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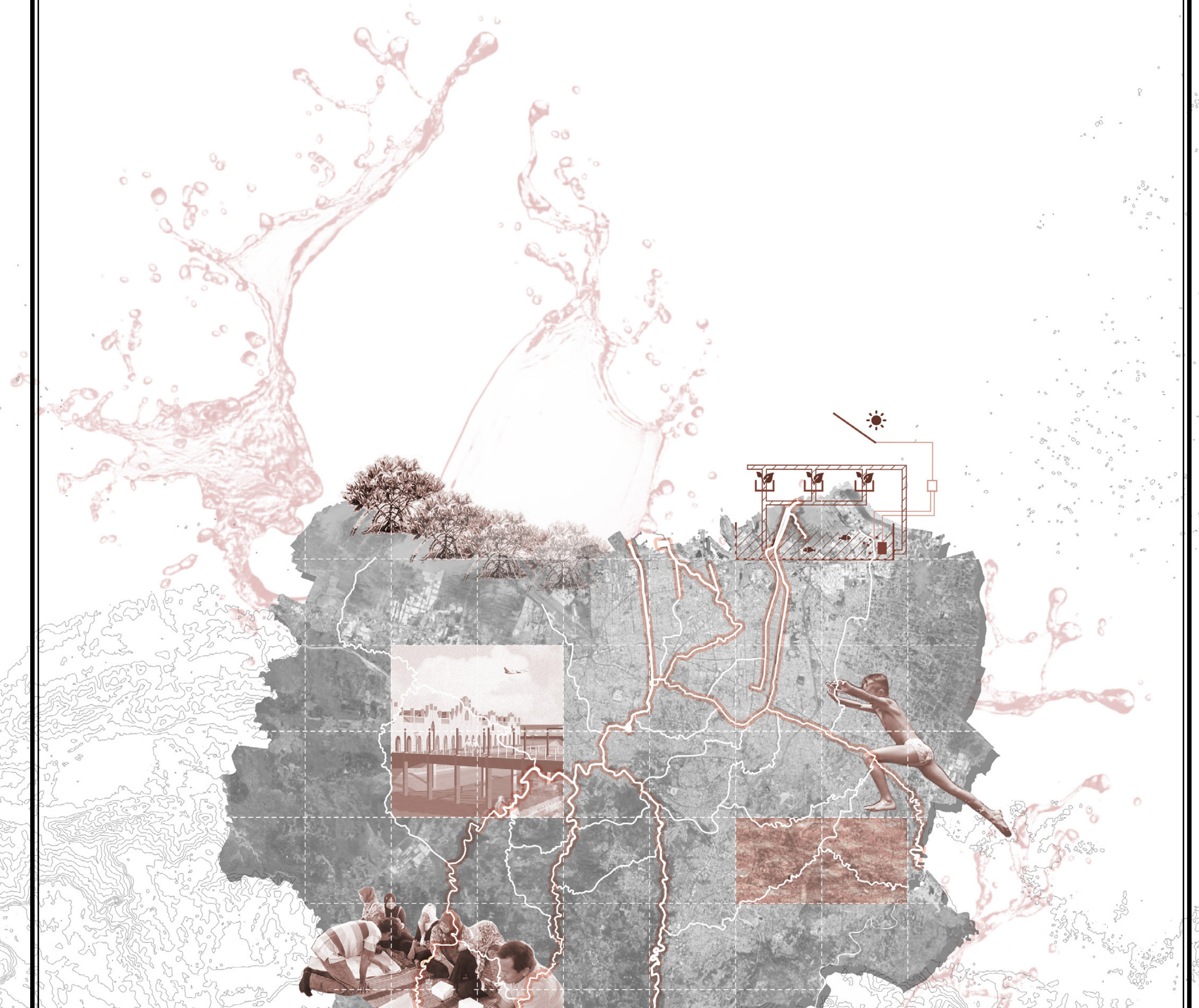

Flush and Splash:
Regenerative Capacity for Semarang Urban Water Management

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Flush and Splash:
Regenerative Capacity for Semarang Urban Water Management
Semarang, Indonesia

Graduation Project
P5 Report

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Research studio:
Transitional Territories
Shared Heritage Lab

This graduation project follows the annotation:
Infrastructure and Environment Design
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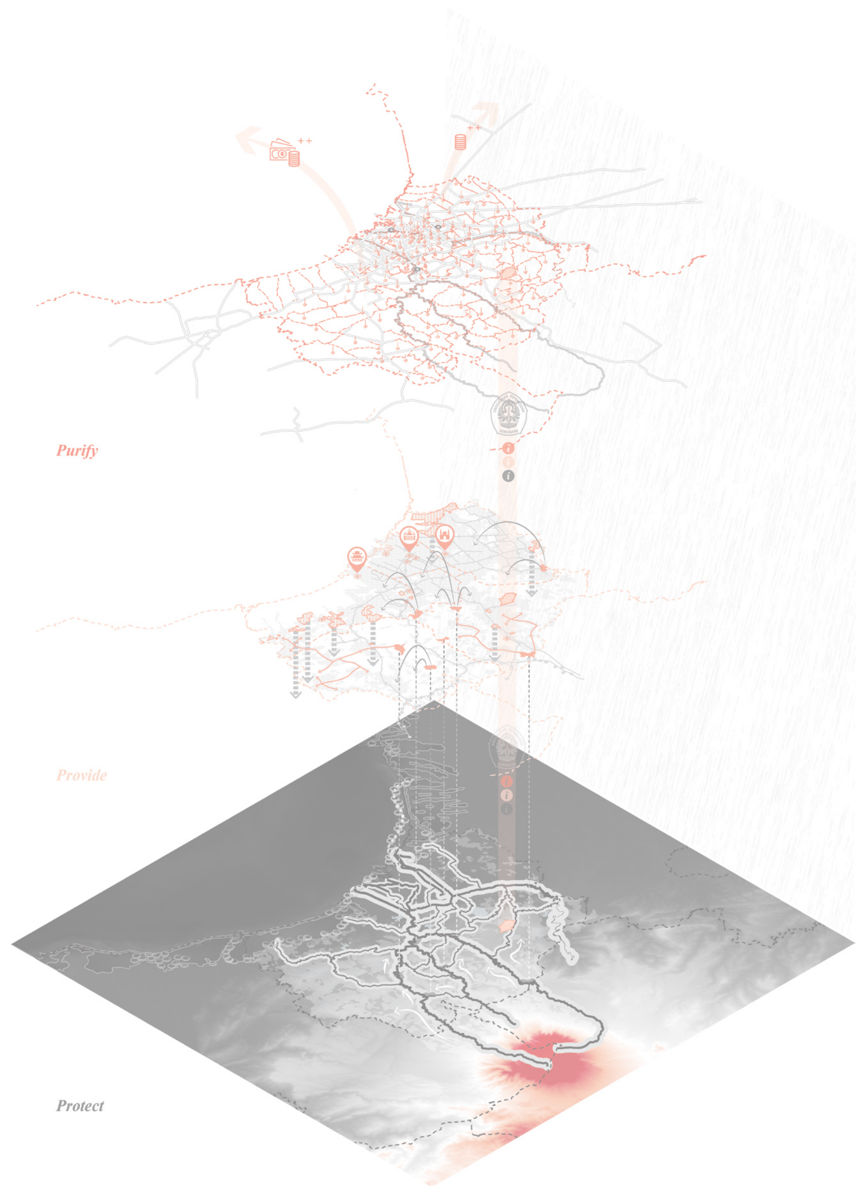

Flush and Splash:
Regenerative Capacity for Semarang Urban Water Management

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With Love,
Prinka A.

Abstract

The Flush and Splash project proposes to reconnect the cultural and the natural heritage of the city through the Semarang river watershed. It begins with acknowledging how the Semarang river have been facing continuous landscape degradation despite it being a backbone of the city based on the observation of historical trajectory and site visits. Following the synthesis, the thesis then constructs its foundation by the theory of risk = (hazard x vulnerability) / coping capacity (Cardona. et al., 2012). Hence, the analysis proceed by investigating the variables of the equation which leads to the findings of multiple water related challenges: (1) land subsidence due to uncontrolled groundwater extraction; (2) coastal, pluvial, and fluvial flooding; and (3) low water quality due to poor waste management in the city. These hazards are currently dominating the equation as the coping capacity and the vulnerability of the citizens have not been able to balance the scale. This framework then developed the equation by changing the coping capacity into regenerative capacity, which is the combination of the theories of ecosystem services biomimicry (Zari, 2018) and socio-ecological resilience (Cote & Nightingale, 2012), in order to guide the project in developing water sensitive urban design strategies. A regenerative design means that interventions contain elements which mimic the ecosystem services that they become productive landscapes for the community to be able to sustain themselves in facing possible future hazards. Hence, the proposed strategies would try their best to engage with the local communities through participatory planning. Examples of these interventions are shown in this thesis through the three sub-projects of Purify, Protect, and Provide; which are pioneered by a series of multifunctional bridges along the Semarang River.

***Keyword**: Regenerative Design, Ecosystem Services Biomimicry, Socio-ecological Resilience, Paricipatory Planning.*

A. Introduction

Introduction to Semarang, Indonesia

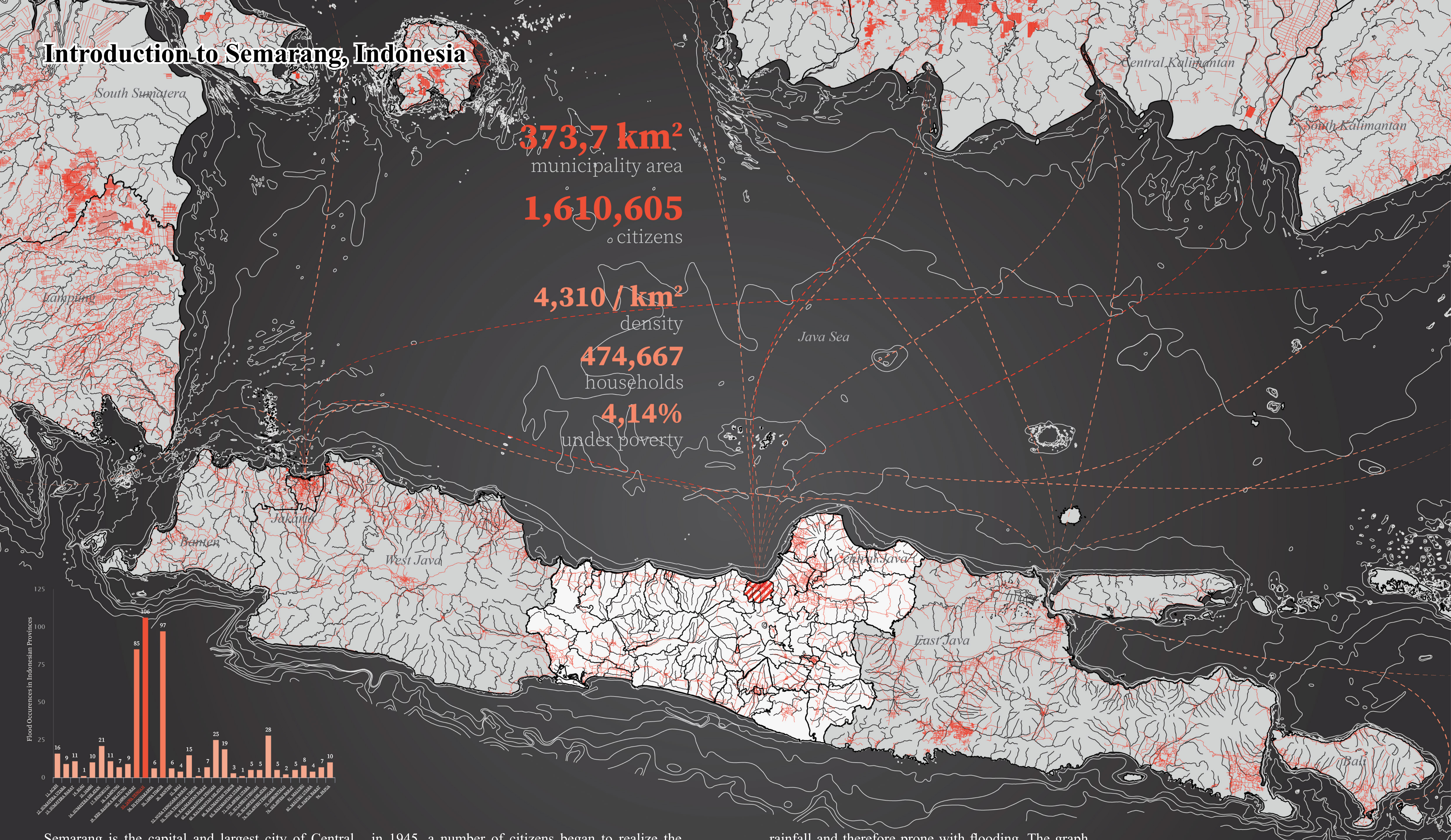
373,7 km²
municipality area

1,610,605
citizens

4,310 / km²
density

474,667
households

4,14%
under poverty

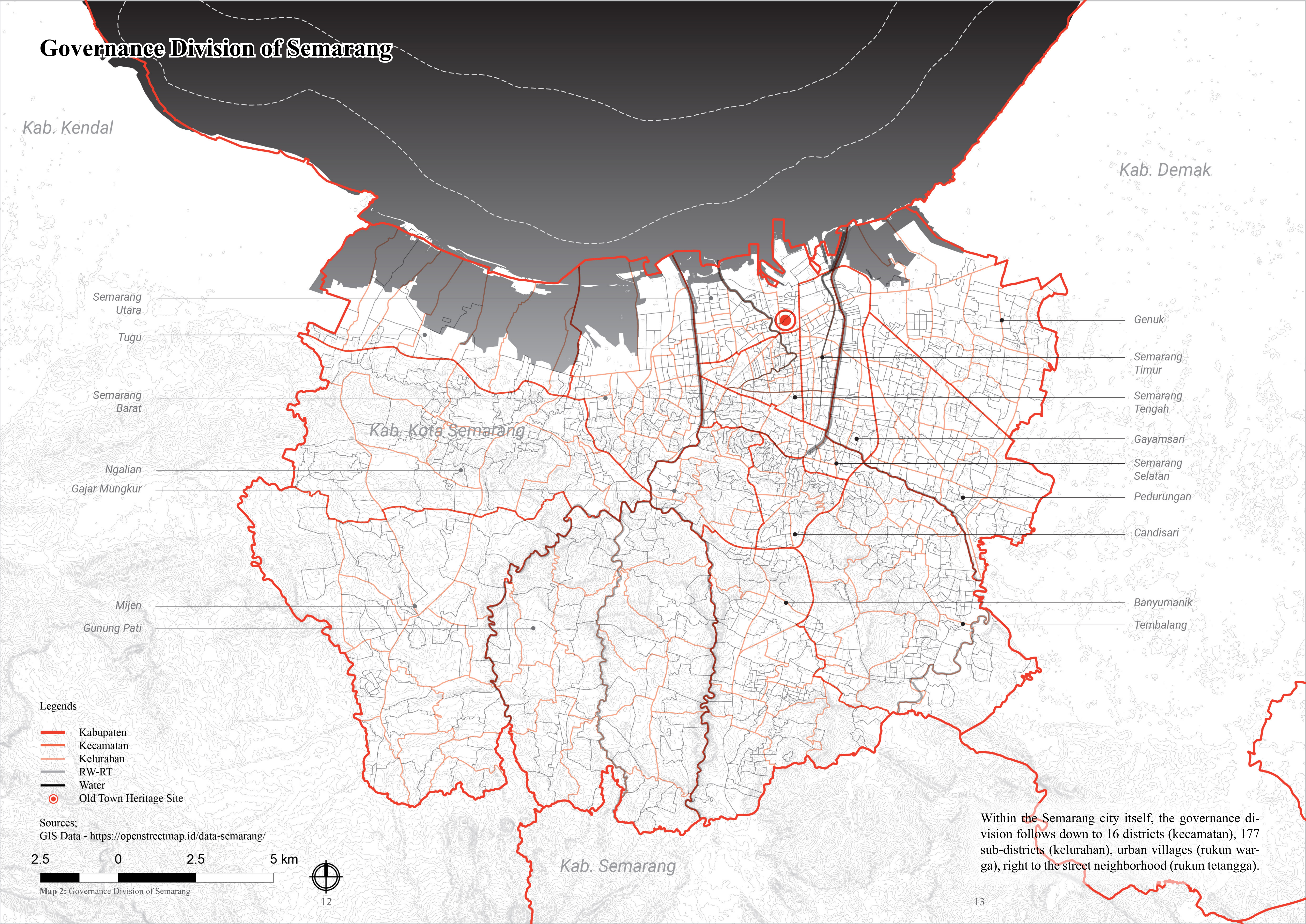


Semarang is the capital and largest city of Central Java province in Indonesia. Being located on the northern coast of Java, the city serves as a major port during the Dutch colonial era, and still an important regional centre and port today. It is also the main hub connecting Jakarta and Surabaya, as well as cities in the southern part of Java such as Surakarta and Yogyakarta. Decades after the Indonesian Independence in 1945, a number of citizens began to realize the necessity to nourish the remarkable buildings of the Old Town as the aesthetic value of the city became encapsulated by informalities. However, the extreme climate heighten the challenges. Semarang City elevation ranges from 2 meters below sea level up to 340 meters above the sea level. Together with a seasonal moonsoon climate, Semarang also deals with heavy rainfall and therefore prone with flooding. The graph above shows that Central Java has highest number of flood occurences. This report will address the extensive hazards that Semarang is facing, the consequences that are exposed to it, as well as the strategies to mitigate the water-related challenges so that Semarang could remain as an important urban centre in Indonesia with developed resilient measures.

Map 1: Semarang Geographical Location

Source: Statistics of Semarang Municipality, Badan Nasional Penanggulangan Bencana (BNPB).

Governance Division of Semarang



Sources;
GIS Data - https://openstreetmap.id/data-semarang/

Map 2: Governance Division of Semarang

Within the Semarang city itself, the governance division follows down to 16 districts (kecamatan), 177 sub-districts (kelurahan), urban villages (rukun warga), right to the street neighborhood (rukun tetangga).

Water and Settlements throughout Time

Historical Momentum

6th Century
Arrival of Chinese traders lead by Zheng He in Bergotta island

15th Century
Kyai Pandan Arang brought islamic teachings and become first mayor of Semarang

1650
The Dutch East Indies Company (VOC) arrived in present-day-Indonesia for trading purposes

1830
Implementation of Cultuurstelsel a.k.a forced cultivation system as the VOC went bankrupt

1872
New Tanjung Mas Port of Semarang

1864
The first railway of Indonesia from Semarang to Solo has been established

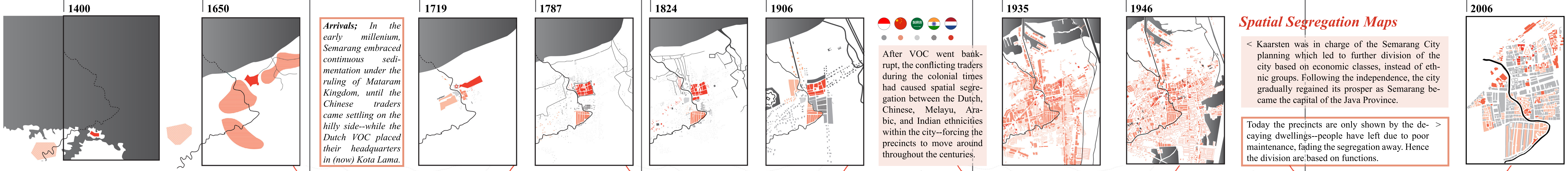
1936
Implementation of the 'Nieuw Tjandi' area on Semarang higher grounds as degined by Thomas Kaarsten

1945
Indonesia declared its Independence Day on August 17th, 1945

1945
A five days battle occured between Indonesian forces and Japanese forces of the 16th Army

1990
One of the worst flooding of Semarang in history--about 2 meters height and causing 100 fatalities

Population Growth



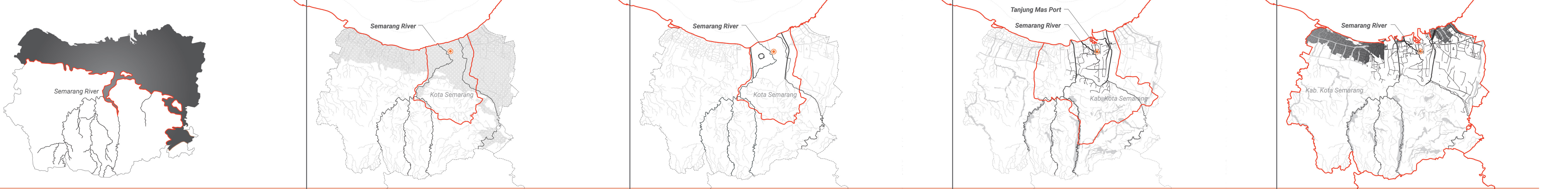
Arrivals; *In the early millenium, Semarang embraced continuous sedimentation under the ruling of Mataram Kingdom, until the Chinese traders came settling on the hilly side--while the Dutch VOC placed their headquarters in (now) Kota Lama.*

After VOC went bankrupt, the conflicting traders during the colonial times had caused spatial segregation between the Dutch, Chinese, Melayu, Arabic, and Indian ethnicities within the city--forcing the precincts to move around throughout the centuries.

Spatial Segregation Maps

< Kaarsten was in charge of the Semarang City planning which led to further division of the city based on economic classes, instead of ethnic groups. Following the independence, the city gradually regained its prosper as Semarang became the capital of the Java Province.

Today the precincts are only shown by the decaying dwellings--people have left due to poor maintenance, fading the segregation away. Hence the division are based on functions. >



9th Century
Semarang coastline prior to the millenium sedimentation.

1600
Semarang major waterways prior to human intervention. Only local settlements can be found at that time.

1900
Two main floodways shape the DNA of the city. With the establishment of the two floodways, the city morphology was transformed and extended horizontally. It also change the activities along Semarang river from port activities to daily use.

1940
Construction of minor canals within the Semarang City Centre. With the development of minal canals, Semarang has its first integrated urban drainage system, but meanwhile, it 'kills' the natural waterways of the city.

2017
Current flood risk management and measures within Semarang City. The current water related infrastructures were mapped out to show the general water system now in Semarang. And also the flooding and inundation areas were also mapped out.

Water Networks

Sources: Historical Trajectory: Roosmalen, 2019. / Population: http://www.populstat.info/Asia/indonesc.htm / Water Networks: Miladan, 2016. / Spatial Segregation: http://colonialarchitecture.eu/

Map 3: Semarang Water and Settlements Timeline

Current Urban Water Infrastructures

in response to flood-risk mitigation

Image 1: West Canal Flooding

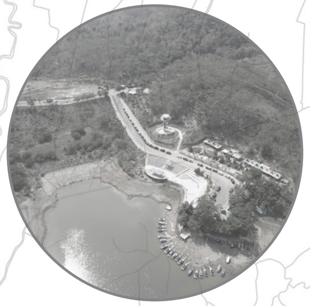
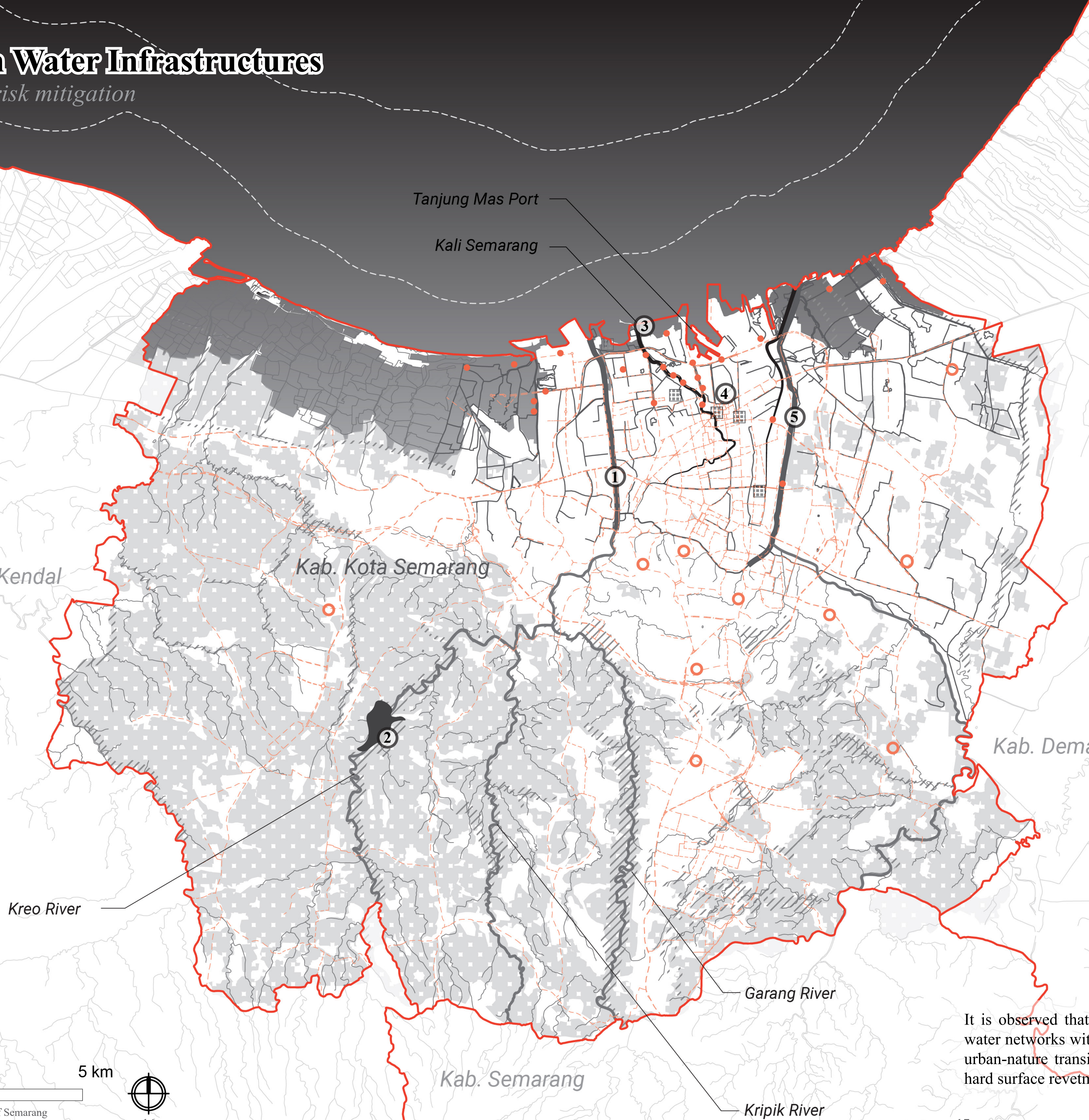


Image 2: Jatibarang Dam



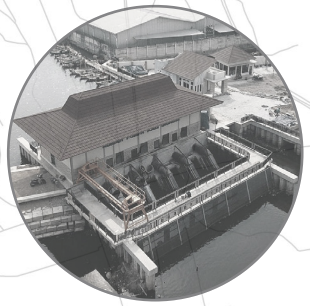


Image 3: Pump Stations

Image 4: Tawang Polder

Image 5: East Canal Flooding

Legend

- inundation area
- retention pond
- land absorption
- Jatibarang Dam
- polders
- reservoirs
- pump stations
- water treatment centre
- river
- major canals
- drainage channels (assuming by the streets)

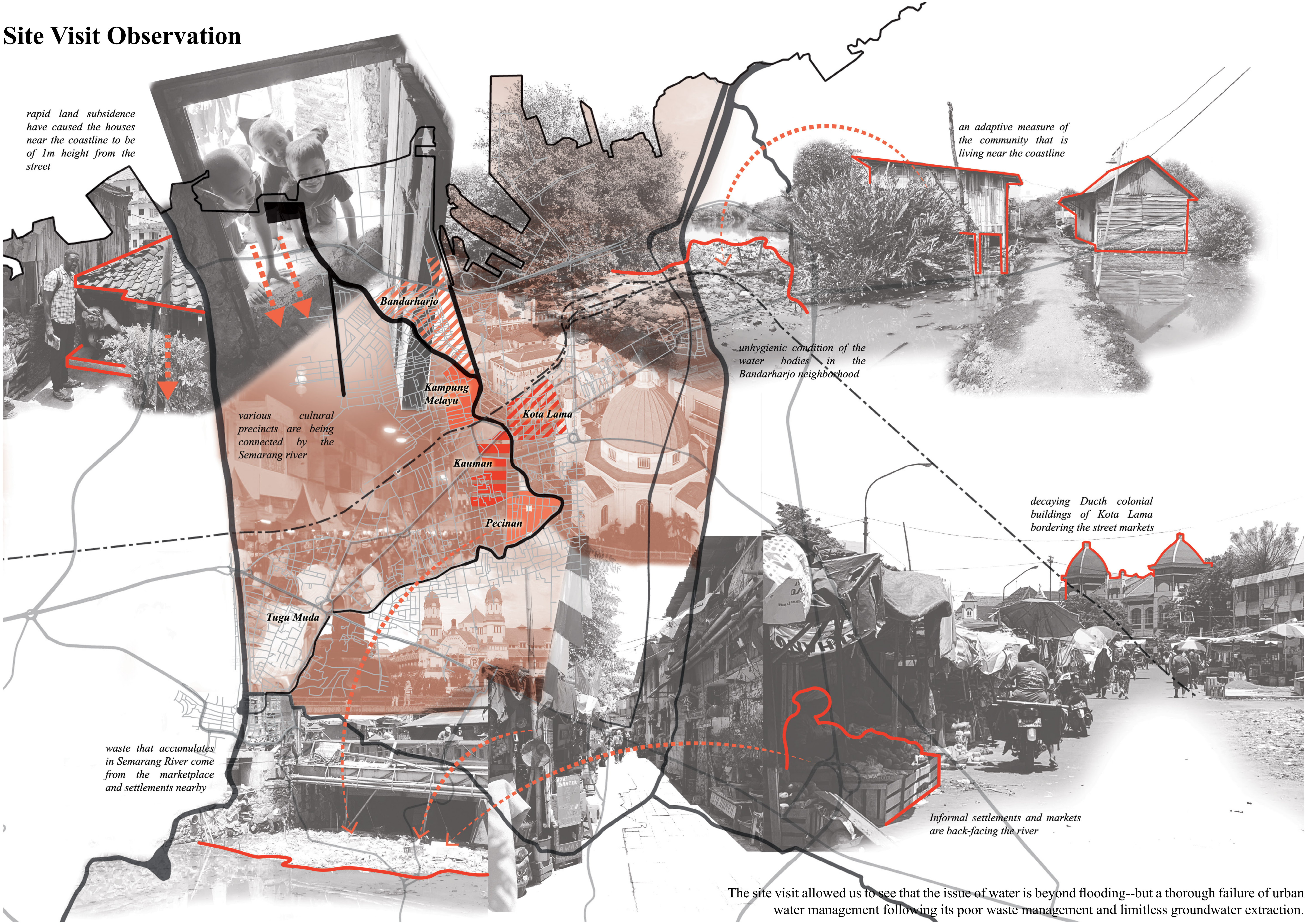
Sources:
City Report Semarang, 2017

2.5 0 2.5 5 km

Map 4: Current Water-related Infrastructures of Semarang

It is observed that most of the management of the water networks within the city serves as edges to the urban-nature transition--as most still accentuate the hard surface revetments within the infrastructures.

Site Visit Observation



The site visit allowed us to see that the issue of water is beyond flooding--but a thorough failure of urban water management following its poor waste management and limitless groundwater extraction.

Figure 1: Collage of Semarang water related issues

Thesis Aspirations

Aside from the urge to mitigate the problems, this thesis begin by pondering upon the established connection between the city's urban and nature environment. The pictures on the side reflect the desired relationship of which the water bodies of Semarang come to contact with the citizens.

1. Life Before Canals
An archive from 190, shows how the community lived without boundaries on to the Semarang River.

2. River Ceremony
A community in Jombang, East Java, performed a flag ceremony following their river clean-up communal work in August 2018.

3. Padma Aquaculture
Aquaculture landscape found on the West part of Semarang City--would this be the ideal life prior to industrialisation?

Picture sources:
1. http://colonialarchitecture.eu/
2. https://www.nu.or.id/post/read/94258/komunitas-santri-jogo-kali-dan-warga-jombang-bersihkan-sungai-
3. author's picture

Image 6: Kali Semarang 1890

Image 7: Flag ceremony in Jombang, August, 2018

Image 8: Aquaculture at Padma, West Semarang

B. Research Design

i. Synthesis
ii. Road Map Methodology
iii. Conceptual Framework
iv. Theoritical Framework
v. Problem Statement
vi. Research Questions & Expected Outcomes
vii. Thesis Plan

Early Synthesis

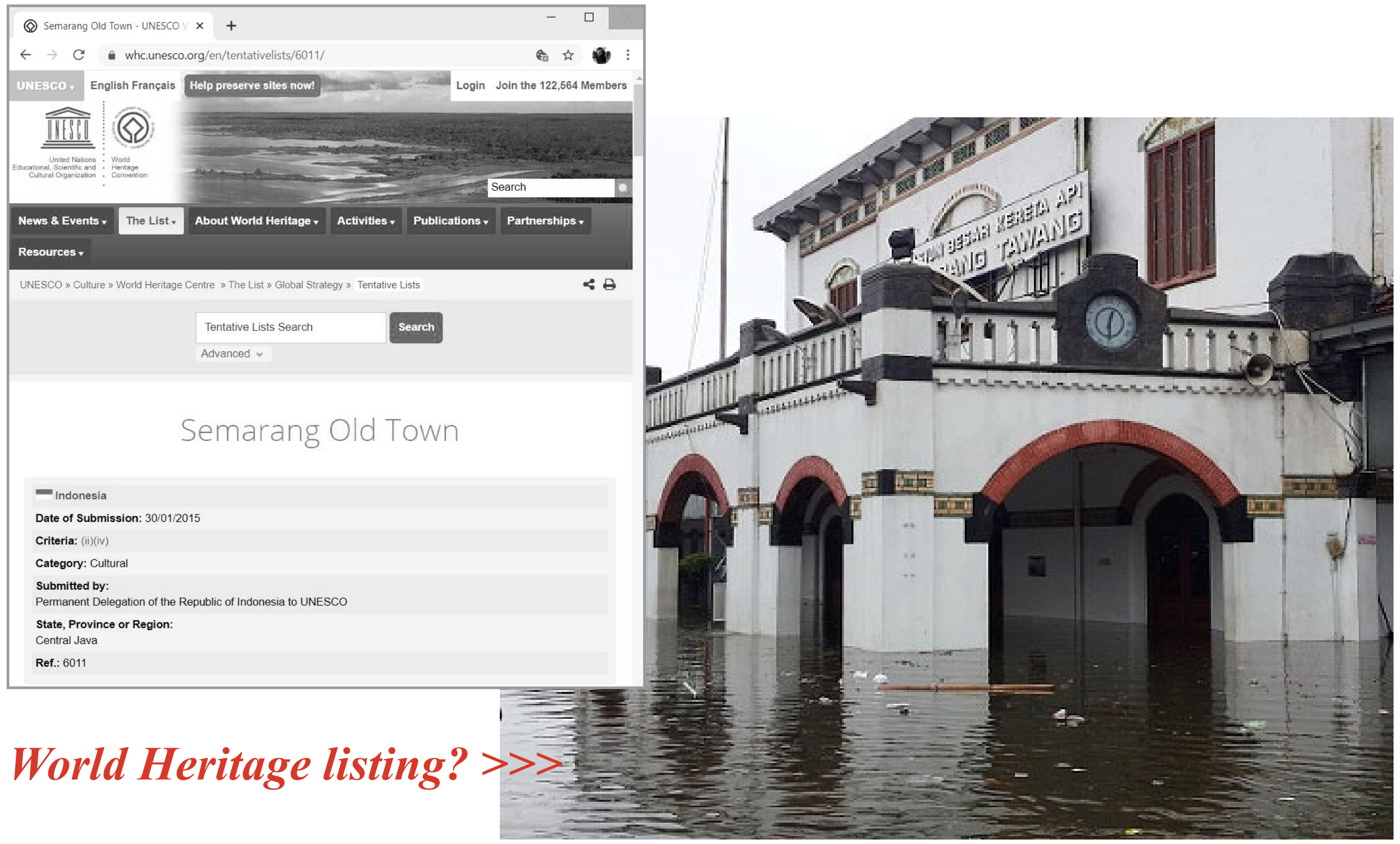


Image 9: Collage on reflecting the current nomintation to the flooded Semarang Tawang Station in February 2013

In Indonesia, a city called Semarang is about to repeat the mistake of the capital city, Jakarta. Moments after independence, the shared-heritage dwellings of the Dutch Old Town area were neglected for the time being. Uncontrolled informal settlements had therefore grown within its perimeter, as seen on google maps. Unfortunately, most of these settlements were built with the back of the houses facing the river. Hence, it induced a psychological effect where waterscapes are most of the time neglected. This mindset must have caused Semarang to be more prone to water-related problems such as fluvial flooding and intricate water sanitary issues as the factories are not concerned to dump their waste to the river. This challenge is amplified by the global phenomena of climate change where the sea level rises up to 20cm/year (Cascading Semarang, 2018). Another limits to the implementation of flood risk management in Semarang is the lack of data, financial support, and the clashing stakeholders which by rule of thumb, causes delay in the progress. This gap between the urban environment and the appreciation of natural elements may require certain attention. Speaking of this aim, this ‘nature re-introduction’ could be brought up by the Old Town where the most valued region meets the city’s meandering backbone—the Semarang River—which flows from Mt. Ungaran upstream to the main port. The aim of this thesis is to prevent the echoing problems in the cities of Indonesia by emphasizing the presence of water in the daily lives of people. The idea is to increase the awareness of water quality in the city which would allow them to embrace the notion of living *with* water for future resilience. This could eventually give themselves a chance of a better quality of life within this developing country. Especially in Semarang, where the decaying beauty of the Old Town are sought to be nominated as listed World Heritage. Hence, the water bodies would play an important role on the everlasting image of the city. In order to achieve this ambition, a deeper understanding on the hydrological risk and the context of Semarang is required. What are behind the key issues of flooding? Are there any current initiatives that have been done to mitigate the issue? Also, who are the people involved behind the water management of the City? Is this what they need?

Research Methodology

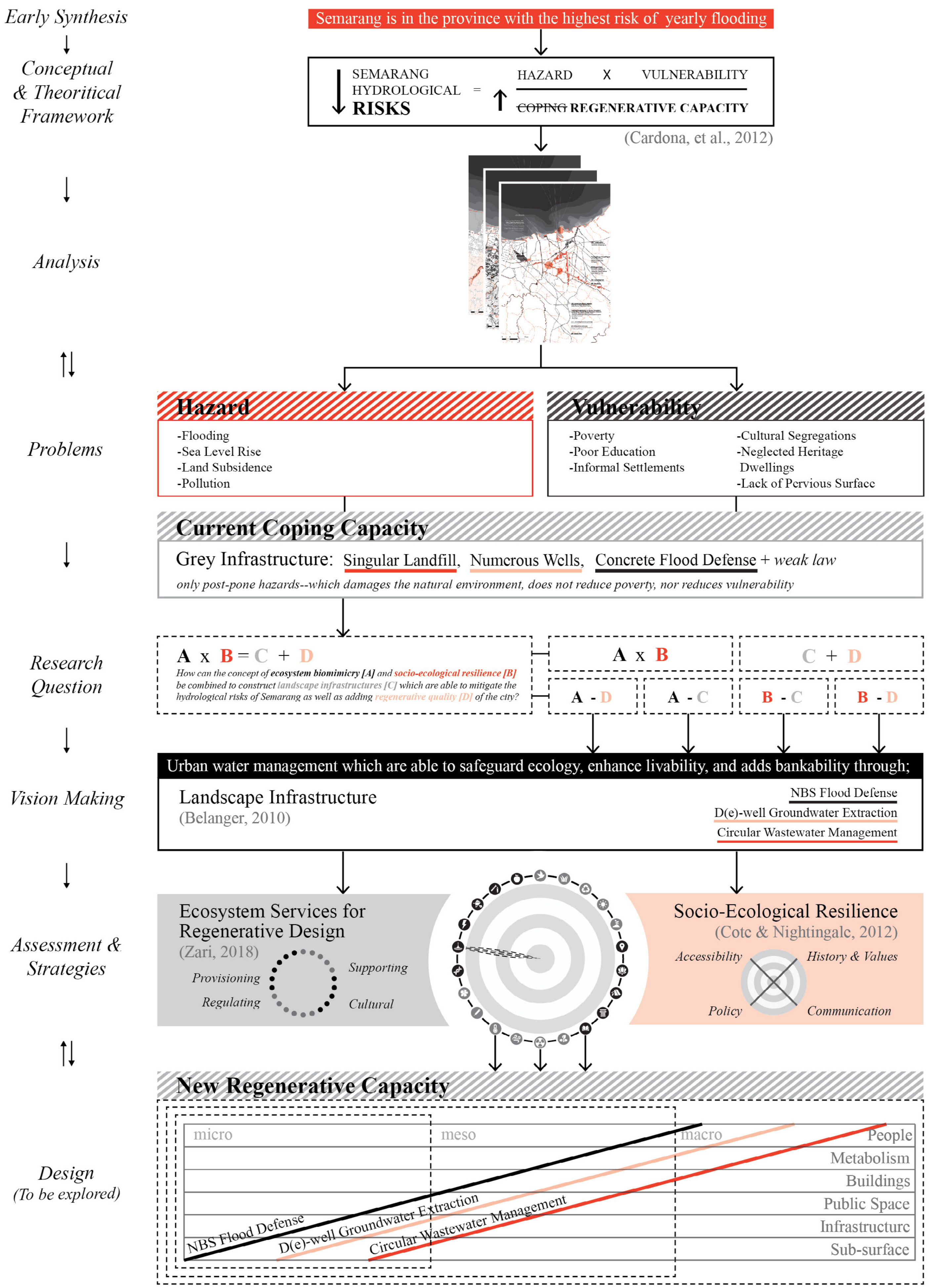


Figure 2: The road map of methodology of this thesis

- (LR) being informed on the key issue of Semarang which is **flooding**
- (LR) read, review, and construct theories of urban design strategies to mitigate hydrological risks
- (LR) further reading on site problems and existing solutions that has been established to reduce the environmental, economical, and societal risks
- (SV) obtaining personal perspective on actual key issues: **water pollution, land subsidence, and flooding** itself; documenting relevant hazards, vulnerabilities, and coping capacities; as well as validating data
- (I) interviewing stakeholders to understand the local point of view of issues, obtaining data, and other specificities
- (M) conduct GIS analysis to obtain quantitative data of hazards and organize relevant data to draw problem conclusions
- (S) defining the **hierarchy of stakeholders** engaged within the planning of landscape infrastructure
- (LR) formulate the research aims and gaps in order to progress on actions
- (LR) read, review, and construct assessment tool with **regenerative design, ecosystem services, and socio-ecological resilience variables** to mitigate hydrological risks with **landscape infrastructures**
- (CS) observe design precedents that use similar theoritical framework
- (I) interview the locals in order to assess present actions of ecosystem services in Semarang city, as well as the current functioning governance
- (S) re-defining social system based on socio-ecological resilience theory
- (M) map and draw design strategies of **circular waste management, enhanced fresh-water systems, and nature-based flood defense** to mitigate hidrological risks in Semarang
- (CS) observe design precedents that could be applicable on site
- (LR) adopt design framework to implement intervention on various urban layers and scales
- (SV) acquire necessary **measurements** for design intervention

(LR) Literature Review
Previous journals, books, and news for design and theory references

(M) Mapping
GIS drawing and analysis from open-streemap data, google maps, etc

(S) Stakeholders
acknowledging the parties involved throughout the project

(SV) Site Visits
Data taken from site trips and observations

(I) Interview
Experience local point of view on issues

(CS) Case Studies
Exemplary projects which contains similar approach

Conceptual Framework

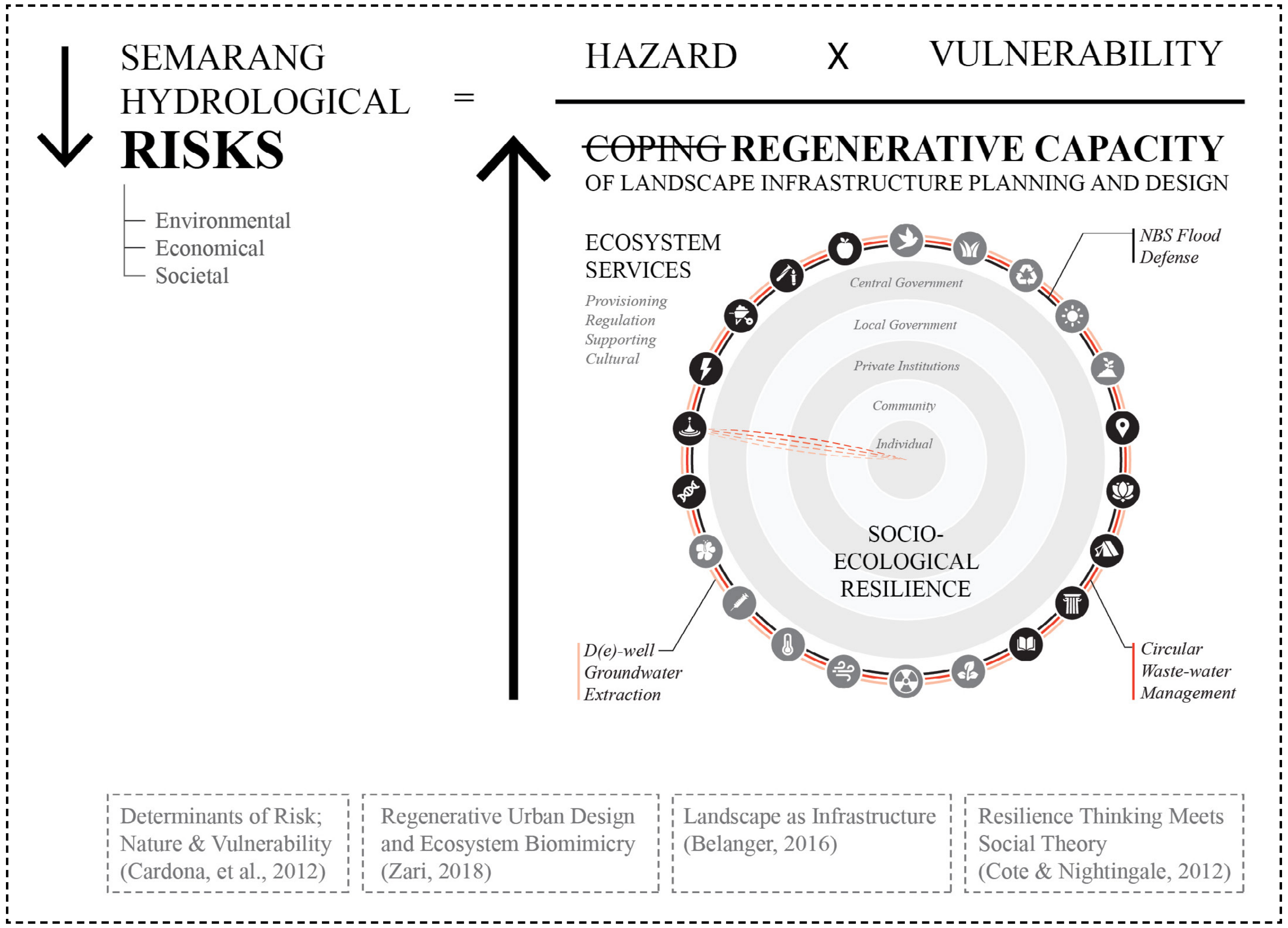


Figure 3: the conceptual framework of this thesis

The conceptual framework takes the **'risk equals to hazard times vulnerability over coping capacity'** as the overarching theory for the methodology of this thesis. This framework however modifies the coping capacity into **regenerative capacity** in order to give added values while mitigating the risk; this could be in a form of ecological conservation and bankability for the community. In order to achieve this, the regenerative capacity utilize **landscape infrastructure** as the main tool, which will focus on three infrastructures of the following system: nature-based flood defense, fresh-water extraction, and circular waste management; since the weight of the hazards are heaviest on flooding, pollution, and subsidence issues. Furthermore, to ensure that these landscape infrastructures perform regenerative manners, they must first be assessed through the actions of **ecosystem services** and the social system of **socio-ecological resilience** theory. Each theory will be elaborated further on the next section.

Theoretical Framework

I. Determinants of Risk

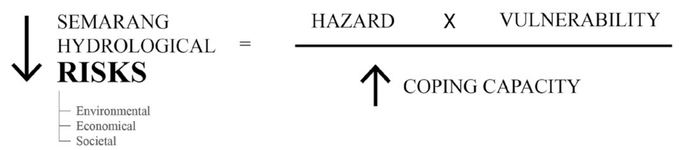


Figure 4: step one of conceptual framework

Flooding issues in Semarang have caused turbulences amongst societal and economical risk as one of its occasion would require evacuations up to ten thousand citizens, and therefore daily business stagnancy as the commercial grounds are also inundated. The flood which unfortunately carry pollutants due to the neglected water quality further spread contaminants to the surface which also put weight on environmental risk. Prior to listing mitigation actions, let us first define the term flood risk. One amongst numerous definitions mentioned in recent literature: Mitig Adapt Strateg Glob Change FLOODsite (2009b), stated that risk is probability times the consequences of flooding. Natural scientist and engineers tend to use this equation as they wo uld be able to quantify the risk when deciding suitable flood protection measures through probabilistic calculations. This conventional engineering approach is what have had shaped our urban environment today with grey edges such that along the canals. Another commonly used definition is to define flood risk as hazard combined with the vulnerability of the society in the area. This definition is commonly used in the field of social scientists such as planners who consider hazard as given and therefore works on the spatial strategies to influence people's behaviour in order to adapt to that given. A parallel approach has also considered the capacity of the community to indicate positive circumstances that could be seen to offset vulnerability (Cardona, et al., 2012) which equates risk to hazard times vulnerability over coping (or sometimes adaptive) capacity.

II. Regenerative Capacity

Figure 5: step two of conceptual framework

The demand on the context of Semarang is to have an added value of bankability--knowing well the aid for risk mitigation may not always be sufficient in developing country. By definition coping capacity focus on the moment, survival, and previously used tactics, whereas adaptive capacity do anticipate the future but still have a limited assumptions on future resource availability (Cardona, et al., 2012). Fearing the reappearance of grey infrastructures that consider not the environmental risks, we propose the term regenerative capacity for the equation. This implies that the built environment should contribute more than it consumes to ecosystems while simultaneously remediating past and current environmental damage. Because it is not possible to replace the entire built environment, new regenerative developments will have to reduce and counter not only their own negative impacts but also those of existing buildings in a given urban environment (Zari, 2018, p.5). Regenerative design targets to reciprocate the continued degradation of ecosystem services by designing and developing the built environment to regenerate the capacity of ecosystems, to an extent that it may go beyond restoration following the occurence of hydrological hazards.

III. Ecosystem Services Mimicry

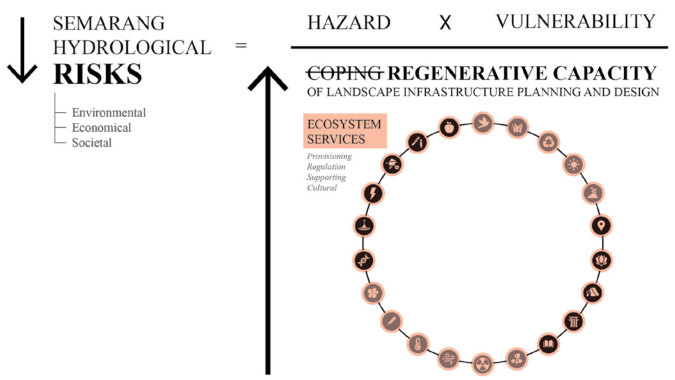


Figure 6: step three of conceptual framework

Ecosystem services are the benefits that humans derive, either directly or indirectly, from ecosystems that support human physical, psychological and economic wellbeing. A focus on ecosystem services has been widely adopted among ecology and policy professionals (Potschin et al., 2016, Martín-López et al., 2014), and was formalised by the United Nations' Millennium Ecosystem Assessment of ecosystems and human wellbeing (Millennium Ecosystem Assessment, 2005b). Although there are many classifications, majority categories the services that humans receive from ecosystems into provisioning services such as food and medicines; regulation services such as pollination and climate regulation; supporting services such as soil formation and fixation of solar energy; and cultural services such as artistic inspiration and recreation.

1. *Provisioning Services*	2. *Regulating Services (human time scale)*	3. *Supporting Services (long time scale)*	4. *Cultural Services*
1.1 Food – Human (land/fresh water/marine) – Forage	2.1 Pollination and seed dispersal	3.1 Soil – Formation – Retention – Renewal of fertility – Quality control	4.1 Education and knowledge
1.2 Biochemicals – Medicines – Other	2.2 Biological control – Pest regulation – Invasive species resistance – Disease regulation	3.2 Fixation of solar energy – Primary production/plant growth (above ground, below ground, marine, fresh water)	4.2 Aesthetic value and artistic inspiration
1.3 Raw materials – Timber – Fibre – Stone – Minerals/ores	2.3 Climate regulation – GHG regulation – UV protection – Moderation of temperature – Moderation of noise	3.3 Nutrient cycling – Regulation of biogeochemical cycles – Retention of nutrients	4.3 Recreation, relaxation and psychological wellbeing
1.4 Fuel/energy – Biomass – Solar – Hydro – Other	2.4 Prevention of disturbance and moderation of extremes – Wind/wave/runoff force modification – Mitigation of flood/drought – Erosion control	3.4 Habitat provision – Suitable habitat for organisms – Suitable reproduction habitat	4.4 Spiritual inspiration
1.5 Fresh water – Consumption – Irrigation – Industrial processes	2.5 Decomposition – Waste removal	3.5 Species maintenance – Biodiversity – Natural selection – Self-organisation	4.5 Creation of a sense of place and relationship. Cultural Diversity and history
1.6 Genetic information	2.6 Purification – Water/air/soil		

Figure 7: Ecosystem services with reference to urban context (Zari, 2016)

Understanding the friction that our urban environment have transgressed on to the natural environment, biomimicry allows a platform to reflect and formulate restoration strategies. This term is easily interpret as mimicking the shape, function, and metabolism of natural animal and plant niches. Further investigation of biomimicry therefore may provide a means to contribute to regenerative design theory and add to the strategies available to designers to respond to climate change and the decline in biodiversity health. Biomimicry could provide a suitable vehicle for such a shift in thinking because it requires people to understand that humans are not separate from ecosystems but are in fact dependent upon them for survival (Zari, 2018, p.7), which could therefore place ecological significance upon flood risk mitigation strategies. Maibritt Zari have simplified the four aspects of ES in relation to urban context (see Table 1) so that it becomes an easily usable tool that provides an overview for designers with limited background knowledge in ecology (Zari, 2018, p. 112). The symbiotic mutualism nature of ecosystem approaches for flood-prone land management has been positively perceived and widely implemented on many flood adaptation projects in developed countries (Juarez-Lucas & Kibler, 2015; Nienhuis & Leuven, 2001). For instance, floods are considered beneficial for agriculture and fisheries activities (Shankar, Halls, & Barr, 2004). These are also prominent economic sectors in the developing countries. Hence, the application of ES for flood risk mitigation may also be adapted on the setting of less developed nations in such a way that it gives an added value of livelihood benefits.

Actions through cultural context could also be applied in Semarang. Water is often considered as a core spiritual element in many religious practices. With Semarang having a considerably ample amount of active worship places, some could potentially be a strategic location to integrate water as means of spiritual connections and supply of clean water. Semarang is known for its Great Mosque of Central Java, Blenduk Church in Kota Lama, as well as the city with the most temples in Indonesia. These landmarks in the city, if connected as a cultural recreation network, may also contribute to the bankability of the water storage implementation in worship places.

IV. Socio-Ecological Resilience

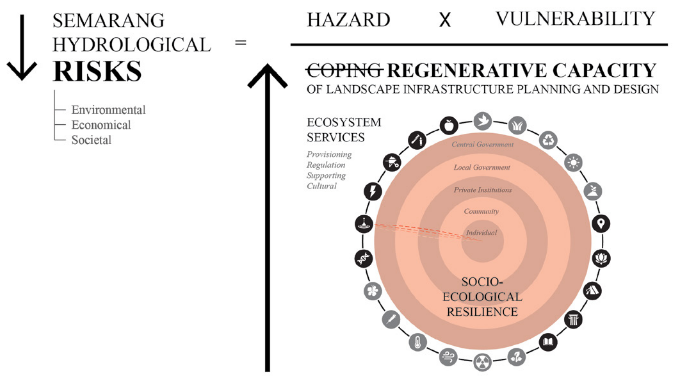


Figure 8: step four of conceptual framework

In the paper of '*Resilience thinking meets social theory: Situating social change in socio-ecological systems research*', Nightingale and Cote argue that the relationship between society to resilient concept has many limitations. The key reason is because it allows too much focus on the structures and 'functionality' of an institutional system, which disregards the political, historical and cultural meaning. For instance, flood risk management is the responsiblility of the Ministry of Public Works--and down to the hierarchy inside it. Discussion of 'resilient stakeholders' have focused on comparing the performance of different management regimes that deals with the risks--which tie themselves to mere policy manuals. The aim is to shift from such flexible governance template towards a situated system where cultural and political categories of specific context are considered (Cote & Nightingale, 2012, 484). It requires a more fundamental shift in how knowledge is understood across various community. Human adaptation to change emerges from diversified processes that must be understood through the iterative relationship between knowledge, agents and context as mediated by power, culture and history (ibid.).

Nightingale repeatedly emphasize the question of 'resilience of what and for whom?' or 'who defines the desirable threshold?'. This trigger inquiries on the local perspective of water management. Knowing that Indonesia was under the Dutch colony for three and a half centuries, the country must have received the Netherlands' influence on managing water-related infrastructures. A country which would have been the sea, and would not have existed without layers of flood defence systems (Nienhuis & Leuven, 2001, p. 93). The East and West Canals of Semarang are the product of the colonial times to tackle flooding issues at the time, which also happened to centralize the water flow to the two respective canals. On the other hand, the local community is formed by the cycle of subsistence agriculture. Community within the *kampungs* were attached to their patches of land for sustenance of their socio-ecological metabolisms. With such spatial-temporal sequence of *kampungs*, it seemed that the domestic water management was organised on a neighbourhood scale. Certainly, issues of densification were absent during the time and the wastewater treatment also remained questionable. Nevertheless, domestic water management were detached from the interventions of higher institutions (Putri, 2017, p. 197).

The next move hereby situate the '*kampung* citizenship' within the socio-ecological system, together with cross cutting layers of (1) the site history and values, (2) fair accessibility to knowledge and infrastructure, (3) the ability to act (this would be in a form of policies), and most importantly (4) a regular communication intralayers.

V. Landscape Infrastructure

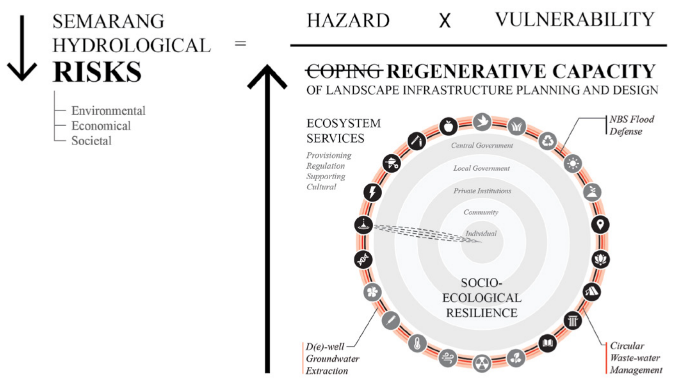
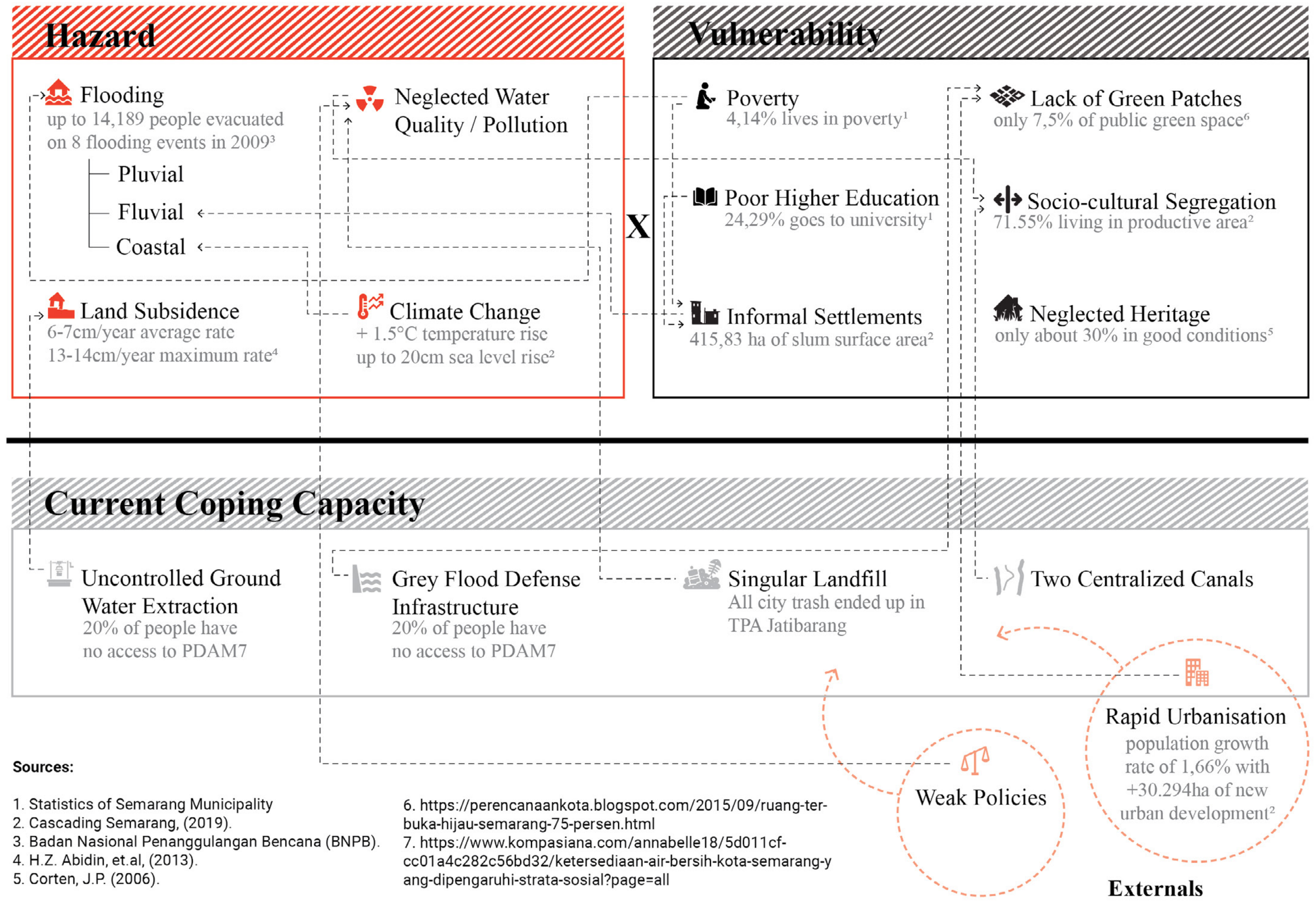


Figure 9: step five of conceptual framework

In a conventional stance, large construction projects such as roads, buildings, airports, tunnels, including water-related infrastructure such as dams, bridges, water supply systems, and sewage treatment are the task of civil engineers. However, the management of water, waste, food, transport, and energy infrastructure frequently clash landscape practitioners when the play comes to change urban-regional structure and thus the region's respective 'silk-road'. Food production and energy networks can no longer be engineered without considering the cascade of waste streams and the cycling of raw material inputs. Landfills, land farms, laydown areas, and sorting facilities can no longer be designed without their wastesheds. Highway networks, sewage systems, and subdivisions can no longer be planned without their watersheds. In summary, the urban-regional landscape ***is*** infrastructure (Belanger, 2016) which links the domains of environmental, social, and economy. The thesis will put emphasis on three landscape infrastructures: nature-based flood defense, fresh-water extraction system, as well as circular waste management to perform regenerative capacity of Semarang city.

Problem Statement



Sources:

1. Statistics of Semarang Municipality
2. Cascading Semarang, (2019).
3. Badan Nasional Penanggulangan Bencana (BNPB).
4. H.Z. Abidin, et.al, (2013).
5. Corten, J.P. (2006).
6. https://perencanaankota.blogspot.com/2015/09/ruang-ter-buka-hijau-semarang-75-persen.html
7. https://www.kompasiana.com/annabelle18/5d011cf-cc01a4c282c56bd32/ketersediaan-air-bersih-kota-semarang-yang-dipengaruhi-strata-sosial?page=all

Figure 10:diagram of site problems and interrelations

Together with all the data gathered during the analysis, this section answered the queries posed on the early synthesis, and categorized it into the framework of '(hazards x vulnerability) / coping capacity'. These problems which are spread across the domain of social, environmental, and economy occur simultaneously, hence deducing their correlations is necessary. Understanding this would help the research in figuring out the longest chain of problems, allowing accurate key issues to point. For instance, poverty have certainly caused many to live on informal settlements which tend to occupy the edges of the river, this causes the river body to narrow, and therefore fluvial flooding. The grey flood defense structure as shown on bottom right picture, together with the one and only massive Jatibarang landfill, also equally serve to reduce the chances of available green patches which would have absorbed the excessive water. To yet bear in mind, poor countries need to think twice to invest a great sum of money for a parallel nature conservation as long as their basic needs of food and shelter are not fulfilled. They demand to witness a valid proof of technological intervention such as dam projects for the irrigation system of their agriculture field as well as water storage to last the changing seasons (Nienhuis & Leuven, 2001, p. 91). Another example would be the weak policy which made many self-conduct ground water extractions to such uncontrollable extent that the land subsides rather rapidly. From this observation, the current coping capacity, which mostly are of grey infrastructures, have not yet been successful to reduce the hazards nor vulnerability. Instead, it only post-pone certain hazard (e.g; flooding) whilst amplifying the other hazards (e.g; river pollution due to the non-circular waste management). This would ironically increases the vulnerabilty of the people by living on unhygienic water. Many papers have discussed holistic and nature-based flood risk measures, but rarely with the entangled complexities of a developing country. We need not to revise this into an efficient coping capacity only, but to jump higher towards regenerative capacity for a greater return period of resilience. Further exploration to implement the proposed conceptual framework in order to reduce Semarang's current hydrological risks would be elaborated on the next section--with the hope that it could be an exemplar for other developing countries facing similar issues.

Key images of Semarang hydrological risk

Image 10: significant impact of land subsidence in Bandarharjo Village

Image 12: flooded coastal region of Kampung Bandarharjo

Image 11: kids playing on the polluted Semarang River

Image 13: narrow gray infrastructure of Semarang River by the Tugu Roundabout

Research Questions and Expected Outcomes

[A x B = C + D]

How can the concept of **ecosystem biomimicry [A]** and **socio-ecological resilience [B]** be combined to construct **landscape infrastructures [C]** which are able to mitigate the hydrological risks of Semarang as well as adding **regenerative quality [D]** of the city?

An assessment framework to guide the implementation of 'Regenerative Development' in Semarang.

[A x B]

How can we further situate social system within ecosystem biomimicry?
Assurance of multilayer stakeholder feedback within each variable of ES.

[C + D]

What are the type of measures and spatial implications of landscape infrastructure that would enable regenerative manners?
Biomimicry engineering on flood-prone lands, water supplication at local public places (e.g; worship places), and decentralizing existing landfills to more circular stations.

