

(Re)introducing co-existence

Unfolding the urban-water-soil metabolism on the coast of Paramaribo

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June, 2023



METROPOLITAN ECOLOGIES OF PLACES SERIES

*“We cannot solve our problems with the same thinking we
used when we created them.”*

- Albert Einstein

Master Thesis - P5 Report
MSc Architecture, Urbanism and Building Sciences-Track Urbanism
Faculty of Architecture and the Built Environment
Delft University of Technology

Title:
(Re)introducing co-existence

Sub title:
Unfolding the urban-water-soil metabolism on the coast of Paramaribo

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Title page image: Manifesto

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Restored mangroves behind a man made pond, made by author (December 2022)



Dead mangroves on the coast of Paramaribo, made by the author (December, 2022)

Preface

(Re)introducing co-existence is the result of a year-long graduation project in the Metropolitan Ecologies of Places graduation studio for the Urbanism master track at the Faculty of Architecture and the Built Environment of the Delft University of Technology.

I would like to thank my first mentor, Cecilia Furlan, for her continuous enthusiastic encouragement and calming support throughout this past year. I am also grateful for all the infectious exuberant encouragement and support from Remon Rooij, my second mentor. All in all, I have had great guidance from both of my mentors during this year and am very grateful for them.

Furthermore, I want to thank all on-site experts who took the time to discuss my project with me and gave me a very much-needed insight into the coast of Paramaribo. I also want to thank the residents who invited me into their homes and with whom I had inspiring conversations which gave me inspiration for both the designs and the pattern language.

Special thanks and gratitude to my friends, especially Misha Nesty, Elisabeth Veldkamp and Kate Schuitemaker for their contribution, support and encouragement during this project. Furthermore, I would like to express my unending appreciation and gratitude to my wonderful partner, Mick Steenland, who has been my biggest supporter and source of encouragement throughout this project. Finally, I would like to thank my family for their unwavering support this last year.

Without further ado, please enjoy (Re)introducing co-existence.

Many thanks,
Nicole



Young mangroves, growing in a stream on the coast of Paramaribo, made by author (December 2022)

Abstract

The coast of Paramaribo is predicted to undergo urban expansion due to the growing population of Paramaribo. However, the coast has to do with several challenges; tidal- and urban flooding and coastal erosion. This does not make the coast the most habitable place for urban expansion. The urban, water and soil systems are not functioning in harmony on the coast. Hence, a spatial transition to a dynamic co-existence between the urban-water-soil metabolism is necessary.

With this information, the following research question is formulated “How can an insight into the urban-water-soil metabolism develop a more socially and environmentally resilient coast in Paramaribo?”.

In order to answer this question an analysis was done on the three systems; urban, water and soil. The analysis was concluded with a site visit, which lead to the potential for a general strategy to achieve a resilient coast. As the urban-water-soil metabolism presents itself differently in several areas on the coast, 3 locations were chosen for which a strategy was designed with the help of the pattern deck, which was developed for this project.

The systemic change of the urban, water and soil systems will lead to a resilient coast of Paramaribo. The existing housing and urban expansion will be transformed/ designed to be resilient, the urban expansion will be a mixed living and working environment. Tidal flooding will be addressed by strengthening the coast with a green belt and clay dykes. The water management system will be properly maintained and upgraded and the coast will be strengthened and protected from coastal erosion by rehabilitating the depleted mangrove forests. This in turn will also boost biodiversity.

In conclusion, the coast of Paramaribo can become resilient by (re)introducing co-existence of the urban-water-soil metabolism.

Keywords: urban-water-soil metabolism, urban expansion, tidal flooding, urban flooding, coastal erosion, nature-based solutions, the coast of Paramaribo.



Fully grown mangroves on the coast of Paramaribo, made by author (December, 2022)

Glossary

Coastal erosion - rocks, soils, and/or sands near the shore are worn down or carried away as a result of local sea level rise, powerful wave action, and coastal flooding.

Flooding - a big body of water engulfing or submerging ordinarily dry terrain.

Mangroves - a tree or shrub that prospers in tidal wetlands along the coast, particularly tropical ones. Its many entangled roots grow above ground to form dense thickets.

Nature-based solutions - Actions to safeguard, sustainably manage, and restore natural and modified ecosystems are referred to as nature-based solutions, which concurrently benefit both people and the environment.

Pattern Language - A pattern language is a set of patterns that are well-organized and coherent and that each explains a problem and the essential elements of a solution that can be applied in various contexts within a certain area of expertise.

Sediment Trapping Units - To encourage coarse particle settling before water is disseminated throughout the wetland, sediment traps are made up of small swales or ponds that are placed between the input and the main wetland.

Urban expansion - city and town geographic areas are rapidly expanding.



Young mangroves growing next to dead mangroves on the coast of Paramaribo, made by author (December 2022)

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Introduction



Eroded coast on the coast of Weg naar Zee, made by author (December 2022)

1.1 Introduction

The world is facing one common threat, climate change. Climate change is the crucial crisis of this time and is not developing at a glacial pace. Sea levels are rising due to the glaciers and ice sheets in polar and mountain regions melting quicker than ever. Global warming has a negative impact on the world's water and food security. About 500 million people live in areas that are affected by erosion (United Nations, 2019). On average, the world has been heated up by about 1,2oC since the preindustrial era (Milman et al., 2021).

