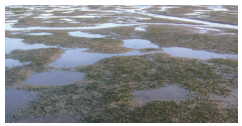
Naturally,
A Port City Often Shrinks

Yi-Chuan Huang
TU Delft Urbanism Master Thesis

dune

tidal flat

slufter



seagrass bed

salt marsh

oyster bed

Ecosystem services. Wave attenuation patches

Wadden Sea

UNESCO World Heritage. The largest unbroken system of intertidal sand-mud ecosystem.

-- Declared by EU (2009) and protected by Trilateral Wadden Sea Plan 2010 (Danish, Germay, Netherlands).

— Dutch Wadden Sea conserved area

World Heritage Nomination Group 2008; UNESCO2009
Trilateral Wadden Sea Plan (WSP). 2010

Carrying force of North Sea

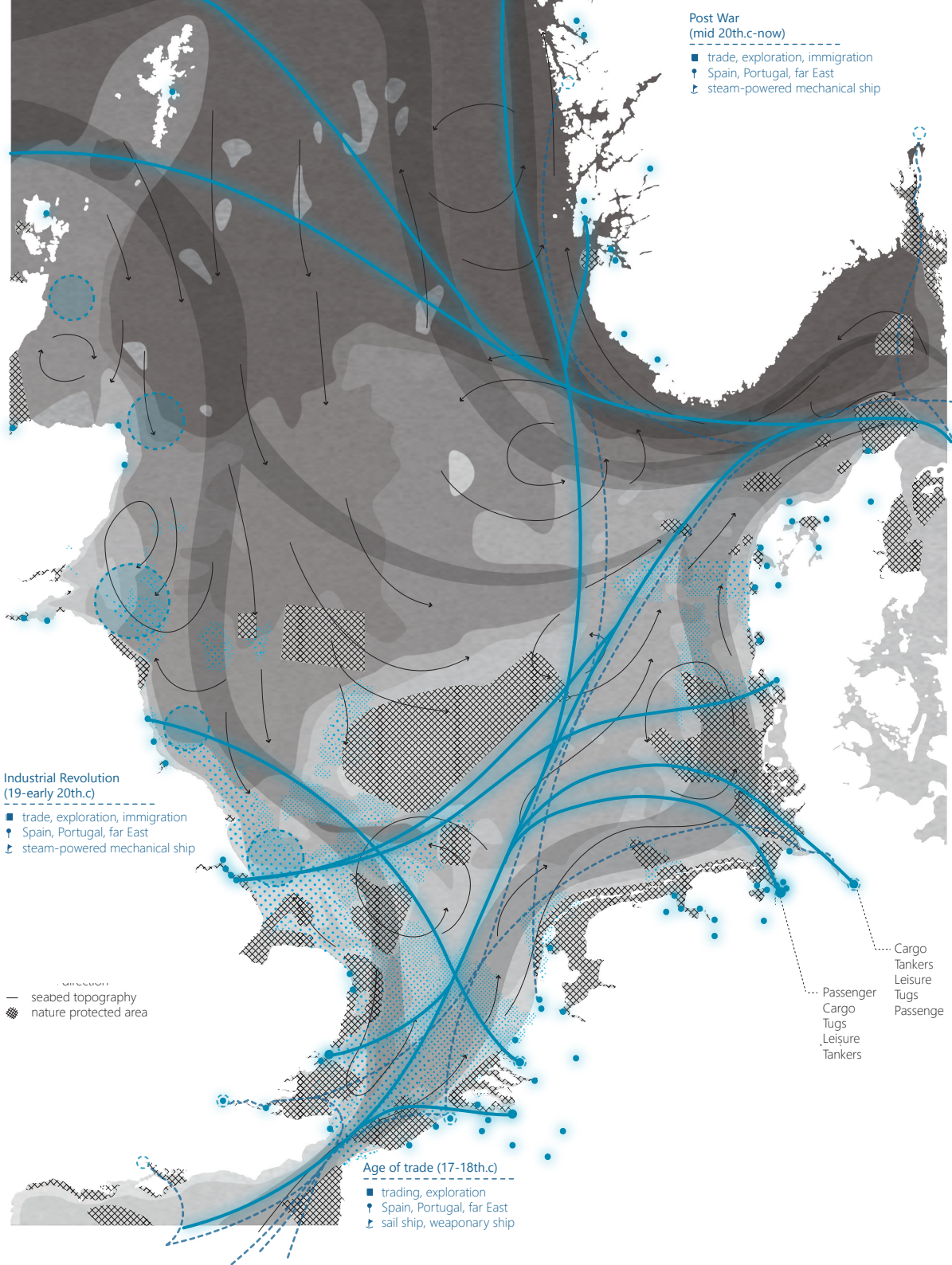
Shipping network portrait economic depandancy of coastal urbanization on marine dynamics.

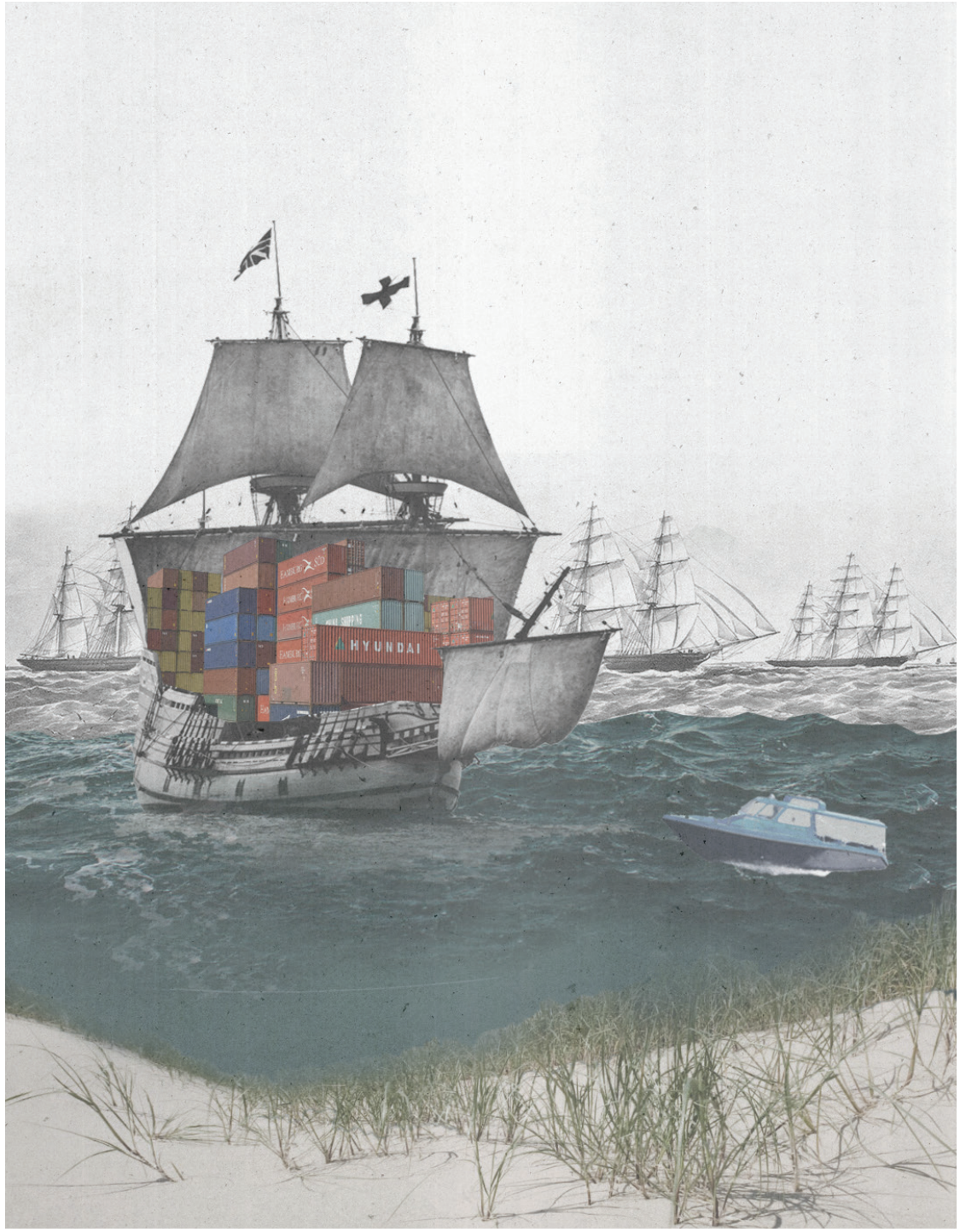
Shipping activity

- Post war shipping route
- Post war main harbor
- World War main battle field
- 17th.c trading route
- 17th.c main harbor

Nature system

- Ocean current
- Wave direction
- Nature protected zone
- Sediment





North Sea Urbanization

A Shifting Economy

Age of trade (17-18th.c)

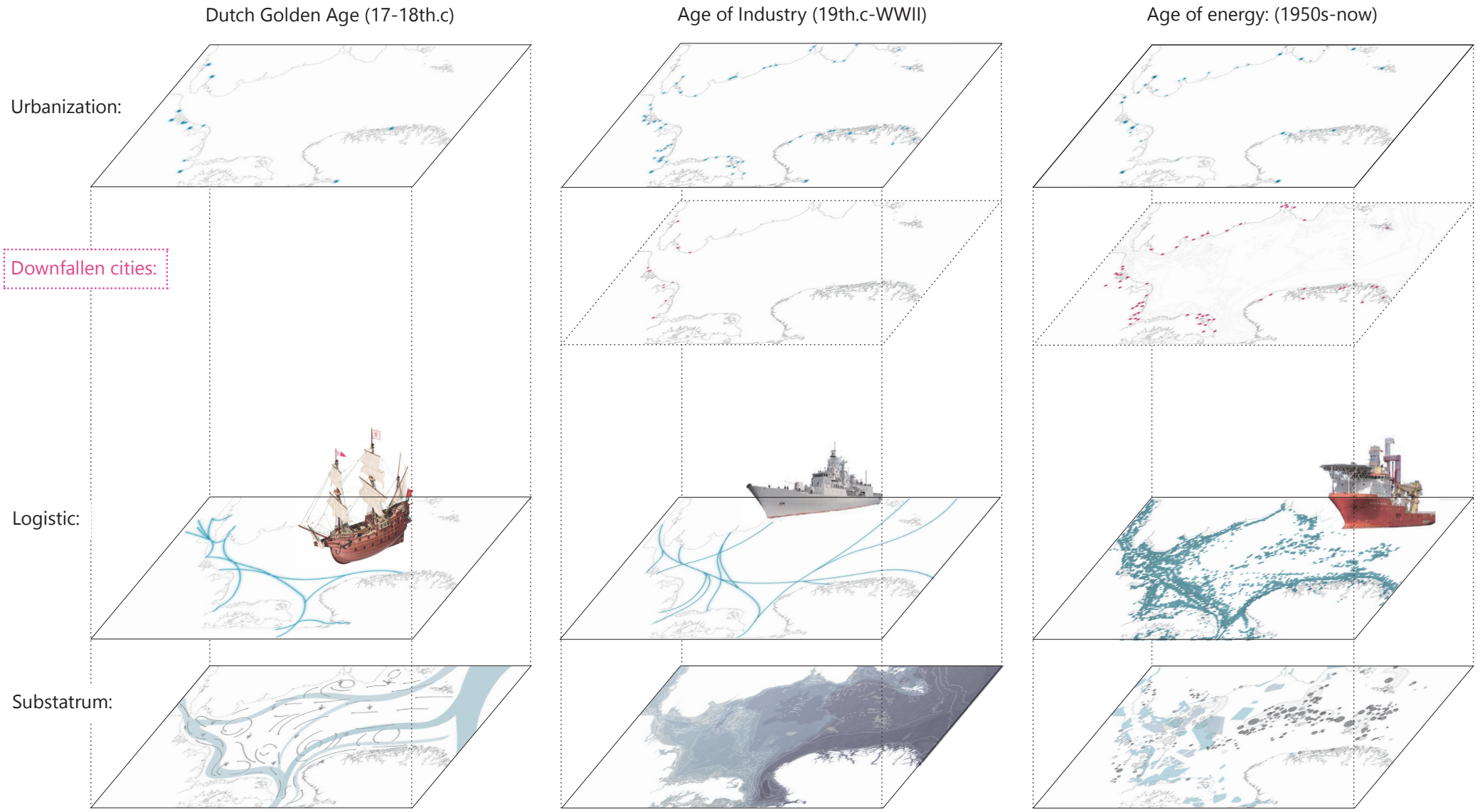
- Fishery, trading, exploration
- Spain, Portugal, far East
- Sail ship, weaponary ship

Age of Industry (19th.c-World War)

- Immigration. Battle
- US. British and German coastline
- Steam-powered ship,. War ship, submarine

Age of Energy (post war -)

- Cargo. Energy (oil, gas, wind farm). Leisure
- China, Russia. North Sea coastal
- Container ship. Drilling ship. Ferry



3 Ages x 3 Layers

Three active shipping periods are chosen to explore major changes in economy (shipping destination, purpose), technology (ship types) and their relation with substatrum (current, wave, sediments). Strong correlations are revealed in **the way human leverage natural forces and shift of coastal development** (urbanizing or shrinking).

Shrinking Wadden cities

Wadden Sea coastal development encounters severe recession. Port cities are compulsary to go through transformation within low environmental impact.

High density of shrinking port cities along coastline

Prognose 2017-2040 bevolking,huishoudens en woning. (2017). Noord-Holland Provinvie

Dilemma of
Waddden port city development

Exploitation & potential

In the Netherlands, Wadden Sea coastal cities are particularly sensitive to economic shift and environmental change, regarding to the delicate **coexistence of protected tidal ecosystem and port-initiated urbaniazation.**

Conservation & limitation

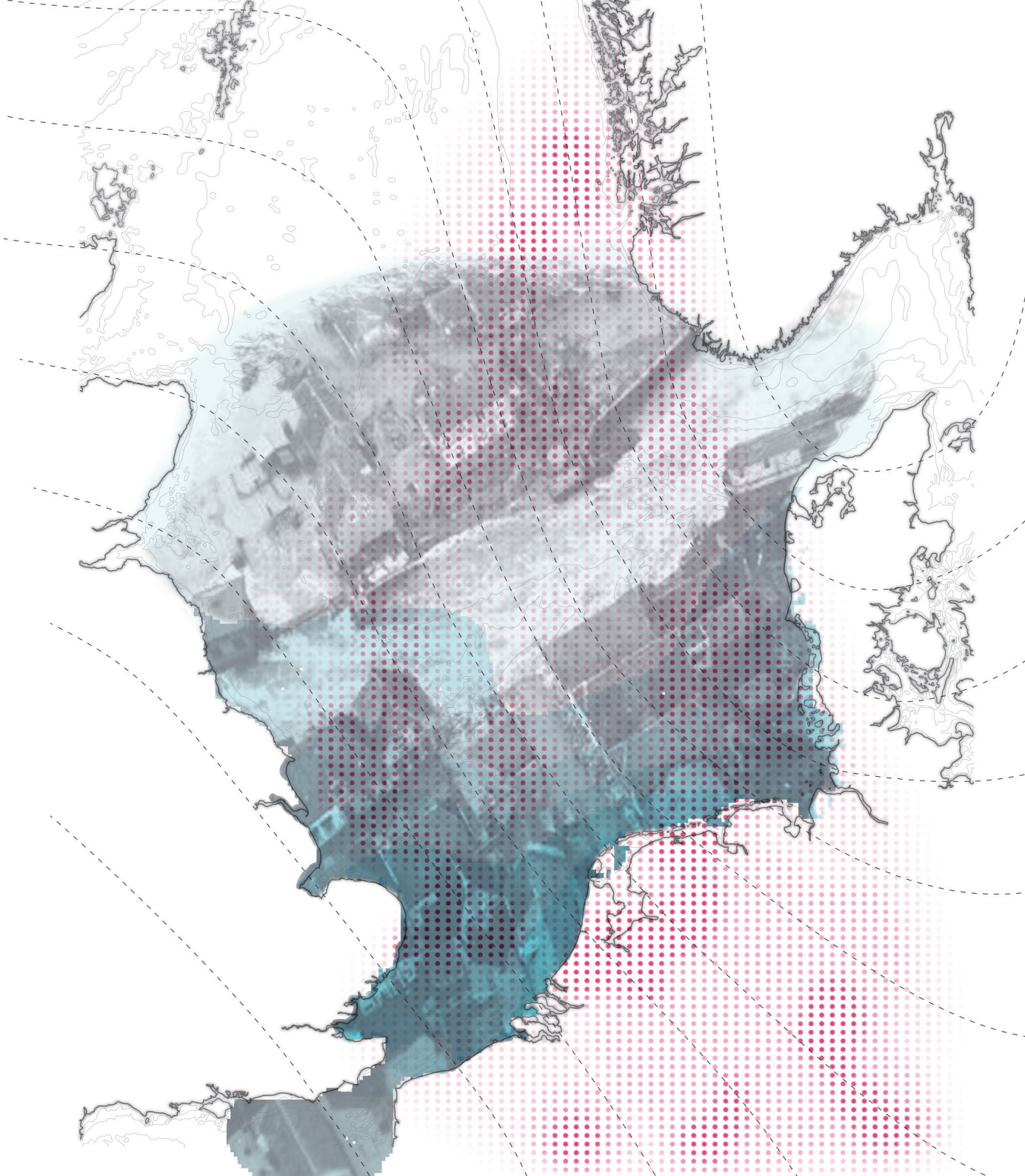
Since 1978, coastal development at Wadden region has been limited by EU and Trilateral Wadden Sea Cooperation, in order to reduce disturbance on the precious habitat. Nations are obliged to protect the tidal ecosystem, ranging from complete transition zone of saltwater to sweet water.

Coastal activites, including fishery, industrial facilities, ports and maritime traffic, residential and tourism development and climate change, are all regarded as potential threats.

Surging force of North Sea

Representative occurence pattern
of flood-producing storms in the
North Sea

--- Isobaric topography
— Bathymetric
Probability of storm surge occurence
1953 storm surge influence



Pressure: Environmental change

MAN-INTENSIFIED FLOOD RISK

Closure of Afsluitdike + Rising Sea Level

flood volume raised significantly (30%).

Ebb volume increases due to fresh water from Ijsselmeer

Draining of low lying hinterland will become more difficult, especially in combination with more extreme precipitation.

Sediments & Erosion

The maintenance of these coastlines are the most intensive work of entire Dutch coast.

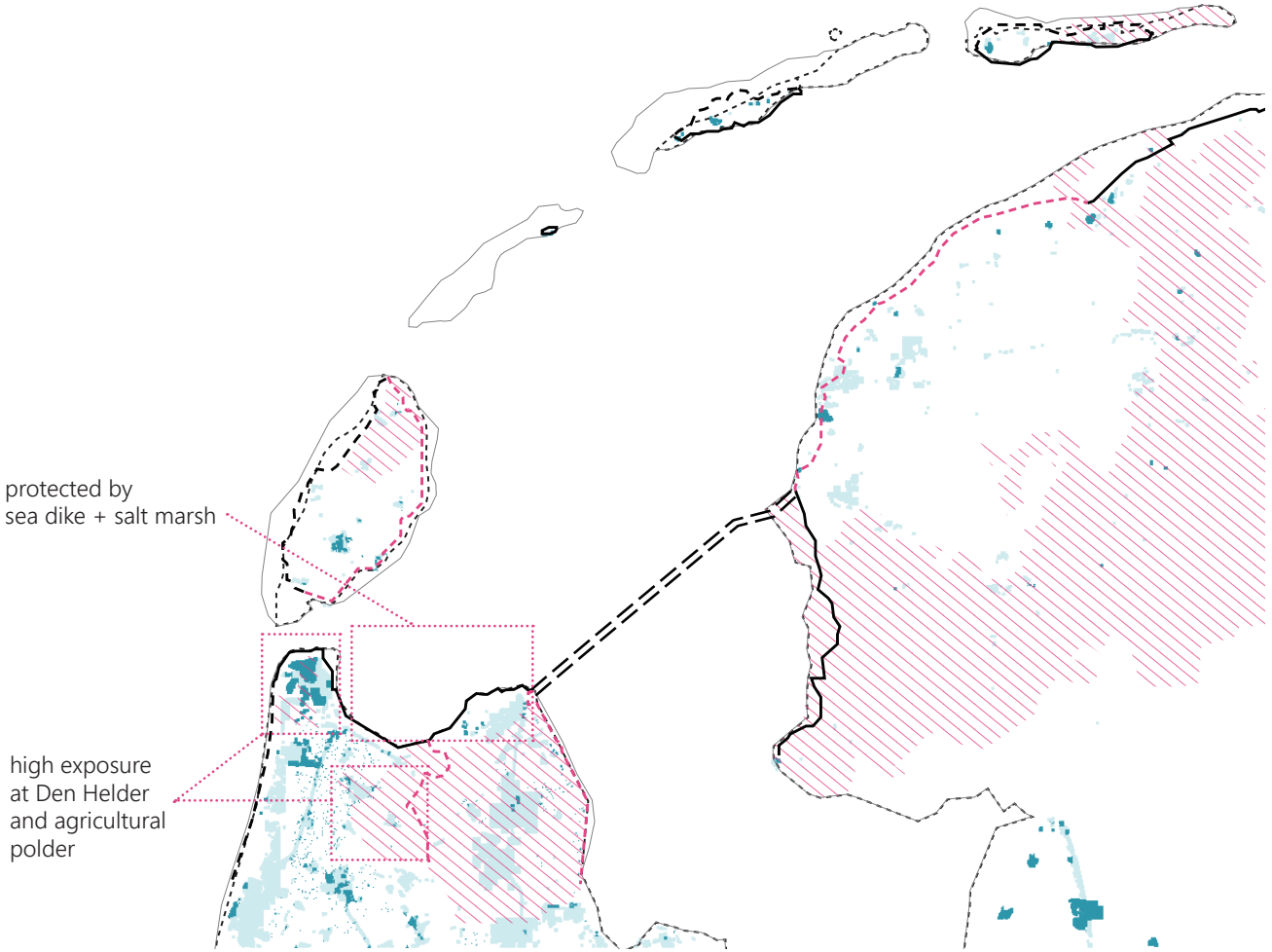
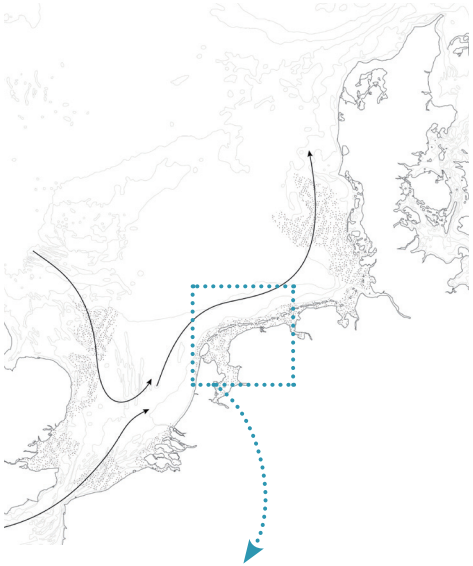


Fig. Increased flood risk due to rising sea level. Different types of sea defense structures are indicated.

— sea-defense dikes
== sea-defense dam
--- sea-defense duins
--- defense requires reinforcement

areas expected to loss 2-3 mil euros if flooded
areas expected to loss >3 mil euros if flooded
flooded area if sea level rises 1m
flood-prone (100 to 1000-year flood chance)



Sediment & Erosion:

Wadden marsh erosion

Ports require frequent **dredging**

hydrodynamics + morphodynamics changes:

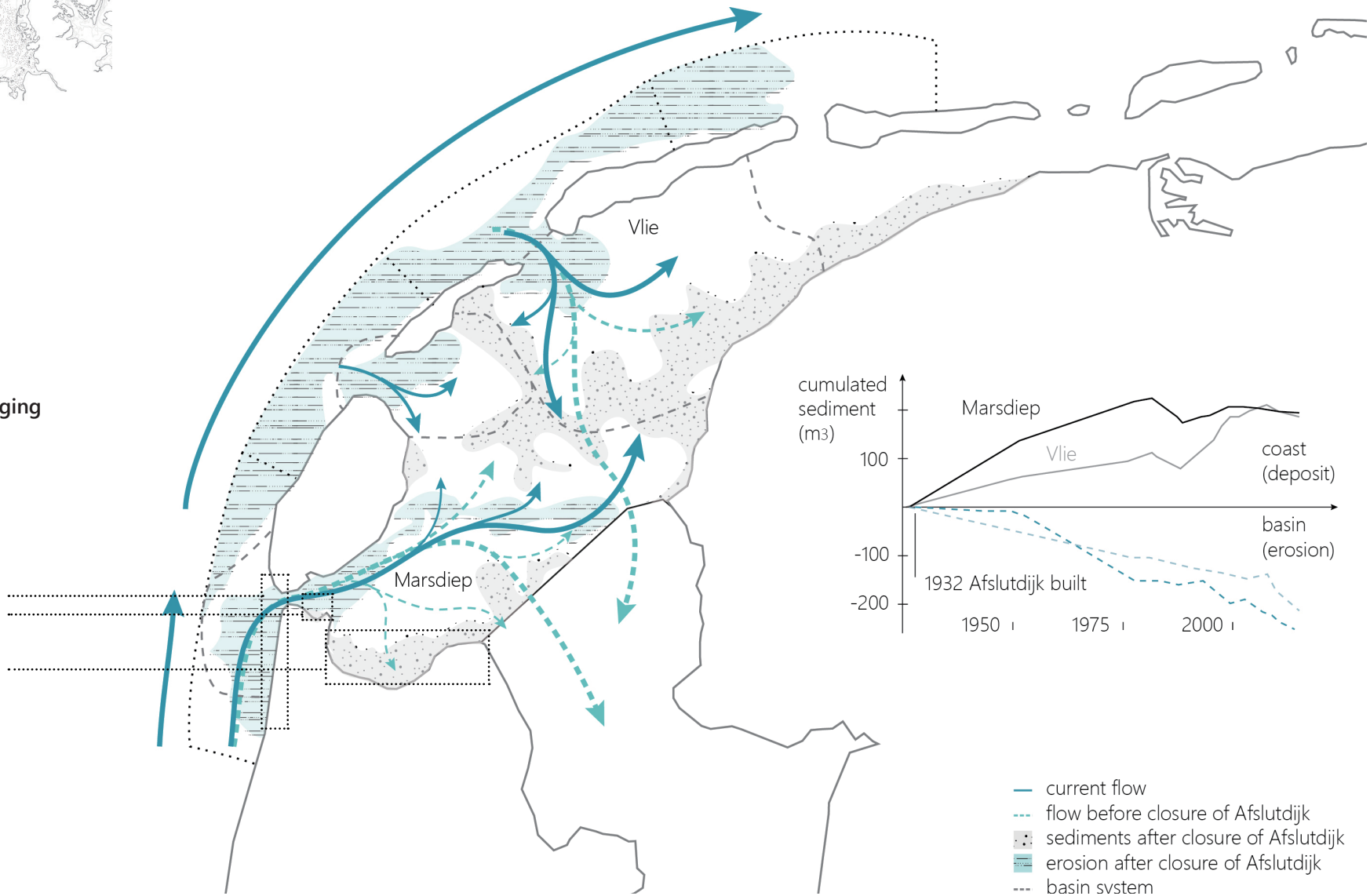
Higher wave height

Stronger **erosion at outer dunes**

Dune: higher erosion

Port: High dredging cost

Reclaming salt marsh:
lack of new inflow



- current flow
- flow before closure of Afslutdijk
- sediments after closure of Afslutdijk
- erosion after closure of Afslutdijk
- basin system

PORT CITIES
A HIGH RISK INVESTMENT

Homogeneous economy under multiple risks

Along the coastline hundreds of ports and cities have been raised to facilitate exploitation. But once the dominating port economy encounters recession, cities collapse significantly. Rapid shifts in trading economy and logistic technology challenge the adaptability of traditional port cities. Today, under the threat of climate change, port-dominated development becomes rather unsustainable.

SHRINKING Port Cities:
at the forefront of Flood Risk & Economic Shift

Common main causes of shrinking port city

- Maritime industry, logistic recessed
  (economy structure too homogeneous)
- Environmental restrictions
  (siltation, natural protection, climate risk)
- Marginalised in on-land transport network
  (low accessibility, distance to urban core)
- Technology advancement
  (limited infrastructure to cope with new, larger marine technology)

EU policy reference:

Nature Based Solutions (NBS)

NBS is propagated and defined by EU as approaches **'inspired and supported by nature, which are** cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience'.

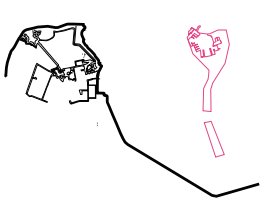
Conservation of ecosystem services becomes a mean to address environmental and societal challenges simultaneously.

Conservation

Den Helder is surrounded by Wadden Sea tidal zone - the downstream sediment basin of North Sea and River Rhine.

Exploitation

Den Helder is the intersection of Dutch land and sea (Exclusive Economic Zone, wind farms)



Wadden dike reinforce agenda

Port expansion agenda

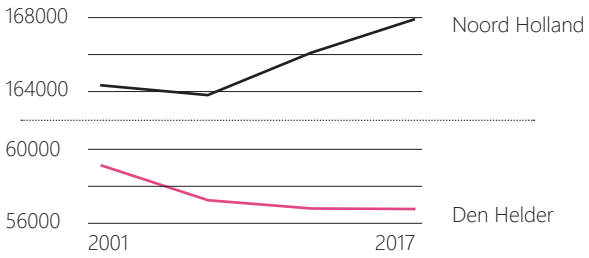
UNESCO World Heritage PSSA fishing forbiden

The worst case

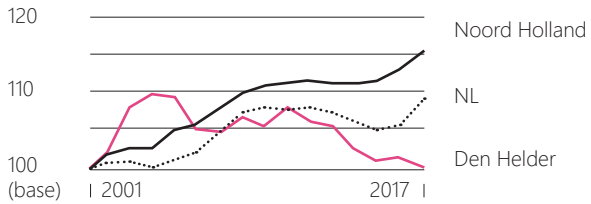
Den Helder and Balgzand bay

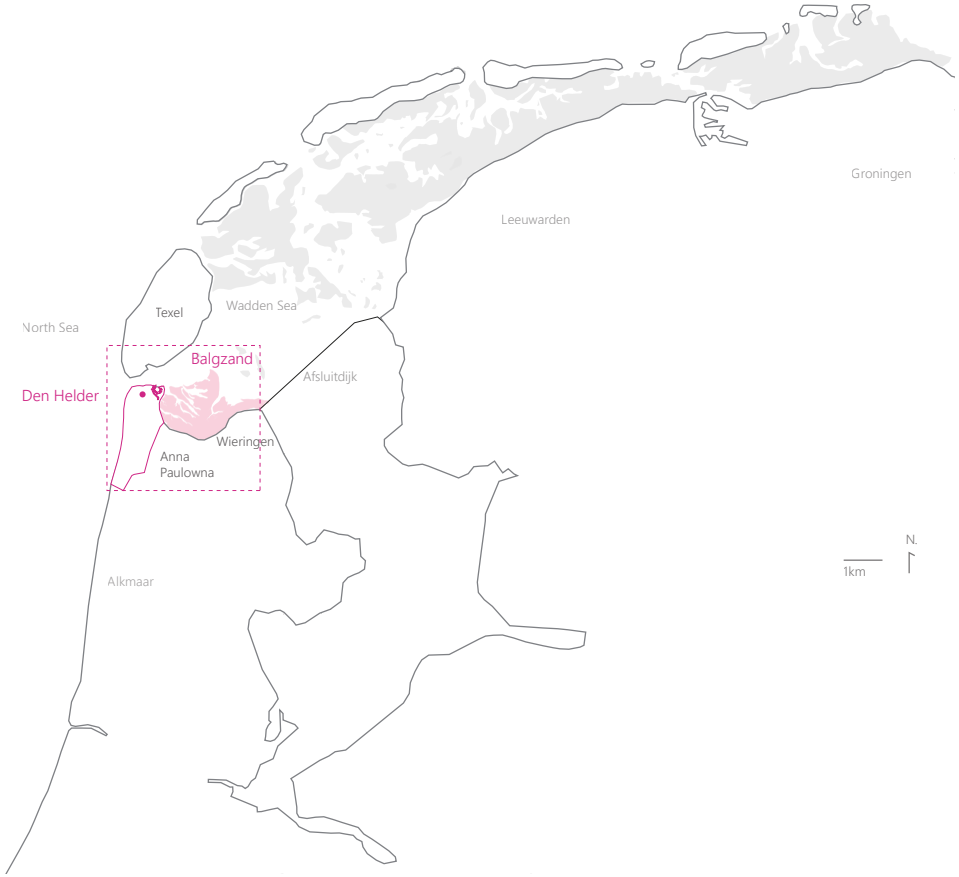
Den Helder is the city of the highest shrinking rate in the Netherlands for a decade already. It's also the Northern tip of the Dutch North Sea coast. Its strategic location for navy base and marine logistic once brought prosperity to the city, especially during post-war reconstruction phase.

