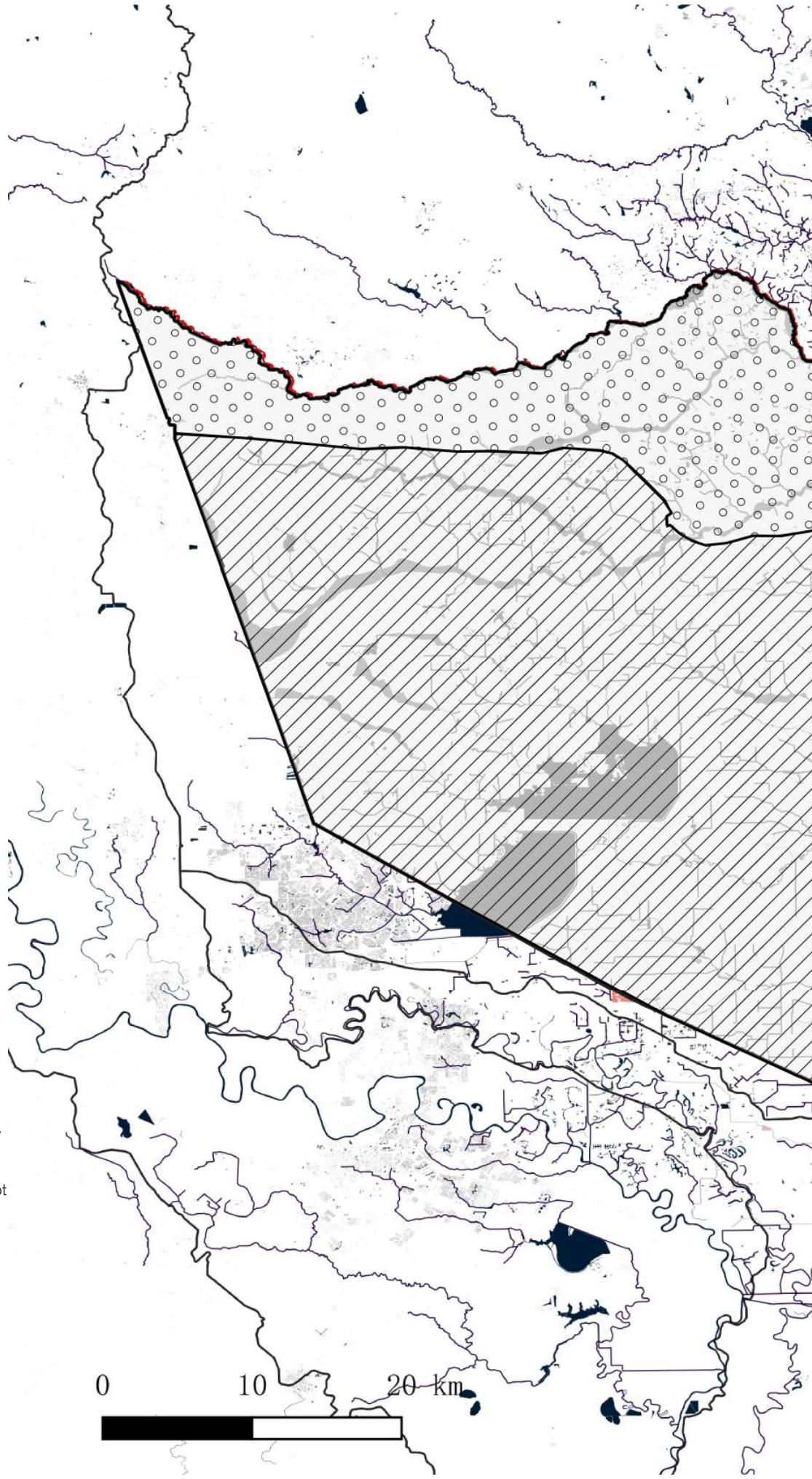
Bayou City

There are a large amount of bayous flowing in Harris County. Houston is famous for its Bayou City. Accroding to data, there is 2047km of natural water system running through city.

- Water
- Flooding way
- 100 year floodplain
- 500 year floodplain
- Harris County Boundary
- Great East End

0 10 km



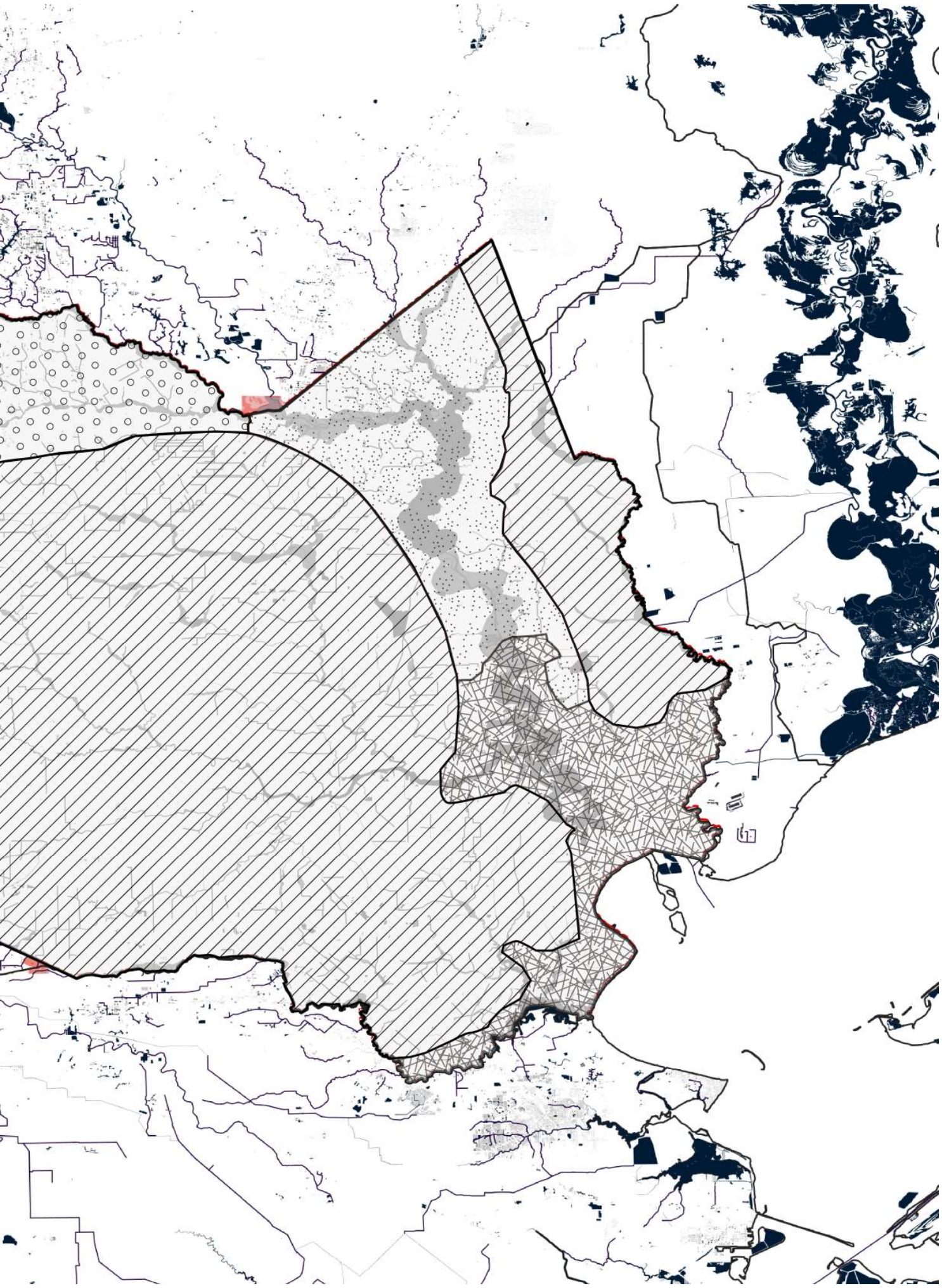


Floodplains

A shallow floodplain covers the whole city of Houston.Normally, the water is mainly shallow and slow at the normal period. Flooding begins when the capcity of channel is exceeded. In Houston, the process is even faster. This landscape typology has affected the ecosystem a lot in many aspects.

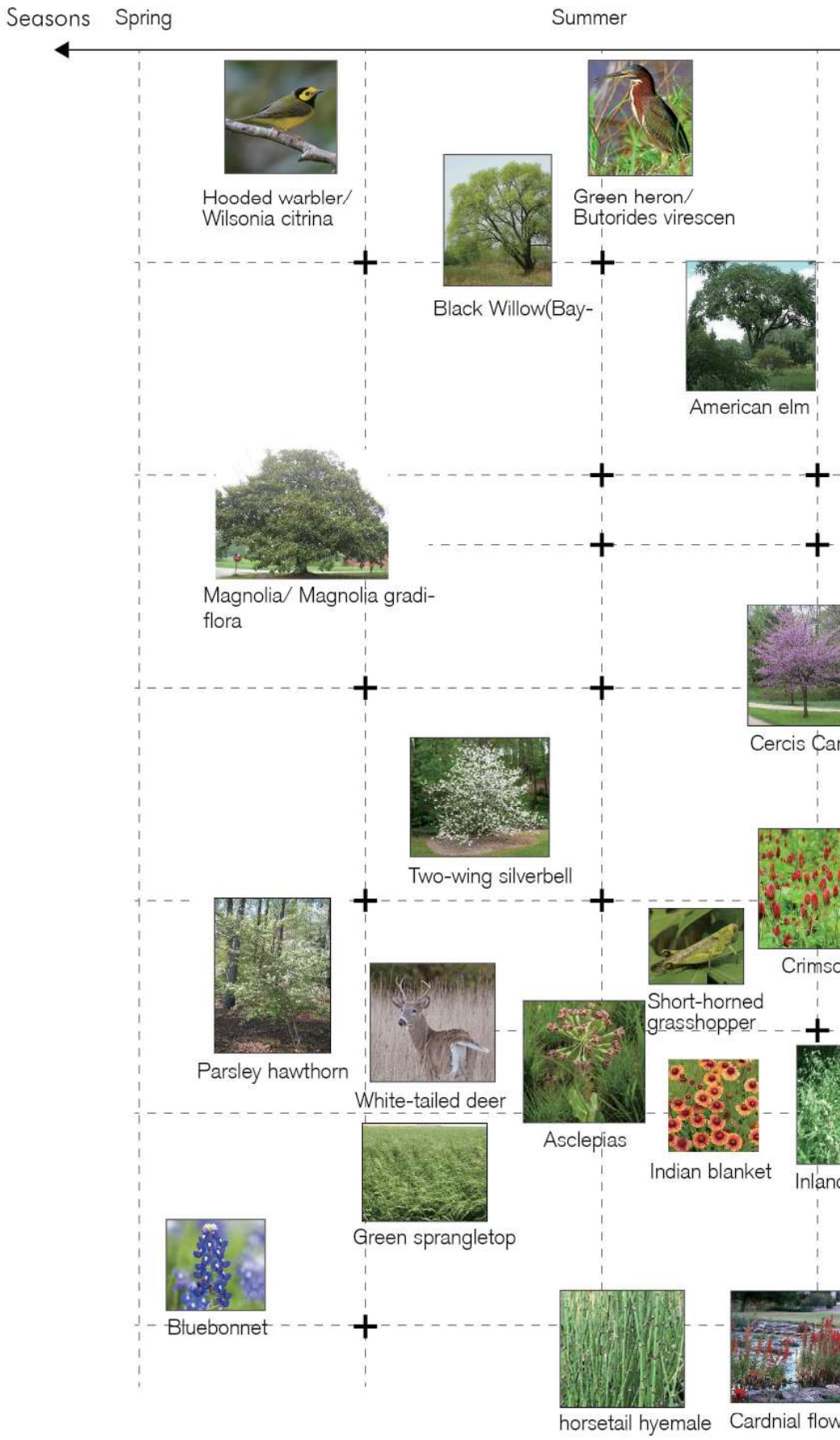
- Coastal Floodplain
- Major River Floodplain
- Valley Floodplain
- Shallow Floodplain

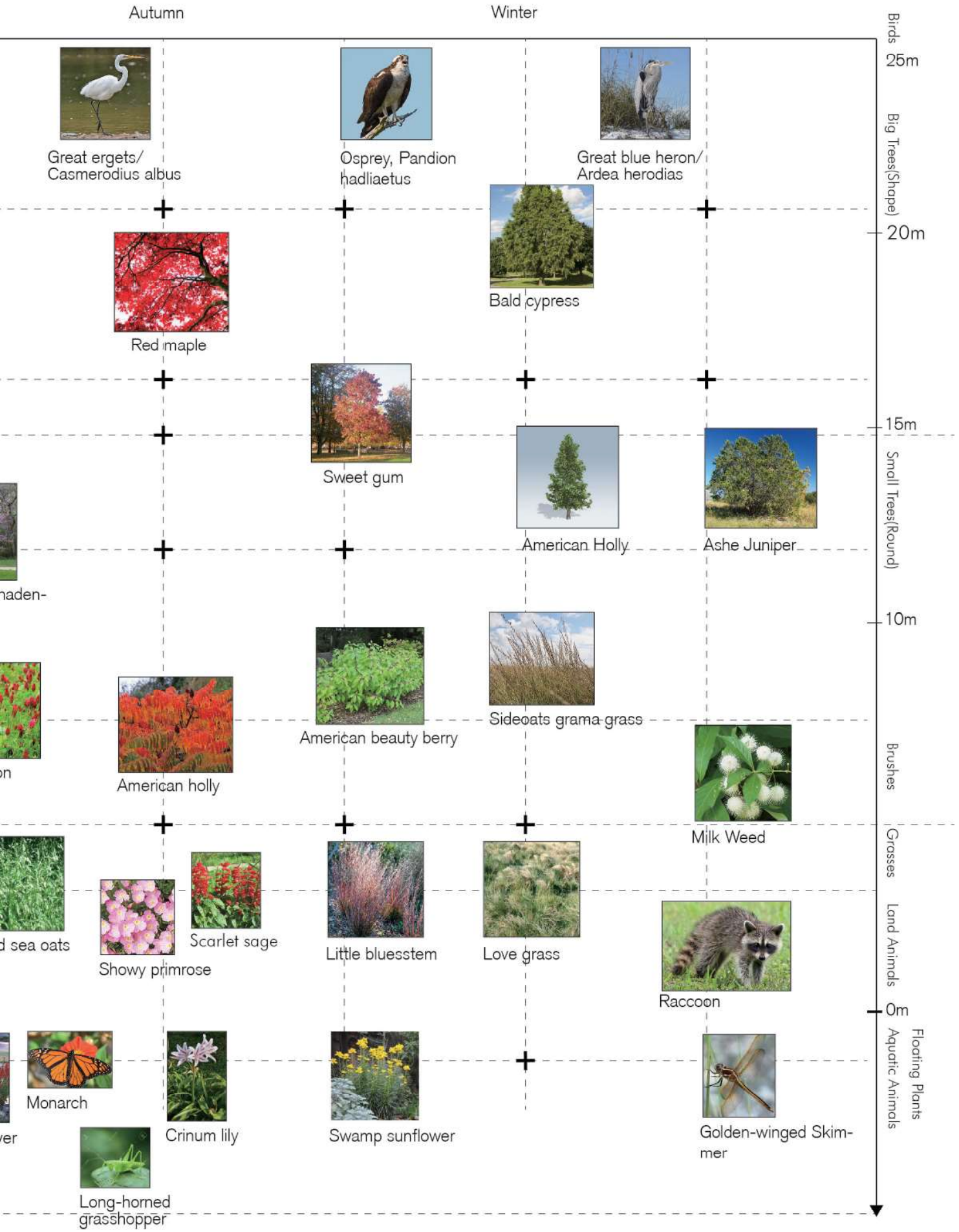
0 10 km



Flora and Fauna

Flora and fauna analysis is based on two systems: prairie and bayou. In the table of floara and fauna, the sequence of time and height has been applied to organzie and represent the diverisfied species in Houston.




Autumn
Winter
Birds
25m
Big Trees(Shape)
20m
15m
Small Trees(Round)
10m
Brushes
Grasses
Land Animals
0m
Floating Plants
Aquatic Animals
Great ergets/
Casmerodius albus
Osprey, Pandion
hadliaetus
Great blue heron/
Ardea herodias
Bald cypress
Red maple
Sweet gum
American Holly
Ashe Juniper
haden-
American beauty berry
Sideoats grama grass
American holly
Milk Weed
on
d sea oats
Scarlet sage
Showy primrose
Little bluesstem
Love grass
Raccoon
Monarch
Crinum lily
Swamp sunflower
Golden-winged Skim-
mer
ver
Long-horned
grasshopper



Flora

Overstory Trees(OT): Highest layer of vegetation, forming the canopy(above15m)

Understory Trees(UT): Growing and living beneath the canopy(10-15m)

Shrubs(S): under understory trees, 5-10m

Grass(G):under 5m

Wildflowers:under 5m

Trees (Prairie)



American Elm / Ulmus Americana

Origin: US
Soil and Humidity: tolerant to drought and cold
Use:decoration,



Red maple / Acer rubrum

Origin: US
Soil and Humidity: swamps, poor dry soils.
Viewing Season: Autumn



Ceder Elm / Ulmus crassifolia

Origin:Texas Native
Soil and Humidity:distributed widely in East, South, near streams, humid
Use: manufacture wheel hubs, furniture, etc



Sweetgum / Liquidambar styraciflua

Origin:North America
Soil and Humidity:grows best in moist, acidic loam or clay soil, and tolerates poor drainage
Use: ornamental tree



Magnolia / Magnolia gradiflora

Origin:East Asia/ Southeast Asia
Soil and Humidity: tolerate wet, soggy soil
Use:ornamental tree

Grasses



Inland sea oats / Chasmanthium latifolium

Origin:East America
Soil and Humidity:grows along streams and rivers in woodland areas and flood plains
Use: Gardening



Sideoats grama grass / Bouteloua curtipendula

Origin: temperate and tropical Western Hemisphere
Soil and Humidity:mountainous plateaus, rocky slopes, and sandy plains. Drought- and cold-tolera



Green sprangletop / Leptochloa dubia

Origin:Grows on rocky hills and in canyons
Soil and Humidity: warm
Use: grazing for wildlife and livestock, palatable



Crimson clover / Trifolium incarnatum

Origin:Europe
Soil and Humidity: tolerate the poor soil
Use: fertilizer of agriculture



Little Bluestem/ Schizachyrium Scoparium

Origin:America
Soil and Humidity:rows best in full sun and on well-drained soils
Use:cultural heritage

Wildflowers



Indian blanket / Gallardia pulchella

Origin: northern Mexico
Soil and Humidity: not picky about soil, though sandy and well-drained are best
Use: used for honey



Plains coreopsis / Coreopsis tinctoria

Origin:North America
Soil and Humidity:r sandy or well-drained soils, drought tolerant



Scarlet sage // Salvia coccinea

Origin:Brazil
Soil and Humidity: soil with good drainge
Use:Viewing



Prairie verbena / Verbena bipinnatifida

Origin:North America
Soil and Humidity:Part sun/shade, drought tolerant
Use:



Showy primrose / Oenothera speciosa

Origin: Texas Native
Soil and Humidity:rocky prairies
Use:gardening



Bluebonnet / Lupinus texensis

Origin:Texas Native
Soil and Humidity: well-draining sandy soil with full sun exposure
Use:cultural Heritage

Bayou Wilderness

Trees (Bayou Wilderness)



Black willow / Salix nigra

Origin:North America
Soil and Humidity:humid, warm and permeable land



Bald cypress / Taxodium Distichum

Origin:New Jersey to Florida
Soil and Humidity: adapts to a wide range of soil types, whether wet, dry, or swampy
Use:decoration



Ashe Juniper / Juniperus Ashei

Origin:Mexico
Soil and Humidity:drought-tolerant



American holly / Ilex opaca

Origin: eastern and south-central US
Soil and Humidity:swampy soil
Use:Drink

Aquatic Vegetation



Horsetail / Equiseturn hyemale

Origin:Australasia
Soil and Humidity:moist, rich soils
Use:medicine



Crinum lily / Crinum americanum

Origin:US
Soil and Humidity:wet,swamps and wetlands
Use:Drinking



Cardinal flower / Lobelia cardinalis

Origin:America
Soil and Humidity: wet places, streambanks, and swamps
Use:Medicine



Swamp sunflower / Helianthus angustifolius

Origin: Central US
Soil and Humidity: wetlands,swamps
Use:Viewing

Fauna

To analyze the fauna, it mainly focus on two prairie and bayou eco systems. Among all of the ecosystems in the Houston, the prairie has been threaten mostly. This endangered system has been overgazed, plowed and developed barely non-existence. Although it seems that prairie is monotonous, it has resilient biodiversity with multiple chains of relationships as the diagram represented.

For bayou system, crayfish, butterflies, turtles and ducks are the native species. The bayou is the habitat for many species. According to Houston Wildnerness, more than 165 species of birds,31 species of mamals, 13 amphilbians and more thann 22 kinds of fishes can be found in bayou system. As Houston expaned and developed, many bayou has been modified and changed. In that case, the biodiversity was eliminated. Only few natural bayou has been remained until now.



Harrier Eagle

SECONDARY PREDATORS



Orchard Orbweaver / Leucauge venusta



Wood duck / Aix sponsa



Great blue heron / Ardea herodias



Great blue heron / Ardea herodias



Great blue heron / Ardea herodias

PRIMARY PREDATORS



Immature Long-horned grasshopper /of the family Tettigonidae



Golden-winged skimmer/Libellula auripennis

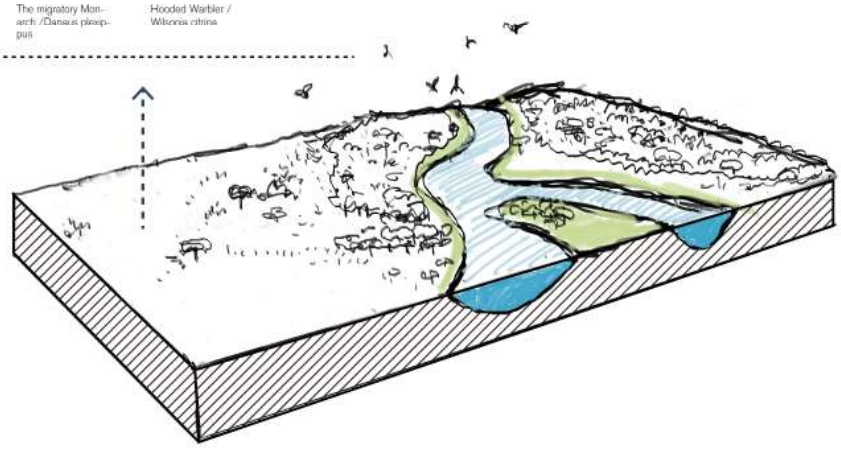


The migratory Monarch /Danaus plexippus



Hooded Warbler / Wilsonia citrina

HERBVORES





Raccoon / Procyon lotor

SECONDARY PREDATORS



Nine-banded armadillo / Dasypus novemcinctus



Burrowing owl / Athene cunicularia



Snow geese / Chen caerulescens.



Immature Assassin bug / of the family Reduviidae



Black & Yellow Argiope / Argiope aurantia

PRIMARY PREDATORS



Short-horned grasshopper / Melanoplus



Spicebush swallowtail / Papilio (Pterourus) troilus

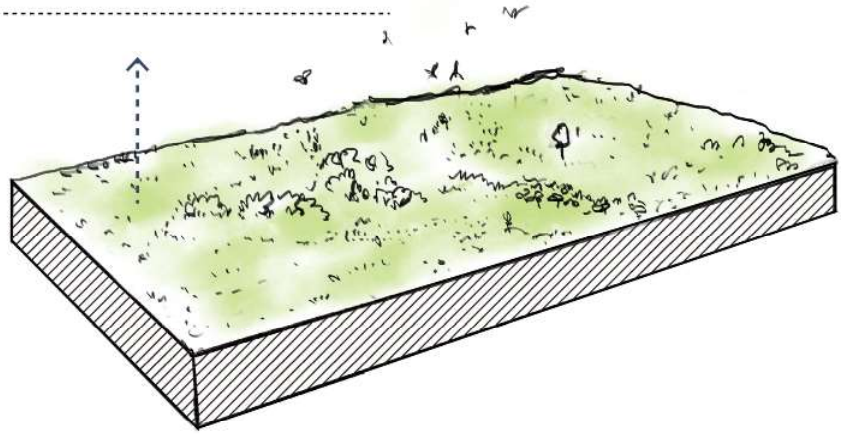


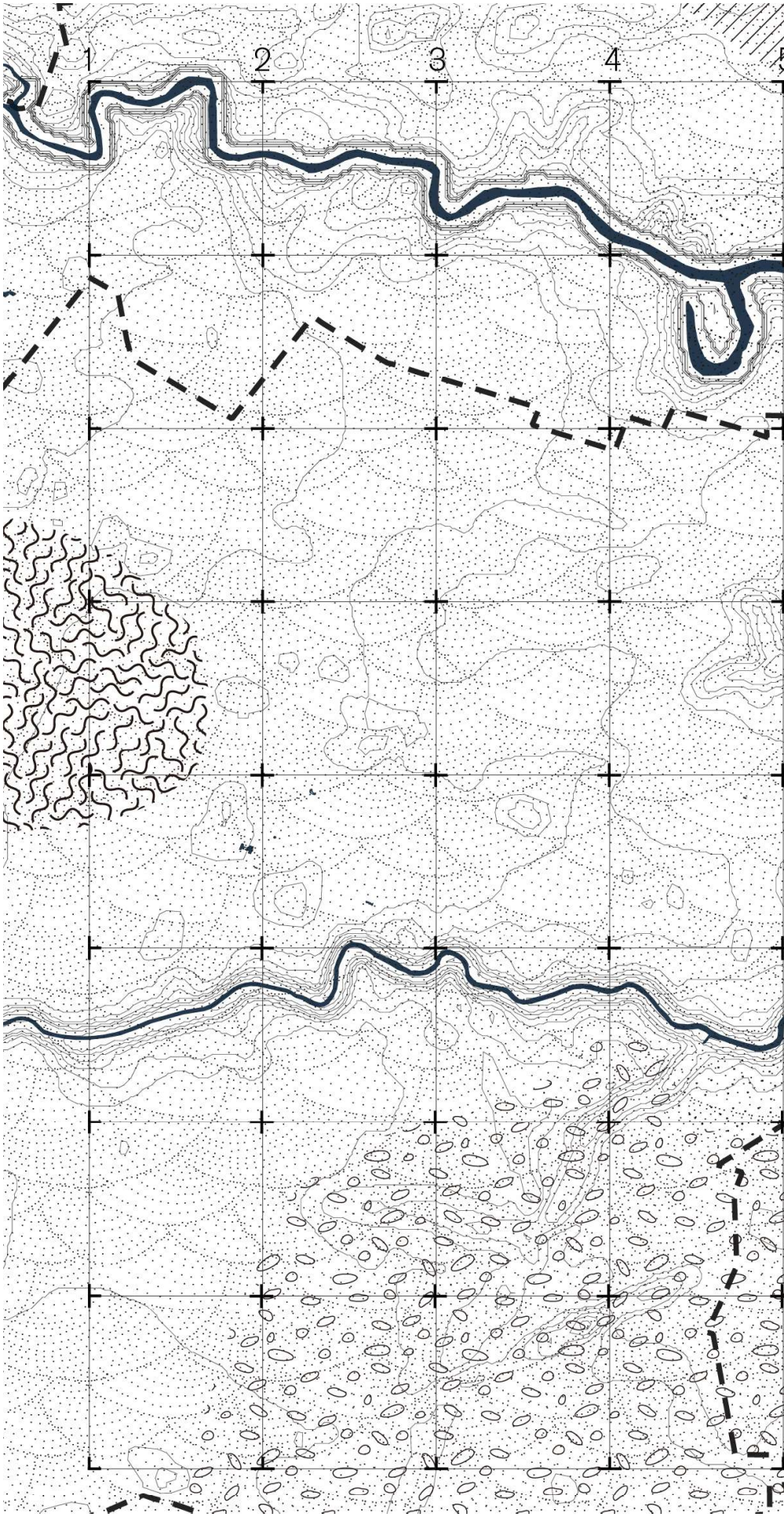
Attwater's Prairie chicken, / Tympanuchus cupido attwateri



White-tailed deer / Odocoileus virginianus

HERBVORES





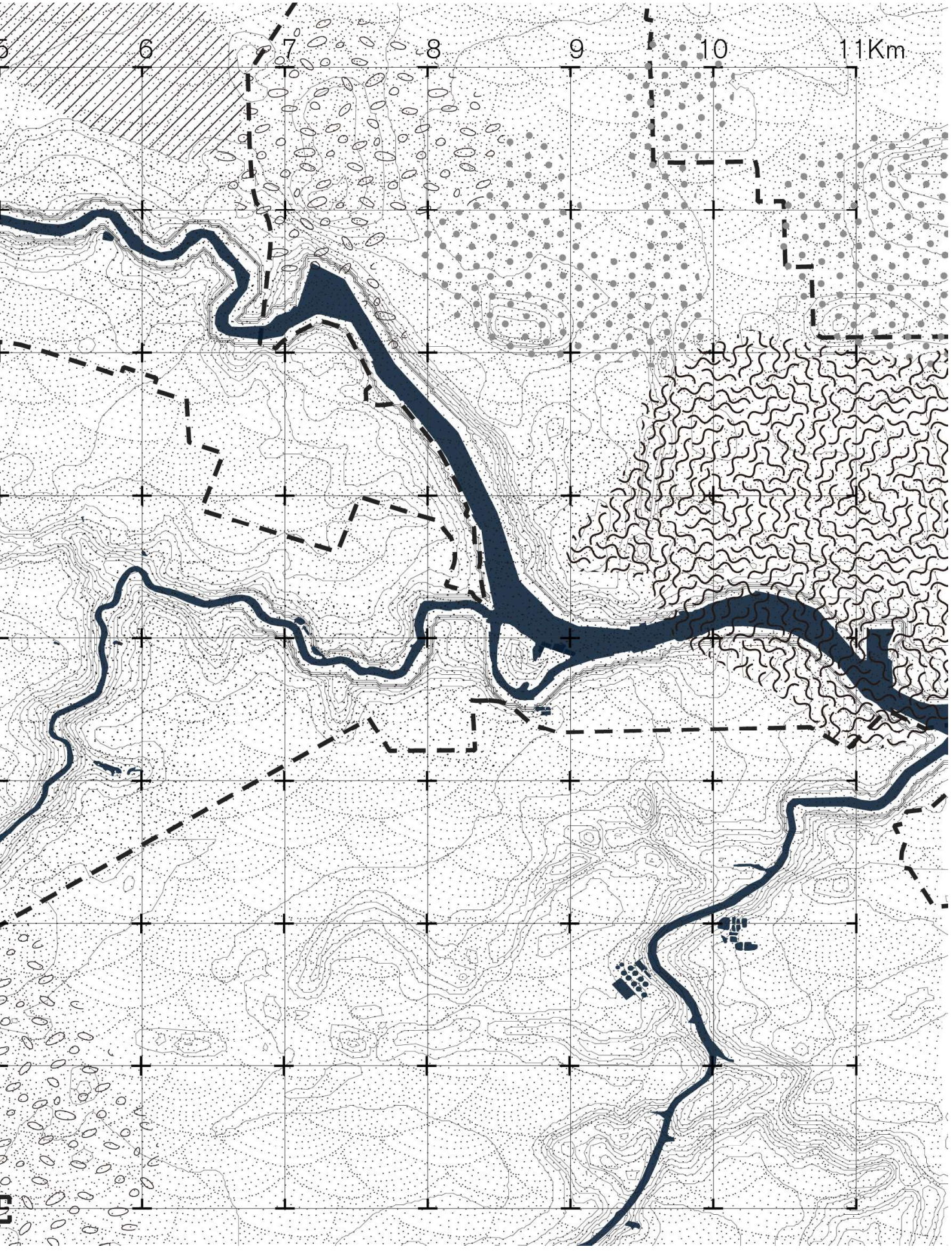
Soil Type

This map divide the soil around Buffalo and Bray bayou into several categories

- Water
- Poorly drained; loam
- Poorly drained; Clay and loam
- Poorly drained; slow permeable;Clay and loam
- Poorly drained; loam
- Moderaly well drained; bottom soil

N

0 | 1 km


6
7
8
9
10
11Km

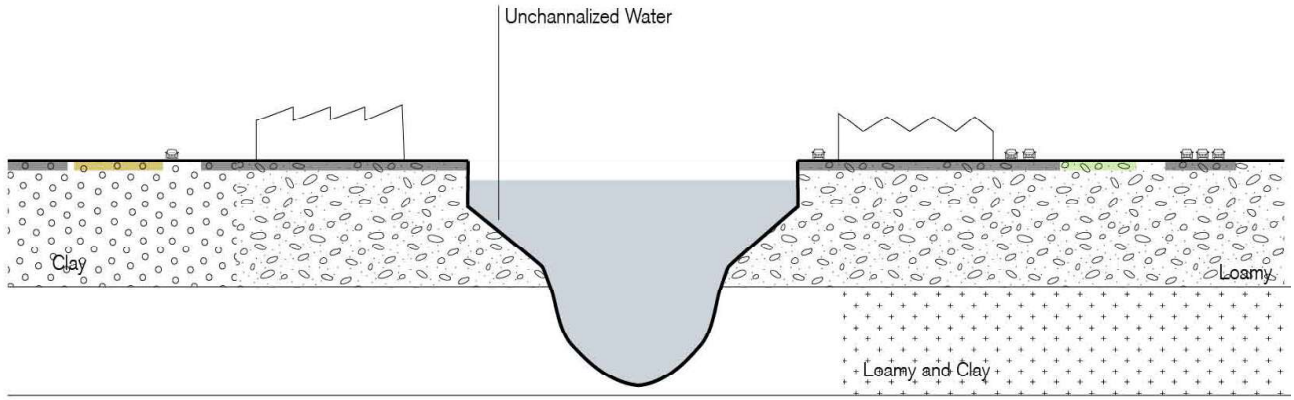
Permeability of land around bayou

In Houston, most of soil types are sand, loam and clay and they are poorly drained under most of circumstances. Because of the soil types, it is difficult for rainfall to be inflitrated. Moreover, the fast urban growth leads to the consequence that most of land has been dominated by hard surface. This situation also has a negative impact on flooding issues.

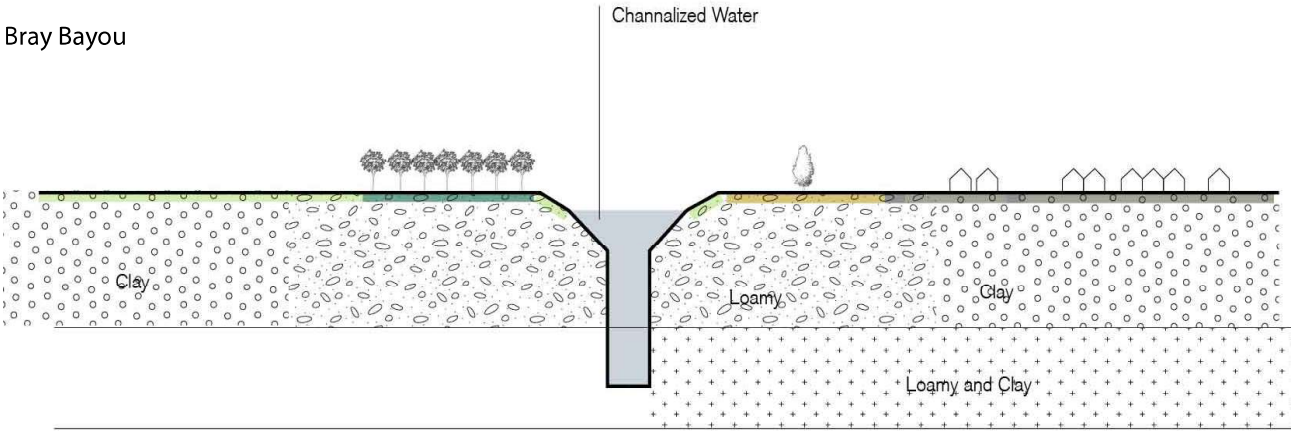
Futhermore, the map also makes a comparison between Bafflao and Bray bayou. Bafflao bayou is natural bayou without channalization process while Bray bayou has been framed by concrete canal. Another difference is the surface layer close to two bayou is opposite: the edge of Bafflao bayou is dominated by industrial area, leading to impermeable surface; the edge of Bray bayou is normally covered by grassland which has comparatively good permeability. It is also shown in the section.

Last but not least, the vegetation affects the permeability of land as well. Native grass can use their roots to create more space between soil partecles. Due to that, the rain water can be easily drained. Compared with native ones, the lawn


0
1
2
3
4
5
6
7
8
9
10
11Km
Bray Bayou


Unchannalized Water
Clay
Loamy
Loamy and Clay

Bray Bayou

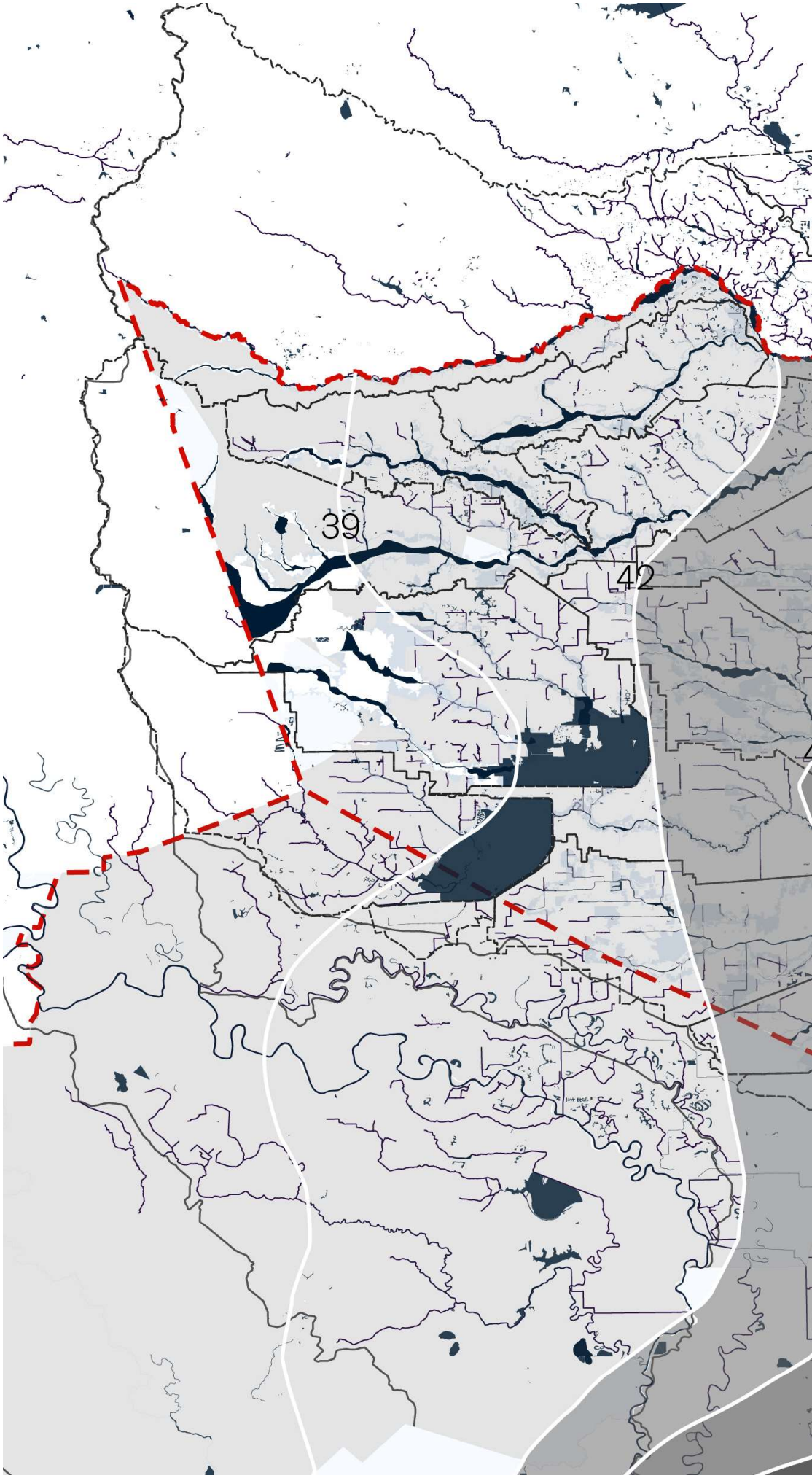

Channalized Water
Clay
Loamy
Clay
Loamy and Clay

Eco-regions Eco-series and Eco-profile

Hsouton contains diversified landcape types, whcih could form vairous eco-regions. Most of eco-regions are water based. Each eco-region covers large are of land and water with distinct characteristics of natural community and species and own environmental conditions. Normally, eco-region boundary does not form hard edges while the ecotones (transitional area between two eco-system) and natural habitats will be established. The biodiversty of the flora, fauna and ecosystem show differences between different eco-regions. More eco-regions denotes to more robust, resilient and sustianable natural environment

Houston is famous for being called “Bayou City”. There are thousands of bayou running through Harris county. Most of the bayou are shallow during the dry season. However, when the heavy rainfall or hurricane arrives at Houston, the water level will exceed the capacity of water canal in a short time with flat topgraphy. Due to this, the Houston was covered by a layer of flooding plain. In that case, the bayou is one of the significant ecosystems in Houston. There are aboundant animals and vegetation growing at the edge of bayou. However, this ecosystem has gradually become fragile and vulnerable due to the land and water development(grey infrastructure network, urban fabric and water system). The data shows that the forest and wetland has lost 40% in total recently.

In Houston, the most threaten ecosystem is the pariries. Due to the fast urbanizaiton and industrial development, most of the prairies have been overgrazed and damaged. In the next analysis, it will mention species of flora and fauna in Harris County. It is mainly based on two eco-systems: prairie and bayou.

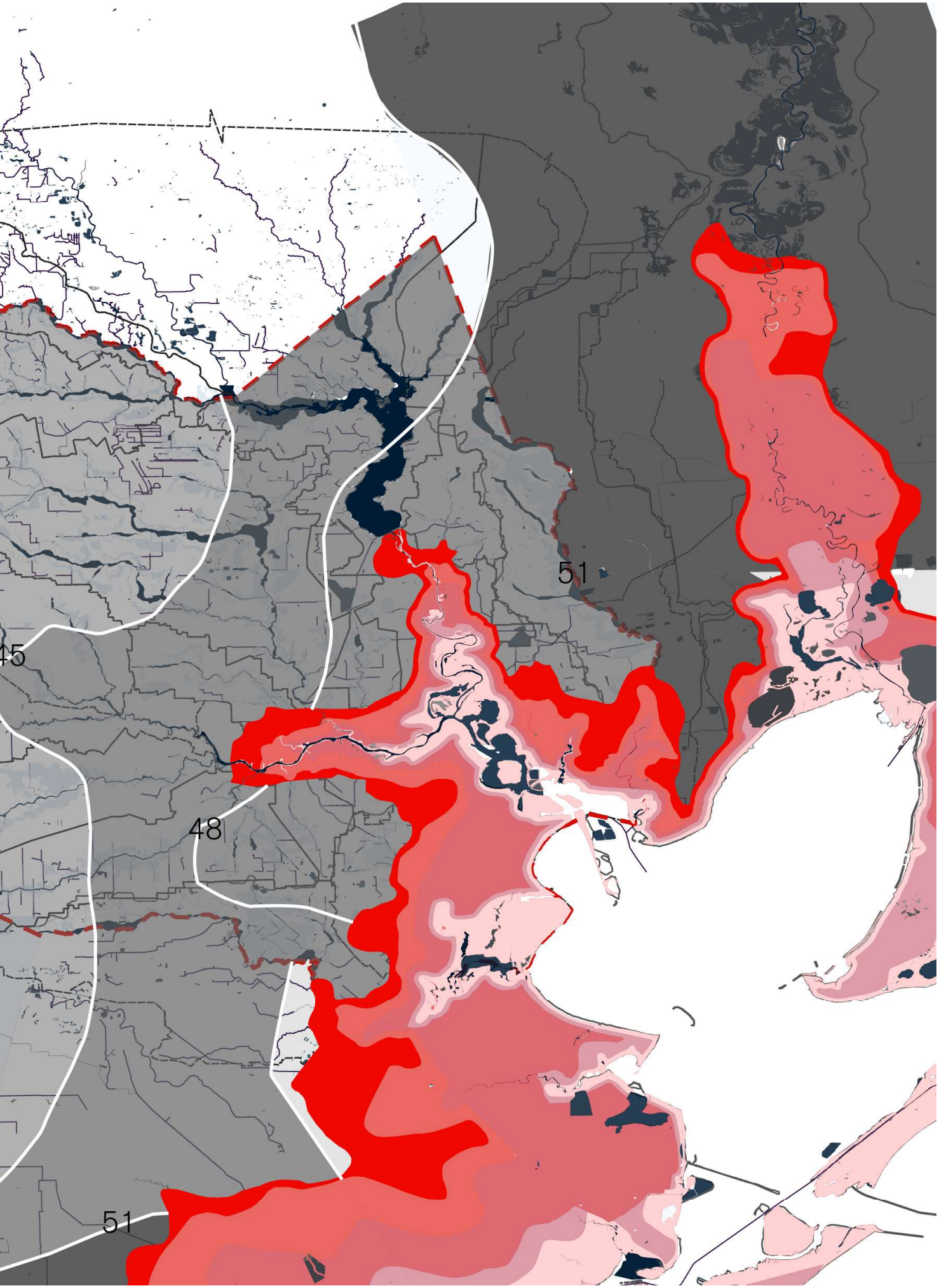


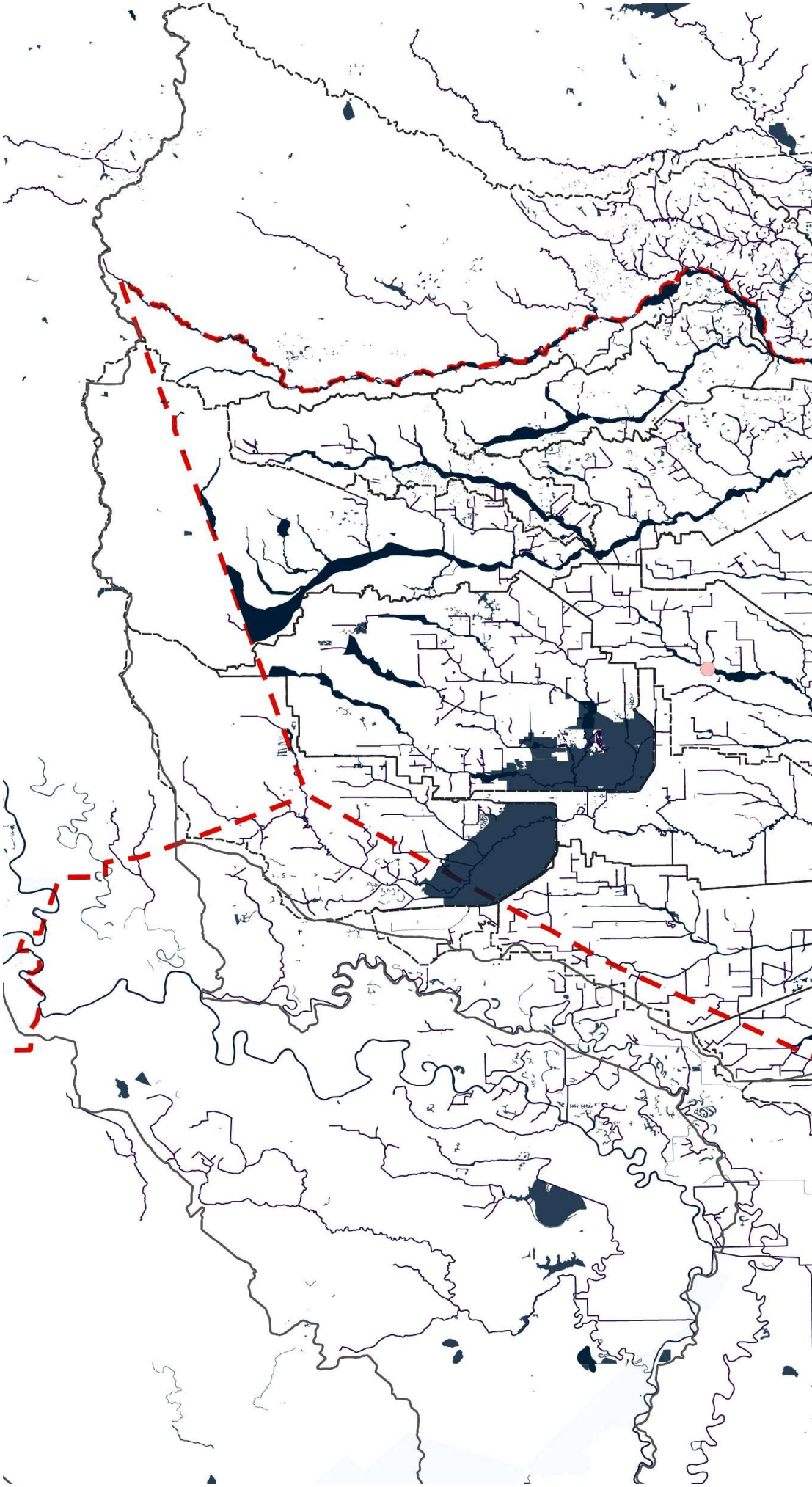
Rainfall and Wind

The map shows the rainfall and wind situation in Houston(Harris County).

- 23-29
- 29-37
- 37-45
- 45-51
- 51-59
- HurricaneWindrisk Category 1
- HurricaneWindrisk Category 2
- HurricaneWindrisk Category 3
- HurricaneWindrisk Category 4
- HurricaneWindrisk Category 5

0 | 10 km


51
45
48
51

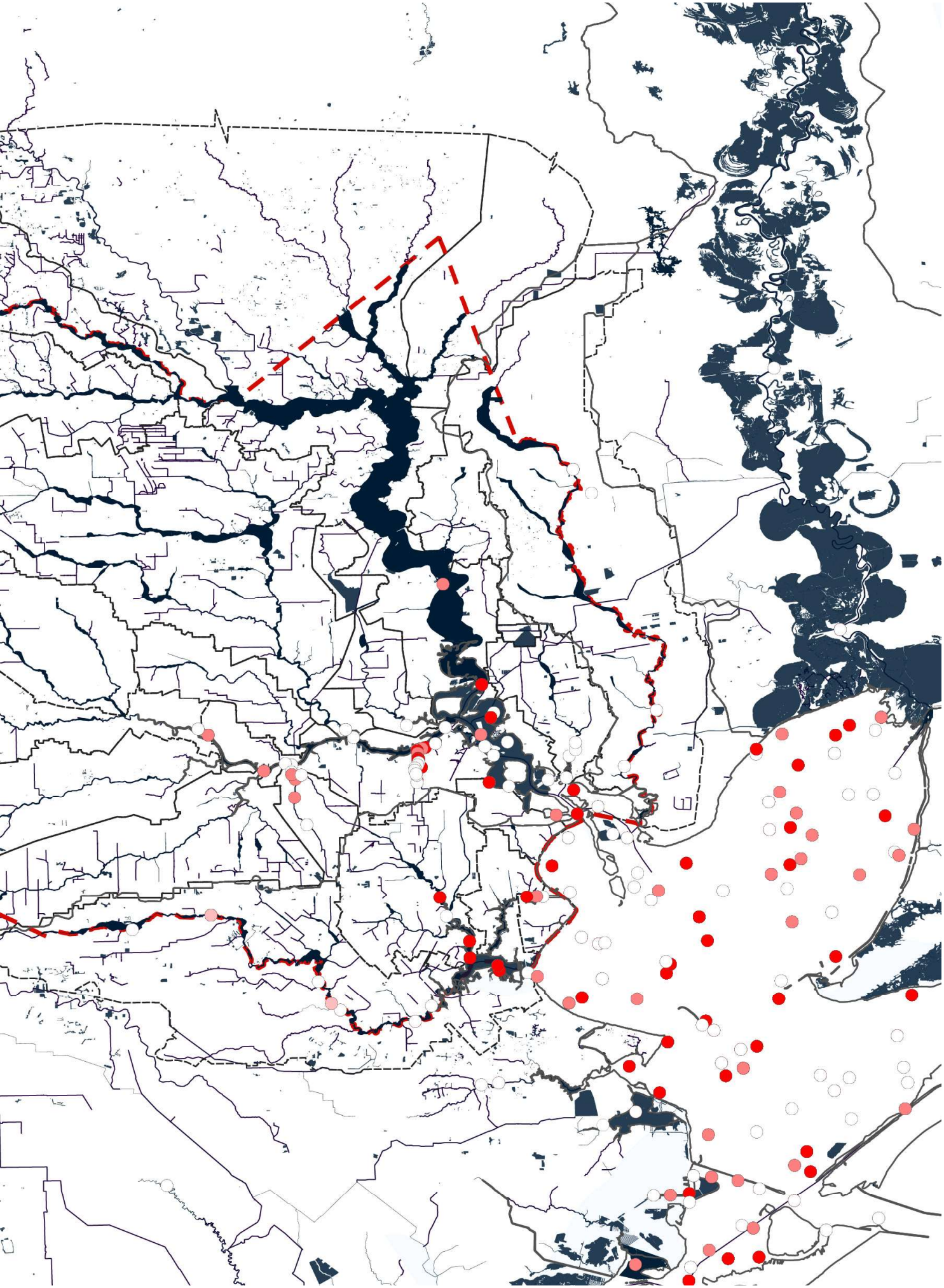


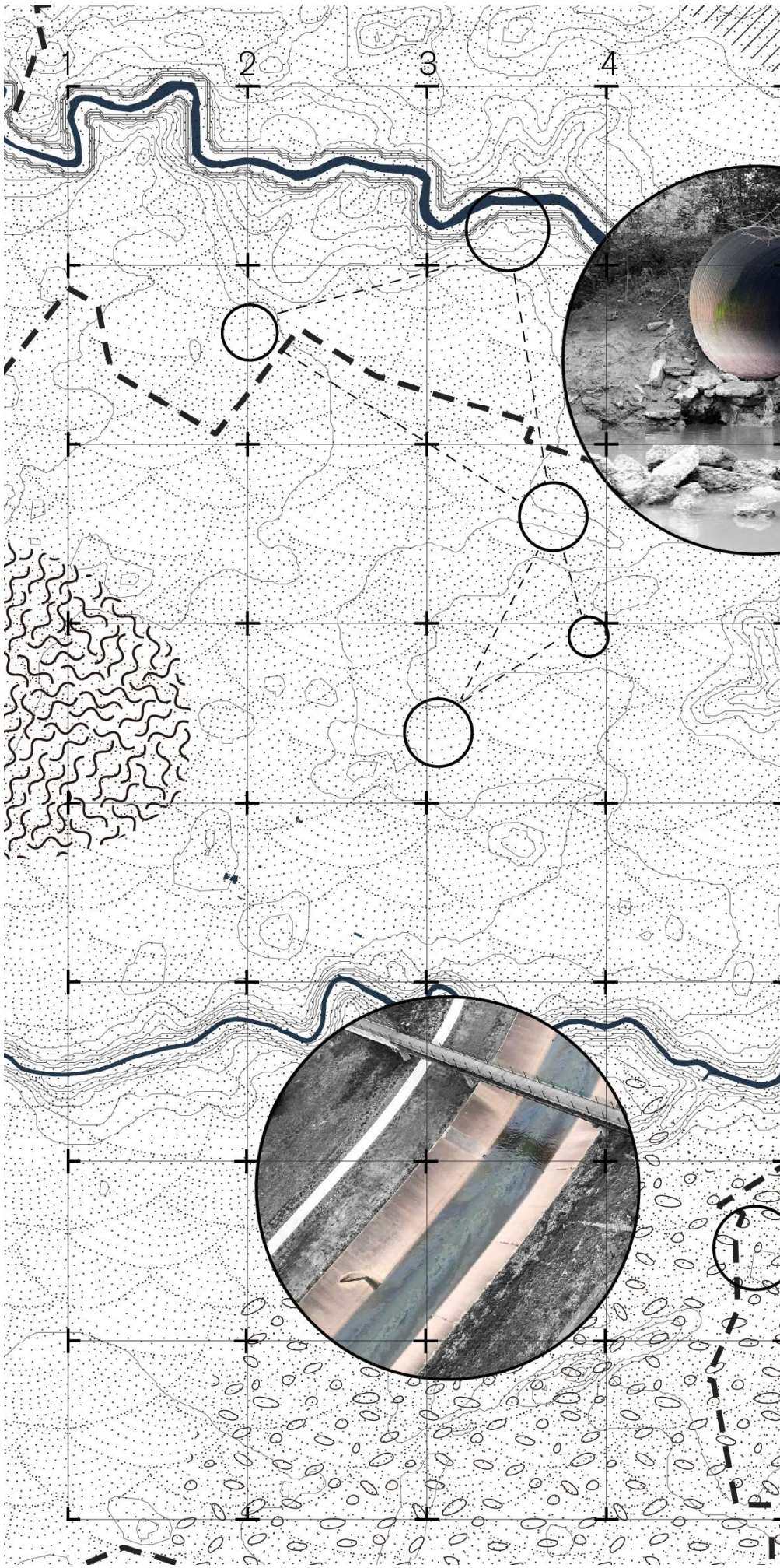
Mental Substance

This map shows the content of mental substance in water basded on the data of water stations. It refelcts that different extent pollution exist in both bay and bayou

367.2-459
275.4-367.2
183.6-275.4
91.8-183.6
0-91.8

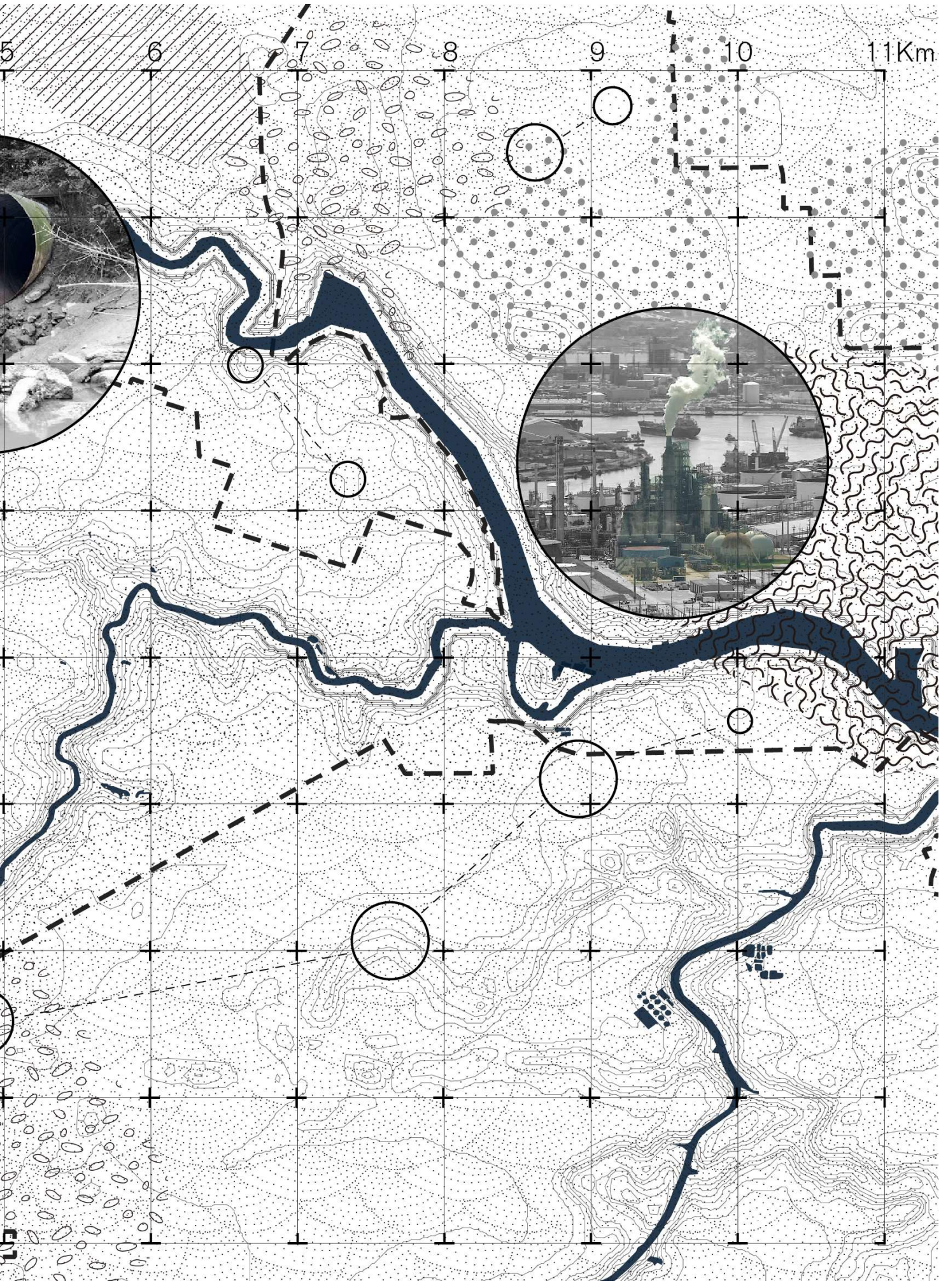
0 10 km

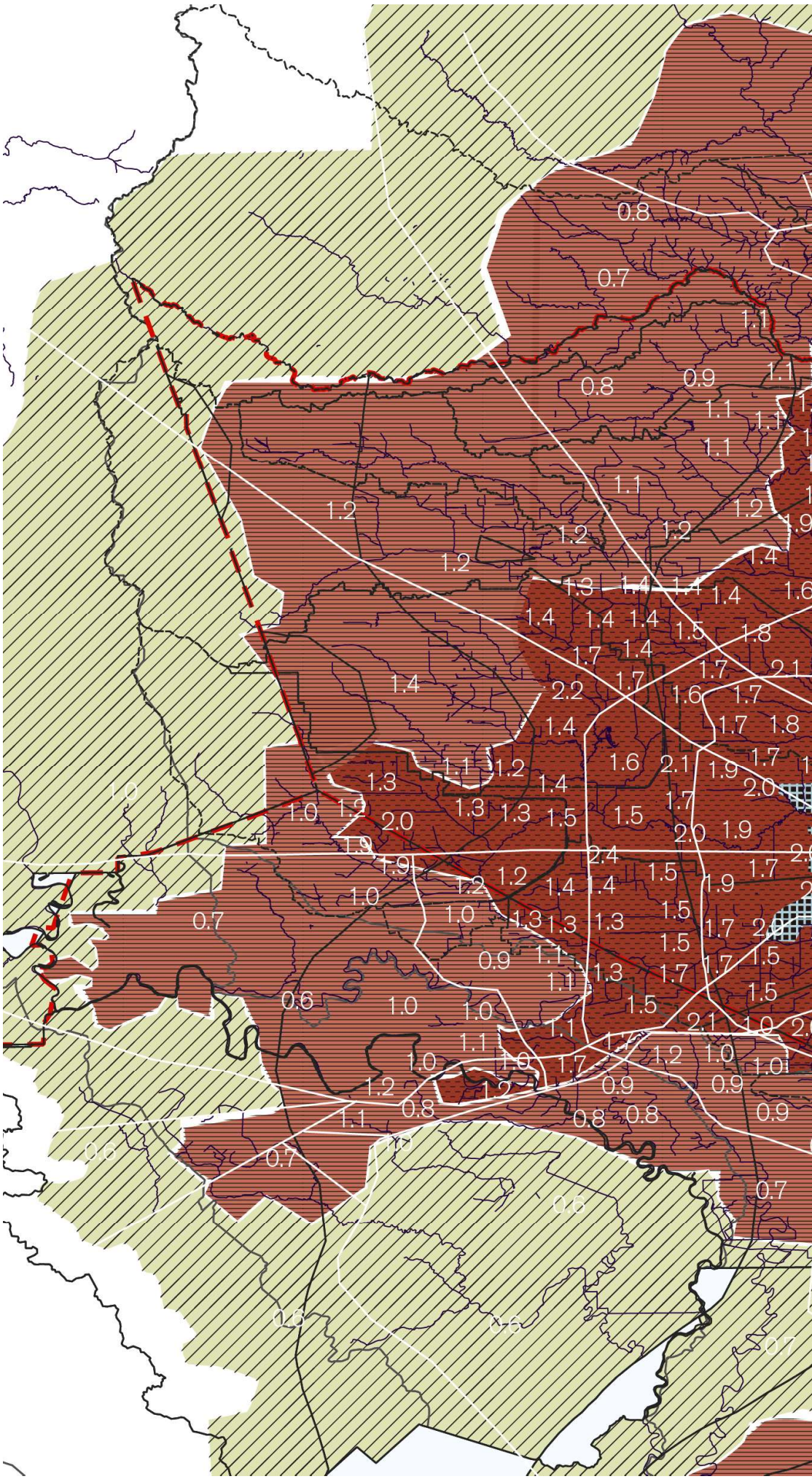




Water Pollution

This map represent the water pollution situtaion in both Bafflao and Bray bayou.


5
6
7
8
9
10
11Km

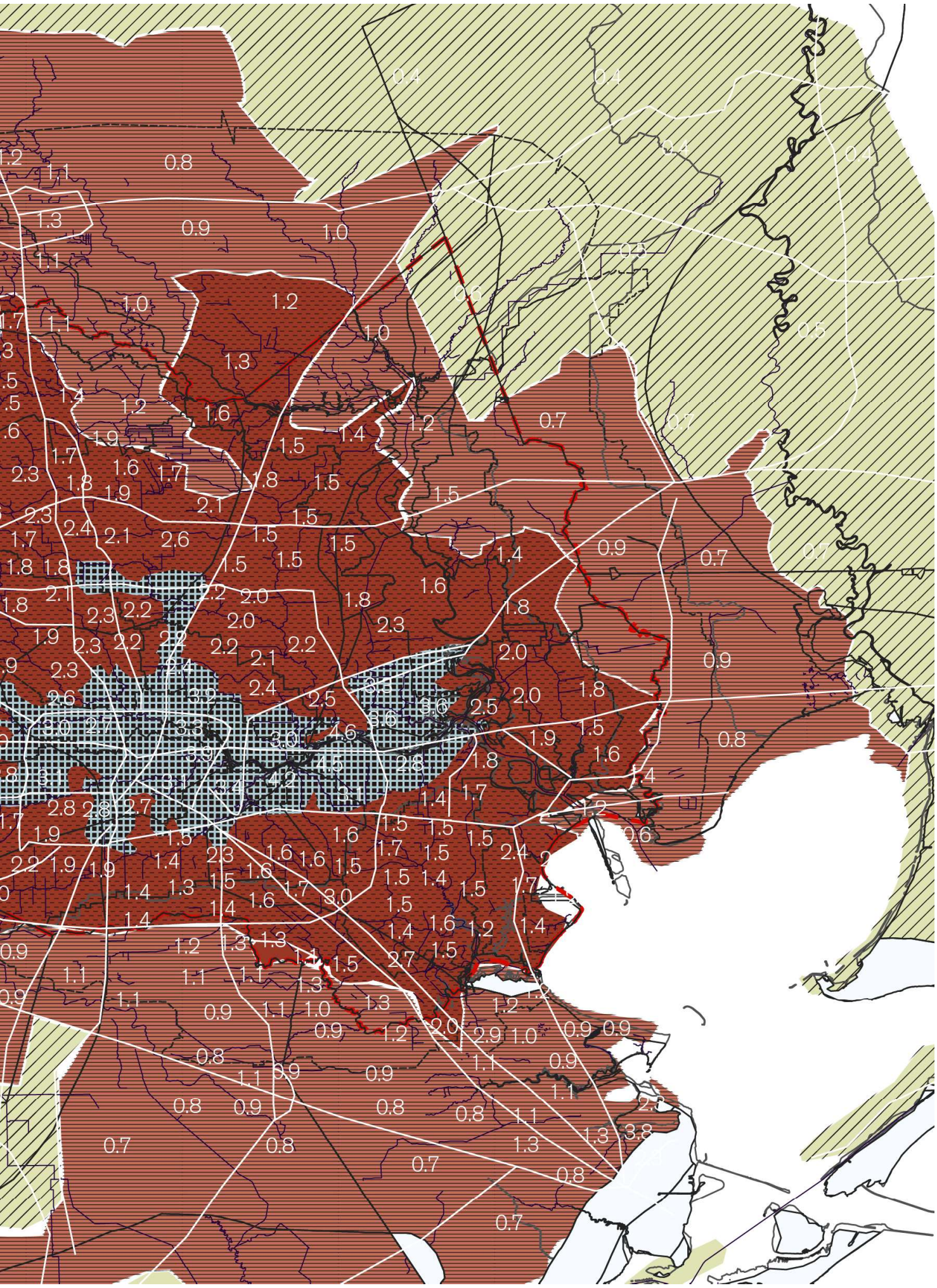


Air Pollution

The map reflects the Benzene concentration has the relationship with acceptable cancer risk of 1 case in 1 million people. The number shows Benzene concentration and colour represents risk per million people from major souce emission.

- 0-1
- 1.001- 5.000
- 5.001-10.000
- 10.001-20.000
- 20.001-53.000

0 10 km

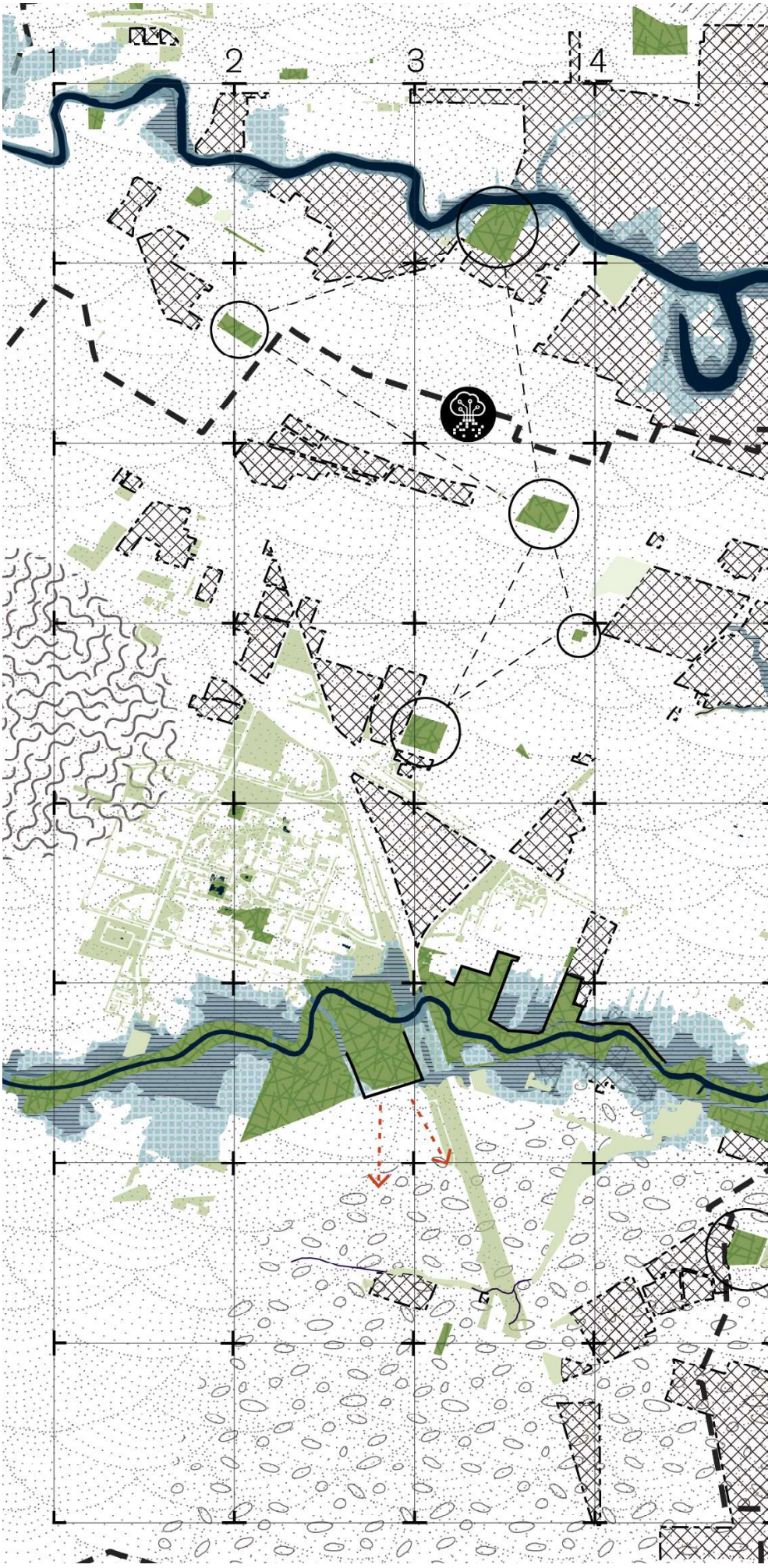


Process

For the climate in Houston, it is categorized as humid subtropical climate, with tropical influences. The normal annual percipitation measures 49.77 inches(1,264mm). Rainfall is aboundant even though drought do happenes. heavy rainfall. Flooding normally happenes in the months of May to Octorber in wet season. Houston will aslo experience tropical cyclones during Antlantic Hurriane season, including Hurricane Harveys in 2017.

Except for experiencing the shock of Hurricane, the Houston also suffers from air pollution and water pollution. As the urban waterway, it has to point out that Bufflao bayou is famous for its vunlernability of low water quality. Industrial and agriculture discharge into water are the mian sources of pollution. What is more, the frequency of flooding carrying the bacteria,pathogens, heavy mentals and construction debris into the waterway. Currently, Buffalo bayou partnership has started program called green& clean program in order to purify the water.

Accoridng to the report, the air pollution is mainly from mobile sources and industrial sources. It is no doubt that Houston is a car dependent city. Car dependency leads to consume of fossil fuel. The most polluted area, east Houston, is the concentration of industry area.

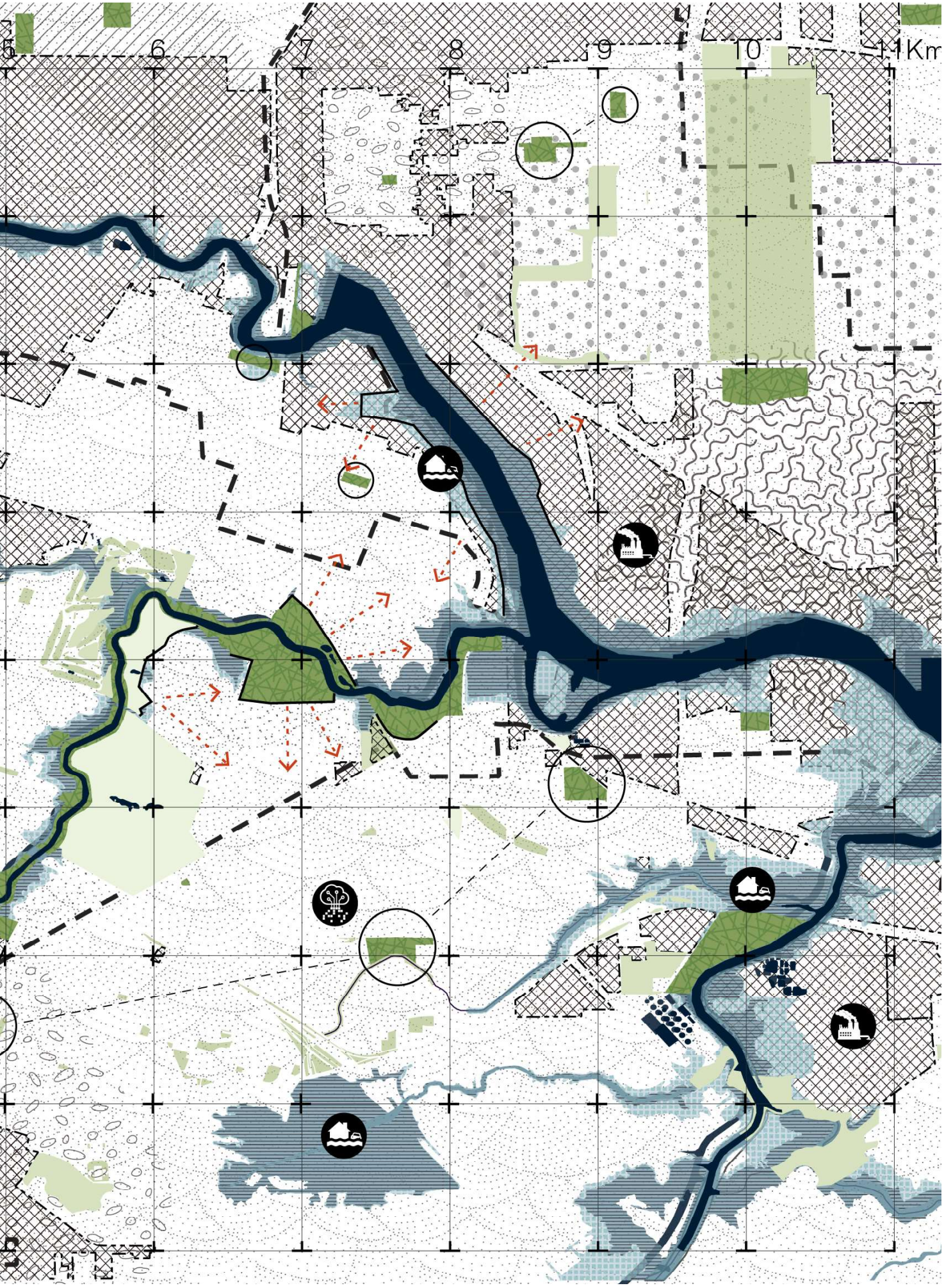


EXTREME WATERSYSTEM

This map indicates that issues and challenges between human and eco-systems surround the Buffalo and Bray Bayous

- Water
- Floodway
- Flooding plain
- Grass
- Park
- Industrial area
- Fragmentation

0 | 1 km


5
6
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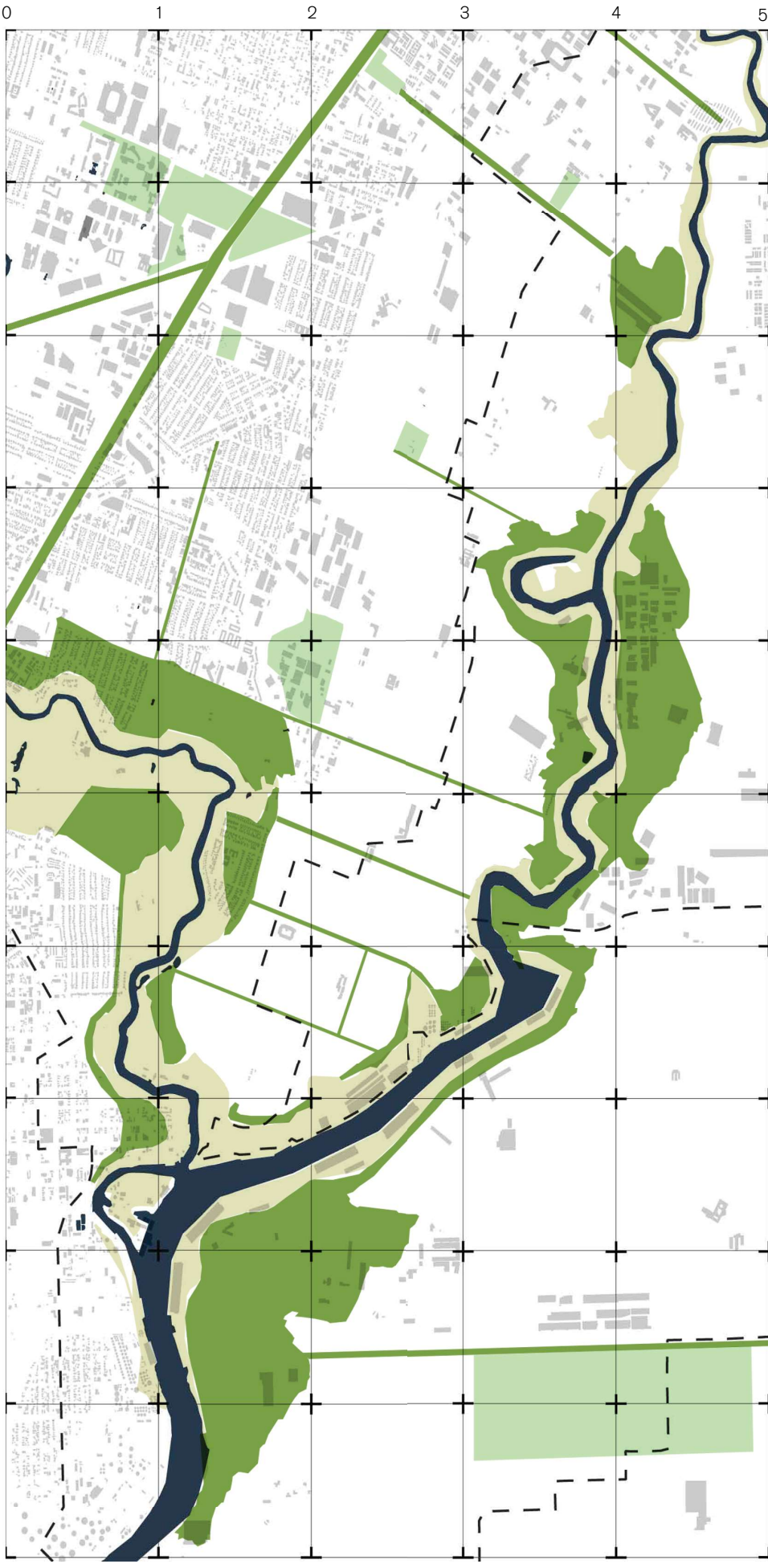
10
11Km



EXTREME WATERSYSTEM

This map shows the opportunities of green-bule infrastructure establishment by analyzing and integrating various essential layers.

First-tier green Corridor

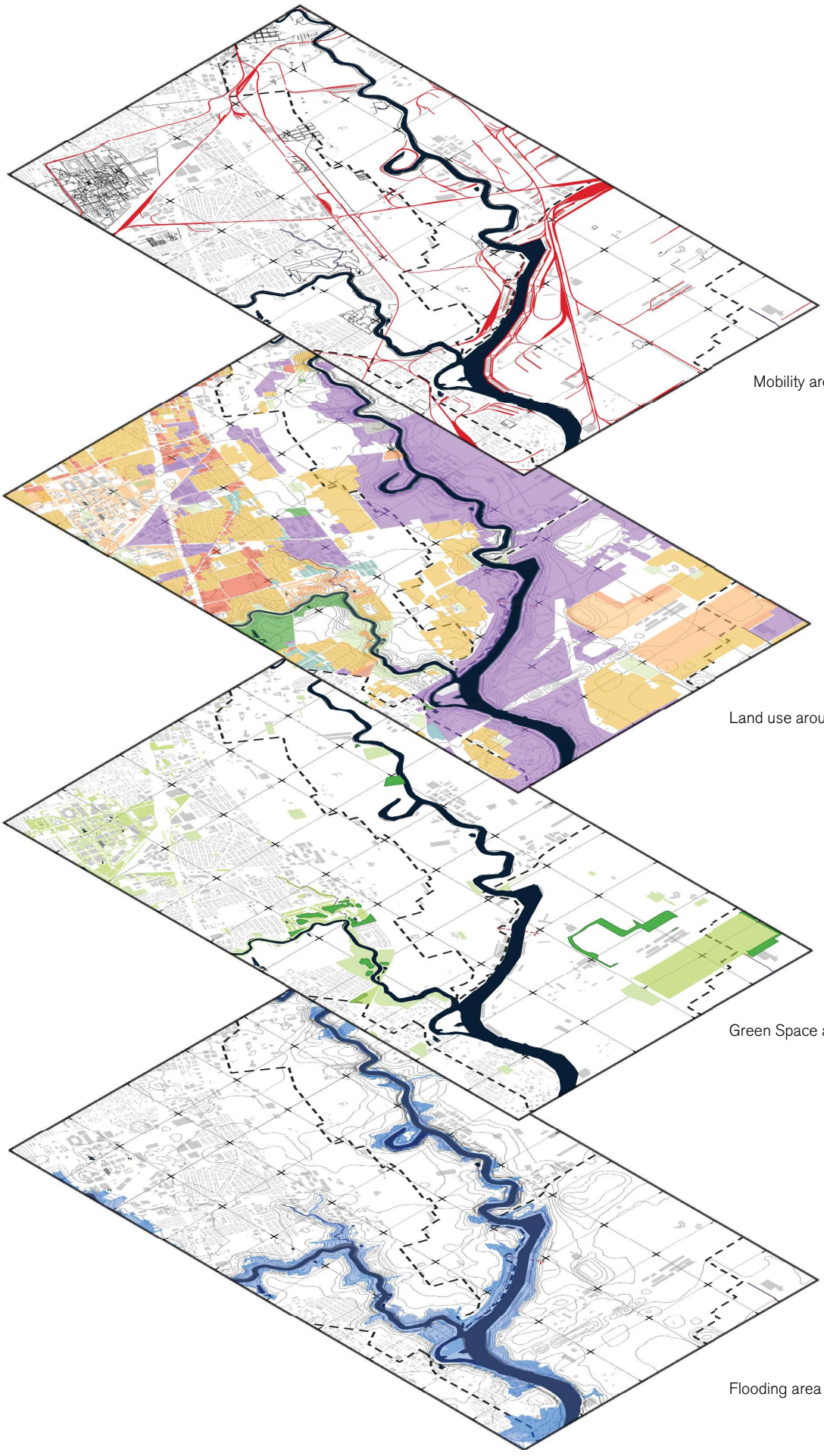
Second-tier green corridor

Parks and green space

water

0 | 100 km

km



Mobility around bayou

Land use around bayou

Green Space around bayou

Flooding area around bayou

Extrme Water System

The conclusion maps draw a conlusion on both challenges and opportunity for water system(Ecology) in terms of extreme environment. For issues and challenges, it could be analyzed from two aspects as follow: stress and shock factors. In addition, the opportunity could be indicated by overlapping mutiple essential layers together.

Stresses are identified as degradation of the eco-systems, fragementation of green spaces, water and air pollution due to industry area and impermeability of land from ecological perspective. Shock refers to the pressure of flooding bring by compound flooding, caused by rainfall and Hurricane.

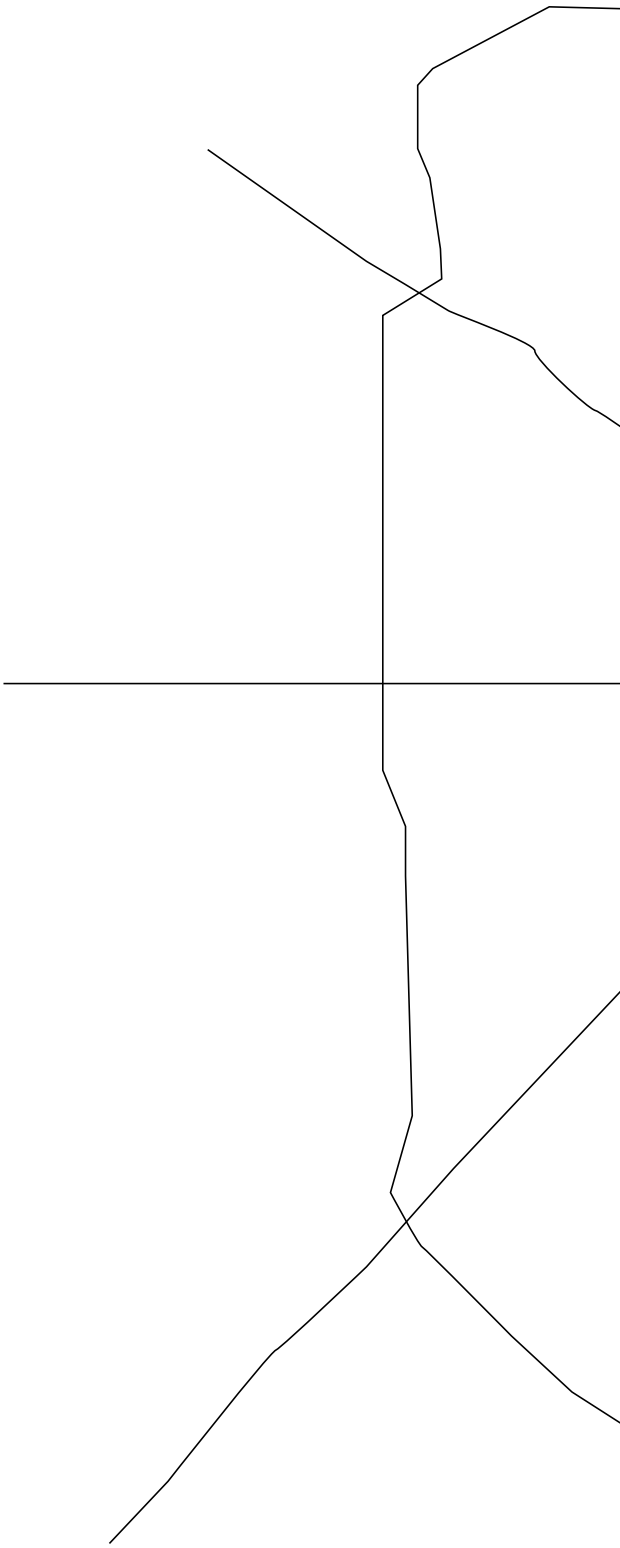
How to deal with the shock and stresses with a more adapative and resilient approach with the sensitive water system? how to rebuild and retrieve the natural habitat? In that sense, EI(ecological infrastructure) could be a major intervention as the way of eco participation in Houston's bayou system. It aims to establish a resilient, roubust nature first. In short term, it could mitigate the negative shocks brought by floodings. In the long run, the stresses could also be released with comprehensive green-blue networks.

In order to design the green-blue infrastructure of Buffalo bayou in Houston, it adpots a strategic way to planninng it by finding more opportunities and potentials from many aspects. The layering approach reflects the relationship between water(flooding), green space, land use, and accessibility. Based on that, it can plan the ecological infrastructrue network which demonstrates the water as the main structure, the urban develpment connect to river is the second branch. This vision provide numerous intervetions for eco participation.

From the analysis, it concludes that problems and challenges of Buffalo bayou comning both shock and stress. To seek the opportunity, the map is provided aming to find the locations of greenways and green corridors.

3.5.

Urban morphology

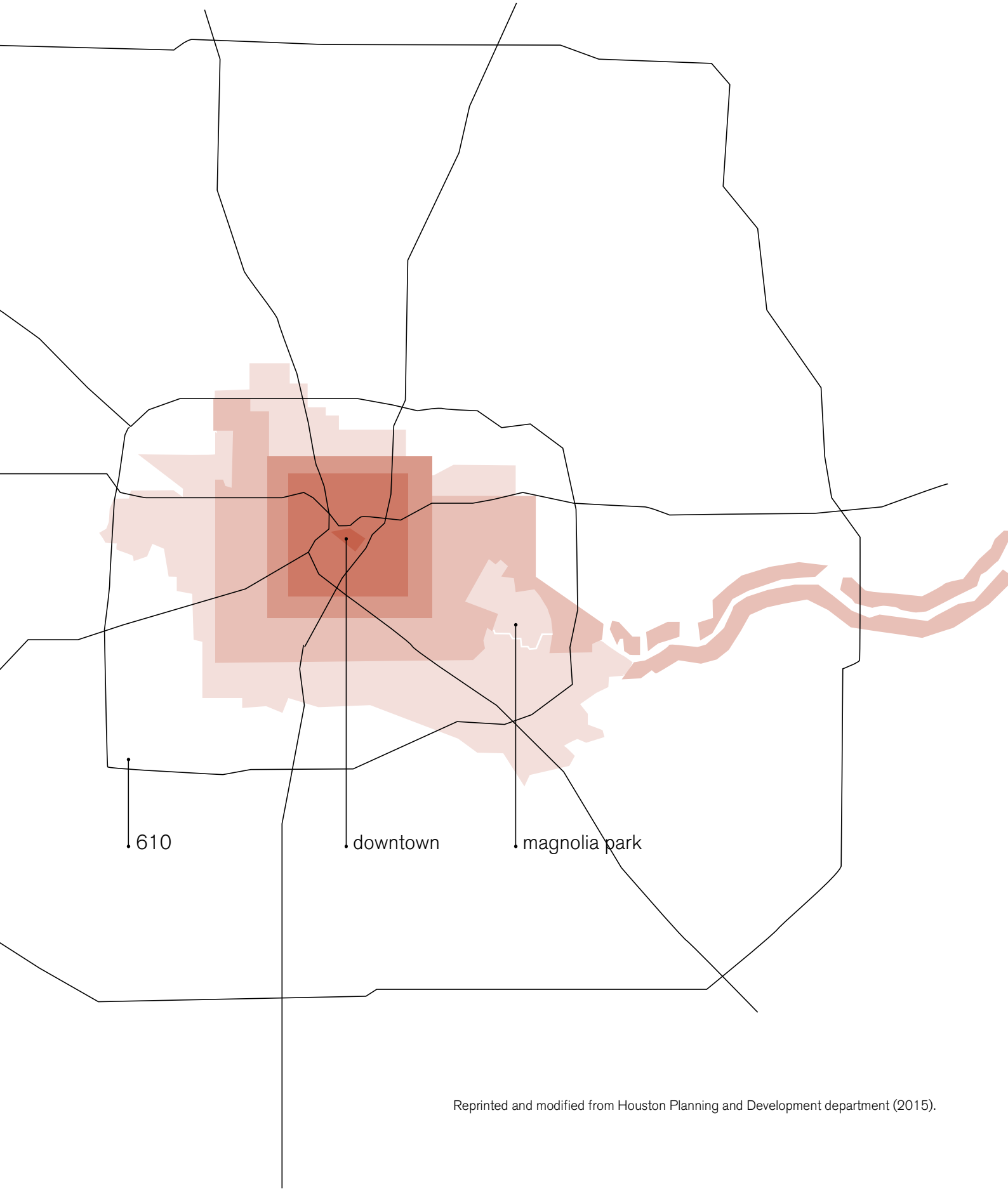


occupation patterns in relation to time

The growth of Houston from 1839 until 1930. In 1839 the city was founded and during 1920 - 1930 the Magnolia park & Harrisburg Manchester area became part of the city (Houston Planning and Development department, 2015).

- 1836
- 1839 - 1840
- 1900 - 1905
- 1910 - 1919
- 1920 - 1930

N



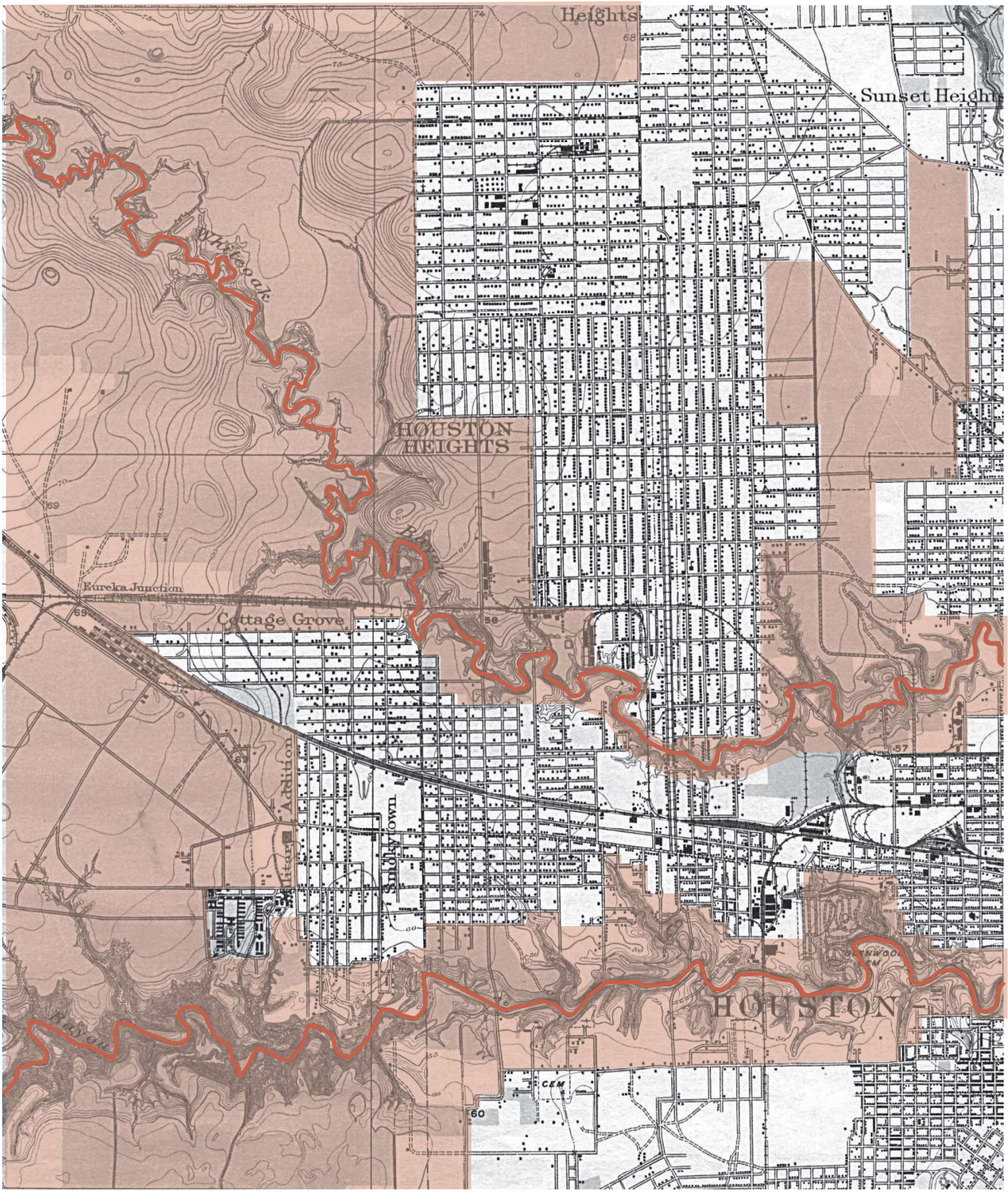
Reprinted and modified from Houston Planning and Development department (2015).

occupation patterns in relation to the landscape

A historical map of Houston around 1922, in which the urban grid in relation to the natural Bayou system is visible. A rigid grid is laid on top of a natural landscape.

N

1922

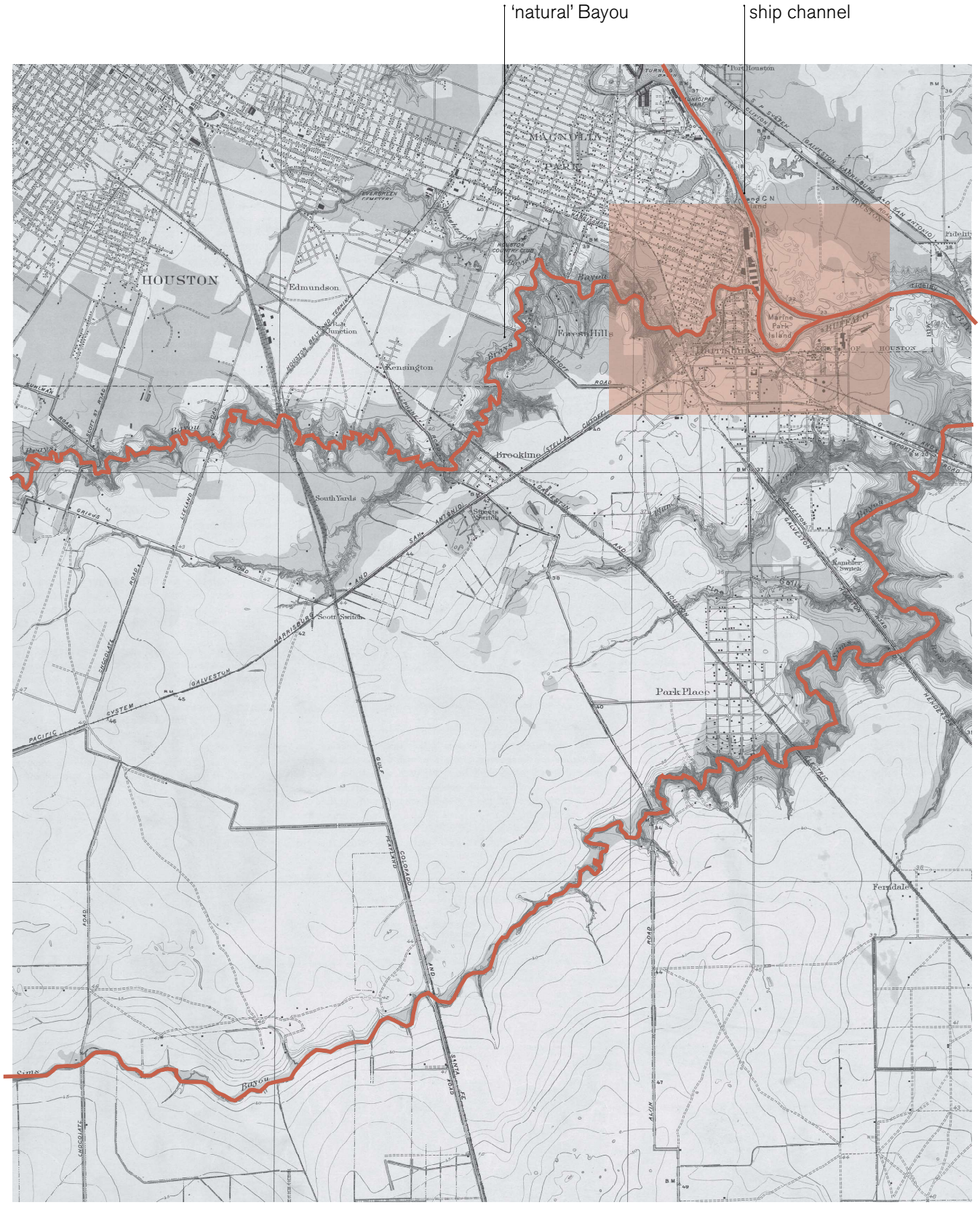


Reprinted and modified from Houston Planning and Development department (2015).

occupation patterns in relation the landscape

Another historical map of Houston around 1922, in which the urban grid in relation to the natural bayou system is visible. A rigid grid is laid on top of a natural landscape. This shows the case study area.

N



Reprinted and modified from Houston Planning and Development department (2015).



urban structure

Within this area there are a couple of elements shaping the urban structure. The confluence of the two bayous and the infrastructural grid. This grid is important because Houstonians are very car dependent. The elements are highlighted in red.

- Roads
- Public spaces
- Buildings

N

0 500 m



Koordinates (2016). Geospatial data for Houston [Data file].

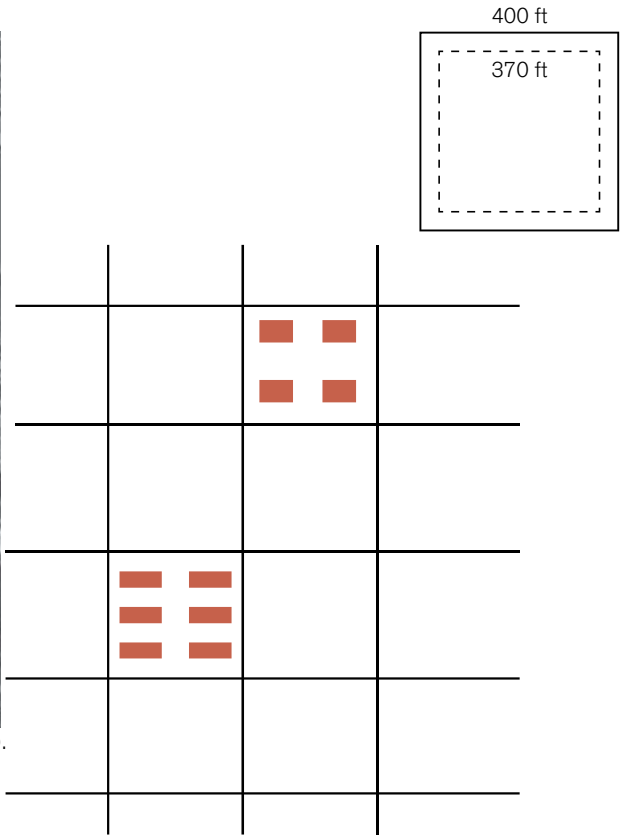
urban structure

This diagram simplifies the structure of the urban block. The grid in Magnolia park is rectangular and the grid in Harrisburg / Manchester is a squared shape grid. In which private lots are placed alongside the roads.
Grids can represent the measurements of the original size of the city when it was founded (Southworth & Owens, 1993).
Harrisburg / Manchester and Magnolia park used to be separate and independent cities, which can be a reason why their grids differentiate. It could also just be a variety in the grid with no evident pattern.
A grid is an easy tool to plan the future, as it subdivides the territory beforehand. Within orthogonal blocks a lot can be catered, from agricultural land to housing. The grid is a set size that repeats itself, and therefore adaptable when land-use changes (Southworth & Owens, 1993).

harrisburg / manchester



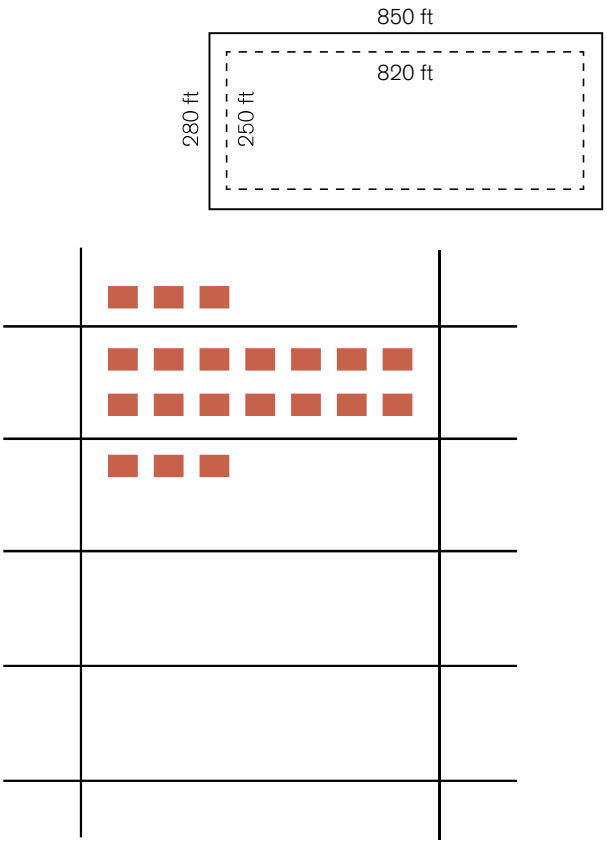
Reprinted from Google Maps (2020).



magnolia park



Reprinted from Google Maps (2020).



Urban morphology

In 1836 Houston was founded. It consisted of 6,600 acres of land alongside the banks of the Buffalo Bayou and White Oak Bayou, this area is currently known as Downtown. The area around Houston was a swamp landscape. Houston was founded with the aim of being a city dependent on water trade (Houston Planning and Development department, 2015).

From 1839 until 1840 the population grew to 2000 inhabitants. The bayous were used by steamboats that imported and exported goods. Trade brought about welfare and growth. The city was expanded within a strict square. This square was divided into wards, each with their own functionality. The name of the wards are still in use to this day (Houston Planning and Development department, 2015).

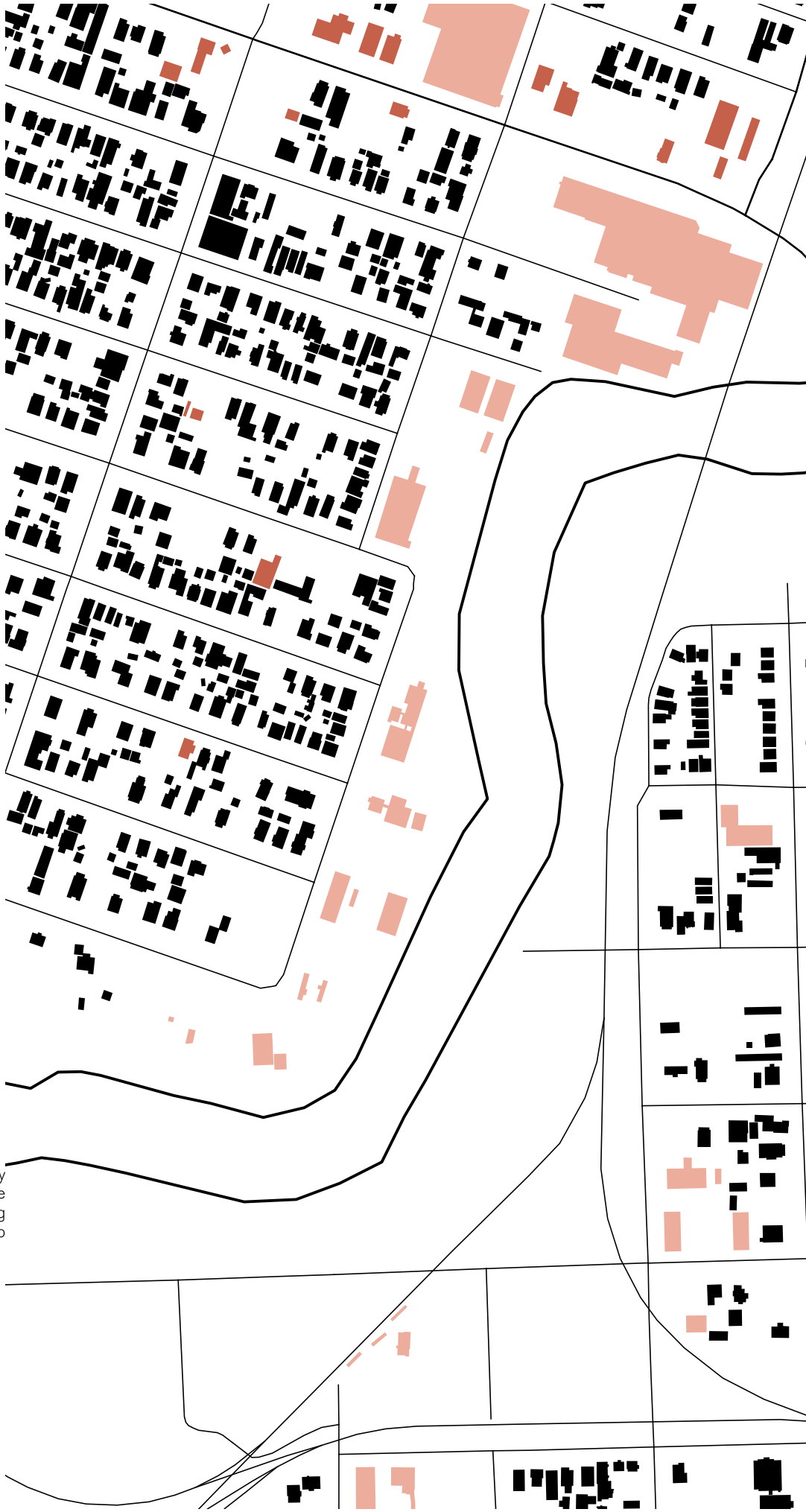
From 1900 – 1905 the population of Houston doubled to almost 45.000 inhabitants and it covered an area of nine square miles. During these years a harbour was dug out in the Buffalo Bayou, taking over the functions of the main port of Texas in Galveston. Which was destructed by the Great Hurricane in 1900. German immigrants arrived in Houston, they had a lot of knowledge, with which they could buy agricultural land or start other new businesses. The railroad was built as a link between the port and its hinterlands. The growt of the port, railroad industry and the discovery of oil during this time transformed Houston from a small town into a big city (Houston Planning and Development department, 2015).

In the years 1910-1920 the population of Houston was approximately 80 000 inhabitants. The city began to expand outside the central core (the square) and the area along both sides of the ship's channel (Buffalo Bayou) was annexed, as well as the area called the Height. This made it easier for the port to grow even more, and Houston's port became a World Port (Houston Planning and Development department, 2015).

From 1920 to 1930, the population grew enormously, reaching almost 140 000 inhabitants. These years are marked as the first boom years, and the city annexed more land to serve the channel and the port. This included Magnolia Park and Harrisburg – Manchester, the birthplace of Texas. These two regions used to be independent towns. The State Highway was built for cars, busses and trucks in 1927. This marked the beginning of the urban sprawl that Houston's urban fabric is known for (Houston Planning and Development department, 2015).

This history is clearly visible in the urban pattern, as both the Bayou system and infastructural systems seem to shape the grid of Houston. On the natural curvy Bayou landscape a rigid rectangular / sqaure grid is placed. It is evident that as the city grew the banks alongside the Bayous became more populated.

In the current state, the way the Bayou and infractructure shaped the city is still very visible.



functionality

Alongside the Bayou there are mostly industrial buildings. In Magnolia park there are mostly residential functions. In Harrisburg / Manchester it is a mix of everything. More to the east it is solely industrial.

- Roads
- Residential
- Offices / commercial
- Industry

N

0 100 m



Koordinates (2016). Geospatial data for Houston [Data file].



building ensembles

The map shows the different years of construction for the houses in the area. Most of the houses are built before 1944 because both Magnolia park and Harrisburg - Manchester used to be independent cities before being annexed around 1920 (Houston Planning and Development department, 2015).

- <1944
- 1945 - 1959
- 1960 - 1984
- 1985 - 2008
- 2009 - 2015

N

0 200 m



building ensembles

The map shows the different housing units
for the houses in the area.
There is not really a discernible pattern.
Growth and densification differentiate per
block and do not relate to a specific typology.

- single family detached
- multi - family (2 - 4 units)
- multi - family (5+ units)

building typology

These are the houses found within the dashed square on the previous maps. It shows a multi - family house and a single family one. The single family one is a shotgun house with one floor. The multi - family one has more stories and is a collection of smaller shotgun houses clustered together on one lot.



Reprinted and modified from Google Maps (2020).

housing units
multi - family



Reprinted and modified from Google Maps (2020).

housing units
single family



green space

This map shows the registered ‘public’ spaces in the area. In red the green spaces, and in grey the paved areas. The grey areas within the neighbourhoods are just the parking lots around public institutions such, as churches and schools.
Although the green spaces are quite big, there are mostly just green spaces next to big infrastructural networks. Only alongside the Brays Bayou this includes recreational functions.
Public space just means not privately owned in this case.

- Roads
- Buildings
- Paved open spaces
- Green open space

N

0 100 m



Koordinates (2016). Geospatial data for Houston [Data file].

green open spaces

In these pictures the public green spaces in the area are visible. They are mostly located along the bayou. They look quite homogeneous, just grass and not a lot of street furniture. The only functions added are related to sports as well as hiking or biking trails.
Also a paved 'public' space is visible. This is just a parking space next to a church. It is not very accessible because you have to enter a gate, and be part of the church community.





Reprinted and modified from Google Maps (2020).





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green open spaces

The public spaces that are there, are not accessible for the residents of the neighbourhood. The recreational areas are separated and cut off from the residential areas by infrastructural networks.



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Urban typology

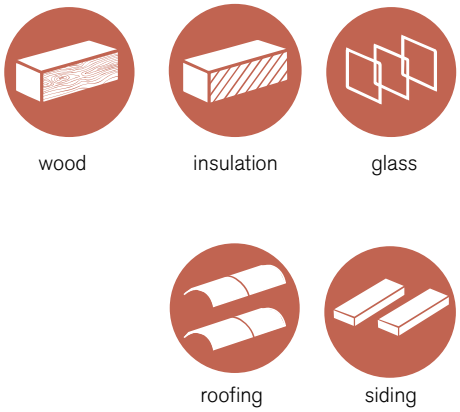
In the case area, which consist of a part of Magnolia Park and a part of Harrisburg / Manchester, the functionality of the buildings is either residential, industrial or commercial / public. Commercial or public functions could be shops, offices, churches or other public institutions.

Alongside the Bayou, there are mostly industrial buildings. Magnolia Park is mostly residential, Harrisburg / Manchester is quite mixed, including all kind of functions. Brady island and the area more to the east are solely industrial.

Looking at the residential buildings, the year of construction and type of housing unit was mapped. It becomes clear that most of the houses were constructed before 1944. The housing typology consists mostly of detached single family houses. Single family houses are mostly shotgun houses with one floor, multi-family houses consist of a collection of smaller houses on one lot and can have multiple stories. There is not really a discernible pattern. Growth and densification differentiate per block and do not relate to a specific typology.

Public spaces in the area can be mainly found alongside the Bayou, there are parks and trails situated there. Furthermore there is not a lot of public space to be found, this is quite typical for America, as most empty lots are still privately owned and can not be converted into pleasant public spaces. Most of the public spaces are grass fields with some paved paths for cyclers or pedestrians. There are some sport fields. Diverse vegetated areas or street furniture is not very common.

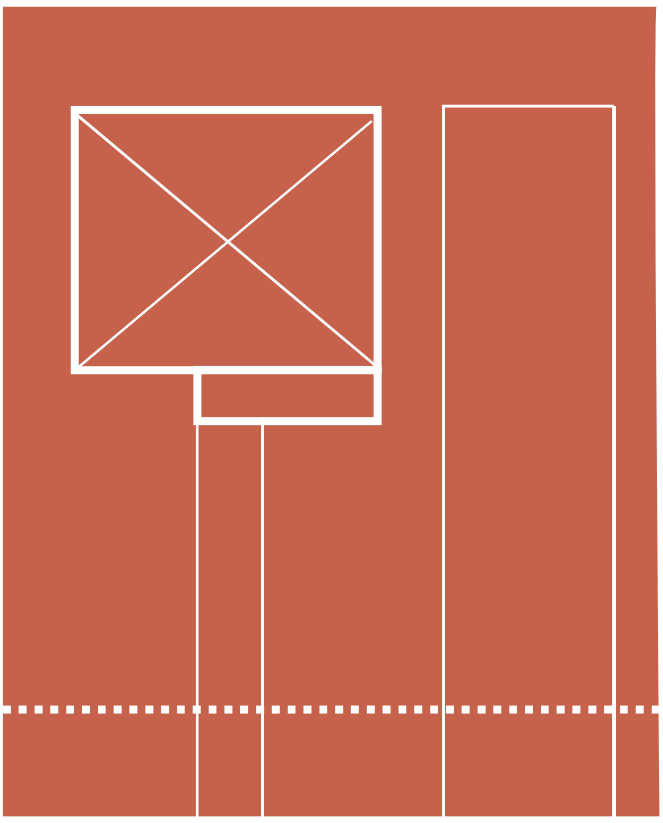
Although there are quite some large recreational areas alongside the Bayous, these are not very accessible for residents living in neighboring areas. These are disconnected from each other by infrastructure. This is due to the fact that Houston was designed to function according to the car, and not according to the pedestrian or cyclist.





building typology Magnolia Park

Typical architectural typologies of Magnolia Park are both the craftsman bungalows with gabled roofs and shotgun houses.
A typical residential plot consists of a house, a driveway and a grass lawn. Clearly bordered by a fence.
Common materials are wood for structural elements, glass for windows and siding as exterior.







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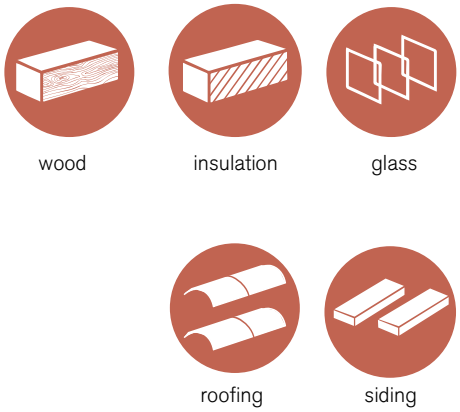



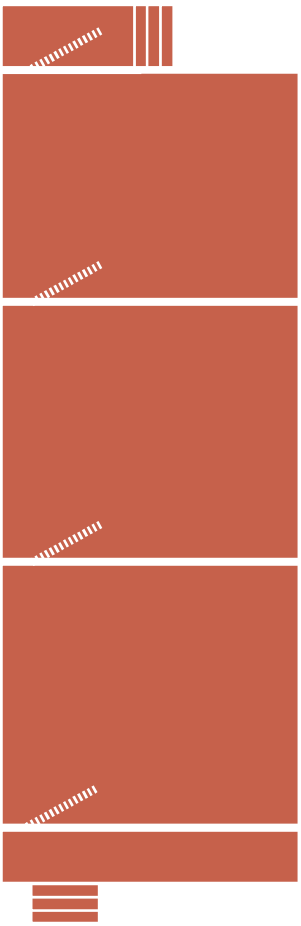



building typology Harrisburg / Manchester

The Harrisburg / Manchester area has only shotgun houses as an architectural typology.

The houses are in a bad state and belong to the poorer Hispanic community living there (The Union of Concerned Scientists, 2016).

Shotgun houses are vernacular architecture in Houston. The name refers to the fact that a bullet can be shot through the front door, travel through all rooms and come out the same at the back door (Sarnoff, 2019).

Common materials are wood for structural elements, glass for windows and siding as exterior.



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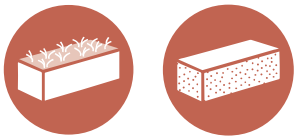

grass asphalt





street typology

These pictures show a standard street. The residential streets in this area, or Houston in general, are very car oriented. The streets have small pedestrian lanes or bikes paths , but they end abruptly to make room for cars.

Common materials are asphalt for roads and some grass stripes, dividing car roads from pedestrian paths.



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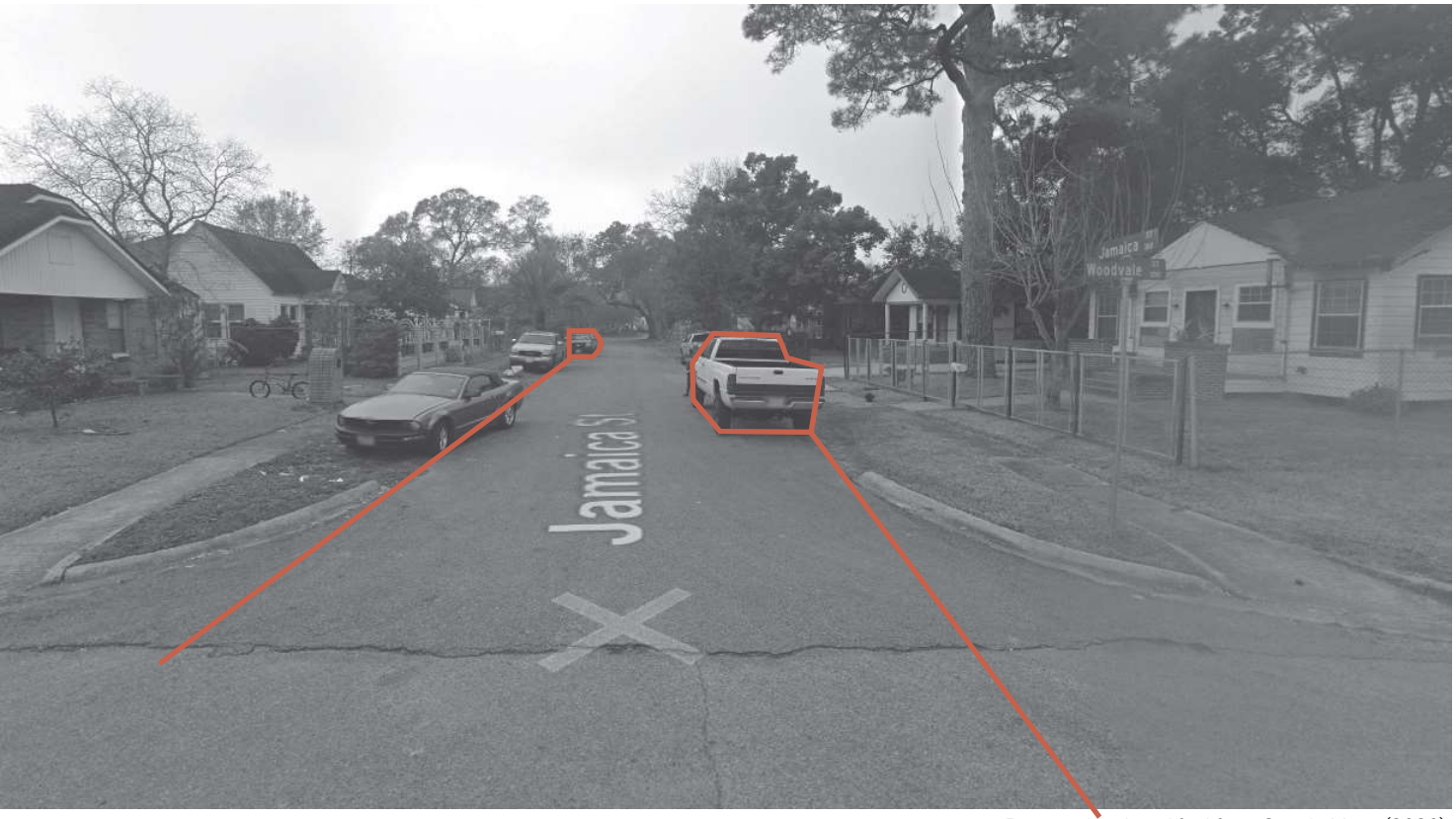

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Architectural morphology

The architectural types that can be found within Magnolia Park are either craftsman bungalows or shotgun houses, which can be seen as the vernacular architecture of Houston. A lot consist of a house with a lawn and a driveway. Private property is clearly separated from the street by a fence. This quite clearly represents the American Dream. Common materials are wood for structural elements and glass and siding for the facades.

The houses in Magnolia park are pretty well maintained and belong to some middle class residents and some lower class residents. Making Magnolia Park socially somewhat vulnerable. This is worse in the residential areas of Harrisburg / Manchester. Here most residents are lower class. This is visible in the poorly maintained shotgun houses that are present in the area (The Union of Concerned Scientists, 2016).

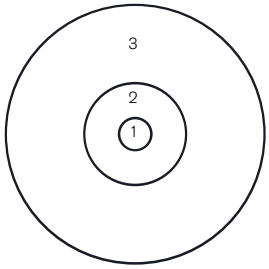
The residential roads clearly show the priority to cars. The roads are characterized by a lot of space for cars and small pedestrian paths. These paths end at every intersection to make way for car roads. The material used in the street is either asphalt or grass stripes, that indicate a separation between slow and faster traffic.

The case area has a large Hispanic community, which is very vulnerable according to their socio-economic status (The Union of Concerned Scientists, 2016).



vital infrastructures - health

This map shows the infrastructure around the case area. Including roads for cars, railroads and bus lines / bus stops. As well as that it includes first need facilities. It shows that there are supermarkets and hospitals relatively close, though only accessible with the car.



approximately

1) 5 minute walk
2) 5 minute bike
3) 5 minute car

- Infrastructure
- Bus stops
- Supermarkets
- Hospitals
- Health centers

N

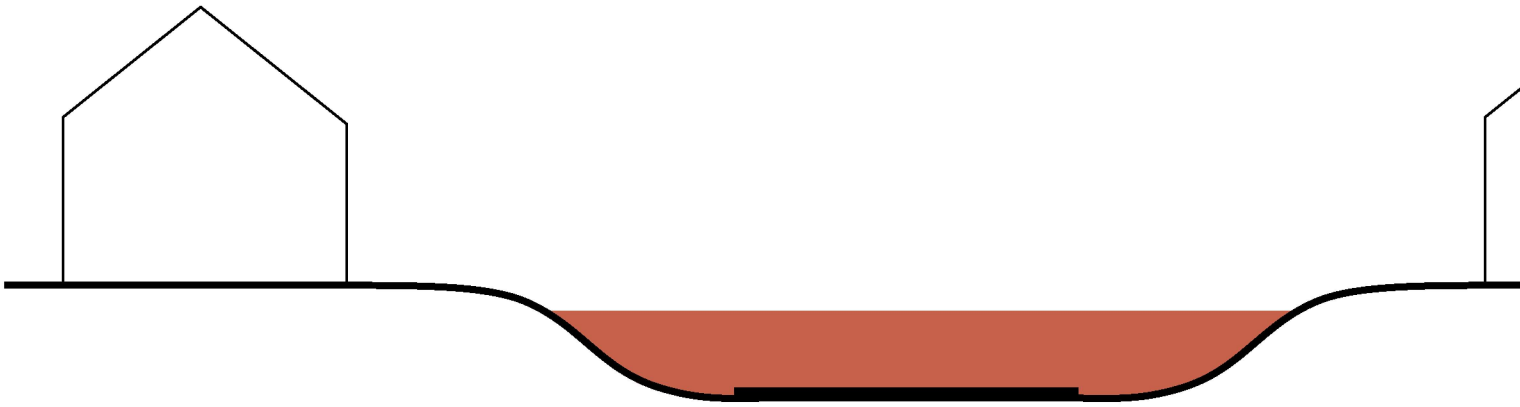
0 600 m





Reprinted and mod

A single family house with four cars parked on the driveway. Indicating the car dependency of the Houstonians.



Flood defence mechanism of residential streets, 'bowl' shaped. This way it can store water, and release it gradually to the sewers (Sebastian et al., 2017).



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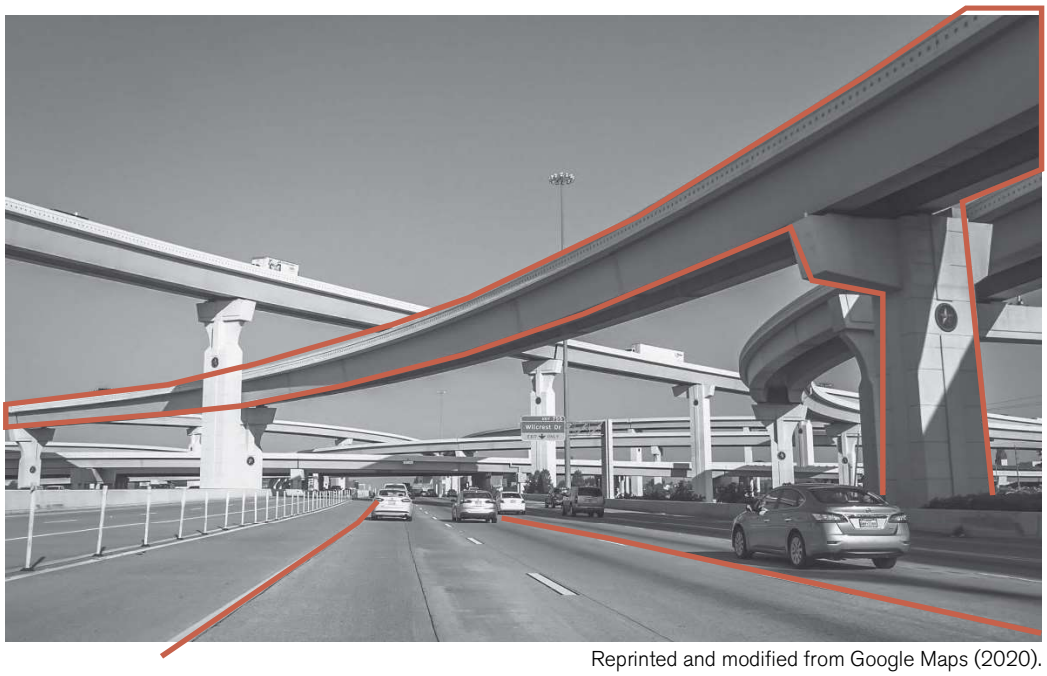

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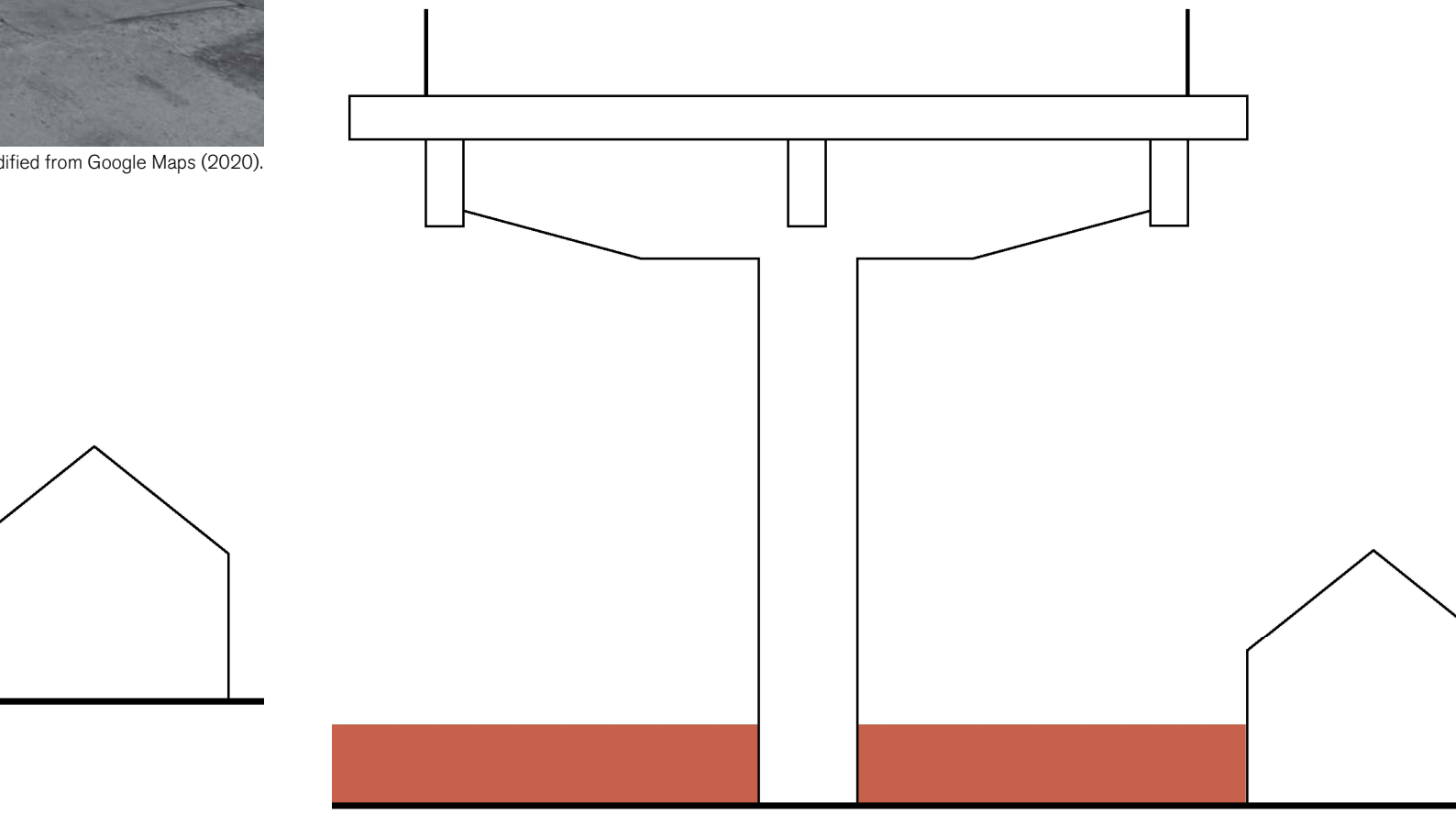


Most highways are on stilts. They can cater a lot of cars in this way and are less flood sensitive on short term.



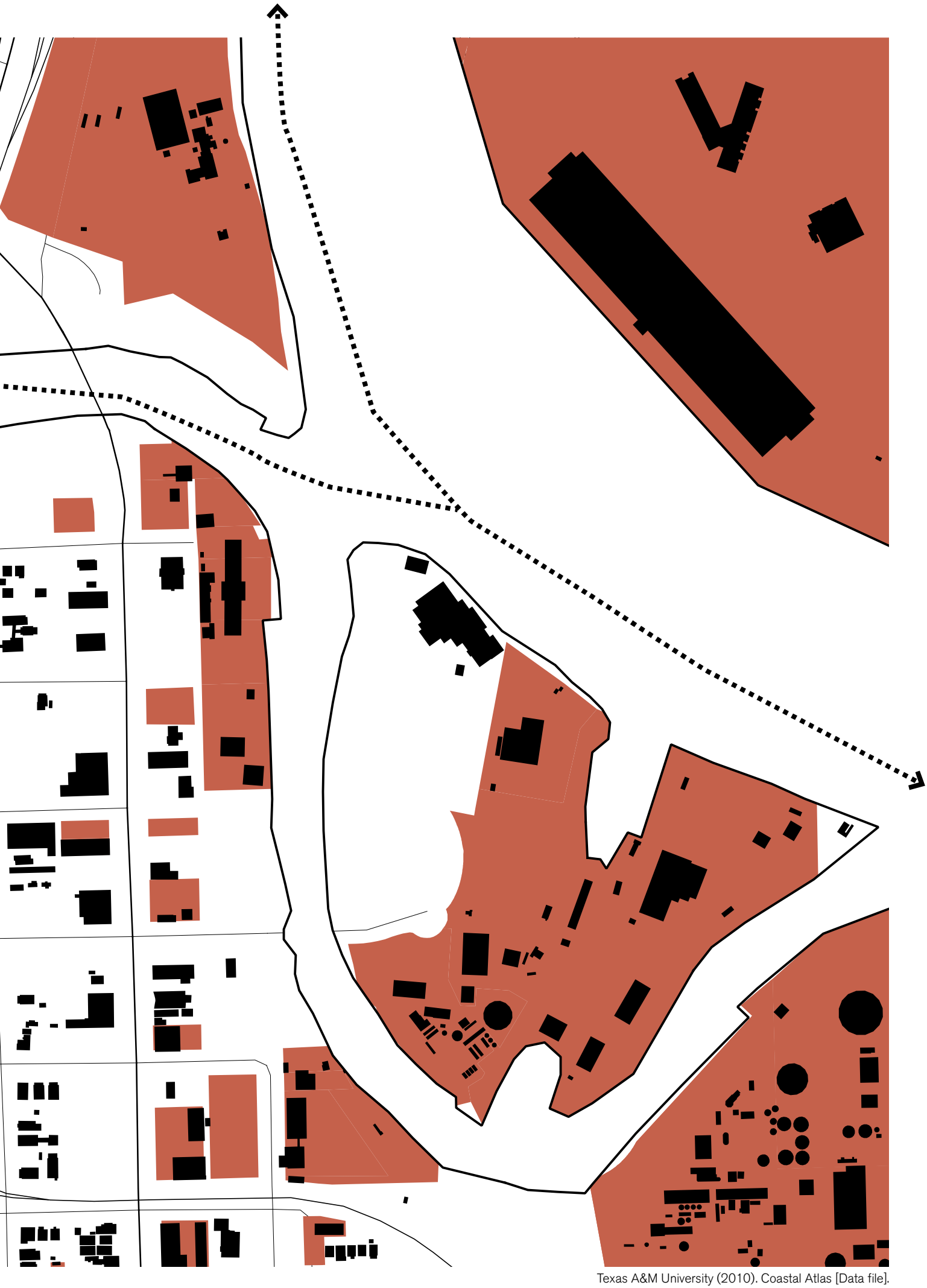
vital infrastructures - industry

the map shows the industrial areas, which cause a threat to the health of the residents of Houston. It can cause nuisances as well as air, noise, ground and water pollution (The Union of Concerned Scientists, 2016). Although it is dangerous, the economy largely depends on the oil industry.

Roads
Industry
Buildings

N

0 100 m



Texas A&M University (2010). Coastal Atlas [Data file].



vital infrastructures - health

In this picture and section the closeness of the industry to the residential area is depicted. Once water hits the industry, it could be very dangerous for the houses close to it (The Union of Concerned Scientists, 2016).
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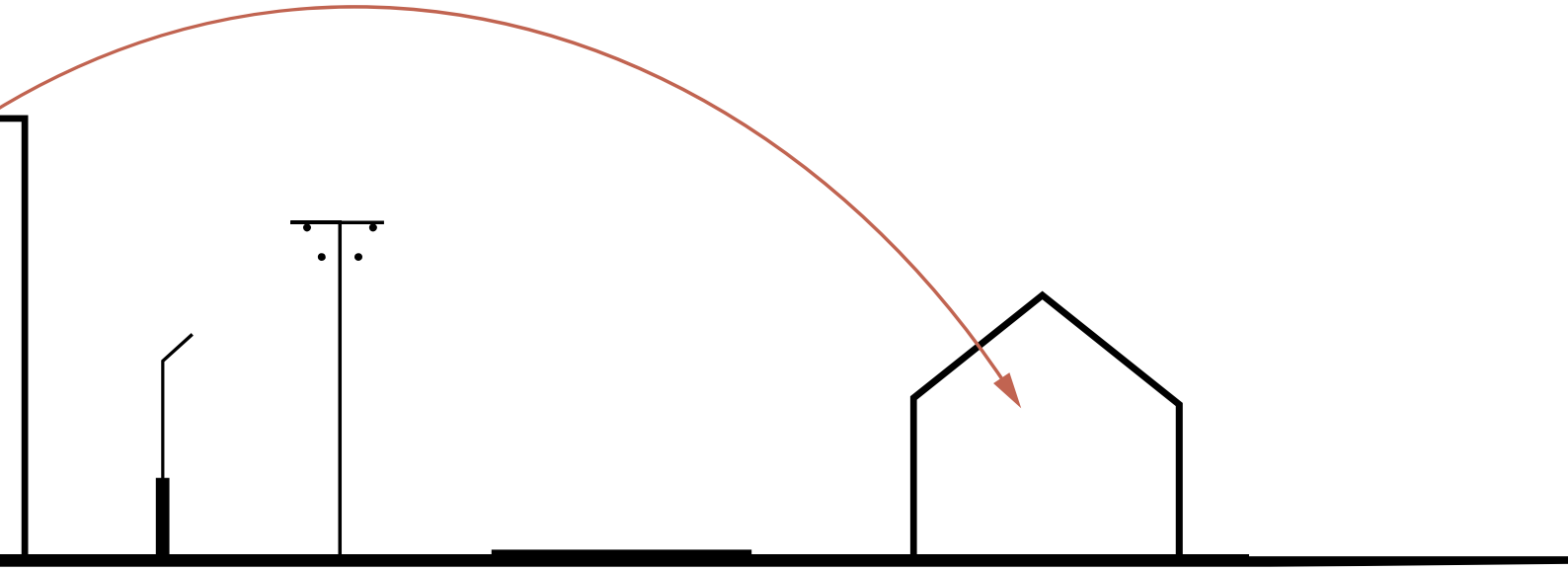
Reprinted and modified from Google Maps (2020).



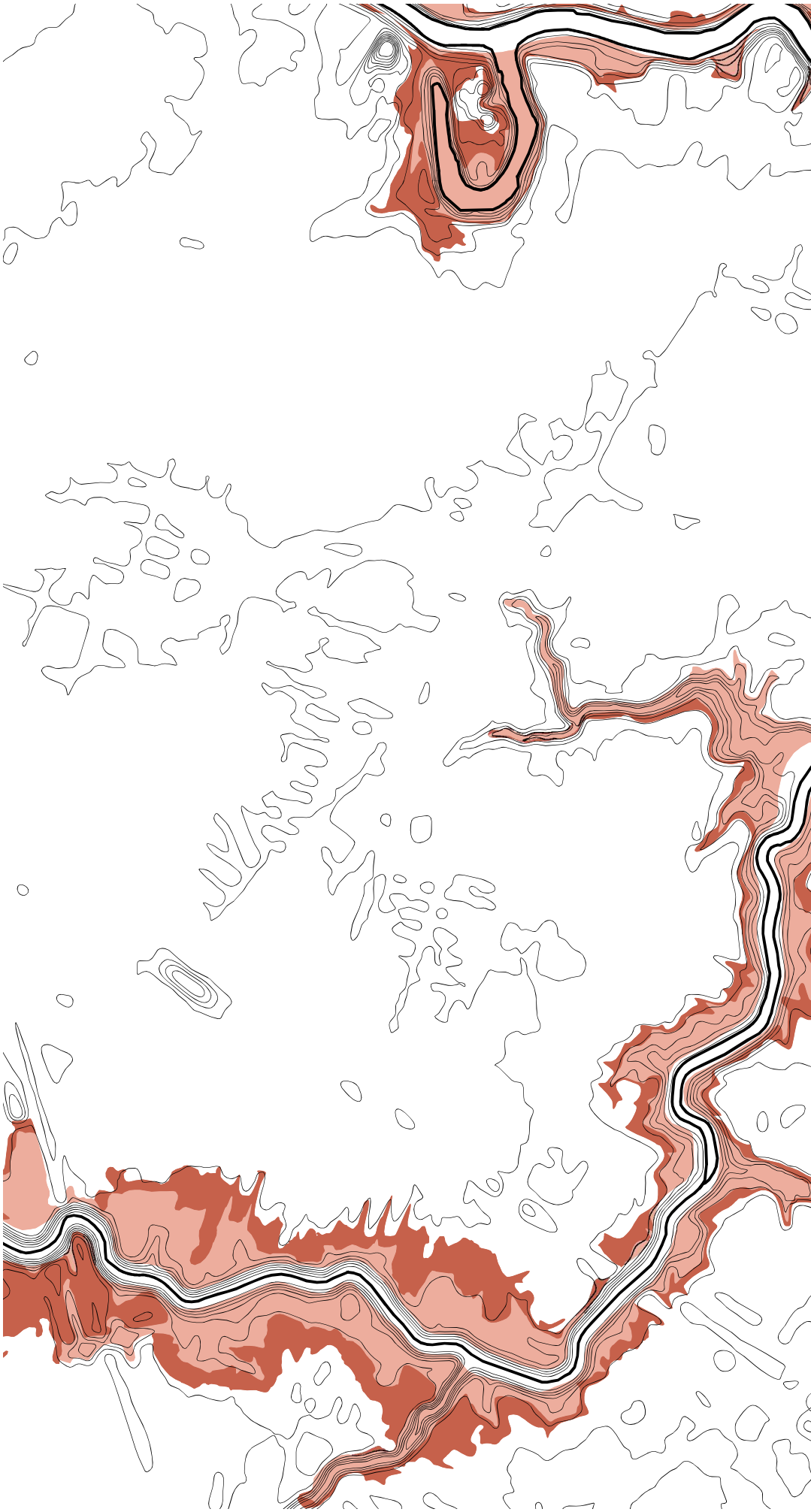
Vital infrastructures

Within this part of the report, vital infrastructures are indicated. These are divided into roads and industry. As they are the two important reason why Houston looks the way it looks. The residents depend on infrastructure to get to their work, and access their basic needs.

The infrastructure is designed in a way that it is a part of the flood defence mechanism. Highways are on stilts and residential streets are in a bowl shape, so that private property will not be flooded (Sebastian et al., 2017).

There are a couple of health facility and grocery stores in the area, but these are not accessible by foot or bike. For Houstonians to fulfil their basic needs, they will need to own a car. This is why a lot of traffic is part of Houston's daily routine. This causes a lot of traffic jams, especially in rush hour as well as that it causes quite some air pollution (The Union of Concerned Scientists, 2016).

The industry is what most of the economy of Houston depends on. Although this causes a lot of economic welfare, there are also downside to the industry. Especially once the water hits the industry, this could have serious consequences being air, soil and water pollution. Due to a lack of zoning rules in Houston, the industry is situated very close to residential function. In this way residents experience a lot of nuisance from this. A lot of noise pollution is experienced by the residents due to both the infrastructure and industry (The Union of Concerned Scientists, 2016).



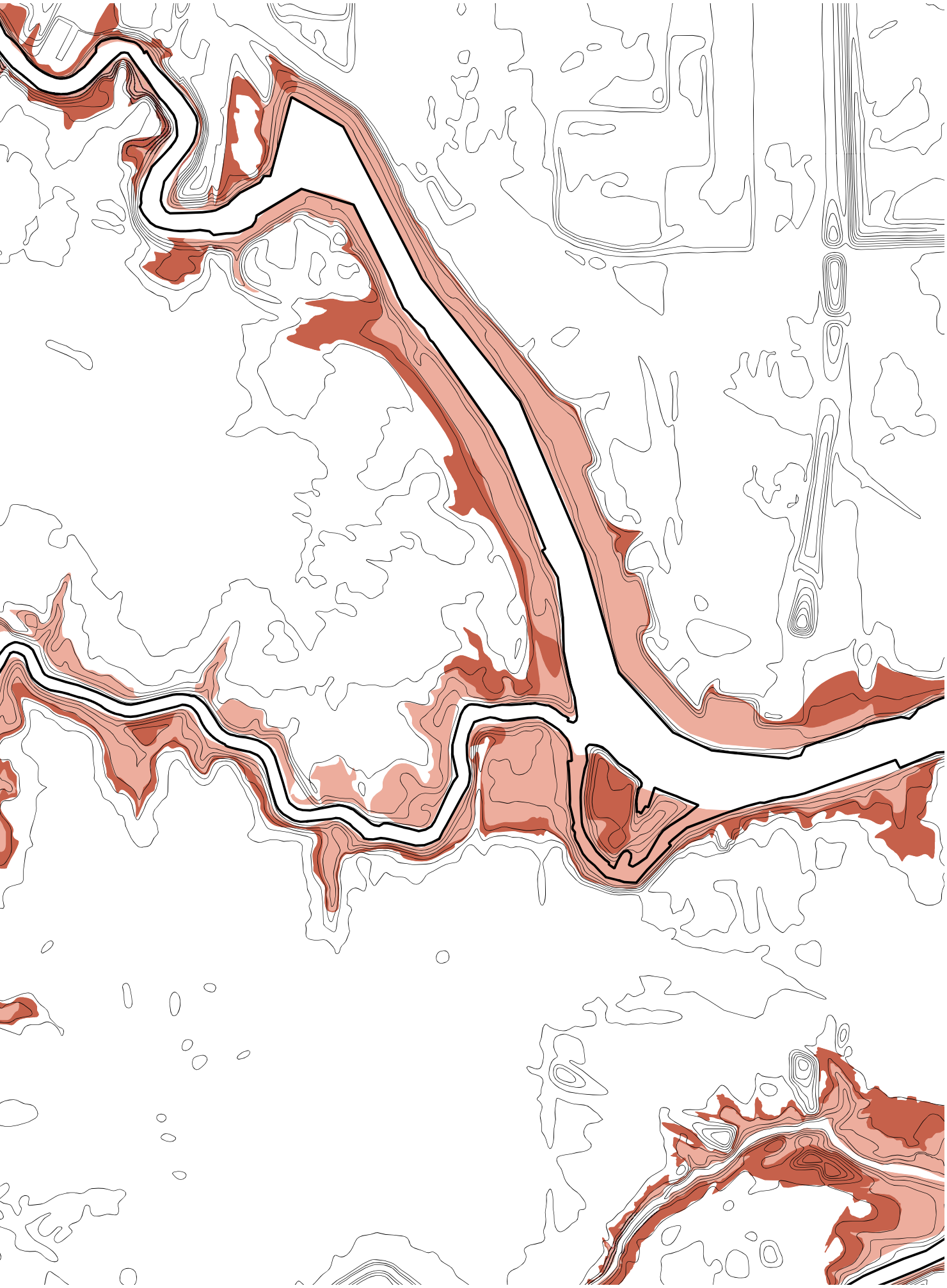
Flooding hazard

This map shows the flood risk according to the floodplains in the areas around the Buffalo bayou and Brays bayou. Our area is prone to flooding because it is at the confluence of two big bayous.

- 500 year floodplain
- 100 year floodplain
- Contour lines

N

0 100 m





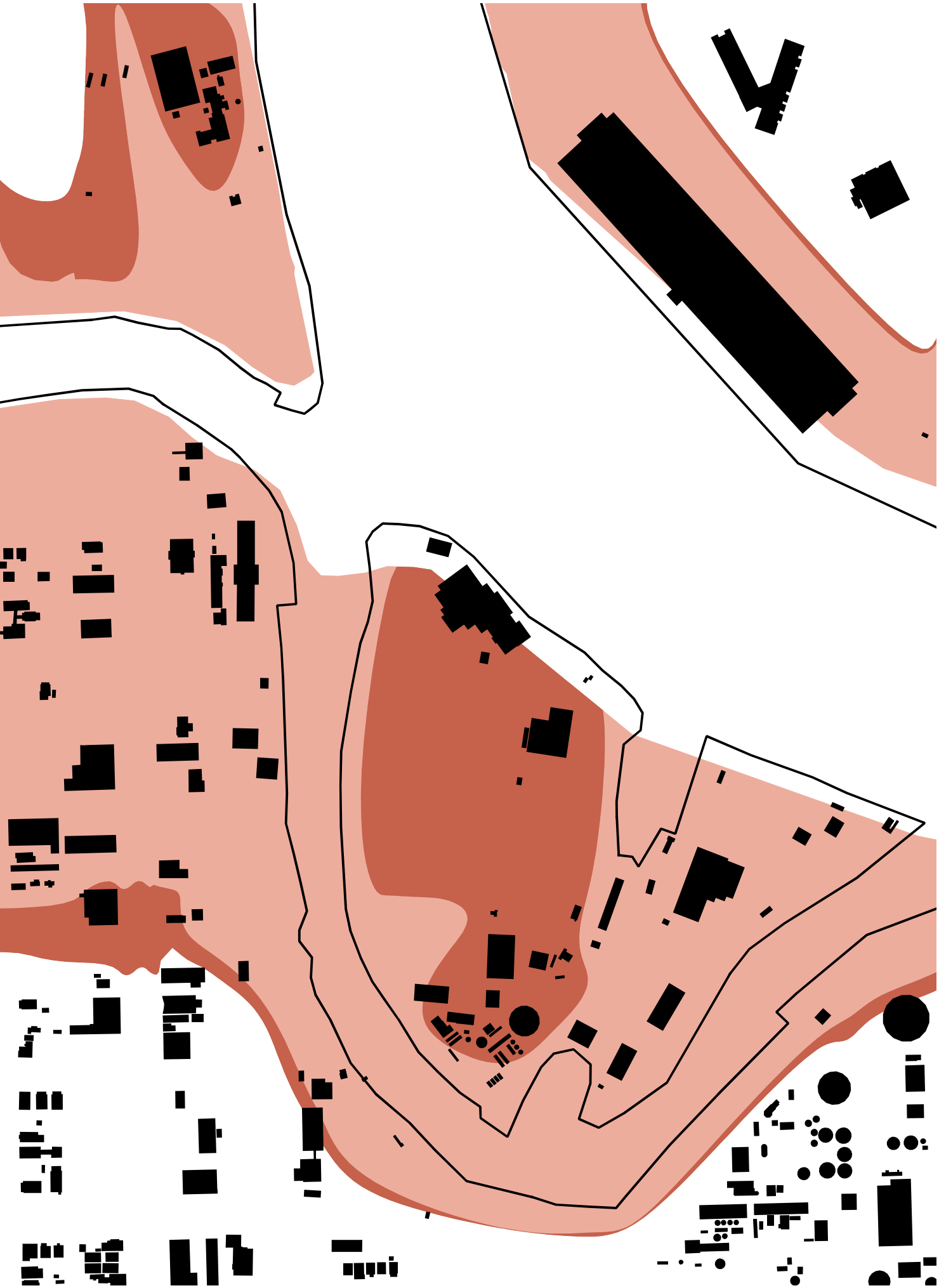
Flooding hazard

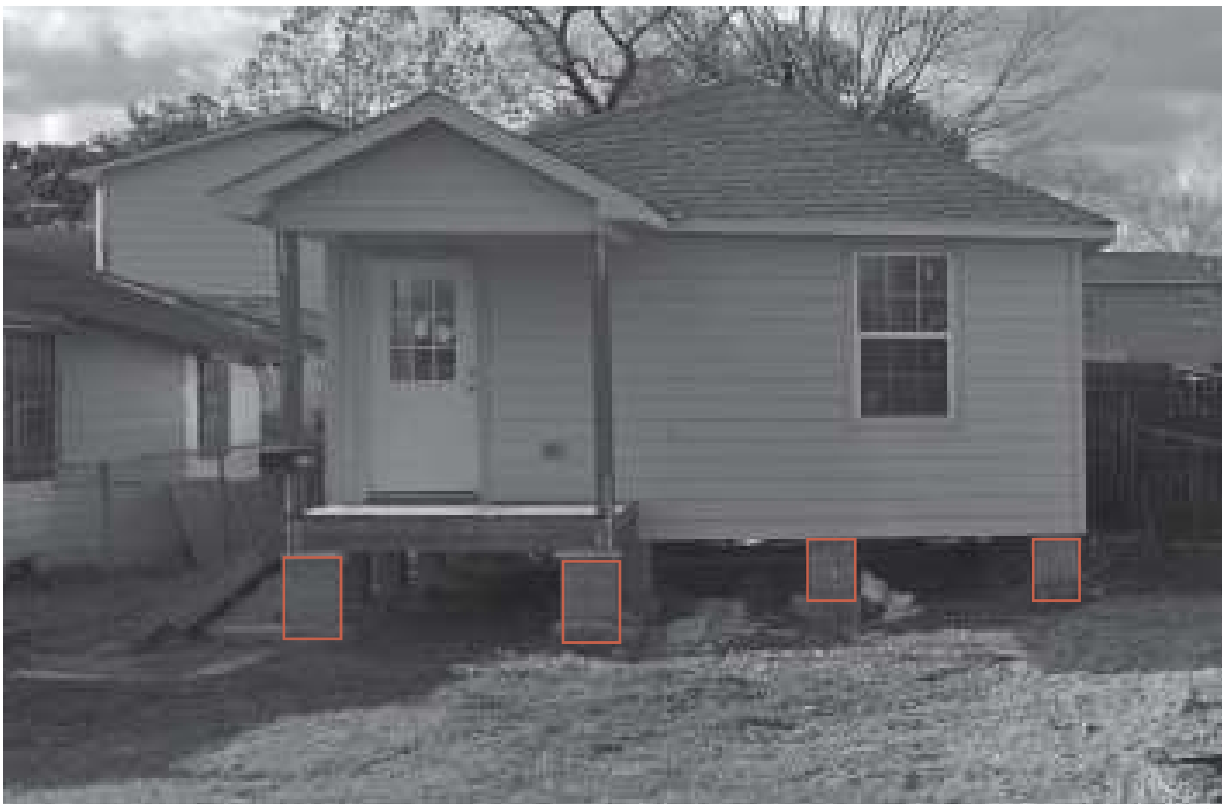
On this scale it is visible which buildings are within the floodplains. Most of Harrisburg / Manchester and a large part of Magnolia Park might be affected.

500 year floodplain
100 year floodplain
Buildings

N

0 100 m





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MAY 2011 well maintained housing



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MAY 2019 not maintained housing



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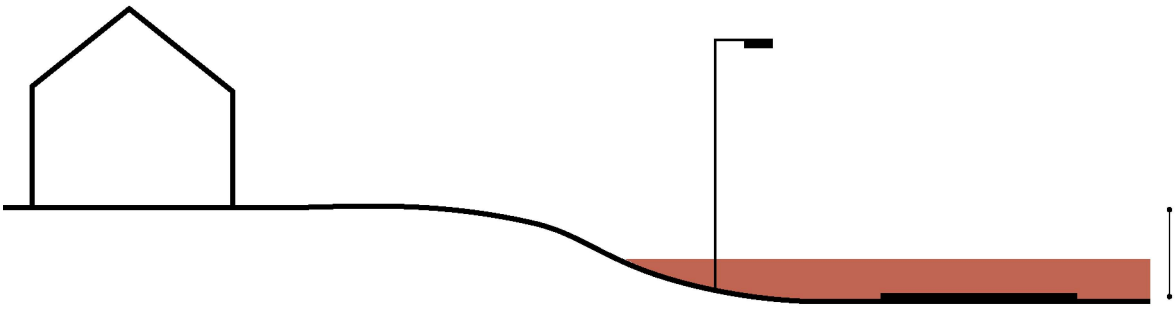
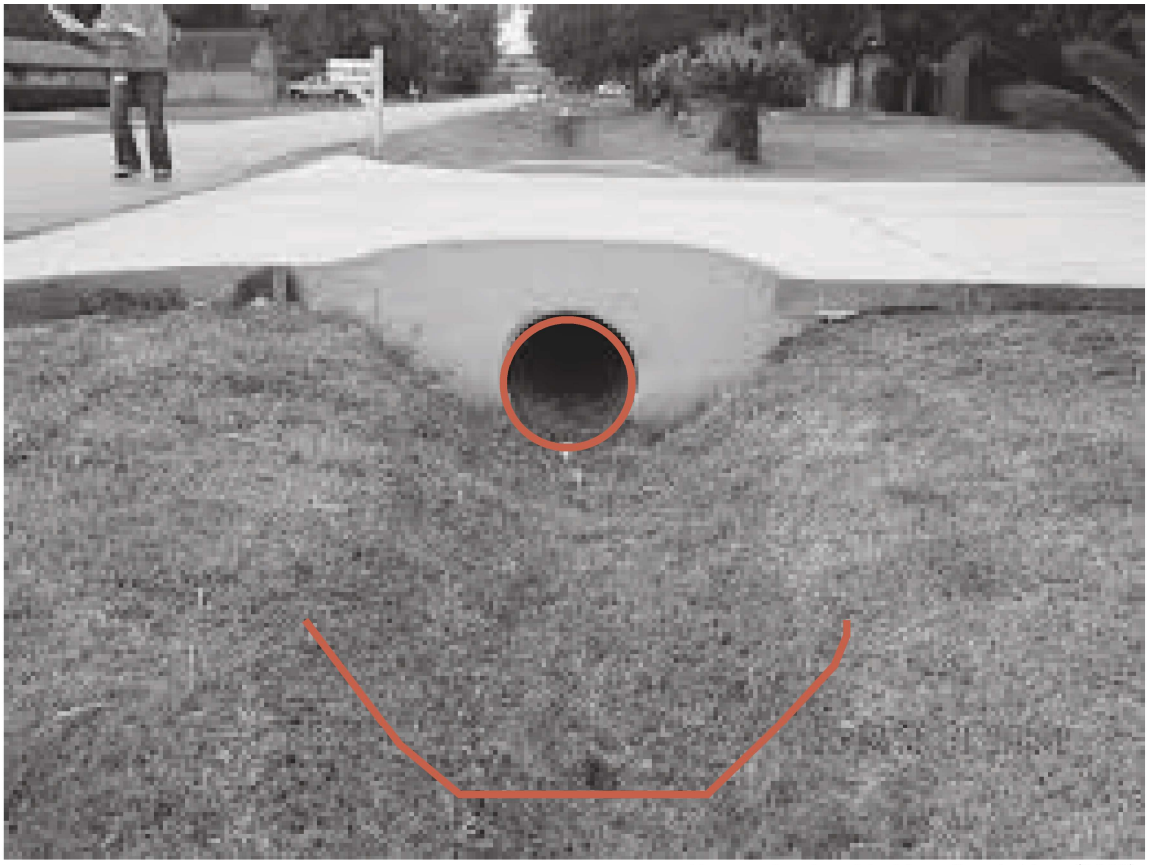


The residential streets are designed as a flood defence mechanism, in a 'bowl' shape to drain water (Sebastian et al., 2017).



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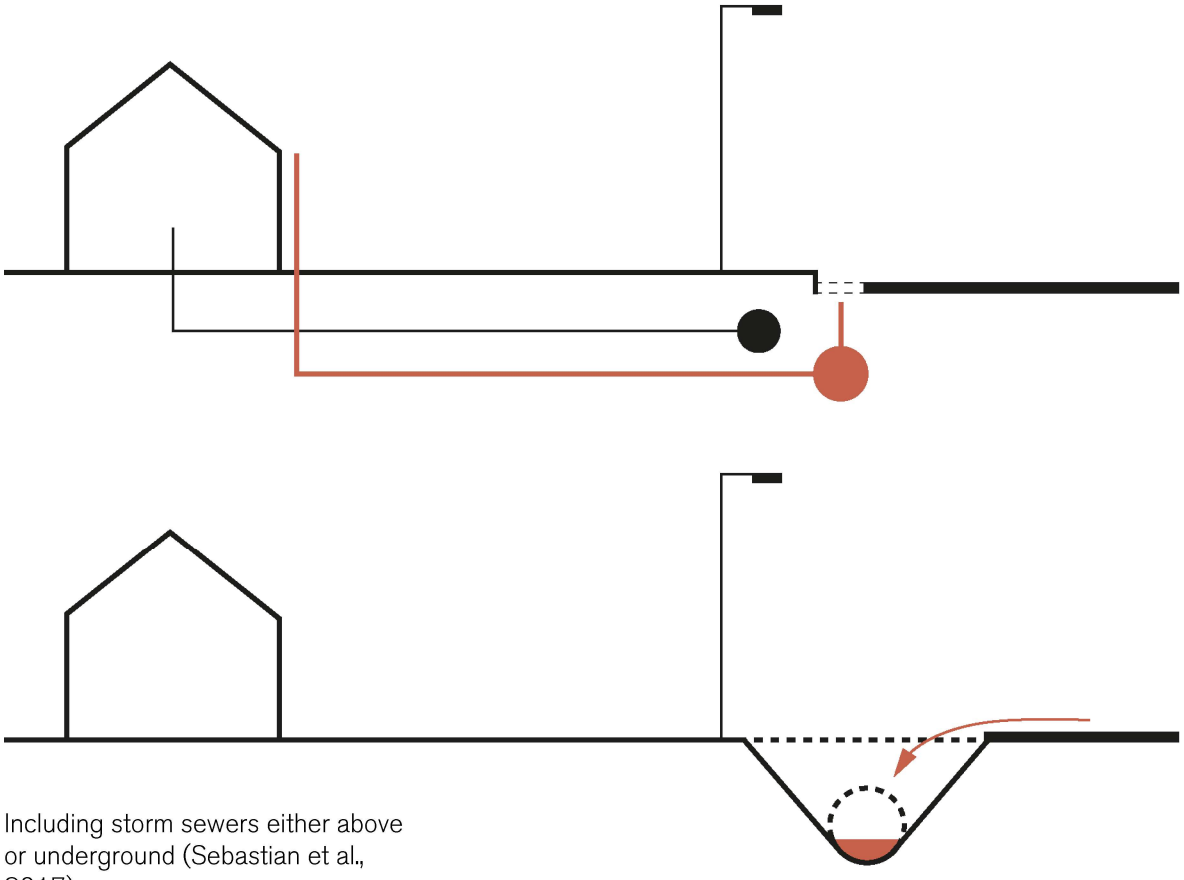


Including storm sewers either above or underground (Sebastian et al., 2017).

Construction artworks (hydraulic engineering interventions)

One of the biggest environmental problems that Houston encounters are big flooding events, either through storm surge, heavy rainfall and bayou overflow or a combination of the three. A lot of flooding events have happened in the past, and Houstonians are quite used to these kind of events happening.

Within the whole of Harris County, floodplain are indicated. Either in a 100 year floodplain or a 500 year floodplain. They indicate the area that could be flooded in case of such an event (Sebastian et al., 2017). Overlaying the floodplain map with the buildings, indicated which areas and houses are most prone to flooding. A large part of both Harrisburg / Manchester and Magnolia park will be underwater.

Zooming in on these parts, some mitigating and preventive measures can be found. For example elevated houses, storm sewers and a street profile that is designed to drain water, as a flood defence mechanism. Most residential streets are part of this system, they can store water and release it gradually in case of a flood (Sebastian et al., 2017).

Although there are some preventive measures to be found, the city and residents are mostly reactive. The flood damage is dealt with once the event has happened. This reactive approach becomes visible looking into the maintenance of houses throughout time. House owners depend on insurance to fix their houses after the storm (Sebastian et al., 2017). For this reason they will postpone this work to after a storm, because they do not have to pay for it.



extreme constructions

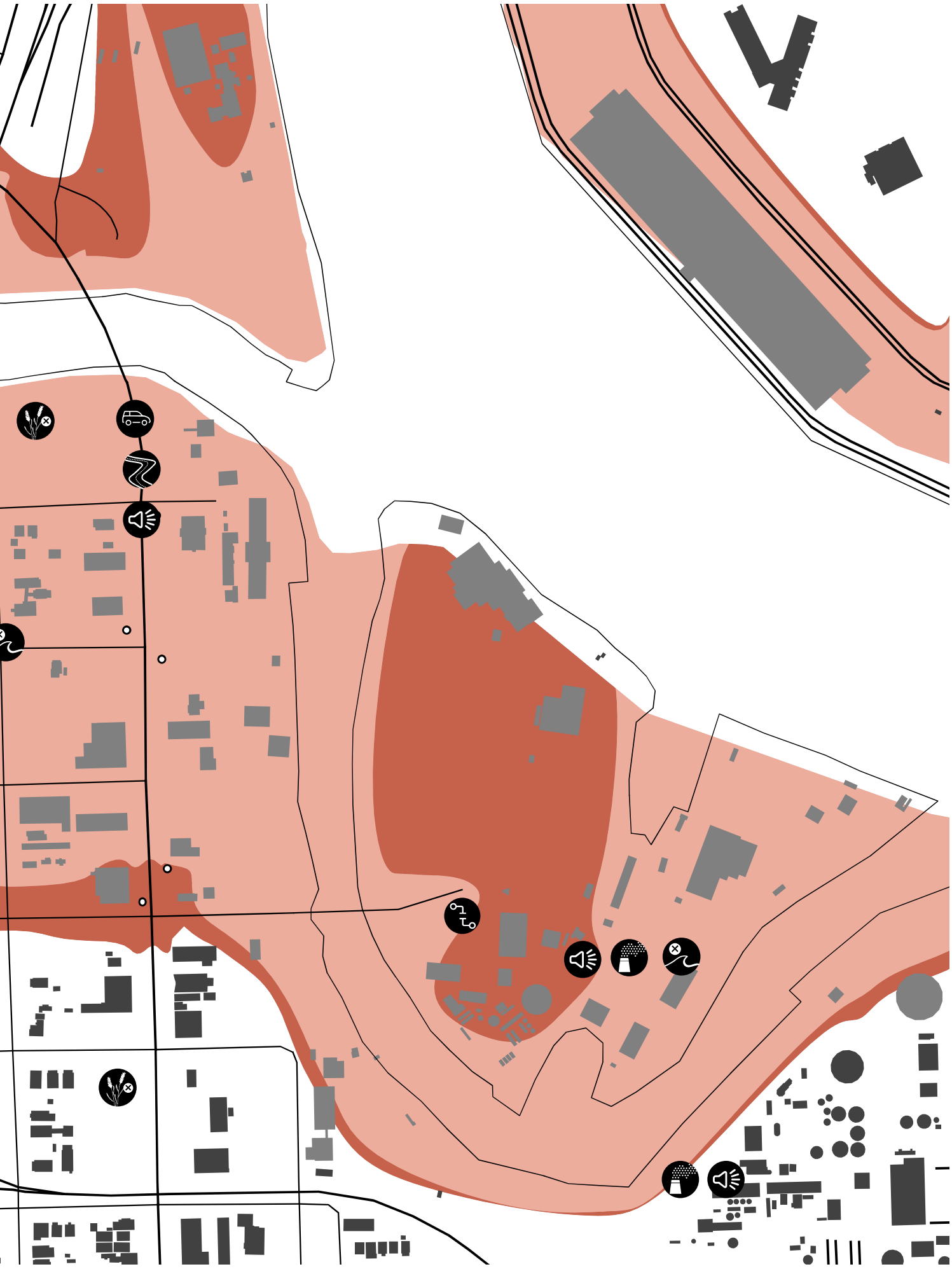
This is the concluding map of the urban perspective. Indicating both the shock of flooding and stress of infrastructure and industry that cause for the extreme environment. Both put pressure on the urban fabric.
Other more general problems, such as a lot of impervious surfaces, are indicated with icons on the map.

- flood prone
- poor (bio)diversity
- air pollution
- noise pollution
- car dependency
- impervious surfaces
- disconnected

- 500 year floodplain
- 100 year floodplain
- Roads
- Bus stops
- Buildings
- Affected buildings

N

0 — 100 m



Extreme Constructions

The conclusion map indicates the influence the extreme environment has on the urban fabric. The extreme environment consists of stress and shock factors.

Stress is put on the environment through the oil industry, as well as heavy infrastructure and car dependency, which has caused sprawl and a big amount of paved and impervious surfaces in the area.

Shock is encountered due to storm surge, heavy rainfall and bayou overflow. This causes all types of flooding, such as pluvial, fluvial and coastal flooding.

Due to unpredictability of the situation and the variety of possible events, the Houstonians have had a more reactive than preventive approach towards the extreme environment they are living in. Ecosystem participation could be a plausible way of changing towards a more adaptive approach. Mitigating both the effects humans have on the ecosystem they live in, as well as making sure people learn to live within their extreme environment the best way possible.

Looking into ecosystem participation from an urban perspective is looking at a more integrated approach on multiple scales. These are mainly the individual lot, the block /street and the neighbourhood. For there are some adaptive measures to be found in all scales separately, but they are not connected to each other. As well as that most measures are dependent on hard infrastructure, which have a high failure risk, as they are not able to include the unpredictable flows an extreme environment might have.

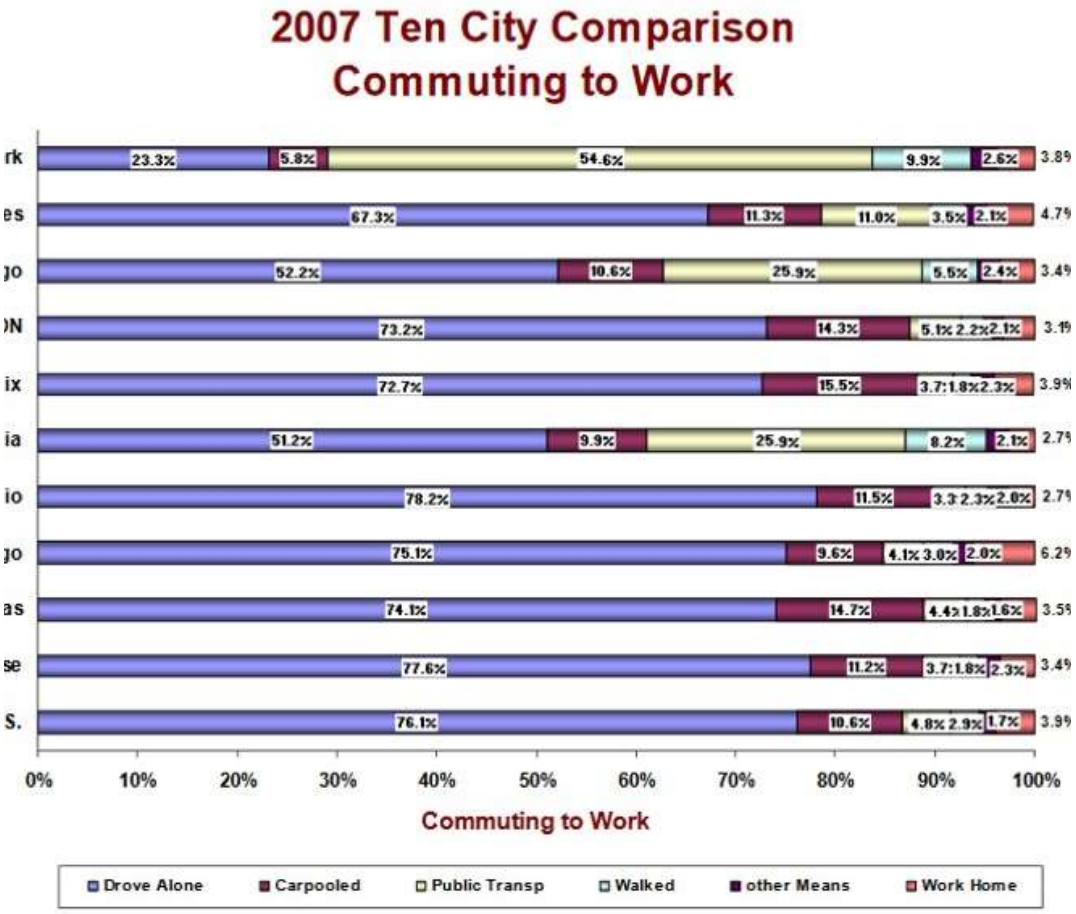
It would be recommended to start at the places where the environment is ‘most’ extreme, and for this reason most fragile. This could be the places where both shock and stress factors come together. The buildings, which are mostly affected by both flooding and infrastructural problems in Magnolia Park and Harrisburg / Manchester are indicated in grey in the conclusion map.

3.6. Mobility and transport [TIL]

Introduction

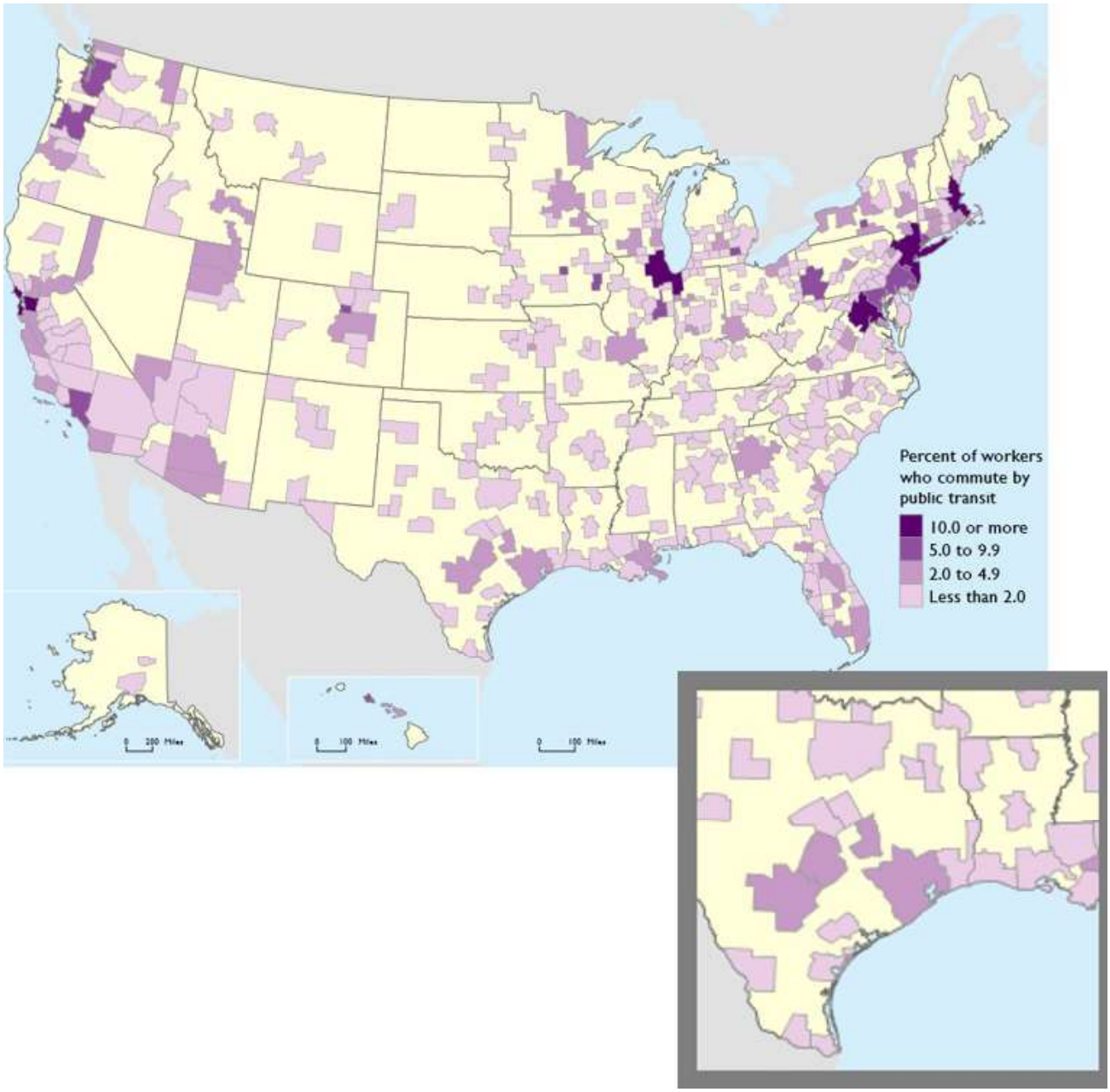
In this analysis the mobility and transportation system of the city of Houston, Texas, was analysed using the TIL perspective method. The results are visualized in the pre-established framework and further expanded upon using relevant literature. This framework offers a brief overview of how and why certain Stressors and Shocks impact the mobility flows and access to activity nodes within Harris County. The choice has been made to mainly focus on mobility flows and activity nodes as the human scale of travel and movement is far more relevant to the case area of Magnolia-Park and Harrisburg-Manchester, than the logistic side of the transportation network. While, yes, certain parts of the Buffalo Bayou are used for (inland) shipping and the seaside of the American city features large petrochemical industrial bases near its harbor, these factors, at least in matter of transportation, aren't analysed. This has been done because the social side of the transportation system is seen as more important in establishing guidelines for designs to improve environmental participation on the local neighborhood level.

This chapter is structured in the following manner; Firstly, context is given to the mobility and travel behaviour of the average Houstonian. Especially the importance and the prevalence of the car will be analysed. Secondly, the Shock on the transport system that is flooding will be discussed as well as the impact the inundation of roads has on the accessibility of emergency facilities. After this, the Stress of Houston's chronic congestion problem as well as its overreliance on the car as a means of transport will be discussed. This is followed by an analysis of the effect on this stress on reaching activity nodes, in this case the socio-economic problems related to food deserts that affects the case area. Lastly, based on other papers and projects about increasing ecosystem participation in other parts of Houston, a design guideline proposition is made for the response to lessen the impact of stressors and shocks.



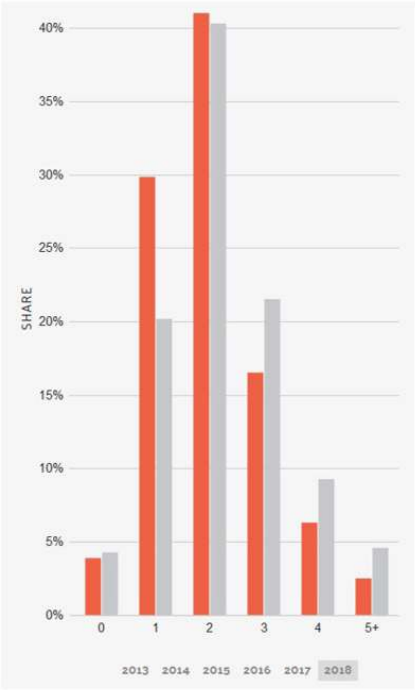
1.Context; Facts and figures about Houston travel

Houston is a fast-growing city in south-eastern Texas. When describing how people move around in the city,oftentimes the car is brought up as the de facto sole method of transportation. A Texan Holy cow of sorts. However,to what extent is this preconception about the city and its inhabitants true?



Mode of transport for commute in Houston

In Houston, only 5.1% of inhabitants use Public Transport for their daily commute, against 87% Houstonians commuting by car. In Houston, 73.2% of the commuters drive alone in their vehicles, lower than the U.S. average (76.1%). The percentage of commuters in Houston using public transportation is 5.1%, far less than percentage of commuters in New York, Chicago and Philadelphia. (City of Houston, 2009). Specific travel mode comparisons to other cities can be seen on the left side of Figure 1. Being a large city, the percentage of public transit use is still much higher than its surrounding areas. However, even more recent national surveys from 2017 show no significant change in the percentual use of public transport, their use for commute being just short of 5% (U.S. Department of Transportation, 2017). This can be seen in the righthand of figure 1.



Number of owned vehicles per household (2018)

N=12901	Q11a Household County	
	Harris	Other
Total	8502	4399
	65.9%	34.1%
Q4 Type of Vehicle		
Motorcycle	105	71
	1.2%	1.6%
Car	4093	1806
	48.1%	41.1%
Van	689	340
	8.1%	7.7%
Sport Utility	1799	827
	21.2%	18.8%
Pickup Truck	1768	1320
	20.8%	30.0%
Cargo Transport	19	6
	0.2%	0.1%
Service Vehicle	6	8
	0.1%	0.2%
Other	7	9
	0.1%	0.2%
Don't Know	16	12
	0.2%	0.3%

Percentage of Vehicles Used for Commerical Purposes

N=12901	Q11a Household County	
	Harris	Other
Total	8502	4399
	65.9%	34.1%
Q12 Commercial Use		
Yes	359	197
	4.2%	4.5%
No	8123	4191
	95.5%	95.3%
Don't Know	19	11
	0.2%	0.3%
Refused	1	0
	0.0%	0.0%

Household Survey on vehicle ownership from (2009)

Vehicle ownership in Houston

Vehicle ownership in Houston is comparable to if not slightly lower than the U.S. average. The left hand of figure 2 offers data on personal vehicle ownership. 41% of Houstonian households (orange) own 2 cars, being similar to the average American household (grey). The share of 1 vehicle households is higher than the U.S. average, the 3 vehicle household share lower (Datausa.io, 2020).

The righthand of figure 2 offers data on the precise choice of personal vehicle. The car is the dominating choice of vehicle in Harris county at 48%, pick-up trucks (21%) and sport utility vehicles (21%) like hummers also being widely owned. The vehicle is for personal use in the vast majority of cases, only 5% of owned vehicles being for direct commercial use (ETC Institute, 2009).

HOUSEHOLD TRIP RATES--Trips by Household Size

Q39 Total HH Trips	Mean	SD	N	Pct.
For Entire Sample (Missing = 0)	10.45	8.68	5810	100.0%
Q16 Number of Persons				
1=1	3.82	2.94	649	11.2%
2=2	6.29	4.78	1636	28.2%
3=3	9.26	5.91	1228	21.1%
4=4 or More	15.93	9.89	2297	39.5%

Percentage of Employed Participants Who Telecommute

N=8049	Q11a Household County		Total
	Harris	Other	
Total	5443	2606	8049
	67.6%	32.4%	100.0%
Q23 Telecommute			
Yes	712	297	1009
	13.1%	11.4%	12.5%
No	4729	2308	7037
	86.9%	88.6%	87.4%
Don't Know	0	1	1
	0.0%	0.0%	0.0%
Refused	1	0	1
	0.0%	0.0%	0.0%

Percentage of Employed Participants Who Have a Home Office

N=8049	Q11a Household County		Total
	Harris	Other	
Total	5443	2606	8049
	67.6%	32.4%	100.0%
Q22 Home Office			
Yes	535	259	794
	9.8%	9.9%	9.9%
No	4907	2346	7253
	90.2%	90.0%	90.1%
Don't Know	1	1	2
	0.0%	0.0%	0.0%

Delivery Drivers

N=8049	Q11a Household County		Total
	Harris	Other	
Total	5443	2606	8049
	67.6%	32.4%	100.0%
Q16 Delivery			
Yes	282	194	476
	5.2%	7.4%	5.9%
No	5161	2412	7573
	94.8%	92.6%	94.1%

Trip rates and household travel

The majority of average Houstonians commute to work. The percentage of employed people telecommuting or working at home offices both being around 10%. Furthermore, 5% of households feature someone employed in delivery in some form. 68% of Houstonian households use their vehicle (personal or commercial) for delivery of some sort (ETC Institute, 2009). Thus the personal vehicle is ingrained in the life of the Houstonian. Specific data on household travel can be found in figure 3.

2.Shock; (Fluvial) flooding and the mobility system

Houston suffers from flooding related to hurricanes or other storm events. Houston's road network in the case area, but also the city in generally, is especially affected by fluvial flooding. Excess rainwater makes the bayou overflow, flooding streets, or it overflows streets directly.

Houston's road network and flooding

Much like the rest of Houston's urban environment, Houston has to deal with the fact that any form of infrastructure construction has been done with incorrect floodmaps in mind. According to these floodmaps about 25% of Harris County is within the 100-year flood plain and 34% within the 500 year floodplain. These maps were possibly proven wrong in the last few years, during increasingly intensive and frequent rain events, like hurricane Harvey. This could pose problems for the road system, which might not be built with the correct actual risk of flooding in mind. As a result, Harrison County has proposed to use the 500-year flood plain for future planning and regulatory purposes. A quote from the Houston Chronicle might grant some further insight; "In some flood events, as much as 50 percent of Harris County flooding damage is outside of mapped 100-year flood plains. Some of this is due to our 100-year floodplain being too small, but some is also due to the fact that the road system in the city of Houston is our secondary drainage system, holding up to a 25-year (4 percent) storm. When the streets fill up, the water flows into yards and down any slope in the neighborhood, often flooding houses by overtopping the curb. This type of flooding is typically not mapped as a flood plain" (Blackburn, 2017).

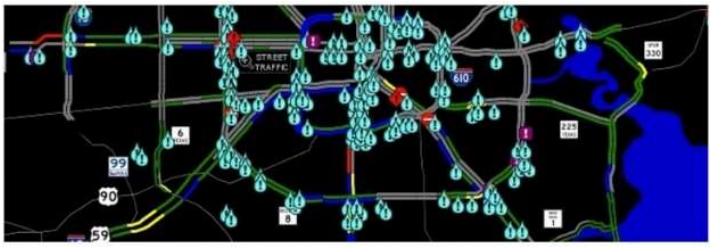


Interstate highway 45 is submerged
Texas, August 27, 2017.
Richard Carson / Reuters



from the effects of Hurricane Harvey seen during widespread flooding in Houston,

- 41000 block of FM 1774
- Melton Street between FM 1488 and Buddy Riley Boulevard
- Oak Crossing at FM 1774
- Nichols Sawmill Road at Connie Avenue
- 25600 block of Magnolia Pines Drive
- 14700 block of Wildwood Circle
- West Rollingwood Street at Hwy. 249 southbound
- 16800 Boothill Road
- Walnut Creek Road at Stagecoach Road
- Walnut Creek Road at Walnut Creek
- Silver Spur at Hunters Grove
- Indigo Lake Drive at Nichols Sawmill Road
- Nichols Sawmill Road at Walnut Creek
- Nichols Sawmill Road at Winding Creek Lane
- Nichols Sawmill Road at Butera Road
- Baneberry Road at Bob Link Street
- Butera Road at Sunset Lane
- Roberts Cemetery Road at Crooked Creek Road
- Glenmont Estates Boulevard at Rose Circle
- Roberts Cemetery Road at Spring Creek
- Sanders Cemetery Road at Spring Creek
- Decker Prairie-Rosehill Road at Spring Creek
- Decker Prairie-Rosehill Road at Fawnwood Lane
- Peden Road
- Hardin Store Road to Decker Oaks subdivision
- Hardin Store Road at Mill Creek
- Hardin Store Road at Riata Drive



There were nearly 350 high-water spots on Houston roads on Monday morning. / **Screenshot/Houston TranStar**

On Day 3 of Harvey, Houston's Transportation Remains Paralyzed

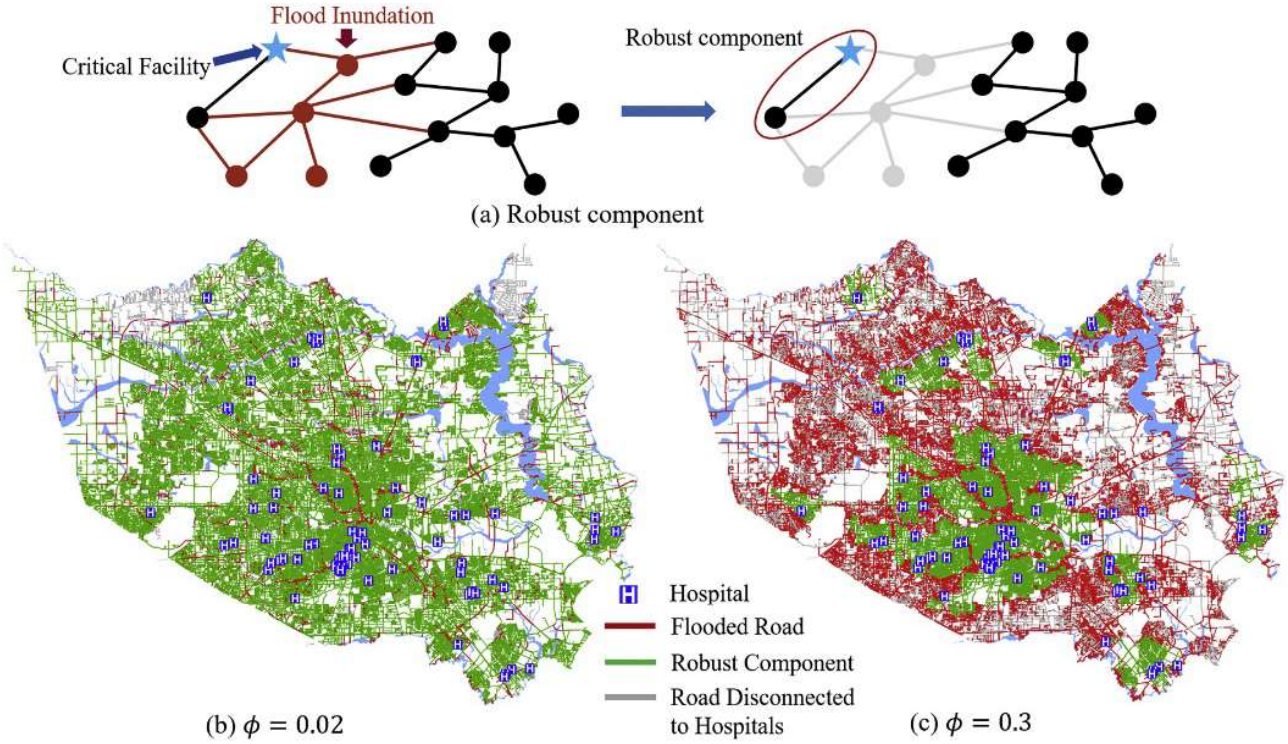
ZACH DESPART | AUGUST 28, 2017 | 12:53PM

Monday brought more pounding rain to the Houston area as Tropical Storm Harvey battered the city for the third straight day. Widespread flooding still affects much of Houston, and driving remains difficult. In addition, METRO suspended rail and bus service indefinitely on Sunday, and both Hobby Airport and Bush Intercontinental Airport are closed.

Most of Houston's interstates and arterial roads are partially closed. The bottom line is this: Avoid driving anywhere on Monday if you can.

Reality of Houston's road system as secondary drainage

The reality is that, while Houston's road system is planned to be used as a secondary drainage system, it's unclear exactly what roads will be flooded during storms. Steps have been taken to identify and alert citizens to the inundation of these roads whenever and wherever they happen. Since the Harvey storm in 2017, an app has been developed by Houston Transstar in collaboration with the Harris County Flood Control District, to report floodrisk realtime using rainfall sensors. It does not provide historical data (Delaughter, 2018). This development is in line with advise from experts following Harvey; "The roadways in Houston serve as secondary drainage systems. Our roads fill with water during intense rainfall events. Most any road in Houston can and will flood. Some drain better than others. Some have low spots that are deeper than you think. Some underpasses are simply deadly. During heavy rains, always look for depth indicators on underpasses. In general, do not enter a flooded underpass. Hopefully, the city and the county will install flood gates at such underpasses, as well as develop mobile phone app devices that will give information about street flooding conditions, including streets to avoid and those that are safe to travel. It is difficult to give definitive advice about street flooding in all areas. The best way to learn about an area's accessibility is to talk to your neighbors. Ask what roads are the first to flood during rains, which intersections to avoid, and which roads to use during a flood" (Blackburn, December 2017, p.25). Accounts and reports of flooded roads during Harvey also paint a picture of the impact of the heavy rainfall on the road system. Figure 4 shows roadways that were designated as impassable in the Magnolia Park area during the Harvey flooding, according to the Montgomery County Office of Emergency Management (August, 2017). The reality is also that even sections of the large interstate freeways near Magnolia Park and Harrisburg-Manchester, including the I-45 and I-610, are prone to flooding (Delaughter, 2018). An impression of flooded interstates is given in figure 5 (Harrington, 2017). The effects of flooding on mobility flows can last for days (Despart, 2017), as shown in figure 6.

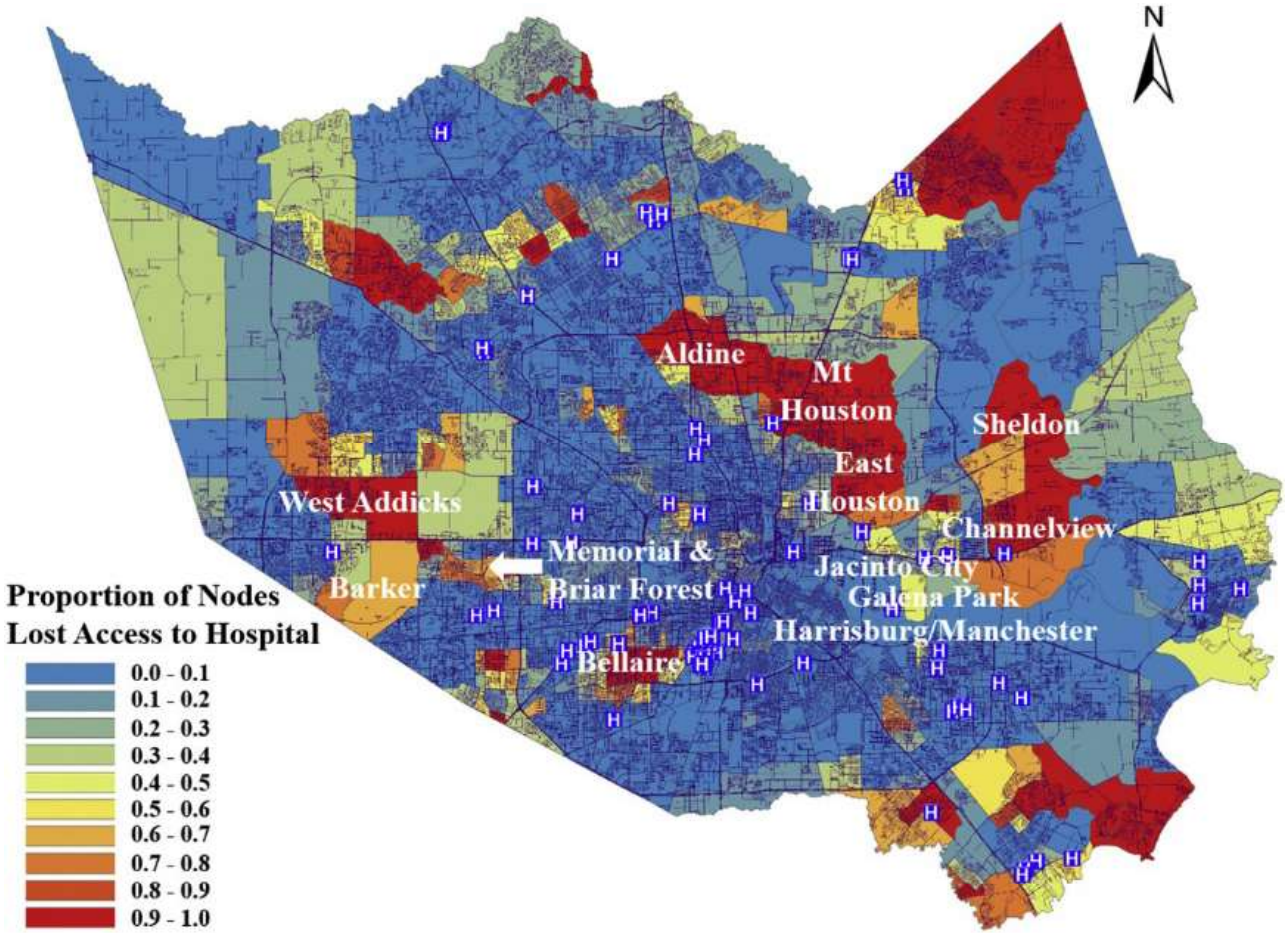


3.Shock; Access to critical facilities under shock

While historic data on which parts of Harris County's road system are prone to flooding, or actually did flood, is scarce or unavailable, the accessibility of Houston's road network during floods has been the topic of much scientific research since Harvey. As roads flood, or become inundated, by fluvial flooding they become unusable by cars, limiting the mobility of Houstonians. With the car being the main mode of transport in Houston, yet the road being secondary drainage system, one can wonders how this affects mobility during tropical storms. More importantly, how is access to critical facilities, like hospitals, affected during this kind of natural disaster? In the paper An integrated physical-social analysis of disrupted access to critical facilities and community service-loss tolerance in urban flooding by Dong et al. published in march 2020, this has been researched using graph theory through the creation of a model of Harris County's road network. This model can be seen in figure 7. The roads in green are the roads that remain functional and allow Houstonians access to hospitals, the roads in red have become inundated. The graph on the left shows a low rainfall scenario, whereas the one on the right shows a Harvey level rainstorm scenario.

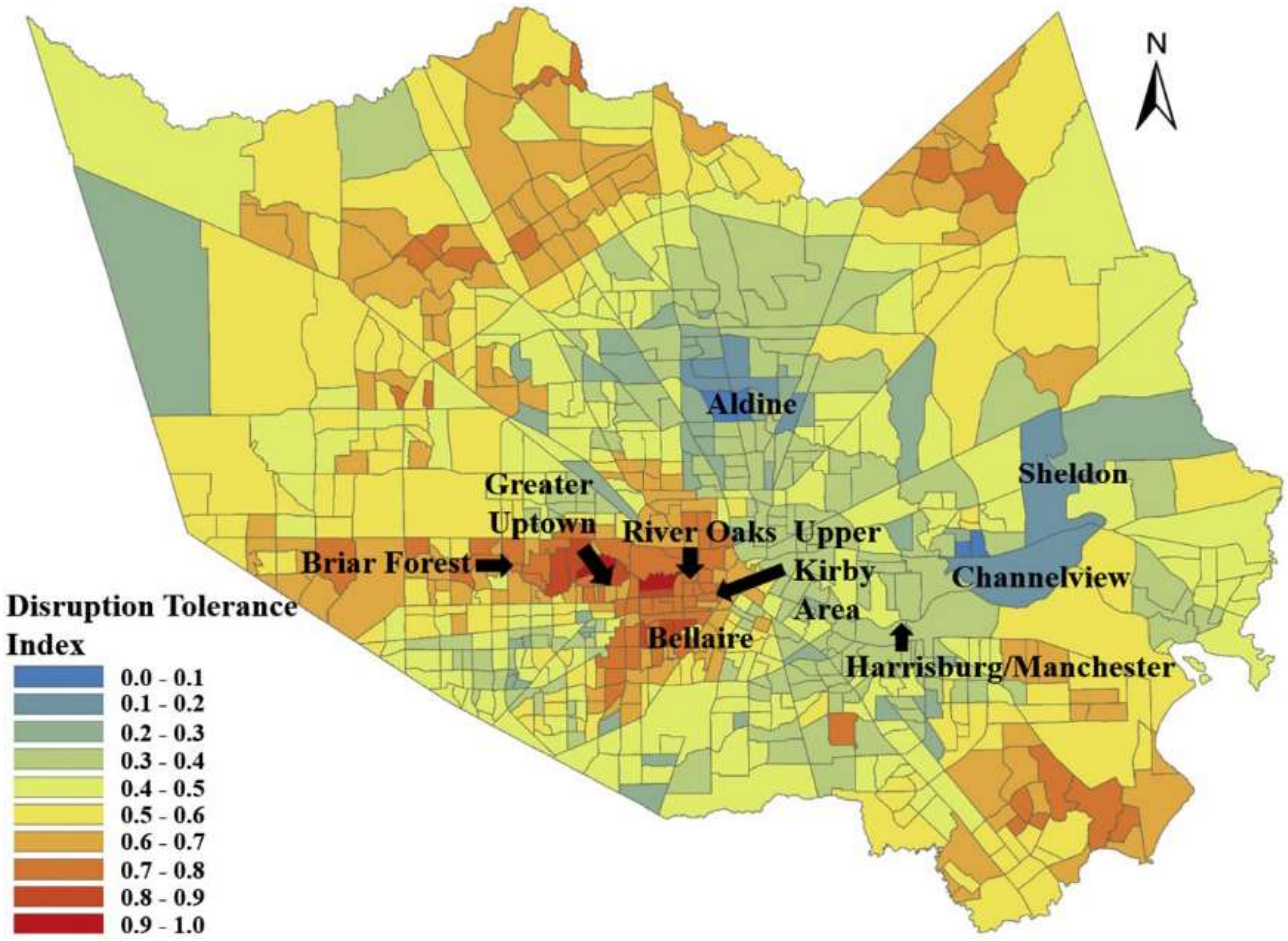
Specific effect on case area Magnolia Park & Harrisburg-Manchester
When specifically looking at the selected case area it's noticeable that the roads within the area around which the Brays Bayou flows into the Buffalo Bayou will become inundated. This can be seen in figure 8, where this specific area is marked on the graph. This means that, according to Dong et al.'s model, the people dependent on these roads will lose accessibility to hospital by road. It must also be noted that, while not exactly being a part of the case area, the northern parts of Magnolia Park and the eastern half of Harrisburg-Manchester will be affected in accessibility to critical facilities. This is however the result of a model; How did the inhabitants of these areas themselves then experience their access to hospitals during Harvey?

Actual loss of access to hospital during Harvey and physical vulnerability
Based on surveys taken after hurricane Harvey, Dong et al. (2020) determined which parts of Harris county lost access to hospitals. As can be seen in the diagram in figure 9, the case area was generally not



Physical vulnerability clusters and social vulnerability to flooding

The social vulnerability of the area should however also be taken into account. The case area, specifically the Harrisburg-Manchester area, has an average to low 'Disruption Tolerance Index'. This 'Disruption Tolerance Index' is a way to measure social vulnerability and is used by Dong et al. (2020) when analysing Harris County. This indexed value takes certain social factors into account. In this case these factors are Income, Education, Elderly, Minority, No Vehicle and Children. A low index value means high vulnerability. Figure 10 features a map of social vulnerability.All-in all, while the case area features a low physical vulnerability to flooding, it does feature a high social vulnerability. This means that generally floods do not affect the areas access to critical facilities too much. However, once it does, the disruptive impact of the flooding on the local community will be rather high.



Responses in place to flooding of road infrastructure system and access to critical facilities

After Ike, hospitals started to develop their own independent flood warning systems (SSPEED Center, 2020). As it stands, after Harvey most plans for future mitigation of the impact of flooding on the road system were not so much in changes to the infrastructure itself, but rather in ensuring people would get up to date information on flooding as well as gathering data on the weaker or more significant points of the road network itself. Future changes to the road network can be based on these types of analyses (Wang, et al., 2019). A fear can be that certain bigger actors develop their own private rainfall measurement or flood warning systems, causing an effect of the haves being protected and the not haves remaining unprotected, as there is no incentive for developing a public system. After the Harvey public real time flood warning systems have been put in place however.

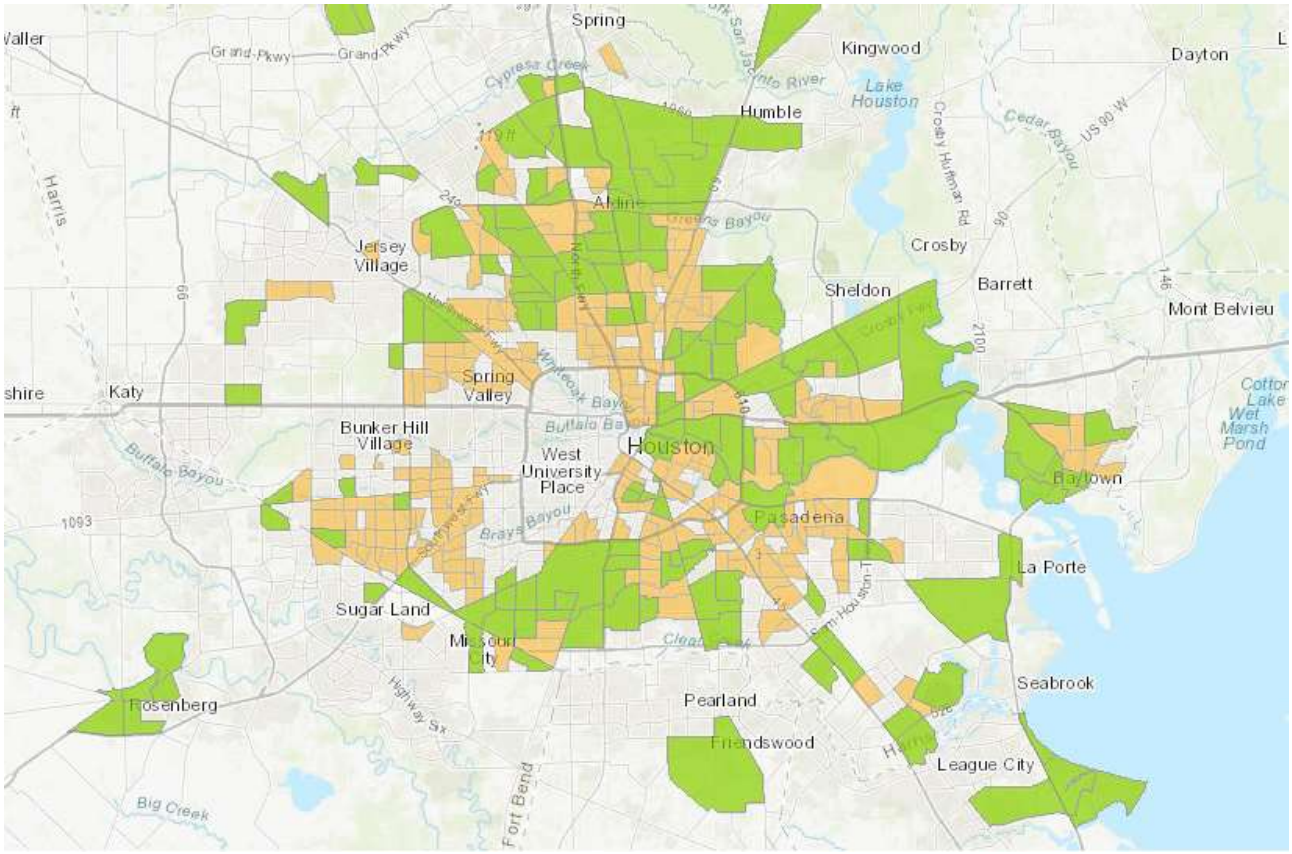
4.Stress; Access to critical facilities under stress

The Houston road network suffers from increasing congestion. The annual person-hours of highway traffic delay for auto commuters has been increasing quickly over the years. Over the period of 1982-2014 the traffic delay has increased by 45% ranking the Houston area 99th in the U.S., which seems relatively good. However, over the period of 2009-2014 traffic delay increased by 20%, ranking Houston 3rd in delay increase (USDT, 2018), underlining that congestion is a recent, relevant and increasing problem. Houston now ranks 16 in the U.S. for the top average travel time for the daily commute (Pasley, 2019). In a city where most jobs are (solely) reachable per car, this is a serious problem (USDT, 2017).

Plans for dealing with congestion
When looking at problems in Houston's transportation system, plans for dealing with congestion tend to be implemented on a larger macro scale through the expansion of capacity on the supply side of the transport system. In other words, the growing demand for mobility within Houston tends to be accommodated through the construction of extra infrastructure. The transport infrastructures that have recently been proposed to be expanded are Houston's freeway system and its public transit system, in this case rail infrastructure and bus service. One of the main plans proposed by lawmakers for dealing with this problem of congestion is the expansion of the freeway system. An example of this is the proposed $7 Billion expansion of the I-45 (Sisson, 2019). This expansion is mostly taking place in northern Houston (TxDOT, 2019). The other main plan in dealing with congestion and accommodating increasing traffic demand is the expansion of the public transit system (METRONext, 2020). An example of this is the proposed $3.5 Billion expansion of the public transit system through the construction of new rail connections and expansion of the public bus system (Begley, 2019).

5.Stress; Access to critical facilities under stress

How is access to grocery stores and fresh produce affected by car based design in socially vulnerable areas?; There are areas in Houston where food and fresh produce are not always readily available to its inhabitants. These so called 'food deserts' are situated in the poorer, more socially vulnerable areas of the city where personal vehicle ownership is low, but the distance to grocery stores or other facilities critical to day to day life is high. This shows the downsides of a car based city where pedestrian options for movement, even on a neigborhood level, are of lesser quality. "The paucity of grocery stores in many of these communities reduces easy access to fresh and healthy foods, exacerbating these health problems. Over 500,000 Houston residents live in USDA-designated food desert areas. Many residents of food desert neighborhoods face transportation challenges such as not having public transportation or access to private transportation. In some areas of Harris County, over 50 percent of the residents report travelling over 6 miles to reach the nearest grocery store. In spite of the increased attention to food deserts, of the 20 grocery stores established in Houston between 2011 and 2015, only one of them was located in a food desert area" (Schuler & Koka, s.d.). "Families without a car are reliant on neighborhood stores for their groceries, which may be more expensive and of poorer quality. Families without cars have alternative options to get to other grocery stores - take a bus, carpool with a friend, or hail a taxi; however, these options can be time consuming, limit the amount that families purchase due constraints on how much they can carry, are unreliable or at inconvenient times, and can be expensive. The location of stores and public transportation can greatly impact a family's access to healthy food" (Banks, 2013).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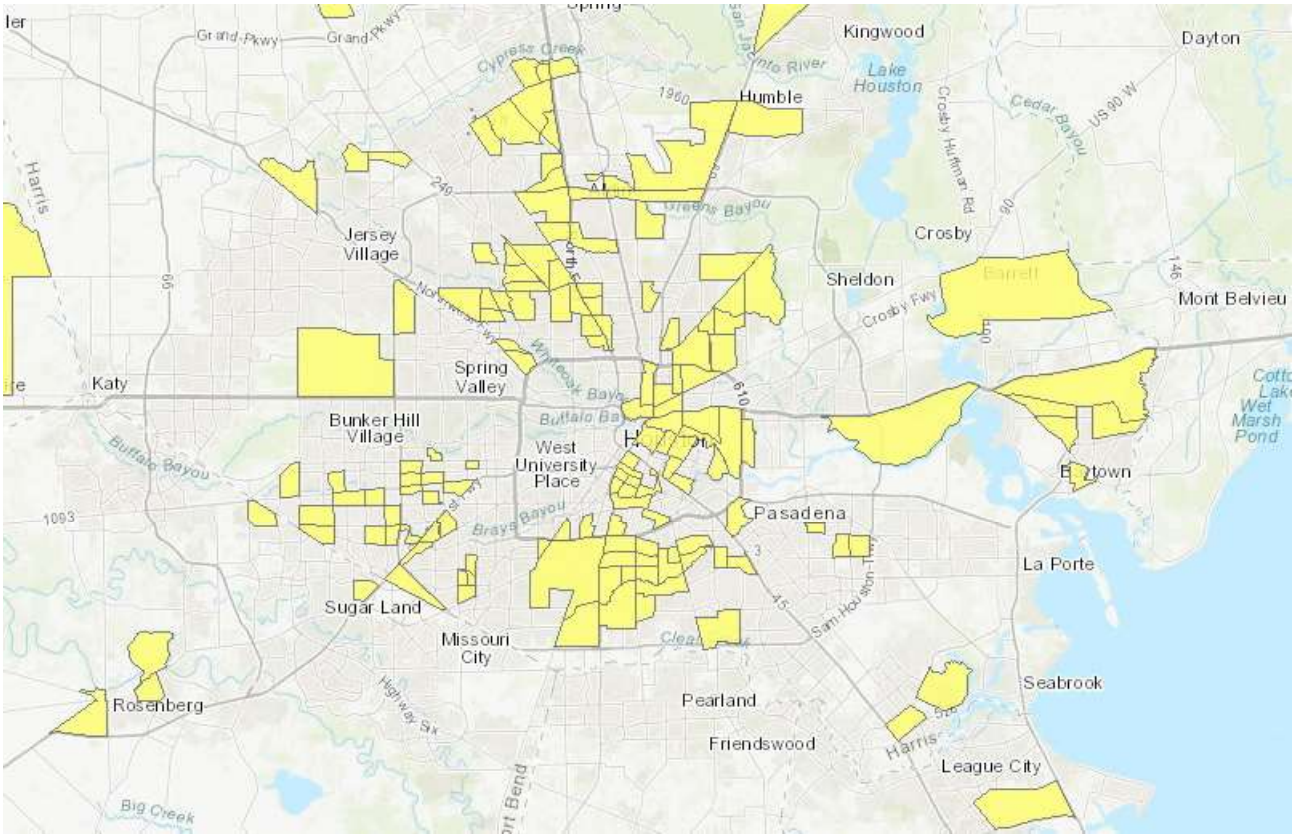
Kingwood
Dayton
Humble
Lake Houston
Aldine
Jersey Village
Crosby
Sheldon
Barrett
Mont Belvieu
Spring Valley
Katy
Bunker Hill Village
West University Place
Houston
Baytown
Pasadena
La Porte
Sugar Land
Missouri City
Seabrook
Rosenberg
Pearland
Friendswood
League City
Harris
Fort Bend
Big Creek
Buffalo Bayou
Brays Bayou
Whiteoak Bayou
Cypress Creek
Greens Bayou
Cedar Bayou
Crosby Huffman Rd
Cotton Lake Wet Marsh Pond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Mont Belvieu
Spring Valley
Katy
Bunker Hill Village
West University Place
Baytown
Pasadena
La Porte
Sugar Land
Missouri City
Seabrook
Rosenberg
Pearland
Friendswood
League City
Harris
Big Creek
Buffalo Bayou
Brays Bayou
Whiteoak Bayou
Cypress Creek
Greens Bayou
Cedar Bayou
Crosby Huffman Rd
Cotton Lake Wet Marsh Pond

Distance to grocery stores within Harris County neighborhoods

The maps in figure 11 use the Food Access Research Atlas by the United States Department of Agriculture to portray the distance that inhabitants of certain Houstonian neighborhoods need to travel to reach the nearest grocery store.

Green; Low-income census tracts where a significant number or share of residents is more than 1 mile (urban) or 10 miles (rural) from the nearest supermarket.

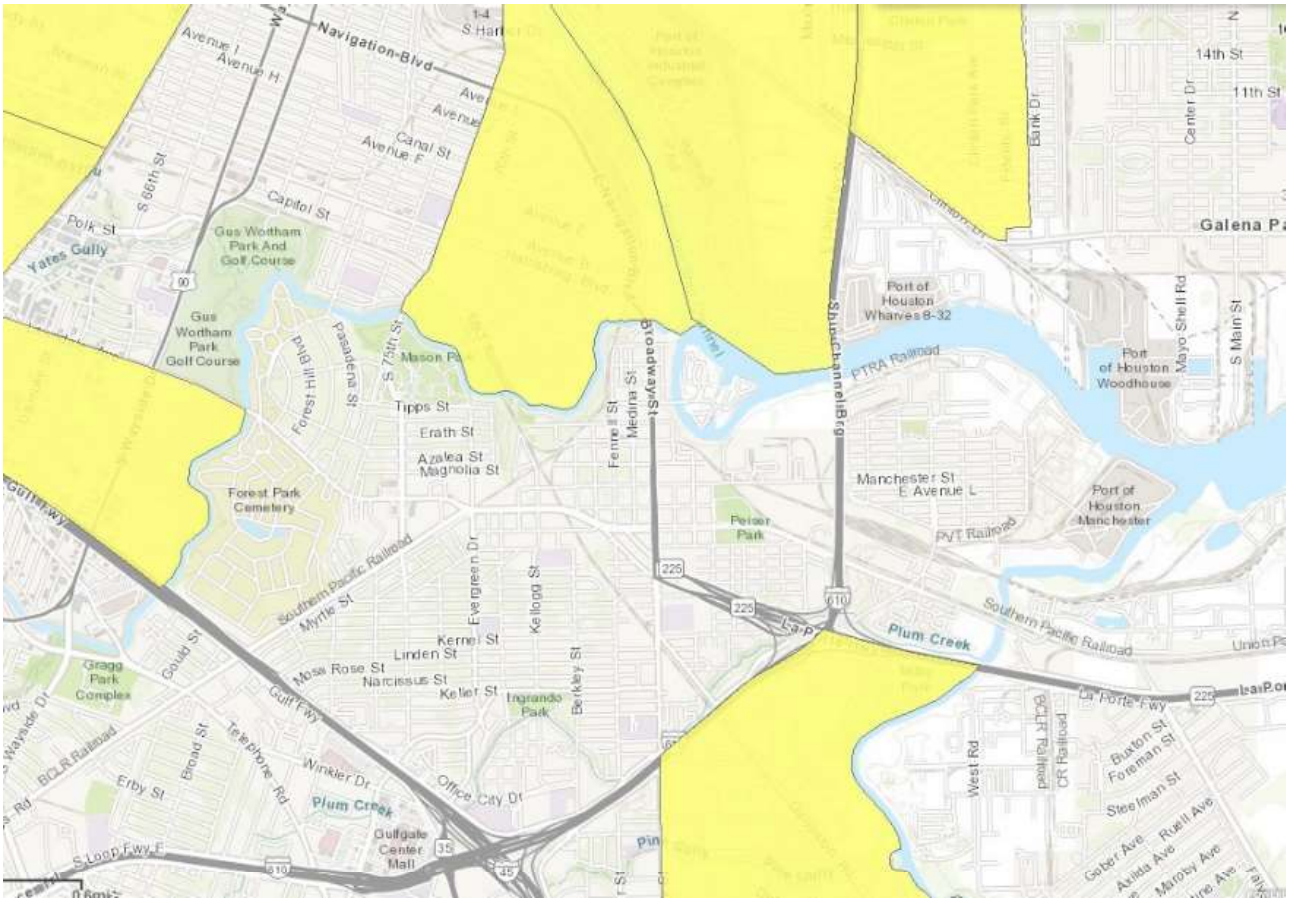
Orange; Low-income census tracts where a significant number or share of residents is more than ½ mile (urban) or 10 miles (rural) from the nearest supermarket.

Yellow; Low-income census tract where more than 100 housing units do not have a vehicle and are more than ½ mile from the nearest supermarket, or a significant number or share of residents are more than 20 miles from the nearest supermarket.

Distance to grocery stores within Magnolia-Park and Harrisburg-Manchester

Harrisburg-Manchester and Magnolia park, both being more socially vulnerable neighborhoods, feature a possibly strenuous relationship access to food or fresh produce. Magnolia Park in particular is at risk of being a so-called food desert. A significant amount of households does not own a vehicle while the nearest grocery store is at least half a mile away (USDA, 2020). This can be viewed in figure 12.


Navigation Blvd
S Harbor Dr
Port of Houston Industrial Complex
Clinton Park
Mississippi St
14th St
11th St
Sherman St
Avenue I
Avenue H
Avenue L
Avenue J
Canal St
Avenue F
76th St
HB&T Railroad
Railroad
AMTK Railroad
Clinton Park Ave
Fidelity St
Bank Dr
Center Dr
Galena P
S 66th St
Capitol St
Polk St
Yates Gully
Gus Wortham Park And Golf Course
Avenue E
Avenue B
Harrisburg Blvd
E Navigation Blvd
Houston Ship Channel
E Loop Fwy N
Clinton Dr
Port of Houston Wharves 8-32
Port of Houston Woodhouse
Mayo Shell Rd
S Main St
Lawndale Ave
S Wayside Dr
Forest Hill Blvd
Pasadena St
S 75th St
Mason Park
MKT Railroad
Broadway St
Ship Channel Brg
PTRA Railroad
Tipps St
Erath St
Azalea St
Magnolia St
Fennell St
Medina St
Forest Park Cemetery
Manchester St
E Avenue L
Port of Houston Manchester
Peiser Park
PVT Railroad
Southern Pacific Railroad
Myrtle St
Evergreen Dr
Kellogg St
La Porte Hwy
Plum Creek
Kernel St
Linden St
Moss Rose St
Narcissus St
Keller St
Ingrando Park
Berkley St
Milby Park
Gragg Park Complex
Gould St
Gulf Fwy
BCLR Railroad
Broad St
Telephone Rd
Winkler Dr
Erby St
Office City Dr
West Rd
CR Railroad
Buxton St
Foreman St
Steelman St


Navigation Blvd
S Harbor Dr
Avenue I
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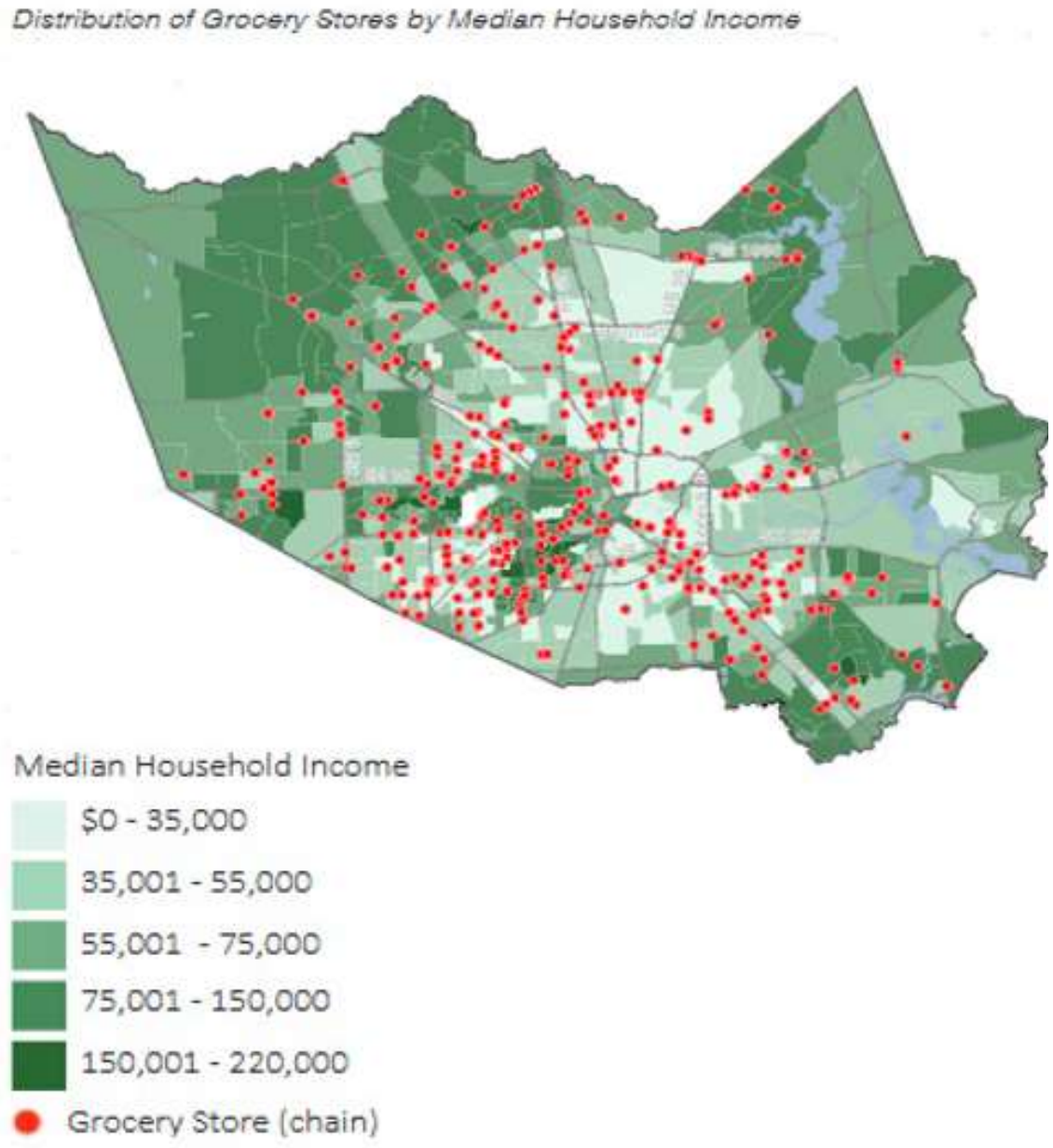
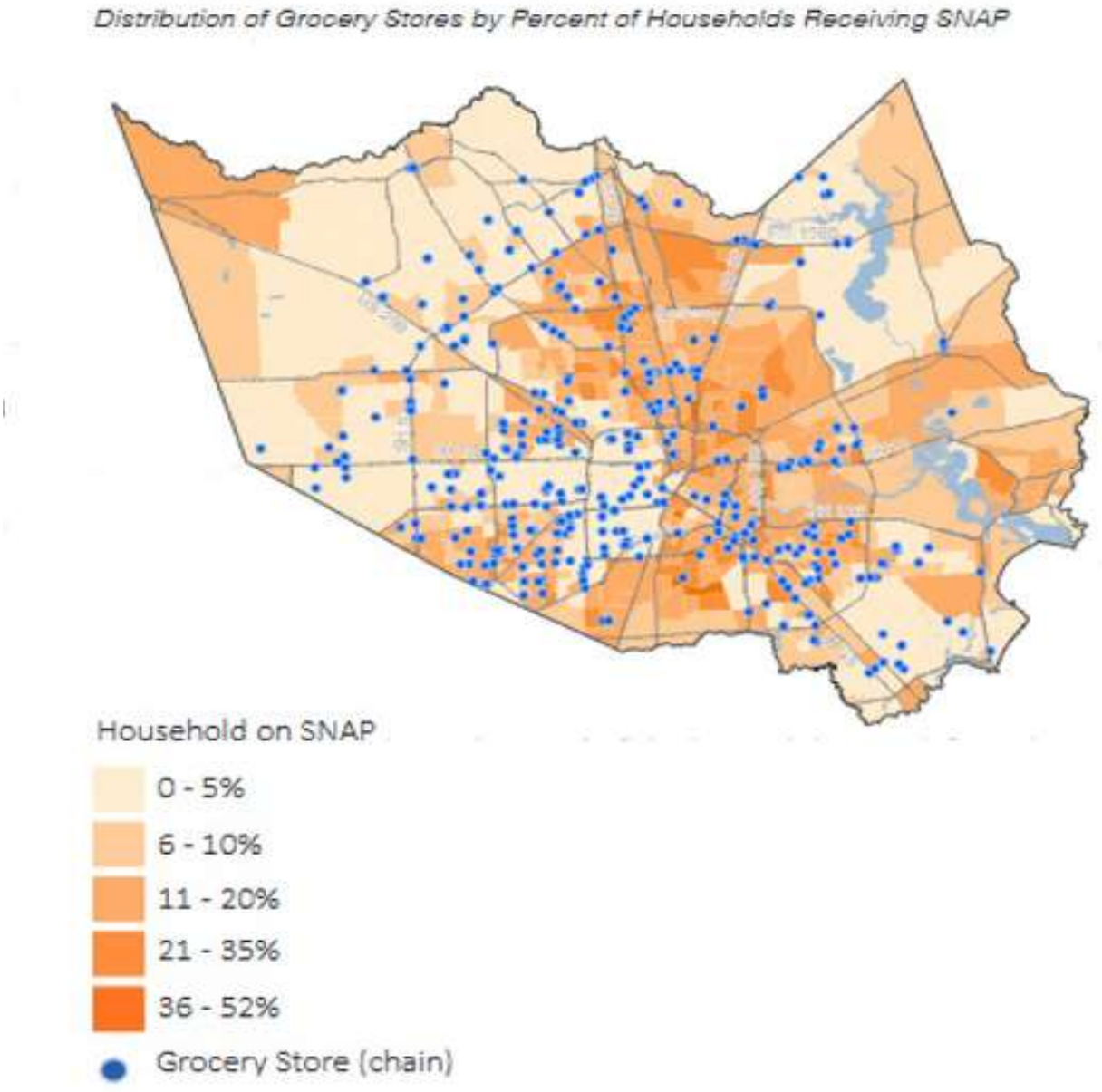
Canal St
Avenue F
14th St
11th St
Bank Dr
Center Dr
Galena P
S 66th St
Capitol St
Polk St
Yates Gully
Gus Wortham Park And Golf Course
Port of Houston Wharves 8-32
Port of Houston Woodhouse
Mayo Shell Rd
S Main St
Forest Hill Blvd
Pasadena St
S 75th St
Mason Park
Broadway St
Ship Channel Brg
PTRA Railroad
Tipps St
Erath St
Azalea St
Magnolia St
Fennell St
Medina St
Forest Park Cemetery
Manchester St
E Avenue L
Port of Houston Manchester
Peiser Park
PVT Railroad
Southern Pacific Railroad
Myrtle St
Evergreen Dr
Kellogg St
Plum Creek
Kernel St
Linden St
Moss Rose St
Narcissus St
Keller St
Ingrando Park
Berkley St
Gragg Park Complex
Gould St
Gulf Fwy
BCLR Railroad
Broad St
Telephone Rd
Winkler Dr
Erby St
Office City Dr
Gulfgate Center Mall
S Loop Fwy E
West Rd
CR Railroad
Buxton St
Foreman St
Steelman St
Gober Ave
Ruell Ave
Axilda Ave
Maroby Ave



Food retail and local socio-economic circumstances

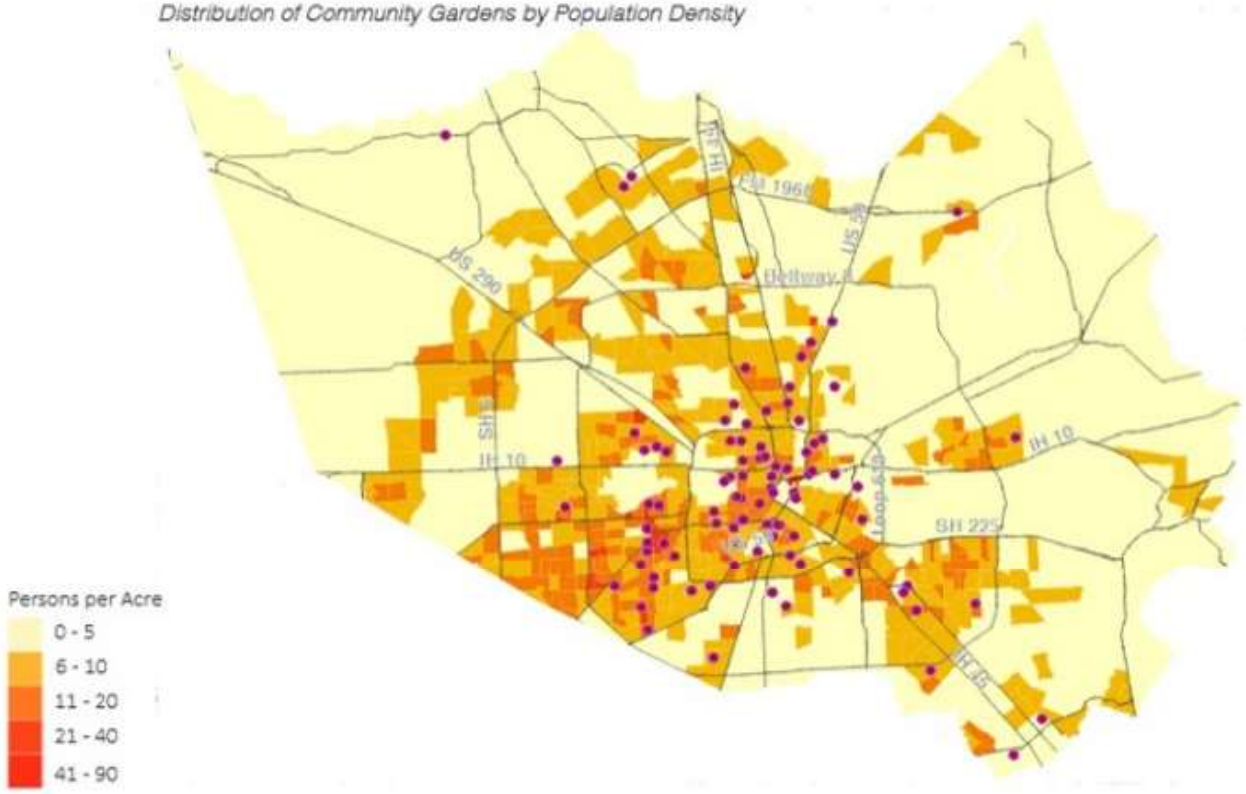
Grocery stores are spatially spread unevenly within Harris County. This can have an impact on the inhabitants accessibility to produce and other foods. A considerable amount of inhabitants within the Magnolia-Park and Harrisburg-Manchester are on SNAP (Banks, 2013). SNAP is the updated version of the older American food stamps program (Center on Budget and Policy Priorities, 2019). Furthermore the median household income is relatively low (Banks, 2013). The distribution of food retail within Harris County can be seen in figure 13.



To serve as a remedy for urban 'Food Deserts' community gardening programs have been established in Houston to offer freshly grown local produce to local inhabitants. These gardens are however not as prevalent in poorer more socially vulnerable areas, like around Magnolia Park and Harrisburg-Manchester. There is 1 nearby community garden present in northern Magnolia Park (Banks, 2013). The distribution of community gardens can be viewed in figure 14.

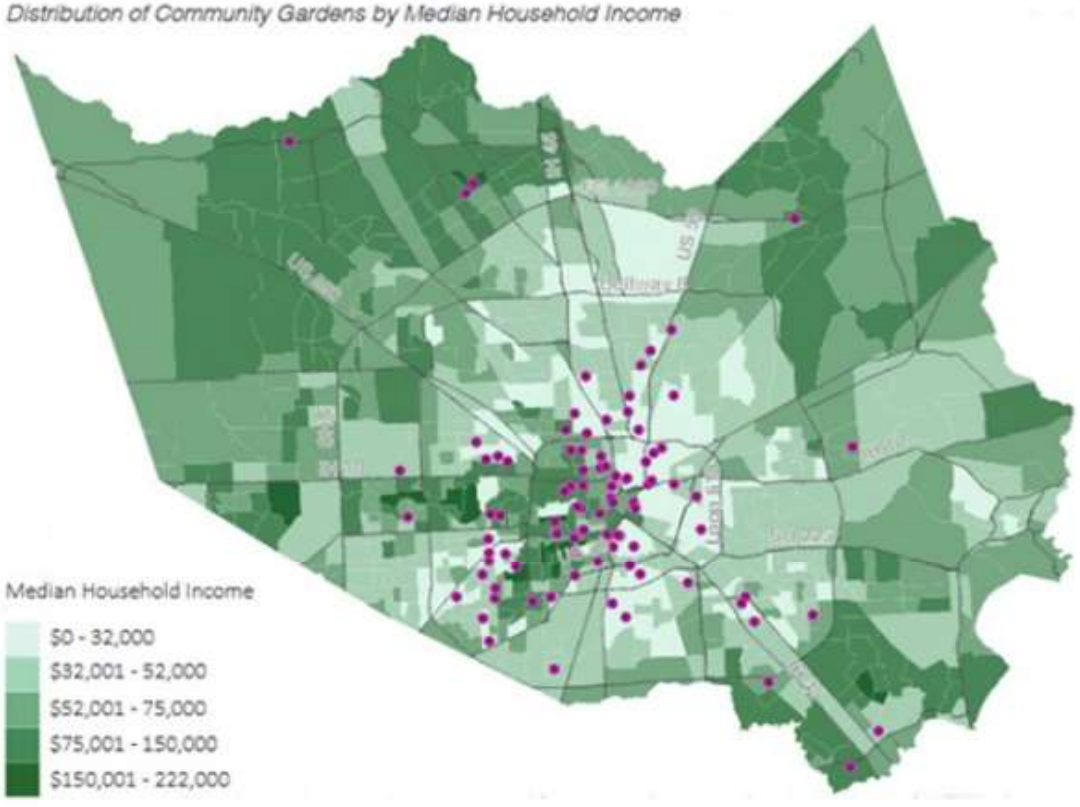
The map on this page shows the distribution of community gardens in Harris County by population density. The dis
community gardens aligns with the densest parts of the County. Of note is the scarcity of community gardens along SH 6, or
northwest Harris County. While the population in this region is increasing however, development is scattered so the area is stil

Distribution of Community Gardens by Population Density



he map on this page shows the distribution of community gardens in Harris County by median household income. Of note
entration of community gardens in southwest Harris County, an area that tends to have higher income households. Ther
ver, numerous community gardens northeast of downtown Houston which tends to have lower income households.

Distribution of Community Gardens by Median Household Income



6. Conclusion and Design Guideline Proposals

There are several important main take-aways from the analysis of the Houston mobility system in relation to the shock of flooding and the stress of chronic congestion and overt dependence on the car. Houston is built and structured on private car use. Public transit exists and its use is significant, but still stagnant and low. The car is economically significant and can't simply be removed from the lives of Houstonians. Future expansions of the mobility system are planned for both public transit as well as road infrastructure, this happens on a citywide macro scale. Building for such car reliance is a hindrance because;
- The road system is by design used as secondary drainage and might get inundated during storm related flooding events.
- The city's rapid expansion is slowly clogging up its road system up with cars.
- Socially vulnerable neighborhoods are prone to being 'food deserts'. This is problematic due to these areas featuring large amounts of inhabitants that are without a personal vehicle. The areas are not built for pedestrian movement.
So what can be done?; Small changes can be made on a local level to storm-proof neighborhoods and make the areas more pedestrian friendly as to lessen the necessity of the car.

Similar projects in other parts of Houston

In other parts of Houston, local projects to make neighborhoods more storm proof while at the same time improving walkability are being drafted or put in place. These plans mix the ecosystem participation of greenery with more grey infrastructures like large underground stormwater storage units. The following ideas are from the paper; From disaster to sustainability: breaking the cycle of floods in Houston (2019); "New countywide flood hazard assessment with new rainfall data, as well as many other projects found in the program will be valuable and are long overdue, but at this point the introduction of green infrastructure suggested in this study was not identified as part of the existing projects.

The proposed underground storage units can potentially provide the total (water) detention volume and be incorporated to most priority areas. The underground storage vaults in parking lots, and the LID tools integrated to the urbanized areas in form of green alleys and eco-boulevards would work in parallel to ensure absorbency to other impervious areas. Results imply that the reclamation of stormwater—a natural asset too important to be discarded—can be achieved with the use of underground storage. The sustainabilization of urbanized areas is also attainable, via the integration of LID methods, and the enhancement of community areas can promote a healthier lifestyle, with the implementation of green alleys, water squares and eco-boulevards. Moreover, the combination of these procedures could reduce considerably the flood volume in the area". Design examples from the paper can be found in figure 15 and 16.

Proposal and guidelines

It could be interesting to look into making sure, on a neighbourhood level, that walkability is improved. As proposed by Hampshire & Sipes (2019), pedestrian movement based greenways that connect critical facilities, like schools and perhaps community gardens or grocery/fresh produce stores, could be an interesting solution in dealing with flooding in urbanised areas of Houston.

The idea would be to create a new pedestrian based (green) infrastructure that offers an alternative to the existing road grid. While changes could of course be made to the road system itself, the goal shouldn't be to erase or replace the road infrastructure grid, given the economic importance of the car or the role of road infrastructure in offering emergency access to for example health services. Rather, the idea should be to implement green lanes for people that do not require or have access to the car, for example children or those without cars that rely on public transit for their movement. These green areas could include underground stormwater storage, bioswales and possible community gardening. These areas serve mobility of course, but can also be used to emphasise social gathering; "Studies of pedestrian behaviour make it clear that people seek out concentrations of other people, whenever they are available" (Alexander et al., 1977, p.164).

When implementing such areas, a design choice can be made to either establish a major greenway in an area, almost functioning as a more traditional main street, or to establish a pedestrian network that exists out of smaller public squares that serve as nodes within the pedestrian network. In this second option small paths connect these nodes. These pedestrian networks should be free from the effects of cars, as they may pose a danger or simply a distraction from pedestrian life. The reality is however that, to set up proper lively public squares, car accessibility to important areas, such as shopping areas, must remain. In that sense the two networks, pedestrian and road, must be near to one another, but not closely parallel. Pedestrian paths should run through building blocks, roads around (Alexander et al., 1977, p.164). As, within the guidelines for the Houston case designs, emphasis is put on on the importance of community centers and community gardening inside the case area, connecting these areas with grocerystores and schools through a green pe-

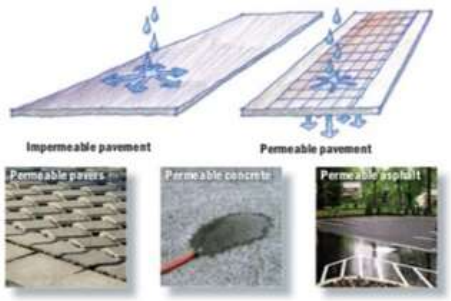


Figure 8. Examples of permeable pavement. Chicago Green Alley Handbook, 2010.

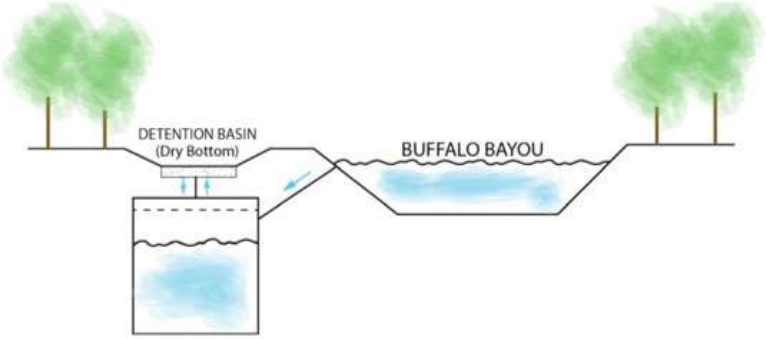


Figure 10. Schematic of the proposed underground stormwater storage unit.

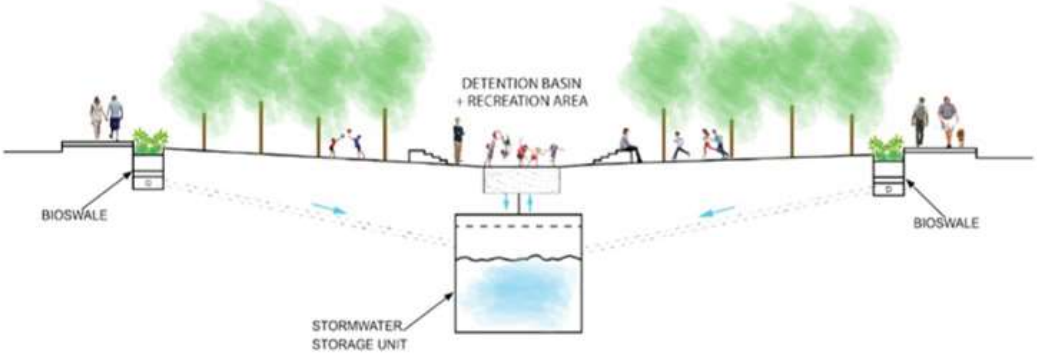


Figure 12. Schematic of stormwater storage unit under proposed recreation area.

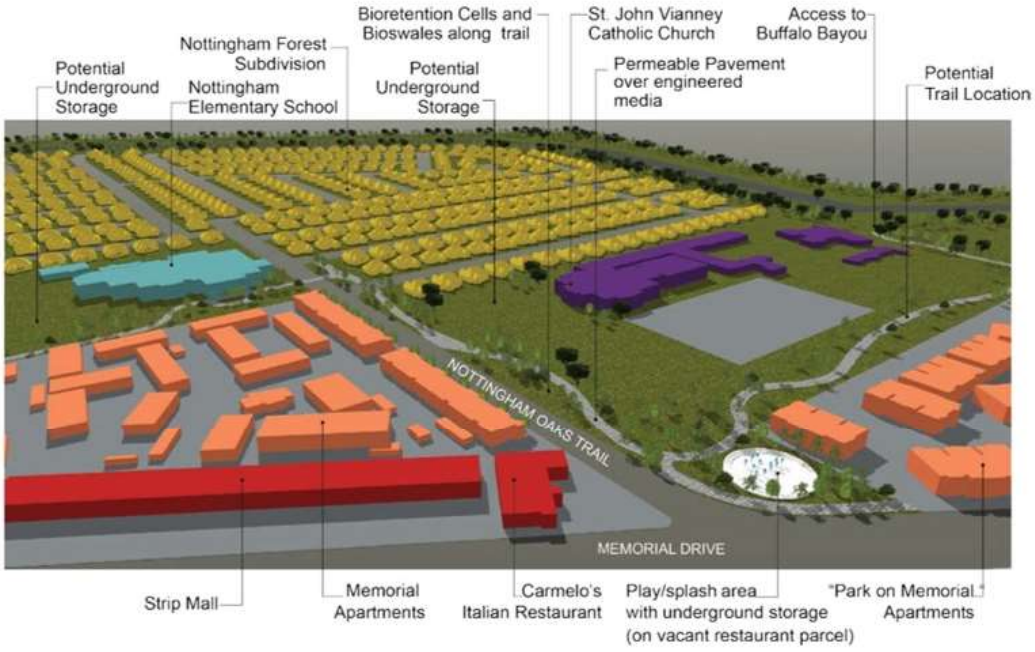


Figure 16. 3D rendering of conceptual green alley produced with Esri City Engine.

	Shocks; Fluvial Flooding (and possible surge compound flooding)		**Stress;** Chronic road congesti
	Accessibility and **connectivity**	**Vulnerability** (Physical and Social) & **Reliability** (current mitigation or risk)	**Accessibility** and **connectivity**
Mobility flows: Public Transit (PT) /Road network	**Accessibility;** During floods, access to the road network, including the main freeways, will be limited. Public transit will also cease. **Connectivity;** This is due to the disrupting (partial) disconnection of the road system.	**Physical;** Roads are prone to flooding and storms will knock out public transport. **Social;** The vast majority of Houstonians commute to work by car, knockout of the system is impactful. **Reliability;** As roads serve as secondary drainage, they're meant to be flooded. It's unclear which roads exactly. Realtime information on flooding and minor roadside ditches are currently in place.	**Accessibility;** While the Hous road network remains access congestion has increased significantly. Certain parts of city do lack serious PT alterna to the car. **Connectivity;** Houston doesn suffer from issues in direct ro connectivity due to overuse o system. However, it is true th vast majority of jobs is not reachable by mode of public or biking/walking.
Activity nodes: Critical facilities	**Accessibility;** During flooding access to emergency facilities may be limited. **Connectivity;** This is due to the disrupting (partial) disconnection of the road network and other means of mobility to hospitals.	**Physical;** Due to roads being prone to floods, inundated roads will affect routes to emergency facilities. **Social;** Certain parts of the Houston might lose access to hospitals, this can have a larger impact depending on its certain socio-economic factors affecting its inhabitants. **Reliability;** Spatial redundancy of hospitals is present in Magnolia Park – Harrisburg area.	**Accessibility;** Houston is a ca based city. Not everyone has to a private vehicle however. transit and carpool are availa a macro level, but expensive. **Connectivity;** Proper alternat for reaching grocery stores ar really in place, as the pedestr network in the area is underdeveloped necessitatin private car use.
Logistics flows: Roads/waterways	n / a	n / a	n / a
Transfer nodes: harbours/airports	n / a	n / a	n / a
Conclusions and recommendations	Houston is a car based city; It's inhabitants depend on the car as a means to travel around. The car is of m transportation system are chronic road congestion and an overdependence on the car. The main shock th city. In the case area of Magnolia-Park and, to a lesser extent, Harrisburg-Manchester, social vulnerability requires solutions to lessen their impact and possibly improve ecosystem participation. On a macro scale shocks is done through analysis and reinforcing critical intersections. Changes should be made on a local impact through increased water permeation, retainment and connecting important neighborhood facilitie		

on & Overdependence on the car		
y	**Vulnerability** (Physical and Social) & **Reliability** (current mitigation or risk)	**Recovery** and future **mitigation / adaptability**
ton ible the tives 't ad f the at a ransit	**Physical;** As capacity of roads and PT is generally constant, growing demand for either is not easily accommodated. **Social;** The vast majority of Houstonians commute to work by personal vehicle. 5% of households have a member employed in the (road) transport sector. **Reliability;** Time spent in congestion has increased and commute by PT has remained low.	**Shock;** Recovery from storm events can move slowly, road systems and public transit taking several days to regain proper function. Future plans for mitigation proposed by experts include the expansion of the flood warning system and the construction of floodgates near lower areas like tunnels. Other research also recognizes that identifying critical intersections and climate proofing these areas will help in creating a more robust road system. **Stress;** As it stands, to accommodate growing current and future demand for mobility, plans have been made for future and ongoing changes to the both the road a PT network on macro scale. West Houston and the city centre plan for public transit expansion through rail construction. For areas further removed from the city centre, mostly in the north, expansions to the I-45 freeway are planned.
- access Public ble on ives e not ian g	**Physical;** In large parts of Houston, including Magnolia Park and Harris-burg inhabitants have to travel around a mile to reach a grocery store. **Social;** Significant amounts of households do not own a car and are on SNAP. The area is a food 'desert'. **Reliability;** Local stores can be expensive and not feature adequate fresh produce.	**Shock**; After hurricane Ike, flood alert systems were developed to ensure proper prevention of the flooding of and around hospitals. After Harvey a flood warning system for the road network was developed. Critical intersections of the road network have been identified and should be made more floodproof. Further construction can only take place in 500-year floodplains. Freeways need better stormwater protection. **Stress**; On a local scale, green pedestrian networks could be introduced. This network should connect important facilities in the area like grocery stores, community centres and schools to lessen car necessity. These areas will also serve to lessen flood impact on the neighborhood through the increase of permeation and implementation of storm-water storage.
	n / a	n / a
	n / a	n / a

ajor economic importance and can't simply be eliminated as a form of transport. The main stressors that affect Houston's at affects Houston's transportation system is flooding that inundates the road system and knocks out most public transit in the to the effects of possible food deserts, as well as vulnerability to the effects of loss of access to critical facilities during floods, policymakers are set in expanding the capacity of the transportation system to meet growing mobility demand and mitigating neighborhood level. Establishing an alternative green pedestrian network, parallel to existing road systems, could lessen flood es. Lessening the necessity of the car and by extend the dependence on the personal vehicle.

4.

Systems description and synthesis

Hybrid system drawing

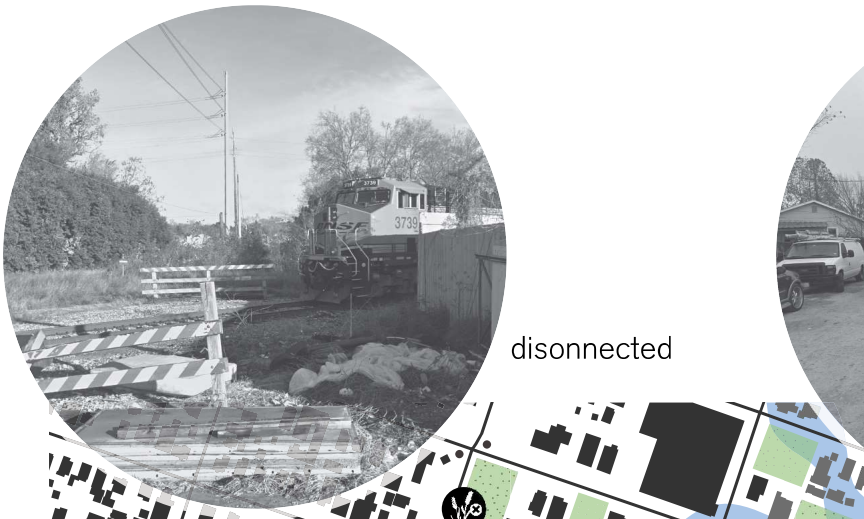
Ecosystem participation is a new concept. It is similar to ecosystem services, but a step higher in its hierarchy. Instead of the idea that ecosystems can contribute to humans, ecosystem participation is meant to explore what humans can contribute to their ecosystems. In that way ecosystem participation may work as a catalyst for healthy, climate-proof extreme urban environments.

All perspectives combined, there are a lot of factors contributing to the distance between humans and their natural environment in the case of Magnolia Park and Harrisburg / Manchester. These factors are both related to social and physical processes. In the hybrid systems drawing the social and physical factors that prohibit a healthy and climate - proof urban environment found in the critical cartography are combined.

The unhealthy extreme urban environment is caused by both stress and shock factors. Stress is put on the areas through infrastructure and industry, shock is experienced through flood and heavy rainfall events. Currently the social and physical processes present in the area are causing a cumulative effect. Instead of measures that might help to mitigate the impact, most measures currently facilitate the damage that is being done. There are potentials present in the area, but they are not used to their full capability. For example , the number of vacant spaces in the area.

Right now flooding of the area will cause a lot of damage to private property, infrastructural systems or water edges. As most of the Bayous are channelized and there are no flood proof houses in the area. Environmental problems are caused by polluted air, polluted grounds, polluted water and a lack of biodiversity. Although there is a lot that can be changed in the physical structure to cater for a more climate proof environment, there is also a big social component contributing. Houstonians tend to have a very reactive approach when it comes to damage control, as well as that most of them are very individualistic, where in their opinion contributing should carry direct benefits

In conclusion, both physical structures as well as human behaviour are facilitating damage done by the extreme urban environment. These factors are depicted in the hybrid system drawing, with different elements on the map, several icons and pictures.



disonnected



flood prone

poor biodiversity

channelized edges

air pollution

noise pollution

socio-economic vulnerability

car dependency

impervious surfaces

disconnected

Hybrid systems

bayou

floodplain

greenery around bayou

vacant areas

water pollution

ground pollution

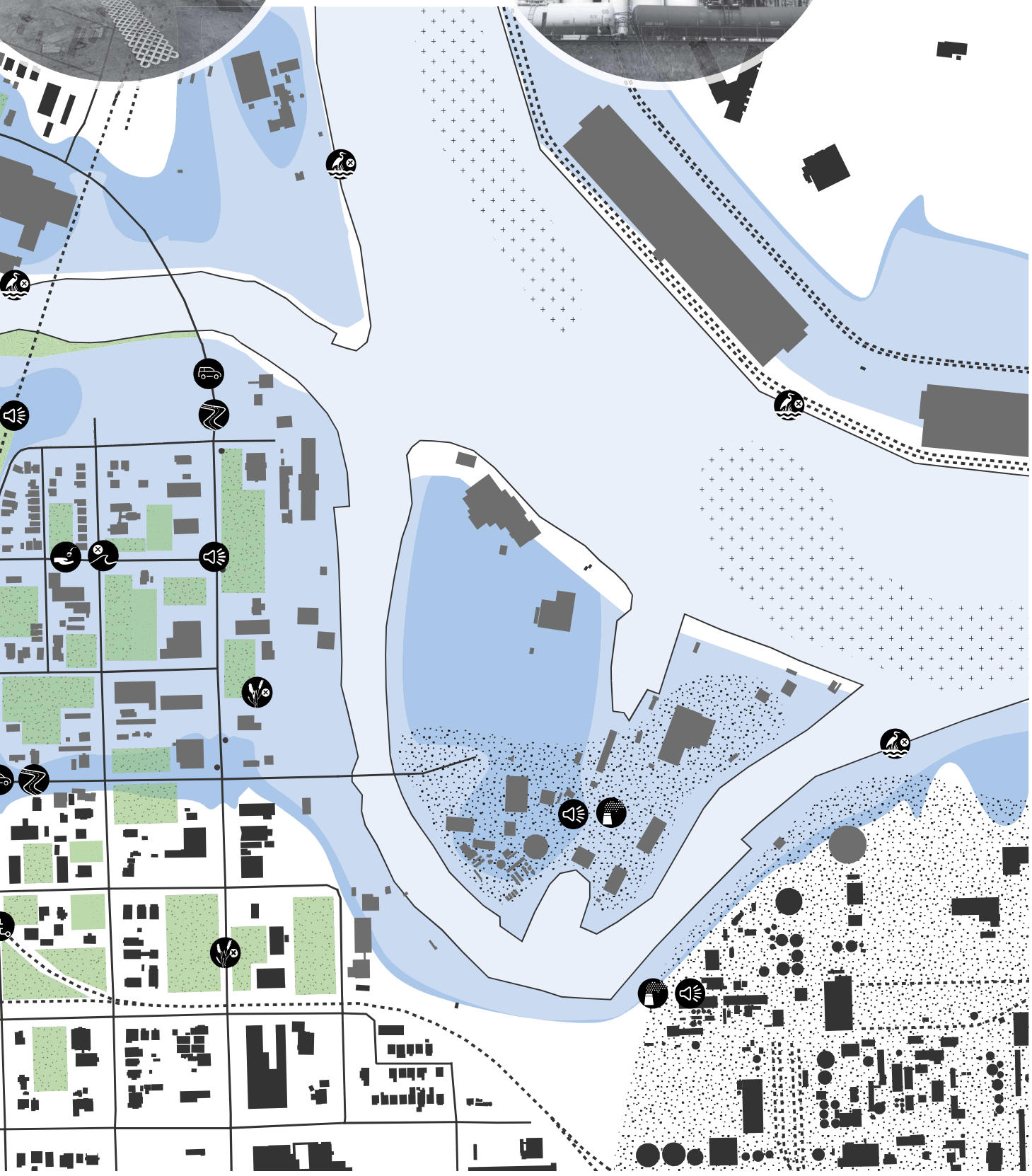
flood sensitive buildings

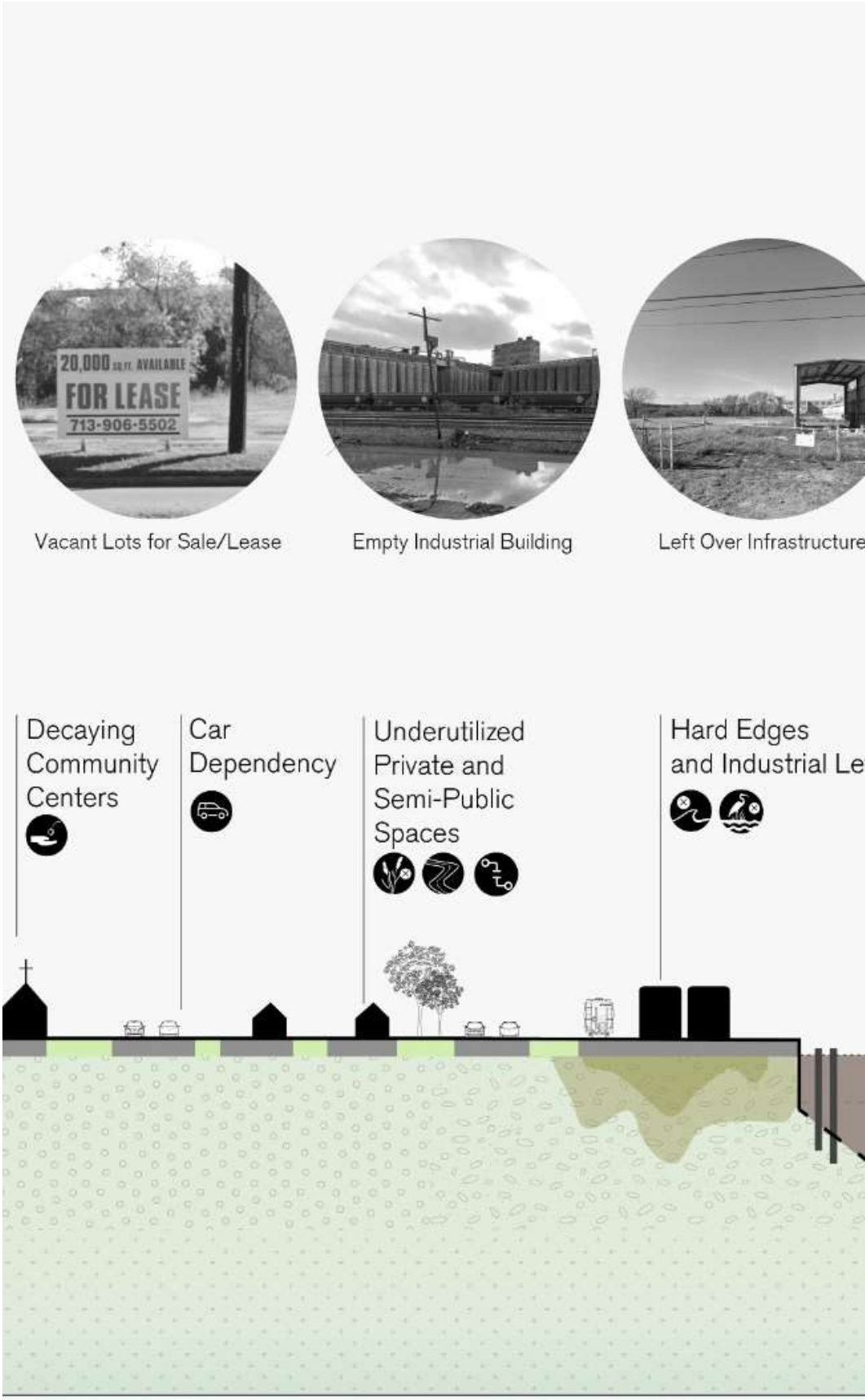


car dependent



unhealthy pollution





Problem Statement section

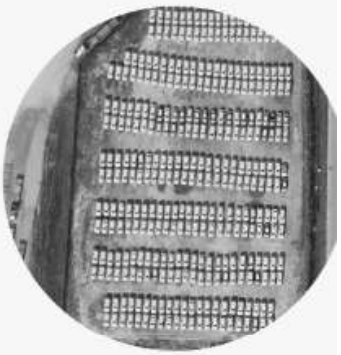
Schematic overview of the problems the Manchester Harrisburg area is dealing with during stress and shock situations.



Industrial Disasters



Visual, Air, Water, Soil Pollution



Car-Centric Space

ftovers

Air Pollution from Petrochemical Plants

Obsolete Industrial Sites

Industrial Railways

Sprawling Parking lots

BUFFALO BAYOU

5.

Scenario application

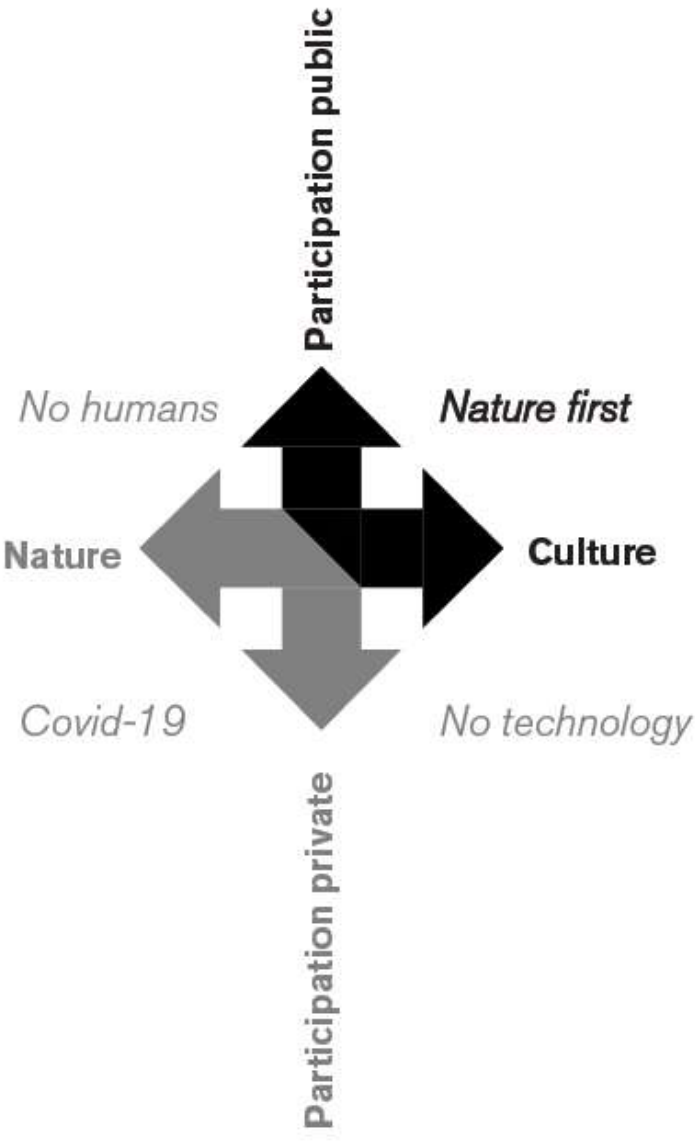
Scenarios

1. Nature First

2. No technology

3. No humans

4. COVID-19


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Participation private

Scenario 1 . Nature First

In the nature first scenario, natural systems are prioritized. In the redesign of the city nature is put central and also implies the concepts of 'degrowth/give back to nature' and nature first. Restoration to the historical ecosystem is unlikely given the changes humans have had on their environment - so new habitats are formed to sustain native and non-native species which have settled in the area.

In the case of Houston, nature revolves mostly around the bayous system. The nature first scenario changes the way the bayous are treated from a human to a nature perspective. In the current situation the bayous are suppressed by human influence. The bayous are channelized, with hard edges. The bayous are under great pressure with buildings in the natural floodplains. In the nature first scenario the bayous and small streams are revitalized and protected, with native vegetation, the edges are restored. The buildings located to the edges are replaced, to give back area to the bayous and restore the natural floodplains. With this change the area is anticipated to climate change and water level rise. Underutilized spaces and standardized grass lawns are replanted to form new ecotopes.

Scenario Scale

Student Hadrien Cassan





Nature First

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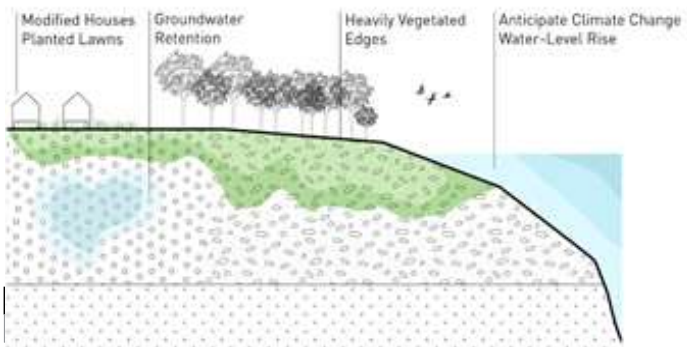
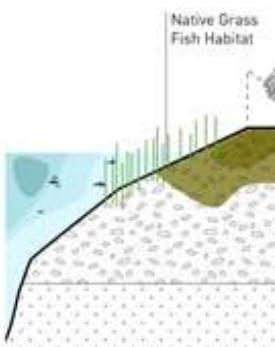
Use as much text space as needed.





N

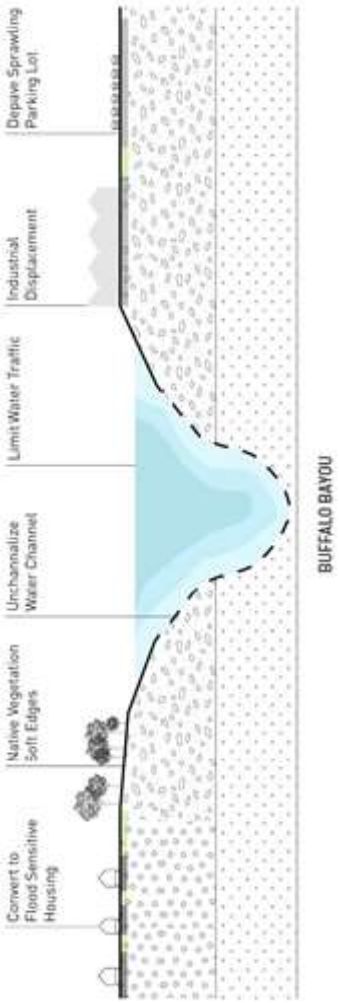
0 100 km

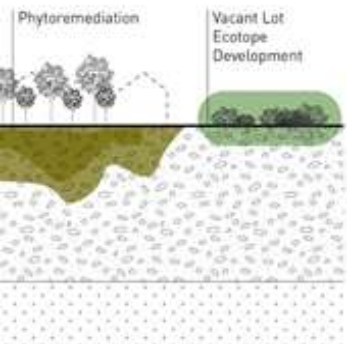


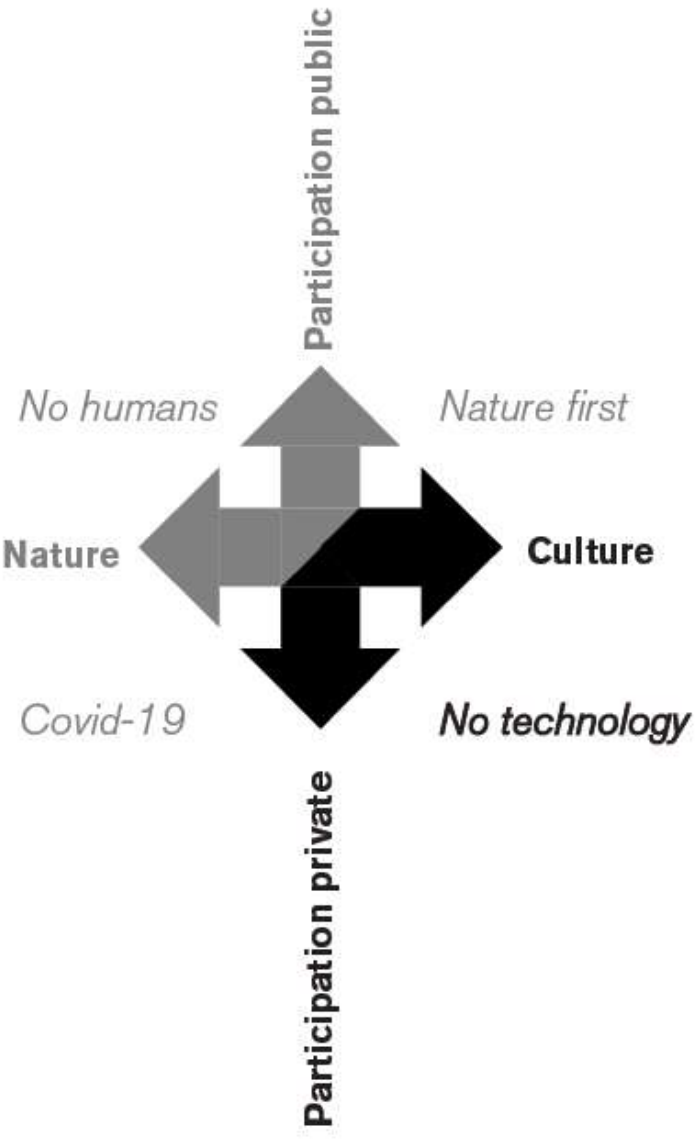

5.8 ft.
Average height
man


AVAILABLE
713.303.3223




Depave Sprawling Parking Lot
Industrial Displacement
Limit Water Traffic
Unchannalize Water Channel
Native Vegetation Soft Edges
Convert to Flood Sensitive Housing
BUFFALO BAYOU


Phytoremediation
Vacant Lot
Ecotope
Development


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Participation private

Scenario 2 . No technology

In the no technology scenario, most modern, hightech systems are non existing, this means no cars, no technology to forecast and predict storms and no heavy industry. As a result the community has to change to more locally for food access and other basic needs. A transformation of the productive landscape is needed. In the case of extreme weather the reactive approach has to change to a more preventive approach instead.