[A - C]

Which form of ecosystem services could possibly be mimicked by landscape infrastructure to mitigate the hydrological risks?
Water provisioning system, habitat for human and ecology, a climate regulator zone, etc

[A - D]

What ecosystem services variables could trigger bankability projects in Semarang City?
Food provisioning; agriculture/aquaculture designated zones, decomposition and re-production of city waste, bio-mass fuel energy, establishment of natural recreation sites, etc.

[B - C]

Who are the stakeholders involved during the assessment, project construction, and monitoring of the landscape infrastructures?
The management must be centralized on community level to enhance sense of belonging.

[B - D]

How can each social layers from the highest government institutions down to the individual level contribute to the regeneration of ecosystem services?
Through multi-scalar key projects that are distributed through the different institutional level.

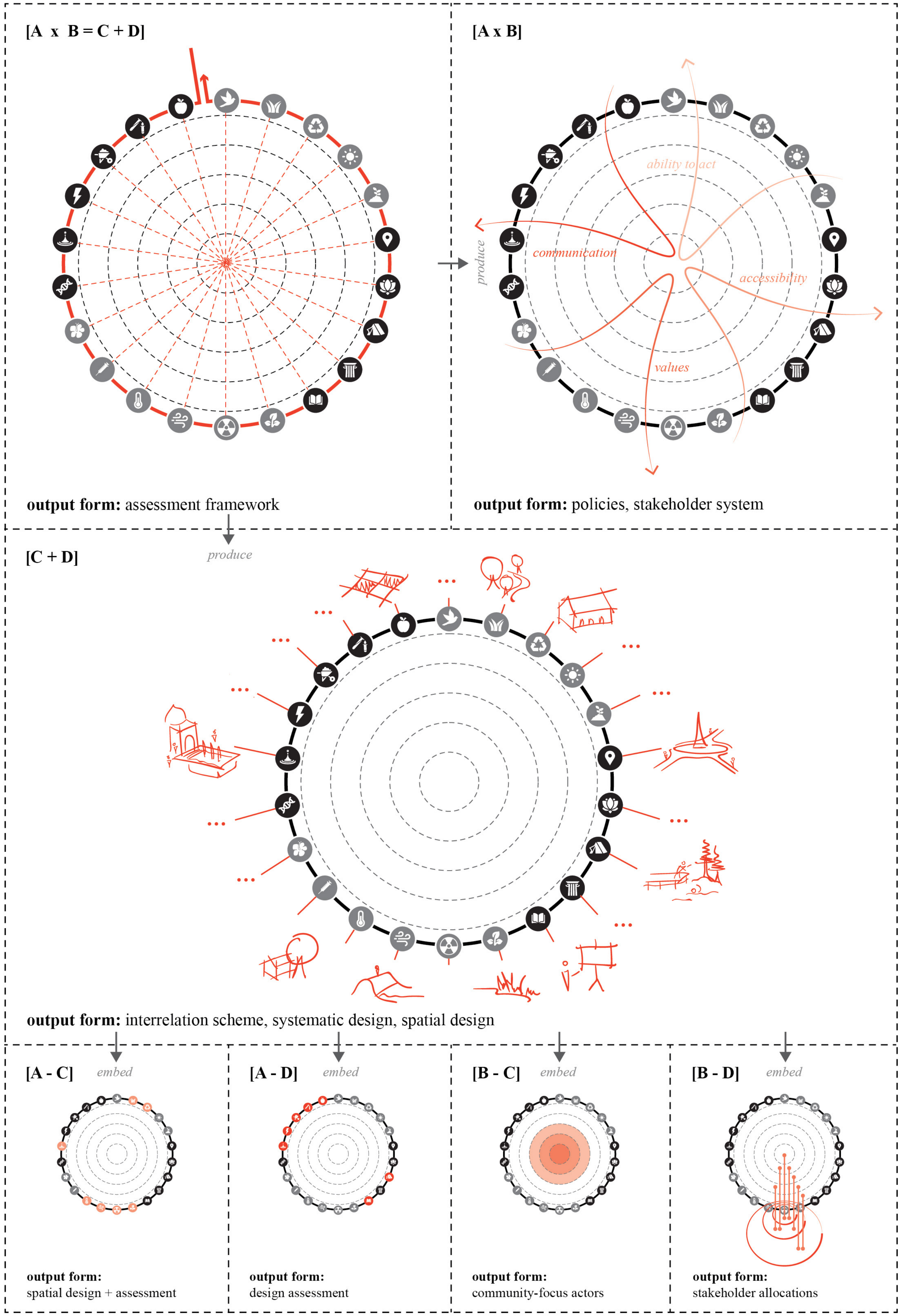


Figure 11: Expected outcome diagramatic concept on how it centralized itself on the main assessment framework

C. Analysis

i. Dual Nature of Externalities
ii. Crises of Representation
iii. Typology and Morphology
iv. Analysis Summary

What to Analyse?

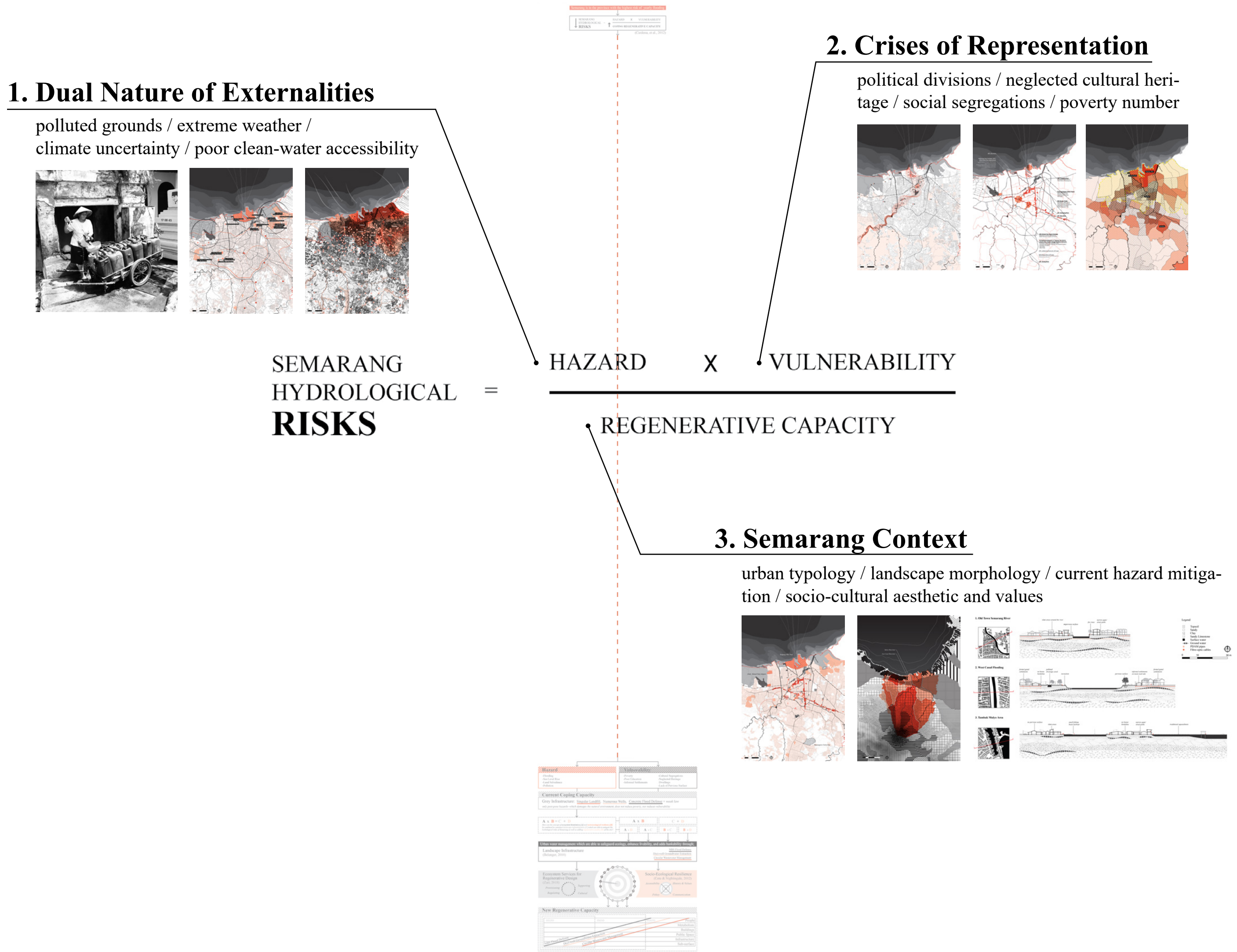


Figure 12: analysis chapter clusters

The analysis is divided in to three sections, beginning with **nature externalities** which trigger the **hazards**, the **crises of representation** which enhance the **vulnerability** of the society, and eventually the **context of Semarang** itself to see potentials of **regenerative capacity** through the daily activities of the citizens and the available services upon Semarang's ecosystem. The findings would be represented through multi-scalar mapping, chart diagrams, documentation of site pictures and interviews, sections, 3D drawings, and elaborated descriptions.

Extreme Weather Challenges

Semarang features a tropical rainforest climate that borders on a tropical monsoon climate (Am). The city features distinctly wetter and drier months, with June-August being the driest months and January-February being the wettest month. Average temperatures in the city are relatively consistent, hovering around 28 degrees Celsius. Semarang is also known for having Indonesia's hottest maximum temperature record; reaching a scorching 39.5º degrees Celsius (103.1º F) on October 14, 2014 [16]

Semarang places second highest amongst other municipalities in Central Java with flood occurences. Although the second graph shows that landslide occures more often on the recent years, the number of the consequences exposed is less. Thirty-eight landslide occurences in 201 have caused damage to 23 houses whereas 8 flooding happened in have affected 14.189 houses (BNPB).

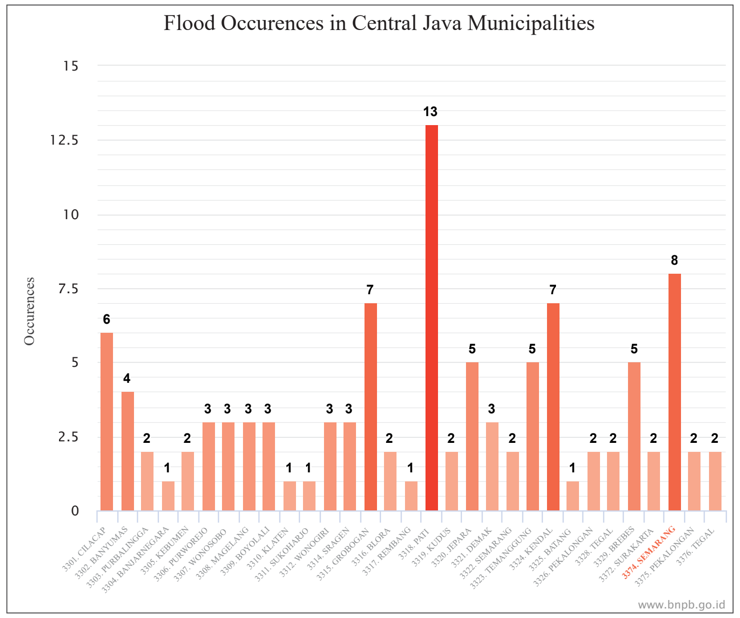


Figure 13: flood occurences graph in Central Java municipalities

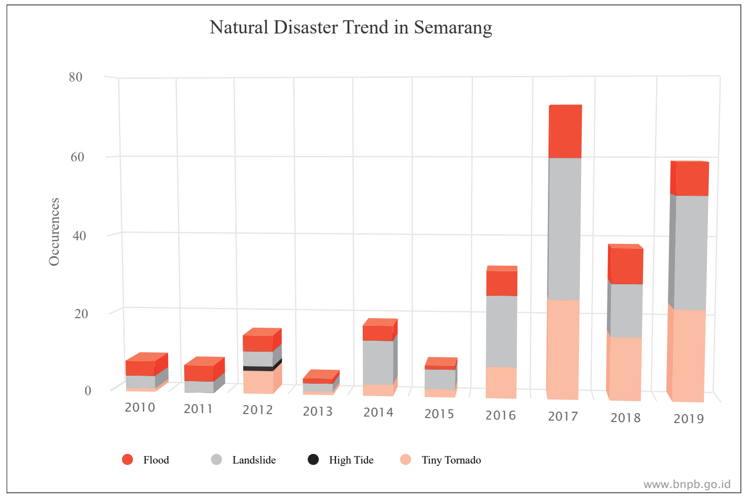
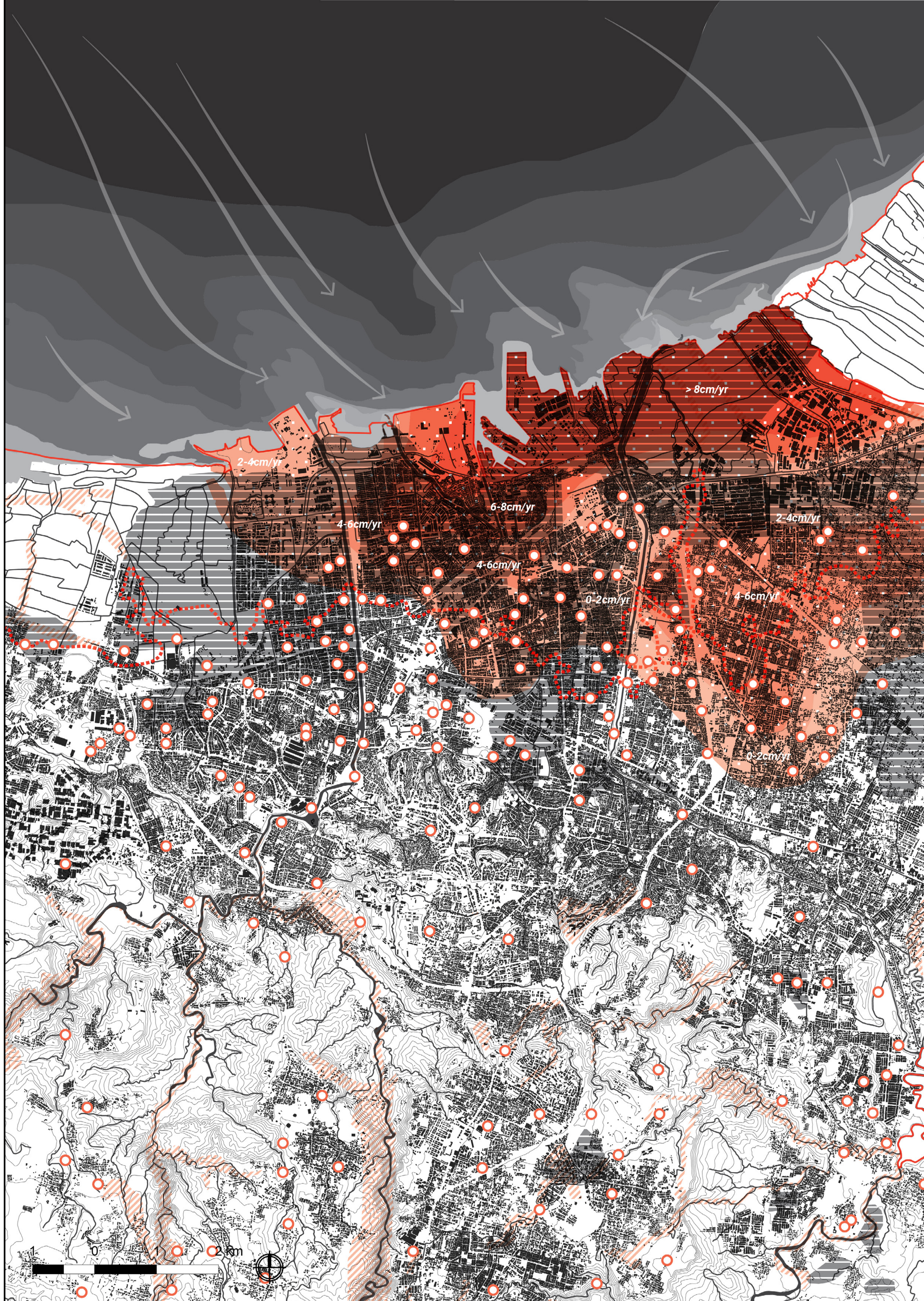


Figure 14: natural disaster trends in Semarang

	Average Rainfall (Mm)	No. of Rainy Days (Days)	Total Rainfall (Mm)
January	348	18	5 565
February	413	20	6 605
March	261	15	3 651
April	141	9	2 112
May	87	6	1 388
June	78	5	1 163
July	11	2	11
August	6	1	41
September	26	2	131
October	75	4	1 058
November	220	11	3 306
December	299	14	4 180

Figure 15: monthly average rainfall in Semarang

Source: Statistics of Semarang Municipality, Badan Nasional Penanggulangan Bencana (BNPB).



Legends

- Inundation Area
- Wells
- Flood Risk
- Rob Flood Line
- Land Subsidence (0-8cm/yr)
- Wind Direction

Sources;
Susanto, N., et. al. (2017), Nugraha, A. L., et. al. (2018)

Map 5: Semarang Extreme Weather Challenges

Polluted Grounds

Image 14: Jatibarang Landfill

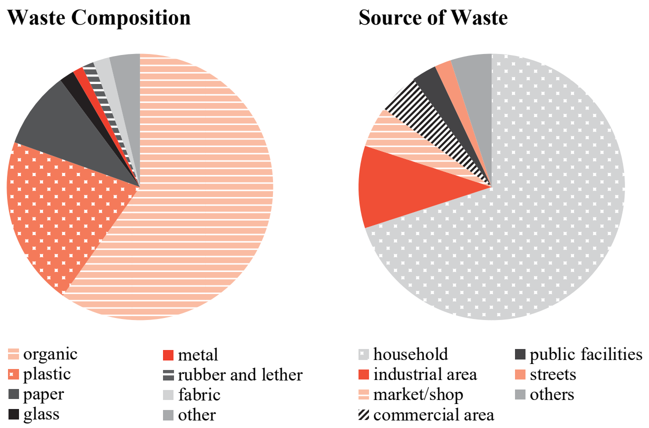


Figure 16: Semarang waste statistics

Legends

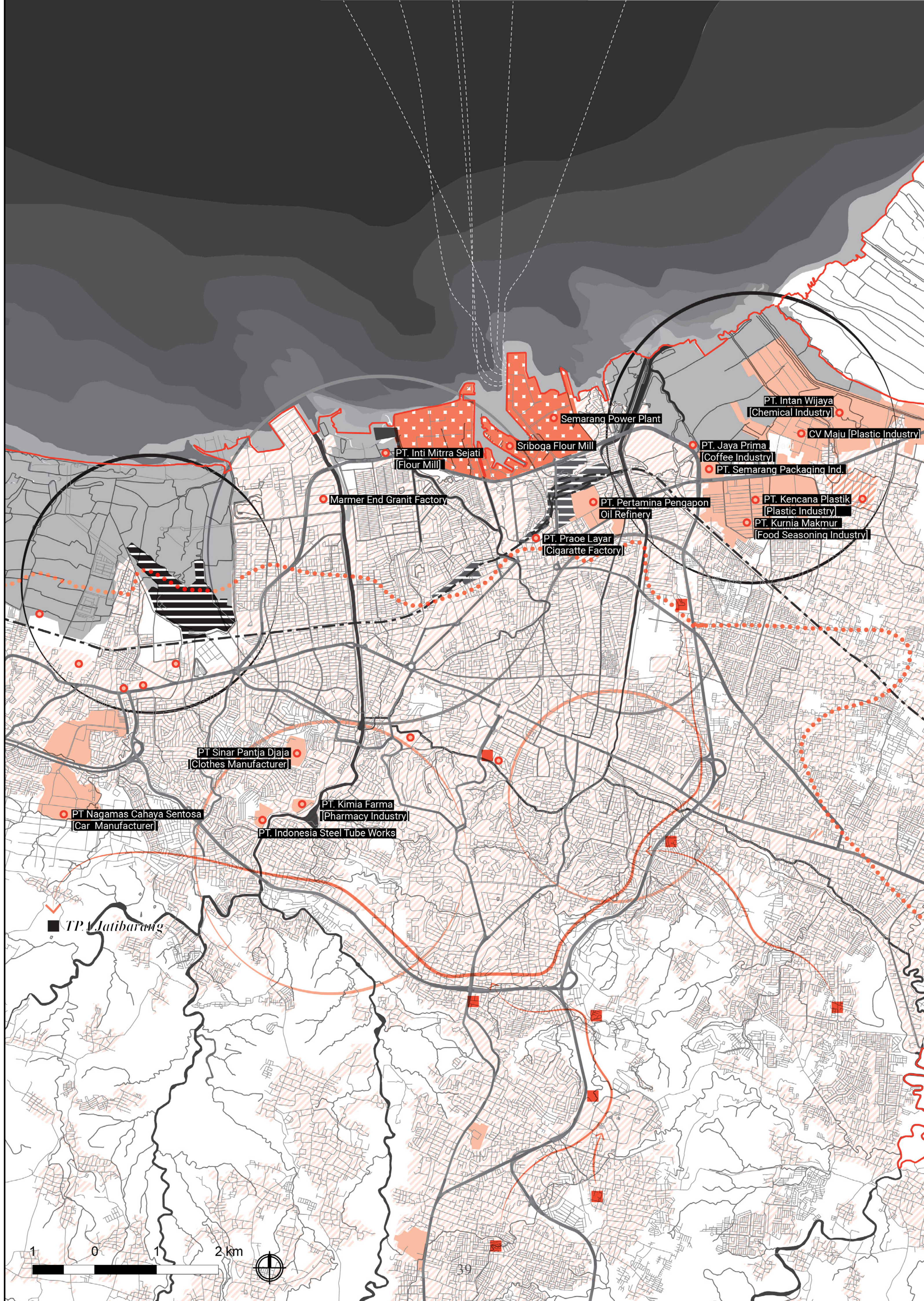
- Train Station
- Airport
- Industries & Warehouse
- Port
- Main Garbage Dumps
- End-point Landfill
- High Water Pollution
- Medium Water Pollution
- Light Water Pollution
- Ship Routes
- Main Street
- Main Water Networks
- Salination Line

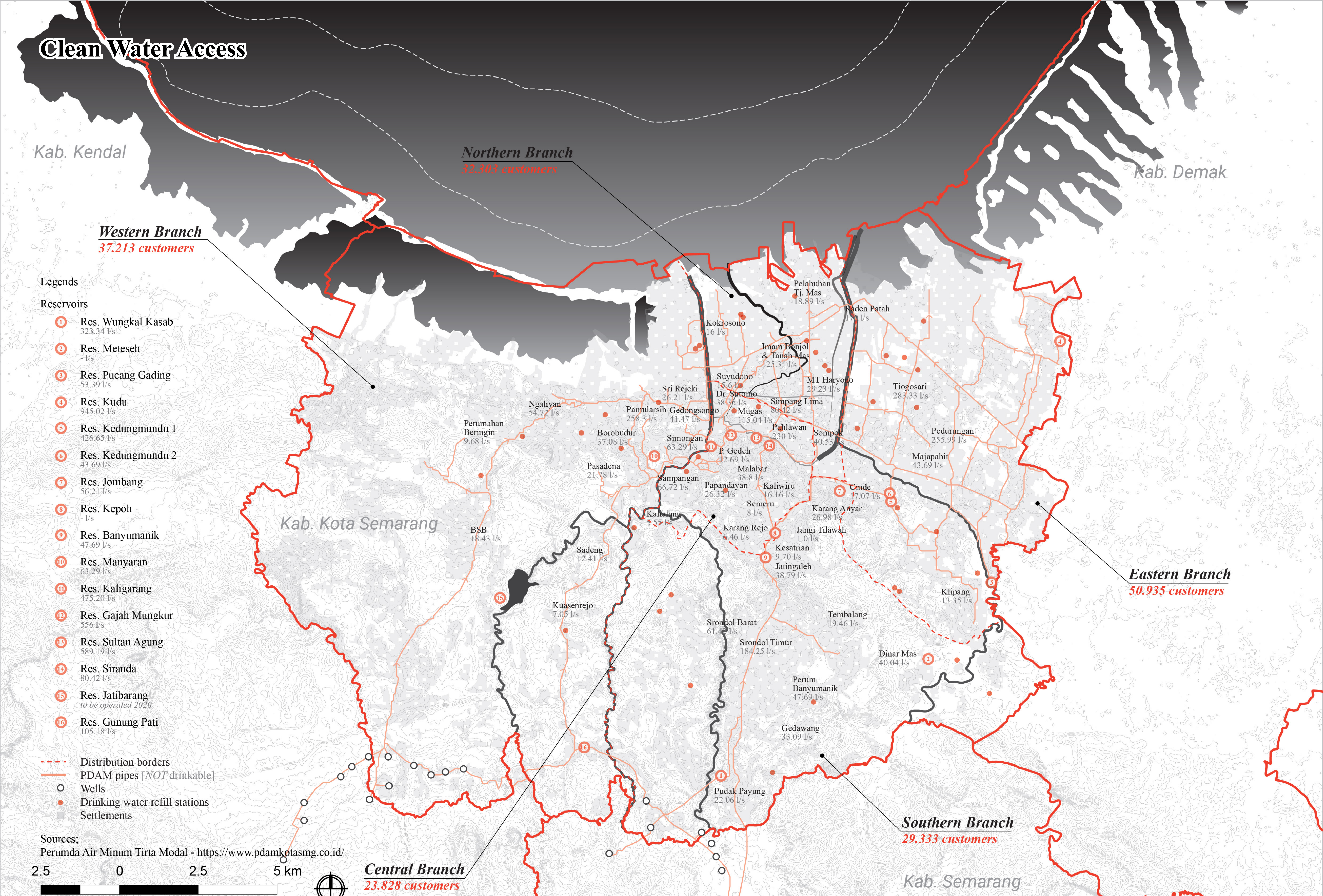
Sources;
City Report Semarang, 2017., Cascading Semarang, 2019., Google Maps, GIS dataset from openstreetmap.id

Map 6: Polluted Grounds

The map shows that the area with highest water pollution are amongst the industrial area, which are on the outer sides of the east and west canal. It is observed that there are plenty of chemical plants which substances might have resulted to the hazardous water quality on these areas. Pollution in the Semarang River is mostly caused by the local themselves who dumped their garbages in the river. This condition is worsen by the fact that the water is not flowing, since multiple water doorways had been made to prevent sea water from coming in.

TPA Jatibarang is currently holding 27 hectares of landfill and is expected to grow wider as the population increases. The waste would not only remain intact but the landfill leachates can enter the Kreo river through the contaminated groundwater flow and surface run-off (Hendrayani 2010). Although attempts of converting waste to energy or composts have been done at the landfill, this centralized end point have limited the movement of circular waste management within the city, which then trigger many to end up in the water bodies. This issue causes a certain setback upon resilient densification plannings of living *with* water as the water quality does not meet the standard of livability. This poses a question; is it tackling the flooding issue or the water quality that makes a priority?





Map 7: Clean water access within Semarang

Clean Water Access 1: Tap Water

From the map above it shows that the distribution is not yet throughout. It is mostly centralized on the city centre, whereas the villages closer to the hinterland have less access from the PDAM. Kudu and Garang Reservoirs are the two biggest reservoirs that supply the city of Semarang. Although to date, only 59% of Semarang urban areas have been covered.

Another factor prolonging the coverage of distribution lies on the geographic condition of Semarang. For instance, Kali Garang can only be extracted 1250 L/second while for instance, in Surabaya can have 11000 L/second (Joko, PDAM). This is also emphasized by the fact that the water quality is not constantly feasible, especially during wet season. Too much of a low water quality entering the pump will exceed the capability of the filtration system to convert it to clean water, risking contaminated water to escape to the pipes. This forces PDAM to shut the gate during high rainfall. The rivers are more stable during dry season.

The current water treatment plant dwellings are also exposed to the outside air, hence chanelling the external debris to the filtered water. This and the limited investment to the water treatment sector have caused the distributed water to be **undrinkable**. Although there has been many regulations to mitigate ground water extraction, the question should be directed to the capability of PDAM to supply clean water. If it could not be fulfilled, the people will dig their wells.

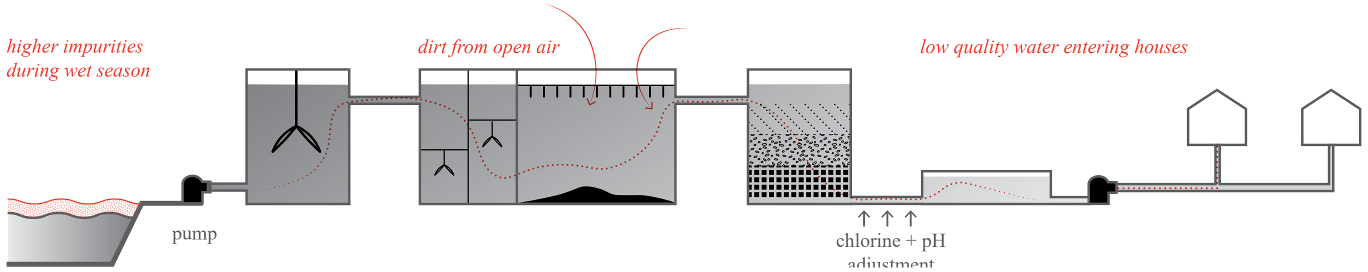


Figure 17: understanding the water treatment processes

Image 15: Garang River PDAM

Clean Water Access 2: Drinking Water

So where do people get their drinking water?

Technically, the current PDAM water reservoirs are only one more step away into having their treated water, drinkable. This would be the ozone filtration step which is most costly. But this is followed by another obstacle in which there is a lack of management on the ground piping system which may risk the contamination of drinking water as it flows through the pipes on to the houses. Hence, people came up with other ways to access their drinking water.

1. Re-fill Units from Ungaran Spring

Image 18: ozone-filtered installation by private local businesses which collect the water from Mt. Ungaran

2. Listed wells from PDAM

Image 17: Tirta Moedal well, Sumurrejo Sub-district, Semarang as one of the official listed wells from the PDAM

3. Private wells

Image 16: a lady extracting water from an unregistered well at the community compound

4. Heated Tapwater

Image 20: people filter/heat their own water from PDAM

5. Bottled Water Company

Image 19: packaging water from Ungaran spring or private protected wells by each drinking water company

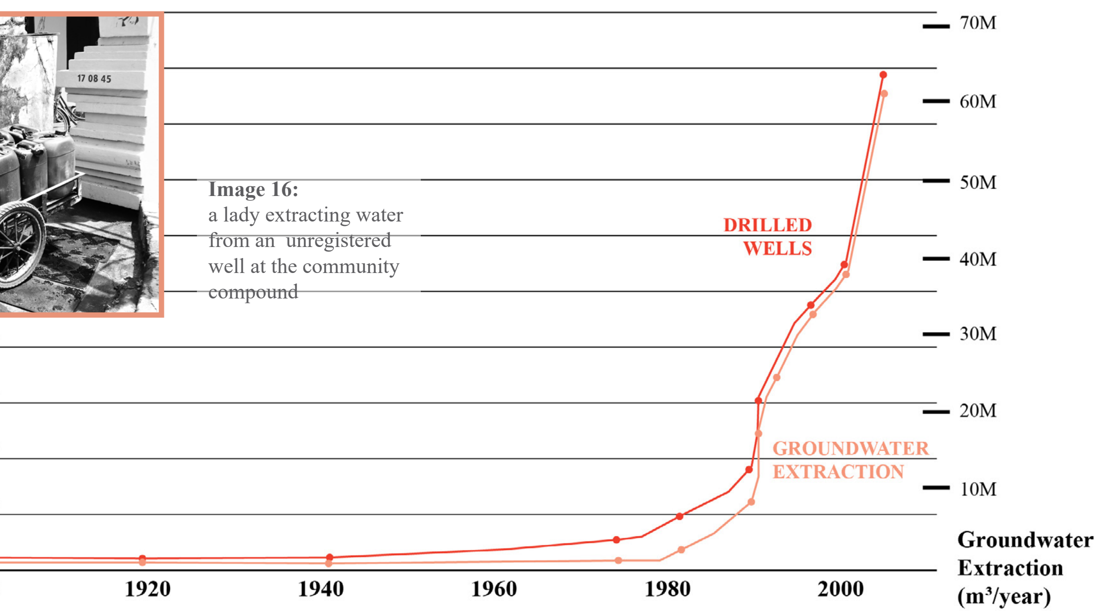


Figure 18: increase statistic of ground water extraction

Recent Flood Risk Projects & Stakeholders

Image 21: West Canal Dam

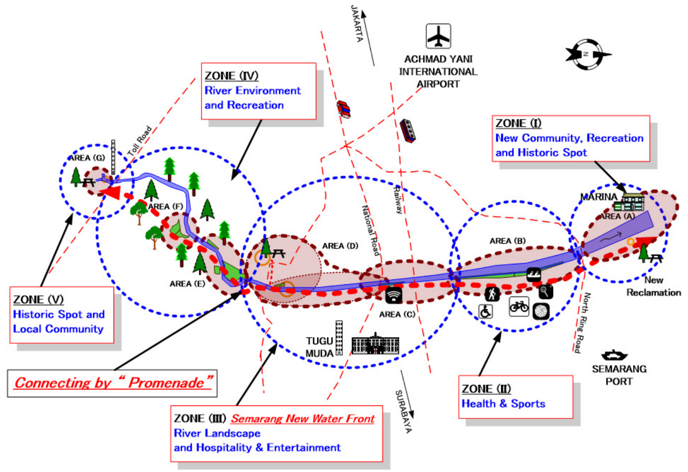


Image 22: West Flood Way Planning

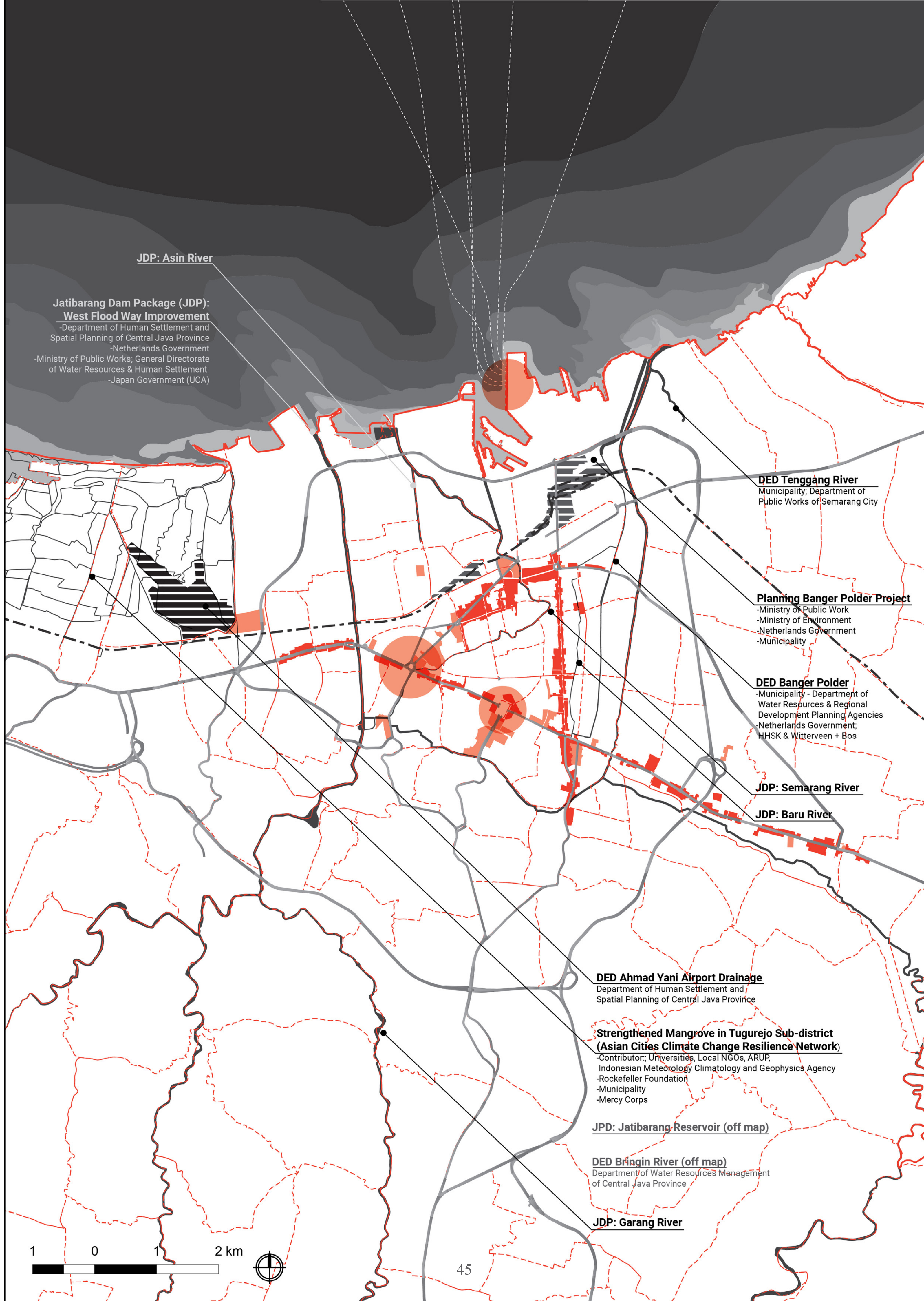
Since the 1990s, we could note sixteen highlighted projects related to the hydrological risk management in Semarang city. It can be seen that the responsible stake holders are within different layers--be it municipal level, provincial level, central government, or international institutions. However, out of 16 projects that was planned, only three have had been executed: one being the West Flood Way improvement which attempt to create a sense of place through the different zoning (see Image 22), the Banger Polder project, and the mangrove rehabilitation by the Asian Cities Climate Change Resilience Network. This shows the inconsistency between planning and development (Miladan 2015). The collaboration between stakeholders has initiated many hydrological projects but at the same time causes the delay due to the complexity of governance--especially when reshuffling the government takes place every 5 years.

Legends

- Commercial
- Offices
- Train Station
- Airport
- Economic Centres
- Main River / Canals
- Main Roads
- Kelurahan Boundaries

Sources;
Miladan, N. (2016).

Map 8: Stakeholders of recent flood risk management projects



Current Water-related Stakeholders

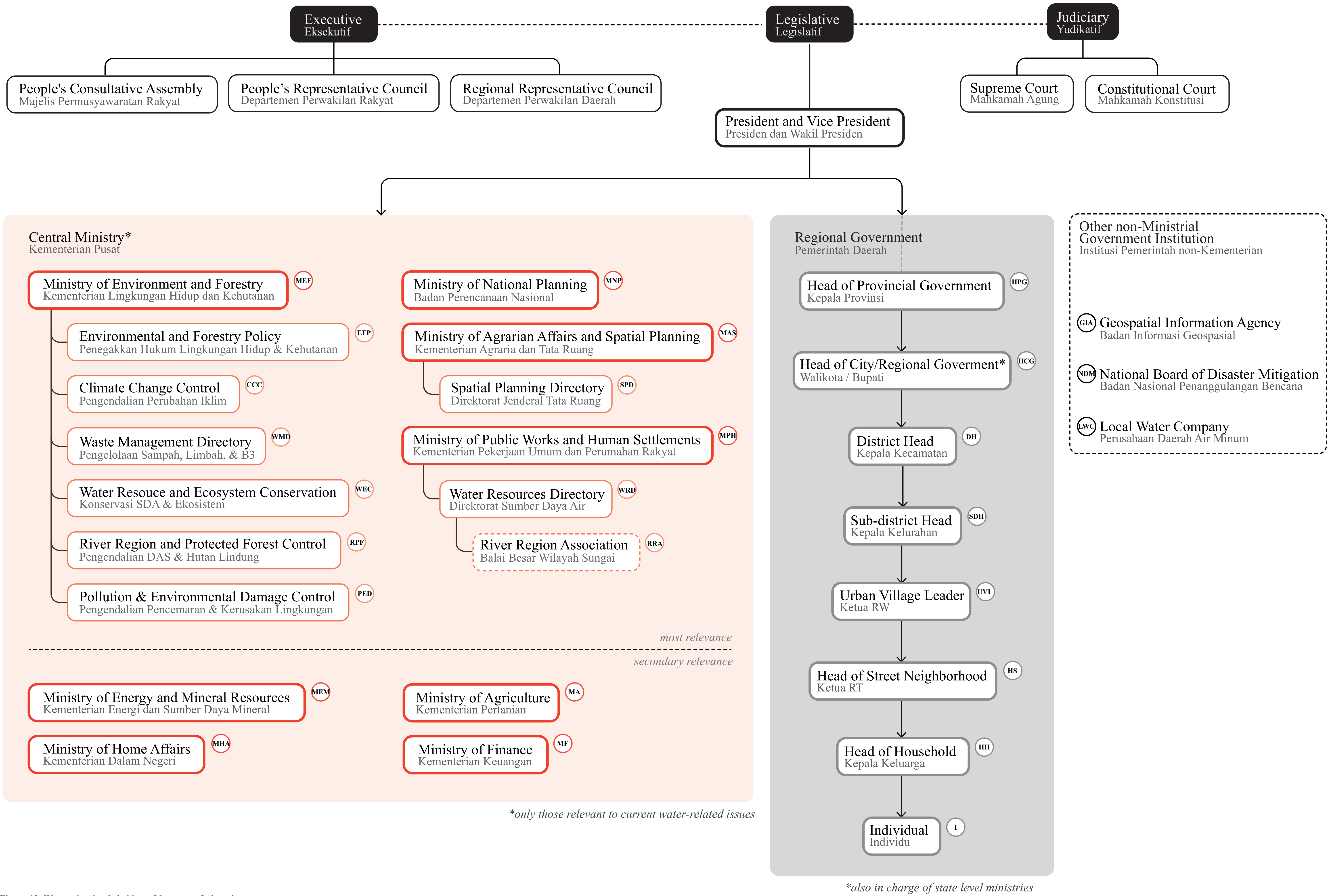
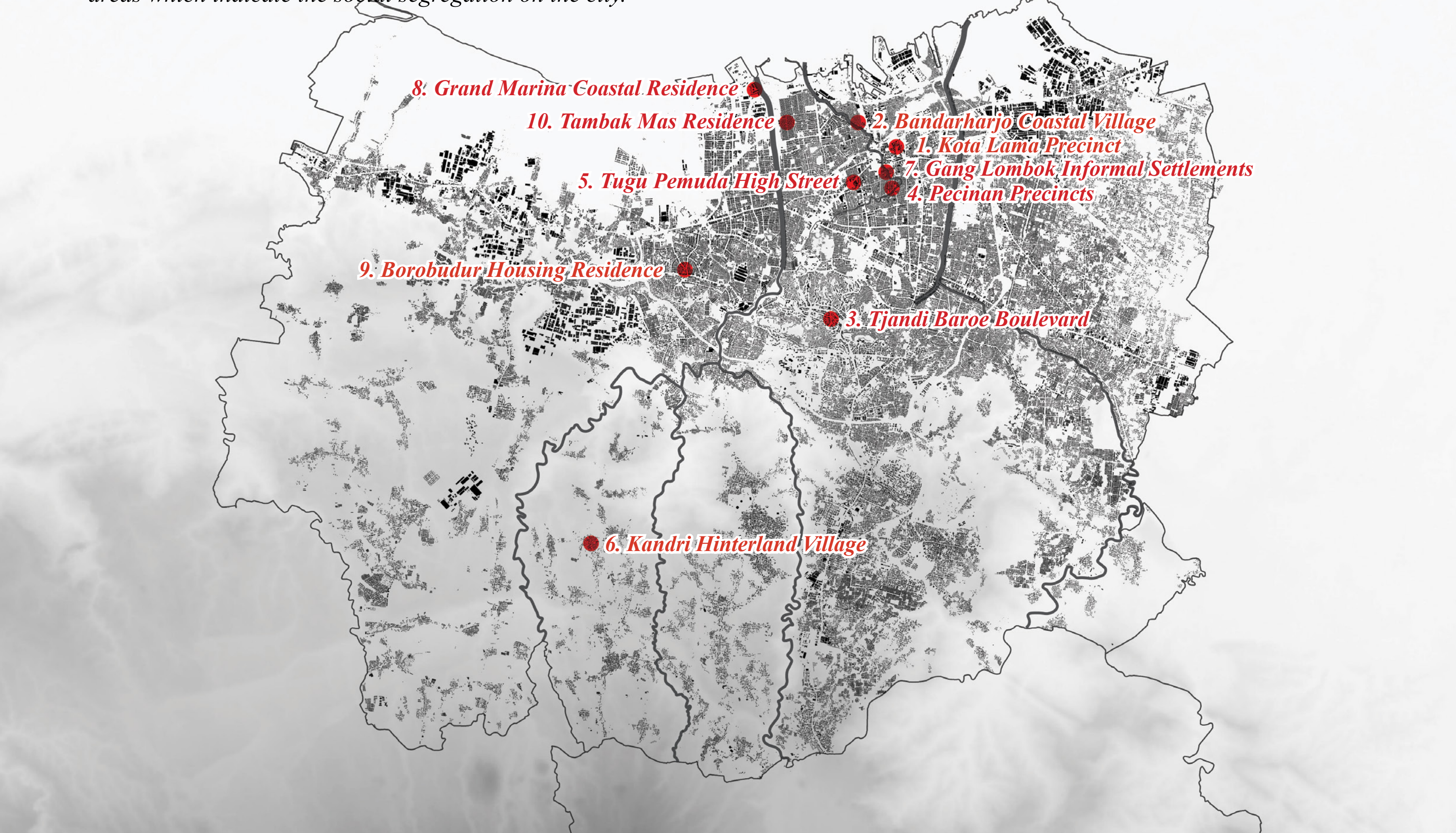


Figure 19: Water-related stakeholders of Semarang, Indonesia

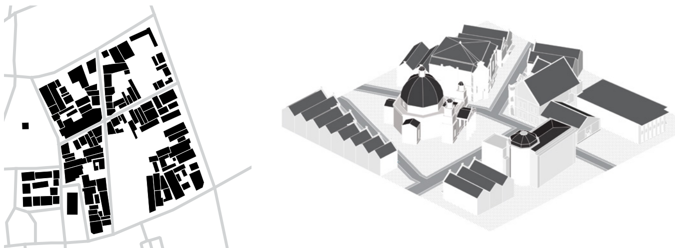
Urban Typologies

The 10 selected parcels appointed the main fabrics which represent the urban typologies of Semarang--varying between the important precincts, low and high land, as well as elite and poor areas which indicate the social segregation on the city.



Map 9: built areas of Semarang

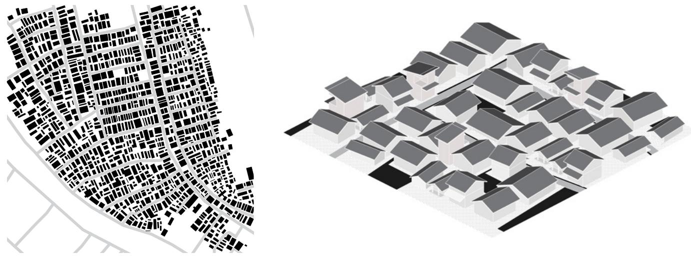
1.



Ave. Size : 1500 m²
Material : plastered Dutch brickwork
Height : 2-4 storeys
Year : 1750
Condition : prosper

Post-colonial Dutch heritage dwellings which many are nowadays vacant due to the degrading condition.

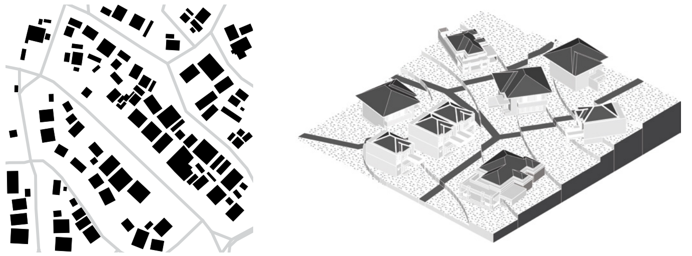
2.



Ave. Size : 100 m²
Material : raw brick / triplex
Height : single storey
Year : est. 1960
Condition : vulnerable

Sinking neighborhood by the coastline with a statis and critical waste issues on the water channels inbetween the houses.

3.

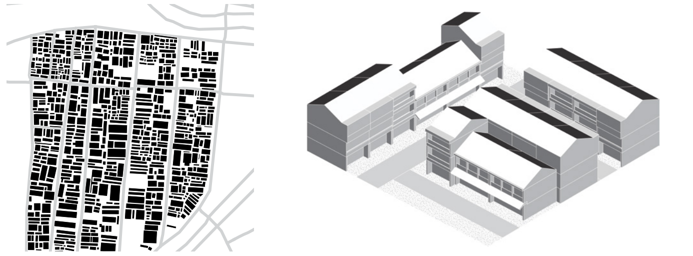


Ave. Size : 600m²
Material : plastered brickwork
Height : 2-3 storeys
Year : 1936
Condition : prosper

Planned by Thomas Karsten, this plot of land was designated for the rich in the South hilly side of Semarang.

Figure 20: selected urban typology set of Semarang City

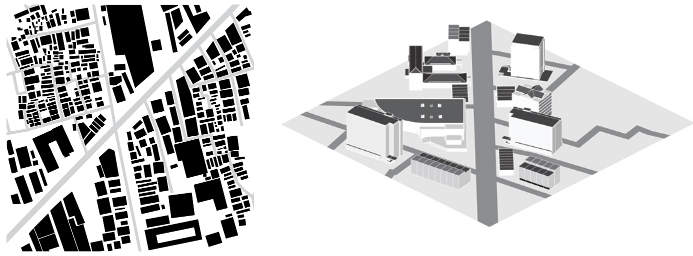
4.



Ave. Size : 300 m²
Material : plastered brickwork
Height : 3-4 storeys
Year : 1750
Condition : Prosper

Unlike most China town, the dwellings are plain shophouses with minimal ornaments; filled with markets on the weekends.

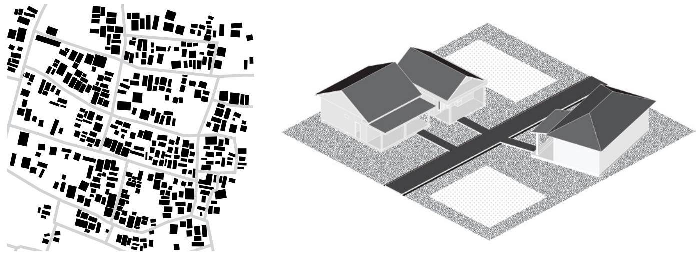
5.



Ave. Size : 1500 m²
Material : concrete/glass highrises
Height : 4-15 storeys
Year : est.1920
Condition : prosper

Car high street between the main government offices, hotels, malls and private offices.

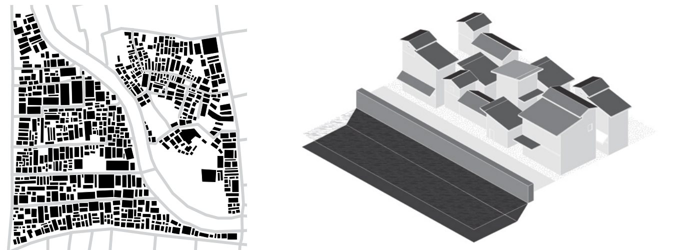
6.



Ave. Size : 150 m²
Material : plastered brickwork
Height : single storey
Year : est. 1970
Condition : sufficient

Houses are relatively small but the areas are sparse, permaculture activities are still prominent on the hinterland kampungs.

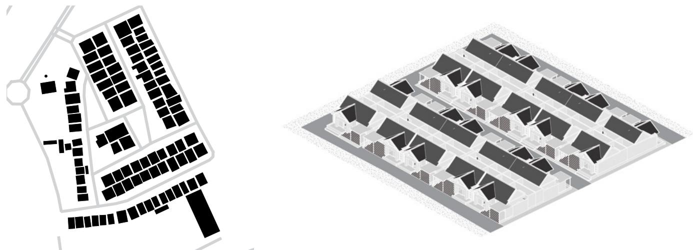
7.



Ave. Size : 20 m²
Material : raw brick / triplex
Height : 1-2 storeys
Year : est. 1990
Condition : vulnerable

Illegal housing which grow on the narrow edges of Semarang river; an attempt to live close to the city centre from the poor immigrants

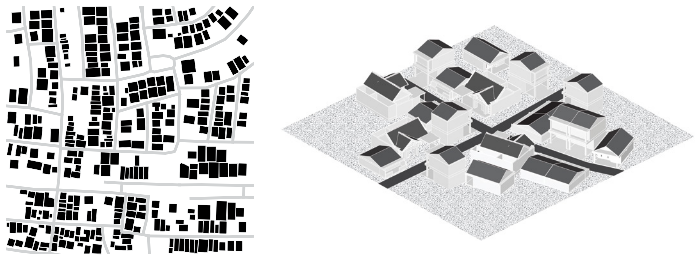
8.



Ave. Size : 300 m²
Material : plastered brickwork
Height : 2 storeys
Year : 2005
Condition : prosper

Medium size residence upon reclamated land, in which the subsidence issue still proceed.

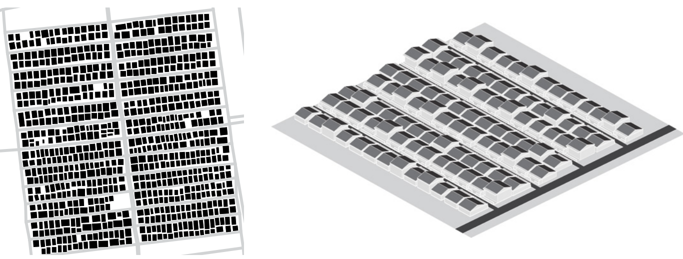
9.



Ave. Size : 200 m²
Material : plastered brickwork
Height : 1-2 storeys
Year : est. 1970
Condition : sufficient

The land between building blocks are relatively sparse for being in the city; whereas the dwellings are not uniform.

10.

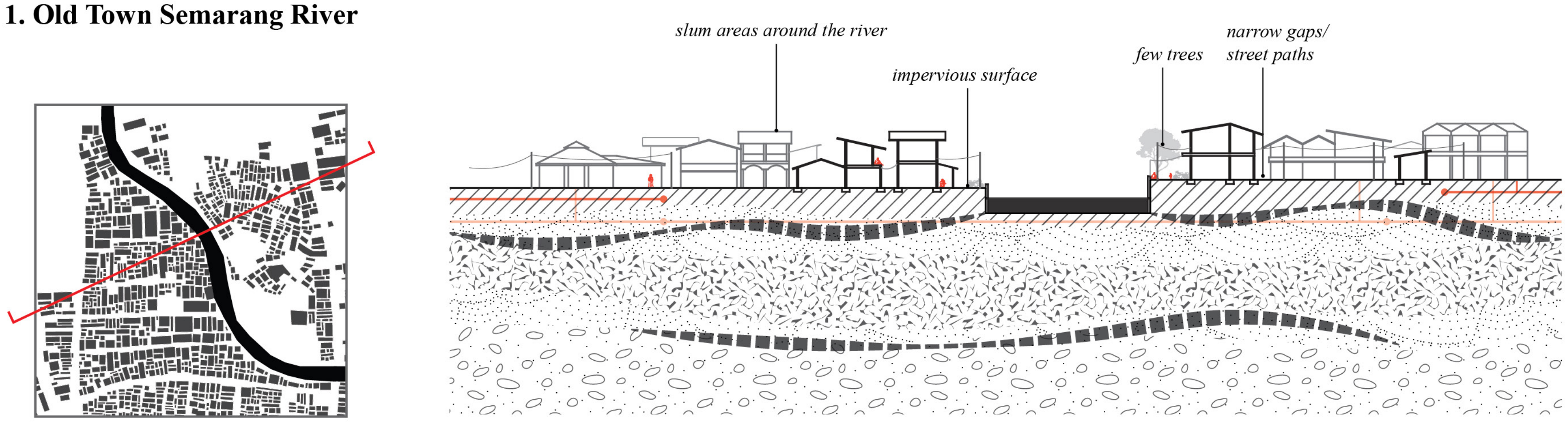


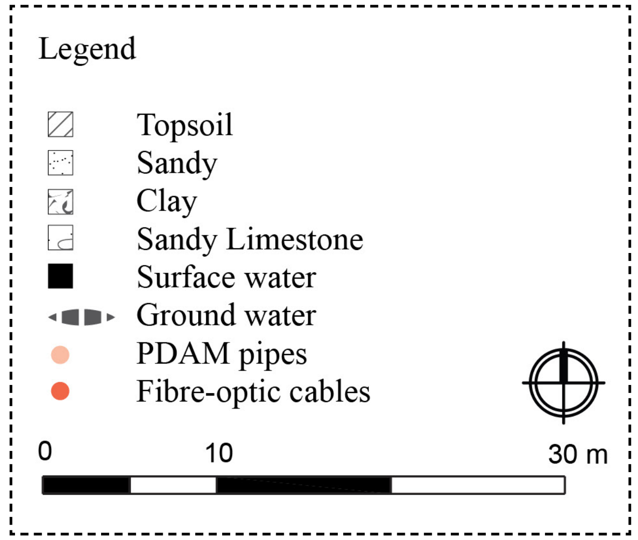
Ave. Sizes : 150 m²
Material : plastered brickwork
Height : 1-2 storeys
Year : 1976
Condition : sufficient

A dense, small residential housing on what appears to be the only grid parcels in the city.

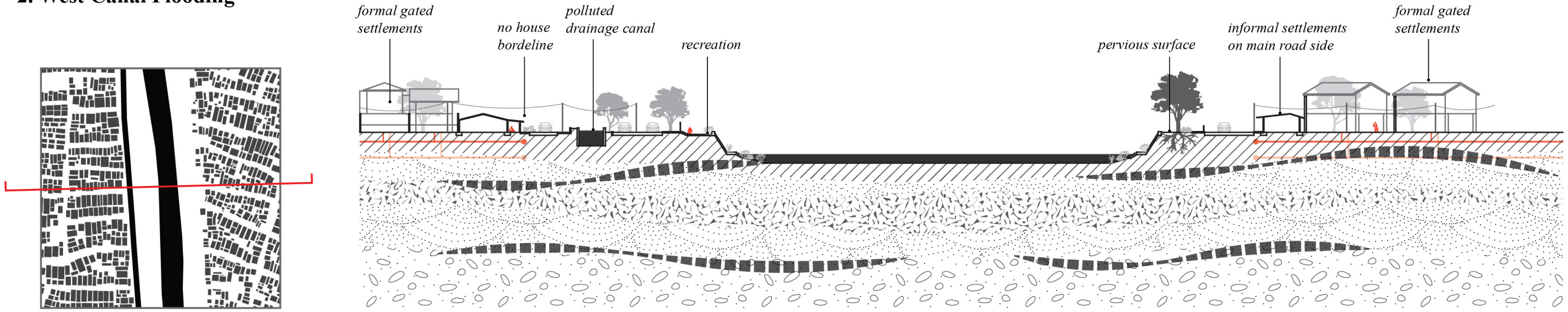
Sections of Major Water Bodies

1. Old Town Semarang River





2. West Canal Flooding



3. Tambak Mulyo Area

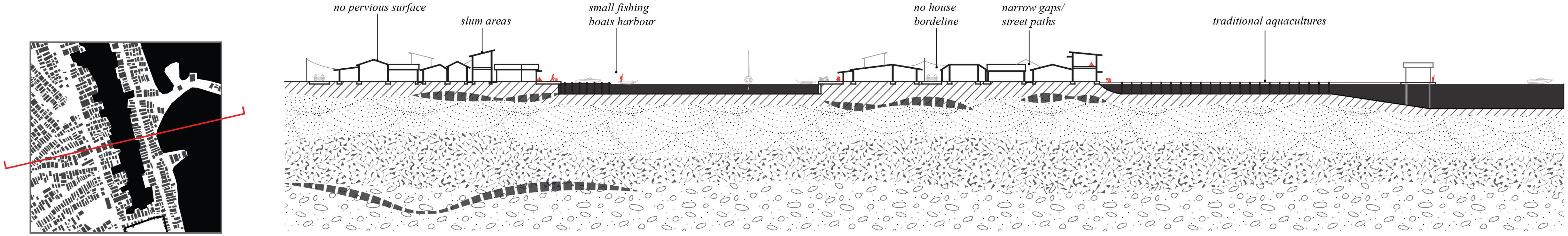


Figure 21: sections of major water bodies in Semarang

It is observed that width of kali Semarang (section 1) is less than a third of the West Canal Flooding (section 2). Bordering it (by perimeter) are the 90 degree hard surface concrete, impervious pathway, and the slum dwellings that fit up to 4 families in a single row. It is almost seem that the canal that was the origin of the civilisation in the city has been treated as a mere drainage. The West Canal Flooding implies a better scenario where parks are seen to buffer the water. The elevation down towards the canal are also sloped gently which allow people to have recreational means. The neighborhood closeby are seen to be organized and sufficient, although informalities can still be observed right next to the main street. It appears that this canal is being treated as a priority. However it does not serve justice if a 3-meters wide ditch next to it are still openly polluted and neglected. The neighborhood in the coastal region are informally similar to the one around Kali Semarang. However, as they live next to the unlimited ocean surface, interactions with the ecosystem service of water are more prominent. Small fising ports and aquacultures are part of their daily activities.

Most Frequent Used Street

in relation to water bodies

1. Connectivity **2. Choice - R750m** **3. Integrated - R750m**

Figure 22: space syntax analysis of Semarang streets

These space syntax analysis are made to understand the most common destination within the city. The first map above shows that the connectivity within the city are pretty well established. The next two maps observe the most chosen street and the most centre areas within 750m radius in relation to the main water bodies. These analysis aim to see which nodes are worth improving to promote livability and comfort for people to walk, and eventually changes the transport culture gradually. We could see that people tend to walk around the Semarang River watershed areas (Kota Lama is a part of this), as well as South of Babon River area--despite plenty central nodes seen on the Integrated 750m map analysis.

The map on the right page shows the landuse being overlayed with the most used street by choice of a 5km radius. It could be deduced that the most used streets are accessed by the citizens' private vehicles since Indonesian people tend to use their own cars/motorcycles to travel beyond 2 kilometers in order to avoid the heat. We could also say that the areas of the thicker road lines show the headquarter(s) of the city. Overlayed with the main water networks, this map help prioritize areas of pilot projects for urban flood risk management.

Legends

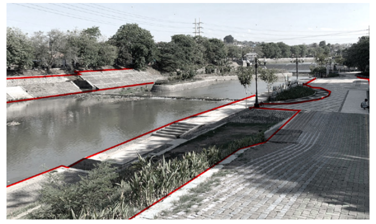
- Commercial
- Offices
- Train Station
- Airport
- Industries & Warehouse
- Port
- Health Centres
- Education
- Public Service
- Main Worship Places
- Accomodation
- Most Used Street
- Train Line
- Hotspot

Sources;
GIS Data Source

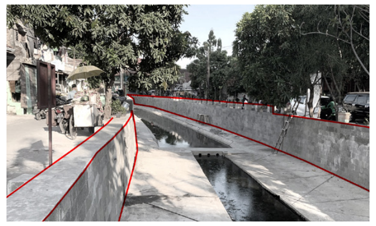
Map 10: Most Frequent Used Streets of Semarang

Hotspots relationship with water

1. The wide riverside buffer closer to the hinterland allowed people to have farming activities



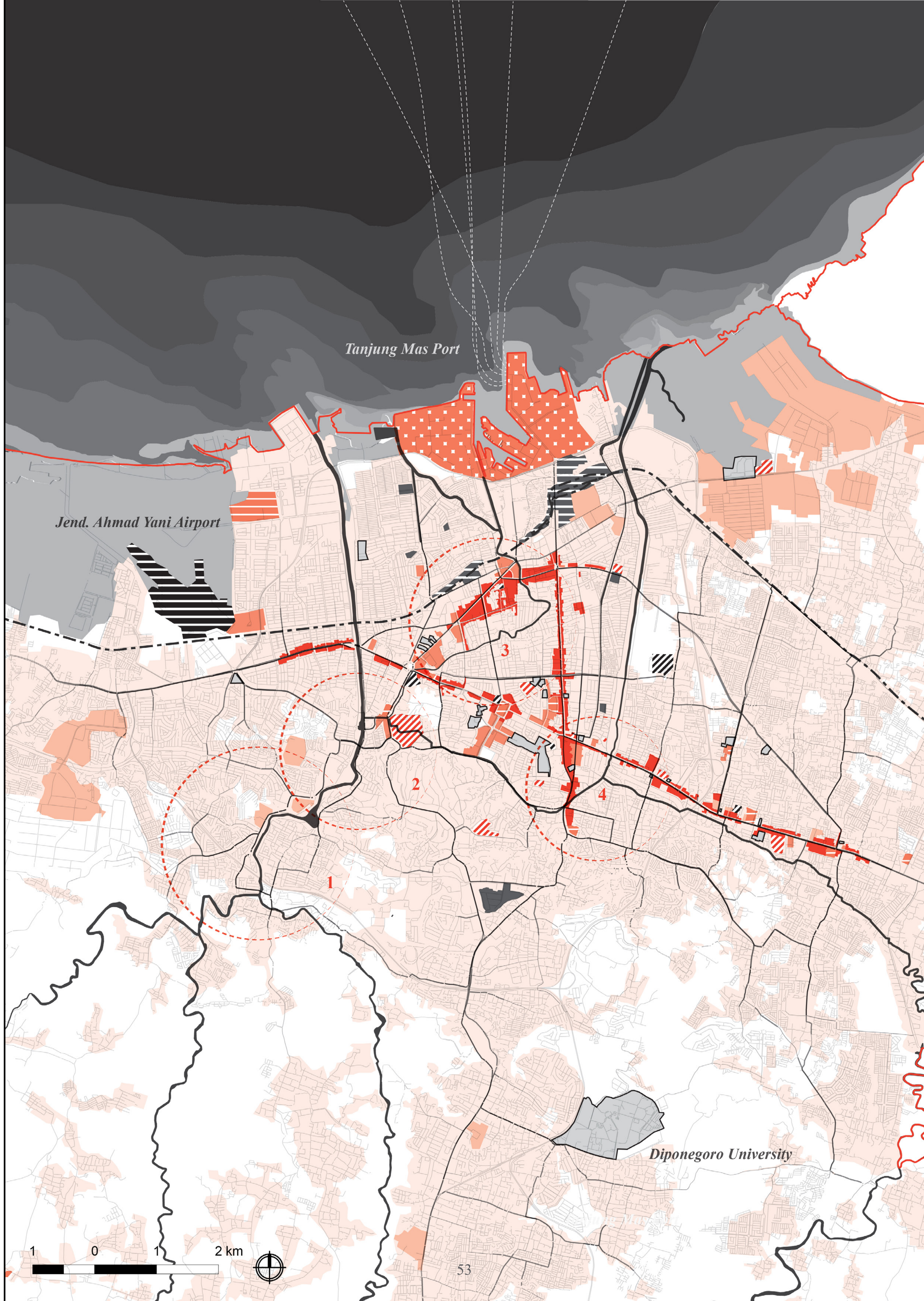
2. Designated for public space, the waterfront are however still dominated by hard surfaces



3. The canal normalisation have strongly mark a grey infrastructure along the historical line of Semarang River

4. Like most minor canals passing through the city, houses are back-facing the waterbody and treating them as a drainage

Figure 23: urban riverside connections



Vulnerable Society

Image 24: target citizens to the social-housing project of Bandarharjo

Image 23: the built social housing on the area fails to accomadate the targetted residents, rather they are filled with regional immigrants

The map on the right shows the most dense area being around the midpoint of Kali Semarang, which is a relatively prosper area. However, it is surrounded by a perimeter of sub-districts with a significant number of poverty--appear wanting to live close to the prime zone. The poorest sub-districts are pushed to the edges of the coastline, an area of major hazards, with the people living on worrysome dwellings as analysed previously on Urban Typology number two (see Figure 20 on page 48). Thoughts on relocation have emerged many times, but never worked as the provider most of the time failed to fulfil their socio-economic needs in their new place. These vulnerable citizens living around the main delta of Semarang River have only amplified the lack of management to the water body.