Climate change just accentuates the existing challenges the world faces. In fact, the World Bank believes that should there not be action about 140 million people in Sub-Saharan Africa, Latin America, and South Asia will have to shift within their region by 2050 (United Nations, 2019).

“No corner of the globe is immune from the devastating consequences of climate change. Rising temperatures are fuelling environmental degradation, natural disasters, weather extremes, food and water insecurity, economic disruption, conflict, and terrorism. Sea levels are rising, the Arctic is melting, coral reefs are dying, oceans are acidifying, and forests are burning. It is clear that business as usual is not good enough. As the infinite cost of climate change reaches irreversible highs, now is the time for bold collective action.” (United Nations, 2019)

However, this does not mean that the world is powerless when facing this threat (United Nations, 2019). Technology has been a negative contributing factor to climate change, but with new and capable technologies a better world can be built (United Nations, 2019).

While technology has contributed to climate change,

new and efficient technologies can help to reduce net emissions and create a cleaner world (United Nations, 2019).

Nature-based solutions provide the needed “breathing room” in order to decarbonize our economy in the meantime. With the help of these solutions, the carbon footprint can be reduced while also promoting important ecosystem functions including biodiversity, freshwater access, improved livelihoods, and food security (United Nations, 2019).

According to Thiagarajan and Jayaraman, the understanding that we are dealing with global warming in a world marked by inequality and injustice has yet to sink in. We cannot successfully combat climate change without equity and equality, which equates to peace and security (Jayaraman & Sidhva, 2019).

Despite this, the world is not helpless in the face of this menace (United Nations, 2019).

1.2 Problem Field

1.2.1 Current situation coast of Paramaribo

Suriname is a Republic on South America’s north coast and is part of the Caribbean. It borders French Guyana in the east, Guyana in the west, Brazil in the south, and the Atlantic Ocean in the north (figure 1.1).



Figure 1.1 Location Suriname on a global scale. Source: QGIS worldmap

Since Suriname is sandwiched between Guyana and French Guyana it is also part of the Guianas. From 1667 to 1954 Suriname was a Dutch colony after which it was a country within the Kingdom of the Netherlands. Suriname became a Republic on 25 November 1975, after the reclassification in 1985 the country was divided into 10 districts. These are Paramaribo, Wanica, Commewijne, Marowijne, Coronie, Nickerie, Para, Saramacca, Brokopondo, and Sipaliwini The country has a surface of 163.820 km2 of which the coastline spans about 386 km. The landscape consists of swamps, hilly landscapes, and mountain ranges (NOS, 2012). The land is largely covered by tropical rainforest and is intersected by several rivers that flow from south to north. Throughout the years the amount of forested area in Suriname has gone down,

in 1990 it was 98,6%, and in 2020 this percentage had gone down to about 97,4% (figure 1.2) (Forest area (% of land area) - Suriname Data, 2020).

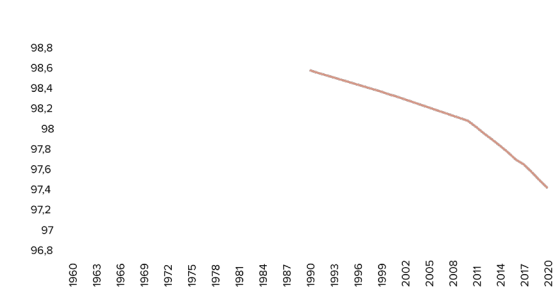


Figure 1.2 Percentage forest area until 2020 (Forest area (% of land area))

One of the nations most susceptible to the effects of sea level rise brought on by climate change is Suriname. Because the majority of people reside just some meters above sea level, coastal communities are especially vulnerable to the threats of coastal erosion and flooding (Guzman et al., 2017). The shoreline of Suriname is very dynamic, which will expeditiously escalate with climate change.

1.2.2 Urban

Paramaribo, Suriname’s capital lies on the coast of the country and borders the left bank of the Suriname River. The low-lying city which stretches along the coast is the most cultivated and is therefore the most urbanized part of Suriname.

In 1613 the Dutch first colonized Suriname with a trading post on the Suriname River, right near present-day Paramaribo (Claes & Debaene, 2009). The first settlement is still known as the centre of the historic inner city. The English overtook Suriname during which the colonists moved to the city of Paramaribo. In 1667 the area with about 175 plantations was repossessed by the Netherlands.

The first official urban development of Paramaribo was in 1683, after which the plantation colony kept expanding due to the rapid economic development. This meant that there was constant urban development and expansion which was mostly concentrated in Paramaribo. The construction of more plantations was done according to the planned organization of space, and this specific structure of plots remains clearly discernible to this day (Claes & Debaene, 2009). At the beginning of the 19th century, Paramaribo had hardly changed, but due to the large influx of ex-slaves, there was the first major urban expansion of Paramaribo. Since then there has hardly been any structural growth in Paramaribo.

During the Second World War Suriname was an important military area, due to the many available raw materials which was an important aspect of the American aircraft industry. However, after the Second World War ended Suriname became less beneficial to the Netherlands in that aspect (Claes & Debaene, 2009). Nonetheless, the city kept expanding in neighbourhoods on previous plantations.