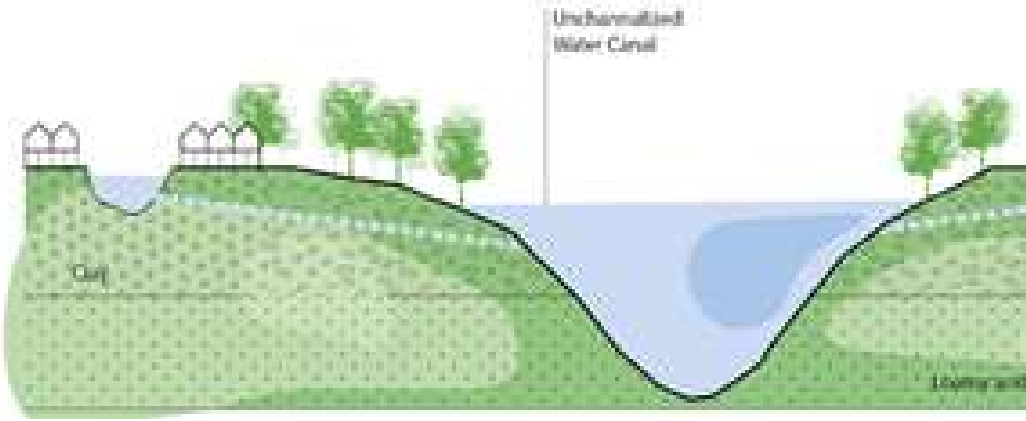
In the case of Houston, vernacular and nature based systems are used to control water. The street system is designed to be hybrid, humans and nature coexist. Streets are not only used for transportation purposes, but are also designed to store and hold water (mimicking the bayou system based on gravity). In the current situation the system is mostly based on a city scale, but without technology community based systems are needed. Food is produced locally in the productive landscape of the riverbeds/wetlands. Public functions are linked to public spaces to create responsibility.

Scenario Scale: Local

Student Noa te Duits







No Technology

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N

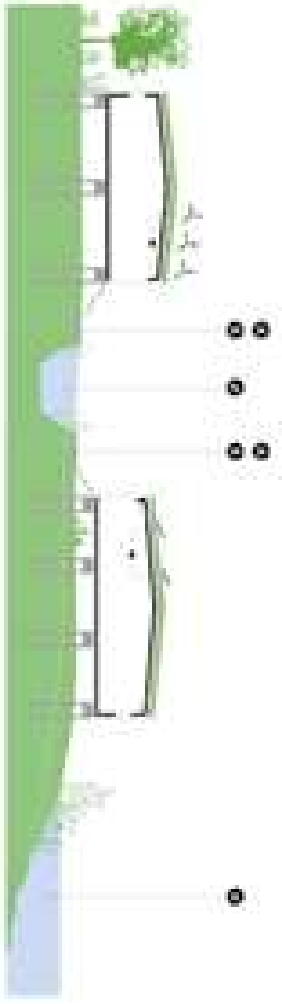
0 100 km

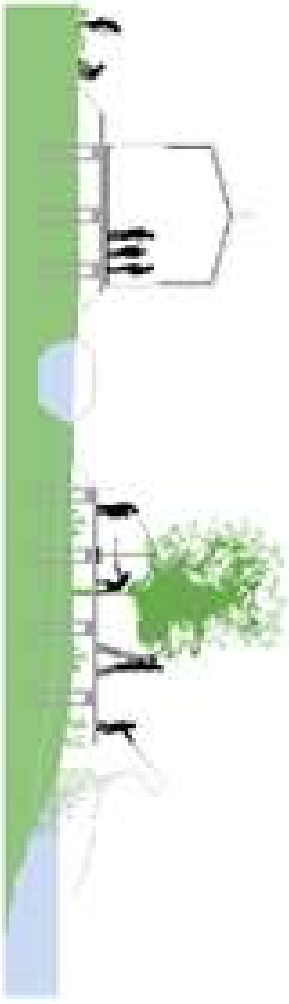




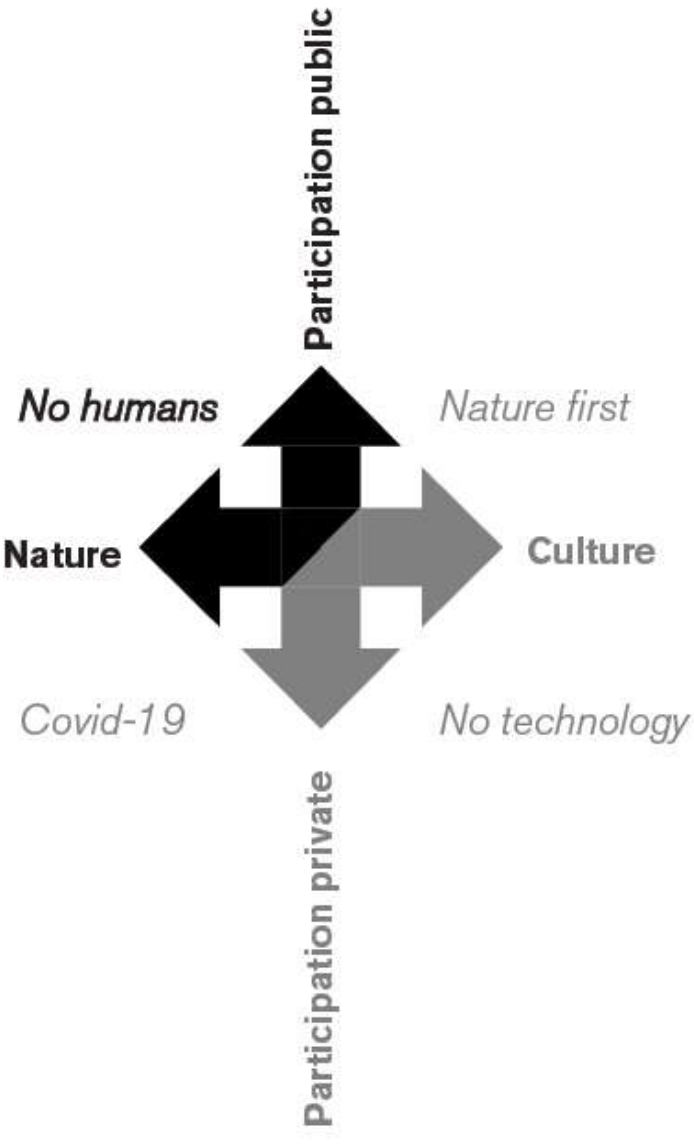

IGLESIA
BAUTISTA CRISTIANA MARANATH










Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Participation private

Scenario 3. No humans

In the no human scenario, a retreat strategy of what leaves first is shown over a long time. Humans are gradually moving out, depending on their interests and needs. Eventually all of them leave, resulting in a no human city. Buildings and infrastructure are left behind, depending on the legislation or economic benefits of cleaning up. Materials might be reused, depending on their value.

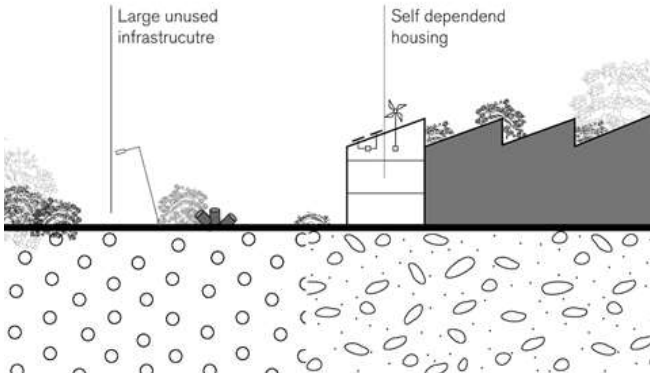
In the case of Houston, the area is largely humanised by large infrastructures, buildings and restrained nature. With humans moving out the buildings in Magnolia Park are left first, as the people living here are richer and not bound to the location. Industries alongside the bayous are abandoned with the consequences of pollution leakage and piling trash. People living near the bayous are more likely to stay, as the water is the source of life of all species. The leftover people are segregated and can no longer make use of the large city systems. In result they need to change to a self dependent system of a.o. local energy and food production. The large infrastructures are mostly abandoned and together with public spaces overtaken by nature.

Scenario Scale

Student Stefan Vermeulen







No Humans

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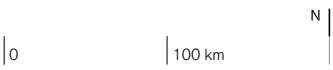
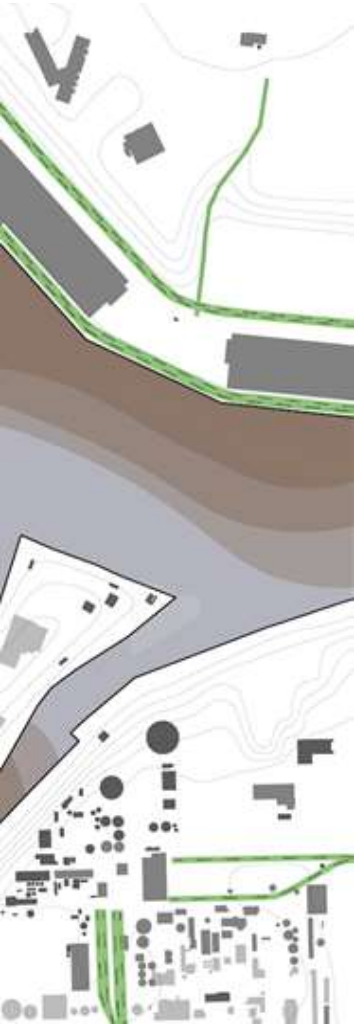
Use as much text space as needed.

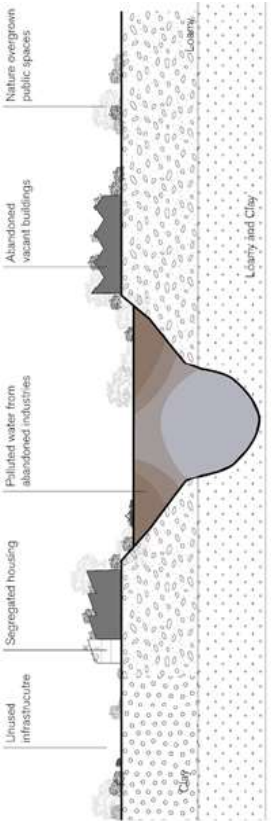


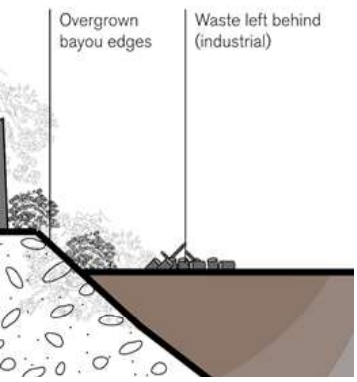


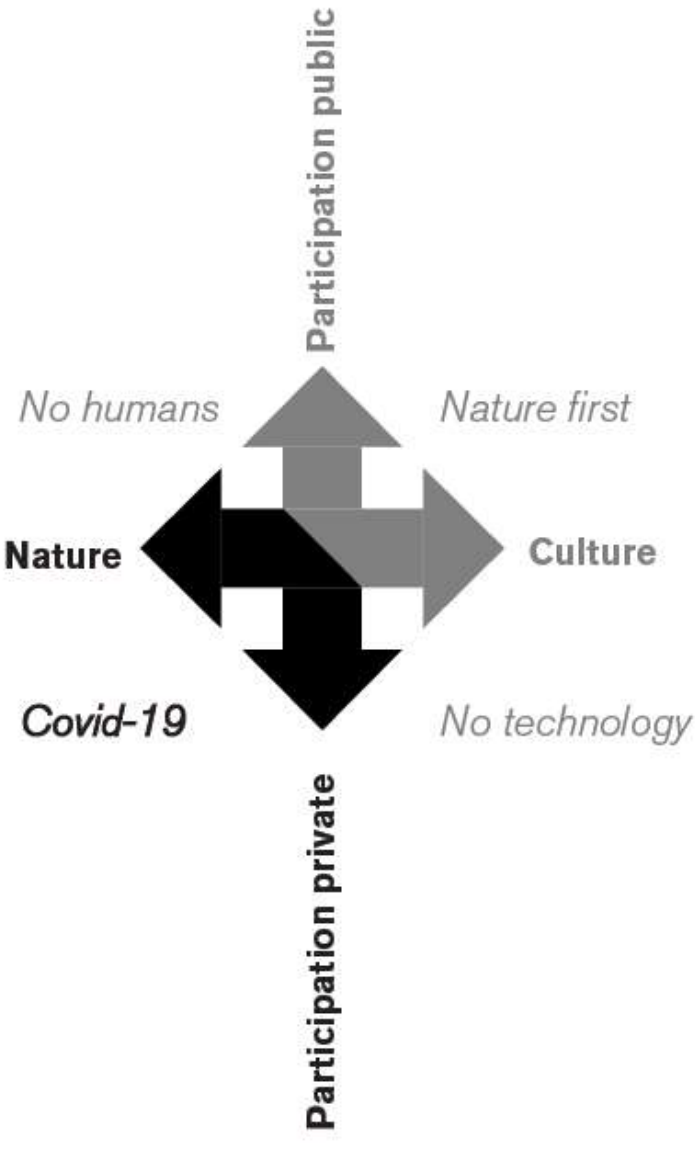







Nature overgrown public spaces
Abandoned vacant buildings
Polluted water from abandoned industries
Segregated housing
Unused infrastructure
Loamy
Loamy and Clay
Clay


Overgrown bayou edges
Waste left behind (industrial)


Participation public
No humans
Nature first
Nature
Culture
Covid-19
No technology
Participation private

Scenario 4. COVID-19

In the COVID-19 scenario, a pandemic virus has the city under its control. This results in social distancing, reduction of mobility and coming back to the local scale. The social needs of people are increasing as social activities are decreased. Income stability is threatened for social vulnerable groups.

In the case of Houston, small communities are established around churches. These communities provide local systems and self-sustaining living patterns. Public spaces are more valuable as these are the only places people can be safe outside, the public spaces are adapted to ensure a safe distance between people. Currently public utilities are centralized and used by the whole neighborhood. With a pandemic virus contact is needed to be reduced as much as possible, so public utilities are decentralized to a local use. The use of public transport is not without risk as it brings large groups of people in close distance to each other. The car dependency is enhanced as the use of public transport is not recommended.

Scenario Scale: Local scale

Student Baokun Wei



Covid-19

Here you can write a brief explanation.
Use as much text space as needed.

N

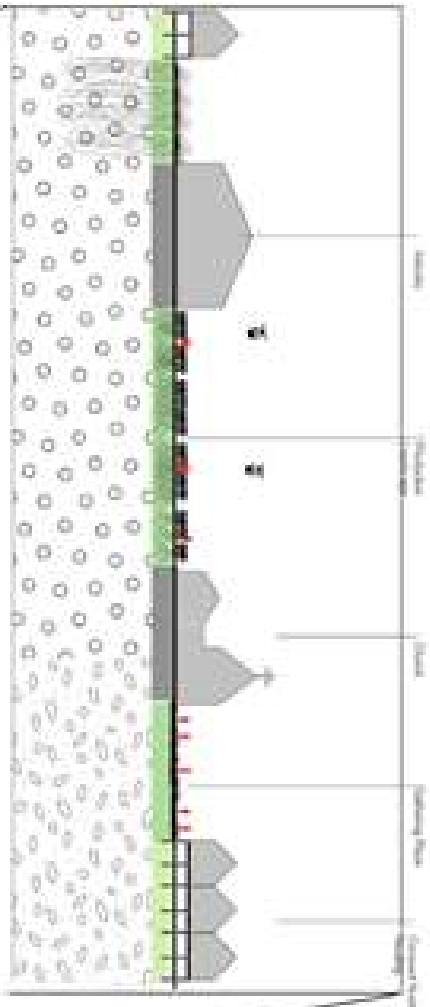
0 100 km

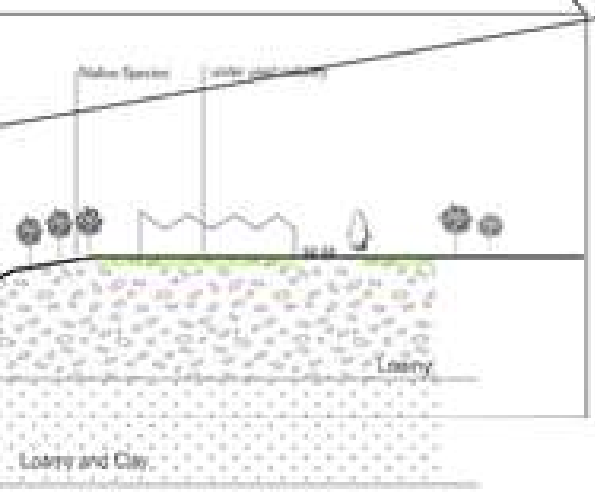











Loamy
Loamy and Clay

6.

System intervention

System intervention

Leading from the hybrid systems map and the different scenarios, aims and guidelines for interventions are developed. The systemic interventions we propose to better ecosystem participation in the Greater East End are two fold and separated into social-ecosystem and environmental-ecosystem interventions. The social-ecosystem interventions are developed to create a balance between the natural and human systems, as well as the aim of enhancing the community and changing to a preventive approach. The environmental-ecosystem interventions could be elaborated on a more physical level. Within the interventions the aims are creating hybrid systems/infrastructures, mixing high- and low-tech solutions and a multiscalar approach. Specific guidelines are proposed, regarding the different perspectives of landscape, ecology, urban, systems and anthropology. The guidelines also consider the physical and social distinction.

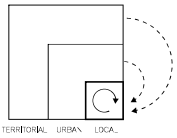
Combing with four previous scenarios, it concludes with our systematic interventions to transfer Harrisburg/Manchester. Firstly, it claims that the interventions will happen in terms of both physical and social aspects. For physical change, alongside the bayou edge, it will give more space for nature habitat, including greenway, wetlands and parks. For instance, it proposes to remove the industry for soil remediations and transfer the channelized bray bayou into natural one.Secondly, it suggests to use the street as the blue and green infrastructure to increase the nature resilience of the area. During flooding time, the streets are part of the drainage system. last but not least, the room for flooding should be preserved in order to face the shock in time.

From social perspective, the main aims of the intervention is to decrease the social and economical vulnerability, increasing the sense of community and transferring the attitude to flooding. Due to that, the targeting interventions should be as follows: firstly, adopting the urban agriculture strategy to ensure the local food access. By taking this advantage, it is better to localize the production, consumption and circularity. Moreover, it encourages to share the information and skill to face the threats and hazards by local residents. By using the open space(vacant space)with flexibility, the social network and community sense will be strengthened. Additionally, the key centers could be used as the base for activities. Finally, it requires the people to change their reactive attitude and join in this eco-participation.

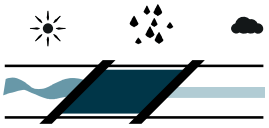
AIMS

BUILD AND NATURAL ENVIRONMENT

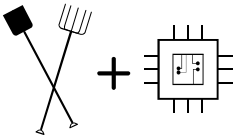
MULTISCALAR



HYBRID SYSTEMS / INFRASTRUCTURE

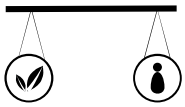


MIX OF HIGH - TECH & LOW - TECH SOLUTIONS

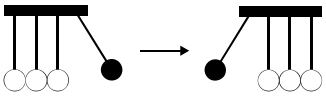


SOCIAL

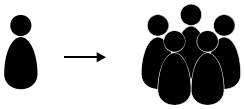
BALANCE BETWEEN NATURAL AND HUMAN



PREVENTIVE (MITIGATING) ATTITUDE



COMMUNITY BASED



Guidelines

- Balance between natural and human
- Preventive (mitigating) attitude
- Community based
- Multiscalar
- Hybrid systems / infrastructure
- Mix of high-tech & low-tech solutions

Spatial Guidelines

Explanatory scheme

GUIDELINES

BUILD AND NATURAL ENVIRONMENT


Improve permeability of land by reducing paved roads and paved lots. (ecology)


Remediate soil, and clean air and water pollution caused by industries and infrastructure. (ecology)


Optimize vacant / residual spaces for flood mitigation, biodiversity, and social activities. (landscape/ecology)


Restoration of vegetated bayou edges/ riparian corridor. (landscape/ecology)


Allow for the safe flooding of floodplains in times of shocks. Incorporate floodable buildings, lots, and roads. (urban/landscape/systems)


Flood proof and hurricane proof buildings. Promoting plot elevation and resilient building materials. (urban/landscape/systems)


Incorporate flood protection and ecological processes with (transport) infrastructures. (urban/landscape)


Increase accessibility to daily needs such as parks, food, and health care. (urban)


Create multi - functional open areas. By including leisure, food and energy production, and temporary activities. (urban, systems)


Create multi - mobility opportunities. Include space for natural processes, pedestrians, bikes, and cars. (urban)


Participate actively in mitigating measures from house, lot, street, block, neighboorhood, and district level. (systems, urban)

SOCIAL

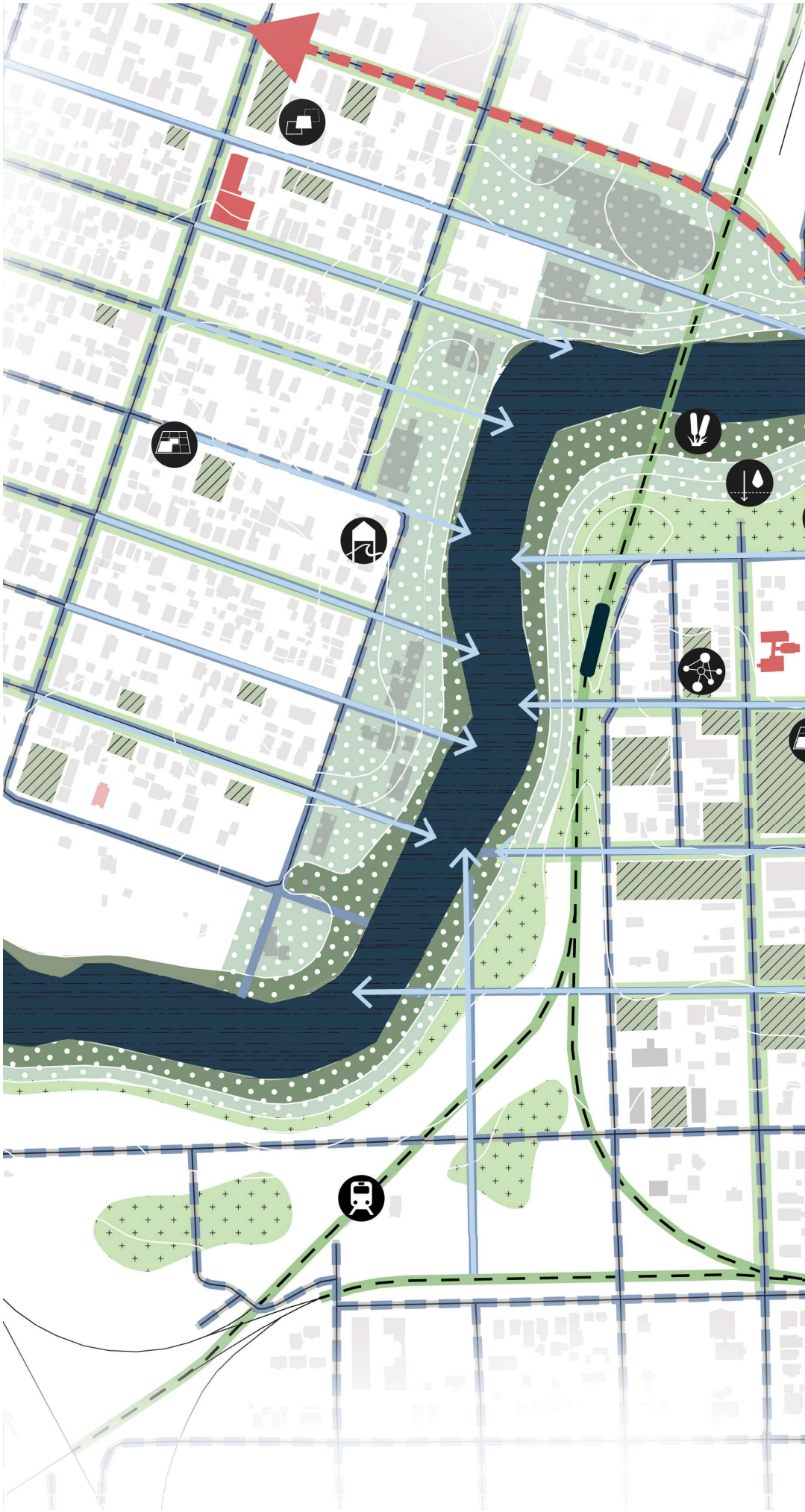

Decrease socio-economic vulnerability, by strengthening social networks (through apps and community centers) and promoting spatial connectivity. (anthropology)


Amplify key centers as base for activities / a community (religious, cultural, educational). (anthropology)


Less car dependency, being open to other ways of transport depending on distances (public transport, bikes, pedestrians). (urban, anthropology)


Incentivize local production, consumption, and circularity (food, house/car repair, energy, water). (anthropology, systems)


Ensure transparency of threats, and hazards to residents (apps, data, news). (anthropology)



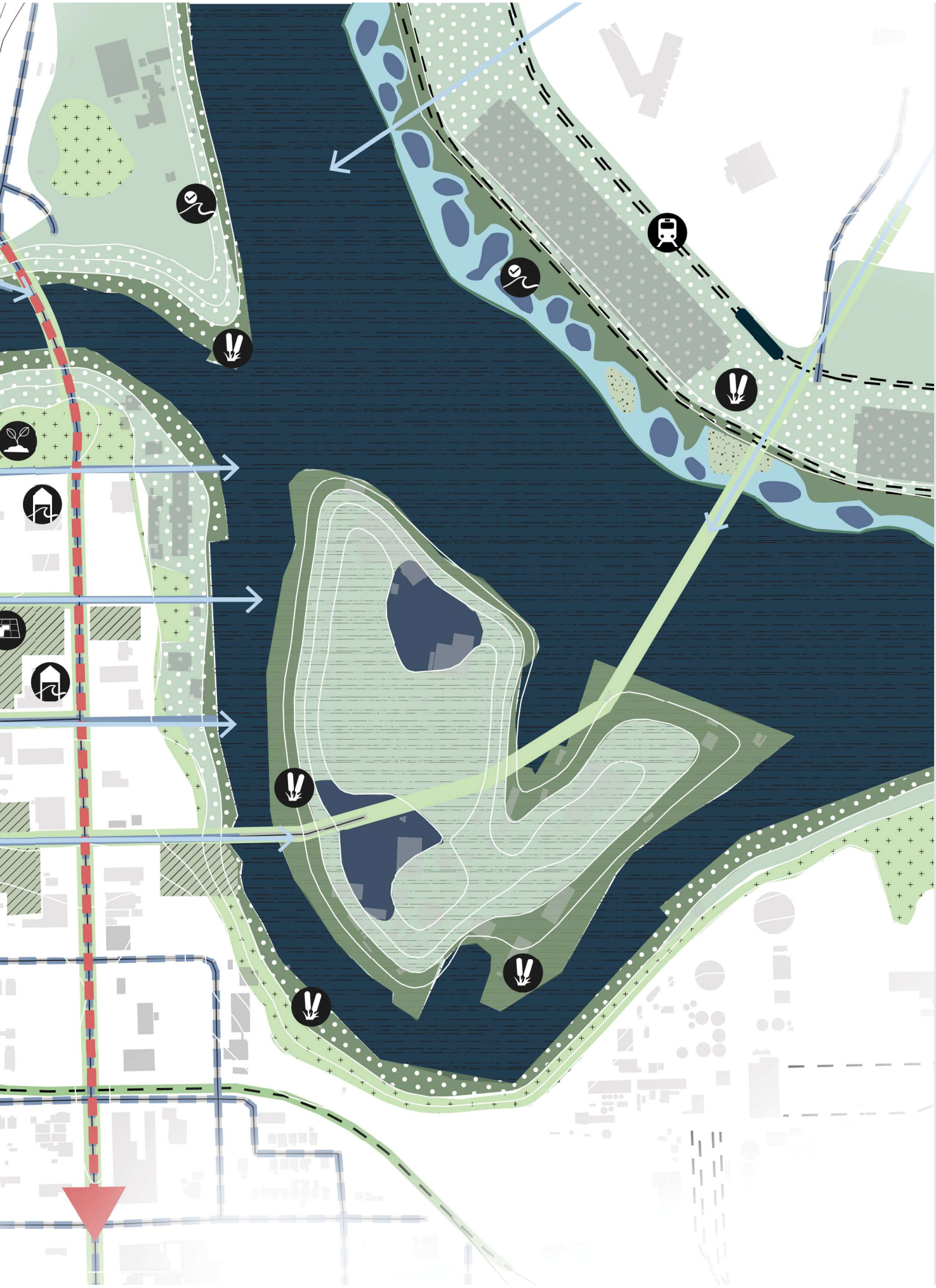
System intervention map

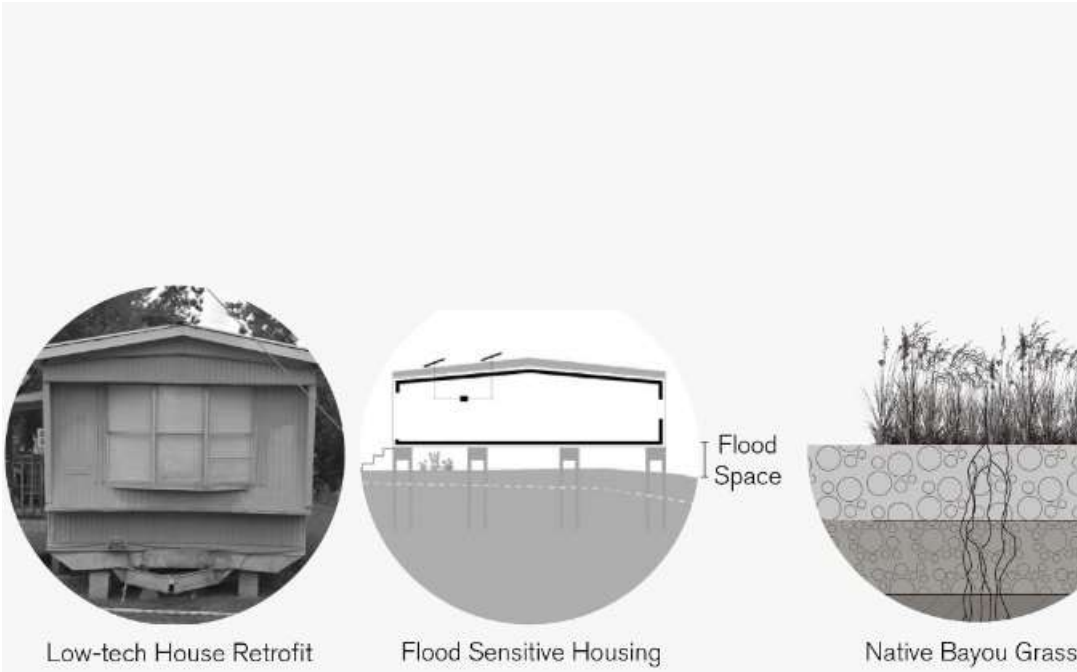
Spatial guidelines

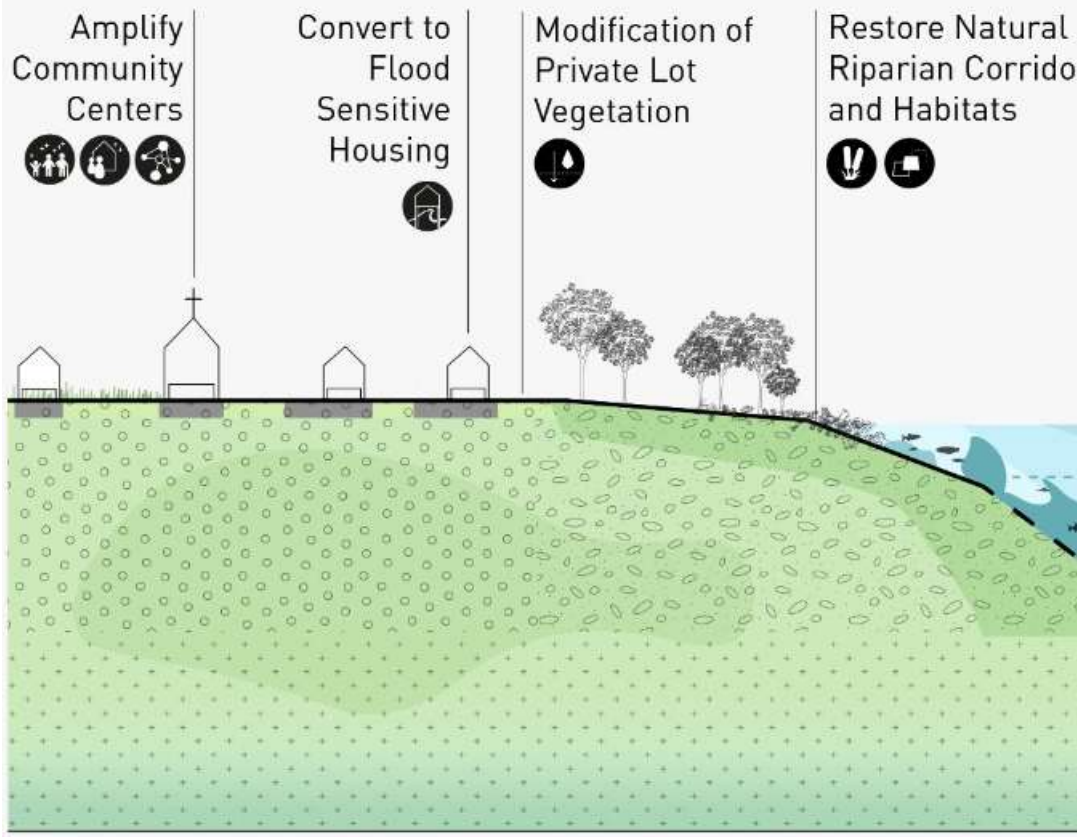
- Improve permeability of land
- Restoration of vegetated bayou edges
- Allow for the safe flooding of floodplains in times of shocks
- Increase accessibility to daily needs such as parks, food, and health care
- Restoration of vegetated bayou edges
- Restoration of vegetated bayou edges
- Restoration of vegetated bayou edges
- Highway
- Street as water system
- Wetland
- Greenery edge of Bayou
- Vacant Space
- Transtional green space
- Flooding plain
- Public Building(Church)

N

0 100 km







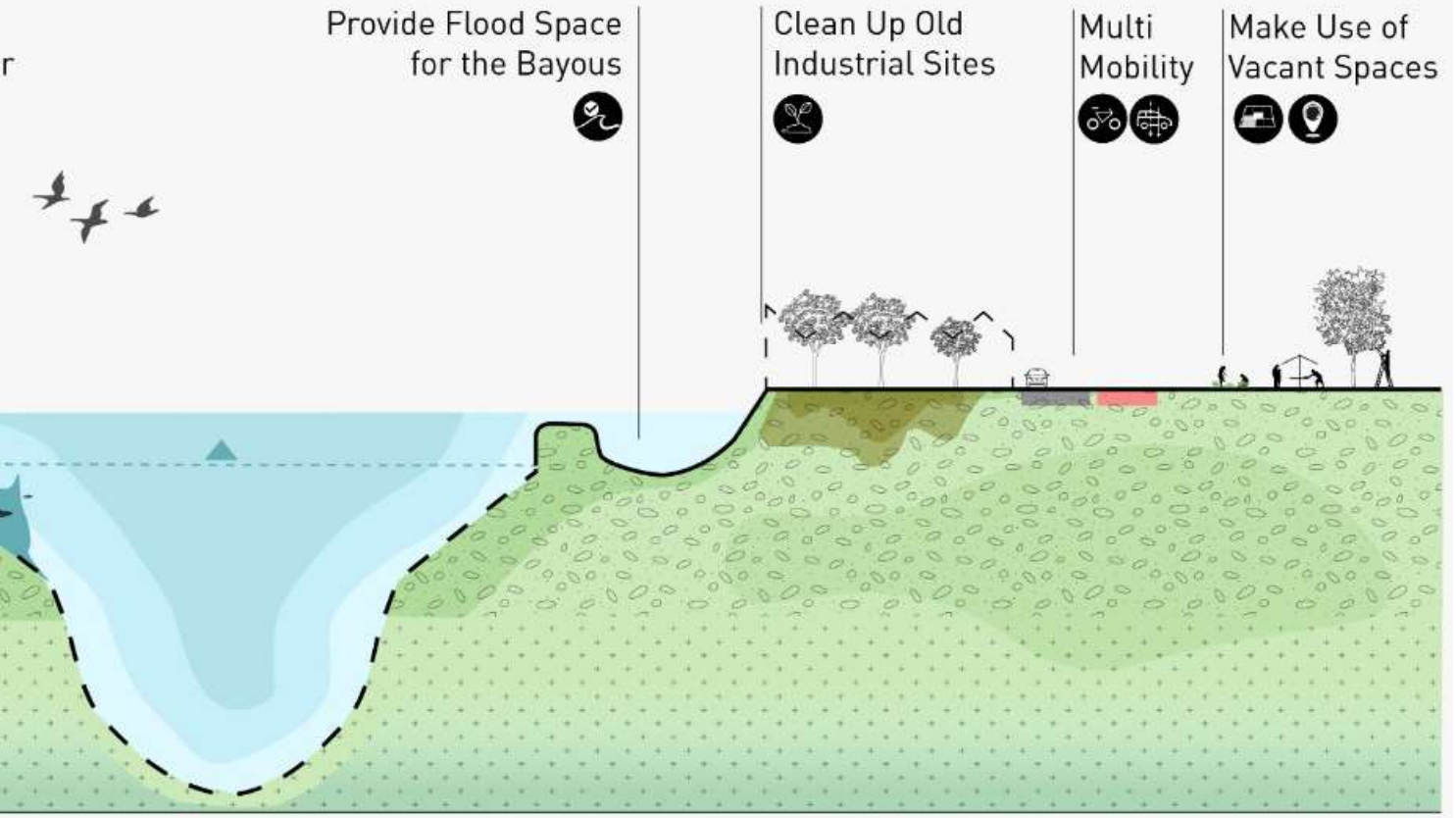
System intervention map

Spatial guidelines

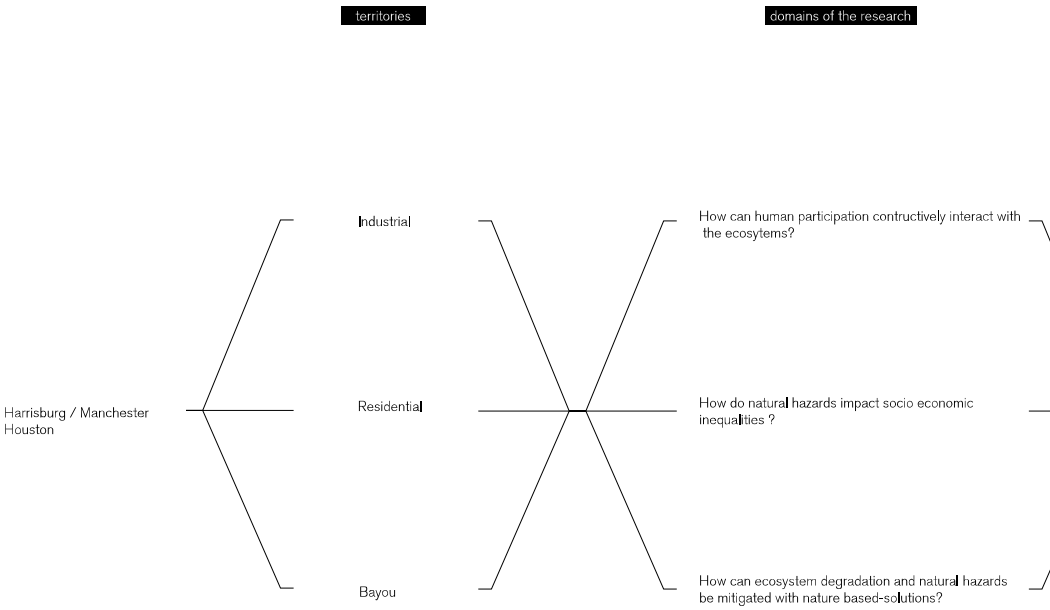
N

0 100 km





BUFFALO BAYOU

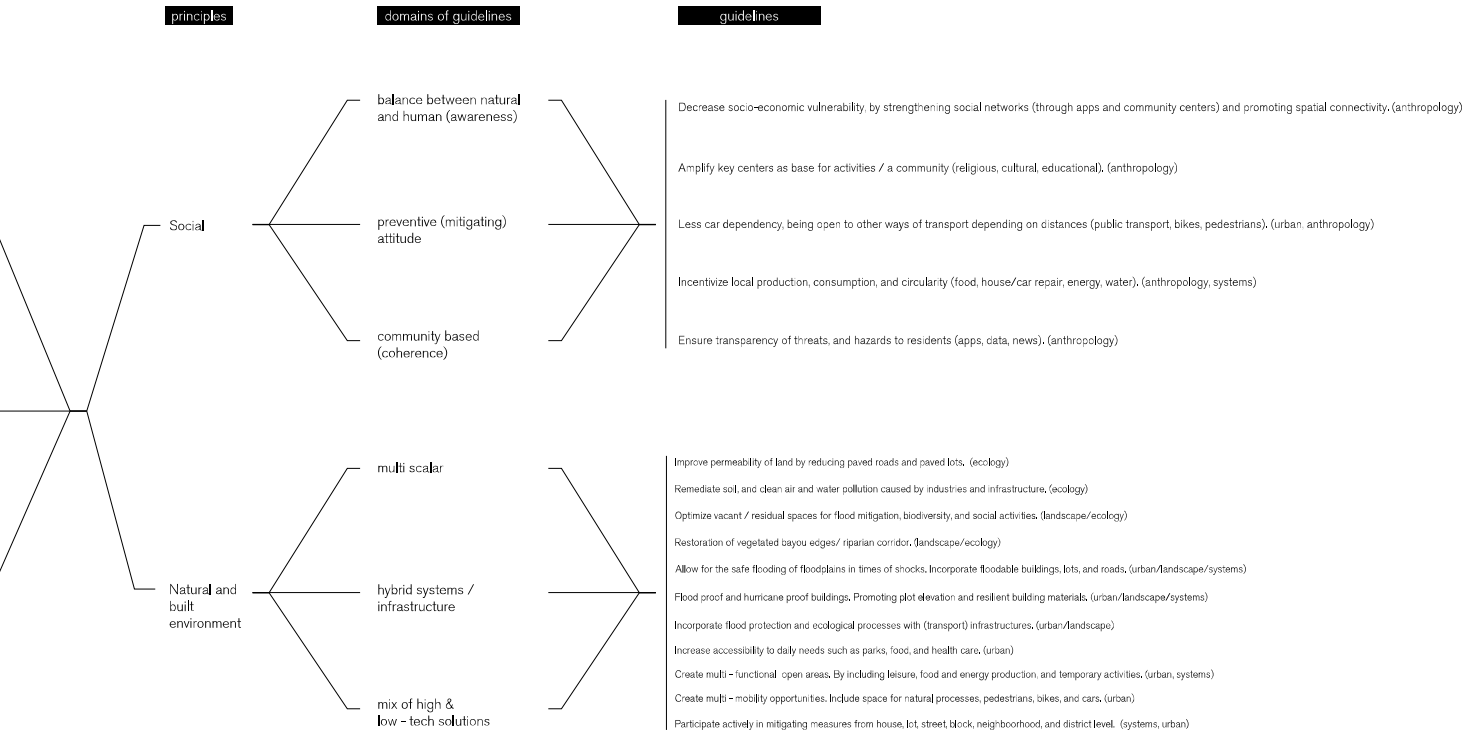






Conclusive Framework for Design Experiments

The Design Experiments propose interventions promoting ecosystem participation in the Harrisburg Manchester area. Each focussing on a specific set of territory, principles and domains, regarding to the spatial guidelines.


principles
domains of guidelines
guidelines
Social
Natural and built environment
balance between natural and human (awareness)
preventive (mitigating) attitude
community based (coherence)
multi scalar
hybrid systems / infrastructure
mix of high & low - tech solutions
Decrease socio-economic vulnerability, by strengthening social networks (through apps and community centers) and promoting spatial connectivity. (anthropology)
Amplify key centers as base for activities / a community (religious, cultural, educational). (anthropology)
Less car dependency, being open to other ways of transport depending on distances (public transport, bikes, pedestrians). (urban, anthropology)
Incentivize local production, consumption, and circularity (food, house/car repair, energy, water). (anthropology, systems)
Ensure transparency of threats, and hazards to residents (apps, data, news). (anthropology)
Improve permeability of land by reducing paved roads and paved lots. (ecology)
Remediate soil, and clean air and water pollution caused by industries and infrastructure. (ecology)
Optimize vacant / residual spaces for flood mitigation, biodiversity, and social activities. (landscape/ecology)
Restoration of vegetated bayou edges/ riparian corridor. (landscape/ecology)
Allow for the safe flooding of floodplains in times of shocks. Incorporate floodable buildings, lots, and roads. (urban/landscape/systems)
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Create multi - mobility opportunities. Include space for natural processes, pedestrians, bikes, and cars. (urban)
Participate actively in mitigating measures from house, lot, street, block, neighboorhood, and district level. (systems, urban)







Designated Floodplains

Stefan Vermeulen

Manifesto

Human vs nature

The confluence of several bayous causes Houston to be a flood prone city. The aim of this manifesto is to create safe, designated floodplains to restore the balance between nature and human.

Over years the surroundings of the bayous changed from a natural to an urbanized environment. The urbanized areas, consisting of elements like infrastructure, public spaces and buildings are primarily designed to be used by humans. With the focus on human activity, the natural areas are highly suppressed which causes problems during extreme weathers.

The Nature First scenario, elaborated and discussed before, touches the subject of bringing priority back to nature, like in a world before humanization. In this scenario the suppressed bayous are given more space, which leads to a shift in the position of human activity.

The outcome of the scenario resembles a concept used in the Netherlands, ‘Ruimte voor de Rivier’ (Room for the River). This government design program addresses several rivers in the Netherlands and their floodplains. An important aspect is the change in approach, from enhancing flood protection, to creating an integrated river basin management.

In the case of Houston, the bayous are in an urbanized area, where human activity cannot be erased, so nature can take its course. That is why an integrated system is needed where the bayous are no longer suppressed by human activity, whereas the humans are no longer suppressed by the flooding bayous. Human and nature can coexist, while sharing the usage of the floodplain areas. With this the area is adaptable to climate change and the balance between human and nature is restored.



Collage of Human and Nature coexisting alongside the bayous

Design experiment

The topic of this design experiment is 'Designated floodplains at the confluence of human and nature' applied in the area of Harrisburg/Manchester, a neighborhood in Houston. The aim of this design is creating an area in between nature and human, consisting of designated floodplains. These designated floodplains are neither specifically designed for human activity nor nature. The concept of this design is that the use of the interventions depends on the stage of flooding. Four different stages are distinguished with each their own characteristics considering human and nature.

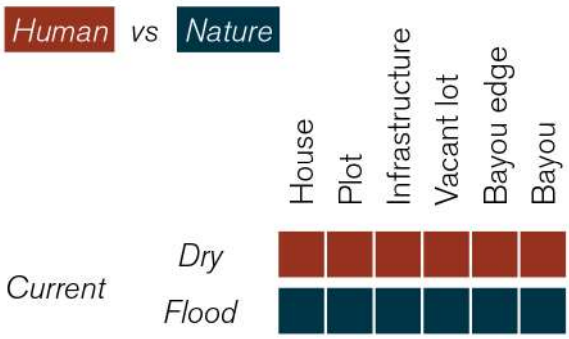
Stage 1, the dry situation. In this stage there is no flooding and the bayou edges are extended to create more space to breath. The soft, natural edges are designed with local species, to enhance the ecosystem. Vacant lots are transformed into public spaces, to create space for the inhabitants to meet, which enhances the community. Infrastructure is focused on bot car mobility and slow traffic.

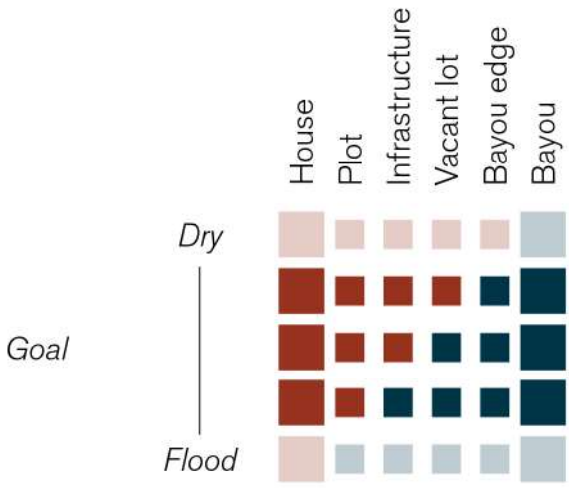
Stage 2, a minor stress situation. In this stage the water level of the bayous is rising into the public spaces. Parts of these areas are designed to be flooded, so that other parts are still accessible as public space. The public spaces in the neighborhood are designed to store rainwater, allowing it to infiltrate slowly. Infrastructure is still accessible for transportation.

Stage 3, a major stress situation. In this stage the water level extends across the bayou edges, all the way into the vacant lots. These lots are no longer available as public space, so the inhabitants are withdrawn into their plots. Some roads are designed to be flooded, but the major roads are still in use to provide access to other neighborhoods for daily needs.

Stage 4, a shock situation, where the area reaches its limits. In this situation a controlled breakthrough is needed which floods a certain area. However, the houses in this area are provided with extra flood control measures, to ensure the safety for the residents. With this controlled breakthrough the other parts of the neighborhood are safe from flooding.

When rainfall is over, the water will slowly infiltrate and returning to the bayous, with the areas opening to the humans again. In this way an environment where nature and humans can coexist is created.



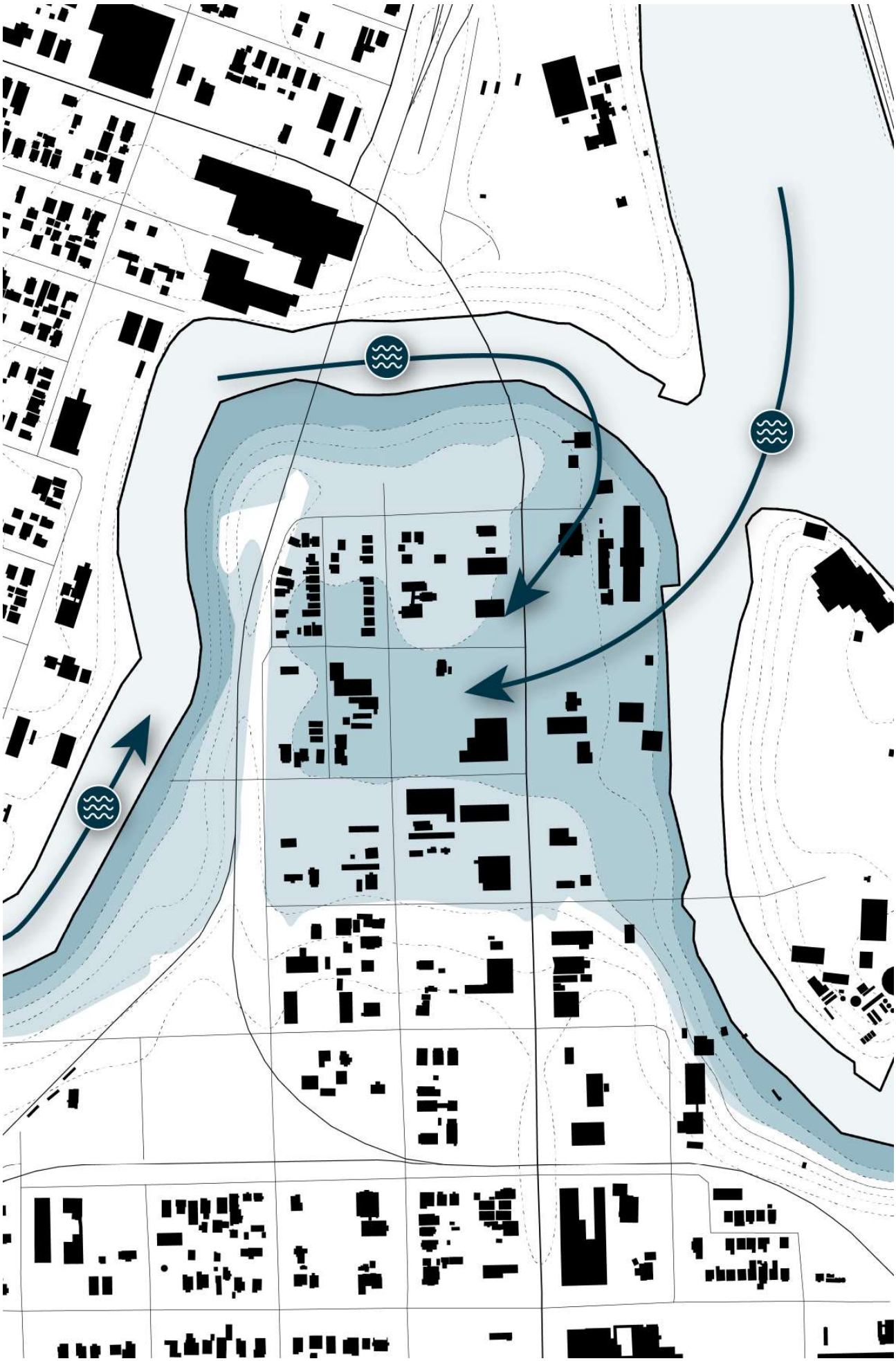


Current situation and goal

The map shows the current floodplains in the neighborhood. The floodplains extend all the way into the urbanised area, which puts a huge risk on the inhabitants.

It is a constant battle between human and nature, where the humans take over the area in a dry situation, while the nature takes back in a flood situation.

The goal is to create a hybrid system where the area is used by either human or nature, depending on the flood stage.

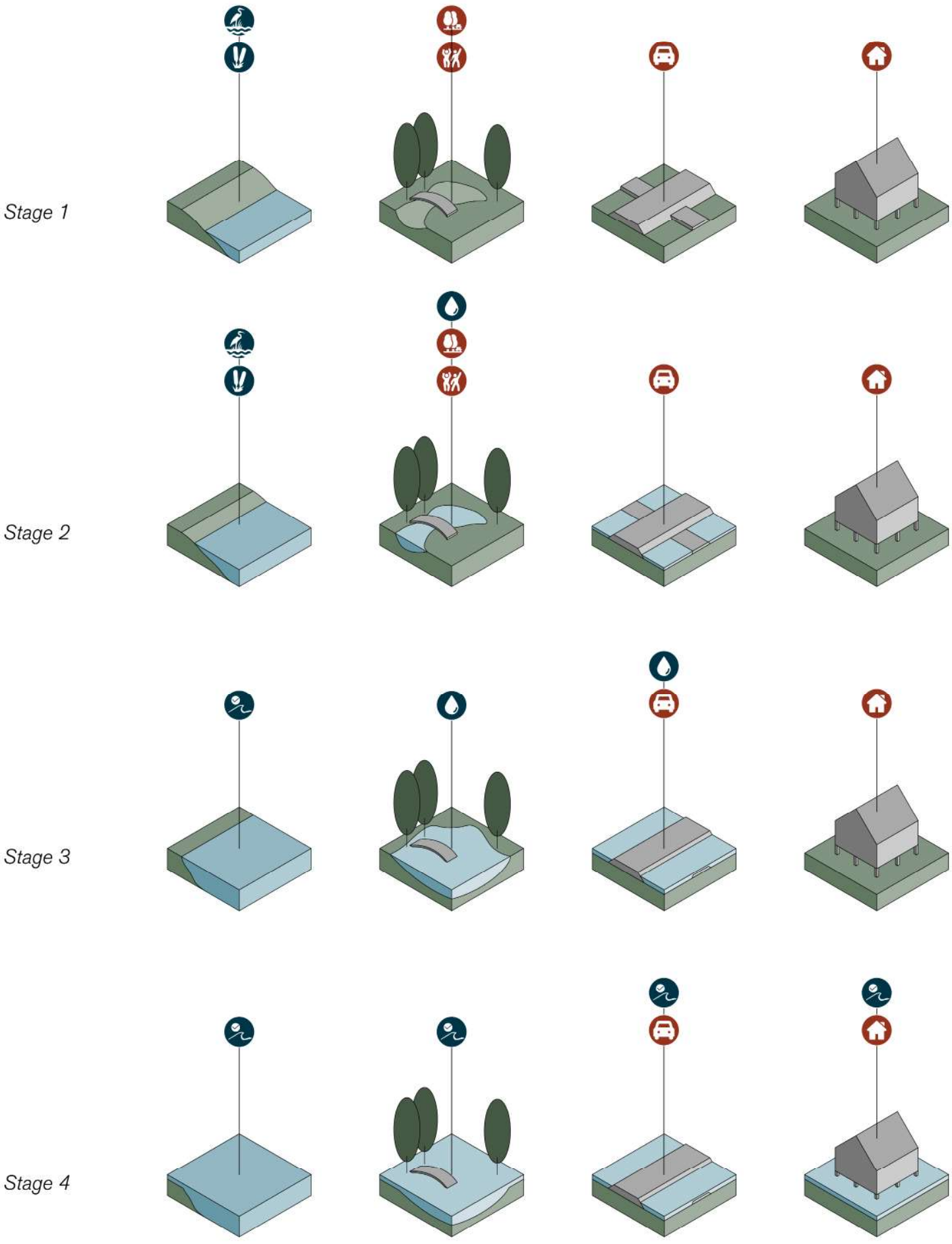


Concept tiles

To reach the goal of a hybrid, intergrated system, the urbanised area is devided into four categories, plots, infrastructure, vacant lots and bayou edges. The function of each tile is bound to the different flood stages. Stage 1, a dry situation where there is no flooding. Stage 2 with little rainfall, creating a minor stress situation. Stage 3 where there is more heavy rainfall, creating a major stress situation. And stage 4 where there is a shock situation with the consequence of major flooding.

With each stage the use of space differs between human activity and nature. These concept tiles are not location bound and can be applicable in all parts of Houston.




Stage 1
Stage 2
Stage 3
Stage 4
Bayou edge
Vacant lot
Infrastructure
Plot



Stage 1: dry

Designated Floodplains

These maps show how the neighborhood changes, considering the four different flood stages. In each stage the icons represent the activity by either human or nature. In stages one and two the area is mainly used by humans, whereas in stages three and four nature is predominantly present. Important to notice is that during all four stages neither human nor nature is surpressed. It is a hybrid system where both can coexist.



Stage 2: minor stress



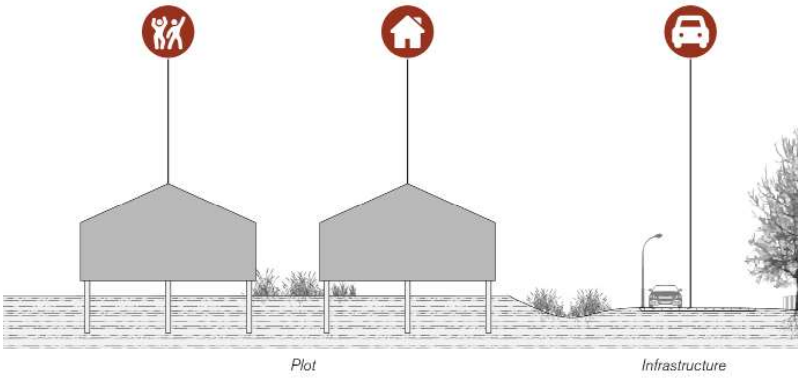
Stage 3: major stress



Stage 4: shock

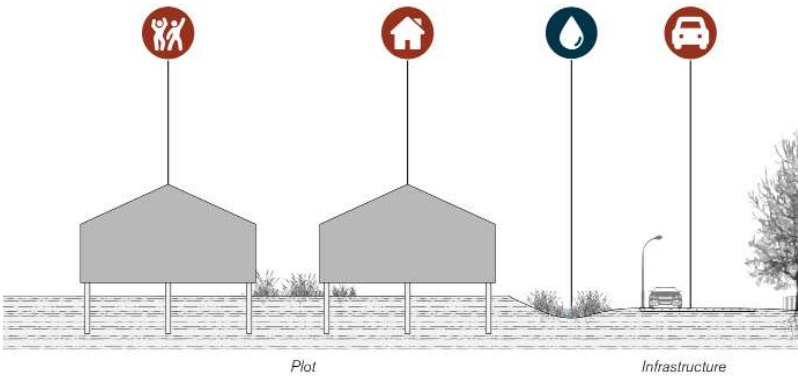
Section Stage 1: dry

In this section water is present in the bayous, whereas both infrastructure and public spaces are predominantly used by humans. Public spaces and community centers enhance the local living quality.



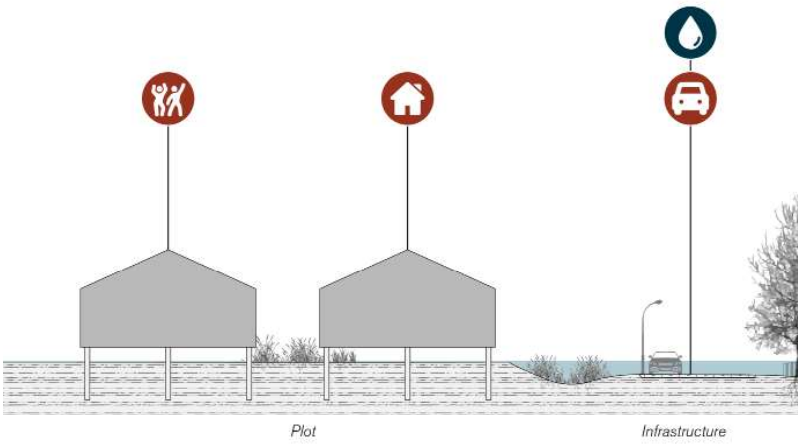
Section Stage 2: minor stress

In this section the water level of the bayous is rising, taking space of the public spaces or water storage. Parts of the areas are in possession of nature, while other parts are still accessible for human activity.



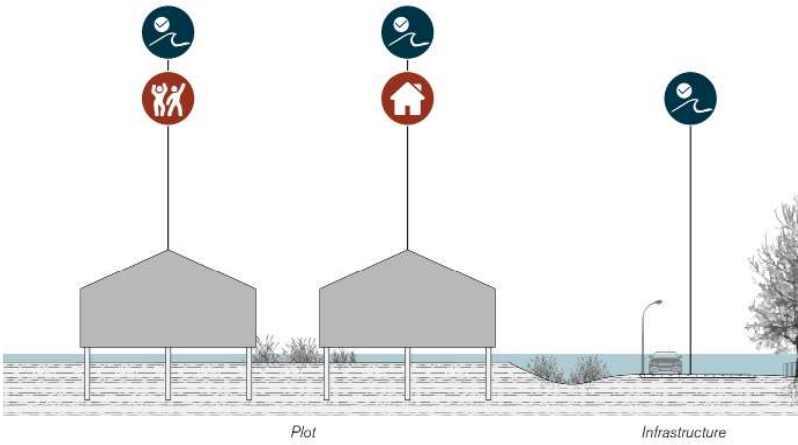
Section Stage 3: major stress

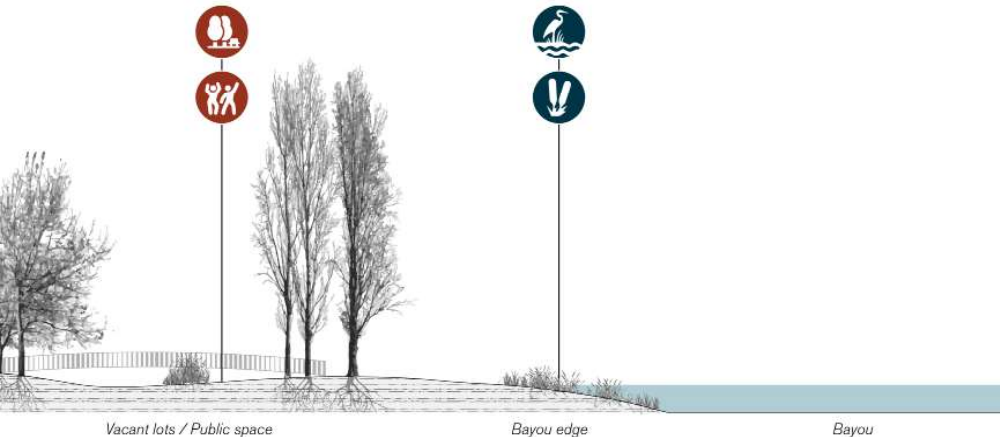
In this section water level extends all the way across the bayou edges. Nature is slowly taking over the area, as some roads are now also acting as a floodplain. Major roads are still used to access other neighborhoods and to supply for daily needs.

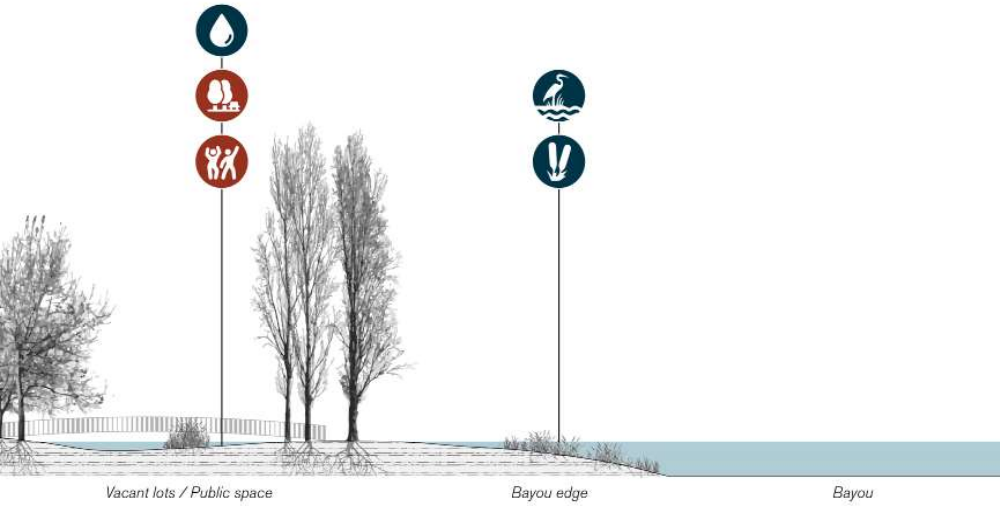


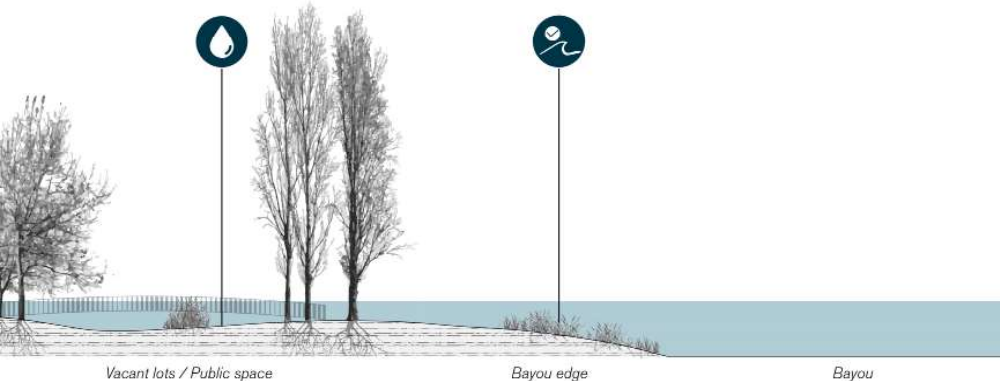
Section Stage 4: shock

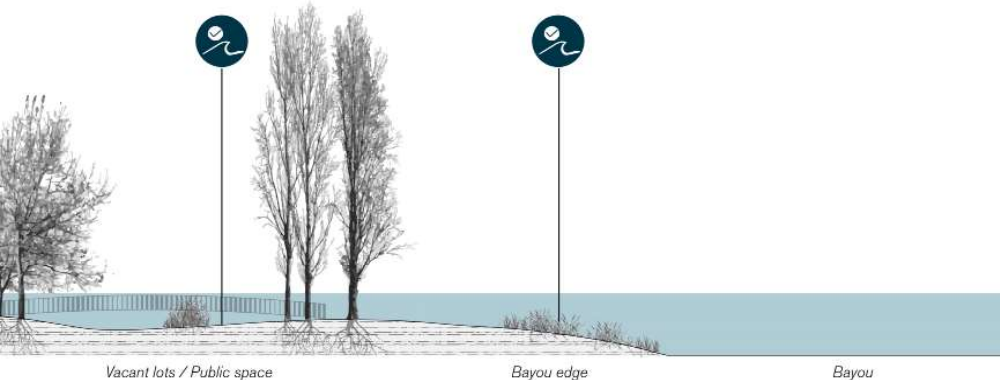
In this section human activity is withdrawn to the plot level. Infrastructure and pubic space are fully operating as floodplains (with the exception of evacuation routes), and some plots with extra flood protection are also flooded











Human
- Public space
- Community
- Mobility
- Residence

Nature
- Local species
- Soft edges
- Water storage
- Flood resilient

Impression Public Space

These impressions show the situation both during dry and a wet situation. In the dry situation the public space is used for recreational purposes. The inhabitants can meet each other, which enhances the community.

During rainfall, parts of the public space are designed to be flooded. In this way preassure of the bayous is released. Higher elevated parts of the public space are still accessible for human activity.



Public space in a dry situation



Public space in a wet situation

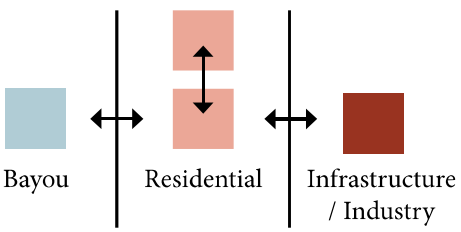




Breaking Barriers

Jurriënne Heijnen




Bayou
Residential
Infrastructure
/ Industry

Manifesto

BREAKING BARRIERS

Pushing industries out of backyards

Healthy and resilient neighborhoods despite their vulnerable position in extreme environments can only sustain upon strong social networks and strong connections between human and nature. Despite the individualistic American Dream, strong individuals exist through strong communities.

Crises such as the current pandemic show that transitions of the human systems are possible and unltimately inevitable in order to sustain. On the local scale of Houston such shifts are possible and inevitable as well even though they do not seem to be at first sight. They are a shift from rebuilding to mitigating, a shift from denying to educating and understanding, a shift in mobility, and a shift in ownership. Within the current individualistic and private ownership environment in Houston, these shifts require governmental action and responsability on public space, communities to connect and individuals to participate.

At the confluence of Buffalo and Brays Bayou, this desing experiment breaks the barriers between humans and human and nature which are formed by polluting industries. This design experiment proposes key spatial interventions to restore the human to nature connection as well as the human to human connection, both essential for resilient residents in such extreme environments.

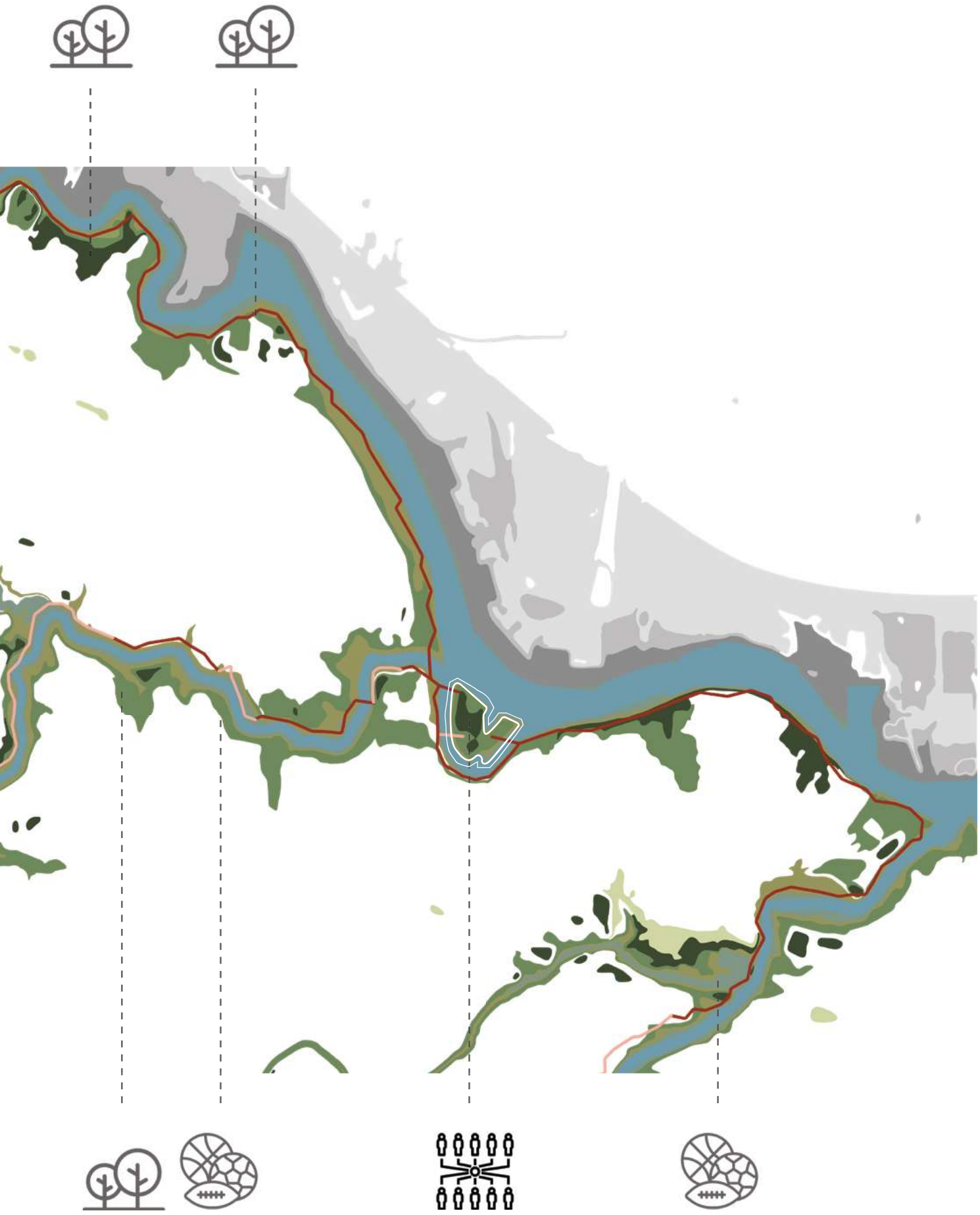
The set of interventions serve as an examplary implementation of a strategy that can be applied to the Bayou system beyond the Harrisburg Manchester neighborhood. They are the physical manifestation of the existing implicit but strong social structure, allowing it to strenghten, grow and facilitate ecosystem participation.



Defining the border

Through connecting the Buffalo, Brays and Sims Bayou parks, riparian corridors will replace the polluting industries and define a green remediating edge between the residential and industrial areas of Houston.

Within the Bayou park system itself, at the confluence of three neighborhoods and the two bayous, Bradys landing fullfills a communal function in the place at an edge of nature, industry and residential for rethinking living with industy and nature.





Okt 2015 - Bike Trip destination



March 2017 - Womens Rights Conference

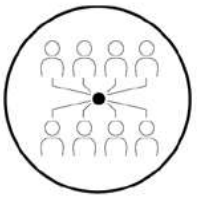
Brady's Island

At the edge for rethinking living with industy and nature, a community center is rebuild upon the already existing strong social structure. The original recreational and communal functions are restored and fortified.

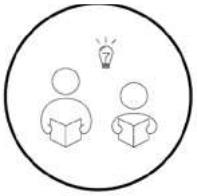
During shock events such as flooding, storms or the current pandemic, the island functions as a place of refuge or distribution of resources.



June 2016 - Dinner with friends



Community



Education



Deliberation

+



Jan 2018 - Park to Port Bike Ride



Refuge

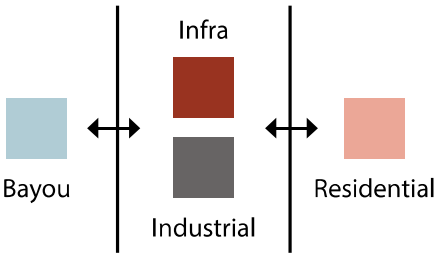


Distribution

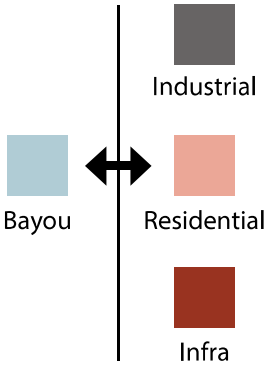


Rapid Response Center

FROM
BARRIER



TO
CONNECTION



Breaking Barriers

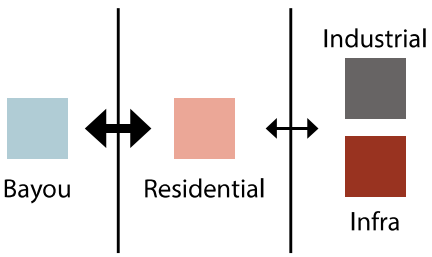
Based on the theorie of the residential area as a connection between low dynamic nature and high dynamic infrastructure and industry (Tjallingi, 2002), connections between human and nature are restored.

At the bayou banks, industry is replaced by riparian bufferzones forming the green connections between the bayou and residential areas. Shifting the areas from barriers into connections.

The secundary mobility system of bike and walking paths along and across the bayou connects the neighbourhoods to the Bayou park system and to eachother and functions as the main mobility system for short distance travel such as social and sporting activities. During shock events, this system partly floods and partly expands the car infrastructure that functions as the main evacuation system.

The resilient and healthy neighbourhoods of Harrisburg / Manchester / Magnoliapark are connected with the bayou and with each other.

SHIFT

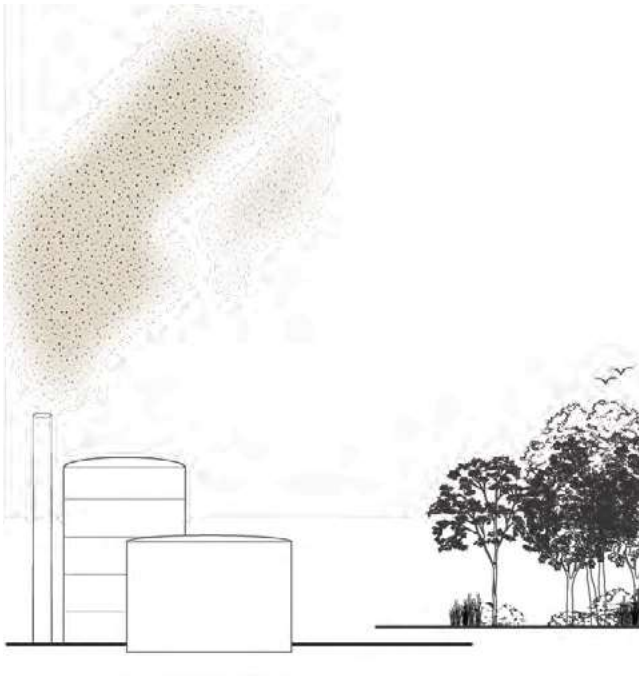


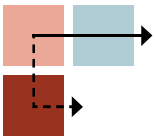


Industry → Riparian

Shock
Commuting → Stress
Short-distance







Breaking Barriers

Polluting industries such as oil refineries are relocated at a distance from the residential area and replaced by green riparian zones.



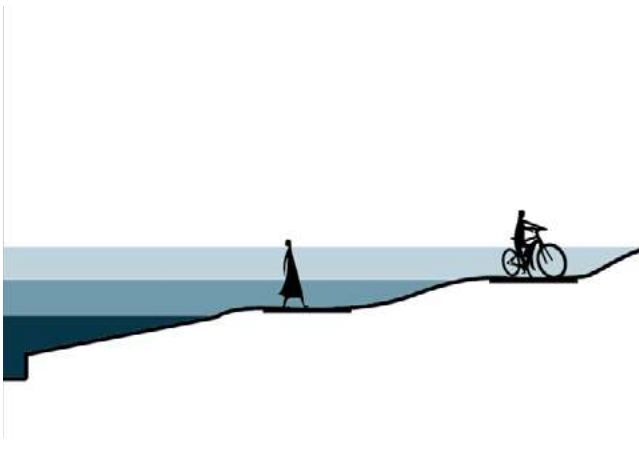
Neighborhoods are connected to eachother across the bayou through bike and walking paths.



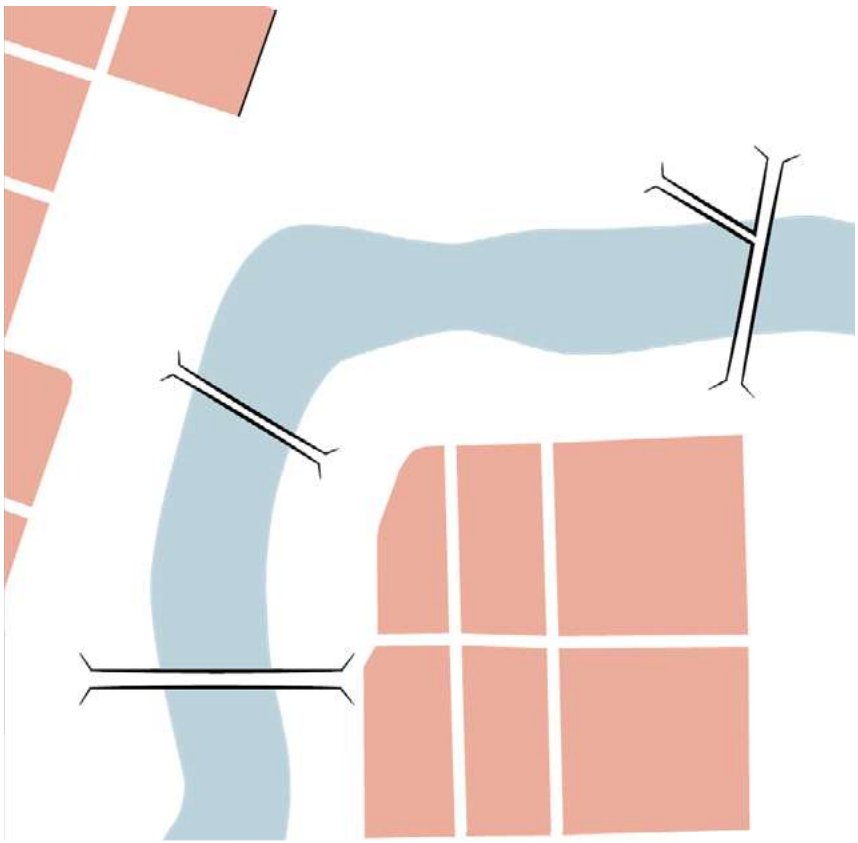
Existing communal functions are connected with Brady Island through walking paths renforcing the connection during stress and shock events.

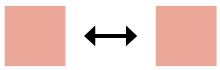
The secundary mobility system partly floods during shock events to allow room for the bayou while the main car evacuation routes remain accessible.



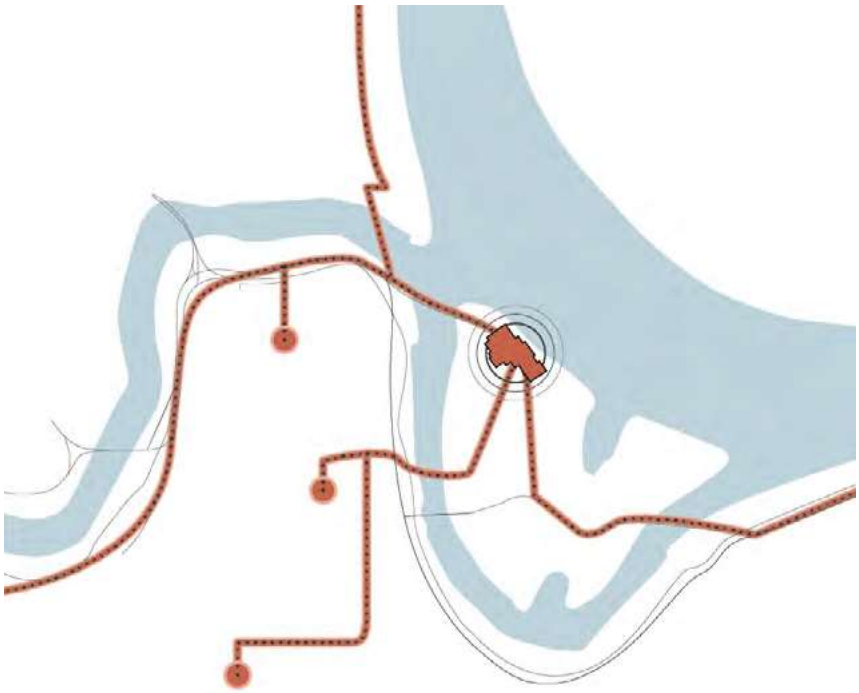














Breaking Barriers

The partly elevated bike and walking paths connect the Bayou Park System and partly support the main car evaquation infrastructure during shock events.

Brady's Island at the confluence of human, nature and industy territory functions as a community and a place of refuge during shock events.

Industry is replaced with a riparian zone

Bike and walking paths connect the neighborhoods to the Bayou and across, to eachother.

Existing communal functions such as churches are connected to the Bayou Park System and the Brady Island shelter

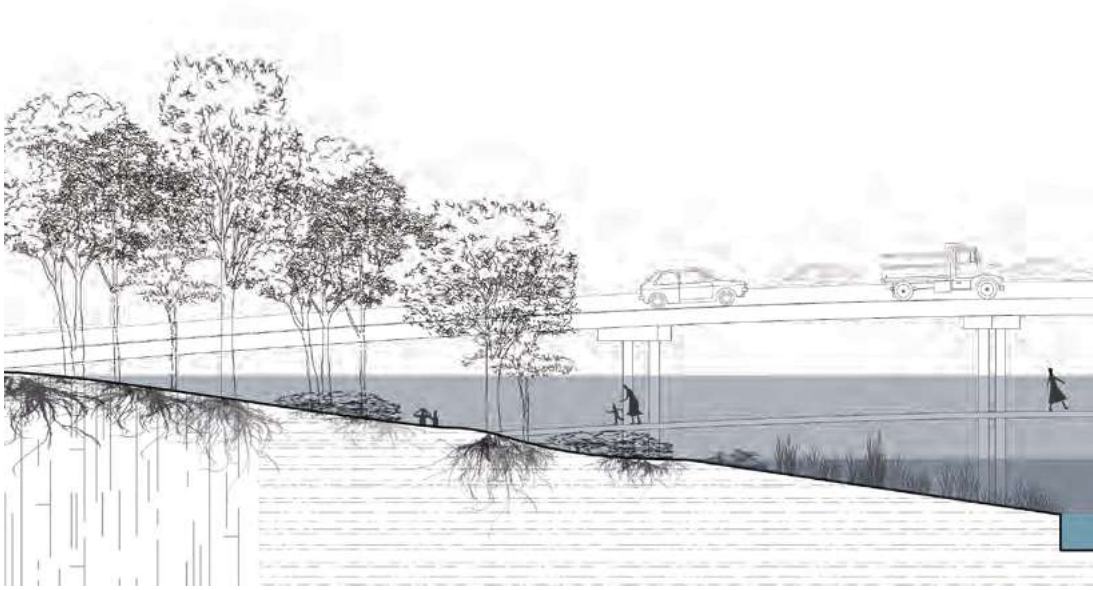
- Former industrial area
- Bayou
- Riparian zone
- Community function
- Residential area

N

0 100 km





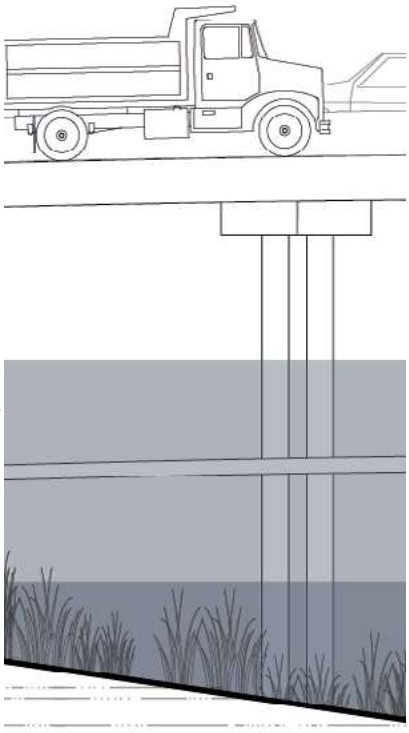


Bayou Park System

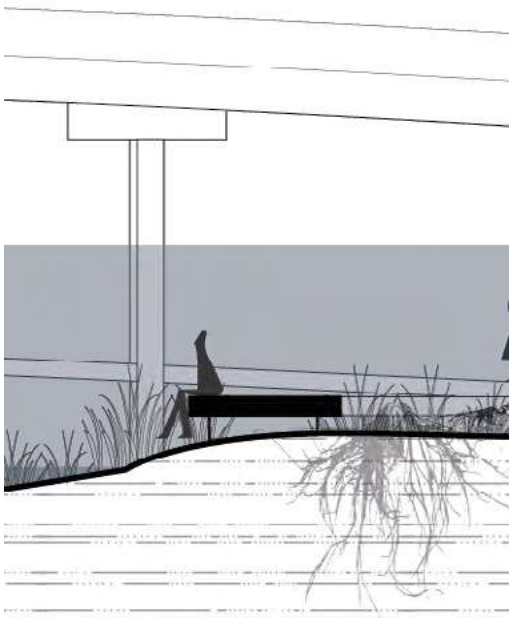
The Bayou Parks are connected through bike and walking paths located in the riparian and remediation zones of the bayou embankment.

Application of Phytoremediation to River Pollution Remediation and fish forests remediate the polluted water. Furthermore, grasses and trees remediate air and soil pollution. Elevated walking paths and bikepaths through the remediating vegetation are able to flood during high water. Altogehter this green embankment will enlarge the sponge capability of the city.

- Extreme Flooding
- High water
- Median water level



Elevated emergency infrastructure



Elevated walking paths

0 | 100 km | N



water

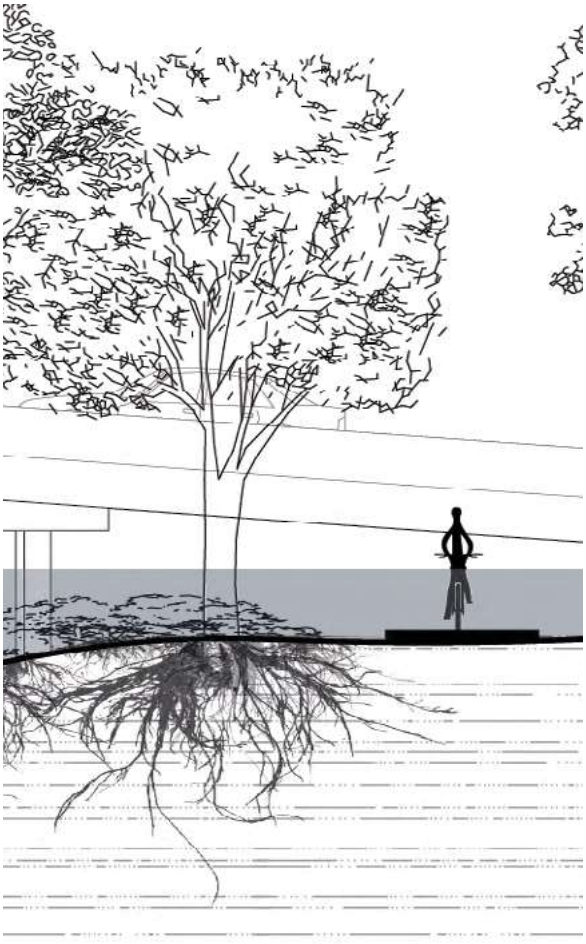


soil

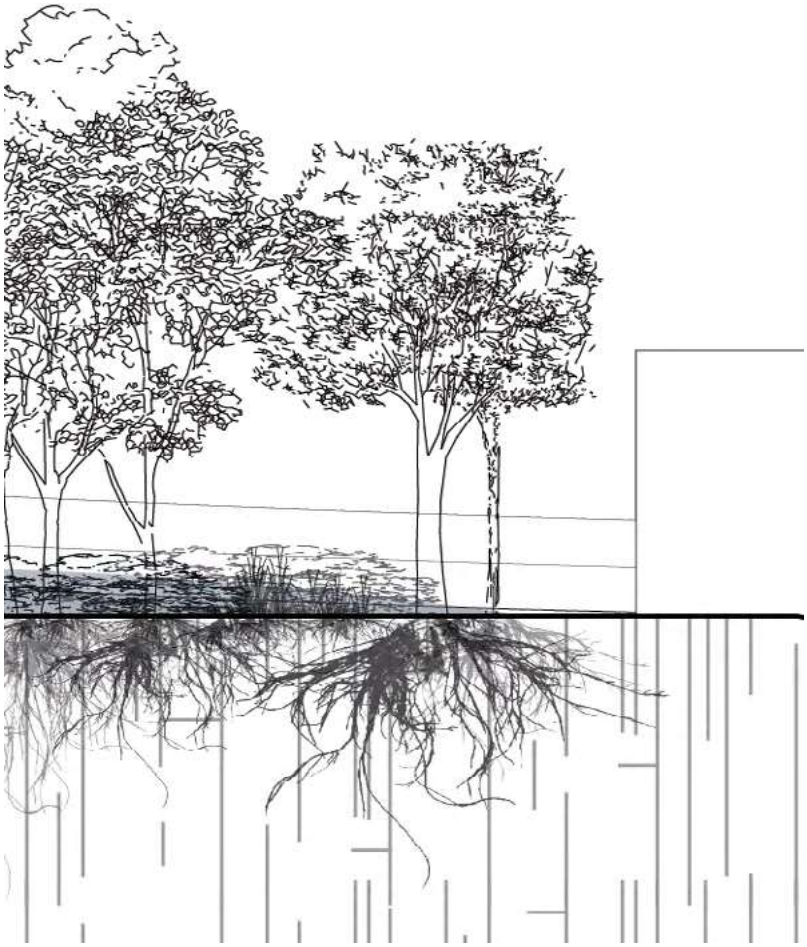


air





Bike paths canopy



Sponge function



Debate Center
Where conflicting groups can be brought closer together, such as industrial companies and residents dealing with environmental racism.

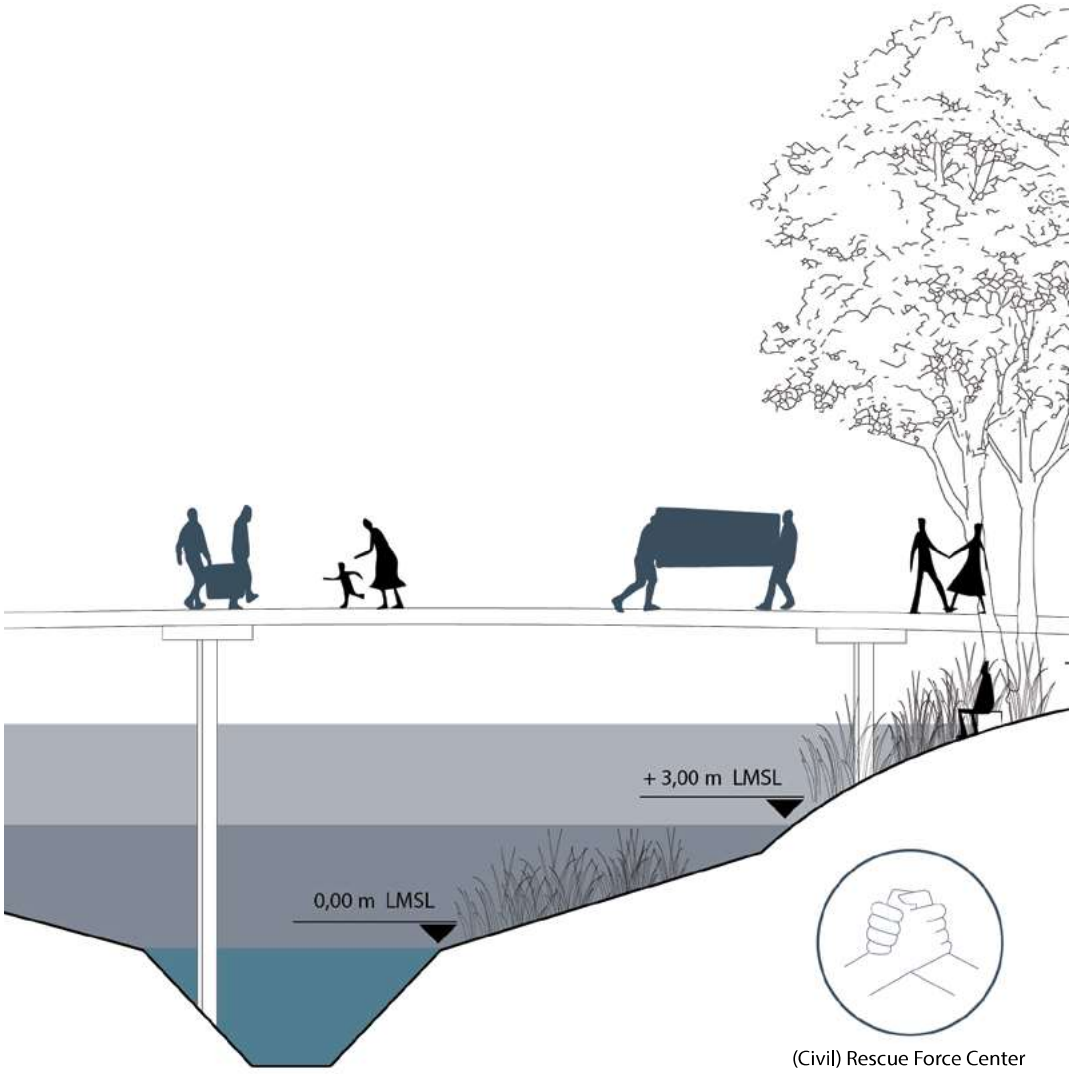
Learning Center
Educating houstonians on
with nature and polluting i

Island Connection

At the confluence of the greenblue Bayou Parks, the residential areas and the industy, as mentioned before, Bradys Island is the place for strengthening existing social networks and resilient residents. Accessibility of Brady's Island during stress and shock is essential.

While the bluegreen Bayou Parks are the main connectors most of the year during times of stress (heat, traffic, pollution and weak socio-economic status), the Harrison Boulevard Bridge is the main connecting infrastructure during shock events. Brady's Island is connected to the bridge through the elevated biking path. Making it accessible for locals to find temporal refuge or for rescue forces to efficiently provide rapid response during floods and storms.

- Extreme Flooding
- High water
- Median water level



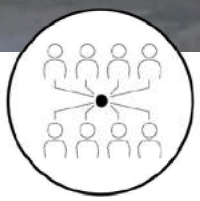
(Civil) Rescue Force Center
of rapid response management

Shock

0 100 km N



living together
ndustries.



Community Center
Building and reinforcing social networks whitin
and inbetween minority neighborhoods.





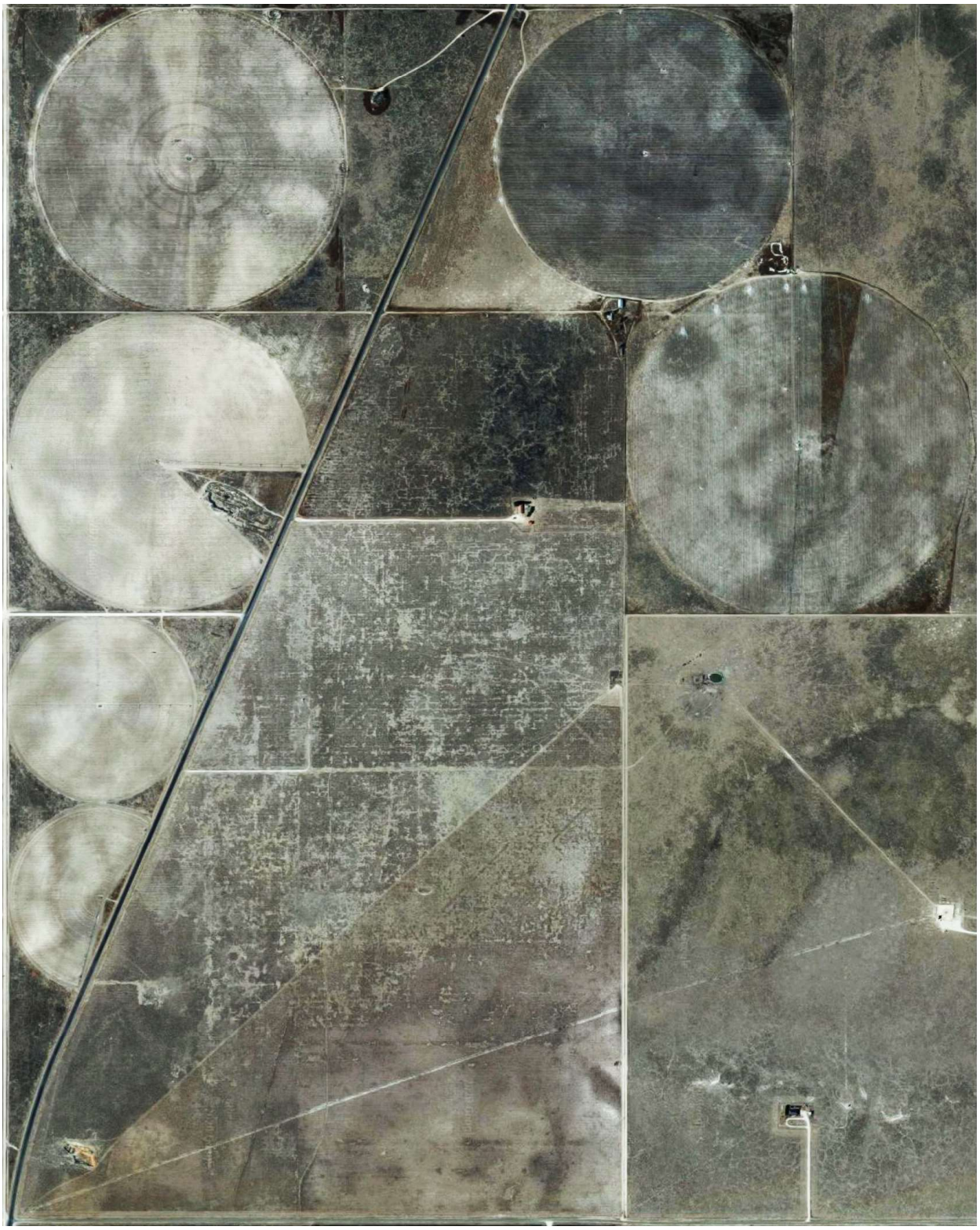
Distribution of resources
such as water, medical and other critical
supplies to provide early relief.



Place of Refuge
offering temporary shelter during hurrica-
nes and floods.

Eco-tropic Communities
Toward Symbiotic Productivity

Hadrien Cassan



Intensive Agriculture and Oil Fracking Landscape in Western Texas

Source: Google Maps 2020

A Transition Toward A New Era // An Era of Symbiotic Productivity

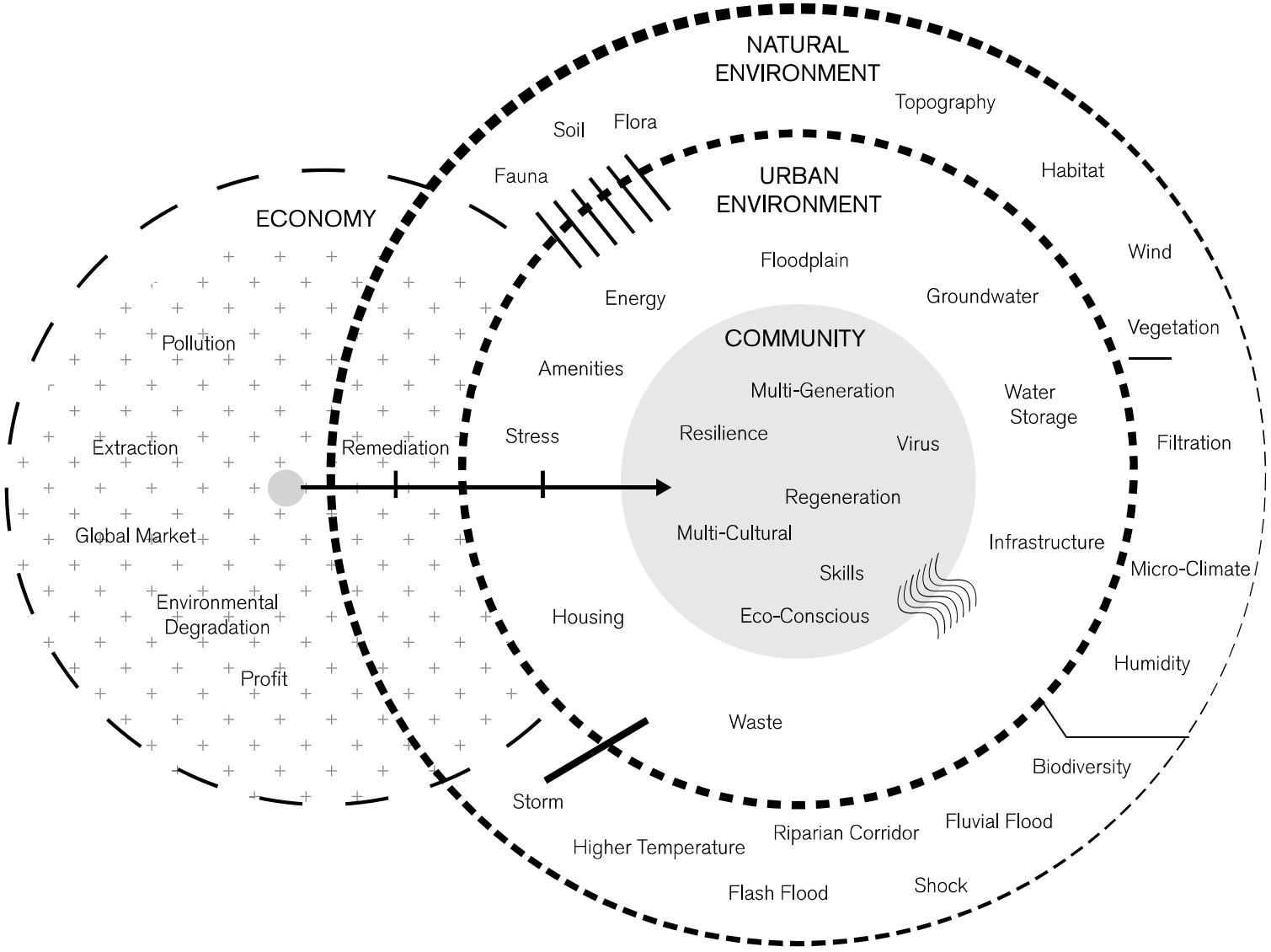
We are in crisis: a health crisis, a social crisis, an environmental crisis. All three have exposed systemic limitations, socioeconomic inequalities, and ecosystems collapse. We need to fundamentally reposition our priorities if we are to ensure the sustainable prosperity of the human race on Earth. Now that we have considerably colonized communities, exploited landscapes, and asphyxiated species, how do we transition toward a new era? One where creation does not imply destruction. Where do we place ourselves in the restoration and revitalization of vital systems we have been dismantling for so long? What would be the priorities for a post-industrial, post-capitalist, post-egotistic era?

Today, we are seeing the limits of our economic neoliberal capitalism. A system we have superimposed on the environment that does not favor well-being but profit, that does not ensure multi-species cohabitation but furthers anthropocentric domination, that sees the landscape as a resource to be exploited as opposed to a habitat to preserve. The distinction we have created between economy and ecology - steaming from the same pre-fix |eco| from the greek oikos meaning house - implies our disconnect to the environment and the other living species with whom we share it. The Anthropocene, the current geological epoch, derives from the unprecedented changes human-activity has had on surface and subsurface environments. We have been living in an age of excess and seemingly infinite growth, where our actions favor short term gains over long term effects. The feebleness of our civilization due to the dependency of finite resources and chemical additives foreshadows a bleak future. We are now confronted with the reality of our impacts and must imperatively shift our way of seeing our environment as a precious and unique space that needs nurturing. After an era of destruction, we are in need of an era of regeneration.

Tomorrow, we must play an active role in revitalizing landscapes we have so profoundly affected by integrating our way of life in the larger ecosystem. We must significantly alter what we have been building, and rethink what we will build tomorrow. We are in need of a reconsideration of how we extract, cultivate, use, and dispose of our resources. A regenerative system based on moderation and optimization and integrated with eco-logical processes as oppose to eco-normative ones is critical. We are in need of a shift in our modes of production and consumption, which reflects the reality of our planet's carrying capacity and which strongly considers ecological and social apparatus. A formalized decolonization of ecosystems and communities is needed to alleviate capital-minded perspectives and foster local generational resilience. An era of social justice where we strive for equity and celebration of multi-culturalism as oppose to global hegemony. An era where differences are not feared but seen as a strength. One where native and low-technology practices are looked upon as innovative and integrated into high-technology advances. We must learn from hybrid living models and apply them to our disoriented present to achieve a symbiotic future for all species on our shared planet.

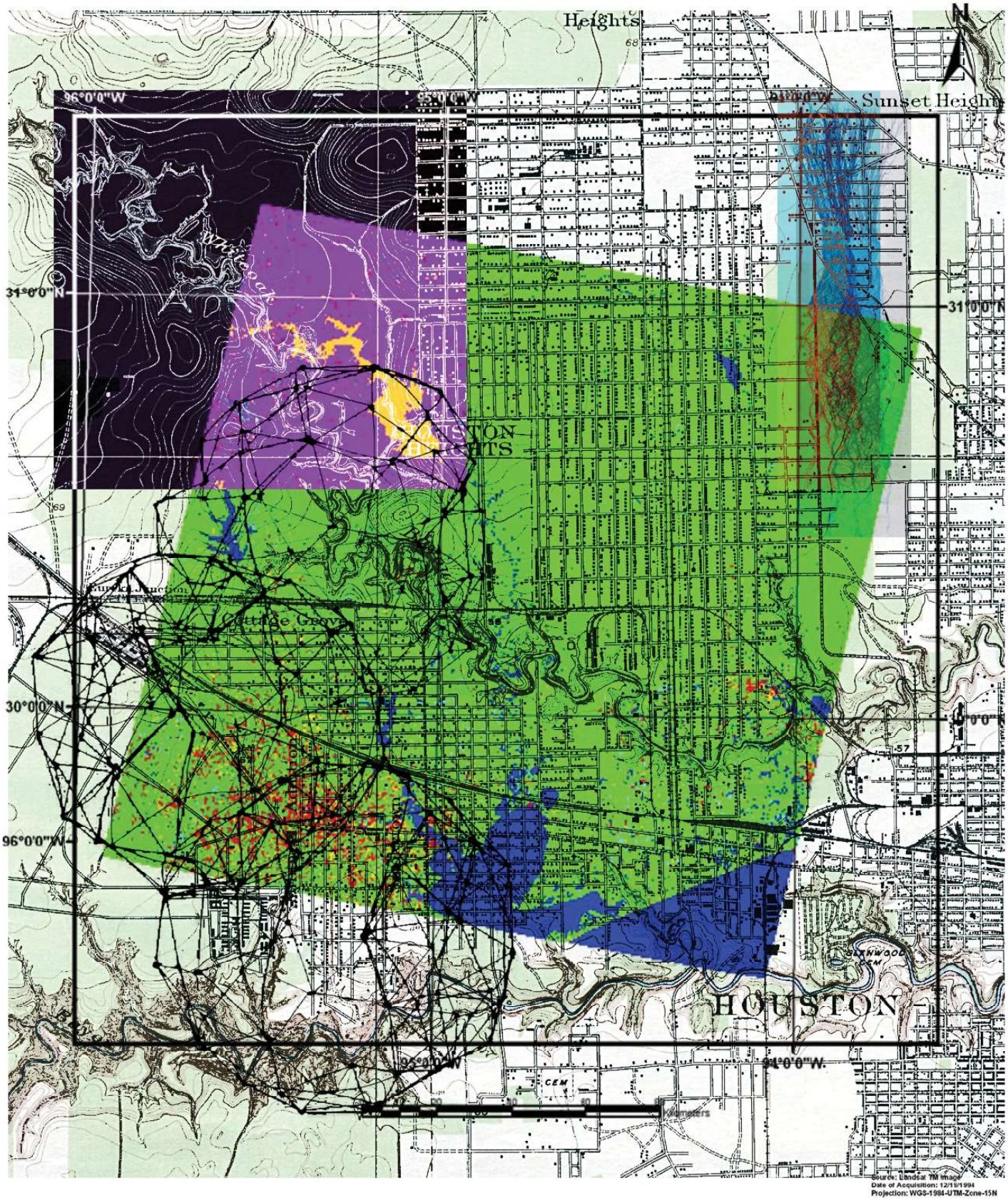
This is a call for a transition toward

symbiotic living
equity and stability
durability and circularity
flexibility and resilience
and active local regeneration



Schematic Relations Diagram

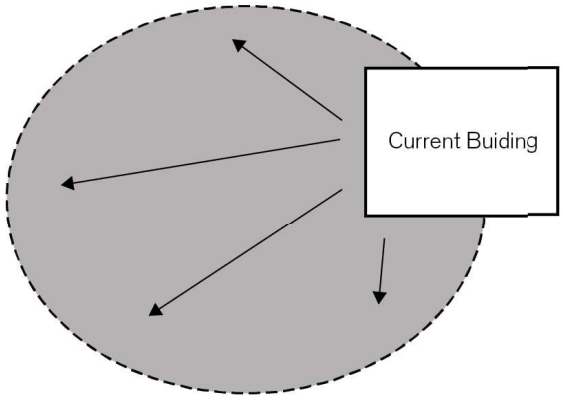
Placing current and future processes which should shape ecosystems and communities in the natural and urban envrionments.



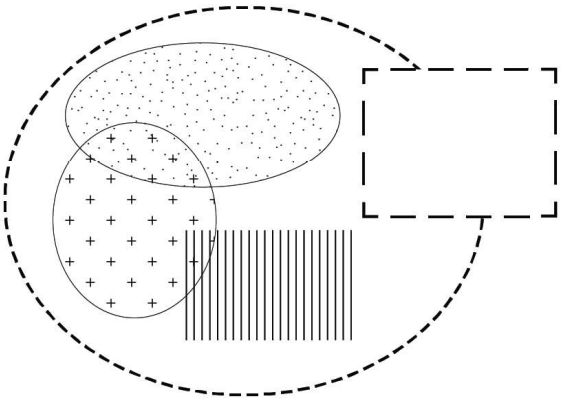
Houston's New Land Surveys

An image representing a cross-temporal and cross-scalar ecologically sensitive analysis of Houston's urban development and expansion using low and high technology available.

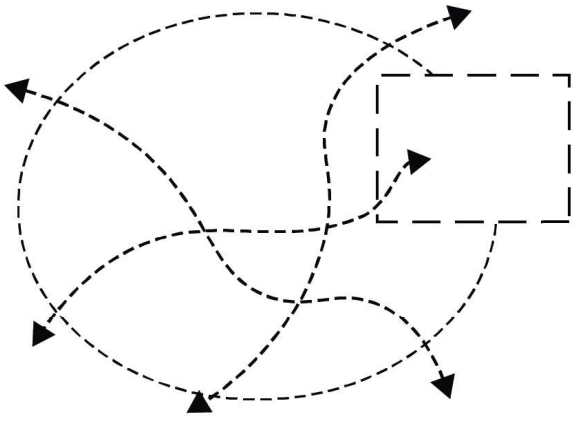
Spatial Guidelines of Industrial Shift in Harrisburg/Manchester



Extended Sphere of Influence

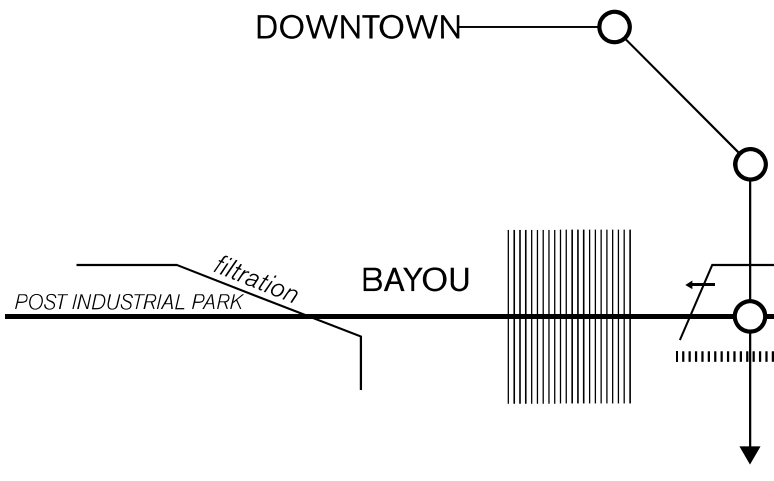


Multi-Benefit Community Space



Fluid Mobility

From Economic Spaces
To
Community and Ecosystem Spaces



Conceptual Section of Localized and Eco-Sensitive Economic System

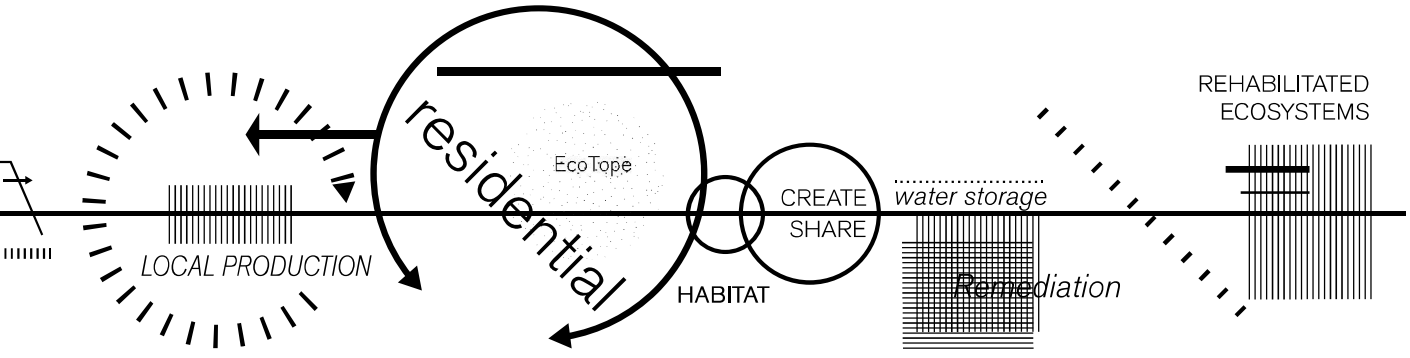
Eco-Tropic Communities

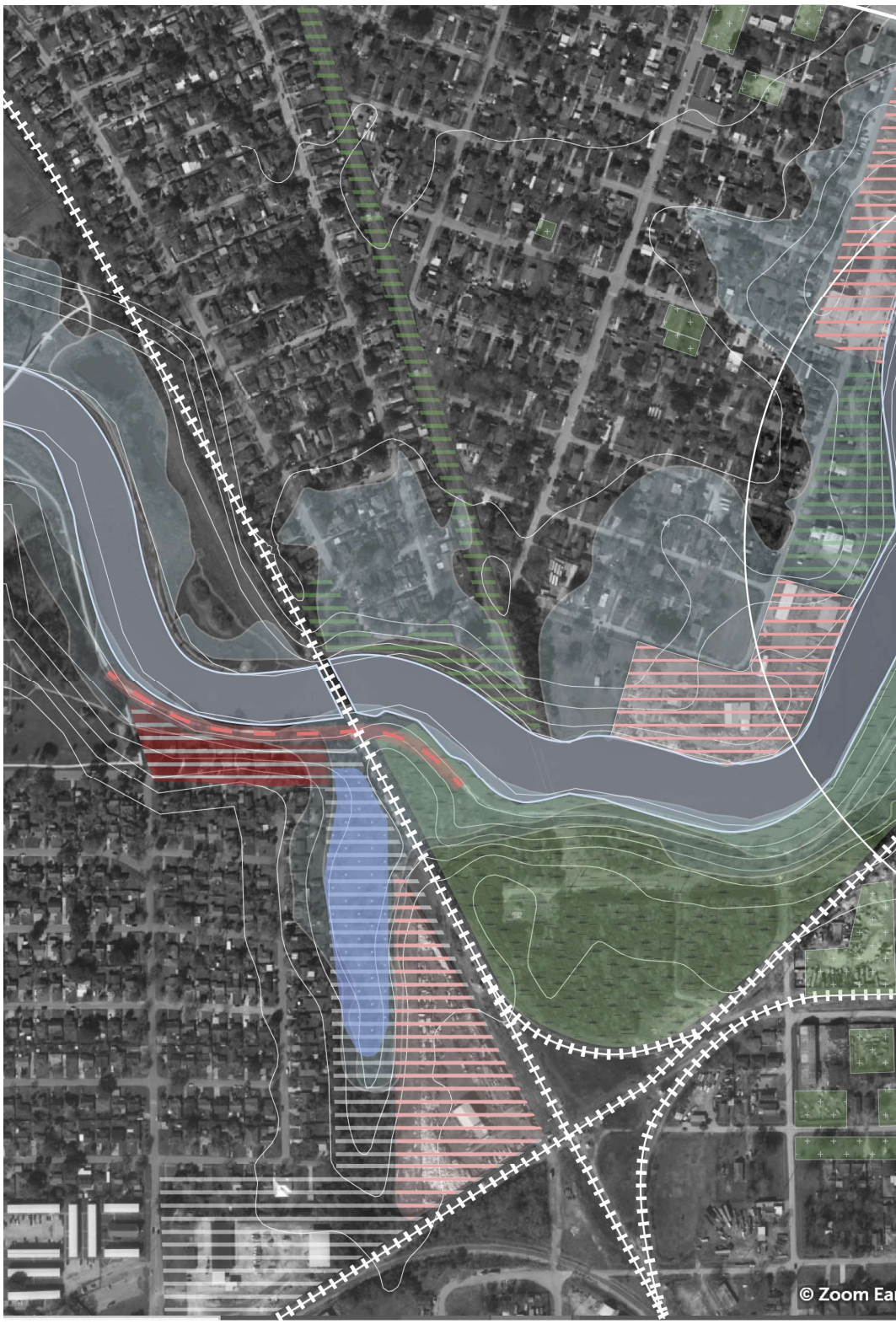
Makers in an Eco-Responsible Community of Harrisburg/Manchester

Transition Industries
To
Empower Communities
To
Restore Ecosystems
To
Ensure Resilience

Informed by data and research-based analysis, inspired by scenarios and existing conditions, this design proposes a post-fossil fuel, pre-self-sufficient neighborhood at the confluence of two bayous. By converting existing light industries and businesses in the neighborhood to community-enhancing services, Harrisburg/Manchester becomes a prototype for new self-serving communities. Open-space adjacent to business becoming hubs of community production, knowledge sharing, and inter-generational bond. Past fossil-fuel-based industries that once occupied the bayou edges have been dismantled and lands on which they once stood are now being rehabilitated into ecological hotspots. Alleviated from industrial and urbanization stresses, the landscape is most capable of withstanding shocks such as intense rain events. Communities, now better protected by the natural system, have become more resilient as they intricately integrate their lifestyle into this larger ecosystem. Humans now play an active role in ecological processes by giving flora and fauna space to develop and thrive and by basing their daily needs on a more circular and low-tech production. This project exemplifies what an eco-community filled with active eco-system members look like in a city like Houston, Texas.

Hadrien Cassan





Problem Statement Map

This map highlights the main problems and opportunities concerning a shift from globalized to localized industries. The bayou edges have been considerably colonized for global trades of goods and oil. These industrial complexes are large contributors to habitat fragmentation, subsurface pollution and bad air quality. The state-wide industrial rail infrastructure network considerably disconnects various communities at a local scale. These neighborhoods have not been particularly invested in and are therefore punctuared by many vacant and derelict lots. Amenities here are limited and of particularly poor quality. The following design is concerned with how these limitations can serve as a starting point to revitalize forgotten communities?

- Highly Polluting Industry
- Housing in Riparian Corridor
- Remediation Site
- Vacant Lot
- Natural Ravine
- Bayou

N

0 100 m


rth, Microsoft



Current Light Industry Map

Local Businesses which can be harnest to
create a more resilient community landscape.

- Food
- Cultural
- Sales
- Light Manufacturing
- Industries to Displace



















Pallette of Signs of Existing Businesses

CONVERSION OF SINGLE-FOCUSED INDUSTRIES INTO MULTI-USE COMMUNITY HUBS

CONTRACTOR → BUILDING HUB

CATERING → URBAN AGRICULTURE HUB

CAR REPAIR → MULTI-MOBILITY HUB

EVENT HALL → GATHER AND SHELTER HUB

ART CENTER → MULTI-CULTURE HUB



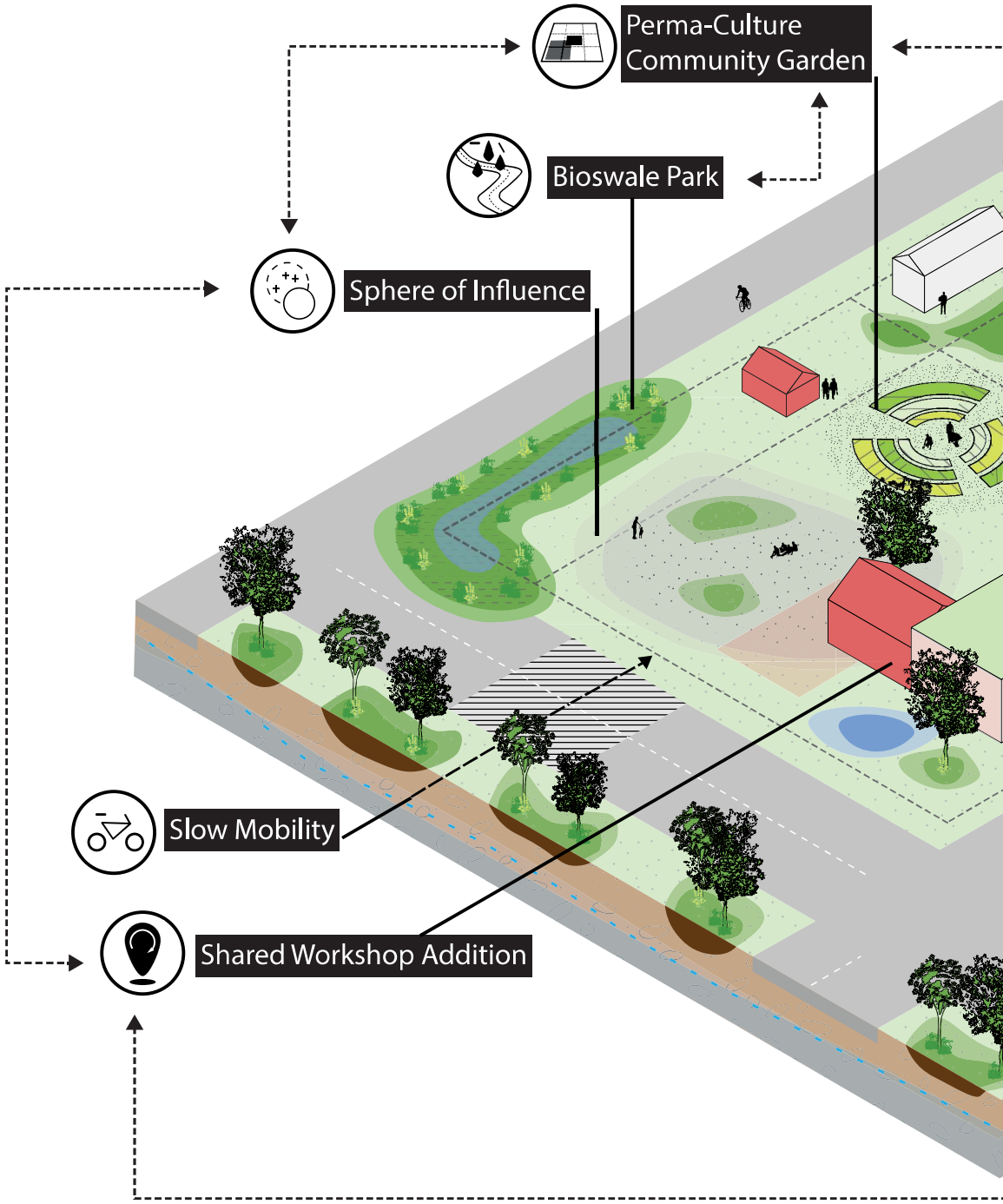
Intervention Map

This map highlights the potential open spaces that businesses can start spreading on to as public amenities for communities and species - these spaces are now converted to multi-functional hubs influenced by the adjacent building program. Due to a city-wide switch in business model (from global trade to local production), the bayou edges are alleviated of industrial stress and can be rehabilitated into active riparian corridors and nature reserves.

N

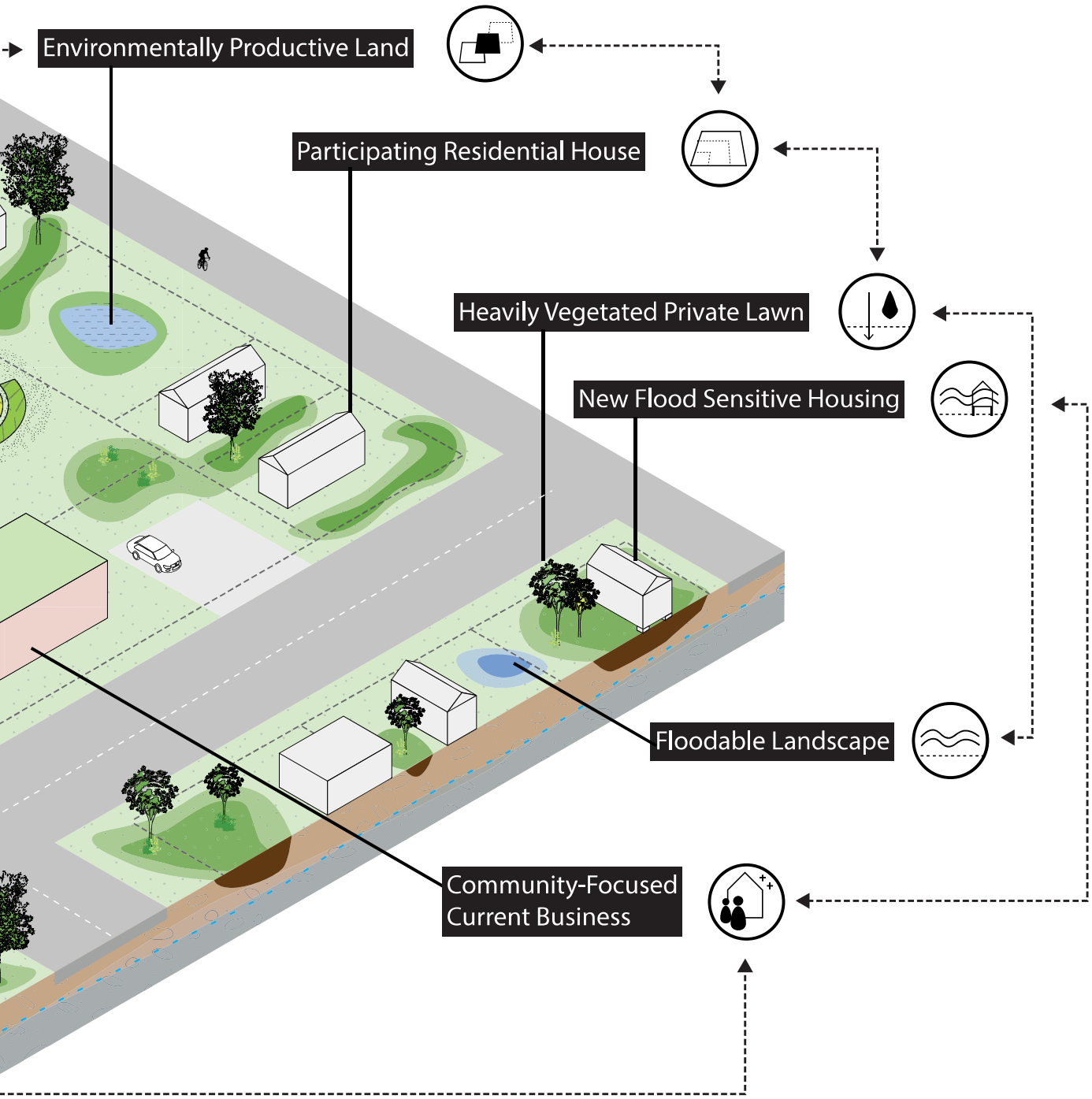
0 50 m





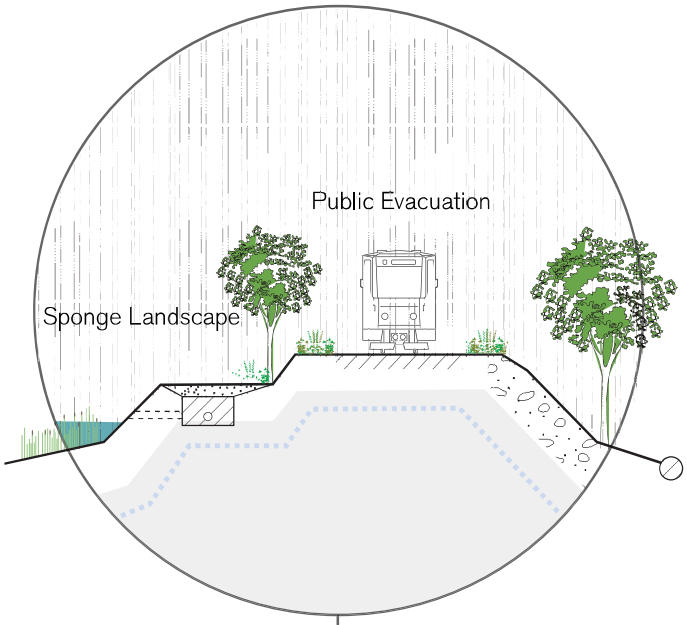
Modified Block Isolated Isometric

A new block where open space becomes activated by communties and ecosystems through the platform the local business offers. Striving for self-sustaining, a perma-culture garden serves the few homes of the block and serves as a key habitat for diverse species of birds, mamals, and insects.


Environmentally Productive Land
Participating Residential House
Heavily Vegetated Private Lawn
New Flood Sensitive Housing
Floodable Landscape
Community-Focused
Current Business

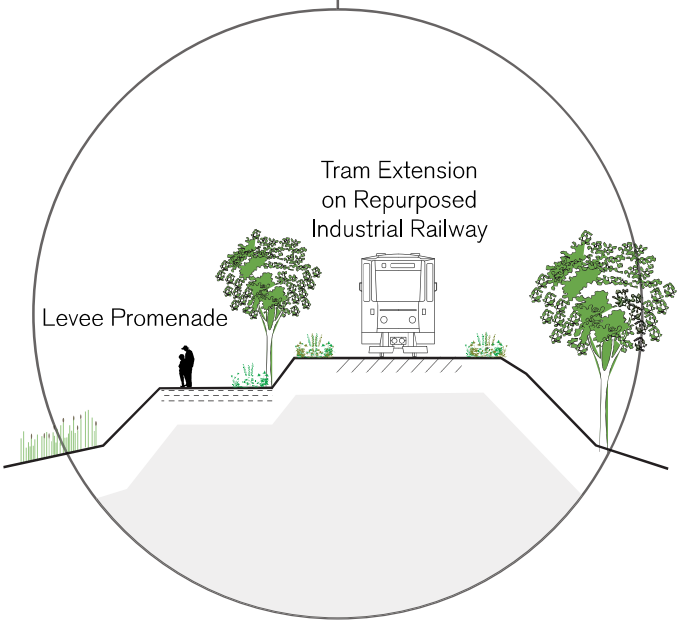
Section Zoom-In (Rain)

During an intense period of rainfall, the landscape transforms into a water management focused environment. Collection, retention, filtration occur in all areas of the neighborhood, from the road to the lawn, to the building.



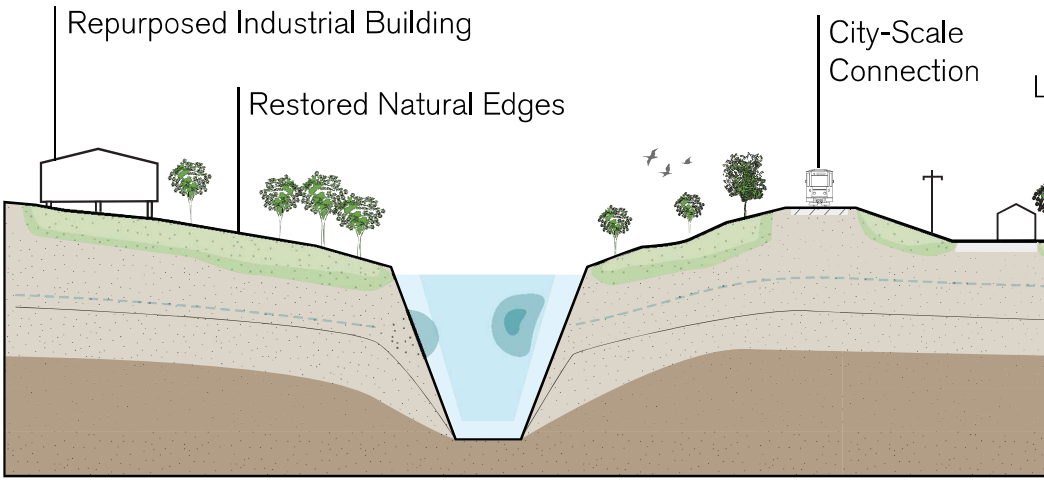
Section Zoom-In

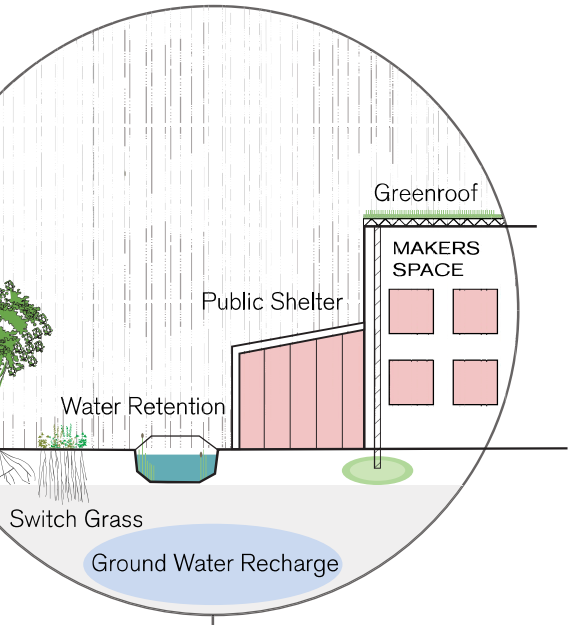
On a normal day in H/M lands have become productive for communities and ecosystems, the new tram line now connects the neighborhood to the larger urban area, the waterfront edges have become striving eco-leisure hub.

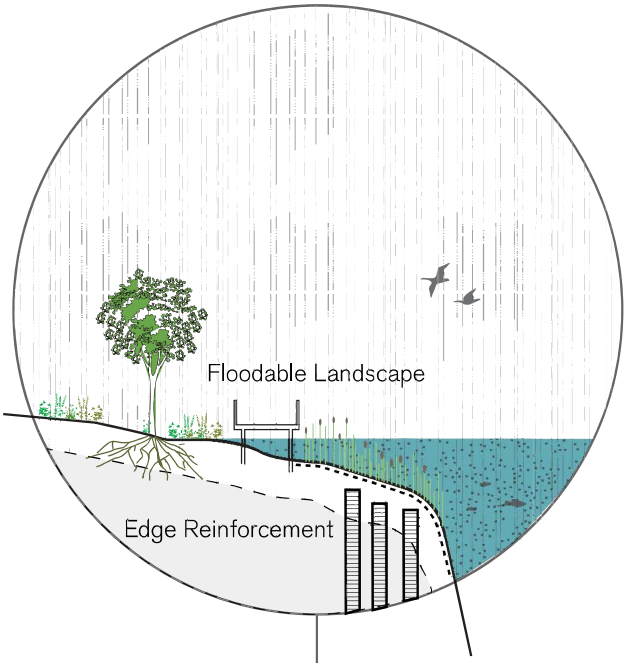


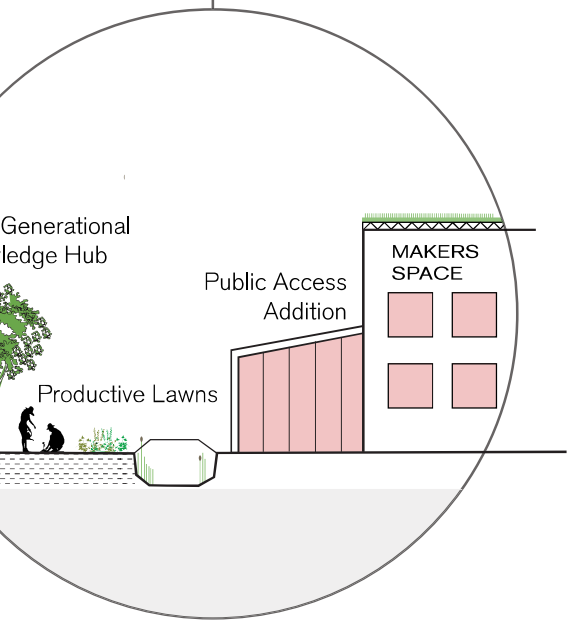
Section

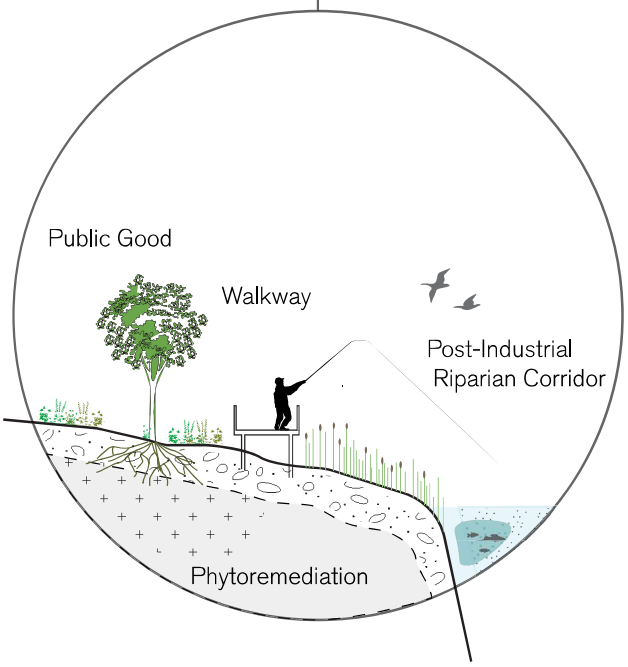
A section crossing the peninsula of the neighborhood. This drawing shows the rearrangement of the neighborhood amenities, the restoration of the current industrial edges and the main subsoil processes.

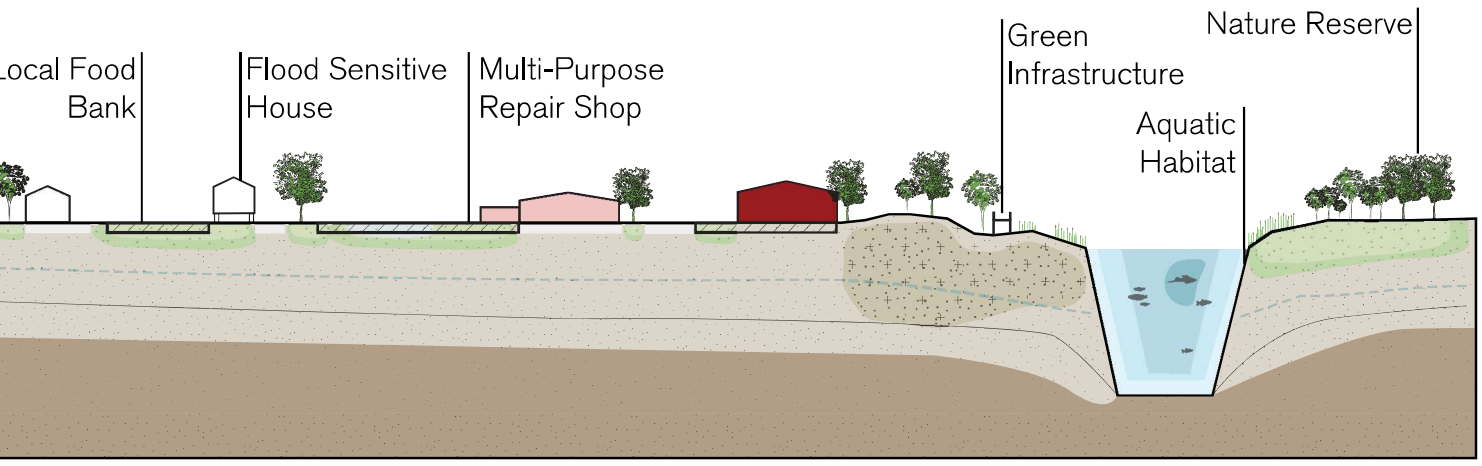



Greenroof
MAKERS SPACE
Public Shelter
Water Retention
Switch Grass
Ground Water Recharge


Floodable Landscape
Edge Reinforcement


Generational
ledge Hub
MAKERS SPACE
Public Access Addition
Productive Lawns


Public Good
Walkway
Post-Industrial
Riparian Corridor
Phytoremediation


Local Food Bank
Flood Sensitive House
Multi-Purpose Repair Shop
Green Infrastructure
Aquatic Habitat
Nature Reserve



Activated Lot

Here a vacant lot has been transformed with the help of El Jardin Restaurant into a striving urban garden for community members to cultivate, and enjoy.



Activated Building

Sergio's Auto Sales has been retrofitted into a beacon of DIY mechanics for the community. The street has heavily been modified to participate in water retention and filtration in times of heavy rainfall.


El Jardin


AUTO SALES
Google



Harrisburg Bridge

The post-industrial Brays Bayou is now comfortably re-naturalized activating new habitats for animals and people. The barrier which the bayou was once has become a shared public good crossed by multi-mobility networks.



Harrisburg Bridge (rain)

During an extreme weather event, the natural edges serve to slow down water discharge and facilitate infiltration. Hybrid infrastructure elements aid the natural soil to withstand the shock and prevent corrosion. And the large mobility networks have become safe haven connectors.







Multi-Species Bridge

This bridge serves as a social and environmental connector between species on both sides of the bayous. The tram network connects anthropic groups around the City of Houston. The green corridor serves multi-species and limits habitat fragmentation.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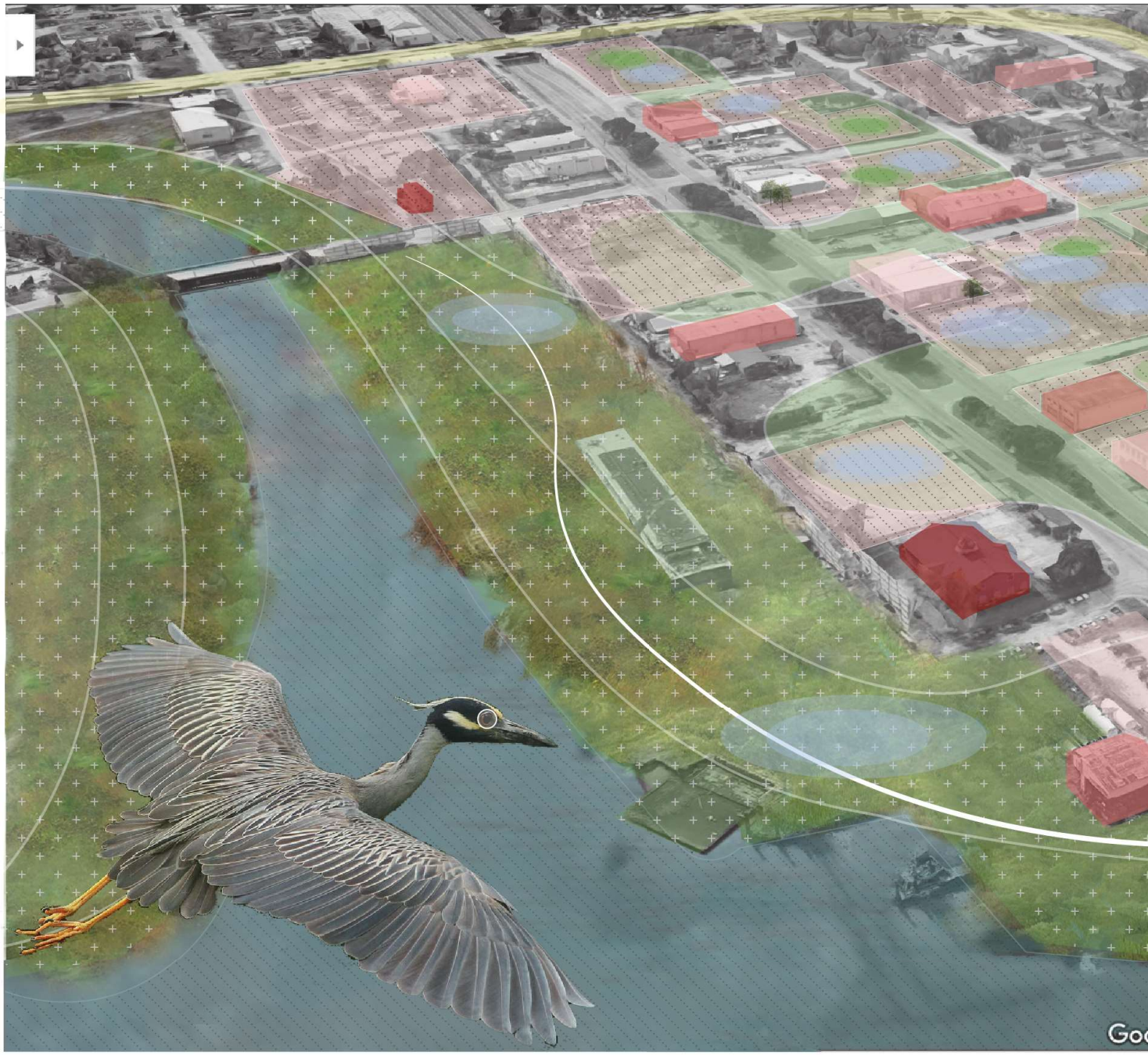
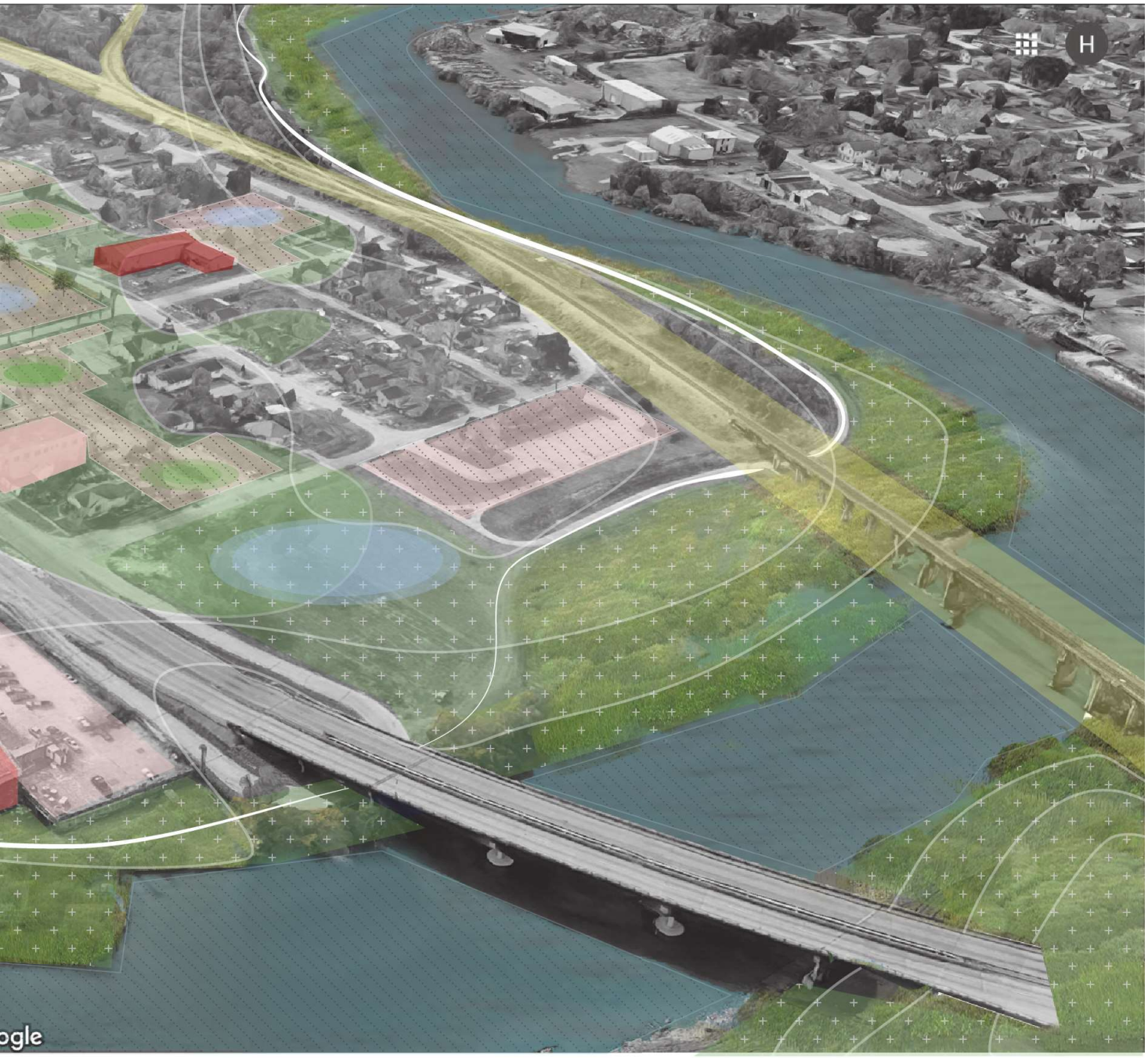


Bird's Eye View

An overview of Harrisburg/Manchester where ecosytems have been revitalized and industries localized for the benefit of communities.


H
ogle

Living with bayou

Baokun Wei

Manifesto

It is the time to rethink of the relationship between human being and bayous for every Houstoner.

Houston, as the city for bayous, has always been enjoying the essential benefits and valuable gifts from bayous: It offers wild landscape and natural habitat simultaneously with abundant biodiversity; It offers convenient transportation network for transporting rich oil resources; it offers healthy, beautiful social space for having diversified leisure activities. However, urban sprawl and infrastructure expansion has exposed and exacerbated inherent conflicts between human and nature- compound flooding. The extreme climate,such as hurricane Harvey, deeply revealed the vulnerability of Houston.In response to the extreme flooding, it calls for the eco- participation to transfer the bayou edge to a protective and adaptive landscape while providing locally needed recreational, ecological and socio-economic benefits at all levels.

The conflicts emphasizes the relationship with nature and human being, which puts the nature first while considers social behaviour and issues at the same time. By reclaiming bayou and surrounding green space as an integrated system. We, as the bottom up niches, will regard the resilience as the most important priority for planning participation, acting locally and shaping our community into this new system. For natural resilience improvement ,the ecology is no longer a luxury rather than a necessity. In that sense, the local habitat will be preserved; the migratory habitat will be enhanced;the biodiversity will be increased; water will be purified.Additional, after suffering from extreme flooding, the natural system will be bounced back as soon as possible. For social resilience improvement, we dedicate to explore self-sustaining methods with productive landscape. Furthermore, we will increase the aesthetics and cultural activities to endure and recover from life stressors and social segregation. Social resilience will be improved to response under several extreme scenarios, such as Harvey storm and COVID-19 pandemic.

In Harris burg/Manchester area, it will exhibit a model for robust community living with bayou. It will introduce a series of natural elements to invest in the resilience in terms of both natural and social resilience. Our space will be focused more on green space close to residential plots,and also vacant place within residential plots where both natural and artificial intervention could be merged together for natural recovery and self-sustaining. It aims to introduce the green space to community while eliminate the boundary of landscapes which are divided by infrastructure and stitch them into a complete system. The most interesting, inspiring and innovative part is that we try to pursue new balance between human and nature by establishing multiple links.

Urban Scale

BaokunWei










Challenges and opportunities

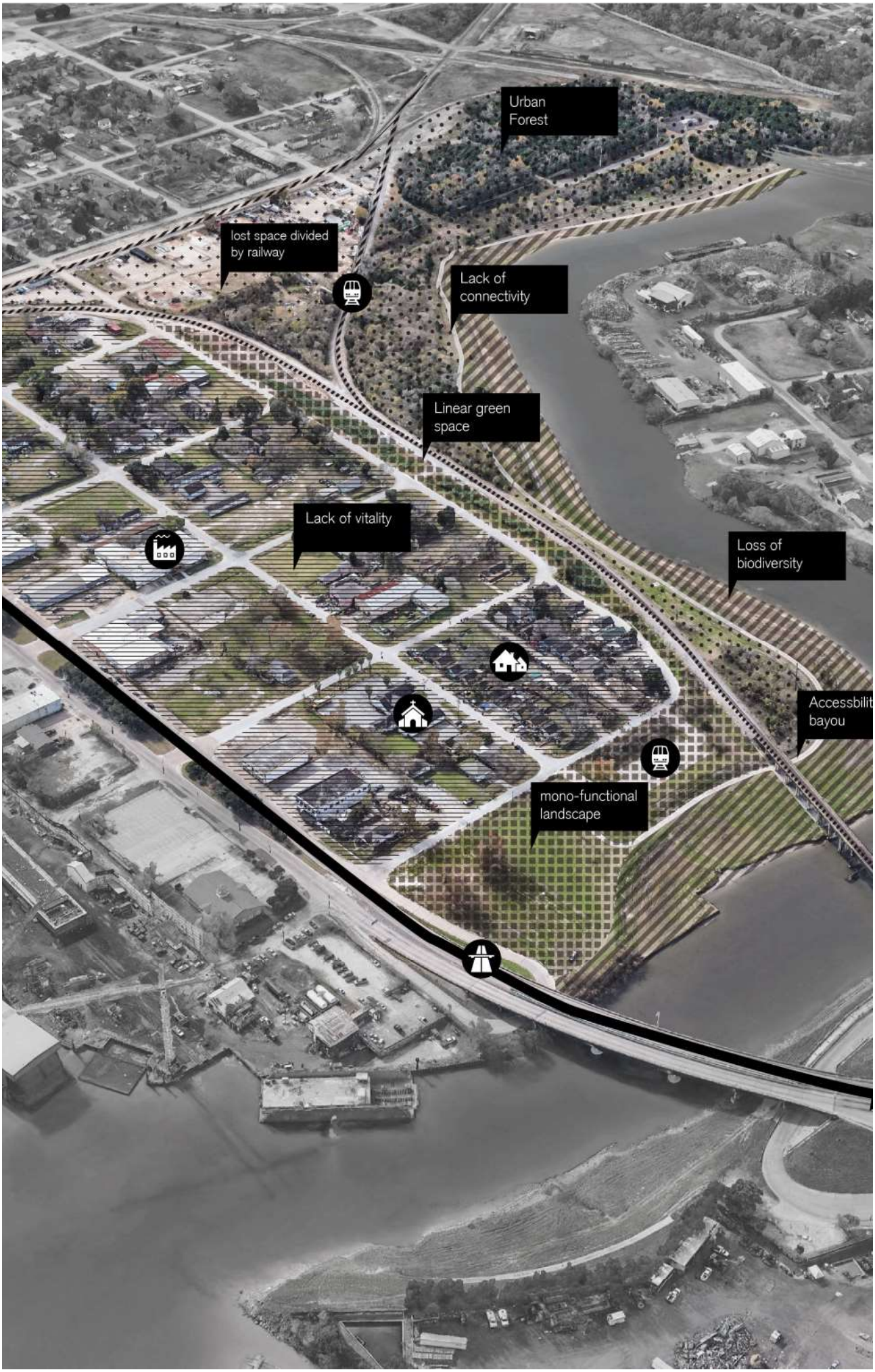
In Harris/Manchester, there are both challenges and opportunities.

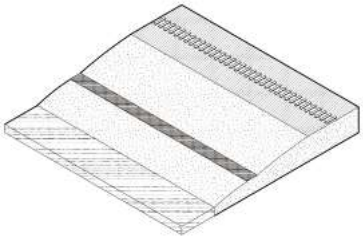
Firstly, the site is divided by infrastructure. Several railways has cut it into different pieces, causing fragmentation of the landscape.Original, uniting bayou has separated from the residential compounds. Due to that, the connectivity and accessibility is lost. Moreover, most of bayou edge along Harris/Manchester has been dominated by homogeneous and mono functional landscape. In that sense, there is no rich biodiversity. A lost space has been created by infrastructure as well and it forms a clear boundary between the urban forest and residential plots.

In terms of the community, except from the disconnection to bayou, there are many vacant plots existing in compound. Most of this places are under-used and lack of vitality. According to the previous analysis, there is a large percentage of low income people living in this neighborhood. The community sense and community participation is also an essential challenge.

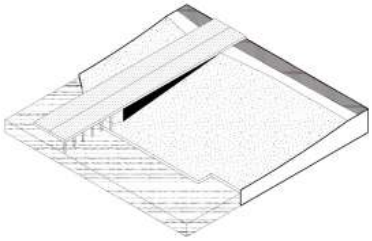
The assets of the Harris/Manchester are also obvious, urban forest, the church(main public building or community center) and vancant places in residential plots. Even though landscapes have different qualities and performances,the opportunity to reunite them into integrated system is still there. By grabing the opportunties, the design will try to improve both soical resilience and nature resilience.

From the analysis, it concludes that problems and challenges from different aspects. The design should target at solutions of these challenges.

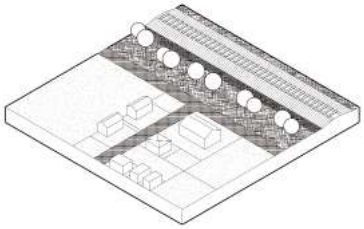

Urban
Forest
lost space divided
by railway
Lack of
connectivity
Linear green
space
Lack of vitality
Loss of
biodiversity
Accessbilit
bayou
mono-functional
landscape



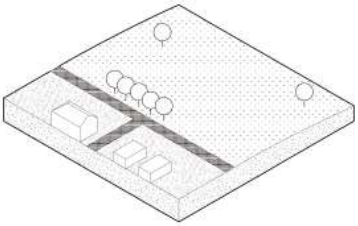
type1: bayou bank



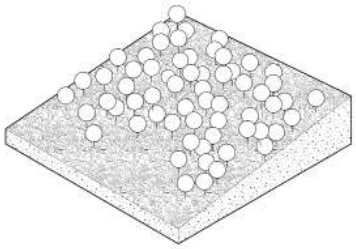
type1: bayou bank



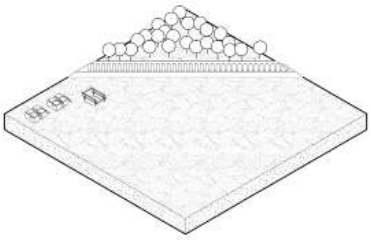
type2: transitional area



type3: residential plot



type4: urban forest



type5: vacant place

Fragmentation of landscape

From the map, it shows that the bayou has been divided into ioslated landscapes by different quality ,function and performance. There are five types of landscapes in this site, including: Vacant plot, residential compound,transitional area, bayou edge and urban forest. Each categroy has its own characteristics.

It notices that the edges between different landscapes are clear. There is no soft transition of two closed landscapes. Most of them are just divided by road or railway. Moreover, there is no buffer zone and no area where animal and human can interact together. Due to that, it is import to think of how re-integrate the different landscapes into united system? How to create space for nature(animal) and human separately and space for them to interact together? How to break the edges and add soft transtions of eco-tones? these questions could be the core of design experiments.

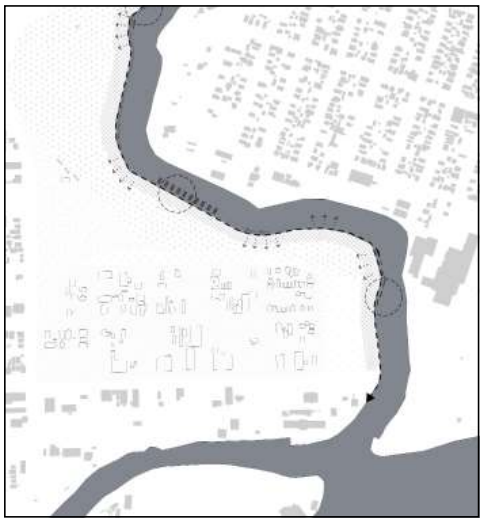


Vacant plot
residential compound
transitional area
bayou edge
urban forest

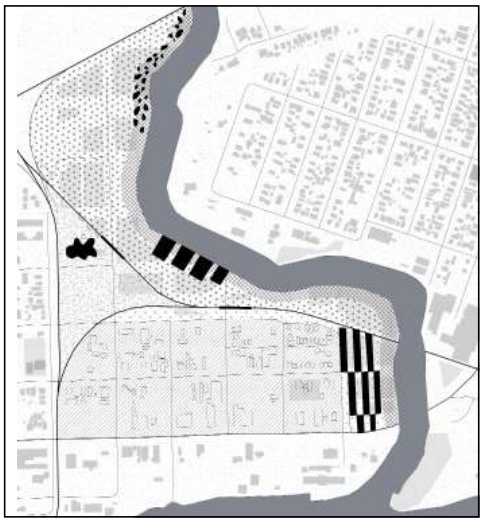
Design Concept

+Systematic Intervention

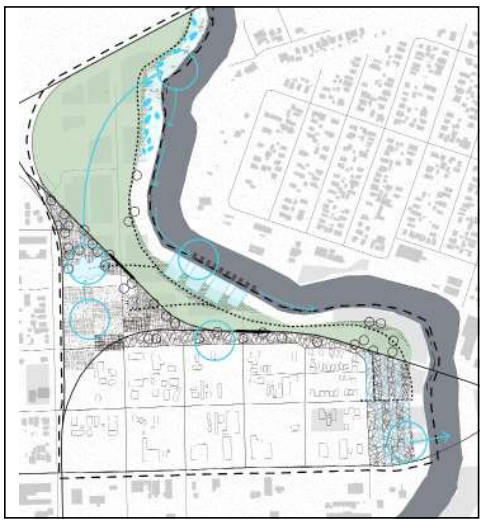
In my concept, I propose a new way to re-integrate the different landscape typologies together by providing a soft transition between edges and improving connectivity as well. In order to achieve the goal, the concept will be explained step by step. Firstly, the part of water canal will remove the concrete surface and give it back to nature. Becasue of that, the water bank will be enlarged and remained in cove shape in some extent. Along side the water canal, small biodviersity islands are provided as the animal habitats. Next, introducing a series of water-related elements including wetlands, bio-terraces, rain garden and fish ponds for site to establish a complete water system. Green patches around the water elements will erase the hard edges between different landscapes.Then the strategy is to break the boundary of residential compound. Combing with pedestrain system and urban grids, the bayou green system will be reunite with human being. To achieve that, the streets are also green-blue infrastructure .The vacant spaces has been attached to the green blue infrastrcuture. Theyare diversified in the future in terms of use and activities. Along North-South direction road, there is a pollinator path as the main structure of proposed green-blue infrastructure(linear park)



enlarge bayou bank



water element



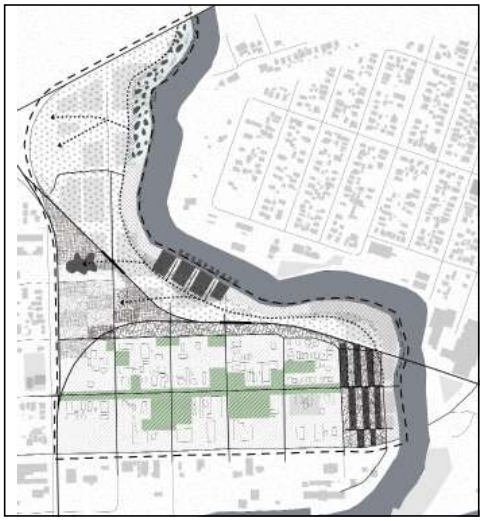
integrated system



green patches



green-blue street



plot design

Systematic intervention

1.pedestrain bridge



2.rain garden



3.greenway



4.fishing pond



5.aquaponic farming



6.biodiversity island



7.bio-terraces



8.farming land



9.pollinator path



10.bio-wale



11.new public space



12. plot pond



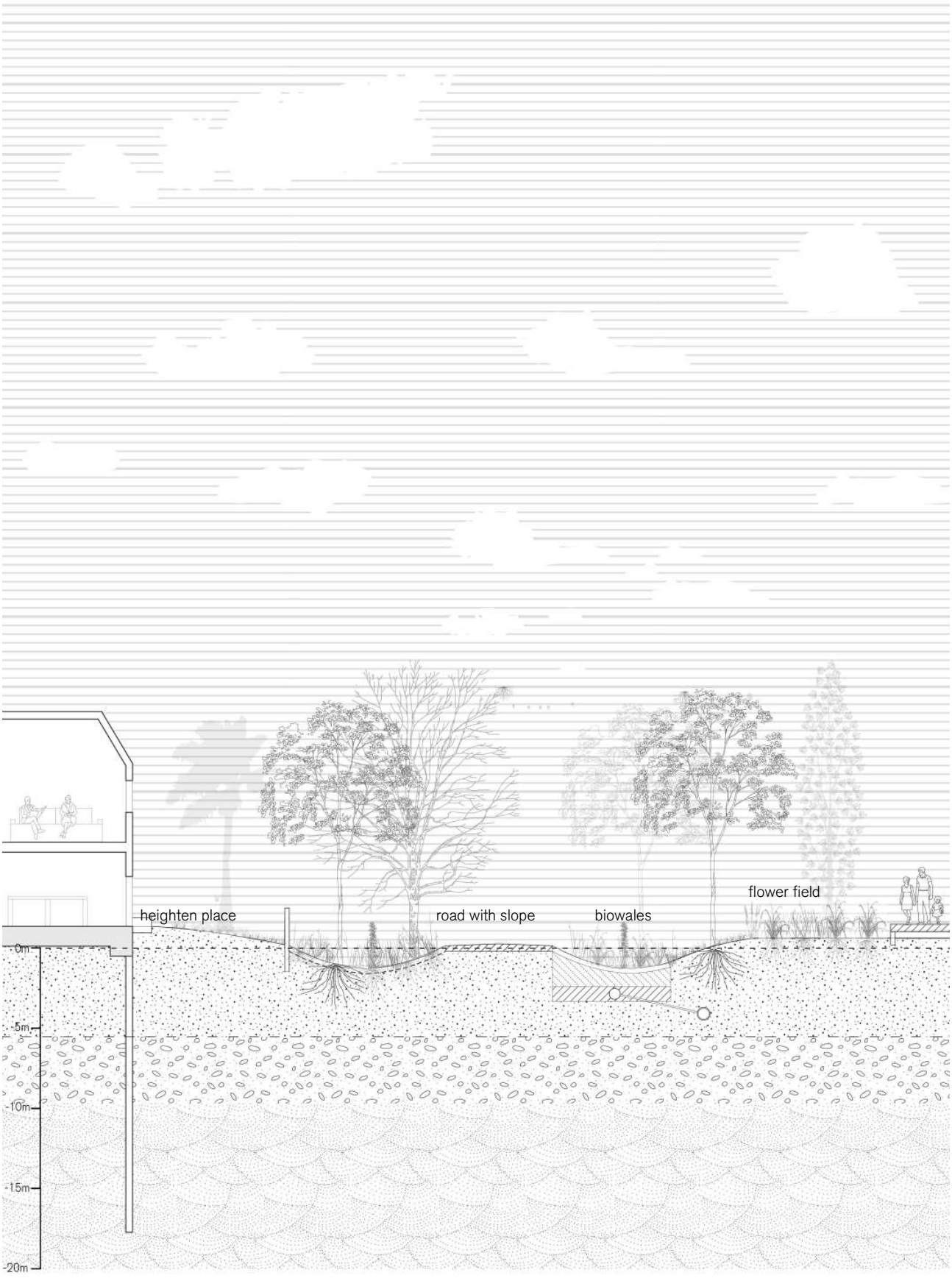


N

0 20m

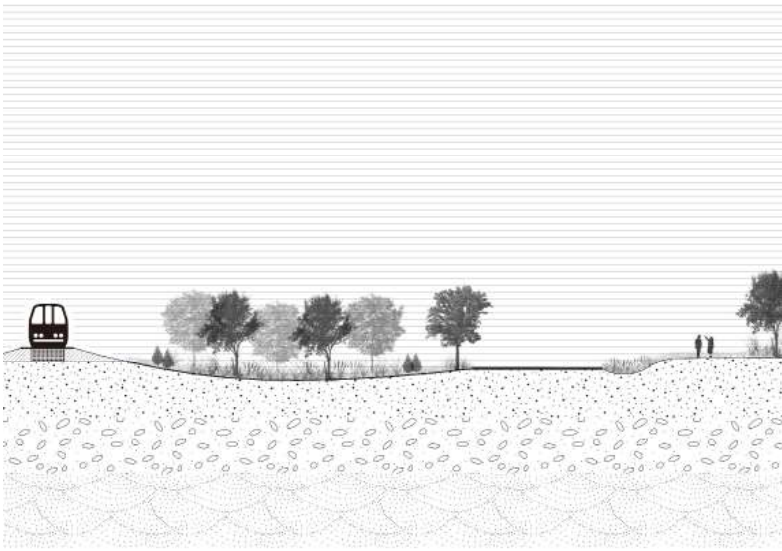
Technical Sections

the section at 1:500 scale shows different performance under different circumstances. It selects the backyard of residential plot and the closed transitional park. During the normal period, the nature can be used as the habitat for animals within different eco-tones. At the same time, human will attach to the nature as well. The open green space provides diverisfied services for people. The traditonal car and people-orientated zone will be transferred into people and nature orineted zone. Furthermore, it also shows the circumstance of floodings season. The park and the backyard is floodable when dealing with hazards. During heavy rainfall, the transitional park and biowales along street will be taken over by water. Also, the water level of the pond will increase. When the storm comes, all space is the room for water except for residential plot. The section 1:200 considers how to implment the water management solutios including the road, biowales and pollinator path


heighten place
road with slope
biowales
flower field
0m
-5m
-10m
-15m
-20m

Normal Time

a section represents new transitional area, new vacant plots and relationships between human and nature in order to deal with shock and stress



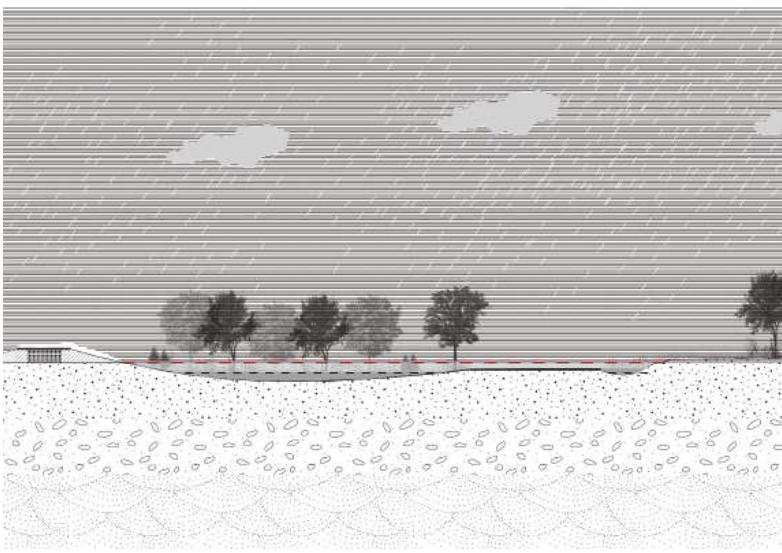
0 5 m

Shock-Rainfall

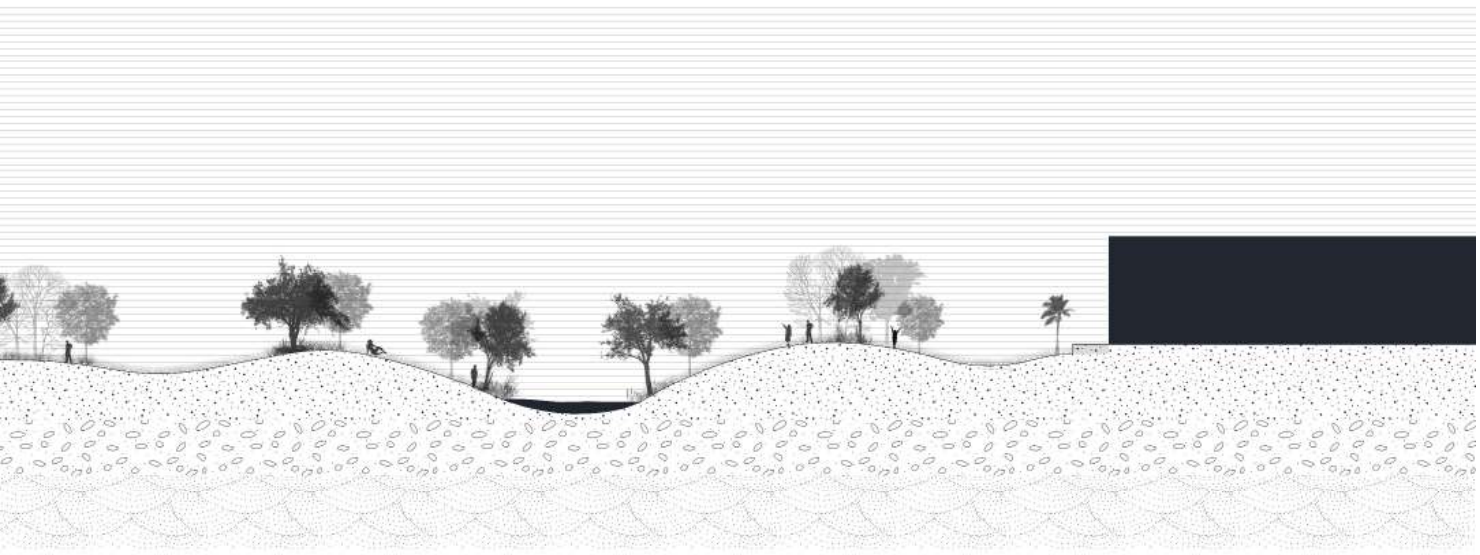


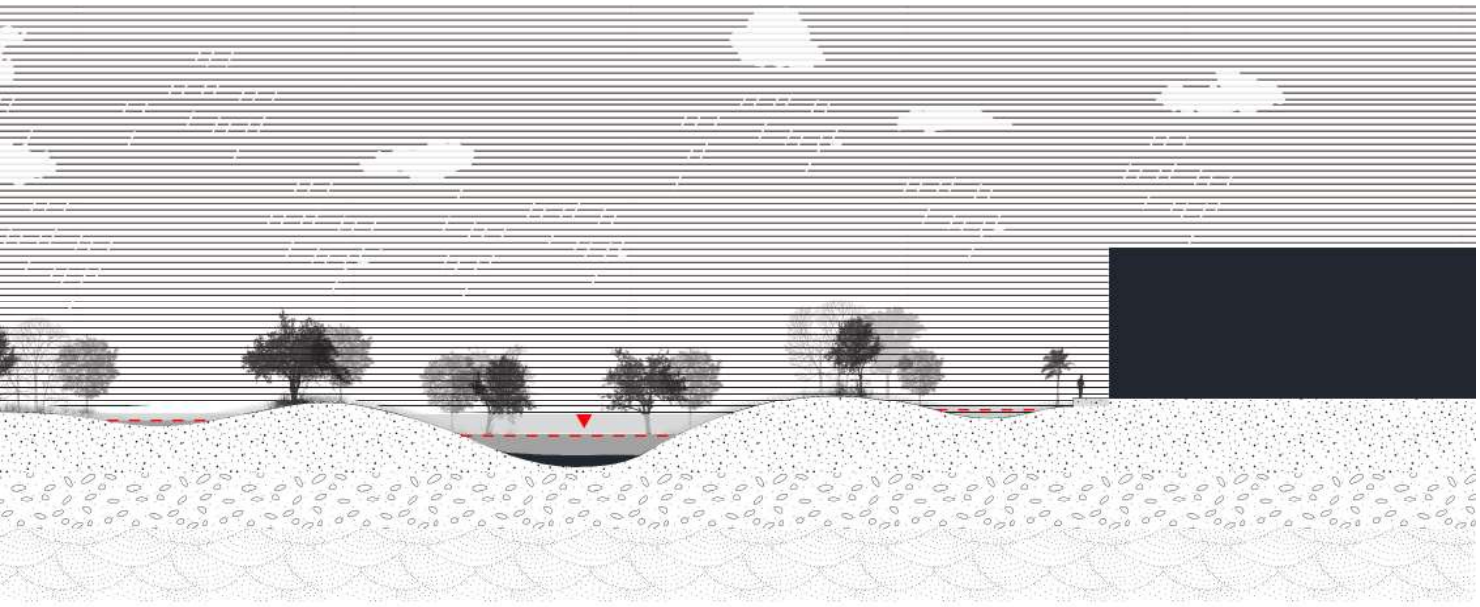
0 5 m

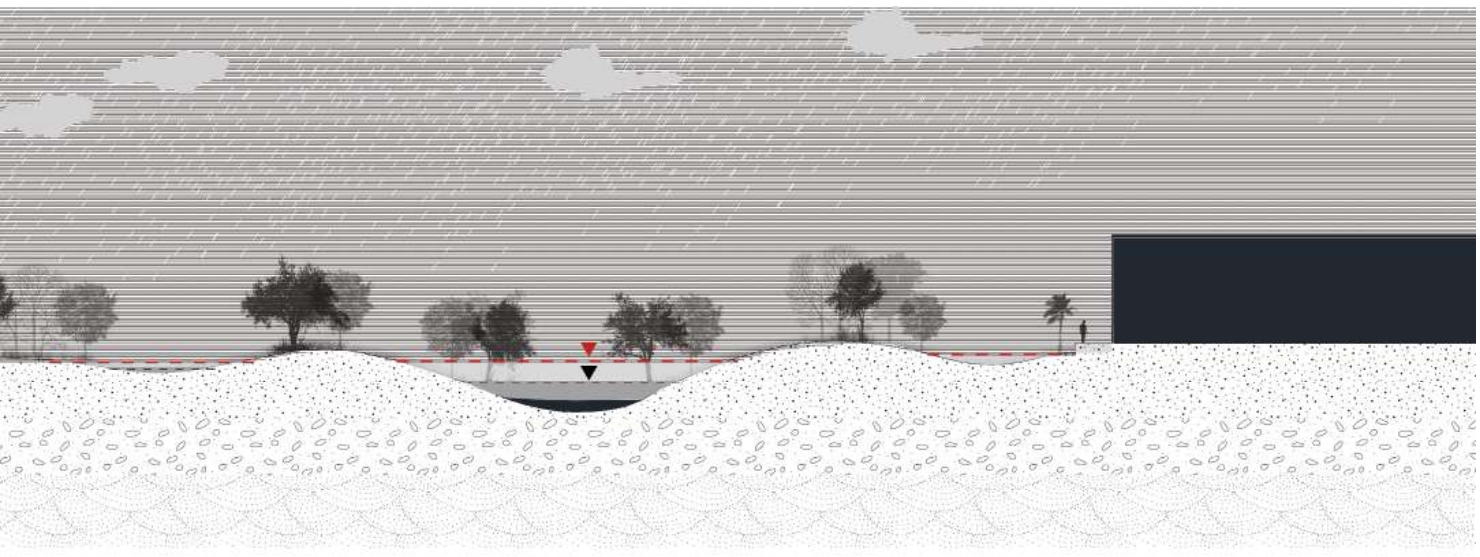
Shock-Storm



0 5 m







Nature Resilience &

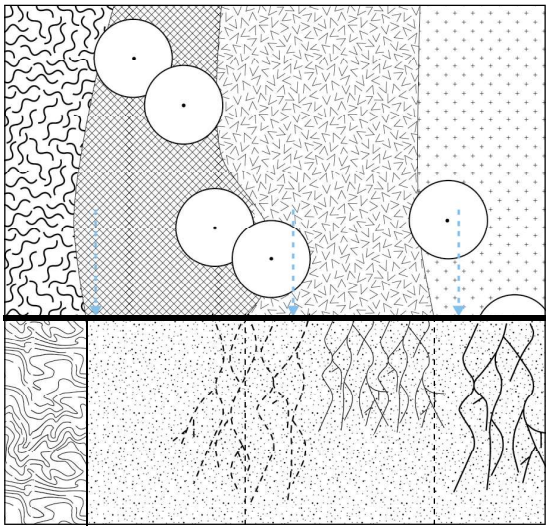
Soical Resilience

the community combines nature, agriculture and social elements together to form a healthy relationship bewteen human and nature.To put nature first, a rich and diversified green spaces has been re-introduced along bayou and gradually extend into residential plots. it has different gradient of landscape typologies to protect the local eco-habitats and biodiversity. You can see a very clear and soft transition from bayou to community(Martix- corridor-patches).It also refers to discuss how to design a self-sustaining community with all kinds of productive landscape. In addition, vacant spaces in community have been re-organized and re-used for different purpose such as local market, playfield and meeting place. In next, it will explain how nature and soical resilience will be improved through relative design guidelines

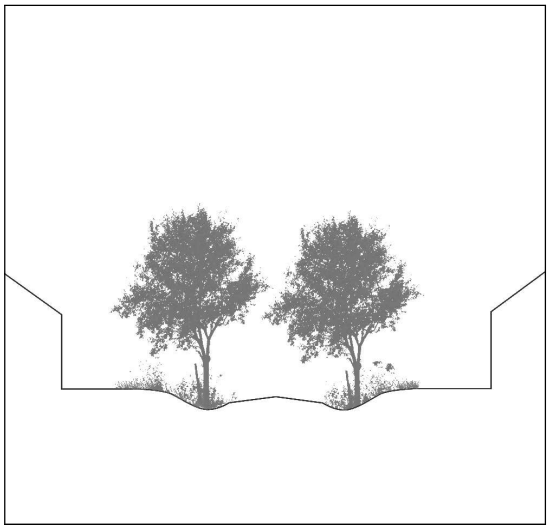


Nature Resilience

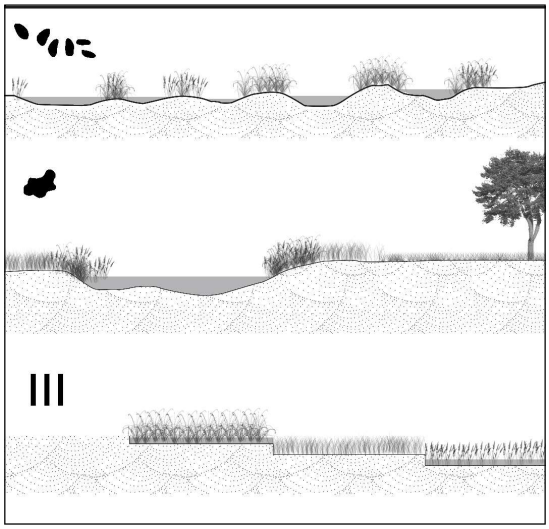
nature resilience mainly reflects on two aspects: the ability to mitgate the nature stress(water pollution, loss of eco habitat, loss of biodiversity) and shock(extreme flooding risk).In order to improve the capacity of nature recovery, it suggests to use native species as much as possible. Softing the edges of different eco-tones to create multiple habitats is another measure. In addition, for the water management, it adpots the concepts of sponage city idea. Wetlands, rain gardens and bio-terrace will help with water infiltration and water purfication. during the shock, it also could be the room for water. In addtion, in order to protect the biodiversity, it will build up a pedestrain bridge for habitat protection.Many green and blues infrastructure have been implemented for storm water management. They aims to protect the residential plots and give the community ability to recover from storms as soon as possible.



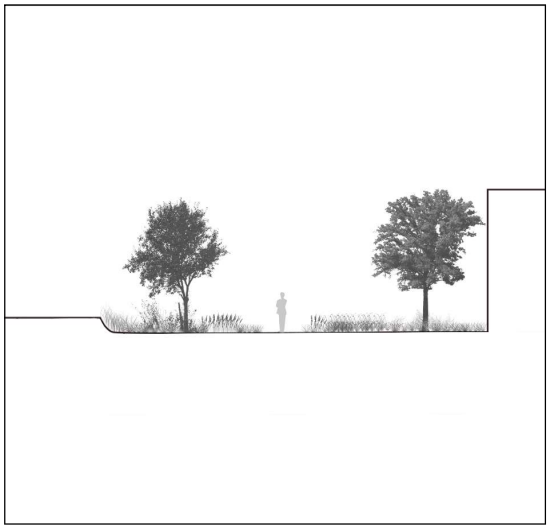
use native vegatation and related pattern to establish different habitat



green street to collect the rainfall by trees and biowales



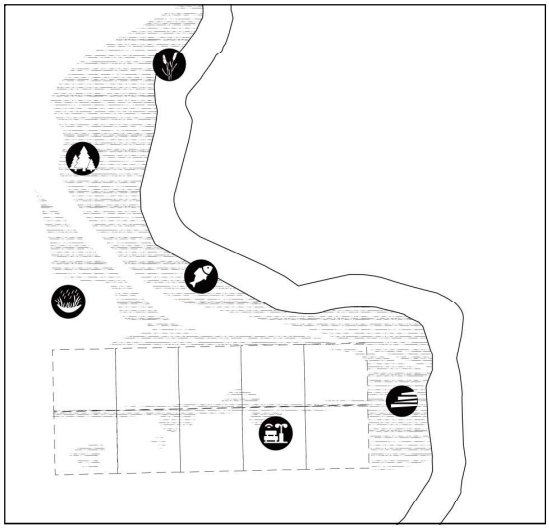
using wetlands, rain garden, remediation terraces for water purfication



linear park used as the room for water and also pollinator path



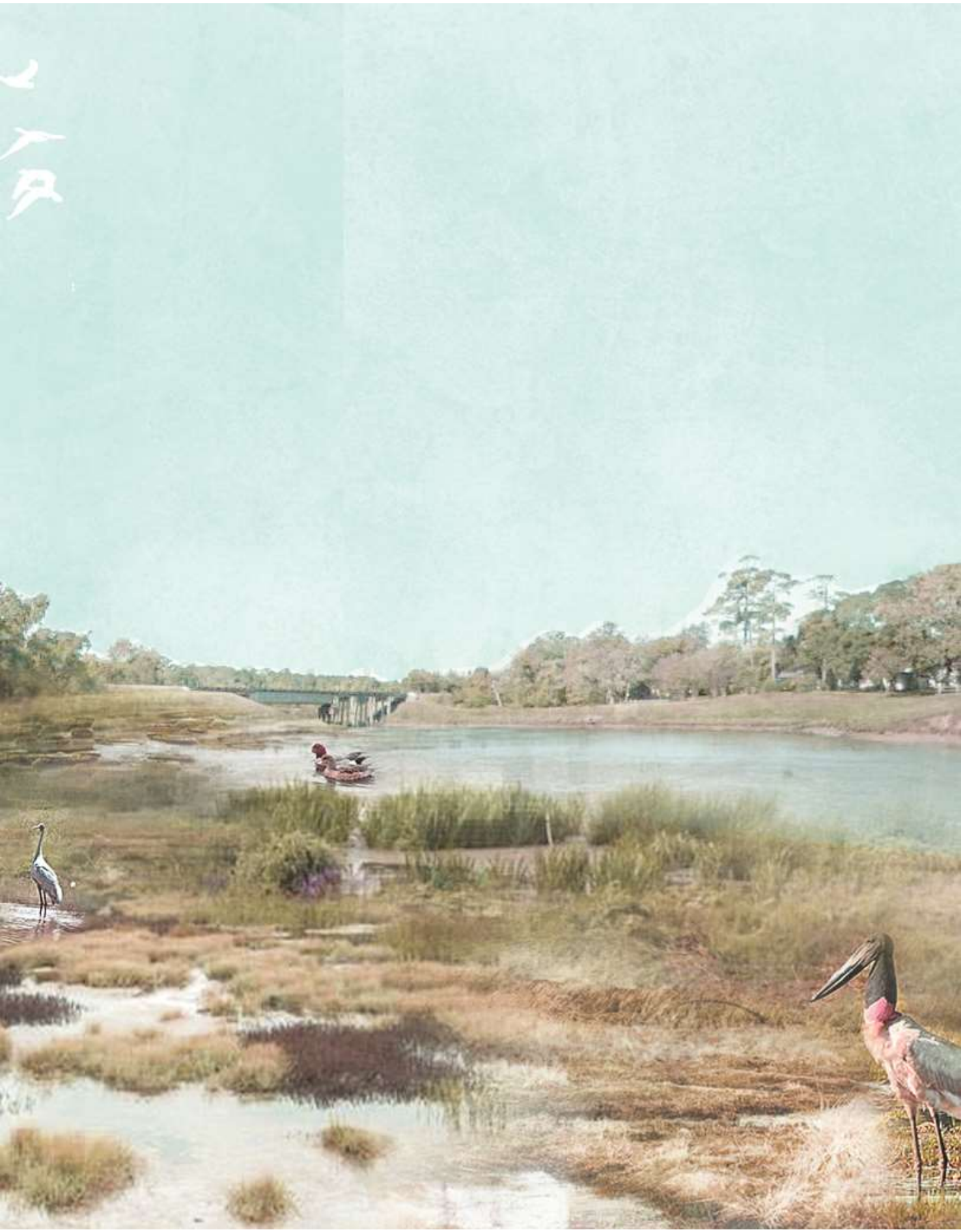
lifting the pedestrain path for habitat protection



floodable elements to protect the residential plots

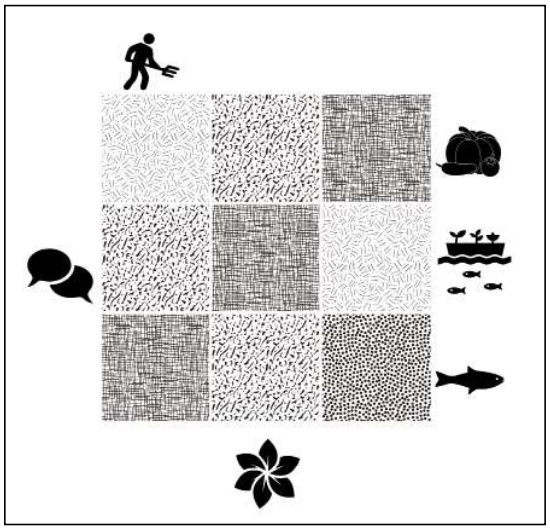


A diversified green system along the bayou can ensure the local nature resilience. With the increase of local biodiversity, a more healthy robust ecosystem will be established. In addition, the ability to deal with harzard will be reinforced as well.

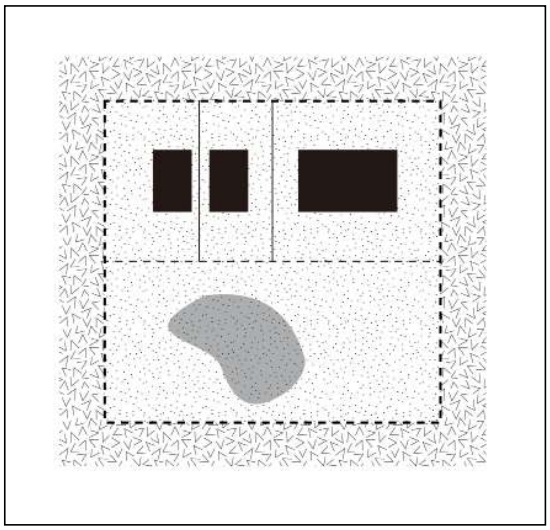


Social Resilience

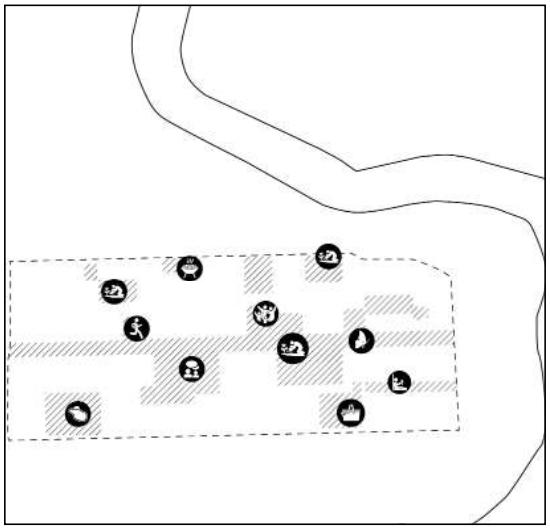
soical resilience mainly refers to two aspects as well: stress(food acess, low-income, loss of funcitonal public space, loss of community sense and pedestrain -oriented) and shock(evacuation for flooding and Covid-19)In order to solve the food access challenges, urban farming land, finishing and aquaponic farming has been introduced to create a local food systems with urba argriculture strategy. To organized the vacant space, it use linear network of streets and grids to connect these spaces, transferring into vibrant public realm. It also help with reinforcement of community sense. In addtion, the pedestrain netork seamlessly conncets both bayou and community plots for better accessibility.It also vsions the public spaces for emergency use during hurricane and Covid-19 to help the low income community to get through this.



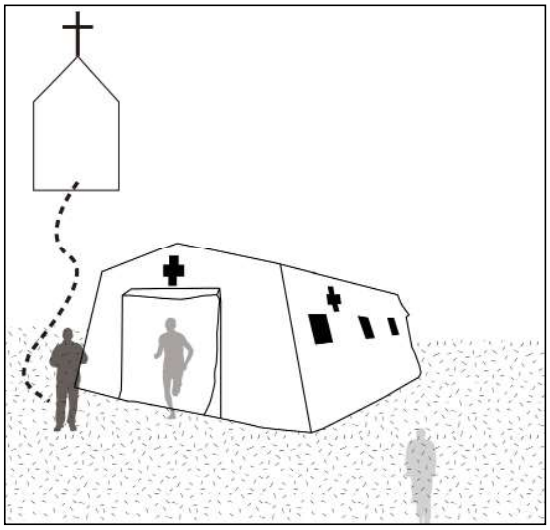
urban farming land, aquaponic farming,
fishing for self-sustaining



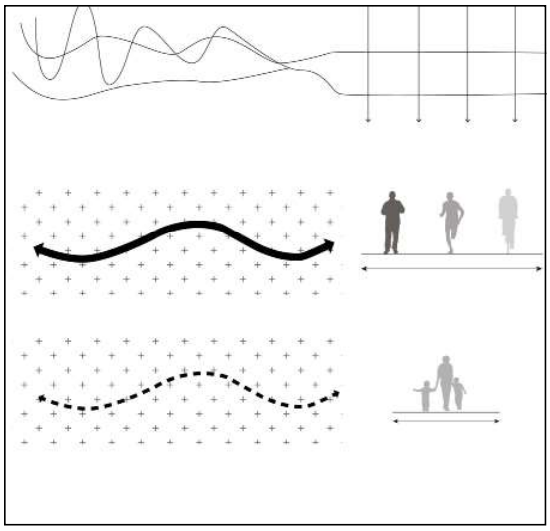
Highten place added pond at backyard
for water storage



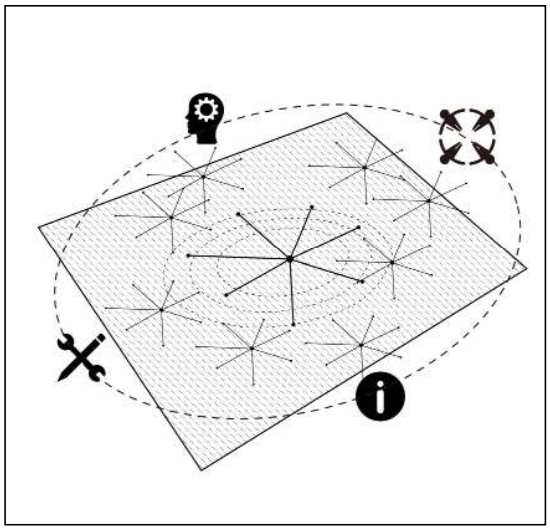
transfer the vacant places for felxable
purposes and various funcitionality



green space and public building used
for emergency quarantine



improve the experience of pedestrain
and combing it with street system



public space for knowlege and
information sharing



A resilient community with vibrant public spaces. The usages of green spaces are based on people's particpation. It can be used as urban gardens, playground for kids, and parks for entertainments. During the risk, it also could be changed for other purposes.



Community based flood resilience

Noa te Duits

Manifesto Noa te Duits

Rewriting a collective narrative

Historically, rupture has always caused major global change, both affecting behaviorism as well as the physical shape of our world. World wars, recessions and revolutions have had invisible and visible impact on our living environment. Currently we are facing a common enemy that has disrupted daily life all over the world. The hurricane–like impact of this pandemic has had a way of drowning our foresight. It is impossible to predict how and when we ever will be able return to our 'normal' life.

However, instead of focusing only on the drawbacks, this interruption of everything that is considered normal can also be liberating. Any priority, value or outlook on life acquired prior to March 2020, which had been started to become tedious, is no longer beholden to you. Isolation can be a time of selectively re-evaluating your life, followed by personal regeneration.

Although re-orientation of personal beliefs or attitudes is of great importance, there are broader issues that require our attention. With the world on pause, growing voids are also appearing on a societal level. For which some re-evaluation and regeneration is in order. A more universal form of regenerating, that can contribute to improving public health or help mitigate the effects of climate change.

This major global change ahead, for once should not prioritize individual regeneration. It is not a format, or a one – size – fits all approach, which focusses mostly on commercial or financial viability. It is not based on the thought that everything is subordinated to human needs, and nature and its ecosystems are seen as our service. This change ahead should focus on reconsidering our role as humans in our natural environment. Mainly it is about learning to be part of the ecosystem we inhabit. We need nature and nature might need us too, but this is only possible when nature and natural processes start to find a way back into our lives and our urban fabrics. It involves recognizing that growth is limited by the pitfalls and opportunities of an area.

The changes in progress are beginning to brew in Houston as case counts begin to increase. In the case of the residents of Harrisburg / Manchester change should encompass re-evaluation of their core values (liberty, equality, democracy and opportunity) which are summarized in the American Dream. Originally these ideals were seen as a way to pursue happiness and achieve success, available for everyone according to his or her ability. However, throughout history, this led more and more to greed, excessive consumerism and individualism.

The new way of regeneration in Harrisburg Manchester is about reconsidering these values. A new dream for which the ideals community, diversity, frugality and holisticness are the base principles. It is about recognizing that as an individual you are part of a bigger system. Personal growth and individual success is either confined by rules and regulations or natural boundaries and limitations. Individual growth does not necessarily mean improvement, and it might even undermine the growth of your neighbor. Regeneration can happen though changing from a individualistic approach towards more collaborative but autonomous communities. The local bonds residents are dependent on during this pandemic could form the base of these communities.

As a design experiment, I will elaborate on one community in Harrisburg/ Manchester. For which I will explore how a community can be more flood – resilient. The outcome would represent what Harrisburg / Manchester can look like if citizens take a more preventive attitude. This will be accomplished by both implementing nature – based mitigation measures, as well as amplifying the value of interaction and cooperation between two scales, the neighborhood and individual property.



Ecosystem participation in Houston (collage based on images Superstudio)

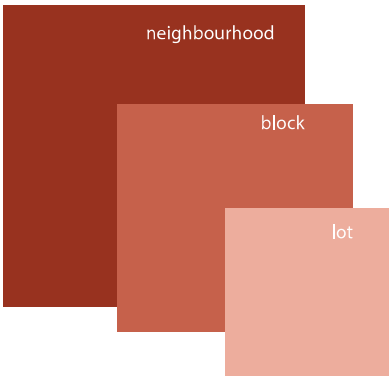
In our case area Harrisburg / Manchester there is a large Hispanic community. This community faces a number of vulnerabilities. They live close to industrial facilities, therefore they have a higher health risk caused by pollution. Furthermore, the area is situated at the confluence of two Bayous, making it more flood – prone in case of Bayou overflow. Flooding of the area happens quite often and can either be caused by periods of heavy rainfall or extreme weather events, such as hurricanes (The Union of Concerned Scientists, 2016).

All disasters combined would cause a cumulative effect and would make evacuation necessary, which is only possible via infrastructure meant for cars. The need for evacuation via highways is because very little preventive measures are in place in the area itself to mitigate the impacts of these flooding events. The residential roads are designed to hold some water in case of heavy rain, but are far from enough to obviate the need for evacuation and avoid serious damage.

This reactive attitude is partly caused by the belief that this is happening due to external forces, and risk is not coming from local facilities or circumstances , a large part of the community is very religious (Thomas et al., 2018). Another contributor to this reactive attitude is the strong sense of individualism and protection of private property. Houstonians and Americans in general are very protective over private property and have a not in my backyard mentality. Enforced by the fact that implementing mitigating measures, means having to pay for it yourself„ and does not guarantee escaping totally unscathed.

As a design experiment I will explore how a part of Harrisburg / Manchester can be more flood – resilient. As I described in my manifesto, I think this is done through designing for collaborating but autonomous communities. Within this community I will design a secondary and more informal grid, that helps to store and retain water during floods. This grid connects individual lots and more public function by implementing nature – based and sustainable mitigating measures (bioswales as storm sewers, pedestrian routes etc.). At the center of this community, a church will function as a safe haven. A building to which evacuation in time of floods is possible, and to which the individual lots can be connected.

As this community and grid starts to grow and expand, the value of interaction and cooperation between public land and private property will be amplified. If both scales participate actively the more water – resilient the area will become.

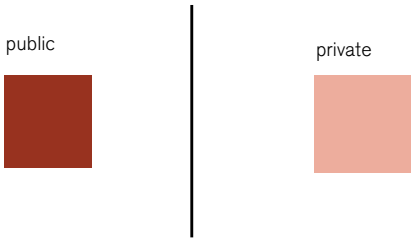


neighourhood should be shock 'proof' (safe haven during hurricane)

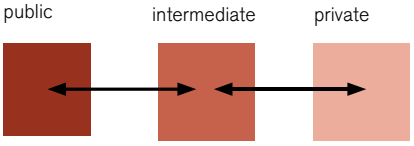
individual lot should at least be stress 'proof' (sponge during heavy rainfall)

block is the connector

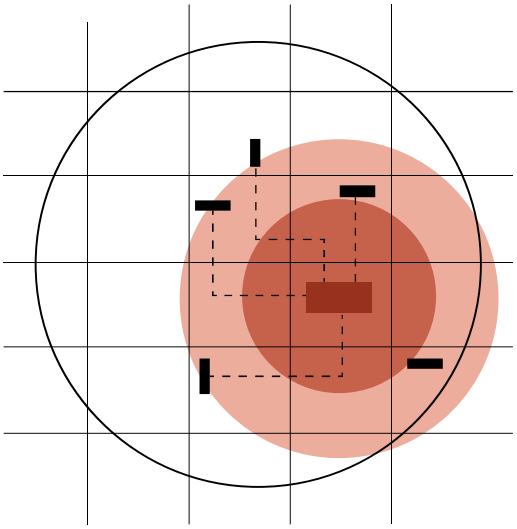
To create a resilient grid, a multiscalar approach in flood control strategies is necessary. Different scales have a different role in mitigating shock or stress events.



Representation of current flood control mechanism. Although there are some measures in place, both on the public and private scale, they do not cooperate.



The intermediate scale describes the collaboration between the public and the private scale, and amplifies the effect of the separate measures.



community hub (church)

private lot

physical connection (path, waterway)
or
connection through means (knowledge, tools, people)

A church as the central hub and safe haven of the community. In this way safety during floods is guaranteed for social vulnerable groups during floods.

measures

Within these three maps some of the guidelines of the group work are connected to specific themes and locations. To create a water - resilient community a couple of measures have to be implemented regarding greenery, the water system and social structure.
These measures will help to hold, store and drain water. In that way it relieves the discharge system. Natural drainage can be done through canopy interception, evaporation, infiltration into the soil and flow into surface water.
These heavy rainfall events are accompanied by longer dry periods. A water - resilient grid should therefore moderate between the two extreme situations. The community should function as a sponge. It should absorb water during heavy rainfall, hold it and afterwards gradually return it in time of drought.



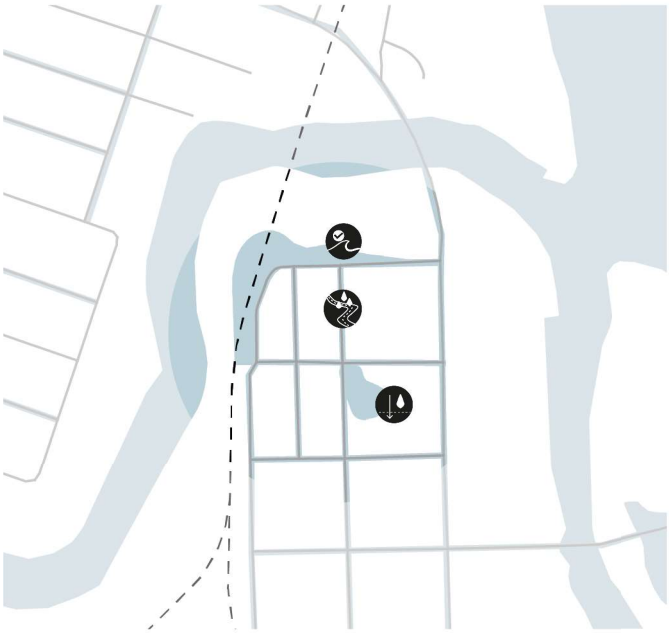


greenery

Restore natural edges / riparian corridor alongside the Bayou

Create a green buffer zone between the neighbourhood and bayou, in case of an overflow.

Depave and connect vacant lots, add more native species of plants that are accustomed to the local environment.



water structure

Create a green buffer zone between the neighbourhood and bayou, in case of an overflow.

Incorporate flood protection and ecological processes with (transport) infrastructure.

Increase permeability of vacant lots, and make sure the can temporarily store water.



social structure

Create multi - mobility opportunities, include space for natural processes, bikes and pedestrians.

Increase accessibility to daily needs. Parks, sport facilities, grocery stores and health care.

Amplify key centres as base for a community / activities

Strengthening social networks and promote spatial connectivity

Flood and wind proof buildings. Promoting plot elevation and resilient building materials.



vision map

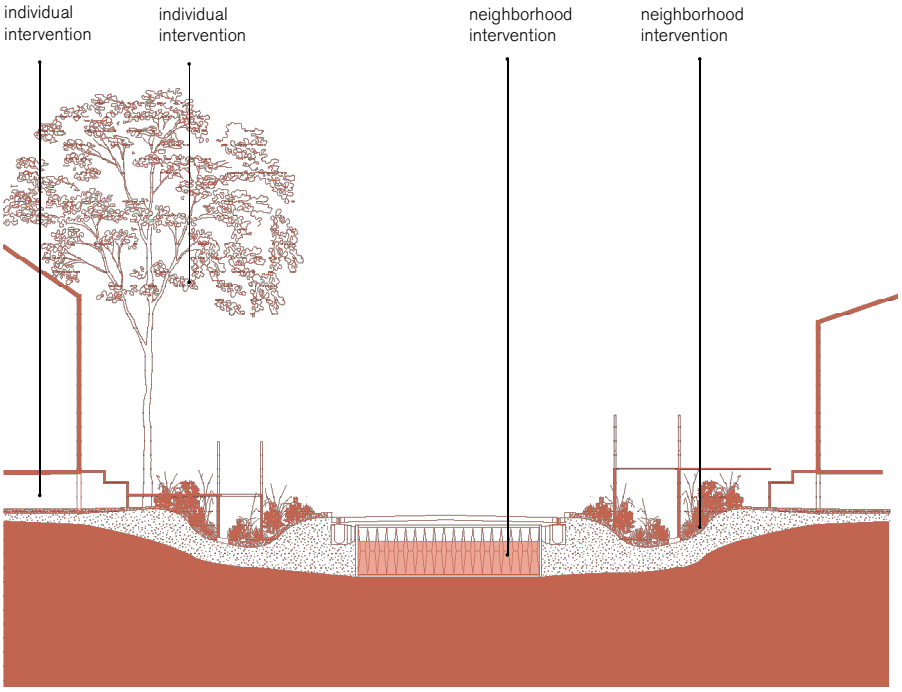
This map combines all the measures describes in the previous maps. On a neighbourhood level the water - resilient grid includes streets with bioswales, transformation of vacant lots to increase biodiversity, permeability and storage. It also incorporates a slow traffic path that connects the houses to the community hub and the natural edges of the Bayou. This can also be used as an evacuation route to the safe haven in time of an extreme event.

- Water
- Street with flood protection
- Greenery
- Former vacant areas
- Pedestrian path
- Railroad
- Church - safe haven
- Private property
- Buildings

N

0 50 m





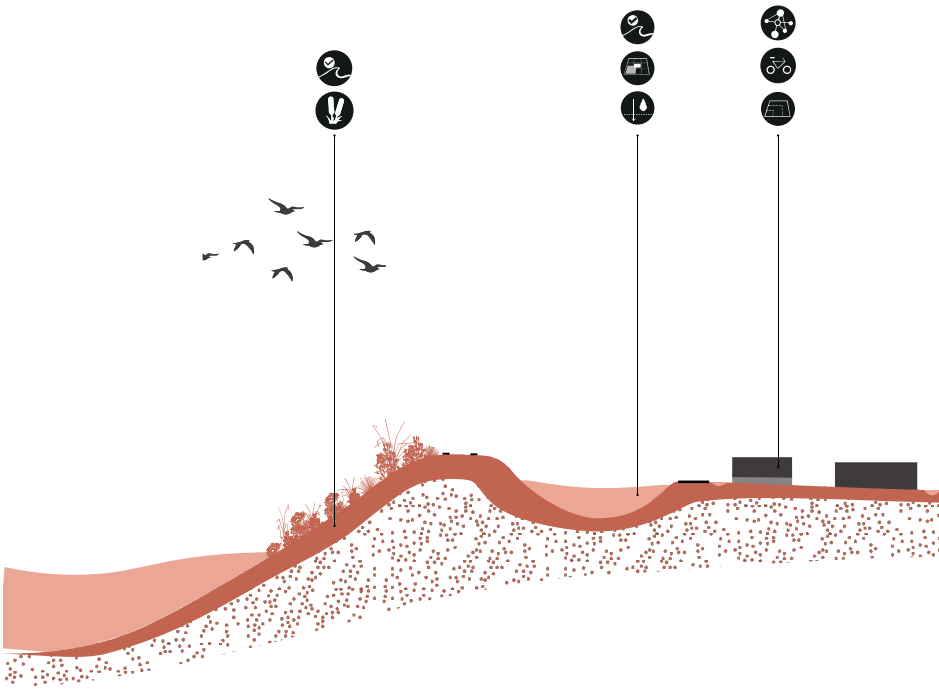
Street
In time of heavy rainfall

sections

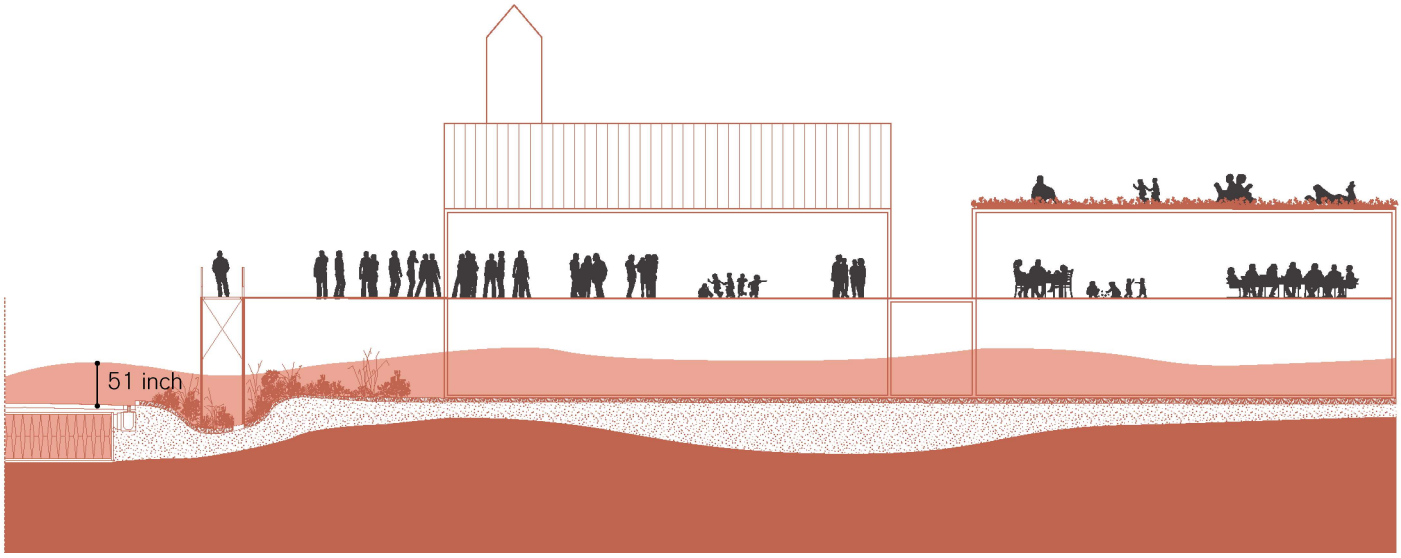
These three sections each depict something different. At the bottom the new situation is shown. It includes increased biodiversity on the former vacant lots, space for water storage and flood proof buildings.

Top right shows the community centre in time of an extreme event, during the last storm (Harvey), there was about 51 inches (1, 3 m) of rainfall in 5 days. It is impossible to design a system that can take in that much water in such a short amount of time without causing water nuisance. Therefore it is important to have local evacuation possibilities, that are elevated. Either through buildings and paths on stilts, floodable first floors or buoyant foundations.

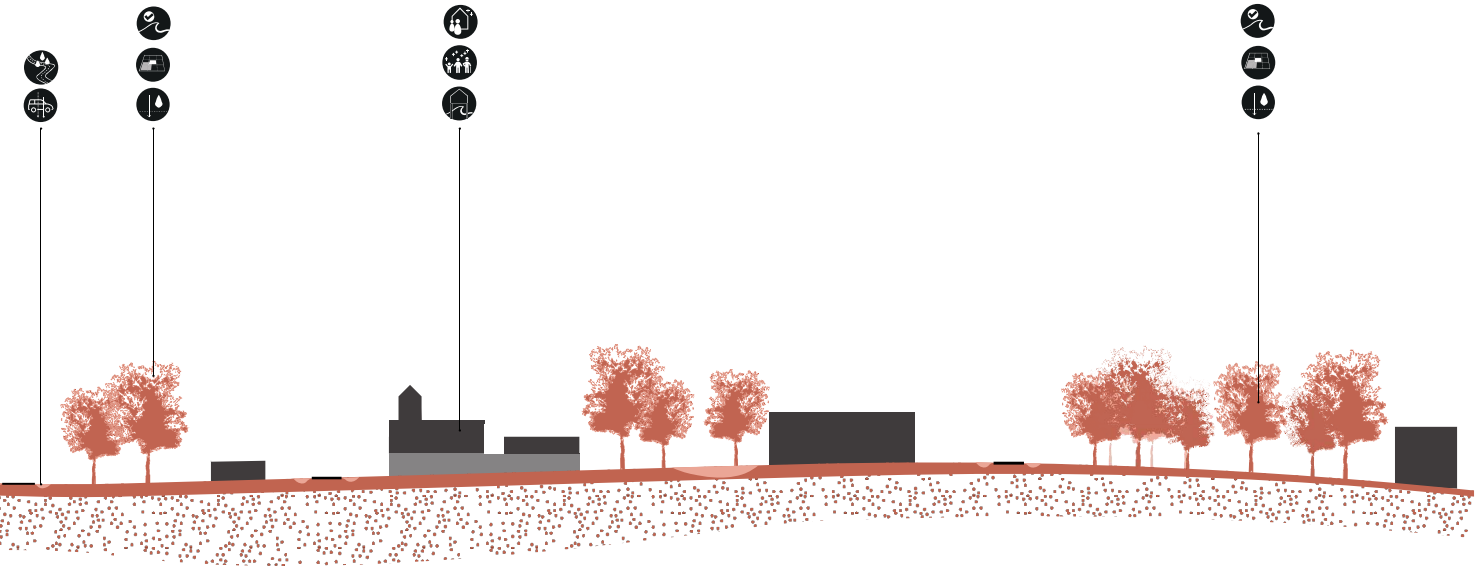
The top left shows a section in case of heavy rainfall. Throughout the year, periods of heavy rainfall occur in Houston. To reduce water nuisance, bioswales and infiltration boxes can be added to the streets, to help store and release the water gradually. During heavy rainfall events 10 inches (25 cm) of rain can fall within a day time.



New situation



Safe haven
In time of extreme event

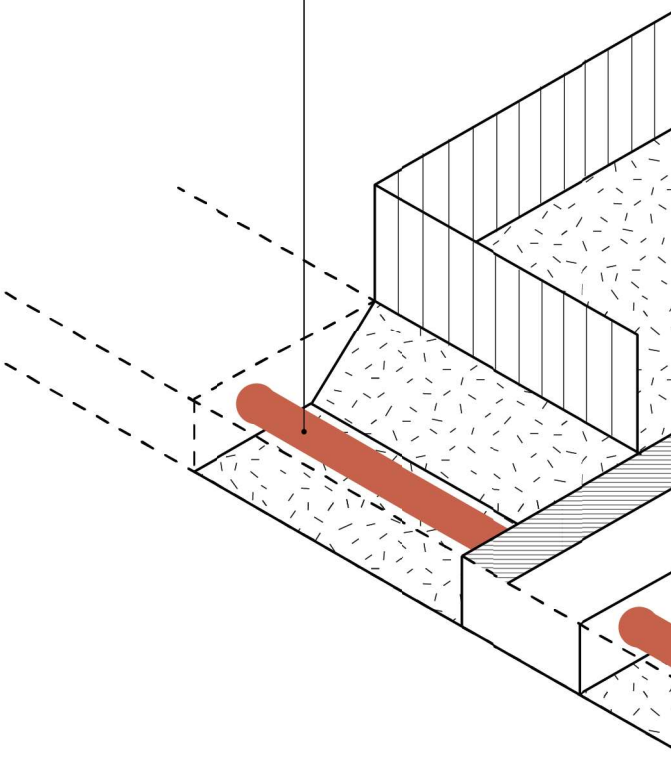


Bioswale as the new storm sewer, to store water and release it gradually.



Help st





participation from private property

Although there is a lot that can be implemented on the neighbourhood scale to create a water resilient grid. To succeed, participation from each individual in the community is also of vital essence.

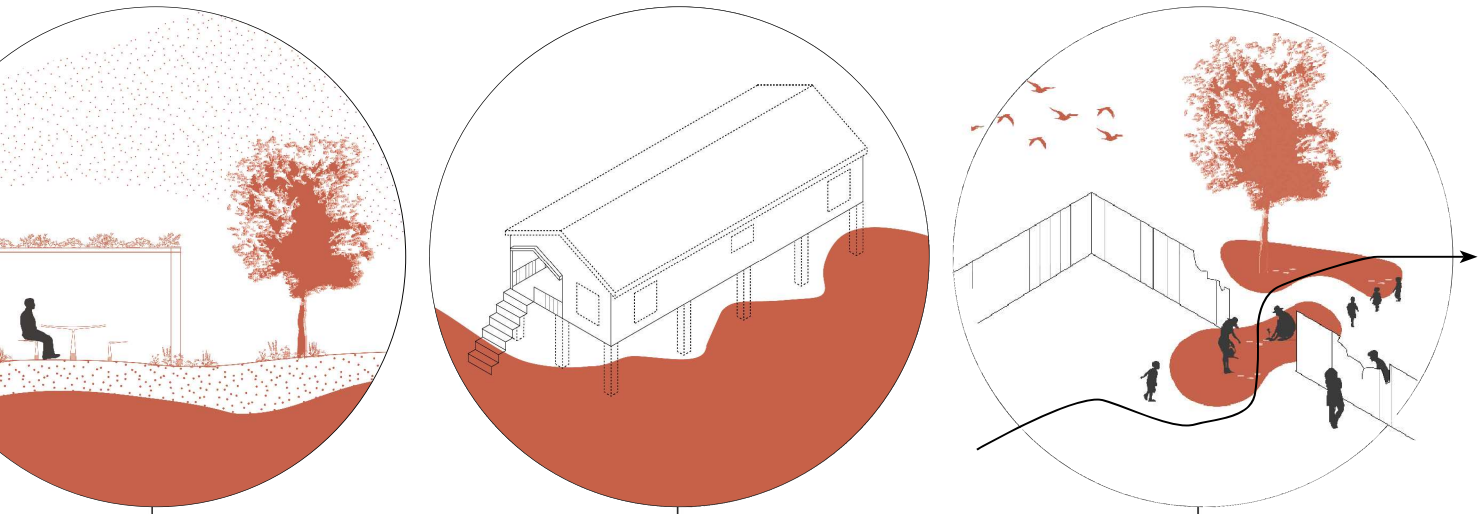
Currently storm sewers are closed of because private property owners put their drive way over it, which makes the whole interconnected system disfunctional. Minimum participation to the water resilient grid would mean to conserve this system., even though it is within the boundaries of the private property.

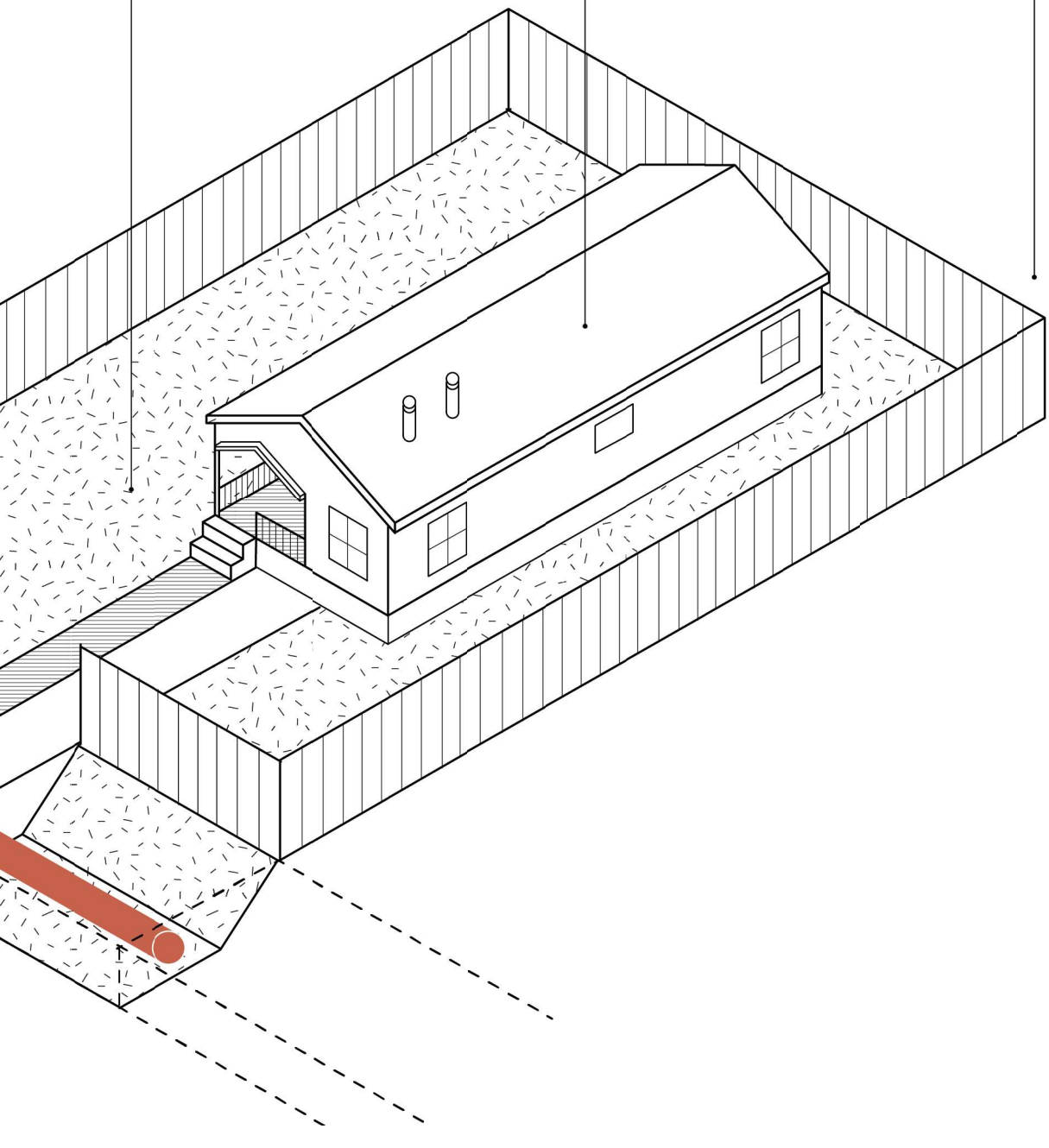
Adding more flood protection measures would improve the grid and increase participation. As the sum of all individual measures accounts for a big contribution on the larger scale. Possible ways to participate are indicated on the top.

ore water in lawn and garden, by increasing permeability and biodiversity.

Built / transform houses to withstand storms. Use Flood - proof materials.

Break down fences to collaborate with neighbors and adjacent vacant lots. Connect to pedestrian path.





Intergrated slow tr



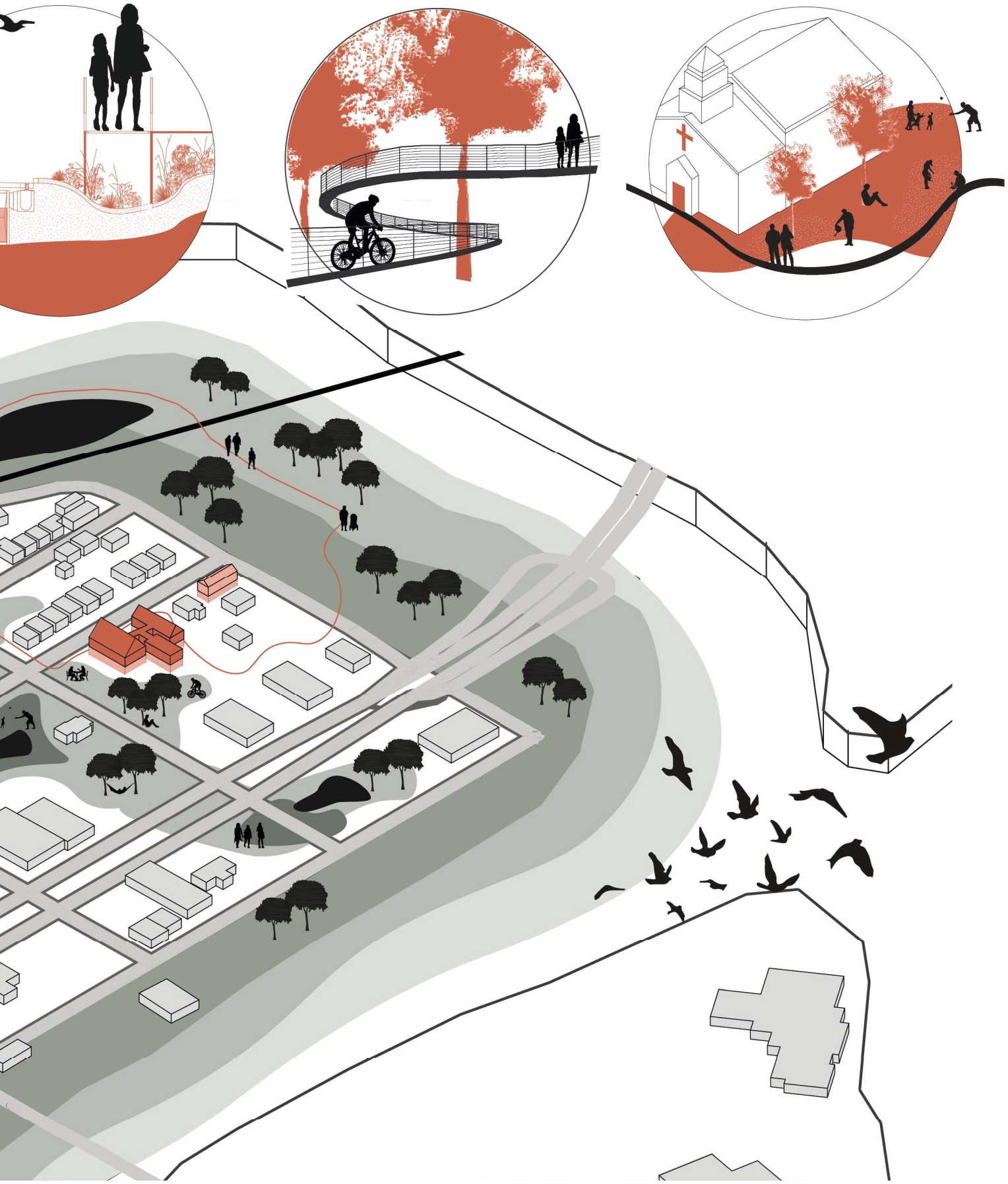
neighbourhood

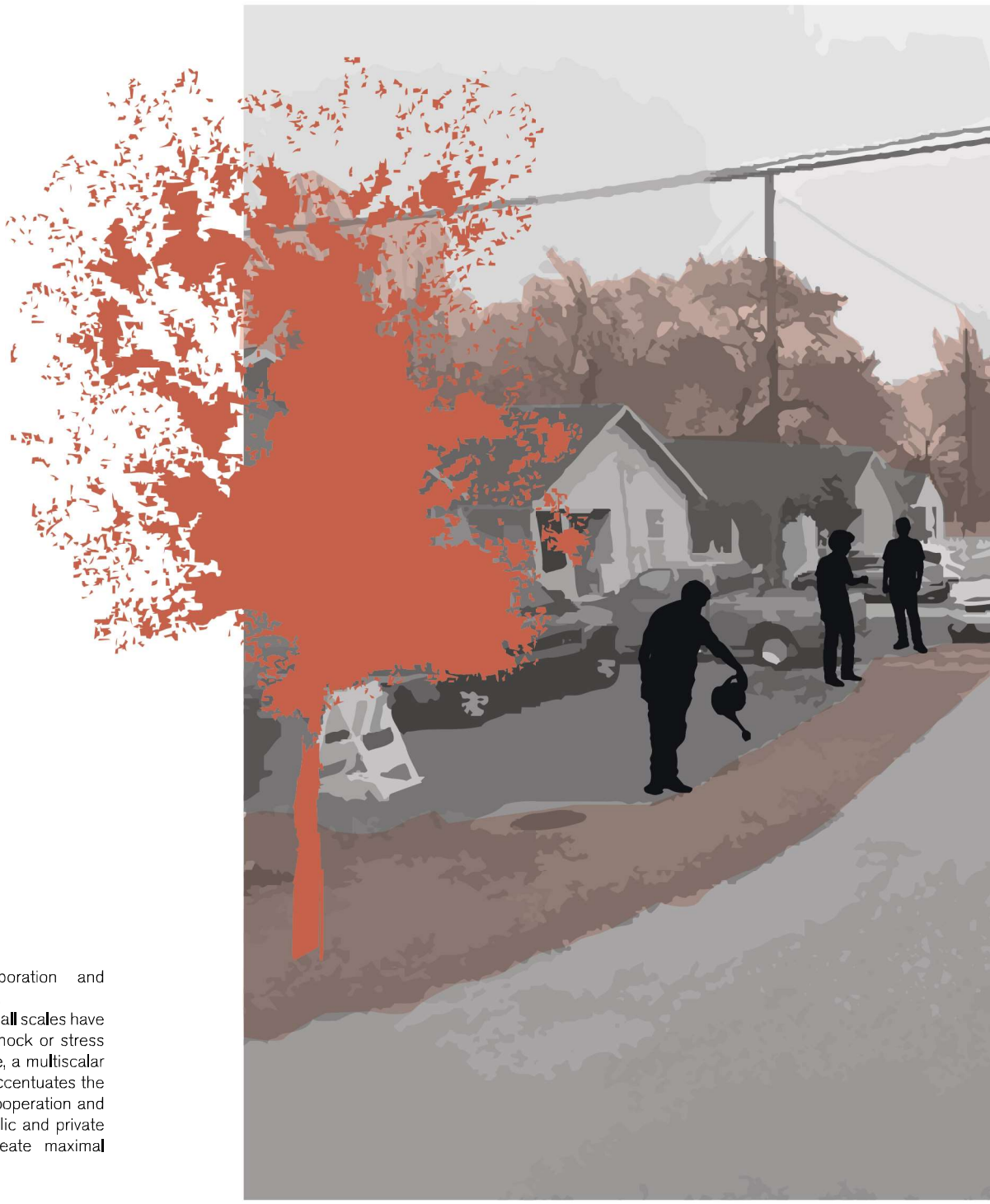
This perspective shows the neighbourhood scale. This scale is about the connection of all the seperate measures, combining the measures taking on both a public and private level.
On this scale the independent transformed vacant lots are connected to each other. The pedestrian path that joins the houses, the church and the restored Bayou is visible.
Throughout time and according to socio - economic capability the private properties are slowly starting to participate in flood protection, more houses and plots are build to withstand storms.

raffic route as connector between different scales

Partly elevated, so it can be used for evacuation

Leading to the safe haven / community hub





impression

This collage shows collaboration and cooperation in flood protection.
Within a flood proof community all scales have a different role in mitigating shock or stress events. To create full resilience, a multiscalar approach is put into place. It accentuates the intermediate scale, in which cooperation and collaboration between the public and private property is facilitated, to create maximal participation.



5. Bain Town, Bahamas

Ecosystem participation in a hurricane region

July 2020

Suzan van Werkhoven
Menno Aerts
Chen Gao
Ilse van Milaan
Li Yangzi
Richard Commandeur

1.

Introduction to Bain Town

1. Environmental risks to be tackled

Climate change

The small island developing states (SIDS) of the Caribbean region, where the Bahamas are part of, are among the most vulnerable to negative climate change impacts (Bhaptiste & Rhiney, 2016). Because of their small size, high exposure to a range of natural hazards, high density of settlements and infrastructure along low-lying coastal strips, narrow natural resource base and the population's dependence on agricultural activities, the ability of these island nations to cope with, and adapt to negative climate change impacts are constrained (Bhaptiste & Rhiney, 2016). Climate change presents new challenges due to the speed of the anticipated changes and the magnitude of the investments needed to adapt to predicted changes.

Sea level rise and floods

If projected sea level rise is reached by 2050, between 10-12% of territory will be lost, especially in coastal zones where the main tourism assets are located. The change in rainfall for The Bahamas would decrease by as much as 5-11% in most islands. Drier regions such as the southeast (e.g. Inagua) will become drier while the wet regions in the northwest will experience decrease in rainfall but not as much as the southeast region. Additionally, the seasonal differences will be greater ranging from 6-20% decrease. Recent analysis of the temperature record shows that the average annual temperatures have been steadily increasing over the last 30 years (1971-2000) and this trend is likely to continue in the foreseeable future (McSweeney, et al. 2009).

Hurricanes

Added to these trends is a marked increase in hurricane and intense tropical storm activities in the region since the mid-1990s, which may or may not be linked to multi-decadal changes in Atlantic sea surface temperatures. In the past twenty years the Bahamas has been impacted by many major hurricanes as Frances (2004), Katrina (2005), Wilma (2005), Irene (2011), Sandy (2012), Joaquin (2015), Mathew (2016) and Irma (2017). Tropical storms and hurricanes most frequently occur in the months of September, October, August and November. On 1st September 2019, hurricane Dorian made landfall on the Abaco Islands in northwest Bahamas. Dorian was the strongest Atlantic hurricane to make landfall since records began, and for 3 days it made very slow progress through the Abaco Islands and Grand Bahama, with wind gusts over 220 miles per hour and storm surges up to 25 ft. Dorian caused devastating damage to eastern Grand Bahama and central Abaco, in particular the Marsh Harbour area.

2. Local experience of the risk

Cultural and Societal aspects

The natural resources of the country are very limited. The economy is built on tourism. The Caribbean region was subjugated for centuries, leaving many states broken and playing 'catch up' in a global system that is stacked in favor of those who have power both politically and economically. Now centuries later, with the impact of a global environmental phenomenon – climate change – the subjugated region is substantially behind in having the resources to effectively react to the current climate problem, much less undertake a proactive approach. According to an CSM article from 2011 80% of the people in the Bahamas cannot swim. Moreover, the local population and governments do not own (enough) boats. Inhabitants are more eager to spend their money on a car, as a status symbol, than on boats.

Governance

Furthermore, the governing institutions on the Grand Bahama island are divided. The town of Freeport is under the authority of a private company that also owns the port at the city. As a company it does not have the intention to govern and spend money on resilient houses and infrastructure.The area outside Freeport is governed by the Grand Bahama government, and then there is also the national government of the Bahamas. The airport and hotel, that is of significant importance for the tourism on the island, are both owned by a company from Hong Kong. After Dorian, the company did not invest in the damaged terminals at the airport and took the insurance money of the hotel, without investing in the properties. The island government bought the hotel to rebuild it.

Inadequate shelters and lack of safe choices

Over the past few years, the Bahamas has been seriously affected by three major hurricanes, all Category 4 or stronger, depleting family resources and significantly impacting the ability of communities to recover from disasters. Prior to hurricane Dorian, residents on Grand Bahama were urged to move inlands, inhabitants of outlying towns were evacuated. The Bahamian government also urged people to move to shelters on Grand Bahama (ABC news, 2019), although many shelters were not adequate. Some inhabitants did choose to shelter at closed resorts, which were unsafe according government officials.Research found that currently thirteen of the twenty-five official shelters are usable, providing a capacity for just over 1,500 people, or 2% of the population. The majority of shelters did not have their own generators, source of emergency freshwater, adequate sewage treatment facilities, first aid kits, fire extinguishers, flashlights, or sleeping equipment. There are a small number of very capable and dedicated emergency professionals, local administrators, community leaders and volunteer organisations across the islands who know exactly what needs to be done to ensure the shelters provide safe haven during hurricanes, but they are lacking resources and finance to be able to execute these plans.

3. Project scales and the involved actors

a) Macro-scale: Regional level

At the macro scale there are two important actors, the Grand Bahama Port Authority and the West Grand Bahama district. The Grand Bahama Port Authority (GBPA), is a privately held company that next to owning the port also acts as the municipal authority of the city of Freeport. The company and municipal authority has their main interest in the port. The district government of the West Grand Bahama is covering the whole west part of Grand Bahama, excluding Freeport. In West Grand Bahama there are several settlements and also is the district where the capital of Grand Bahama, West End lies.Thereby for this scale, the townships are of importance. Some towns have this Township where a chairperson runs the town.

The existing mechanisms and infrastructure for addressing disasters and to responding to the adverse effects of climate change include the National Emergency Management Agency (NEMA), and an effective early warning system. In addition, the GOB has had to provide infrastructure and support mechanisms to respond to on-set events, for example, the placement of seawalls. The Bahamas National Trust Act of 1959 established The Bahamas National Trust (BNT) to preserve sites of “natural beauty”. The BNT holds jurisdiction over more than 25 national parks and protected areas throughout the country and is the only non-governmental organization in the world with this mandate. The establishment of The Bahamas Environment, Science and Technology (BEST) Commission in 1994 and the Conservation and Protection of the Physical Landscape Act of 1997 made way for increased conservation action and use of scientific data in management decisions relating to the environment.

b) Meso-scale: Urban level

In the Meso scale the area to the west of Freeport, including the port, Baintown and Wild Goose Town is chosen to analyse. For this scale the actors of the GBPA, district government and the townships are important.

c) Micro-scale: Urban fragment level

For the third scale we mainly focus on bain town. Here inhabitants play an important role. Knowledgeable residents can be useful for climate adaptation strategies. They have an extensive history and knowledge of the surrounding regions.

2.

Research question and Theoretical framework

Aims of the Project

To deal with the challenges of climate change and the more severe hurricanes Bain town has to come up with new climate adaptation strategies. Bain town will be developed to hold more people living a eco-friendly and sustainable lifestyle, and have significant resilience improvement in tackling hurricane hazards and pandemic in both social and spatial aspects.

With a eco-friendly and sustainable lifestyle expansion of the agriculture and fisheries sectors in sustainable, cost effective ways can only assist in the diversification of the local economy and reduce its dependency on imports. The fishing industry will become increasingly important for the inhabitants of Grand Bahama. Oil company will eventually move out with the increased use of clean energy, as solar panel and windmills. Tourism interested in nature and traditional cultures will still visit the island.

The aim of this project is to finally form a system of possible and feasible guidelines, coping with the extreme environment issues Grand Bahama is facing, by interventions related to natural conditions, social aspect and technological potential and possibilities in urban environments. The guidelines including strategies and policies will come to both the spatial design and the social agenda. According to these guidelines and tools based on them, the resilience of the urban environment will be improved, making it possible for residents and habitats in Bain Town to get along with the hazards with more ecosystem participation. Integrating traditional knowledge systems with new research ideas and development of innovative technologies will reduce vulnerability of Bahamian communities to disasters. Natural infrastructure and combinations of natural and built infrastructure can enhance coastal resilience by providing important storm and coastal flooding protection, while also providing other benefits. With the new climate adaptation strategy for Bain Town the aim is to increase physical, ecological, and social resilience.

Research Questions

The main research question of the research is: 'How can ecosystem participation work as a catalyst for healthy, climate proof extreme urban environments?' The case of Baintown represents a more specific issue of hurricanes in archipelago landscape and thereby questions a definite approach. How can Bain Town *stimulate* *ecosystem participation in the tropical savanna landscape* to reach a *hurricane and flood proof, circulair and self sustaining economy* that is the base for *social resilience*?

Sub questions

How will increased ecosystem participation influence social interaction of the Bahamians within the landscape?

Objects of approach: Ecosystem participation in the tropical savanne landscape & Social resilience
Territorial scale: Infrastructure, economy, governance
Urban scale: Energy, ecology
Local scale: Architecture, gardens

How can ecosystem participation prepare Bahamian for and reduce harm caused by upcoming storms in the Bahamas?

Objects of approach: Ecosystem participation in the tropical savanne landscape & Hurrican and flood proof, circulair and self sustaining economy
Territorial scale: National storm barriers, Natural elevation
Urban scale:
Local scale: Architecture

What spatial implementations can prepare Bain Town for and reduce harm caused by climate change and the more severe hurricanes to reach social resilience?

Objects of approach: Hurricane and flood proof, circulair and self sustaining economy & Social resilience
Territorial scale: Integral evacuation plans, governance, research
Urban scale: Regional governments, education
Local scale: Civic initiatives, recreation



Referential Theories and Practices - Nature Based Flood Protection

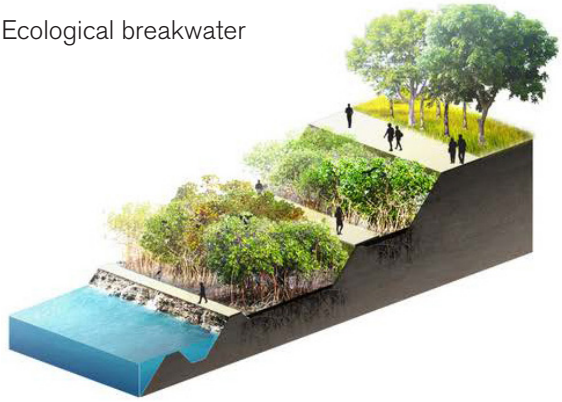
Sources and references in literature and case studies are used to establish this framework of referential theories and practises for the Grand Bahama. The page on the right illustrates a summary of the theories. Since the environment is quite different around the island, the theories and practices are divided into 3 categories: North coast, land and South coast.

The North coast of Grand Bahama has shallow waters, marshes and mangrove forests. By installing an ecological breakwater or a mangrove edge, flood protection is enhanced. The coastline is 'softened' and therefore better resistence against high waves and water, protecting the hinterland.

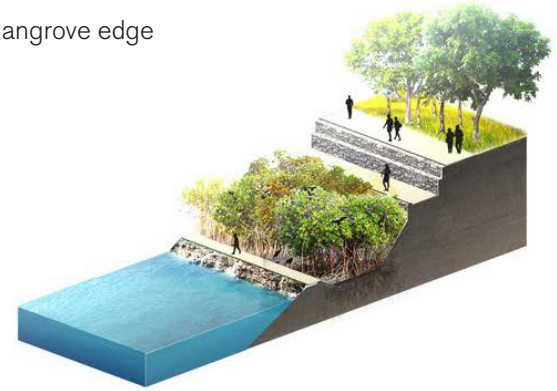
On land it is of high importance to manage the water. This can be done by watershed management in which the water from precipitation flows to lower lying areas. Therefore this is a form of drainage, not only with heavy precipitation, but also when a flood occurs. Furthermore, floodplains can serve as buffer zones. Some areas will be purposefully flooded, while other areas can stay dry. In this way, more discharge capacity is created.

The South coast of Grand Bahama has deep waters, urbanization close to the waterline and a port. The port needs to be dredged regularly to maintain functional. In Harlingen, the Netherlands they re-use this mud to protect the coastline: The Mud Motor. Moreover, islands are very functional, natural breakwaters. There are various examples that small islands in front of the coast protect the main land from major floods, like in the Netherlands or Australia. Additionally, breakwaters can be designed in such a way that it becomes a habitat for animals and benefits the ecosystem. Besides, coral reefs have proven to be very successful in breaking waves and floods.

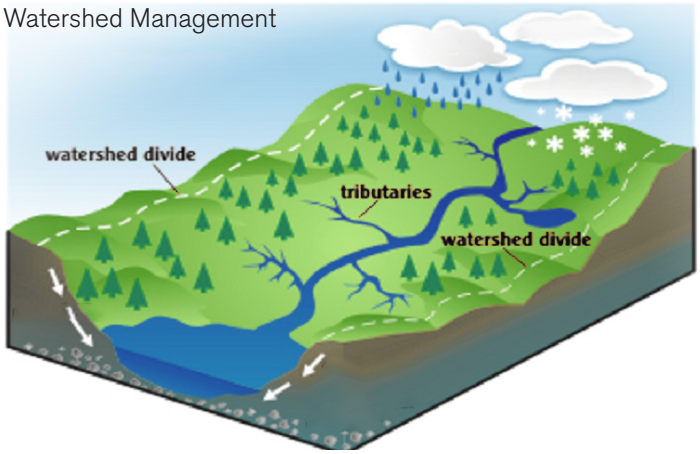
Ecological breakwater



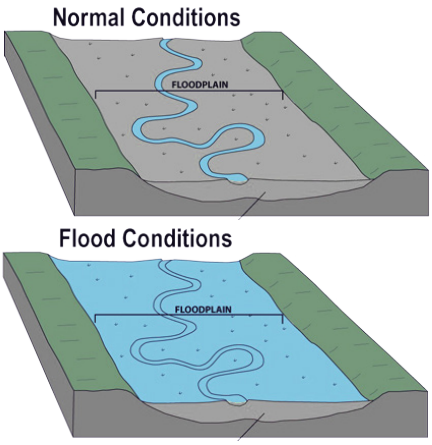
Mangrove edge



Watershed Management



Floodplain Management



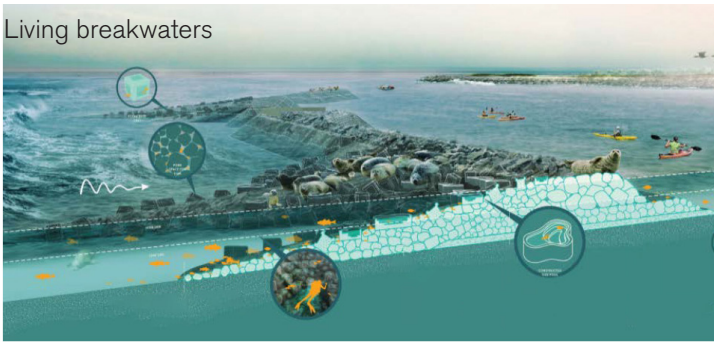
Re-use dredging mud



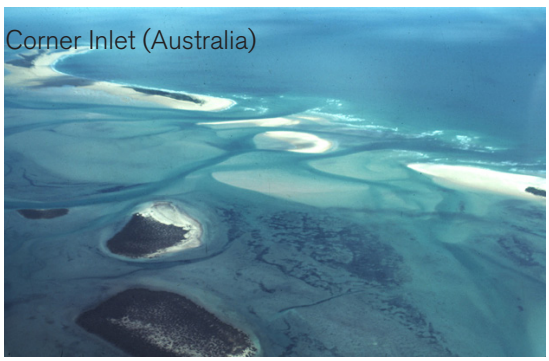
Waddeneilanden (Netherlands)



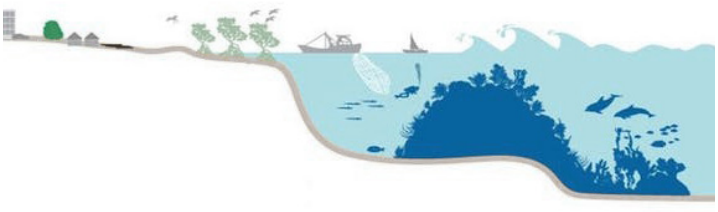
Living breakwaters



Corner Inlet (Australia)



Coral reefs



Referential Theories and Practices - Indigenous knowledge

The awareness and involvement of communities in their own climate change risks is a critical part of climate change policy making and risk communication. Misunderstandings by the public about the causes and consequences of climate change can lead to inappropriate adjustment and even passivity (Thomas & Benjamin, 2018). There are different ways of community participation in different contexts. In the urbanized area, the community participation of NBSs is greatly shown in Urban Community Gardens (UCG). These gardens are not only contributing to ecosystem resilience but also helps to build social resilience. The gardens can increase the infiltration rate and enhance biodiversity while functioning as a meeting place to build social cohesion and a sense of identity. Also, with more people working in the gardens, the awareness of environmental issues is raised so that shifting to a more sustainable lifestyle will be easier (la Fortezza, 2017, p. 437).

In the coastal context, a method called Local Knowledge mapping is used to encourage community members to share knowledge and perception in Coastal Louisiana. This area have experienced a globally high rate of wetland loss due in part to a combination of sea level rise, subsidence, saltwater intrusion, and reduced sediment inflow, which not only causing ecological and economic problems, but also taking away the natural protection buffer against coastal hazard for local community. (Barras et al. 2003; Blum and Roberts 2009; Day et al. 2000, 2011; Scavia et al. 2002; Turner 1997).

Due to the limited resources on the island, it may be useful to build on existing opportunities to reduce vulnerability to environmental threats. It may be interesting for policy makers to combine both scientific and local knowledge, a mix of both top-down and bottom-up approaches (Mercer, Taranis, & Suchet-Pearson, 2010). Residents can have compelling and innovative solutions to their circumstances and therefore help devise effective and resilient adaptation strategies (Thomas & Benjamin, 2018).

Project approach

ackground Research

view
research

Grand Bahama analysis

scape morphology analysis
nd ecology analysis
morphology
ems of systems
opology
ional perspective TIL

Research question

How can Bain Town stimulate ecosystem participation in the tropical savanna landscape to reach a hurricane and flood proof, circulair and self sustaining economy that is the base for social resilience?

Problem statement

1. Hurricane
In the past twenty years, the Bahamas has been impacted by many major hurricanes. On September 2, 2019, Hurricane Dorian hit the island of Grand Bahama. The Island Grand Bahama suffered from direct damage due to the wind and water.

2. Climate change
Climate change presents new challenges due to the speed of the anticipated changes and the magnitude of the investments needed to adapt to predicted changes.

3. Social involvement
There are inadequate shelters, lack of public knowledge for resistance, lack of resources, and finance for execution.

Theoretical Framework

1. Indigenous knowledge
Literature has indicated although some communities have little choice but to apply traditional knowledge practice, by integrating these traditional disaster risk reduction efforts with contemporary technologies/systems could reduce vulnerability of local communities to disasters (Macnight, 2018)

2. Hybrid and natural solutions
There is substantial evidence that natural infrastructure (i.e., healthy ecosystems) and combinations of natural and built infrastructure ("hybrid" approaches) enhance coastal resilience by providing important storm and coastal flooding protection, while also providing other benefits (Sutton-Grier, et al. ,2015).

4 scenario's

No humans
Nature first
No technology
Covid-19

Vision

Towards a social resilient Bain Town where ecosystem participation can stimulate a hurricane and flood proof, circulair and self sustaining economy.

Guidelines

Domains
Buildings & built environment
Public services
Flows
Nature system
Social agenda

3.

Critical Cartography

Process of collecting data

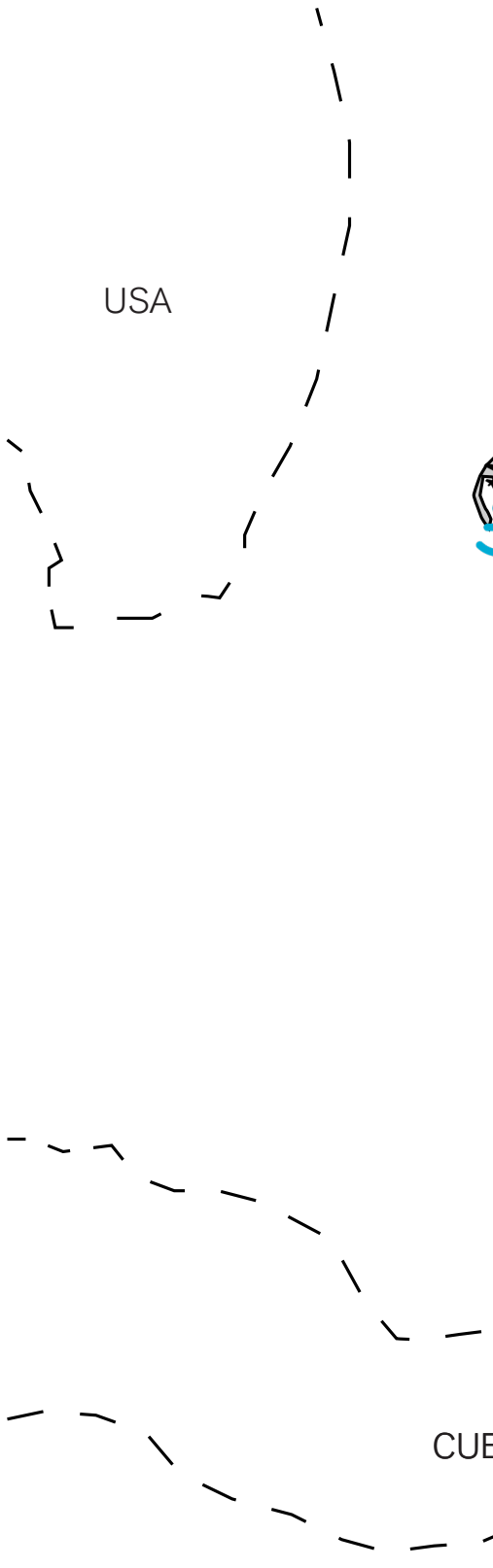
Various methods of data collection are used to gain a concrete knowledge of the Grand Bahama and analysis from different perspectives. Several literature review aspects are done under the topic “ecosystem participation” and offer information on collecting direction and similar researches.

To make the base-knowledge and analysis specifically for the Grand Bahama, geographic information is collected from multiple layers. The landscape, urban development, ecosystem, anthropology, system, and logistic data are put together to Acquire a comprehensive knowledge of the island. From a large scale covering the whole island to a medium scale in the west part of Grand Bahama and a small scale in the Bain Town, different levels of the information are gathered from flows to living species.

Not only the GIS data rea collected, but also the information from reports, government documents, historic drawings, photos, and scientific papers are gained and translated into drawings. These sources not only enrich our basic data, but also include research from different organizations with different perspectives, which allows us to understand the extreme climate impact on the island through diversified eyes.

3.1.

Systems of systems

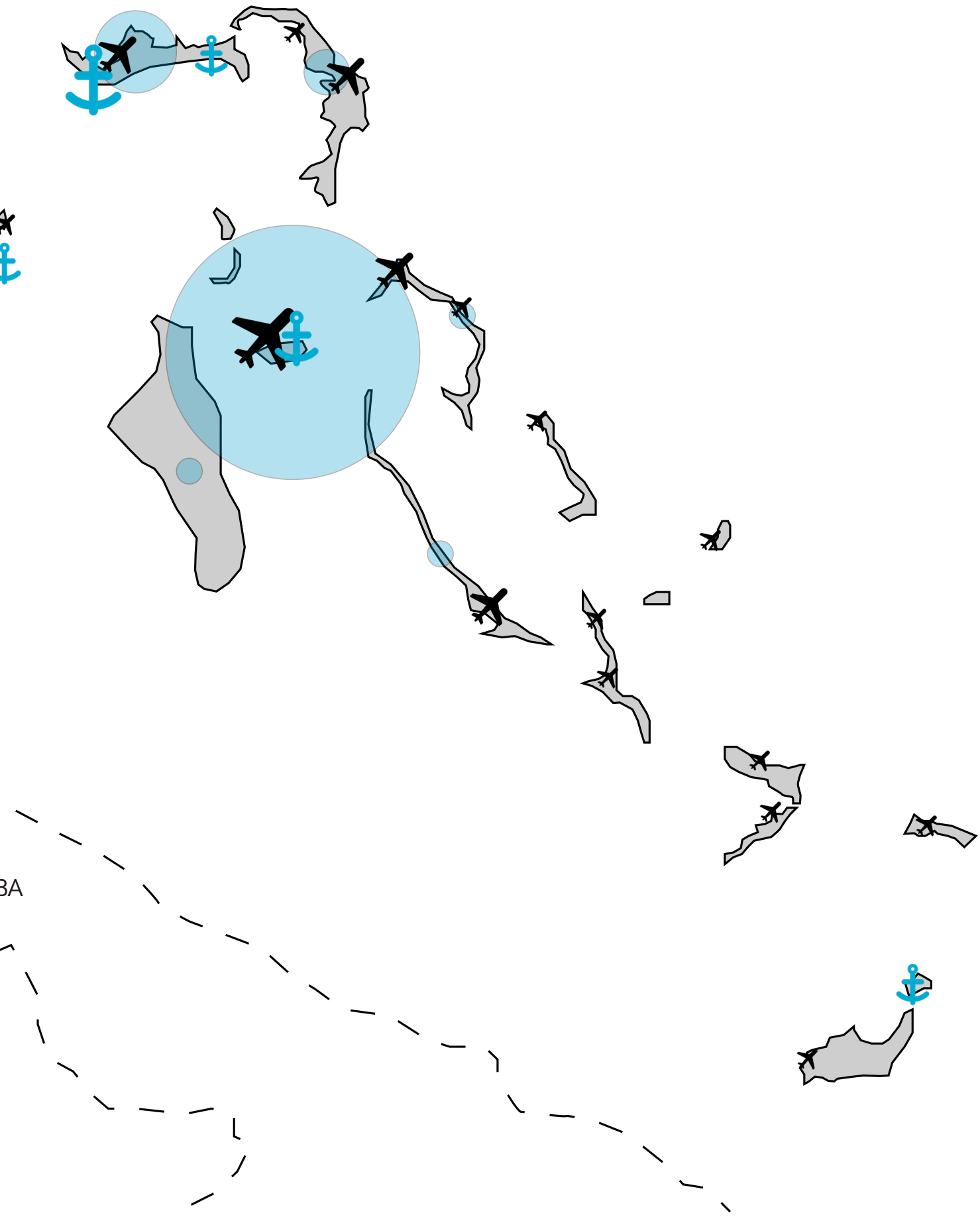


The Bahamas population and interconnectedness

The Bahamas is an archipelago with many islands. However, the size of the island does not reflect its contribution to the economy or population size. The blue circles indicate a relative population size: the larger the diameter, the more people live on the island. The size of the airport and harbour icons illustrate its capacity and importance to the Bahamas. There are many more airports (61 in total), but the most important ones are depicted in this figure.

The capital city is located on New Privince. This island houses 2/3 of the population. Grand Bahama Islands has 2 large ports and its inhabitants make up 1/6 of the total population of the Bahamas.

Population
Airport
Harbour


BA

The Grand Bahama districts

The Bahamas is a country which is spread over many islands. The country is divided into 23 districts. 3 of those are located on the island Grand Bahama. Left of the island is West Grand Bahama, right is East Grand Bahama and in the south City of Freeport.

- East Grand Bahama
- West Grand Bahama
- City of Freeport

0



The Grand Bahama Subdivisions

The Port Authority owns the Freeport harbour. The harbour is very important in the supply of goods to the inhabitants of Grand Bahama, but also the rest of the Bahama islands.
They are a very important link in the system. However, private parties usually are more interested in making a profit, rather than investing in the well-being of the people and environment. Therefore this can be sen as a conflict.
The Bahamians are very dependent on the service of this Port Authority.

- Governmental
- Privately Owned (Port Authority)

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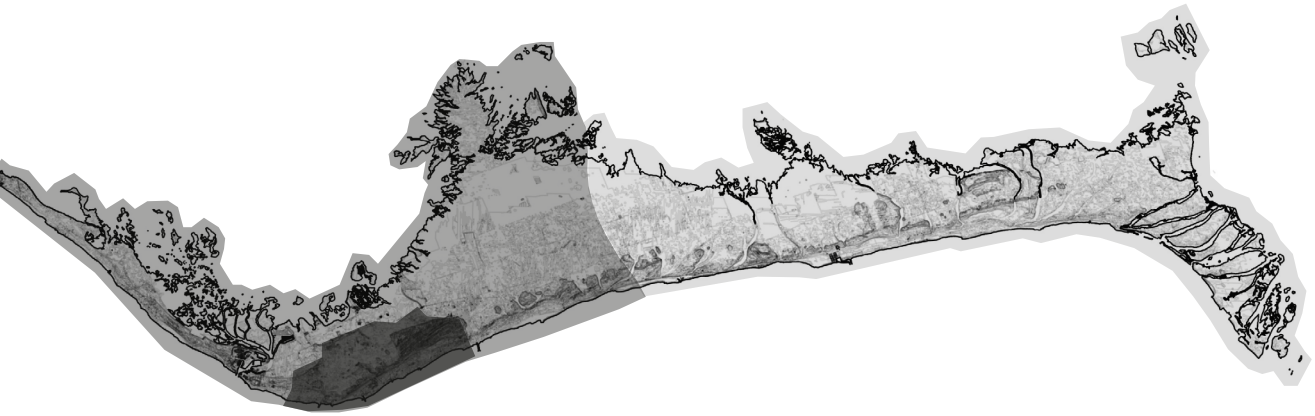
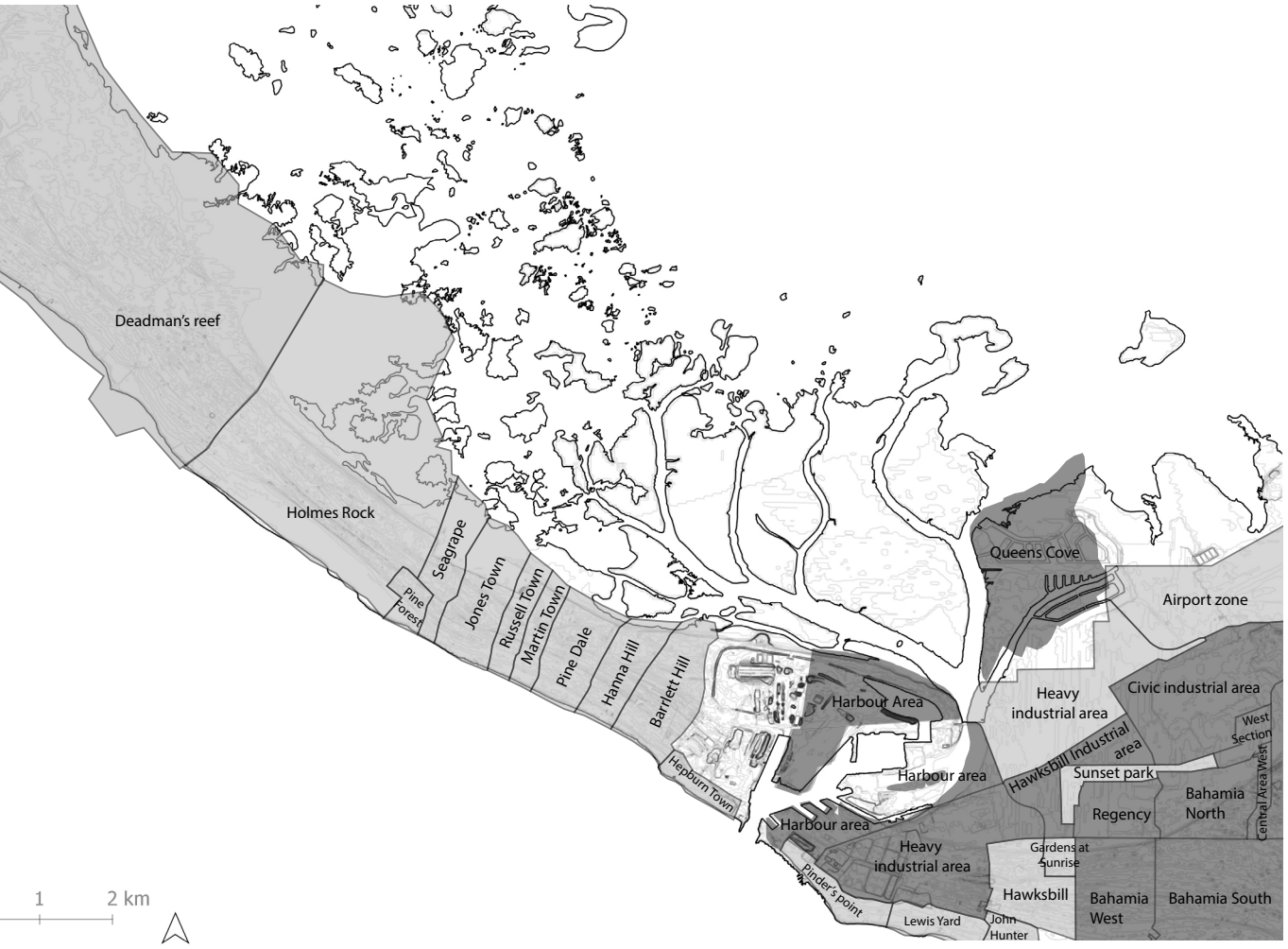
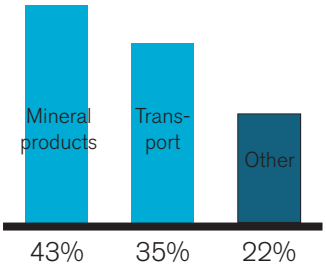


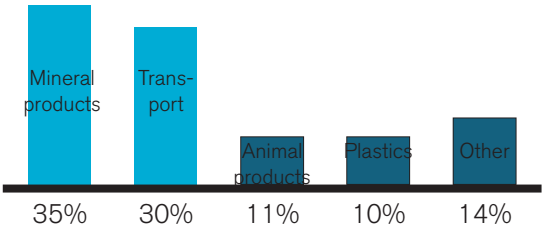
10 20 km


Deadman's reef
Holmes Rock
Seagrape
Jones Town
Russell Town
Martin Town
Pine Dale
Hanna Hill
Barrlett Hill
Pine Forest
Hepburn Town
Harbour Area
Harbour area
Harbour area
Queens Cove
Airport zone
Heavy industrial area
Civic industrial area
West Section
Hawksbill Industrial area
Sunset park
Central Area West
Bahamia North
Regency
Gardens at Sunrise
Heavy industrial area
Pinder's point
Hawksbill
Bahamia West
Bahamia South
Lewis Yard
John Hunter

1 2 km



Import

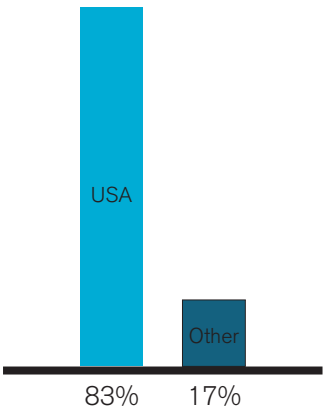


Export

Economy - Import and Export

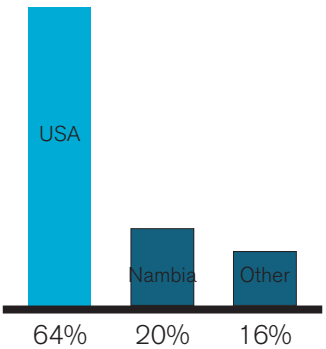
The harbour and the surrounding land, including the city of Freeport, is governed by a private company, The Port Authority. It has an agreement with the government of the Bahamas named The Hawksbill Creek Agreement, in which the responsbilities of the Port Authority are described. The Port Authority was pledged to plan, construct, and administer a port area (Freeport) and to license businesses and industries therein in exchange for various tax exemptions and privileges.
Thanks to the management Port Authority the harbour of Freeport plays a significant role in the economic position and touristic sector of Grand Bahama Island, but also the rest of the Bahamas.

The airport and the harbour are important for the mobility and economy of Grand Bahama Island. They can be seen as the main transport and economy hub on the island: the connection to the rest of the world.
The two diagrams above represent the total import and export percentages for the harbour and port. 'transport' in the diagrams are the movement of people, which occurs mainly by planes. The import of mineral products is primarily mineral fuels, while the export of mineral products is largely crude salt.



Import - Harbour

Fossil fuels (mineral products)
Machinery and transport equipment
Food and live animals
Chemicals



Export - Harbour

Aragonite (mineral products)
Crude salt (mineral products)
Rock lobster (animal products)
Polystrene products (plastics)

The Grand Bahama infras (road) and political border

The main road is critical infrastru mobility of the inhabitants and tr of goods across the island. How road is crossing various borders, hard to maintain it. Many parties including private companies own of the land (Port Authority). They an opinion and having different r financing and interest.

- Privately Governed
- Locally Governed
- Large scale Governed

Airport

Grand Bahama International Airp ports primarily people from and t land of Athe United States of Am The national flights mainly go to city Nassau.