Legends

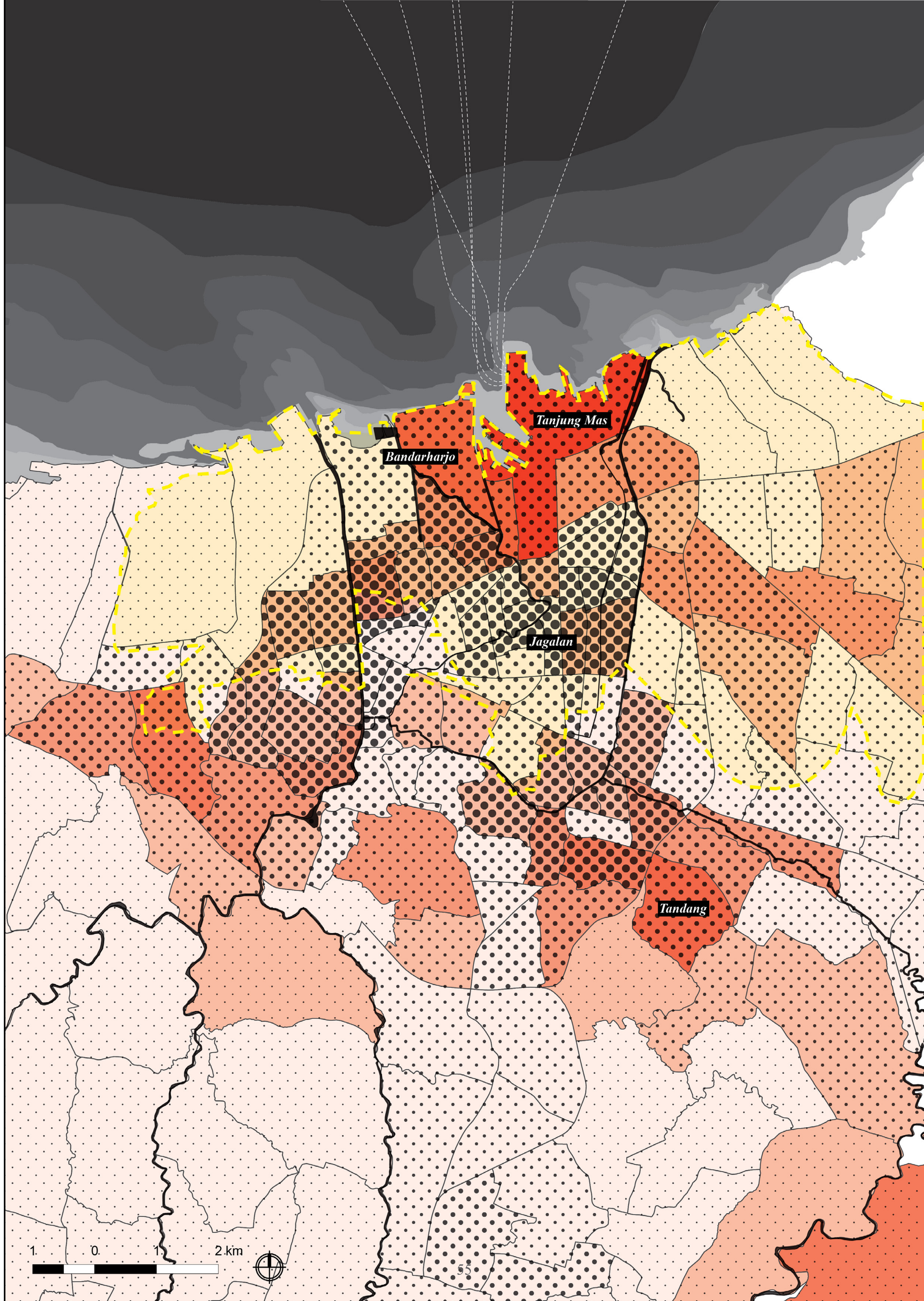
Density (people/km²)
- 1,43 - 23,92
- 23,92 - 56,24
- 56,24 - 120, 43
- 120,43 - 166,26
- 166,26 - 298,35

Poverty
- 0 - 2000
- 2001 - 4000
- 4001 - 6000
- 6001 - 8000
- 8001 - 1000
- 14000 - 16000

- Sub-district Boundary
- Hazard Area

Sources;
http://pusdataru.jatengprov.go.id/

Map 11: Density and Poverty in Semarang



Cultural and Natural Heritage Values

Figure 24: collection of images of valuable cultural and natural heritage landmarks in Semarang

Cultural Heritage, Landmarks, and Local Favorite Destinations

1. Kota Lama Semarang
2. Masjid Agung Jawa Tengah
3. Lawang Sewu
4. Museum Mandala Bhakti
5. Gereja Blenduk Semarang
6. Klenteng Sam Po Kong
7. Pasar Johar
8. Kelenteng Tay Kak Sie
9. Vihara Mahavira Graha
10. Museum Ronggowarsito
11. Candi Tugu
12. Tugu Muda
13. Stasiun Tawang
14. Semawis Market
15. Kampung Pelangi
16. Simpang Lima
17. Mercusuar Tanjung Mas

Natural Heritage and Local Favorite Destinations

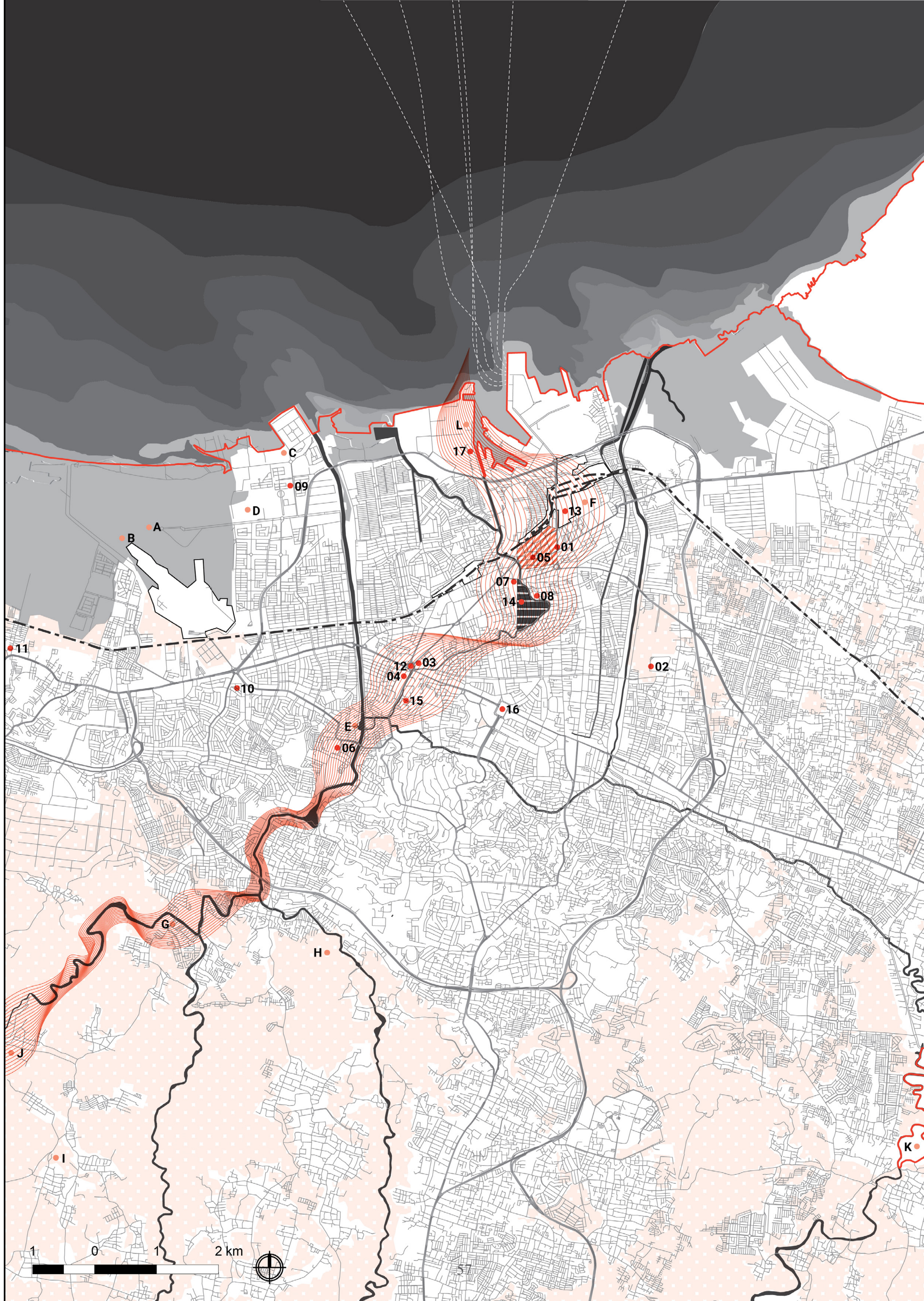
A. Pantai Maron
B. Magrove EduPark
C. Pantai Marina
D. Taman Macrokoco
E. Bendungan Plered Simongan
F. Polder Tawang
G. Wisata Lembah Kalipancur
H. Hutan Wisata Tinjomoyo
I. Desa Wisata Kandri
J. Gua Kreo
K. Brown Canyon
L. Tanjung Mas Port

Upon marking the valuable landmarks and favorite local destination within Semarang city, be it cultural or natural--it forms a trail that seem to align with the Semarang river watershed. This triggers a question whether bringing back the continuity of Semarang river could promote a natural public goods as a common ground for current spatial segregations: ethnicity or economy.

Legends

- Dutch Old Town
- Pecinan (China Town)
- Natural Landscape
- Cultural Heritage/Landmarks/ significant place
- Natural heritage
- Main River / Canals
- Main Roads
- Trail of interest

Sources;
https://www.aroengbinang.com/2018/01/peta-wisata-semarang.html



Map 12: Cultural and Natural Heritage trail in Semarang

Landscape Morphology

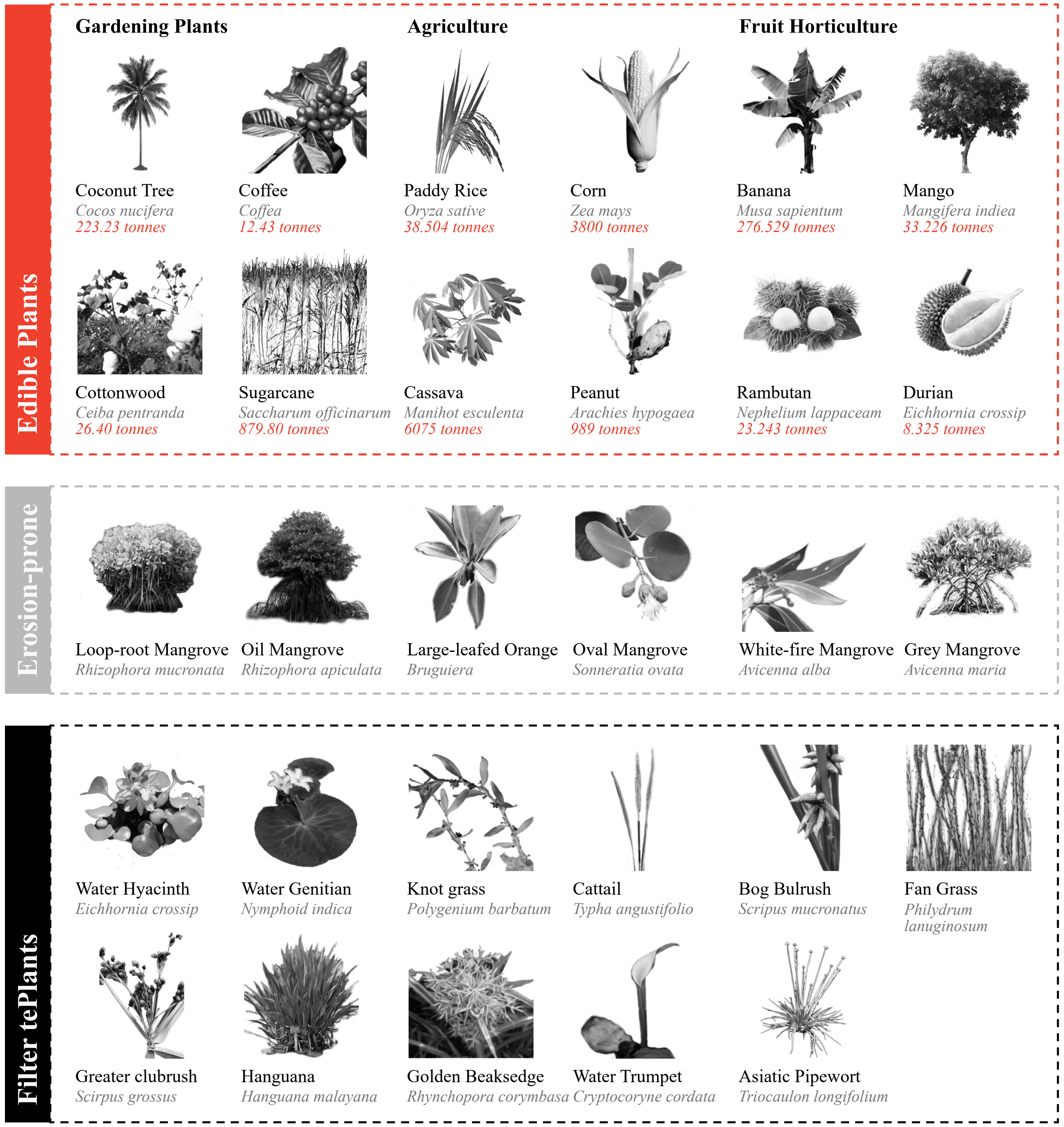
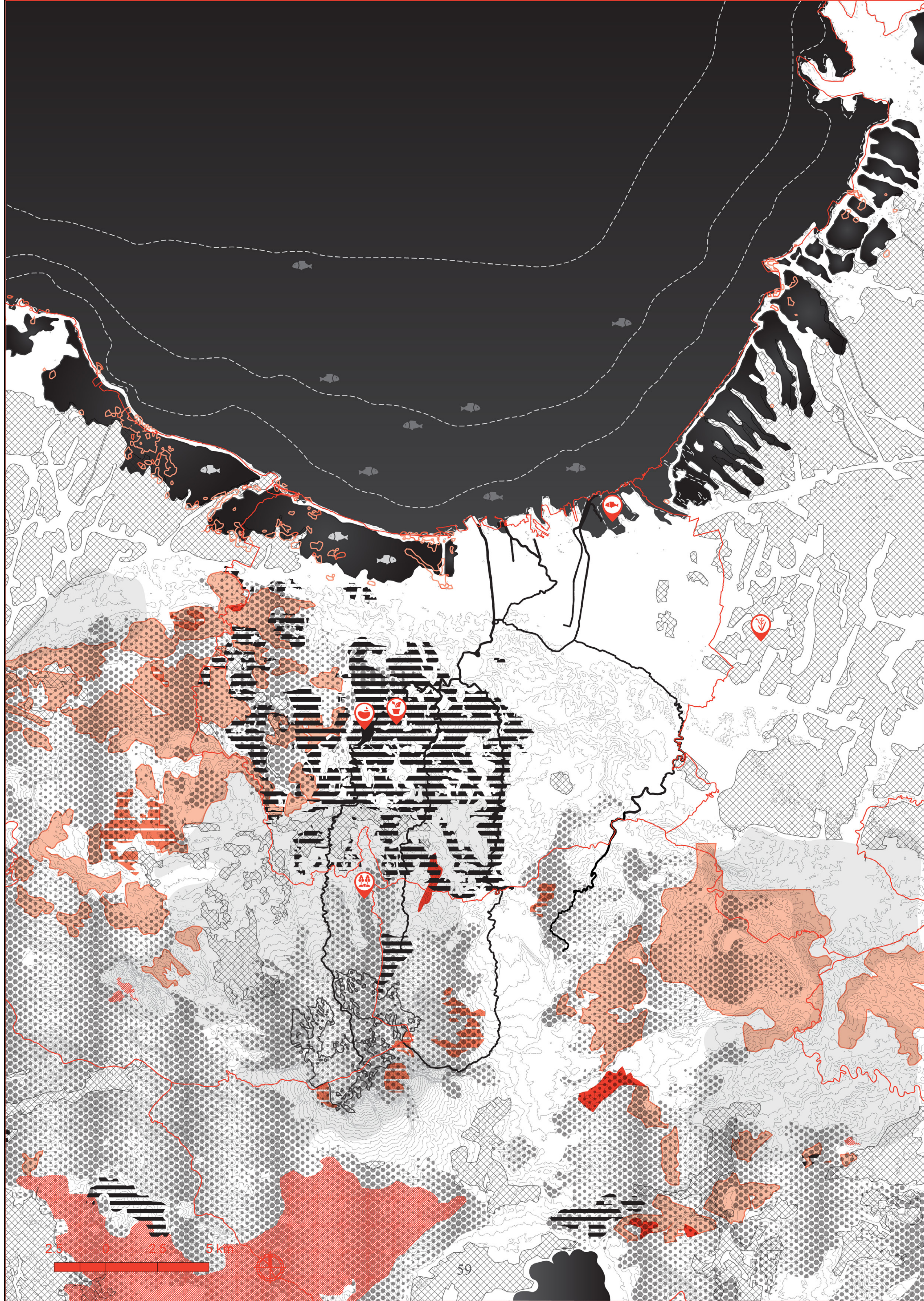


Figure 25: list of plants prominent for each function within Semarang city landscape



Legend

- Green field
- Rice field
- Mangrove
- Vegetation
- Coastal mangrove
- Higher-ground mangrove
- Fruits
- Rubber
- Forestry
- Timber forest
- Oil palm
- Aquaculture
- On-sea-fisheries
- Tanjung Mas Fishpond
- Jatibarang Dam
- Kandri Aquponic Village
- Ungaran Forest
- Demak rice-field

Source:
ArcGis - Soil Type of Central Java / Google maps

Map 13: Semarang landscape morphology

Landscape Morphology

Image 25:
Demak rice-field - These low-land rice fields are currently depleting as many acres are being bought by industries--causing many farmers to lose their job as well as the need to export rice from other region.
Source: https://www.desalogi.id/jalur-padat-pantura-dan-kisah-pensiun-dini-petani-demak/

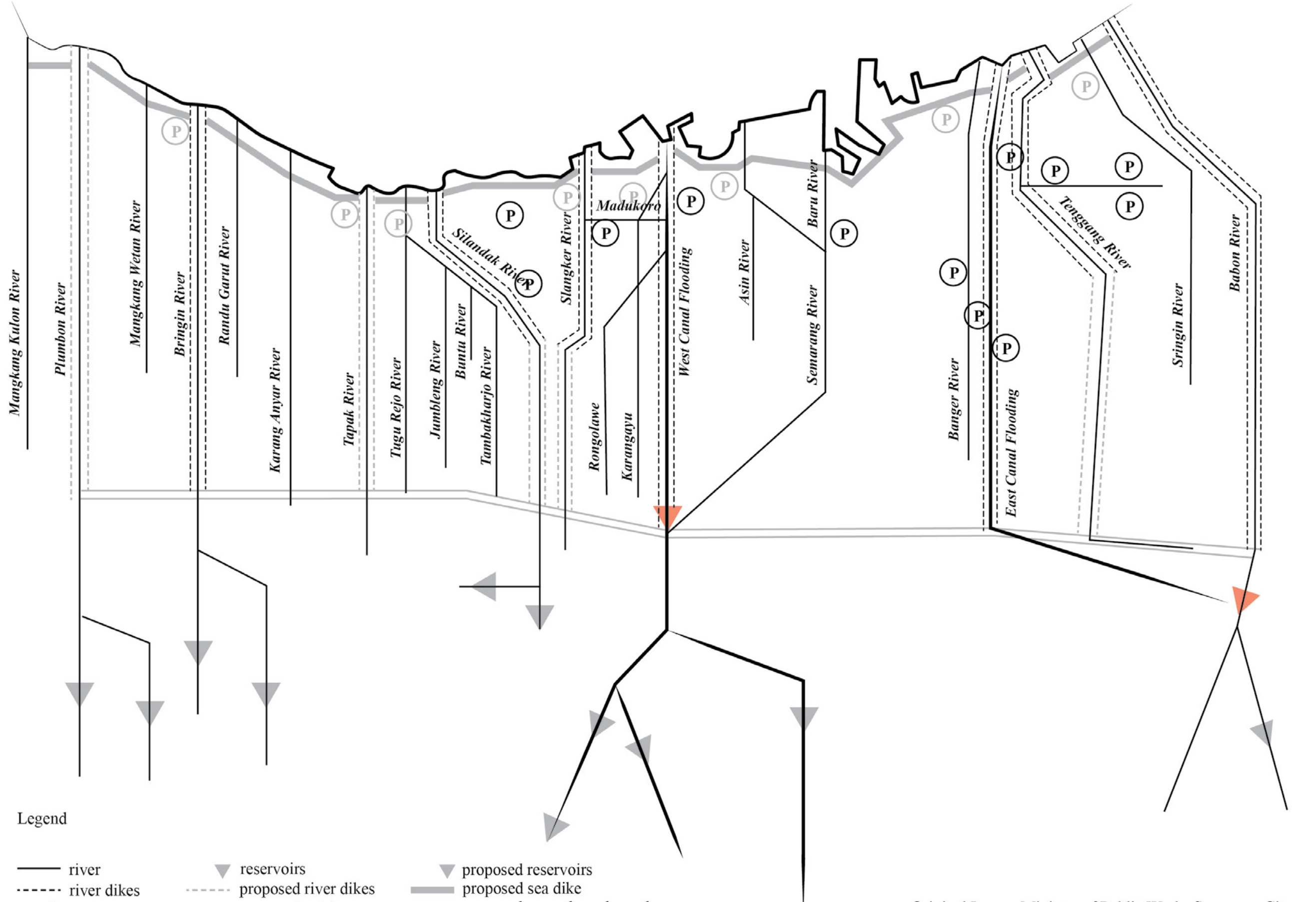
Image 26:
Tanjung Mas Fishpond - Although fisheries play an important role to the local economy, conversion of coastal mangrove to intensive aquaculture have accelereated coastal erosion.

Image 27:
Kandri Aquaponic Village - Located nearby Jatibarang Dam, Kandri would be the only urban village in the region which puts on consistent effort to cultivate their own basic ingredients.

Image 28:
Ungaran Mountain - Away from the dense urban area, the hinterland serves as large pervious surface through its forest and plantations.
Source: https://coretanpetualang.files.wordpress.com/2011/01/kebun-teh-gunung-ungaran2.jpg

Image 29:
Jatibarang Dam - Completed in the year of 2015, the dam have significantly reduce flood risk, create recreation area for the community, as well as giving new economic opportunities. By 2021, it is also expected to be able to distribute clean water access to the surroundings.

Watershed Profiles



Original Image: Ministry of Public Works Semarang City

Figure 26: watershed diagram of Semarang

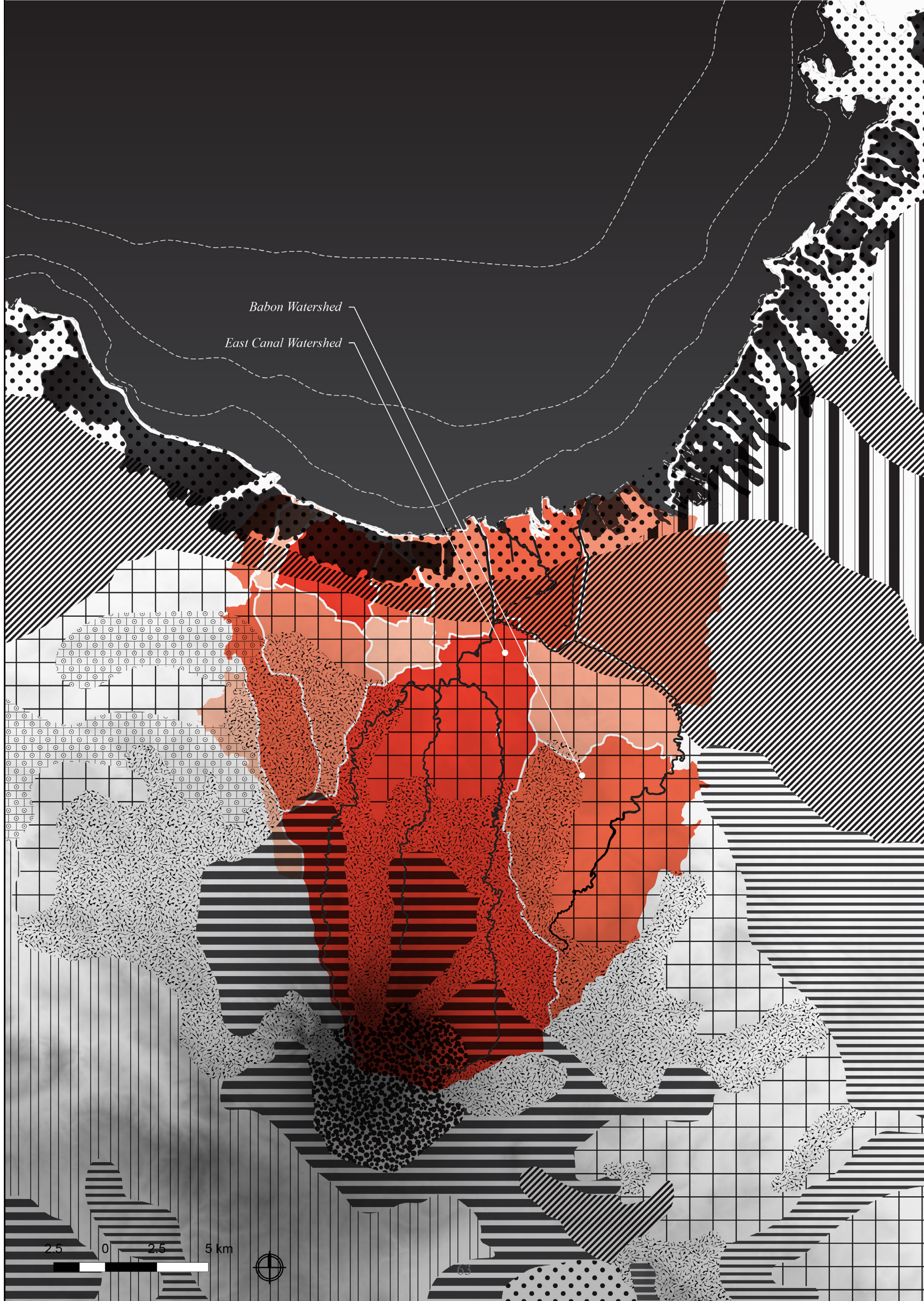
The figure above shows the city drainage concept towards the sea--yet, the one that cross the urban centre is mainly Semarang River, which also belong to the biggest watershed cluster (see Map 14). The lines in grey are the proposed measures of these deltas. The smaller rivers outside the canals are seen to be potentials to rechannel the water from the hinterland, to not put weight only on Semarang River. The map on the right also shows the soil type along the watershed to explore which areas have the best soil potentials to allocate the listed plants on Figure 25, as well as to explore sites containing suitable core dike materials.

Legend

- Hydromorph Aluvial
- Gray and Brown Aluvial
- Gray Grumusols and Litosol
- Dark Gray Grumusol
- Mediteranean Brown and Regosol
- Mediteranean Maroon and Regosol
- Gray Regosol and Dark Gray Grumosol
- Mediteranean Brown and Litosol
- Brown Andosol
- Brown Latosol

Source:
Balai PSDA Jragung Tuntang
ArcGis - Soil Type of Central Java

Map 14: Soil Type along Watershed Clusters



Semarang Hydrological Flow
and the concern of pollutants

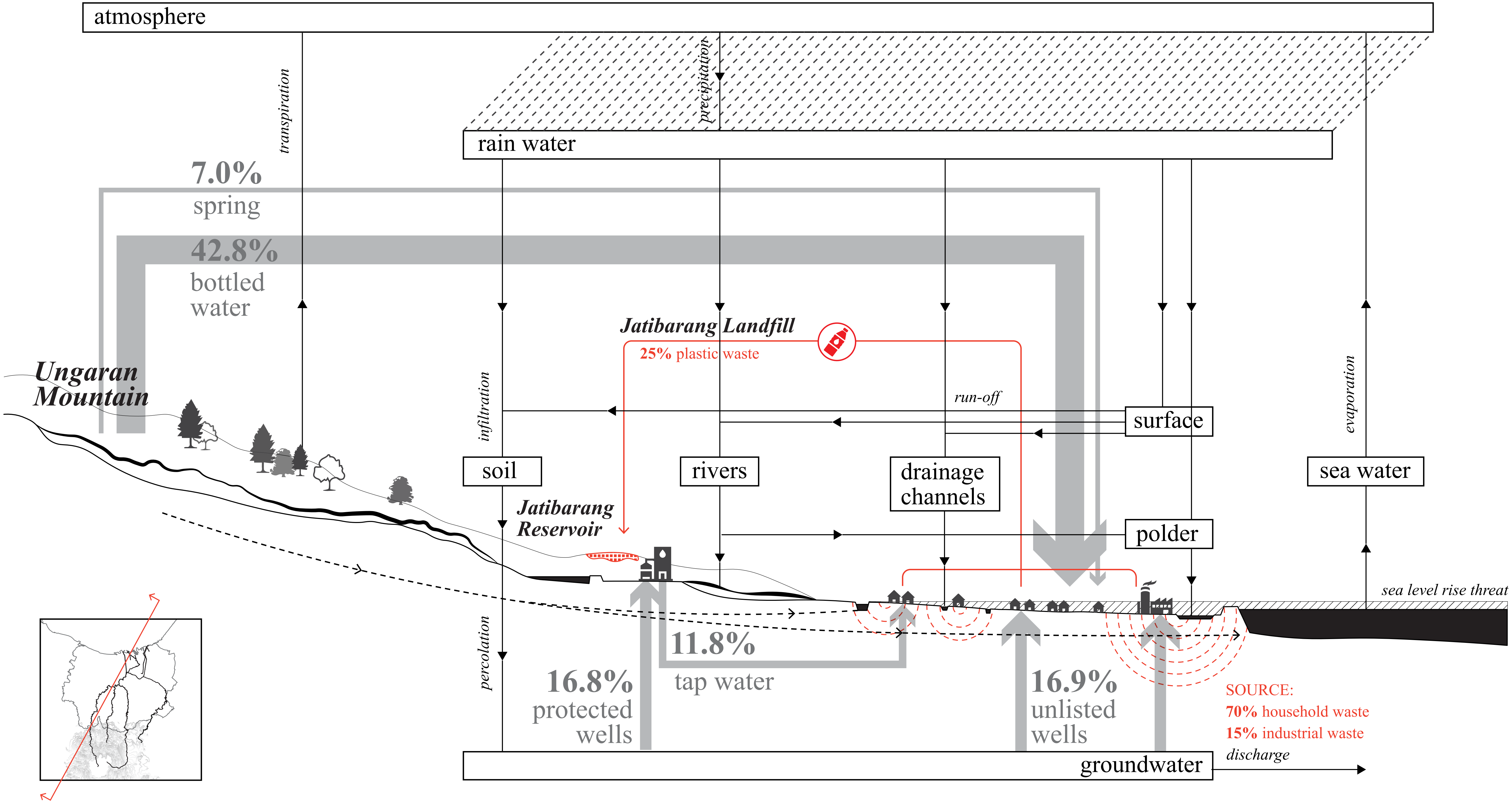


Figure 27: Schematic diagram of Semarang Hydrological Flow

The diagram above depicts the natural flow of water along the watershed of Semarang--from up the Ungaran mountain down to the coastline--and the flow to which the water are being used by the people. It also shows conceptually the areas where the water have high risk of contamination.

Source: Drinking water; https://beritagar.id/artikel/gaya-hidup/nyaris-separuh-warga-indonesia-minum-air-mineral-kemasan / Cascading Semarang, 2018.

Analysis Map Summary

Being present on site have allowed us to see that the flooding issues have made progress in a way that the past 3 years have experienced no major flooding. Although, the land subsidence nearby the coastline is seen to be a very prominent problem. Local resident of Bandarharjo mentioned that they have to heighten their houses every 5 years. If this carries on, the flooding issue would eventually hits back. It is also not sustainable as these precinct appear to have the most vulnerable citizens financially.

We also understood that many significant cultural precincts surround the Semarang River: Bandarharjo, Kampung Melayu, Kauman, Kota Lama, and Pecinan--which also signifies the river. However it contradicts the current river condition. It is not just the densification and informal growth that hinder the possibilities of nature-based solution along the rivers, but also the neglected waste management that continuously degrades the water quality.

The fact that there are multiple government stakeholders within different water networks in Semarang also prolonged the decision making process of development.

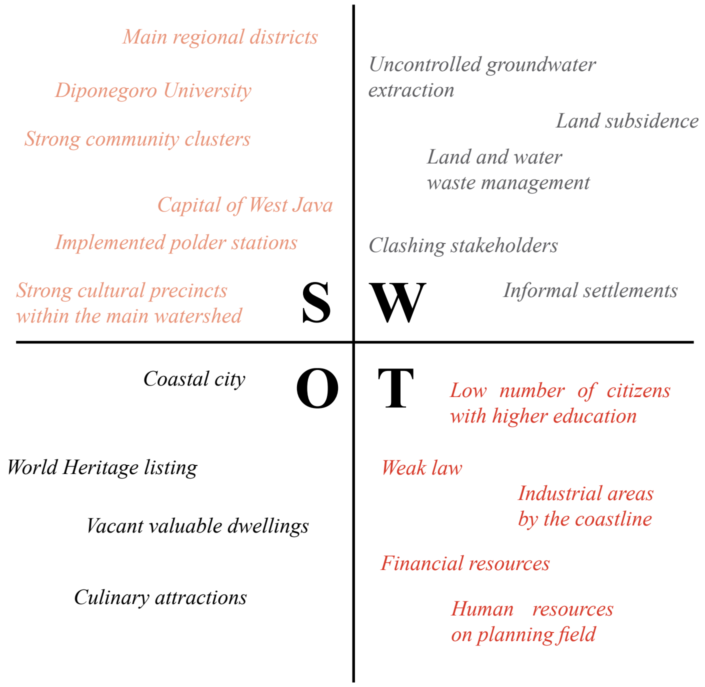


Figure 28: SWOT summary diagram of the conditions in Semarang

Legends

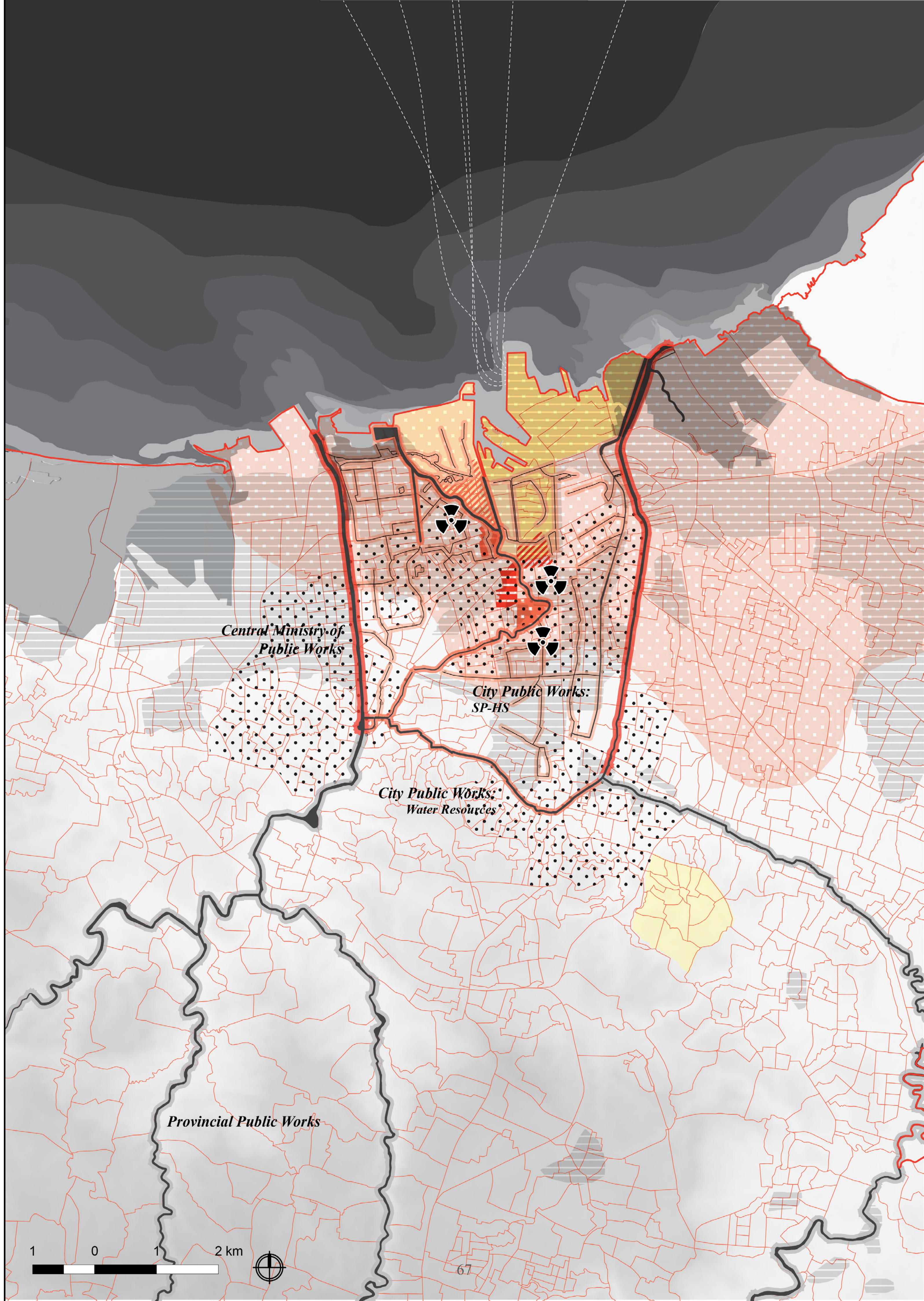
- Flood Risk
- Land Subsidence
- Highest Density
- Highest Poverty
- River Pollution

- Water network Stakeholders
- Central Ministry of Public Works (PUPR)
- Provincial Public Works
- City Public Works - Water Resources Directory
- City Public Works - Spatial Planning and Human Settlements Directory

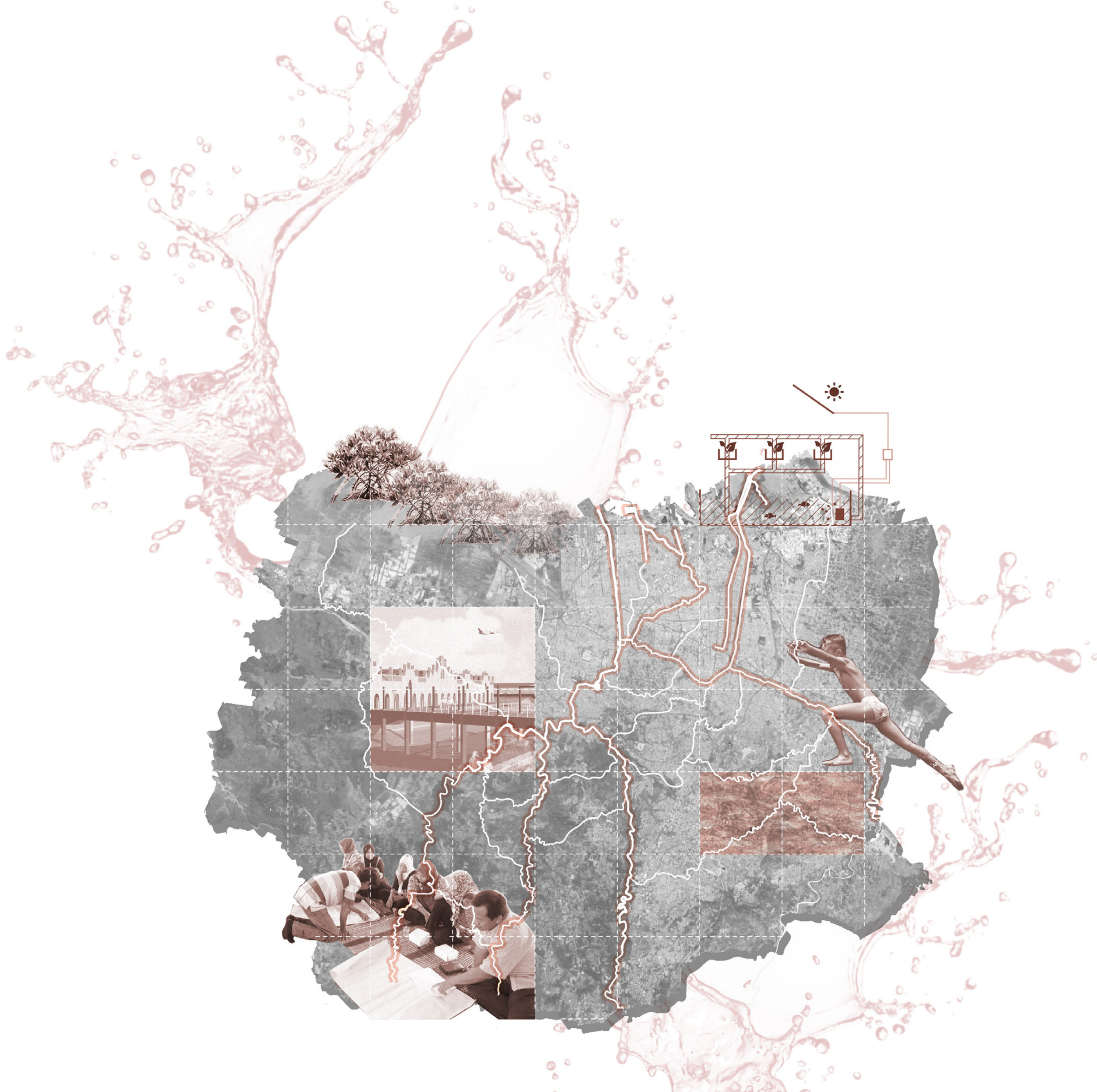
- Cultural Precincts
- Bandarharjo
- Kampung Melayu
- Kota Lama
- Kauman
- Pecinan

Sources;
Susanto, N., et. al. (2017), Nugraha, A. L., et. al. (2018)

Map 15: Analysis Sumaary Map of Semarang Hazards



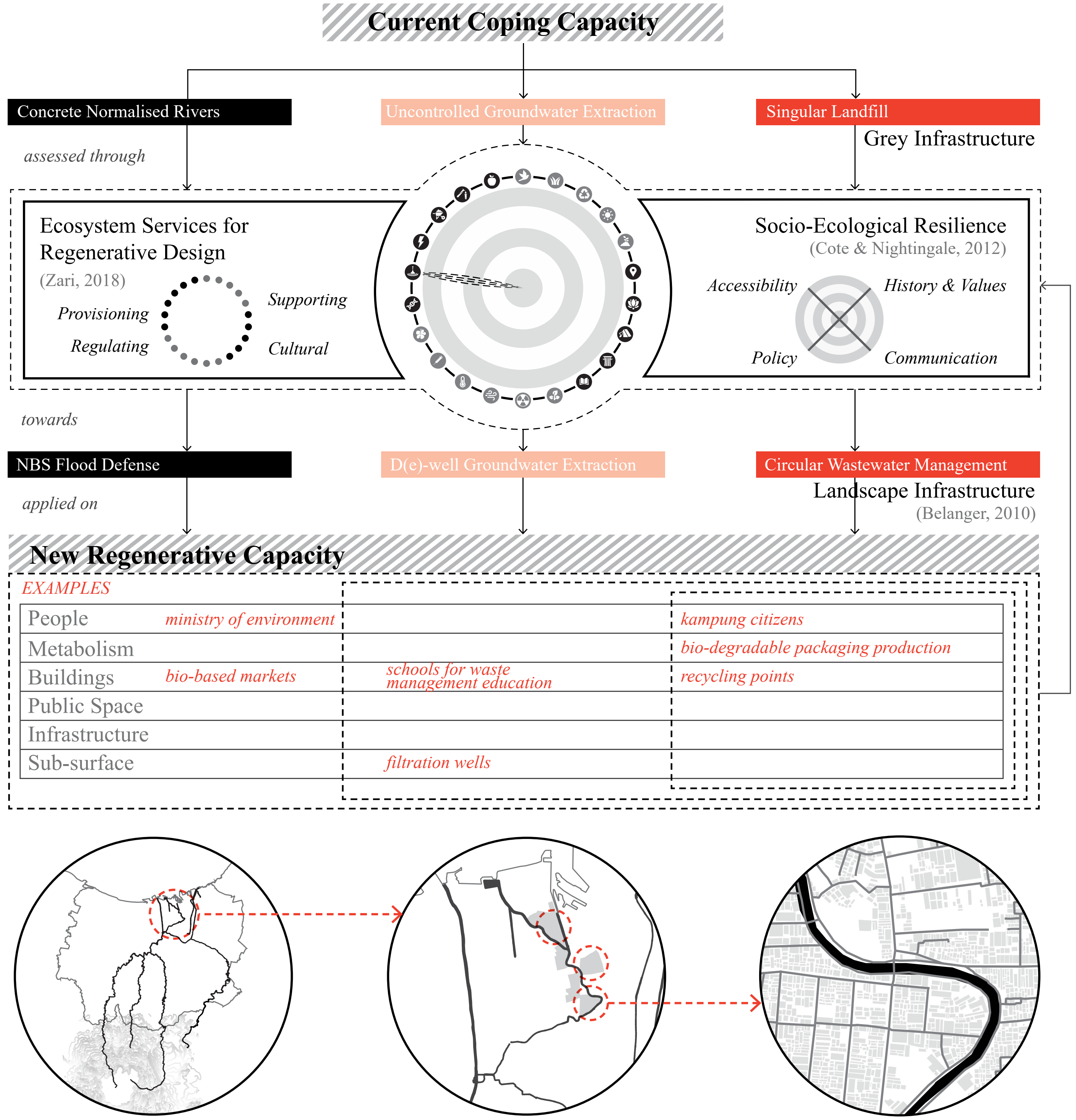
D. Vision & Strategies



*'The vision is to conduct an urban water management which are able to enhance livability by **attaining hygienic environment, safeguarding the ecology, and inducing bankability** of the local community in Semarang City. This will be achieved through fixing the waste management system alongside, promoting a nature-based flood defense, as well as seeking alternative water and food supply with the participation of the community.'*

Vision Realisation Roadmap

'Urban water management which are able to safeguard ecology, enhance livability, and adds bankability'



Macro Scale

The scale takes on the whole watershed which flows from Ungaran mountain down to the coastline of Semarang city, whcih comprised of Kreo River, Garang River, Kripik River, and Semarang River. The aim is to seek possible flood risk measures from up the hinterland.

Meso Scale

This scale focuses on Semarang River itself which has been an important backbone to the city in which the water quality is severly declining. The river is home to various cultural precincts with heritage significance and a witness to the city's daily metabolism flow. Hence, the health of the river is necessary to be observed at this scale.

Micro Scale

The final scale will zoom in to the compound level of Pecinan precinct where many commercial and residential activities collide, as well as the Bandarharjo precinct where the subsidience issue is critical. This would help to have a closer look on the daily activities of the citizens and the infrastructures they engage to nearby the Semarang river.

Figure 29: last section from the roadmap of the overall methodology

The diagram on the left is the recurring last half of the methodology to remind where we are at on this paper. After stating the vision, this thesis will present the Regenerative Assessment to transform the current coping capacities to new regenerative capacity projects. The strategies of each sub-project would then be derived through scales and layers, and then followed by analysing the site potential and limitation on each scale--in order to locate the interventions at the suitable place.

Assessment Framework
of regeneratve capacity

ES + SER

The framework takes the key projects on a loop to be assessed through the twenty-two variables of ecosystem services that could be mimicked in the built environment. Each variable will have the feedback on the engagement of the 5 social layers within its implementation; be it about communication efficiency, values, ability to act, and accessibility.

Legend

Ecosysytem Services Mimicry

- **P** Provision
- **R** Regulating
- **S** Supporting
- **C** Cultural

Applicable for the following vision;

- NBS Flood Defense
- Clean Water Access
- Waste Management

Socio Ecological Implementation*

- Communication
  Are there available facilities/platform on each layer to execute the project?
- History & Values
  Does the current application contain historical relevance on how it was managed in the past?
- Ability to Act
  Are there policies to deal with the matter on each layer?
- Accessibility
  Could everyone contribute or access the knowledge of this facility?

- - - - Missing Connection
—— Established Connection

*Engagement would not be considered if it only covers a certain community group

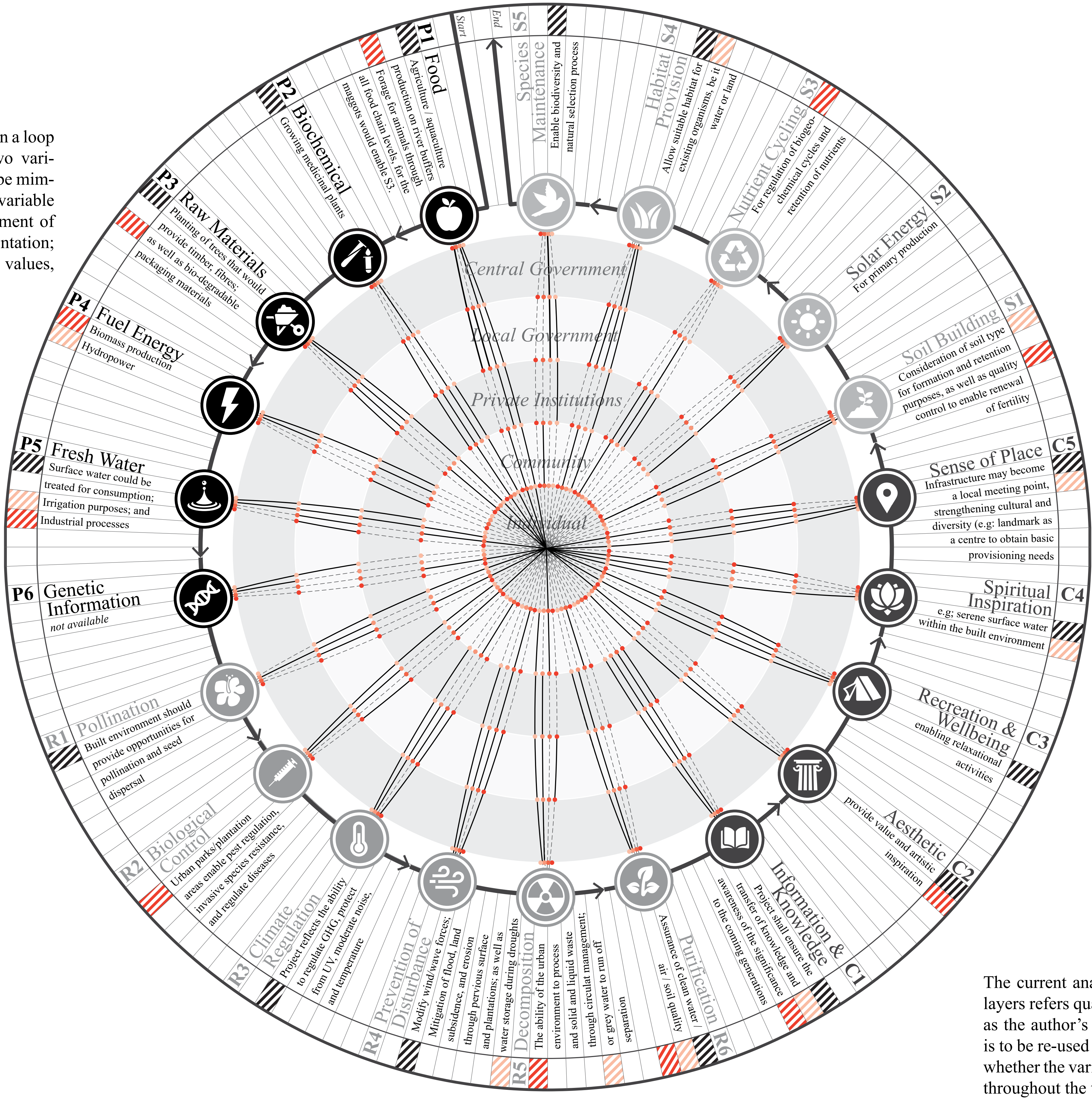


Figure 30: Assessment Framework of Regenerative Capacity

Long Term Development Planning of Semarang City 2005-2025 - Semarang City Regional Policy no. 6, 2010

Medium Term Development Planning of Semarang City 2016-2021 - Semarang City Regional Policy no. 11, 2017

Guidelines on the Implementation of Community Participatory Planning from the Deliberation of Development Planning with the Regional Sub-Districts and Urban Villages of Semarang City 2020

Surface Water Quality - Government Policy no. 82, 2001

Wastewater Policy - Ministry of Environment and Forestry Policy no. 68, 2016

Water Quality Standard for Health - Ministry of Health Policy no.32, 2017

Criteria and Placement of Watershed Region - Ministry of Public Works and Settlements Policy no. 04, 2015

Unit Typology Criteria for the Technical Implementation of Watershed Management - Ministry of Public Works and Settlements Policy no. 12, 2016

Guidance on Horticulture Region Development - Ministry of Agriculture Policy no. 40, 2016

Physical Implementation of Renewable Energy Usage and Conservation - Ministry of Energy and Mineral Resources Policy no. 12, 2018

The current analysis on the engagement of the social layers refers qualitatively to the policies above as well as the author's site visit observation. This assessment is to be re-used after the design stage in order to justify whether the variables of ES and SER have been applied throughout the three scales throughout the project.

Assessment Highlights

The assessment begin by searching the variables of Ecosystem Services and Socio-ecological Resilience throughout the mentioned guidance and policies. The discussion that we will focus here would be on those in Semarang, hence the first three planning policies.

1. Glancing current community participation

This becomes the priority concern as the local community would be the ones utilizing the available landscape infrastructures as well as the caretakers. Seen on the *'Guidelines on the Implementation of Community Participatory Planning from the Deliberation of Development Planning with the Regional Sub-Districts and Urban Villages of Semarang City 2020'* are survey forms of land potentials, suggestion on actions and infrastructure, as well as priority actions that would be filled in together with the community upon gatherings. Below are the list of community sectors that are being involved:

1. Sub-district Government (kelurahan), namely the Lurah; Lurah Secretary; structural officials and sub-district staff;
2. Management of Sub-district Community Empowerment Institution (LPMK);
3. Members of People's Representative Council (DPRD), namely Semarang City DPRD members from the local Electoral District or who are domiciled in the local Sub-district area;
4. Political Party Administrators at the sub-district level;
5. Urban village (RW) Delegations and community organizations in the Sub-district, that is:

a) At least 3 delegations from each Urban Village;
b) Representatives of the sub-district Self-Supporting Body (BKM);
c) Community organizations or institutions at the sub-district level (Karang Taruna, Posyandu cadre, Village Children Forum, PKK, PAUD Pos Management, Healthy Village Working Group, Village Elderly Regional Commission, and others);
d) Religious / Community Leaders, women leaders or administrators of women's organizations;
e) Taklim Assembly or other religious assemblies in the sub-district;
f) Staff and student representatives from Islamic Boarding Schools;
g) Representatives of poor citizens;
h) Professional Groups (teachers, doctors, entrepreneurs, etc.);
i) Small business groups (informal sector);
j) Public and Private School Committees in the Sub-district area;
k) NGOs domiciled and active in the local Sub-district area;
l) other NGOs concerned with the participatory development planning process in Semarang City;
m) Head of the clinic in charge of the Sub-district area concerned;
n) Representative Office / Agency Technical Implementation Unit (UPTD / B) of the Regional Organization in the Sub-district / District area

The survey act is a noble start, however the decision making process should also be guided by the community. What also needs to be enabled here is the education of the core problems as local interviews (appendix) indicate how they are oblivious to the fact that the sinking land is due to groundwater extractions. A lesson on ecosystem services, their interrelations, and future planning exercises with the citizens should be conducted to respond to their aspirations. Eventually, a clear documentation and publication of this exercise should be made accessible and done with integrity.

PROPOSED COMMUNITY EMPOWERMENT ACTIVITIES

Sub-district : ....
District : ....

Rank of Priority	*Type of Activities*	*Location*	*Urban Village*	*Street Neighbor*	*Volume*	*Budget Suggestion (Rp)*	*Old/new Suggestions*	*Explanation*	*Regional Authority*
1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*

Team Organizer ....

Semarang,...................

Event Head

Secretary

Figure 31: example of a translated form template to fill during community gatherings (see real form on appendix)

2. Awareness on ecosystem services;

BAB II

KEDUDUKAN DAN TUJUAN REMBUG WARGA, MUSRENBANGKEL DAN MUSRENBANGCAM

Pasal 2

Rembug Warga merupakan forum musyawarah warga tahunan yang berkedudukan di tingkat RW untuk membahas dan merumuskan usulan prioritas yang dilakukan melalui penggalian potensi sarana dan prasarana, ekonomi, sosial dan budaya di tingkat RT/RW sebagai bahan masukan pelaksanaan Musrenbangkel dan akan disinergikan dengan prioritas pembangunan Kelurahan.

Figure 33: translation of chapter 2 and article 2 of Semarang City Medium Term Development Planning

The translation being '*Rembug Warga* is a yearly deliberation at the urban village level to discuss ... potential public facilities, economy, social, and culture upon urban village level,' has explicitly no mention on the discussions upon environment despite the evergrowing hazards. The *'Medium Term Development Planning of Semarang City 2016-2021 - Semarang City Regional Policy no. 11, 2017'* have summarized progress on various environmental and public infrastructure works as seen on the table below.

The summary indicates an alarming number of illegal settlements, followed by a questionable number of city pervious surface (*ruang terbuka hijau*)--which appear so much less on google maps. The managed-trash-piles are also only 42% of the overall landfills. Water supply have only reached 67.5% of the population. Yet only 12% industries abide the rules of waste-water filtration, contradicting the 100% claim of law establishment. On the otherhand, fishery, agriculture, and tourism industries experienced growth in the city. Integrating this sectors to the realisation of public works and environmental works may open up new opportunities.

Having travelled and witness the lack of public parks, waste on rivers, and burried houses; it seems like the regulating actions have never existed--whereas reading the laws have somehow convinced that there have been attempts. Upon the reviewed policies, a detailed stakeholder tasks have not been well distributed amongst the community layers--hence the proposed assessment to help aid it. Has it been the lack of communication or the citizens' limited ability to act which prevented the synergy of ecosystem services? The further design would therefore emphasize on having stations for these feedback gatherings (C5) and public workshops (C1) of regenerative development.

No	Task	Year						
		2011	2012	2013	2014	2015	2016	
Performance Evaluation of Public Works and Housing								
1	Tap water supply	66	66,5	67	67,5	60	67,5	~
2	Ratio of waste end points for every 1.000 citizens (%)	2,26	2,81	2,85	2,4	2,45	2,5	↑
3	River buffer used as illegal settlements (%)	50	48,7	47,1	46	44,2	44,1	↓
4	Drainage which are in good condition/unblocked (%)	75	76	77	78	79	80,5	↑
5	Good irrigation width condition (%)	1836	1896	1961	2031	2106	3062	↑
6	Waste management percentage (%)	79	81	83	85	87	87,5	~
7	Trash piles (m3)	N/A	N/A	5.807,23	5.995,47	6.109,00	6.189,00	↑
8	Percentage of household served by drinking water (%)	87,4	87,6	87,8	88	87	87,58	~
9	Ratio of green open space over unit area of Semarang city (%)	N/A	N/A	N/A	N/A	43,26	43,76	↑
Performance Evaluation of Environmental Affairs								
1	State of water pollution (%)	50	54	60	60	60	60	~
2	Environmental law enforcement (%)	100	100	100	100	100	100	
3	The percentage of businesses or activities that comply with administrative and technical requirements to prevent water pollution (%)	7	8,4	11	12	12	12	contradict!
4	Prevention of water pollution (%)	125	96,2	102,5	100	100	100	contradict!
5	Provision of damage and / or soil status information for biomass production (%)	N/A	N/A	95,84	88,12	100	100	parameter?
Performance Evaluation of Marine and Fisheries								
1	Captured fisheries production (tonnes)	650,15	715,53	1.296,50	1.465,50	2.136,29	2.392,56	↑
2	Aquaculture production (tonnes)	1.672,98	1.823,83	1.826,19	1.884,38	2.705,19	3.200,57	↑
3	Fish consumption (kg/capita/year)	23,37	24,04	24,93	25,93	30,26	30,94	↑
Performance evaluation of tourism								
1	Number of tourist visitors	2.100.923	2.712.442	3.129.099	4.007.192	4.376.359	4.683.974	↑
Performance evaluation of agricultural affairs								
1	Rice production or other main local commestibles (tonnes)	43.209	43.766	43.858	43.897	43.941	43.642	~
2	Plantation commodity production (tonnes)	925	795	412	223	146	789	↑

Figure 32: table of performance evaluation of selected environmental and public works according to different ministries

Macro Scale Land-use Potential and Limitations

Macro

The macro scale seeks the possibility of expanding the water-related networks within the city. Hence, the map plots the potential and limitations of the land surrounding the Garang River watershed in order to decide where the measures of (1) nature-based flood defense, (2) waste-water management, and (3) coordinated water storage to prevent uncontrolled ground water extraction can be executed.

The potentials take note of the, supposedly extensive, greeneries by the hinterlands of the watershed, existing reservoirs, as well as the smaller river branches, which both could be utilized to divert the water before flowing down to the coastline. It also mark the ample-sized 'empty' lands for consideration of waste management infrastructures. On the other hand, the limitations highlighted the urban density, and the industries as the major polutant sources. Thickness of the contour approaching the top of Mt. Ungaran also indicates that it is no longer feasible to do any infrastructural intervention.

Meso *(next page)*

As seen on the macro scale, the density hardly allow any remaining green space on the centre of the city. Hence, the potential and limitations on the meso scale observes the porosity surrounding the Semarang River. Supposedly applicable for the other rivers, the meso scale zoomed in to the Semarang River due to its historical significance, richness of the culture, central location, and contradictively the one facing most hazards.

The potential targets the tiniest green areas as well as grey spaces nearby, projecting them for river rehabilitation sites. It also observes the derelicts areas or vacant building which are able to be re-used for water-management coordination hub and educational purposes. The house of worships, regardless the religion, are also important community nodes in Semarang, hence may be given an added value to the palces. The limitations plot the protected areas as well as industries where any intervetions are not flexible. Informal settlements, although illegal, weighs more as limitation since relocating the residents might extent to ethical issues.