In 1965 there was a major shift away from the centre, which is when the centre shifted from residential to more business oriented. During the major urban expansion during the 60s, there was not as much attention to the infrastructure. New neighbourhoods were rapidly developed, the infrastructure however did not undergo the necessary development. This caused major traffic problems that the city still struggles with to this day (Claes & Debaene, 2009).

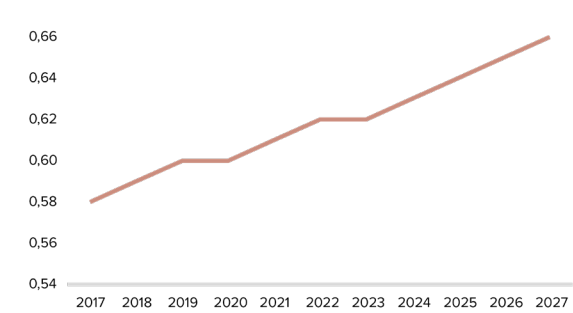


Figure 1.3 Population growth prediction until 2027 (IMF, 2022)

As of 2022, the population of Suriname counts approximately 598.429 people (Suriname, 2022). About 240.924 of those people live in the nation’s capital, Paramaribo, which is where most of the population is concentrated (Suriname: Districts, Cities & Urban Communes - Population Statistics, Maps, Charts, Weather and Web Information, n.d.). Suriname’s population is increasing steadily. Due to this, the nation is seeing urban growth in order to accommodate the expanding population (figure 1.3). The most populous region, Paramaribo, is where the country is growing at the fastest rate.

Although the population is steadily growing, migration has gone down in recent years (figure 1.4) (Net migration - Suriname I Data, 2022). Meaning that more people are emigrating than immigrating. Due to the economic

recession of 2015, the country is still in the process of recovering. Although this has not been an easy feat. The economic recession was characterized by a significant economic decline, major fiscal decline and external imbalances, and a rapid increase in government debt. The recent COVID-19 pandemic has not lent a helping hand in this (Khadan, 2021).

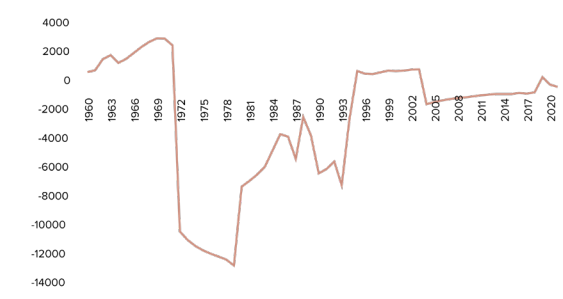


Figure 1.4 Migration until 2020 (Net migration - Suriname | Data, 2022)

1.2.3 Water

Like other countries in South America, Suriname is suffering from flood issues. These floods have gotten worse over the past 15 years, after the nationwide flood in 2006 the floods have become more frequent and intense (Suriname staat al maanden onder water, 2022). According to the EU Commission report (2022), Suriname has the highest flood risk index of the Caribbean, South America, and Latin America with an index of 8,6 out of 10 (figure 1.5) (European Commission, 2022).

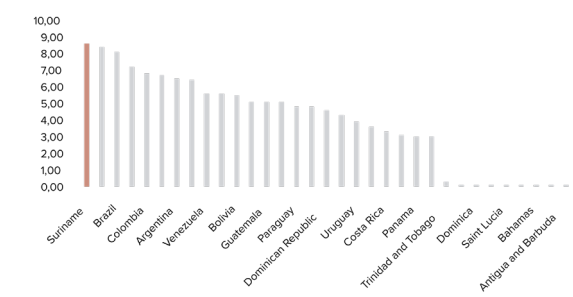


Figure 1.5 Flood risk index Suriname (European Commission, 2022)

Suriname is dealing with 4 major flood risks namely; coastal flooding, urban flooding, river flooding, and coastal erosion (Nature-based solutions for disaster risk management: booklet, n.d.). Climate change plays a big role in this, as this just aggravates the challenges (Suriname: Floods - Apr 2021, 2022).

River and surface water flooding are the main causes of floods in Suriname, which are especially severe during spring tides due to the country’s constrained drainage capacity. The largest populated urban area on Suriname’s coast is Paramaribo, which is also the country’s capital. The current status of water management exacerbates the city’s already high risk of flooding. According to Guzman et al. (2017), the water management system is poorly maintained, has sufficient drainage capacity, and hasn’t been changed in a while. High danger of coastal

flooding exists in Paramaribo, whereas medium risks exist for urban and river floods (Think Hazard - Suriname - River flood, n.d.). Although Suriname as a whole has a significant risk of flooding, this study will concentrate on the risk of coastal flooding around Paramaribo.

The shore of Paramaribo is highly susceptible to coastal flooding; low-lying sections like Weg naar Zee have more frequent flooding, whilst Rainville and Blauwgrond’s neighbourhoods experience less frequent and shallow flooding. Seasons, among other things, have an impact on how much flooding occurs. Since Suriname has a tropical climate there are wet and dry seasons as can be seen in Figure 1.6. It rains frequently and very heavily throughout the rainy seasons. Floods are more likely to be severe when high tide coincides with rainy seasons (Guzman et al., 2017).