Declining population growth



Declining employment rate





Dead End Situation

Economic shift and environmental change are transcalar and interdependent challenges particular for shrinking port cities.

However, socio-economy and marine ecosystem are usually rigidly blocked off and addressed by segregate parties.

NORTH SEA STORM SURGE

1916 Flood

1953 Flood

2007 Flood

2012 Flood

2053 Flood

A Recurring Natural Hazard

In 1953, a catastrophic North Sea storm surge ruined the Northwest Europe's coastal. Floods covered 9% of Dutch farmland, killed 2000 people and damaged 47300 properties. 60-years later, in 2012 December, a storm of similar magnitude hit the Netherlands, over 2800 properties were flooded. In terms of reduced damage, Dutch flood defense measures taken after 1953 can be considered a success.

However, it is certain that dramatic storm surge will happen again and again According to bathymetry and funnel shape of the North Sea, storm surge flood is a natural reoccurring event for its coastal cities. Isobaric tracks that push cyclones down to the Dutch coast occur approx. every ten years (Rijkswaterstaat, KNMI 1961). Facing unexpected threats of climate change, no defensive construction can guarantee us a sustainable homeland.

Raised by North Sea,

Sunk by North Sea

Fiction: 2053 The End of Netherlands

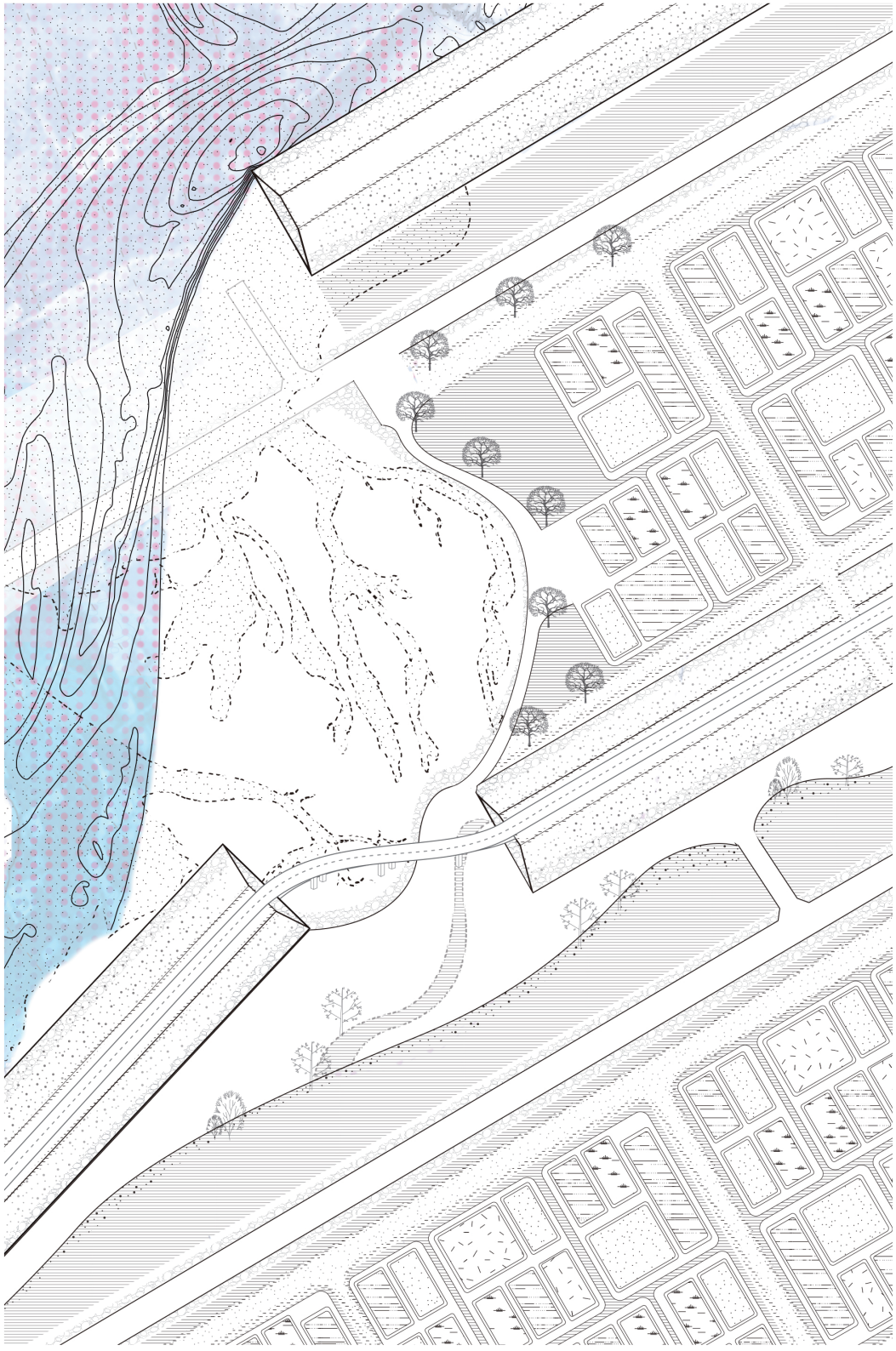
Transcripting local imaginations to qualitative scenarios

In 2053 winter, a North Sea storm surge breached the invincible Dutch dike and swallowed the Wadden Sea.

What being left is neither sea nor land, but a floodplain of marshes. At the Northern endpoint of Netherlands, it used to be Den Helder, the small maritime city that only being recalled when the Navy port and the ferry terminal to Texel island is mentioned.

During the storm, a flood invades the marine base and surrounding polders. People of Den Helder lost faith in the dike protection and port economy, seeking for steadier forces to pilot their revitalization.

They looked beyond the edge, and realized that no force is as sustainable as the sea. “What if we cooperate with the sea...”

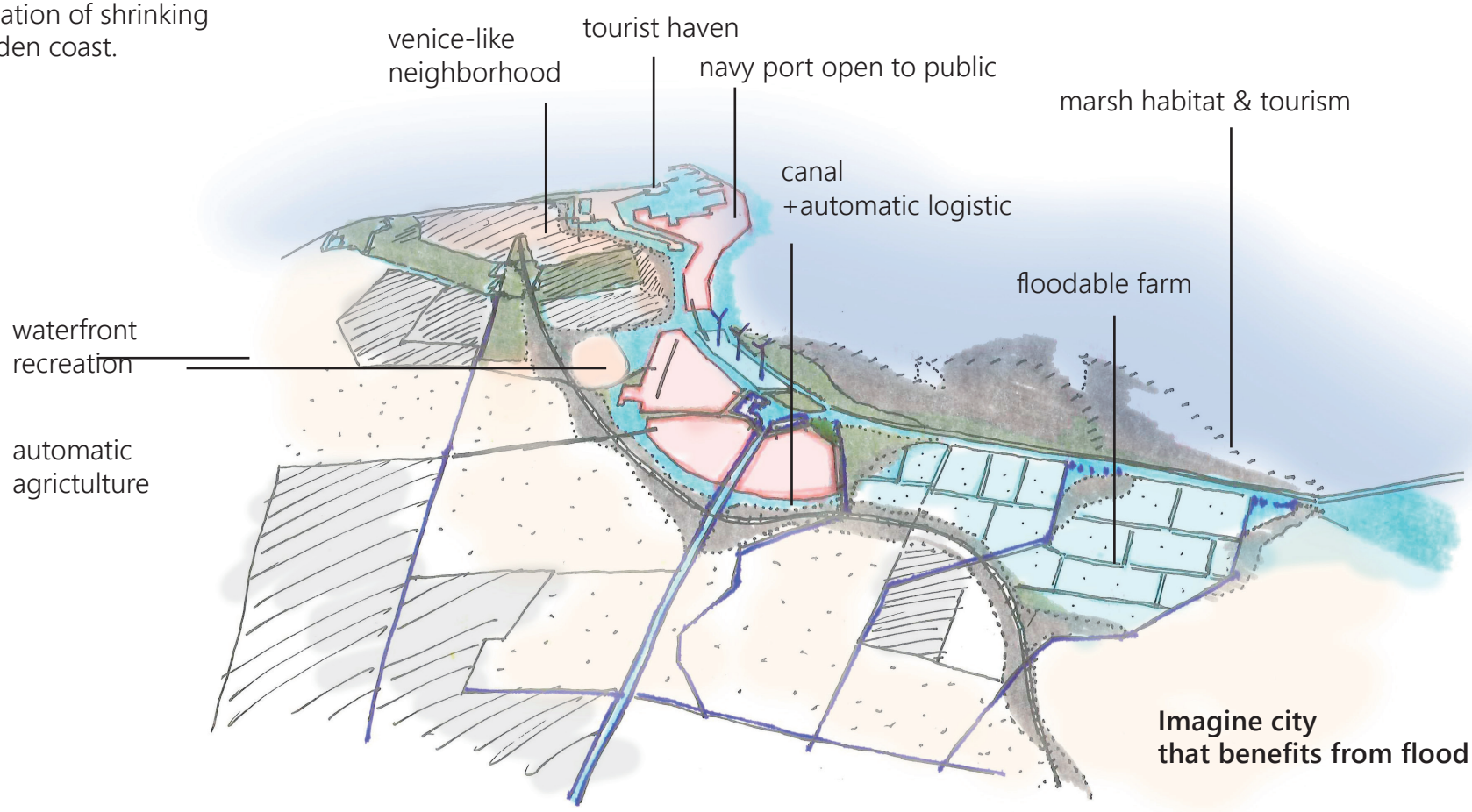


after 2053 Flood

the New Edge

Decades after, Den Helder becomes the well-known city reborned by 2053 Flood.

Some even says the dike breach is manufactured by Dutch 'Building with Nature' techiques. The new flows re-irrigates the sealed, flattened ground and triggers urban transformation of shrinking cities along Wadden coast.



" After 2053 storm, floods frequently happen in Den Helder. What are the incentives that make you willing to stay? And what would you like to make a change while rebuilding Den Helder? "

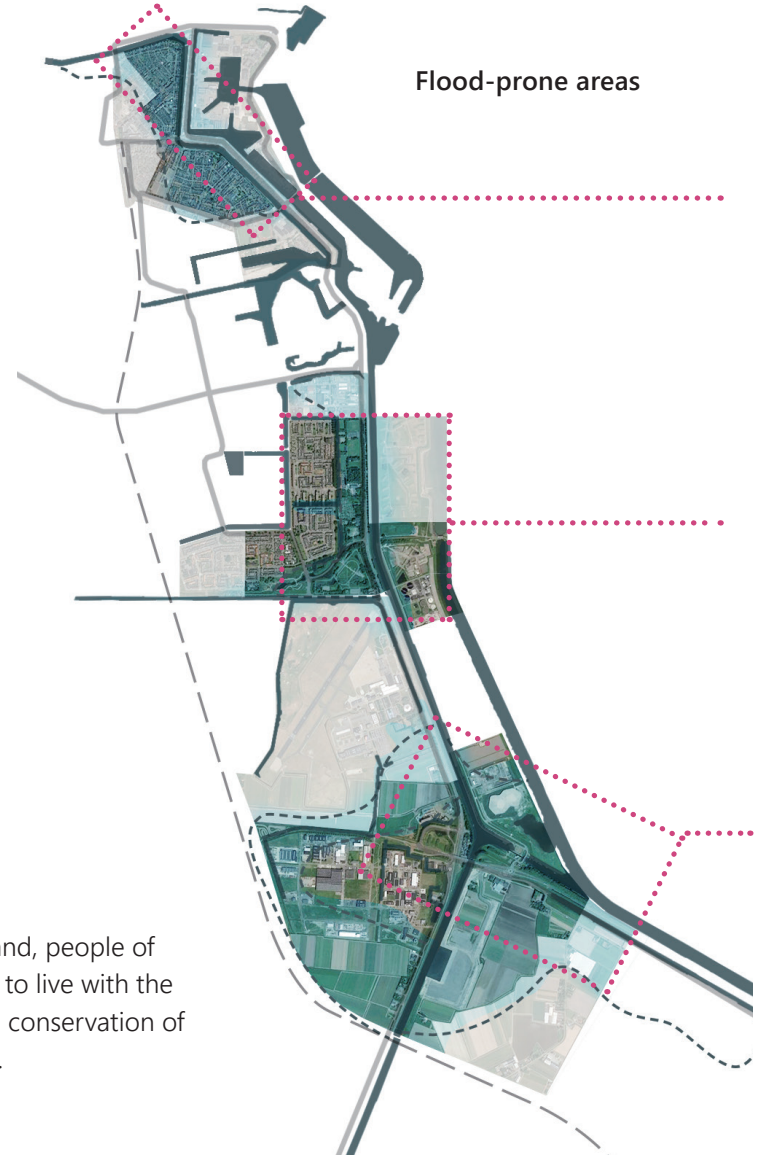
After having children, we moved from city central to the neighborhood at South station, where has **more parks, new houses and shopping center.** We won't move away soon because the children love this place. We often take them to the beach or the mud to find some mussel. If the area will be flooded in the future, I guess they will be happy to replace my car with a boat and **play with more water.** Den Helder can be the **Dutch Venice** with many canals.

My whole life has been living here with the sea so I'm not leaving even if it is flooded. The shipyard we work for is a bit outdated anyway. Maybe with the **compensation**, we can transform it into a bar and the boats can be **rented to tourists.** We have a very beautiful coast with many animals. With the sea and our boats, we can always make a living even being flooded.

We are colleague at a logistic company delivering goods between Den Helder and Texel. We have network on both land and sea, so as long as the flood **doesn't interrupt both connections**, the company can survive. Flood will cause much bigger trouble to our warehouse. But I guess the **low-laying farmlands surrounding** Kooypunt will be flooded first. Or let the **airport** flooded, so we can have some quiet moments.

People of Den Helder

On the new edge of sea and land, people of Den Helder find their own way to live with the dynamic sea and benefits from conservation of Wadden Sea natural resources.



Flood-prone areas

Proposal

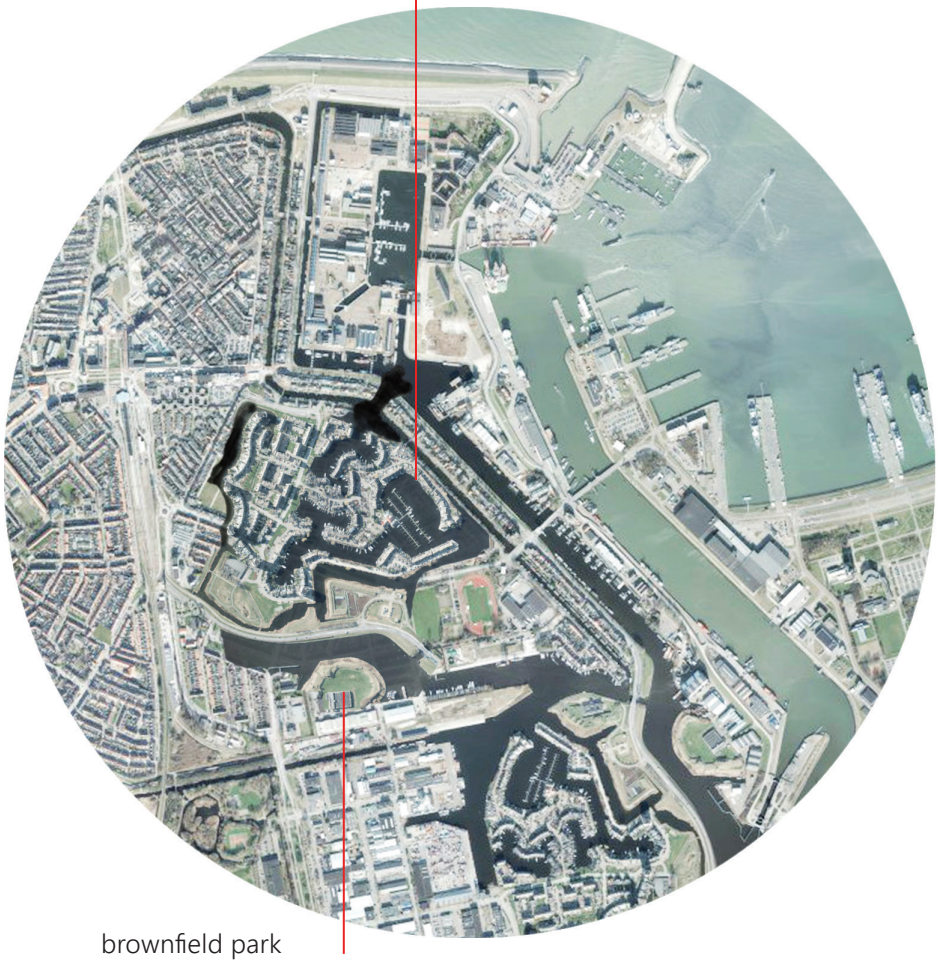
- Attract tourists by transforming port and preserving marshland

- More waterfront neighborhood
- Develop waterways as Venice
- Coastal recreation

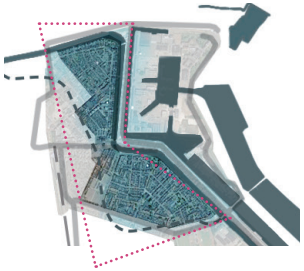
- Alternative transport
- Airport noise control

Interpretations

Port-front residential area before flood



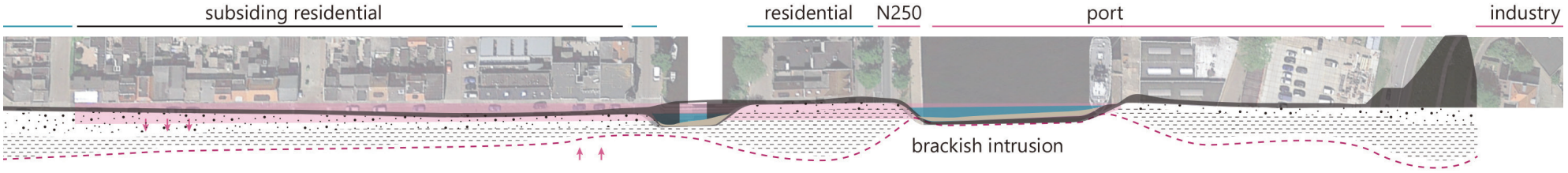
Lagoon city after 2053



- Risk:
  subsidence
  oldest housing district with low quality houses

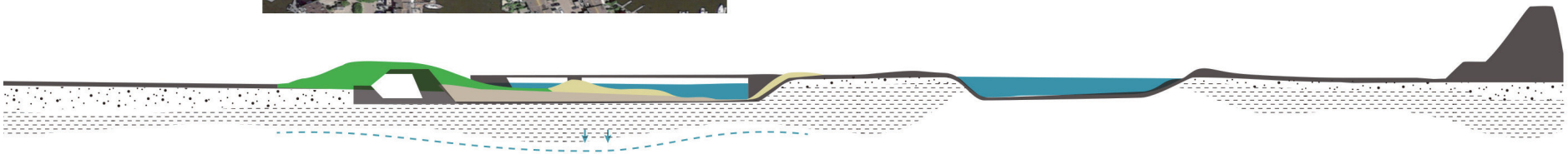
- Land-use:
  city central mix-used, residential
  adjoins to port

Situation before flood



Proposed section for reconstruction

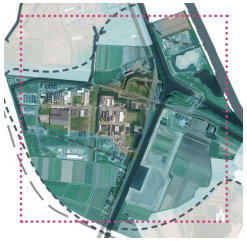
Reference: lagoon neighborhood in Den Helder



Interpretations

Maritime manufacture and logistic hubs before flood

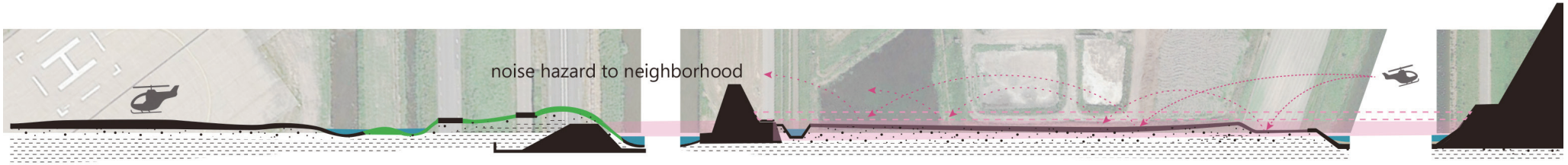
Lagoon business park after 2053 flood



- Risk:
  Outlet joint of sea current, lake and polder drainage

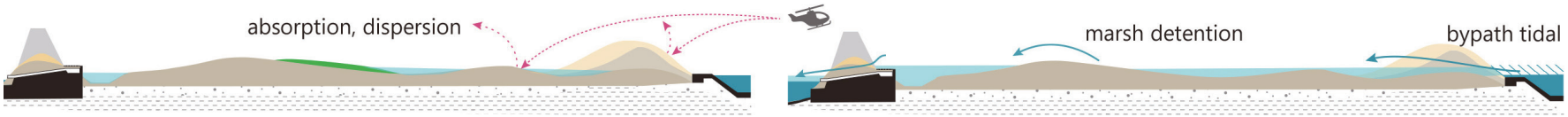
- Land-use:
  residential district
  maritime industry, vacant industrial land
  airport, A9 motorway

Situation before flood



reference: Buitenschot Land Art Park beside Schipol Airport

Proposed section for reconstruction



Case reference

TEXEL DIKE MAINTENANCE

A Building with Nature method

Prins Hendrik dike in Texel is reinforced with a soft, natural barrier of 30 million cubic metres of sand on the seaside of the dike. This 'natural' method ensures that the flood defense can keep up to rising flood threat, and preserve agricultural property and Wadden tidal habitat.

Advantage:
1. Reduce sediments at port.
   Less dredging work is needed.
2. Conserve Wadden Sea tidal ecosystem
3. Stabilize dike foreshore.
   Reduce frequency, costly dike maintenance.

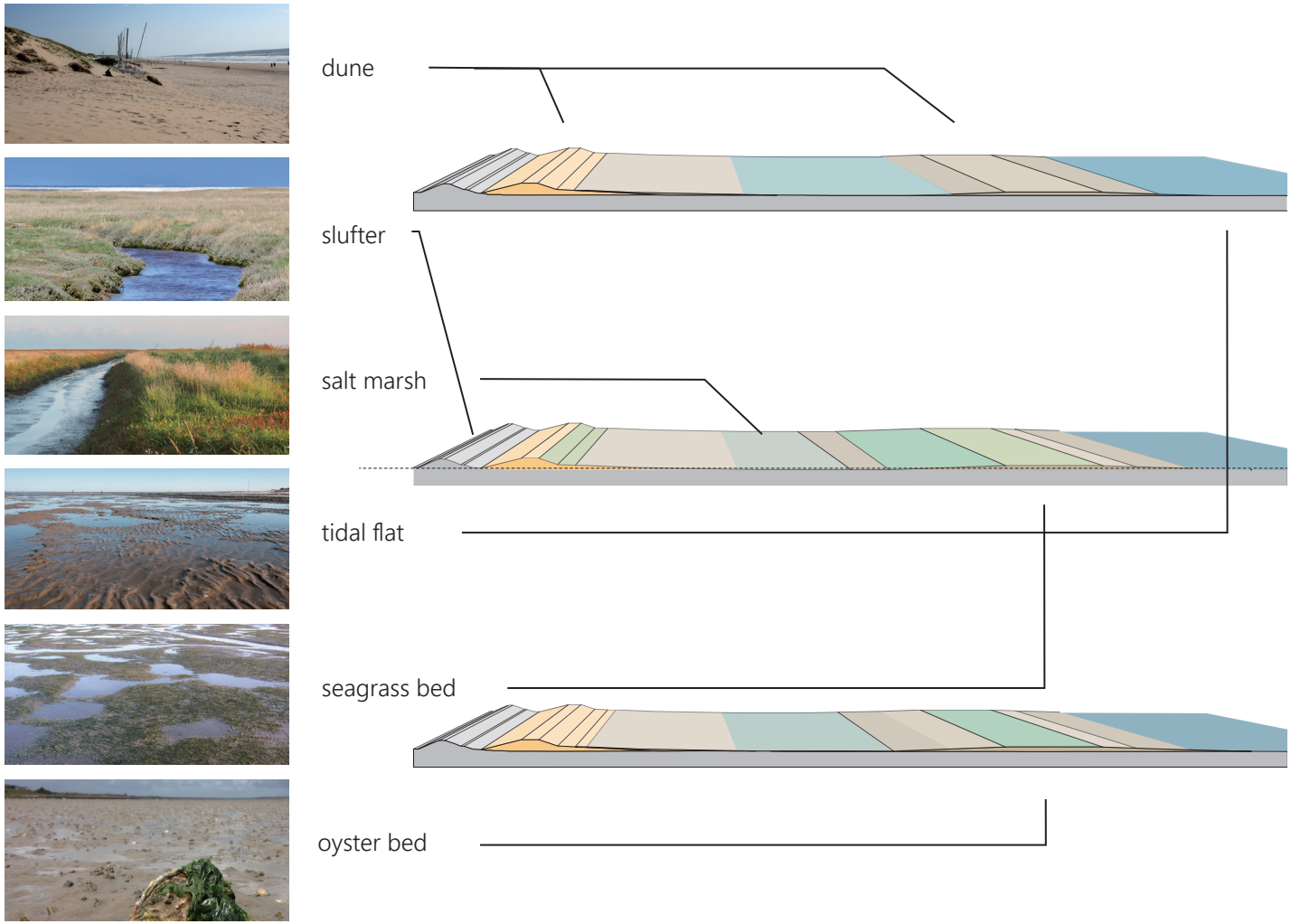


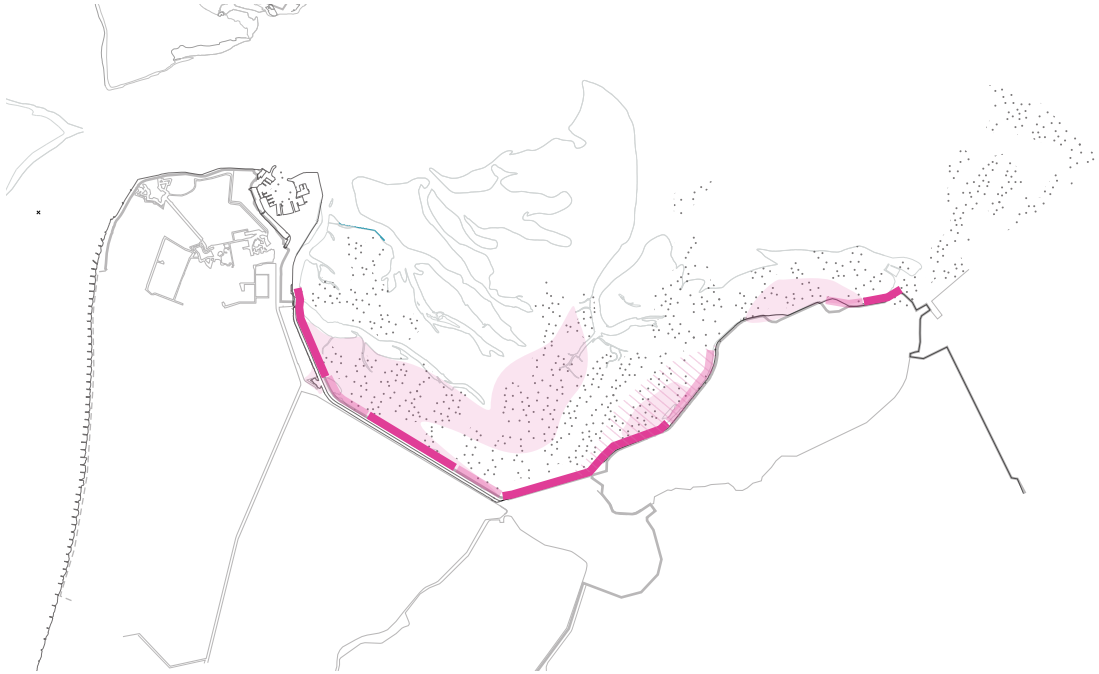
Fig. Transect of functional habitats.

Ecosystem services evaluation

Ecosystem services (coastal)	Provision		Regulation				Supporting		Culture			
	biodiversity nourishment	raw material	wave attenuation	sediment trapping	erosion control	water qualification	nutrient recovery	primary productivity	recreation	accessibility	cost-benefit (maintenance)	
Sandy dune, beach	■	■	■■■	■■	■■		■	■	■■■	■■■	■■	
Tidal flats	■■■	■■■	■	■	■	■	■■■	■■	■	■	■■	
Vegetated salt marsh	■■	■■	■■	■■■	■■■	■■■	■■■	■■■	■■	■■	■■	
Seagrass	■■■	■■■	■	■■	■■	■■■	■■■	■■■	■	■	■	■
Oyster bed	■■	■■■	■■	■■■	■■■	■■	■■	■■■	■	■	■	

Fig. Quantified ecosystem services of different tidal habitats. Flood regulation and support for coastal light industries are highlighted.

Potential for Den Helder



Presence of a 1000m minimum wide salt-marsh zone would result in stable water depth in front of the dike. If it could keep pace with the rising sea level, only modest dike reinforcements would be needed in 2050. If without, all dikes along the Wadden Sea need to be heightened by up to 0.5 m.