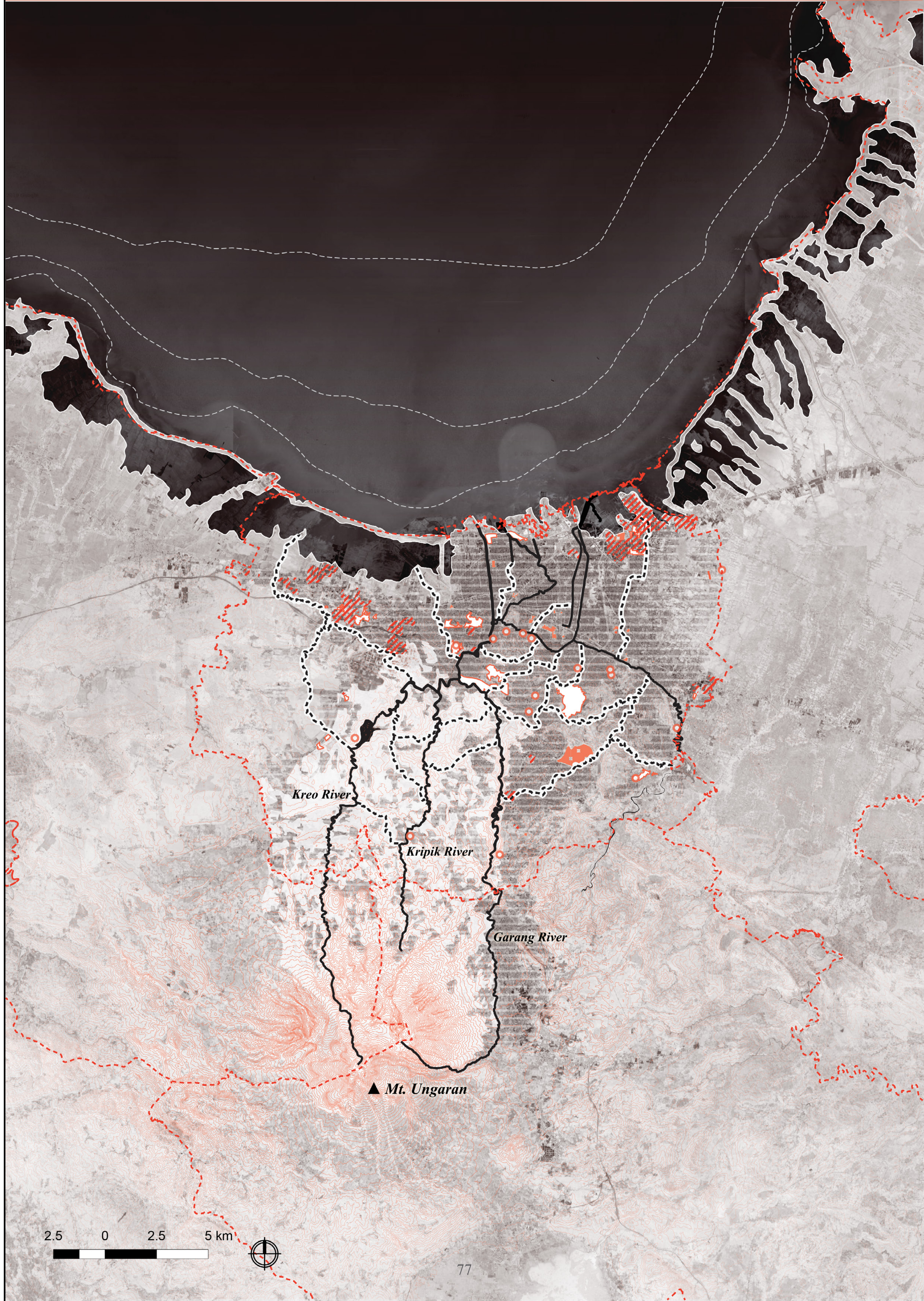
Legend

Potentials
- Green Areas
- Empty Land
- Potential River Linkages
- Existing Reservoirs
- Diponegoro University

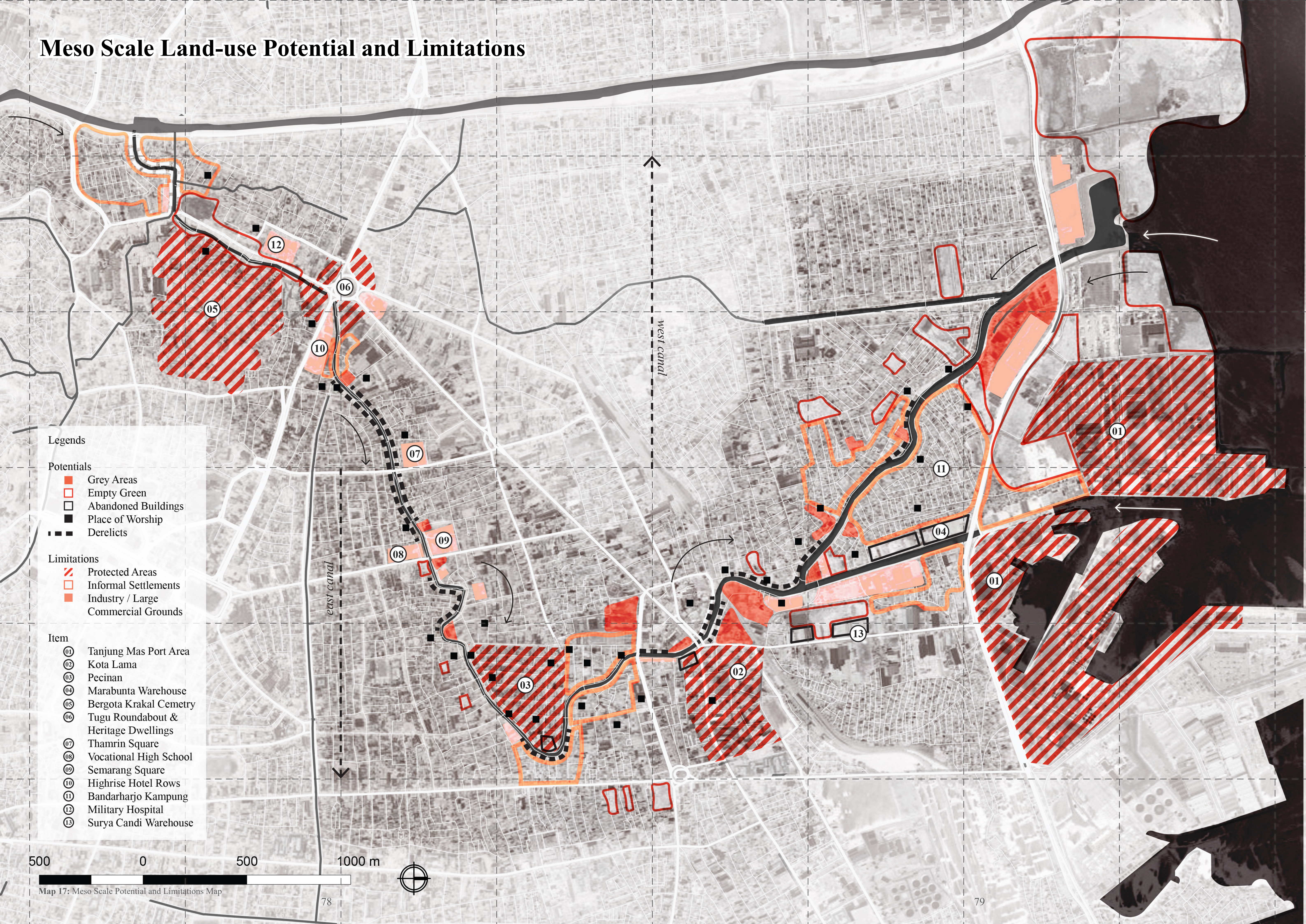
Limitations
- Urban Areas
- Industry Areas

Source:
Google Earth / Satu Data Kota Seamarang / PDAM Kota Seamarang

Map 16: Macro Scale Potential and Limitations Map



Meso Scale Land-use Potential and Limitations



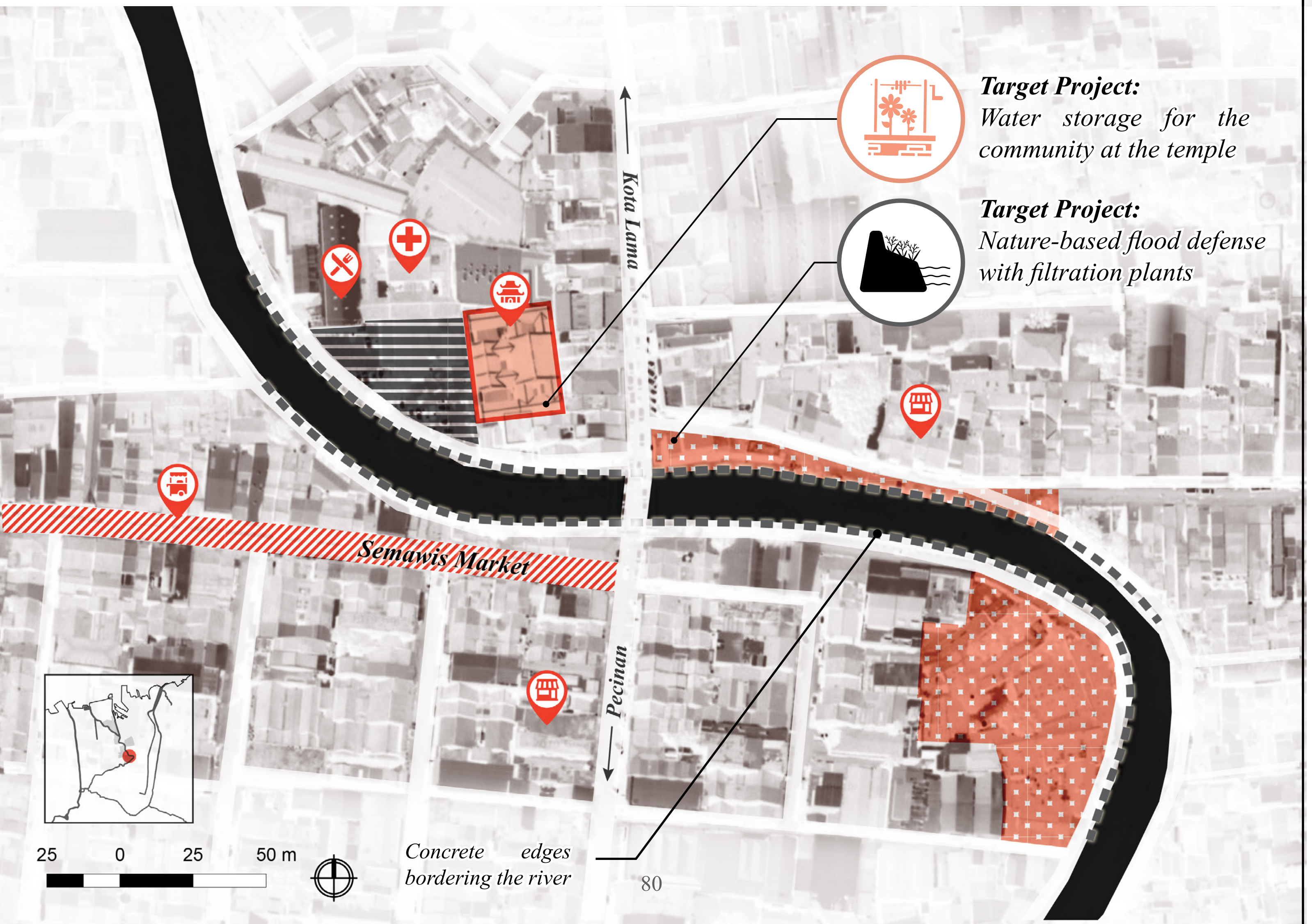
Map 17: Meso Scale Potential and Limitations Map

Micro Scale Land-use Potential and Limitations

1. Tay Kak Sie Temple, Pecinan

Pecinan precincts is one of the significant contributor to the river waste pollutants having an active martketplace daily. The site is also rich with temples who require water as a spiritual element. Standing on the riverside and being frequently visited, the Tay Kak Sie temple could potentially promote a healthy waterfront which filter river pollutants, as well as a site for a coordinated water storage.

Figure 34: current street view of Tay Kek Sie temple



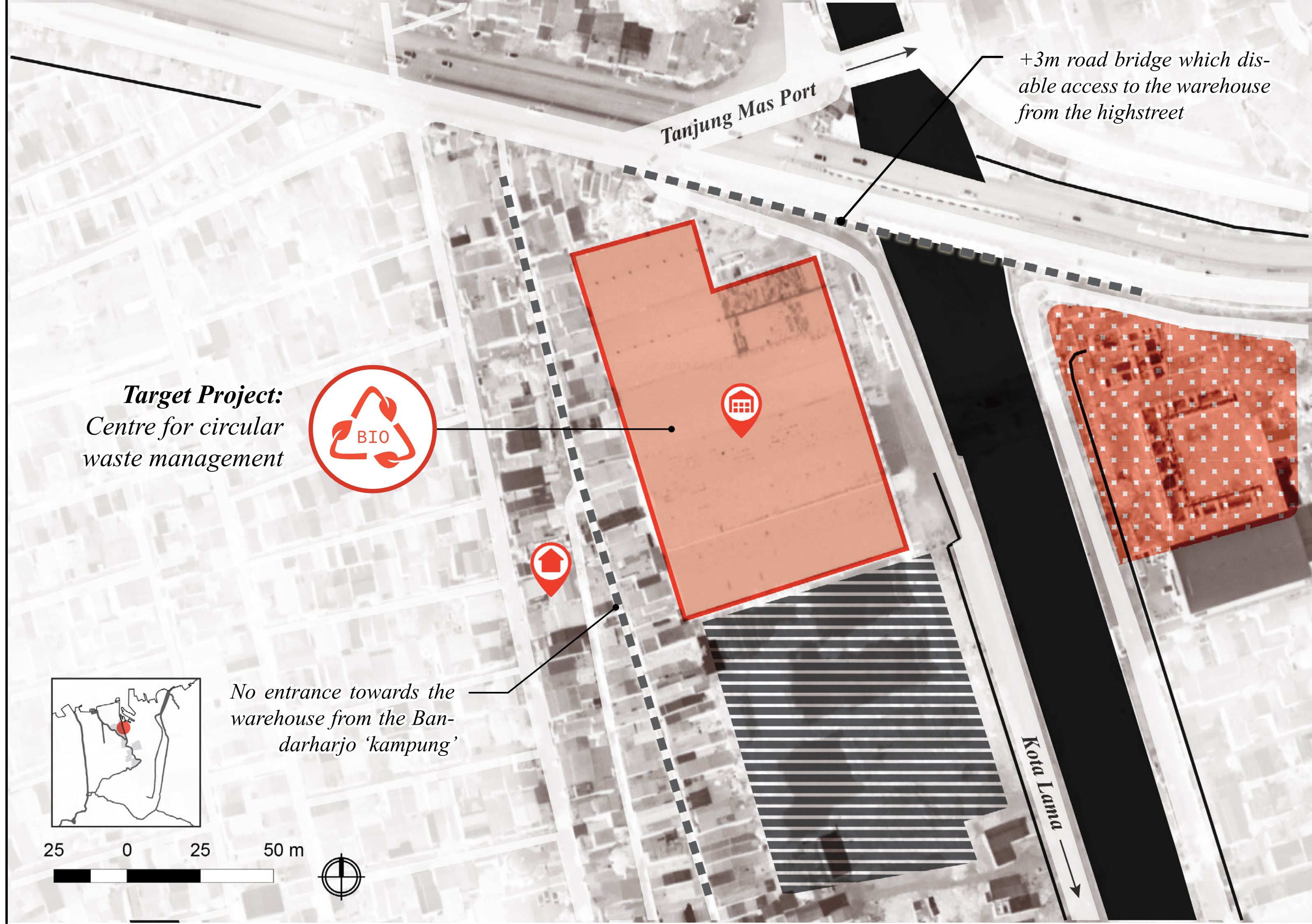


Figure 35: current street view in front of Marabunta Warehouse

2. Marabunta Warehouse, Bandarharjo

Bandarharjo kampung indicates the urgency of regenerative capacity as it faces the overlapping hazards whereas the local economy could not adhere to these problems. Adjacent to the sinking houses, an old warehouse called the Marabunta have had been left abandoned. This could be a great potential site for circular waste management where the products and job availability could favor the local residents.

Legend

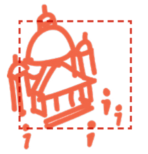
- Appointed site
- Empty areas
- Derelict area
- Edges

Map 18: Pecinan Potential and Limitations Map
Map 19: Marabunta Potential and Limitations Map

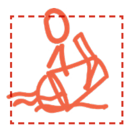
#1 Purify: *Semarang Circular Waste Management Project*

'It is to everyone's advantage that waste is properly taken care of; after all, no one wants rubbish piled high on the streets, not just because of the unpleasant sights and smells, but also because of the health hazard it would cause, the pests it would attract, and the potential pollution of drinking water.' -Hall, 2013

What would be the beneficial impact?



Increased value of heritage sites
Aesthetic quality that could help generate income from tourism sector



A clean Semarang watershed
Enabling hygienic environment and closer access to clean water supply which activate other provisioning services.

Possibility of housing-on-stilts
Create opportunities to implement adaptive housing in response to the rising sea level due to climate change

Water as a new common ground
Allowing water to promote social inclusivity across various cultural precincts

Regenerative Capacity Assessment

Based on the **ecosystem bio-mimicry** assessment that correspond to the issue of waste management, the current approach have yet a poor establishment on;

(1) purification system on waste water
(2) implementation of bio-fuel, although planning on 'Waste to Energy' project had been initiated (Semarang City Environmental Agency 2017)
(3) nutrient cycling capacity, as 600m³/hour of methane are being dissipated from the current landfill
(4) city aesthetic, which are currently still dominated by wastescapes on rivers and pedestrian
(5) education to community on this matter

whereas the **socio-ecological feedback** are mostly still lacking of;

(a) communication across the social layers
(b) the ability of act upon the community level
(c) the value of the implementation of these variables

Interellation

To achieve the targetted goals, the link between each ES variables need to be traced down as the implementation of one may be dependent on the other. On the case of the 'purify' project, attention needs to be made on;

(1) how proper waste decomposition (R5) may improve the city's aesthetic (C2), enrich food production through compost (P1), and provide alternative renewable energy (P4).
(2) how filtration ponds or riverside landscape (R5) may promote access to clean water (P4)
(3) adequate nutrient cycling (S3) which balances the ecosystem food chain (R2)

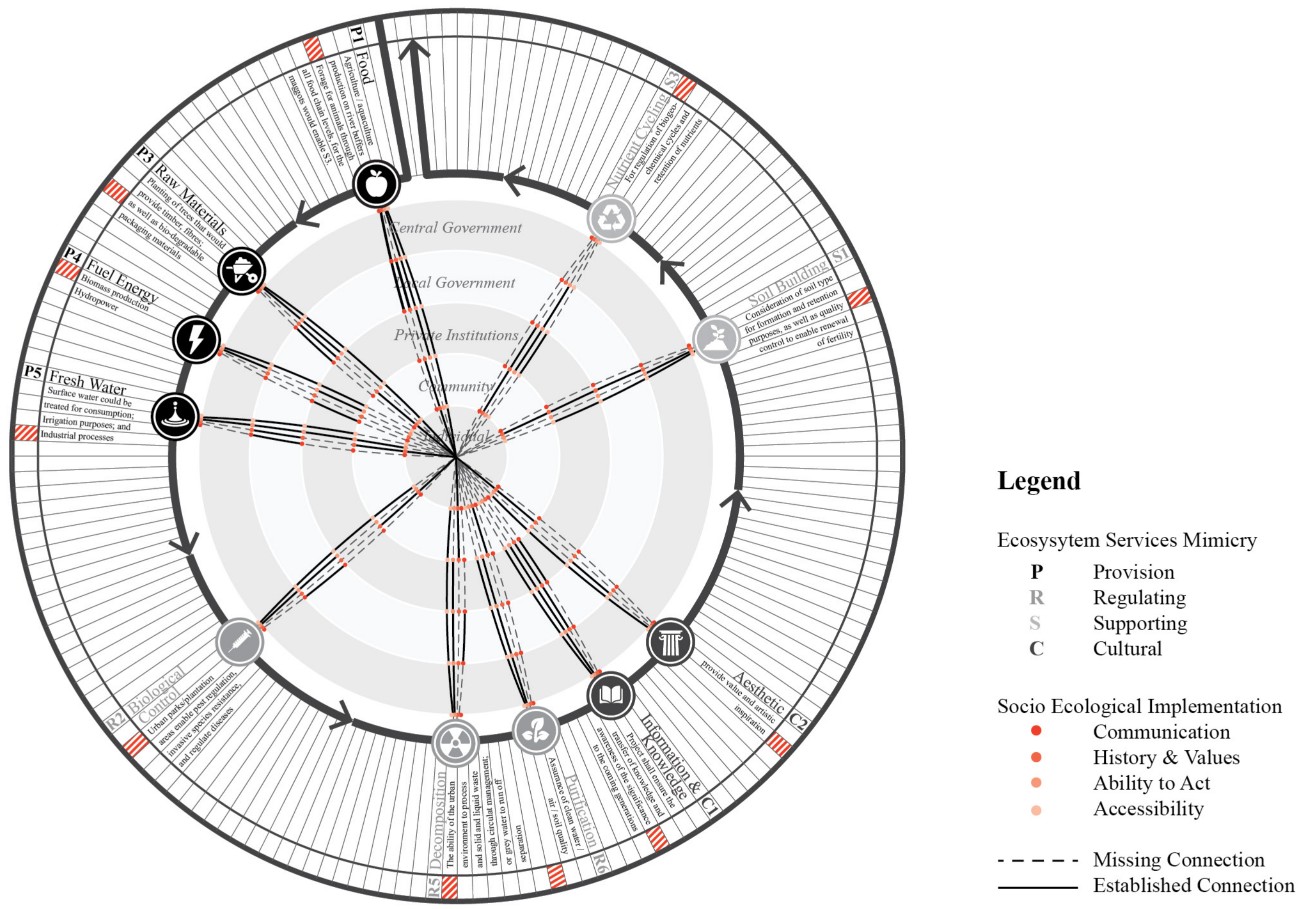


Figure 36: Regenerative Capacity assessment in relation the 'Purify' project

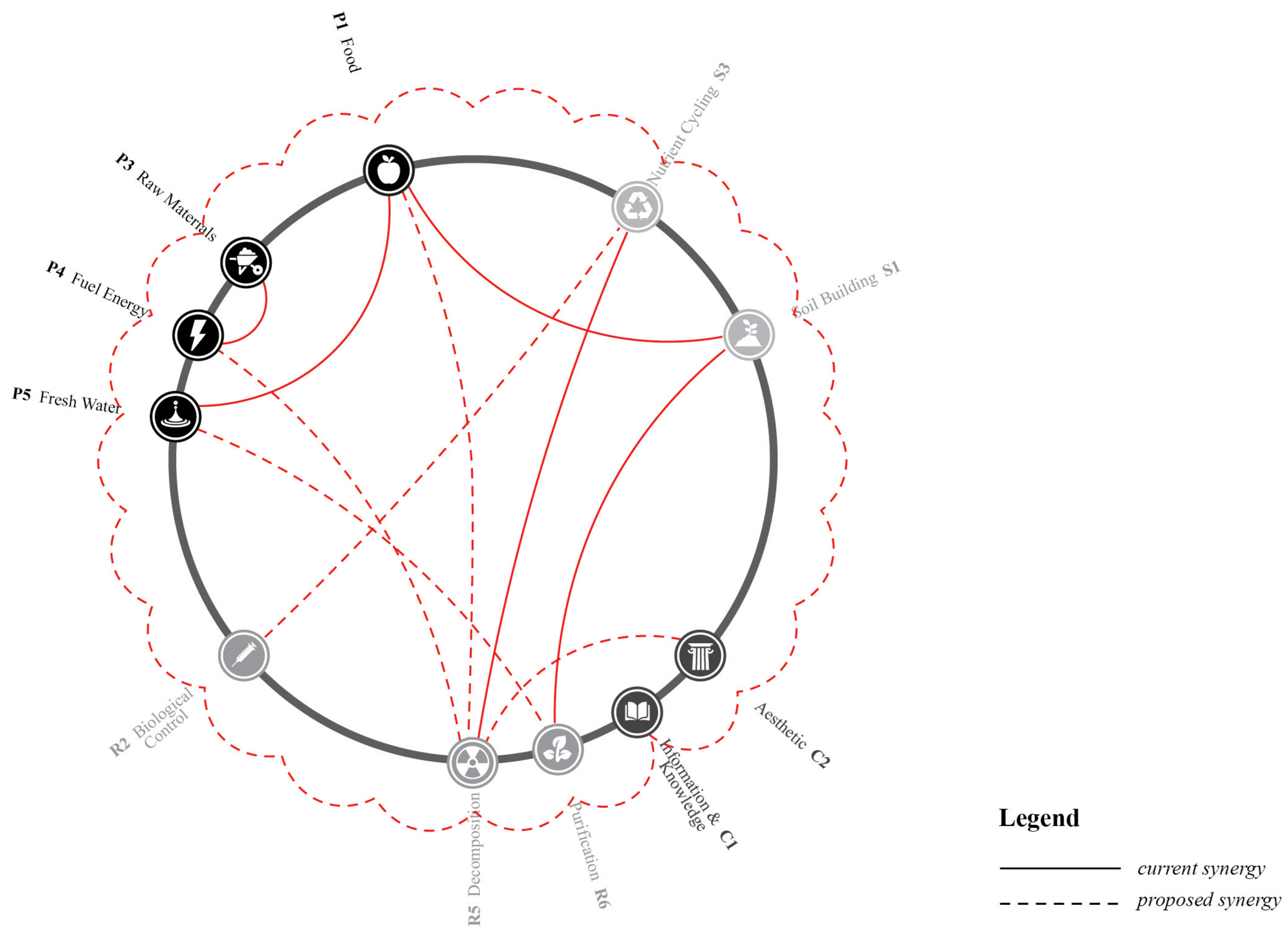


Figure 37: Interrelation of the Ecosystem Bio-mimicry elements of 'Purify' project

Strategy Implementation

The diagram below map the possible measures of circular waste management, which align with the aspects of regenerative capacity, through the different urban design layers and scales of Semarang. The main goal is simply to convert the polluted water back to its provisioning service, by understanding the flow and connections of the various multi-scalar processes.

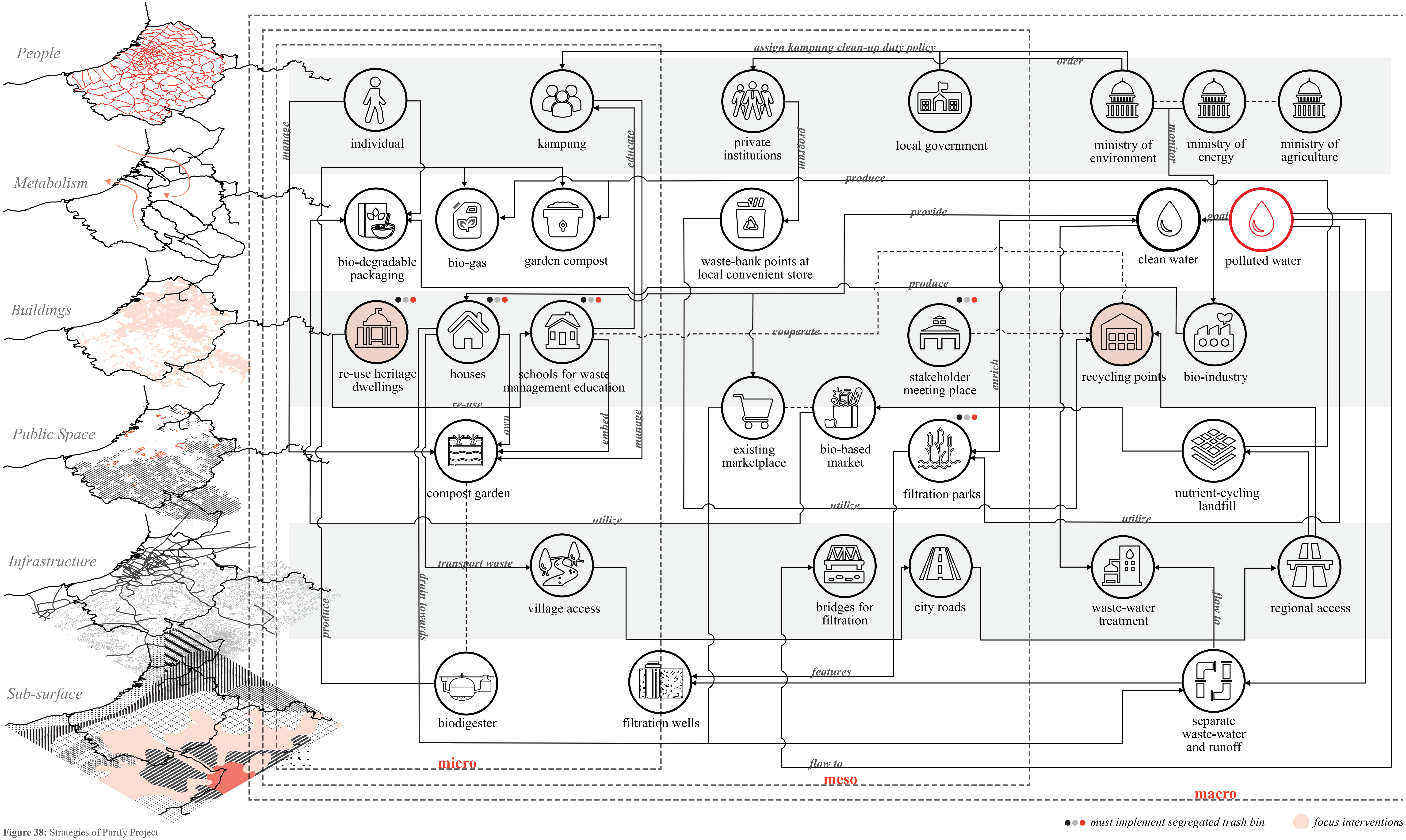
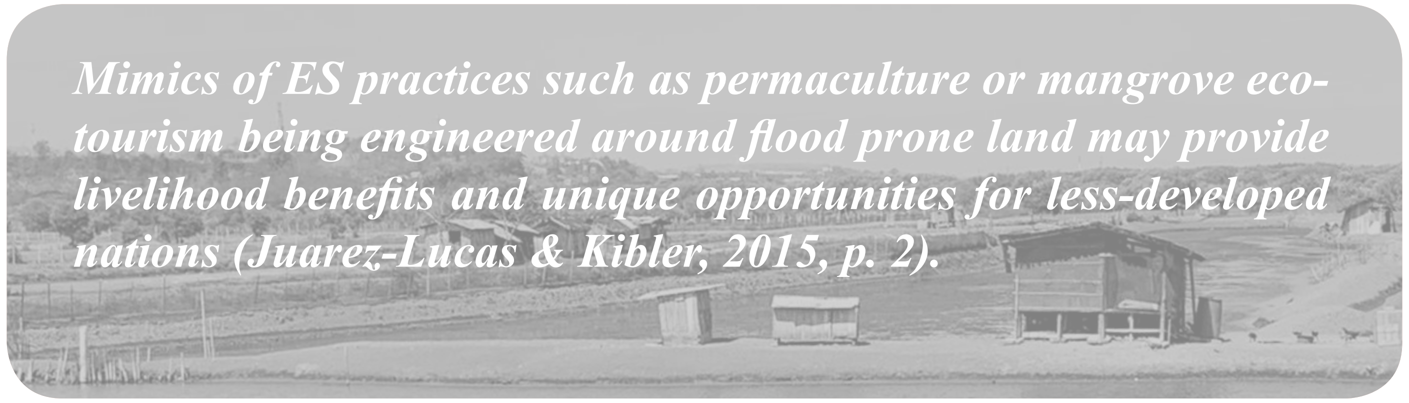


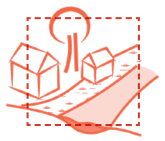
Figure 38: Strategies of Purify Project

#2 Protect: *Nature-based Flood Defense*



Mimics of ES practices such as permaculture or mangrove eco-tourism being engineered around flood prone land may provide livelihood benefits and unique opportunities for less-developed nations (Juarez-Lucas & Kibler, 2015, p. 2).

What would be the beneficial impact?



Oneness of urban and nature
Avoid constructed edges hence allow water bodies to become more appreciated and accessible as a common ground

Encourage biodiversity
Riverside green networks preserve habitat for the non-human as well as allowing the city to have an urban climate regulator

An added value of ecosystem provisioning service
A green dike system which may incorporate permaculture activities may enrich the local economy

Regenerative Capacity Assessment

Based on the **ecosystem bio-mimicry** assessment that correspond to the issue of flood defense, the current approach have not yet associate these aspects;

(1) urban climate regulator, as the normalised edges and narrowed width have limited the chance for the river to function as a cooler
(2) the integration of provisioning services on the riverside buffers
(3) nature as cultural services--since the sense of place and aesthetic of the city are mostly still detached from natural elements
(4) education to community on this matter

whereas the **socio-ecological feedback** are mostly still lacking of;

(a) communication down to the community level
(b) the ability of act upon the community level
(c) the awareness on the historical values of the river

Interellation

To aim for the beneficial impact, the 'protect' project would like to target on several synergies across the variables of ecosystem services such as;

(1) how measures to prevent disturbance (R4) shall also meet aesthetic requirements (C2) instead of emphasizing the hazards
(2) the prevention of disturbance (R4) could utilize biodiversity as a soil-and water-bioengineering approach while also perform its provisioning service (P1)
(3) nature-based flood defense which also funtions to purify the water (R6) may enhance the water quality (P5) which would enrich the sense of place (C5)

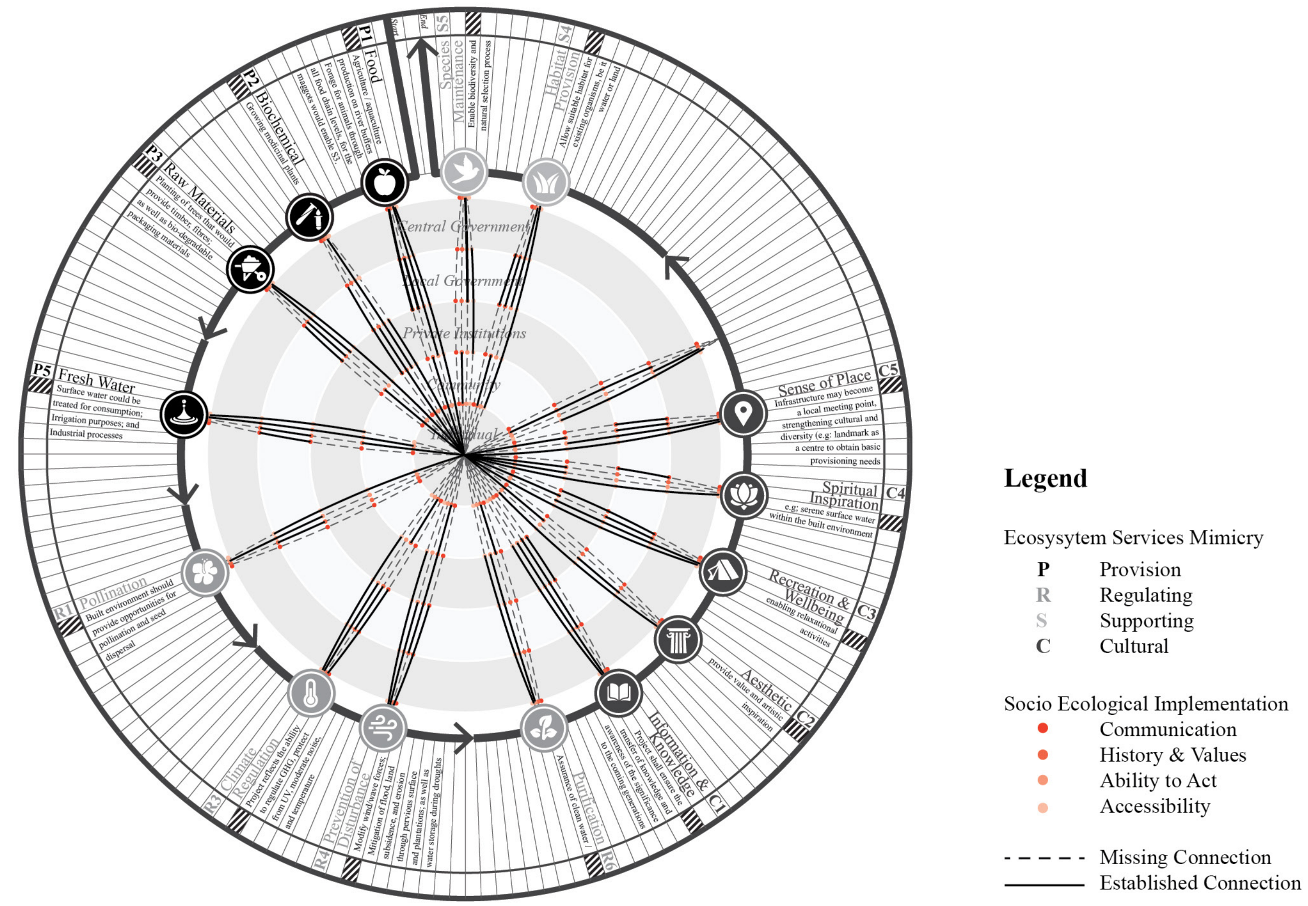


Figure 39: Regenerative Capacity assessment in relation the 'Protect' project

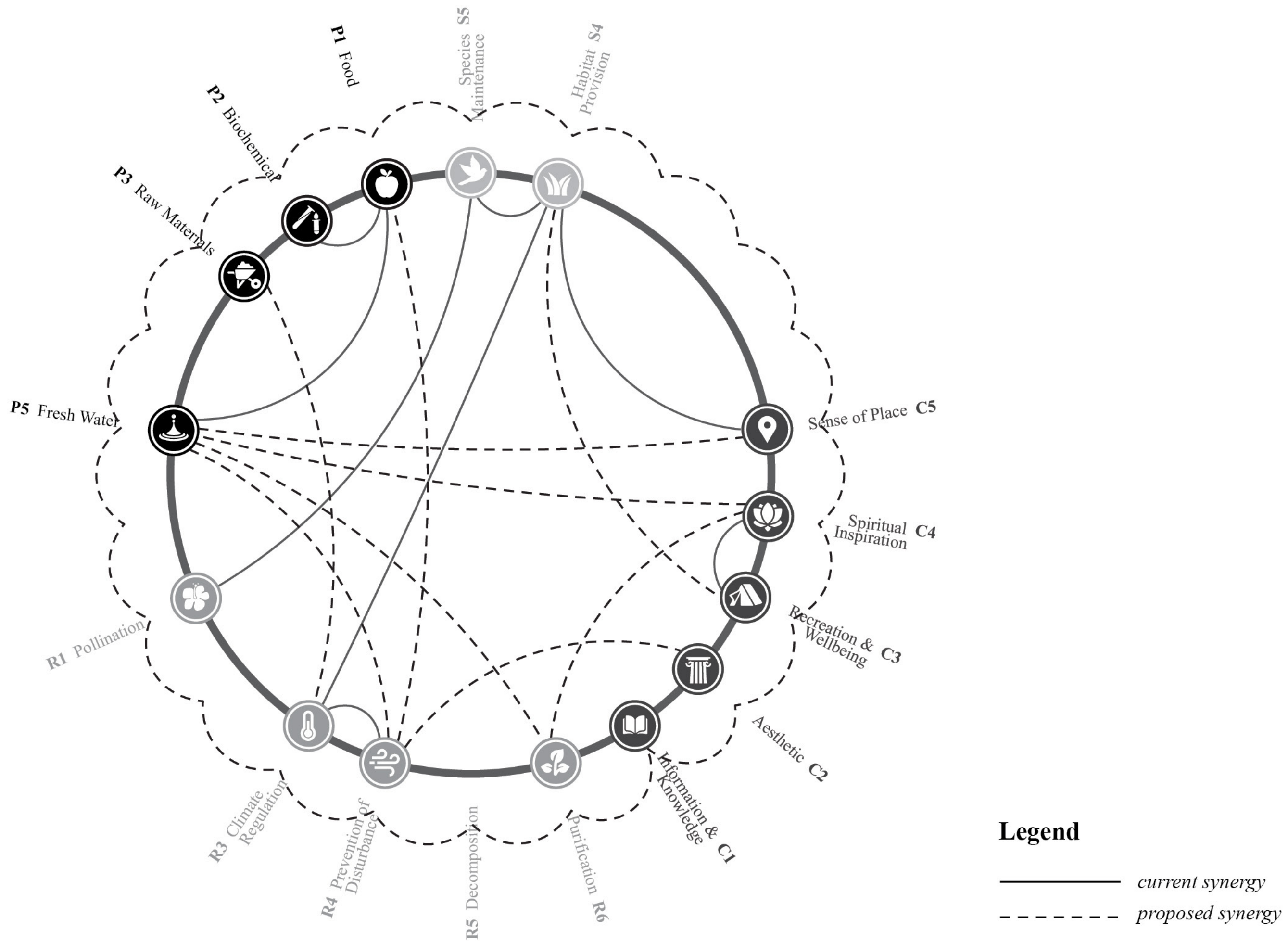


Figure 40: Interrelation of the Ecosystem Bio-mimicry elements of 'Protect' project

Strategy Implementation

The diagram below map the possible measures of nature-based flood defense, which align with the aspects of regenerative capacity, through the different urban design layers and scales of Semarang. The main goal is to achieve an integrated flood management beyond the domain of engineering, by understanding the flow and connections of the various multi-scalar processes.

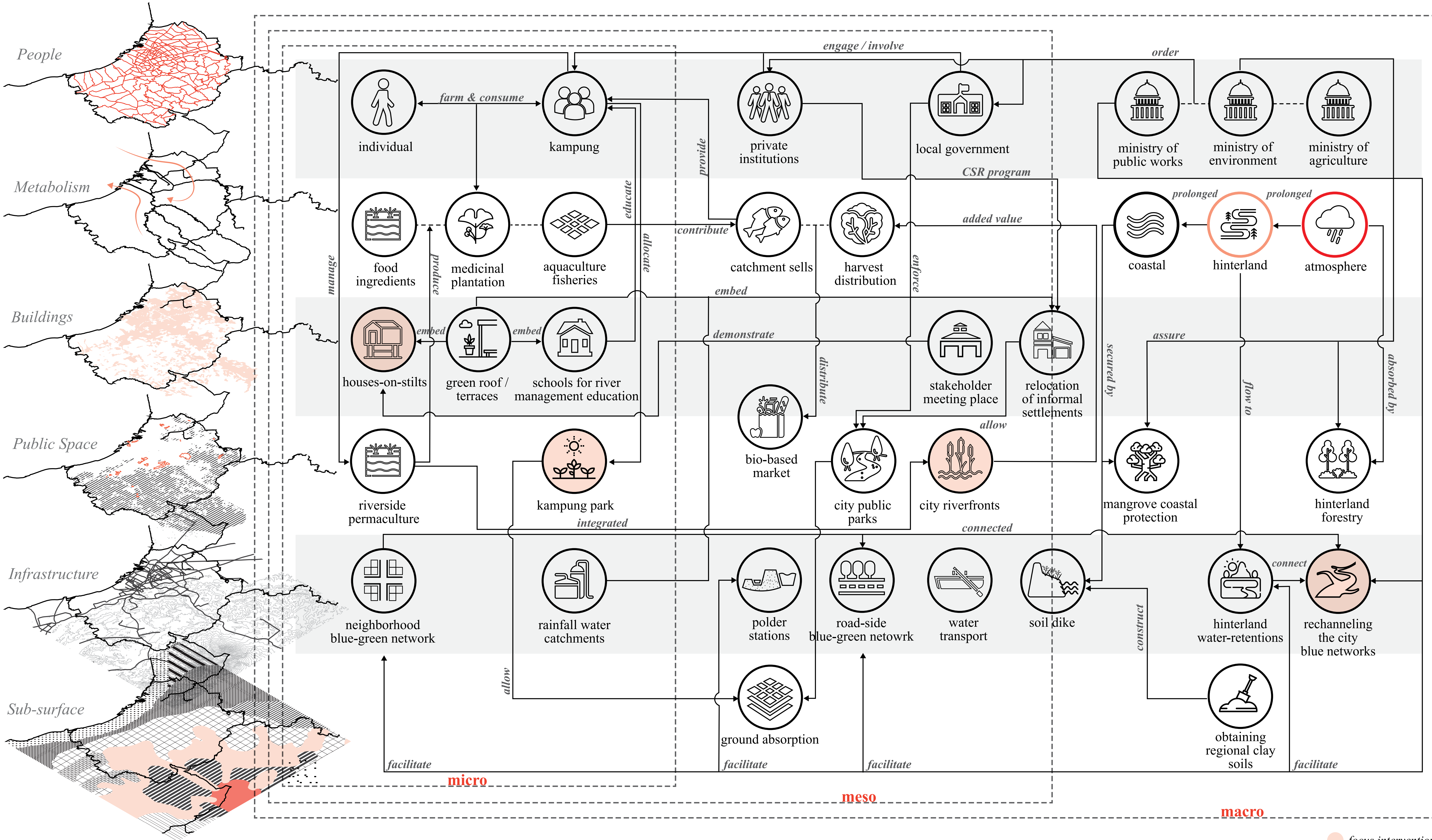
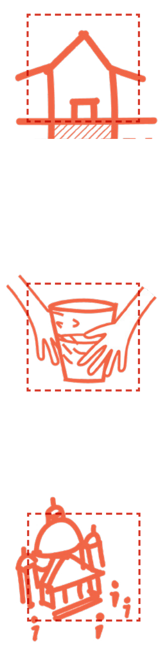


Figure 41: Strategies of Protect Project

#3 Provide: *D(e)-well Groundwater Extraction*

This project seeks for alternative clean water access for all Semarang citizens to avoid the uncontrolled private extractions which would enhance existing hazards.

What would be the beneficial impact?



More stable ground

Certainly, if there would be a significant reduce of groundwater extractions, residents would not have to heighten their houses once every five years.

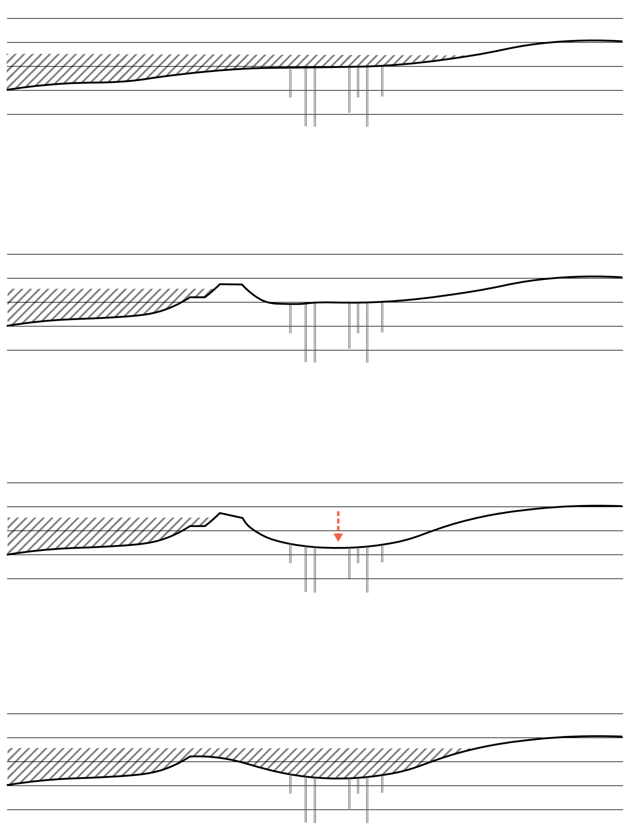
Clean water access for all

Independent from the tap water company (PDAM), this project provide resilience at times of water shortage.

Increased value of heritage sites

Authorizing heritage and cultural sites for clean water supply may create opportunities for the neglected dwellings to rejuvenate as communal grounds.

Despite any planning of coastal dike...



Flooding scenario may re-occur due to numerous extractions!

Figure 42: Scenario of a sea dike whilst facing land subsidence issues

Regenerative Capacity Assessment

Based on the **ecosystem bio-mimicry** assessment that correspond to the issue of uncontrolled groundwater extractions, the current condition still lack;
(1) the awareness of the disturbance and the action of mitigation
(2) thorough supply of fresh clean water to the city
(3) alternative methods such as maximizing surface hydrolic flow
(4) education to community on this matter
(5) connection to spatial design and sense of place

whereas the **socio-ecological feedback** are mostly still lacking of;
(a) the outlook on communal strategy to mitigate the issue
(b) the communication of policies down from the government level

Interrelation

To achieve the vision, the 'provide' project would like to enhance the synergies between ecosystem service variables such as;
(1) associating fresh water (P5) to spiritual inspiration (C4) since majority citizens utilize worship buildings
(2) promote natural purification techniques (R5) to increase water quality (P4)
(3) ensure the extraction of fresh water (P4) does not invite disturbance (R4) such as land subsidence
(4) chanelling new opportunities of hydropower energy (P4) through water treatment reservoirs (R5)

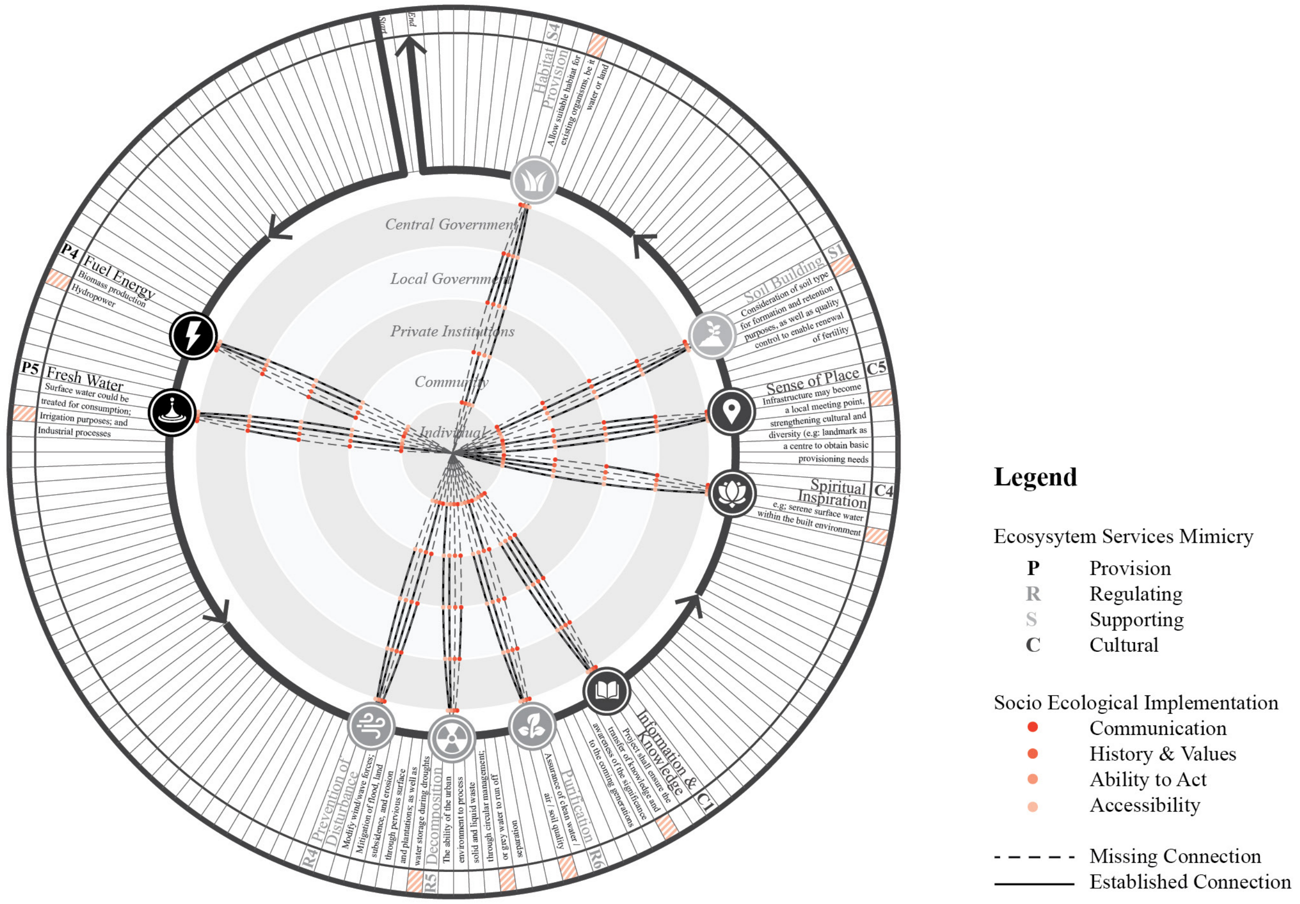


Figure 43: Regenerative Capacity assessment in relation the 'Provide' project

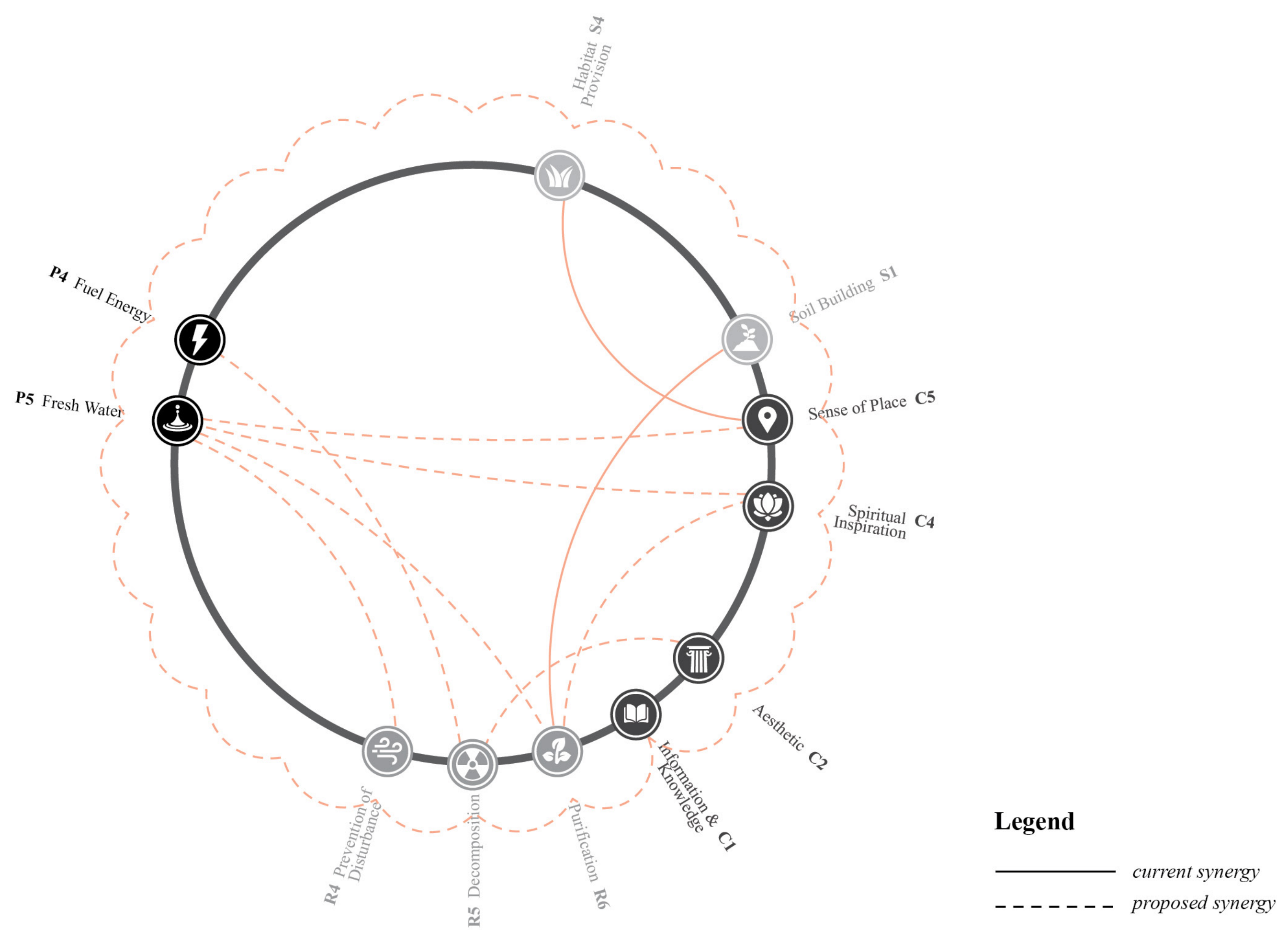


Figure 44: Interrelation of the Ecosystem Bio-mimicry elements of 'Provide' project

Strategy Implementation

The diagram below map the possible measures of alternative water supply and urban farming activities which align with the aspects of regenerative capacity, through the different urban design layers and scales of Semarang. The goal is to centralize the provisioning activities within the city in ways that do not trigger hazards like land subsidence due to excessive ground water extraction.

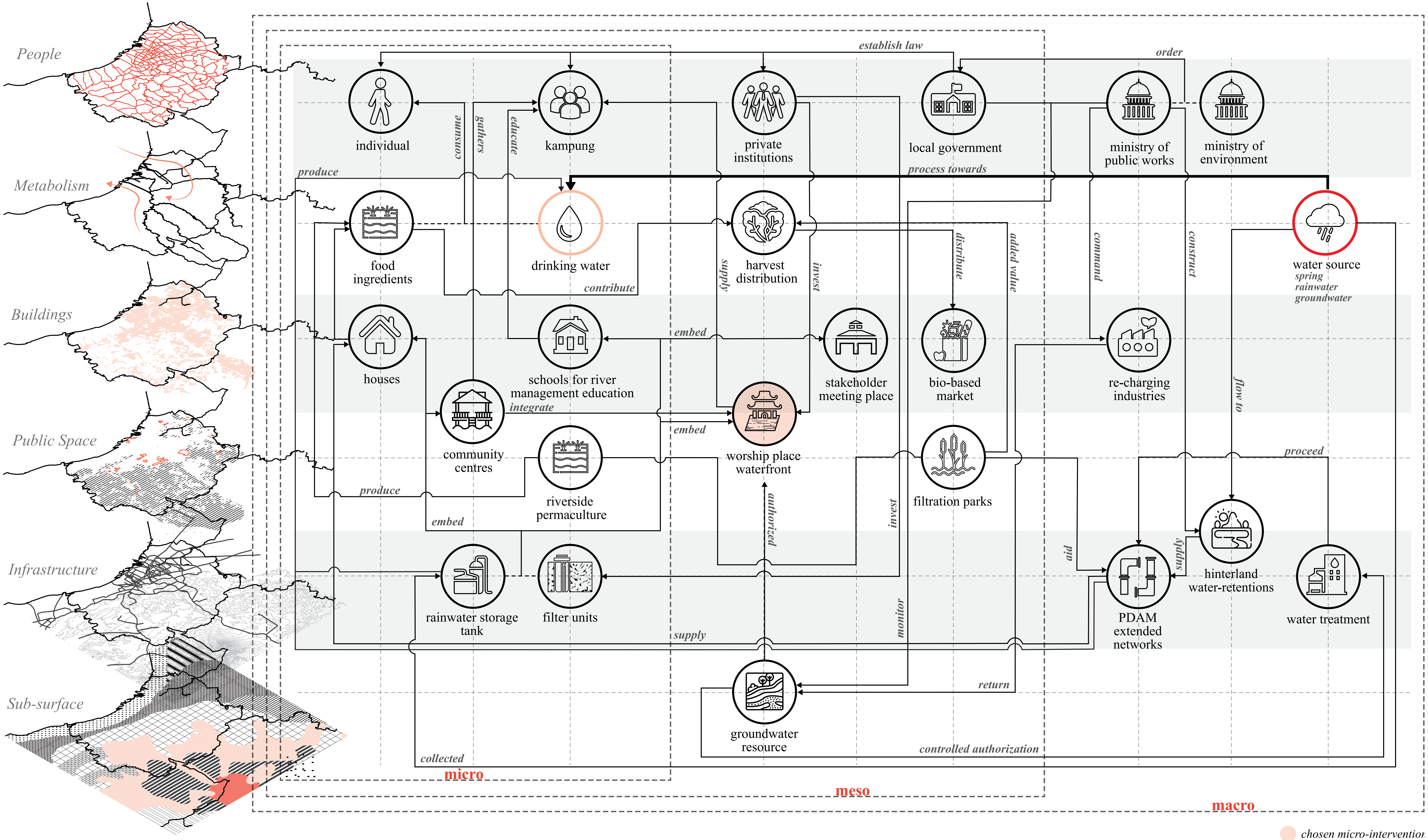


Figure 45: Strategies of Provide Project

Interrelations

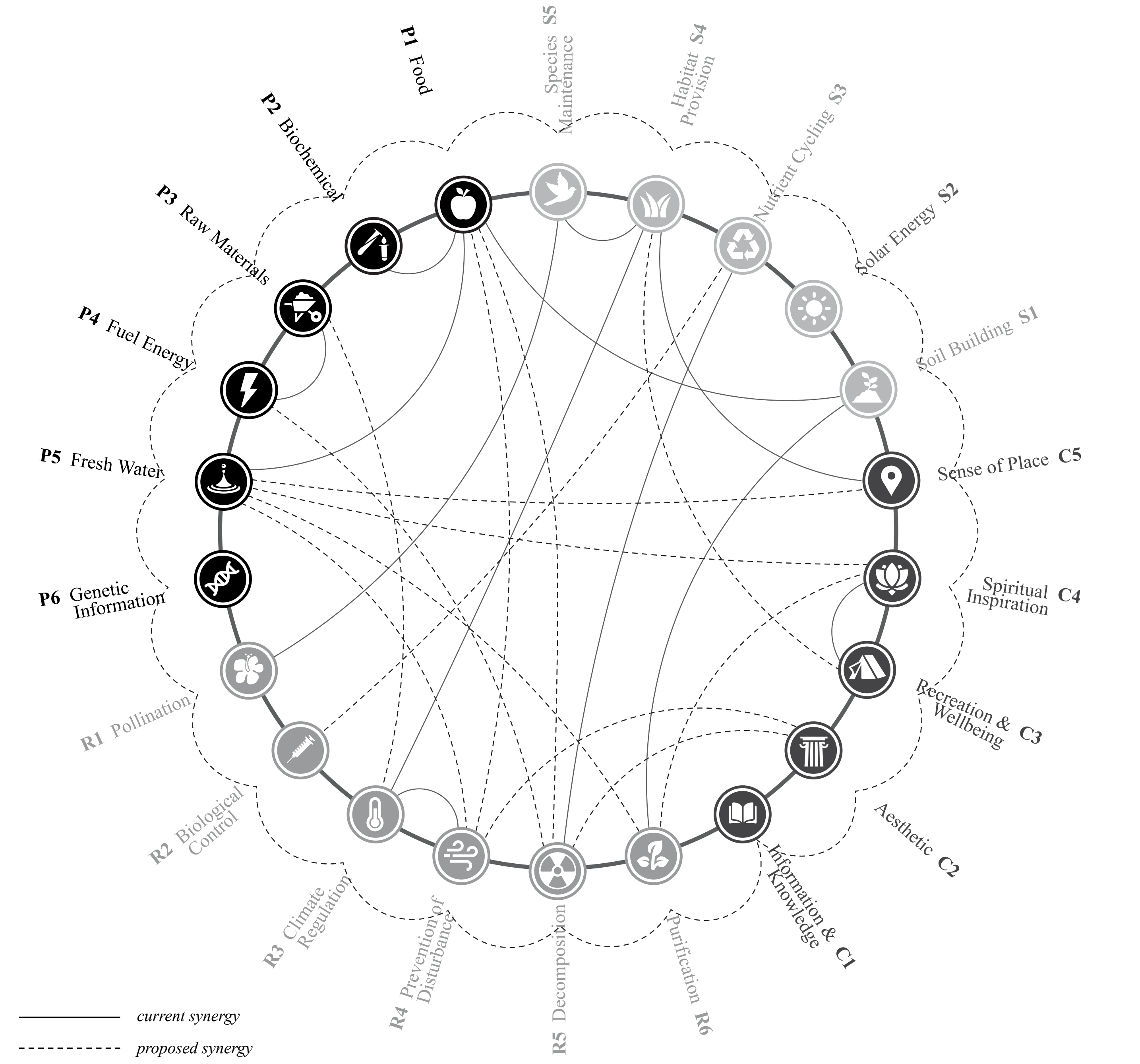


Figure 46: Interrelations of Ecosystem Service variables

Determining the interrelation helps understand which green infrastructures are involved for the projects of regenerative design. It also helps to trace which implementation should be set first on the timeline. On proposing the synergies, some line of thoughts are being applied such as: safety (R4) is proposed to meet aesthetic quality (C2) in a way that it does not only illustrate the possible flood threat but also how it could be embraced as a daily public space. Another one would be how to 'engage with the fate of materials beyond their commodity phase (Hall, 2013).'

In the mechanism of landfill, the perception to waste are to release, disassociate, and let alone disappear. This is the root of the current waste issues in Semarang, to which we propose that the decomposition measures must be balanced thoroughly with the provisioning services. Aside from the other interrelations which make regenerative capacity as a solid goal, the spread of information and knowledge (C1) to all variables weights the most to open the possibility of project execution.

A Comparison with current City's Vision

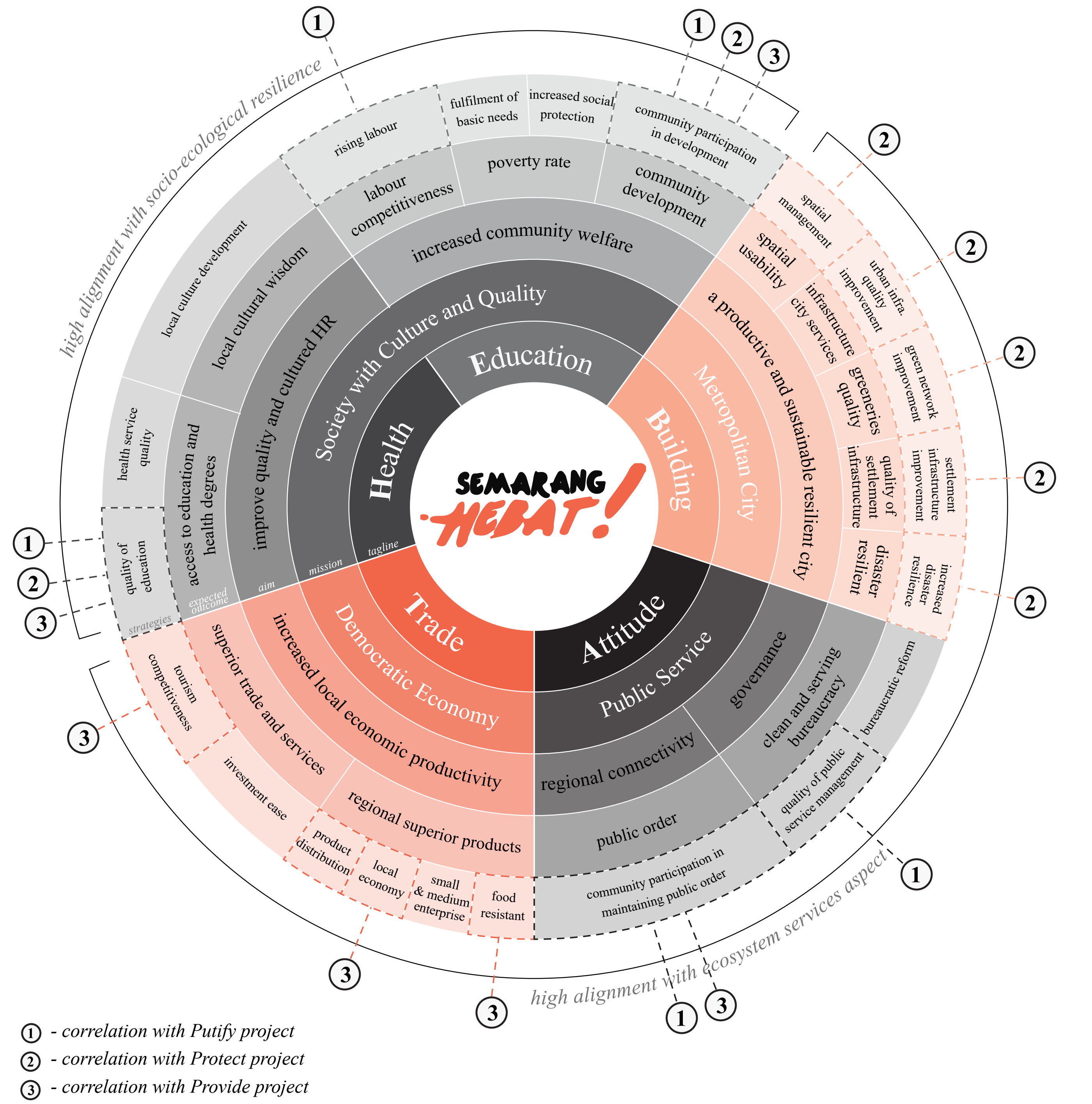


Figure 47: Relationship between aim, expected outcome, and strategies of the Medium Term Development Planning of Semarang City 2016-2021 (translated and re-drawn by author) with the proposed project of the author.

The chart of the Semarang city vision seem to lack of water related strategies despite the city hazards that mostly centralized on water issues. Strategies to achieve hygienic environment, which supposedly should fall under the Health or Attitude sections, are also missing although currently the city seems to have a poor waste management.

It is observed that around half of the government strategies focus on the human resources development, with no touch of biodiversity aspects. With the current critical natural ecosystem in the city, this project would like to blend the strategies with regenerative aspects in order to achieve quality human resources with adequate ecosystem services.

Meso-scale intervention approach

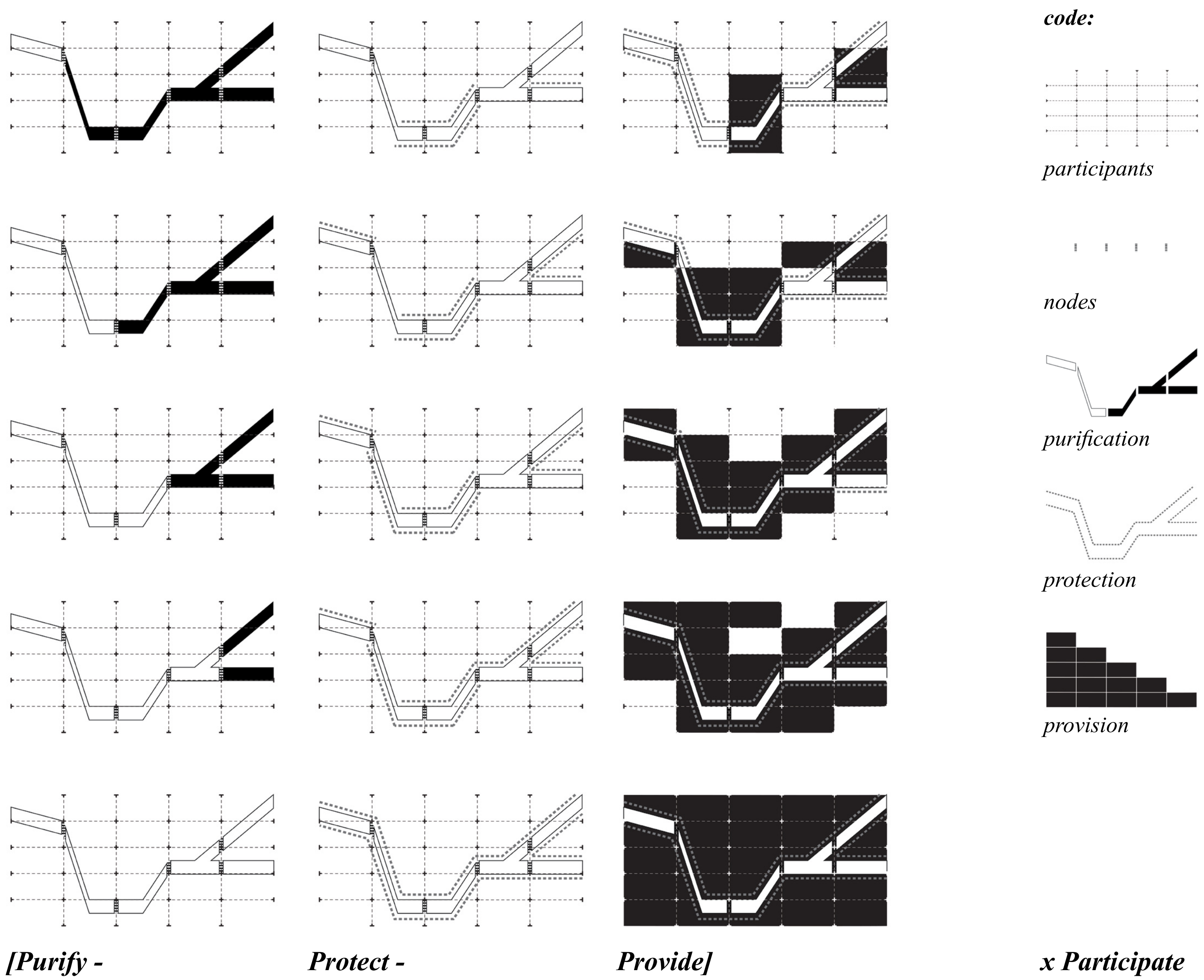


Figure 48: Meso project hierarchy

In a meso scale, the hierarchy of the three projects could be shown clearer. The first one starts with river purification as the cleaner the surface water is, the more people want to engage with water-related activities. Second would be the act of mitigating the hazards, which is the protect project for the region of vulnerable society. Until then, the project shifts to focus on providing residents around Semarang River with clean water and basic permaculture outcome. Throughout the three, participation of the local community would play a significant role in order to achieve the goals of the projects. They will gather to meet by the designated nodes on the Semarang River.