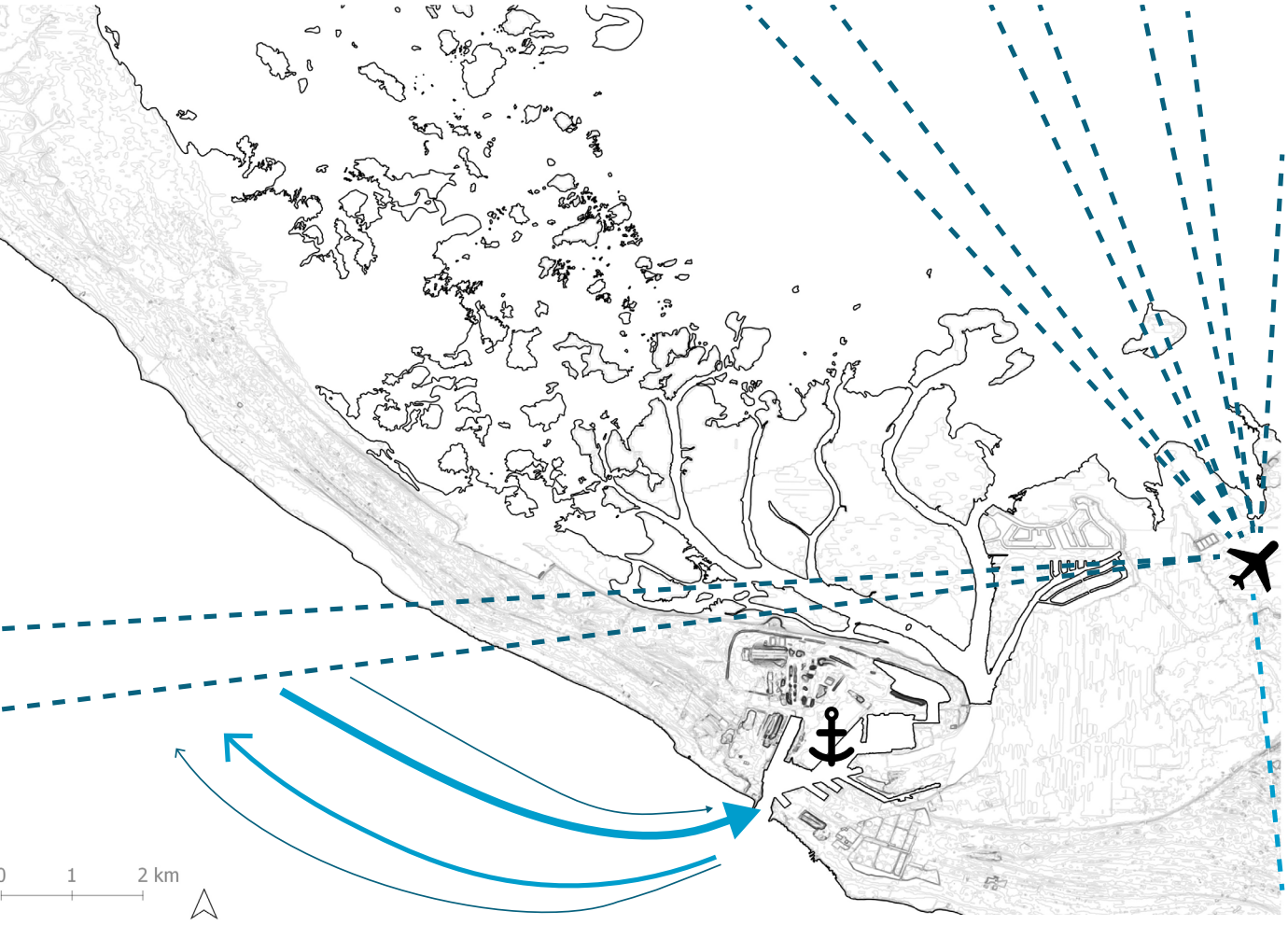
- National
- International

Harbour

The Freeport Harbour is a contai transhipment port. It is crucial for of goods for the Bahamians, like cars and other products that are produced.

- USA
- Other


0
1
2 km


0
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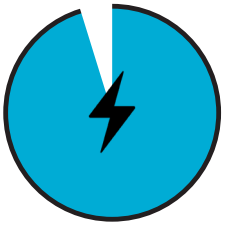
2 km

Energy Production & Consumption

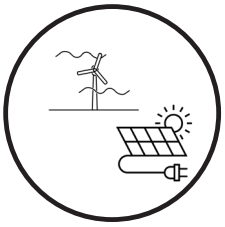
The data shown on the right is based on the total production and consuption of energy and fuel from all the Bahama islands. Since the population of Grand Bahama Island is 1/6th of the total popualtion, the consumption numbers can be multiplied by that number to have an accurate estimation of the consumption of Grand Bahama Island.
Additionally, Grand Bahama plays an important role in importing goods and fuels. Therefore, most of the imported energy will go throught Freeport Harbour.

All needed electricity is generated on The Bahamas from fossil fuels. Not all energy produced is consumed. No renewable energy sources are used in the process of generating energy.
There is no consuption of crude oil, so there is also no import of it.
All petroleum products and natural gas are imported. There is no reserves on the island: all that is imported is consumed.

- Locally produced
- Imported
- Not consumed/ imported/ exported



Electricity
Consumption: 1654 bil. kWh
Production: 1778 bil. kWh
Import: -
Export: -



Renewable Energy Sources
Consumption: -
Production: -
Import: -
Export: -



Crude Oil
Consumption: -
Production: -
Import: -
Export: -



Refined Petroleum Products
Consumption: 20040 bbl/day
Production: -
Import: 19150 bbl/day
Export: -



Natural Gas
Consumption: 48020 cu m
Production: -
Import: 48020 cu m
Export: -

Waste Disposal

At Grand Bahama Islar
collection company, pic
everybody. Next, they c
landfills. There are no r
the island.

Energy transition

Grand Bahama Island c
cling facilities and educ
about recycling. This co
their waste disposal pr

Moreover, the electricit
locally, is not green ene
sun hours in the Bahar
on buildings could prov
clean energy to match

Wind turbines could be
there is enough wind. H
be a sustainable option
of hurricanes, which wi
turbines.

The consumption of re
ducts can be reduced,
travel less by car and n
of transportation. Or sw

- Solar panels on bui

nd there is a waste
cking up waste from
lispose it at the
ecycling facilities at



could invest in recy-
cating their inhabitants
ould help in solving
oblem.

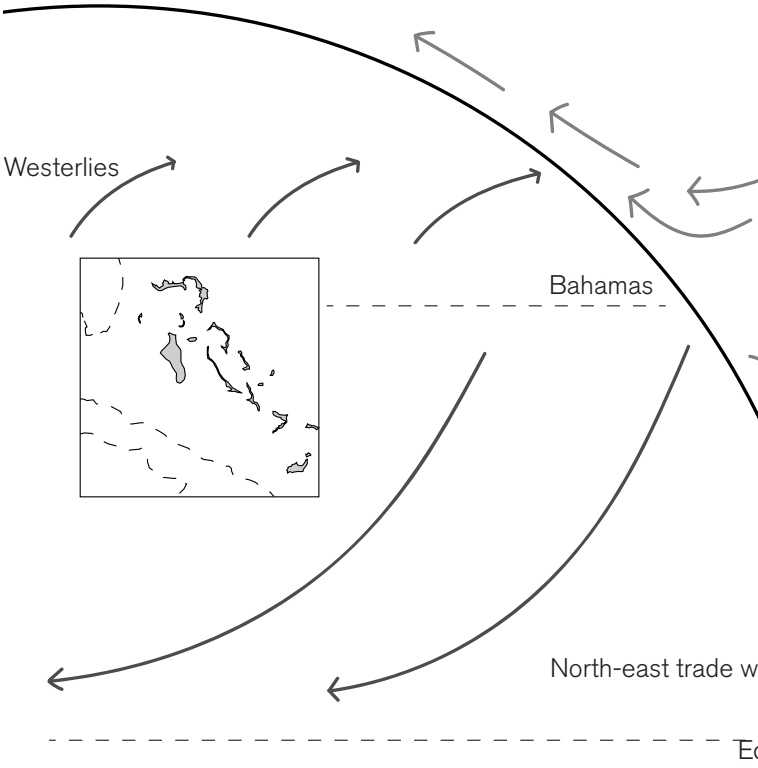
y that is produced
ergy. There are many
mas, so solar panels
vide renewable and
the electricty demand.

e built at sea, since
However, this will not
, given the frequency
ll destroy the wind

fined petroleum pro-
when the Bahamians
more by other modes
witch to electric cars.

ldings



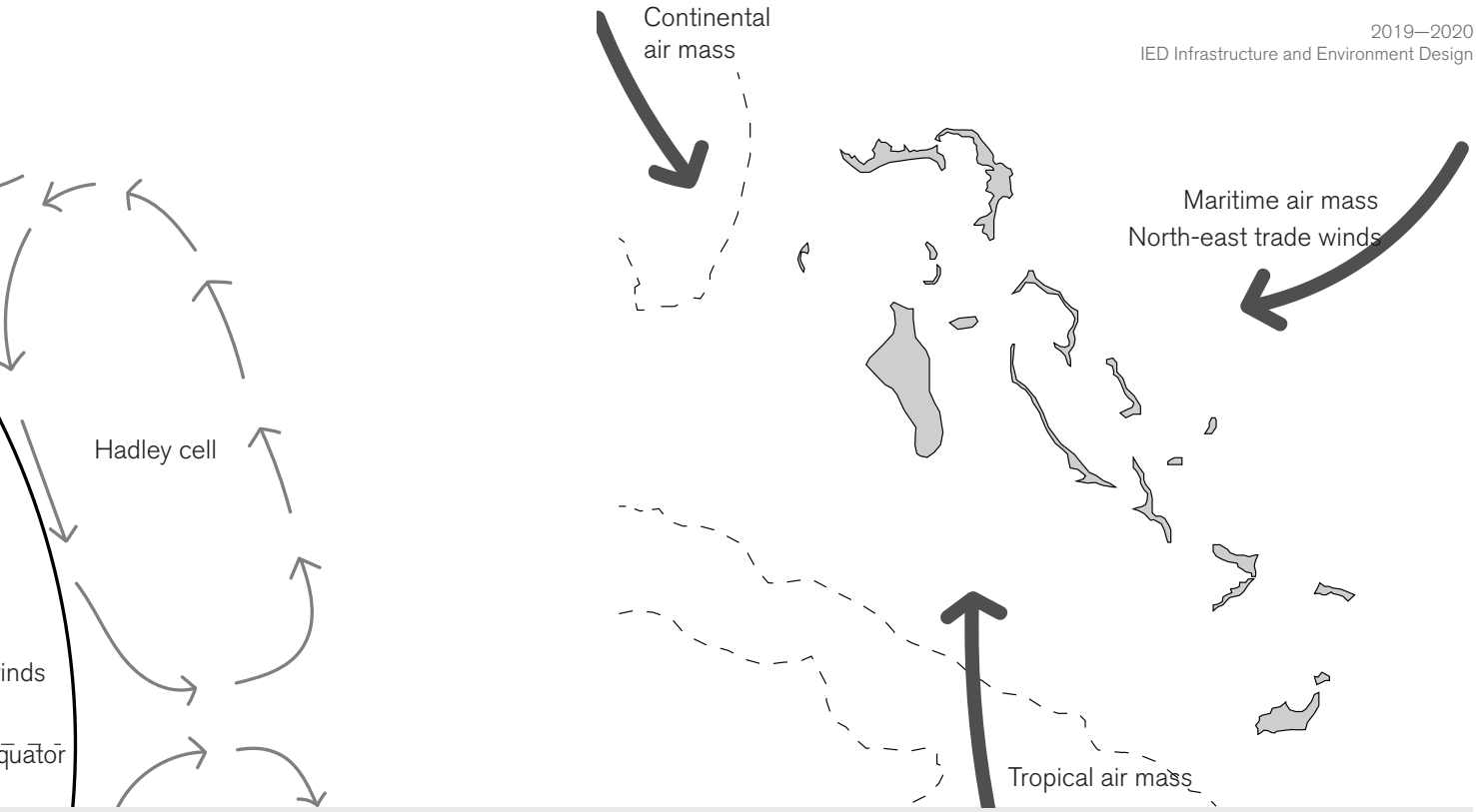


Wind system

Considering the global winds, The Bahamas are located at the edge of the Hadley cell, in between the Westerlies and North-east trade winds. This is explains the dynamic hurricane season. There are 3 main airmasses moving towards the Bahamas: a continental, maritime and tropical air mass. The most common wind direction is Eastern winds. At sea the average wind speed is 5 m/s. Most coastal areas have 4 m/s and the inland and urban areas less than 3 m/s.

- 5 m/s
- 4 m/s
- < 3m/s




Continental
air mass
Maritime air mass
North-east trade winds
Hadley cell
inds
quator
Tropical air mass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J
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Water system

There are two main currents flanking the Bahamas: the Florida Current on the North-West and the Antilles Current along the entire East side of the Bahamas. These currents cause the motion of the waters around the Bahama islands. The Florida Current travels with a relatively high velocity and there are circles of flows of water formed around the scattered islands. The sea temperature is warm during the year and increases in the summer months.

- 0 m/s
- 0.25 m/s
- 0.5 m/s
- 0.75 m/s
- 1 m/s
- 1.5 m/s

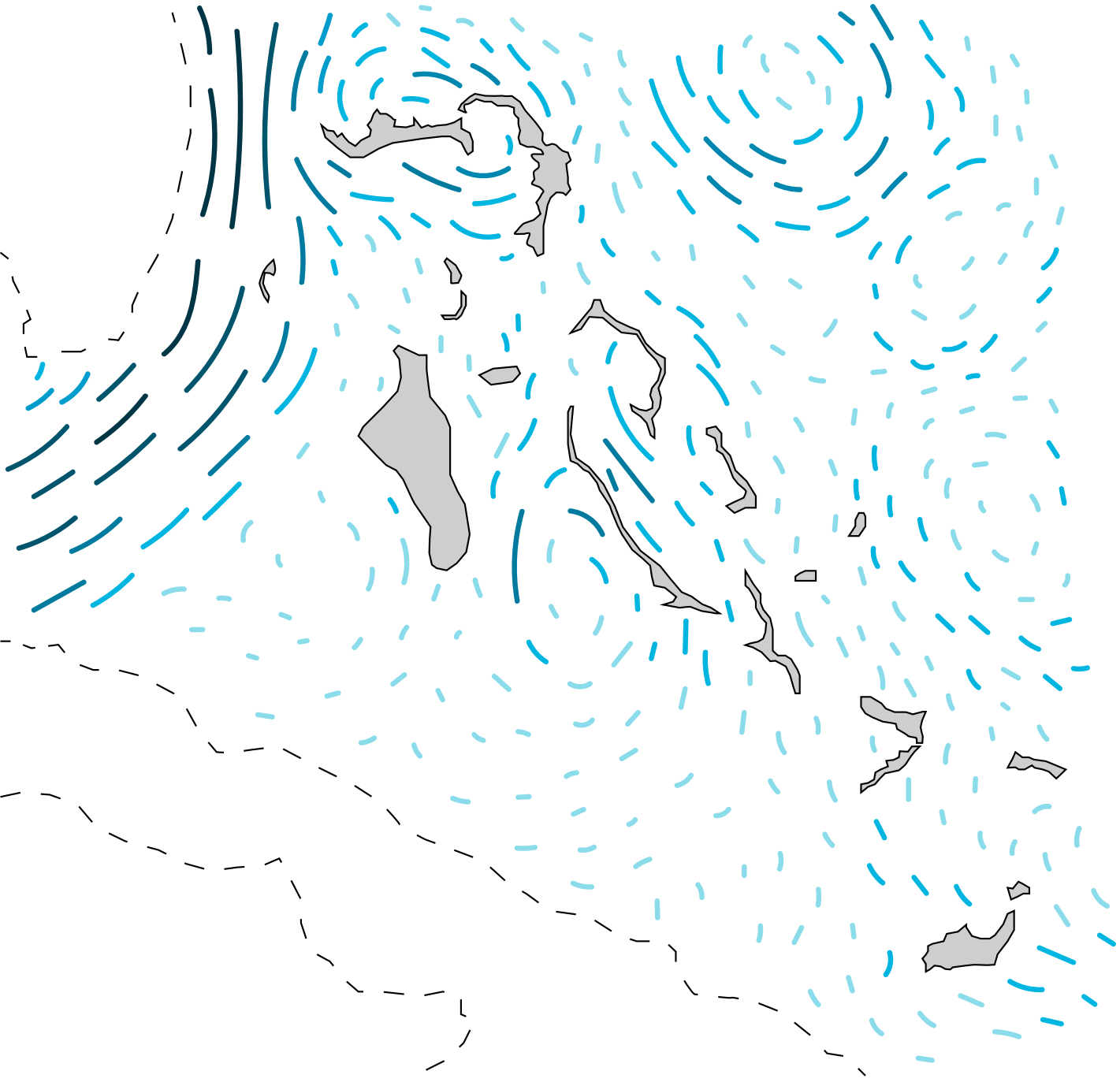
Florida Current

Antilles Current

Sea temperatures

20 C 30 C

Jan
Feb
Mar
Apr
May
June
July
Aug
Sep
Oct
Nov
Dec



Ocean and water depth

The north side of the Grand Bahama is a marsh land, including shallow waters (0-2 meters deep) and many little pieces of land. Coral reef can be found here too.

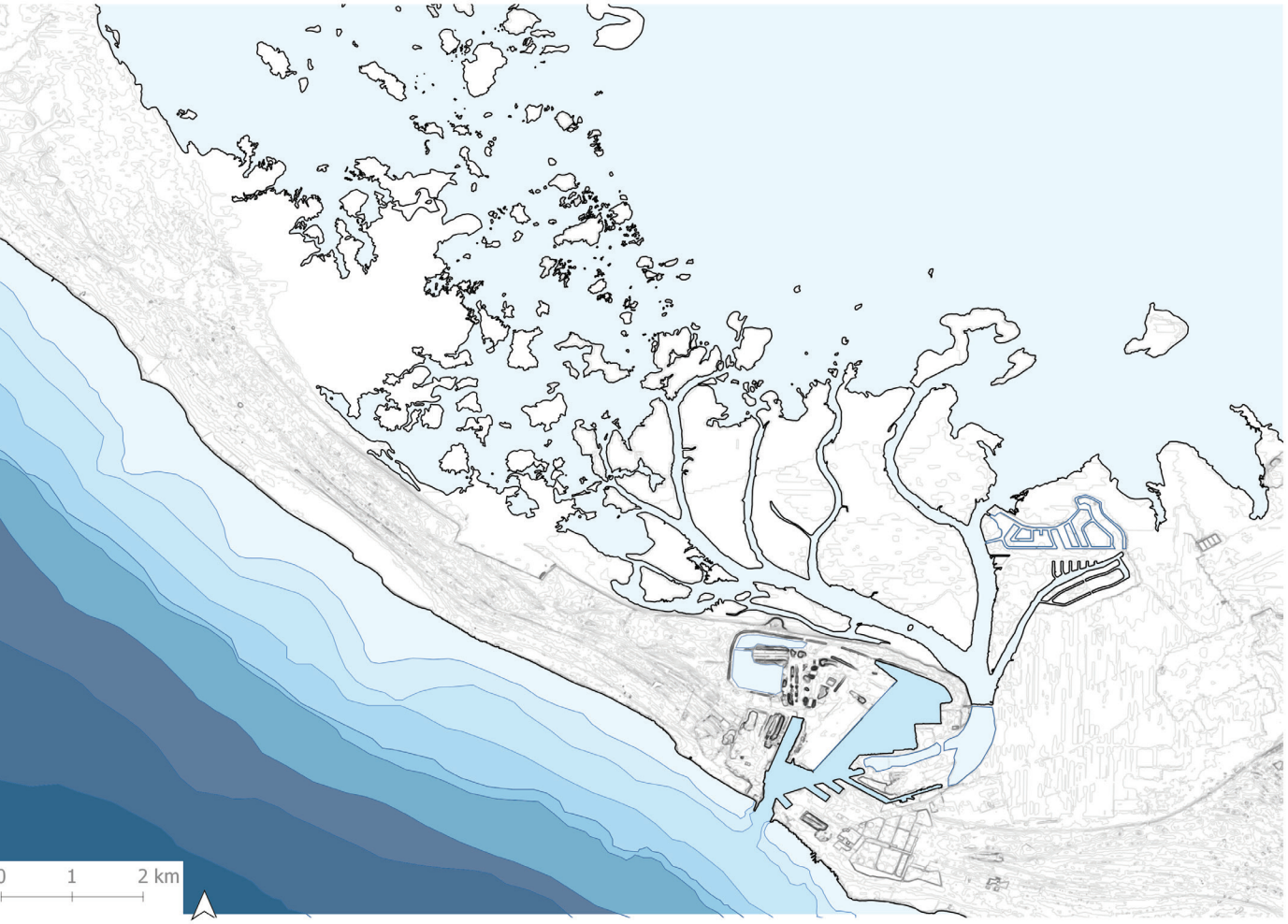
The south side of the Grand Bahama is aligned with deep ocean waters. On the south side there is a harbour. The deep waters are very suitable for large ships.

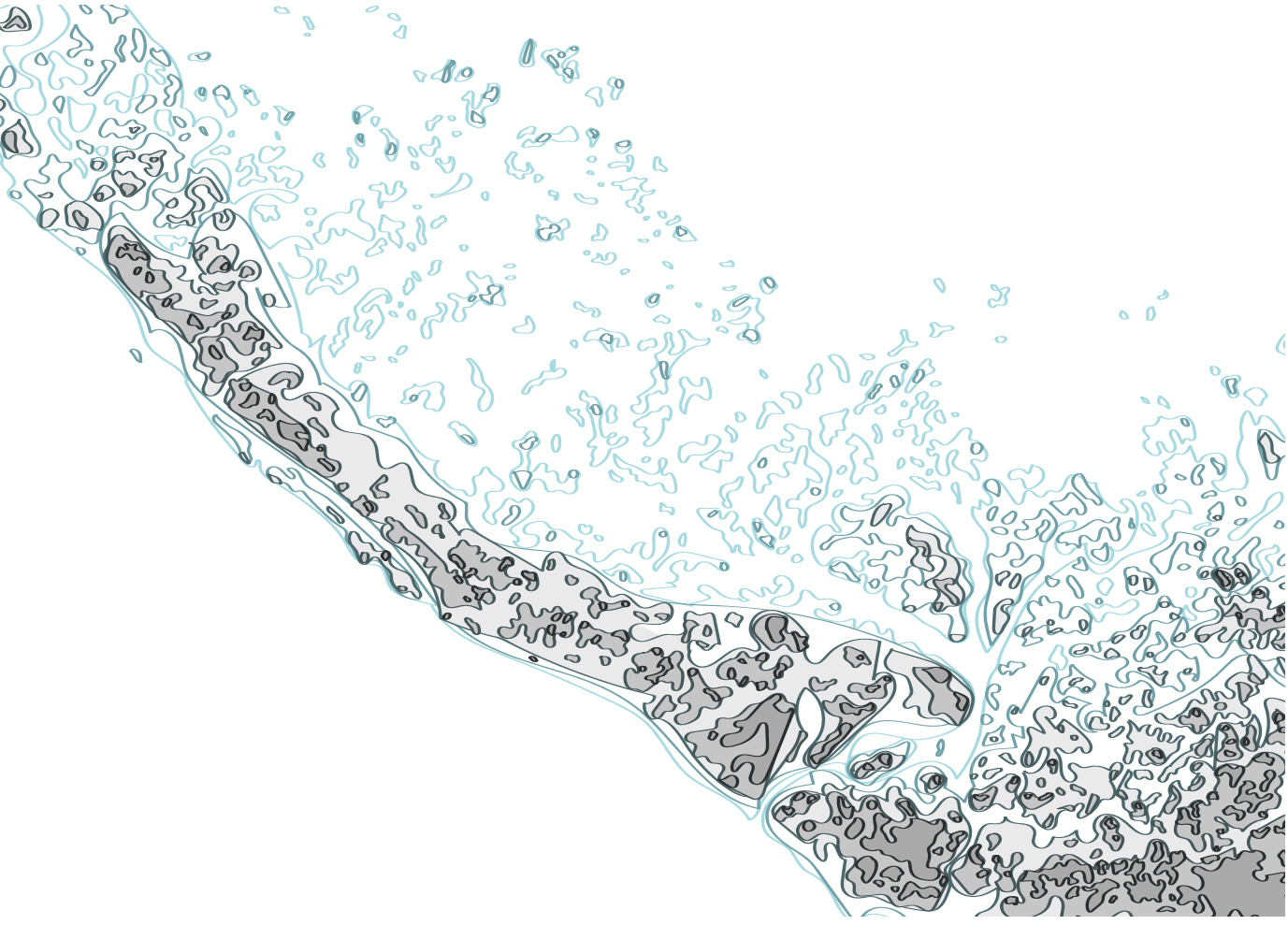
- 0 - 5 m
- 5 - 10 m
- 10 - 15 m
- 15 - 50 m
- 50 - 100 m
- 100 - 200 m
- 200 - 300 m
- 300 - 400 m
- 400 - 500 m
- 500+ m

Flood risk map

Due to climate change, the sea level will rise and therefore the height of the waves will increase to. From this map it can be concluded that the north side of Grand Bahama Island is likely to flood wth relatively low waves and water heigths. Bain Town and other small settlements are relatively save. However, the water will surround the towns and create isolated groups of people.
This map can be used to choose a location for shelters (in the dark grey areas) and calculate the capacity and action radius of this shelter (light grey areas).

- 2 m
- 4 m
- 6 m
- 8 m
- 10 m


0
1
2 km



Hurrican Damage

The black arrow on the x-axis shows the intensity of the winds and floods which we need to prepare for considering hurrican level 3 or higher conditions.

Damage by windspeed is growing exponentially and has approximately the same impact on residential as commercial buildings.

On the other hand, strom surges cause more damage to the commercial sector.

Both factors need to be included when designing the Grand Bahama Island and Bain Town to be climate proof.
Buildings and cities need to be designed to be resistent against high winds. Examples could be planting trees or the configuration of the buildings itself.

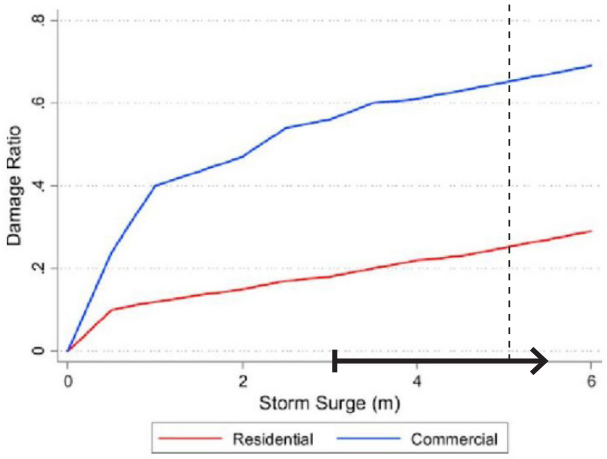
Sea level rise and the system

The low lying land on the Grand Bahama is very vulnerable to flooding. The civilized areas are relatively safe, since those are more locatied on the south side of the area.

However, floods might cause to split the critical infrastructure into small pieces, making it impossible to travel long distances across the island by car or any other road vehicle. Moreover, the airport is flooded, meaning there is no way to use this as a mode of transportation during a flood.

The system as it was functioning before needs to be replaced with another system. Instead of having one road connecting everything from left to right on the island, there should be hubs on the higher lands, that can function as a main point and shelter in case of hurricanes and floods.

In case of an evacuation, there should be enough shelters on those isolated areas. Besides, there should be means to evacuate the island in this condition. The blue arrows in the map suggest evacualtion on these location by boats.



Figure

Caption

Fig. 5. Storm surge damage function.

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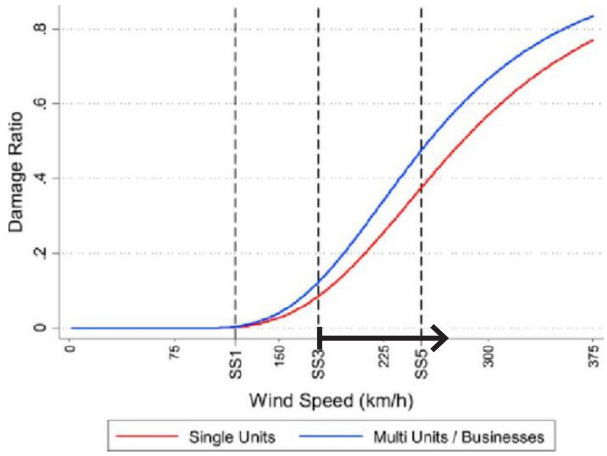

Figure

Caption

Fig. 4. Wind damage function.

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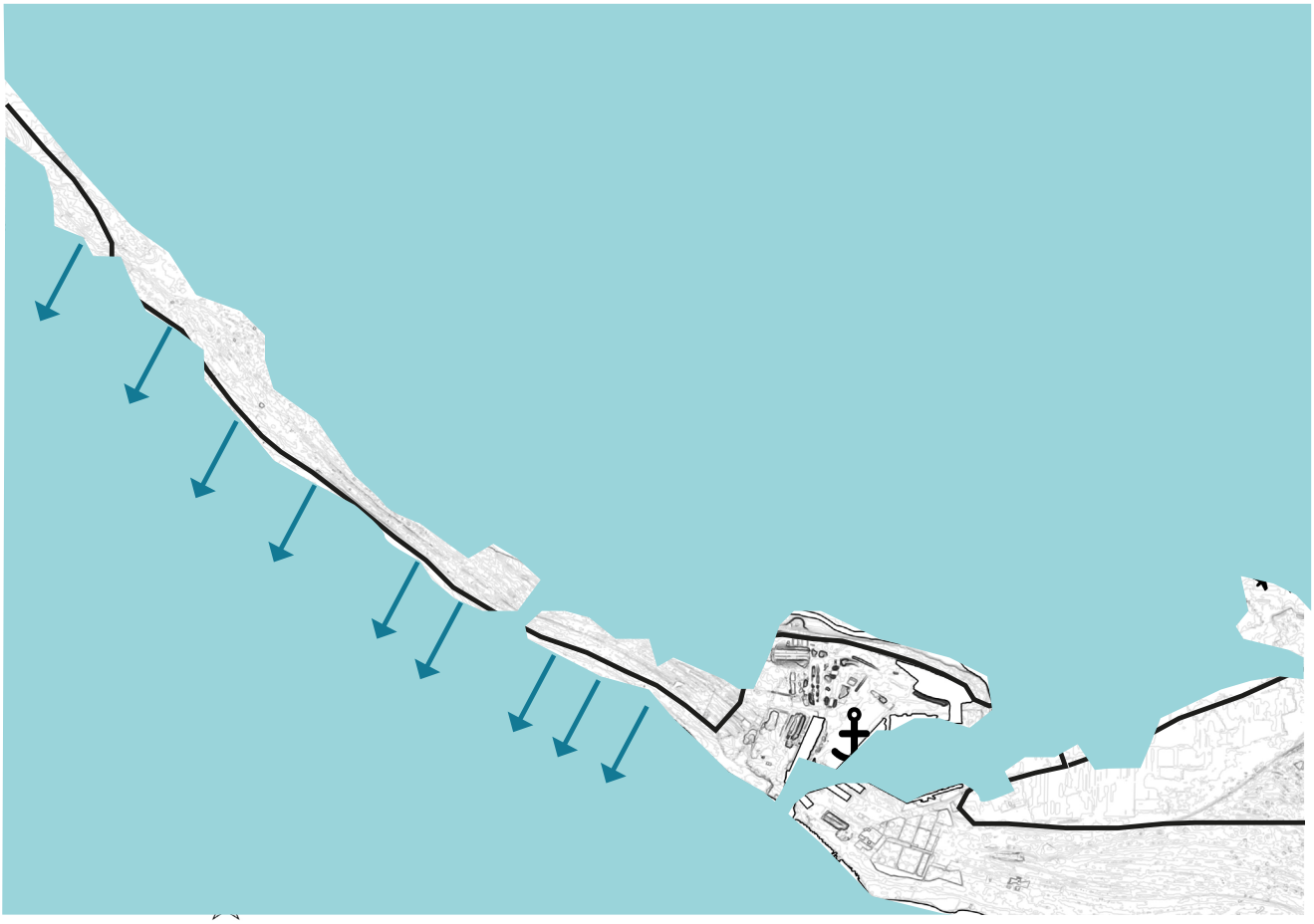


3.2.

Anthropology

Timeline Grand Bahama

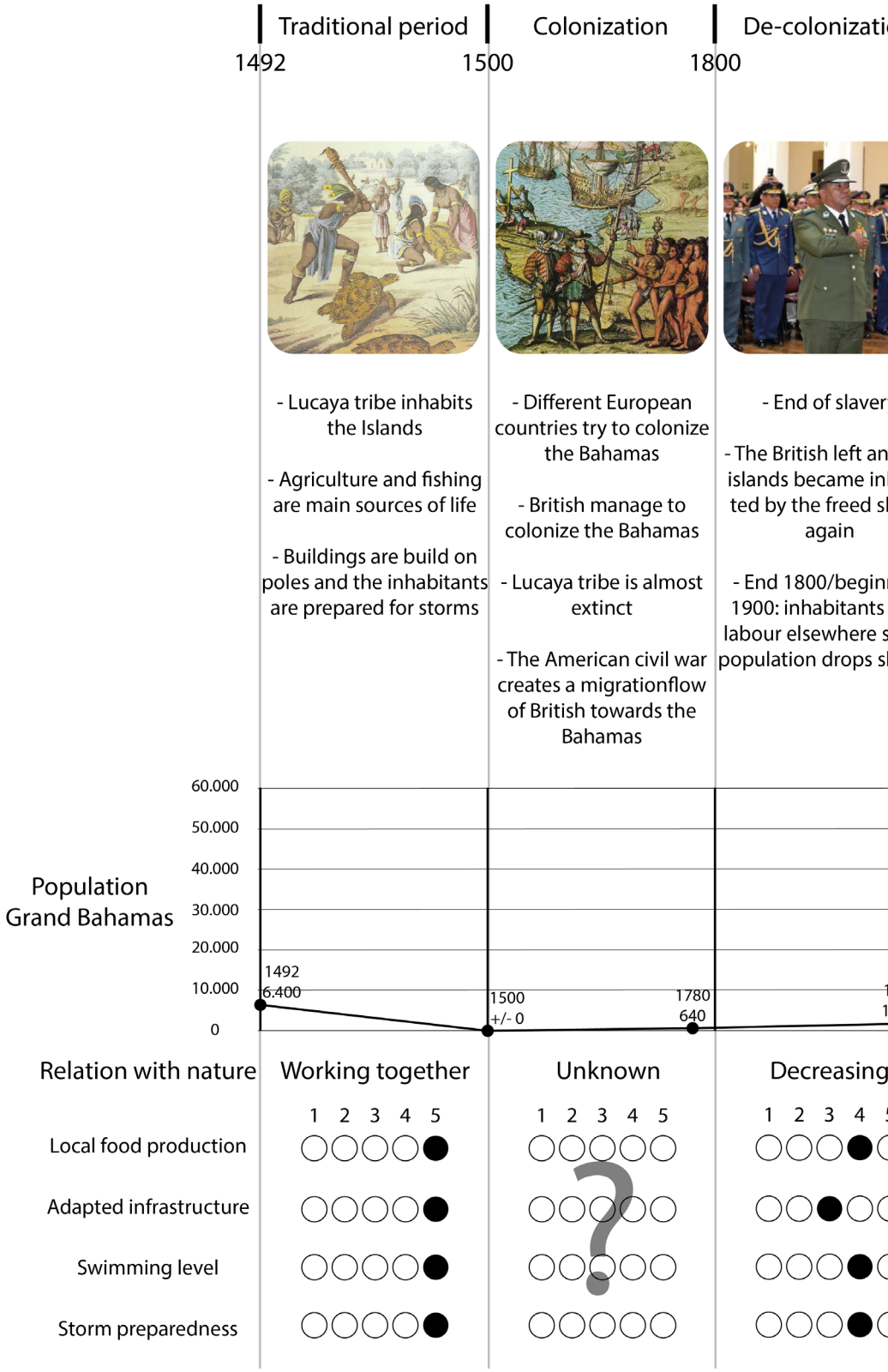
From origin Grand Bahama was inhabited by a small tribe named the Lucayana tribe (Buchan, 2000). This tribe was living closely together with nature. As soon as the Spanish and British people arive, the population of the Lucaya tribe went down dramatically, caused by sicknesses and the use of the Lucaya people as slaves (Buchan, 2000).

In the 19th century the British stopped the slavery and left the Island, but the American civil war resulted in a new flee of British people towards Grand Bahama. This last group settled with the left over Lucaya inhabitants and they are the basic of the current population (Buchan, 2000).

In the 20th century the population increased drastically as the inhabitants switch from a natural way of living towards an economical way of living (Buchan, 2000). Boats were replaced by cars, houses were build in the American style and the industry focussed on tourism (I. Stachan, Lecture 30-04-2020.

During all these centuries the island had to coop with heavy storms (noaa, 2020). As the traditional population was able to adapt to these storms, the modern population is not anymore. This makes the damage of casualties and buildings/infrastructure heavier then needed. Another effect is the decreases of the population. After Dorian hit in 2019 an estimated amount of a couple thousand people left the island since it was unsafe for them to stay (I. Stachan, Lecture 30-04-2020; Kaur & Britton, 2019; Al Jazeera News, 2019). What will happen in the future depends on how the island will adapt towards the storms.

note: For the population after 1920 an estimation is used of the total population of the Bahamas and the percentage living on Grand Bahama in the years before. Real data is not available of the islands total population



on	Modern period	Dorian preparation	Dorian	Rebuild period	Future	
1920	August 2019	1st september 2019	4th september 2019	June 2020		Future











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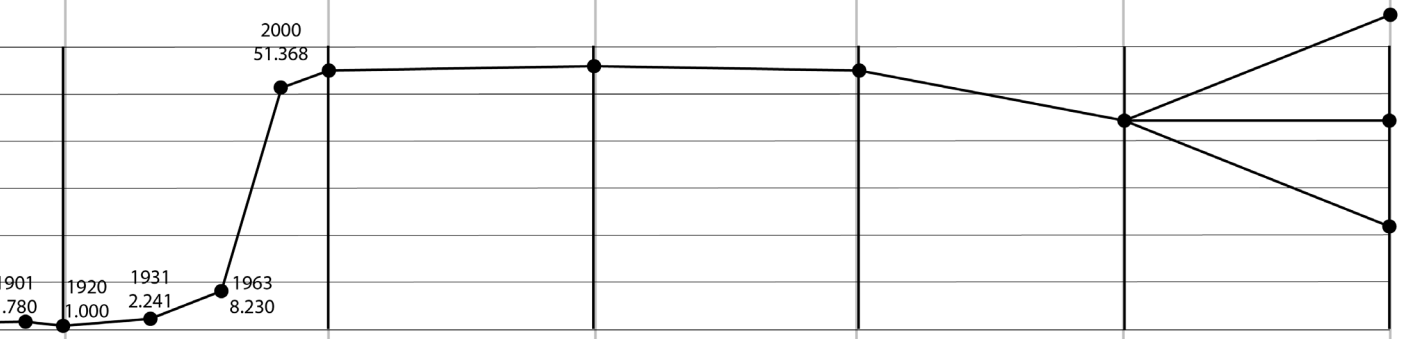
- Agriculture and fishery make place for a tourism based economy
- The culture and history are being forgotten
- The amount of inhabitants increases enormously

- The standard protocols are being taken
- Inhabitants create a small food and water supply
- Inhabitants move away from dangerous areas
- Evacuation shelters are supplied
- Tourists leave the island

- Storm is heavier then expected
- Shelters get demolished and inhabitants have to evacuate again

- The damage is enormous
- Inhabitants and the surroundings were not prepared against these type of storms
- Government focusses on rebuild for tourism
- Inhabitants leave the island

- More equal or heavier storms are expected
- Inhabitants will evacuate next time
- Buildings and inhabitants should be prepared more



	Decreasing	Barely present	Barely present	Barely present	Should increase
1 2 3 4 5	○○○●○	○○●○○	○○●○○	○○●○○	○○●○○ →
	○●○○○	●○○○○	●○○○○	●○○○○	●○○○○ →
	○○●○○	○●○○○	○●○○○	○●○○○	○●○○○ →
	○○●○○	○●○○○	○●○○○	○●○○○	○●○○○ →

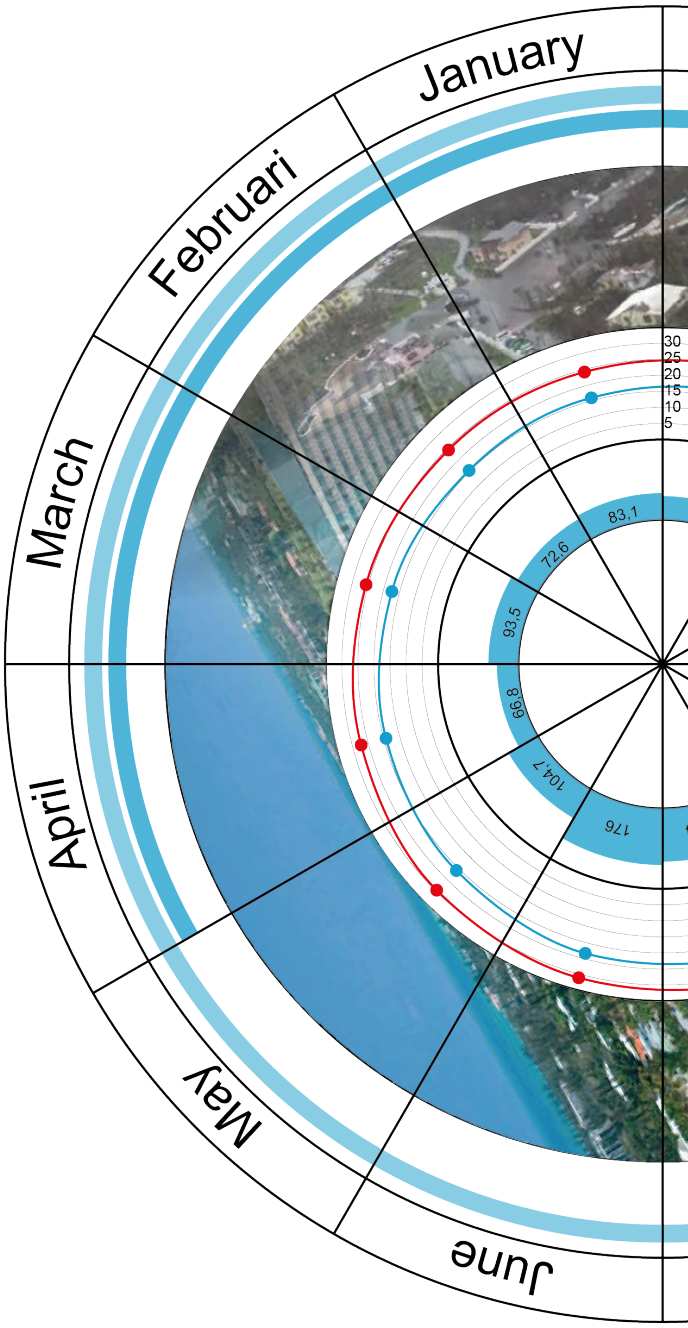
Yearly timeline Grand Bahama

Besides a historical timeline Grand Bahama also has a seasonal timeline which includes three major seasons. In the timeline on the right these different seasons are shown with it's weather information.

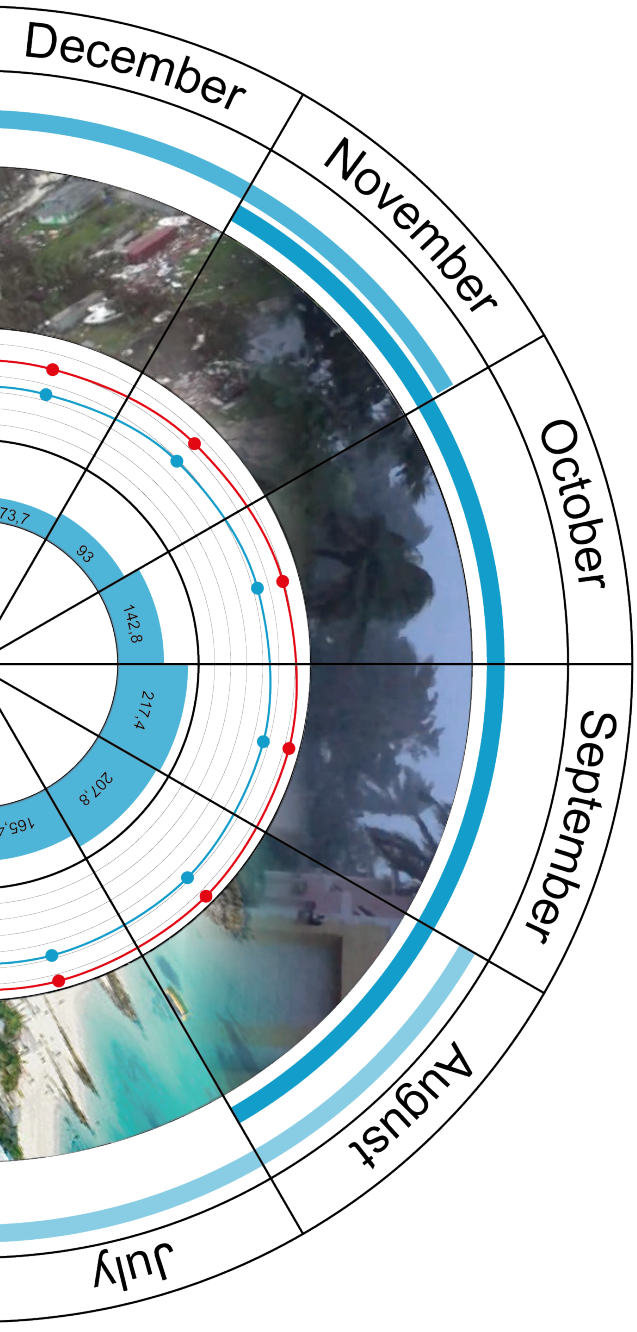
The tourism season starts around January and takes place untill around august, when the hurricane season starts. In this period about 750 mm of rain falls down and the temperature goes from a minimum mean of 15,5°C and a maximum mean of 32,2°C (WMO, 2020) which makes it an ideal weather situation for tourists who seek the sun.

This tourism season mostly comes to an end when the first hurricane strikes the land. On avarage about 1 major storms Grand Bahama every year (noaa, 2020), which results in problems for almost every island in every season. These storms already leave a devastating ravage behind and with the expected increase of heavyness and amount of storms caused by climate change, this problem will only increase.

After the hurricane season a period of restoration takes places. When the hurricane wasn't to heavy this could take a couple of weeks or months, but in case of the hurricane Dorian this is already taking a year, and probably won't be finished before the next hurrican season starts (I. Stachan, Lecture 30-04-2020).



- Hurricane season
- Restore season
- Tourism season



A bahamians life

On the image on the next page the interior of a basic Bahamian house is shown (The Bahamas Government department of Housing, 2013). The upper section shows the Bahamian life in a normal situation and to lower section shows the Bahamian life during and after a storm. Different aspects regarding normal life and living with the storms are taken out and described according to information written by Buchan (2000) and told in a lecture by I. Stacham, dean of the University of the Bahamas.

These different aspects are compared to the concept of "A Credible Biospehere" by Mary Douglas (1992). The symbols used show 4 stages of change by natural or human interference in a natural situation. In most of these cases it becomes visible that the current way of living on Grand Bahama is vulnerable to change. Also resilient to change is showing up often, while uncertainty to change and a nature drive change are barely visible. This shows again that the current life of the Bahamian people is vulnerable towards the storms, and changes need to be made to make reduce the harm of the storms in the future.


Uncertainty to change


Nature drives change, in control


Vulnerable to change


Resilient to change

Nature

Sea life

Luxury

Fishery

Community

People

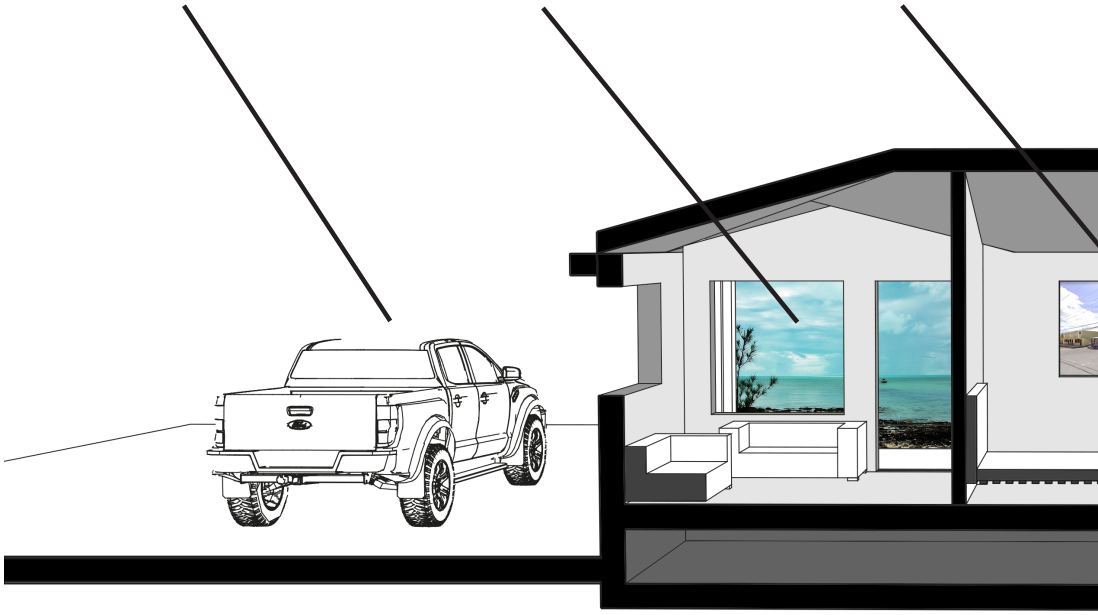
1

2

3

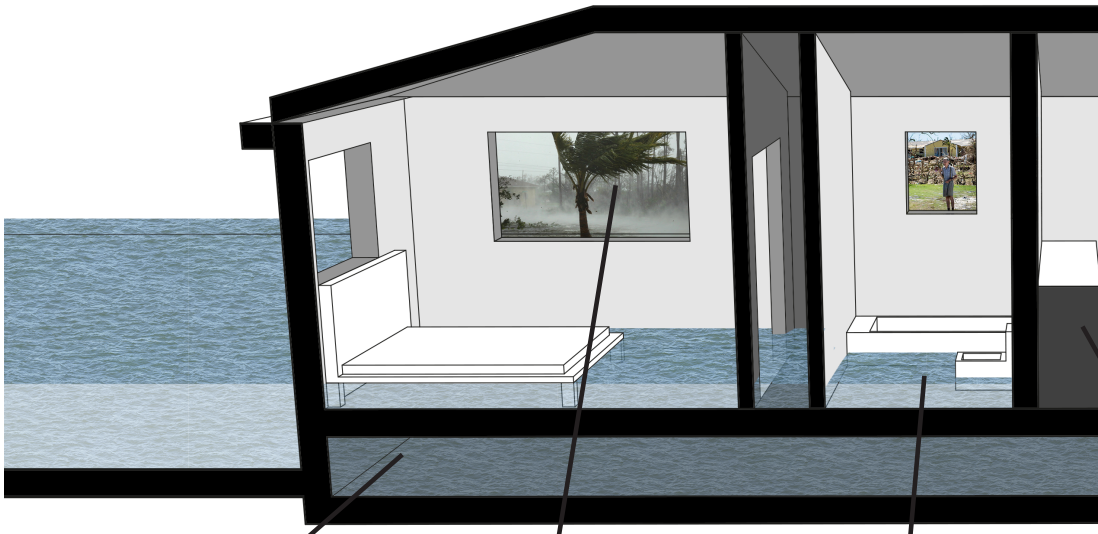
1. Luxury is more important then safety. Inhabitants earlier spend their money on cars, to show wealth, then on boats to flee in a disaster situation

2. People rely on the water for fishery. Water is close-by and mainly on the same height as the buildings



3. The community feeling is important for the inhabitants, but the community buildings don't fullfill as shelters during disasters

4. Most of the natural places are turned into urban areas to facilitate the tourism industry. Classic farming, forestry and mining is almost completely gone



5. Most clothes in the closets are daily or evenement based clothing, but protection for disasters are barely available

6. Most houses have private ground around it, which is partly used for some food supply

7

8

9

Waterbuffer

Buildings

People

Storm

Water

Nature

Nature

Tourism

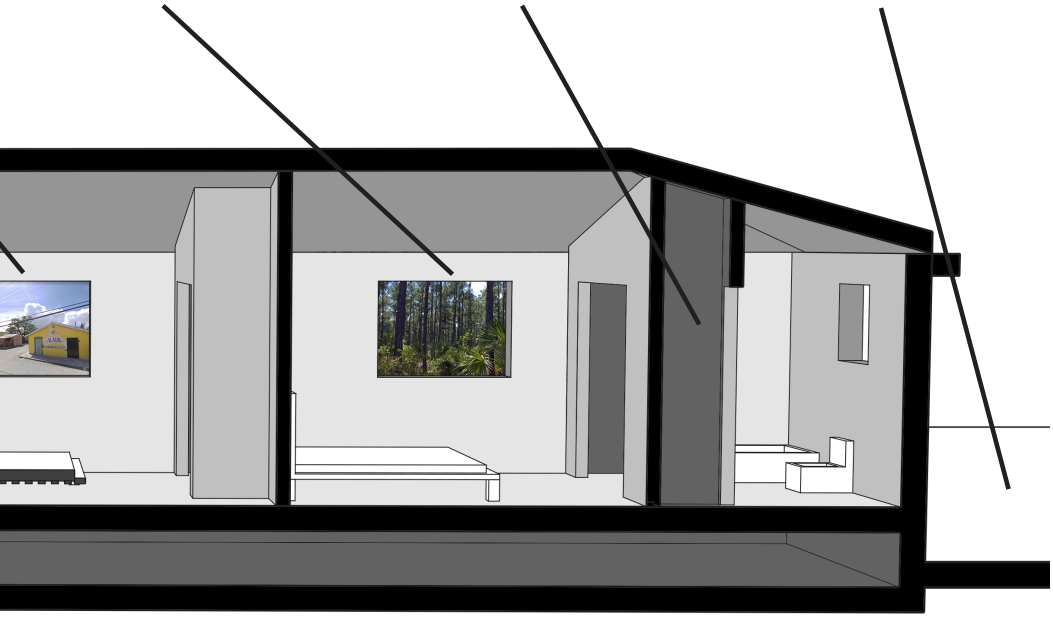
Clothing

Farming

4

5

6

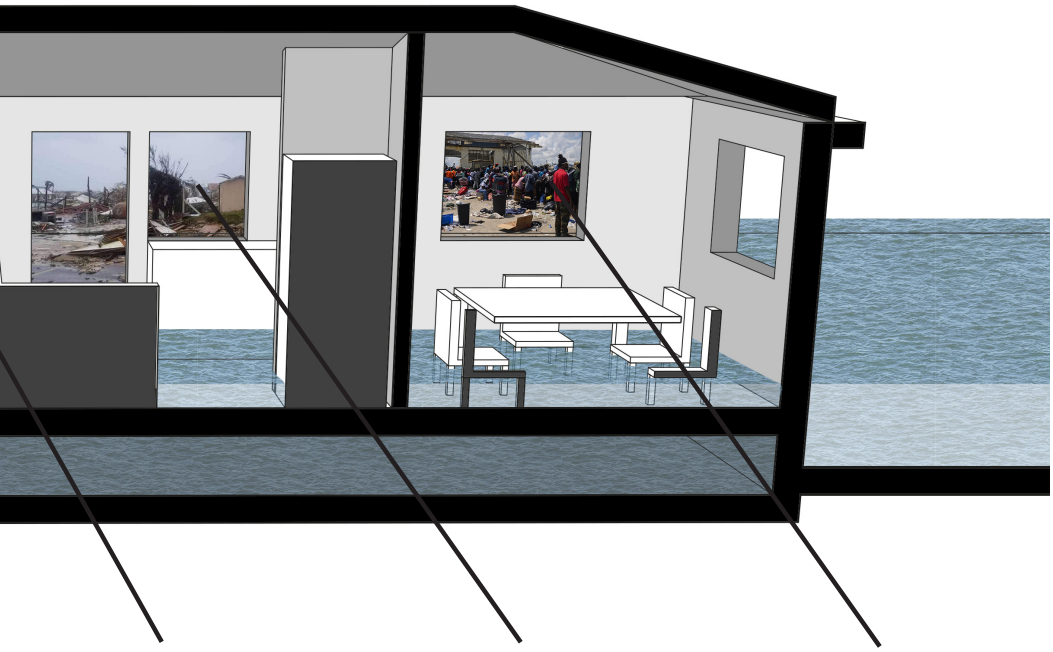


7. Buildings are build higher then the ground level, which creates a possible water buffer. Still a lot of water run into the buildings, which is a problem since most people can't swim

8. The storm stayed on the island for about 3 days, which made it impossible to go outside safely

9. A lot of building flooded, and since a lot of them are just one floor, this resulted in unsafe situation for a lot of families

10. Bahamians love good food and use local products a lot, but they didn't had a big supply to foresee in food for during and after the storm



11. Most of the island got demolished by the storm. A lot of people had to flee during the storm and others fled forever after the storm. Most people were not insured against the ravage

12. Inhabitants got in problems by the big ravage caused by the storm. The high amount of poverty in the Bahamas made that a lot of people had shortages of food and a shelter

10

11

12

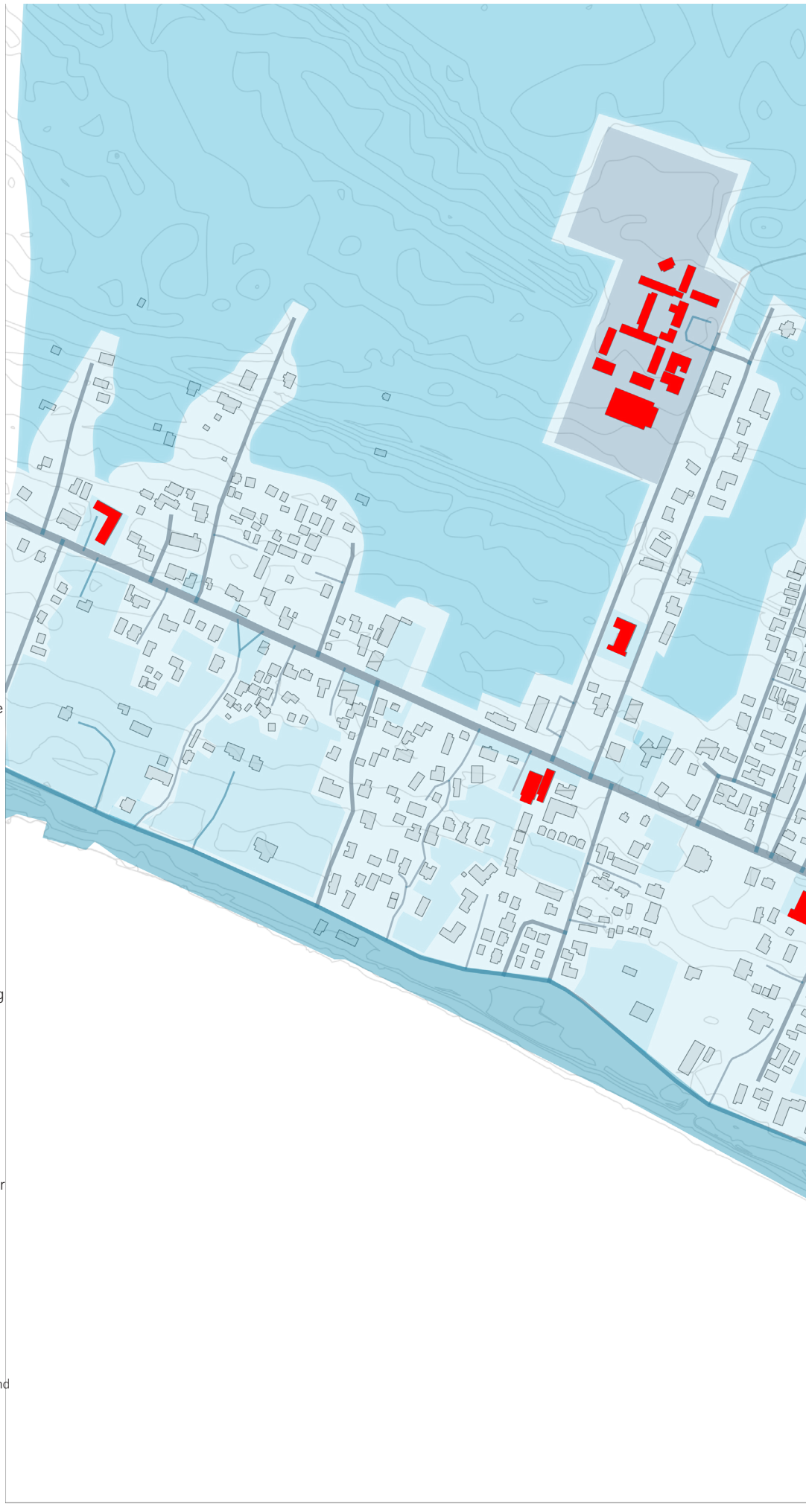
Food supply

Insurance

Impact

Spatial and environmental justice

As the map shows, most of the land of Bain Town is occupied by the government. This land is mainly free to be used by nature and the government doesn't bother to much about this land. However, this land could become a great natural storm buffer, but to get this done, some human involvement could help. As the national government is to far away from this area, they won't undertake action. Therefor it's important to make this land available for the local community in coporation with the government. The same counts for the red shown buildings. These governmental buildings could be ideal to be used as shelter, but currently they are not being used (Lines & Morris, 2020).
To the south of the main road it's clear that a lot of community ground is present. To the north this community land is scarce. This can be beneficial since the community areas are more located to one area which brings everyone to the same place, but the disadvantage is the large distance towards these community areas. This could lead to a feeling of exludeness for these people.
Also the high amount of private land could be beneficial as well as a problem. It shows that all inhabitants have a private place to use for what they want it, which makes people go outside easier and gives people a better feeling. However, when the area should be developed to make it storm proof, these pieces of land are harder to get involved. Therefor not only the government or community, but also the individual inhabitants should be convinced of these kind of interventions.





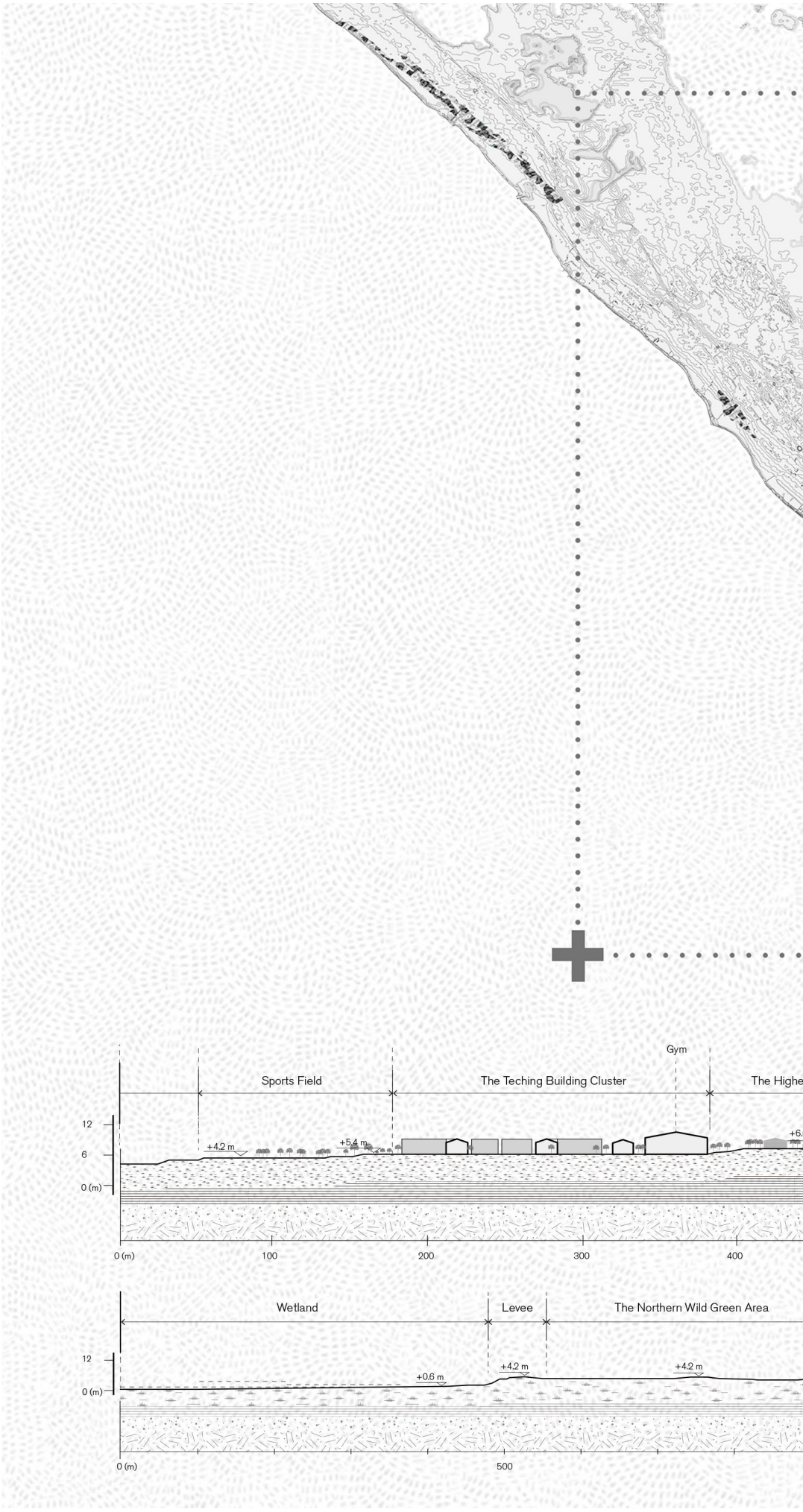
3.3.

Landscape Morphology

Chen Gao

Elevation

The middle west part of the Gand Bahama is a narrow island with large floodplain in the north and sharper slope in the south (Open street map, 2019; BNGIS Centre, n.d.). Gennerally it is plain and human settlements are located in the higher part in the middle.
Because of the island situation, most of the soil are sand and clay. (Simpson, L., 2013).

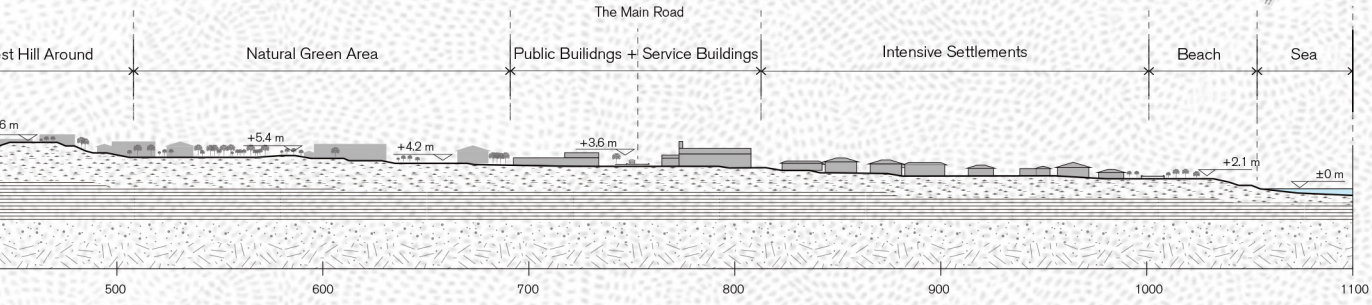


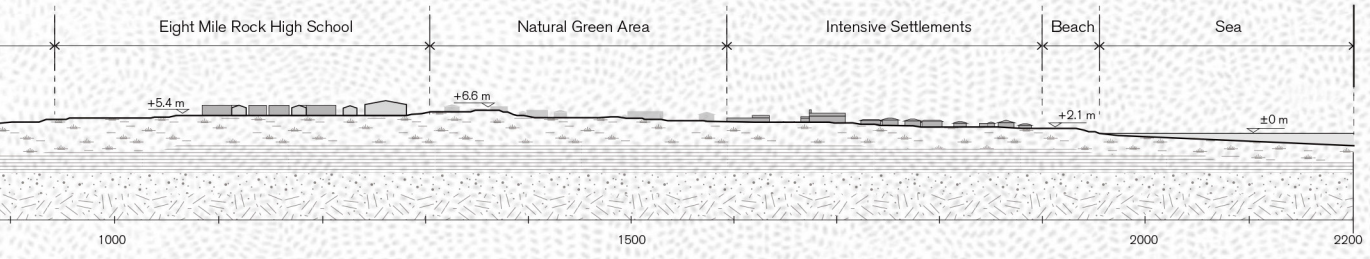
Island
Water
Wetland
Counter line

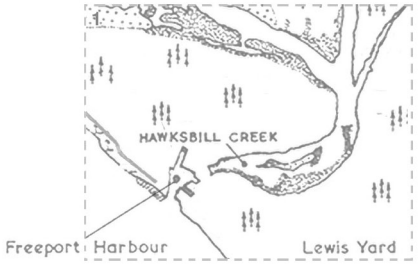
N

0 1 2 km

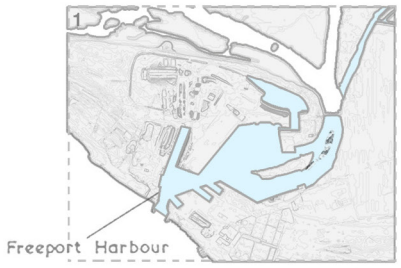

1
1


The Main Road
st Hill Around
Natural Green Area
Public Builidngs + Service Buildings
Intensive Settlements
Beach
Sea
6 m
+5.4 m
+4.2 m
+3.6 m
+2.1 m
±0 m
500
600
700
800
900
1000
1100

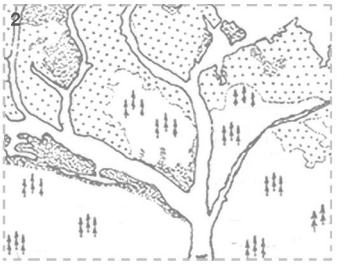

Eight Mile Rock High School
Natural Green Area
Intensive Settlements
Beach
Sea
+5.4 m
+6.6 m
+2.1 m
±0 m
1000
1500
2000
2200



1966



Now



1966

Vegetation(Now and history)

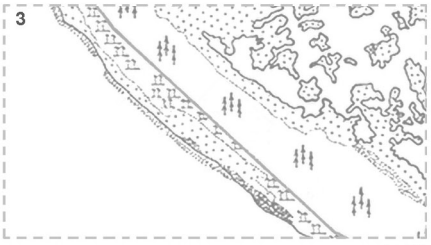
The island is occupied with mangrove and pine forest in the past. However, because of the human activities like expansion of the living area and habour, many Hashimoto plants have degenerated into shrubs or wetlands. (Groner-Youngerman International Limited. & Bahamas Properties limited, 1966; Open street map, 2019; Little, B. G., BG, L., & PWT, H, 1977; The Bahamas Department of Lands and Surveys, n.d.).



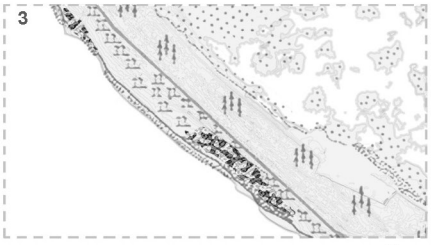
Now



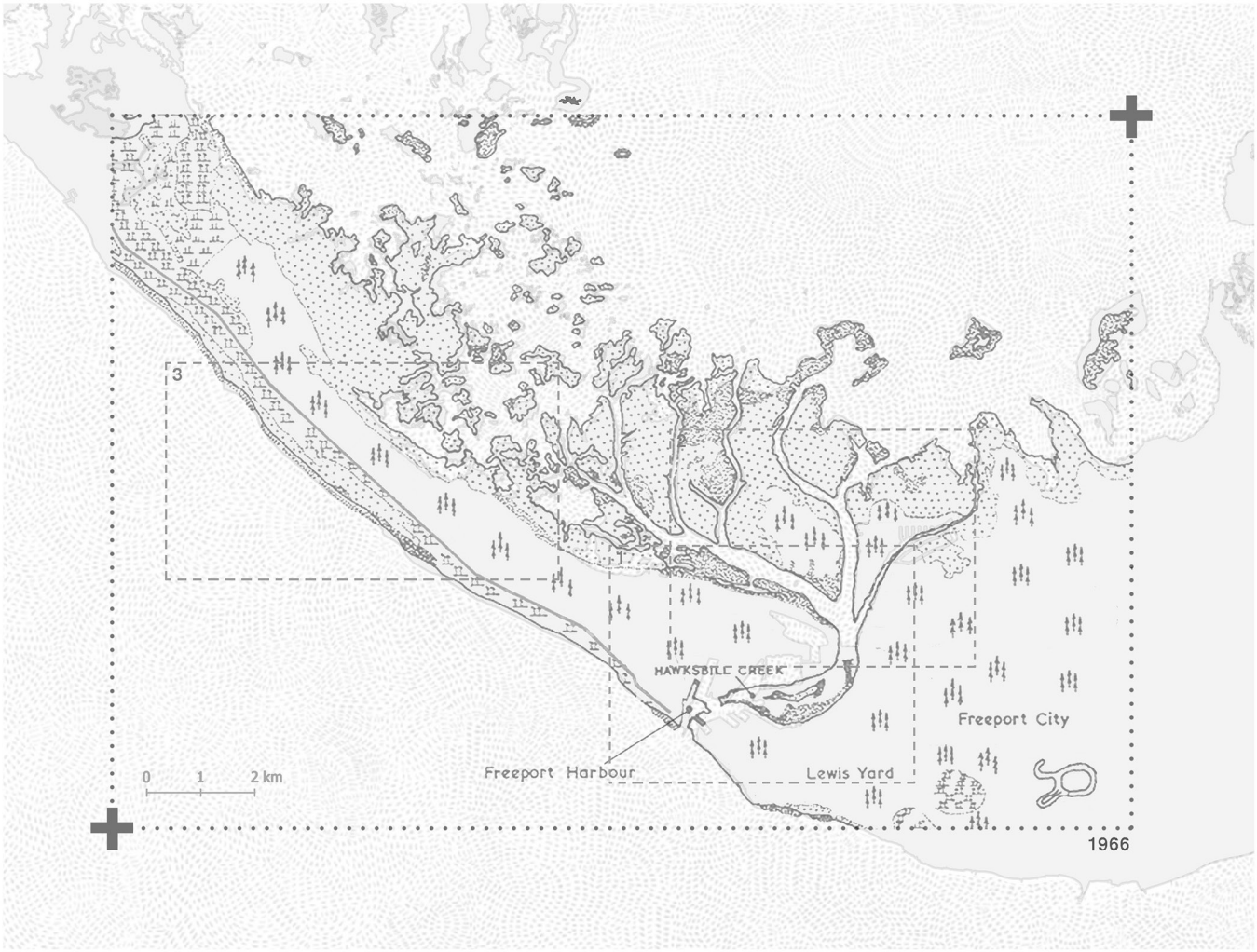




1966



Now


3
HAWKSBILL CREEK
Freeport City
Freeport Harbour
Lewis Yard
0 1 2 km
1966


0 1 2 km
Freeport Harbour
Now

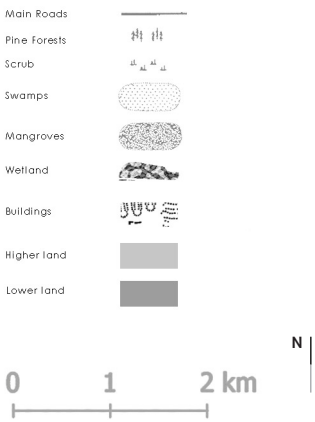


Shrubs surrounding buildings SCOTT OLSON (2019)

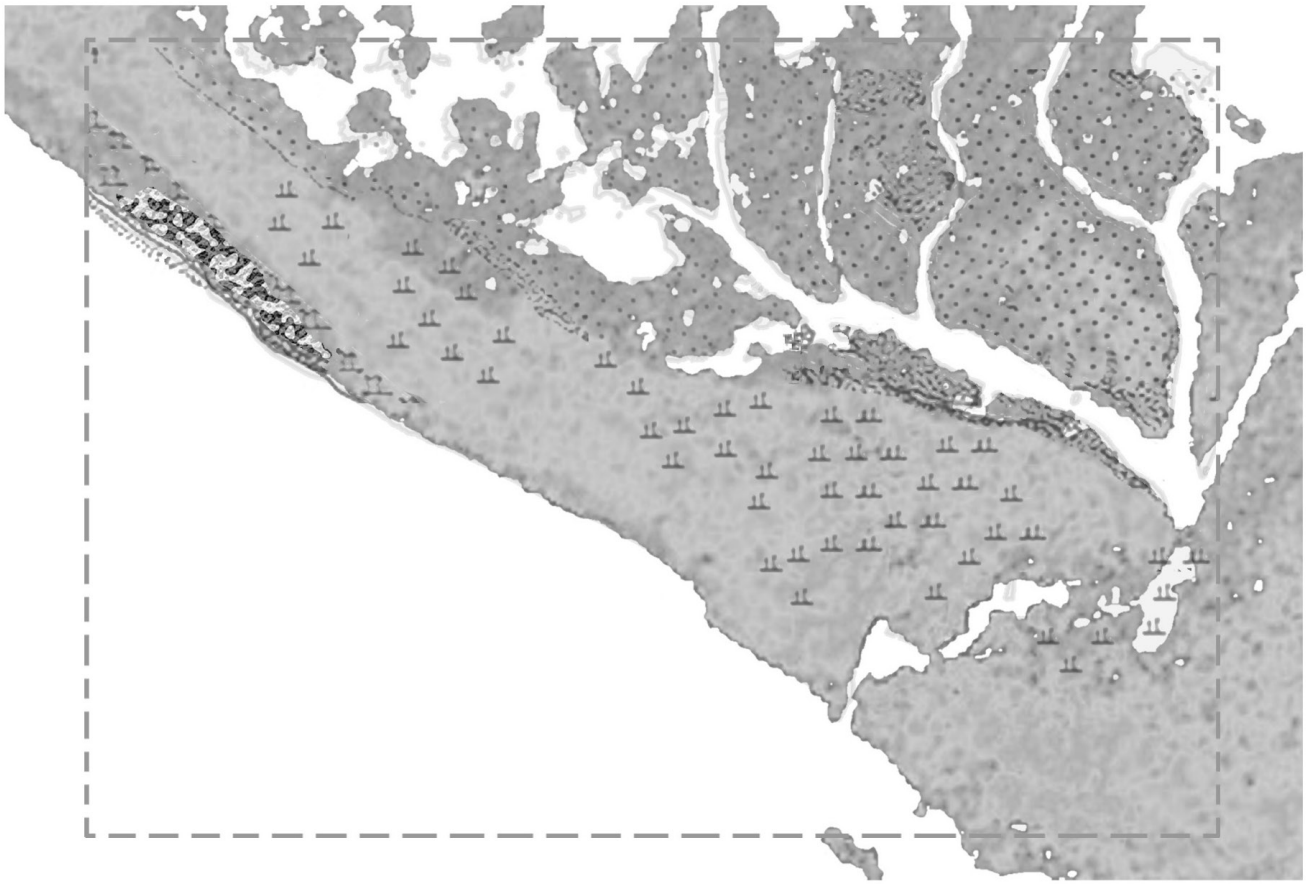
Composition map

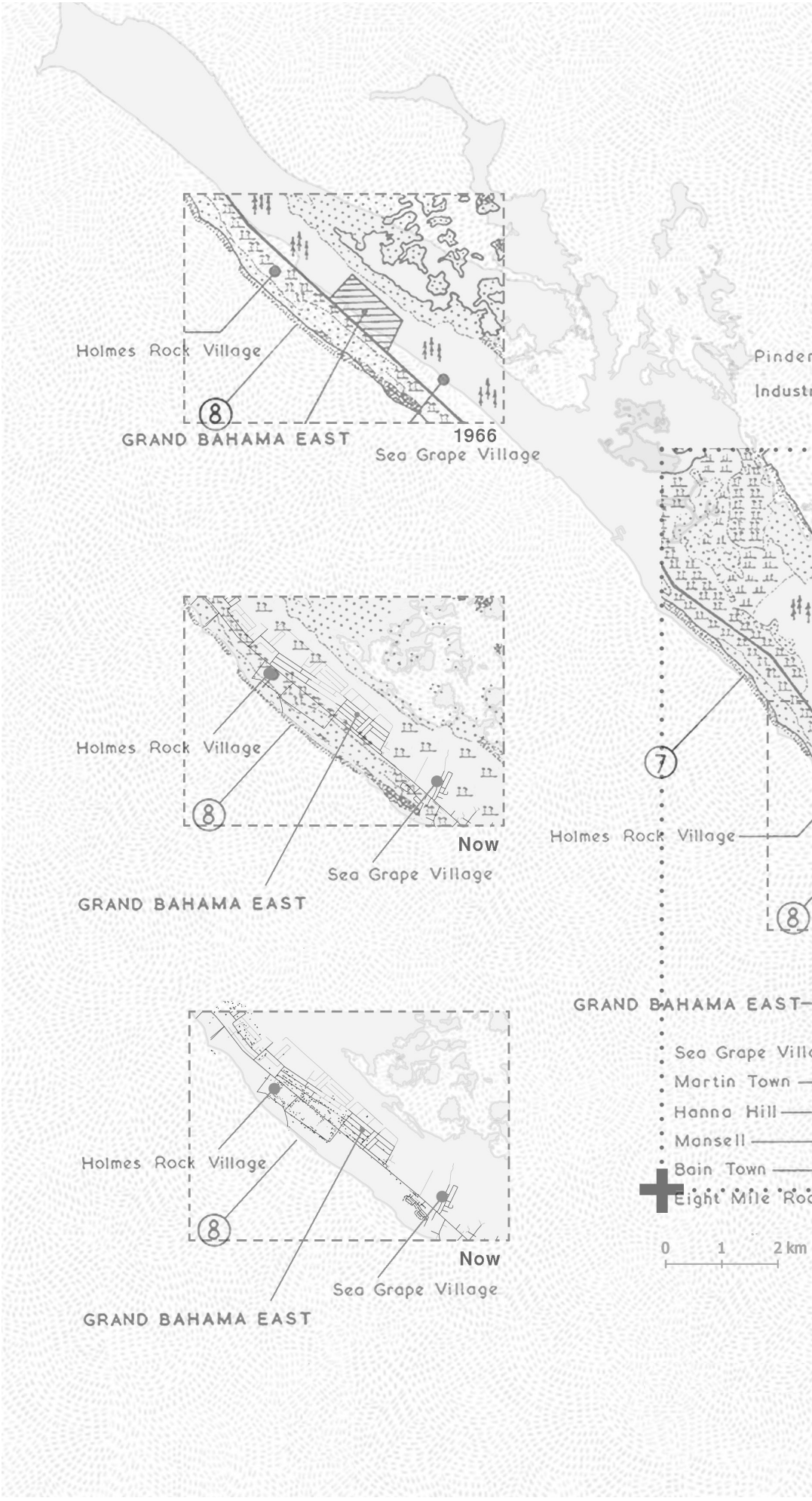
Swamps are in the floodplain of north islands away from human and shrubs is surrounding the settlements.
Mangrove and swamps are in the lower land near the saline water. (Groner-Youngerman International Limited. & Bahamas Properties limited, 1966; Open street map, 2019)





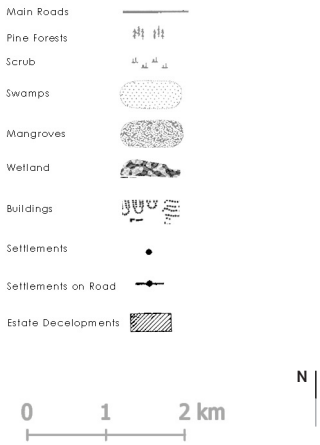




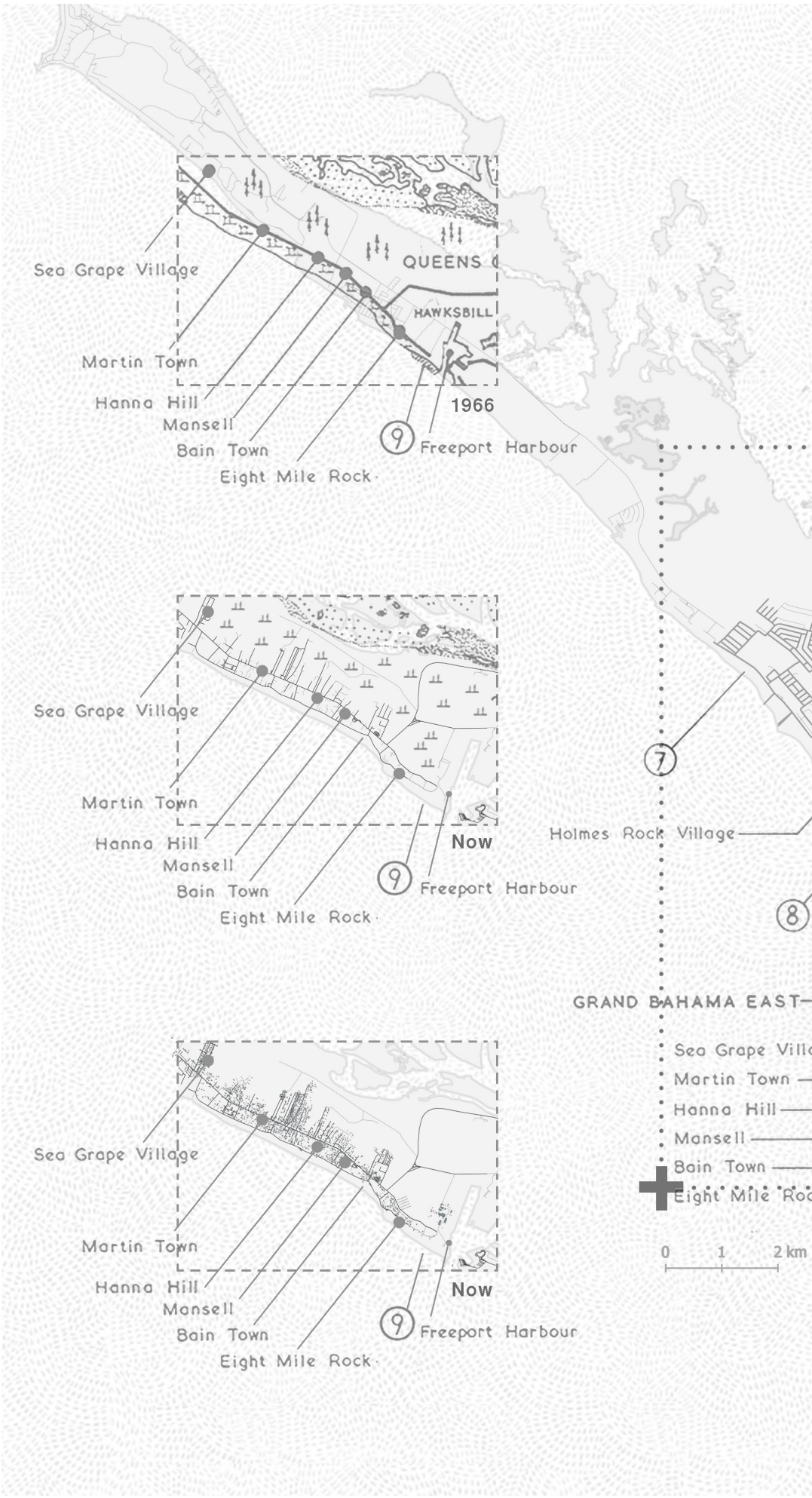


Urban development (History)

It is shown in the history map of 1966 that the main road system has already built but the forest is still exist before the real estate growth went in. The most typical example is The community in the west and Freeport. (Groner-Youngerman International Limited. & Bahamas Properties limited, 1966; Open street map, 2019)

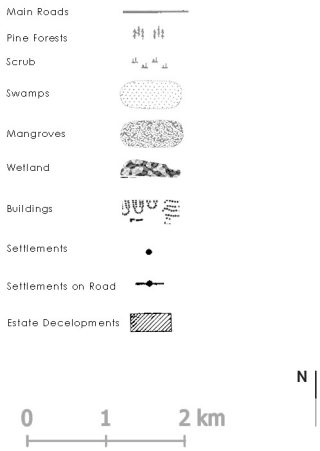


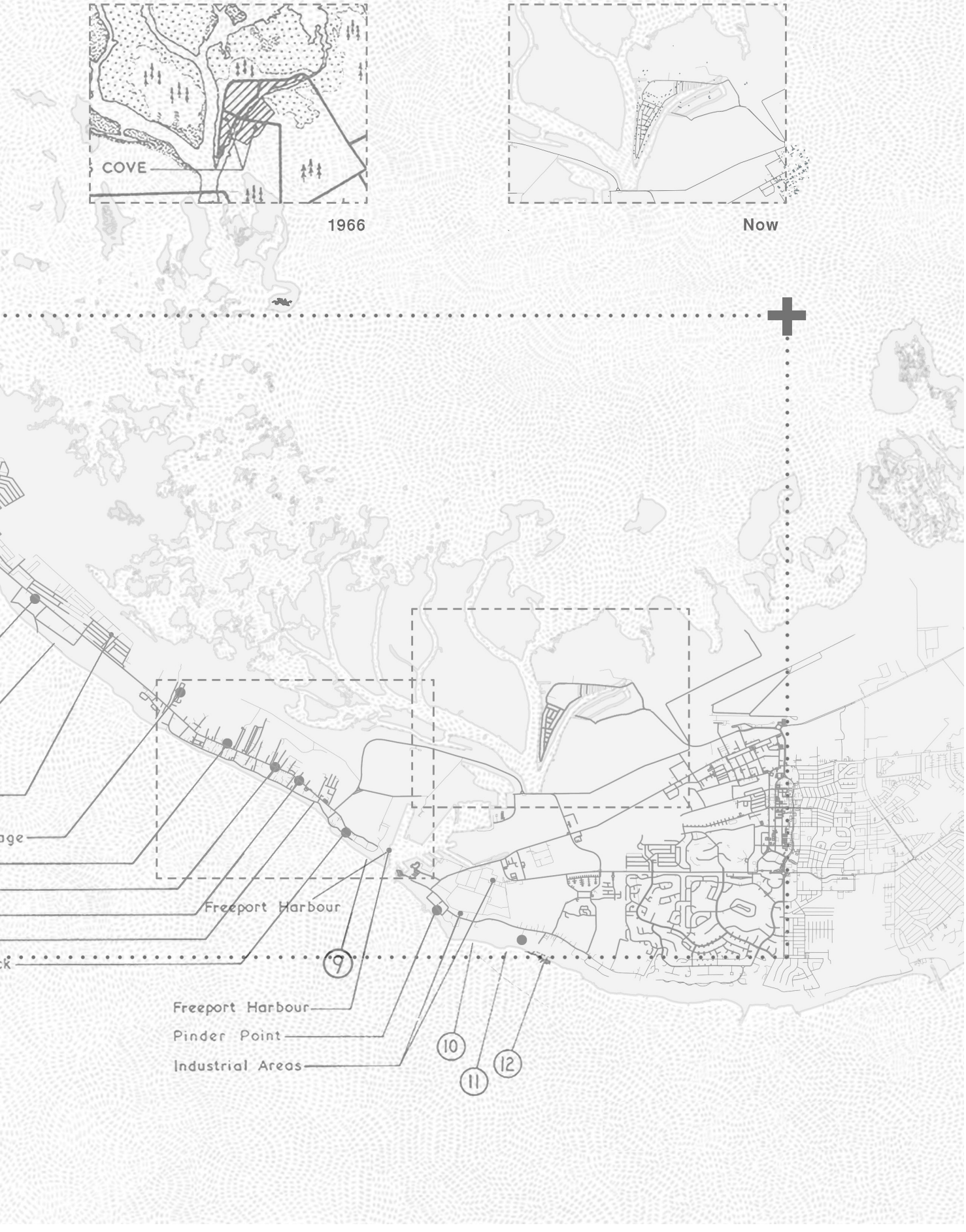

QUEENS COVE
HAWKSBILL CREEK
Lewis Yard
1966
Now
Pinder Point
Industrial Areas
10
11
12
60
Little
Cross Cay
QUEENS COVE
HAWKSBILL CREEK
Freeport City
Freeport Harbour
Lewis Yard
9
Freeport Harbour
Pinder Point
Industrial Areas
10
11
12



Urban development (Now)

The road system is enriched but buildings are not filling in the blocks (Open street map, 2019). Freeport harbor expended and the greenery in the built environment degenerated (Sherman, K. D et al, 2018). The typical example is Bain town and community in the north ialand (GAF AG, 2019; e-GEOS, 2019a; e-GEOS, 2019b; e-GEOS, 2019c).



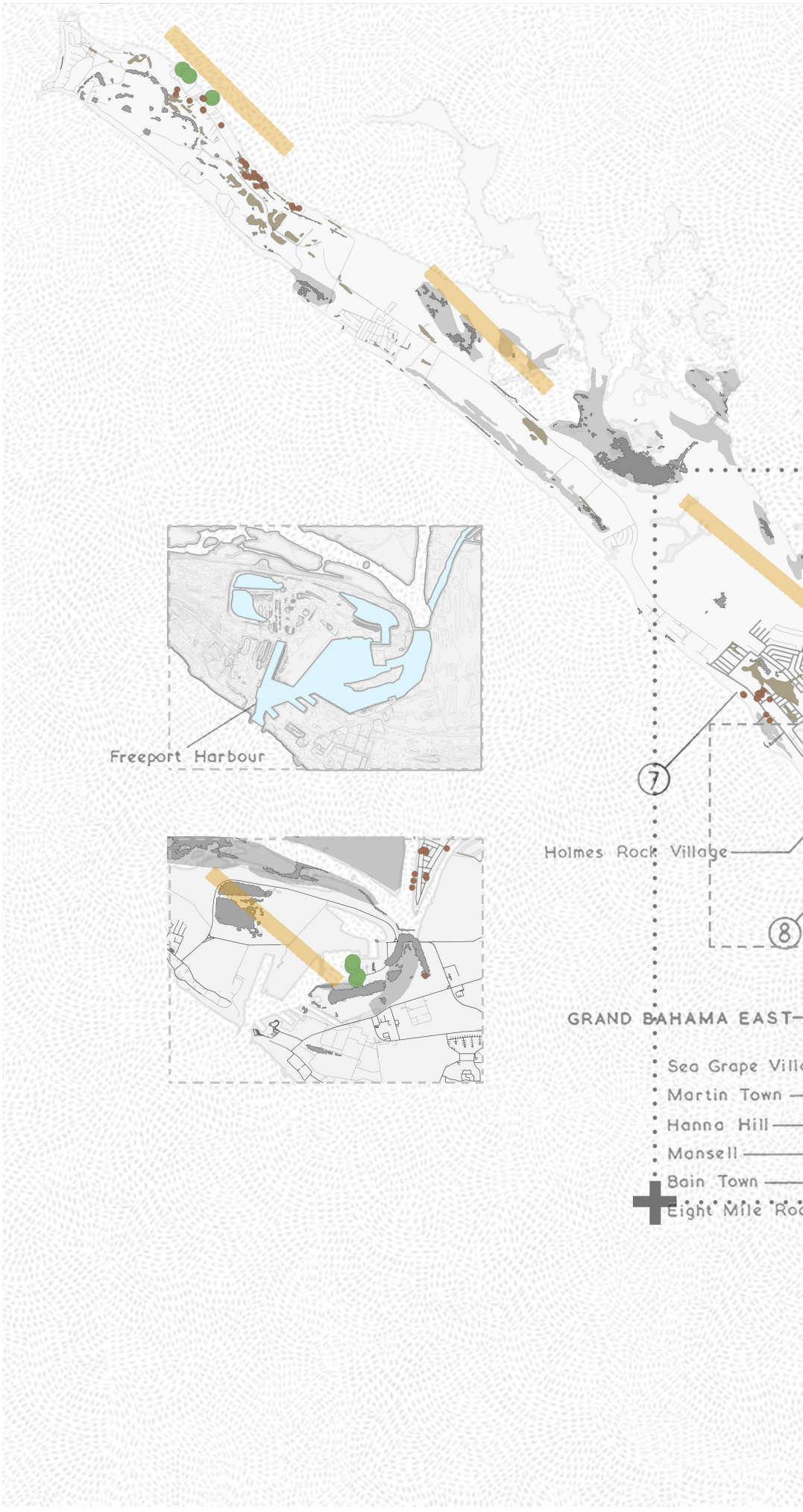

COVE
1966
Now
Freeport Harbour
9
Freeport Harbour
Pinder Point
Industrial Areas
10
11
12

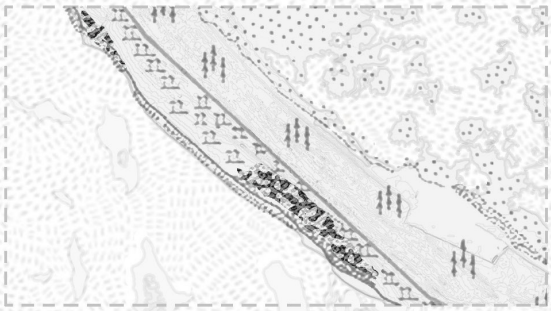
Harzard prone

Large area in the north and edge in the south is lower land facing the stress of flooding and sealevel rise (Roebuck, L., Pochatila, J., & Ortiz, T, 2004). The wetland inland is also a flood-prone area which is more dangerous due to the location next to the buildings (Pacific Disaster Center, 2017).

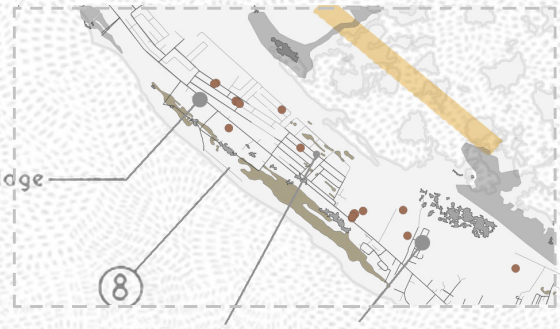
Some of the buildings and infrastructure are facing both the pressure from strong wind and flood (NASA GPM IMERGE, 2019; NOAA, 2019; Department of Social Services and the BNGIS Centre, 2019), the harbour facilities are under this risk as well (MapAction, 04/09/2019; MapAction, 08/09/2019; MapAction, 11/09/2019).

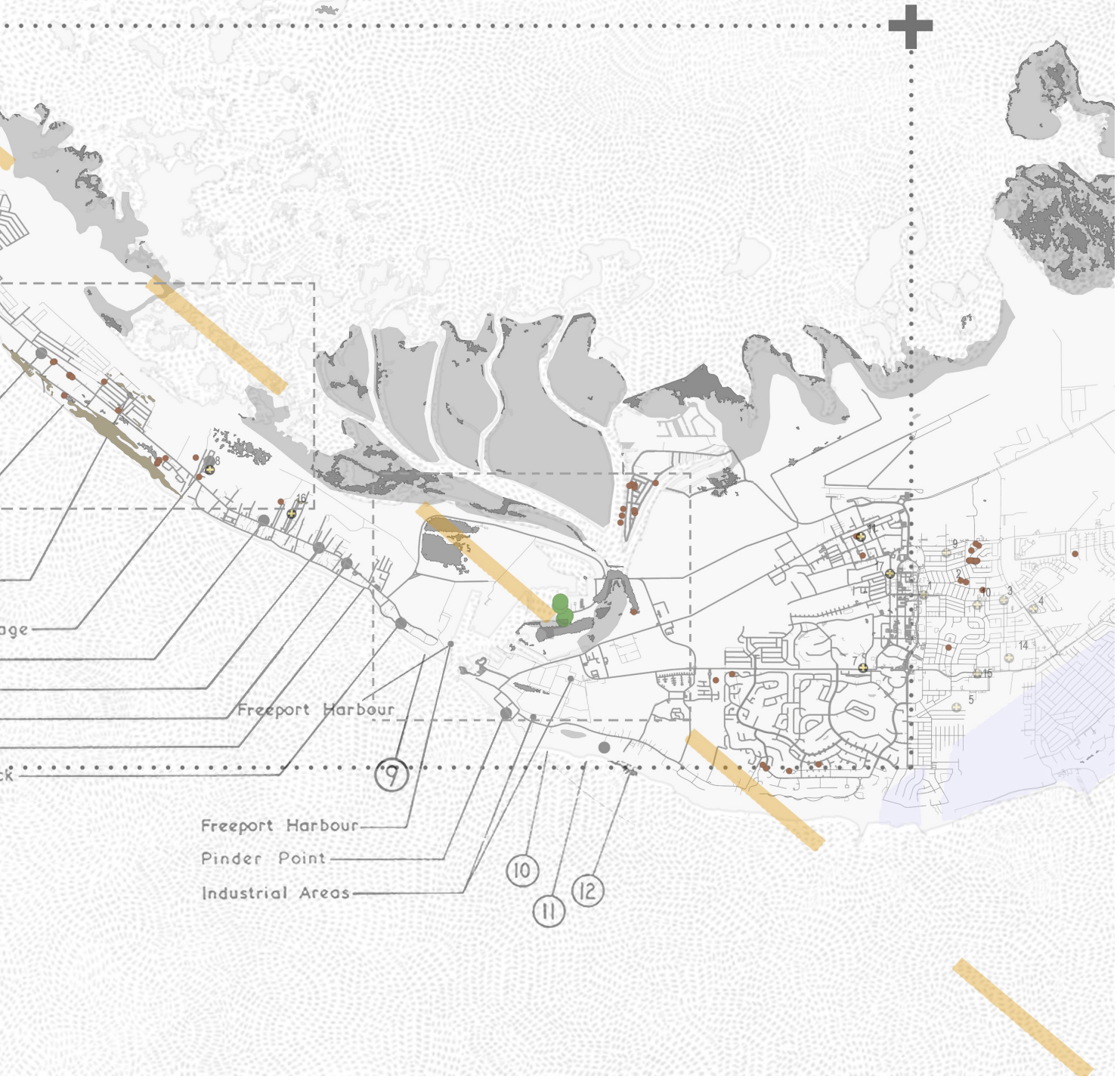
The islands in the north also under the pressure of strong wind in the hurricane season. The vegetation on the island was destroyed by repeated hurricane and flooding (e-GEOS, 2019a; e-GEOS, 2019b; e-GEOS, 2019c).





Now


Holmes Rock Village
8
GRAND BAHAMA EAST
Sea Grape Village


Freeport Harbour
9
Freeport Harbour
Pinder Point
Industrial Areas
10
11
12

Landscape Bain town

The lush trees are distributed on the land at a relatively high altitude, and people's houses are surrounded by these trees (Google map, 2019; Open street map, 2019).

Mass index

The dark part in the top map is above the eyelevel.
In the situation now, the island is sight open with all the shrubs, wetland and open space in the living area. Only some of the open space and margin of the human settlements are covered by lush trees(Google map, 2019; Open street map, 2019).
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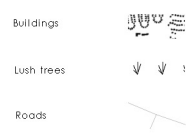
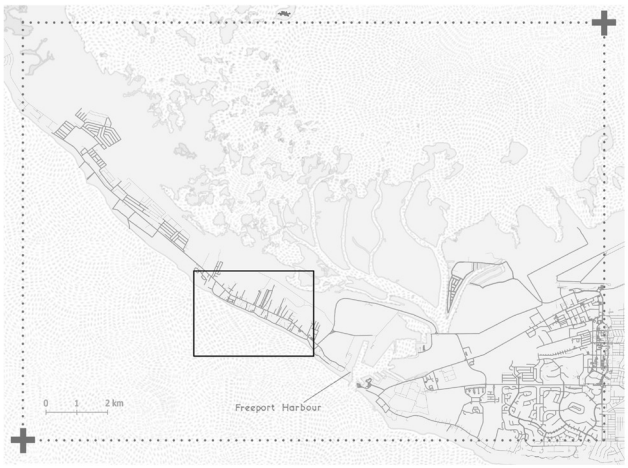
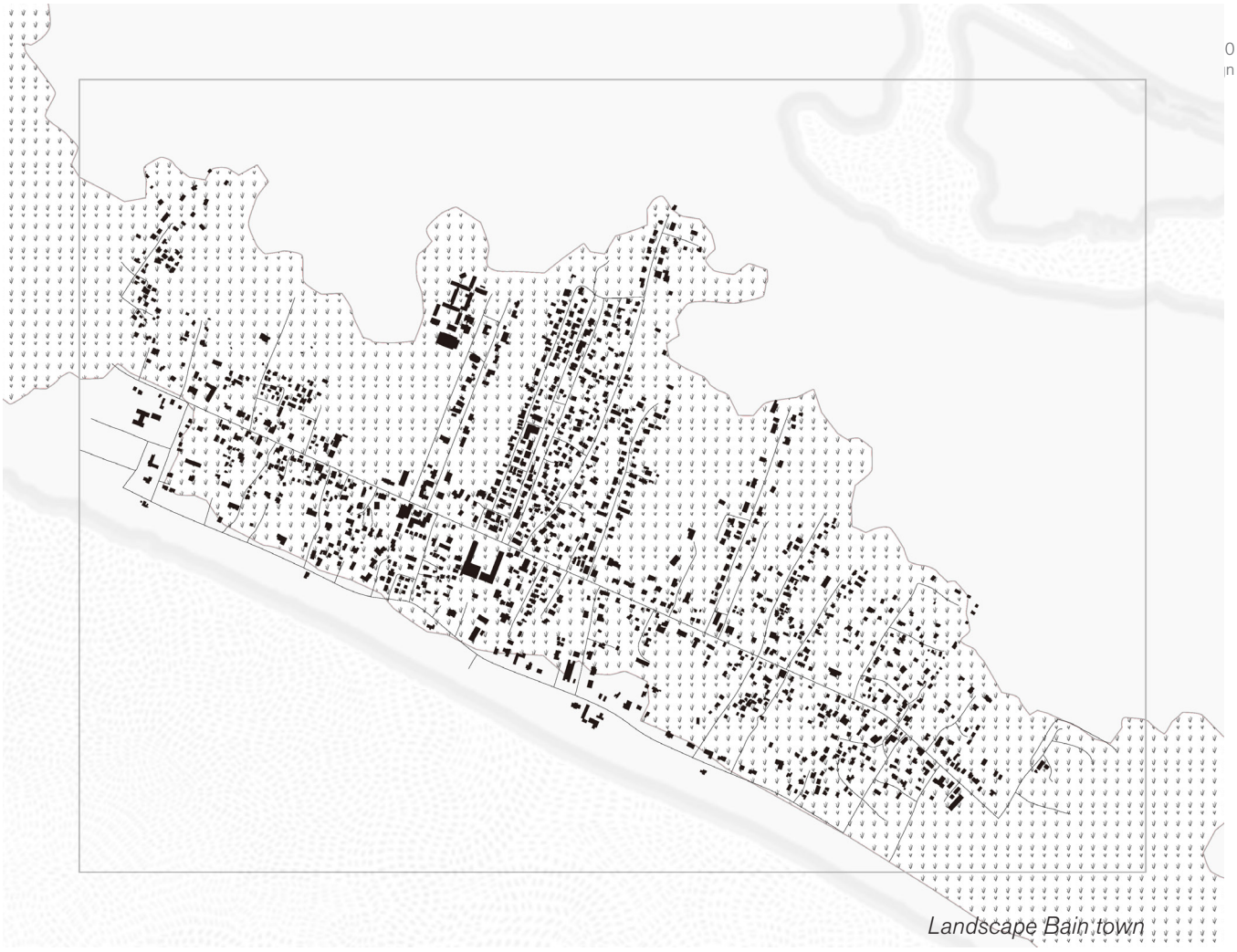
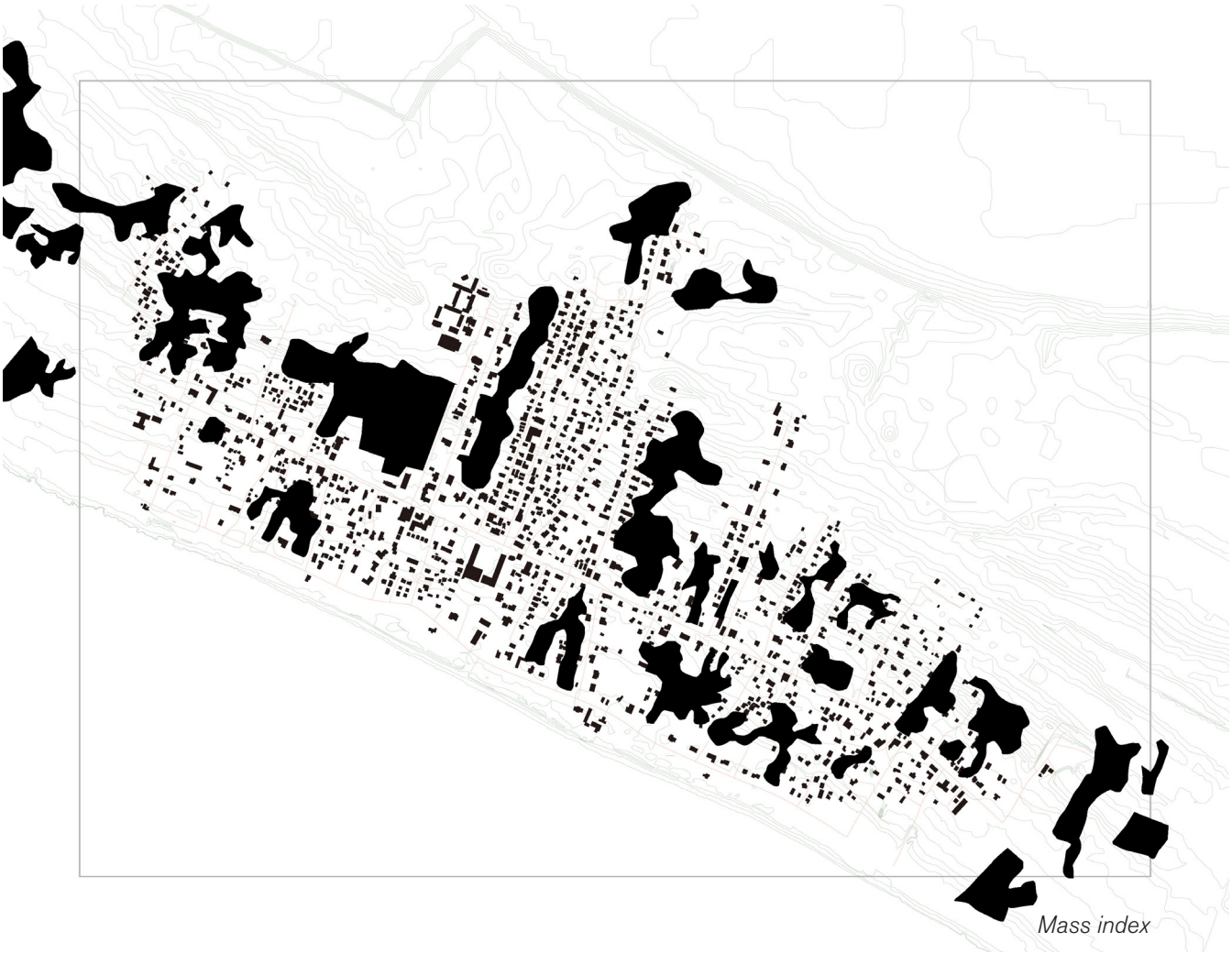






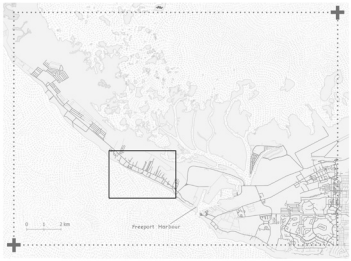


Landscape Bain town



Mass index





Birdseye view

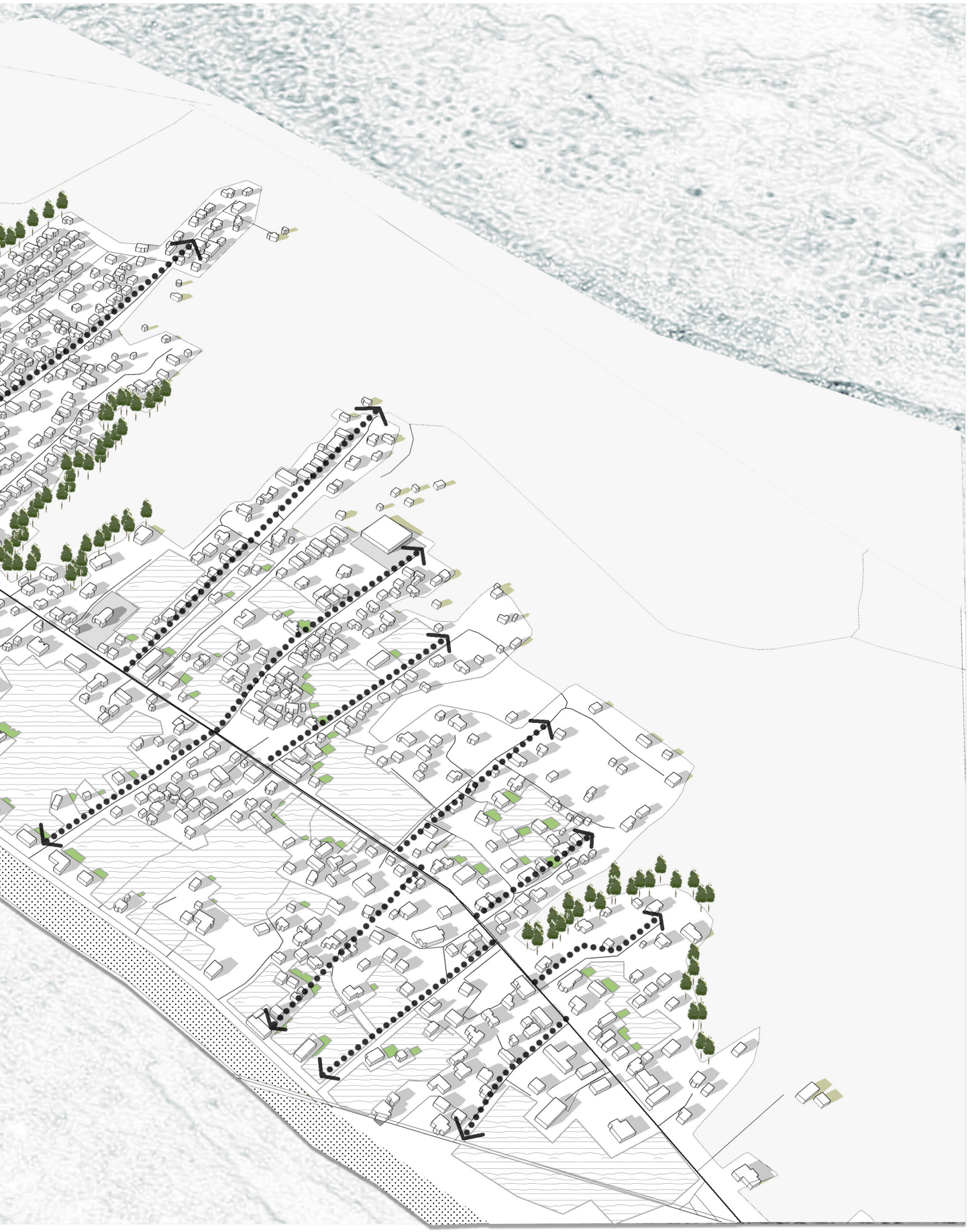
Human settlements developed along the main road in the shape of fish bones and with lush trees in the margin.
There are still planty of vacant open soil in the living area (Google map, 2019; Open street map, 2019).
.

Trees

Structure

Open space

Beach



Upscale housing

The quality of the house is quite well, and the wall decoration is more particular. After careful care, the courtyard has hard paths and gardens. The houe is far from the road.

Downscale housing

The condition of the house is a bit lower. There is not always a paved path and the greenery surrounding is not taken care particularly and the house is close to the main road.

Multi Storey building

The surrounding land is all paved and seperate with a fance. A belt of grass are used to distinguish between internal and external space.

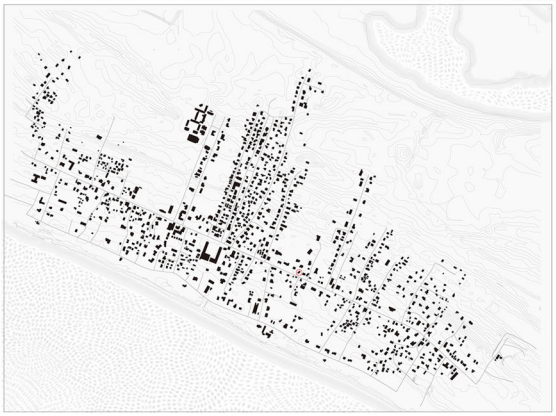
Landscape typology

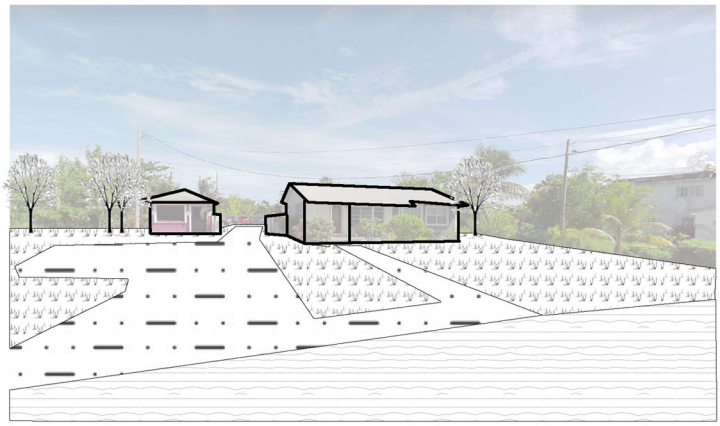
There are three typical landscapes: pavement or grass land surrounding the building and concrete road linking the houses. Larger or public houses always surrounded by pavement and small private houses is greenphilic (Google map, 2019; Open street map, 2019).

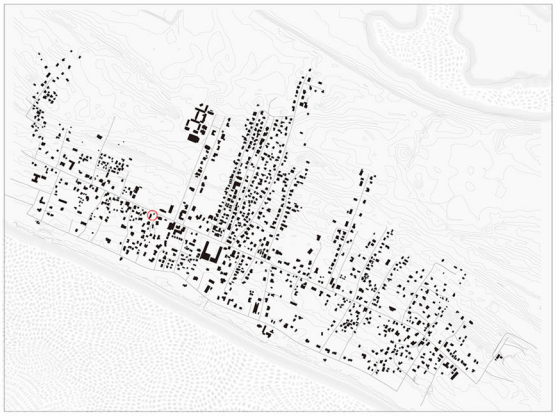


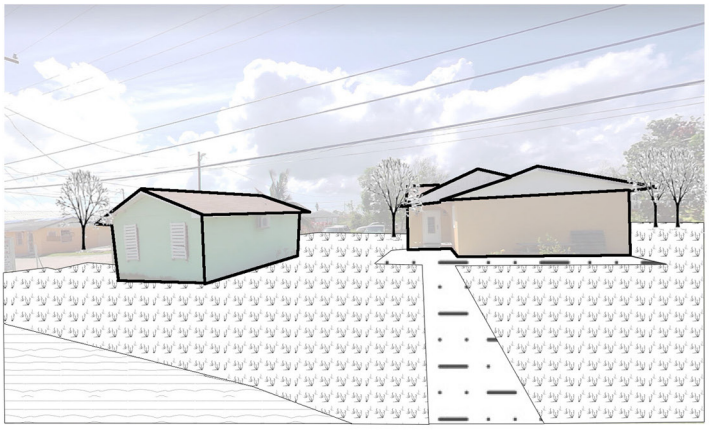
Public building (church)

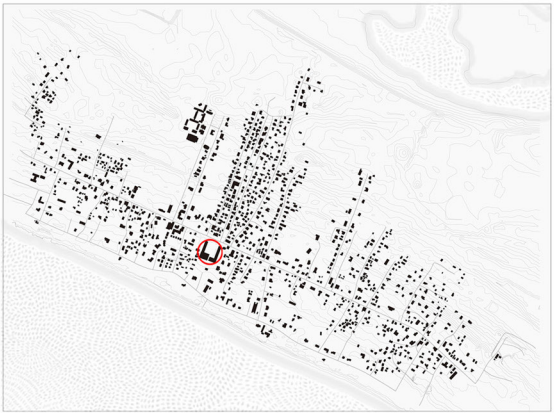
The surrounding land is all paved and in the same material as the road. The paved yard is used for public use like parking.

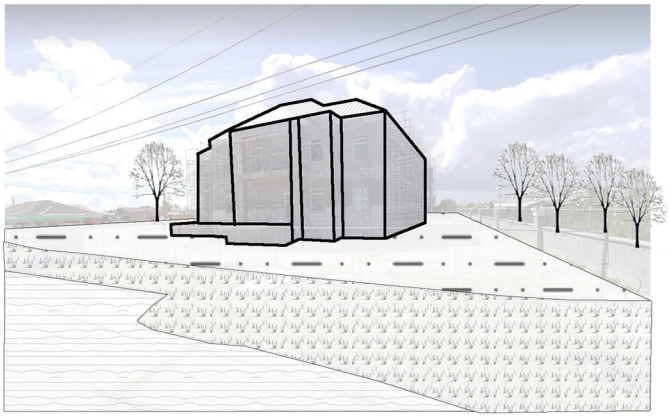


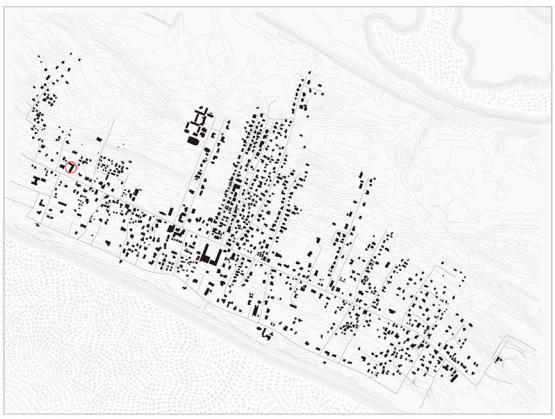


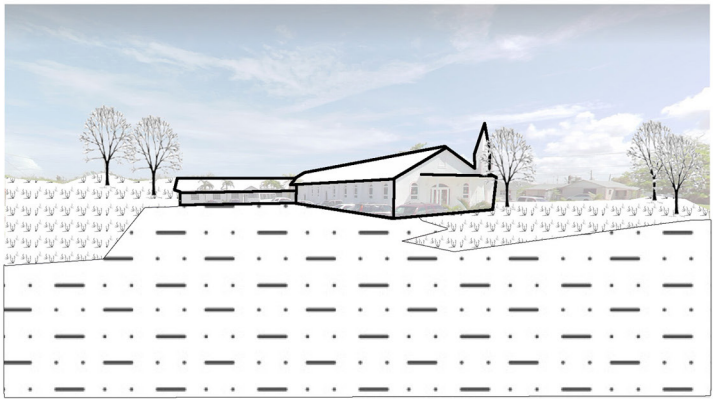






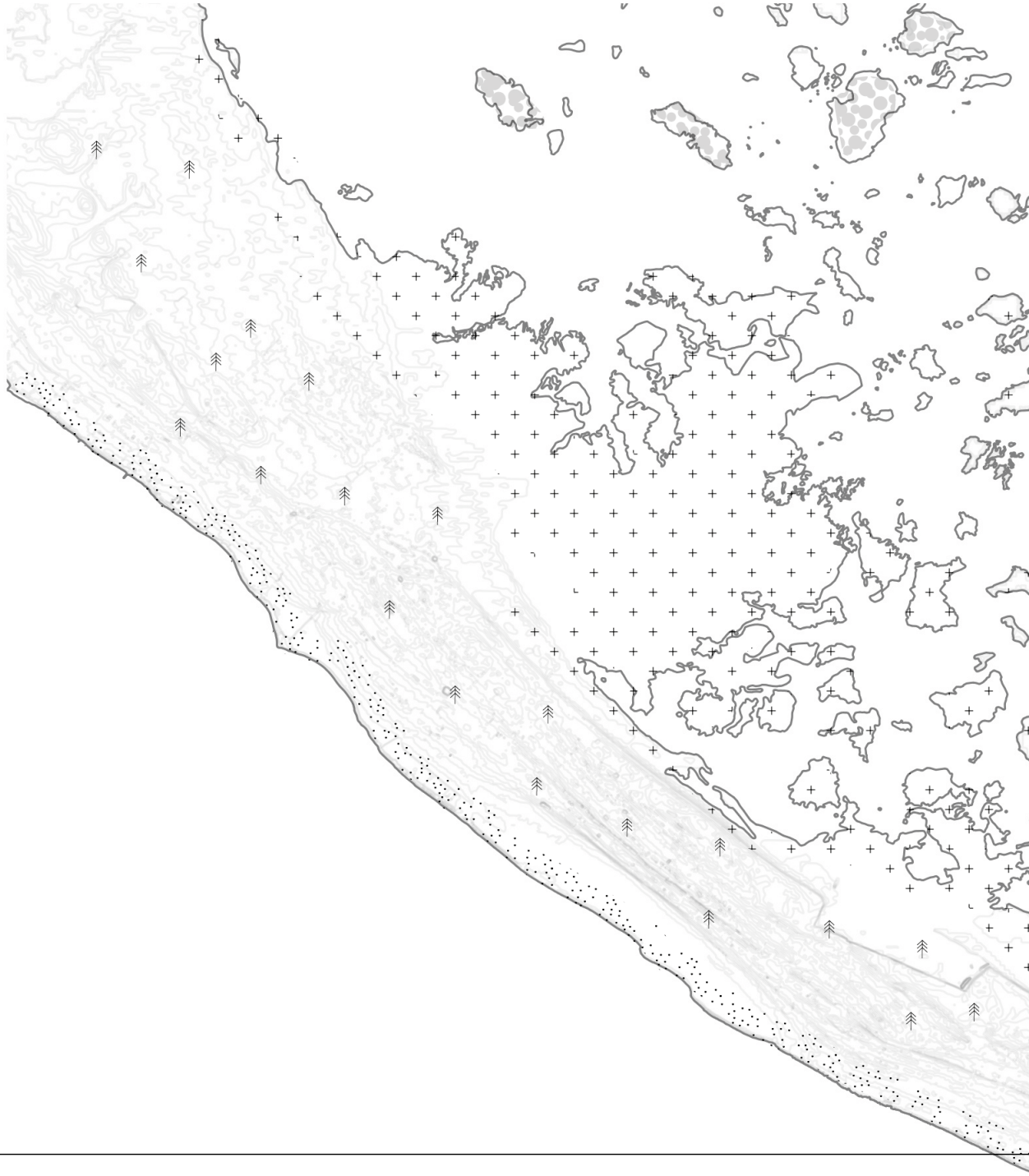






3.4.

Ecology



Ecoregions

The grand Bahama island is part of a neotropical region of 11,400 km2 consisting of different ecosystems.

- Pine forest
- Mangrove/swamp
- Scrub

ECOREGIONS

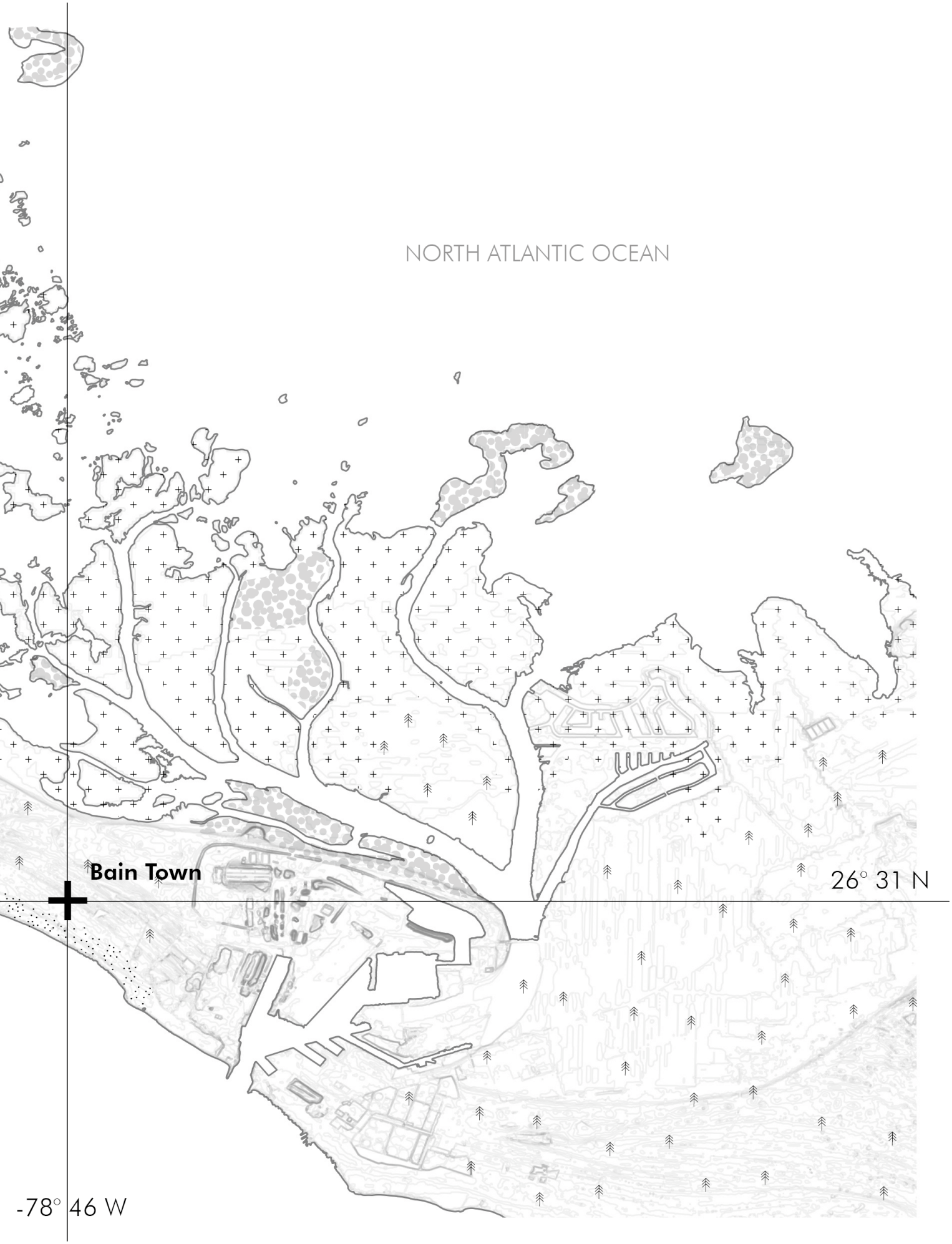
Pine forest

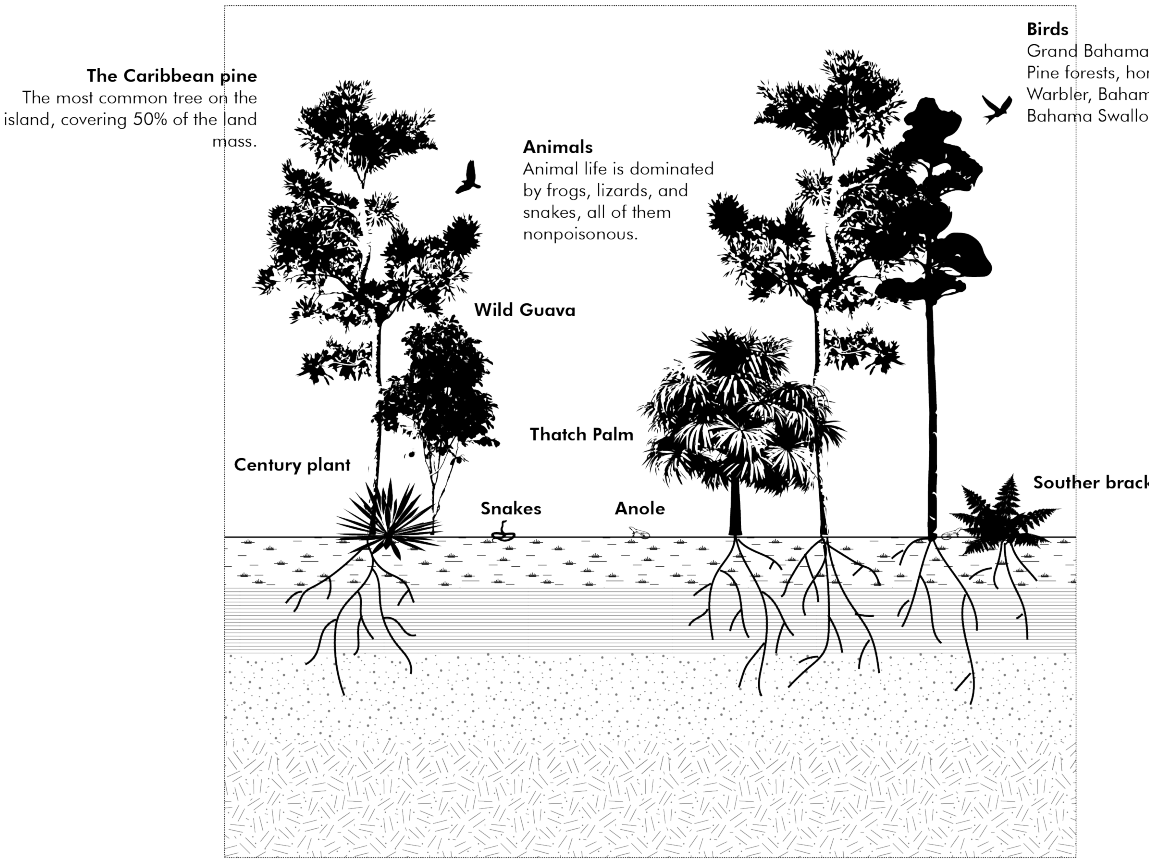
Mangrove/Swamp

Scrub

0 1 2 km

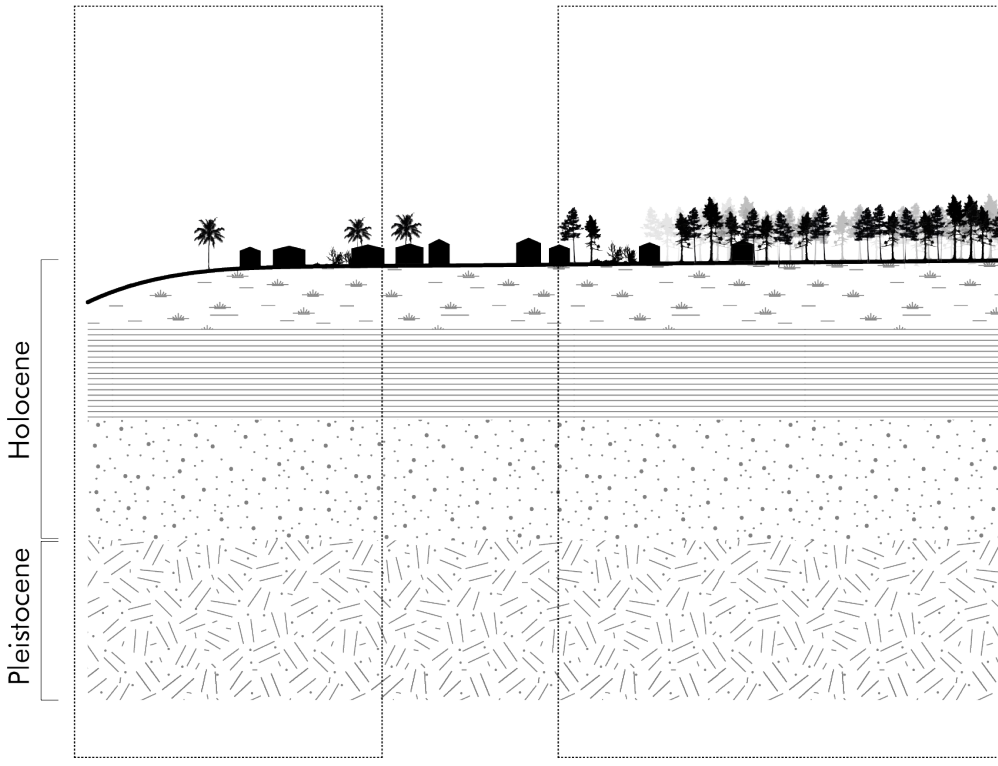
0 1km


NORTH ATLANTIC OCEAN
Bain Town
26° 31 N
-78° 46 W



PINE FOREST

BEACH



Ecosystems

Geologically, Grand Bahama Island is a long low ridge of limestone of Pleistocene age, rising at its highest point to only about 10 m above sea level (Emlen, 1977). The island consists of three main ecosystems. Dominated by the pine forest and the Mangroves.

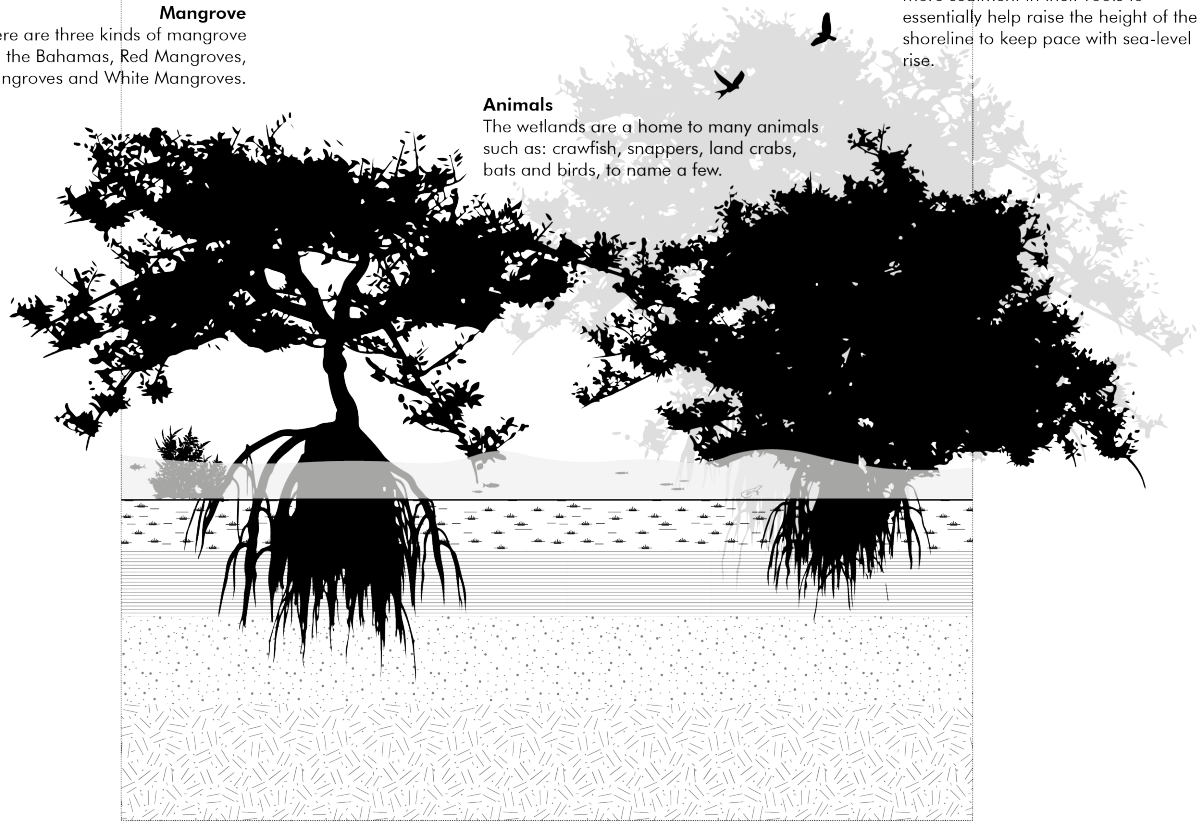
has vast Caribbean
me to the Bahama
a Yellowthroat and
w.

ken fern

Mangrove
There are three kinds of mangrove species in the Bahamas, Red Mangroves, Black Mangroves and White Mangroves.

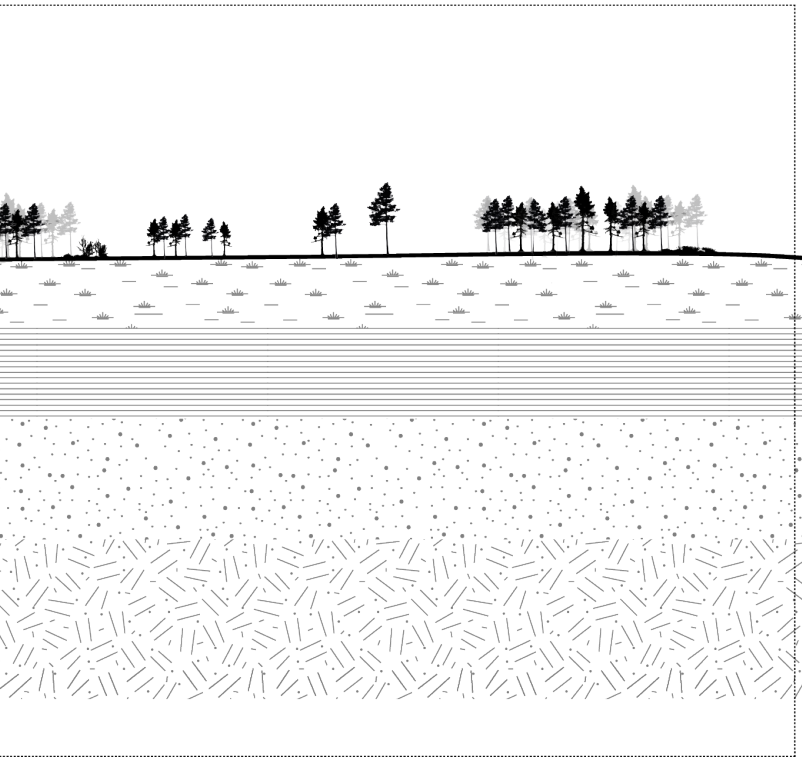
Protection
Mangroves can secure more and more sediment in their roots to essentially help raise the height of the shoreline to keep pace with sea-level rise.

Animals
The wetlands are a home to many animals such as: crawfish, snappers, land crabs, bats and birds, to name a few.

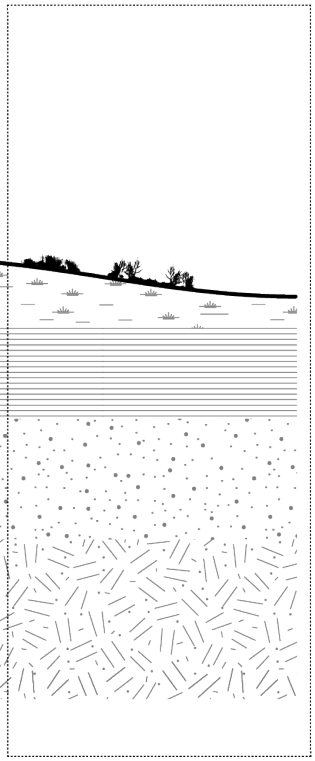


MANGROVE

PINE FOREST



MANGROVE



Beach, dune and subtidal deposits

Limestone:
bioclastic beach and aeolian sediments

Limestone:
aeolianites

Limestone:
aeolianites, beach-face to subtidal sediments

Ecosystems

The islands of the Bahamas are all composed of limestone rock and skeletal remains of coral fossils and other marine organisms (Harris, Albury, & Saunders, 2020). Limestone is a very common rock worldwide. In mountainous and dry areas it is virtually unusable for agriculture (Sealy, 2010). Nearly all of the country's foodstuffs are imported, largely from the United States (Harris, Albury, & Saunders, 2020). The procedure for preparing the limestone surface for mechanical farming is known as scarification, a process developed in South Florida in the early 20th Century. As long as the land is in use this should be continued annually. A suitable crop should be planted into this raw mix to help create a protosol and provide a residue that can be disced back into the ground. This is a rather expensive business (Sealy, 2010).

The Bahamas has been blessed with numerous breathtaking sites that attract huge numbers of tourists to the nation. Tourism is the country's largest sector, and economic growth is mainly driven by it. With few natural resources and a limited industrial sector, the economy depends heavily on tourism and, to a lesser degree, on financial services (Groupe Société Générale, 2020).

Pine forest - The Caribbean pine (Pinus caribaea var. bahamensis), also known as Yellow Pine, is actually the most common tree on the island, covering 50% of the land mass. This unique tree is endemic to only four of The Islands of The Bahamas. Internationals organizations have recognized the uniqueness, rarity and good conditions of the Bahmian pineland landscape, and believe it should be a conservation priority. In the past, they were heavily harvested for lumber (Moultrie, n.d.). As trees of sufficient diameter for lumber making became scarce, the industry turned its attention to harvesting immature secondary trees which were ground into pulp for paper making. Understory plants are used for bush medicine and craft items and animals in the ecosystem are hunted (Gape & Sweeting, 2000). Forests in the Bahamas have been exploited for a long period that dates back to the 18th century. During this period, Bahamian hardwoods were cut down for export which greatly reduced the country's forest cover. The Forestry Act allows Government to set aside areas of forest for different levels of use, some may completely protected while others are harvested or otherwise used in a sustainable way. As part of the shift in focus, the Bahamian government partnered with the Inter-American Development Bank to create a forest management system. Approximately 90% of the pineland of The Bahamas is state-owned Crown Land. On Grand Bahama there are two national parks where this ecosystem is represented and protected. The 100-acre Rand Nature Centre is located two miles from downtown Freeport. The 42-acre Lucayan National Park is located between Freeport and Freetown and contains the longest underwater cave system in the world. The Park contains all the vegetative zones representative of the Bahamas.

Mangrove Swamp - The Mangrove swamp is an environment where land and sea systems interweave.Wetlands are one of the most threatened ecosystems in the world. In the Bahamas they are suffering heavily from the effects of unsustainable development, illegal dumping and invasive species (The Bahamas National Trust, n.d. a).

Rocky Coppice - The Rocky Coppice is a transitional zone between the Mangrove Swamp and the Pine Forest and is frequently flooded at high tide. It is distinguished by limestone outcrops and an abundance of Ming trees, which the locals call “prickly trees.” Their tiered branches are reminiscent of Asian bonsai trees. Also common in this zone are mahogany and red cedar trees (Moultrie, n.d.).

Beach – The land’s last bastion before it reaches the sea, the beach/ shoreline zone features both sandy strands and coastal rock formations and is distinguished by plants that tolerate the harsh environment of salt and wind. Among these plants is the Sea Purslane, the Sandfly Bush, Bay Marigold, the Bay Lavender and the Bay Cedar. Also growing here are two plants with beautiful flowers: the white- petal Spider Lily and the purple-petal Cordia (Moultrie, n.d.). The animals and plants found in these regions have to be very tough organism to survive. They are often well adapted to the pounding of waves, drying out by the sun, changes in salinity and temperature as well as the exposure to wind (The Bahamas National Trust, n.d. b).

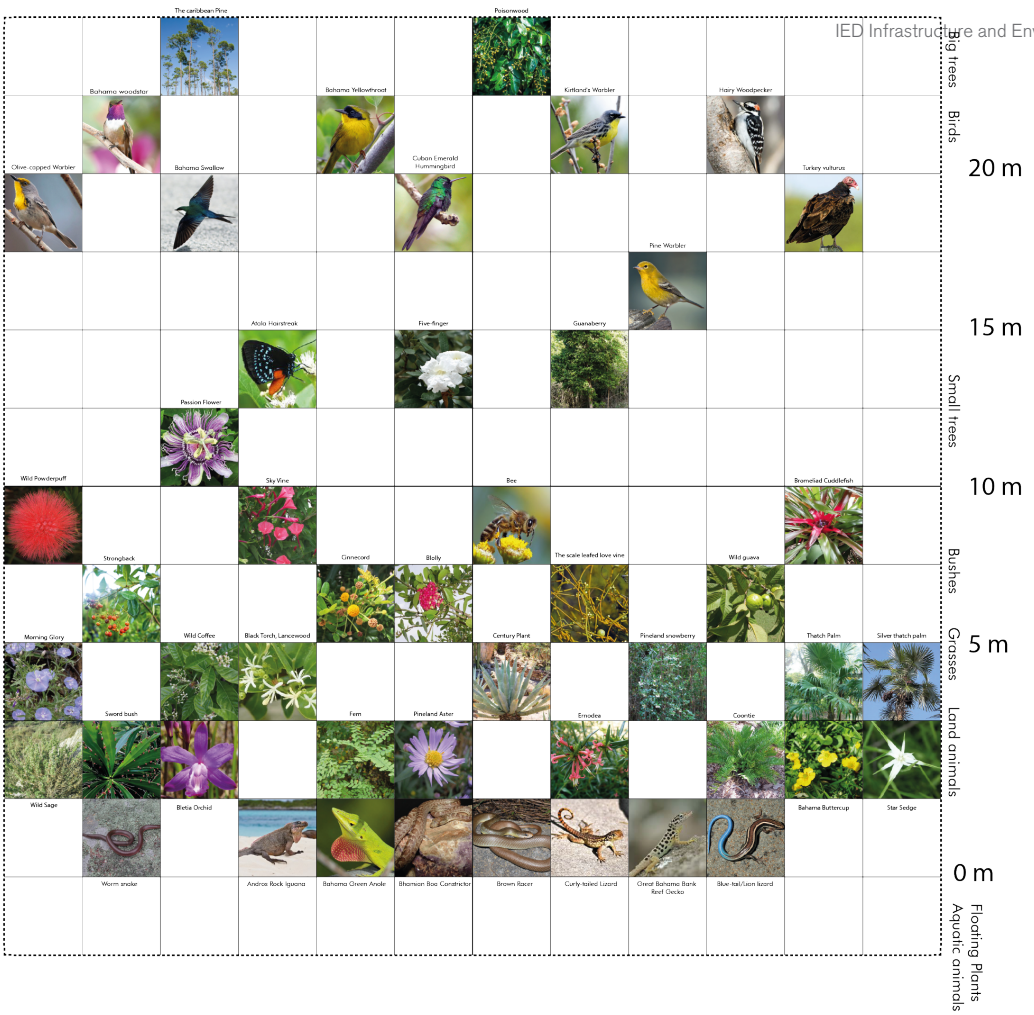
Whiteland coppice - This zone forms a transition from the beach areas to the mangroves. It is especially rich in plant life, due to the fact that it is somewhat protected by the nearby sand dunes. One of its most predominant trees is the giant poisonwood, which carries exactly the same kind of allergenic oil as poison ivy. Here you can also find Akacia and tall Sabal Palm, as well as Wild Coffee in the shade of the canopy (Moultrie, n.d.).

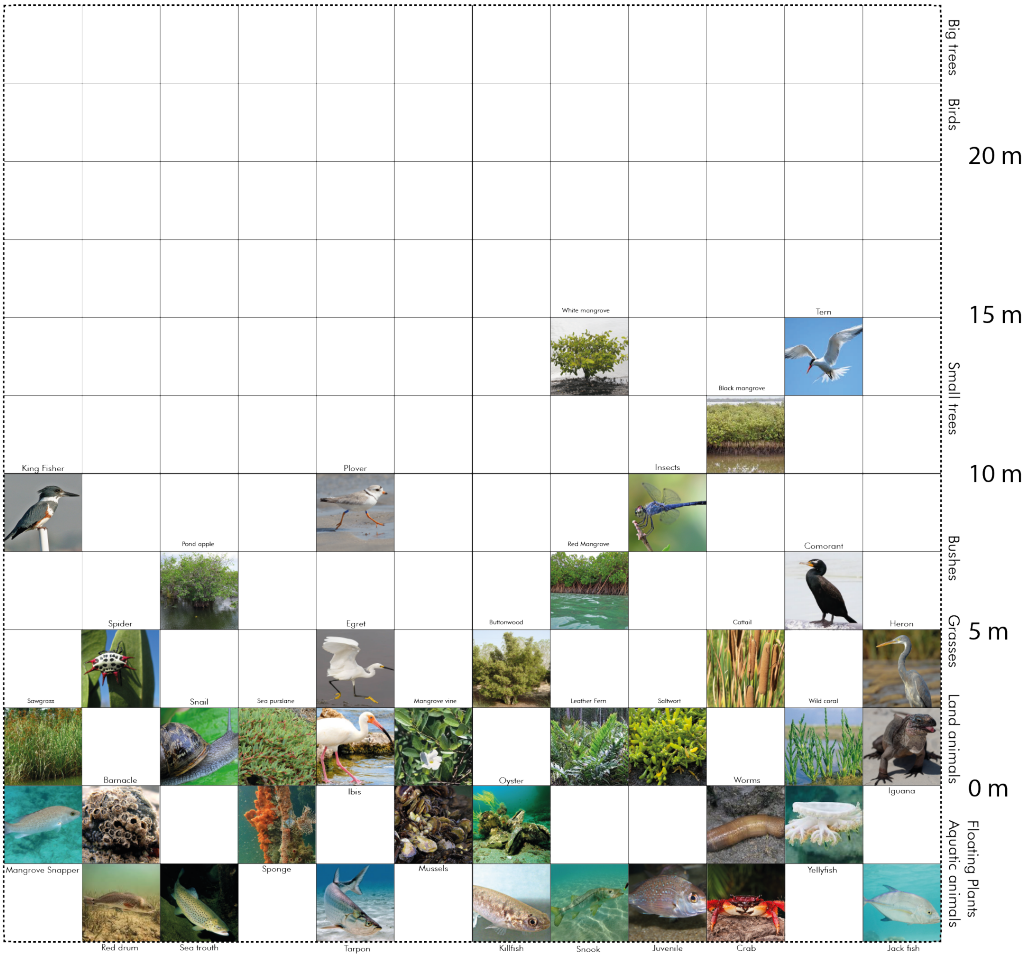
Flora and Fauna

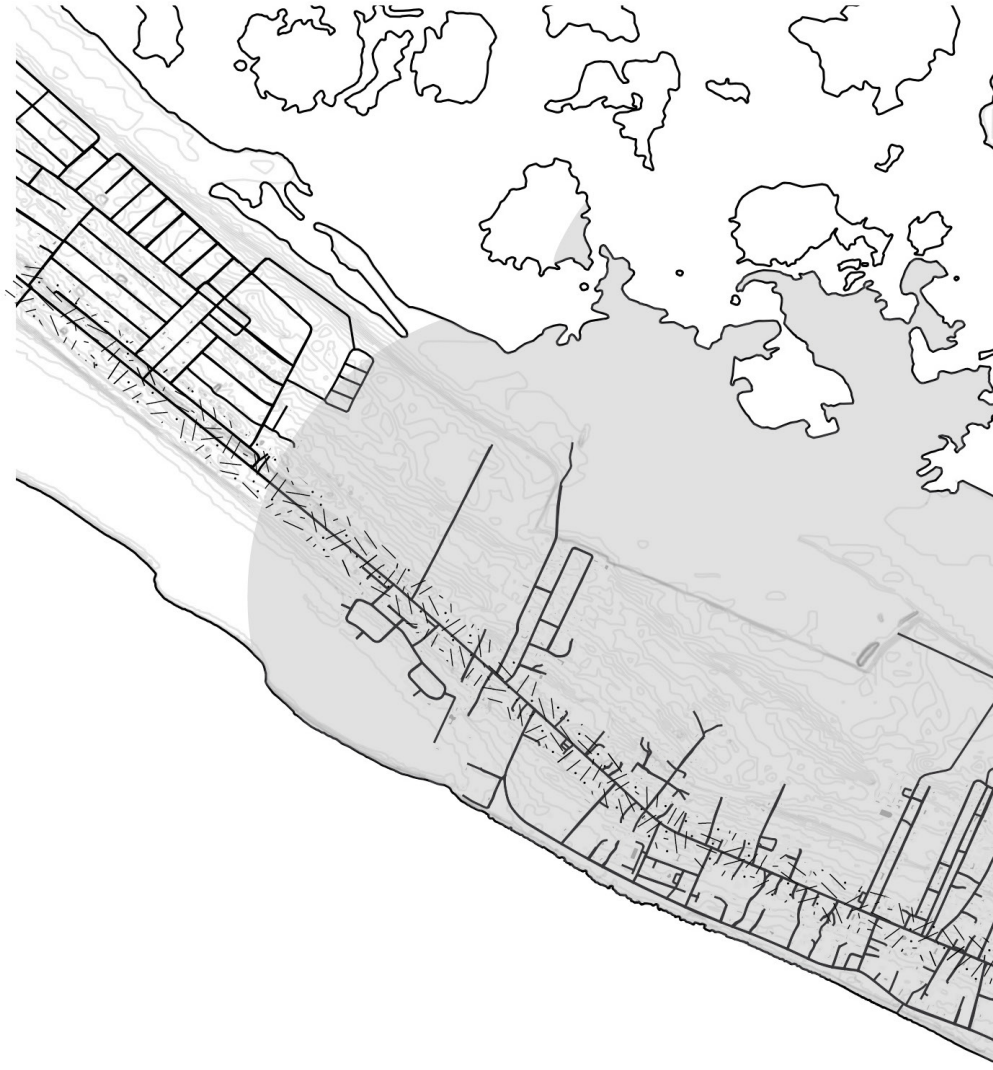
Bahama Islands have not long been above sea level —geologically speaking they probably emerged as dry land in the late Tertiary. Consequently the flora and fauna have only occupied the islands 'recently' (Little at al., 1977). Grand Bahama is part of the Caribbean Islands Biodiversity Hotspot. The Caribbean Islands Biodiversity Hotspot is one of 36 biodiversity hotspots in the world. Animal life is dominated by frogs, lizards, and snakes, all of them nonpoisonous, and several species of bats are found in caves along the more rocky coasts. Larger animals include the agouti, a rodent; the raccoon; the iguana; and the elegant flamingo, the national bird. All of these have been much reduced in numbers and in distribution. In addition, several animals—notably sheep, horses, and other livestock—have been introduced from Europe (Harris, Albury, & Saunders, 2020). In the future, endangered birds on oceanic islands must also contend with stronger and more frequent hurricanes driven by climate change.

Common in the ecological pine forest zone are also the Agave, or Century plant, and Palmetto. Decomposing leaf matter inside the Pine forest creates the Blackland Coppice, which nurtures indigenous fig trees, Dogwood, Lancewood, and Gumbo-Limbo trees. Also growing here is the Satin Leaf tree, which produces a dark red edible fruit that migratory North American birds feast on in late winter. The shade created by all these trees makes a perfect habitat for various ferns, bromeliads, and orchids (Moultrie, n.d.).

The wetlands are a home to many animals such as: crawfish, snappers, land crabs, bats and birds, to name a few. It is vital that we help conserve this unique habitat. The huge, gnarly-rooted Red Mangrove trees grow in brackish water, secreting salt through their leaves. There are three kinds of mangrove species in the Bahamas, Red Mangroves, Black Mangroves and White Mangroves. The red Mangrove is the most water-loving of all the Mangrove trees. The Red Mangroves collect sediment, a process that actually extends the land over time. This zone also has orchids and ferns (Moultrie, n.d.).


The caribbean Pine
Poisonwood
Bahama woodstar
Bahama Yellowthroat
Kirtland's Warbler
Hairy Woodpecker
Olive-capped Warbler
Bahama Swallow
Cuban Emerald Hummingbird
Turkey vulturus
Pine Warbler
Atala Hairstreak
Five-finger
Guanaberry
Passion Flower
Wild Powderpuff
Sky Vine
Bee
Bromeliad Cuddlefish
Strongback
Ginnecord
Blolly
The scale leafed love vine
Wild guava
Morning Glory
Wild Coffee
Black Torch, Lancewood
Century Plant
Pineland snowberry
Thatch Palm
Silver thatch palm
Sword bush
Fern
Pineland Aster
Ernodea
Coontie
Wild Sage
Bletia Orchid
Bahama Buttercup
Star Sedge
Worm snake
Andros Rock Iguana
Bahama Green Anole
Bhamian Boa Constrictor
Brown Racer
Curly-tailed Lizard
Great Bahamic Bank Reef Gecko
Blue-tail/Lion lizard
Big trees
Birds
Small trees
Bushes
Grasses
Land animals
Floating Plants
Aquatic animals
20 m
15 m
10 m
5 m
0 m


White mangrove
Tern
Black mangrove
King Fisher
Plover
Insects
Pond apple
Red Mangrove
Cormorant
Spider
Egret
Buttonwood
Cattail
Heron
Sawgrass
Snail
Sea purslane
Mangrove vine
Leather Fern
Saltwort
Wild coral
Barnacle
Oyster
Worms
Iguana
Ibis
Mangrove Snapper
Sponge
Mussels
Yellyfish
Red drum
Sea trouth
Tarpon
Killfish
Snook
Juvenile
Crab
Jack fish
Big trees
Birds
Small trees
Bushes
Grasses
Land animals
Floating Plants
Aquatic animals
20 m
15 m
10 m
5 m
0 m



Pollution

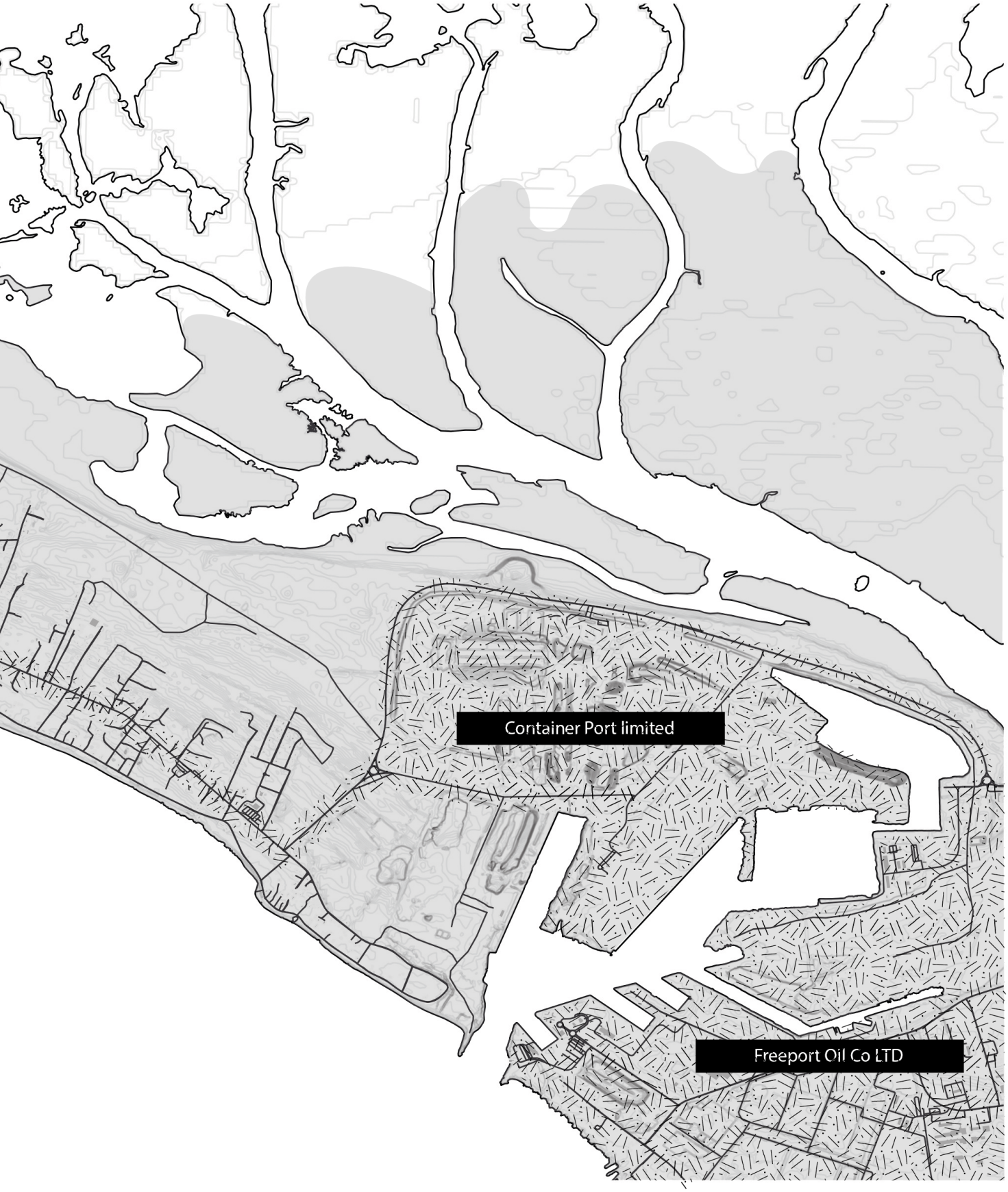
An inland spill of crude oil, with approximate length and width of 7 and 3 miles respectively, occurred as a result of the hurricane's impact on Equinor's South Riding Point oil storage facility on Grand Bahama Island (UNEP/OCHA Joint Environment Unit, 2019).

Many of the beaches in the Bahamas, especially on the island of Grand Bahama (the locus of petroleum trans-shipment and refining, as well as intense tourist development), are contaminated to a greater or lesser extent by petroleum residue. This pollution, commonly referred to as "tar balls", occurs in the form of semi-solid, flattened, rounded masses, generally less than 10 cm in maximum dimension. These are recognized as global phenomena and as alarming indicators of world-wide pollution of the oceans and coastal waters by petroleum discharges of various types (accidental spills, irresponsible discharges of tanker washings and coastal zone oil production). In the Bahamas, the economic and aesthetic impact on tourist amenities is considerable, as these tar balls attach themselves to the feet and clothing of sun-bathers and are brought inside to damage carpets and flooring. The tar balls that settle on the sea-bottom may also affect the health of benthic organisms and bottom-feeding fish (Coakley & Rasul, 2000).

Noise pollution
Soil pollution (oil)

N

0 0,5 km

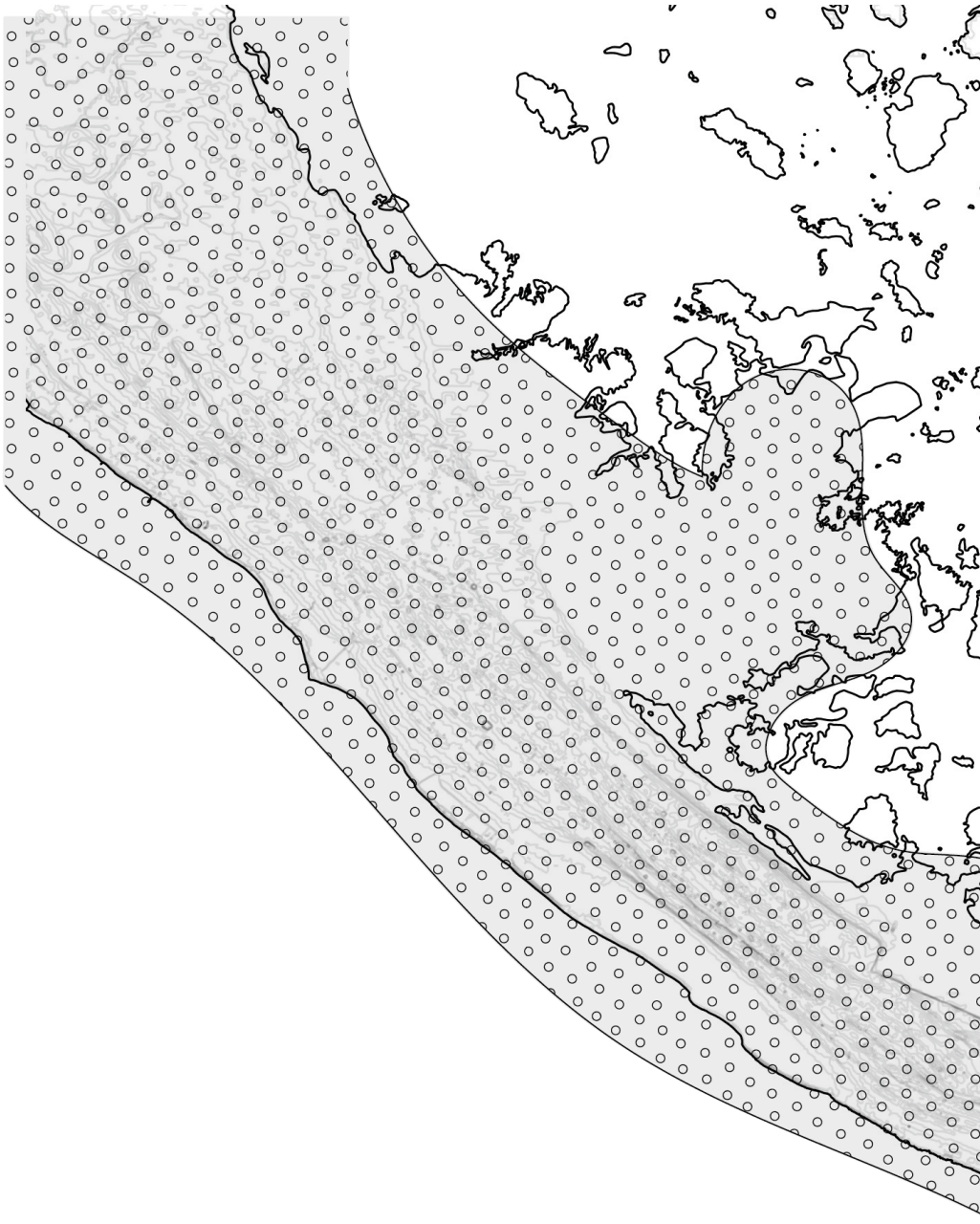

Container Port limited
Freeport Oil Co LTD

Climate

The Bahamas has a marine tropical climate as defined by Miller and described by him as characterised by persistent north-east trade winds, with warm, wetter summers and cooler, drier winters (Little at al., 1977). The average temperature varies from about 21 °C during the winter to about 27 °C during the summer, and extremes seldom fall below the about 16 °C or rise above 32 °C (Harris, Albury, & Saunders, 2020).

The average annual rainfall is about 1,120 mm, occurring mostly during the summer months. Prevailing winds, coming from the northeast in winter and from the southeast in summer, lend a cooling influence to a generally humid atmosphere (Harris et al., 2020). Tropical cyclones (hurricanes) pose a threat during the period from June to November and have occasionally caused great.

■ Mean wind speed
➡ Mean wind direction



WIND

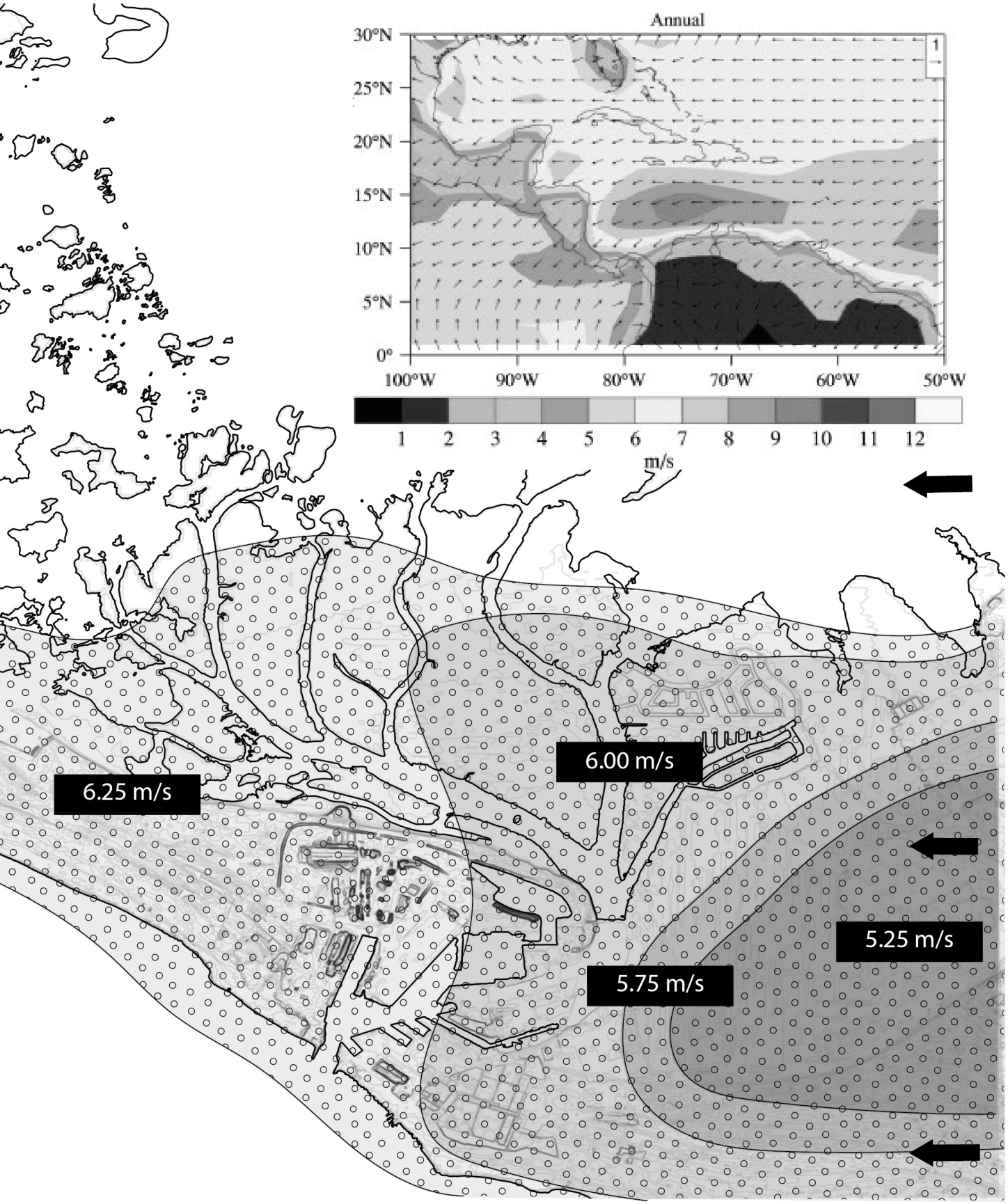
6.25 m/s Mean wind speed

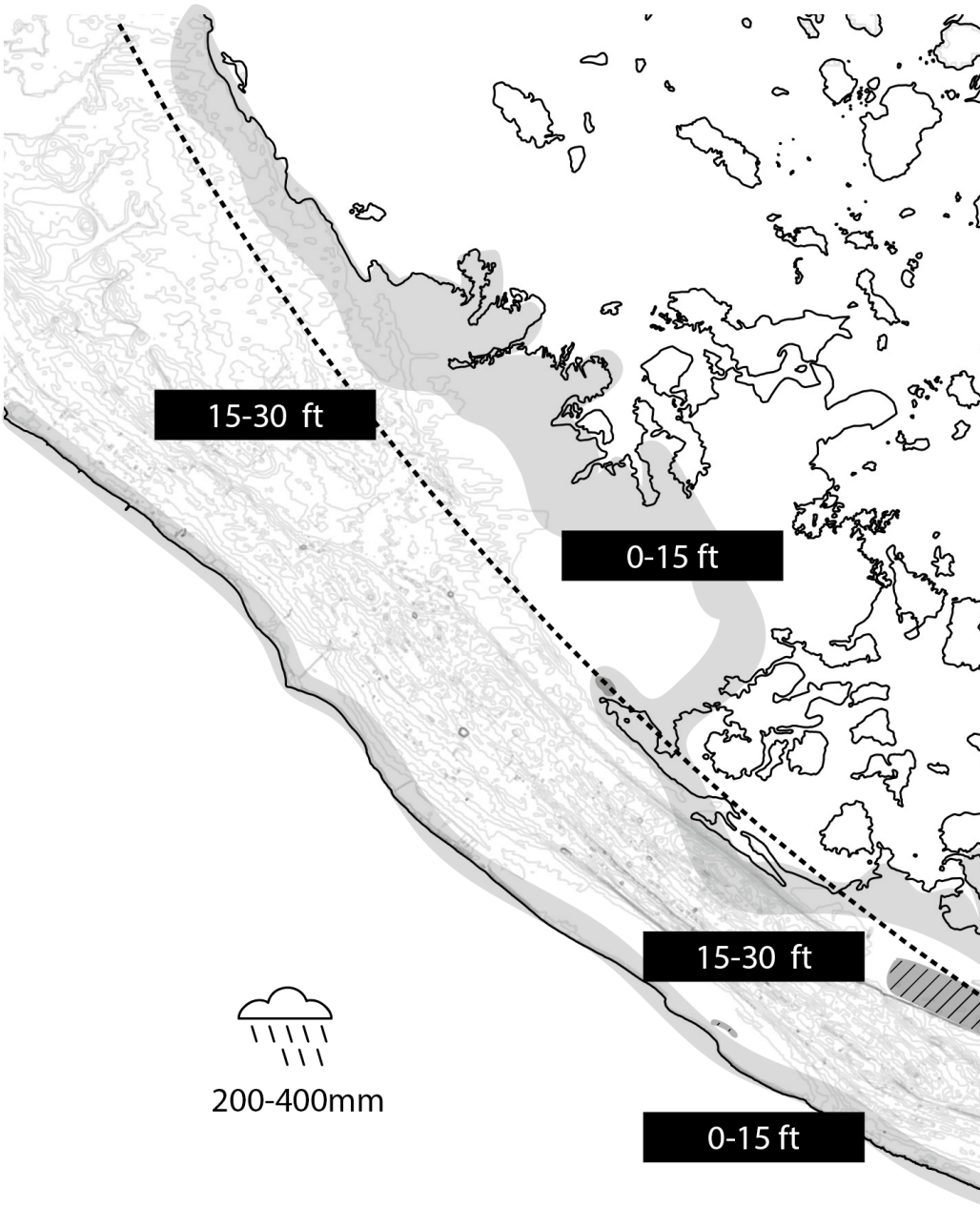
Mean wind direction

0 1 2 km

N

0 1km


Annual
30°N
25°N
20°N
15°N
10°N
5°N
0°
100°W
90°W
80°W
70°W
60°W
50°W
1
2
3
4
5
6
7
8
9
10
11
12
m/s
6.25 m/s
6.00 m/s
5.75 m/s
5.25 m/s



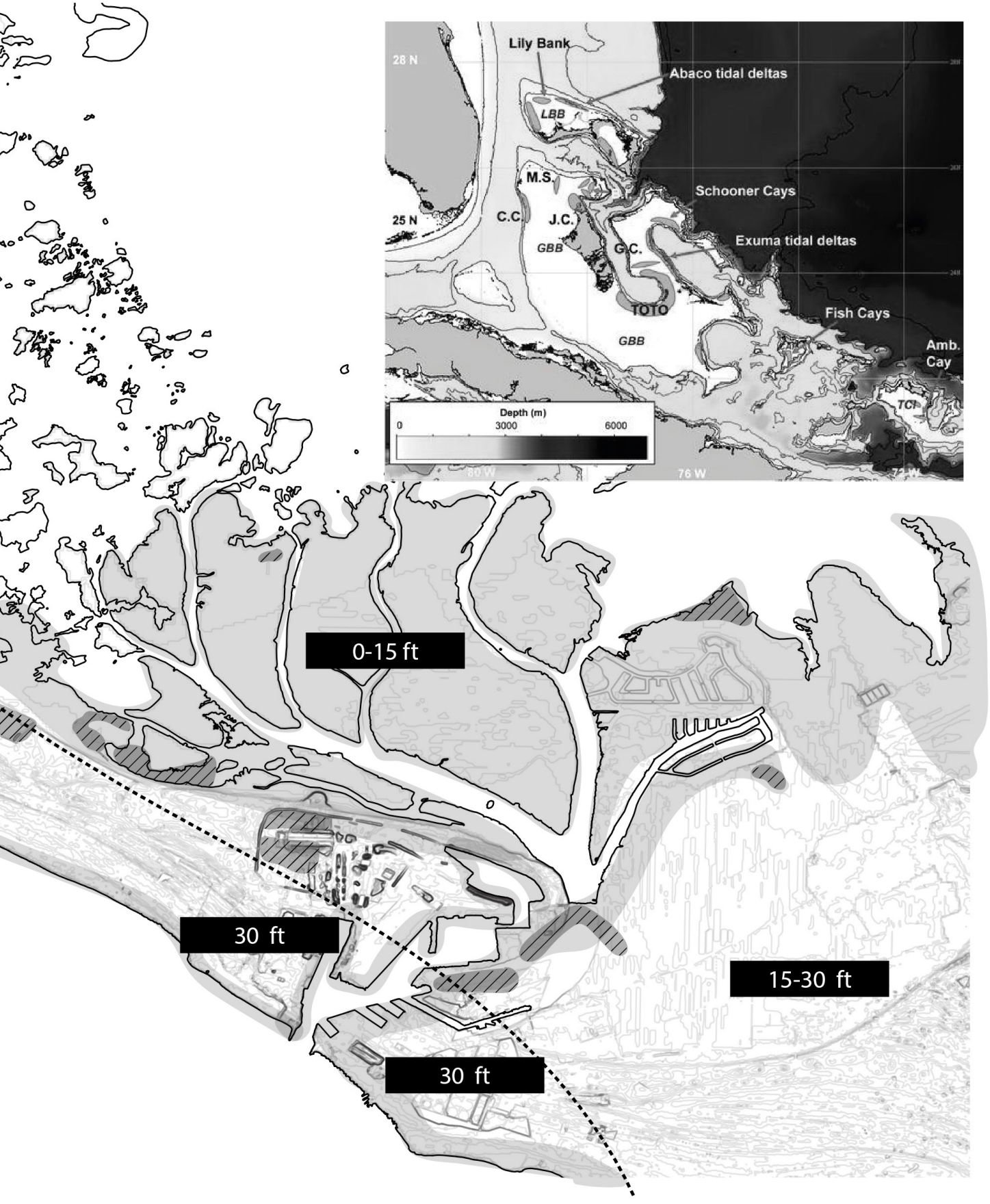
Dynamics Dorian

Although previous assessments in The Bahamas indicate that ecosystems in the country have adapted over time to become resilient to tropical weather, the intensity and duration of Hurricane Dorian still caused moderate to significant environmental effects. Ecosystems were left in a critical state and pre-existent vulnerab lities were exacerbated with an expected decrease in ecosystem services provision in the short and medium term. Damage to mangroves, coral reefs, seagrass beds and protected areas account for around $7 million (IDB, World Health Organization, & ECLAC, n.d.). Since ecosystems are crucial to the economy and society in The Bahamas, it is expected that the impacts of the hurricane on their ecosystem services will result in losses of approximately $27 million (IDB et al., n.d.).

- Height
- Land subject to inundation
- Flooded area
- Rainfall
- Winds 13 m/s or greater

N

0 1km


Lily Bank
28 N
Abaco tidal deltas
LBB
M.S.
Schooner Cays
25 N
C.C.
J.C.
GBB
G.C.
Exuma tidal deltas
TOTO
Fish Cays
GBB
Amb.
Cay
TCI
Depth (m)
0
3000
6000
80 W
76 W
72 W
0-15 ft
30 ft
15-30 ft
30 ft



Extreme landscape

Grand Bahama has to deal with diverse threats to the ecosystem as sea level rise, hurricanes, invasive species and industry.

- Pine forest
- Mangrove/swamp
- Scrub

N

0 1km


NORTH ATLANTIC OCEAN
Bain Town
26° 31 N
-78° 46 W

3.5.

Urban morphology



Figure. 5.2.5.1. Urban patterns of Bain Town in 1969 (Fairy Surveys Ltd., 1969)

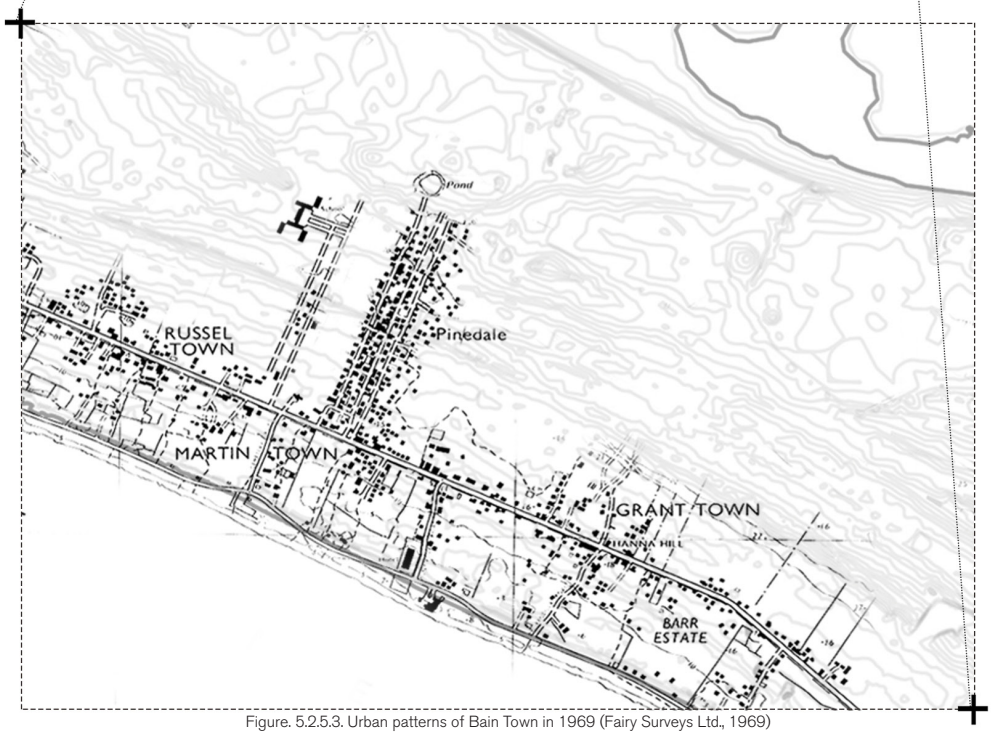


Figure. 5.2.5.3. Urban patterns of Bain Town in 1969 (Fairy Surveys Ltd., 1969)

Urban Patterns

By comparison of maps, from 1969 to 2019, the urban pattern of Bain Town grew but not in a significant way. The growth is based on the main road, along the smaller roads spreaded from the main road. However, the structure of the urban pattern did not change.

- Buildings
- Roads
- Contour line

Figure. 5.2.5.2. Urban patterns of Bain Town in 2019

Figure. 5.2.5.4. Urban patterns of Bain Town in 2019 (1:50000)

Urban Structure

In the focused location of Freeport, the urban structure is very simple - “One town, One industrial area, One way through“ (fig. 5.2.5.5). From the North to South, located in the natural environment, urban areas, and the beach. In zoomed-in scope (fig. 5.2.5.7), it can be seen that buildings are attached with roads.

Vital Infrastructure Construction Artworks

The vital infrastructure here is rare, only including road networks. There is basicly no hydraulic engineering construction except for the port which could be used as a canal for water goes through in flooding situations. However, in the border between the wetland in the North and the higher land, lies a string of levee, which could prevent the surge from the sea in hurricane times.

In hurricane times, extensive located churches and the school with larger interal spaces have the potential to be used as shelters. Therefore, as illustrated in figures. 5.2.5.6 and 5.2.5.8, these area can be considered as “vital infrastructures“ as well.

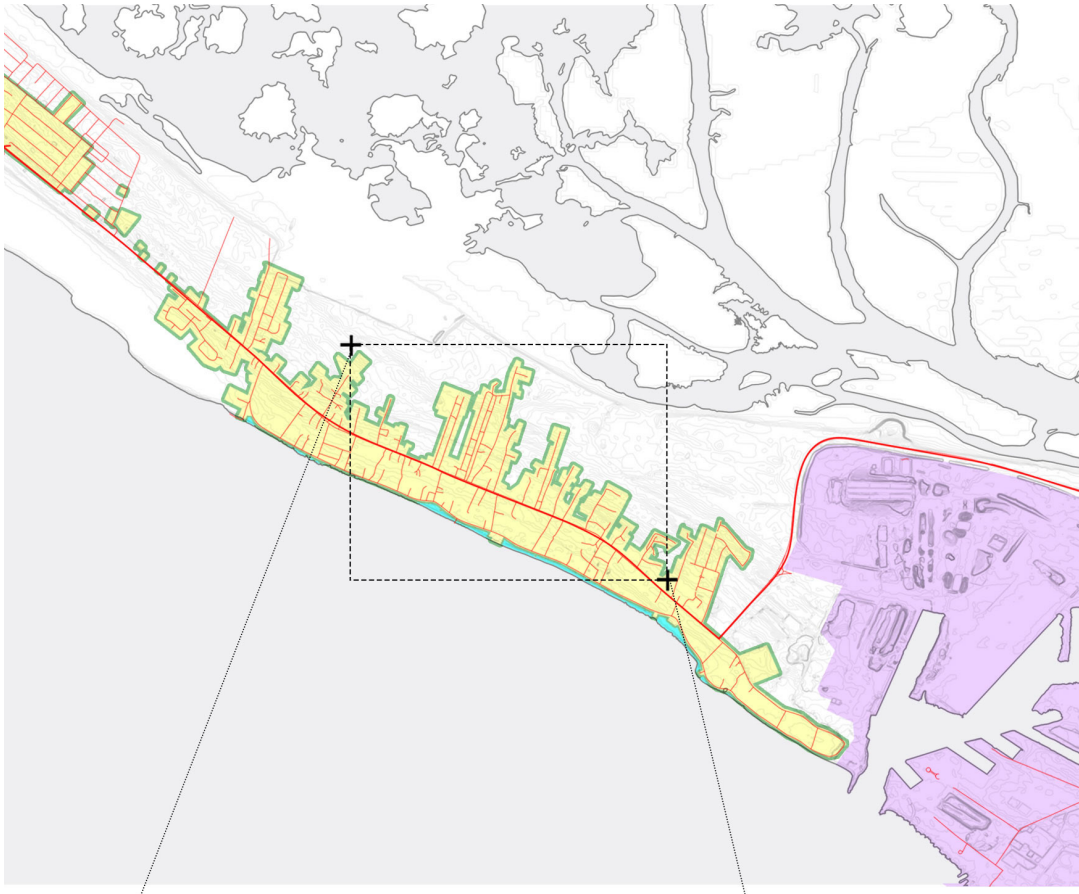


Figure. 5.2.5.5. the Urban Structure (1:250000)

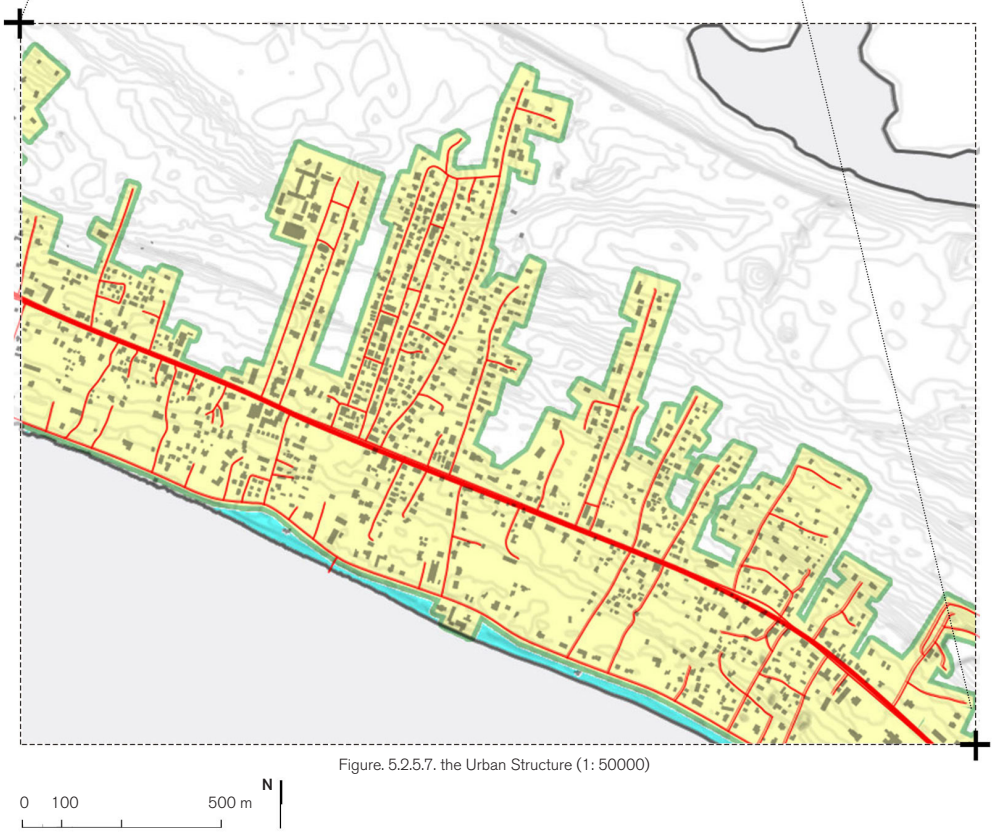


Figure. 5.2.5.7. the Urban Structure (1: 50000)

- Buildings
- Buildings
- Urban Settlements
- Industrial Area
- Beach
- Water
- Canal
- School
- Church
- Roads
- Levee line
- Possible Surge

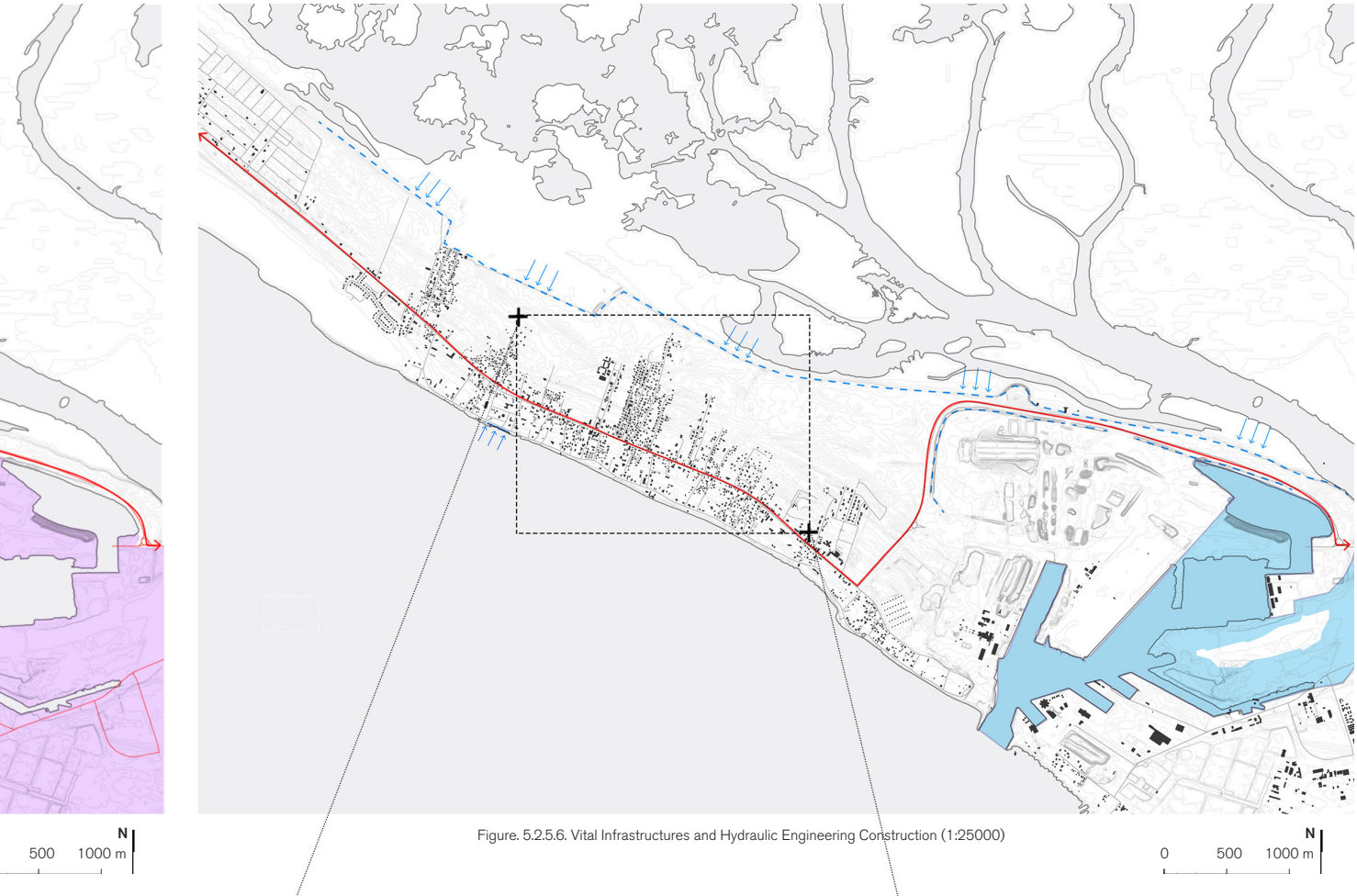


Figure. 5.2.5.6. Vital Infrastructures and Hydraulic Engineering Construction (1:25000)

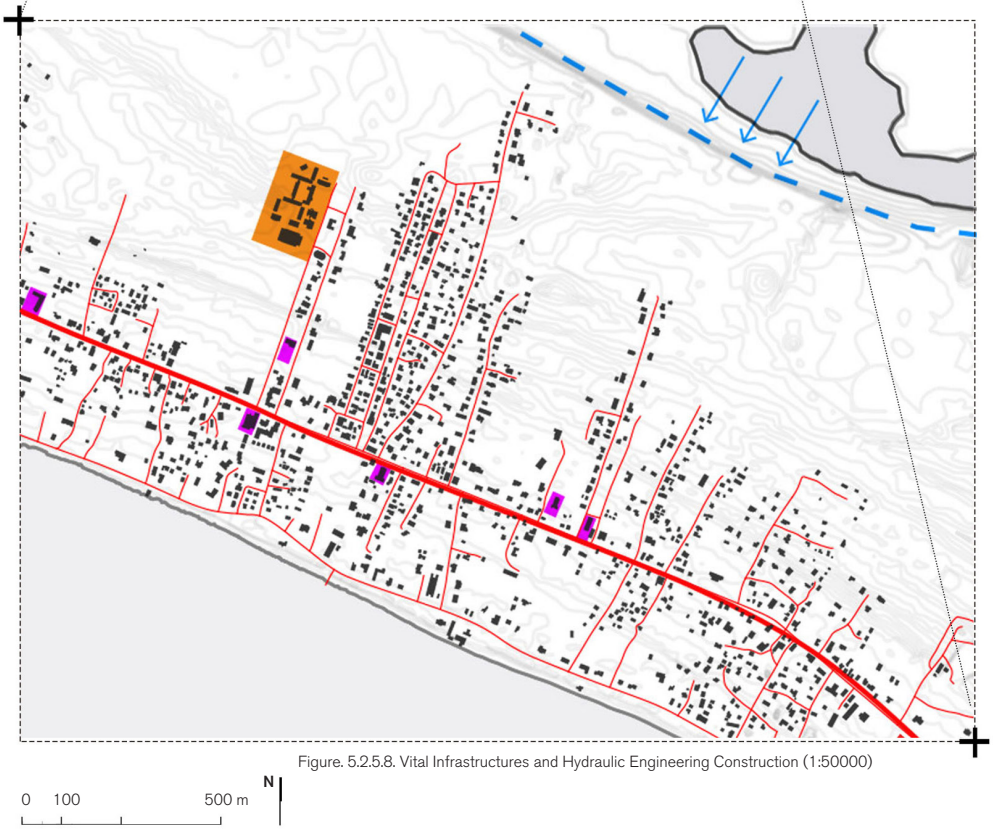
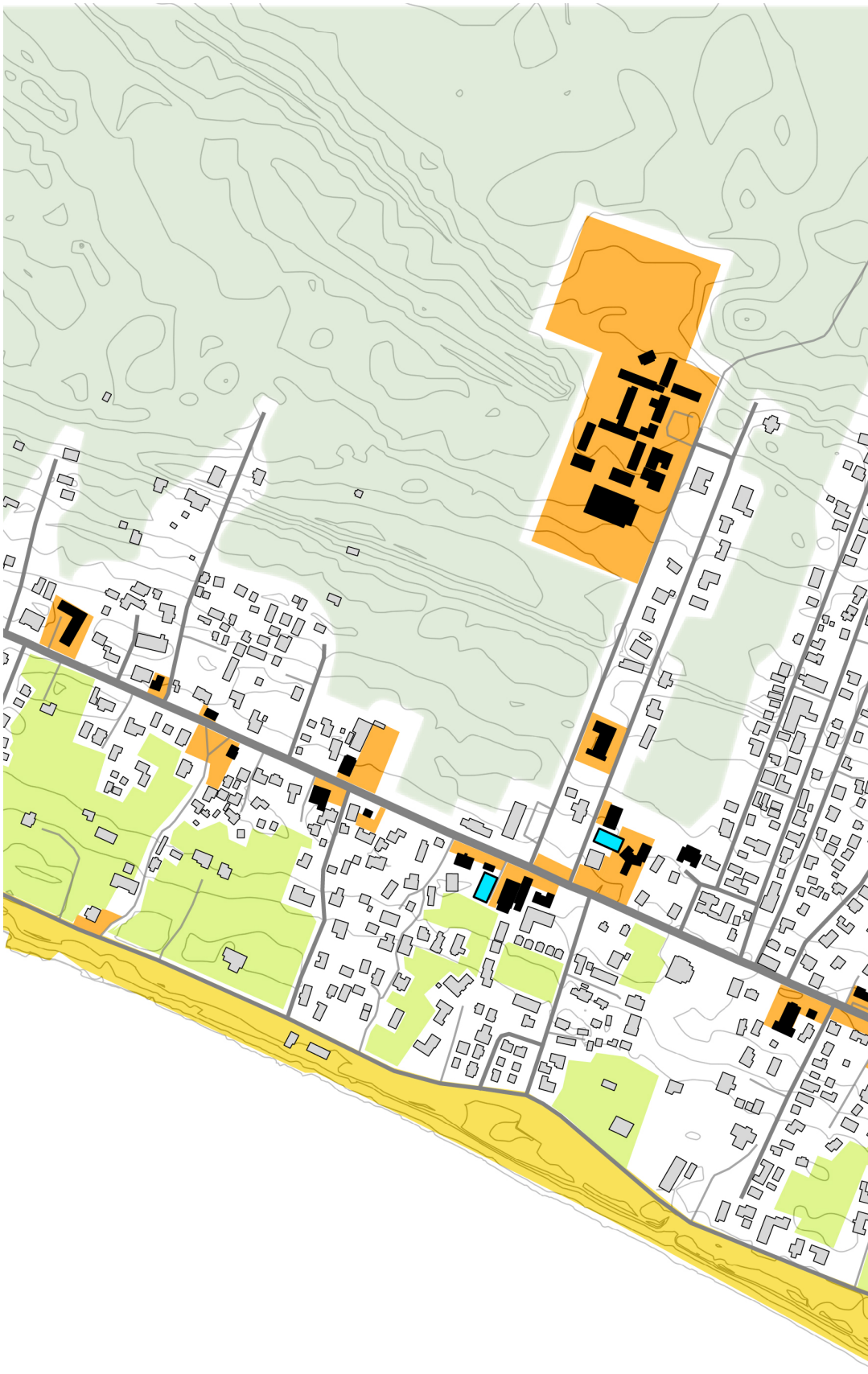


Figure. 5.2.5.8. Vital Infrastructures and Hydraulic Engineering Construction (1:50000)



Urban Typology

The urban typology in the project location is categorized into tree types: building ensembles, green open spaces, and public spaces.

Unlike other more unbanized areas, in Bain Town the elements of urban typology are more informal and broken. The natural environment and built environment are intersected almost everywhere.

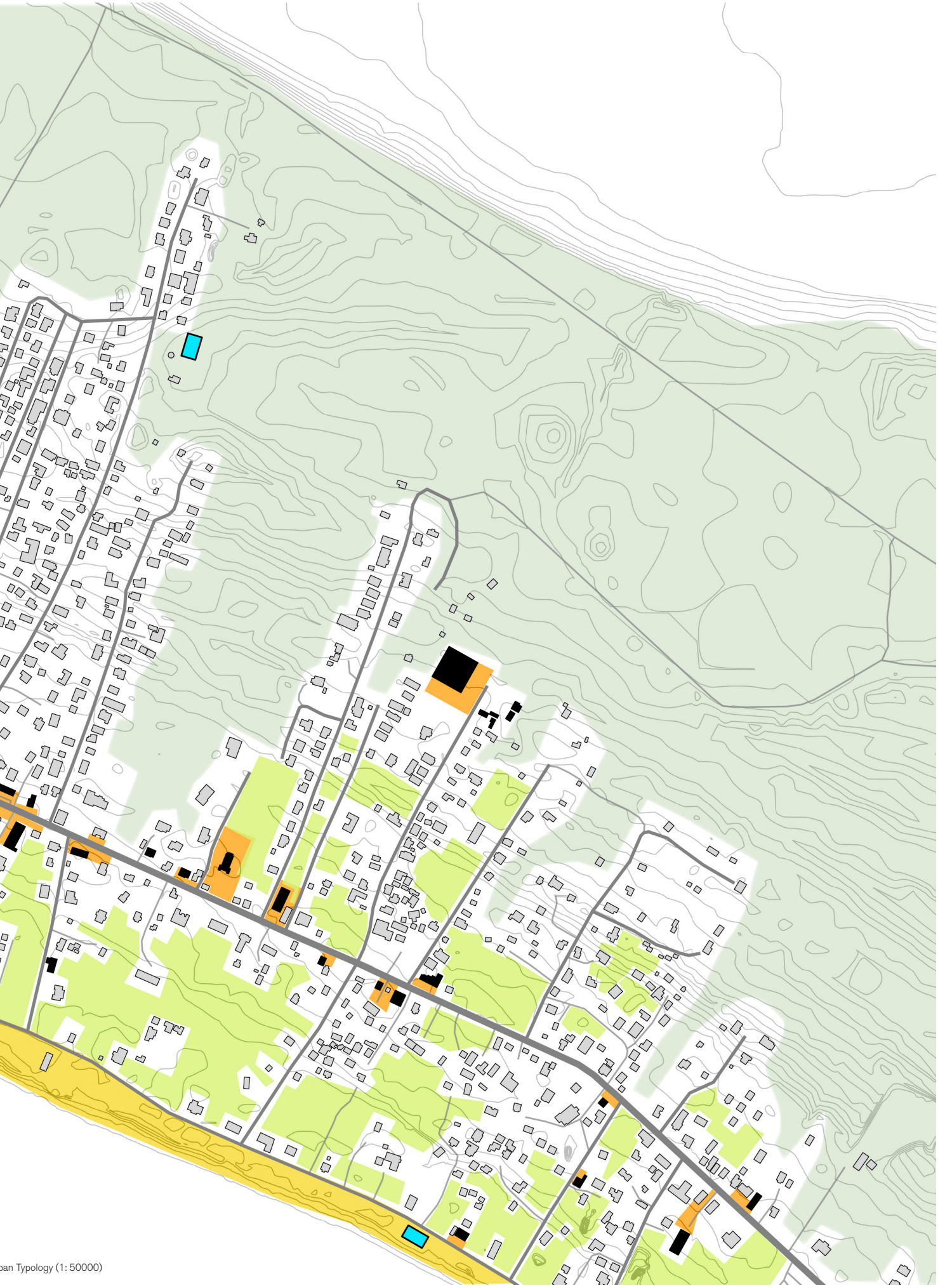
Detailed decomposition will be shown in following pages.

- Public and Commercial Buildings
- Residential Buildings
- Wild Green Open Spaces
- Inner Green Open Spaces
- Main Public Spaces
- Beach
- Basketball Courts
- Roads

N

0 100 250 m

Figure. 5.2.5.9-0. the Urb



ban Typology (1: 50000)

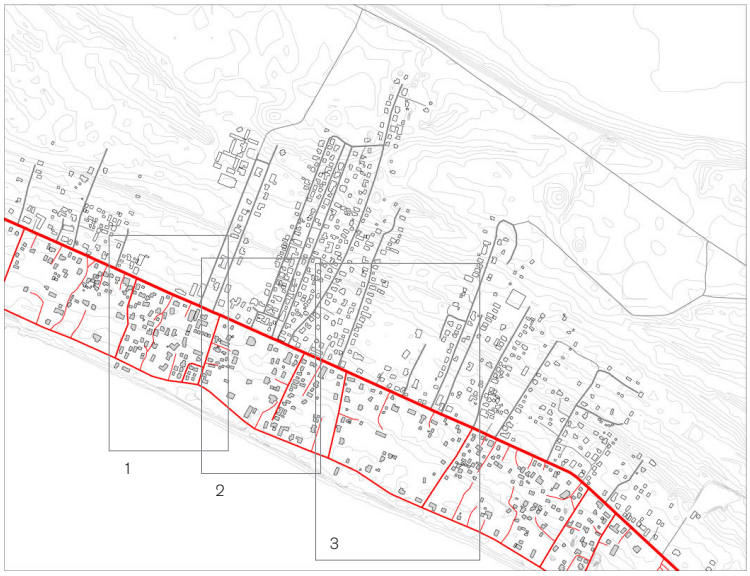


Figure. 5.2.5.9. the Buiding Ensemble on the South of the Main Road



Figure. 5.2.5.11. the Buiding Ensemble on the North of the Main Road

Urban Typology - Building Ensembles

In this location, there are mainly three types of building ensembles, and the distribution of each is directly related to the road network.

In conclusion, the buiding ensembles are structured in a simple way - the accessiblity to services - instead of being organized in spatial relationships such as communities or clusters.



Figure. 5.2.5.13. Public and Commercial Buildings

School
Church
Commercial Buildigs
Residential Buildings
Northen or Southern Roads
the Main Road

N

0 250 500 m

Observation

In the three chosen districts as representatives for the buiding ensemble on the South of the main road, it can be seen that the buildings are located around the closed road network. The roads are closed rectangles.



Figure. 5.2.5.10. Images of representative districts (Google Map, 2019)

Observation

In the two chosen districts as representatives for the buiding ensemble on the North of the main road, it can be seen that the buildings are located around the open road network. The roads are like branches instead of closed rectangles.



Figure. 5.2.5.12. Images of representative districts (Google Map, 2019)

Observation

The public facilities and commercial buildings are located mainly along the main road except for the school and the mall. All of these buildings have open public spaces round them as figure. 3-1 shows.



Figure. 5.2.5.14. Images of representative districts (Google Map, 2019)



Figure. 5.2.5.15. the Wild Green Open Spaces



Figure. 5.2.5.17. the Inner Green Open Spaces

Urban Typology - Green Open Spaces

In this location, the green open spaces can be categorized into three types: wild green open spaces, inner green open spaces and the beach.

With almost no parks here and confined yards around some buildings, the green spaces are totally open. In this sense, the whole natural environment is a large natural park. However, there are still some differences in each types as the figures show.

In conclusion, the green open spaces here are mostly natural green spaces or in total natural conditions. Also, these spaces are lack of development and maintaining.

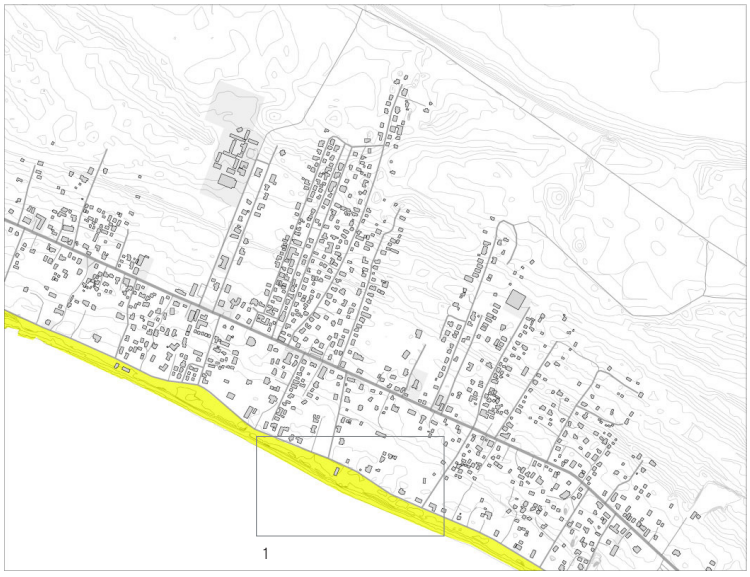


Figure. 5.2.5.19. the Beach

Wild Green Open Spaces
Inner Green Open Spaces
Beach
Buildings
Roads

N

0 250 500 m

Observation

In the Northern part of the location, there are massive wild green open spaces. The building ensembles just grow into the green area. No clear boundaries are between urban areas and green areas here.

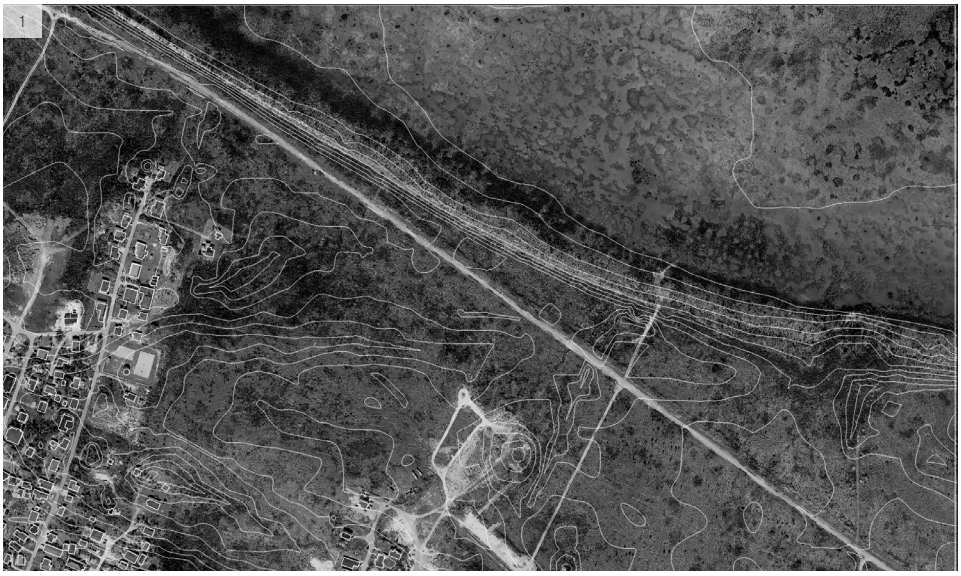


Figure. 5.2.5.16. An image of the wild green open spaces (Google Map, 2019)

Observation

The inner green open spaces are confined within the road network or the building ensembles in the Southern part. A lot of them are totally open, as the green area showed in figure. 2. However, the confined yards around buildings appears around buildings too. Therefore, there is also no common regularity in detailed level.



Figure. 5.2.5.18. Images of the inner green open spaces (Google Map, 2019)

Observation

The beach is also an important part of the green open spaces, for its openness and its undeveloped conditions with trees and grass.



Figure. 5.2.5.20. An image of the beach (Google Map, 2019)



Figure. 5.2.5.21. the Pedestrian Areas along the Mian Road and Paths to Buildings



Figure. 5.2.5.23. Basketball Courts

Urban Typology - Public Spaces

Considering a lot of green spaces are public, public spaces in this location are massive. However, the public spaces would be really rare and informal as the building ensembles are if considering the urban public spaces for public activities and gathering.

Basicly, there are three types of public spaces here, including informal pedestrian area along the main road and paths to buildings, several public basketball courts, and public areas around public and commercial buildings.

In conlusion, the public spaces in this location are rare, informal and in low quality.

- Basketball Courts
- Public Spaces around Buildings
- Public and Commercial Buildings
- Other Buildings
- Pedestrian areas along roads



Figure. 5.2.5.25. Public Spaces around the Public and Commercial Buildings

N

0 250 500 m

Observation

Although without offical pedestrian areas, the belts along the main road is for walking, staying and even some activities. However, the spaces do not appear along residential roads for its mixed use for both cars and pedestrians. Also, the paths to buildings outside the personal yards are places possible for public activities.



Figure. 5.2.5.22. Images of pedestrian area along the main road and paths to buildings (Google Map, 2019)

Observation

Basketball courts are the only public sports fields in Bain Town. And these limited sports spaces are in low quality.



Figure. 5.2.5.24. Images of basketball courts (Google Map, 2019)

Observation

The main public spaces are those spaces around public buildings and commercial buildings. This shows the main spaces for people to have activities related to the use of those buildings.

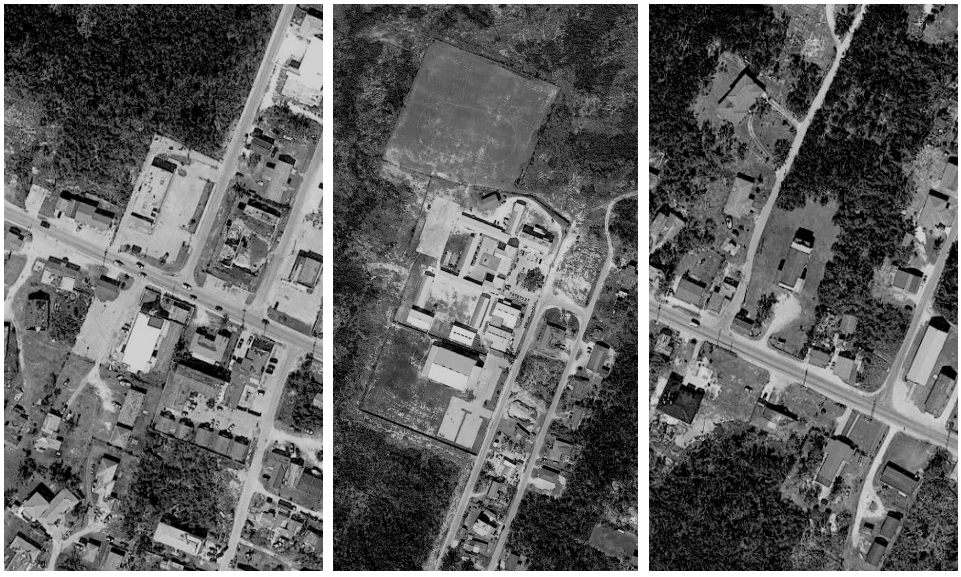
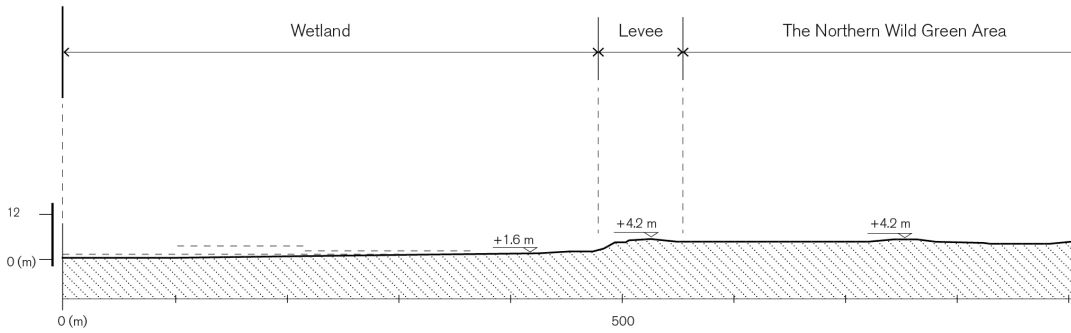


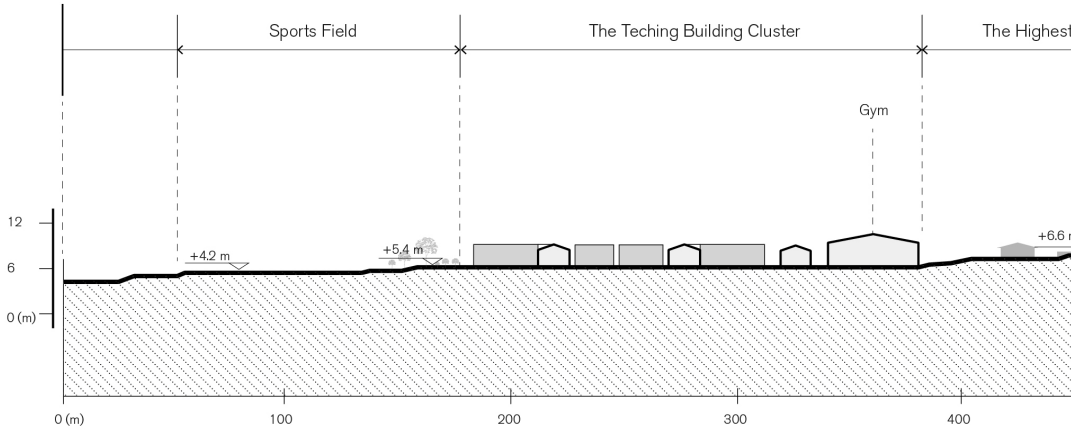
Figure. 5.2.5.26. Images of public spaces around buildings (Google Map, 2019)



Figure. 5.2.5.27. Location of section AA'

Section AA'





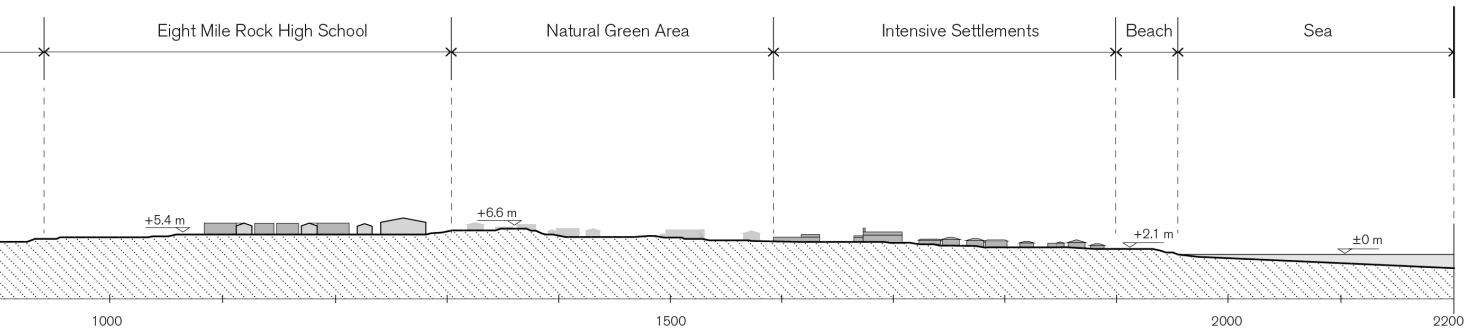
Urban Typology - Sections

The spatial configuration from the North side to the South is basicly from nature to the ubanized area as section AA' illustated. From both sections AA' and BB', it can be seen that the distribution of urban settlements are irrelevant to the elevation.

The elevation in settlement areas is from around 2 meters to 6.6 meters.



Figure. 5.2.5.28. Location of section BB'



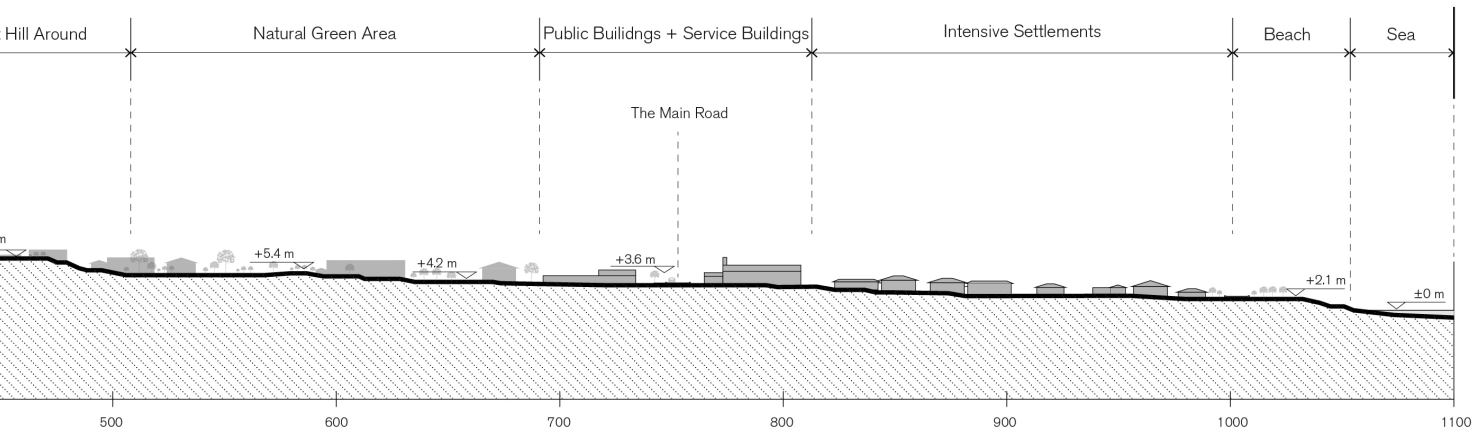


Figure. 5.2.5.29. Location of section AA'



1. Service buildings 2. Public buildings 3. Small residential houses 4. Large residential houses

Figure. 5.2.5.30. Typical building types in Bain Town (Google Map, 2019)

Typology - Building Types

In Bain Town, there are four main types of buildings:

1. service buildings including commercial and retail buildings
2. public buildings including schools, churches, and public organization buildings.
3. Small residential houses
4. Large residential houses

Section CC' illustrate a typical distibution of different buildings in which service buildings and public buildings gather along the main road and settlements spread from the main road to each side.

- Service Buildings
- Church
- Residential Buildings





Figure. 5.2.5.31. Location of section CC'

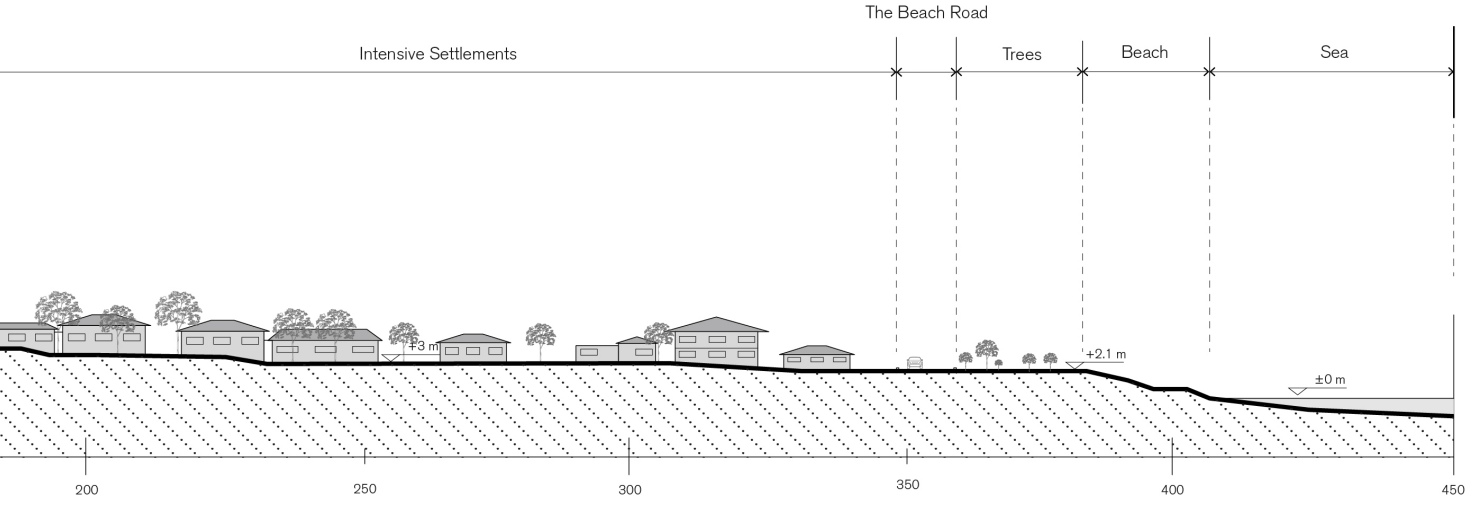


Figure. 5.2.5.32. Location of section CC'

Typology - Vernacular Architecture

There are three typical vernacular Architectures in Bahamas: Conch Houses, Clapboard Houses and Colonial Houses, as figure 5.2.5.33, 34, 35 illustrated. Vernacular and traditional building forms and technologies can be found in these types of buildings.

The typical vernacular features include piers and posts, sash windows with shutters, pitched or hipped roofs, louvered doors and porches, as figures 5.2.5.36-40 show. These features exist for different technical reasons, but the common use is to adapt buildings to the local climate including heat waves, hurricanes and flooding.

However, in Bain Town, these features seldom show up except for pitched roofs due to several reasons. Firstly, a lot of buildings in Bain Town are poorly built and lack of enforcement of building codes, and this make it hard to implement these “helpful“ features. Also, the American lifestyle with yards and cars as well as the modernism process have great impacts on the buit environment, thus making people here do not treasure these traditions anymore. Last, although extreme hazards from hurricanes like Dorians always remind people of the importance of adaptive buidlings, a lot of people with resources and good finance will migrate to safer conditions or even abroad, and people in poor conditions do not have the finacial power to move. And they do not have enough focus and finance to build their homes in an adaptve way with vernacular technologies.

Conch Houses



Figure.5.2.5.33. A conch house in Key West (Ivanko, 2013)

This vernacular architecture was typically the work of shipbuilders-turned-carpenters from the Bahamas and Key West. These "conch" houses feature a one-and-one-half or two-story rectangular mass, with broad gabled or low, hipped roofs. They are usually of balloon frame construction, rather than the original cross-braced system of heavy timbers based on shipbuilding techniques. Buildings are raised off the ground on wood posts or masonry piers, allowing air circulation underneath the house. Exterior surfaces are of horizontal weatherboards and windows are double-hung sash type. The most prominent feature of these buildings is the balustraded front porch, sometimes wrapping around the sides on both stories (Janus Research, n.d.).

Clapboard Houses



Figure. 5.2.5.34. A demolished clapboard house on William’s Street (Coulson, 2020)

The once-revered Bahamian clapboard house emerged as an architectural style in the 19th century as one of the most commonly-used styles in the region (Oliver, 2017). The ground floor of the cottages are elevated on low stilts, allowing air to circulate while avoiding rainwater floods below. These homes are designed with the intention of staying cool, with large windows and high ceilings to increase airflow complementing pushed out shutters to shade windows and help direct breezes indoors, even during rainstorms. The buildings themselves are also angled to receive trade winds (Pinder, 2017).

Colonial Houses



Figure. 5.2.5.35. The government house of the Bahamas(Carribbean Cruise, n.d.)

These colonial houses display the oldest architectural style found throughout the islands, and are most commonly used for government buildings. While the style is based on the architecture brought to the country by early British estate owners, Bahamian builders made more functional adaptations to work with the climate in the islands. These buildings may have the same traditionally thick walls as found in Europe, but in The Bahamas, they’re painted light colours to reflect the sun. In an attempt to make indoors even breezier, more windows, verandahs and porches can be found on these Bahamian buildings to encourage stronger airflow (Pinder, 2017).

Typical Vernacular Features

1. Piers and posts

- The base for buildings built on
- Lifting groundfloor
- Cooling by creating air circulation
- Avoiding rainwater flooding



Figure. 5.2.5.36. Piers and posts (Greg, n.d.; Lahongrais, n.d.)

2. Sash windows with shutters

- Creating shading
- Directing breeze indoors
- Receiving trade winds
- Protecting windows from storms



Figure. 5.2.5.37. Sash windows with shutters (Lane, 2011; The Dunmore, 2020)

3. Pitched or hipped roofs

- Creating better thermal insulation
- Stable for withsatnding strong rain and wind



Figure. 5.2.5.38. Pitched or hipped roofs (Alvino, n.d.; Tim Tucker LRPS, n.d.)

4. Louvered doors

- Creating shading
- Directing breeze indoors
- Receiving trade winds
- Protecting doors from storms



Figure. 5.2.5.39. Louvered doors ("Louvered doors," n.d.; McIntyre, n.d.)

5. Porches

- Creating shading
- Receiving trade winds
- Encouraging stronger airflow for ventilation and cooling
- Creating spaces for staying, relaxing and sightseeing



Figure. 5.2.5.40. Porches (Janus Research, n.d.; Maisna, n.d.)

Hazard Types in Extreme Conditions

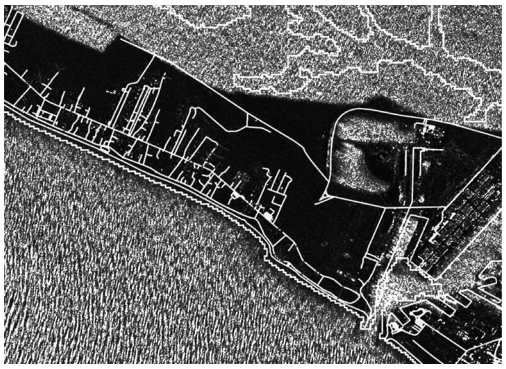


Figure. 5.2.5.41. the flooding map of Dorian (ICEYE, 2019)

Extreme Construction

In Bain Town, there are four main types of hazards from hurricanes: hurricane surge, rush from heavy precipitation, strong wind and pluvial flooding, as figure 5.2.5.41-44 illustrated.

According to the analysis of data, two conclusion maps of extreme conditions are worked out(fig. 5.2.5.45, fig. 5.2.5.46). In these maps, lower areas in danger of possible surge, rush, puvial flooding are remarked.

In conclusion, firstly, settlements in low areas in risk of being flooding should be migrate to higher areas or be improved with relevant technologies. Secondly, the natural elevaton should be used for drainage of water from both heavy precipitation and pluvial flooding. Thirdly, shelters development should be considered in higher areas for evacuation in hurricane times. Last, reinforcement and lifting of buildings should be proporly considered to improve the capacity of dealing with strong wind and flooding.



Figure. 5.2.5.42. the image of rush from heavy precipitation in Dorian (Reuters, 2019)



Figure. 5.2.5.43. the image of destroyed settlements in Dorian (Espinosa, 2019a)

- Flooding line by surge in Dorian
- Low areas in danger of flooding
- Possible rush
- Possible surge
- Low areas in danger of future surge
- Inner flooded areas in Dorian

Figure. 5.2.5.45

- Above 5m
- 4-5m
- 3-4m
- 2-3m
- 1-2m
- 0-1m
- =<0m

Figure. 5.2.5.46

- Above 4m
- 3-4m
- 2-3m
- 1-2m
- 0-1m
- =<0m



Figure. 5.2.5.44. the image of pluvial flooding in the streets in Dorian (Espinosa, 2019b)

Weakness according to Hazards

Hurricane surge

In Dorian, although Bain Town was not direc flooded by surge from the sea gue to its relativ high elevation, the settlements in lower areas a still in danger of flooding from the surge in possib strongger hurricanes in the future.

Rush from Heavy Precipitation

In hurricanes, heavy precipitation is anoth hazard causing rush which might flood house infrastructures and cars in low areas. Also, residents are not evacuated before it, a lot of peop will be trapped in flooded areas and even die fr it. Some settlements in Bain Town are not bu according to the elevation and in low areas, and th might cause a lot of damages.

Strong wind

Strong wind in hurricanes can cause seve damages to properties including houses. People lo homes because of that. According to the buildi code, the houses should be built take wind spee at 150mph (Oliver, 2017). However, due to t poor building conditions and lack of enforcement the building standards, a lot of buildings have be destored in Bahamas including Bain Town duri the Dorian time.

Pluvial flooding

Puvial flooding is very common in hurrica times. When the flooding last for long time d to the precipitation and poor choices of locati for buildings, settlements and infrastructure w suffer from flooding for a long time. Buidlin without higher groudfloors and sufficient draini environment will suffer more, and these kind buildings are very common in Bain Town.

Conclusion Maps of Extreme Conditions

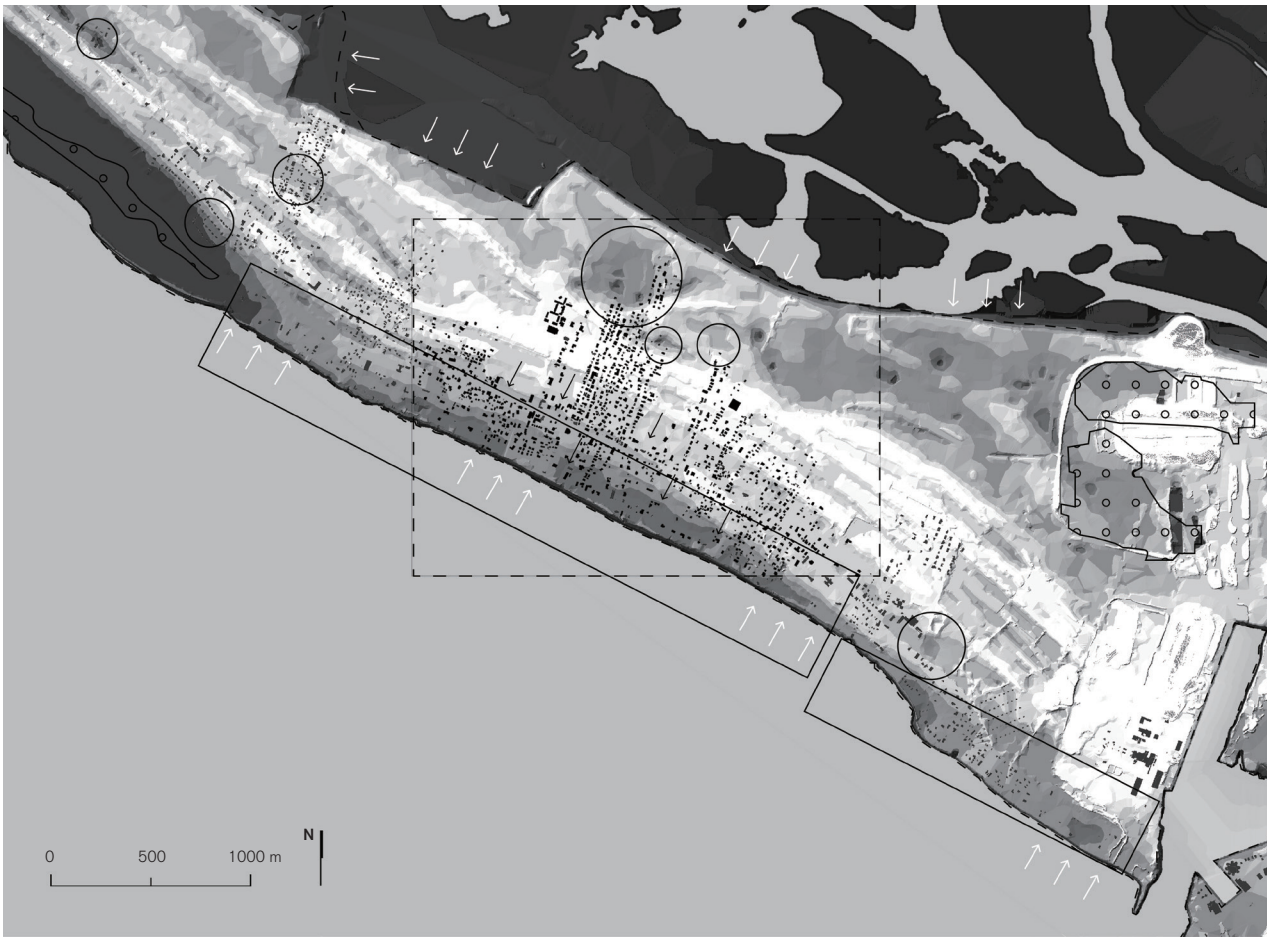


Figure. 5.2.5.45. the conclusion map in 1:250000

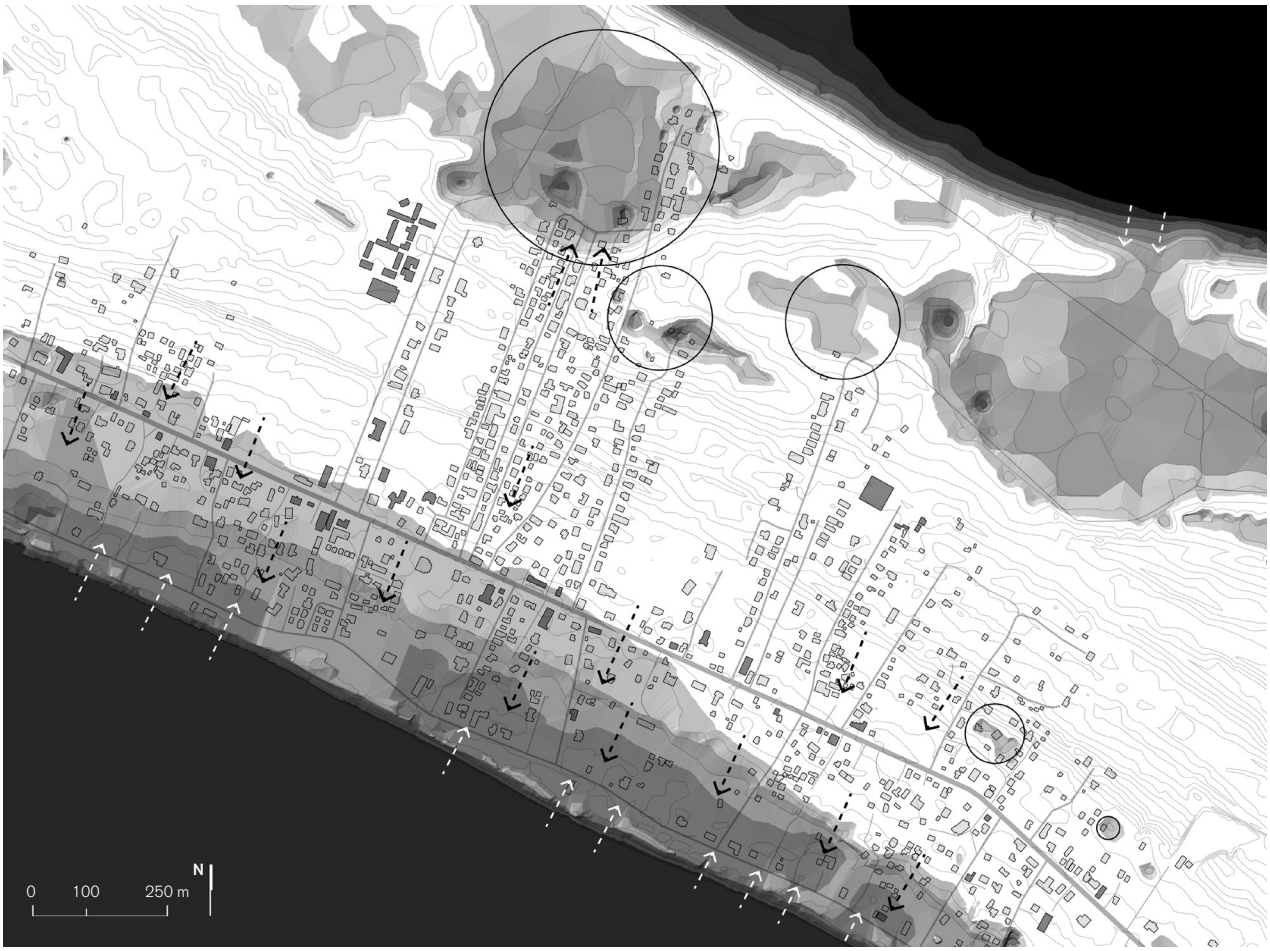


Figure. 5.2.5.46. the conclusion map in 1:50000

5.6.

Mobility and Transport

Introduction

The island of Grand Bahama will be analysed from a transport, infrastructure and logistic (TIL) perspective. The following research question is applicable to this analysis: “How can environmental participation add to ecosystem building from a transportation and mobility perspective on the Grand Bahama island?”. There is a distinction between transport and mobility made, transport focusses on the flows of goods and mobility is linked to the flows of people. For a detailed description of the perspective is referred to the TIL extreme landscape assessment framework (research proposal).

This analysis will discuss the shock and stresses, then, assess the transport and mobility system and fill in the framework. This will lead to a conclusion and recommendations on how to deal with the stresses and shocks with paying attention to ecosystem participation.

Context: Shock and Stress(es)

The Grand Bahama island was inhabited to around 50,000 people in 2010 (Department of Statistics, 2014) and mainly inhabited on the southern shore of the island. The northern part is (originally) mainly nature, consisting of pine forest and mangroves. Large establishments on the island are the capital West End and Freeport.

The island of Grand Bahama is not mountainous at all. The flat landscape is a reason why large parts of the island flood in case of hurricanes (see figure 1). The Grand Bahama island faces shocks as hurricanes annually (Buchanan, 2000). Shocks are acute problems, like floods and hurricanes, shocks cannot be mitigated (Spaans & Waterhout, 2017).

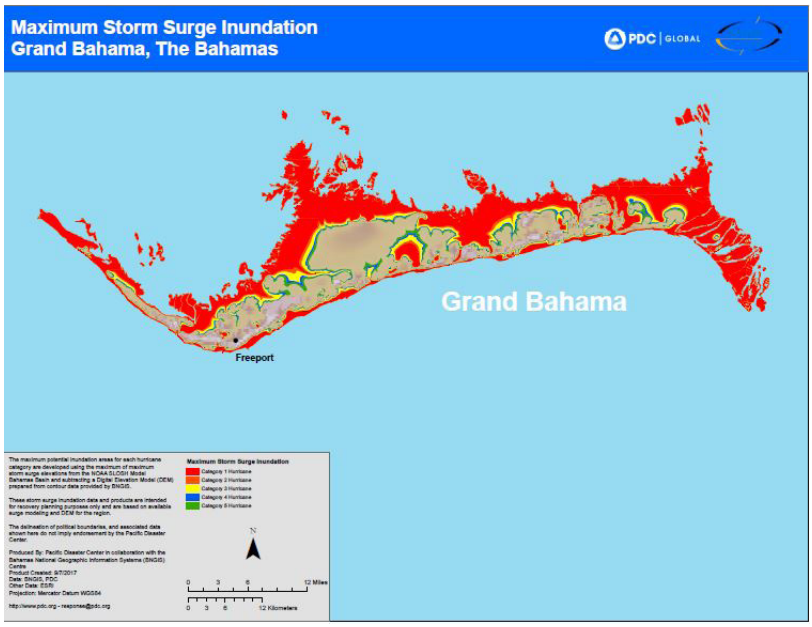


Figure 1 Storm surge Grand Bahama (Pacific Disaster Center, 2017)

The mobility and transport network on Grand Bahama

The mobility and transport network will be addressed by describing the important flows and nodes on the island. The mobility flows and activity nodes are the movements and reasons to move for people. As mentioned, the Bahamians have a preference for using the car as their main mode of transport. The only public transport modes are busses. The road network of The Grand Bahama is not very dense, the main road from West to East is the Queens highway. In the middle of Freeport another highway is situated which is eventually connect to Queens highway on both sides.

The activity nodes on the Grand Bahama islands are somewhat concentrated, every township or settlement has nodes for attraction of people. Even smaller towns have churches, markets and other services. The larger towns of Freeport and West End have a larger attraction since these towns also provide island wide services and are important locations for jobs, like tourism or a (air)port (Harris et al., 2020).

The Grand Bahama island has several important locations in terms of logistic flows and transfer nodes, since it is an island it is much dependent on import and export of goods and materials, but also food, water and fossil fuels (Inter-American Development Bank, 2017). The island has two airports, one close by Freeport and the other island is situated near the capital West End. Both airports are both situated a few metres above sea level, thus prone to floods. The airport in the north is owned by a Hong Kong company, called Hutchison Whampoa (Freeport News, 2019). Furthermore there are two other runways located in the eastern part of Grand Bahama, however these are not used for (civil) aviation now.

The harbour of Freeport is an important harbour, established in the Hawksbill Creek agreement (Encyclopaedia Britannica, 2013). The Grand Bahama Port Authority (GBPA) was given a large piece of land, which developed to a large harbour for container ships and cruise ships. The GBPA also has government tasks, it is the government authority of the town Freeport and parts of its surroundings.



Figure 2 Map of flood surge (CBC News, 2019)

Framework

The analysis will use the framework described in the research proposal, using the identified shocks and stresses to assess the mobility and transport network. The filled in framework can be found at the end of the analysis.

A shock, like hurricane Dorian, had a large impact on the transport network. Figure 2 showed that the main highway on the Grand Bahama island was submerged for large parts. Land transport was impossible, a model built by ICEYE (2019) showed that the highway was flooded severely on several parts. Especially towns in the direction of West End and the east part of Grand Bahama were hard to reach via land, with potential consequences.

In terms of logistics or transport of goods, the airport near Freeport was submerged for 48 hours, but usable when the flood lowered (Andone, 2019)(UNICEF, 2019). In the eastern part of the island two other runways are located, but it is unknown if they were flooded or used after Dorian. Furthermore, the harbour of Freeport was not damaged by Dorian, however bringing goods to Grand Bahama is only one step. Because the goods could not be transported via land. There were also not enough smaller boats located at the island to distribute the goods. Aid and rescue workers had to travel to Grand Bahama via Abaco islands and from there with boats to Grand Bahama or people were rescued by the US coast guard (Randolph & Lafferty, 2019)(OCHA, 2019).

The flood that comes with hurricanes opposes a threat to humans, in terms of evacuating, rescuing and transport of aid and food.

The framework provides solutions that can reduce the impacts for shocks but also address the stress of societal unpreparedness. There are three categories of solutions provided: infrastructural, social and emergency.

Elements of the network can be changed to decrease vulnerability of the network. The airport can be moved or elevated, the same can be applied to parts of the highway. Since the island and population is relatively small, building of new highways is probably not useful. The airport near Freeport should be elevated to keep it dry in case of floods, but again it should be reachable by land to transport people or aid. A problem is that the airport in owned by a company Hutchison Whampoa. If the government wants to elevate or move it, the government needs to buy or invest in the airport, which they are thinking of (Freeport News, 2020).

Building strategically placed dikes, by using natural elevation like a dune is also an infrastructural solution. Dikes are expensive and often not a pretty site, including a more nature built approach can increase aesthetics of the landscape. Good example is a kind of natural formed barrier northern of Baintown.

Social solutions include the promoting of boat ownership under Grand Bahamas inhabitants and also among local governments. Boats can be useful to reach places on the island when the land network is submerged. The boats can be useful for tourism and fishing too in normal situations. Another social adaptability is the deployment of swimming programs, since so few people can in the Bahamas.

A combination of social and infrastructural solutions that could be suggested are car sharing platforms and the implementation of electrical vehicles (EV). Car sharing can reduce the amount of cars on the island, thus people can spend money more wisely than large parts of their income, as Adderley (2008) described. Furthermore, car sharing and EVs both can reduce the amount of emitted GHGs. However Bahamians own their cars, the wide adoption of car sharing seems therefore an unlikely incentive. Also implementing EVs and their needed charging infrastructure seem practically less feasible. The island is already dependent on importing energy, like fossil fuels to create electricity and the use of solar panels seem not practical since the hurricanes can destroy them. Furthermore, a Canadian company is the owner and the sole provider of energy on Grand Bahama (Bradshaw,2019), to incentivize them the government should invest again.

Emergency solutions include the increase of rescue boats, flood warning systems, well-organised air/naval supply lines in case of a shock.

	Shock: Hurricanes
	Accessibility & Co
Mobility flows:	During hurricanes t will be in some part main connecting hig situated mainly on t the island, which is during hurricanes. However figure 1 sh more remote part i practically cut off fr transport. Freeport submerged in the n
Activity nodes:	The access to safe a cut off due to flood hospitals, food supp become important these situations car unreachable.
Logistic flows:	Logistic flows on th postponed during s while.
Transfer nodes:	North airport termi will be damaged. Th useable after 24-48 Port in Freeport wil damaged a lot. High encountered.
Conclusions:	In cases of shocks, t The mobility and tra boats interrupts thi Main solutions will people that can swi

Conclusions and Recommendations

The framework for the Bahama case shows that the mobility and transport network on the Grand Bahama tried provide an answer on the research question: "How can environmental participation add to ecosystem building from a transportation and mobility perspective on the Grand Bahama island?".

The framework and assessment of the stress and shock show that there are different solutions that can reduce the vulnerabilities and risks to the distribution of goods and movement of people. Those solutions are focussed on three categories: infrastructural, emergency and social.

Infrastructural solutions imply changes to the current important nodes and links, like the highway and airport. Improvements on this side can increase reliability of the network and reduce vulnerability to society.

Emergency solutions provided focus mainly on the increase of (emergency) boats by government and inhabitants. The boats provide excellent movement in case of floods.

On a level of social solutions and social adaptability, the lack of swimming capabilities should be drastically improved.

As a final remark, there is a lack of data collection on the Bahamas. The amount of official government reports that are based on statistics is very little. With advanced models (see ICEYE in references) and statistics strategic evacuation plans and sheltering can be made to reduce risks to humans in case of shocks. Furthermore, the island critical transfer nodes are owned by companies, which do not necessarily have society's will as their priority. A critical research into actor investigation/collaboration might be useful for Grand Bahama.

s		**Stress:** Societal unpreparedness/responsibility		
nnectivity	**Vulnerability & Reliability**	**Accessibility & Connectivity**	**Vulnerability & Reliability**	**Recovery and future mitigation/adaptability**
he road network s flooded. The ghway is the south side of flooded less nows that the n the East will be rom land will be orth east part.	Roads will be cut off due to floods. This leads to a cut off for the parts on the island. In case of hurricanes people in these cut off areas are vulnerable. After floods the roads are not damaged, but can be littered. There are no significant impacts on reliability. A lot of people cannot swim, this leaves them extremely vulnerable in floods.	Accessibility is not affected in stress. The network is quite simple on the island, there is no need for large dense road networks or public transit lines. Car ownership is really high, more eco-friendly solutions are preferred.	The transport system is potentially vulnerable. There are not many roads, in case of evacuation these roads can be too small or cut off due to floods. The road system is reliable and solid. No information about congestion available.	**Emergency:** Flood warning systems **Social:** Encourage boat ownership under the Bahamian people. Increase emergency boat fleet. Swim programs, to teach people to swim and safe themselves in floods. **Infrastructural:** Dikes (natural) Reroute/Elevate the main Queens highway
areas might be s. Shelters, plies which activity nodes in n be	Emergency nodes or prone areas can be unreachable. Vulnerable people cannot reach aid or cannot be reach via land.	Accessibility is not affected in stress. The network is quite simple on the island, there is no need for large dense road networks or public transit lines.		**Emergency:** Flood warning systems
e island will be hocks for a	People need to be self-sufficient or deal with the supply/storage they have. The longer it takes to pick up the logistic flows the more dangerous it can get for people's wellbeing and security.			**Emergency:** Air/Naval supply lines
nals and hangars he runway hours. l not be n tides can be	The airport is not useable for 24-48 hours, this means that for quick rescue and respondents the island needs to be reached via sea. This takes longer and also the hurricane's track is important for reaching the island.			**Infrastructural:** Elevate/Move airport. **Emergency:** Emergency Port Act

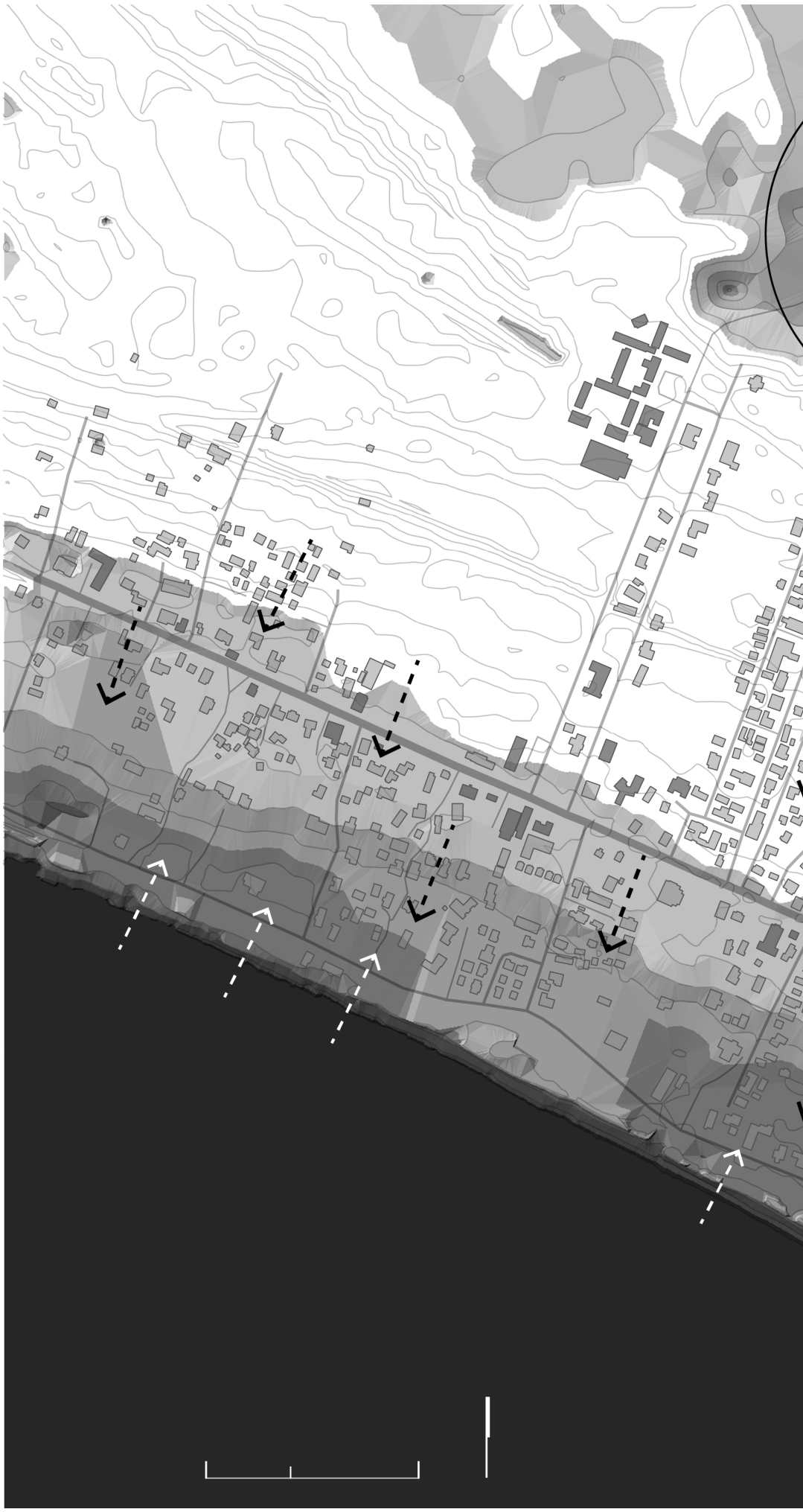
he mobility and transport network is vulnerable, where stresses contribute to the vulnerability.
ansport flows via land are almost impossible, which has implications on the safe being of people. Mobility and transport flows via boats are possible, but a lack of s. The low elevated locations of highway and important airports are also a part of the problem, to rescue and help people on the island of Grand Bahama.
be increase the amount of rescue boats, look at possibilities to strategically elevate/reroute infrastructure. More societal solutions are increasing the amount of m, this can be the difference between life and death in shocks.

4.

Systems description and synthesis

Hybrid system drawing

Combining the six perspectives we come to the synthesis for the future of Grand Bahama. As the island is vulnerable to high wind and flooding by its geographical location, with the climate change the island will get even more exposed to these threats. It has to deal with sea level rise, more rainfall and heavier storms. We suspect for some parts of the island the hazards will become too difficult for people to live and have to move their infrastructure, buildings and assets to a higher part. The Bahamians have to change their way of living and building to be prepared for the more intensive storms. They have to be more self-sufficient and grow their own crops, have a few animals so they could supply their own food. Have a boat to be able to stay mobile after a storm stuck the island. With the energy transition they will have to switch to sustainable energy solutions as windmills and solar panels. Understanding and awareness the effects of climate change among inhabitants on the vulnerable Grand Bahama island is essential for the development and implementation of a sustainable and resilience future. The animals and plants found in these regions have to be very tough organism to survive. They are often well adapted to the pounding of waves, drying out by the sun, changes in salinity and temperature as well as the exposure to wind. Although previous assessments in The Bahamas indicate that ecosystems in the country have adapted over time to become resilient to tropical weather, the intensity and duration of Hurricane Dorian still caused moderate to significant environmental effects. Ecosystems were left in a critical state and pre-existent vulnerabilities were exacerbated with an expected decrease in ecosystem services provision in the short and medium term.

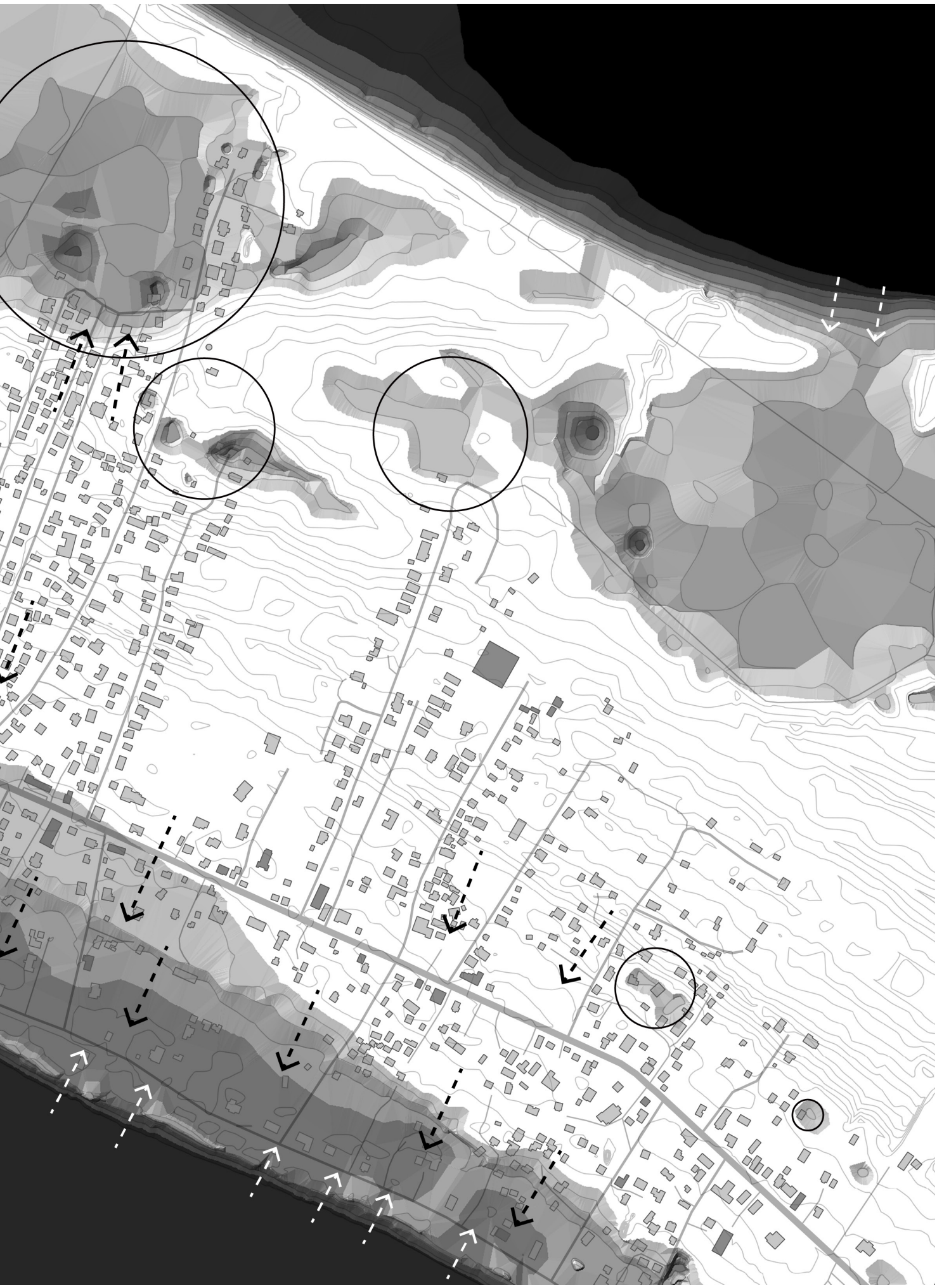


Synthesis Map

- Low areas in danger of flooding
- Possible rush
- Possible surge
- Above 4m
- 3-4m
- 2-3m
- 1-2m
- 0-1m
- =<0m

N

0 100 250 m



5.

Scenario making

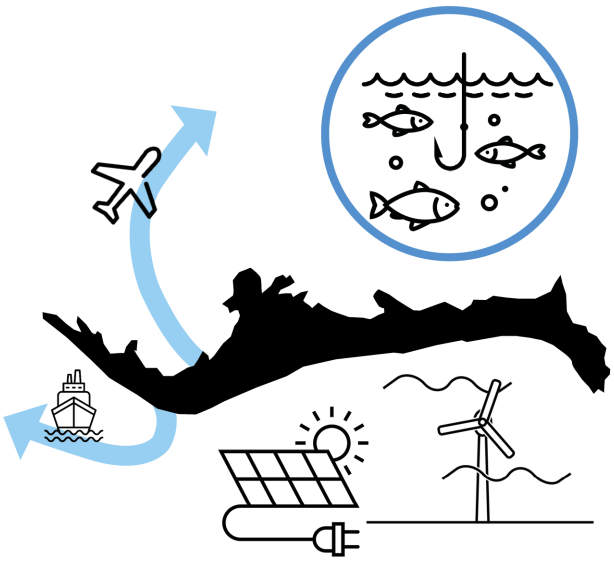
Scenarios

1. Nature First

2. No technology

3. No humans

4. COVID-19



Scenario 1 . Nature First

In the scenario of nature first, nature really is the priority in this part of the island.

from the larger perspective of the landscape and systems, the island is occupied with way more green and blue area and permeable surface to make it nature friendly. The human settlements are Dispersed to let nature getting together. The necessities would be more locally produced and there will be less import and export because that reduce the industry activities will protect nature. to reduce the pollution from mobility, vehicles are less used and clean energy will boost, for instance, the solar panel and the windmills.

in the anthropology, the human need to work with nature and become self-sustaining to survive

in architecture, The black ones are the public buildings and the public services are shrinking but still there. a lot of buildings would be demolished or abandoned to leave space for nature. Only the buildings located in a higher space left because they are safer in the extreme weather. the open soil surrounding the building would be used for farming.

in the flora&fauna, man controlled space will also partly occupied by nature like the green facades and rooftops. Agriculture and farming focused on restoring the native biodiversity and thereby regulate the invasive plants. There would be controlled farming, protected pine forest, wetland in the settlements and the return of the mangroves

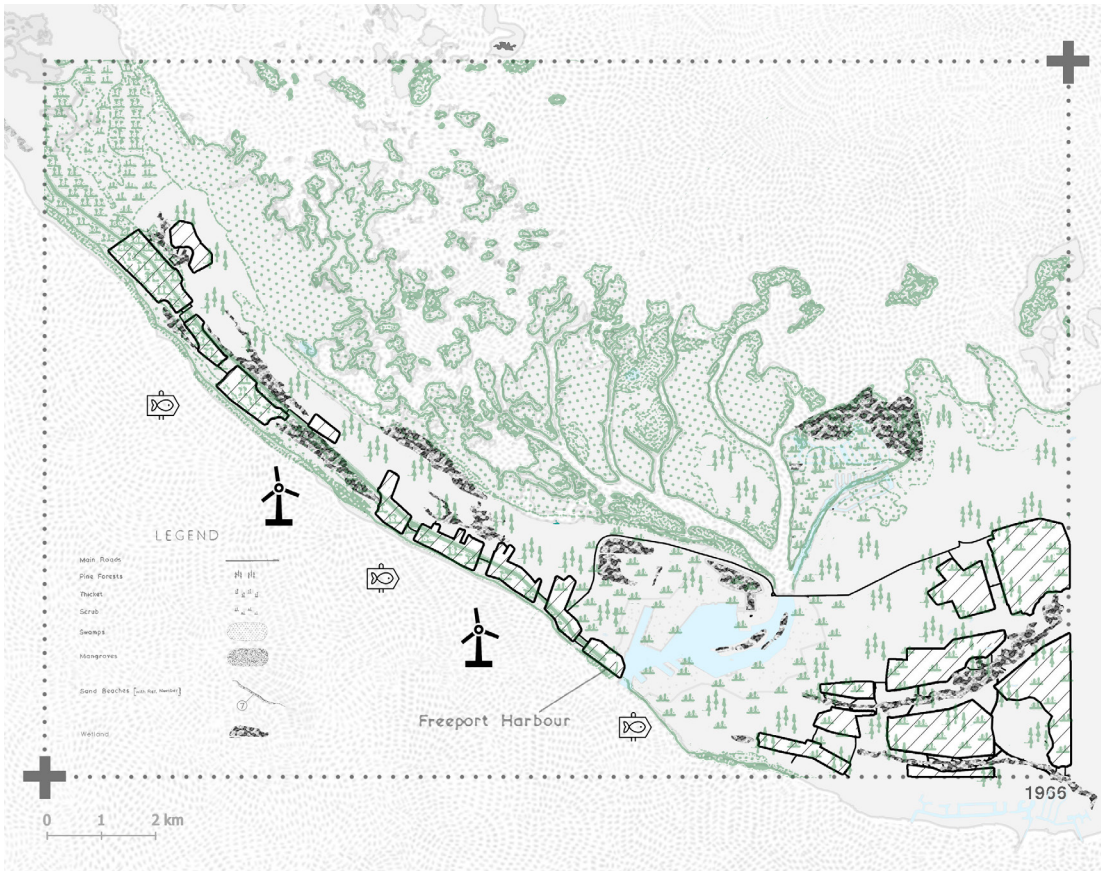
in conclusion

-Getting along with the ecosystem function and live an eco-friendly lifestyle

-Clean energy

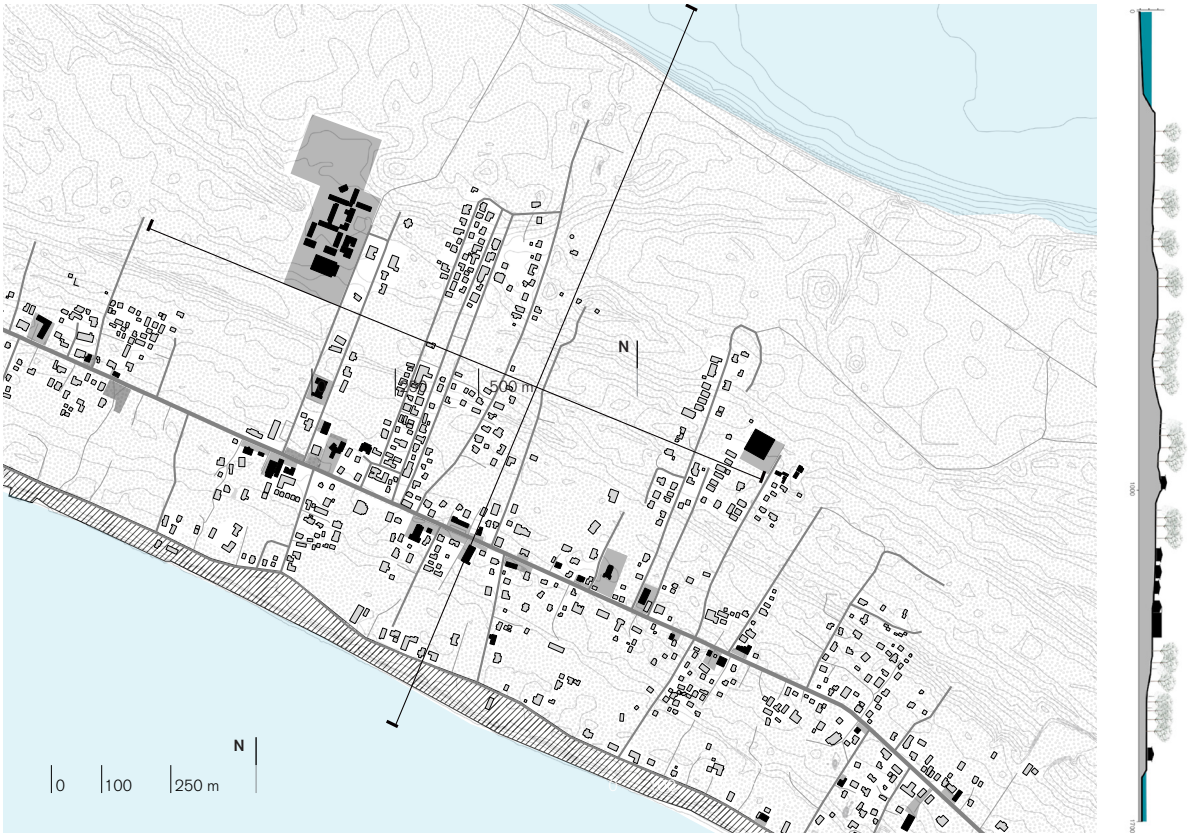
-Make full use of the natural resource in a sustainable way

Nature first
Large-context Landscape & system



Scenario Layout

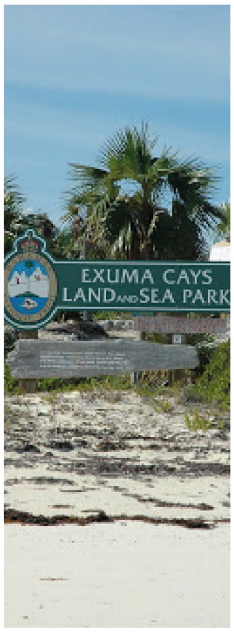
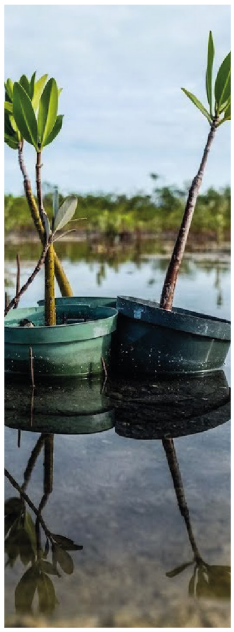




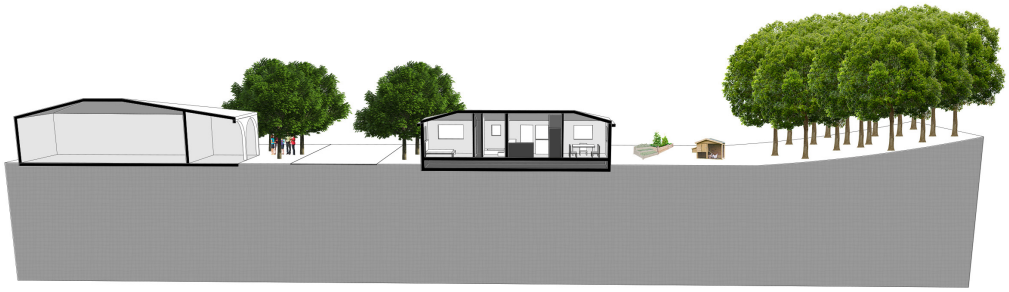
Flora & Fauna

SOUTH

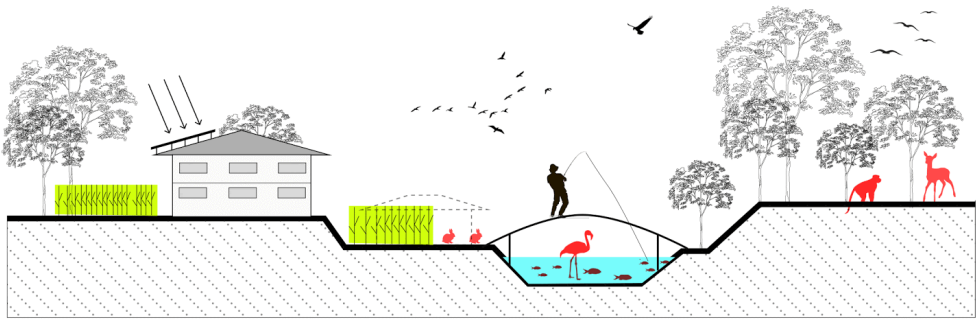
NORTH

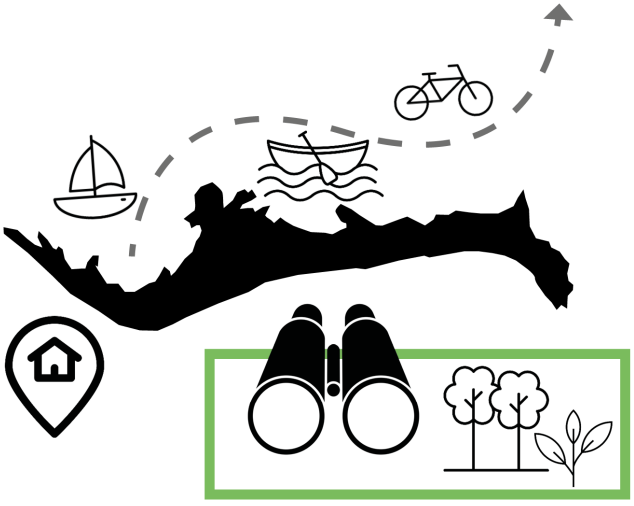
Controlled farming	Protected Pine forest	Urban water buffer	Protected mangrove
			
			
Crops Poultry Livestock Dairy	Bee Hummingbird Bahamas Rock Iguana Bahama Swallow Bahaman lesser funnel-eared bat Cerulean warbler Kirtland wood warbler	Sawgrass Cattail	Red Mangrove Black Mangrove Buttonwood White Mangrove

Human



Architecture





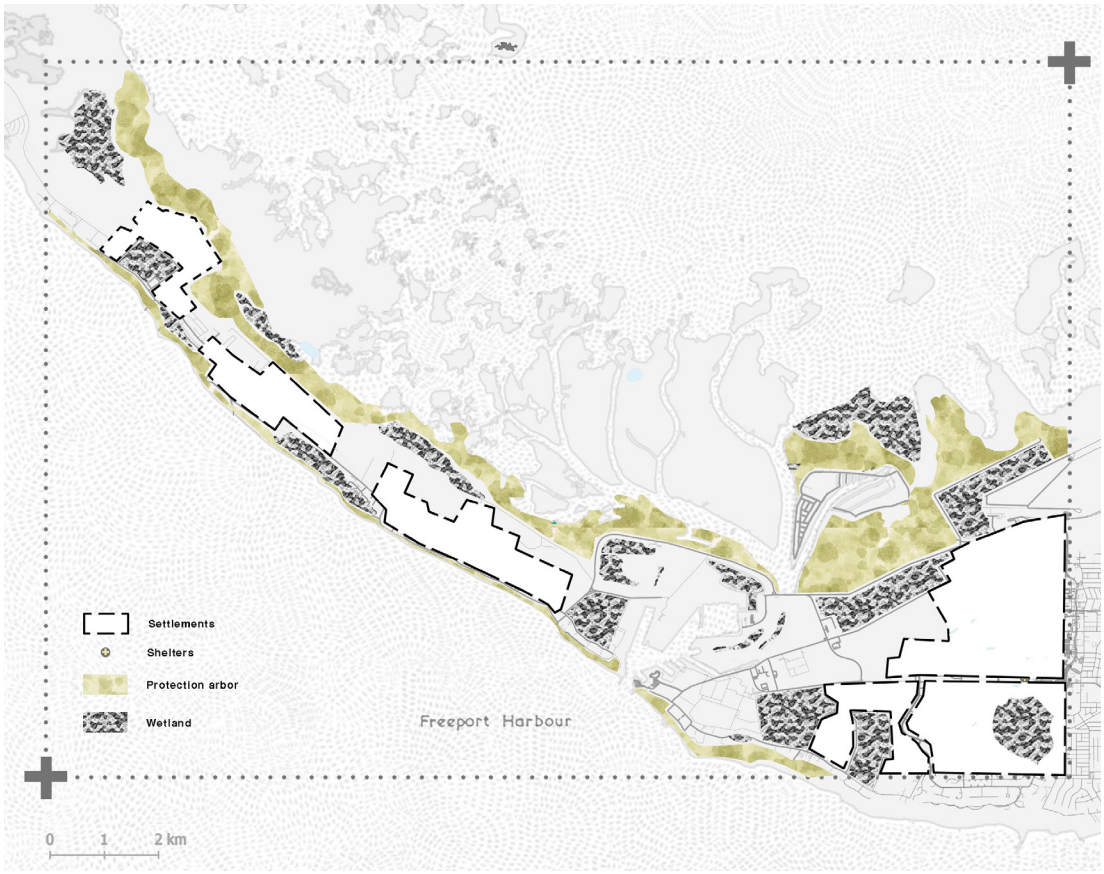
Scenario 2 . No technology

The no technology scenario came pretty close to the current living situation within the Grand Bahamas. Within the scenario There won't be any improved knowledge about the current technology that is available. The amount of technology that is currently available, however, is not being used yet within the Grand Bahamas. The main reason for this is the lack of money and governance. As most important companies are from abroad, they just want to make money with as few investments as possible. Since the governmental structure on the island is also extremely complicated with the national government, local government and port authorities, it seems like there's no-one really willing or able to invest within better technology to improve the life of the Bahamians.