Fig. potential area for marsh nourish

- potential habitat for salt marsh
- existing salt marsh
- potential habitat for seagrass
- previous oyster bed location
- sedimentation issue

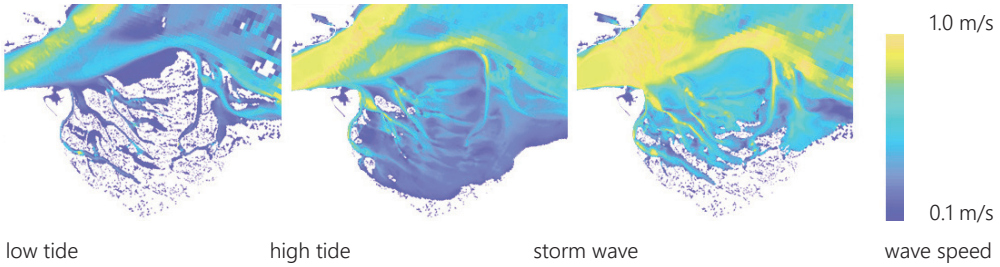
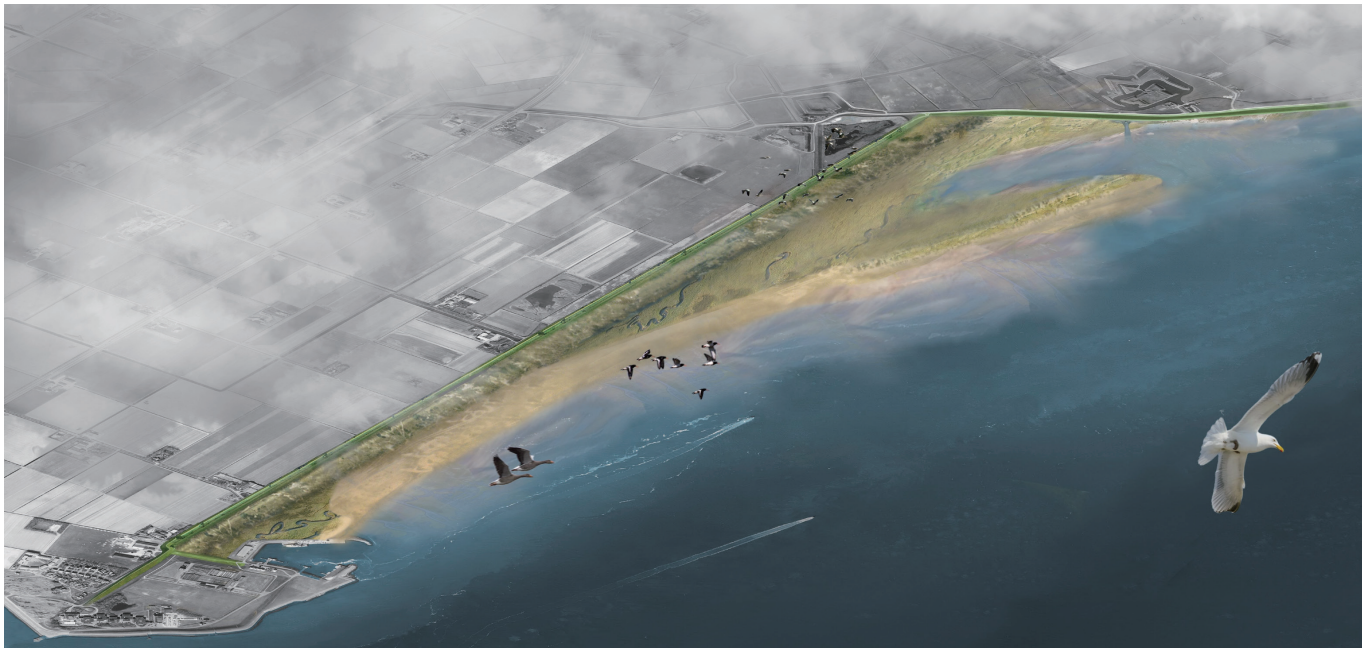


Fig. simulation of wave speed reduction by salt marsh.
(credit: RHDHV hydrologic report)



Observations from fictional exploration

An interesting finding from residents' stories is their ability, confidence and skills to live with water. On the other hand, however, rather low risk awareness is observed. Over-trust upon national flood defense is a major reason for awareness gap.

Perhaps the social affiliation to water can be regarded as a gifted strength of port cities to face climate change. But the "awareness gap" may become the biggest barrier. Thus, a critical question is how to increase the awareness of environmental risks, to engage more property owners and businesses in adaptive transformation?

Impact: Threats

Projective flood risk

Business as Usual+environmental change

Land use

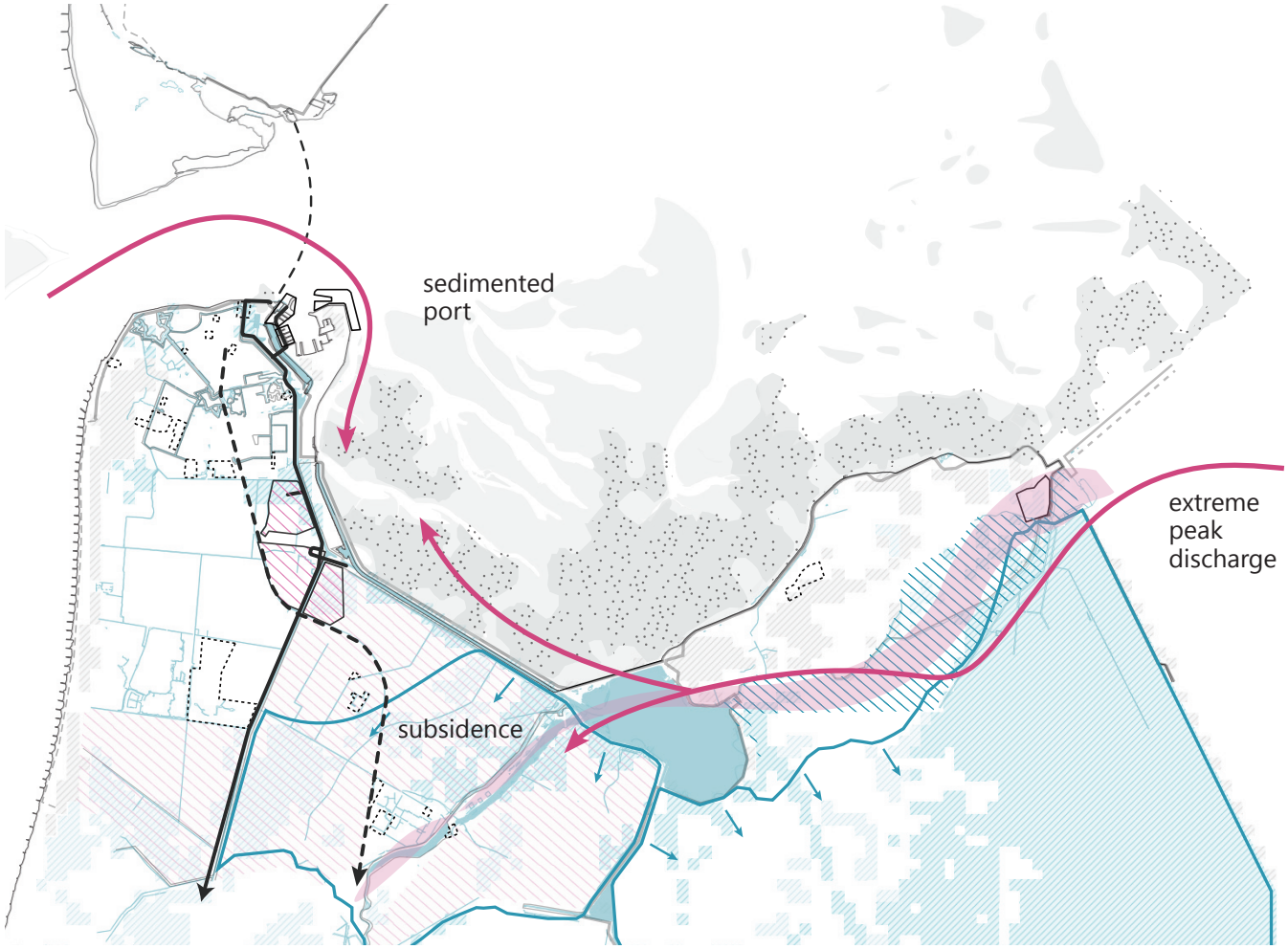
- expansion for offshore business
- densify for residential
- shrinking bulb-growing field due to seepage, soil compact
- room for river project

Transport

- loading on highway to Amsterdam port increase
- more frequent connection by rail
- more frequent connection to Texel

Risk

- higher vulnerabililty to flood
- high flood chance inflow
- sedimenation problem



What if ...

A catastrophic flood hits again one day ...

DESIGN FOR FLOODING

Perhaps the *shrinking* trend of a city is a push to the crossroad between breakdown and breakthrough. And a flood chaos could be an opportunity to "leap to a new civilization"

Since climate change is such unpredictable and coastal substratum is of high dynamics, perhaps what nature-based design should explore is how to leverage on upcoming floods, instead of seeking for the most robust defense. Based on the history that storm surge is a recurring natural event, flooding can also be designed as transforming point to regions if it is anticipated.

Local imaginations

By immersing readers, stakeholders in a fictional narrative, local imaginations of possible future development are encouraged. The objective is to raise awareness that provokes participation in urban transformation. Thus, visions collected from on-site interviews are important qualitative principles of this project.

Design Fiction Approach

To explore a site specific nature-based development vision, this project is driven by Design Fiction and Scenario approaches. The narratology expresses coastal uncertainty with provocative fictional setting.

A projective storyline based on trajectory of climate change risk is first showcased to interviewees. Then through semi-structured interview, local perceptions and imaginations on coexisted development of environment and socio-economy are provoked, collected, and further collaged into prospective scenarios. How to proceed from reality to this vision draws the design objectives. Possible spatial interventions toward this desirable future are portrayed in reference to state-of-the-art Building with Nature projects in Netherlands. This strengthen the linkage between design output, social content and cultural ecosystem services.

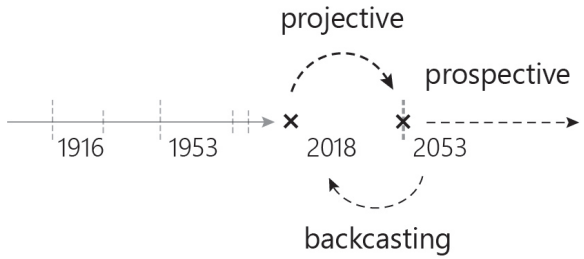


Fig. The research-by-design framework is structured through design fiction approach as a loop.

Experimental setting

A catastrophic flood event is fabricated at 2053 (in memory of 1953 flood). The story setting is distinctly designed according to GIS stimulation. Yet, it is portrayed with provocative image to stimulate local imagination of living with flood, and to challenge the status quo with innovative interventions.

2053 Flood event setting

Simulation: 0.1% recurrence rate flood event
- North Sea storm surge
- Amstelmeer extreme discharge
- low atmospheric pressure

Relevant trends:
- rising sea level
- canal silt
- urban low infiltration
- land subsidence

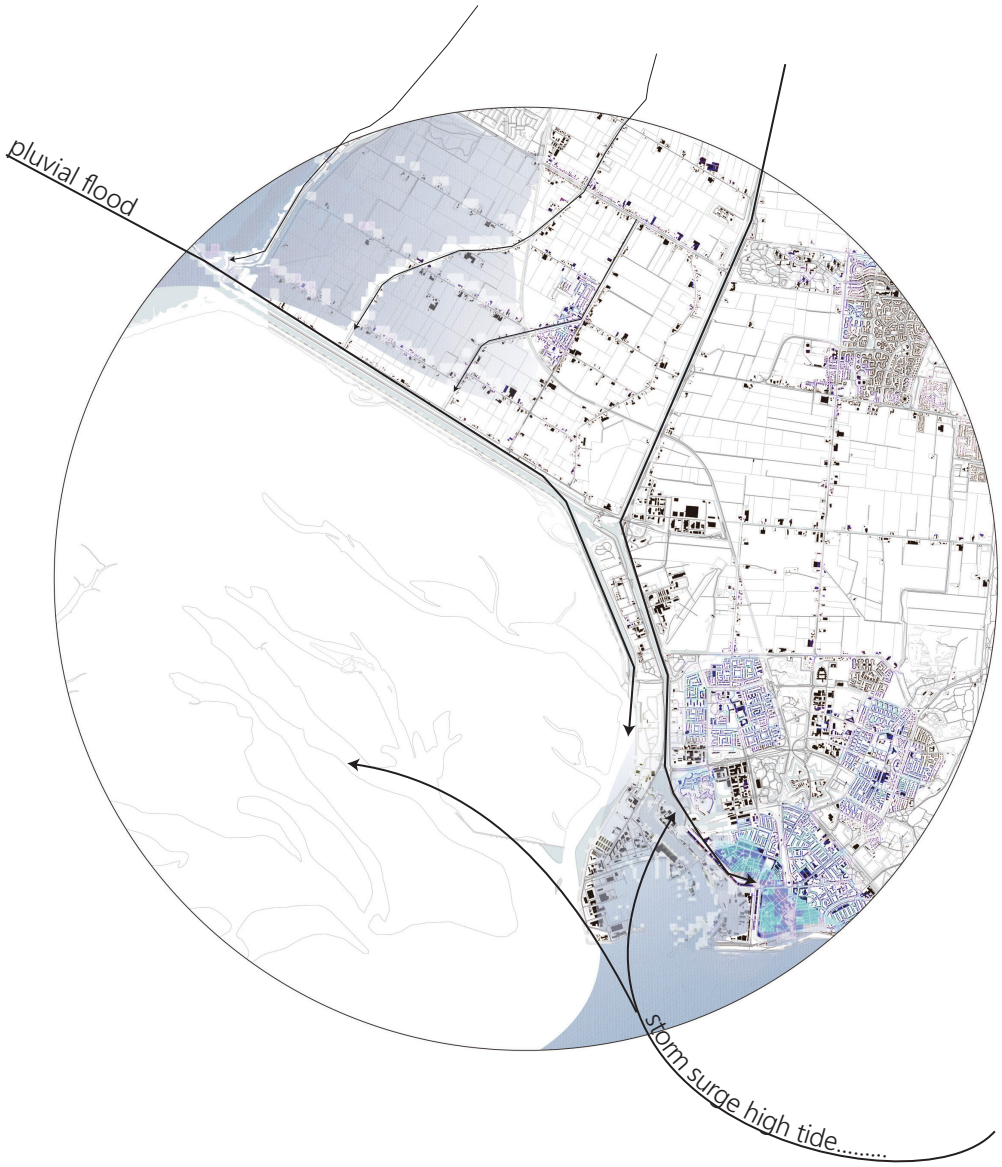


Fig. Illustrated 2053 flood scene based on GIS simulation. Data retrieve:
Klimaateffectatlas. http://www.klimaateffectatlas.nl/nl/
PDOK. https://boerenbunder.nl/page/welcome?next=%2F

Participatory exploration

CO-DESIGN WORKSHOP

Facilitate local imaginations on
"prospective qualities of living with nature"

in order to
"identify critical natural services and values that can promote nature-based solutions to strengthen Den Helder's adaptability to risk"

Semi-Structured Interview

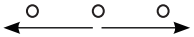
The interview emphasizes that residents, as key stakeholders, are able to provide first-hand descriptions on environmental impacts and trends through "stories" (Kok et al., 2011). On the next page shows the key guiding questions. Urban designers are experts of the innovation process and to leverage scientific information, whereas locals are experts of their own experiences. This project adopts the qualitative research and GIS simulation to bridge local imagination and scientific data into urban planning.

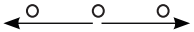
Geodesign and scenarios

Geodesign aims to tightly couple the creation of design proposals with impact simulations informed by geographic contexts." (Steinitz. C 2012). Current GIS application in adaptation design often built up through two process: the layering observations of integrated geodatabase (ecology, geology, social demography...); and the visualized simulation or scenario upon analyzed outcomes.

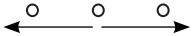
Questionnaire:

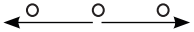
' To revive Den Helder from shrinking, how do you measure the effectiveness of following development objectives? And are you willing to invest or be involved in the process? '

promising  not promising

interested  not interested

' To recover Den Helder from flood damage, how do you measure the effectiveness of following development objectives? And are you willing to invest or be involved in the process? '

promising  not promising

interested  not interested

Interview:

' After 2053 storm, floods frequently happen in Den Helder.
What are the incentives that make you willing to stay?
And what would you like to change about while rebuilding Den Helder? '

Indicators

Pressure: trends of environmental and socio-economic changes
State: results from spatial analysis
Impact: risk; limitations; potentials

Bussiness as usual: policy, official plans

Prospective scenario:

The preferred options and first-hand stories shared by locals are documented and transcripted into the fiction.

Projective scenario:

A projection of where current policies coupled with market trends are likely to lead. The municipality of Den Helder has set several agendas for port and urban revitalization.

Design Fiction

2053 Storm Surge

Voting cards:

The 14 objectives are retrieved from official agendas of three major public parties. Each objective card is illustrated with relevant image of Wadden Sea region, and is annotated with its dependency on economic support and ecosystem services.

Referenced official agendas:

Gemeente Den Helder
*Strategische visie 2020
*Ontwerp Structuurvisie 2025

Port of Den Helder, Koninklijke Marine
*Structuurvisie Den Helder 2025

Waddenzee
*Programma Naar een Rijke Waddenzee
*Projectteam Gebiedsagenda Wadden 2050

Port expansion

Offshore industry

Maritime logistic

Marine industry

Mobility

Maritime R&D

Agricultural upgrade

Port publicization

Urban renewal

Renewable energy

Flood defense

Climate mitigation

Tourism

Wadden Sea conservation

' To revive Den Helder, how do you measure the effectiveness of following development objectives? And are you willing to invest or be involved in the process? '

promising ⟷ not promising

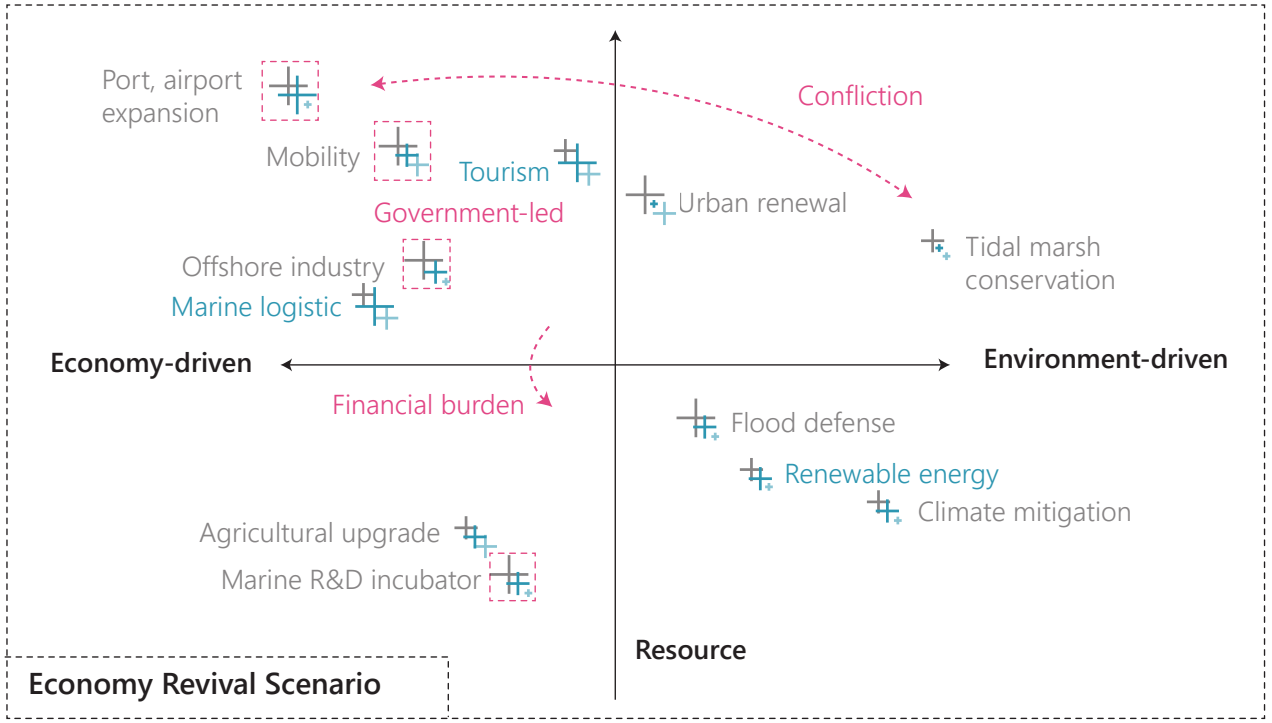
interested ⟷ not interested

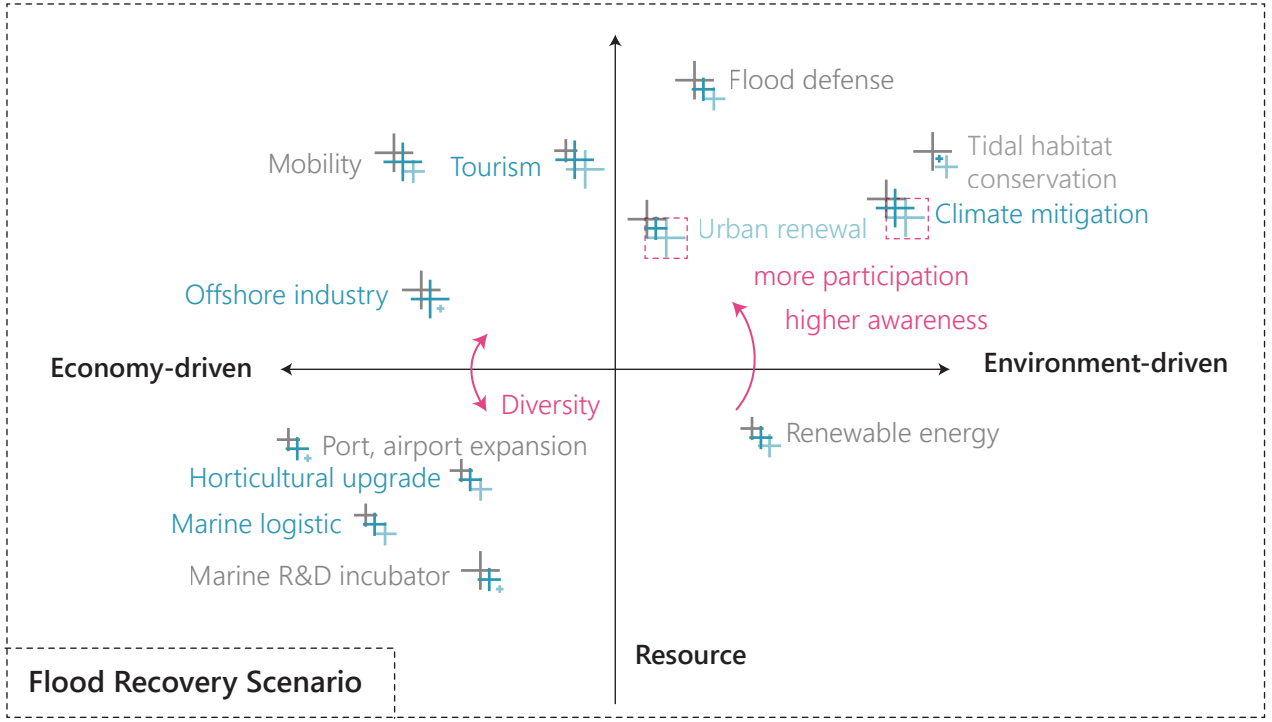
Economic revival objective:

- Government-led economic development
- Port development dominated

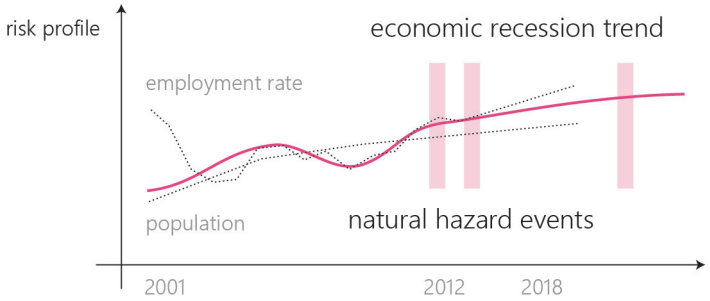
Natural hazard recovery objective:

- Incline to environmental-driven options
- More balanced, diversed development
- Higher willingness to participate



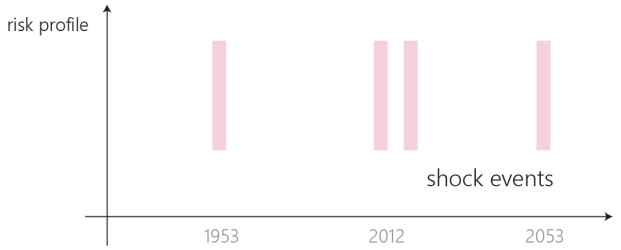


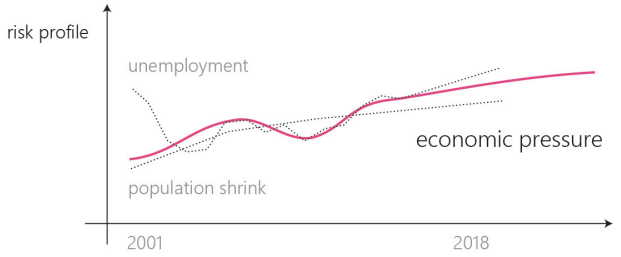
Den Helder in Risk



Coastal risk management:

short-term shocks + long-term pressure



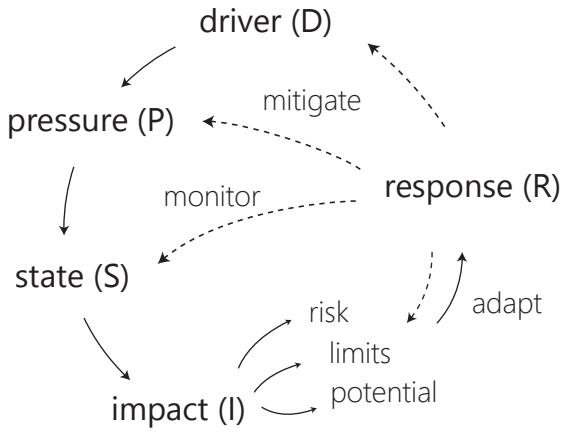


the need to
Cope With Two Faces Of Sea

Approach: DPSIR Framework

DPSIR is a ICZM decision-support framework proposed by European Environment Agency (EEA, 2007). It examines interactions between society and the environment through the cycle of driving forces (D), pressures (P), states (S), impacts (I) and responses (R).

The framework regards risks as pressure driving changes on current state to evaluate possible environmental and societal responses to these changes (Smeets and Weterings, 1999). It is often applied to **analyze human-environmental interactions and impacts under pressure from climate change.**



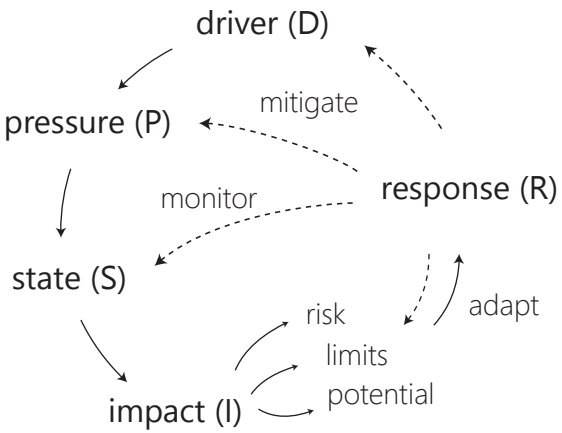
Integrated Coastal Zone Management

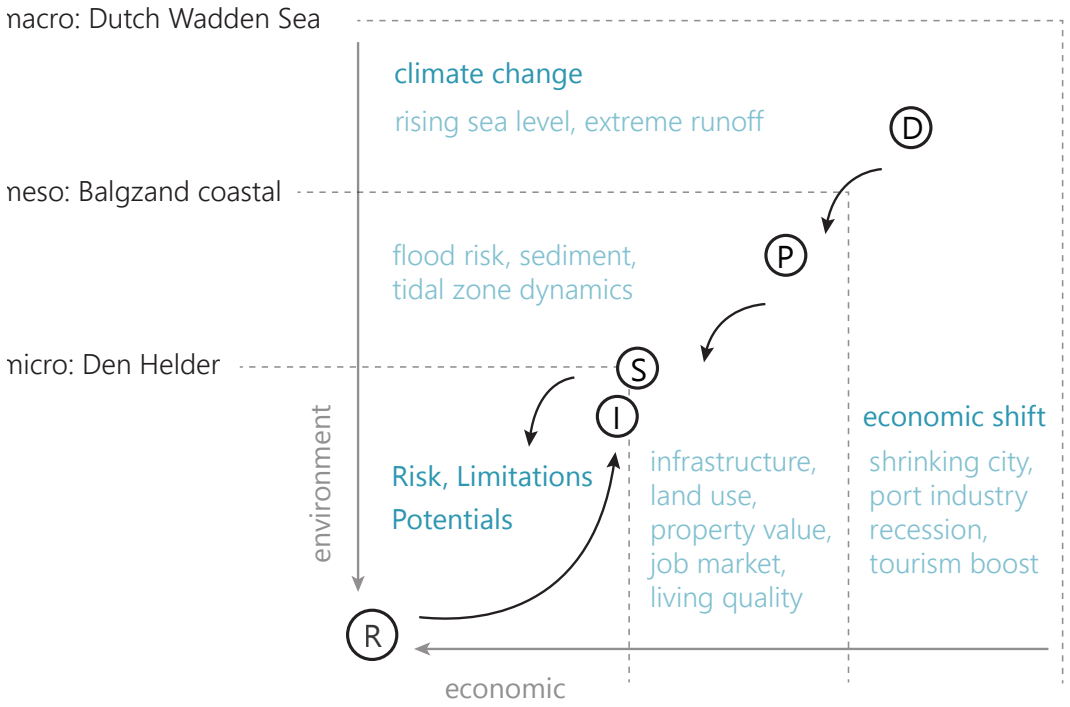
"ICZM seeks, over long-term, to balance environmental, economic, social, cultural and recreational objectives, all within the limits set by natural dynamics."

-- EU. (2013). Maritime Spatial Planning and Integrated Coastal Management.

Scope of Risk

DPSIR +
TRANSCALAR APPROACH





EXPLORATORY HYPOTHESIS

NBS is propagated to facilitate transformation that turn environmental and social challenges into innovation opportunities (EC 2015), by managing natural capital as a source for sustainable societal development.

This project focuses on exploring the NBS performance in adaptative transformation for shrinking port cities. The adopted hypothesis of this project is that -

*Adaptability of shrinking port cities to coastal risks depends **reciprocal collaboration** between economy and ecosystem.*

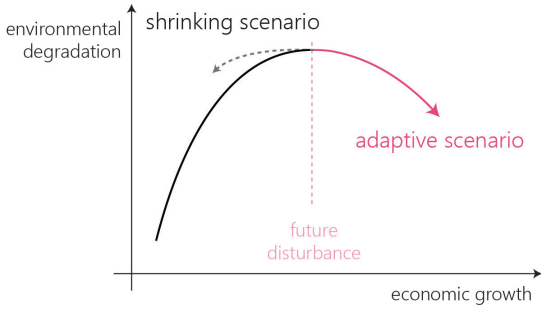
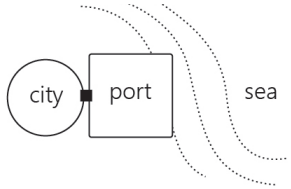
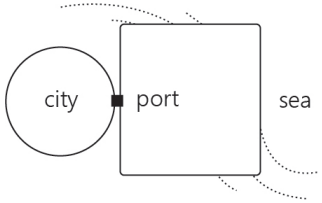


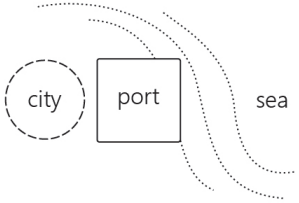
Fig. Concept diagram of project hypothesis modified from EKC. (by author)



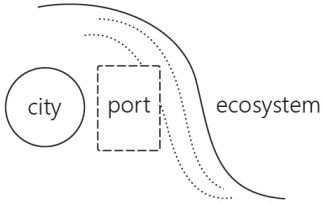
Port generates urbanization



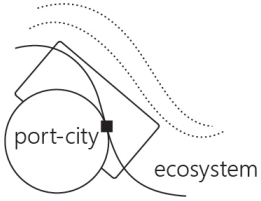
Port expansion boost city growth



Port recession causes urban shrinkage



Wadden sea protection limits port function



New Wadden city: ecosystem coexistence

Methodology Framework

INTERDISCIPLINARY APPROACH

The general theoretical background is based on *Landscape Urbanism* that regards cities as urbanizing landscape where ***transcalar, process-oriented and imageability*** should be emphasized in design process. To reinforce transferability in coastal planning, the theory is comprised into ***Driver-Pressure-State-Impact-Response (DPSIR)*** framework, which is often applied in ***Integrated Coastal Zone Management (ICZM)*** to adapt both environmental and socio-economic changes.

