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DESIGNING A RESILIENT LANDSCAPE FRAMEWORK THAT FACILITATES WATER SAFETY AND BATIK DEVELOPMENT IN PEKALONGAN CITY

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Designing a resilient landscape framework that facilitates water safety and batik development in Pekalongan city

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I would like to show my great thanks to my mentors, Stefen and Taneha, for their patience, support and trust. They give me the freedom to develop my interests. They helped me out from chaos and trouble with their solid knowledge and inspiring ideas. They are always kind, encouraging and helpful. Thanks to them for accompanying my journey of discovery and learning.

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ABSTRACT

Keywords:

Resilient coastal landscape; Research by design; Water safety; Batik; Pekalongan

As one of the most important ecosystems on the planet, the coastal zone accommodates a more dense population than the hinterland and faces faster urbanization and higher population growth. Meanwhile, the coastal zone is exposed to several climate change disasters in the context of a sensitive environment dominated by water. It is considered with limited resources and capacities to respond to stress, thus the coastal zone is also one of the most vulnerable ecosystems.

This master thesis in Landscape Architecture focuses on the Northern Java island, specifically Pekalongan city, Indonesia. The local see a dilemma between natural resources and batik development, for this dominant industry is highly reliant on water. Pekalongan people actively fight against natural disasters and try to boom the cultural significance. But, without understanding the natural process and resilience thinking, the interventions are slightly ineffective, and even could be counterproductive from a long-term perspective.

Therefore the objective of the thesis is to create a resilient landscape framework to facilitate water safety and batik development in Pekalongan city by focusing on the three dominant water-related design assignments, known as water circulation, discharge capacity, and coastal protection. Moreover, the project aims to consolidate and enhance the cultural significance of batik and raise awareness of landscape potentials.

Under the resilient landscape theoretical framework, with the guidance of landscape-based solutions, the project seeks to build a new relationship between people and nature to mitigate the threats of climate change disasters and batik development from a long term and sustainable perspective. Design research and research by design provide the methods to conduct the investigations.

The design work is conducted in three different scales, proposing strategies on a regional scale; detailed elaboration on selected sites; infrastructure design. Besides, a toolbox is also included to provide inspirations and glues for coastal zones which face similar threats and dilemmas as Pekalongan city.

I RESEARCH BASE

01 INTRODUCTION

Located on the water-dominant area and known as Kota Batik,
the city has a diverse landscape and is well known for its batik.

1.1 Nature

The study area, Pekalongan, locates on the northern coast of Java island. Meanwhile, it is also the central point of Java island.

-Geographical conditions

Geographically, the city locates in the downstream area of the Kupang watershed with an average height of around 1 m above sea level. The highest point of the city is about 6.5 m above the Java sea. The Dieng plateau at the South is 2000 meter in height and the Java sea is at the North of the city.

Monsoon weather dominants the city. It is the typical rainforest climate there with little rainfall from June to October and intense precipitation from November to May.

-Water network

As a coastal city, Peklaongan has a close relationship with seawater and freshwater. Four watercourses are within the city territory nowadays, they are Meduri River, Bremi River, Pekalongan River and Banger Canal. Pekalongan River goes through the city and functions as the main drainage of Pekalongan city. Besides, secondary and tertiary networks including subsystems and drainage channels consist of the complete drainage system.

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1.2-Culture

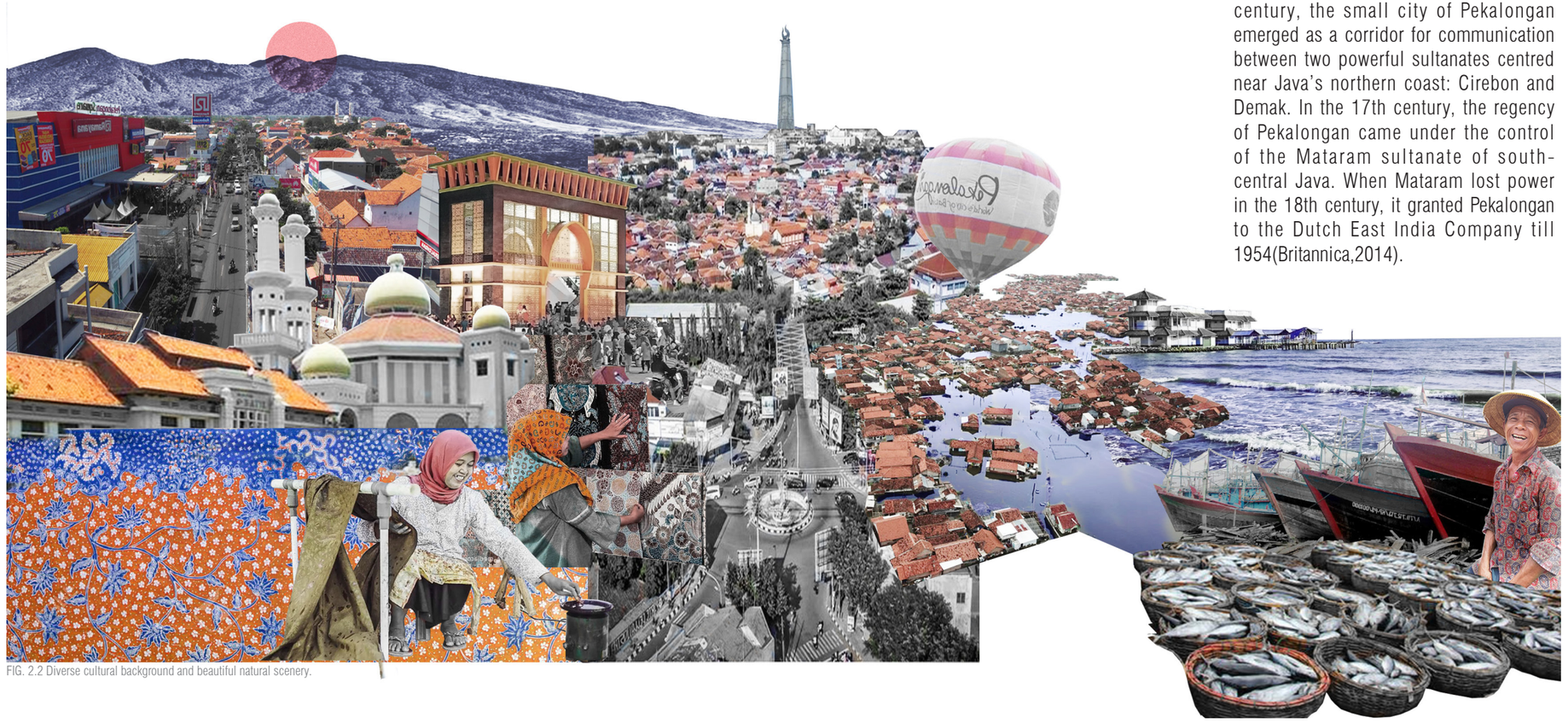

FIG. 2.2 Diverse cultural background and beautiful natural scenery.

-History
The history of Pekalongan dated back to the early 12th century. It was then a seaport of Java(Wikipedia, 2021). In the 15th–16th century, the small city of Pekalongan emerged as a corridor for communication between two powerful sultanates centred near Java's northern coast: Cirebon and Demak. In the 17th century, the regency of Pekalongan came under the control of the Mataram sultanate of south-central Java. When Mataram lost power in the 18th century, it granted Pekalongan to the Dutch East India Company till 1954(Britannica,2014).

-Livelihood
Fishery and batik are the most important industries in Pekalongan city.
Pekalongan Harbour, which lies within the city limits, is one of the principal fishing ports on Java. The coastal environment and sufficient water make the city thrive for aquaculture. The city itself is home to one of the island's largest fresh-fish markets.
Besides, the city has a long history of batik. With the increasing demand for batik internationally and domestically, now the dominant industry in Peklaongan is batik. Besides, it also activates other industries related to it like the manufacture of chemicals and tools.

-Population
The current metro area population of Pekalongan in 2021 is 317,000, a 1.28% increase from 2020.
The population of Pekalongan city is primarily Javanese, with a notable ethnic Chinese minority, particularly in the city(Britannica,2014).

Reference

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-Pekalongan, Indonesia Metro Area Population 1950-2021. (n.d.). MacroTrends. https://www.macrotrends.net/cities/21466/pekalongan/population

02 FASCINATION

The local people have taken many measures,
but the situation is even getting worse

FIG. 2.1 The local cannot stand up straight within the house in 2020.
Source: *Rising Threats From the Sea*, https://www.youtube.com/watch?v=foXMXCAgKq4, edited by the author.

2.1-Water

Peklongan locates where the seawater meets with fresh water from the Dieng plateau.
The location also contributes to the intense precipitation in the rainy season.

FIG.2.2 Storm surge in Pekalongan city.

2.1.1Seawater + Pekalongan

"People who have little money just manage to raise the floor of their home and now they cannot stand up straight within their house."

FIG.2.3 Bricks and tiles used to raise the floor.

FIG.2.4 The local cannot stand up straight within the house in 2020.

FIG.2.2, Storm surge in Pekalongan city, Source: https://otomotifnet.gridoto.com/read/232179885/jeep-wrangler-tak-goyah-disembur-ombak-2-meter-pekalongan-dikepung-banjir-rob

FIG.2.3 Bricks and tiles used to raise the floor, Source: *Rising Threats From the Sea*, https://www.youtube.com/watch?v=foXMXCAgKq4.

FIG.2.4 The local cannot stand up straight within the house in 2020, *Rising Threats From the Sea*, Source: https://www.youtube.com/watch?v=foXMXCAgKq4.

FIG.2.5,FIG.2.6 Historical map of Pekalongan, *Google Earth* Source: https://earth.google.com/web/@-6.88981563,109.67459166,-56282.28832987a,73258.46256089d,35y,0h,0t,0r?utm_source=earth7&utm_campaign=vine&hl=zh-CN

FIG.2.7 The city faces with more flooding, Source: http://www.kebumenekspres.com/2017/06/banjir-rob-rendam-9100-rumah-di.html

Like any other coastal city, Pekalongan is facing rising sea level, but three times the average global sea level rising speed. The sea level rises from 6cm to 10cm per year(Kemitraan,2016) and at some location, the land sank at a speed of 34cm per year.

To adapt to the more frequent inundation, people raised their floor half-meter every five years to prevent water from getting into the house(DW Documentary, 2020). The poor can only afford to raise their floor and that leads to the circumstance that they cannot stand up straight within their house after ten years of raising the floor.

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2.1.2 Fresh water + Pekalongan

"The flow capacity of the Pekalongan river decreased by 19.33% since 1989 after the construction of the Banger canal. The city is facing more flooding"

FIG.2.5 Pekalongan river in 1987.

FIG.2.6 Banger canal built in 1988 and a new pass by built in 2003.

FIG.2.7 The city faces with more flooding.

Besides seawater, people also struggle with rainwater and water from the upper stream. Several rivers flow through the city and end into the Java Sea, with the Pekalongan River as the main discharge course in the city.

-Phase I: The rapid urbanization of the city has resulted in settlements and roads encroaching on the river channel, limiting its capacity, and resulting in regular flooding.
-Phase II: To adapt to the situation, the Banger canal was built in 1989. The overflow of water that exceeds the carrying capacity of the Pekalongan River is very large but the Banger Channel, which has an adequate surface, only accommodates less than the average capacity as a result of sitting in the corner of the Kupang-Pekalongan River.

-Phase III: What's more, because the water from the upper stream was dispersed, sediments originating from the Pekalongan watershed cannot be carried along with the river flow and cause a rise of the riverbed of the Pekalongan river.
-Phase IV: Because of the flood incident around 2003, Since 2004, the two rivers became two estuaries. The condition caused a negative impact on sediment in the river mouth.
And now, the city is facing more flooding.

The natural living environment in Pekalongan is closely related to seawater, freshwater and rainwater.

2.2-Batik

UNESCO has declared Indonesian batik as a world heritage since 2009.
It made the demand continue to increase and directly proportional to the growth of the industry in the Batik city Pekalongan.
But, at the same time, it aggravates the freshwater shortage.

-History

Batik has a long history in Pekalongan since 1800, then there was a significant development after the great war of 1825-1830, the Diponegoro War (Devi,2020). Many people were urged to leave the kingdom and spread to the east and west. As a result, Pekalongan has become the most developed area of the batik industry and named Kota Batik.

-Dominant industry - Family mode

Batik is the principal livelihood of the people in Pekalongan that employs 75% of working adults in this area and generates a lot of economic chains, like the supply of fuel, production of pens and stamps etc. In 2014, Pekalongan City has 917 batik industries and 90% of batik activities happened in family mode (Budiyanto et al., 2018). The batik industry in the City of Pekalongan does not gather at one point but is spread over several points as if it centred.

-Social significance

Batik is not only an economic activity here, but it also evokes development in all aspects. Based on cultural heritage, the citizens, especially women got their places in this dominant industry and improve their life qualities in all aspects.

-Against nature

Physically, Pekalongan city locates in an area with sufficient groundwater. Within three-meter beyond the ground, freshwater exists. Whereas, with the overwater extraction to support the batik industry, they were forced to abandon their wells because the water becomes brackish.

FIG.2.8 Batik is a representative of Pekalongan city.
Source: https://id.m.wikipedia.org/wiki/Berkas:Solo_Batik_Carnival.jpg

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FIG.2.9 Water extracted from the ground was the dominant water source for the batik industry.

FIG.2.10 BPBD is distributing clean water in viallage affected by droughts and pollution.

FIG.2.11 River water in Pekalongan always change colors due to the batik industry.

FIG.2.9 Water extracted from the ground was the dominant water source for the batik industry.
Source: https://www.posjateng.id/warta/pemkab-pekalongan-alokasikan-rp200-juta-untuk-sumur-pompa-b1Xoo9crH

FIG.2.10 BPBD is distributing clean water in a village affected by droughts and pollution.
Source: https://radarpekalongan.co.id/84452/pemkab-pekalongan-akan-manfaatkan-embung-untuk-persediaan-air-bagi-warga/

FIG.2.11 River water in Pekalongan always change colors due to the batik industry.
Source: https://jateng.tribunnews.com/tag/limbah-batik

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2.3-Batik & Water & Pekalongan

Due to located in the water-dominant area, water influences Pekalongan's spatial structure and supports cultural and economic activities.

The unique geological distribution decided the close relationship between water and Pekalongan city. Located in this water-dominant environment, Pekalongan is heavily affected by water features, not only spatially, but the water here is also important to economic activities.

Under the effects of dynamic water and human intervention, the city witness changes in the coastal zone and watercourses. Besides, people also experience changes in their daily life like the different ways of water supply.

The water here also provides people with a living, supports industry like batik and fishery. And that somehow also put an effect on the city's spatial development and urban expansion.

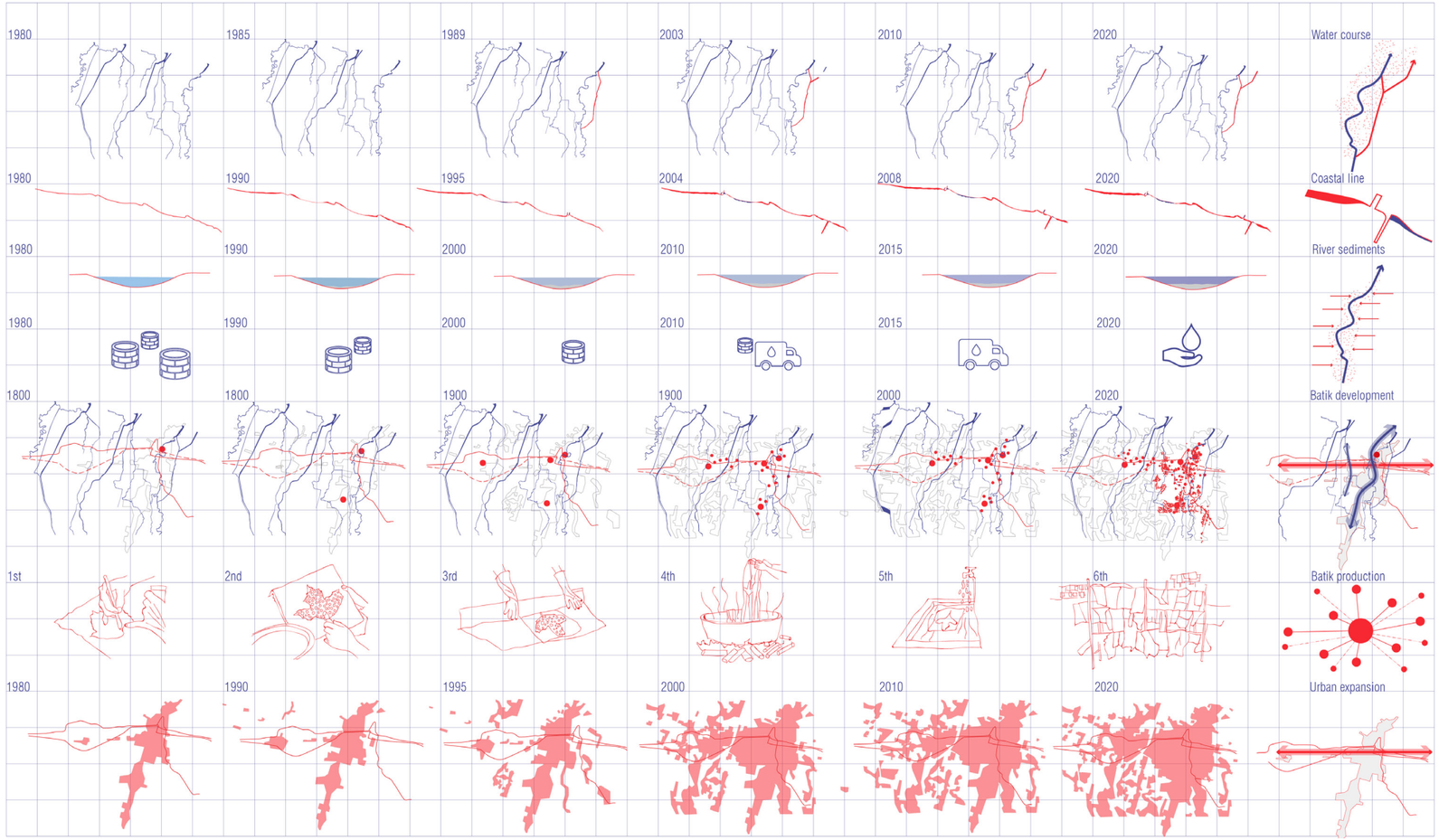

FIG.2.12 Pekalongan city develops over the past decades in all aspects.

-Watercourses:
One by-pass canal and one short-cut were added to the natural water system aimed at getting rid of water in the rainy season.

-Coastal line:
Due to the storm surge, inappropriate protection and overdevelopment, the coastal line lost a lot of soil, and there is serious erosion.

-River sediments:
Garbage disposed of carelessly by the people into the water channel, together with sediments from the upper stream, cause clogging and the flow of water is not smooth.

-Water supply:
The overwhelming water extraction put Pekalongan city in the crisis of freshwater scarcity, especially in dry seasons. People no longer can use the water extracted water the well.

-Batik production & development
The traditional batik production includes six steps. This industry puts effects on spatial structure from urban scale to house plan. The batik industries are spread over several points as if they were centres.

-Urban expansion
Pekalongan saw a significant urban expansion during the past decades. It expands a lot in the west-east direction, along the two main traffic lines which connect it to other cities.

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2.4-Conclusion

The unique water-dominant geography provides many opportunities, but at the same time, it brings a lot of threats.

The Pekalongan people are actively fighting against natural disasters and tried to boom their cultural significance. But, from all the above stories, the results are opposite to what they intend to achieve. Their interventions even make situations worse.

So what exactly causes this, and what is the future will be like in the city ? And what is the ideal relationship between nature and human ?

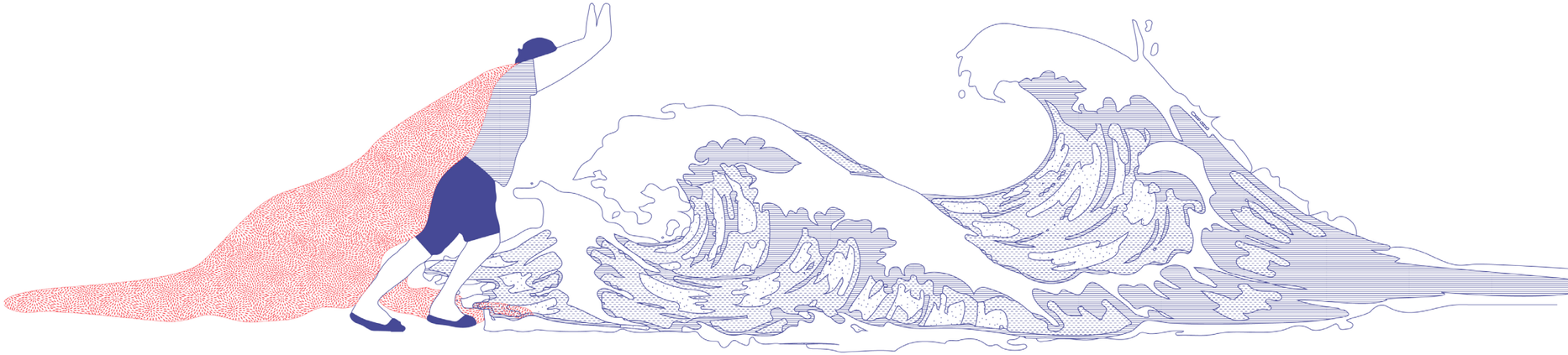

FIG.2.13 People is turning them against nature in Pekalongan.

Reference

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03 PROBLEM FIELD

People changed the way how nature works.

FIG.3.1 A helpless woman in flooding.
Source: https://www.aleqt.com/2020/01/04/article_1740096.html, edited by the author.

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3.1-Causes

3.1.1Human Intervention

People changed the pattern of the land.

Pekalongan city locates within 15km of the coast, and in the downstream area of the Kupang watershed. The city is about 45km from the Dieng Plateau. In the middle and upper stream area, there are fewer settlements than in the downstream area.

By comparing the nature pattern with the one interfered with by humans, it is easy to tell people made so many changes. And that makes nature does not function as before.

-Human intervention

The coastal zone is mainly occupied by fish ponds and rice fields. The settlements/impervious zone is close to the coast, replaced previous wetlands. In the middle stream area, there is a great amount of agricultural land with villages expanding. The economical forest and agricultural land occupy the upper stream area.

-The nature

The mangrove forest grows along the coast, protecting the land from erosion. The beach ridge behind rich the biodiversity. The wetland and shrubs in the downstream area help to absorb water. In the middle stream and upper stream area, the forests and wetlands retain great mount water in rainy seasons, helping to balance the runoff.

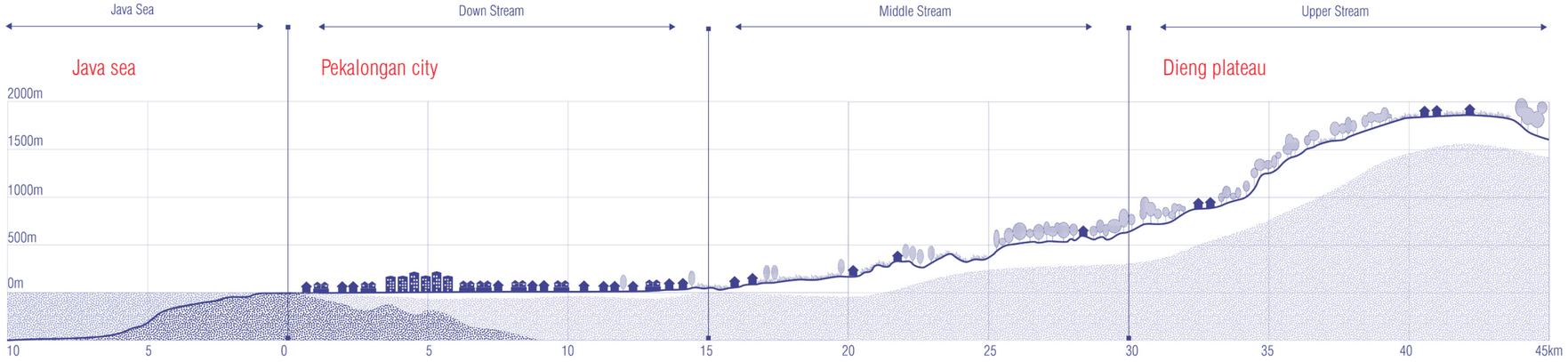

FIG.3.2 Section-From the Java sea to the Dieng Plateau.

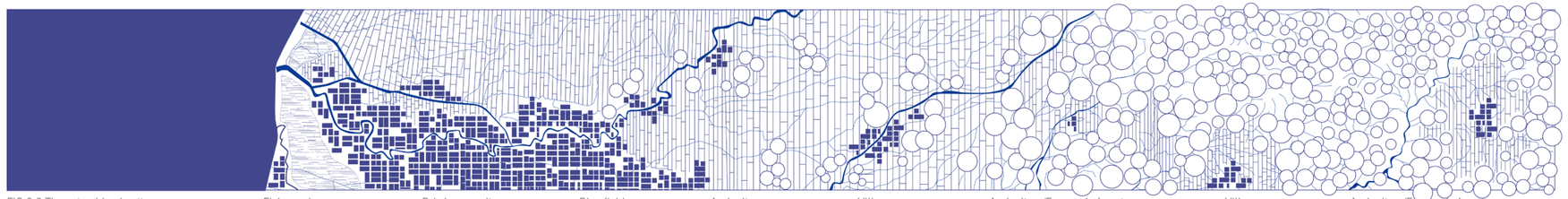

FIG.3.3 The natural land pattern.

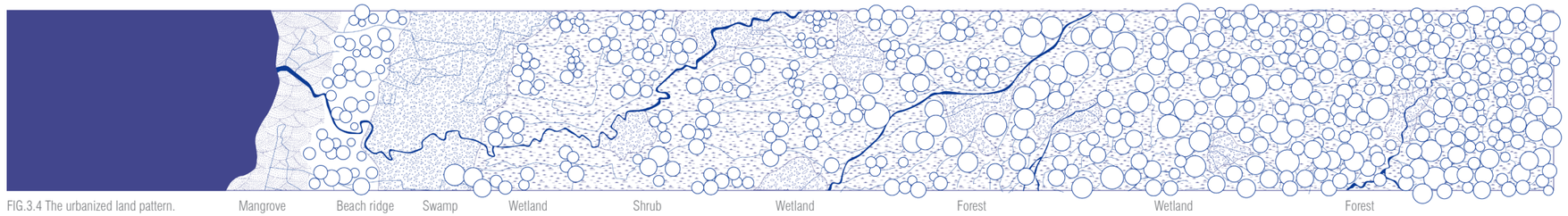

FIG.3.4 The urbanized land pattern.

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Urban expansion, agriculture development, aquaculture development and batik industry are mainly responsible for the landcover change in Pekalongan city.

-Urban Expansion

During the past decades, the city experiences a great expansion from north to south and also extends in the east-west direction, along the important traffic line. The land was changed into the impervious ground. The hydrological infrastructure made also made an influence on Pekalongan city.

-Agriculture Development

In the 1960s, there was an increasing demand for food, thus a lot of wetlands is turned into agricultural land (Priyanto, 2010).

-Aquaculture Development

Located on the north coast of Java with the first fish port, aquaculture has an important role in the economic development of Pekalongan City. In the 1980s, the great development of fishery increases the degradation of the coastal zone, especially the mangrove forests(Priyanto, 2010).

-Batik Development

Batik has been a cultural significance in Pekalongan city for a long time, and UNESCO's declaration makes a great increase in the batik market. A lot of forests was cut down for fuel in batik production.

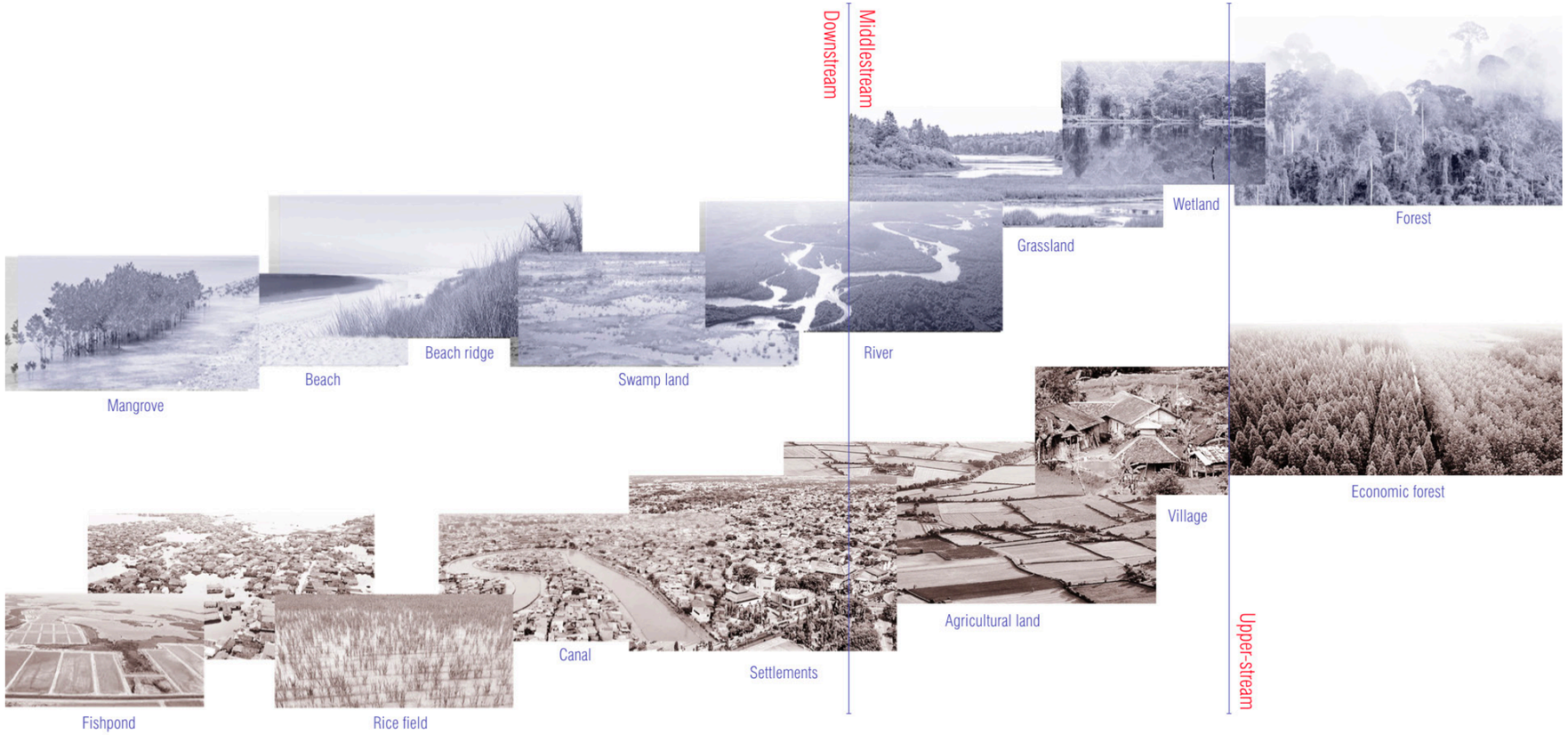

FIG.3.5 Comparison of nature and urbanization

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3.1.2-Natural Force

Nature plays quite an important role in this area.

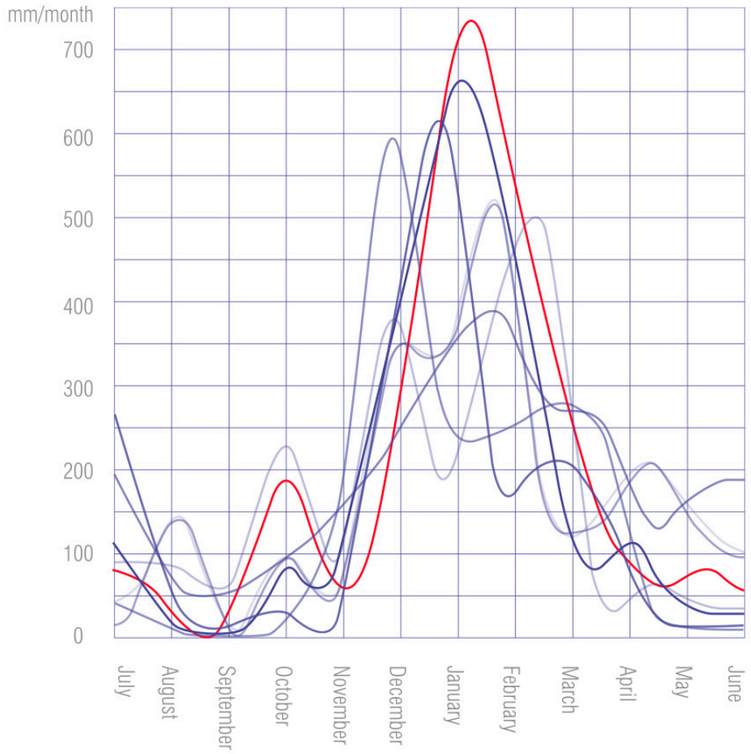

FIG.3.6 The precipitation changes during the last decade.

-More intense and shorter precipitation

Research shows the precipitation in Pekalongan City has changed in 40 years period (Pekalongan city government, 2016). There is more intense precipitation during the rainy season while the period is shifting into a shorter one.

A shorter rainy season is suspected in the future, from November to January, accompanied by an increase in flooding intensity due to the intense precipitation.

Correspondingly, the dry season will become longer with a little amount of rainwater, which means it likely to happen with prolonging droughts and freshwater scarcity.