The problems caused by the hurricane Dorian and the COVID-19 situation are feld by the inhabitants and have made them to become more self-sufficient and better aware of the impact these situations can have on their lifes. The will to be prepared for storms is increasing but the lack of money is making the people to look at simple solutions.

We think that this way of thinking will lead to a more traditional way of living. Houses could be build on poles in higher areas, streams could be dugged and dikes could be build to lead the water, the inhabitants create their own food supplies in the form of small vegetable gardens and some animals. This will make the inhabitants less relying on other powers and more resilient against the storm, without having the need of big technological infrastructures.

No technology
Large-context Landscape & system



Scenario Layout

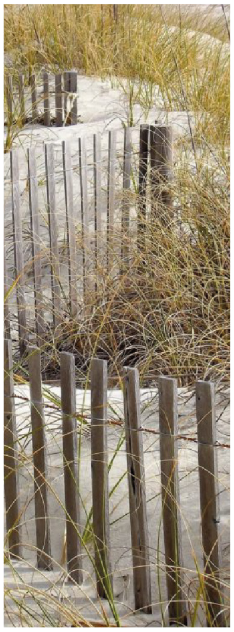




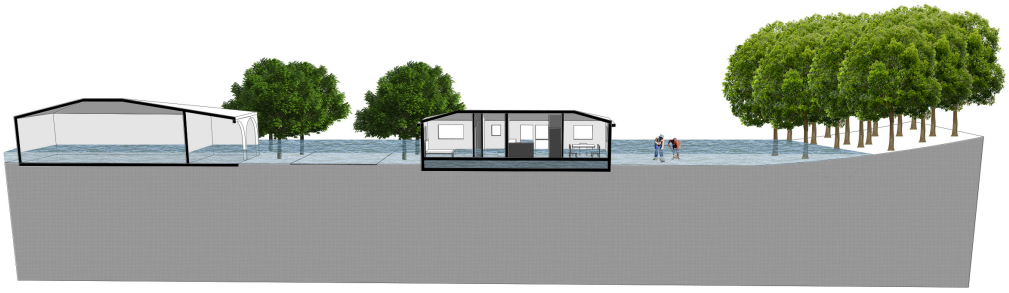
Flora & Fauna

SOUTH

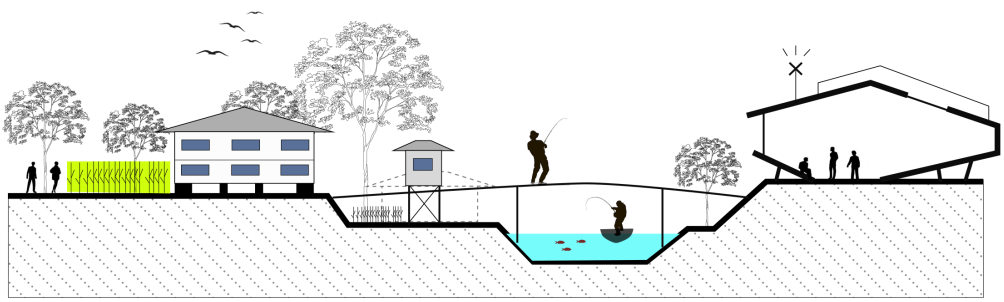
NORTH

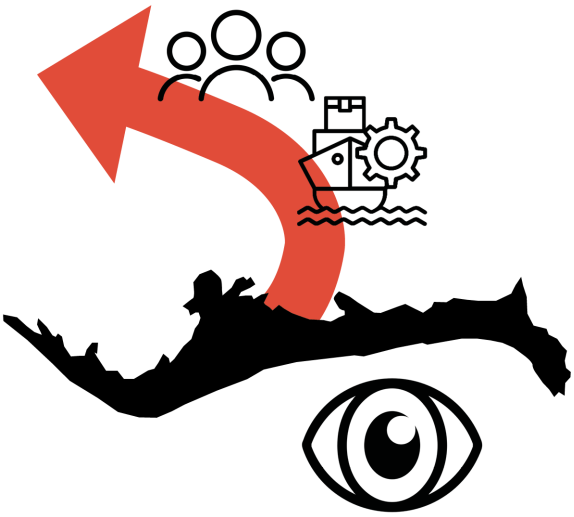
Beach	Restoring Pine forest	Nature inclusive city	Protect mangrove
			
			
Least Tern Cat Island Turtle Inuagana island turtle Lucifuga spelaeotes	Bee Hummingbird Bahamas Rock Iguana Bahama Swallow Bahaman lesser funnel-eared bat Cerulean warbler Kirtland wood warbler	Juniper Bee Hummingbird Bahamas Rock Iguana Bahama Swallow Bahaman lesser funnel-eared bat Cerulean warbler Kirtland wood warbler	Red Mangrove Black Mangrove Buttonwood White Mangrove

Human



Architecture





Scenario 3. No humans

In the scenario of no humans, we assume that people will leave gradually. First the rich, then the poor. Abandoning the island, until it is a deserted location. Our references were Pompeii and deserted Auckland Islands.

With the sea level rise, due to climate change, it is assumed that a large amount of the Grand Bahama will be flooded. Depending on the height of the rise and the height of the floods, you can see 3 sketched scenarios on the bottom right of this slide: water levels of +2, +6, +8m, compared to the current situation.

Because there are no humans to fight the water, some land will be permanently under water.

Currently, there is a Port Authority, ruling part of the area. In this scenario their interest in the location will drop and they will leave with the other people quickly. This means that the island needs to be governed at a higher level. And in the final stages of this scenario, this might even result in a construction where people are just 'observing' the island from a distance, by from the mainland Florida.

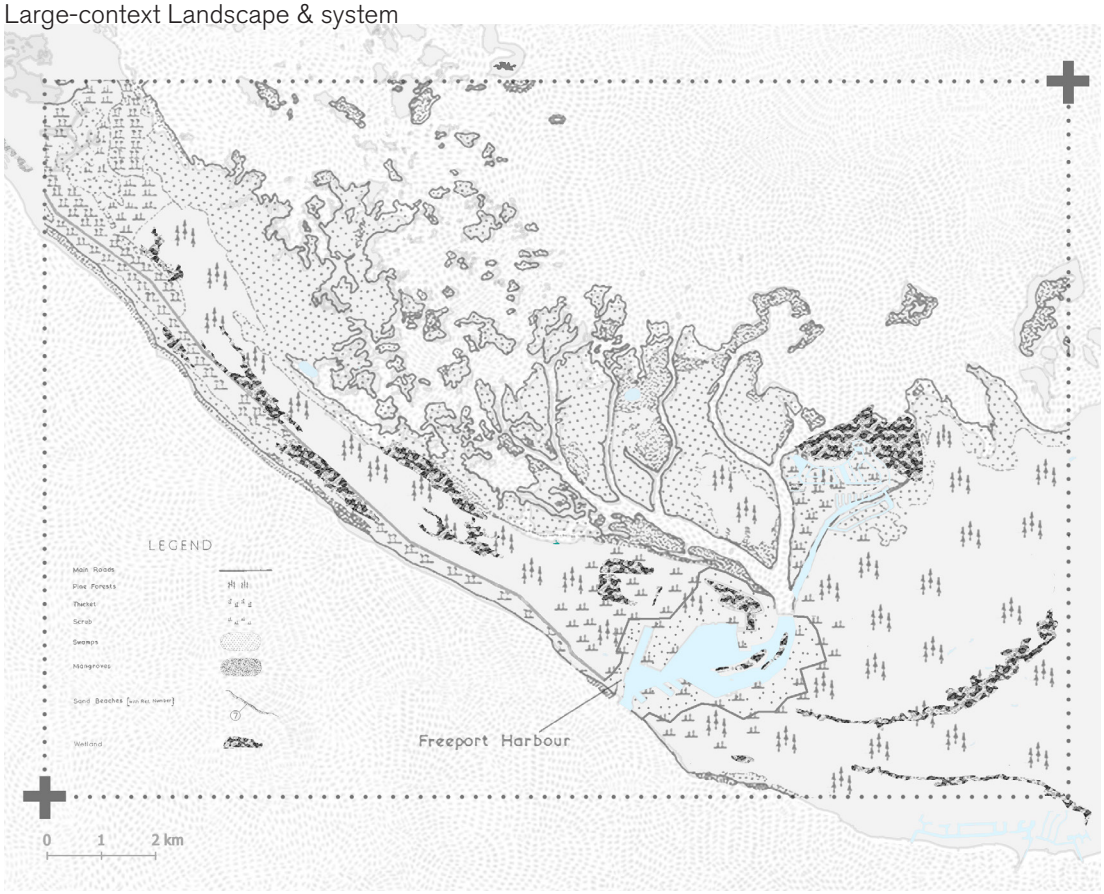
The ecosystem will recover and rebuild itself when the humans leave. This will result in a balanced ecosystem. Nature will not be limited by human factors and therefore be able to develop freely. It will grow and make use of the abandoned man-made constructions and tools. Buildings become shelters and might even be adopted as 'fish tanks' in low lying areas.

From the human perspective, it can be argued that segregation between fortunate and poor people will become very noticable, since richer people have the means to leave the island (sooner). Moreover, the deserted island itself might turn into an interesting archeological area over time.

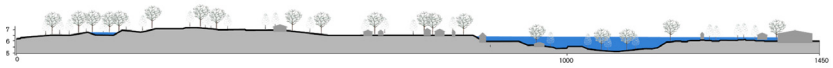
To conclude, this scenario of no humans results in loss of land to the ocean and facilitates nature to be in balance again, without human disruption.

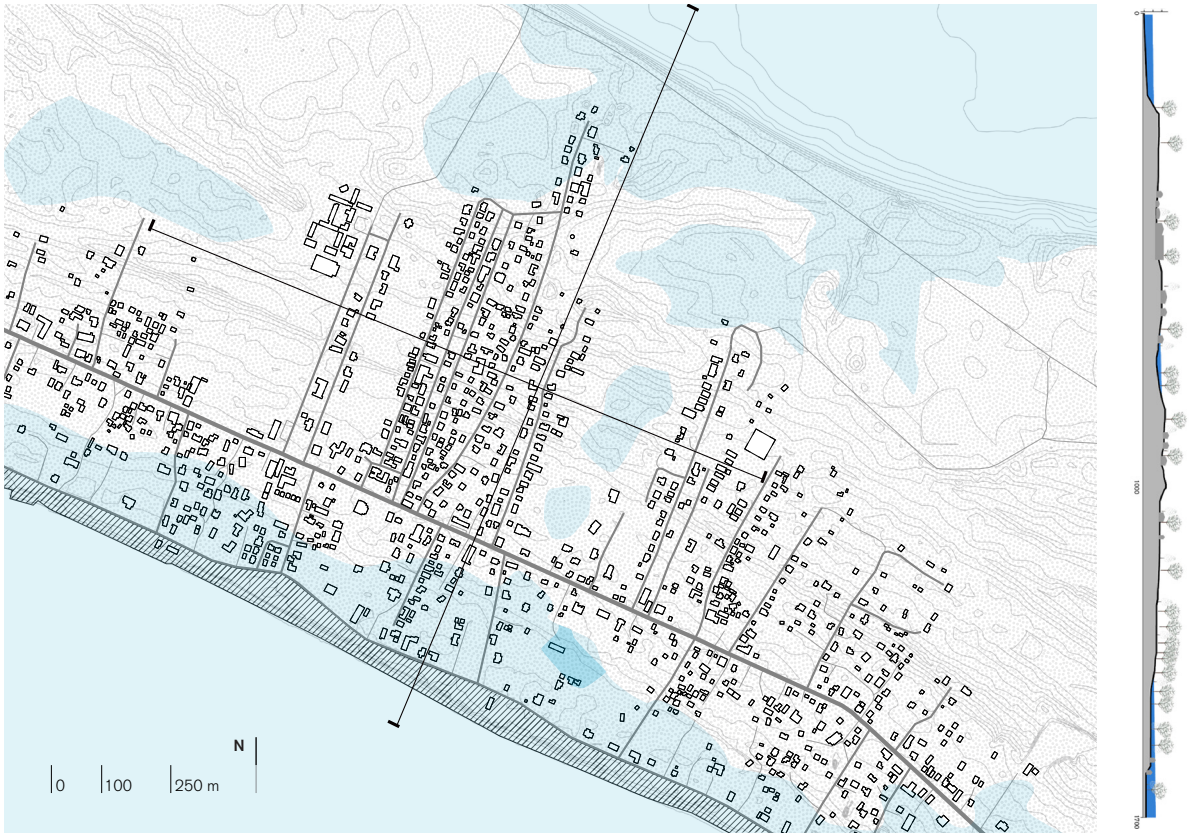
Nature humans

Large-context Landscape & system



Scenario Layout

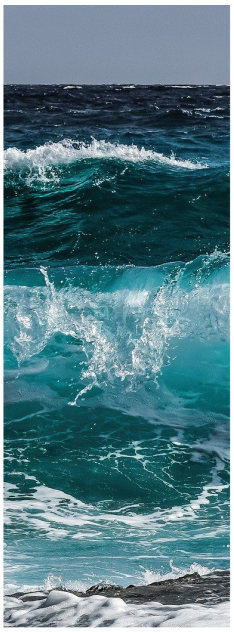
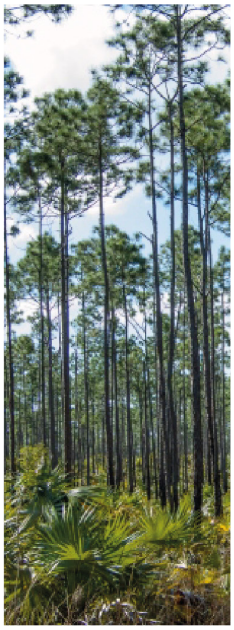
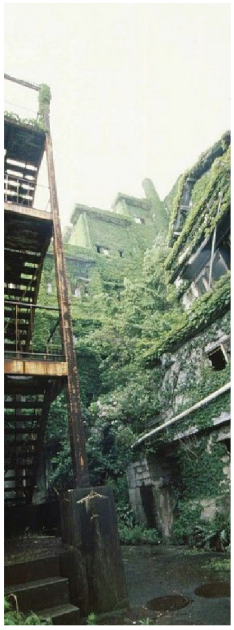
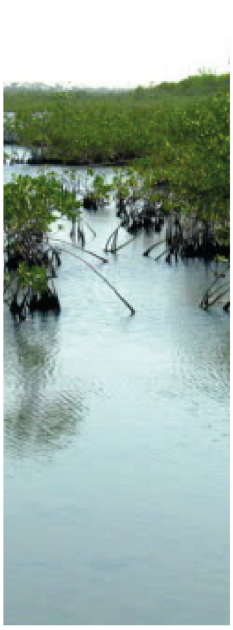




Flora & Fauna

SOUTH

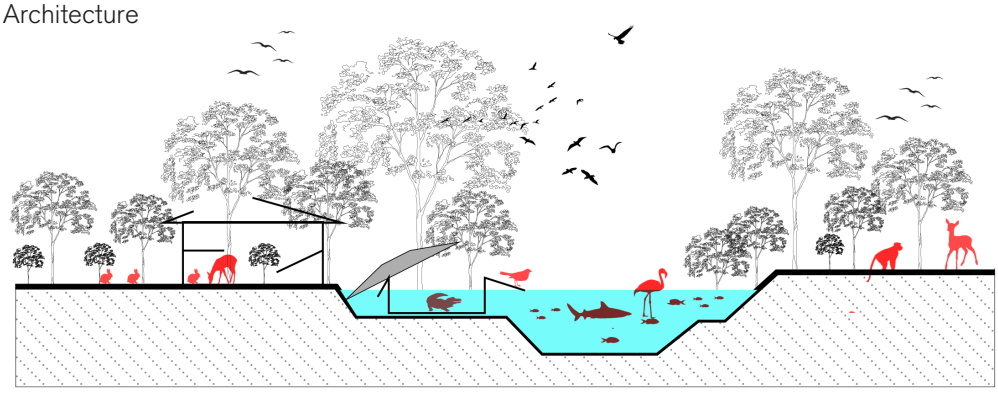
NORTH

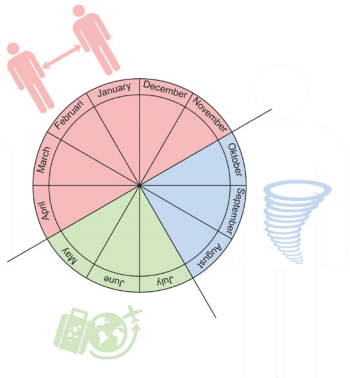
Sea	Pine forest	BE adopted by nature	Mangrove
			
			
Cat Island Turtle Inuagana island turtle Lucifuga spelaeotes	Bee Hummingbird Bahamas Rock Iguana Bahama Swallow Bahaman lesser funnel-eared bat Cerulean warbler Kirtland wood warbler	Bee Hummingbird Bahamas Rock Iguana Bahama Swallow Bahaman lesser funnel-eared bat Cerulean warbler Kirtland wood warbler	Red Mangrove Black Mangrove Buttonwood White Mangrove

Human



Architecture




January
December
November
February
March
October
September
April
August
May
June
July



Scenario 4. COVID-19

In this scenario of COVID-19, a year cycle would possibly appear, in which the year will be divided by tourism, the hurricane, and pandemic.

In the large-context landscape and system perspective, automation in the harbor and agriculture would appear, but if this is not possible according to other reasons, Freeport will really depend on local food production and supply. The price of imported goods will remain very high or even higher in pandemic season because there will be limitation in transportation. Local fishing industry will continue and be boosted.

In flora and fauna perspective, the whole realm will go through the year cycle. In tourism season, the flora and fauna will be used, in hurricane season, they will be destroyed, and in pandemic season, they will recover themselves.

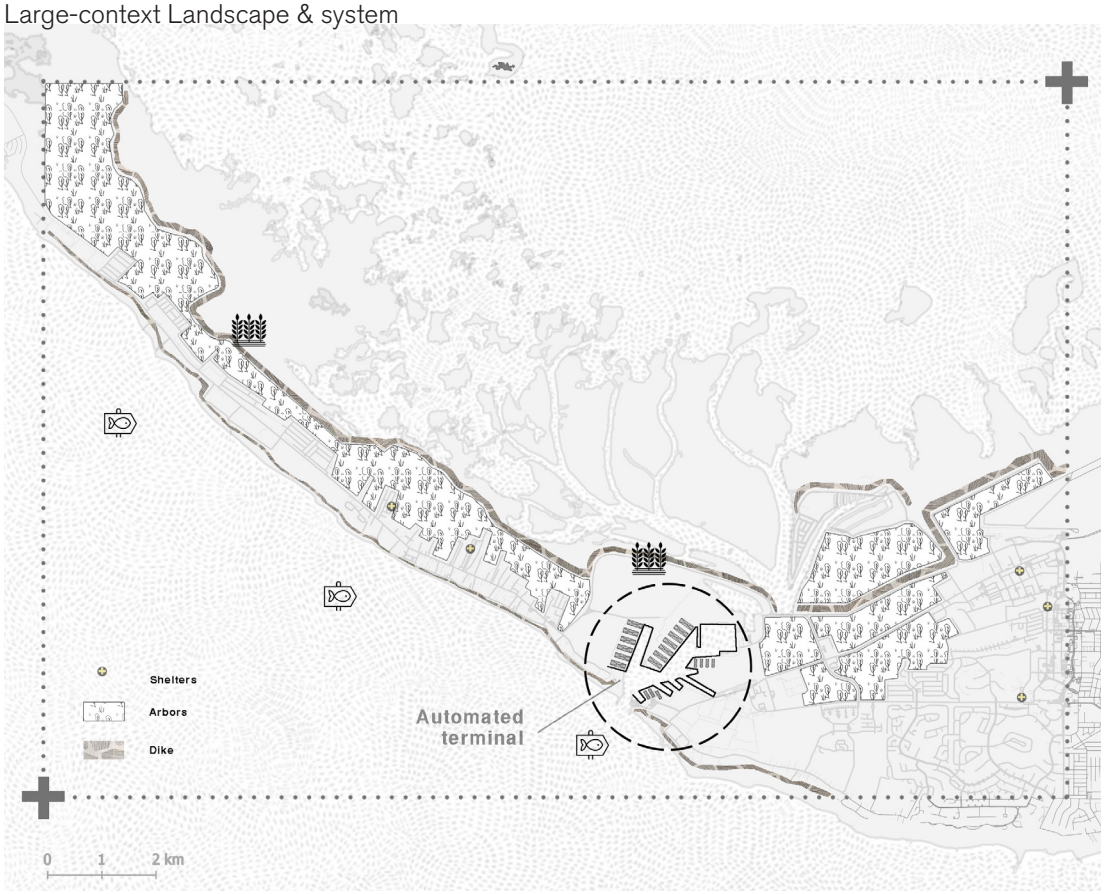
In human perspective, the properties will be focused more on tourism and safety of citizens. Due to the short working season, people need to work extreme hard and a lot within that period. New jobs are need to be found outside of tourism season. In this extreme condition, the gap between the rich and the poor will be bigger.

In architecture perspective, public buildings and collective shelters will be reformed to adaptive structures which can be changed into temporary health care centers, providing spaces and resources for expansion of hospitals, emergency organization. The garden and yards around houses will be able to be transformed into local food supply.

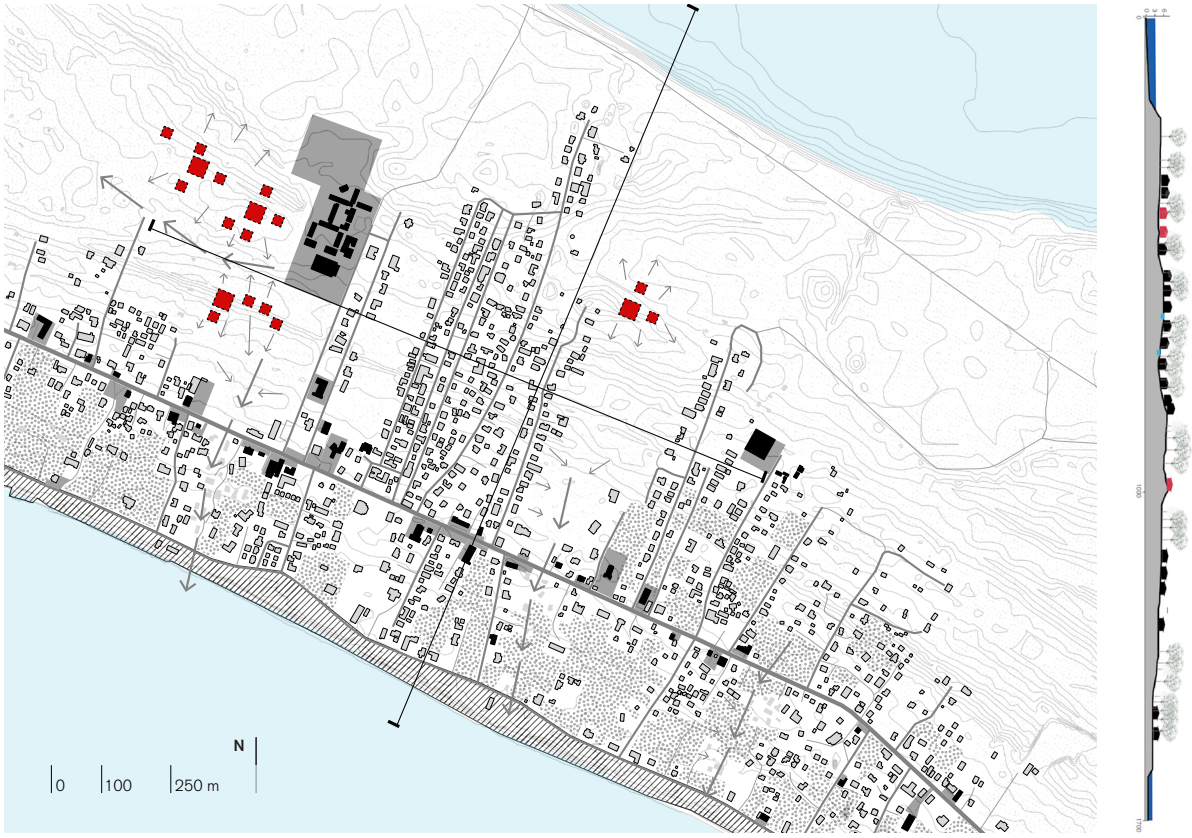
In conclusion, this scenario will be very complicated due to the extra variable of COVID. local production towards self-sustainable is reasonable, and agriculture and fishing becomes increasingly important. Also, the automatic harbor and agriculture is the future, and tourism towards nature and local culture will be more important. Buildings will be reformed into a flexible status to adapt the situation.

COVID-19

Large-context Landscape & system



Scenario Layout



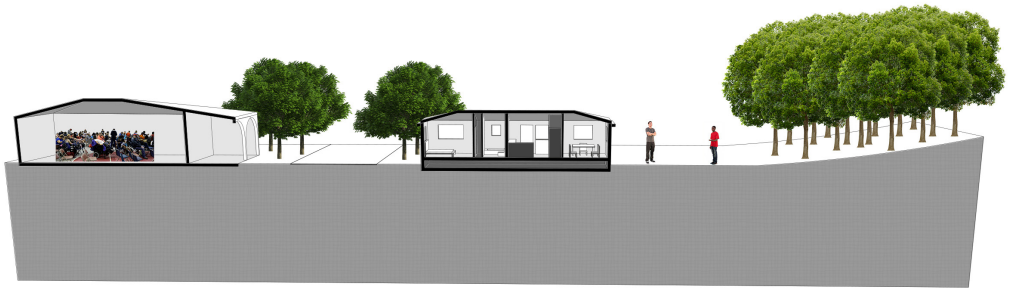
Flora & Fauna

Destroyed beach | Destroyed pine forest | Recovery pine forest | Tourism beach

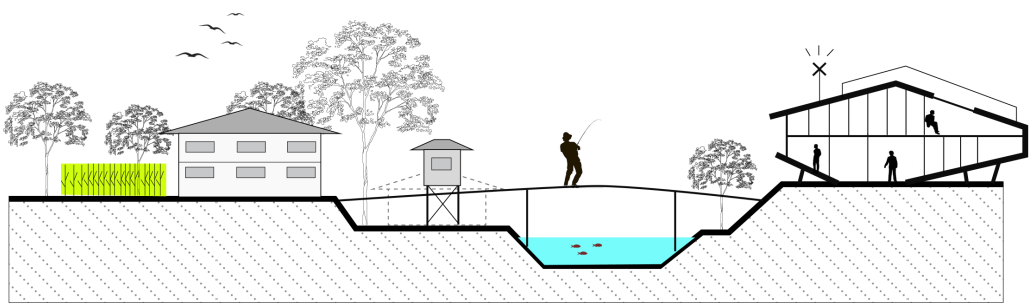


Juniper
Bee Hummingbird
Bahamas Rock Iguana
Bahama Swallow
Bahaman lesser funnel-eared bat
Cerulean warbler
Kirtland wood warbler

Human



Architecture



Conclusion

In the conclusion the four different scenarios are shortly explained and a main conclusion is drawn from this.

For the no human scenario we found out if the citizens leave the island, first the rich, then the poor, nature takes over. The natural ecosystem of the island will restore itself. Native plants, often themselves now endangered, will grow. If the rest of the world will continue living this unsustainable way, sea level will probably rise and the storm surge during hurricane season will become worse. This means that parts of the island will flood due to the geologically low location.

In nature first, the nature system is prior to the human system. Therefore the cicitizens will live a more eco-friendly lifestyle make use of clean energy and make use of the nature in a sustainable way.

Without Technology not a lot will change for the bahamians. Currently, there is a lack of technology already, the mindset of Bahamians is comparable to ‘no technology scenario’. However they will go back to a more traditional lifestyle. They will make more use of primitive transportation (boats and bikes), where the island is now mainly car-driven. They will be using abandoned airports and harbours to fulfil a local function

In the covid-19 scenario yearly cycle: Tourism, Hurricanes and Isolation. I will be depended on own food supply and production. Short tourism season, people need to work extreme hard and a lot within that period.

In every scenario the island has to deal with climate change. Sea level rise and storm surge will shape the form the island and have an influence on the ecology, humans and economy.

The ecology will adapt first easily and quick.

People will move away, but over time the people who stay will be able to adapt to the new situation.

In all situations the tourism flow will be reduced, which will have a direct impact on the main economy of the Bahamas.

6.

System intervention

6.1 System intervention

Start from the four scenarios, each one is concluded into several principles. Nature first requires intensive ecosystem participation and clean green space. The no technology asks for safe settlements and a new lifestyle. The no human focus on the sea level rising issue and COVID situation is asking for isolation-proof intervention.

From the scenario testing, the conclusions out of it refer to different topics in Bain Town. They are climate change, hurricane issues, COVID period, and social measures.

Climate change in the Bain town refers to the sea-level rise and degenerated forest due to human settlements development and human activities. Though there is climate pressure, there is also a chance to change for clean energy using and natural-based solution for the sea-level issues. All in all, Bain town needs a sustainable lifestyle.

Hurricane is the most urgent problem here with great loss of every storm season. To protect the people, and promote nature succession, a safer settlement with nature is needed.

COVID pandemic situation might last a bit longer or a similar situation might come back again somewhere. Therefore, the new Bain town will develop into an isolation-proof condition.

There is a wide variety of social issues such as injustice, public participation, and community identity. The new development of Bain town offers a chance to put all these issues into the agenda.

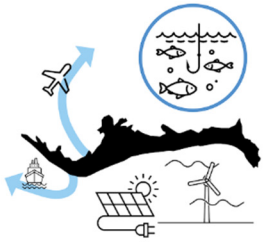
Last, because of the heavy flooding issue in the frreport city, Bain town could be more densified to hold more people in the higher and safer land.

SCENARIOS

CONCLUSION FROM TESTS

MAIN ISSUES

Nature first



- Clean energy
- Intensive ecosystem participation
- give back space to nature
- Local food production

No tech



- Settlements migrate to higher areas
- Natural sewer system for flooding
- Shelters with public function
- Vernacular building technology
- Primitive transportation (boats and bikes)
- More local collaboration and sharing knowledge in dealing with hazards
- Intensive social connection in communities

No human



- Sea level rise
- Nature take over

Covid-19



- local self-sustainable production
- Tourism towards nature and local culture
- Shelters following 1.5m
- Health care system
- Social justice of public health

GOALS → VISION → GUIDELINES

Climate change

Climate change

Hurricane | Climate change

Climate change | Hurricane

Hurricane

Hurricane | Climate change

Hurricane

Hurricane | Climate change

Climate change

Lack of public participation

lack of community identity

Climate change

Covid period | Hurricane

Covid period | Hurricane

Covid period

Covid period

Social injustice

Urban growth

Settlements migration from areas in risk of flooding

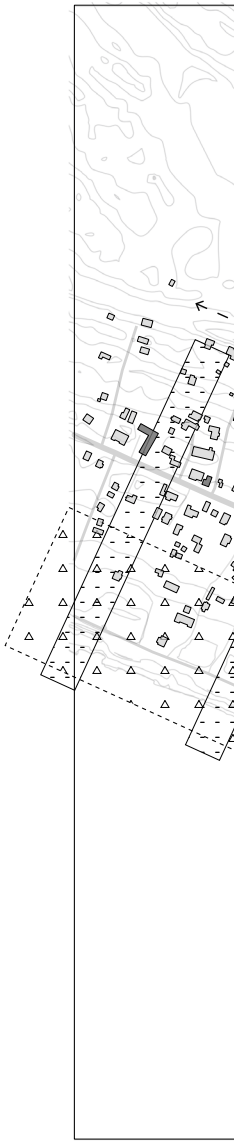


Sustainable life style

Safer settlements with nature

Dealing with seasonal Virus

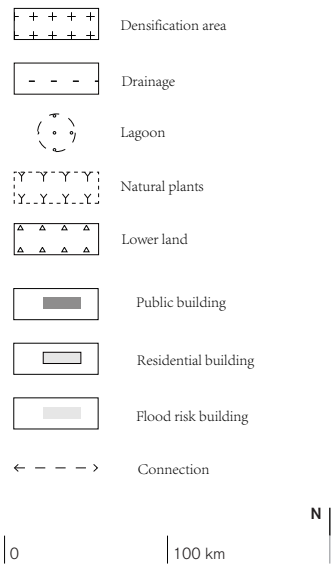
Resilient social agenda for recovering from hazards

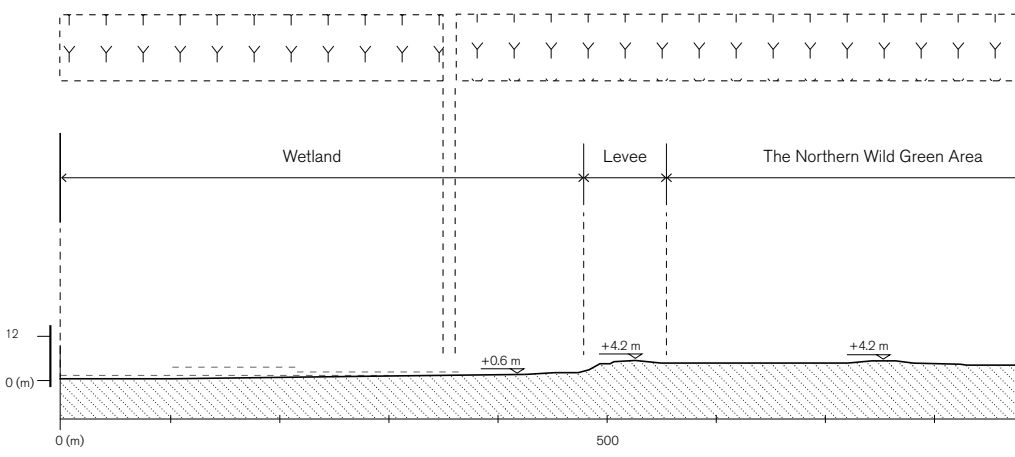


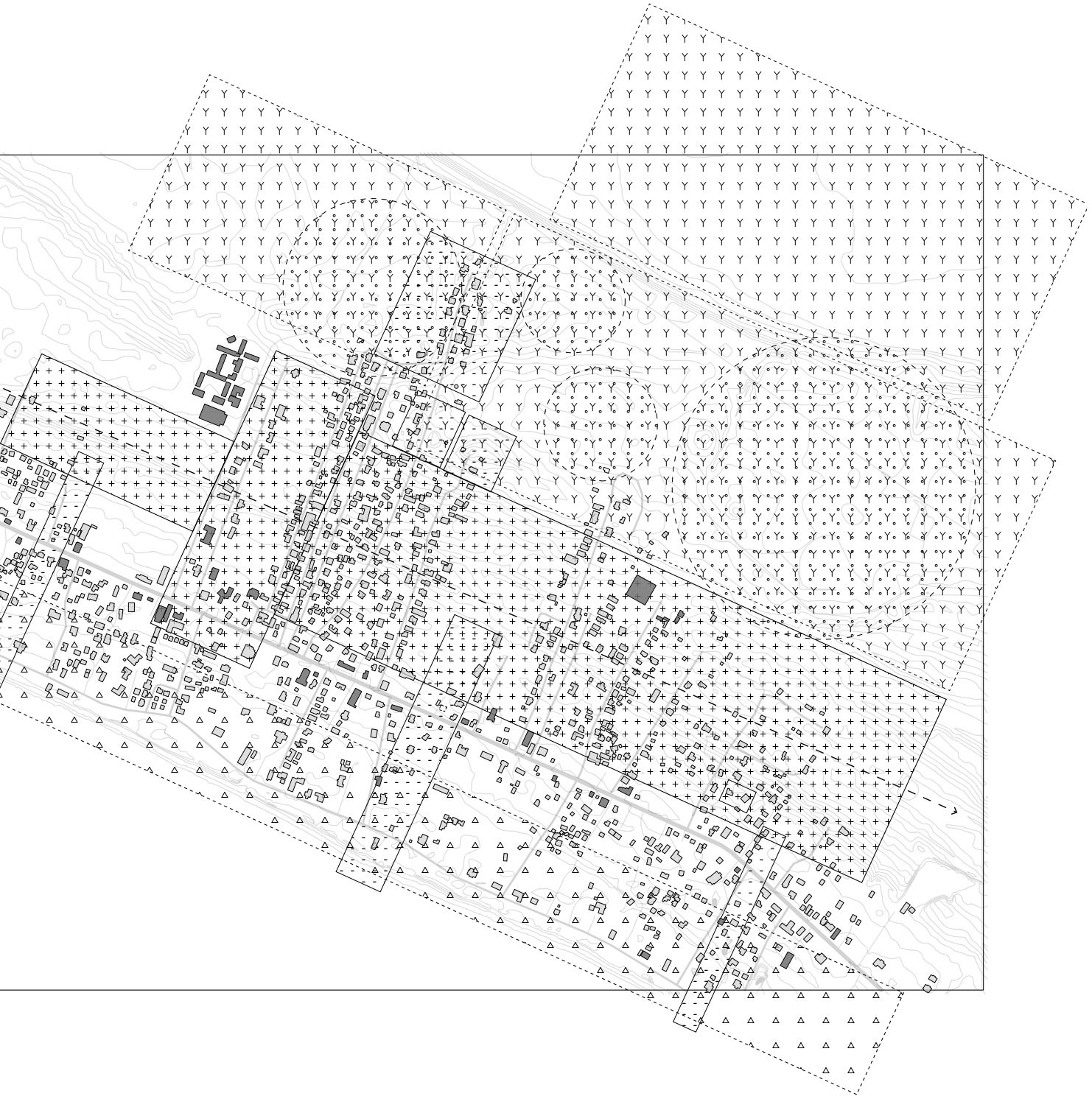
Vision map

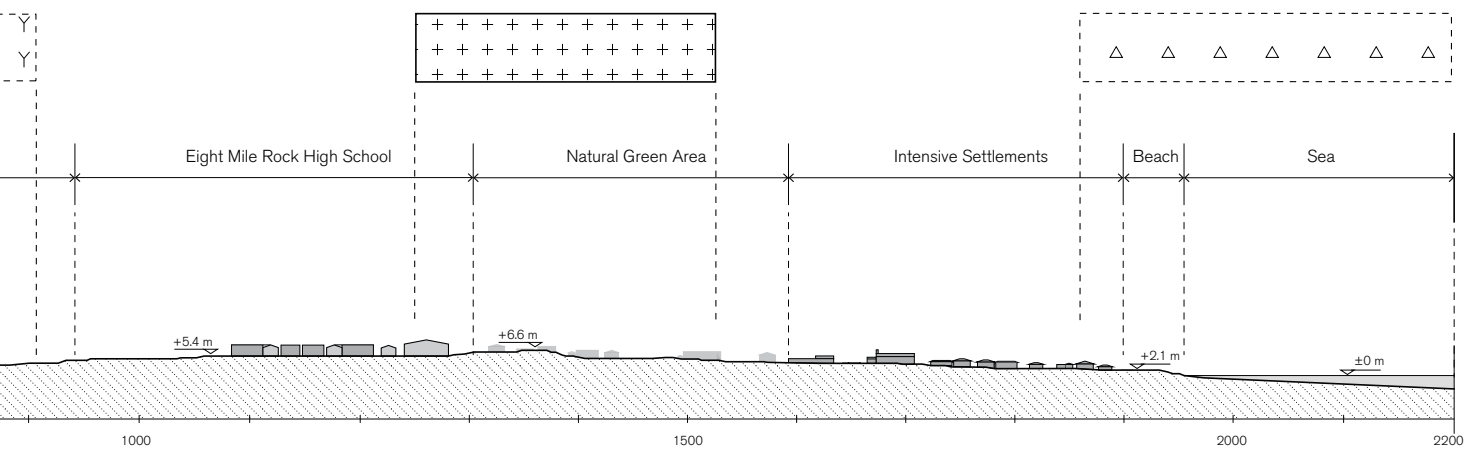
The possible future of Bain town.
Bain town will be developed to hold more people living a Eco-friendly and sustainable life style ,and have significant resilience improvement in tackling hurricane hazards and pandemic in both social and spatial aspects.

In the north of Bain town, lower land is suitable for flood-protection vegetations like mangroves. Some of the lower land can be lagoons with the function of rainwater storage. The higher land in the middle is densified part in the future. The south coast is under the risk of flooding and sealevel rise, and allowing the drainage sysytem to go into the southern ocean.








Eight Mile Rock High School
Natural Green Area
Intensive Settlements
Beach
Sea
+5.4 m
+6.6 m
+2.1 m
±0 m
1000
1500
2000
2200

Domains of Guideli

BUILDINGS &
BUILT ENVIRONMENT

PUBLIC SERVICES

FLOWS

NATURE SYSTEM

SOCIAL AGENDA

6.2. Guidelines

Based on the vision and four scenarios, guidelines for urban design in the next stage have been carried out. In order to integrate the results from the scenario testing and put the tools and strategies into a more realistic situation, the vision has combined mainly with “no technology” and “nature first”, considering “no human” and ”COVID-19” simultaneously. Therefore, guidelines are developed mainly based on the former two scenarios, with some consideration from the latter two in a more realistic way.

The guidelines here are developed and integrated in 5 groups, and these groups are “Buildings and Built Environment”, “Public Services”, “Flows”, “Nature System”, and “Social Agenda”. In order to make sure guidelines can work coherently with the vision map, the division of groups is based on the domains of intervention. Also, to solve extreme issues caused not only by the climate and the urban form but also by the relationship between human and nature as well as social issues, the guidelines include interventions in different scales and social level, apart from spatial ones.

nes

Guidelines

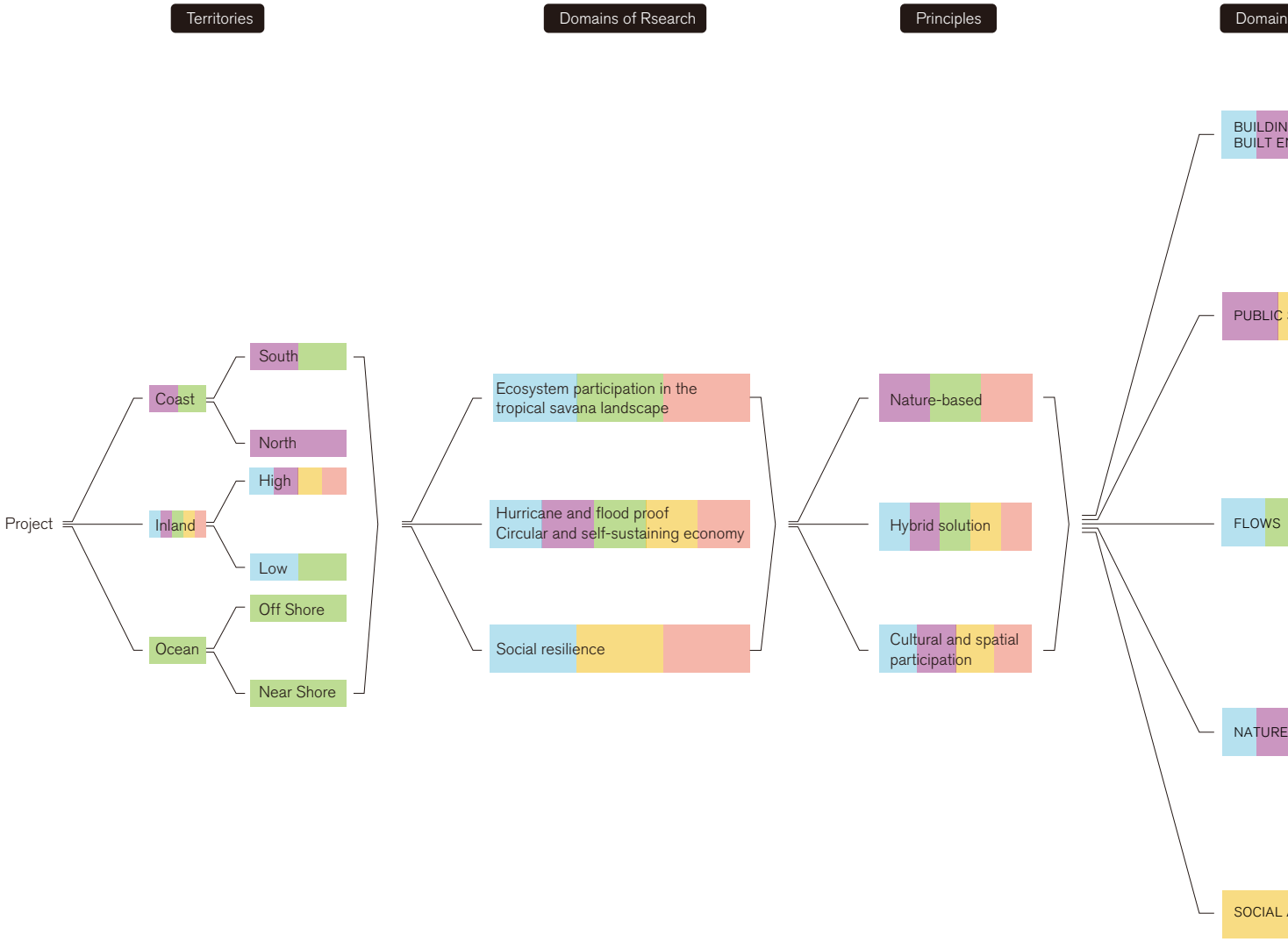
Bulding new settlements for people who need safer homes in higher areas
Using more vernacular building technologies and tranditional techniques to adapt to hazards
Establishing pluvial infrastructure system by natural environment
Facilitating settlements with nature-based structure

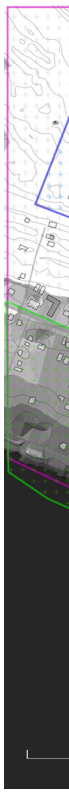
Building hurricane-proof shelters with public functions
Facilitate public buildings with the function of hurricane-proof shelters
Using public buildings for necessaries storage in hurricane time
Adapting public buildings and shelters into space for local health care system for pandemic time
Adapting shelters for quarantine units

Using the garden and developing urban farming area for local food production
Using clean energy from rooftop solar panels and windmills
Making the open tunnel system following the elevation
Reuse the domestic waste water by natural purification system
Using biobased material for buildings and infratructure
Making use of rain water for urban farming
Creating cycling pathes and planning boat routes

Creating green barrier & buffers to protect settements from the flood
Reserving and maintaining floodplain
Making urban farming part of the natural system

Eduction of awearness and methods dealing with hazards
Instruction of storage of emergency goods in community and household level
Instruction of warning and evacuation agenda
Instruction of public participation in recovery from hazards





6.3. Focus of design experiments

As the diagram shows, each of the deisgn experiments has different focuses in 5 columns, including terretorries, domains of research, principles. domains of guidelines, and guidelines. With the variety of focuses in design experiments, different ways of the ecosystem participation are explored. In the map, the locations of each experiment are illustrated.

s of Guidelines | Guidelines | Aims

GS & NVIRONMENT
- Bulding new settlements for people who need safer homes in higher areas
- Using more vernacular building technologies and tranditional techniques to adapt to hazards
- Establishing pluvial infrastructure system by natural environment
- Facilitating settlements with nature-based structure

SERVICES
- Building hurricane-proof shelters with public functions
- Facilitate public buildings with the function of hurricane-proof shelters
- Using public buildings for necessaries storage in hurricane time
- Adapting public buildings and shelters into space for local health care system for pandemic time
- Adapting shelters for quarantine units

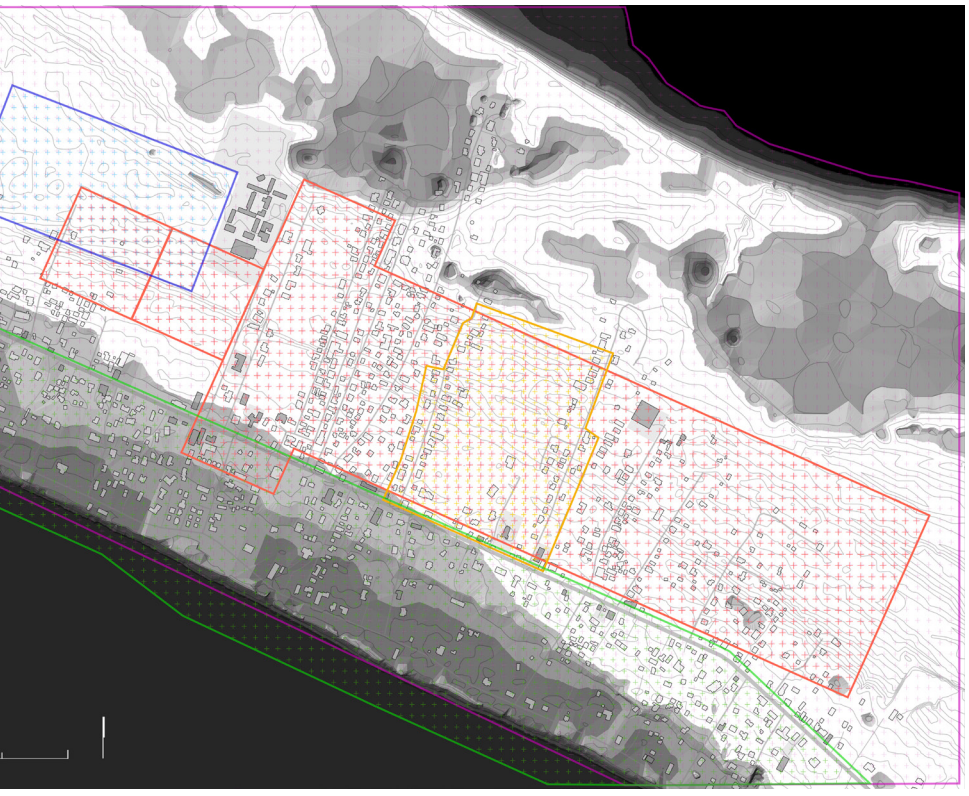
- Using the garden and developing urban farming area for local food production
- Using clean energy from rooftop solar panels and windmills
- Making the open tunnel system following the elevation
- Reuse the domestic waste water by natural purification system
- Using biobased material for buildings and infratructure
- Making use of rain water for urban farming
- Creating cycling pathes and planning boat routes

SYSTEM
- Creating green barrier & buffers to protect settements from the flood
- Reserving and maintaining floodplain
- Making urban farming part of the natural system

AGENDA
- Eduction of awearness and methods dealing with hazards
- Instruction of storage of emergency goods in community and household level
- Instruction of warning and evacuation agenda
- Instruction of public participation in recovery from hazards

- Closing the cycle - Suzan van Werkhoven
- Benefit from Storm Water - Menno Aerts
- Saline-Based Bain Town - Chen Gao
- New Traditional - Ilse van Milaan
- Hurricane-proof Settlement Units - Li Yangzi

Indication of individual projects



Positions of design experiments

- Closing the cycle - Suzan van Werkhoven
- Benefit from Storm Water - Menno Aerts
- Saline-Based Bain Town - Chen Gao
- New Traditional - Ilse van Milaan
- Hurricane-proof Settlement Units - Li Yangzi
- Public & Commercial Buildings
- Residential Buildings
- Existing Roads
- Above 4m
- 3-4m
- 2-3m
- 1-2m
- 0-1m
- =<0m

6.3. Closing the cycle

Suzan van Werkhoven

Manifesto

Most of the products consumed by Bahamians are imported. During the event of a disaster or a lock down like in a corona situation, this dependency can be risky and dangerous for the supply of products and goods towards Grand Bahama Island. To become less dependent, Grand Bahama needs to become self-sufficient and strive to close the goods and energy cycles. This will be the main focus of this manifesto.

Electricity will play a main role in the energy supply of Grand Bahama. All buildings, cars, other vehicles and electric products should run on electricity to achieve this goal.

Sustainability should be of high priority. Eventhough the impact of the small islands of The Bahamas might not be the largest to the emission of greenhouse gasses. Their contribution should be equally important in minimizing greenhouse gas emissions. Nonetheless, the Bahamas are very vulnerable to flooding, storm surges and hurricanes. Current climate change will not benefit the local climate and circumstances of the Bahamians. The cycles that will be tackled in the following design experiment will have to include sustainable measures.

When Grand Bahama becomes more self-sufficient, less products need to be imported. This means that there will be less international transport and harbour activity. This reduces the greenhouse gas emissions. On the other hand, de reduction of this economy will have to be compensated with employment in a different sector.

The following design experiment is a translation of this manifesto.



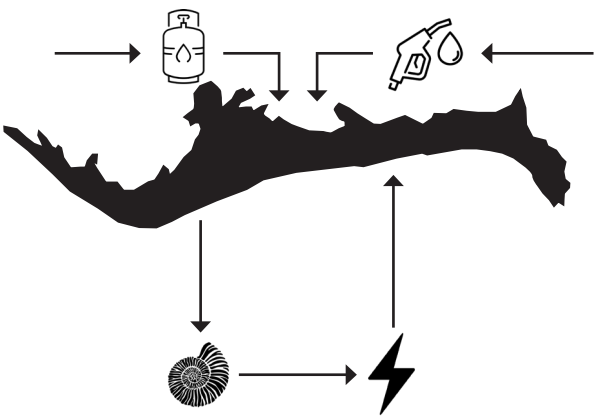
Design experiment

One aspect is to have most energy consumption based on and powered by electricty. This includes using electric cars, which are more sustainable than traditional ones, and installing home batteries in every house and building. These batteries are a great way to store excess electricity. Additionally, the cars are mobile batteries, which make them an alternative to the electricity grid in transporting the electricity.

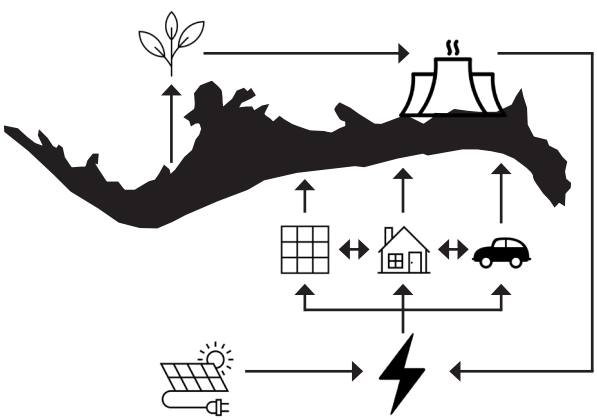
It would be more sustainable to remove the cars from Grand Bahama. However, the car is a very important mode of transportation and it embedded in the lifestyle of the Bahamians. Therefore electric cars will be introduced. Moreover, from experience it can be concluded that cars are very hazard proof. Many cars were stil intact after hurricane Dorian.

This should be realised in a sustainable way. The generation of electricity is currently done by burning fossil fuels. This can be done more sustainable by the implementation of solar panels. There are many sunhours, so this sould provide a lot of electricity when installed on houses, commercial and public buildings. When more surface is needed, it is possible to have floating solar panels or empty land covered with panels. Wind turbines are sustainable too. However, they are less suitable in this place, since they are vulnerable to hurricane winds and strom surges. Moreover a biomass powerplant will recycle farming and food waste and turn it into electricity and heat for the Bahamians.

Current system



New system





Bain Town new system

People can drop their food, garden and green waste at the recycling points, indicated with the recycle triangle in the map. The action radius of the collection point is indicated with the dashed line. This serves as biomass for the fueling of the power plant. The collection points are located at the terain of farmers, since they are big producers of biomass material.

The electric charger points for car batteries are located along the main road, since there are many people traveling along this road. These are public facilities. Additionally every home is expected to have a charger too.

Collection points

Electric charger points

Biomass power plant

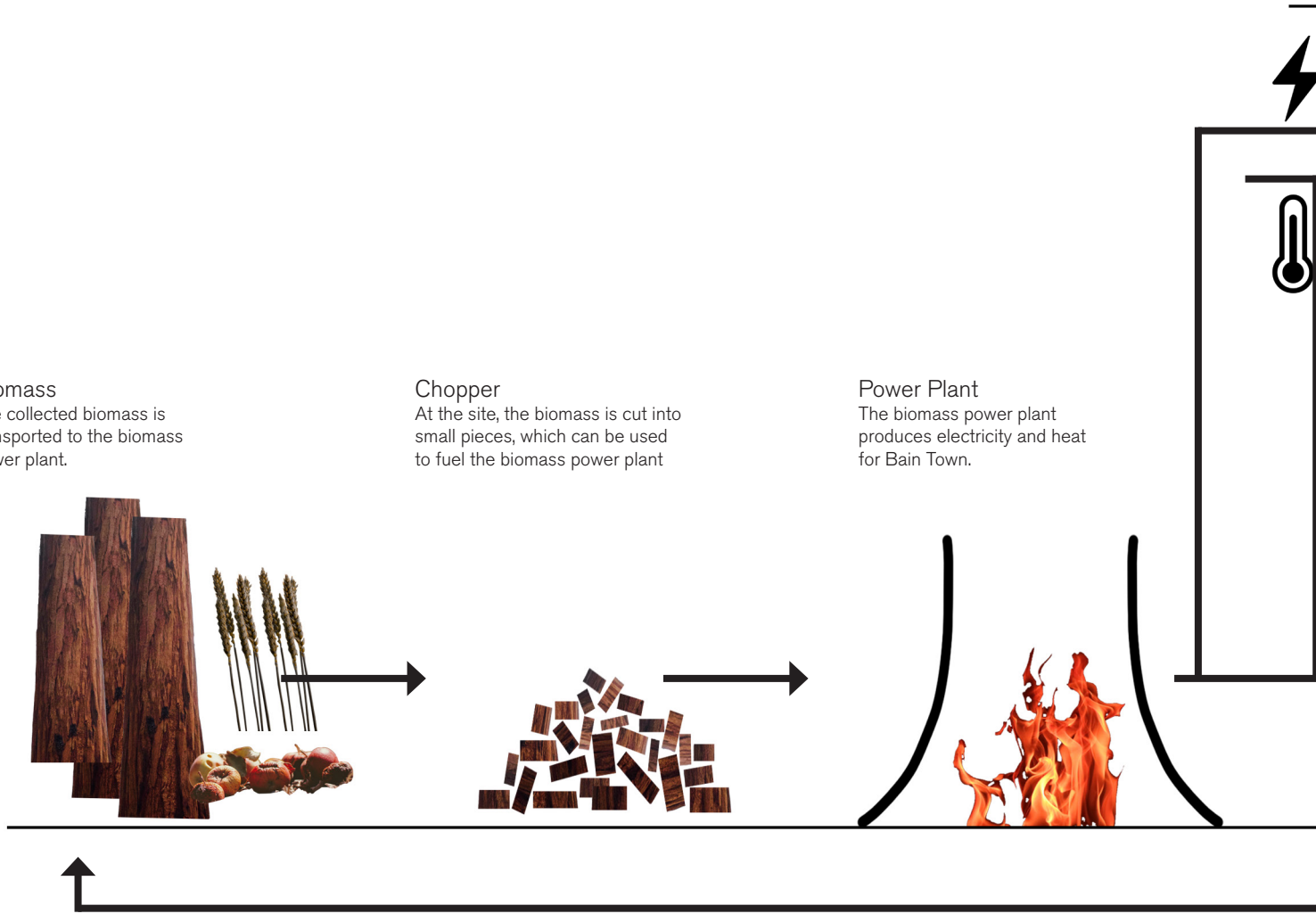
0 100 200 m



Biomass
The collected biomass is transported to the biomass power plant.

Chopper
At the site, the biomass is cut into small pieces, which can be used to fuel the biomass power plant

Power Plant
The biomass power plant produces electricity and heat for Bain Town.

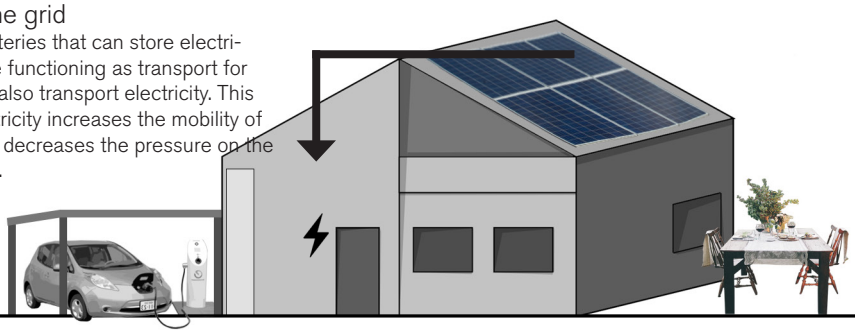


Solar panels and batteries

Homes are equiped with solar panels to generate electricity and store it in home batteries. These batteries are also connected to the main grid, which could provide them with electricity generated from the power plant.

Cars and the grid

Cars have batteries that can store electricity. So beside functioning as transport for people, it can also transport electricity. This buffer of electricity increases the mobility of electricity and decreases the pressure on the electricity grid.

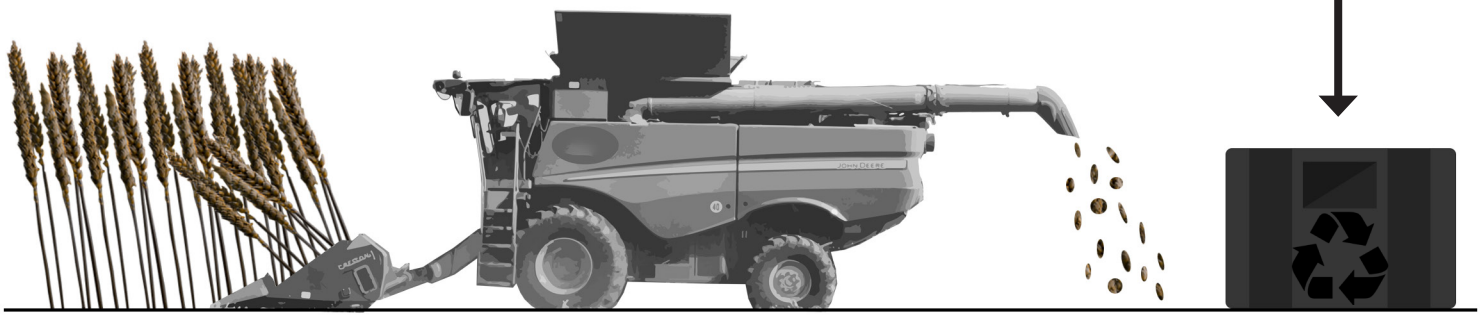


Farming

Farming will become more important for the production of food for the Bahamians. Local food production will strengthen the local economy. More people will be employed in this sector to provide for the community.

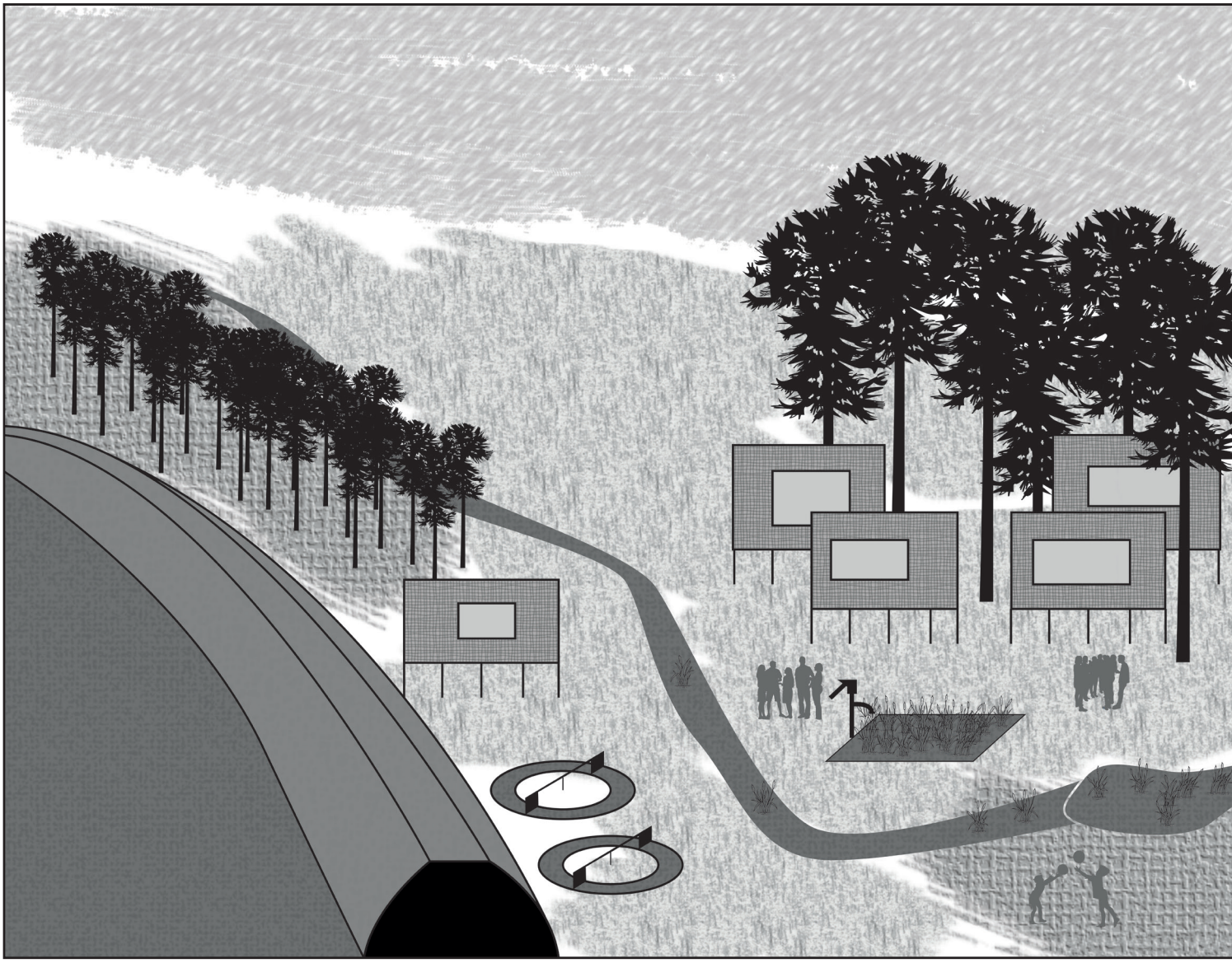
Recycle waste

Left over food and green products are gathered at the local farms. These collection points are in central locations in the neighbouorhoods. All biomass produced by the households will be collected here.



6.4. Benefit from storm water

Menno Aerts





Manifesto

During and after hurricane Dorian took place over the Grand Bahamas the clean water system of the island broke down, which let to unavailability of clean water towards the inhabitants of the Grand Bahamas. One of the areas suffering from this was Baintown, a small town on the west of Freeport. The second disaster passing by within 12 months after Dorian took place was the COVID-19 virus. This virus has shown the population that they should become less relying on foreign countries. One of the main import products are food and drinks, including water. Since the own water system is not creating “clean” enough water for the inhabitants to drink, there drinking water supply is fully relying on the import.

As the population is also not to wealthy and since there is a lack of knowledge there are not a lot of opportunities for them to improve or create the water system to be less relying on others. Since this low wealth within the Bahamas, and the high amount of external reliabilities, a solution for these problems will be sought by using the nature as a source for the drinking water. This will be done in three different situations: the normal situation, the hurricane season and the restore period. For each of these situations different demands will be made and a system will be designed to make sure that the drinking water supply doesn’t get empty, and supply isn’t relying on external powers anymore.

1. Normal situation

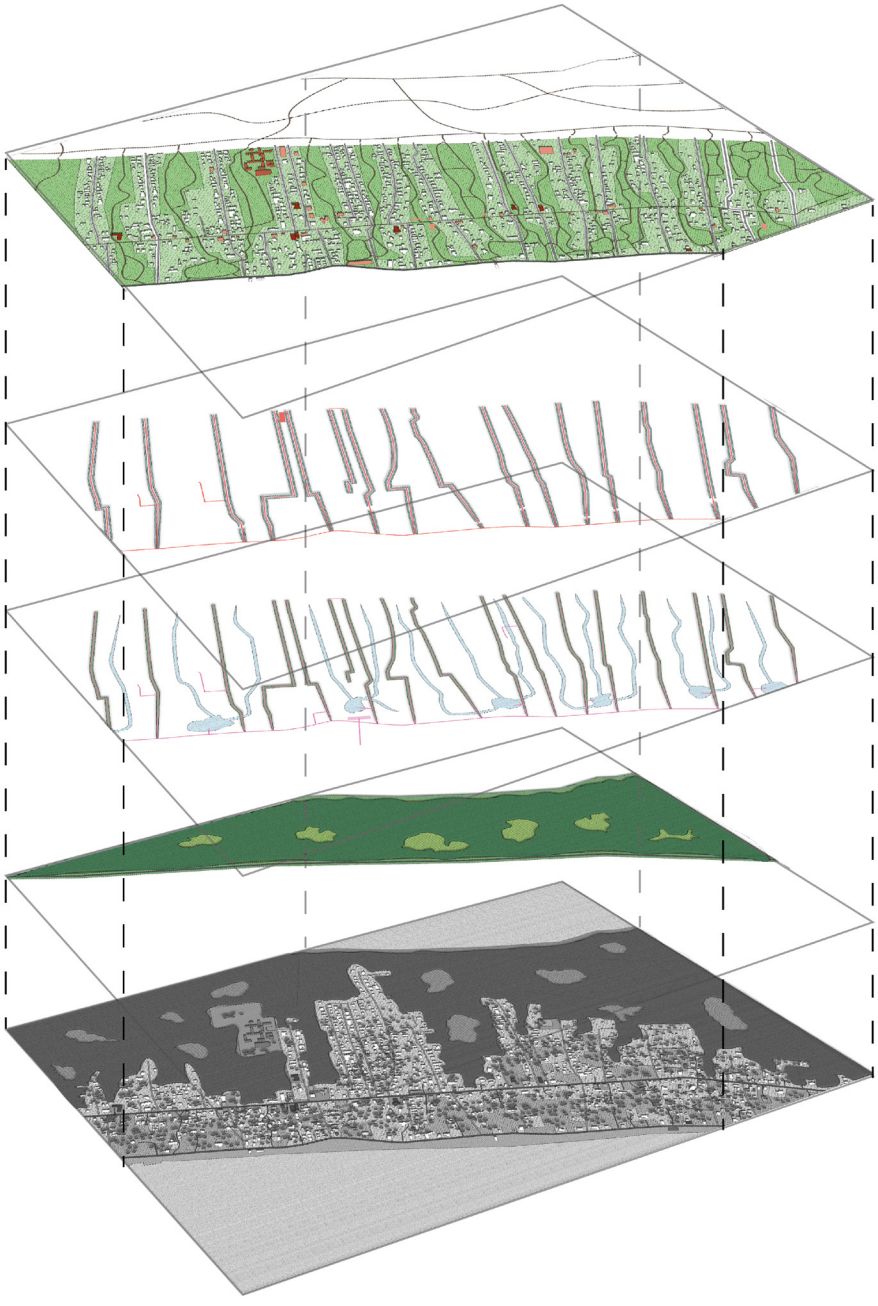
During the normal situation multiple aspects are important. Whatever weather situation is there, the water system should be functioning. This means that during rain periods, this rainwater could be caught and filtered. However, during drought periods the water supply should also function. This could be done by investigating the possibility of the use of ground water, by creating a (clean) water buffer after a rainfall period or a combination of both. During the normal situation it’s also important to create a water supply to foresee in water during and after storm periods. Thereby it’s also important to think about where to place these supplies (closer to shelters is more logical then around housing).

2. Hurricane season

Since the water system of the island broke down during Dorian, a system should be created where this doesn’t happen anymore. Therefor the focus will be on creating private supply systems, in which the water supply for during and after the storm will be at the location already. During the hurricane season it’s also important to catch the water. Since this is the period where most of the rain will fall down, most of the sweet water could be caught during these periods. The best way of catching would be to create systems together with the nature, in which the water will go into the ground and could later be raised when needed.

3. Restore period

As the hurricane Dorian left a devastating ravage behind, and it’s likely to heavy similar situations in the future, it’s also important to make sure that there is a local supply for water during this restore period. People won’t be able to go home immediately but still need the water. In this situation the water supply of the hurricane season could still be used, but that means that this supply should be big enough. Another why is to use the caught water during the hurricane season and clean this water. Since this period is more focused on the rebuild of the private property’s, it’s more likely that the people will corporate in the community sphere during this period. Therefor a small local water system would be ideal for this period. Another problem is that most of the system could be damaged. If a detachable system would be created it could be kept safe during the hurricane season and could be quickly build up at the start of the restore period.



Social network

Fresh water network

Brakish water networ

Floodplain

Current situation

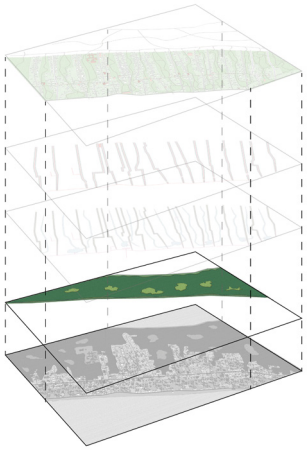
Design experiment

Bain Town has suffered a lot from storms and the damage they leave behind. The people and structures are not well prepared against these storms arriving in this town almost every year. One of the problems that Bain Town suffered from after the hurricane Dorian in 2019 was a failure of the fresh water system, which was a centralized system over the whole island. In february 2020 this fresh water system was still not restored (personal conversation). Within this design experiment a decentralized water system will be created that will foresee the inhabitants of Bain Town from water during the whole year. This system will also make use of natural water sources like storm and ground water and will not cause any disturbance with the current social system of the town. On the axonometric the different steps within this process are being shown. The bottom map shows the current situation, on which the top maps will create a new situation.

At first a floodplain will be created which will prevent the floodwater from reaching the inhabitants of Bain Town, or it will mitigate the effects of the flood water when it can't be stopped. Since most of the floodings happen from the north side of the town, this floodplain will be located between the sea and the highest strip of the town. Any buildings within this area will be relocated towards the southern part of the town. At the sea a dike is already located and a second east- west oriented dike will be created on the highest strip of the island to stop of reduce the speed and amount of storm water passing by.

Secondly the watersystem will be created. These are divided into a brackish water system , to flush the toilet, and a fresh water system, to be used as household water. These two system will work seperatly from eachother. The brackish water system will make use of stormwater that reaches over the east-west oriented dikes and will be let into small lakes at the southern side of the island. When these lakes would be empty, sea water can be used as brackish water. Dikes are created within the north-south direction to keep the people moveable when the island would be flooded. On the dikes and on the roofs of houses rain water will be caught. This water will be let into wadi's alocated against the dike, from where the water will go into the ground. This ground water will be pumped up, cleaned an is then ready to be used.

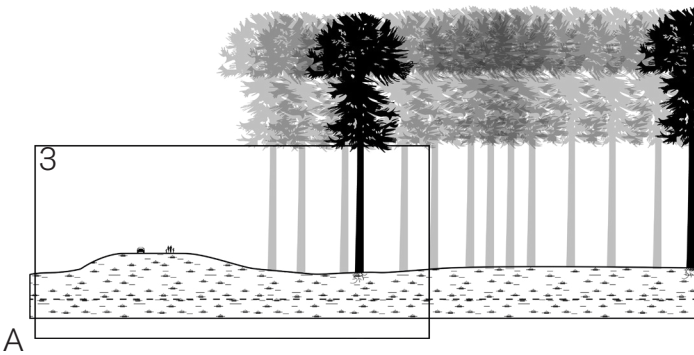
The last step that will be taken is a reformation of the urban structure of the city. Most important was to use the current structure to have as less interference as possible. Therefore most of the roads are kept and some are added in the same direction. Also most of the buildings are kept as they are currently, and their private grounds are also being kept. Over the rest of the area public greenery with a walking path network are being created. Also the old main road will be replaced by the pathsystem, which supports the current social system



Section 1

With creating the floodplain a big area of land could safely stream under water. The first dike, on the right of the section, Is currently already there and will be strengthened. This dike will prevent the floodplain from getting under water in minor floods and will reduce the speed during bigger floods, to prevent the vegetation within the floodplain. The second dike, on the left of the section, will prevent Bain Town from getting under water. In cases when the flood is really heavy, this dike will reduce the damage done by the water by reducing the speed of the flood.

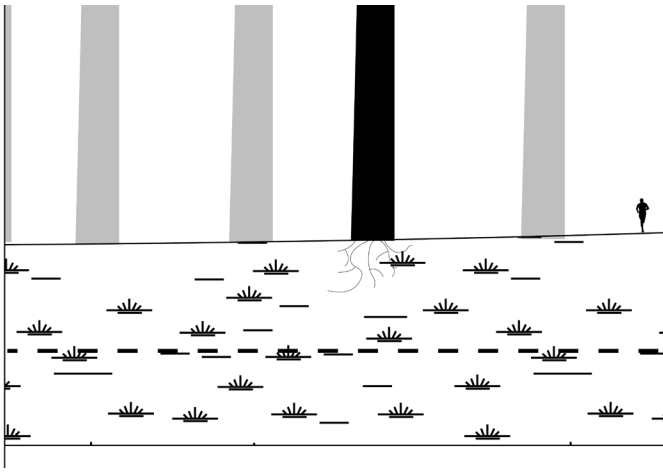
0 | 50 meter



Section 2

The first dike will be about 4 meters above the ground and about 7 meters above sea level. This height difference makes that all waves untill 7 meters will be blocked by this dike.
In the section the water level is drawn about 3 meters above the current sea level. Within one of the worse sea level rises, the rise is expected to be 2 meters. Therefor this dike will also be able to resist waves of about 5 meters when the sea level will be rising.

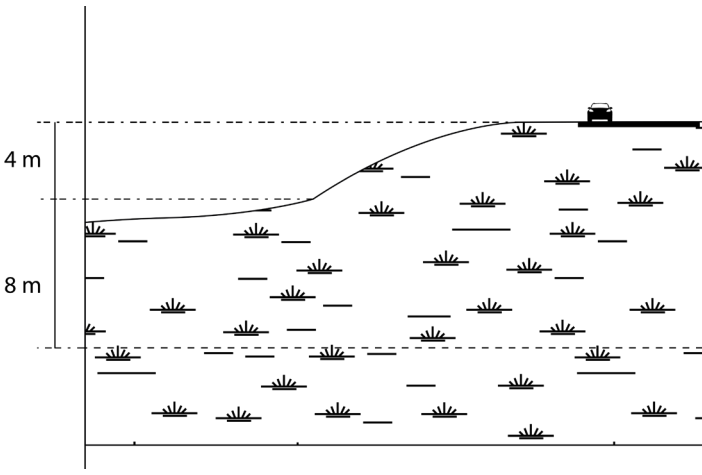
0 | 10 meter

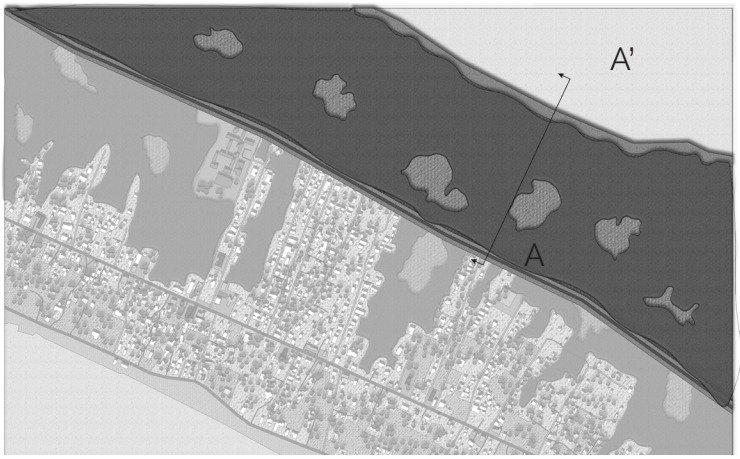


Section 3

The second dike is about 12 meters above the current sea level. As the flood plain is about 500 meters long and the top of the dike is 6 meters above the ground level, the flood plain is able to hold up of 30.000 m3 water per strip of 1 meter from the first dike to the second dike.
On top of the dike the main road from Freeport to West End will be build. The high location of this road makes the road accessible in almost all situations. Thereby, these cities can also be foreseen of supplies or the people are able to escape the cities for a longer peiod during storm.

0 | 10 meter

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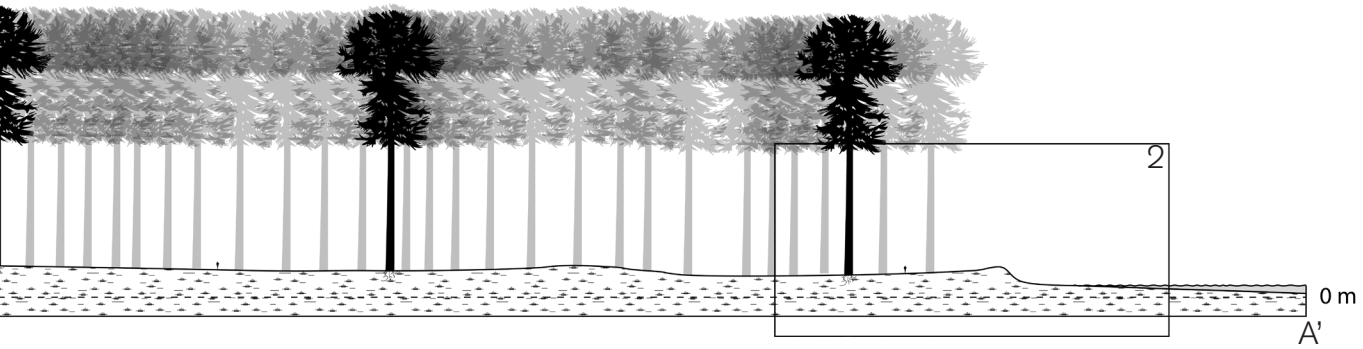
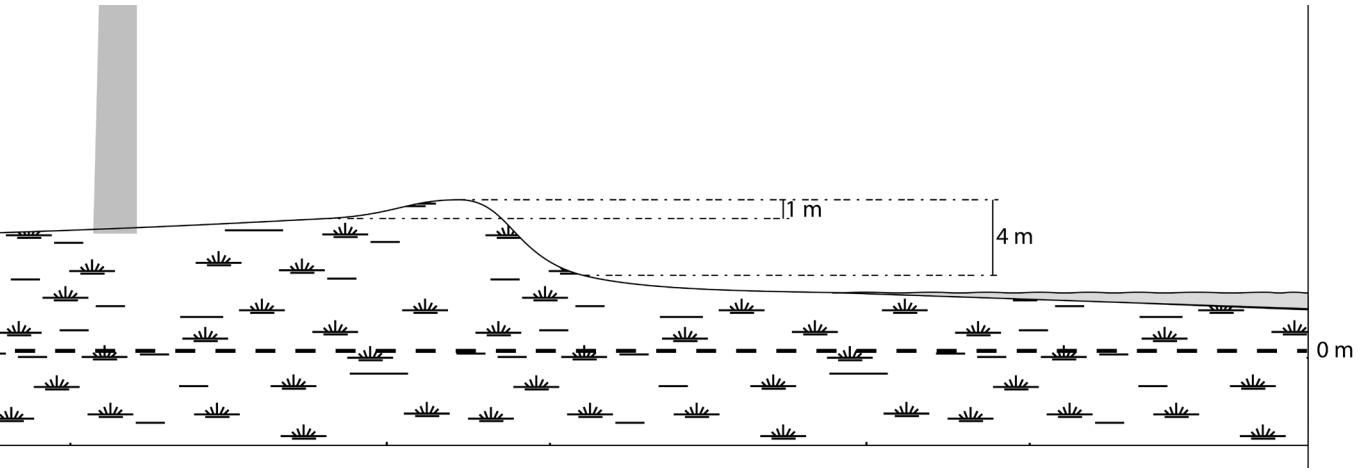
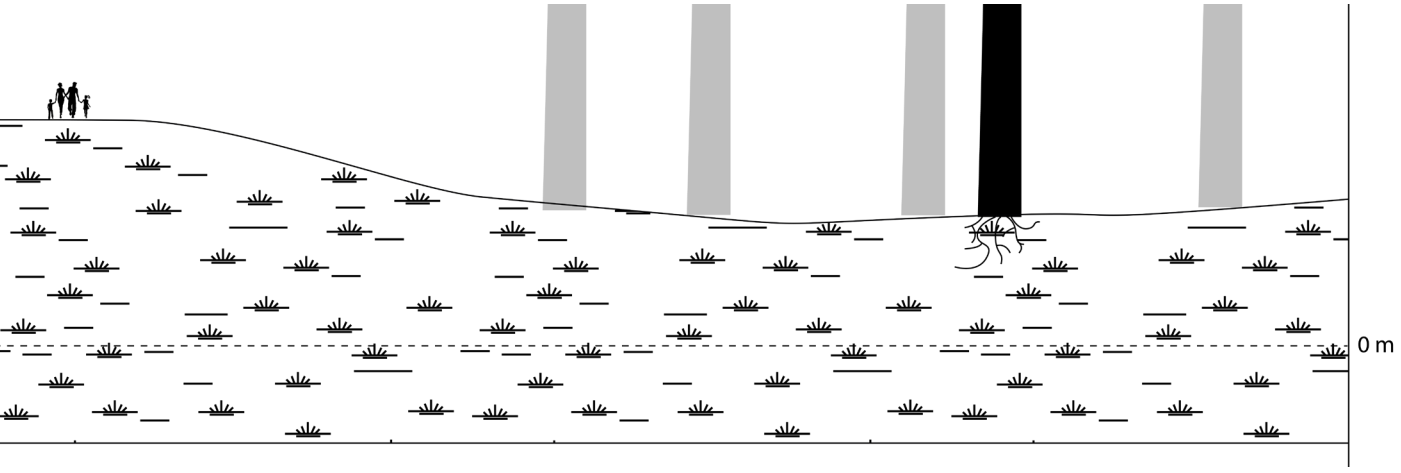
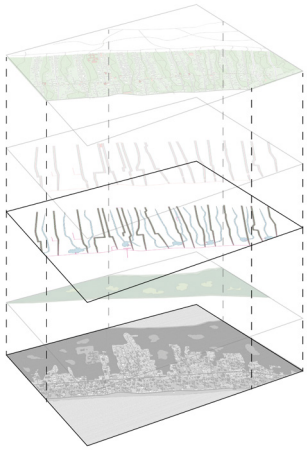

2
0 m
A'


1 m
4 m
0 m


0 m

Map 1

Map 1 shows the brakish water system. Current road are being replaced by dikes with a road on top of it. This creates a better opportunity for people to escape the town towards the main road in case of a heavy flood. In between of the dikes streams are being dug. These streams will move the brakish water, which arrives in the stream from rainfall and flooding, into lakes on the south of the island. From these lakes the brakish water is taken out, filtered and brought to the homes. The network of pipes to transport this water will be located under the roads, to keep it good accessible.



Brakish water system
Brakish water treatment plant
Brakish water stream or lake
Dike

N

0 100 meter

Section 4

The section shows a more technical view of this brackish water system. The different steps will be explained:

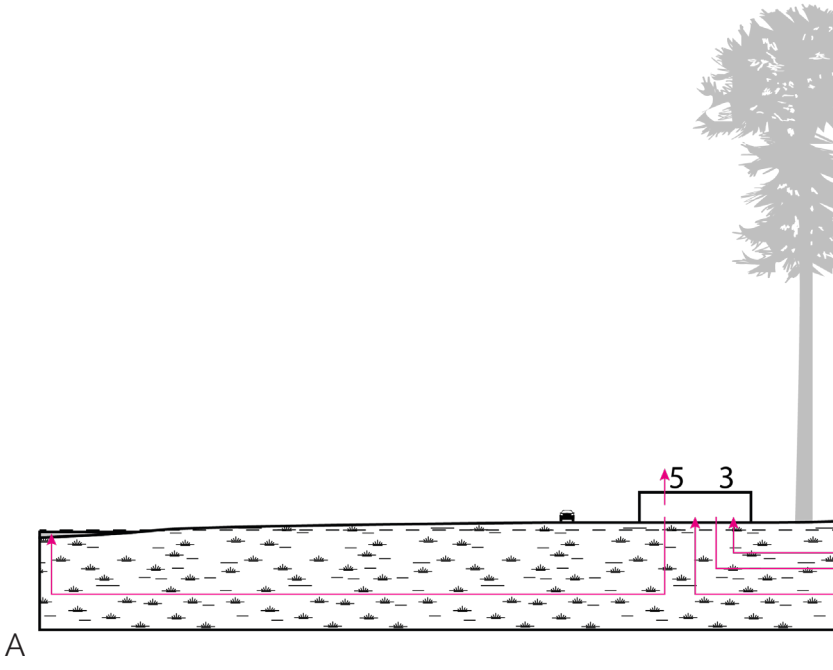
1. When the storm water arrives within the area, it will be moved towards the streams. This will be done by creating a small elevation from the dike towards the stream. To prevent water from filtering through the ground, the ground will be foreseen from a layer of limestone. This will prevent ground water from getting mixed with brakish water. These streams move the water into the lakes on the south of the island.

2. The lakes function as a water storage. The water that arrives here will be kept stored within the lakes untill it get's pumped up. When these lakes would become empty, sea water can be used as brakish water to make sure that the water supply never get's empty.

3. The water will be pumped into the water treatment plant, where it will be filtered and transported towards the homes. Since it's used as toilet water, the filters only have to take out the most important trash from the water.

4. The water is being transported to the homes, where it will be used and from where it will be transported back.

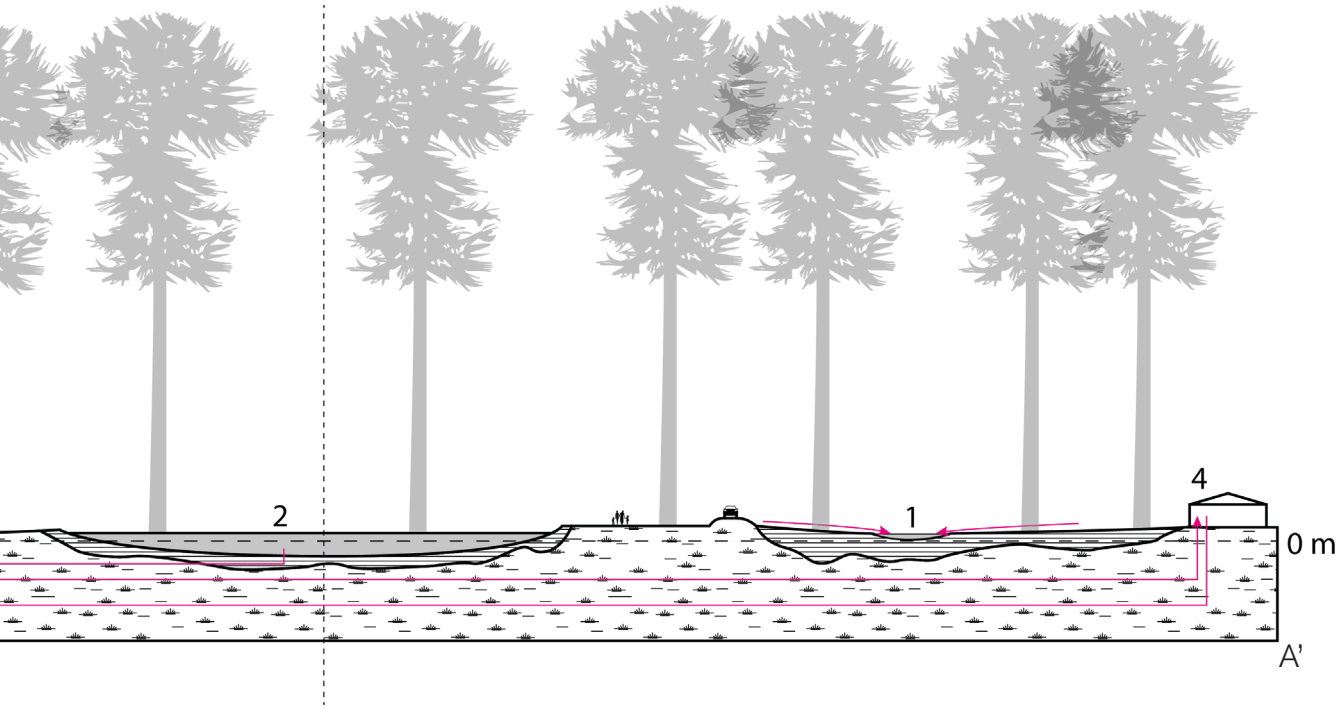
5. The black water coming from the houses is being filtered again. The water is then being released into the sea, where it could improve the ecosystems (Yang et all.).
The waste that's being filtered out can be used to generate energy in biomass plants.



Brakish water system

0 20 meter


A
A'


2
1
4
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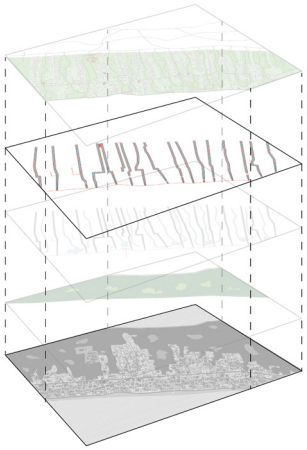


Map 2

On this map the fresh water system is shown. Rain water is being caught on the roofs and dikes within the area and moved into wadis. These wadis are located against the dikes and 1 meter above the ground level. This is done to keep the fresh and brakish water separated from eachother. The wadis will be build step alike to create a horizontal water ground level. This makes that the water won't stream downwards, but will stay in the wadi's and get the time to filter into the ground.

Fresh water system
Fresh water treatment plant
Wadis

N

0 | 100 meter

Section 5

The section shows a more technical view of this fresh water system. The different steps will be explained:

1. Rain water is being caught on roofs and on the dike. This water will be let into the wadi's from where it will filter into the ground.

2. Within the ground the soil will filter the water which makes it almost ready to be used as fresh water. As mentioned in the brakish water system, the ground where the brakish water could filter into the ground consist of a layer of limestone to prevent the water from filtering through. Below the dikes and the wadis

3. In the water treatment plant the water will be filtered from it's remaining waste before it gets distributed towards the homes.

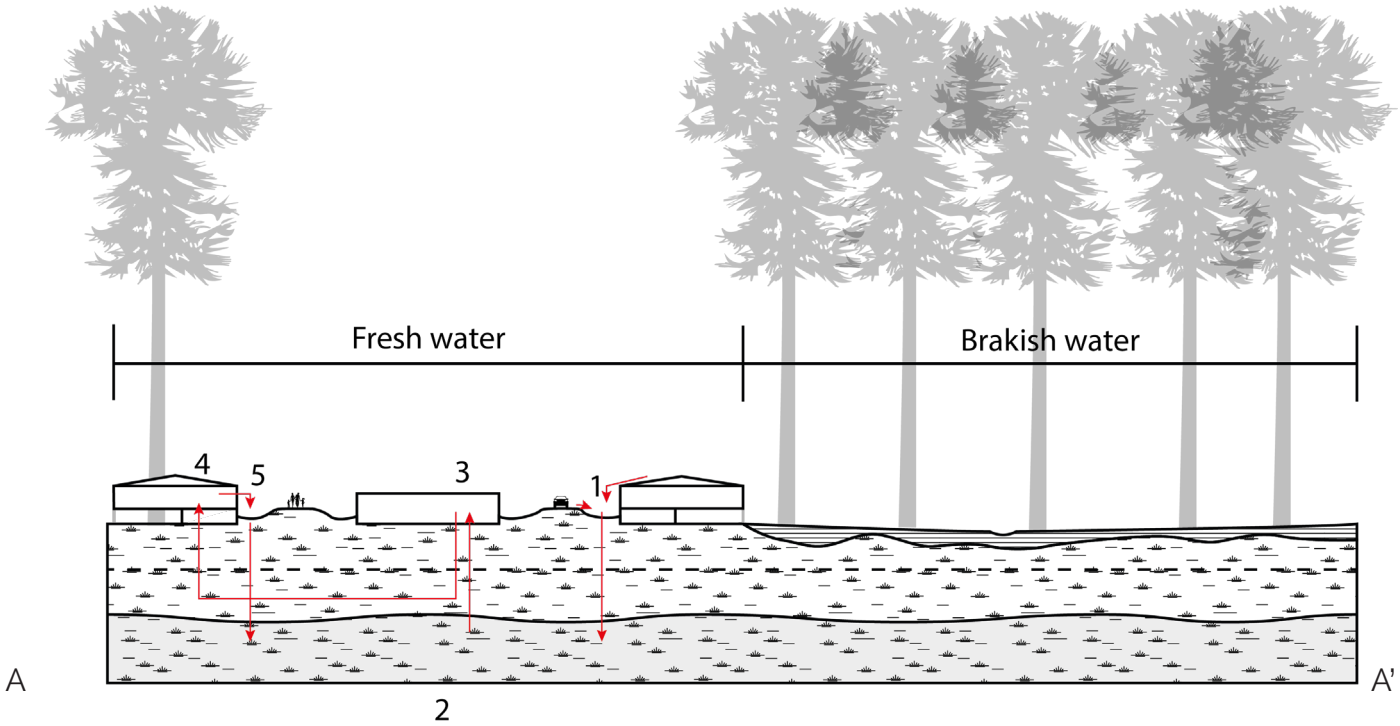
4. Within the homes the water will be used for every function except for toiletwater. This is about 2/3 of all the water use within the house.

5. After the water is being used it is released into the wadis, which also consists of helophytefilters. Here the water get cleaned again and will be filtered into the ground. This makes the fresh water system a closed loop, which reduces the need of the addition of fresh water. In periods of drought a supply of freshwater is always available..

Fresh water system

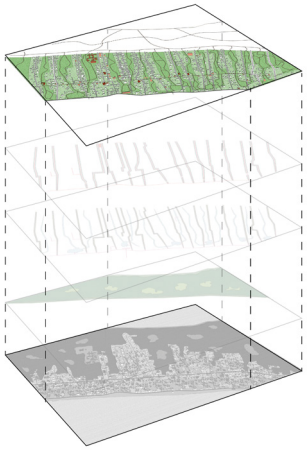
0 | 20 meter


A
A'


Fresh water
Brakish water
4
5
3
1
A
A'
2

Map 3

Now that the new watersystem are being placed, Bain Town has gone through a lot of changes. To minimize the impact on the urban structure the new roads are kept as much as possible in place of the former roads. Also most of the buildings are kept, and the removed buildings are placed back at another location. Within the area there's also made a differentiation between public and private green. Through the public green a network of walking paths is created. This network is connected by a walking path which replaces the old main road through the middle, and the walking system though the floodplain on the northen part. This system is also reachable from every private property within the area.



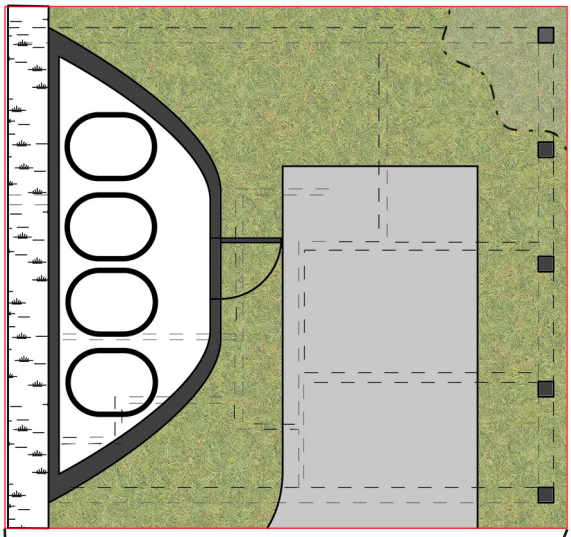
- Walking path
- Private green
- Public green
- Playground
- Sports court
- Retail or commercial building
- Church
- School

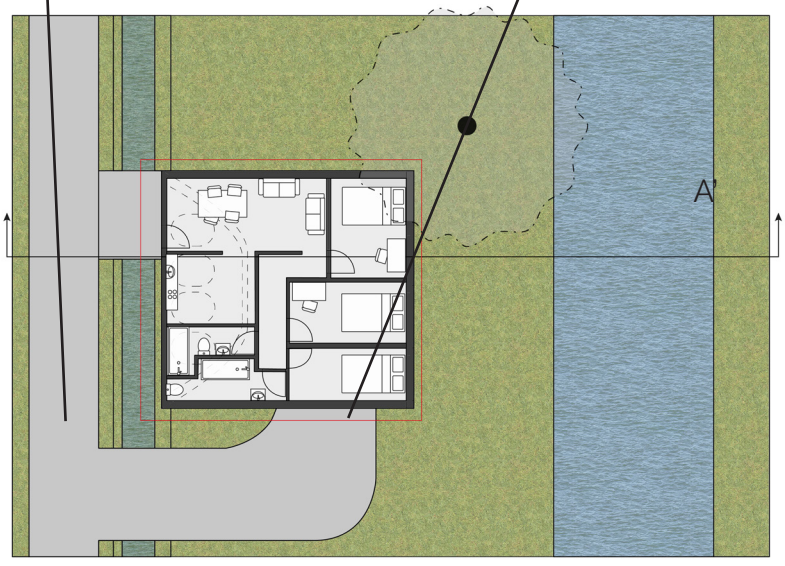
N

0 — 100 meter

Map 4 + zoom in & Section 6

The maps and the section show the new architectural style which will be more flood resistent. The building will be lifted up of the ground by about 2 meters, similar to the top of the dike. On the bottom floor a small room is created where the fresh and brakish water arrive into the building. This room could be shaped similar to the shape used, to make the flood water pass by easier.
A green roof is added on the building. This roof is able to hold the rain water a bit longer to create a small buffer of water during drought periods, but it's also a constructive element that makes the building heavier. The downforce it creates makes that the building is more stable, which makes it more resistent during floods as well.

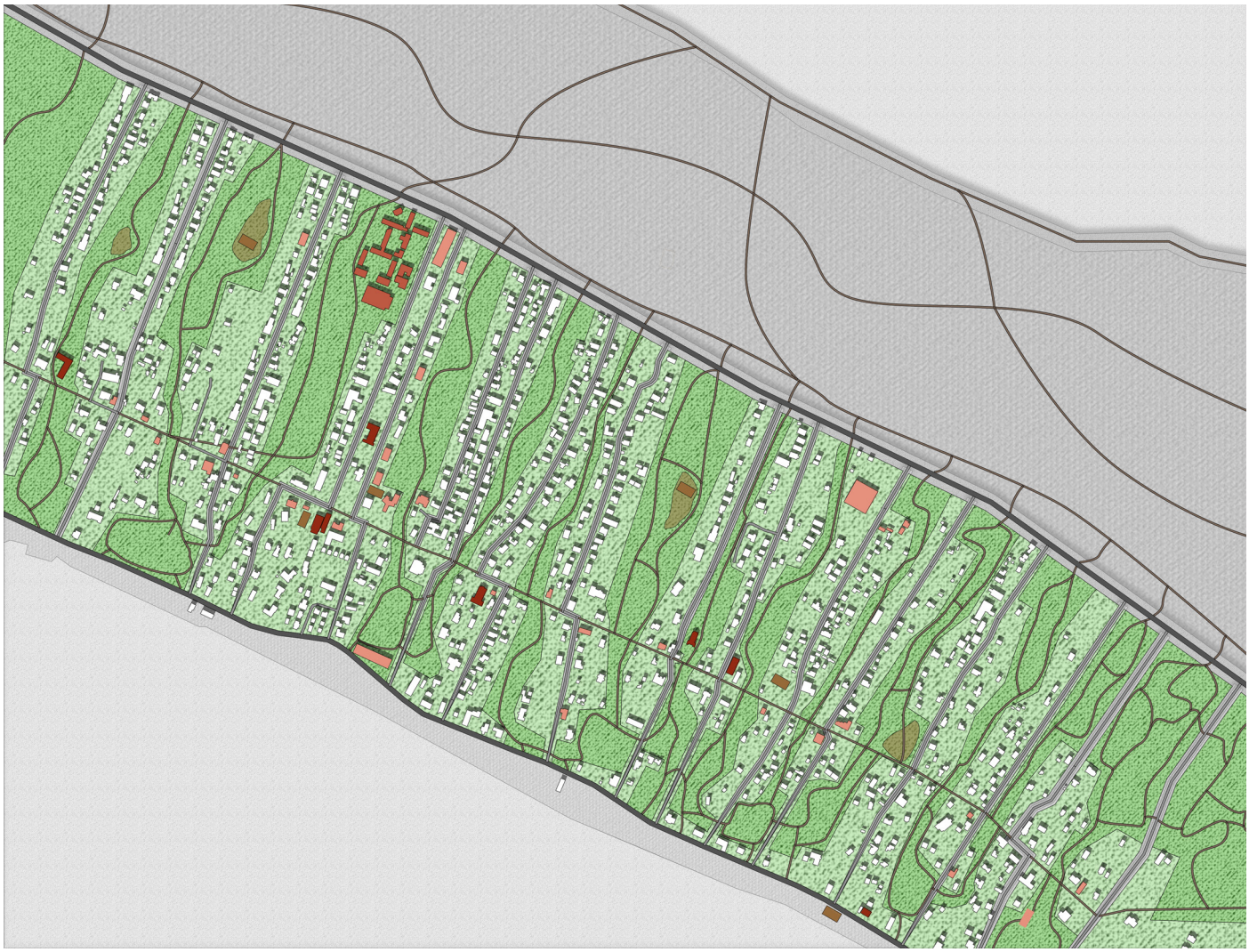


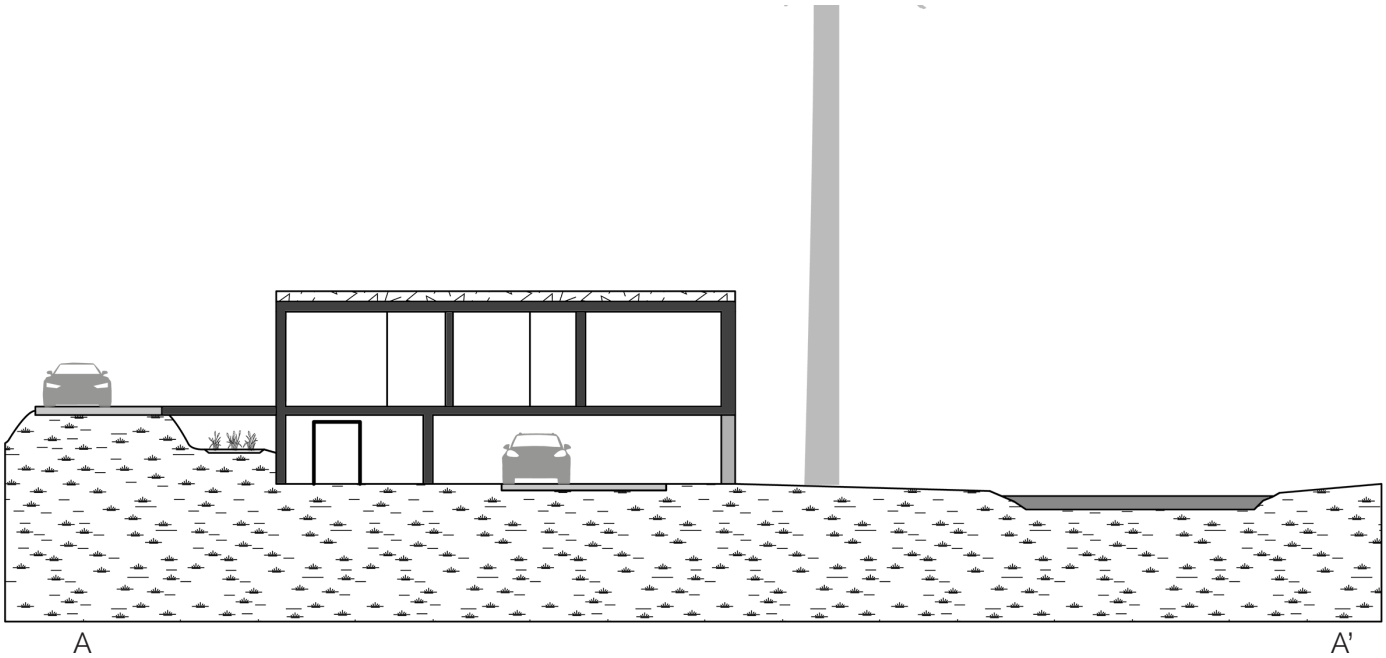


- Brakish water
- Fresh water
- Grass
- Asphalt

Map
N
0 — 10 m

Zoom in & Section
0 — 5 m




A
A'

Map 4

This map shows how the 4 different interventions will be looking together. Clearly visible is the ostensible low impact on the structure of the town, eventhough the interventions do have a big impact on the life of the inhabitants of Bain Town. The impressions to show the impact on the human scale are made in 3 different areas to show the differences of these areas.

N

0 100 meter



Impression 1

The first impression is from the floodplain on the north of Bain Town. This area will be a natural area which will be accessible for everyone by the walking paths. As the floodplain is likely to be flooded, no structures are being build within this area, which gives the nature a totally free space to develop

Impression 2

The second impression is made over the walking path which is located on the former main road. Around this area a mix of public and private buildings, as well as sports and other recreation spaces are being created. This zone is ideal for the inhabitants to meet up.



Impression 3

The final impression is made around a brakish water lake on the south of the island. This area is a mixture of nature and human life. Also around these lakes places are created for people to meet up, but here there are no public buildings to support it. Therefore, these places will be more quiet





6.5. Saline-Based Bain Town

Chen Gao



Domain

Over 90% of the land in the south of the main road is under 3.6m, facing flooding and sea-level rising pressure. However, a lot of people in Bain town live in this flood-prone area which needs interventions toward safety life.

A Saline-based structure

The local ecosystem baseline is the most optimized way of solving the extreme climate events stably and long-term effectively.

The fact that Grand Bahama is an island means it is embedded in a saline environment, the Atlantic sea with tidal water, and wind dynamics shaping the saline baseline of the island habitats. Living with the salt environment is the kick-off point for the Bain town to form an innovative solution to adapt the extreme wind and water conditions and make full use of the ecosystem functions.

Build on the saline system structure, merged new technology and vernacular building allows the human settlements to be symbiotic with the salty habitat and seawater. Building on this saline ecosystem the town will be re-urbanized with the utilization and introduction of eco-dikes and eco-drainages.

1. Under/Above water reef

The underwater coral reef will act as a wave breaker and a new seabed ecosystem benefiting the offshore fisheries. Above the water, the introduction of hills creates an inland habitat with a wetland that functions as a buffer zone to tackle the issue of swell during hurricane season that increases due to sea-level rising.

2. Eco-system baseline

Lagoons are created in the densified area of Bain town based on the natural elevation of the landscape. The transitional zone of brackish water around the ponds is connecting the coastal reef/hill habitat with the drainage ecological corridor. The ditches are alined with a different elevation that creates various habitat in wetland and drylands. Moreover, the saline ecosystem scheme shapes the urban form of Bain town.

3. Life style

The Bain town will address natural demands to human life to adjust to the issue of hurricanes, sea-level rising, and isolation time of the pandemic. The safe areas meet in a sustainable way the requirement of eco-future and home-quarantine. Farming and fishery as a part of the saline ecosystem provide a new way of local agriculture and self-sufficient living methods.

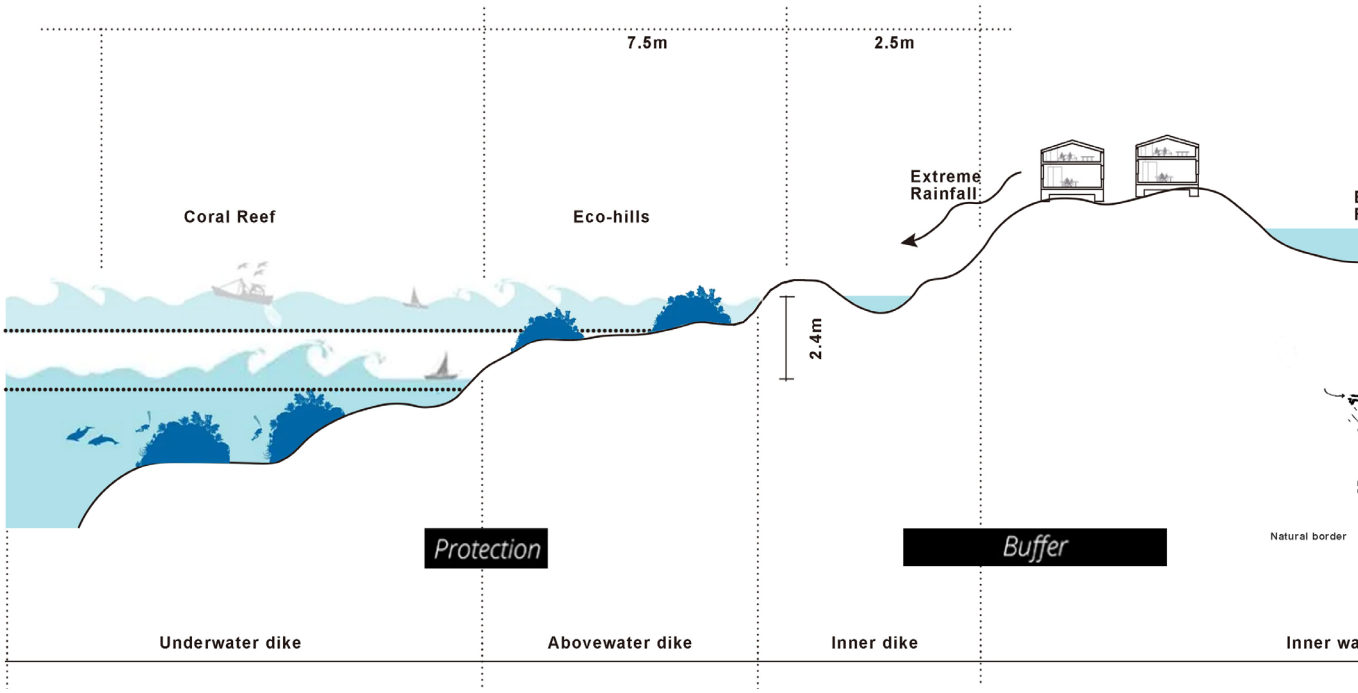


Coral reef, Eco-hills, and Buffer

wetland.

Quartet coastal measures





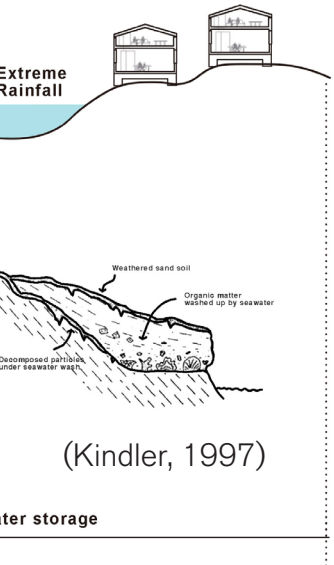
Design experiment



(NOAA, 2017)

In the southern coastal zone of Bain town, human settlements are well developed with private detached houses. Standing in this savanna landscape, buildings have taken the higher land which is lush trees before (Byrne, 1980). However, the south coast is still not safe due to its lower elevation and lack of protection. Most of the land there is under the pressure of the hurricane flooding and sea-level rise. Moreover, during hurricane Dorain, the infrastructure in the Bain Town is out of function and many houses were destroyed. People lost their houses and step into a pandemic situation in the meantime which means they need both shelters and isolation conditions.

To tackle these overlapping issues, the best way is to mitigate the hurricane hazard with a nature-based solution and allow people to stay in their house safe and sound during the hurricane time in the future. Therefore, they got the ability to go through these difficult times and become resilient when facing extreme climate.



(Kindler, 1997)

Starting from the coral reef idea, this kind of barrier is expended to both underwater reef and above water dikes. The coral reef is the first defense line made from natural stones and natural succession in order to break the wave power and enrich the offshore ecosystem (Beck et al., 2018). The second defense measure is the eco-hills working together with the marsh behind it. Two eco-hills are one lower and another higher to play a different role in different times. In the normal storm time, the first hill block the wave power, give the marsh behind it time to grow. When it is heavy hurricane time, the first hill and wetland are drowned but the last hill still holding the hazard mitigation function with the marsh backing. Both the two hills are made of natural composition and would be a part of the eco-system.

Then comes the buffer ponds to store the water from heavy rainfall in the hurricane period. Moreover, in the lower land of the densified district, several lagoons would be operating to keep flooding away. The buildings on the south coast would turn into vernacular ones with the overhead basement.

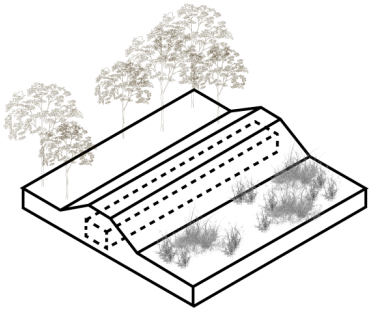
The saline eco-system is lasting from eco-hills to the lagoon through the drainage system, which creates a larger and connecting stable environment.

Bain town coastal zone south

Dikes formation principles

(Making the dikes in an ecology way)

Eco-hills



Eco-hills

The dike in the coastal zone will start with artificial bones. Through nature succession, the inland dike will be covered by soil and become small eco-hills with natural habitat.

"Y"

"Y" di

"Y" sh
the fl
ebb o
hance

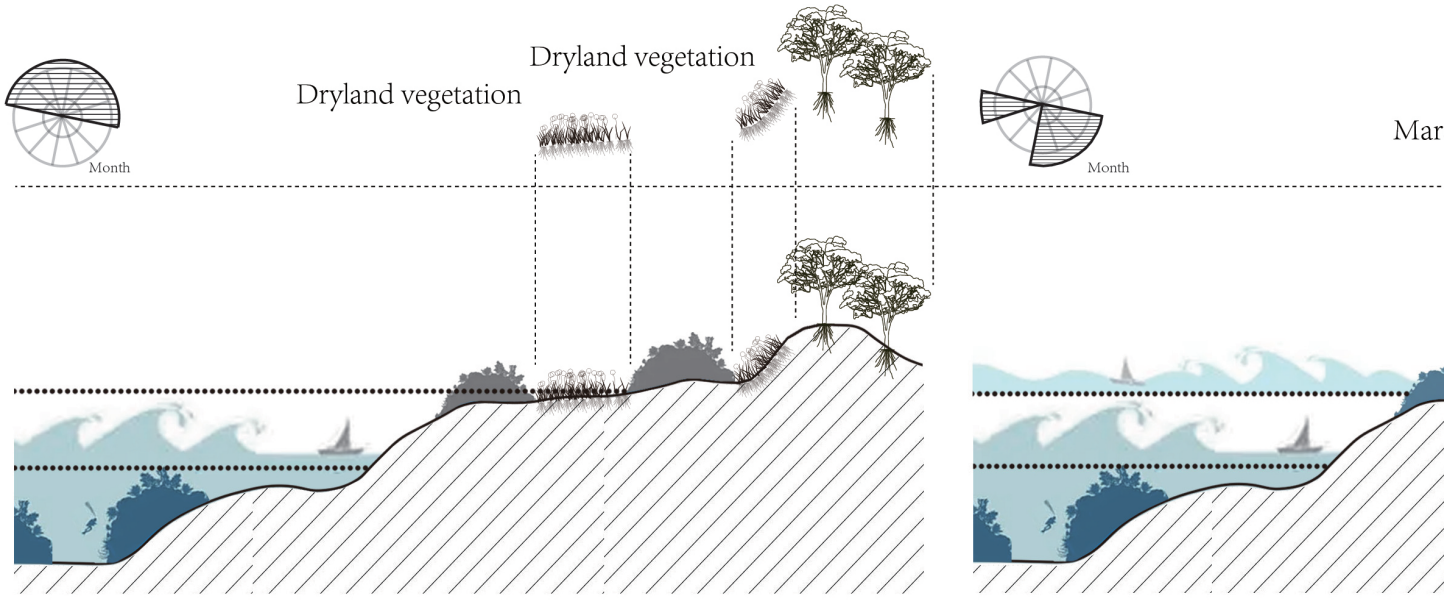
Coastal habitat in a different timeslot

Two eco-hills consists of four natural buffer zones: two hills created by natural succession and two temporary wetland behind the hills. In the normal time, which is in hurricane category 1-3, the seawater level is below the first hill, all the four zones are suitable for vegetations in the dry land. In the storm time of hurricane 4, the first hill and buffer zone are drowned and only suitable for the marsh. In the hurricane 5 times, only the last buffer zone is still occupied with the marsh.

This eco-hill system creates multiple levels of natural habitat to act as dikes or buffer zones in the different hurricane periods, which use the ecosystem to protect the coastal zone and give the system ability to recover from storms.

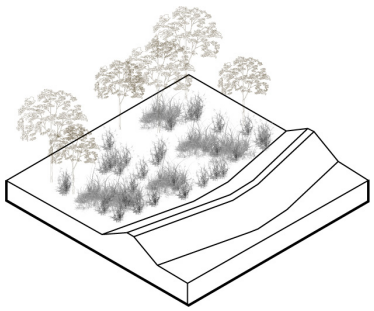
Dryland

Marsh



Normal time Hurricane 1-3

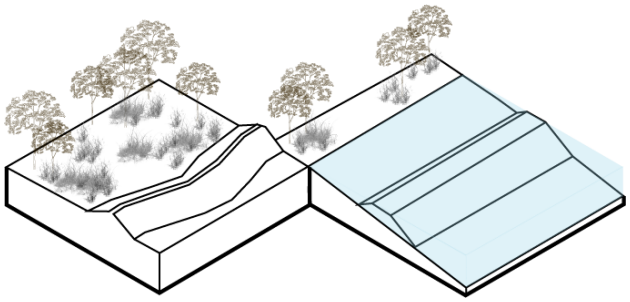
style dike for soil catchment



kes

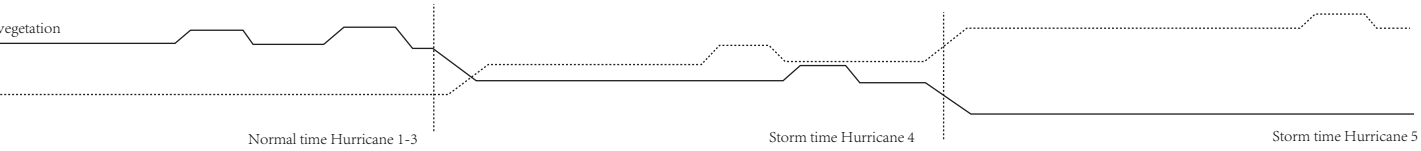
nape dike is functional for slowing down owing speed of the drainage water and f tidewater to catch the sand soil to en- e the dike itself.

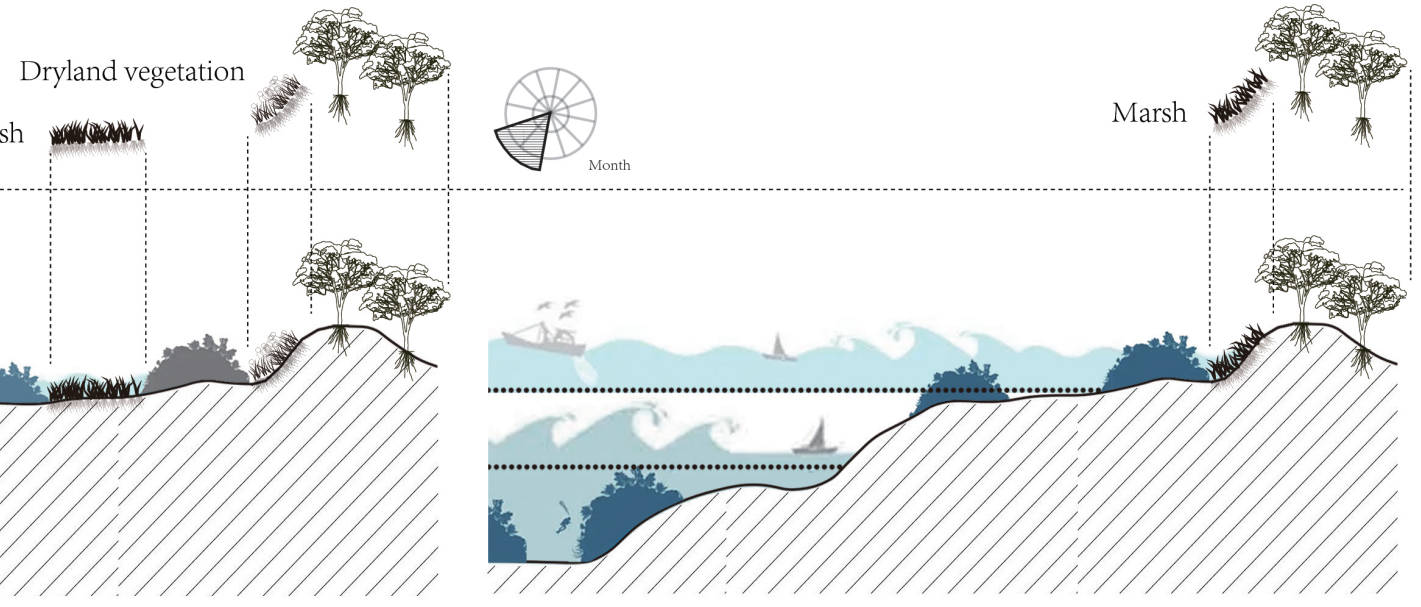
Co-work of in and outer dike



Co-work

Staggering of the inland hills and underwater dikes will make it more efficient for soil catchment and flood mitigation. In the meantime keep the open sight of the beach.



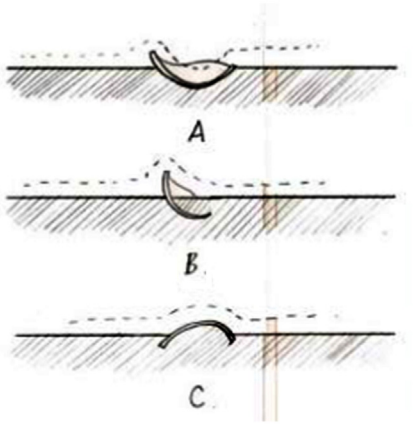


Storm time Hurricane 4

Storm time Hurricane 5

Start of the eco-hills

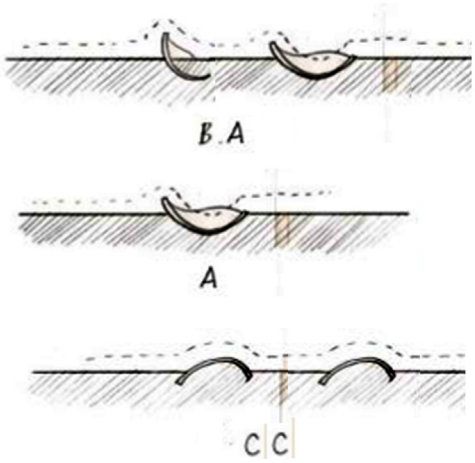
Dike foundation inserted into the soil



A: Quicker catch and natural succession

B: power migitation and soil catchment

C: Quicker natural succession and leisure suitable



B: power migitation and soil catchment
A: Quicker catch and natural succession

A: Quicker catch and natural succession

C: Quicker natural succession and leisure suitable

Underwater dike

Abovewater hill

Marsh

0 100 200m N

Style location

"A" style only
natural succe
coastal zone
natural zone.

"BA" style tak
on into accou
coast and acc

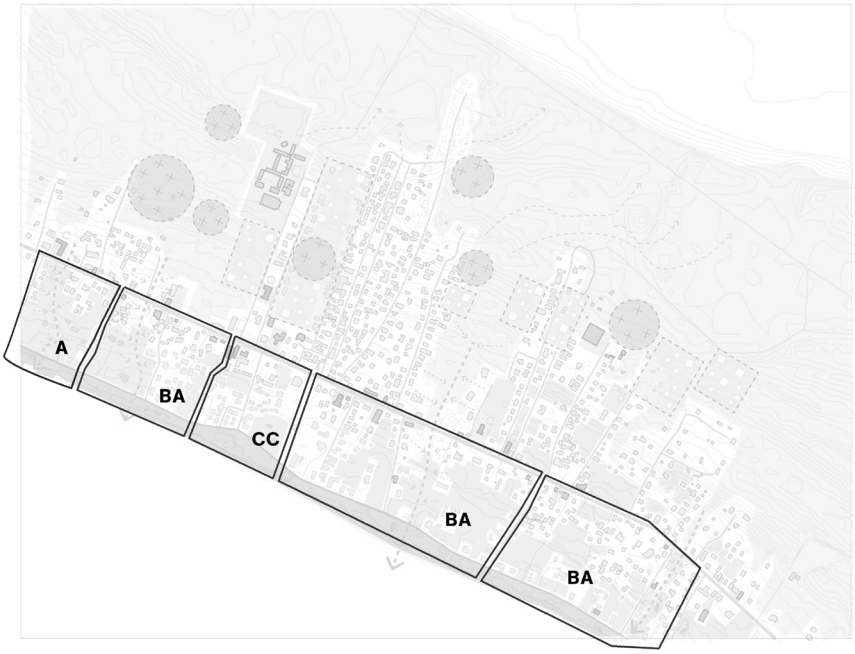
"CC" style hol
natural succe
shape which
tion of the co

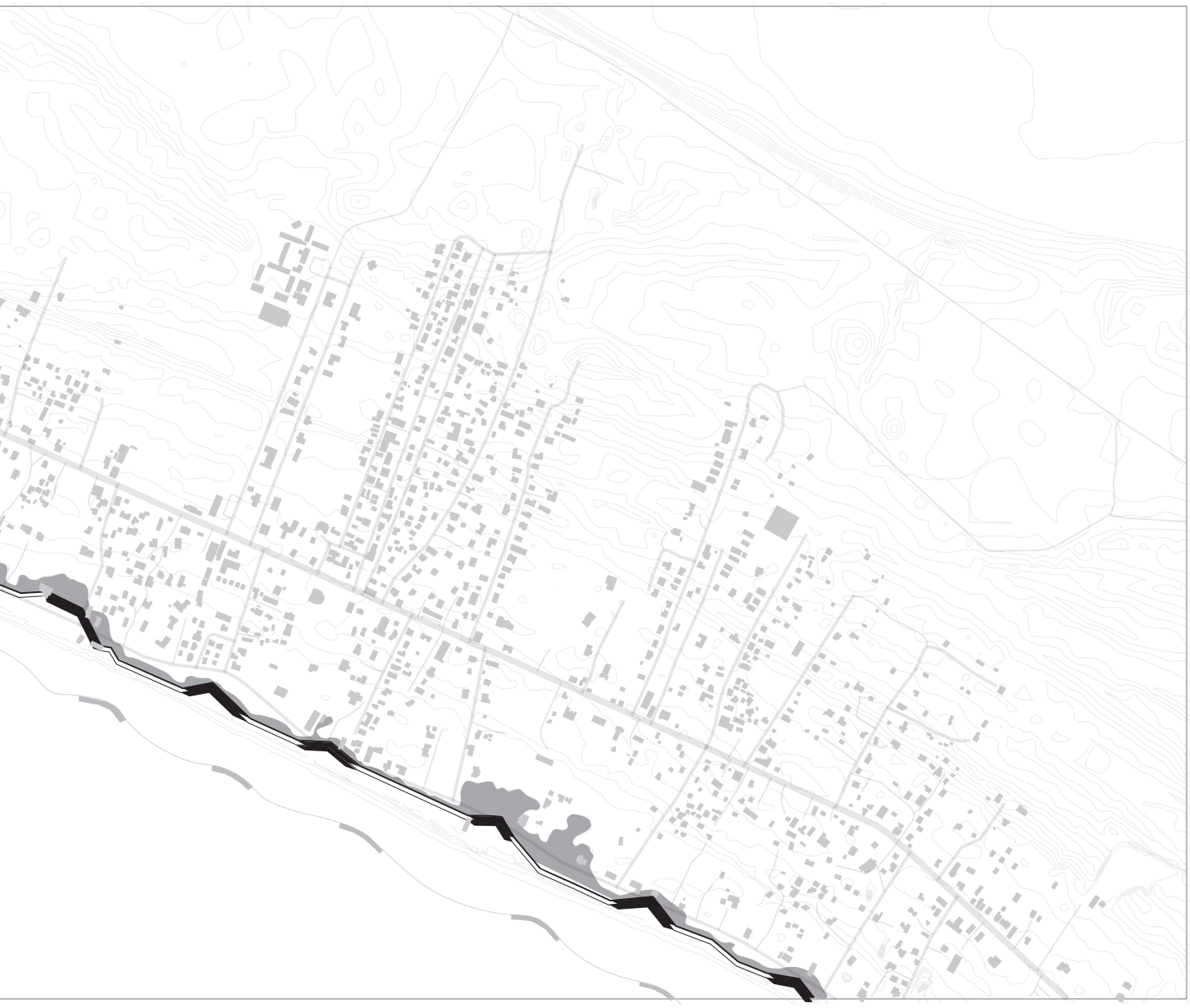


pursues a quicker soil catchment and
ssion. So it is applied in the west part of the
where fewer people living and could be a

es soil catchment and wave-power mitigati-
nt at the same time that would enhance the
celerate natural succession.

ds both a slower soil catchment and slower
ssion. But it offers a leisure suitable dike
s in line with the characteristics of this sec-
ast: higher elevation and charming beach.



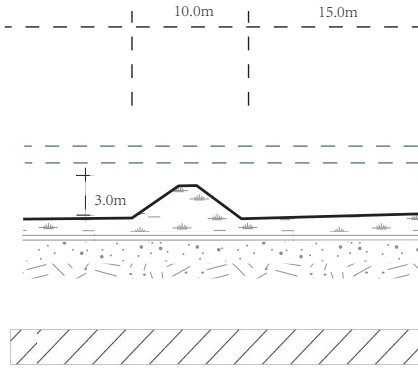


“A“ style coast

One eco-hill on the coast is co-working with the two underwater dikes in the function of wave power mitigation and natural system succession separately. A landscape walkway is between the be-hind-hill wetland and inland-lagoon for sight viewing.



A



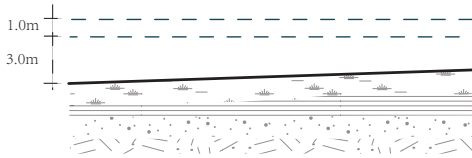
Underwater dike + Wave power mitigation

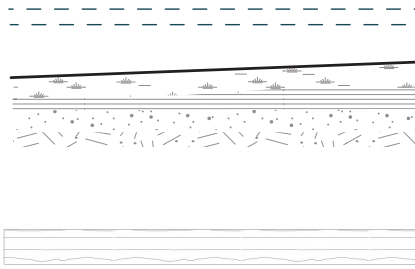
“CC“ style coast

This is a leisure suitable coast zone with a touchable wetland, beach, and seawater. Some part of the coastline is still with natural dikes of greenery where people could be intimate contact with nature and seawater. Some parts of the coastline in front of the vacation buildings are paved to create a wonderful beach and seawater pool for tourists.



CC





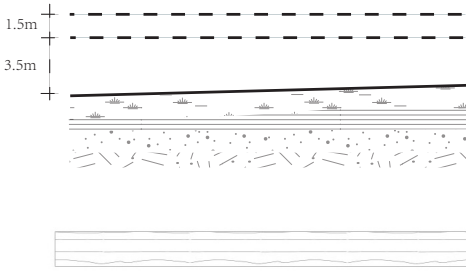
Long buf

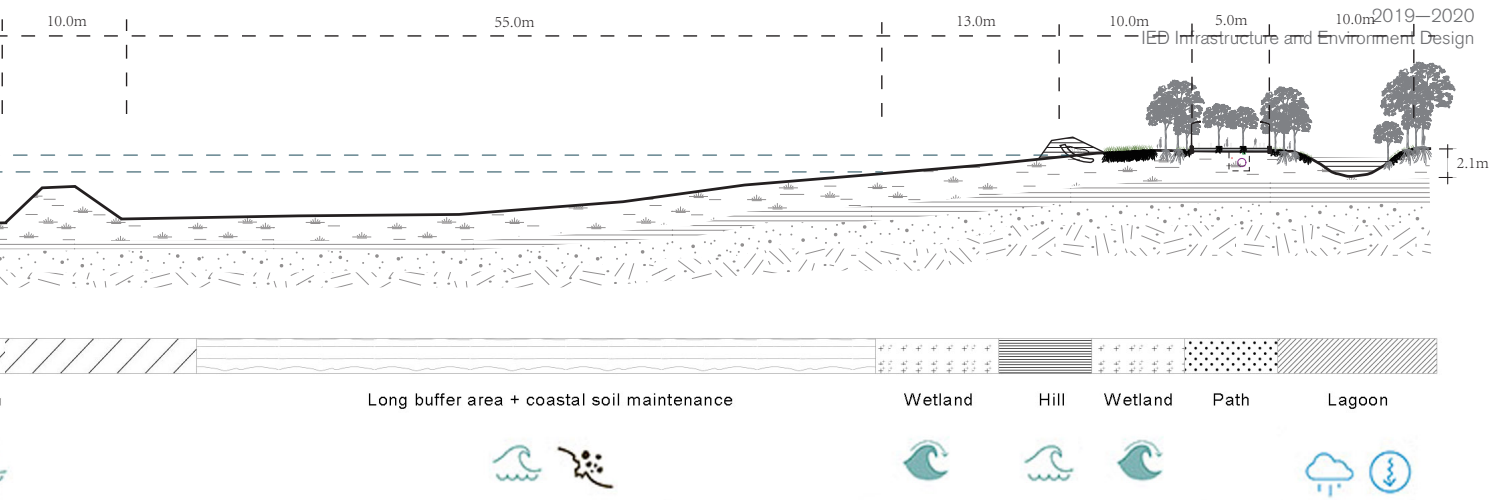
“BA“ style coast

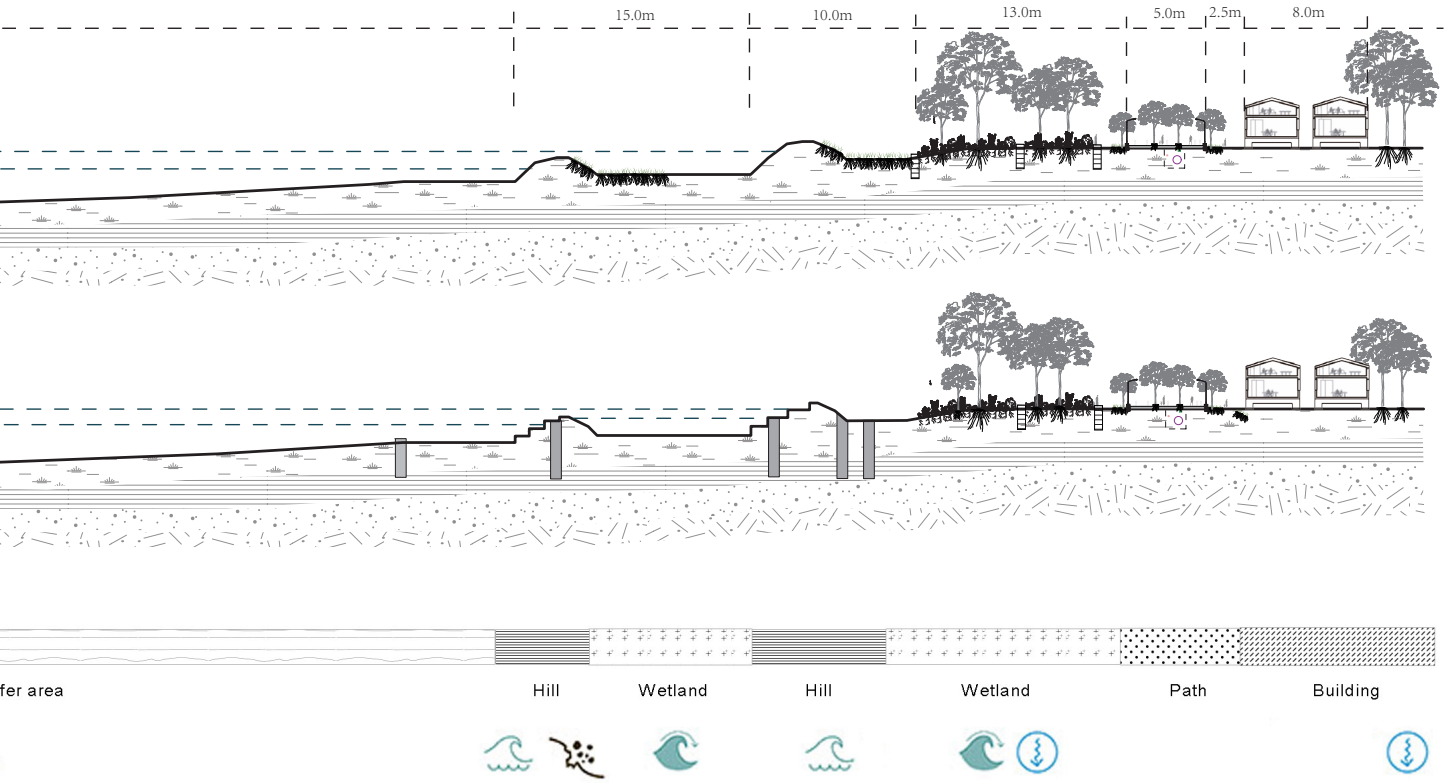
The most common dike in the Bain Town, two eco-hills consists of the hazard barrier with the wetland behind as the buffer zone. Wider wetland area would form a stable saline habitat to reinforce the caught soil. Flexible platforms are there as well for habitant to enjoy the natural time.

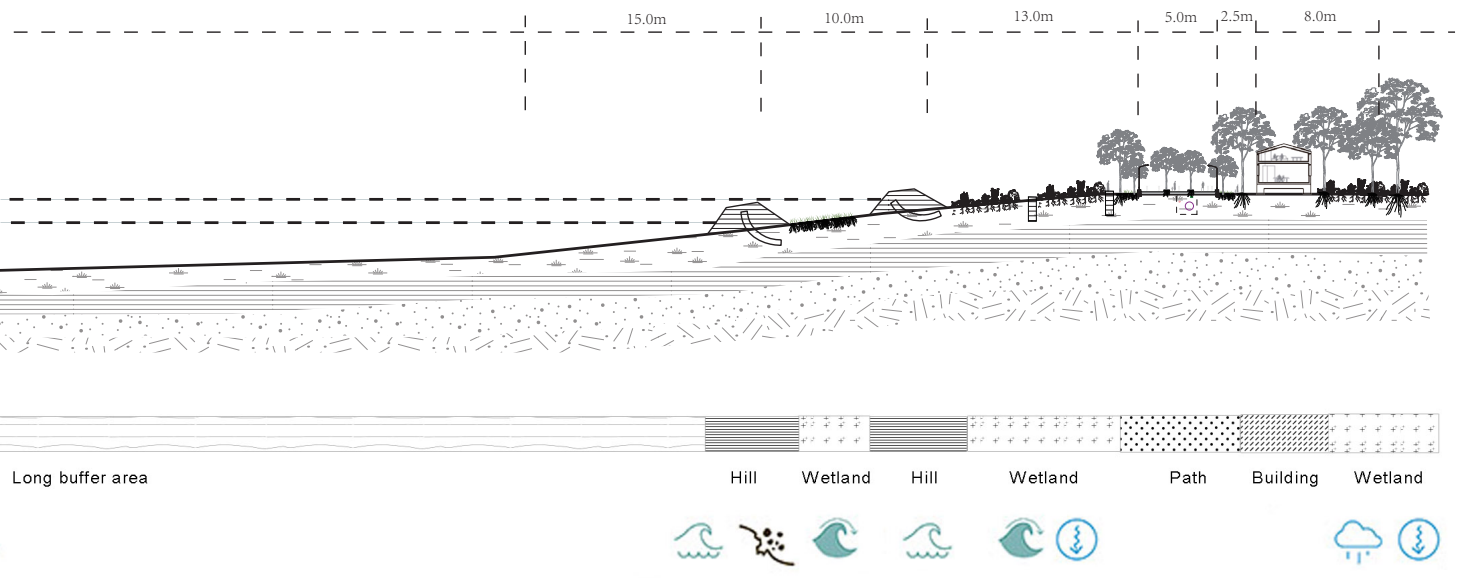


BA




10.0m
55.0m
13.0m
10.0m
5.0m
10.0m
2.1m
Long buffer area + coastal soil maintenance
Wetland
Hill
Wetland
Path
Lagoon


15.0m
10.0m
13.0m
5.0m
2.5m
8.0m
fer area
Hill
Wetland
Hill
Wetland
Path
Building


15.0m
10.0m
13.0m
5.0m
2.5m
8.0m
Long buffer area
Hill
Wetland
Hill
Wetland
Path
Building
Wetland

Drainage system

Several drainage systems created with green habitat

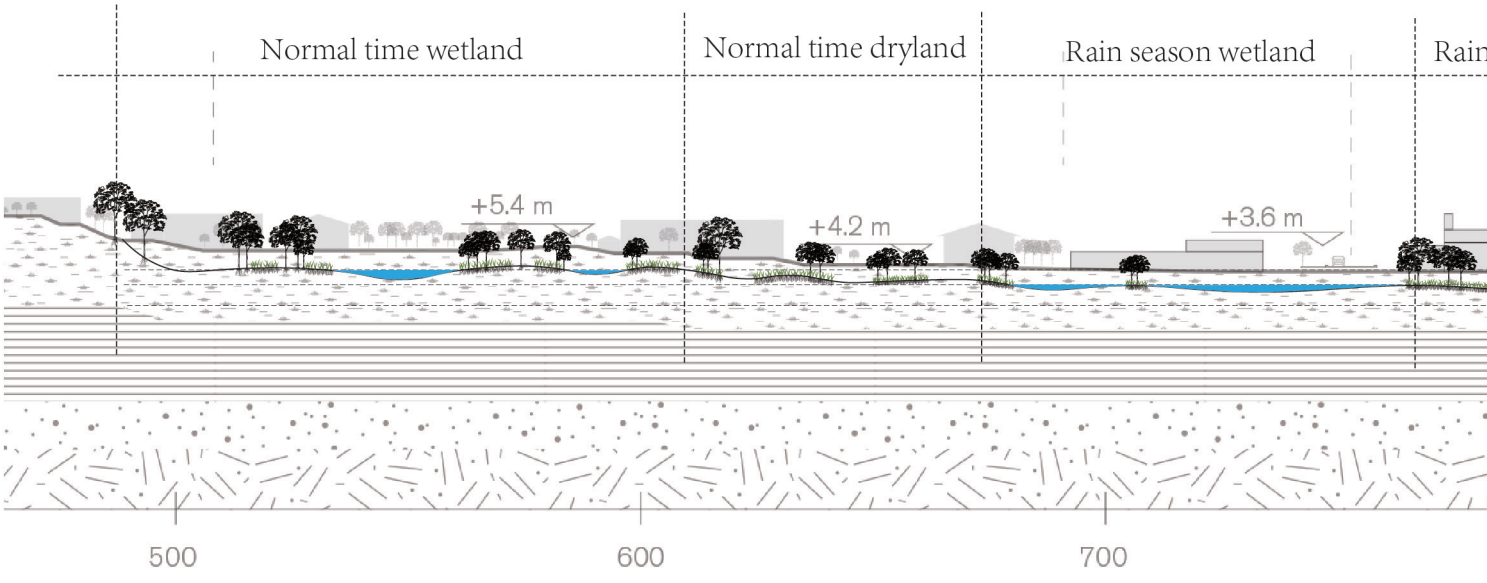
Four drainage system

The drainage system takes place in the lower land from the urbanized area to the sea. When the hurricane season comes, the tiny slope in the built environment will bring the rainfall into the drainage and flow to the south coast. According to Byrne, R. (1980), the margin of the drainage will also be a saline habitat. Therefore, along with it, there is space for marsh and trees. When it is close to a public building, it can be a public space for a higher pavement rate. Together with the wetland of the eco-hills, the larger saline habitat makes it more stable and resilient.

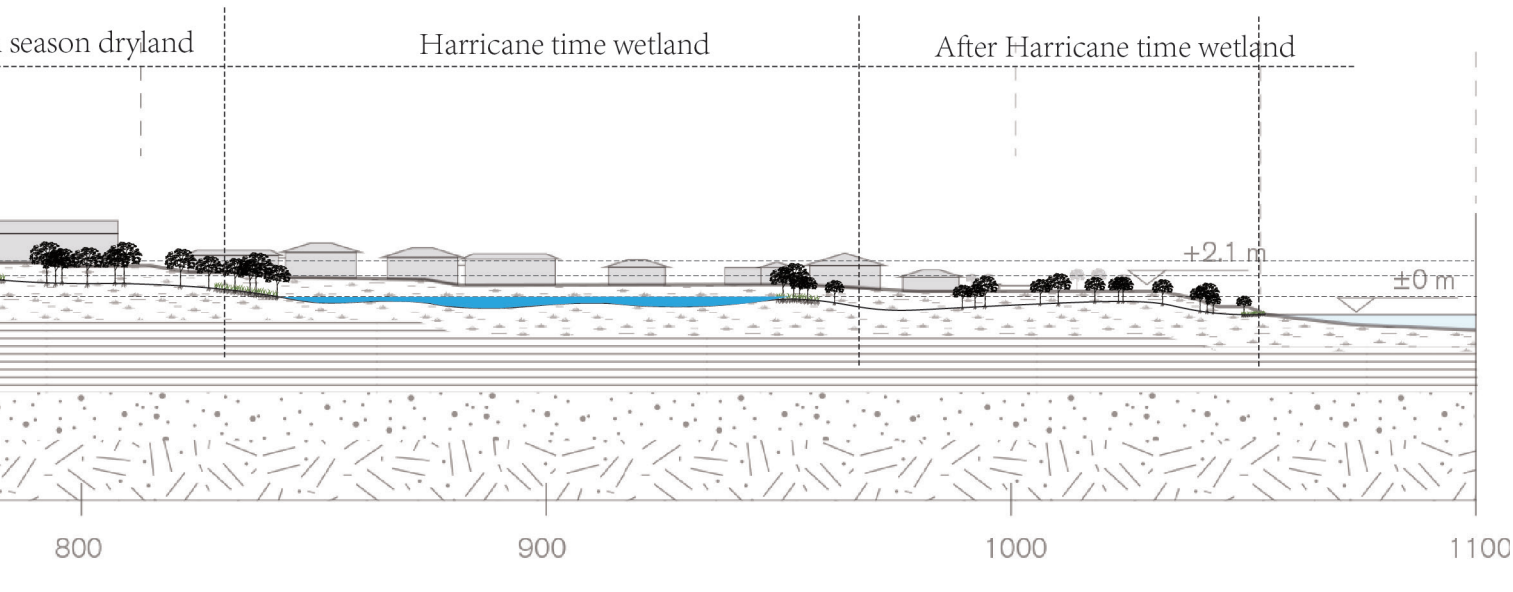


Longitudinal section

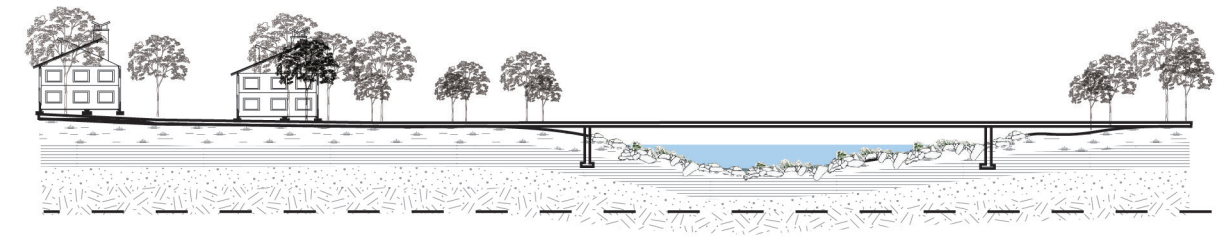
The drainage system has various conditions in terms of elevation. In the normal time, the higher part will be wetland with stagnant rainwater for a while and dry bed as well. In the rain season, there will be a larger wetland in the beginning part of the system. And more wetland in the hurricane time. In terms of biocoenosis design, according to the different environmental regions formed by each micro-topography, different water storage, a variety of local plant biocoenosis were selected to grow here.

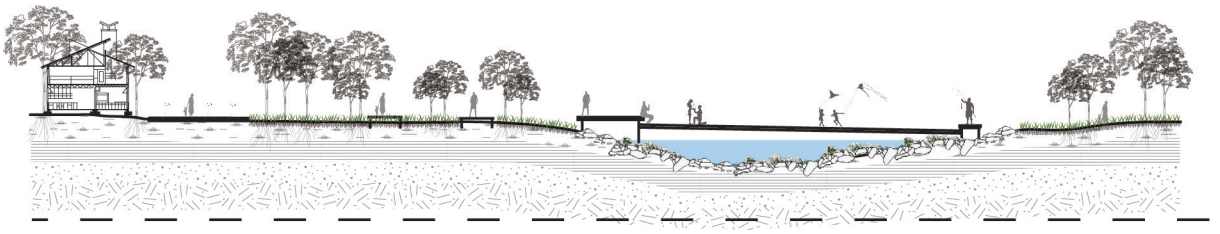


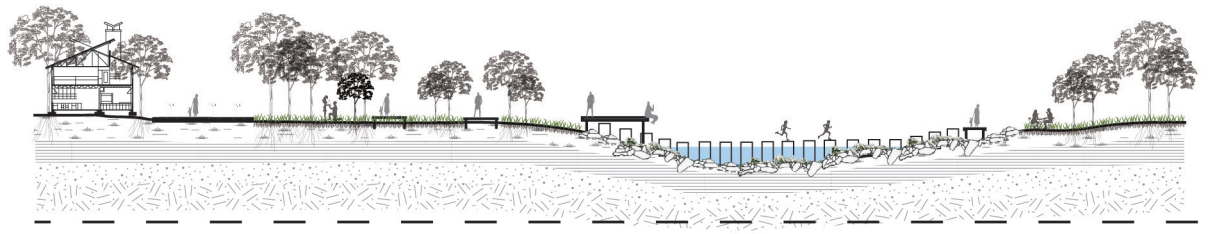


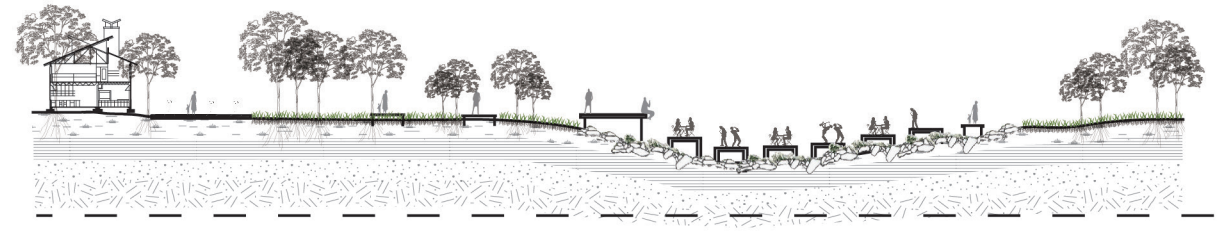

season dryland
Harricane time wetland
After Harricane time wetland
+2.1 m
±0 m
800
900
1000
1100

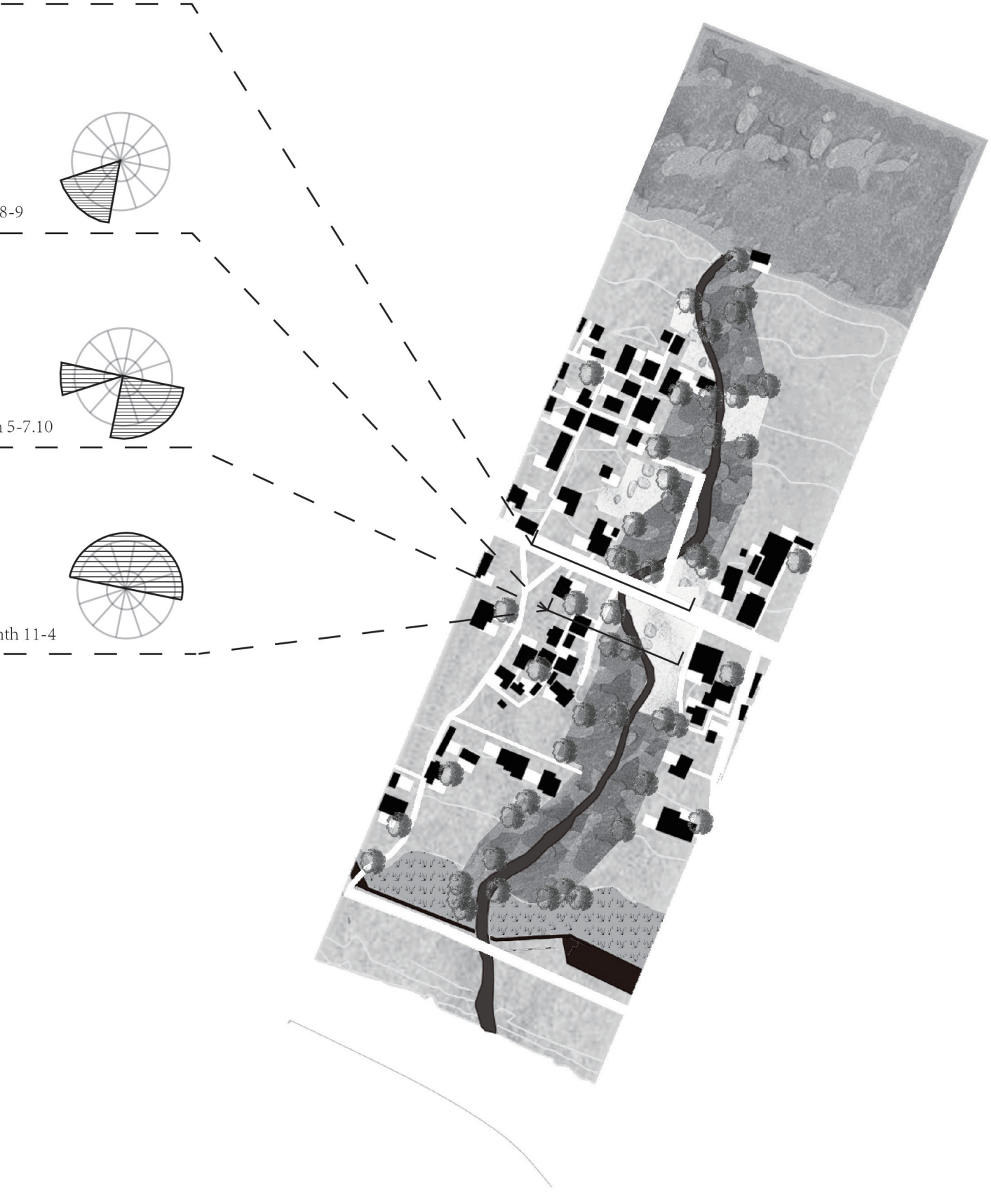
Activated drainage system









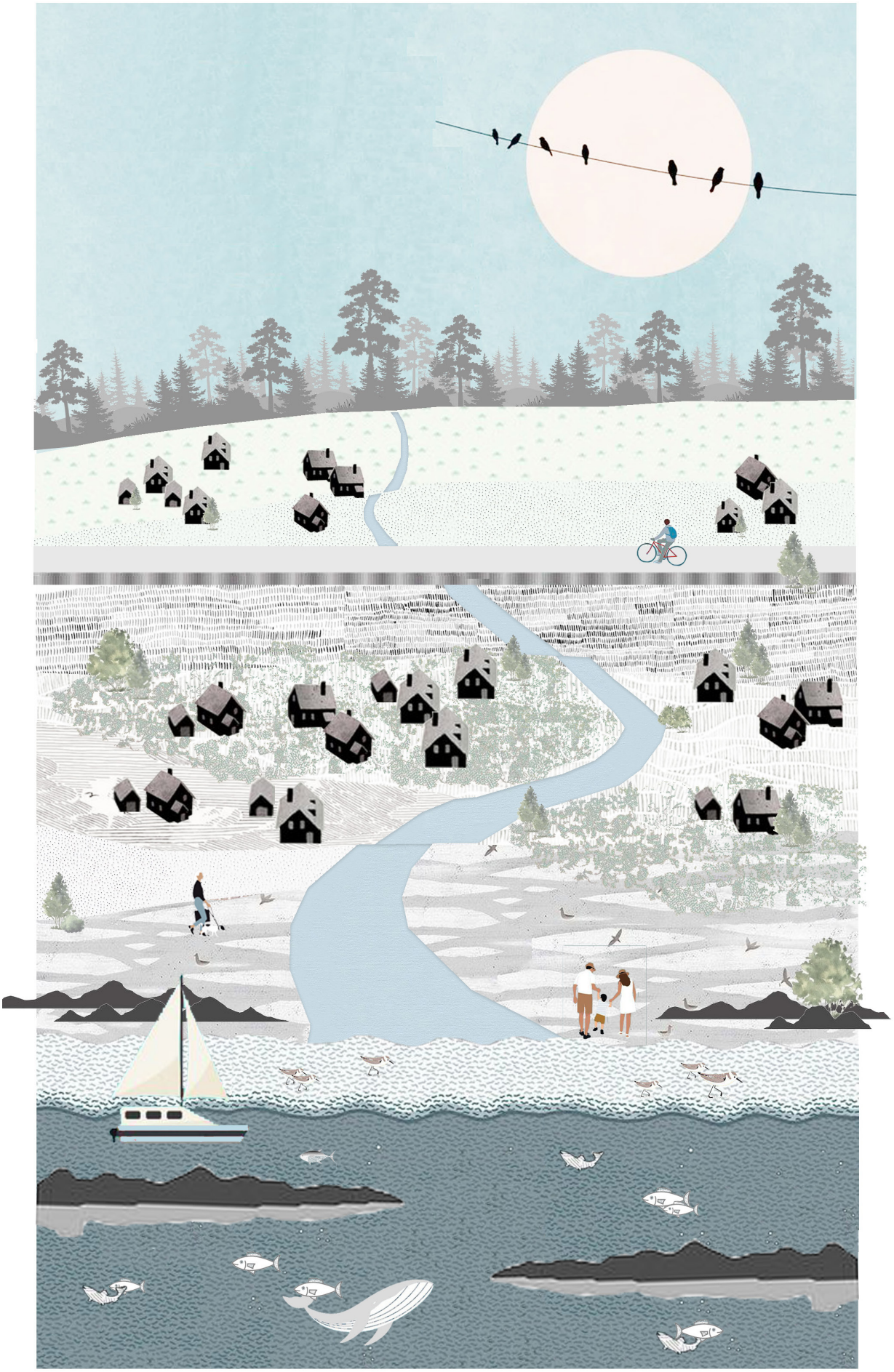

8-9
5-7.10
nth 11-4

Eco-life

Ecological life getting along with the eco-dikes and eco-drainage

Saline life

An eco-based new Bain town is coming in the near future. It seems that nothing changed, inhabitants still living in their own house with a large garden, the charming beach still waving and wetland still protecting the lives there.
It seems that something changed as well. Two lines of flood defense make the coastal zone strong and people safe. The drainage system and vernacular buildings make the town undisturbed during the storm period. Co-work with the eco-hills, the habitat along the drainage forms a greener and stable biocoenosis.
Along with the saline water, saline habitat, and saline building basement, a new eco-life is here in Bain Town.



6.6. New Traditional

Towards a new traditional eco-friendly and sustainable lifestyle

Ilse van Milaan



Wellington Street Dwelling

Melissa Maura's 1983 oil on canvas painting entitled Wellington Street Dwelling is a glimpse into an insider's experience of island life and landscape. Showing three small yellow clapboard houses clustered together in what could be the same yard.

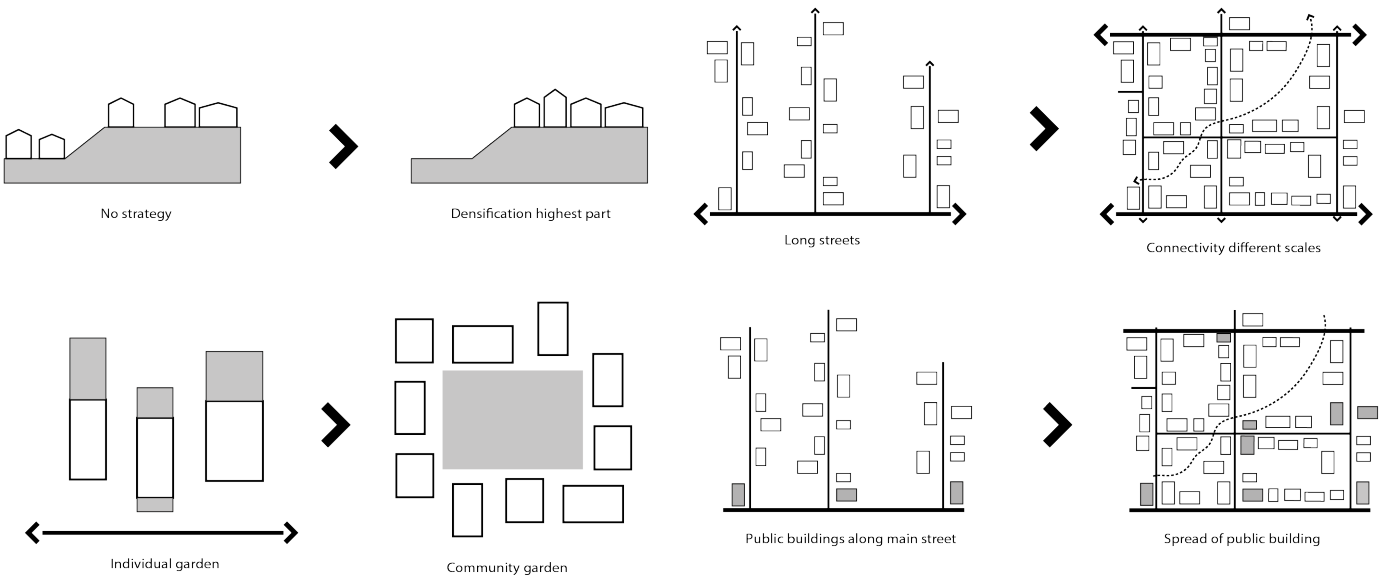
Manifesto

Big cars with associated infrastructure networks, supermarkets supplying food from all over the world and colossal modern houses. The American lifestyle gave the Bahamians the illusion they could work towards a good, rich and full life for everyone, with opportunities for each according to ability or achievement. With the current climate crisis, the American dream seems to burst.

In 2019 the category 5 hurricane Dorian left a devastating trace behind on the island of the Grand Bahamas. Shelters and homes were flooded an badly damaged, the storage of food, drinking water and other aid was decreasing rapidly and since the food, drinking water and other aid is all coming from abroad. The modern population is not able to adapt to these storms, not as the traditional population was.

Maura's Wellington Street Dwelling, 1983 painting is a scene typical of early Bahamian community on any Bahamian island. The landscape features three small yellow clapboard houses clustered together in what could be the same yard. The houses are elevated on concrete blocks and situated among breadfruit, banana and coconut trees. Clapboard houses, most popular during the 19th century, were built on stilts or masonry pilings and angled to promote airflow through the house. The clapboard construction with its raised floors served to keep floors cool in hot weather, safely above floodwaters during storms, and mobile when the time came to relocate. The push-out Bahama shutters over the windows also allow for shade, protection from rain and maximize ventilation.

This indigenous knowledge of the Bahamians is oppressed by the difficult challenges they face including globalisation, environmental pressures, marginalisation, racism, and economic and health inequity. While many indigenous groups have generated, maintained and applied a broad and deep knowledge base for disaster risk reduction. Even though indigenous knowledge has long supported their communities' capacities, indigenous peoples may be facing challenges outside of their knowledge and experience. Consequently, a combination of indigenous and external approaches could help disaster risk to engage communities reduction.


No strategy
Densification highest part
Long streets
Connectivity different scales
Individual garden
Community garden
Public buildings along main street
Spread of public building

Design experiment

Using traditional allotment and program to create strong communities supported by external approaches and scientific knowledge to create social resilience in Bain town.

Densification highest part

The sea level rise will be concerning for Bain Town who is susceptible to coastal flooding and rising sea levels because a large proportion of their population, infrastructure and assets are located in the coastal zone. By building the new settlements in higher areas thereby using more vernacular building technologies and traditional techniques, the housing will improve its adaptability to hazards. Using energy from rooftop solar panels and windmills to provide the new buildings with clean energy.

Connectivity street map

The community of Bain Town is nowadays mostly car driven with a long freeway crossing the Grand Bahama landscape. By creating cycling and walking paths the connectivity will switch from a regional to a more local scale and improve the community feeling of Bain Town. Thereby the developments will increase physical and visual access to the water's edge and near-shore waters for recreation, education, research, and stewardship activities.

Community garden

Creating large courtyards with exuberant greenery, which invites residents to go outside. This offers plenty of space for meeting, playing and relaxing and also promotes biodiversity in Bain town. Creating social networks to connect multiple levels and sources of information. Using the garden and developing urban farming area for local food production and thereby making urban farming part of the natural system.

Spread of public building

The public buildings can be used as for shops with goods from the courtyards, education centre and for research. Thereby providing programming that builds a community around education on self-sufficiency and ecosystem stewardship. They will offer education of awareness and methods dealing with hazards and instruction of public participation in recovery from hazards. All buildings with a public function will be hurricane-proof shelters as there is a lack of adequate protection.



Design Experiment

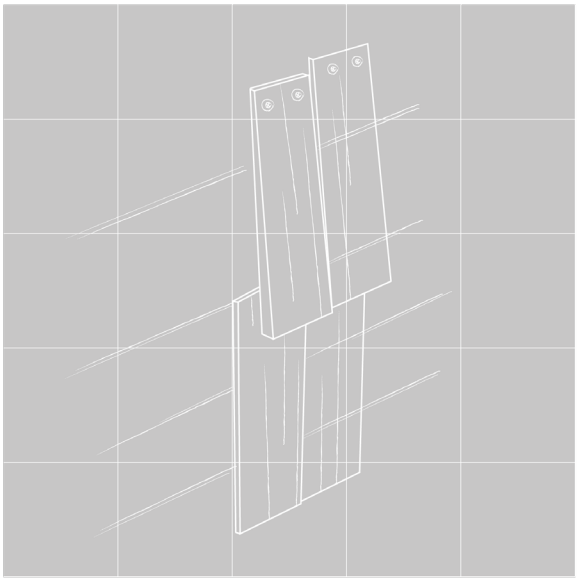
Showing the spatial plan with the densification, networked street, courtyards and public buildings

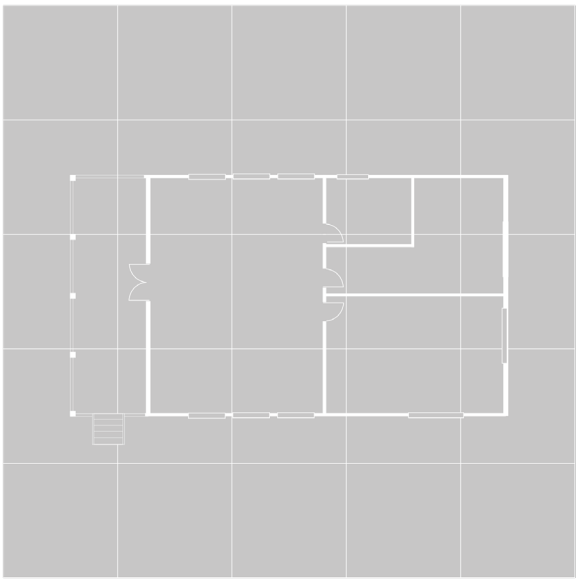
← → New street
Commercial
School
Churches
New housing

N

0 100 km



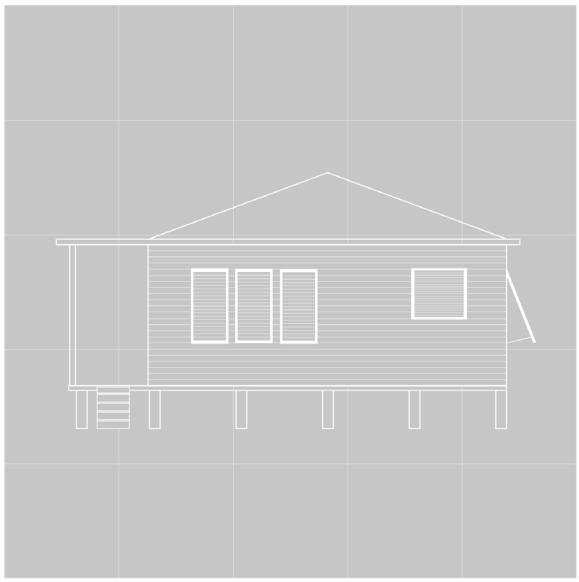


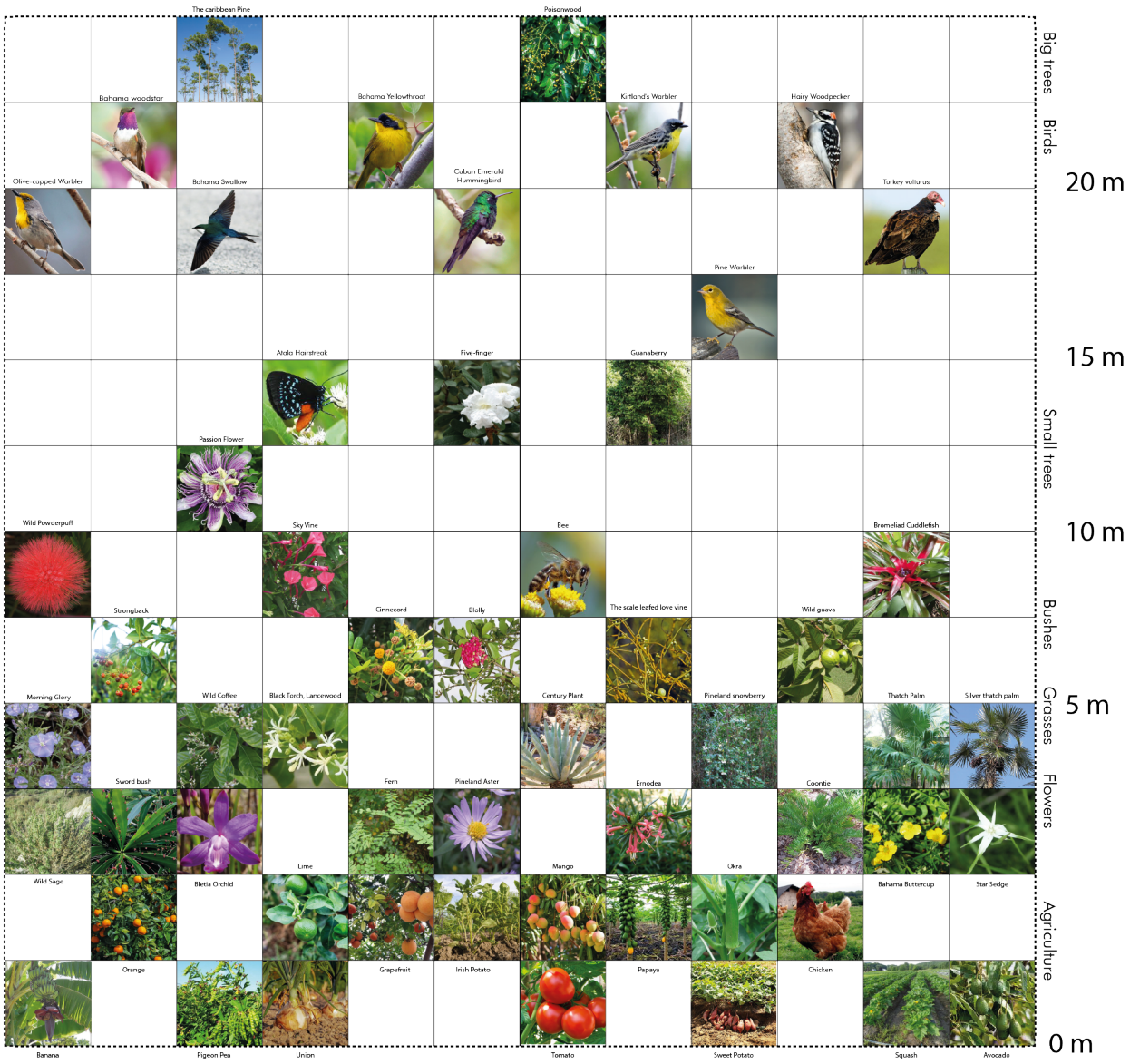


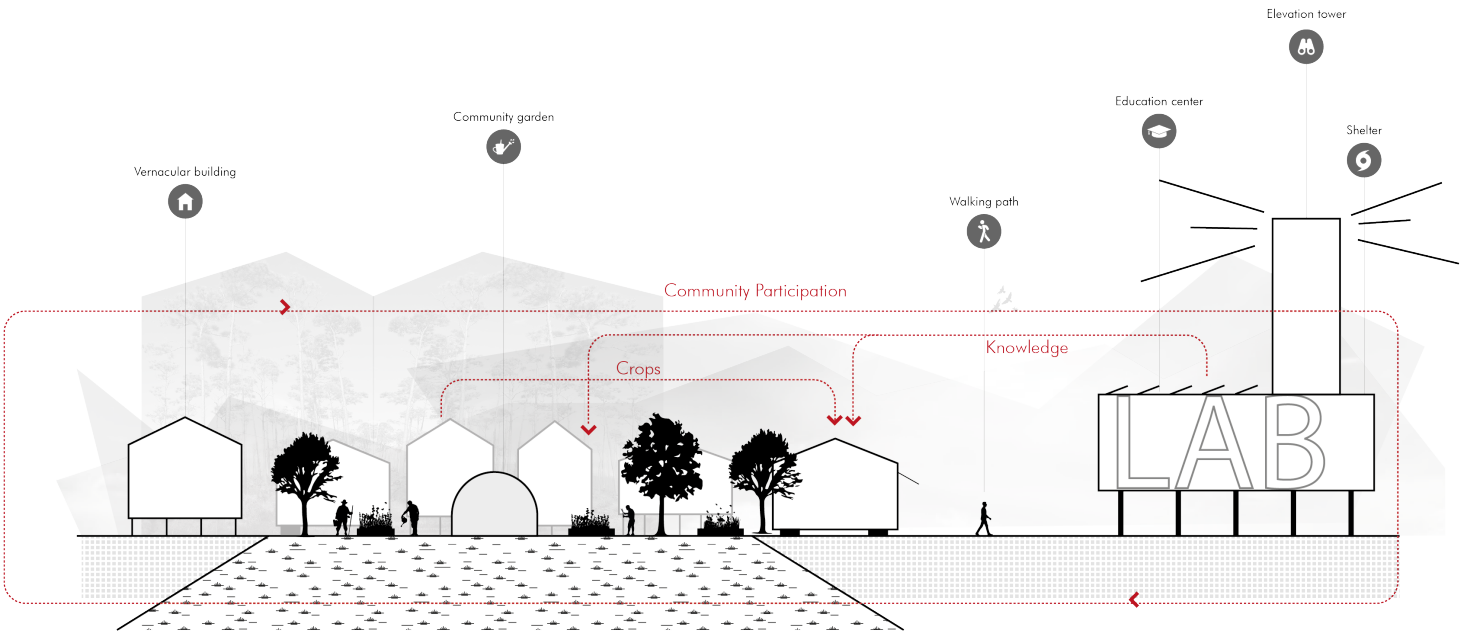
Courtyards

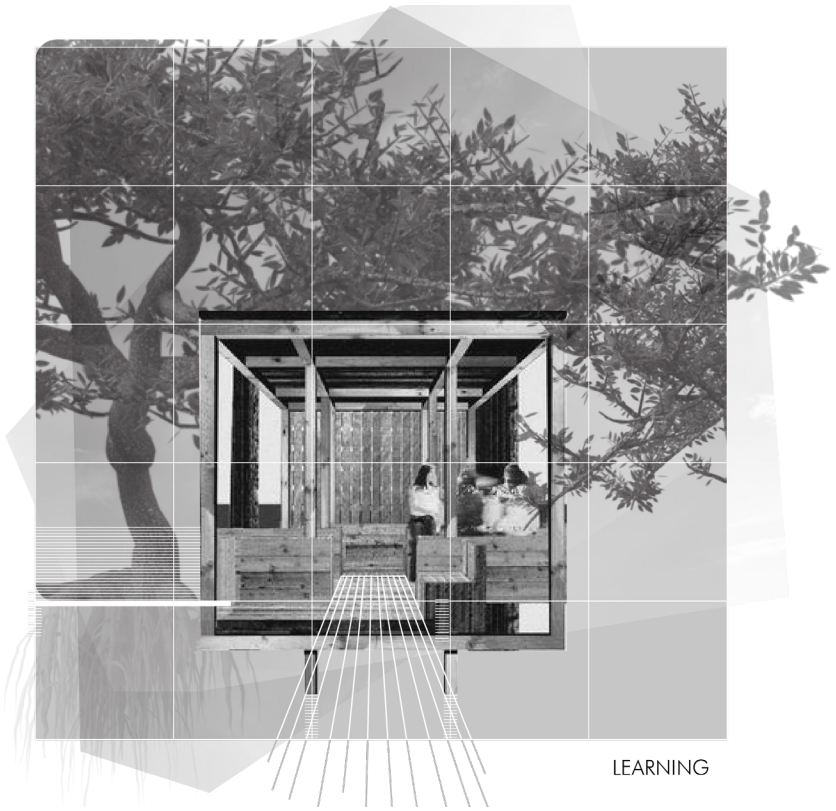
The courtyards invites residents to go outside and promoting self-sufficiency in Bain town. Using the garden for local food production and sustaining the endemic species of the island. The plants and trees of the pine forest are having a hard time with the storms and climate change. The community can help sustain the biodiversity hotspot of the Bahamas by protecting and planting them.

With knowledge from farmers and community members they can grow their own goods as grapefruits, okra, papaya and sweet potatoes. Invasive species are a big problem to endemic plants and trees in the Bahamas. To teach the community it can be useful to invite speakers knowledgeable on the invasive species issue to speak to garden clubs, schools and other community groups. Thereby organizing neighbourhood work groups to remove invasive plant species under the guidance of knowledgeable professionals can help the biodiversity.

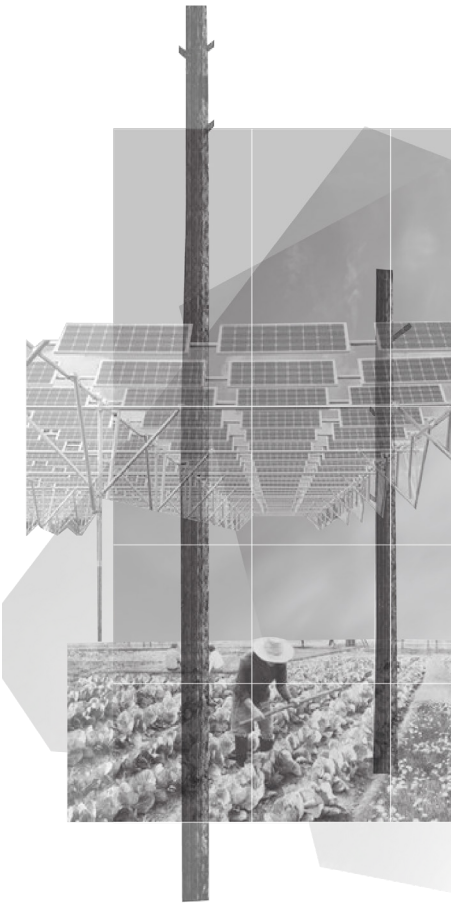


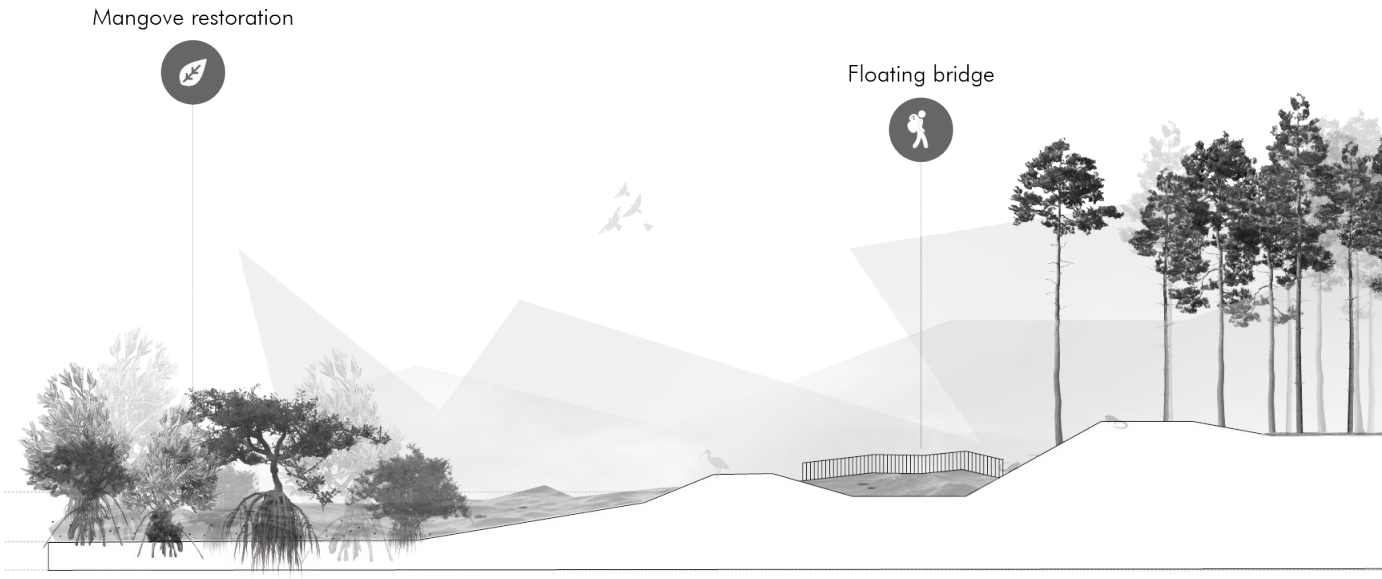

The caribbean Pine
Poisonwood
Bahama woodstar
Bahama Yellowthroat
Kirtland's Warbler
Hairy Woodpecker
Olive-capped Warbler
Bahama Swallow
Cuban Emerald Hummingbird
Turkey vulturus
Pine Warbler
Atala Hairstreak
Five-finger
Guanaberry
Passion Flower
Wild Powderpuff
Sky Vine
Bee
Bromeliad Cuddlefish
Strongback
Ginnecord
Blolly
The scale leafed love vine
Wild guava
Morning Glory
Wild Coffee
Black Torch, Lancewood
Century Plant
Pineland snowberry
Thatch Palm
Silver thatch palm
Sword bush
Fern
Pineland Aster
Ernodea
Coontie
Wild Sage
Lime
Mango
Okra
Bletia Orchid
Bahama Buttercup
Star Sedge
Orange
Grapefruit
Irish Potato
Papaya
Chicken
Banana
Pigeon Pea
Union
Tomato
Sweet Potato
Squash
Avocado
Big trees
Birds
Small trees
Bushes
Grasses
Flowers
Agriculture
20 m
15 m
10 m
5 m
0 m


Elevation tower
Education center
Shelter
Community garden
Vernacular building
Walking path
Community Participation
Knowledge
Crops
LAB



LEARNING



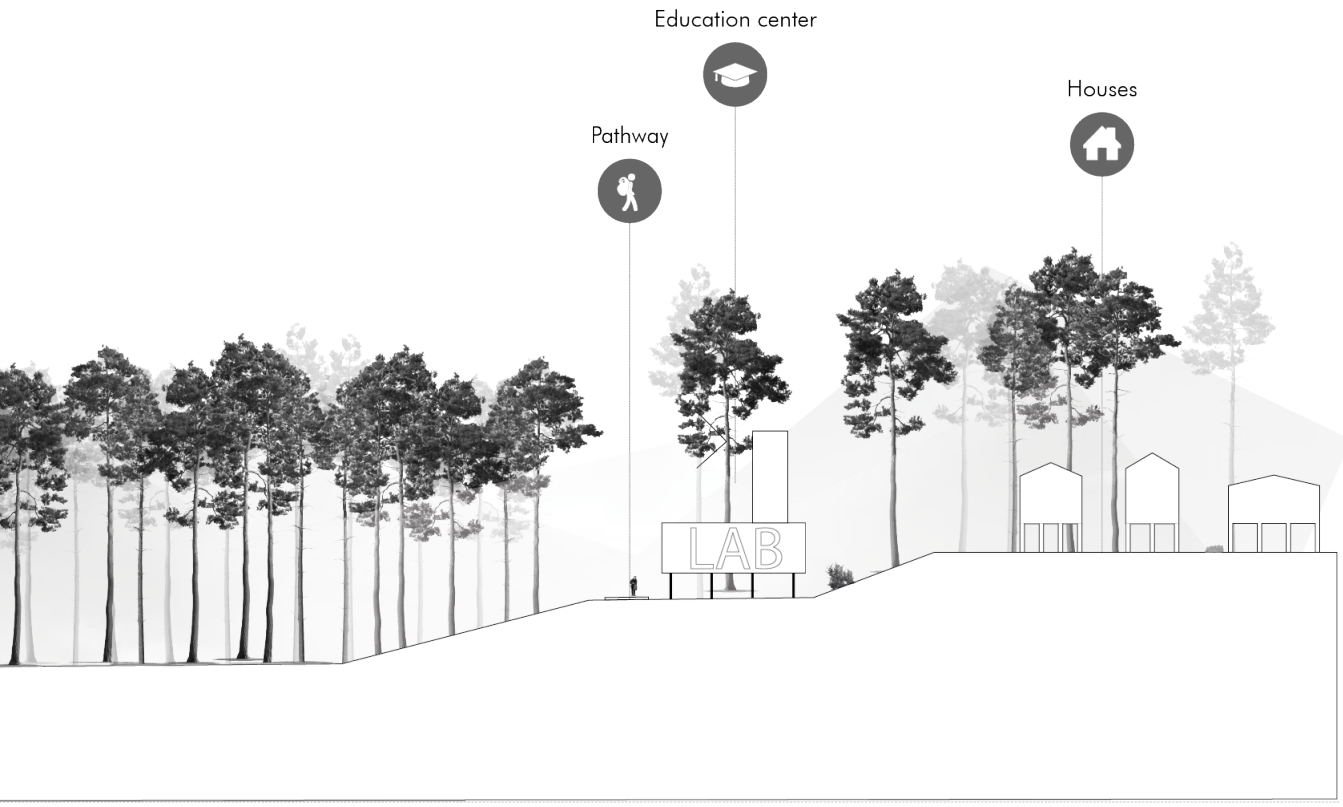


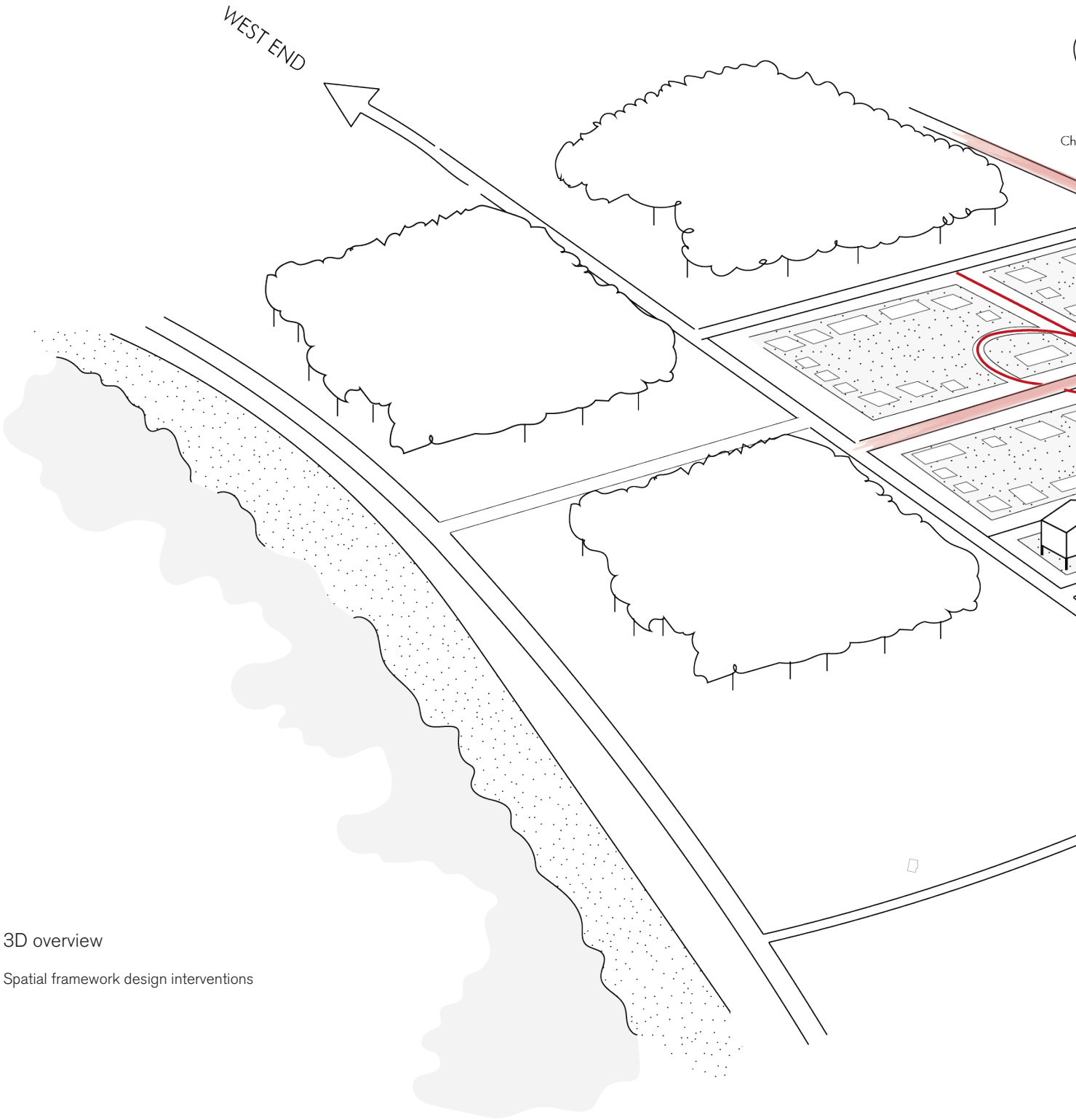


CREATING



LIVING

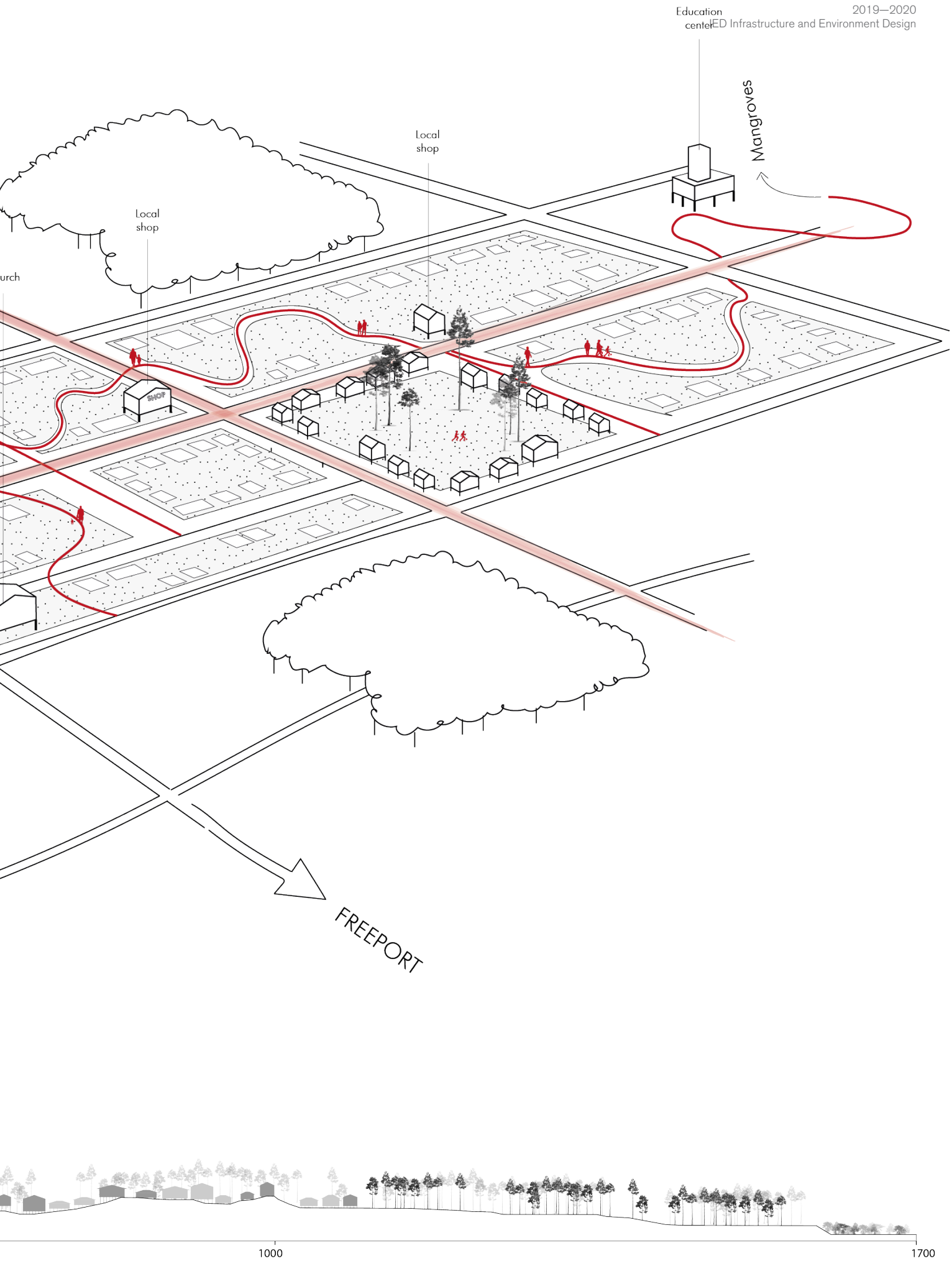




3D overview

Spatial framework design interventions




Education center
Mangroves
Local shop
Local shop
urch
SWOP
FREEPORT

1000
1700

6.7. Hurricane-proof Settlements Units

Li Yangzi

Manifesto

Towards a resilient tomorrow of Bain Town

Faced with hazards caused by hurricanes several times per decades, the Bahamas is suffering from damages from strong wind, heavy precipitation, the surge from the sea, and pluvial flooding. Bain Town, a small group of settlements in Freeport, probably have suffered more due to the rough unshaped relationship with nature, the relatively poor condition of the built environment, and lack of community participation in dealing with hurricane hazards. People living there are suffering, leaving their hometown, or staying with helplessness in danger.

To guarantee the well-being of residents in Bain town, a new, safe, resilient built environment with nature is needed! In the higher inland of Bain Town, a piece of promising land for the better natural environment, safer homes, and united communities with solidarity located.

A better nature system

The relationship between nature and habitats will be rebuilt into a status in which they support each other. It is not only about bringing nature back and using nature to protect settlements from hazards, but also, more importantly, it is about supporting and maintaining the natural environment. In this way, the stewardship of a better nature system will appear in Bain Town, making a resilient natural environment for the habitat.

A safer urban environment

As a necessity in the condition living with hurricanes, the safety of habitats has to be ensured. Vernacular wisdom and modern technologies will be brought together in the building of new settlements and future urban development in Bain Town. Nature-based solutions, traditional building technologies, modern facilities, and necessary infrastructures will be used to foster safer homes and life, to build strong and resilient urban environments.

A group of united communities

The bright vision cannot be realized only by individuals and public organizations, but can be achieved with unity and solidarity. Social power is significantly important to help each one of residents in Bain Town to be better prepared before disasters, to have a safer life during disasters and to help habitats recover fast after disasters.

Supporting nature, bringing back vernacular wisdom, everyone united together, Bain Town, although with a less developed urban environment, will become a new paradigm for a safer life with hurricane hazards.

Conceptualizing the Model

As the diagram shows, the location of experiment is in the higher area in the inland of Bain Town. Based on the principles included, schemes are made for what will be explored in this experiment. In each scheme, certain aspects are focused to make sure the experiment keep selective on variables. In the end, this experiment will try to work out a new urban development model in Bain Town, to deal with hurricane hazards.

The collage shows what will happen on the day after certain hurricane in Bain town. Settlemts with shelters are stable through the hurricane, and the natural environment is enjoyable with paths. Pluvial green networks function well during and after the hurricane time, evacuating the rest storm water out, forming a special plvial landscape in Bain Town.

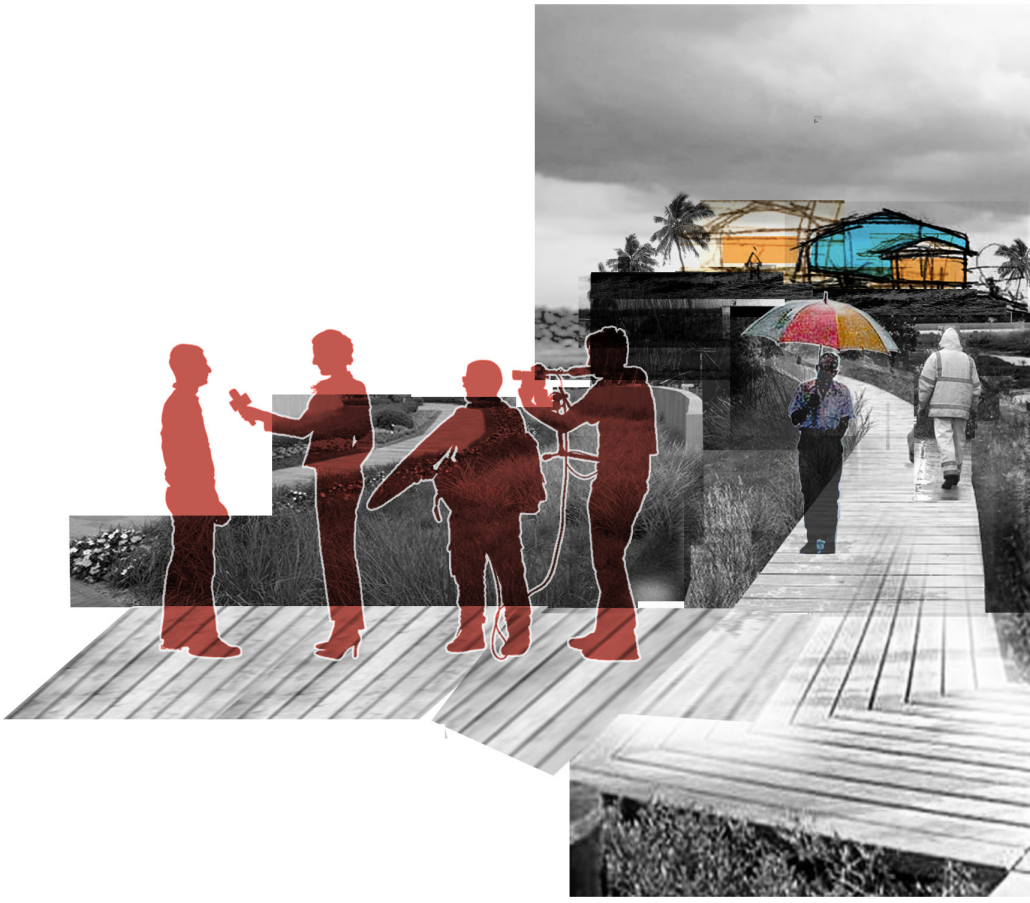




Figure. 2. the Collage of the Units

Model of Hurricane-proof Settlements Units

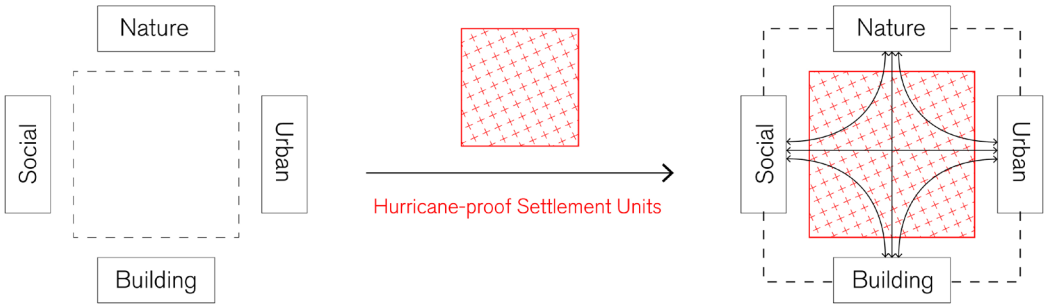


Figure. 3. the Conceptual Diagram of the Unit Model

Unit Division & Experiment Location



U01 Unit Number
Experiment Units
the Rest of Units
Planned Road Networks
Public & Commercial Buildings
Residential Buildings
Existing Roads
Above 4m
3-4m
2-3m
1-2m
0-1m
=<0m

Figure. 4. the Unit Division & Experiment Location of the Unit Model

Design experiment

- A Hurricane-proof Settlement Unit Model

This experiment will try to integrate some key guidelines about dealing with hurricane hazards, and explore the possibility of reconfiguring urban environment of Bain Town in a new way. Specifically, a new settlement unit model with better hurricane-dealing capacity will be explored. As the location shows, the relatively higher area for new urban development in the vision will be divided into 17 units, with each around 250* 250m. The experiment will be carried out in unit 01 and unit 02.

An Integrated unit model

This model will integrate elements in natural and urban environments, as well as consideration in the building level and the social aspect. The natural environment in this unit model will participate more and deeper in hurricane-dealing process, instead of just existing wildly or around houses as grassland. The urban environment will be more structured with public services, open spaces, and hurricane-dealing facilities including shelters and flexible public buildings. Vernacular technologies will be used in buildings to improve the adaptive ability to the climate and hurricane hazards (Pinder, 2017). This unit also can help establish communities and integrate social power into hurricane-dealing activities by organizing residents in maintaining the hurricane-dealing facilities and supporting the natural environment in each unit. All of the four systems will work together and support each other in this unit model. Also, the general overall plan for the whole area and the way units cooperated both with larger spatial networks and between each other will be introduced.

A dynamic unit model

This experiment will focus on introducing the unit prototype 01 and test the hurricane-dealing performance in four typical scenarios. However, to make this idea feasible in further exploration, an implementation plan including phasing and corresponding working system will also be introduced. This will help to make the unit model be upgraded based on feedbacks in use and research involving several groups of “actors“, instead of staying in prototype level without improvement.

The Densification Area in Bain Town

Composition of the Model Prototype 01

Hurricane-dealing Organization Center
Skills and Knowledge Sharing Center
Settlement Recovering Workshops
Shelters



Figure. 5. the Community Participation (Habtamu, 2010)

Road Networks
Buildings
Public Spaces



Figure. 6. the Referential Building Form (Miami MLS, n.d.)

Natural Networks
Pluvial Green Networks
Open Green Spaces



Figure. 7. the Pluvial Green Area (Brenner, 2018)

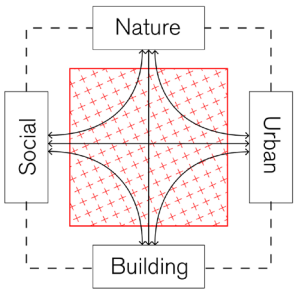
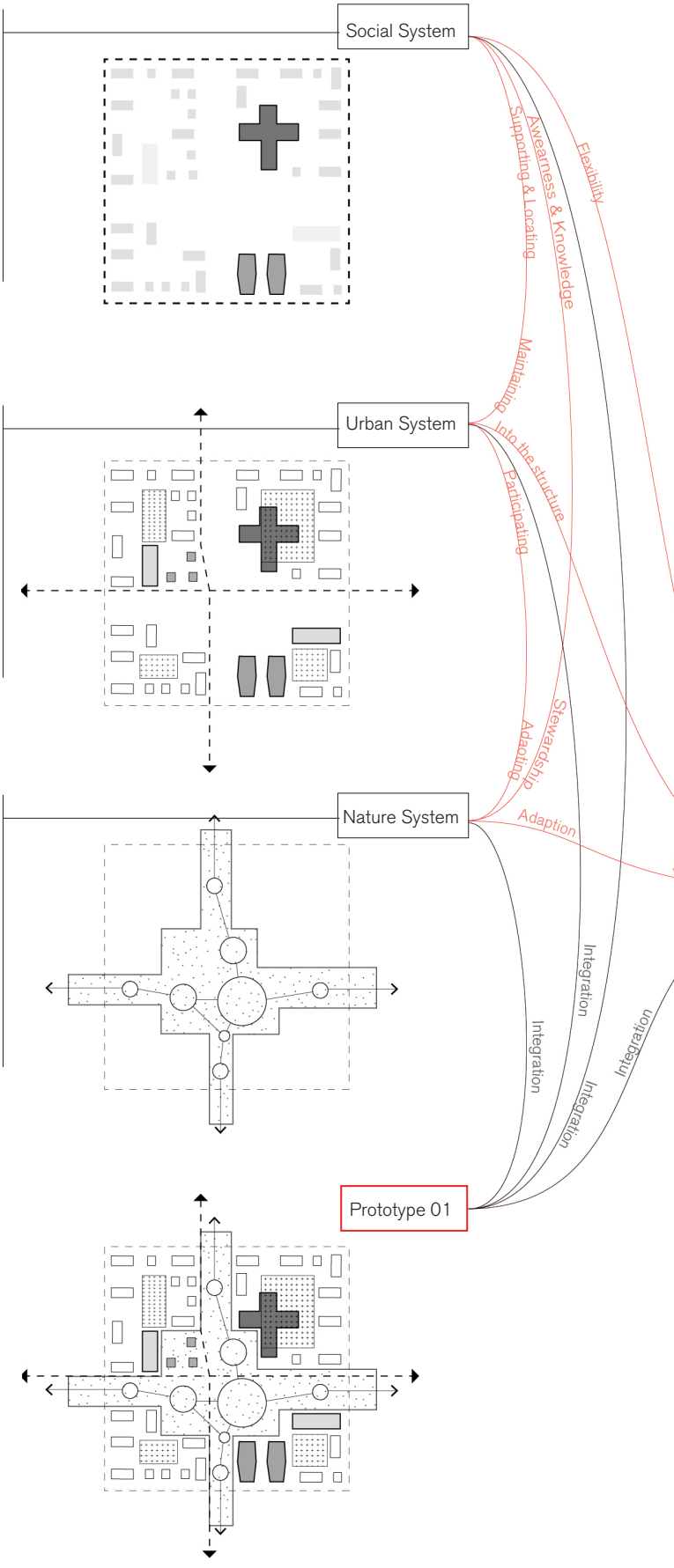


Figure. 9. the Integration of the Model



Prototype 01

According to the concept model, the prototype 01 include 4 main parts: the nature system, the urban system, the social system and the building typology. Each of these systems include some key elements as the diagram shows.

With one system supported by others as the diagram shows, all of the key elements in each system are integrated in the model prototype 01(fig. 5 - 9, fig. 12).

As the concept masterplan shows, in unit 01 and 02, the prototype 01 was implemented according to the specific conditions, forming their unique charactoristics both inside and in connction with the lager context.

This implementation of prototype 01 will be tested in 4 scenarios to show how it works in dealing with hurricanes. Perspectives of people's activities, stewardship of the natural environment, flexibility of buildings, and performance of hurricane-dealing facilities will be included.

- ○ Pluvial Swamp
- □ Green Area
- ⊞ Public Space
- Road Networks
- Open Tunnel
- □ Above 4m
- 3-4m
- 2-3m
- 1-2m
- 0-1m

Implementation Results of Prototype 01

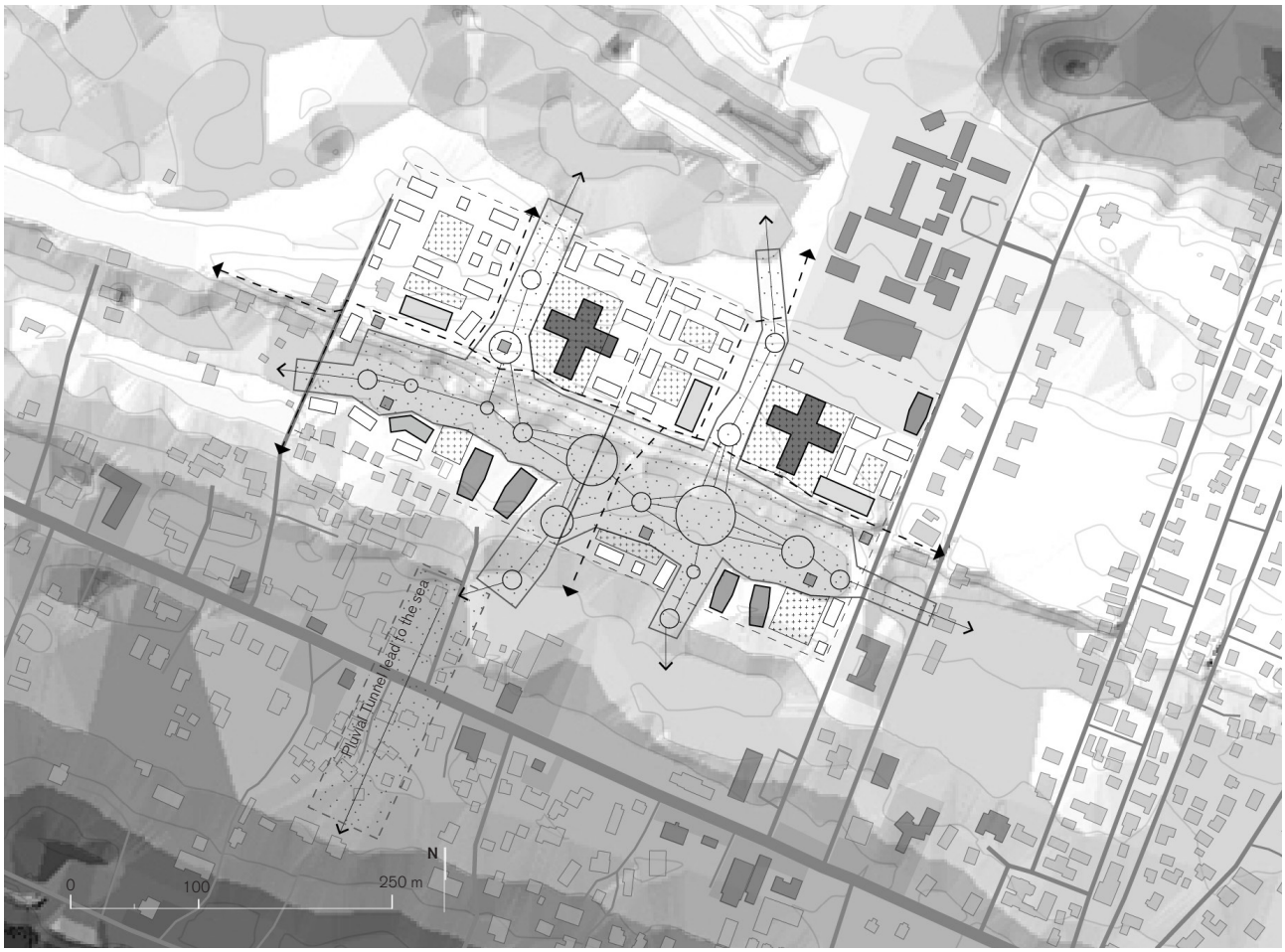


Figure. 10. Implementation Results of Prototype 01

Organizing the use
Framing
Shapping

Building Typology

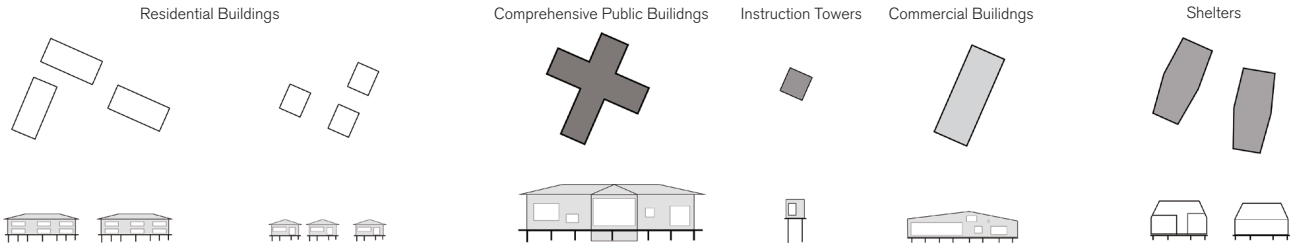


Figure. 11. Conceptual Building Prototypes

Vernacular building technologies

Posts and Piers



- The base for buildings built on
- Lifting groundfloor
- Cooling by creating air circulation
- Avoiding rainwater flooding

Windows with Shutters



- Creating shading
- Directing breeze indoors
- Receiving trade winds
- Protecting windows from storms

Pitched or Hipped Roofs



- Creating better thermal insulation
- Stable for withsatnding strong rain and wind

Louvered Doors



- Creating shading
- Directing breeze indoors
- Receiving trade winds
- Protecting doors from storms

Porches



- Creating shading
- Receiving trade winds
- Encouraging stronger airflow for ventilation and cooling

Figure. 12. The typical vernacular building technologies (Greg, n.d.; Janus Research, n.d.; McIntyre, n.d.; The Dunmore, 2020; Tim Tucker LRPS, n.d.)

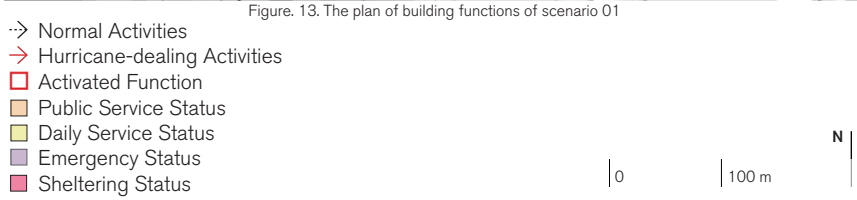
Scenario 01 - Normal times

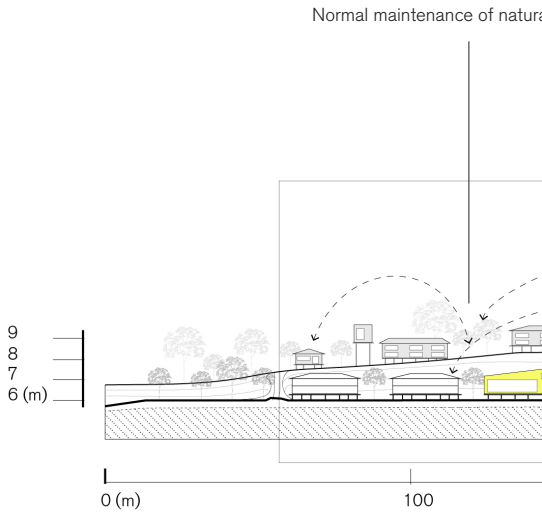
During normal times in the units, life would be very normal but more interesting than before.

WIth more sufficient public spaces and facilities, daily activities would be more interesting than before. However, there would also be normal maintenance to not only make sure the natural environment is in good condition but also keep the pluvial green networks function properly. With a more properly structured relationship between settlements and nature, the former wild natural environments would be introduced into the urban landscape in the units rather than just exist. The shelters would function as public buildings and warehouses during this time, and the comprehensive public buildings would also be knowledge-sharing centers teaching people how to deal with hurricanes and skills including swimming. Small towers would function as sightseeing spots for residents and tourists to enjoy the view of Freeport.



Figure. 13. The plan of building functions of scenario 01





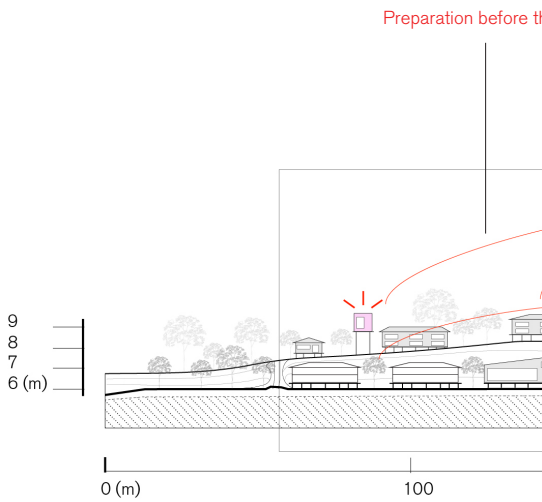
Scenario 02 - Before the Hurricane

Before the hurricane, life would be a little intensive to be well prepared but still in good order.

People would go back and forth from homes and shops to shelters, to store the daily goods and necessities in the most dangerous days. Also, urgent strengthening and maintenance would be practiced to finally make sure all the hurricane-dealing facilities including open tunnels and pluvial green networks work well. Shelters including some parts of the comprehensive public buildings would be prepared into emergent conditions for a larger capacity of sheltering, the comprehensive public buildings would become hurricane-dealing organization centers, to organize the whole preparation in the unit together with the instruction towers.



Figure. 15. The plan of building functions of scenario 02



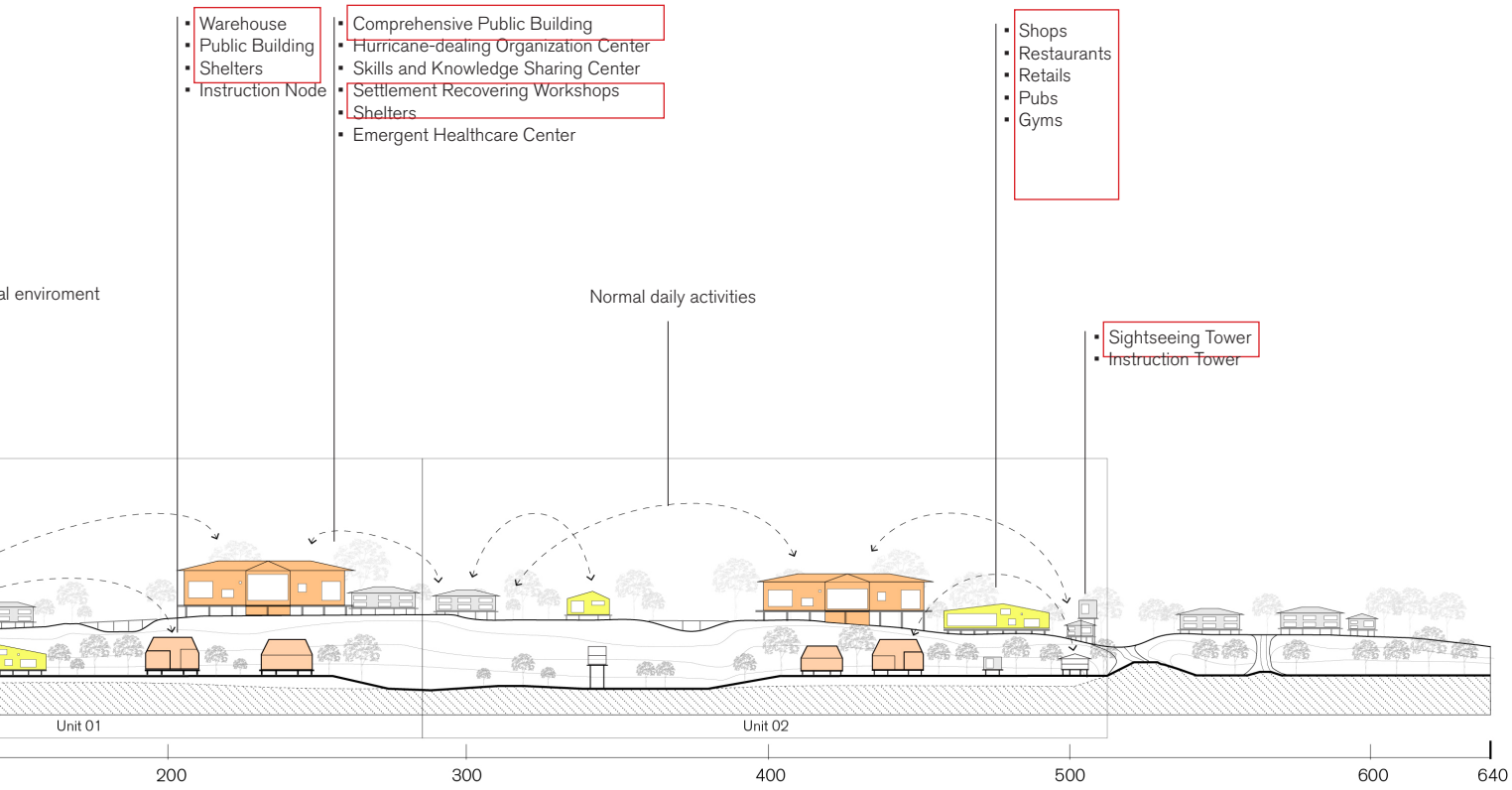


Figure. 14. The section of scenario 01

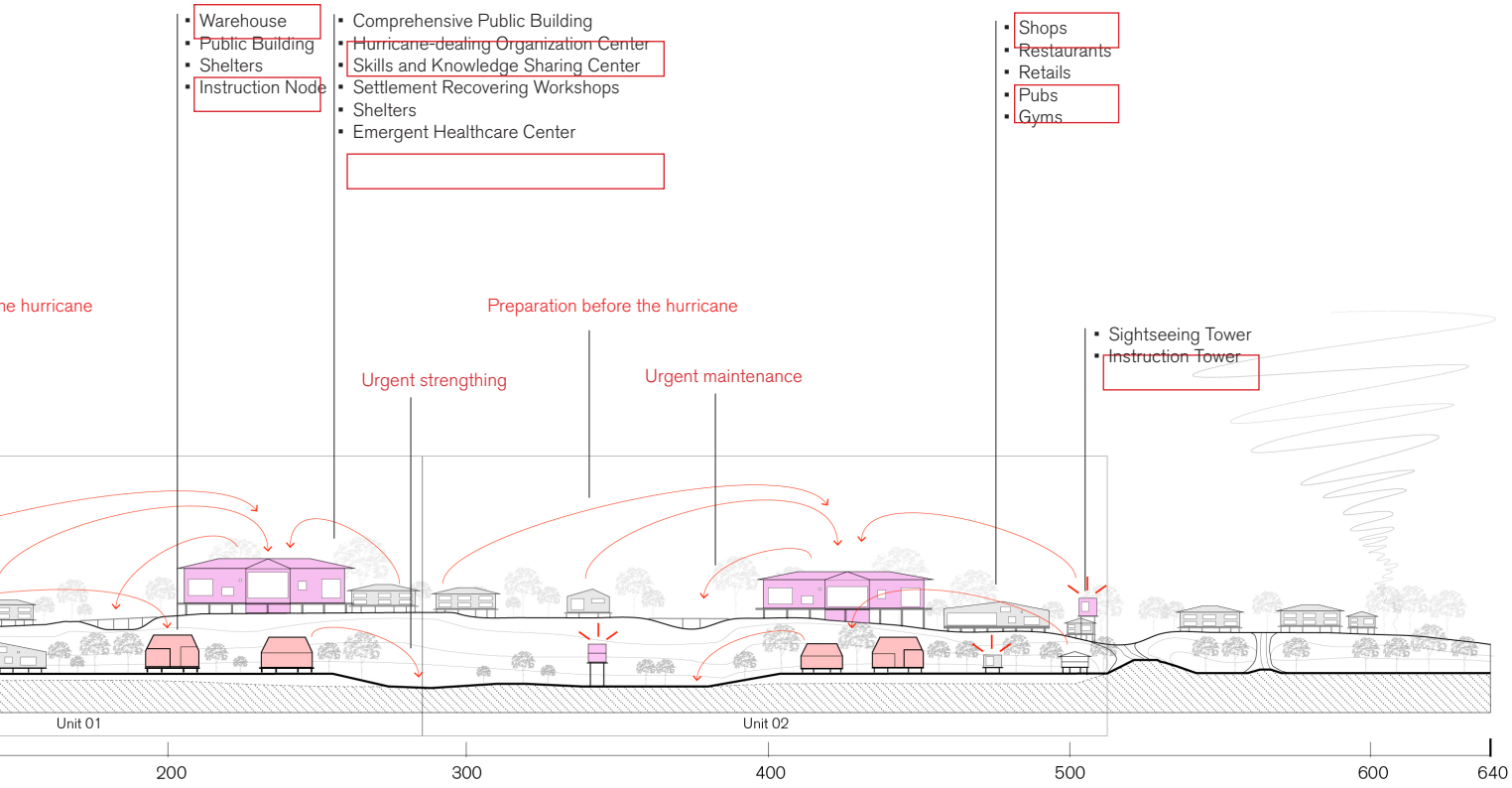


Figure. 16. The section of scenario 02

Scenario 03 - During the Hurricane

During the hurricane, life would be quiet in units but safe, which is the most important thing.

Basically, there would be no human activities outside. People would stay inside the shelters and the comprehensive public buildings, and also probably in some houses which have really good re-inforcement according to the building code. The pluvial green networks would take and evacuate the pluvial flooding water, to make sure there would be as less water storage as possible in house areas. Apart from the hurricane-dealing organization center, the comprehensive public buildings would function also as the emergent healthcare center, to deal with injuries, and take care of the ill people who would stay and rest in their homes in normal times.

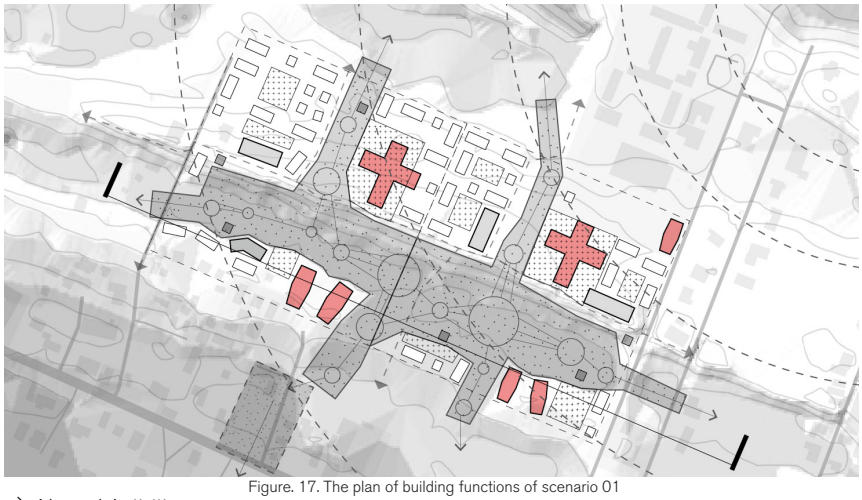
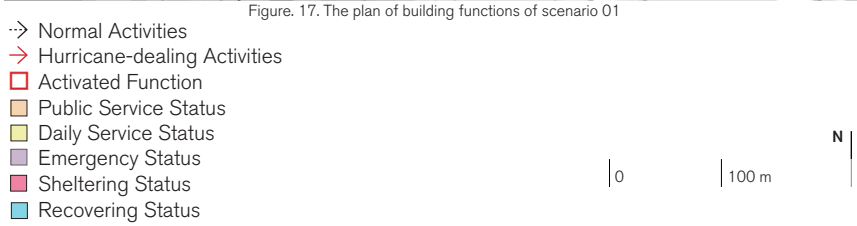
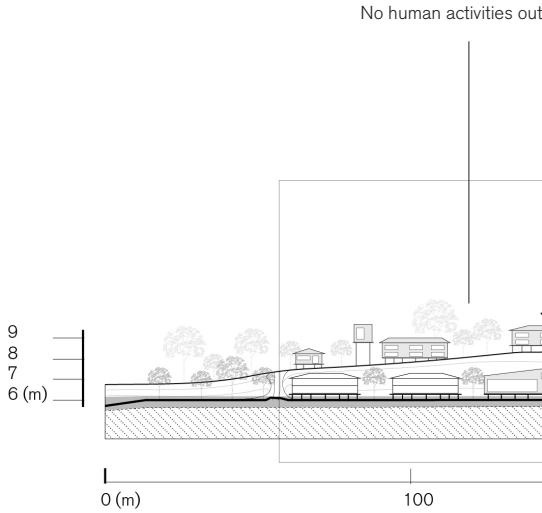


Figure. 17. The plan of building functions of scenario 01





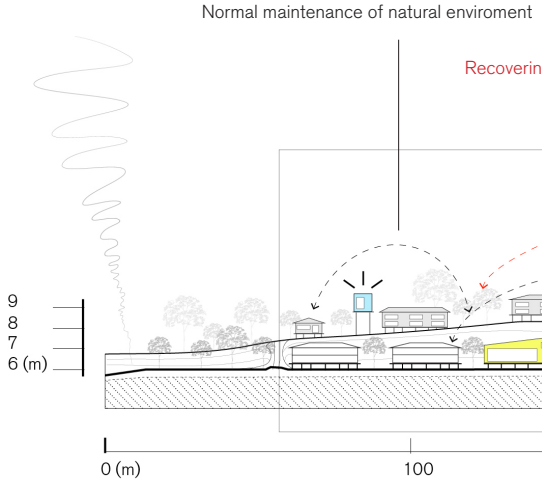
Scenario 04 - After the Hurricane

After the hurricane, life would go back to normal basically but with the work of recovering.

Daily life would be back. However, people in each unit would be organized into the activities of examining the damage, recovering, strengthening, and maintenance of hurricane-dealing facilities, including shelters, pluvial networks, open tunnels. Damage of houses would also be examined and reported also, for repairing and reinforcement. The recovering and maintenance of the natural environment would also be practiced according to each unit's responsibility. All these activities would be organized by comprehensive public buildings with s series of functions in the recovering time together with the instruction towers. For example, experts would come for workshops for feedbacks and upgrading of the units. Shelters would also function as instruction nodes apart from being used for temporary homes for people whose homes have been damaged.



Figure. 19. The plan of building functions of scenario 02



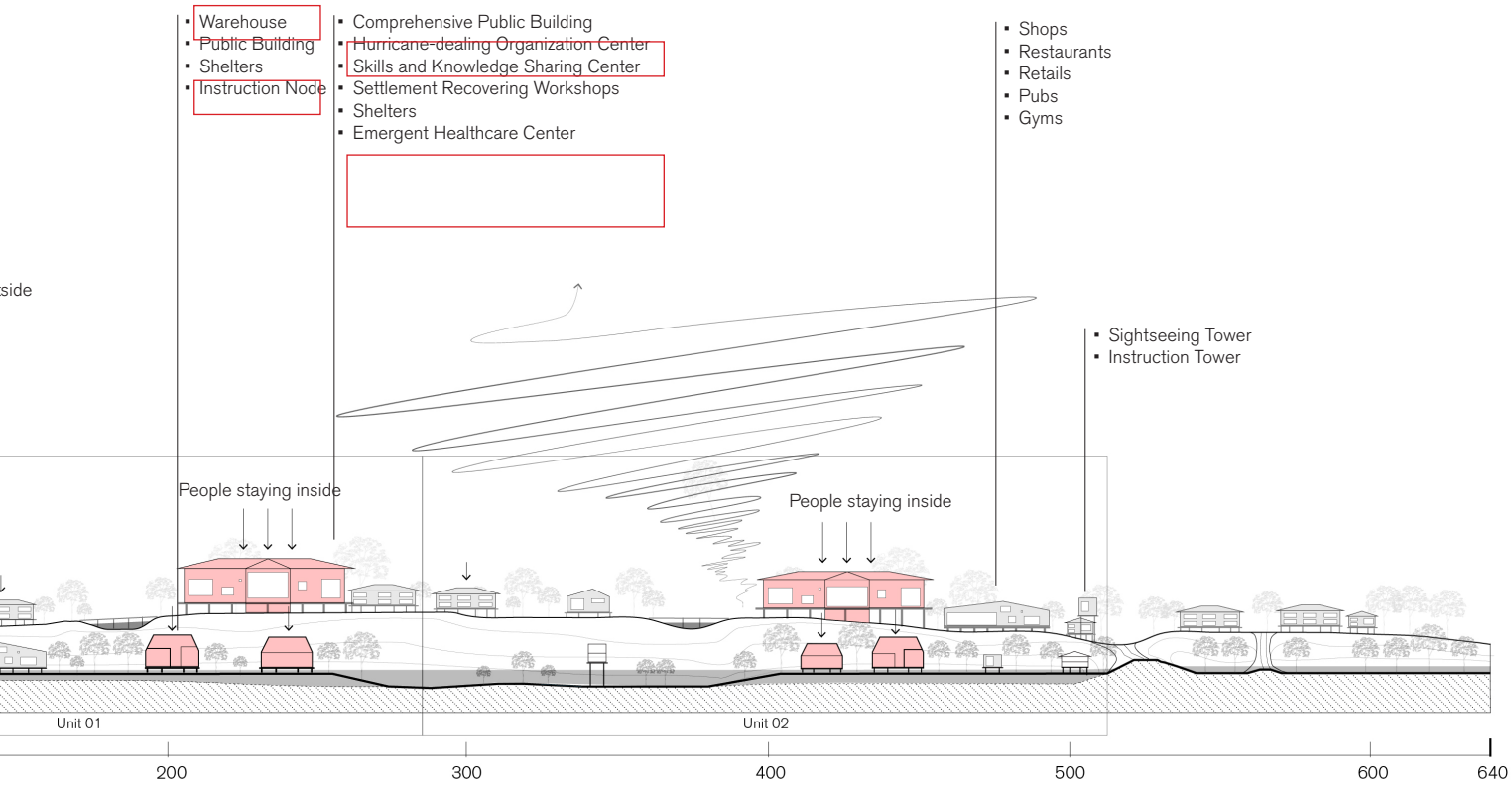


Figure. 18. The section of scenario 01

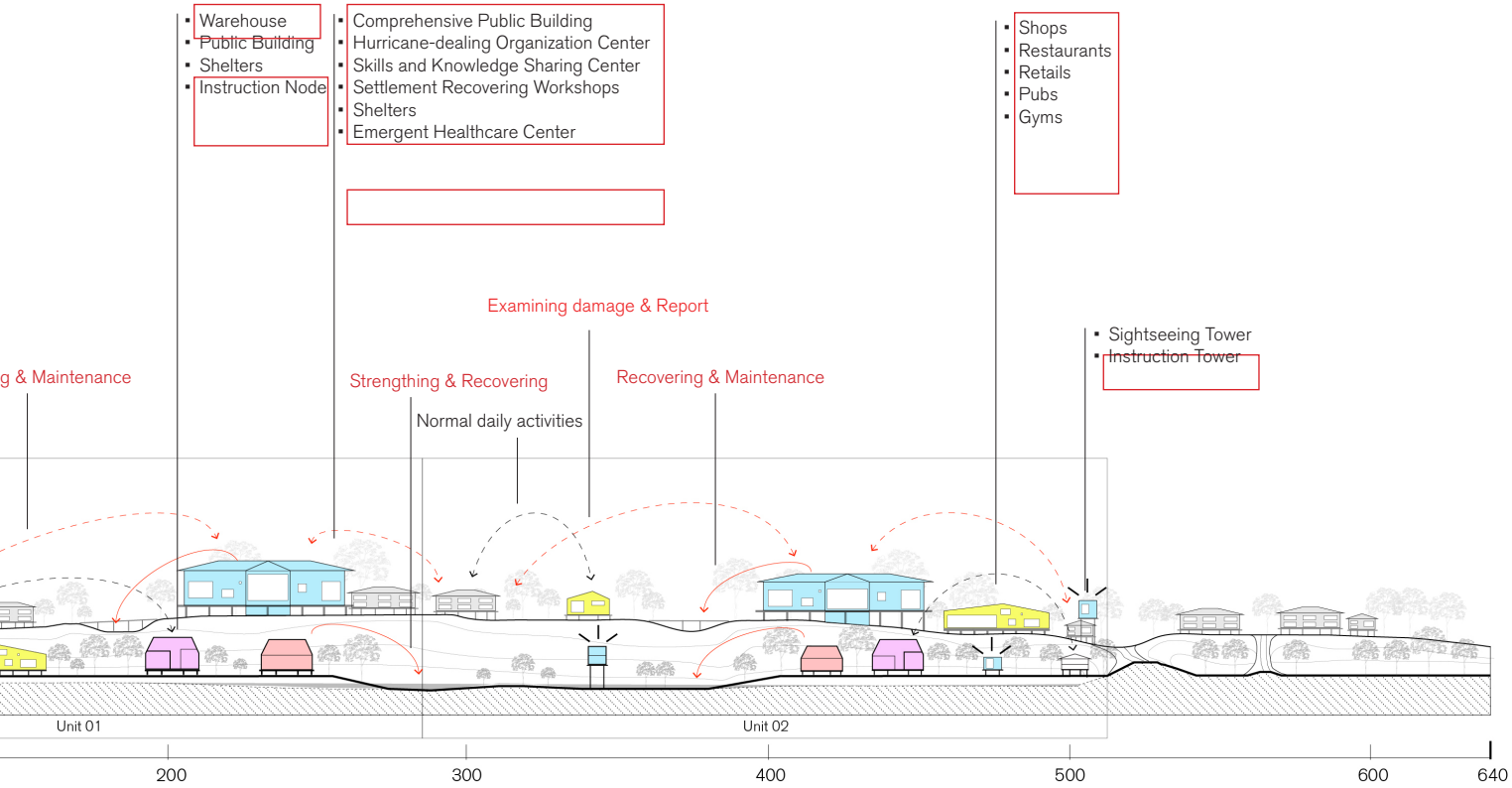


Figure. 20. The section of scenario 02

Implementation Plan

This implementation plan includes two parts. The first part is about general guidelines for implementation of the prototype 01. The second part is about the implementation practice of the upgraded unit model.

Part 1

Firstly, a rough overall plan was carried out showing how pluvial green networks, road networks, and public services and spaces would be connected in the overall level. Based on this plan, each unit implementation would figure out the way to connect with the larger spatial structure according to the specific urban environment, including the elevation, location of built areas, and the structure of existing buildings.

Secondly, for connections between units, the pluvial green networks will join together in lower areas for the best capacity of taking pluvial flooding in hurricane times, and the road networks will be connected in higher areas, integrating the settlements together.

Thirdly, a phasing plan for implementation was made. After the experiments of U01 and U02, the second phase will include those units with lest existing buildings. This will make sure people living in houses to be demolished have places to settle down. Then, phase 3 is for the next steps. Finally, phase 4 is for the units having most existing buildings and urban functions.

Part 2

To make the unit model feasible, more experts are involved, responsible for different scopes, as the graph illustrated. With cooperation between experts, the public, the government, and construction companies, the construction plan for each unit would be carried out. Also, the construction activities will be participated by residents in each unit.

After each hurricane, there would be a recovering session participated by all groups to help recover the existing units. Feedbacks would be given by each perspective, and this will help to upgrade the model, forming the next generation of the prototype, which will perform better in the next hurricane. With this dynamic process, as the dashboard illustrated, the capacity for dealing with hurricanes of both the unit model and implemented ones will be improved. Finally, the resilience of the whole settlements in hurricane hazards will reach a very high level, leading to a stable and safe habitat in Bain Town.

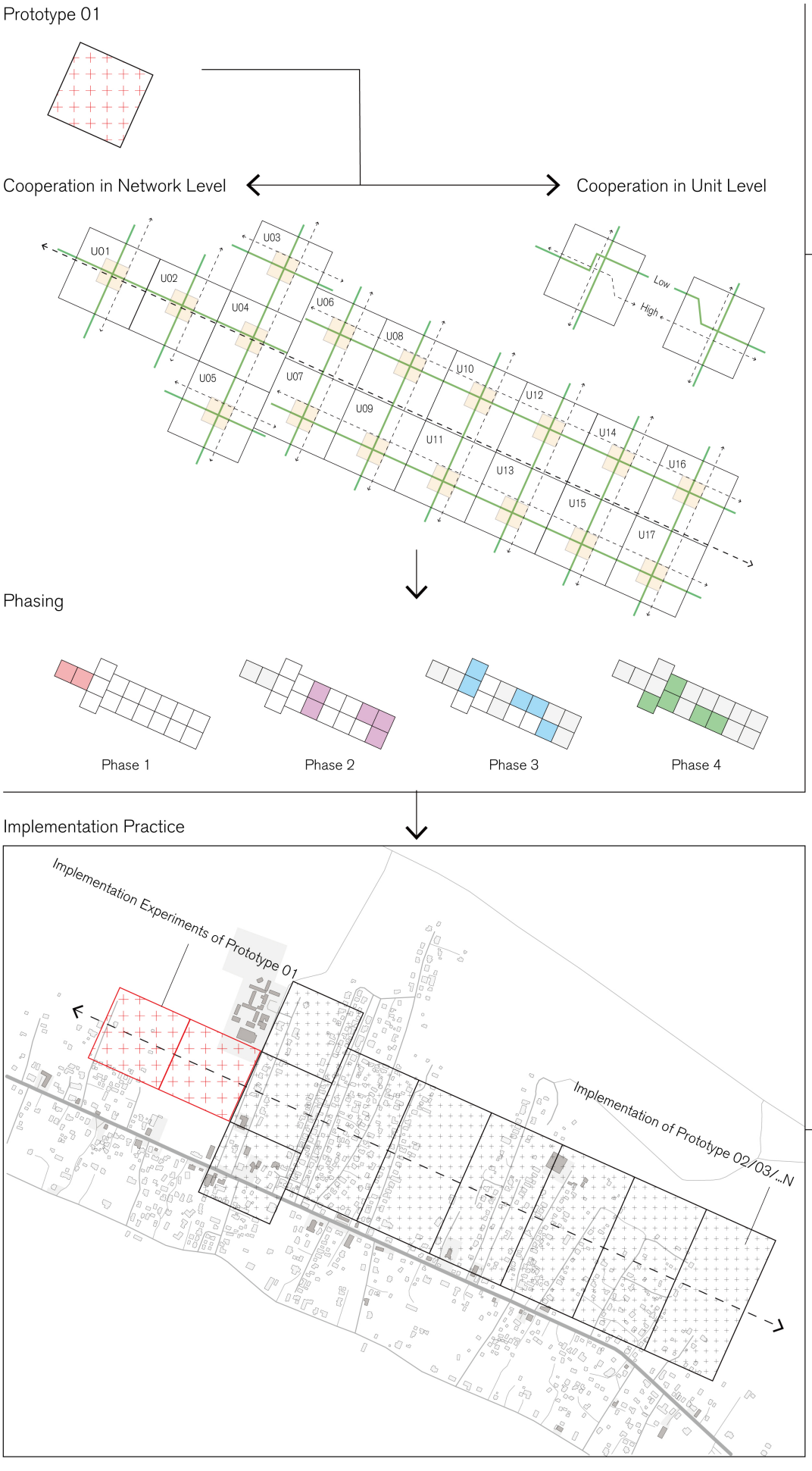
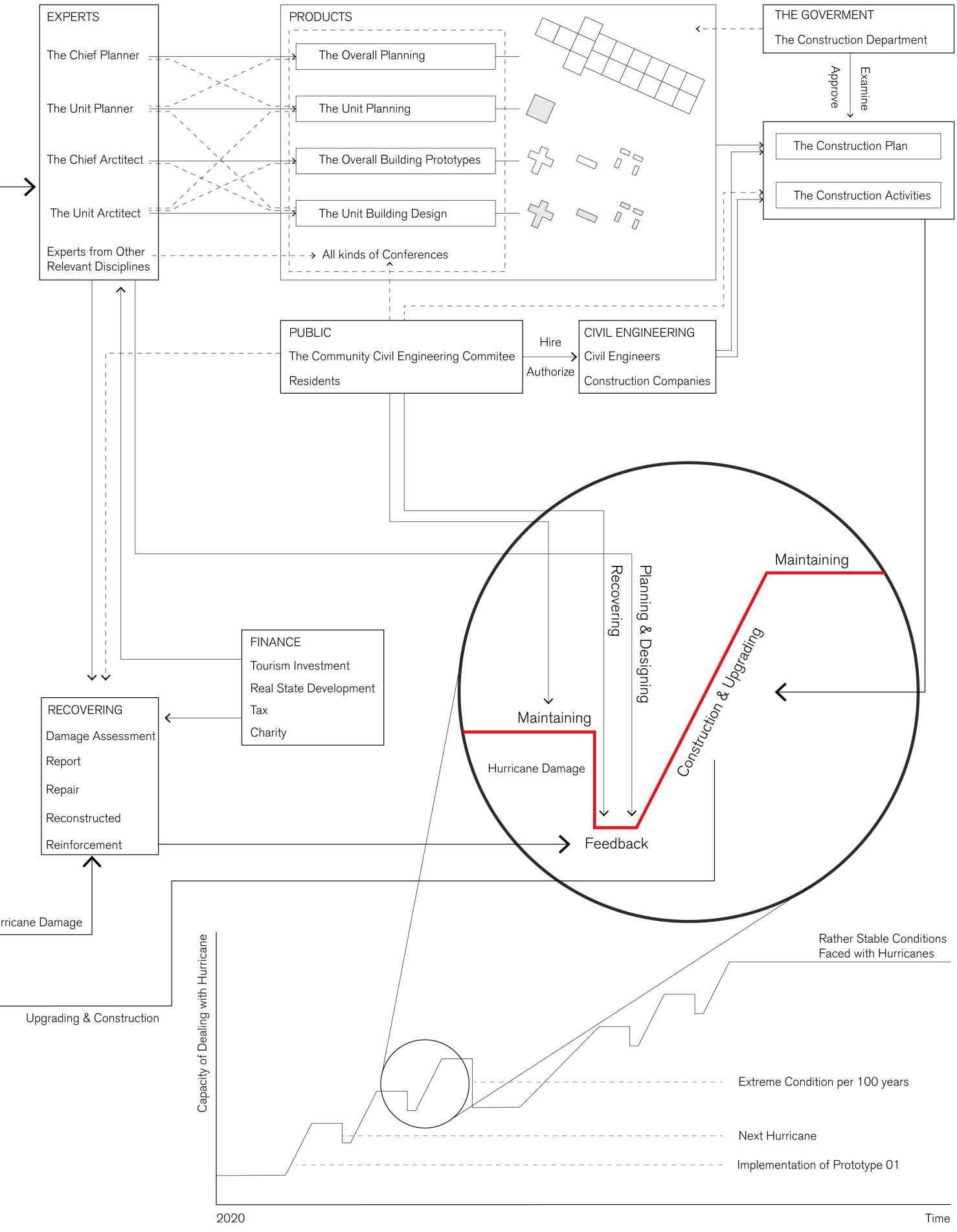


Figure.

Implementation Plan



21. The system of implementation of the unit model

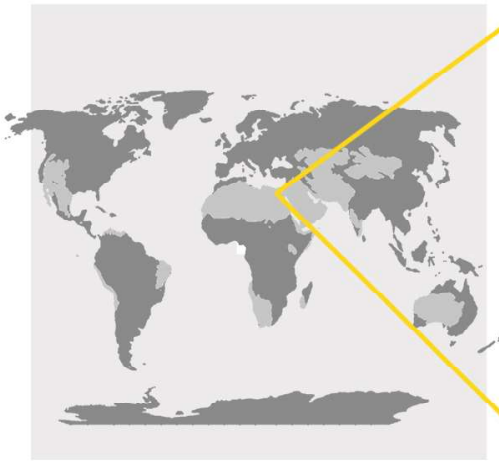
6.

Cairo, Egypt

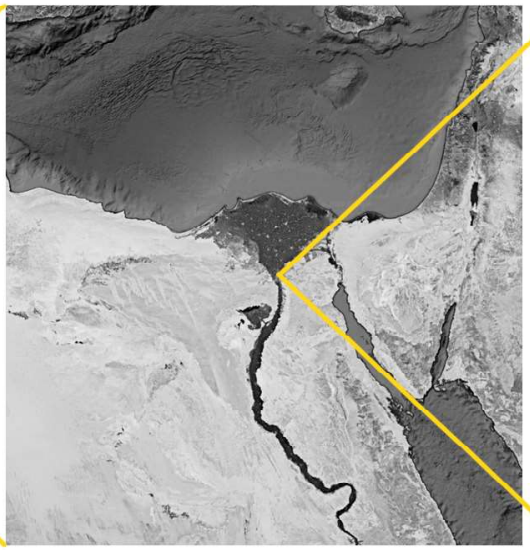
A shift towards a more connected and anticipating urban-desert environment.

Laura Conijn
Johan Klaas Krom
Esmée van Eeden
Jort van den Broek
Leanne van Bentem
Jan Eggink

Worlds Deserts



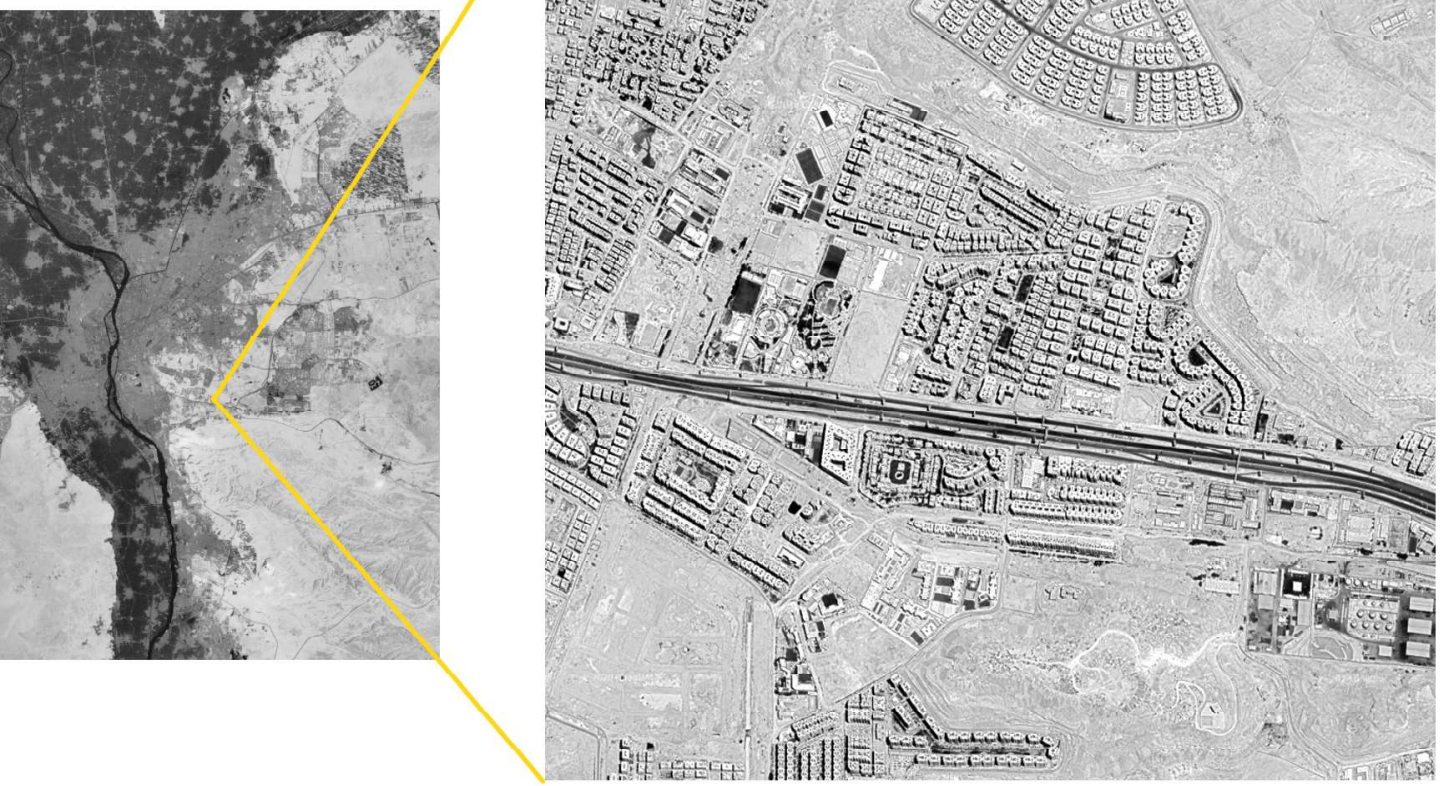
Egypt



Cairo



El-Habada El-Wosta



Zooming into project site
Based on Google Earth (n.d.)

1.

Introduction to Cairo

Introduction

This case study explores the potential of ecosystem participation as catalyst for healthy and climate proof urban development in the capital city of Egypt, Cairo. It presents a case at the intersection of several extreme conditions. A desert country, Egypt consists for 95% of drylands. The limited range of arable land, roughly equivalent to the state of Belgium, is home to about 95% of the country's estimated 104-million population. About one-fifth of this population lives in Cairo. The country's population is both urbanising and growing fast, with Egypt having seen an 46% increase in its population between 1994 and 2014 (CIA, 2020).

The following section will explore three key questions that serve as starting point to further analysis. Note on language: some names and concepts are transliterations from Arabic and their English spelling may vary.

Climate change: this is likely to cause temperatures in Egypt to increase more than the global mean. Conversely, the annual level of precipitation is likely to decrease, resulting in harsher and longer droughts (Daoud, 2015). Evaporation from open water sources such as the Nile will also increase, putting stress on current irrigation systems (Daoud, 2015). The impact of these trends is heightened by human activities such as urban development, pollution and extreme fishing activities (IH Cantabria, 2011).

Drought: a severe drought from 1995 to 2010 saw annual rainfall levels drop to 140 mm heavily affecting rangeland and vegetation cover, and aggravating water scarcity, land degradation, livestock and crop activities (Daoud, 2015). remaining water sources are contaminated by air pollution, human waste, animal waste, organic matter, dissolved salts, eroded soil and fuel oil (Ali et al., 2009). Drylands are extremely fragile environments. Overexploitation, mismanagement of water and high runoff can cause irreversible damage (Ali et al., 2009).

Heavy rainfall and flooding: although precipitation will decrease, climate change is expected to increase the intensity what rainfall remains. Cairo's drainage networks are often unable to cope with such peak loads, making the city prone to regular flooding. The literature identifies five types of flooding damage: the inundation of structures, erosion and scouring of embankments, impact damage due to debris, the erosion of top soils, and finally the release of sewage and toxic matter from wastewater treatment plants and damaged infrastructure. Desert river beds, 'wadis' are prone to cause flash floods (Malek, 2020).

As a country consisting mostly of dryland, Egypt has witnessed several level of policy measures to deal with this reality. On the national level, public authorities have pursued three categories of policy measures over recent decades. First, land reclamation: With urban growth and salination decreasing the availability of agricultural land in the Nile valley, the Egyptian authorities have committed to a long-running effort of preparing desert land for agriculture instead. Second, by developing a series of 'new cities': urban centres deliberately located in the desert. These areas are currently aimed at higher-income populations. However, vacancy levels remain relatively low (Tadamun, 2016). Third, water harvesting and water retention. Traditional techniques such as cisterns or reimagined uses of natural features such as wadis are being explored to reduce the current dependency on the Nile (Malek, 2020). Nevertheless, studies show that local stakeholders attribute averse development like climate change, flooding risk, and coastal erosion a low level of importance (IH Cantabria, 2011).

The city of Cairo uses a lot of water 208 m3 daily, compared to e.g. 138 m3 for the similarly sized city of Beijing (Ministry of Housing, 2017). In addition, substantial amounts of wastewater are flushed away. The Greater Cairo Urban Development Strategy for 2052 outlines three overarching policy goals: first, to reduce water consumption by raising awareness and implementing structural measures. Second, to improve water quality and reduce pollution. Third, the city sets out to enhance urban water retention capabilities by 'closing the loop' on water and wastewater flows by connecting all city neighbourhoods on fixed potable and wastewater piping and using reprocessed water for irrigation. This study identifies four relevant levels of analysis: an overarching regional level, and the lower city level (macro), municipal (meso) level and neighbourhood (micro). Respectively, these areas are considered at map scales of 1:250,000, 1:50,000, 1:25,000, and 1:5,000. The following parts identify primary stakeholders relevant to urban design projects set at the micro level.

At the regional level the Greater Cairo area is considered. Egyptian governorates of Cairo, Qalyubia and Giza are considered, as well as new cities such as New Cairo, El Obour City and the 6th of October City. Other relevant actors include those in vthe area of network planning, environmental policymaking, economics and urban design. Examples of such organisations are the Planning Sector of Egyptian Ministry of Water Resources and Irrigation (MWR), the Egyptian Ministry of Planning and Economic Development (MPMAR) and the Egyptian Environmental Affairs Agency (EEAA). At the city level major municipalities such as Maadi, Nasr City, Al Khalifa and New Cairo are identified. Relevant actors at this level include water management authorities, public transit operators and larger commercial entities.

At the municipal level the Sabein Fadan, Sabhaa Husayn, Asaeid, Albsatin Alshrqia and Alainshatun neighbourhoods are considered. At this level local water management authorities and pumping station managers may be relevant stakeholders for this scale. Other stakeholders include regular non-daily shopping or recreational activities by local residents. Other stakeholders might include utilities managers and inter-neighbourhood organisations. As a section of the Cairo Ringroad passes through the scale, city level motorists are also stakeholders to developments at the municipal level. The micro level entails the El Hadaba El Wosta neighbourhood. For this scale, the daily activities of residents, land and shop owners and other commercial parties are considered.



2.

Research Question and

Theoretical Framework

Research Questions

This study sets out to explore how ecosystem participation may be used to enhance the resilience and adaptation of a Cairo neighbourhood to the extreme environmental and social conditions to which it is exposed. The aim is to do this in the most sustainable way by connecting different complex system.

Eventually we apply different scenarios and design experiments to the project site. From these studies we can draw conclusions which ways to go are most suitable to reach the main objective.

The overarching research question guiding the case study is:

“How can we use the ecosystem participation approach as a tool to mitigate risks in Egypts extreme urban environment, while stimulating the city’s social cohesion and awareness of environmental sustainability?”

We attempt to answer this research question by keeping in mind the extreme environment in combination with the community.

“How can ecosystem participation be used to reduce Cairo’s vulnerability to flooding?’

‘How can ecosystem participation be used to reduce Cairo’s vulnerability to extreme drought?”

How can ecosystem participation be used to enhance the cohesion of Cairo’s urban community?’

Conceptual framework

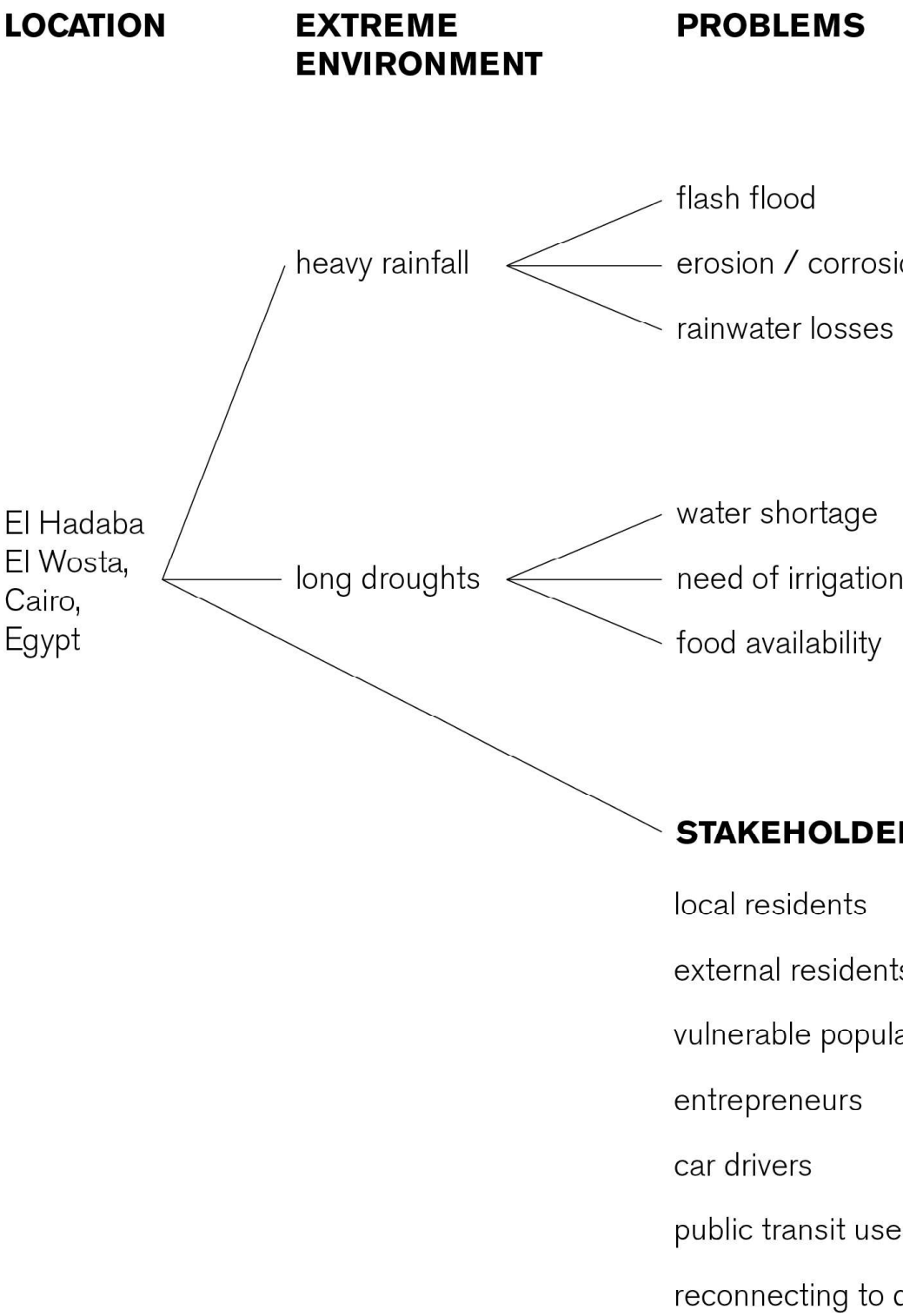
As its conceptual starting point the study selects the work on 'wadi urbanism' by Malek (2020). This concept is chosen as it provides a frame through which we may conceive of integrating a feature of the natural Egyptian desert landscape with the highly artificial dimension of a growing urban sphere. Moreover, it offer space for productive and community activities, both of which fit with the research questions specified previously. This creates an approach to ecosystem participation that is inherently rooted in both the natural landscape, as well as traditional societal frameworks.

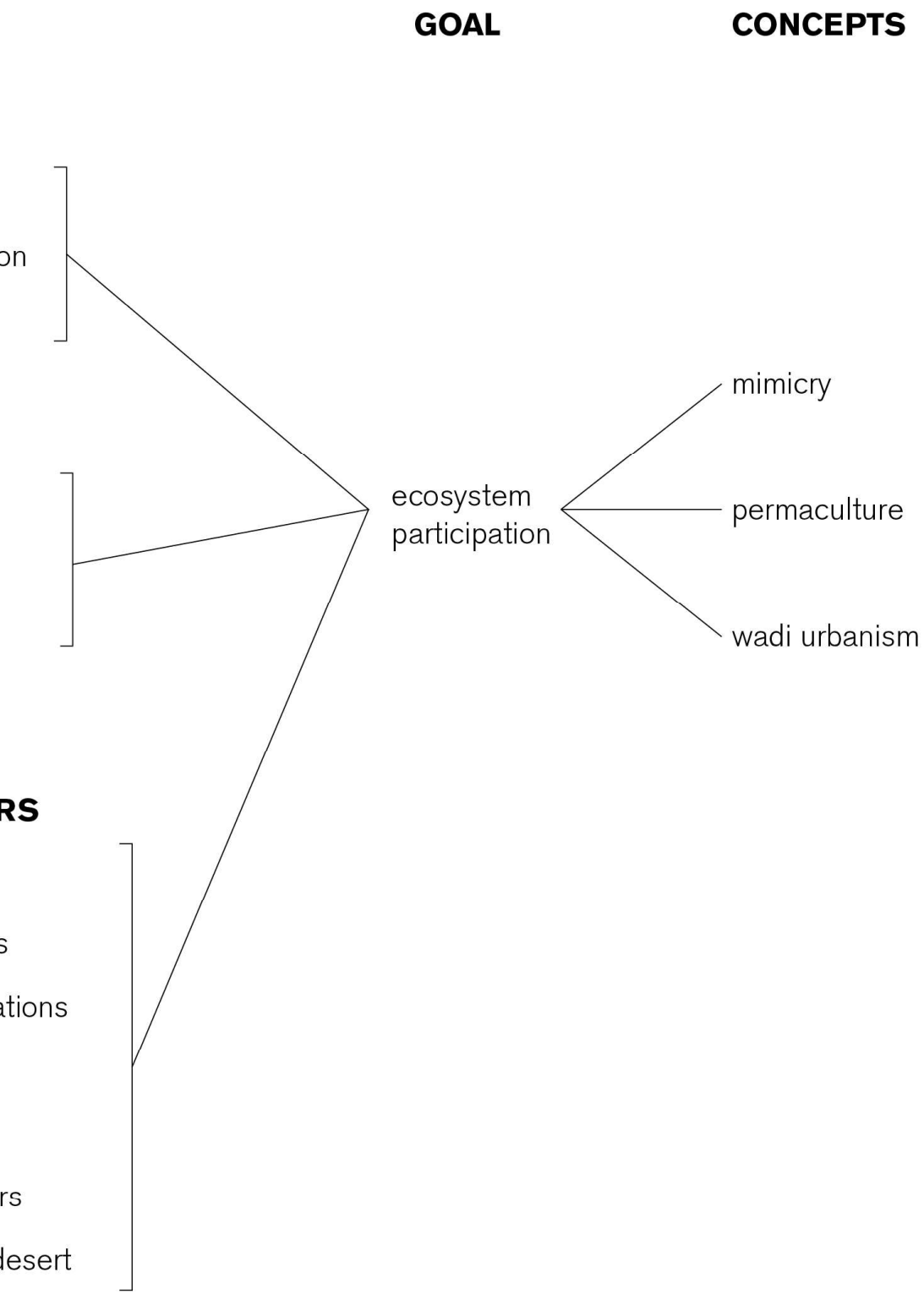
This vantage point permits us to construct a theoretical framework based around four overarching concepts: resilience, mimicry, wadi urbanism and permaculture. Resilience is understood as the management of exposure and vulnerability to risks (Kunkel et al., 1999). Although socio-economic systems are often dependent on some level of infrastructural engineering, natural ecosystems can find survival mechanisms in their ability to adapt (e.g. Wall & Virginia, 1999). By implementing nature-based solutions in water sensitive urban design, ecosystems can be used to enhance urban resilience.