Research objective

RESEARCH QUESTIONS

The thesis adopts a "research by design" method, attempting to respond the question:

" How to adapt shrinking port cities to economic and environmental uncertainties with nature-based solutions? "

Sub-questions

The objective to explore adaptive pathway with nature inclusive design is unfolded with following three main sub-questions:

◦ How to facilitate reciprocal collaboration between ecosystem and economy through urban design?

◦ How to employ integrated coastal zone management in coastal urban design?

◦ How to employ Nature-Based Solutions to strengthen adaptability of shrinking Den Helder to flood risks?

Respondence

Sub-questions

1. Assess **risk impacts** on port city from both environmental change and economic shift.

◦ DPSIR:
an analysis framework to integrate coastal zone management with urban design.

How to employ integrated coastal zone management in coastal urban design?

- How to integrate risk management in transcalar spatial design?

2. Explore extreme scenario to collect local imaginations and BwN **references**.

◦ Design Fiction:
transcript computer-aid projective stimulation to proactive narrative

◦ Semi-structured interviews and workshops:
collect local qualitative narratives for prospective scenario

How to employ integrated coastal zone management in coastal urban design?

- How to comprise local spatial quality with coastal engineering?

How to employ Nature-Based Solutions to strengthen adaptability of shrinking Den Helder to flood risks?

- What are the values of Nature-Based Solutions that can strengthen local adaptability to flood risk?

3. **Backcasting design** and reflection

◦ Nature-based urban development strategy

◦ Transcalar spatial design:
regional development (infrastructure, landuse) and local transformation

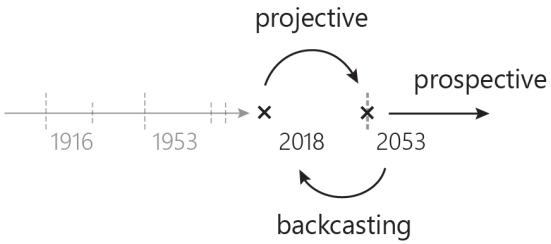
◦ Risk management:
propose scheme to share risk, responsibility and benefits

How to employ Nature-Based Solutions to strengthen adaptability of shrinking Den Helder to flood risks?

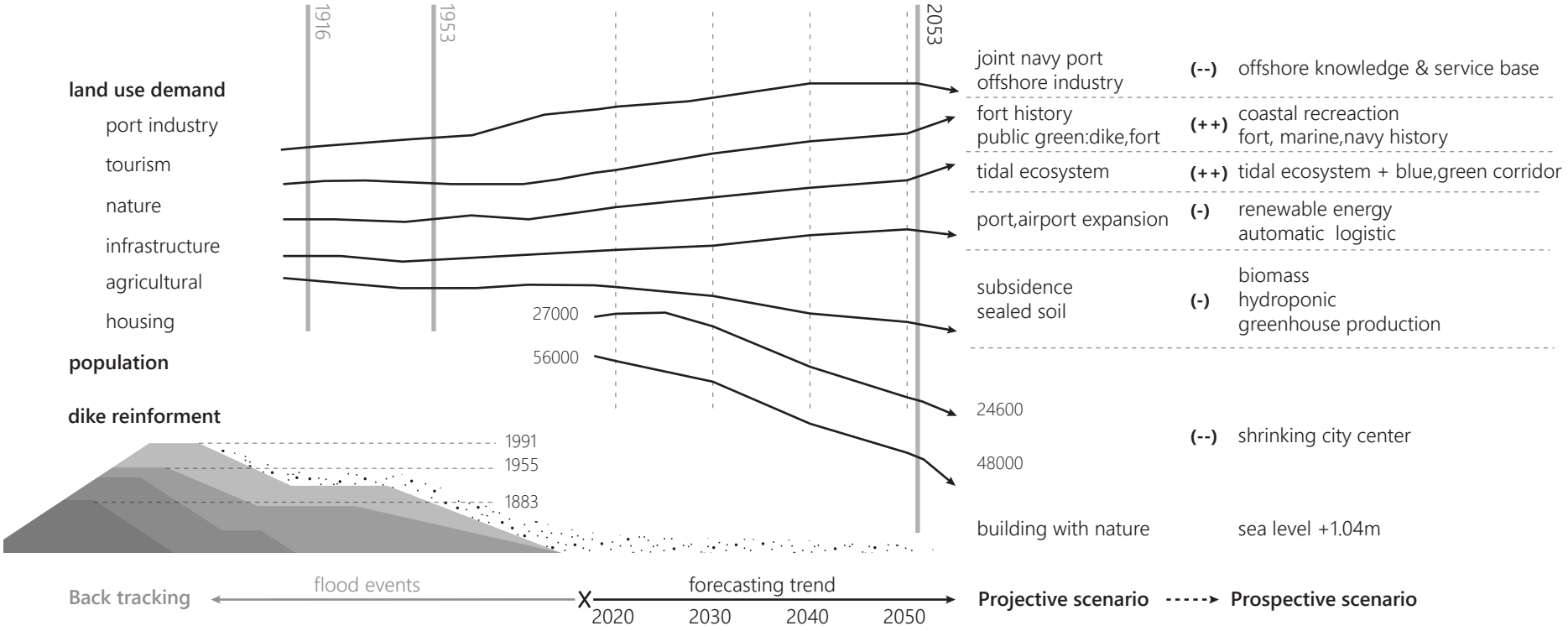
- How to conserve ecosystem services and natural evolution in a shrinking economy?
- How to support Den Helder's long-term development with Wadden Sea ecosystem services?

Back to reality:

Den Helder Shrinks



Economic recession trend:

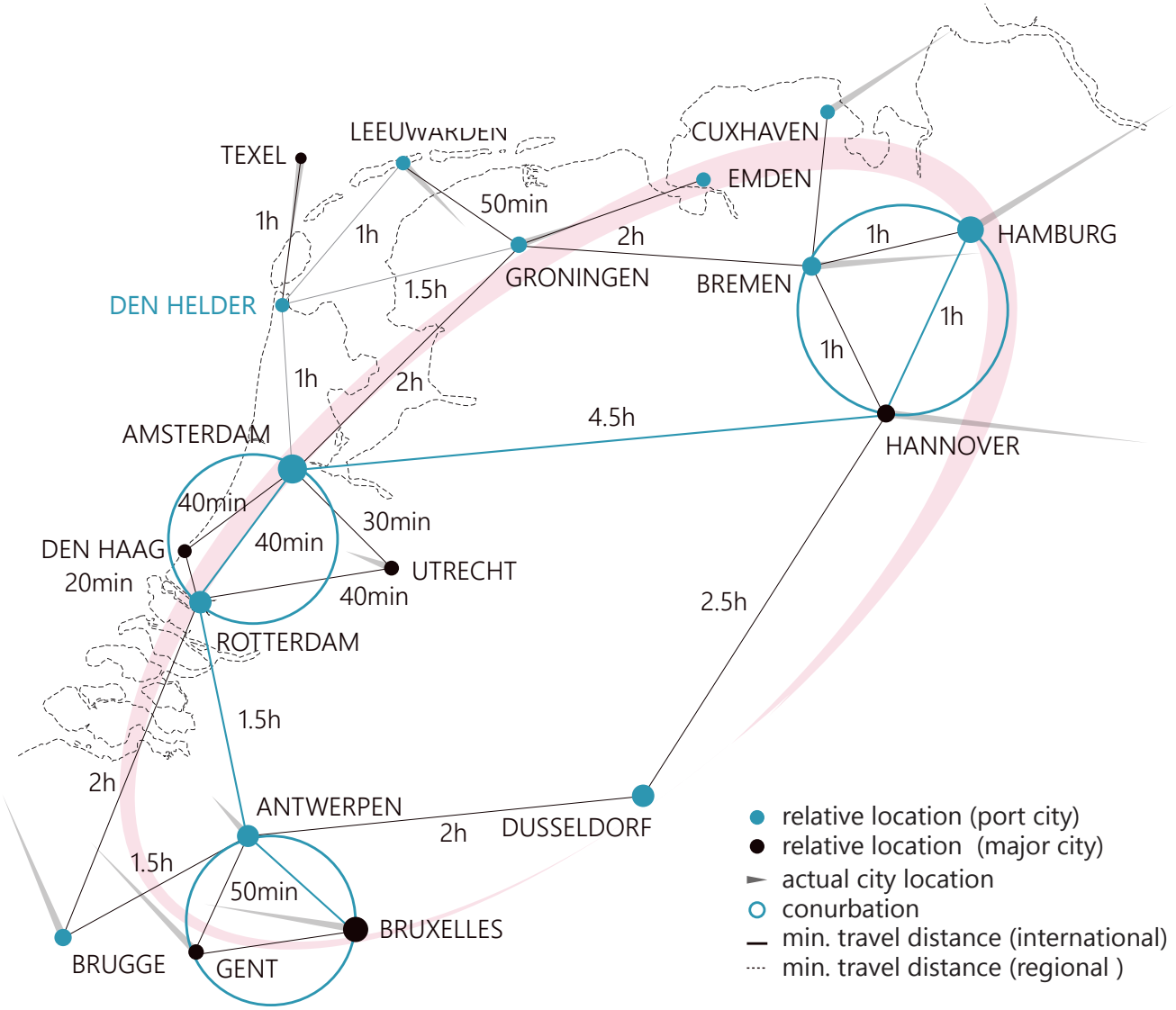


gnose bevolking, huishoudens (2017). Sector Onderzoek en Informatie, Provincie Noord-Holland.

Pressure: Economic shift

From Logistic Hub To Marginalization

Fig. Distorted relative location of Den Helder to other cities, based on travel time.



Impact: Limitations

Constrainted Infrastructural Capacity

Limitations

- Joint touristic and port industrial traffic flow causes frequent congestion on A205.
- 8m high sea dike blocks accessibility to waterfront recreation.
- Maritime port too shallow and small for offshore windfarm construction ships

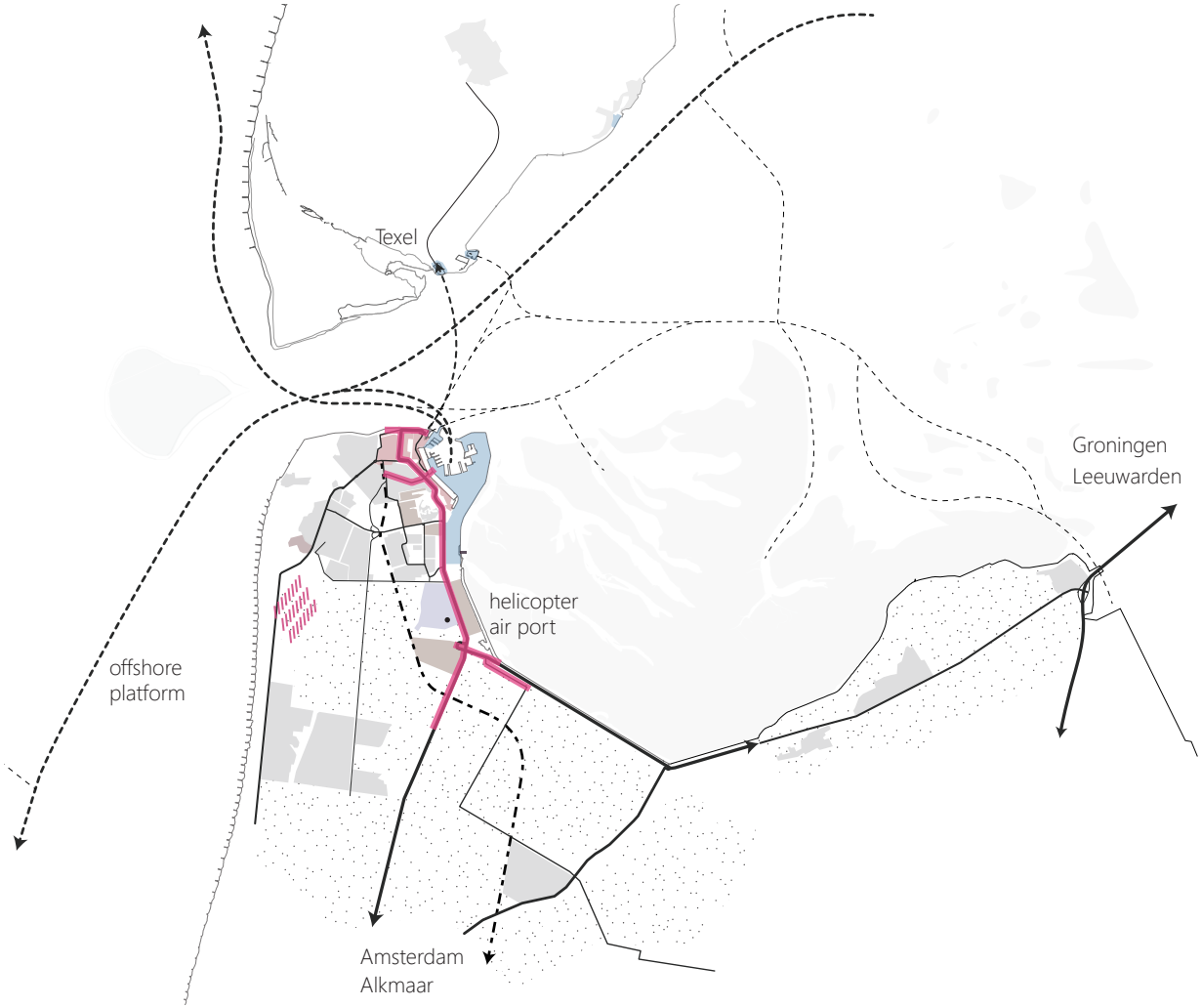


Fig. Infrastructural limitations to shifting economic activities.

Backcasting

LESSONS TAKEN FROM FLOOD

Local perception of natural values

Cost-efficiency:
- multi-functions
- supported by natural resources

Inclusiveness:
- more parties can be invloved
- lower barrier for bottom-up participation

Sustainability:
- risk awareness
- support diverse economic activities
- preferable living quality

Opportunities to apply NBS

Common visions against shrinking:

- Attract population...
- Increase job opportunities...
- Long-term development...

Proposed NBS principles for coastal cities to adapt shrinkage

- by optimizing coexistence with nature in living quality
- by promoting diverse ES productions and network
- by rising awareness, involving more parties and optimizing cost-efficiency in risk management

Shrinking cities

Definition

" A densely populated urban area with a minimum population of 10.000 residents that has faced population losses in large parts for more than two years and is undergoing economic transformations with some symptoms of a structural drop in shrinkage " (Hospers, 2010).

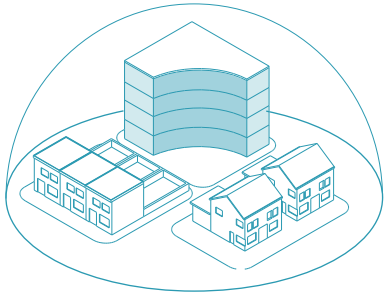
Main pushing forces including:
low employment rate, low accessibility, poor public facilities, unpleasant quality of the housing stocks and living environment.

Although it is usually being unfolded with economic angle, what the *hypothesis of this project propagates is to* ***address this structural phenomenon through both socio and environmental perspectives.***

Hoekstra I., Mulkens J.(2014). City shrinkage: Renewing the casco approach for shrinking cities in the Netherlands. Wageningen University.

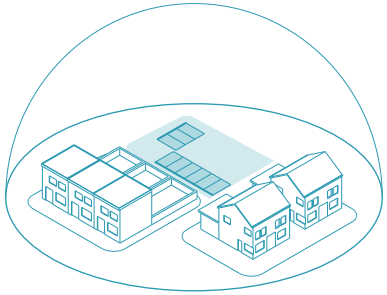
OPPOSING

Ignore shrinking trend. **Upscale existing sectors** with new development to create attractions and jobs.
ex. Construct social housing, new business park.



GUIDING

Adjust to shrinking trend. **Transit, re-scale landuse programs** to better resource efficiency.
ex. Reuse vacant warehouses for smaller business units.



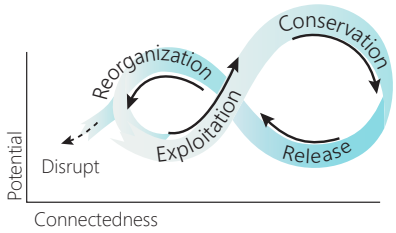
UTILIZING

Follow shrinking trend. **Transform** current landuse programs to **relieve pressure on** environment.
ex. Transform brownfield to tourist spot.

Synthesis

ADAPTIVE CYCLE OF NATURE

To align with such natural adaptive cycle, perhaps the *shrinking* of a city should also be addressed as nature-based succession. That is, the strategies for shrinking cities shall **follow a systematic process of conserve - release - reorganization**

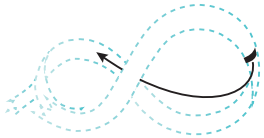


Status of shrinking Den Helder

Common strategies for shrinking cities in Netherlands

OPPOSING

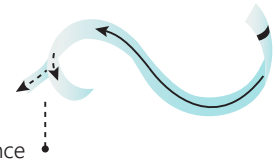
GUIDING



UTILIZING

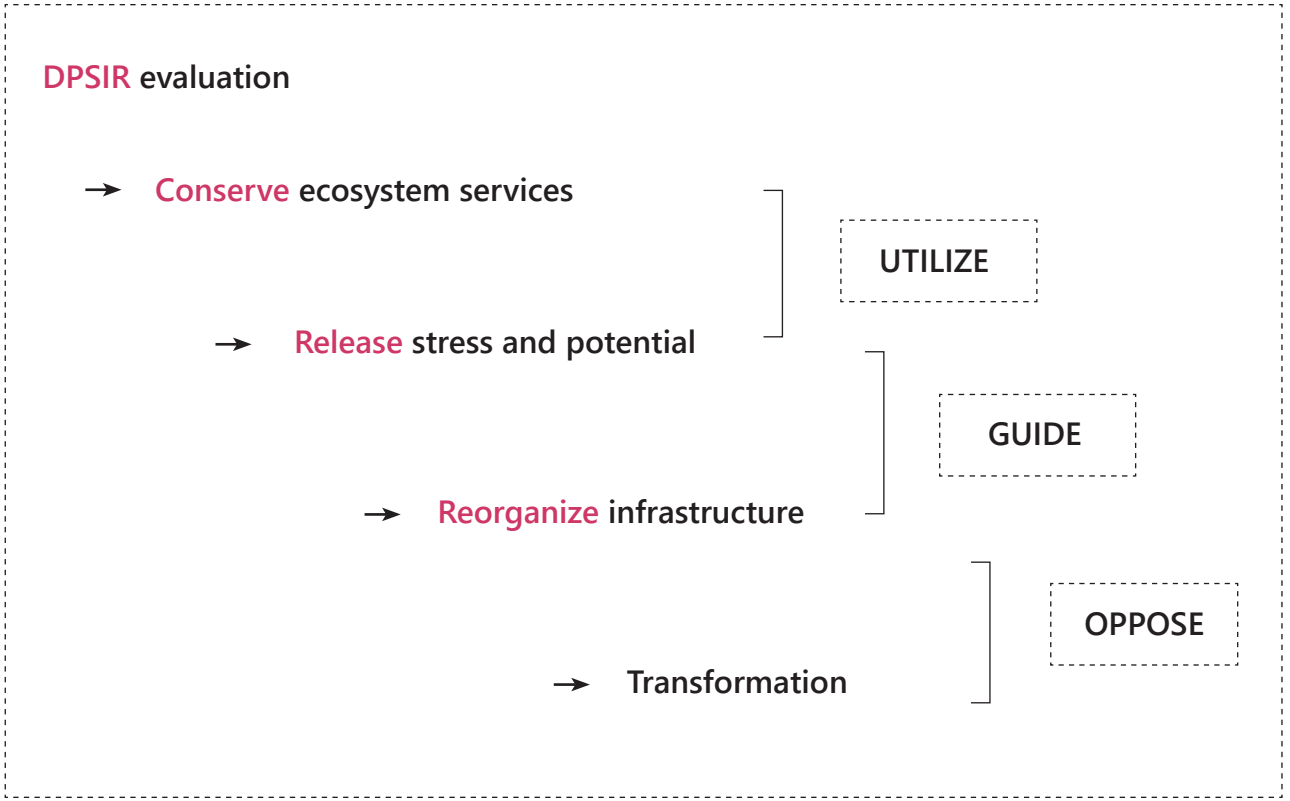
NATURE-BASED SOLUTION

Take advantage of shrinking trend.
Conserve natural capital to align with **RELEASE, REORGANIZE** and to prepare for disturbance.



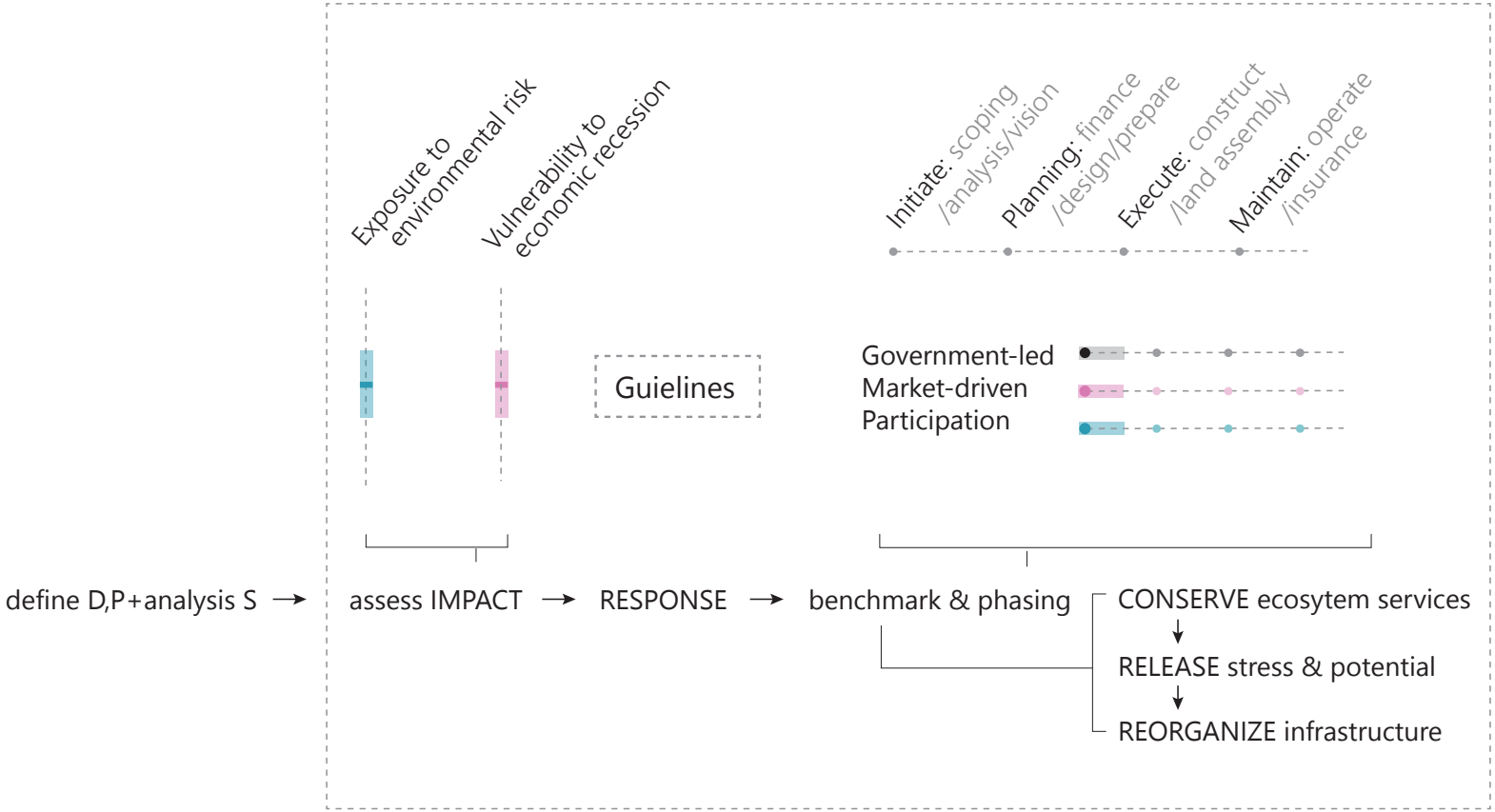
Holling, C. S. 1986. Resilience of ecosystems; local surprise and global change. pp. 292-317 in Sustainable Development of the Biosphere, W. C. Clark and R. E. Munn, editors. Cambridge University Press, Cambridge.

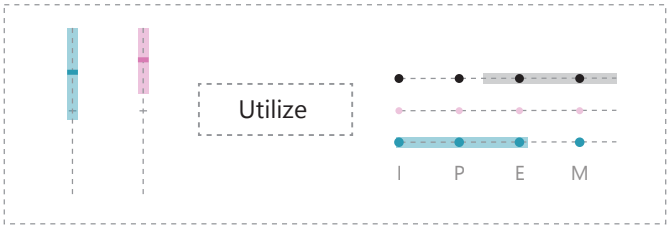
Spatial Intervention Guidance



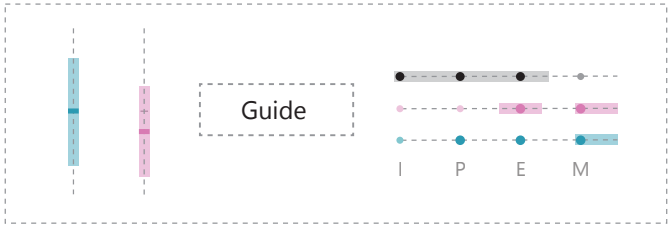
Nature-based adaptive strategy for shrinking city:

Phasing is evaluated by the impact of risk on current exposure and vulnerability state.

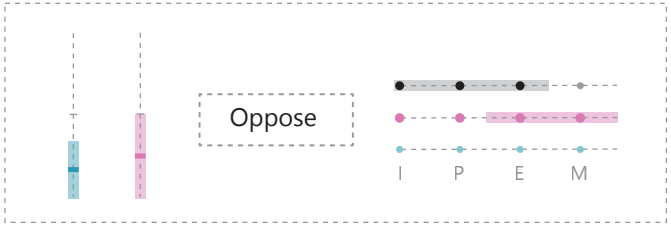




UTILIZE:
Focus on *Conserving* ecosystem services to *Release* stress on exploited land or resources.
Apply to areas with high risk exposure and high vulnerability.



GUIDE:
Reorganize the delivery of ecosystem services to prepare for future development.
Applied when risk exposure and vulnerability are mitigated in a reducing trend.



OPPOSE:
Leverage on natural capital and economic opportunities to launch interventions for intensive urban growth.
Applied only after impacts of risk are well decreased or adapted.

BLUE VITALIZING INFRASTRUCTURE

From blue print to organic growth

Blue infrastructural network is usually the backbone of port cities To refuel the city as a whole, it is efficiency and system wise to pilot a revival move with existing blue infrastructure. However, regarding to environmental changes, new adaptive structures are also required.

The strategy proposed is to

1. reuse existing canal system to deliver tidal ecosystem services
2. embed ecosystem services in recessing economic plots along the flows

in order to

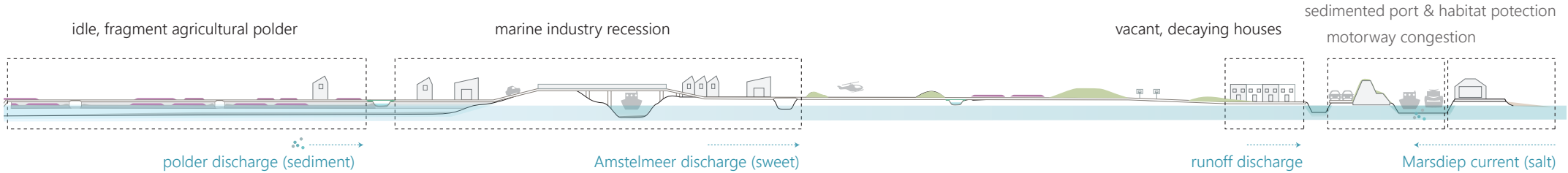
reinforce flood resiliency, catalyze urban transformation and to create values.

Fig. As a result of canal logistic recession and agriculture, many canals in the region are low in function.

- low functiong canals
- sediments flow dirction
- main sedimentation area

Balgzand synergy corridor

Balgzand canal is where tidal current meets discharge of urban runoff, Amstelmeer and polders.The canal motored the birth of Den Helder port-city, but is currently low-functioning.



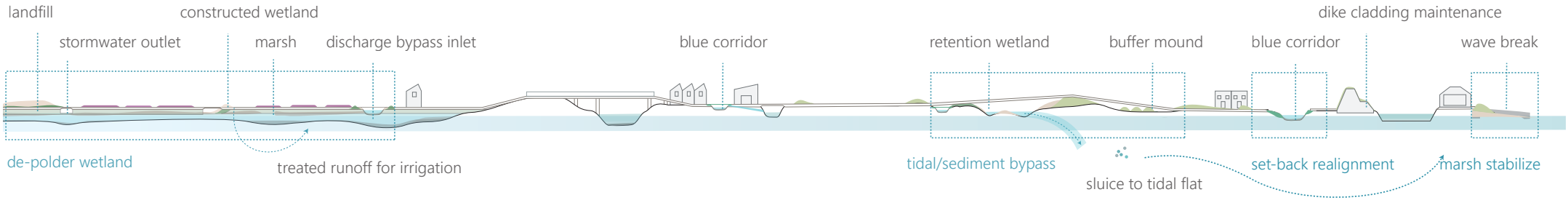
Leveraging on its well connection to both economic and environmental assets, the transformation proposes a synergy scheme of two corridors to vitalize tidal ecosystem, industries and urban renewal following conserve-release-reorganize cycle.

Fig. Section showing conflicting flows (discharge,tidal, sediments) in Balgzand canal with current economic recession issues:

Corridor of Natural Infrastructure:

Target:

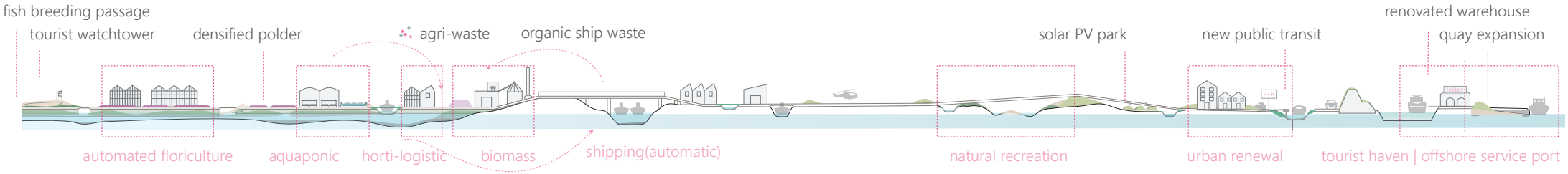
- Conserve estuarine dynamic, tidal ecosystem
- Release confliction between freshwater discharge, tidal current and sediment
- Release idle polders and spaces to nourish natural capital.