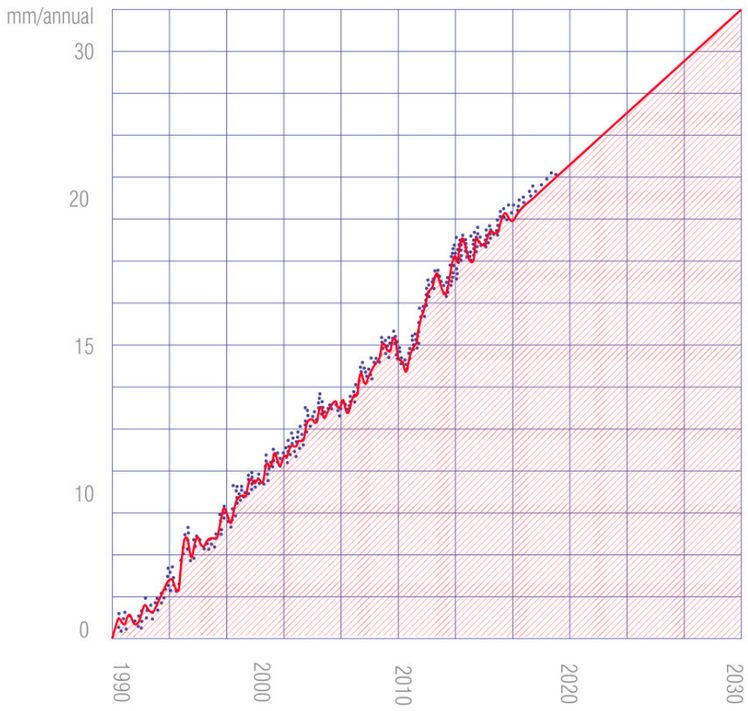

FIG.3.7 The speed of rising sea level.

-Rising sea level

The north coast of Java, including Pekalongan city experience serious problems of sea-level rise caused by climate change. The rate of decline in the soil reaches between 8-13 cm/year at the north coast of Java, and according to observation sea level rise at a speed of 12.83 mm/year 2009-2011(Cahyadi et al., 2016). The rate of sea-level rise in Pekalongan city is three times the global average rate(DW Documentary,2020).

In 2030, this number is projected to increase up to 22.5±1.5 cm annually; and in 2100, sea-level rise in Pekalongan City is projected to reach 0.8 m(Pekalongan City Government, 2016).

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3.1.3-Conclusion

Both human interventions and climate changes have posed huge influences on Pekalongan city.

-Coastal area

The rising sea level, storm surge and intenser precipitation make the coast environment very vulnerable. Human's activities, like mangrove logging, overdeveloped fishponds, accelerate the disasters in the coastal zone.

-Downstream area

The impervious pavement, improper hydrological infrastructure, water extraction, wastewater discharge and intense precipitation aggravate the hidden dangers of downstream areas, especially water safety issues.

-Middle stream area

Logging is the most serious problem in the middle stream area. It does not only cost a loss in the middle stream biodiversity but also has a huge effect on the downstream area.

-Upper stream area

The loss of forest in the upper stream area puts a huge effect on the water retention function. And for sure the biodiversity decrease because the single spices economical forests

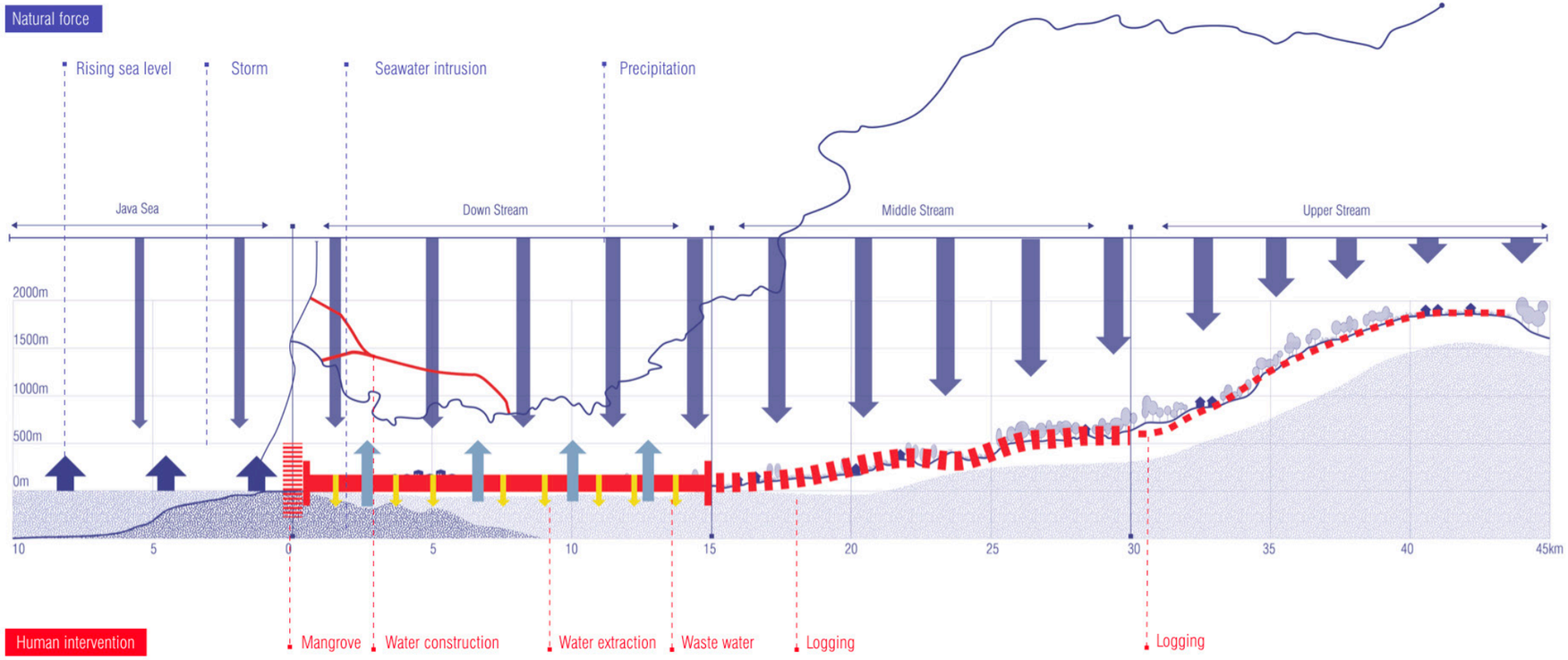

FIG.3.8 The natural forces and human interventions.

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3.2-Threats

Now Pekalongan city is facing serious challenges,
as a consequence of human intervention and climate change.

-Coastal area

Over-development on the coast zone accelerates seawater intrusion and coastal erosion. With the continuous rising sea level, in 2050, the maximum inundation water level could reach 135 cm and consequently affect 913.8 Ha area.

-Downstream area

Overflow from the Pekalongan River causes 50-100cm inundation in many communities in wet seasons. The city does not have reliable surface water sources because the rivers are highly polluted, the situation even worse in the dry season. And the water extraction accelerates the land subsidence.

-Middle stream area

The rice fields and fields in the middle stream area are affected by the seasonal shift, suffering from unbalanced water, and eventually, cause food crises. Logging imposes the area danger of landslide. With insufficient sponge capacity, the middle stream area is also prone to flooding.

-Upper stream area

With the great amount of forest loss, the upper stream area suffers from a water retention decrease that causes seasonal droughts and landslide.

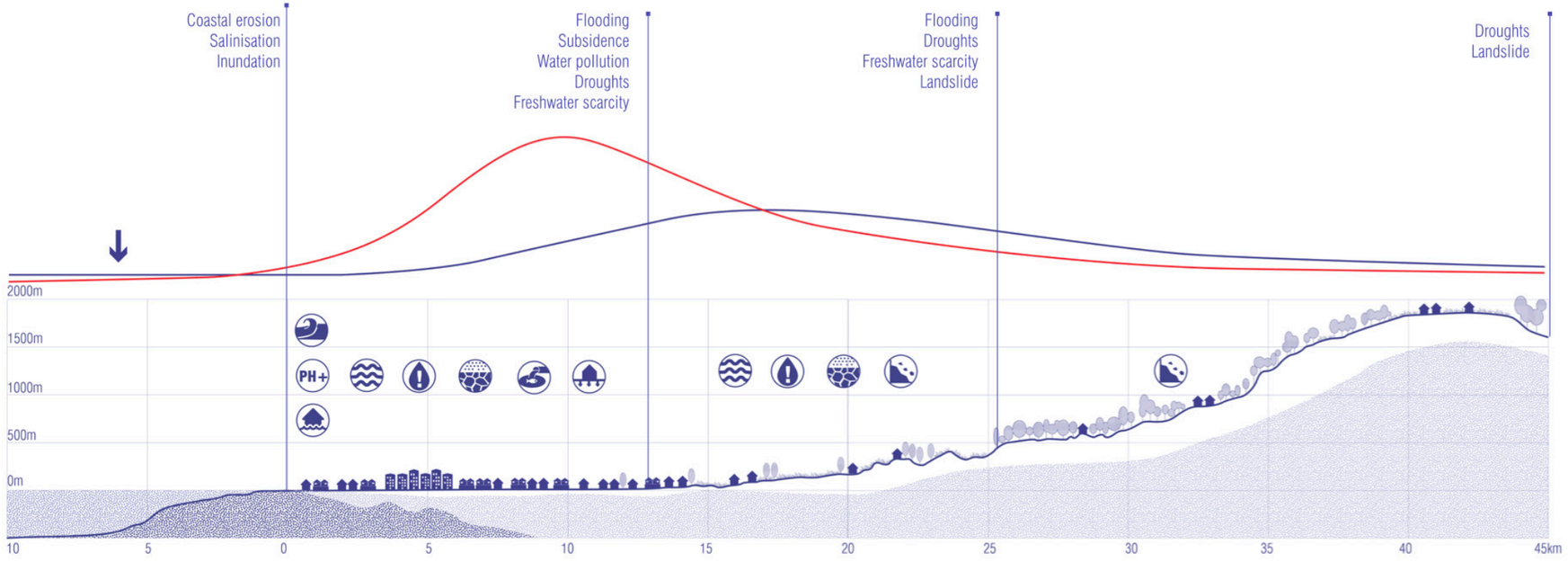

FIG.3.9 The challenges and threats.

Due to the geological conditions, different parts of the Kupand watershed are suffering from different problems and challenges brought by human interventions and climate change.

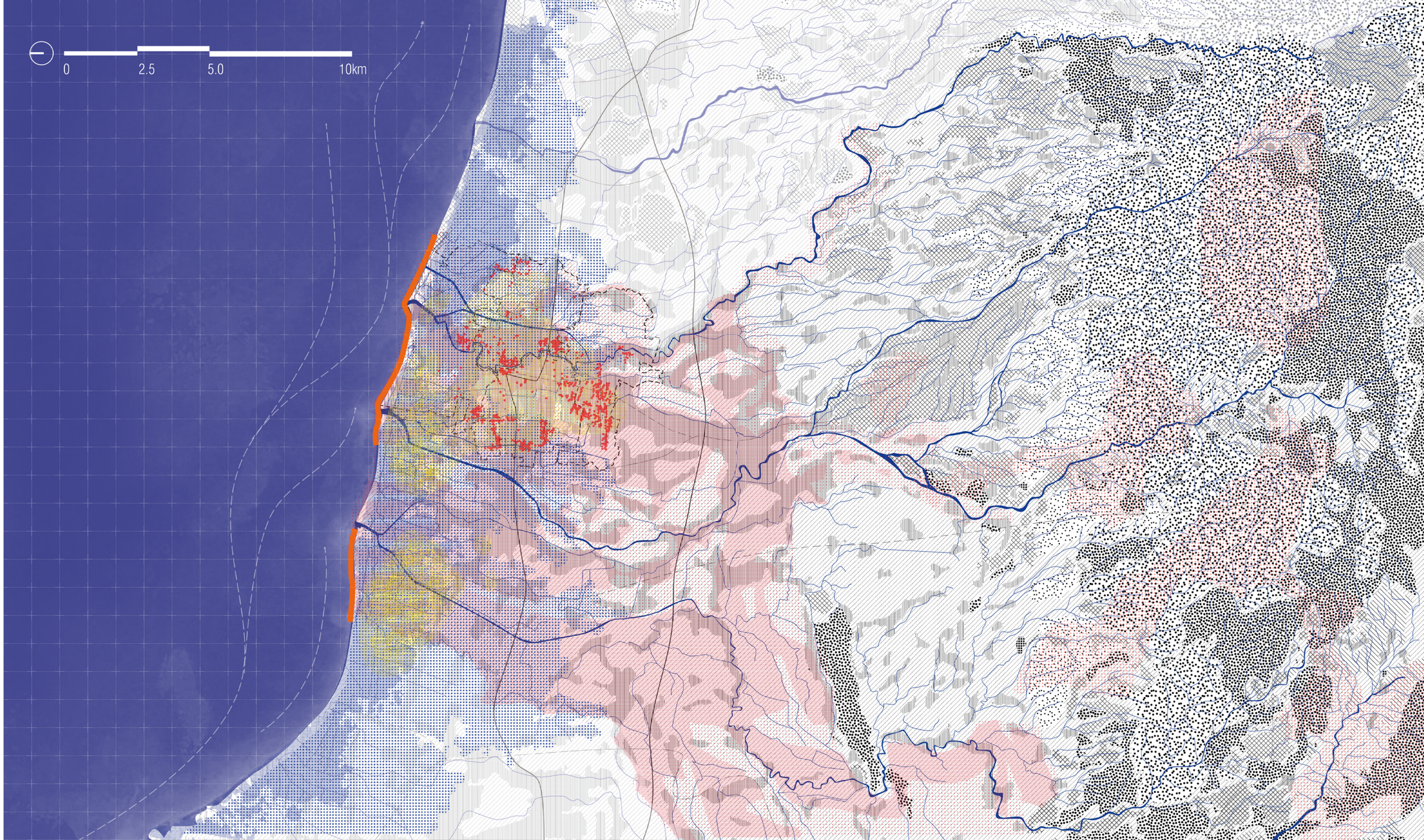

FIG.3.10 Map of the challenges.

3.3-Problem Statement

In general, problems are described in three categories, (1) The city is facing severe water safety issues, (2)The conflict between the batik development and natural resources and (3)the potential of natural resources and potential are ignored.

-Water safety-
Located on the interface of Java sea and Dieng plateau, Pekalongan city is facing water-related disasters. The threats from the ocean caused by dramatic climate change and human activities include tidal floods, rising sea level, storm surge and seawater intrusion. Meanwhile, the water from upper steam and intense precipitation caused serious and more frequent flooding within the city while also resulted in a longer droughts period.

-Dilemma between cultural development and natural resources-
Batik is the dominant industry in the city. The traditional way of batik production is highly reliant on water. The sensitive and unstable water conditions sometimes make batik production impossible, because of lack of water supply or severe flooding. At the same time, the industry causes severe water pollution. 95% of the water used in the production process will be discharged into river systems, mixed with rainwater, without any treatment.

-Potentials of the landscape are ignored-
The locals actively fight against natural disasters by elevating the floor, building bypass and dikes. The y fail to make use of natural conditions and forces. The potential of landscape, including the mangrove ecosystem, the rainfall, the water flow and the soil etc. are ignored.

The current measures were conducted partially. Without understanding the natural process and resilience thinking, the interventions are slightly ineffective, and even could be counterproductive from a long-term perspective.

All the above problems threaten people's life, affect the city's economic development and also cause harms to the local ecosystem and put the whole system into a vicious circle.

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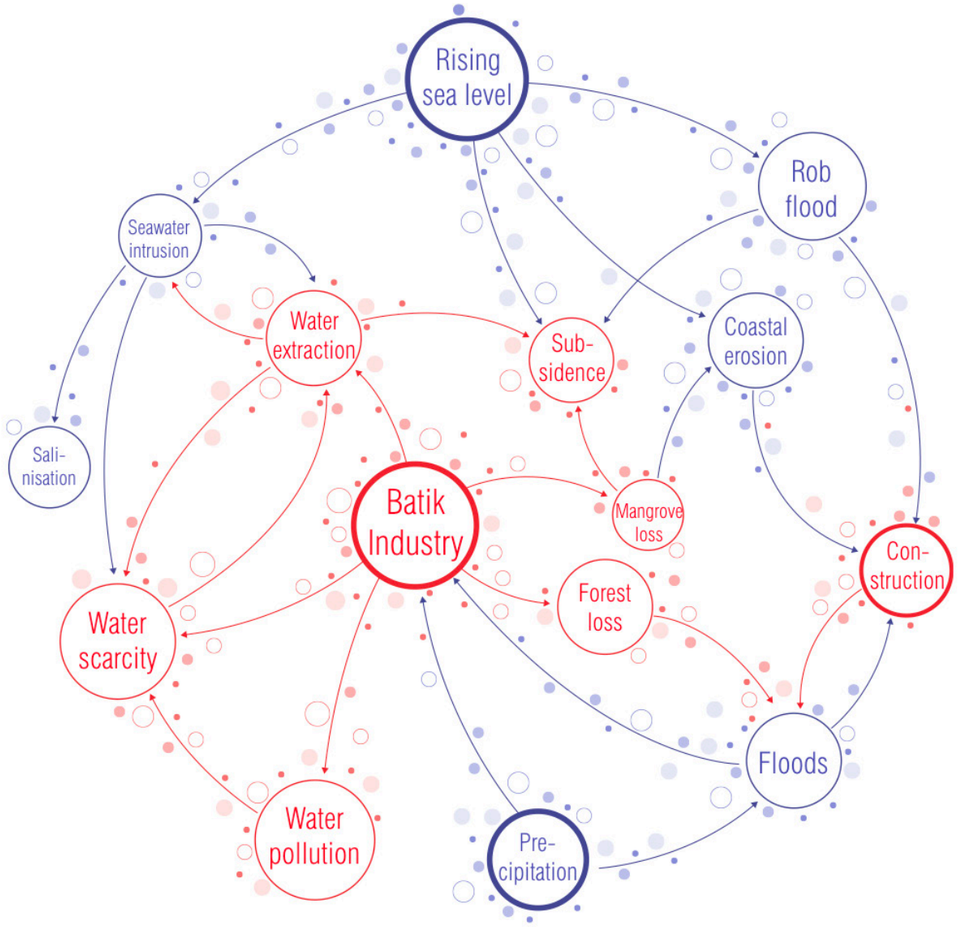

FIG.3.11 The logic map of causes and challenges.

04 RESEARCH STATEMENT

How to improve the relationship between human and nature?

FIG.4.1 Banger canal in the dry season is full of garbage, 08/10/2018.
Source: https://jateng.tribunnews.com/2018/10/08/tercemar-kondisi-kali-lohji-kota-pekalongan-semakin-memprihatinkan
Edited by the author.

4.1-Objective

Based on the understanding of Pekalongan city, the research objective as follows, and five sub-research questions were raised to better develop the thesis.

How to develop
a resilient landscape framework
that could facilitate
water safety
and cultural **batik development**
in Pekalongan city.

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4.2-Research Questions

①	To understand the study location and the water-batik system.	What is the water safety issue, and the interconnection with the Batik industry?
②	To understand resilience and its practical meaning in Pekalongan city.	What does resilience mean for water safety and batik development?
③	To build up the toolbox for more in-depth research and design.	What are the principles to increase water safety?
④	To explore the site-specific characteristics and address the specific challenges.	How to apply the strategy and principles within the cultural and natural conditions of Pekalongan city?
⑤	To explore the spatial structures in the terms of landscape view of the strategies.	How to generate the spatial potentials in different scales in the terms of landscape view?

05 METHODOLOGY

To achieve the objective, it is important to understand the context and choose the proper approach. Therefore the thesis applied one theory and three methods&approaches as a foundation. **(1) Landscape resilience** provides the theoretical framework and guidelines, On the other hand, the combination of **(2)Design research** and **(3)Research by design** provides a systematic approach to understand the context, investigate study area, summarize toolbox and conduct the actual design. **(4)Landscape-based solutions/Landscape approach** indicates the design methods.

FIG.5.1 The batik element is everywhere in the city.
Source: https://explearth.org/pekalongan-batik-city/

5.1-Theoretical Framework

"More recent thinking about change, disturbance, uncertainty, and adaptability is fundamental to the emerging science of resilience, the capacity of systems to reorganize and recover from change and disturbance without changing to other states--in other words, systems that are "safe to fail." "

Ahern, J. (2011).
From fail-safe to safe-to-fail: Sustainability and resilience in the new urban world.

Resilience: In 1973, the ecologist Crawford Holling first described the concept of resilience, according to his definition, resilience is the ability of the ecological system to absorb change and disturbance(Holling, 1973), being able to remain in the original state and balance. With years' development, the application of resilience has gone far beyond its initial definition, more frequently apply to the social-ecology systems (Beller et al., 2015), in addition to the ecological system. Besides the ability to absorb disturbance, recovering from disturbance without changing to another state is also important. More explicitly, resilience grants systems become “safe to fail” (Ahern, 2011).

Landscape: The evolution of landscape decides its characteristics as heterogeneous spatial entities. So the landscape is going to experiencing disturbances that are different in terms of types, frequency, intensity. (Ahern, 2011). Thus the non-equilibrium opinion counts to landscape architecture planning and design.

Landscape resilience: Therefore landscape resilience could be described as “the ability of a landscape to sustain desired ecological functions, robust native biodiversity, and critical landscape processes over time, under changing conditions, and despite multiple stressors and uncertainties”(Beller et al., 2015).

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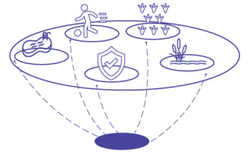
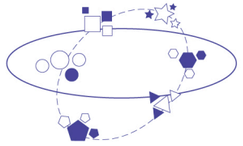
According to Ahern(2011), there are five design strategies for building resilience to address the dynamics between nature, society and also the planning process. The five strategies are:

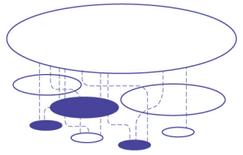


-Multifunctionality
Multifunctionality means achieving different functions in different timing/conditions by combining or intertwining functions.
It finds a way to ensure sustainable ecosystem service in compact spaces and benefits by support from different stakeholders regarding the diversity in functions it provides.

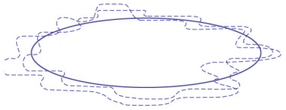
-Modularization & Redundancy
When multiple elements in one system can provide similar or backup functions, the system is modularised and redundant. Compare to a centralized entity or infrastructure, this distributed system allows more dynamics and failures for it spreads the risk across time, space and systems.



-Bio & Social Diversity
When a larger number of species provide the same or similar eco service, the system is considered to be sustained over a wide range of expectations and has a better capacity to recover from disturbances without flipping into other conditions. In the same vein, the social-economical system which is more diverse will be sooner recover from socio-economic disturbance.



-Multi-scale networks and connectivity
Network and connectivity through multi-scales are important especially the planned function operating at multiple scales. It builds up connections from small scale to large scale. Arguably, network and connectivity help decrease the fragmentation of landscape elements and ensures the ecological process. Multiple connectivities are more sustained in changing environments than in a single network.



-Adaptive planning and design
Since it is always difficult to make decisions with perfect knowledge, the adaptive design allows the opportunity to “learn by design” with uncertain disturbances. Under an adaptive mode, new knowledge is gained through continuous analysis and monitoring.

FIG.5.2 Five principles of resilience

5.2-Methods & Approach

"Research is seen as an activity to create verifiable knowledge that predicts or explains the physical, behavioural, aesthetic and cultural outcomes of design. "

Chenoweth, R. (1992)
'Research: hype and reality', Landscape Architecture Magazine

According to Stiles, the planning, design and management of landscape are the main activities in the wide definition of landscape architecture(Stiles,1994a,1994b). A multi-layer understanding is necessary for the three activities because they address different scales and they also overlap.
So under the complex situations, design research and research by design could be combined systematically to better understand the formative elements of landscape and guide the design assignment(Nijhuis and Bobbink, 2012).

5.2.1 Design research

By analysing the existing situations or precedents, design research provides object-specific or topological design knowledge. According to Nijhuis and Bobbink (2012), design research is often conducted in plan analysis and comparative analysis.

-Plan analysis
Plan analysis includes the analysis and descriptions of all aspects, including its functions and the way it has been made. Systematically, it can be distinguished in four general layers: basic form, spatial form, metaphorical form and programmatic form (Steenbergen and Reh, 2003; Steenbergen et al., 2008).

-Basic form: The change or the development in topography compared to the ground plan of the design.
-Spatial form: The dynamics in form and functions within three-dimensional landscape space.
-Metaphorical form: The connections between mythological images, architectonic structural forms and the natural element.
-Programmatic form: The functional layout and the movements.

Plan analysis provides a deeper understanding of the object, based on which landscape architect can grasp the principles for further design and intervention.

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-Comparative analysis

By comparing several landscape-architecture designs, specifically distinguishing composition elements, schemes and understanding the transformations, comparative analysis detach the determined objects from the generic context and become applicable to another context.

The comparative analysis could help provide the toolbox for design assignment by clarifying principles in their relation to the specific problem posed.

5.2.2 Research by design

Landscape design can be seen as a research strategy or a culture of thinking (Nijhuis & de Vries, 2020). Research by design answers the research question and produce knowledge through design exploration. It is a systematic process that involves analysis, synthesis and evaluation. The process leads to the solution while the solution also reflects on problems.

Three approaches specifically focused on concept/ context and program are considered as three categories of approaches of Research by Design(Nijhuis & de Vries, 2020).

-Design approach focused on the concept: Usually as a foundation of design, which is relatively intuitive and associative. Type, form and model are the key elements to focus on.
-Design approach focused on context: The characters of the place, whether tangible or intangible. How the current social, ecological, geographic context, etc. as the foundation to influence the future development.
-Design approach focused on the program: Indication and standards play the leading role in the approach focus on functions.

Depends on the objective of the research question, different approaches are chosen.

5.2.3 Nature Based Solution

Nature has its system functions well. Nature-based solutions refer to the sustainable measures to deal with global challenges including climate change, biodiversity loss and food crisis etc.
According to the IUCN Global Standard for NbS(2016), the use of nature for simultaneous benefits to biodiversity and human well-being is NbS.

“Actions to protect, sustainably manage and restore natural or modified ecosystems that address societal challenges effectively and adaptively, simultaneously providing human well-being and biodiversity benefits.”

(Cohen-Shacham,2016)

This document outlines eight preliminary practice principles to help benchmark progress.

“ i. NbS embrace nature conservation norms (and principles);

ii. NbS can be implemented alone or in an integrated manner with other solutions to societal challenges (e.g. technological and engineering solutions);

iii. NbS is determined by site-specific natural and cultural contexts that include traditional, local and scientific knowledge;

iv. NbS produce societal benefits in a fair and equitable way in a manner that promotes transparency and broad participation;

v. NbS maintain biological and cultural diversity and the ability of ecosystems to evolve over time;

vi. NbS are applied at a landscape scale;

vii. NbS recognise and address the tradeoffs between the production of a few immediate economic benefits for development, and future options for the production of the full range of ecosystems services;

viii. NbS are an integral part of the overall design of policies, and measures or actions, to address a specific challenge. ”

-IUCN global standard for NbS 2020

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5.3-Scope & Relevance

The outcome of the thesis represents a nature-based solution that provides a resilient landscape framework to solve the water safety issues while facilitating the development of social, ecological and economic aspects.

The design strategy provides a resilient and sustainable way to deal with three water-related problems, which are coastal protection, water circulation and discharge capacity. The integration of the three kinds of strategies is also explored for more regional development planning. Meanwhile, it also proposed new possibilities in terms of housing, aquaculture, industry and recreation based on the new landscape. The nature-based approach offers awareness for the decision-makers, stakeholder as well as citizens who are fed on this land to reconsider their relationship with nature.

In a broader context, the thesis responds to how nature-based solutions prepare the city, especially the most vulnerable coastal city to face the global climate challenge and find a balance between nature and man-made structure.

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II DESIGN RESEARCH

06 UNDERSTANDING

A more in-depth understanding of three **systems**, three **challenges**, five **potentials** and three design **assignments**.

FIG.6.1 A boy is washing the batik in the Pekalongan river.
Source: https://docplayer.info/65128833-Pemodelan-spasial-untuk-penentuan-lokasi-instalasi-pengolahan-air-limbah-ipal-batik-di-kota-pekalongan-jawa-tengah-putri-yasmin-nurul-fajri.html

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6.1-Analysis

For more in-depth understanding, three topics are explored:
(1)The water (2) The batik industry and (3) The relationship between water and batik.

6.1.1Water system- the Kupang watershed

Kupang Watershed mainly dominant Pekalongan city. In general, the upstream part is vegetated areas with the cover of fields, grass, shrubs and forests. The middle part is rice fields and fields, while the downstream is the settlement, ponds, and swamp.
With the fast urban expansion and agriculture development, landcover changes a lot

-Upper area: Plantation forest decreased, secondary forest increased.
-Middle area: Settlement increased more grassland and rice field
-Lower area: Settlement increased

The Kupang watershed has a forest area of 11.63%, and WHC (Water Holding Capacity) is 196.8 mm(Purnama et al., 2012).

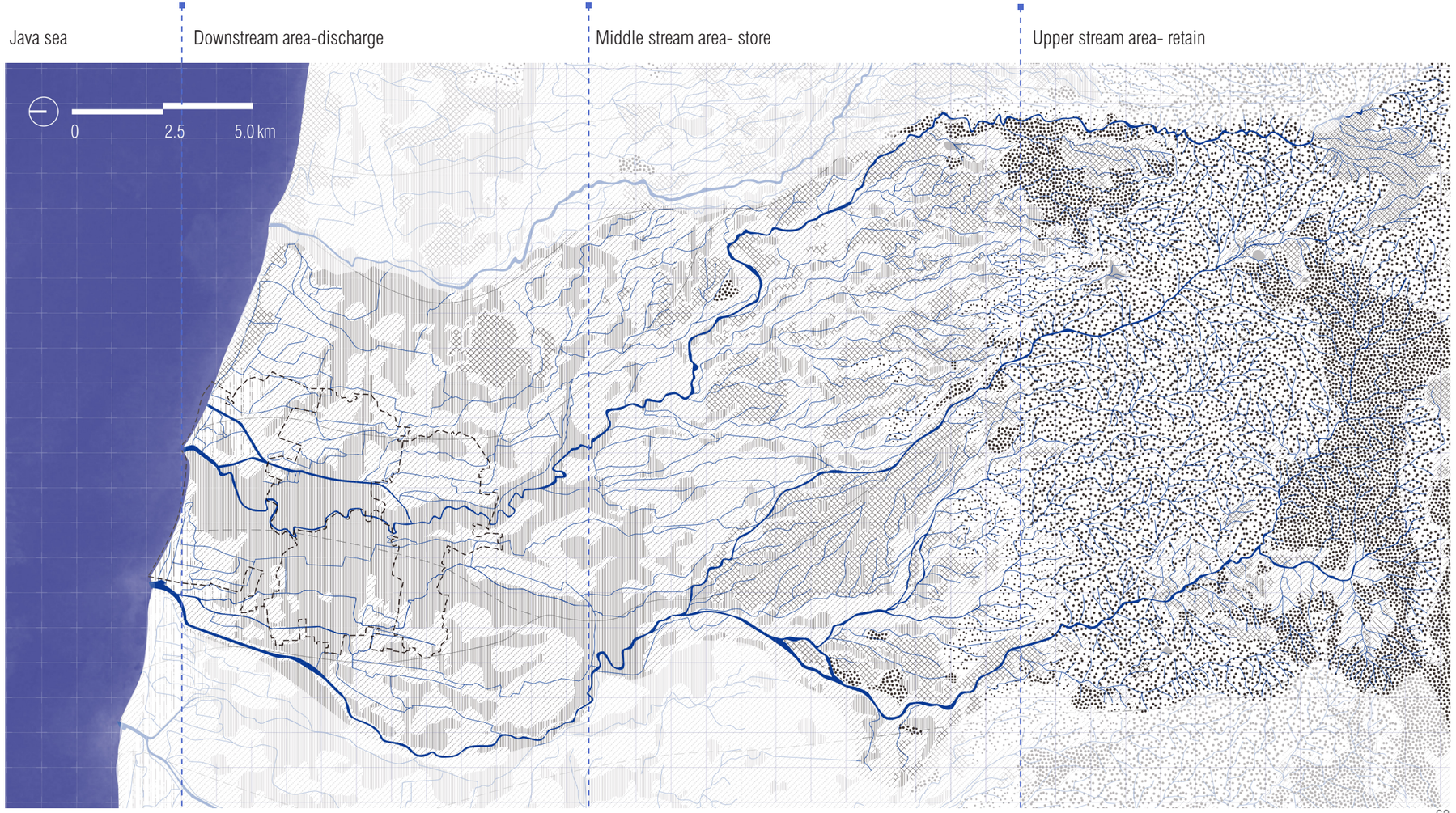

FIG.6.2 Different interventions at Kupang watershed.

FIG.6.3 Water system and water flows

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6.1.1 Water system - the downstream area

Located at the intersection of Java sea and downstream Kupand watershed, Pekalongan city has a complex water system for both natural and construction.

Constructed and natural water systems integrate at the downstream area of Dieng plateau. Generally, there are four water systems intersect in Pekalongan, (1)the North Java sea, (2)the rivers (Pekalongan river, Banger canal and Bremi River), (3)agricultural field irrigation/fishpond and (4)urban drainage ditches.