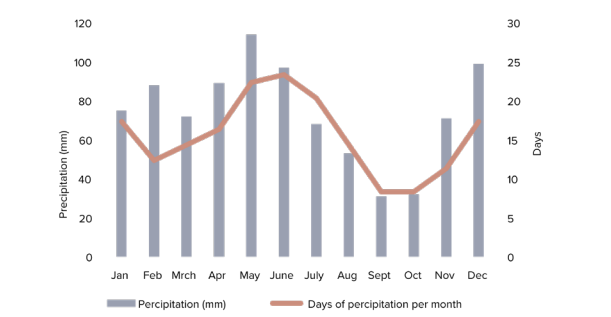


Figure 1.6 Precipitation and days of precipitation per month Suriname (Het klimaat van Suriname - klimaatinfo Suriname, 2021)

1.2.4 Soil

Understanding the coastal system and combatting the effects of climate change in Suriname and the Greater Paramaribo Area requires an understanding of soil.

The Guianas are located in the northeast of South America. Guyana, French Guyana, Suriname, and portions of Venezuela and Brazil make up the five nations that form this region. The Guyana current flows along the coastline, and the Guianas are found north of the Amazon. Until it reaches the Orinoco River in Venezuela, the current transport of the soil from the Amazon is in a northwest path along the coast (Wit, 2018). The Guianese coast is the longest mud shore in the world as a result of all this sediment. Mud banks emerge as a result of soil build-up close to Cabo Cassipore Figure 1.7.



Figure 1.7 Overview area from Amazone to Orinoco (Wit, 2018).

Approximately every 10-20 years, a new mud bank forms. With the current, these banks move along the coastline. The coast can be enlarged where these mudbanks are located to make new land. The setting is ideal for the development of mangrove forests. The fresh portions of the coast eventually become exposed again because the mudbanks are continually shifting (Wit, 2018). Whole tracts of land, including mangrove forests, will soon vanish when the waves recapture the area.

The size and location of intertidal flats and large migratory mud banks both affect how ocean waves approach the coast. These muddy formations function to dissipate wave energy before it reaches the coastline, albeit the extent of this dissipation is quite localized and depends on the state of the offshore mud banks, the direction of the waves, and the sea level during an event (Guzman et al., 2017). The course that waves take from generation to reaching the coast, as well as the change from deep to shallow water, are all important aspects of the complicated process that is wave movement. The degree of any wave-induced flood or erosion consequences is determined by the interaction of these components. Trade winds are primarily responsible for creating storm waves in the deep ocean, which then move toward land (Guzman et al., 2017). As they go, they move into shallow water where wave transformation takes place as a result of the contact of the waves with the seabed below.

Paramaribo's mud banks are currently in their lowest state, which means wave penetration is at its highest level in 40 years. Due to human activity, this movement has worsened erosion in places like Weg naar Zee (Fernandes, 2015). Because the currents affect the dynamics of sediment movement and erosion/accretion processes, ocean currents also affect the risk of coastal flooding and erosion in Suriname (Guzman et al., 2017). The stability and behaviour of the mangroves are subsequently impacted by this. The trade winds and tides are the two main factors that influence coastal currents. Suriname is situated roughly where the Southeast winds and their currents merge with the Northeast winds (Guzman et al., 2017). Seasonally shifting Inter-Tropical Convergence Zone (ITCZ) causes this convergence to result in the steady westward Guianas Current along the coast (figure 1.8) (Inter Tropical Convergence Zone (ITCZ) | SKYbrary Aviation Safety, 2021). Tidal flows,

however, are particularly perpendicular to the coast. A complex current structure is created by the interaction of the Guianese Current with local components like mud banks, mangroves, and wave-driven currents (Guzman et al., 2017).

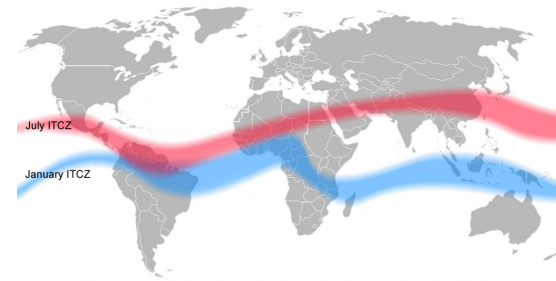


Figure 1.8 ITCZ zones (Inter Tropical Convergence Zone (ITCZ) | SKYbrary Aviation Safety, 2021)

1.3 Problem Statement

Urban

Paramaribo is a growing city with expansion predicted in the north of the city which is the coast. Urban expansion in this area will not be an easy feat since the city and the coast specifically is most susceptible to the effects of sea level rise. Because the land along the coast is just some meters above sea level the coast is even more perceptible to floods. The floods differ in origin going from coastal floods to river floods and urban floods. In addition to this, parts of the coast of Paramaribo suffer from the threats of coastal erosion.

Water

Paramaribo is perceptible to flooding, the kind of flood depends on the location and the specific parameters of this location. Depending on the location along the coast the floods have different origins, they can be coastal-, river- or urban floods. In some cases, there are multiple origins for the floods in the area. The flood risk is aggravated by the low-lying land and climate change.