Micro-scale intervention approach

Image 31: Integrated bridge as nodes by LCLA Office + Agenda

In ***Flush and Splash***, the nodes will be the pioneer to introduce all three meso scale projects. Each would perform a community-size demonstration before all of the 'purify, protect, and provide' interventions could extend along the river perimeter. This puts the smallest scale interventions on top of the hierarchy.

This idea was inspired by a project in Medellin River, Colombia, by LCLA Office + Agenda. It is observed that the Medellin River faces an irreversible condition due to intense processes of urbanization which degrades the aquatic ecosystem of the river which transform the blue network to a mere constructed canal dominated by the side transport infrastructure. 'Re-naturalizing the river is naive and impossible,' described the architect. Aside from the major and costly engineering to reverse the canal into its meandering form, the climate and geographical condition also does not support the ideal 'renaturalisation' scenario of the river as well. This is due to not enough rainfall and poor soil permeability within the river ecosystem.

Responding on the naive initiative to restore the river landscape, this project diverts the idea by redefining the city's hydric backbone with a series of hard and soft public platforms on top of the river itself. These platforms are planned to host programs such as libraries, kindergartens and sport facilities which normally took place on public buildings. Being installed at the points where the streams meet the polluted river, this project aims to trigger the public users on the thought of re-enliven the hard canal with meaningful landscape interventions.

This naration aspires the thought to construct the nodes of ***Flush and Splash*** micro-interventions. In other words, this chain of multi-purpose bridges aim to pull and connect the 'participants' directly above the troubled water. Each bridge will have a different highlighted features depending on the site's urgency (e.g: filtration skate-park for the most polluted area). In order to maximize the localized interventions, a further understanding of the site will be observed through its (1) dominant aesthetic, (2) community activities, (3) current water-related measures, and (4) main local issues on the next chapters.

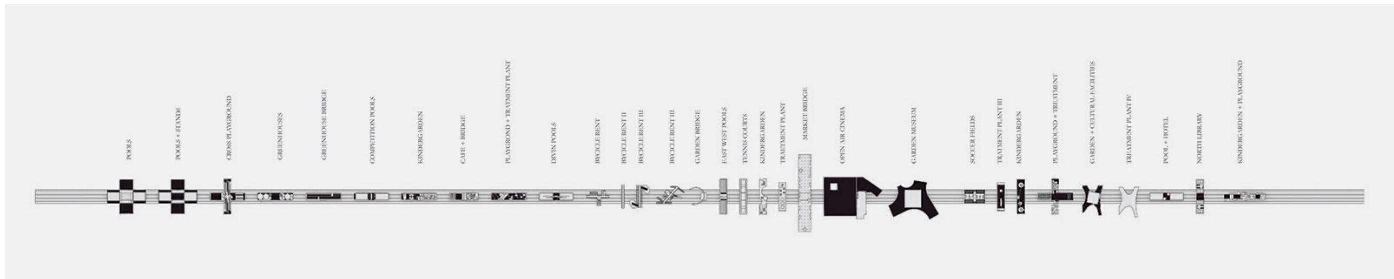
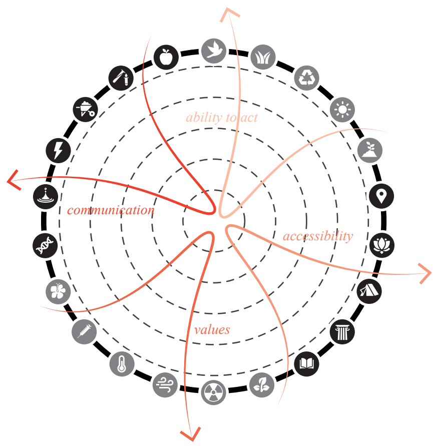


Image 30: Units of localized intervention at Medellin River by LCLA Office + Agenda
[Image source: https://www.luiscallejas.com/MEDELLIN-The-river-that-is-not]

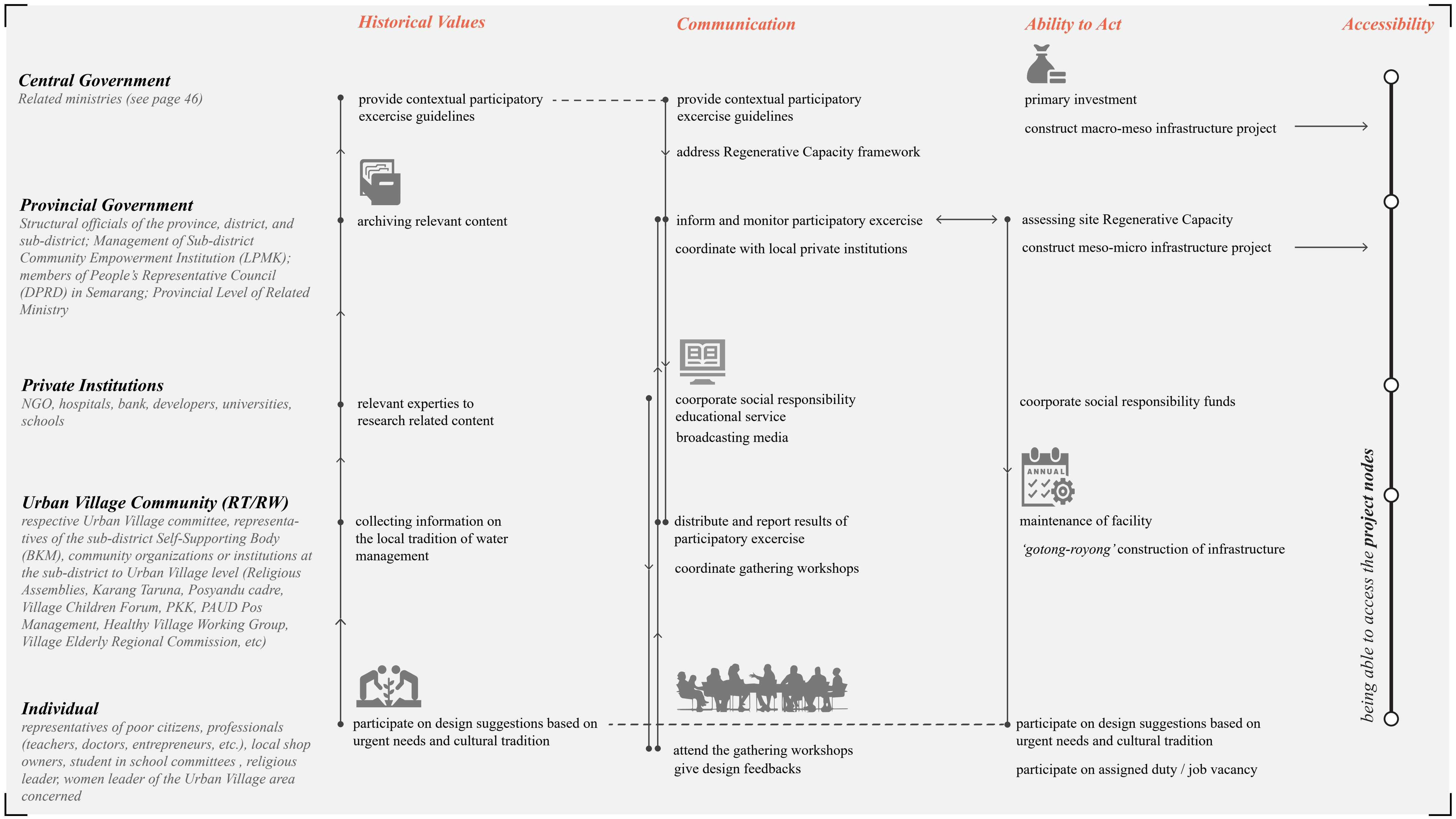
Stakeholder Engagements

Recalling Expected Outcome of Research Question



[A x B]
output form: policies, stakeholder system

In respond to research question [A x B], as well as to reach the answers of sub-research questions [B - C] and [B - D] (see page 32), this guideline attempts to situate the different social layers on the project through the four variables of socio-ecological resilience. All the suggested actions would eventually lead to having the urban village community as the leading player as they would be the main users of the project outcome.



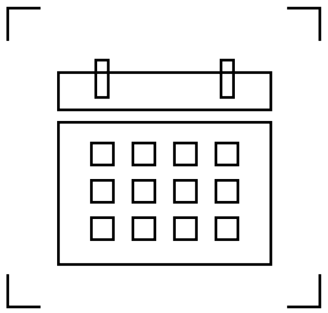
1. Division of Roles

Assign responsibility to comply with the **Socio-Ecological Resilience**

5. Gaining Benefits

Local provision of water, food, and recycled goods as well as job vacancy within a healthy environment

e.g: free water supply

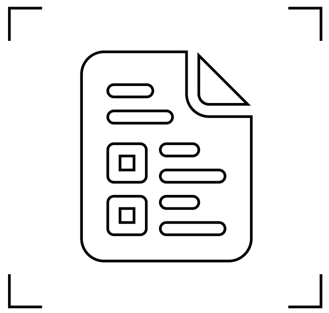


4. Conduct Participatory Duties

Providing agenda for weekly or seasonal activities

e.g: scheduling types of trash and their submission days

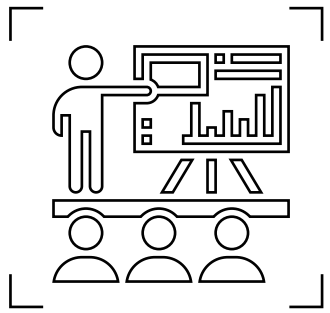
construction of extended measures



3. Participatory Exercise

Recognizing the need of the locals through design exercises and providing manuals

e.g: design adaptive housing collectively, choosing urban permaculture types



2. Community Education

Utilizing the project nodes as a demo site

construction of the project nodes

Figure 49: Stakeholder Engagements Chart

Figure 50: Preliminary collage of project

E. Activating the Actions

Flush & Splash!
Purify, Protect, and Provide

*On achieving a regenerative urban water management, the project begins with **purify**, to flush away all impurities, since the provisioning service of water would not be possible without the desirable quality. Adding to a hygienic environment, assurance that water plays a beneficial role instead of a threat needs to be realized through the **protect** project; where hinterland land absorption are put forward to prevent excessive flow to the city. These livable quality of a healthy and safe city would then be wrapped up with **provide**, where it could open up channels to invest on the project through new circular economy; splashing the public goods.*

Shown here are the macro scale vision;

Purify
Circular waste management throughout Semarang City

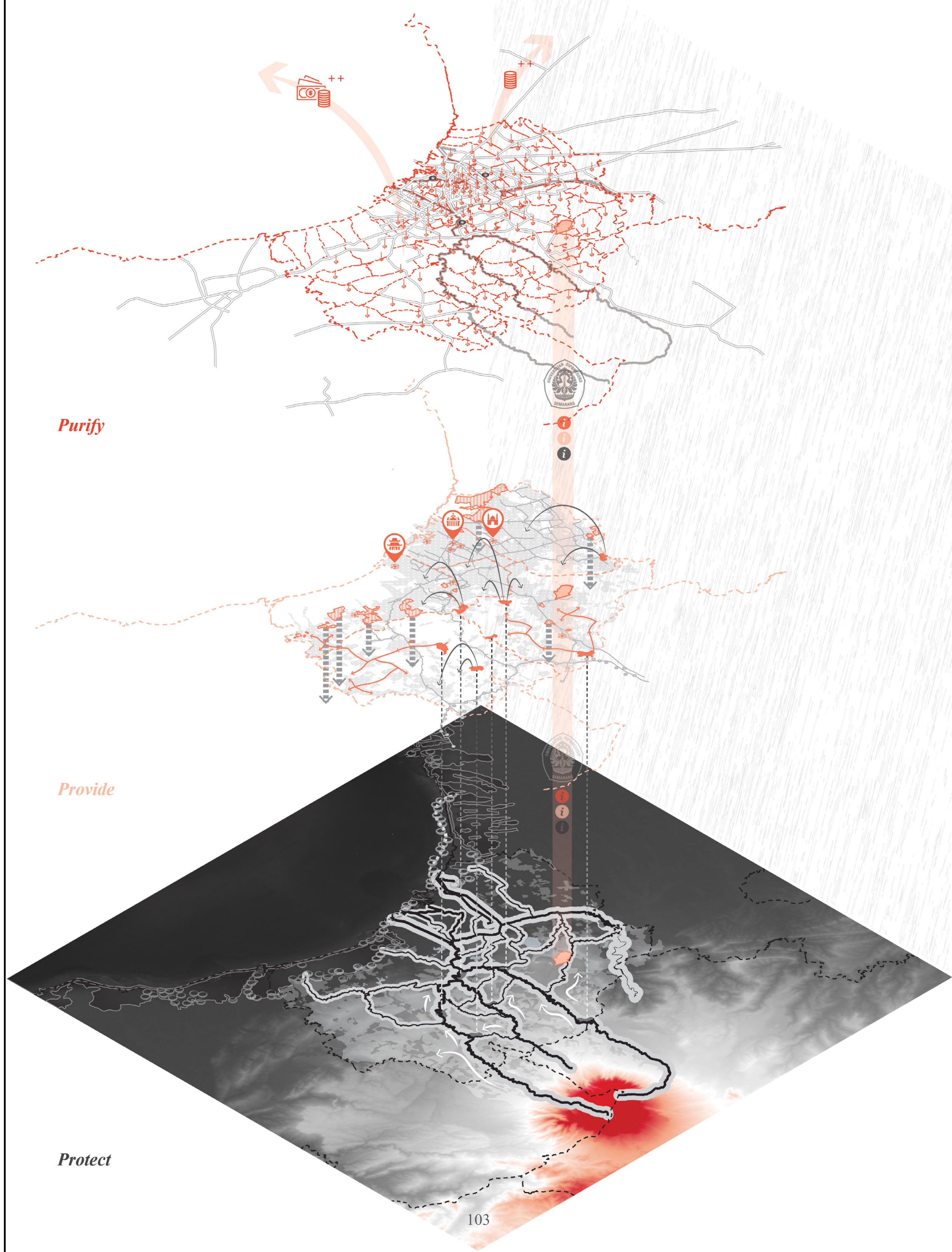
	urban villages waste management and recycling centres
	grey water treatment centres
	separate run-off and waste-water system
	facilitate educational means (Diponegoro University)

Protect
Nature-based flood defense throughout the watershed

	rechanneling the city (Cascading Semarang, 2019)
	protect hinterland greeneries & maximize empty plot on city
	add mangrove coastal protection
	hinterland water storages
	facilitate educational means (Diponegoro University)

Provide
Dwelling with ground water extraction whilst providing water storage for the community

	recharging the aquifer (Cascading Semarang, 2019)
	hinterland water storages
	extended PDAM distribution through water reservoirs
	rainwater water storage / certified wells on cultural precincts
	facilitate educational means (Diponegoro University)



Map 20: Axonometric of the macro-scale projects

Macro-scale Interventions

Space and Flows

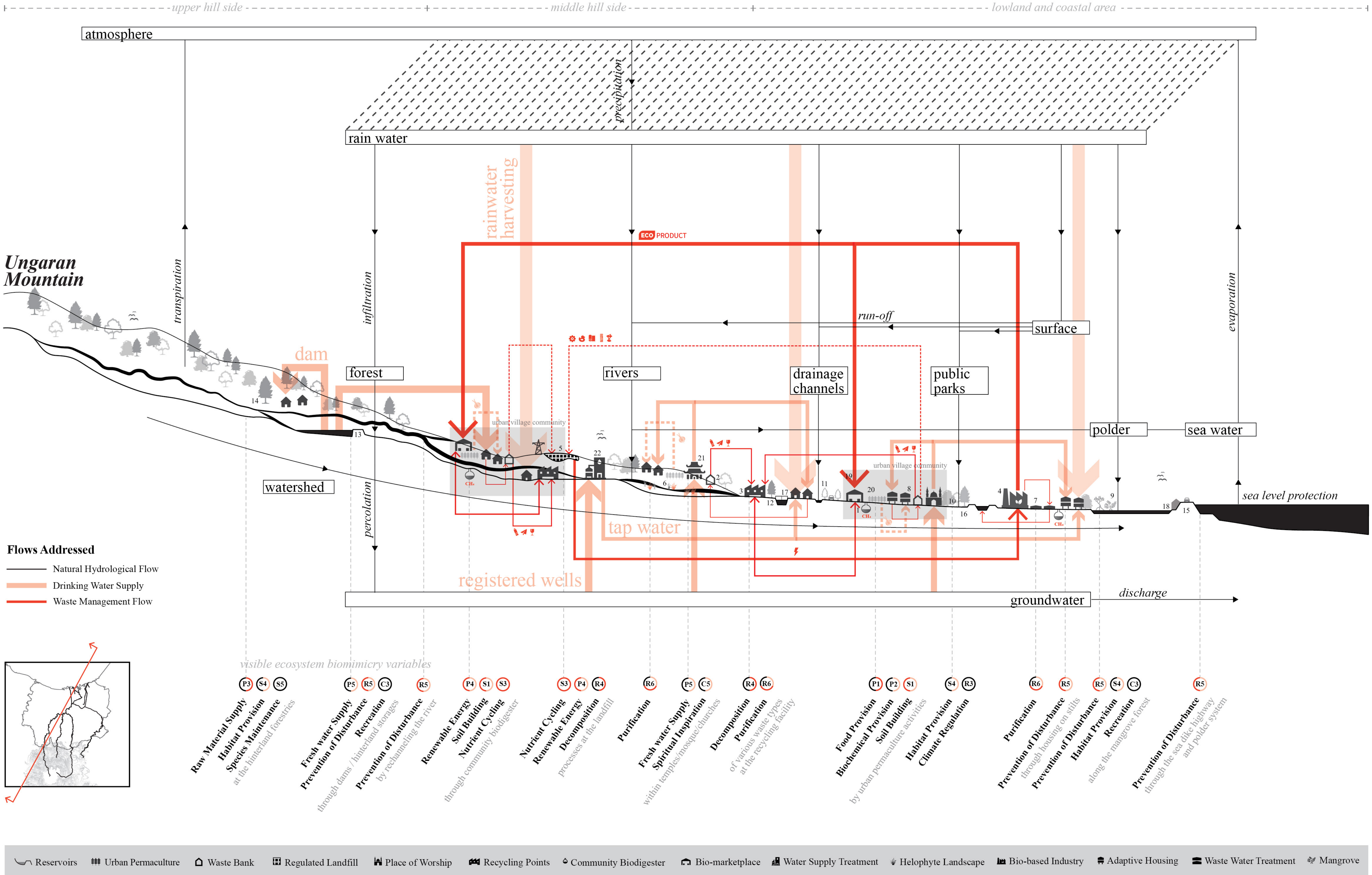
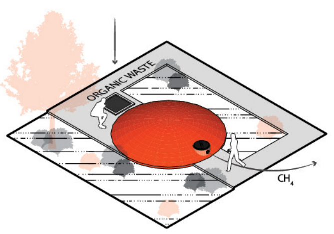
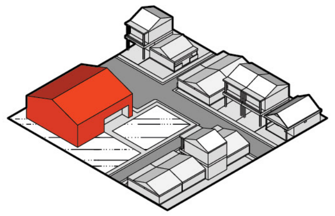


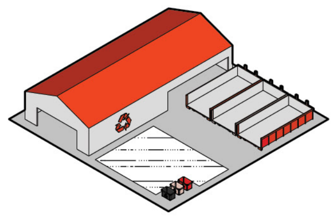
Figure 51: Schematic marco section of the proposed project

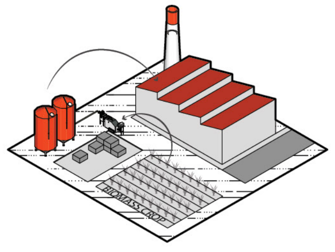
Cross-scalar Spatial Typology
The Infrastructure of the Flows

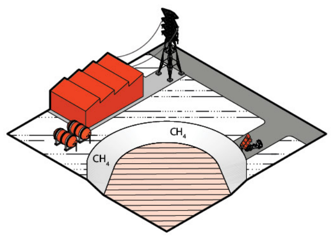
associated with circular waste management

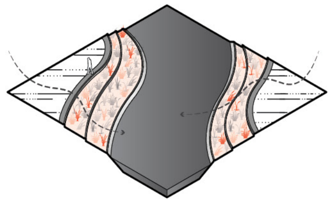

1. Community Biodigester

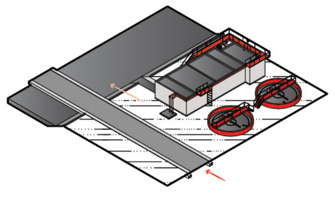

2. Waste Bank


3. Recycling Points

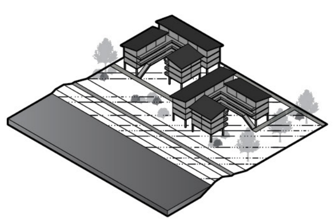

4. Bio-based Industry

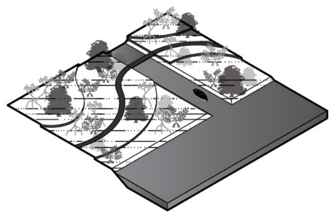

5. Regulated Landfill

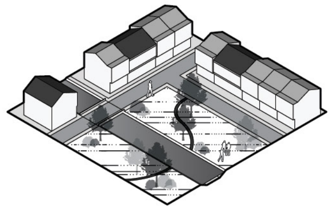

6. Helophyte Landscape

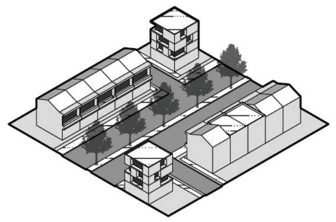

7. Waste Water Treatment

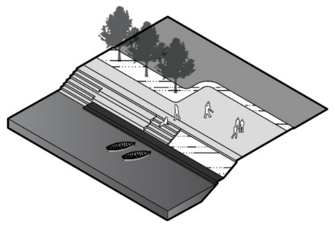
associated with flood preventions

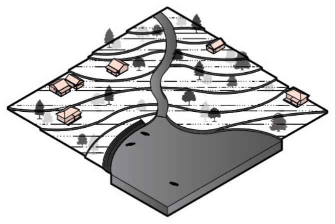

8 Adaptive Housing

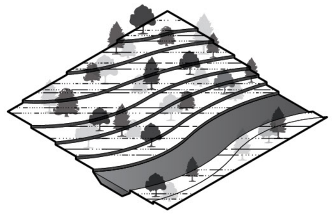

9. Mangrove

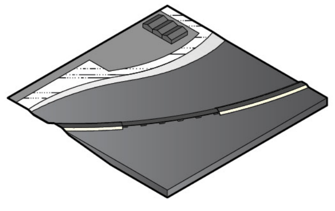

10. City Park

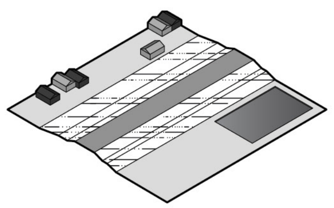

11. City Green Nework

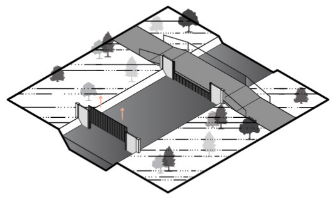

12. Waterfronts

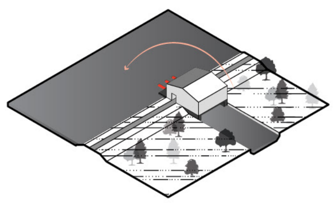

13. Reservoirs


14. Hinterland Forestry

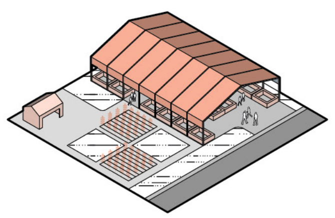

15. Highway Sea Dike

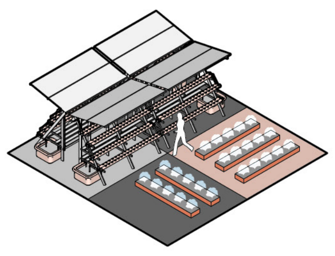

16. River Dikes

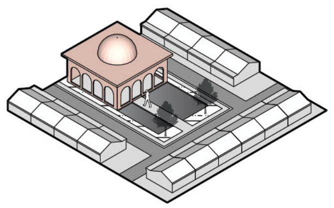

17. Sluice


18. Polder Stations

associated with provisioning activities


19. Bio-marketplace


20. Urban Permaculture


21. Place of Worship

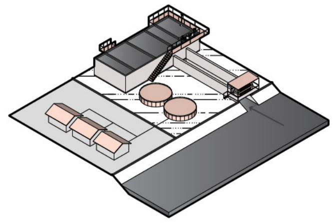

22. Water Supply Treatment

Figure 52: spatial typologies of regenerative landscape infrastructure

Meso-scale Interventions
Masterplan Scenario of Semarang River

The project further investigates how the strategies could be translated spatially at the scale of Semarang River. The list below are some of the meso strategies embedded which helps explain the schematic maps on the next three pages.

Purify
(Map 21 on page 108)

i. facilitate the waterfront of the river with helophyte plantations
ii. allocate waste bank on each of the urban villages (RW) adjacent to the river
iii. re-activate water transport at the river as a mean to deliver solid waste from the river or other precincts or the river on to the recycling points
iv. assurance that the marketplace utilizes degradable packaging from the bio-industries

Protect
(Map 22 on page 110)

i. maximize the city's pervious surface through green networks, patches, and riverfront
ii. rejuvenate informal settlement area into regenerative social housing complex in several stages
iii. provide temporary relocation sites which are close by
iv. rechannel excess water through nature-based canals and refurbished drainage systems

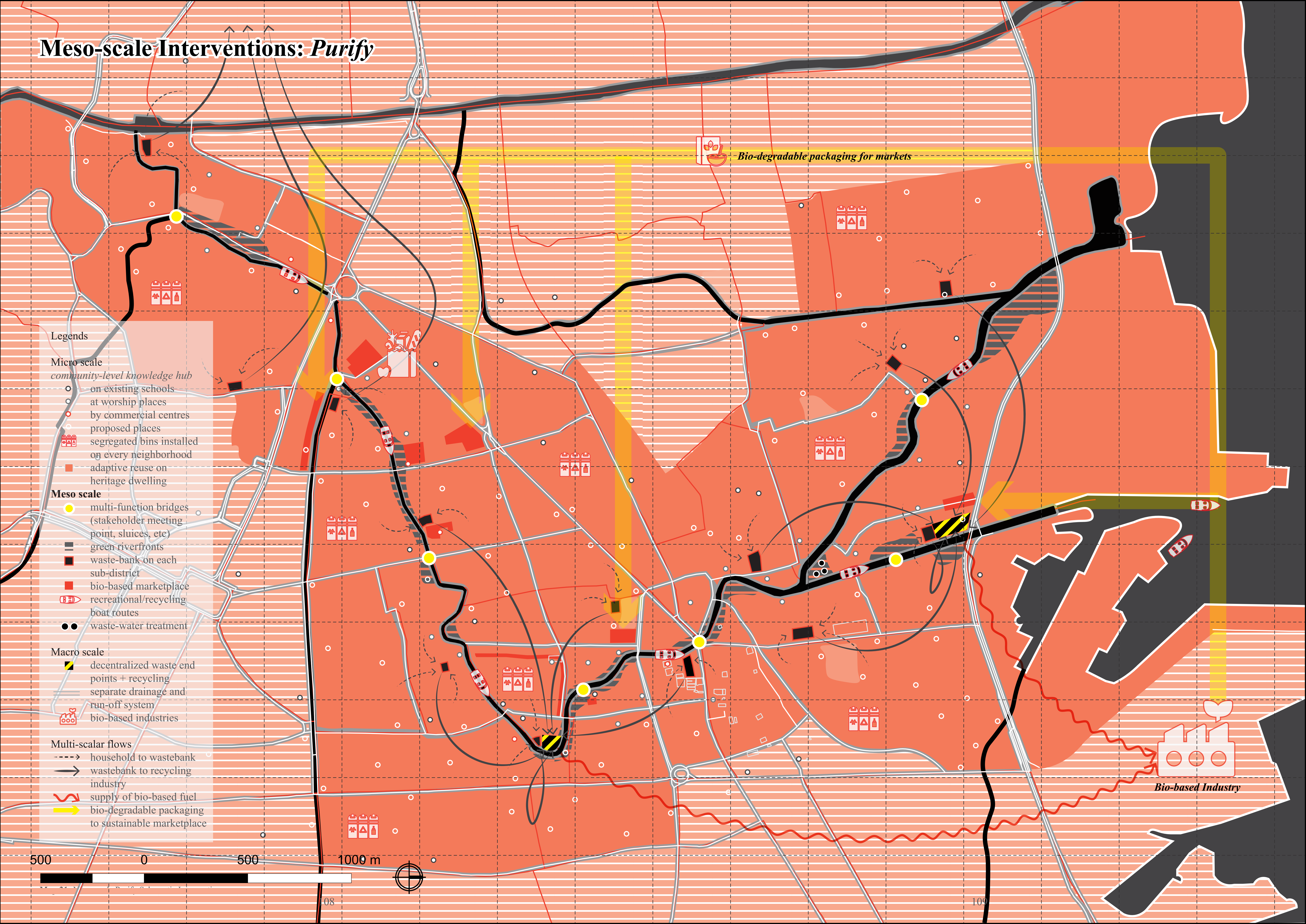
Provide
(Map 23 on page 112)

i. have the industries recharging back excess water to the ground
ii. extend supply of tap water (PDAM) to un covered areas
iii. utilize the waterfront greeneries as urban permaculture
iv. thorough application of rainwater harvesting (to be explored more on micro scale)

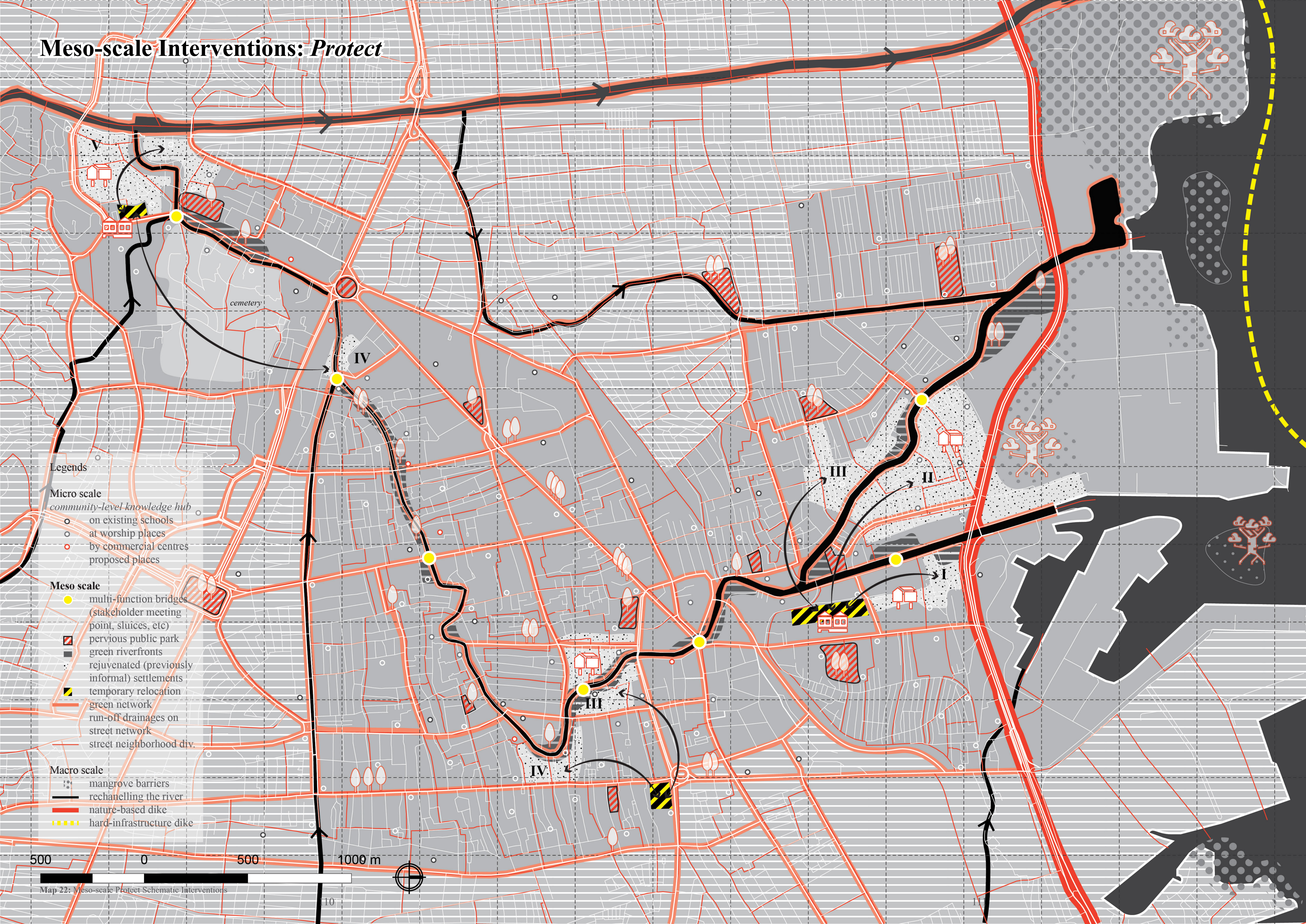
Aside from those listed; the proposed multifunction bridges, schools, worship places, and commercial places will have a duty to educate the citizens with all the mentioned strategies.

Eventually, the final masterplan combines the three schematic planning of Purify, Protect, and Provide sub-projects throughout the watershed of Semarang River (see Map 24 on page 114). Understanding that the coastal area would eventually sink, the masterplan visualizes bold rechanneling measures in a way that it floods the previously informal settlements area to which now become a complex of water-sensitive social housing. The plan of the new social housings are rendered conceptually as it will take shape according to the results of participatory planning exercises with the locals. However, it would like to convey the idea of self-sustaining community where each new dwelling could accomodate all members of an urban village (RW) and is provided with plots for urban permaculture.

On the other hand, the extended surface water by the means of rechanneling also trigger a more frequent interaction between the citizens and water bodies; be it through waterfronts, water transport, or living on stilts. These regenerative actions altogether would resignify the city's natural backbone, which eventually tie back together Semarang's valued cultural precincts to its natural heritage.

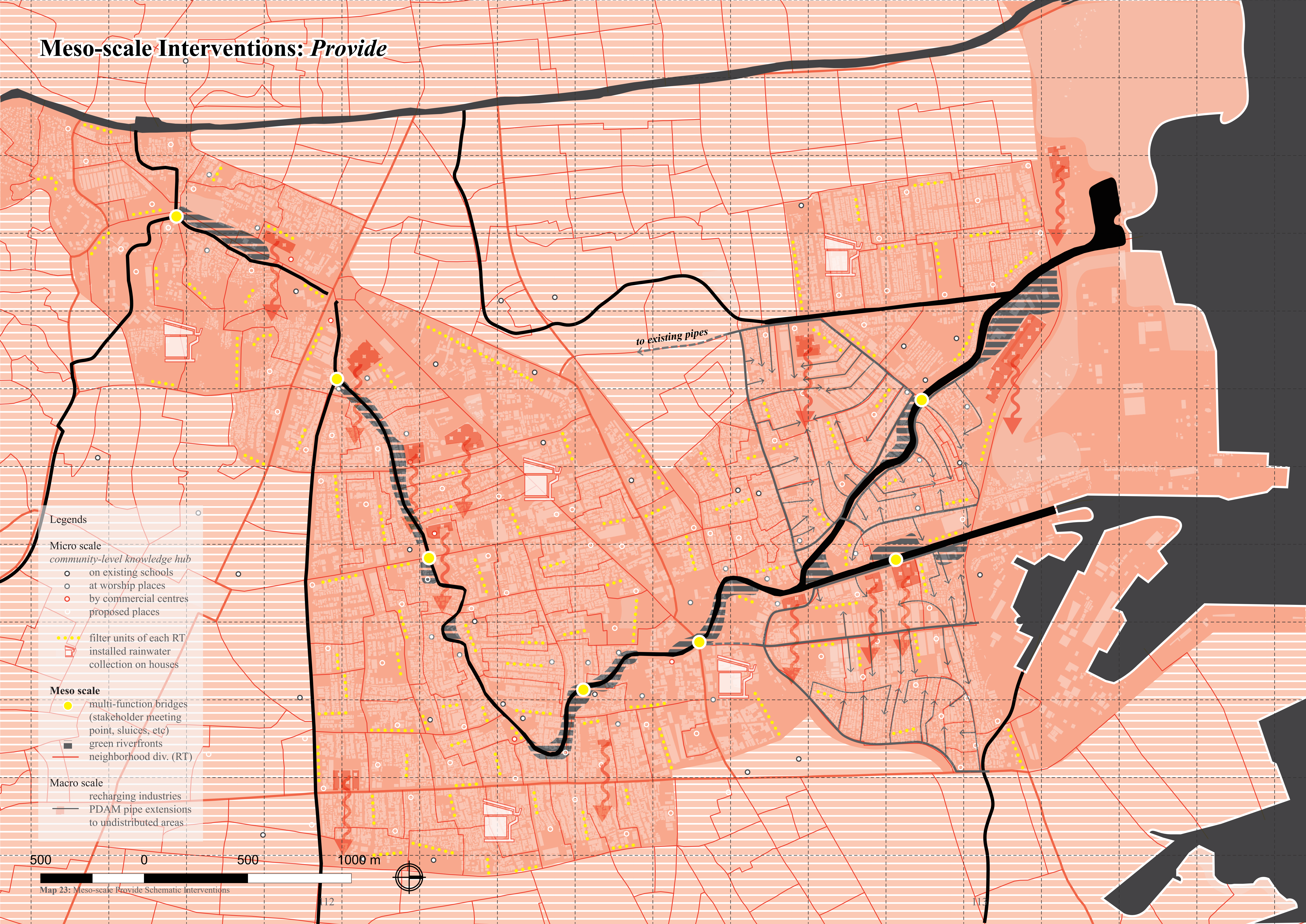

Meso-scale Interventions: Purify
Bio-degradable packaging for markets
Bio-based Industry
Legends
Micro scale
community-level knowledge hub
on existing schools
at worship places
by commercial centres
proposed places
segregated bins installed
on every neighborhood
adaptive reuse on
heritage dwelling
Meso scale
multi-function bridges
(stakeholder meeting
point, sluices, etc)
green riverfronts
waste-bank on each
sub-district
bio-based marketplace
recreational/recycling
boat routes
waste-water treatment
Macro scale
decentralized waste end
points + recycling
separate drainage and
run-off system
bio-based industries
Multi-scalar flows
household to wastebank
wastebank to recycling
industry
supply of bio-based fuel
bio-degradable packaging
to sustainable marketplace
500
0
500
1000 m
108
109

Meso-scale Interventions: *Protect*



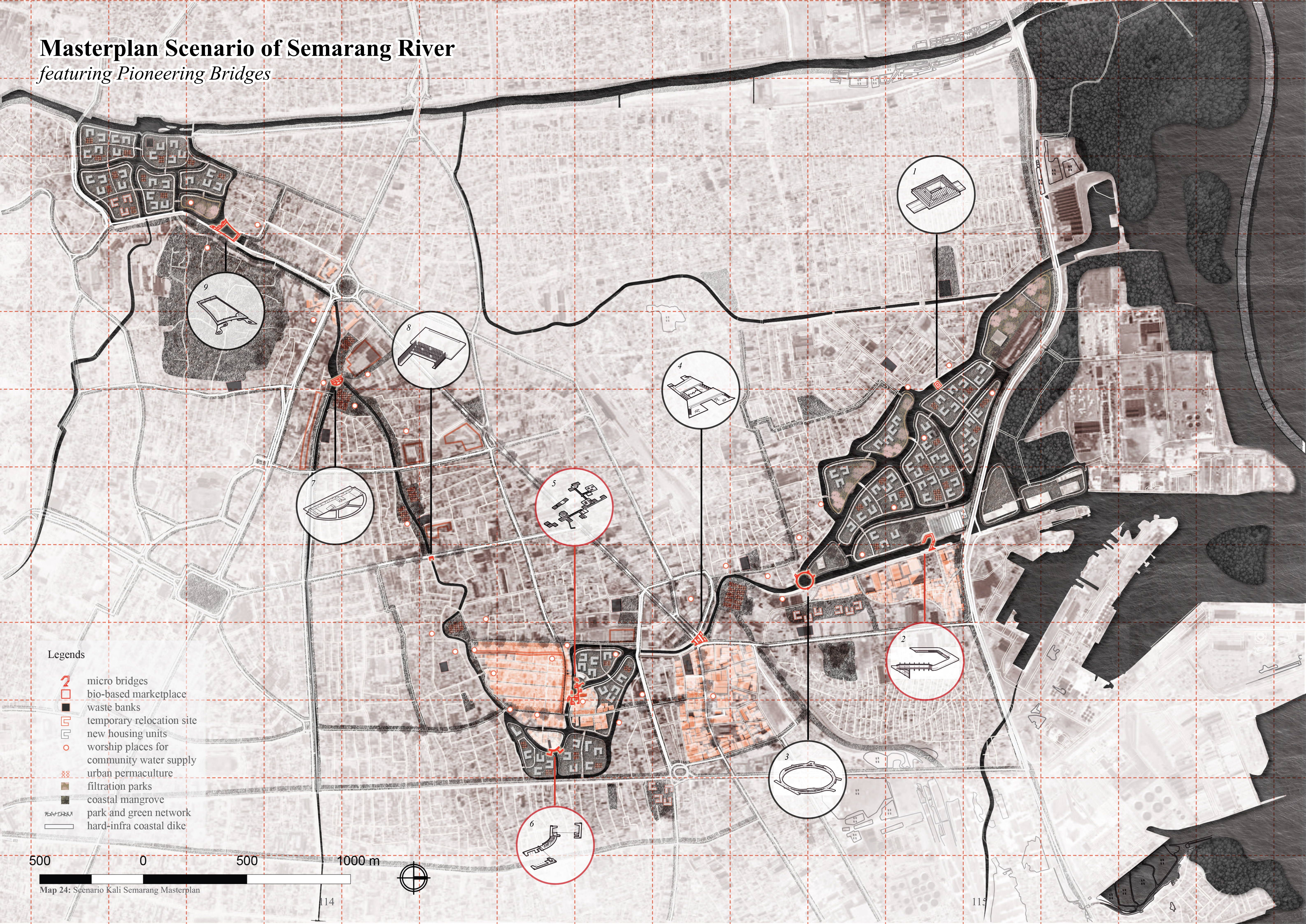
Map 22: Meso-scale Protect Schematic Interventions

Meso-scale Interventions: *Provide*



Map 23: Meso-scale Provide Schematic Interventions

Masterplan Scenario of Semarang River
featuring Pioneering Bridges

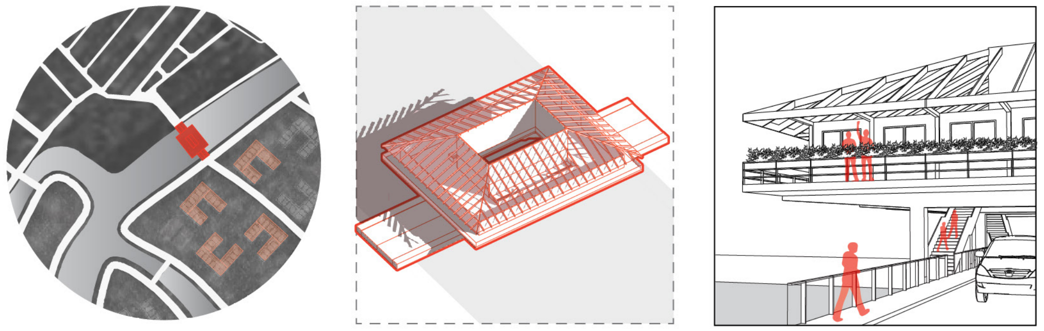


Map 24: Scenario Kali Semarang Masterplan

Micro-scale Interventions
The Bridges as Pioneering Projects

The *Flush and Splash* project begin by erecting 9 multifunction bridges, on top of the degraded river itself, which promote the variables of ecosystem services as well as providing space for regular community gatherings. They are spread across various junctions where the Semarang River meet with the important precincts or places of high traffic. Later in this thesis, the project would zoom in to three nodes to explore the possible extended measures on each micro sites.

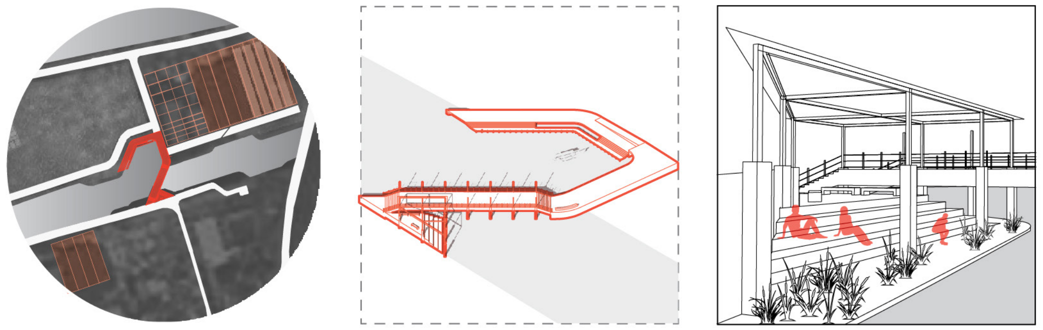
1. The Floating Library



Context:
adaptive social housing, residential

Description:
facilitate educational means to increase the awareness of local hazards

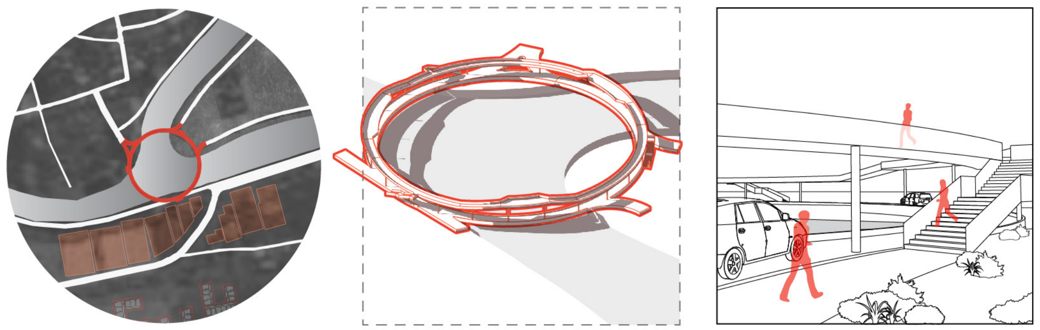
2. Marabunta Pier*



Context:
industrial area, Marabunta recycling centre, social housing

Description:
main stop for the recycling boat which collect solid waste from the river, etc to be delivered to Marabunta recycling centre

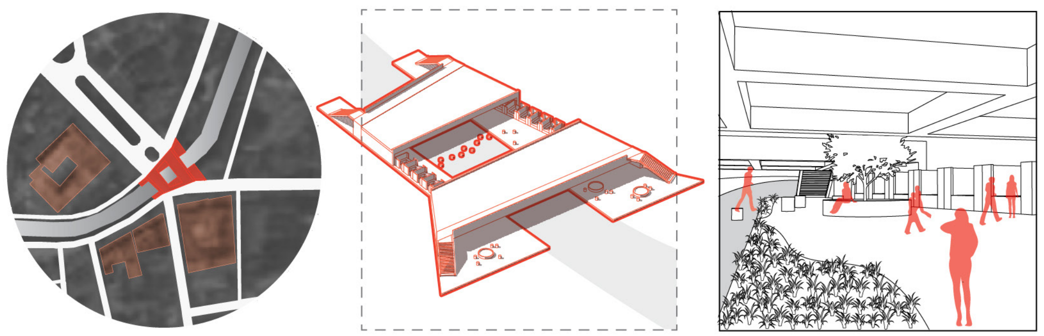
3. The Delta Ring



Context:
residential, industrial area, park

Description:
a double-layered node which consist of a jogging track for citizens to exercise

4. Kota Lama Shade

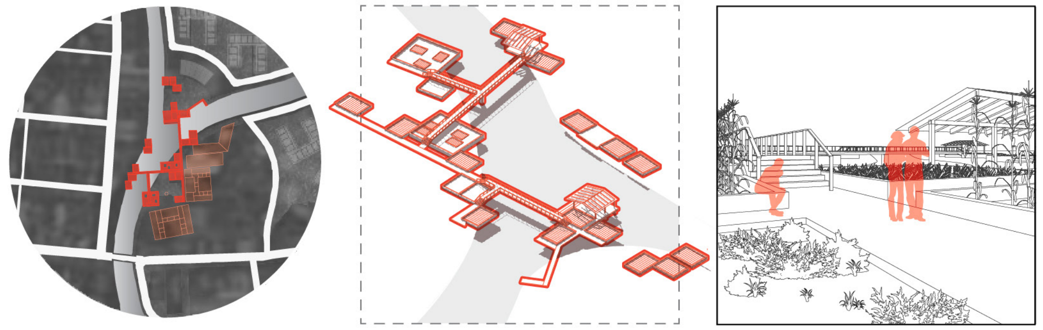


Context:
Kota Lama Heritage Precinct, Governor street

Description:
being the main bridge as an entrance to the historical precinct, the node invites the visitors to enjoy local food stalls at the riverfront underneath

Figure 53: micro bridge typology series

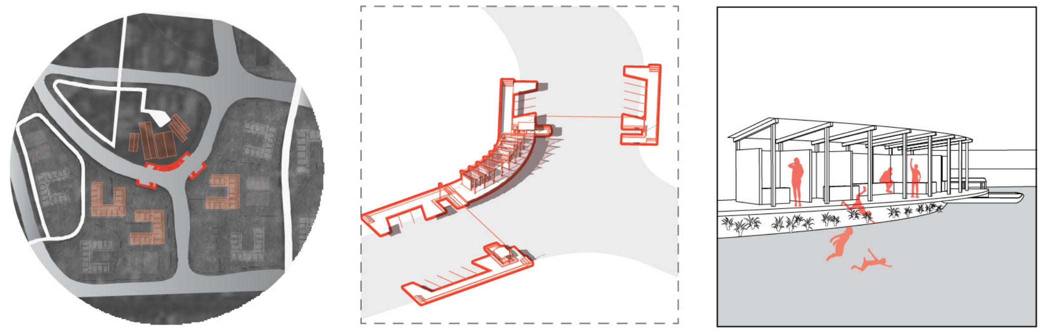
5. Tay Kek Sie Harvestry*



Context:
market, temple, school, Pecinan

Description:
a node which promotes urban permaculture and circular metabolism flow within the neighborhood

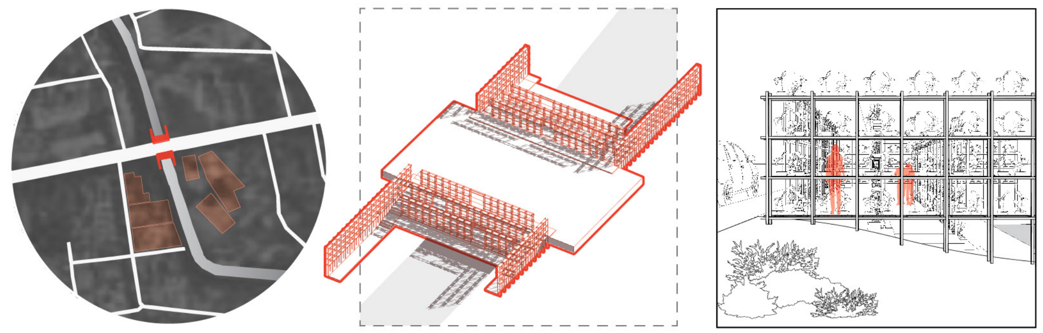
6. Pecinan's Earing*



Context:
adaptive social housing, Pecinan, waste bank

Description:
promote modes of water transport for citizens around Kali Semarang

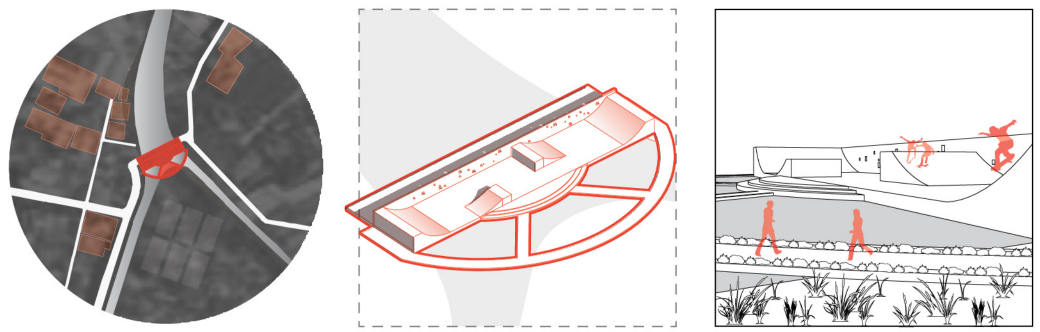
7. Potted Arcade



Context:
residential

Description:
promotes innovative urban permaculture within dense region

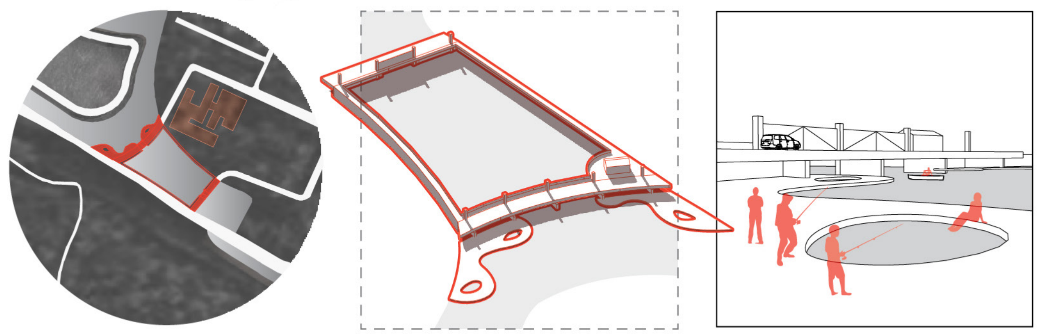
8. Skate Cross



Context:
malls, shops, residential

Description:
youth skate park which could be a potential node to promote the urgency of Flush & Splash measures to the youth

9. East Canal Fishing Bay



Context:
East Canal opening, residential

Description:
a set of bridge with sluices to control water entering Semarang River whilst provide fishing spots for the citizens

**selected micro sites*

F. Purify:
Circular Waste Management

i. Precedent Studies
ii. Zoom-in site Analysis
iii.The Purify Bridge and its Extended Measures

Discussion and Precedents

On the assumptions made from seeing old pictures, the reason why the water quality was well-managed in the past, aside from being less densified, was also because it was used as water routes. Due to the coastal flooding that causes permanent closure of Kali Baru, these routes are no longer alive. However, a consideration to reopen this blockage may re-introduce the water transport system, this time with a contextual purpose: for solid waste collection and deliveries as well as heritage recreation trail.

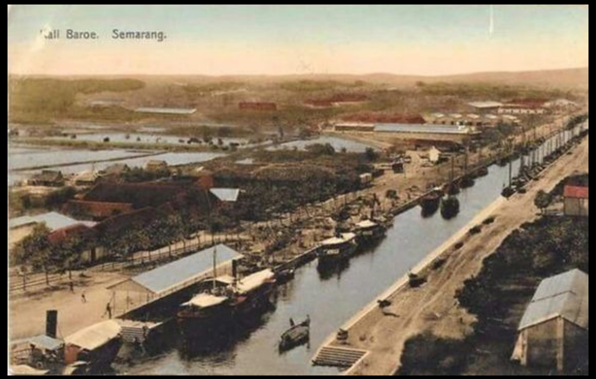


Image 32: Kali Baru on the early 20th Century

The waste deliveries through the water transport shall meet entrusted collection points. A local example of 'Malang Waste Bank' project have been proven successful with over four hundred collection points and 32,000 costumers. It is a win win solution for the community as they would receive money when they collect their waste. This system could be adopted on the purify project, utilizing Marabunta warehouse as part of the facility.

Image 33: citizens delivering recycled material to Malang Waste Bank

To complete the system, Tianjin Qiaoyuan park portrays an exemplary softscape which transform a former garbage dump to a low maintenance urban park. This twenty-two hectares park in the northern coastal city of Tianjin, China align itself with regenerative manners through various natural services such as: containing and purifying storm water, improving the saline-alkali soil, as well as environmental education and remarkable aesthetic experience.

Sources:
Malang Waste Bank - http://urbansdgplatform.org/profile/profile_caseView_detail.msc?no_case=251
Tianjin Qiaoyuan - http://landezine.com/index.php/2011/03/tianjin-qiaoyuan-park-by-turenscape-landscape-architecture/


Image 34: Tianjin Qiaoyuan phytoremediation urban park

Existing Condition

The aerial sketch on the left reveals the accumulating physical problems of Bandarharjo. Having low living standards, the locals--which daily activities are mostly hard-labour--finds it normal to live on a sinking house with a designated spend to raise their house regularly. This form of coping mechanism does not deal with the source of the problem straight away. Secondly, the clustered density of the *kampung* limits their frequent social interaction on the streets. Potential spaces that could be enhanced for the daily activites remain unknown for them. The next obvious one is the Marabunta warehouse, which shape dominates the site without having any meaning to the surrounding citizens. Now how to re-use this site to fit the context needs?

Dominant Physical Features

A. Marabunta ornaments
B. exposed brick facade
C. fish pond
D. industrial dwellings
E. sinking facade
F. garbage accumulation
G. alley gateway
H. street kiosks
I. port boats
J. truck containers

Figure 54: collage of dominant physical features in Marabunta

Daily Activities and Local Issues

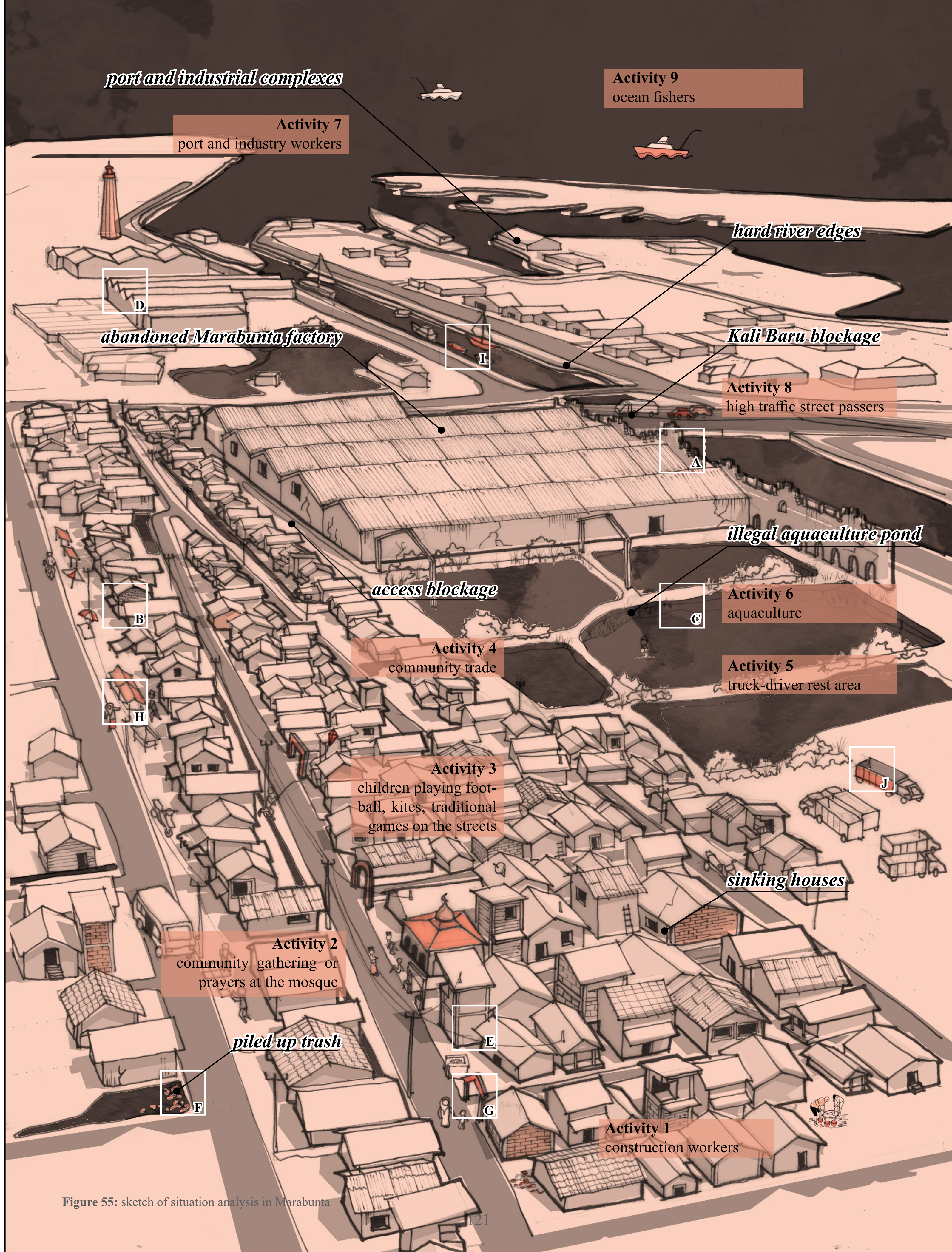
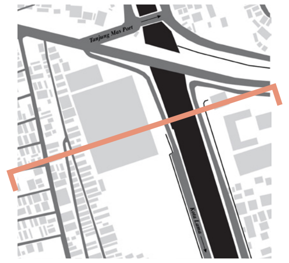


Figure 55: sketch of situation analysis in Marabunta

Existing Condition

Current Flows in relation to 'Purify'



Indeed, the saline water and low quality surface water have placed the community in a situation to dig 15-20 meters depth of wells for clean water access. On the other hand, since the emergence of the kampung dating back to 1960s, these houses have sinked for 2 to 4 meters. And that is in 60 years. The current coping mechanism to gain access to clean water clearly have not helped the other coping mechanism of rising house elevation due to land subsidence. Money is an issue in limiting their choice of alternative solutions. Hence, could the bulk warehouse host a regenerative activity for their sustenance?