The Pekalongan river generates from the Dieng Plateau and flows to the North Java Sea. Most ditches discharge the water into the Pekalongan river, for it is utilized as the main drainage watercourse in the city, functions with Banger canal to discharge water into Java sea.

-(1)The North Java sea

In the past four decades, the coastline has receded by approximately 60 to100 meters (Yulianto et al., 2019), due to the rising sea level and also the mangrove degradation. The ecosystem and land use have been changed a lot along the coast.
The tide ranges between 0.2 to 1.0 meters, since there is no sluice between rivers and the Java sea when the tide is high, the seawater will pour into the river.
The rising sea level and poor defence cause loss in both biodiversity and the economy.

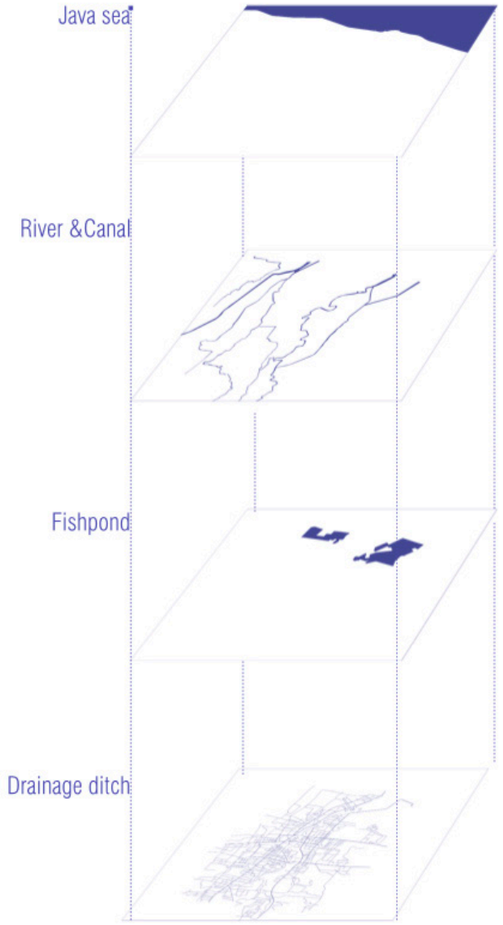

FIG.6.4 Four types of water the downstream of Kupang watershed

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-(2)Pekalongan river & Banger canal

Pekalongan river is a natural river derived from the Kupang river. It flows through Pekalongan city with a catchment area of 199 km^2.

Banger river is a constructed canal built in 1988, to relieve the pressure of the Pekalongan river, help to discharge water. In general, it is 40 m wide and 2 km.

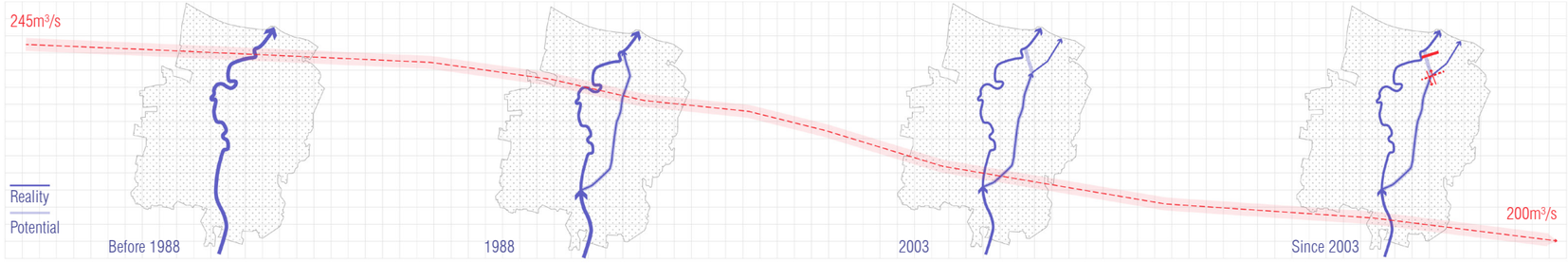

FIG.6.5 The development of water systems and the discharge capacity in Pekalongan.

Since1980s, the river course was continuously encroached due to rapid urbanization which companies with the construction of settlements and roads. The capacity is limited. Frequent flooding disrupts daily activities and economic activities.

In 1988, a bypass canal, the Banger canal was built to relieve the stress of the Pekalongan river. The elevation of the Pekalongan river bed is lower than the basic elevation of the Banger canal, the bypass does not function optimally and the water still empties into the Pekalongan river.

Research indicated that the flow capacity of the Pekalongan River has decreased by 19.33% since the construction of the Banger canal. One of the reasons is that the sediments start to gather in the river course because of the distracted water flow especially in dry seasons(DPU Kota Pekalongan).

In 2003, a floodway was created, it is hoped that when the annual peak discharge occurs, the river will not overflow. However, the shedding resulted in reduced flushing of the Pekalongan River so that sediment could not move into the sea, cause more sediments in the river course and resulting in more flooding.

-(3)Agricultural fields/ fishpond

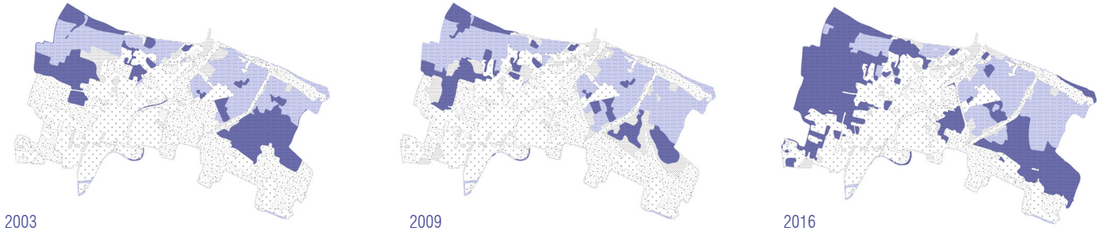

FIG.6.6 The fishery shrinks a lot due to the expanding inundation zone at the coast.

Due to the rapid urbanisation and serious seawater intrusion, the fishpond shrinks a lot in the past decade. A great amount of coastal zone became permanent inundation area. Due to economic development, people abandon the traditional way of agriculture, like the Tambak system and the silvo fishery system.

-(4)Drainage ditches:

The poor maintenance of drainage ditches is the most severe problems. Inhabitants throw their garbage away in the water which causes clogging. Roads and houses are built where not benefit the flow of the water. As a result, water accumulates in the drainage canals. According to Rifai(2020), 48% depth of some ditches is filled with sediment and rubbish, which eventually, causing overflows.

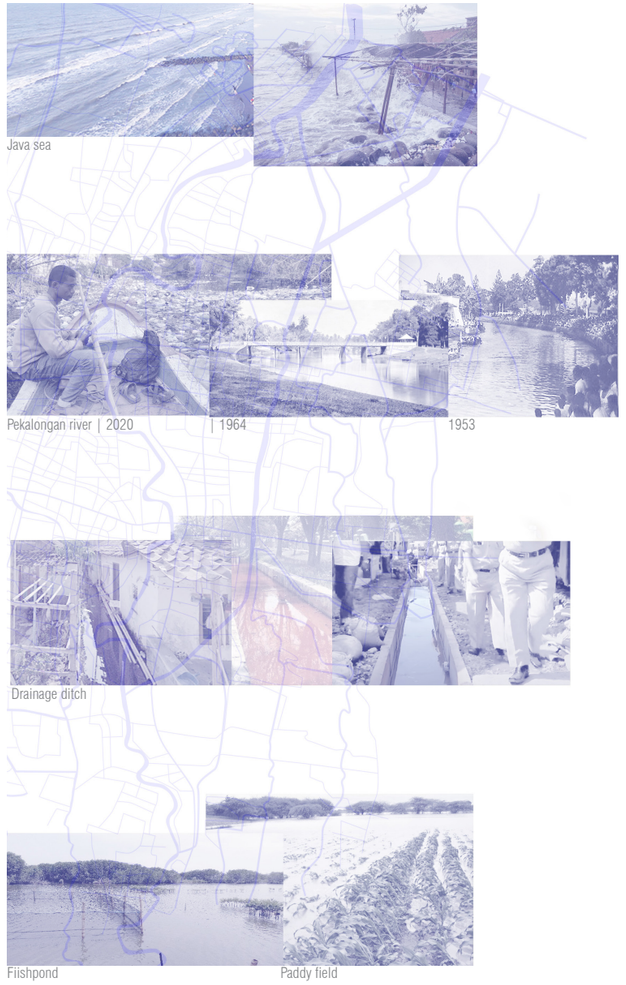

FIG.6.7 Perception of the water systems.

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6.1.1 Water system - Water quality

The water is polluted in Pekalongan, due to the untreated wastewater and the use of inorganic chemical dyes.

Research conducted on 13 samples of Pekalongan river water flow(Pekalongan river & Banger canal) showed that heavy metal content exceeds the maximum level of the quality standard established by Government Regulation No.82 of 2001 on Water Quality Management and Water Pollution Control. (Firmansyah et al., 2020)

Upstream: Pekalongan River and Banger canal are slightly polluted.
Downstream: Pekalongan river and Banger canal are severely polluted especially the part that passes through settlement with a lot of batik industries. (Budiyanto et al., 2018).

-Chemical dyes: Wastewater from the batik industry contains heavy metals. The chemical dyes are mainly responsible for heavy metal such as Cd, Cr, Pb, Co, Cu, Hg, Ni, Mg, Fe and Mn in the wastewater from batik production.
(Budiyanto et al., 2018)

-Lack of wastewater treatment: In Pekalongan, due to the high cost and poor awareness, only 0.6% (Fajri et al., 2013) of all textile industries have wastewater treatment plants and the other textile industries disposed of their wastewater into water bodies directly.

The wastewater from the batik industry and garbage made Pekalongan city turned its back to the Banger canal and Pekalongan river. Meanwhile, it also causes biodiversity loss in these water ecosystem.

FIG.6.8 A boy is washing batik in the river.
Source: https://docplayer.info/65128833-Pemodelan-spasial-untuk-penentuan-lokasi-instalasi-pengolahan-air-limbah-ipal-batik-di-kota-pekalongan-jawa-tengah-putri-yasmin-nurul-fajri.html

FIG.6.9 The ditch is coloured by waste water from the batik industry.
Source: https://www.jawapos.com/jpg-today/21/10/2018/ulah-pabrik-tekstil-bikin-air-pdam-jadi-merah/

FIG.6.10 The wastewater is discharged into ditches without any treatment.
Source: https://www.greennews.ro/article/impactul-industriei-fashion-asupra-planetei-doar-15-din-deseurile-textile-se-recicleaza-desi-95-s-ar-putea-valorifica

FIG.6.8 A boy is washing batik in the river.

FIG.6.9 The ditch is coloured by waste water from the batik industry.

FIG.6.10 The wastewater is discharged into ditches without any treatment.

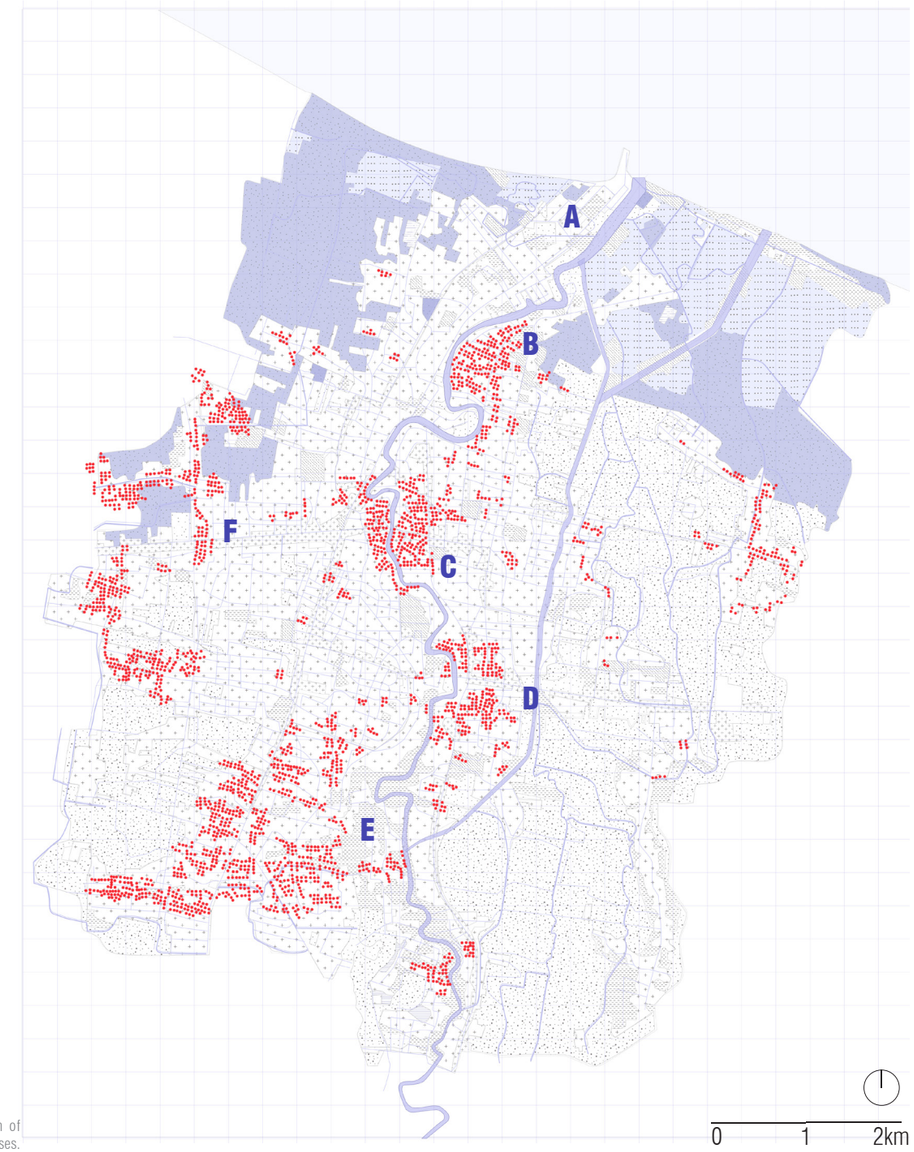

FIG.6.11 The distribution of batik factories and watercourses.

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6.1.2 Batik

Batik is the dominant industry and employs around 70% of people in the city.
90% of batik industries are in family mode. Its production is closely related to water.

The production of batik generally consists of 6 steps.

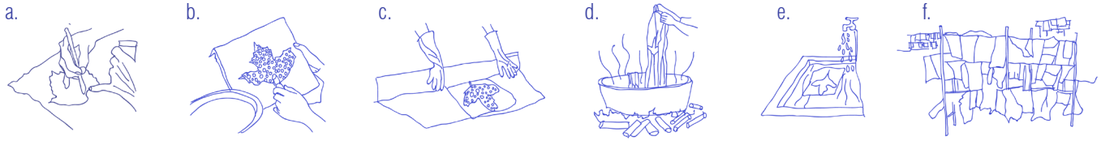

FIG.6.12 The six steps of batik production.

a.Draw on a motif fabric.
b.Fill the background with dot patterns to presents a three-dimensional impression.

c.Block the motives which are going coloured different from its background
d. Colour with chemical dyes and water.

e. Fix colours by boiling the fabric in water
f. Wash extra colour and dry in natural conditions.

-Water based indusrty

The batik production consumes a great amount of water in several processes, and the local used to extract the groundwater for production. The colouring process, fixing process and final washing process are mainly responsible for water consumption. According to the research,(Budiyanto et al., 2018d), 917 batik industries in Pekalongan consumes around 1,023,324 m^3 of water in 2014, and 972,157m^3 of wastewater was discharged into rivers without any treatment, which occupies nearly 95% of the consumption.

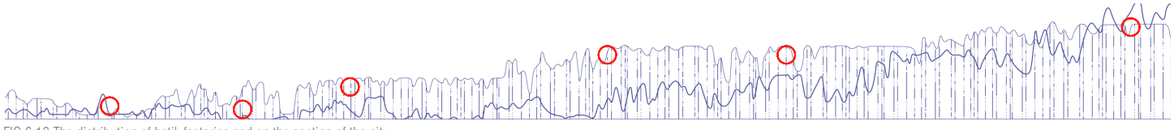

FIG.6.13 The distribution of batik factories and on the section of the city.

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6.1.3 Batik-Water System

The logic and procedure behind the batik industry formed a unique relationship and connections in the batik-water system.

FIG.6.14 The water-batik system, what are the flows connected with batik industry.

① The forests of Kalimantan, which is around 500km away from Pekalongan city provides wood fuel for the batik industry.
② Water is extracted from the ground for the dying, fixing and washing process.
③ The handmade process happens in a particular indoor space.
④ Particular structures are built in the house for washing and boiling batik. The require function affects the indoor layout of the production houses.
⑤ Open space is needed for drying the batik under natural conditions.
⑥ Wastewater is discharged into the river, mix with rainfall, without any treatment.
⑦ Another part of the production house is for living.
⑧ The floor and road are raised with bricks and tiles to avoid frequent inundation.
⑨ Drainage ditches are along the road to help discharge rainfall and wastewater from the batik industry.

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The special family mode industries, specific production procedure and affects the spatial structure.

Batik Space

Open space

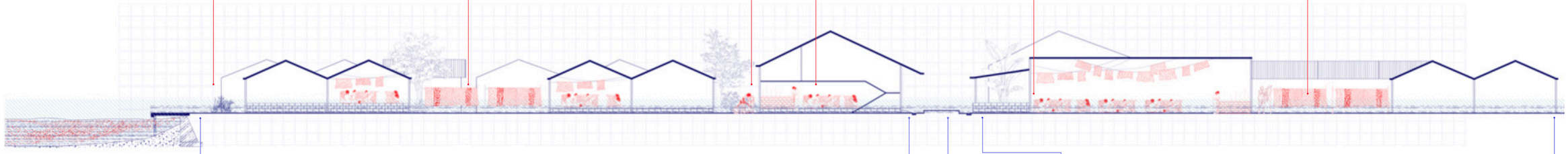
Open space

Open space

Open space

Open space

Open space



Water-related Elements

Pekalongan river

Drainage ditch - roadside

Drainage ditch

Inundated main street and raised sideroad

Small canal

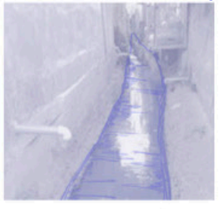


FIG.6.15 The space structure is defined by batik industry and water elements.

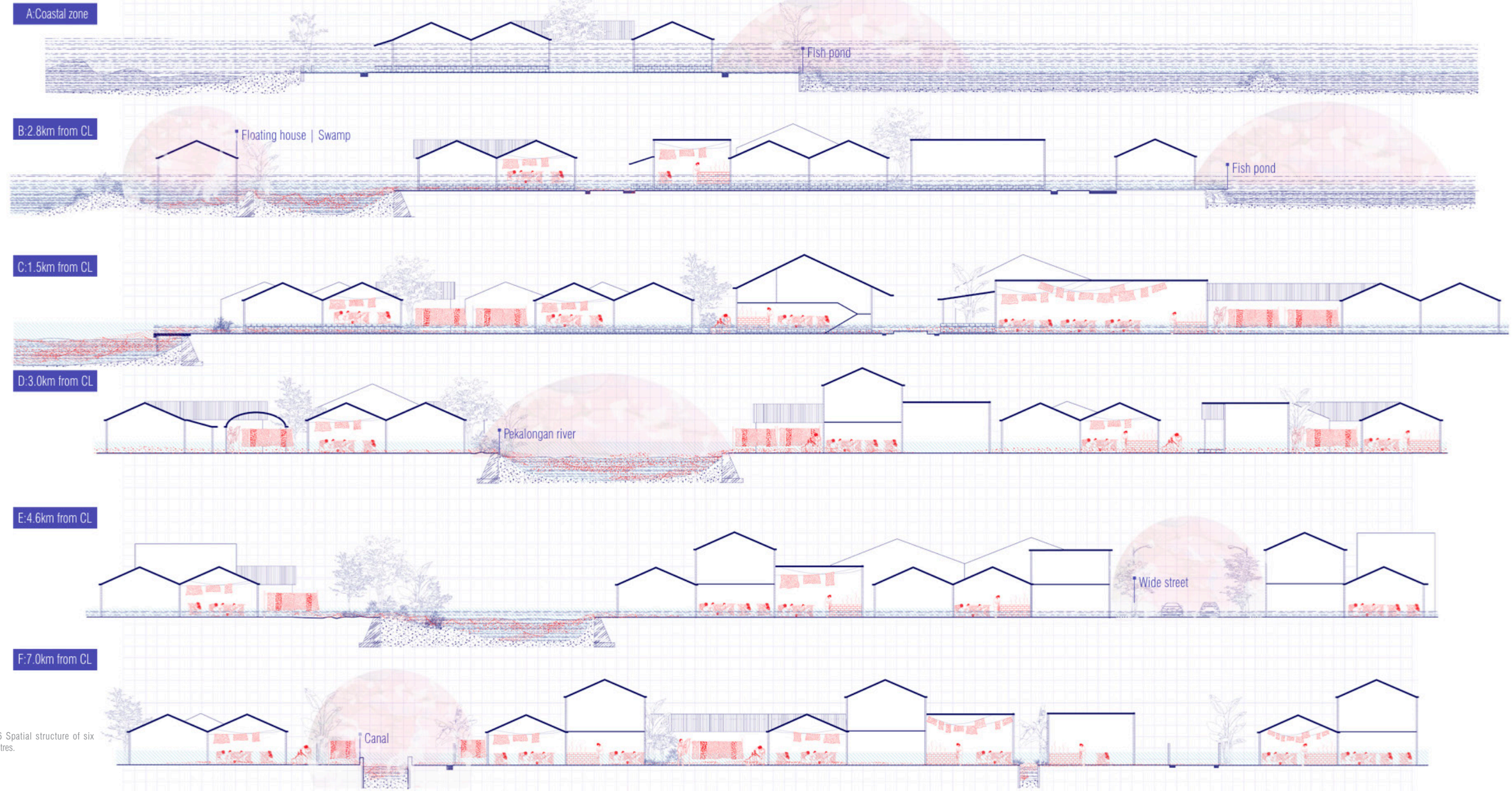


FIG.6.16 Spatial structure of six batik centres.

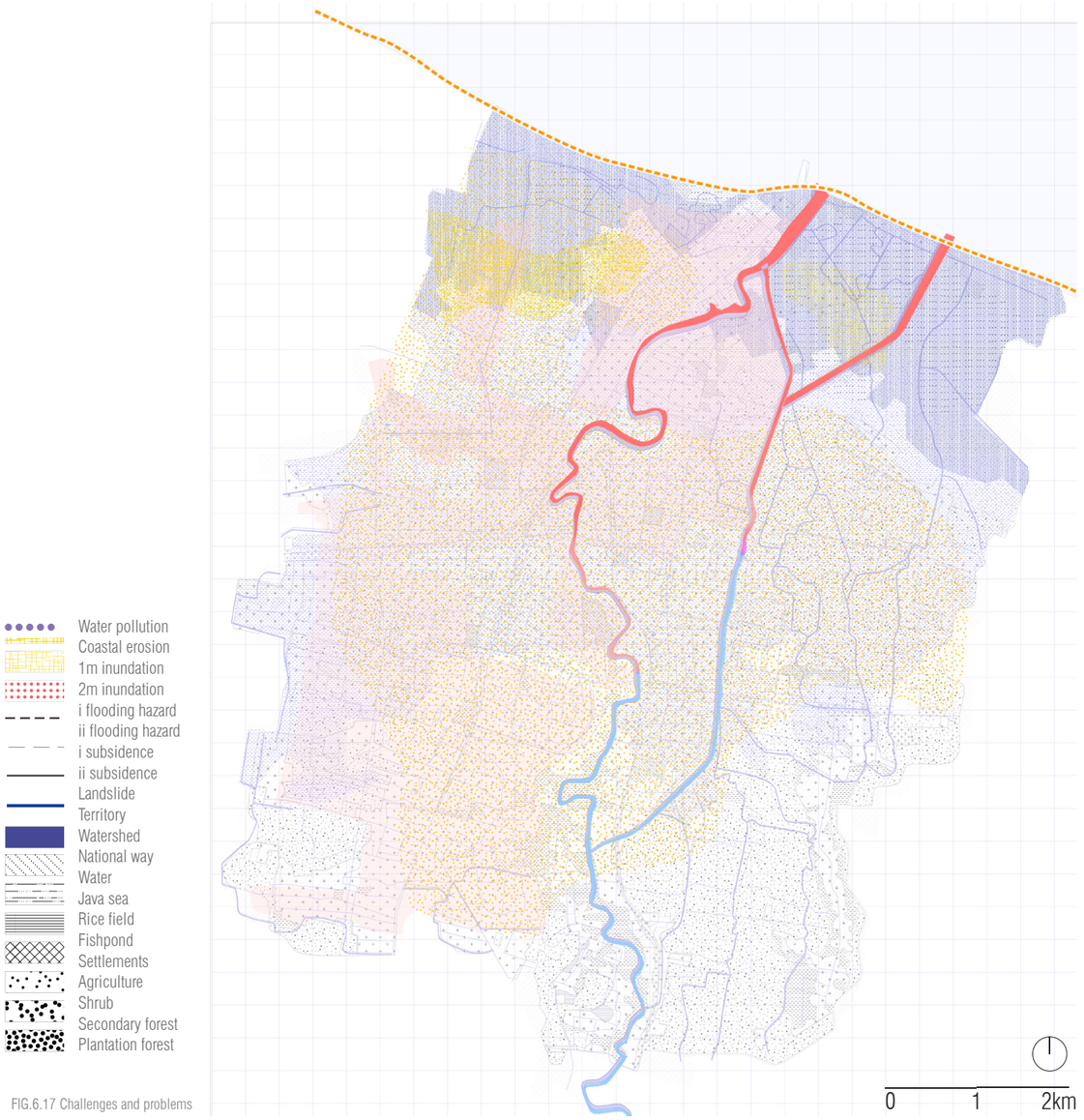


FIG.6.17 Challenges and problems

6.2 Threats & Challenges

Threats and challenges are described into three categories: (1)a safety production/living environment; (2)sufficient and stable water supply to ensure long-term batik production and (3) harmless by-products/ waste.

(1)Safe/stable environment: Safe environment, especially water safety is very important for both the citizen's life and batik production. More and more frequent flash floods and tidal floods need to be addressed to protect the city. Meanwhile, unpredictable rain may disrupt or prolong the drying stage, for the batik is usually dry under the natural condition in outdoor space.

(2)Sufficient/stable water supply: The monsoon weather type causes a huge difference in precipitation during the dry season and rainy season, either little or too much rain disrupts the production process. The drying process could be prolonged in the rainy season while the little rain in the dry season cannot provide the water batik production needs.

(3)Harmless by-products/waste: The mass use of chemical dyes and untreated wastewater explore the city and citizens under high risk of sanitation problems. The ecology, especially the Pekalongan river ecosystem has been heavily destroyed.

In summary, the threats and challenges in Pekalongan are mainly about water safety issues and the local dominant industry, batik development.

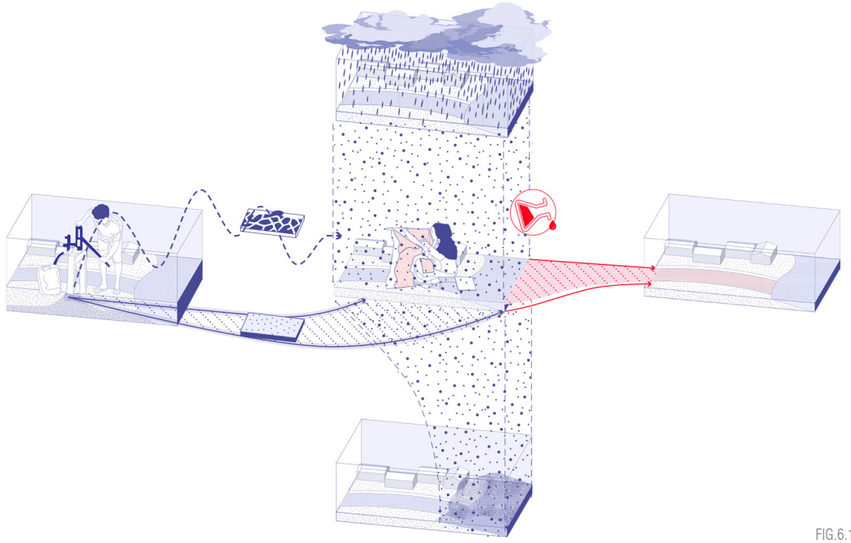


FIG.6.18 Three challenges in the water-batik system.

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FIG.6.19 Drought, agriculture field, Pekalongan, 08/16/2017
Source: https://www.shutterstock.com/zh/search/dry+season+in+indonesia

FIG.6.20 Flood in Pekalongan, 01/17/2019
Source: https://www.antaranews.com/video/1984701/banjir-pekalongan-belum-surut-bantuan-terus-mengalir

FIG.6.21 Flood in Pekalongan, 06/02/2021
Source: https://www.bbc.com/news/world-asia-55966175

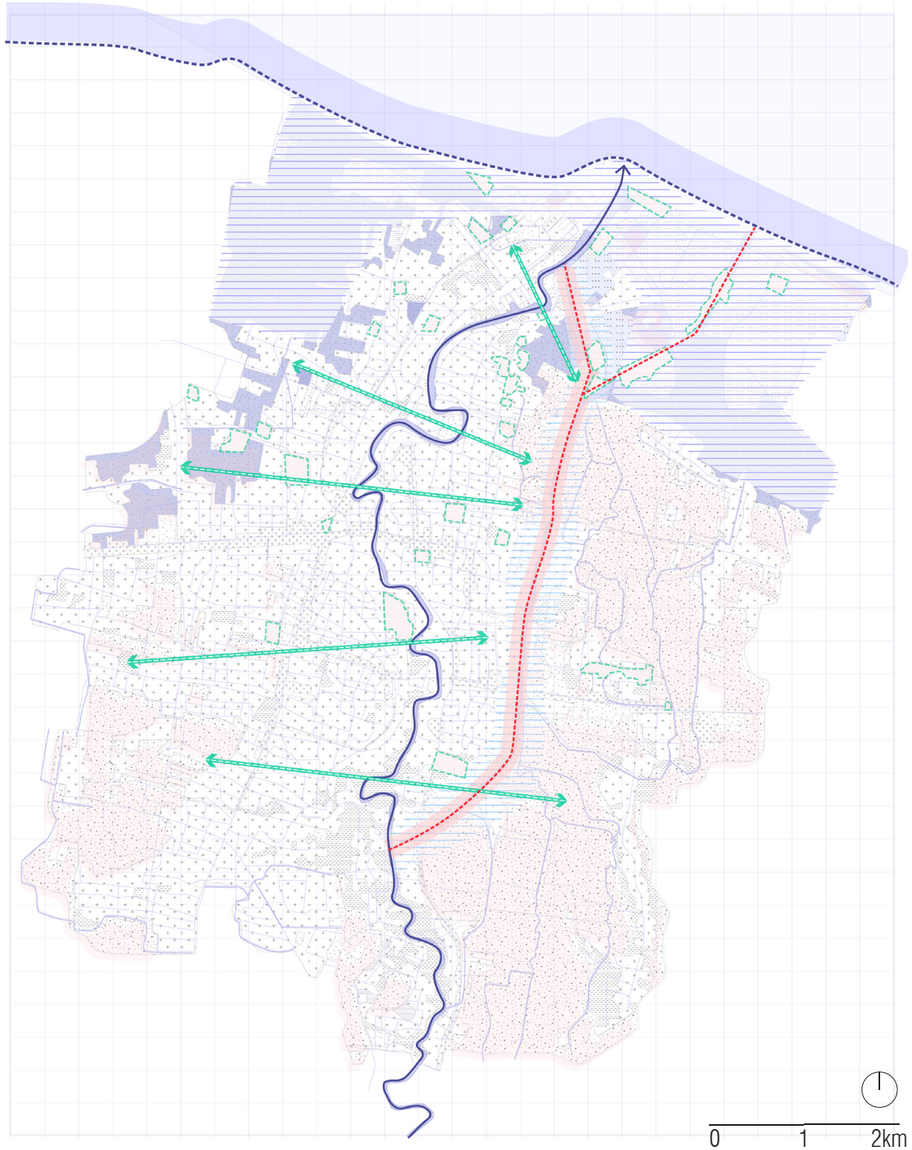

FIG.6.22 Potential map of the landscape

6.3 Potentials & Value

Despite the threats happening in Pekalongan city, there are huge potentials embedded in the landscape and natural process. (1) Natural process(I rainwater, II sediments) can be turned into important resources for protection and production. (2)The watercourses(III Pekalogan ricer, IV Banger cannal) can play a great role in culture and ecology. (3)The mangrove ecosystem(V) can be revived and contribute greatly to local development.

6.3.1 Sediments as the defence

Instead of fighting against the natural forces and natural process, try to make use of them could turn the threatening natural disasters into values.

-I-Sediments could be collected at certain locations and then used for coastal protection.

Human intervention disturbed the balance between sedimentation and erosion.

The sediments raised the riverbed and caused more frequent flooding. The soil is causing problems in the river courses, but the coast is losing soil due to coastal erosion and insufficient supplement from the upper stream area.