Soil

The coast of Paramaribo is part of the Guianese coast meaning that there are dynamic mudbanks moving from east to west. Because the mudbanks are constantly moving the coast is more perceptible to coastal erosion. Nature has a natural protection for this in the form of mangrove forests. These mangrove forests not only protect the coast from erosion but even add soil to the coast in some locations. The combination of the dynamic mudbanks and the mangrove forests forms a coast that is in balance. This balance was disrupted when large parts of mangrove forests along the coast of Paramaribo were taken down. The dynamic mudbanks along the coast of Paramaribo combined with a lack of coastal protection is causing a drastic coastal erosion problem, mostly along Weg naar Zee which has led to an exaggeration in coastal flooding along the entire coast of Paramaribo.

Urban-water-soil metabolism

Like many cities around the world, Paramaribo has a problem with flooding and coastal erosion. The city suffers from river flooding and urban flooding due to the city lying low, poor water management system, and rising sea levels. At the same time, it suffers from coastal flooding due to the low-lying land and a lack of coastal protection and coastal erosion. In fact, a part of Paramaribo's coast, namely Weg naar Zee, has had a rapidly receding coastline. Even though the whole city has a significant flood risk, the coast is at higher risk since the risk is combined with the coastal erosion issue and lower-lying land. In addition, the coast of Paramaribo is expected to have urban growth. Combining the three systems, urban expansion, water (flood risks), and soil (coastal erosion) make up the metabolism that this project will focus on. Understanding how this system works independently and combined will lead to a new proposed system for a resilient coast.

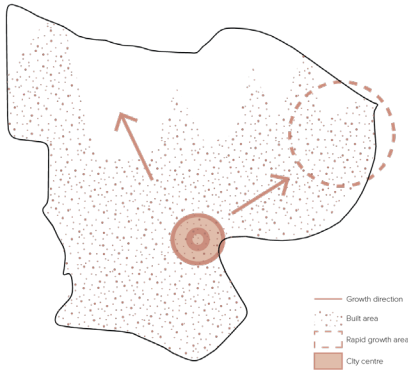


Figure 1.9 Diagram urban growth prediction



Figure 1.10 Diagram flood risk

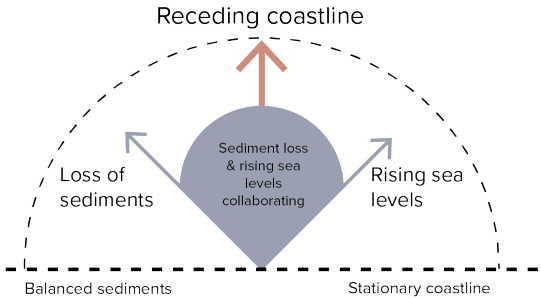


Figure 1.11 Diagram coastal erosion

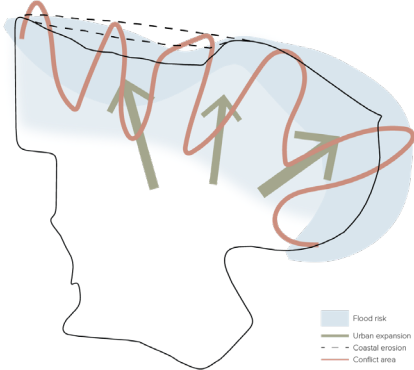


Figure 1.12 Diagram urban-water-soil metabolism problem

Chapter 2 marks the introduction of research with the theoretical framework. Afterwhich a conceptual framework is contrived. An assessment framework is established with the Sustainable Development Goals. After which the main research questions and sub research questions are formulated. This chapter also explains the project approach.

Theory, Project Approach & Methods

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2.1 Theoretical framework

2.1.1 Urban Metabolism

Due to the fact that cities have evolved into the catalyst for both economic growth and societal well-being, the idea of urban metabolism has been around since the nineteenth century (Wolman, 1965).

The primary objective of the accounting system known as urban metabolism (UM) is to measure the inflows, outflows, and accumulation of resources (such as materials and energy) within a city (Shi et al., 2021). Urban metabolism in short means the synergy of different flows and/or systems within a city. And how the flows and/or systems work together.

Cities in developing nations waste resources, but many people are also excluded from the value chain (Davis et al., 2016). Of course, cities are home to numerous organisms, including humans, animals, and flora, and are more complicated than single organisms. Consequently, it is equally legitimate to say that cities are like ecosystems (Kennedy et al., 2011).

The idea of “urban metabolism” takes into account the fluxes of resources into, through, and out of metropolitan areas. The focus of metabolism is mostly on the mass balances of materials and water as well as the associated energy flows. However, metabolism can also be utilized to understand how organisms or ecosystems work, pointing us in the direction of natural systems’ superior resource efficiency. (Renouf et al., 2017).

This project focuses on the coastal metabolism of a city. Since the study area of this project lies along the coast of a city, coastal metabolism is the most fitting when speaking of the synergy of different systems. When speaking of coastal metabolism in this case the focus will be on the 3 systems represented in the project, namely urban, water, and soil. The 3 mentioned systems are all

very broad and can be interpreted in many different ways. In this framework, the main systems will be explained first after which they will be specified.

2.1.2 Urban

Without underestimating the impact of population expansion, we must better understand the relationships between societies, the environment, mass, and energy flows (production and consumption) in order to have an impact on urban metabolism (Ulgiati & Zucaro, 2019) .

Based on this theory this project will take the relationships between expansion and the relationships it has with the different systems that have influence on it when looking at the urban expansion and its prediction.