Mimicry is understood as observing and copying natural processes and solutions to achieve some desired effect (Young, 2017). By applying natural water flows and vegetation, trees and perennial crops provide a fertile soil around the tree/shrub and a microclimate with cooler air and a higher humidity, which in turn reinforces a fertile cycle (Lewis, 2014). This can significantly improve rainfall infiltration and soil water distribution dynamics (Lui et al., 2015). In drylands, natural vegetation patterns can be achieved through various techniques such as pastoralism, agroforestry and afforestation.

As a form of agroforestry, the concept of 'urban wadis' is considered (Malek, 2020). Wadis, which are natural stormwater runoff valleys in dryland environments offer natural for precious water resources to accumulate. Malek instrumentalizes wadis for urban development, defining wadi urbanism as "[…] an urban design approach in which Wadis emerge [...] as a landscape tool for design, where Wadi potentially act as a green lungs that defines a more ecological framework for infrastructure and aligning urban development." As noted by Malek, current spatial planning conventions regard wadis as hazards for flash floods, soil erosion and water loss. However, by applying principles of urban storm water management, such risks can be mitigated and wadis can become places of water retention.

Finally, the concept of wadi urbanism is complemented with the notion of urban permaculture: cultivated ecologies that are self-perpetuating and are based within the built-up urban area. When developed correctly, this creates a regenerative form of urban agriculture which is capable of supporting higher levels of food production that would be achieved under purely 'natural' circumstances (Chaney, 2019). As noted by Hemenway (2015), urban permaculture is about agricultural food production, but also community building as local residents become engaged in maintenance of these systems. By implementing such systems in f El Hadaba El Wosta, it offers a means of relieving agricultural pressure from the central Nile valley and of stimulating local community cohesion.


LOCATION
EXTREME ENVIRONMENT
PROBLEMS
El Hadaba
El Wosta,
Cairo,
Egypt
heavy rainfall
long droughts
flash flood
erosion / corrosi
rainwater losses
water shortage
need of irrigation
food availability
STAKEHOLDE
local residents
external resident
vulnerable popula
entrepreneurs
car drivers
public transit use
reconnecting to c


GOAL
CONCEPTS
on
ecosystem
participation
mimicry
permaculture
wadi urbanism
RS
s
ations
rs
desert

3.

Critical Cartography

3.1. Process of collecting data

To analyse the neighbourhood El-Hadaba El-Wosta in Cairo, Egypt in the perspectives: ecology, landscape, urban, antropology, systems and TIL; data is collected. Sources such as Google maps and OpenStreetMaps are used for collecting data in the form of maps. In these maps information about buildings, roads, heights, types of landscapes and public spaces can be found. More detailed information on this area and these topics can mostly be found in scientific papers. These papers can involve the actual neighbourhood, but also the information about comparable neighbourhoods can also be used for data collection.

Data about wadi urbanism, permaculture and mimicry is also gathered as these are the concepts to use in the individual design experiment. Important sources for the project in Egypt are Sims (2010) that was written about the understanding of Cairo and Malek (2020) who has researched the topic of Wadi Urbanism.

Malek has also been a source of information through meeting sessions about the Egypt case and Malek's research about Wadi Urbanism.

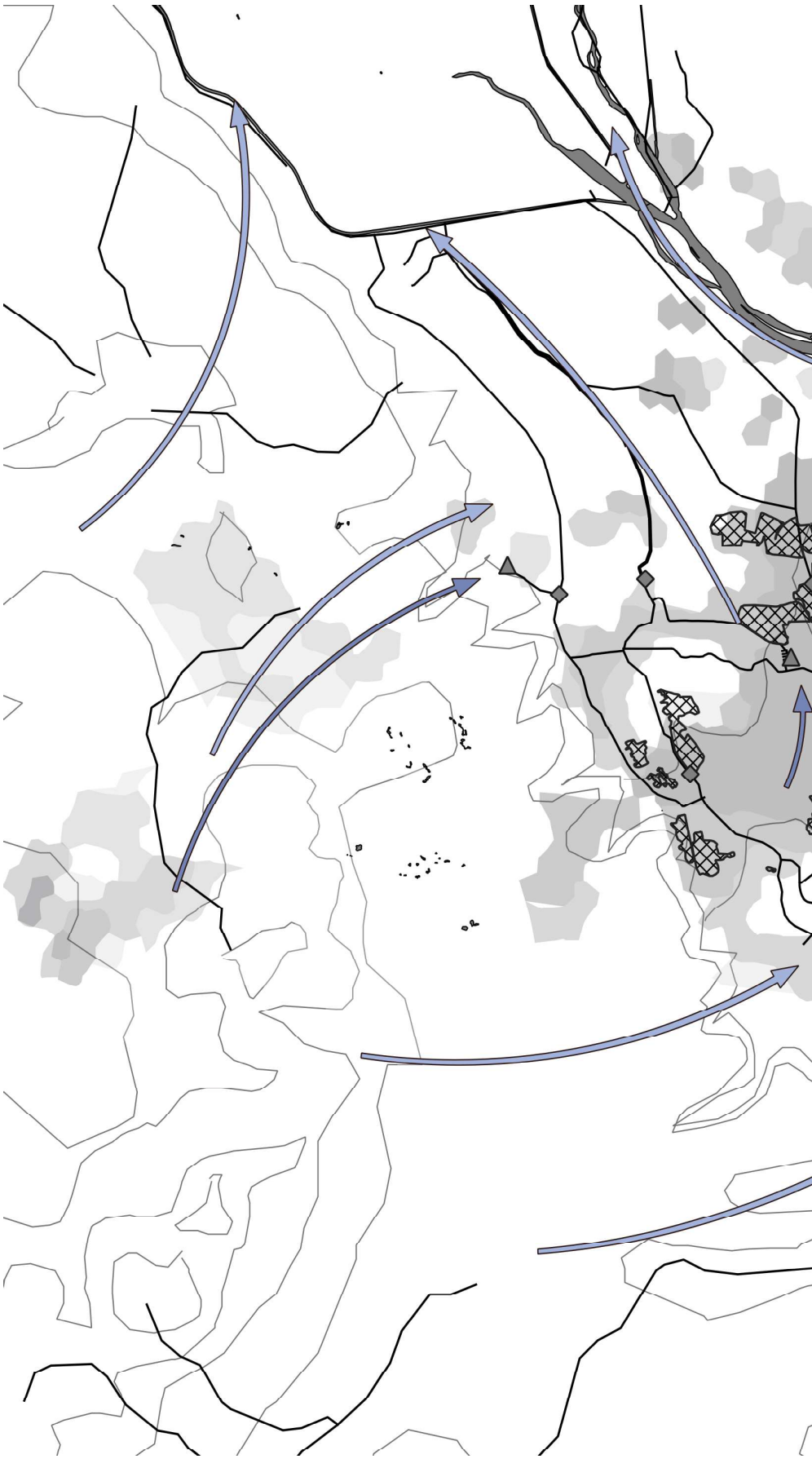
3.2. System of Systems

3.2.1.

Water flows and population

This map represents the general water circulation of the Greater Cairo region. Despite being a highly artificial landscape, elevation continues to pose the boundary between the lush Nile valley and surrounding arid desert land. This map shows four water flows: first, northward natural runoff from through the Nile valley. Second, seasonal stormwater runoff from the desert highlands towards the river valley. Outside of the built up areas these streams pass through a natural network of wadis (desert river beds), the courses of which are clearly visible on satellite imagery. These streams run into the city and cause occasional flash floods.

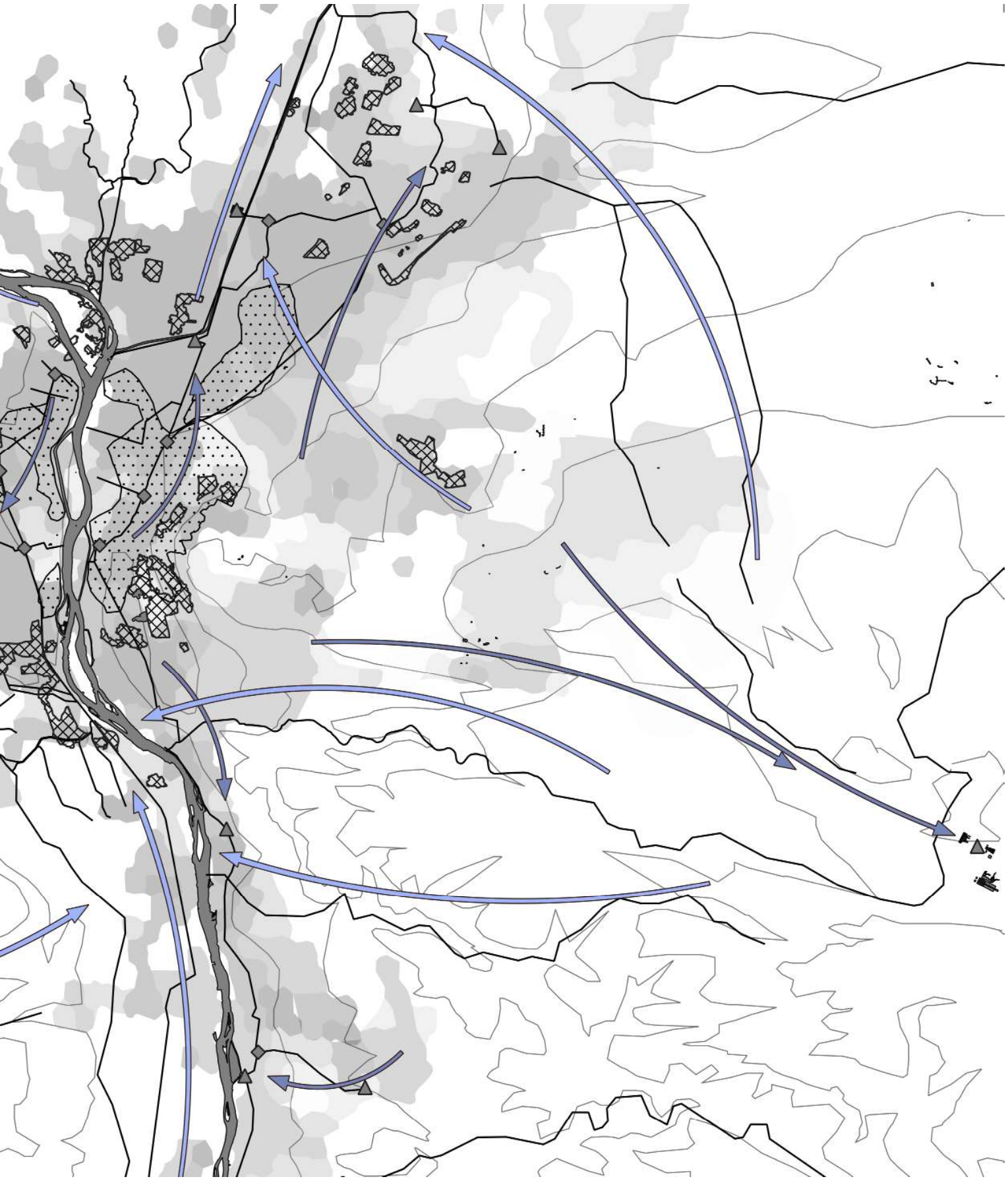
Third, wastewater flows from population concentrations to a network of wastewater treatment plants. Fourth, we see a system of channels guiding water from wastewater plants further northwest and northeast into the Nile delta through man-made canal systems. These channels feed treated wastewater back into the open water system from which it may be used for irrigation. Indeed, the Greater Cairo region development plan identifies this as part of its plan to conserve scarce water resources. The backbone of the wastewater network was constructed in the late 80's, in part to deal with recurring flooding incidents which were happening across the city's low-lying areas. Since its construction, the city has however grown and the sewer system as of yet does not cover the entire city.



3.2.1.
Water flows and population

Drawn by author, based on Dawes (1988), Floodmap (2020), Google (n.d.), Kalila and Mahfouz (2019), Open Street Map (n.d.), Roberts and Flaxman (1985) and Hegab (2019).

- Water: runoff flows
- Water: wastewater flows
- Wastewater treatment plants
- Pumping stations
- Water channels and sewers
- Unsewered areas
- Historical flooding incidents
- Population density



3.2.2. Mobility and housing

This map illustrates the predominant mobility patterns throughout the Greater Cairo region, and the way in which these patterns break down per mode. Different modes have different capacities and can serve different societal needs. Ideally, a city is designed so that modes are adapted to such needs. The map shows that roughly a relationship appears to exist between mode and the levels of vacant housing per governorate and new city municipality: the lower capacity the mode, either by vehicle type (i.e. bus or car), or infrastructure throughput (i.e. congestion) the more houses stand vacant.

Additionally, the map highlights a relationship between modes and property types: the new cities 6th of October and New Cairo feature high concentrations of gated communities. This corresponds to the higher levels of incomes found on map two. Conversely, the Nile valley urban core shows extensive unplanned housing areas. Satellite images show that many of these unplanned housing areas constitute exceedingly dense patches of urban landscape. Dense urban development supports high capacity modes, such as metro lines. However, as much of the housing illustrated here is unplanned, it suggests that high-capacity modes simultaneously drive housing development, as it offers an efficient alternative to reach opportunities in the city centre.



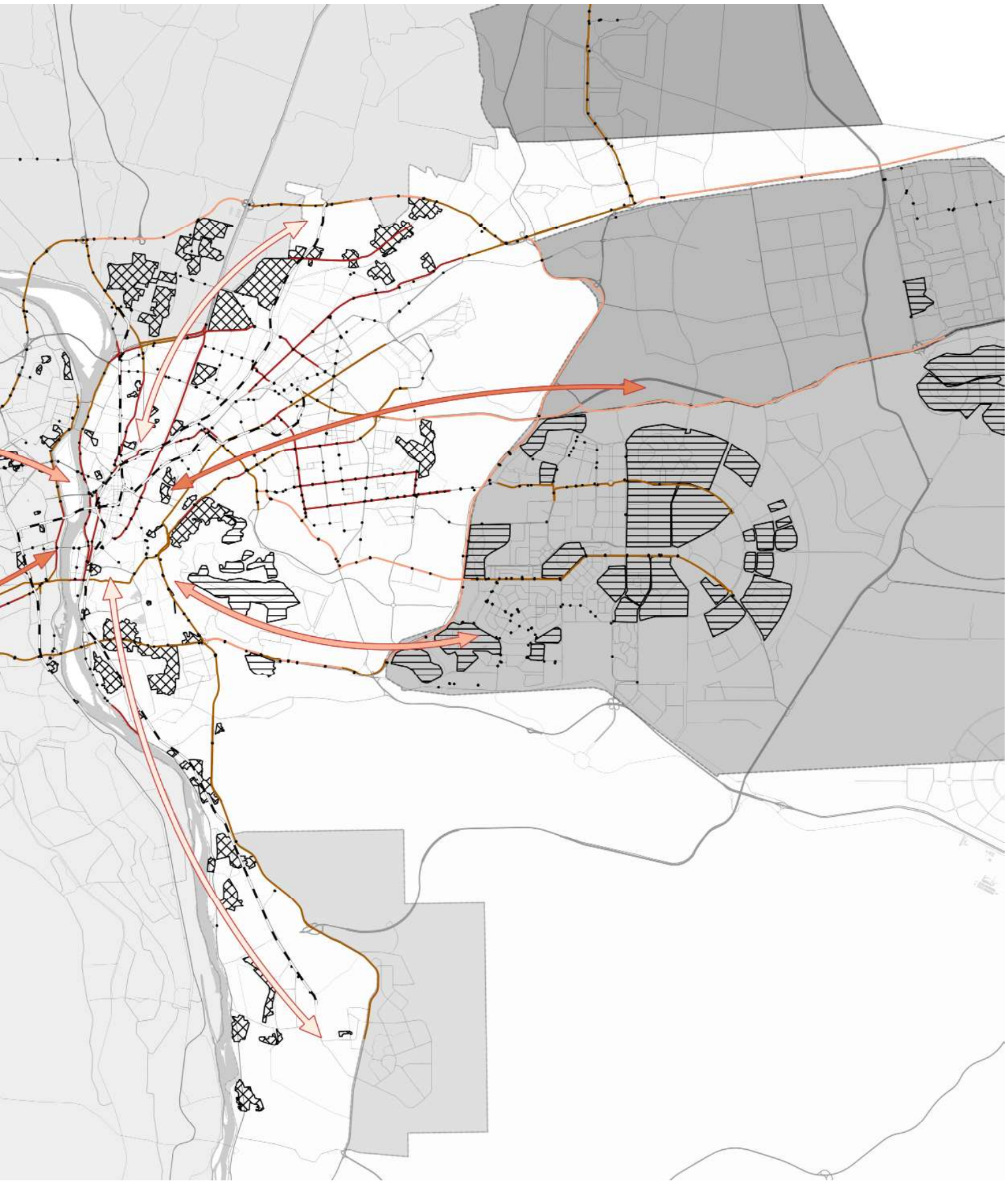
3.2.2.
Mobility and housing

Drawn by author, based on Kalila and Mahfouz (2019), Mahrous and Maher (2017), Ministry of Housing (2012), Nasreldin (2011) and the Built Environment Observatory (2016).

- Mobility: metro rail flows
- Mobility: bus and minibus flow
- Mobility: private car flows
- Metro lines
- Bus stops
- Congestion (darker: more congested)
- Gated communities
- Unplanned settlements
- Intensity level of vacant housing

N

0 5 km



3.2.3.

Income and suburbanisation

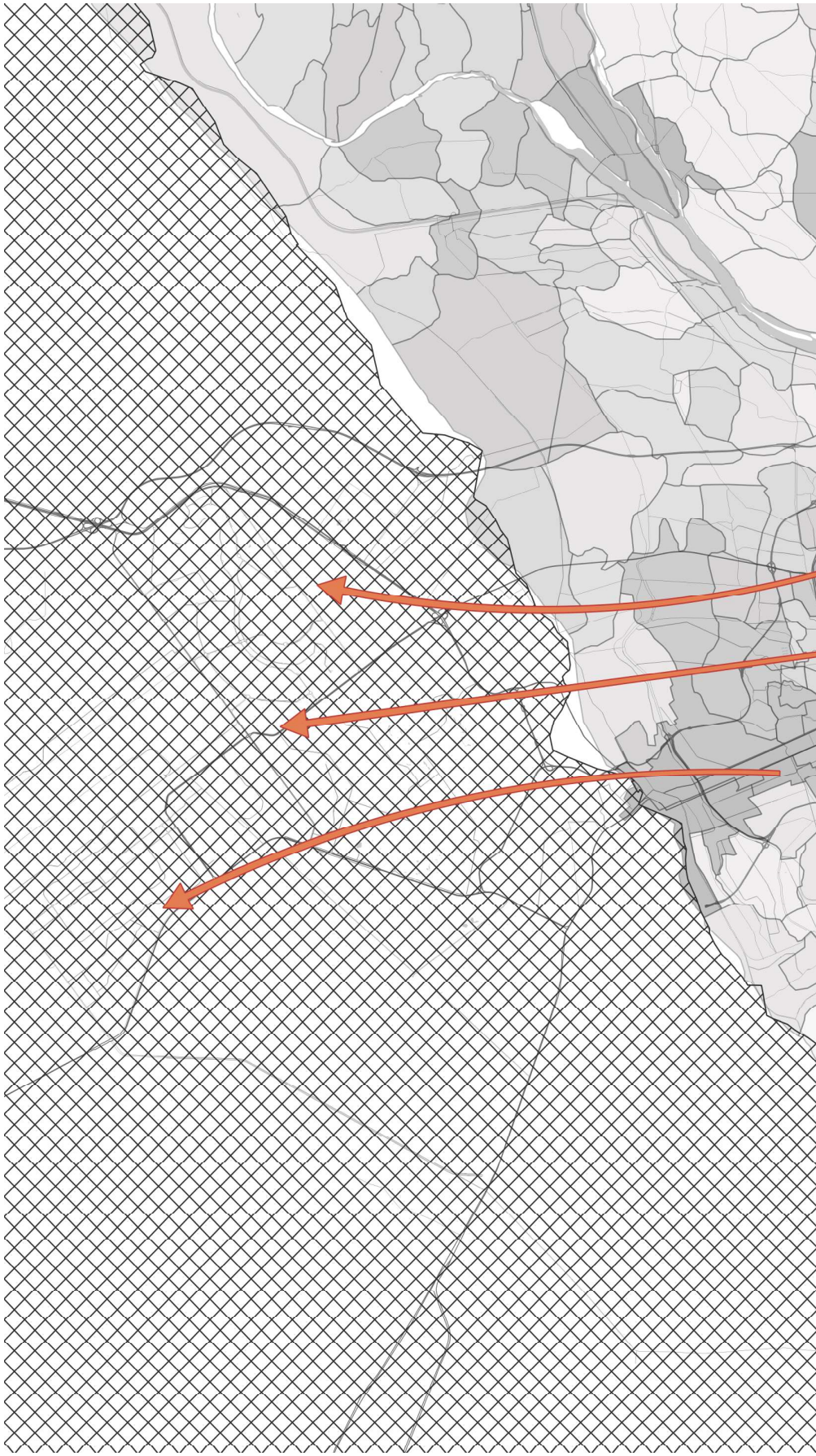
This map illustrates the shift of wealth out of the dense urban core into desert-based suburbs. As such, it touched on the ways by which human society has organised itself throughout the Greater Cairo Region. Municipal-level administrative units are shown and shaded according to their mean level of income: the darker, the higher the average income earned. The hashed areas illustrate the natural arid, desert land rising above the Nile valley.

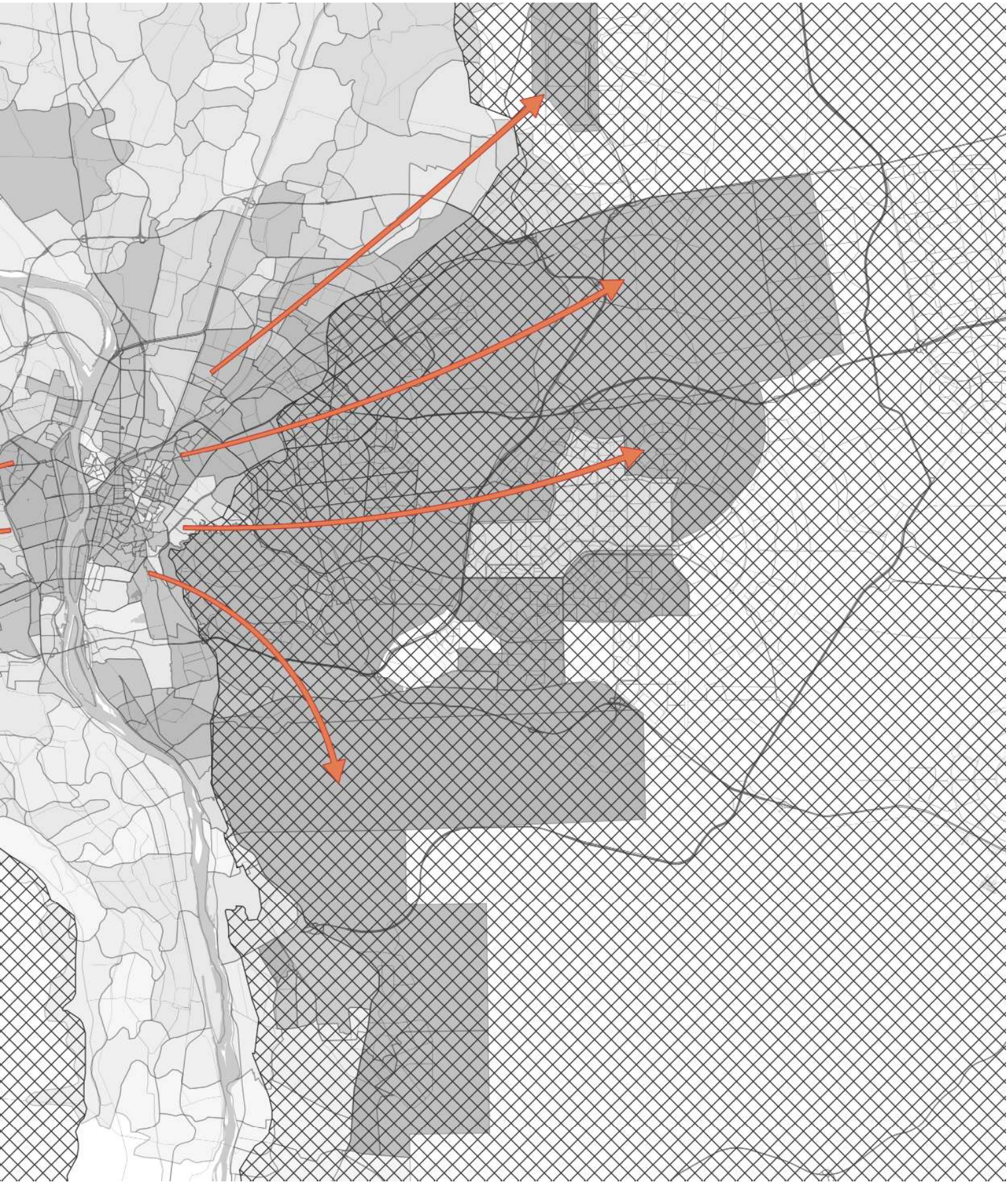
The city is seeing extensive urban expansion, including the development of 'new cities' such as the 6th of October City on the west bank, and New Cairo and the 10th of Ramadan City to the east. However, to sustain these populations, forms of irrigation are required. Most new cities are built in the like of US suburbs: spread out single-family houses based around a car-oriented infrastructure. Current city planning tailors these areas for to well-to-do Egyptians, and income levels are noticeably higher there. The arrows illustrate this suburbanisation or higher-income demographics

3.2.3. Suburbnisation

Note on data: no information was found on income levels for the 6th of October city. Satellite imagery suggests that residential patterns there are similar to those in the darker-shaded eastern areas, suggesting comparable income distributions.

Drawn by author, based on Google (n.d.), Tadamun (2016) and OCHA (2017).





3.2.4.

Extreme Systems Water Sensitive Development

Based on the three preceding maps, the following conclusion map is drawn up. This map illustrates areas where water flows and human mobility coincide. Often mobility infrastructures are used to accommodate water flows: either as natural channels, or as locations with a gradual decline allowing for the construction of smooth waterways. For instance, some of Cairo's major sewers follow the railway and the long north-south Port Saeed road. As such, areas where fast flows of mobility and slow flows of water coincide, may be worth exploring for further natzure-based urban water designs.

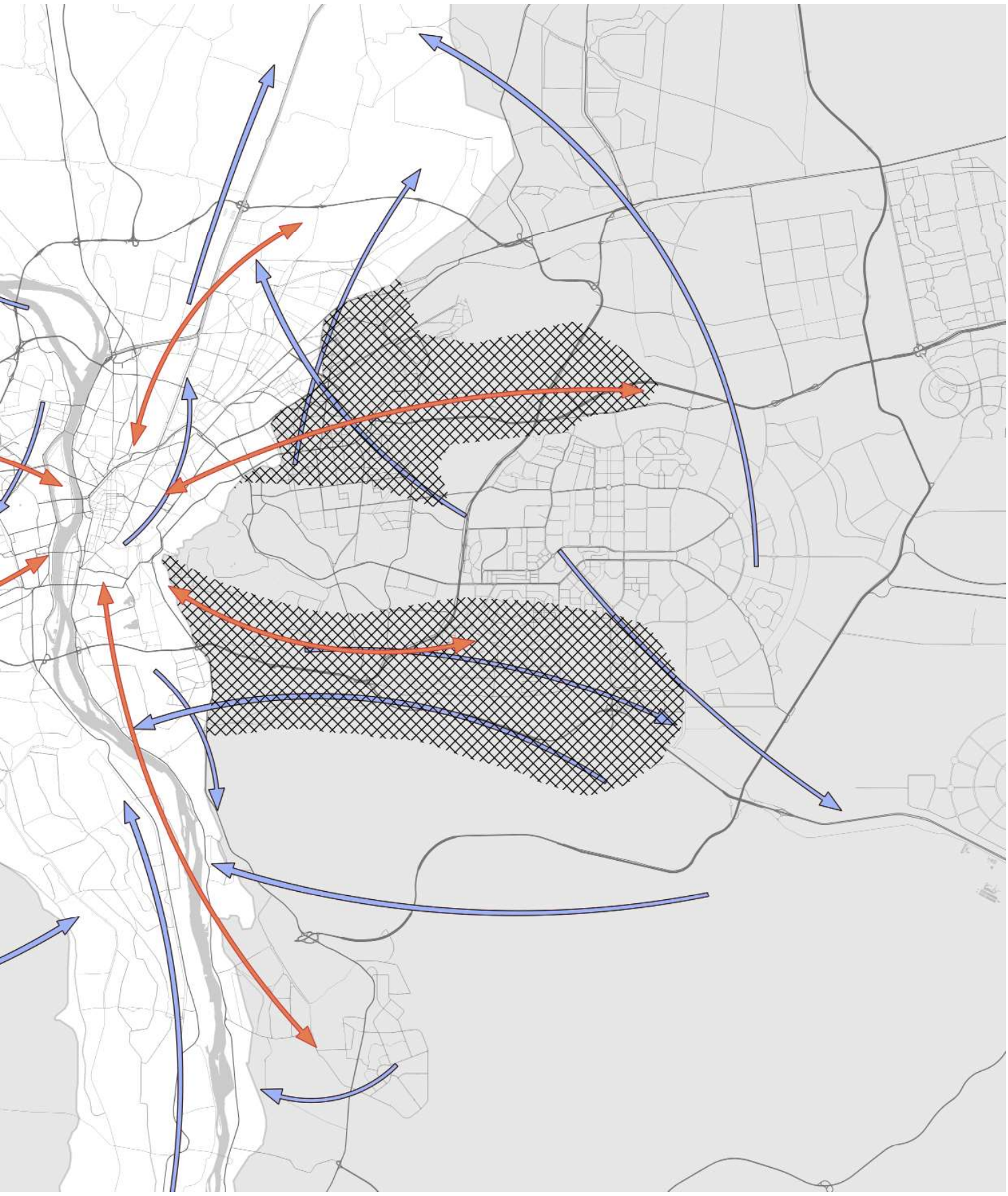
This map draws on the observation that areas connected by road only draw relatively sparse population patterns. Despite the higher levels of income in the New Cities, not too many people are in fact living there. These areas also require complex irrigation and water pumping systems to remain habitable. Moreover, as suggested by the map on water management, large amounts of water are flushed out of the city through channels and big engineering systems. In an alternative design, such scarce water resources might also be retained in the urban environment. Recognising that high population densities in the river valley aren't sustainable, but that the current new cities are hard to reach and only draw limited populations, this map concludes that a more productive synthesis of these flows may be worth exploring and identifed areas in which such water sensitive development may be located.



Extreme Systems
water-sensitive development

Drawn by author, based on Google (n.d.)

- Water: flows (wastewater and runoff)
- Mobility: flows (bus, car, metro)
- Avenues for water sensitive development
- Arid or desert areas



3.3. Anthropology

3.3.1. Time Systems

This timeline indicates several periods of time. The first line shows the year of 2019 with different extreme environments events related to it. The bottom line shows several major events that have taken place related to extreme environments and the way people have perceived and experienced it. At the bottom, several demographic characteristics of egypt are shown and are related to the element of time.

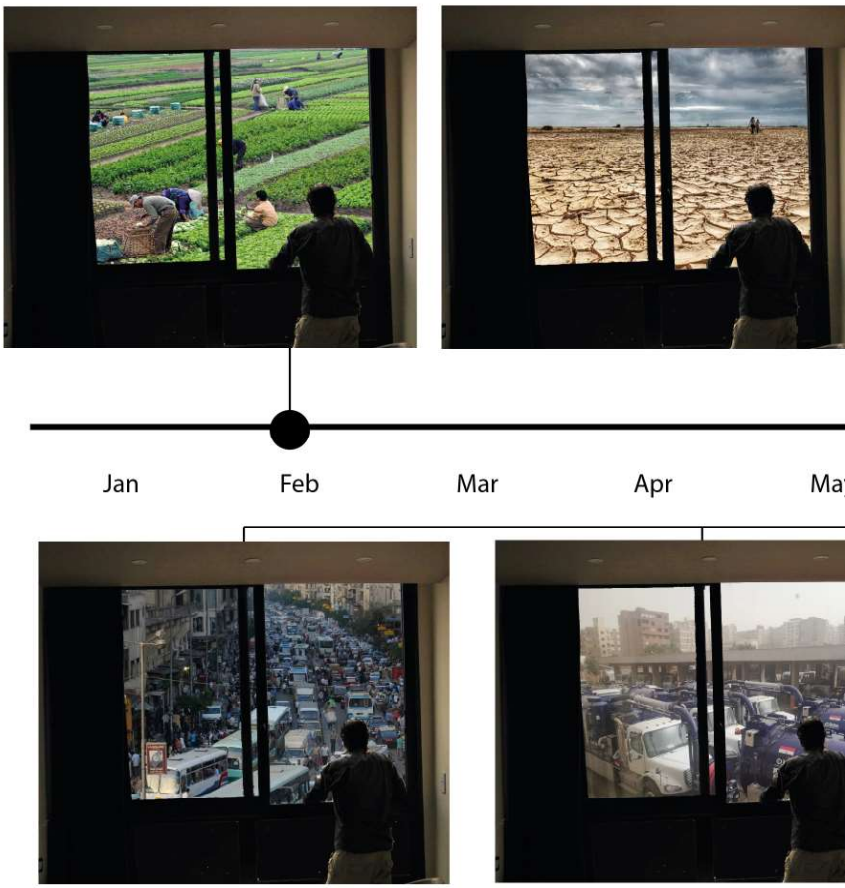
Starting off with the top line, it shows a person looking from its window and observing the production of vegetables. In this period of time this is still possible. When moving to mid May, it can be seen concluded that the production soil has become arid (Bar'el, 2020). No type of production can be facilitaded on this soil. At the end of the year, in mid December, the water level in the ground has risen and the soil is capable of producing some vegetables again (Nada, 2014).

Around the end of october, several heavy rainfalls have taken place. Wadi's, visible from the windowscapes, function as touristattractions in dry periods. Because of the drought the soil is not capable of absorbing the rainwater. As a result the wadi immediately floods (Maswini Press, 2019). Over a period of time, the water is absorbed in the soil, resulting in productive areas where green is present (Cooke, 2017).

Zooming in to Cairo in the period of september-october, when the dragon-storms, occur. We see, in normal situation, a busy street in the centre of Cairo. When a dragon-storm is expected, vehicles capable of collecting rain water enter the streets and are positioned in key places (Mohammed, 2020). During an actual dragon-storm, the army enters the street, helping people in need. Because there is no sufficient way of absorbing the water from a dragon-storm, the street eventually flood (National Oceanic and Atmospheric Administration, 2020) (Maswini Press, 2019). After the dragon-storm the vehicles capable of collecting the rain water are put into action, clearing the streets for pedestrians and vehicles once again. The way dragon-storms are handled in Cairo can be seen as reactive in stead of pro-active. Measurements are taken to mitigate the negative outcome but no measurements are taken on forehand to mitigate the effects, such as a way to absorb the abondence of rainwater by using rain water collections or a irrigation system for example (El-menawy, 2018).

If we look at major events in relation to the extreme environment in the history of Egypt we see that in ancient Egypt the Nile flooded several areas over the year. This was the type of irrigation that was used and it led to productive land around the Nile. Although the outcome was positive the way and the period of flooding was hard to predict (Tanner, n.d.).

Because of this, in 1902, the construction of the High Dam started. The result of this was that the Nile did



Timeline

Irrigation by using flooding of the Nile.



End of flooding nile: Building of dam High Dam in Aswan.



Expa
start
push



0 715 1933

Demographic characteristics

Population	15,9 million
Average age	21,8 years
Urban population	28%
Life Expectancy	34,5 years old

Extreme environments

Average temperature	20,1 degrees
Precipitation per month	2,62 mm



y Jun Jul Aug Sep Oct Nov Dec



nsion of Cairo into the desert
s. Moving into arid areas and
ing the desert back.



1950

20 million
20,7 years
33%
41,1 years old

21,2 degrees
2,7 mm

Irrigation by using underground wells and Chinese workers.



2018

98 million
24.3 years
43%
71,7 years old

23,5 degrees
2,8 mm

Grand Ethiopian Renaissance Dam completed.



2020

102 million
24.6 years old
44%
72,5 years old

23,6 degrees
2,9 mm

The UN predicts it will be approaching a state of "absolute water crisis"



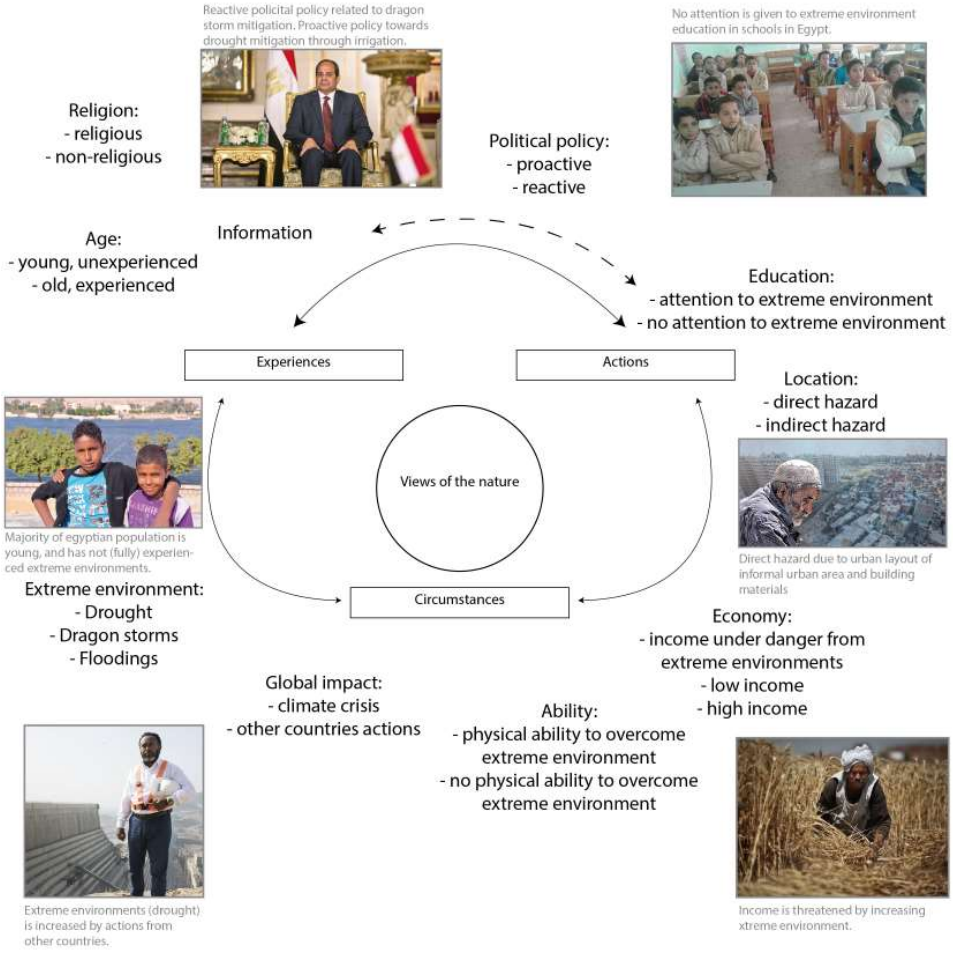
Future -> 2025

111 million
25.1 years old
46%
73,1 years old

24,3 degrees
3,2 mm

3.3.2. Mindmap

The previous mindmap shows how the view of the nature is comprised. The mindmap is made up out of three major elements; Experiences, Actions and circumstances. The circumstances describe what kind of extreme enviroment is affecting the person in mind, what kind of ability the person in mind has. Is he/she capable to physically overcome the extreme enviroment, is the person in question capable to financially overcome the extreme environment. Furthermore, what kind of experiences has this person experienced in the past. Is this person relatively young, or relatively old? In Egypt, most of the population is relatively young and has not experiences so many extreme climate situations (Unicef, 2015). Furthermore, in education not much time is spend describing the different extreme environmental situations (Samad, 2015). So little to no infromation is offered to adolescents in egypt regarding the climate.



A famous anthropological perpective on how humans cope with nature and the related 'myths' (one may say 'the socialized perception's) is by Mary Douglas. She describes four different types of nature. Capricious nature, nature is fragile, nature is robust and nature is robust within limits. These four types are applied to the different extreme environmental situations present in Egypt: drought, flashfloods/ dragon storms, flooding of wadi's. These four types are also applied to the human aspect, what is the human perspective in these extreme situations.

Applied to the drought:
For the natural perspective: nature is robus within limits. A certain drought can be overcome by rainfall but if a drought lasts to long, nature can not recover from it and the result is a arid area. Applied to the human perspective, humans are robust. If drought will last for a longer time water will be imported from other countries/area's. By using political means humans can be protected from drought by collaborating with other countries for the import of water (Cooke, 2017).

Applied to flashfloods/ dragon storm:
For the nature, this type is fragile. This is because the environment can not cope with the amount of water a dragonstorm/ flashfloods unleashes on a city. Because of the current environment, nature is not used to absorbing rain water. This results in extra dry nature, which in terms can not absorb water. The human perspective related to the flashfloods/dragon storm is that of capricious. Sudden and unnacountable change can not be handled (El-menawy, 2018).

Appied to flooding of wadi's:
Related to the natural perspective, it is robust within certain limits. Because of the shape of the wadi's they are ideal to transport large amount of rainwater, but they have a limit. This is related to the human perspective. Because people live relatively close to wadi's they also are robust to a certain level. If a wadi floods, this directly affects several humans that live closely to it (Maswini Press, 2019).

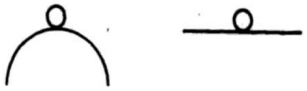
Different perspectives, related to nature and humans.
Retrieved from: Stolz (2014).

Nature Humans





Drought.
Retrieved from:
Ezz, Arafat (2015).





Flashfloods / dragon storm.
Retrieved from:
Kandil (2018).





Flooding of wadi's.
Retrieved from:
Fox (2018)

Several types of egyptian residents are described here and related to their vieuws on (the extreme) nature.

For people of higher age, >70, the impact extreme environments could have is known and recognized (Worldometers, 2020) (CIA World Factbook, 2019). On multiple occassions they have encountered the extreme environments (ARAB NEWS, 2018). Some people might have experienced the building of the Aswan dam, and also have experienced the flooding prior to the construction of the dam (Tanner, n.d.) (Cairo scene team, 2016).
Furthermore, the impact that the extreme environment can have on them personally has risen due to the higher age. Health impacts related to the extreme environment has risen.

The majority of the population of Egypt, the youth, has a little amount of experience with the extreme environments (Unicef, 2015). Althought they are physically more capable to resist the extreme environment they are socially and foremost economically endagered by the extreme environments (Nada, 2014).

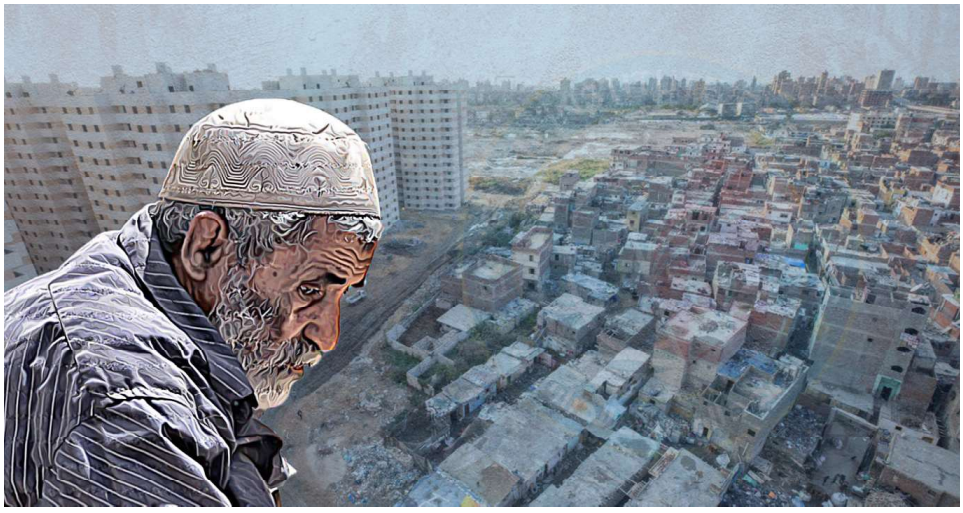
For residents of the informal settings in Cairo and other cities in Egypt the extreme environments are more dangerousdue to the urban layout. Because this layout is less capable of absorbing and/ or mitigating the extreme environment the residents are under more danger. Furthermore, due to less financial resources, the residents of the informal settings are not resilient to extreme environments and there consequences (Burgess, Jenks, 2001).



Old person >70.
Retrieved from: Press Trust of India (2019).



Young person <35.
Retrieved from: Capelli (2011).



Resident of informal setting.
Retrieved from: Muwafi (2020).

Several types of egyptian residents are described here and related to their vieuws on (the extreme) nature.

For the government, and in this case the prime minister, the extreme environments are seen as a problem. This is due to the domestic environmental problems and the actions undertaken by other countries that effect the water source of the Nile. As the government, they have a responsibility to prepare citizens and cities for coming environmental challenges and extreme environments. Several plans and actions are drafted to provide people with water and energy, even in times of extreme environments (Hammad, 2020) (ARAB NEWS, 2018).

As a farmer, the extreme environments not only cause physical danger but also cause danger related to their job and thus to their financial future. Their existence is challenged by environmental challenges and they rely strongly on plans and actions being undertaken by the government to provide them with an functioning irrigation infrastructure, even in times of extreme drought (Omar, Moussa, 2016).



Politician.
Retrieved from: Gillon (2019).



Farmer.
Retrieved from: Khaled (2016).

3.3.3. Softmap

The different cultural systems connected to the extreme enviroments are described here. These systems are described by looking at artefacts that are used in that particular system.

Starting off with the drought in Egypt, which is increasing in period and intensity. Some farmers are struck hard and have lost their means of production. Even so, the egyptian agriculture export has risen (Middle East Monitor, 2018).

Because of the increasing drought and growing water shortage due to the construction of the ethiopian dam, the United Nations predict that Egypt will be in the situation of water scarcity by late 2025 (Ezz, Arafat, 2015). Due to this prospect plans are put in motion to provide resilient irrigation infrastructure throughout Egypt to counter the fear among farmers (Mahmoud, 2017) (Nada, 2014).

This is due to the ever increasing amount of water that is being used for the production of vegetables. So the consequence is that more water is being pumped in, and as a consequence more is produced and more is exported (Keegan, 2019).



Egyptian drought - Human reaction.
Retrieved from: Ezz, Arafat (2015).



Egyptian drought - agricultural consequence.
Retrieved from: Khaled (2016)



Egyptian agriculture - present
Retrieved from: Middle East Monitor. (2018

When comparing the egyptain agricultulture system of the past versus the present we see that most of the artifacts remain the same. A wooden cart is used to gather the crops. In the past a wooden cart was used to plough through the soil. Animal power was used for this (Keegan, 2019). Nowadays, the function of a animal driven plough is replaced by a tractor connected to a plough.

Because of the changing environment, the increasing drought (Nada, 2014) and the ending of the flooding of the nile (Tanner, n.d.) the ecosystem is changed. This has an impact on the way agriculture is carried out in Egypt.

What has not changed is that human power and the human mind is required in these processes. The human remains central in these processes, although nowadays heavy machinery is used in the process of agriculture.

Focussing on action related to the nile. We see that in the past the human scale was central, water was extracted from the nile by means of ceramic pot. They were used for drinking water. The artefacts in this image are all man-made, a man-made crane and a man-made ceramic pot to transport the water.

In the present we see that the human scale is abandoned. Big dams have been built and are under construction. Concrete, biq equipment and numerous workers are used to tame the Nile (Schenkel, 2019) (Hammad, 2020).
These dams are build to counter the flooding. Although there were usefull, they were hard to predict and control. Modernday constructed infrastructure is to be resisten to these extreme environments such as the drought or floodings, but this is not the case (Hammad, 2020).

Humans and nature were central in the processes related to drought in Egypt. Nowadays, nature has moved away from the centre. Infrastructure is placed central, to protect humans from the extreme enviroments but as a result, nature is neglected. The artefacts used in modernday processes related to the drought are factory produced and used by humans. Although humans operate and control these artefacts, no man-made artefacts are present in this process.



Egyptian agriculture - past
Retrieved from: Colwell (2019).



Egyptian drought - action related to the nile. past.
Retrieved from: Gharabighi (n.d.)



Egyptian drought - action related to the nile. present.
Retrieved from: Champion, Manek (2019).

The different cultural systems connected to the extreme enviroments are described here. These systems are described by looking at artefacts that are used in that particular system.

For the subject of water digging / irrigation we see that in the past by channeling the flooding of the Nile agricultural land was formed. Here the human scale was central once more (Tanner, n.d.) (Nada, 2014). Furthermore, all the artefacts showen are man-made. The irrigation chanels are dug by man-made shovel and water is extracted by man-made cranes.

If we compare that to the present we see that water is either imported, or extracted from wells located deeply underground. Workers and material are imported from other countries, such as China, to foresee in the irrigation. Humans are still required but in the role of aiding the machines (Binian, 2018).

Less workers are required to do the job, and the humans are not central in this proces. Heavy machinery such as pumps, cars and storage tanks are used. These different machines support the workers.



Egyptian drought - water digging. past.
Retrieved from: Managing Water for Sustainable Agriculture (2016).



Egyptian drought - water digging. present.
Retrieved from: Xinhua (2018).



Egyptian storm - past.
Retrieved from: Fleur (2017).

In modernday egypt, at least once a year a dragon storm is experienced. A cyclon endangers residents of Egypt. Machines are used to free people and help them to evacuate.
Humans are endangered by the Dragon storm. Because of modern day society in Egypt, cars and major infrastructure are of major importance. That is why the streets are cleared first, so urban life can commence again.

In the past, storms also occured but were mainly the consequence of a volcanic eruption. Next to that, heavy rainfall and other storms also occured. These types of extreme natural environments caused climatic changes which resulted in crop failure. They did not affect the population directly at that time, but the population was affected by the change in agricultural possibilities (National Oceanic and Atmospheric Administration, 2020).

The subject of the flooding of Nile was already adressed in a few sentences. In the past, this water from the Nile was used to irrigate the agricultural land. Egyptians dug their own irrigation chanels, complete with manmade dams. As a result, it became possible to produce agricultural products on the ground surrounding the Nile. Nonetheless, because the flooding intensified and was hard to anticipate the decision was made to construct a dam in the Nile. Due to the construction of the Aswan dam, the flooding of the Nile stopped (Tanner, n.d.) (Schenkel, 2019).

Due to the construction of the Aswan High Dam, the flooding cyclus of the Nile was stopped. In this process, the construction of the dam infrastructure project, great amounts of workers, heavy machinery and concrete was required.
As a result of the construction of the Aswan dam, the Nile does not flood but this also entails that several areas surrounding the Nile now became arid (Cairo scene team, 2016).



Egyptian storm - present.
Retrieved from: Hammad (2020).



Egyptian flooding - flooding of the Nile. past.
Retrieved from: Shokry (2017).



Egyptian flooding - flooding of the Nile. present.
Retrieved from: Cairo scene team (2016).

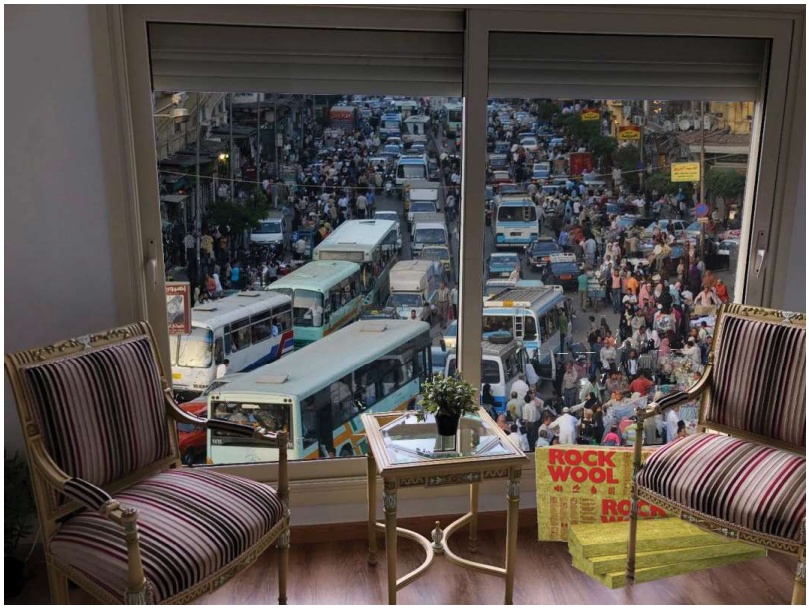
3.3.4. Window scapes

These windowscapes show how people experience the different extreme environemtns and show how they prepare or react to a certain extreme environment.

First of all, we start with the dragon storm / flash floods. Before the dragon storm is present in the city, we recognize a busy street with numerous cars and busses. No visible protection from a dragon storm can be seen. Some residents of the area might choose to reinforce their roofs with isolation, so they remain functioning, even in times of a dragon storm. This is mostly done in the informal settings.

When a dragon storm is expected to take place some measurements are activated. Adel Hassan, head of the Cairo Wastewater Company, said that Egypt had been preparing for bad weather and that proper equipment had been employed, including 120 vehicles that have collected rainwater from the streets of Cairo. Next to that, residents of several houses take measurements into their own hands and buy water tanks to connect to the buildings pipelines for when the water is cut off due to the sewage system overload (Mohammed, 2020).

During the dragon storm the streets flood and the army is present to help, guide and rescue people. People complain because no active measurements were taken to prevent the flooding and not enough equipment was made available to help people. As a consequence people are stuck in traffic, and some buildings are cut off from electricity. That is why some residents choose to buy a generator to provide for electricity (ARAB NEWS, 2018).



Before dragon storm
Drawn by Eggink.



Leading up to dragon storm.
Drawn by Eggink.

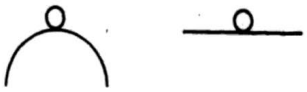


During dragon storm.
Drawn by Eggink.

This is visible in the directly after windowscape, where cars can not move due to the flooding. Public life comes to a hold because movement is not possible anymore. Because of the pressure from the rainwater on the drainage systems, the water pressure is cut off and people are stuck in their homes without water and in certain cases even without power. Some basements or other areas of buildings might flood, that is why some residents choose to buy a water pomp (National Oceanic and Atmospheric Administration, 2020).

WIth the 120 vehicles capable of collecting rainwater working around the day, streets slowly begin to become visible again. Public life starts again and slowly the situation as it was before the dragon storm begins to become visible. As a consequence of the dragon storm certain areas struck the hardest are destroyed or damages in such a way that repair is necessary. Most of the times these are informal setting areas, where (construction) materials are not of high quality and thus can not withstand the extreme dragon storm (Burgess, Jenks, 2001).

Douglas perspectives related to the dragon storm.
Nature Human

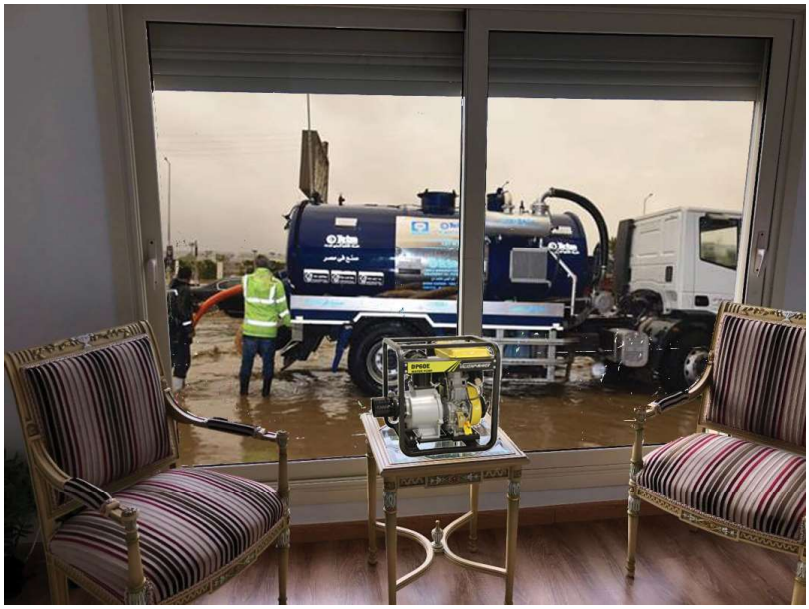


The nature perspective related to the dragon storm is fragile. The nature needs more time to recover from a dragon storm and because it is neglected in modernday Egypt the capacity to absorb the heavy rain as a consequence of a dragon storm is not sufficient enough.

The human perspective related to the dragon storm is capricious. This is due to the fact that humans can prepare themselves, as is shown in the different windowscapes. For humans it is possible to purchase broken items and easily repair or replace certain elements. Nonetheless, due the unpredictability and power of the dragon storm humans need to be carefull.



Directly after dragon storm.
Drawn by Eggink.



After dragon storm.
Drawn by Eggink.

These windowscapes show how people experience the different extreme environemtns and show how they prepare or react to a certain extreme environment.

The first three windowscapes are related to the agriculture of egypt. These are related to the drought of the environment. First of all, we start with the droughts. The drought in egypt are increasing in time and in temperature. The temperature has risen throughout the last few years. Before the drought workers are busy with picking vegetables. The agricultural land is green with a lot of plants (Middle East Monitor, 2018) (Keegan, 2019).

During the drought the agricultural land turns arid. No workers can be seen, only a few bypassers. This has a economic and social impact on people. People lose their income and come in financial problems. Some farmers with enough financial resources, take matters into their own hands by buying water tanks that they use for irrigation. Next to that, social contacts are not maintained because people do not meet each other in and around work (Mahmoud, 2017).

When the drought is partially over, farmers invest in plants that are able to wistand drought better than other plants. Furthermore, in certain parts of egypt the government is investing in irrigation infrastructure so that farmers can wistand the drought. Next to that, farmers are trained and advised how to cope with the extreme enviroment (Nada, 2014).

Douglas perspectives related to the drought.

Nature Human



The nature perspective related to drought is robust within limits. The nature is capable of transforming to a dry area but within certain limits. Plants capable of dealing with drought are present in Egypt. Furthermore, by drilling wells, pocktets of water can be used to irrigate the nature and prevent the plants and organisms from dying. However, if the dry period continous to exist, the result can be a dead nature, with no living plants or organisms.

The human perspective related to drought is robust. The interior climate can easily be regulated compared to the outside climate by implementing and using different types of cooling. If the dry period continuous to exist the water used for irrigation of the nature will be diverted to drinking water, used for humans. That is why the human perspective is robust.



Before drought
Drawn by Eggink.



During drought
Drawn by Eggink.



After drought
Drawn by Eggink.

The following set of windowscapes is related to the flooding of wadi's.
The first windowscape shows how wadi"s are used in modern day Egypt. They funciton as an touristic attraction. Scientists and tourist are attracted to the wadi's and several tours are given (Malek, 2020).

During the flooding of the wadi's the area is unaccessible. Buildings and roads close to wadi's are destroyed, damaged or made unaccessible. Because the wadi's are very dry, they can not absorb all the water. In some cases this means that the area around the wadi will flood, which result in even more damage to buildings and people. People are scared for flooding and take measurements, buying isolation and a water pomp (Malek, 2020) .

After the flooding of the wadi's the arid landscape slowly turns green again. Some vegetation can be recognized and in some cases an area becomes an agricultural area where vegetables are produced. This can function as an economic and social gathering place. The surrounding becomes greener again (Malek, 2020).

Douglas perspectives related to the flooding of wadi's.

Nature Human



The nature perspective related to the flooding of wadi's is robust within limits. Due to the drought and it effect it has on the soil of the wadi, a wadi is capable of absorbing a certain amount of rain water. Due to geographical characteristics a wadi can also function as a river, letting water flow to rivers or other bodies of water. But due to the unpredictability of the rain in Egypt this wadi can also flood and cause damage to the surrounding.

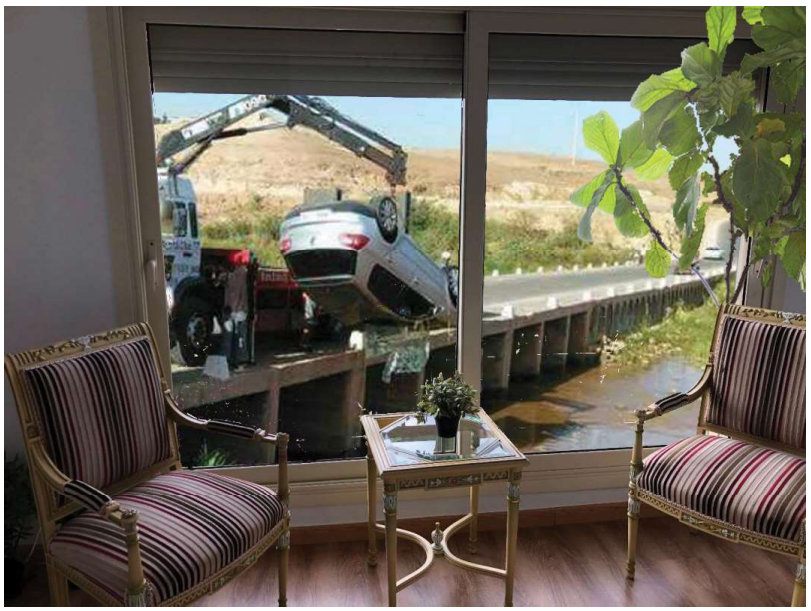
The human perspective related to the flooding of wadi's is robust within limits. Humans can can prepare themselves for the flooding of a wadi. However, because this flooding can have a lot of power, humans can also be caught of guard. If the flooding of the wadi is big and strong enough it can destroy and or move cars, people and even parts of houses down stream.



Before flooding of wadi
Drawn by Eggink.



During flooding of wadi
Drawn by Eggink.



After flooding of wadi
Drawn by Eggink.

3.3.5. Deepmap

The social structure of the plan area can be derived from the typologie of the buildings. As seen in the map, most of the buildings are residential buildings. For the social structure, people are relying on the social clubs, just to the left of the project area and rely on the different mosques in the area. The buildings in black are public buildings.

The social clubs on the left are all placed within a gated community. This community is comprised off a shooting club, sport club, garden club and a swimming club. These clubs are mostly used by the (middle) higher class. This is a result of the fragmentation of the social structure of the egyptian society. These different classes have different ways of social interaction. With the lower classes, not present in our project area, meeting on the streets and in houses, the middle and higher classes use social clubs for their social structure (DAI, 2012).

The social structure of this area can be related to the infrastructure present in this project area. With much attention adressed to car infrastructure, it can be concluded that the social structure is interrelated to the infrastructure. The car is used for the social structure of the inhabtitants and so it has been given much space in this area, compared to the area for pedestrians. The area for pedestrians in this project area are the English landscape gardens, located in several courts surrounded by buildings.



Drawn by Eggink based on OpenStreetMap (n.d.).





3.4. Landscape

3.4.1. The Natural Layer

The River Nile is defining the natural layer of Cairo and all of Egypt. The counrty is relying on the river and its delta. Most of North Africa is desert, and Egypt is not different. Only around the Nile there is a riverline landscape, which is fertile and suitable for cultivation and urbanisation (European Soil Data Centre ,1975). The desert landscape of Egypt has a natural wadi system to drain the scarce rainwater. (Malek, 2020)

These wadi's are visible in the geomorphological map. The wadi's start at the top of a hill in the desert and they become larger towards the Nile (Allan et al, 2019). The desert around Cairo is hilly. Along the River Nile the landscape is plane, but when the landscape becomes desert, there are steep slopes and cliffs. These cliffs are at the location where the contour lines come together and the hill shade is dark (Bubenzer, Embabi, & Ashour, 2020). The main wadi in the area is the Wadi Deglah, more to the east in the map.

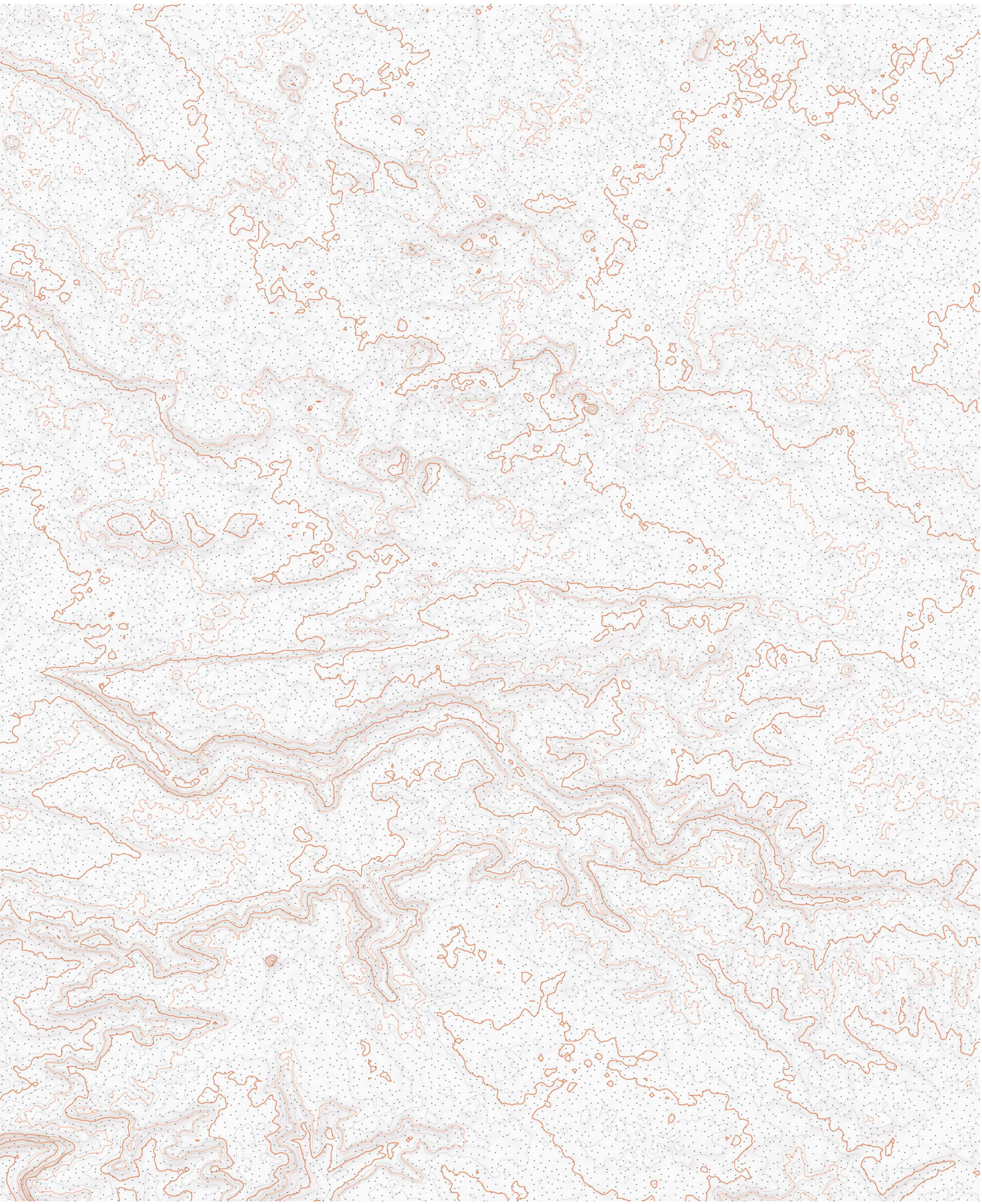
The soil along the Nile, at the riverline landscape, is Nile Alluvium. The soil is fertile and used for agriculture and urbanisation. Towards the desert, the soil becomes gravel and gravelly sand. It is a combination of the Nile Alluvium and lithosols of the desert. In the desert landscape, the soil is made out of limestone with lithosols (European Soil Data Centre ,1975).



Natural Layer Map

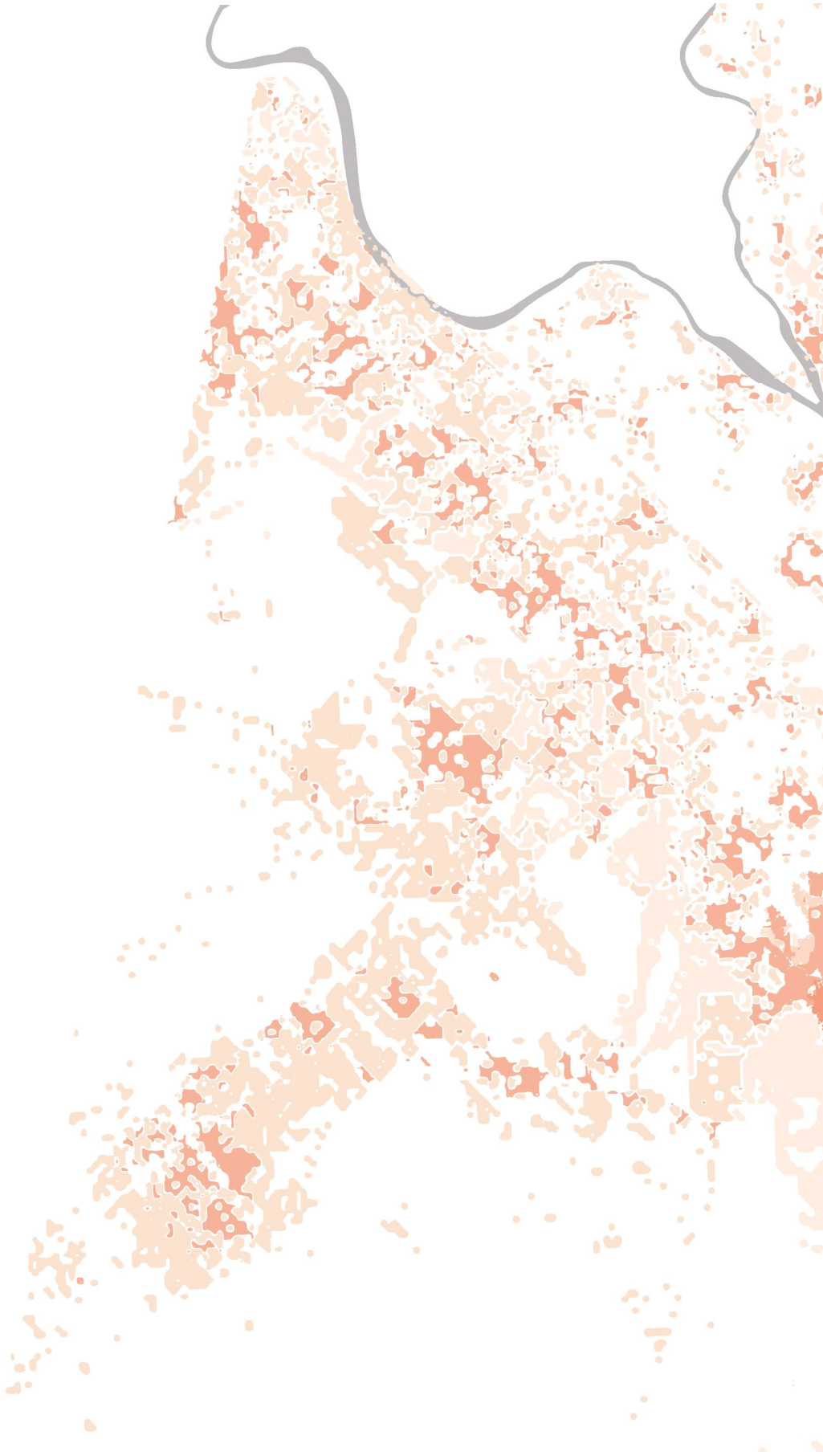
drawn by Van den Broek, based on European Soil Data Centre (1975), MilvusMap (n.d.), and OpenStreetMap (n.d.)

- Contour Lines
- Riverline Landscape
- Desert Landscape
- Nile alluvium
  Pellusters, Vertic Torrifluvents, Eutric Fluvisols, Pellic Vertisols
- Gravels and gravelly sand soils
  of the alluvial fans, outwash plains, Nile terraces and Piedmont plains. Calciorthids, Gypsiorthids, Torriorthents, Calcaric and Eutric Regosols, Calcic and Gypsic Yarmosols, Lithosols
- Dissected Limestone plateau
  with lithosols
- Nile River

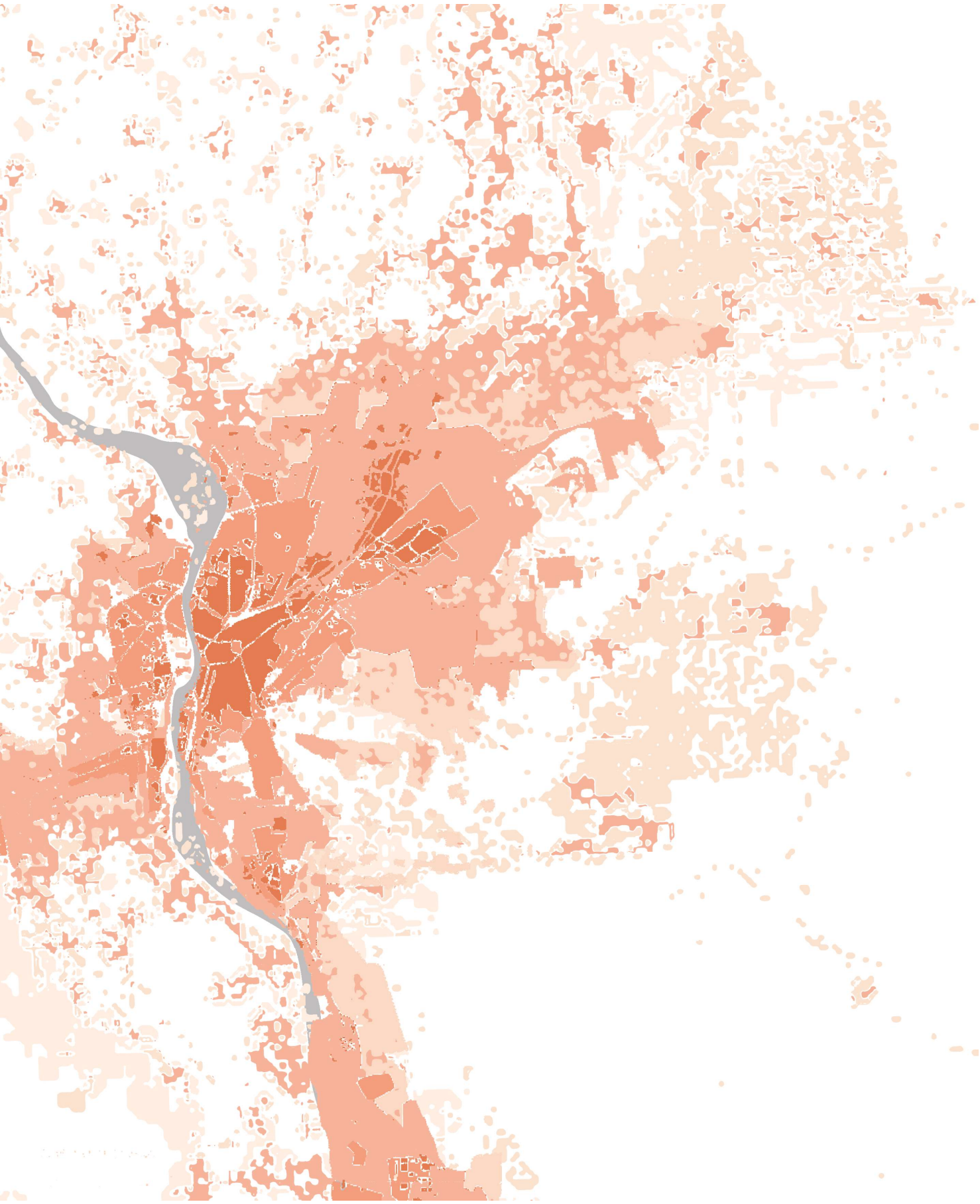


3.4.2. Cultural Layer

The settlements in and around Cairo are based on the natural layer. First settlements were around the Nile at the flat and fertile landscape (Wagner & Debnes, 1911). From the 1950's the city started to grow exponentially and there was no space anymore on the riverline landscape. The newer settlements were built on the boundary of riverline and desert landscape, around the gravel soil type. Eventually, also this space was fully built. Egypt started creating complete new cities in the desert, such as New Cairo and 6 October (Sims, 2010). This process is still ongoing, with the new administrative capital city as crown jewel.



Building Age Map
drawn by Van den Broek, based on Megahed et al. (2015) and Moharram et al. (2008)



3.4.2. Cultural Layer

Looking at the ways these settlements are connected, it can be seen that the car has a dominance, especially in the desert settlements. There are only train and metro lines along the Nile, not towards the desert. The water is scarce in Egypt, and therefore there are large water treatment plants to reuse wastewater (Al Baz, Otterpohl, & Wendland, 2008). This wastewater is mainly used to irrigate green areas, especially in New Cairo. On top of that, canals transport water to irrigate the soil, especially used for agriculture. Although the water is scarce, there is also a flooding risk (Floodmap, n.d.). The Aswan Dam is protecting Egypt for flooding from the Nile, but along the wadi's there is no protection. However, the people are protected from the heat. The building blocks are high and dense to create shadow.

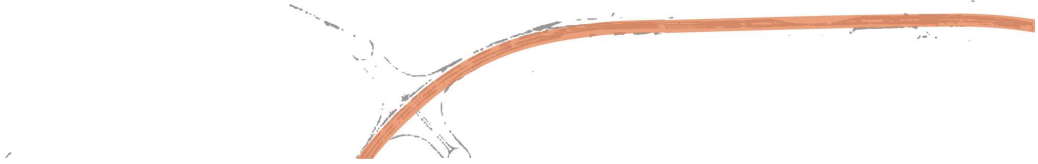
Cairo is exhausting the landscape by creating cities in the desert with irrigated parks, as well as using all possible fertile soil for agriculture. The streams of the wadi are cut off the create the new desert cities. The cultural layer does not give the natural layer enough space to breath.



Cultural Layer Map

drawn by Van den Broek, based on Google Earth (n.d.), Google Maps (n.d.), and OpenStreetMap (n.d.).



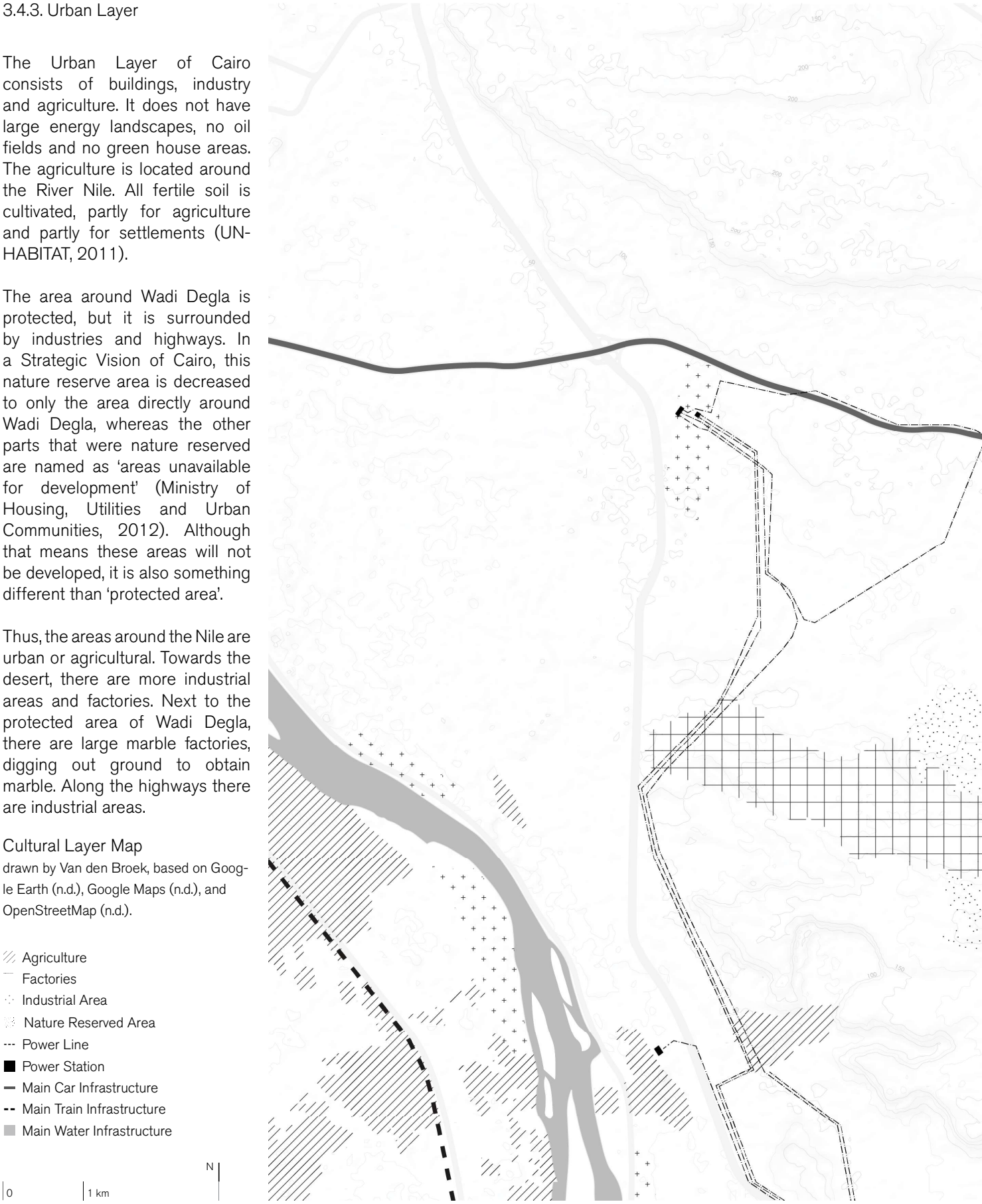


3.4.3. Urban Layer

The Urban Layer of Cairo consists of buildings, industry and agriculture. It does not have large energy landscapes, no oil fields and no green house areas. The agriculture is located around the River Nile. All fertile soil is cultivated, partly for agriculture and partly for settlements (UN-HABITAT, 2011).

The area around Wadi Degla is protected, but it is surrounded by industries and highways. In a Strategic Vision of Cairo, this nature reserve area is decreased to only the area directly around Wadi Degla, whereas the other parts that were nature reserved are named as 'areas unavailable for development' (Ministry of Housing, Utilities and Urban Communities, 2012). Although that means these areas will not be developed, it is also something different than 'protected area'.

Thus, the areas around the Nile are urban or agricultural. Towards the desert, there are more industrial areas and factories. Next to the protected area of Wadi Degla, there are large marble factories, digging out ground to obtain marble. Along the highways there are industrial areas.



Cultural Layer Map

drawn by Van den Broek, based on Google Earth (n.d.), Google Maps (n.d.), and OpenStreetMap (n.d.).



3.4.4. Spatial Experience & Mass Index

At the meso scale of 1 : 25,000 the area can be clearly divided in urban area and desert, or mass and space. The urban areas follow the landform. When the land is too steap, there is not built. Both in the urban area in the desert there is no natural green, so the spatial experience is focused on the buildings. The residential areas are divided in two types: dense and high or sprawled and low.

New Cairo consists more expensive neighbourhoods, where the buildings are low and sprawled. Residents have more private space around the building and the roads and public spaces are more spacious. The greenery in the parks and gardens are irrigated. The areas more towards Cairo have high and dense middle class dwellings. Residents have almost no exterior private space and roads are smaller.

Space and Mass are clearly divided in Cairo. Most urban areas have high buildings and a high density, whereas the desert is completely untouched. The Mass Index Maps confirm that.



L02 B Mass Index Map

Every mass is a neighbourhood or block (drawn by Van den Broek, based on Google Earth, n.d.)

Space
Mass



L02 B Mass Index Map

Every mass is a neighbourhood or block (drawn by Van den Broek, based on Google Earth, n.d.)

Space
Mass

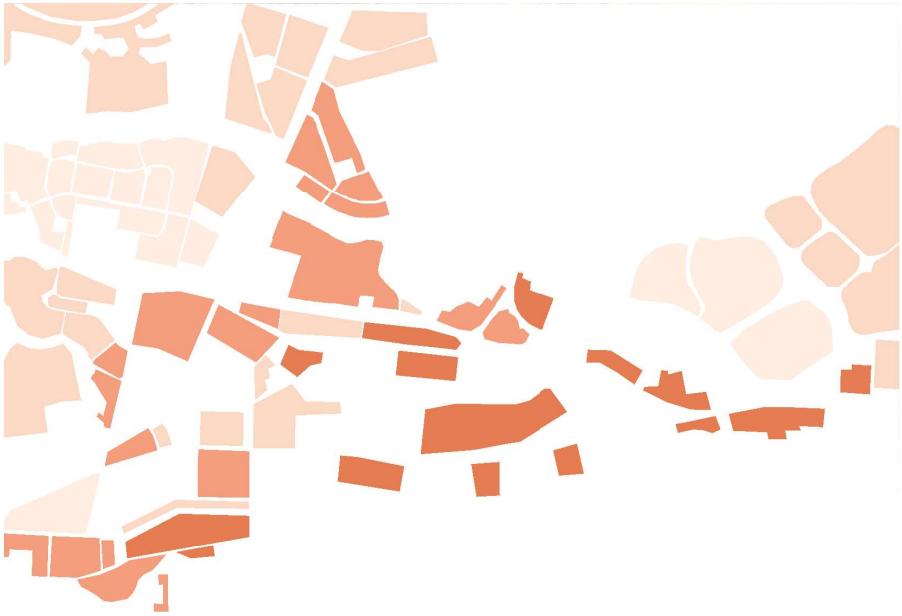
L02 A Building Size

Average per neighbourhood (drawn by Van den Broek, based on Google Earth, n.d.)

- < 500 m²
- 500 - 750 m²
- 750 - 1000 m²
- > 1000 m²

N

0 1 km



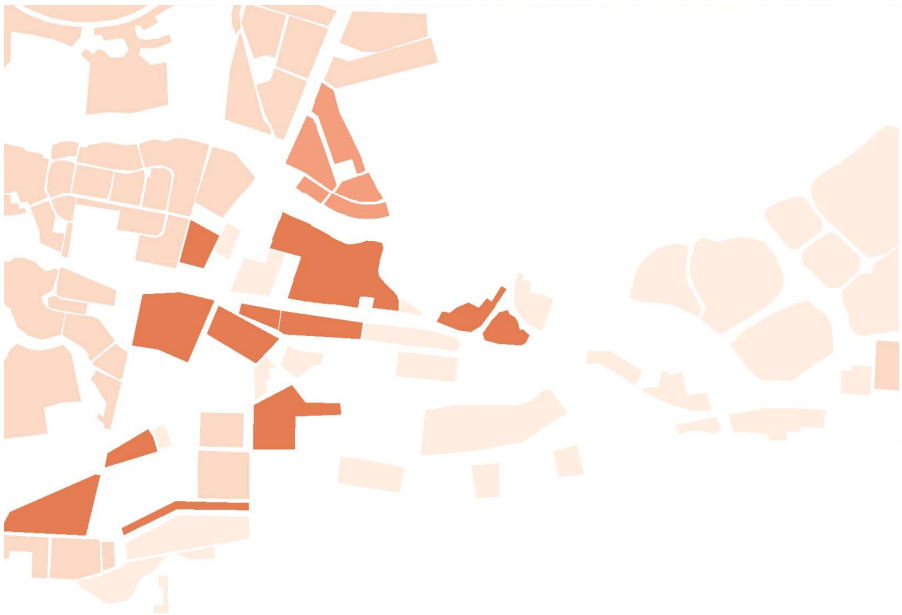
L02 A Building Density

Average per neighbourhood (drawn by Van den Broek, based on Google Earth, n.d.)

- low density
- medium density
- high density
- very high density

N

0 1 km



L02 A Building Height

Average per neighbourhood (drawn by Van den Broek, based on Google Earth, n.d.)

- 1 - 4 floors
- 4 - 7 floors
- 7 - 10 floors
- > 10 floors

N

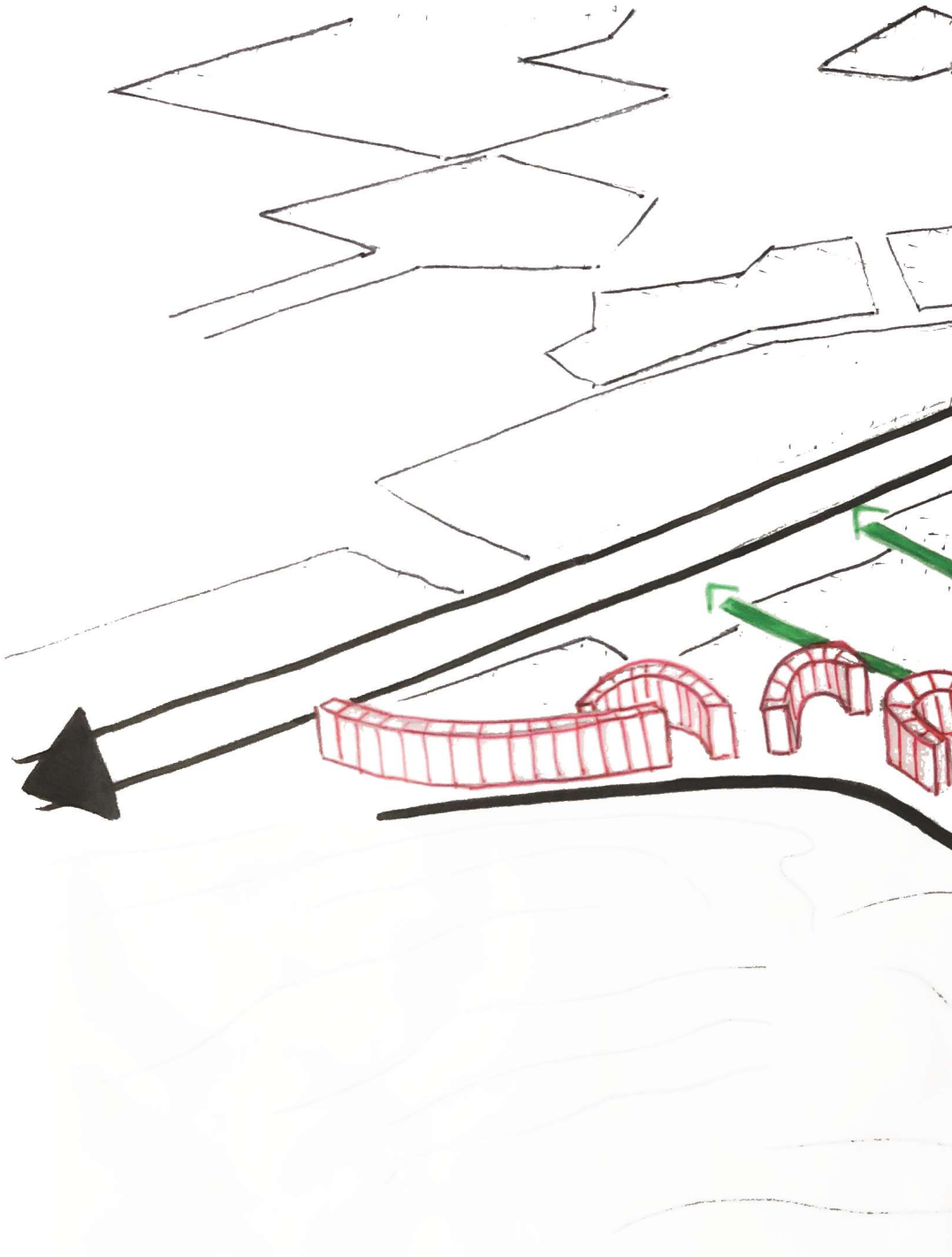
0 1 km

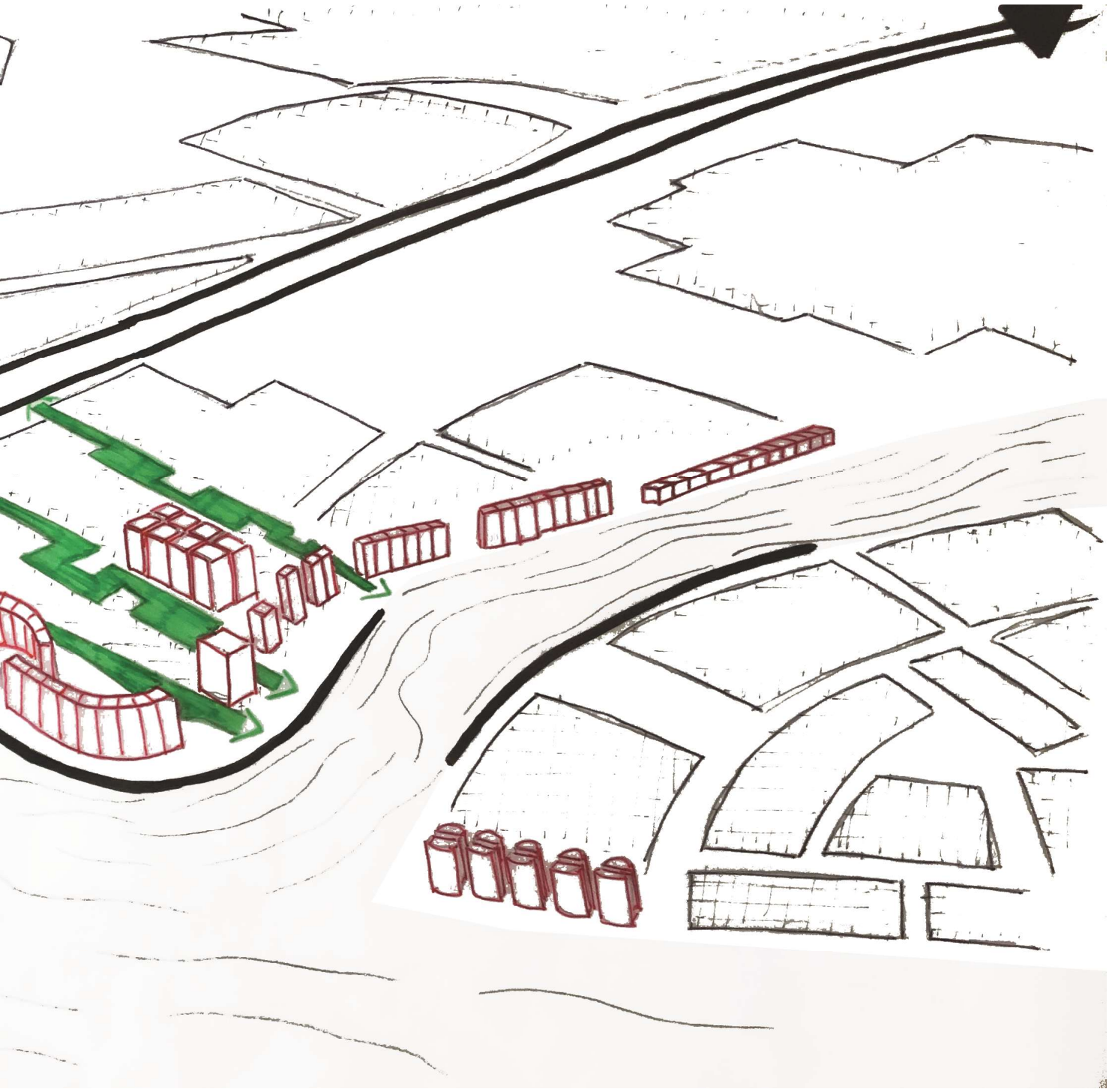


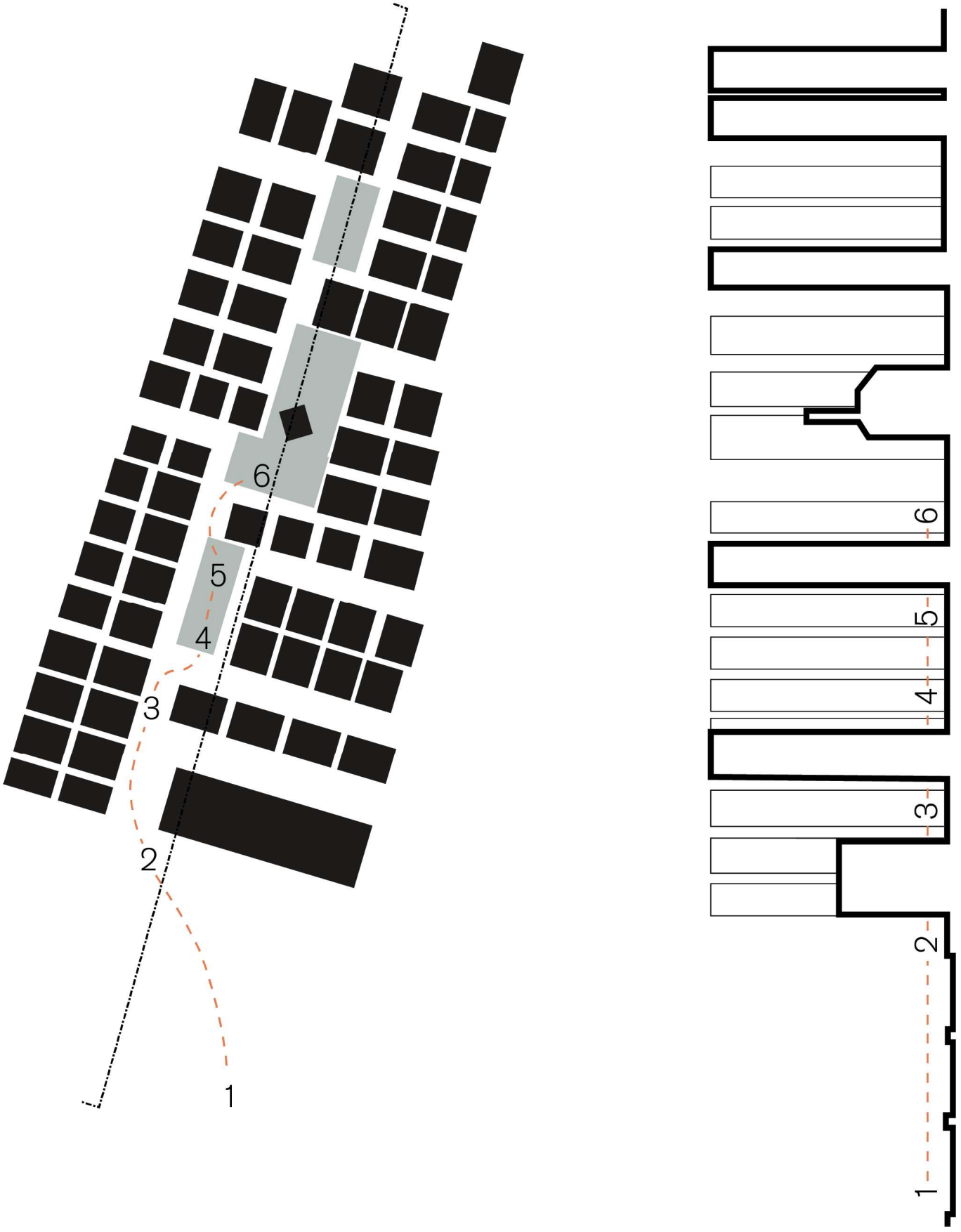
3.4.5.
Orientation Points & Sightlines
(drawn by Van den Broek)

A large wall on the north and east side protects the neighbourhood from floods and sandstorms, but it also creates an even larger barrier between the desert and the urban. On top of this wall, the desert and the buildings are visible. However, it is not possible to look over the neighbourhood, because all buildings along the wall have 12 floors and therefore block the view. This also means there is not a highest building in the area, because they are mainly the same height. On top of that there is not much vegetation, except for native desert vegetation and irrigated green in the parks.

The roads form the major sightlines of the area, especially the main highway along the south of the neighbourhood. It is a straight and wide road from Cairo to New Cairo. The large protection wall also forms a sightline along the building edge. Inside the neighbourhood, the smaller roads between building blocks form sightlines. Often, a mosque is located in the middle of the neighbourhood. In El-Hadaba El-Wosta it is the same. There are two mosques in the middle of the neighbourhood, which can be seen from the edge of the areas.

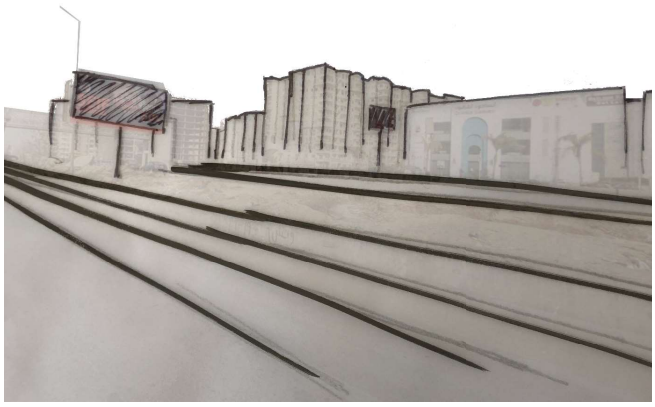






3.4.6. Gordon Cullen Sequence

A Gordon Cullen sequence shows a list of locations which form a sequence, a route through a certain area. (drawn by Van den Broek, based on Google Streetview, n.d.)



1



2



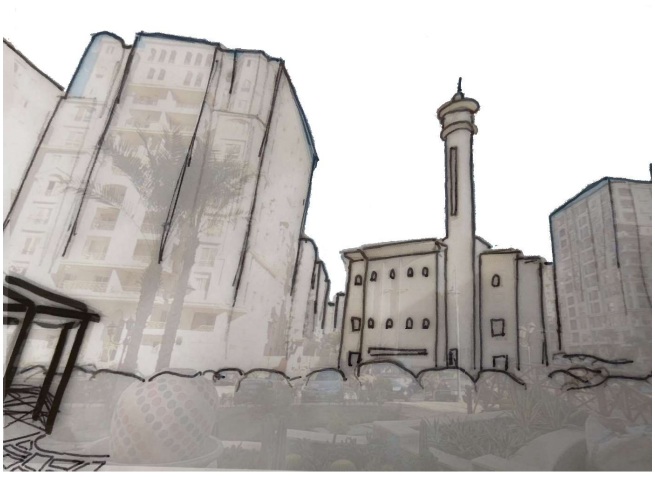
3



4



5



6



3.4.6. Gordon Cullen Sequence

This Gordon Cullen sequence shows a route from outside the neighbourhood towards the central point: a mosque. It also shows the contrast of the outside and inside of the neighbourhood. The sequence starts on the highway south of the area. The neighbourhood is enclosed by high buildings and from the highway it does not seem possible to enter this area. Coming closer, an entrance to the neighbourhood is found between two large buildings. The second picture still shows the large size of the highway and the continuous facades along it.



When entered the neighbourhood, the view is completely enclosed by buildings. All buildings have 12 floors and are built with the same material in the same style. Above eyelevel, the only thing that can be seen are the buildings touching the sky. Along the road there is a continuous row of parked cars. In the distance, a small pavilion is visible at the end of a park. Picture 4 and 5 of the sequence show the pavilion coming closer. It is the central point in the park and it seems a place to gather and recreate. Even though the pictures are made from out the park, the surroundings remain the same: high buildings touching the sky and continuous rows of parked cars.

The last picture shows the end of the sequence. The pavilion might be the central point of the small parks inbetween the buildings, it is subordinate to the major central point of the neighbourhood: the mosque. The mosque is a unique building. All buildings have the same style, except for the mosque. All buildings are densely packed to each other, the mosque stands free. This shows the importance of the mosque and therefore the importance of religion in the Egyption culture.



3.4.7. Colours and Materials

The collages to the right show the colours and materials used in the built environment. The facades are mainly plastered, and have yellow, brown and orange teints. These colours are not much different than the colours of the desert. The light colour helps to reflect the sunlight to keep the buildings cooler. Also the asphalt has a brown teint and is often covered by a layer of sand. The collage at the left bottom shows the similarities of the buildings and the sand. The two collages on the right have a green teint. This is irrigated green space. The irrigated spaces differ from large grass fields or small green bushes.



From these observations, three different types of landscape can be divided, which is done on the far right. First, there is the natural landscape, which is the desert. The area contains sand and limestone and native vegetation which is used to drought. The landscape is shaped by the wadi's flowing through. The second landscape is the urban landscape. It consists of high and dense buildings with a light plastered facade. Inside and on the edges of this urban landscape, the artificial landscape arises. It is the landscape of irrigated green. These landscapes are mainly located in New Cairo, but also in and around the







3.4.8. Hazard Prone Areas

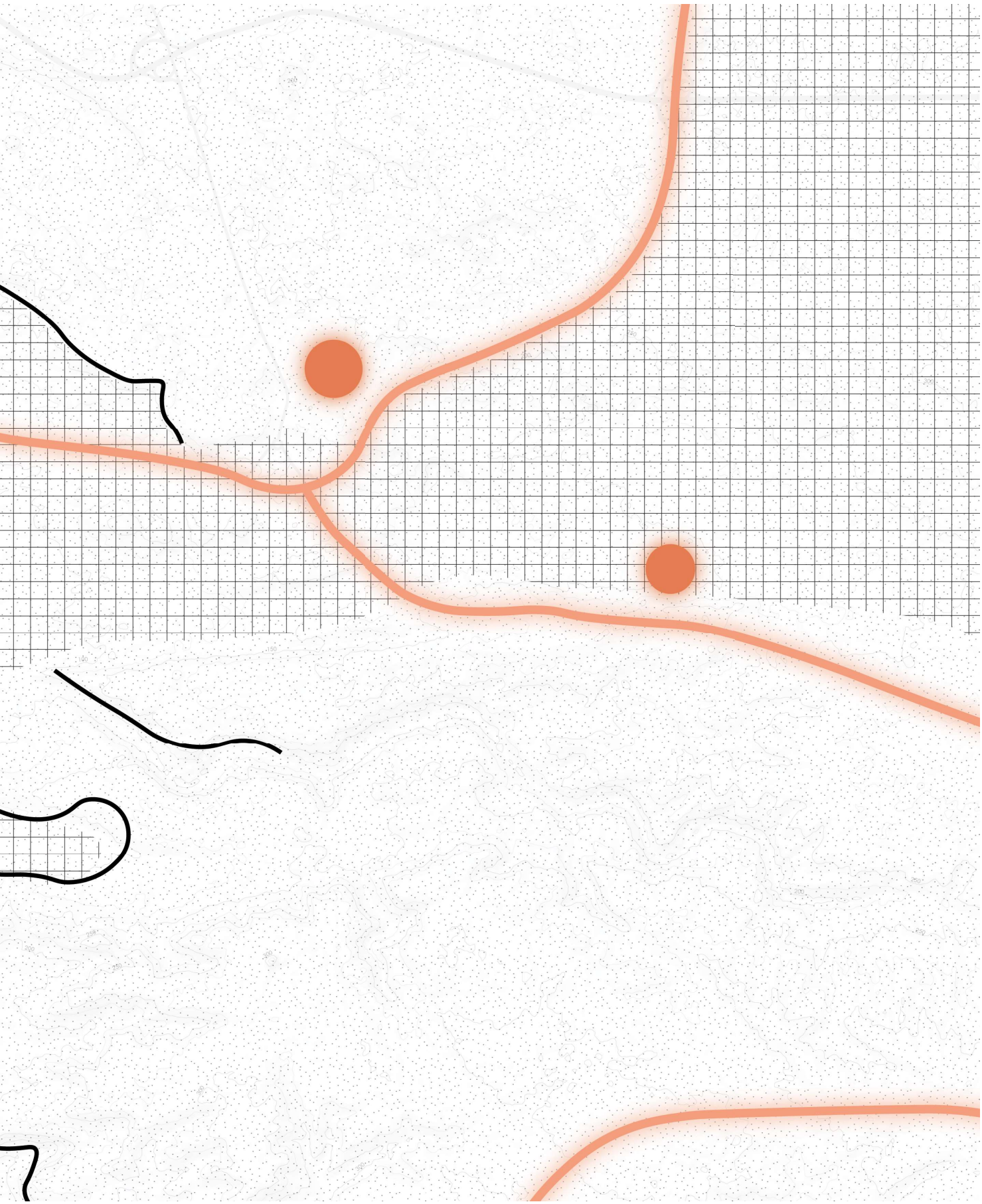
The plot has two major hazards wherefore they are prone: floods and drought. The River Nile does not have dikes and it is flat, which make the areas around if flood prone (Floodmap, n.d.). However, inland the Aswan Dams control the water and therefore the chance of flooding is relatively low. The areas in the desert are more flood prone because of peak rainfall. It only rains a few times a year, but the areas are not protected (Malek, 2020). The wadi's are bringing the rainwater to the Nile or the sea, but at some points the wadi is interrupted. Additionally, there are steep slopes and cliffs that seperate the desert and riverline landscape. These steep slopes can be hazardous with heavy rainfall or storms.

Another hazard, which is created by humans, is pollution. The car is the major form of transport, but this is causing a high amount of air pollution. On top of that, there are large polluting factories and industrial areas closeby nature and residential areas. This is not a natural hazard, but it is still dangerous for humans and their health. It is also a hazard which humans can control.



Hazards Map

Drawn by Van den Broek, based on Floodmap (n.d.), Google Maps (n.d.), and OpenStreetMap (n.d.).

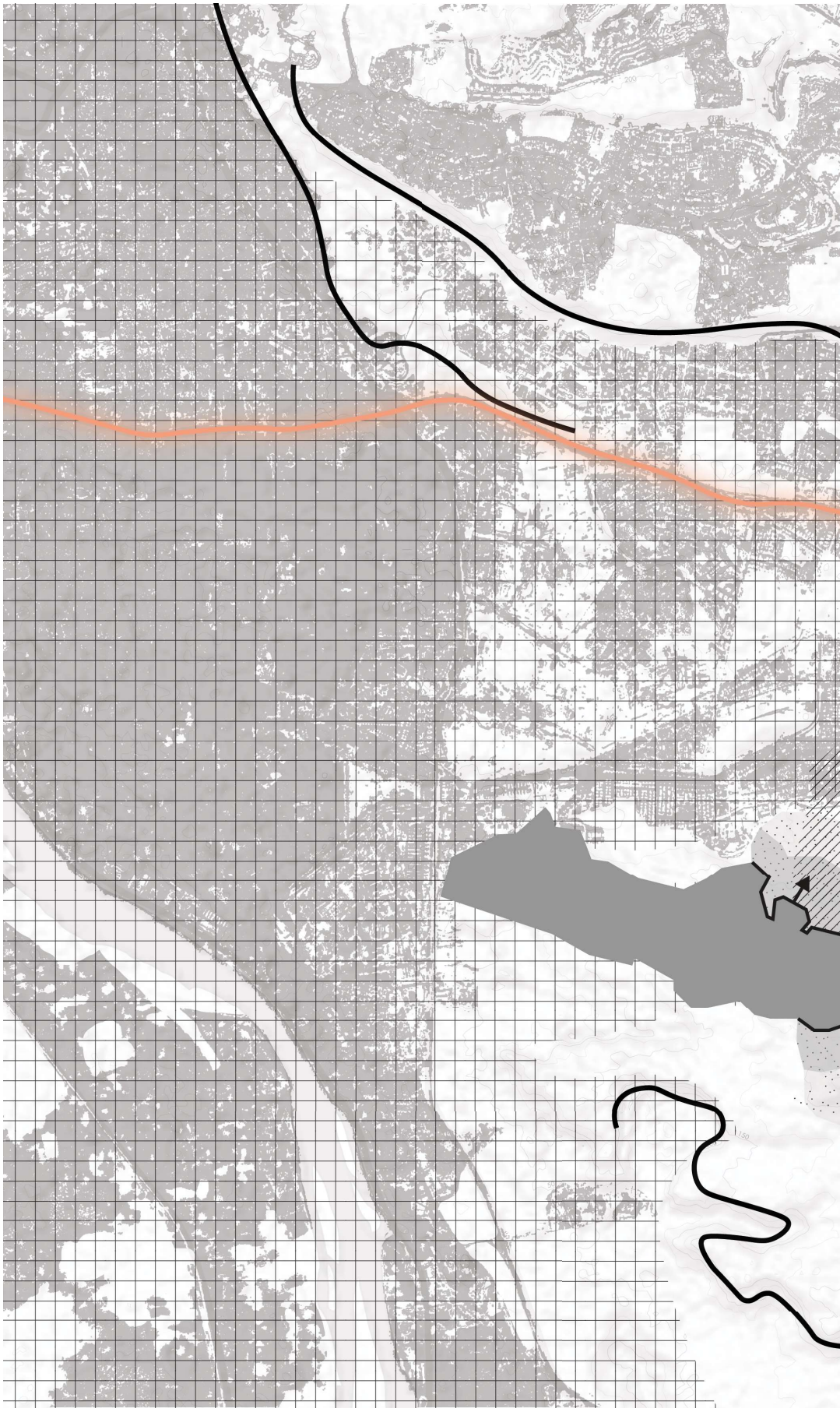


3.4.9. Exposure

Overlaying the urban settlements with the flood prone areas, there can be concluded that a large amount of settlements have a flooding risk. Along the River Nile, the settlements have a risk of flooding of the river. In the desert areas, there is a risk of flooding due to rainfall. The settlements along the Nile are protected by the Aswan Dams, whereas the desert areas do not have a proper protection. On top of that, when it does not rain, the settlements in the desert landscape are drought prone.

The settlements in the desert pressure the natural areas by cutting of the wadi's and exhausting the landscape. There is a natural reservation area around Wadi Deglah. However, the industries and highways around it are pressuring it, especially the marble industries on the west side of the reserved area. Through the years the marble industrie digged out land to win marble. In a strategic vision of Cairo, there has been made a new preservation area, which is only surrounding the main wadi of Wadi Deglah, and not the whole nature reserved area.

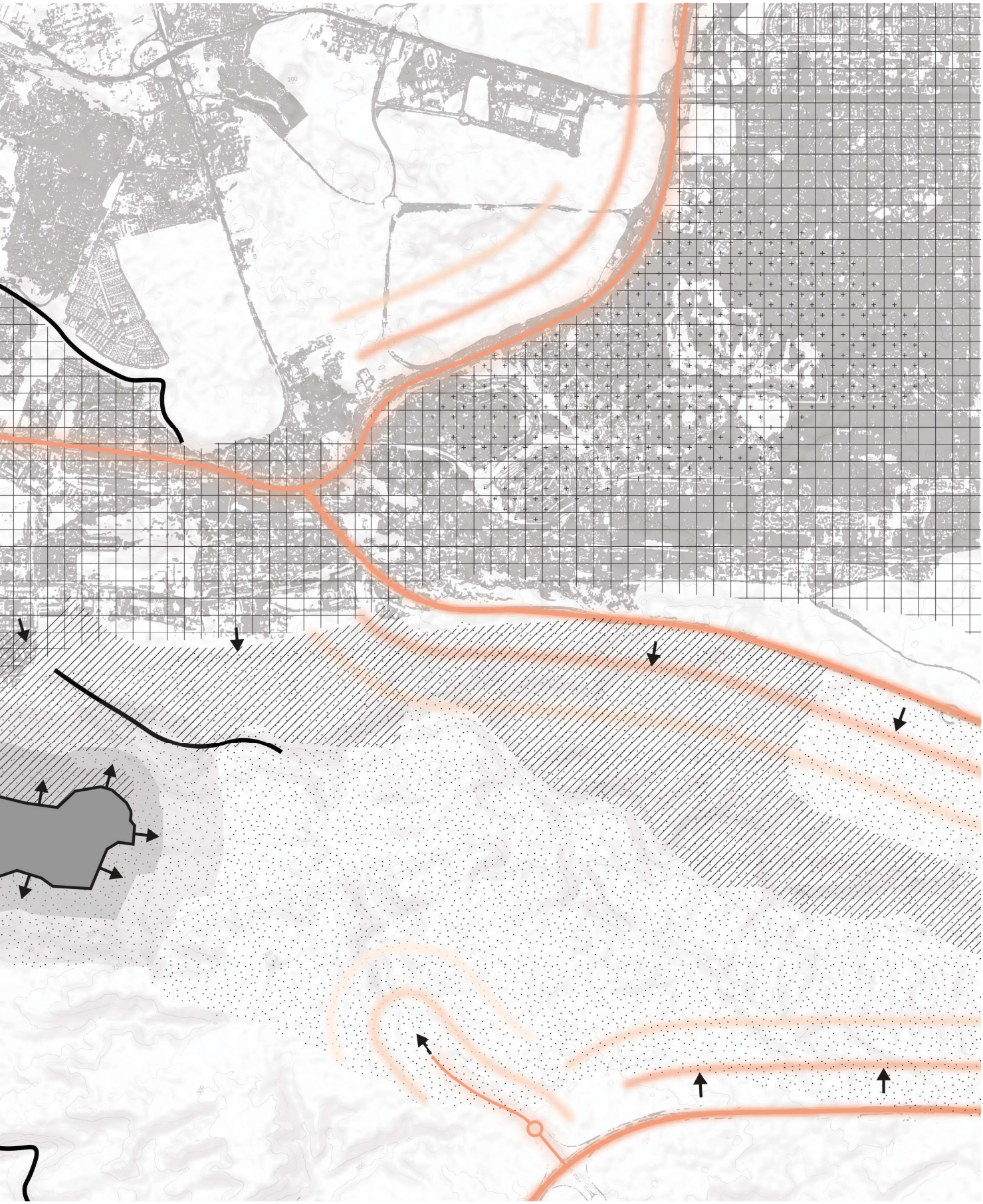
In addition to this pollution, the irrigation of greenery is exhausting the landscape and increasing water scarcity. Especially the



Exposure Map

drawn by Van den Broek, based on Floodmap (n.d.), Google Maps (n.d.), Malek (2020), MHUUC (2012), and OpenStreetMap (n.d.)

- Flood Prone Area
- Nature Reserved Area
- Wadi Deglah Preservation Area
- Irrigated Area
- Polluting Highway
- Highway affecting natural areas
- Steep Slopes
- Marble Factory
- Settlements
- Urban areas affecting natural areas



3.4.10. Fragility

The transition from desert to urban landscape is very abrupt. At certain location in the area they are even seperated by a wall, most of the time to cover a large height difference. The edge of the urban area follows the contour lines, it stops when there is a steep slope (MilvusMap, n.d.). This means the city of Cairo expanded until it was not possible anymore. After that it started creating desert cities further outside the city. These desert cities contain sprawled lowrise buildings. The earlier expansions until the steep slopes however, are high and dense. These areas are also prone to flooding (Floodmap, n.d.). This is already a problem, but the amount of people living in these areas make it catastrophic.



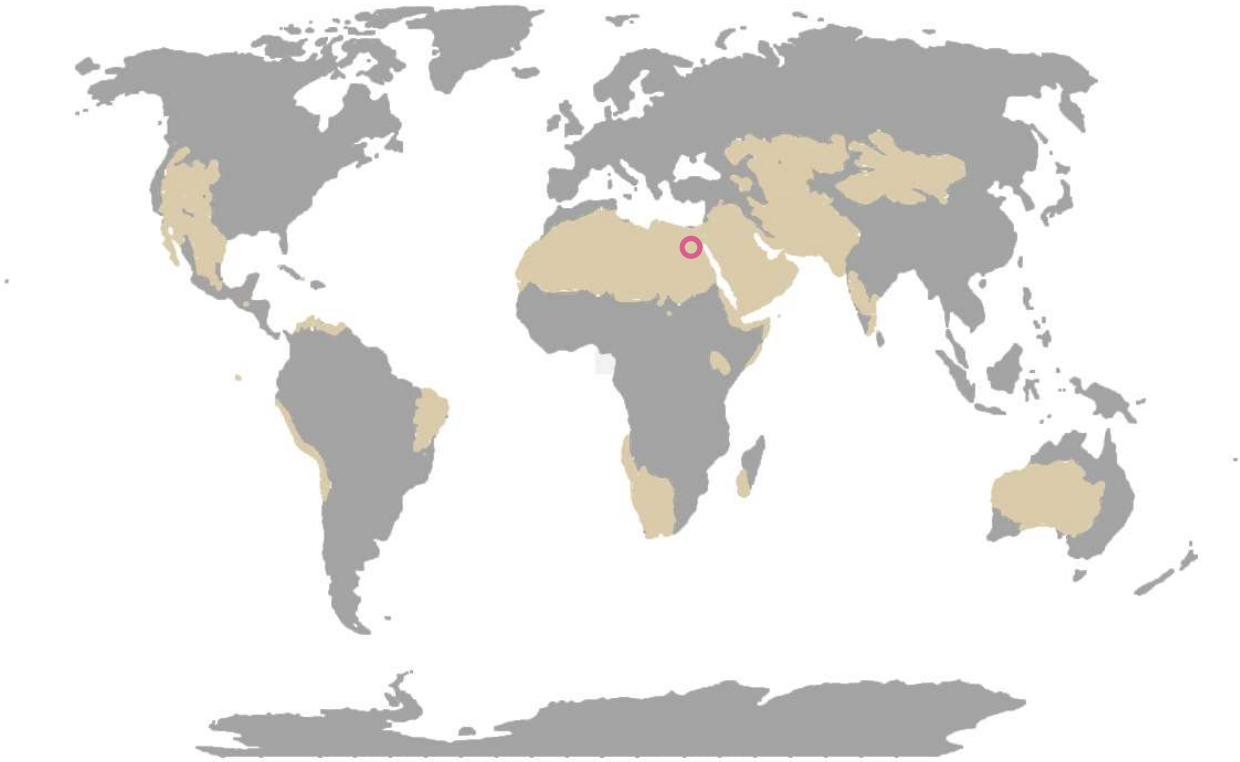
Fragility Map
drawn by Van den Broek, based on Floodmap (n.d.), Google Earth (n.d.), & MilvusMap (n.d.)

- Contour Line
- Mass
- Space
- Flood Prone Area
- Drought Prone Area



3.5. Ecology

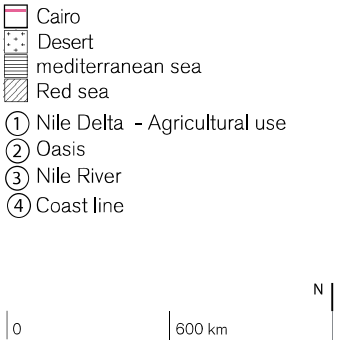
The world's tropical deserts.



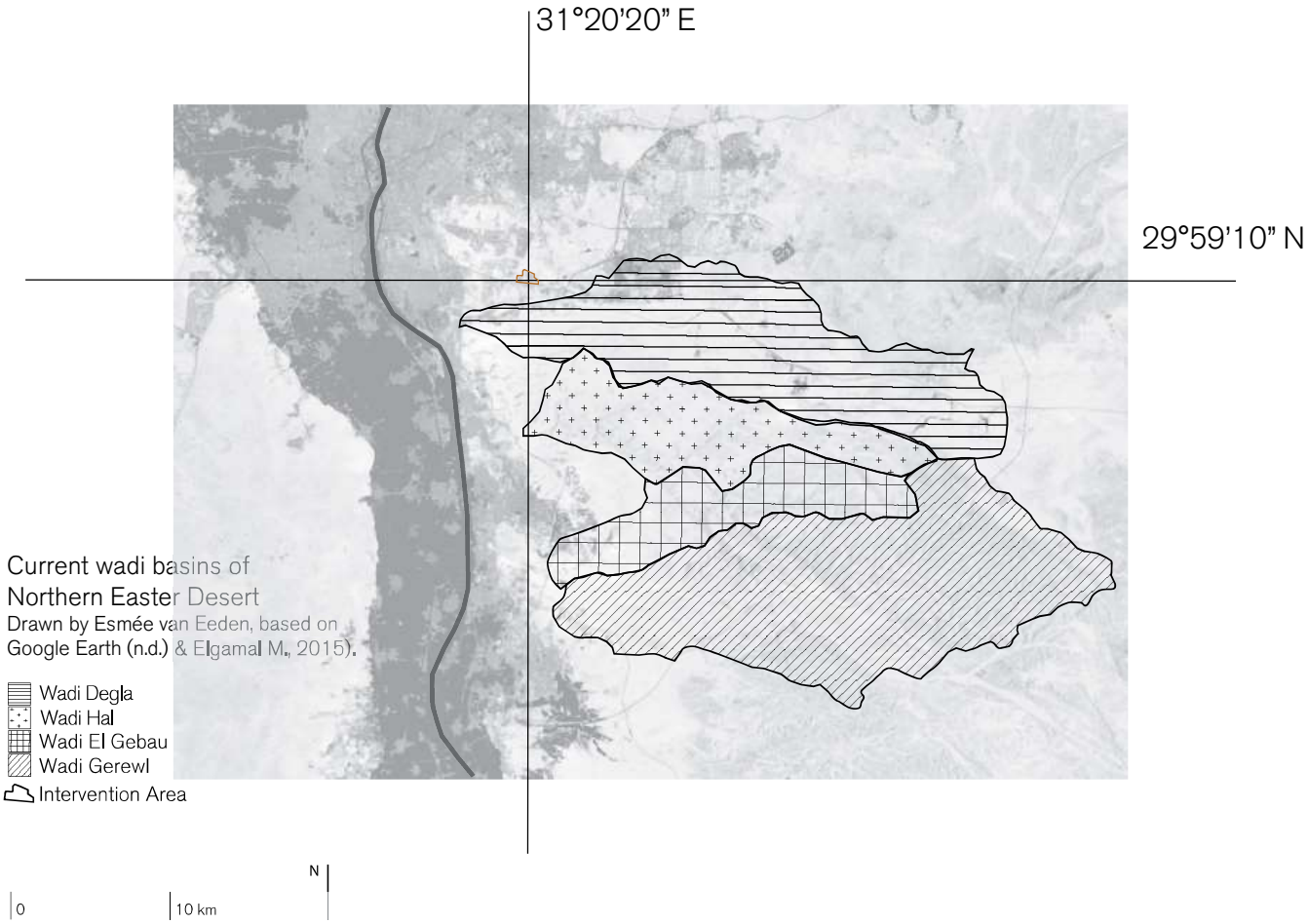
3.5.1. Biomes and Ecotones

Egypt is located south of the Mediterranean Sea and north-east on the continent of Africa. Egypt has an arid desert climate with warm days and cold nights. About 95% of Egypt's land is almost uninhabited desert and is part of the Sahara. The other 5% is mainly covered by the Nile Delta. A small amount is defined by the oasis' and the coast line. The transition between the desert and Nile river and Delta is quite abrupt and is defined by irrigated and non-irrigated land. Cairo is situated at the transition between the Nile as river to the Nile as a Delta. A strategic location for water security and food security. (El-Ramady H. L., El-Marsafawy S. M., and Lewis L. N., 2013).
At the east side Cairo is situated next to the Eastern Desert of Egypt. This part of Cairo is the most recently built part.

Biomes and Ecotones
Drawn by Van Eeden, based on Google Earth (n.d.)

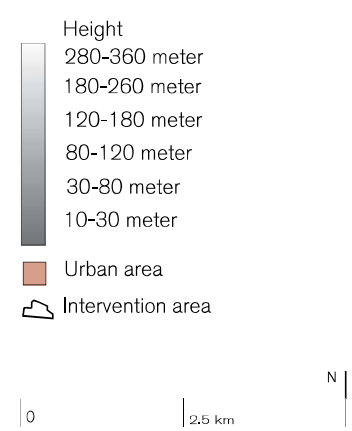


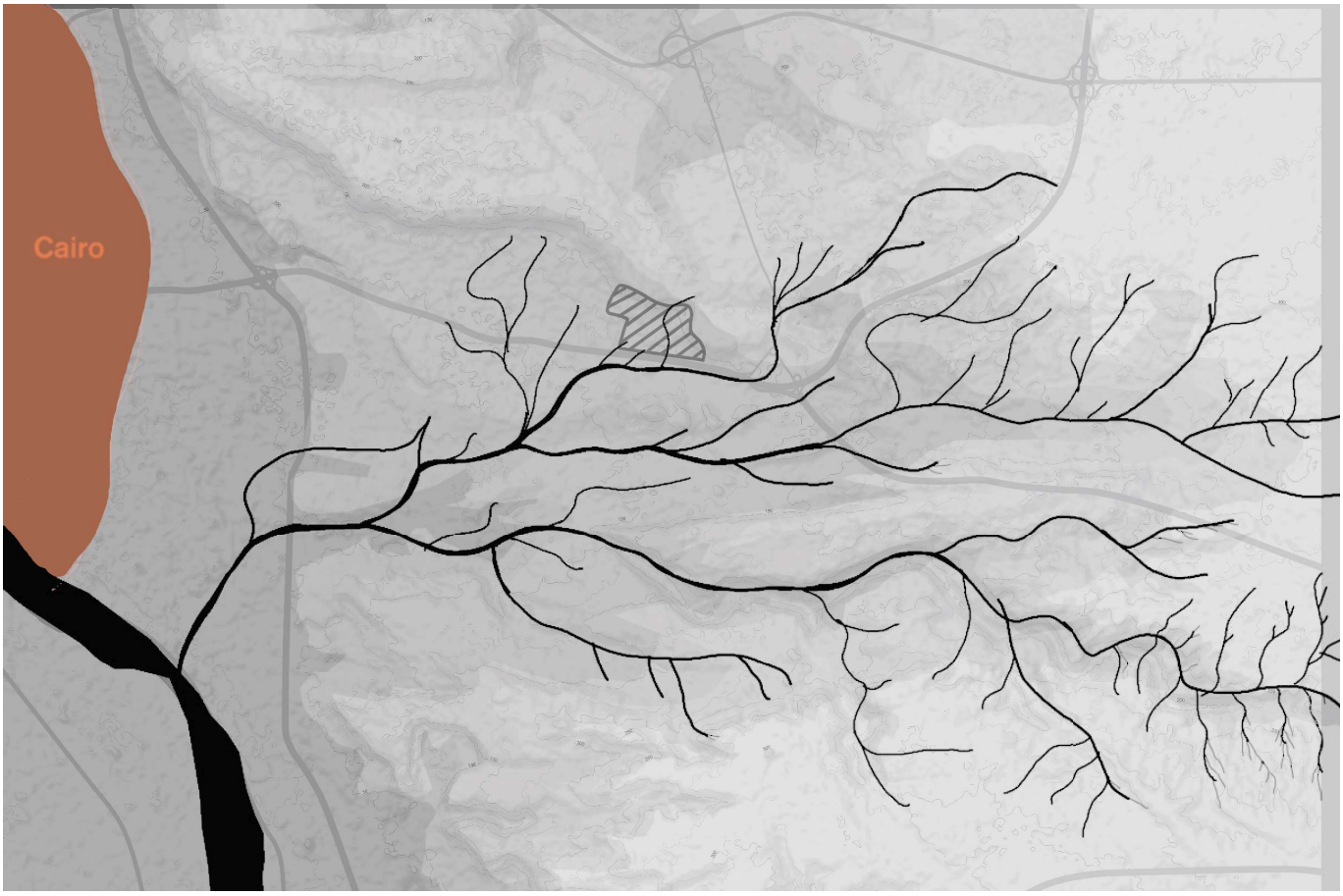

4
1
2
3



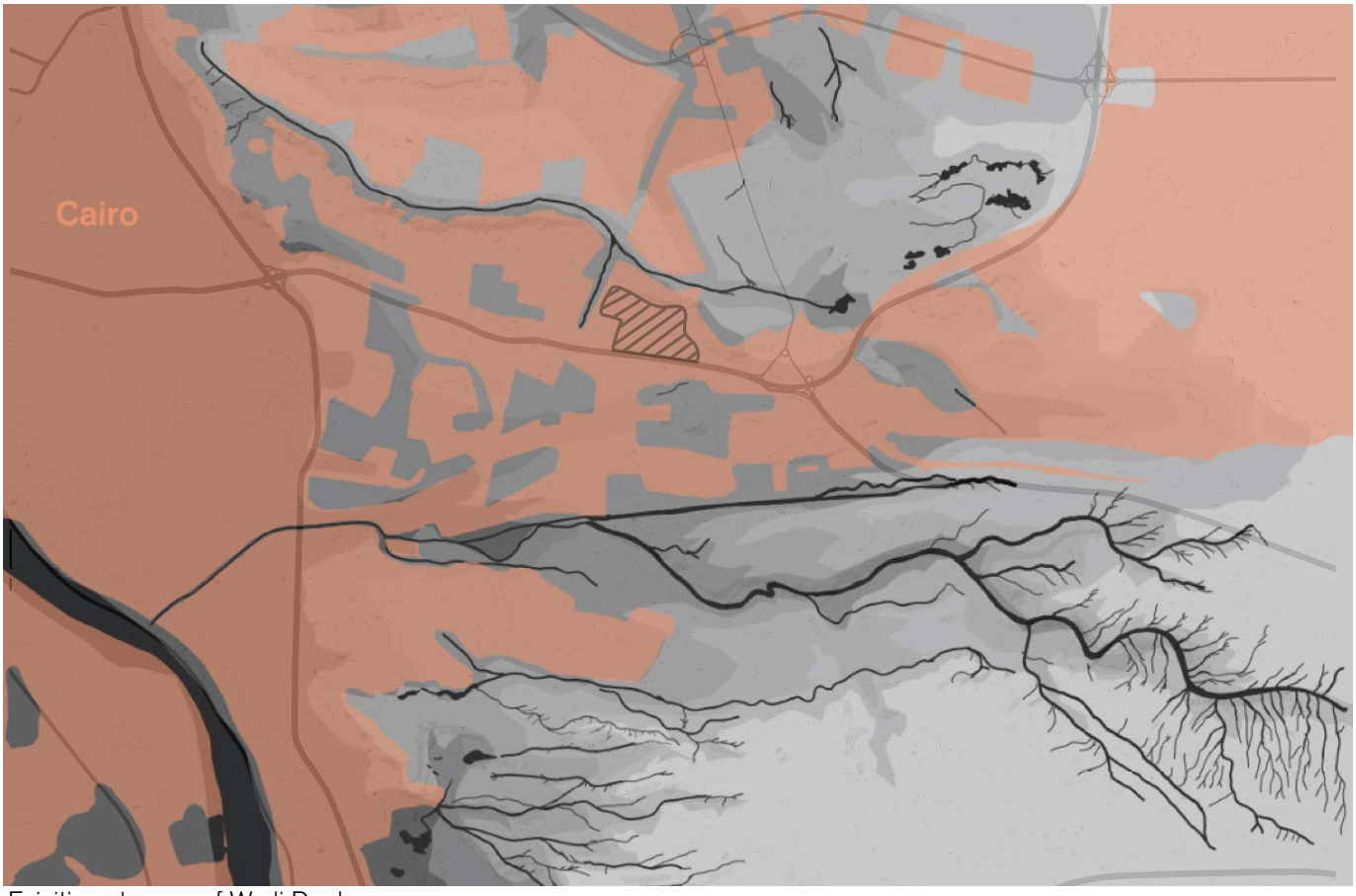
3.5.2. Wadi Degla basin

The ecology and environment in and around the intervention area is mainly defined by the desert ecotope and Wadi Degla. A wadi is a stream basin where rain water is captured before it naturally drains toward the Nile or the sea. In the Northern part of Egypts eastern desert are four wadi basins situated (figure above). The top one is called Wadi Degla which overlaps with Cairo and the project site. Due to urbanization the wadi streams are cut off. Since a proper drainage system is lacking in Cairo, flash floods will occur when there is heavy rain. The neglections of the original wadi streams also have as consequence that rainwater is not harvested any more and that specific micro habitats are demolished. (Elgamal M., 2015)

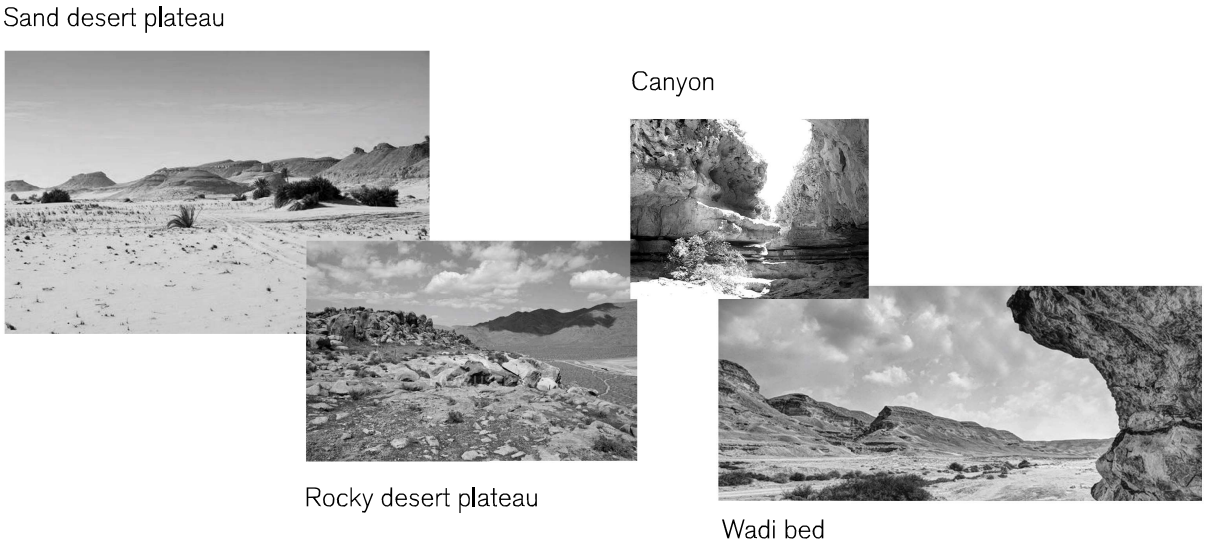




Topographical and morphological
assessment of the Wadi Degla basin with ancient contours of Cairo.



Exisiting streams of Wadi Degla
with current urbanization.



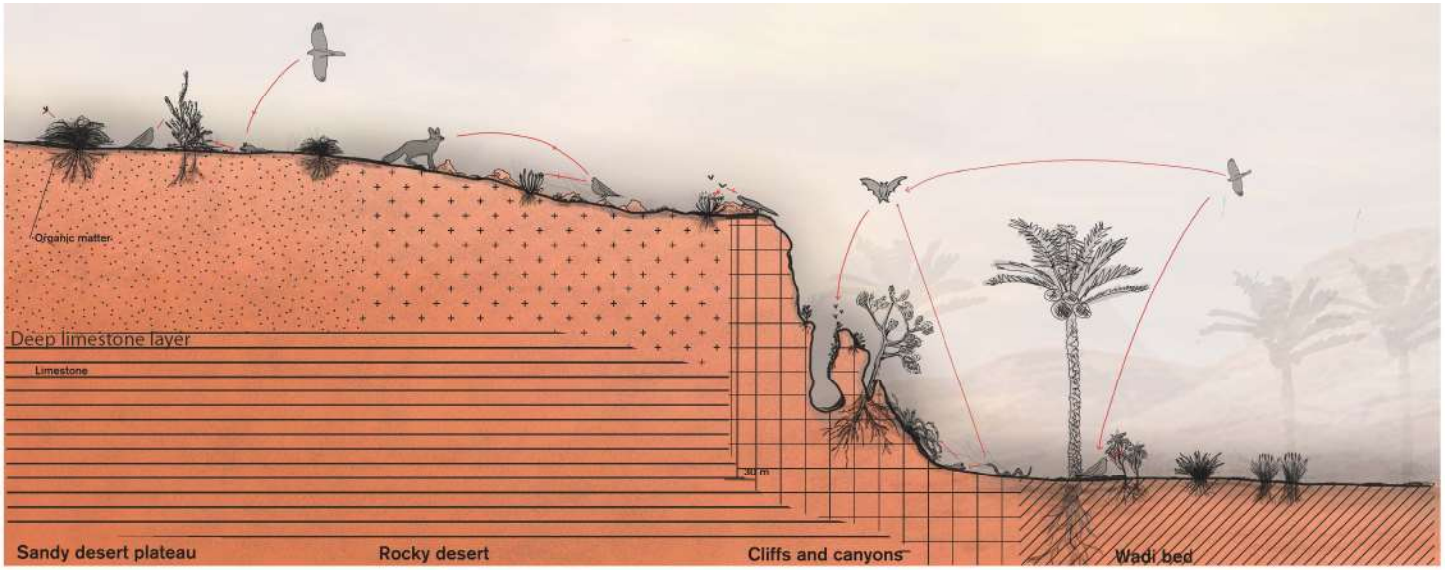
Collage of pictures of Wadi Delga
Collected by Van Eeden, by Google imaged (n.d.)

3.5.2. Habitats of Wadi Degla

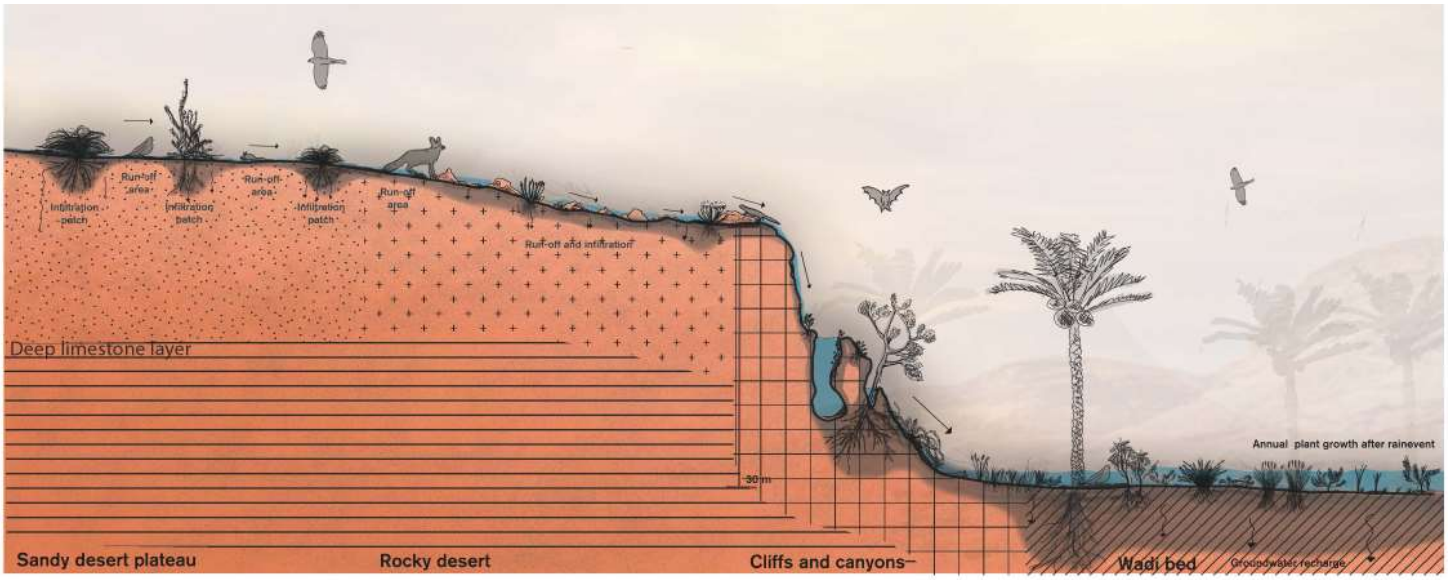
Wadi basins have a range of different habitats. These habitats are derived from the height differences of the land and it's waterflow directions and accumulations. The most higher parts are the most dry and sandy areas. Here, the water does barely infiltrate into the soil but mainly runs off. The vegetation is anticipated on this phenomena. Shrubs place themselves with several meters distance from each other so that they gain enough runoff water from the bare slope around them. The excess amount of water continu to the more rocky area of the desert. Here, the runoff streams are already a bit bigger so the water is taking the sand and is leaving stones behind. The stones and rocks create another habitat suitable for different kinds of life. The next habitat where the water flows arrives are the canyons and cliffs which are cut out by erosion. These habitats are often deep and narrow spaces between the rocks which stay wet and humid for a long time. Therefore in these areas more water needing species can be found and animals who seek for shelter. The wadi bed is the last habitat which we define in this booklet. It's the main stream where most of the water is accumulated. The water drains from this place to the Nile or the sea. The wadi bed stands dry most of the year but is flooded when there is rain. After the flood the vegetation thrives. The plants sprout and bloom and spread and disperse for the following year. These wadi beds are also suitable to harvest rain or to use for rainfed agriculture. (Elgamal M., 2015)

Drawn by Van Eeden, based on the information from (Elgamal M., 2015).

Ecology of Wadi Degla with foodchain



Wadi Degla during rain

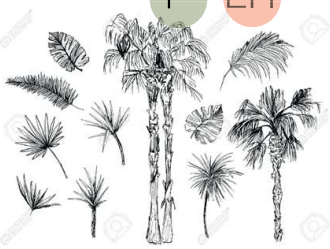


3.5.3. Flora of the Eastern Desert

In this scheme the flora is presented which can be found in the Eastern Desert and its local habitats and biotopes. In general the vegetation is dominated by shrubs or small plants. Trees are barely found in the wild, only in urban areas where the tree can be irrigated. The shape of the leafs are often very small or like a needle. In that way the plant has as little evaporation as possible. (Kassas M., Girgis W. A., 1964), Elgamal M., 2015).

Flora of the Eastern Desert

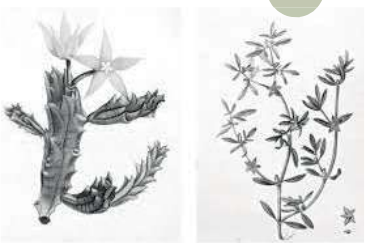
Collected and drawn by Van Eeden by Google Images, different unknown authors.

Biotope		
Sand Desert	Lycium shawii P M 	Atriplex halimus P M EL 
Rocky Desert	Gymnocarpos decandrus P 	stachys aegyptiaca A M 
Cliff and Canyons Desert	Tamarix nilotica P M 	Phragmites australis P EL 
Wadi bed	Atriplex halimus M EL P 	Iphiona mucronata P 
Urban	Poaceae P EL 	Arecaceae P EH 

A Annual

P Perennial

EL

Deverra triradiata A 	Pennisetum divisum P 	Nitraria retusa P EH 
Farsetia aegyptia P 	Iphiona mucronatav P 	Reaumuria hirtella P 
Capparis spinosa EH A P 	Fagonia mollis A M 	Zygophyllum coocineum A 
Ephedra aphylla M P 	Anabasis setifera P 	Deverra tortuosa P M 
Buxus P 	Tamarisk tp. P 	Morus sp. P EH EL 

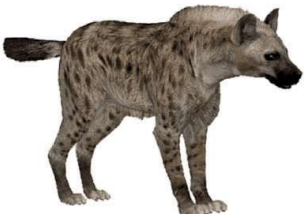
M Medicinal qualities

EH Edible qualities (livestock (I)) or Humans (H)

P Productive qualities

3.5.2. Fauna of the Eastern Desert

The fauna is divided in species. Egypt has only a few larger mammals like the hyena. Overall, the animals are quite small in the desert environment, simply because small animals need less water. All the species are adapted to the little amount of water and shelter or heat in the desert. Some animals have big ears to cool done or protective colours to hide themselves for predators. (Temraz T. A., 2016)

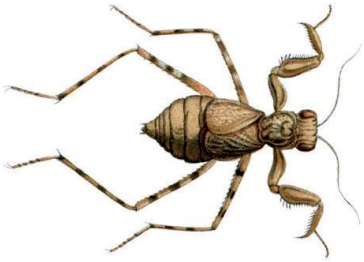
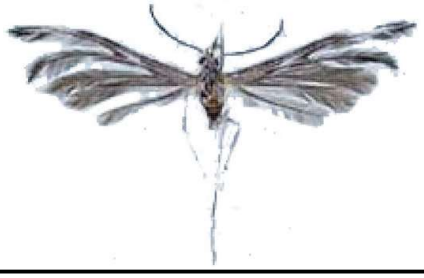
Type		
Birds	Pterocle S 	Houbara bustard S 
Amphibians and Reptiles	Echis W 	Erycinae W 
Mammals	Canis hyaena W 	Fennec S 
Insects	Ameles aegyptiaca W 	Copelatus ibrahimi W 

S Saharian

W Spread Worldwide

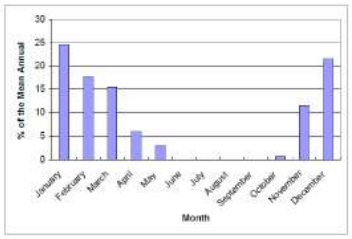
Fauna of the Eastern Desert

Collected and drawn by Van Eeden by Google Images, different unknown authors.

	Nightjars W 	Buteo jamaicensis W 	Strix alba W 
	Agama stellio W 	Minihil int S 	Ptyodactylus oudrii S 
	Mustela W 	Jerboa S 	Acomys W 
	Danaus chrysippus S 	Eremiaphila typhon S 	Porrittia imbecilla S 

3.5.3. Climate - Wind and Rain

This map presents the annual rain and average wind of the Northern part of Egypts Eastern Desert. The rain is very little and almost everything falls in winter time. Deeper land inwards the rain decreases. Closer to the sea and the Nile the rain increases. Most of the time the wind is coming from the North. However, the wind is quite mild and is barely influencing the climate. (Elgamal M., 2015)



Monthly rainfall as percentage of the annual mean. (Elgamal M., 2015)

Climate - Wind and Rain

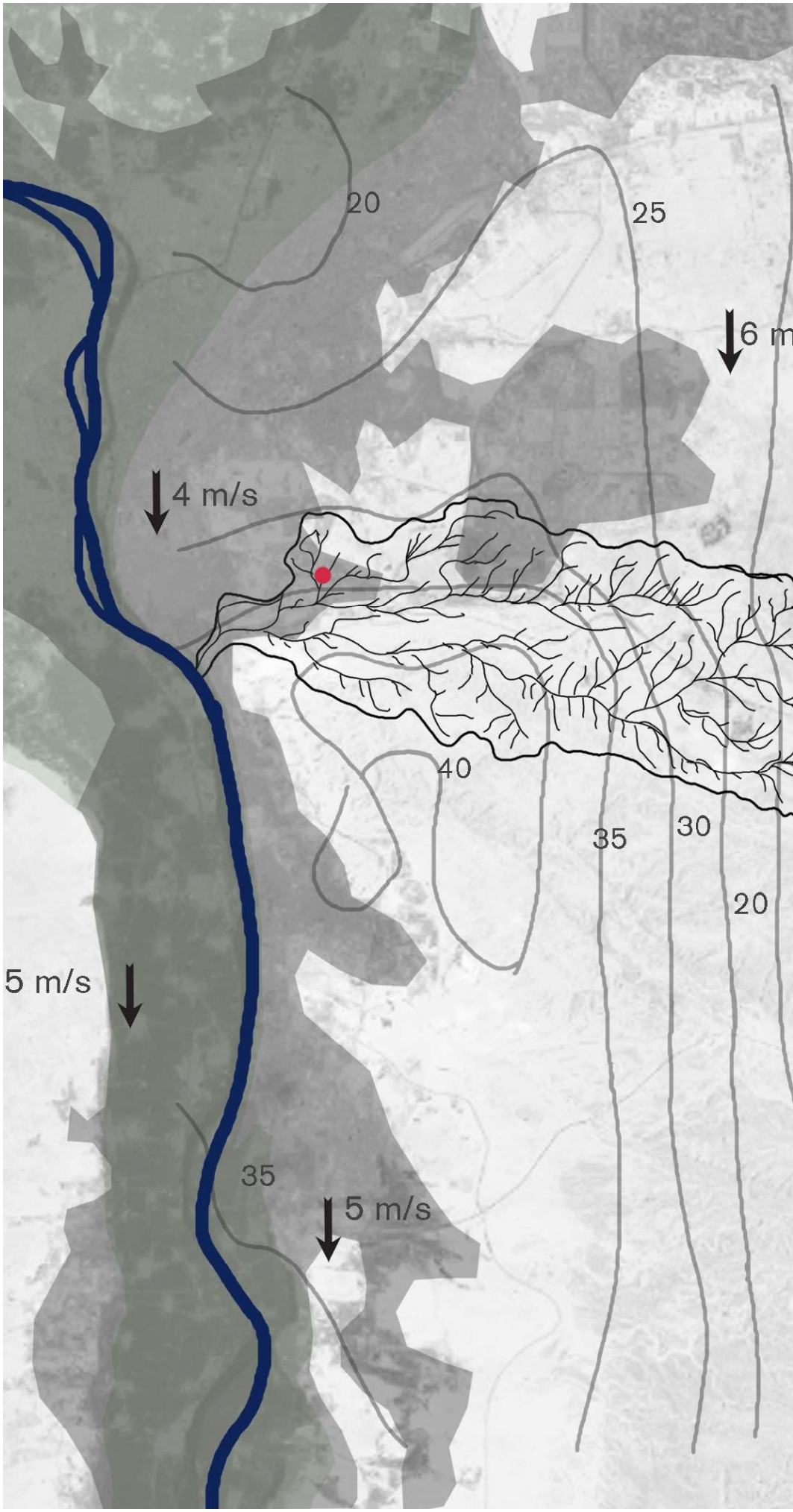
Drawn by Van Eeden based on Google Earth (n.d), (Elgamal M., 2015), Meteoblue (n.d.).

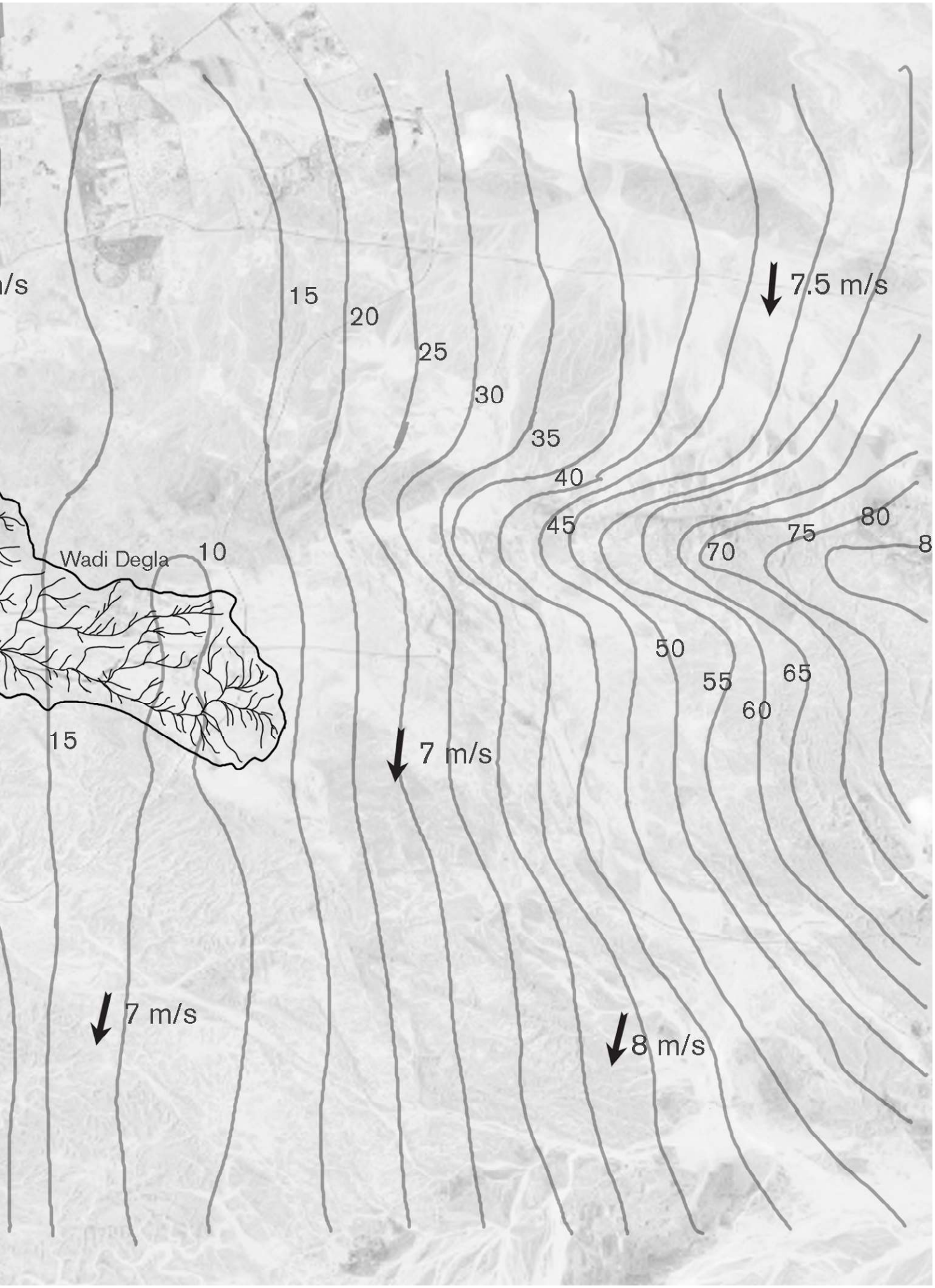
m/s Average windspeed

Average winddirection

Study area

30 Average rainfall per year




/s
15
20
25
30
35
40
45
50
55
60
65
70
75
80
8
10
15
Wadi Degla
7.5 m/s
7 m/s
7 m/s
8 m/s

3.5.4. Soil type and land use

The soil type of the desert environment come from the limestone plateau. Some of it in the form of stone and rock and other part in the from of sand and gravel. Around the Nile the soil is different. Clay and sludges was sedimented every time the Nile flooded. This used to be every year but ever since the Aswan dam was built in 1960 the Nile was stopped from flooding. The clay and sludge provided fertile land around the Nile. Therefore this is the only place where agricultural practices can be found. (Kassas M., Girgis W. A., 1964)

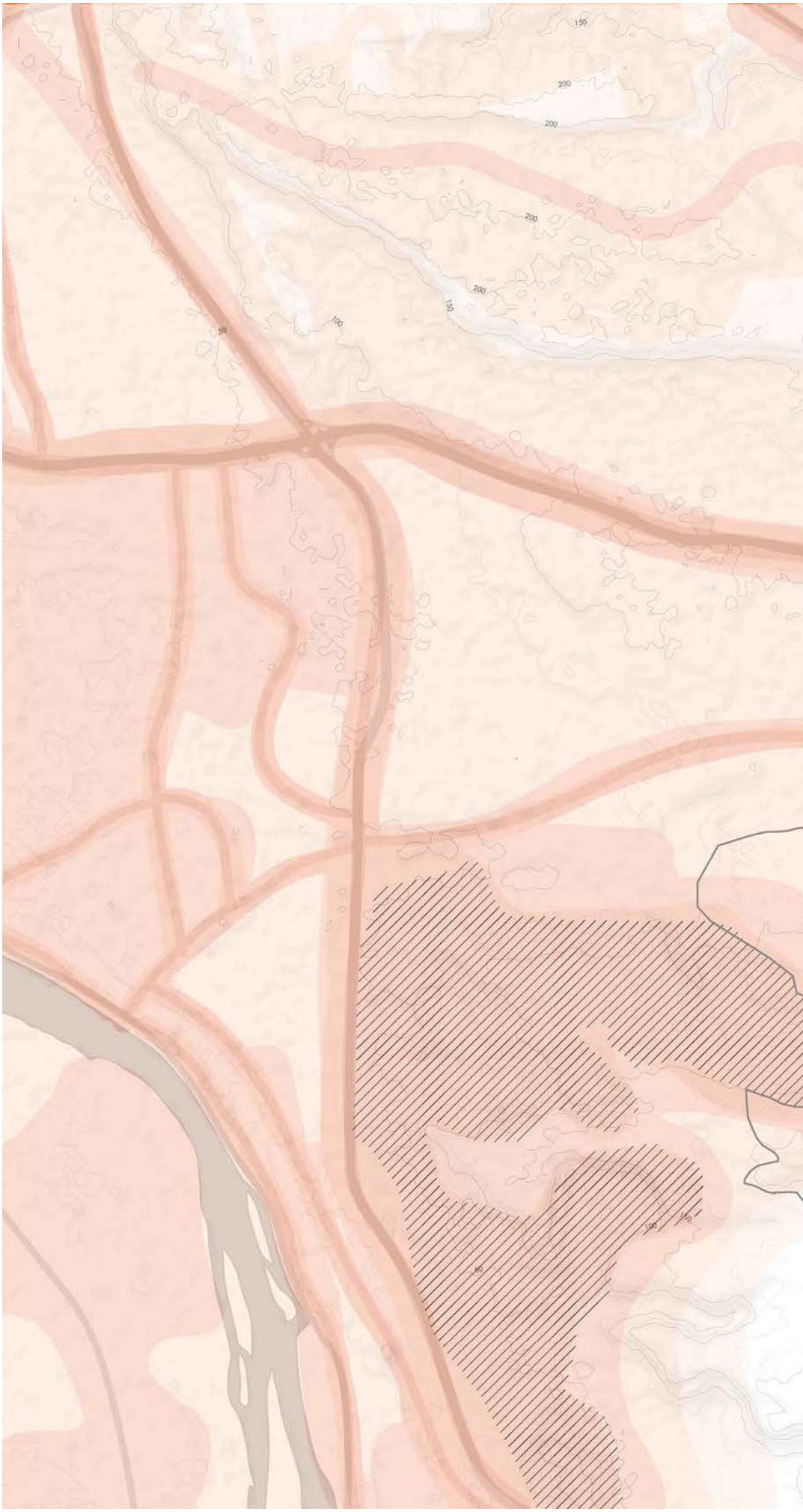


Soil types and Land Use
Drawn by Van Eeden based on Google Earth (n.d), (Kassas M., Girgis W. A., 1964).

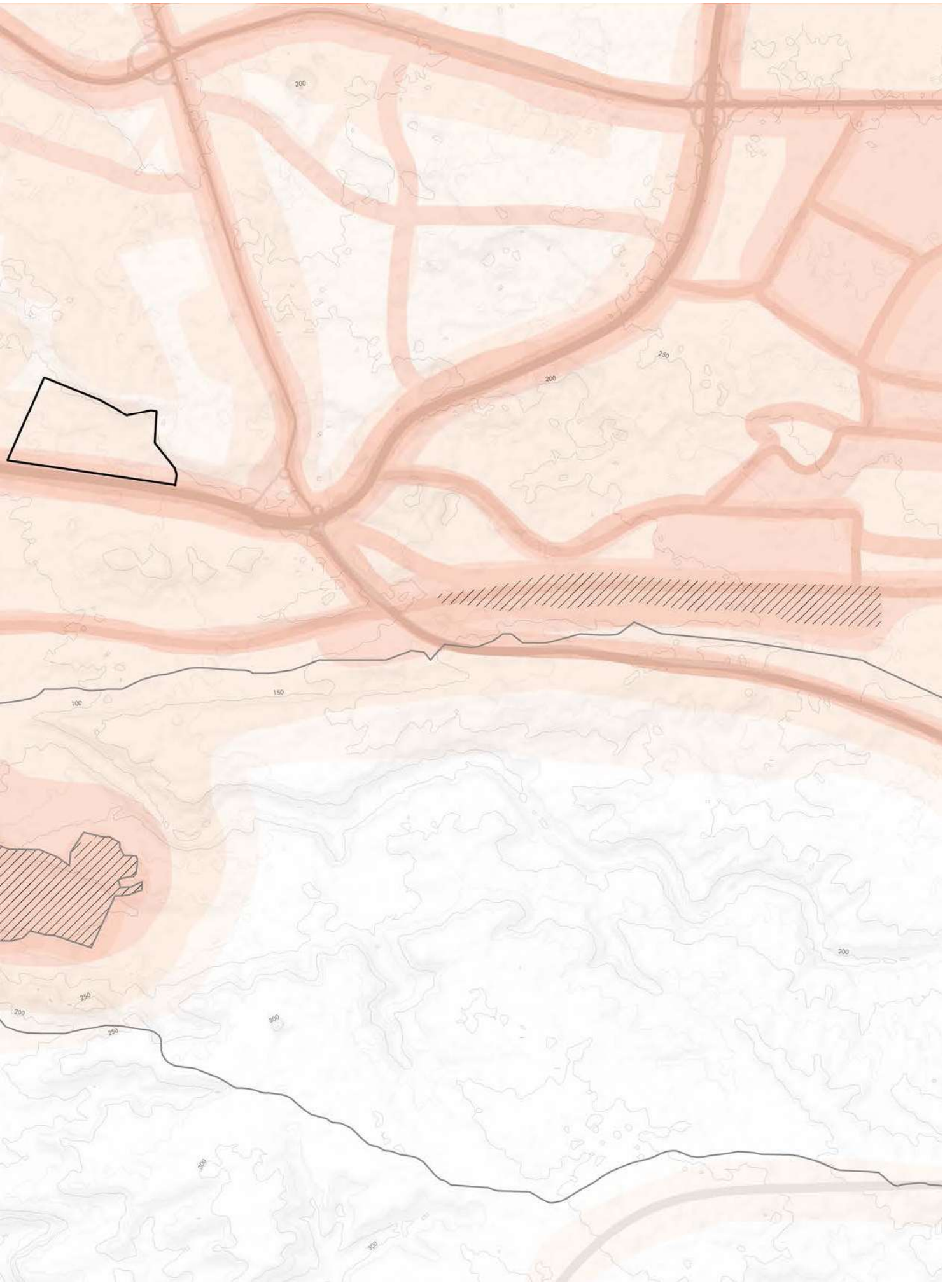


3.5.4.
Air and noise pollution by industrie and roads

Cairo is in general a very polluted city. Especially in terms of garbage on the streets and smog. The big amount of cars and dense population is the main cause. At the project site the smock is a bit less because the urban tissue is less dense than in the city centre of Cairo. Pollution is mainly coming from the main ring road south of the area. The industries are the main source of pollution for the protective nature area of Wadi Degla.



Air and noise pollution by industries and roads
Drawn by Van Eeden based on Google Earth (n.d)


200
250
200
100
150
200
250
200
300
300
300

3.5.5. Climate change

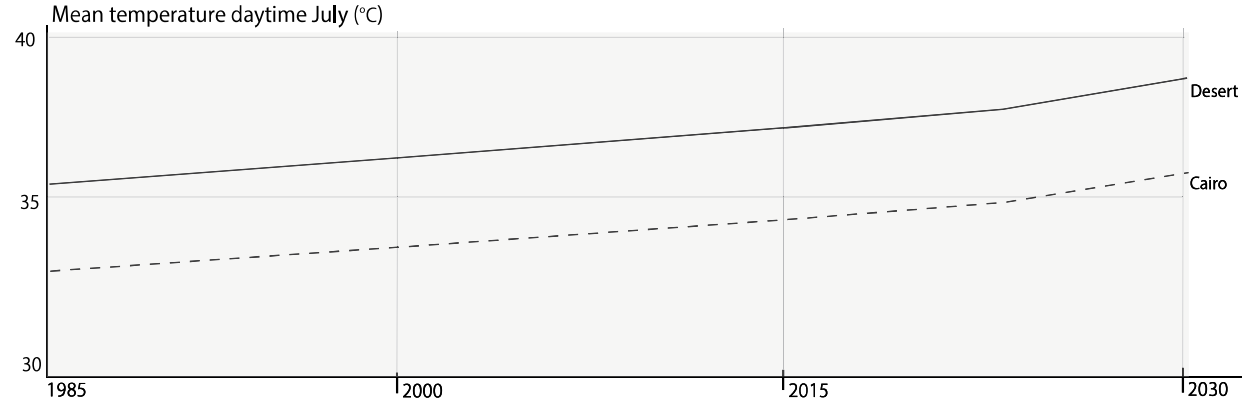
Since the industrial revolution the greenhouse gas emissions has increased enormously. Globally the effects are noticable. This is the same in Cairo. Altough specific and consistent data is lacking, there are quite some trends going on. From these trends we can draw some careful conclusions about how climate change will affect the environment of Egypt and Cairo specifically.

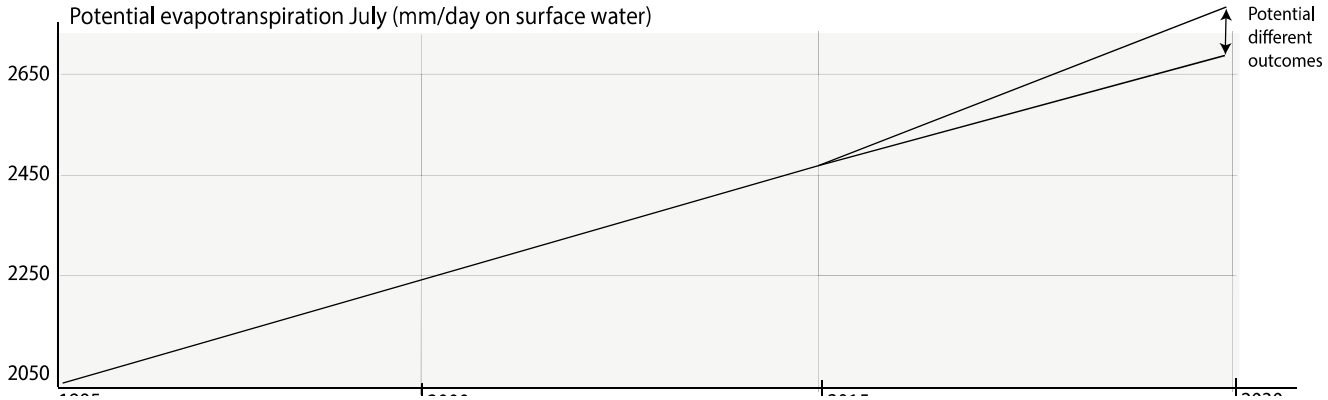
The increasing temperature has a direct effect on the evapotranspiration. The hotter the environment the higher the evapotranspiration. This can lead to an increase in water losses and thus a decrease in water availability.
As far as can be measured (there is little data about rainfall collected in Egypt) the amount of rain stayed quite the same until 2015. After 2015 there is a trend going on in an average decrease in rainfall with 2 mm per year. This seems contractionary with the increase of extreme rain events that take place the last years. This can be explained by the division of the rain. Less rainy days but more rain in one time.

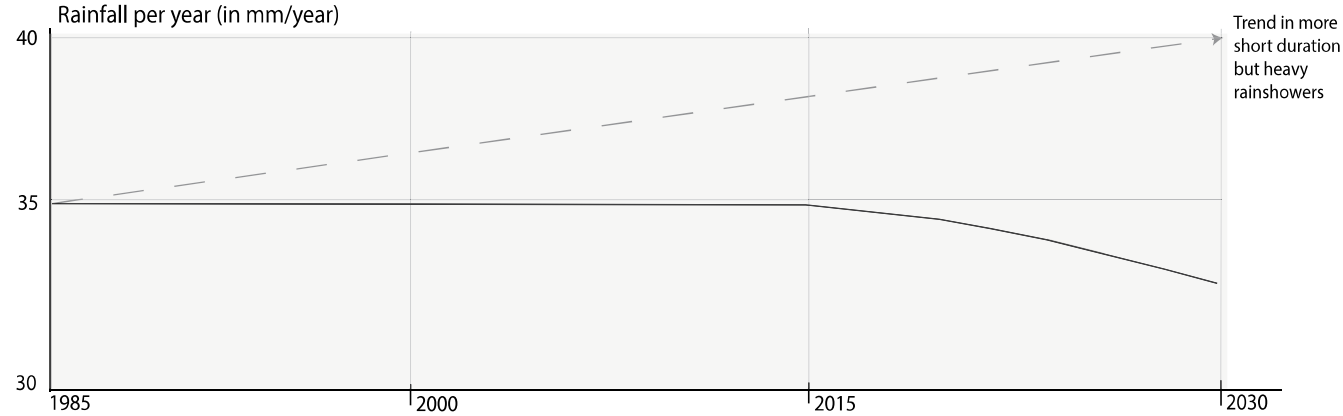
To slow these trends down the global greenhouse gas emissions must be drastically lowered. If Egypt participates in this, it will also mean that the local smog is lowered.

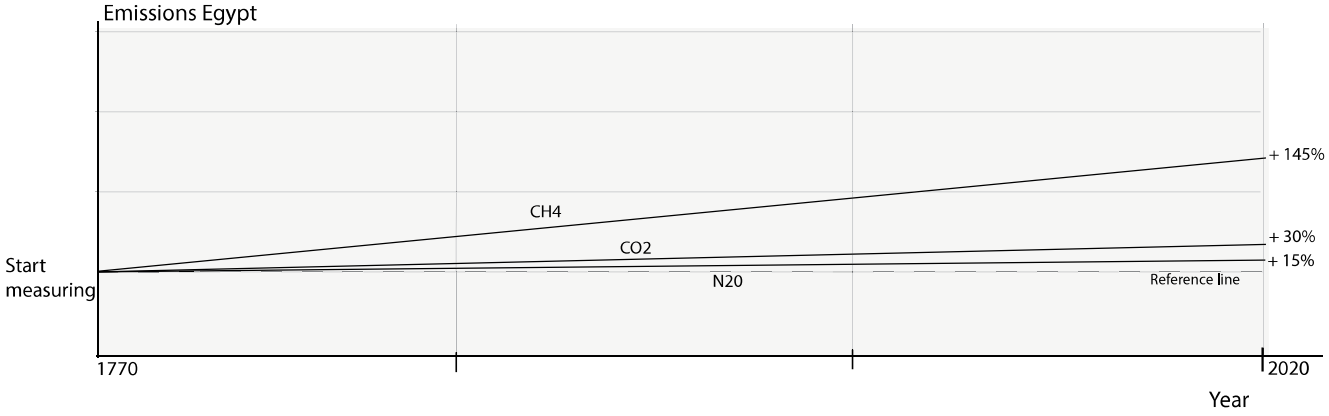
Combining these trends shows us that the main problems of Egypt, namely drought and water scarcity, flash floods and pollution will all increase in the coming years. The trend of population growth and urbanization will only enhance the effect and damage that the extreme events can cause.

Drawn by Van Eeden based on the information from:
(Gado A., El-Hagsry R. M., Rashwan I.M.H., 2018), (El-Ramady H. L., El-Marsafawy S. M., and Lewis L. N., 2013), (Huhne C., Slingo J., 2011), (Yassen A. Y., Nam W., Hong E., 2020)


Mean temperature daytime July (°C)
40
35
30
1985
2000
2015
2030
Desert
Cairo


Potential evapotranspiration July (mm/day on surface water)
2650
2450
2250
2050
Potential different outcomes


Rainfall per year (in mm/year)
40
35
30
1985
2000
2015
2030
Trend in more short duration but heavy rainshowers

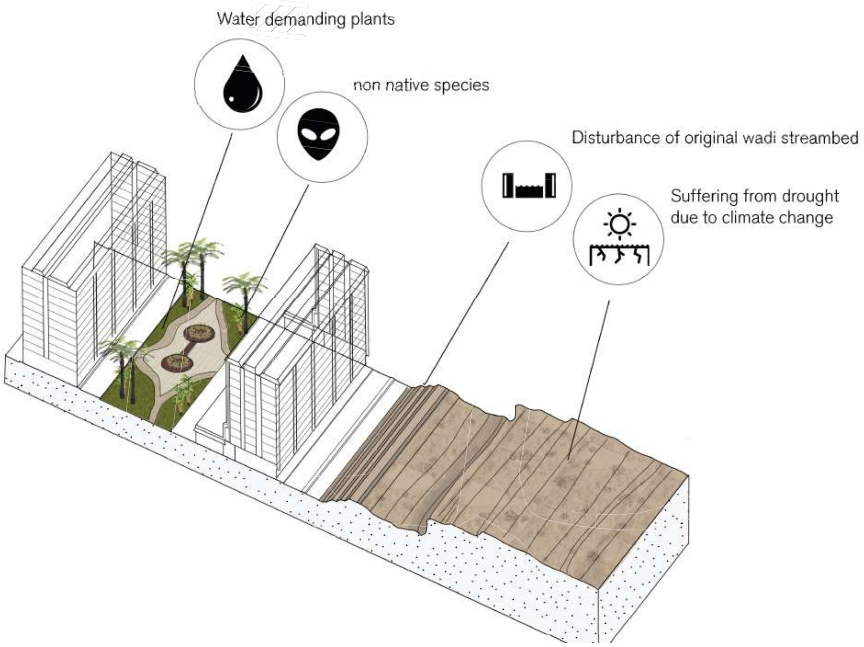

Emissions Egypt
Start measuring
1770
2020
Year
CH4
CO2
N20
Reference line
+ 145%
+ 30%
+ 15%

3.5.6. Vegetation map

The vegetation of the urban park in the project area differs from the vegetation outside the urban tissue. The urban parks are often irrigated parks with water demanding species that are non-native to Egypt.
In such a dry environment where water is a big scarcity the water demand for irrigation seems unnecessary and excessive.

The vegetation around the neighbourhood in the desert are native desert species but are dealing with increasing droughts. More and more vegetation will die or fail to grow bigger. This means that less and less rainwater can be captured and that the runoff water and the corresponding erosion will create a negative feedback loop where lesser amounts of rainwater is captured.



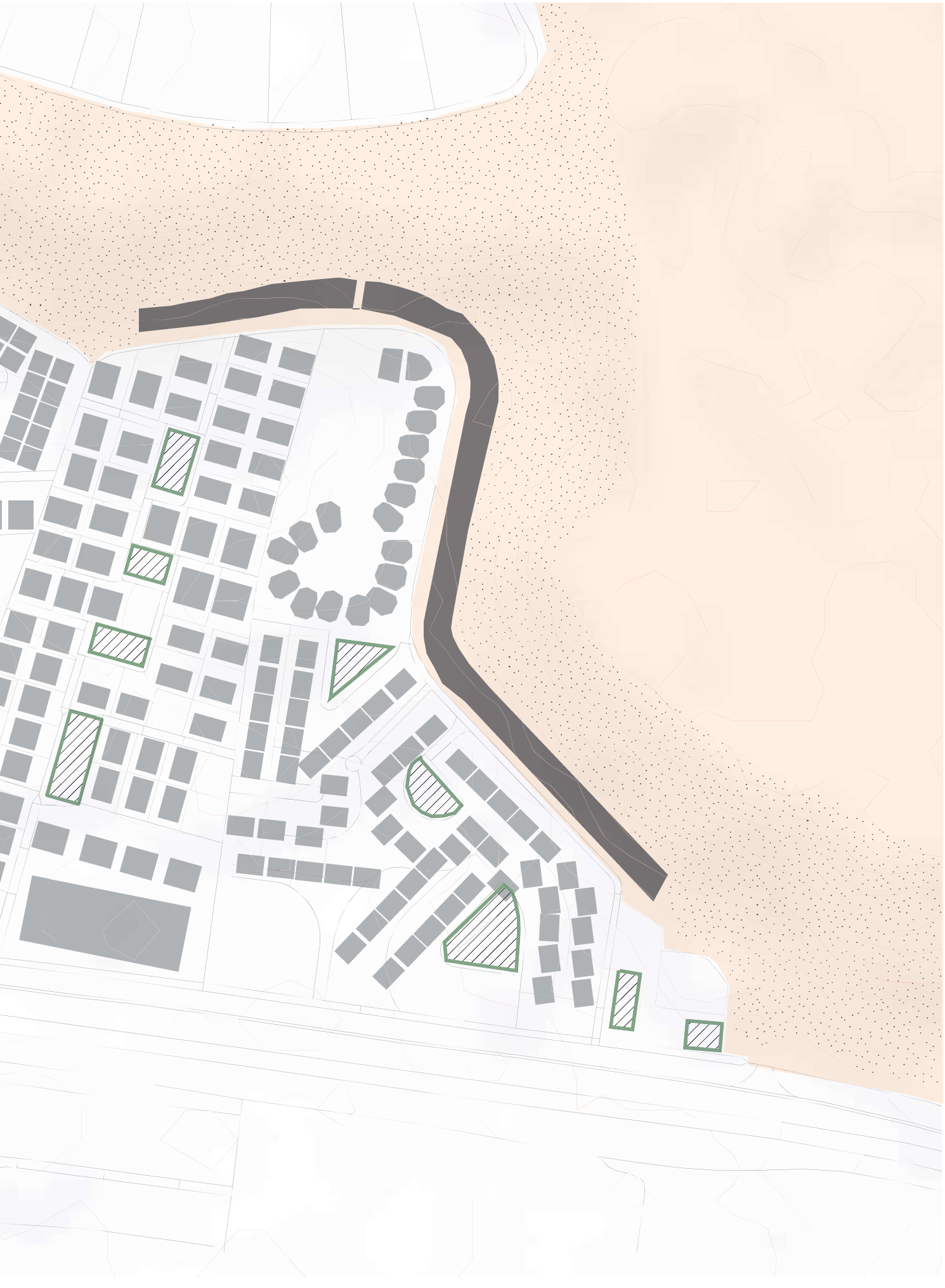


Vegetation map
Drawn by Van Eeden based on Google Earth (n.d)

- Wall (7-10 meters high)
- Desert environment with little vegetation
- Natural shrub vegetation
- Irrigated public park environment

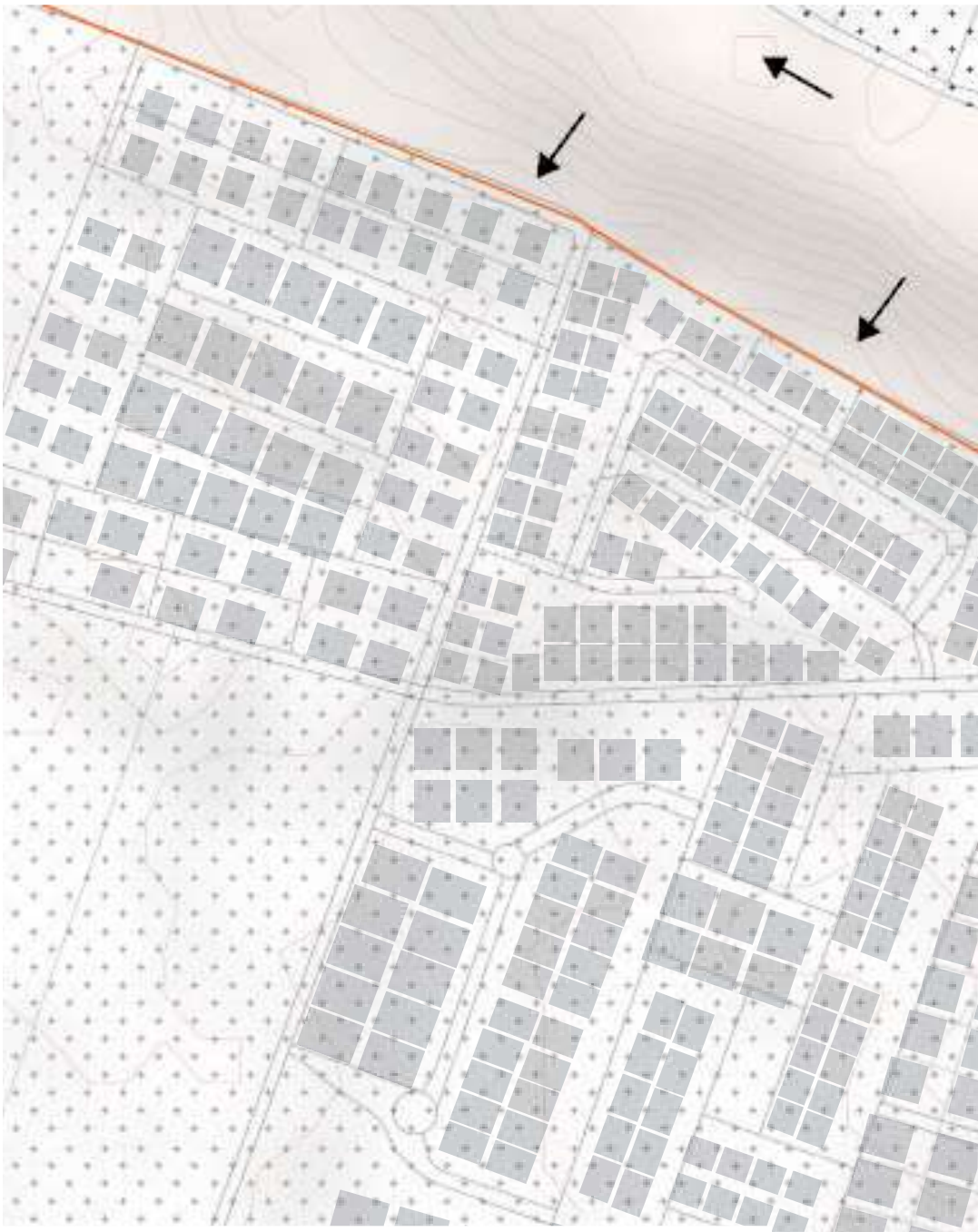
N

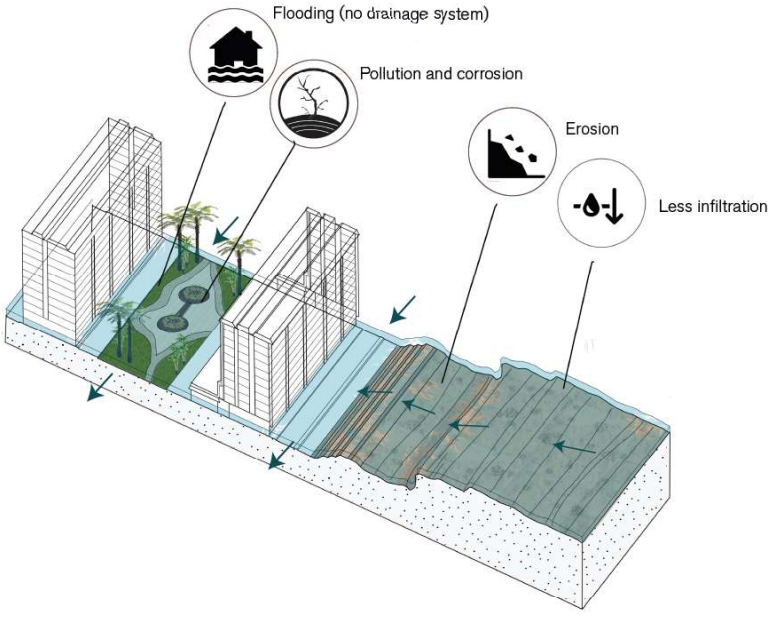
0 100 km



3.5.7. Erosion / Flood map

The entire urban area and infrastructure is situated at a lower elevation than the surrounding desert. As a consequence heavy rain will flow upon the streets and roads causing flash floods. During the heavy rain the steep slopes are eroding. The wall which seperated the neighbourhood with the desert prevents the neighbourhood from the mudstreams that are coming downhill. The speed velocity of the runoff water is too high to let the water infiltrate into the soil. As a consequence all the rainwater can be considered a loss.



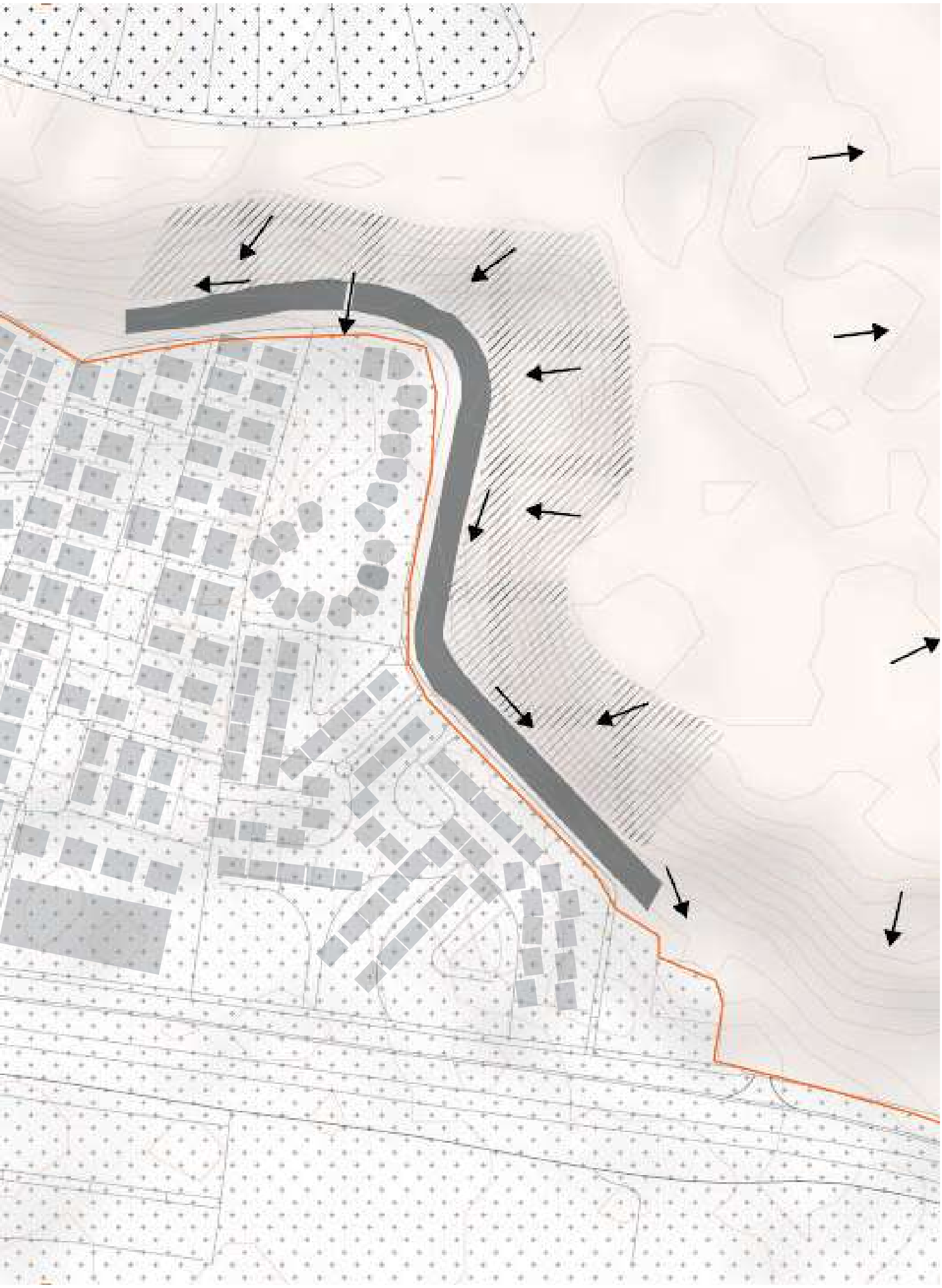


Erosion/Flood map
Drawn by Van Eeden based on Google Earth (n.d).

- Wall (7-10 meters high)
- Non builded desert environment
- Stream flow direction
- Erosion prone area
- Flood prone area

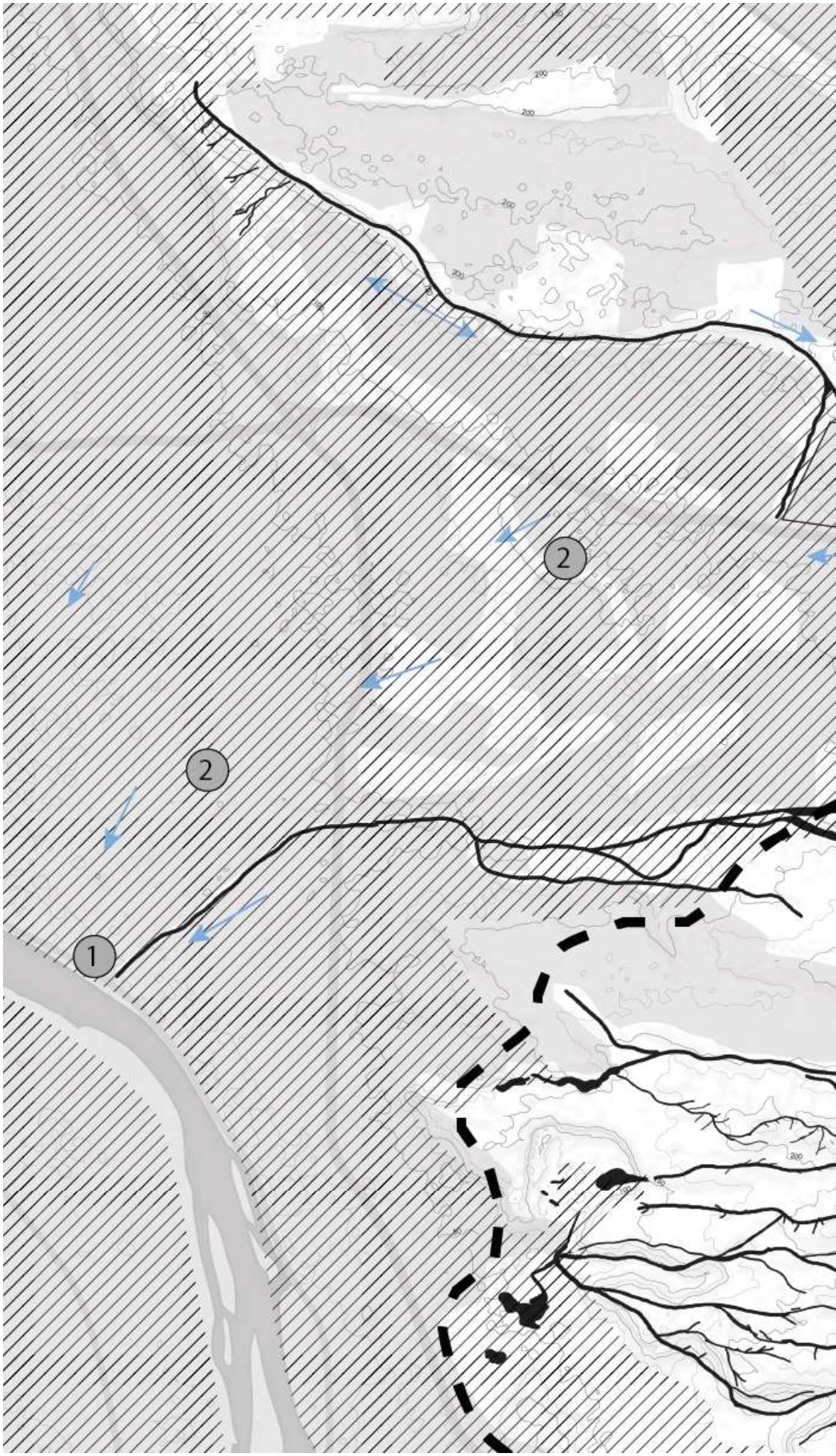
N

0 100 km



3.5.8. Extreme ecology

The extreme ecology in this area is defined by the stress situation consisting of long extending droughts and the shock situation consisting of heavy rainfall in a short period of time. The natural environment is adapted to both these situation. The species are adapted to drought situations and the wadi's drain the heavy rain creating habitats for different forms of life. The expansion of the urban tissue breaks with these rules of nature. The original wadi basin is cut off and the original streams are replaced into urban areas where heavy rain now creates flash floods. The native vegetation in the urban area is replaced to an aesthetic park environment with non-native and water demanding species, increasing the water shortage. The urban expansions have neglected the original desert environments and by that increasing the problems.



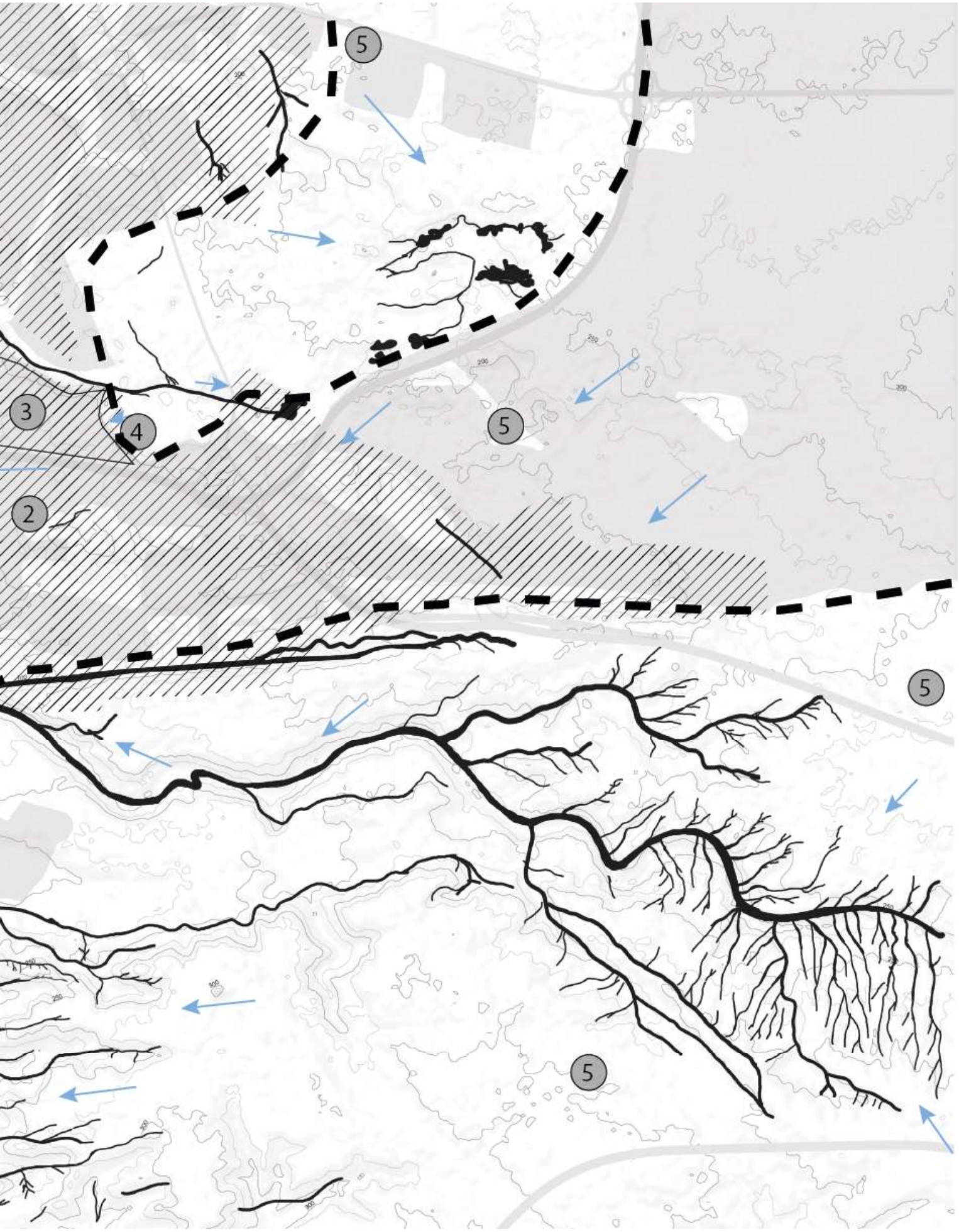
Extreme Ecology
Drawn by Van Eeden based on earlier maps and (Elgamal M., 2015).

- Flash flood prone area
- Non builded desert environment
- Stream flow direction
- Erosion prone area
- 1 Discharge of rainwater
- 2 Pollution by surface water
- 3 Water use for public space
- 4 Erosion on slope by rain
- 5 Rain catchment area

Boundary between the urban tissue and the desert, neglecting each others presence.

N

0 100 km

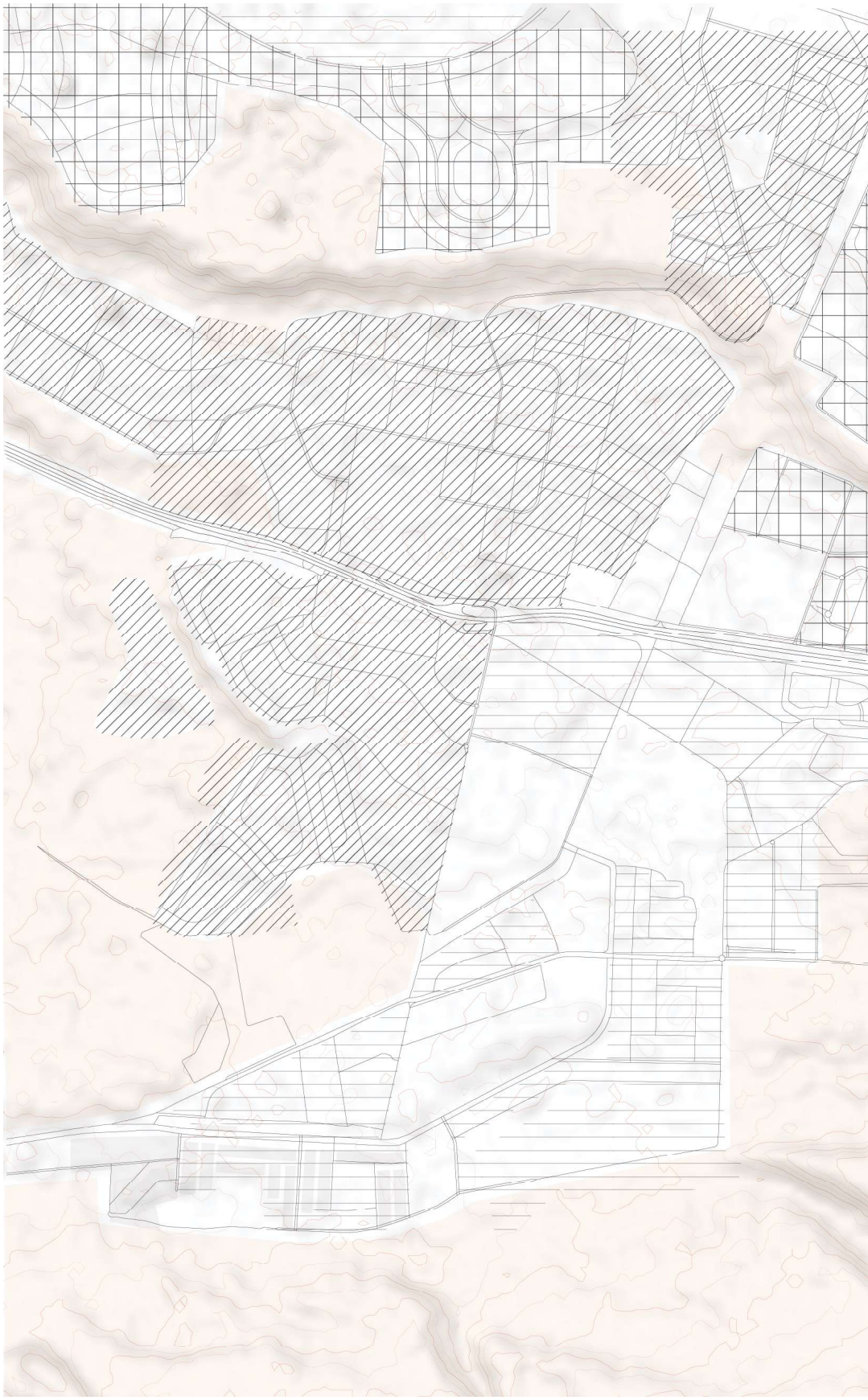

5
3
4
5
2
5
5

3.6. Urban Morphology

3.6.1. Urban Tissue

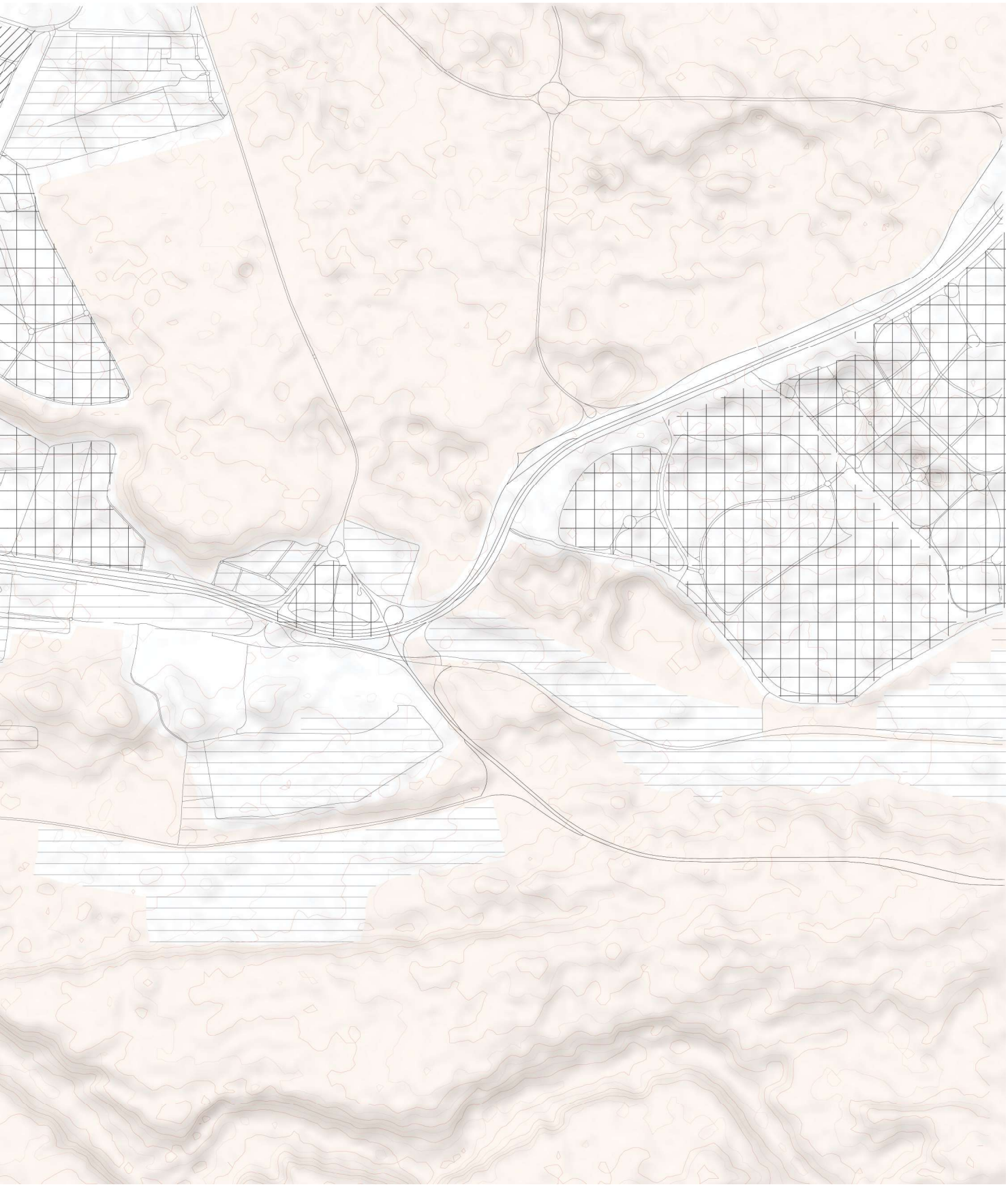
The expansion of the old city of Cairo that comes together with the new city center New Cairo

The neighbourhood El-Hadaba El-Wosta is mostly built up from the east to the west. This is caused by the way the city of Cairo has been expanding. The initial concept was to expand the city along the border of Cairo into the desert, however, after the municipality of Cairo decided to establish a new city center called New Cairo to the east of the old city of Cairo, the expansion along the border of the old city center was slowed down (Ministry of Housing and UN-Habitat, 2012). The development of New Cairo and the expansion of older Cairo are connected by the neighbourhood El-Hadaba El-Wosta (Google, 2020). Currently, there is still a lot of development in this area to fill up the current empty spaces in the urban tissue.



Urban Tissue Map

Drawn by Conijn, based on data from Ministry of Housing and UN-Habitat (2012), MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)



3.6.2. Building ensembles

Different urban ensembles based on building typology and time.

The building ensembles in El-Hadaba El-Wosta can be divided in four zones. These four zones are created by the differences in time of building. In the west of the neighbourhood narrow, low buildings represent the area in a orthogonal order. This is the total opposite from the zone that is located on the east side of this part of the neighbourhood, where the area is represented by wide, tall buildings that are placed along curving streets. The differences in building ensembles can also be seen in a map of public spaces, where the orthagonal ordered streets do not have any public spaces, which can not be compared to the amount of public spaces that are located in the other types of building ensembles (Google, 2020).



Building Ensembles Map

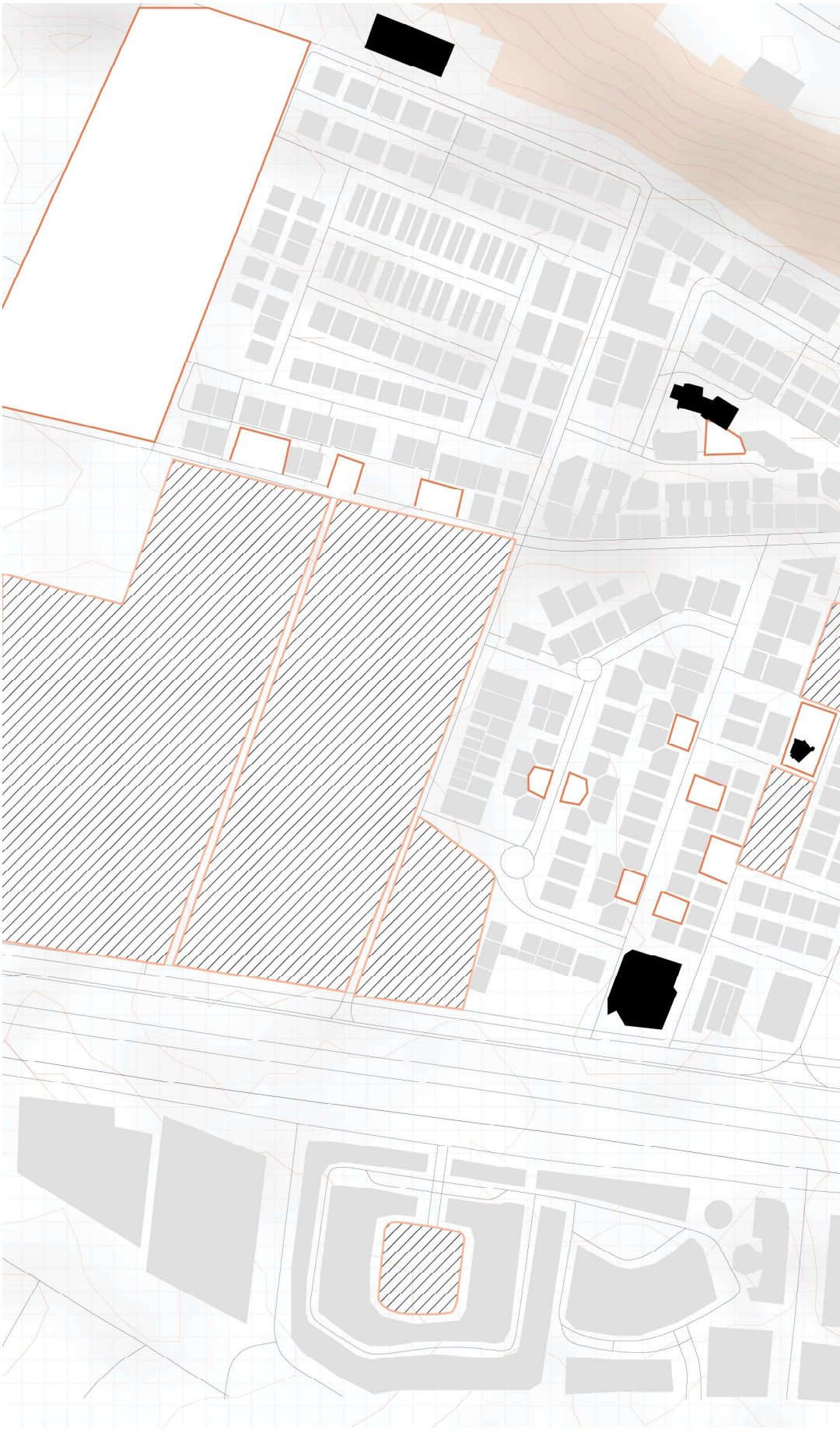
Drawn by Conijn, based on data from, MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)



3.6.3. Public spaces

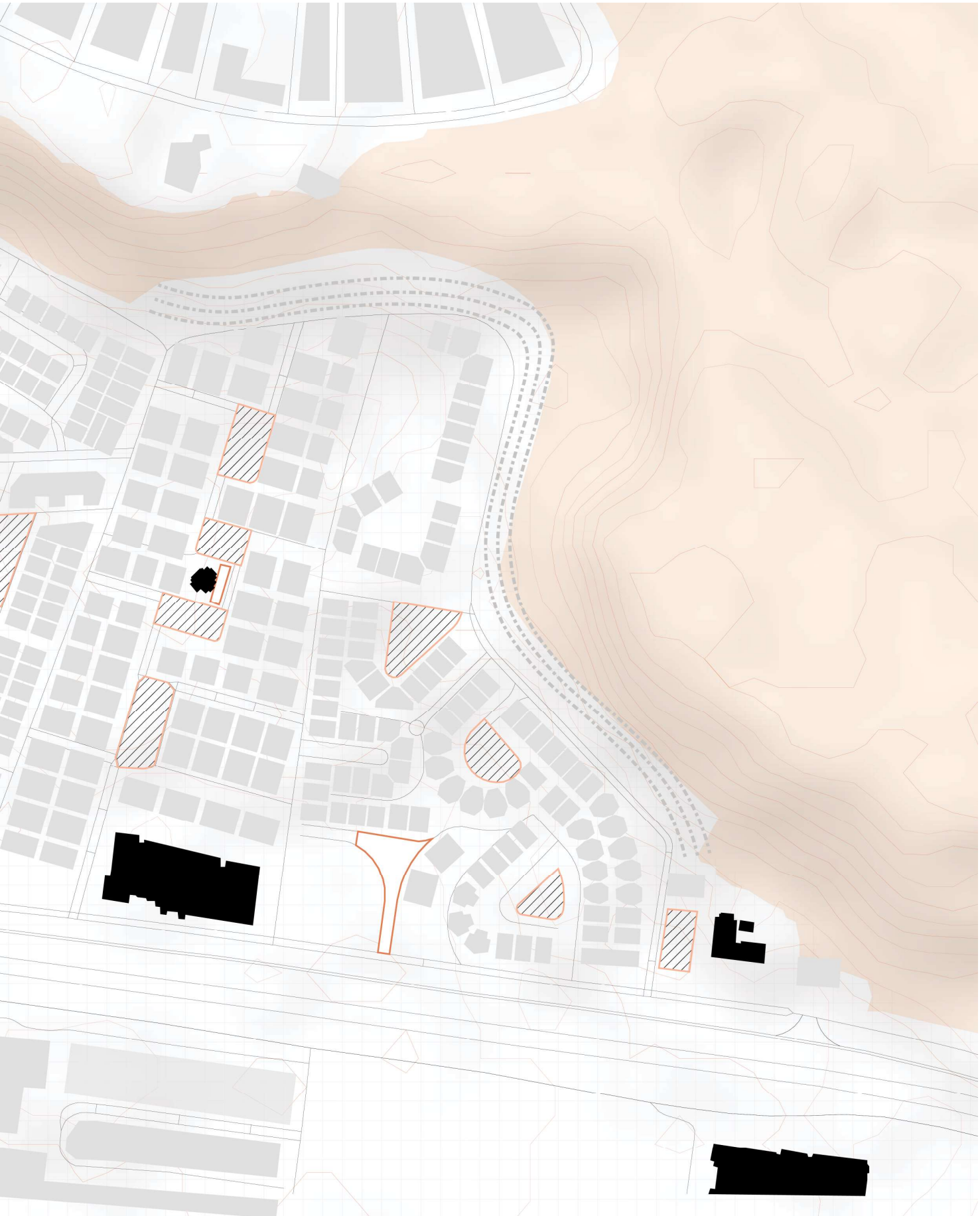
The location of artificial green parks, squares and public buildings.

In the neighbourhood several public spaces can be found. Artificial green spaces, public squares and public buildings. At the edge of the neighbourhood, next to the highway, a shopping mall is located. Together with two hospitals, one school, one office building and two mosques are these the only buildings that do not have housing as their initial function (Google, 2020).The big number of appartment buildings with low amounts of private outside space in this area means that there is a need for outside public space. Artificial green spaces and public squares are established to fulfill this need.



Public Spaces Map

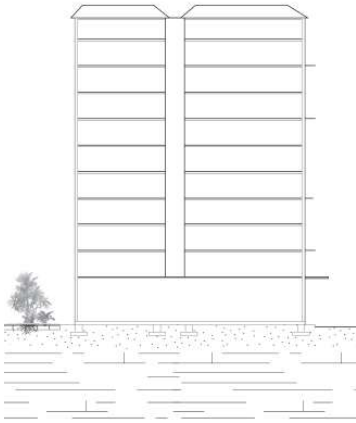
Drawn by Conijn, based on data from, MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)

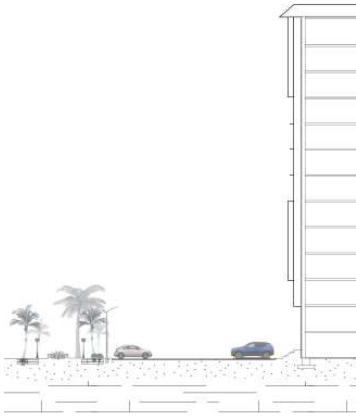


3.6.4. Sections of the most characteristic spaces

The most characteristic spaces in the neighbourhood of El-Hadaba El-Wosta are the barriers that enclose the neighbourhood, the high density pattern of 10 to 13 storey buildings that are located with little space inbetween and the artificial green spaces that are scattered around the area for residents to look at and enjoy without even taking the water scarcity in mind.

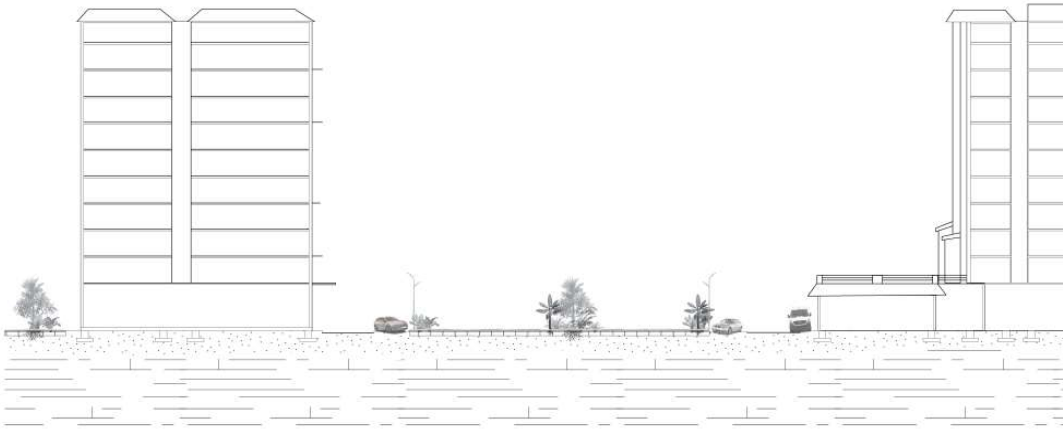
Artificial green spaces form a characteristic space in this area, as the natural environment does not support these areas. The lack of water and the soil of sand and limestone in combination with the choice for almost English landscape habits in green space causes a need for artificial ways to maintain the green spaces (Shata, 1988). Another characteristic space is the wall that has been build on the east border of the neighbourhood to protect this part of the neighbourhood from flash floods but also creating a barrier between the natural environment and the urban tissue. The eight-laned highway creates a different kind of barrier (Google, 2020). This barrier cuts the high density neighbourhood horizontally in two halves.





Characteristic Spaces Sections

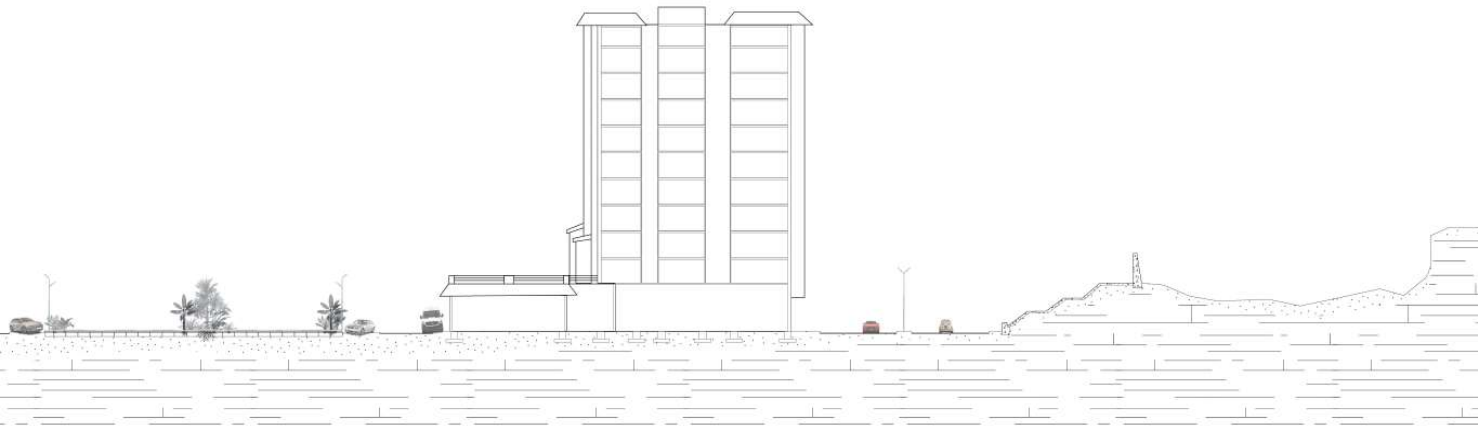
Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020), OpenStreetMap (n.d.), Moustafa et al (1991), Shata (1988) and photos by Eldeeb (2017)

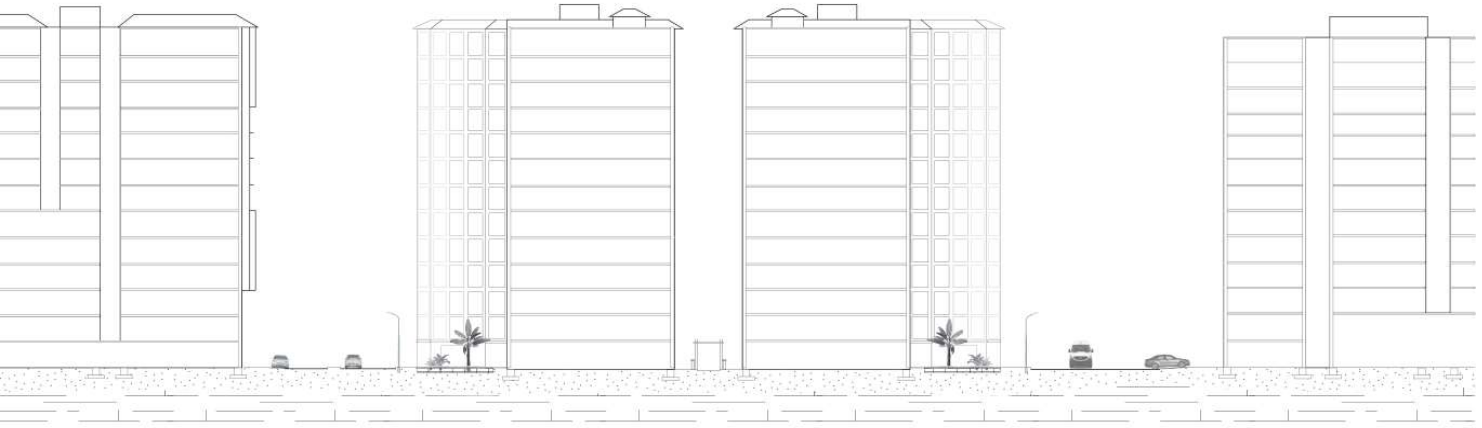


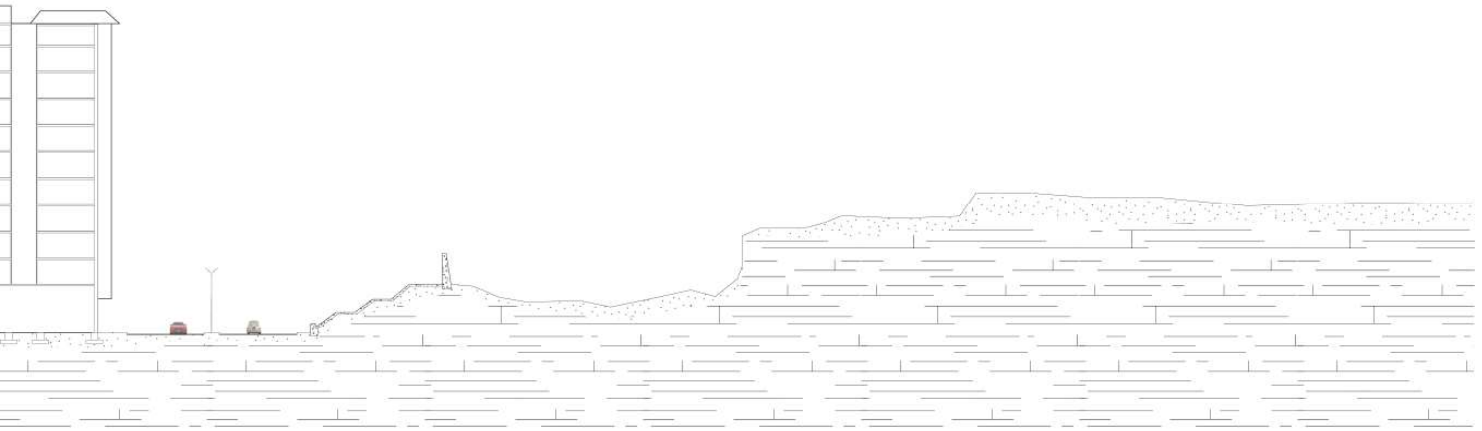
☐ Building
▤ Limestone
☐ Sand
▨ Stone

N

0 25 m

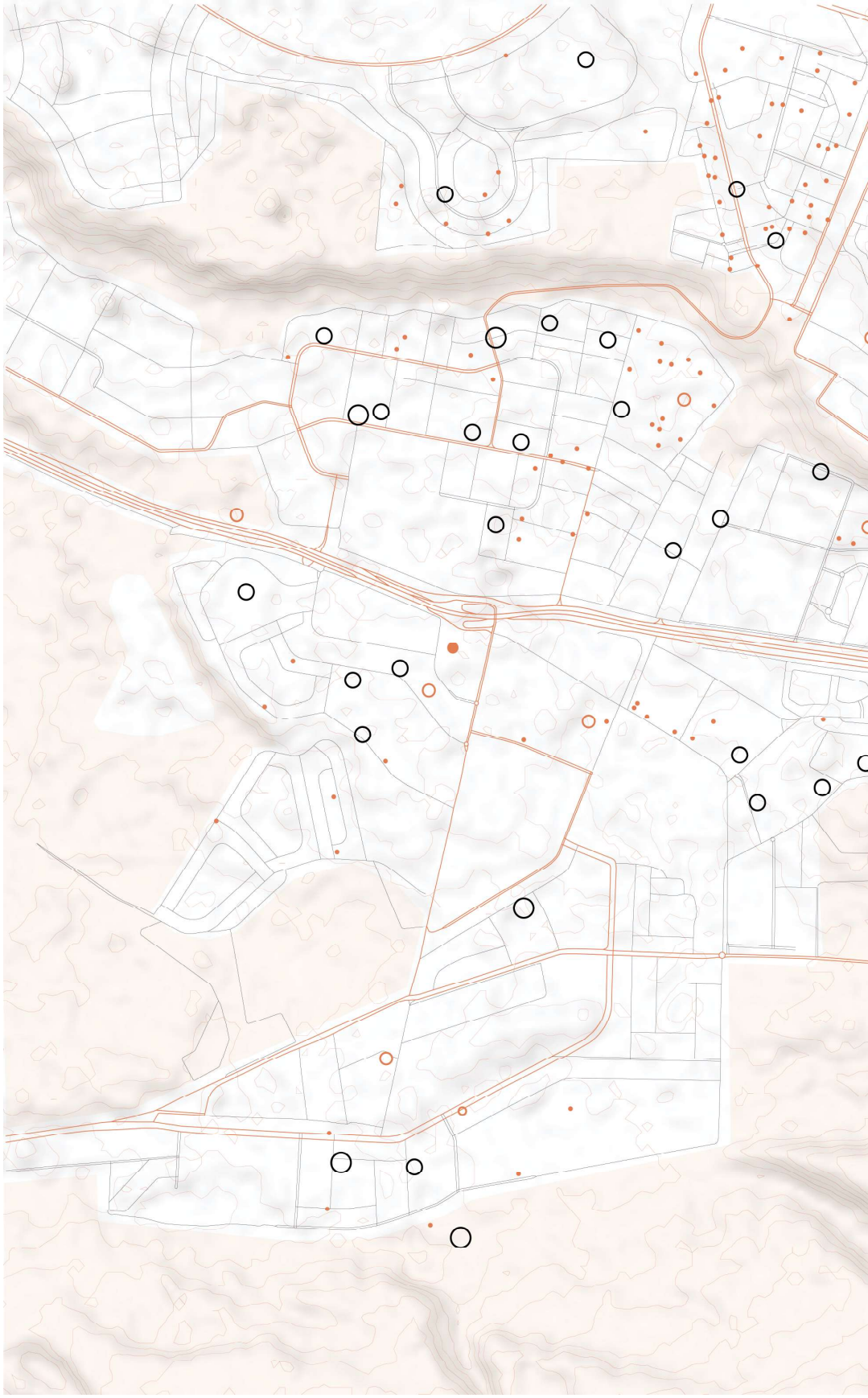






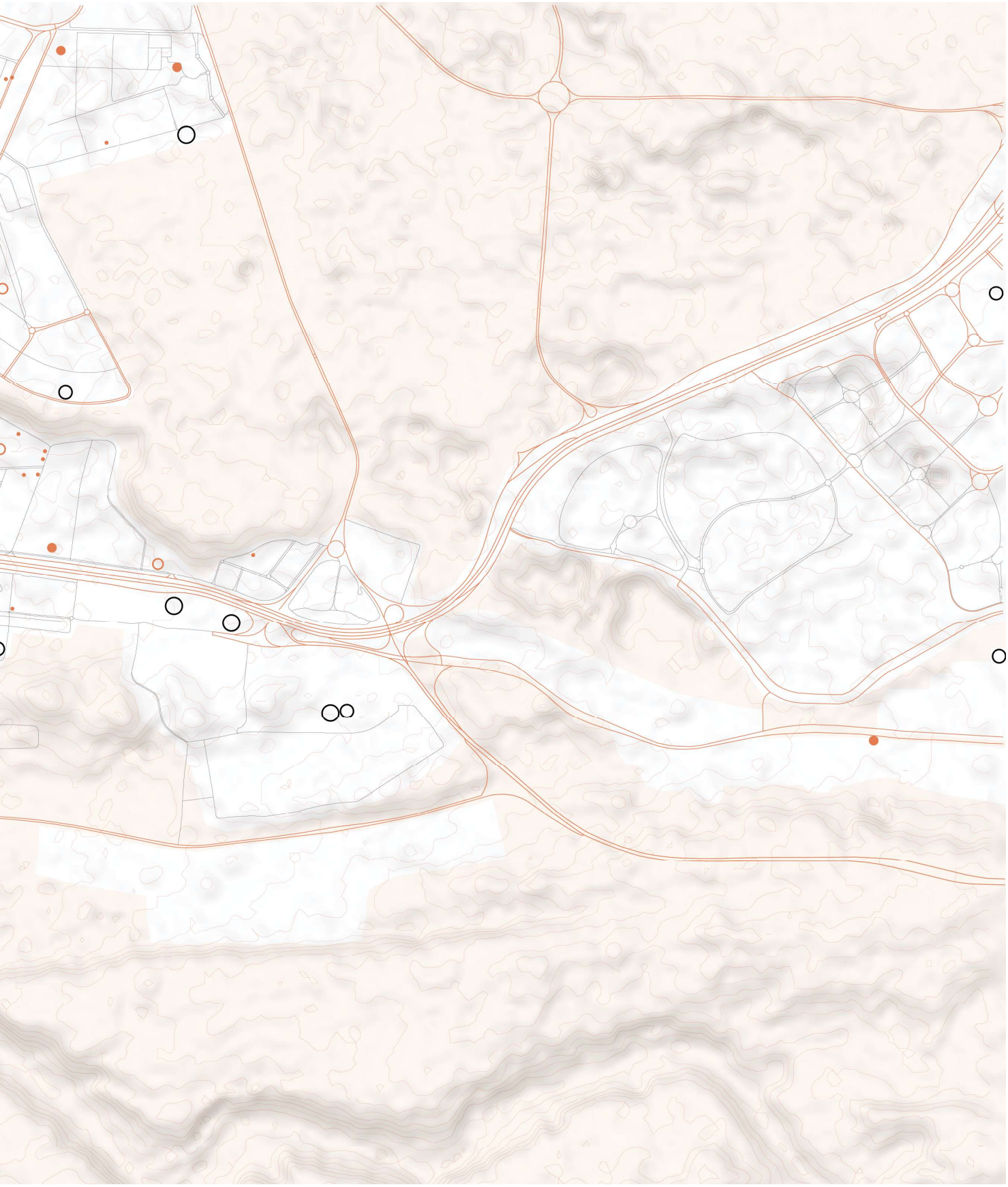
3.6.5. Vital Infrastructure

The highway barrier is part of the vital infrastructure of El-Hadaba El-Wosta. Several hospitals are located near this highway or other big roads. Schools can be found all over the neighbourhood as in the east of this neighbourhood a university is located including several buildings. Supermarkets can be found in several areas (Google, 2020). However, most of these supermarkets are informal and located in areas that fit these informalities.



Vital Infrastructure Map

Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)

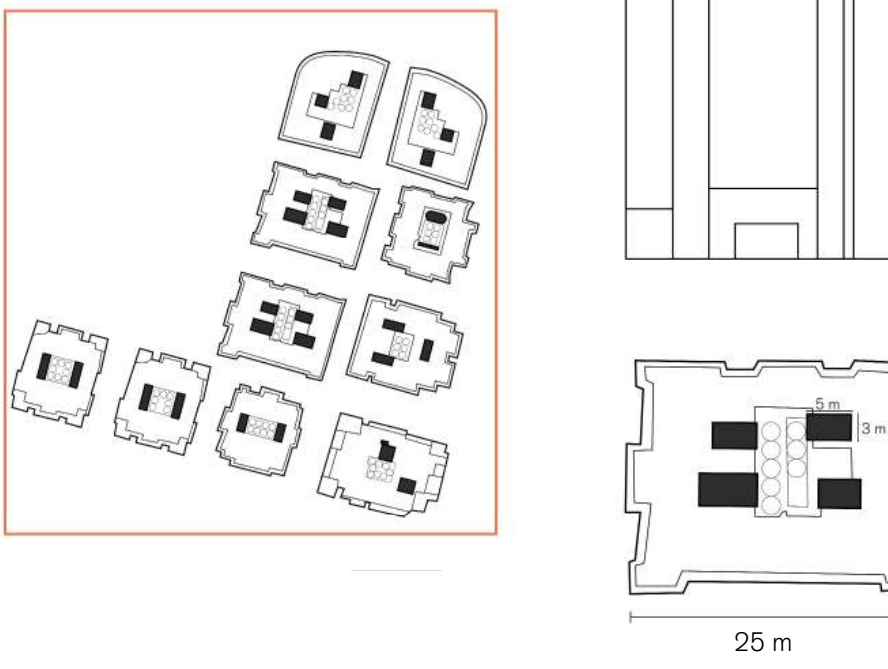


3.6.6. Typology

Two typologies that can be found in the neighbourhood El-Hadaba El-Wosta are shown, high density housing and low density housing.

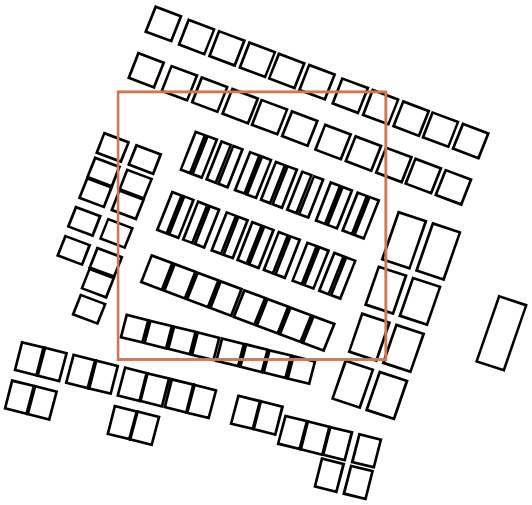
Social housing (high density, left) and informal housing (low density, right).

El-Hadaba El-Wosta is a neighbourhood that is formed by a few compounds consisting of a great amount of high density, 10-13 storey apartment buildings. These compounds create a relatively luxurious form of housing compared to the other building typology that can be found in the city of Cairo: informal housing. In informal housing residents are able to adjust their buildings to their own preferences as there is no legislation and are no regulations for these buildings (Khaldi, 2015). This lack of regulations creates diverse streets and are the total opposite of the monotonous blocks of apartment buildings.



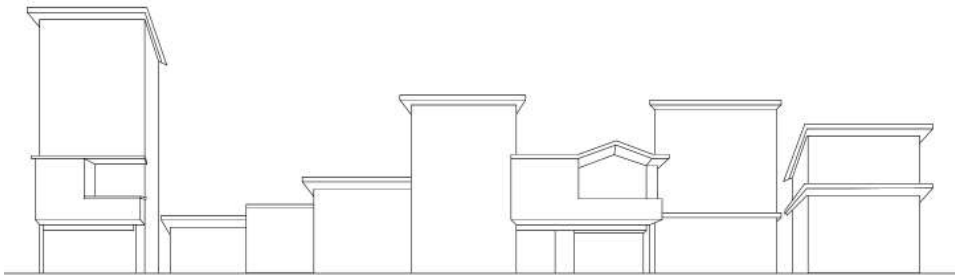
Typology

Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020), OpenStreetMap (n.d.) and Khaldi (2015).



40 m

20 m





3.6.6. Typology

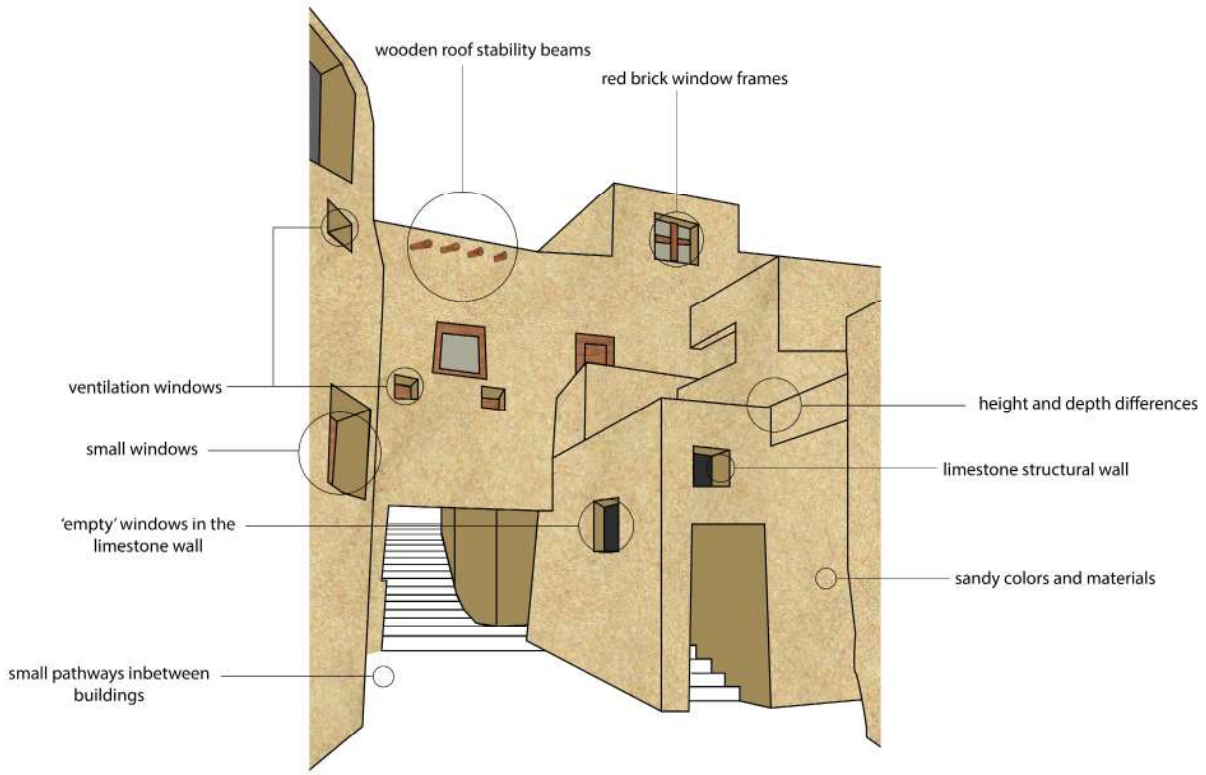
Today's architecture of El-Hadaba El-Wosta in comparison to vernacular architecture of Egypt.

The monotonous blocks of apartment buildings do have their advantages as there are many relations to the vernacular architecture. This is shown in drawings by Conijn based on images from Real Estate Egypt (2020) and Aly (2016).

The use of small windows, covered entrances, local materials and the clustering of housing can be related back to the vernacular architecture and include ways to deal with the extreme climate that is common in Egypt. There are also a lot of differences, including the water storage and other new technologies to deal with this climate. Both old and new technologies are combined in the current apartment buildings to create the best possible environment for Cairo its residents.

Typology
Drawn by Conijn, redrawn from Osus Home (n.d.) and Pinterest (n.d)

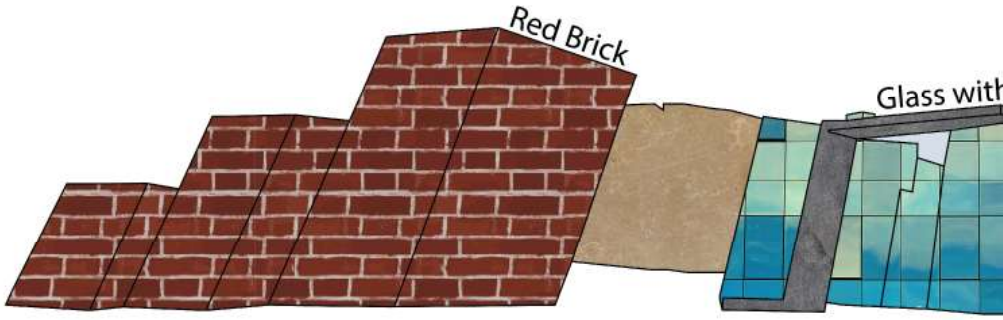

partly saddled roof
depth differences
water storage
loggia
ventilation windows
small windows
ledges in facade
sandy color and materials
covered entrance
small pathways inbetween buildings
identical concepts


wooden roof stability beams
red brick window frames
ventilation windows
height and depth differences
small windows
limestone structural wall
'empty' windows in the limestone wall
sandy colors and materials
small pathways inbetween buildings

3.6.6. Typology

Materials are used for different types of structures and functions.

The diverse use of technologies can also be found in the use of materials. Different types of buildings make use of different materials. In the neighbourhood El-Hadaba El-Wosta materials such as red brick, limestone and concrete are used, but also modern materials as glass can on occasion be found in the area (Google, 2020). The difference in legislation and regulations is not only shown in the building typology but also in the materials that are used. Red brick is mostly used in informal housing and slums, whereas limestone, concrete and glass are more used in legal buildings such as public buildings, social housing and new neighbourhoods (Attia & Wanas, 2012). This difference in materials and legislation and regulations causes great price differences for these different types of housing (Khaldi, 2015).



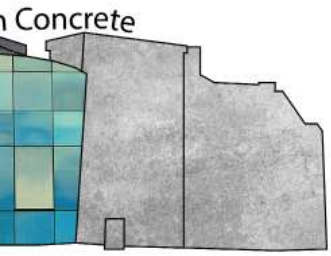
Red brick:
Single Red Brick Wall
Double Red Brick Wall
Cement Brick Wall

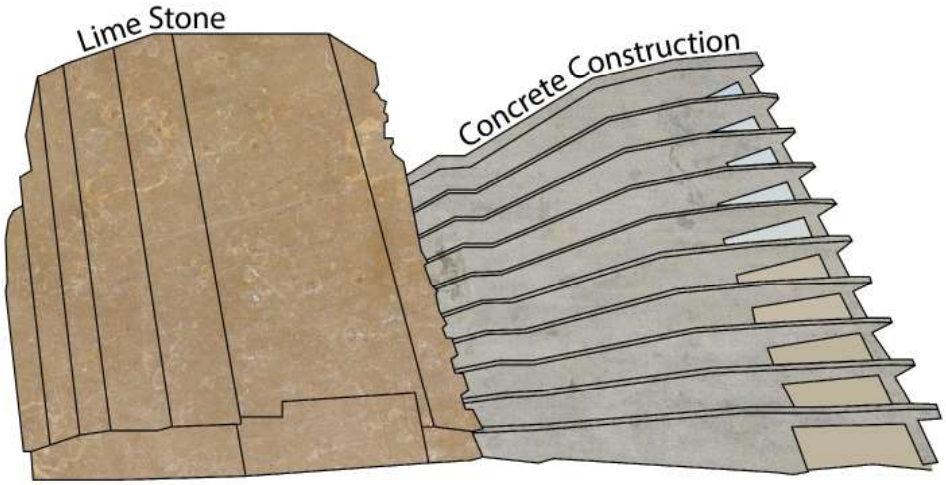
used for
- informal housing
- slums

Glass with Concre
Glass
Cement Brick Wal
Plaster
Concrete

used for
- modern types of
such as malls, offi

Typology
Drawn by Conijn, redrawn from Moawad (2017b) and data used from Attia & Wanas (2012).





ete
l

public buildings
ce buildings etc.

Limestone
Plaster
Concrete

used for
- Social housing
- High rise apartment buildings
- New neighbourhoods

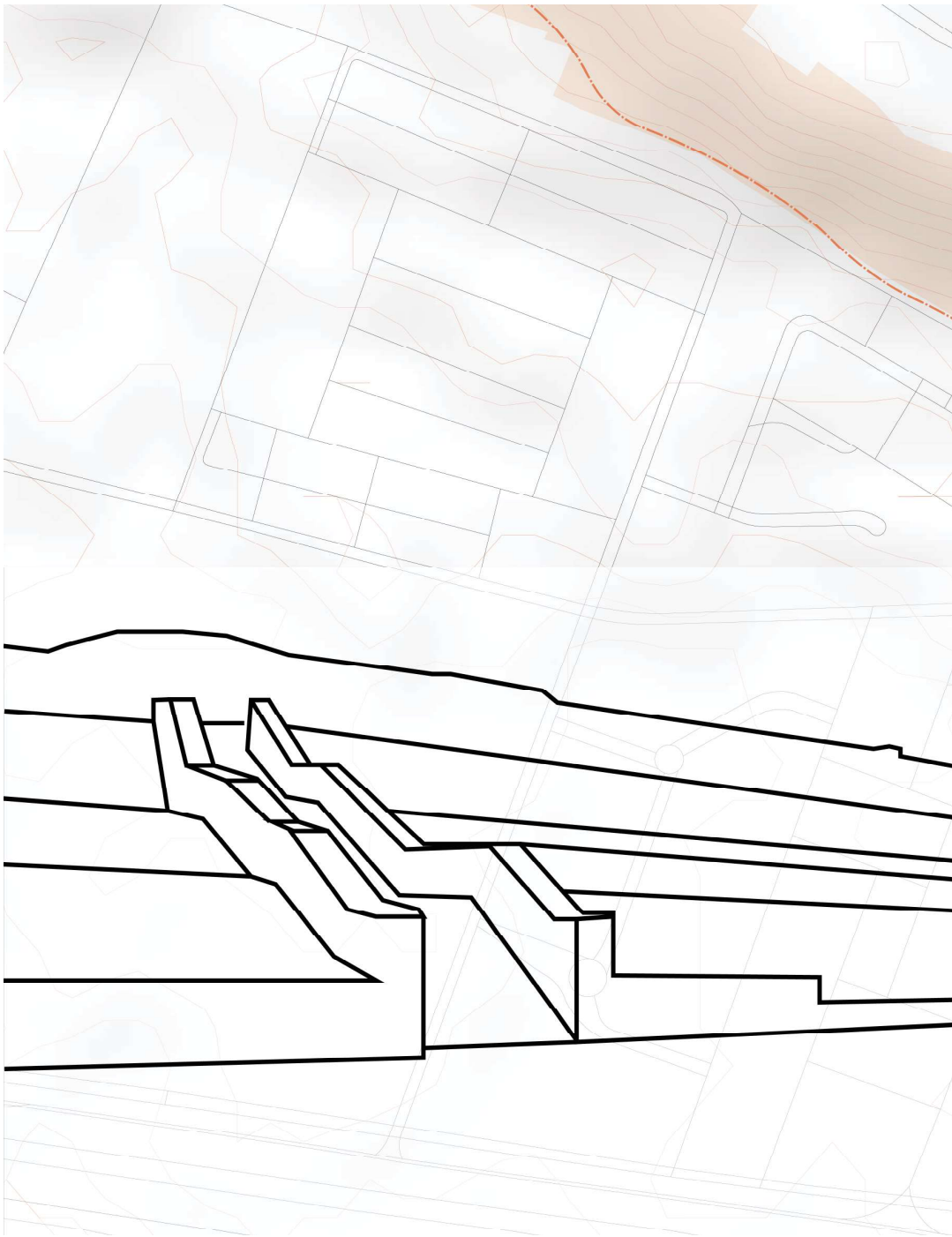
Concrete Construction
Ground Slab Floor
Flat Slab Floor

used for
- constructions for every type of building, excluding parts of informal housing

3.6.7. Landscape alterations and hazard protection

Structure that is used to protect the area from the effects of flash floods. However, these measures are not taken everywhere along built areas.

This difference is price range is not only shown in the materials and types of housing, but also the hazard protection for these more expensive housing is provided. In El-Hadaba El-Wosta, the compounds, that consist of apartment buildings only, are protected from flash floods by a landscape alteration in the form of a wall (Suites, n.d). This structure can be found on the border between the city and the desert. The location of this structure causes a barrier between the two environments that are present in the area: the desert environment and the urban environment. The wall seperates these two environments, causing them to coexist instead of collaborate.



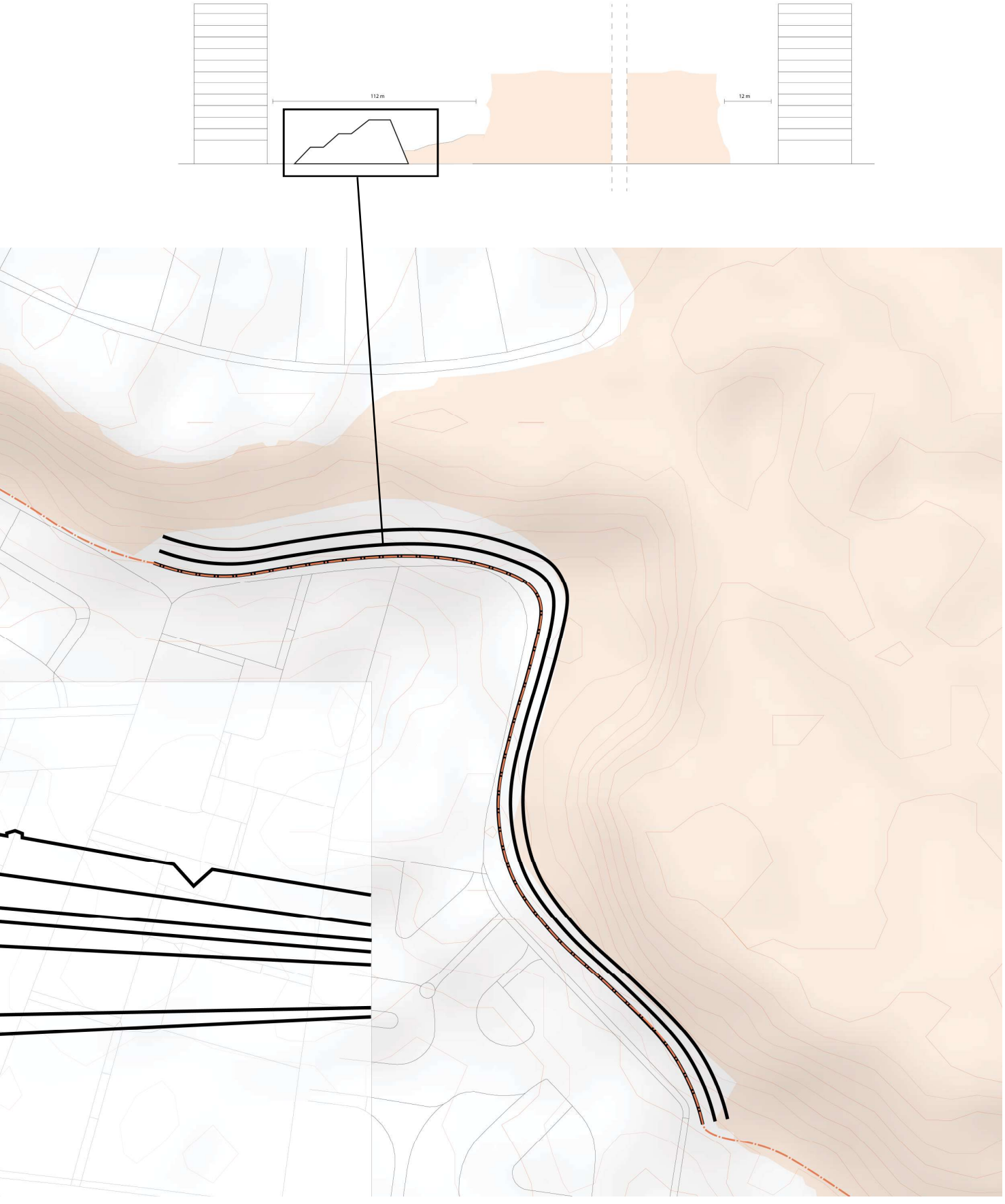
Landscape alterations

Drawn by Conijn, redrawn from Moawad (2017a) and data used from MilvusMap (n.d.), Google (2020), OpenStreetMap (n.d.)

Desert environment
Contour lines
Landscape alteration
Border built environment

N

0 80 m


112 m
12 m

3.6.8. Extreme Constructions

From the analysis a conclusion can be made about the extreme constructions that are present in the neighbourhood El-Hadaba El-Wosta. This map shows that the neighbourhood's borders are created by barriers in the form of the highway and the landscape alteration that is made for hazard protection. These barriers are also keeping the desert environment out of the city.

The desert environment is not only kept out of the city by these barriers, but is also ignored by the urban tissue. Cairo is expanding and, therefore, needs more space. This means that the desert has to hand in space to make place for new neighbourhoods. In these new neighbourhoods, there is no recognition of the desert environment. Parks and squares are designed to represent a diverse, green oasis in the middle of the urban area. However, these parks are not representing the climate that is natural in Egypt, which is the, high temperature and dry, desert climate. The current parks are filled with plants and shrubs that are high in water maintenance, whereas water is limited in the area. Therefore, these parks are highly artificial and a waste of water that should be used more cautious and could be used for other purposes that do benefit the neighbourhood.

Not only parks have a function for coming together, also public buildings and public squares have these purposes. The public buildings are well-divided through the neighbourhood and serve different functions. These buildings all have an impact range that is based on their function in combination with the size of the building. On the edges of the neighbourhood some of these impact ranges are limited because of the barrier that is formed by the highway. However, some functions, for example hospitals, do





3.7. Mobility and Transport

Framework

Framework for the Mobillity and Transport perspective to understand the transport, infrastructure and logistic in the El-Hadaba El-Wosta neighbourhood.

In this analysis, potential shocks and stressors affecting the mobility and transportation system of the El-Hadaba El-Wosta area in Cairo were analyzed using the TIL perspective methodology. The results are visualized in the framework and further explained in the additional literature. Some response ideas are given to participate with the environment. These responses are mainly focused on reducing the road traffic demand, by improving the accessibility to public transport services. The traffic demand in Cairo has increased enormously over the past decades. This has exerting consequences on energy needs and bearings on environmental impacts.

	Shocks: *Heavy rainfalls*		*Stressors* *Congest*
	Accessibility and connectivity	*Vulnerability (Physical and Social) & Reliability:* *(current mitigation or risk in place)*	*Accessib*
Mobility flows: PT/road network	Heavy rainfalls can cause flash floods. Even key roads are not accessible anymore.	Especially tunnels are at risk as they are low located, but also key roads are vulnerable in extreme heavy rainfalls.	The trans road-bas located r capital. T is the mi cles that road syst There als ver, El-H ble by th
Activity nodes: Critical facilities	Critical facilities also heavily depend on the road network system and are less accessible when roads are flooding.		Royal ho accessib The ring hospital
	Shocks: *Heavy rainfalls*		*Stressors* *Fragmen*
Logistics flows: Road/waterway network	Heavy rainfalls and flooding also have a major impact on the supply of products, as the freight industry mainly exists of road-based modes.		Food not access t Small an
Transfer nodes: Harbours/airports			Multiple volved. D distributi

Conclusions:	The main stress is the high traffic demand and the fragmentation of logistic transfer noc The main shock are heavy rainfalls that cause flooding. This could be improved by provid source and for electricity generation.

s: *ion due to overpopulation*		
ility and connectivity	*Vulnerability (Physical and Social) & Reliability:* *(current mitigation or risk in place)*	*Response*
sport system mainly consists of sed modes. The analyzed area is next to the ring road to the new The main public transport service crobus that is also motorized vehi- are part of the heavily congested tem. so exists a metro system. Howe- adaba El Wosta is poorly accessi- is mobility service.	Congestion due to a large traffic demand, faulty urban planning decisions and insufficient public transport. This congestion leads to unnecessary emissions, energy consumption and travel delays. The public transport system is weak, inefficient and unreliable, so people prefer not to use it.	Make public transport system more reliable and accessible to increase its use and reduce traffic emissions. Introduce more stops/stations and develop safe pedestrian walking routes to these stops. Expand underground network to the El-Hadaba El Wosta area (possibly combining with the ring road). Introduction of large-capacity electric buses. Take advantage of heavy rainfalls: use water as a water source and for electricity generation.
spital is close to ring road: le by car but less by other modes. road forms a barrier to access the from the other side of the road.	Congestion on the roads while traveling to a hospital.	Provide other non-road mobility services.
s: *tation*		
equally accessible and poor o fresh products. d uncooled vehicles.	Food quality and safety not guaranteed.	Create more awareness for food quality and safety. Closer harvesting of fresh products for better food supply. Provide other non-road freight transportation systems: combine with expanding underground mobility network.
traders and wholesalers are in- Due to the high fragmentation, the on system is very complex.	Inefficient use of transportation system, causing long transit times and inefficient fossil fuel consumption.	Implement policies to provide a fairer distribution of markets to prevent fragmentation.

des. One could respond to this by improving the public transport system, e.g. by expanding the underground network and by harvesting closer by. ding other, flood resilient, transportation systems that are independent from the vulnerable road network. Also, the rainfall could be used as a water

Mobility and Transport

As the population of Cairo is growing, the city is densely settled and over-crowded. This growing population has bearings on the travel demand. As the mobility system in Cairo is very limited as it mainly consists of road-based modes, it is difficult to expand this system with the same rate of travel demand growth. Besides, it's also difficult to introduce efficient transport supply management and to apply travel demand management measures (Huzayyin and Salem, 2012). Instead, new residential and industrial areas are expanding into the desert and into cultivated land (EEAA, 1999).

With this growing travel demand, the number of vehicles on the roads has grown over the last few decades. A decrease in car taxes and the mortgage system encourages even more people to buy a vehicle (Samir, 2012). This increase of vehicle traffic leads to insufficient capacity and to negative (environmental) consequences, such as urban congestion and traffic delays, increased energy consumption and greenhouse gas and pollutant emissions (Huzayyin and Salem, 2013). The road traffic demand in Cairo is shown in this map.

The analyzed area El-Hadaba El-Wosta is located next to the ring road to the new capital. This ring road was built in 1995 to prevent through traffic from crossing the city of Cairo (DRTPC Study Experts, 2009). This already led to the reduction of some bottlenecks. It also provides a better accessibility to jobs, as can be seen in this map. However, this road can form a barrier for people traveling from one side to the other. This for example can be a problem for people going to a hospital and need to be there as soon as possible. There are for example no pedestrian crossings of tunnels, making the hospital less accessible.



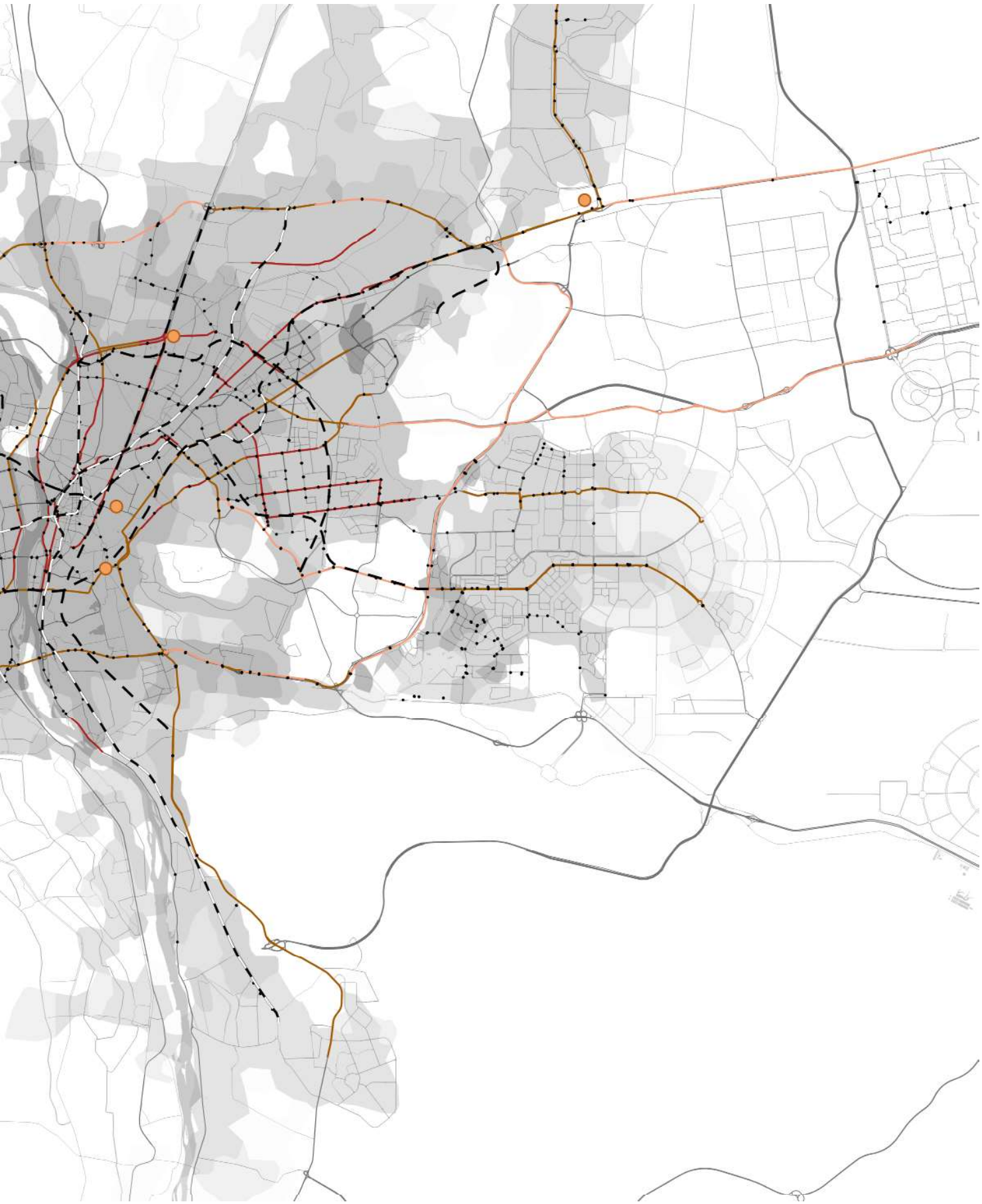
Mobility and Transport

Drawn by van Bentem, based on information from Google Maps (n.d.)

- Metro line
- Planned metro line
- Bus stops
- Warehouses
- Accesibility to jobs (High to Low)
- Traffic Congestion (high to low)

N

0 100 km



Insufficient public transport

Public transport is more efficient to facilitate the movement of a large number of people than private cars. During rush hours, cars often carry only the driver for commuting. If the space of all these cars was replaced with microbuses that transport more people, congestion would decrease. For this reason, as opposed to this single-occupancy automobile-based mobility, a functioning public transport network is very desirable (Abdou, 2018). However, the public transport system is weak, insufficient and unreliable, so people prefer not to use it (Samir, 2012; Cairo Traffic Congestion Study, 2014).

The public transport system does not cover enough areas and is underdeveloped for intermodal transfer. Also, there are inadequate public transport stations and the access to these stations is often insufficient (Waldhauer et al, 2015; Cairo Traffic Congestion Study, 2014; Kalila et al., 2019). Besides, the widely used microbuses are also motorized vehicles and are also part of the heavily congested road system. Not only the roads, but also buses themselves are overcrowded, especially during peak hours. Citizens use hand signals so that a microbus will notice them and know where they're headed (Shohayeb, 2018). Microbuses are mostly old vehicles operating on certain routes, sometimes unlicensed. They often operate without fixed schedules or pick-up and drop-off points. There are no regulations for this. Nevertheless, there is a bus stop Maadi Club Kattamia located next the ring road, close to the El-Hadaba El Wosta area, making this an accessible location. The official bus stops are shown in the mobility and transport map.

There are metro lines in the middle part of the city parallel to the Nile over the northern and southern directions. The stretches of the metro are shown in mobility and transport map . However, the city is expanding to the eastern and western directions. There are some new metro lines planned, as seen in figure #, but the mass public transport infrastructure is still not keeping up with the urbanization and people are still highly dependent on their private car. Road infrastructure keeps expanding without coordination with rapid public transport planning with a focus on easing congestion, while neglecting a strategic vision of the urban growth with sustainable mobility (Abdou, 2018).

It could be a good investment to expand the underground transport network. By this, the public transport system will become more reliable and hopefully used more, while the landscape above ground remains unaffected. As the use of this network would decrease the number of cars on the roads, it could reduce congestion and emissions and thus be more sustainable. Next to that, expanding the public transport system will make some locations better accessible for different groups of people, making the public transport system also more equitable. Furthermore, the introduction of large-capacity electric buses could improve the efficiency of mobility flows, as these use less space on the roads.

Logistics

Freight industry in Cairo is fragmented with a large number of small firms and a small number of large firms and it is dominated by road-based modes (Gray et al., 1998). Multiple traders and wholesalers are involved. Some of these wholesale markets are shown in figure #. Due to the high fragmentation with a large number of very small stores, the distribution system is more complex as the supply chains have more chain links with longer transit times (Waldhauer et al, 2015). Furthermore, traffic congestion is a major issue in freight transportation. Due to traffic jams, the subsequent delays and the fragmented product supply, truck transport costs have increased (Van den Broek and Boerrigter, 2014; Cairo Traffic Congestion Study, 2014). City distribution is inefficient due to the complete traffic chaos in downtown Cairo (Van den Broek and Boerrigter, 2014). This is at the expense of fuel efficiency and emissions, and thus of the environment. The high number of transits and congestion lead to high transportation costs and a low responsiveness to orders. A response to this could be to provide other non-road transportation systems for freight. This could for example be combined with expanding the underground mobility network. This will also contribute to a reduction of road traffic demand and thus to less emissions.

Next to that, the food quality suffers with high food losses and issues regarding food safety. The cooling in transportation is insufficient and underdeveloped. There seems to be a shortage in cooled trucks. Rather than refrigerated trucks, cooling is done by “dipping natural fibre sheets in water which are set up in the truck and lead to cooling of the produce” (Van den Broek and Boerrigter, 2014). To assure food safety, there should be more awareness in the transportation affecting the quality of the products.

Besides, modern supermarkets target middle- and higher-income groups and therefore are mainly located in the affluent districts of the city (Waldhauer et al, 2015). Due to this, especially lower income groups heavily rely on traditional market outlets. (Waldhauer et al, 2015). In 2011 about 25% of the inhabitants of Greater Cairo had poor access to food and lived in a state of food insecurity (Waldhauer et al, 2015). An idea could be to harvest fresh products closer to the living areas for a better food supply. This environmental participation will reduce the transportation needs for food products.

Flash Floods

Despite the fact that Cairo normally suffers from drought and water scarcity, sometimes heavy rainfalls occur that can bring areas of Cairo near standstill. It can lead to massive traffic jams and the flooding tunnels and even to the flooding of key roads when the rainfall is too extreme. The rainfall can submerge some cars entirely under water (Uddin, 2019). Even parts of the ring road, that is expected to withstand heavy rainfall, were shut down during a heavy storm in April 2018 (CBS news, 2018). One could mitigate on this by providing more flood resilient transportation systems that are independent from the vulnerable road network.

Egypt does not have a system yet to recycle the rainwater, even though collecting and treating rainwater is less costly than treating sewage. Proposals have been made for establishing a system for storm water drainage and collection and even for using it to generate electricity, but these have not been initiated yet (Hamad, 2020).

Conclusions

The mobility and transport methodology gave some new insights in development potentials in the El-Hadaba El Wosta area of Cairo. Multiple stressors and shocks were found that have an influence on the extreme landscape of Cairo. The main stress that Cairo is experiencing is the high traffic demand due to its growing population and the additional congestion problems. As the public transport is unreliable and insufficient, the mobility flows are dominated by the use of private cars. Also, the freight industry is dominated by road-based modes. Due to the high fragmentation, the distribution system is very complex. Next to that, the cooling in transportation is insufficient and underdeveloped. One could respond to these stressors by expanding the underground transportation and by the closer harvesting of fresh products. By this, the traffic demand will decrease and thus less energy will be consumed and traffic emissions will be reduced, which will contribute to a better environment. It would also be an interesting idea to combine the expansion of the underground mobility network with a freight transportation system.

The main shock that impacts the city of Cairo are heavy rainfalls that cause flooding. This could be improved by providing other, flood resilient, transportation systems that are independent from the vulnerable road network. To better participate with the environment this situation, one could make use of this situation by recycling the water and by using it for electricity generation.

4.

Systems description and synthesis

Analysis Conclusion

The problem statement of the project set two extreme elements: drought and heavy rainfall. These elements give problems in flash floods, erosion and water loss, as well as water shortage, irrigation need and inavailability of food. In the neighbourhood of El Hadaba El Wosta, these extremes are very present.

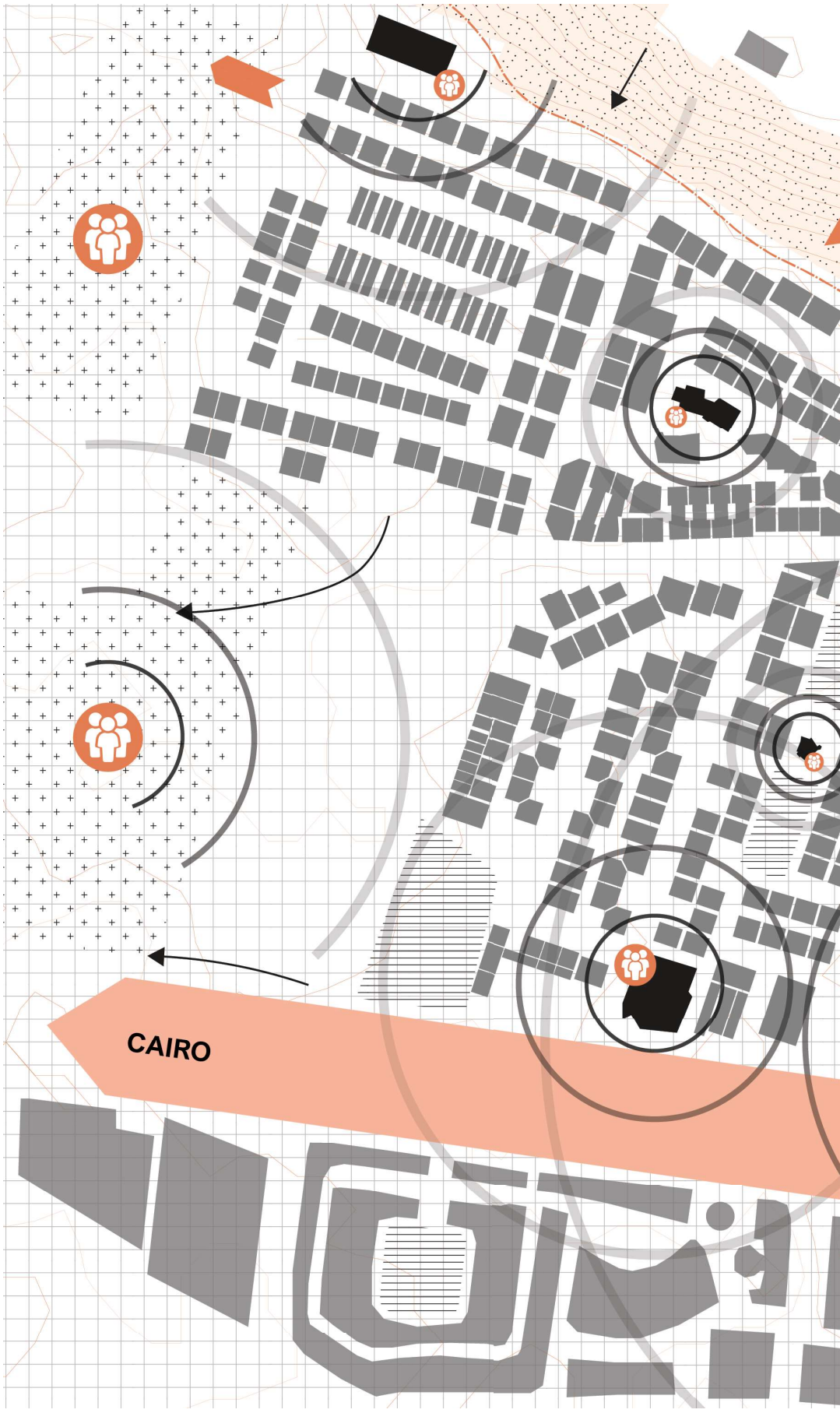
The neighbourhood is on the edge of a steep slope, and the water stream goes through the area. Currently, there is no drainage system. This steep slope is protected on the northeast side by a large wall. Although this wall protects the area, it is also causing erosion.

The wall also represents the human interventions in Cairo and its surrounding natural areas. The urban area has a large effect on the natural areas. To create the desert cities, ground is digged and leveled out to build new neighbourhoods. On the one hand, the natural areas seem ignored because of the endless claiming of land. On the other hand, the building edge follows the contour lines, which shows that the humans actually listened to nature. But this ignoring does not stop with the claiming of land. Large highways and industries are polluting the area. This puts a lot of pressure on natural areas.

Another factor which shows the ignorance of landscape, is the design of public space. They contain irrigated green parks with grass and vegetation which is not native to Egypt and the desert environment. These irrigated green spaces expel native species and vegetation. On top of that, the irrigation of these green spaces needs a lot of water.