FIG.6.23 Excavator is cleaning up river sediment | Pekalongan river | 09.2020

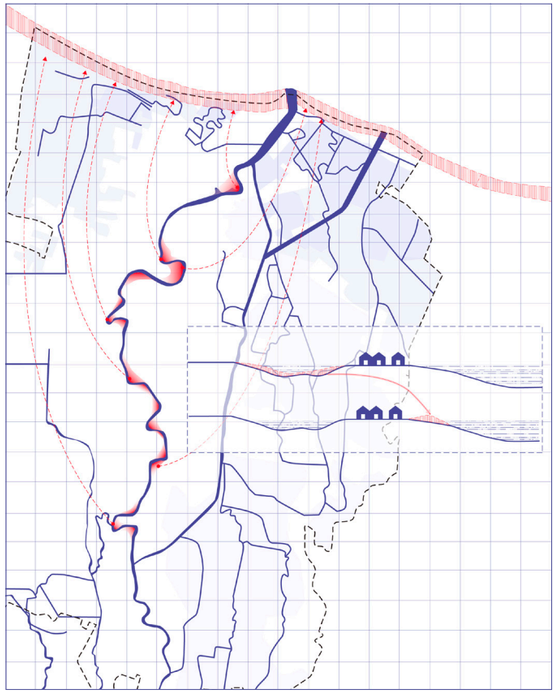

FIG.6.24 The diagram of how to make use of the sediments for coastal protection.

6.3.2 Rainfall as the water supply

The average precipitation in Pekalongan is around 2300mm/year, the study area is around 3,000,000m^2. And according to the research(Budiyanto et al., 2018d), 917 batik industries in Pekalongan consumes around 252,00 m^3 of water in 2014.

Instead of extracting groundwater for the batik industry, the local can make use of the precipitation. In this way, people can reduce flooding risk and avoid further subsidence.

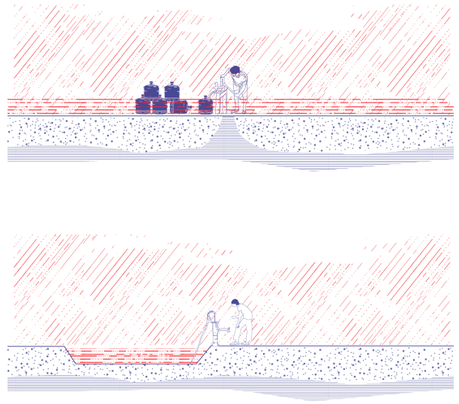

FIG.6.25 The diagram of storing the rainwater instead of discharging it.

6.3.3 Banger canal

The city is turning its back to the Pekalongan river and the Banger canal, which have the potential for ecology, recreation and water storage.

-The Pekalongan river
Due to the heavy pollution, the Pekalongan river is blocked by dense houses and trees. People have no access to the river and the ecology is poor. But as the main river goes through the densely populated area, the river should have high potential in recreation and ecology.

-The Banger canal
The Banger canal was built to discharge water, but the water volume is far away from reaching its capacity. The Banger canal is about 40m wide. The discharge capacity of the Banger canal is 400m^3/s, but the average water volume is less than 175m^3/s. Thus the Banger canal has the potential to store water for agricultural irrigation and batik production in dry seasons.

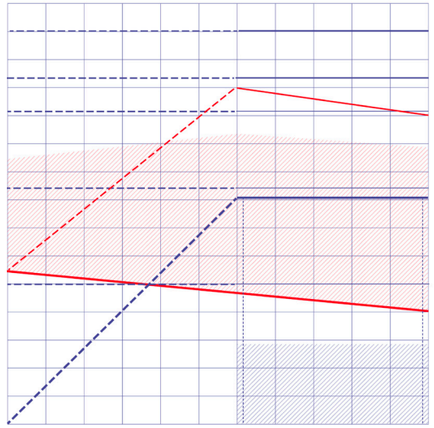

FIG.6.26 The discharge capacity and real water volume of Pekalongan river and Banger canal.

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6.3.4 Pekalongan river

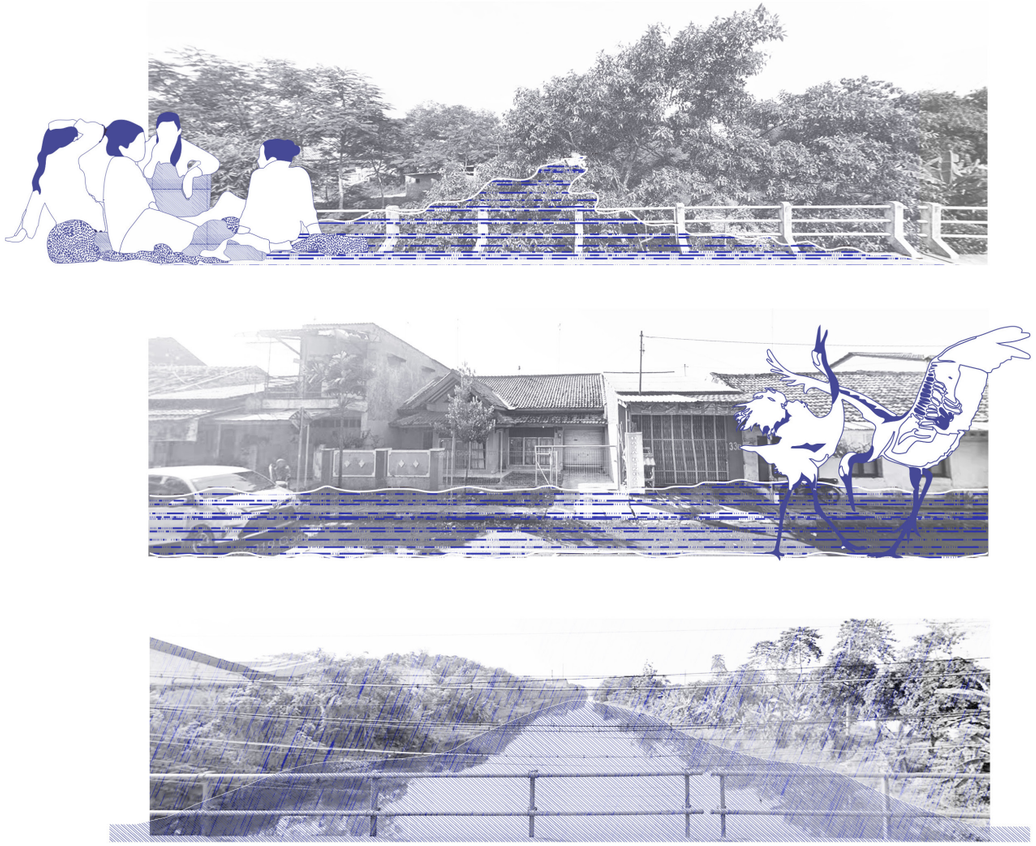

FIG.6.27 Pekalongan river has potential in ecology and recreation.
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916, edited by the author.

6.3.5 Mangrove

Mangrove ecosystem has great value in ecology and coastal development.
Meanwhile, its fruit and bark can serve as the rare red natural dye for the batik industry.

The mangrove degradation in Pekalongan happened in three periods of time, the 1960s' agriculture development, the 1980s' aquaculture development and 2000s' batik development. According to the Ministry of Forestry (2006), 94% of the 35,338 hectares mangrove ecosystem in Central Java was damaged.

The basic substrate in the coastal area of Pekalongan City which is dominated by mud with mangrove and coastal pine vegetation is the optimal medium for mangrove growth.

-Natural dyes

The use of chemical dyes in the batik industry poses a health risk for people and a greater threat to the environment. The dominance of colours in usual natural dyes/plants is found mostly in green and blue. The waste fruit and bark from mangrove can provide precious red colour for natural dyes, and the colour can be varied depending on the mordant used((Pringgenies, Ridlo, Fatma Dewi, & Djunaedi, 2021, p. 5).

The natural dyed clothes and fabric have high commercial value because of their artistry, unique colours and the sustainability by which they are made and sourced. The use of natural mangrove dye in batik also give impressions of regional characteristics of Pekalongan, the unique ecosystem at coastal zone.

-Coastal protection

The dense root systems of mangrove forests trap sediments flowing down rivers and off the land. This helps stabilizes the coastline and prevents erosion from waves and storms.

-Fishery development

Mangroves play an important role in the productivity of marine fisheries, providing habitat, spawning grounds and nutrients for a variety of fish (Hutchison et al., 2014). Fishes lay and hatch their eggs in the dense roots of mangrove trees. Later the mangrove forest also provides the nutrients they need for growing. Besides, the constantly shed leaves provide food for sea life after being broken down by bacteria and fungi.

FIG.6.28 Beautiful batik dyed by waste fruit from mangrove.
Source: http://www.asiantextilestudies.com/brown.html

FIG.6.29 The landscape pattern of Silvo fishery.
Source: https://www.wetlands.org/publications/technical-guidelines-associated-mangrove-aquaculture-farms/

FIG.6.30 Mangrove rehabilitation for coastal protection.
Source: https://www.wetlands.org/casestudy/building-with-nature-indonesia/

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FIG.6.28 Beautiful batik dyed by waste fruit from mangrove.

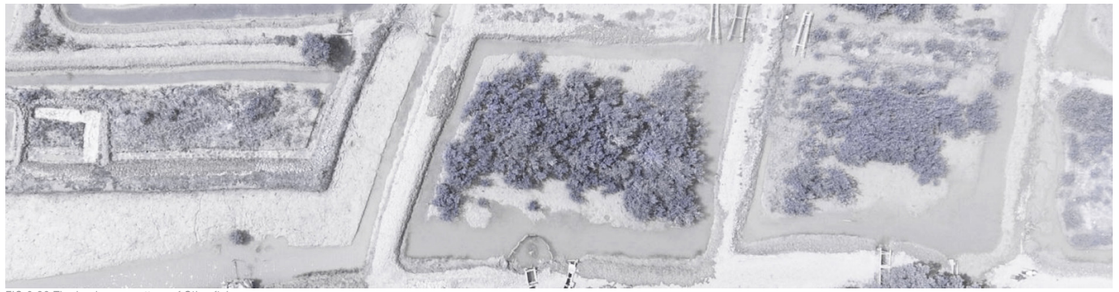
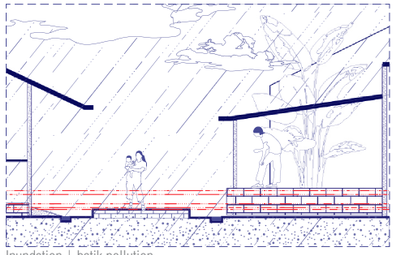


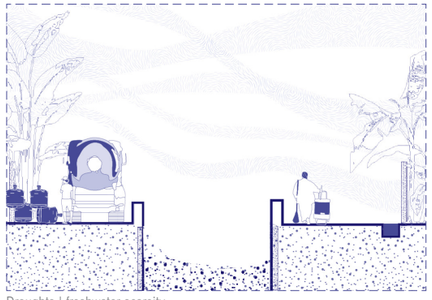
FIG.6.29 The landscape pattern of Silvo fishery.

FIG.6.30 Mangrove rehabilitation for coastal protection.

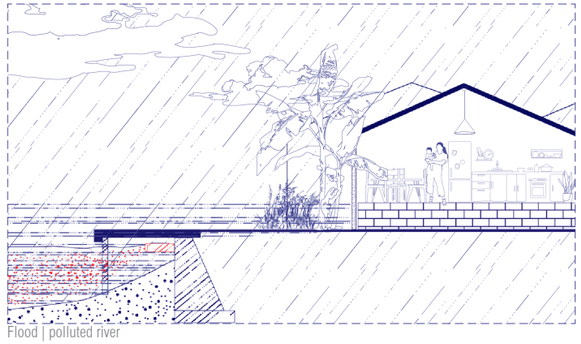
Water extraction | subsidence



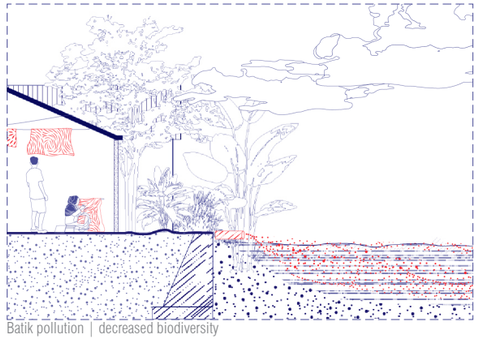
Inundation | batik pollution



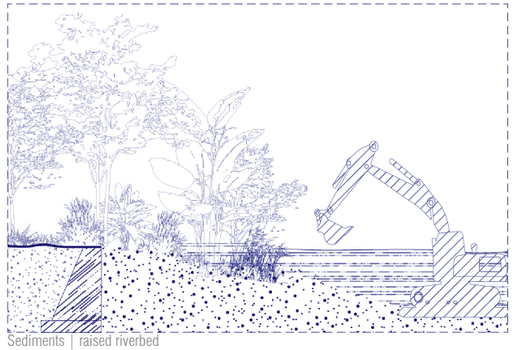
Droughts | freshwater scarcity



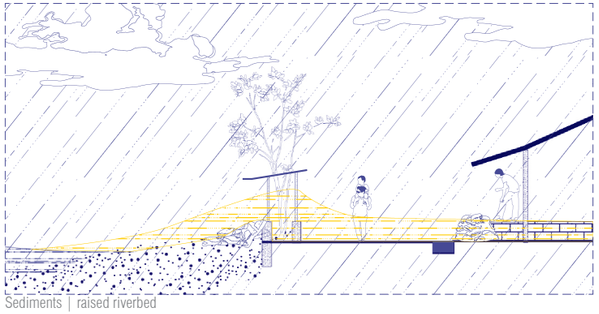
Flood | polluted river



Batik pollution | decreased biodiversity



Sediments | raised riverbed



Sediments | raised riverbed

FIG.6.31 Threats and challenges

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6.4 Design Assignment

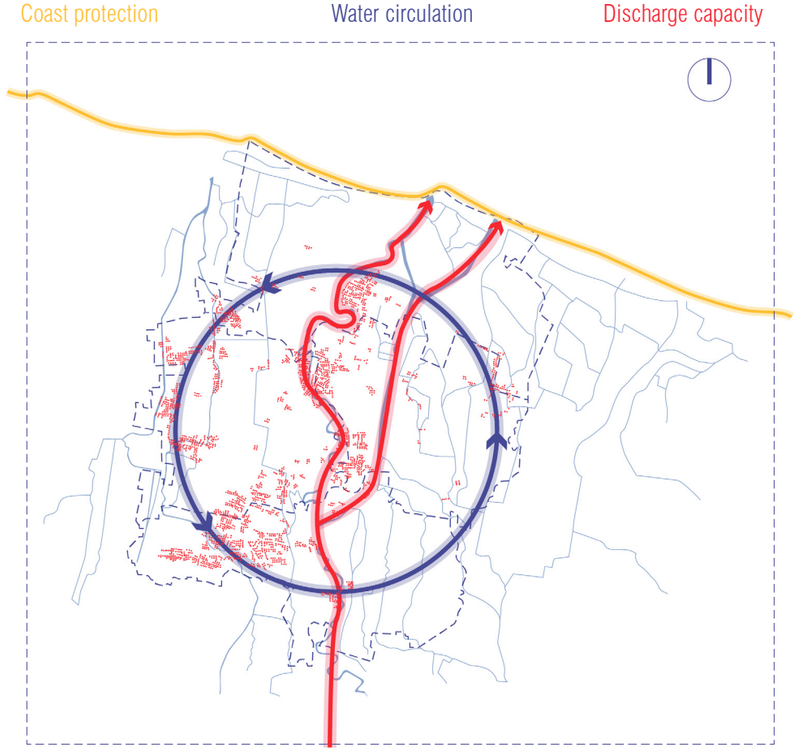

FIG.6.32 Three design assignment, coastal protection, discharge capacity and water circulation.

07 PRINCIPLES

Under the resilience theoretical framework, principles about water circulation, discharge capacity and coastal protection are extracted from case study and literature review among small, middle and large scale.

FIG.7.1Climate change has brought stronger winds and bigger waves which sometimes breach this embankment in Pekalongan city,
Photo: Nivell Rayda
Source: https://thestringernews.com/2021/03/16/this-city-in-java-could-disappear-in-15-years-due-to-land-subsidence-and-coastal-flooding/

7.1 Case Study

Bishan-Ang Mo Kio Park | Singpore

Ramboll Studio Dreiseitl

By transforming the concrete canal into a natural river, the design finds a way to integrate nature and cities.

The Bishan-Ang Mo Kio Park project is part of the ABC Waters Programme in Singapore which aims to transform the river courses beyond their functions of drainage into beautiful space for both recreation and ecology.

The previous straight concrete river course was transformed into a meandering river with a gradient riverbank, which integrated with stormwater management. This prepares the city for flooding at the same time people get more access to the water.

Soil Bioengineering which greatly combines the plants, rocks, and engineering technique achieves the aesthetic purpose in terms of landscape architecture while providing adaptive protection.

This design shows how the landscape solution achieves flood protection and recreation at the same time. Bring nature back into the city also creates more possibilities for urban development.

FIG.7.1 Aerial view of the park

FIG.7.2 More room for water and more recreational space.

FIG.7.1 Aerial view of the park
Source: https://www.gooood.cn/river-restoration-singapore.htm
FIG.7.2 More room for water and more recreational space.
Source: https://www.gooood.cn/river-restoration-singapore.htm

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Bheri Wastewater Aquaculture| Kolkata, India

A traditional aquaculture system 1920CE

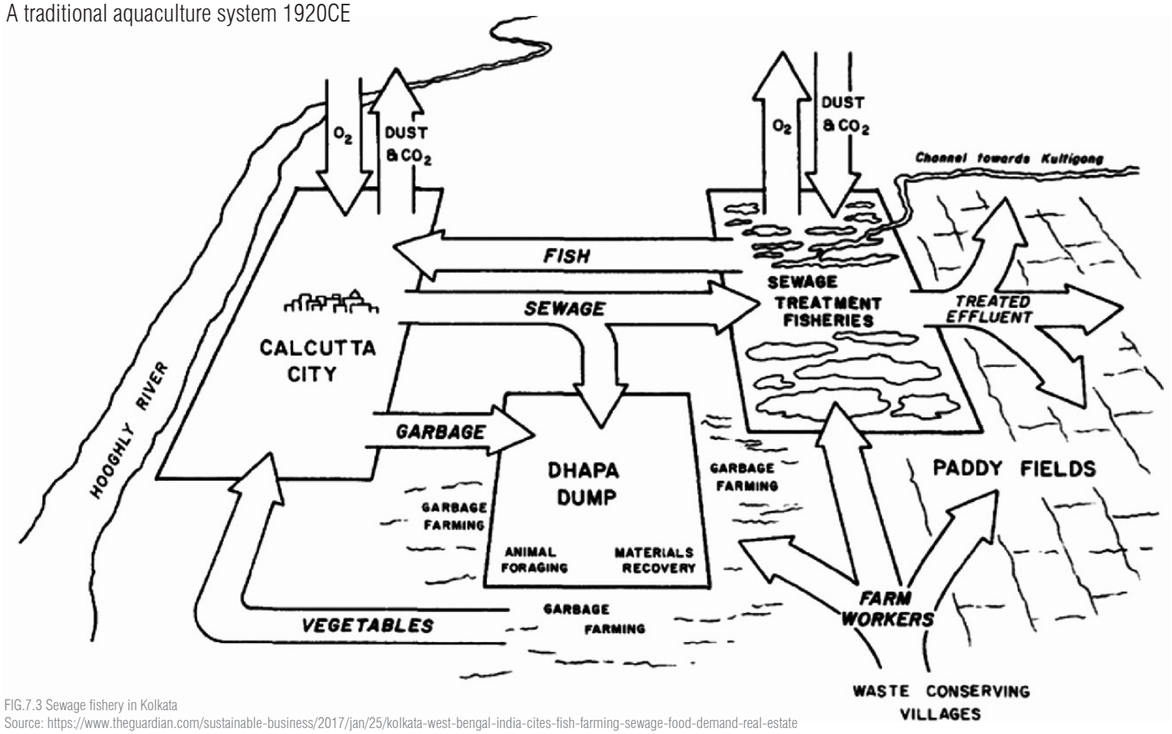

FIG.7.3 Sewage fishery in Kolkata
Source: https://www.theguardian.com/sustainable-business/2017/jan/25/kolkata-west-bengal-india-cites-fish-farming-sewage-food-demand-real-estate

The green and blue expanse in Kolkata shows how a living and resilient urban circulatory system work.

The Bheri wastewater aquaculture system is a great combination of fishery, waste management system, agriculture field, community hub and heritage site.
The fishery industry here is based on the constant and free wastewater from the city. The fish and vegetables consume the nutrient within the wastewater. Food is produced while the nutritious water is cleaned by a natural process.

The combination of productive landscape and water purification system shows how the natures bridge two systems that benefit each other.

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7.2 Design Principle

The toolbox concluded from the various case study provide design principles to address the three assignments through different scales. Based on nature-based solution thinking, restore natural or modified ecosystems to address the challenges.

Discharge capacity

Deal with the fluctuating water level.

Coastal protection

Not against nature force but work with it

Water circulation

Make use of the natural source.

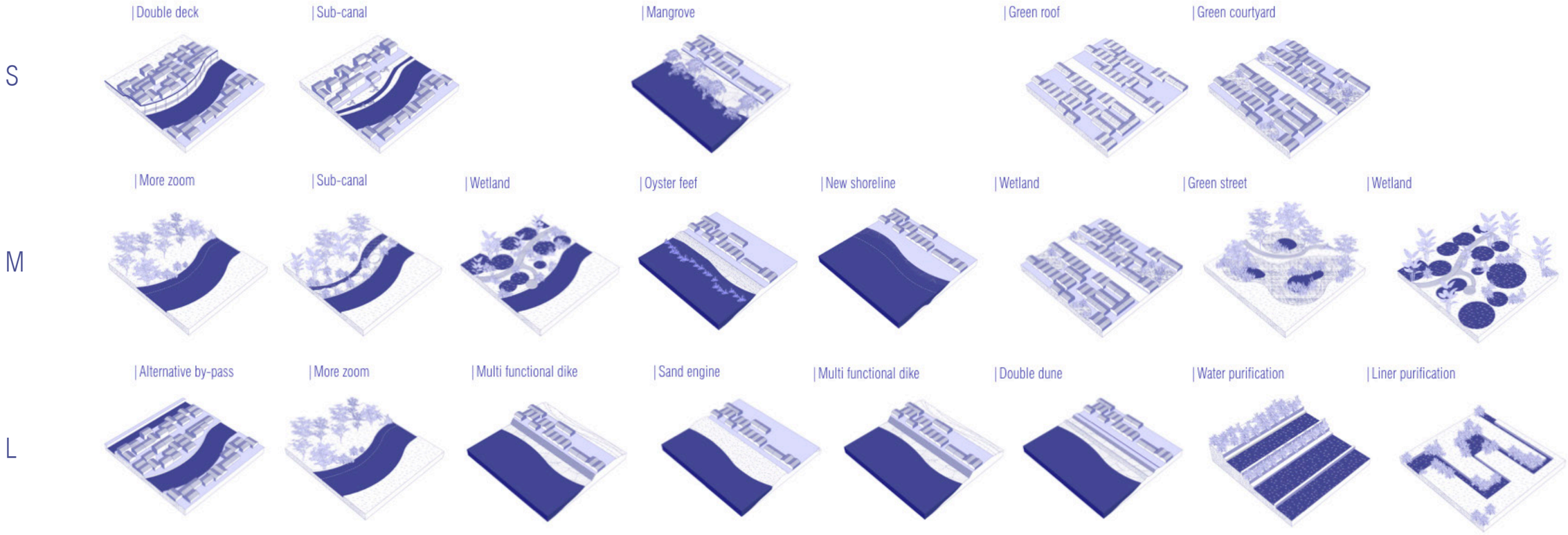

FIG.7.4 Design principles about coastal protection, discharge capacity and water circulation

7.3 CONCLUSION

All the case study shows one thing in common: instead of fighting against nature, finding and following the logic behind the landscape is the way to turn challenges into oppourinities.

For discharge capacity, how to help the water flows smoothly is the question. Bypass, wider river course and sub-canals are the opinions. Besides, the riverbank design is important in this topic, resilient riverbanks could help the city adapts to fluctuating water level. And the urban context can be connected with it in terms of wetland, double dike and floating houses etc.

For coastal protection, how to defend the city from rising sea level and storm surge is one of the most important things to consider about. The principle is trying to work with the natural force. Soft defence like mangrove, dune and hidden dikes are the options. Besides it is also important to generate the economic potential of the coastal zone, different kinds of fishery industry can be combined with this soft infrastructure. The water type(brackish water or sweat water) could provide the clue for making decisions.

For water circulation, it is important to realise, instead of getting rid of the rainwater during the wet season, it is wiser to find space to store it and let it recharge the city during the droughts. The sponge space in the city can happen on all scales, and resilient thinking could create space for water while without disrupting daily functions in the city.

After all, landscape develops with time and composes of several elements which connected. Look back into the palimpsest and make the predictions that indicate the solutions for the problems and challenges. The design should always follow and respect the local landscape logic.

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Budiyanto, S., Anies, Purnaweni, H., & Rya Sunoko, H. (2018d). Environmental Analysis of The Impacts of Batik Waste Water Polution on The Quality of Dug Well Water in The Batik Industrial Center of Jenggot Pekalongan City. E3S Web of Conferences, 31, 09008. https://doi.org/10.1051/e3sconf/20183109008

III RESEARCH BY DESIGN

08 DESIGN EXPLORATION

Based on the previous analysis challenges and potential, the exploration focuses on
- A more sustainable batik-water system
- How the system can be achieved spatially in terms of water circulation/ discharge capacity and coastal production.
-The integration of the three strategies.
-The possibilities in ecological and social development based on the strategies.

FIG.8.1 Pekalongan-World's city of batik, edited by the author.
Source: https://www.abadikini.com/2019/06/07/balon-udara-ganggu-penerbangan-ini-penjelasan-pilot/

8.1 Water-Batik System

The current water-batik system is facing three kinds of challenges. By creating a new water-batik system based on making use of the landscape potentials in the area, these challenges can be addressed.

The current water-batik system

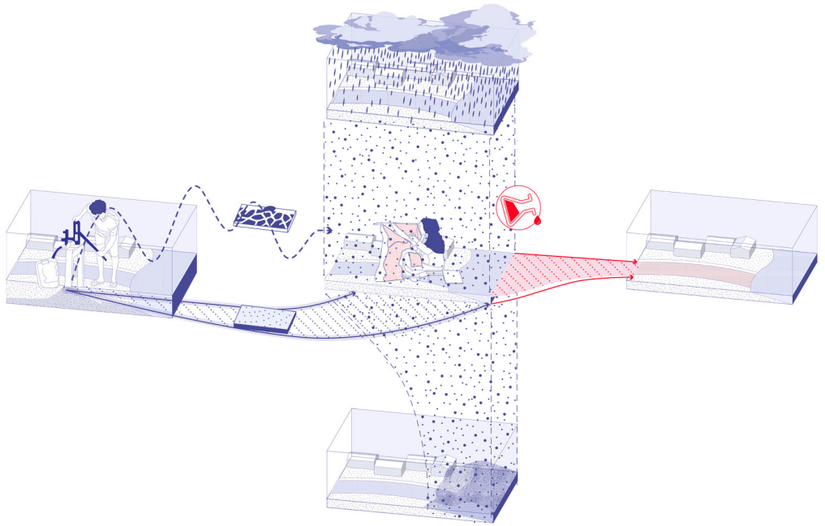

FIG.8.2 Current water-batik system.

×A safe living/production environment: the intense precipitation and storm surge make the city vulnerable to the water-related disasters

×A sustainable water supply: The batik industry consumes a great amount of water every year, people are used to extracting water from the ground. This caused severe subsidence. Meanwhile, there is a freshwater shortage during dry seasons.

×A eco-friendly process: The batik industry in Pekalongan city relies on chemical dyes. Only 0.6% of wastewater from batik is processed before discharging into the river because of the high cost of the treatment plant. So the water discharged into the river contains a lot of heavy metals and that cause serious problems to the environment.

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The new water-batik system

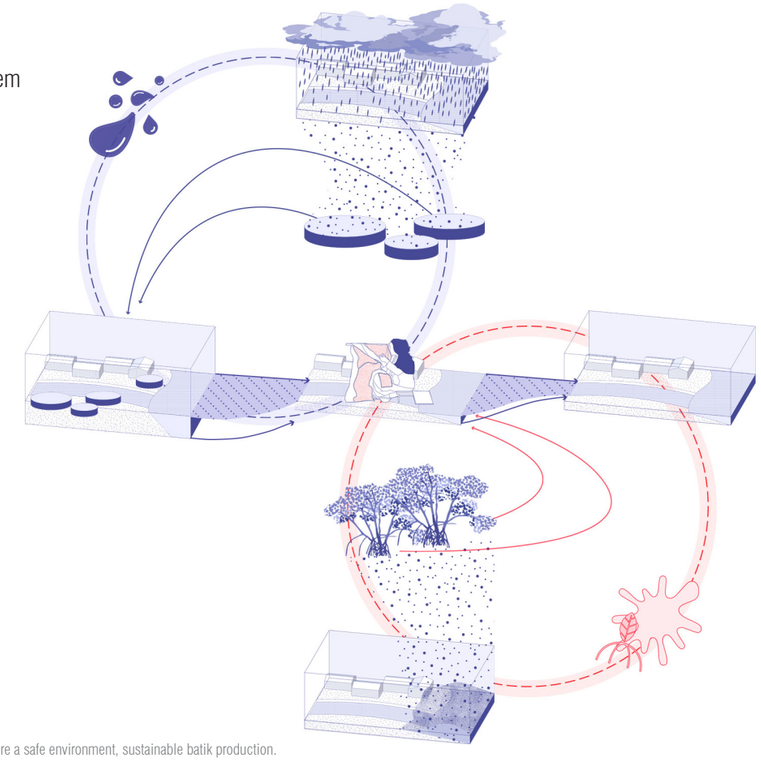

FIG.8.3 A proposed new system to ensure a safe environment, sustainable batik production.

√A safe living/production environment: By collecting the rainwater and increasing the discharge capacity, the flooding caused by intense precipitation can be addressed. Meanwhile, soft defence like mangrove can protect the city from storm surge.

√A sustainable water supply: The water collected from precipitation during the rainy season can be purified and used as a sustainable water source for the batik industry and daily use.

√An eco-friendly process: The waste fruit from mangrove replace the chemical dyes in the batik industry as an environmental-friendly natural dye and reduce the pollutions relieved into the environment.

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8.2 Water systems as the base

Water systems are the base in Pekalongan.

Water always works as the base for Pekalongan city and its livelihood. Based on the previous understanding of the water system, four kinds of water, seawater, rainfall, wastewater and water from the upstream area are mixed. Meanwhile, they belong to the three design assignments, which are known as coastal protection, discharge capacity and water circulation. By dealing with these different kinds of water separately first could simplify the problems in this area.

New opportunities and integration arise during the process of addressing this assignment individually and finally form a resilient landscape framework for the Pekalongan city which help to facilitate the water safety issues, batik development and other values like recreation and ecology.