Site Coping Capacity

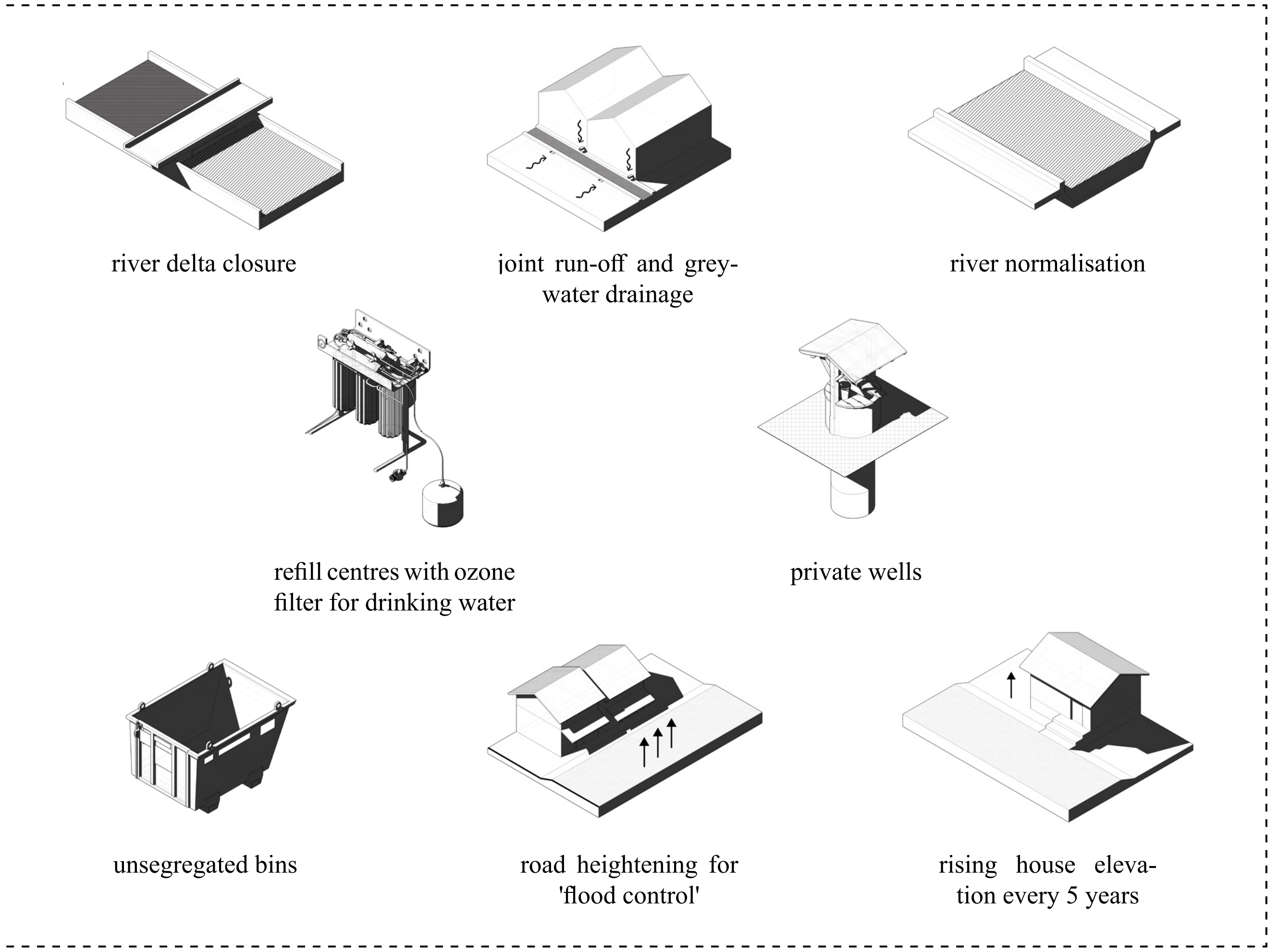


Figure 57: current local coping capacities around Marabunta

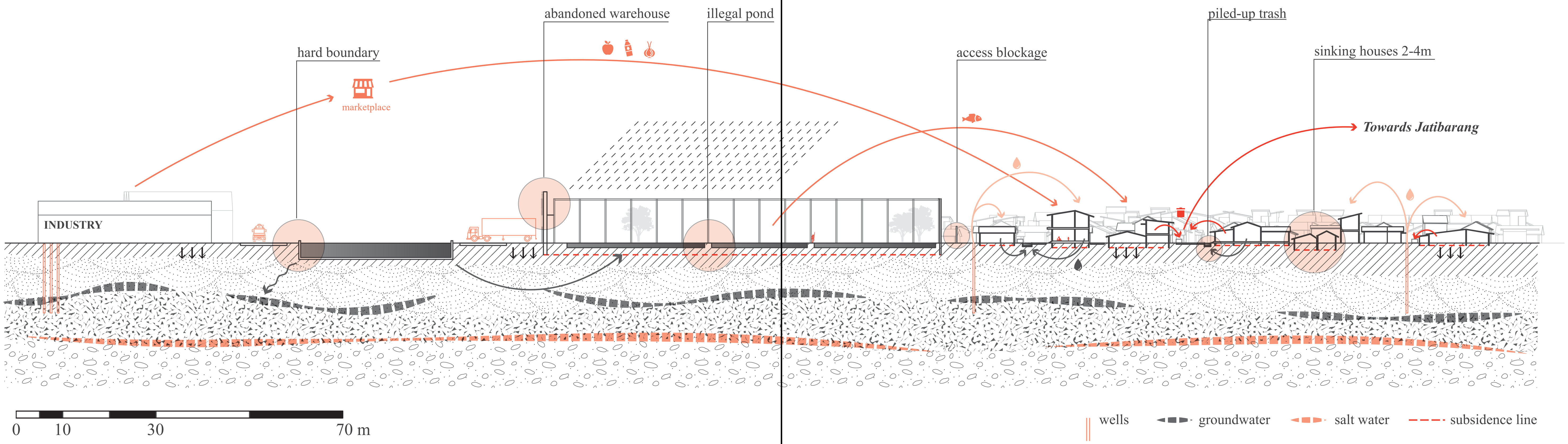
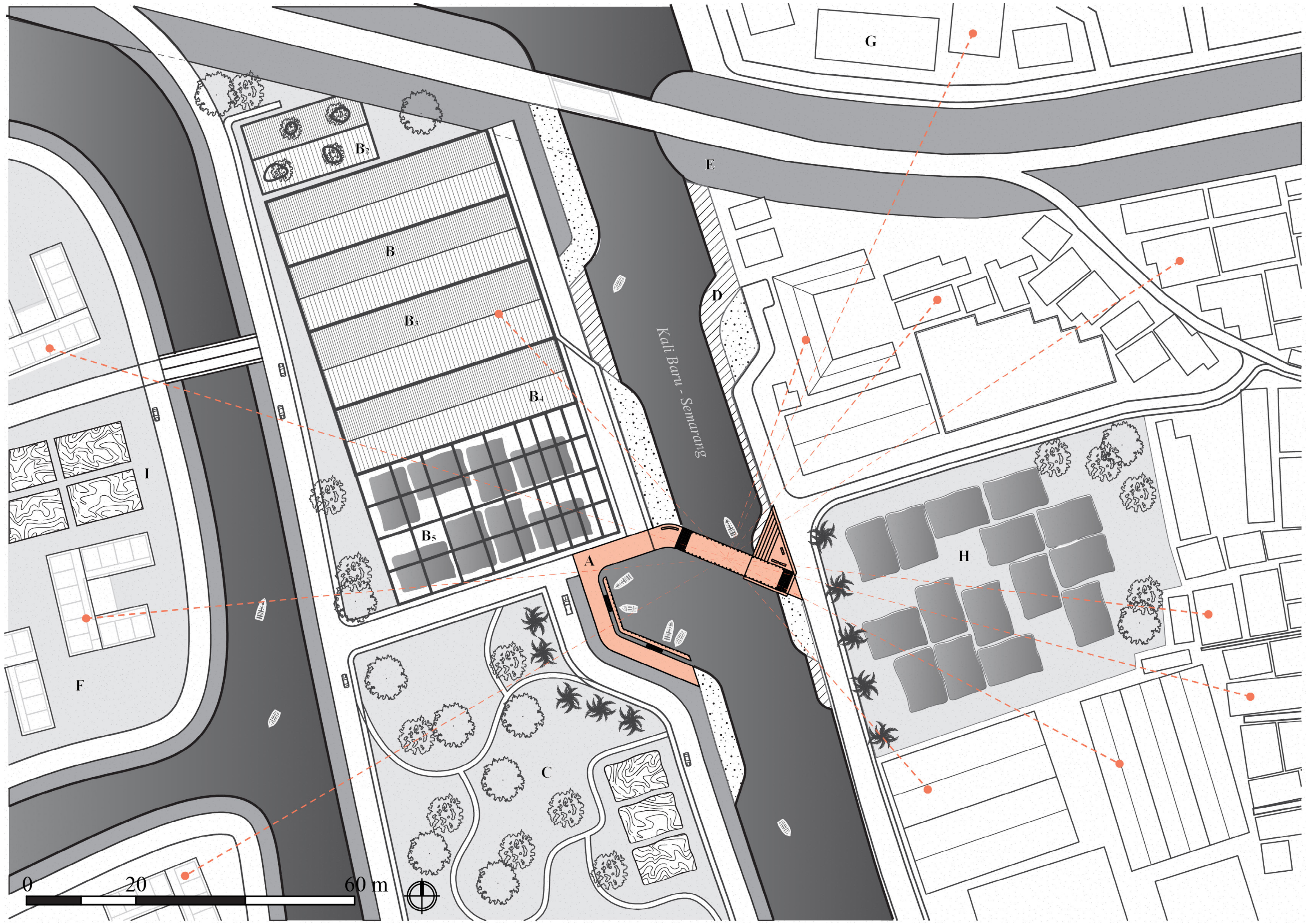


Figure 56: existing condition section at Purify site

Purify Node: *Plan and Phases*

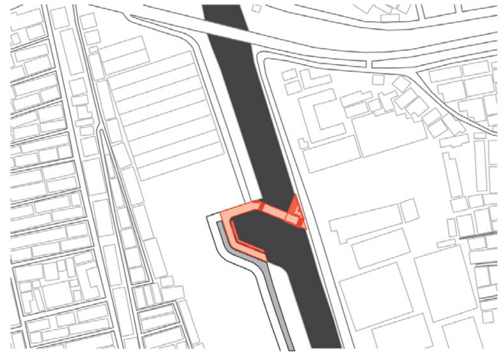


Map 25: proposed plan at Marabunta site rejuvenation

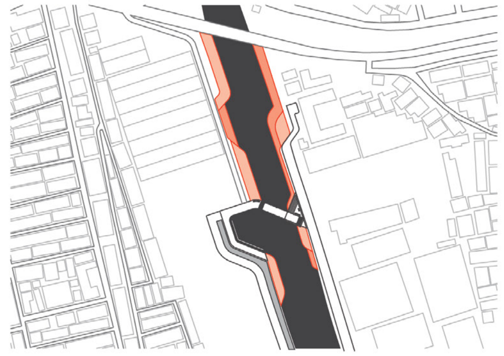
By conducting multi-level stakeholder meeting and local waste management lessons at the node, the plan is to transform the abandoned warehouse into an intergrated recycling centre where it may solve environmental and social problem simultaneously. Firstly, Marabunta Centre would be able collect local waste from Bandarrharjo precinct, neighbouring industries, river solid waste, and deliveries from other precincts upon closer proximity. Secondly, the multi-function recycling centre would create more local jobs for the local community.

Legends

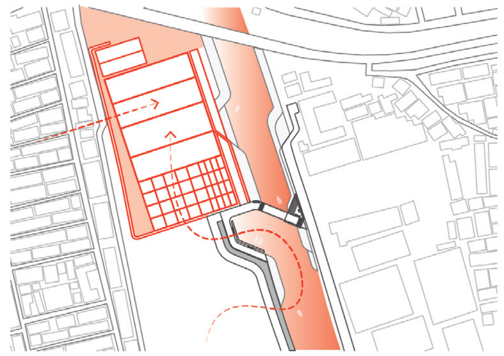
A	Purify bridge project
B	Marabunta recycling centre
B2	Marabunta education centre
B3	Marabunta waste bank
B4	Marabunta marketplace
B5	aquaculture
C	public park
D	filtration plants
E	inner natural dike
F	rejuvenated Bandarharjo
G	Tanjung Mas port
H	aquaculture park
I	permaculture



1. Construct the 'Purify' bridge as a participation node

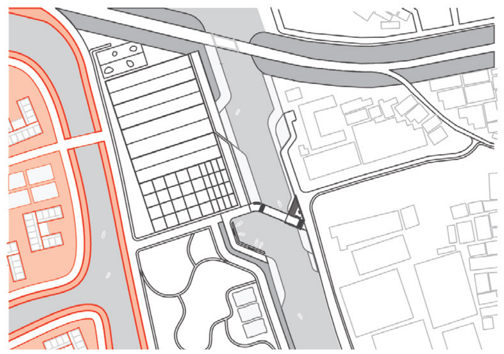


2. Enable phytoremediation system with helophyte plants



3. Conduct adaptive re-use of Marabunta warehouse and activate recycling boat waste delivery system

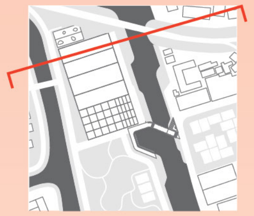
4. Construct dike by the main northern coastal road



5. Rejuvenation of the Bandarharjo villages

Map 26: transformation phases in Marabunta

Purify Node: *Proposed Section*



The section below illustrates the node with the rest of the purify measures. It depicts how the Marabunta warehouse would eventually be the epicentrum of the Bandarharjo Sub-district community activities. The diagram on the right explains the activities of the solid waste management dealt on the site. Aside from the solid waste, waste-water of the warehouse and adjacent neighborhood are being treated with phytoremediation landscape before entering the river.

phytoremediation landscape section

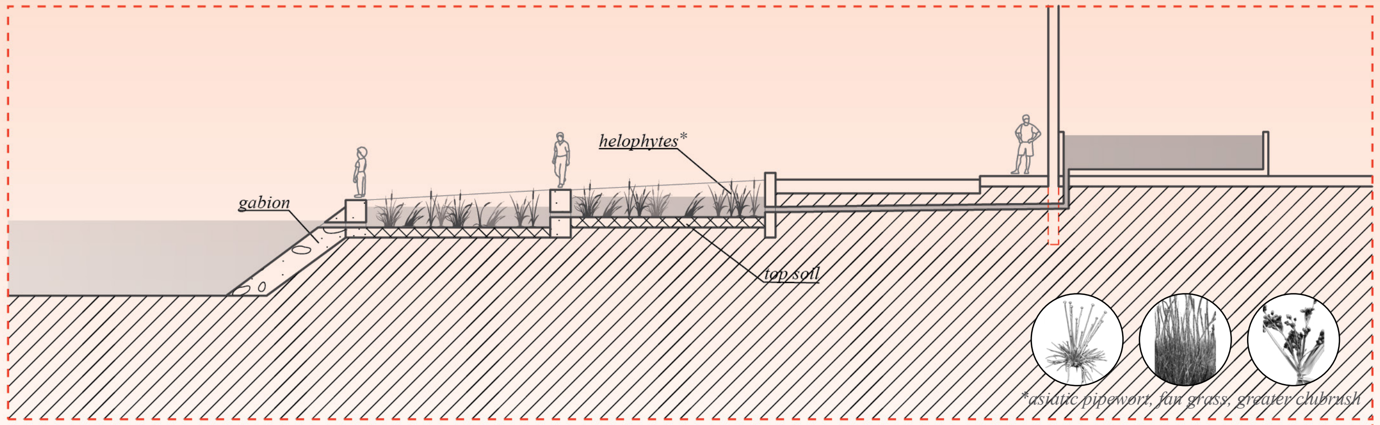


Figure 58: Marabunta zoomed-in waterfront section

waste-bank activities

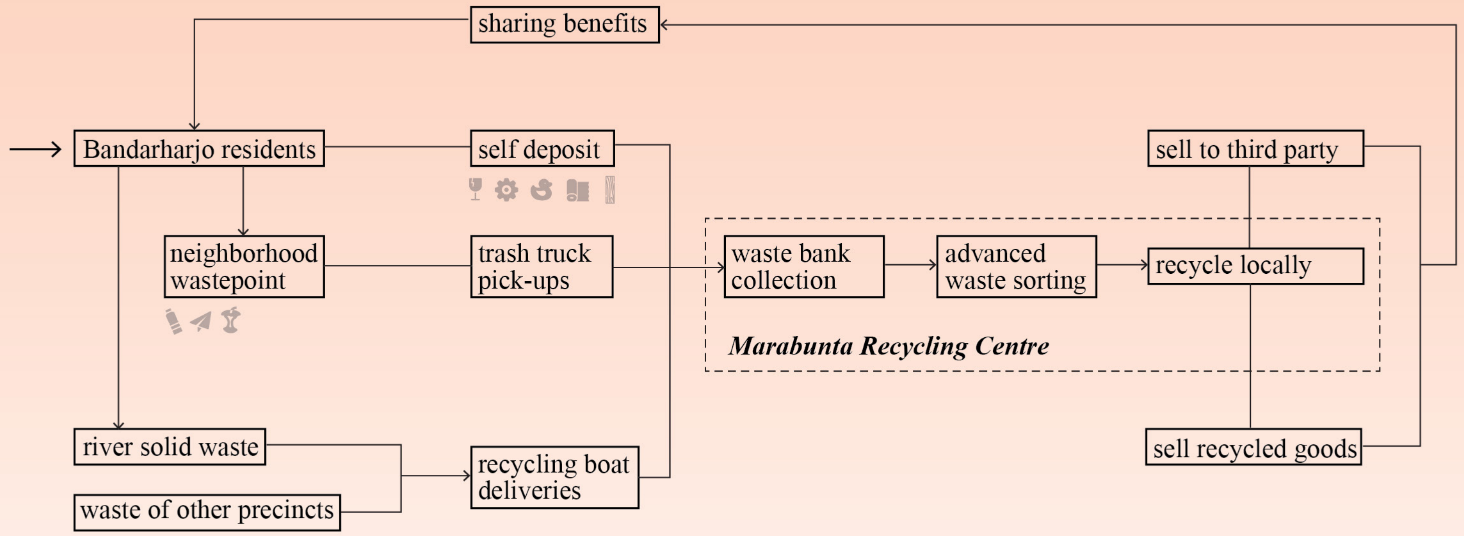


Figure 60: flow-chart of waste bank activities

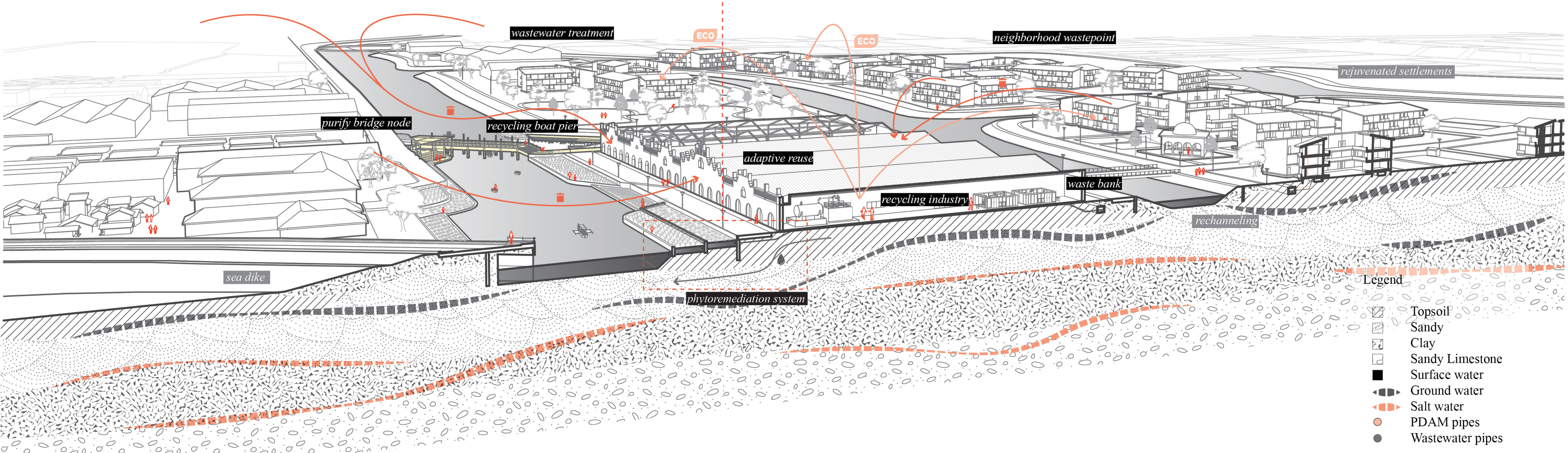


Figure 59: proposed section at Marabunta site rejuvenation

Purify Node: *Marabunta Recycling Pier*

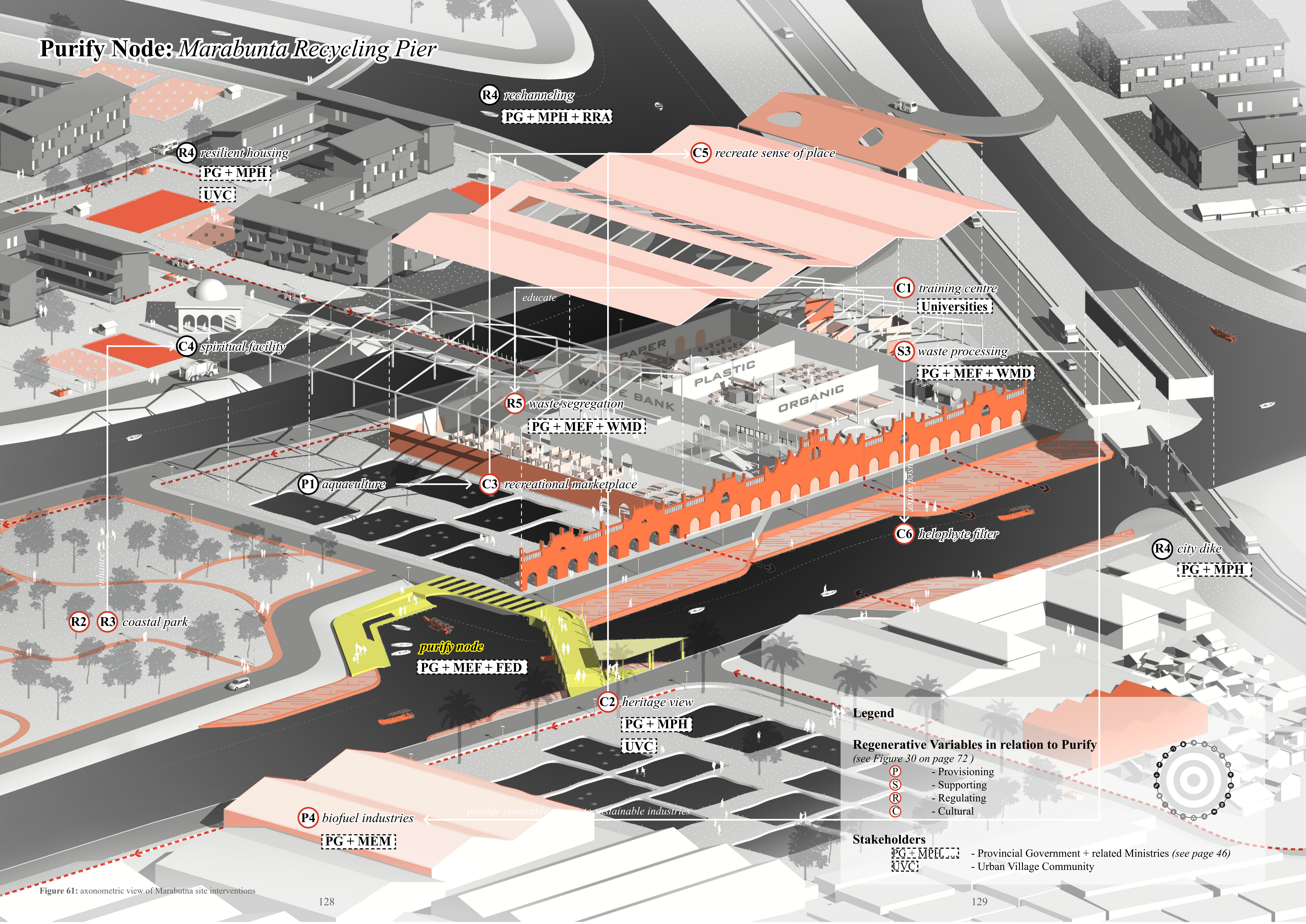


Figure 61: axonometric view of Marabutna site interventions

Purify Node: *Street Views*

Figure 62: waste bank and offices as part of the adaptive re-sed program

Figure 63: market hall to host local fisheries and food businesses

Figure 64: phytoremediation landscape to filter waste water enetering the river

The sets of view imagines the successive events that are possible within the warehouse conservation project, following the installation of the node which ties the Marabunta building back to the water body. The dynamic social activities such as marketplace, community workshops, and waste collection duties being pulled close to the Kali Semarang hopes to increase the awareness of Bandarharjo citizens on the importance of keeping a hygienic environment.

Figure 65: a perspective showing how the bridge stitches the cultural and natural heritage

Normalizing Interaction with Waste

To Extract its Bankability

Waste Type	Percentage	Amount per Year in Tonnes	Lowest Price Paid / Tonnes*	Highest Price Paid / Tonnes*	Lowest Total Market Value	Highest Total Market Value
Paper	10,96%	48.004,80	Rp. 450.000,- € 28,13	Rp. 3.500.000,- € 218,75	Rp. 21.602.160.000,- € 1.350.135,00	Rp. 168.017.000.000,00 € 10.501.050,10
Plastic	16,28%	71.306,40	Rp. 450.000,- € 28,13	Rp. 1.250.000,- € 78,13	Rp. 32.087.880.000,- € 2.005.492,50	Rp. 89.133.000.000,00 € 5.570.812,50
Metal	1,28%	5.606,40	Rp. 1.750.000,- € 109,38	Rp. 7.500.000,- € 468,75	Rp. 9.811.200.000,- € 613.200,00	Rp. 42.048.000.000,00 € 2.628.000,00
Glass	1,78%	7.796,40	Rp. 125.000,- € 7,81	Rp. 125.000,- € 7,81	Rp. 974.550.000,- € 60.909,38	Rp. 974.550.000,00 € 60.909,36
						Rp. 300.019.111.077,-

Share for citizens / year (commonly 10%): Rp. 30.019.111.077,-

Share for citizens below poverty: 30.019.111.077 / 1.288.084 *citizens of Semarang* x 4.14% living below poverty

Rp. 562.928,58 / year / person
(€ 35,18)

Figure 66: A rough calculation on the potential benefits of recycling

Semarang produces **1.200 tonnes** of waste each day, in which it accumulates to **438.000 tonnes yearly**. Based on the available data, the recycleable waste (this context speaks of paper, plastic, metal, and glass) found at Jatibarang landfill comprises up to 30,3%. The current market price for these recycleable materials might vary from low to high, however, with the volumes collected yearly, it may generate to a signicant number (UN Environment, 2017). Hence the calculations above. Bear in mind this is the best scenario where all the waste are successfully separated and that the market value are predicted to be highest. However, these figures were intended to show the potential benefits of recycling instead of having them ended up at the landfill.

As for the organic waste, keeping a closed loop within each street neighborhood clusters (RT) could potentially benefit the local directly through electricity savings as well as regenerate compost for local permaculture activity. The diagram below shows the numbers to which the organic waste could be productive.

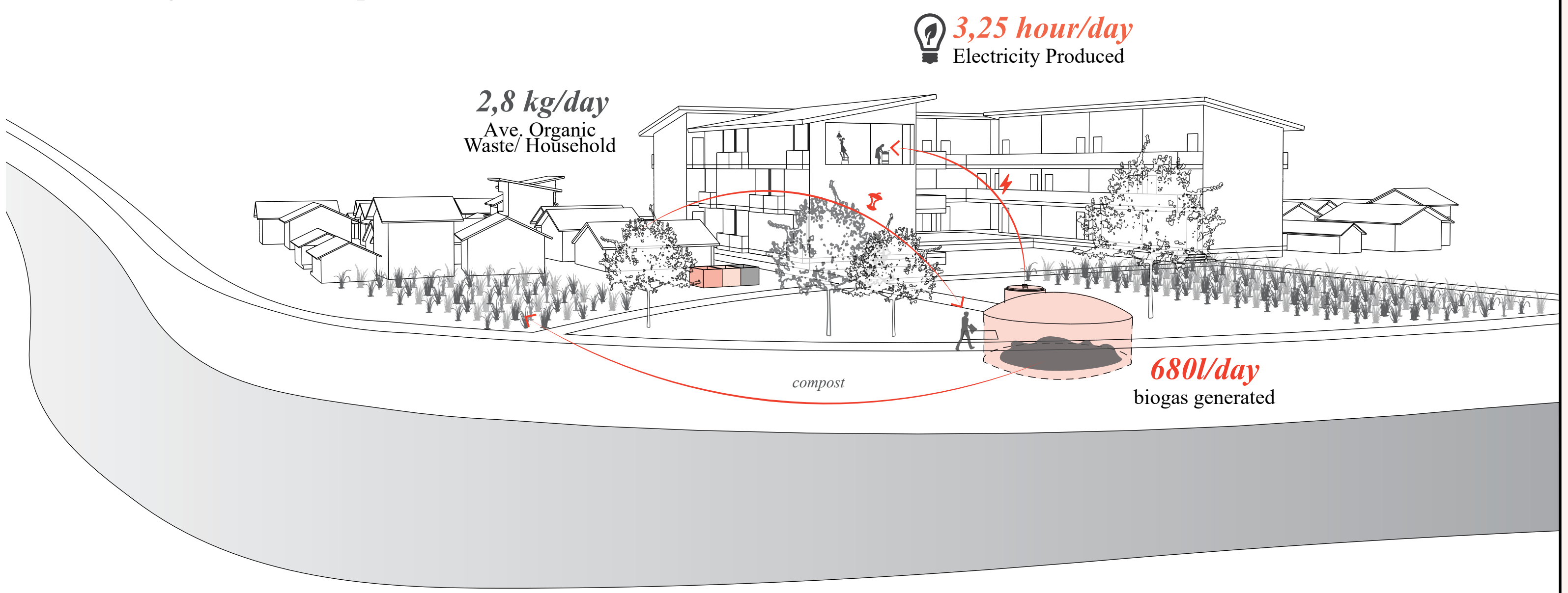


Figure 67: Local biodigester system

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G. Protect:
Nature-based Flood Defense

i. Precedent Studies
ii. Zoom-in site Analysis
iii.The Purify Bridge and its Extended Measures

Discussion and Precedents

Today, flooding issues along the Semarang River has been reduced significantly due to the installation of pumping station back in 2016. However, the dense city still needs to deal with pluvial flooding on wet seasons as well as considering with the fact that its sinking land could re-expose them to coastal flooding. Aside from the maximizing pervious surface in the midst of the density, one also have to prepare the extreme scenario of living on water. Luckily, it does not need to be introduced from an empty scratch of paper.

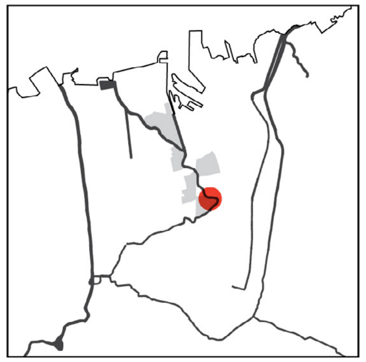
Wooden houses on stilts could still be found within the coastline community of Semarang. Although appears to be very fragile, the idea of living on surface water have existed in the mindset of the people. The Schoonship project in Amsterdam (Image 37) could be the direction where the rehabilitation of informal settlements and their temporary relocation site could appear to be. Looking at some 'bridges' in the river today (Image 36) that utilize boats for crossing makes it possible for water transport to again be common following these adjustments. Further adjustments with the context, integration of other water-sensitive facilities, and promotion of these so-called resilient housing might be an essential coping mechanism to respond to the rising sea level and uncertainty of climate change.

Image 36: crossing boats at Kali Baru Semarang

Image 35: water sensitive public space at Roombek, Enschede

Image 37:aerial picture of Schoonship floating housing project in Amsterdam

Existing Condition



This site brought up the interest to undergo protect project as it represents the common challenge of normalisation-naturalisation these days on a dense city. The density pressure have narrowed the river width and the inspection roads are certainly not helping as it reduce and adequate length of pervious surface to act as a buffer zone. Trading activities are strong in this precinct, which attracts poor migrants to live on the riverside, however the river is nothing but the backhouse of this area. The challenge now is to draw the people's attention towards the river and make it a significant element of a healthy and circular metabolism flow.

Dominant Physical Features

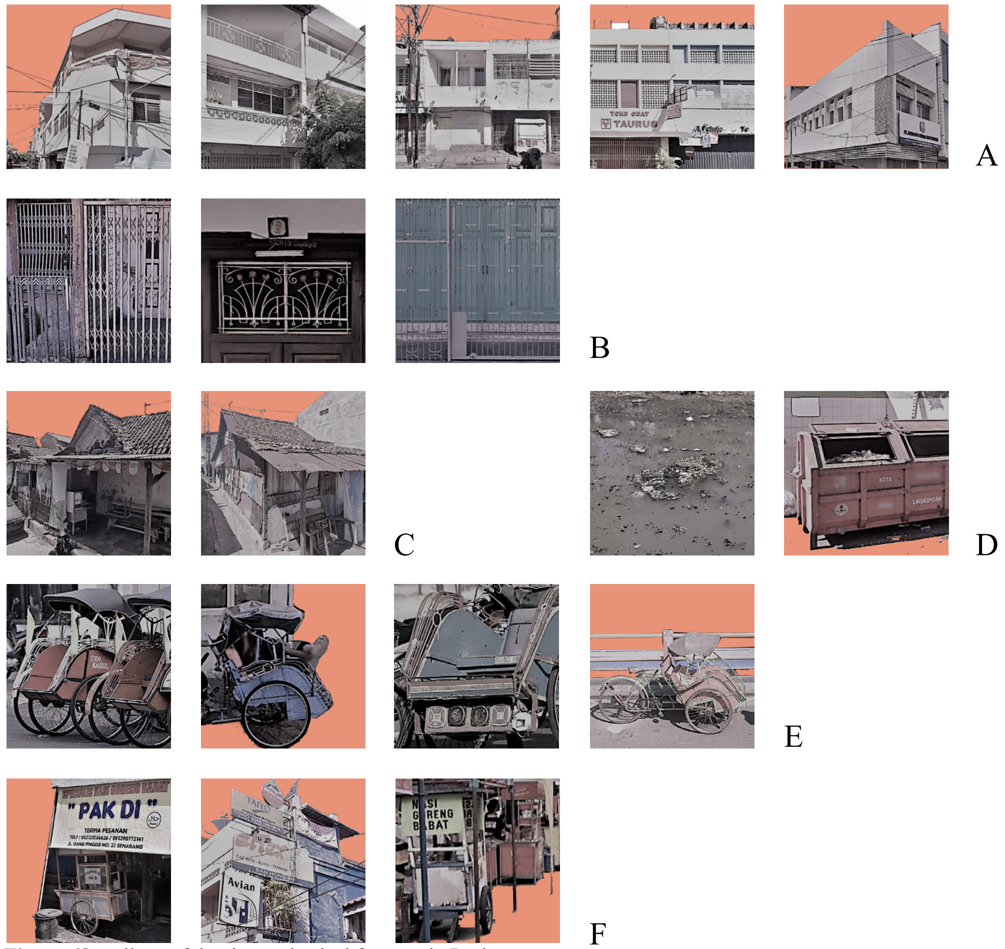


Figure 68: collage of dominant physical features in Pecinan

A. Pecinan settlements
B. iron works
C. informal settlements
D. solid waste
E. becak
F. shop signages

Daily Activities and Local Issues

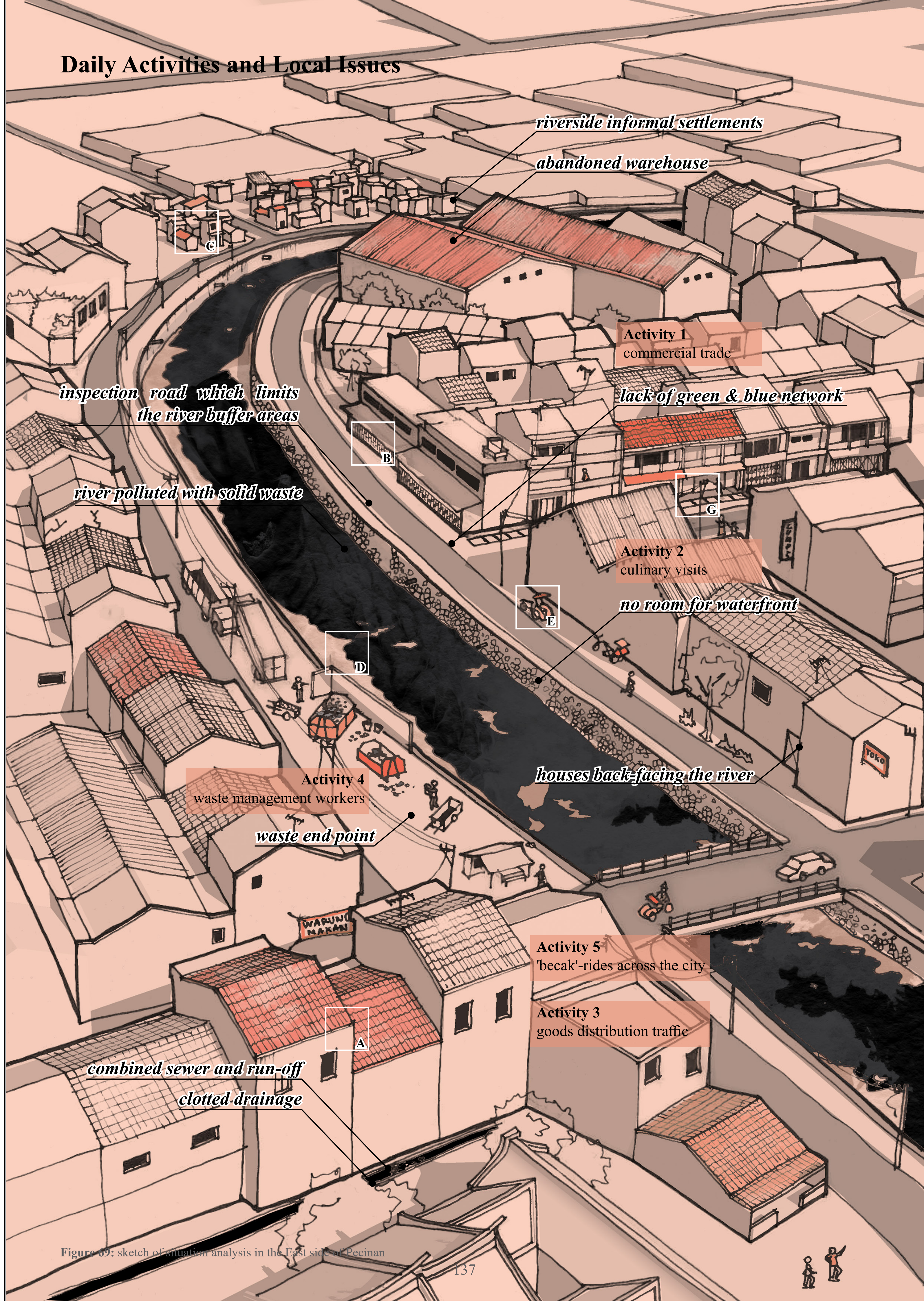


Figure 69: sketch of situation analysis in the East side of Pecinan

Existing Condition

Current Flows in relation to 'Protect'

Although Pecinan is a relatively steady precinct in terms of economy, some residents are still extracting their water resource from the well, which may quicken the subsidence and heighten the risk of flooding. Being further away from the sea, the site are more familiar with pluvial flooding, as the drainage system often gets overwhelmed with the excessive water flow during wet season. The section drawing is necessary to observe which areas by the riverside could potentially be converted to means of containing the water flow. This indeed relates to the issue that 'purify project' aims to tackle, in a way that the drainage blockage are due to unorganized solid waste.

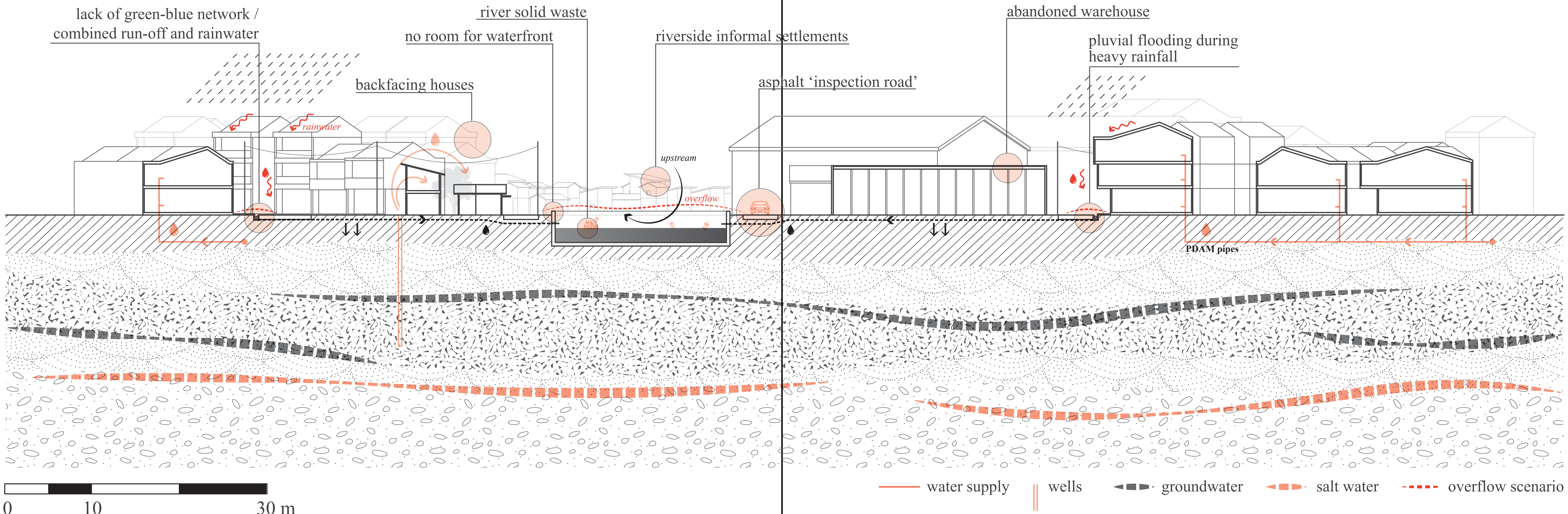


Figure 70: existing condition section at Protect site

Site Coping Capacity

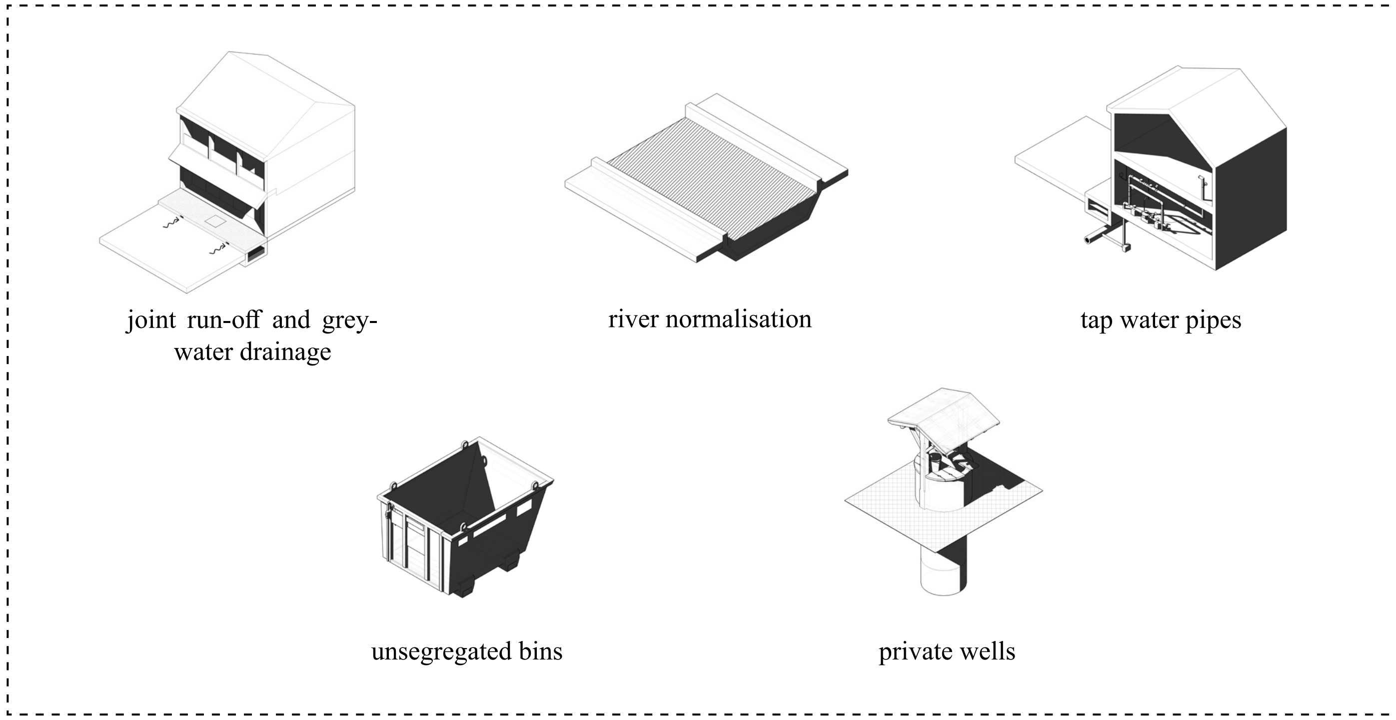
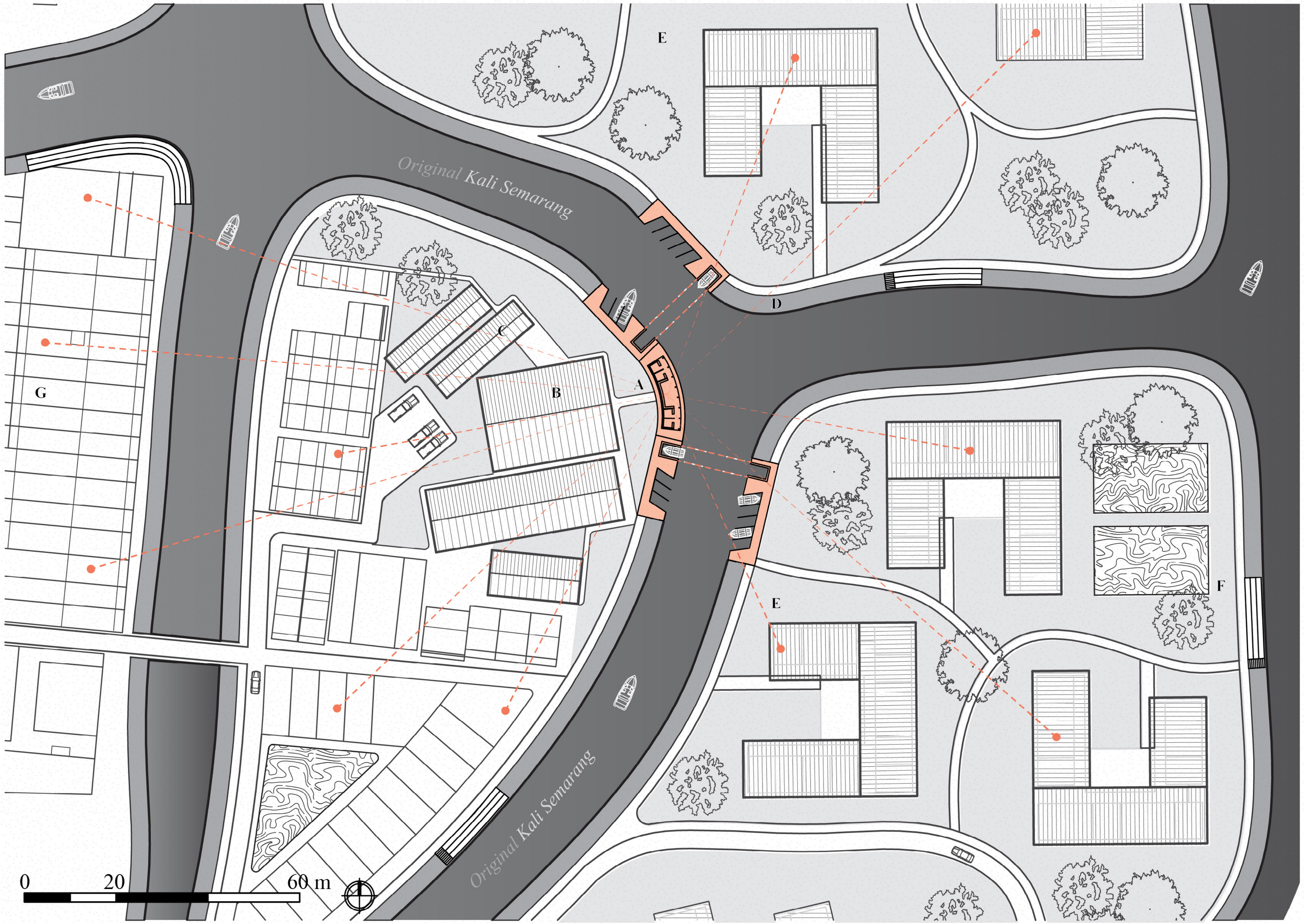


Figure 71: current local coping capacities in Pecinan

Protect Node: *Plan and Phases*

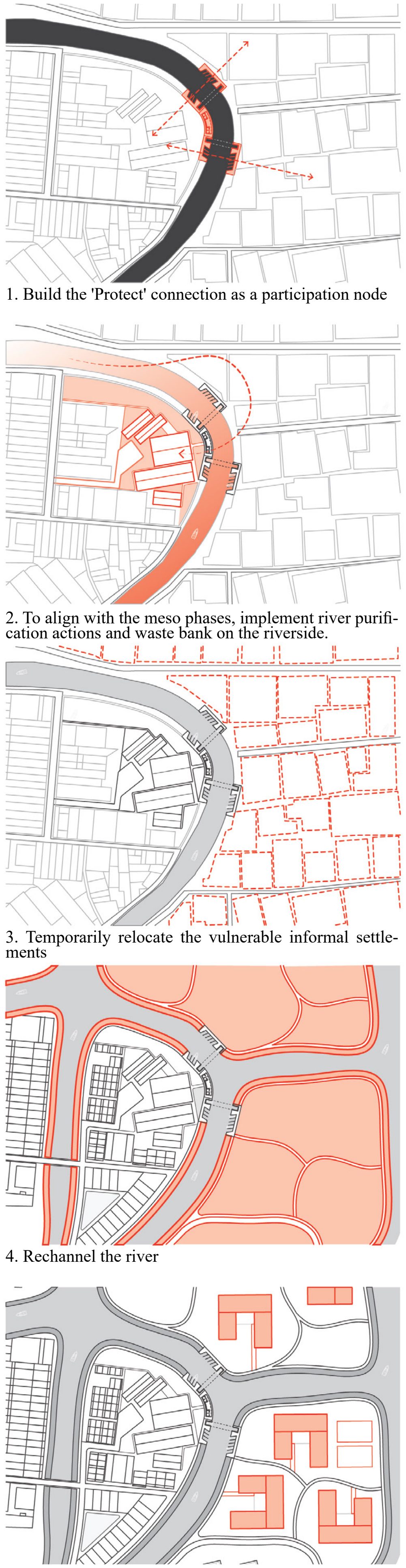


Map 27: proposed plan surrounding Pecinan Protect node

By experiencing the water while crossing, the node here would like to emphasize the notion of adaptive living as the foreseeable future suggest unescapable flooding scenarios. Hence, regularizing boat transport. The accompanying measures also include rechanneling the river and transforming the vulnerable housing into flood-resilient social housing.

Legend

A	Protect bridge project
B	Pecinan recycling hub
C	Pecinan waste bank
D	erosion resistant plant
E	rejuvenated informal settlements
F	urban permaculture
G	Pecinan precinct



1. Build the 'Protect' connection as a participation node

2. To align with the meso phases, implement river purification actions and waste bank on the riverside.

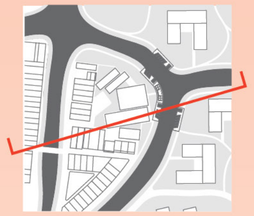
3. Temporarily relocate the vulnerable informal settlements

4. Rechannel the river

5. Rejuvenation of the Pecinan informal settlements by means of adaptive housing

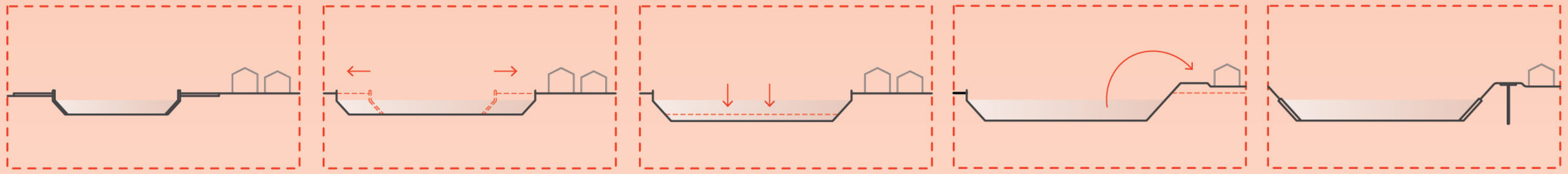
Map 28: transformation phases on the East side of Pecinan

Protect Node: *Proposed Section*



The section below shows the added value of the future Pecinan precinct where the water transport would be central and the informal settlements nearby are rejuvenated into adaptive housing through participatory planning.

mounding phases



1. normal state
2. expand width
3. dig deeper
4. mound to new island
5. dike revetments

Figure 74: mounding stages of Semarang River

water transport system

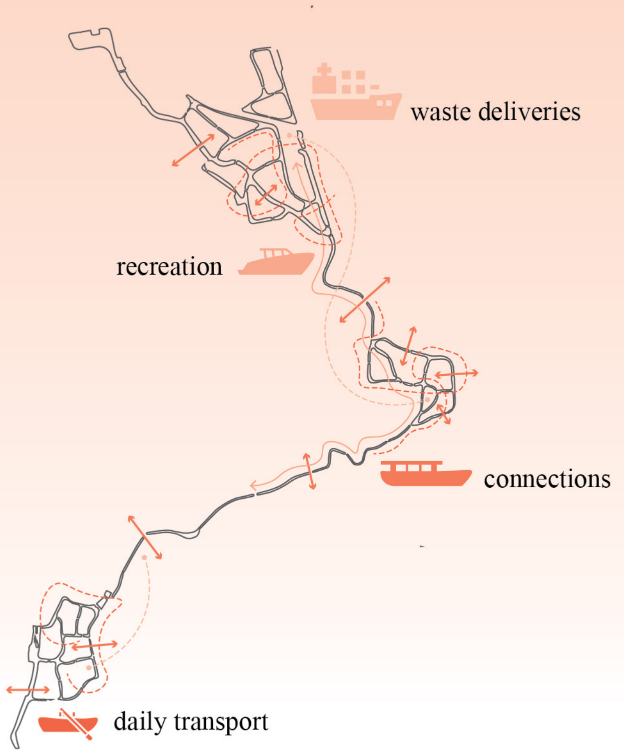


Figure 72: water transport routes within Semarang River

adaptive housing elements

raised ground level

light material

equipped water storage

multiple storeys to prevent overcrowding density

Figure 75: requirements of an adaptive housing settlements

sources:
Elemental Project, Alejandro Aravena -
https://www.dezeen.com/2016/01/13/key-projects-by-2016-pritzker-prize-laureate-alejandro-aravena-elemental/amp/
Baan Non Bua School, Junsekino Architect and Design -
https://www.archdaily.com/776074/baan-nong-bua-school-junsekino-architect-and-design

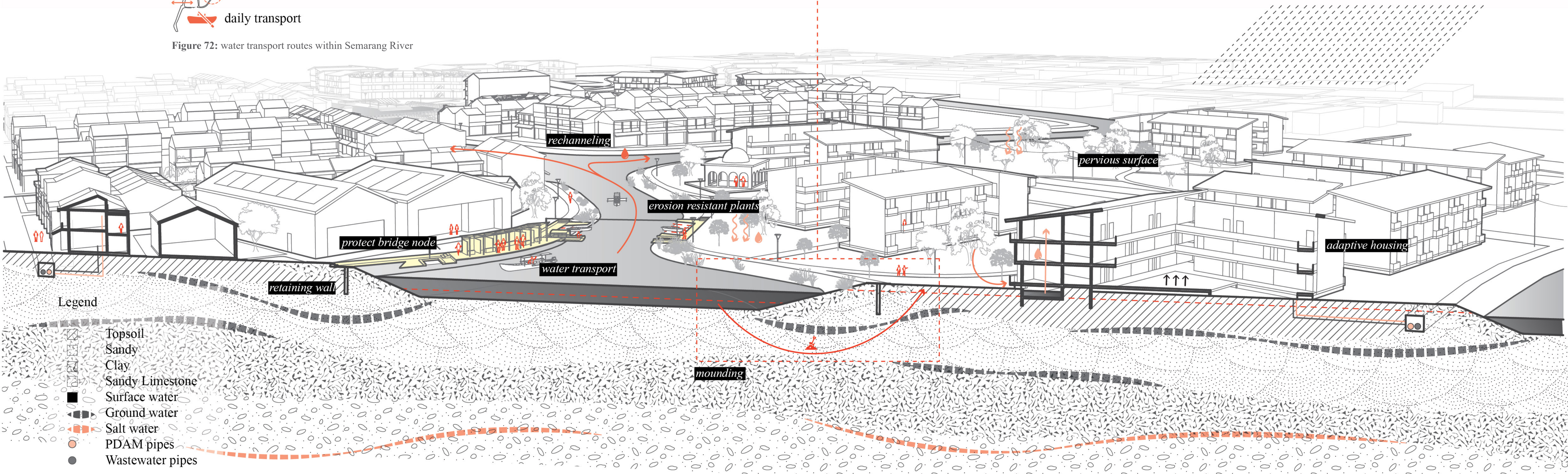


Figure 73: sections of the rejuvenated Pecinan informal settlements area

Protect Node: *Pecinan Island Corner*

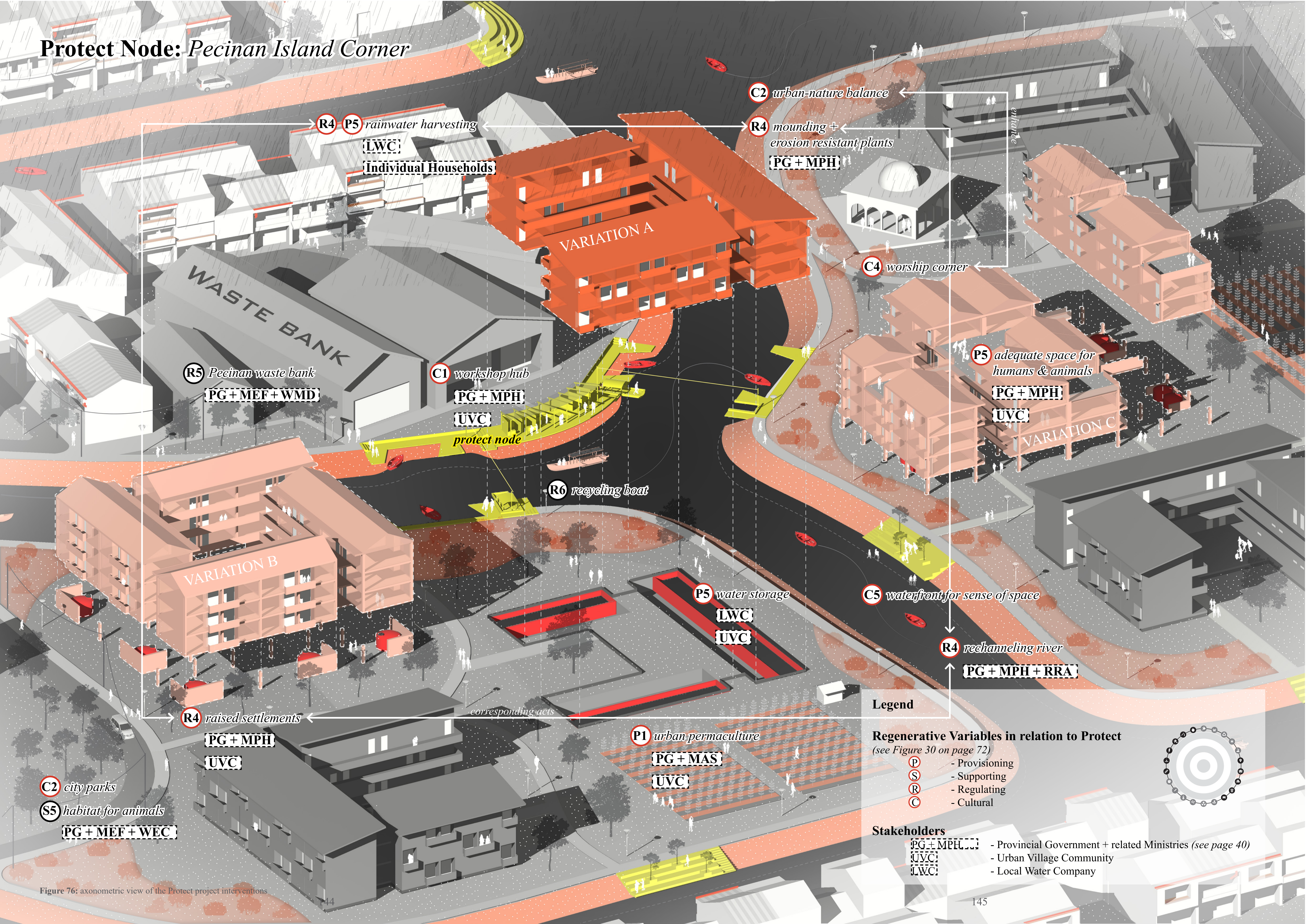


Figure 76: axonometric view of the Protect project interventions

Protect Node: *Street Views*

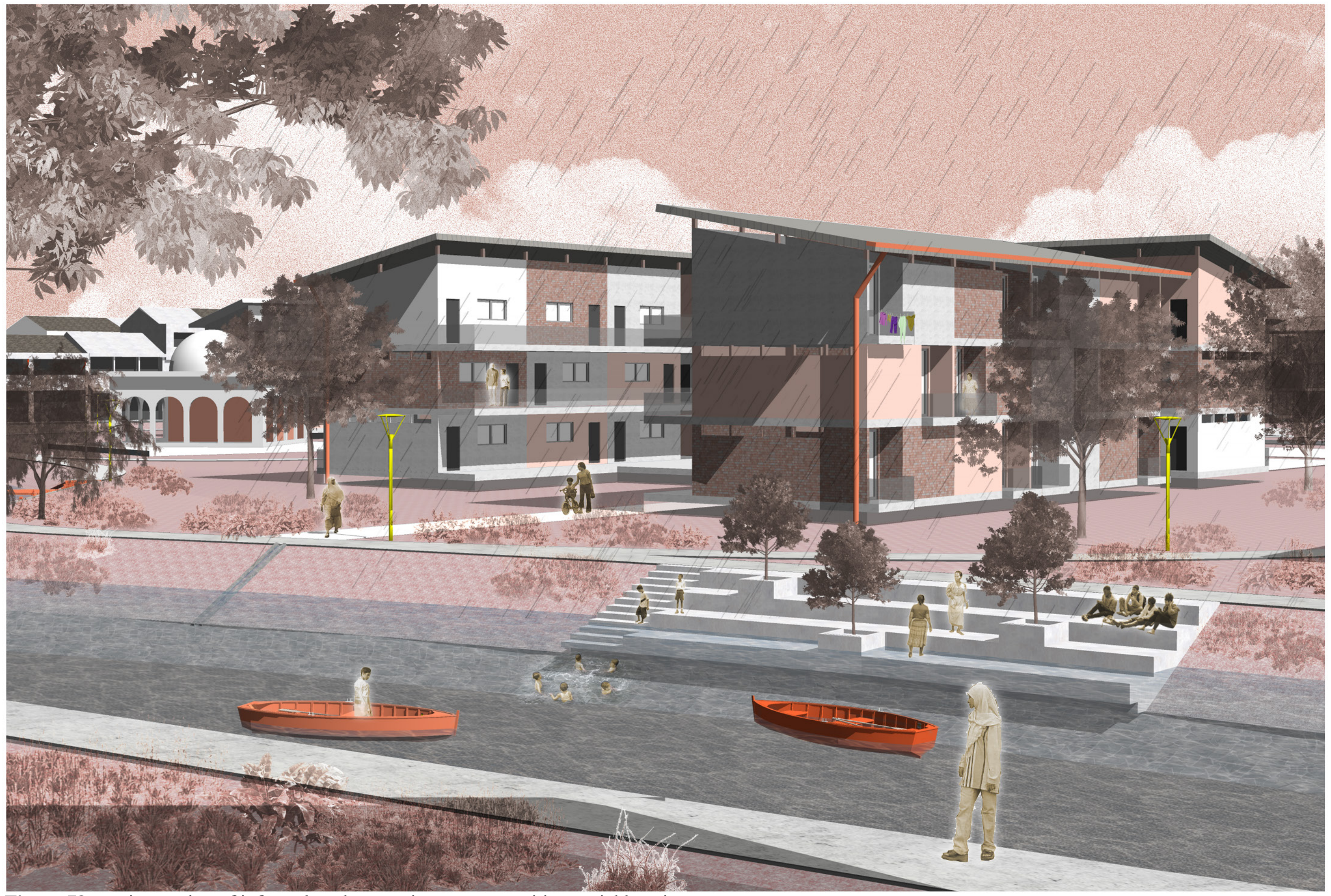


Figure 79: a rejuvenation of informal settlements into water sensitive social housing

The node triggers an interaction between the local citizens and the water body through water transport, preparing them to adjust with a water-sensitive way of living. The perspectives illustrate an example of rejuvenated social housing to which one dwelling could fit up to 50 family members or a community of one street neighborhood. It will not change the existing social clusters other than upgrading the household with flood preventive measures.

Figure 80: *Protect* node which promotes water transportation upon Semarang River

H. Provide:
D(e)-well Groundwater Extraction

i. Precedent Studies
ii. Zoom-in site Analysis
iii.The Purify Bridge and its Extended Measures

Discussion and Precedents

Water is often considered as a core spiritual element in many religious practices. With Semarang having a considerably ample amount of active worship places, some could potentially be a strategic location to integrate water as means of spiritual connections and supply of clean water. Semarang is known for its Great Mosque of Central Java, Blenduk Church in Kota Lama, as well as the city with the most temples in Indonesia. These landmarks in the city, if connected as a cultural recreation network, may also contribute to the bankability of the water storage implementation in worship places. Tay Kek Sie temple can initiate this movement on shifting people's habit from digging wells to cooperate on accessing worship site water storage.

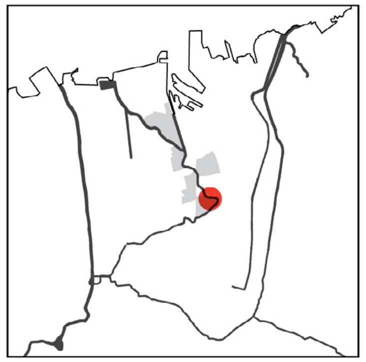
The provide project goes beyond supplying water but also designing urban food provisioning spaces. On the higher ground of Semarang, Kandri Village have been persistent in their aquaponic movement for the past 9 years (). This culture could carry on by riverside of Kali Semarang, as demonstrated by the Floating Fields project in Shen Zhen, China (fig xx).

Image 40: Water as a spiritual element at Al-Irsyad mosque, Bandung, Indonesia

Image 39: A villager's aquaponic set up

Image 38: Urban permaculture landscape by Thomas Chung in Shenzhen, China

Existing Condition



Worship sites are the centre of regular community gathering, especially when it is surrounded with a school and market. Hence, this strategic site serves as a potential to be able to nourish public benefits. The aerial drawing on the side shows that there has not been an effort to collect rainwater as an alternative clean water resource. The next question also poses: with the weekly culinary market on site, how far away is the footprint to the provisional goods? Because it is certainly not on the area.

Dominant Physical Features

A. Pecinan settlements
B. Semawis market
C. temple ornaments
D. impervious surfaces
E. informal settlements

Figure 81: collage of dominant physical features in North side of Pecinan

Daily Activities and Local Issues

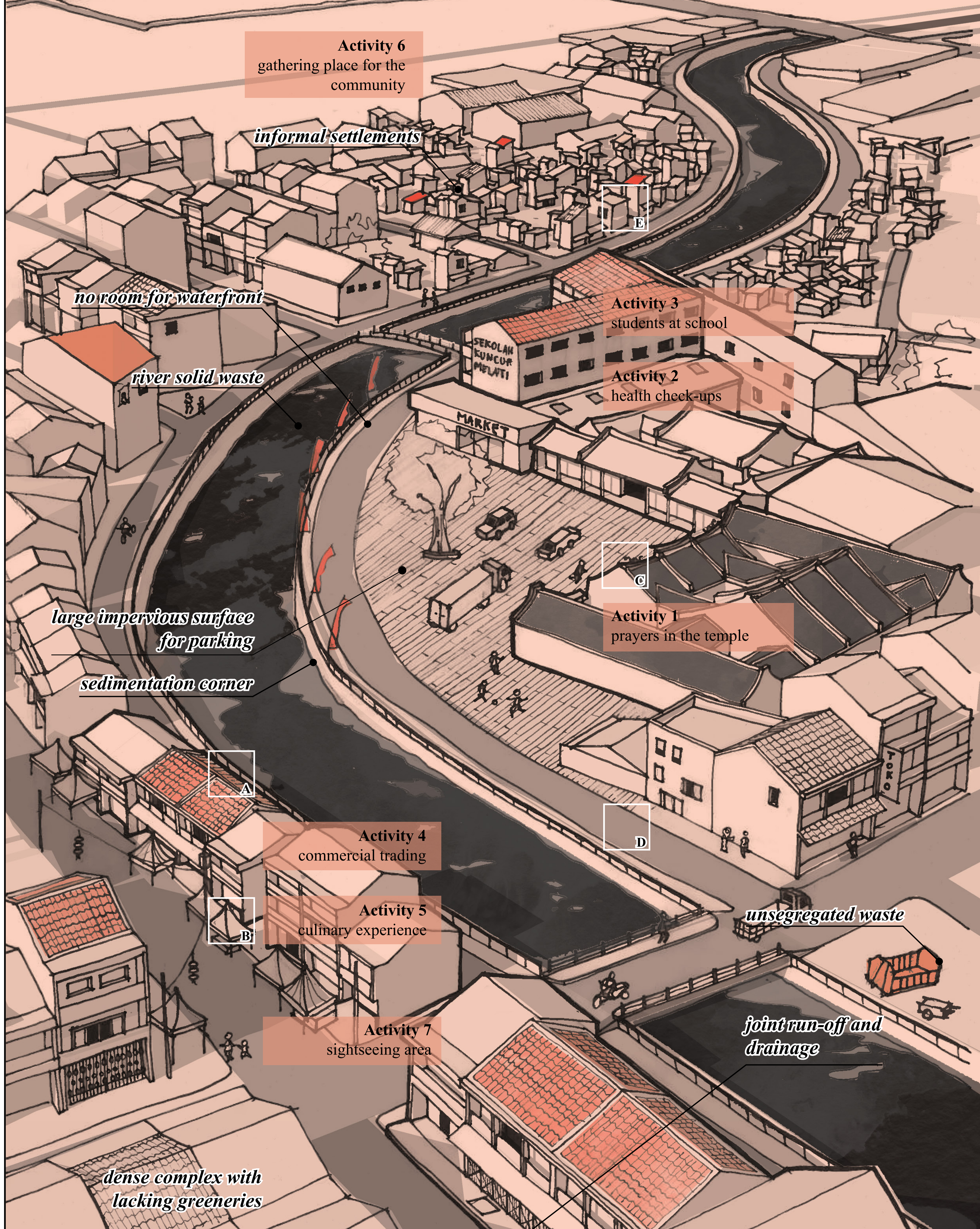


Figure 82: sketch of situation analysis in the North side of Pecinan

Existing Condition

Current Flows

At the moment, there is no on-site circular water system which means there are larger footprint for clean water delivery or channeling waste water. This would risk higher mismanagement in the context of the current governance system. Another one would be related with the issues on purify chapter: if people continue purchasing bottled water as drinking water source, this may heighten the pressure on controlling the solid waste management.