The buildings in El Hadaba El Wosta are large, dense and quite anonymous, since they are all similar. This is done because it generates shade, but it also fits the demand of the residents to have privacy. Egyptians are very social people, and they meet at sports facilities and the centrally placed mosques. But outside of that, they are fund of their privacy, which the buildings give them.

As mentioned, the neighbourhood is dealing with long droughts and heavy rainfall. The location on the edge of a steep slope make it even more vulnerable. On top of that, human interventions are pressuring the natural areas, which is adding on to the vulnerability.



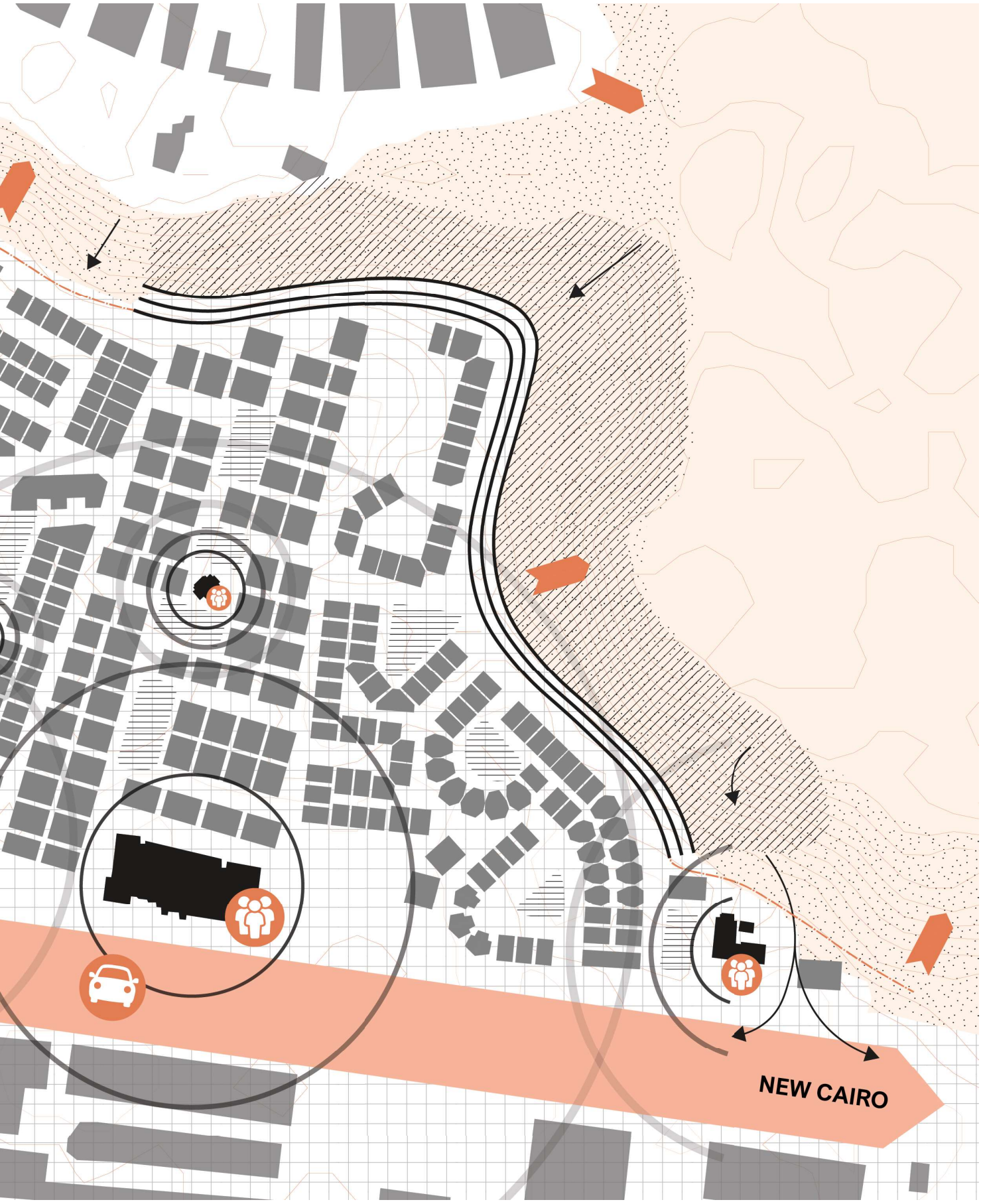
Conclusion Map

drawn by Van Den Broek
(based on critical cartography)

- Public Building
- Building
- Building Block
- Highway
- Desert
- Erosion Prone Area
- Flood Prone Area
- Natural Shrub Vegetation
- Irrigated Green Space
- Sports Facilities
- Wall
- Building Edge
- Contour Lines
- Stream Flow
- Pressure on Nature
- Catchment Area
- Meeting Place
- Car Dominance

N

0 100 m


NEW CAIRO



Current situation
(Google Earth, 2020)

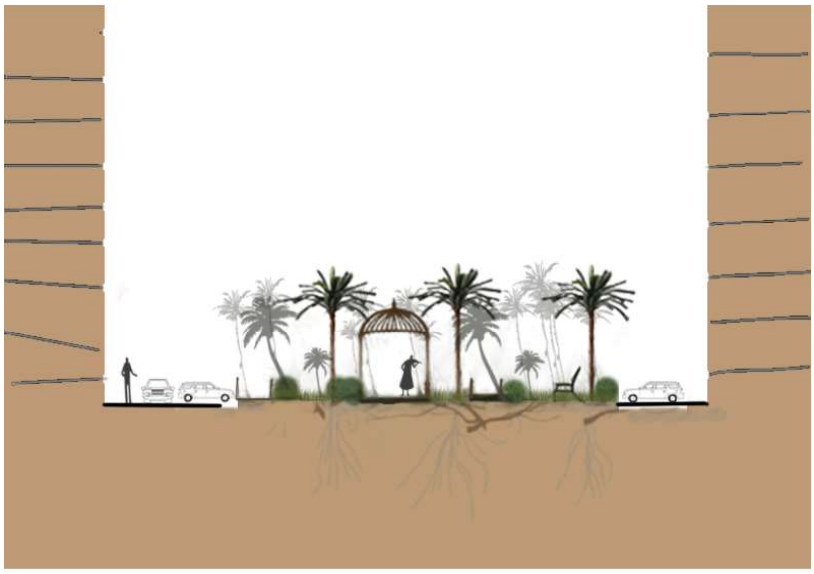
N

0 100 m





Buildings
drawn by Conijn



Ecology Section
drawn by Van Eeden



Windowscape
drawn by Eggink

Current Situation

The current situation foms our base for the scenario making. At the project site there is only one building type. This building typology is a 12 stored appartment complex. The housing blocks are placed in a dense grid so as little sunlight as possible can go through the windows.

The public space consists of car lanes, parking lots and parks. The park are quite neat and enclosed by fences. The vegetation within the parks is irrigated and consist of mainly non-native species.

The windowscape shows how the Egyptians live in such a neighbourhood. The inhabitants are part of the Egyptians middles class.

5.

Scenario making

5.1. Nature First

In the redesign of the city nature is put central and also implies ‘de-growth/ give back to nature’ and ‘nature first’.

5.2. No technology

In the design of the city natural solutions are preferred over technological solutions, but the technology is still there, it implies ‘deep ecology’ – so designing nature/ re-nature process.

5.3. No humans

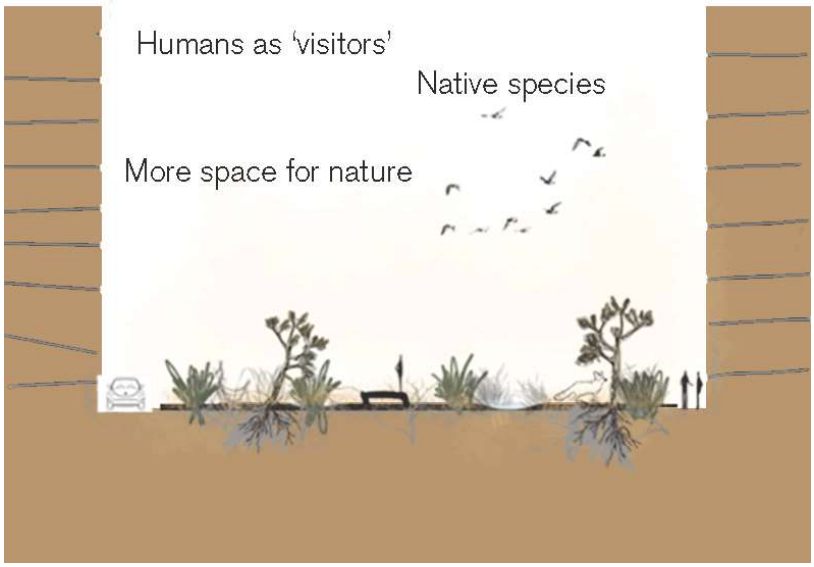
This is part of a retreat strategy over a long time, what leaves first. People will gradually leave, first a few (rich and not location bound), eventually all of them. People will leave the buildings and infrastructure behind. (depending on if there is probably no legislation or economic benefit of cleaning up). Maybe the less rich and fortunate people might reuse the materials.

5.4. COVID-19

Based on social distancing, reduction of mobility, coming back to local scale.



Buildings
drawn by Conijn



Ecology Section
drawn by Van Eeden



Windowscape
drawn by Eggink

Scenario 1 . Nature First

In 'Nature First', nature is put central in the redesign of the city. Currently, the neighbourhood is completely focuses on people and movement. There are small parks, but they are completely enclosed by buildings, and the parks are irrigated and have artificial vegetation. When putting nature first, there will be a shift from nature enclosed by buildings towards buildings enclosed by nature. This will mean there will be a small de-growth in the neighbourhood.

De built environment is organised in small clusters. New buildings are constructed out of local materials and in a non-polluting way. This means there will be no highrise and large concrete or steel constructions used. The existing buildings stay the same, but can be adapted. For example, green roofs can be constructed.

There will be less parks and agricultural areas, they will make place for reserved natural areas. These natural areas will not have strict boundaries, they have the freedom to grow or gradually move into the city. Large highways decrease in size. This creates space for wadi's to flow through the neighbourhood. However, the wadi's will be regulated in the area, so they will not cause damage to the people. Humans are 'visitors' in the neighbourhood, but they still have to be able to live safe and healthy. Making the humans visitors gives a chance to native species and vegetation to live and grow in the city.

Although the focus is on natural development and not on human development, technology will still be present. This can actually be used to preserve natural value en protect natural areas.



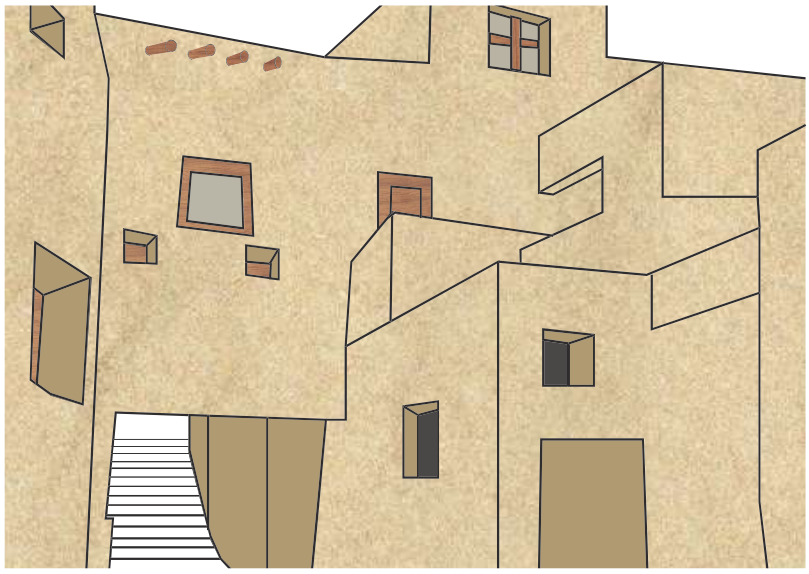
Scenario 1 - Nature First
drawn by Van Den Broek
(underlay: Google Earth, 2020)

- Buildings
- Public Space
- Rural Area
- Water Stream / Wadi

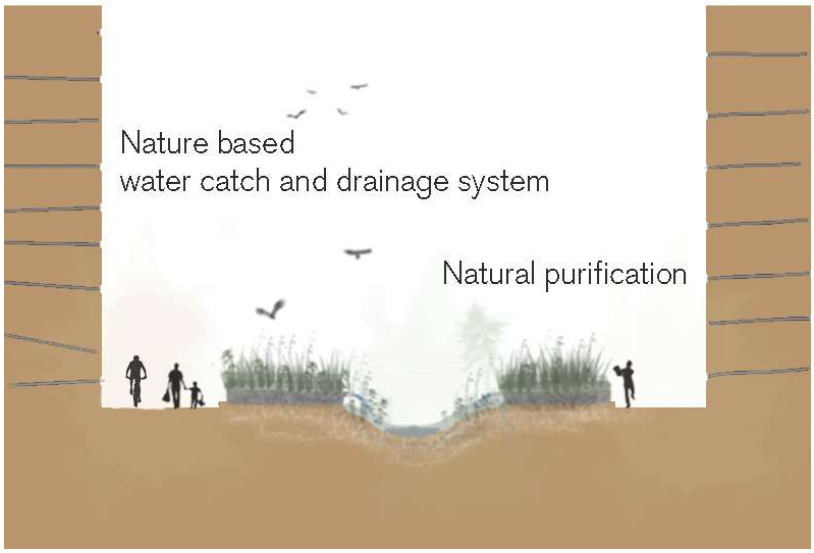
N

0 100 m


Water can run freely through the neighbourhood
New buildings constructed out of local materials
Wall broken open to let nature in the neighbourhood
Public space is transforming from artificial to native vegetation, and it is less organized and bordered
Descaled highway



Buildings
drawn by Conijn



Ecology Section
drawn by Van Eeden



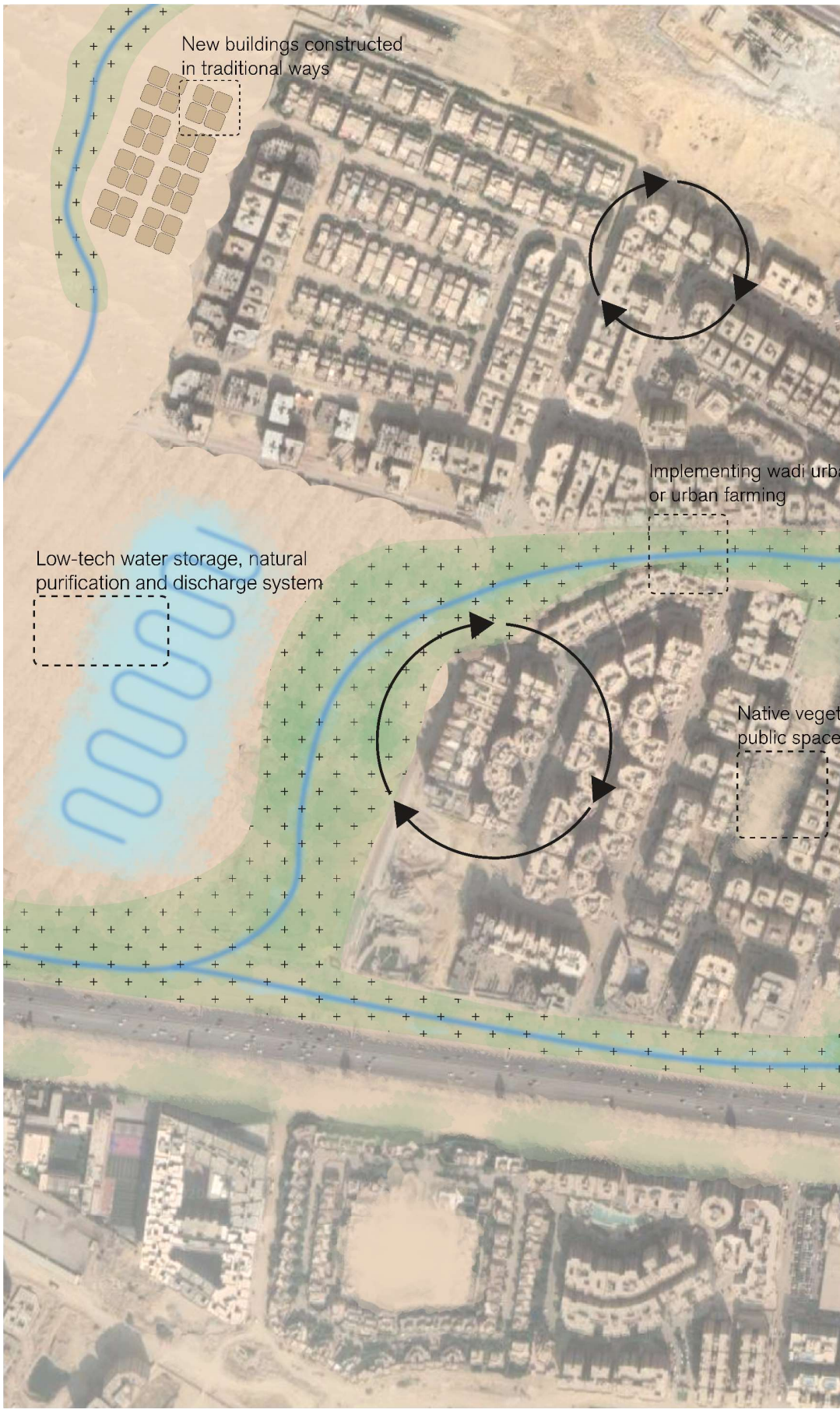
Windowscape
drawn by Eggink

Scenario 2 . No Technology

Natural solutions are preferred over technical solutions in the ‘No Technology’ scenario. To realise that, society retreats itself to small communities, mostly families. These small communities still live in the neighbourhood, there will be no new typology and no urban sprawl. Since large constructions and transportations are not possible anymore, as well as for example airconditioning, the communities live on a more traditional way. They are self sufficient with their own agriculture and water purification. A wadi through the neighbourhood gives fertile grounds to cultivate.

The new desert cities will not be possible anymore, since irrigation is not achievable. This is because large storage and sewage systems are not achievable. Wastewater and rainwater can be stored and harvested, but on a natural way. Water will be purified naturally by e.g. reed bed filtration systems.

Protection to hazards must be done on a natural or manual way, since no technology can be used. The Aswan Dams and the protection wall northeast of the neighbourhood can remain, but there cannot be made any new large constructions. This means lower areas are mode flood prone, and people will move to more safe areas. The biodiversity will increase on the locations where people leave. Where people stay, it will remain mainly the same, but pollution will decrease. In general, the ecology will benefit from this scenario.

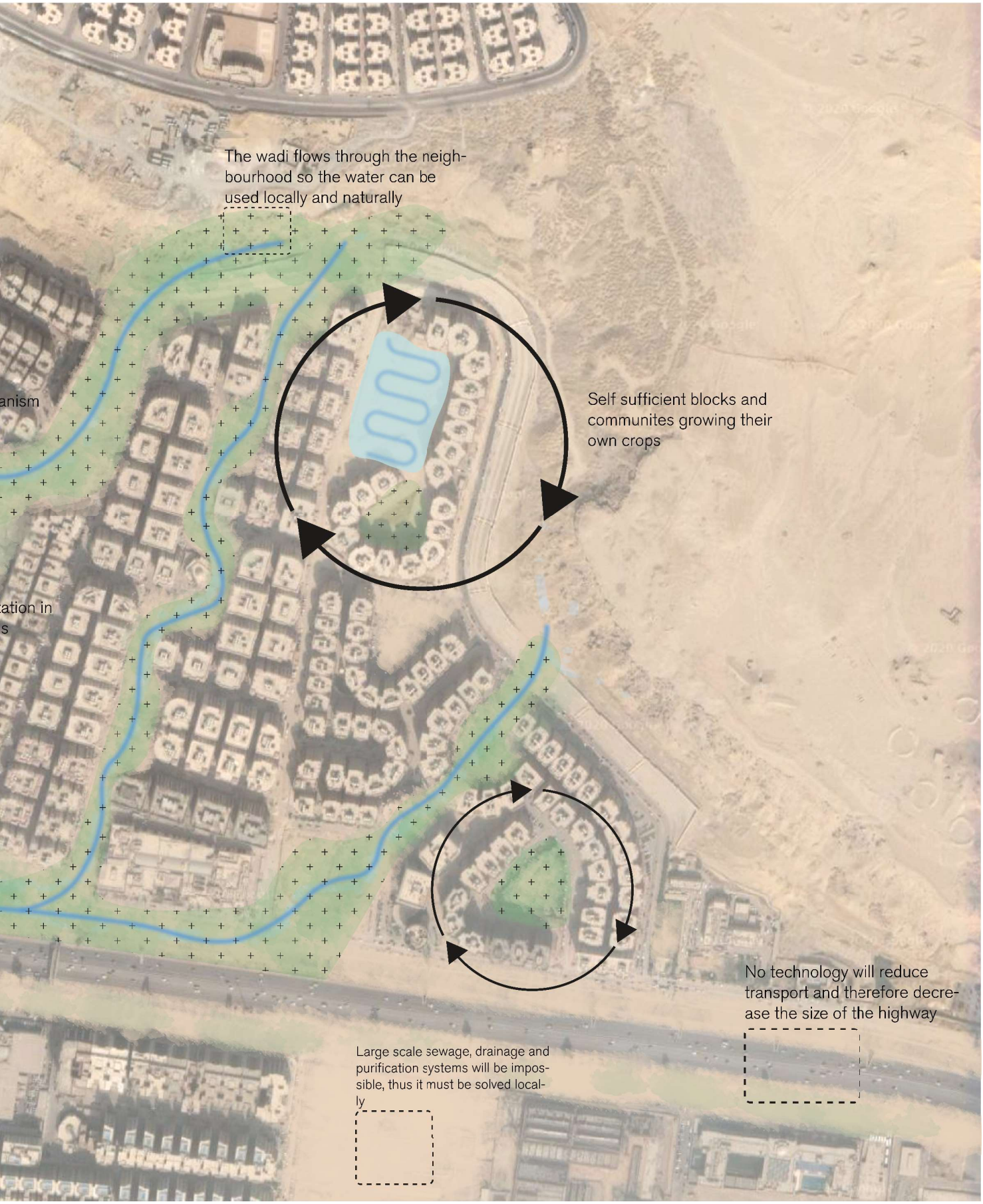


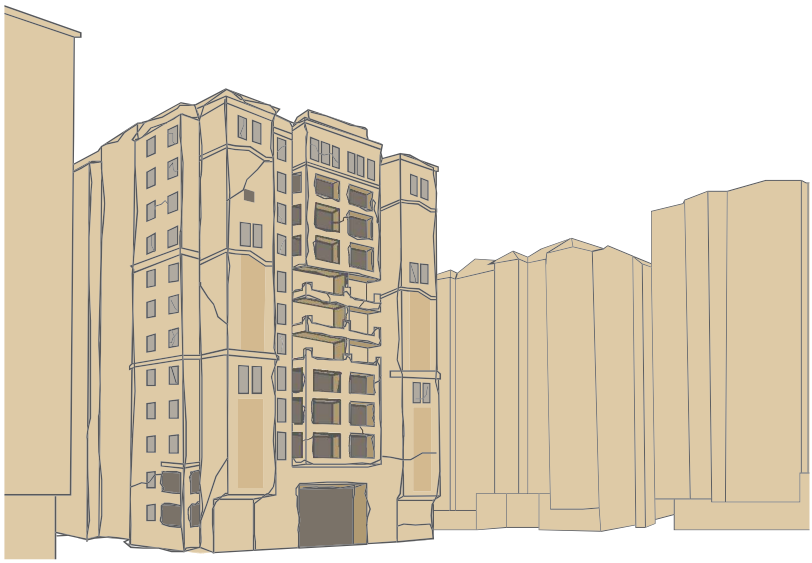
Scenario 2 - No Technology
drawn by Van Den Broek
(underlay: Google Earth, 2020)

- Buildings
- Wadi Agriculture
- Self Sufficient Community
- Water Stream / Wadi
- Natural Purification

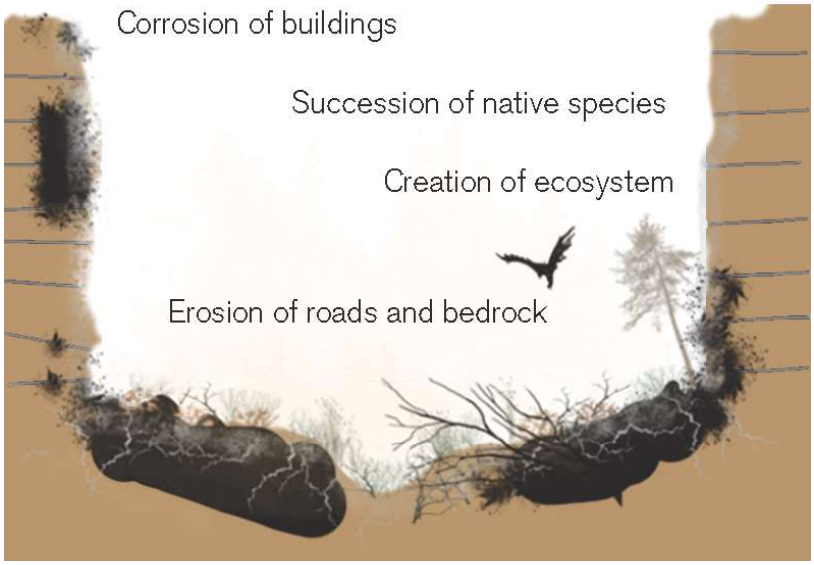
N

0 100 m


The wadi flows through the neighbourhood so the water can be used locally and naturally
Self sufficient blocks and communites growing their own crops
No technology will reduce transport and therefore decrease the size of the highway
Large scale sewage, drainage and purification systems will be impossible, thus it must be solved locally



Buildings
drawn by Conijn



Ecology Section
drawn by Van Eeden



Windowscape
drawn by Eggink

Scenario 3 . No Humans

When people gradually leave the neighbourhood, nature will gradually take over. First, the residents who are rich and not location bound are leaving. Lastly, the vulnerable populations leave, and they take useable parts of the neighbourhood with them, such as furniture or materials.

The buildings stay, but will dilapidate. The nature is finding its way through the buildings, thus public space becomes natural space. The buildings will become part of the ecosystem. There will be corrosion of buildings and erosion of roads. New wadi's will meander through the neighbourhood. They reconnect the wadi's in the desert with the Nile. Natural areas reappear in the desert, but also along the Nile. The new desert cities dry out, since they cannot be irrigated anymore.

Since people left the neighbourhood and the city, a new way of living arises. Or better, a traditional way of living. People will live as nomads again and they stroll with their relatives and herds of animals through the country, so also through the abandoned neighbourhood. The traditional way of living causes that there will be no climate change and pollution anymore.



Scenario 3 - No Humans
drawn by Van Den Broek
(underlay: Google Earth, 2020)

Nomads
Water Stream / Wadi

N

0 100 m


s all freedom to
create new wadi's
The wall is covered by sand and dust and
nature overakes the neighbourhood



Buildings
drawn by Conijn



Ecology Section
drawn by Van Eeden



Windowscape
drawn by Eggink

Scenario 4 . COVID-19

The fourth scenario is based on social distancing, reducing mobility and focussing on the local scale. This will mean there will be smaller and more intense communities in the neighbourhood. Since Egyptions are fund op their privacy, this scenario can lead to more gated communities. These communities will have more private exterior space. In this private space food could be produced and garden will be beautified.

Public space has to be reformed to realize social distancing. The roads and parks will be much less busy. Routes have to be made on roads and sidewalks, and parks must have recreational space where social distance can be maintained. Because people are making less use of public space, flora and fauna has the chance to come into the city.

Buildings also need to be transformed. Communal space must have clear routes and staircases, elevators and hallways should be larger or more regulated. New buildings and neighbourhoods will have less density and less communal space. This could lead to more sprawl and therefore less accessibility. This does not have to be a major problem, since people travel less.

The scenario of COVID-19 will decrease climate change because there will be less polluting movement. Communities will be more intense and private space becomes more important.



Scenario 4 - COVID-19
drawn by Van Den Broek
(underlay: Google Earth, 2020)

- Buildings
- Flora & Fauna
- Private Exterior Space

N

0 100 m


re restructured to retain
ancing, e.g. adapting hal-
entrances
Native flora and fauna can enter
the neighbourhood since the
public spaces are abandoned
private exterior space is prioritized,
expanded and improved
Public space is more regulated
and there is no space for spon-
tanuous meetings
Communities become smaller,
but more intense
ublic spaces are abandoned
Public spaces transform into communal
spaces for the surrounding blocks
More routing and regula-
tion in movement
Highway decreases in size since
there is more local activity and less
large transport

6.

System intervention

Vision

Currently Egypt has lost it's connection with the natural environment. Ancient knowledge about water harvesting, water purification, building typologies and permacultural practices seems forgotten. The Egypt that we see in our analysis deals with the extreme environment with solutions that stand on their own. The water demanding dry parks are irrigated by tap water, the heavy rain is not havrested nor drained and can be seen as a loss. The desert is cut out by seperating it with a wall from the urban areas.

Our vision is to look at this area with a comprehensive view. We want to understand the natural processen and find out how these natural processen can take place in an environment where the urban tissue is working togehter with the natural desert landscape.

Guidelines

The El-Hadaba El-Wosta neighbourhood can use some improvements in different types of perspectives. Improvements should be made to create a more resilient and eco friendly neighbourhood in the city of Cairo. For these improvements guidelines for a new design are formed for a small area in the El-Hadaba El-Wosta neighbourhood. The guidelines involve the efficiency of water use and wadi urbanism, but also spatial planning is involved in these guidelines.

Space for wadi's should be reserved to handle the discharge of peak water flows and the harvesting of rain water. The reuse of domestic waste water through natural purification should be introduced to the area to maintain greenery in public spaces. Barriers between the natural desert environment and the urban environment should be removed to create an interaction with this environment. This interaction can also provide awareness about the desert environment that is natural in Cairo, Egypt. Removing this barrier means designing parks by using native species instead of the current 'English gardens' and thus creating a connection between the living environment and the desert environment. This is also why natural and local ways of building are preferred over current techniques. However, these ways can also be used to improve the ecological footprint of the neighbourhood and invite local environments in the city. Also densification is favored over expansion to prevent urban sprawl and preserve the desert environment around the city. These dense neighbourhoods should be diverse in social classes with equal job opportunities, facilities and public goods.

In the project in Cairo local residents will benefit from the improvements that will be made in the neighbourhood. The neighbourhood El-Hadaba El-Wosta will become a more attractive urban area for residents to live in. The new guidelines create an interactive connection between the residents and the public space. Another stakeholder that will benefit from these interventions is the municipality of Cairo. The design guidelines focus on creating a resilient future for the neighbourhood, this means that there will be less maintenance and problems in the future. Money can be saved on the long term and can be used for other projects and neighbourhoods.



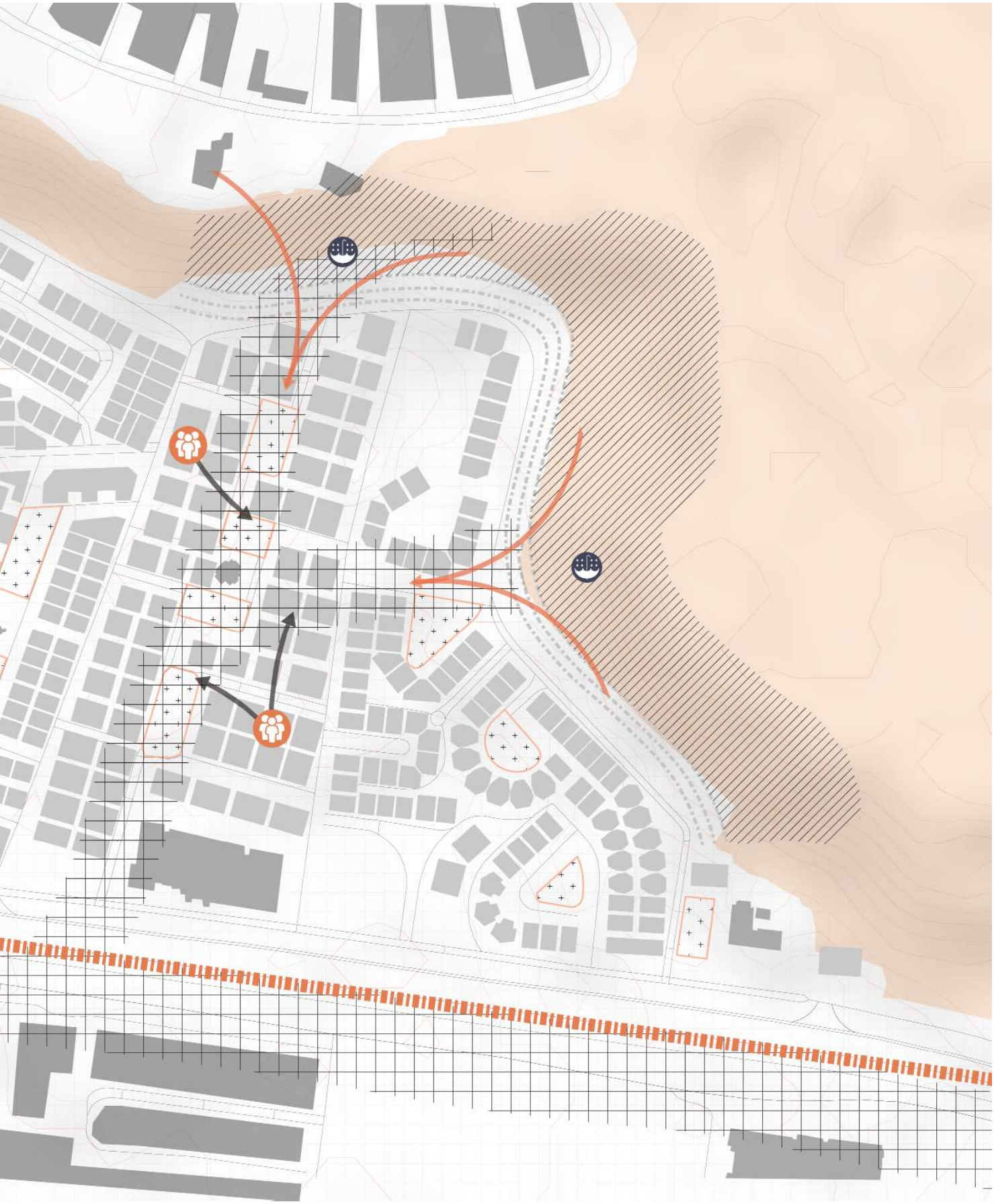
Guidelines Map

Implementing the guidelines in the design area.

- Desert environment
- Contour lines
- Natural green space
- Water collection
- Wadi Urbanism
- Introducing desert in city
- Harvesting water
- Accessibility
- Neighbourhood participation

N

0 80 m

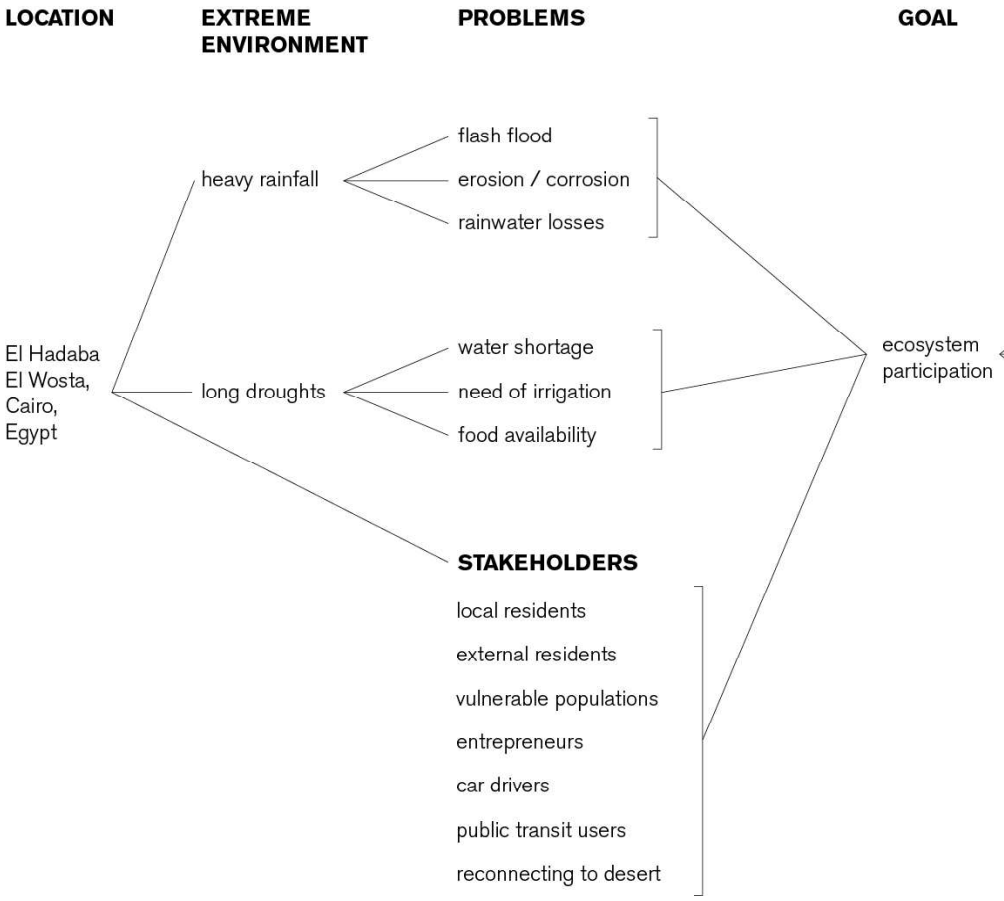


System intervention

To reach ecosystem participation in the neighbourhood El-Hadaba El-Wosta there are certain topics that need to be taken into account. This Egyptian neighbourhood has to cope with seasonal heavy rainfalls and long droughts. This means flash floods, erosion and rainwater losses are problems in this area, but also water shortage, irrigation needs and decreased food availability go hand in hand with these extreme climate events. In order to achieve the goal of ecosystem participation in this neighbourhood, these extreme climate events should be dealt with in a design experiment.

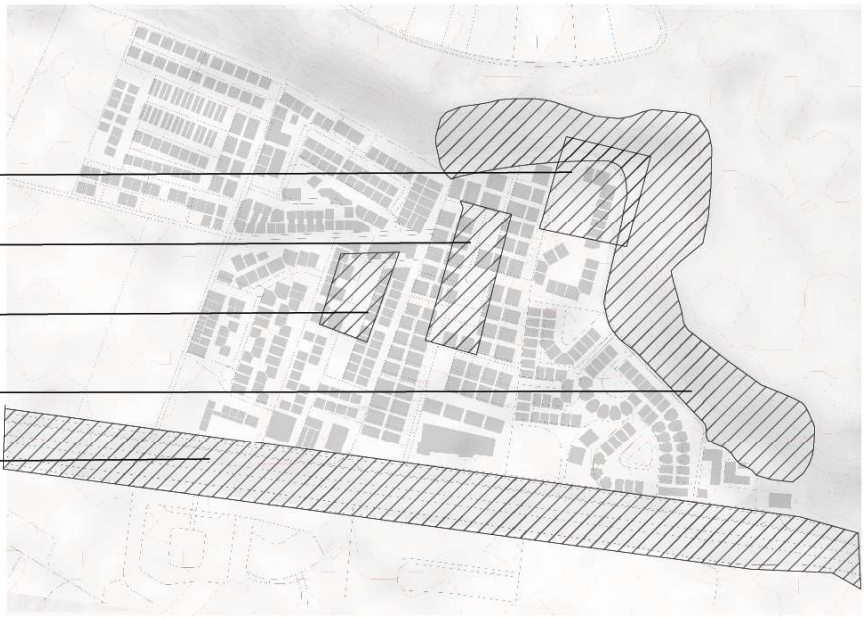
The concepts mimicry, permaculture and wadi urbanism could be the answers to achieve this goal of ecosystem participation. Possible implementation of these concepts is set up in guidelines for a design experiment involving part of the neighbourhood El-Hadaba El-Wosta.

Taxonomy



CONCEPTS	PRINCIPLES	SOLUTION SPACE	DESIGN CONCEPT	ACHIEVEMENT
mimicry	resilient environment water harvesting water = food multifunctional public green space for water storage reuse of waste water	in / on building road park neighbourhood edge rural area underground	Permacultural park Permacommunity From artificial to natural New Neighbourhood Merging Flows	
permaculture	reuse of organic waste specie adjustments small food chains natural infrastructure reconnecting to desert natural purification			
wadi urbanism				

Locations of interventions



6.2. Design Experiements

6.2.1.

Permacultural Park

Esmée van Eeden

6.2.2.

Merging Flows

Johan Klaas Krom

6.2.3.

From Artificial to Natural

Laura Conijn

6.2.4.

Permacommunity

Jort van den Broek

6.2.5.

New Neighbourhood

Jan Eggink

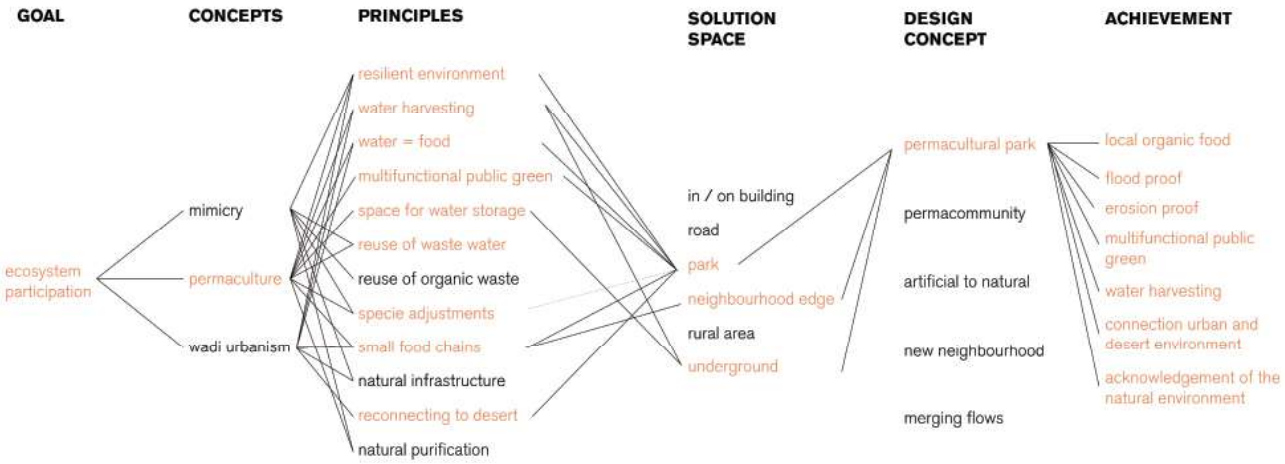
Permacultural Park

Esmée van Eeden

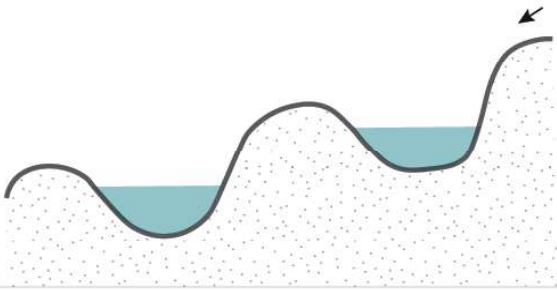


Manifesto

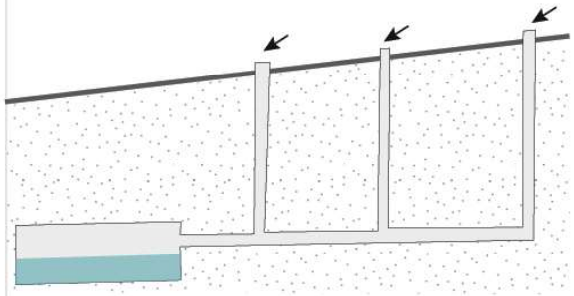
The analysis learns us that long intense droughts and flash floods form the extreme landscape and environment in Egypt. With a history of living with the dry desert and capturing the heavy rain, Egypt was once very in harmony with its nature. However, the modern civilization we have now cannot be more disconnected with its own environment. The presence of the desert seems to be totally neglected. Where once was a wadi is now a dense urban neighbourhood. A big wall separates the desert from the urban tissue and within the urban tissue irrigated green replaces the dry and low vegetation that is natural to the desert. Dealing with the flash floods and droughts is hard in the urban environment. There is no drainage system or water capturing system. The water availability is decreasing while the water demand is rising. Big infrastructural measures are needed to bring in the water and the food to the people. All the problems and events that are occurring are dealt with on its own, while combining the problems can lead to more comprehensive solutions. In this booklet we are talking about ecosystem participation. In this manifesto I continue on this concept by adding the concept of permaculture.. Permaculture aims for a human living environment which is ecological sustainable and stable with the aim of food production. There is space for water storage, water purification, crops and natural manure. Permaculture is proven to work really well in other Arabic countries, mainly Jordan, where with only a little bit of water food can be grown. The fascination I go trough is how the presence of the desert can be acknowledged again, and how involving the desert in the daily urban life will create a more sustainable urban-desert system.



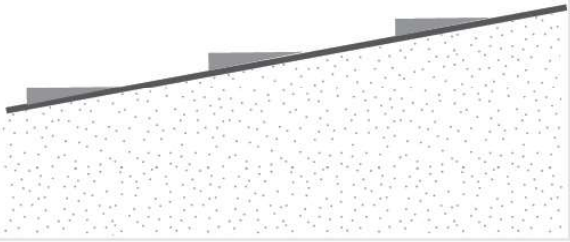
Water infiltration - Swales



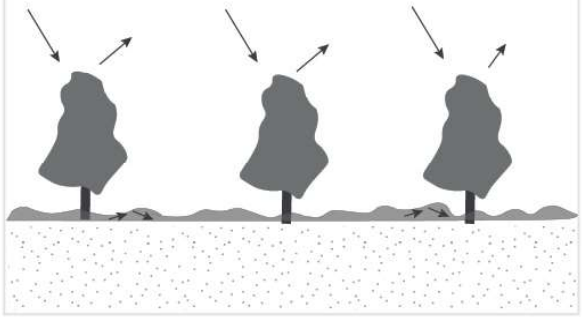
Water Storage - Qanats



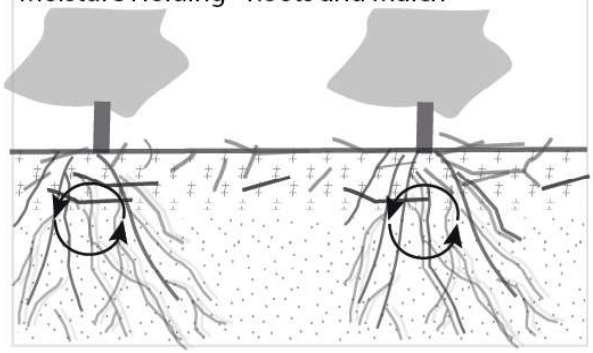
Erosion prevention - Terraces



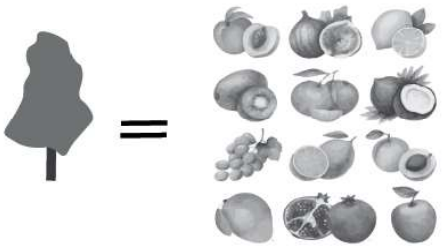
Decrease Evaporation - Shading + Groundcover



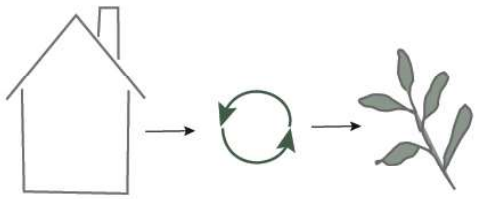
Moisture Holding - Roots and Mulch



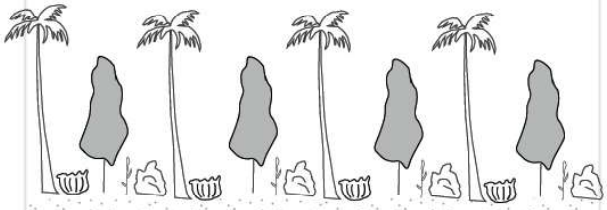
Vegetation = Food Growth



Organic waste = Fertilizer



Specie Divers Planting and Intercropping



Design Experiment

My focus was captured by the big wall separating the desert and the residential neighbourhood. This seven meter high wall is the direct representation of the neglection of the desert. Replacing the wall for something natural, creates space for permaculture practices.

Permaculture includes many technologies and ideas which are based on the natural bias of a specific place. In this case I selected the following guiding principles to use in my design.

Terraces, swales and qanats can harvest the rainwater and also prevent erosion. With some manure, coming from organic waste, food can be cultivated on the terraces. A mixture of trees, crops, and supporting species can work as an ecosystem creating shade and mulch and will prevent the soil for drying out and depletion. Furthermore, planting in not planted only for its aesthetic value but always with a multifunctional aim such as food, shade, nutrition.

The entire design is multifunctional and will replace the irrigated parks with water demanding non-native species in the residential area. Footpaths and picnic spots enrich the green environment for the park like experience of its visitors. Local organic food can be sold on the farmers market. The green zone around the neighbourhood keeps the air cooler and cleaner. The residents can climb up the hill in the green buffer until they leave the green buffer behind and enter the highest point of desert in surroundings with nice views. You cannot get closer to the natural environment.

Plan Permacultural Park

The agricultural park replaces the concrete wall which currently seperates the desert from the urban area. Besides this replacement the park also entail the entire desert slope behind the park until it reaches the highest point of the hill.
The place where the wall is, is the most steepest place of the area and will be replaced by swales. Thereafter, at the more flat area there is place for agricultural practices and bike and pedestrian paths. More uphill, where the slope gets a little bit steeper again the park transforms into terraces with olive trees.
In that way the entire slope is erosion proof, rainwater is catched and the excess run-off water is slown down and guided to the water storage basins or wadi's.
The crops from the park are sold at the local farmers market. The farmersmarket starts along the wadi's beds and continues all the way to the middle part of the park. In that way visitors and residents are dragged into the placed where the crops are coming from and see with there own eyes how they are growing. This will enhance the understanding of the natural processes which are going on.



Plan
Permacultural Park
Drawn by van Eeden

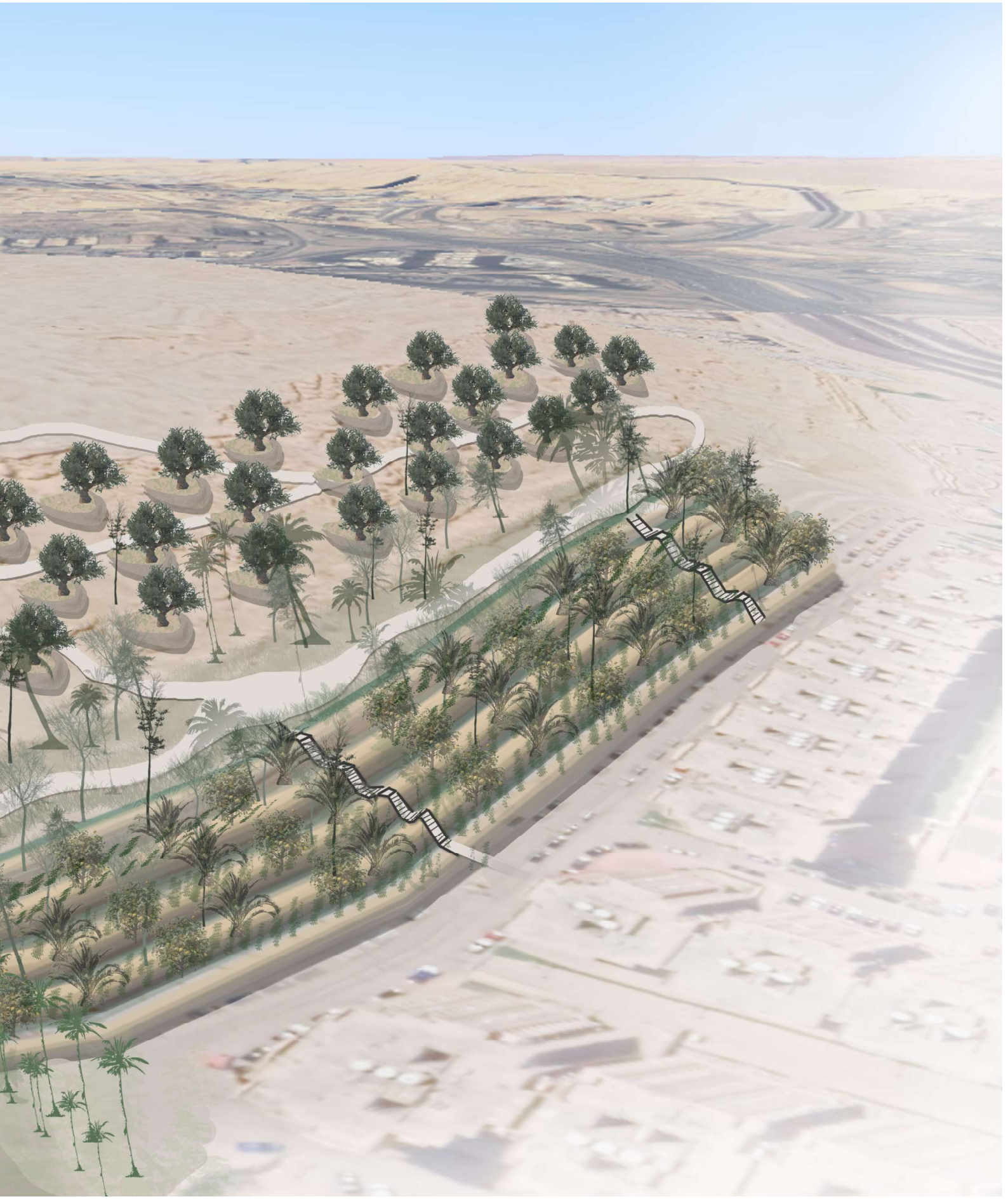


Bird-eye view

This bird-eye view gives an impression of the entire park situated on the slope. The park serves as a public place where visitors can walk or cycle around and stop and rest in the middle of the different areas. The park serves as the transition zone between the urban area and the desert landscape. The park will guide the visitor to explore and wander around untill the visitor eventually reaches the highest possible point. The view from this top point must be very beautifull with on the one sight the neighbourhood and on the other side the desert landscape.

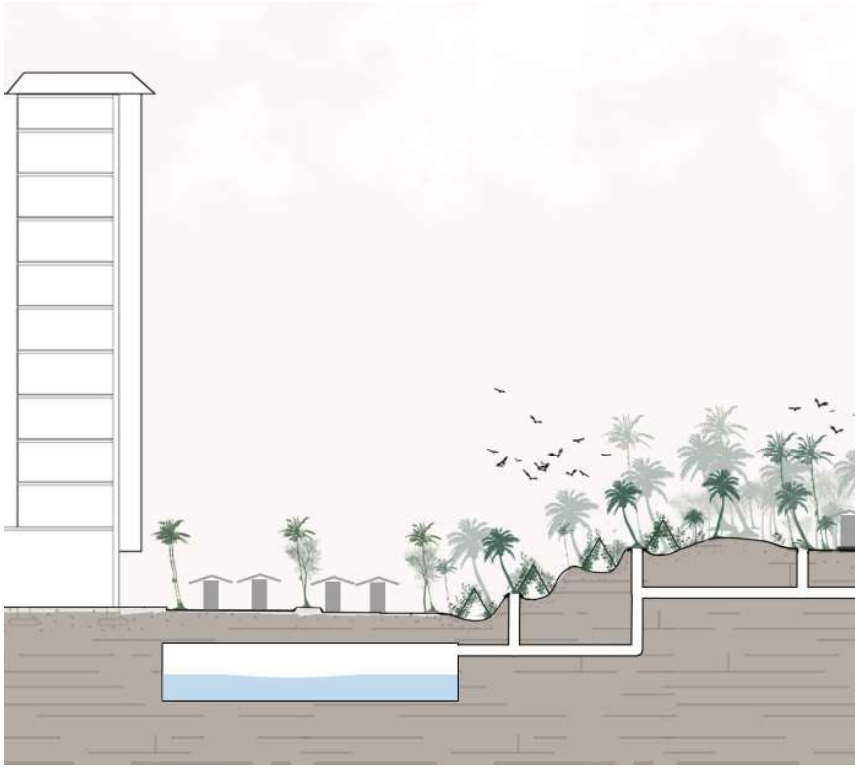


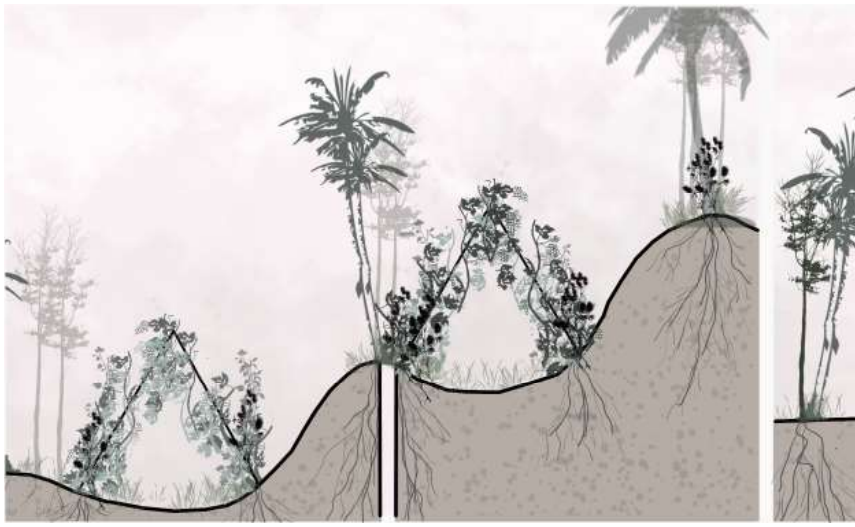
Bird-eye view - Permacultural Park
Drawn by van Eeden background from Google Earth (n.d.)



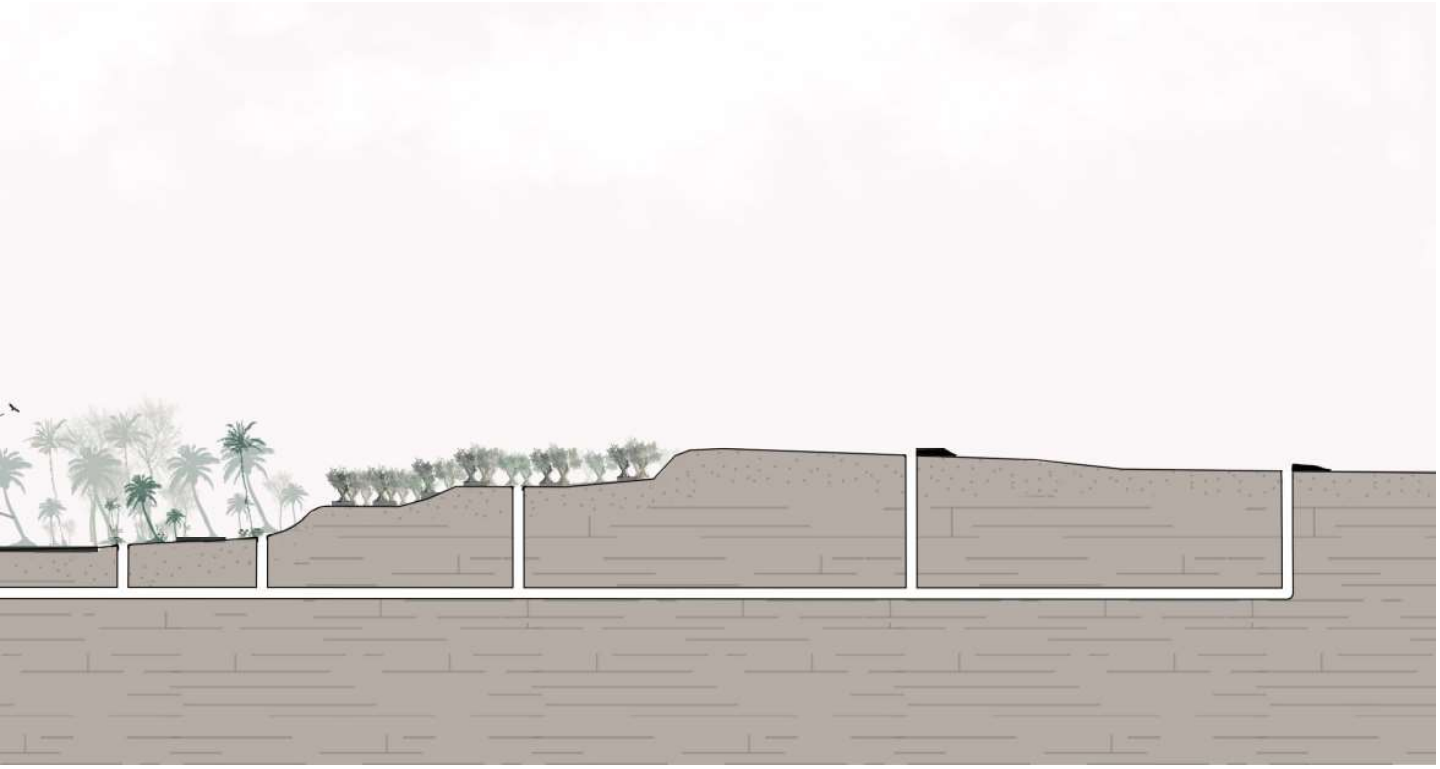
Section

This section gives a clear overview of how the guiding principles are placed. The qanat is extending over a huge amount of deserts land, even beyond the boundaries of the park. In this way the qanat can stor an enormous amount of rainwater during a storm.
At the swales, grape ranks are placed in a roof shape over the swale. This prevents the soil from direct sunlight and decreases the evapotransipration of the swale.

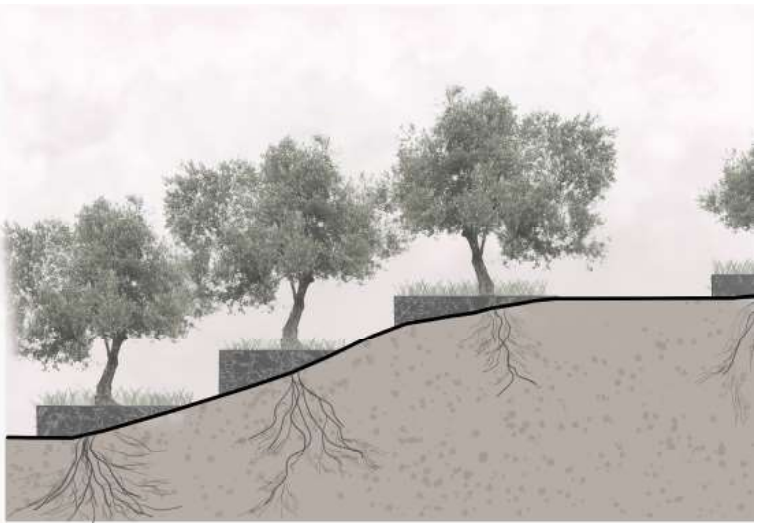




Section
Permacultural Park
Drawn by van Eeden







Routing Impressions

The impression provide a visual representation of how a park visitor will move through the park and what activities belong to that. The main activities are based on leisure, sports, social gathering and shopping fruit and vegetables. Eventually one will move through the park from the built environment to the desert environment. This transition is now a joyfull experience where all the different environments can be appreciated. The urban and the desert are no longer ignoring each others existence but value each others presence in orde to deal with Egypts extreme environment.









Routing Impressions
Permacultural Park
Drawn by van Eeden









Merging Flows

Johan Klaas Krom







Manifesto

They say the Egyptian is wedded to its car. It is the most prized possession, protection against the heat and means of getting from anywhere to anywhere else. If reducing car usage isn't feasible on the short term, fitting its usage in with the urban environment just might. The manifesto, presented on the other page offers a vision of what such a city might look like. The experimental process which led to this conclusion is discussed over the folllowing pages.

The Cairo ringroad slices along El Hadaba El Wosra with a wide slab of asphalt, dust, emissions and noise. It is an artery that leads from A to B, but offers no remorse to those places it passes. The ringroad preceded the development of the neighbourhood. Aside from a few rickety foorbridges, the no attempt seems to have been made to fit the road into its newly inhabited surroundings. Despite following the historical Wadi Degla estuary, the road is dry and not attuned to its hydrologocal context.

In this manifesto I have sought to make the road infrastructure participate in the native desert landscape. In doing so, this process transforms it from a barrier into a place of interaction; from an arid wasteland into a fertile oasis. Drawing on the concepts of environmental infrastructure and resiliency, the ringroad is reconceived as an element of carrying infrastructure which supports not just mobility, but also urban green space, water retention and local food production.

Theoretically, this vision draws heavily on the work of Tjallingii (2015). Under this theory, water and traffic networks are seen as a pair carrying structures supporting the run of respectively slow and fast flows through the urban landscape. With regards to the area, flow and actor perspectives inherent to Tjallingii's work, these are reflected in how the design draws in the natural desert landscape by reestablishing a wadi. By creating a space of shade and briges to local destinations, the design creates space for stakeholders such as local residents to include the ringroad basin in their daily lives.

Manifesto Illustrations

These images provide an illustration of the design which is proposed as solution to the ringroad basin.

Top-right: a photo of the current situation, with the ringroad running as a wide and open slab of asphalt and dust between the neigbourhoods (source: Moawad, 2017)

Top-left: an illustration of the rondroad and the underlying wadi after the design has been implemented. This illustration shows the situation at the end of a long dry seasons, with the wadi bed almost dry, but still capable of supporting agriculture and serving as a shadowed island connecting the neighbourhoods.

Bottom-left: an second illsutration of the ringroad and the underlying wadi after the design has been implemented. This illustration shows the sitiuation during an intense stormwater surge. The wadi is turned into a river, but manages to prevent nearby neighbourhoods from flooding. Bridges run above the water level, making daily life possible.

Compositions by the author using base images retrieved from Malek (2020), Khaleej Times (2017), Pngimg.com, (2020), Djekic (2019) and Levine (2017).







Sources of inspiration

Top: artistic render of the Lermontovsky Shopping Mall, Moscow. This image was selected as it superimposes a major motorway over a park-like green environment. It moreover highlights both the issue and a solution as to how destinations and origins such as shopping malls and residences can be seperated by a motorway (image source: MLA+, 2018).

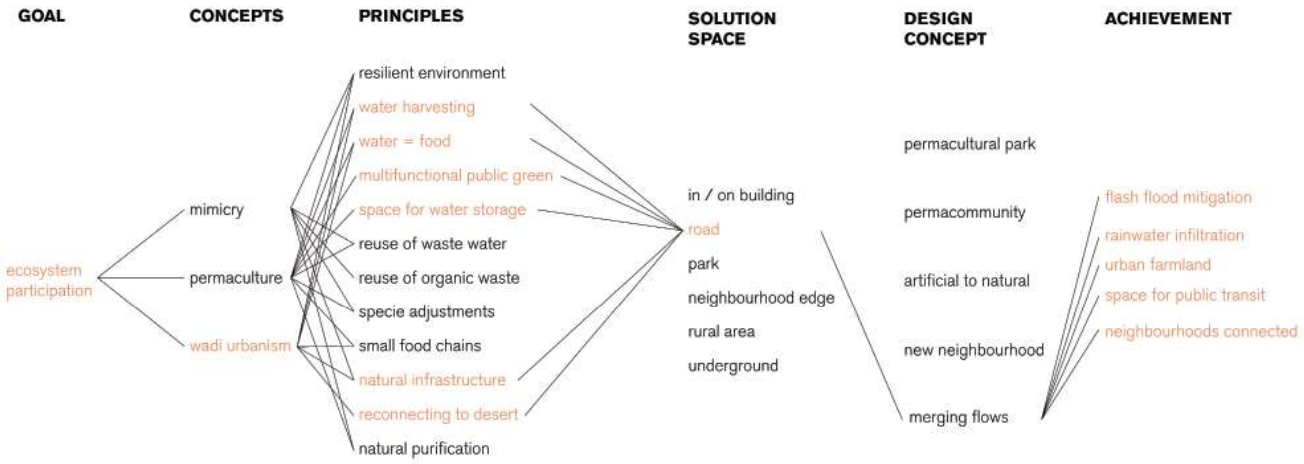
Middle: a photo of the [X] flyover park in Mumbai, India. This image was selected to prosent a vision of how areas beneath flyovers can be made into human-sized, green parks (image source: Tahseen, 2016).

Bottom: artistic render of [X]. This image contrasts the blinding heat of the desert with the lush and fertile environments which it may harbour if given some respite from the blistering sun. The design presented here suggests that man-made roofs may be used to facilitate a more susainable model of desert gardening than the current approach focused on extensive irrigation (image source Stevens, 2014).

Design experiment

The following pages will perform a design experiment on the ringroad basin area just south of El Hadaba El Wosra. Following the principles outlines in the guidelines map, this study will investigate how the concepts of mimickry, permaculture and wadi urbanism may be applied to this area. As identified in the guidelines map, the elevation pattern of the area makes the ringroad a natural main artery for water runoff from both the ridge north of case map, as well as from the Wadi Degla area to the south. Drawing on the concept of wadi urbanism, I seek to solve these issues by constructing a wadi in the area. This exploration is supported by the images presented on the other page, which illustrate how the extreme landscapes of urban car-based mobility and desert heat might be merged with urben green areas.

In this experiment I test three alternatives through which a wadi may be fitted into the ringroad basin area: by embedding the ringroad onto a berm, by putting it in a tunnel, and by elevating all roads onto a network of flyovers. These solutions are only illustrated for the case area, but it is assumed adequate soltuions can be found both up and downstream of the case area. Each scenario is assessed for its effectiveness on four objectives: first, to enhance water rentention; second, to stimulate pedestrian traffic across the ringroad; third, to create space for permaculture and urban agriculture; fourth, to mitigate disturbance to traffic flows which do in fact require the ringroad; and, fifth, to mitigate noise and particle pollution from car traffic. Based on the findings of these tests, a final design is proposed. This is the design which has been illstrated in the manifesto previously.



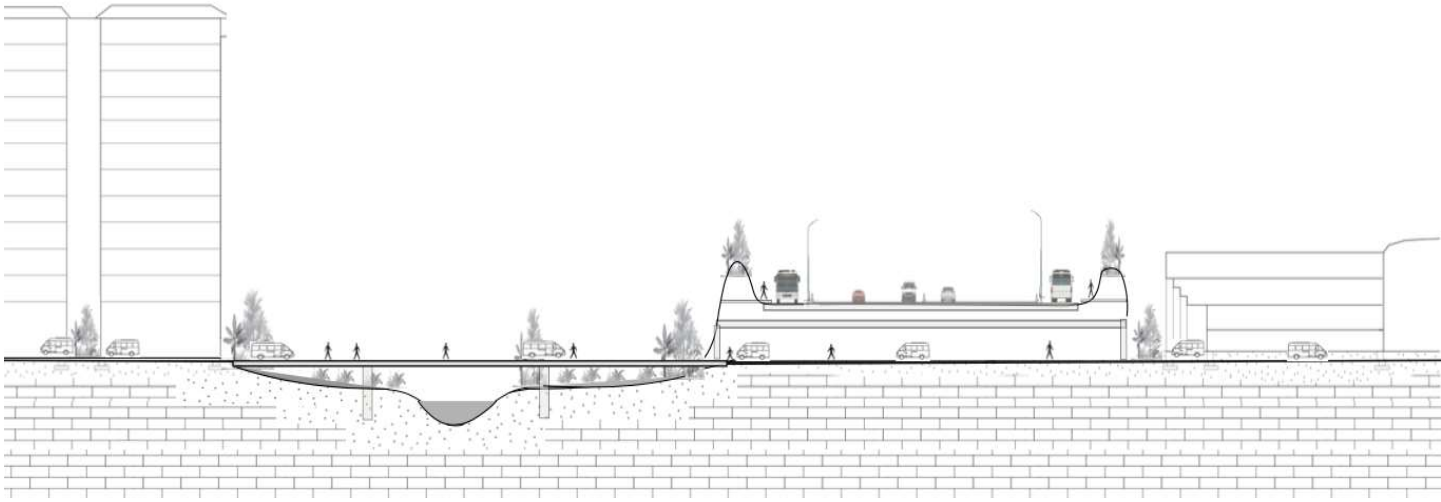




Alternative one: an earthen berm.

In this design a wadi is fit into the ringroad basin, while keeping the mobility situation as close to the way it was before. For this, the rindroad is moved to the southern edge of the current rindroad basin, and elevated above the landscape by placing it on an earthen rampart. To contain sound and particle pollution, the road is flanked by dams. All through traffic, both transit and private cars are located on the rampart. To enhance transit access, dedicated bus and minibus lates are added. The remaining area of the former rindroad basin is used to locate the wadi.

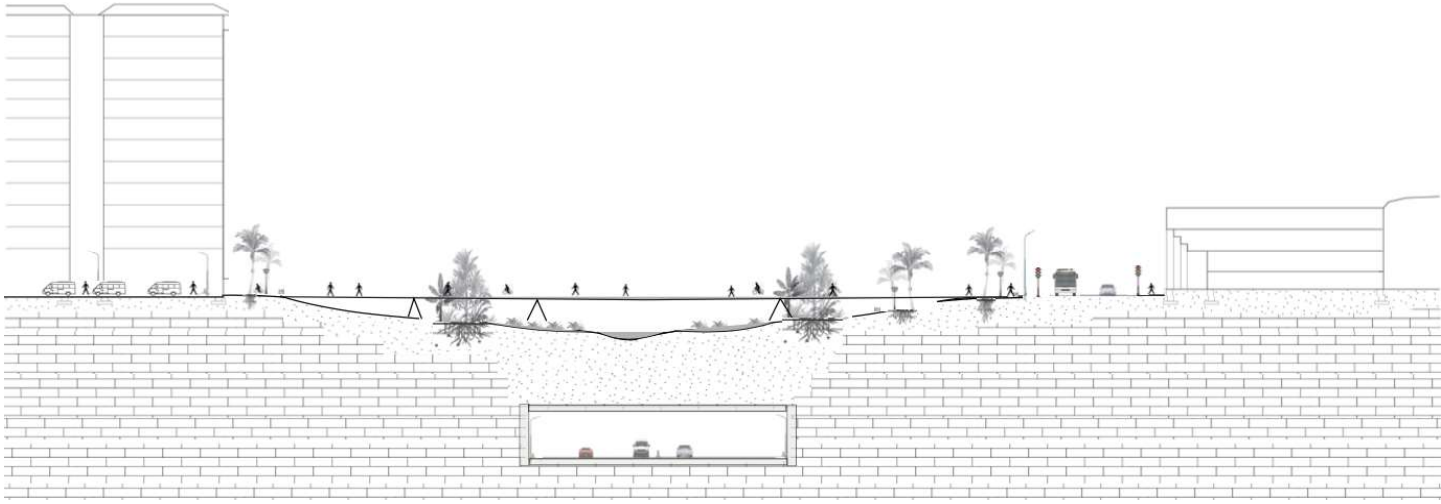
To facilitate access to the neighbourhood on the northern wadi embankment, car-capable bridges and tunnels lead through the berm and provide access to on-and0off ramps further down. This leads to mixed local traffix crossing the wadi. The berm provides some shadow to the wadi, providing some relief ot agricultural work. There is however little space for wide meandering, meaning that it will be harder toslow down peak stormwater charges. To have sufficient capacity tp handle such runoff and protect surrounding neighbourhoods against floowing, the main wadi channel is deepened.



Alternative two: a tunnel

In this design the entire rindroad basin is dedicated to the wadi, and the ringroad itself is moved underground (alternatively this may be conceived of as rerouting the ringroad out of the case study area). A small local road is left abive ground for local traffic, along the southern adge of the rindroad basin. This creates maximal space for agricultural activity, and recreation in the wadi basin. To facilitate cycling across the basin an even level dbridges are constructed spanning the basin, in addition to a network of walkways along and throughout the wadi.

This design permits a lot of space for meanders and does not need to be deepened excessively to cope with stormwater runoff. As such, more rainwater may filter into the soil. By constructing the tunnel through an open cut dig, it is possible to substitute topsoils with types which are well suited for retaining water. However, with no high structures throughout the basin, it is relatively exposed to direct sunlight. Trees will be the primary source of shade.. This may make the area less appealing for pedestrians carrying heave bags back from the shop. Finally it must be noted that tunnels are generally expensive to construct. As Cairo is not as wealthy as e.g. Dubai, such projects may not be considered feasible.



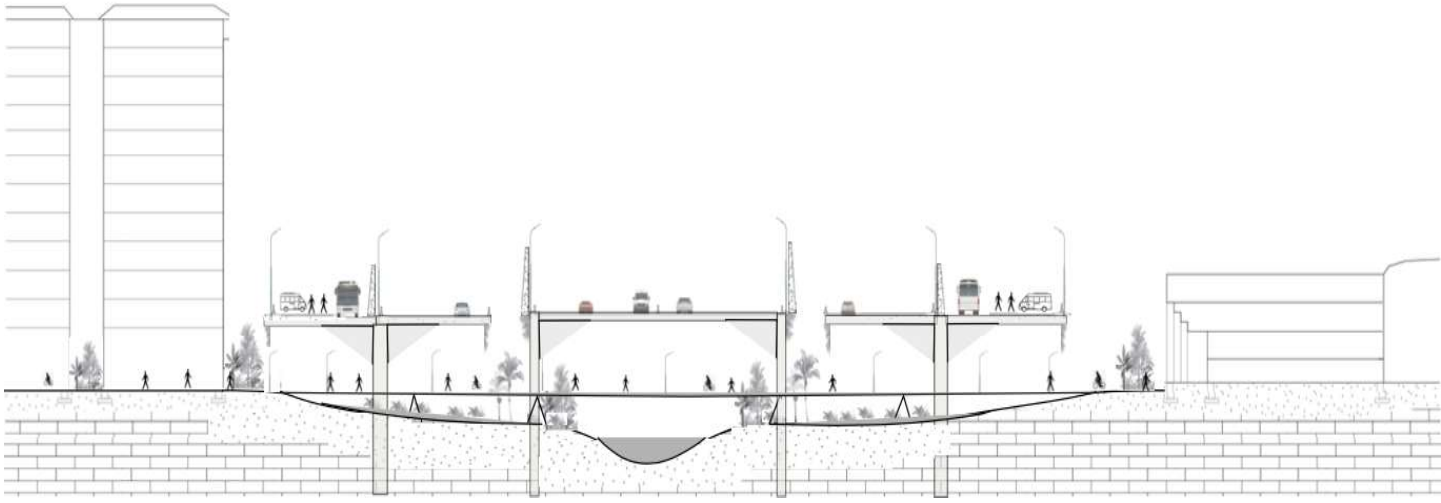




Alternative three: an extensive flyover system

In this design the entirety of the current road system is elevated onto a set of flyovers. The secondary entry and exit roads are preserved. Additionally, platforms are added to serve as public transport bus and minivan stops. As in the tunnel design, this permits dedicating the full width of the ringroad basin to the wadi and stormwater runoff mitigation.

In a distinct contrast with the tunnel design, local residents remain exposed to noise and particle pollution, although newly added sound barriers along the roads will mitigate these effects considerably over the current situation. In another distinct contrast, the flyover setup as envisioned in this design provides a nearly complete covers the wadi, making it a cool shadowed environment. With less water evaporating due exposure to direct sunlight, more water is retained. This allows for far greater agricultural activity. The shadow will also make the walkways to the other side more attractive for daily use by local residents for other purposes than recreation.



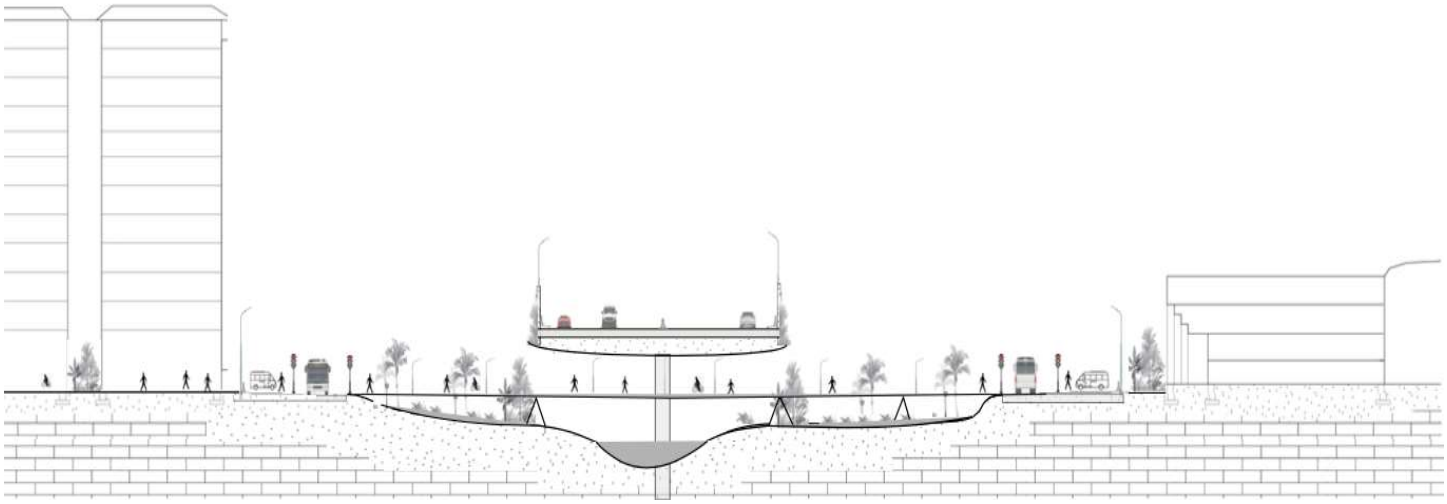


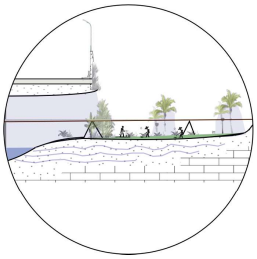


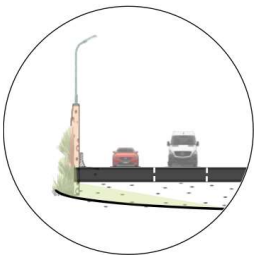
Design proposal

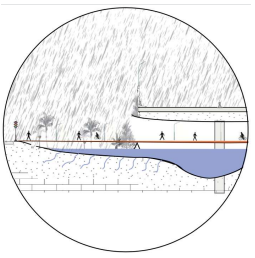
After considering the previous alternatives, their avantages and disadvantages, the following design is proposed as optimal solution for the selexted area. Firstly, a cross-section of the design is presented to present the design's main principles. Secondly these principles are projected upon a map to show how they are embedded within the wider urban structure.

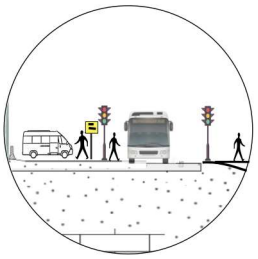
These concepts presented here are are worked out over the next to pages.

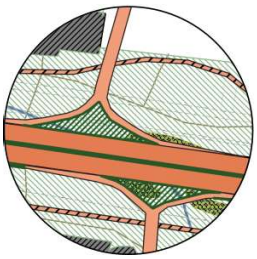


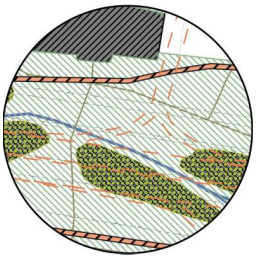


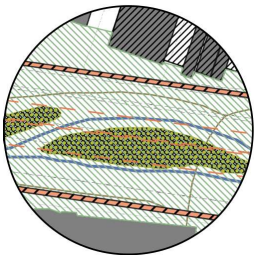


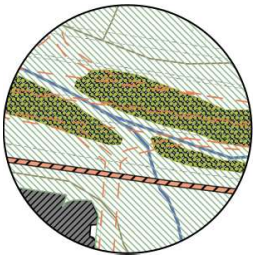


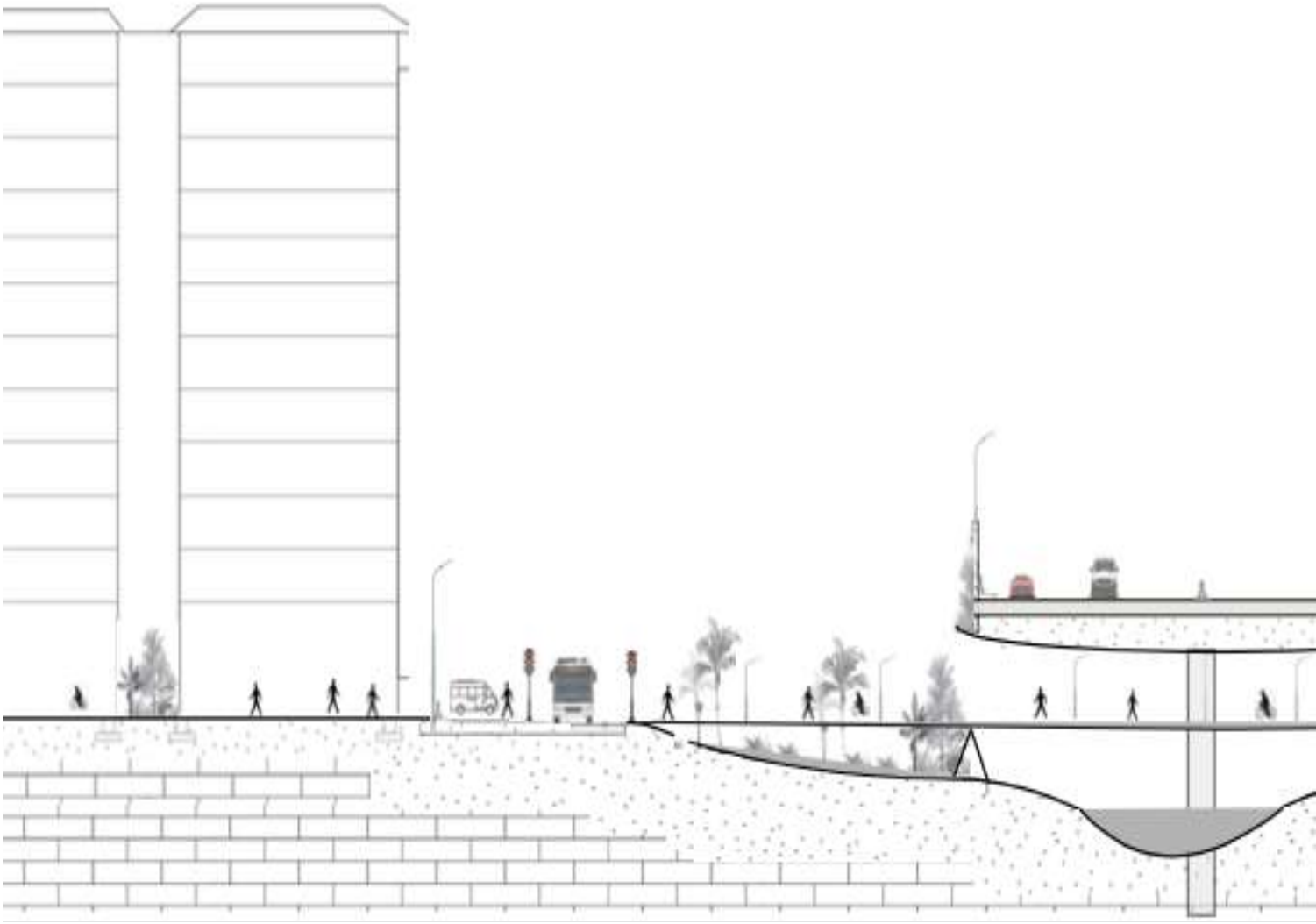


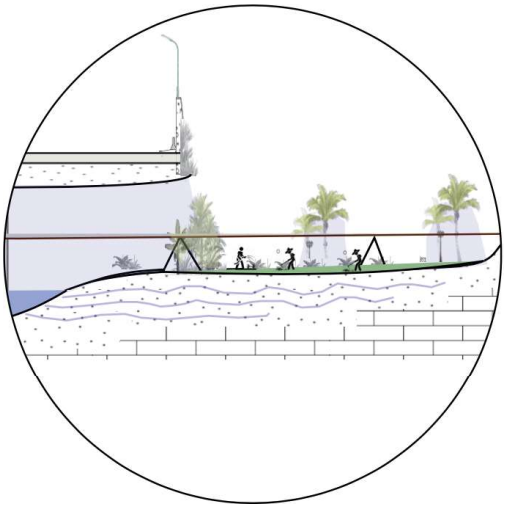






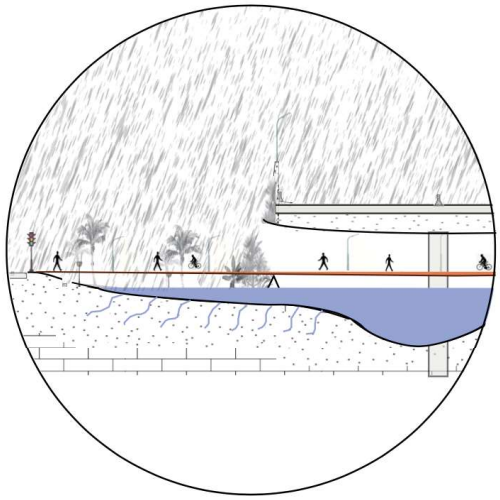






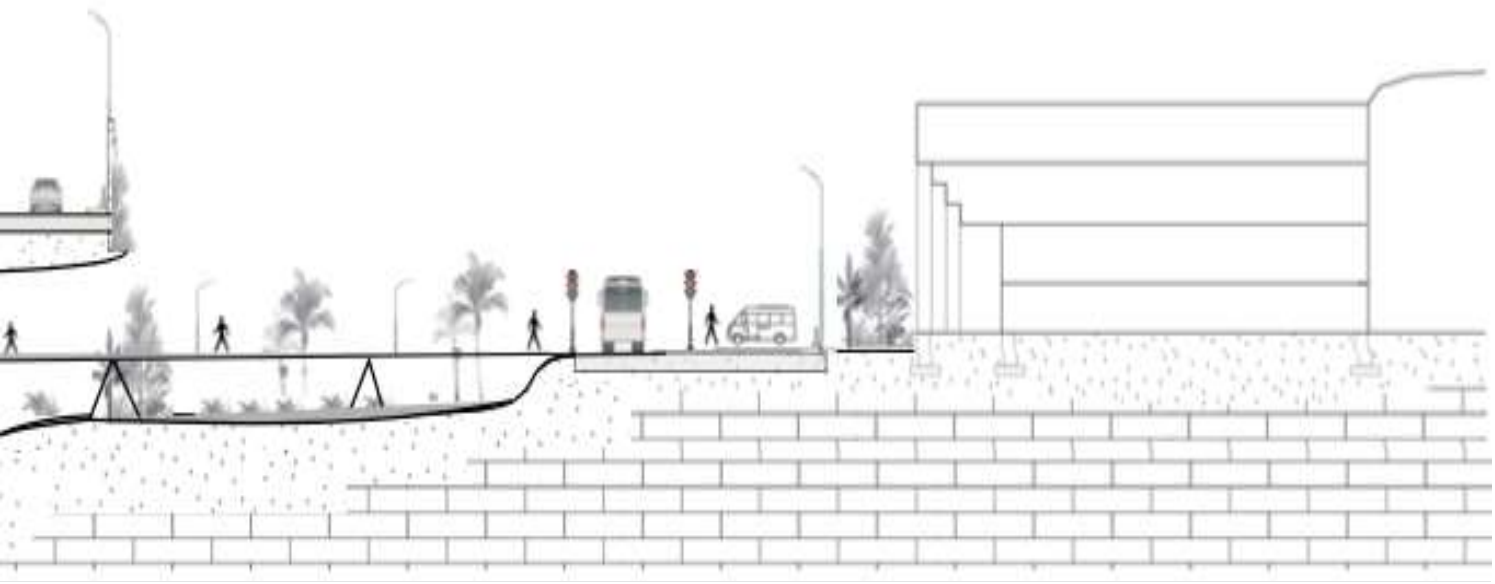
Shadow and space for permaculture

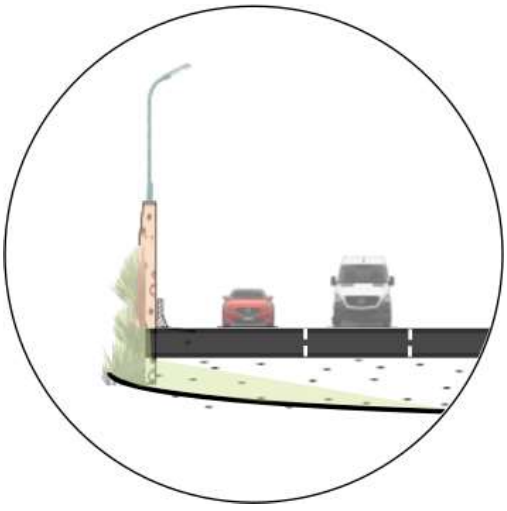
Through the vicinity of the wadi steam, as well as periodic stormwater floods the wadi valley is relatively moist. The ringroad overhead, as well as interspaced palm trees provide shadow, thus reducing evaporation. This makes the area suitable for agricultural and recreational use. Over time the soil becomes enriched with root systems which further enhance water retention in the wadi valley.



Peak load capacity and retention

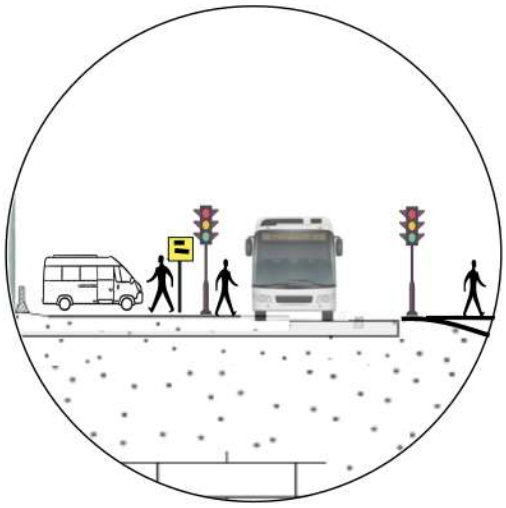
Cairo rains come in short, intense bursts. This design mimicks natural wadis' form as a distinct valley in the landscape, whilst keeping all urban processes on ground level. This provides capacity for sudden significant increases in water runoff, whilst keeping daily life resilient against any damage such runoff might cause. By deliberately building in horisontal flats, used for agriculture in dry months, water stays in place longer after rains subside, allowing for more effective groundwater infiltration.





Protecting against pollution

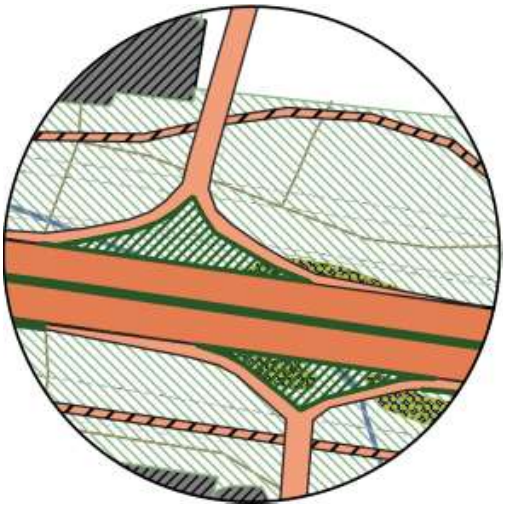
Road traffic is a major source of nitrogen, pm10 and other locally polluting particles. Moreover, road traffic causes substantial noice pollution to local residents. The design foresees encasing the ringroad flyover between high walls, to block noise and prevent an excess of particle pollution from spilling into the wadi. To blend the flyover into the landscape and perform some initial filtering of the air, the barriers are covered with vegetation which is in part fed by poluted stormwaterrun off from the road.



Dedicated public transit lanes

As the network of local roads is cut back to space for the wadi, alternative modes of transport need to be offered. Such modes are moreover necessary to transport wadi farmers to the site, as they may not always live in the area. For this, the design foresees in two dedicated public transit lanes, one on either side of the wadi valley. Although busses may not travel at the speeds permitted on the rindroad, the lack of intervening traffic makes service provision more reliable and as such attractive.





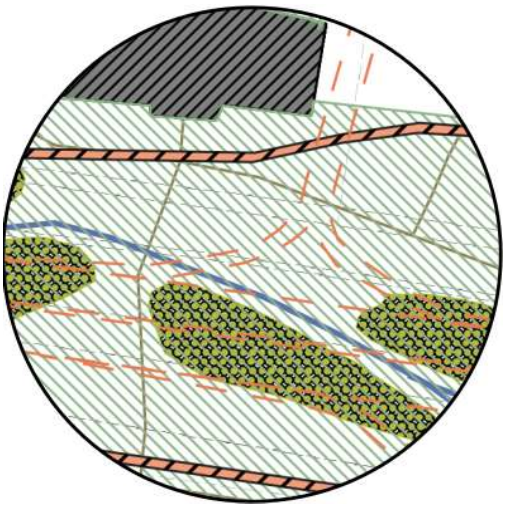
Final design: maps (above: left and right)

The proposed design sees the establishment of the ringroad on a flyover. The left-hand map shows the road in place. The right-hand map exposes the lush wadi landscape protected in the shadow below.

Off-ramps

Illustrated with orange lines.

In the original setup the ringroad was surrounded by a network of secondary roads and options for cars to enter and exit the ringroad proper. Redicing entry and exit activity causes fewer disturbances on the road, thus enhancing traffic flow. Simultaneously, to keep surrounding communities accessible, a set of strategically located off-ramps have been included in the design.

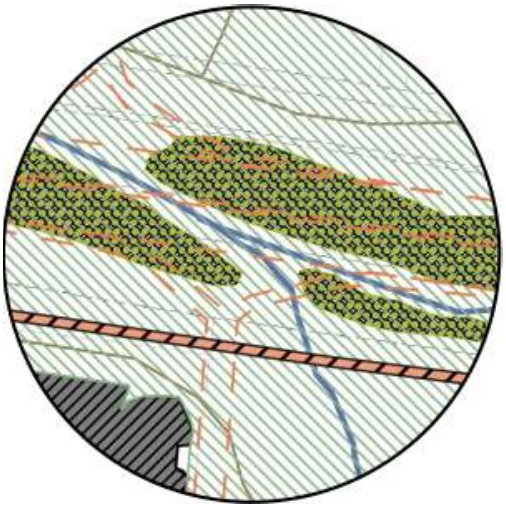


Walkways and buslanes

Illustrated with thin brown lines.

THe nighbuorhoods both north and south of the ringroad are home to residential and commercial properties. The design includes a network of walkways and bikelanes interconnecting these businesses and residences. These walkways similarly allow for easy access to the fast buslane on either side of the rindroad, without risking exposure to the sun or needing to laboriously climbbridges.

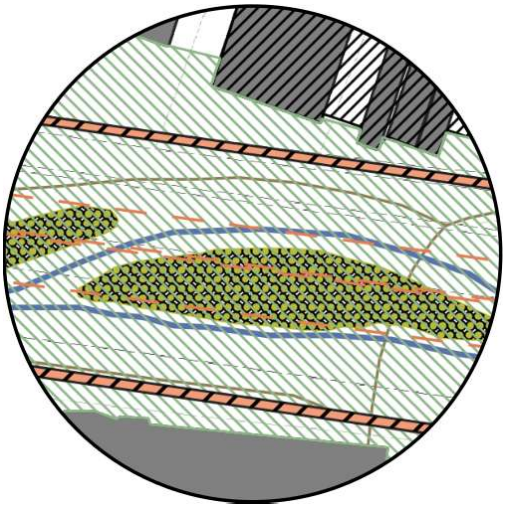




Confluence with Wadi Degla runoff

Illustrated with wide blue lines.

The current Nature Reserve of Wadi Degla is located immediately south of the case study area. As the name suggests, this area is also based around a natural wadi, or stormwater runoff landscape. In this design part of the Wadi Degla runoff in redirected into the ringroad area to facilitate its retention.



Wadi meanders and agriculture

Illustrated with wide blue lines and green patches, respectively.

Straight waterways result in fast stormwater runoff, causing erosion and the risk of flooding when runoff reaches less conducive channels further downstream. By mimicking meanders of a natural river, runoff is slowed down and more water can be filter into the soil, facilitating more productive farming in dry months. In this design, the full width of the rindroad area is used for this dynamic, making is the most effective.

From Artificial to Natural

Laura Conijn



The Green Machine

The image shows a collage of a concept from 2014 for a machine by Malka and Bouhaya that uses the natural environment to provide greenery in the dry desert environment. This concept of using the natural environment to provide water and food can also be used in the artificial parks in the El-Hadaba El-Wosta neighbourhood.

In this concept a natural green environment is created as a machine in the middle of the urban environment, this is supported by the use of the sun's energy and the condensation of water. This concept of this green machine in the city can be used in the design experiment.

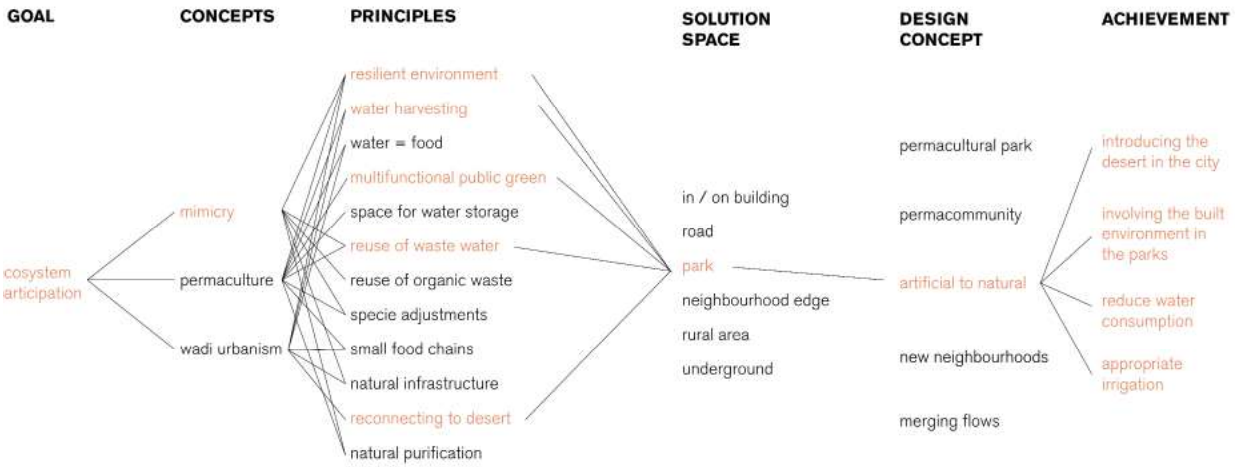
Drawn by Conijn, data from Pinterest (n.d) and Laylin (2014)

Manifesto

Everyone thinks of Egypt as a country that is giant desert. The only exceptions to these thoughts are the areas around the river Nile and the Faiyum oasis. Along this river, lots of green space can be found. The area where the river Nile makes a connection to the Mediterranean is filled with such an amount of green that one would forget that there even is a desert nearby. Cairo can be found at the southern edge of this green area. On the west side, the city is enclosed by greenery, on the east side, Cairo is enclosed by desert. There is sand everywhere. As the river Nile is the only consistent source of water, this calls for a problem in many neighbourhoods in the city of Cairo: water scarcity.

In the neighbourhood El-Hadaba El-Wosta, which is located around 10 kilometers away from the river Nile, this problem of water scarcity is very much ignored in the built environment. In many places artificial green areas are designed to create an enjoyable area for the residents, away from all the sand. The neighbourhood is built up by several housing compounds that create an illusion of an environment that will never be natural in the city of Cairo or any other desert city. The artificial green areas are designed to be comparable to English gardening habits. However, the English climate is far from comparable to the desert climate that Cairo has to deal with. The difference in climate also causes a contrast in maintenance, but also a visual contrast. Where in England the gardens main worry is the trimming of the grass and shrubs, lies the focus of maintenance in the gardens of Cairo on the lack of natural sources of water and the need for artificial ways of watering to keep the plants alive. This lack of water is visible in the growth of the plants too, making the gardens look dull.

These artificial green gardens are currently a waste of water in the desert cities and call for a resilient solution. Mimicry of the natural environment in combination with appropriate measures for the water consumption should be considered for the neighbourhood El-Hadaba El-Wosta in the city of Cairo.







Natural water treatment

Examples of current designs of natural water treatment that can be used in the design experiment for the case of Egypt.

Photos by Klein Leichman (2015) & Mahmoud (2018).

Design experiment

As mentioned in the manifesto, the goal for this design experiment is the removal of artificial green gardens en designing a way to include green elements in the desert environment that is natural in the city of Cairo. As there is a water scarcity in the city, a way to reuse water for non-potable purposes is needed for this design experiment.

For the design experiment the artificial green parks in the neighbourhood of El-Hadaba El-Wosta have been chosen to redesign to meet the requirements of a water sensitive urban design by using the natural environment of the desert.

The main goal of the design is to create ecosystem participation. In the Egyptian neighbourhood this could be realised by mimicry of the desert environment in combination with several principles regarding the use of water. Water treatment and reuse are the main principles in this design experiment. Examples of implementations of water treatment in a park is shown in the figures xx.

In this design experiment water will be treated by natural purification. This means waste water should be collected and stored. Therefore, it is necessary to select the types of waste water that should be reused. Grey water is, in this case, the best water for reuse. This water can be collected from kitchens, bathrooms and laundry. Also condensated water of the A/C can be collected for treatment. Appropriate planting should be considered for treatment, but also for the parks. Hydrozones will be designed with different types of planting. Three zones can be indentified, a zone with low water use, medium water use and high water use.

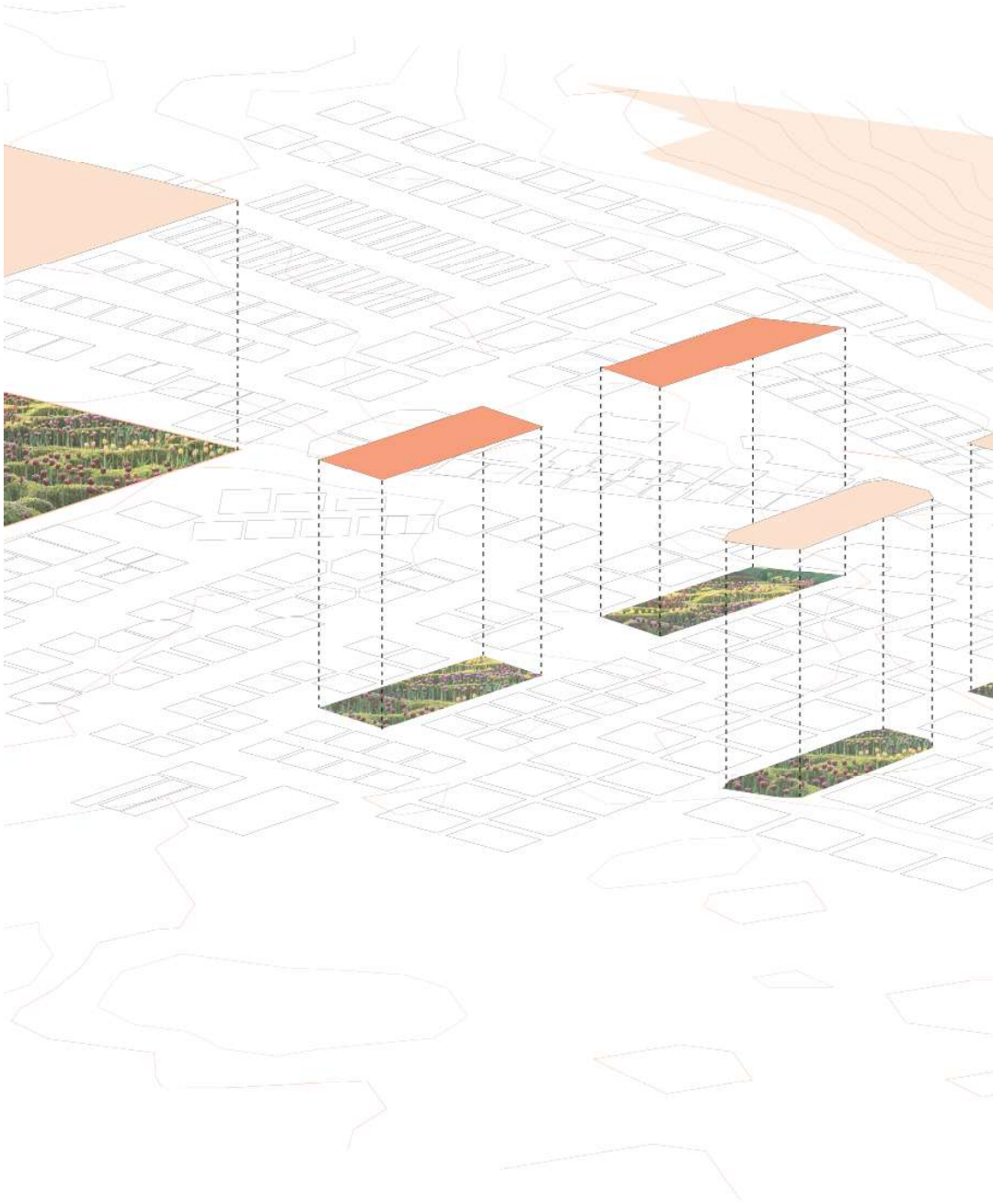
Other design principles in this design experiment will be the connection of the built environment and parks by water surfaces, and the shading by buildings and/or shelters, to create a useable environment even in the hottest of days.

Scenario scale: building ensemble

Artificial to natural parks

Location of current artificial parks that need a transformation to a park that fits the water consumption of the neighbourhood. These locations are suitable for a transformation to water treatment parks.

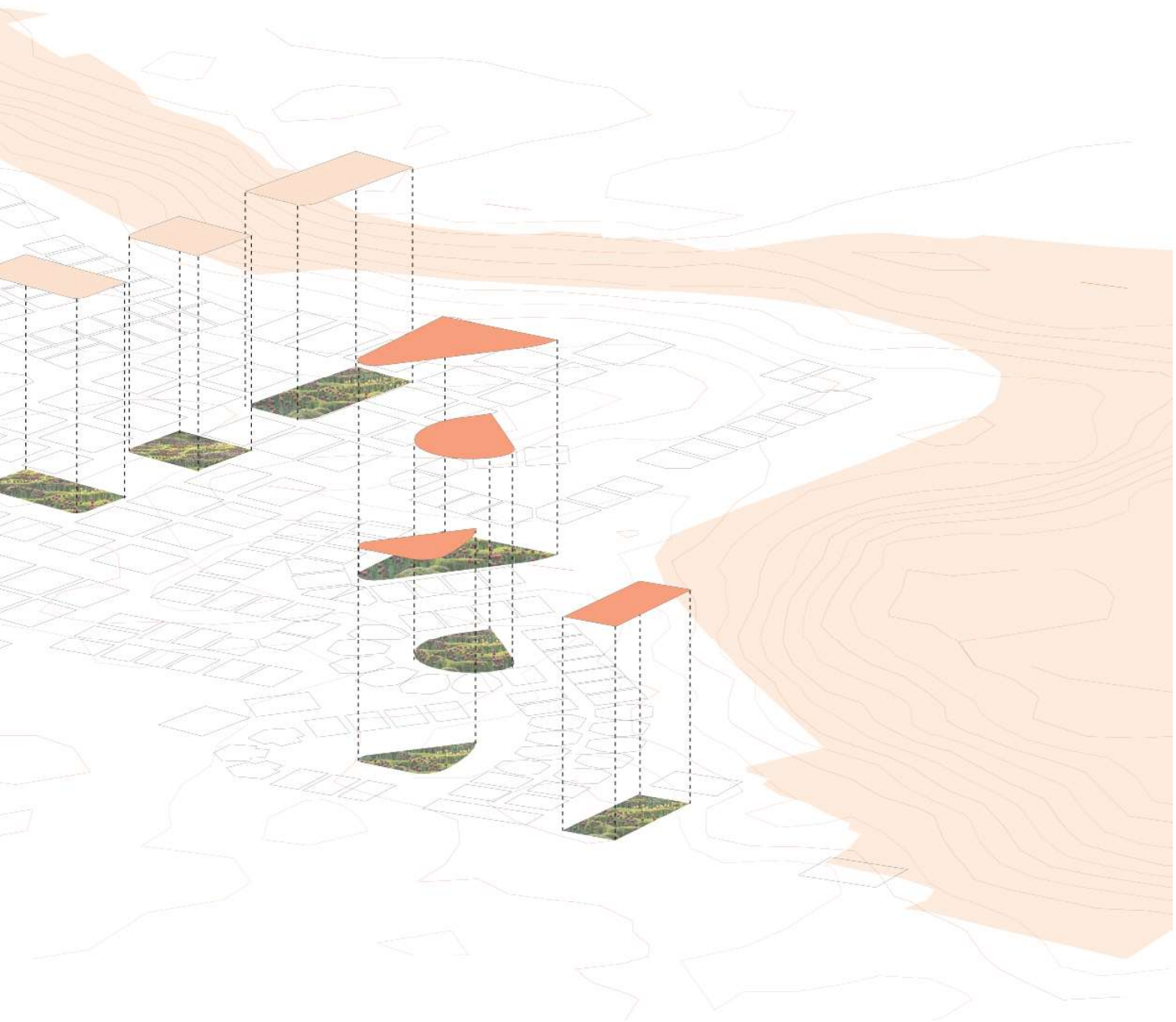
Other currently artificial parks in the neighbourhood will be crossed by wadi's and will undergo a different transformation.



Artificial parks

Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)

- Artificial parks
- Desert parks
- Water treatment parks



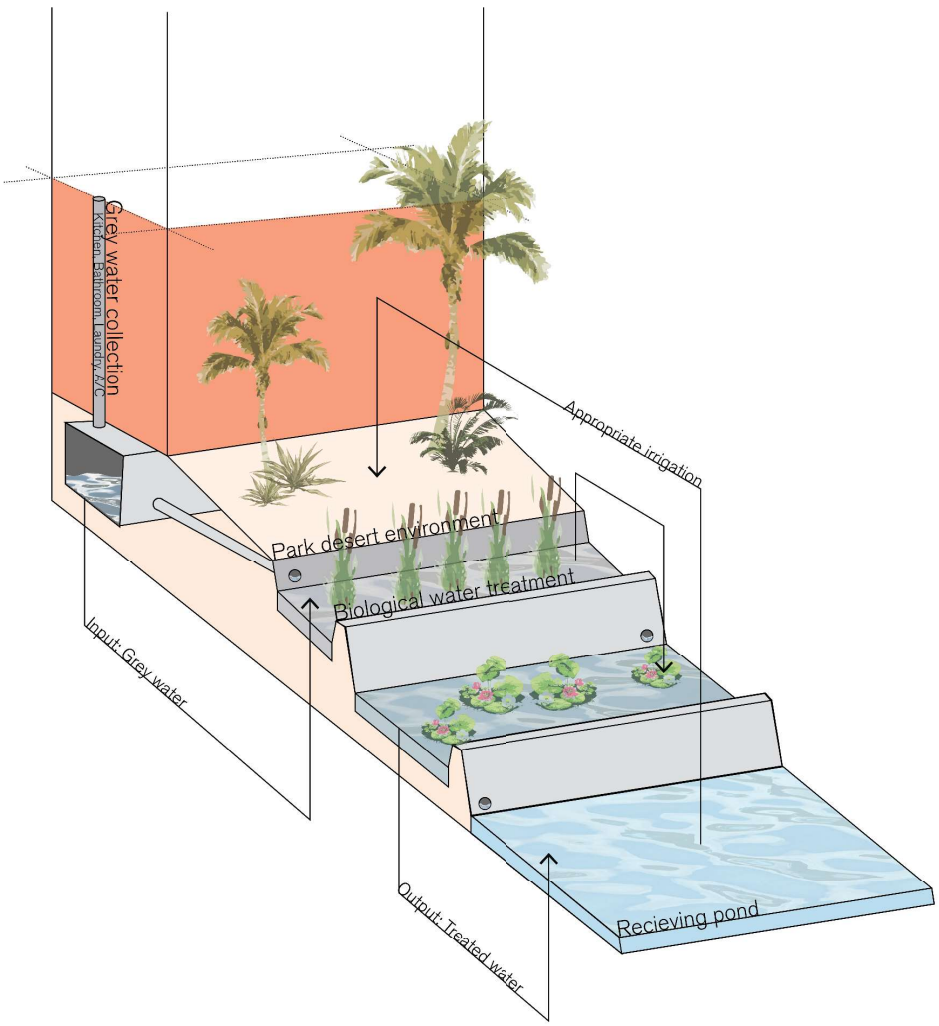
Concept of interventions

For the design experiment a concept of water reuse and water treatment is used. Grey water that is produced by housing is collected, treated and reused for non-potable uses. To water will be treated in a natural way by using helophytes. The water will flow through water bassins filled with these plants and the water will be cleaned by these plants. When the water is cleaned it will be collected in the receiving pond and can, from there, be reused for other uses. This water will, in this design be used for non-potable uses. Irrigation is one of those uses. This concept will decrease the water consumption and lead to a more appropriate use of water in a city where water scarcity is a big topic.

For irrigation purposes, three hydrozones are designed. These hydrozones consist of plants that have different water needs. Plants with low water use will be located furthest away from the receiving pond to decrease the travel distance of water. Closest to the water collection the plants with the relatively highest water use are located.

For this design experiment an attempt was made to involve the built environment in the water treatment parks. Often the water is adjacent to several buildings.

The concept is designed for one examplary location, however this concept should also be used for the other locations shown in the artificial to natural parks image.



Intervention concepts

Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020) and OpenStreetMap (n.d.)

N

0 20 m

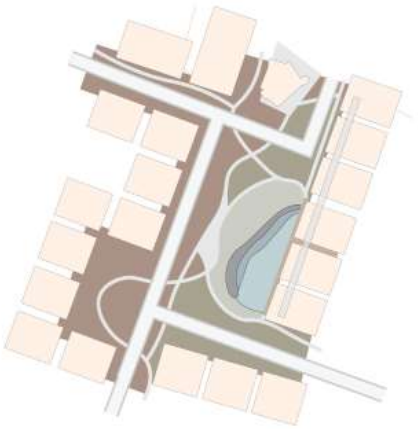

Low water use
Medium water use
High water use
Water receiving pond

Implementing the concept

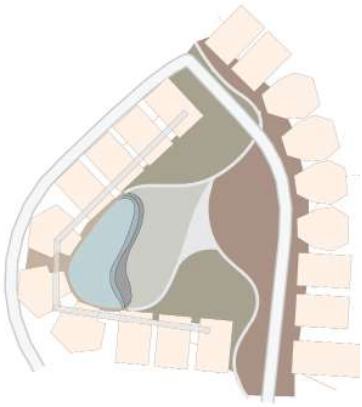
The concept is implemented in different parks that are currently fully artificial. The implementation of the concept of water treatment and reuse in combination with hydrozoning the area will decrease the water stress and water scarcity in the area.

This concept is appropriate for every park that is currently green through artificial watering.

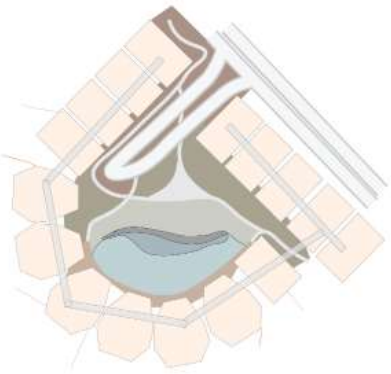
Knights compound
catameya



Al Hadaba Al Wosta



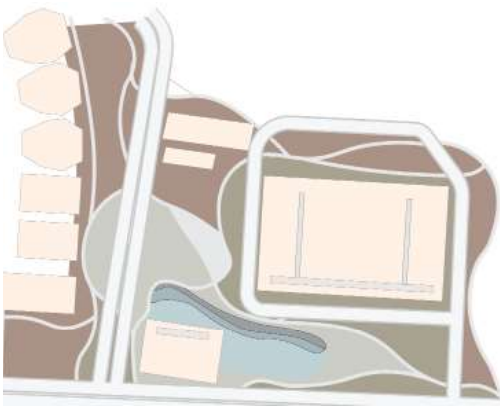
Sama El-Qahera
Gate 1 Rd



Sama El-Qahera
Gate 7 Rd



Hospital
Sama El-Qahera
Gate 1 Rd



N

0 20 m



Al Fursan City

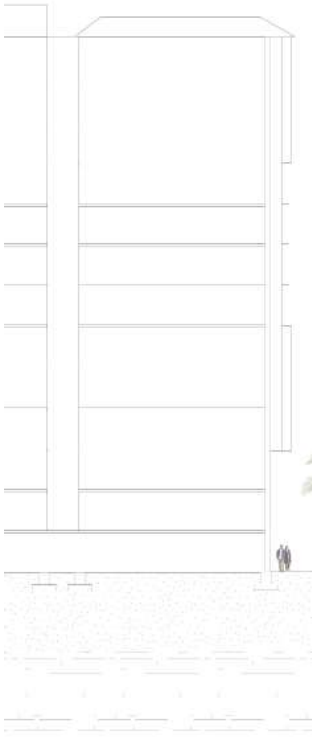
N

0 20 m

AA’

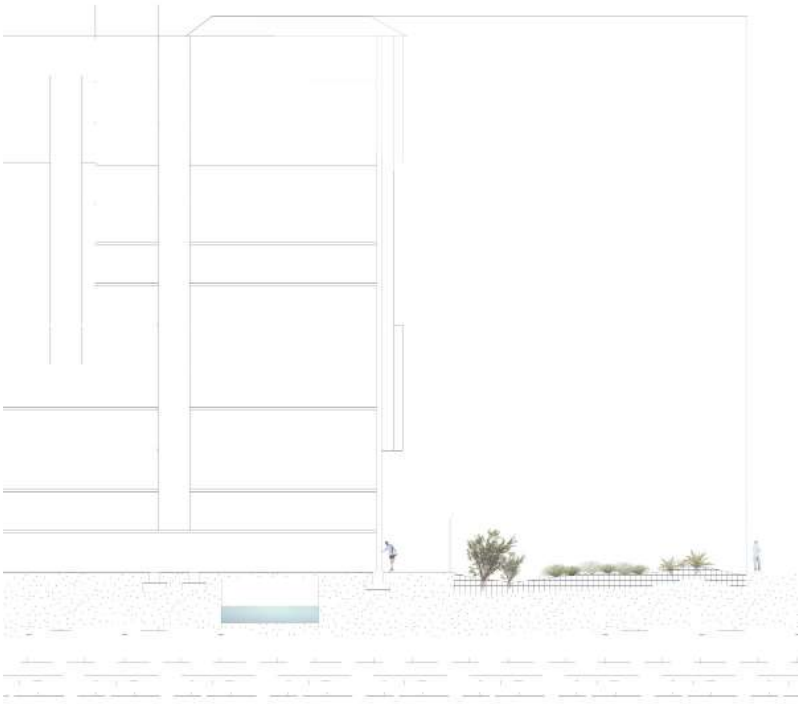
Section where the three hydrozones are shown. From left to right the water use of the plants decreases. This sectin can be found in the southern part of the park.





Section CC’

Section including all the hydrozones. Left to right: medium water use, high water use, medium water use, low water use.



☐ Building
▤ Limestone
☐ Sand

N

0 10 m





Perspective section Water treatment area

The connection of the built environment to the receiving pond and the connection of the water treatment area to the high water use hydrozone.



Section BB'

A section through the water treatment area including the receiving pond, a hydrozone of high water use and a hydrozone of low water use.



Characteristic Spaces Sections

Drawn by Conijn, based on data from MilvusMap (n.d.), Google (2020), OpenStreetMap (n.d.), Moustafa et al (1991) and Shata (1988) in combination with the design principles made by Conijn.

☐ Building
▤ Limestone
☐ Sand

N

0 10 m





Low water use

An impression of the low water use areas in combination with the road for cars including parking spaces and a walkway.



Inbetween buildings

An impression of a medium water use area inbetween buildings.



N

0 10 m





Permacommunity

Jort van den Broek

Current Situation

Monotone and car-dominated neighbourhood, with artificial green

(picture by: monaelameer, 2015).



Manifesto

Cairo is growing exponentially, and all fertile land is already in use. Therefore, the new desert cities are created. These planned cities are mainly for higher classes. The new, artificial environment in the desert cities is ignoring the existing landscape. This ignorance is a problem, since Cairo is dealing with long droughts and heavy rainfall. The objective of this report is to find a way to use ecosystem participation as a catalyst for healthy and climate-proof extreme environments. The main challenges in Cairo are thus the drought and rainfall, the ignorance of landscape and the exponential growth.

One of the concepts brought forward in the conceptual framework, is permaculture. It is a way to design sustainable human environments. The aim of permaculture is to produce energy and food, recover landscapes, improve water systems, and create a resilient environment. The last three are important in the environmental challenge against drought and rainfall. The human ignorance of the landscape can be recovered and an improved water system can reduce drought, recovering landscape. The production of energy and food also have a positive effect on the resiliency of the neighbourhood, but also on the community. Cairo is segregated by class systems, and this is ingrained in society. The improvement of communities in neighbourhoods could decrease this segregation, as well as improving the ecosystem participation.

This manifesto is integrating permaculture and community participation in a PermaCommunity. It is mainly based on two scenarios created in chapter 5: 'Nature First' and 'No Technology', together with theory from the conceptual framework and analysis from the critical cartography. Both scenarios introduce a wadi through the area. The wadi can drain the heavy rainfall through the area towards the Nile, but the water can also be used for wadi agriculture to produce food. The wadi agriculture gives an oppurtunity to participate and meet each other. Since the food is produced for local use, people will feel more responsibility for maintenance. Thus, the wadi is dealing with the environmental issues of the area, but it is also increasing community participation.

Currently, El Hadaba El Wosta is a monotone, car dominated, artificial neighbourhood. The landscape is ignored and human interventions pressure the natural areas and environment. Introducing the PermaCommunity in the area will improve the resiliciency of the neighbourhood, both environmentally and socially. It deals with drought, heavy rainfall, but also improves the social infrastructure. The wadi gives colour to the area, literally and figuratively. El-Hadaba El-Wosta sets an example of a sustainable way of creating desert neighbourhoods, which can be used in further expansions of the ever growing Cairo.



PermaCommunity: Dry Day

Lively wadi with wadi agriculture and reed-bed filtration to purify grey water. Throught the dry wadi there can be mountainbiked or walked. People, young and old, are participating in the wadi agriculture.



PermaCommunity: Rainy Day

When there is a scarce heavy rainstorm, the wadi drains the water towards the Nile. The buildings and people are safe from flooding.

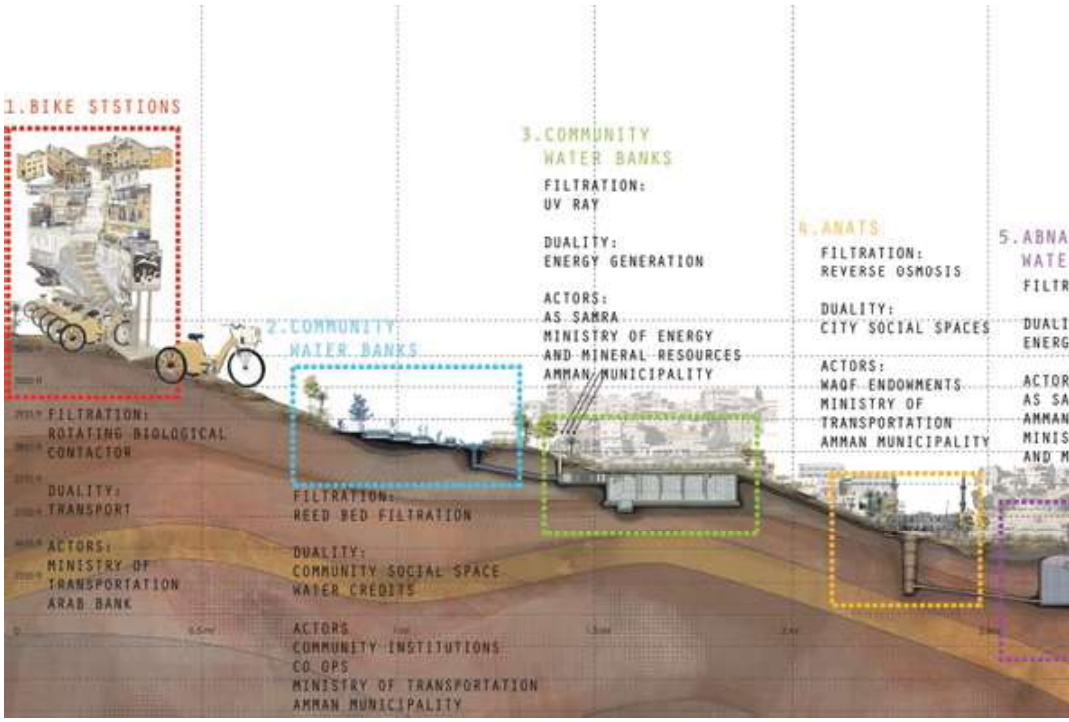


Design experiment

PermaCommunity is based on the concept of permaculture, and uses the concept of wadi urbanism to realise that. A strip in El-Hadaba El-Wosta, named Baron City, will be transformed into a wadi. Currently, the strip contains roads and public spaces with irrigated green.

PermaCommunity introduces two types of public space. The first one is wadi agriculture. It contains a wadi which flows through the area that makes sure the water flows safely at heavy rainfall. Along this wadi the ground can be cultivated. Diverse crops can grow in the desert environment: alfalfa, small grains, onions, carrots, potatoes, tomatoes and zucchinis. The second type of public space is the urban desert. This type is introduced to let the natural area move back into the urban area. The urban desert gives space for native species and vegetation to live and grow again in the city. This is also increasing the resiliency of the neighbourhood, and there is no irrigation needed anymore. On top of that, the urban desert will be a silent public space as a reaction on the highly public wadi area. Therefore, the urban desert will be close to the buildings and compounds. The residents will have the desert right in front of their door, but their privacy will be preserved.

In the current society with class systems, the upper middle class living in the neighbourhood will not work on the farmlands. Therefore, gardeners are brought into the area to work. Besides, a market is introduced where the produced food can be sold. Other public buildings like shops and restaurant, also making use of the local food, also create jobs for lower classes. These people will have the opportunity to live inside the neighbourhood, to diversify the area. This should be a booster for the neighbourhood to slowly break down the class systems in public life. The mosque is an important element, it will be a place where all classes come together. The diversification should lead to a diverse public life where all residents work together on a healthy and climate-proof extreme environment.





Inspirations

Besides the critical cartography, conceptual framework and scenarios, I had four major influences for my design experiment.

top left:

Water Urbanism: Amman

Columbia Urban Design (2017). *Water Urbanism: Amman.* https://www.arch.columbia.edu/books/reader/194-water-urbanism-amman

top right:

Wadi Urbanism

Malek, Y. (2020). Wadi Urbanism. New Cairo: German University in Cairo

bottom left:

Eva Lanxmeer, Culemborg

Blauwdruk (n.d.). *Portret van Ecologische Voorbeeldwijk.* Retrieved on June 15, 2020, from https://www.uitgeverij-blauwdruk.nl/evalanxmeer/

bottom right:

Wadi Hanifa Wetlands

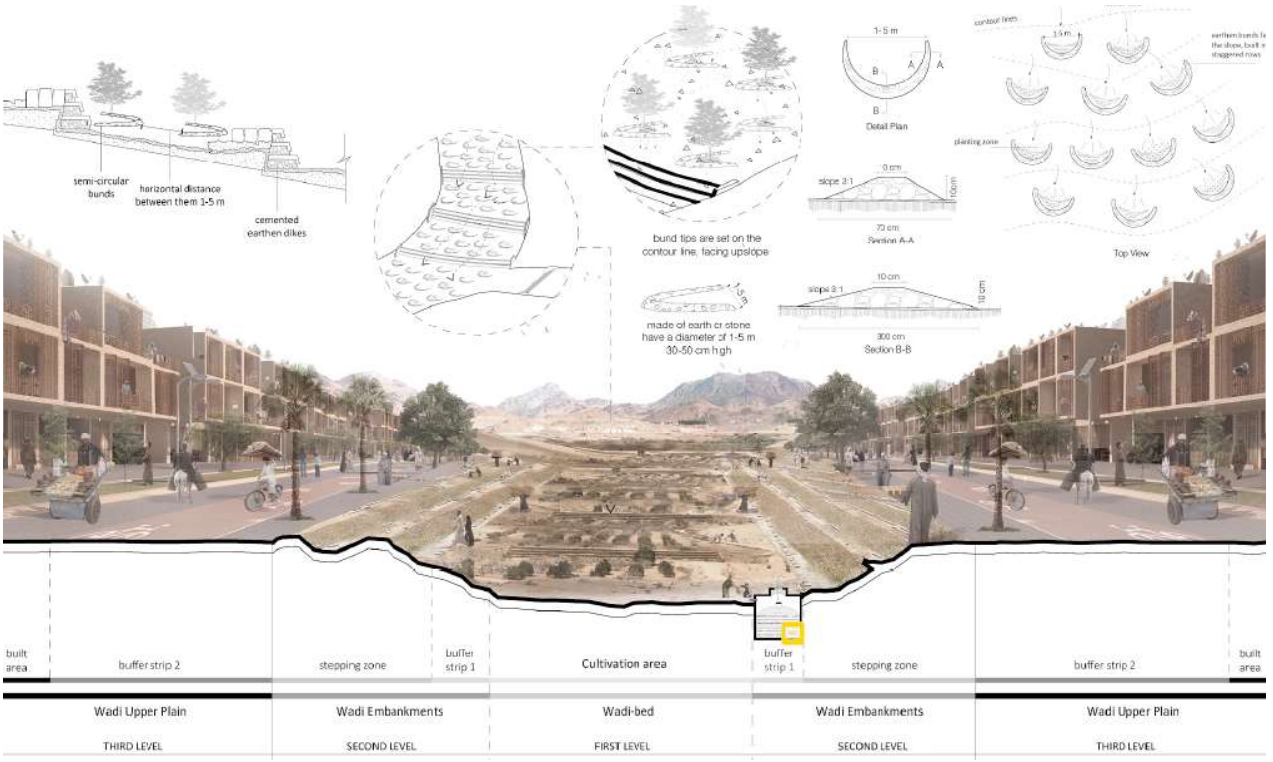
Michler (2010). *Wadi Hanifa Wetlands.* Retrieved on May 29, 2020, from https://inhabitat.com/aga-khan-award-for-architecture-wadi-hanifa-wetlands/10_wadi-hanifa-wetlands-2/

R
R TREATMENT
ATION

TY:
Y GENERATION

S:
MRA
MUNICIPALITY
TRY OF ENERGY
INERAL RESOURCES











Concept Plan

The concept plan shows the complete Baron City Compound with a wadi flowing through. The concept is that all buildings stay, but all public space is taken over by the wadi. The more communal spaces and silent strees will transform into an urban desert. The wadi deals with environmental issues, but also enhances the community and opportunity for community participation.

- Wadi
- Buildings Plot
- Other Buildings
- Wadi Agriculture
- Urban Desert

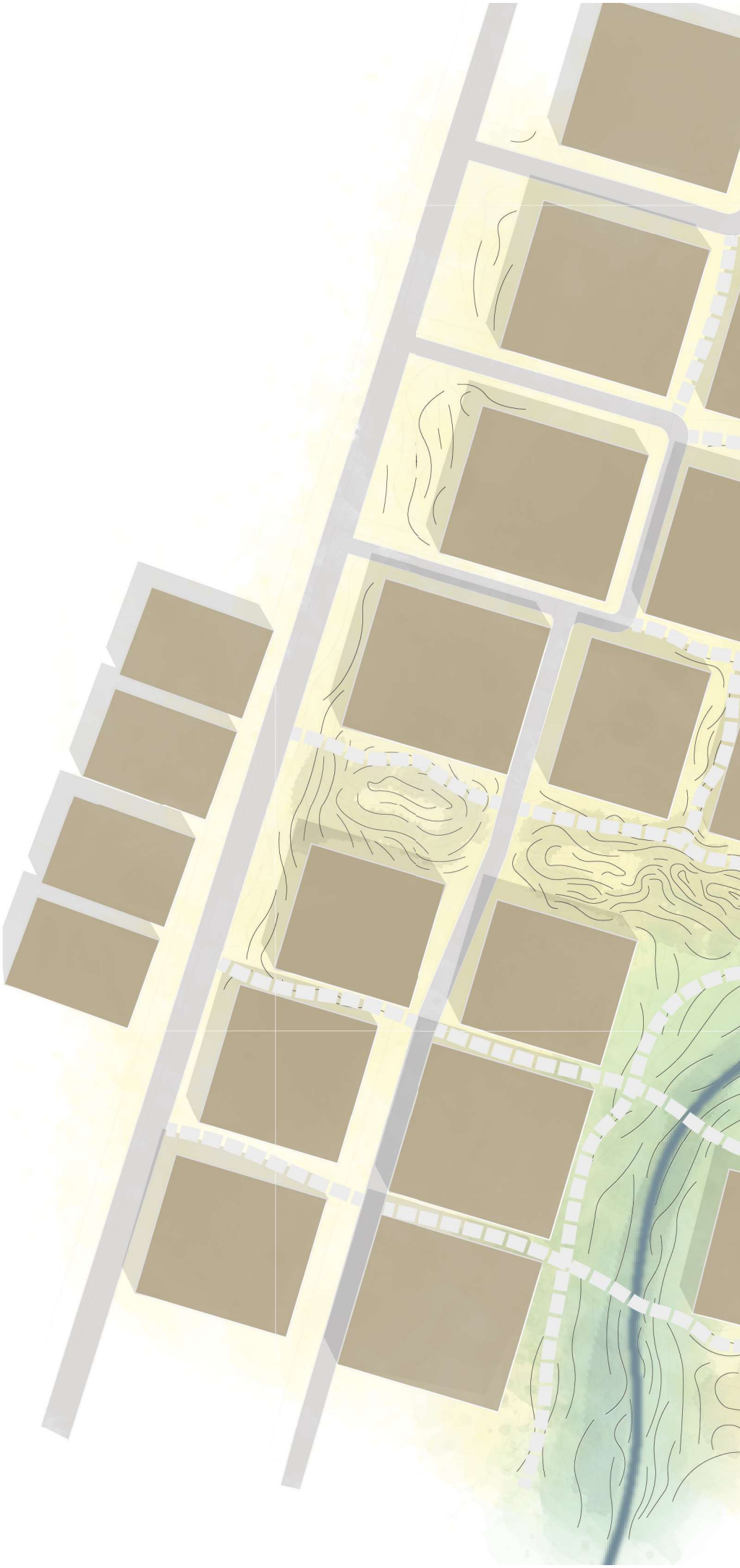
N

0 50 m

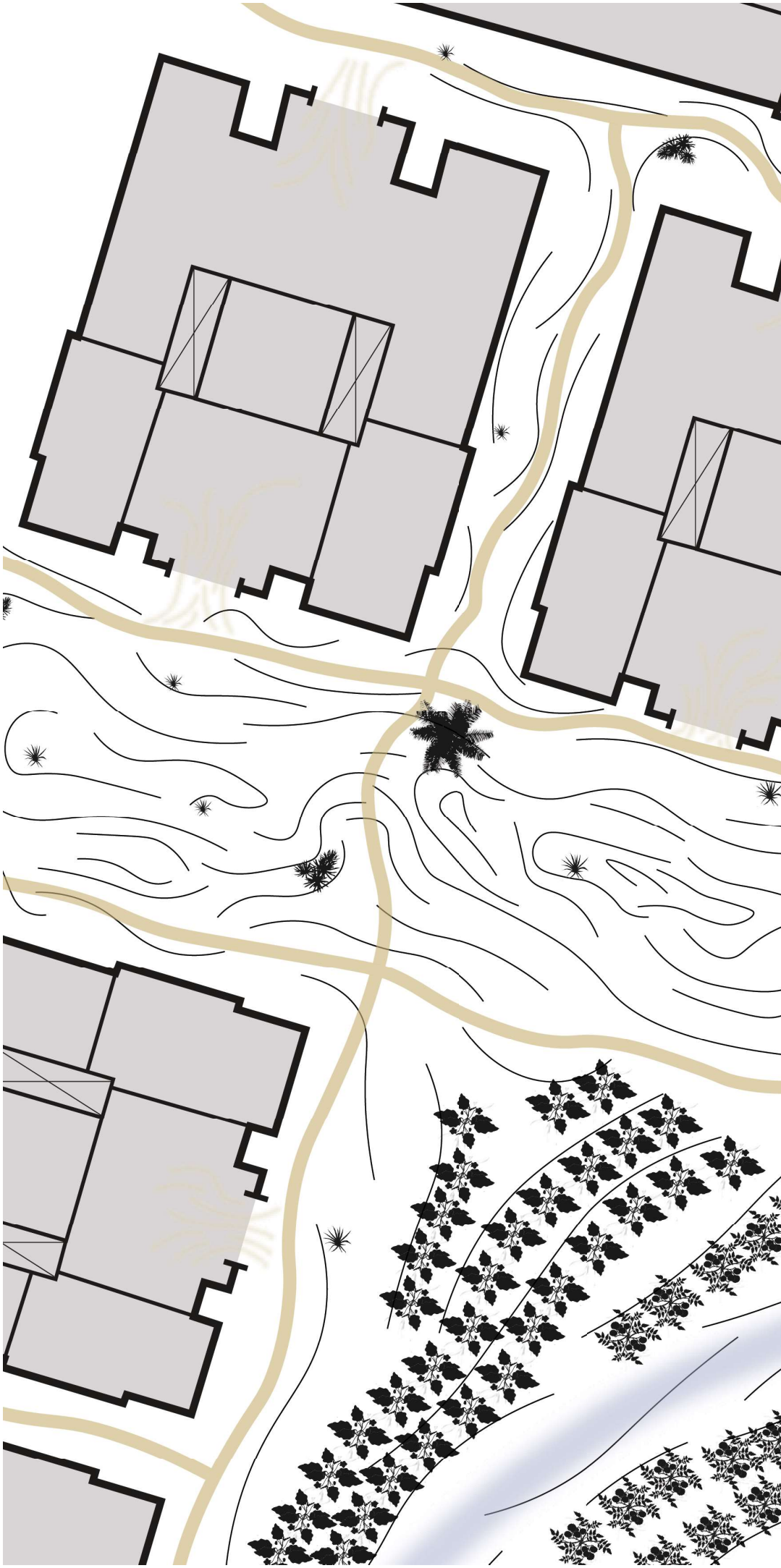

A
A'
B
B'
C'
D'

Master Plan

The masterplan shows the collaboration of the mosque and mosque square with the wadi to create a highly public area where people come together. It will be a place for meeting, producing and creating communities. The responsibility for the agricultural areas lay with the gardeners, but there is space to participate. Towards the buildings the space becomes more communal and private, this is where the urban desert comes in.







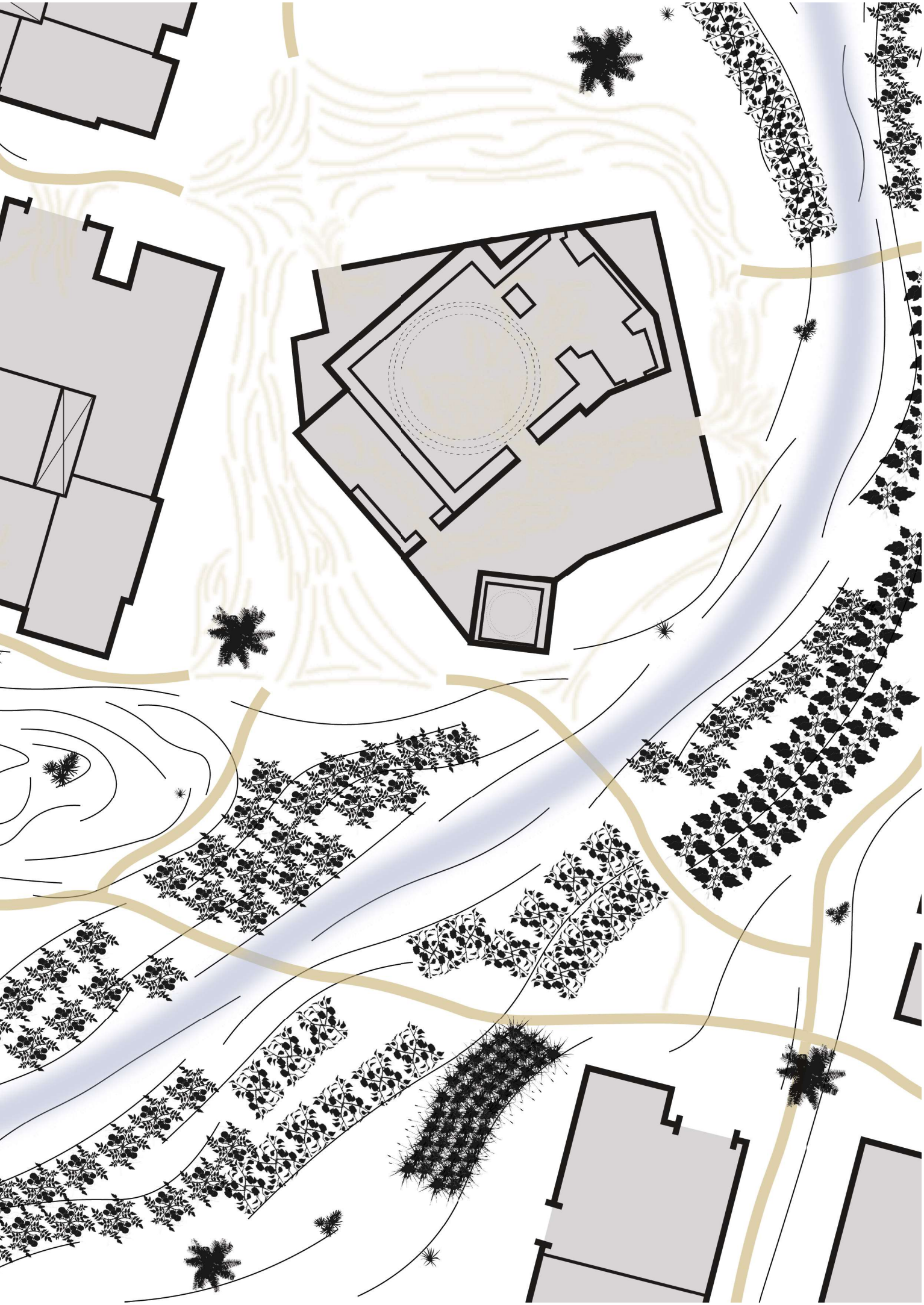
Urban Design Plan

This plan shows the cultivation around the wadi and the urban desert between the buildings. Paths that follow the contour lines are created for pedestrian movement. The mosque square is the central point of the neighbourhood for movement and meeting.

Wadi
Building Interior
Wall
Path
Movement
Contour Lines

N

0 5 m



Section A-A'

Showing the wadi and cultivation flowing through building blocks. Roads for cars are located at the backside of the buildings.

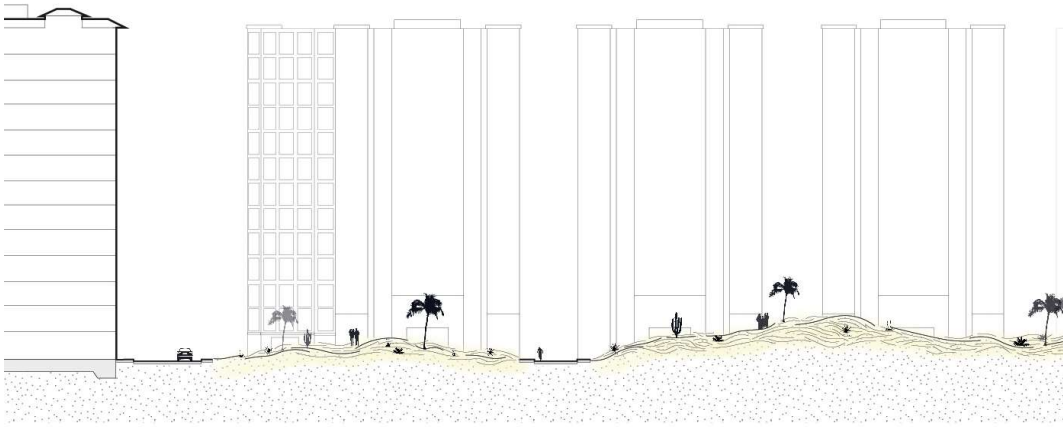
0 10 m



Section B-B'

Showing the mosque as a central element, together with the wadi a highly public area. To the left, the urban desert forms a more silent public space that creates a soft border between public and private.

0 10 m



Section C-C'

Showing another location with the wadi and its agriculture and the urban desert. Towards the urban desert, there is also reedbed filtration which purifies grey and waste water from the buildings.

0 10 m

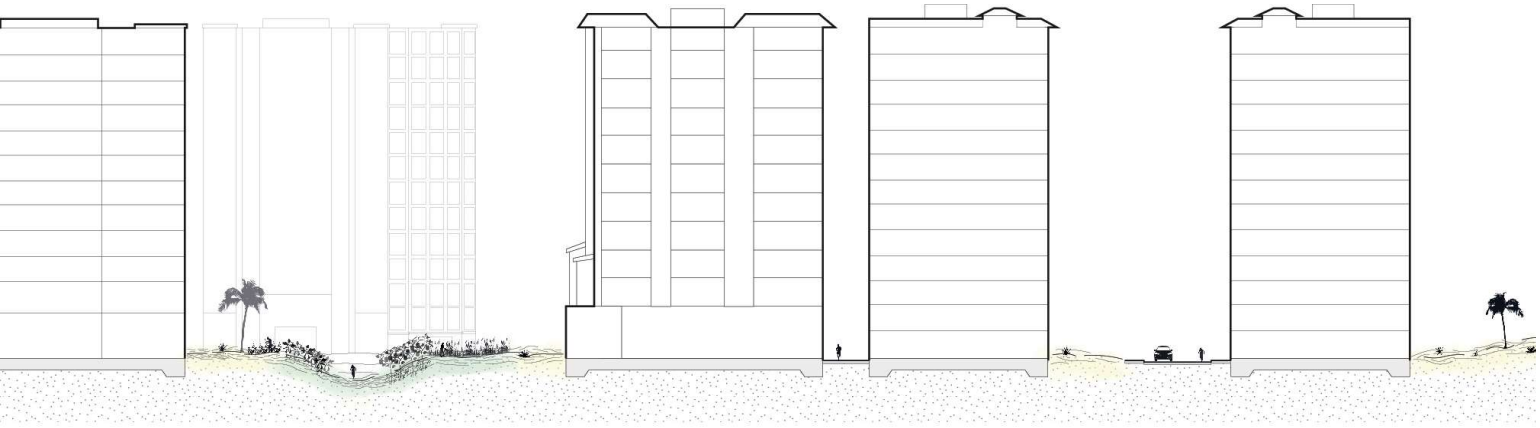


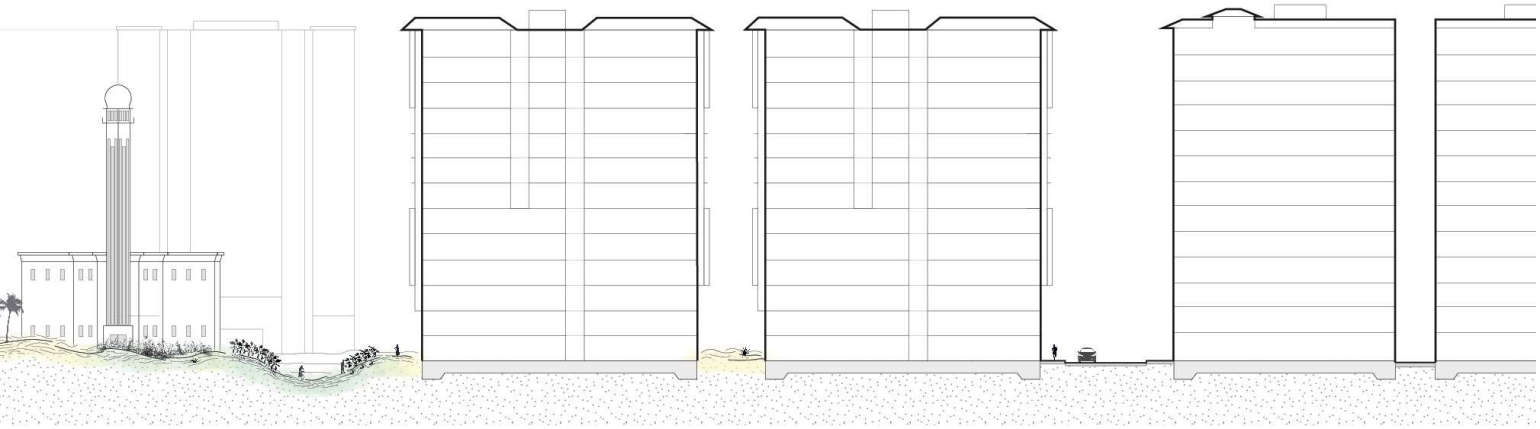
Section D-D'

Showing a location where the wadi flows inbetween two buildings, with little space. At these locations there is no agriculture, it is just the wadi. The agriculture is only located at wider locations.

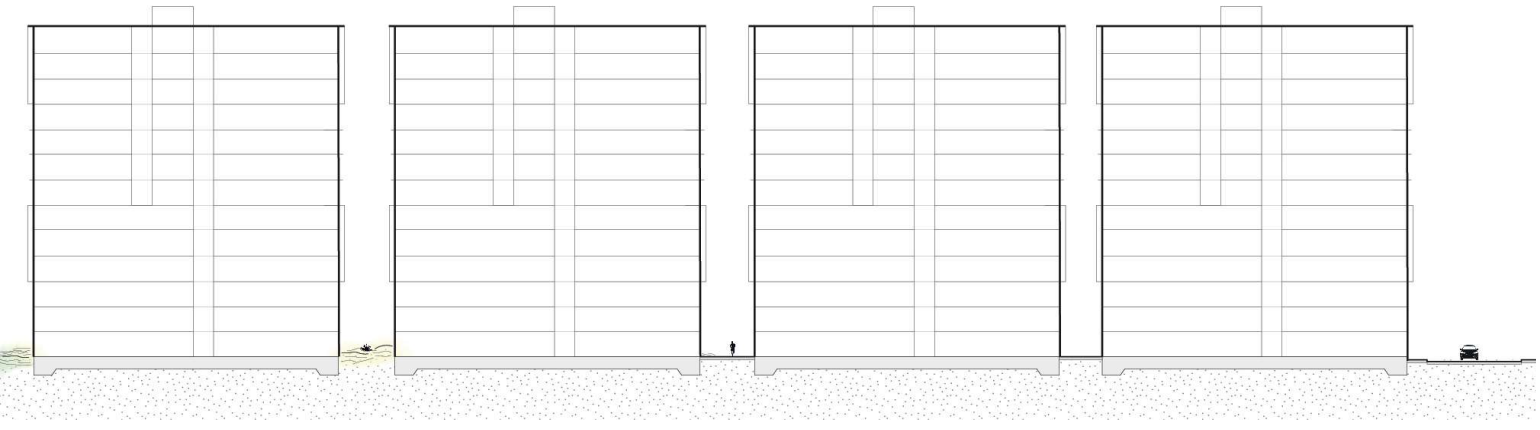
0 10 m











Residential Buildings

All existing residential buildings are preserved and keep their current form and privacy. However, they will be retrofitted to increase the sustainability of the buildings. On top of that, parts of the buildings will be transformed into housing for lower income classes.

Public Buildings

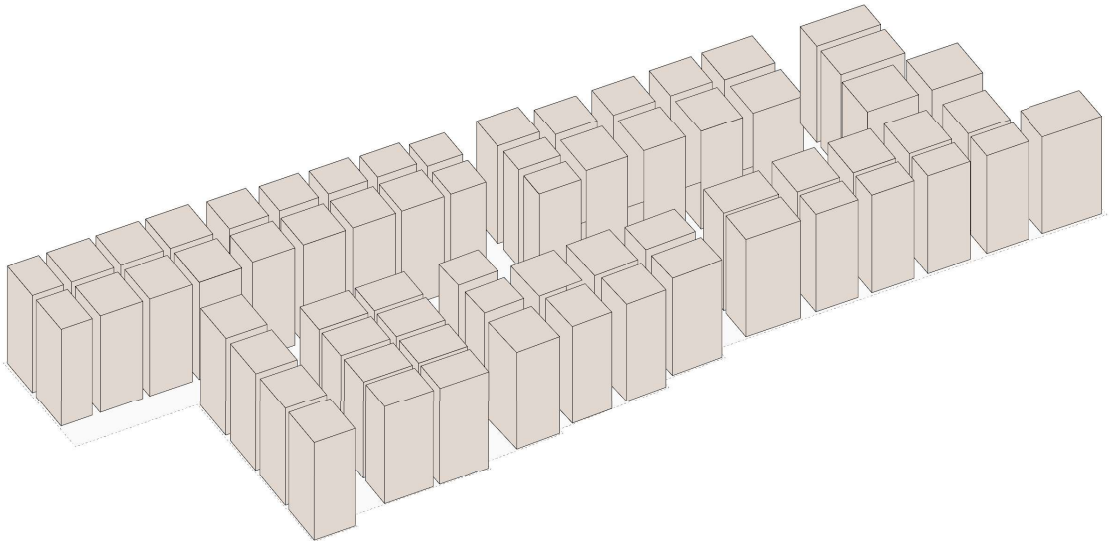
The mosque is currently the only public building. Along the wadi, more public buildings will be introduced to increase public life and strenghten communities. There will be a market, several shops, restaurants and cafes.

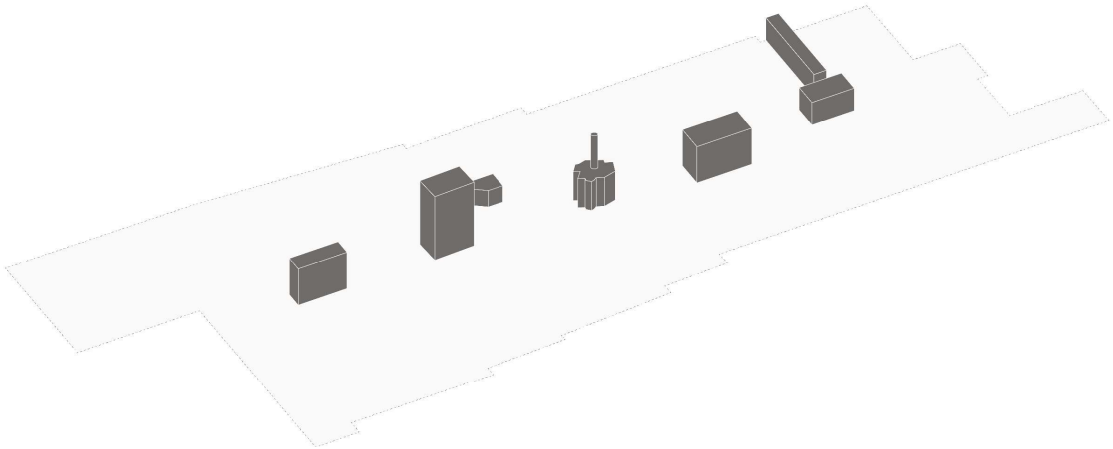
Public Space

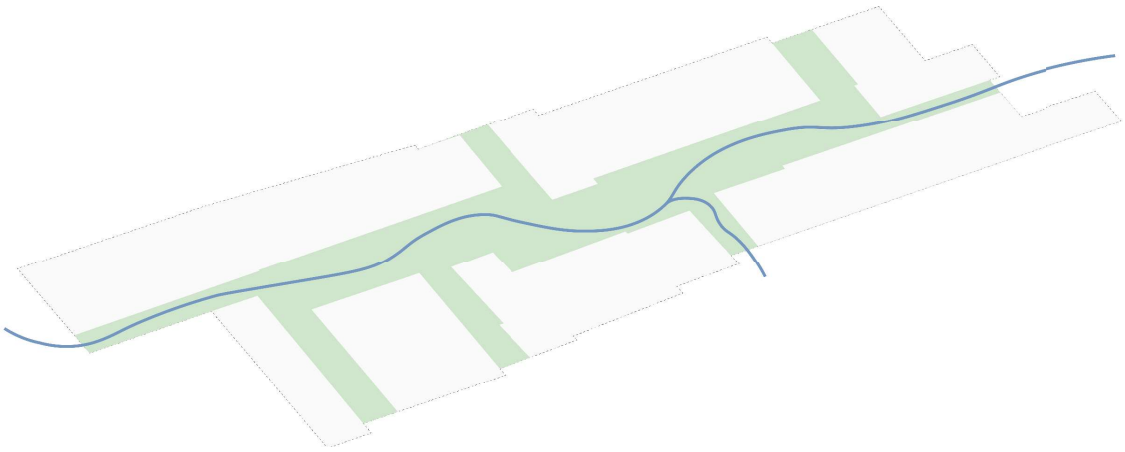
All space around the buildings will transform into the waterbed of the wadi or into urban desert. Public space will vary from highly public around the wadi, to semi public in the urban deserts. The car moves to the back of the building blocks and the wadi strip has space for slow traffic movement.

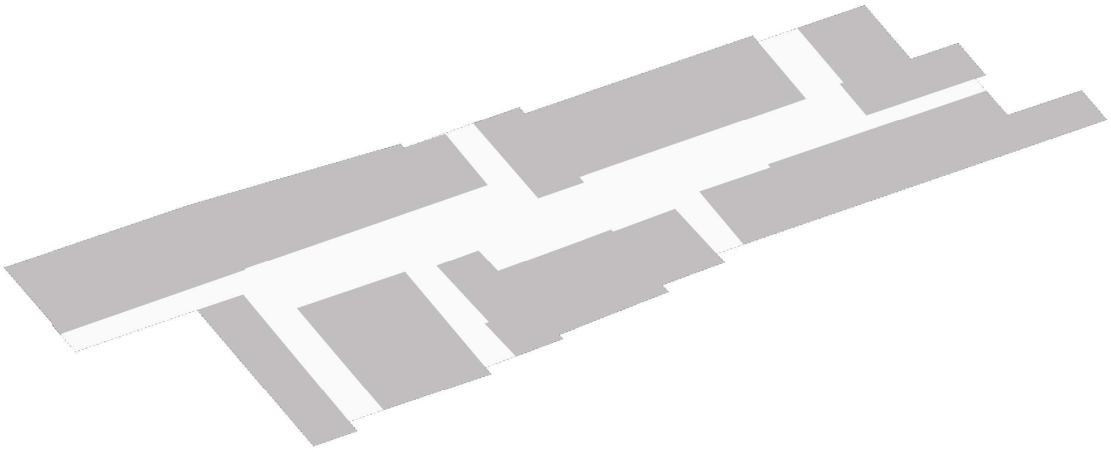
Compounds

To maintain the desired privacy for the residents, the compounds are maintained and public space is only located around these compounds. The narrow streets and paths within the compounds will be communal.











PermaCommunity

Introducing the PermaCommunity in the area will improve the resiliciency of the neighbourhood, both environmentally and socially. It deals with drought, heavy rainfall, but also improves the social infrastructure.



New Neighbourhood

Jan Eggink


Pump systems
available

Manifesto

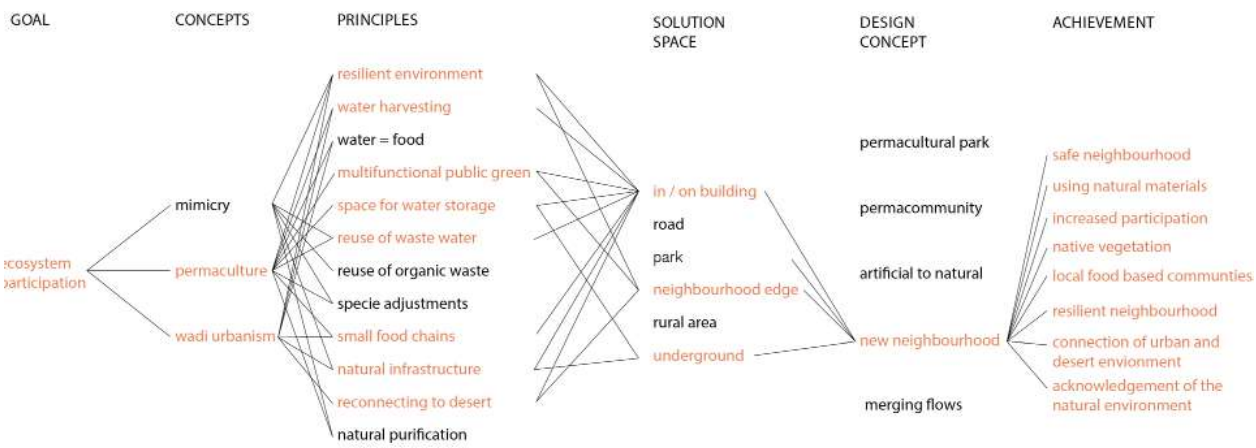
The continous growth of Cairo means that there is an increasing pressure on the landscape. Due to the expansion need of Cairo, the desert is pushed back furthermore and the new artifical parts of Cairo are ignoring the landscape. This ignorance is problematic because Cairo is facing several environmental challenges such as long droughts, heavy rainfall and increasing temperature. The goal of this report is to define a way to use ecosystem participation as a catalyst for healthy and climate-proof extreme environments.

Cairo is facing different challenges, the increasing extreme environments and growing population are two of those. To ensure human participation in ecosystems in Cairo, while facilitating population growth and mitigating extreme climate consequences a different and 'new' type of neighbourhood is required. By integrating and interweaving nature and the built environment the need for vernacular architecture is reintegrated. Egyptian vernacular architecture has experience with arid and desert landscapes and has developed certain characteristics to create a pleasant climate, in and outside the building.

This vernacular architecture will be used in an contemporary way. This means integrating certain (technical) elements suited for mitigating extreme environmental consequences and providing a pleasant interior climate. This new neighbourhood integrates permaculture and aims to create a social and economic mixture to strenghten the (social) resilience of the area. Furthermore, by implementing permaculture, nature is used to create an integrated and ecologically friendly and resilient landscape. This results in using natural resources, such as water storage and a local food chain. The permaculture together with the vernacular architecture will positively influence the social and economic mixture and vice versa.

This manifesto combines two scenarios described in chapter 5: nature first and no technology. In these scenarios self sufficient blocks and communities growing their own crops are combined with wadi's flowing through the area. Furthermore, new buildings are constructed out of local materials and the wall is broken open to let nature enter the neighbourhood. Since the food is produced locally, people will feel more connected to the nature and eventually will feel more responsbility towards maintaining the nature. Furthermore, this way of producing food creates a food based local community.

El Hadaba El Wosta is a monofunctional, artificial neighbourhood. The landscape is ignored and human interventions pressure the natural areas and environment. By introducting and implementing the new neighbourhood the monofuntionality of the area is disrupted and a social and economic mixture is created. The contemporary vernacular architecture is more suited for the climate, ensures food production and water storage and is more resilient. this can be seen as the way forwards for new neighbourhoods at the edge of Cairo, connecting and placed in the desert.



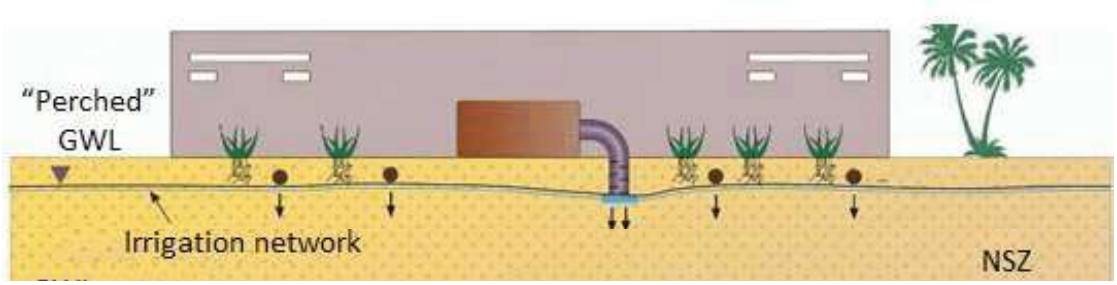
Inspiration.



Adding on the input from the critical cartography, conceptual framework and scenarios, I found several sources that were of great influence to my design experiment.

- Water storage in and outside building. Water storage is used to harvest rainwater in times of extreme rainfall. This could offer a huge change to store water in arid climates. (Sticklor, 2016).
- Using passive cooling characteristics of vernacular architecture. The building material and layout are used to create a maximum passive cooling capacity. There are several characteristics that vernacular architecture has that create a passive cooling effect (Mady, 2010). The image on the right shows an example of typical Egyptian vernacular architecture (Farouk Mohamed, 2020).
- Solar energy to become self sufficient. Solar energy could provide up to 42% of energy in 2035 (International Renewable Energy Agency, 2018). The solar energy which is produced by the solar panels on top of the roof are used for the eletrical equipments needed inside. Furthermore, the energy can be used to mitigate the extreme environmental consequences.
- Underground irrigation system. This system offers possibilities in arid climate because the irrigation chanels are not exposed to heat from the sun (Boumans, 1987). This underground irrigation system is linked to the water storage under the building. With pipes, water is distributed to plants and crops close to the building to become self sufficient and for the crops and plants to function as cooling elements.





Design experiment

The New Neighbourhood is based on the concept of wadi urbanism and combined with permaculture. In this new neighbourhood contemporary vernacular architecture is implemented. This means using traditional building typlogies and building materials and connecting them to modernday technology to ensure a resilient neighbourhood, capable of facing the challenges the extreme environment of Cairo offers.

This new neighbourhood uses the characteristics of the landscape, the wall is broken down and turned into a hill. The configuration of the building block is placed in such a way that wind, desert and wadi can enter but desert storms are kept out. The hill is used to let wadi flow down and filter the water on different levels. On the lowest level, the water will be filtered and can be used for several purposes. The wadi is connected by pipes to different areas close around the building blocks where agriculture is placed. Through this agriculture the area becomes self sufficient and this greenery helps by passively cooling the area.

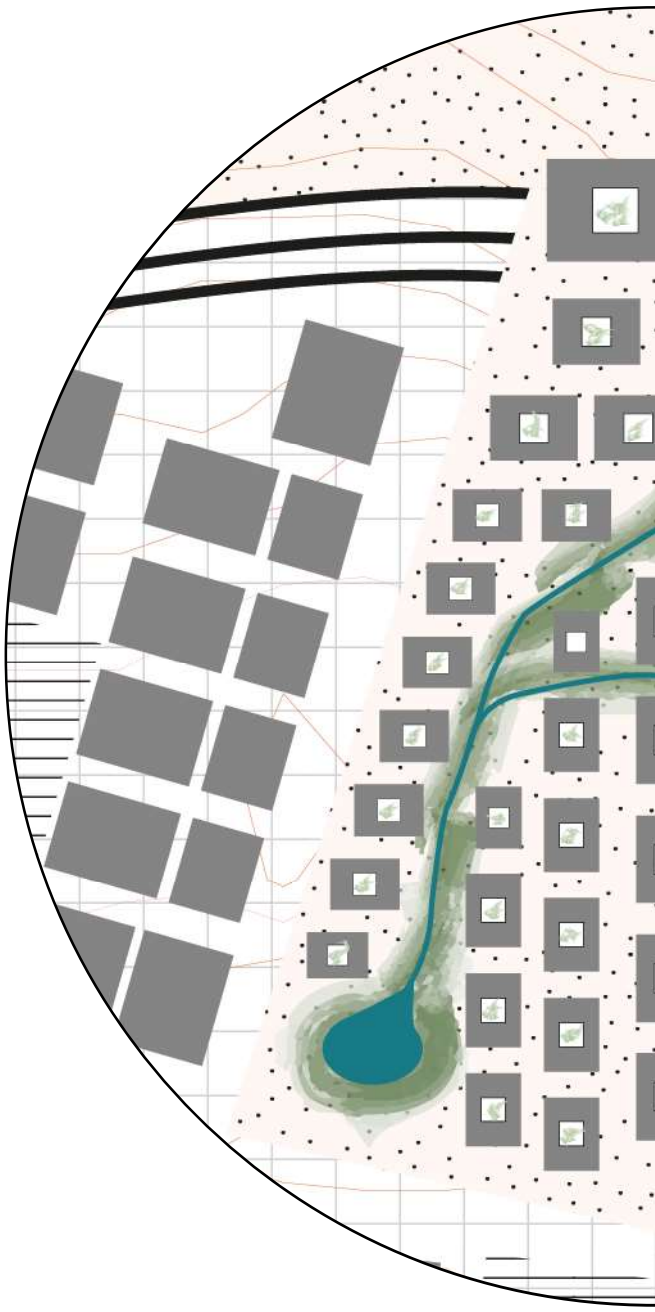
The new neighbourhood has a mix in building typologies, this is to ensure a mix in social classes in the neighbourhood. Furthermore, several public buildings are introduced so that residents can purchase everything they need in the area. The new neighbourhood is a largely car free neighbourhood although the outer rings can have cars. This is done because the highest social class is placed at the outer edge of the neighbourhood and they are car reliant.

The building typologies have several characteristics in common: Thick clay walls, courtyards with greenery, front gardens with greenery, use of solar energy for heating, cooking and cooling (in extreme environments). This new neighbourhood not only brings different social classes further together but also connects these different social classes to the environment and gets them to acknowledge their environment and creates a sense of responsibility towards the environment.

Concept plan

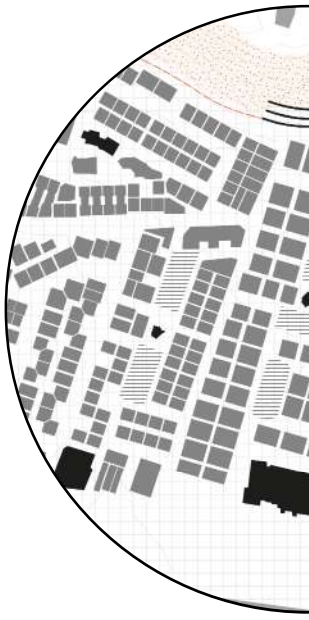
This plan shows the concept: implementing contemporary vernacular architecture. The buildings have in common that they are all one or two floors, have courtyards with greenery and have thick clay walls. The buildings are placed on the hill which connect the highest point of the wall to the lowest point, close to the water resevoir. The building typologies differ, with the biggest placed on the edge. Here the upper social class are places.

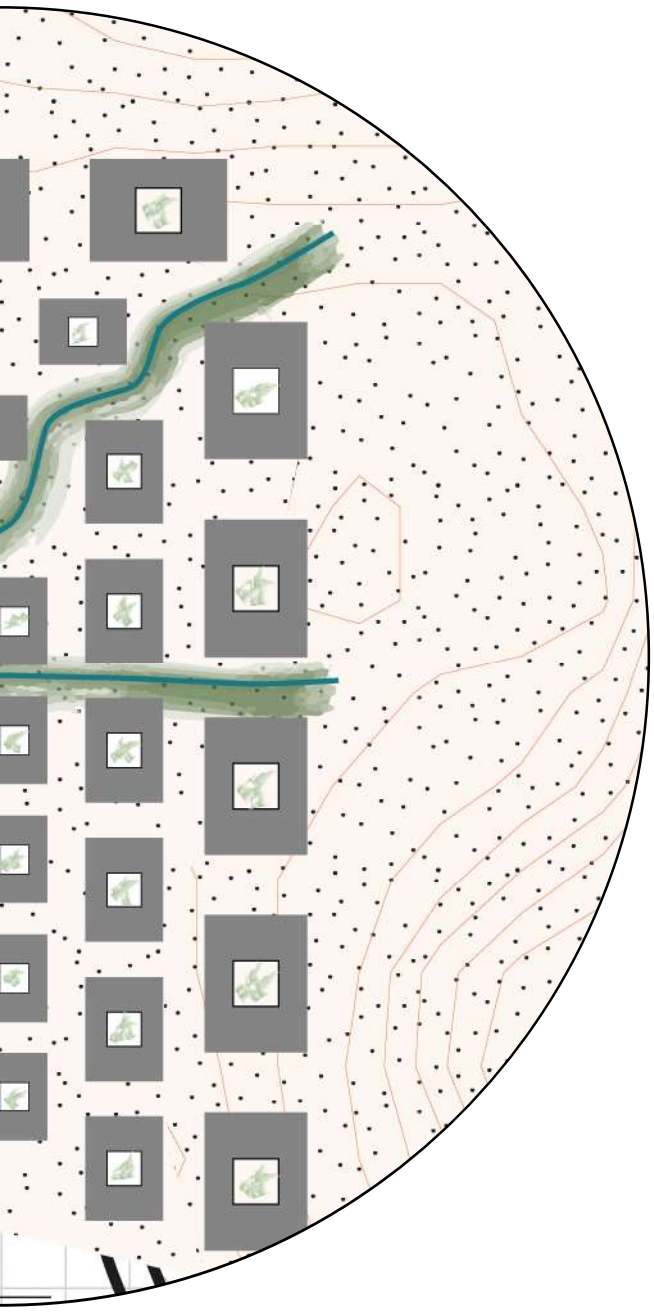
The building configuration is done in such a way that wind and the desert can enter. Nevertheless, in case of a desert storm, the building configuration offers maximum protection.



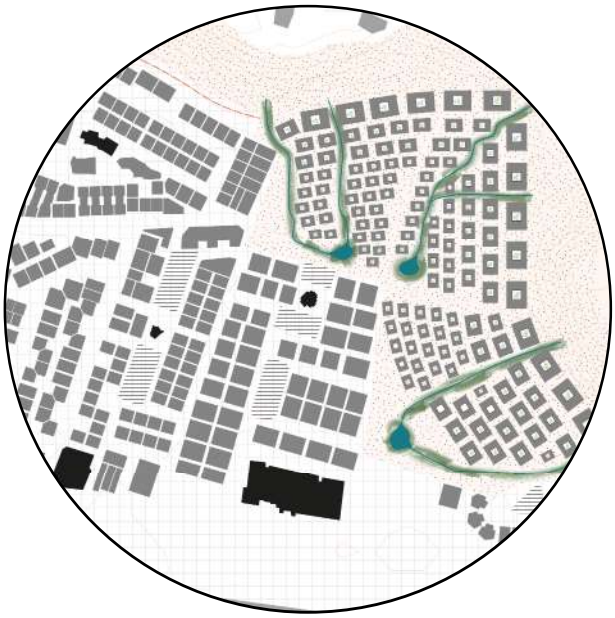
These three images show in what way this design experiment will transform the existing situation. The first image shows the current situation, the second situation shows the proposed plan. Furthermore, it shows that the development could eventually change the adjecent areas and eventually change the entire plan area.











Urban design

These concept drawings describe the guiding principles for the urban design. The current situation of the design area is compared to the future situation and the choices are explained.

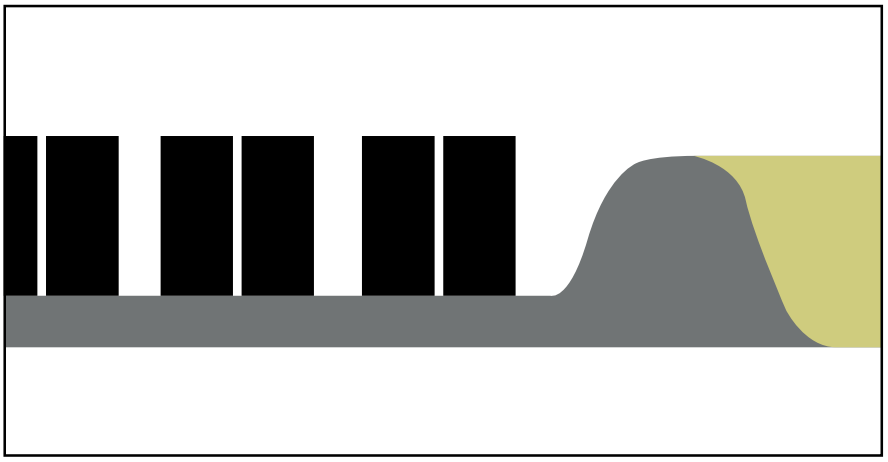
In the current situation the topography is not present in the design area. Originally a desert area, the desert is now pushed back and placed behind a 7 m. high wall.
In the future situation, the design area becomes an even slope. The houses are placed on different levels of this slope. By implementing the slope, the nature is once again allowed into the design area and people can more easily move in and out of the desert area.

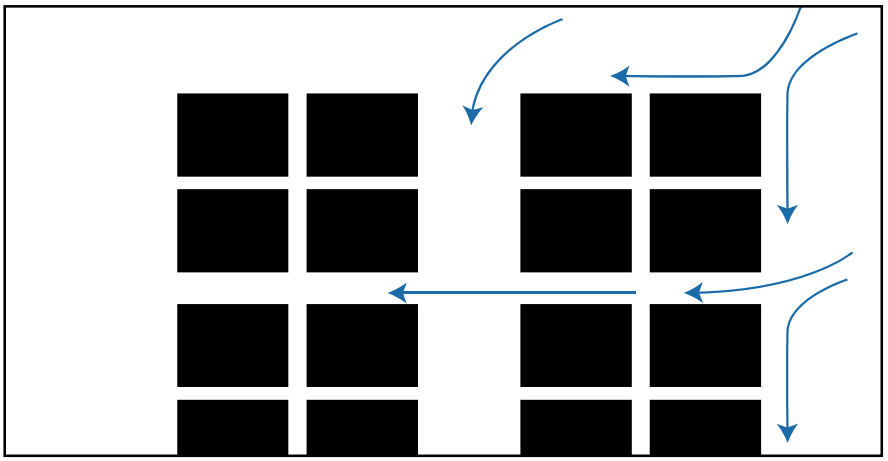
Due to the current positioning of the buildings in relation to the wind, the spaces in between the buildings has no direct wind. This results in an unpleasant climate.
In the future situation the biggest building typologies are placed on top of the slope. The building typologies decrease in size moving down the slope. The buildings are positioned in a way that the wind can enter the area and reach the green interior of the neighbourhood and all the streets and interior spaces of the buildings.

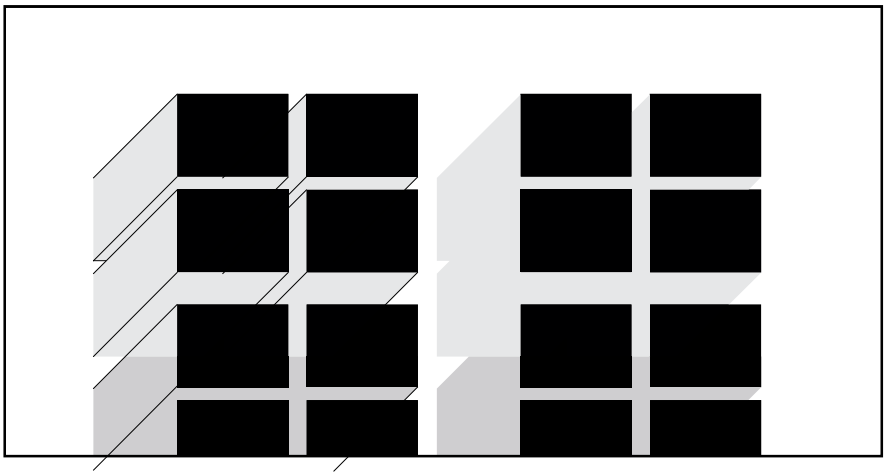
In the current situation the building blocks are placed in a high concentration, close to each other. This results in wide streets crossing the design area. In the new situation, the buildings are placed in a less concentrated and more linear way. This is done to create an almost continuous shaded area in front of the houses. This results in a pleasant local climate in front of the houses for the pedestrians, for whom the public space is designed. Together with the irrigation channels and the plants, the air is cooled. This eventually cools the interior and the area in front of the building.

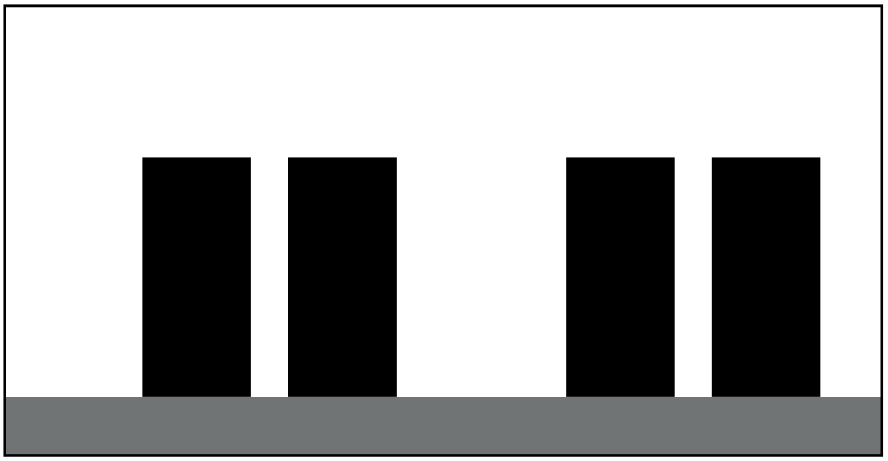
In the current situation, the street profile consist of non-permeable material. This street profile is mainly designed for the car. Buildings are placed close to each other to create a wide street where cars can move. In the new situation, the street profile changes. The nature is allowed into the area, eventually connecting the desert to the design area. Paths and areas for agriculture are implemented in the street profile. The slope is made visible in the street profile. By doing so, the street profile is actually divided. In normal situations the pedestrians can walk in a shaded area close to the vegetation in front of the house, while agriculture can take place in the lower section of the street. In a rainy situation, it is still possible for the pedestrian to access the street because of the height difference. The lower area of the street profile is flooded, while the higher area remains dry and accessible to pedestrians. The lower area, when flooded, offers the possibility to fresh water for the residents of the area.

Current situation



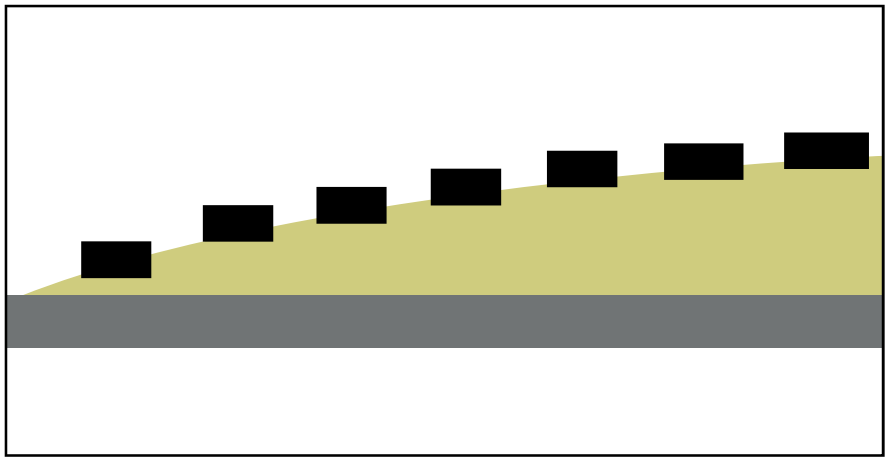




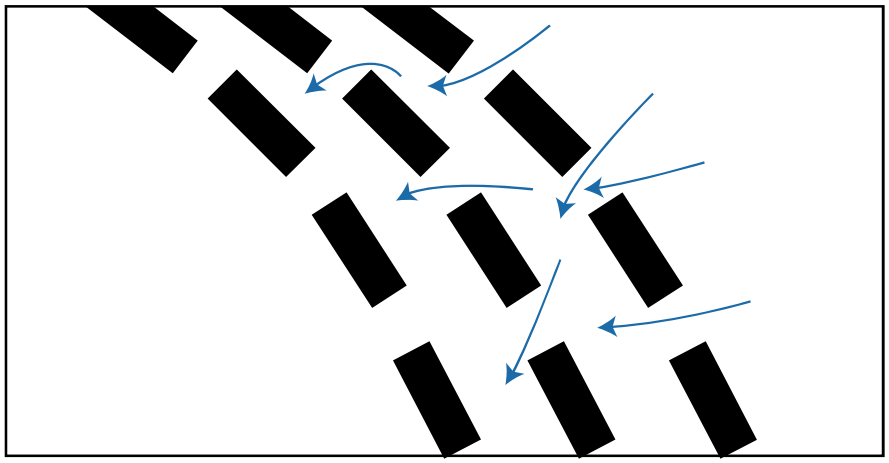


New situation

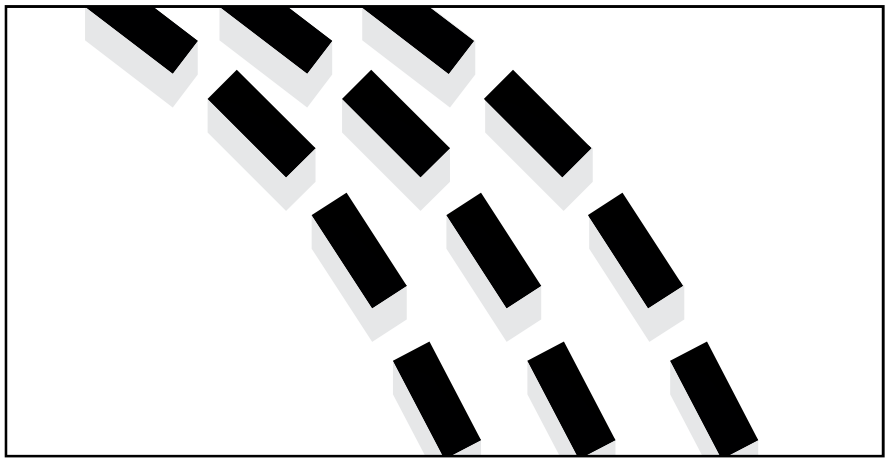
Topography



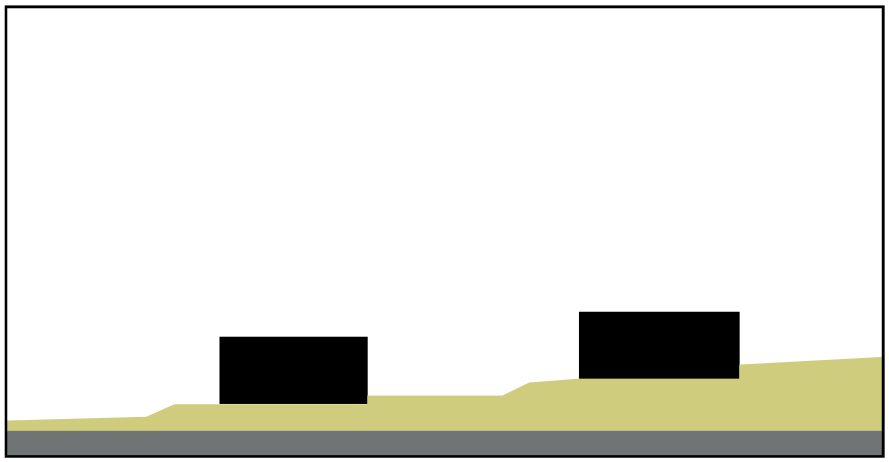
Wind



Shade



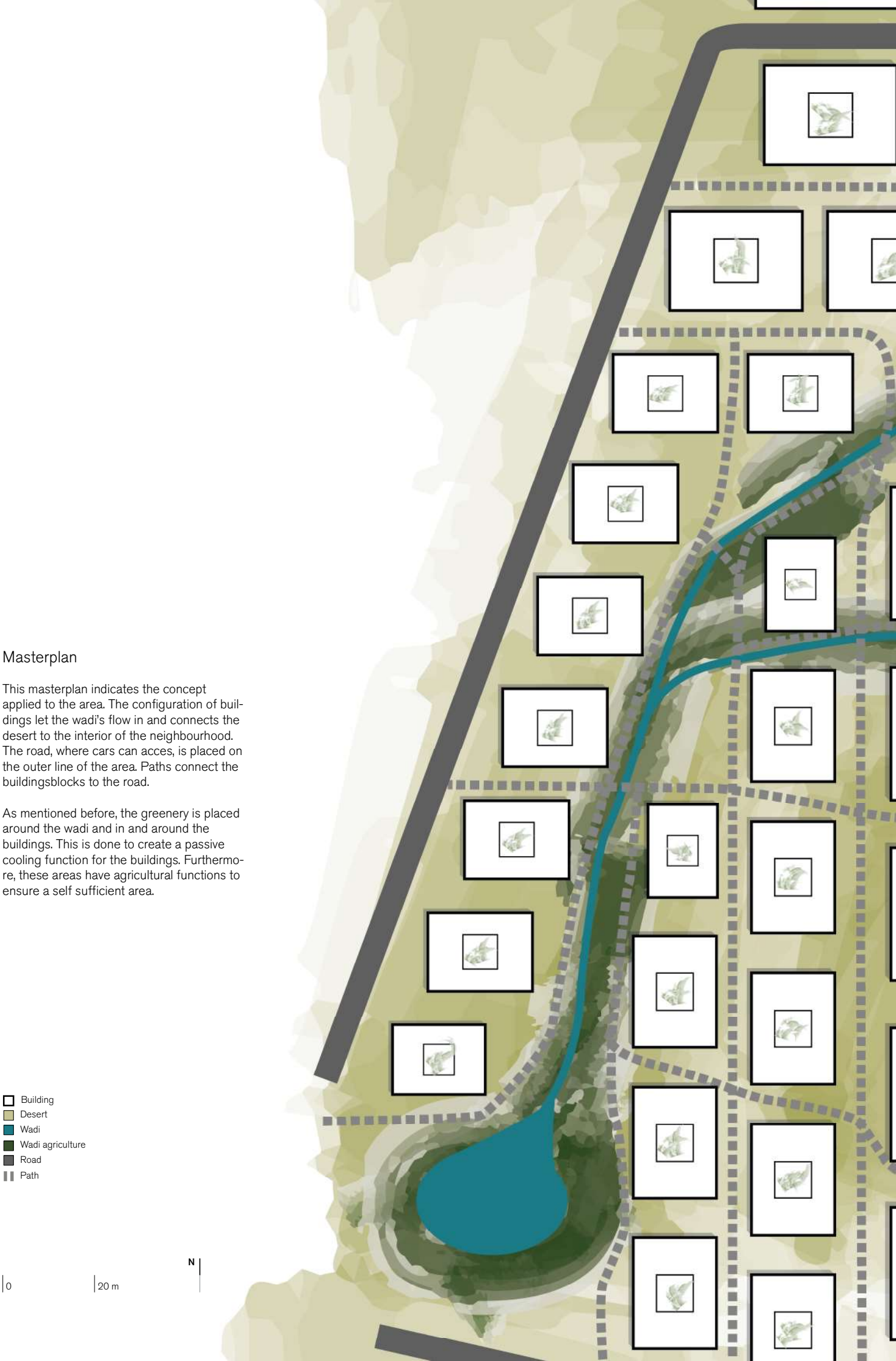
Street

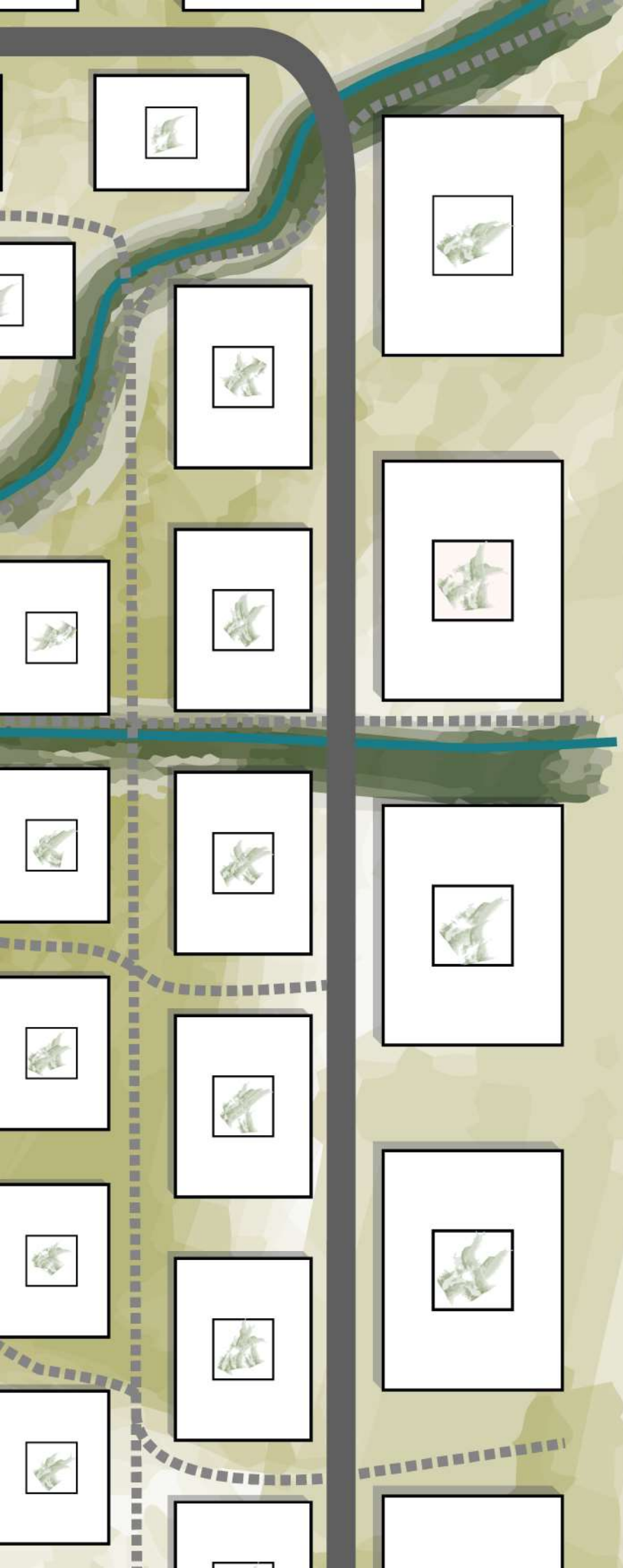


Masterplan

This masterplan indicates the concept applied to the area. The configuration of buildings let the wadi's flow in and connects the desert to the interior of the neighbourhood. The road, where cars can acces, is placed on the outer line of the area. Paths connect the buildingsblocks to the road.

As mentioned before, the greenery is placed around the wadi and in and around the buildings. This is done to create a passive cooling function for the buildings. Furthermore, these areas have agricultural functions to ensure a self sufficient area.



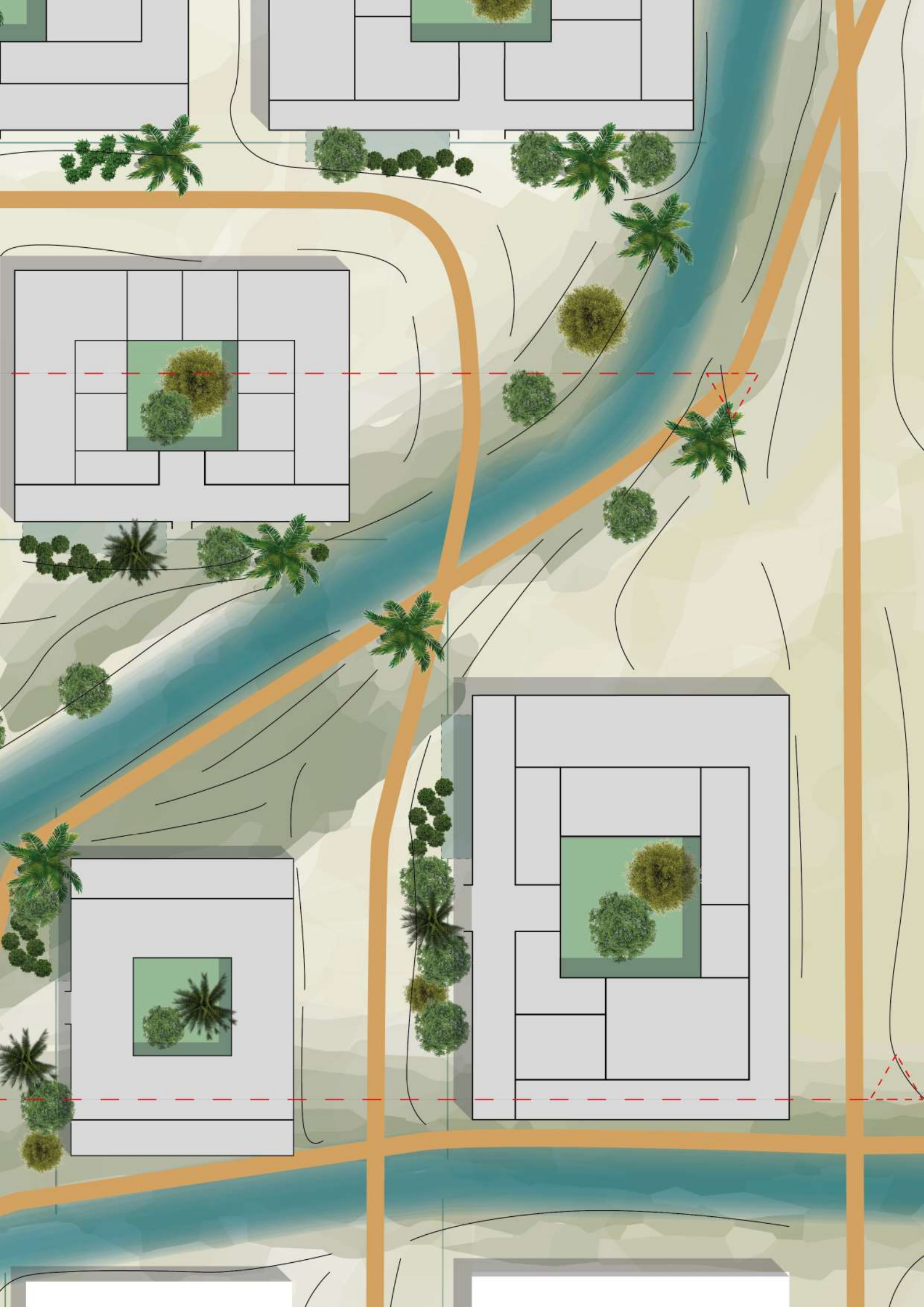


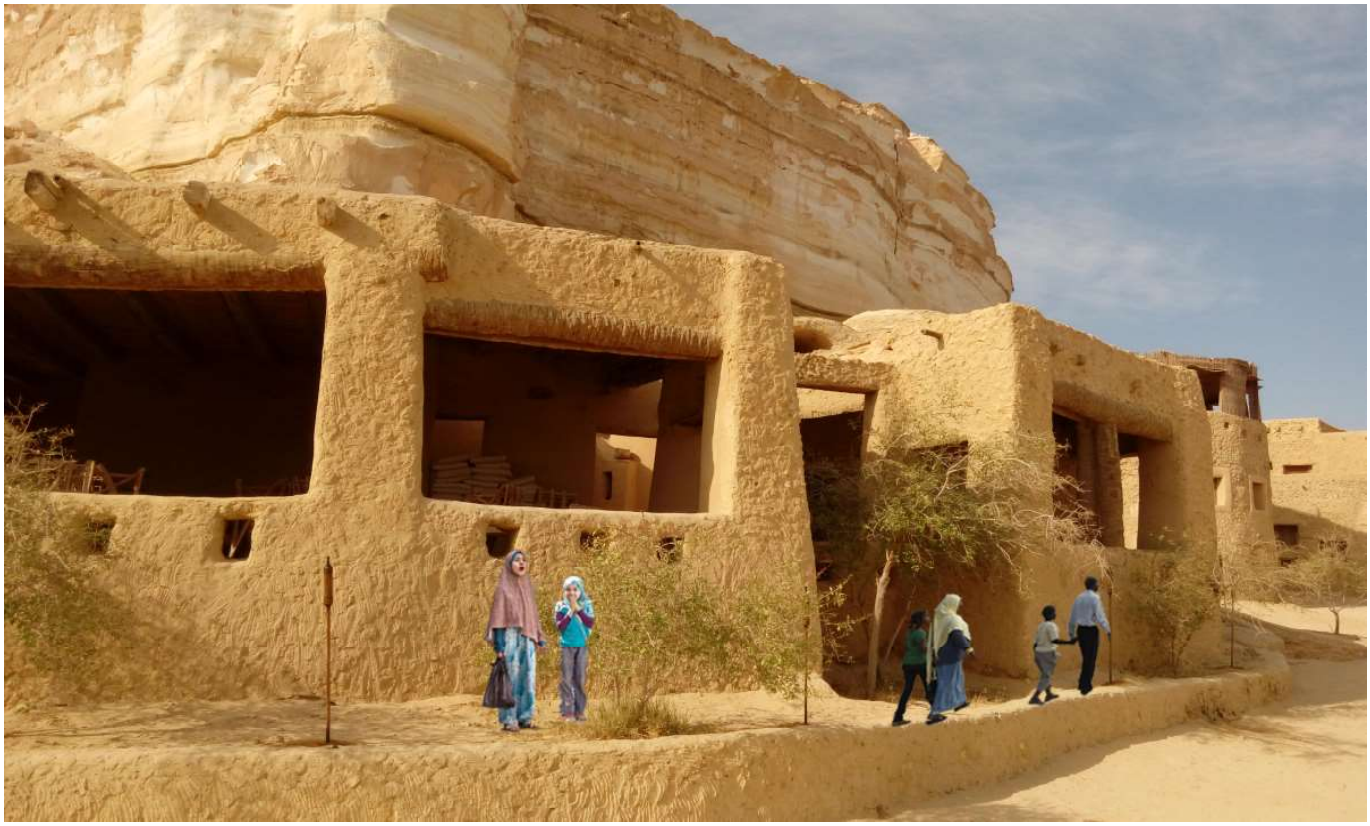
Urban design plan

The urban design plan shows the layout of the buildings. Furthermore, the underground irrigation system is shown how it runs from the wadi to the water storage tank under the house. The trees and crops are placed close to the irrigated area. The indoor area of the house is linked to the greenery in front of the house to create a cooling function. Furthermore, the courtyard is linked to several rooms to create a passive cooling function throughout the building. The water storage tank is linked to the grass sedum roof, which infiltrates the water to the storage tank. In this way, the storage tank can be filled by either the roof and the irrigation system.

The building layout is constructed in a way that the traffic room is placed on the outside, and the accomodations linked to the courtyard to create a pleasant inside environment.







Vernacular architecture in Egypt.

This type of building structure did not have any changes to it. Some characteristics that can be recognized here are the thick clay walls, the courtyard, visible in the middle of the image and the front garden with several plants that is connected to the covered area of the building.



Contemporary vernacular architecture in a normal period.

First changes to be observed are the solar panels, the grass sedum roof and the irrigation strip in front of the house connected to the underground water storage. Solar energy is implemented in the building typology and connected to the electrical equipment in the house. People use the paths close to the building while the excess space is used for agriculture to ensure a self sufficient neighbourhood.



Contemporary vernacular architecture in a dry period.

In extreme drought, certain plants will dry out. Nevertheless, the roof will still have a sedum grass roof. The plants in front of the building will still live, since they are connected to the stored water through the underground irrigation system.



Contemporary vernacular architecture in a rainy period.

In times of extreme rainfall, the space in front of the building is flooded. The water storage tank under the building is filled through the precipitation landing on the roof and filtered through to the storage tank. Furthermore, the water storage tank is connected to the wadi, to take on excess water flowing through the wadi.

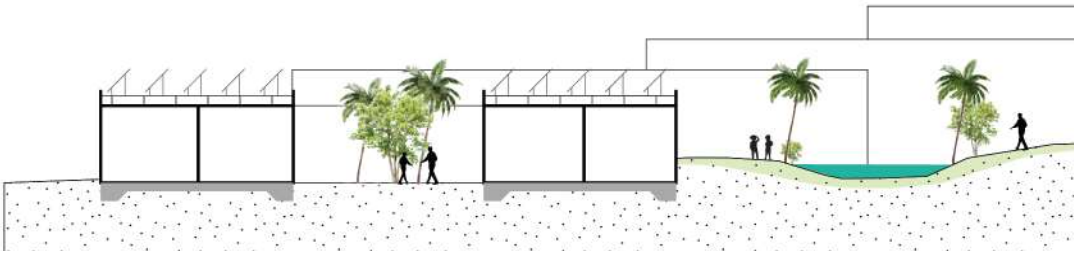
Section A-A'

This section shows the wadi flowing threw the landscape. Furthermore, it shows the pipes of the underground irrigation system and how it is connected to the water storage tank. The sedum roof is also shown in the section and the way it is connected to the water storage tank.

The hill, on which the new neighbourhood is placed, is also shown in the section. The solar panels on top of the roof are also shown in the section.

The green area indicates where trees can be planted and crops can be grown. This is linked to the river and the irrigation chanels.

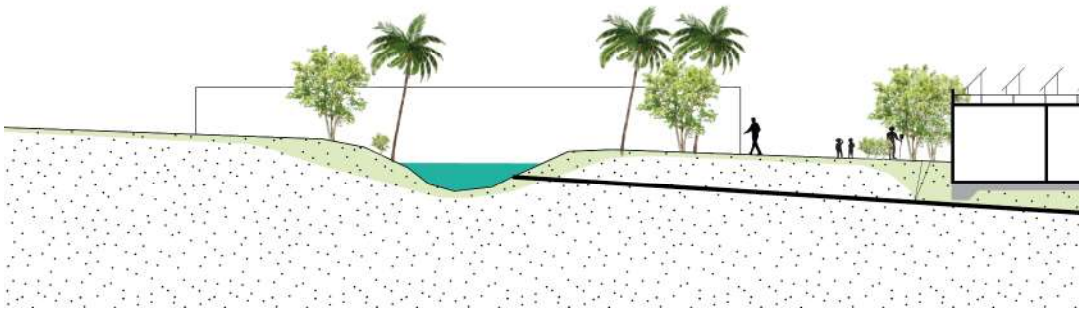
The width of the street is generally around the 6 meters. With two thirds of the street used for irrigation or for water storage in times of heavy rainfall. This width is based on the 5% increase of the slope together with the available space.

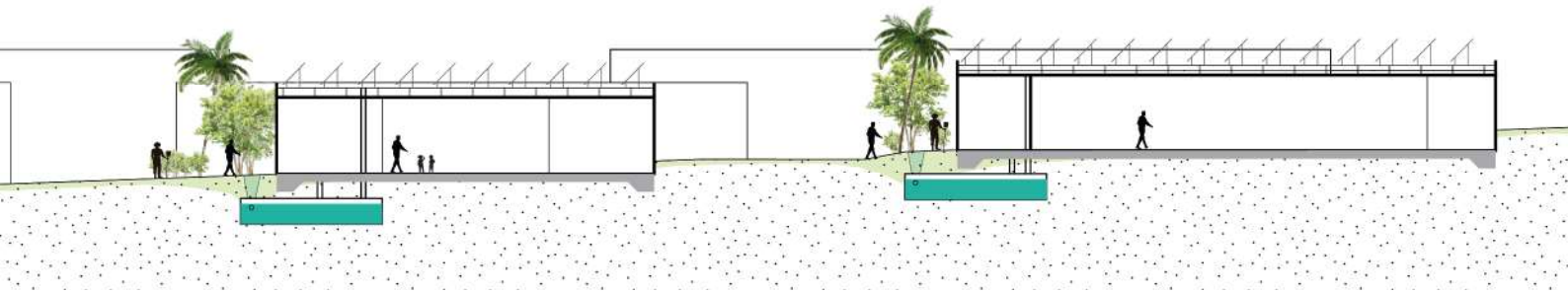


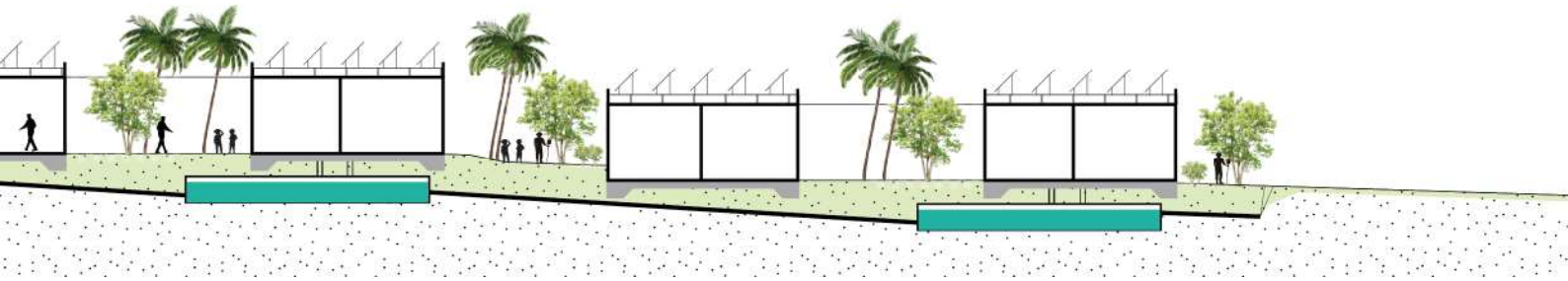
Section B-B'

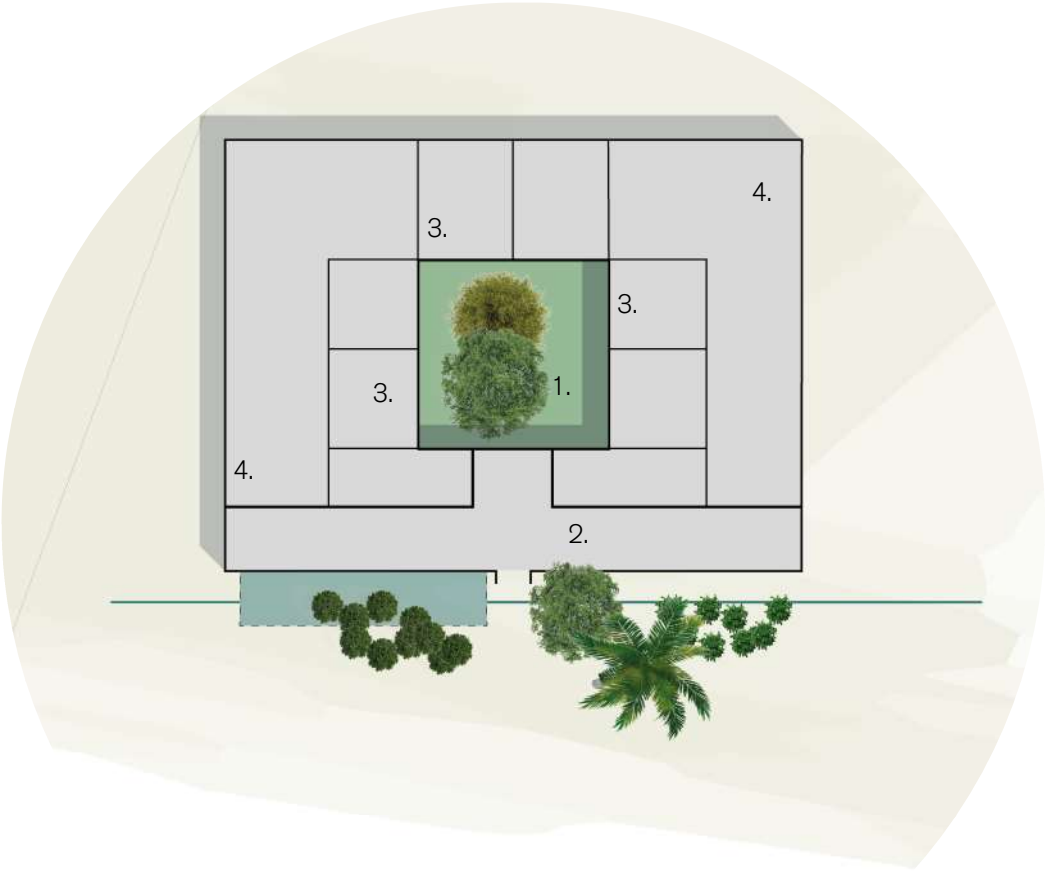
This sections shows how the underground water system is linked to the wadi. Furthermore, it shows the two pipes connecting the building to the water storage tank under the building. One connection is for the usage of water, the other one is connected to the green roof and forms the connection between the green roof and the underground water storage tank.

This section shows the pipe connecting the river to the water storage tanks under the houses. Furthermore, it indicates where the irrigation chanel starts, and from where the trees, plants and crops can be planted.









Building with passive cooling elements.

This image shows the different characteristics this building block has that ensures a passive way of cooling.

The courtyard enhances thermal comfort by producing cool breezes. In the evening, the warm air of the courtyard, that was heated directly by the sun and indirectly by the warm buildings, rises and is gradually replaced by the cooled night air from above.
This cooled air accumulates in the courtyard in layers and leaks into the surrounding rooms cooling them (Mady, 2010).

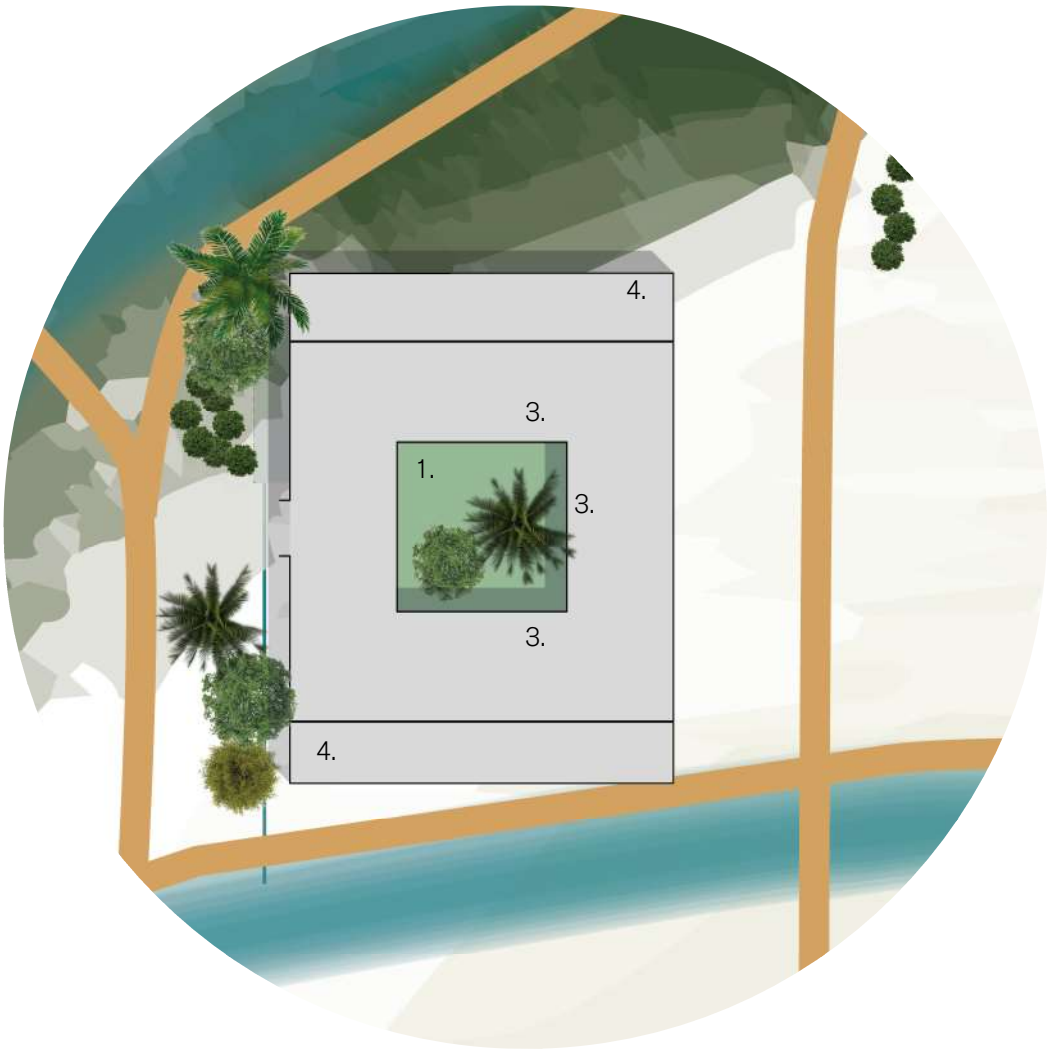
To ensure the air flow, a covered area at the ground level was introduced to the traditional house. It is located between the courtyard and the garden. Since the garden is larger and thus less shaded than the courtyard, air heats up more than in the courtyard. The heated air rising in the garden draws cool air from the courtyard through the takhtabush, creating a steady cool breeze (Mady, 2010).



1. Courtyard.



2. Covered outdoor sitting at ground level.



Building with passive cooling elements.

This image shows the different characteristics this building block has that ensures a passive way of cooling.

The open woden screen can do five functions according to its design. These functions are to control the passage of the light, to control the air follow, to reduce the temperature of the current air, to increase the humidity of the current air current and to ensure privacy (Mady, 2010).

Old houses in Egypt included “Rusha” or “Taka” which is placed higher than the window and facing it. This causes different speed in the air movement and in turn causes the cross ventilation. Thus, the air will be sucked down across the occupants (Mady, 2010).



3. Open woden lattice screens.



4. A small opening at an upper level of a wall.

7.

Bhuj, India

Towards water security

Asmita Puspasari
Ganesh Babu R P
Johnathan Subendran
Lucas Di Gioia
Menno de Roode



Aerial of Bhuj
Sapan Mehta, Retrieved on 05-07-2020



1.

Introduction to Bhuj

Bhuj is a city in the western state of Gujarat in India. Over the course of history, Bhuj has seen significant shifts in its socio-economic, ecological, infrastructural and political paradigms. It evolved from a princely state to a colonized territory and now, part of a rapidly growing country with infrastructure deficits and adaptation gaps in relation to current and future climatic, societal and economic changes.

By vary of it's geographic realities of being situated in an arid environmental condition, the city is exposed to a wide variety of water related issues. Water is critical to life in a desert, and as such, in Bhuj too. The city is facing increasing water stress due to irregular monsoons as a result of global climate change. The irregular monsoons have led to both droughts and floods in recent years with increasing frequency. It is also in an earthquake prone zone to destructive earthquakes.

The water stress is a result of multiple reasons. An increasing urbanization of Bhuj due to rural-urban migration, exacerbated by climate uncertainties in the rural hinterlands of the Kutch region demands more water for sustaining the population. While the nature of economic development characterized by industrial activity and sprawl is in conflict with the environmental realities, leading to exponential growth in demand for water, which couldn't be solved locally.

As a result of this, Bhuj depends on a huge array of infrastructural arrangements that brings water to the city from the hinterlands. These heavy engineering systems create environmental externalities elsewhere. The infrastructural gaps left by public water supply is filled by private players in a free market system, which creates inequalities in terms of access to drinking water and sanitation systems.

In recent years, an increasing environmental awareness through grassroots activism by expert groups and non-governmental organizations has created momentum towards reviving traditional systems of water infrastructure and sustainable development models. While small in scale, they present an alternative to an unsustainable paradigm.

Context and Problem Field

Today, Bhuj can be characterized by its various historical transformations; from its establishment in the 16th century, to a subject under colonial rule and now, part of a republic. These political shifts have influenced social and ecological dynamics of the area that has majorly transformed the population's coping capacity to shocks and stresses from socio-economic, environmental and political rifts over time.

In Bhuj, transitions of economies and infrastructures from the use of indigenous to modern mechanisms has impacted the way people of Bhuj deal with the extreme realities of the territory. Over-population and urbanisation has confronted the capacity of the existing systems and institutions such as water infrastructures and urban local bodies to ensure accessibility to basic services to all its inhabitants.

Many informal settlements have no clean water provision. Increasing private water extraction within the inner city has led to a decrease in quality and quantity of groundwater. Existing water systems which are heavily dependent on water sourced elsewhere have leakage and quality issues as well.

With infrastructure on the verge of its limits, inhabitants have no other choice but to manage their demands on their own. As a result, increasing environmental degradation through private exploitation and unsustainable behaviors are leading the city towards a downward spiral in the age of climate change.

Coupled with a need to generate economic activity to sustain a growing population, industrial activity and unsustainable sprawl conditions are generated that are disconnected from the realities of the territorial conditions.

Problem Statement

As Bhuj is in an arid environmental condition, engagement with water defines the quality and nature of human systems. Engaging with water in a central position and leveraging it can help deal with other uncertainties. Thus, intersection of water and space becomes the primary focal point where environmental deterioration, unsustainable behaviors and insufficient water infrastructure capacity are the problematic parameters.

The challenge is to redefine the relationships between water infrastructure and the fragile environment, in a sustainable economic paradigm. The redefined relationship between human, nature and infrastructure is to create positive feedback loops for peaceful coexistence.

2.

Research Question and Theoretical Framework

Aims of the Project

With a research and design approach, the project aims to review existing practices for water management and provision, by experimenting with scenarios that focus on ecosystem participation. By understanding that drought is an inherent characteristic of the region, designing with water becomes central in addressing the multitude of challenges Bhuj faces.

We expect to reconfigure the spatial relationship with water and urbanization, where urban occupation will consider the natural hydrological dynamics of the region, and if possible, enhance them to safeguard water provision. Reintegration of water with people through participatory approaches that focus on communal management and sustainability of the system will strengthen the relationship and values Bhuj has with the provision and use of water.

Research Questions

How can ecosystem participation acts as catalyst to ensure water security through sensitive, inclusive and sustainable practices in drought prone areas?

The following sub-questions contextualize the main research question to the context of Bhuj at three different scales:

Territorial Scale

How to transition development to consider regional hydrological flows, preserving and enhancing water and ecological dynamics?

Urban Scale

How to revitalize traditional forms of water collection and management, in order to shift to a more localized water provision ecosystem that integrates existing patterns of urbanization and social organization?

Local Scale

How can urban spaces, public/communal buildings and water artefacts potentialize social participation in preserving hydrological activities?

Referential Theories and Practices

The main starting point for analysis derives from the project goals and is ecosystem participation in urban and extreme climates. This can be split into four concepts: (1.) Ecosystem, (2.) Participation, (3.) Urban and (4.) Extreme climates.

Scientific theories are used to define and understand each concept. The graph on the right shows the relation of these different concepts with each other. This graph is explained in the paragraphs below:

Urban

The study focuses on the urban area of Bhuj. Besides formal structures, this urban area also consists of informalities. Informal structures and practices are acknowledged as playing an important role in Bhuj. Sometimes these informal practices are preferred by inhabitants, even if formal practices are present. To illustrate, Burt and Ray (2014) gave several reasons for citizens to prefer informal over the formal water supply, such as liking water convenience over water quality and lack of trust in the utility infrastructures.

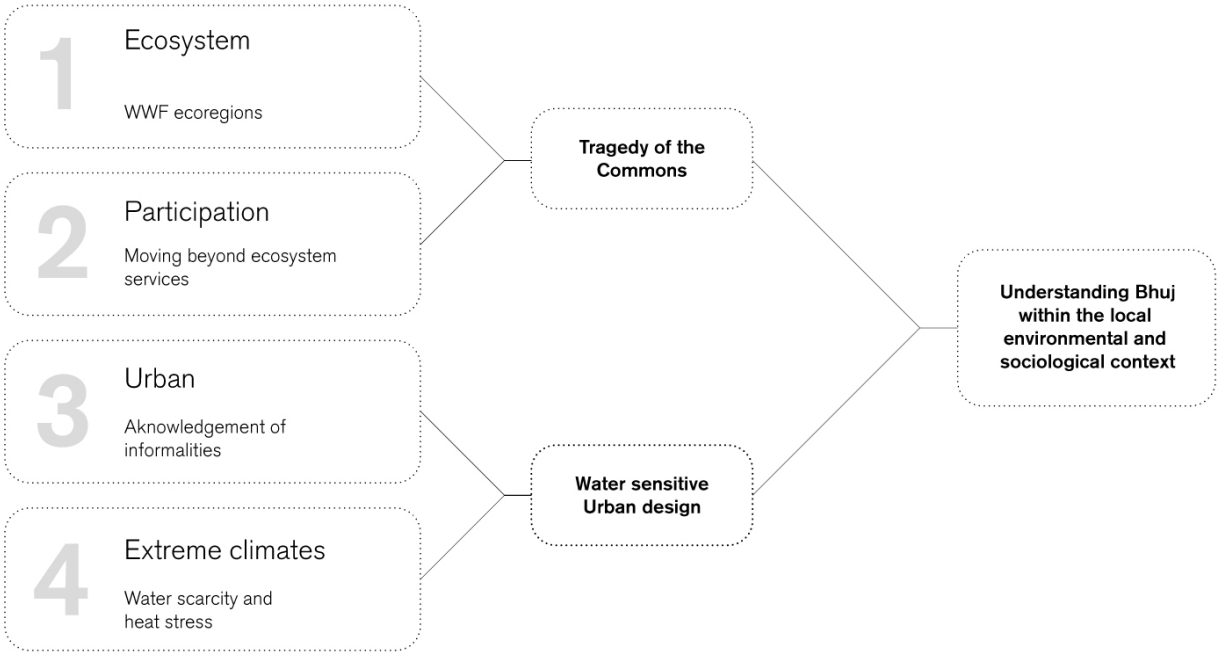
Ecosystem

The ecosystem of Bhuj is understood as the ecozone that is described by the WWF. The ecosystem that is currently present is a degraded version of this original ecosystem, as will be explained in the next chapter.

Participation

Participation in conjunction with ecosystems has evolved from the concept of ecosystem services (Leemans & De Groot, 2003). Participation entails that people are seeing nature not just as some static features and processes that provide services, but as something we have to actively participate in. It moves away from the human-nature dichotomy and acknowledges the fact that people are part of the ecosystem.

The participation concept also touches upon the understanding of and engaging with the local inhabitants and culture. The conflict between traditional knowledge and infrastructures and modern superimposed knowledge and infrastructures is part of this understanding. The concept of the tragedy of the commons is used to understand the processes that have led to environmental degradation (Hardin, 2009).



Extreme climates

The extremities in the climate of Bhuj are found within the extremely high temperatures combined with the little and unpredictable rainfall. As stated before, the area is also prone to earthquakes. Nevertheless, we have decided to focus on water availability in this desert climate, as this is the main challenge. Water sensitive urban design (Wong, 2016) is one of the measures that will be explored in the report. However, this theory should be contextualised to Bhuj, as it was originally developed for the Australian context.

3.

Critical Cartography

3.1. Process of collecting data

One of the challenges of the project was the availability of the data. Technical information on the city scale was provided by two reports by CEPT University (CEPT University, 2016; CEPT University 2017). This data was used to understand the water system and its functioning in the city. Nevertheless, data regarding the social dynamics in the city from the perspective of the local people were hard to collect. We think this is partly due to the fact that Indian cities know a lot of informalities. Informal structures, but also informal practices such as street-side vendors. These informalities are often not well-documented, making them hard to access to from the outside (online) world. Furthermore, not all data was available in the English language. To address this challenge, we made assumptions where needed. These assumptions were verified by three PhD students working on the issue of contextualising water sensitive urban design to the context of India.

GIS was used to systematically analyse data on larger scales. Open Street Map and WWF were found to be useful sources. Unfortunately, individual buildings were not documented on these platforms. Since Google Street View is not available in the city, the smaller scale was analysed using pictures and texts of different online blogs written by locals, such as https://www.bhujbolechhe.org/

3.2. Systems of Systems

The systems of systems perspective towards understanding the realities of Bhuj, focuses on looking at the interplay of complex systems. By bringing together disparate systems which are not traditionaly studied together, we can get new insights towards understanding the nature of human occupation, the infrastructural regimes that sustain the occupation and its environmental impacts.

The territory is first understood through systems of topography, climate and hydrology to establish the natural logic of the region. This is followed by a reading of the territroy through the lens of political boundaries over time and in various scales, which looks at the human logic of dividing the territory for administrative reasons and how that interfaces with the natural logic of the territory. The third reading is through infrastructures of sustenance and extraction that have been built in the region, which gives insight in terms of the objectives and shortcomings of human occupation in the region.

Withing this triptych, and in the arid desert condition of Bhuj, water plays a critical role. This water system as an infrastructural regime is explored further accompanied by an understanding of flow of people in this region acting as drivers of change.

A future extrapolation in terms of extremes that the region can potentially experience is mapped to understand the critical vulnerabilities that need to be addressed.

(3.2.1.) Natural Systems

Topography, Climate and Hydrological systems.

The territory of Kutch is virtually an island, as it is surrounded by the Gulf of Kutch in south and southeast, the Arabian Sea in the west; and Rann of Kutch in north and northeast. The border with Pakistan lies along the northern edge of the Rann of Kutch, of the Sir Creek.

The terrain is mostly flat with a few hills punctuating it. This terrain means that there is not enough resistance against the moisture laden South West monsoon winds blowing from the Arabian sea to bring rain to the region. The relatively small Charwar and Katrol hills running east-west break the incoming winds to a certain extent, creating river systems on the windward side of the hills.

Kutch is one of the most arid regions in India, receiving an annual rainfall of around 430mm, with a variance of 65%. As the territory of Kutch was buried beneath the sea everal million years ago, the rocks that formed during this time are saline. The water stored in such rocks are thus inherently saline. Any recharge that occurs over these marine formations is rendered unsuitable for human usage. The scanty rainfall coupled with difficult geology means that water is extremely scare in the region.

In the Kutch region, the city of Bhuj has a peculiar hydro-geological condition. Bhuj resides on a large porous sandstone aquifer. This cretaceous sandstone belt is one of the few in Kutch, and has a capacity to hold large volumes of water for year-round use. Thus Bhuj is where it is, owing to a deeper understanding of the geological and hydrological systems of the region by the people of Kutch for over centuries.

The Great Rann of Kutch is a 7500 km2 large salt marsh in the north of Kutch. It is one of the largest salt deserts in the world. It is a seasonal marsh and attracts large numbers of migratory birds during the monsoon season.

These unique natural conditions are fundamental to the way of life in Bhuj, and the larger Kutch territory for over centuries of human occupation.

(3.2.2.) Political Systems

Administrative boundaries and ecological boundaries.

Bhuj was founded by Rao Hamir in 1510 and was made the capital of Kutch by Rao Khengarji I in 1549. The kingdom acknowledged Mughal supremacy in 1590 and British supremacy by 1819. Over its long history, the power centrality has shifted further away from the territory.

The Kingdom of Cutch could be considered a hydraulic state as they built a system of traditional water management structures from lakes and canals to wells and stepwells. However, the British took over the water management of the region from the Cutch state and this marks a deterioration of the traditional systems.

This is further exasperated post independence and the 2001 earthquake of Bhuj, as India took a western technocratic approach to water management, that was not very contextual.

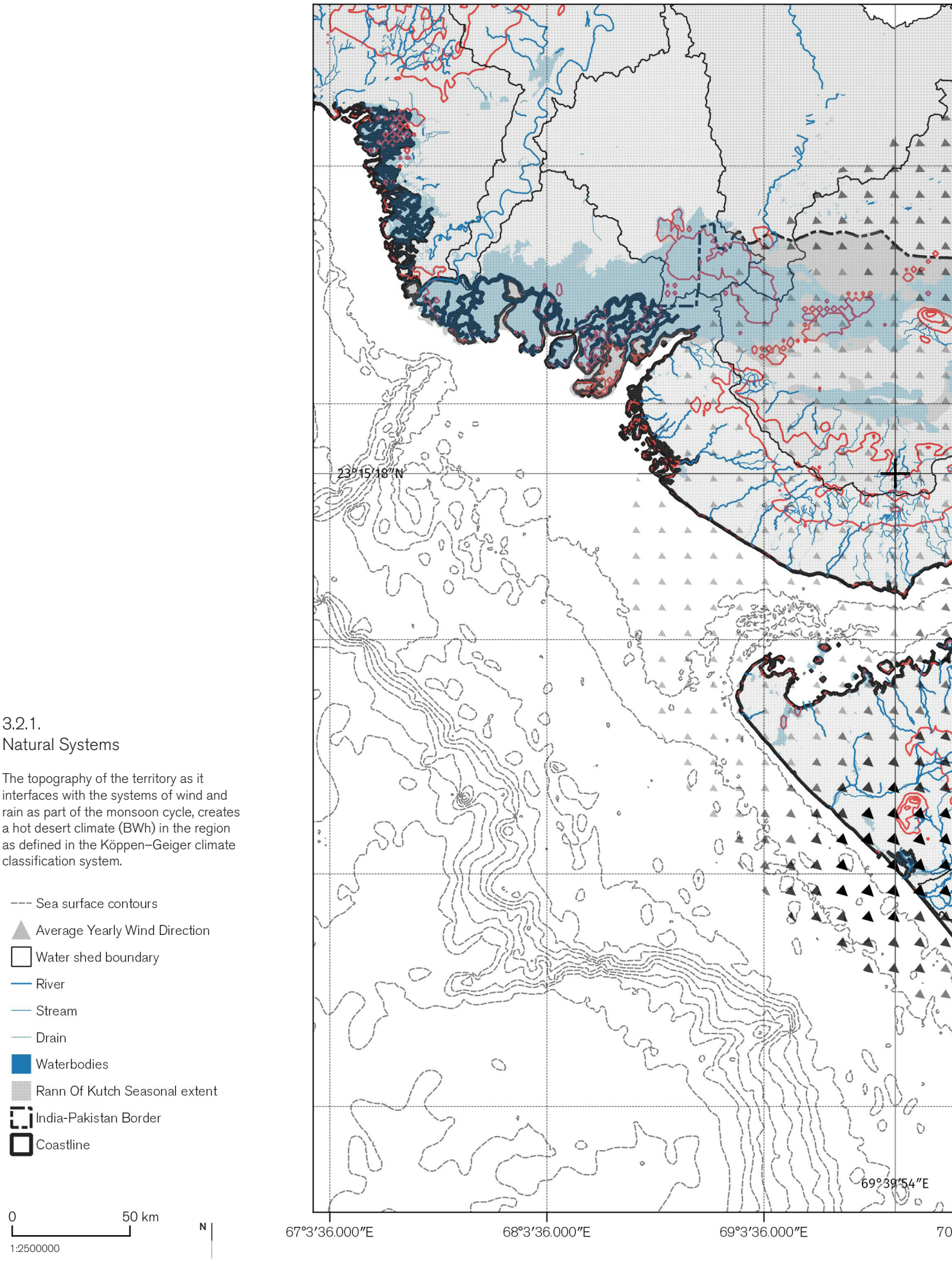
When Bhuj was the capital of the Kingdom of Cutch, the rulers were able to take decisions and build systems that were reflective of the natural condition of the territory. After independence, a lot of decisions were taken at the state capital and the national capital, disconnected from the reality of the region.

The region was also culturally similar to the sindh region across the border with Pakistan. That was lost post independence.

While we can still see alignment between political borders and ecological regions at the state level to a certain degree, all alignment is lost when we focus on the city scale.

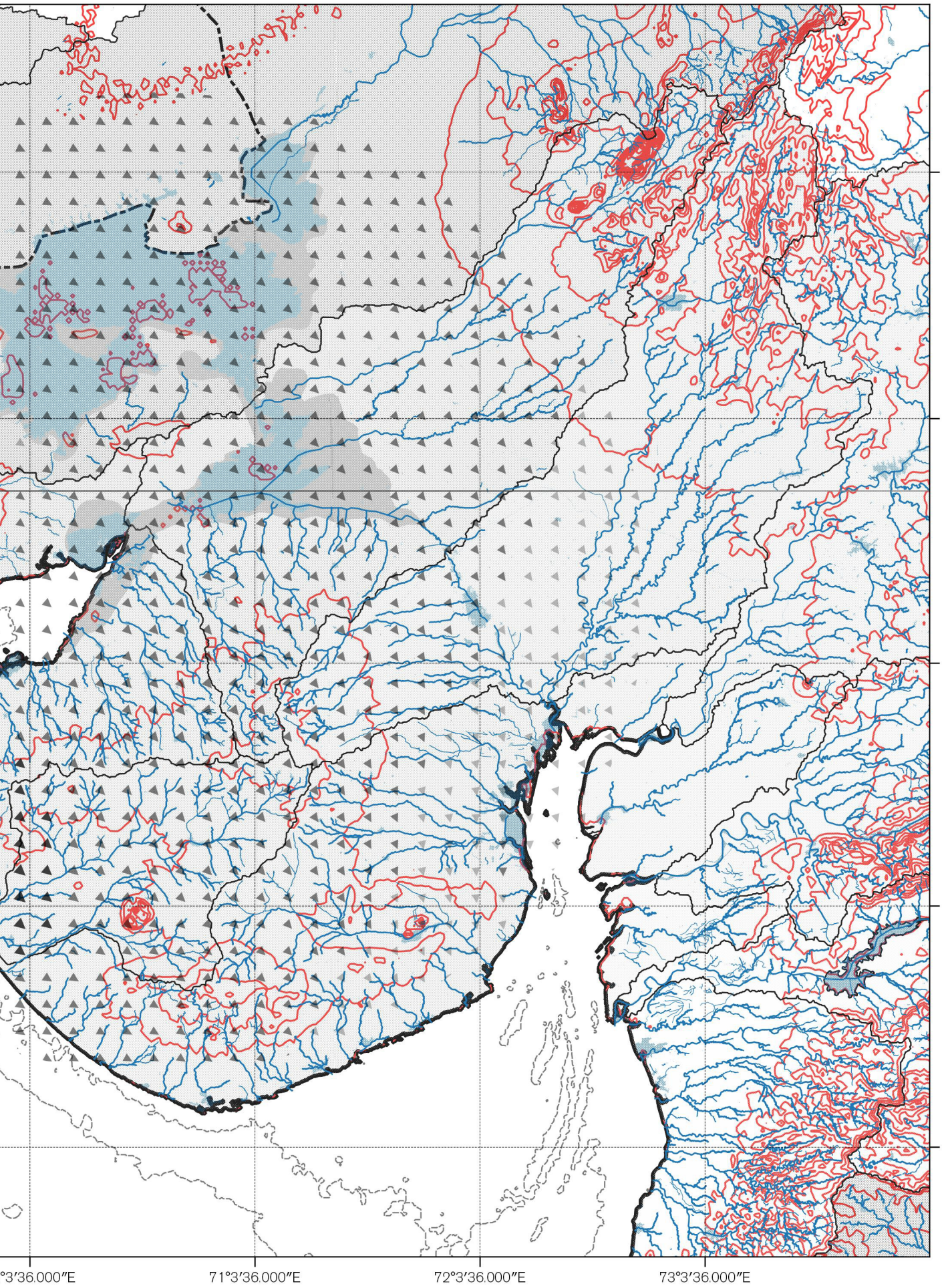
The wards are carved based on population metrics and not based on the environmental conditions and as such, we see water catchment areas split between multiple governing bodies, resulting in ill maintenance.

A cohesion issue in terms of who manages what in the Indian bureaucratic system has left the urban local body in Bhuj with not as much power to maintain the water systems of the city.



3.2.1.
Natural Systems

The topography of the territory as it interfaces with the systems of wind and rain as part of the monsoon cycle, creates a hot desert climate (BWh) in the region as defined in the Köppen–Geiger climate classification system.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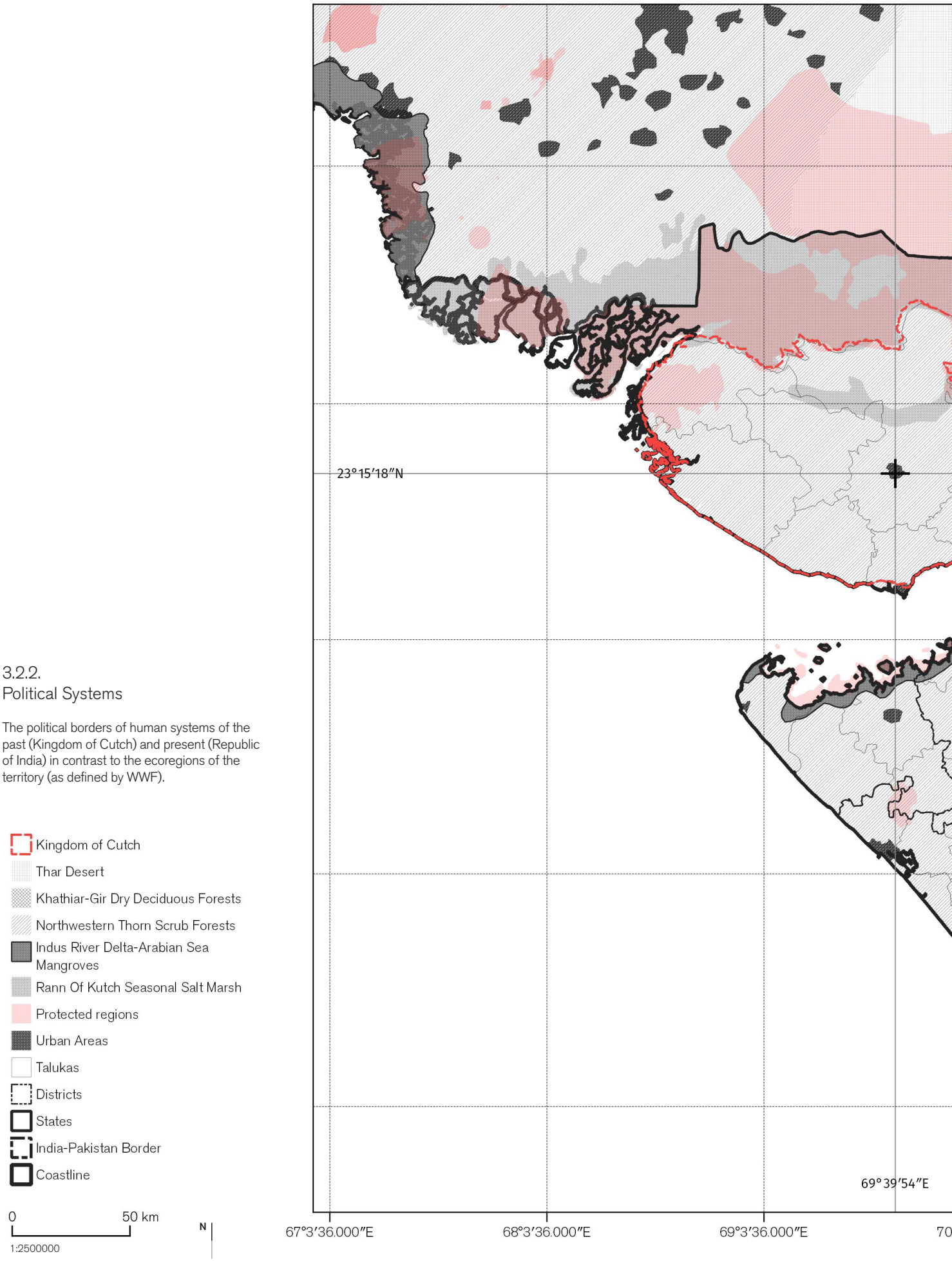
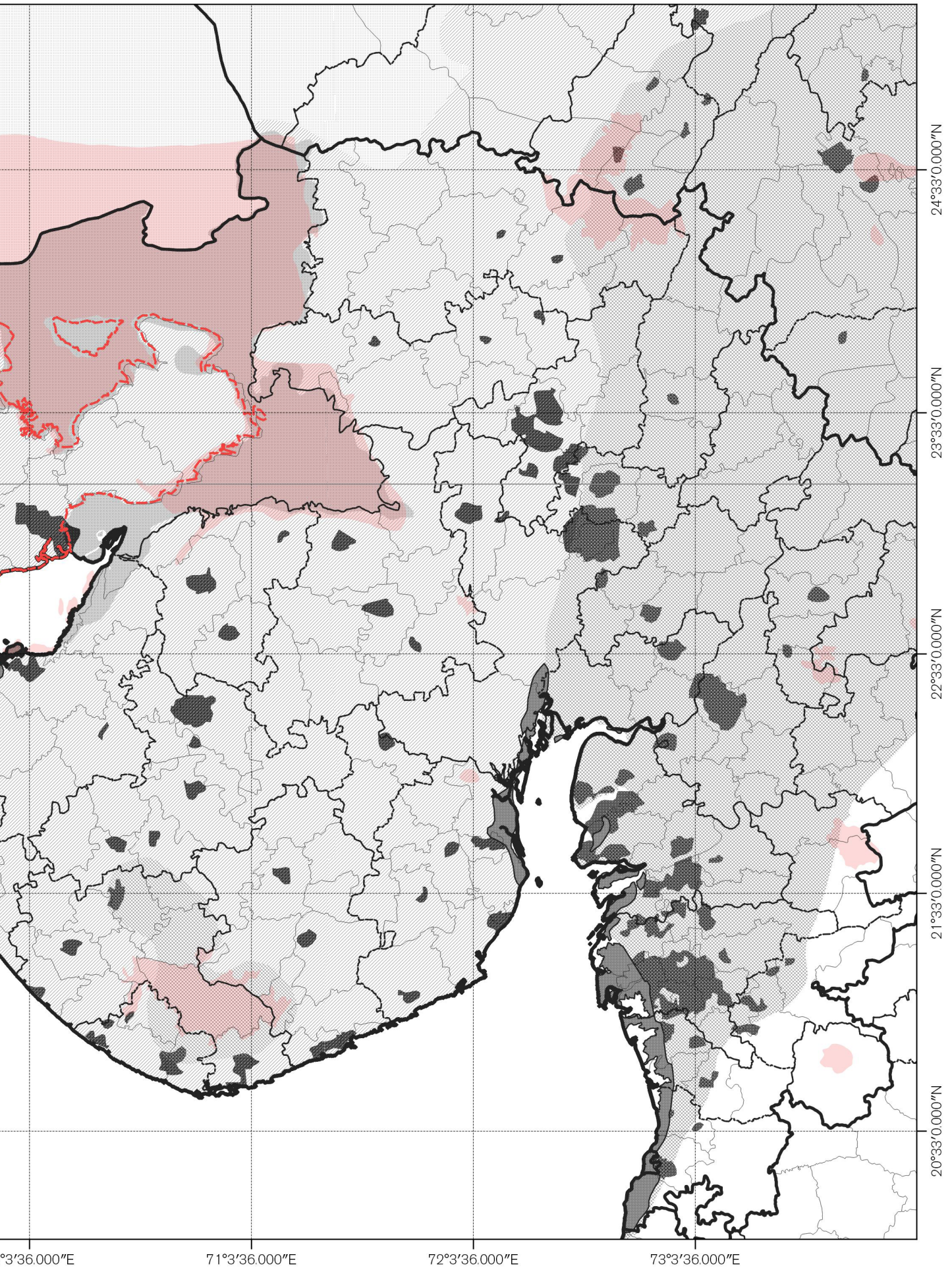


3.2.2.
Political Systems

The political borders of human systems of the past (Kingdom of Cutch) and present (Republic of India) in contrast to the ecoregions of the territory (as defined by WWF).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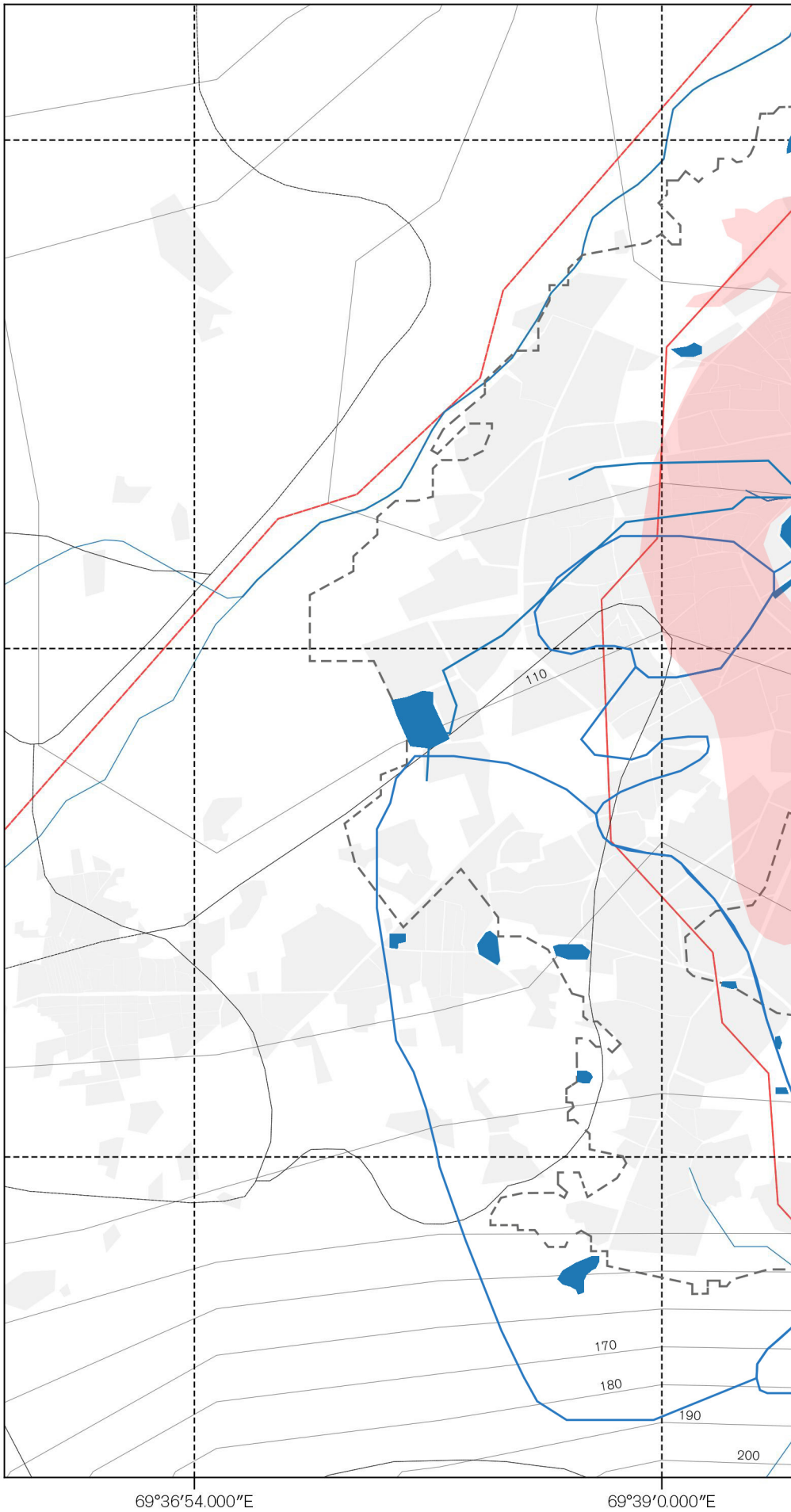
3.2.2.
Political Systems

The political borders of human systems such as the municipal, ward and village boundaries in contrast to natural features such as the topography, soil type and water bodies.



- Water Catchment
- Sandstone
- 5m Contours
- Watershed Boundary
- River
- Stream
- Drain
- Waterbodies
- Bhuj Municipality
- Ward Boundary
- Urban Area
- Village Boundaries

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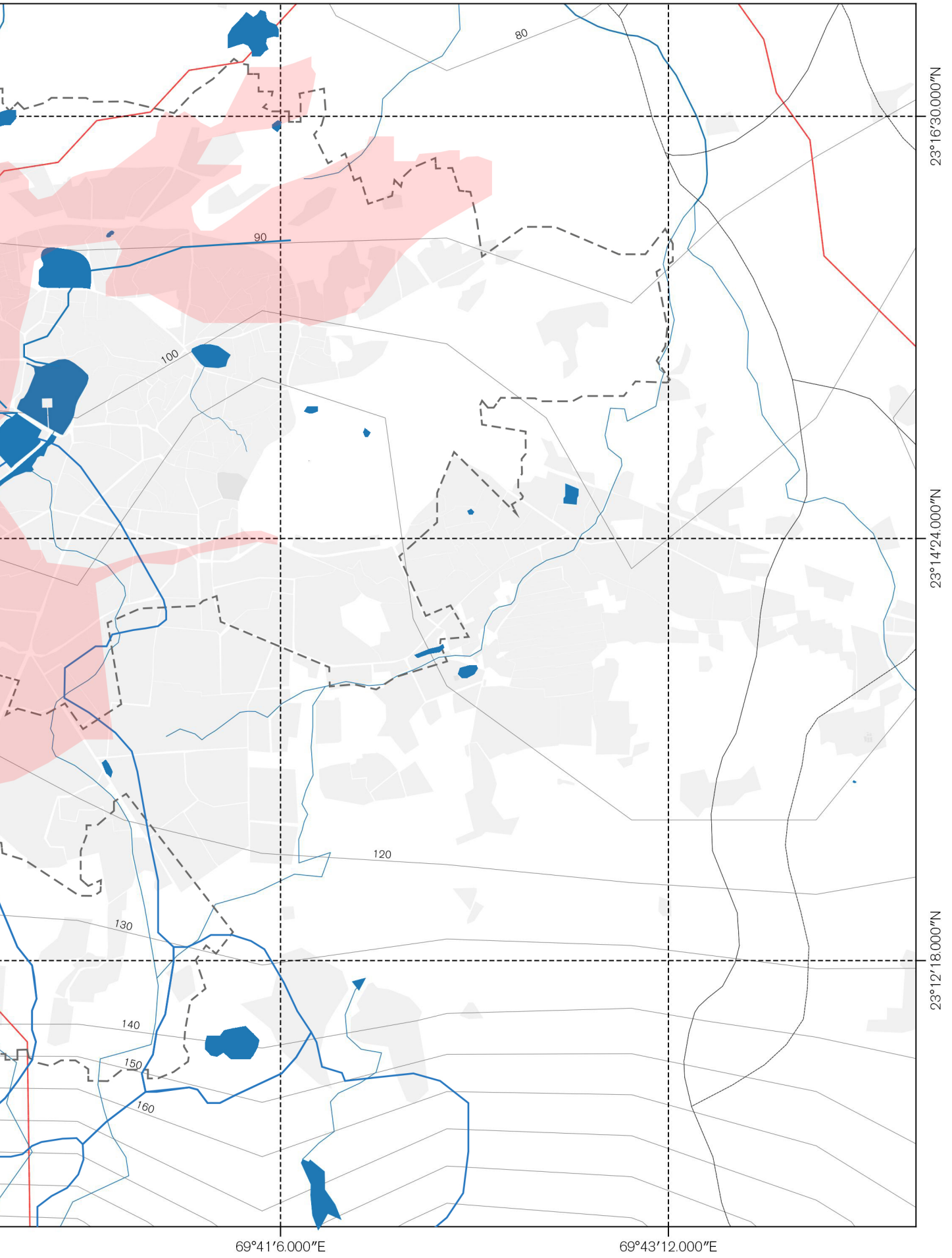
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(3.2.3.) Infrastructural Systems

Networks of infrastrucre and economic systems

70 years ago, the rich flew to Bhuj, the capital of the then princely state of Kutch, from Mumbai in 4 hours. 125 years ago, a traveller had two equally difficult options from Mumbai: a 35-hour long train and boat journey, or a two-day voyage on a slow steamer ship through the rabian Sea. Even further back in time, around 200 years ago, a good 50 years before the British laid the first railway line in India - it took a traveller anywhere between ten to twenty days, depending on the weather, to reach Kutch from Mumbai on a local Kutchi boat.

This was the status quo for hundreds of years. Kutch was difficult for outsiders to access, it remained isolated and content in itself. The territory was practically an island, and the culture evolved in the region was unique onto itself.

As the Indian economy 'opened-up' through its liberalisation policies in 1991 coupled with the massive earthquake in Kutch in 2001 and the successive flood of international funding, accelerated 'development' through large investments of private capital in mining, petroleum and ports.

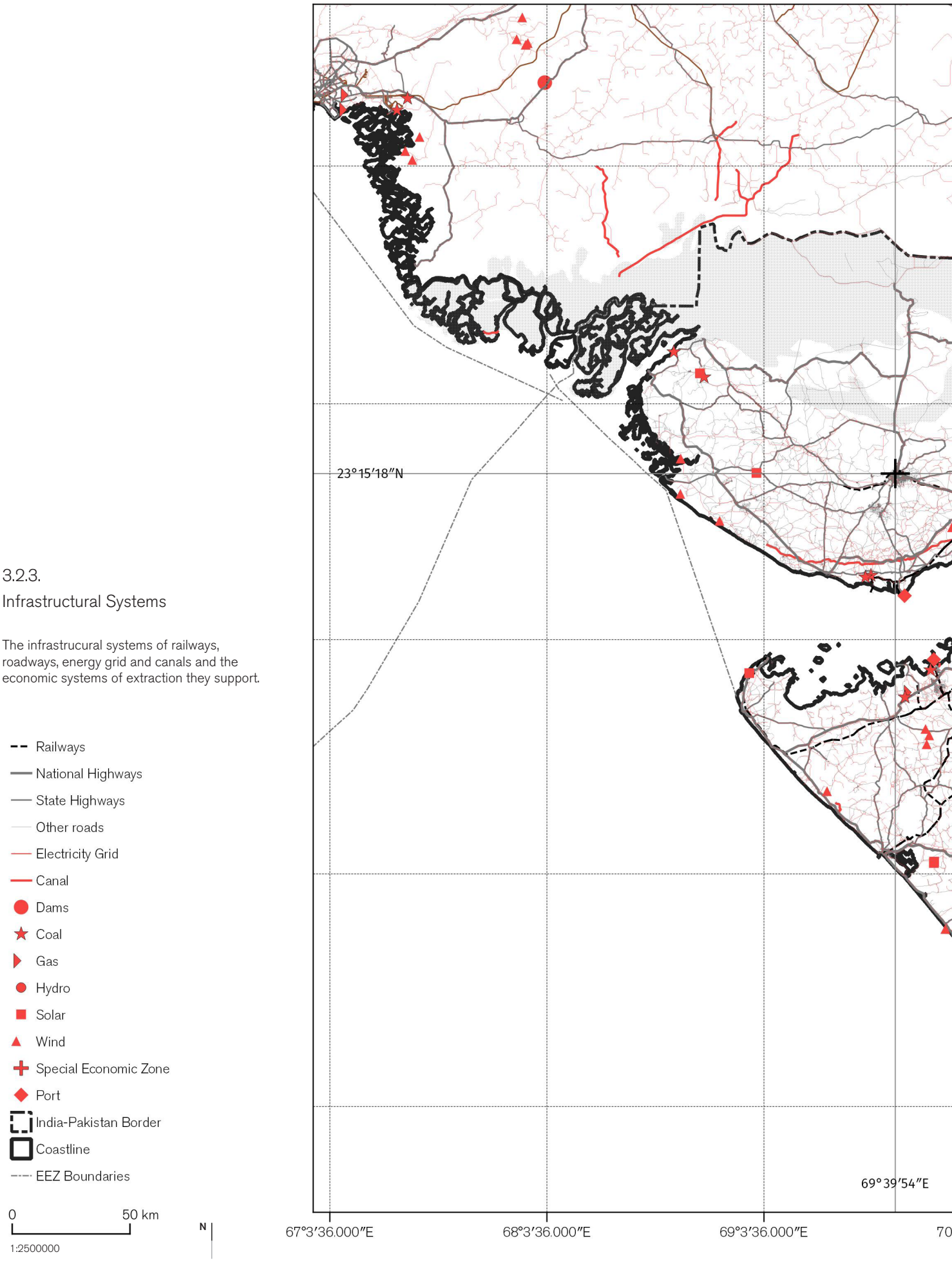
The states role transformed from building infrastructures of sustenance in the arid desert conditions to building infrastructures of extraction to boost economic development in the region. The abundance of coal, bauxite, and a long coastline, coupled with the tax breaks and special economic zones devised by the Gujarat government acted as a major attractor of large corporates such as Adani, Reliance and Welspun.

What is touted as the Gujarat model of development bought forth a huge jump in economic metrics, while the state, and especially the district og Kutch still lags in social metrics compared to other parts of the nation.

The neo-liberal policies bought a huge number of new entreprises to the region, however they didn't fill the coffers of the government and thus the state is unable to fulfill the basic infrastructural necessities demanded by an increasingly urbanising population.

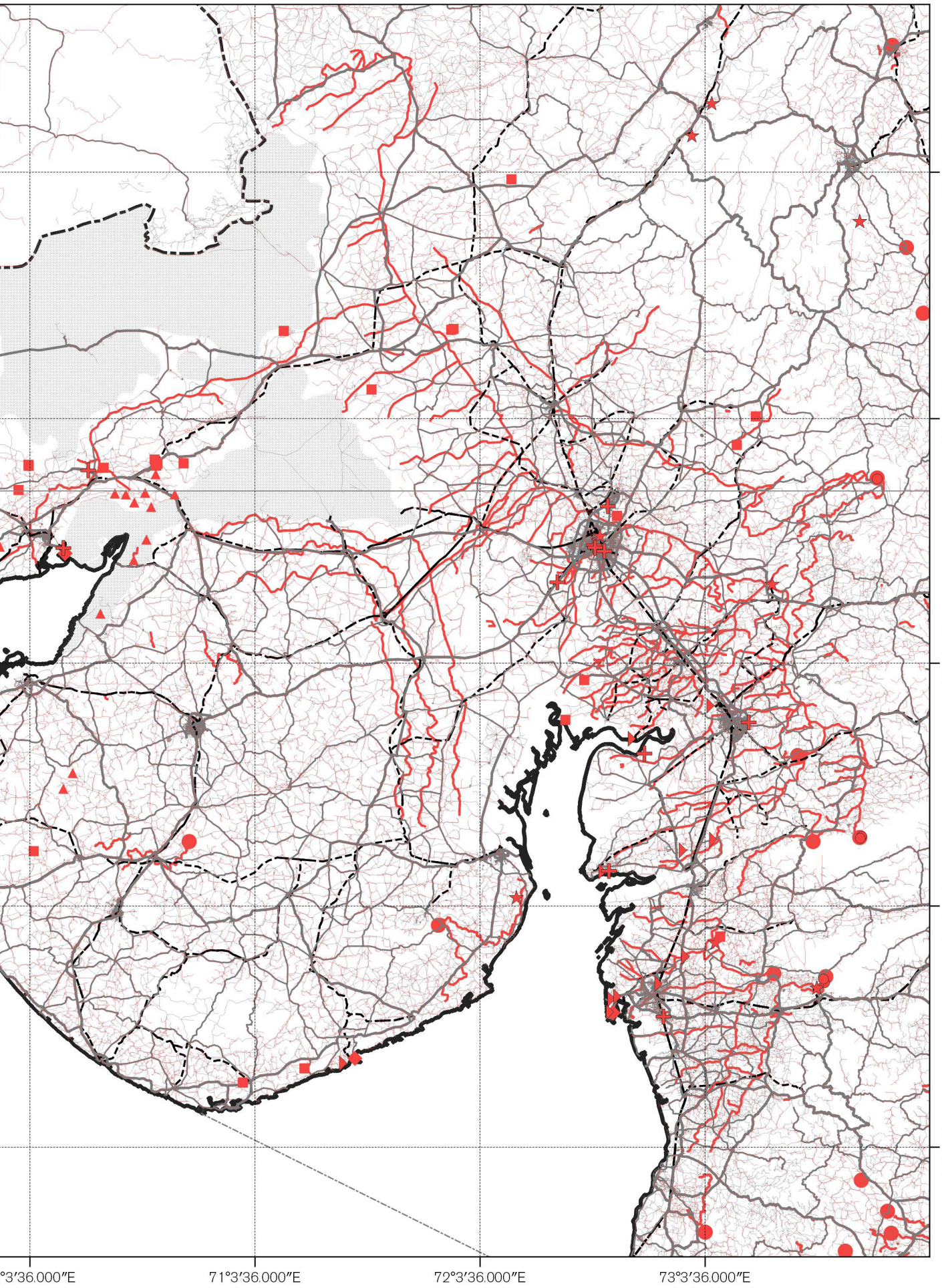
The location of Bhuj, which was necessitated by the unique geomorphological conditions are irrelevant now, as water reaches the city from hundreds of kilometres away through the Narmada canal project from the Sardar Sarovar Dam. The city now thrives due to its position in the network of ports, extraction sites and other industrial areas.

Increasing urbanisation due to rural-urban migration is causing stress on the infrastructure of the city, especially the water infrastructure. The gaps created due to this are again filled by private players, thus increasing inequalities in terms of access to potable water.



3.2.3.
Infrastructural Systems

The infrastrucural systems of railways, roadways, energy grid and canals and the economic systems of extraction they support.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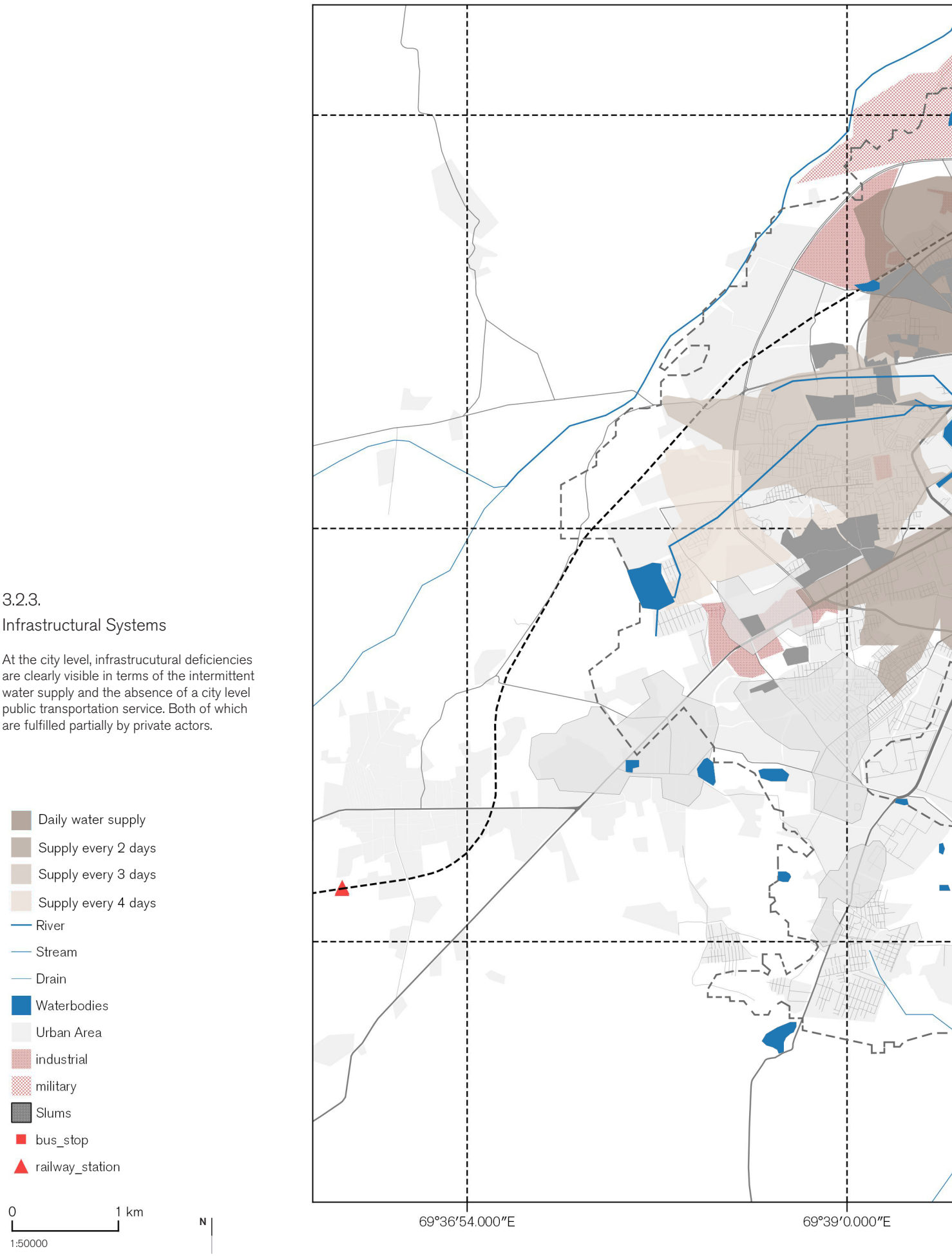
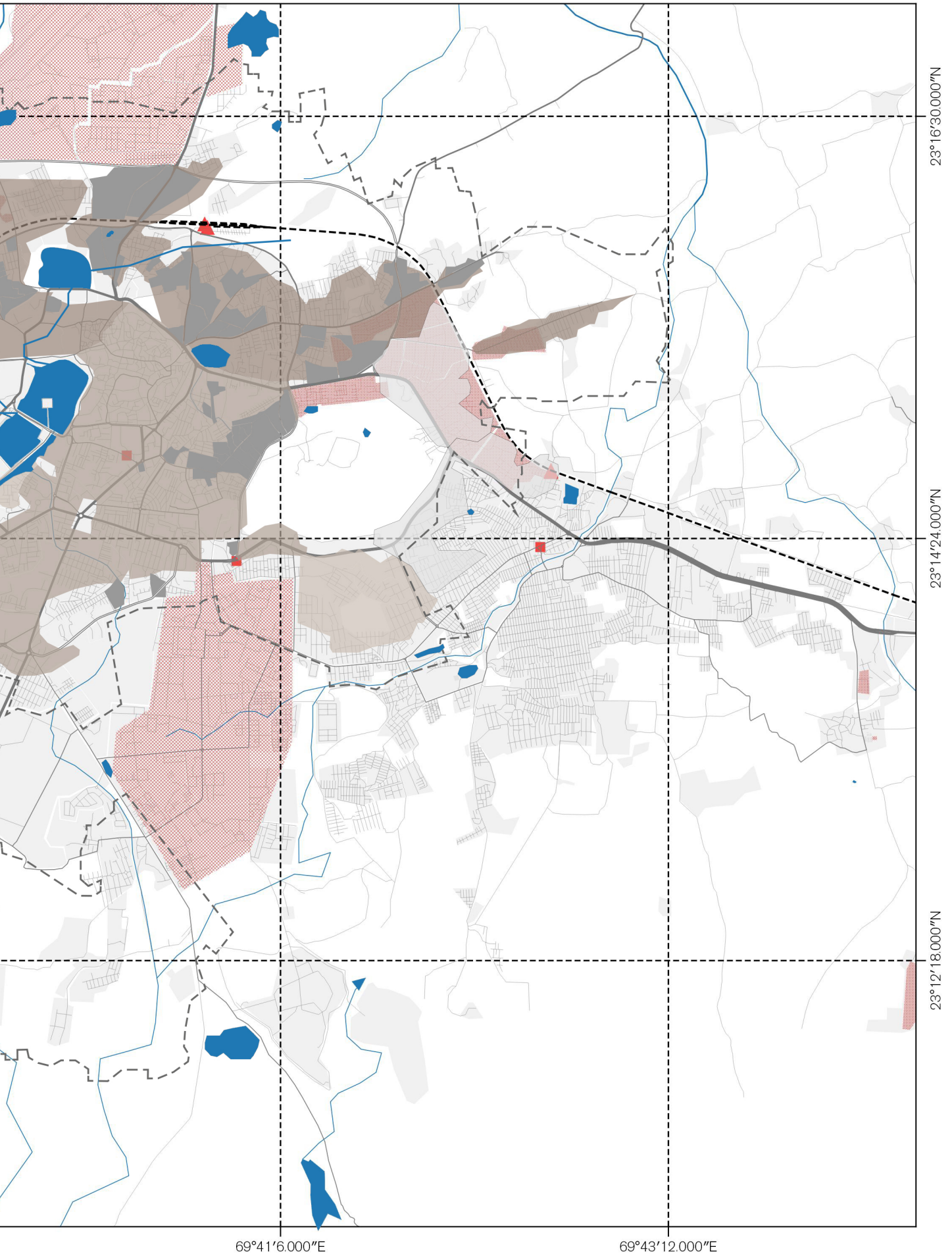
3.2.3.
Infrastructural Systems

At the city level, infrastrucutural deficiencies are clearly visible in terms of the intermittent water supply and the absence of a city level public transportation service. Both of which are fulfilled partially by private actors.