The current water flow

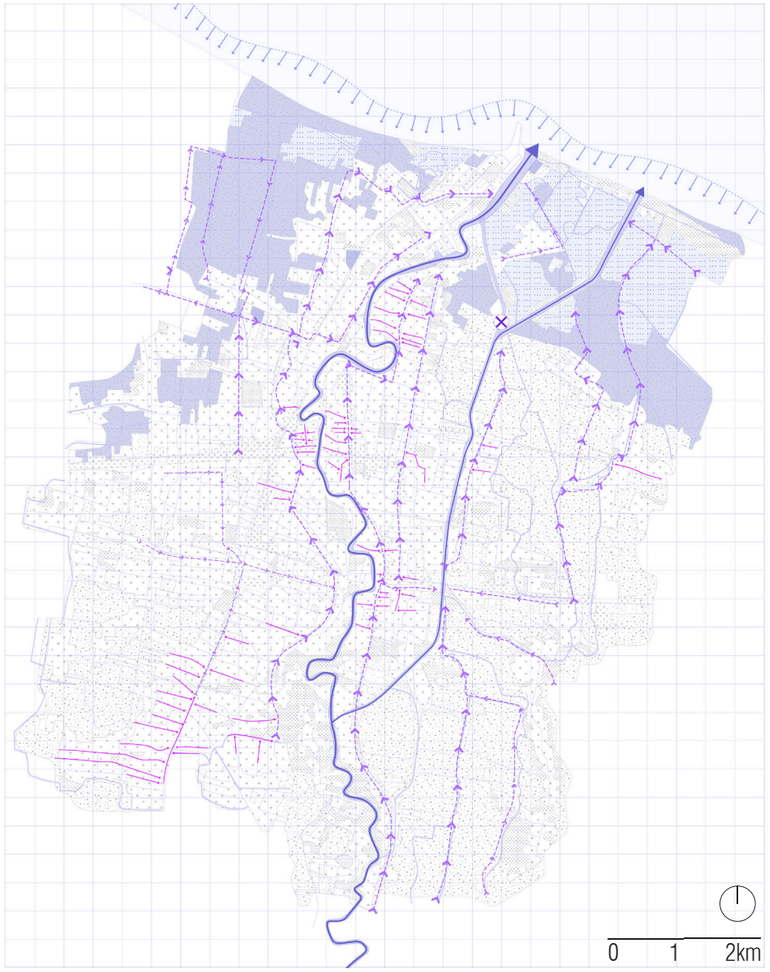
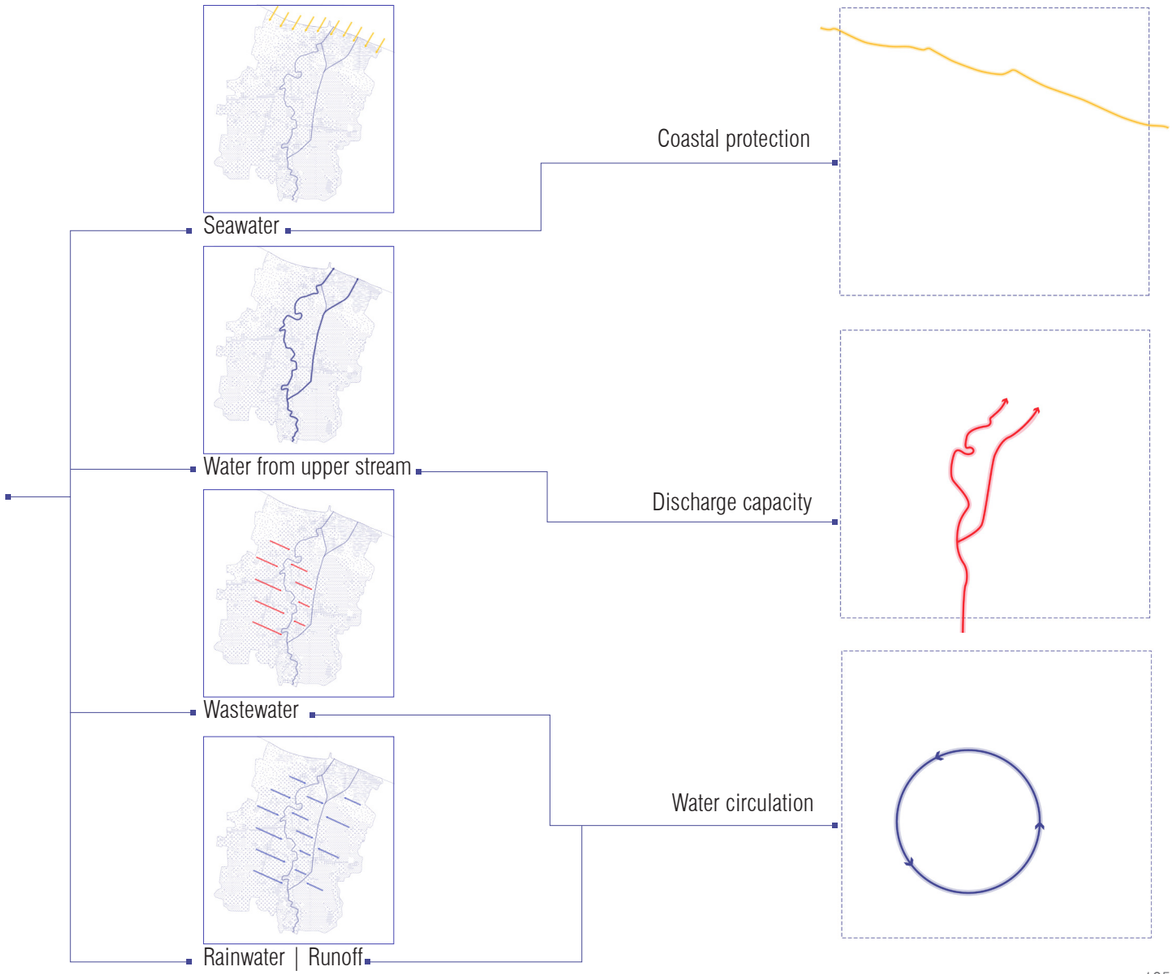


FIG.8.4 Current water flow

The design assignment



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-The designed water flow

The core concept is to separate rainwater, river water and wastewater to relieve the discharge pressure of the Pekalongan river | achieve water circulation by collecting, purifying and reusing rainwater and |improve water quality.
The rainwater is directed away from the Pekalongan river, into the Banger canal at the east and the fields at the north. Wastewater will be collected.

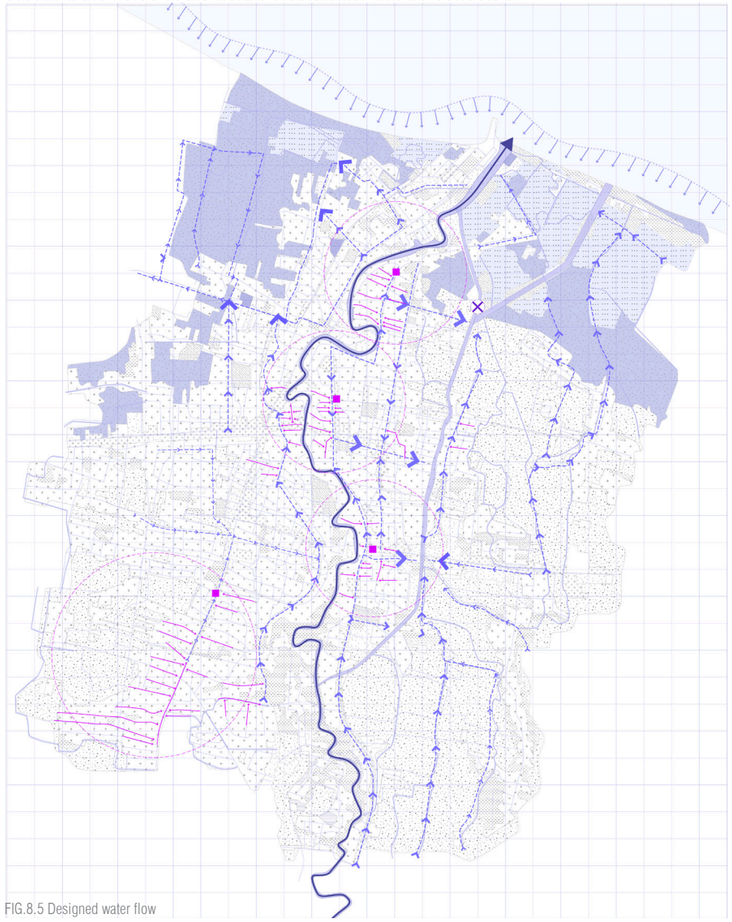

FIG.8.5 Designed water flow

-The proposed three water systems

The Pekalongan river will focus on discharging the water from upstream Kupang river into the Java sea.
In the North, rainwater collection is combined with coastal aquaculture and at the east, the Banger canal will be the core sponge to store the rainwater during the rainy season.

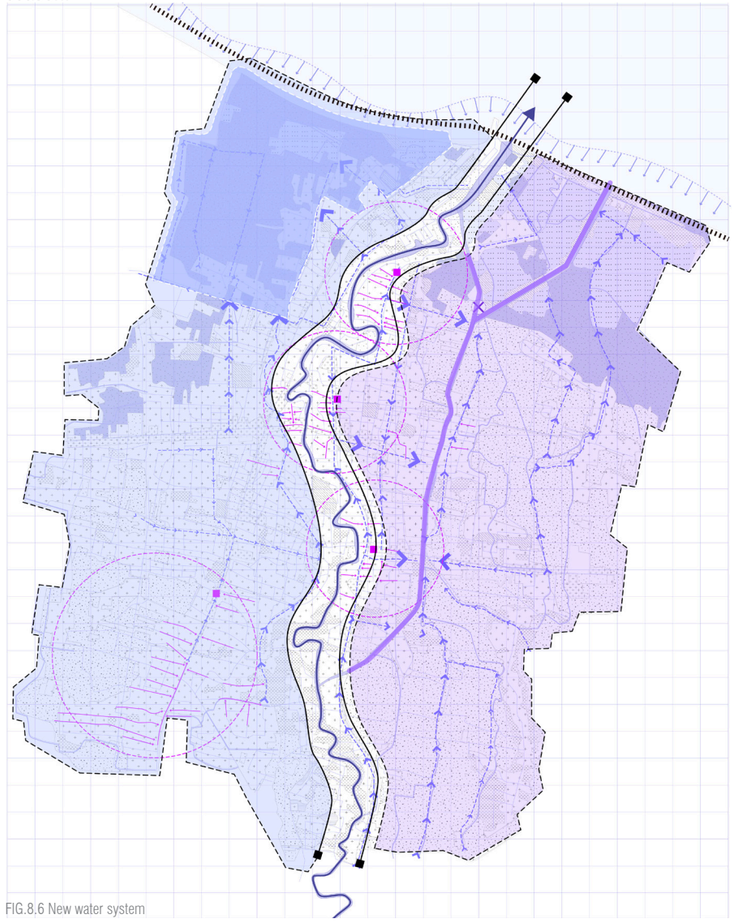

FIG.8.6 New water system

-The water infrastructure

Necessary water infrastructure like hidden dikes, sluices, pumps, new river courses is planned to achieve the concept idea.

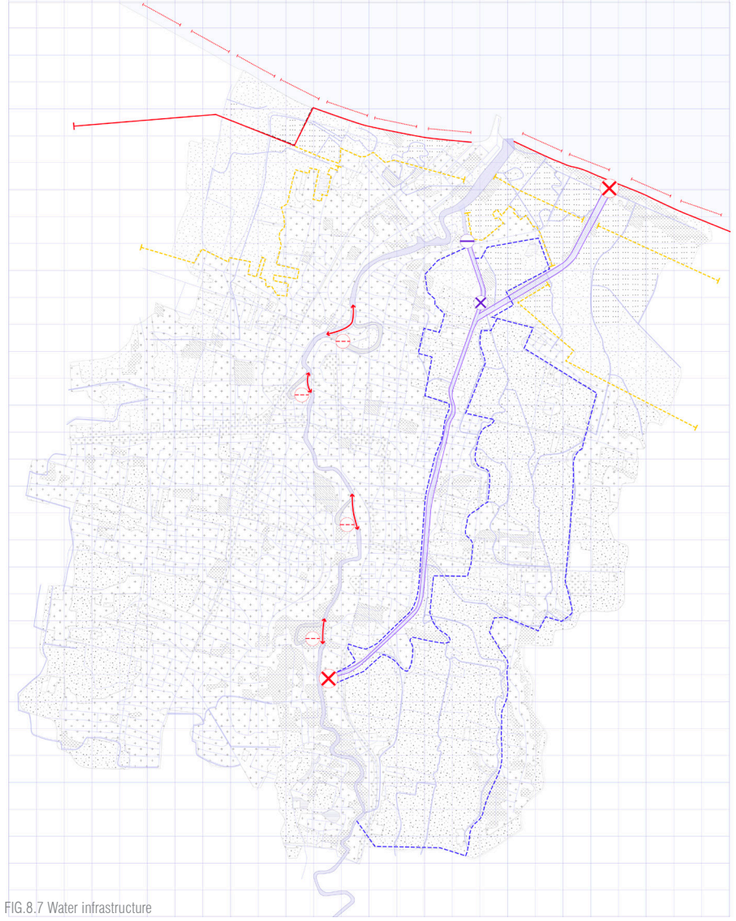

FIG.8.7 Water infrastructure

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8.3 Spatial design

-1/3 Coastal proctection

The strategy intends to make the transition zone from Java sea to hinterland to be protective and productive. Mangrove forest and hidden dike are considered as the main defence. The hidden dike will be designed as a green connection along the coast and the mangrove forest is combined with an aquaculture system.

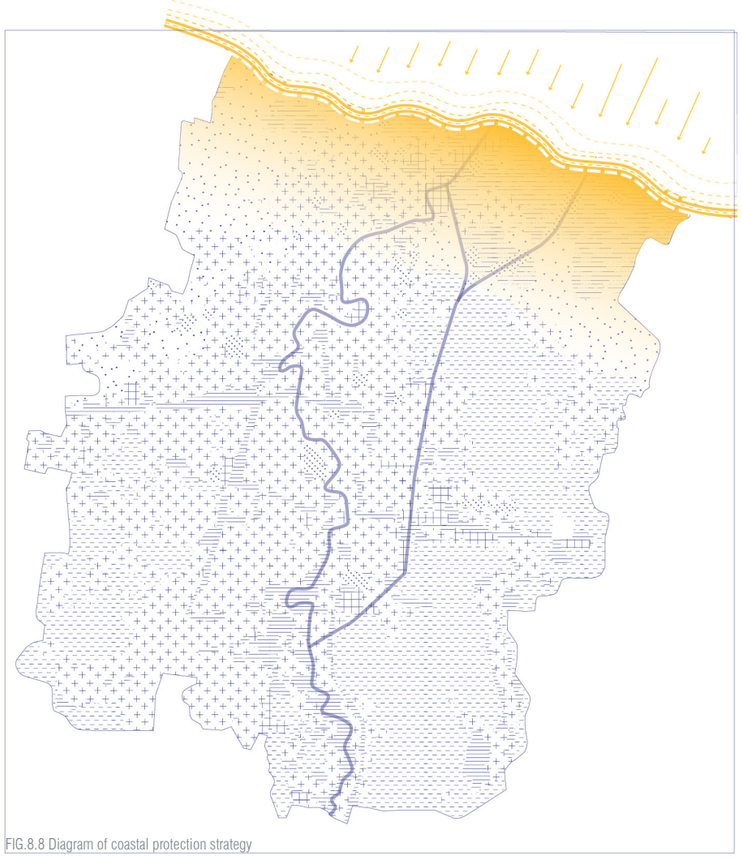

FIG.8.8 Diagram of coastal protection strategy

-2/3 Discharge capacity

River shortcuts are designed to reconnect the Pekalongan river and help the water flow more smoothly within the high populated urban context. New river dikes and previous river bend are combined with the green structure providing recreation and ecological functions.

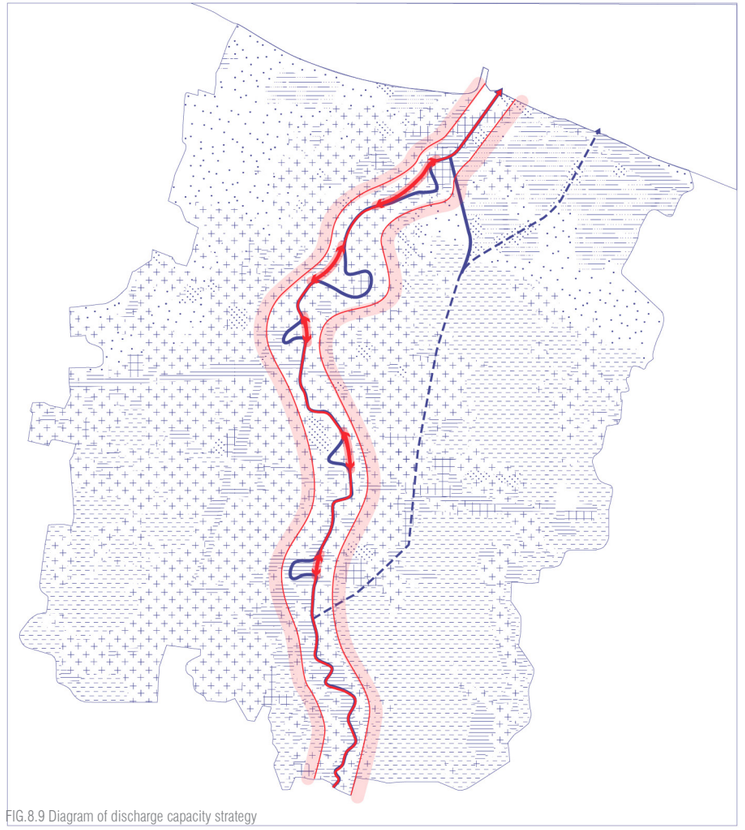

FIG.8.9 Diagram of discharge capacity strategy

-3/3 Water circulation

Rainwater is collected in urban green space through all scales, from the courtyard to the Banger cannal. The aquaculture system at the north and Banger canal are core sponge space. The collected water will be released to fill the dry land and support the Batik industry during the dry season.

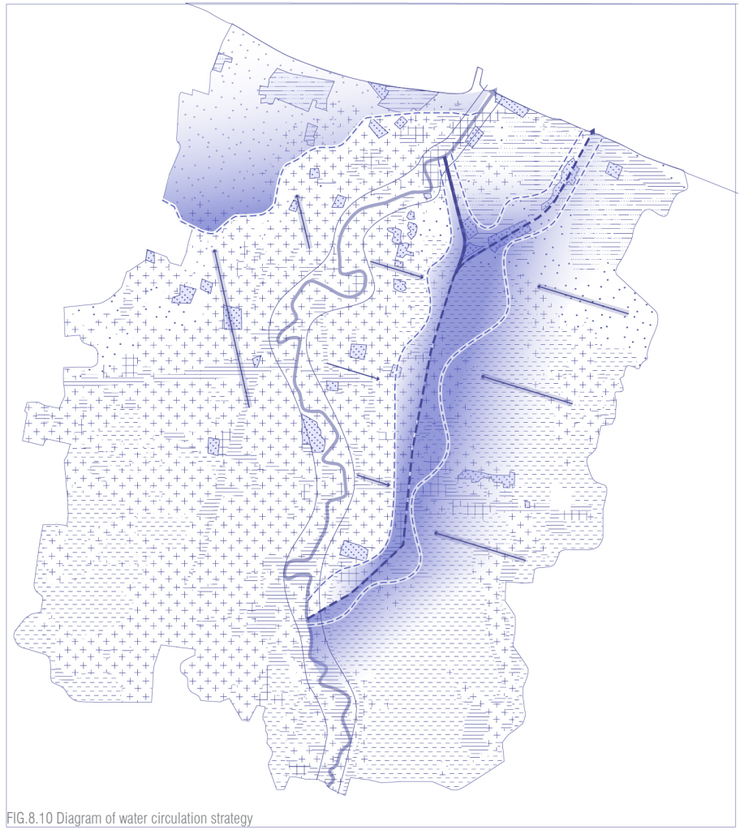

FIG.8.10 Diagram of water circulation strategy

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8.2.1 COASTAL PROTECTION

1/3 COASTAL PROTECTION

In the past decades, due to the rising sea level/mangrove logging/ over development of aquaculture, the Pekalongan coastal is suffering from rob floods, permanent inundation and biodiversity decline.

FIG.8.11 Pekalongan | Coastal area | 2003
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916, edited by the author.

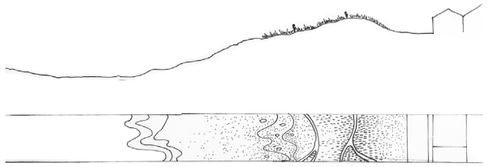
FIG.8.12 Pekalongan | Coastal area | 2020
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916, edited by the author.

1/3 COASTAL PROTECTION

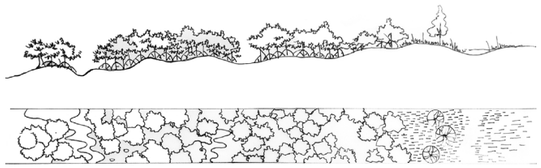
-Exploration process

Alternatives and different combinations

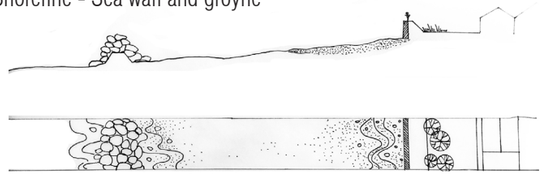
Shoreline - dune landscape



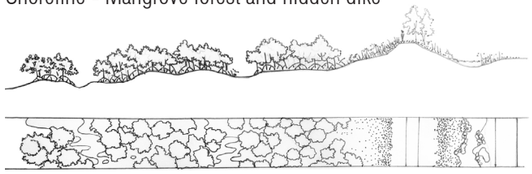
Shoreline - Mangrove forest



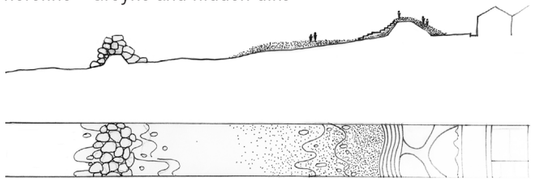
Shoreline - Sea wall and groyne



Shoreline - Mangrove forest and hidden dike



Shoreline - Groyne and hidden dike

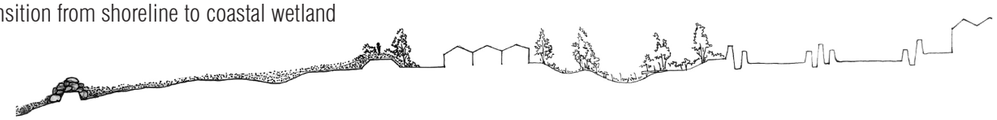


Coastal landscape- shrimp ponds and tanbak system

Coastal landscape- Wetland

Transition from shoreline to coastal fishery

Transition from shoreline to coastal wetland



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Shifts of different combinations

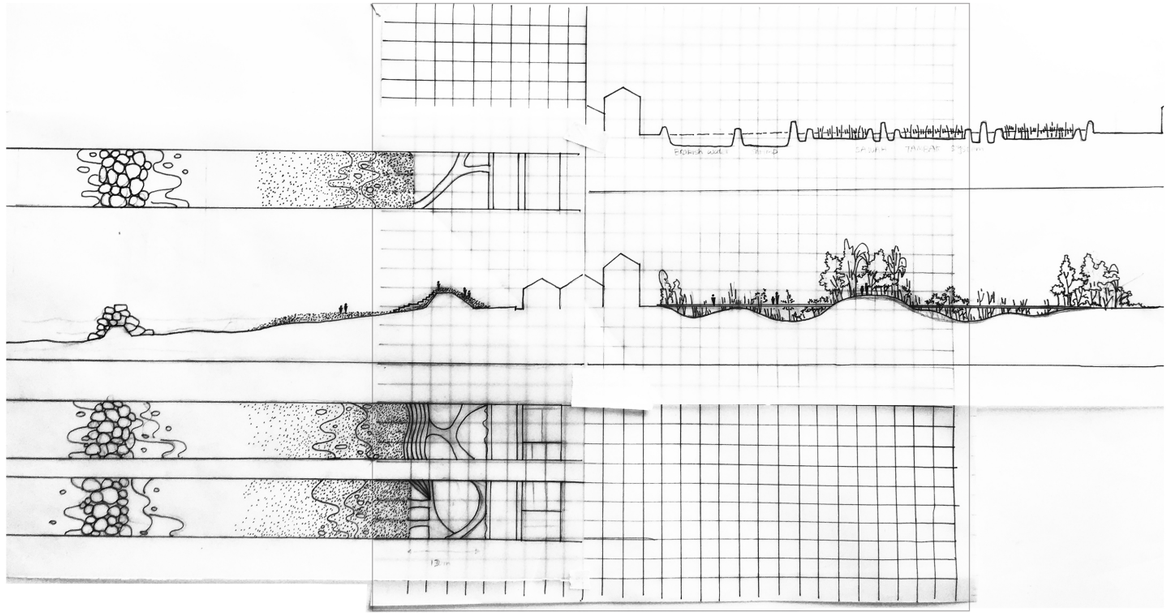

FIG.8.13 The sketched during the exploration process.

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1/3 COASTAL PROTECTION

-General concept

Three parts of the defence system

Outer dike (mangrove or groynes), a hidden dike that functions as the greenway along the coast, and the buffer zone focused on aquaculture, these three parts consist of the transition zone from Java sea to the hinterland of Pekalongan city.

-Outer dike: Groynes help to catch sediments for the beach where people can have more close relationship with the Java sea. Mangrove reduces wave strength and improves the coastal ecology. More importantly, it provides natural dyes for the batik industry and it is an important part of the coastal aquaculture system.

-Hidden dike: Cover by vegetation, the hidden is part of the coastal landscape, meanwhile, it is also the important connection, a greenway where people can experience the different landscape along the coast.

-Coastal buffer zone: The aquaculture types are decided on the types of water. The aquaculture shifts from a brackish system to a freshwater fishery from the coast to the hinterland. The intermediate canal enables the fishponds to store water and connected it with the water circulation system.

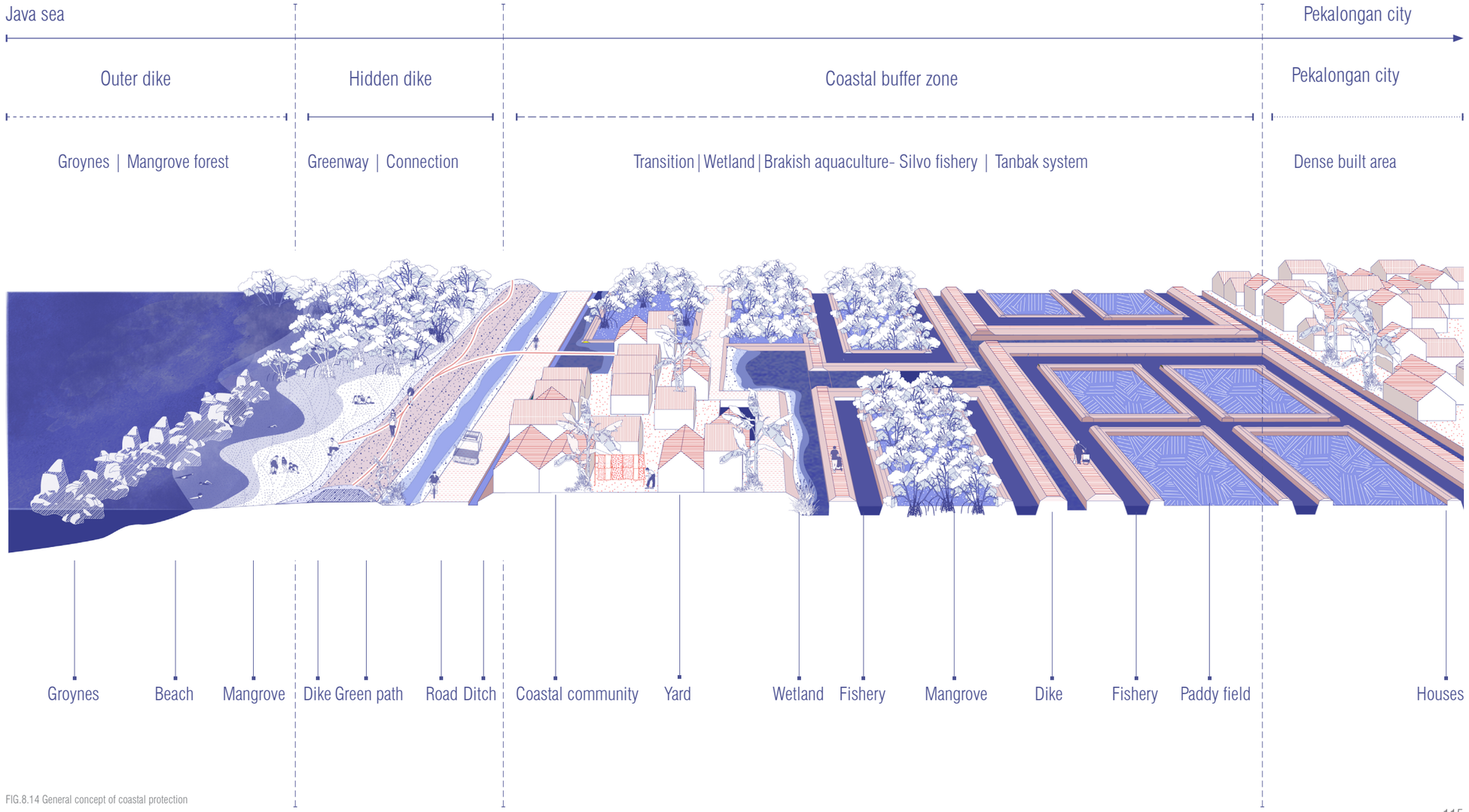

FIG.8.14 General concept of coastal protection

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1/3 COASTAL PROTECTION

-General concept

New oppourinities in the landscape

The coast intervention is not only a protective strategy that prepares the zone for rising sea level and storm surge. It also generates possibilities in all the following aspects:

-Food supply: The Tambak aquaculture system provides fish and vegetation.

-Recreation: The hidden provides a green way to experience the coastal landscape. A beach is also a good place for relaxing.

-Job opportunity: Fishery and recreation beach create job opportunities for the local people. Meanwhile, the construction process also provide people with job opportunities

-Ecology: The mangrove frost and beach not only functions as a defence, but they also rich the types of habitats along the coast and increase the biodiversity.

-Water store and purification: The natural process of plants and fish farming could help reduce the nutrients in rainwater and sewage.

-Integration: Sediments from river course can supply the materials for hidden dike construction and the waster fruit from mangrove can provide eco-friendly dynes for the batik industry.

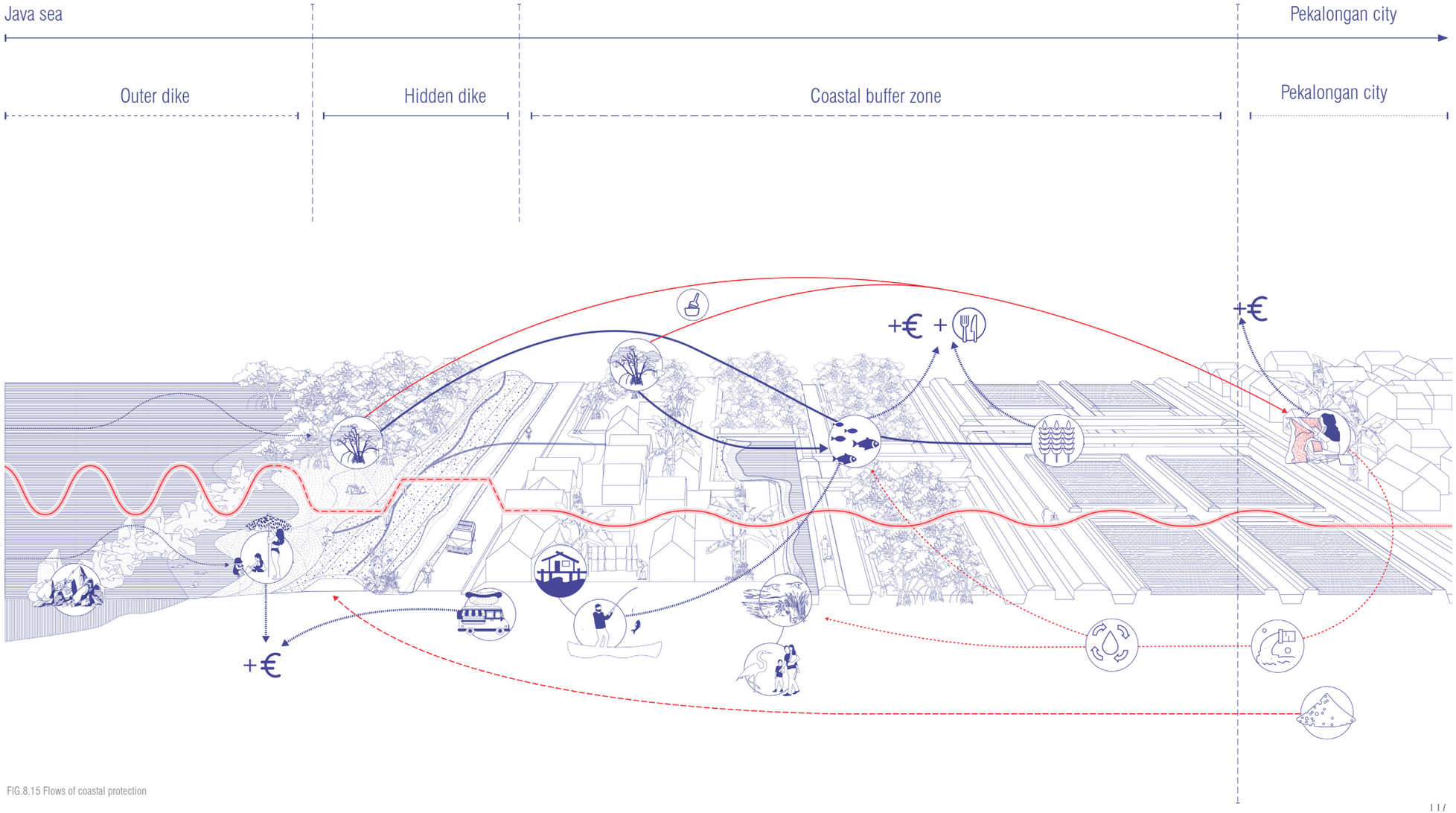

FIG.8.15 Flows of coastal protection

1/3 COASTAL PROTECTION

-Local implementation

Study area

FIG.8.16 Two types of landscape at the coast
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916, edited by the author.

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Location A - fishpond | inundation zone

The area is losing its fishery industry. Fish huts and a dike under construction are the "landmarks" here.

FIG.8.17 Location A - The landscape

Location B - Pekalongan beach

Pekalongan beach is the most famous beach in the city. But the facilities and infrastructures there quite poor.