2.1.3 Water

For direct use, urban areas rely on local and regional water supplies. Additionally, they utilize virtual or indirect water sources from throughout the world (embodied in goods and services consumed by urban dwellers). Urban communities’ local water resources are under increasing pressure.(McDonald, 2014; Richter, 2013),.

Urban areas are more susceptible to these external stresses due to both internal and external factors, including reliance on a single water source, non-use of available water generated within the city itself, and the linearity of urban water flows (Renouf et al., 2016), as well as factors like growing urban populations, competition with agricultural production, and more erratic supply due to climate change (OECD, 2015).

Along with the more common water shortages that cause competition for water between urban and regional uses as well as between urban uses, controlling stormwater

runoff, declining water quality, and floods are typical issues that urban and regional planners must address. However, the methods they use to address these difficulties might not be enough. The current methods for evaluating urban water resources do not take a comprehensive approach, frequently concentrating on the water supply and drainage systems within cities rather than assessing the urban area as a whole (Renouf et al., 2016), and they do not take into account the various functions of water in the urban landscape or the water connections between cities and their supplying regions. This limits how effectively we can plan cities for resilience, security, and water efficiency. This theory opens up the conversation between water and planning resilient cities.

2.1.4 Soil

Urban soil is often connected to contamination and health issues. But in parks, gardens, and by the sides of the roads, the soil actually supports many aspects of daily life. Urban soil benefits wellbeing, holds water, grows food, fights climate change, and supports animals. Moreover, soil serves as a reservoir for water, preventing localized flooding in populated areas. Cities are increasingly putting up sustainable drainage systems, or SuDS, like swales and rain gardens (O’Riordan, 2021). With this theory in mind, the soil system of the coast of Paramaribo will be assessed.

With a general understanding of the 3 systems urban, water and soil a deeper dive into these systems follows. For each of the systems there will be a specific field on which the project will focus.

2.1.5 Expansion

When speaking of urban expansion it refers to the development of the built environment. Urban expansion

often comes hand in hand with urban growth, in some cases urban expansion and urban growth are understood as the same thing. Contrary to this belief, urban expansion and growth refer to the development of different things. Where urban expansion refers to the development of the built enviroment, urban growth in turn refers to the development (growth) of the population (Key definitions - GSDRC, 2016).

2.1.6 Flood risk

Flooding is to fill or cover something with water, especially in a way that creates issues (Cambridge Dictionary, 2023b). Floods are a natural occurrence, but when they cause damage to life and property and outpace the ability of the affected communities to cope, they become a severe worry. Floods are the devastating natural disasters that happen most frequently on a global scale and have an impact on both rural and urban areas. The world’s demographic expansion is now characterized by urbanization, with burgeoning populations in cities, towns, and villages, particularly in developing nations.

Due to increased paving and other impermeable surfaces, aging drainage infrastructures, unplanned construction in floodplains, a lack of flood risk reduction initiatives, and rising flooding, more metropolitan areas are now affected by - and devastated by - floods. The results of a changing climate exacerbate these issues (Jha, 2012).

Understanding flood hazards is crucial for disaster management because it enables activities like mitigation, planning, and damage control both in the midst of an emergency situation involving flooding as well as before it occurs. Understanding flood kinds and causes is necessary for managing flood risk (Jha, 2012). This knowledge is crucial for developing strategies

and solutions that can reduce or prevent damage from particular flood types.

2.1.7 Coastal erosion

Although constructive waves also contribute to coastal erosion, destructive waves are frequently responsible for wearing away the coast in coastal erosion, which is the loss of land by the sea (Internet Geography, 2022).

Low-lying coastal areas are more urbanized than other regions, which increases their vulnerability to risks brought on by sea level rise. Therefore, the risk that these hazards provide to societies will be influenced by both the physical forces driving change and the rate and structure of urban growth, which will be greatly influenced by decisions on future urban development (Wolff et al., 2020).

As coastal towns grow, habitat loss related to land reclamation and coastline development is becoming more common (Lai et al., 2015)

2.1.8 Resilient vs. adaptable

Planning for mitigation, adaption, and recovery from change are all components of urban resilience. It focuses on a community or area's capacity to recover and restart a business-as-usual pace in the wake of a significant incident or environmental change (Urban Resiliency: What is it and Why does it matter? | OPPI, n.d).

Adaptability is the ability of a construction that involves changing, to evolve, and to adjust itself, much as it is in architecture (Graaf, R. de, 2012). Therefore, the fact that a project integrates the idea of time is one of its inherent qualities.

Adaptive urban expansion is the planning, building, and ongoing evolution of urban areas to foresee and respond to societal and environmental changes. Both internal city operations and foreign factors are part of these shifts (Graaf, R. de, 2012).

For this project the question was whether to strive for resilience or adaptability. According to the theories mentioned above the project will focus on resilience.

As the theories have been assessed it is time to determine the proposed outcome, what this project will result in. It is the aim of this project to propose a strategy and design to (re)introduce the co-existence of the urban-water-soil metabolism along the coast. For this outcome (re)introduction and co-existence must first be defined.

2.1.9 Co-existence

According to Cambridge Dictionary (2023a), co-existence is the reality of being present simultaneously at the same time or location.