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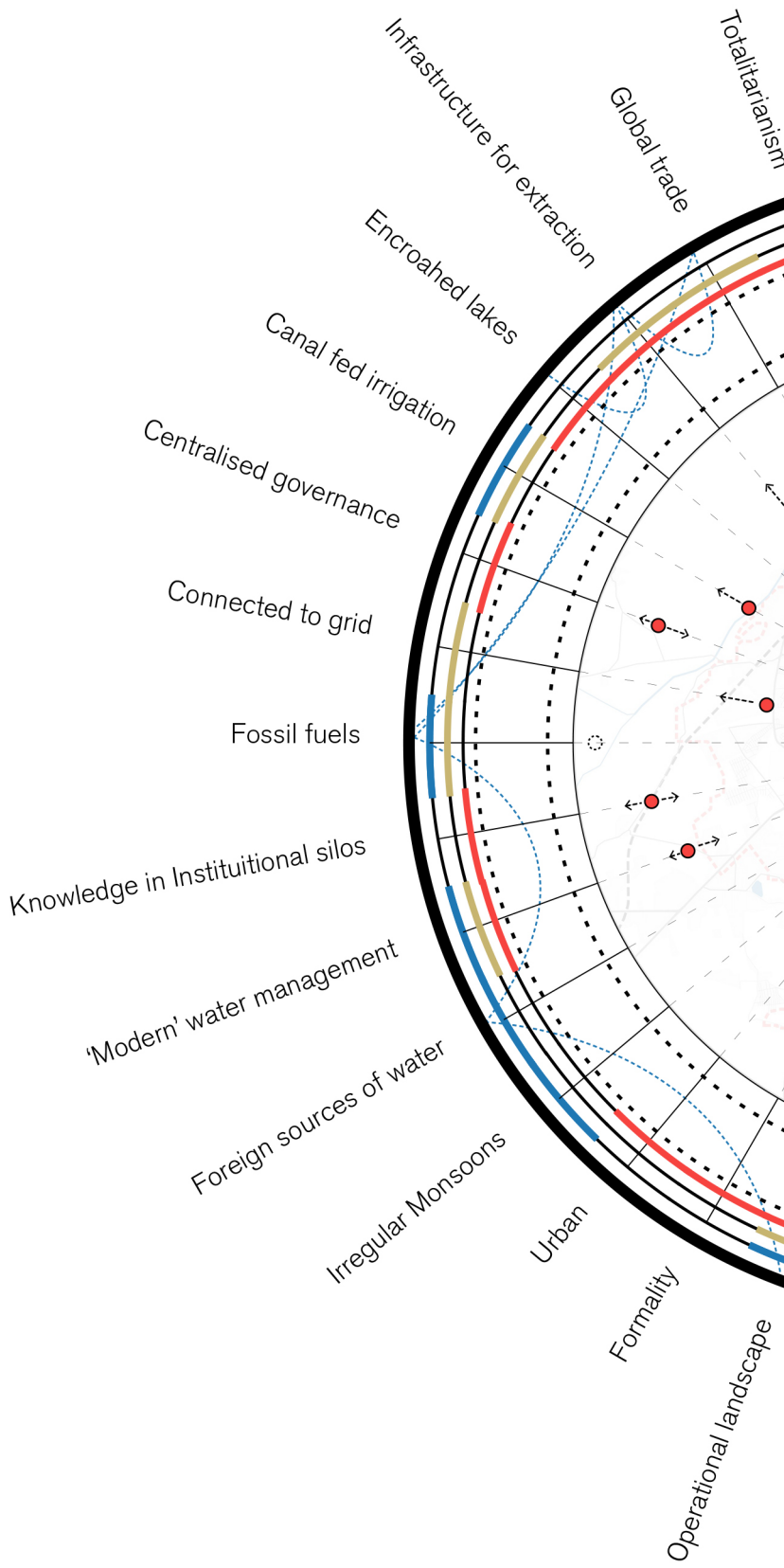
Assemblages and Dissonances

The Interrelationships between various systems as identified in the previous maps are expressed here as a synthesized version. A partial map of existing dichotomies observed are represented. While some dichotomies such as urban-rural show a clear trend in one direction, a few other show tension due to trends along both ends.

The existing economic system that focuses on development at any cost acts as a driver of change towards a certain end of the spectrum. While, community led initiatives to improve water security in the region suggest an alternate way of doing things.

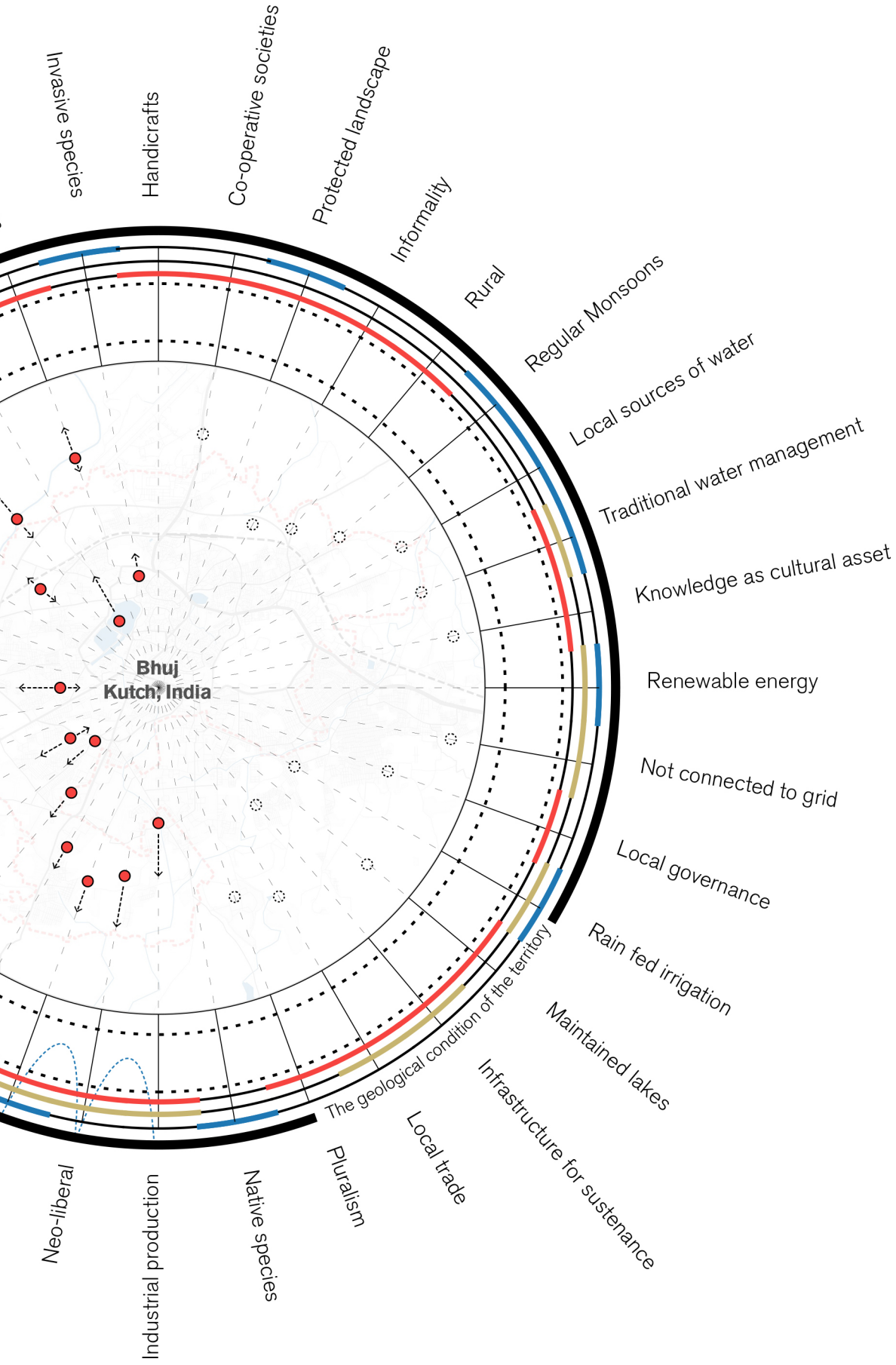
These dichotomies don't exist in vacuum and are a part of contemporary and traditional, environmental, infrastructural and socio-cultural systems. They overlap at certain dichotomies such as water management and attitude towards the landscape. These are potential areas of intervention to promote a more sustainable development for the future.



Current trend in the spectrum

Assemblages of the current economic paradigm

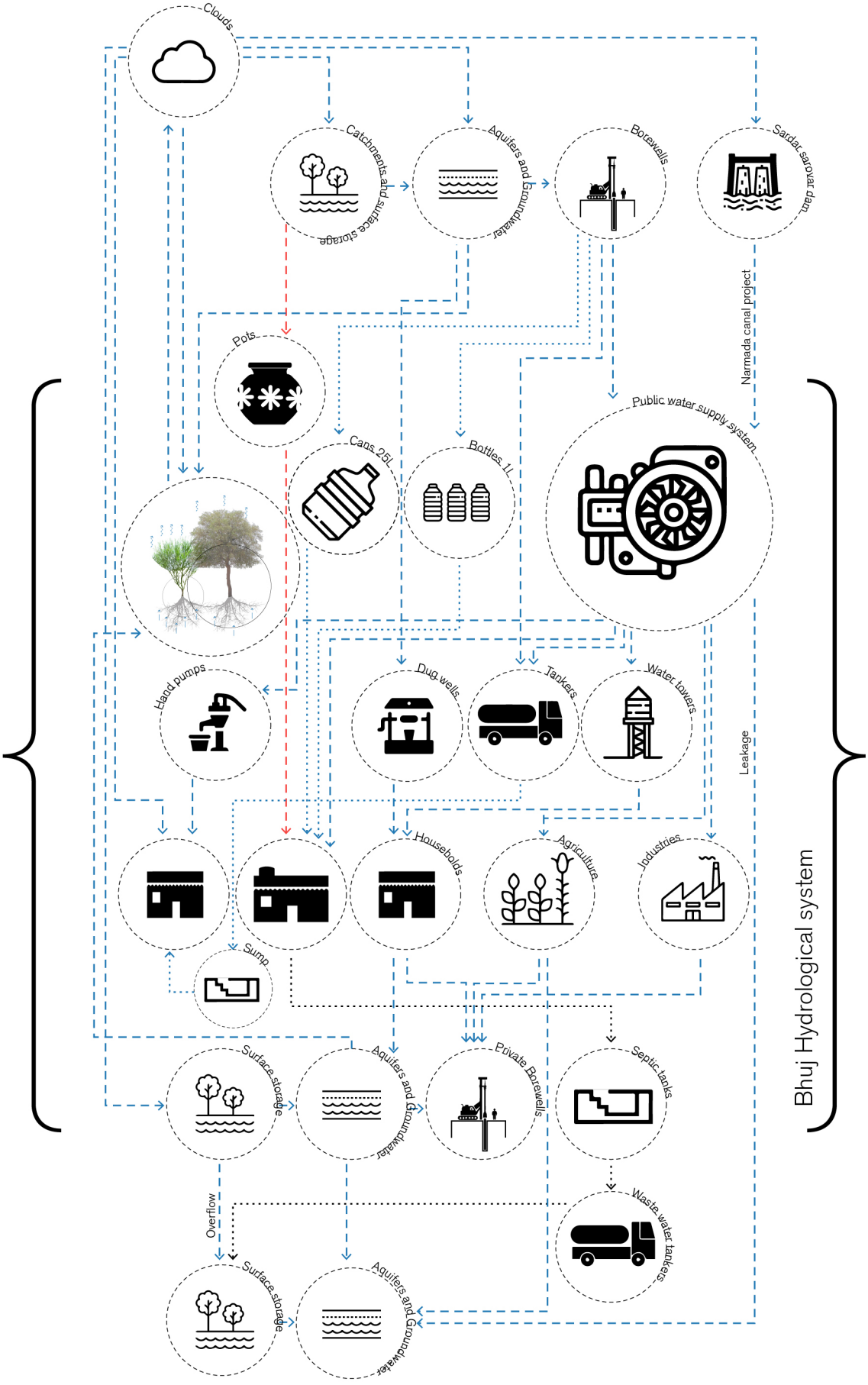
Environmental system
Infrastructural system
Socio-Cultural system


Bhuj
Kutch, India
The geological condition of the territory
Invasive species
Handicrafts
Co-operative societies
Protected landscape
Informality
Rural
Regular Monsoons
Local sources of water
Traditional water management
Knowledge as cultural asset
Renewable energy
Not connected to grid
Local governance
Rain fed irrigation
Maintained lakes
Infrastructure for sustenance
Local trade
Pluralism
Native species
Industrial production
Neo-liberal

Water System: Systems Diagram

The water system in Bhuj is a complicated mess. A generic water balance equation can help us understand the natural flow of water in the hydrological system of Bhuj. However, infrastructural systems of water management operating at various scales and free market interventions to fulfill gaps in the said infrastructure systems creates a bricolage of a water system.

– → Water flow
····› Private supply
····› Waste water
– → Traditional system

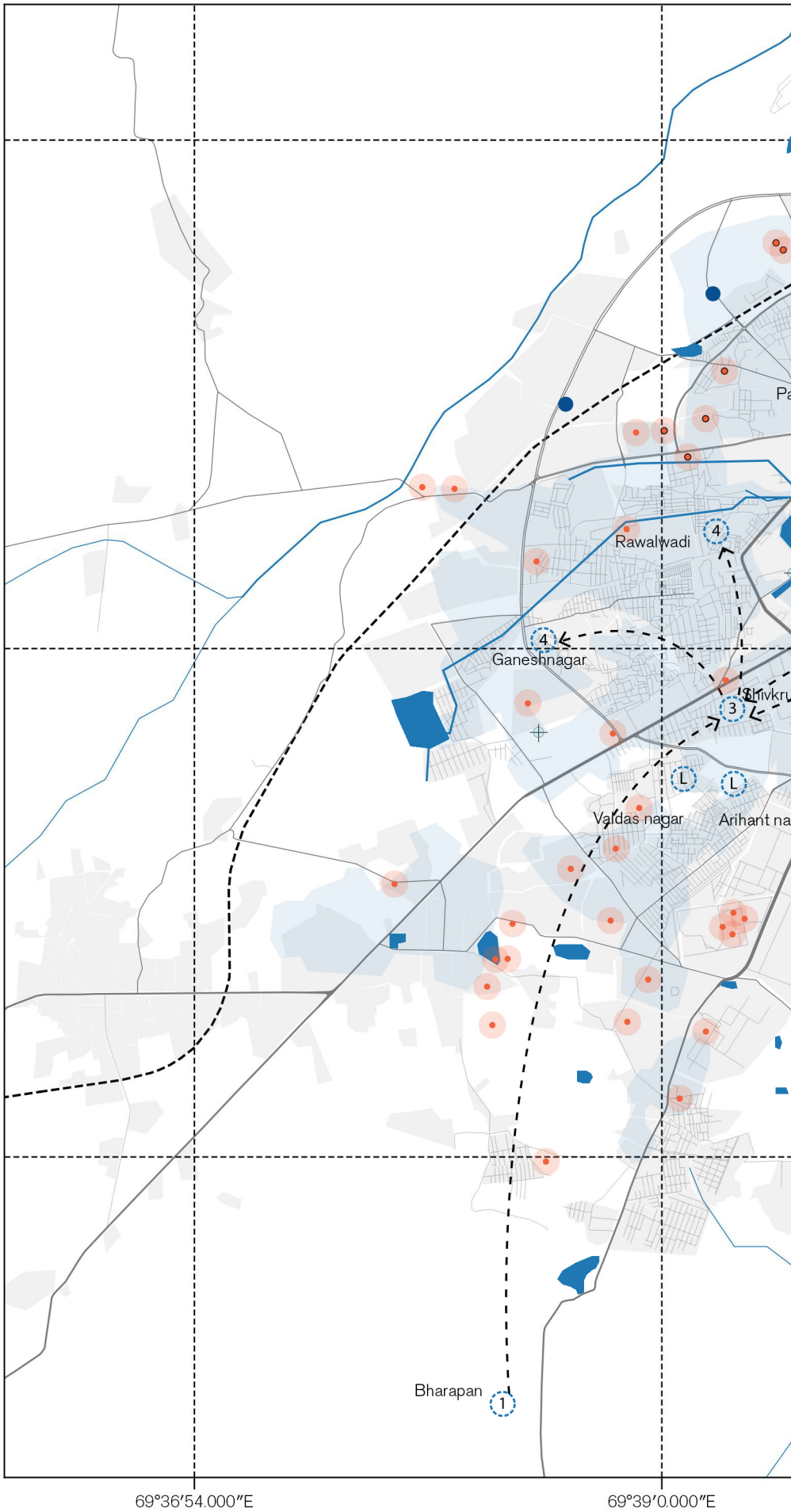

Clouds
Catchments and surface storage
Aquifers and Groundwater
Borewells
Sardar sarovar dam
Narmada canal project
Pots
Cans 25L
Bottles 1L
Public water supply system
Hand pumps
Dug wells
Tankers
Water towers
Leakage
Households
Agriculture
Industries
Sump
Surface storage
Aquifers and Groundwater
Private Borewells
Septic tanks
Overflow
Waste water tankers
Surface storage
Aquifers and Groundwater
Bhuj Hydrological system

Water System: Flows

A scientific analysis of the water flow in the Bhuj Water system is difficult to carry out due to the lack of reliable data and oftentimes contradicting data from various sources.

As it stands now, Bhuj receives a majority of its water through extraction from groundwater and surface water storage. While a good proportion of it still comes from hundreds of kilometers away through the Narmada Canal Project.

The extraction of water from groundwater sources through borewells has threatened the water security of the region due to increasing salination.



- (1) First stage source
- (2) Second stage source
- (3) Third stage source
- (4) Fourth stage source
- (L) Local source
- (N) Narmada source
- Private tanker
- Dug wells
- Bore wells
- River
- Waterbodies
- Roads
- Public Water Supply

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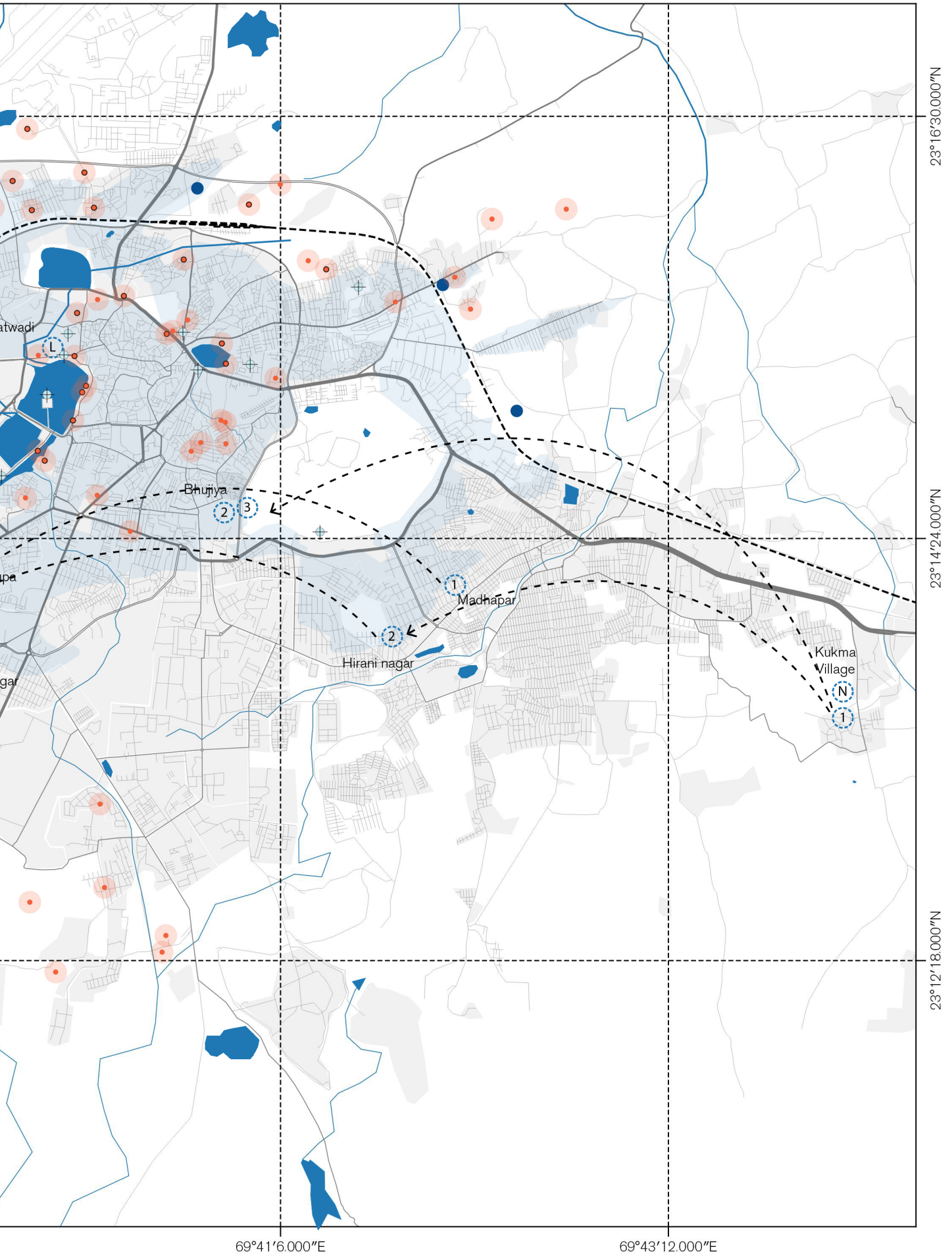
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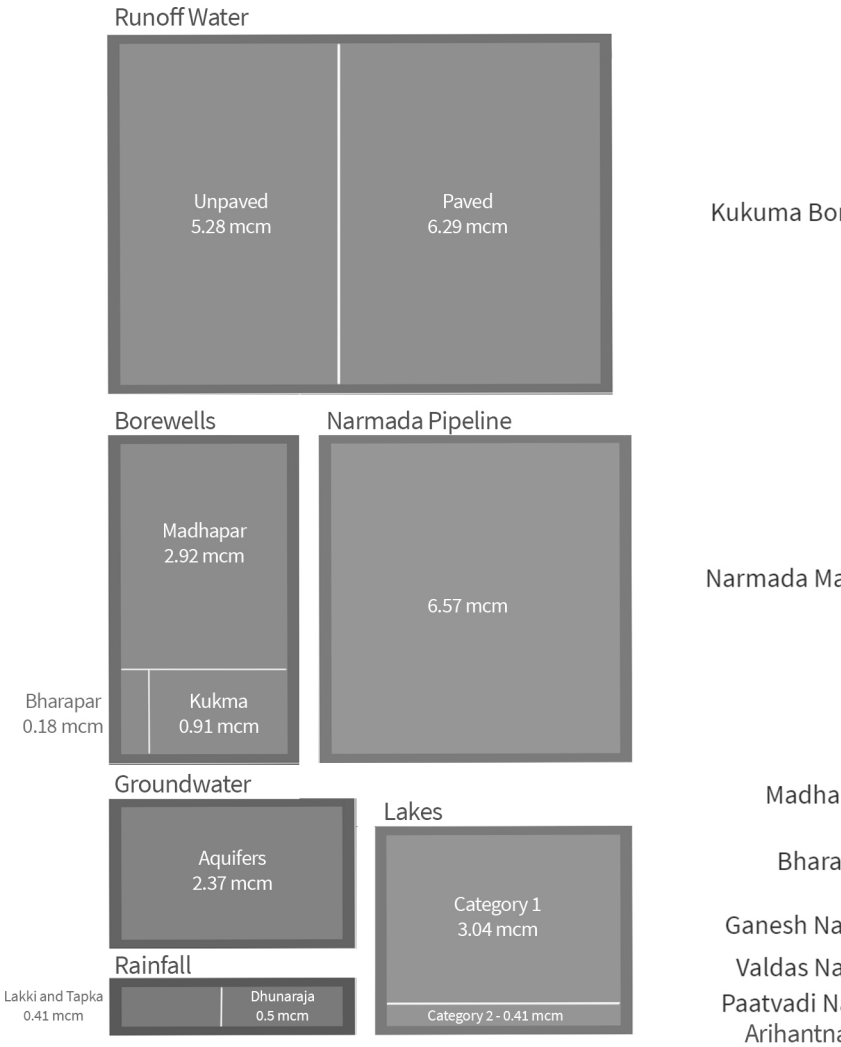


Water inflow (MCM)

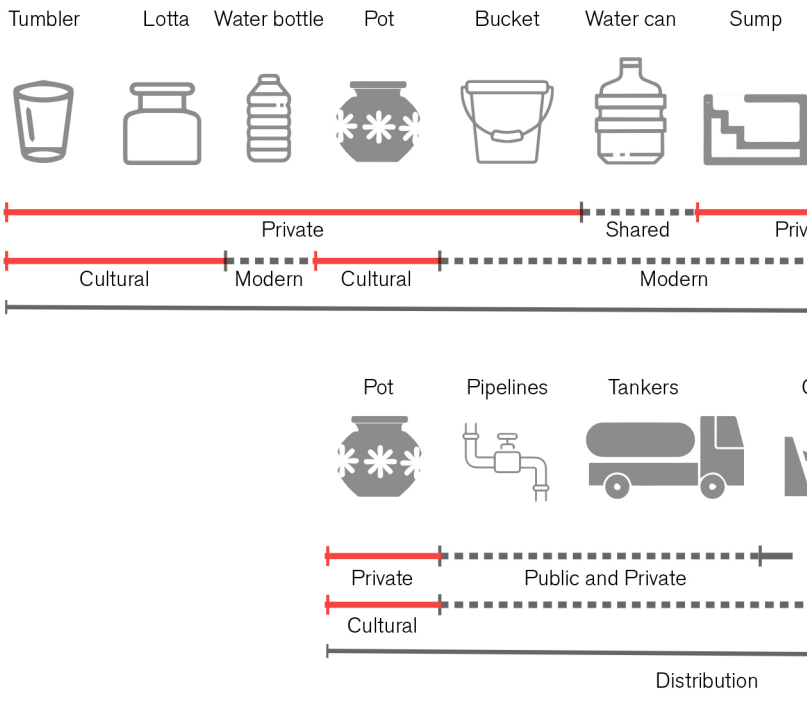
Water System: Stocks

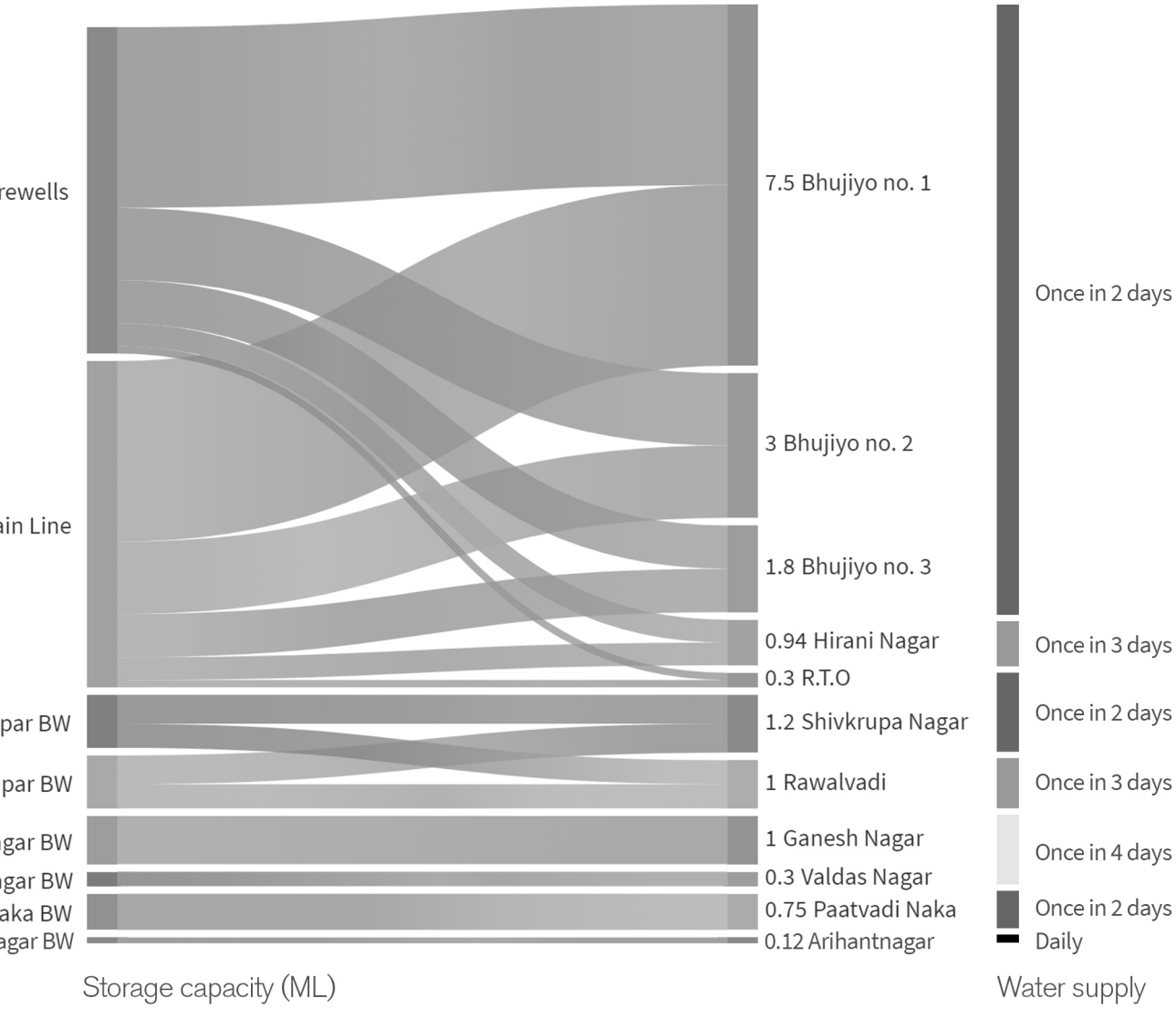
The major watersource for the region is through precipitation. However, it rains only for a few months in the summer during the south west monsoon for an average of 358mm. This has led to the development of large array of man made water bodies as part of a traditional water management system.

Even today, due to the intermittent water supply through the public system, there is a requirement for both public and private water storage systems.

The major water stock however, is ground water and aquifers in the region. An increasing amount of localised extraction is resulting in the lowering of the water table and an eventual increase in salination due to the geology of the marine rocks, that are characteristic of the region.

Effective rain water harvesting and infiltration has been taken up through community initiatives and this represents a ray of hope as the city moves forward.

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3 Bhujiyo no. 2
1.8 Bhujiyo no. 3
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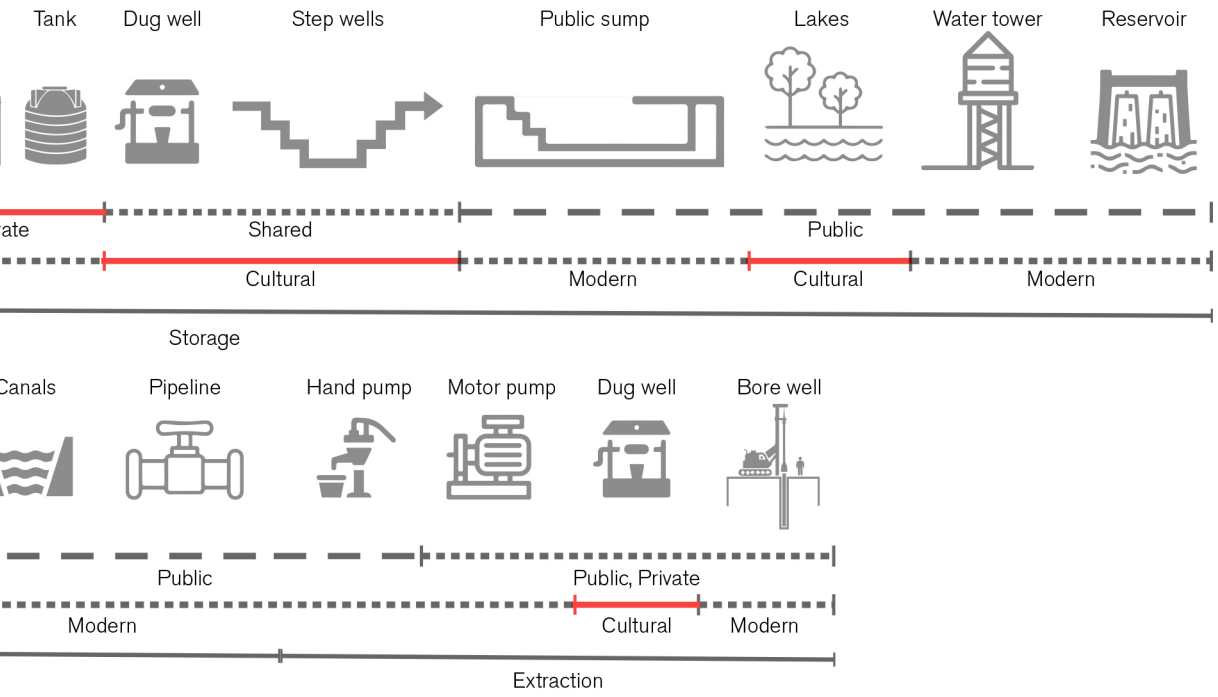
0.3 R.T.O
1.2 Shivkrupa Nagar
1 Rawalvadi
1 Ganesh Nagar
0.3 Valdas Nagar
0.75 Paatvadi Naka
0.12 Arihantnagar
Once in 2 days
Once in 3 days
Once in 2 days
Once in 3 days
Once in 4 days
Once in 2 days
Daily
Storage capacity (ML)
Water supply


Tank
Dug well
Step wells
Public sump
Lakes
Water tower
Reservoir
rate
Shared
Public
Cultural
Modern
Cultural
Modern
Storage
Canals
Pipeline
Hand pump
Motor pump
Dug well
Bore well
Public
Public, Private
Modern
Cultural
Modern
Extraction

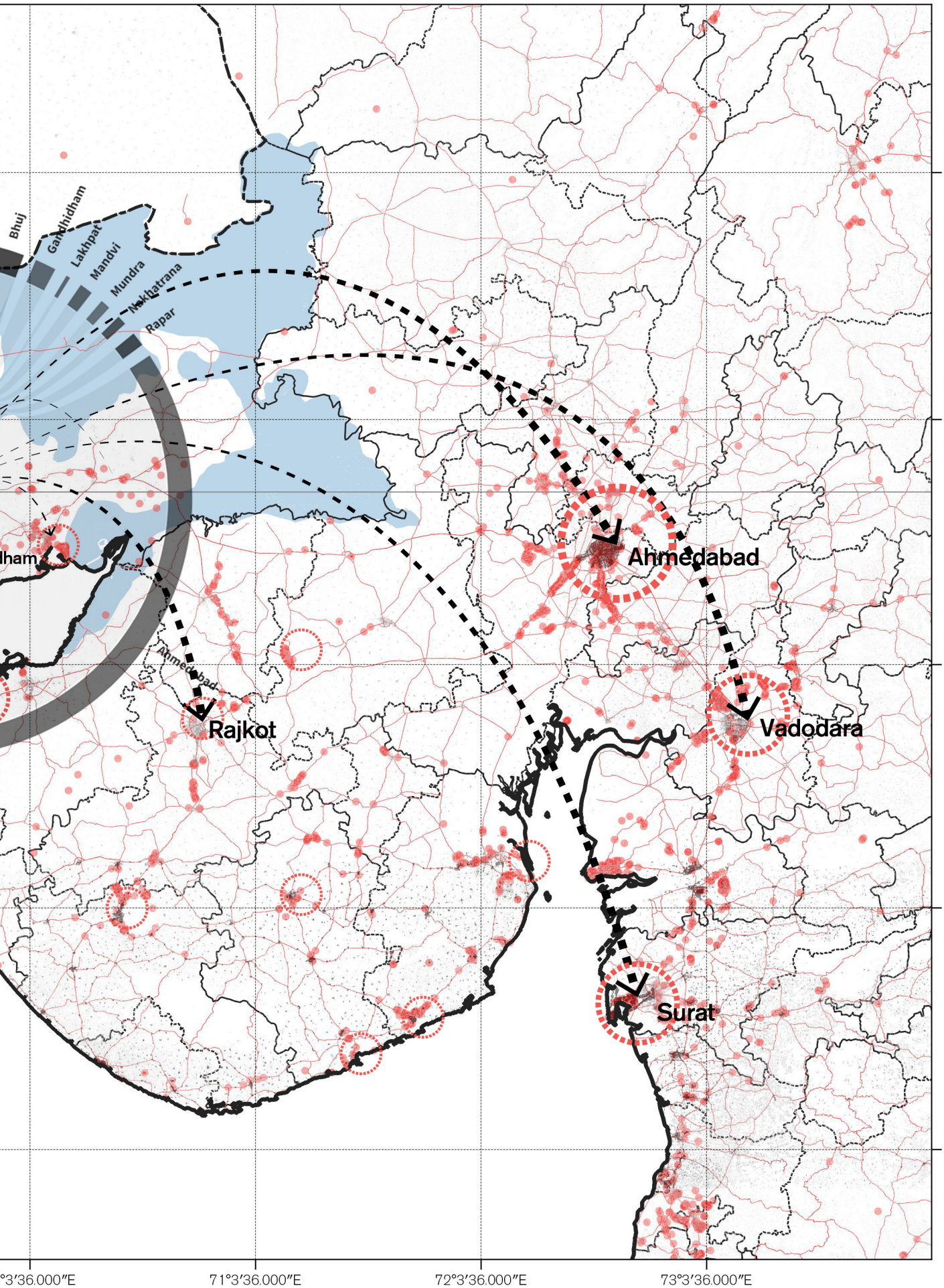


Human System:
People and economic flows;
Migration and employment

Development throughout the state of Gujarat isn't uniform. The disparity in public and private investments in Rural vs Urban areas are very evident.

The low resilience of rural hinterlands to face climate uncertainties creates a seasonal flow of people from villages to urban centres around the state during droughts.

A neo-liberal model of development has left a lot of farmers landless along city edges to pave way for industries that build on network strengths of the cities.


Bhuj
Gandhidham
Lakhpat
Mandvi
Mundra
Nakhatrana
Rapar
Ahmedabad
Rajkot
Vadodara
Surat
24°33'0.000"N
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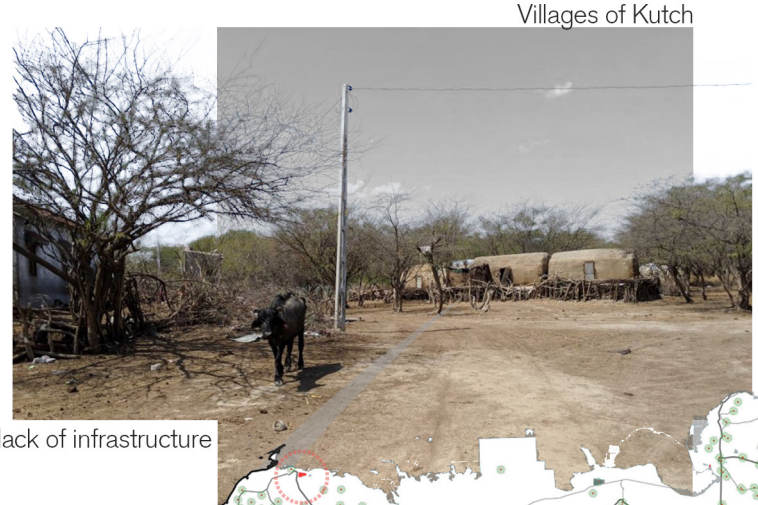
21°33'0.000"N
20°33'0.000"N
71°3'36.000"E
72°3'36.000"E
73°3'36.000"E

Human System:
People and economic flows;
Migration and employment

Rapid urbanisation due to rural to urban migration causes increased stress on the infrastructure of Bhuj. Gaps in housing, water and other utilities are filled by private and informal actors, which are profit driven and causes inequalities in access to basics of sustenance in an arid environmental condition such as that of Bhuj

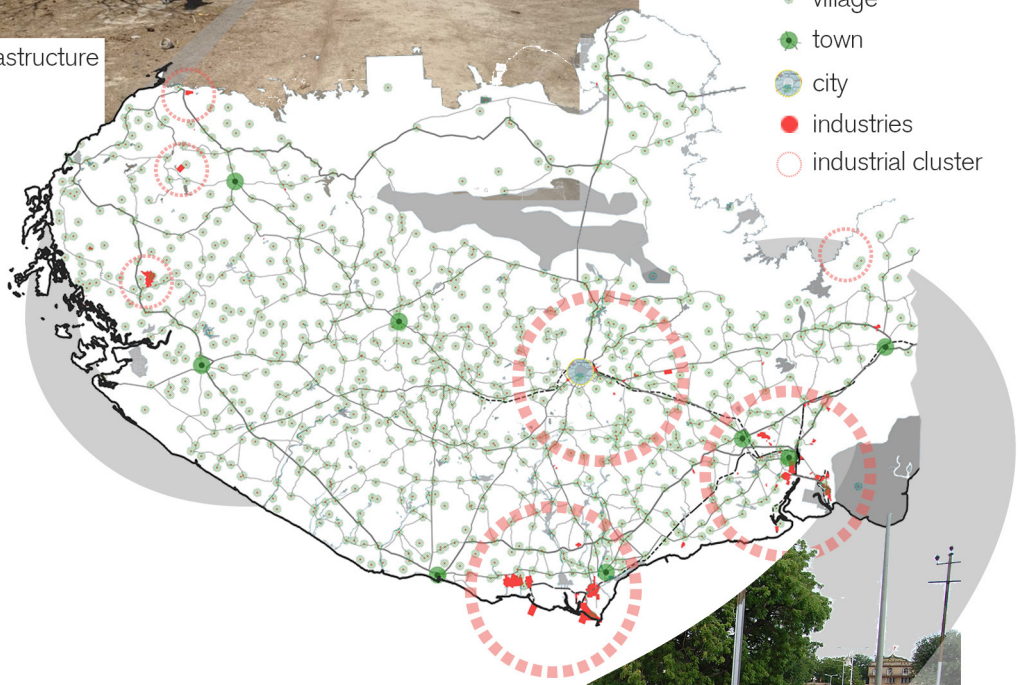
Industrial activity and other economic activity including construction and tourism in the city are neither sustainable nor contextualised and pose an increased resource dependency on hinterlands. While there is an increased focus on increasing economic activity through facilitating private investments, the trickle down logic doesn't play out as expected, resulting in increasingly wide economic inequalities.

Villages of Kutch



lack of infrastructure

village
town
city
industries
industrial cluster





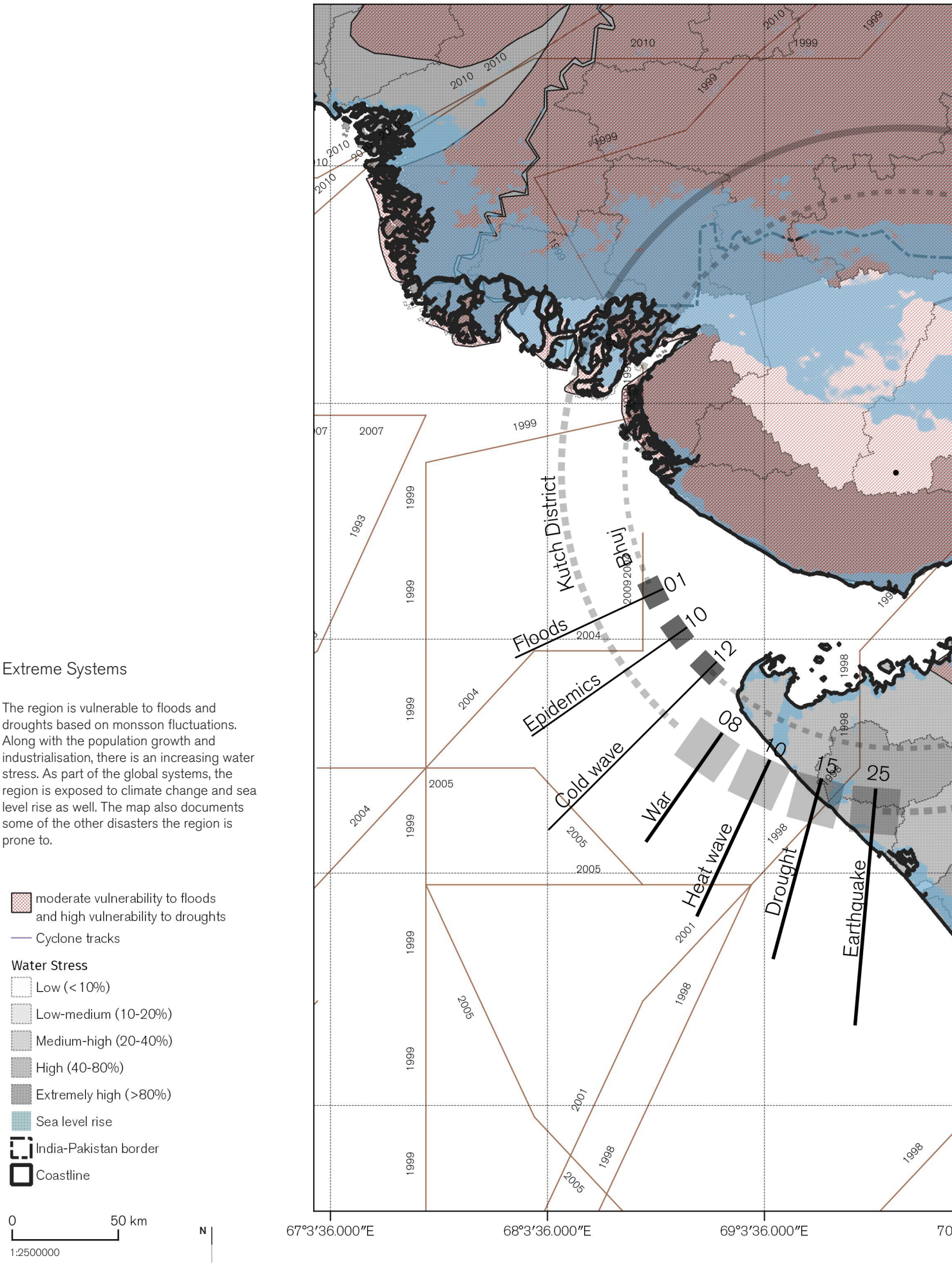
Overburdened Infrastructure
Bhuj

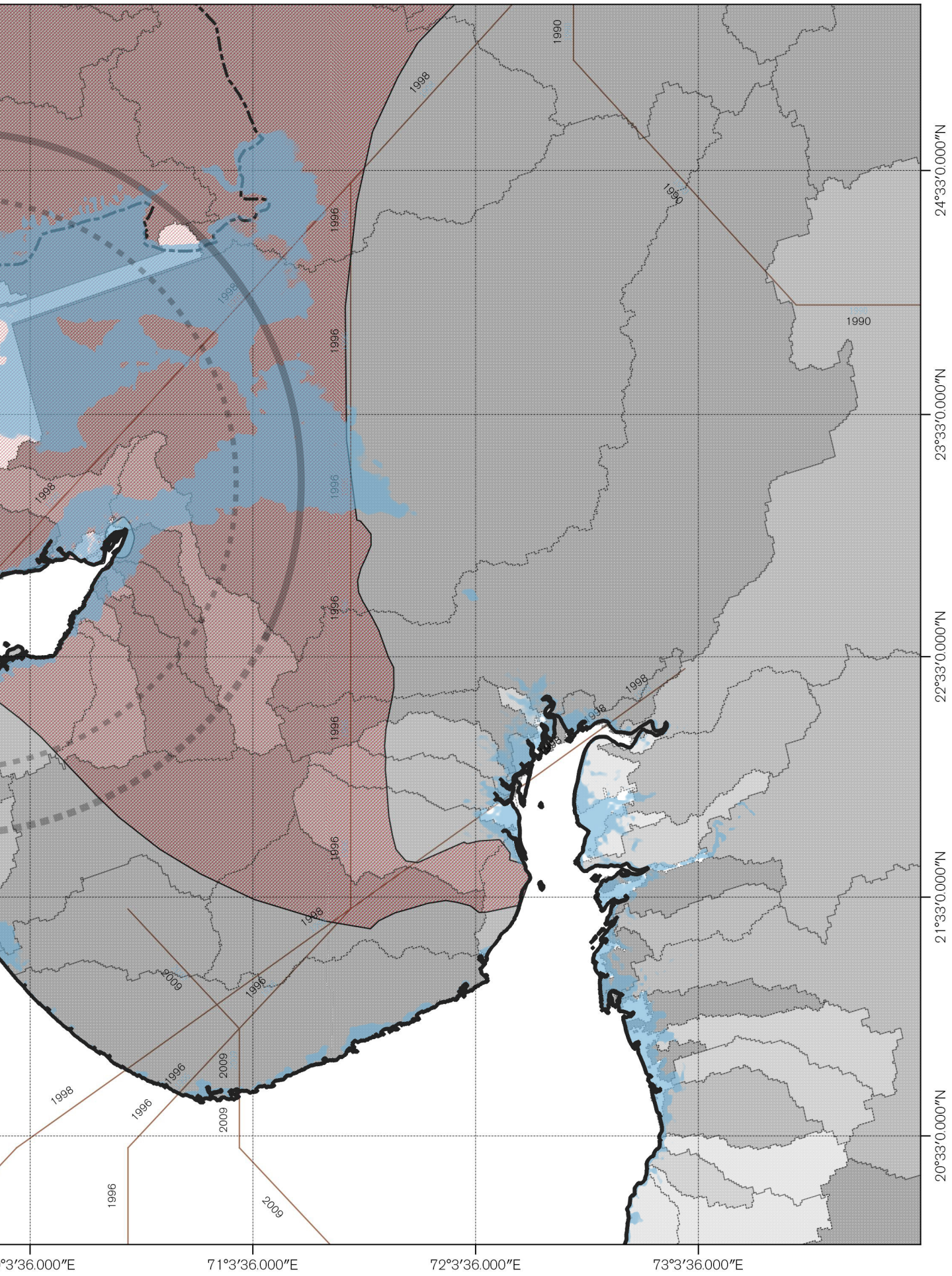


Special economic zones
tax breaks
non-contextual industries

Extreme Systems

The region is vulnerable to floods and droughts based on monsson fluctuations. Along with the population growth and industrialisation, there is an increasing water stress. As part of the global systems, the region is exposed to climate change and sea level rise as well. The map also documents some of the other disasters the region is prone to.




24°33'0.000"N
23°33'0.000"N
22°33'0.000"N
21°33'0.000"N
20°33'0.000"N
71°3'36.000"E
72°3'36.000"E
73°3'36.000"E
1990
1996
1998
2009

Assemblages and Dissonances: The Interrelationships between various systems

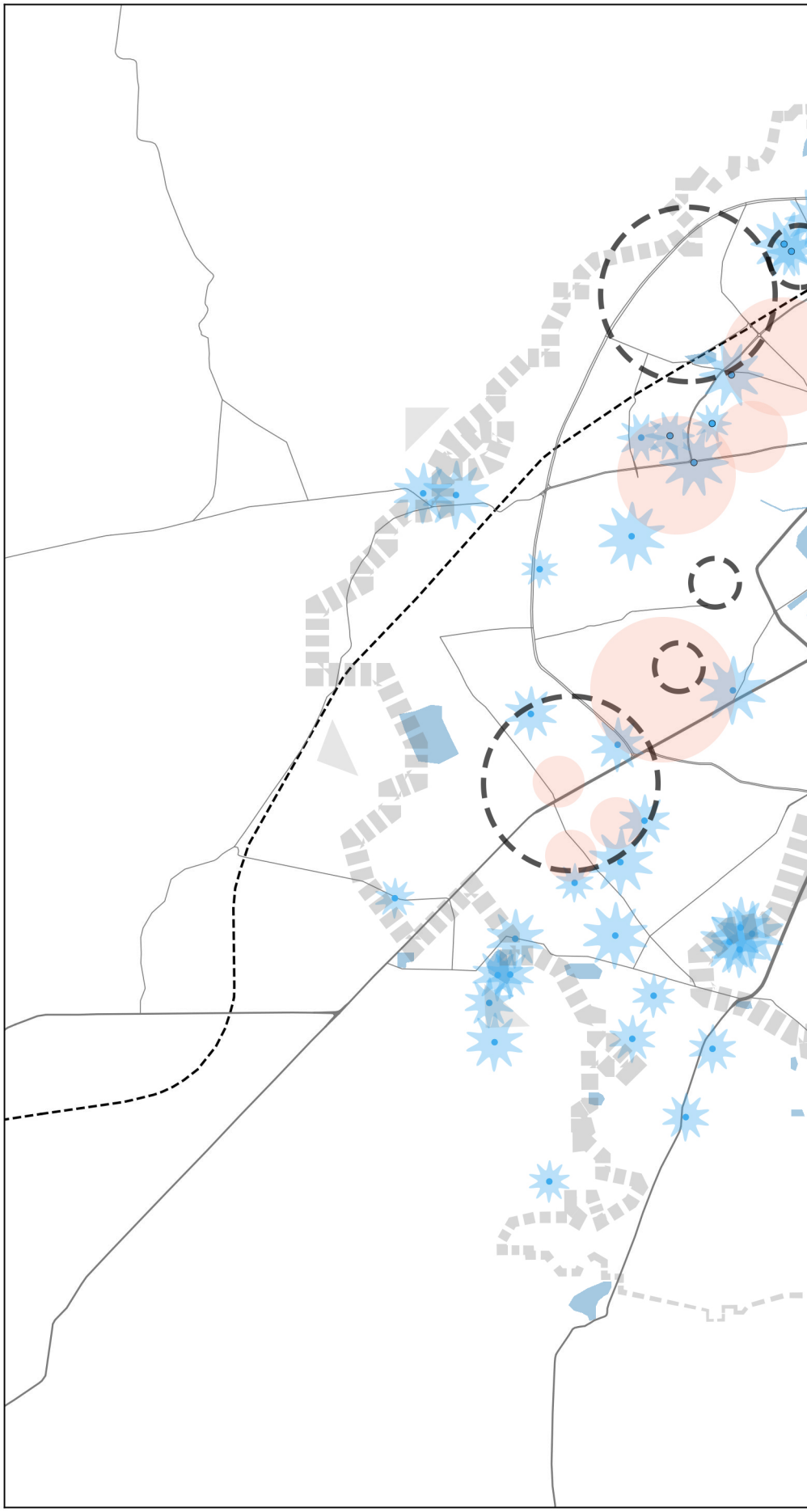
We understand the importance of water for sustenance in an arid environment like that of Bhuj.

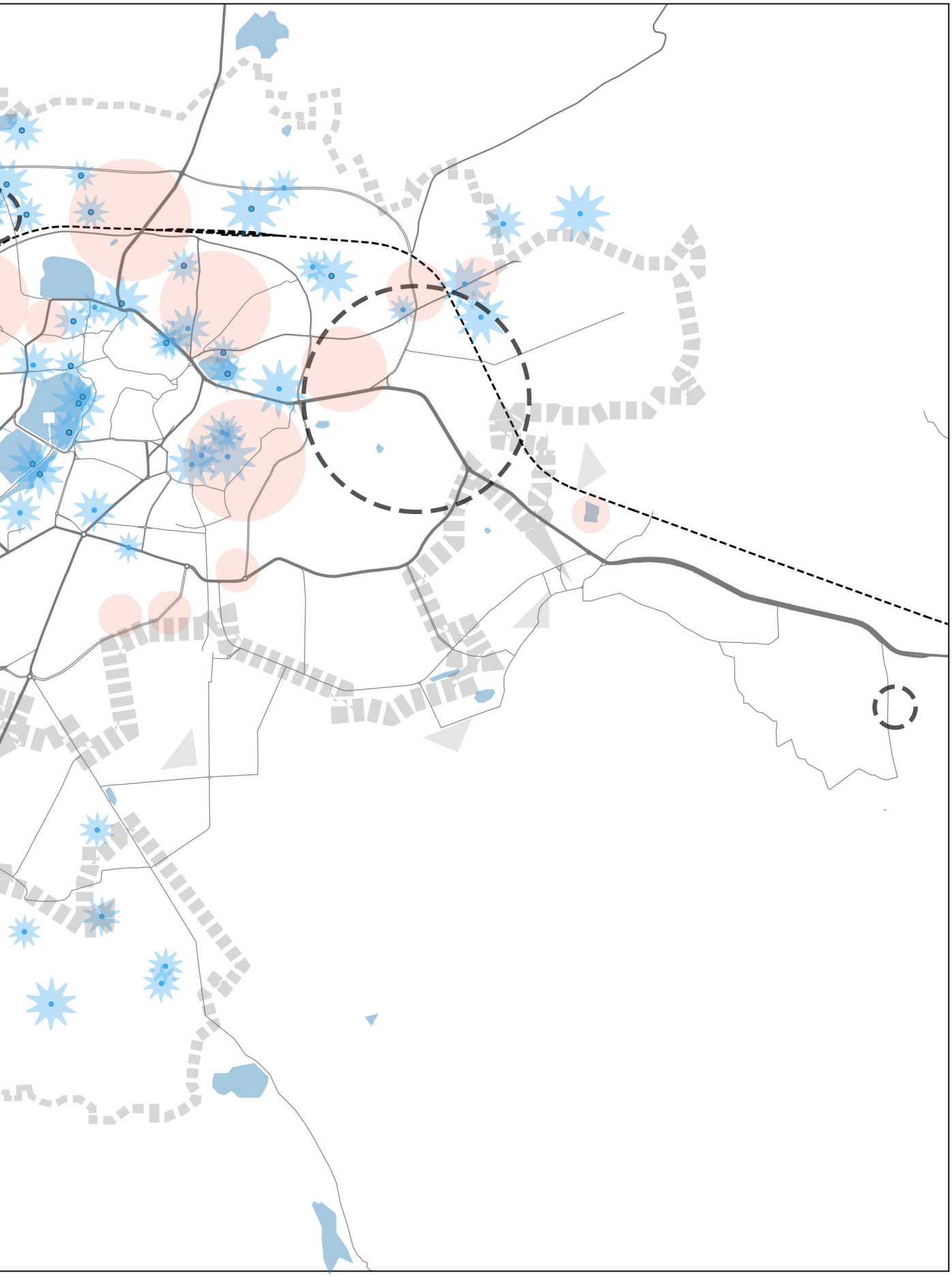
The city as it stands today is a product of various socio-economic paradigms including colonisation and neo-liberalisation. This process has corrupted the relationship between water infrastructure and life in the city and has created an unsustainable status quo.

A network of fragile villages feed a study influx of migrants to the city who occupy slums due to a lack of housing. The city expands along with this.

Industrial activity and other economic activity including construction in the city are not contextualised and pose an increased resource dependency on hinterlands.

A neo-liberal model of development has left the local governments with very little resources to develop the required infrastructure, which is filled by private and informal actors acting in unregularised manner, exacerbating an already unsustainable water relationship.





3.3. Anthropology

Over the course of history Bhuj, like many cities in India, has experienced dramatic transformation in its social, political, economic, infrastructure and environmental systems. This is largely due to the influence of varying political powers and deep class based hierarchies in Indian culture.

The anthropological overview of Bhuj attempts to understand the intersection of time and cultural systems with how the local population coexists with the extreme environment both currently and in the past. In this case, where the population has dealt with the scarcity of water over thousands of years, water has played a central role in lives of people. Moreover, water infrastructure such as step wells play a crucial role in cultural and religious practices which extends to sanitation and bathing places for women.

As the population is faced with modernization and rapid urban development traditional systems and knowledge start to lost their value and position in society. In result, the degradation and continuing negligence has led to pollution, exploitation and depletion of water systems. Unfortunately, those who rely on the natural systems for water and cannot afford individualized supply from external sources are the first victims to the increasing challenges.

However, due to recent extreme earthquakes, a slow realization of the values of traditional knowledge and systems begin expose the fragility of current modern systems. This revitalization process has begun to bring awareness to the challenges of water and enables community led processes to reactivate the role of traditional knowledge in the pursuit to find solutions to issues of water scarcity.

(3.3.1.) Time Systems

Evolution of Anthropological Systems

Over the course of time, Bhuj has experienced dramatic transformation through its social, political, economic and environmental systems. From the establishment of Bhuj, to British colonization to post independence, and increasing frequency of extreme earthquake and drought, the city has evolved. Each of these notable time frames can be associated with perspectives on social structure and behavior. Mainly to say, the city has been transgressed from collective to individualize dynamics.

As water plays a central role in the lives of people within arid environments like Bhuj, the overall relationship between people and water has seen major change due to transition from collective to individual behavior. Traditionally, water was seen as collective resource or commons, where members of the community would contribute to the overall maintenance and sustainable usage of the local water system. Moreover, the understanding of the natural system was a crucial aspect to sustain such a scarce resource like water. However, from increasing influence of foreign perspectives such as colonial rule, those natural based logics and understands slowly become obsolete. The reliance on heavy engineered and external sources became the norm, where the relationship between people and water weakened. This led to the emergence of individualistic and privatized pathways undermined the fragility of natural system such as the proliferation of private borewell drilling and individualize water supply. Water became a commodity which exacerbated socio-economic inequalities throughout the city, leaving the fortunate and disenfranchised population to find solutions upon themselves.

Since extreme climatic events such as the major earthquake in 2001, city dwellers became to understand the increase fragility of the current infrastructure systems. This exposed the lack of flexibility and resilience in the systems that has driven by the exploitation and exhaustion of resources. In result, community groups begun to take matters in their own hands to revitalize natural systems through promoting awareness and supporting community agency in water related challenges. The active process of reviving traditional perspective and natural techniques not only aim to recharge the ecological system but also recover collective practices from the past.

(3.3.2.) Human Perspectives and Cultural Systems

Coexistence with Extreme Environments

The historical evolution of Bhuj has directly affected the daily lives and perspectives of the extreme environment across the city's population. In fact extreme arid and drought are in embedded into the daily life of people. Traditionally, the population had developed ways to adapt to extremity of water scarcity with in depth knowledge of the natural systems. They created techniques that would sustain water demand and preserve the integrity of this scarce resource in the ground by developing nature based solutions. Water was only a resource but central to social, cultural and religious practices. In result, water infrastructure became a place to host these multiplicities. However due to increasing urbanization of the land, privatizing of resource extraction and individualize practices, these collective practices slowly dissipated.

This evolution can be explained through the credible biosphere theory conceptualized by Mary Douglas (XXX). Part of this theory was defined by four terms used to theorize humans relationship with nature. This was used to understand the if this human vs nature co-existence was led by considerations of nature's capacity, acting within balance, acting in full negligence or acting within the confines of nature's fragility. These four terms can be associated to key moments of how humans of Bhuj co-existed with extremity of water scarcity. These moments consist of traditional nature based techniques, individual orientated distribution, neglecting scarcity as a whole and understand the importance to revive the natural system.

Each of these instances can also be classified into social profiles such as hierarchists who plan and control, entrepreneurs who expand, fatalists who observe and communard who reduce demands.

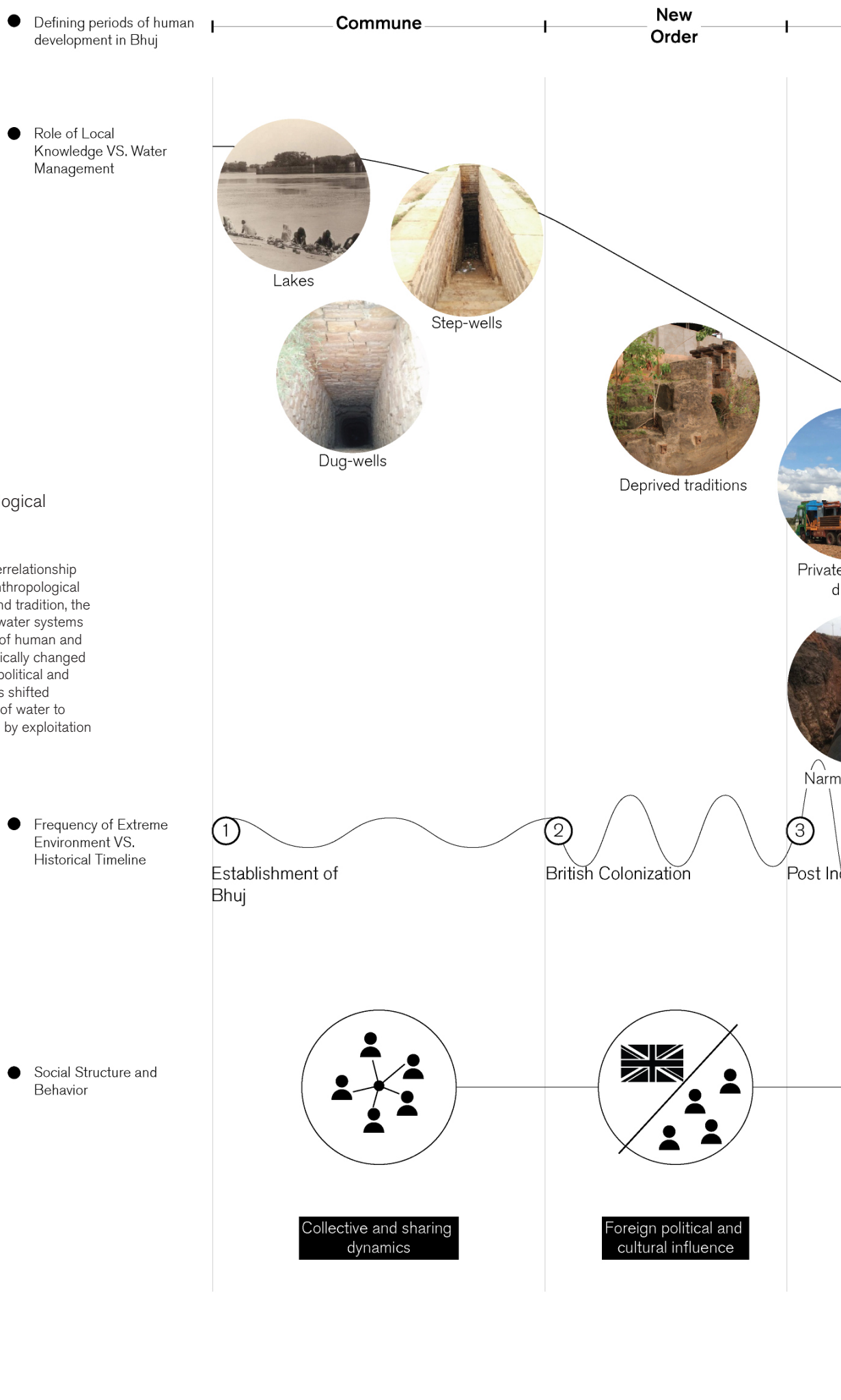
This cross analysis of human perspectives and cultural systems with theories of the credible biosphere help to define how the humans coexistence with extreme environments has evolved.

3.3.1.

Time Systems:

Evolution of Anthropological Systems

This drawing shows the interrelationship between the evolution of anthropological systems such as practice and tradition, the people's engagement with water systems over time. The coexistence of human and natural systems has dramatically changed over time due to key socio-political and environment events that has shifted the collective management of water to individualized actions driven by exploitation and self-interest.



Identity Search | **Confronting Vulnerability** | **Revival**



Communal maintenance



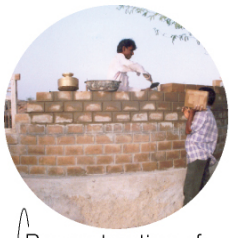
Revial processes



Community empowerment



Building awareness



Reconstruction of Bhuj



borewell rilling



Private tankers



Building local capacity



Severe losses and damages



ada pipeline

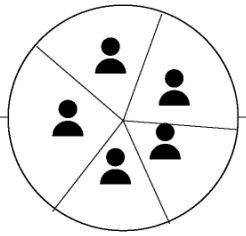


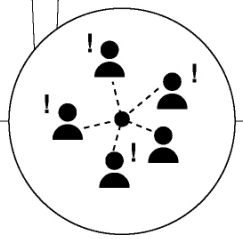
Individual supply

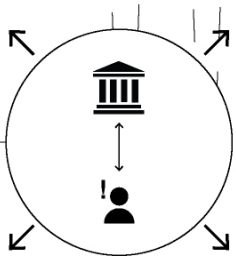
dependence

4 2001 Earthquake

5 Revial







Traditional neglegence, individual behaviour, and increased privatization

Awareness to ignored local context knowledge

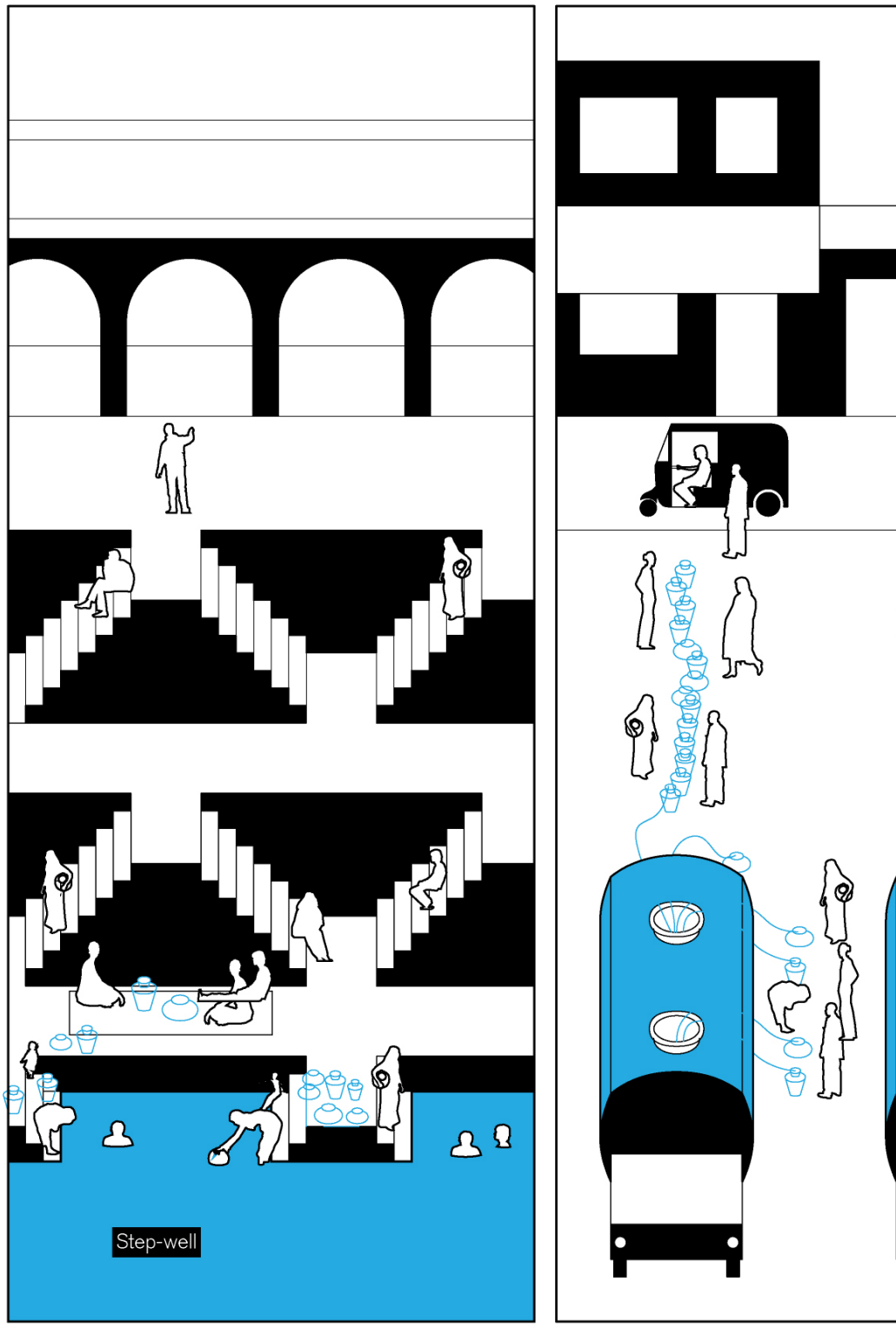
How to institionalize and scale up bottom up processes to create active dialogue between top down and bottom up processes?

Belief

Credible Biopshere Concepts (Mary Douglas)

Nature is robust within limits

Nature is robust



3.3.2.

Human Perspectives and Cultural Systems:

Coexistence with Extreme Environments

This drawing aims to visualize the coexistence of people with extreme environments. In Bhuj, water security and management systems experiences significant transformation while being the a pressing challenge for the area. This evolution of varying behaviors and situations can be understood through four dominant relations between water scarcity and society and intersected with concepts of the Credible Biosphere by Mary Douglas. The four terms are meant to combine environmental and human systems to understand how humans coexist with nature. The four perspectives can be understood through specific moments over time where the relationship people and water scarcity has changed.

Water source

Heirarchists (plan + control)

Water was used in a collective way and mult-functional way, intersecting relgion, recreation, cleaning and drinking purposes

Entrepreneurs (expanist policies

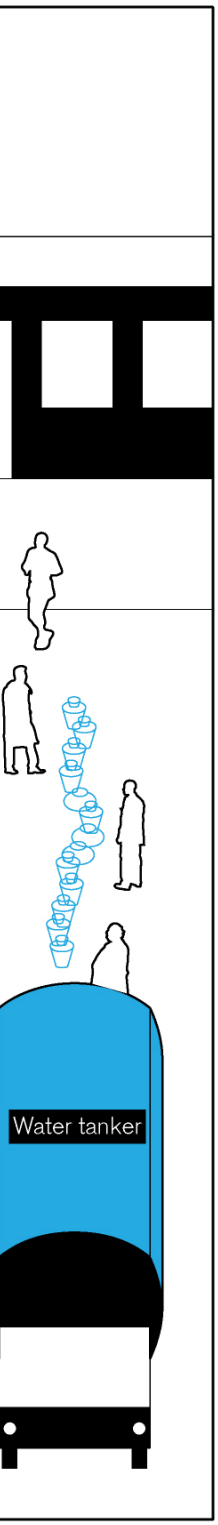
Increased privatization of water

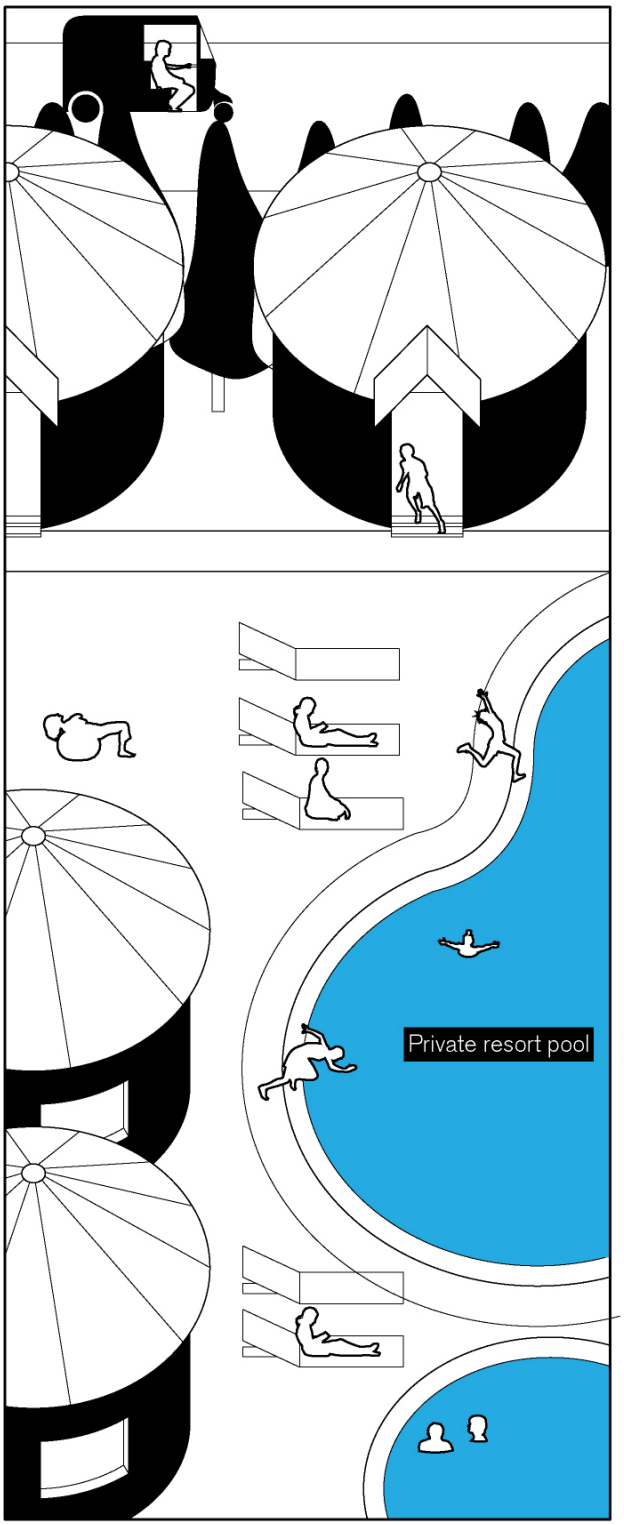
Non-Belief

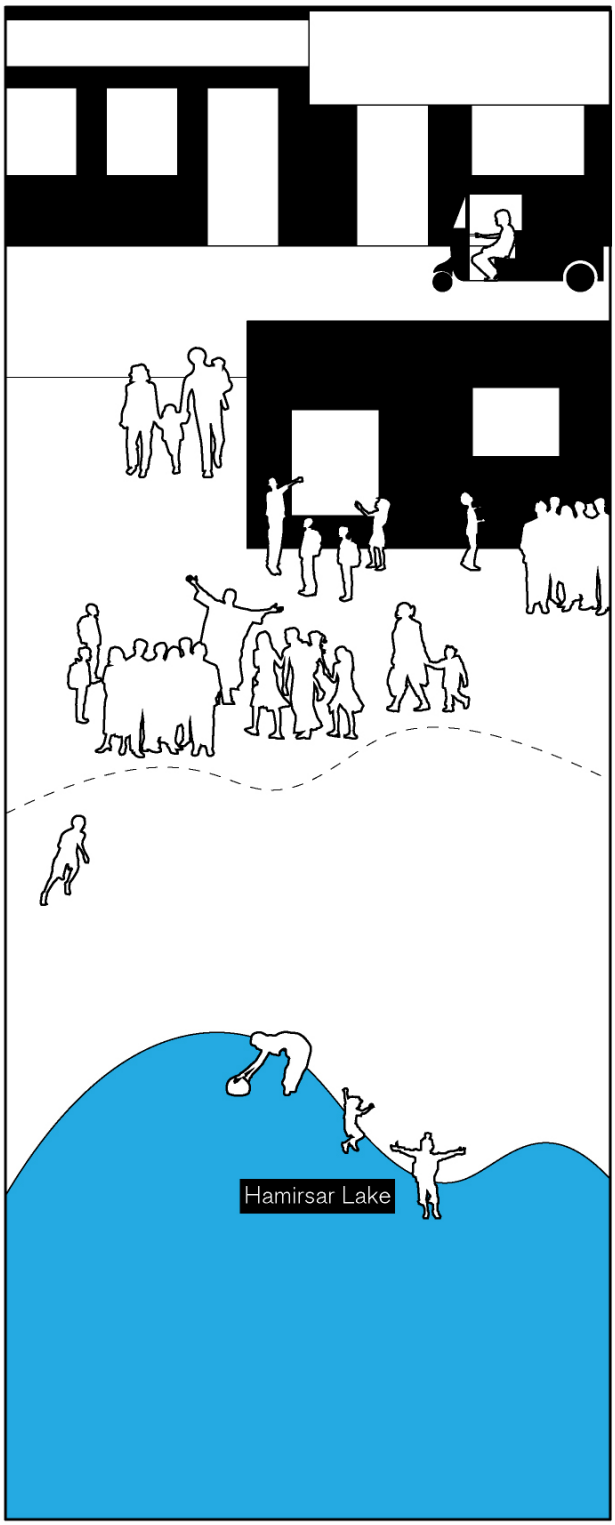
Belief

Nature is capricious

Nature is fragile







)

Fatalists (oberservant and mocking)

Incrasing neglegence and unsustainable behaviors between society and water, the distant between human and importance of natural systems increase

Communards (reducing demands)

Acknowledgement of past and natural ways of water management in which the revival of those systems are begining to take shape through collective community engagement

(3.3.3.) Extremes and Vulnerabilities

As previously mentioned, Bhuj has developed ways to co-exist with challenges of water scarcity. These can be seen as coping mechanisms to which can be categorize as either adaptive or mitigative. In the context of Bhuj, nature based techniques such as the varying man-made lakes to catch rainwater and recharge the aquifer and infrastructure such as stepwells and dugwells to coordinate water storage and ground water recharge. On the contrary, mitigative mechanisms have been led privatizing drilling and increasing reliance on external water sources such as the Narmada river. In combination with urban development and encroachment, the many natured based and overall hydrological system as led to states of heavy pollution, exploited, banishment or partially encroached. The population who undermine the issues are the ones who can afford to rely on individualized supply and promote privatized water extraction practice but the vulnerabilities are most evident and experienced by the disenfranchised population. In fact, a significant portion of informal settlements are situated near these exploited conditions where they cannot utilize the natural system to harness water. This has further increased the demand for water in these areas and leaves them in vulnerable state.

This urges awareness of the unsustainable practices surrounding water and further demands attention to those who suffer and are at the brunt of these depleting environmental conditions.

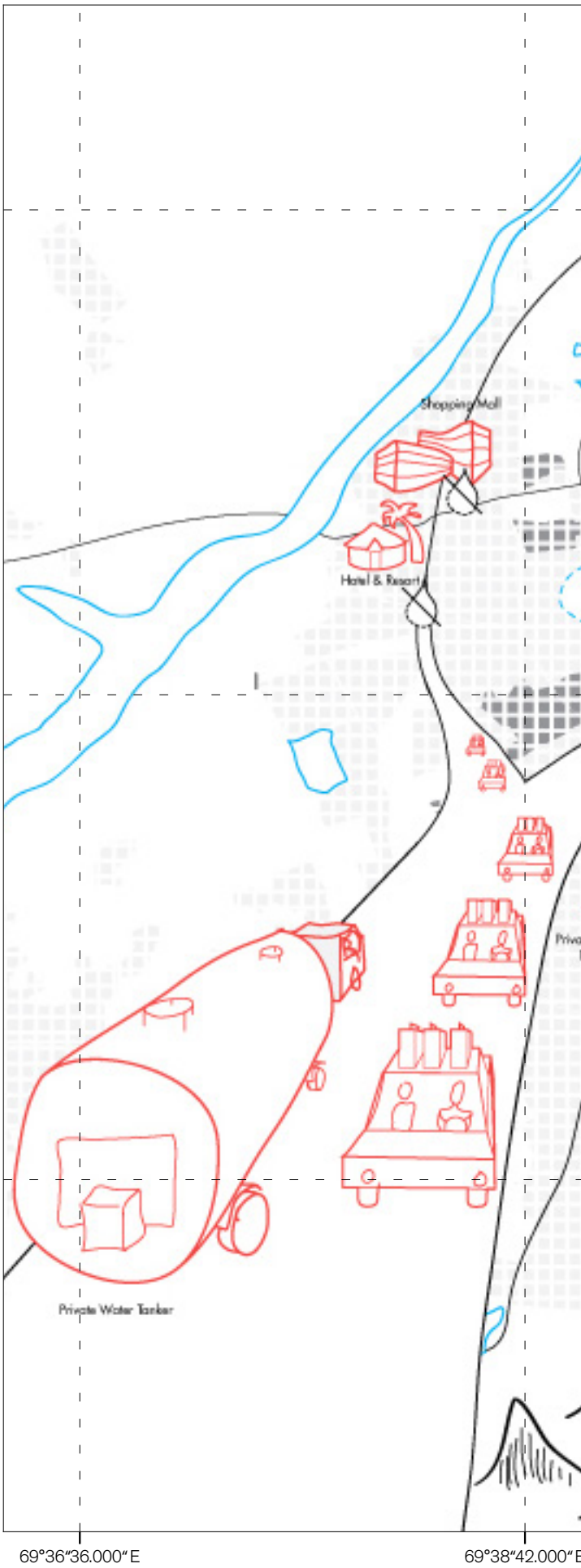
3.3.3.
Extremes and Vulnerabilities

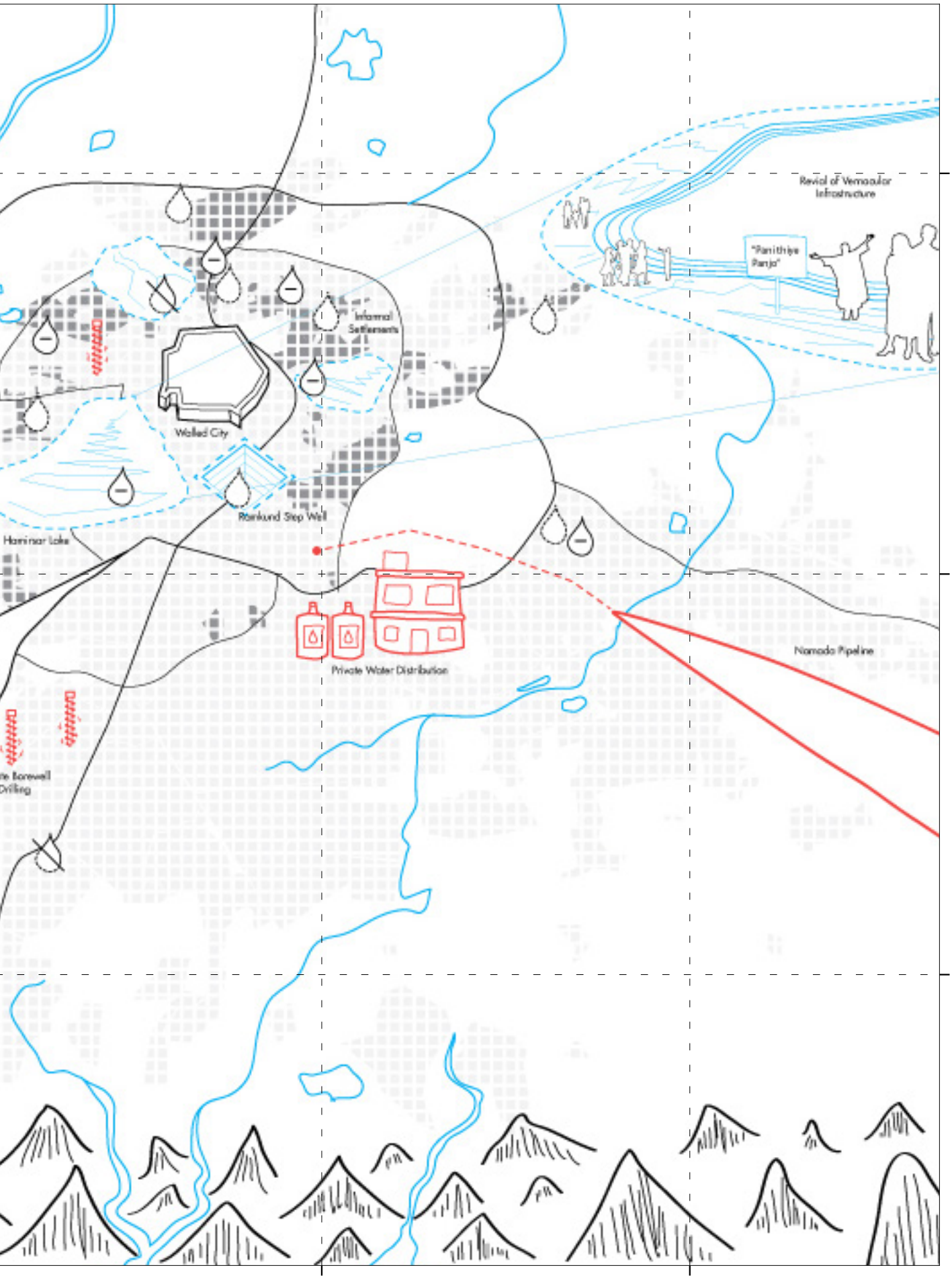
Over time, Bhuj has developed a variety of mechanism to cope with extreme environments and vulnerabilities. These mechanisms can be understood as adaptive and nature based or mitigative and technical. However due to heavy pollution, encroachment and general over consumption of resource, the adaptive and nature based coping mechanisms have been depleted or vanished. The extreme drought reality of the area in relation to the depleting coping mechanisms expose the sensitivities of the most vulnerable populations such as the informal settlements in this area. This drawing aims to show the spatial conflict of informal settlements and their proximity to depleted coping mechanisms that cannot be utilized to their previous potential.

Coping Mechanism
- Adaptive/Natural
- Inactive
- Mitigative/Technical

Water Quality
- Partially Encroached
- Vanished
- Heavily Polluted

Living Conditions
- Average
- Poor




Revial of Vernacular Infrastructure
"Panithiye Panjo"
Informal Settlements
Walled City
Rankund Step Well
Hamirsar Lake
Private Water Distribution
Narmada Pipeline
23°16"30.000" N
23°14"24.000" N
23°12"18.000" N
69°40"48.000" E
69°42"54.000" E

3.4. Landscape

Bhuj is located in semi-arid climate. With low precipitation and high evaporation rates, the city experiences constant water shortages. However, for about 450 years, this city survived due to traditional knowledge on its local water system. By understanding the landscape condition in the past, present and future, the challenges related to the water system and its provision can be addressed.

(3.4.1.) The Natural Layer

Bhuj is a city within the Kutch region which has a strategic position due to its unique geo-hydrology and aquifer system. The landscape of Bhuj resides on a large aquifer made of porous sandstone. This cretaceous sandstone belt has enormous capacity to store the water for year-round demands and only one of a few in the Kutch region (CEPT University, 2016).

Over the Bhuj, lakes are spread and act as a spongy layer for recharging water. On the south, east, and west, there are fault lines that form confined aquifers and have a reverse dipping against the slope of the area (see the section 1). There are two systems of lakes in Bhuj. The first system is located in the core of the city that acts as the main catchment in the urban areas. The system consists of five receiver lakes that are located on a previous sandstone lake. The second system consists of feeder lakes in the upper areas and located on impervious shale in the upper area which prevents the percolation process until the water can be moved into the urban area where the water is most needed (CEPT University, 2016).

(3.4.2.) The Cultural Layer

The starting point of the abandonment of the traditional water system is in British colonization. In this regime, there was little determination to understand and to advance the traditional water system to become adaptable to the latest demand. In1968 the piped water system was introduced to be directly transferred to each household. This direct water transfer caused an increase of water consumption and water demand resulting in the urgencies of bringing the water from other sources. Not only that, very cheap rates of external source water price also alter the culture of water usage in Bhuj or people tend to have less water respect due to undervaluation of water availability (CEPT University, 2016). Then, it is very important to re-address society's water awareness in order to press the excessive water demands.

After the earthquake in 2001 with the new government rule: not allowing new housing settlements to have more than two stories, caused massive decentralization, uncontrolled development, and rapid urbanization that led to several problems mainly water scarcity and ecological system damage (CEPT University, 2016). Poor quality of wastewater treatment from slums and pesticides from agriculture in the upstream areas also caused eutrophication on several lakes in the downstream part of Bhuj. As a result, many lakes suffer from physically and/or biochemically dead now.

Not only that, private bore wells uncontrolled exploitation causing the urges of people to deepen their wells. As the depth of water extraction increases, the quality of ground water also decreases (higher TDS concentration, salinity, and iron concentration) (CEPT University, 2016). As a result, many households are not able again to extract water from their dug wells due to its poor drinking water quality and some invasive species of trees are clogging up the water system.

(3.4.3.) The Urban Layer

Bhuj was determined to become the capital city of Kutch since 1510. Start from this year, Harmisar Lake system was designed to provide the water for the whole city. This system was planned and built to tackle water from catchment and consisted of a series of lakes, water channels, canals, and open wells in the surrounding of the lake to accommodate the recharging process.

Due to its prominence, the city was decentralized from 1950 to 1994 and it caused water demand increase. During these years, the alteration of water system already changed to become more pipes system. However in 2001, the earthquake caused massive decentralization thus decreasing permeable surfaces within the city that result in more run-offs.

(3.4.4.) The Perception Layer

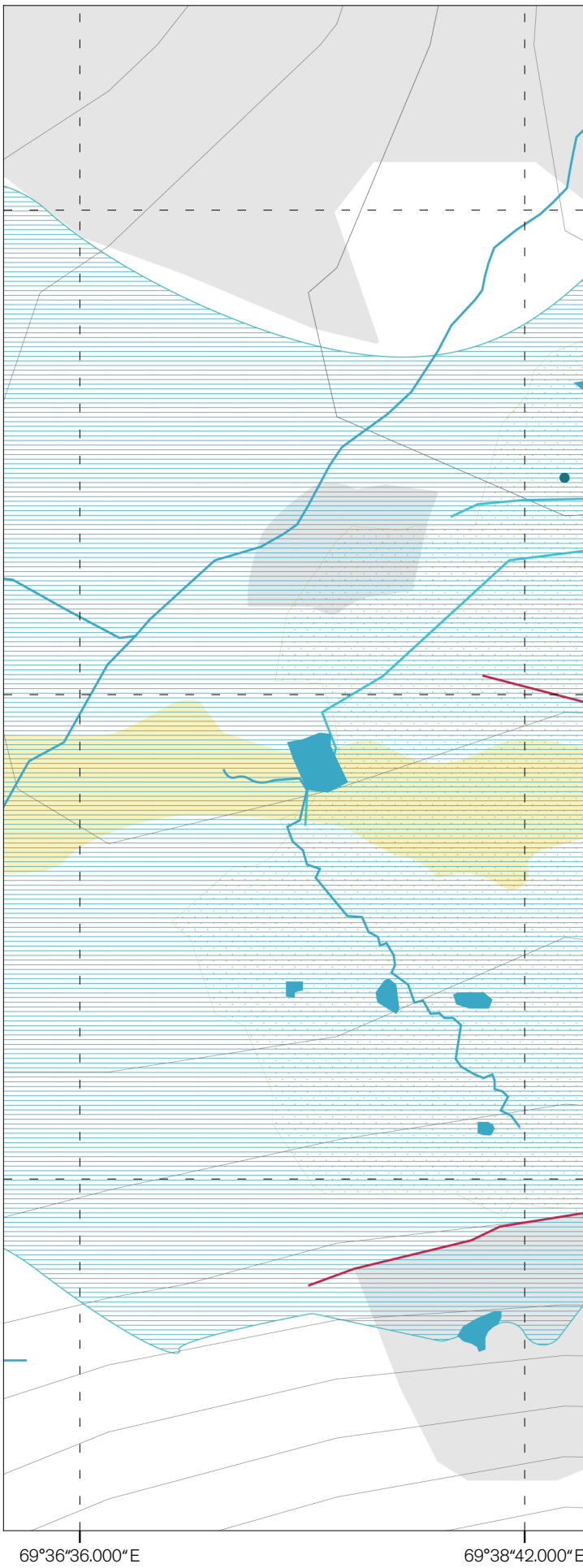
Perception layer explains the differences of interpretation of city fabrics due to the semi-arid climate. For example, despite the vast spaces of open spaces, city dwellers tend to choose neighborhood street or small parks nearby their houses as their public spaces. The reason is because in this climate, narrow streets create shades that make the spaces more convinient to be used.

In the core of the city, there is the main three lakes system that is functioning for the main water catchment. The three lakes consists of Harmisar Lake, Dhobi Lake, and Chattedi Lake. Harmisar Lake, as the most prominent lake, is used as drinking water supplier to the city since 15th century and there are many religious places surrounding this lake. These are also the reasons why Harmisar Lake has high level of importance to the society.

Close to the Harmisar, Dhobi, and Chattedi Lakes, there is Pragsar Lake that was used as the catchment area for water overflow from Harmisar Lake. But, due to eutrophication and building construction debris from 2001 earthquake, this lake is physically dead now. Thus, floods become a frequent issues mostly within the area nearby this lake.

Within the walled city, there is a Prag Mahal – 19th century palace that was built by the king in the era. This place has a 45 meters height tower that is the highest building in Bhuj. However, despite this area is very prominent historically, the surrounded areas of this place is not very well-maintained and some ruins of building from earthquake in 2001.

In the eastern area, there is a Bhujia Hills that acted as fortress wall in the previous era. After earthquake in 2001, a memorial park and museum – Smritivan was built within the area. About 13,800 trees were planted in the garden as representatives of earthquake victim and 108 small water reservoirs were also created on the hill.



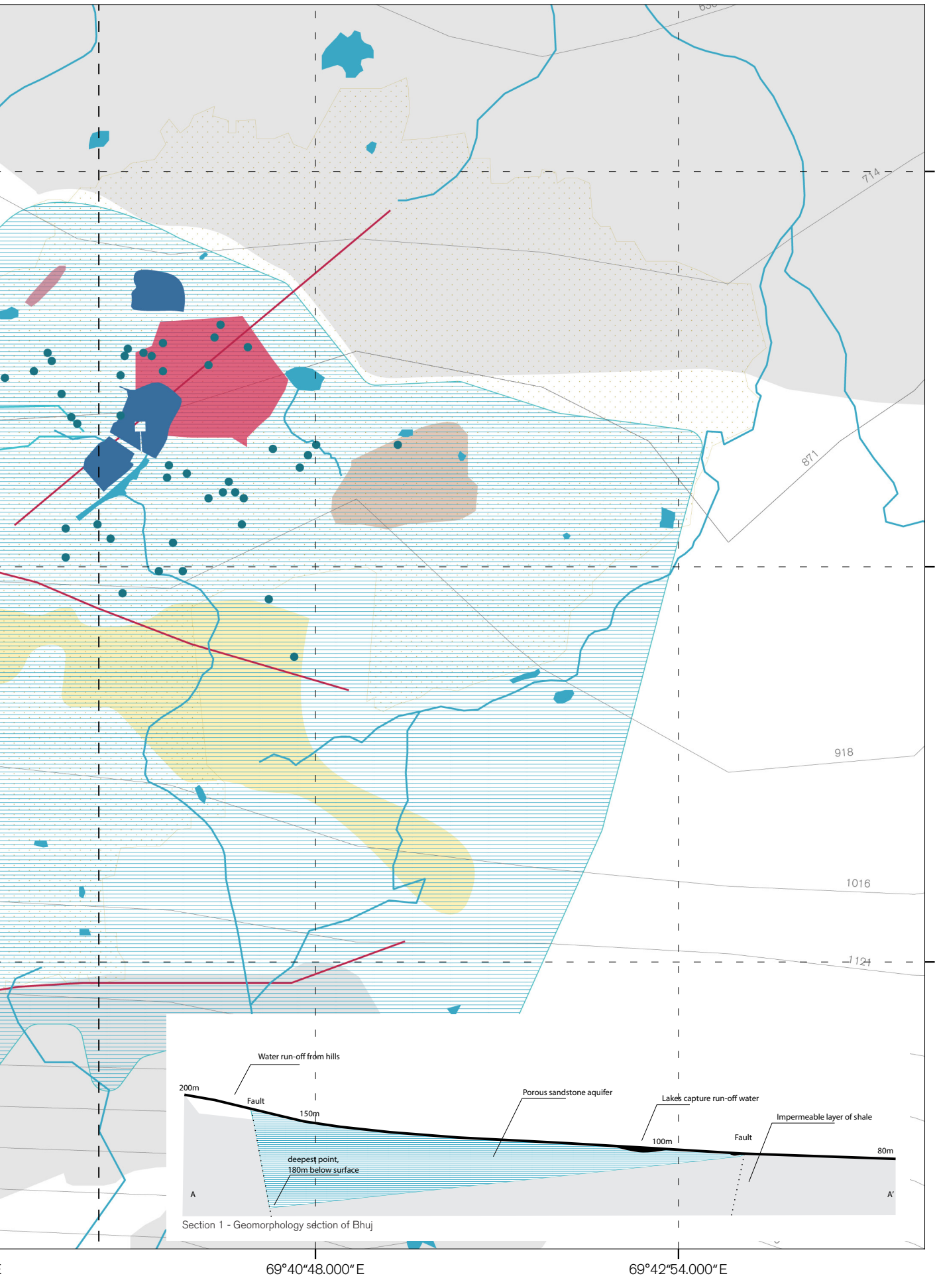
3.4.1.
The Natural Layer

Bhuj is situated on top of a porous sandstone aquifer of 180m depth. In the past, lakes were constructed to collect run-off water from the hills. This water would infiltrate into the aquifer. And the people extract water from ground water through wells.

- Bhuj Territory
- Faults Geology
- The Four Lakes
- Water Reservoirs
- Wells
- Bhujiya Hill
- Dyke
- Porous sandstone
- Ferricrates
- Alluvium and non-Permeable Shale
- Aquifer
- Walled City
- Water Engineering

N

0 100 km



Section 1 - Geomorphology section of Bhuj

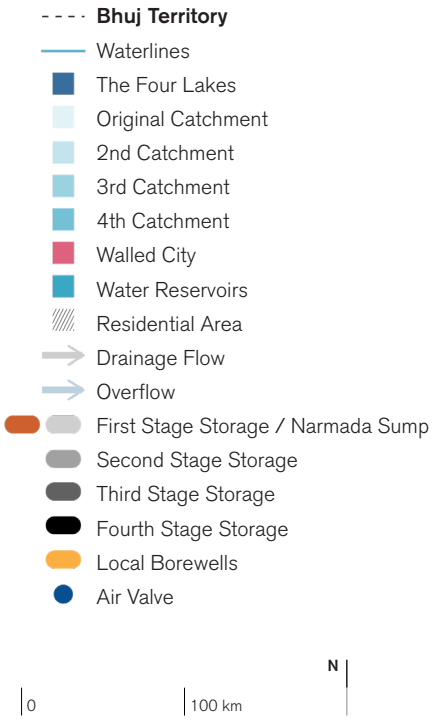
3.4.2.
The Cultural Layer

The traditional water supply system was a carefully arranged by water network of waterbasins and run-off areas. These would all flow to the city, providing resident water needs. Due to the increase of water demand, there are two new water systems that were developed over the years: 1. Blue colour gradients show the phase of the expansion (light to dark means original to fourth development); 2. The sump-water system that allows the transmission of drinking water from outskirts area to consumer ends. Despite huge amount of water loss occur by this system.

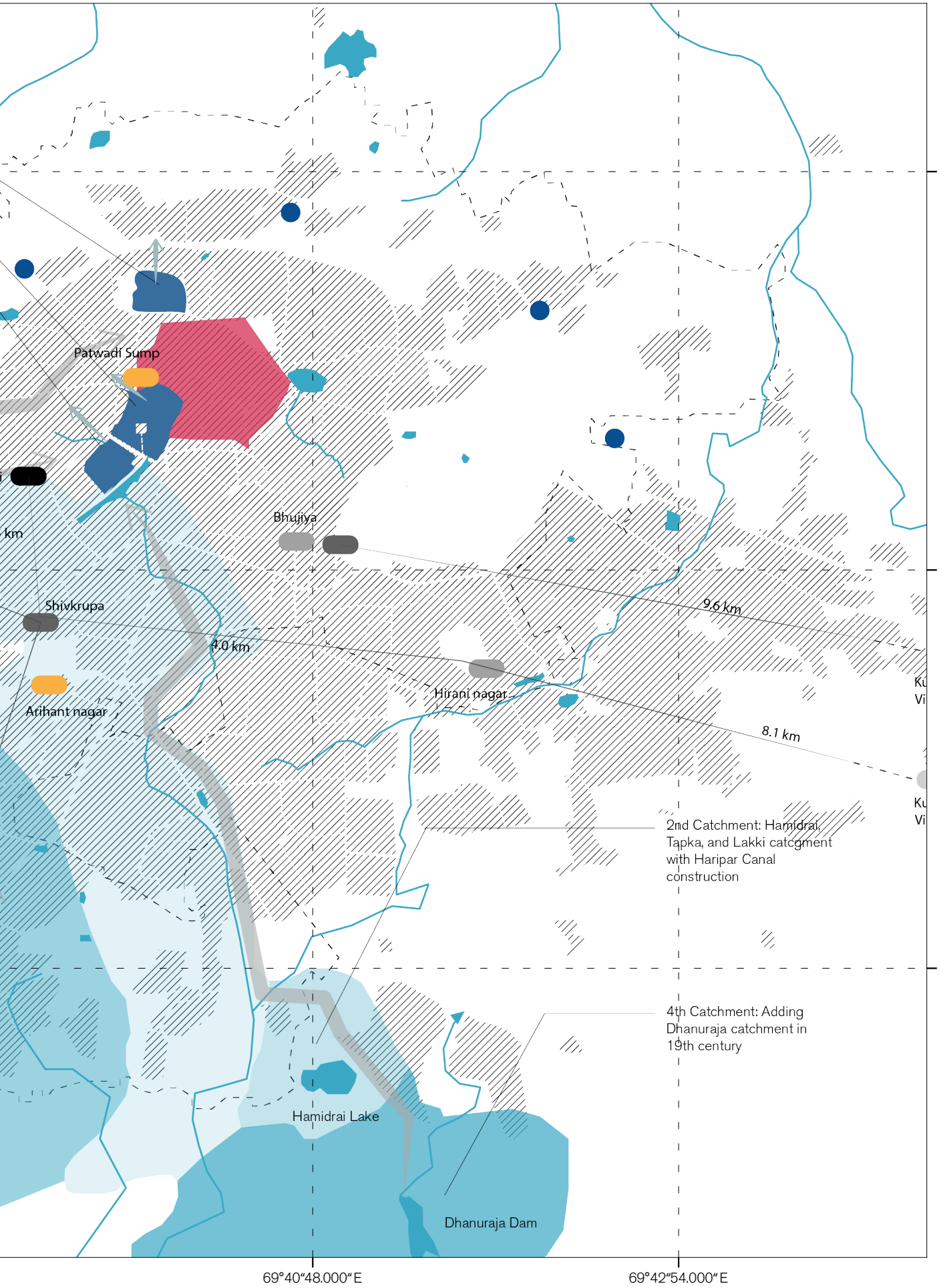
In the core of the city, there are the three lakes that were usually kept at full capacity:

1. Dhobi Talav: reserved for washing;
2. Chattedi: wetland area for local and migratory fauna;
3. Hamirsar kept as a drinking water supplier to the city.

According to ACT's calculations, only 175 mm of rainfall over this catchment is enough to completely fill Hamirsar. However in recent times, even with an average of 325 mm of rainfall, the lake was rarely observed full (ACT, 2015). This can be attributed to increased "concrete cover" with recent developments which leads to more runoff and less percolation of rainwater as well as broken links in the catchment system. Increased runoff and modifications in natural geography for human habitat in turn lead to the issue of localized flooding.



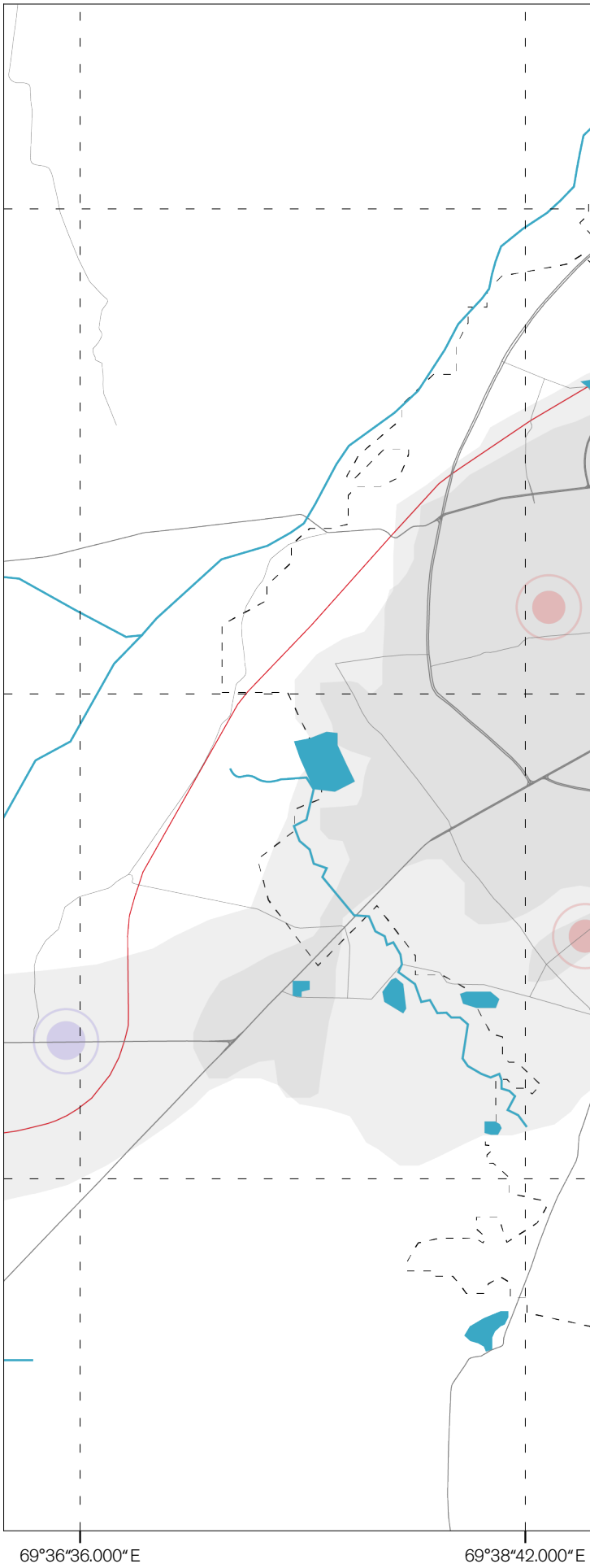



Patwadi Sump
Bhujiya
Shivkrupa
Arihant nagar
Hirani nagar
9.6 km
8.1 km
4.0 km
2nd Catchment: Hamidrai, Tapka, and Lakki catcgment with Haripar Canal construction
4th Catchment: Adding Dhanuraja catchment in 19th century
Hamidrai Lake
Dhanuraja Dam
23°16"30.000"N
23°14"24.000"N
23°12"18.000"N
69°40"48.000"E
69°42"54.000"E

3.4.3.
The Urban Layer

The original Bhuj in 1950 is located in a close proximity to the Harmisar Lake as a central water catchement. The city expaln-sion from the year of 1984 to 2001 was not very significant (13,1 km2) comparing to the upcoming years.

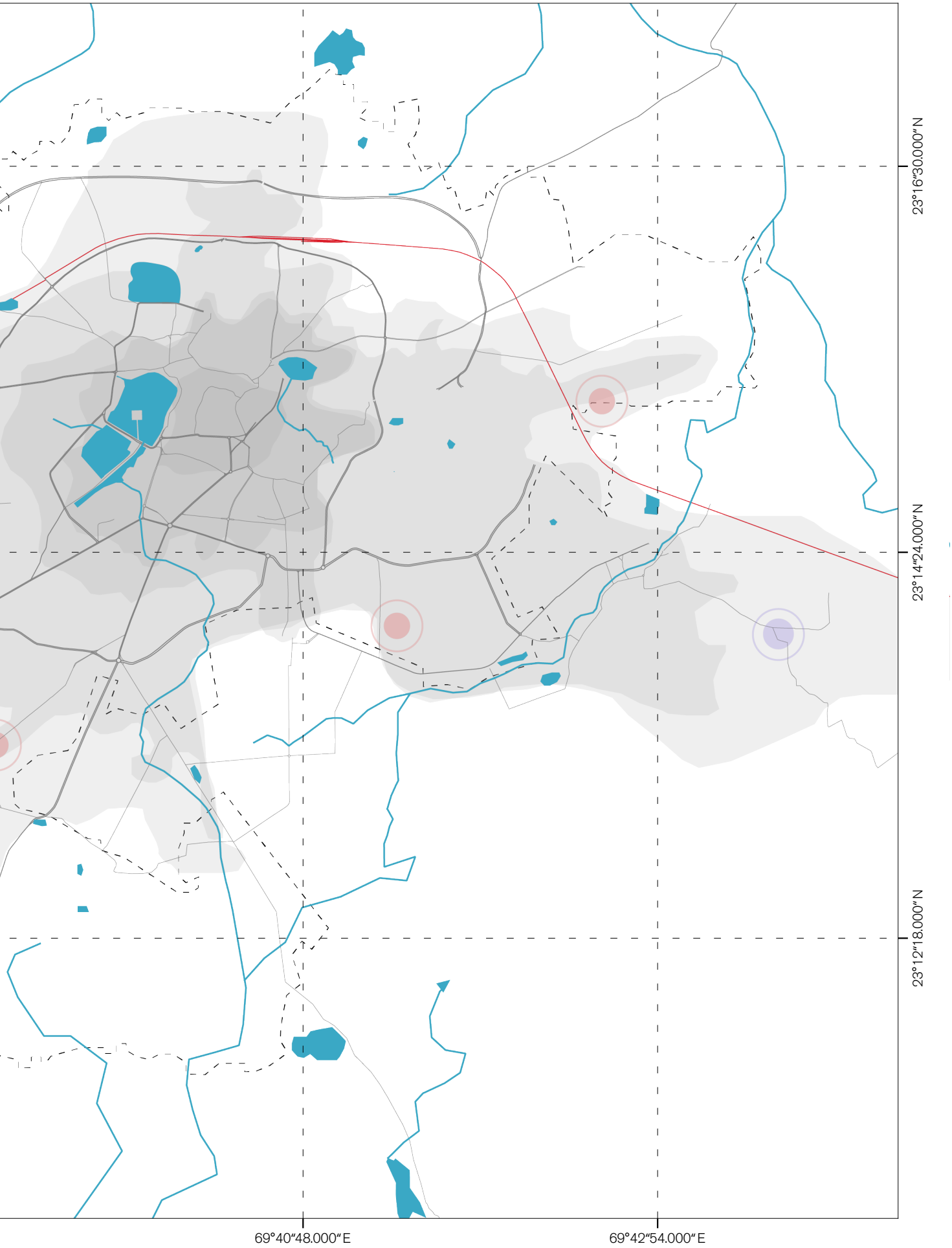
The earthquake happened in 2001, and from that year the municipality of Bhuj created a regulation to not build housing more than two storeys and also relocation sites to over-come the destruction of the city core. Thus, resulting ambitious expansion and influenc-ing the emergence of peri-urban centres that leads to more decentralized.



- Bhuj Territory
- Railroad
- Road
- Waterbody
- 1950 - Gamtal (rural) - 1 km2
- 1984 - Decentralization 1 - 4.8 km2
- 1994 - Decentralization 2 - 7.3 km2
- 2001 - Earthquake +BHADA
- 2005 - Periurban villages - 30.9 km2
- Relocation Sites
- Peri-urban centres

N

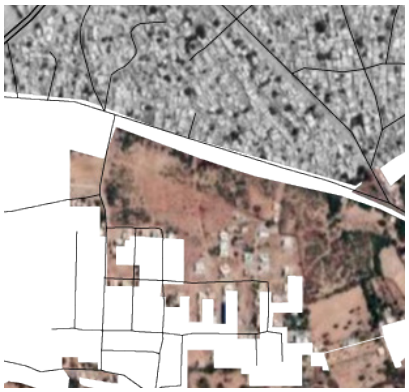
0 100 km


23°16'30.000"N
23°14'24.000"N
23°12'18.000"N
69°40'48.000"E
69°42'54.000"E

3.4.4.
The Perception Layer

Two illustration below show the density housing settlement and the size of open spaces inside and outside the walled city. Within the walled city, housing are is very dense and the residents use all open spaces for their outdoor activities. On the other hand, despite the vast amount of open spaces in the outside walled city area, residents tend to not use those spaces due to the arid climate.





The Lakes Water System

Three prominent lakes (Harmisar Lake, Chattedi Lake, and Dhobi Lake) in the core of the city are integrated. Harmisar lake acts as the main of water catchment of Bhuj City and the overflow of the water will flow to Pragsar Lake. However, it is not functioning now due to the encroachment. This lakes water system also becomes water sources to the farm areas.



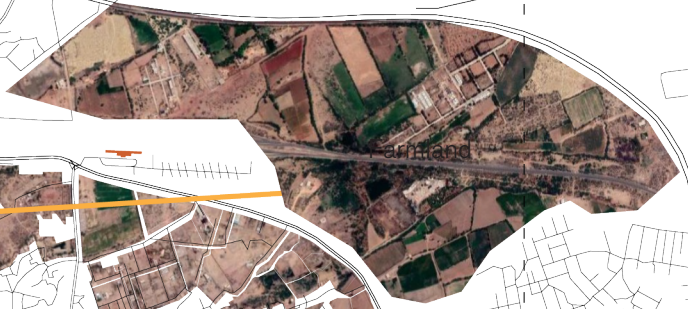




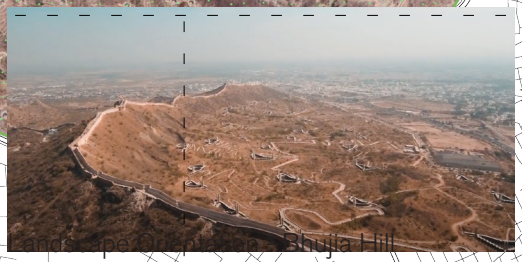


Orientation 1 - Prag Mahal

This 19th century palace is the most ambitious building built by the king. It has a 45m height tower that is the highest building in Bhuj.



Farmland



Bhujia Hill

Orientation 2 - Bhujia Hill

Bhujia Hill or Bhujiyo Dungar is a hill located in the outskirts of the town of Bhuj in the district of Kutch, Gujarat, India. At the lower part, there is a memorial park namely Smritivan and museum dedicated for the rememberance of 2001 Gujarat earthquake.

23°16"30.000"N

23°14"24.000"N

23°12"18.000"N

69°40"48.000"E

69°42"54.000"E

3.5. Ecology

In this project, where human participation with nature is desired, the ecology perspective is essential. In this section, the ecological processes in and around Bhuj will be discussed. We will see that these processes are strongly interrelated with social and economical practices. Furthermore, they have the potential to be the foundation of a solution to the many pressing challenges in the area.

(3.5.1.) Ecological landscape

The northern shrub forest ecozone of Bhuj surrounds the Thar Desert. The area is mostly flat with some low hills. The area also borders salt marshes, causing the soil to have a high saline content at certain locations (CEPT University, 2016).

The landscape and ecology has been degraded over years from a deciduous forest into a shrubland. The extraction of timber combined with overgrazing by livestock has resulted into a landscape were only large trees and thorny shrubs thrive (WWF, 2020).

(3.5.2.) Climate

Bhuj has a hot semi-arid climate. The annual precipitation is highly variable, ranging from 21 to 1177 mm. Most years are very dry however, with an average of about 350mm rainfall per year. Since most of the rain falls in large amounts during the monsoon season, large pluvial floods are not uncommon (CEPT University, 2016).

Temperatures are hot during the day (30-40C) and much colder during the night (10-20C). The hottest period is from March till mid-June. During the monsoon season the temperatures are lower, with highs still above 30 C. The prevailing wind direction is South-West to North-East (Meteoblue, 2020).

(3.5.3.) Flora and fauna

The degradation of the ecoregion has caused many species to dissapear. However, the region is still home to over 300 different bird species, of which two are endemic. Some of those species are know to visit the lakes in the city when these were not yet neglected. Many plants that naturally occur in this area contain parts that are used for medicinal purposes and rituals. One tree species (Prosopis juliflora) is invasive. This tree was originally introduced to cultivate wood, but is hard to remove and clogs up water systems. Furthermore, its roots reach over 53 meter in depth, allowing it to use scarce water resources (CEPT University, 2016; WWF, 2020).

(3.5.4.) Geomorphology

The geomorphology around Bhuj has been influenced by earthquakes, which have formed a natural sandstone aquifer in the subsurface. Mainly because of this aquifer, Bhuj could sustain itself in this unpredictable desert environment. The aquifer is made out of porous sandstone and is 180m deep at its deepest point in the South (see section below). A non-permeable layer of shale located directly underneath the aquifer is preventing the water from infiltrating further into the soil.

In the past, lakes were constructed to catch the run-off water from the hills in the south and to allow this water to infiltrate into the aquifer.

(3.5.5.) Water quality and accessibility

The water quality in Bhuj has decreased over the years as a result of multiple factors. Over-exploitation of the water reserve in the aquifer has caused the water to become more salty, since the rocks have some natural salt content. Additionally, the systems that recharge the aquifer are not used to their fullest potential and often even neglected. Finally, industries in the area pollute the ground water, reducing the quality even further.

This is problematic as a lot of Bhuj water supply is coming from this ground water, through man-made wells. Not all inhabitants of Bhuj have access to these wells. Some informal settlements rely completely on water sources from outside the city, such as private tanker suppliers that transport water to the city.

(3.5.6.) Recharge Potential

The aquifer of Bhuj can be recharged due to the infiltration of rainwater. The sandy soil that is present in the area naturally facilitates this process. However, a large part of this soil is paved with asphalt or compacted as a result of trampling by cattle, all factors that reduce the infiltration capacity. Furthermore, pollution makes infiltration undesirable in certain locations, as this would pollute the ground water in the aquifer.

This map shows the locations with the highest infiltration potential, based on the pollution of the soil and the slope of the terrain.

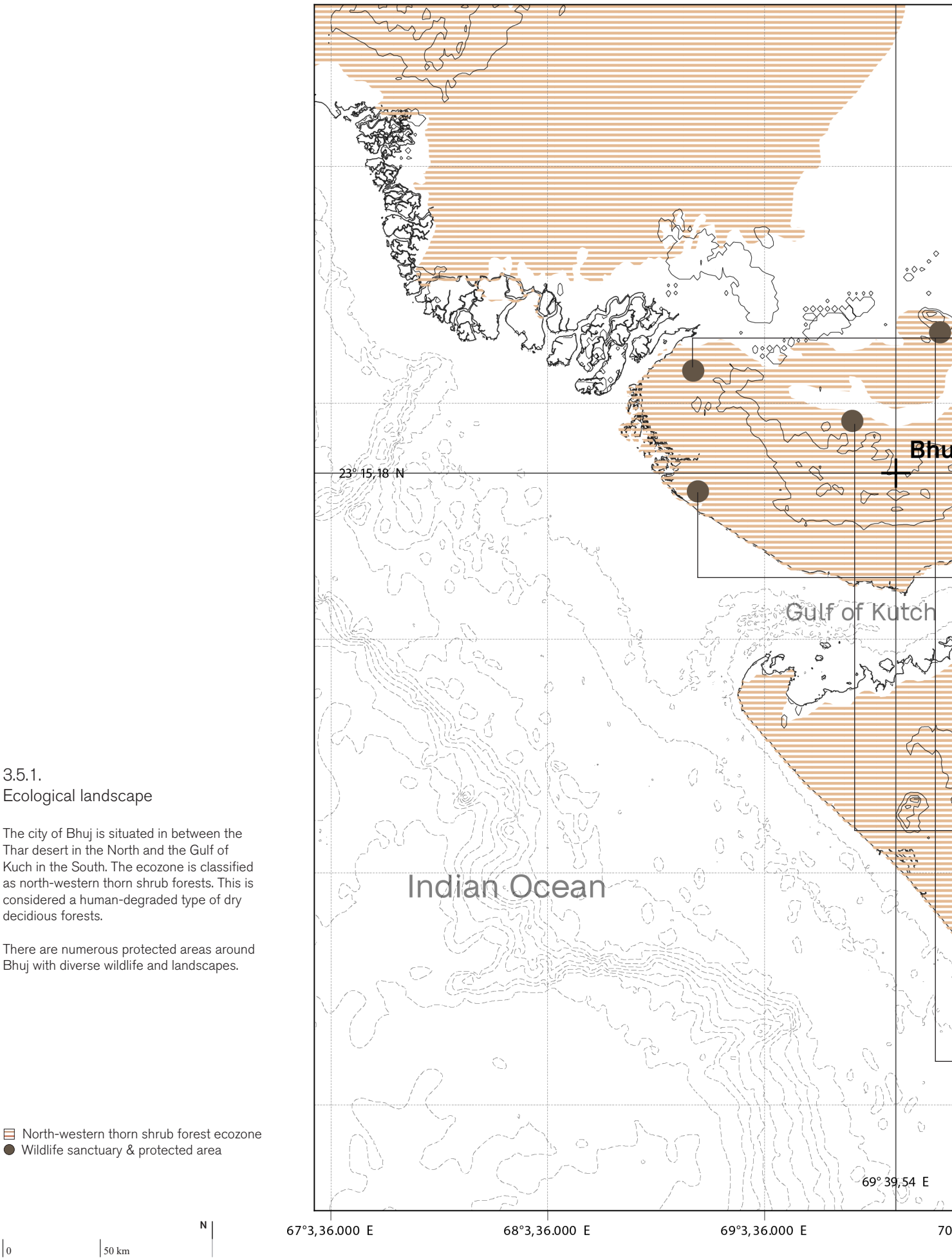
(3.5.7.) Extreme ecosystems

The extreme ecosystem map summarizes the environmental challenges that are present in Bhuj. The vulnerable water system in this extreme climate plays a central role in the definition of these challenges.

The water system that was constructed in the past to supply the city of Bhuj its water is no longer being used to its fullest potential. This results in water shortages and an unsustainable water supplier during droughts, while floods occur after rainfalls. Apart from the neglecting and abandonment of the traditional water infrastructure, the use of the soil is also contributing to this challenge. Impermeable pavement and buildings do not allow infiltration to happen but generate run-off water. Cattle trampling results in an impermeable compact soil and overgrazing leaves no vegetation that would normally intercept water so it can infiltrate.

On top of this, native bird species have left the city lakes, while an invasive tree species (Prosopis julifora) clogs up the water system and uses its long roots to reach the water in the aquifer.

The extreme dry and hot climate of Bhuj amplify these challenges, and request for a more sustainable solution.



3.5.1.
Ecological landscape

The city of Bhuj is situated in between the Thar desert in the North and the Gulf of Kuch in the South. The ecozone is classified as north-western thorn shrub forests. This is considered a human-degraded type of dry decidious forests.

There are numerous protected areas around Bhuj with diverse wildlife and landscapes.

North-western thorn shrub forest ecozone
Wildlife sanctuary & protected area

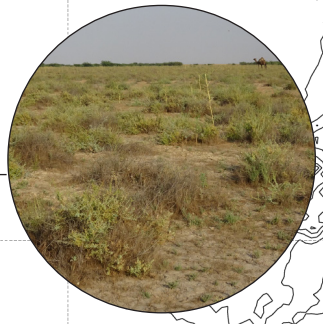
Thar Desert



Narayan Sarovar Sanctuary



Kutch Bustard Sanctuary



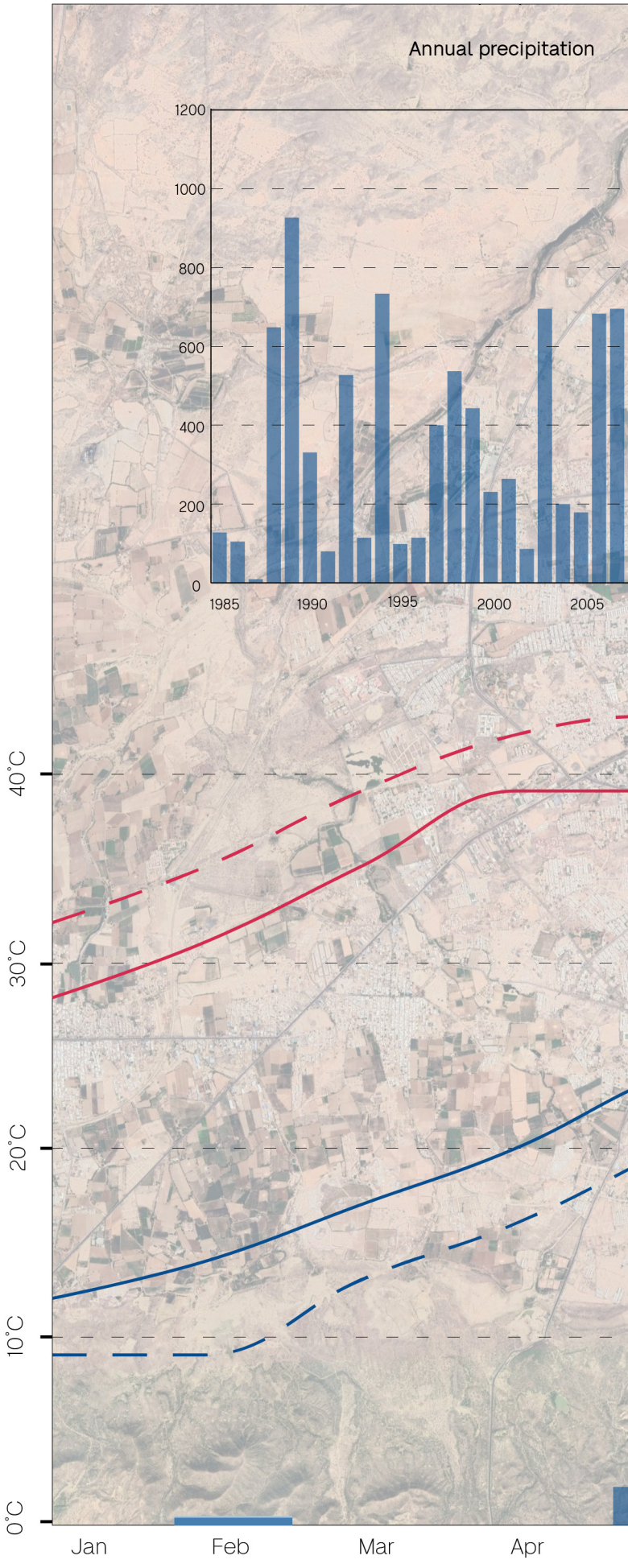
Banni Grasslands Reserve



Chari Dhand Wetland Conservation Reserve

24°33,0.000 N
23°33,0.000 N
22°33,0.000 N
21°33,0.000 N
20°33,0.000 N

°3,36.000 E
71°3,36.000 E
72°3,36.000 E
73°3,36.000 E

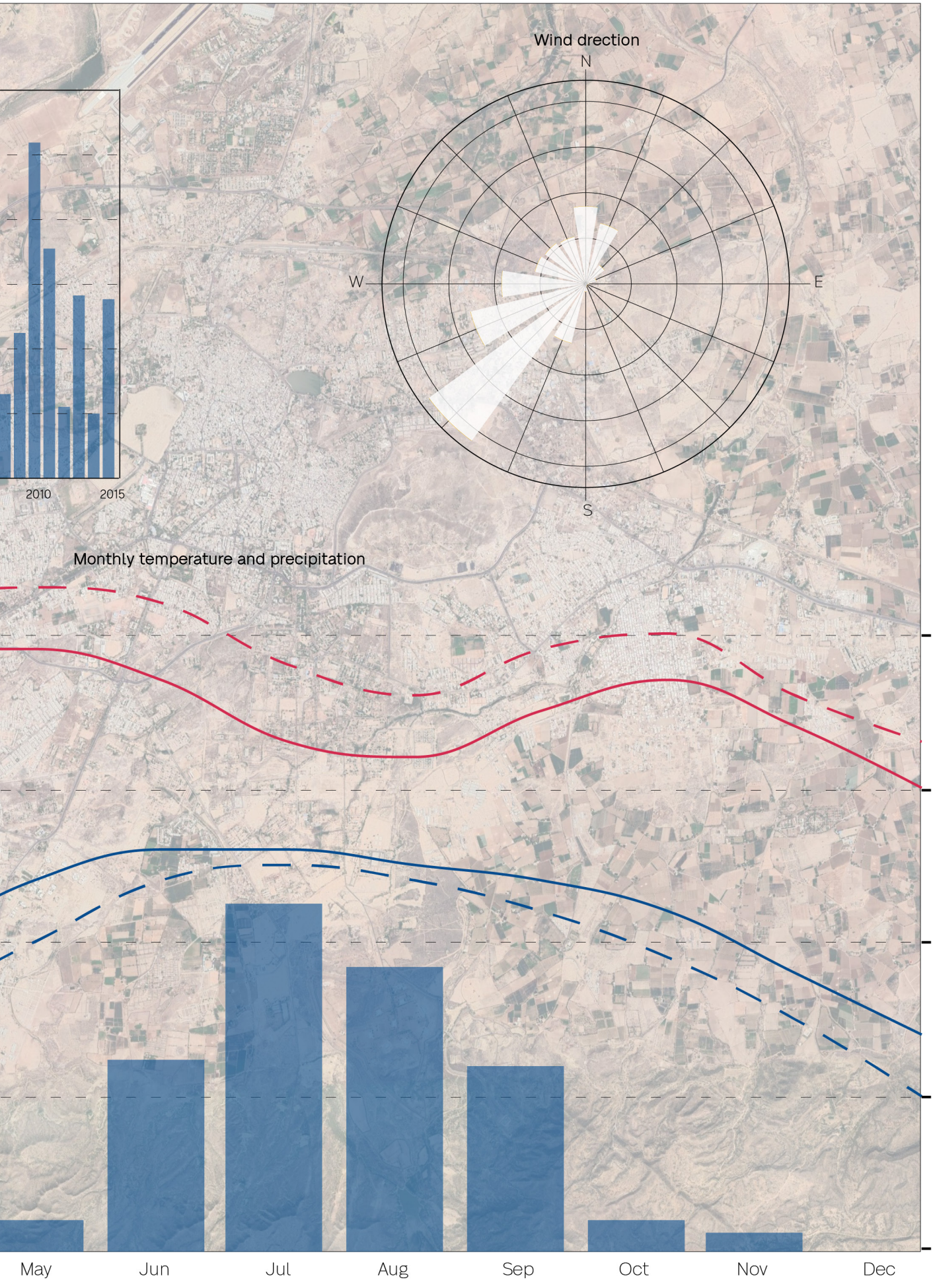


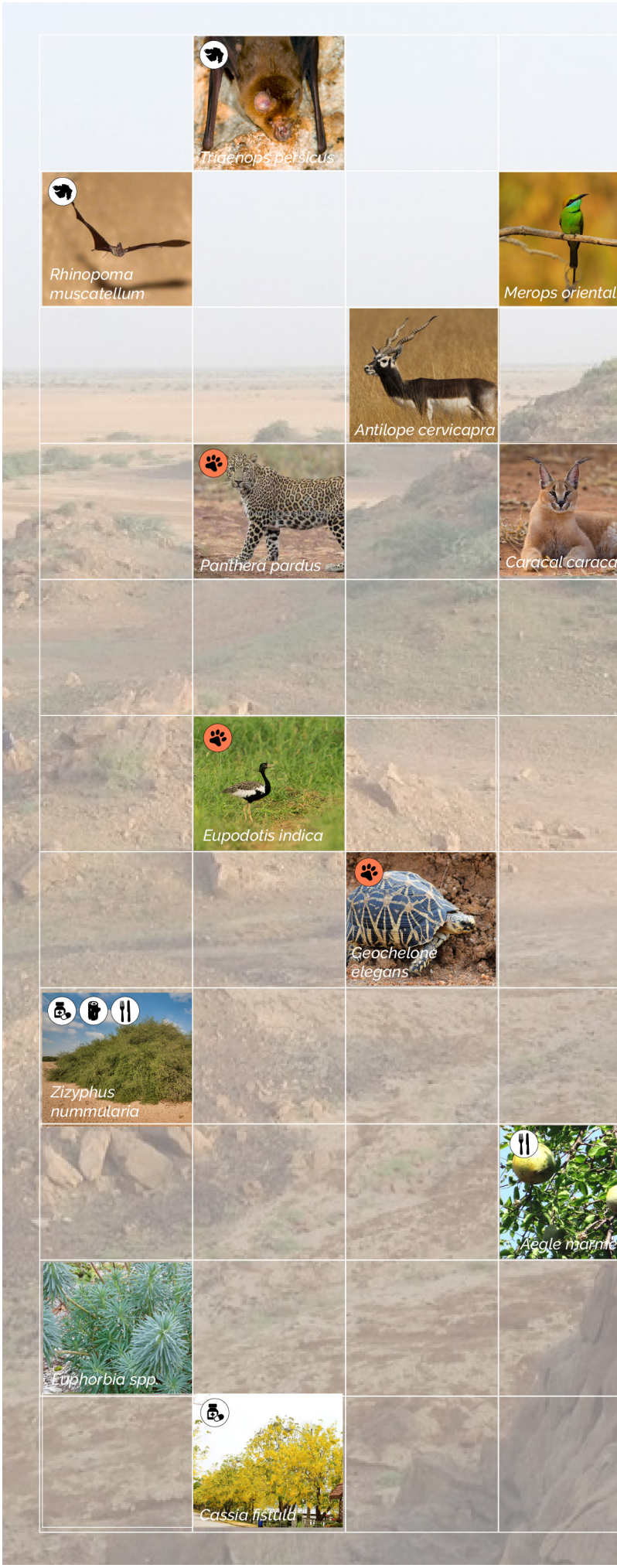
3.5.2.
Climate

Bhuj has a hot semi-arid climate. The annual precipitation is highly variable and averages around 350mm. The weather is generally hot, with temperatures often exceeding 40 C during the day. The hottest period is from March till mid-June. During the monsoon season the temperatures are lower, with highs still above 30 C.

Precipitation and wind
- Precipitation
- Wind direction

Temperature
- Mean daily minimum
- Main daily maximum
- Cold nights
- Hot days


Wind drection
N
W
E
S
2010
2015
Monthly temperature and precipitation
100 mm
75 mm
50 mm
25 mm
0 mm
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec



3.5.3.
Local flora and fauna

Albeit situated in the desert, many different bird species inhabit the ecoregion around Bhuj. This includes the endangered Bustard. Some birds used to inhabit the city lakes before these were polluted.
The local flora consists mainly of out of thorny shrubs and some drought resistant trees. This is a result of overgrazing.

Flora

- Parts of the plant are used in traditional medicine
- Plant yields valuable materials
- Parts of the plant are edible
- Invasive species

Fauna

- IUCN threatened species
- Endemic to this region
- Used to inhabit city lakes


Phoenicurus ochruros


Phoeniconaias minor


Parus nuchalis


Laticilla burnesii


Ardeotis nigriceps


Pelecanus sp.

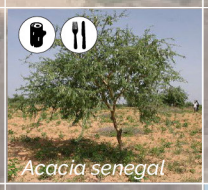

Anas acuta


Tetracerus quadricornis


Gazella bennettii


Crocodylus palustris


Diospyros melanoxylon


Acacia senegal


Anogeissus pendula




Acacia leucophloea


Mitragyna parviflora

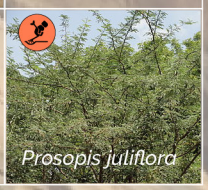

Capparis zeylanica


Dicrostachys cinerea


Prosopis spicigera


Wrightia tinctoria


Tinospora spp.


Prosopis juliflora

3.5.4. Geomorphology

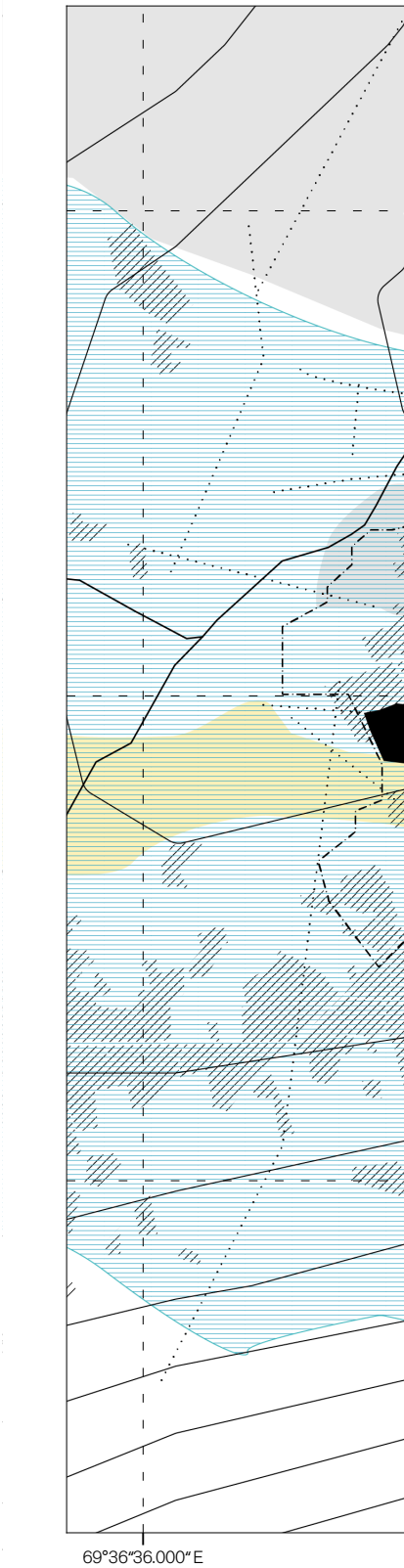
Bhuj is situated on top of a large sandstone aquifer, which has naturally been formed due to the unique geological conditions of this area. The region is prone to earthquakes and there are multiple fault lines crossing the urban area of Bhuj.

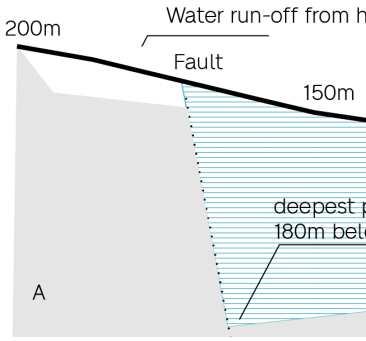
- Fault line
- Bhujiya hill
- Porous sandstone
- Ferricrates
- Alluvium and non-permeable shale
- Aquifer

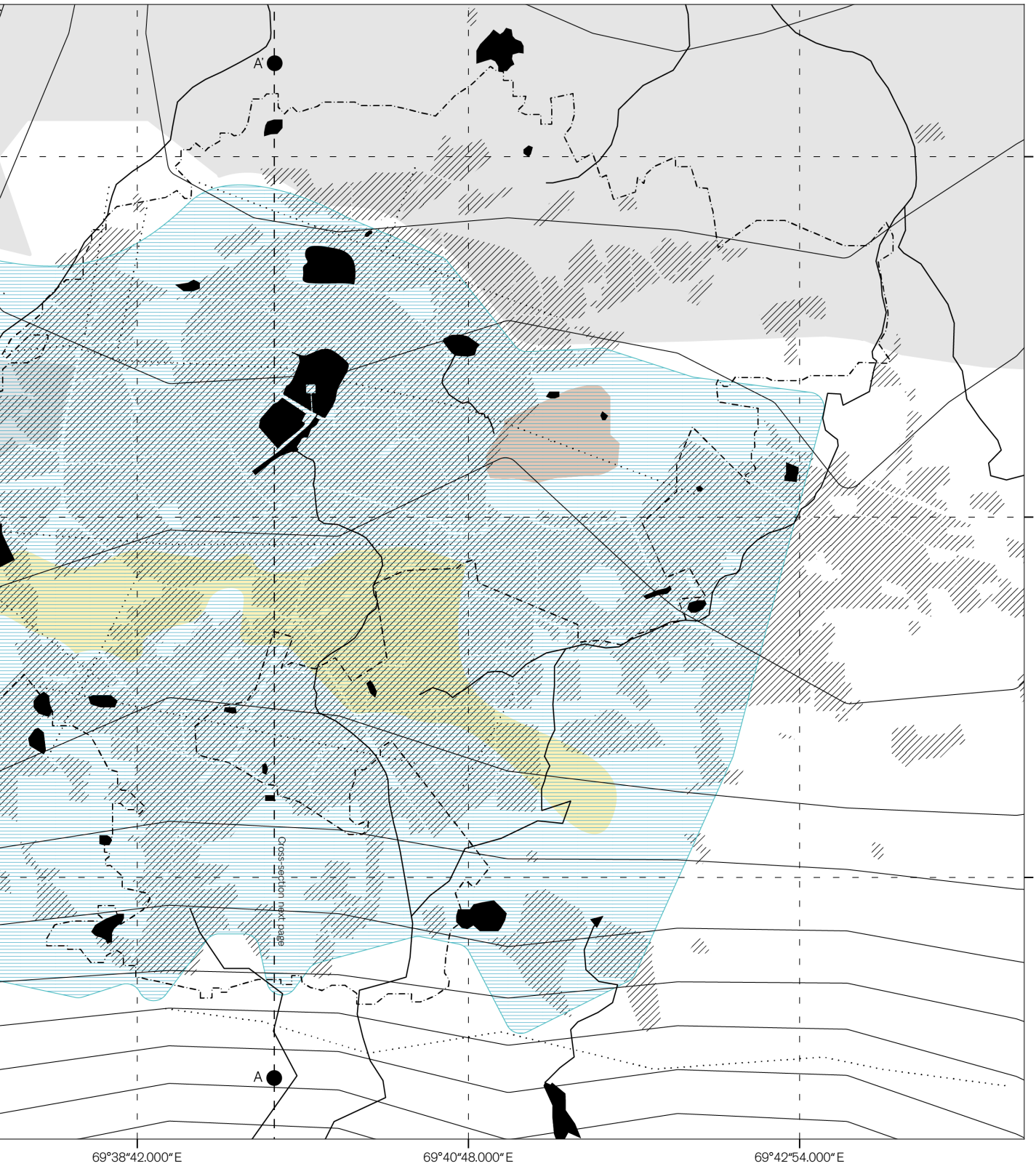
Basemap

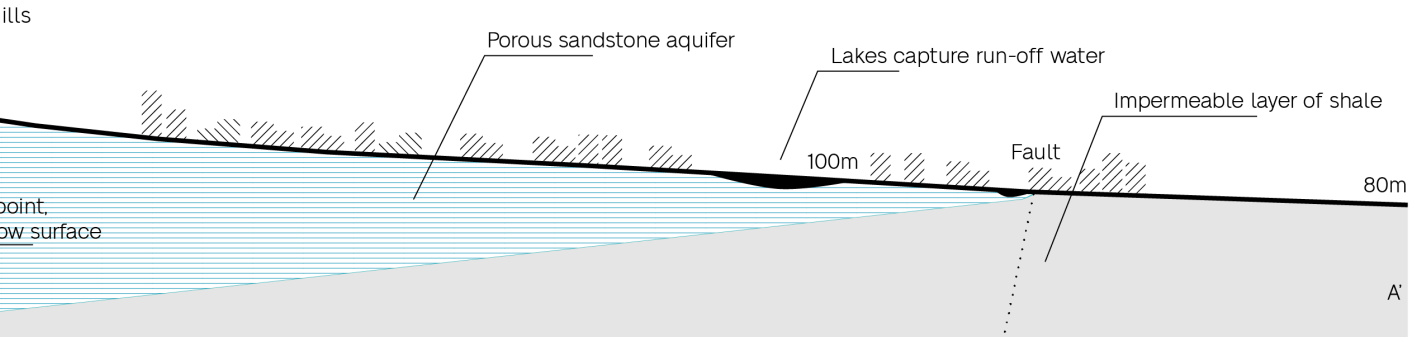
- Bhuj city boundary
- Residential area
- River
- Waterbody

0 1 km N






A'
A
Cross-section next page
23°16'30.000"N
23°14'24.000"N
23°12'18.000"N
69°38'42.000"E
69°40'48.000"E
69°42'54.000"E


ills
Porous sandstone aquifer
Lakes capture run-off water
Impermeable layer of shale
100m
Fault
80m
A'
oint,
ow surface

3.5.4.
Soil Quality

The topsoil of Bhuj is sandy. This does not hold moisture very well and is generally not nutritious by itself. Agriculture is therefore only possible with irrigation and the addition of fertilizer.

There are several industrial areas in Bhuj which are expected to have a negative effect on the soil quality (Open Street Map, 2020).



Industrial area
Agriculture

Base map

Waterbody
River
Road

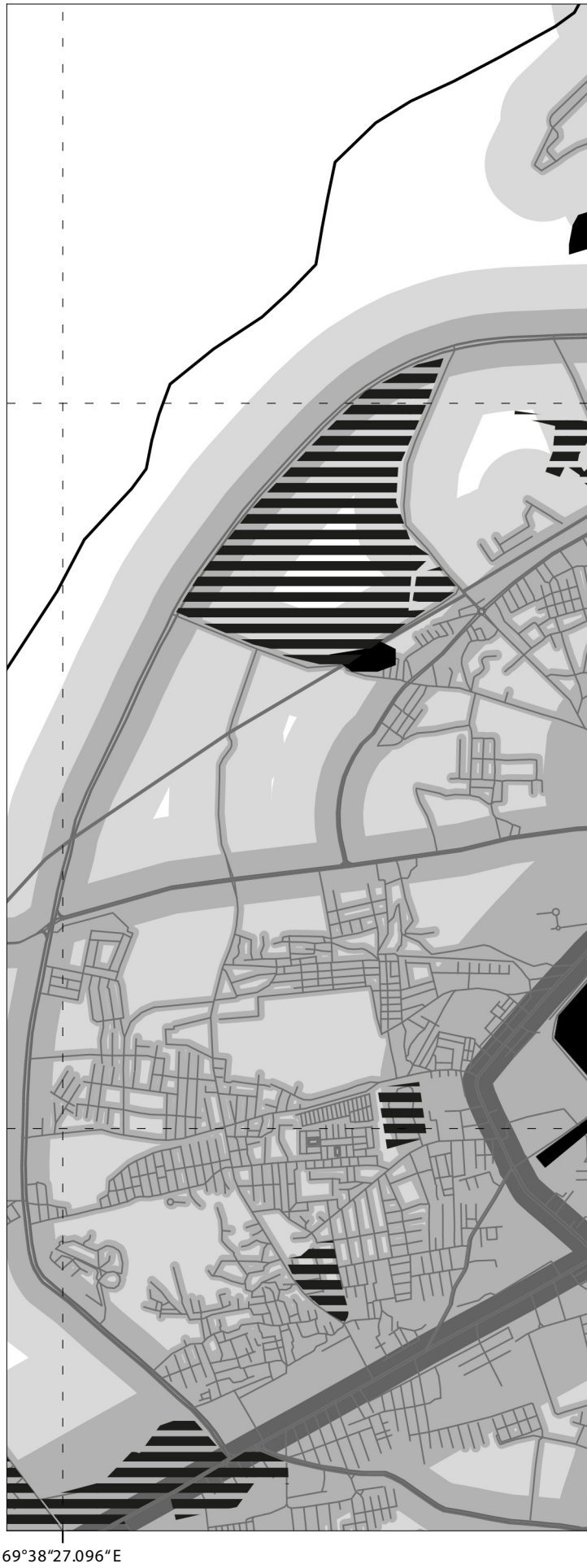
N

0 500 m


23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E

3.5.4.
Pollution

Since there is no open pollution data available for Bhuj at a small scale, the pollution shown in the map is an estimation based on the road classification in Open Street Map (2020). It is expected that larger roads are used more often, resulting in higher levels of noise and air pollution. The main air quality pollutant in Bhuj is PM2.5. This is an indication of fine particles, often originating from combustion engines of either cars or factories (IQ Air, 2020).

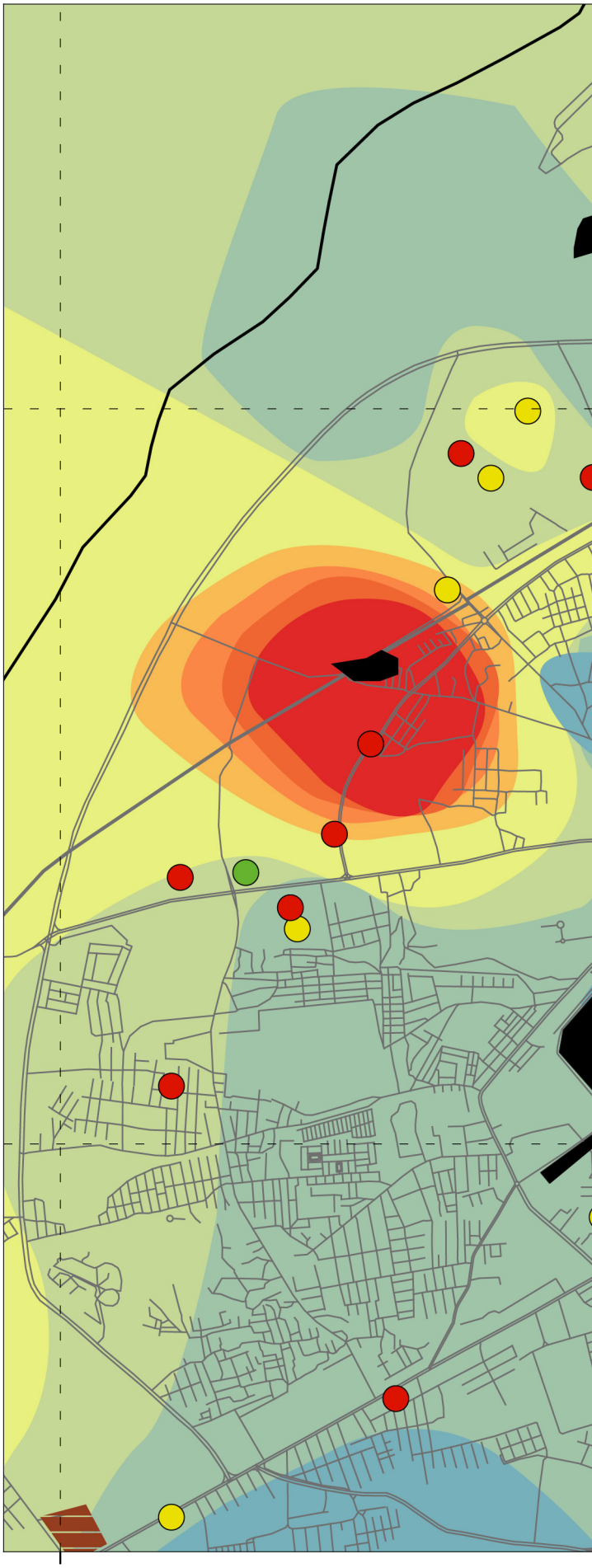



23°16′8.544″N
23°14′40.920″N
69°39″54.720″E
69°41″22.344″E

3.5.5.
Water quality and accessibility

The ground water quality is measured in TDS (total dissolved solids). A TDS value can be high as a result of salt bearing rocks or pollution in the water. The TDS value also increases as a result of over-exploitation of the water resources (CEPT University, 2016).

There are a number of (private) wells in the city. Some informal settlements do not have access to water and rely on water sources from outside the city, such as tankers.



TDS concentration in ground water in mg/L

- 500
- 1000
- 1500
- 2000
- 3000
- 3500
- 4000
- 4500
- >5000

TDS concentration in wells in mg/L

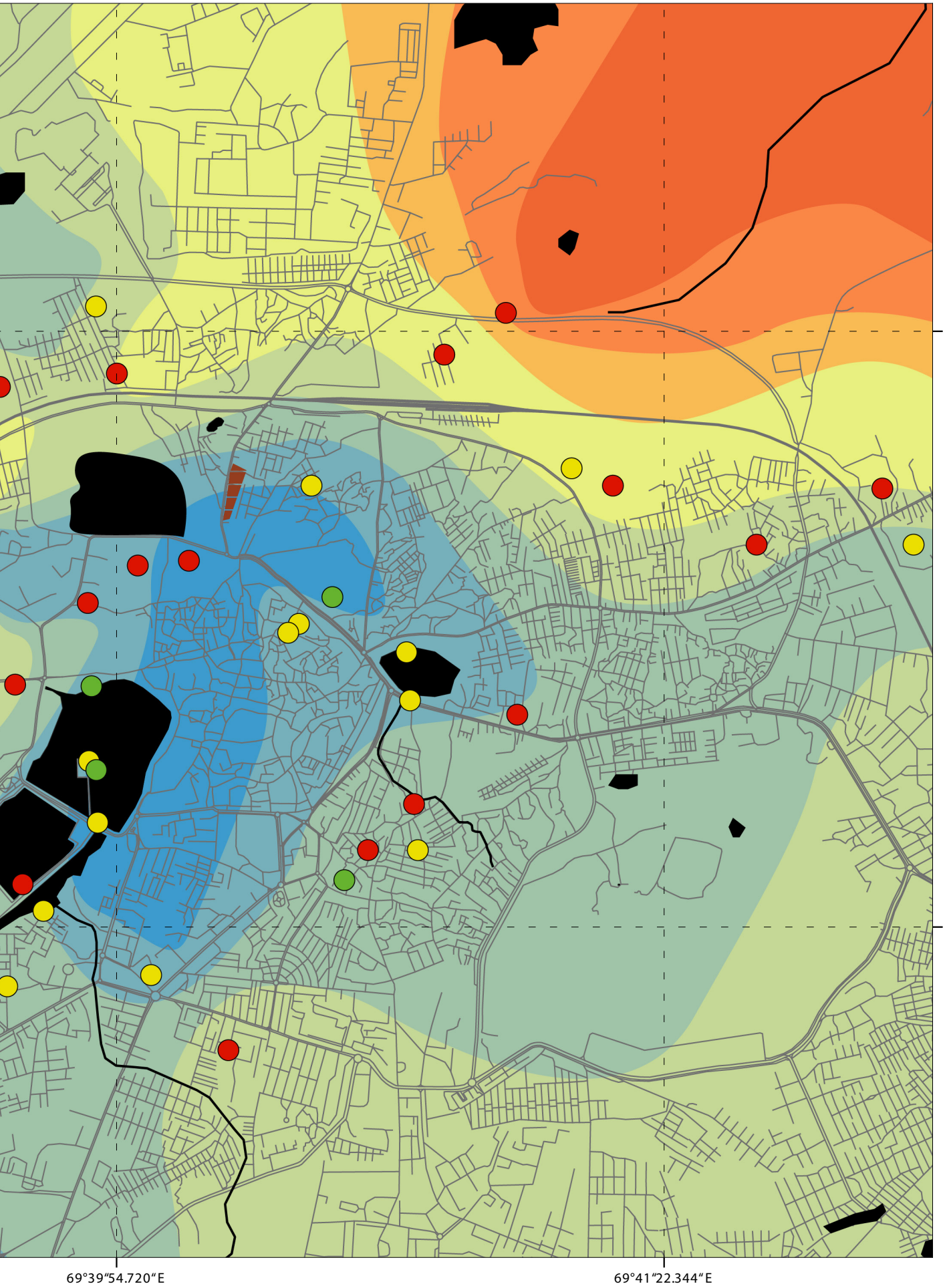
- 0-500
- 501-2000
- >2000

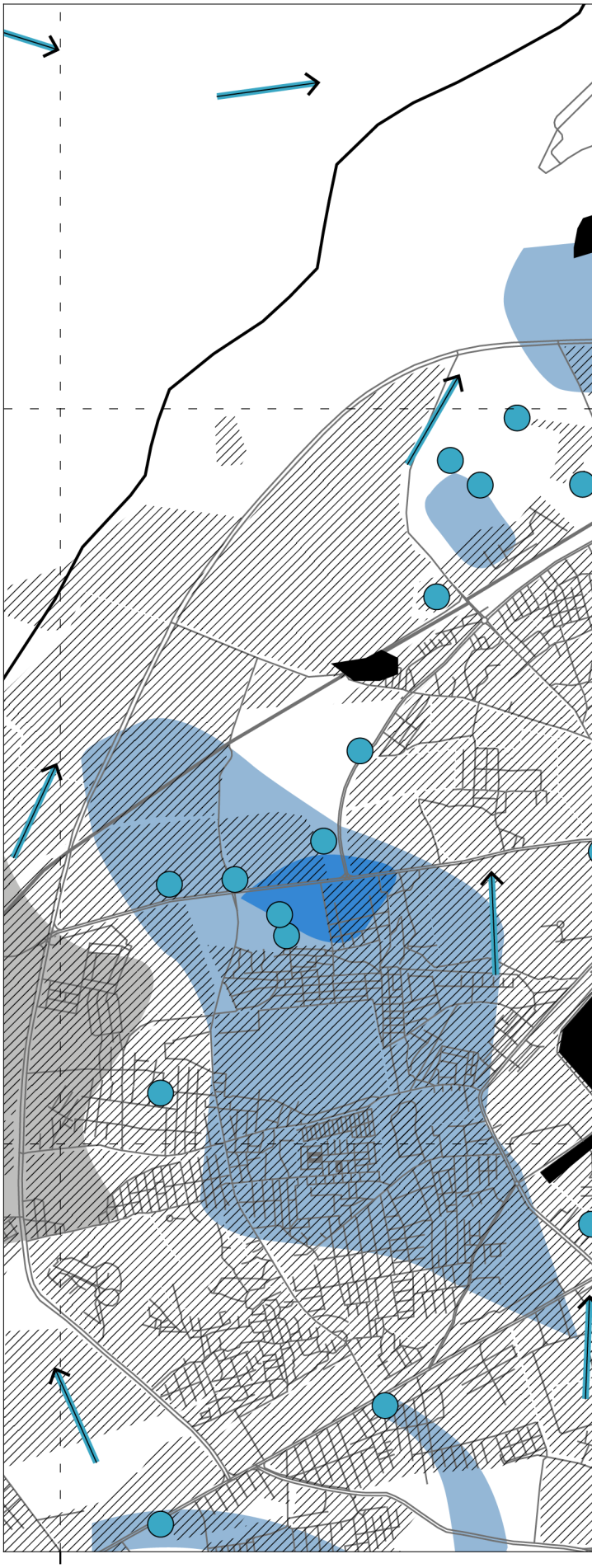
Water access

- Slums without water access

Base map

- Waterbody
- River
- Road


23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E



3.5.6.
Recharge potential

This maps shows the suitability of areas for recharging the ground water in the aquifer. This is based on the water quality map and the soil properties. Currently, this potential is not achieved as water cannot infiltrate due to impermeable land uses.

- Highest feasibility
- Moderate feasibility
- Average feasibility
- Low feasibility
- Very low feasibility

- Well
- Run-off flow direction
- Impermeable land-use

Base map

- Waterbody
- River
- Road

N

0 500 m


23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E

3.5.7.
Extreme ecosystems

The extreme ecosystem map shows conflicts and challenges between the ecosystem and the people.

Pluvial flooding
- Mostly impermeable surface

Ground water pollution
- Heavily polluted (TDS>3000)

Unpredictable preciptation and unreliable water supply
- Cow pastures and crop farming

Unpredictable preciptation and unreliable water supply
- Private water tanker supplier

Neglectance of traditional water system
- Disappeared lakes
- Water stagnation or paralysed flow
- Heavily polluted lakes
- Waste dumping

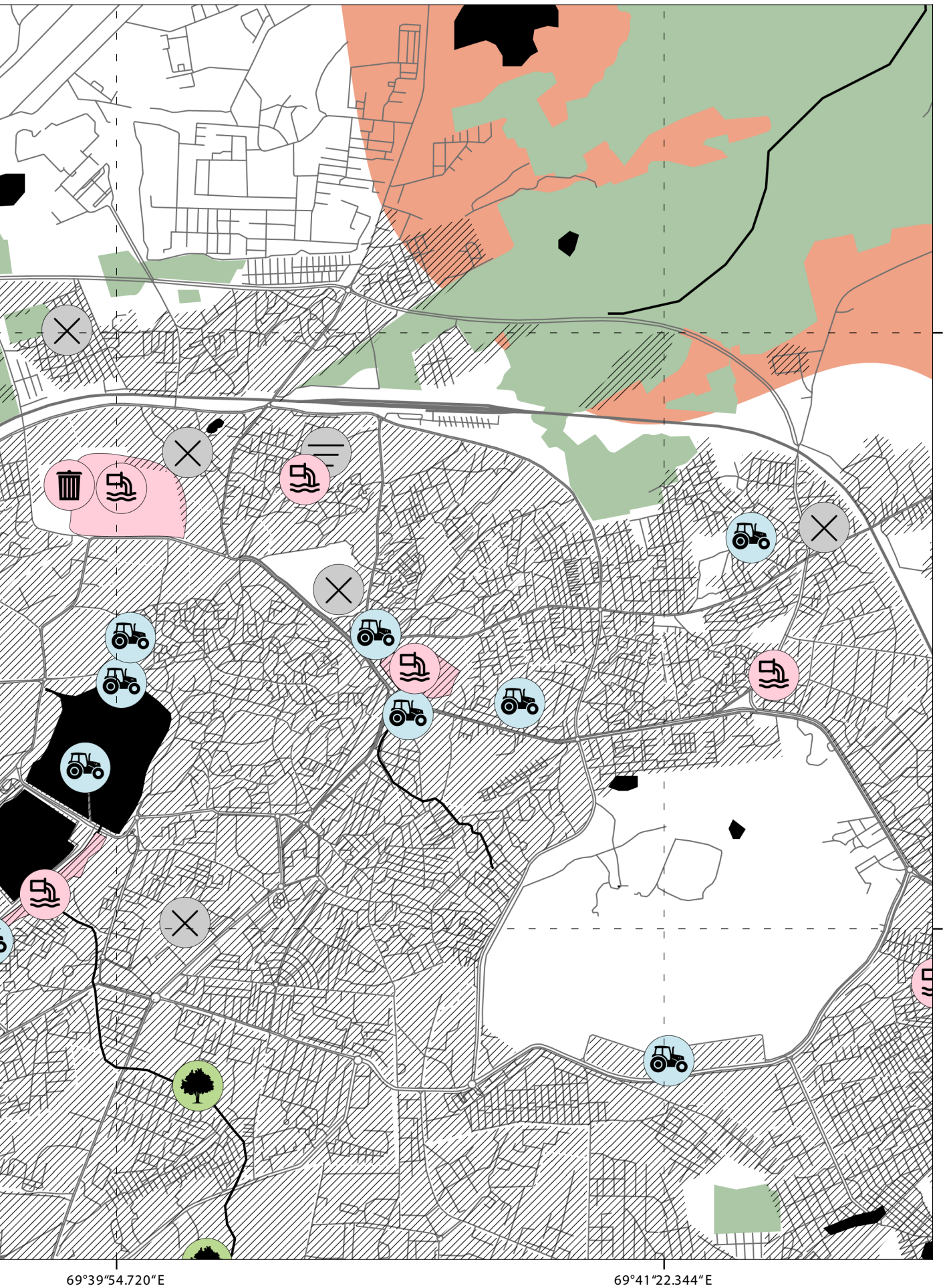
Invasive species
- Prosopis julifora

Base map
- Waterbody
- River
- Road



N

0 100 km


23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E

3.6. Urban

Access to reliable information online for Bhuj is limited. This is an indicative of the planning challenges faced by NGOs, agencies and institutions. Working remotely, most of the information collected was done by tracing maps available from the CEPT University report from 2017 and gathering open access information from Open Street Maps using GIS. Reports available online on ISSUU were also consulted, especially when closer to ground observations were needed.

An Urban Historical Summary

Historically, Bhuj urbanized limited to local water provision. In pre-colonial times, local rulers developed the water system to harness and store water with interconnected canals and lakes that functioned with the natural catchment areas. With British Colonization, this system was abandoned, and a more centralized and westernized water system was favoured by the colonial civil engineers.

The city has a radial morphology, with clear dense historic core, delineated by the walled pre-existence that was later demolished to make way for roads and greater accessibility. The city expanded as workers arrived seeking work in industries that installed in the cities periphery seeking the advantages of centralized water and energy infrastructures the concentration of work force. Earthquakes, distinctive characteristic to the region, have also fragmented the urban fabric, due to infrastructure being permanently damaged and not fully reconstructed, leaving gabs in the urban fabric that never fully become reoccupied.

As water became scarce, caused by a combination of overconsumption and reduction of infiltration capacity of the traditional water system, and the centralization of water provision to service mainly industries, the city's population grew and so did water demand. Expansion favoured the south, where most of the aquifer subsurface and catchment areas could be exploited with wells to extract water. Consequently, more catchment areas were paved over and disrupted, reducing water infiltration. Moreover, the nature of occupation was private with closed developments, and the new wells service only a few families. This fragmented development weakened urban cohesion and reinforced the social disconnection with territorial hydrologic dynamics. Climatic cycles, such as monsoons, became perceived as disasters rather than opportunities.

(3.6.1.) Urban Infrastructure

Given the unplanned nature of urban expansion in Bhuj, most road structures grew based solely on the demand for urbanization. This model of development allowed for a disintegrated urban fabric which only exacerbates the existing social and economic disparities. It is possible to read the road fabric as gridded patches, where each patch looks to provide cohesion within their designated site limit, but on the city scale, fail to integrate between themselves and to greater networks. This indicates there is a lack of management and coordination capacity on the city to regional scales. Ona regional level, the reduced railway infrastructure available within the city for urban transport corroborates with this understanding that city management lacks the capacity to plan and manage the growth of Bhuj.

(3.6.2.) Land Use

The north of the city tends to concentrate most of the zones dedicated to industry, while the south expands mainly with residential areas, and in many cases over agricultural land or river flood areas from dried up catchment areas. Slums have concentrated around the city centre where previously formal buildings existed, levelled by earthquake disasters. Despite this, these areas continue to be relatively well serviced and near industrial sites, which motivated their informal occupation.

(3.6.3.) Urban Morphology and (3.6.4.) Typology

Understanding the urban morphology of Bhuj is important in order to grasp the potential influence that these urbanized areas have o the local ecology and hydrology dynamics that directly affect underground water quality and quantity. The vast majority of urbanization is impermeable and given the lack of drainage infrastructure in most urban areas, most of the precious water to recharge the underground aquifer and maintain ecology is lost. The urban fragmentation and lack of compact urbanization in most of the city also impedes urban cohesion and more just access to amenities and services.

Four sites were selected that exemplify the main urban typologies and their relationship with the urban fabric, these are:

1. Historic centre, where the city is characteristically compact and with mixed use programs, which allows for a multitude of activities and services to happen at walking distances from residences. The informal street pattern inhibits a clear hierarchy of flows, which can be disorienting especially with emergencies. The organic dense urbanization of this area has also left few public spaces, since this area was developed with a different intent in the past, maximizing habitable space within a defensive walled perimeter.

2. Most lakes around the city centre are rimmed by institutional edifications, mainly for religious practices, configured with buildings placed on the

extremities of the site and open private spaces left to the centre. Due to this introspective nature, the public areas around the sites tend to be neglected with no open program towards the public space.

3. The slums have developed in areas with little service of amenities and on undesirable land for building such as flood zones or brownfields. The stark contrast of spatial occupation of institutional formal sites to the south and east show that land ownership is enforced, given that the informal slum settlements have not occupied these areas. This also goes to show that the informality is maintained, since their existence was allowed on certain sites.

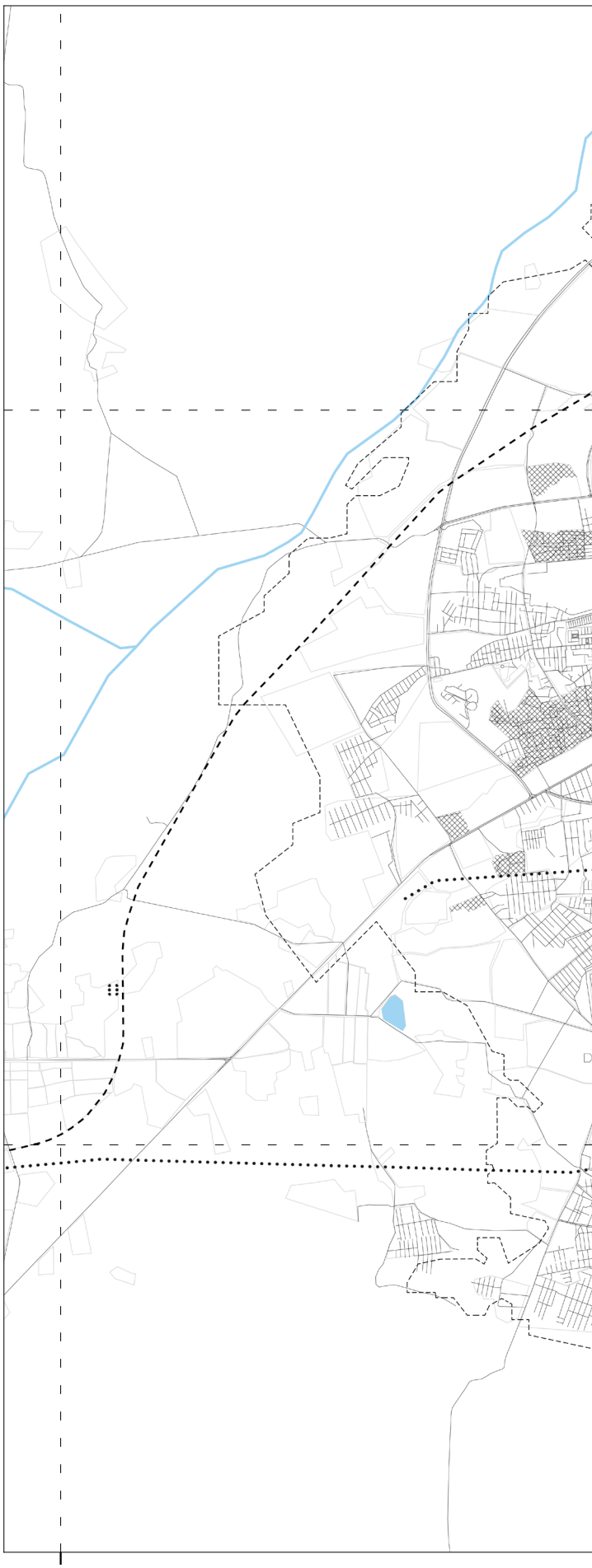
4. Colonies & enclosed residential developments have expanded greatly after the earthquake of 2001 where emergency financial packages and extraordinary management coalitions were formed to redevelop Bhuj. This motivated rapid urbanization, and many private developers looked to develop housing in cheap areas around Bhuj, maximizing profit. The subsequent lack of a continuous and sustainable planning and management model in Bhuj, led to a disorganized development where the fragmentation of the urban fabric surged. Again, the need to maximize space, but in this instance for increasing profit margins, led to minimal or inexistent spaces for public activities or spaces considered “idle” such as green spaces.

(3.6.5.) Infrastructure for Welbeing

Most of the wellbeing infrastructure concentrates around the central part of Bhuj. The predominance of wells indicates that water provision in these areas is mostly dependent on the aquifer, if compared to the outer areas of Bhuj which are serviced by sump wells and pipeline water. Hospitals and health centres also concentrate around the central areas of Bhuj, although these are more evenly distributed throughout Bhuj if compared to the well system. It is important to take into consideration that there is no distinction between public or private wells. This distinction could indicate where there is more just distribution to water, considering that most poorer dwellings do not have piped access to water. We can assume that access to water for slums are done by nearby wells, them being private or public.

(3.6.6.) Water Artefacts in the Urban Environment

A series of water artefacts have contributed to the relationship and perception that residents have with water in Bhuj. These vary in scale and capacity. The most influential and traditional water systems are the natural and man-made lake systems present throughout Bhuj since precolonial times. We have looked at the conformation of three of the oldest of these lakes which have been influenced differently through time yet belonging to the same water systems that provide essential water to the city and recharging of the aquifer.



3.6.1.
Urban Infrastructure

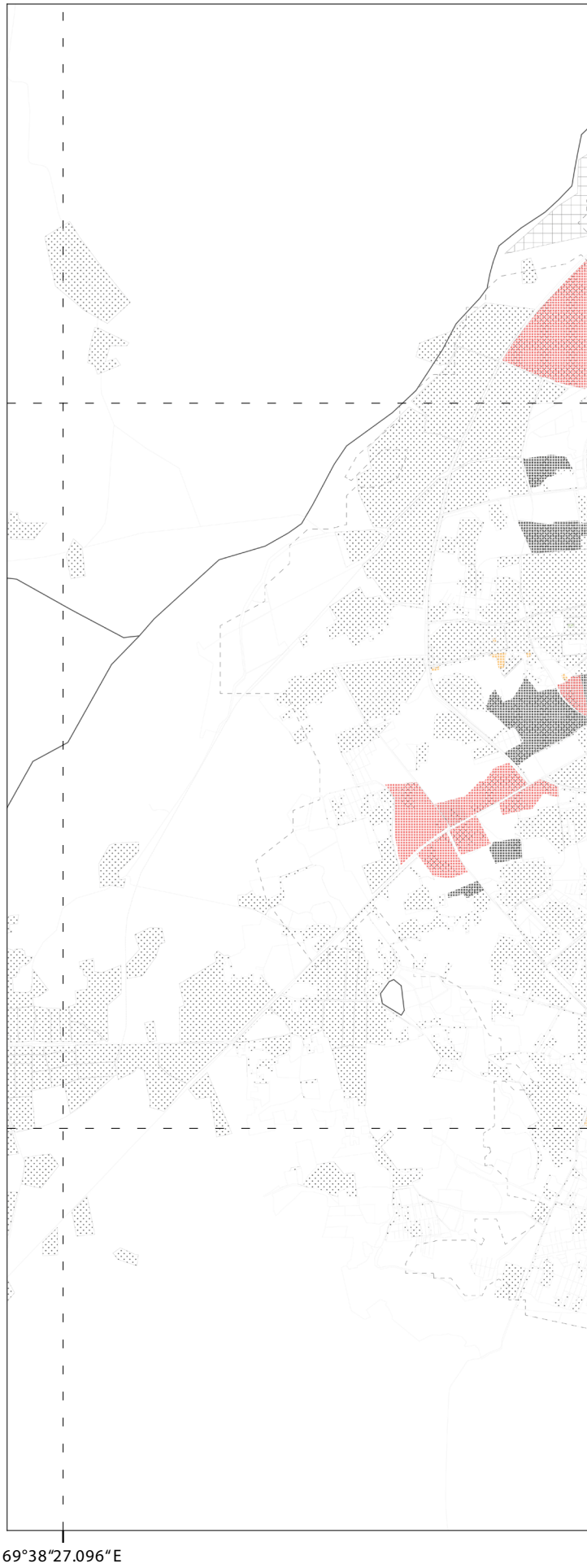
This map shows the main urban infrastructure of Bhuj. More recently, the city has expanded south with disconnected grids from private allotments and colonies.

Bhuj City Boundary
Water Bodies
Rail Station
Main Roads
Road / Path
Railway
Power lines
Rivers / Canals

N

0 1 km


23°16'8.544"N
23°14'40.920"N
69°39'54.720"E
69°41'22.344"E



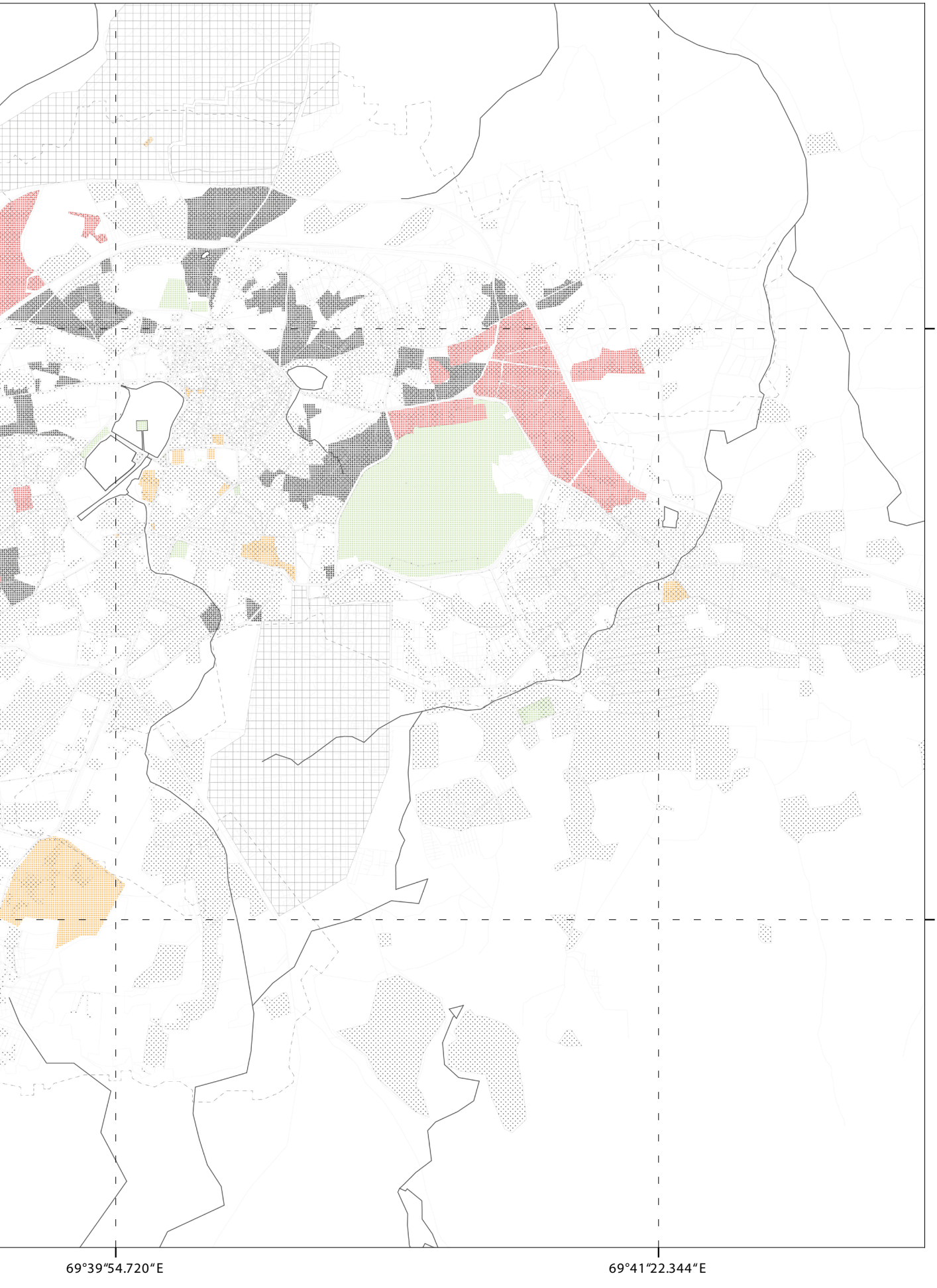
3.6.2.
Land Use

Zones for commercial, industrial, residential and other uses of land are spaced out and seem to be positioned based on pre-existing conditions or simply attending directly to programmatic needs.

- Bhuj City Boundary
- Urban Foorprint
- Open Areas
- Institutional Areas
- Park and leisure Areas
- Informal Settlements / Slums
- Industrial Areas
- Military Zones
- Water Bodies
- Road / Path
- Rivers / Canals

N

0 1 km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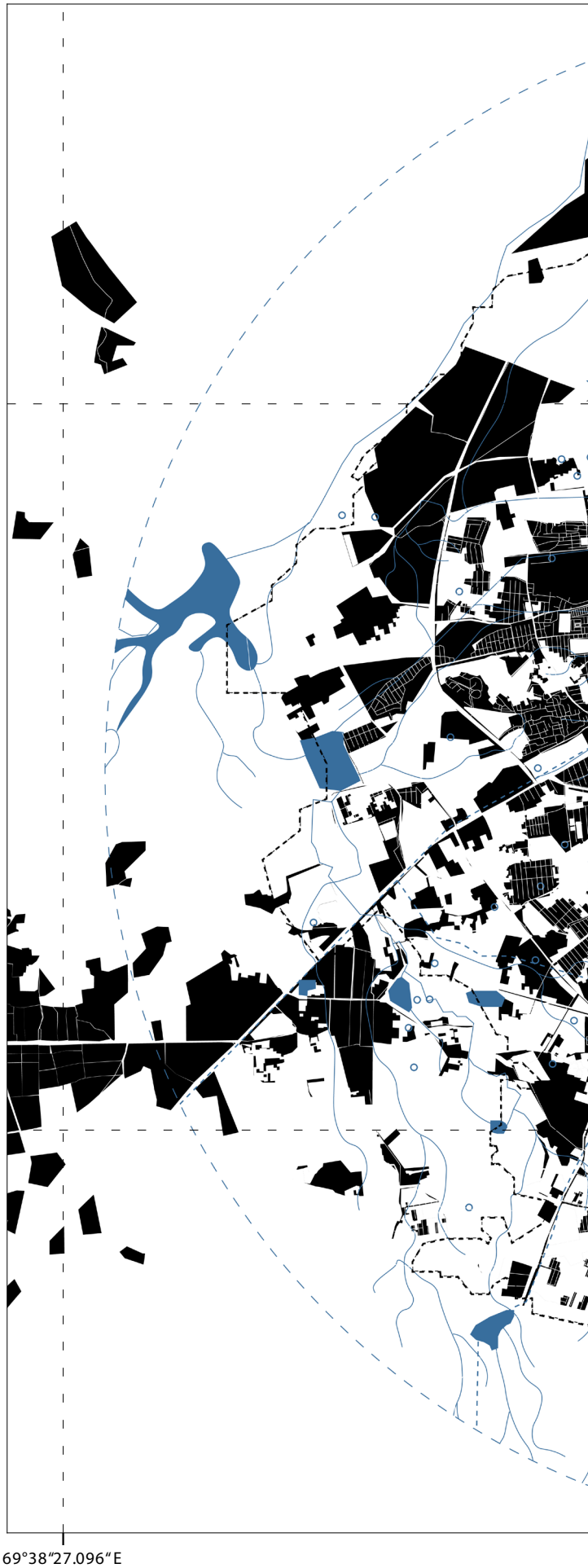
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E



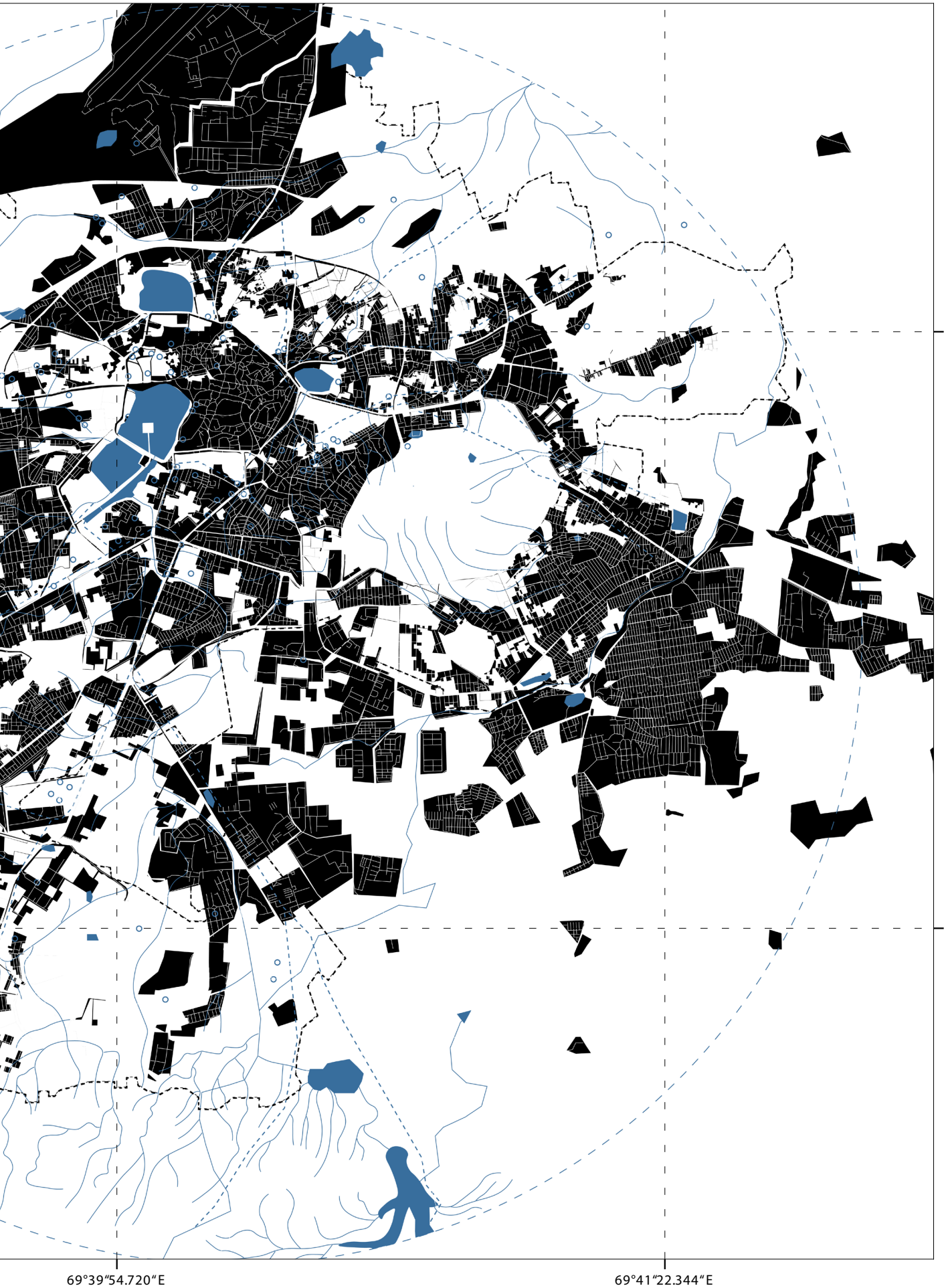
3.6.3.
Urban Morphology

This map shows the urban footprint and illustrates how fragmented and sparse development has impacted Bhuj. There is a direct relationship between the surface water body system disconnection and urban development patched growth.

- Bhuj City Boundary
- Open Areas
- Urbanized Urban Areas
- Water Bodies
- Road / Path
- Rivers / Canals

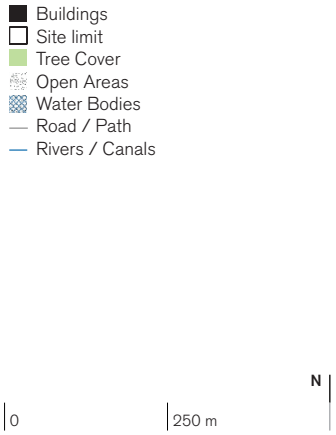
N

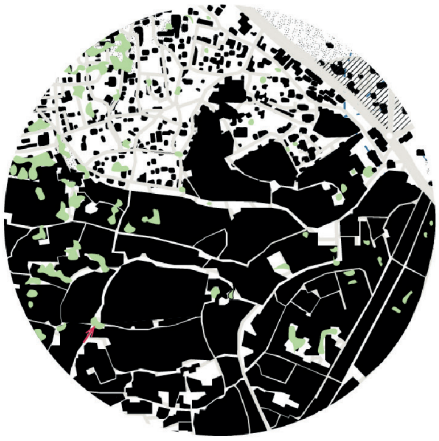
0 | 1 km


23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E

3.6.4.
Urban Typology

Four instances that exemplify the most common urban typologies seen in Bhuj. Historic, Institutional, Slum and Colony/ enclosed residential development.







1. Historic Centre

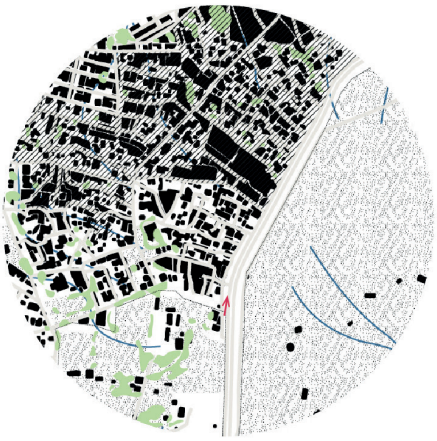
Dense mixuse area with little public green space and water management spaces.





2. Institutional

Large allotments with limited public access and program uses. Often have little relationship with surrounding public spaces.

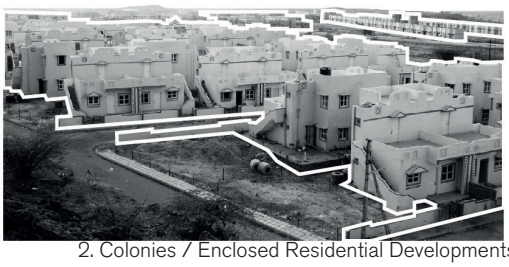




3. Slums

Dense areas with little or no access to public amenities. Often developed in sites with low demand or contaminated soil.



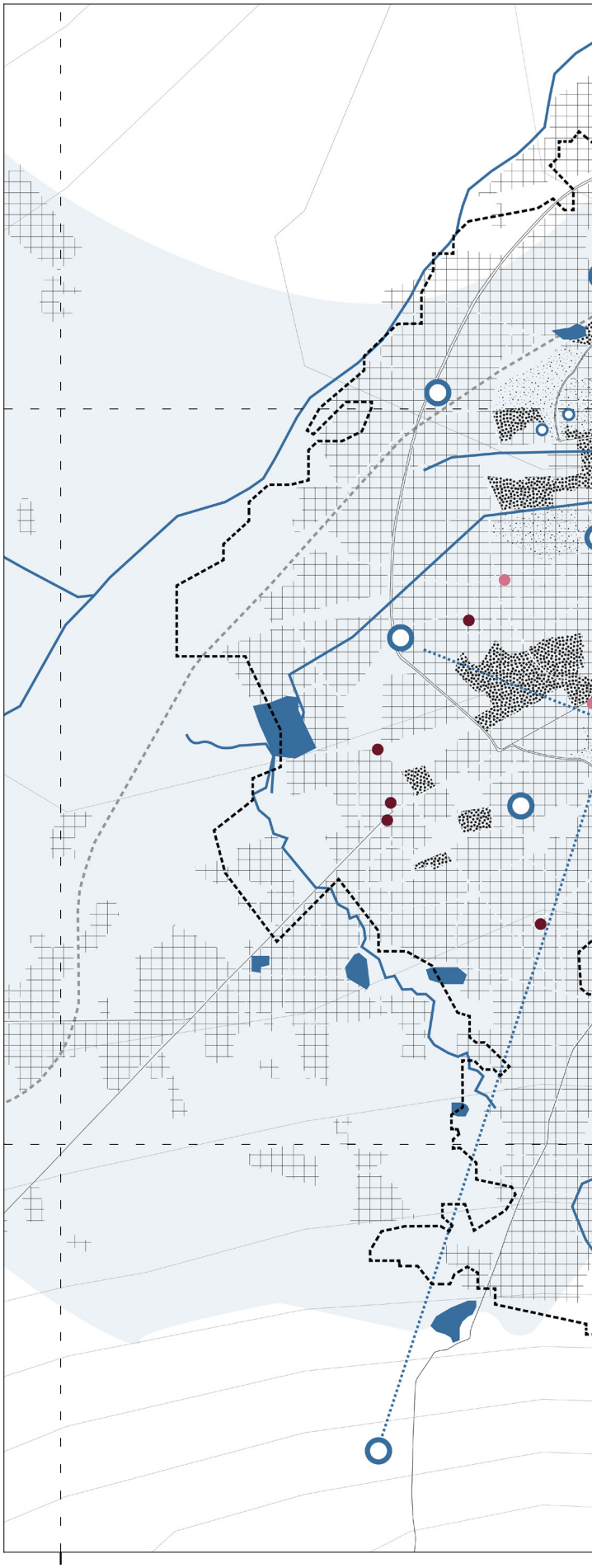


2. Colonies / Enclosed Residential Developments

Monofunctional sites with little or no integration with public areas and urban fabric. Lack of quality green-blue spaces.

3.6.5.
Infrastructure for Well-being

The map indicates all infrastructure related to water and health, grouped as “well-being” since these are considered key elements for the maintenance of health in urban environments.



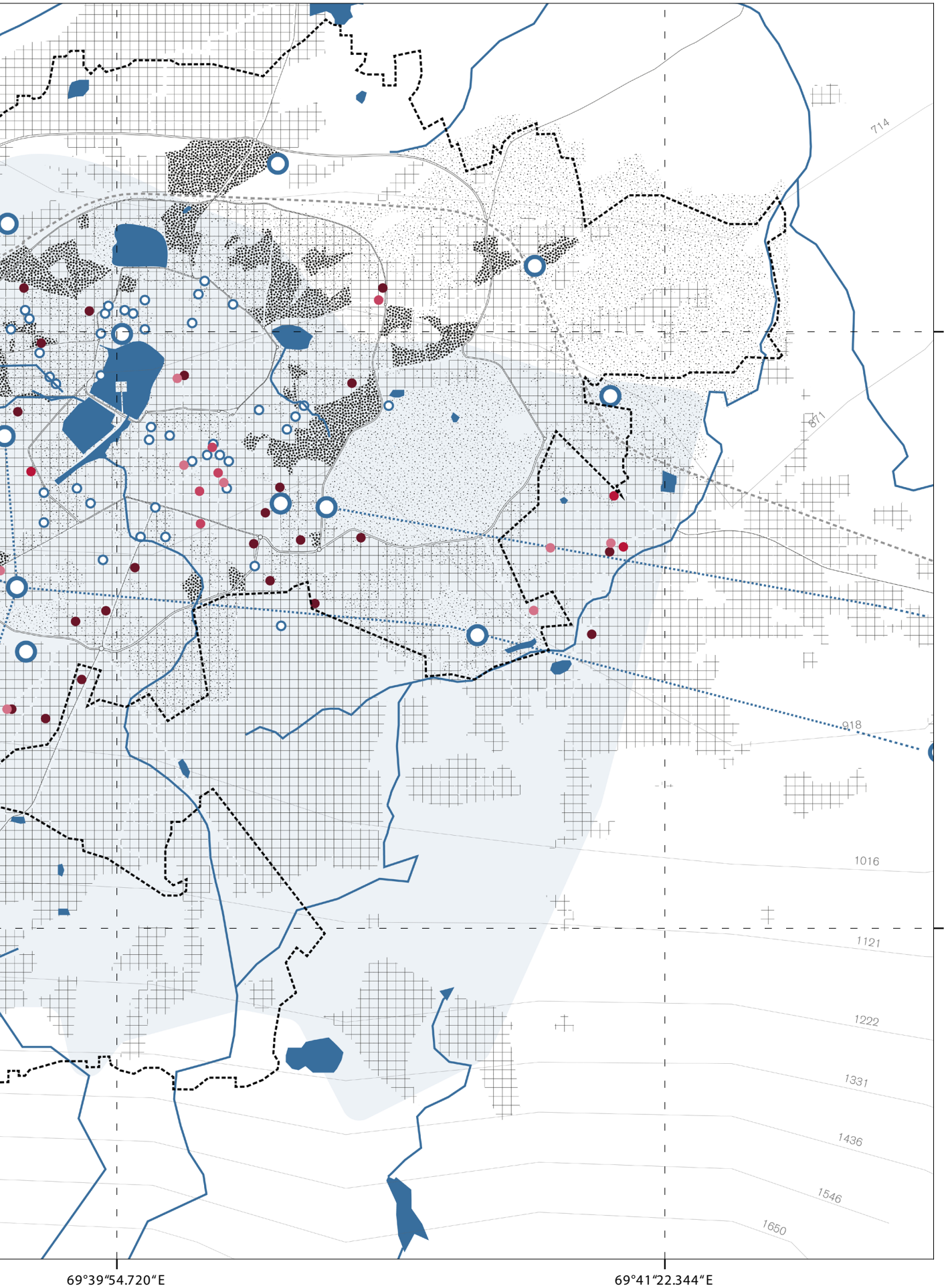
Water and Health Infrastructure
- Bhuj City Boundary
- Urban Footprint
- Open Areas
- Informal Settlements
- Military Zone / Infrastructure

Health
- Hospitals
- Health Center
- Policlinic
- Clinic

Water
- Water Bodies
- Aquifer
- River / Canal
- Sumps
- Wells
- Underground pipes

N

0 1 km


714
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1222
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1436
1546
1650
23°16'8.544"N
23°14'40.920"N
69°39"54.720"E
69°41"22.344"E

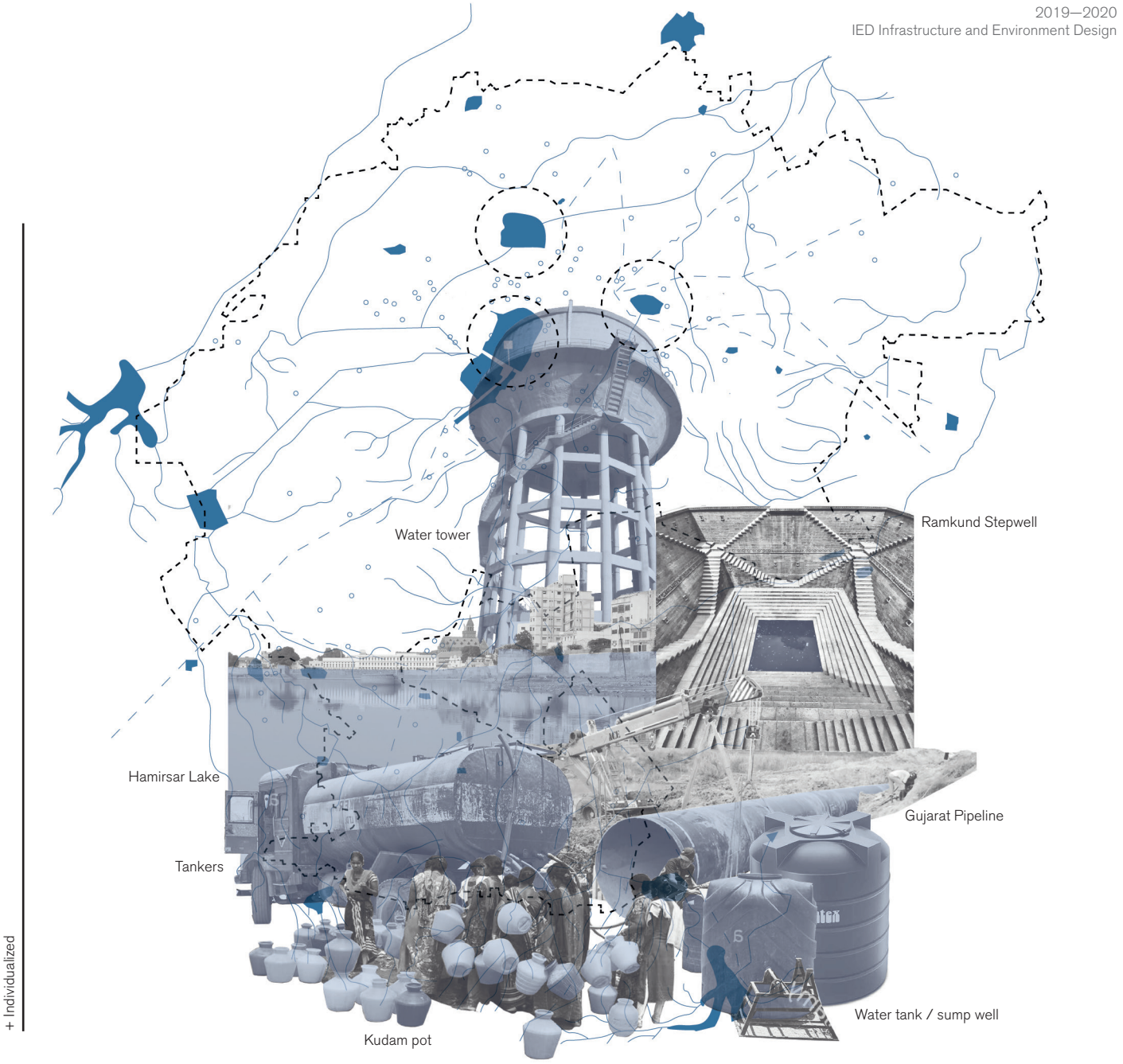
3.6.6.
Water Artefacts in the Urban Environment

Water provision is key to understand the urban structure of Bhuj. Water is provided by various systems for extraction and distribution using a combination of artefacts related to water. These vary in capacity and scale, and the urban and social dynamics related to them shape the relationship and perception of water.

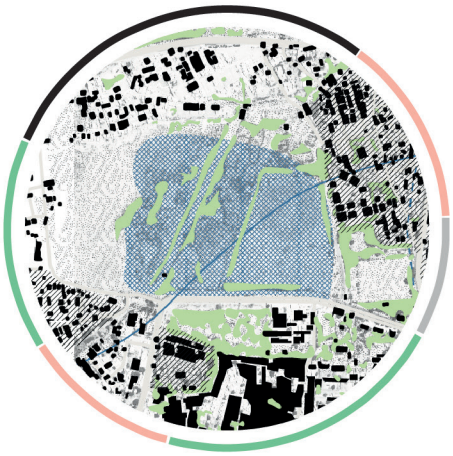
Lake margin typology

- Mainly Buildings
- Slums
- Park / Recreational space
- Agriculture
- Institutional
- Religious
- Water body



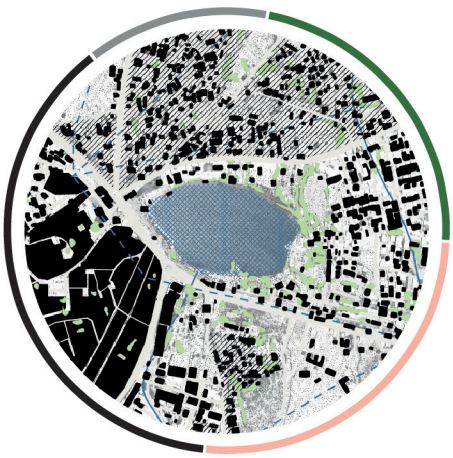


Lake Pragsar (Partial encroached and dry)



Due to the prolonged time that it has been dry, the lake bed has been partically urbanized with formaland informal settlements and uses. The lake has lost all of its natural characteristics.

Lake Deshalsar (Heavily Polluted)



Sitting withing a fairly urban context, yet with little historic significance, the lake water quality has dropped and due to the extreme pollution the water is unfit for use. prximity of slum areas and agricultural land also contribute to water low quality.

Lake Hamirsar (Historic and preserved)



Given its historical and religious significance, the lake is margined mostly by temples and institutional spaces like hotels and parks. This has allowed the lake to maintain its water quality good and water levels preserved most of the time.

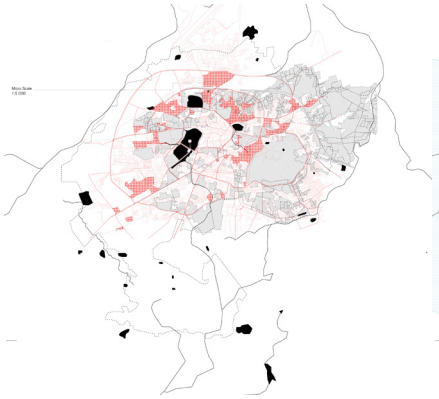
4.

Systems description and synthesis

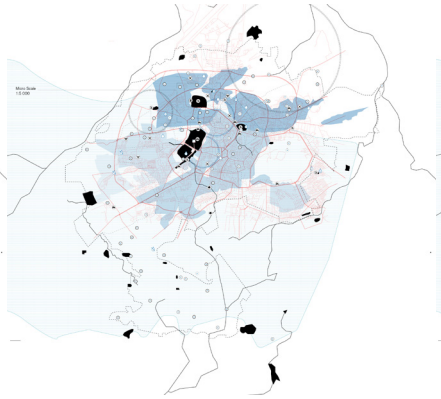
4.1. Hybrid system drawing

In the previous section, the city of Bhuj was analysed from five different perspectives. In this section, the most important findings of this analysis will be combined into one hybrid system drawing. This drawing gives new insights into where potential challenges and opportunities might occur. Interesting synergies and conflicts are discussed. The hybrid system drawing is drawn for two scales: 1:5000 and 1:5000. These two maps will be the foundation for the next section, the scenario building.

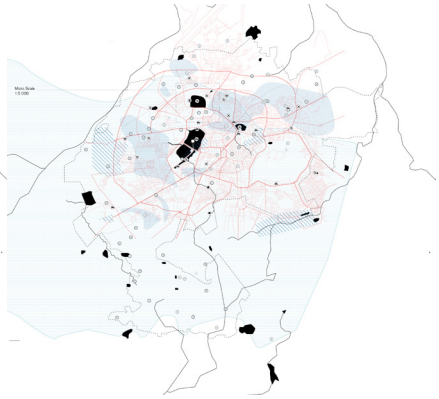
Understanding Challenges of Bhuj



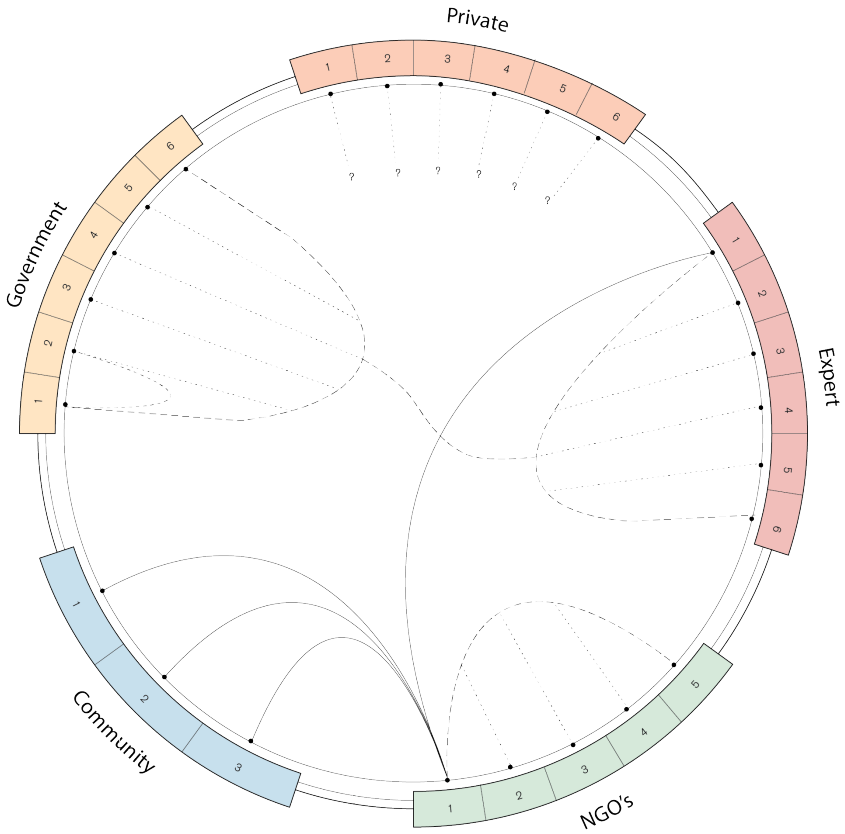
Socio-Spatial Inequalities



Exploited Hydrological System



People and Water



Local State National

Government
1. Bhuj Urban Development Authority
2. Bhuj Municipal corporation
3. Health Agencies
4. Department of Narmada Water Resources & Water Supplies
5. Ministry of Health
6. Ministry of Environment and Forest

Private
1. Drilling companies
2. Private tanker and supply companies
3. Local businesses
4. Independent Clinic Practices
5. Sardar Sarovar Narmada Nigam Ltd.
6. Gujarat State Drinking Water Company Limited

Expert
1. CEPT University
2. Ecologists
3. Urban water managers
4. Water treatment professionals
5. Drought resistance agriculture experts
6. National Institute of Urban Affairs (NIUA)

NGOs
1. ACT
2. Sahjeevan
3. Kutch Mahila Vikas Sangathan
4. Kachchh Nav Nirman Abhiyam
5. Hunnarshalaa Foundation

Community
1. Jalstrot Sneh Smavardhan Samiti (JSSS)
2. School/Education institutes
3. Religious Institutions

Existing Stakeholder Ecosystem

Currently, in the water project of Bhuj, the partnership between CEPT University and ACT has been strong enough. For the bottom-ups projects, the collaborations between community and NGO's need to be promoted more. However, the relationship between government and expert is still lack and enforcing them can promote decision making based on strong evidence provided by the experts. Moreover, private sectors are also possible to be cooperated with in the future projects to achieve multidiscipline synergy.

Synethesizing Challenges of Bhuj

This drawing aims to synthesize hydrological conditions with key urban morphologies. The overlaying of layers provides insights of the most sensitive areas in Bhuj.

The concentration of slums are located in the northern areas where water conditions are deteriorated. This suggests the excaccerabation of existing socio-economic inequalities through challenges of water scarcity. These inequalities can be seen across a north to south gradient of the city where the challenges of water such as accessibility is more severe within the informal settlement areas (north and central parts) and less severe near the many hotels, resorts and private development, where water is consumed on a recreational and individualized basis. It is also notable the water conditions are most severe in the northern which receives the most frequent supply. It would be important to understand who benefits from the frequent water supply.

The vast open space area and pockets of recharge potential provides opportunities to revitalize the current state of the hydrological network, and could empower surrounding communities in participating within their lands potential.

Political-Spatial Conditions
- Road
- Waterline
- Ward Boundary
- Municipal Boundary
- Water Body
- Slum
- Open Area Space

Water Supply Frequency
- Daily Water Supply
- Supply every 2 days
- Supply every 3 days
- Supply every 4 days

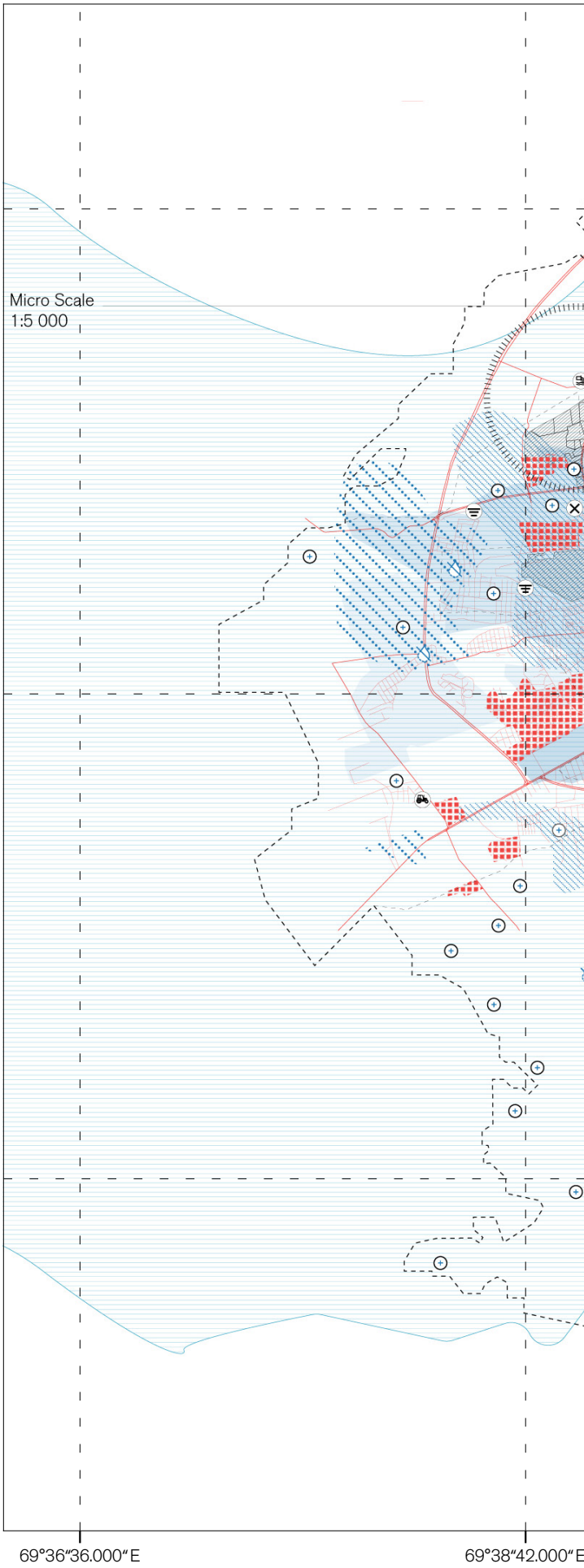
Water Recharge Potential
- Moderate-High Recharge Potential
- Low Recharge Potential

Water Quality
- Vanished
- Heavily Polluted
- Partially Encroached

TDS Concentration in Water Wells (mg/L)
- 0-500
- 501-1000
- >2000

TDS Concentration in Ground Water (mg/L)
- 500-1000
- >3500

Hydrological Conditions
- Waste Dumping
- Heavily Polluted Lakes
- Private Water Tanker
- Prosopis Julifora
- Disappeared Lakes
- Water Stagnation
- Aquifer



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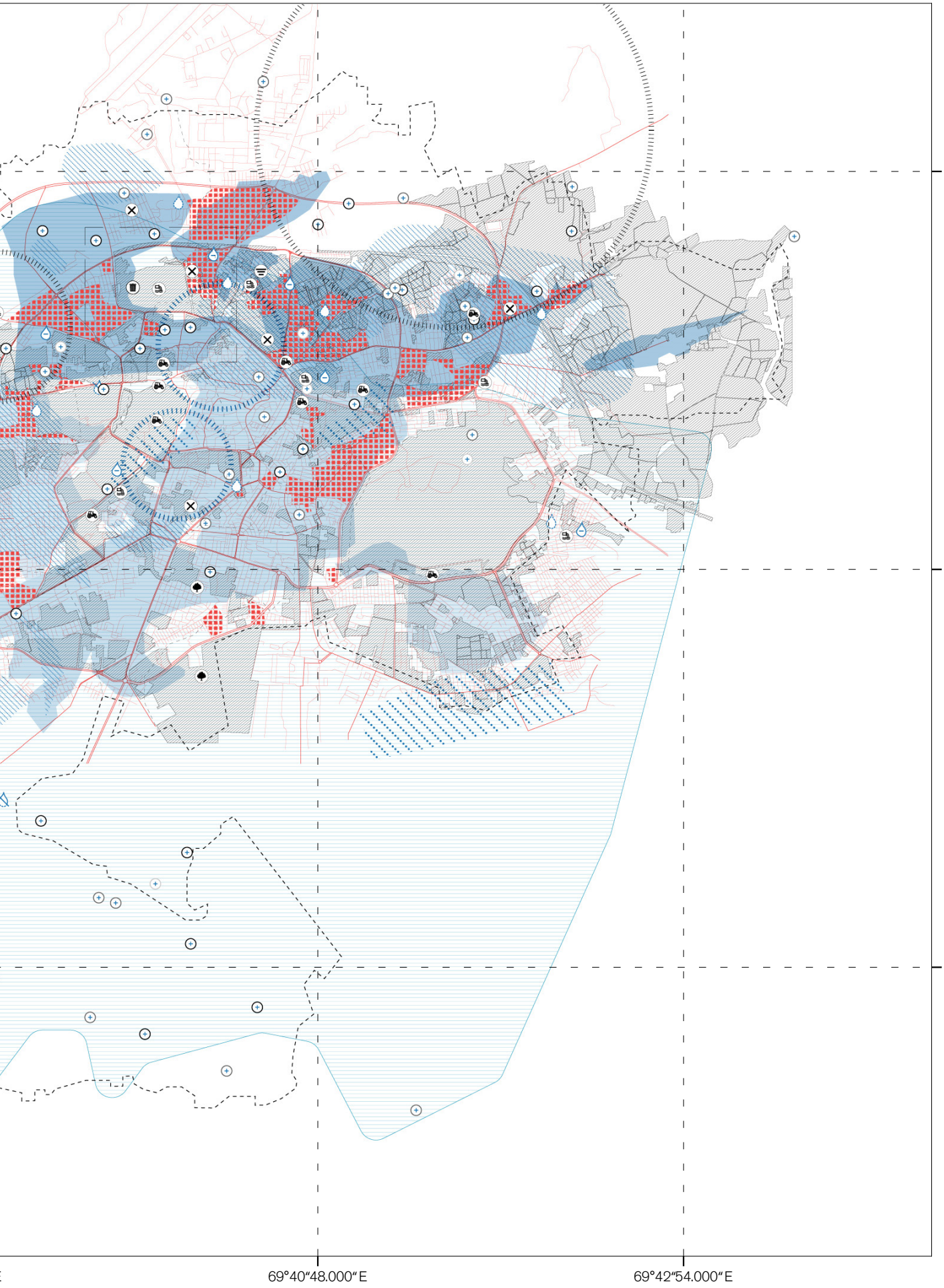

23°16′30.000″N
23°14′24.000″N
23°12′18.000″N
69°40′48.000″E
69°42′54.000″E

Understanding Challenges of Bhuj

The intersection of various challenges expresses in the macro synthesis can be understood a the micro scale. The selected site is based on the diversity of conditions such as open space, informal and formal settlements as well as varying water quality.

The challenges can be considered as opportunities that can improve the environmental degradation and social inequalities through possible experimentation and scenarios.

Political-Spatial Conditions
- Road
- Waterline
- Ward Boundary
- Municipal Boundary
- Water Body
- Slum
- Open Area Space
- Building

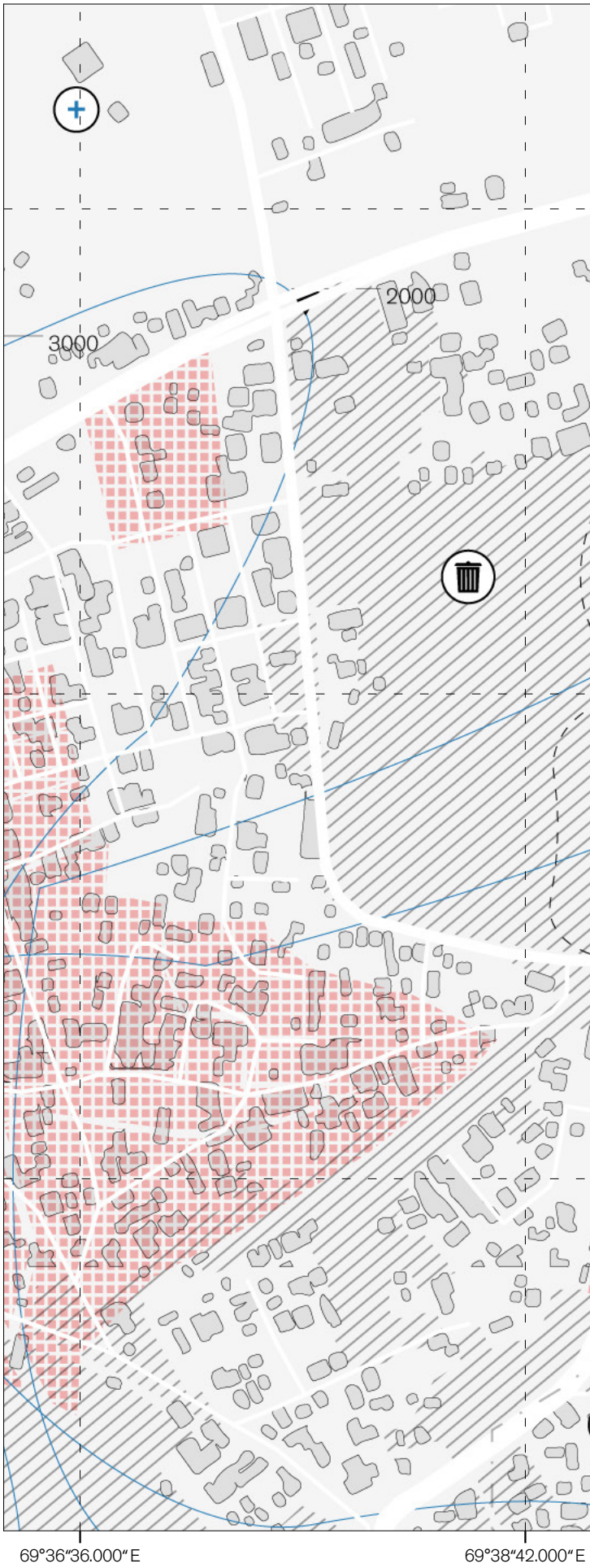
Water Recharge Potential
- Moderate-High Recharge Potential
- Low Recharge Potential

Water Quality
- Vanished
- Heavily Polluted
- Partially Encroached

TDS Concentration in Water Wells (mg/L)
- 0-500
- 501-1000
- >2000

TDS Concentration in Ground Water (mg/L)
- 500-1000
- >3500

Hydrological Conditions
- Waste Dumping
- Heavily Polluted Lakes
- Private Water Tanker
- Prosopis Julifora
- Disappeared Lakes
- Water Stagnation
- Aquifer



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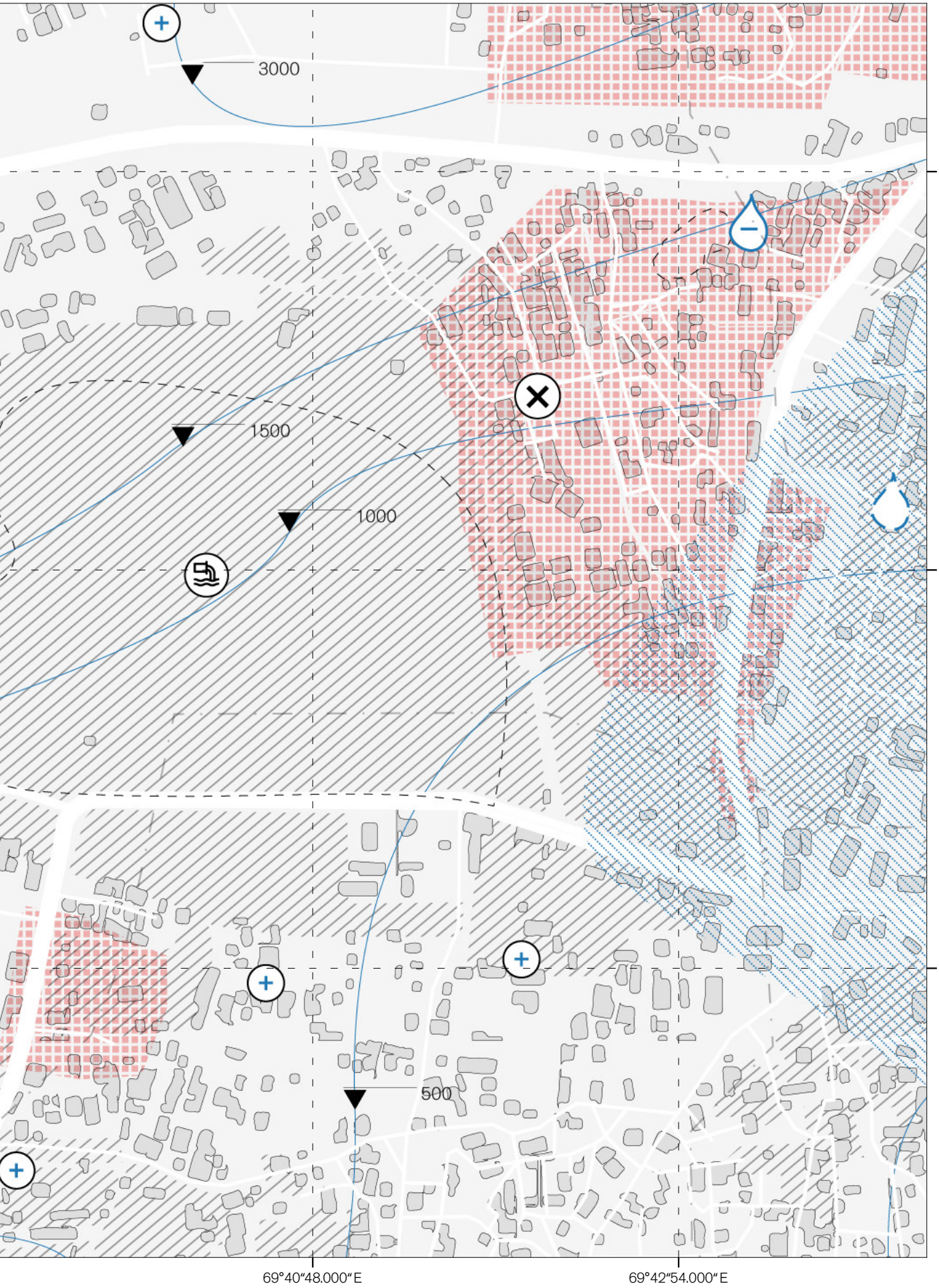
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23°14"24.000" N
23°12"18.000" N
69°40"48.000" E
69°42"54.000" E

5.

Scenario making

5.1. Nature First

Nature is put central in the design of Bhuj. There is a fine balance between urban development related to water scarcity and ecological performance.

5.2. No technology

In the design of Bhuj natural and human based solutions are preferred over heavy technological solutions, which in some cases means using vernacular techniques.

5.3. No humans

People will gradually leave Bhuj, first a few, eventually all of them including the inhabitants of the informal settlements. What's left is only nature.

5.4. COVID-19

Health and the spread of diseases play a key role in the design of Bhuj.

5.5. More Technology

Technical solutions are used to sustain Bhuj and its thirst for water in this extreme desert environment.

5.1. Nature First Scenario

In this scenario, nature is put central in the redesign of Bhuj. However, Bhuj will still be a thriving city. This means that urban development is integrated and strongly related to ecological and environmental performance.

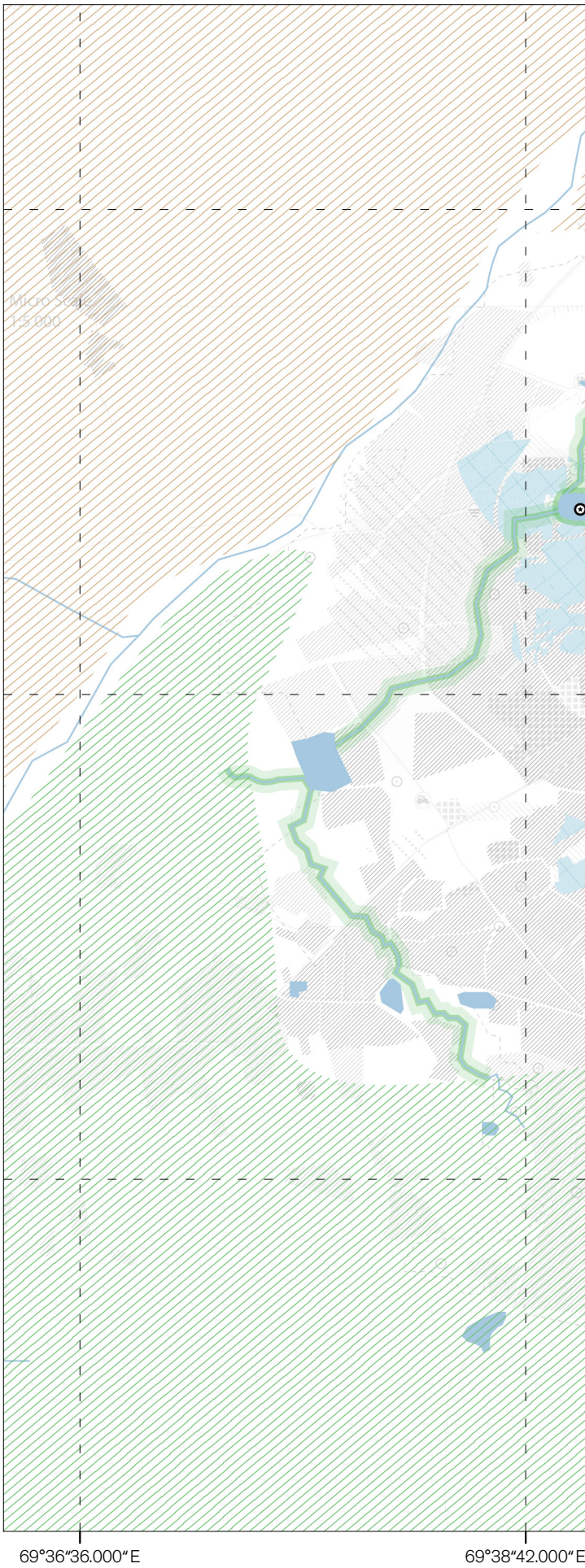
The most important environmental factors are deriving from the extreme dry and hot climate. This means that the water system will play a major role in this scenario. The original water system is restored and even expanded. Some disappeared lakes are restored, which means people will have to leave that area. More streams are added that connect the lakes with each other which will transform the water infrastructure into an ecological network. These added streams act as drains during heavy rainfall events.

Cattle grazing is only allowed into the north, to minimize the influence of cattle on water infiltration into the aquifer in the South. In the south, the tropical dry forests are restored with tree planting. There can be extensive management and extraction of useful materials for the citizens.

On a smaller scale the focus is on combining social and ecological functions. Lake fronts are revitilized and infiltration parks become public spaces. Drought resistant vegetation in the city provides shade and creates a comfortable micro-climate. Roofs are used to collect rain water and natural water purification zones are introduced in areas that did not have sewage treatment

As this will all take space, the city itself will shrink. The number of inhabitants decreases to a level where the people can sustain themselves with local extensive agriculture and sustainable water extraction from the aquifer.

Menno de Roode



Nature first - Macro scale

On the macro scale, the city of Bhuj relates land use to natural features and uses the water system as an ecological network.

Water system
- Revival of water network
- Waterbody
- New waterbody
- Permeable recharge zone

Ecology
- Ecological corridor
- Natural sewage treatment
- Extensive grazing
- Restoration of tropical dry forest

Urban
- Urban area
- Disappearance of urban area
- Socio-ecological waterfront

N

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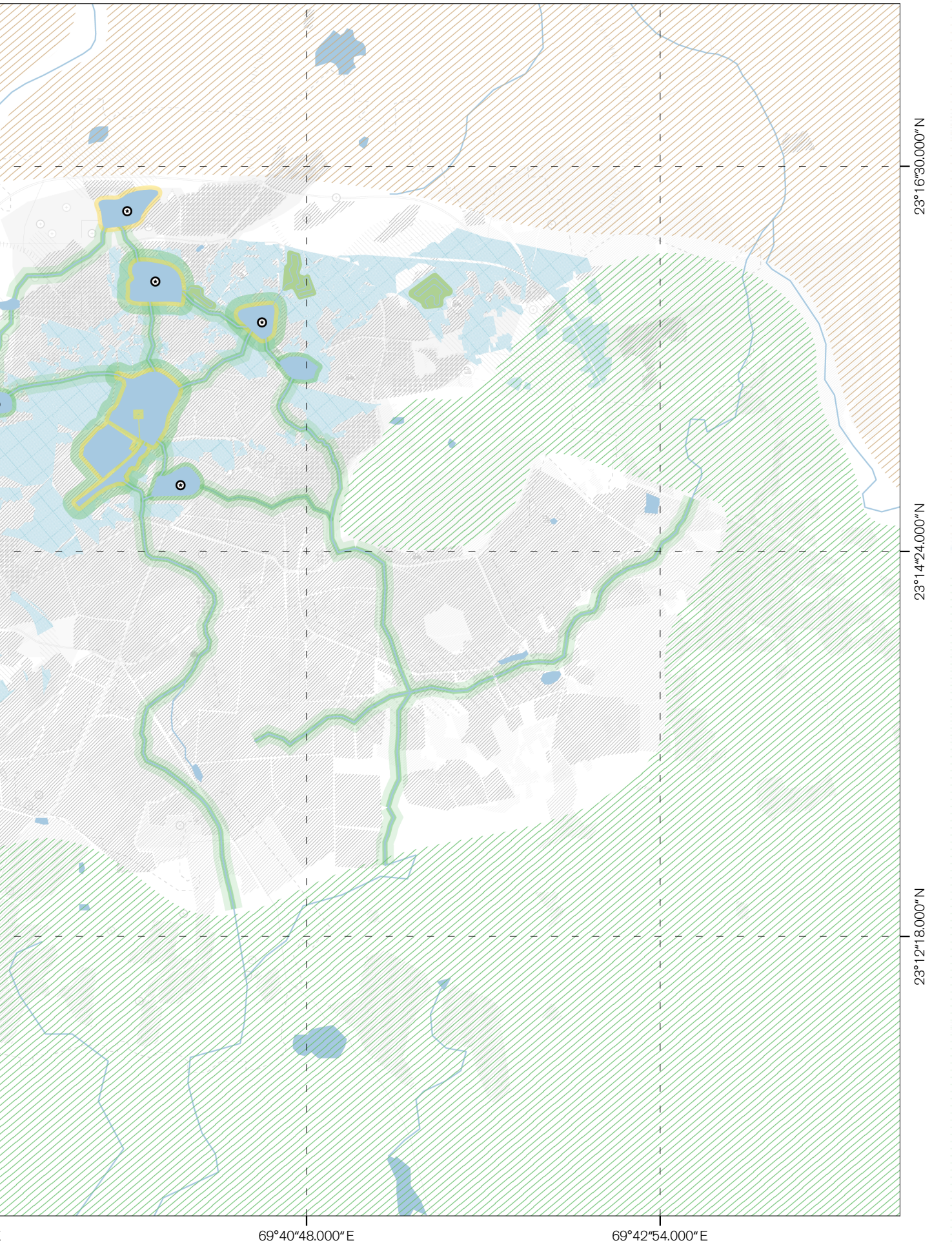
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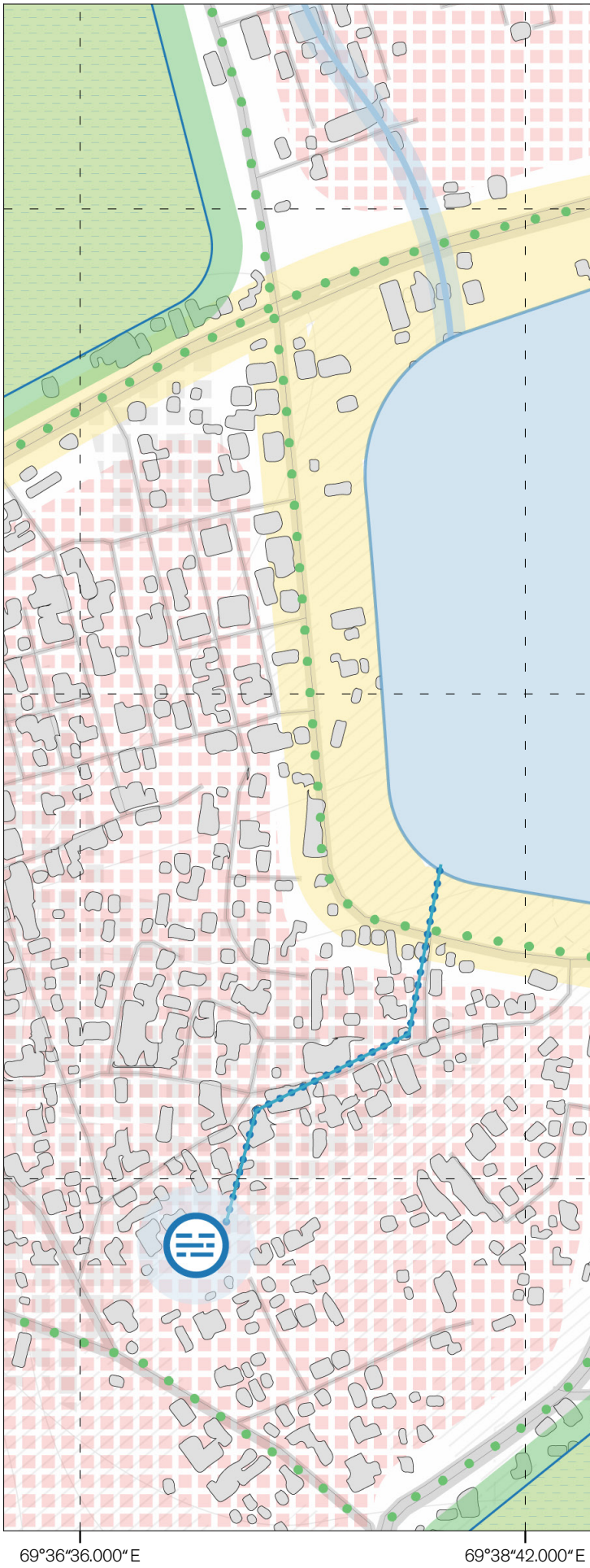
69°42'54.000" E



Nature first - Micro scale

On the micro scale, natural and social functions are interrelated, as nature becomes a part of people's daily live.

Water system
- Lake
- Natural open drain
- Sunken infiltration point
- Infiltration area

Ecology
- Natural sewage treatment
- Ecological forest zone
- Tree-lined streets

Urban
- Urban area
- Road
- Socio-ecological waterfront

N

0 1 km


3000
23°16'30.000"N
23°14'24.000"N
23°12'18.000"N
69°40'48.000"E
69°42'54.000"E

5.2. No Technology Scenario

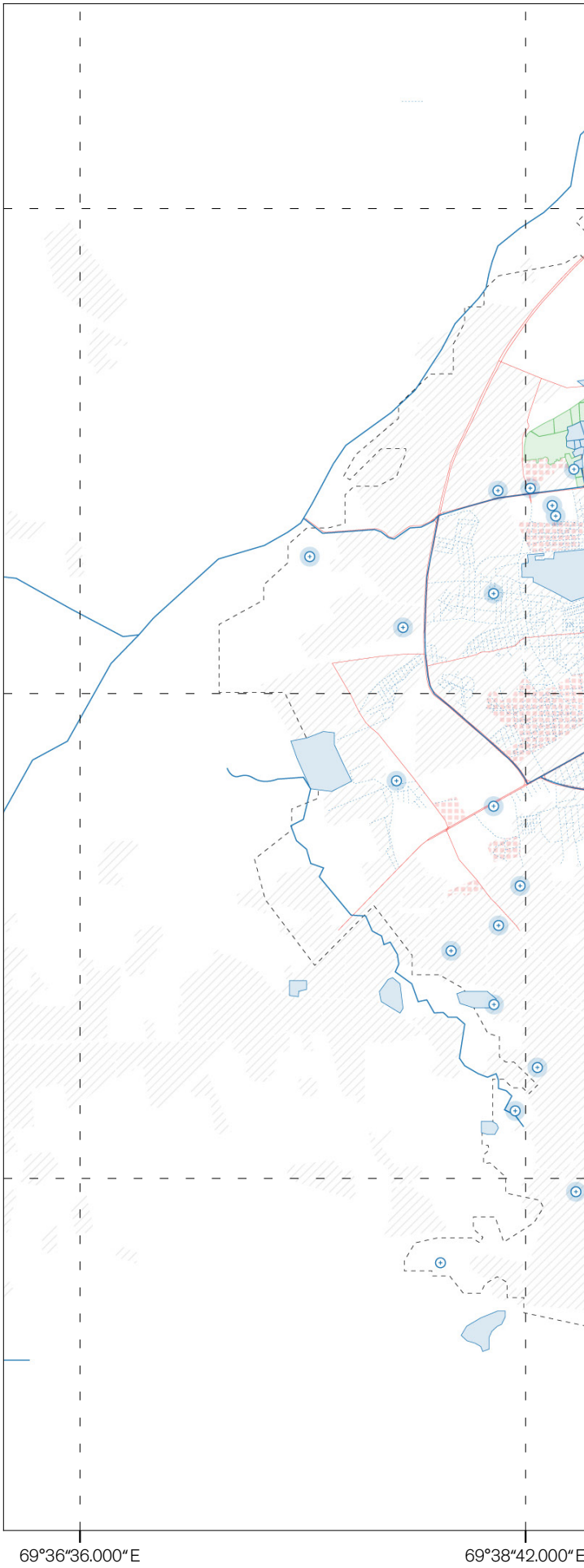
The aim for the no technology scenario comprises of a decentralized interconnected water network that aims to redistribute, remediate and increase retention capacity. This is done through the revival of traditional water infrastructure and collective behavior that was once heavily practiced on this land. In which the wells are revitalized and the optimization of the vast open space is zoned in a way that decentralizes water supply, reuse residual wastewater flows for local agriculture and groundwater recharge, and increases rain water retention capacity both in the new catchments and all suitable roof surfaces. The interconnected water network is supported by the creation of new water channels coupled along the existing mobility network. Moreover, the localized distribution and recycling increases the availability of water resources for local production of food which serves as a means of alternative employment for the vulnerable population, as well as provide space for recreation and cultural practice.

Johnathan Subendran

No Technology

The macro scale map illustrates a decentralized interconnected water network that is comprised of water catchment, hyperproductiver and bioremediation zones. Additional the system repurposes the existing network of wells to redistribute water evenly and revive the traditional systems at the same time.

Ultimately this scenario aims to reimagine the water system to contribute to a self-sustainable city that remediates, redistributes and increases storage capacity to revitalize the deprive natural system and enable localized production and consumption cycles.



Spatial Conditions
- Road
- Municipal Boundary
- Slum

Hydrological and Remediation
- Interconnected Water Network
- Water Catchment
- Hyper-Productive Zone
- Phytoremediation Zone
- Recharge Well
- Grey Water Recycling
- Rainwater Roof Catchment

N

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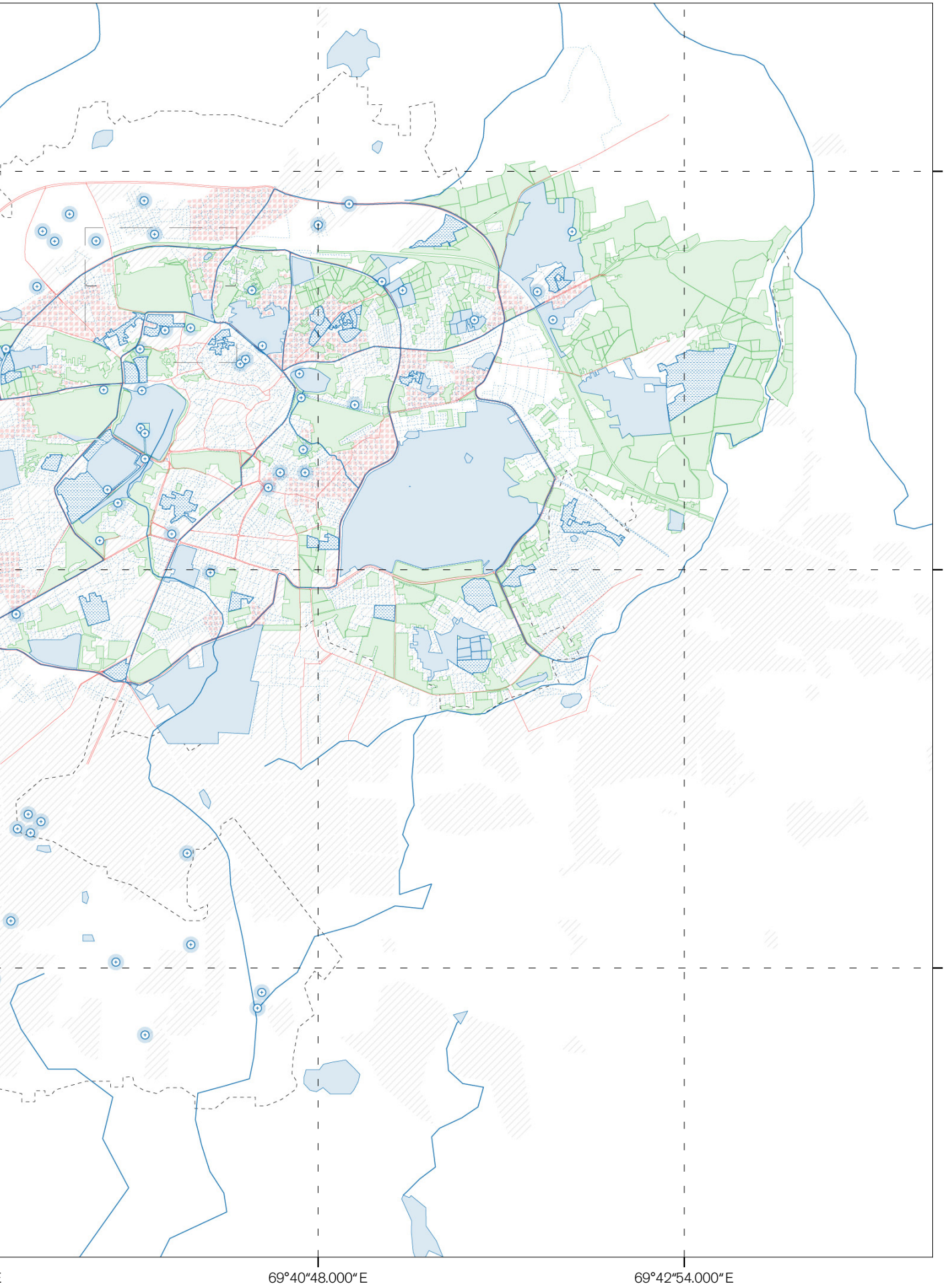
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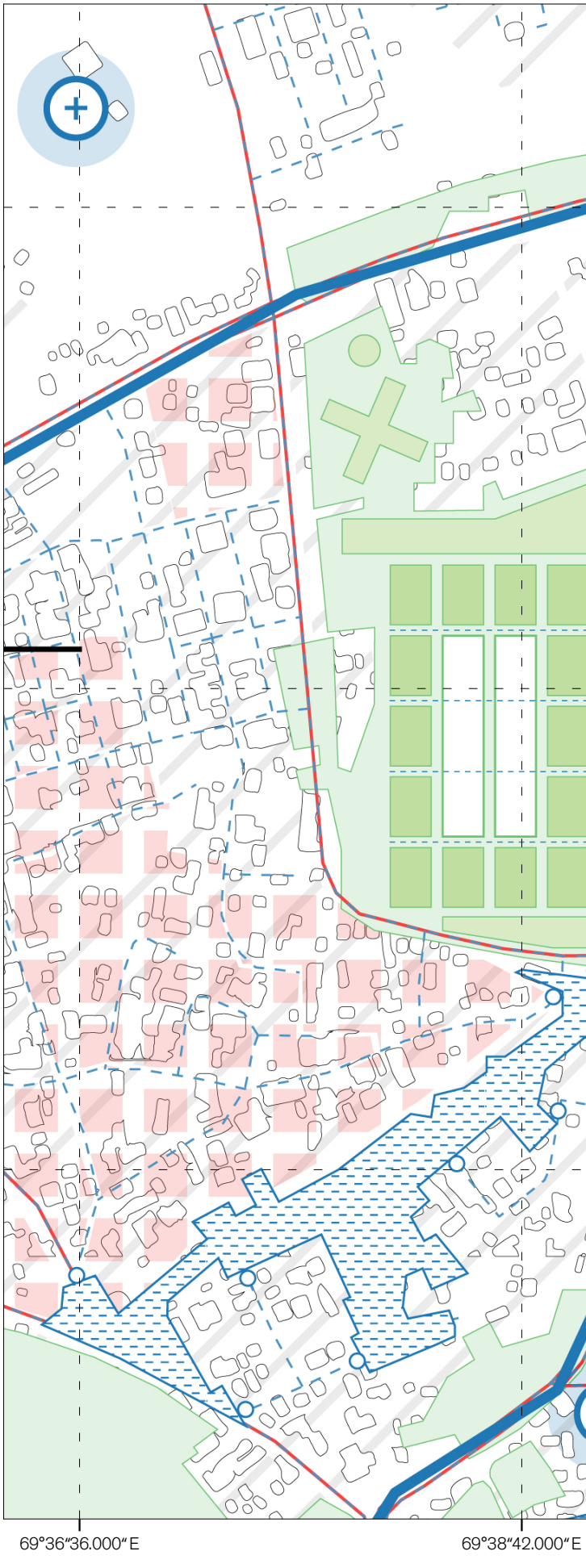
23°12′18.000″N
69°40′48.000″E
69°42′54.000″E



No Technology

This site explores the possibilities of a decentralized network of local economies of production and consumption through agriculture, residual water recycling and local provision of water to those who cannot usually access it.

Spatial Conditions
- Road
- Municipal Boundary
- Slum

Hydrological and Remediation
- Interconnected Water Network
- Water Catchment
- Hyper-Productive Zone
- Phytoremediation Zone
- Recharge Well
- Grey Water Recycling
- Rainwater Roof Catchment

N

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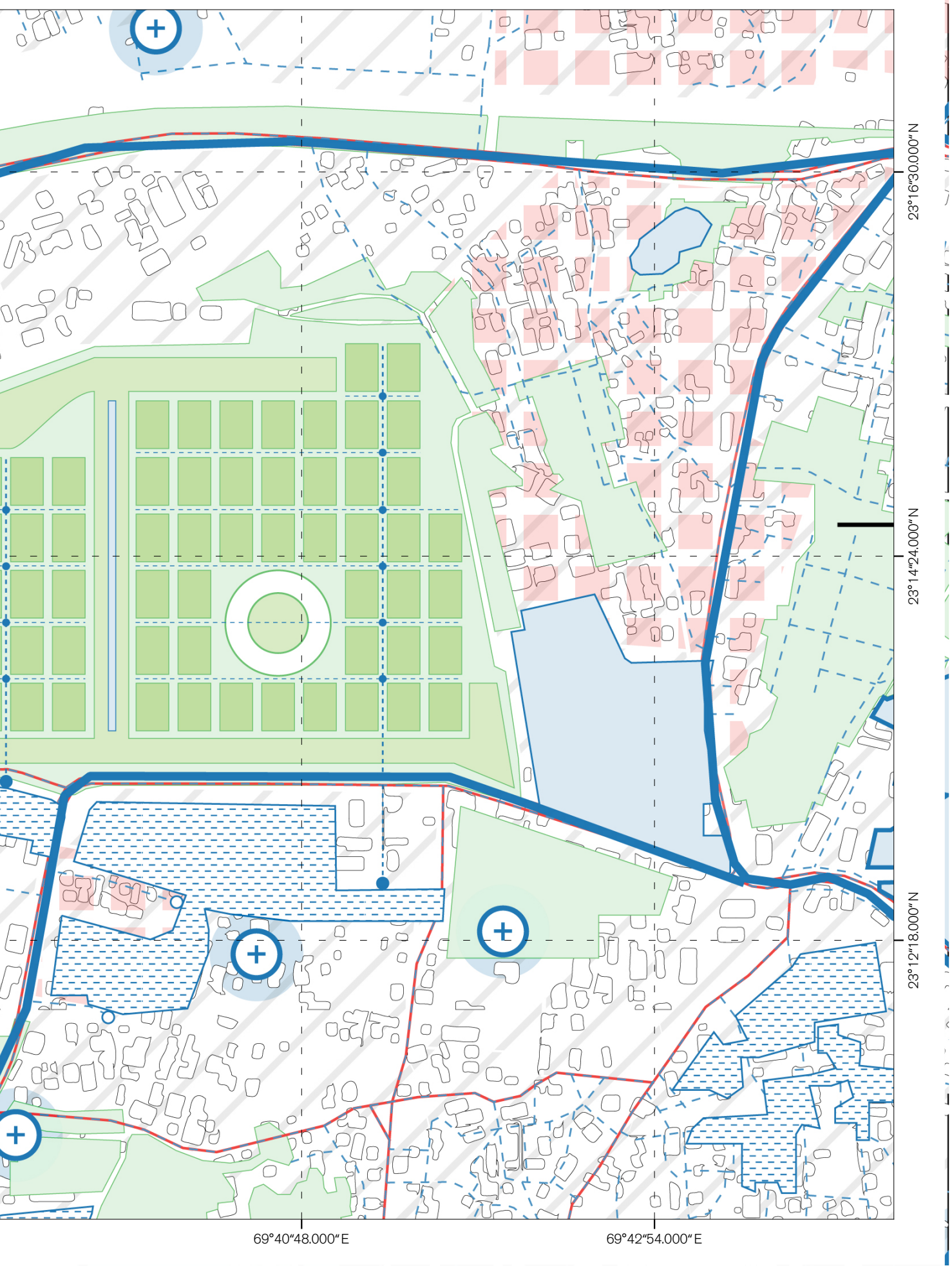
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5.3. No Humans Scenario

Due to urbanization, water demand in Bhuj City is also increasing. However, vigorous water extraction and decentralization of settlement causes depletion on ground water supply and small amount of infiltration.

Thus, no human scenario may become a solution to save both people and nature. However, prior to the implementation transition planning should be conducted in order to guarantee that every human will be allocated to new appropriate living and be employed.

The allocation plan is designed by considering:

1. *The diversity of people should be maintained*, since implementing this scenario needs a huge amount of municipal budget. Government should make sure that there will be social housing for low income and subsidies for renting or buying new homes for middle end groups.

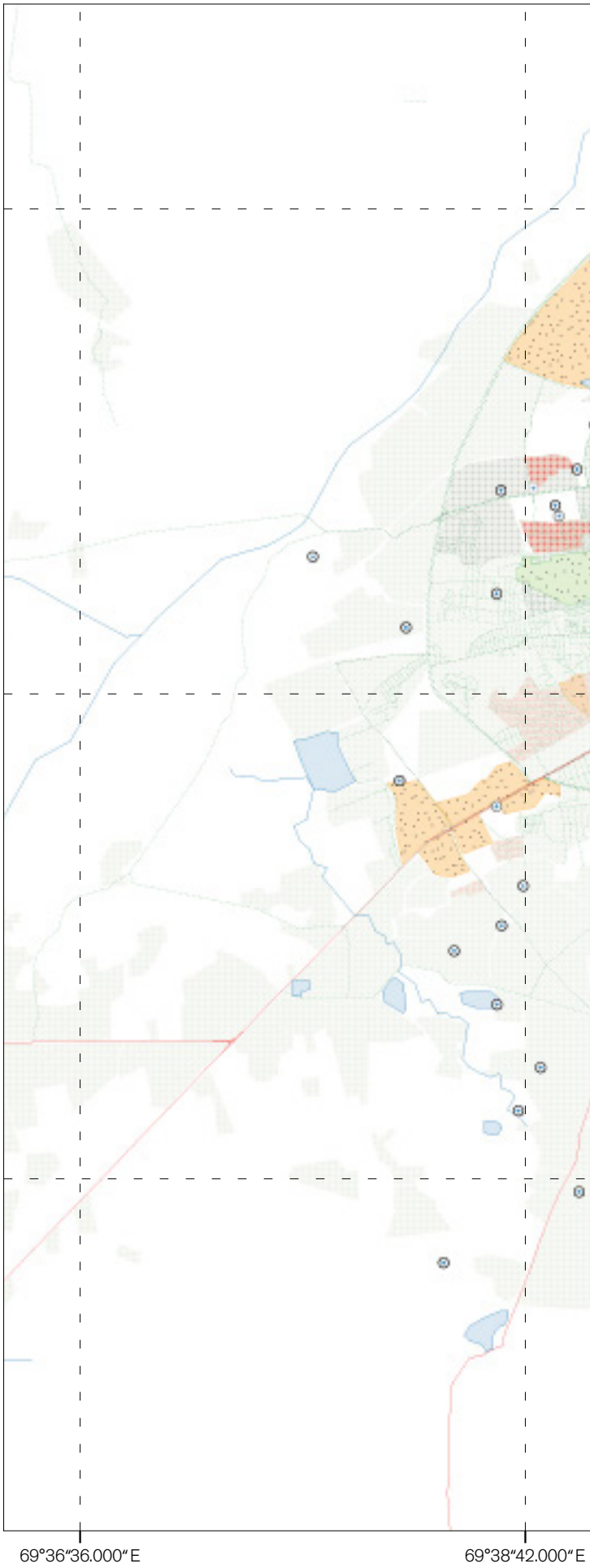
2. *Distance proximity to water catchment area and water availability level.* Area within the original water catchment and within the most frequent water availability will be the last step to be allocated to fulfill water demand of last person. Moreover, the rest of the area that have been left will be the first to be remediated.

3. *Distance proximity to traditional wells and lakes nodes*. Residential and slums which are located close to the wells and lakes will be allocated later than the others which are not.

While doing the allocation, both community capacity and water remediation become the main concern in order to make sure everyone will get their sufficient needs. Community development is encouraged by using existing community hub (mosque and temples). Water remediation will be focusing on revitalization of lakes, wells, and rivers and depavement for most of the street mainly secondary, tertiary, and local street.

At the end of this scenario, restabilization of ecology caused by land abandonment will also leads to water storage recharge. Thus, focusing the land use for tourism, productive landscape or industrial may become alternatives with the note of more appropriate planning prior to the implementation.

Asmita Puspasari



No Human Transition Phases

Abandoning the city to achieve no human population needs a planning in order to guarantee the fulfillment of human water demand.

Political-Spatial Conditions
- Road
- Waterline
- Ward Boundary
- Muncipal Boundary

Housing Allocation Phase
- First Phase (Residential | Slums)
- Second Phase (Residential | Slums)
- Third Phase (Residential | Slums)

Water Remediation Strategy

Water Wells Phase based on TDS concentration (mg/L)
- First Phase (>2000)
- Second Phase (501-2000)
- Third Phase (0-500)

Waterbody Priority
- First Priority Lakes
- Second Priority Lakes

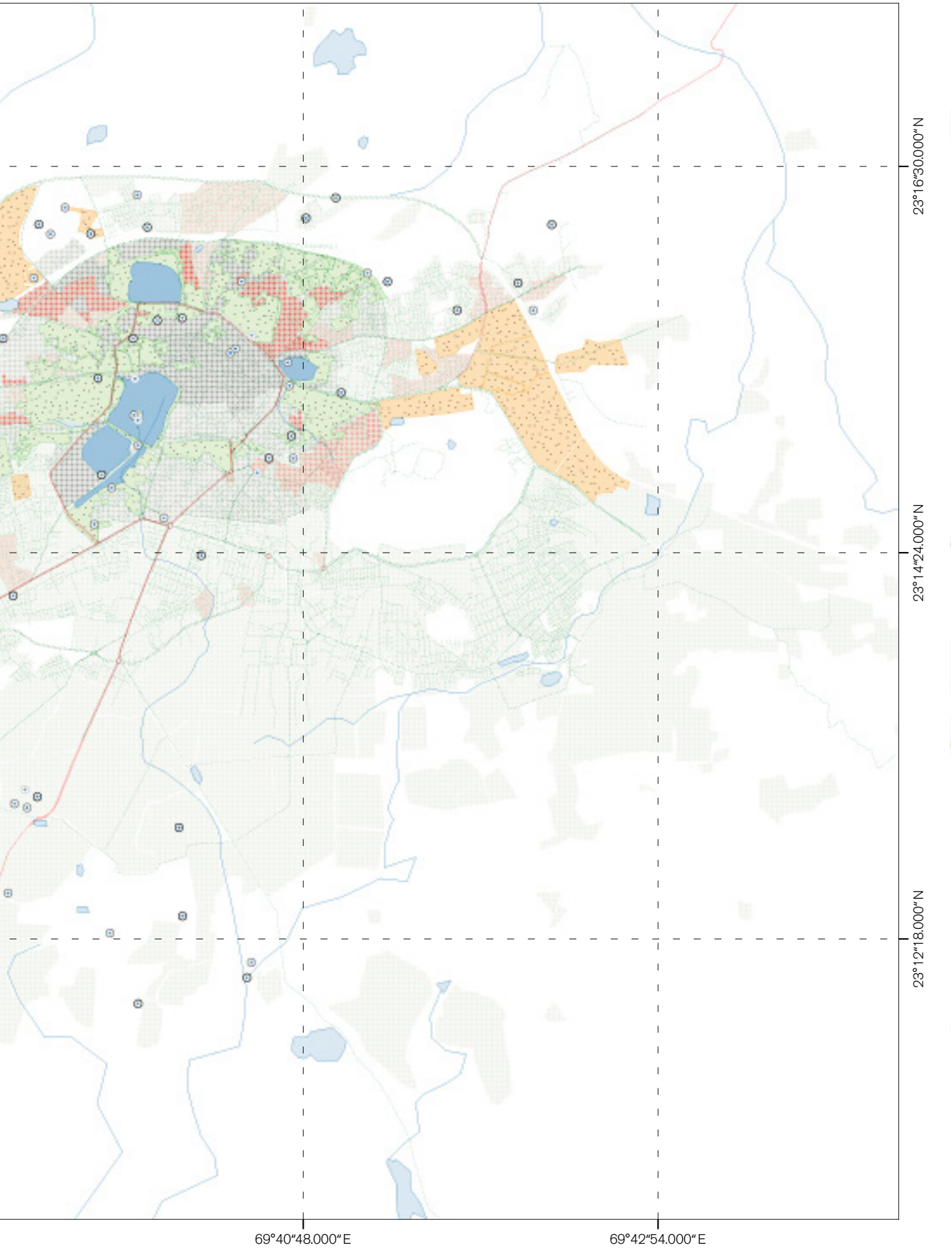
Green and Depavement Strategy
- *Secondary/Tertiary Road*
- *Local Road*

Water Harvesting Pond
- Open Spaces Potentials

Future Potential Transformation
- Industry
- Open Spaces for Agriculture

N

0 1 km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No Human Resilience Map

In the process of human allocation to other city means that there will be a phase with small group of people. Relying basic needs to import-export will become not possible, thus self-sufficient plan need to be conducted collectively through community development.

- Main Road
- Slums
- Residential
- Open Space

Water Remediation Strategy

- Lakes
- De-paving road
- Wells (TDS conc. : >2000 mg/L)
- Wells Integration
- Wetlands and Rain Water Harvesting Pond

Societal Resiliency

- Community Hub (Mosque Nodes)
- Food Community-Sufficient Area

Future Potential Development

- Temporary Staying Places
- Building demolishment

N

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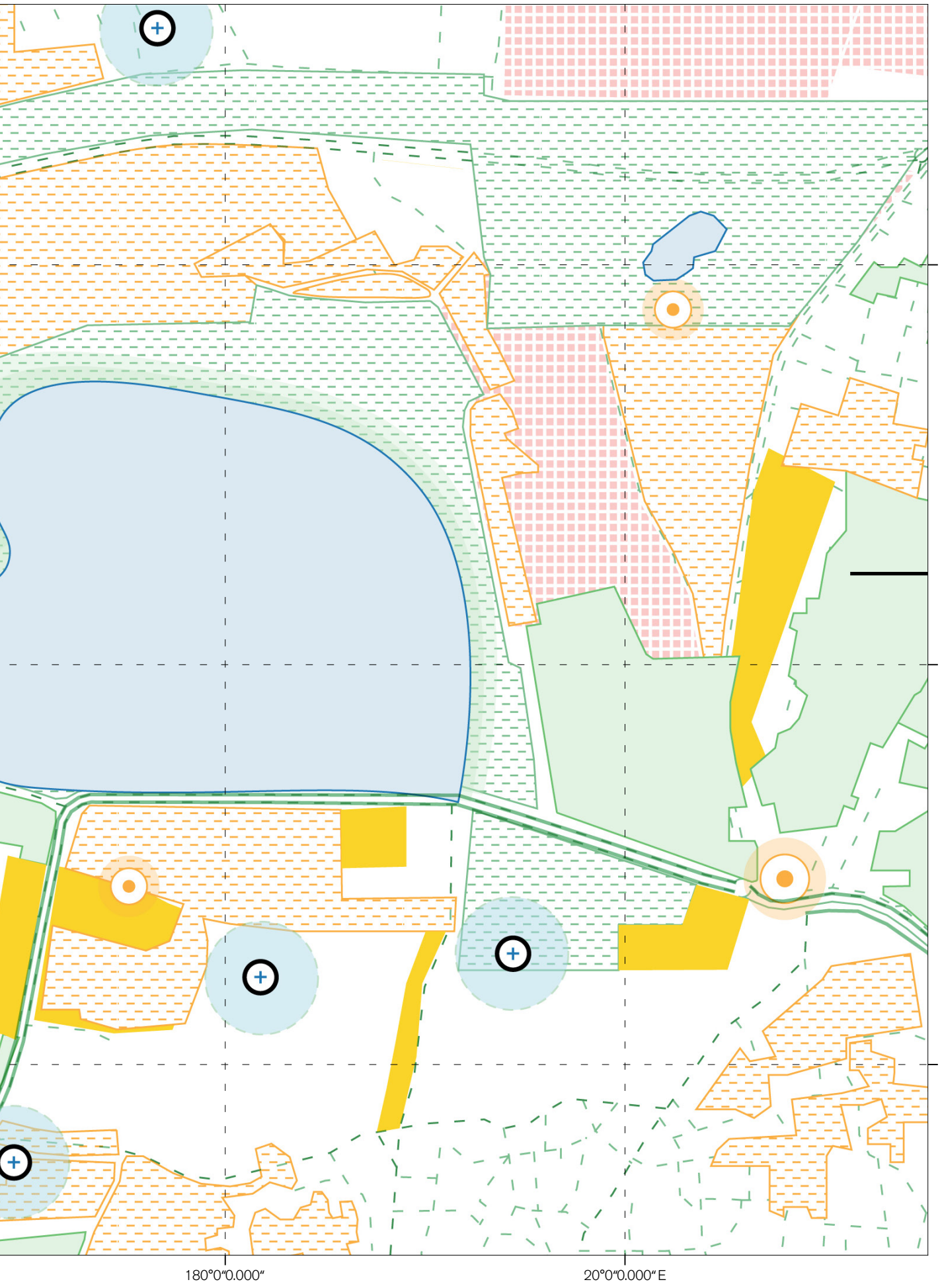
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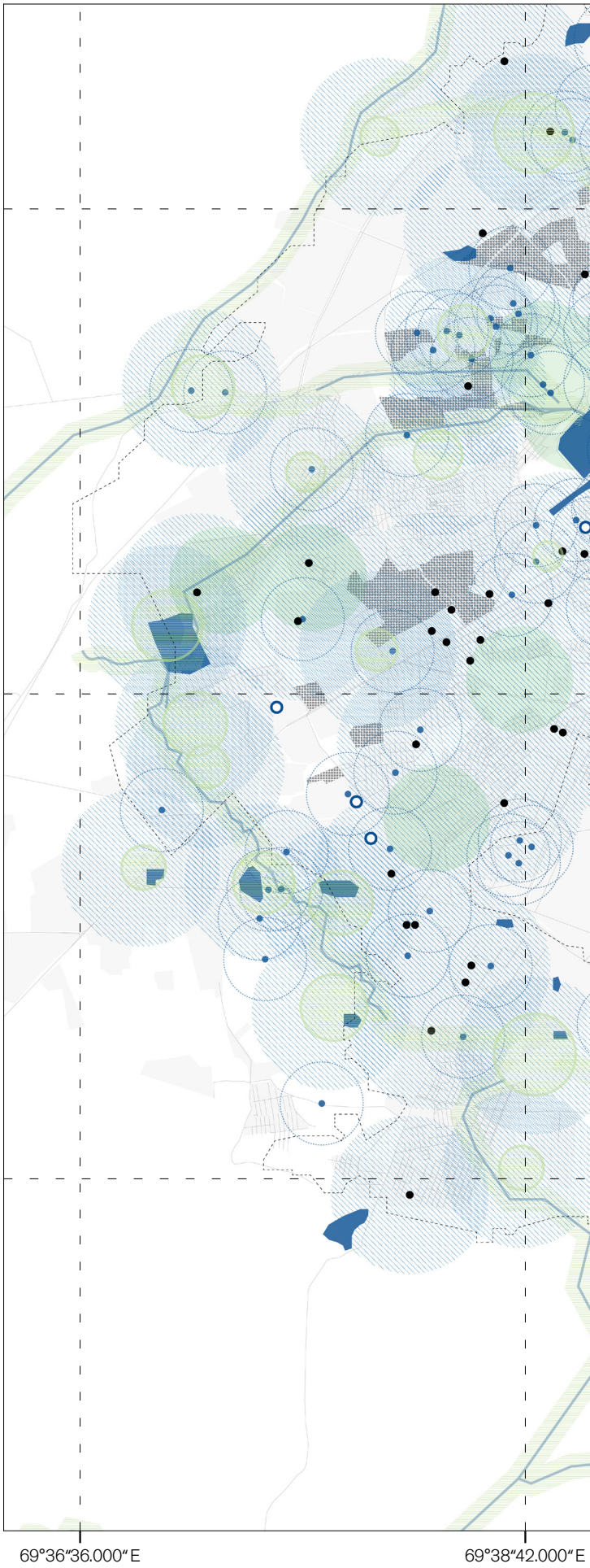
5.4. COVID-19 Scenario

In a scenario that deals with Covid-19 or in a broader perspective, how to manage Bhuj considering a pandemic crisis containment, we look to secure an urban environment that attempts to guarantee good public spaces that can provide healthy living and reduction of conditions for the spread of disease.

The difficulty of applying centrally managed systems for clean water distribution overshadows the difficulties encountered for hygiene requirements. In this sense, to address the covid-19 scenario applied to Bhuj`s context, localized solutions that address lack of quality public space, increasing air quality around key roots and the increase of local water public access spots are plausible solutions to address this scenario.

Existing parks will be enhanced in greenery and public space quality. Riparian vegetation will be preserved to guarantee water flow and surface water quality. More public artefacts for water provision will be coupled with existing and new proposed parks. Most public green spaces will be interconnected, allowing for alternative roots to roads to move around the city. Public institutions and other buildings of public interest will be incentivised to implement systems for natural water collection, enhancing the provision of clean water availability for residents.

Lucas Di Gioia



COVID-19 , Macro Scale

Green-blue corridors will be interconnected to ensure alternative healthy routes from existing road systems. These corridors will interconnect existing green park spaces with new green-blue spaces with public water provision based on the existing catalogue of water artefacts.