FIG.8.18 Location B - The landscape

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1/3 COASTAL PROTECTION

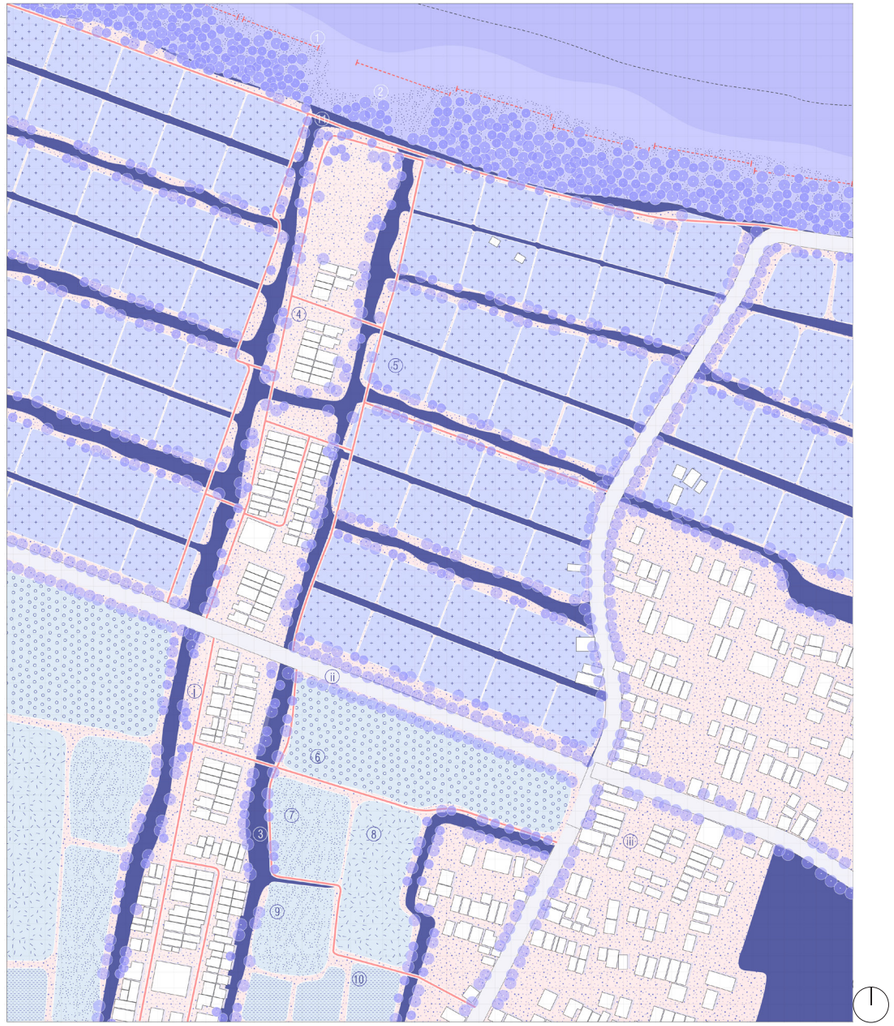
Local implementation

Location A Plan

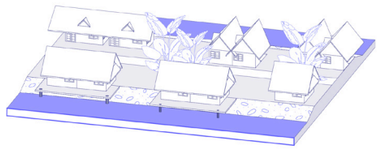
A temporary ecological structure helps stabilize mangrove forest and protect the fishery industry along the coast.
Outside the main dike is the brackish fishery combined with mangrove. Within the dike, based on the traditional Tambak structure, fresh aquaculture functions also in water purification and storage by letting the livings reduce the nutrient within the water.

i Current dike
ii existing fishing huts
iii Urban settlements

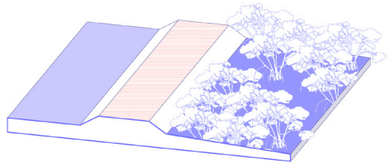
1 Permarble infrastructure
2 Mangrove defence
3 Freshwater course
4 Newly built fish huts
5 Fishery with mangrove
6 Harvest pond
7 Pretreatment pond
8 Filterlization pond
9 Stocking pond
10 Hatch pond
11 Hidden dike



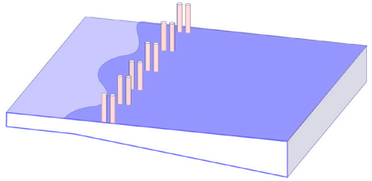
① fish hut



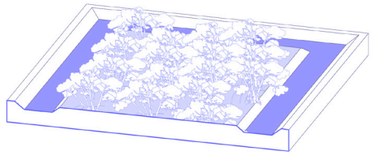
② green path



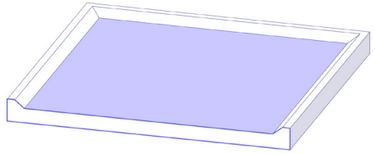
④ Temporary structure



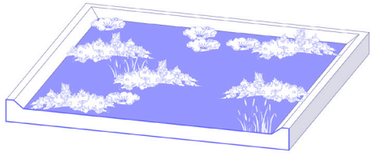
③ Brackish water fishery



⑦ Pre-treatment pond



⑥ Filterlization pond



⑤ Freshwater fishery-harvest pond/stocking pond

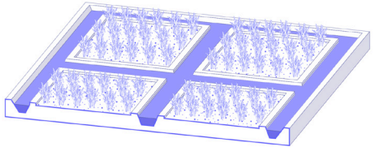


FIG.8.19 Plan of the fishery transition zone
FIG.8.20 Types of landscape

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1/3 COASTAL PROTECTION

Local implementation

Location A

The flat landscape is turned into a diverse landscape which also protective and productive. Mangrove rehabilitation and the sewage aquaculture system are very important two design intentions there.

Current situation

Flat vulnerable landscape with hard infrastructure under construction.

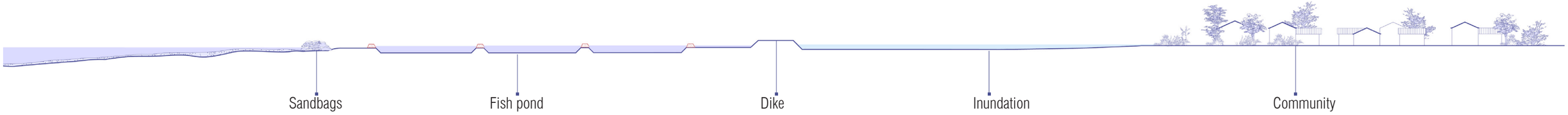

FIG.8.21 Location A - current profile

Design proposal

Productive and productive landscape which also provides ecological functions.

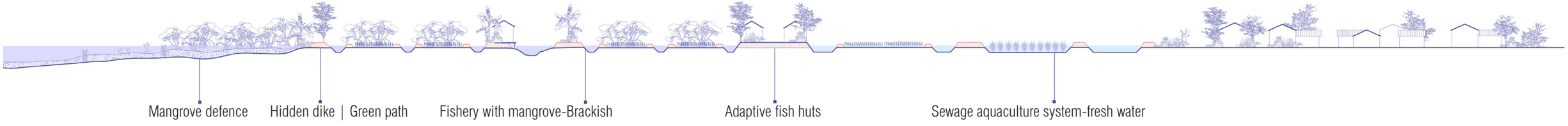

FIG.8.22 Location A - a proposed fishery buffer zone between Java sea and the city.

1/3 COASTAL PROTECTION

Local implementation

Location A | Mangrove development

Temporary structure and mangrove development

The temporary structure which made of wood are used to catch sediments which brought by the wave. It will prepare the growth conditions for the mangrove to rehabilitate. Once the mangrove mature, it can be moved forward and prepare the conditions for the next generation.

It is a small intervention and cost very little. It is aimed to prepare condition for nature to take over. Most work will leave for nature to take, including sedimentation and mangrove rehabilitation.

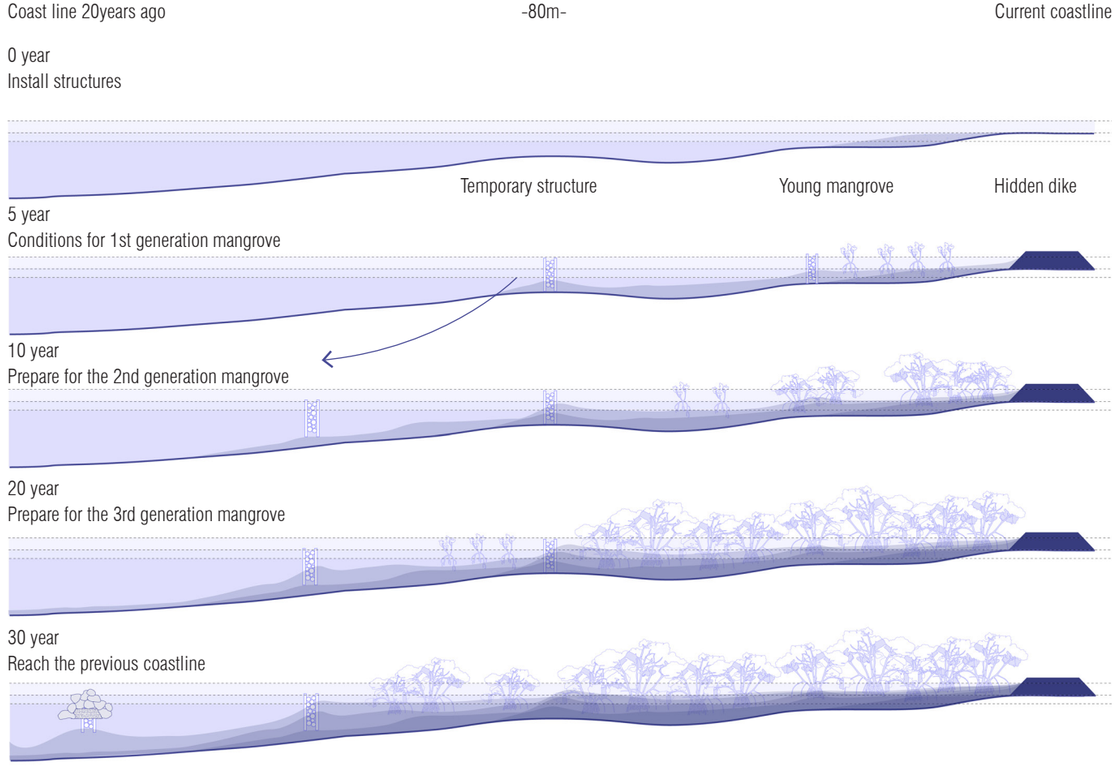

FIG.8.23 Location A - the process of mangrove rehabilitation.

Location A | Sewage purification system

Water purification

A combination of the traditional Indonesia tam-bak system with water purification. After pre-treatment in the anaerobic pond, the sewage from the urban provides the nutrient for the vegetables and fish. And the freshwater, as a product from the system can be recharged into the city for batik production.

Sponge capacity

In the meantime, the peripheral canal helps to deal with the fluctuating water level.

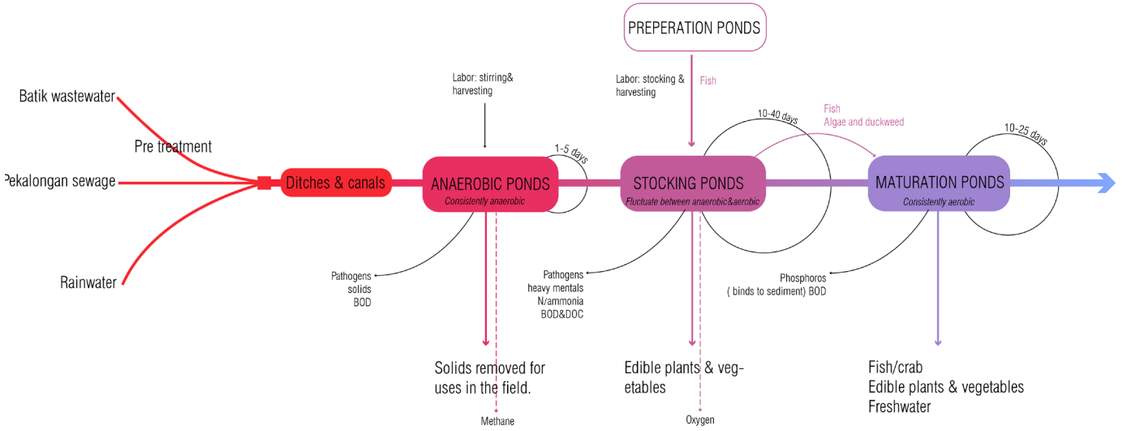

FIG.8.24 The sewage purification system and its production.

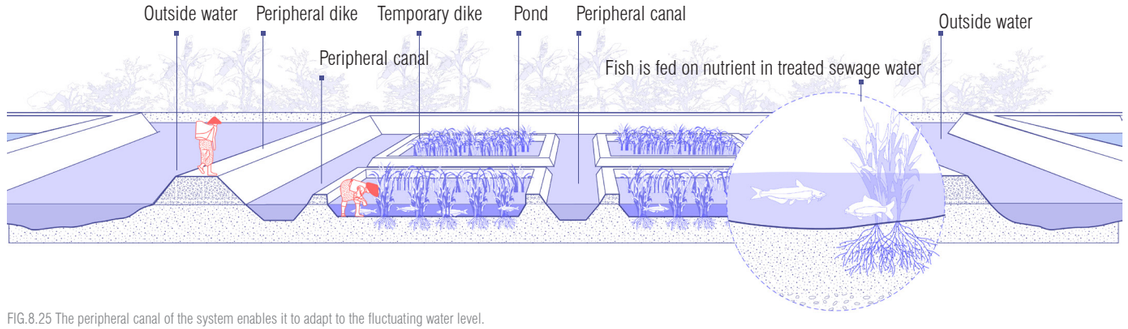

FIG.8.25 The peripheral canal of the system enables it to adapt to the fluctuating water level.

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1/3 COASTAL PROTECTION

Local implementation

Location B | Pekalongan beach

Current situation

Poor facilities and vulnerable coastal community

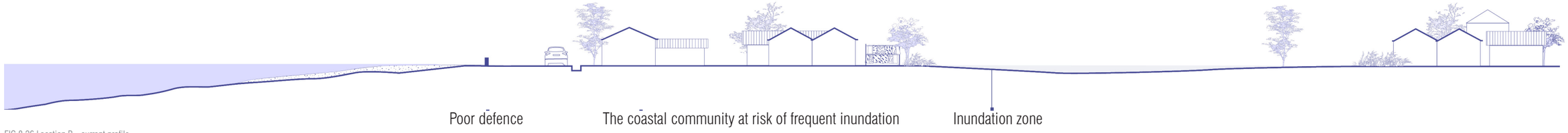

FIG.8.26 Location B - current profile

Design proposal

Landscape as infrastructure, growing beach with adaptive coastal community

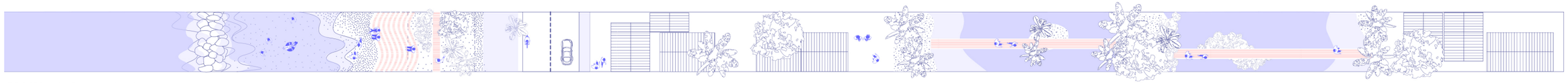

FIG.8.27 Location B - a recreational beach

The three-part also works there, an outer dike which is groynes, to accumulate and stabilise the beach. A multifunctional hidden defence and wetland as the buffer zone.

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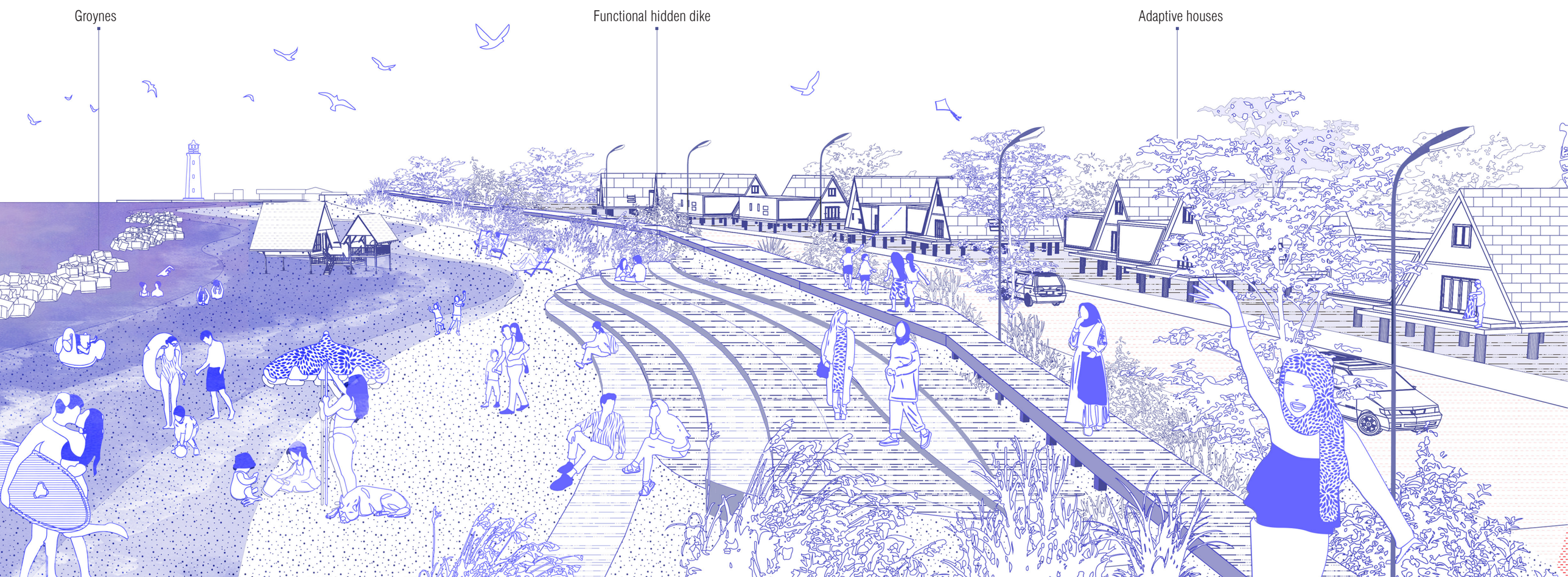
1/3 COASTAL PROTECTION

Local implementation

Location B | Perspective-Pekalongan beach

FIG.8.28 Perspective-Pekalongan beach

The new landscape at the Pekalongan beach, steps and path integrated with the hidden dike and adaptive houses in the coastal community.



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8.2.2 DISCHARGE CAPACITY

2/3 DISCHARGE CAPACITY

The river is dynamic in the natural context. The speed of water flows differently in a curved channel and causes sediments and erosion. So the river keeps meandering. But due to the rapid urbanization, the constructed land constrained the development of river courses and limits its capacity which leads to serious floods.

FIG.8.29 Meandering river under natural conditions
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916,
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2/3 DISCHARGE CAPACITY

-General concept

The structure of new river connections

The design focus on how to increase the discharge capacity, and make the water more accessible while increasing the local's care for the water.

New shortcuts and original river bend are the core element in this design assignment. The design of the shortcut focus on discharge capacity and protection, while the original river bend, due to its special curve, shows potential in water purification, and become a great important part of the urban green structure.

New shortcuts reconnect the curved river bend which helps the water flows smoothly. The new riverbank is designed with facilities that can provide multi-functions for daily use (like staking and benches). The design of height difference protects the city from flooding in emergent situations.

The previous river bend is isolated from the main river by sluices. And it is divided into different parts according to the need for an ecological water purification system. Different plants are designed there which helps purify the water while improving the landscape quality of the Pekalongan river.

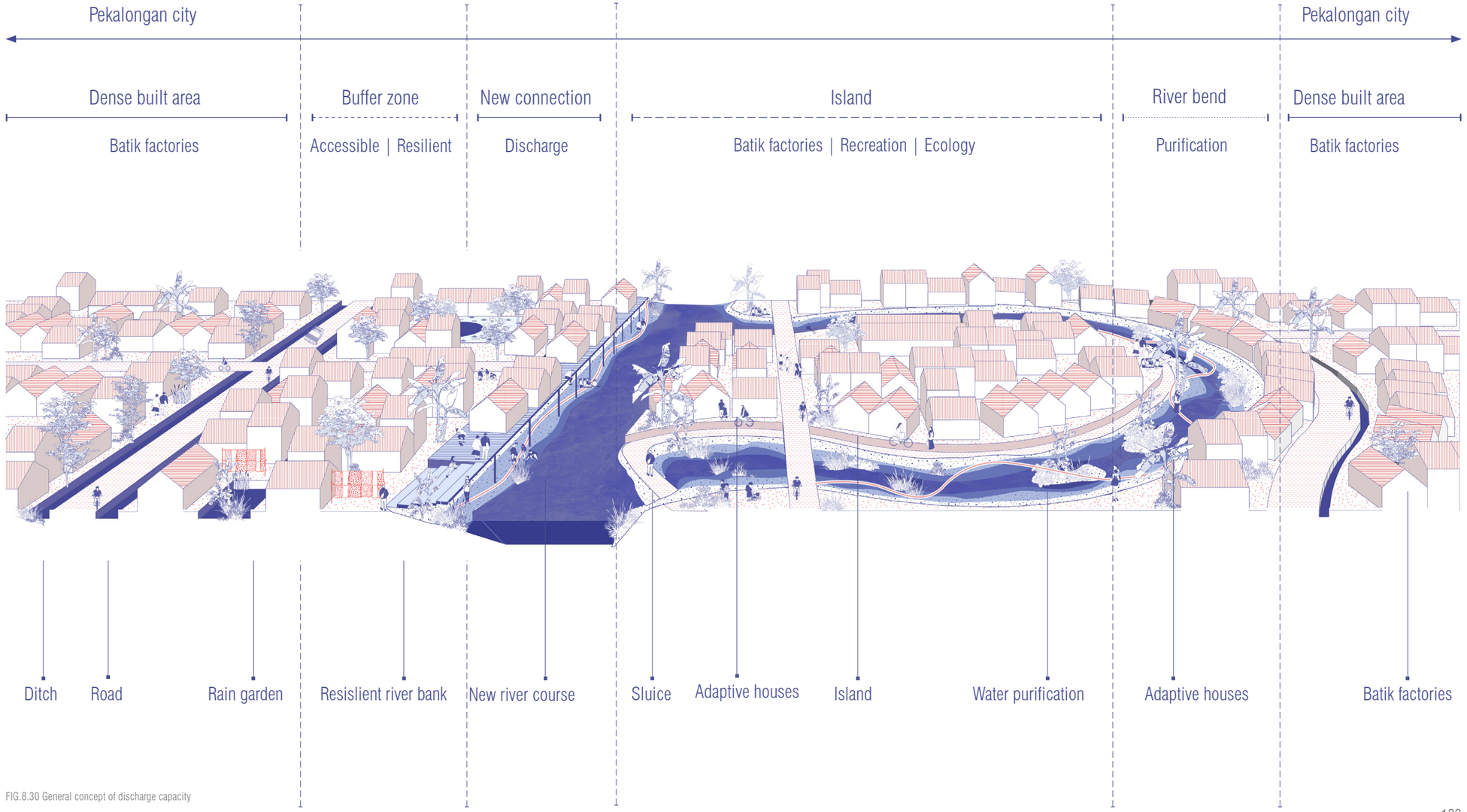

FIG.8.30 General concept of discharge capacity

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2/3 DISCHARGE CAPACITY

-General concept

Flows and the green structure

Water flow: The new shortcut aims to discharge the river water from the upper stream area, while sluice controls the water get into the previous river bend which now functions as a purification wetland. The water goes through ponds designed with different plants and elements. At the end of the wetland, the clean water will be pumped into surrounding batik factories. The river water is purified and supply as the source for batik production.

Sediments: The sediments brought by water will be collected and transported into the coast for the construction of a hidden dike. The river course can keep clean while providing materials for coastal protection.

Urban green structure: The water is more accessible with a resilient riverbank. And the new island and wetland will be connected to other green space, form the new green urban structure.

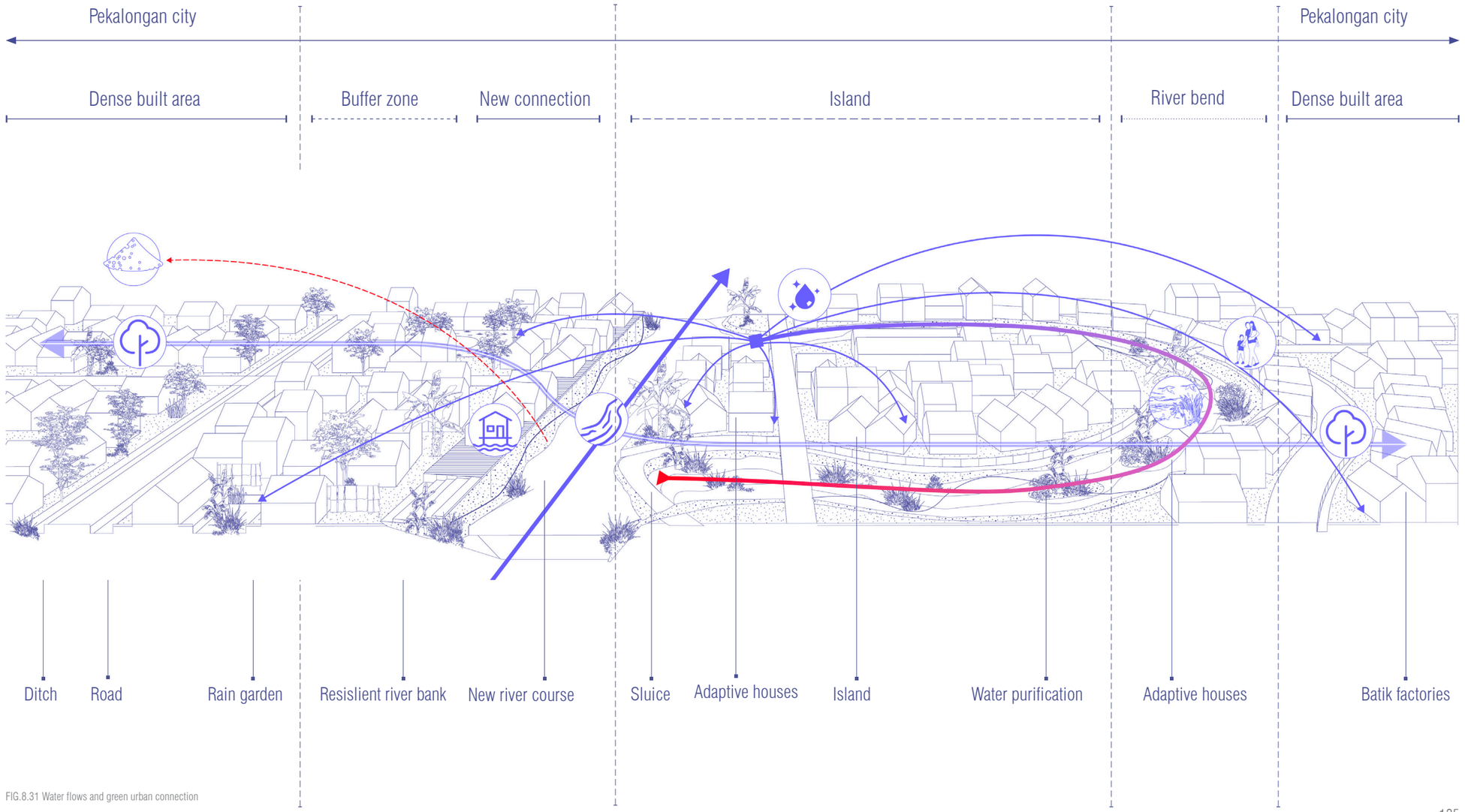

FIG.8.31 Water flows and green urban connection

2/3 DISCHARGE CAPACITY

-Local implementation

Study location

The Pekalongan center

The selected location is a representative constrained river bend in the city. Negative and positive impressions are there. It is densely populated, heavily polluted. But it the city centre which has the landmark batik museum and a lot of batik factories.

FIG.8.32 Study location
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916, edited by the author.

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The Pekalongan river is turning its back to the city

FIG.8.33 Study location

FIG.8.34 Wastewater is discharge into the river and the river is densely clocked by houses.
Source: https://www.youtube.com/watch?v=VRpiViJcTRk&list=PLIjHHQqrIWu_tolzkp6N-iKrrheNNpup8&index=20

FIG.8.35 The garbage appears in the river during the dry season when the water level is low.
Source: https://www.youtube.com/watch?v=VRpiViJcTRk&list=PLIjHHQqrIWu_tolzkp6N-iKrrheNNpup8&index=20

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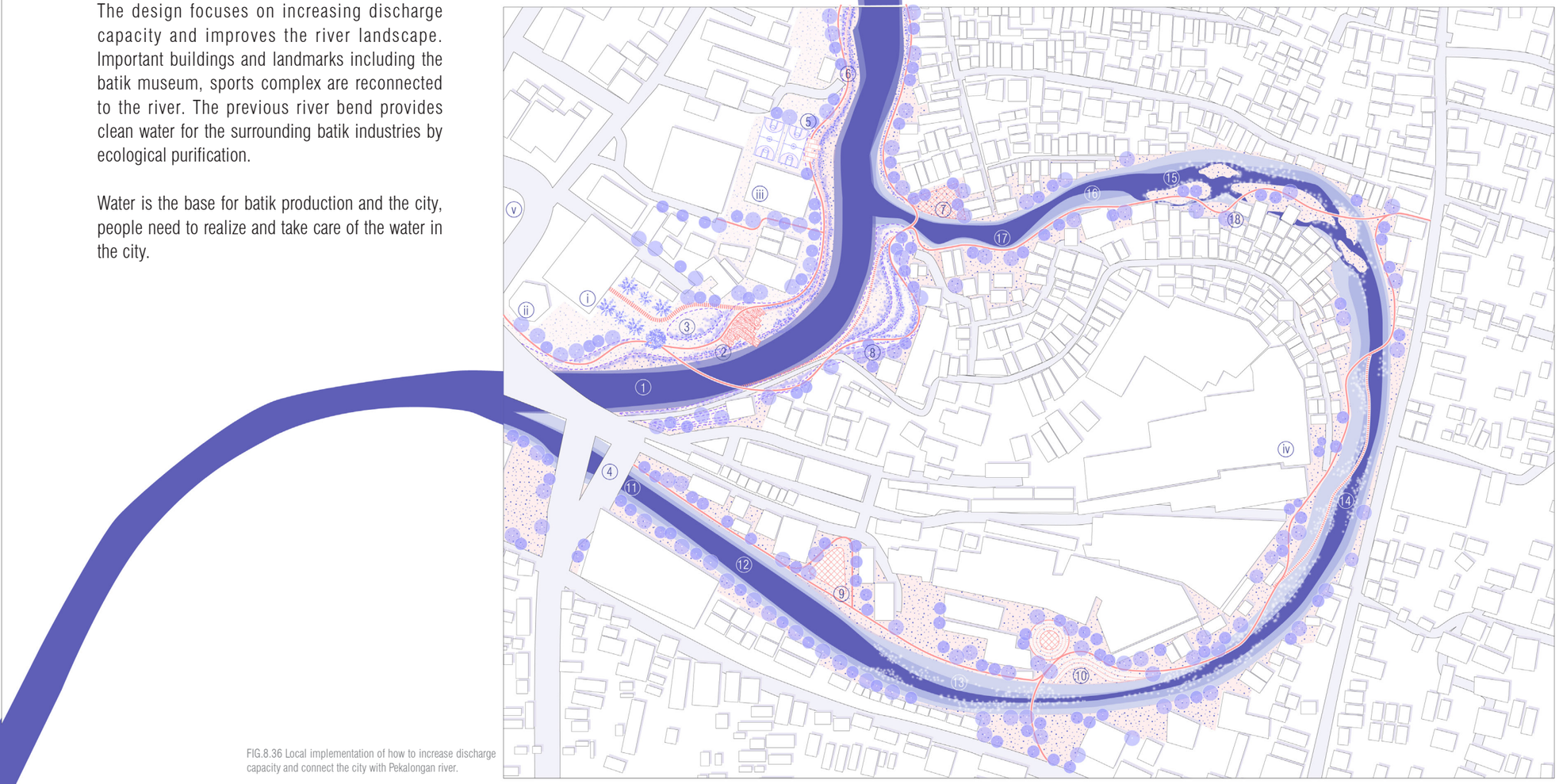
2/3 DISCHARGE CAPACITY

-Local implementation

Plan

The design focuses on increasing discharge capacity and improves the river landscape. Important buildings and landmarks including the batik museum, sports complex are reconnected to the river. The previous river bend provides clean water for the surrounding batik industries by ecological purification.

Water is the base for batik production and the city, people need to realize and take care of the water in the city.



i Batik museum
ii Mosque
iii Sports complex
iv Batik industry
v The central point of Java island

1 New river course
2 Waterfront steps
3 Landmark
4 Bridge
5 Sports
6 Waterfront path
7 Waterfront square
8 Bridge
9 Waterfront square
10 Waterfront platform
11 Pump
12 Purification-Natural aeration
13 Purification-Heavy mental removal
14 Purification-Nutrient removal
15 Purification-Biological purification
16 Purification-Sand filter
17 Purification-Clean water
18 Floating deck

FIG.8.36 Local implementation of how to increase discharge capacity and connect the city with Pekalongan river.

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2/3 DISCHARGE CAPACITY

-Local implementation

Design process

First, remove the prison which now is between the batik museum and the street. Then dig up the new river course. Build a connection between the batik museum with the new shortcut. Resilient riverbank provides defence and functions.

For the previous Riverbend. Sluice is here to control the water. Gradient river bank prepares it for water purification. Small interventions to the houses to make them be adaptive to the water. And a wetland purification urban park is achieved.