When translating this definition to apply to this project co-existence refers to the synergy of the urban-, water- and soil systems. Establishing how these systems exist and how they exist together along the coast.

The concept of co-existence portrays two things, firstly the manner in which space is occupied albeit compatible or incompatible. Secondly, that different spaces can have particular applications and are held together according to this. Therefore co-existence proposes different prospects and probabilities for spaces within cities (Porter, 2013).

2.1.10 (Re)introduction

Cambridge Dictionary (2023c) says that introduction is the act of bringing something to a place or using it for the first time.

While reintroduction is the act of putting something back into use after a period of inactivity; the process of placing something where it has been absent for a period of inactivity (Cambridge Dictionary, 2023d)

Taking these definitions into account the project will aim for (re)introduction since in some cases things will be brought together that had not been brought together before. While in some instances things will be brought together that had already been together but are not together in the present day.

According to Gindroz (2002), the concept of (re)introduction in an urban setting refers to the constant expansion and improvement, the exchange of knowledge and the general health and well-being within urban areas.

2.2 Conceptual framework

In figure 2.1 the conceptual framework of this project is depicted. The framework is divided into different sections, the sections refer to the journey the project has taken.

The social metabolism of a coastal city is the first thing that is defined. The project focusses on the metabolism of three systems namely urban, water and soil. The three systems are then specified into three different problems and/or challenges in each of the systems.

The challenges are urban expansion, flood risk and coastal erosion. These 3 problems and/or challenges are analysed according how they present themselves along the coast of Paramaribo. The challenges are the assessed by doing an in depth analysis by doing literature research, mapping and field work.

This results in a overview of the challenges along the coast, leading to the potentials the different challenges have and how the challenges overlap each other and effect each other. Afterwhich the potentials will be assessed and translated into a strategy for the coast which aims to achieve a resilience along the coast while densifying the coast. The strategy will therefore propose a system along the coast to achieve resilient coast while using the urban-water-soil metabolism.

Now, the strategy is made in order to demonstrate how co-existence can be (re)introduced on the coast. The proposed strategy will be tested by translating the strategy into a design for a location along the coast. This location is seen as a pilot project. The strategy is a main framework for the coast, but how this strategy actually translates into a design will differ depending on location.