Site Coping Capacity

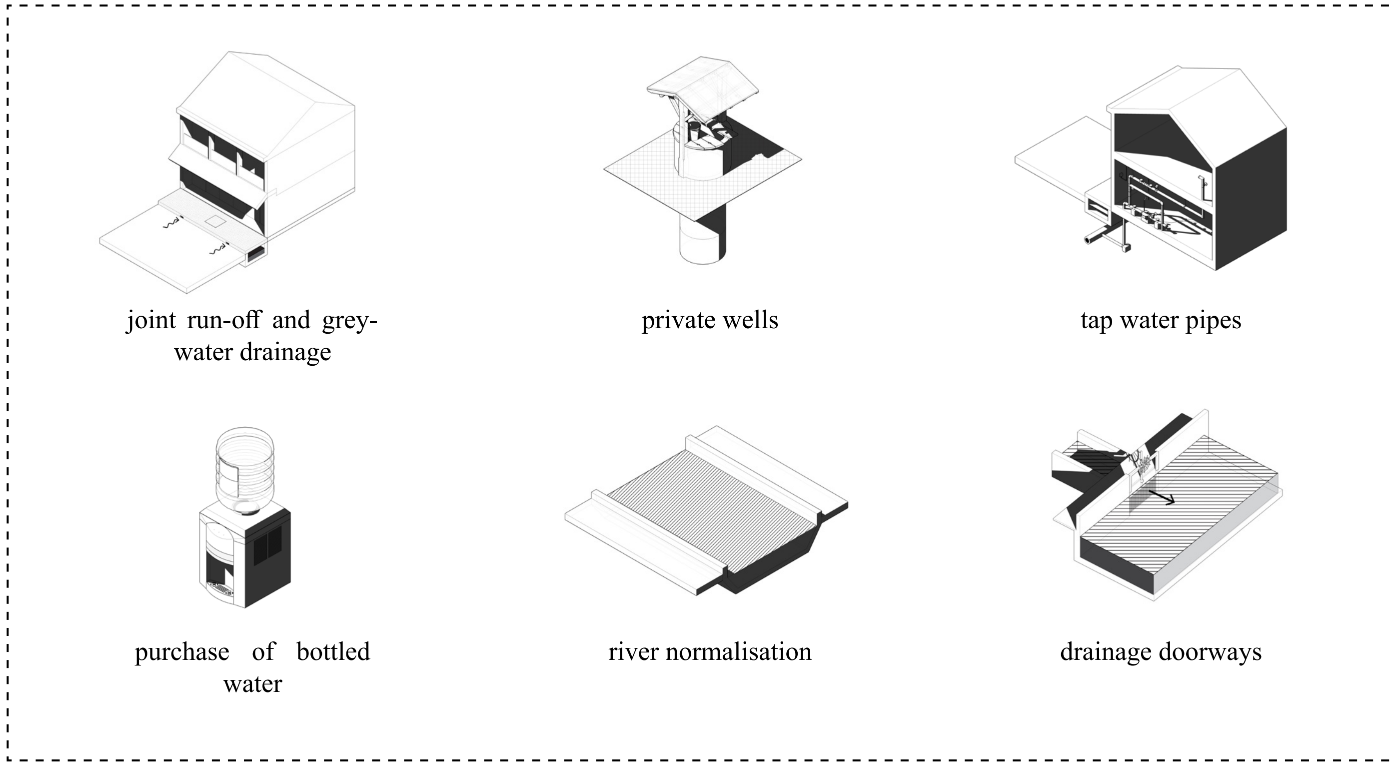


Figure 84: current local coping capacities around North side of Pecinan

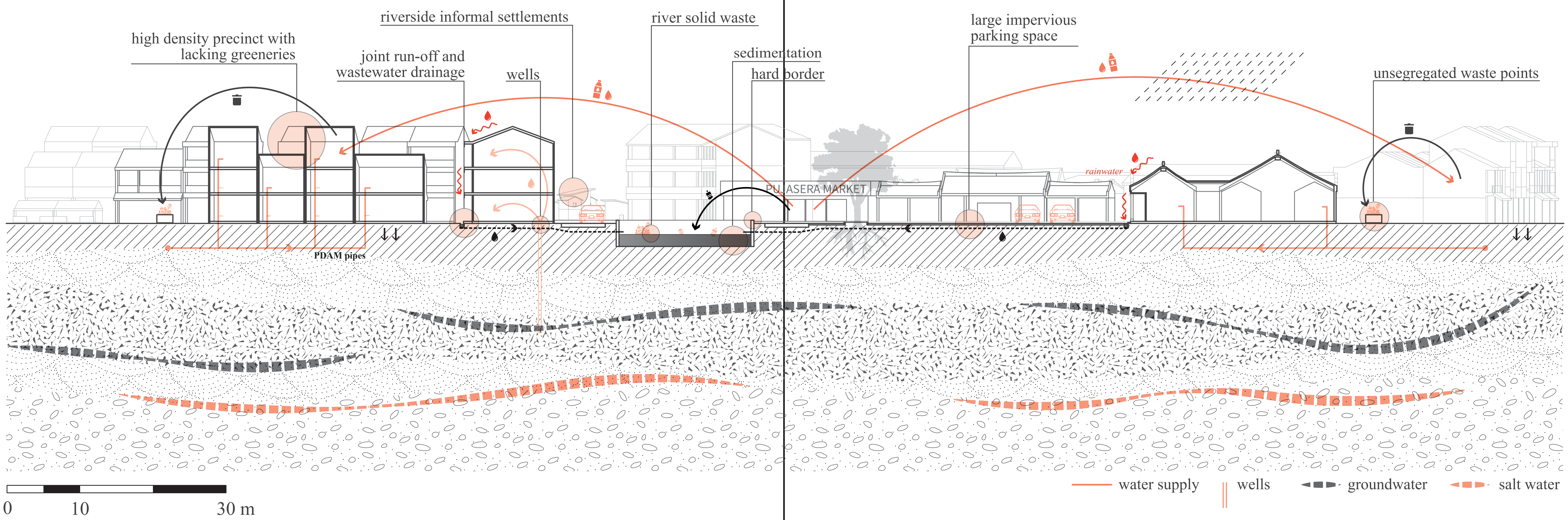
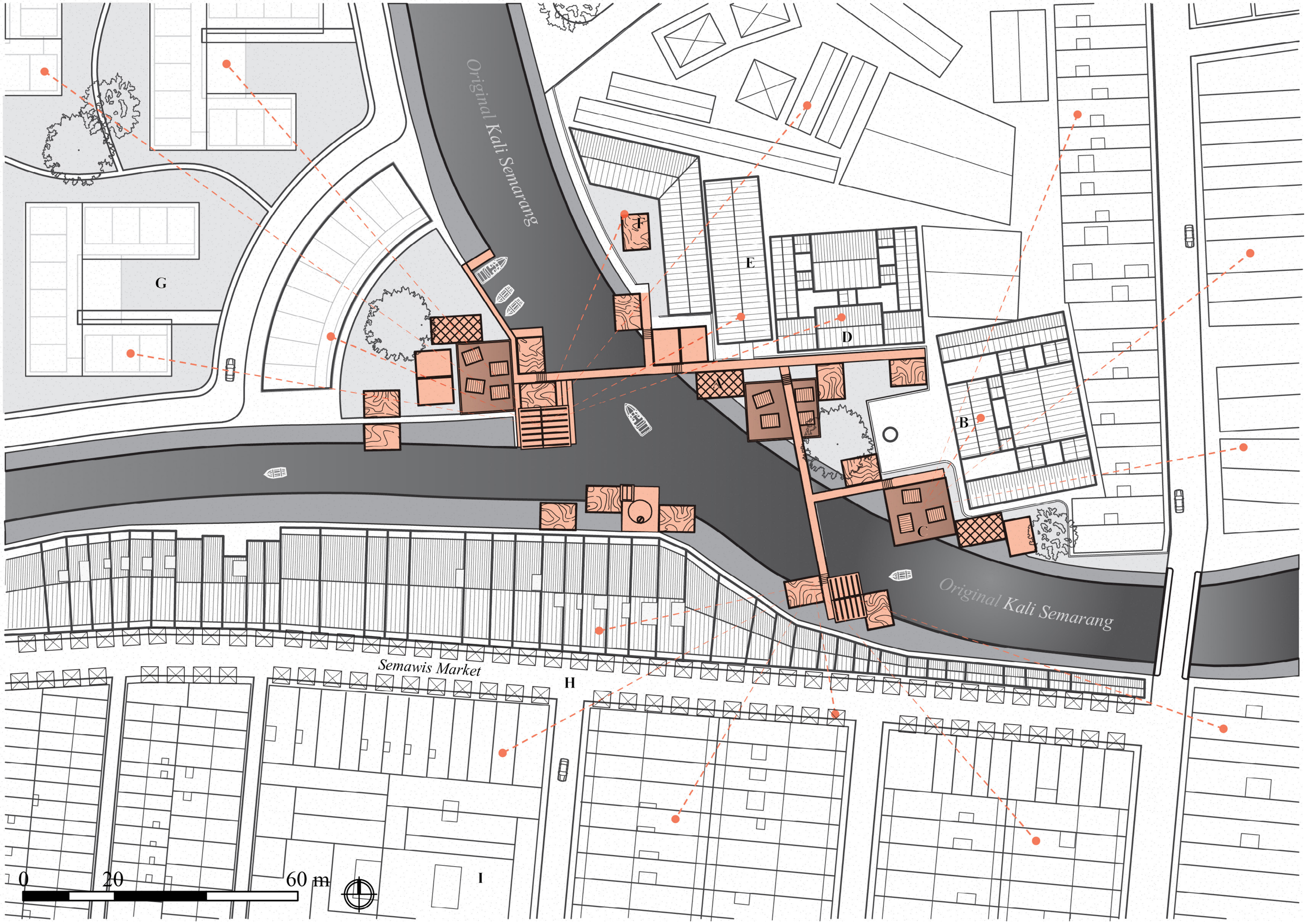


Figure 83: existing condition section at Provide site

Provide Node: *Plan and Phases*

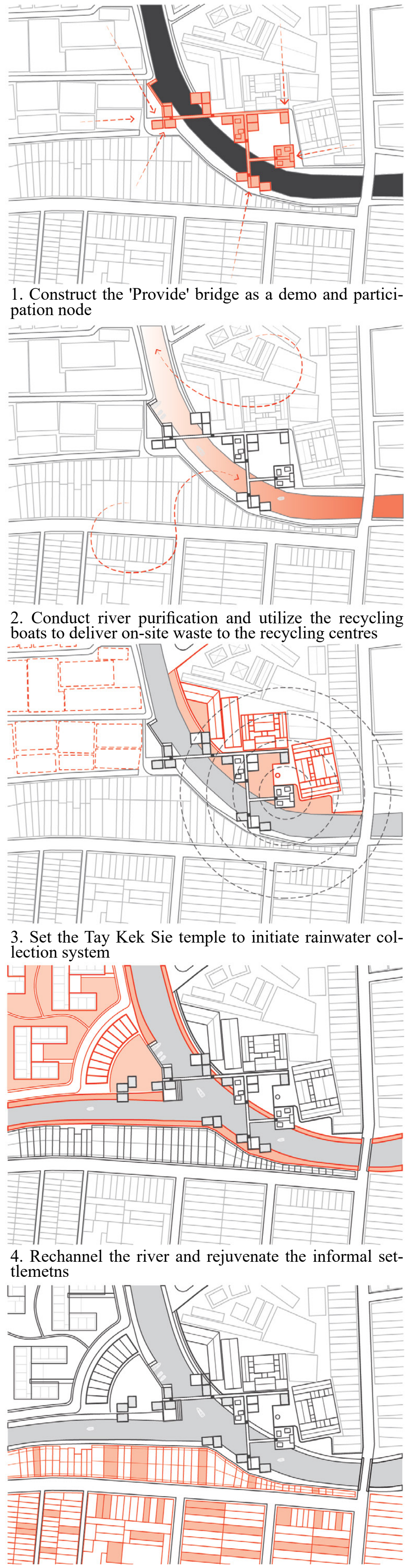


Map 29: proposed plan surrounding Pecinan Provde node

The node serves to promote regenerative provisional activities through urban permaculture and rainwater harvesting which enhances the existing on-site facilities such as the market, heritage temple, clinic, and the school--fabricating a common ground for all the attendees of the different places. This self-sustaining measures are brought above the Semarang River with the agenda to also increase the awareness of the water quality. In addition, the Pecinan houses which primarily back-facing the river should now have back-yard activites to enliven the river ecosystem.

Legend

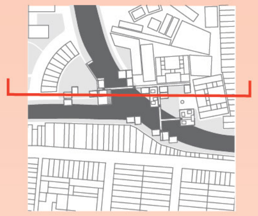
A	Provide bridge project
B	Tay Kek Sie temple
C	temple well
D	clinic
E	marketplace
F	school
G	rejuvenated informal settlements
H	weekly Semawis street market
I	Pecinan precinct



1. Construct the 'Provide' bridge as a demo and participation node
2. Conduct river purification and utilize the recycling boats to deliver on-site waste to the recycling centres
3. Set the Tay Kek Sie temple to initiate rainwater collection system
4. Rechannel the river and rejuvenate the informal settlemetns
5. Apply the rainwater collection system on the rest of the Pecinan houses

Map 30: transformation phases upon Tay Kek Sie temple

Provide Node: *Proposed Section*



Aside from introducing a new habit of urban permaculture, this extensive bridge hopes to drag the attention of the Pecinan community right to the river which encapsulates the precinct. This hopes to provoke the locals to take a better care of river water quality which flows beside the harvest plots.

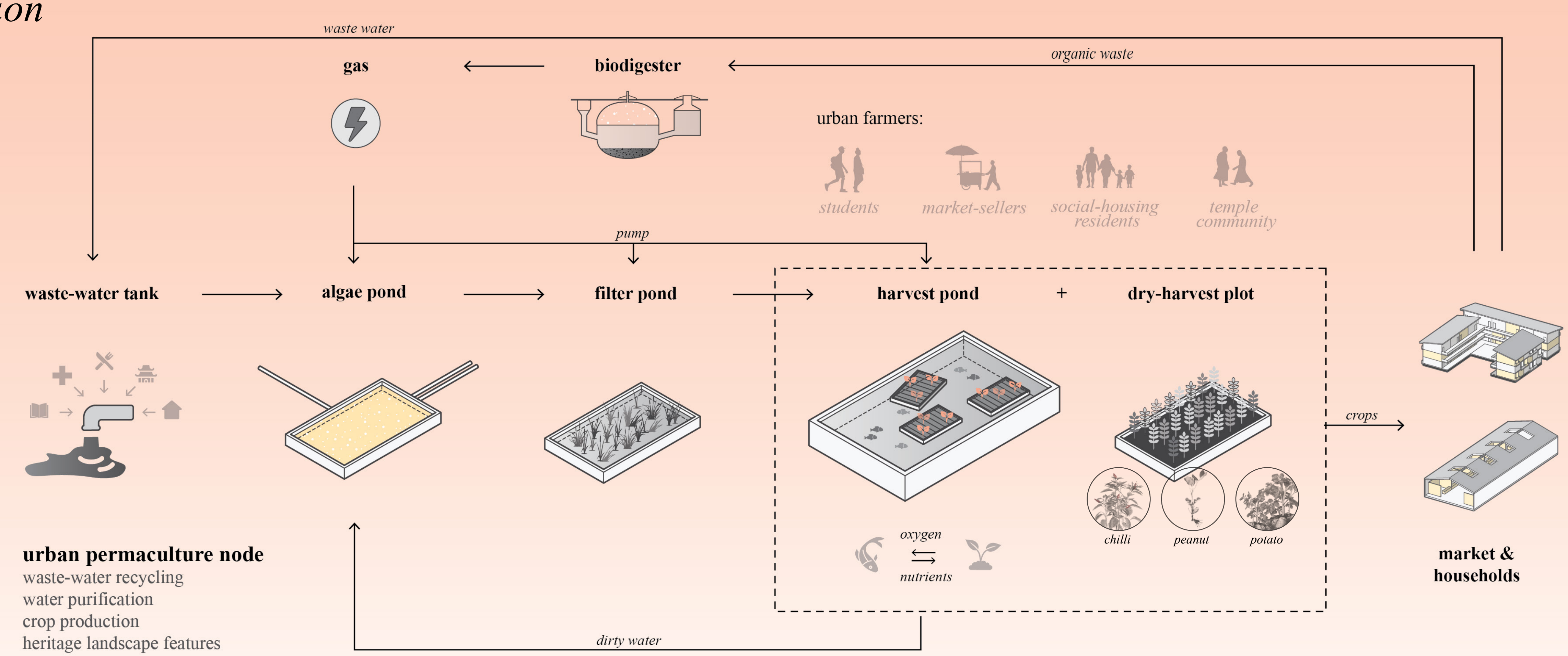


Figure 86: circular food provisioning supply at

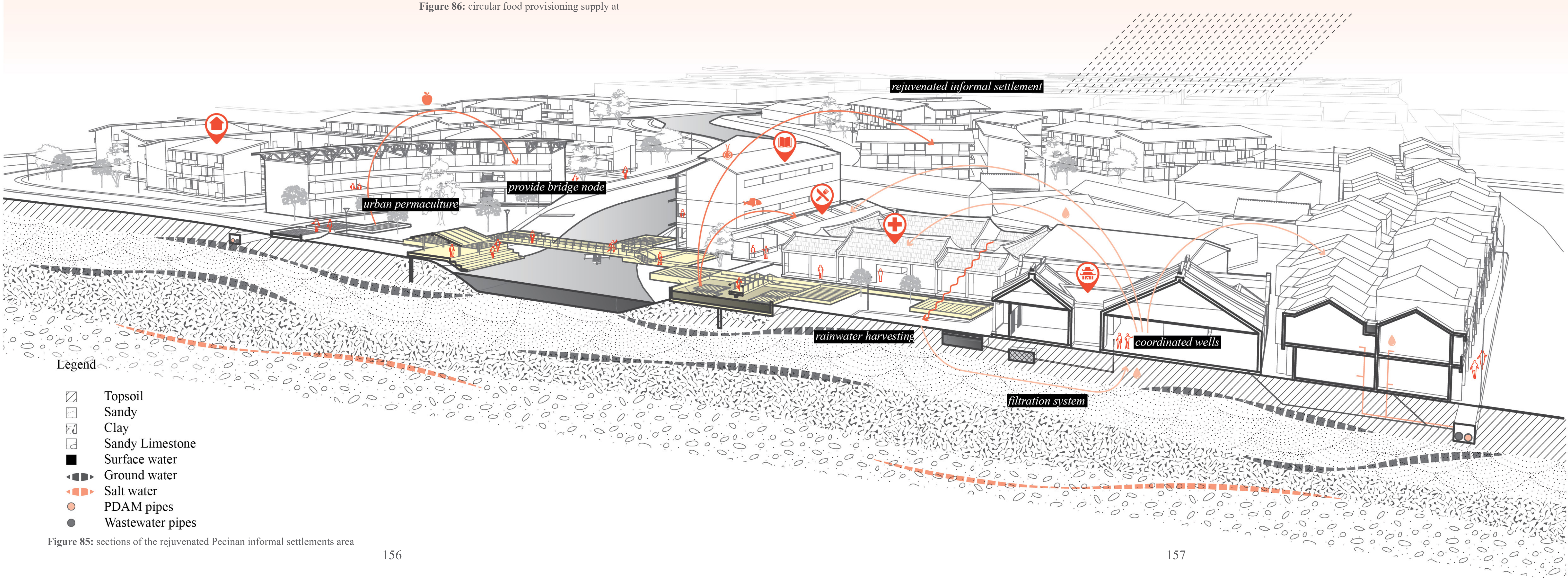


Figure 85: sections of the rejuvenated Pecinan informal settlements area

Provide Node: *Tay Kek Sie Harvestry*

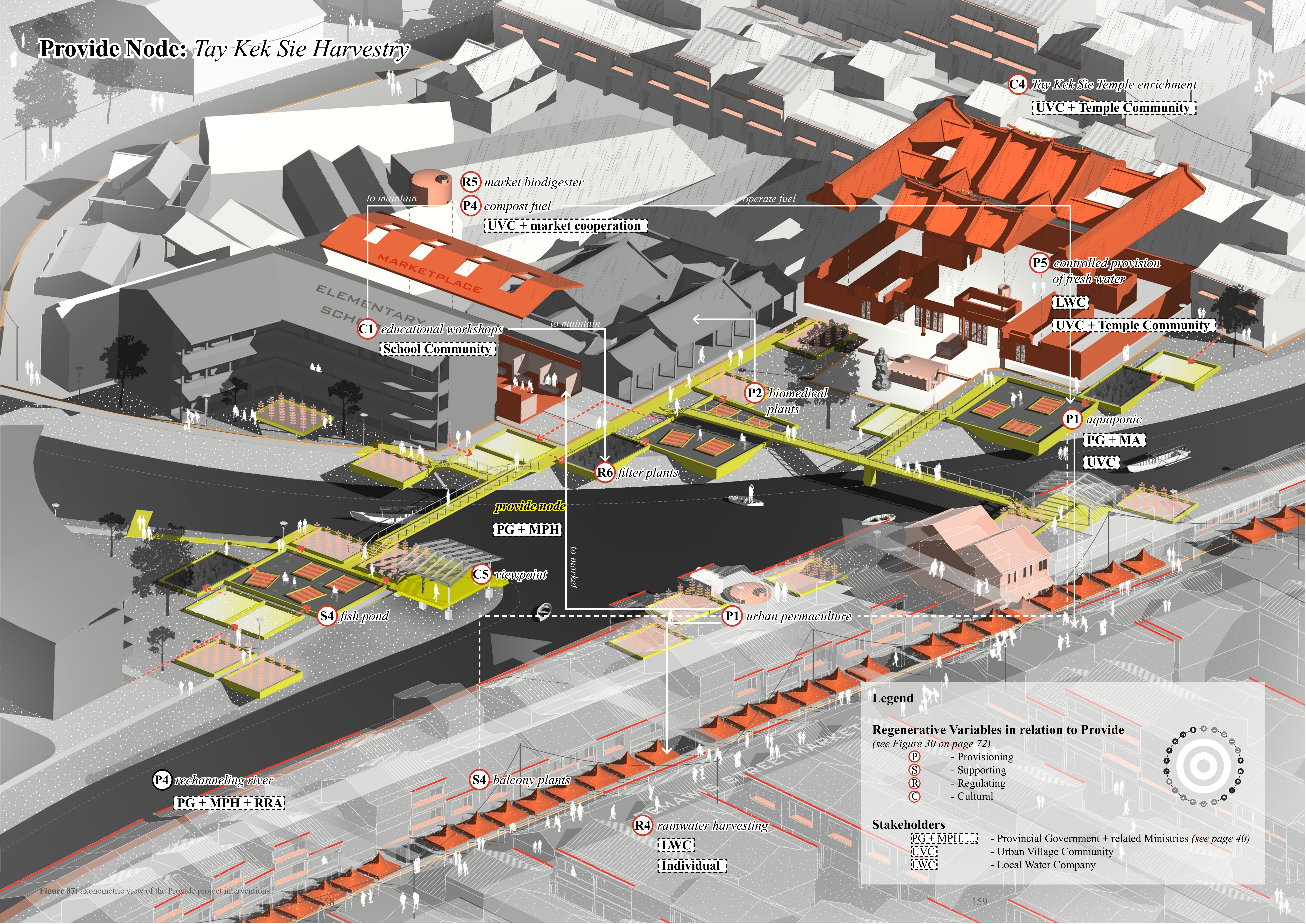


Figure 87: axonometric view of the Provide project interventions

Provide Node: *Street Views*

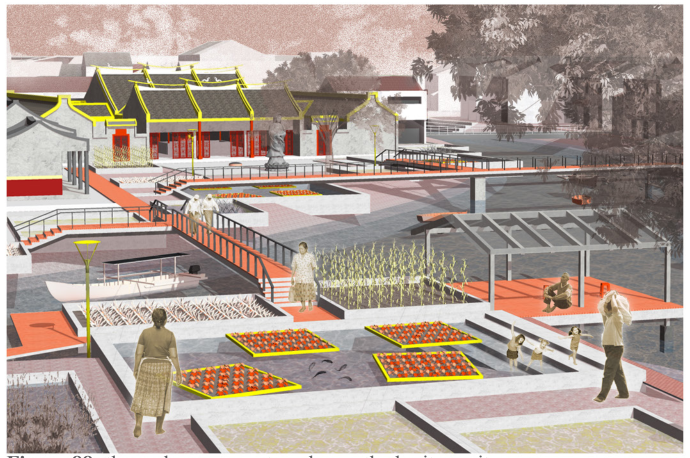


Figure 88: the node as means to enhance the heritage site

Figure 89: local community obtaining water inside the temple

Figure 90: attempts to green the Pecinan street

The set of perspectives aim to provoke the possibility of re-establishing the relationship between the Pecinan cultural elements to the Semarang river through the means of productive landscape infrastructure. Having the river highly accessible due to the project bridge and the soft river boundaries should stitch the river closer to the daily lives of Pecinan citizens--making it once again a crucial backbone that would be taken good care of.

Figure 91: urban permaculture landscape from the point of view of existing Pecinan houses which shall no longer treat the river as their backyards

Counting the Benefits

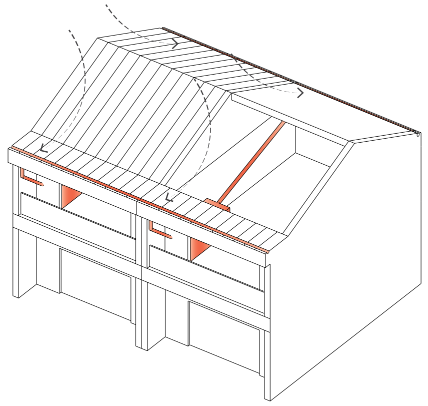
Surviving the Dry Season

The measurement on the rough benefits of having rainwater catchments installed at the households are demonstrated at the existing Pecinan precinct. This precinct is set to be an example due to its high density and the uniform dwelling roofs. Hence, the findings on this calculation could set the minimum bar of the water volume gained from the catchments--ensuring that it would certainly be sufficient for other areas. Bear in mind that this is the best scene scenario where all household installed the catchments.

In the case of droughts and access disruption from the PDAM...

Daily drinking water consumption	: **2 *l*/day**
Households in Pecinan	: **1589**
Residents in Pecinan	: **6078**
Recommended Rainwater Catchment Area /Household, /Temple*	: **2 m³, 5 m³**
Total Area	: **3178 m³**

*Fuchs et al., 2017



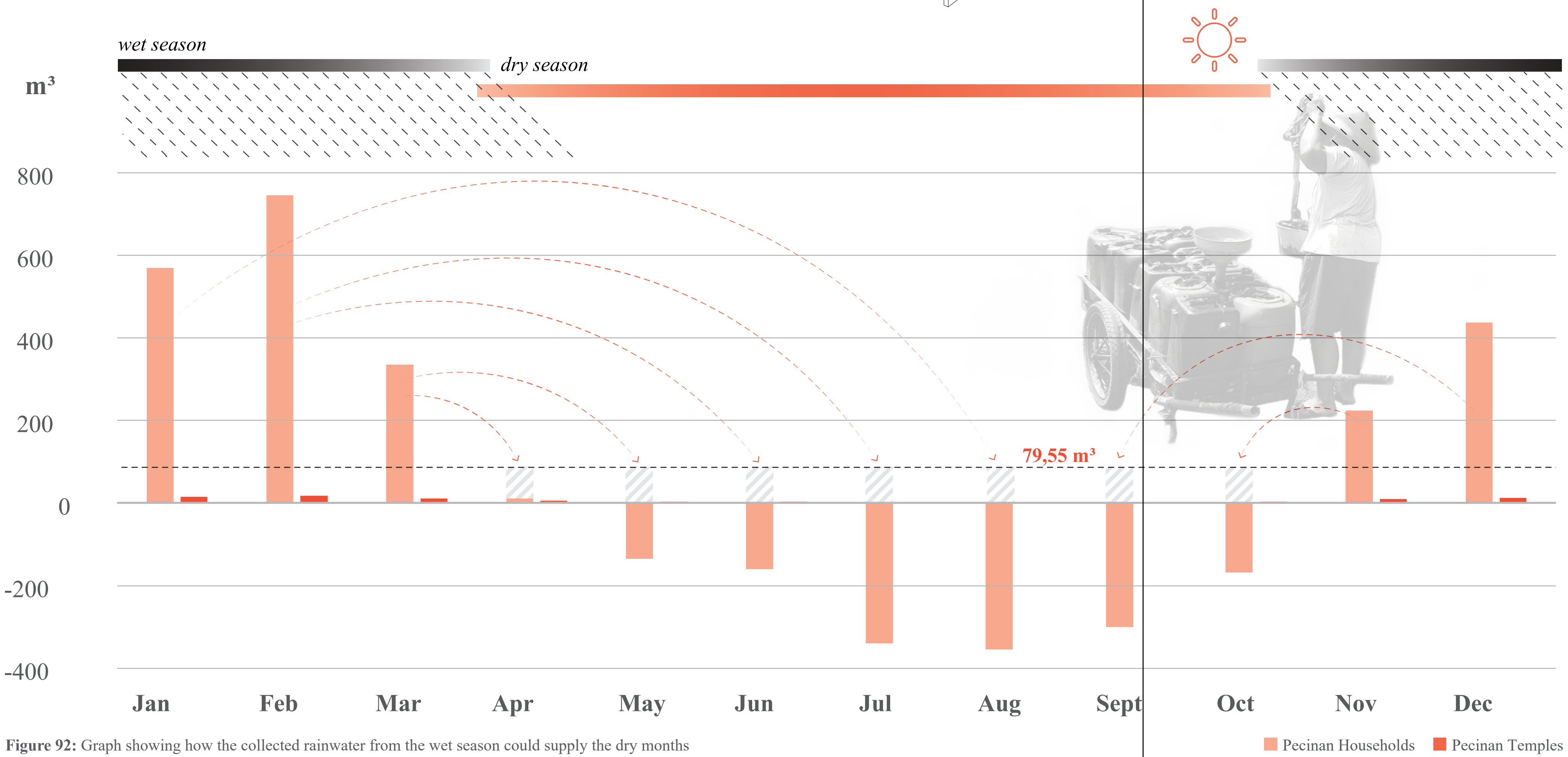


Figure 92: Graph showing how the collected rainwater from the wet season could supply the dry months

Calculations

Month	Precipitation (mm)	Collected (m³)		Efficiency	Consumed (m³)	End of Month Inventory (m³)	
		prec.(mm) x 3178 (m³)	prec.(mm) x 5 (m³) x 10 temples		$\frac{2(l) \times 6078p \times 365}{12}$		
January	348	1105,94	17,40	0,85	369,75	570,31	14,79
February	413	1312,51	20,65	0,85	369,75	745,89	17,55
March	261	829,46	13,05	0,85	369,75	335,29	11,09
April	141	448,10	7,05	0,85	369,75	11,14	6,00
May	87	276,49	4,35	0,85	369,75	-134,73	3,70
June	78	247,88	3,90	0,85	369,75	-159,04	3,32
July	11	34,96	0,55	0,85	369,75	-340,03	0,47
August	6	19,07	0,30	0,85	369,75	-353,54	0,26
September	26	82,63	1,30	0,85	369,75	-299,51	1,11
October	75	238,35	3,75	0,85	369,75	-167,15	3,19
November	220	699,16	11,00	0,85	369,75	224,54	9,35
December	299	950,22	14,95	0,85	369,75	437,94	12,71
						871,11	**83,51**

Figure 93: Calculations of harvested rainwater monthly after being reduced to daily consumption

+79,55 m³ / month

+++

What's the average benefit for each individual?

79,500l / 6078

Extra 13,10*l* / person / month

Other options to distribute the extra catchments!

Savings from mineral water bottle purchases:

2*l* Water: Rp. 5.000,-

Saves Rp. 1.825.000,- / year / person

I. Project Implementation and Feasibility

Allocating the Project to the Current Planning System

How does the planning works in Indonesia?

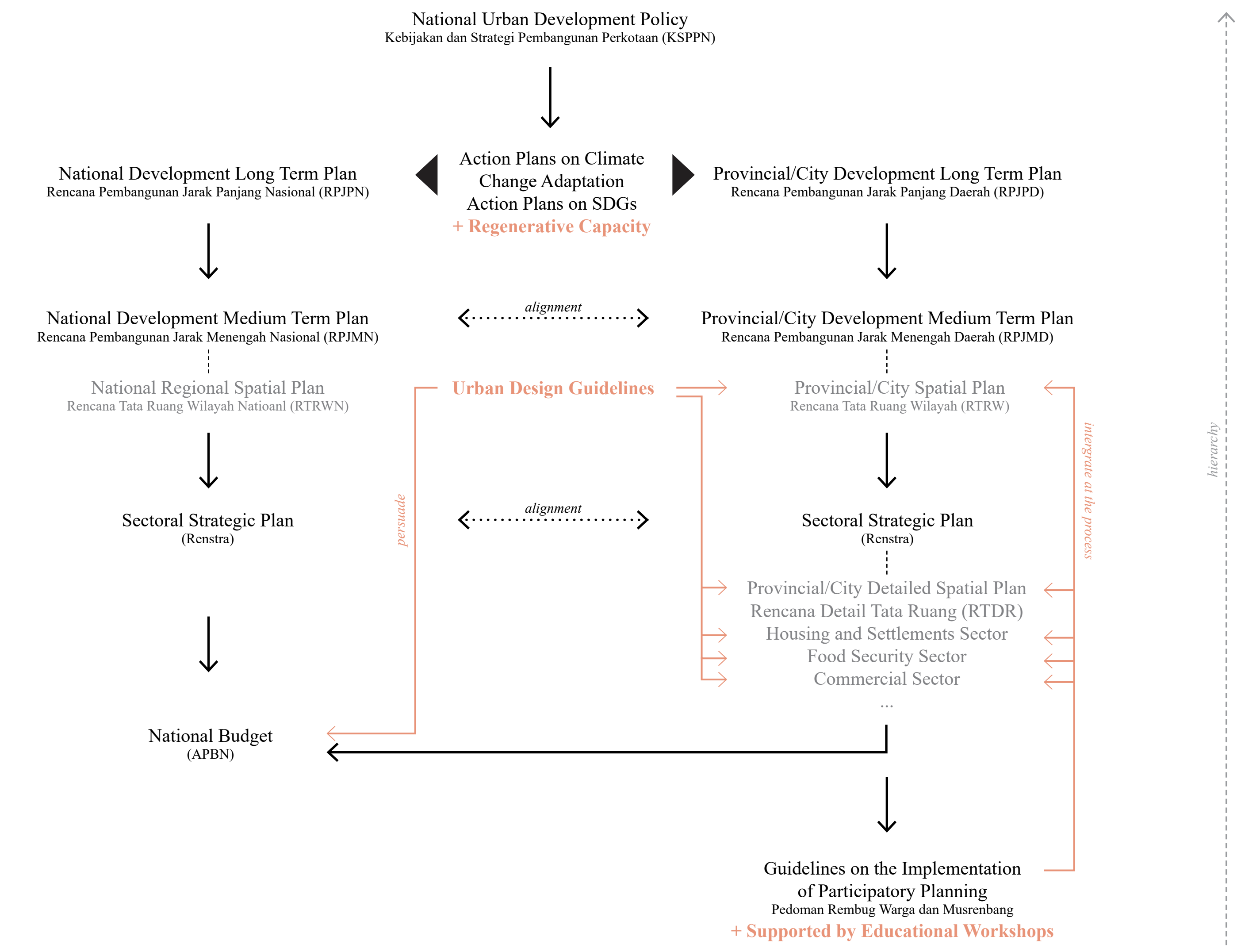


Figure 94: Simplified hierarchy of planning documents in Indonesia

It is undeniable that the planning guidelines in Indonesia are rather complex. This is due to the ample planning documents at the scale of both national and the city local levels. Moreover, the government also align itself with global agreements such as the Sustainable Development Goals (SDGs), New Urban Agenda (NUA), and Paris Agreement on Climate. Therefore, the vision may often come fragmented at the different stages of planning. The diagram above explains the simplified version of the planning scheme which are relevant to this project, as well as the tactics to situate this project into the relevant planning documents.

Aside from adjusting the planning orientation from mere 'Sustainability' to 'Regenerative', part of the goal of this project is to put extra weight on the voices of community. Hence it aims to have the bottom-up scheme to be as equally structured as the top-bottom planning. This would automatically raise the awareness of the contextual issues and climate hazards to the locals. The diagram on the next two pages will explain the step by step activities involved on the proposed participatory framework, followed by a timeline which map all the strategies in the order of execution priority. In addition, suggested regulations adhering to this project are being proposed to be integrated at the future planning documents.

Content Highlights on Local Participatory Planning

	Division of Roles	Construction of Project Nodes	Community Education	Participatory Exercise	Construction of Extended Measures	Conduct Duties	Local Benefits
Purify		MF MPH HCG UD	LP UNI NGO UVC LR	MNP MEF WMD PED UNI UD UNI UD UVC PC KT RA VCF LR	MF MEF WMD MAS SPD UD KT LR	MNP LP UVC LR	LR UVC
Protect		MF MPH HCG UD	LP UNI NGO NDM UVC LR	MNP MPH RRA MAS SPD UNI UD UNI UD DEV UVC PC KT RA VCF LR	MF MEF RPF MPH RRA MAS SPD UD DEV KT LR	MNP LP UVC LR	LR UVC
Provide		MF MPH HCG UD	LP UNI NGO LWC UVC LR	MNP MEM MA MEF WEC UNI UD UNI UD LWC UVC PC KT RA VCF LR	MF MEF WEC MA MAS SPD UD KT LR	MNP LP UVC LR	LR UVC

The flow highlights the events where there are strong engagements with the urban village community, whiile simultaneously showcasing how the stakeholders from the other layers could contribute to the participatory planning.

Central Government
Related ministries (see page 46)
MEF MNP EFP MAS CCC SPD WMD MPH WEC WRD RPF RRA PED MA MEM MF MHA

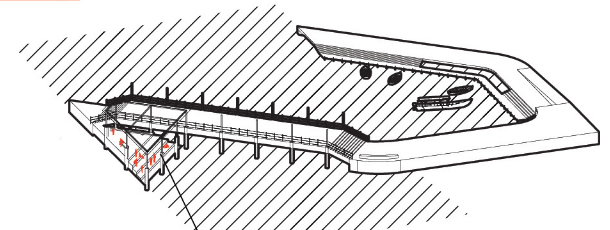
Provincial Government
MEF MNP EFP MAS CCC SPD WMD MPH WEC WRD RPF RRA PED MA MEM MF MHA
HPG head of provincial govt.
HCG head of city govt.
LP community empowerment
DPR people representative council

Private Institutions
GIA geospatial info agency
NDM disaster management
LWC local water company
NGO non-govt organisation
HOS hospital
DEV developers
UNI university
UD urban designers

Urban Village Community (RT/RW)
UVC urban village committee
RA religious assemblies
KT karang taruna — youth organisation
PC posyandu cadre — health clinics
VCF village children forum

Individual
LR local residents

Purify

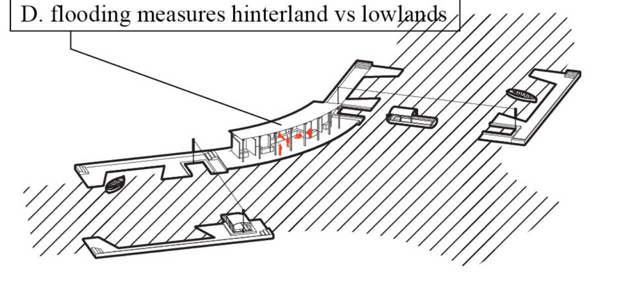


A. source of river pollutants
B. recycled craftmanship
C. decentralized waste system

Protect

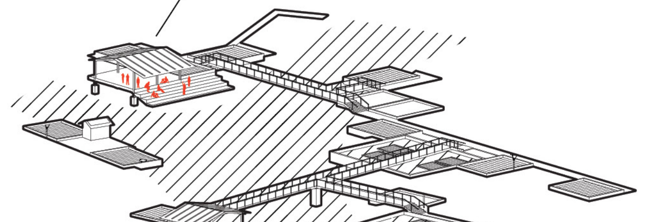
A. climate change
B. sea level rise
C. construction techniques for relocation site
D. flooding measures hinterland vs lowlands

engage further



Provide

A. the threat of digging wells
B. alternative water access
C. circular permaculture system



Participatory Exercise Toolkit

Understanding Household Metabolism

Reduce ⟶ *Manage* ⟶ *Recycle*

bring own... bag, container, bottle — segregate — composting
recycle to...
deliver to waste bank
buy organic packaging — re-use — packaging, clothes

Resilient Neighborhood Toolkit

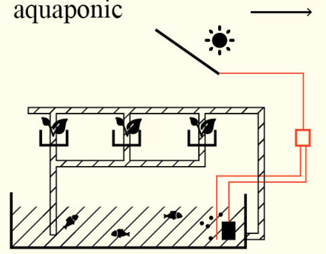
1. raised dwellings — on-stilts / mounding / amphibuous
2. light material — light steel / wooden / cor. polycarbonat
3. multiple storeys — average context height + highest on-site
4. biodiversity interaction — access to river / plant balconies
5. cultural needs — common terrace / playground / *warung*
6. rainwater harvesting — upper roof / underground / open tank

Urban Permaculture Toolkit

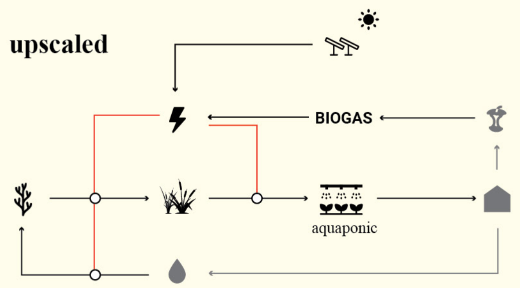
Food Provisioning — permaculture / aquaculture

Water Provisioning

Alternative Innovation
aquaponic

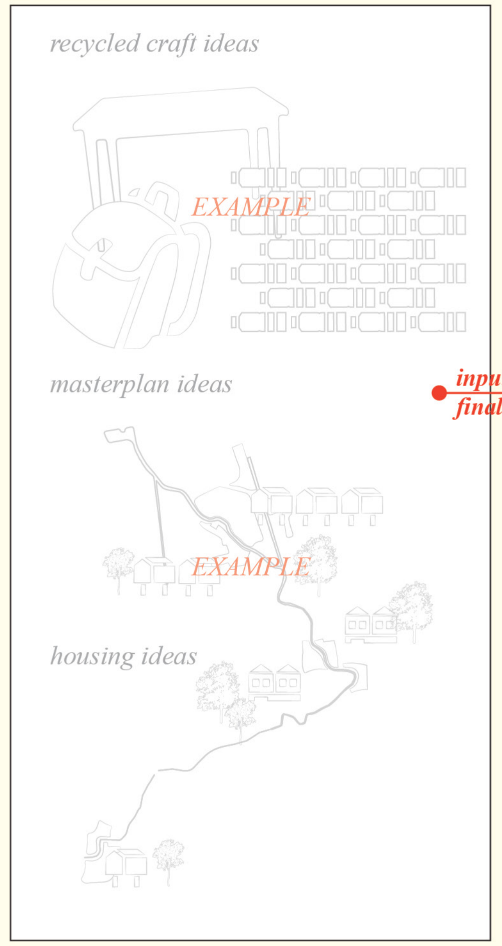


upscaled



added value: circulate waste water + organic waste

Sketches



input & finalize

waste bank
recycling industries
filtration parks
separate run-off and waste water

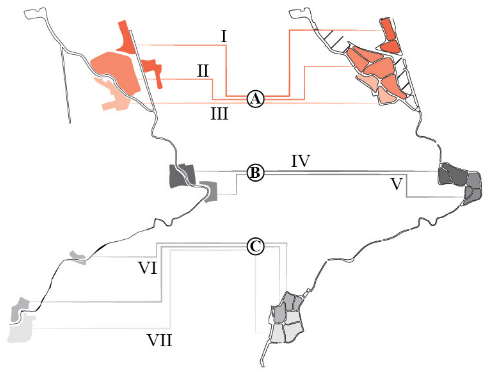
weekly citizens duty

M	in-house waste segregation*
T	paper waste pick-up
W	organic waste pick-up
T	monthly control gathering
F	recycling labour training
S	waste bank collection**
S	craftmanship workshop***

* everyday
** for other types of waste
*** optional

drainage revitalisation
build temporary & new housings
rechanneling the city
compound & city parks

temporary relocation procedure



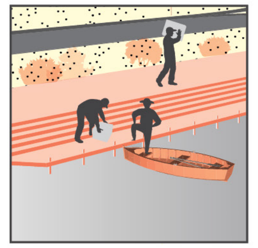
apply rainwater harvesting at existing houses
allocating urban permaculture landuse

alternative water supply

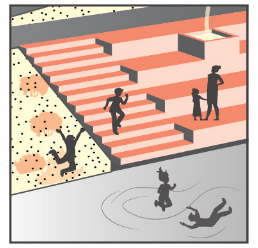
November - April	May - October
170-250l/day @ 2m³ tank	10-90l/day @ 2m³ tank
self rain water harvesting	extra weekly collection at community centre / worship centres

*more measures om strategy chapter

infrastructure maintenance by locals

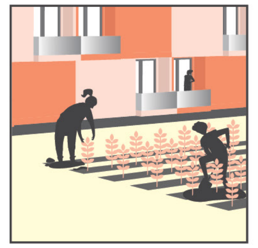


job vacancy



hygienic environment

better shelter and living quality

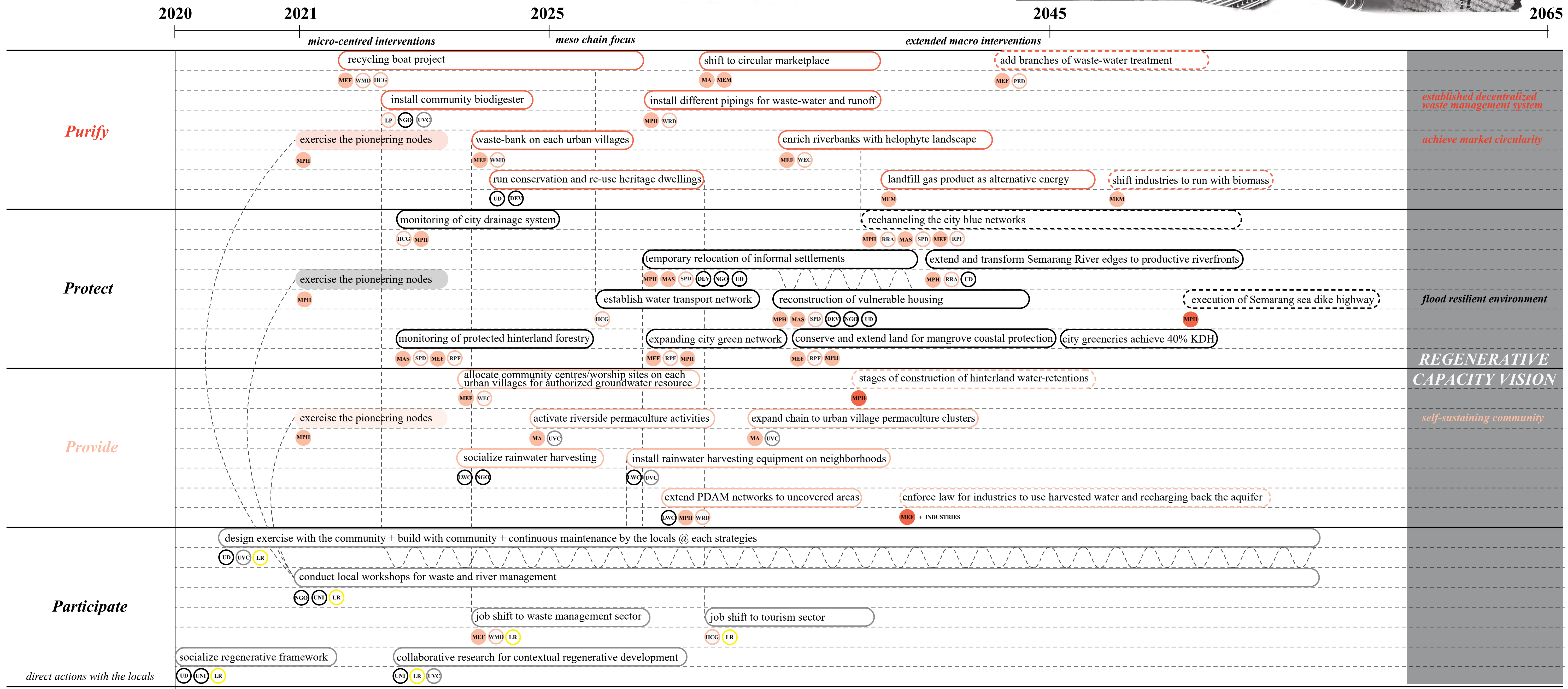


lower carbon footprints

saves long-term expenditure

Figure 95: Participatory planning flow chart on how to achieve the designated strategies with the local communitoes

Flush and Splash Actions Timeline



Planning Regulation and Policy (Suggested Focus)

RPJPD 2006-2025

proposal preparation

UD

thorough cost-benefit analysis for strategies

MF

RPJMD 2021-2025

strengthen and fund research sector for regenerative development
regenerative capacity assessment must be conducted for projects

@ RTRW (Spatial Planning)
allocate zoning for waste banks
allocate zoning for riverside permaculture
allocate zoning for protected hinterland forestry
allocate zoning of vulnerable settlements

RPJPD 2026-2045

manage coorporate social responsibility to conduct research and funding towards regenerative development
strengthen policies upon circular waste management: bio-degradable packaging, community fines, operate waste banks
planning guidelines on temporary relocation and housing rejuvenation
planning guidelines for a reduced ecological footprints of food and water consumption

RPJMD 2026-2030

allocate maintenance duty for infrastructure within the Urban Village

@ RTRW
informal settlements rejuvenation planning

RPJMD 2031-2035

regenerative assessment mid-evaluation I

@ RTRW
extended river networks expand zoning for mangrove forest

RPJMD 2036-2040

@ RTRW
review the necessity and plan extensive hinterland water retentions

RPJMD 2041-2045

regenerative assessment evaluation I

@ RTRW
review the necessity for sea dike planning

RPJPD 2046-2065

review regenerative assessment evaluation and conduct adjustment
exercise laws for renewable energy source
strive for the standards of World Heritage Nomination (align with https://whc.unesco.org/en/hul/)

RPJMD 2046-2050

emphasize maintenance planning of urban water infrastructures

RPJMD 2051-2055

regenerative assessment mid-evaluation II

allow shift focus to tourism planning

RPJMD 2056-2060

plan the network for other alternative renewable energies (e.g: hydraulic energy)

RPJMD 2061-2065

regenerative assessment evaluation II

Yearly Guidelines on the Implementation of Community Participatory Planning; *see previous page*

Rencana Pembangunan Jarak Panjang Daerah (RPJPD) - Long Term Development Planning of Semarang City

Rencana Pembangunan Jarak Menengah Daerah (RPJMD) - Medium Term Development Planning of Semarang City

Figure 96: Flush and Splash Project Timeline

J. Conclusion

Conclusion

Problem

Based on the analysis chapter and site visit, the main problems of Semarang are land subsidence, flooding, and low water quality--as well as poor urban water management. Although all of these problems have water as the common element, the main problem seem to have rooted elsewhere. As seen on page 30 of the report, the weight on the site vulnerabilities and the non-reciprocal coping capacities seem to amplify the water-related risks. The lack of awareness on the causes of these hazards, the insufficient financial support from the authority, and the current measures which separate the relationship between the natural and the cultural element are the key factors to the disproportionate equation. Hence, the thesis would like to explore the theories on how to establish closer relationship between the human activities and the ecosystem services so that both may work together to tackle Semarang's degrading environment.

Guiding Theory

Referring back to page 26, the conceptual framework of this thesis uses **risk = (hazard x vulnerability) / coping capacity** as the theoritical backbone. This framework further alters the coping capacity into **regenerative capacity** so that the measures contain added benefits. Instead of mere hard infrastructures, the regenerative capacity observes the theory of **landscape infrastructure** to mitigate the hazards. To ensure that these landscape infrastructures perform regenerative manners, they first need to be assessed through the variables of **ecosystem services** and **socio-ecological resilience**. This answers the main research question of **[A x B = C + D]** in this thesis (See page 32). As shown by the assessment framework of page 70, any landscape infrastructure must observe whether they have embedded any (a) provisioning, (b) regulating, (c) supporting, or (d) cultural aspects of the ecosystem services whilst at the same time looking at whether the different layers of stakeholders have the (i) historical knowledge, (ii) accessibility, (iii) means of communication, and (iv) the ability to act on the project in order to come up with a regenerative set of spatial measures.

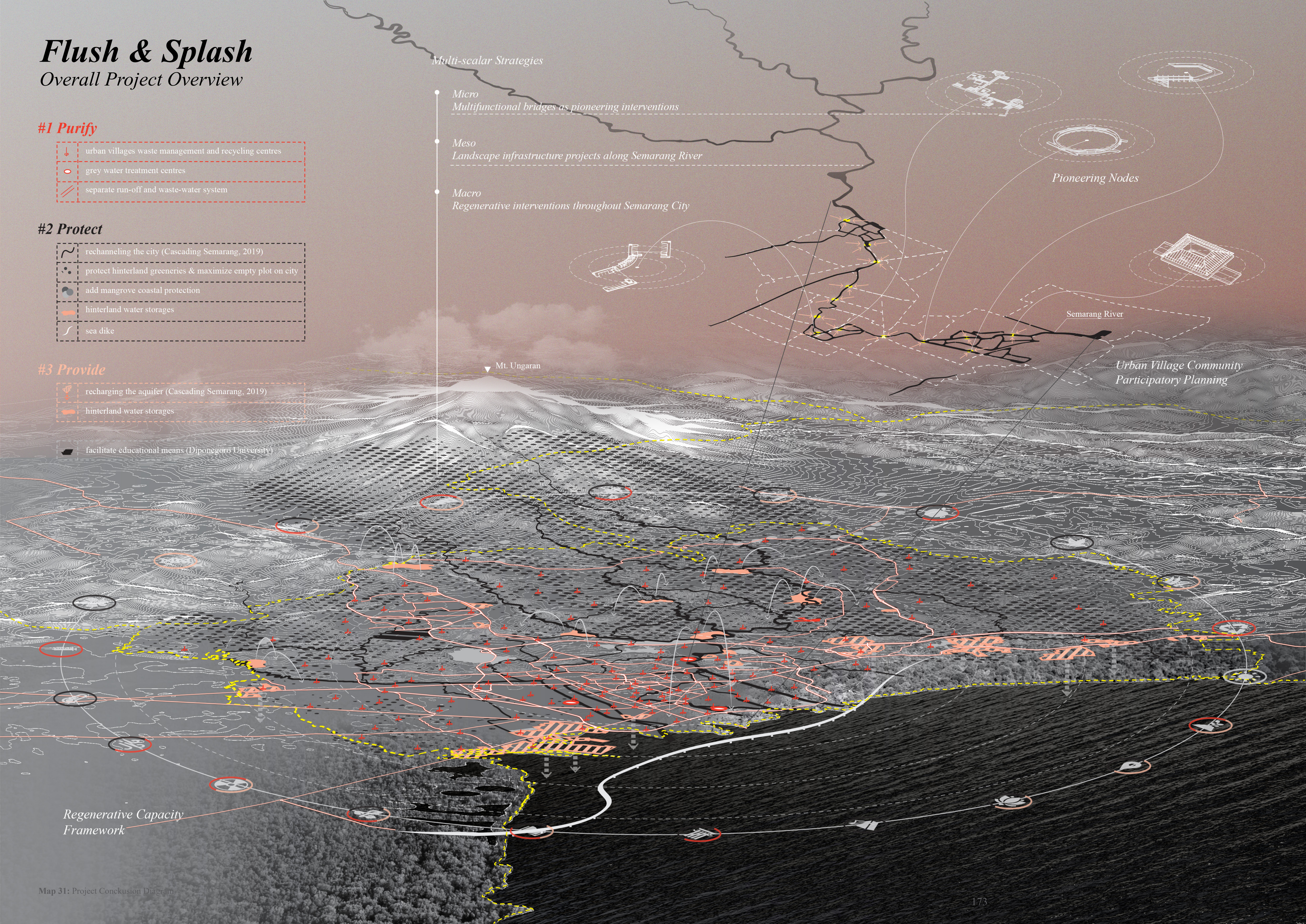
Design Approach

The implementation consists of having the three landscape infrastructure projects, which are *Purify* (waste management), *Protect* (nature-based flood defenses), and *Provide* (alternative water resources) being derived into multiple intervention strategies across the different urban design layers and scales within the city (see pages 82, 86, and 90), answering both the sub-research questions of **[A x B]** and **[C + D]**. At the micro scale, a series of multifunctional bridges act as the pioneering intervention to demonstrate the *Purify, Protect, and Provide* strategies to the community along the Semarang River. After the awareness is heightened, then the other necessary micro interventions of ecosystem biomimicry as shown on page 128, page 144, and page 158 could follow. This answers the sub research question **[A - C].**

Eventually, it is a healthy environment, safe, and self-sustaining community that we want; and it is during the process of making the strategies of each project that I realize they all need to be seen collectively as one big project: ***Flush and Splash***. It is impossible to separate the three since, for instance, to implement a *Protect* strategy of housing on stilts, the surface water must first achieve a good quality for people to live above it. It is later formulated that, given the current conditions, the three have an order of priority. It begins with stragegies of *Purify*, so the following measures could deal with uncontaminated water. Next would be the strategies of Protect, as reducing potential hazards would help secure the continuity of the citizens' activities. Until then would the *Provide* project be suitable to take place. Certainly some of this would overlap, as seen on the timeline map (see Figure 96 on page 168), and that many of the earlier measures, such as the waste bank clusters, would need to be kept running. The separation of the projects to different chapters were intended to highlight each specific measures, although in reality, the three projects tend to hybrid spatially.

Flush & Splash

Overall Project Overview



Map 31: Project Conckusion Diagram

Towards Implementation

Indeed, the rendered products of this thesis aim to be rather persuasive by imagining the bold possibilities of successing multiple strategies. However, the listed strategies were not intended to be executed all at once. They are there to provide all possible options which would go through a set of discussions with the community as well as cost-benefit analysis to see which are deemed most feasible.

The implementation begins by associating the actors as to how can various social layers contribute to the regeneration of ecosystem services. By utilizing the variables of Socio-Ecological Resilience, this thesis explores what actions can the highest government institutions down to the individual level could do, (see Figure 49 on page 98). This would be the answer tothe sub-research question **[B - D].** Hence, the plan continues by denoting what the local community could do, as shown by the diagram on page 158, since growing a sense of belonging and awareness to the projects are the most urgent to implement. Most of this participatory exercise would be conducted at the series of bridges. After several occasions, only then the extended measures would follow which would require a group of professional stakeholders to implement. The timeline on page 168 shows which of these strategies, considering their scale and cost, would be primarily executed. All these would complete the answer for sub-research question **[B - C].** For every 10 years, the project proposes that the city need to assess its public infrastructure with the regenerative capacity variables in order to maintain the ecosystem services in the built environment; and for every 20 years, the credibility of the assessment framework itself needs to be reviewed.

Limitations and Futher Studies

Due to time contraints and financial limitations, a second trip was not able to be conducted yet. Whereas this could have been a potential survey to exercise a participatory planning to obtain a more contextual design preferences. It is also due to the limited data, which would be discussed on the next section, that the research and design of the project weights heavier on qualitative approach. A more quantitative approach to formulate the feasibility is needed for the next step.

To also test its replicability, it would be necessary to observe other areas which are not along the route of Kali Semarang that are exposed to similar risks. A series of unexpected variables such global economic crisis due to pandemic, local conflicts, natural disasaters, or having the central fundings altered to construction of new capital, might change the course of planning over time. This have emphasized a question on the robustness of the current proposed planning, which would require a further research on alternative planning scenarios.

Reflection

Image 41: Bouwkunde Building, TU Delft

First year of masters' track Urbanism at the BK faculty have taught us the art of designing for a cause through coherent stages of methodology: defining problem, mapping analysis, research question and the research itself, to forming a theoretical framework and conceptual framework. Circular economy and spatial justice have always since then been the accompanying principles throughout the design journey. These two lines of thoughts open up perspectives from other domains of study on what could potentially affect the problem or take part as a solution.

Coming from Indonesia, seeing the cross-domain Shared Heritage Lab (SHL) having a project in Semarang, Indonesia sparks a personal interest due to the familiar context. Adjacent to that, the chosen Transitional Territories (TT) studio was brought by the my personal interest on the urban relationship with water, the alarming climate change issues, and the adaptive resilience approach which are highly discussed in the studio. Finding the balance on what to focus by being on the two studios were slightly challenging as most of the TT colleagues dealt with climate issues in the North Sea, which are not always translatable to Indonesian context. The other case was also that most SHL members dealt with the urban fabric of the post-colonial dwellings. Merging the two, the thesis would focus on reconnecting the natural heritage of Semarang River to the city's cultural heritage, which is now removed due to the degraded river ecosystem. Reflecting with the other studios of Urbanism track, if this thesis were to be explored otherwise, it could have the approach of:
CC – cases of informal developments in the global south. It really indicates the complexity of a complex city where a spatial problem is derived from the problem of another domain: socio-economy and governance.
UM – understanding to what extent an act of circularity has been performed throughout the city and to what extent can we improve it; especially within the flow of water and the management of waste which currently affects the contaminated water quality.
HH – by learning from the historical fabric of the city, we could ask ourselves: how can heritage help? One could also discover that a strategy that was made in the past might probably be the best solution at today's time.
UF – investigate the optimum building typology, land-use configurations, and city structures within a designated time frame to plot the rapid urbanization in a developing country.

Thesis Challenges

In the light of finishing the project, there were certainly some valleys of lacking inspirations or missing dataset. Having no established single portal of data in the project country, the research would result to different content / GIS data / images upon different sources. Beginning the studio in a collective manner, we eventually agreed to select our list of the most reliable sources for each topic. Often the cases were outdated datas and the lack precision of the city's urban fabric in GIS, as they are not updated yearly. Hence, we might have used data from five years ago and combined it with the assumptions from google earth and individual drone shots during the site visit. This often cause the final drawings to not look as the intended outcome as the maps might lack of intricate details like the city parcels, river borders, or building geometry. However, finishing the thesis in the year of 2020, we consider ouselves lucky to have done the site visit at the beginning of the graduation year, prior to many travel ban due to the COVID-19. The following challenge includes the ministry planning strategy documents which have very few traces of visual documentation. This often caused me to have a hard time imagining the current measures spatially. On the other hand, language was not a barrier as it is the author's native site, but to translate some sources were essential for our collective studio research.

Content Generalisation

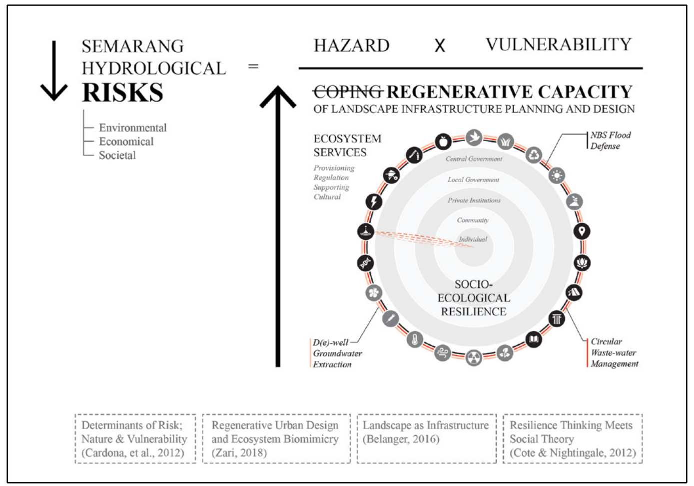


Figure 97: Conceptual framework re-cap by author

As understood, the project is based on combining the planning theories of *Regenerative Urban Design and Ecosystem Biomimicry* (Zari, 2018) and *Socio-ecological Resilience* (Cote & Nightingale, 2012). Upon speaking about the possibility to generalise the research outcome, it would make most sense for the conceptual framework: as all individuals across the world has their part on interacting with the natural ecosystem. Moving on to the implementation, the nature of urbanism and architecture projects have always been contextual. If this was to be exemplary in terms of the strategies--it would only be to coastal cities with a close proximity to mountaneous region. This would call on other Indonesian cities or other archipelago countries that would deal with similar hazards.

The participatory planning approach, however, would be more specific to developing countries as it also involves local workshops to introduce the site hazards and project ideas to vulnerable community that barely completed the minimum education. Hence, it is also a task of adjusting their habits for the better. Lastly, for the micro design project (as seen on page 104 of the report), the idea of the integrated bridge typology could generally be applied to other river networks--although the assigned function would depend on the site requirements. Overall, the replicability varied amongst the different stage of the project.

Scientific Relevance

The limits to the research and development of flood risk management in Semarang is the lack of data, financial support, and the weak governance which causes delay in the progress. Many papers have discussed holistic and nature-based flood risk measures, but rarely with the entangled complexities of a developing country. Although met with unknown challenges, it begins by deriving itself from past theories of hydrological risks, ecosystem services approaches, socio-ecological resilience, combined with the regenerative design principles where it is wished to cover the financial gap of the developing country issues. This thesis would contribute to the scientific researches by reviewing and dissecting the relevant variables of the mentioned theories, and eventually introduces the term 'regenerative capacity' to fit the context of Semarang.

The advantages of the proposed methodology is that it has allowed the author to be aware that our daily consumption and activities are either sourced, aided, or inspired by the natural ecosystem--and it is the responsibility of all stakeholders, regardless their position, to take part on balancing the equation before the hazards dominate the risks. The chosen methodology categorizes the natural ecosystem into multiscalar process and environmental layers which help specify the actions needed to be taken to mitigate the problems. However, the methodology appears to have limited flexibility; as in lacking scenario options, phases, or order of priority--which are only formulated later during the design stages. Unfortunately, it also barely discusses about other accelerating variables such as population rise and densification.

Societal Relevance

Image 42: Aerial view of Kota Lama precinct from Pecinan

In the context of Semarang, not only that the rising sea level is a threat, the water quality issues also hinders the desire for people to live alongside the surface water. This was not the case in the past. Hence, the Shared Heritage approach to revisit old archives are essential to observe the traditional ways to sync with the natural situation in order to adapt with the hazards. As the current problematic sites also tend to deal with economic vulnerability, the challenge here is not only to soften the boundaries between land and water, but to also make it be feasible for the citizens to implement it. The thesis will make use of the strong bonding amongst the community of Indonesian street neighborhood (RT/RW). Therefore the project includes participatory planning stages with the local community to formulate purification measures, protection measures, as well as provisioning measures in order to meet the rights of both people and nature equally. Some of these strategies include job vacancy, clean water supply, and local food production which aid the vulnerable group with monetary income. The proposed measures hereby align with the UN Sustainable Development Goals which seeks equal access and opportunities to every individual. This is very important especially at times like the 2020 COVID-19 pandemic where sufficient sanitation are crucial for all citizens. Aside from water-related challenges, what is relevant for the Semarang citizens is to look at the potentials of conserving the Old Town. As keeping a beautiful legacy is sustainable: it allows people to re-use the heritage dwellings and therefore not wasting our nature resources.