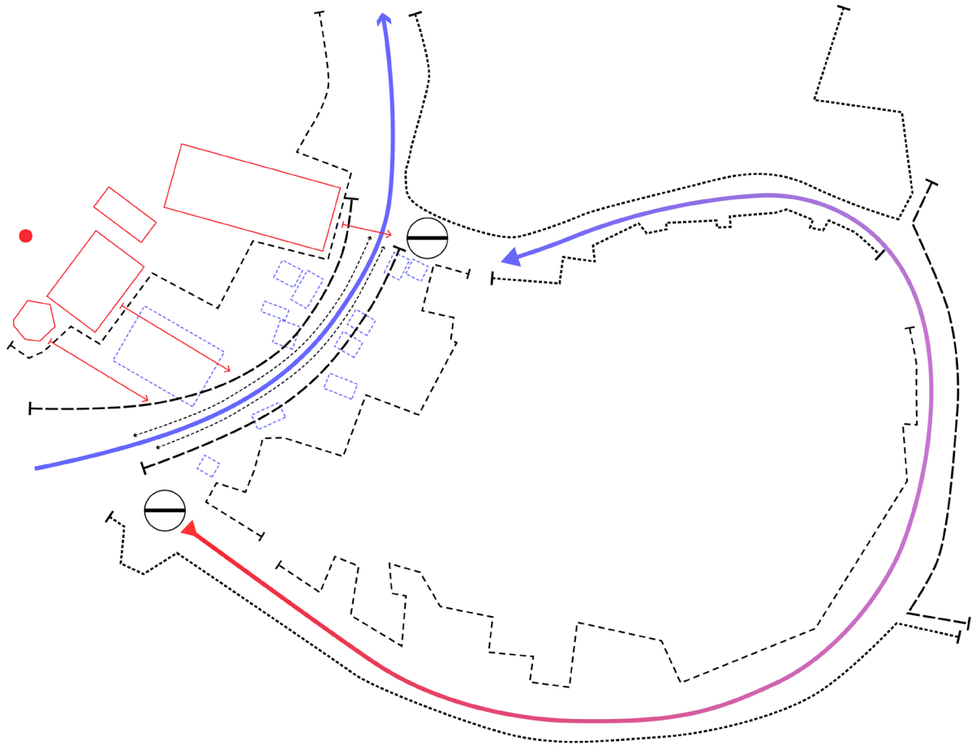

FIG.8.37 Diagram of interventions

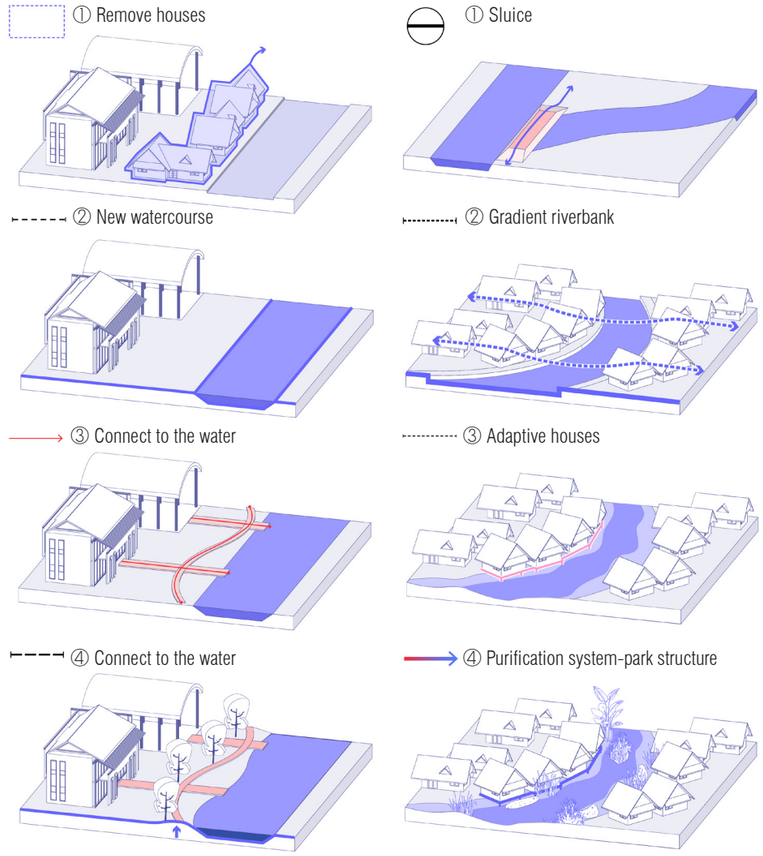

FIG.8.38 Diagram of the plan.

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2/3 DISCHARGE CAPACITY

-Local implementation

Section

In extreme situations, the benches and bridges function as a defence to protect the city from being flooded. And the purification wetland acts as part of the urban green structure.

Current situation

The Pekalongan river is turning its back to the city.

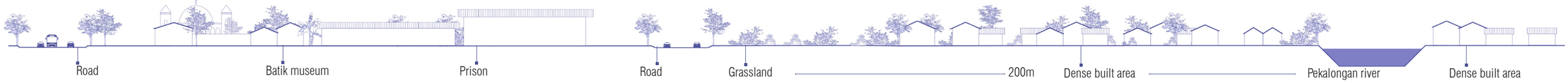

FIG.8.39 Current profile

Design proposal

New shortcuts to help the water flow smoothly, connect the city with the water.

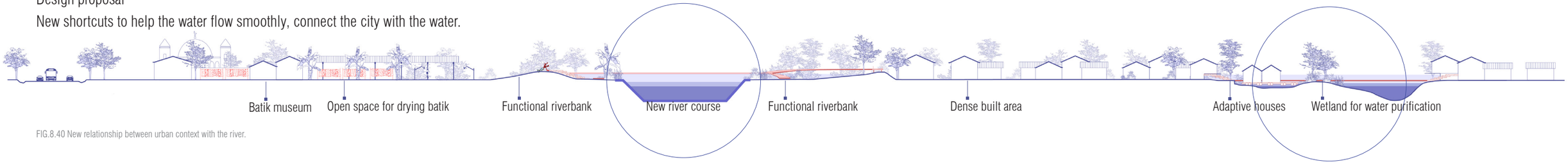

FIG.8.40 New relationship between urban context with the river.

Current situation

Design proposal

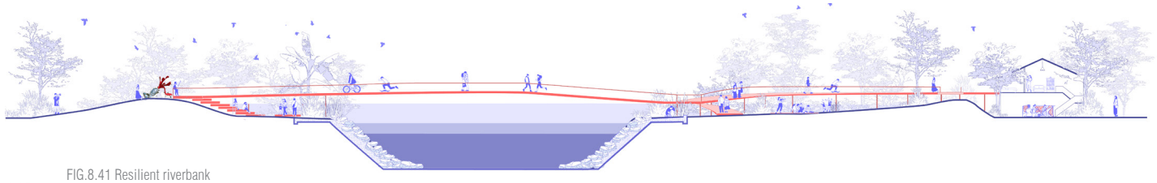

FIG.8.41 Resilient riverbank

Current situation

Design proposal

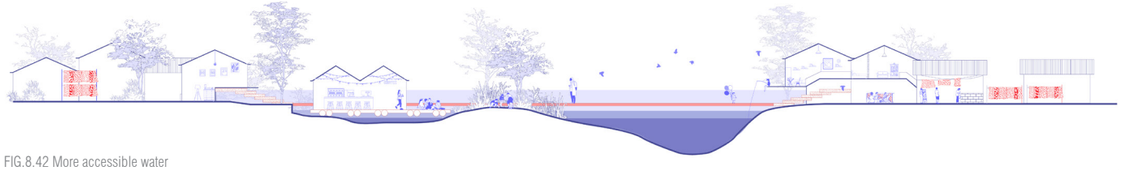

FIG.8.42 More accessible water

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2/3 DISCHARGE CAPACITY

-Local implementation

Purification system

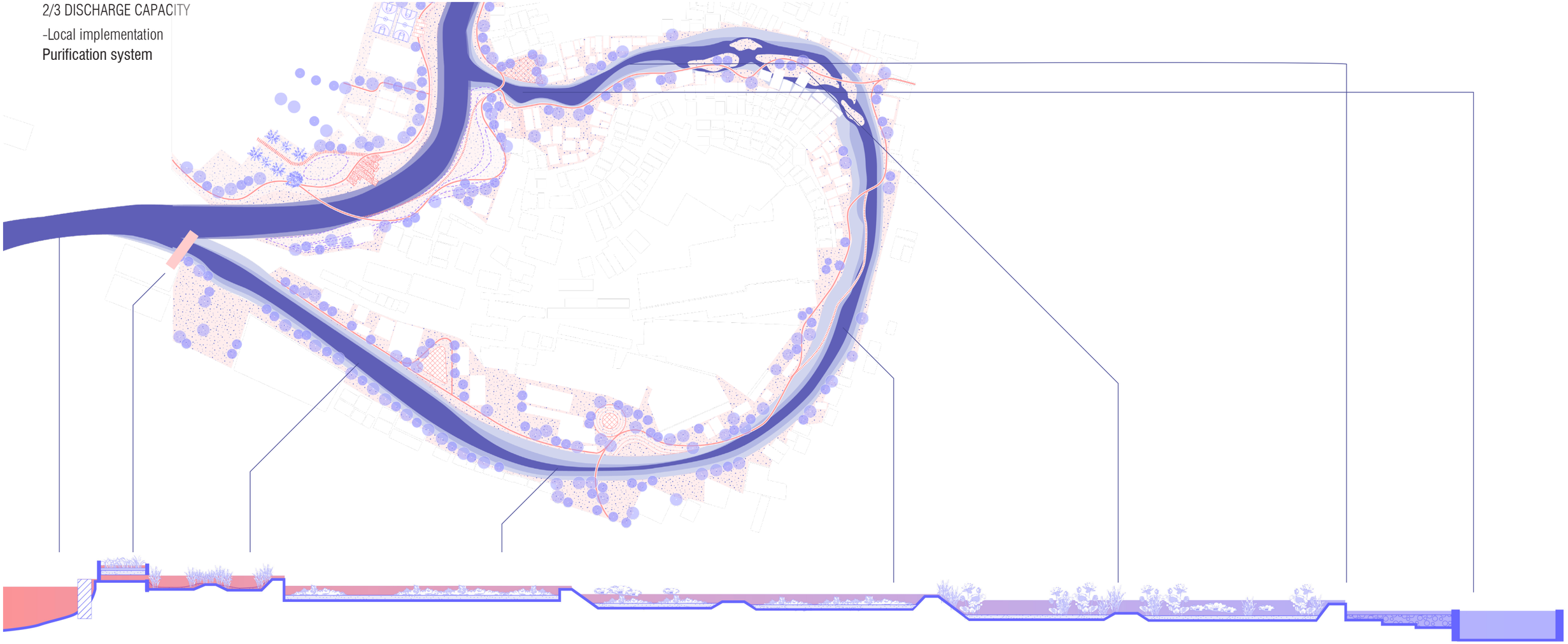

FIG.8.43 Water purification system

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2/3 DISCHARGE CAPACITY

-Local implementation

Riverbank Perspective | Daily vision

FIG.8.44 Riverbank perspective- daily vision

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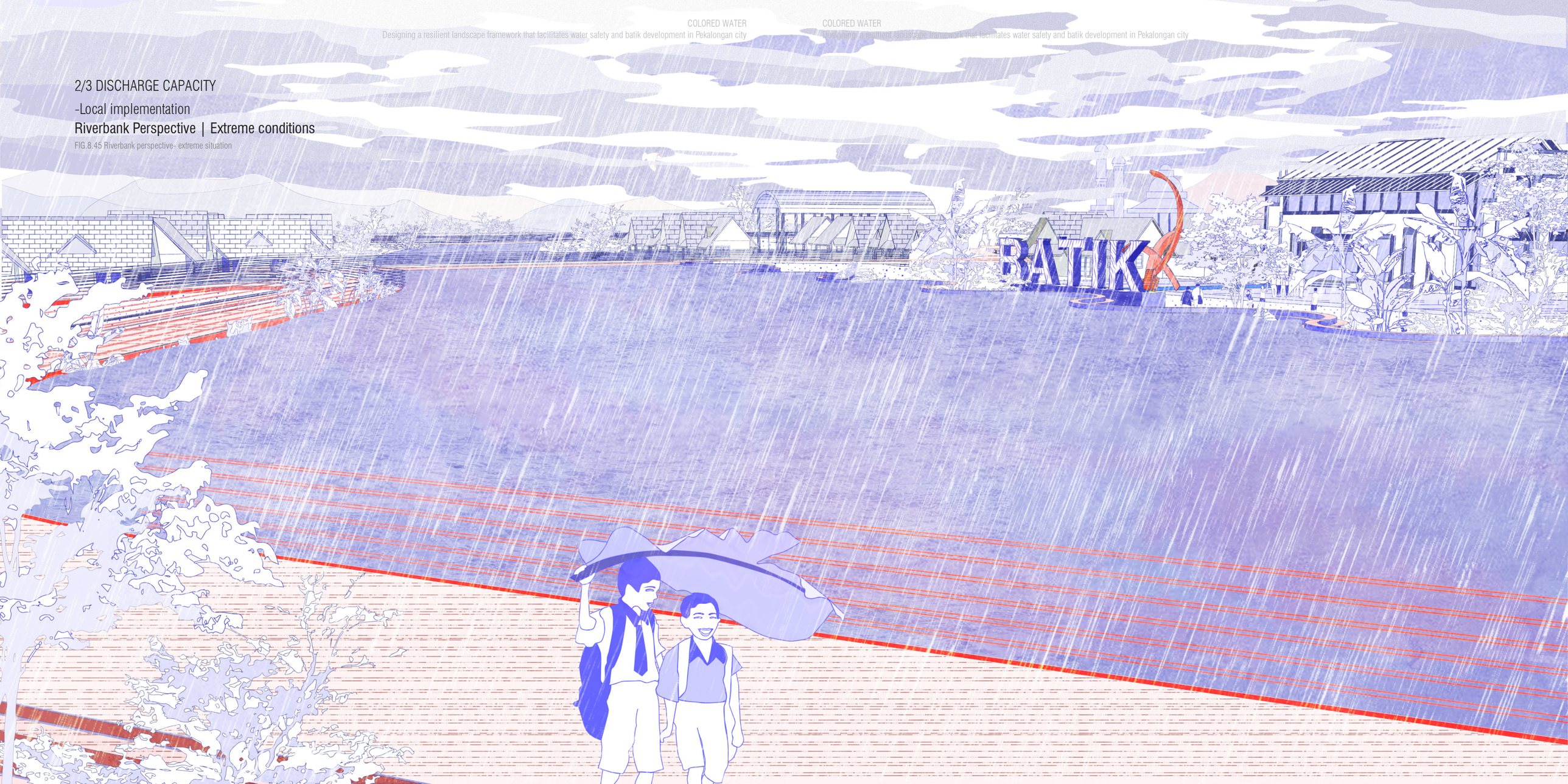
2/3 DISCHARGE CAPACITY

-Local implementation

Riverbank Perspective | Extreme conditions

FIG.8.45 Riverbank perspective- extreme situation



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8.2.3 Water circulation

3/3 WATER CIRCULATION

The imbalance of precipitation between the rainy season and dry season is a challenge, but also an opportunity for Pekalongan city. The idea of water circulation could help solve the problem. And the existing Banger canal and aquaculture system have great potential to be turned into space for water storage.

FIG.8.46 Flood in Pekalongan
Source: https://www.youtube.com/watch?v=E2RymMwem6Q

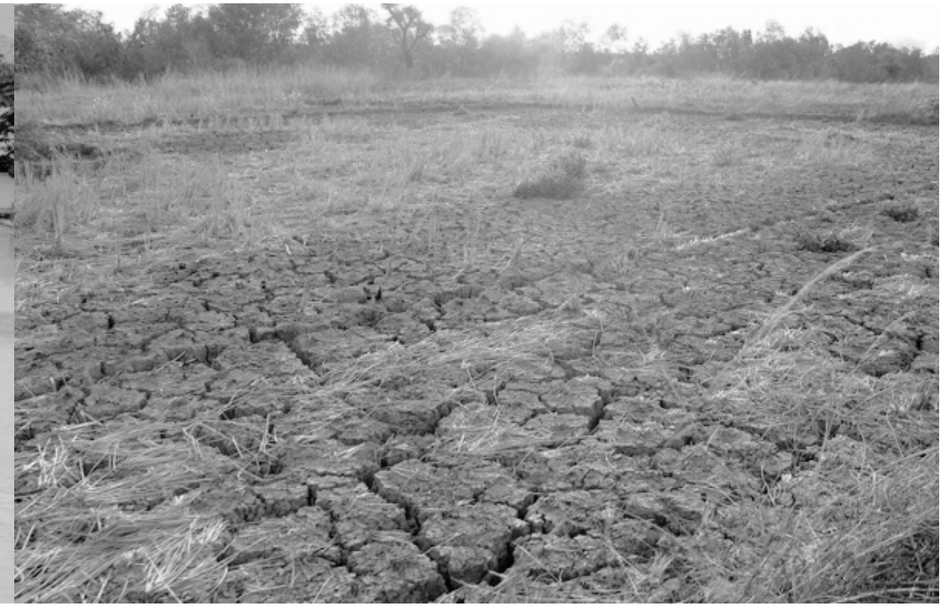

FIG.8.47 Drought, agriculture field, Pekalongan, 08/16/2017
Source: https://www.shutterstock.com/zh/search/dry+season+in+indonesia

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3/3 WATER CIRCULATION

-General concept

Sponge space in all scales

Banger canal and coastal fish ponds are the core sponge space in the city. Meanwhile, other spaces through all scales have the potential to store water, from the courtyard to the urban park.

-Banger canal: Banger canal fail to discharge water into the sea, but it is a great space for water storage. Naturalization helps create a gradient riverbank and give more space for water.

-Courtyard: The idea of a rain garden can be applied in the courtyard where people used to dry batik. The collected rainwater could supply the batik production.

-Street: More green space and designed slope along the street can help retain and store rainwater. Provent the street from being flooded.

-Urban park: The urban park has great potential to store water while providing recreational functions. The sponge space can be combined with different functions.

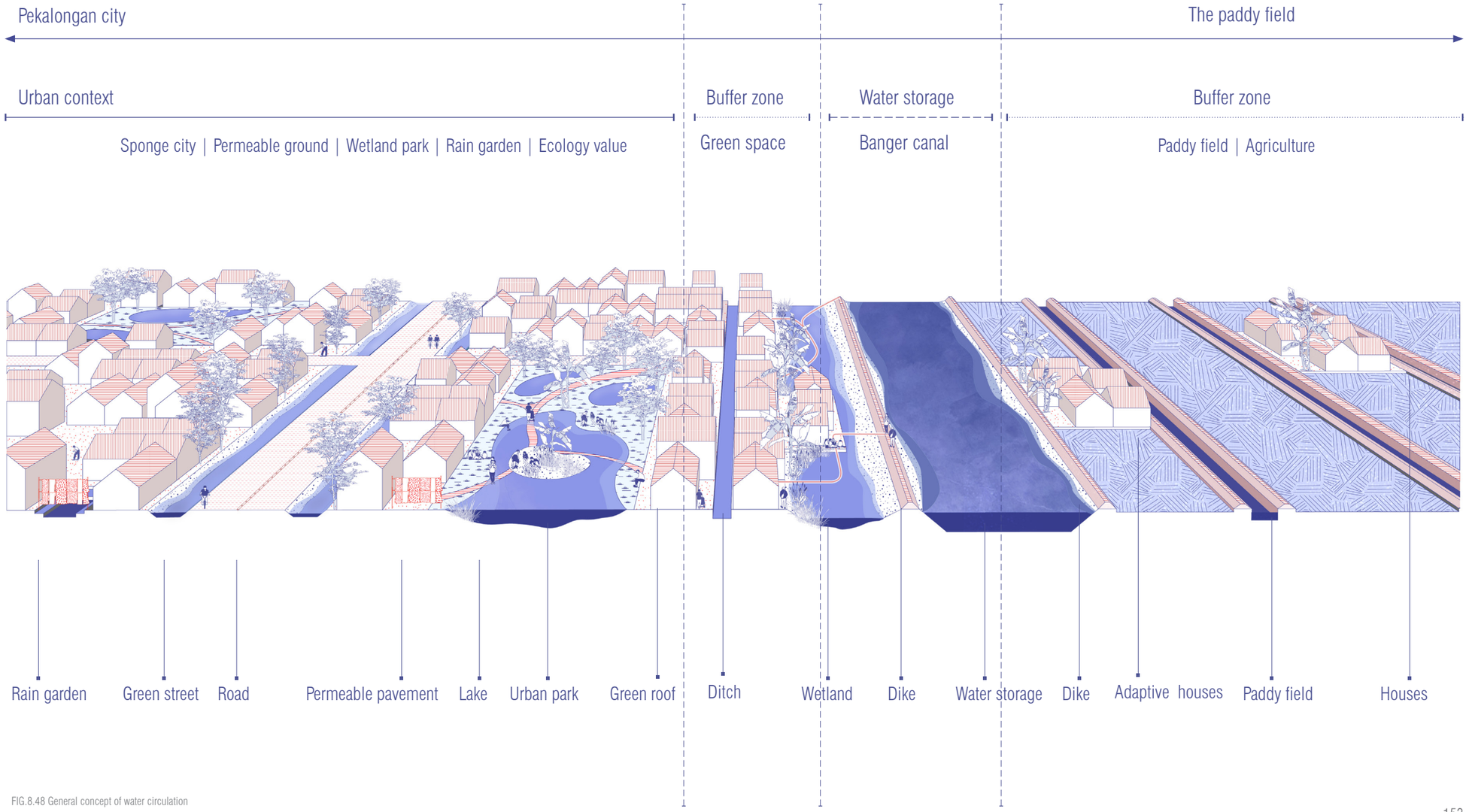

FIG.8.48 General concept of water circulation

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3/3 WATER CIRCULATION

-General concept

Water flow and urban green structure

The rainwater is collected in all scales sponge space, from the courtyard, urban park to the Banger canal. The water will be stored in the Banger canal during the rainy season, and be recharge to the urban area in the dry season when water is needed.

The wastewater will be collected and pre-treated.

While the system achieves its potential to store the water, prevent the city from being flooded and supply water during the droughts, it also becomes an important part of the urban green structure, resilient riverbank helps to build up a close relationship between the water and the urban context, as the green core, it connects with other urban parks, green public space by green streets. A new urban park system is also achieved with great ecological and recreational values.

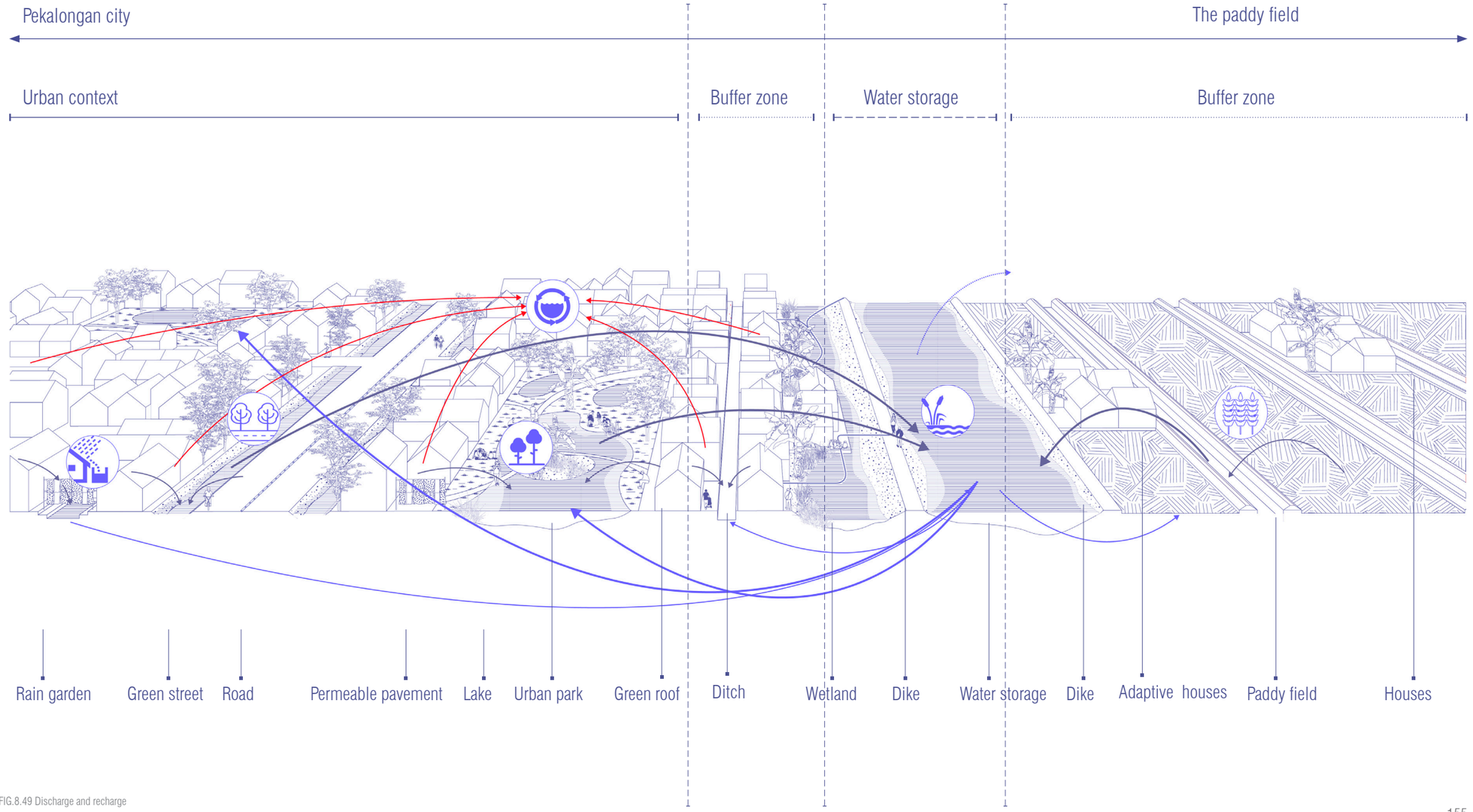

FIG.8.49 Discharge and recharge

3/3 WATER CIRCULATION

-Local implementation

Study location

The Pekalongan center

Banger canal is considered the most important sponge within the city, the land use along the canal is diverse. Meanwhile, it is important to consider the transition from the urban context to the Banger canal and what's potential sponge space through these scales.

FIG.8.50 Study location
Source: Google map, https://www.google.com/maps/place/Pekalongan,+Pekalongan+City,+Central+Java,+Indonesia/@-6.8959407,109.6394839,13z/data=!3m1!4b1!4m5!3m4!1s0x2e70242ca490fe13:0xc0c68a126b258cb6!8m2!3d-6.8898362!4d109.6745916,
edited by the author.

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FIG.8.51 Study location

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3/3 WATER CIRCULATION

-Local implementation

Overall plan

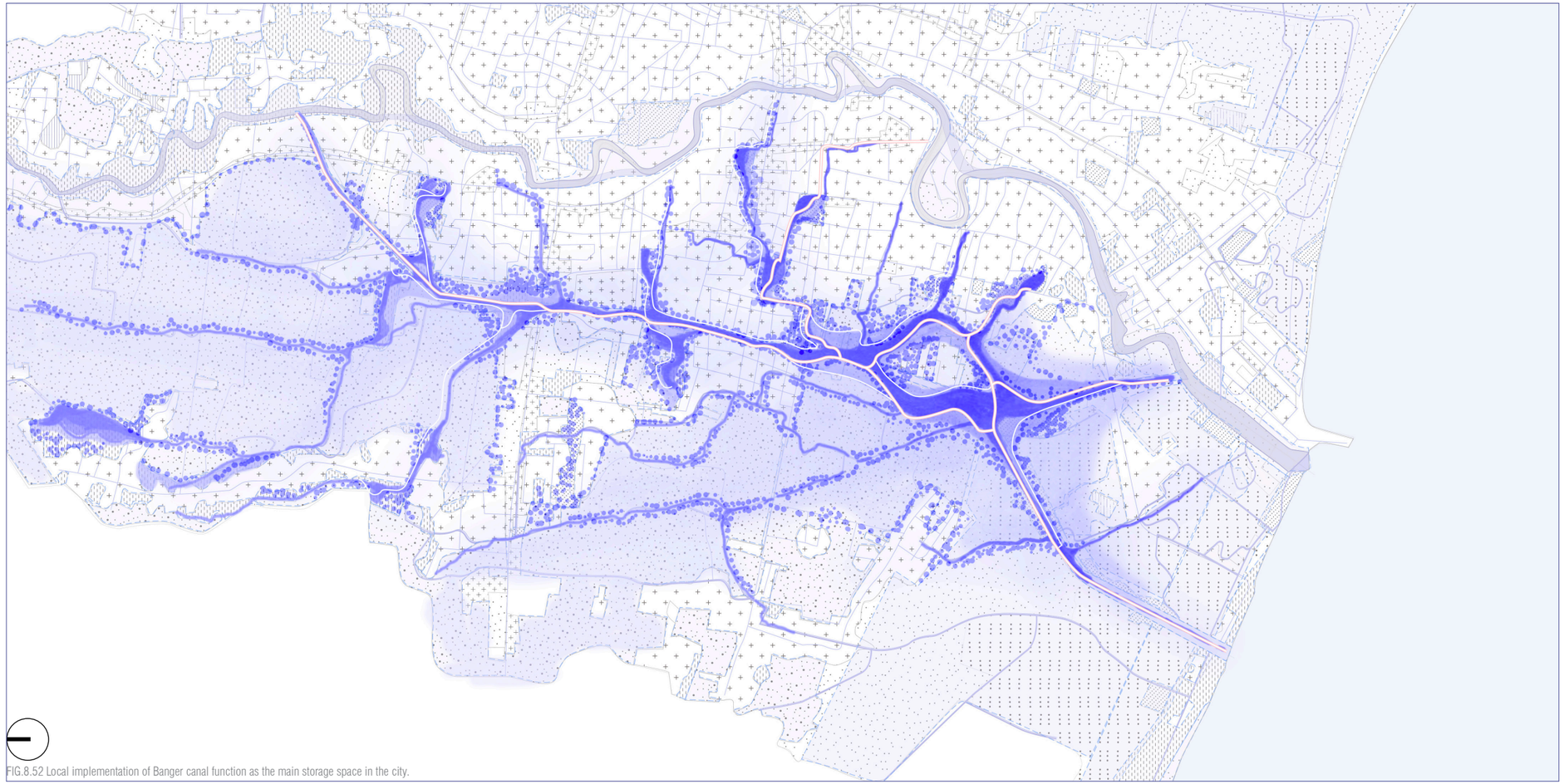
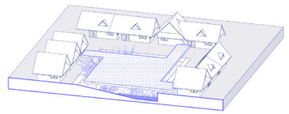
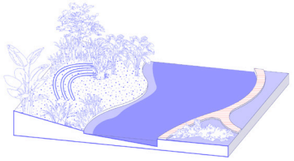


FIG.8.52 Local implementation of Banger canal function as the main storage space in the city.

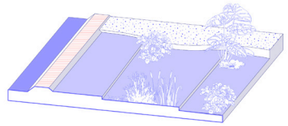
① Courtyard



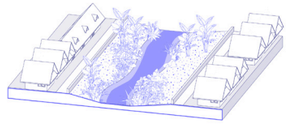
② Green structure



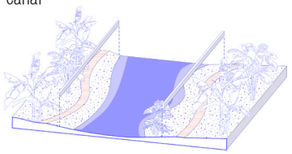
③ Connect to the river



④ Dense populated zone



⑤ Renaturalization canal



⑥ Paddy field

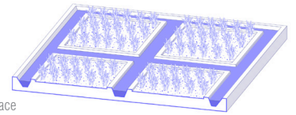


FIG.8.53 Different sponge space

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3/3 WATER CIRCULATION

-Local implementation

Section

Current situation

Hard pavement with little space for water.

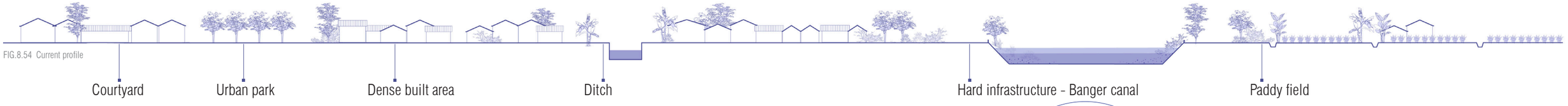

FIG.8.54 Current profile

Design proposal

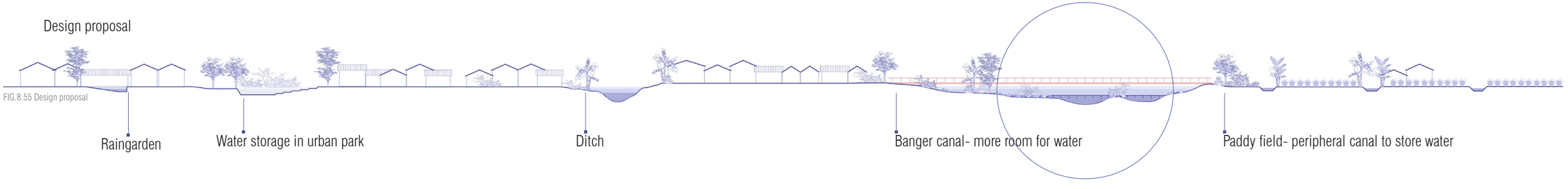

FIG.8.55 Design proposal

Banger canal

Current situation - The canal is full of garbage.

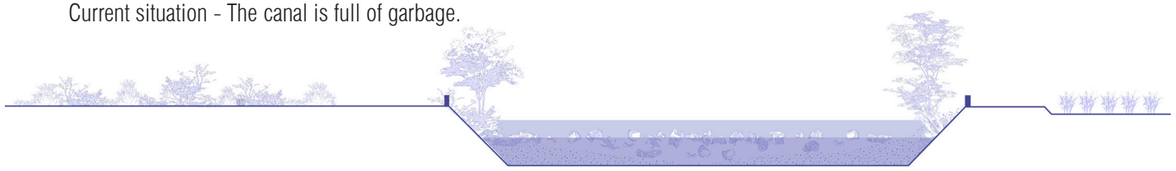

FIG.8.56 Garbage is full fill the Bager canal especially in the dry season when the water level goes down.