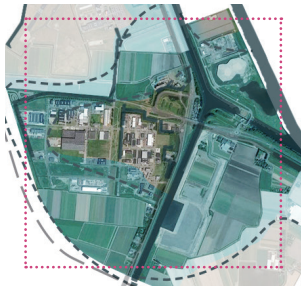


Corridor of Economic backbone:

Target:

- Release domination of maritime industry
- Reorganize landuse to cope with tourism, automation and flood risk
- Facilitate port expansion and urban renewal

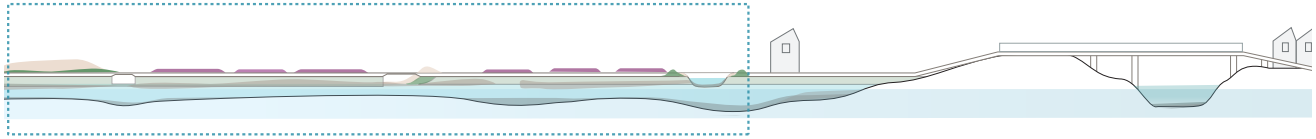




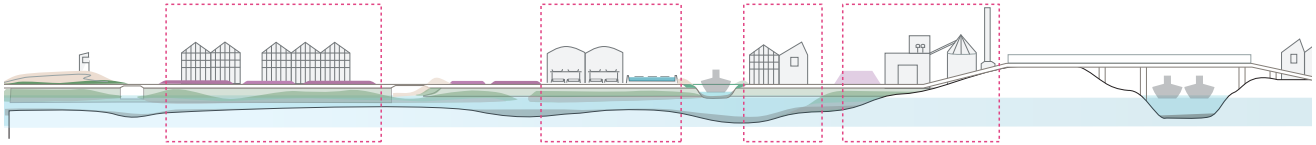
zoom-in: suburban productive landscape

Polder Realignment

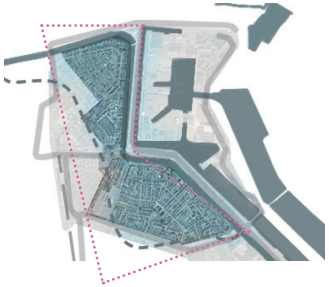
◦ innovate more adaptive uses of polders
◦ local-based and collaborative business model between agriculture & maritime.



de-polder wetland



automated floriculture aquaponic horti-logistic biomass

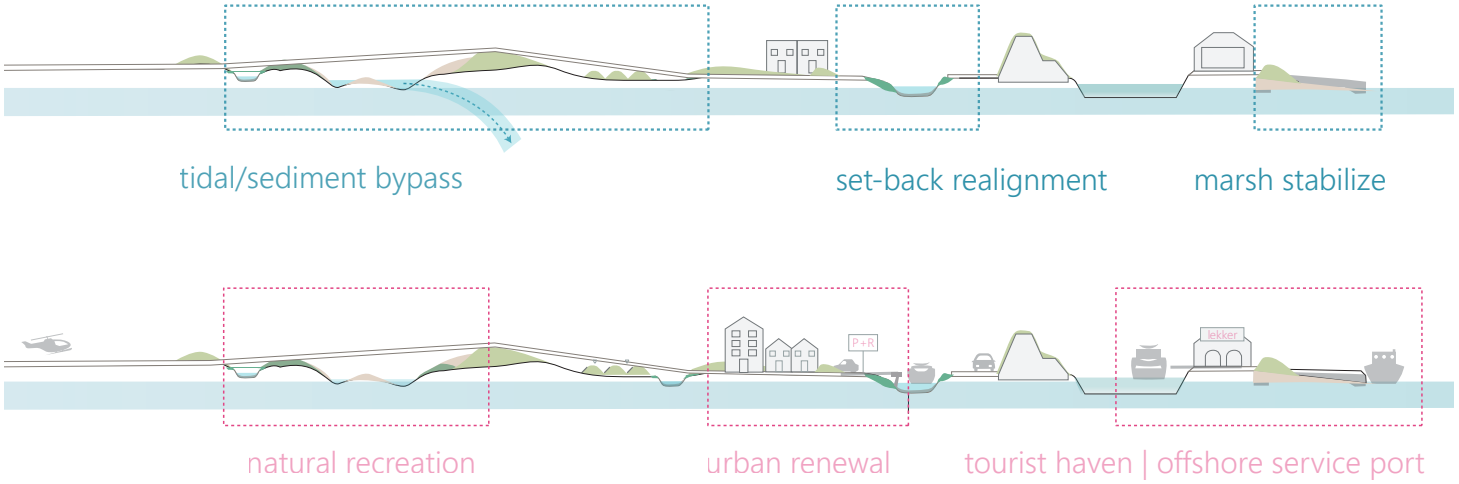


zoom-in: urban core residential

Risk Incentive Urban Renewal

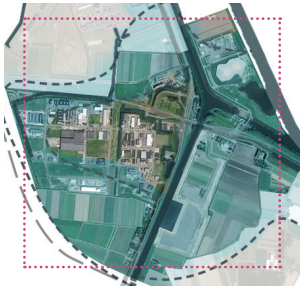
high financial burden and low participation.

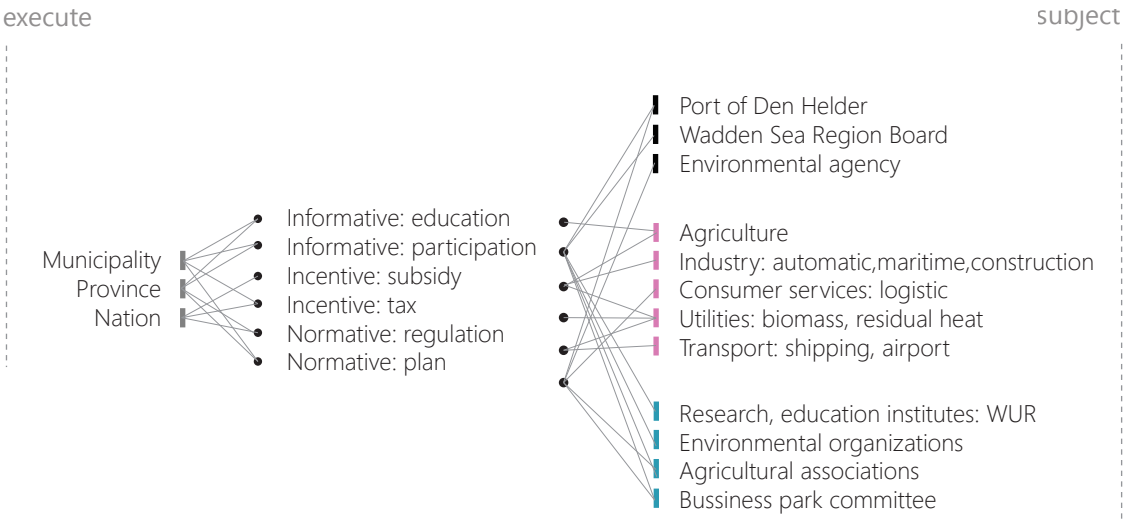
◦ *raise awareness and financial incentives in the name of flood risk management.*



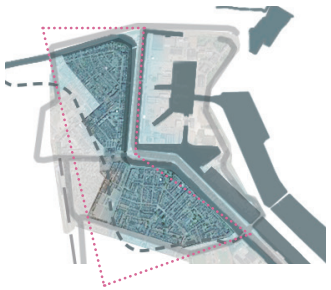
1 corridor x 2 scopes x 3 schemes:

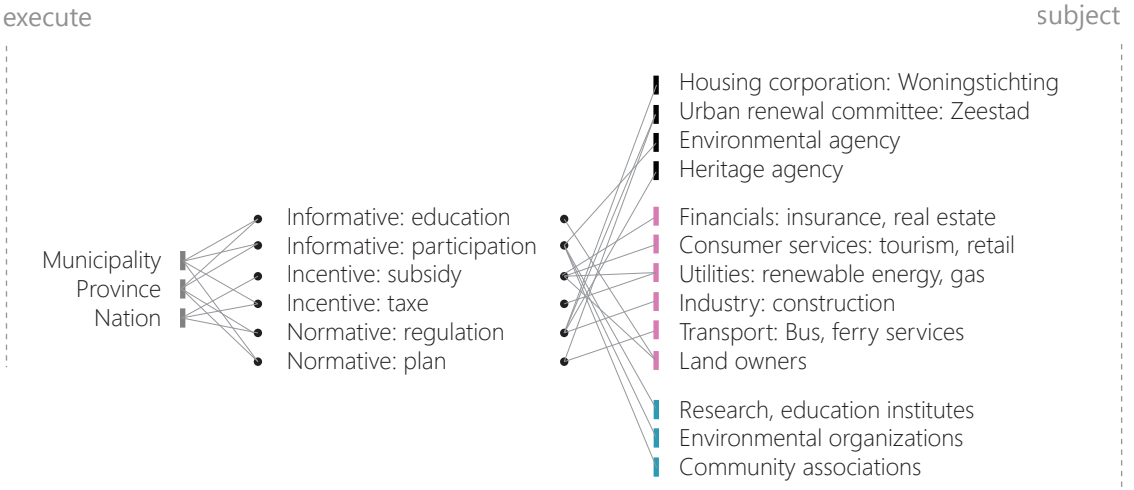
Suburban productive landscape





Urban core residential



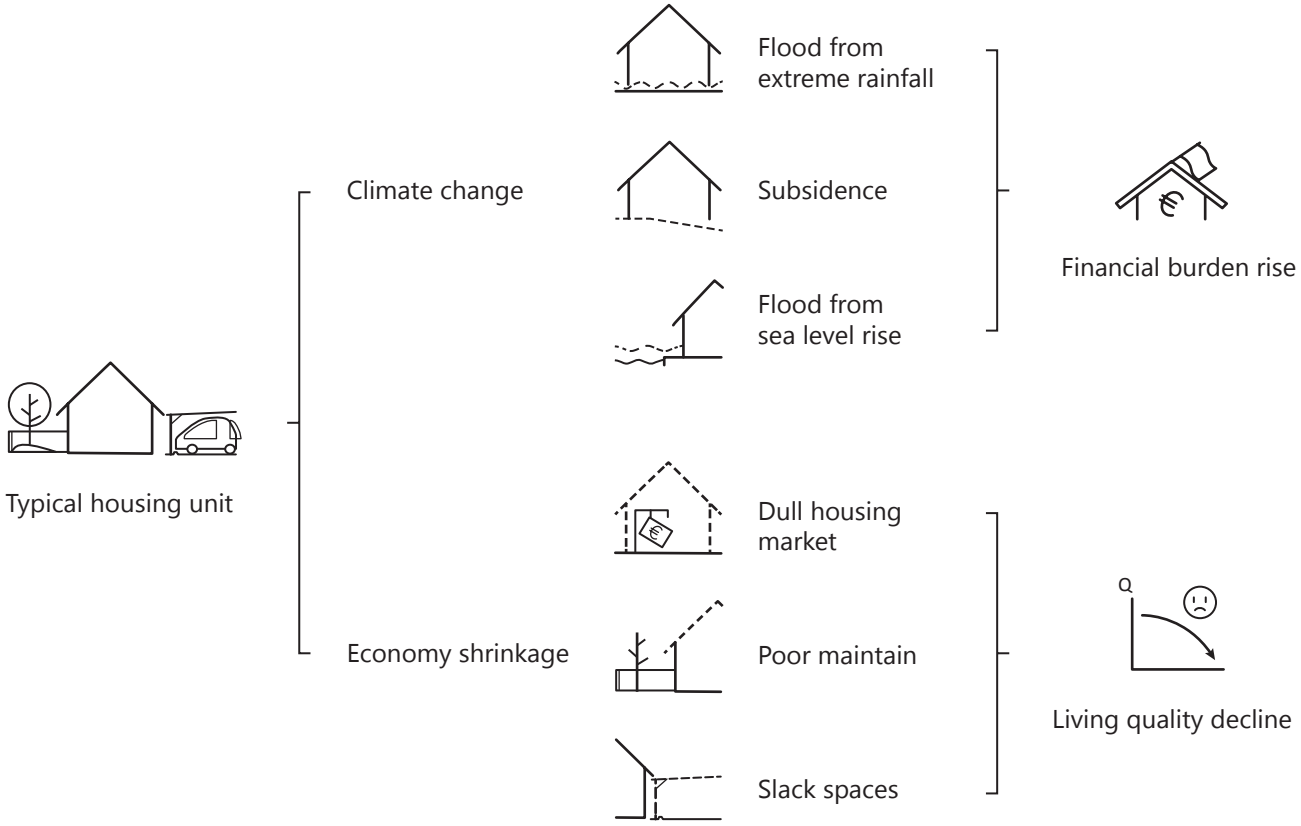


Risk Management Challenge

Current flood protection is completely provided by central government. It causes high financial burden and low individual awareness of risk.

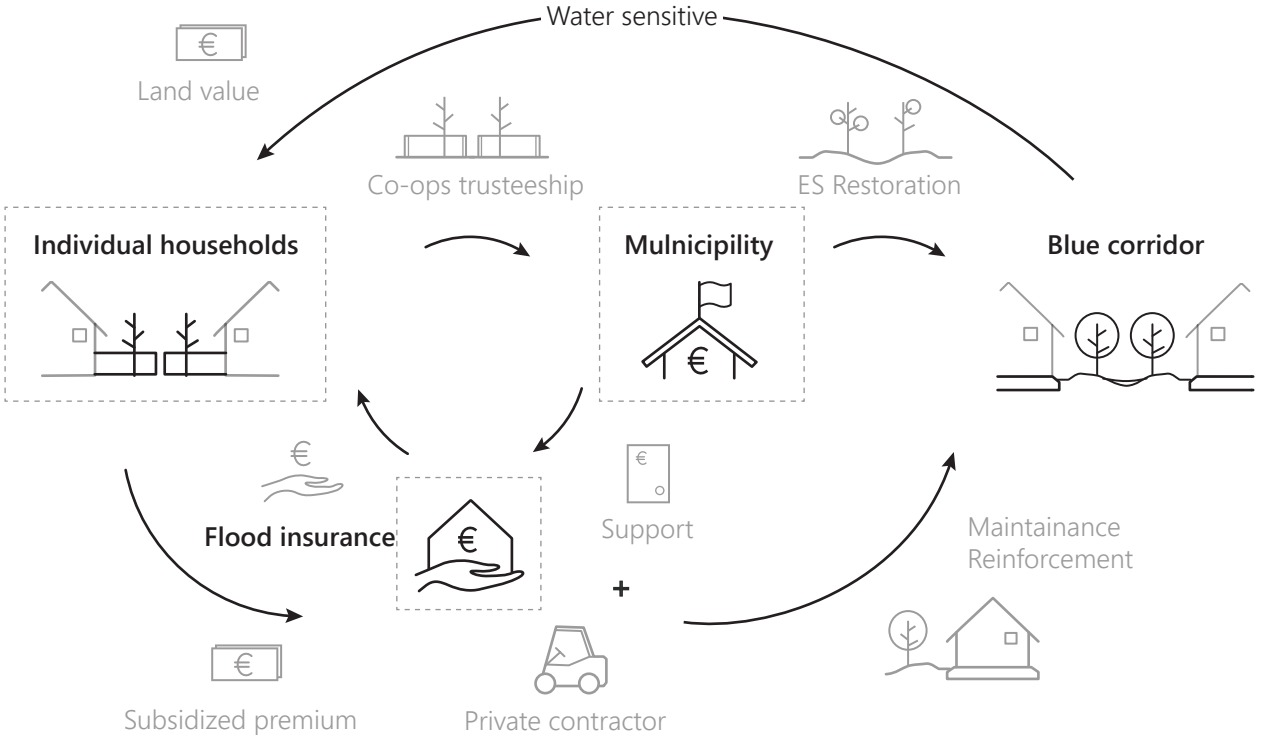
A main risk affecting economic viability is the uncertainty of environmental hazards.(The World Bank,2016)

Unclear measurements of expected damage is the main reason crowding out private insurance market.



Risk and Benefits Sharing

An integrated management package is proposed to facilitate renewal, combining technical renovation of houses and a PPP insurance model to incentivize participation and to share the risk.



Value capture:

Household

- Property price rise
- Better environmental quality
- Subsidized flood insurance
- Lower flood damage

Government

- Spreading risk
- Lower land acquistion barrier
- Urban transformation

Insurance foundation

- Estimable flood risk
- Official finance support
- Community-based maintanance

Prototype

Backyard Intervention

collect of idle yards and undervalued properties to invest in natural capital, in the name of flood risk mitigation

step 1.

Release spare space & sealed soil

- Unseal yards, parkings to enhance infiltration
- Soil remediation and organics nourishment

step 2.

Reorganize underground

- Excavate detention ponds / fill mounds
- Fill mounds
- Geothermal district heating infrastructure

step 3

Nourish livings

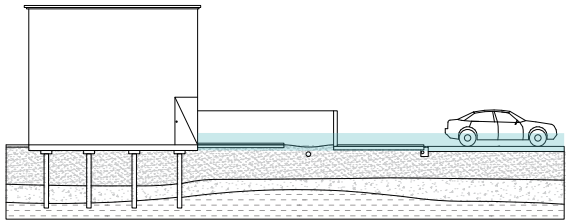
- Encourage passive greenhouse units
- Rain harvest

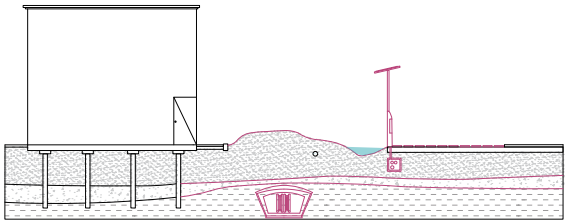
Value creation:

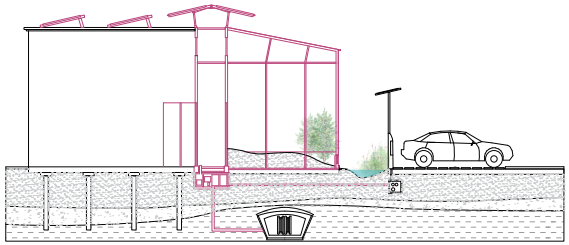
- Lower reconstruction cost
- Lower land acquisition prerequisite

- Multi-functional infrastructure
  (flood-storage & renewable district heating)

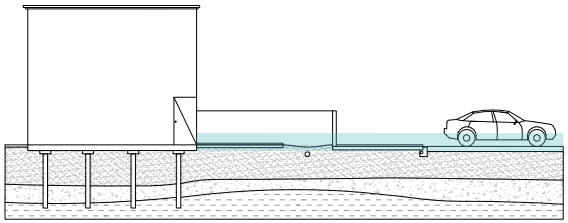
- Lower energy consumption
- Aesthetic landscape



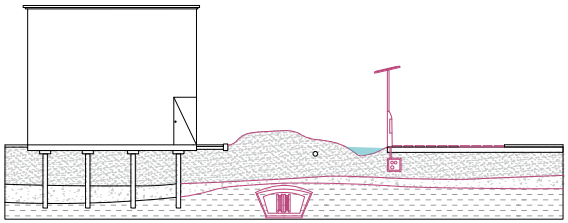




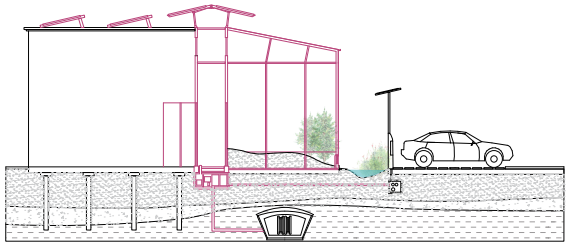
config. S: end-of-terrace/detached house + backyard



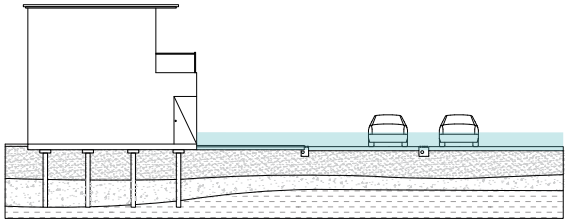
upgrade indoor environment



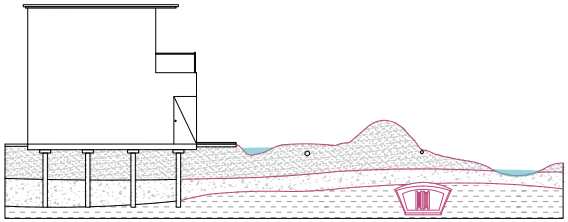
attached private passive house + rain garden



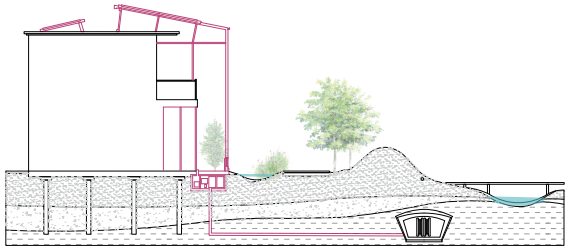
config. M: terraced houses + parking lots



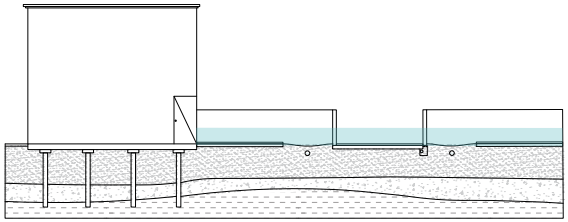
upgrade semi-public space



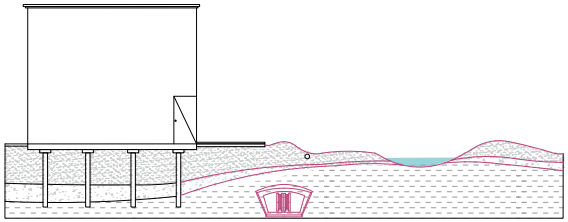
attached shared passive house + flood buffer



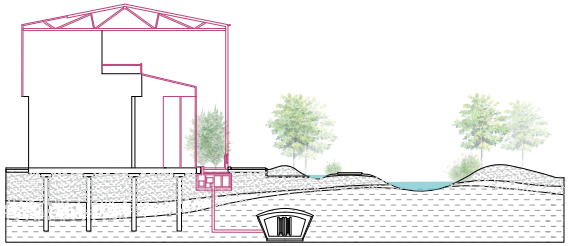
config. L: terraced houses + adjoining backyards

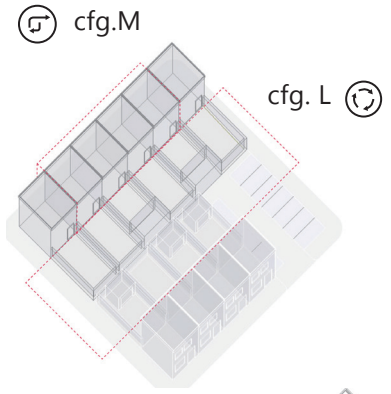


upgrade building typology



house renewal + green corridor




cfg.M
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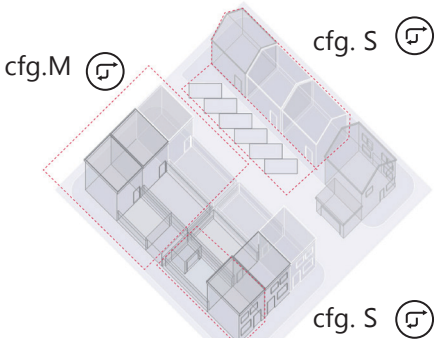
cfg.M
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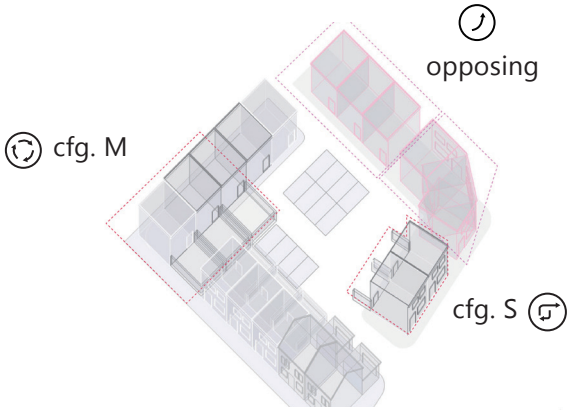
opposing
cfg. M
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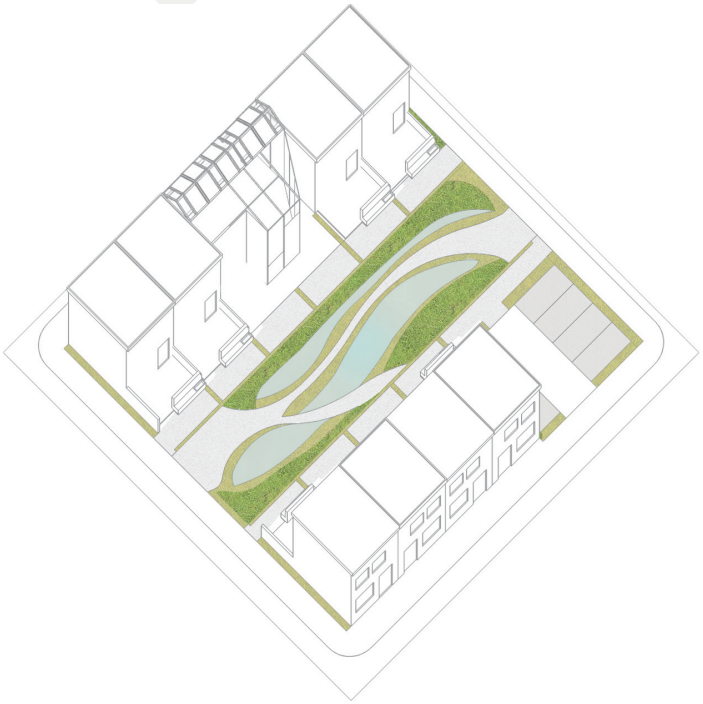
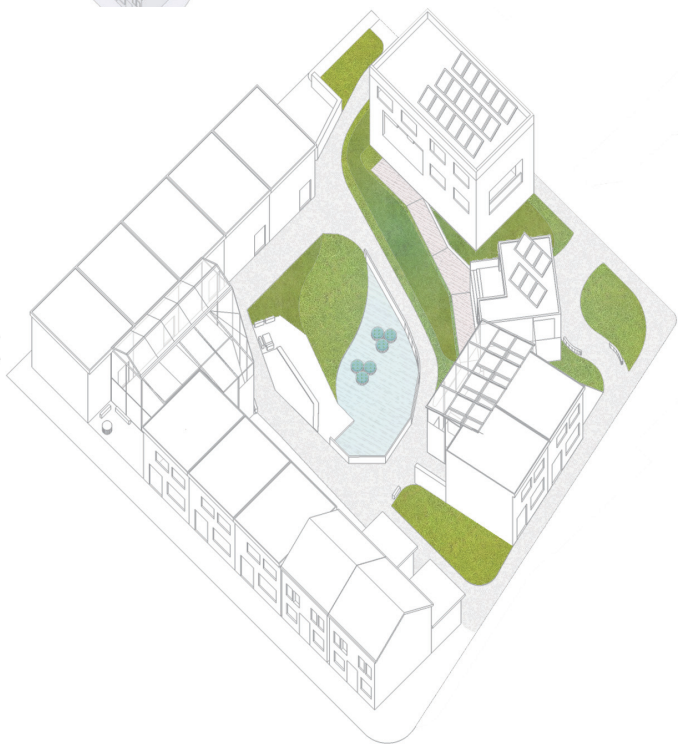
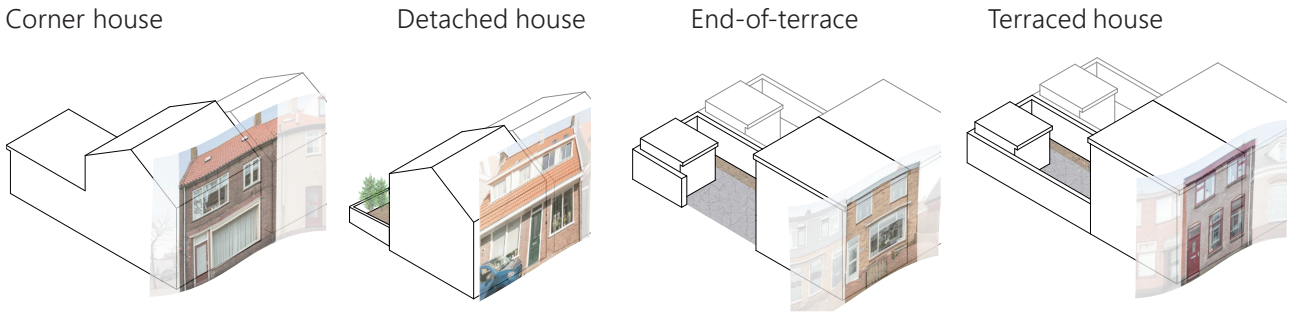


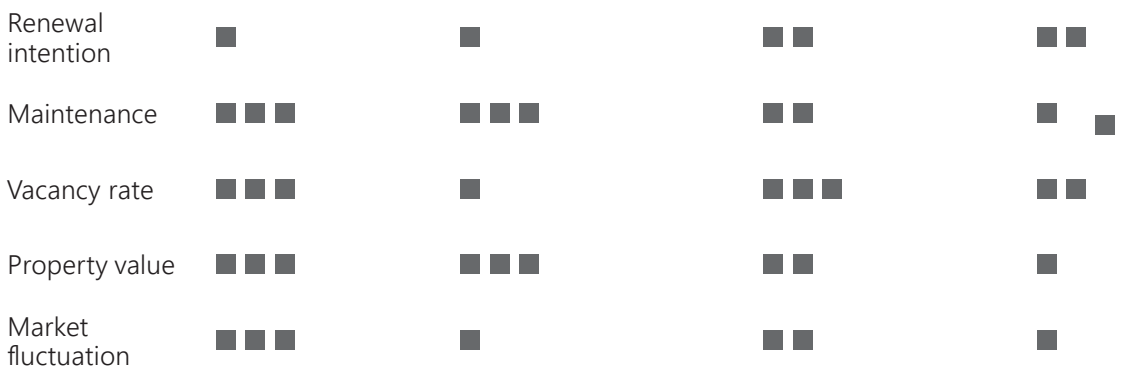


Utilizing Economic Recession

Spatial Impact from Economic Dynamics

Building typology is an important index to estimate the imapct of economic recession on property value and living condition. This also suggests residents' willingness to participate in urban renewal. Regarding high or low dynamics, a phasing transformation towards water and shrinkage resilient neighborhood is proposed.