Ethical Dillemas

The early challenge was that the author(s) that would be primarily involved in this planning project have limited time for site visit and therefore a limited understanding on the nature of the local citizens and governance. The admittance of the variables used in the methodological framework was also rooted to the author's synthesis of the site observation. This may unintentionally lead to a socially biased perspective. Speaking of this, the core of the problematization seems to lie on the mindset of people in terms of sanitary, urgency, and collaboration. Awareness and education need to be heightened and it is beyond the scope of this paper.

A control over rapid informal urbanization also require a strong intervention from then government which often attack people from the vulnerable group. This is a huge ethical problem itself as the poor people are left with no choice in a developing country. Relocation plans have always been a controversy in Indonesia. This is because the people relocated tend to lose more than gaining. For instance, they would no longer live with their community, the new housing did not come with free maintenance, and it became further from their source of income. These bring us back to the country's financial limitations and it had triggered certain dilemmas to this project, as some relocations need to take place in order to develop better natural systems. A more comprehensive strategy was then to engage the locals to plan altogether--and to as much as possible rejuvenate the existing site rather than moving it away. It is also that in the process of aligning the thesis with the existing planning in the country, I discovered how ample and complex the documents are. Hence, there are many simplifications to currate which planning documents really matters to the project and which is not--putting the risk of skipping a certain strategies that has been drafted.

Image 43: Local logistics at Pecinan precinct

With that being said, most renders in this thesis indicate the best scene scenario of the strategy implementations. This sparks another dillema where the designs might seem too ambitions. However, the idea behaves in such a way that with a 100% given, the implementation of the project could be reduced to 40%. Whereas if the design begins realistically on 40%, it might be even more reduced to 10% due to entangled birocracy. In the end, it is unargueably that everyone wants to live in a healthy environment with minimal risk, and it is the responsibility of this project to convince the possibility of the occurence.

Reflection Chart

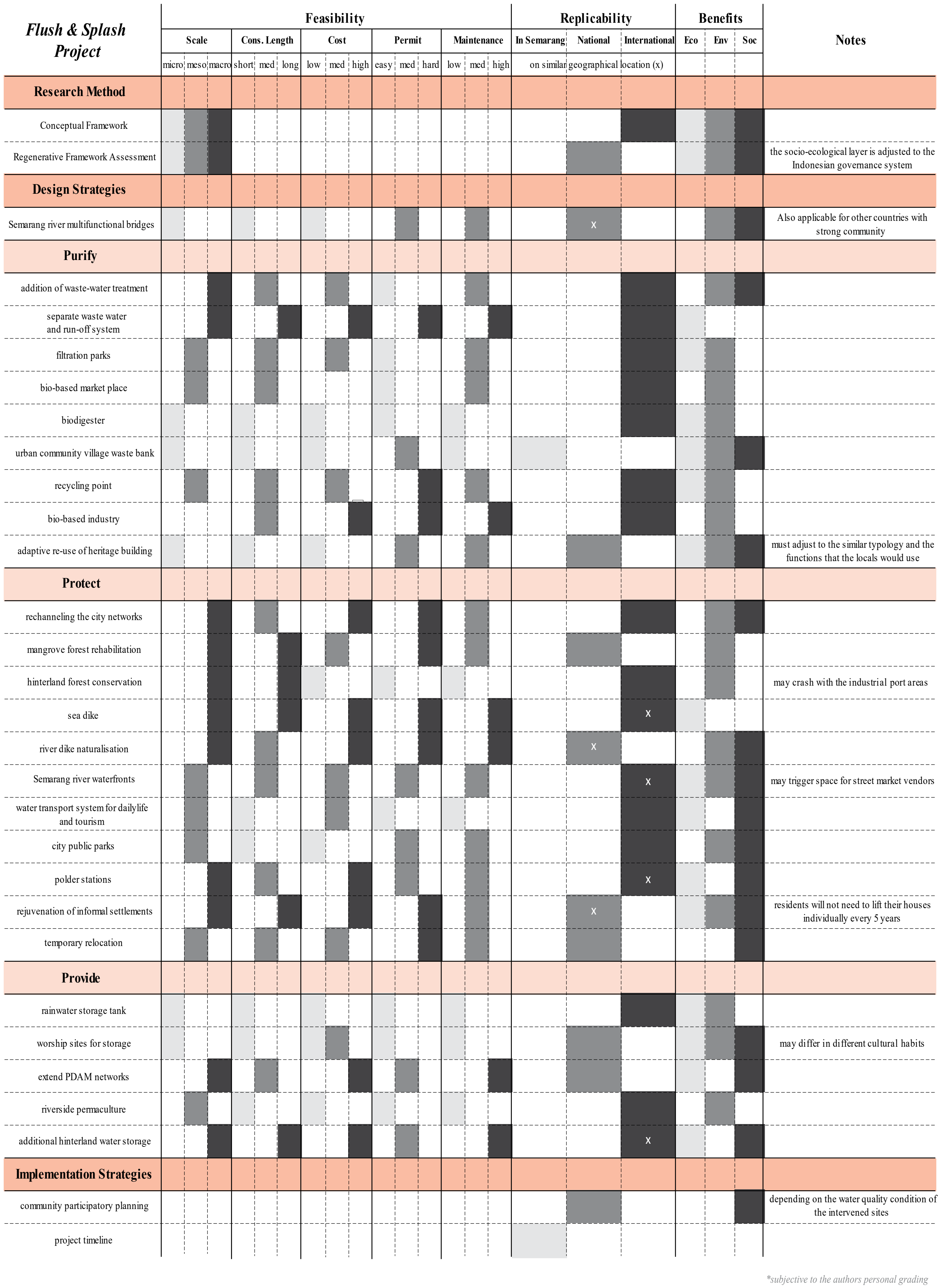


Figure 98: reflection matrix of the project's feasibility and replicability

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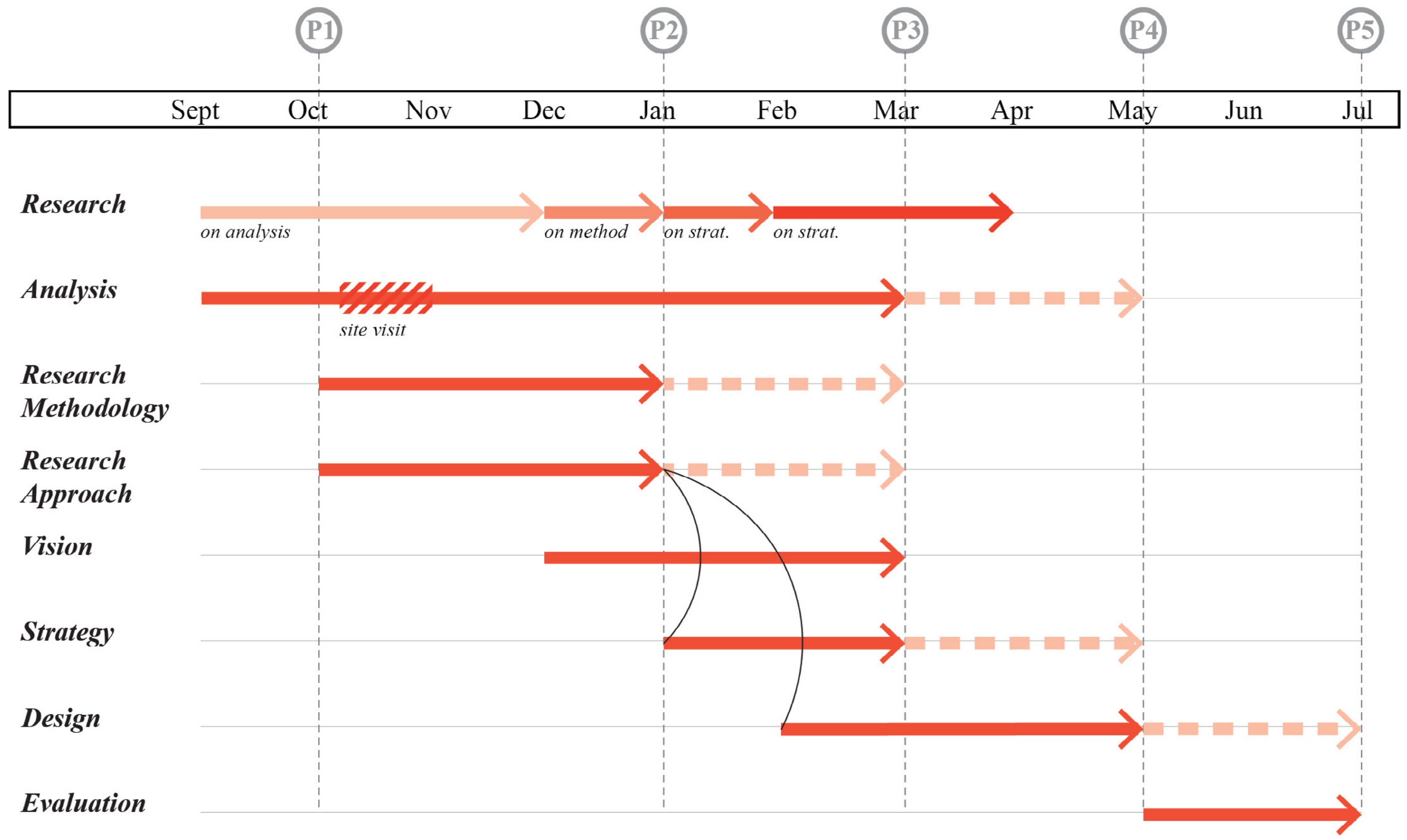
L. Appendix

i. Theory Paper
ii. Interviews
iii. Draft Sketches

Thesis Plan



Nature-based Flood Risk Management: Opportunities and Limitations in Developing Countries (under a case study of Semarang, Indonesia)

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Abstract

The paper examines the possibility of natural flood management (NFM) or natural water retention measures (NWRM) in the developing countries such as Indonesia. In the past decades, re-introducing nature as a significant part of engineering solution had become a trend such that most developed countries have embedded biotic elements on their river restoration. Hence, this research begins with understanding the types and measures of nature-based solutions (NBS) which mitigate flooding issues. It would then be followed by acknowledging the opportunities and limitations of these nature-based solutions. For instance, embedding the ecosystem services (ES) in flood prone areas may contribute to the long-term benefits of this restoration. However, the scale that comes with it may collide with land ownerships within the area. Currently, many papers have discussed holistic and nature-based flood risk measures, but rarely with the entangled complexities of a developing country. In the case of Semarang, the port city is located on a ground of river sediments near the coastline whereas the Semarang river flows from Mt. Ungaran down to the shore; hence the occurrences of pluvial, fluvial, and coastal floods throughout the watershed. Surrounding the rivers lay a rapidly growing informal settlements that continues to narrow the water body. Not to mention the lack of data, financial support, and the weak governance which causes delay in the progress. Hence, this research would assess the capacity of Semarang to start building with nature considering its contextual opportunities and limitations. Following the assessment brought up several inquiries; what happens if the limitations outweigh the possibilities? Would re-configuring the governance be the key intervention to execute NFM? Answering these questions would involve discussion on the theories of flood risk, nature-based solution, and ecosystem services. This would be reviewed in parallel with the evaluation of the current governance system as well as the alignment to the approaches of United Nations Sustainable Development Goals so that Semarang could equip better human resources in facing the changing paradigm.

Keyword: Nature-based Solution, Flood Risk Management, Developing Countries, Ecosystem Services, Weak Governance, Semarang.

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1. Introduction

Urbanisation have accelerated to such unpredictable speed in a way that nature has been regarded as a scarcity in many of our cities. Luckily, the 21st century paradigm have shifted towards re-introducing nature as a significant part of engineering solution and many developed countries have embedded biotic elements to mitigate flood risk. Before going into the details of the natural-based solution (NBS), let us first define the term flood risk. One amongst numerous definitions mentioned in recent literature: Mitig Adapt Strateg Glob Change FLOODsite (2009b), stated that risk is probability times the consequences of flooding. Natural scientist and engineers tend to use this equation as they would be able to quantify the risk when deciding suitable flood protection measures through probabilistic calculations. This conventional engineering approach is what have had shaped our urban environment today with grey edges such that along the canals. Another commonly used definition is to define flood risk as hazard combined with the vulnerability of the society in the area. This definition is commonly used in the field of social scientists such as planners who consider hazard as given and therefore works on the spatial strategies to influence people's behaviour in order to adapt to that given. A parallel approach has also considered the capacity of the community to indicate positive circumstances that could be seen to offset vulnerability (Cardona, et al., 2012). Hence the equation risk = (hazard x vulnerability) / coping capacity. In this formula, the NBS approach is often seen as a coping capacity within the equation as it extended the lungs of the city, allow land absorption, protect biodiversity, and promotes overall health.

So, what is exactly the approach of nature-based solution? Nature-based solutions are "actions which are: (1) inspired by, (2) supported by or (3) copied from nature" (European Commission, 2015, p. 5). The forms of inspiration may be shown through incorporating elements of building materials which mimic the shape and function of natural animal and plant compartments, or most generally, enriching the city corridors with autochthonous tree species in order to reduce the emission caused by urban conglomerations (Lawson, et al., 2014). In dealing with flood risks, NBS could be further derived to natural flood management (NFM) and natural water retention measures (NWRM). NFM refers to the measures that "alter, restore or use landscape features to manage flood risk" (Holstead, Kenyon, Rouillard, Hopkins, & Galán-Díaz, 2014) whereas NWRM includes (1) interception (retaining water in and on plants), (2) increased plant transpiration, (3) improved soil infiltration, (4) ponds and wetlands, and (5) reconnecting the floodplain (Hartmann, Slavíková, & McCarthy, 2019, p. 4).

Examples of the NFM approach includes the coastal dike of Zand voort, Netherlands, which utilizes sandy dunes along the coastline for protection measures. Another would be the urban parks in the city of Beira, Mozambique which have planted 2,200 mangrove trees with active flood mitigation function along River Chiveve as means of NWRM. Although frankly, flood risk measures with ecological restoration are subject to luxurious. Poor countries would not be willing to invest a great sum of money for nature conservation nor the time it takes to construct the planning for as long as their basic needs of food and shelter are not fulfilled. They demand to witness a valid proof of technological intervention such as dam projects for the irrigation system of their agriculture field as well as water storage to last the changing seasons (Nienhuis & Leuven, 2001, p. 91)—which is rather an image of the Western industrial revolution back in the 18th Century. Many papers have discussed holistic and nature-based flood risk measures, but rarely with the entangled complexities of a developing country. This paper would further seek the opportunities and limitations of NFM in general and then proceed to the scenario of Semarang, Indonesia.

1.1 Recognizing the potential and limits of Nature-based Flood Risk Management

To begin with, one should defer from calling it as a "back to nature" process, but rather as a new role that biotic elements and their metabolism are able serve in order to meet the safety and necessity of our society today (Fernandes & Guiomar, 2018, p. 1926). Aside from wetland restoration, soil- and water-bioengineering approach have been opted to solve various technical issues like slope stabilization, streambank protection, and coastal defence (Fernandes & Guiomar, 2018, p. 1929; Stokes, et al., 2014). Having seen to safeguard hydrological processes, application of NBS on flood risk management also provide additional values which integrate nutrient cycles, habitat provision, as well as our aesthetically appealing landscape patterns which according to ecosystem services (ES) affects the health and well-being of living creatures.[1] These potentials also come with great responsibility. It also means that natural-based systems must have an equal treatment of care, surveillance, and cycles of repair like any other 'machineries'. (Fernandes & Guiomar, 2018, p. 1931). However, the allocation of investment towards the maintenance of this system remain questionable especially in the developing countries.

People living on and using flood-prone lands may be exposed to hazards; thus, enhancing coping capacities such as constructing dike trajectories or having seasonal fish-crop systems must be legitimized into strategies to manage risks (Juarez-Lucas & Kibler, 2015, p. 10). The symbiotic mutualism nature of ecosystem approaches for flood-prone land management has been positively perceived and widely implemented on many flood adaptation projects in developed countries (Juarez-Lucas & Kibler, 2015; Nienhuis & Leuven, 2001). In many respects, floods are considered beneficial for agriculture and fisheries activities (Shankar, Halls, & Barr, 2004). These are also prominent economic sectors in the developing countries. Hence, the application of ES for flood risk mitigation may also be adapted on the setting of less developed nations in such a way that it gives an added value of livelihood benefits. So, what are the aspects of ES that are suitable on inundated areas? Maibritt Zari have simplified the four aspects of ES in relation to urban context (see Table 1) so that it becomes an easily usable tool that provides an overview for designers with limited background knowledge in ecology (Zari, 2018, p. 112). From this table, flood-prone land may collaborate to provision basic food needs (1.1), growing raw materials (1.3), or functioning as water storage for clean water supplies (1.5). With the current progress of architecture innovations, housing may be adjusted to withstand some level of inundation (Cuny, 1991), allowing people to live close to or being on the flood-prone land itself. In such contexts, people able to cope with certain levels of inundation obtain direct socio-economic benefits of using flood-prone land (Juarez-Lucas & Kibler, 2015, p. 5).

[1] In the framework of ecosystem services (ES) as constituents of well-being by Millennium Ecosystem Assessment 2005, the supporting, provisioning, regulating, and cultural aspects of ES serves linkage towards basic materials supply, health, security, social relation, and the freedom of choice and action of human being .

1. Provisioning Services	*2. Regulating Services (human time scale)*	*3. Supporting Services (long time scale)*	*4. Cultural Services*
1.1 Food – Human (land/fresh water/marine) – Forage	2.1 Pollination and seed dispersal	3.1 Soil – Formation – Retention – Renewal of fertility – Quality control	4.1 Education and knowledge
1.2 Biochemicals – Medicines – Other	2.2 Biological control – Pest regulation – Invasive species resistance – Disease regulation	3.2 Fixation of solar energy – Primary production/plant growth (above ground, below ground, marine, fresh water)	4.2 Aesthetic value and artistic inspiration
1.3 Raw materials – Timber – Fibre – Stone – Minerals/ores	2.3 Climate regulation – GHG regulation – UV protection – Moderation of temperature – Moderation of noise	3.3 Nutrient cycling – Regulation of biogeochemical cycles – Retention of nutrients	4.3 Recreation, relaxation and psychological wellbeing
1.4 Fuel/energy – Biomass – Solar – Hydro – Other	2.4 Prevention of disturbance and moderation of extremes – Wind/wave/runoff force modification – Mitigation of flood/drought – Erosion control	3.4 Habitat provision – Suitable habitat for organisms – Suitable reproduction habitat	4.4 Spiritual inspiration
1.5 Fresh water – Consumption – Irrigation – Industrial processes	2.5 Decomposition – Waste removal	3.5 Species maintenance – Biodiversity – Natural selection – Self-organisation	4.5 Creation of a sense of place and relationship. Cultural Diversity and history
1.6 Genetic information	2.6 Purification – Water/air/soil		

Table 1 – Ecosystem services with reference to urban context (Zari, 2018)

Despite the recognized potential benefits that could be derived from utilizing flood-prone lands, methods to assess the benefits within flood risk management remain dubious (Meyer & Becker, 2013). On the other hand, nature-based solutions have two interrelated issues in common: first, basically most such measures require more land than traditional grey infrastructure. Second, the land that NBS need is often owned by private landowners rather than public stakeholders. These measures raise conflicts over land (Hartmann, Slavíková, & McCarthy, 2019, p. 5; Van Straalen, Hartmann, & Sheehan, 2018).

2. Nature-based Flood Risk in Semarang, Indonesia

In the case of Semarang, the port city is located on a ground of river sediments near the coastline whereas the Semarang river flows from Mt. Ungaran down to the shore; hence the occurrences of pluvial, fluvial, and coastal floods throughout the watershed. Surrounding the rivers lay a rapidly growing informal settlements that continues to narrow the water body. With a sea level rise of 0.2-0.5m/year, the coastlines from Semarang to Demak have lost 550 hectares of coastal area in the past fifteen years due to erosion—sinking the houses of the vulnerable group of people (Kahfi, 2019). Another limits to the implementation of flood risk management in Semarang is the lack of data, financial support, and the weak governance which causes delay in the progress. Hence, this paper will discuss on ways that Semarang could possibly step up in the game of building with nature considering the limitations in hand. Prior to designating relevant strategies, this research would review on the opportunities and limitations of nature-based solution in the context of Semarang. The discussion would cover fields of spatial planning, engineering, and governance. Would the current opportunities be enough to put forward the trend of NFM in Semarang?

2.1 Opportunities

2.1.1 The application of ecosystem services on flood-prone land

The area of mangrove forests in the coastal area of Semarang is 84.47 ha, with the largest area being in Kecamatan Tugu (Department of Marine and Fisheries of Semarang City, 2010). However, due to the growth of industries, the existing mangrove forests in coastal areas are being scraped away—reducing the capability to resist coastal abrasion. Responding to the coastal flooding as well as fulfilling the traffic demand, the Indonesian Ministry of Public Works and Housing is currently planning to build the Semarang-Demak section of the Northern Java Coastal Tollway. This project could potentially be integrated with mangrove restoration, where the mangrove forests could function to break the tidal waves entering the dike openings.

One component of mangrove forest that has a significant role in maintaining its sustainability is the various types of flora contained in there. Found in the mangrove forest of Semarang are *Rhizophora mucronata, Rhizophora apiculata, Bruguiera, Sonneratia ovata, Sonneratia alba, Avicennia alba,* and *Avicennia marina* (Rahmila & Halim, 2018). Besides as a protector of the coastline and embankment of the aquaculture area, the various types of flora also increase the aquaculture productivity associated with it (Rahmila & Halim, 2018). Currently, aquaculture activity in Semarang shapes about 1,030.21 ha of its coastline. A collaboration to restore the coastal mangrove forest would regenerate multiple point of the ES as listed by Maibritt Zari: 1.1, 2.3, 2.4, 3.4, 3.5 and all of those under cultural services (see Table 1).

Apart from the mangrove forests, the hinterland forests, and few remaining rice fields along the city center of Semarang, one could hardly spot anymore green patches on google map earth view. Despite the seemingly uncontrollable densification and growing informalities on the riversides of Semarang, most of the residents still show attempt on greening their houses. Those with limited lands would either have potted plants by their front door, tiny shrubs on the window balcony, or 'steal' the public pavement as their front yards. It

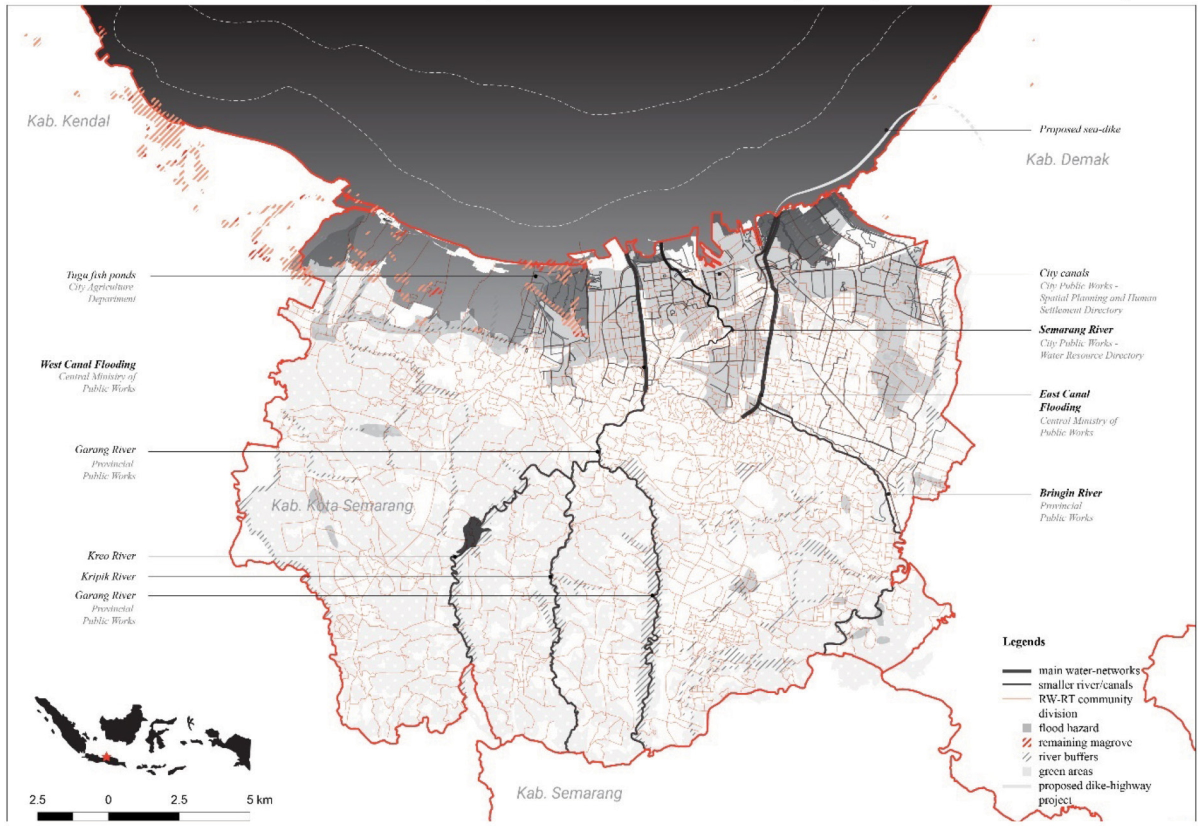

Figure 1 – Map of Semarang showing the flood hazard with key potentials and stakeholders on site (author's work)

is not that they are not aware of the ecosystem services plants could provide, but they just could not afford the land. Meanwhile, on the hinterland of Semarang, Kandri Village have been persistent in their aquaponic movement for the past 9 years. As if each house competes to have their best aquaponic set-up and lush plants collection. Not only that these are sufficient micro interventions for climate regulator, but this also enhances the provisioning service of ecosystem for the residents: basic food ingredients.

Now we are not here to only discuss how to prevent water from coming in by creating green solutions, but also how to appreciate the element itself. Water is often considered as a core spiritual element in many religious practices. With Semarang having a considerably ample amount of active worship places[2], some could potentially be a strategic location to integrate water as means of spiritual connections and supply of clean water. Semarang is known for its Great Mosque of Central Java, Blenduk Church in Kota Lama, as well as the city with the most temples in Indonesia. These landmarks in the city, if connected as a cultural recreation network, may also contribute to the bankability of the water storage implementation in worship places.

2.1.2 Resilient housing design

Upon assessing the magnitude of flood risk, Schanze came up with the term 'risk perception'. This refers to the fact that the overall view on the kind and magnitude of risk of individuals and groups involved in flood risk management depends on their individual and collective backgrounds. For example, individuals who have already experienced an extreme flood event will most probably have a different perception of flood risks than other individuals (Schanze, Zeman, & Marsalek, 2006, p. 8). Having to deal with flooding annually during rainy seasons, wooden houses on stilts could easily be spotted within the coastline community of Semarang. Although appears to be very fragile, the idea of living *on* surface water have existed in the mindset of the people. Further research, innovation, and promotion of these so-called resilient architectural housing might be an essential coping mechanism to respond to the rising sea level and uncertainty of climate change.

2.1.3 Strong community: Smaller scale intervention

Knowing that Indonesia was under the Dutch colony for three and a half centuries, the country must have received the Netherlands' influence on managing water-related infrastructures. The aim to meet the universal needs of water and the exclusionary planning nature of Semarang have had become the conflicting matter of water management. Part of its reasoning could be traced back to its historical trajectory. The Netherlands, which would have been the sea, is a huge reclamation project. Three quarters of the country would not have existed without layers of flood defence systems (Nienhuis & Leuven, 2001, p. 93). The East and West Canals of Semarang are the product of the colonial times to tackle flooding issues at the time, which also happened to centralize the water flow to the two respective canals. On the other hand, the local community is formed by the cycle of subsistence agriculture. Communities within the *kampungs*[3] were attached to their patches of land for sustenance of their socio-ecological metabolisms. With such spatial-temporal sequence of *kampungs* (see Figure 1), it seemed that the domestic water management was organised on a neighbourhood scale. Unfortunately, demographic data on *kampung* communities prior to the colonial era could hardly be traced. However, many old maps from the archives of the Netherlands Royal Tropical Institute indicates that the activity subsistence agriculture left visible signs of ecosystem services in comparison to the central trading activities inside the Dutch walled area. They had closer contact to natural streams, allowing the *kampung* communities to use the surface water for washing and bathing directly. Streams were their first-hand water resources, whilst the wetlands function as water purification systems. The adjacent agricultural activities regulated the natural cycle of water within the household's immediate environment. (Putri, 2017, p. 196). Certainly, issues of densification were absent during the time and the wastewater treatment also remained questionable. Nevertheless, domestic water management were detached from the interventions of higher institutions (Putri, 2017, p. 197). Hence, revisiting the *kampung* citizenship could potentially trigger a successful governance of an NFM.

2.2 Limitations

2.2.2 Not under top priority investment

This section would review the relations of certain ministries on the implementation of NFM. It would begin by looking at how the central government allocates and coordinates their investment and how it is being executed in Semarang. The State Budget (Anggaran Pendapatan dan Belanja Negara) in 2019 according to the website of the Financial Ministry of Indonesia https://www.kemenkeu.go.id/apbn2019 is 2.461,1 trillion Rupiah which is roughly about 158 million Euro. The budget is mostly allocated on Central Government Expenditure of 1.634,3 trillion Rupiah followed by District Funds of 826,8 trillion Rupiah which are spread mostly on the sectors of

[2] According to Central Java Central Bureau of Statistic, Semarang have around 1161 mosque, 1151 *mushola*, 231 Christian chuches, 121 Catholic churches, 35 *vihara* and 8 temples.

[3] The term *kampung* refers to urban villages or street neighbourhood which usually have a strong community association.

Figure 2 – Informal settlements surrounding the Semarang River

Figure 3 – Mangrove forest on the North coastline of Semarang

Figure 4 – Serious waste and water quality issues on the water bodies of Semarang

educational infrastructure and services, health subsidy, and non-renewable energy support. The fact that the support is still for *non*-renewable energy strongly indicates the country's progress on dealing with NBS.

If we look at the Ministry of National Development Planning Regulation no. 7 in 2018, a comparative table to create synergy between the United Nations Development Goals and the state key visions has been made. The highlighted strategies of the ministry lie on human resource development which aims to diminish poverty, adding security, strengthening integrity, as well as economic productivity. This correlates mainly to the societal aspect of the UN SDGs. The concern to balance the built and natural ecosystems however—which are on the 15th and 16th point of the SDG—are still considered very minimally. Zooming in to the Regional Development Planning Regulation no. 11 of Semarang in 2017, they have had only stated that SDG would be embedded in the academic teachings. Meaning, action planning on NBS are still far-fetched. On a positive note, Basuki Hadimuljono, the Minister of Ministry Public Works and Housings, have only just recently declared the idea of implementing natural systems for future infrastructure projects at the Solo Public Works Conference in November 2019, with Cikapundung River restoration being the country's pioneering NFM project. Prior to any infrastructure projects, documents of Environmental Impact Analysis (*AMDAL*) as well as the Environmental Management Efforts and Environment Monitoring Efforts (*UKL-UPL*) must first be approved together with the Ministry of Environment and Forestry. The nature of this assessment, however, emphasize the impact it may cause rather than promoting the integration of NBS.

The previous paragraph shows that the central government have had few incentives on considering nature within planning, but they are still seen separate. Nature is seen as a value, but not yet as an engineering solution. The idea is still reduced to not 'touching' nature, to have the least impact possible during construction. Technically, re-structuring the strategies to be more NBS specific is feasible. However, this needs to be followed by a parameter to validate the actions. Otherwise, in a country where many do not find themselves prosper, non-technical issues may rise: a question on the government's integrity.

2.2.2 Informal settlements along kali Semarang

Having 4,14% of citizens living under poverty have forced certain community to illegally reside on the edges of the city—which some could be found alongside the Semarang River. Due to these informal settlements, the river width is narrowed, offering no spaces for flooding buffer. Their permanency and scale of growth in the urban landscape of developing countries reflects their emergence as a universal city phenomenon which may be tolerated (Jones, 2017), which weakens any eviction policies. Since 2003, the United Nations has defined a slum as a residential household characterized by an absence of basic services including adequate drinking water and sanitation, lack of security of tenure, inadequate and overcrowded living areas, and structurally unsafe housing (UNESCAP, 2015). This describes the condition of informal settlements in Semarang. They are the product of various other urban problems which need to be traced back towards each respective sector. The definition of 'slum' stated previously reflected the resident's inability to manage sanitation, in other words, they are unable to control the metabolism coming out from their homes. This relates to the next point of the limitations of NBS implementation in Semarang.

2.2.3 Waste management

The weak law and the lack of attention to the waste management in the city have caused prominent pollution problems in Indonesian rivers. People throw their trash freely to the same surface water where factory chemicals are being dumped. This daily dose of waste would contaminate the elements of ecosystem services before they could help. It opposes the opportunities of *housing-on-stilts* as the water quality itself would be worrisome. Not only that it would face economic consequences, a flood of unhygienic water would also amplify the health consequences. It appears that to enjoy access to state water and sanitation services in Semarang, one had to follow, and afford, particular standards of living (Putri, 2017, p. 202). The issue of centralizing Semarang water flows to the East and West canals have also contributed to the degrading quality of Semarang river. Surrounding the more regulated canals are adequate housing complex whereas Semarang River faces the contrary. Now the question is, how far behind is Semarang to finally be eligible for NFM?

2.2.4 Stakeholders and Ownership

Ultimately, land is the critical factor that determines whether NBS can be implemented to deal with water-related risks. Land is an essential and inevitable ingredient for the implementation of NBS to mitigate and adapt to water-related risks. Making these land available and persuading land users to implement the measures are thus two key challenges for implementing measures to mitigate or adapt to water-related risks. Usually, flood risk management deals first with technical and hydrological issues before addressing land management (Hartmann, Slavíková, & McCarthy, 2019, p. 6). Land users are often regarded as mere recipients of water management, not as key stakeholders. Authorities need to have dialogues to those residing on the river buffer zones, be it on hazard awareness, or the potentials of NFM. However, having a single watershed under multiple

authorities is also an issue in Semarang. For instance, the East and West Canals are subject to the central Ministry of Public Works (see Figure 1). The West Canal, however, is also connected to Garang River which happens to be monitored by the City Public Works and Provincial Public Works as it goes beyond the municipality border. Multi-layer and intra-layer coordination must be narrated simultaneously.

2.2.5 *Coastal Abrasion*

The sea level rise phenomenon hits the reality hard in archipelago countries. Siswanto, the head of marine and coast section from Semarang Maritime and Fishery Agency affirmed that the coastal erosion have displaced the coastline as far as 1.7 kilometers inwards. Tugu became the district with the worst damage for which 1,200 out of 2,923 hectares experienced severe erosion (Rohmah, 2014). The rate of erosion is also accelerated by the rate of land subsidence, another hazard which poses a great threat to the city. The mangrove forests in the coastal region of Semarang faces a paradoxical state of being eroded and acting preventive. The variables associated with the two scenarios are the magnitude of the wave attacks and the threshold capacity of the mangrove forests. The quantification process to alter the negative scenario is still missing in action, due to the previously listed limitations.

3. Proposed Outlook of Natural Flood Management in Semarang

Mimics of ES practices such as permaculture or mangrove ecotourism being engineered around flood prone land may provide livelihood benefits and unique opportunities for less-developed nations (Juarez-Lucas & Kibler, 2015, p. 2). However, having compared the list, the limitations appear to outweigh the potentials in Semarang. Especially that the limitations contain more qualitative element rather than quantitative, such as ethics, bureaucracy, and human resource quality. This would require a more complex framework to measure the cost and benefit in executing an NFM project in the city.

Therefore, the current review would like to suggest in yet a qualitative manner, that the approach to flood risk management in Semarang must consider the provisioning, supporting, regulating, and cultural aspect of ecosystem services hand in hand with the human resource development

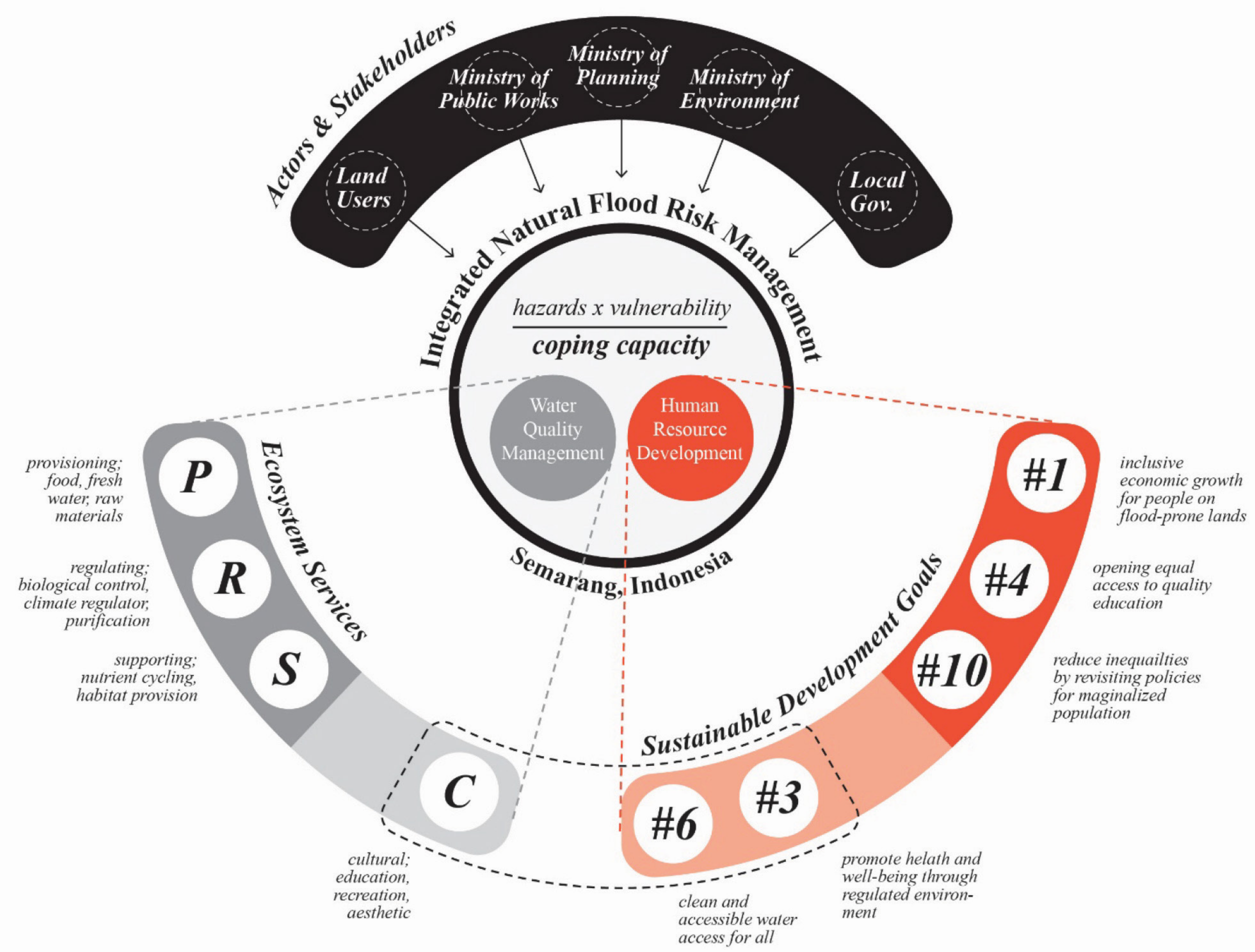

Figure 5 – Conceptual framework on the approach of natural flood management in Semarang

project the Sustainable Development Goals (SDG) have assigned (see Figure 5). It requires few steps back to also review the water quality before solving the flooding issues, as well as re-evaluating the *kampung* typology and their true needs. This refers to the impact of the colonial legacies of Dutch planning ideologies in a way that many local settlements are seen to be informal. The morphology of Semarang neighbourhood in relation to the water networks might have differ otherwise. Afterwards, the synergies could eventually sound like the following; for every social housing complex being planned, it must allocate an efficient land buffer for NFM. For every higher educational support granted, the importance of ES must be resonated. Within the observed pace of developing countries, it is expected to progress slow, but it would prevent the extended happenings of riverside informalities. Policy and guidelines to tie these notions together must yet be established to achieve the designated NFM.

The associated stakeholders must also monitor themselves to secure the coherence of the goal through the different layers of governance and user. Aside from written strategies, conversation with private land users to realize risk reduction and adaptation measures on private land are often still missing in practices (Hartmann, Slavíková, & McCarthy, 2019, p. 6). To conquer this gap, policy action sets should be formulated to fit *kampung* level governance—knowing the bond within Indonesian compounds would allow a more frequent and comprehensive dialogues between the people. Example of these neighbourhood scale actions could be urban farming, allocating minimum land absorption area, or weekly river clean-ups by the community. With great involvement of stakeholders throughout the project, this concept of natural flood management could augment towards an integrated natural flood management (INFM) of Semarang.

4. Conclusion and Reflection

In the equation of flood risk, natural flood system has become the variables of coping capacity. However, in the context of Semarang, this NFM contains immeasurable sub-variables that are beyond the domain of engineering. It involves socio-economic negotiation and few steps back to prepare the capability of the human resources. The task is now to create a stronger linkage between the potentials of mimicking ecosystem services on to the acts of human resource development on site.

Reflecting back on the analysis of the current situation in Semarang with reference to the theories of NBS, ES, and the governance system, this paper still need to investigate deeper on what has been done by the Ministry of Environment and Forestry, as well as the programs that the compound system have done for the environment in order to make fairer comparisons. The outlook should have also considered the worst scene scenario where relocating people would be the last option. For instance, it would involve changing the land-use of flood-prone neighborhood to a place for seasonal fish-crop system and slowly moving the people away. This could convince the local of not losing their land, whilst shifting them to better flood-resilient housing. All these potential actions need to be listed further with site specificity to allow the feasibility of NFM projects in Semarang—and that would be the next assignment to bring us a step further towards making a change.

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Interviews

Interview 1: Bandarharjo Residents

Name: Supriyadi
Job: Drinking water refill store in Bandarharjo

1. How long have you lived here?
I have been living here for 25 years since 1995.

2. Why do you choose to live here?
I choose to join my wife as she is from here.

3. What do you do on a daily basis?
I run this store of refilling drinking water from the mountain.

4. What are the activities of the RT/RW community here?
Well each of us have our own jobs during the day: re-selling groceries, factory workers, etc. Afterwards, we just hang out with the neighboors in the evening.

5. Where is the gathering place?
Mainly in our terraces, or probably on the side of the road.

6a. Where do people here obtain clean water access?
Some people took it from the artetis wells. We have several around here. It is used to be for drinking water, but it is no longer drinkable today due to intrusion. Some have access to the PDAM pipes. For the actual drinking water, everyone tends to buy it from the grocery stores. They would come to re-fill their drinking water gallons to re-fill stations like mine, which I obtain from the Ungaran Mountain.
6b. Do you know where the grey water goes?
Yeah just to the sewer on the streets.

7a. Is there flooding issues?
Not lately, the new drainage system seems to be working here.
7b. If so, how did people deal with it?
We just let it in to our houses or move to relatives house outside.
7c. Has the problem been reduced or worsen?
It has been way reduced, since the pumping station at the end of Kali Semarang has now been built. It appears like we have no coastal floodings anymore since 2015.

8. How is the waste management here being dealt?
Well, every two days a guy comes to take up the trashes in front of our houses. But, that's it.

9. What are your hopes in the future for this place?
I just hope the water around here would not be polluted, and that there would be no future problems related with the water access nor flooding.

Interview 2: Bandarharjo Residents

Name: Mukhtarom
Job: Casual worker

1. How long have you lived here?
I have been living here all my life.

2. Why do you choose to live here?
I have all my families here and sufficient source of income around.

3. What do you do on a daily basis?
I go look for money here and there; sometimes by pulling becak rides, construction work, or fishing to the sea.

4. What are the activities of the RT/RW community here?
Pretty much similar to me.

5. Where is the gathering place?
Just in our houses, we take turns. Although we have a bigger gathering place near the fish factory, just for an official and bigger events though.

6a. Where do people here obtain clean water access?
We have a well on a nearby mosque! That's where we get it.
6b. Do you know where the grey water goes?
Well just on the sewage outside?

interviewee have similar answer to first respondent for Q7 and Q8

9. What are your hopes in the future for this place?
I think what the people need here the most are some help with regards to fundings. Especially on the sinking houses that is of 1m height from the ground and have not yet afford to elevate their houses.

Interview 3: Life around Jatibarang Dam

Name: Mingaisaroh
Job: Owner of food kiosk

1. What do you think was the aim of this dam?
I suppose to tackle the flooding. In the past, the overflow upon this river would flood the Sam Po Kong temple undernearth. The dam is being utilized during rainy season, however we are now facing a long dry season. It has also become the centre of recreation for people within the sub-districts of Kandri, Jatirejo, Jatibarang, and Gedung Pane.

2a. What was this place before?
It was our ricefield
2b. What was the compensation?
We were given 65.000 Rupiah for every m2 of land. They also provided us with commercial spots around this dam to do small business.

3. How has your life changed after this dam? Do you think it has given you benefit or loss?
Well I have definitely changed my job from a farmer to a food stall seller--but everything have turned out to be better. Before, harvesting crops was a seasonal thing and it also took some time. Hence the income was pretty uncertain. With this dam also become a recreation, we get a more frequent income from our visitors.

4. How have other people utilized this place?
I know a lot of people come for fishing, even from other cities. Weekend is also very crowded with families taking boat rides around the dam. I think most of the people are happy.

Interview 4: Kandri Village or what is known as The Aquaponic Village

Name: Syafei Hassanuddin
Job: Aquaponic Activist

1. What are your backgrounds?
I did not go to higher education, but my parents are both farmer. But I like to explore new things on the internet, until one day I came across aquaponic. For someone who have been raised farming on land, aquaponic became a wander to me. How can we practice agriculture not on soil itself? From that on, I started researching and did some experiments myself. Until I found myself one day in national aquaponic community.

2. When and how did you introduce aquaponic to the first time?
It began in 2010 where I just experimented it myself and told my neighbors about it. And then in 2017, the head of our neighborhood community (RW) agreed to make it as a neighborhood program. In our district, each RW has their own theme: culinary, cave recreation, batik art, and so we made ours an aquaponic tourism village. We introduce it to social media in 2017, making the village famous as an ecotourism destination. Only then we start to acknowledge the zero-waste and circular economic aspects of it, slowly.

3. Could you explain a bit of how it works?
sketch

4. What are the types of plants and vegetables that people grow on their aquaponics?
They are mostly vegetables or spices, such as mustard greens, leek, celery, kale, grapes, etc.

5. Is it economicaly viable?
It only takes about 100.000 rupiah (5 euro) to install a minimal set up. I would say it is very viable as you can harvest some spices for ingredients. It is just the maintenance cost that you need to be aware afterwards, but still, it is not that much. I only clean this set-up every four months.

6. Has it reduce people's need to go to the market?
Yes, and they could also trade their harvests.

7. What are the challenges so far?
It would be to keep the consistency of people as well as the clean water access. Many parts of this subdistricts have no clean water pipes installed yet from PDAM. Hence, they obtain water for the aquaponics from the adjacent compounds. This would be a problem during the dry season as the water on the fish ponds may evaporate.

8. What your future hopes on this project?
We need a empty land for the aquaponic waste treatment--processing it to be food for the worms, worms for the fishes, and the fish waste for the aquaponic fertilizers. If this treatment process could be aided by the government it will be very helpful. We also hope that bigger institutions would be able to support us in terms of networking and innovative technology research so this project would non be stagnant.

Interview 5: PDAM

Name: Joko
Job: Public Relation of PDAM

1. How is the process of the water treatment?
The distributed water came from 3 different sources (water springs, dug well, surface water) that will be treated through 5 steps (water intact from the river, coagulation (quick water mixing with chemical substance) + floccuation, sedimentation, filtration, and water storing to reservoir (injected woth chlorine to terminate the germs. The surface water is the main source for clean water, almost 93% of distributed water came from surface water while the other 7% from water springs and dug well. We still have our water source located in Sumber Air Moedal which were built during Dutch Era in 1911.

2. Why does the water is not ready to drink?
The problem is the insufficient infrastructure, some of our pipes are still from Dutch era. The pipes might be full of sediments and crust, and also contaminated from the soil that is not sterile and will reduce the quality of the water. Even though the water from the production house is ready to drink. (Confirmed by the second respondent that this needs another treatment to be drinkable)

3. How long does it takes for regular maintenance?
Depends on the infra condition, if the pipes' infrstructure is needed to be replaced, then a replacement work will be done.

4.Will there be a vision to have drinkable water?
Yes, we have an on going pilot project in Griya Wahid Neighborhood where all the water will be drinkable for the households

5. What is the use of Jatibarang Dam?
Jatibarang Dam will fulfill the demand of the water in western Semarang. With new components and infrastructure, it is expected to be drinkable as well.

6. Does all the areas in Semarang have access to water?
No, it is now only 59% of the total area

7. How does the water distribution work?
It is only 80% of PDAM responsibility to distribute water to households. When an area has no access to PDAM pipes or hard to reach (geographicly), it is not PDAM responsibility to supply clean water, but Bappeda and Pamsimas. Bappeda will then construct water well to serve the community, usually it is done collectively. The funding came from the taxes.

8. What's the obstacles in clean water distribution?
There is an obstacle where each area has their own specific geographic condition. Each area has different conditions of water resources. In Semarang, Kali Garang can only be extracted 1250 L/second while in Surabaya can have 11000 L/second. There are some areas that still have difficult access to clean water, for example Tembalang, Gunung Pati, and west Semarang. That is why we built Jatibarang Dam to supply the water demand in western Semarang area.

9. Is there any assessment for clean water resources?
Yes, this usually done by BBWS. They will do research and study to know the water discharge and the quality of the water and managing the water use, is it for irrigation or drink water sources. The water source has to have full amount or continuous water discharge.

Interview 6: PDAM

Name: Sulistyo
Job: Water Supply Controller

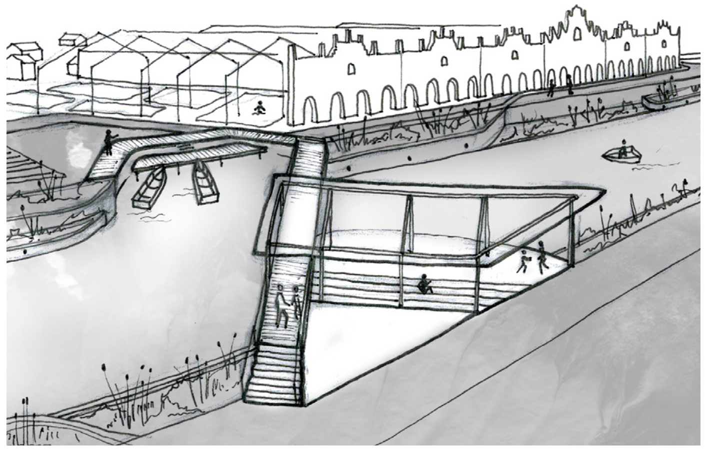
1. So is the water drinkable?
No not yet, we only produce clean water here and it is not ready to drink. It needs another treatment like ozonisation, another filtration and then distributed to drinkable pipes. For now, our focus is only to provide clean water with the standards given by the Health Ministry Regulation no. 492 2010 about the level of turbidity and clarity, but also water quality. If we want to provide drinkable water then we need to rehab all of our infrastructures.
There is a study which shows that if we provide drink water, then the demand will be declining since the people will use drink water to drink only, and not to wash dishes or bath. But there is an example of drinkable water project here in SMA 1 Semarang, all the maintenance is under PDAM, including monitoring and quality control. In this area, the system works firstly, the water from PDAM will be distributed to SMA 1 parcel, and then will be distributed to the RO Filter system which then distributed to 2 water taps. This RO Filter is very expensive that it is quite impossible to install it on a bigger scale like in neighborhood area.

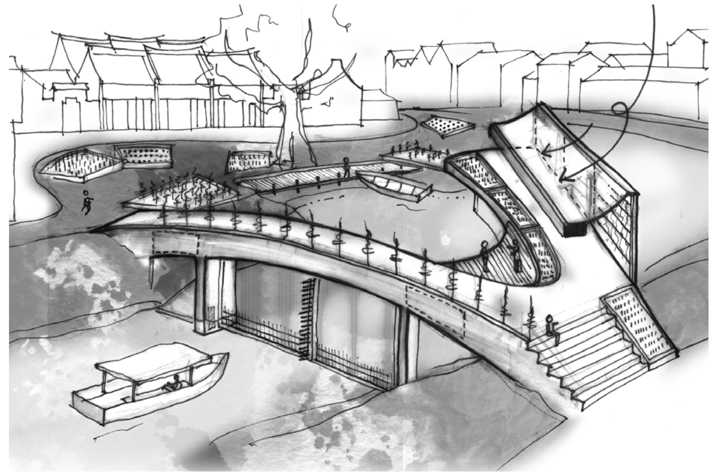
2. What is the problem with the water supply here in Semarang?
The people here usually throw the waste and trash to the river. During the first rain, the temperature of the below surface water will be high enough to move the trash to surface water. This makes the water turns into black and this caused scarcity of clean water supply because PDAM normally will use the surface water. Kali Garang is more stable during dry season. During wet season, PDAM will shut down the activity and will not distribute to households because the water quality is usually low during this season. The government already made a regulation of ground water extraction but this all also depends with the capacity of PDAM to supply clean water. When PDAM cannot fulfill the demand, the people will then dig well.

3. How does PDAM work?
In reality, PDAM works with lots of stakeholders. In Semarang case, PDAM buys the water (L/second) to PJT or Perum Jasa Tirta. Perum Jasa Tirta is under Ministry of Public Works and Public Housing. PJT then will cooperate with BBWS to manage the river including the river use etc. BBWS will then hire firms or consultants to work on water related projects such as dams, canals, etc.

Progress Sketches

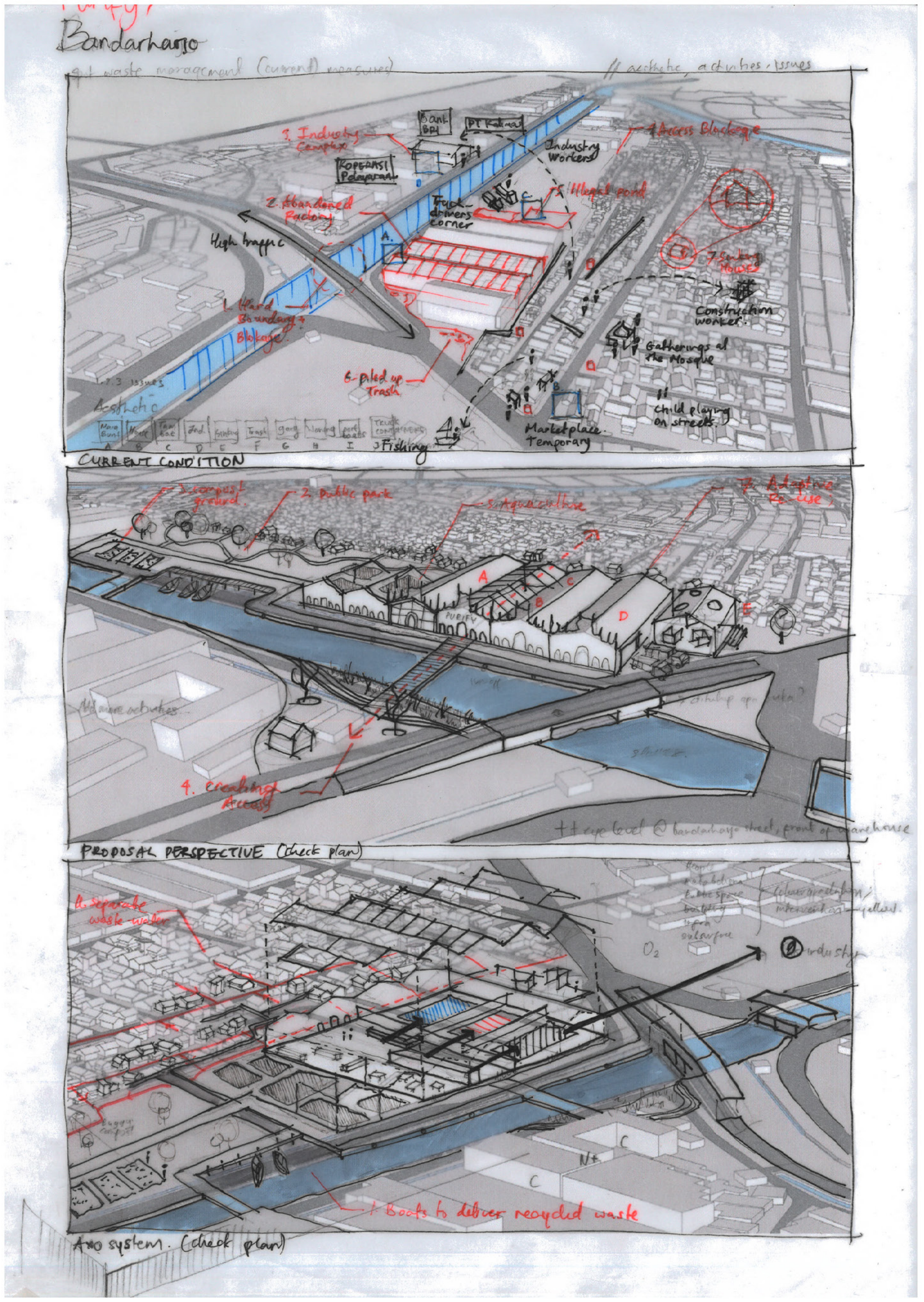
meso masterplan and primary nodes

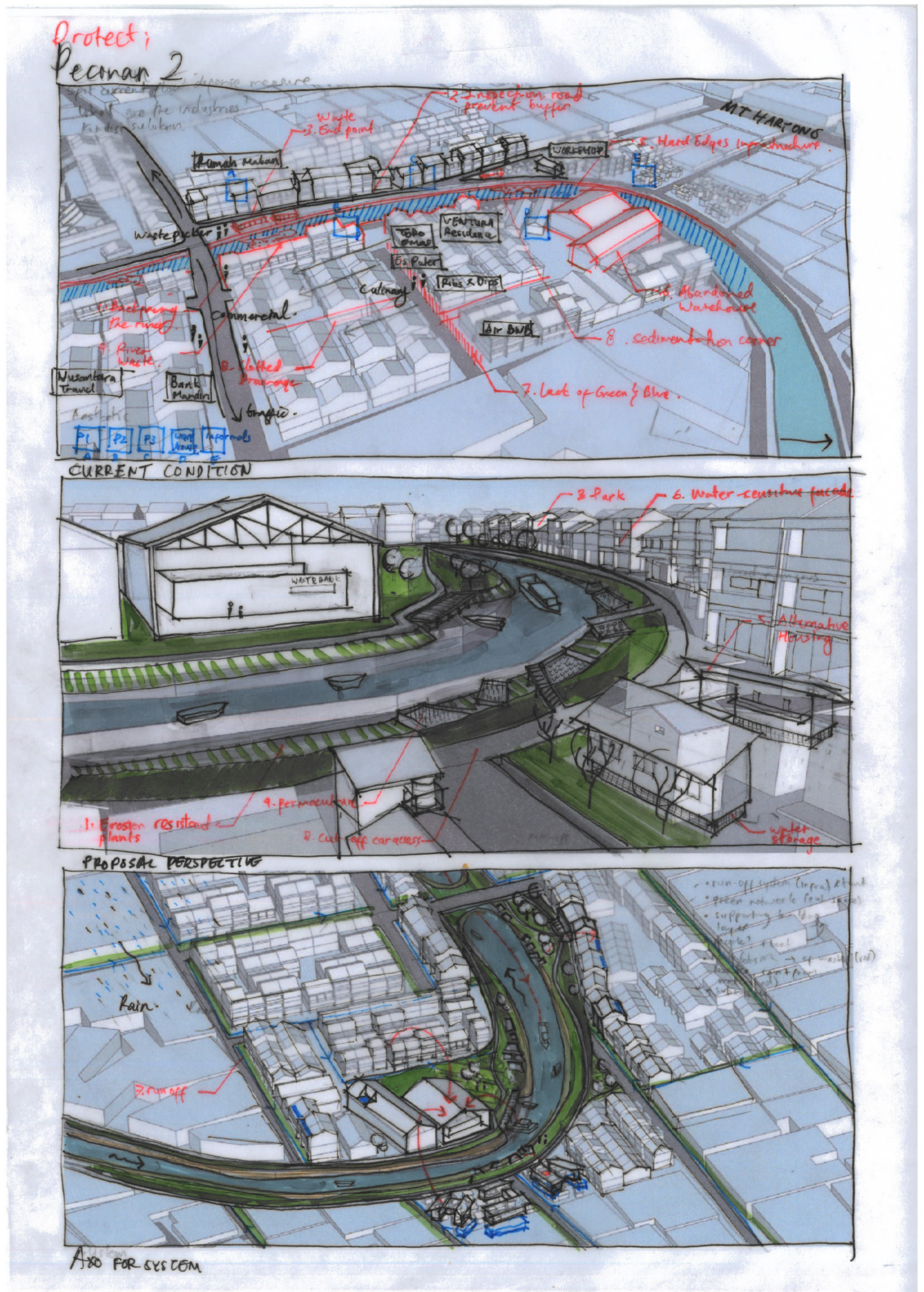


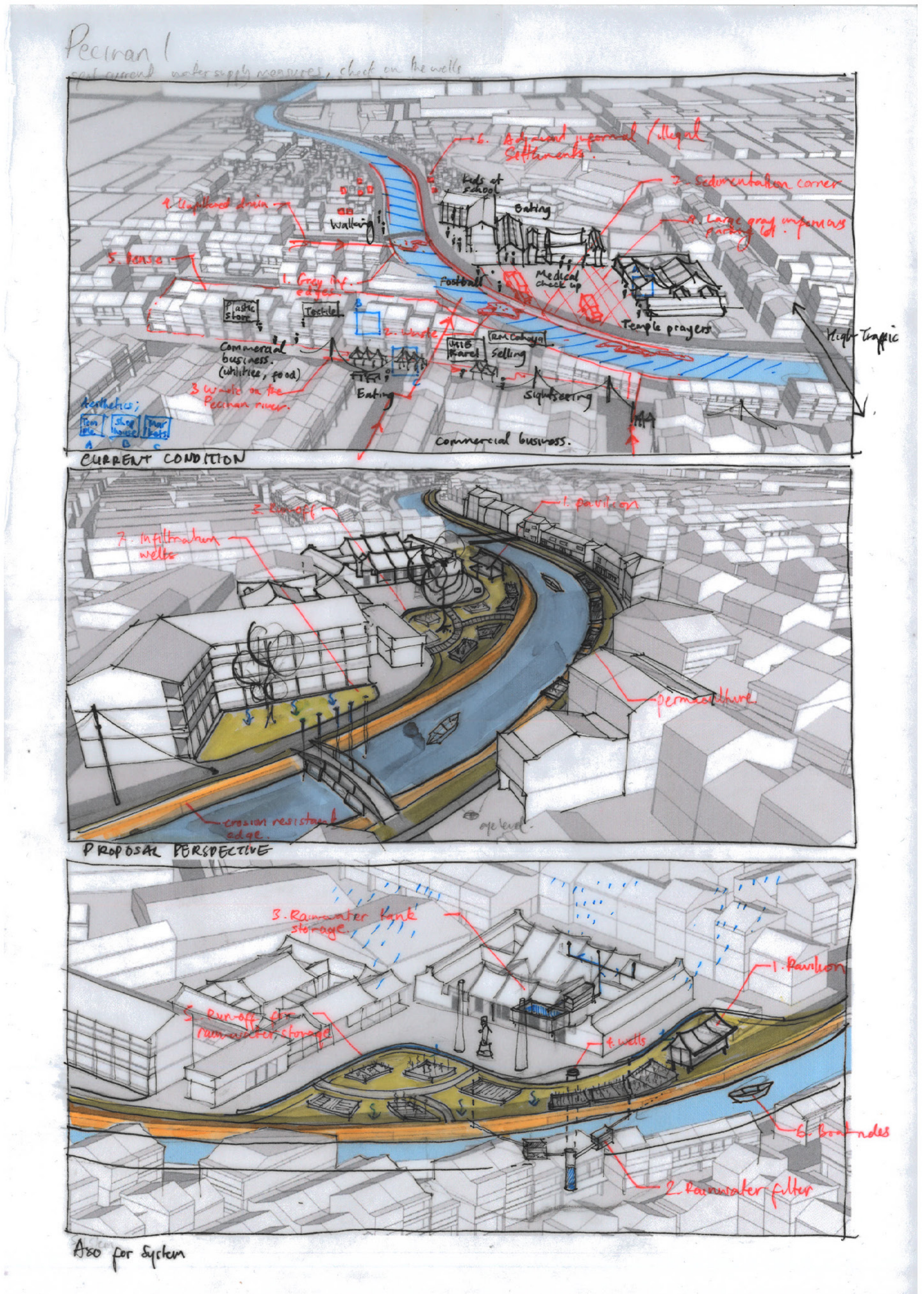


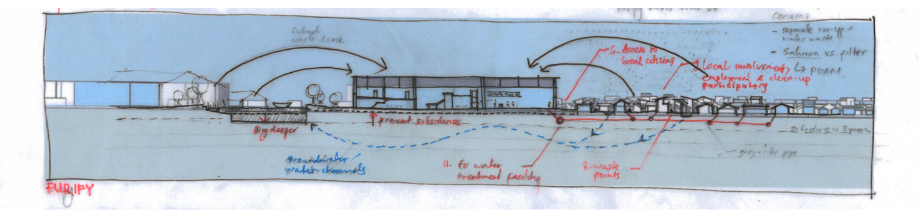
Progress Sketches

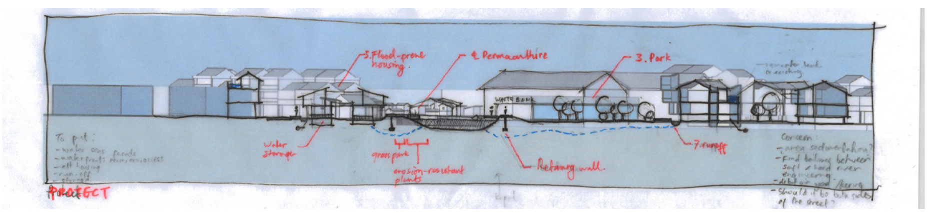
extended micro interventions

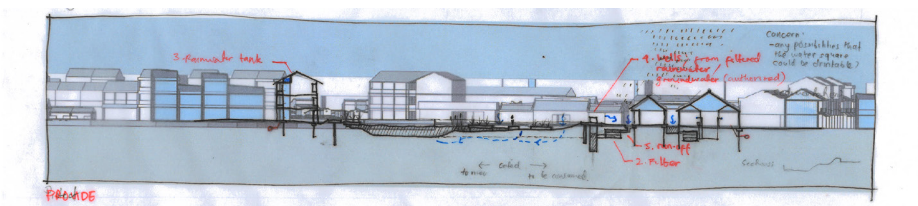












Flush and Splash:

Regenerative Capacity for Semarang Urban Water Management

Prinka Anandawardhani

July, 2020