Water and Health Infrastructure
- Bhuj City Boundary
- Urban Areas
- Informal Settlements
- Roads / Paths

Water Infrastructure (Sanitization)
- Water Bodies
- River / Canal
- School Stumps
- Wells (Private or Public)
- Tanker Suppliers

Park Infrastructure (Open Space)
- Existing Parks
- Proposed Parks with water supply
- Riparian vegetation preservation

N

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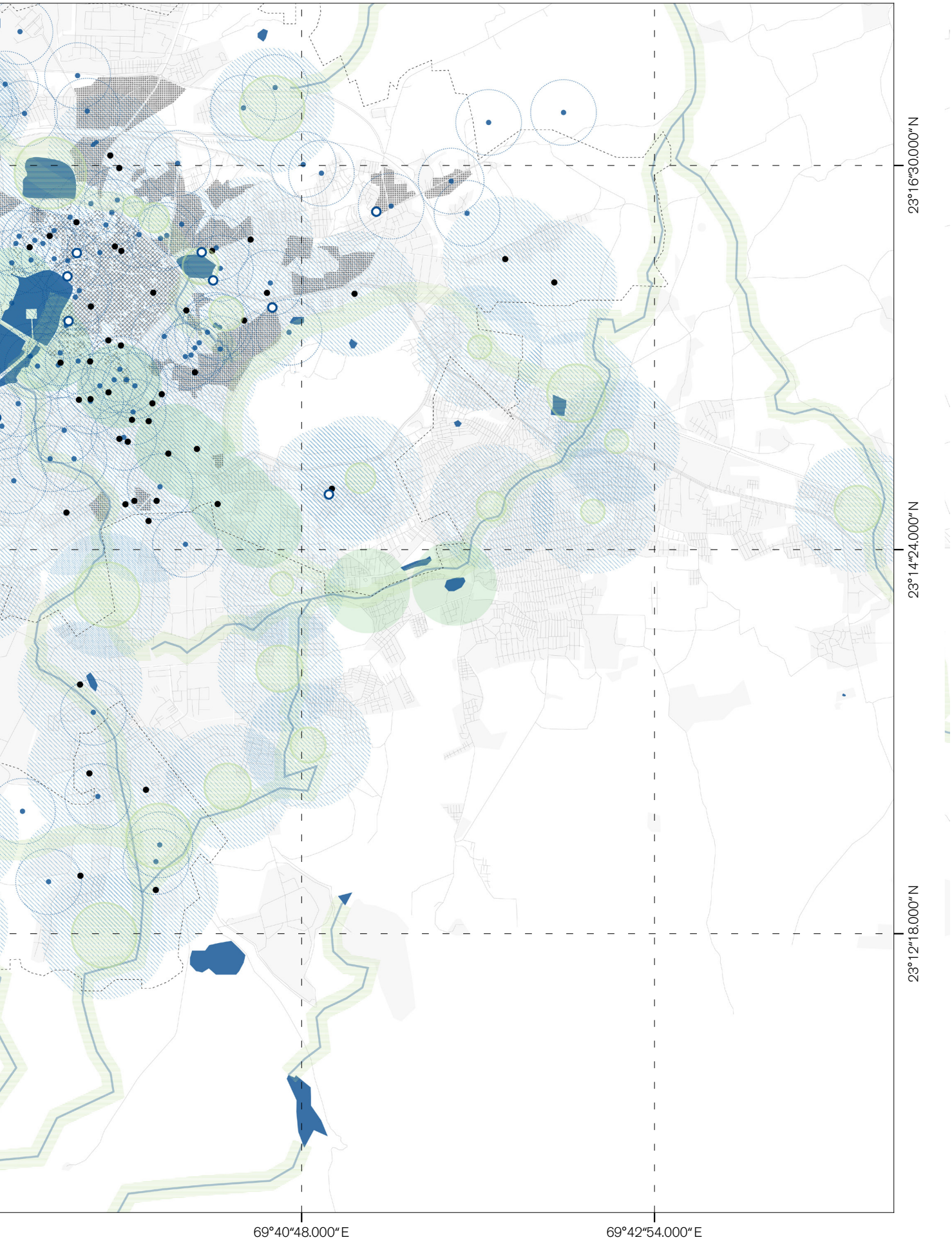
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Covid-19 , Micro Scale

Lakes will be revived as public green-blue park systems. These will hold water drained from neighbouring buildings, into phytoremediation ponds, where clean water will accumulate in designated lake areas. Wells in proximity will tap into filtered groundwater providing clean water for these neighbouring buildings and households.

Water and Health Infrastructure

- Bhuj City Boundary
- Urban Areas
- Informal Settlements
- Roads / Paths

Water Infrastructure (Sanitization)

- Water Bodies
- River / Canal
- School Stumps
- Wells (Private or Public)
- Tanker Suppliers

Park Infrastructure (Open Space)

- Existing Parks
- Proposed Parks with water supply
- Riparian vegetation preservation

N

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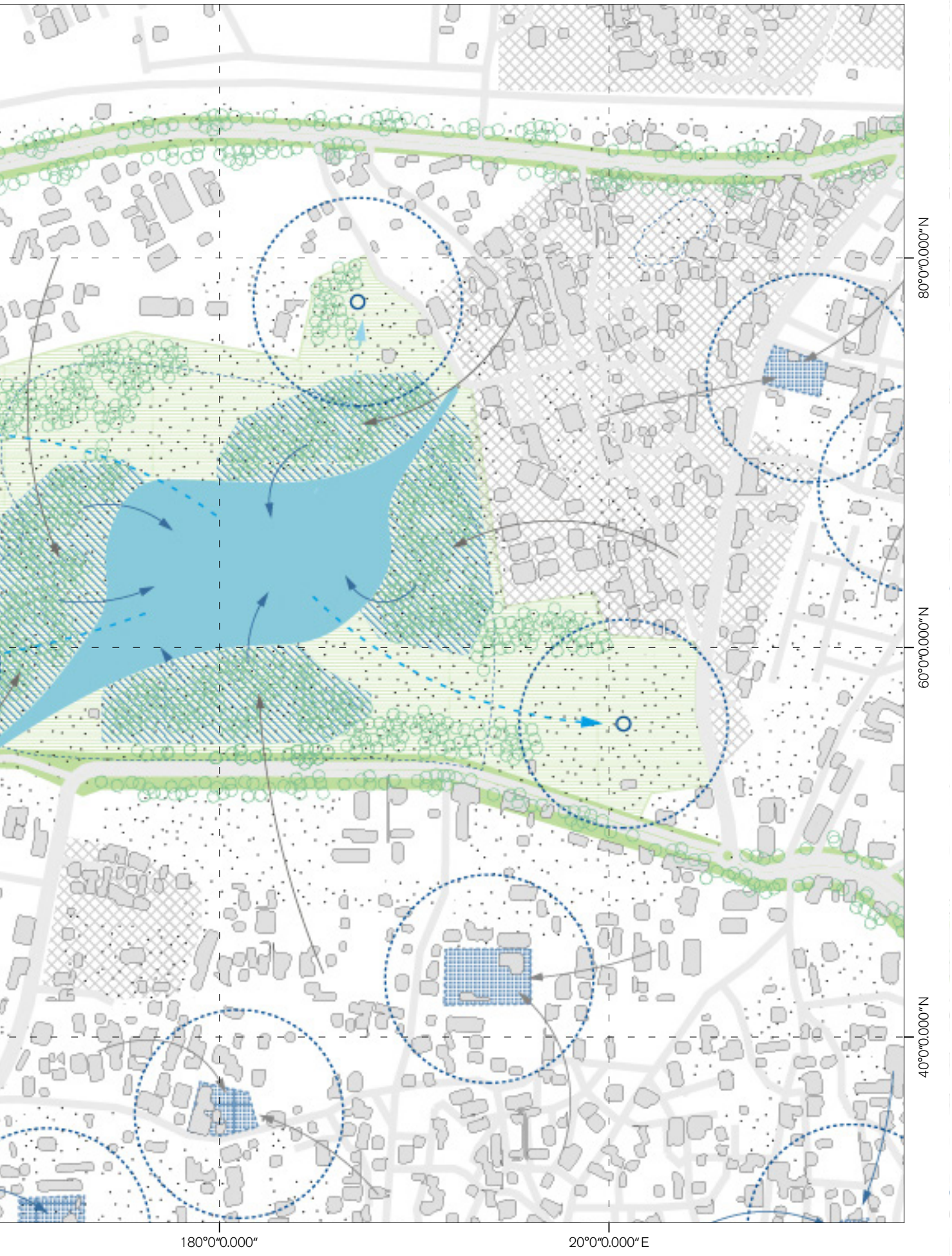
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5.5. More Technology Scenario

The more technology scenario looks at the possibility of increased productivity and economic value generation coupled with an improved quality of life, sustained by the use of technological innovations.

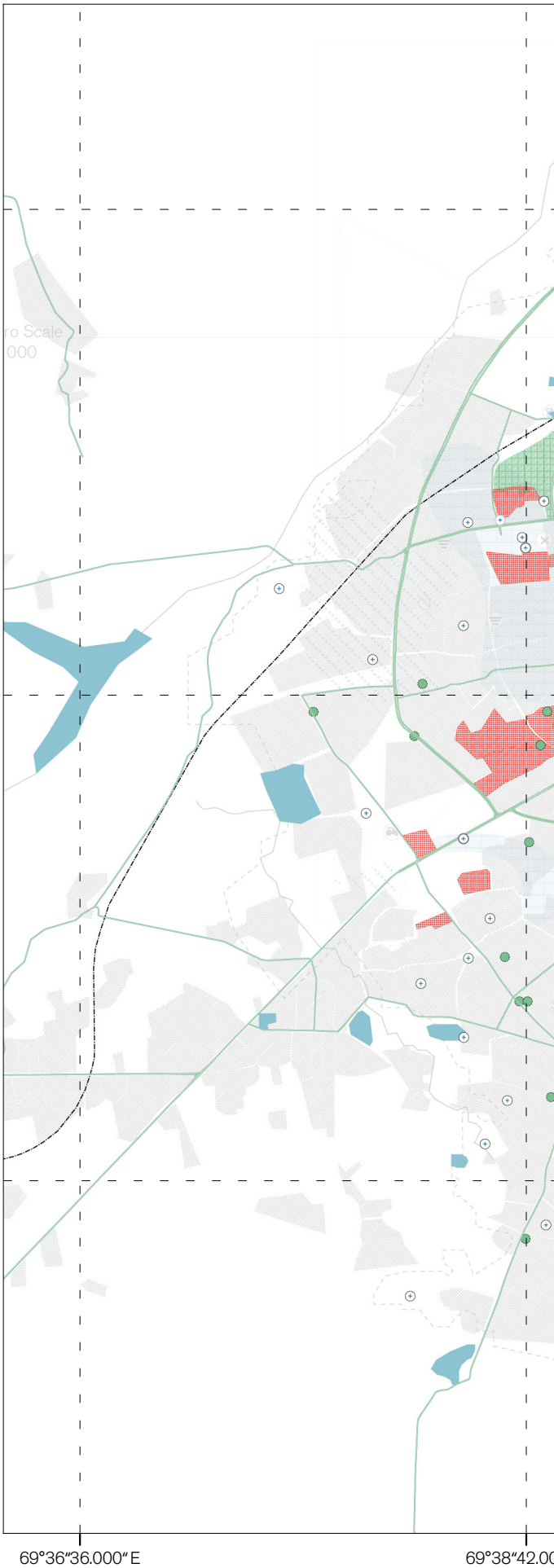
Existing social infrastructure such as schools are used to double up as water processing infrastructure as well, owing to the availability of land and their educational potential for the next generation.

Existing borewells and dugwells in the fabric of the city could be used for water regeneration as well during times of intense rainfall.

Climate controlled greenhouses are to be used for agriculture, and thus manage the use of water and other resources as much as possible within a controlled environment.

The scenario projects a win-win situation, disconnected from the difficult realities of technological investment.

Ganesh Babu Ramaiah Perumalsamy



More Technology

The water network at the scale of the city is expanded to include previously filled in lakes. Lakes are further deepended to improve storage capacity. They are all interconnected.

Productive open spaces are expanded into the damaged landscapes due to overgrazing. This is done in phases using hyper accumulators, followed by plants adapted to this environment.

The existing network of dugwells and borewells double up as water infiltration infrastructure as well.

Water network

- Water body
- Stream/canal

Urban morphology

- Productive Open space
- Green houses
- Multi use development
- Existing residential

Infrastructure

- Water recharge wells
- Water treatment
- Road network with infiltration

N

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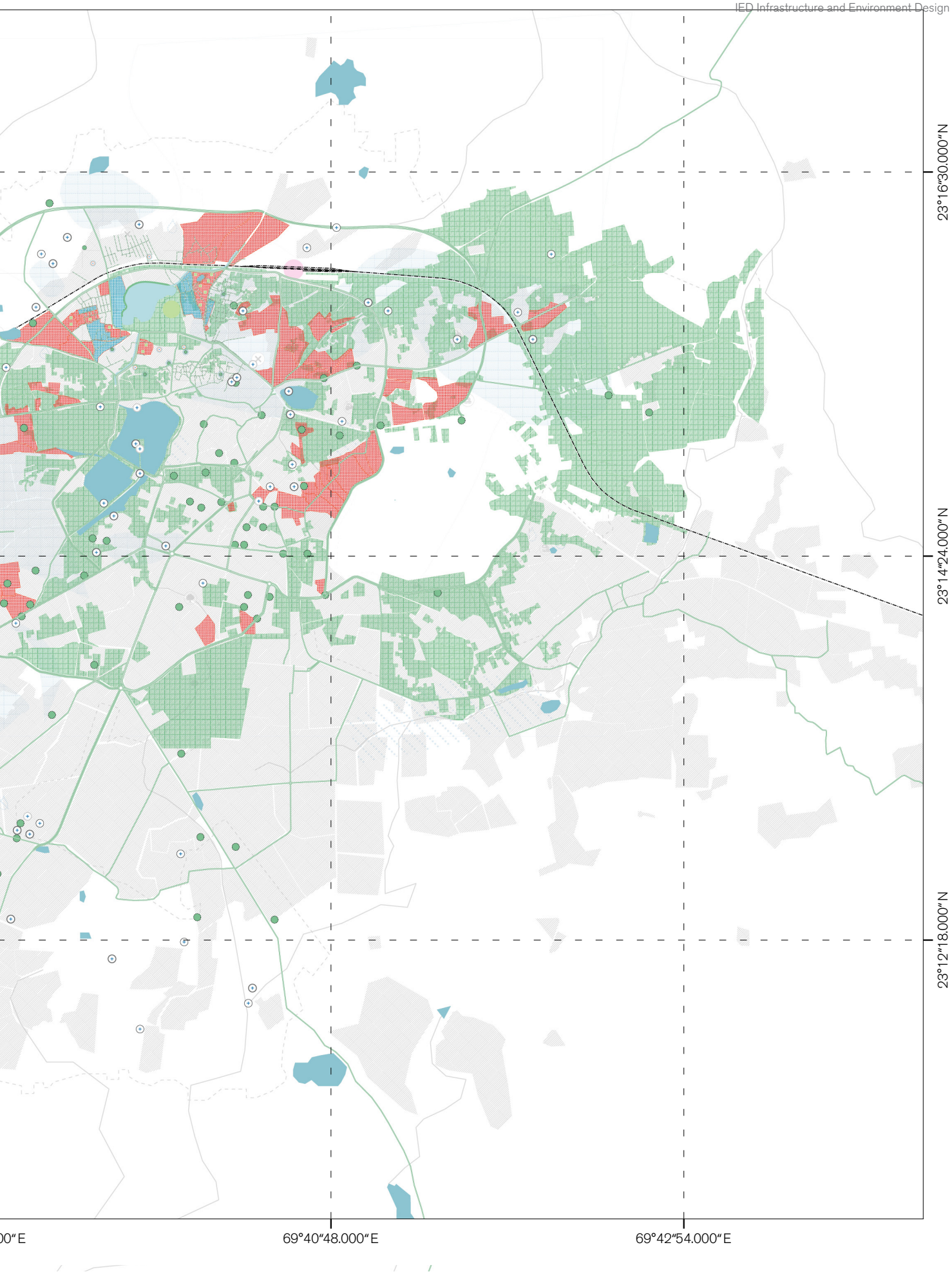
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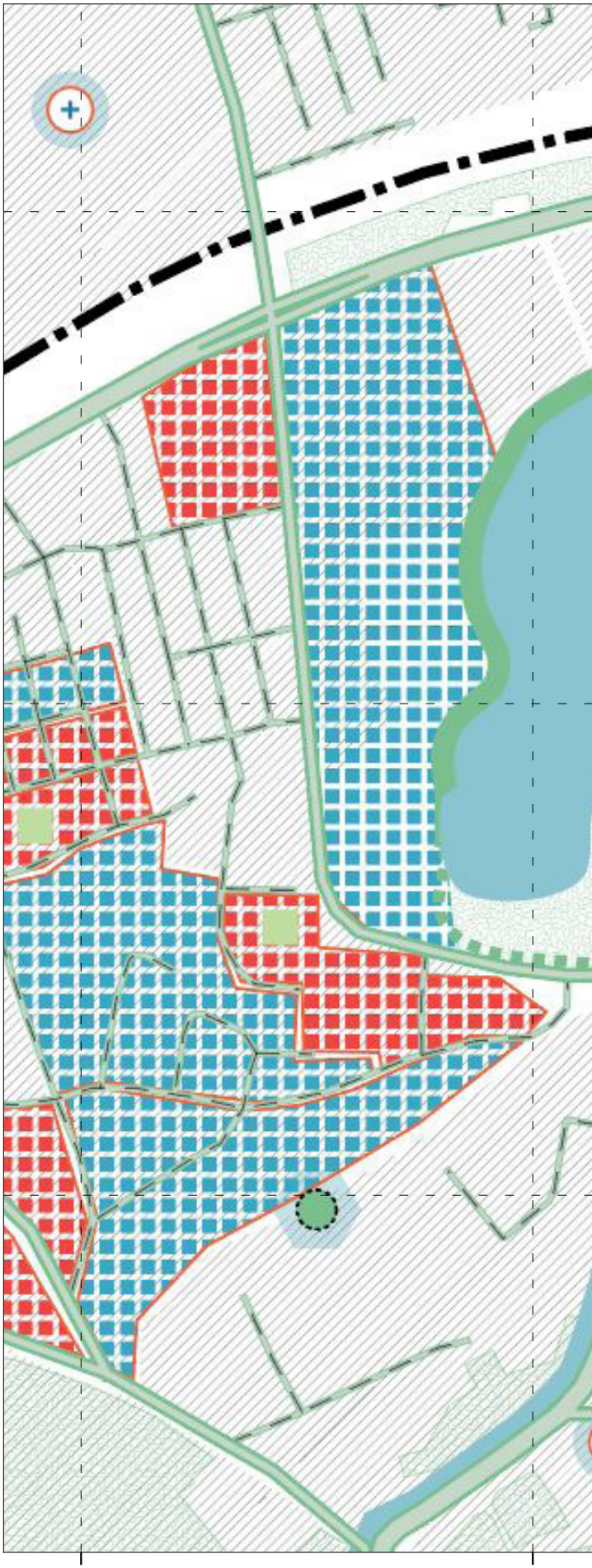


More Technology

The road networks acts as sponge networks, facilitating increased infiltration. The land opened for development by densifying sprawl slum settlements in-situ is used for greenhouse agriculture to create a socio-economic flywheel.

The lakes when dried up during summer months could be used for agriculture as well.

Water network

- Water body
- Stream/canal

Urban morphology

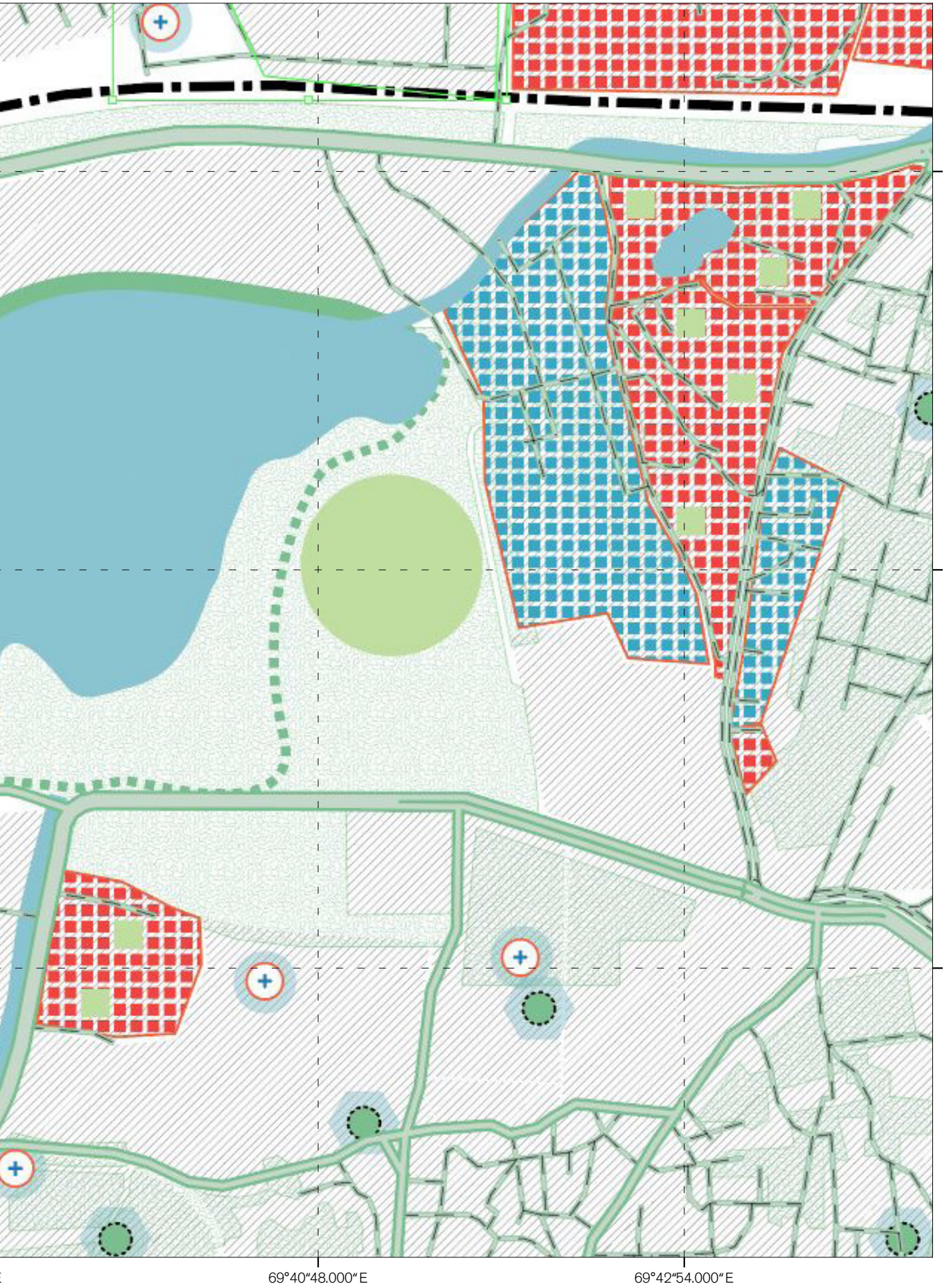
- Productive Open space
- Green houses
- Multi use development
- Existing residential

Infrastructure

- Water recharge wells
- Water treatment
- Road network with infiltration

N

0 100 m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6.

System intervention

6.1. From opportunities to vision

From the reading of territory through five different perspectives and the five scenario building exercises, a pallet of opportunities was formulated. By outlining a multitude of opportunities, it could avoid a defined system intervention were possibilities are constrained by specific decisions. Instead, the pallet of opportunities presents various pathways forward that would act as inputs for further design exploration. Some of opportunities are as follows but not limited to:

Existing array of water infrastructure for extraction, distribution, treatment and storage. As they are insufficient, future proposals could attempt at augmenting them.

Differing water infiltration potential at different parts of the city could be used to increase productive interdependencies.

Drought resistant native species could be used in the repair of ecology

Water is embedded in cultural practices / city life.

City center has good examples of climate sensitive design (heat stress)

Soil is permeable and there is a natural gradient (helps with drainage)

Large potential for solar energy

Active revitalization processes to propel revival of natural systems and sustainable local practices

Based off the opportunities identified, there is an understanding of a general direction forward which can be combined with the three scalar sub-research questions to formulate principles that paves a vision for Bhuj:

Territorial scale - Eco-sensitve development

Urban scale - Sustainable resource management + Resilient local practices

Local scale - Inclusive water-sensitive communities

6.2. Design Experiements

6.2.1.

Common Water Through Women Language

Asmita Puspasari

6.2.2.

Reterritorializing Bhuj: Towards Water Conscious Assemblages

Ganesh Babu Ramaiah Perumalsamy

6.2.3.

Productive Commons

Johnathan Subendran

6.2.4.

South by South: Independence Through Water

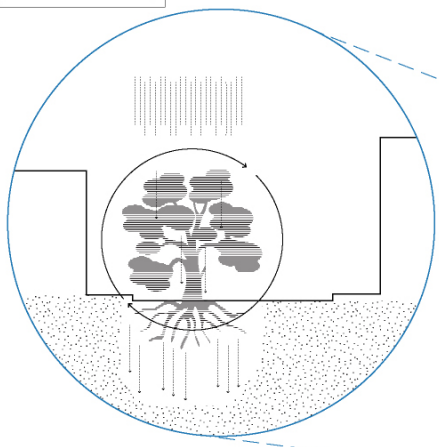
Lucas Di Gioia

6.2.5.

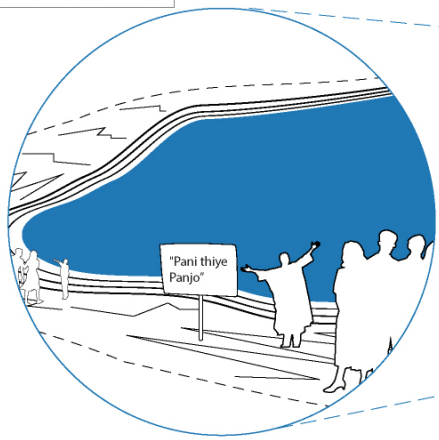
Recharge Bhuj

Menno de Roode

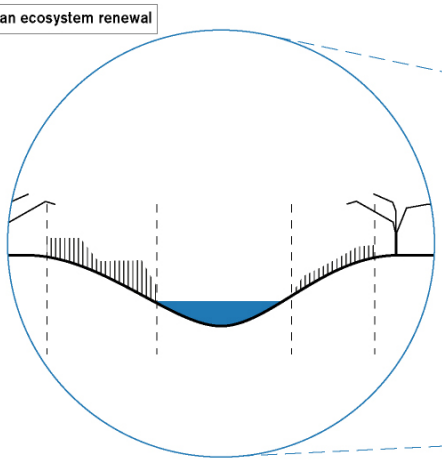
Drough resistant biodiversity

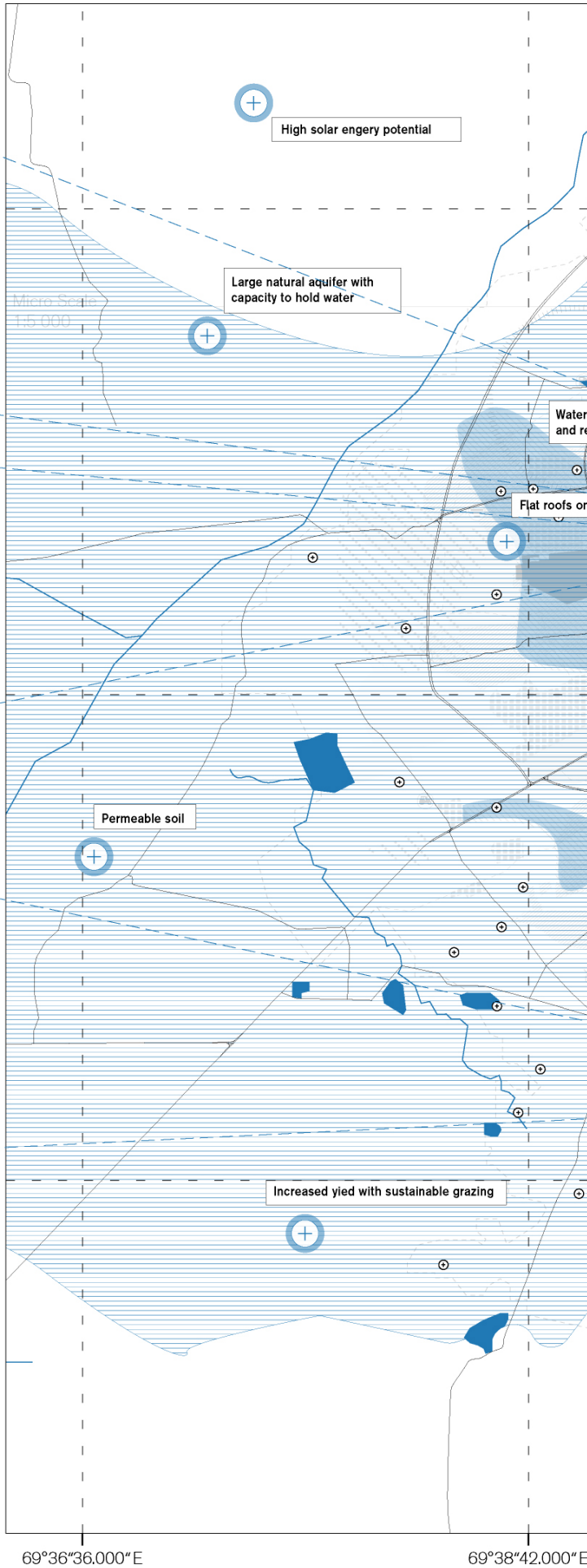


Active revitalization processes



Riparian ecosystem renewal





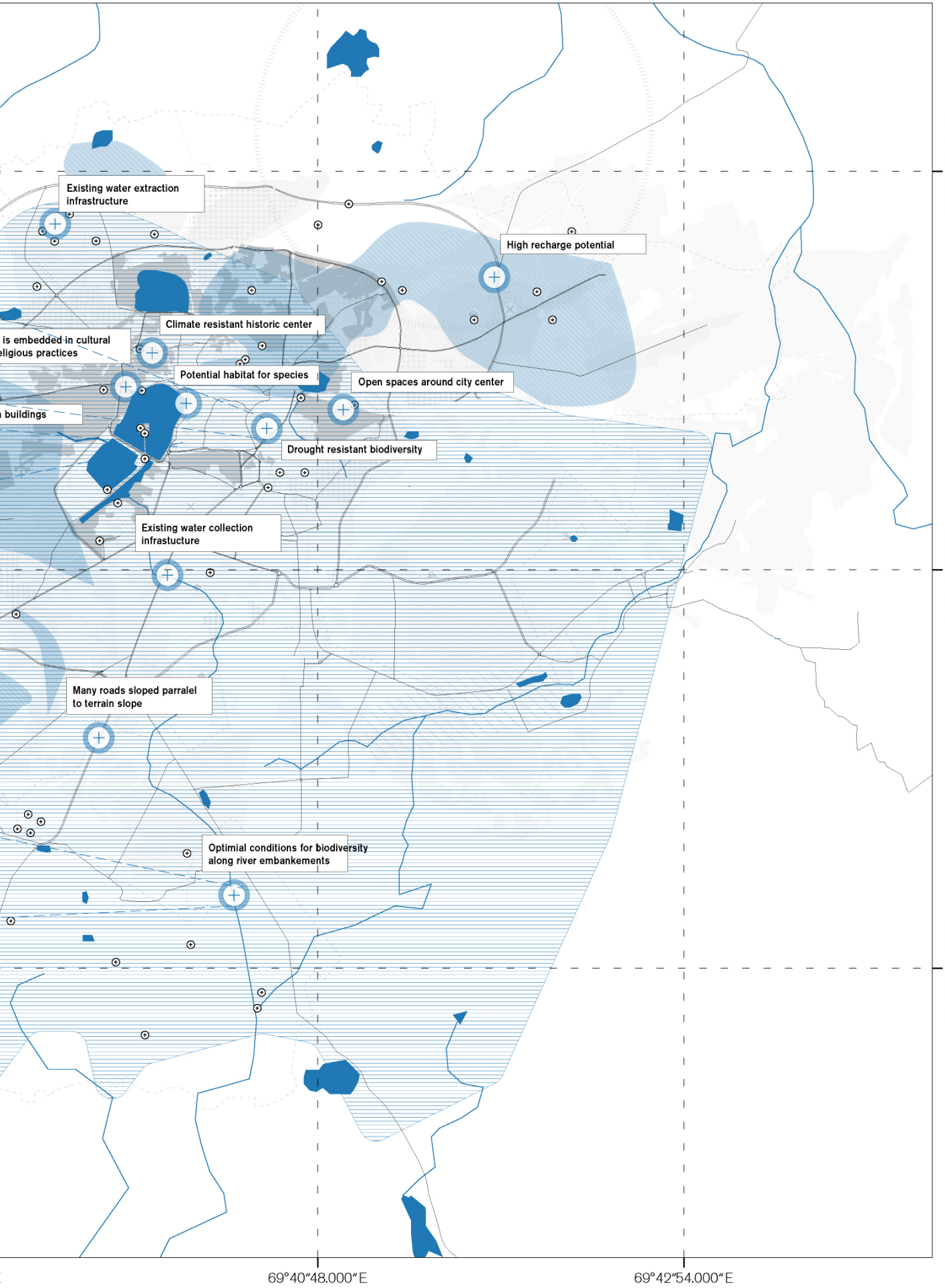
6.1. Opportunity Guidelines

This map aims to combine the opportunities identified throughout the perspectives and preliminary research. The pallet of opportunities serve as a departure point for further exploration and design experiments.

- Opportunity
- High recharge potential;
- Aquifer
- Well
- Open area
- Water infrastructure
- Water body
- Road

N

0 1 km


Existing water extraction infrastructure
High recharge potential
Climate resistant historic center
is embedded in cultural eligious practices
Potential habitat for species
Open spaces around city center
buildings
Drought resistant biodiversity
Existing water collection infrastucture
Many roads sloped parralel to terrain slope
Optimial conditions for biodiversity along river embankements
23°16'30.000"N
23°14'24.000"N
23°12'18.000"N
69°40'48.000"E
69°42'54.000"E

Taxonomy X Individuals Projects

Taxonomy Base

Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	Extraction	Government	Nature based	Social	Subsurface
Gujarat	Distribution	Companies	Traditional systems	Ecological	Streetscapes
Kachchh	Storage	Individual	Heavy engineering	Technical	Open space
Bhuj	Treatment	Collective	Futuristic	Economic	Buildings
				Cultural	

Common Water Through Women Language

Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	Extraction	Government	**Nature based**	**Social**	Subsurface
Gujarat	Distribution	Companies	**Traditional systems**	**Ecological**	**Streetscapes**
Kachchh	Storage	**Individual**	Heavy engineering	Technical	**Open space**
Bhuj	**Treatment**	**Collective**	Futuristic	Economic	**Buildings**
				Cultural	

Reterritorializing Bhuj

Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	**Extraction**	**Government**	**Nature based**	**Social**	**Subsurface**
Gujarat	Distribution	Companies	**Traditional systems**	Ecological	**Streetscapes**
Kachchh	**Storage**	**Individual**	Heavy engineering	**Technical**	Open space
Bhuj	Treatment	**Collective**	**Futuristic**	**Economic**	**Buildings**
				Cultural	

Productive Commons

Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	Extraction	Government	**Nature based**	**Social**	**Subsurface**
Gujarat	**Distribution**	Companies	**Traditional systems**	**Ecological**	Streetscapes
Kachchh	**Storage**	**Individual**	Heavy engineering	Technical	**Open space**
Bhuj	**Treatment**	**Collective**	**Futuristic**	**Economic**	**Buildings**
				Cultural	

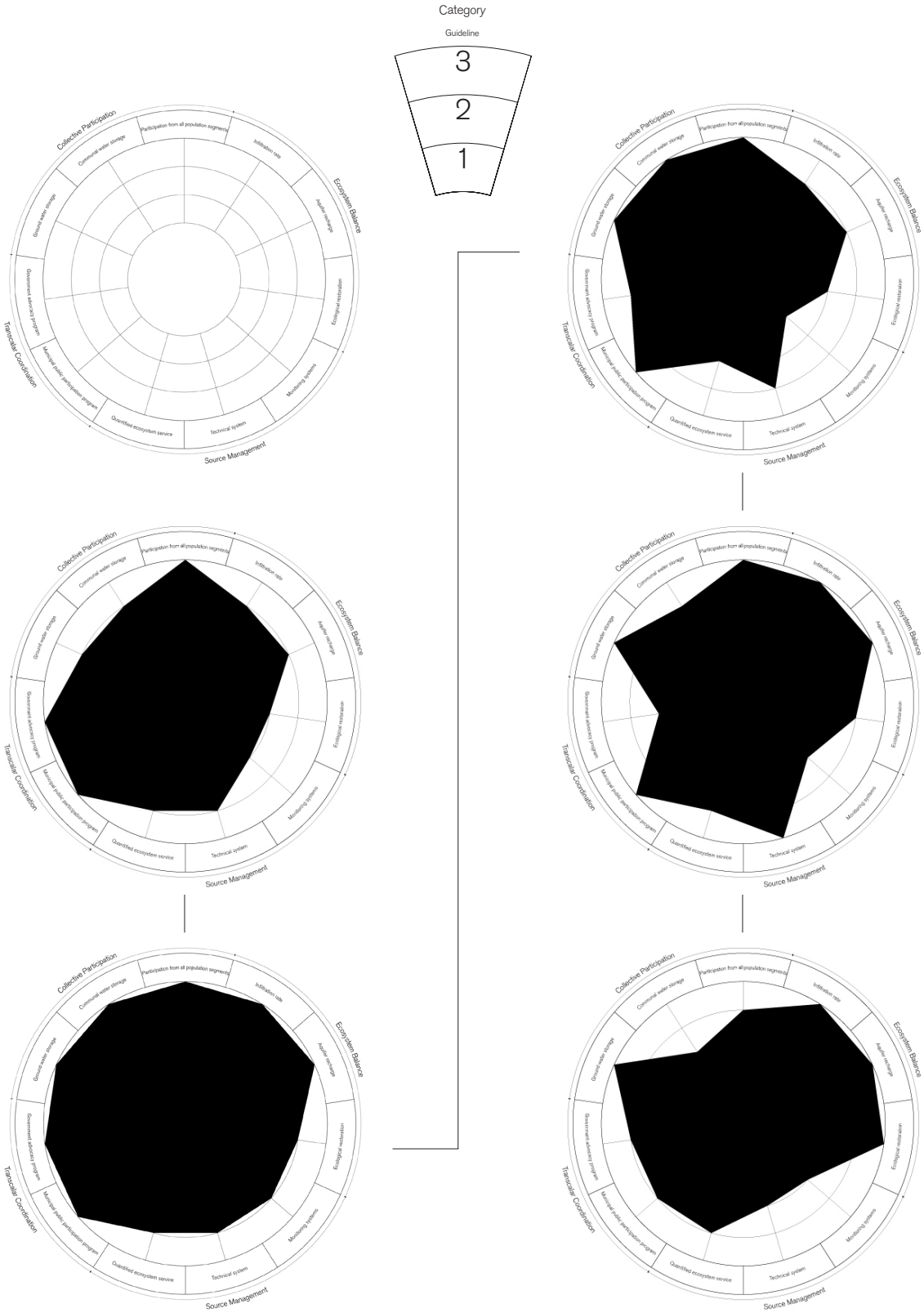
South by South: Independence Through Water

Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	**Extraction**	**Government**	**Nature based**	Social	**Subsurface**
Gujarat	**Distribution**	Companies	**Traditional systems**	**Ecological**	Streetscapes
Kachchh	**Storage**	Individual	**Heavy engineering**	**Technical**	**Open space**
Bhuj	Treatment	**Collective**	Futuristic	Economic	Buildings
				Cultural	

Recharge Bhuj

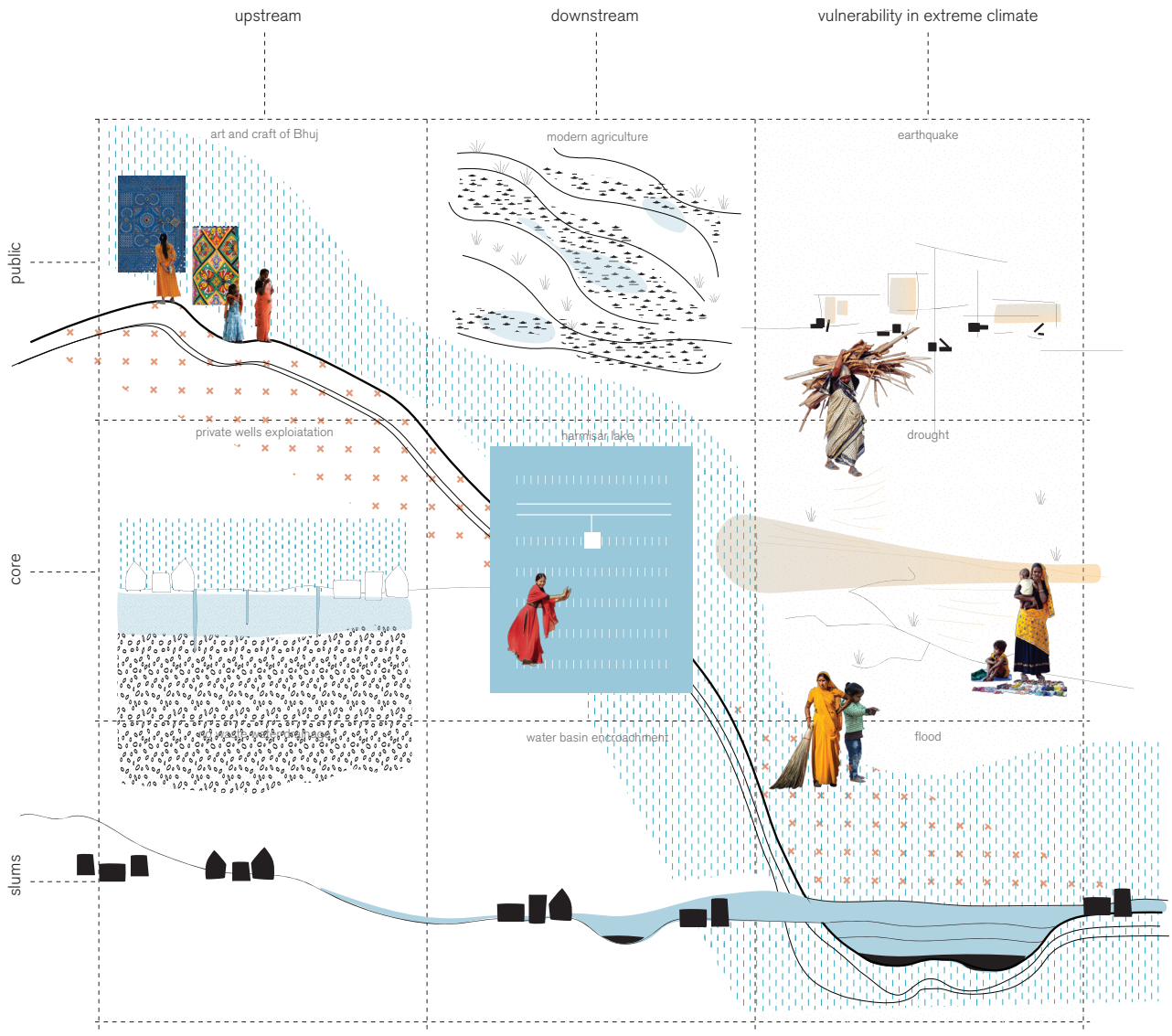
Scale	Water System	Ownership	Technology	Infrastructure	Spatiality
National	Extraction	**Government**	**Nature based**	Social	**Subsurface**
Gujarat	Distribution	Companies	Traditional systems	**Ecological**	**Streetscapes**
Kachchh	**Storage**	Individual	Heavy engineering	Technical	**Open space**
Bhuj	Treatment	**Collective**	Futuristic	Economic	Buildings
				Cultural	

Guidelines X Individual Projects



Common Water Through Women Language

Asmita Puspasari



Common Water Through Women Language

How to build up common water perspective by putting main consideration of woman vulnerability condition in Bhuj extreme climate?

Manifesto

Common Water Through Women Language

Woman in India are percieved as an intimate part of nature. Reflected from Indian cosmology perspective where nature (Prakriti) is a manifestation of Shakti - a personification of the Energy and “The Great Divine Mother” in Hinduism. In order to reach the balance, Prakriti and Prusha (the masuline principle) should move in conjunction. Thus, we can learn that women, men, and nature are supposed to work together and protect each other.

Today, all developments in Bhuj are partriarchy oriented and dominating over women and nature. Male is considered as the main agent of this new model of ‘development’. It can be represented on current water extraction, housing developments, or agricultural systems that extract services from nature without considering its sustainability. Moreover, womens opportunity to be part of this development and to build up their capacity is also limited. Thus, leaving women to be the most vulnerable part of society.

Water scarcity and ecological degradation in Bhuj are the main challenges in the current extreme climate. The intertwining relationship between women, humans, and nature needs to be re-addressed. Looking deeper on how the collective of women power can lead to balance, changing women`s existence dogma in order to get the real balance between human and nature is primordial.

The synergy of women and water in Bhuj city is classified into three main systems:

1. Art, Craft, and Women

Women are gifted with their emotions, and expression. They create art and craft as the manifestation of their gift. Through art and craft, their beauty of gifts can be acknowledged. They will understand their value for Bhuj.

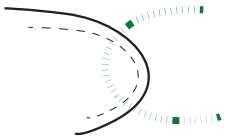
2. Dialogue and Women

Nothing can be more powerful than struggling together in the extreme climate. Then, women should have a voice and be able to voice their perspective. Through sharing their voice, they will understand more about their values and also inspire their dreams over Bhuj City.

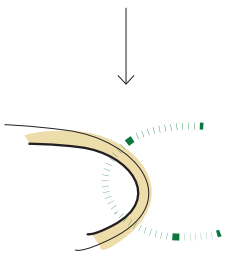
3. Water and Women

All women have the perception to guarantee that water is sufficient for their children now and in the future. This kind of love is very powerful to give women strong reasons to conserve the water in Bhuj.

Reference: Shiva, V. (2015). Staying alive. New Delhi: Women Unlimited.



Patriarchy Development /
Woman Vulnerability



Woman X Human X **Nature** Relationship

Design experiment

Common Water through Women Language is about how to see the vulnerability of women in this extreme climate of Bhuj as potentials. When we see the city, there are three main possible extreme climates: earthquake, drought and flood. And, within these three extreme conditions, women are the most vulnerable segment of people in Bhuj.

The project aims to to synergize water system remediation and extreme climate resiliency of Bhuj through collective women empowerment. The analyses are based on the socio-economic conditions, the current water awareness level, and the possibilities of nature based intervention.

The design experiment is classified into three main systems of interventions with specific main question that are planned to be worked in synergically for all over Bhuj area:

1. Art, Craft, and Women

How to redefine value of arts and crafts by woman while also become the solution to create earthquake resistant settlements?

2. Dialogue and Women;

How to accommodate discourses of all people live in Bhuj by using a common spaces that has high level importance for all?

3. Water and Women

How to recharge ground water storage while also upgrading slum are by implementing nature based solutions?

Streetscape, Open Space, Buildings

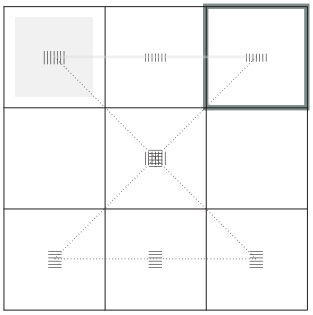
Asmita Puspasari

Analysis

Socio-Economic

Background:
About 35% women in Bhuj are employed as craft making (bandhani, embroidery, fall beading, tailoring and quilt making) and live in the non-slum houses. Also, about 21% women in Bhuj that live in slum areas prefer to choose domestic as their occupancy due to higher income.

Focus Intervention:
How to redefine value of arts and crafts by woman while also become the solution to create earthquake resistant settlements?

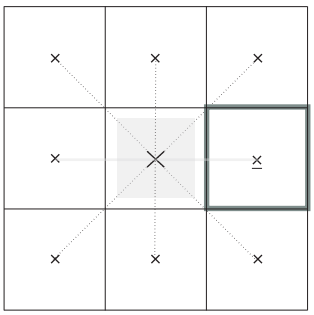


Common Spaces
Main occupancy: craft making*
Main occupancy: Domestic help*

Dialogue Through Water

Background:
Drought and water scarcity can lose trust between people at the most extreme level. Raising awareness of water importance should be held through discourses or dialogues from all people. Therefore, all interventions related to communication are encouraged, from campaign until community building.

Focus Intervention:
How to accommodate discourses of all people live in Bhuj by using a common spaces that has high level importance for all?

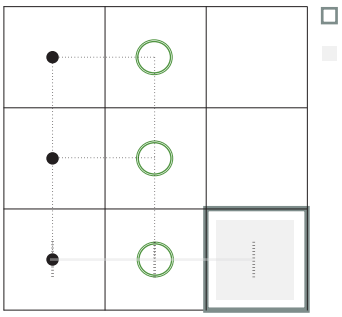


Collective Participation
Vulnerability Possibility
Resilient Community Building

Nature Based Solution

Background:
Recharging ground water storage and remediating water quality need all treatments start from upstream until downstream area. There are only few water infiltration due to enormous pavement and lake defunctions due to sedimentation and water pollution. On the other hand, rapid encroachments happened without water treatment infrastructure that leads to lack of water awareness and eventually to the degradation of waterbody.

Focus Intervention:
How to recharge ground water storage while also upgrading slum are by implementing nature based solutions?

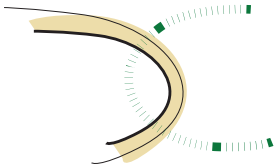


Depavement
Phytoremediation
Simple drainage pipeline

Focus Challenge
Focus Intervention

*) Types of occupancies are based on paper “Work conditions and employment for women in slums :A case study of Bhuj city, Kutch.” by De, I., Kumar, M., & Shylendra, H. S. (2019)

Synthesis



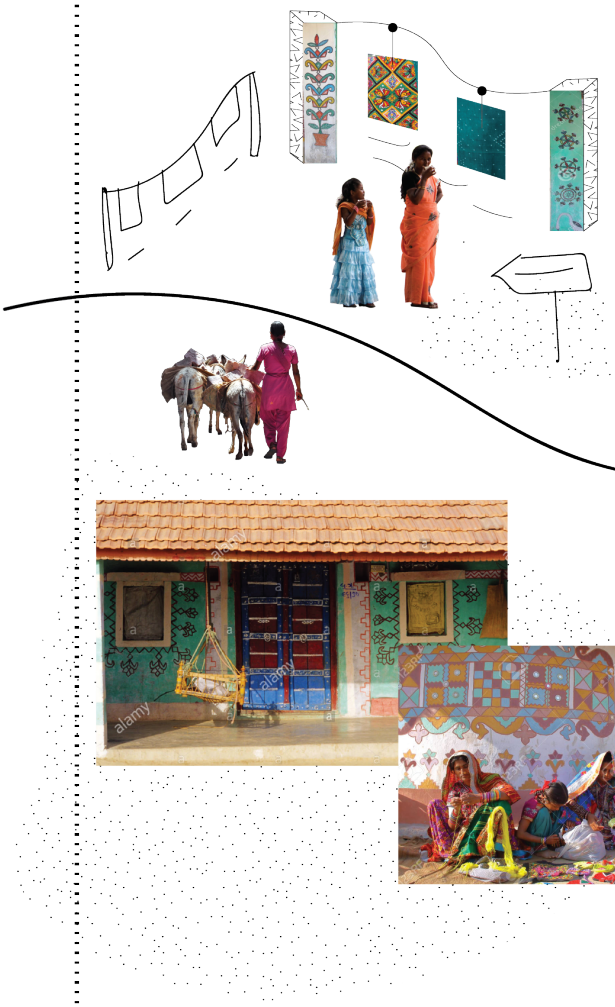
Women as agents of change

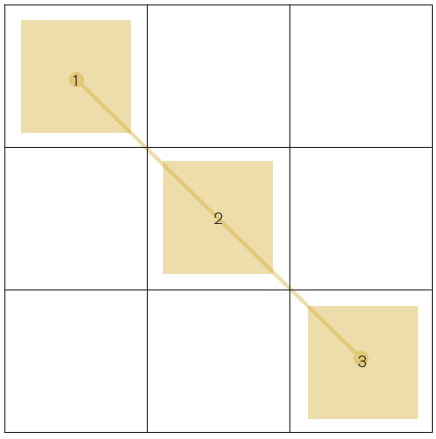


Potential Women Intervention X Vulnerability Matrix

1. Art, Craft, and Women

2. Dialogue a
Wom





Potential Women Intervention X Vulnerability Matrix

Three Systems of Women Intervention

The interwoven between these three systems will leads to the empowerment of Women in Bhuj. The focus that will be elaborated further is Water and Women System.

1	2	3
Art and Craft Community	Communal Spaces for Workshop + Collective Resources and Tools	Integrated Promotions and transportation with other tourism destination

collective women community

Focus Intervention:
3. Water and Women

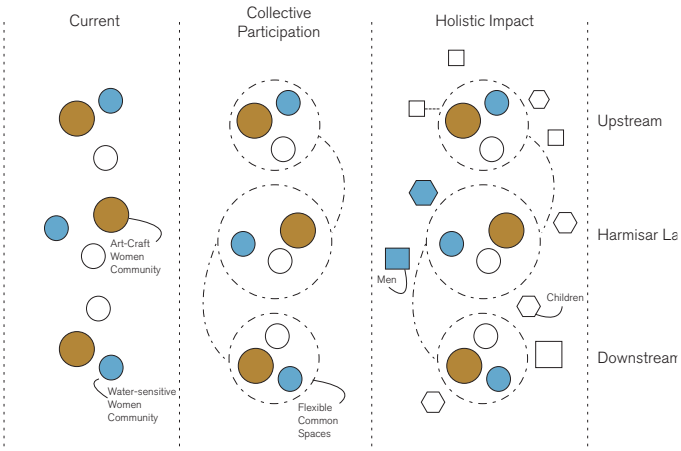


1	2	3
Flexible Spaces for Communal Activity	Women organization for women capacity building program	Dedicated Spaces for Art and Craft Public Market

1	2	3
Communal Water Storage with ground water recharge	Phytoremediation for waterbody	Programs for relocating encroached settlements

Rati Talav Slum Area
(Pilot Project)

How The Social System Work



Advocating Fragmented Women Communities

How Common Flexible Spaces and Advocation Can Promote Synergies of all communities

How the synergy can also influence whole society of Bhuj including men and children

Criterion for Strategic Drivers

Each system has different criterion that determine which area is suitable the most to become the strategic drivers.

1. Art Craft and Women System Criterion

- High number of bandhani workers
- Good accessibility to Harmisar Lake
- High open spaces availability

2. Dialogue and Women System Criterion

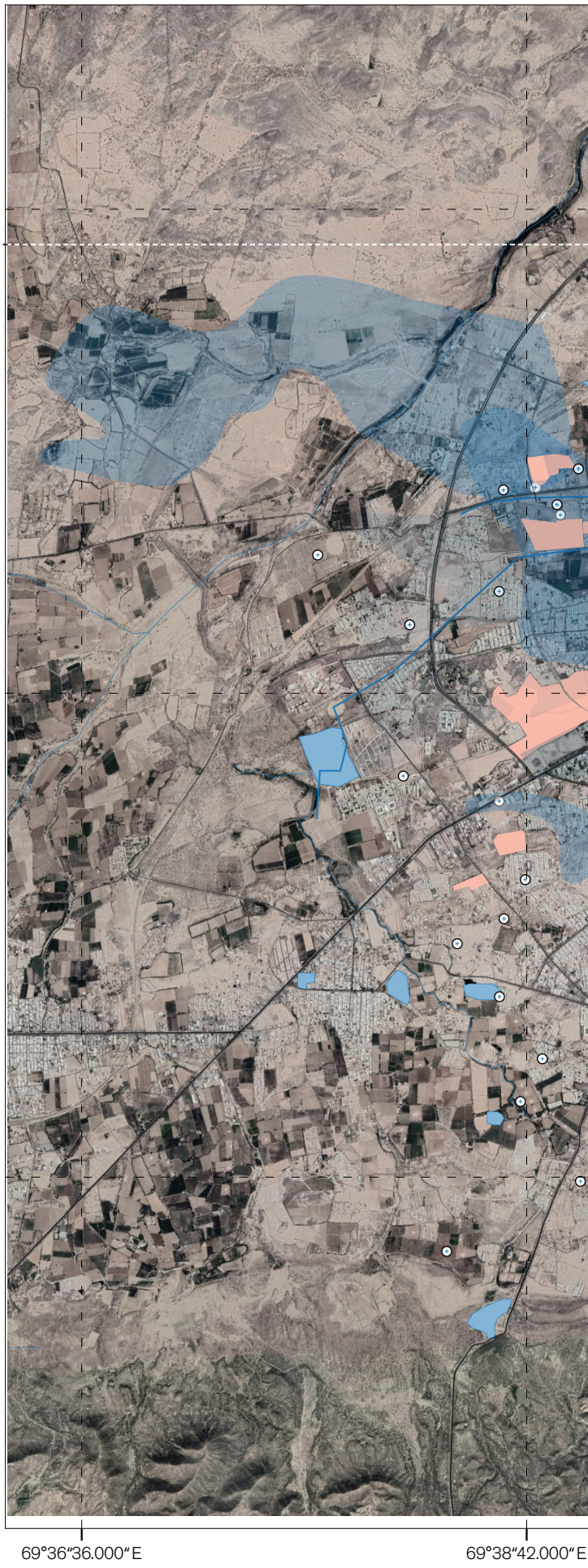
- Good accessibility to every part of Bhuj
- Close to waterbody such as lake, river, etc
- Close in proximity to the heritage buildings
- High importance value of the spaces

3. Water and Women System Criterion

- Vulnerable slums area
- High recharge potential
- Close to the waterbody

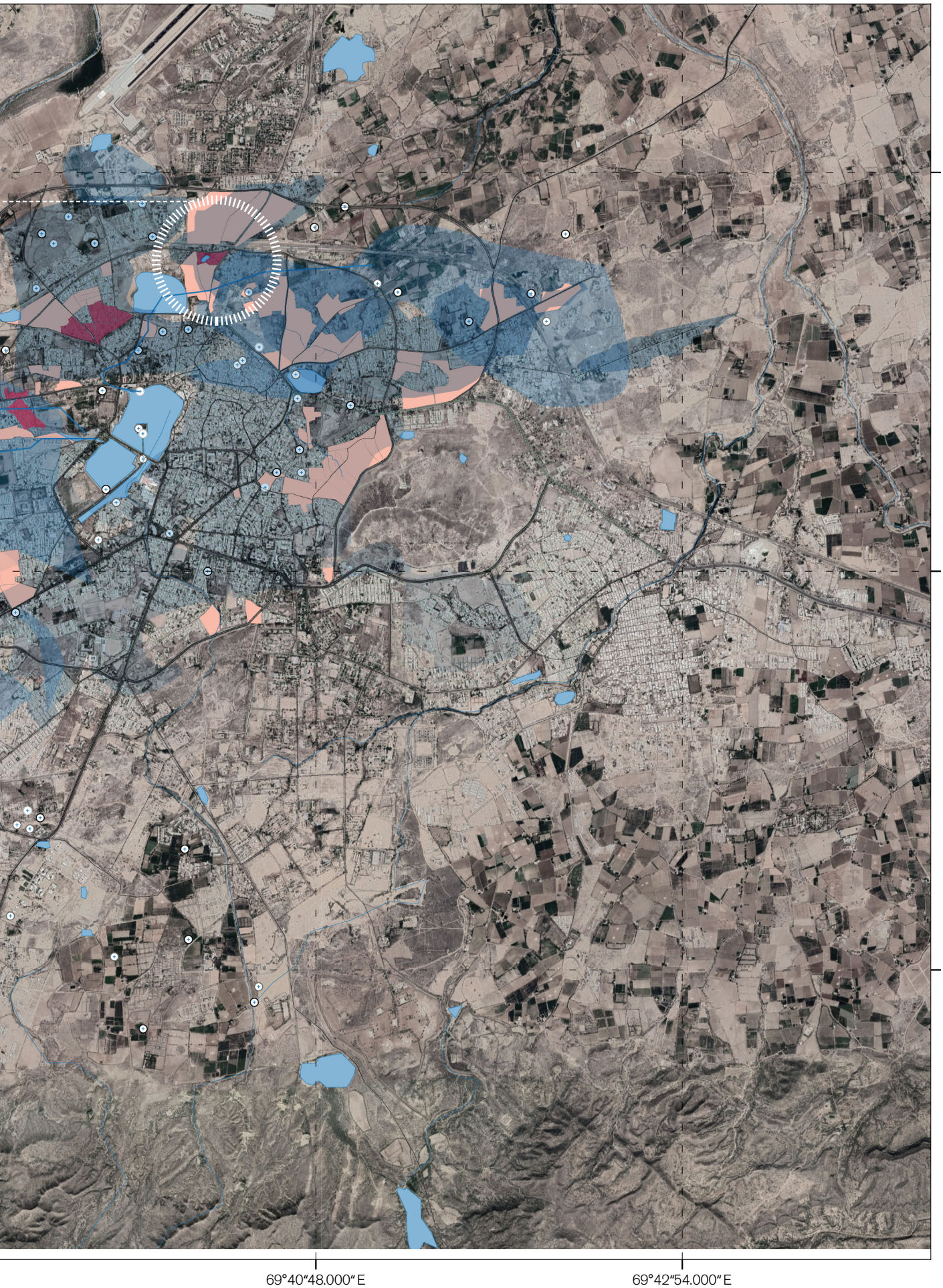
Legend

- Waterbody
- Slums Area
- High Vulnerability Level Slum
- Polluted Wells
- High Recharge Potential



N

0 1 km


23°16'30.000" N
23°14'24.000" N
23°12'18.000" N
69°40'48.000" E
69°42'54.000" E



Pilot Project Condition :
Rati Talav Slum Area

- High accessibility
- Encroachment within waterbody
- Overflow of Pragsar Lake cause flood
- Defunction of Nala Circulation
- Rati Lake is biochemically dead

Rati Talav Slum Area
Main Intervention

1. Rati Lake remediation
2. Encroached settlements relocation
3. Arts and craft homestay
4. Collective water resiliency

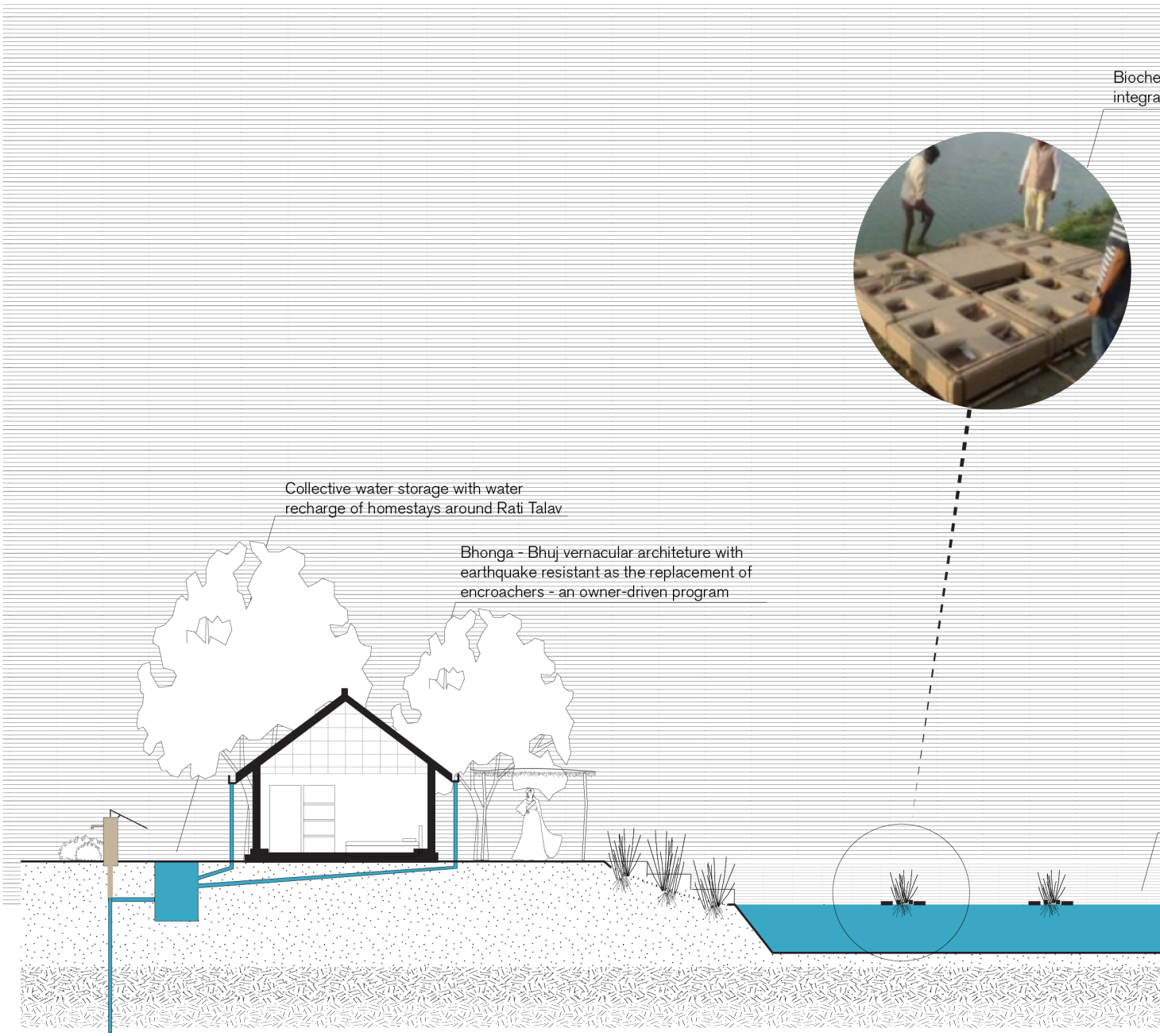
Legend

- Rati Lake
- Lake Basin
- Open Spaces
- Homestay Interventior
- Public Building
- Waste Water Network

N

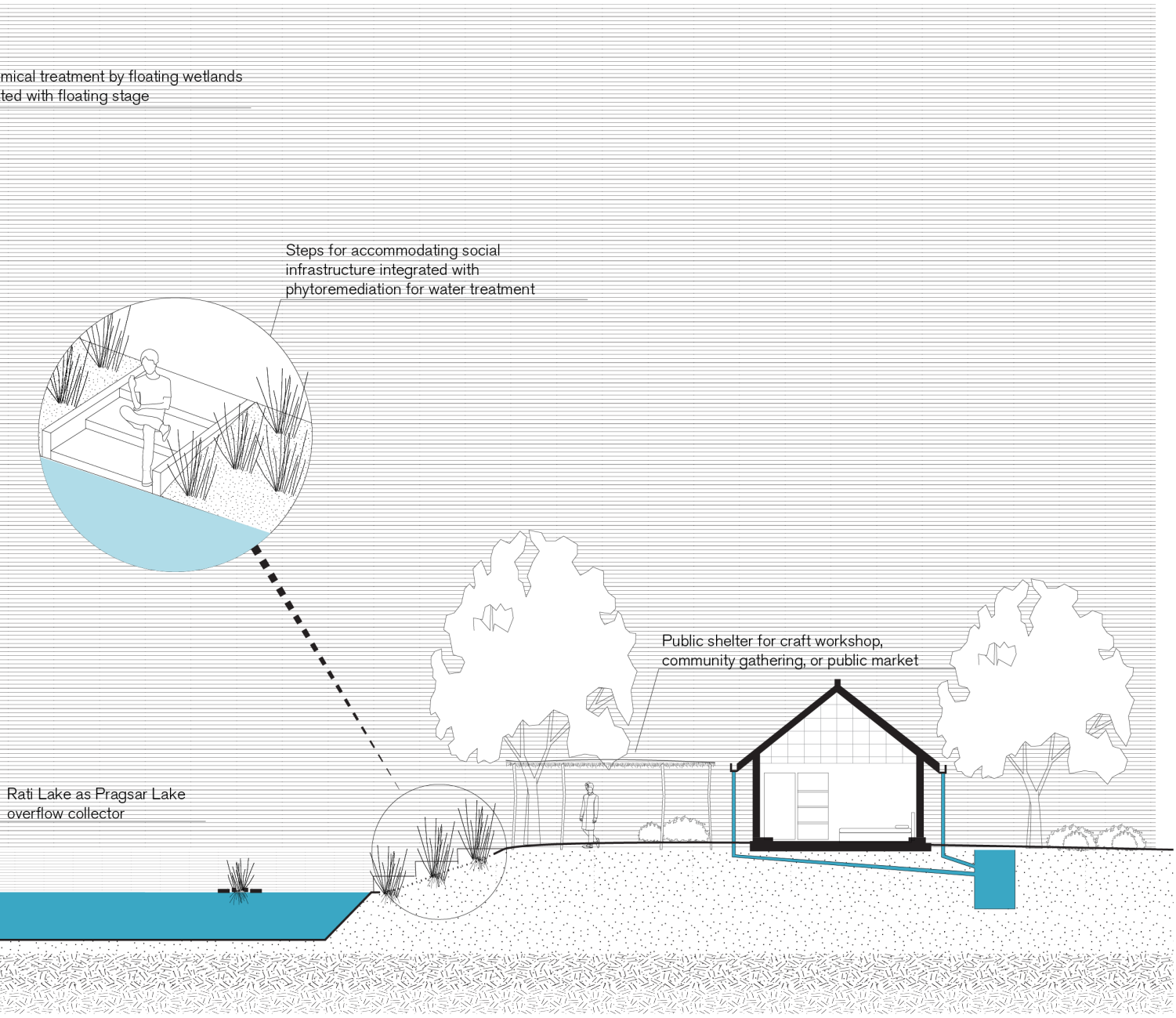
0 250 m





Section A-A': Rati Lake Remediation + Encroached Settlement Relocation

This section explains about how to relocate encroachment aroun water basins and nature based interventions to remediate water quality of the lakes.

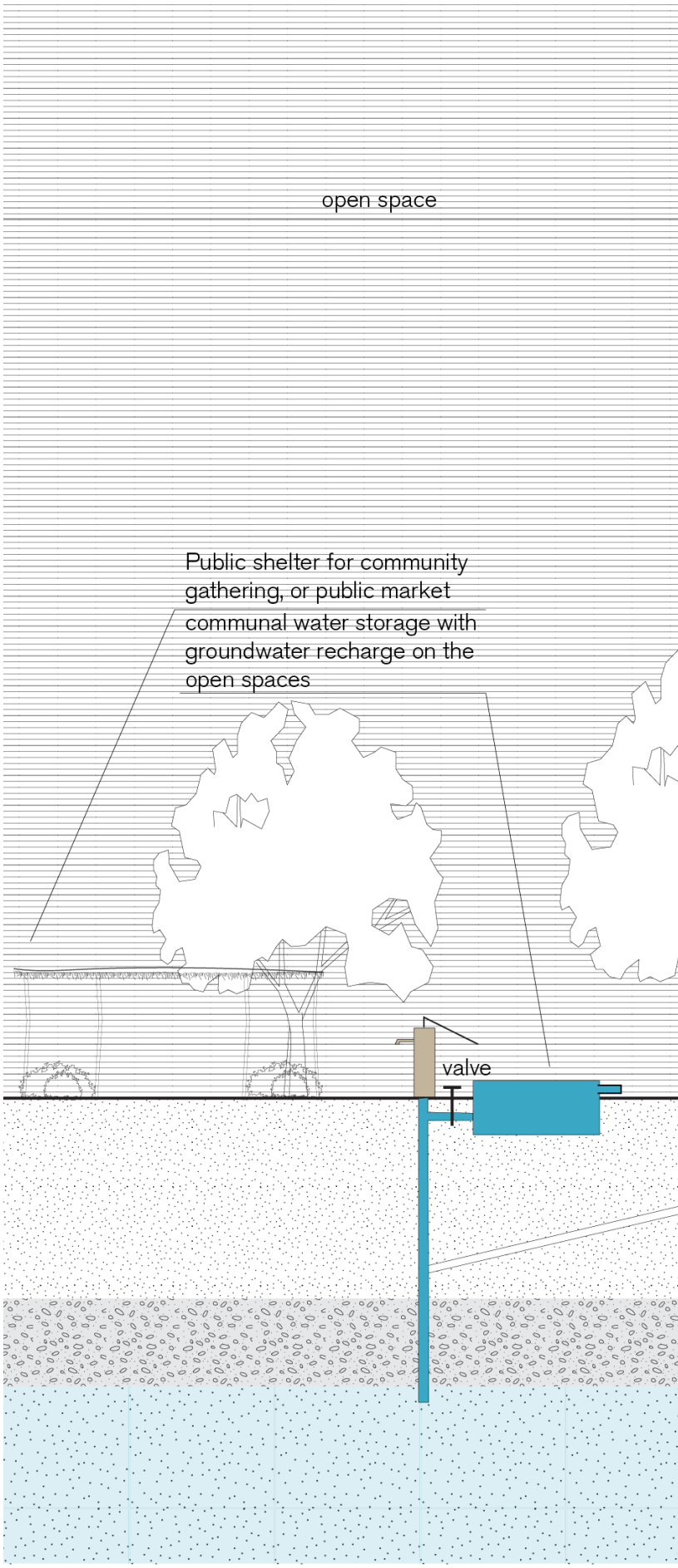


Funding

Bhuj Nagar Palika - 30%	Gujarat Mineral Development - 50%	Crowd Funding - 20%

Prominent Stakeholders

Hunnarshalaa Foundation	Kutch Mahila Vikas Sangathan	ACT



Section B-B': Art and Craft Homestay + Collective Water Resiliency

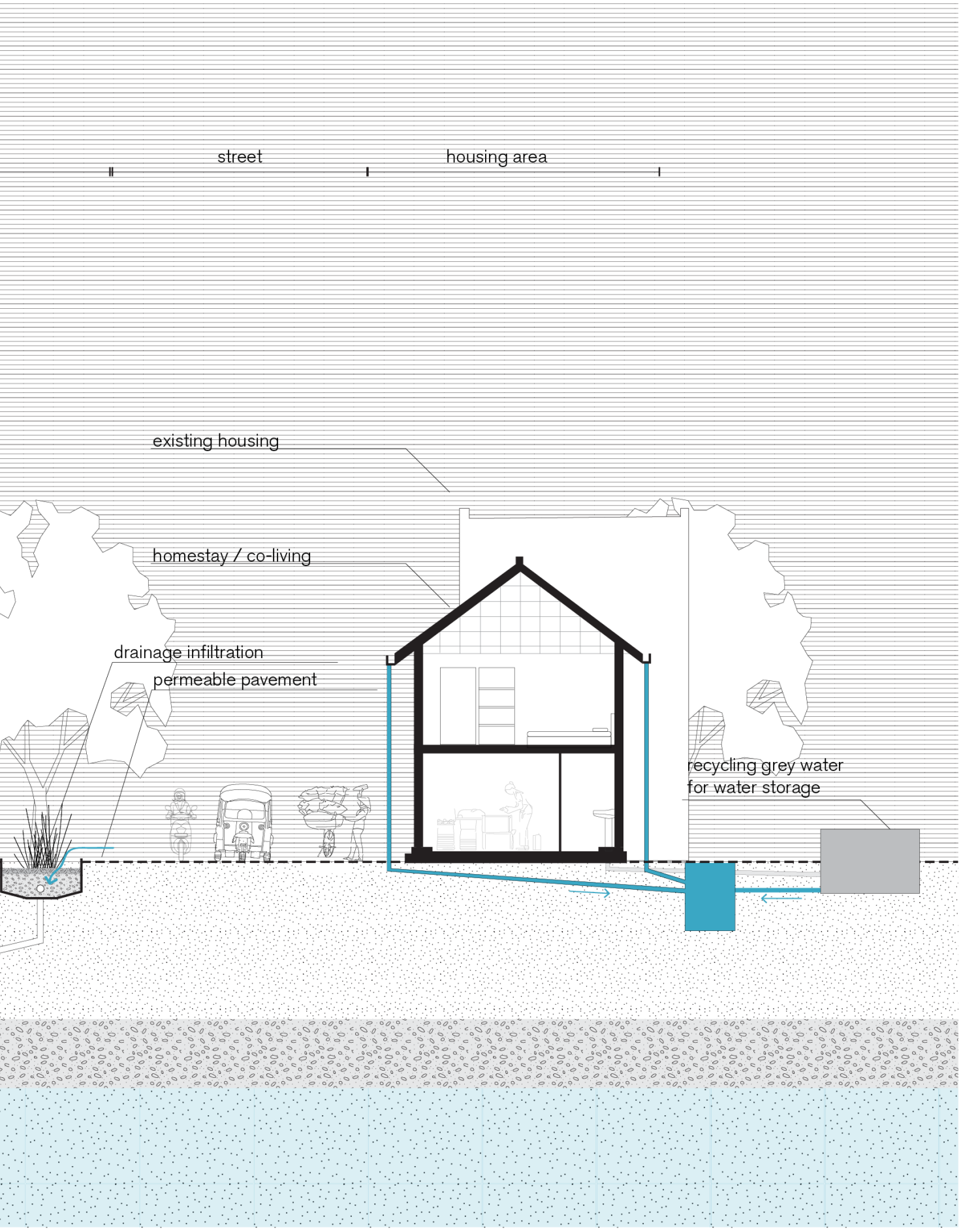
This section explains on how to intervene some houses to be re-constructed with vernacular materials in order to achieve housing with earthquake resistant quality. Also, this new housing intervention can also become the pilot project of communal waste water treatment. Communal water storage with ground water recharge also be implemented on the open spaces.

Funding

Bhuj Nagar Palika - 30%	Gujarat Mineral Development - 20%	Crowd Funding - 50%

Prominent Stakeholders

Hunnarshalaa Foundation	Kutch Mahila Vikas Sangathan	ACT


street
housing area
existing housing
homestay / co-living
drainage infiltration
permeable pavement
recycling grey water
for water storage

Reterritorializing Bhuj:
Towards Water Conscious Assemblages

Ganesh Babu Ramaiah Perumalsamy



Reterritorializing Bhuj

Towards water conscious assemblages

Articulations of new relationships between man and nature through artefacts of increased water consciousness.

Manifesto

We need to look past the colonised relationship with water as a commodified resource for consumption and move to a visceral understanding of water in the collective consciousness of Bhuj for sustenance. An arid territorial condition deterritorialized by disarticulated relationships of human-nature, artefacts of extraction, and the creation of Non-Places is reterritorialized by the Kutchi from Bhuj. This reterritorialization is done through articulations of new relationships between man and nature through artefacts of increased water consciousness.

1. Water consciousness of the territory is established collectively and inclusively for it to build transparency and accountability in an urbanising community of people from multitudinous backgrounds. The process is codified through secular governance processes as opposed to religious rituals.

2. Land use and economic connotations of land are stratified by parameters of engagement with water. Availability, accessibility, permeability, quality and state of water determines the nature of productive activity in the land.

3. Human Relationships with the territory are dynamic and plural based on the multiplicity of water states as established by natural, technical and political processes.

4. A rearticulated human-nature relationship through water consciousness is not a call for Neo-Luddism. Contextualising digital and physical technology to the territory is critical to the reterritorialization process that is relevant in the 21st century.

5. Looking past a human-nature dichotomy in terms of objects and systems, a synergistic combination of natural, social and technological processes for a sustainable reterritorialization that expands on the socio-ecological system of Bhuj.

References:

Deleuze, G. (2004). Anti-oedipus. A&C Black.
Deleuze, G., & Guattari, F. (1988). A thousand plateaus: Capitalism and schizophrenia. Bloomsbury Publishing.

Design experiment

Reterritorializing Bhuj is a multi-scalar, multi-dimensional ambition. The design experiment focuses on building sustainable systems of infiltration and extraction of water within the city limits and building water consciousness through the process.

Condition:

Bhuj, once completely self reliant on water, now relies increasingly on water extraction from its hinterlands and from sources hundreds of kilometres away.

Opportunity:

Leveraging the location of the city on a sandstone aquifer in the semi-arid environment by improving infiltration within the aquifer recharge zone and regulating extraction from the aquifer can help redefine water relationships to be more inclusive and sustainable.

Proposal:

Articulations of new relationships between human and water systems requires spatializing artefacts of infiltration and extraction. By moving these artefacts from a technical and political domain, to one of a social and cultural domain makes water systems more visible and appropriatable in an inclusive framework.

The spatialisation of these water artefacts exposes them to the public realm with various degrees of ownership and responsibilities.

Limitations:

The city is still expanding due to rural-urban migration, and it's water demand is expected to increase. A larger vision for the region is required to engage with water systems at the regional level(Kutch) to deal with other shortcomings. However, the design experiment aims at getting the philosophical underpinnings of a renewed human-nature relationship right, so that future expansions to the regional level can be carried out.

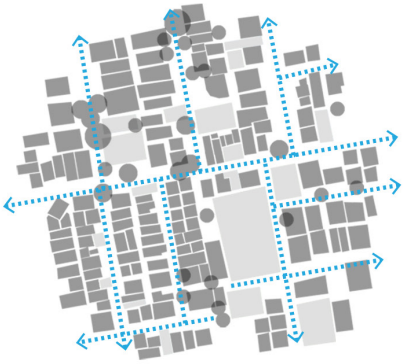
Street scale

Ganesh Babu Ramaiah Perumalsamy



An example tissue from the urban fabric of Bhuj to illustrate the design experiment.

23°14'25.1"N 69°39'08.7"E



1. Green-blue streets
City streets with a focus on improving the infiltration capability through nature based solutions and augmenting the capacity of the green and blue systems in the city.



- Infiltration
- Extraction
- Storage
- Government
- Companies
- Individuals
- Collectives
- Natural systems
- Traditional systems
- Futuristic systems
- Subsurface
- Street
- Buildings



2. Stepwells
A network of stepwells of different scales and sizes across the city based on the site conditions. The stepwells are appropriatable public spaces of water participation which function as neighborhood scale economic hotspots.



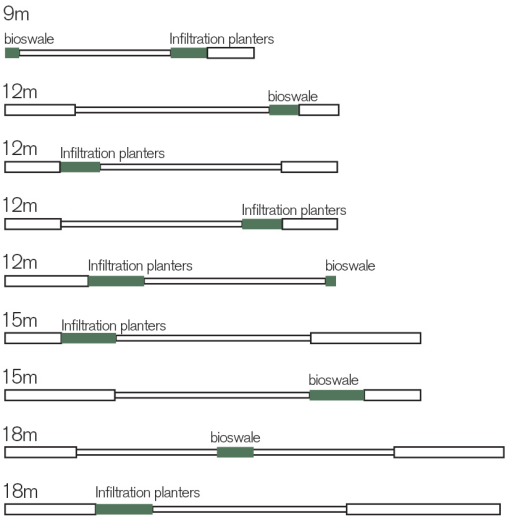
Towards water conscious assemblages

The design experiment, creates a framework for reterritorialising bhuj with water conciousness as part of everyday life, and as a way of life, looking specifically at infiltration and extraction within the city limits.



3. Water courtyards
Water courtyards spatialize artefacts of water extraction and storage in the fabric of Bhuj. These semi-public spaces help improve water-resiliency through shared infrastructures.





Green-Blue Street Network

City streets with a focus on improving the infiltration capability through nature based solutions and augmenting the capacity of the green and blue systems in the city.

Bioswales and infiltration planters along the street help in augmenting the storm water drainage system, while also improving infiltration capacity of the street. The nature based systems help improve the microclimate. The choice of plants used is based on specific requirements of the characteristics of the street.

The augmentation potential is also based on the space availability in streets and the water carrying potential as reflected by the soil conditions in the region.

A. Bioswales

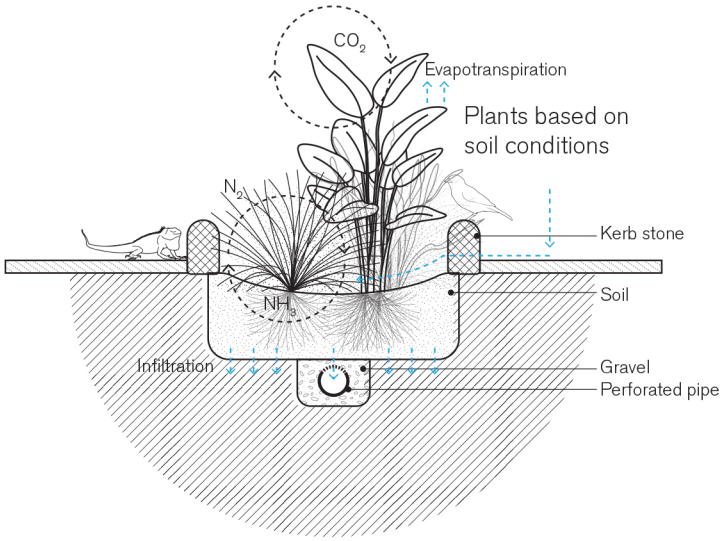
A network of bioswales which can also help improve infiltration, while transporting water slowly.

B. Infiltration planters.

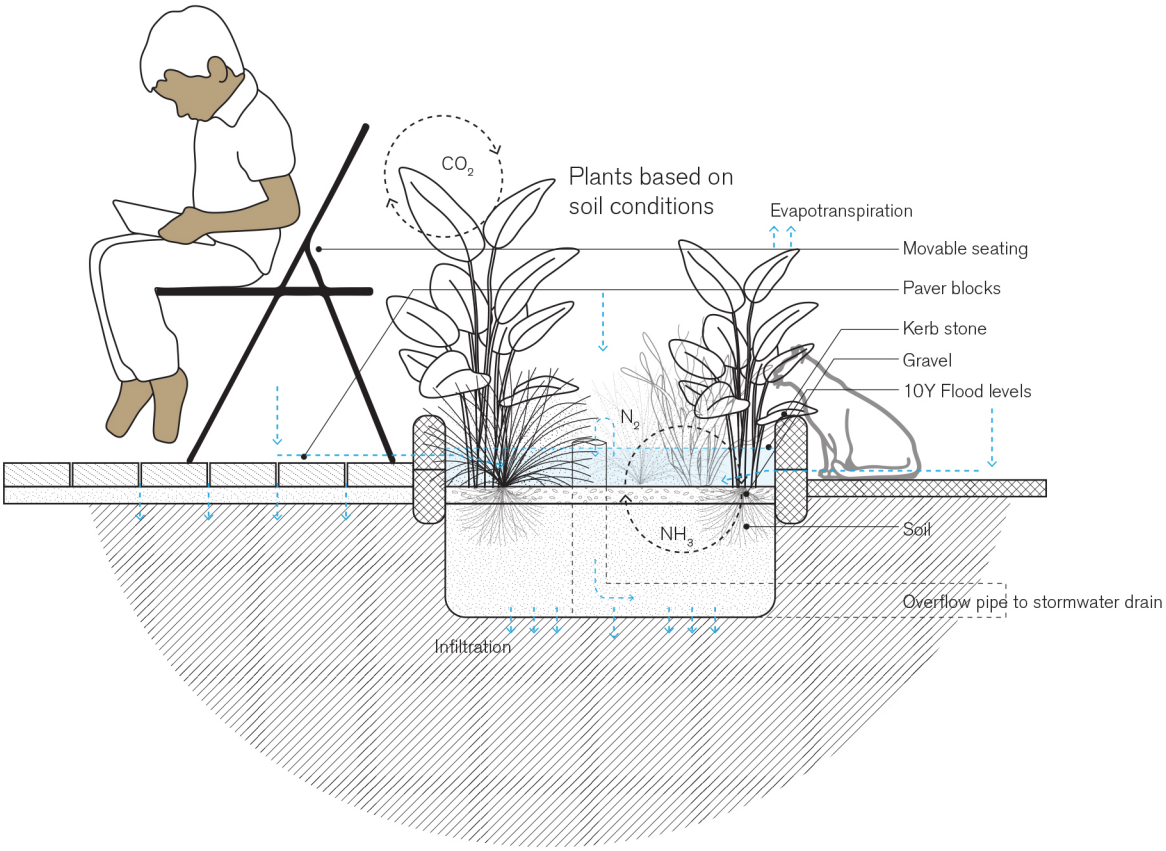
Expands the surface area available for infiltration. The plants used add value based on the context.

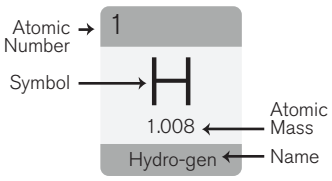
1. Hyperaccumulators in polluted areas.
2. Macronutrient fixers in wider streets.
3. Edible plants in residential neighborhoods.

Bioswale



Infiltration Planters





Plant Matrix

Streets close to industrial neighborhoods can have hyperaccumulator plants specialised in the absorption of heavy metals seen in the soils.

Arterial roads with larger space can house larger infiltration planters with plants that help in nitrogen fixation. The larger area, also attracts birds, which contribute towards phosphorus enrichment. This soil can be periodically repurposed in other parts of the city as its nutrient content increases over time.

In residential neighborhoods, plants and trees with medicinal value and edible products are preferred as they help towards the shared maintenance in the long run.

Bioremediation of contaminated soil

29 Cu 63.546 Copper







48 Cd 112.414 Cadmium











24 Cr 51.9961 Chromium



28 Ni 58.6934 Nickel







82 Pb 207.2 Lead











Fixing macronutrients to soil

7 N 14.007 Nitrogen









15 P 30.973761998 Phosphorus











Native species of Kutch

Medicine











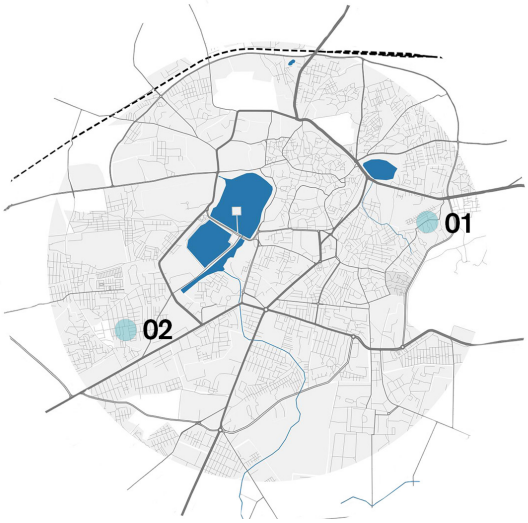
Edible











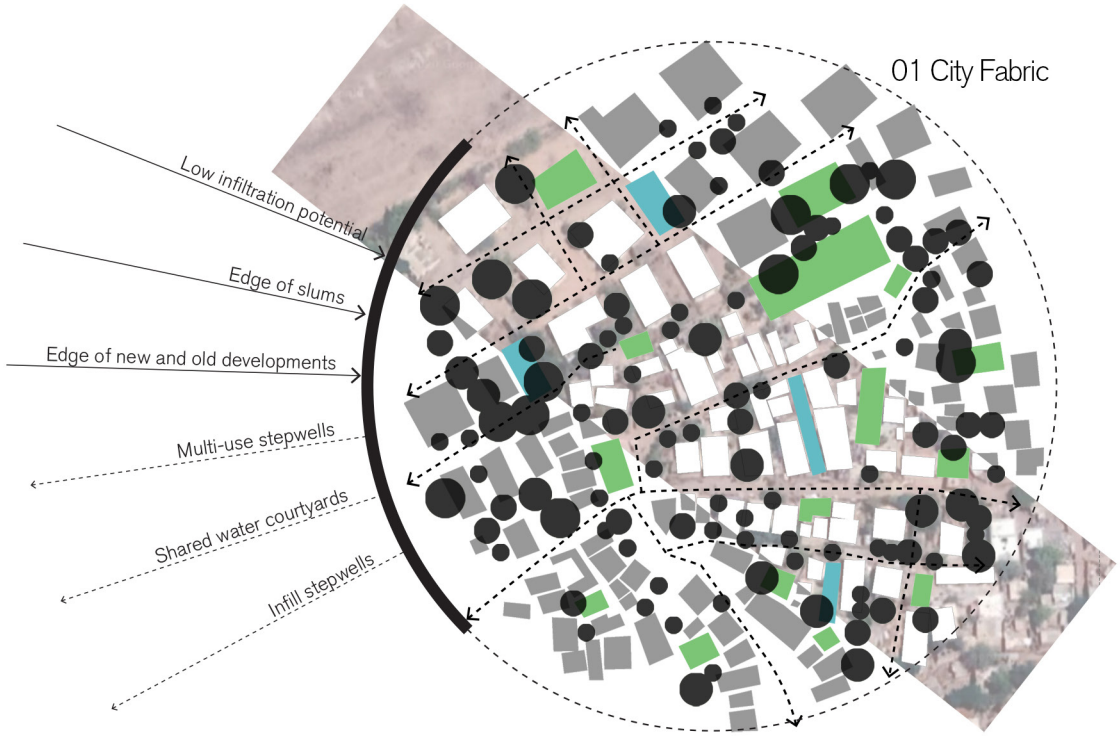
Case examples

The manifestations of the aforementioned tools will vary depending on the contextual conditions. To illustrate this, two areas with different water infiltration potential are selected.

01. Low water infiltration potential
23°14'25.1"N 69°39'08.7"E

02. High water infiltration potential
23°15'01.1"N 69°41'01.2"E

The immediate context of the selected sites differ from each other beyond water infiltration in terms of morphology, open space distribution and formality as well. This will help to illustrate the potentially different possibilities in terms of manifestations of these artefacts of water conciousness.


01 City Fabric
Low infiltration potential
Edge of slums
Edge of new and old developments
Multi-use stepwells
Shared water courtyards
Infill stepwells


02 City Fabric
High infiltration potential
Peri-urban territory
New developments
New productive landscapes
Shared water courtyards
Infill stepwells

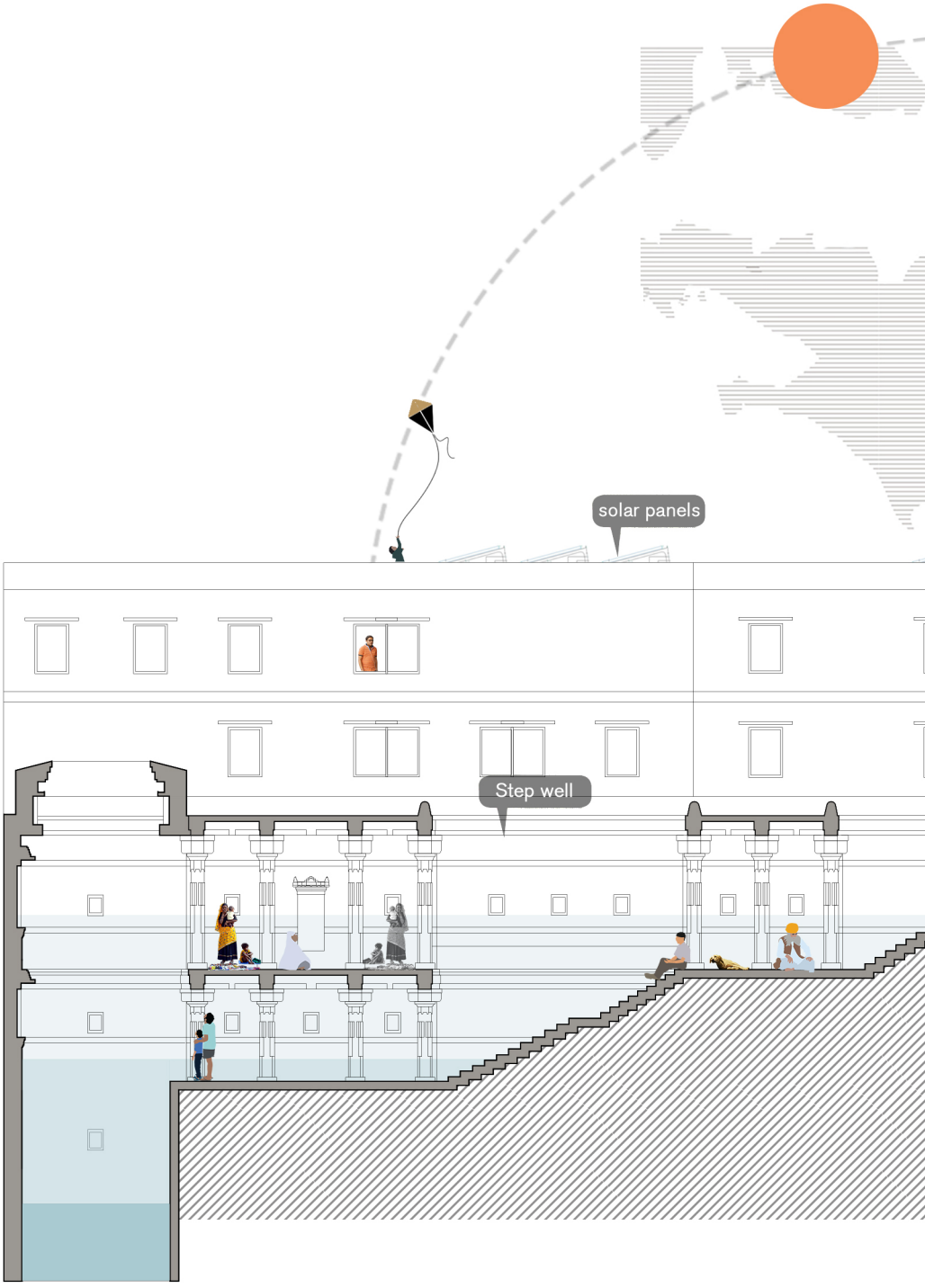
Case Example 01

The stepwells throughought the city reveal the level of the water table and the quality of it in different parts of the city. It helps make the invisible system more visible and part of the everyday realm.

Stepwells are to be constructed as an infill in the existing urban fabric. These are envisioned as public spaces which double as water infrastructure. The temperature differential acts as an attractive public space that facilitates a wide variety of economic, social and cultural activities, depending on the contextual location of the stepwell in the fabric.

In this particular location, it could house women self help groups. The stepwells are also the place for improving water literacy and building awareness towards a sustainable water resource management.

The low water infiltration potential means that the water courtyard has rain water storage and the stepwell is larger to store excess runoff during monsoon.




infiltration planters
water courtyard

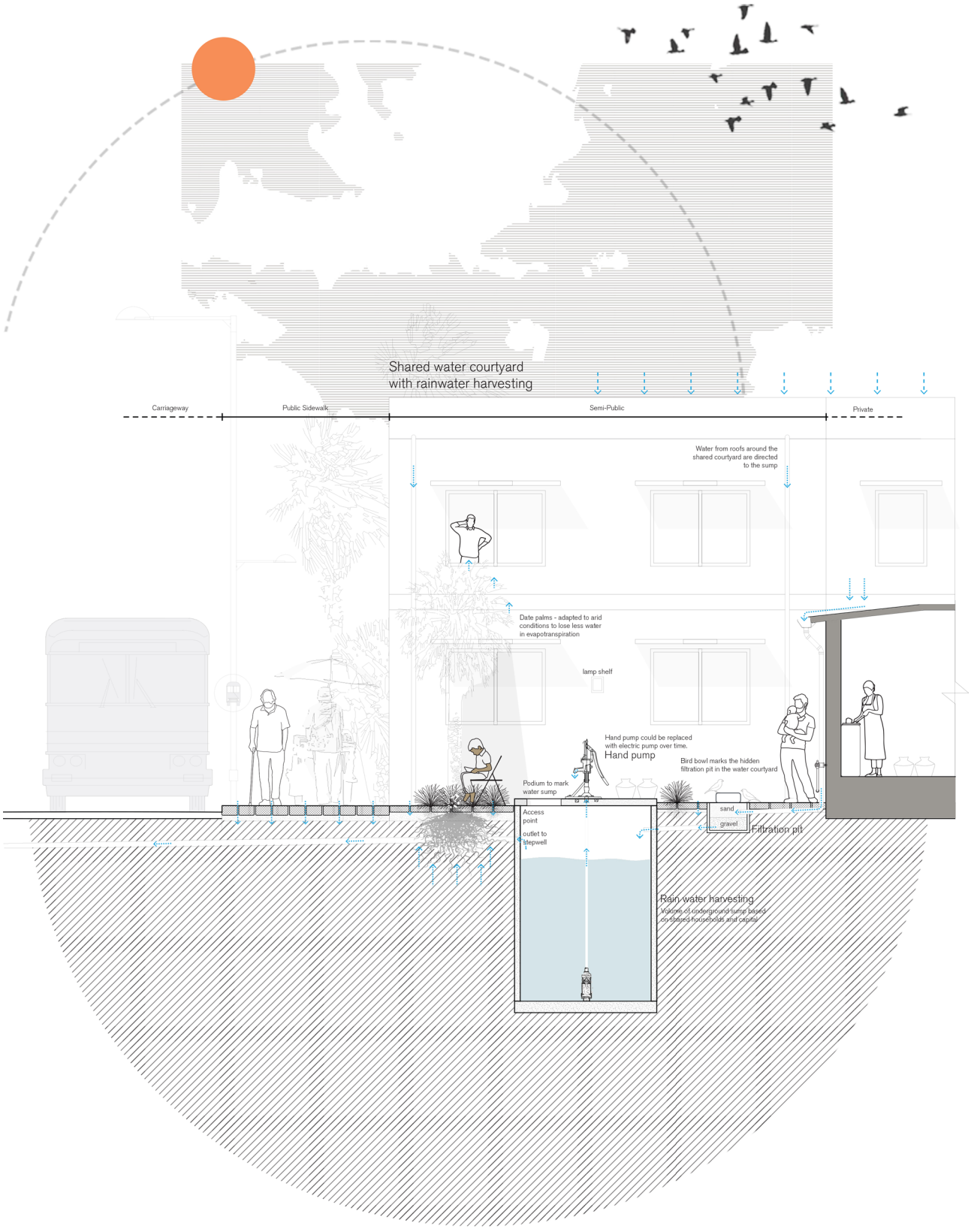
Water courtyard

Water courtyards help towards the decentralisation of water infrastructure through shared capital investment. They help augment the existing water infrastructure of the city, while also creating avenues of self sufficiency for communities.

The land, capital and workforce are shared between the neighboring households of the water courtyard to hedge costs of building water resiliency.

In this context with low water infiltration potential, a water storage tank is built for the needs of the households, affixed with a hand pump. This could be upgraded to an electric pump based on investment ability. The municipality could provide connection to this shared water storage unit.

The semi-public space enables the overlap of the social realm of the neighboring houses.


Shared water courtyard
with rainwater harvesting
Carriageway
Public Sidewalk
Semi-Public
Private
Water from roofs around the shared courtyard are directed to the sump
Date palms - adapted to arid conditions to lose less water in evapotranspiration
lamp shelf
Hand pump could be replaced with electric pump over time.
Hand pump
Bird bowl marks the hidden filtration pit in the water courtyard
Podium to mark water sump
Access point
outlet to stepwell
sand
gravel
Filtration pit
Rain water harvesting
Volume of underground sump based on desired households and capita



Case Example 02

In this example where there is high water infiltration potential. the stepwell is smaller and available land is turned for urban agriculture, with in situ water infiltration pits.

The relatively richer neighborhood means that water courtyards could house borewells along with soak pits for water infiltration.

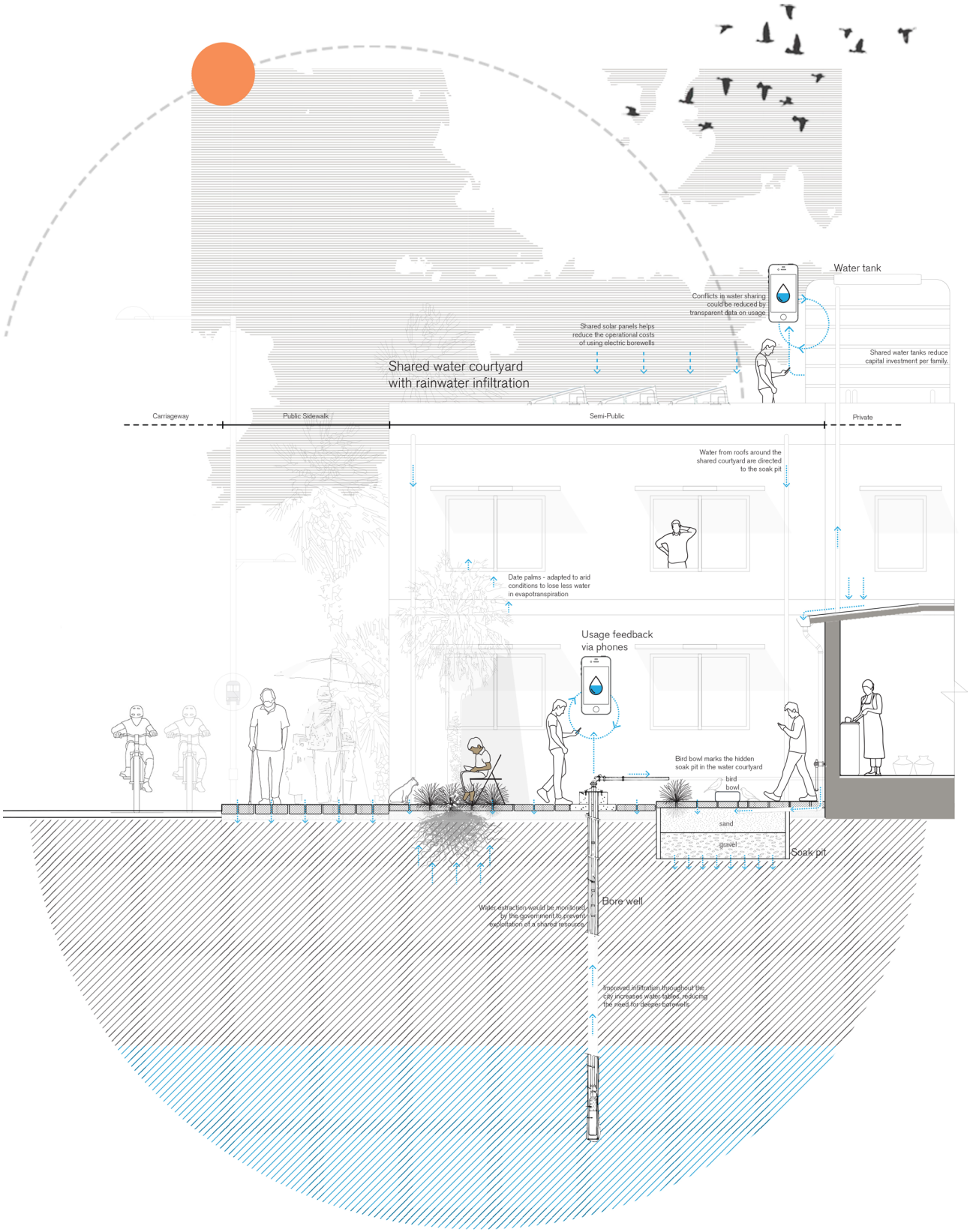

solar panels
solar panels
infiltration planters
water courtyard
Step well

Water courtyard

Water is a shared resource and hence excess extraction is monitored through monitors on the borewell.

This data is public and could be shared between the houses sharing the borewell, and also by the government for taxing the excess usage in higher tax slabs.

The use of digital means makes certain hidden processes more transparent and helps towards the optimisation of water resource management.


Water tank
Conflicts in water sharing could be reduced by transparent data on usage
Shared solar panels helps reduce the operational costs of using electric borewells
Shared water courtyard with rainwater infiltration
Shared water tanks reduce capital investment per family.
Carriageway
Public Sidewalk
Semi-Public
Private
Water from roofs around the shared courtyard are directed to the soak pit
Date palms - adapted to arid conditions to lose less water in evapotranspiration
Usage feedback via phones
Bird bowl marks the hidden soak pit in the water courtyard
bird bowl
sand
gravel
Soak pit
Bore well
Water extraction would be monitored by the government to prevent exploitation of a shared resource
Improved infiltration throughout the city increases water tables, reducing the need for deeper borewells

Governance scheme

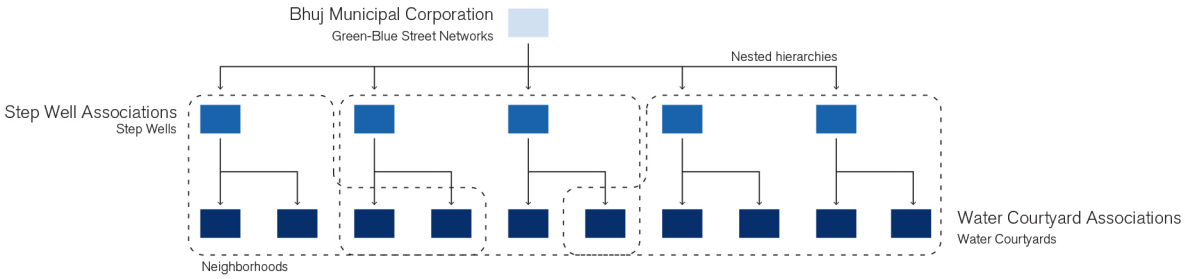
The three components of the design experiment, requires three nodal agencies.

1. The Green-blue street network is under the purview of the Bhuj municipality.
2. The step wells require a creation of a special step well association, which brings together actors in that region.
3. The water courtyard association is a much smaller body of representative houses that share resources.

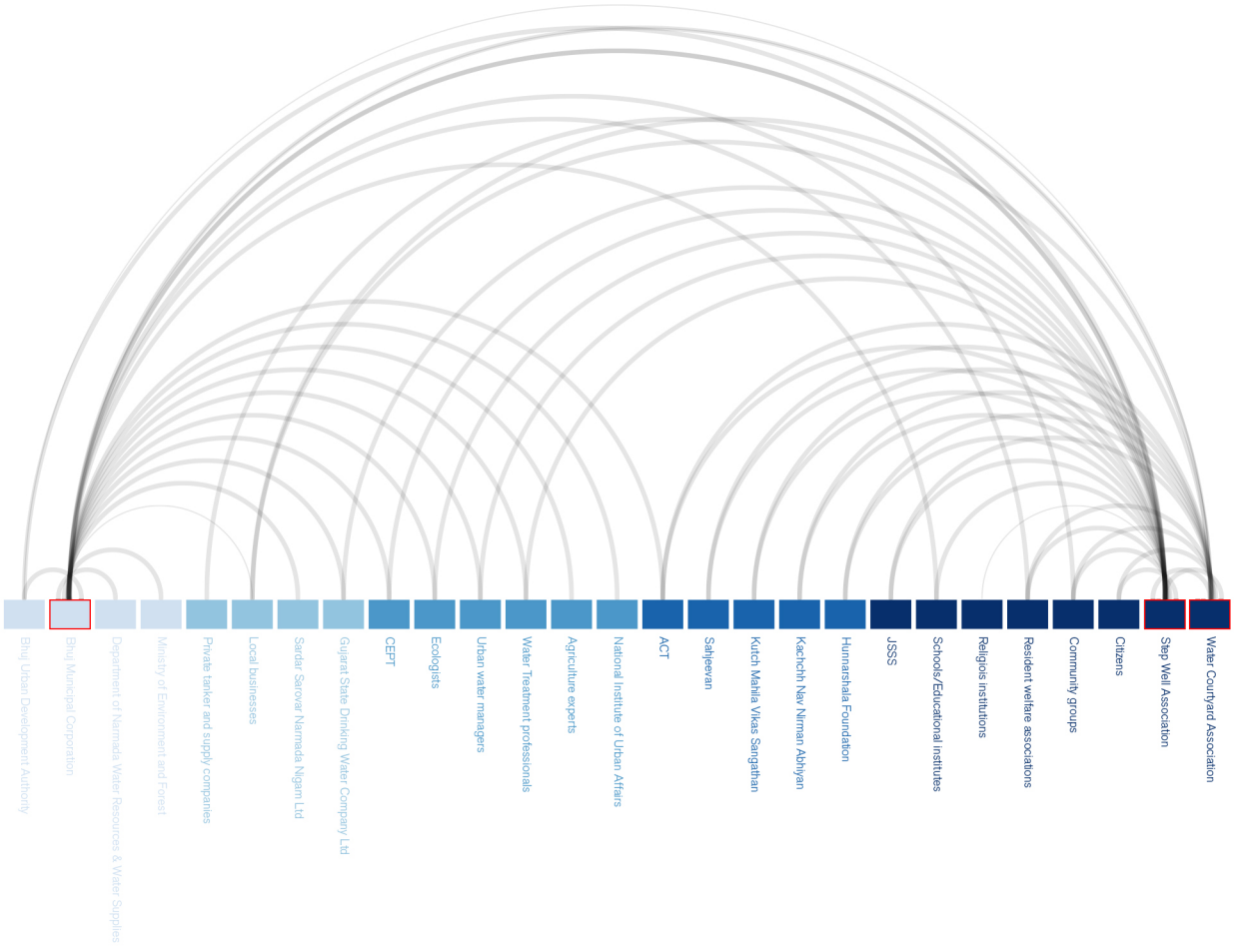
The formalisation of these associations helps in regulating water usage much more effectively and make processes more transparent.

While the street network and step wells are more centrally driven, with funds from central and state governments, supplemented by CSR funds from corporations, the water courtyards are bottom up initiatives subsidised partly by government and private stakeholders.

Governance Scheme

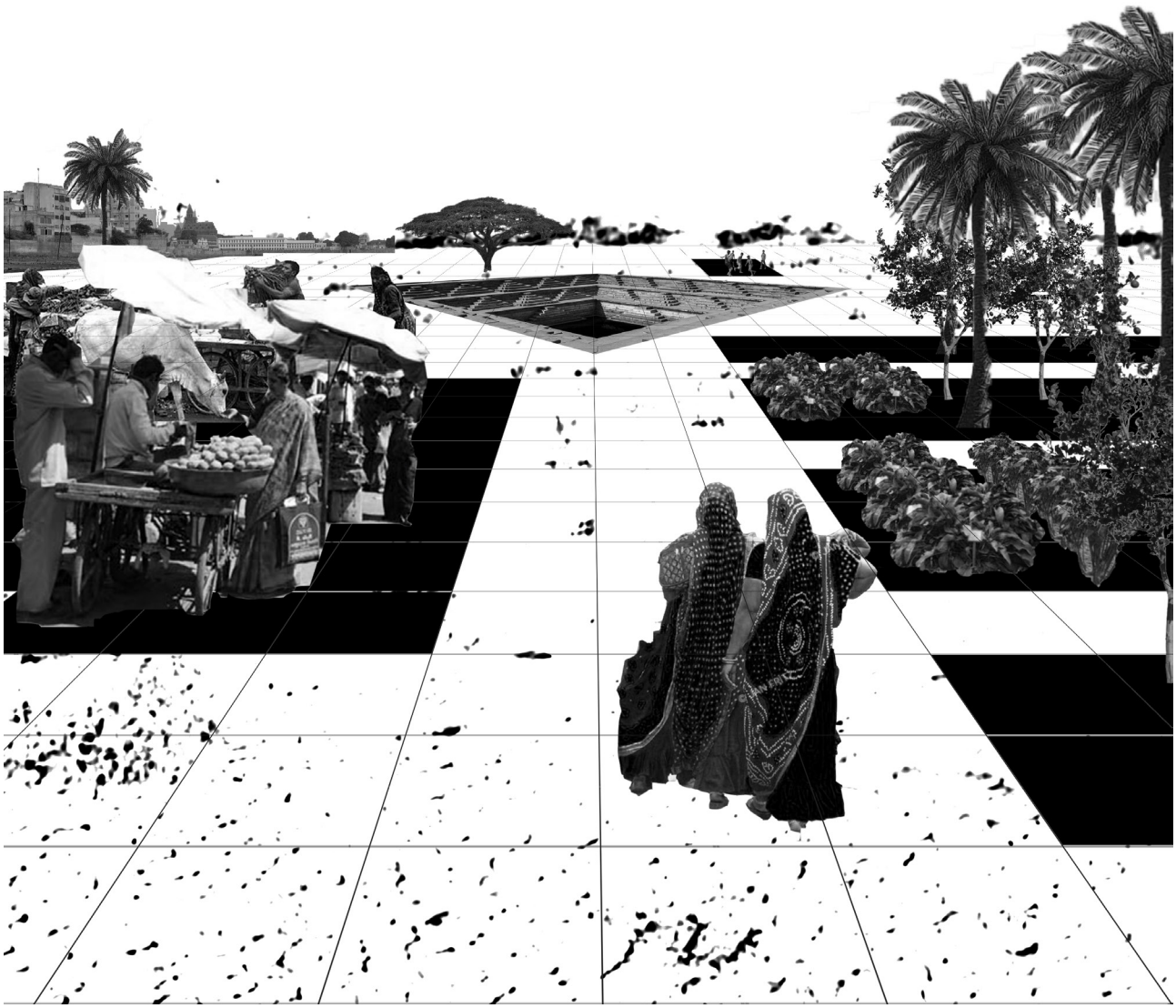


Collaboration Potential



Productive Commons

Johnathan Subendran



The open pockets within the city host a multitude of productive functions to increase water storage and retention capacity, enable local consumption and production cycles while empowering the most vulnerable through alternative means to livelihood. The productive commons is a space for people led by the people.

Manifesto

Bhuj, is self-sustainable.
The city dismantles global dependence .
The city treats its resources as a commons.

Bhuj, is built on local economies.
And, is built by its communities.

Bhuj is governed by its citizens.
The city empowers those who are weak and vulnerable.
The city confers to its citizens upon change.
The city distributes wealth evenly.
The city gives a means to livelihood for all its citizens.
The city is just.

Bhuj, knows its resources are finite in which cycles are closed.
The city reduces its reliance on imports.
The city grows its own food.
The city feeds its inhabitants.

Bhuj, connects its people to its infrastructure.
The city provides space to gather and play.
The city revives water traditions in contemporary form.
The city reduces, reuses and recycles.
The city absorbs water and stores it for later.

Buildings catch water.
Streets absorb and distribute water.
Citizens recycle water.
Open space remediate and store water

Bhuj, reconciles collective practices from the past.
The city breaks up caste and class.
The city abolishes ownership, and promotes sharing.

The city is maintained by its citizens.
The city is beautiful.

Bhuj, as a productive commons.

Inspired by 'A Merry Manifesto' by Michael Sorkin
Noever, P., & Meyer, K. (2010). Urban future manifestos. Ostfildern, Germany: Hatje Cantz.

Design experiment

Productive commons explores the intersection of water treatment, localize economies and nature based technologies to support the agency of all in transition towards a more self-sustainable city.

The project aims to tackle water scarcity through a combined socio-economic and environmental perspective. In doing so, the productive commons acts a testing ground to facilitate an environment that empowers disenfranchised groups through the optimization of under-utilized resources. This would enable the localization of economies, sustainable use of resources and revitalization of the hydrological system.

The productive commons is a design experiment that involves the recycling and storage of grey and rainwater as inputs to recharge the surrounding aquifer through means of natural surface water retention, traditional infrastructure artifacts and bioremedation. This would enable an optimal environment for local agriculture as a means for alternative employment and stimulate local production and consumption cycles.

The design is led by two questions under one main question which is explored through a combined systemic and spatial approach.

A: How to optimize under-utilized resources as inputs towards a more productive self-sustainable city?

A1. How to support the agency and equity for all members of community to contribute in a meaningful way?

A2. What is role of local knowledge/traditions to develop more contextualized strategies

City, Neighborhood and Street and Building Scale

Johnathan Subendran

Challenges of Bhuj

0. Water Scarcity

Individual consumption

Underutilized resources

1. How to optimze underutilized resources as inputs towards a productive self-sustainable city?

2.1 How to support the agency and equity for everyone to participate and contribute in a meaningful way?

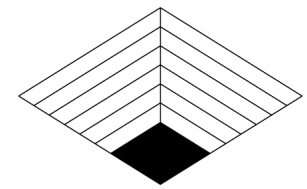
2.2 What is the role of local knowledge/traditions to develop more contextualized strategies?

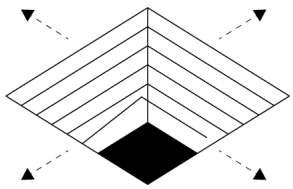
Traditional Stepwell

Water storage
Social, cultural and religious significance
Withstand seismic activity
Public and collective use

+

Local economies
Food production
Water remediation
Water recycling
Water distribution
Collective use
Community participation
Public space







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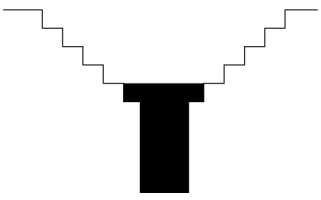
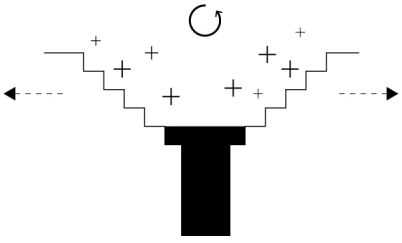




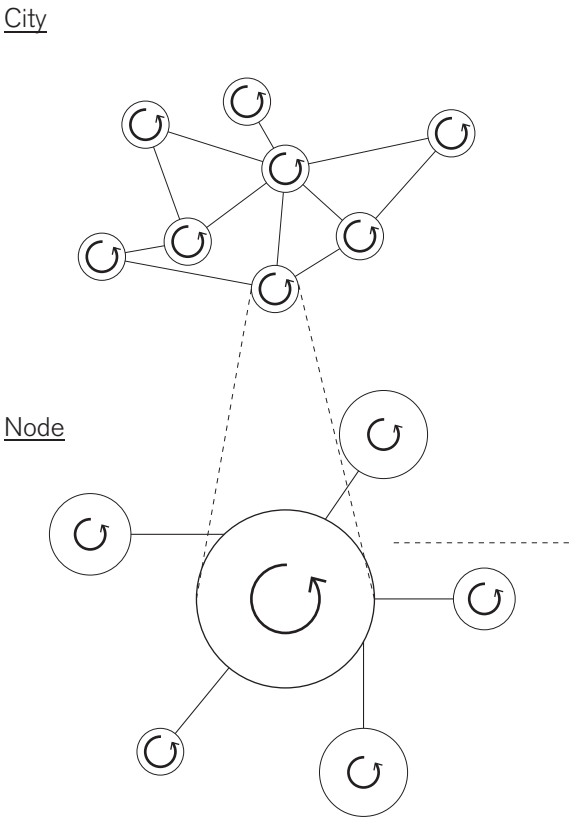
Productive Commons:

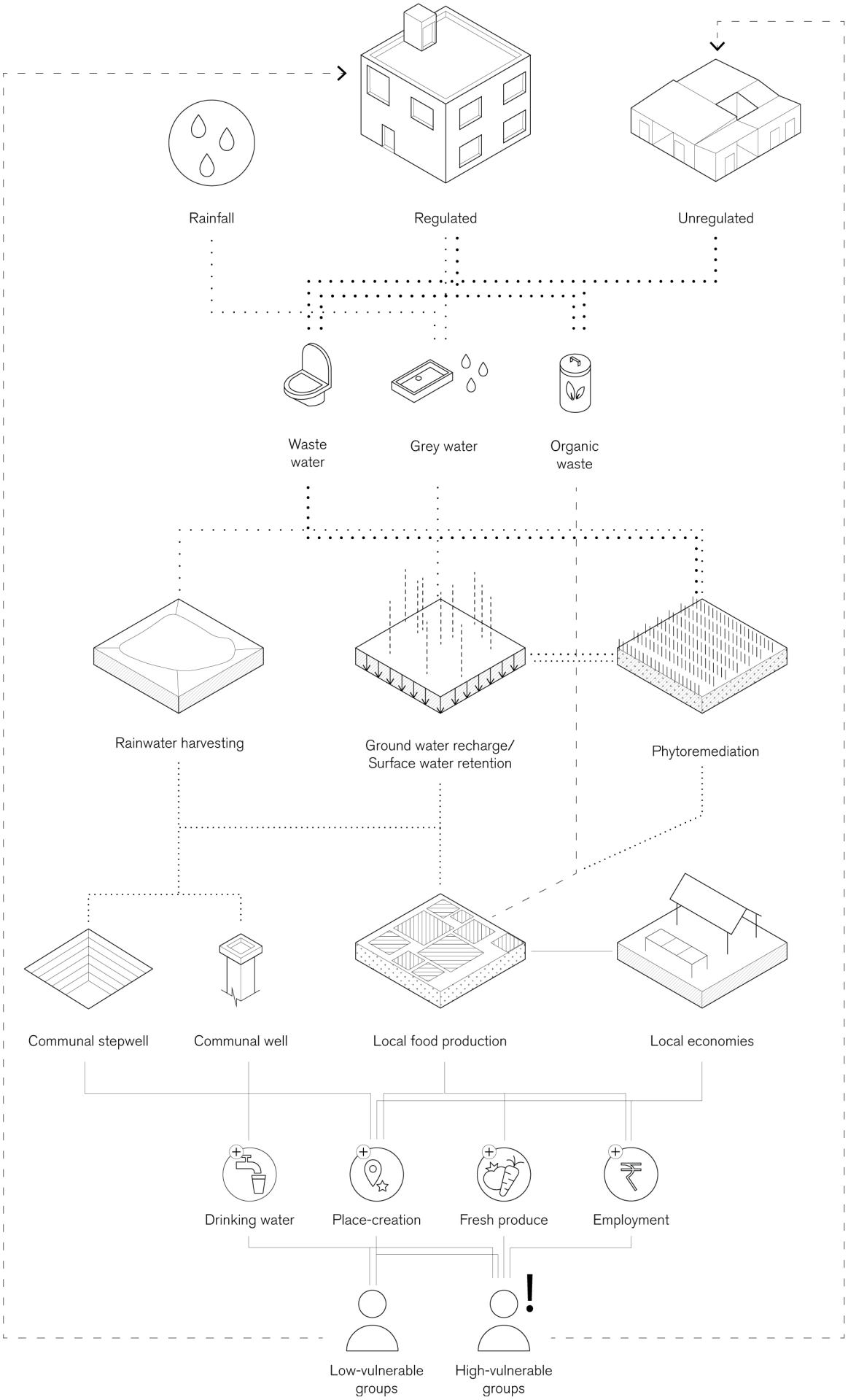
Technical Scheme

This scheme operationalizes the Productive Commons at a micro scale. The operation combines a technical and programmatic framework that facilitates community programming, alternative employment, local economies and the optimization of residual resources such as grey water, organic waste and rainfall. The purpose of this scheme is to promote more sustainable use of water and waste resources while regenerating them to feed into community strengthening programs and functions.

Water Quality
· · · Treated
· · Medium
• • Low

– – Regenerating
— Resource Distribution



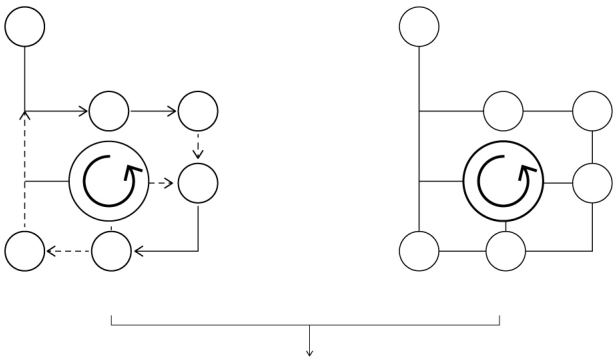

Rainfall
Regulated
Unregulated
Waste water
Grey water
Organic waste
Rainwater harvesting
Ground water recharge/ Surface water retention
Phytoremediation
Communal stepwell
Communal well
Local food production
Local economies
Drinking water
Place-creation
Fresh produce
Employment
Low-vulnerable groups
High-vulnerable groups

Productive Commons:

Design Exploration

Operation: System

Operation: Space



Operation: Combined Approach

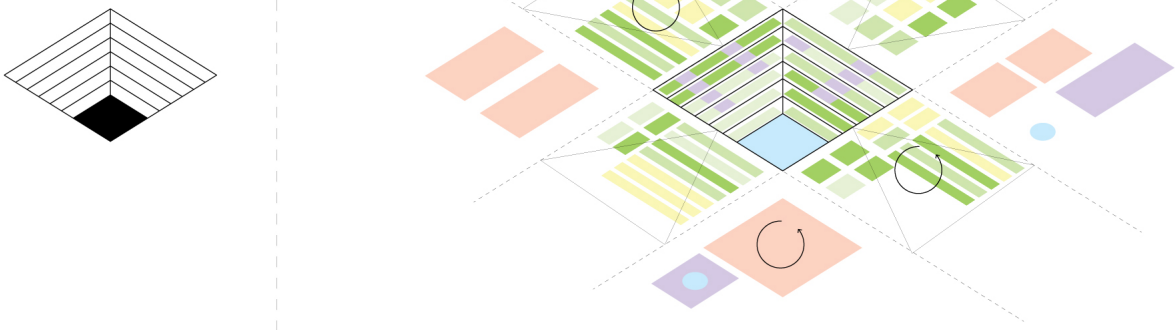
Traditional Stepwell

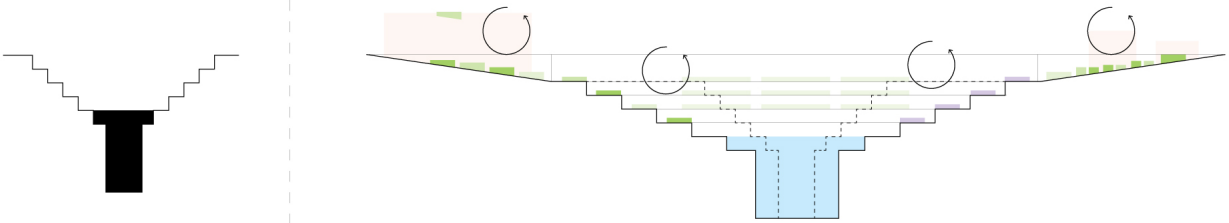
Water storage
Social, cultural and religious significance
Seismic load protection
Collective use
Public space
Sanitation

Productive Commons

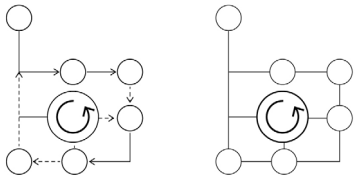
Local economies
Food production
Bioremediation
Water remediation
Water recycling
Water storage
Collective use
Community participation
Public and cultural space

X

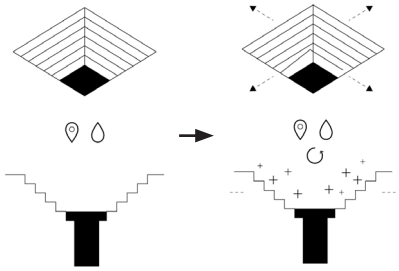




Spatial X Systemic



Combined Approach



Productive Commons: Neighborhood Plan

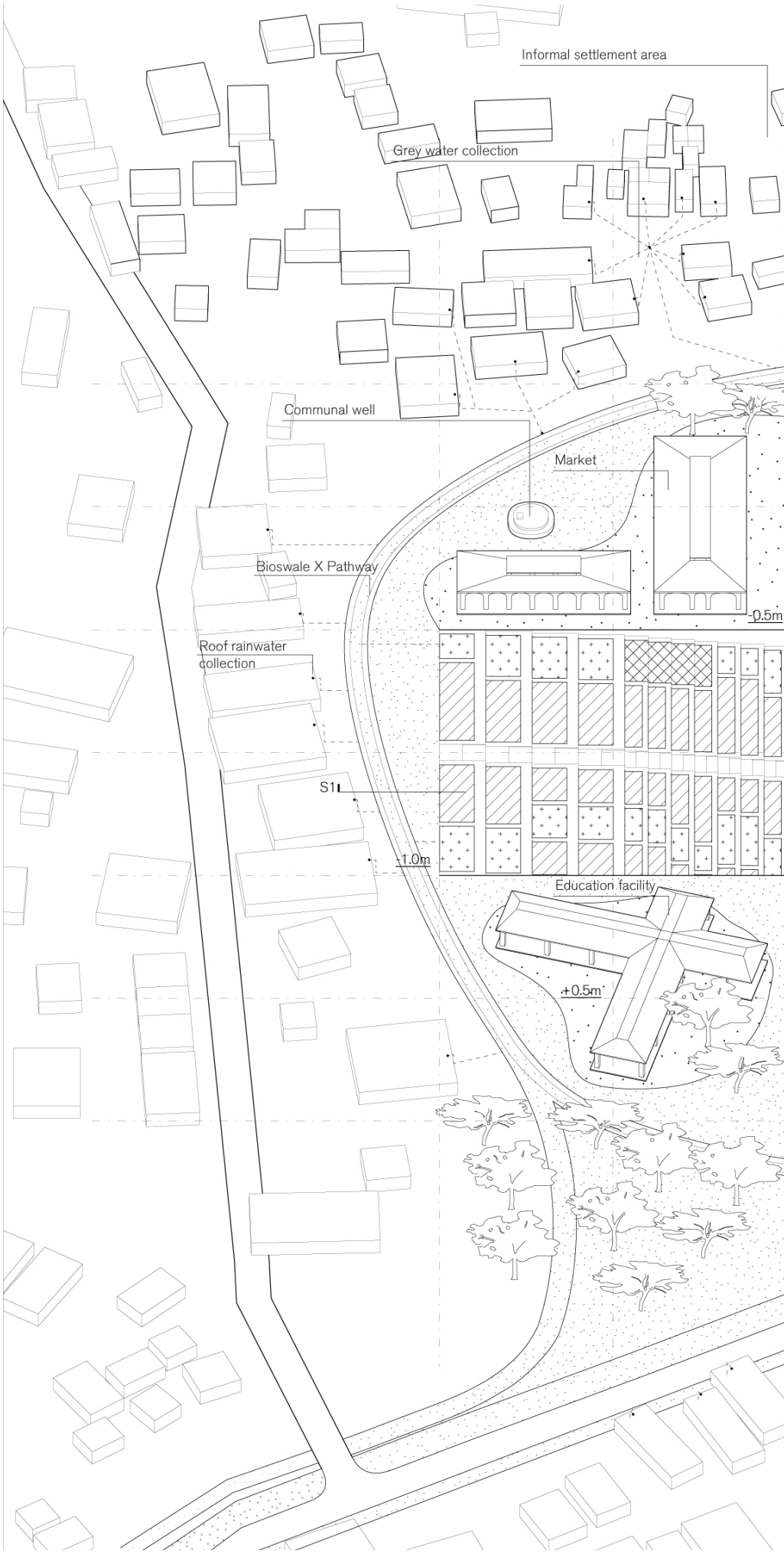
The site for the design experiment is selected based on it be situated between a highly varying urban fabric and water recharge potential zone.

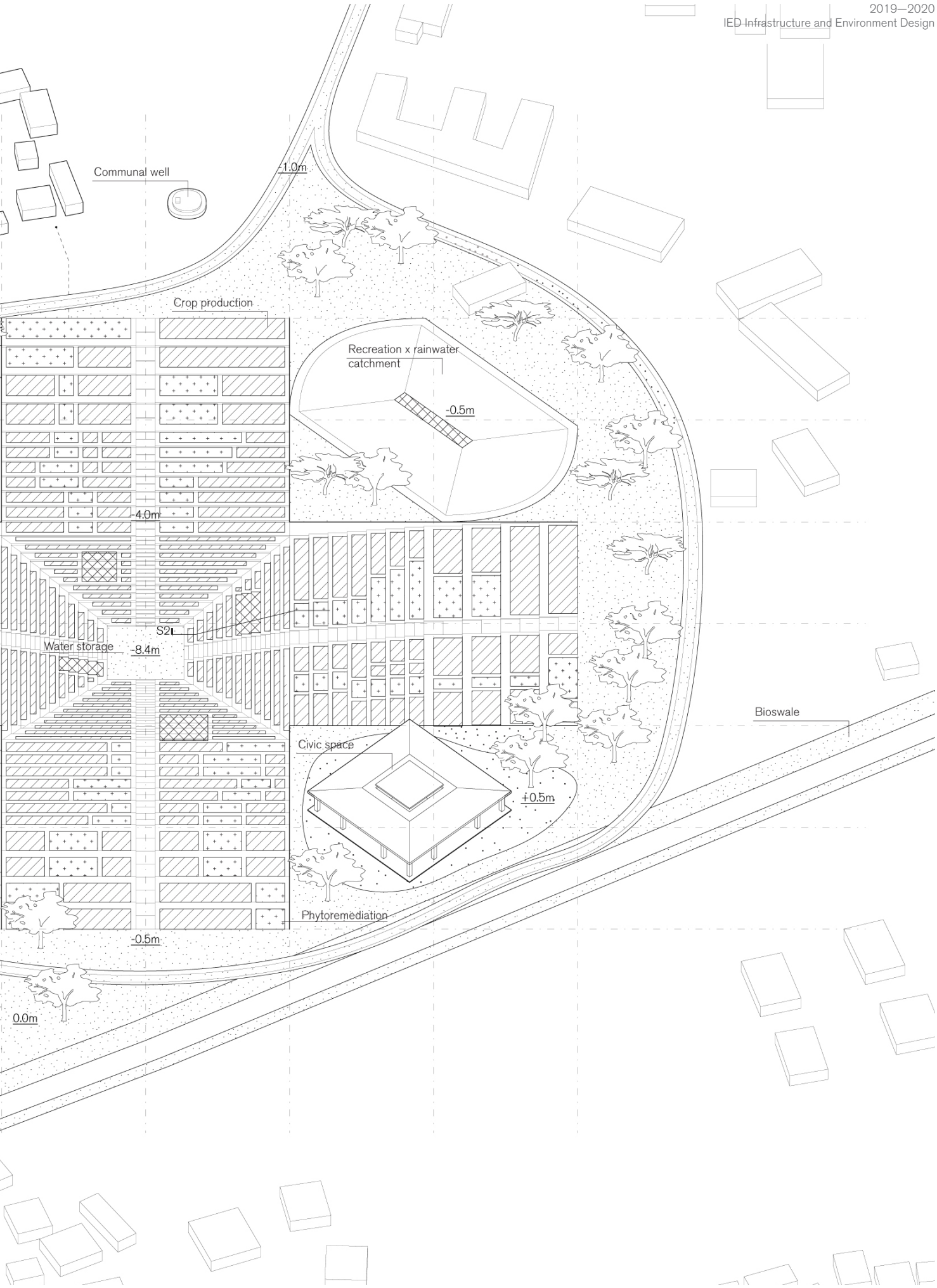
The productive commons within this neighborhood reimagines the role of the stepwell to facilitate an intersection of socio-economic and water infrastructure through a wide range of programs that begins to catalyze local consumption, optimization of underutilized resources and facilitates community building. This stepwell itself is spatially accentuated to host a productive agriculture and bioremediation grounds. In addition, the ancient orthogonal axis is extended to organize a range of education facilities, recreation and local economies.

To tackle water scarcity, this project aims to support the agency of vulnerable groups through alternative means of livelihood and investigate the role traditional/nature based water management techniques.

Surface Permeability
- High Permeability
- Moderate Permeability

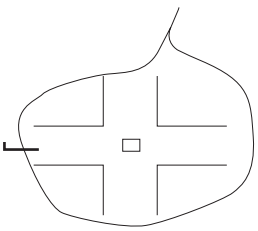
Function
- Crop Production
- Phytoremediation
- Communal Space



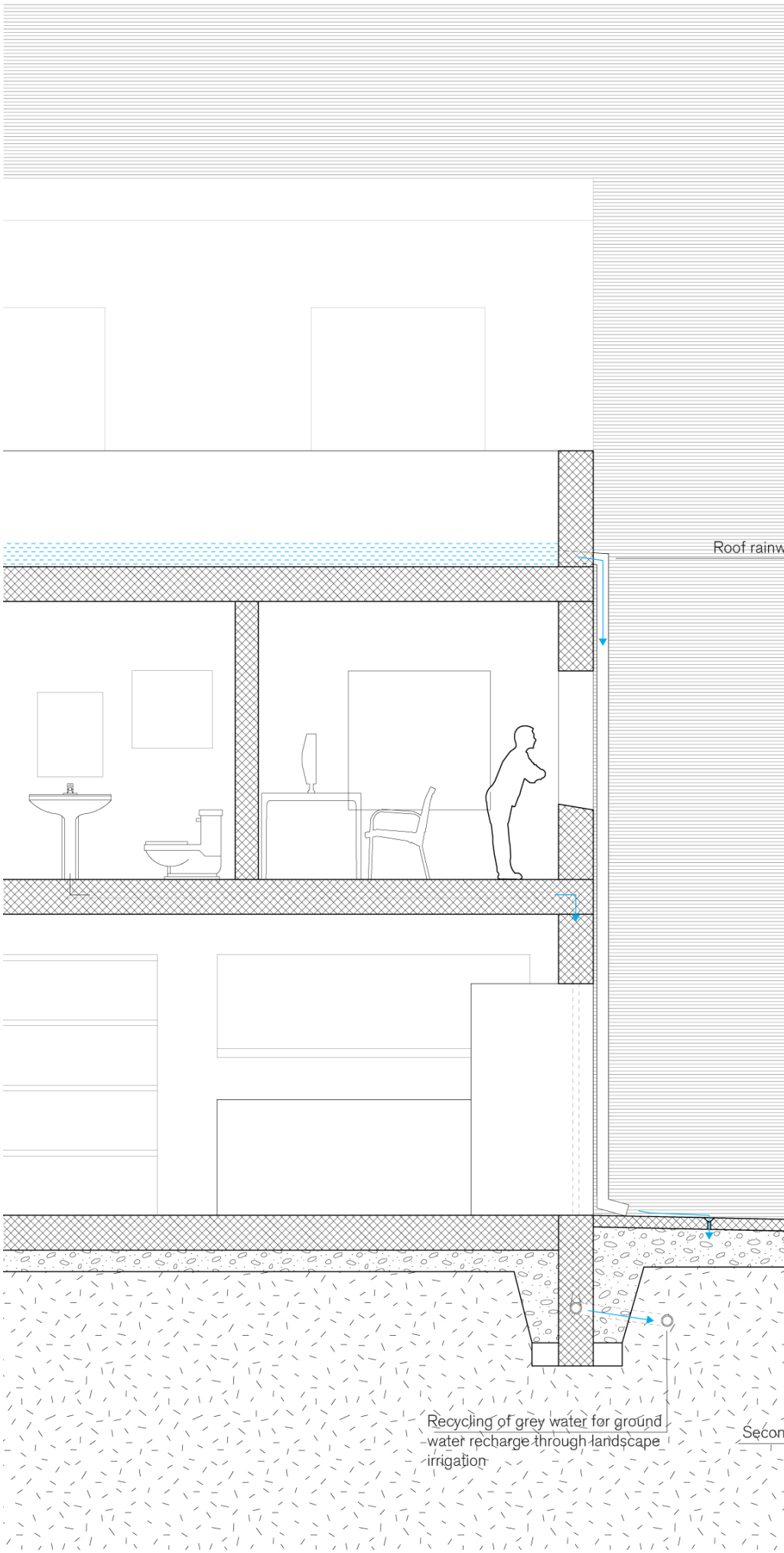

Communal well
-1.0m
Crop production
Recreation x rainwater catchment
-0.5m
-4.0m
S2
Water storage
-8.4m
Bioswale
Civic space
+0.5m
Phytoremediation
-0.5m
0.0m

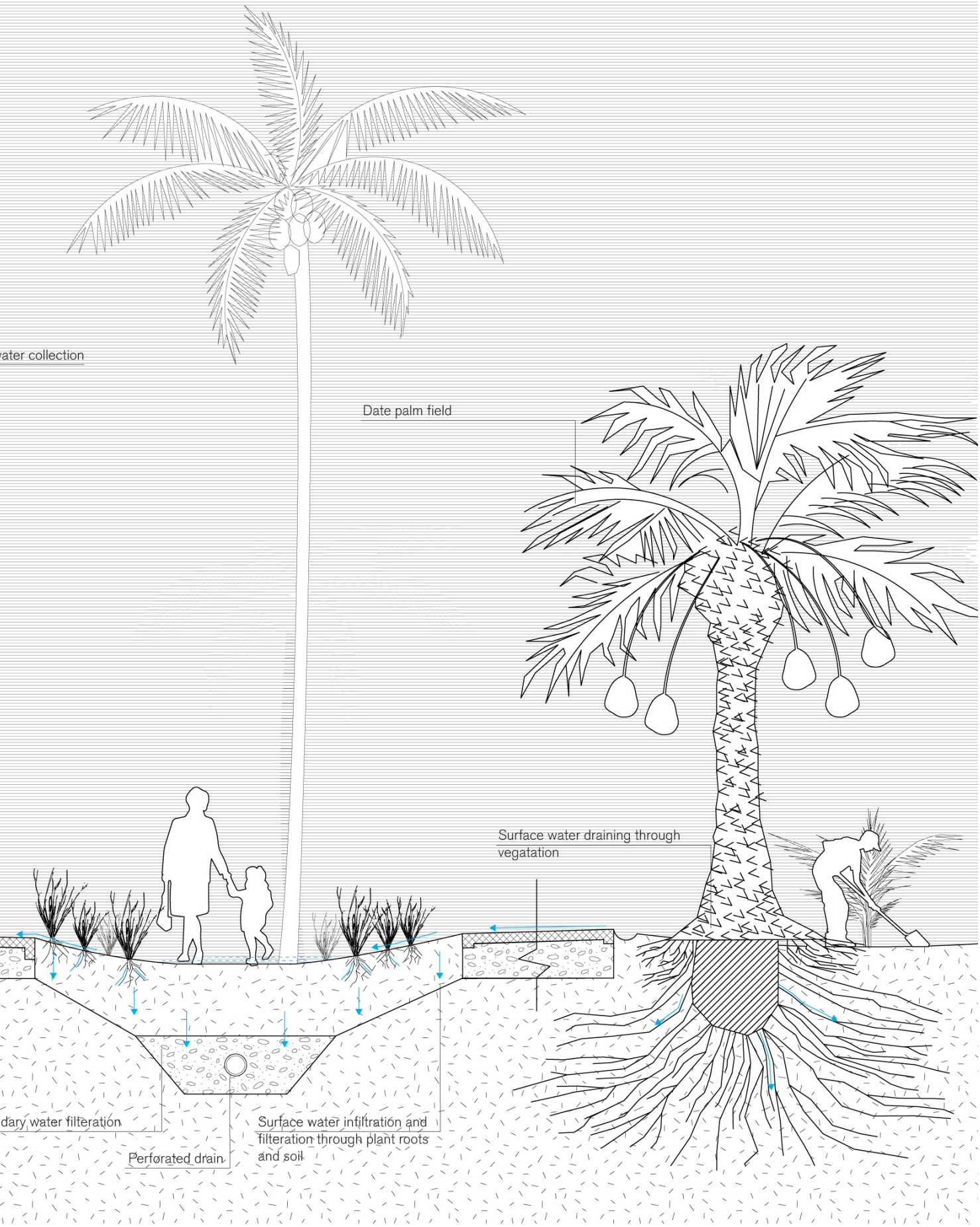
Section 1:

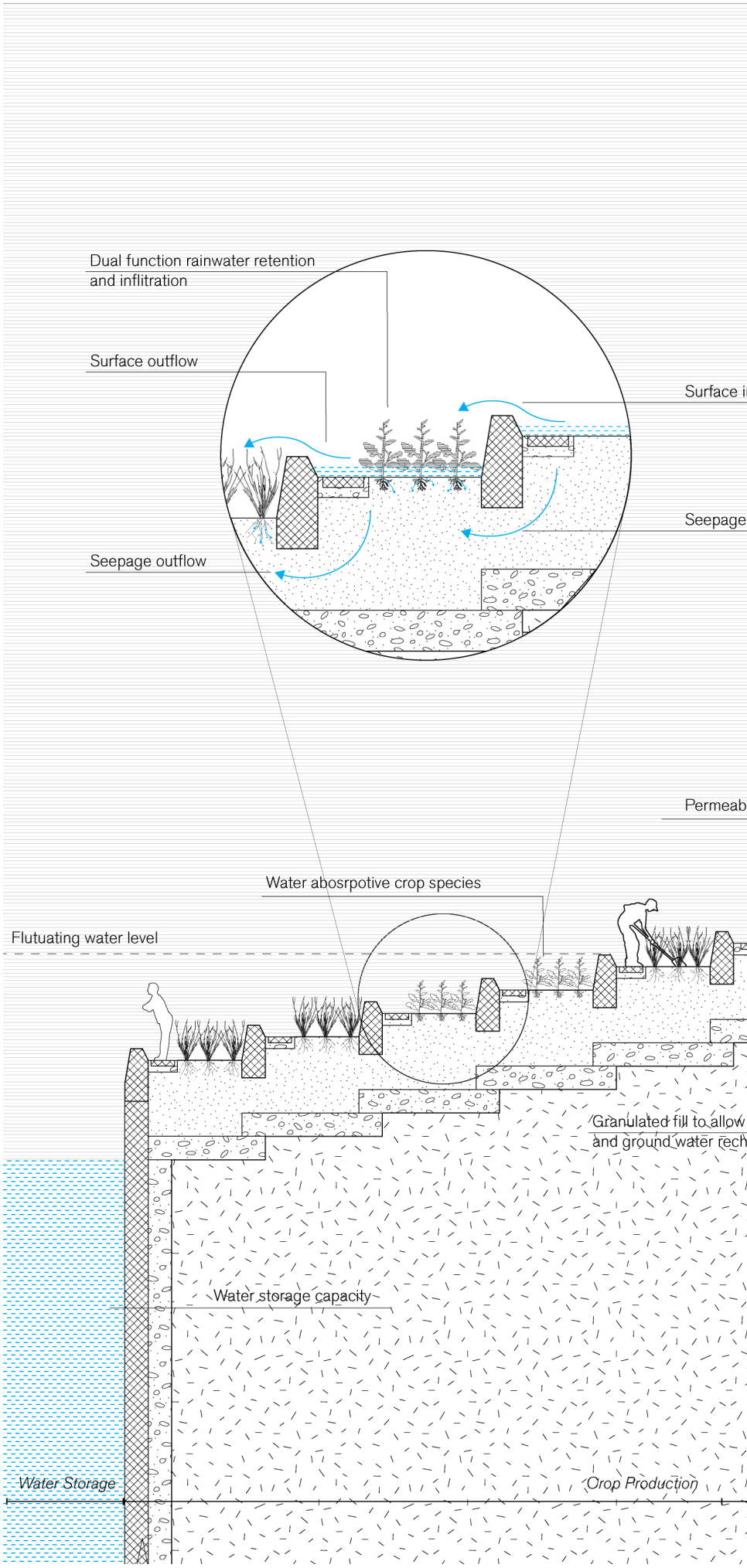
Regenerating and Recharging Resources



Scale 1:50

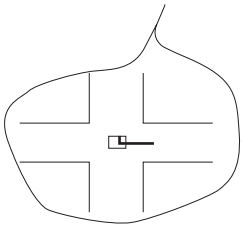



ater collection
Date palm field
Surface water draining through
vegatation
dary water filteration
Perforated drain
Surface water infiltration and
filteration through plant roots
and soil

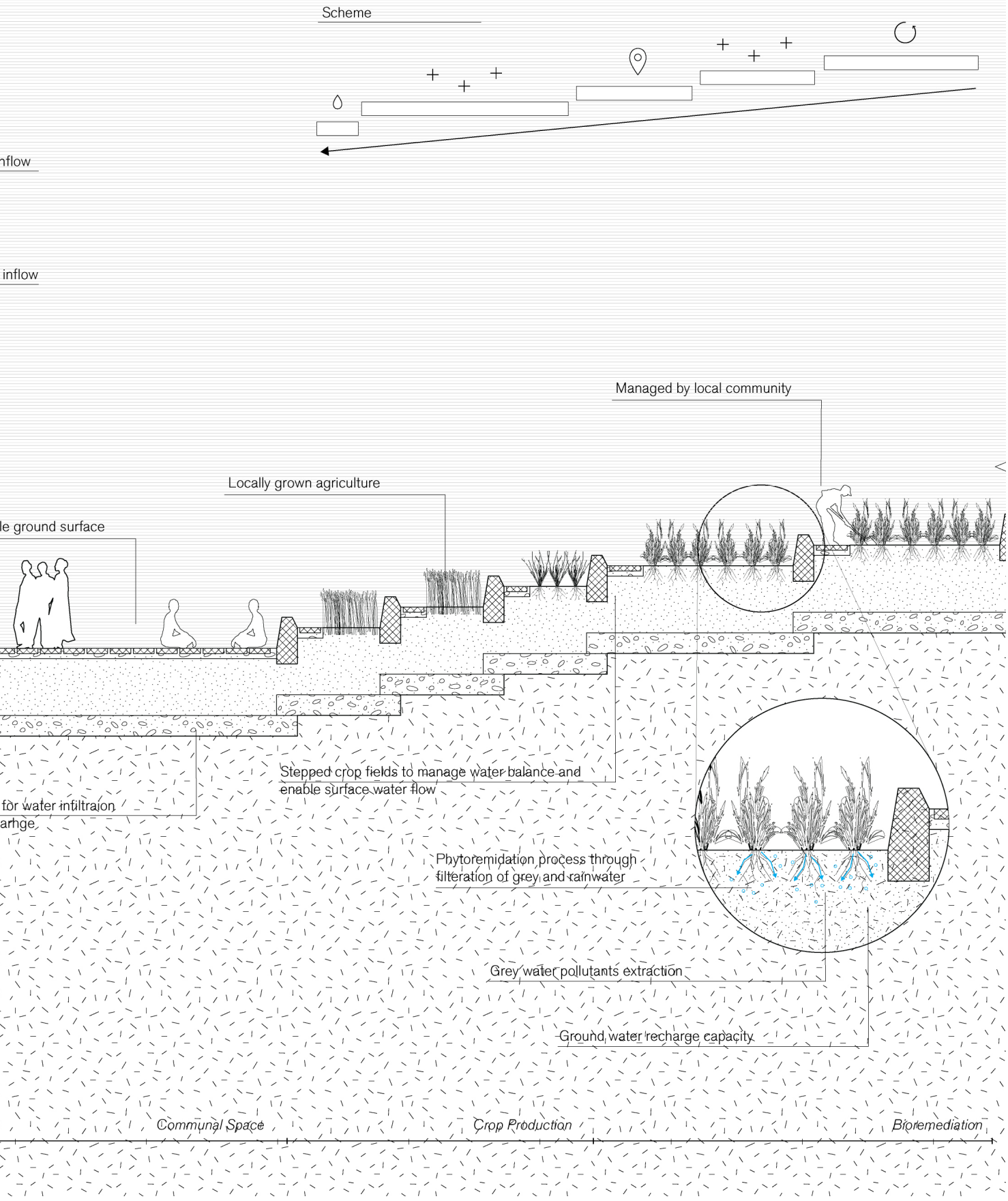


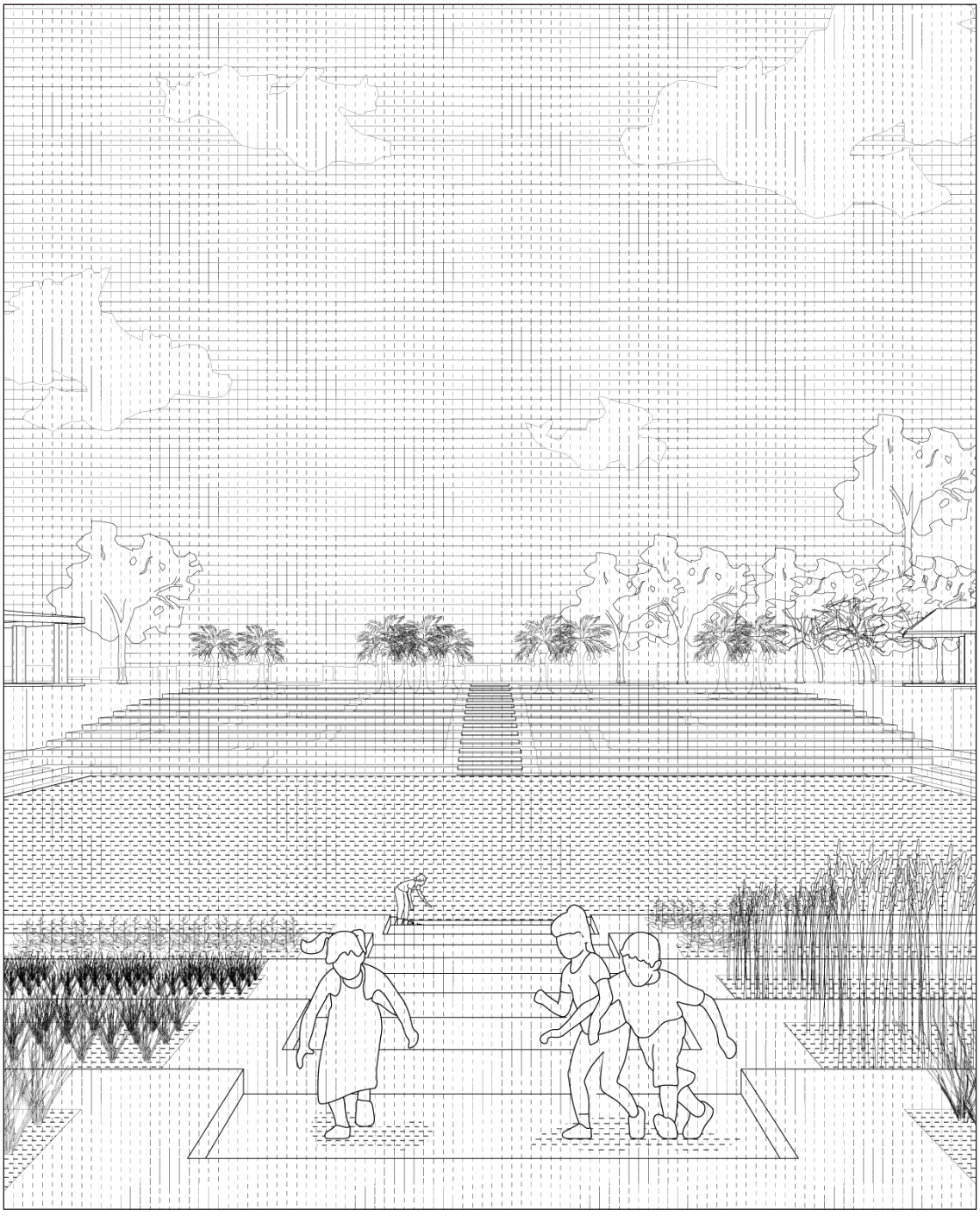
Section 2:

Productive Stepwell

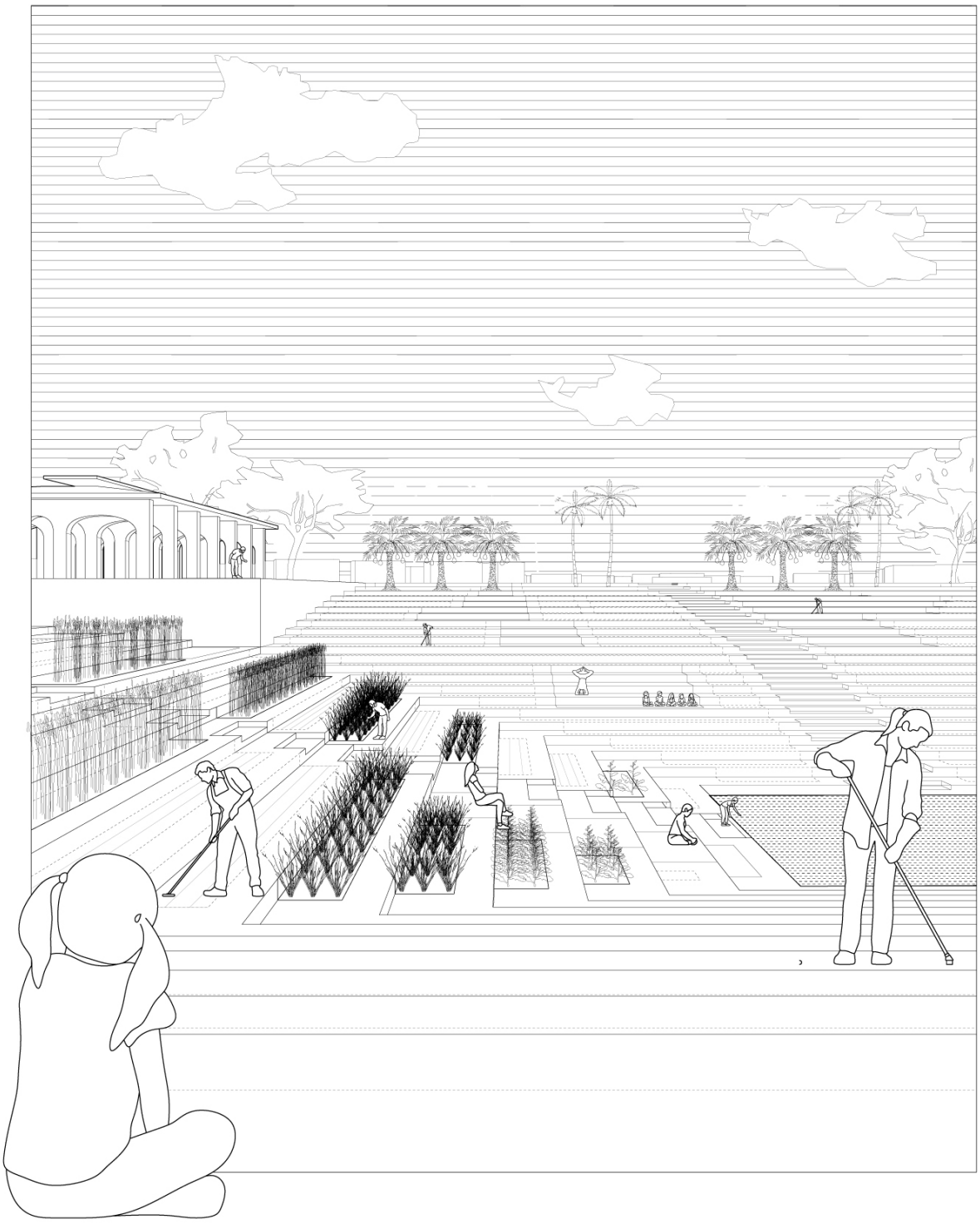


Scale 1:100


Scheme
nflow
inflow
Managed by local community
Locally grown agriculture
le ground surface
Stepped crop fields to manage water balance and
enable surface water flow
for water infiltraion
arhge
Phytoremidation process through
filteration of grey and rainwater
Grey water pollutants extraction
Ground water recharge capacity
Communal Space
Crop Production
Bioremediation



View into the Productive Commons



Growth Strategy

1. Pilot Project

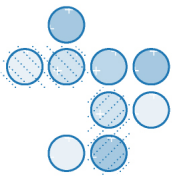
Exploring possibilities of productive commons on test site. Site is selected based on its diversity of surrounding inhabitants, water recharge potential and existing open space.



2. Potential and Capacity Study

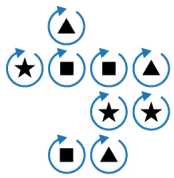
To understand potential scaling up of productive network, the suitability of Bhuj is assessed based on the three indicators:

i. diverse socio-economic conditions
ii. water recharg/catchment potential
iii. within existing open space



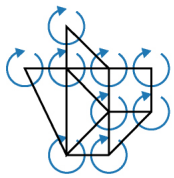
3. Scale up and Coalition Building

The conditions of each site is understood to develop a network of amentiies and economies that considers the capacity, demands and stakeholders (supporting and contradicting) of each site to cooridinate a collborative city-wide integrated network of amenities and economies.



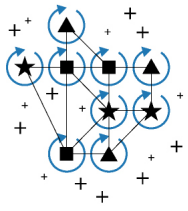
4. Develop Network Infrastructure

In order for the network to operate, it requires the infrastucture to facilitate the flows of goods, peoples and resources. Network infrastructure will be developed between productive nodes to help connect and distribute. This would result in a combination of centralized and decentralized network and would depend on the feasibility of operating local or global.



5. Productive commons

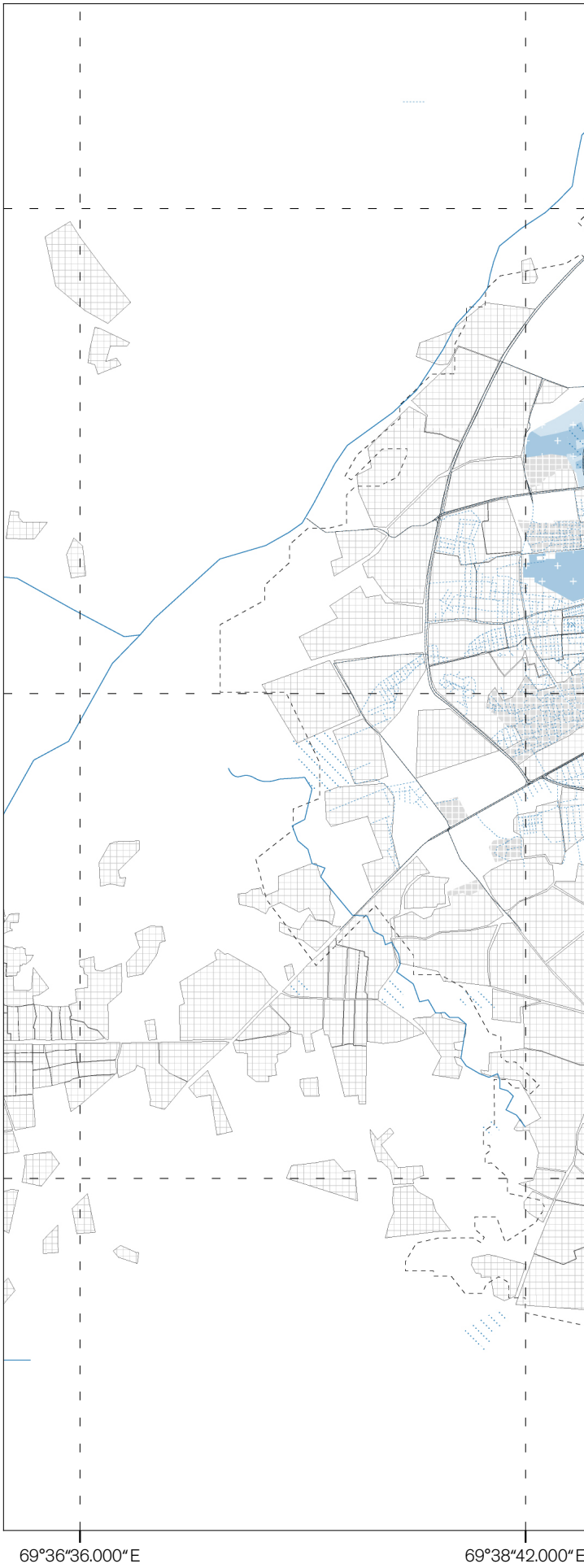
Bhuj operates as a productive network which consists of coperation between productive commons nodes across the city fabric that contributes toward a self-sustainable economy and ecological system.

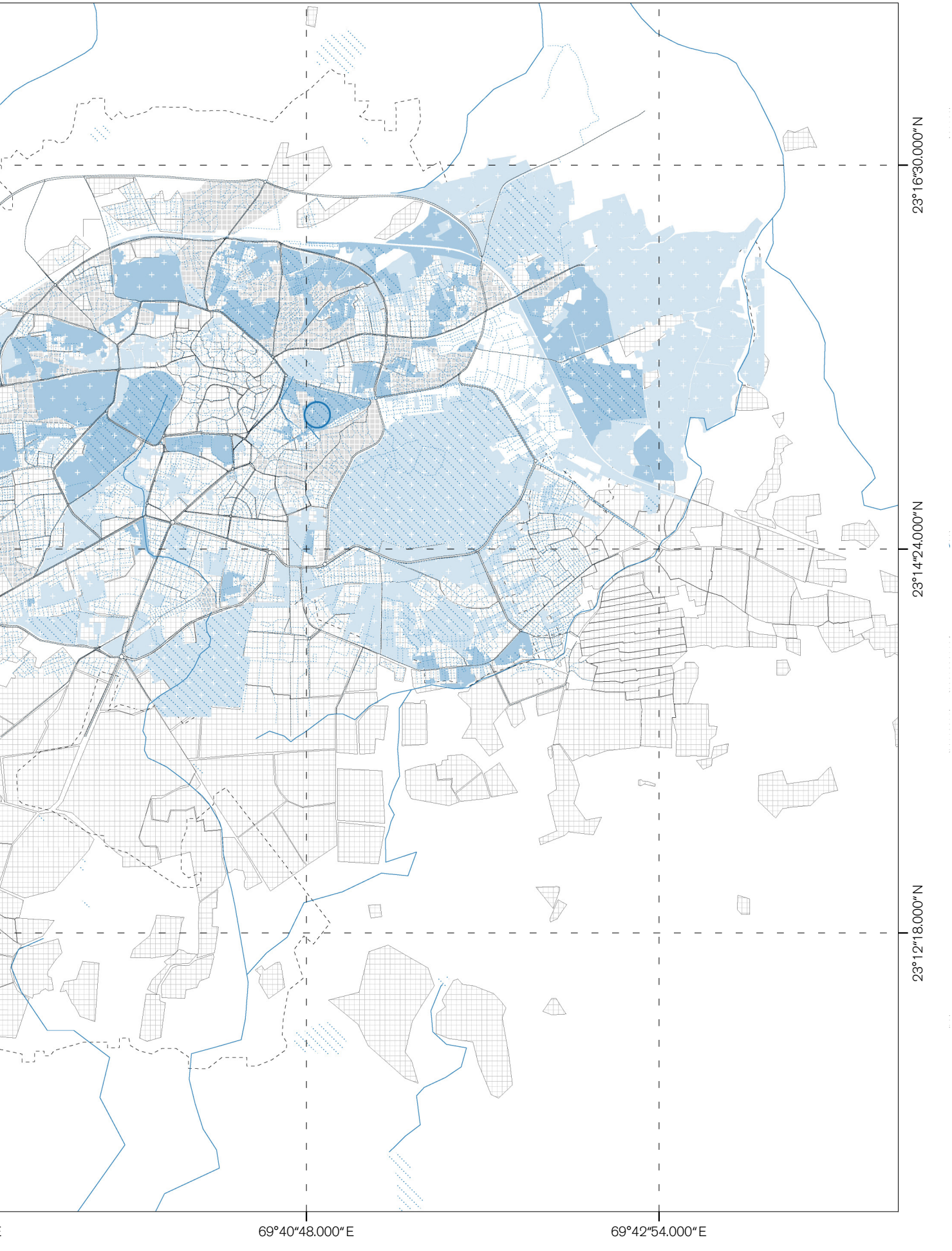


Potential and Capacity Study

Potential
- High
- Moderate
- Recharge/Catchment

- Residential Area
- Informal Settlement
- Water
- Recycled flow
- Road




23°16′30.000″N
23°14′24.000″N
23°12′18.000″N
69°40′48.000″E
69°42′54.000″E

Thirty year growth strategy

The aim of this strategy is to plan the transition towards a self-sustainable city. This strategy involves a hypothetical number of projects with varying intensity and promotes collective action through coalition building, collaboration and participatory processes.

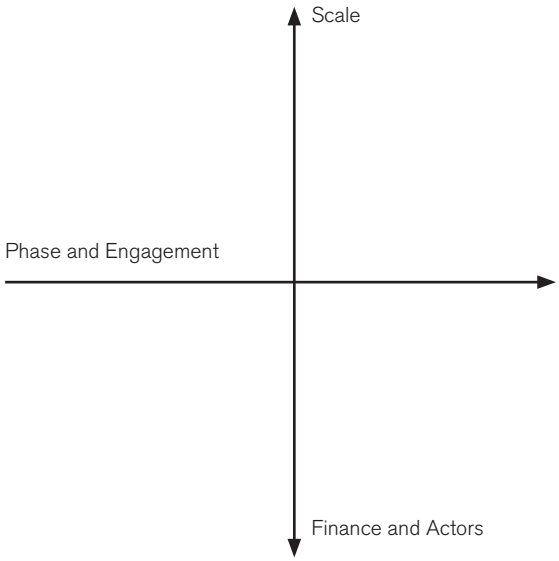
The strategy is phased over thirty years and depicts the scaling up and network evolution towards the productive commons. Each phase includes a financial dimension in which potential stakeholders are identified who would either contribute financially or be involved in the decisions making process.

Project intensity
- ○ Very High
- ○ High
- ○ Moderate

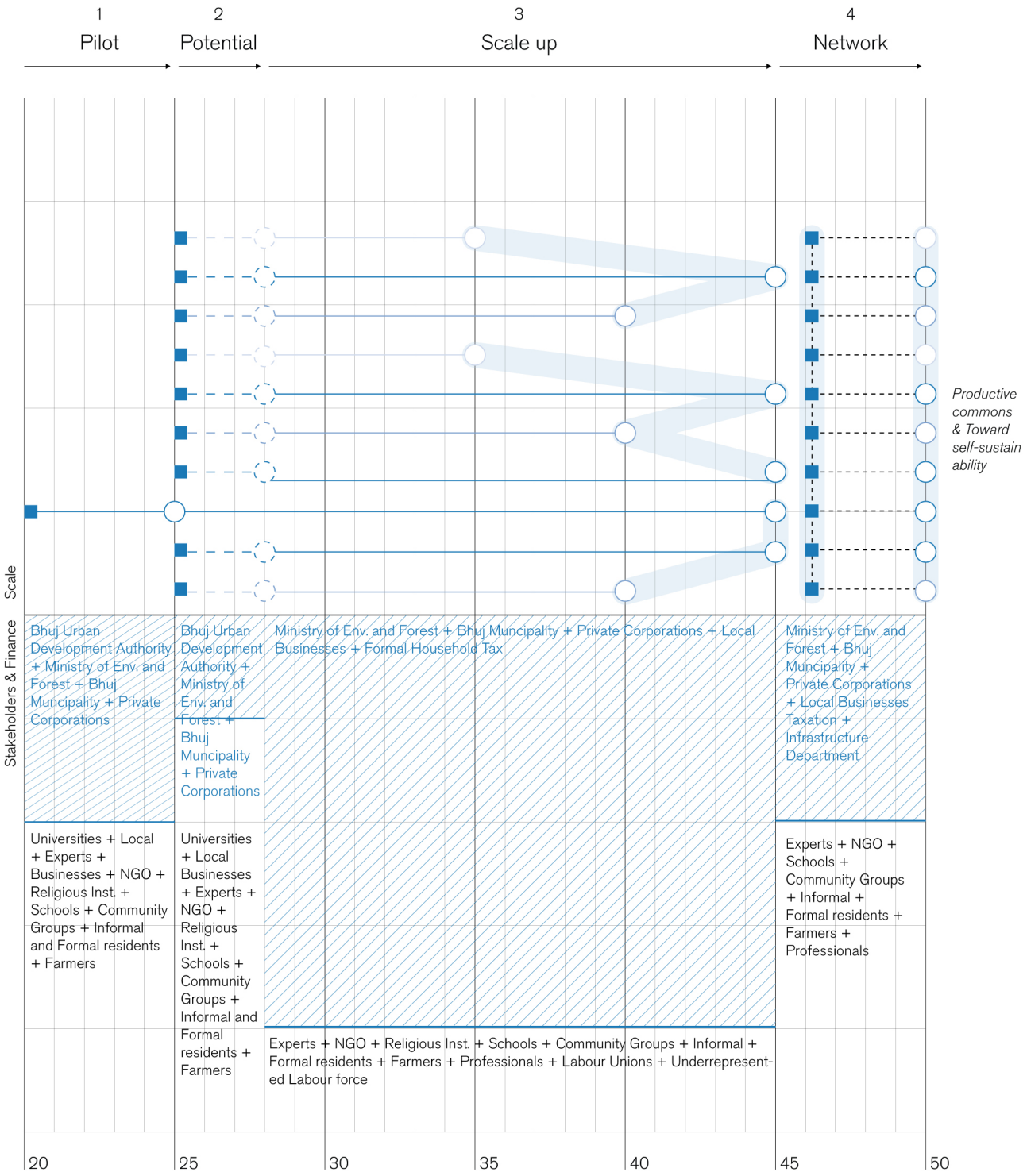
- — Active
- ···· Planning
- ···· Network connection

Engagement
- ● Coalition building
- ■ Participatory

Actors & Finance
- ▨ Financial investment
- A Financial actor
- A Decision actor



Growth strategy



South by South:
Independence Through Water

Lucas Di Gioia



Independence Through Water

Coordination of traditional Global South technologies contextualized for local water cycles and aquifer recharge of Bhuj.

Manifesto

Provision: From Elementary to Balanced

Bhuj was built over an aquifer on the dry desert of the Kutch region. The specific geomorphological arrangement allowed for water, that would run down the nearby mountain range, to infiltrate and settle, entrapped by impermeable underground rock formed by fault movement. This was key for the ecological dynamics that flourished here. Water provision had always been limited to the recharge capacity of this natural system.

The aquifer's capacity to recharge itself has drastically reduced due to the impermeabilization of the catchment surface. To revitalize the system and restore catchment capacity, water is slowed upstream, anticipating infiltration. Programs are organized around these structures, with public spaces and public wells acting as elements for reconnection with the local water system.

Distribution: From Scarce to Cyclic

Through centuries of carefully crafted water management systems, sensitive to ecological characteristics particular to the region, the city enhanced the recharge capacity and ecological dynamics, and thrived with its scarce resource. With the implementation of western modernity, water management shifted from traditionally nature crafted solutions to hard engineered, answering to growing urbanization demands. Canals and catchments that once nourished the water storage lakes were paved over making way for private allotments.

Conscious consumption is a key condition for water use. With Water flow restored as the central driver for life in the city, the ecological dynamics for water flow are made apparent, coupled with other programs and spaces of knowledge, health and wellbeing. Water will is not just an amenity, but a common presence throughout the activities people perform through the day.

Consumption: From Individualistic to Independent

In the past, this society shaped around water. Public spaces were designed coupling water storage and public access. Through communal organization, water provision for liveability was ensured. Cultural manifestations would celebrate the water systems cycles. This dynamic fell into neglect when water came directly from faucets, private wells or in tanker trucks. The shared community constructed around water was substituted by an individualized relationship.

As in the past, water is understood as a collective responsibility once more, and the maintenance of the underground aquifer, the guarantee for perpetuation of Bhuj's autonomy. In this way, the city moved from providing reactive solutions to water scarcity, and into a relationship Intune with the local water cycles, shifting away from solutions that require dependency on extra regional benevolence.

Design experiment

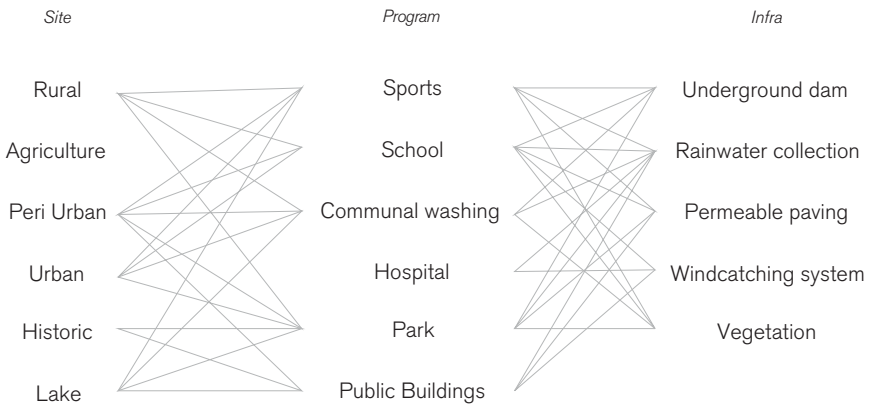
The project addresses the water cycle in the city of Bhuj considering the hydrologic dynamics of the Kutch Region. The territory is read according to its capacity to accommodate infrastructural interventions that can locally provide and secure water for everyday life.

By shifting water extraction and provision solutions from a western oriented and state centralized hard infrastructure approach, to a contextualized scale with Global South technical solutions, similar economic, management and implementation conditions can be transcribed more in tune with realities of developing regions.

The integration of community agents and local bodies in planning, implementation and management processes allows for a sustainable and empowering approach to the local actors, liberating them of extra regional power disputes.

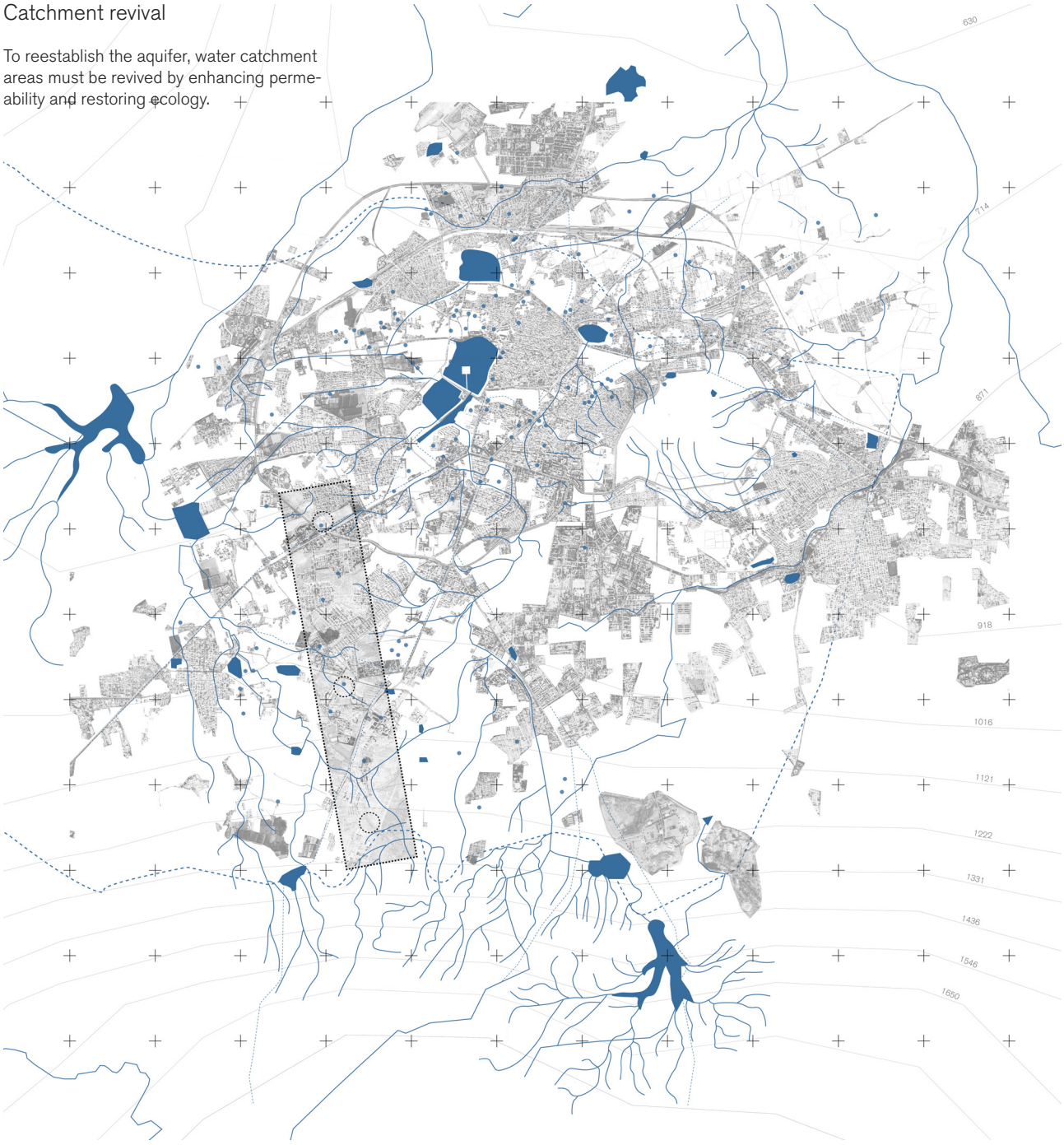
The proposal performs at a territorial scale yet dependent of local site specificities, and yet, can cause immediate and positive local impact without depending on the completion of the whole network.

As a platform for life, the project does not dictate the activities that will occur within its spaces but act as a backdrop for exisiting and future urban activies to strive.



Catchment revival

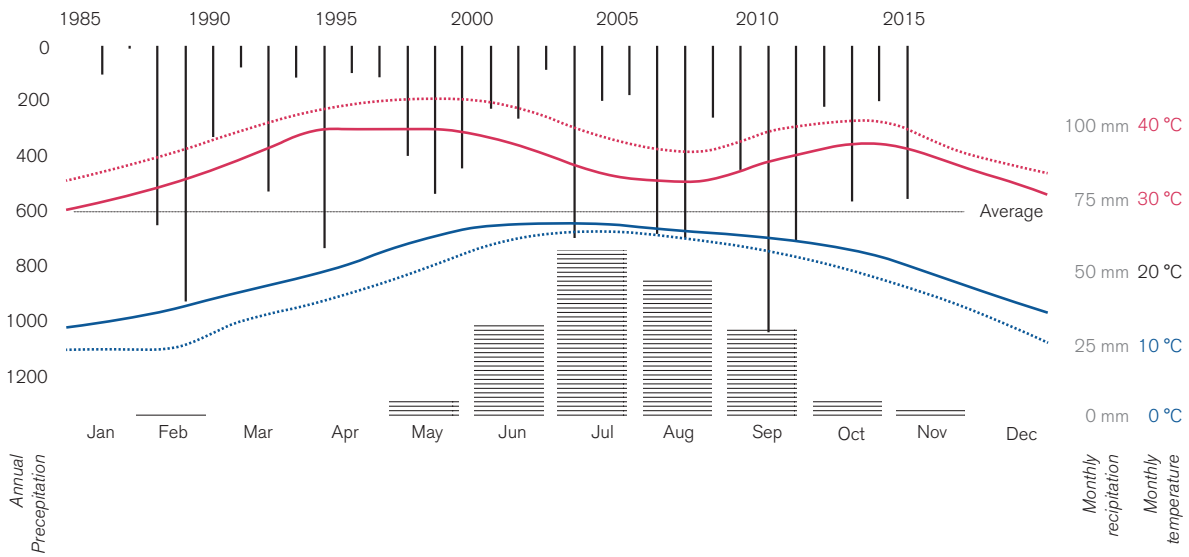
To reestablish the aquifer, water catchment areas must be revived by enhancing permeability and restoring ecology.



Water bodies
Aquifer
Open Areas
Urbanized area
Water Catchments

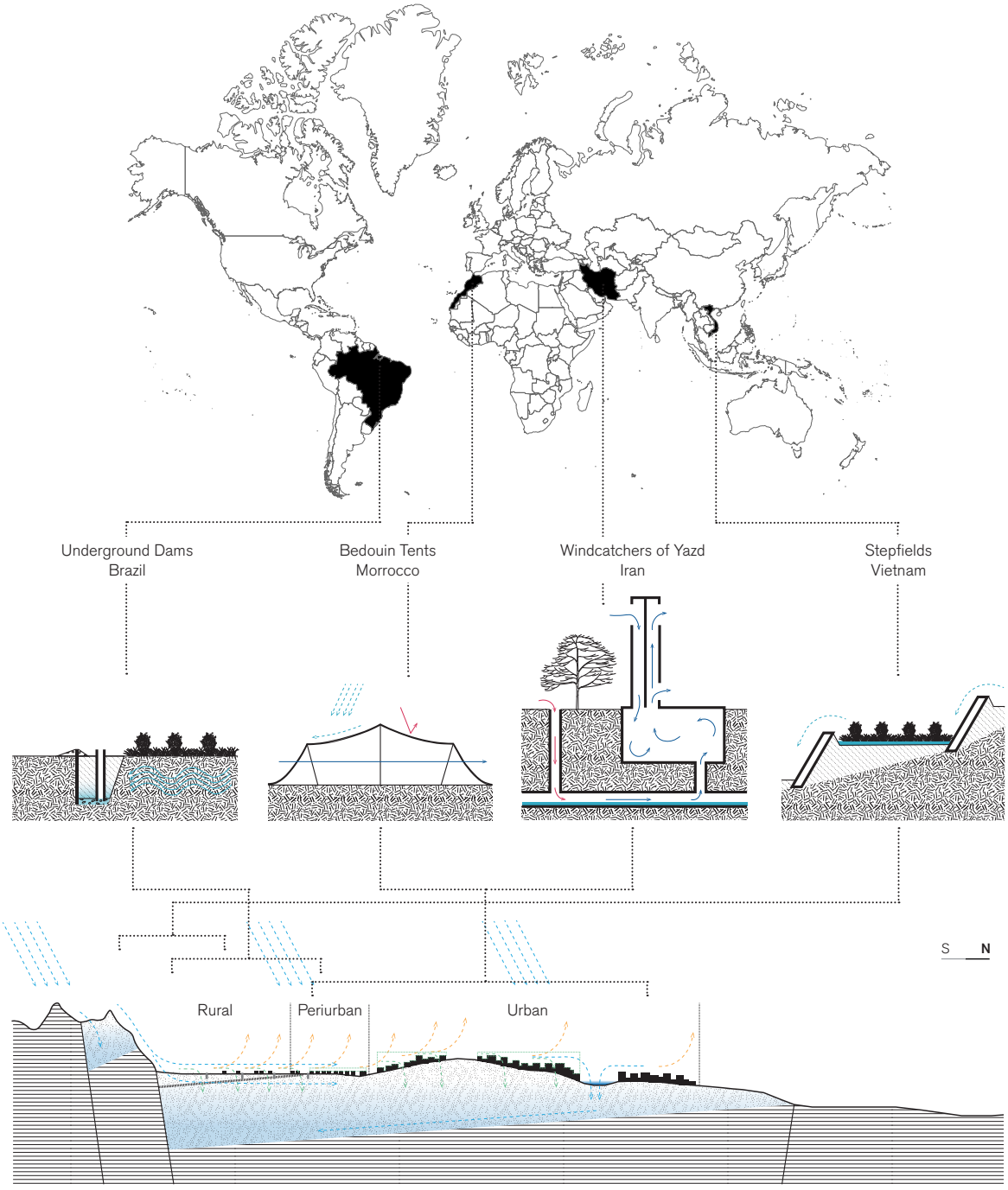
1:50000

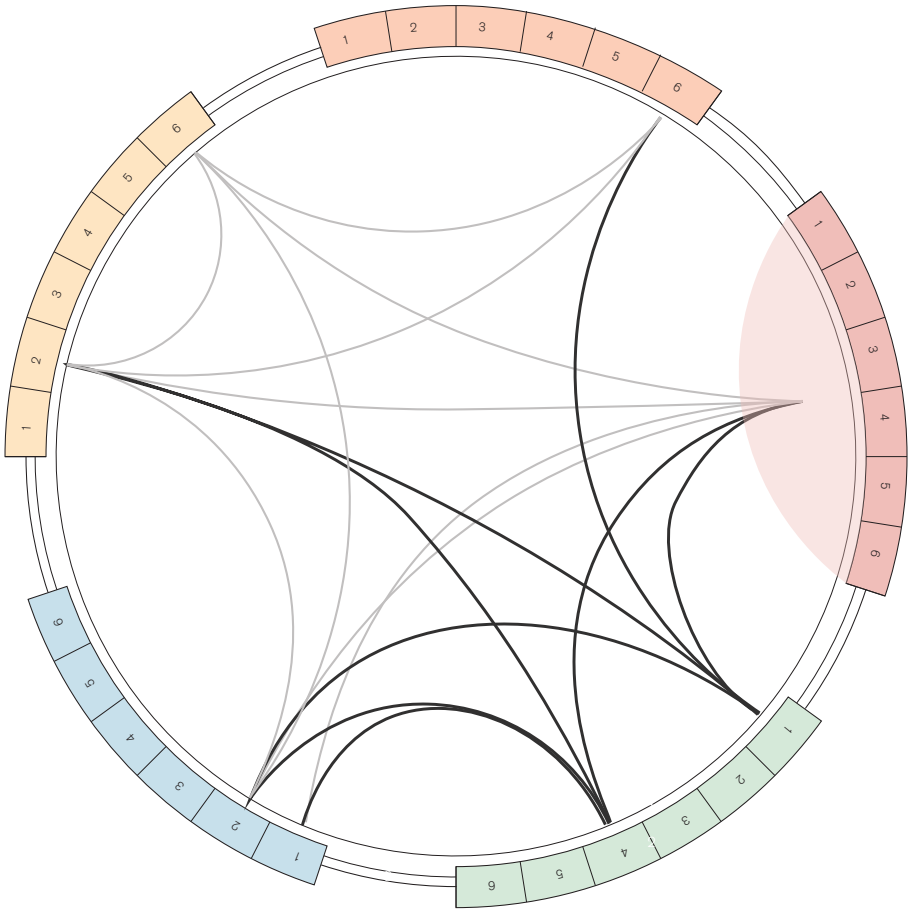
N



New Water Management System

The project proposes to implement water and climate technologies from countries with comparable economic and institutional scenarios, incentivizing countries to develop and exchange solutions that are independent from western knowledge of central capitalist countries.


Underground Dams
Brazil
Bedouin Tents
Morrocco
Windcatchers of Yazd
Iran
Stepfields
Vietnam
S
N
Rural
Periurban
Urban



Local
State
National

Government

1. Bhuj Urban Development Authority
2. Bhuj Municipal corporation
3. Health Agencies
4. Department of Narmada Water Resources & Water Supplies
5. Ministry of Health
6. Ministry of Environment and Forest

Private

1. Drilling companies
2. Private tanker and supply companies
3. Local businesses
4. Independent Clinic Practices
5. Sardar Sarovar Narmada Nigam Ltd.
6. Gujarat State Drinking Water Company Limited

Expert

1. CEPT University
2. Ecologists
3. Urban water managers
4. Water treatment professionals
5. Drought resistance agriculture experts
6. National Institute of Urban Affairs (NIUA)

NGOs

1. ACT
2. Sahjeevan
3. Kutch Mahila Vikas Sangathan
4. Kachchh Nav Nirman Abhiyam
5. Hunnarshalaa Foundation

Community

1. Jalstrot Sneh Smavardhan Samiti (JSSS)
2. School/Education institutes
3. Religious Institutions

Phasing and Stakeholder Engagement

Phase 0:

NGOS and community agents discuss potential kick start catchment and sites for implementing water retention artifacts + rain collection roof grouping, counseled by representatives of Expert groups and local government.

Phase 1:

Implementation of rainwater collection enhancement artefacts (road permeability and roof water catchment enhancement) in one given catchment downstream.

Phase 2:

Implementation of first Underground Dams and Step fields upstream on the same catchment, construction oriented by municipality public works agents and water and ecology experts, executed by a task force of NGO members and community locals.

Phase 3:

Maintenance of site is overseen by local proximity institutions (schools, universities, hospitals and public institutions) and realized by locals and Bhuj Municipality Agents.

Phase 4:

Reproduce procedure until all catchment has enhanced its water infiltration potential.

Phase 5:

Reproduce for remaining catchments.

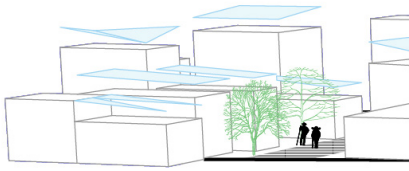
Site 01: Urban

Rain water collection is done with a series of tarpaulin-style cloths, stretched over building roofs and balconies. their inclination directs water to shared rain water collection tanks, that also accommodate wind catching towers and use the stored water to cool the air as wind is directed down to the streets.

Permeable street surfaces also allow infiltration of the soil locally.

Excess water is directed to local flooding pond, while underground water dam system allows for a local well to tap close to surface water.

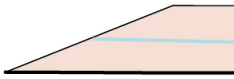




Site 02: Peri Urban

Underground water dam places strategically transecting water flow direction allows for underground water flow to be postponed, and utilized on site for vegetation growth on surface and implementation of wells for fresh water collection.

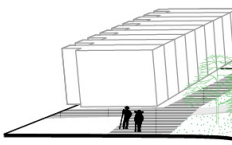




Site 03: Rural

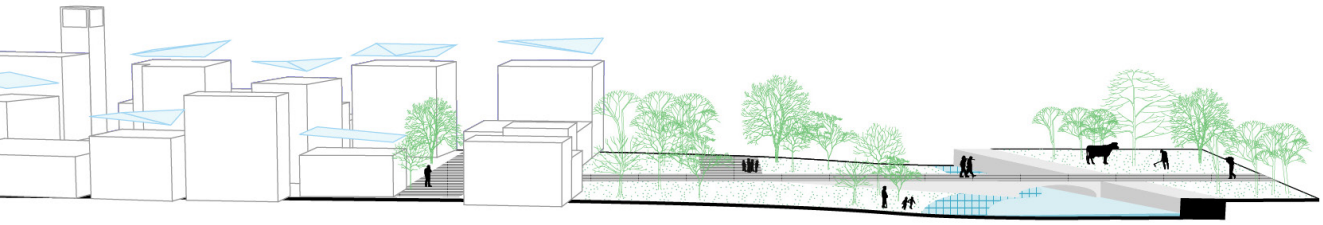
A series of underground dams and stepfields allow for underwater flow capture and agricultural use irrigation during dry seasons and water storage during monsoon season.

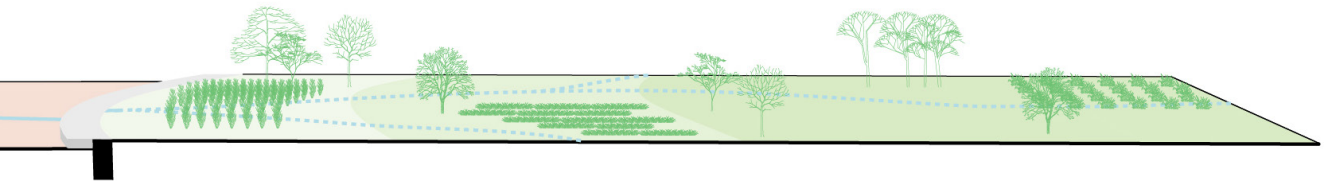


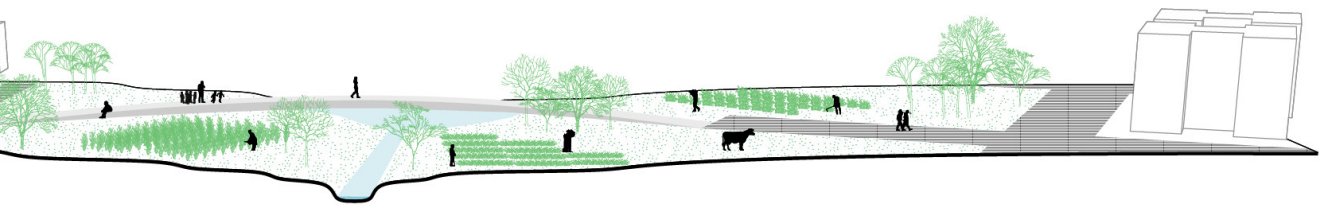


N

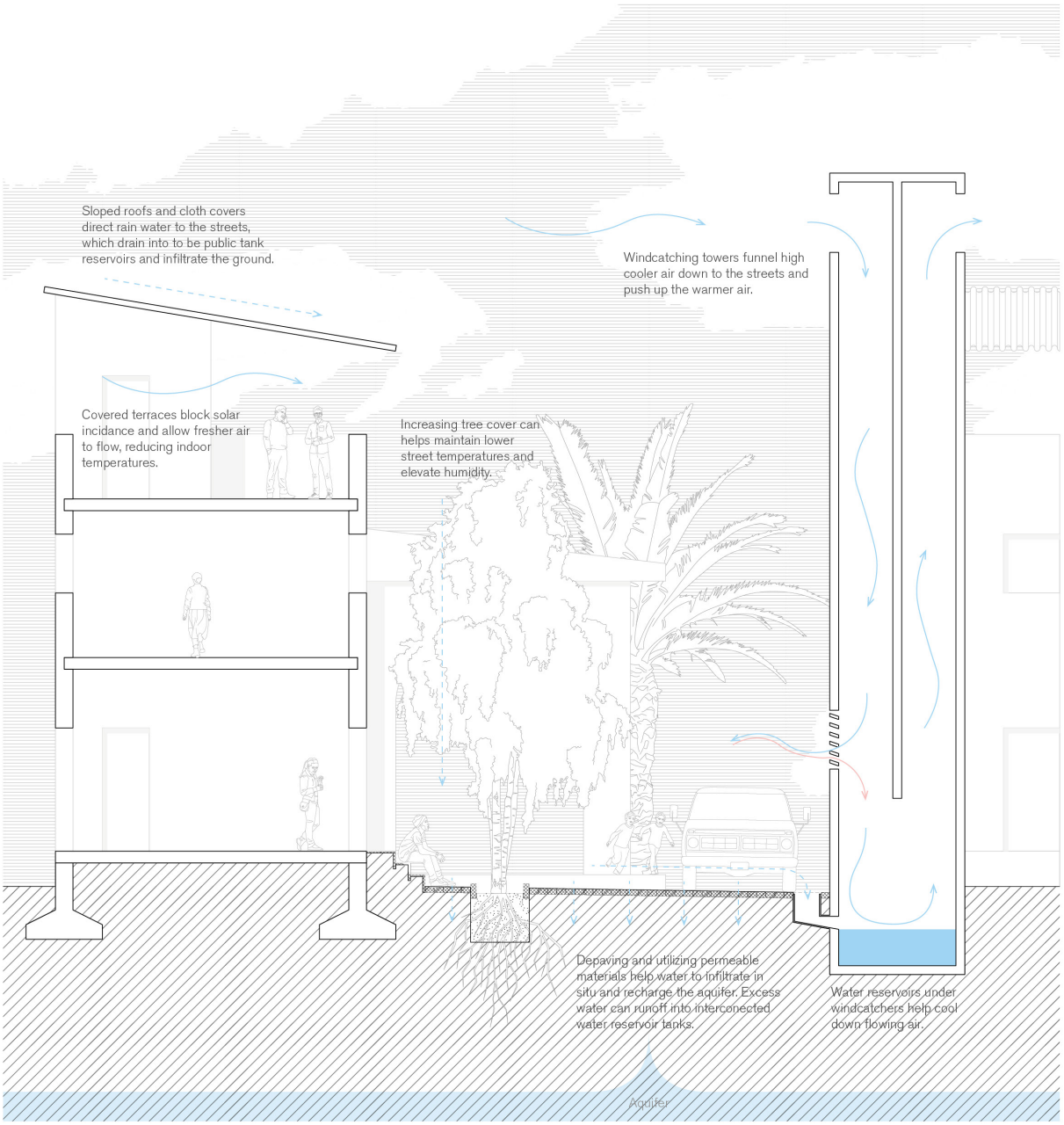
0 100m







0 20m



Site 01:
Urban



Site 02 & 03:
Periurban and Rural

Recharge Bhuj

Menno de Roode

Manifesto

Bhuj was founded about 500 years ago. Due to its location in an extremely dry and hot desert environment, successful territorialization could only occur as a result of cooperation between people and nature. With water being the most scarce resource in the environment, Bhuj became a city built and lived around water. Water infrastructures and ecologies were embedded into the city and the daily life of its inhabitants. Man-made lakes served as an oasis in the desert for people and wildlife, as well as being a vital part of the water infiltration cycle.

However, desert ecosystems are fragile. Over the years, altered topography due to earthquakes, combined with unsustainable practices such as overgrazing and exploitation of water resources drastically changed the environmental processes. They eventually led to the need of water provision from outside. With this transition, development disproportional from the environmental carrying capacity emerged, and the incentive to protect the natural system and ecology slowly faded away. Daily practices and rituals diverted from the natural environment, resulting in environmental unconsciousness and unsustainable development.

But it is not too late. Change can start today. What we need is to acknowledge that nature is something that can enhance our lives, rather then something we have to work against. Nature based-solutions are simple, effective and resilient. In three steps Bhuj will be transformed into a city where natural qualities are embraced and used to improve the quality of life for all.

1. Reviving of the sustainable water infrastructures and restoration of the ecological system. The carrying capacity of the natural environment can be raised and improved to yield more benefits for people and wildlife.

2. Natural features are interwoven into the social and urban fabric. They should be visible and accessible for everyone to enjoy. New meaningful relationships with nature will be developed, eventually nurturing a sense of ownership and encouraging the commitment to protect these infrastructures.

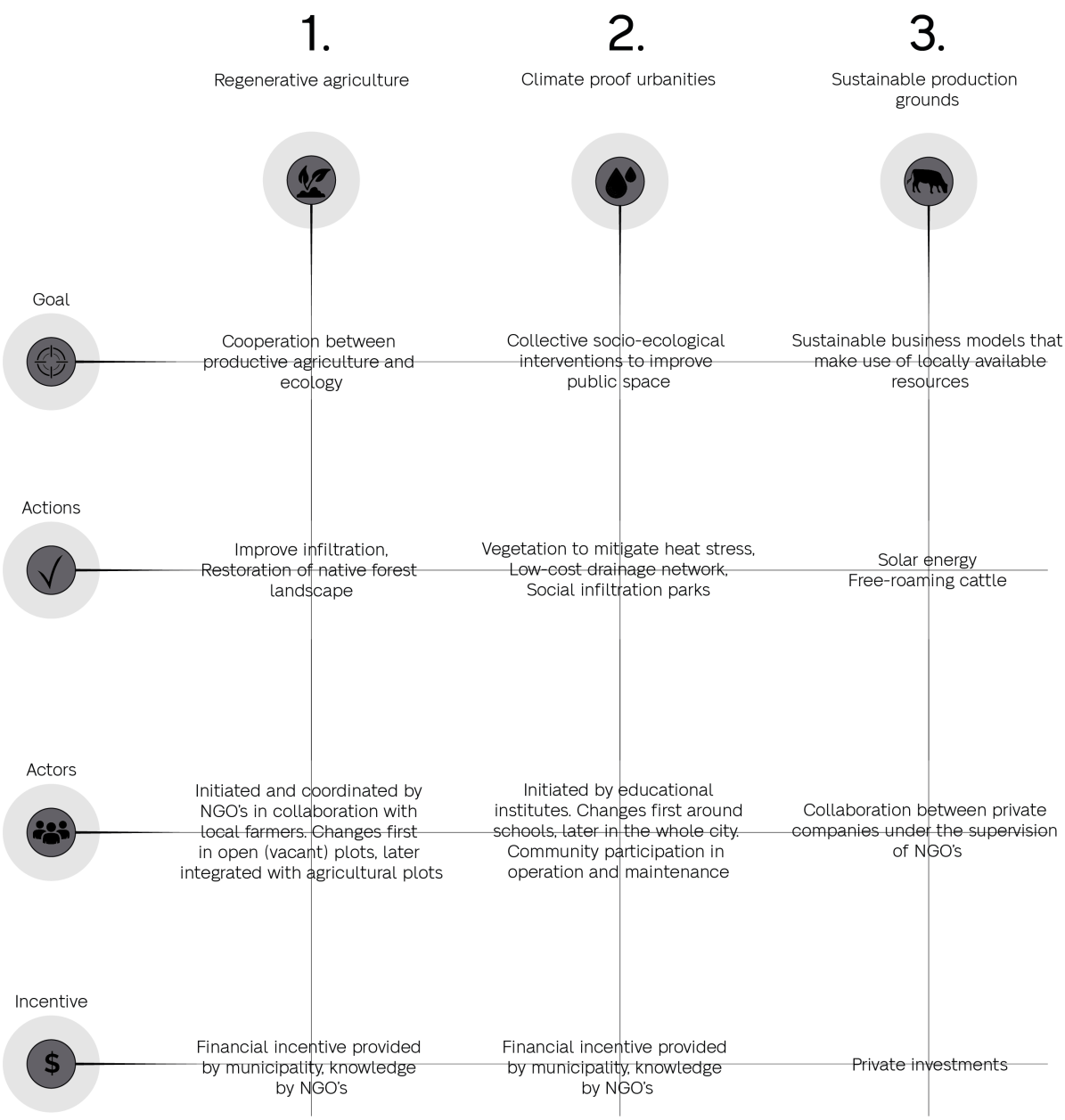
3. Economic activities such as farming and industries should be embedded into the environmental context, while taking into account the opportunities and limitations that come with the available resources.

Combining these three actions will not be easy, and requires close cooperation between public institutions, private agencies and societal groups. Together we can make a difference. Recharge the ecosystem, recharge Bhuj!





Participation diagram



Design experiment

The design experiment is the application of the manifesto to the city. Recharge Bhuj consists of a nature-based framework with three sets of concepts that can be tailored to local spatial and social conditions.

1. *Regenerative agriculture.* On the top of the hills, ecology and agriculture are combined to enhance productivity, and improve the infiltration capacity. The native tropical dry forest is partly restored. Run-off water from the catchments up hill will infiltrate here, before it reaches the city. This prevents floods, while at the same time the aquifer is recharged.

2. *Climate proof urbanities.* The greenery of the agricultural fields continues into the urban area. Here, it helps regulating the temperature, as well as creating a comfortable environment for the inhabitants of Bhuj. Visible and accessible water management infrastructure combines mitigating floods with enhancing the public space. Communities are participating in the operation and management of this infrastructure

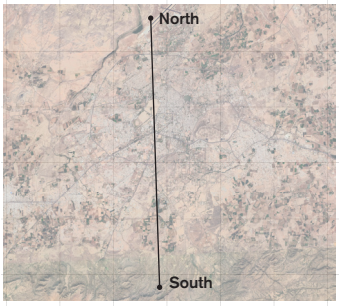
3. *Sustainable productive grounds.* In the North, where infiltration is not possible due to soil characteristics, sustainable industries are harnessing the available resources. (Bird friendly) solar energy gives the city a new financial boost, and can be combined with cattle grazing.

The three concepts are explained with sections on the next pages, and in the participation diagram on the right.

Together, these actions will recharge Bhuj!

Recharge Bhuj

This South-North cross-section shows the framework of the interventions. Three types of interventions are distinguished based on environmental and social conditions. In this way, the city and aquifer will be recharged in a sustainable way.



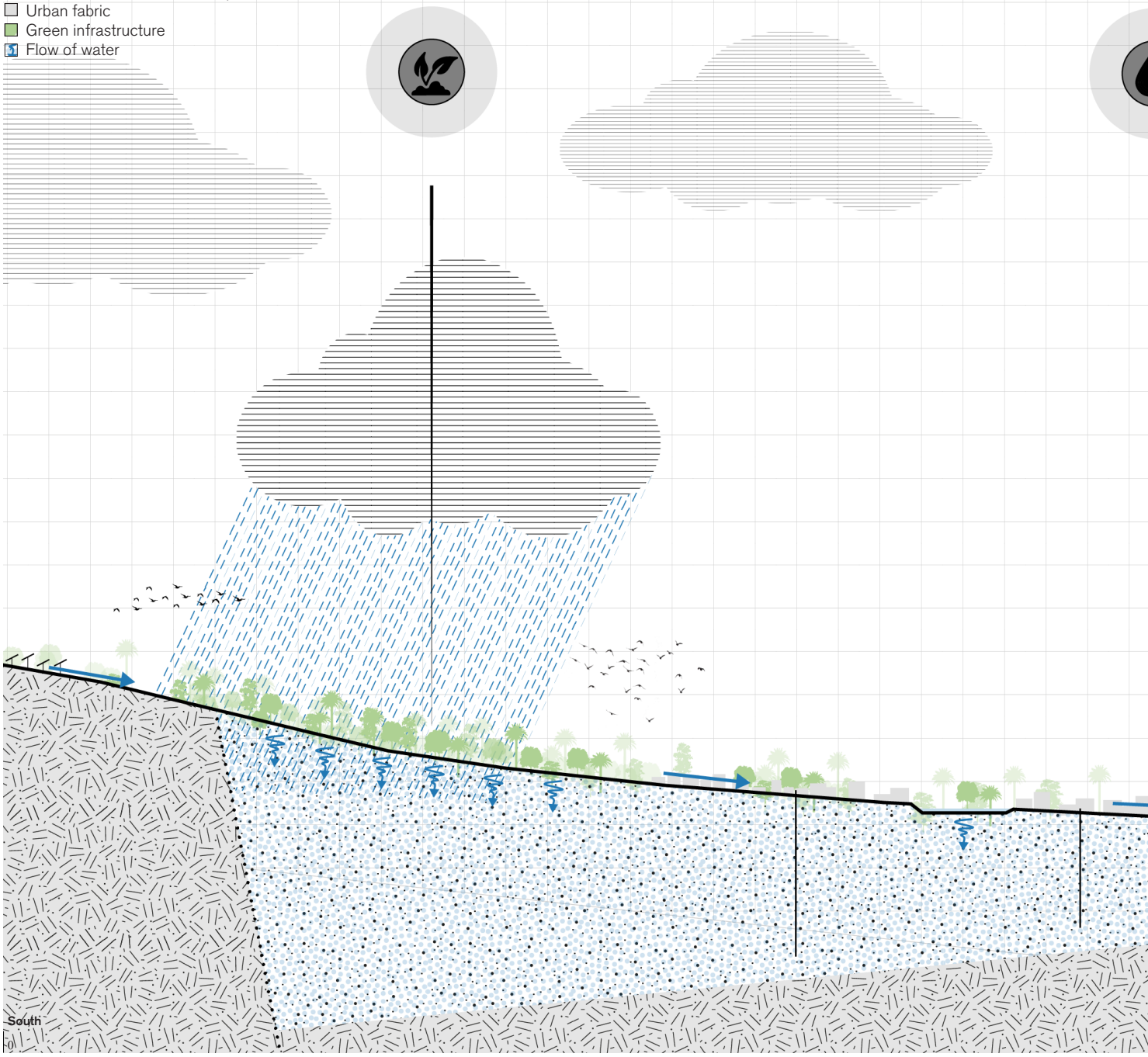
Impermeable soil (shale)
Permeable soil (sandstone aquifer)
Urban fabric
Green infrastructure
Flow of water

1.

Regenerative agriculture

2

Climate pro

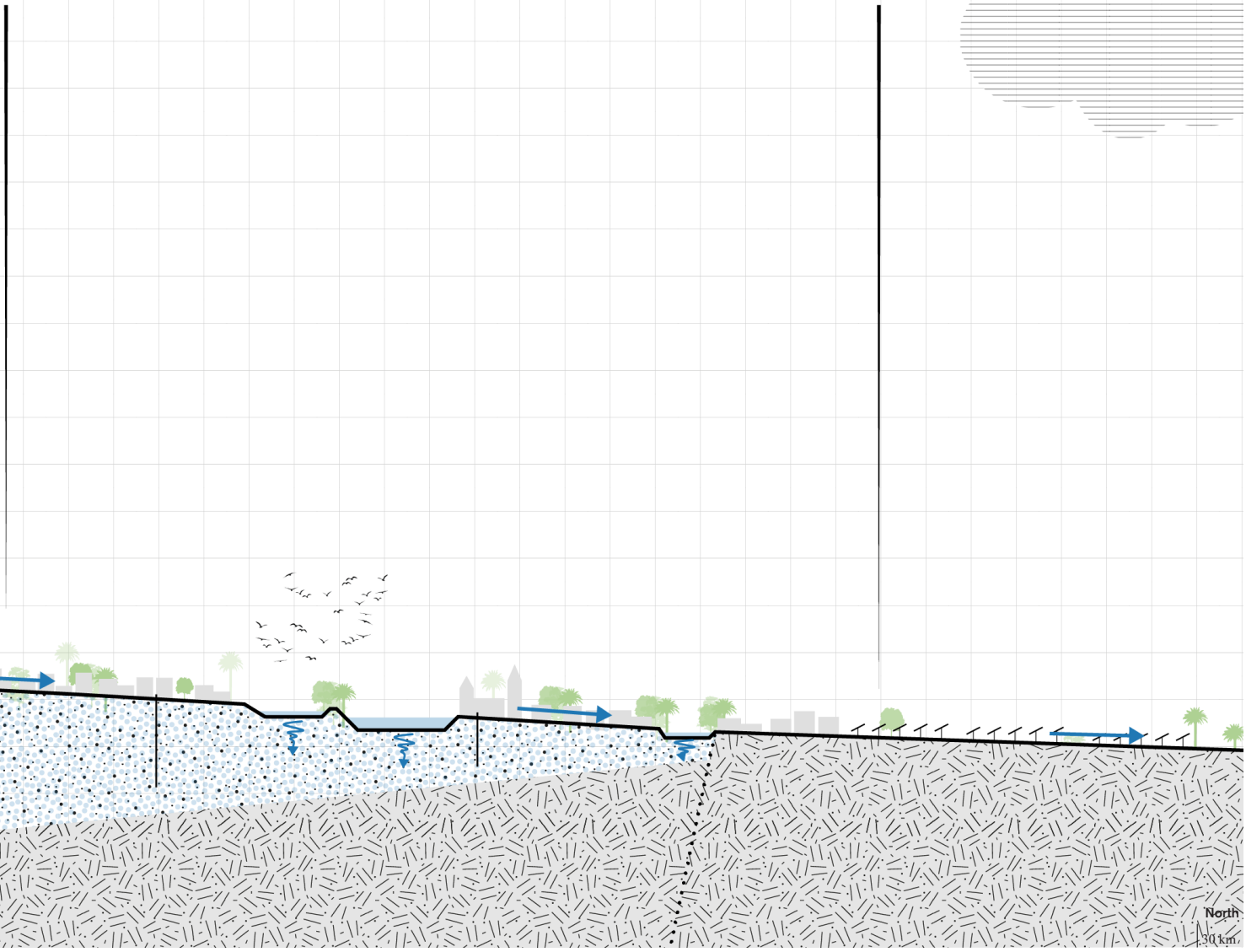


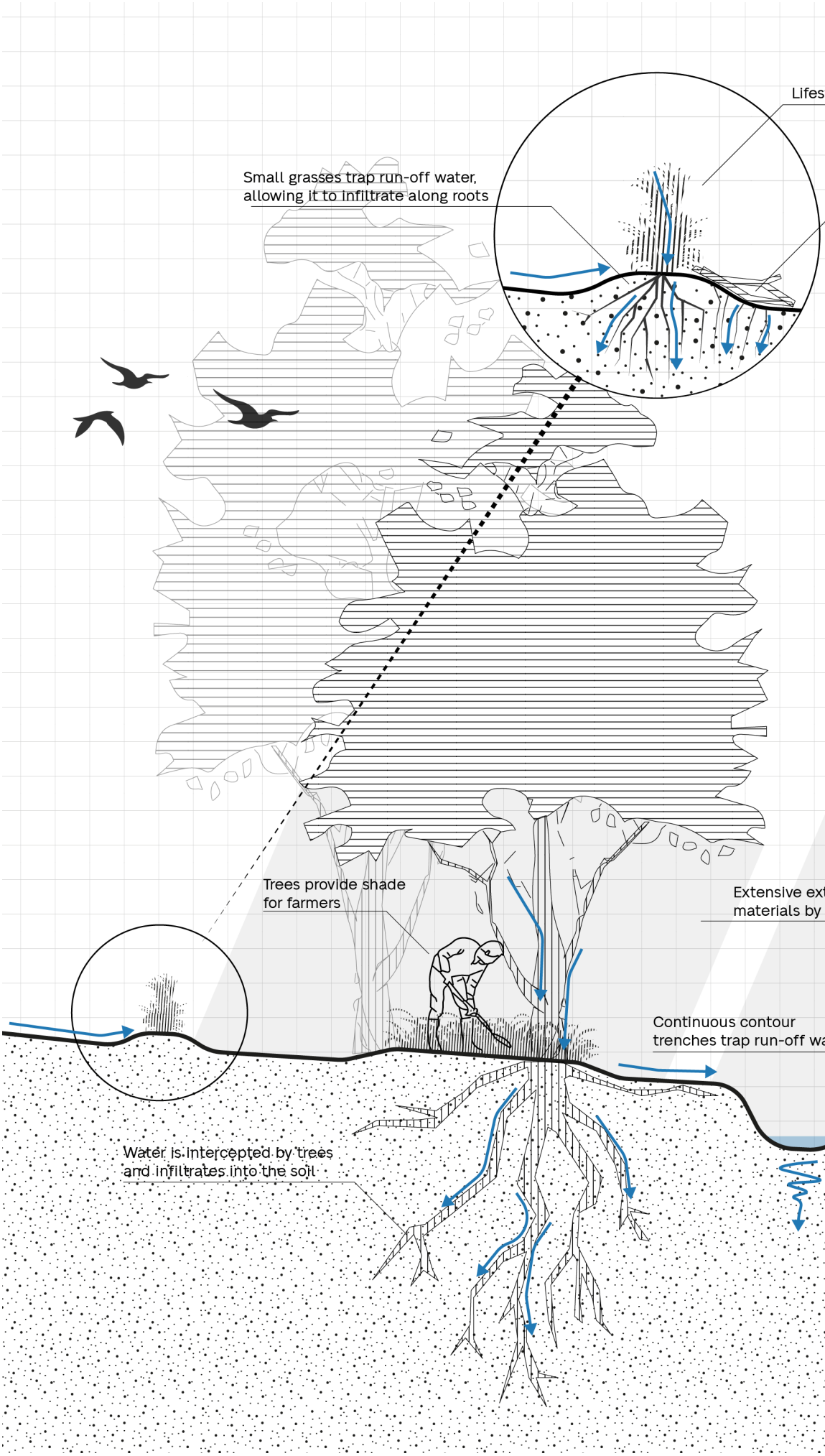
2.

of urbanities

3.

Sustainable production grounds





1. Regenerative agriculture

Healthy and diverse forests play a major role in the hydrological cycle. Restoration of the original tropical dry-land forest will therefore greatly improve the infiltration of water in the soil. Vegetation, together with the construction of continuous contour trenches (CCT), will trap run-off water from uphill. Soil fauna such as termites enhance this process. Grazing is not desired, but the possibility to extensively extract materials provides financial incentive for farmers.

tock grazing is limited

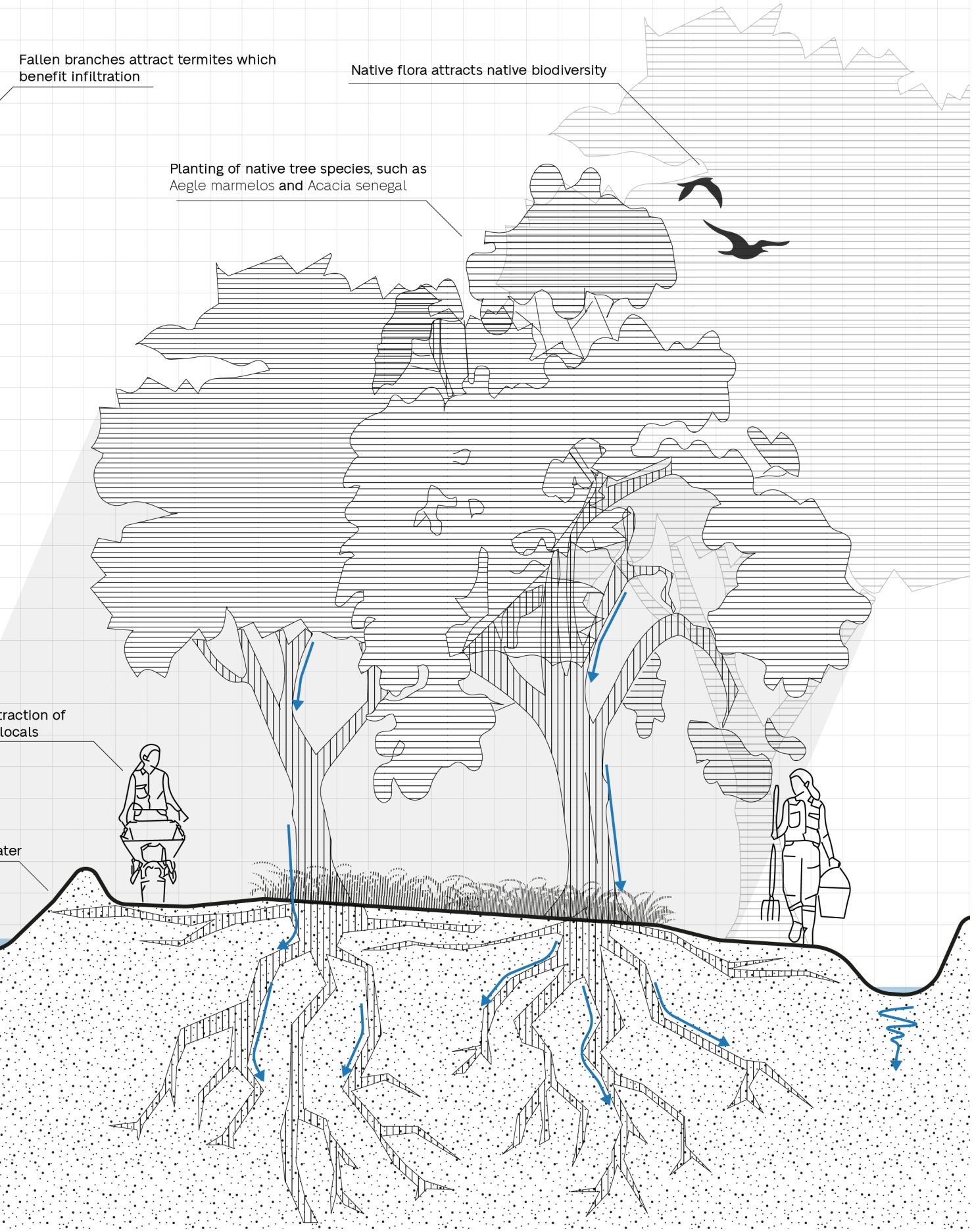
Fallen branches attract termites which benefit infiltration

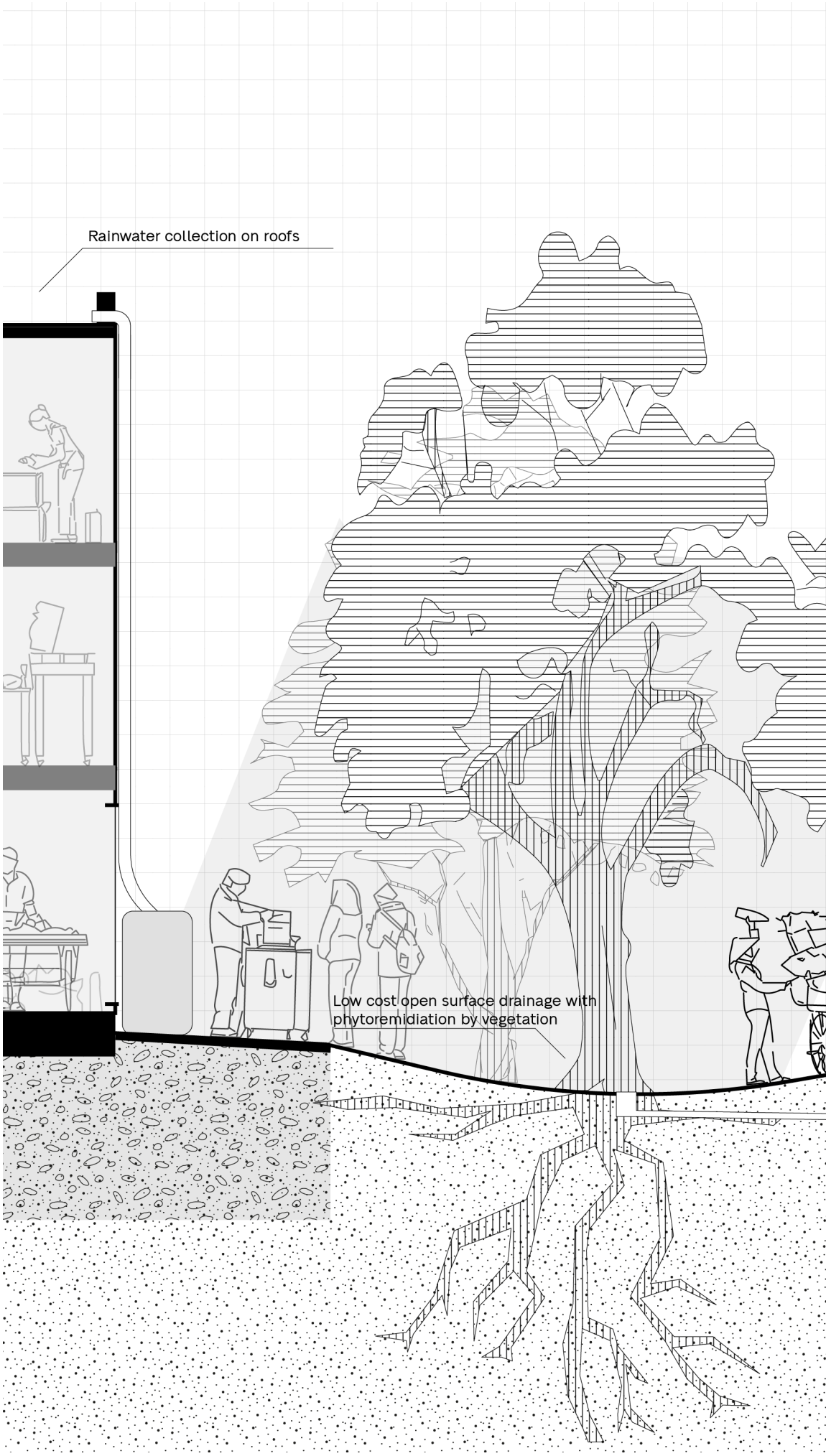
Native flora attracts native biodiversity

Planting of native tree species, such as Aegle marmelos and Acacia senegal

traction of locals

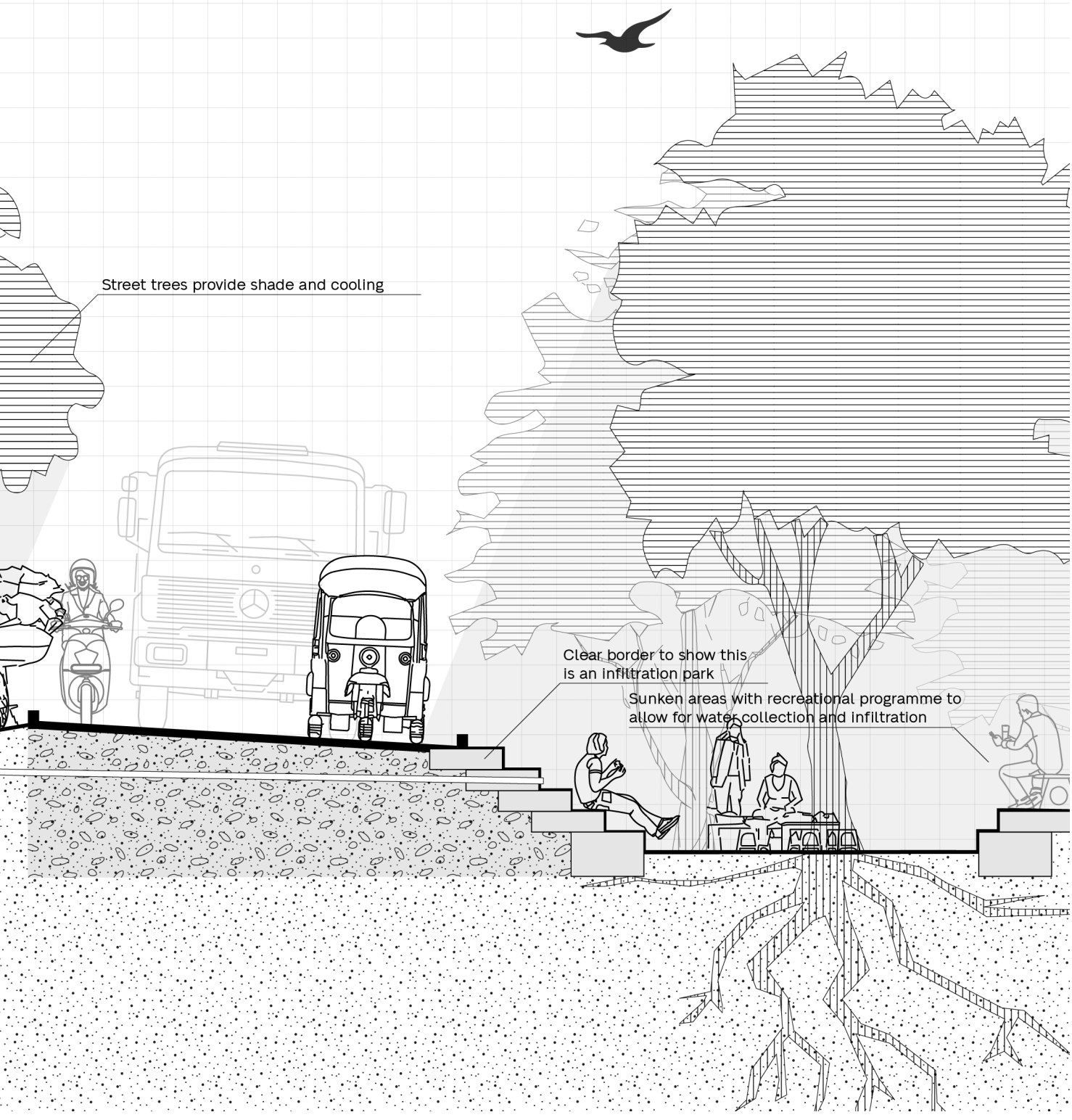
ater

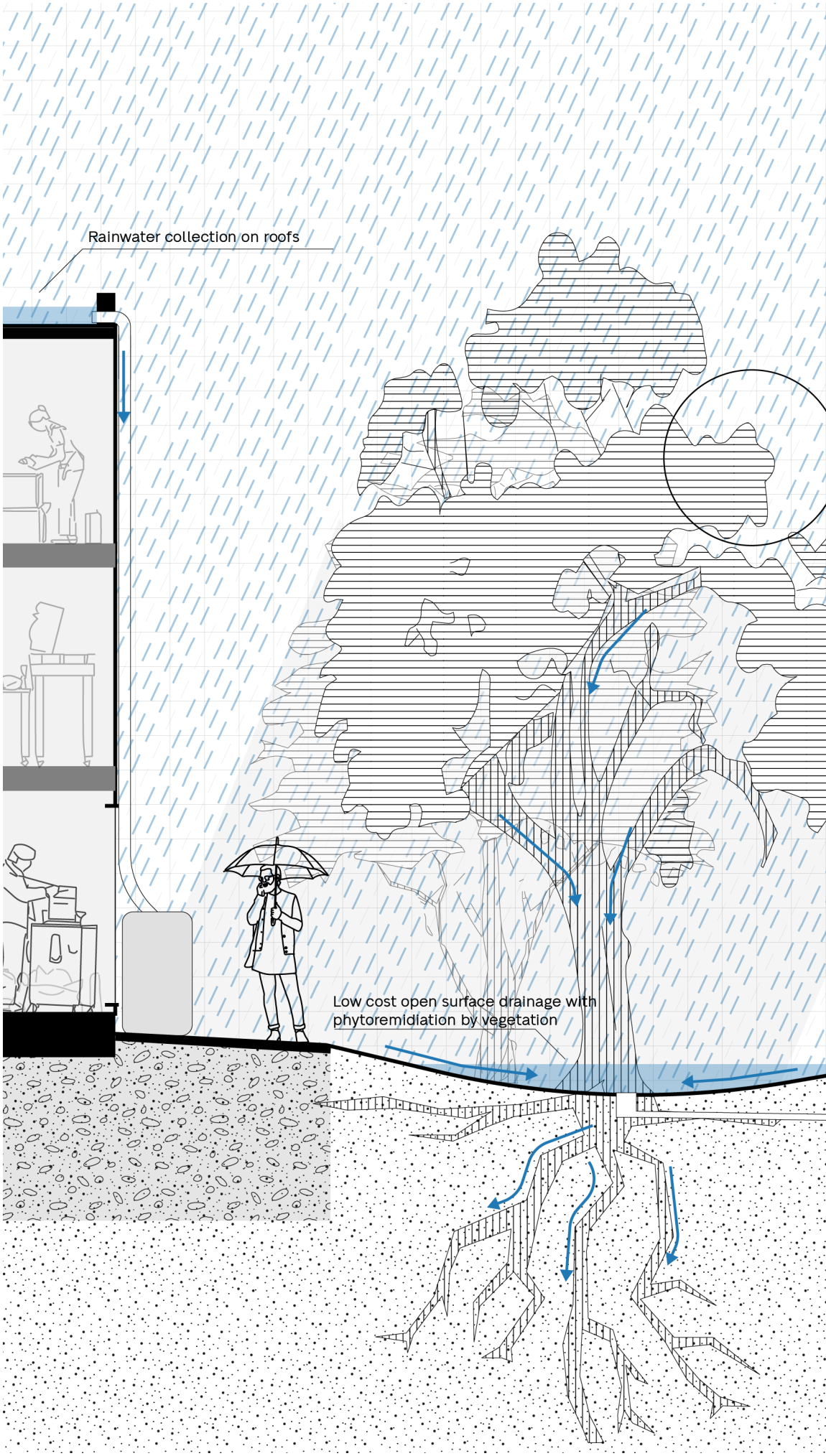




2. Climate proof urbanities - dry situation

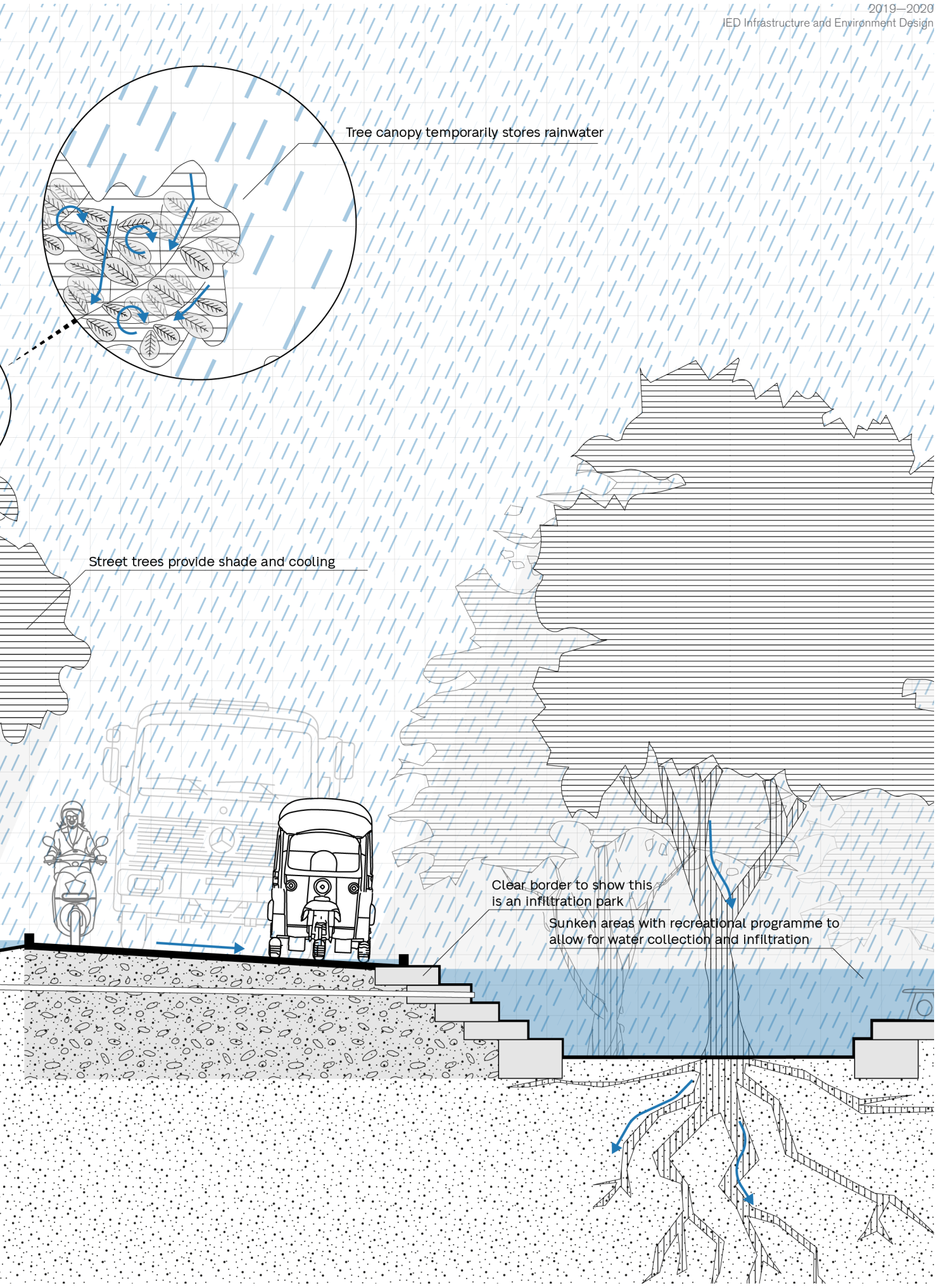
Natural infrastructures make the city less prone to flooding and mitigate the heat stress. These infrastructures have clear boundaries and are operated and managed by communities. The visibility and accessibility of the infrastructures allows anyone to attach meaning to it, eventually nurturing a wider understanding of this important natural system.

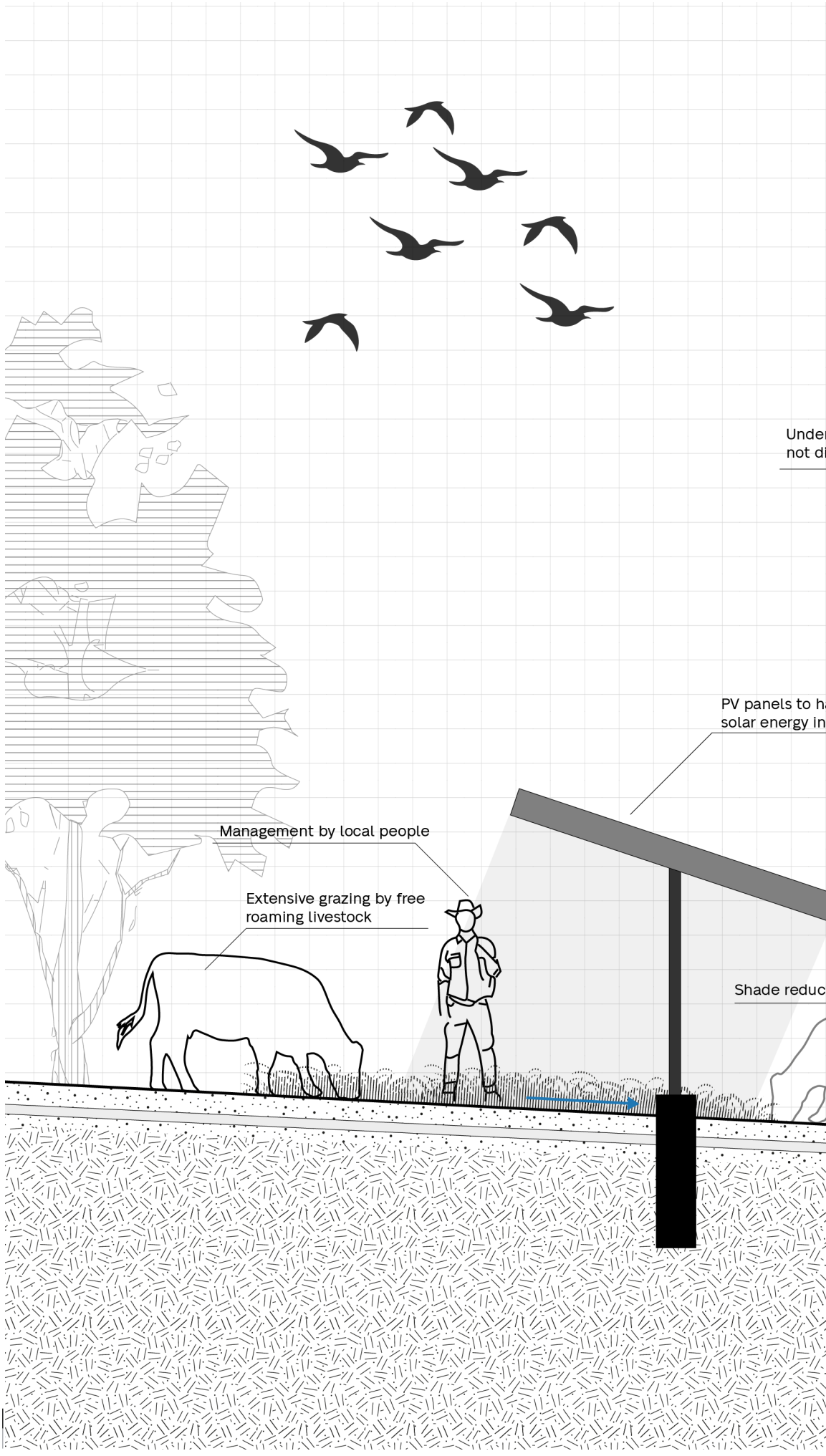

Street trees provide shade and cooling
Clear border to show this is an infiltration park
Sunken areas with recreational programme to allow for water collection and infiltration



2. Climate proof urbanities - wet situation

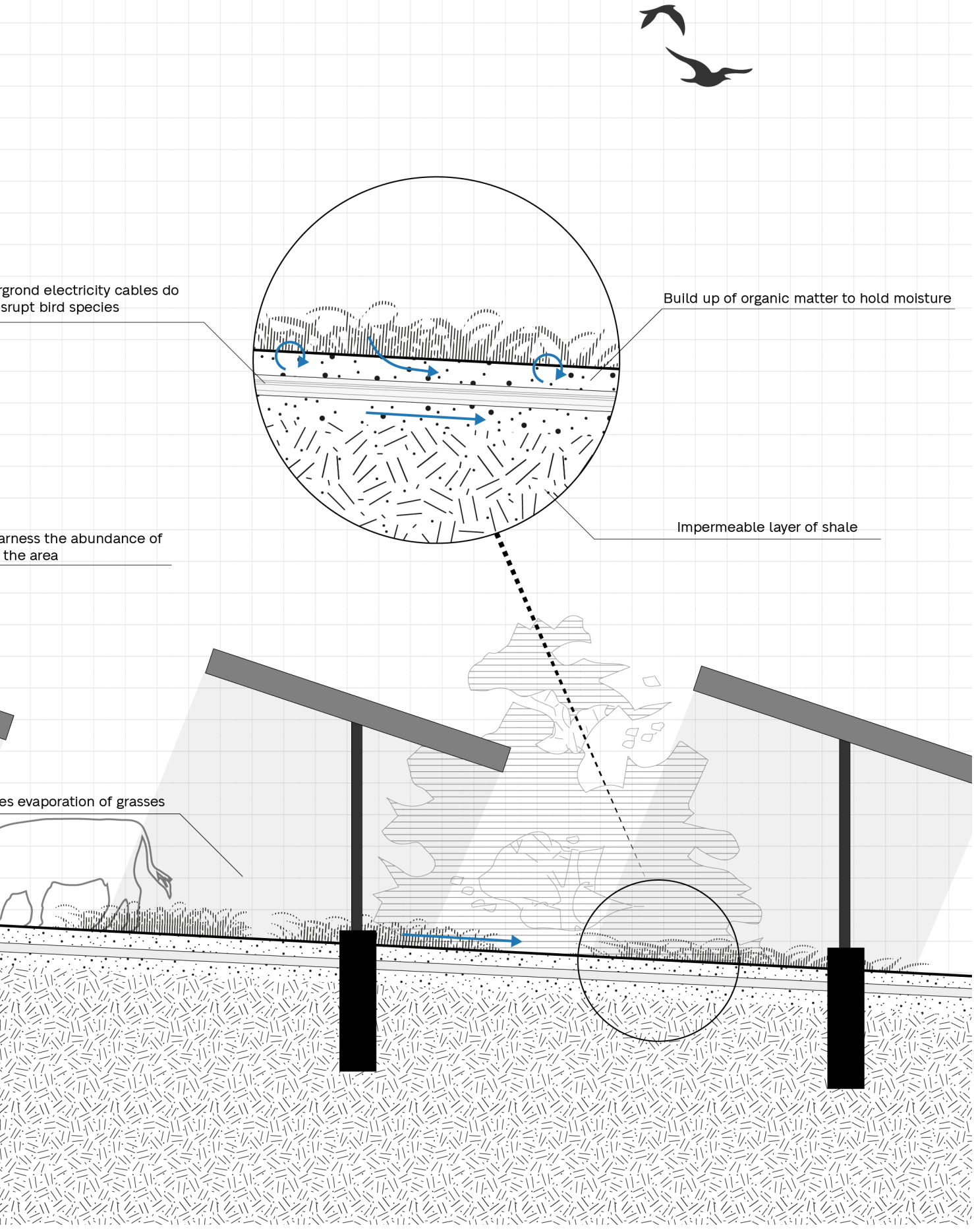
After heavy rainfall the space transforms into a low-cost but efficient water drainage network. The spectacular and extraordinary experience of flowing water over the streets to the infiltration parks connects well to the existing festivals that residents celebrate after rainfall.


Tree canopy temporarily stores rainwater
Street trees provide shade and cooling
Clear border to show this is an infiltration park
Sunken areas with recreational programme to allow for water collection and infiltration



3. Sustainable production grounds

Environmentally embedded private investments under supervision of NGO's will financially support the city. Practices such as solar energy and grazing can be combined at this location where infiltration is not a concern.


rgrond electricity cables do
srupt bird species
Build up of organic matter to hold moisture
arness the abundance of
the area
Impermeable layer of shale
es evaporation of grasses

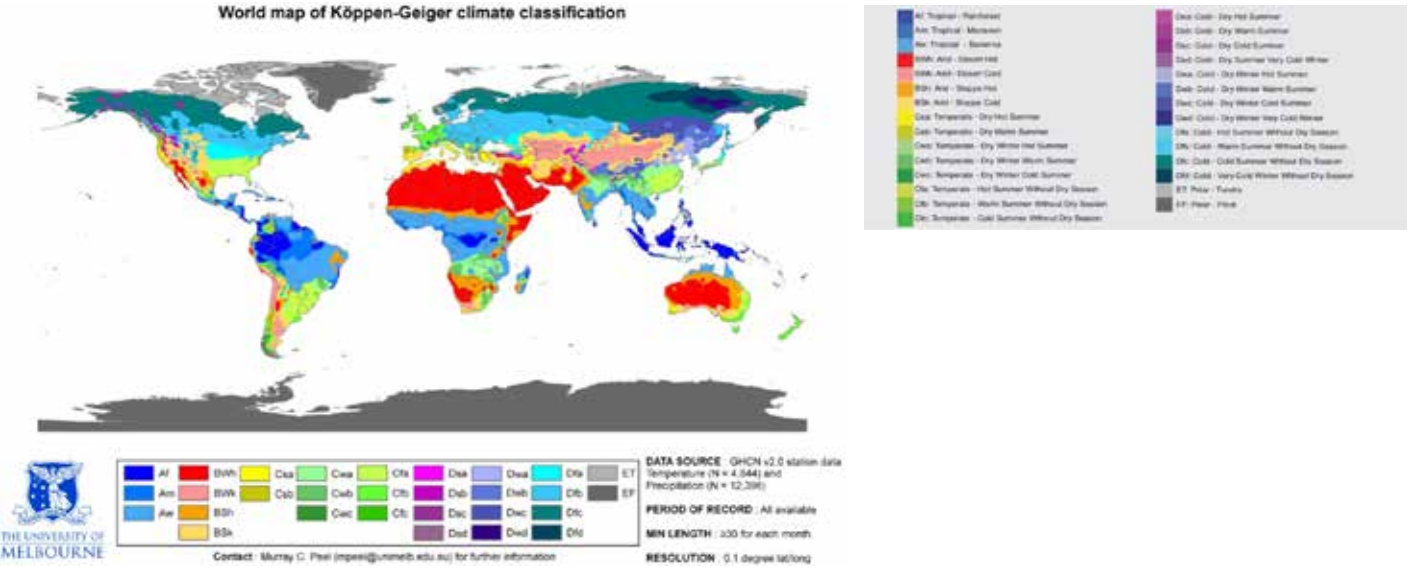
8.

Discussion

Typology of landscape

The landscape typology and position in climate zone is most defining the project in relation to the risk or stress and the potential for ecosystem participation. Second most defining aspect is the level of urbanization which controls the level of risk (by positioning in the landscape) and also posing stress in itself by occupying the landscape by overexploiting the natural system and interfering with the systems.

The cases can be considered in four groups according to the Koppen-Geiger climate classification and connected landscape classification by in see figure. Otsuchi in Japan has a Cold – Hot summer without dry season climate in a mountainous landscape, the two cases in Norway are in a Cold – Cold summer without dry season climate and also mountainous landscape. Both the cases in Egypt and India are in an arid climate and dessert landscape. Both Grand Bahama and Houston have a tropical climate situated in a savanna landscape.



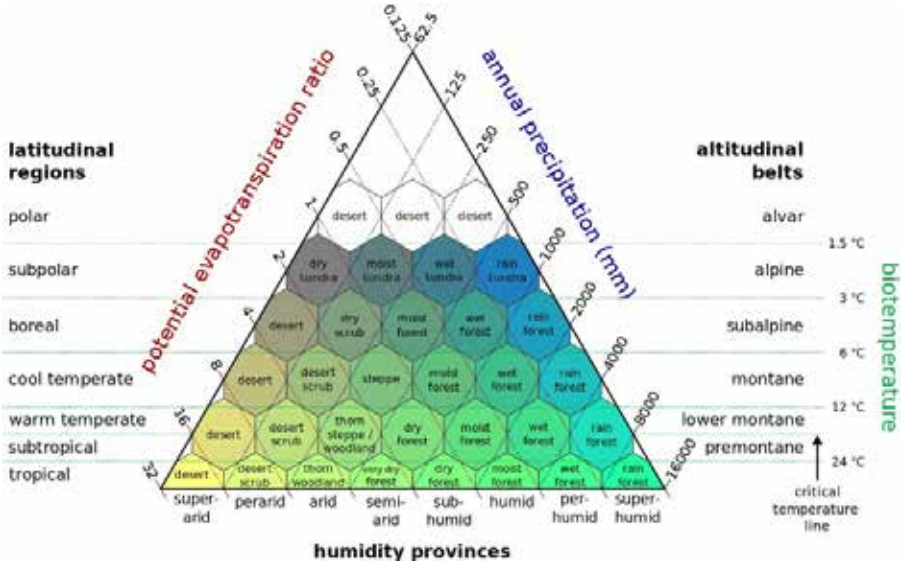
Koppen-Geiger climate classification

Level of interaction with nature?

All cases show a very little interaction with the natural conditions on a citizen level whilst the infrastructure in place is dealing with the natural hazards. From a historical perspective all cased have a strong economic and vernacular relation with the natural system. Otsuchi and Norway cases this is both related to fishing and wood, Grand Bahama also to the fishing and last century as holiday resort, in Norway, Egypt and India the temporality use of the landscape by Bedouin culture, and Houston related to the extraction of resources.

Typology of stress and shock?
The main stress all cases experience is as part of a high or low level of urbanization. In Otchuchi, Grand Bahama and Norway the temporal and shrinking population put stress to the system. Also, drought as natural hazard in Egypt and India, both suffering from the stress of expanding urbanization at the same. Here Houston also experiences the same stress. The cases Otsuchi, Grand Bahama and Houston experience shock in the shape of tsunamis and hurricanes, whilst also Egypt and India suffer from flush floods and Norway from landslides.

Level of interaction with stress and shock?
All cases show quite a low level of dealing with the stress and shocks at hand, in order to analyse responses, the Vulnerability concept is quite useful. Many authors discuss the components of the vulnerability to climate change, hence there are many different views on their definition and understanding. For the purpose of this work the framework from De Graaf (2009) is used



Geigen classification connected to landscape typologies

because it explains the components of vulnerability by the sequence of four building capacities – threshold, coping, recovery and adaptive, by which the term is defined.
The objective of the first capacity, threshold, is decreasing the probability by building dikes or other large hydraulic structures. The objective of the coping and recovery capacities are primarily damage reduction, coping during and recovery after an event. These two capacities are reciprocal in spatial design and can be considered as the boundaries of a scope in which there are many combinations in between. On the coping scope evacuation on the one side

and living on piles on the other can be the extreme. The recovery capacity has a scope that ranges from making certain structures flood proof on the one and having good insurance on the other, with urban structures are made as such that they can be fixed easily in the middle range.
The objective of the adaptive capacity is building understanding and ability to foresee developments for the future in which the main goal is establishing a robust and healthy living environment, this can be making use of all three other capacities as an ensemble (De Graaf, 2009). In his publication The Nature of urban design, a New York Perspective on Resilience, Washburn (2013) proposed the risk formulae as Risk = (probability-mitigation) x (consequence-adaptation).

The following interactions can be defined:
- Threshold: Top down protection for prevention (Otsuchi)
- Recovery: Reactive rather than preventive attitude towards shocks which feeds the stress loop (Houston, Grand Bahama)
- Recovery: Lack of preparedness to shocks (Otsuchi, Grand Bahama, Houston, Egypt)
- Adaptation: Stress becomes a trend as accepted urban form and lifestyle (India, Egypt)
- Recovery: Inability to cope with shocks due to dependency on external resources (India, Grand Bahama)
- Recovery: Continued stress due to the inability to cope with shocks due to lack of infrastructure (Egypt, Grand Bahama, Houston)

Vernacular or traditional interaction with landscape and stress or shock?
Traditional indigenous relation to the climate and landscape conditions can be recognized in the cases:
- India: the water steps
- Egypt: Bedouin culture
- Norway: Samu culture
- Bahamas: architectural vernacular
- Japan: architectural vernacular

cases	Climate	Landscape typology	Level of interaction with nature?	Typology of stress and shock?	Level of interaction with stress and shock?	Vernacular or traditional interaction?
Japan	Cold – Hot summer without dry season	Mountains	Low	Shock: tsunami Stress: shrinkage	Treshold , Recovery	Yes
Norway	Cold – Cold summer without dry season	Mountains	Medium	Shock: land slides Stress: temporality		Yes
Egypt, India	Arid, dessert hot	Dessert	Low	Shock: flush floods Stress: urbanization and drought	Recovery	Yes
Bahamas, USA	Tropical Savanna	Savanna	Low	Shock: hurricane Stress: urbanization and shrinkage	Recovery	Yes

	Norway / Lofoten and Hammerfelt	**Japan / Otsuchi**	USA / Houston
Typology of landscape	The landscape of the Lofoten Islands (Reine) is characterized by steep slopes, plunging into the fjords. The landscape of Hammerfest is characterized by eroded slopes and some rocky outcrops. Inhabitable space is mostly found on the shoreline, extending land inwards along sedimented flats. Settlements are built on terraces to overcome the height differences throughout the urban area. Seasons are important because the winters are very dark and cold and the summers are light and warm.	In Otsuchi, a coastal town in Japan, is situated on the flood plain of two rivers surrounded by mountain landscape with fine forest. The location is tsunami prone and, in the mountains, due to heavy rainfall landslides occur.	The city of Houston is an urbanized area located in a prairies and wetlands landscape. It is a hurricane prone region with hurricane season from June till November resulting in wind and water hazards.
Level of interaction with nature?	In Lofoten due to the landscape morphology characterized mostly by steep slopes, the urban areas are naturally confined. Originally, the only connection throughout the islands was the water, only recently the government has constructed a highway connecting Ä. Hammerfest has largely been focused on its maritime component, although the inland is passable. The territorial infrastructure here is not focussed on connecting, but rather appropriation and restriction. The incoming oil and LNG industry, government owned Equinor AS, has placed boundaries on the landscape.	This area is located at mountainous coastal area, and the lifestyle is closely linked with the landscape of mountains and sea. A large population earn their life by family based fishing industry. Also, the forest on mountains are also a resource of local income. People use the local material to build their houses and boats.	The city is based around the confluence of several bayous. With heavy industrialised areas, and several barriers the interaction between the inhabitants and nature is minimum. The dealing with Hurricanes can be described as coping, the people are insured and rebuild their houses every time they get hit.
Typology of stress and shock?	Reine Shock: Inland Rockfall Stress Seaward Growth - Tourism Hammerfest Shock: Landslide Stress: Growth - LNG	Shock: tsunamis Stress: protection from disaster, economic development, and the revitalization of local communities Japan / Otsuchi	Shock: compound flooding (rainfall and hurricanes) Stress: ecosystem and social degradation, car dependency

	Bahamas / Grand Bahama	Egypt / Cairo	India / Buhj
Typology of landscape	The Grand Bahama Island is part of a neotropical region. There is a tropical savanna landscape. It is a hurricane prone region with hurricane season from June till November resulting in wind and water hazards.	The city of Cairo is an urbanized area in the floodplain of the Nile delta surrounded by desert landscape. It is an arid region in which there is an excess of evaporation over precipitation. The typically bald, rocky, or sandy surfaces in desert climates hold little moisture and evaporate the little rainfall they receive.	The territory of Kutch is a semi-arid dessert region, virtually an island, surrounded by the Gulf of Kutch, the Arabian and Rann of Kutch. The terrain is mostly flat with a few hills punctuating it, with little resistance against the moisture laden South West monsoon winds blowing from the Arabian sea to bring rain to the region. Bhuj is situated on top of a porous sandstone aquifer of 180m depth. In the past lakes were constructed to collect run-off water from the hills, to infiltrate to the aquifer. People extract ground water through wells.
Level of interaction with nature?	The island is located in a hurricane-prone area, which has a big influence on the life of the Bahamians. Grand Bahama has a seasonal timeline which includes three major seasons: hurricane season, restore season and tourism season. Nature plays an important economic role to enhance tourism.	The current interaction with nature is reduced to a minimum. Neighbourhoods are designed 'inwards', with their own artificially created parks and greening. Between the desert environment and the urban fabric of the city several barriers can be found that prevent interaction with nature in the city.	In Bhuj, water security and management systems experience significant transformation while being a pressing challenge for the area. This evolution of varying behaviours and situations can be understood through four dominant relations between water scarcity and society. The four terms are meant to combine environmental and human systems to understand how humans coexist with nature. The four perspectives can be understood through specific moments over time where the relationship people and water scarcity has changed.
Typology of stress and shock?	Shock: Hurricane Stress: Social unpreparedness/ irresponsibility	Stress: Drought and urban sprawl Shock: Flash floods	Shock: floods and droughts based on monsoon fluctuations. Stress: population growth and industrialisation, there is an increasing water stress.

	Norway / Lofoten and Hammerfelt	**Japan / Otsuchi**	USA / Houston
Level of interaction with stress and shock?	Due to climate change Reine landscapes steep slopes are endangered by rockfall, caused by physical fractioning. The geomorphic 'work-done model' shows that most natural changes in the landscape take place when much stress is applied, during for example heavy spring- and fall storms, with a low frequency of occurrence.	Top-down measures are taken to deal with the stress and shocks. High sea walls are built to prevent tsunamis, and land is elevated to protect residents from flood.	The neighbourhoods are not designed to deal with the stress and shock situations making inhabitants reactive instead of a preventive. Most measures are focussed on facilitating damage instead of mitigating the impact. The focus is on an individualistic approach, not dealing with the situation as a community.
Vernacular or traditional interaction with landscape and	Lofoten is often synonymous with the simple fisherman's chalet, the "rorbu". But the image of the simplicity of the "rorbu" does not only stem from its architecture and location at the waterfront. It is also because it is the carrier of the more than 1000 year tradition of the Lofoten fisheries. Fishers from all over Northern Norway and parts of West Coast north of Bergen migrated to Lofoten between New Year and Easter to participate in this massive fisheries. It is this capacity to receive thousands of fisher "visitors", developed through 1000 years, that in later years is transformed into today's even larger capacity to receive tourist "visitors". Hammerfest is a small town with approximately 10,500 inhabitants of which approximately 1200 work in the petroleum industry. Of them, 500 work directly with oil and gas, while other petroleum-related jobs, including the supplier industry, employ approximately 700 people.	In history, people are tending to living at the mountain foot area, where the land is higher, to keep the distance from the sea. But as the technology developed, people were able to build dykes to defend tsunami, they are gradually moving towards the sea. In our project, we try to use the traditional way again and keep the residential area in the mountain foot area and turn the coastal area into a natural zone. Moreover, people in those areas can still have strong relationship with water. Outside the dike, natural-based solutions like salty-marshes and oyster beds are used to block the tsunami.	Houston has always been a flood-prone city. However, the bayous used to have more natural floodplains to cope with the water level rising. Intense urbanisation and industrialisation caused to suppress the natural bayou systems.

	Bahamas / Grand Bahama	Egypt / Cairo	India / Buhj
Level of interaction with stress and shock?	There is a small number of very capable and dedicated people who know exactly what needs to be done to ensure the shelters provide safe haven during hurricanes, but lacking resources and finance means to execute these plans. A lot of people cant swim. The local population and governments also do not own (enough) boats. Inhabitants rather spend their money on a car, as a status symbol, than on boats.	In the neighbourhood El-Hadaba El-Wosta, the drought is supported by inappropriate use of water. It is therefore, is only increasing for other, lower income, areas of the city. Cairo is fast expanding to house its growing population, the desert landscape is ignored in urban design. This causes resilience to deal with either extreme excess or shortage of water. This is a clear lack of shock management.	The city is a product of various socio-economic paradigms including colonisation and neo-liberalisation. This process has corrupted the relationship between water infrastructure and life in the city and has created an unsustainable status quo. People from fragile villages move into slum housing. This and other economic activities are not contextualised and pose an increased resource dependency on hinterlands. Vernacular knowledge on community-based water artefacts such as runoff lakes and wells on top of the aquifer, and particular focus on recharging mechanisms to secure groundwater availability in the long term.
Vernacular or traditional interaction with landscape and	The current population is not able to adapt to these storms, not like the traditional population used to be. The indigenous knowledge of the Bahamians is oppressed by the difficult challenges they face including globalisation, environmental pressures, marginalisation, and economic and health inequity.	Currently the biggest problems with drought are caused by inappropriate use of water sources. Historically, the city of Cairo was confined to the Nile valley and the floods which traditionally occurred there. Beyond supporting human life, water was used for irrigation of the agricultural landscape. The city has grown rapidly in recent years, spreading out into desert areas which were previously uninhabitable. As such, the city was historically less vulnerable to the stress of drought, and was home to fewer people who might have been impacted by stress or shocks events.	Bhuj has developed a variety of mechanisms to cope with extreme environments and vulnerabilities. These mechanisms can be understood as adaptive and nature based or mitigative and technical. However due to heavy pollution, encroachment and general over consumption of resources, the adaptive and nature based coping mechanisms have been depleted or vanished. The extreme drought reality of the area in relation to the depleting coping mechanisms expose the sensitivities of the most vulnerable populations such as the informal settlements in this area.

	Norway / Lofoten and Hammerfelt	Japan / Otsuchi	USA / Houston
Typology of landscape	Relation between temporality and the two different cities. In terms of, social, spatial structures, and industry Reine: expanding Hammerfest: short temporality.	The landscape and ecology here are influencing the anthropology aspects. For example, because of the sea and abundant marine creatures, people are moving from the mountain to the coastal area and making their living by fishing. Because of the severe tsunami, they moved back from coastal again. And all these changes can also be seen on the urban occupation pattern and extreme constructions.	
How the different topics of analysis interact among each other?	The most crucial characteristic of both project is temporality, Therefore, the key point of the vision for Reine is to embrace the seasonality, which leads to temporary industry, visitors and occupation patterns. The challenge from temporality will be changed to opportunity, resulting in a more sustainable coexisting way of human and nature. In Reine, industries and nature go with the seasonal flow. Fishery, tourism and nature are coexisting but taking turns in different seasons. In Hammerfest, change in economy, seasonality and also, the population under the expanding pressure of the oil & LNG industry. The transition in local industry calls for spatial transformation, in which both continuity and temporality are needed. Also, tackle with the harsh weather and the increasing risk of landslides, the project proposes the co-existence and integration of biosphere and technosphere.	The key elements we take for elaborating the vision are various natural-based solutions to defence tsunami. These solutions are used as catalyst to create a safe and liveable environment here.	The current situation should be changed to a more preventive, multiscale, communal approach.

	Bahamas / Grand Bahama	Egypt / Cairo	India / Buhj
Typology of landscape		In several perspectives has been found that the lack of interaction between the natural environment and the built environment causes difficulties in managing the stress and shocks in the city.	Through the topic of vulnerable water system. In this extreme climate it plays a central role in the definition of these challenges. The water system that was constructed in the past to supply the city of Bhuj its water is no longer being used to its fullest potential. This results in water shortages and an unsustainable water supplier during droughts, while floods occur after rainfalls. Apart from the neglecting and abandonment of the traditional water infrastructure, the use of the soil is also contributing to this challenge.
How the different topics of analysis interact among each other?		The natural desert environment should be brought back into the city and should be used as a tool to manage issues of water shortage and flash floods.	Synthesize hydrological conditions with key urban morphologies. The overlaying of layers provides insights of the most sensitive areas in Bhuj. The concentration of slums is located in the northern areas where water conditions are deteriorated. This suggests the exacerbation of existing social-equality through challenges of water scarcity. It is also notable that the water conditions are most severe in the north which receives the most frequent supply. It would be important to understand who benefits from the frequent water supply. The vast open space area and pockets of recharge potential provides opportunities to revitalize the current state of the hydrological network, and could empower surrounding communities in participating within their land's potential.

9.

Conclusions

Exploring the concept ‘Ecosystem Participation’ in the six cases using the same investigation methodology and building on a shared literature review delivered the following insights:

Learning from the past is not old fashioned but gives a lot of insight of how humans without dominant technology responded and participated in the given extreme climate or landscape conditions.

Temporality is an important aspect to the concept of ecosystem participation. Part of the anthropocene perspective is the building of value that is durable, economic value with cost/benefit analysis, life cycles etc etc. Living with extreme conditions like Bedouin (Egypt) and Sami (Norway) did, delivers the insight in how social and physical temporality is part of this landscape and how in the current approach this is paradoxical. Physical temporarily is not beneficial and social temporarity undermines desired social coherence. Designing with seasons is ecosystem participation.

Even if we recognise that traditional ways of dealing with the extreme landscape is an important aspect of ecosystem participation, the question is to which landscape can we return? What is nature? This question in severely altered landscapes is difficult to answer. What was, is and should be the new equilibrium between man and nature in the extreme landscape,how can nature profit from us? In cities we see nature adapting to our environment, birds that live in mountains can live in highrise and eat our leftovers. During the Covid-19 lock down many animals came to cities to find food that was not given to them anymore.

	Norway / Lofoten and Hammerfelt	Japan / Otsuchi	USA / Houston
What does eco system participation for the particular case mean?	The most crucial characteristic of Reine is the seasonality, which leads to temporary industry, visitors and occupation patterns. Therefore, the key point of the vision for Reine is to embrace the extreme temporality instead of fight against it. The challenge from temporality will be changed to opportunity, resulting in a more sustainable coexisting way of human and nature. In Reine, industries and nature go with the seasonal flow. Fishery, tourism and nature are coexisting but taking turns in different seasons. Hammerfest: The project finds a way to deal with the huge change in economy, seasonality and also the population under the expanding pressure of the oil & LNG industry. The transition in local industry calls for spatial transformation, in which both continuity and temporality are needed. Also, tackle with the harsh weather and the increasing risk of landslides, the project proposes the co-existence and integration of biosphere and technosphere.	Ecosystem participation both can be seen in the post-disaster construction process and the daily life of local people. In the construction process, wished to get more access to water of local people is taken, traditional wisdom of local residents to live in mountainous area is used. Also, cost and financial benefits are discussed to make sure different actors can be stimulated. As in the daily life, fishing, recreational activities, tourism and community activities are designed in for people to interact with nature, especially water.	To ensure resilience and prosperity in their extreme environment a greater participation in the ecosystem is needed by creating an integration of human and natural systems, through leveraging the built and natural environment and socio-economic status towards more nature conscious, self-sufficient, and multi-scalar approaches.
How does it relate to stress or shock?	Lofoten: rethinking Fishery and Tourism The surrounding islands will be upgraded with more docks and warehouses to improve the water transportation system. Fossil energy will be gradually replaced by clean energy such as wind and tidal energy.	Local knowledge and nature-based solutions are used to prevent tsunami. The defence system is not only functioning as barriers, human activities are also embedded in it. The oyster beds can be used for economy activate. The forest dike is designed as a daily recreational area.	Integrated systems and knowledge create possibilities to reduce and mitigate the impact of stress and shock situations on the neighbourhood

	Bahamas / Grand Bahama	Egypt / Cairo	India / Buhj
What does eco system participation for the particular case mean?	Understanding and awareness of the effects of climate change among inhabitants on the vulnerable Grand Bahama island is essential for the development and implementation of a sustainable resilience strategy. Engaging citizens and using their indigenous knowledge in combination with external approaches could help to mitigate/reduce disaster risk.	For the Egypt case the extreme desert environment can be reconceived as a carrying infrastructure rather, than a threat, to further urban development. Also, natural features such as wadis within extreme environments can present durable solutions to environmental risks. Furthermore, it remains imperative to include culture and interaction within the ecosystem based design in order to make designs durable on the long term. And lastly, it is necessary to take a multi scalar and multidisciplinary approach in order to create a design that is sustainable in the long term.	To improve the quality of the city of existing social-equality through challenges of water scarcity. Improve the hydrological conditions with key urban morphologies. The concentration of slums is located in the northern areas where water conditions are deteriorated. The vast open space area and pockets of recharge potential provides opportunities to revitalize the current state of the hydrological network, and could empower surrounding communities in participating within their land's potential.
How does it relate to stress or shock?	Awareness and knowledge reduce social unpreparedness/irresponsibility to hurricanes.	Awareness and knowledge of the extreme environment creates possibilities to manage the drought more efficiently and reduce the impact of the flash floods on the built environment.	Improvements and knowledge create possibilities to reduce and mitigate the impact of stress and shock situations in the city. Creates awareness and is a starting point for remodelling the social conditions and marginality.

	Norway / Lofoten and Hammerfelt	Japan / Otsuchi	USA / Houston
	Hammerfest: Economy & LNG industry will improve shifting towards a more automatic and sustainable mode. Season ability: The cargo terminal would only open during summertime, while the Hammerfest port, which is for the LNG industry, would open all year round.	Floating system and natural parks behind the dyke are functioning as buffer zones when water came in, but they are also offering places for fishing industry, tourism and daily recreation.	
Is there a way to make the effects of the stress or shock be made beneficial?	Creating punctual interventions related to a network to rethink the future of the two cities in different ways. From a more touristic opportunity to an automatic improvement of the work. Both cities will be organized following their temporality giving space to nature.	The waves in tsunami can bring in new species into the floating system and the river. So, more diversity can be added by the shock. This is not only beneficial to the ecosystem, but also to the aquaponics industry in the floating community, as more species can be raised here.	Creating hybrid systems to deal with stress and shock situations in both the build and natural environment, as well as in the social environment. In this way the neighbourhood can be more resilient to flooding but it also creates the opportunity to enhance and strengthen the community.
How can the project be considered phase able?	Due to the introduction of the Temporality, a new system of leaving and working in the cities is created.	Working with the current situation to turn the hard measures to soft measures can be considered as the first stage. After that, more activities to build up community can be installed.	The project takes place on different scales, from local neighbourhood scale to a city scale, enhancing changes on different levels
Are the inhabitants part of the development of the project or only beneficial?	They are an active part of the process specially in Lofoten. In constant relation with nature especially in the maintenance of the natural infrastructure and environment.	In this project, the inhabitants are involved after the protection infrastructure are installed, such as the dikes and the floating platforms. At the stage of community building, inhabitants are involved to build their own housed using local materials and develop community gardens, family-based fishing industries and so on.	In this case the inhabitants would be part of the development, as the projects are mostly community based. So in that way the inhabitants can take part in the changes, while also benefiting from it as they will adapt to the shock and stress situation.

	Bahamas / Grand Bahama	Egypt / Cairo	India / Buhj
Is there a way to make the effects of the stress or shock be made beneficial?	Natural infrastructure (i.e., healthy ecosystems) and combinations of natural and built infrastructure (“hybrid” approaches) can enhance coastal resilience by providing important storm and coastal flooding protection, while also providing other benefits as fishery habitat, water quality improvements, carbon sequestration and storage, and recreational use, and can provide these benefits to coastal communities all the time, not just during storm events.	Using natural solutions to make room for the water of the flash floods and store this water could solve both the stress of drought and the potential damage that can be caused by the flash floods. Also, treating used water and reusing this appropriately is a way to decrease the water stress. Overall this means that multifunctional designs are the best way to deal with both the stress and the shock in this neighbourhood in Cairo, Egypt.	A series of interventions in a systematic process can be proposed for vast open space areas and pockets of recharge potential provides opportunities to revitalize the current state of the hydrological network, and could empower surrounding communities in participating within their land’s potential.
How can the project be considered phase able?			Working within different scales, involving different stakeholders, from the local community to the regional and national government.
Are the inhabitants part of the development of the project or only beneficial?		Because upper class Egyptian families are less inclined to participate in projects which might require physical labour, they are not involved. However, the projects we propose are beneficial for the residents as they will experience less problems with shocks and stresses involving water. Moreover, by changing their surroundings and opening new routes, are likely to become involved in designs in a more passive manner.	They are part of the process, in a chain that connects the bigger to the local scale. To create the sense of commu-

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