Transect of transformation

Quantitative Incentives

Quantifying ecosystem services and land usages (FSI and GSI) can provide a casco to launch transformation in process

- Reduce cost of flood damage
- Reduce cost of subsidence damage
- Reduce cost on grey infrastructure
- Reduce water, energy costs of property
- Increase property value
- Economic impact, job creation

- Insurance reduction
- Volume reward
- Subsidy

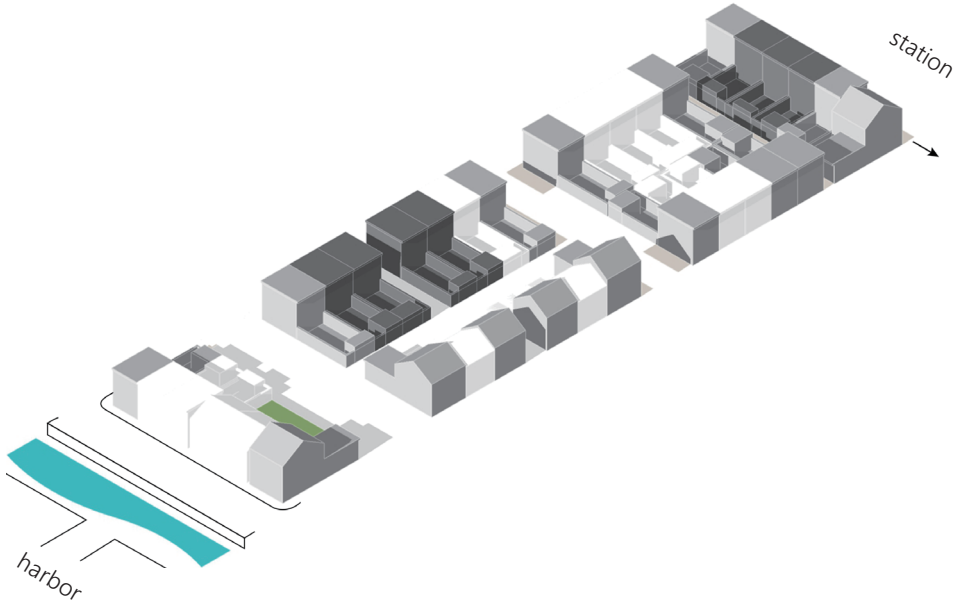
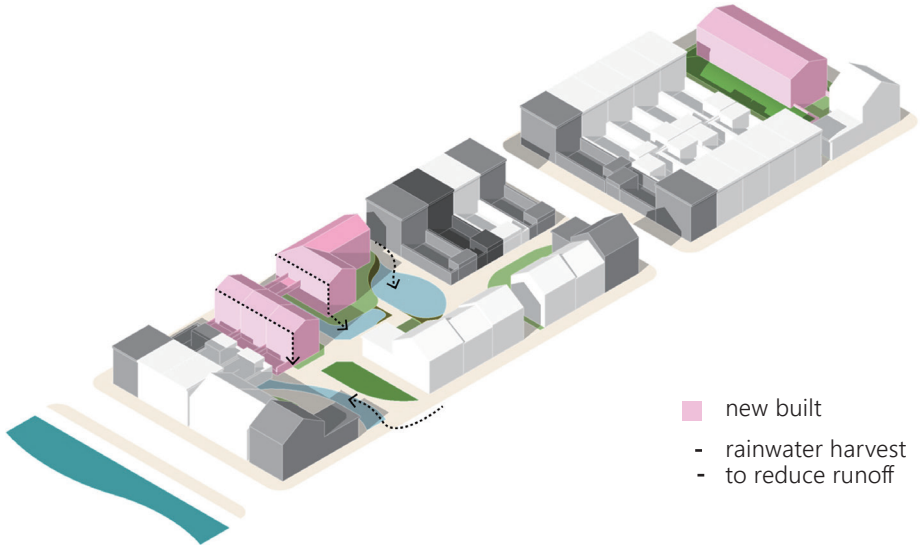


Fig. A transect of plots from waterfront to inner city region.

- house value highly subject to economy status
- devalued houses



phase 1.

Land acquisition for affordable housing

Provide subsidy to acquiste spaces for risk management.

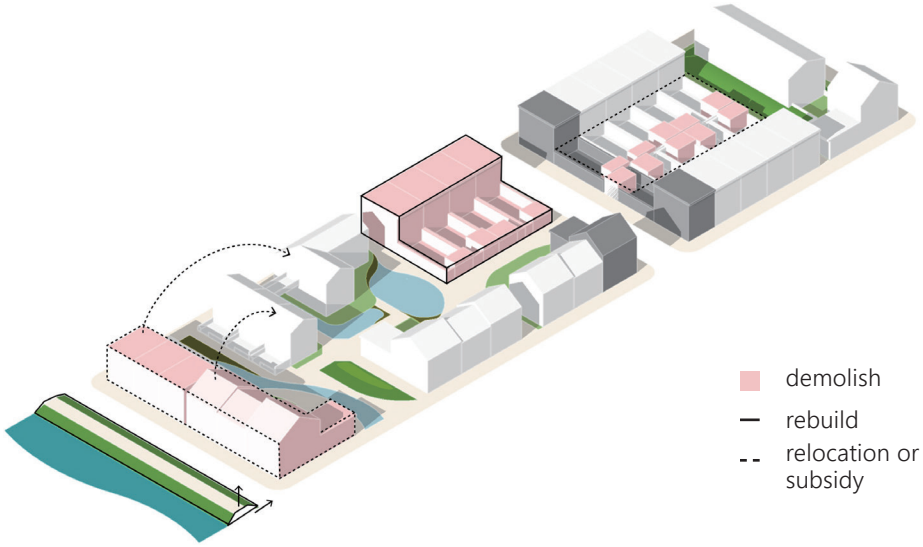
Guidline:
rise FSI
build for relocation, public rental
flood-buffering building

site:
public areas,
devalued / dull sale vacant houses

landscape:
excavate retention pond
filling grass slope

Executive:
government-led rebuilt; BOT

Stakeholders:
mulnicipality; residence;
infrastructure department



phase 2.

Set-back relocation

Flood-prone land acquisition

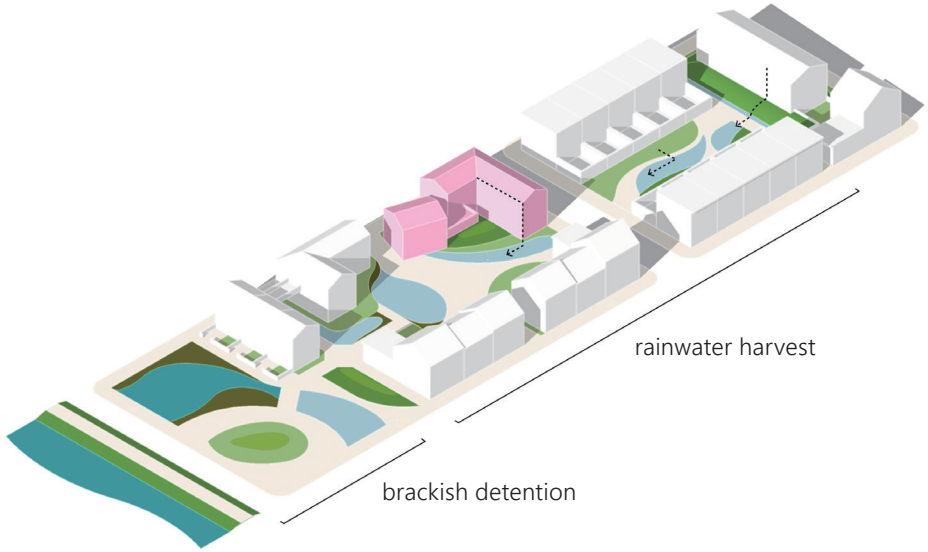
Guidline:
lower GSI, rise OSR
volume transfer and reward

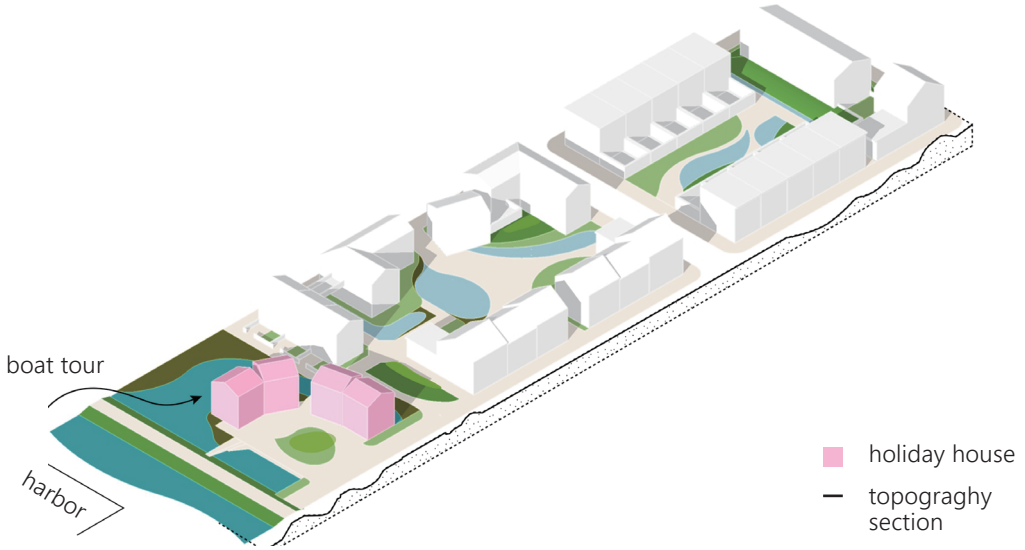
site:
high flood risk housings,
private unbuilt areas

landscape:
filling excavated material at waterfront

Executive:
government-led acquisition

Stakeholders:
mulnicipality; residence;
insurance company





phase 3.

Integrate with green/blue corridor
Backyard transformation

Guidline:
rise OSR
mix-used community

site:
acquisited building units, open spaces

landscape:
create community public space
integrated rain harvest system

Executive:
BOT

Stakeholders:
mulnicipality; residence;
infrastructure department

phase 4.

Multifunctional program
Increase landuse diversity and temporal uses

Guidline:
flood detention zone
recreation program

site:
waterfront

landscape:
marsh nurishment
waterfront recreation

Executive:
comminity assembly

Stakeholders:
mulnicipality; residence;
local company

Risk Incentive Urban Renewal

Risk= Exposure x Vulnerability

- Exposure
  - flood probability
  - flood depth
  - flood damage
- Vulnerability
  - accessibility
  - building age
  - building typology
  - average age

Strategic location for transformation

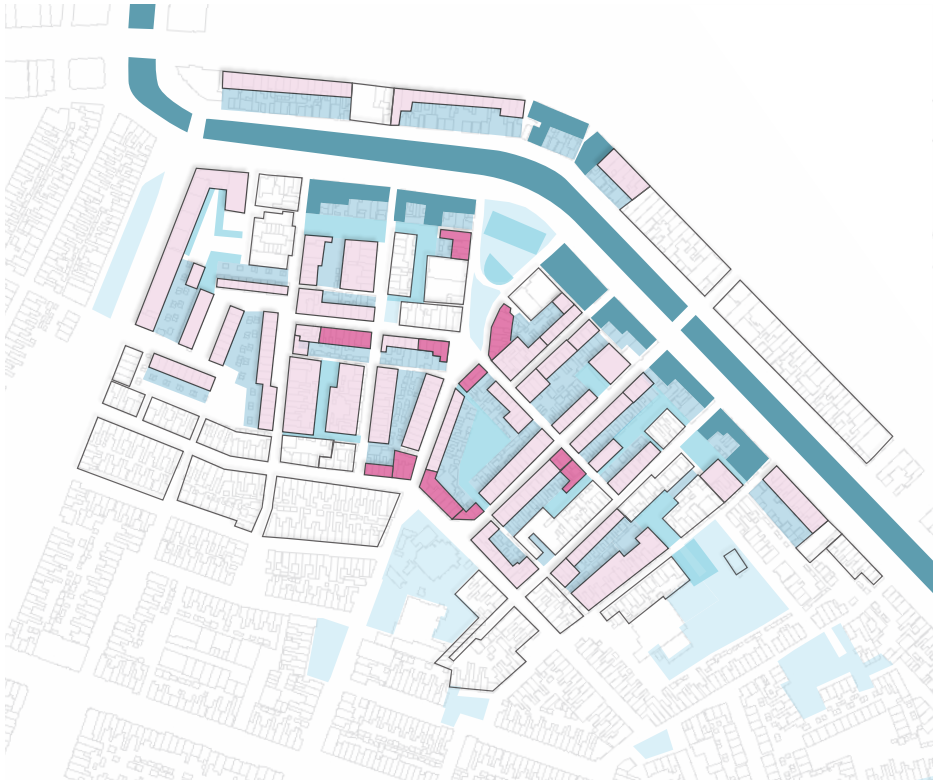
exposure of each house to flood damage and vulnerability of housing value to economic degradation are highlighted.

Exposure:

- flood reported in record
- lowland

Vulnerability:

- major transit routes
- Low accessibility with public transport
- houses built before 20th century



Utilizing:

- Brakish retention: relocate flood-prone houses
- Runoff collection: backyards of terraced houses
- Runoff detention: private parking spaces and laneshouses

Guiding:

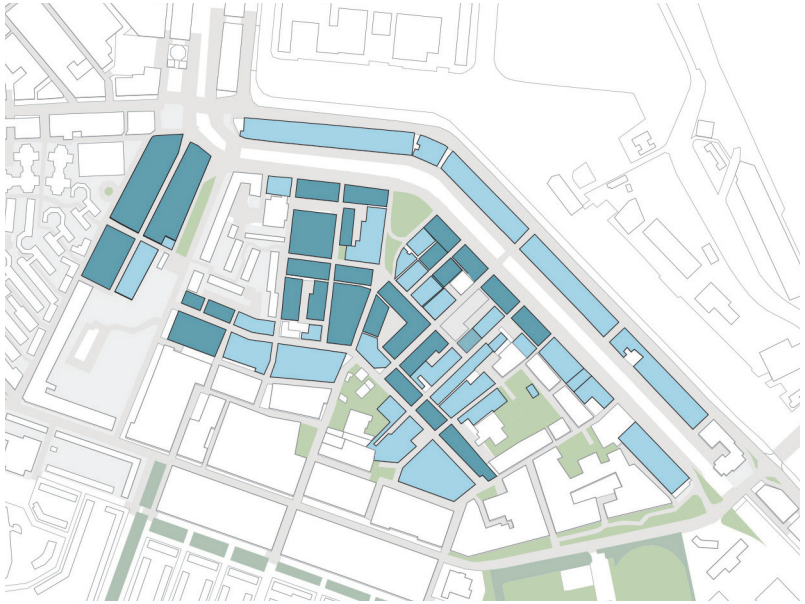
- Renewable district heating: backyards of terraced houses
- Renovation: houses involved with flood insurance

Opposing:

- Renovation: location-wise houses

Utilize: release flood risk

Based on flood risk simulation, partial realignment and set-back is suggested.



Realignment

- Relocation/ realignment blocks: Reconstruction required.
- Retrofit blocks: Added value required.

Guide: reorganize network

Leverage on exsting blue infrastructure and potential mobility.

Blue infrastructure

Reconstructed functions of damaged blocks

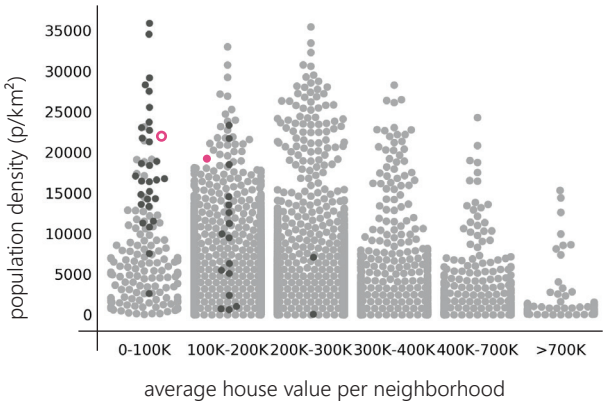
- brackish retention
- runoff detention
- embankment

- proposed major transit axis

Oppose:

Adapted size **for value investment**

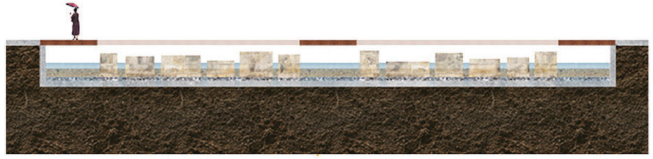
Chart. Designed lower housing density is reflected on potential to gain value.



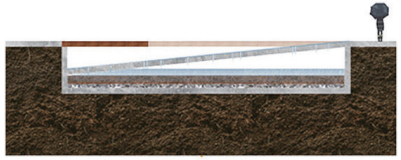
- ○ current
- • designed proposal
- • neighnorhoods of Den Helder
- • neighnorhoods of the Netherlands

Fig. Water sensitive masterplan

- new built
- brackish retention
- runoff detention
- embankment

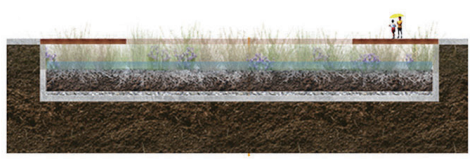


Gravel filtration



Detention pond

Phytoremediation



Bioremediation

Meso intervention: productive landscape

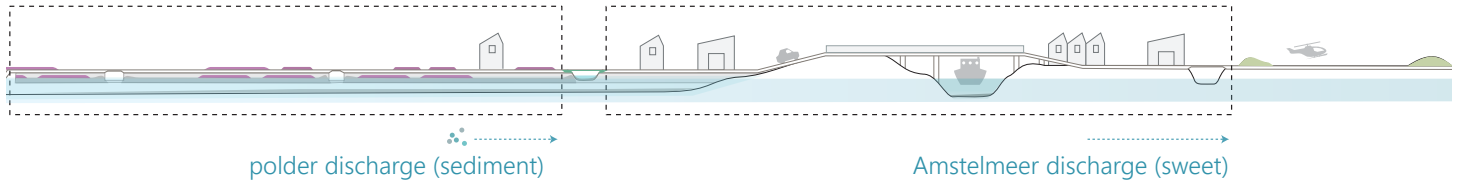
Polder Realignment

From natural infrastructure to regional economy

In response to *higher water storage demand and shrinking horticulture trend, a more efficient use of polder system* (arable lands+controlled water circulation) is proposed.

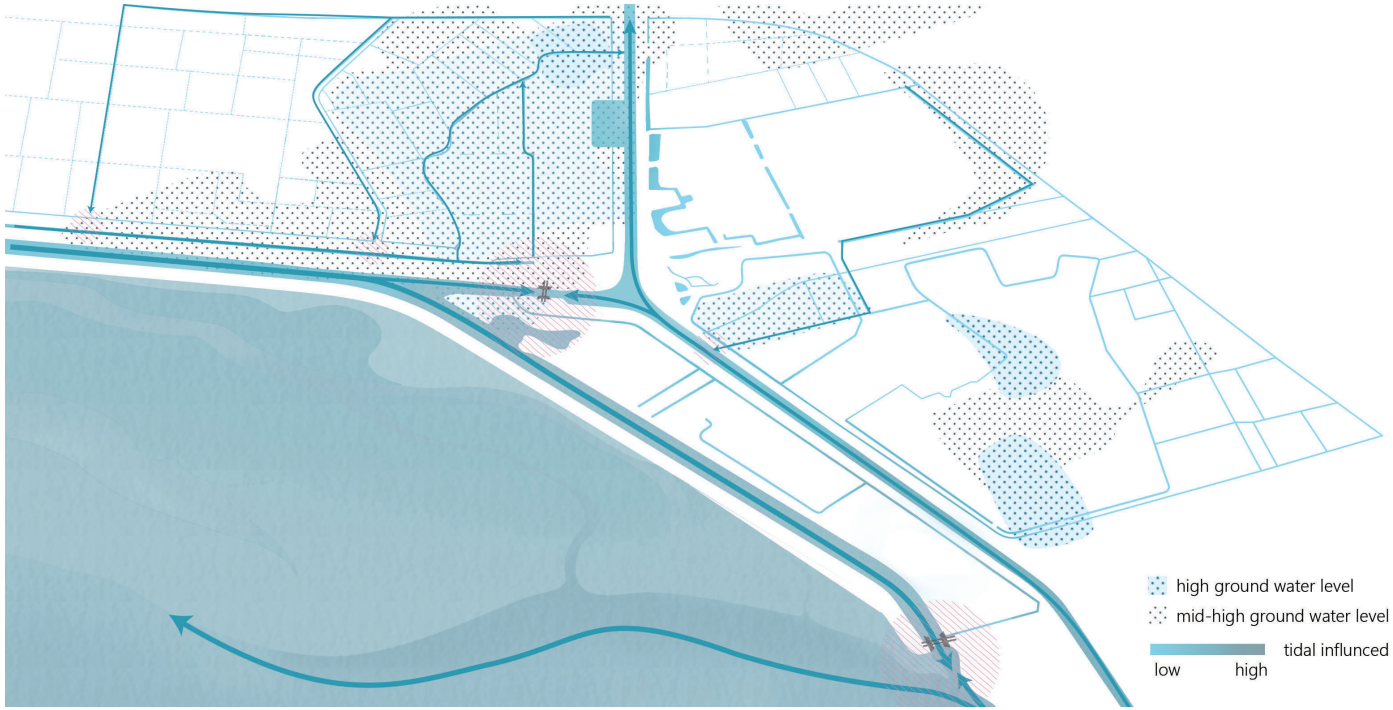
Adaptive Polder Realignment Scheme

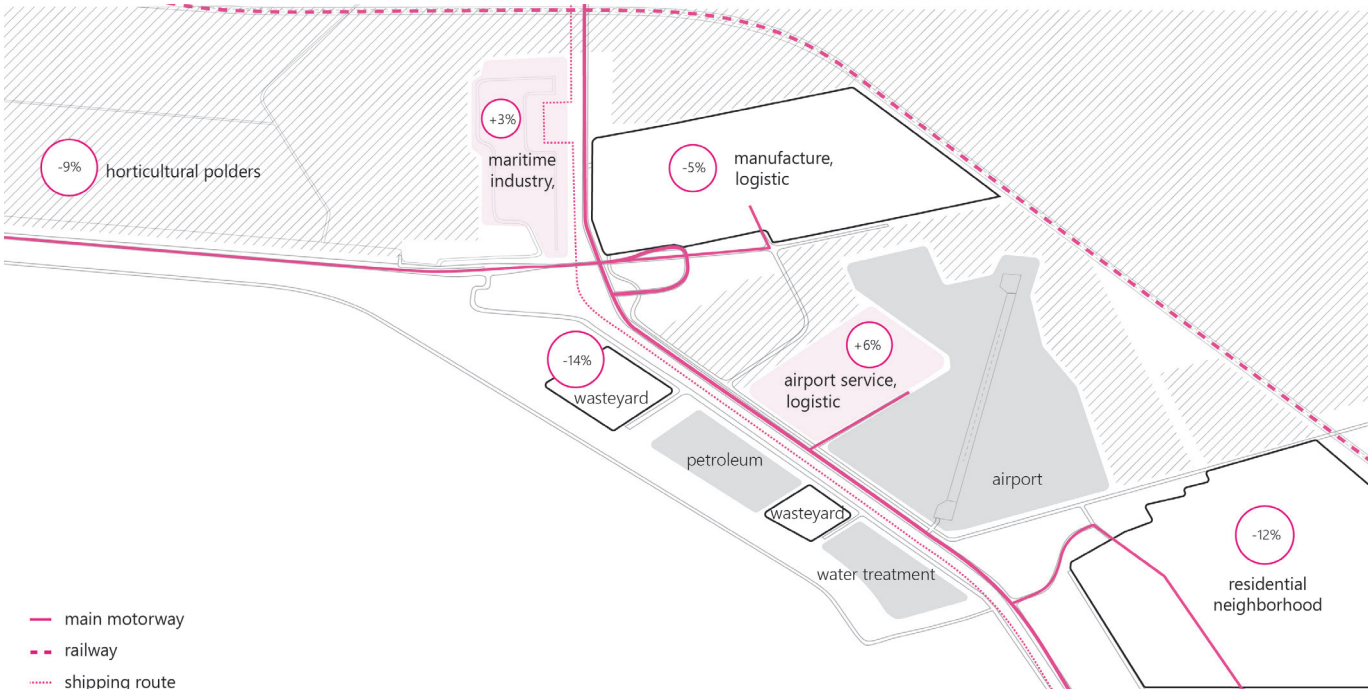
A flexible transformation process leveraging on dynamics of landuse demand and tidal forces.



Environmental trend: **higher flood potential**

++ tidal force
+ groundwater level
++ Amstelmeer extreme discharge volumn
+ sediment
+ sea level

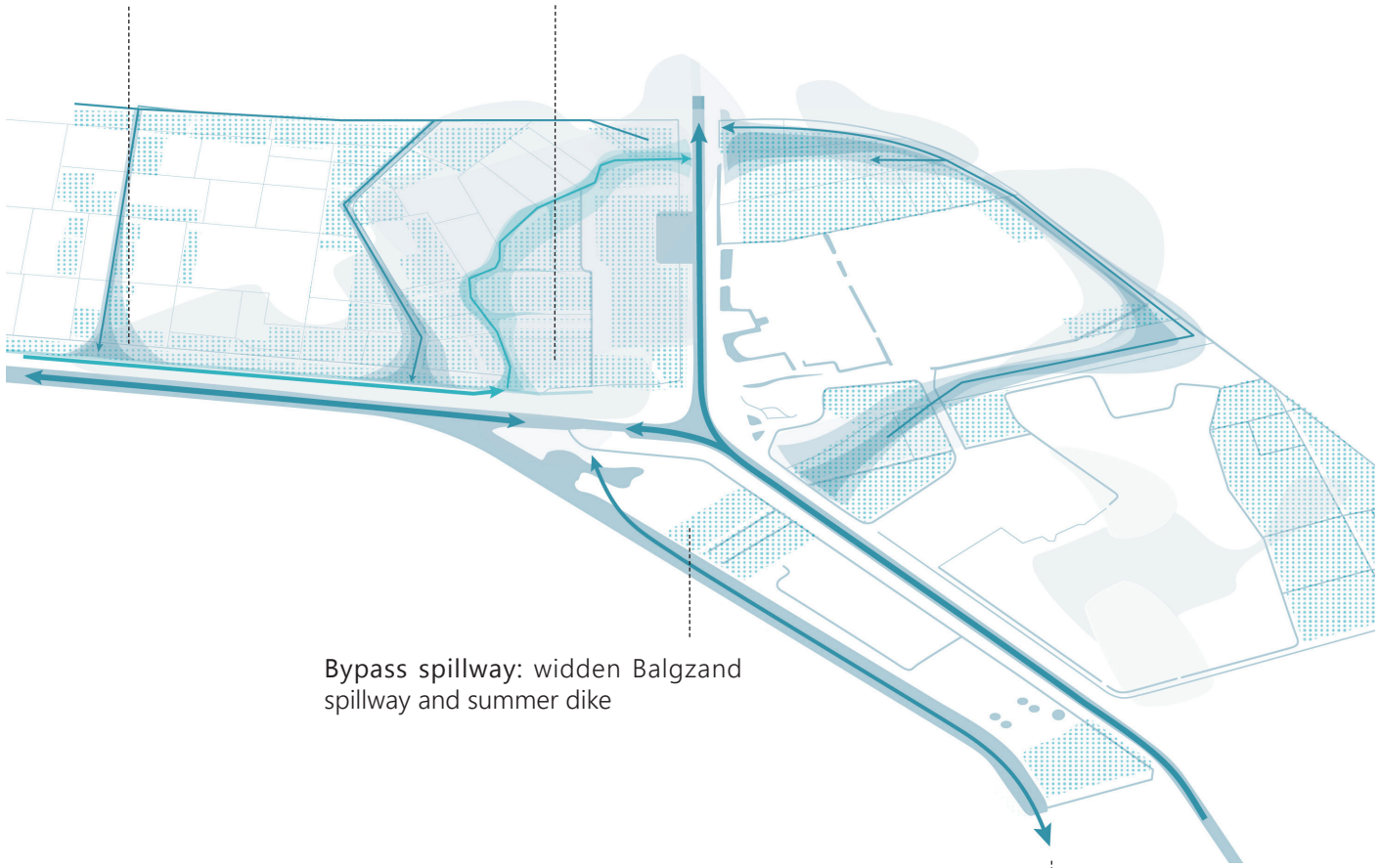




Economic trend: **shrinking landuse demand**

-- arable polder areas
+ maritime industry
- households
+ airport logistic
- cargo logistic

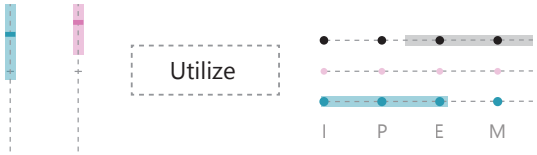
Discharge retention: de-polder areas that are under-valued and of high groundwater level



Bypass spillway: widden Balgzand spillway and summer dike

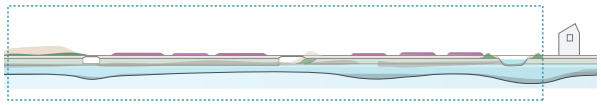
Sediments control:
leverage tidal force to pull sediments from Balgzand sluice to marshland.

Phase 1: 2018-2023

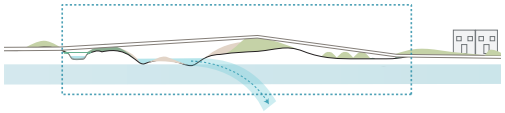


New flood management system

Pilot phase employs nature-based engineering to increase runoff detention, relocate bypass for discharge, nourish saltmarsh/seagrass and manage flood-prone areas.