Design proposal - More space for water

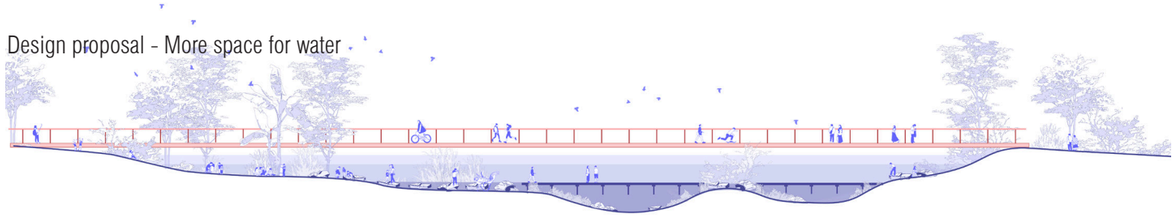

FIG.8.57 Local implementation of Banger canal function as the main storage space in the city.

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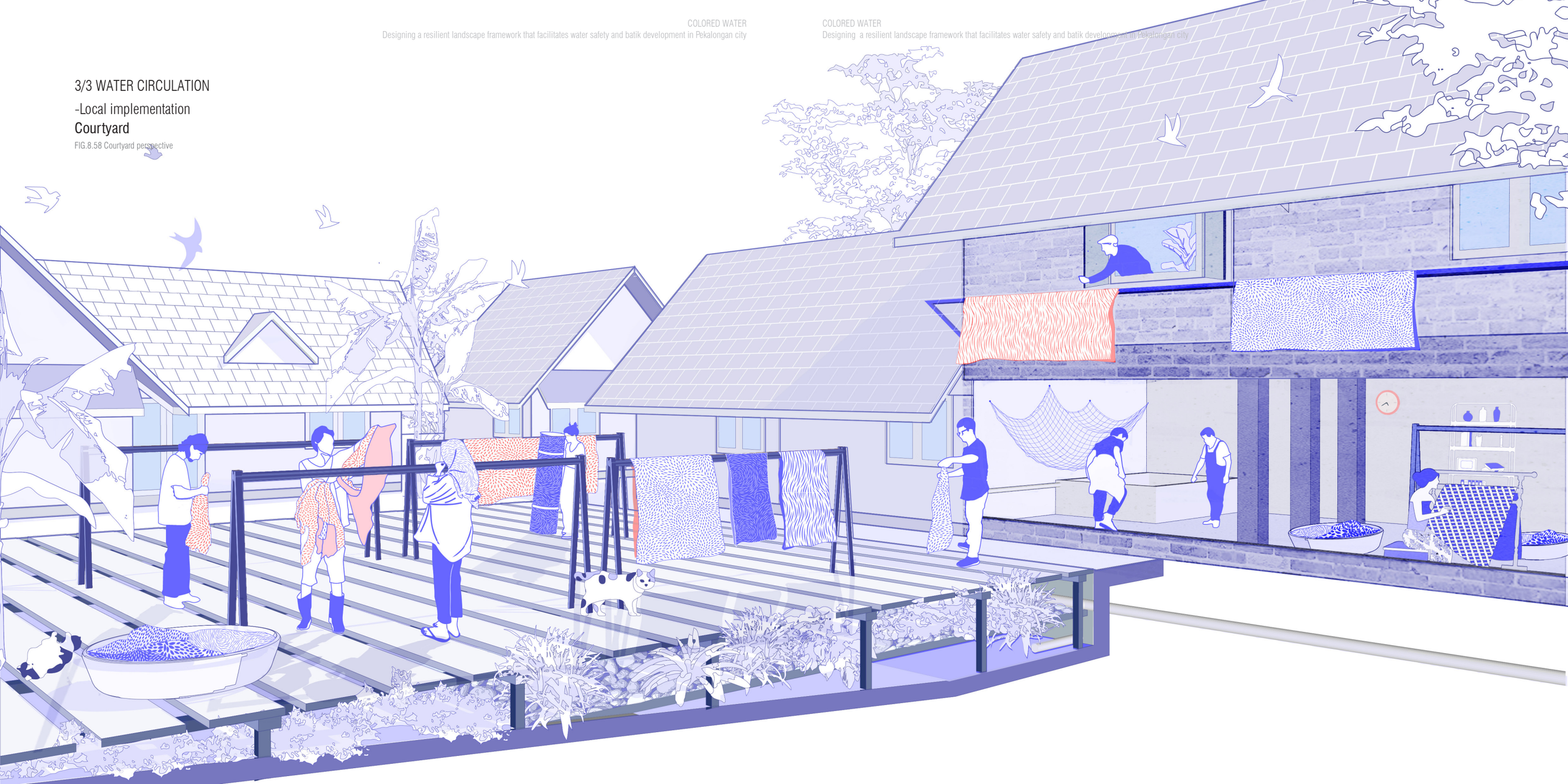
3/3 WATER CIRCULATION

-Local implementation

Courtyard

FIG.8.58 Courtyard perspective



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3/3 WATER CIRCULATION

Local implementation

Banger canal

Now: Banger canal perspective

8.4 Urban Landscape as the whole

8.4.1 The intergration of three strategies

During the exploration process, the three strategies were found connected spatially or logically. There are flows among these systems.

The sediments in the river courses provide the material for coastal protection. The sewage water from the urban provides the nutrients for the coastal fishery. Meanwhile, the purified water from fishponds provides clean water for batik production. The rainwater which used to be discharged by the Pekalongan river now is directed and stored in coastal fishponds and the Banger canal. The mangrove fruit which is the by-product of coastal defence provides eco-friendly materials for the dominant industry, batik production.

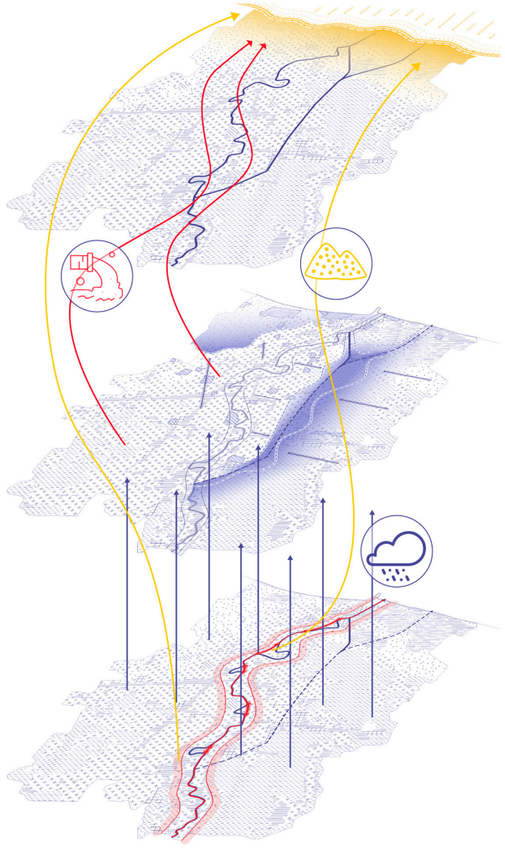

FIG.8.60 Flows among three systems

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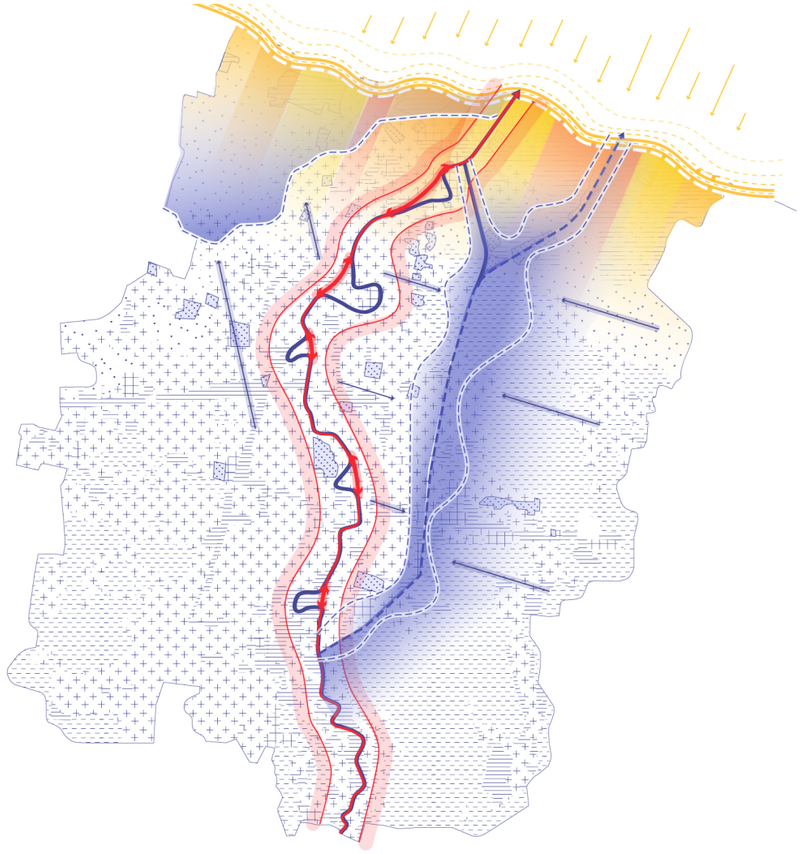

FIG.8.61 Landscape as the whole.

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8.4.2 Time development

The landscape framework is designed to adapt to flatuating water level without being disturbed.

Dry season

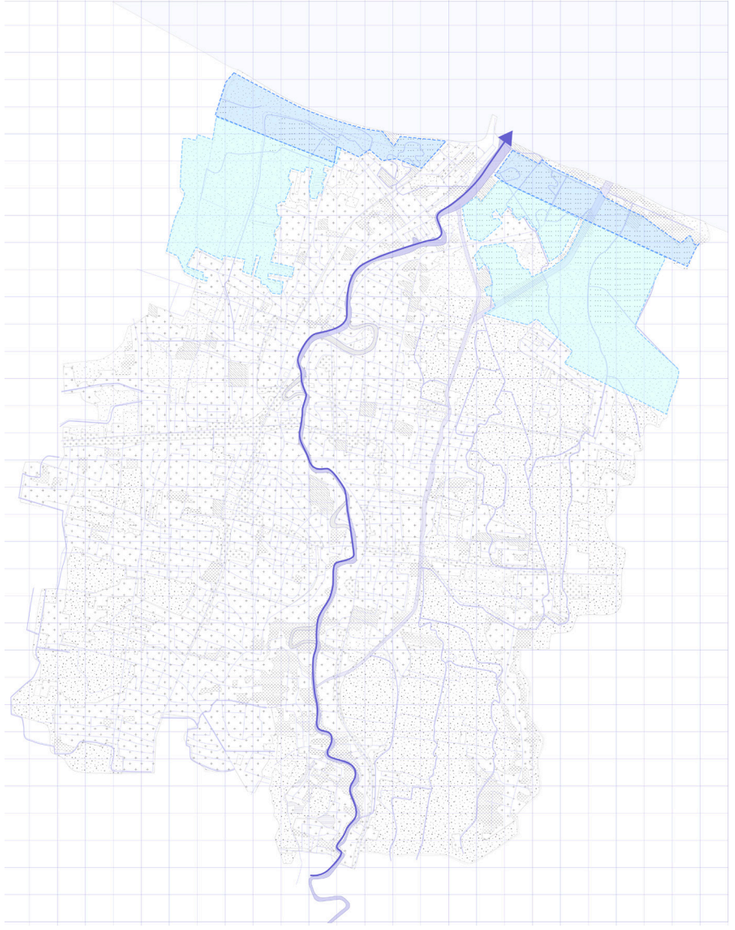

FIG.8.62 The framework in the dry season

Rainy season

FIG.8.63 The framework in the rainy season

Extreme situation

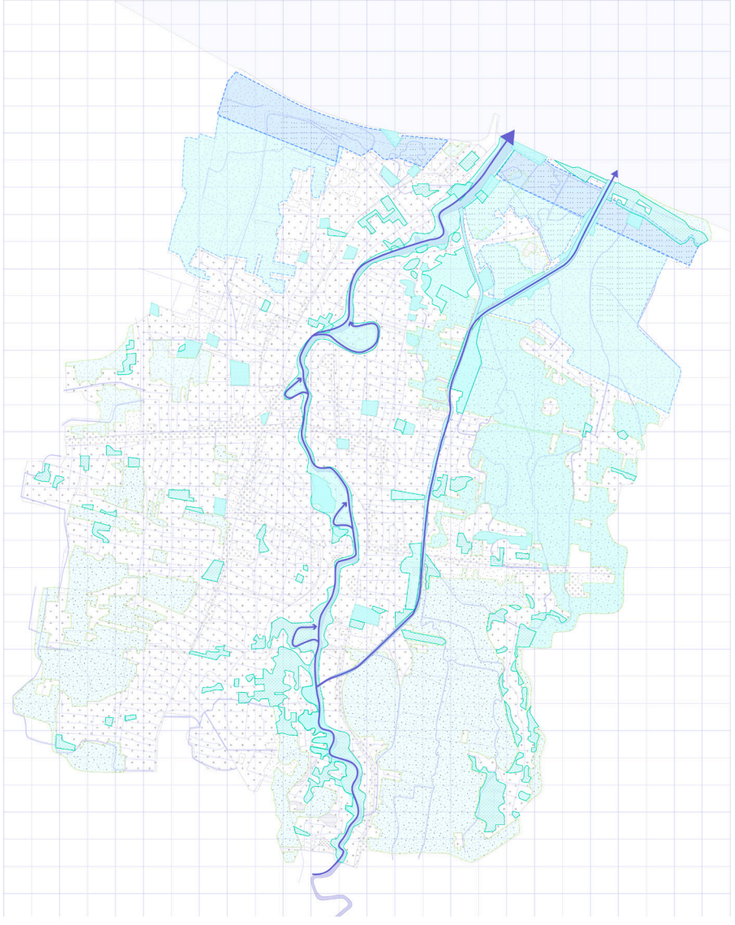

FIG.8.64 The framework in the extreme situation

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8.4.3 Strategic development

The pilot projects are the most effective and important ones. They frame the backbone of the plan. Other values will be added to the framework gradually. In the end, it will achieve the whole resilient framework.

0 Year

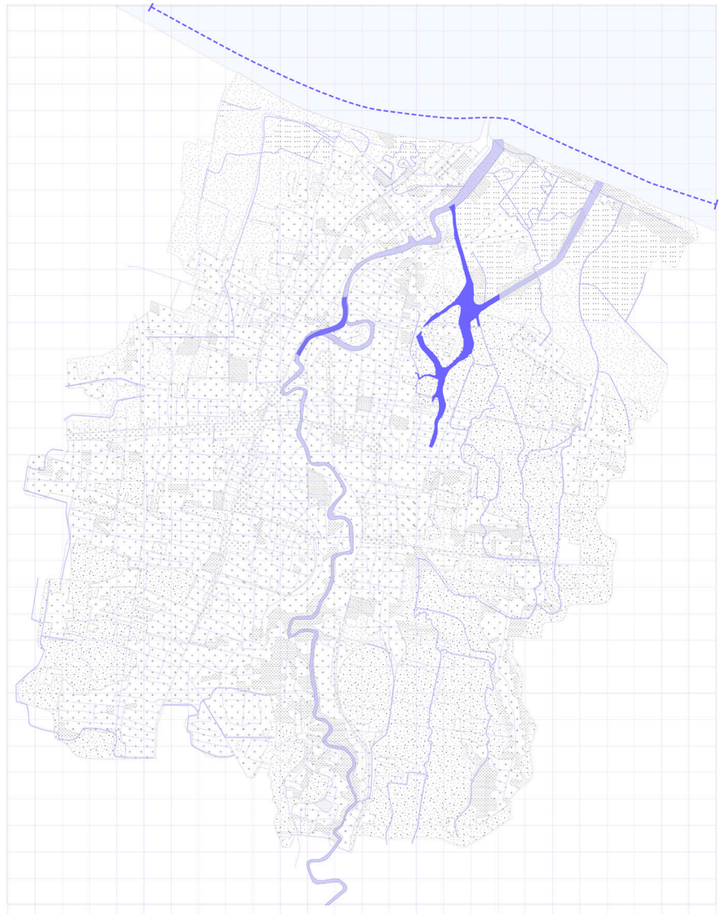

FIG.8.65 The pilot project

20 Year

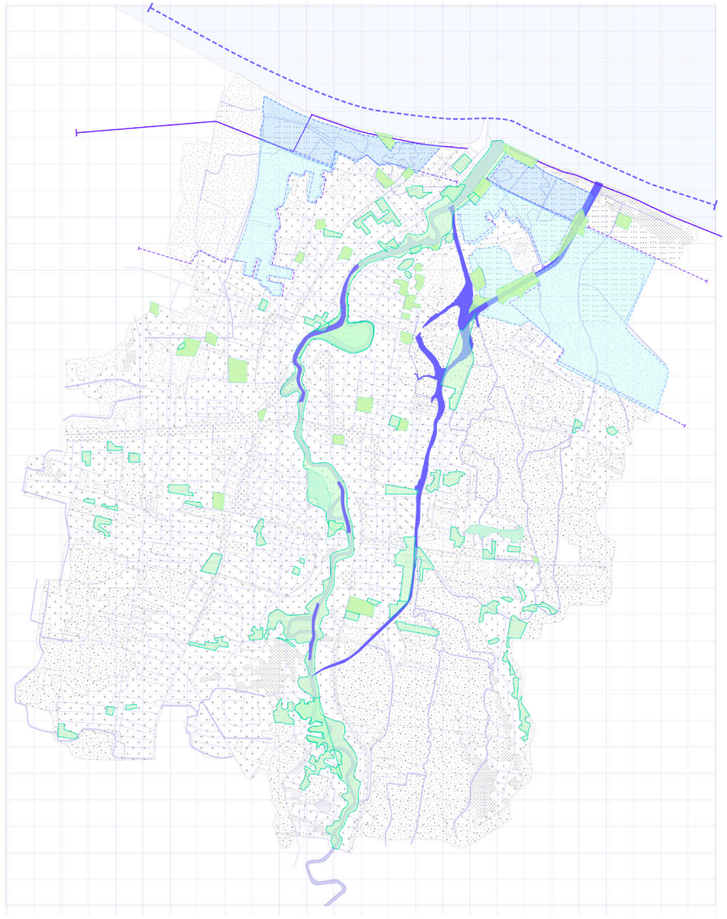

FIG.8.66 The development in 20 years

50 Year

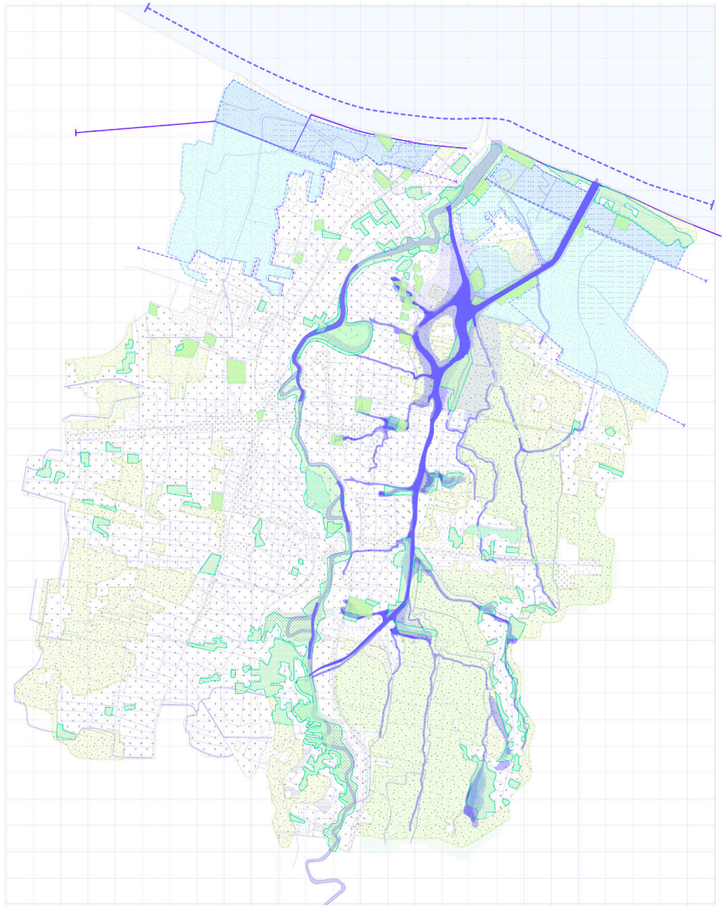

FIG.8.67 The development in 50 years, the whole framework.

IV CONCLUSION & REFLECTION

CONCLUSION

After research and design, the five questions are answered.

What are the water safety issues and their connection with the batik industry?

Water is the backbone and the fundaments for the Pekalongan city as well as its landscape. A densely populated zone located downstream of a watershed, adjust to the Java Sea, the geological location decided the city is close with different types of water.
Water safety issues are caused by climate change and improper human interventions. Namely are floods, freshwater scarcity and water pollution.
What is intereting in Peklaongan is the dominant batik industry is closely related to water. (1)The industry locates in an environment where the water dominates. (2) Water is the basic materials for batik production. (3)Colored water is the main by-product of the batik industry.

The batik industry in Pekalongan city is always regarded as cultural significance, but it is closely based on a natural element, the water.

What does resilience mean for water safety and batik development?

Resilient means each element is safe to fail in one system. To achieve this status, this system needs to have the qualities of functional diversity, transformability, adaptability and redundancy.
In this specific case, from the social-economic perspective, It is not resilient if the city relies only focus on batik production. Develop the batik industry together with other industries like recreation, the fishery may probably generate more possibilities. It is more resilient than people who do not put all the eggs in one basket.
In terms of water safety, resilience means the city is capable to live with fluctuating water levels, whether there is too much or too little water, without not being disturb. And only strategies based on the understanding of the logic behind water can achieve the goal.

What are the principles to increase water safety?

In general, respecting nature and try to live with water instead of against it can increase water safety. And it is important to recognise the characteristics of different water systems, like the rainwater system and sewage water system.
Breaking it down into three water-related assignments, there are some core principles that I apply in this thesis.
Discharge capacity: 1)More plants to help retain water at the upper stream area.2) Reasonable bypass to help water flow smoothly within the concrete urban context.3) The Maintainance of sediments
Water circulation: Instead of getting rid of the rainwater in the city, It is better to create more sponge space within the city. Ecological purification like plants and fishery could improve the water quality while generating new possibilities in landscape and economy.

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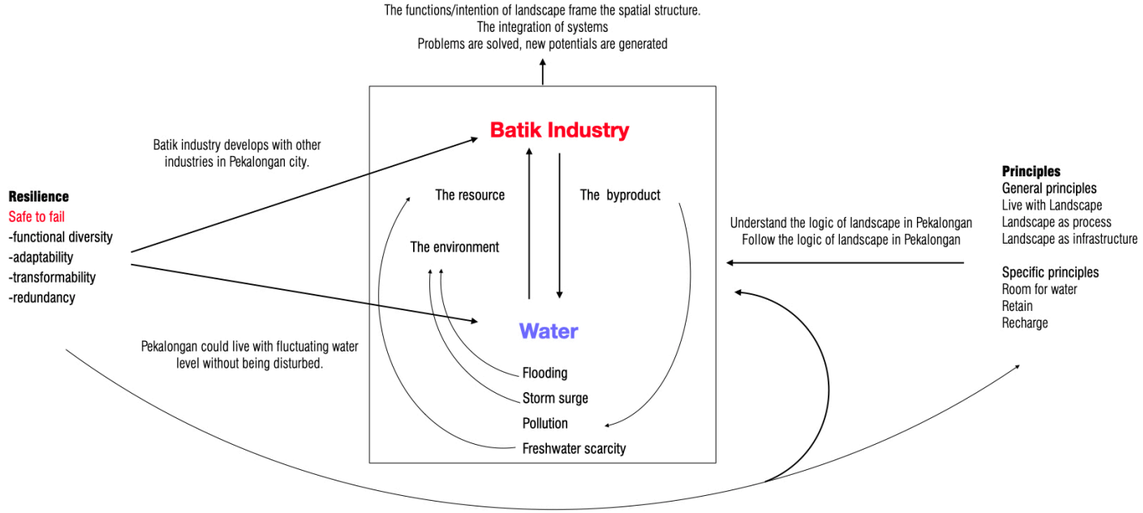
How to apply the principles within the cultural and natural conditions of Pekalongan city?

Understand how things work in the city helps me to choose principles and make decisions. The problem in Pekalongan is complex, but the process of investigating how things work together and the logic behind the landscape helps to select the principles. By testing and applying it in specific conditions gives me clue to adapt the principles to the local conditions.

How to generate the spatial potentials in different scales in the terms of landscape view?

The spatial structure is in parallel with the strategy and the function of the landscape.



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REFLECTION

Relation between graduation project, Flowscape and Resilient Coast Landscapes lab

The project Colored Water is part of Resilient Coastal Landscapes Lab under Flowscape studio. Flowscape offers a renewed understanding of the landscape in terms of space, time and potentials in the situation where the planet is facing climate change, rapid urbanization and ecological crisis. It guides to explore landscape as process and infrastructure while leading to facilitating functional social and ecological integration. Instead of a static and fixed image, “Flowscape” allows the system to adapt to new situations and leave it with space to change.

Under the framework, The Resilient Coastal Landscapes lab explicit the Flowscape specifically in terms of the coastal zone and landscape resilience. It gives more guidance to the selection of study location and specific topic: the dilemma between a water-dominant coast environment and urban development in Pekalongan.

Research and Design

Research and design are the two core methods during the thesis. They complement each other. At different stages, one method may contribute more than another, but they always collaborate and work in parallel.

Research in terms of literature review and existing materials helps to understand the local water systems and batik industry, and later it leads to classifying the project into three water-related design assignments, coast protection, water circulation and discharge capacity. Theoretical-based research builds up the framework of landscape resilience, and it also helps to grab general principles from case studies for further tests. At this stage, design limits the scope of exploration and indicates the important elements to consider, which are water systems, batik industry and spatial structures.

Design is used as a tool to frame spatial problems, explore possibilities and generate solutions. The design uses the results of research as a basis. By applying the learned hydrology theories, design tests and updates the knowledge in specific conditions including coast fishery system and urban water system.

The collaboration of design and research conducts analysis, synthesis, evaluation, the final solutions and also the reflections back to the proposed problems. But during the process, sometimes the research went so far and deep in terms of engineering and hydrology. Sometimes design went into details. They are important but do not necessary to answer the research questions. So research and design should work in parallel during the process, and it is always important to keep the objective to guide the research and design.

Method and Approach

Several methods and approaches are used during the process of understanding and creating. Mapping is one of the most powerful techniques to help figure the water system and its interconnection with the batik industry. Meanwhile, it builds the connection between challenges and the spatial structures which indicate further design. The landscape layer simplifies the design assignment which helps to make the design process more straightforward, and later it facilitates the integration of systems. Descriptive/ synthetic modelling and classification structures existing landscape types and systems prepared to generate new knowledge.

Resilient Thinking and Nature-based solution

Resilient thinking provides the theoretical framework and guidance for design while NBS offers the approach to find out solutions.

Pekalongan shows what the results are in the situation people do interventions without understanding the logic behind the landscape and natural process. The walls, dikes or raised floor can protect people from disasters for a moment, but they are stationary image without any flexibility.

Nature and landscape are always developing with time. Pekalongan has proved that concrete defence cannot adapt to dynamic nature and it contentiously causing new problems. Resilience thinking in the landscape which could enable the system to be diverse-functional, redundant, flexible and adaptive are the answers to dynamic nature.

The way look into the logic and potential behind landscape (how nature balances the rainfall between dry and rainy season, the dynamic process behind erosion and sediments, the movement of water, and the nutrient flow between systems etc,) diagnoses the problems and finds solutions. NBS make simultaneous benefits to biodiversity and human well-being.

Limitation

More steps need to be taken to help things visible for implementation. First of all, the stakeholders need to be involved in the design process. The people in the batik industry / local stakeholders/ could provide the clue for a more detailed design.

Besides, the study needs more modelling to test and modify the proposed strategy. For example, modelling can help figure out whether the shortcuts and temporary structure can function as expected.

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REFLECTION

Lessons learned

During the ten-month research and design, what is landscape resilience and why we should make resilient design, which mentioned above, are two of the most important lessons learned. The exploring process also indicates that landscape design should be considered in both process and space. Besides, landscape architecture is a disciplinary field that interacts with ecological and social aspects, so knowledge in other fields are also acquired, especially hydrology, urban water systems and coast fishery. Above all, I also learned how to integrate these discipline (landscape architecture, social development, hydrologist and industry) based on the landscape to achieve the common goal by building/discovering the spatial connections and flow among them.

Apart from theories and knowledge, it is also important for me to aware there seems no end to design and research, the most important thing is to keep the objective always in mind and let it guides the direction and how depth is the research and design will be.
Another important thing is that figuring out the objective and finding out solutions is not a one direction liner process, through the exercise research-by-design, I amended my objective for few times on the way to finding out the solutions, and it helps to make the objective more clear and straightforward.

Outlook

The goal of the thesis is to recognize the local challenges and address these challenges with landscape solutions. It gives some clue what is the possible connection between the natural environment and the social aspects, batik industry in this case, and how to come up with the solutions based on the understanding of landscape potentials.

The project decomposed the challenges into three water-related assignments and brought them back in one landscape system at the end. In this way, complex challenges can be simplified while keeps the landscape as a whole. Water systems are the base for the project, the design presents what is resilient water design from regional scale, the interaction of three water systems, to local scale, how the rain garden and riverbank acts. It provides a toolbox for coastal protection, discharge capacity and water circulation, which could apply to the coastal city with the same situation.

But since most of the focus is on water, other landscape elements are relatively mentioned less in the thesis, the soil type and vegetation. These elements need to be paid more attention to since they affect the landscape process(sediments and erosion) and proposed landscape functions (purification and fishery,)etc. Besides, the stakeholders are absent in the design process, it is important to involve them into consideration since the plan is quite ambitious and it can only be practical with their participation. It is important to balance the interest of different stakeholders. Another perspective that needs to be improved is that the research and design have most relied on online information, a site visit and interviews with locals could help me understand the spatial structure, cultural background and social environment.

The story in Pekalongan indicates that concrete dike, raised floor and deeper wells cannot protect people from climate change disasters. The project hopes to call for people attention to resilience thinking and nature-based solutions. Understand and follow the logic behind landscape could save Pekalongan from disaster, so it also applies to other vulnerable coastal cities.

COLORED WATER
Designing a resilient landscape framework that facilitates water safety and batik development in Pekalongan city

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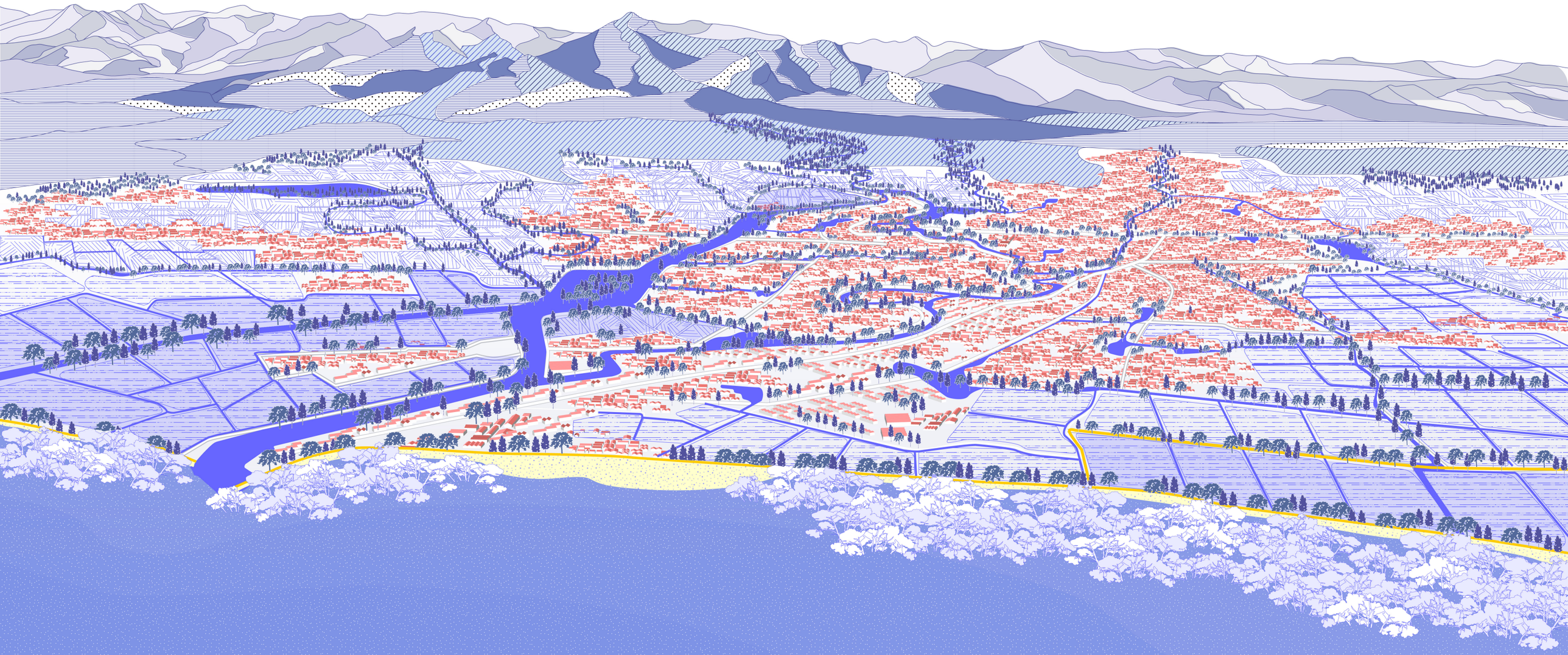

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Do as much with, and as little against, as possible.

06.2021
Delft, The Netherlands