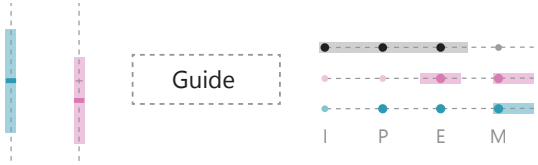


de-polder wetland

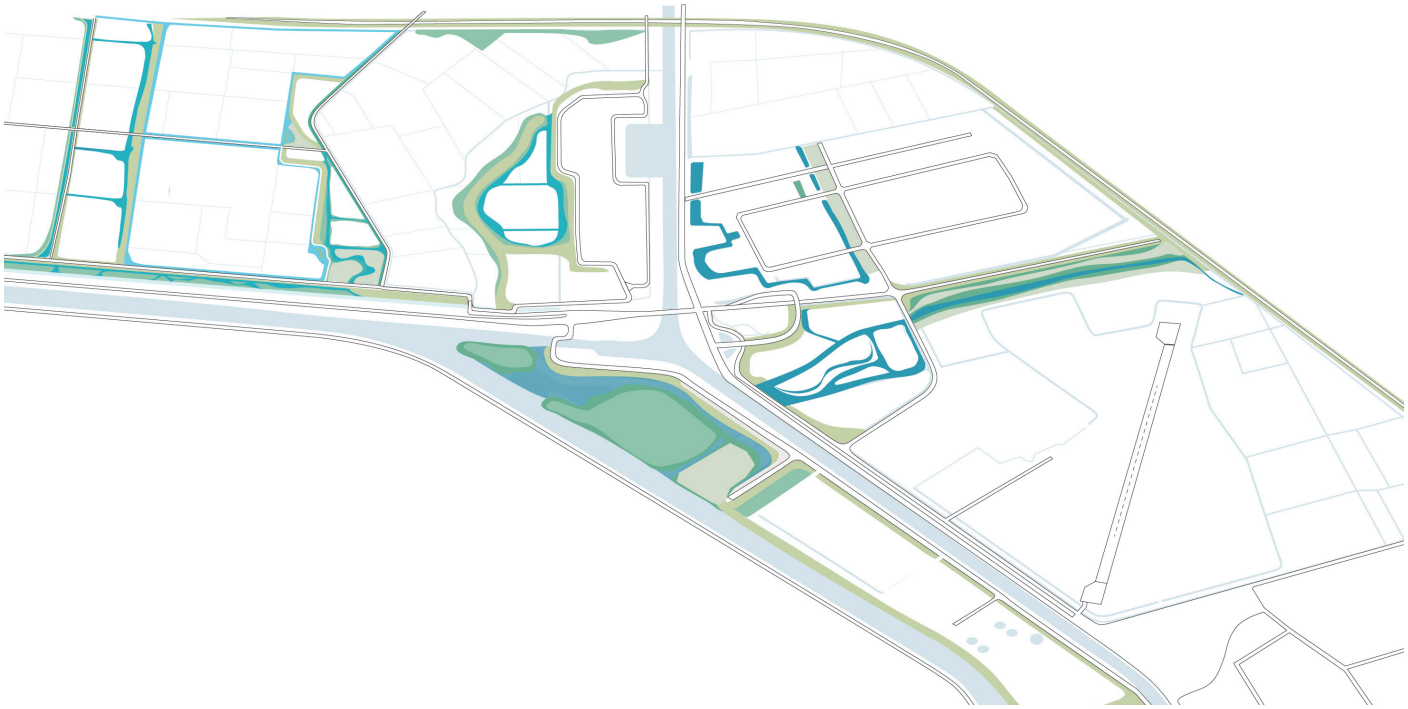


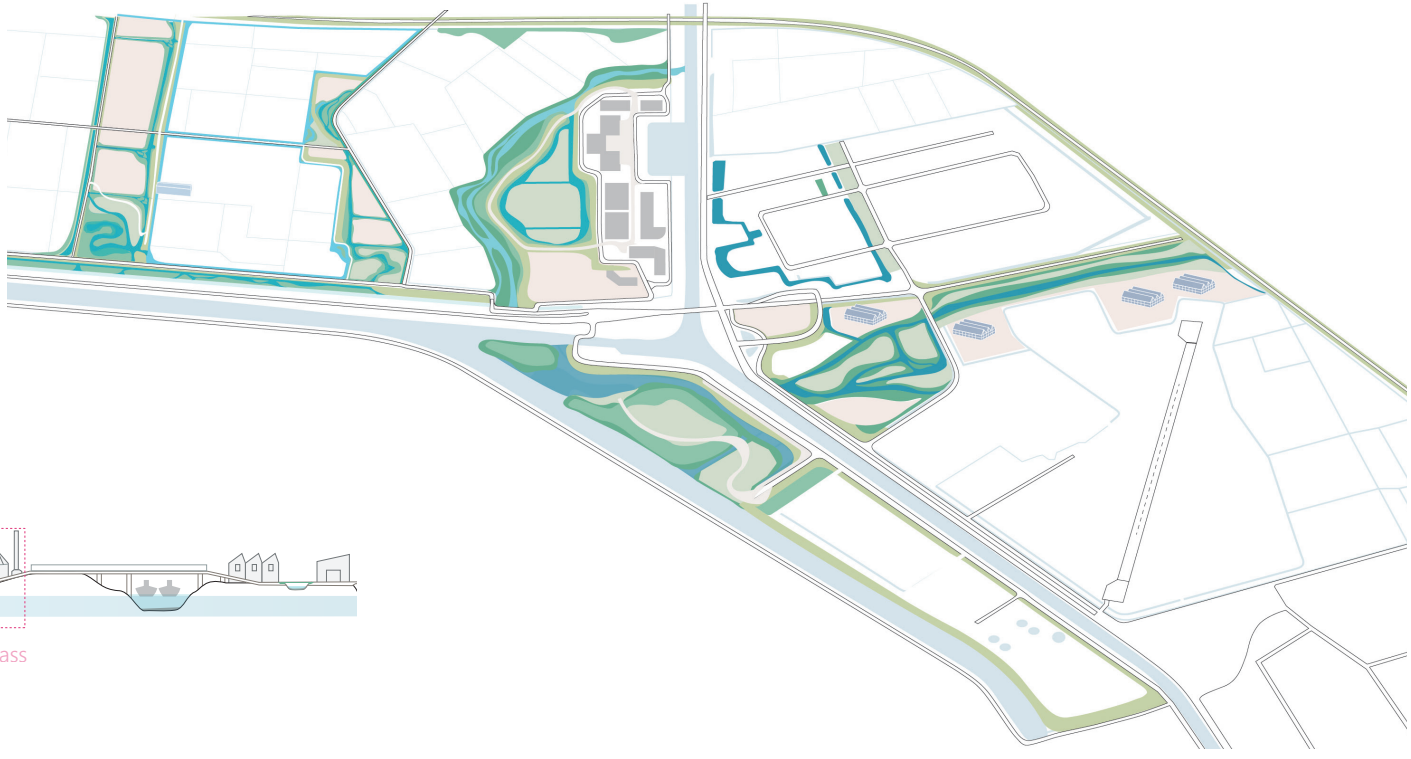
tidal/sediment bypass

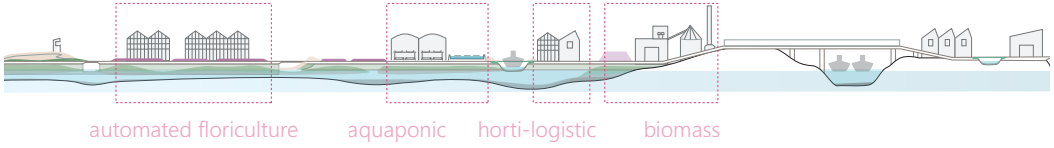
Phase 2: 2020-2030



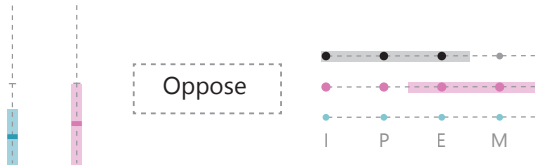
Modified landscape and inflow guide growth of related industries and cooperation among agriculture and maritime logistic. This diverse coexistence sets market for future automated technology that can upgrade current industries.







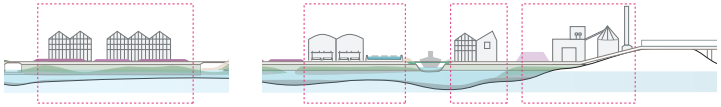
Phase 3: 2025-2050



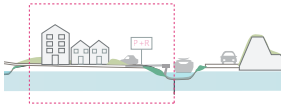
Modified landscape and inflow guide growth of related industries and cooperation among agriculture and maritime logistic. This diverse coexistence sets market for future automated technology that can upgrade current industries.

Waterfront set-back and backyard nursery can improve residential quality and lower flood risk. The optimal goal is to reinforce a stabler, attractive living environment confronting economic flunctuation.

By coping with wave and minimize dredging construction, the disturbance of quay expansion can be compensated by breaking wave and stabalizing Balgzand bay sediments.



automated floriculture aquaponic horti-logistic biomass

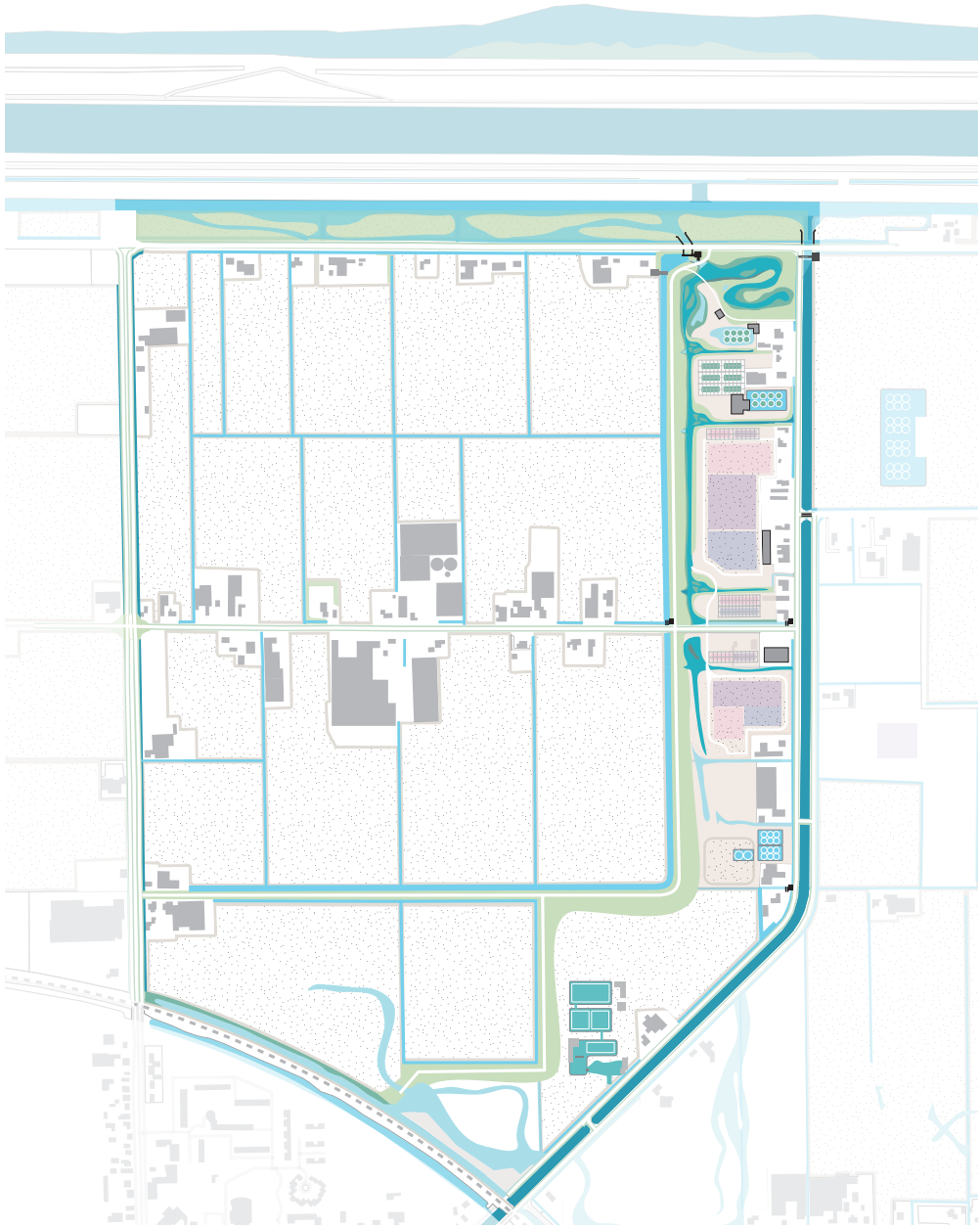


urban renewal tourist

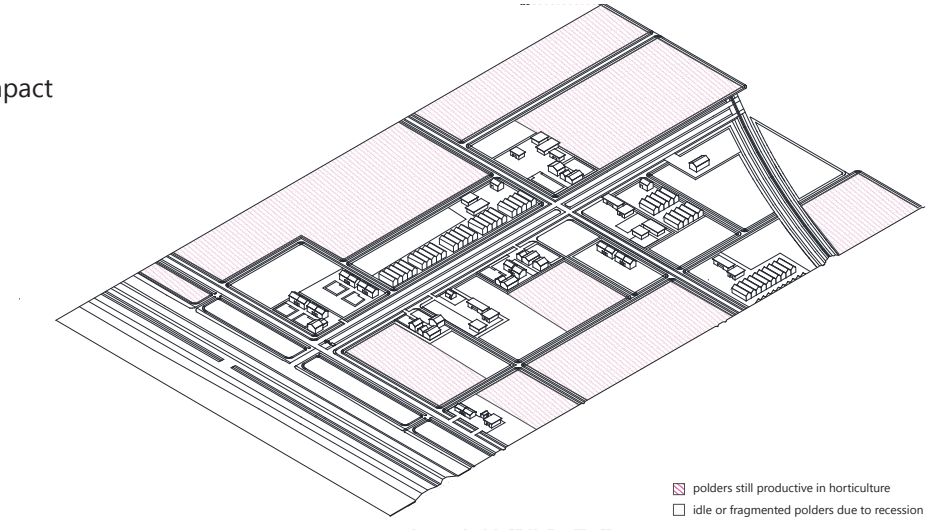
tourist haven | offshore service port

Prototype

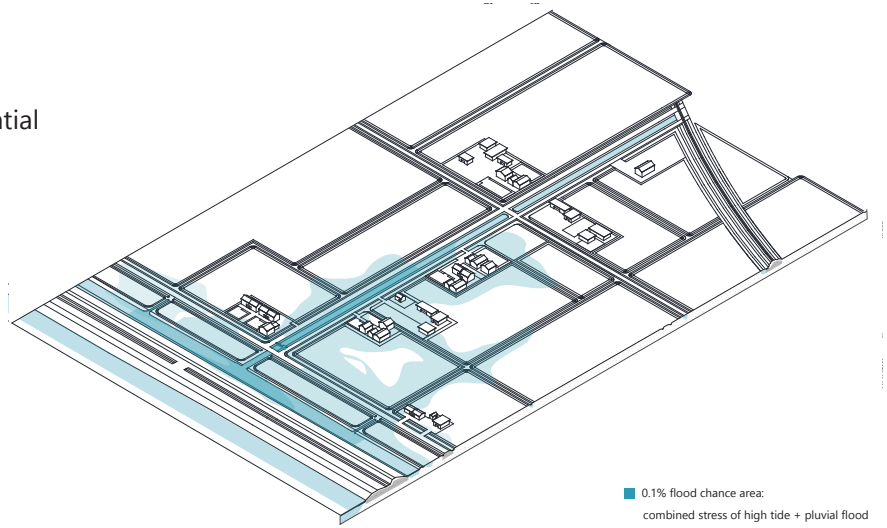
Adaptive new polder unit



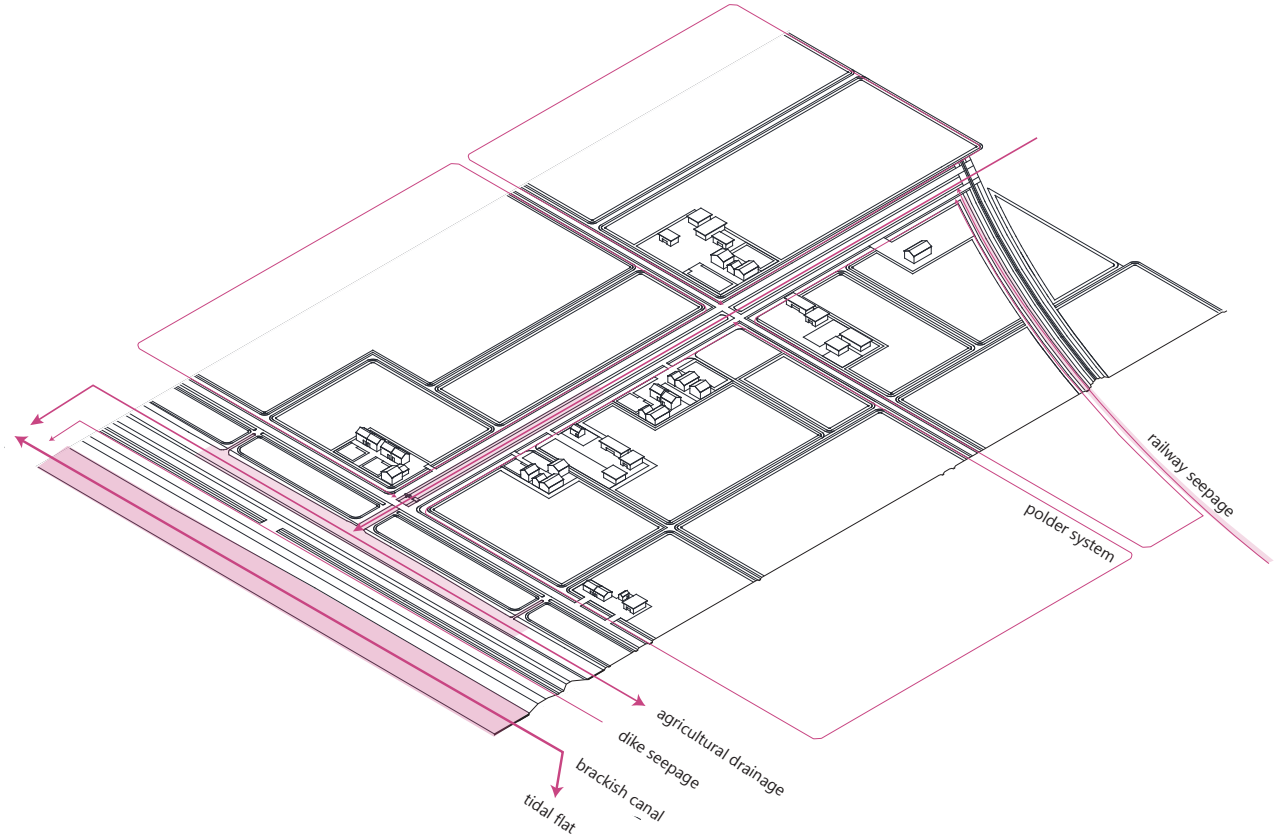
Shrinking trend impact



Flood hazard potential

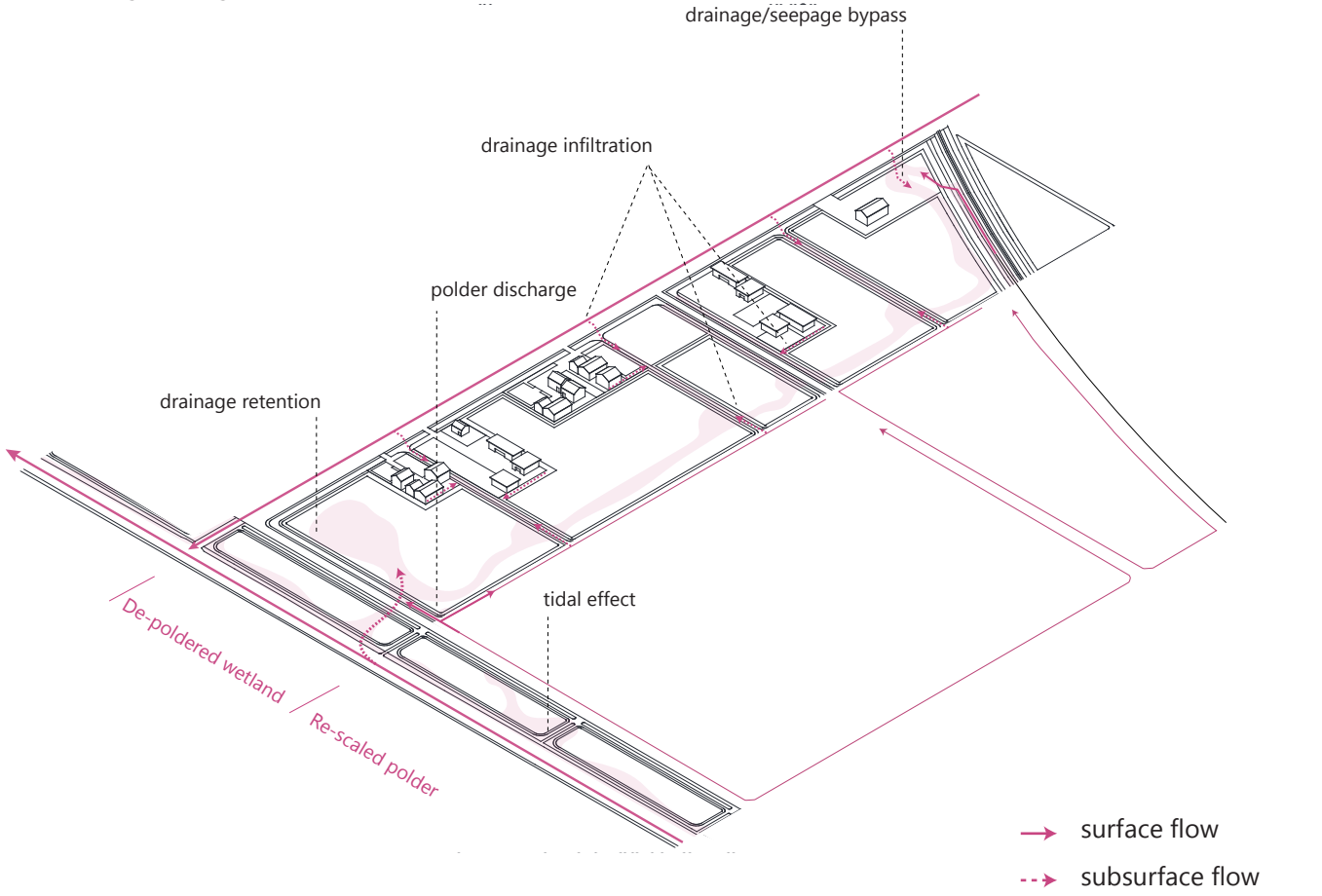


Original combined system of runoff discharge, polder discharge Amstelmeer discharge and irrigation.



Utilize

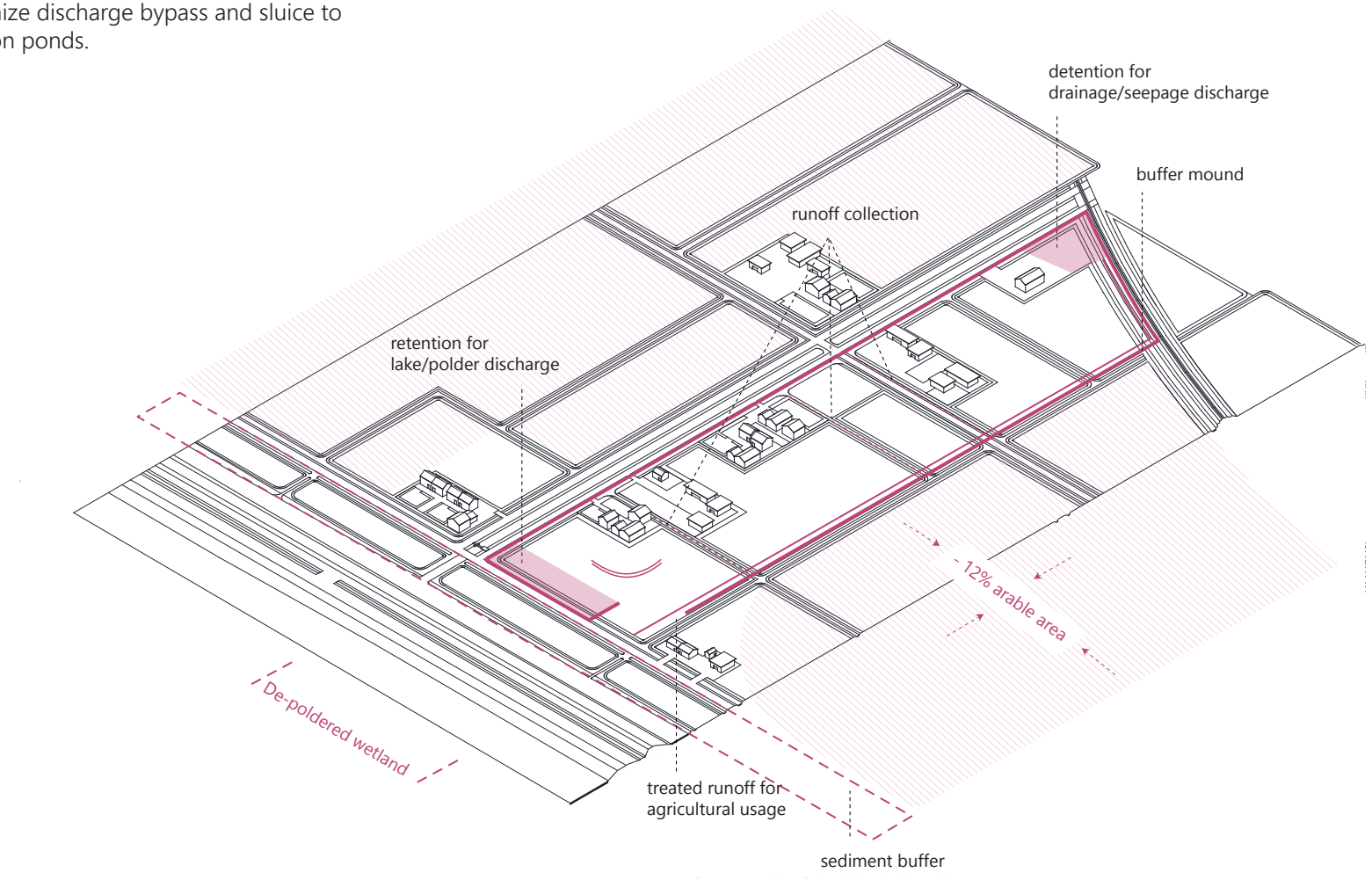
Depolder roadside (gutter side) fragmented polders.
Released plots are conserved for discharge storage.



Guide

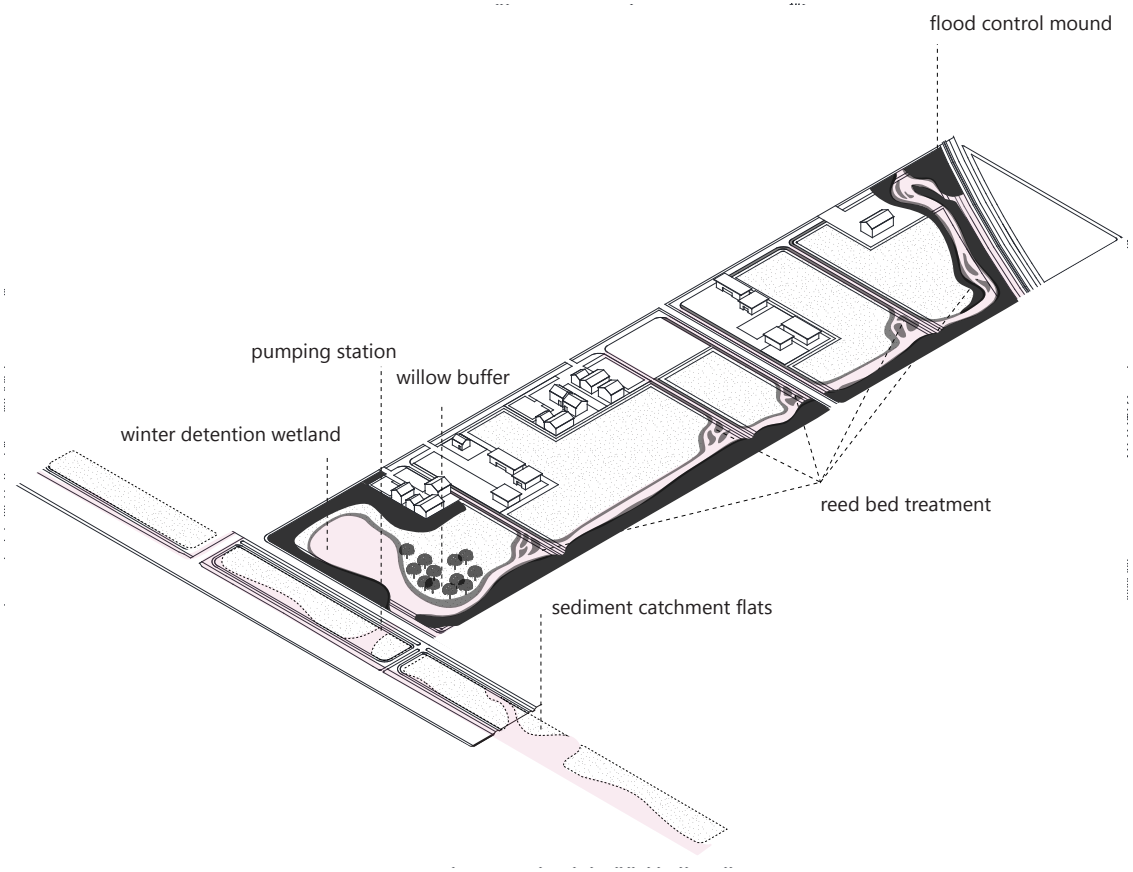
Reorganize smaller polder circulation unit.
Concentrate arablle spaces.

Reorganize discharge bypass and sluice to detention ponds.



Guide

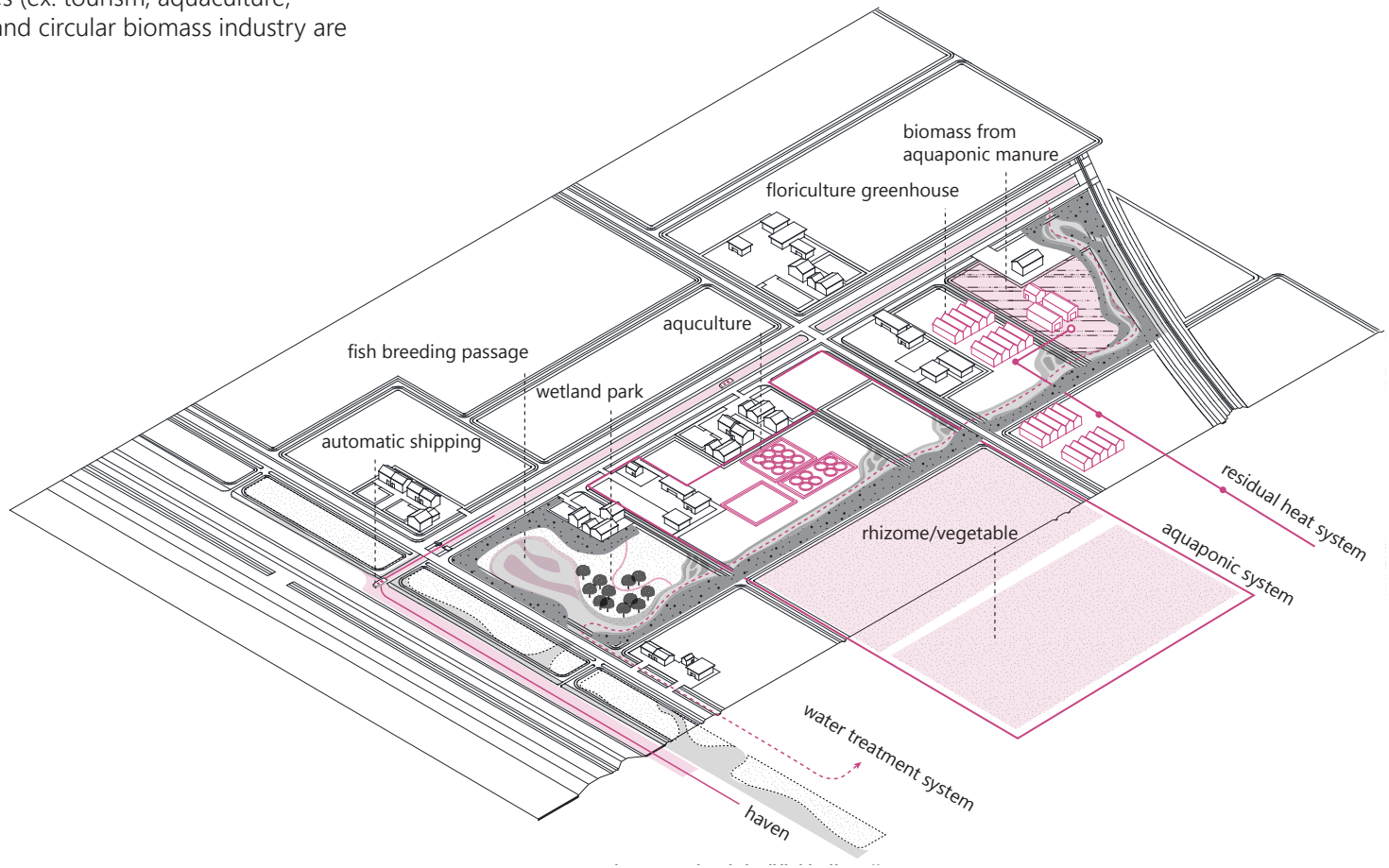
Use marsh, wetland and clay mound ecosystem to construct flood control and runoff treatment corridor.



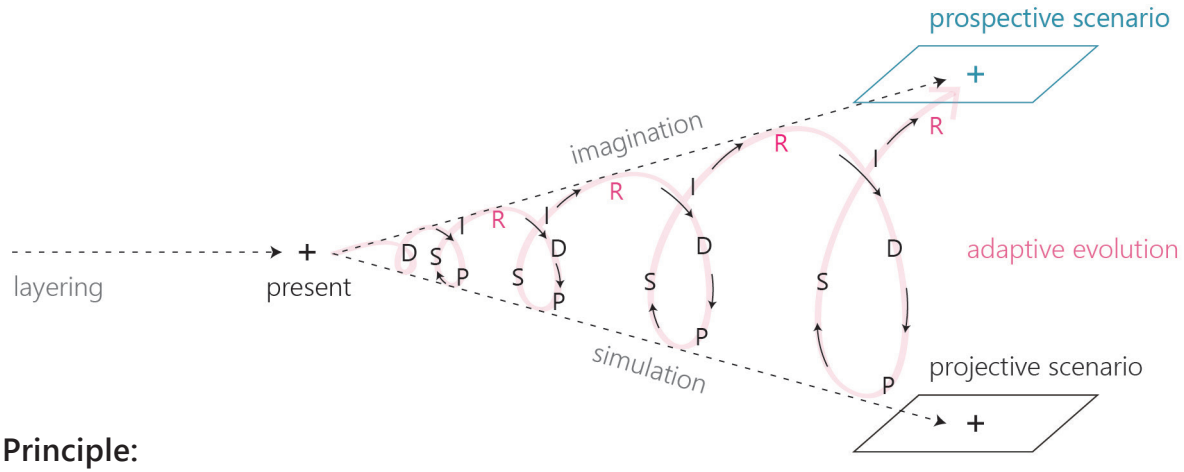
Oppose

New landscape types and future automations can nourish more diverse landuses.

Light industries (ex. tourism, aquaculture, greenhouse) and circular biomass industry are encouraged.



Open-ended Evolution



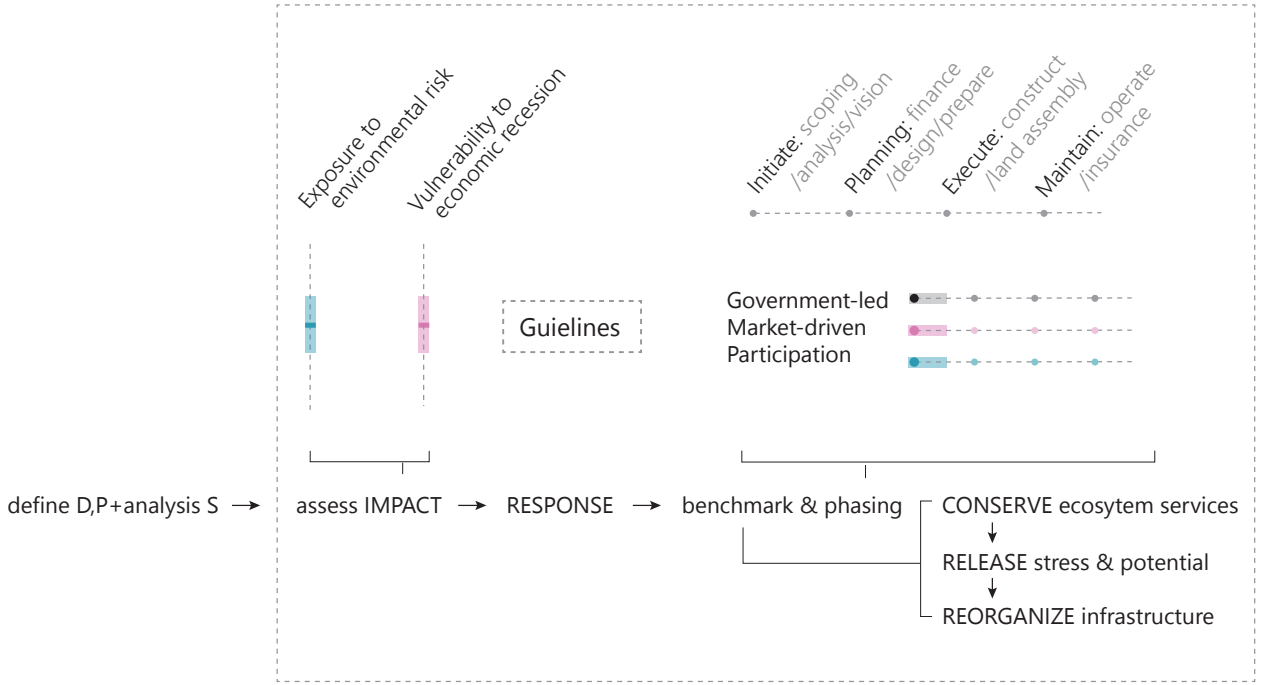
Principle:
Natural system as sustainable fuel

Longterm management

SHRINK NATURALLY

Shrinking is an inevitable fate for many port cities. Aiming to oppose shrinkage may deteriorate the lose of resources, resulting in vulnerable urban decline and higher exposure to coastal risks.

Thus, the proposed adaptive strategy is to reframe shrinkage as a phase of natural evolution, or even as an opportunity to conserve resources, release pressure and reorganize structures. The goal shall be to let such a city 'sustainably shrinks', and to make it a smaller but more attractive living environment, instead of ' poorly sinks'.



Adaptive Pathway

3 STRATEGIC SCHEMES+1 EXPERIMENT

scheme: UTILIZE

High risk exposure+ Recessing economic

Along Balgzand canal, three flood-prone low-laying areas are rezoned temporary detention basin in extreme situation. Idle spaces in these pockets are collected to construct gree/blue infrastructure for water management.

Mud motor

- Manage sediment in port and from de-polder
- Bypass surface runoff from port
- Transform idle canals to tidal park
- Reuse subsiding polders for flood storage

Flow management (water, sediment)

- new outlet of sweet water
- new main drainage direction (existing canals)
- new sediments sources
- sediments transport

Flood management

- mounds
- marsh nurishment

Ecosystem services management

- green patches
- corridor carrying biodiveristy and recreation

scheme: GUIDING LINES

High risk exposure+ Flat economic growth

Diversify industry sectors and facilitate flood-adaptive urban renewal by revitalizing existing canal-drainage-fortage network system.

Blue synergy infrastructure

Den Helder has a high percentage of open field and green/blue areas. By improving the connections between these spaces, a green infrastructure can be designed to enhance ecosystem services.

Connectivity of green/blue area

- Fort heritage
- Sand dunes landscape
- Arable polders
- Wetland and marsh
- Canals

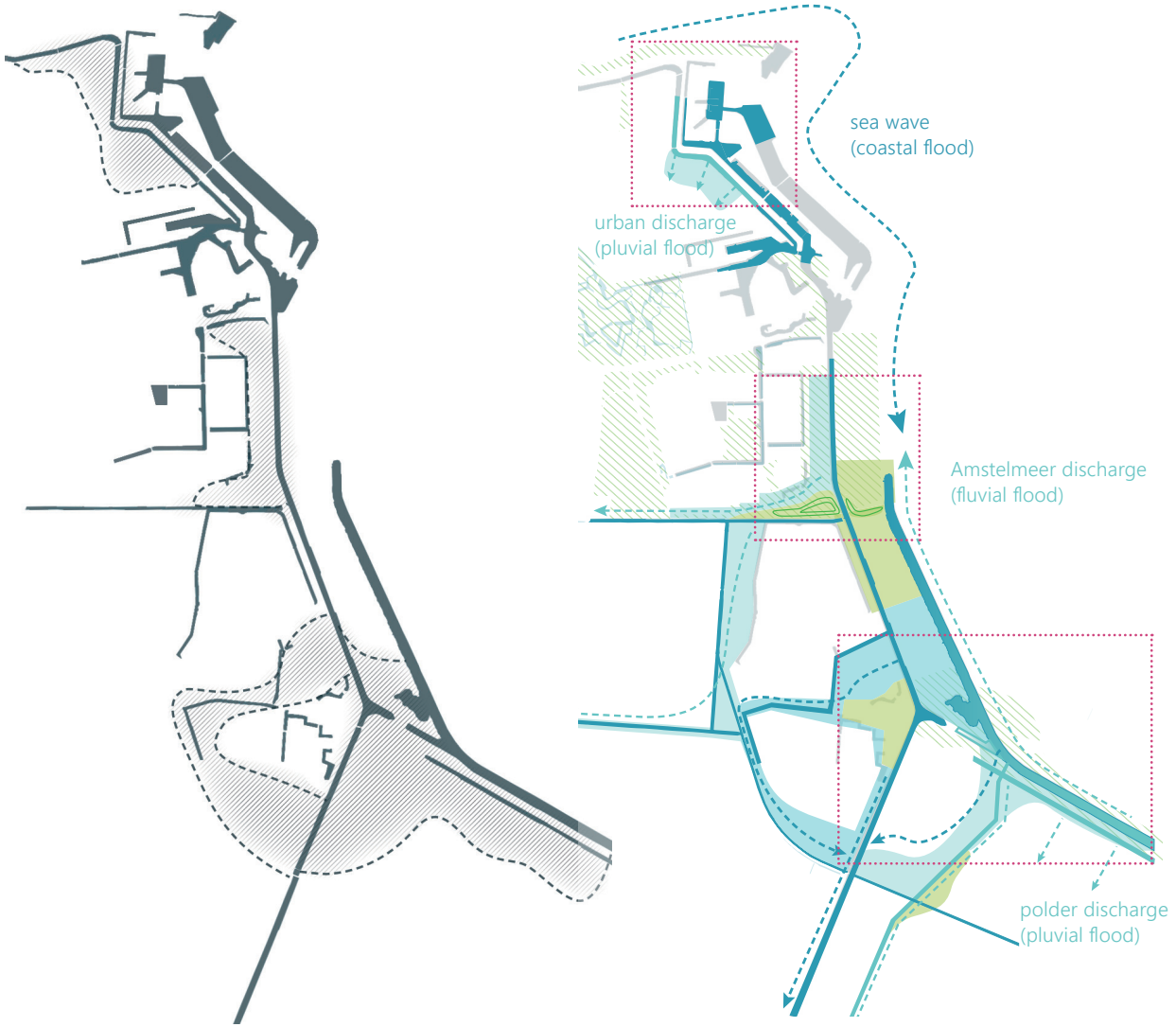


fig. Three detention basins are grid to existing green blue patches to mitigate combinated flood risks.

- green buffer mound
- temporary blue corridor

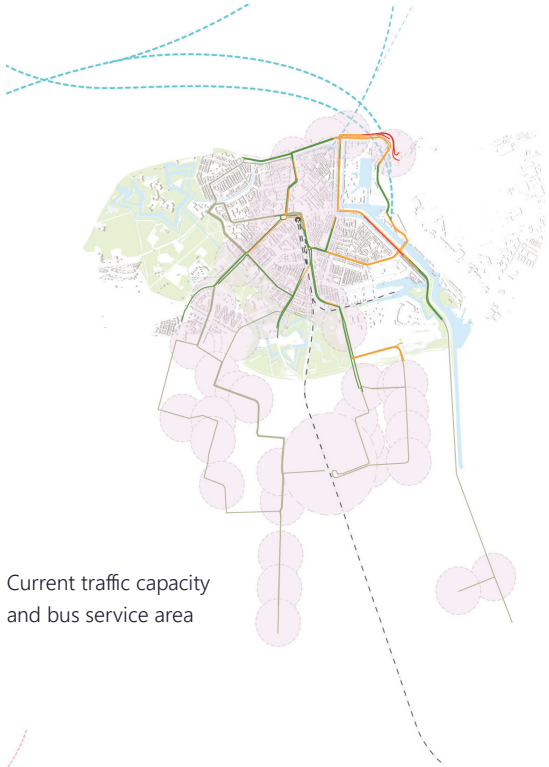
scheme: OPPOSING

Low risk exposure+ economic growth

Enlarge traffic capacity to support scale-up of offshore and tourism industry by cost-efficiently reusing blue infrastructure. Port expansion can be designed to cope with wave and nourish Balgzand marsh.

Building with nature

- Port expansion adapt to current as wavebreak to nourish marsh
- Integrate sea dike with wave attenuation marsh and artificial oyster reef



Current traffic capacity and bus service area

Proposed renew service plan

Fig. New development cope with high/ low dynamic character of places.

(left) Low dynamic structure:
Areas with low economic vitality.
More incentives required.
Conserve natural capital.

(right) High dynamic pockets:
Areas sensitive to economic climate
Leverage on market

Fig. Reuse existing canal and bus lanes to provideTouristic transit service

- areas sensitive to economic growth
- P+R hubs
- canal tour hubs
- bike path
- P+R route
- canal tour

Experiment:

Managed Flood Festival

Objective:

- rise risk awareness
- adjustment
- collect new sediments from sweet flux

Period:

- early Spring: (around King's day)
  medium tidal level+ regular precipitation
  + less traffic load (off-peak touristic season)

Procedure:

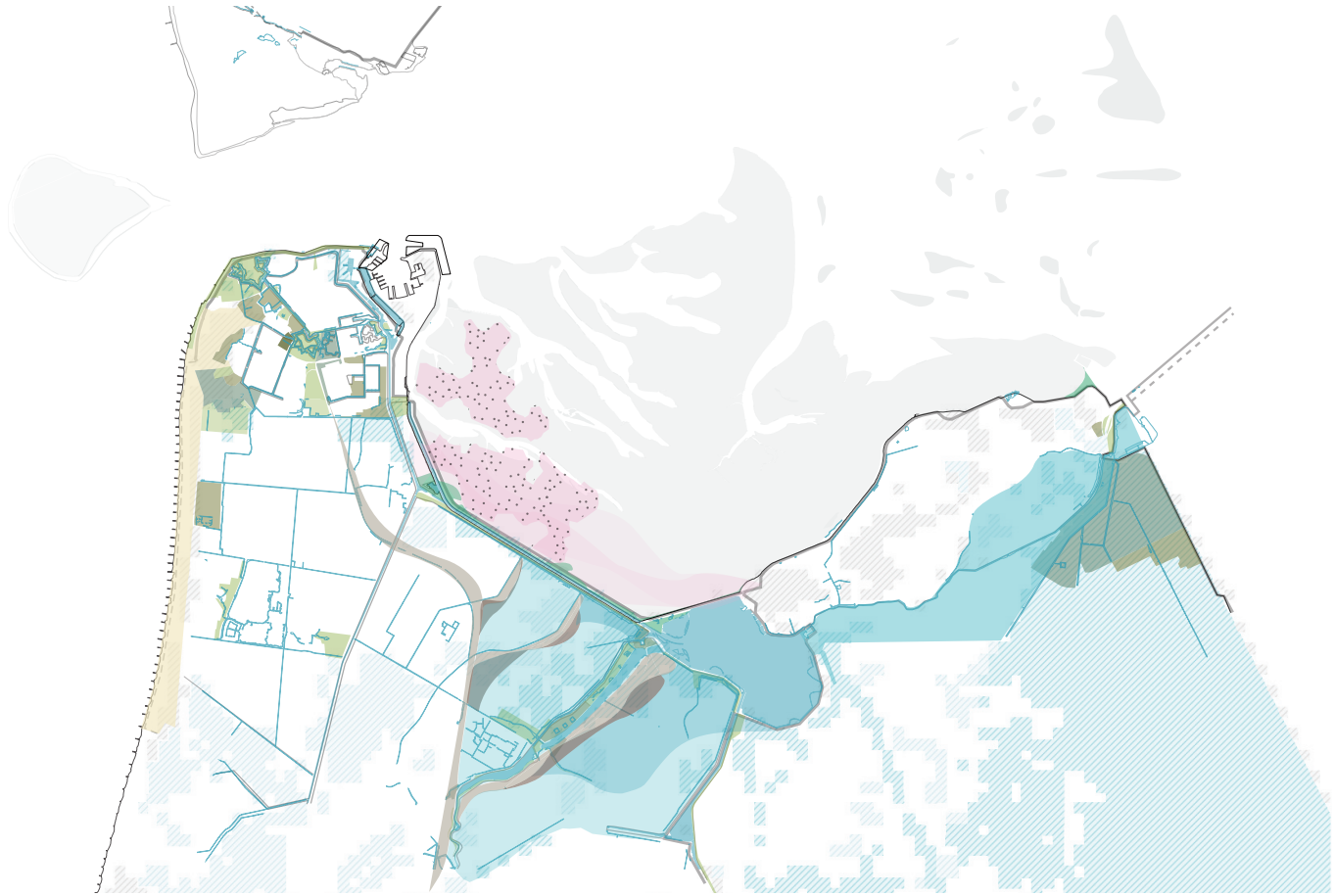
- temporarily open sluice of Amstelmeer to let sweet discharge run through flood detention plains

Evaluation:

- ecosystem services valuing framework
- cost-benefit: nourished marsh area, flood control preformance, dike maintenance
- insurance coverage, participations
- property value; de-polder trade-off
- detention capacity in transformed plots

Adjustment

- flood defense measurements
- land use realignment
- flood simulation accuracy
- insurance package
- policy incentives

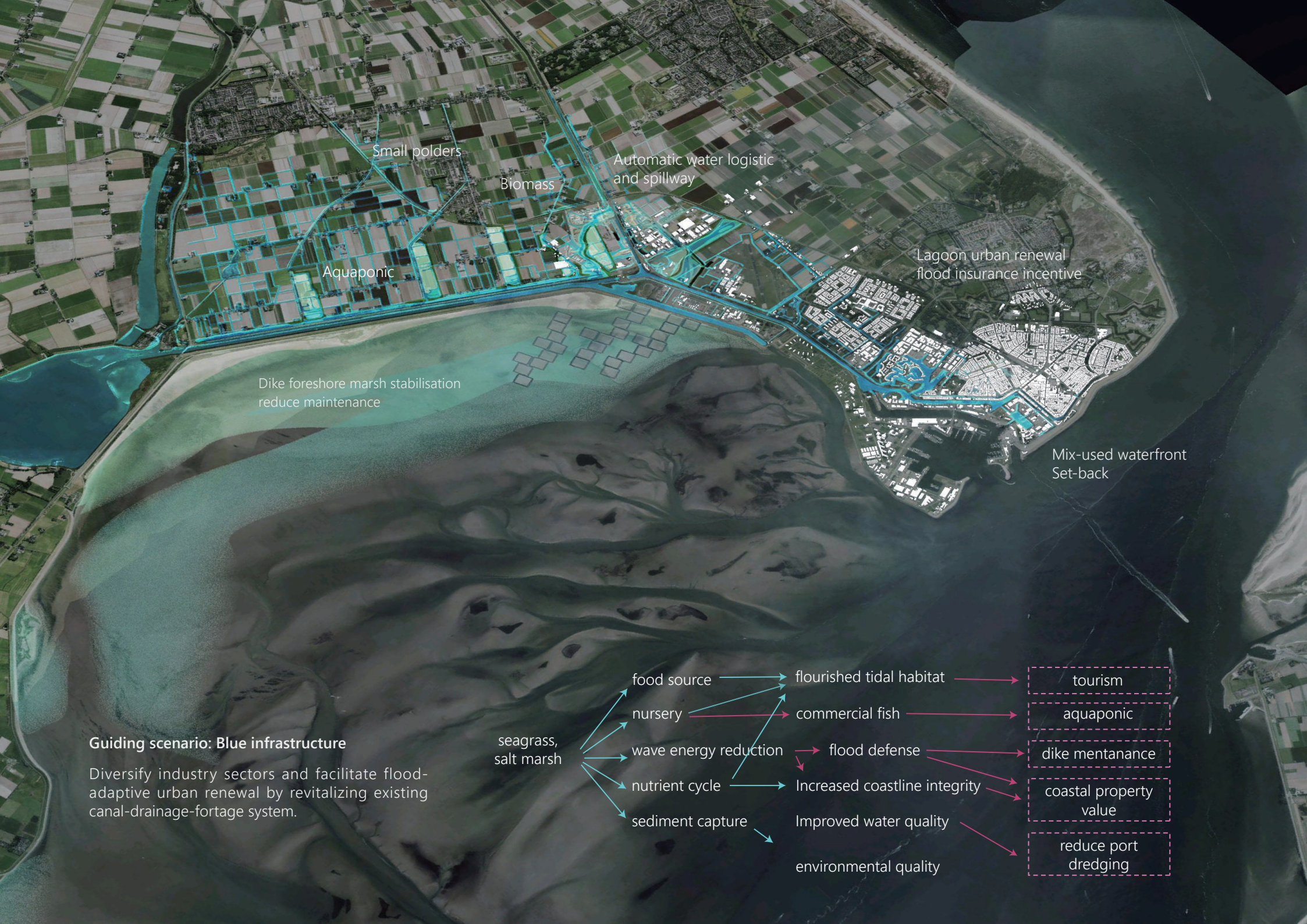


Natural Base: hydraulic forces + tidal ecosystem

Den Helder is an experimental habitat at the edge of Netherlands and Wadden Sea. Its urban development leverages on ecosystem services and flexibly adapts to hydro dynamics – sometimes shrinking and sometimes extensive.

Utilizing scenario: Mud motor

Generated by dredging and drainage, the mud motor operates as systematic management over sediments, flood, ecosystem conservation and productivity, by a sequence of marsh, de-poldered detention basins and idle perneable plots.



Guiding scenario: Blue infrastructure

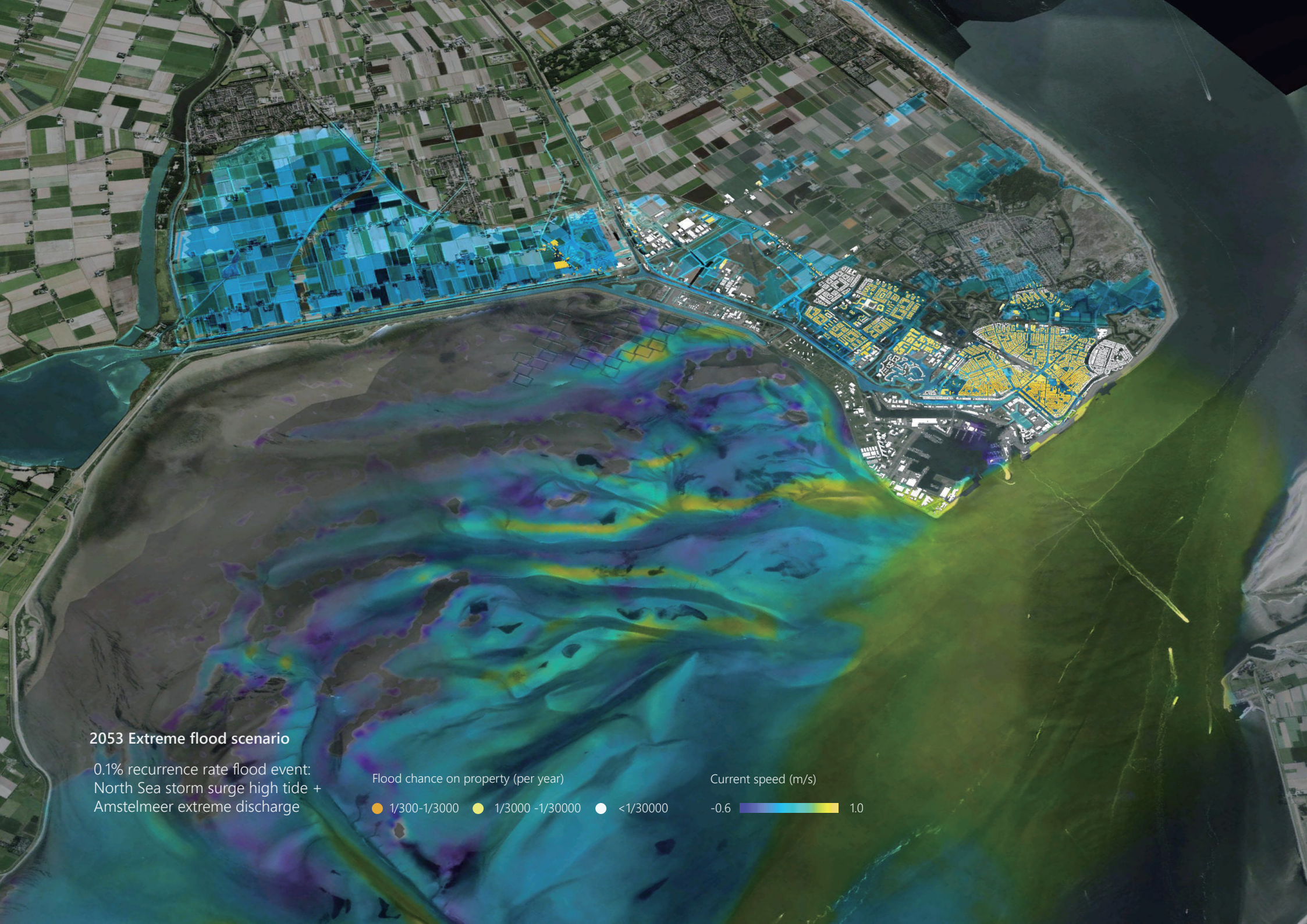
Diversify industry sectors and facilitate flood-adaptive urban renewal by revitalizing existing canal-drainage-fortage system.

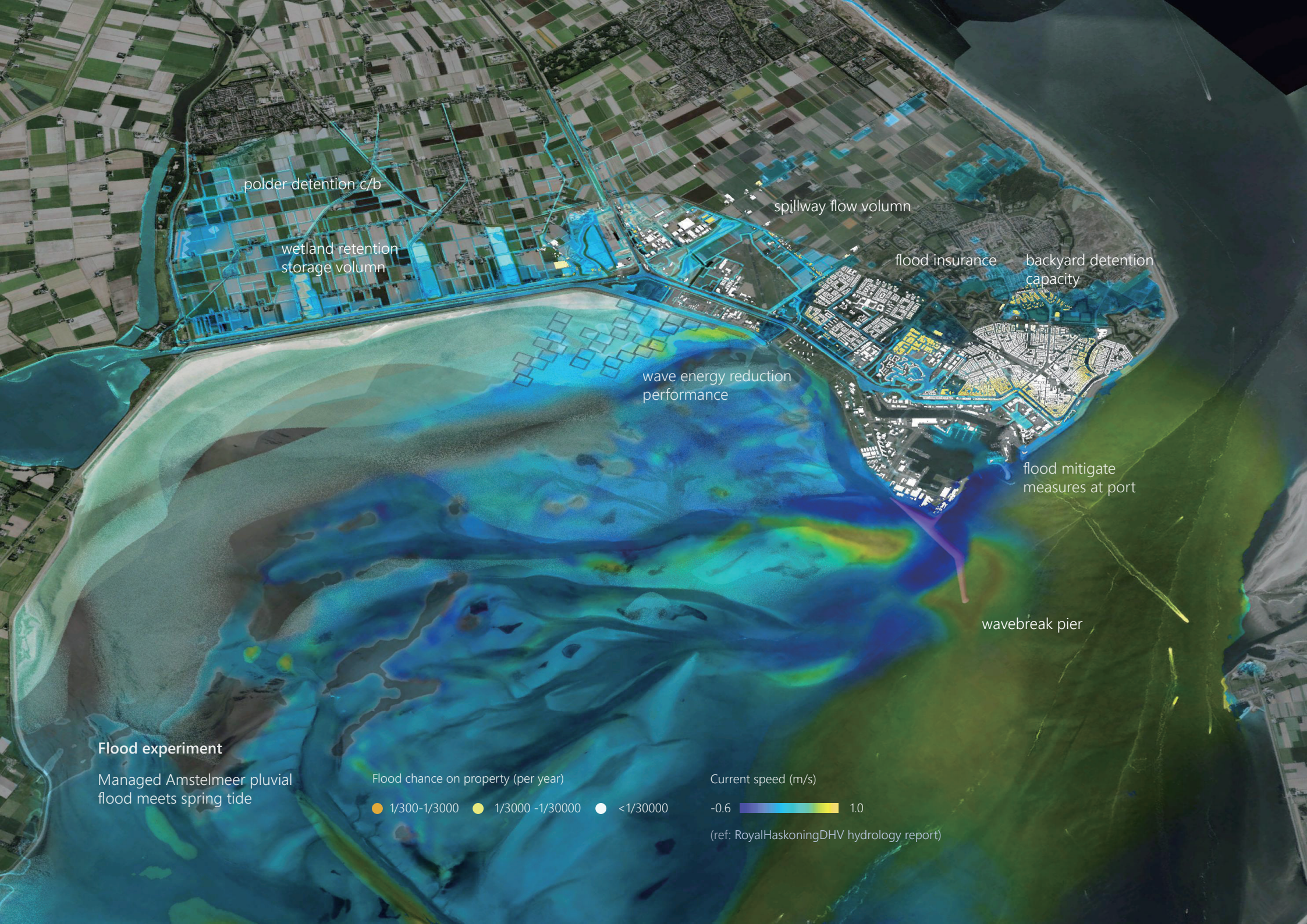
Opposing scenario: Building with nature

Enlarge traffic capacity to support scale-up of offshore and tourism industry by cost-efficiently reusing blue infrastructure. Port expansion can be designed to cope with wave and nourish Balgzand marsh. (ref: RoyalHaskoningDHV hydrology report)

Pilot investment

- areas sensitive to economic growth
- P+R hubs
- canal tour hubs


2053 Extreme flood scenario
0.1% recurrence rate flood event:
North Sea storm surge high tide +
Amstelmeer extreme discharge
Flood chance on property (per year)
1/300-1/3000
1/3000 -1/30000
<1/30000
Current speed (m/s)
-0.6
1.0


polder detention c/b
wetland retention storage volumn
spillway flow volumn
flood insurance
backyard detention capacity
wave energy reduction performance
flood mitigate measures at port
wavebreak pier
Flood experiment
Managed Amstelmeer pluvial flood meets spring tide
Flood chance on property (per year)
1/300-1/3000
1/3000 -1/30000
<1/30000
Current speed (m/s)
-0.6
1.0
(ref: RoyalHaskoningDHV hydrology report)

Reflection

How to employ Nature-Based Solutions to strengthen adaptability of shrinking Den Helder to flood risks?

- What are the values of Nature-Based Solutions that can strengthen local adaptability to flood risk?

◦ For Den Helder locals, *cost-efficiency, inclusiveness, sustainability and better living quality* are highlighted values of nature-based solutions.

How to employ Nature-Based Solutions to strengthen adaptability of shrinking Den Helder to flood risks?

- How to conserve ecosystem services and natural evolution in a shrinking city?
- How to support Den Helder's long-term development with Wadden Sea ecosystem services?

◦ Accept urban shrinkage as part of *natural evolution phase*. What should be avioded is further exploitation and exposure to risk.

◦ Revise common strategies against shrinkage (utilize, guide, oppose) with *adapative cycle (release, reorganize, conserve).*

◦ Highlight *dynamic balance* between economy and ecology development

◦ *Risk sharing insurance* as an incentive to trigger urban renewal process and long-term investment

How to employ integrated coastal zone management in coastal urban design?

- How to integrate risk management in transcalar spatial design?

◦ Address risk from both environmental change and economic shift. *Transcalar DPSIR framework* ensures a holistic scope.

◦ Transcalar, process-oriented: 3x3x3 analysis

◦ *Multi-functional* spatial intervention: natural + logistic+ flood management *landscape infrastructure*

◦ Risk management: combine *spatial intervention with incentive* (insurance scheme) to rise awareness, share risk and facilitate adaptation

How to employ integrated coastal zone management in coastal urban design?

- How to comprise local spatial quality with coastal engineering?

◦ *Design Fiction* as an explorative method to comprise local imaginations and site-based desirable living quality with in spatial design

◦ *BwN* coastal interventions are proved to effectivity leverage on nature-based potential and thus to conserve its quality

' ... bring more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource-efficient and systemic interventions....'

-- *Nature-Based Soultions. European Committee 2015*