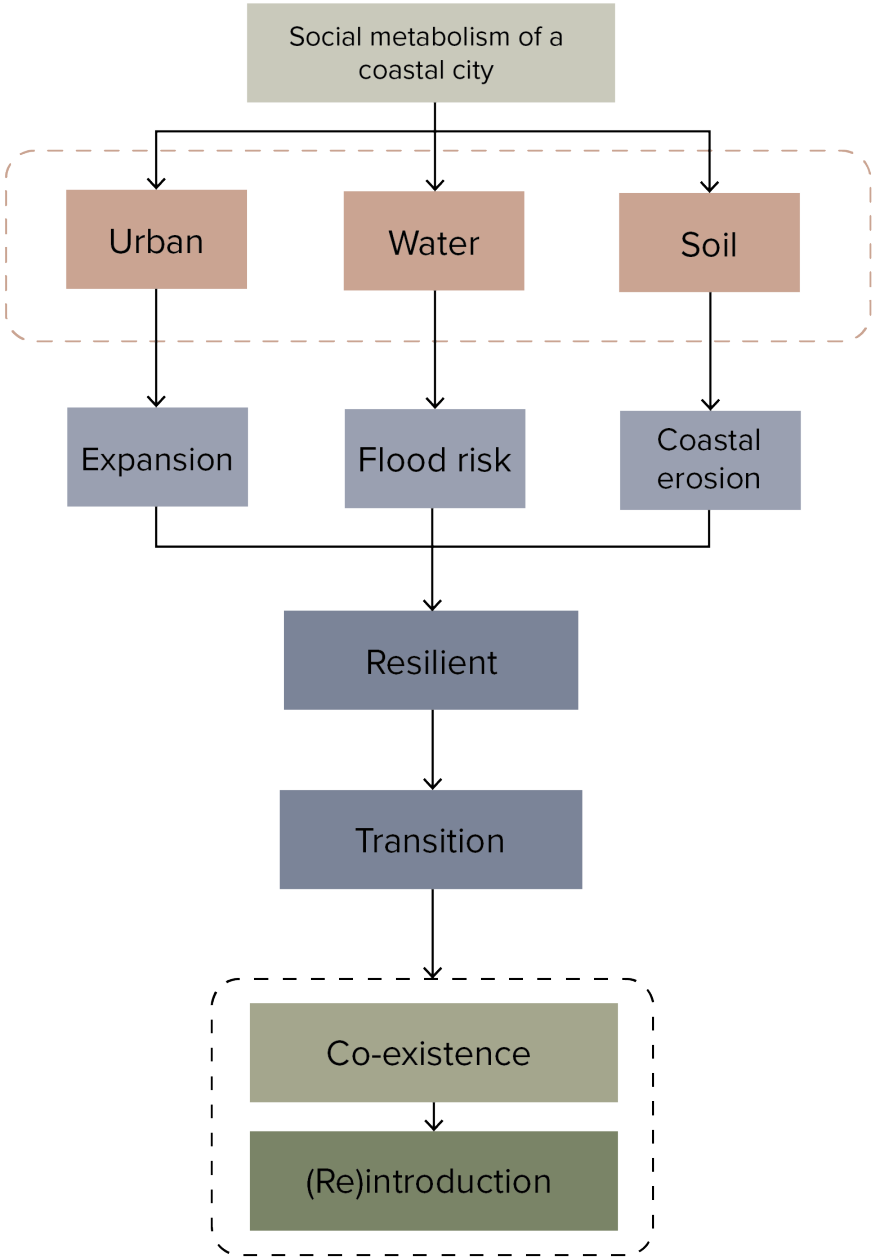


Figure 2.1 Conceptual framework

2.3 Sustainable Development Goals

In 2015 the United Nations Member States endorsed the 2030 agenda for Sustainable Development. This agenda equips the member states with a blue print for peace and prosperity for people and the planet, now and in the future (THE 17 GOALS | Sustainable Development, 2023). The 17 Sustainable Development Goals (SDGs), an urgent call for action by all nations—developed and developing—in a global partnership—are at the center of it. They understand that in order to combat climate change, enhance health and education, lessen inequality, and promote economic growth, we must also act to protect our oceans and forests in addition to eradicating poverty and other forms of deprivation (THE 17 GOALS | Sustainable Development, 2023).

This project refers to the Sustainable Development Goals in order to create a framework in which sustainability, resilience and social justice are at the centre. The scope of this project is to propose a strategy for the coast of Paramaribo that is feasible for the inhabitants to realise and of which the design implications are mostly nature-based. To achieve this certain SDG's are selected, and at the end of the project the goals will be assessed on the integration and how well it is implemented.



Figure 2.2 17 goals to transform the world (THE 17 GOALS | Sustainable Development, 2023)



Reduced Inequalities
UN Goal: Reduce inequality within and among countries
Assets, availability, perks, possibilities, and hazards are not dispersed equally throughout the world due to differences in many areas and between people. While pandemics and climate change are problems for all of humanity, they exacerbate inequity which results in some people suffering more as a consequence.



Sustainable cities and Communities
UN Goal: Make cities and human settlements inclusive, safe, resilient and sustainable
Cities and communities are made up of places where people live and work, which makes them strongly related to the well-being of the populace. The aim of sustainability for the entire world can be attained by creating sustainable cities and communities.



Climate Action
UN Goal: Take urgent action to combat climate change and its impacts
The most urgent threat humanity faces as a whole is the climate crisis. It gets worse because humanity cannot withstand the effects of the climate crisis. It affects almost every nation in different ways, taking coordinated action is therefore essential.



Life on land
UN Goal: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Humankind is only a small part of the ecosystem and depends heavily on it, but the earth is also home to various life forms. The fact that the forest is being turned into a desert, wildlife is losing their natural environments, and biodiversity is diminishing at an unprecedented pace raises concerns about the living conditions for many people. As a result, the ecology is becoming increasingly fragile.



Partnerships for goals
UN Goal: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development
All of the aforementioned concerns and objectives are urgent problems that affect all of humanity. No nation or organization can avoid its obligations to this race against time. To accomplish these goals, powerful cooperation is required.

2.4 Research Question

How can the coast of Paramaribo expand while mixing living and working in a just way?

What will the spatial and social indications of the shift towards coastal resilience and mixed working and living mean?

How can an insight into the urban-water-soil metabolism develop a more socially and environmentally resilient coast in Paramaribo?

How does the urban-water-soil metabolism on the coast of Paramaribo function?

How can the coast of Paramaribo become socially and environmentally resilient in a just way?

2.5 Project approach

The problem field, problem statement, theoretical framework, conceptual framework, assessment criteria and research question based on the literature review have been explained previously. Now follows the project approach explaining how this project has commenced and how the different sub-questions will be answered which lays the foundation for the main research question to be answered.

A strategy will be proposed for the coast of Paramaribo focussing on 3 locations where the urban-water-metabolism presents itself differently. The strategy is developed alongside a pattern deck which acts as a “toolbox” to develop the strategy and translate this strategy into a design.

Analysis

The project began with a literature review of the coast of Paramaribo, focussing on 3 main subjects namely urban, water and soil. Looking at the 3 subjects individually first and then looking at them as 1 main system. The next step was to visualize the literature review and map out the 3 main subjects. Looking more specifically into urban expansion, flooding and coastal erosion and how these challenges connect or overlap with one another. The mapping phase of the project was challenging since there is not a lot of accurate information about Suriname in general. This meant that the literature review and mapping did not give a clear enough picture of the current situation with its challenges.

Site Visit

To get a better picture of the situation and get more accurate information a site visit was crucial quite early on in the project. In general, a site visit gives an idea of how the challenges present themselves on eye level, there is only so much one can see on a map or a section. Seeing it in real life gives a whole picture and a complete

understanding of the situation. The site visit was not only meant to “finalize” the analysis but also to get an insight into how the inhabitants are dealing with the challenges along the coast. This was of great importance for this project since the scope of this project is to propose a strategy and design that the inhabitants can implement themselves. The project needs to be feasible for the inhabitants to realise themselves.

Having conversations with residents who live in the 3 locations the project focuses on and seeing in real life how these residents have dealt with the challenges, meaning how they have protected their homes and terrains against flooding and/or coastal erosion gave a good baseline and blueprint for design implications that residents can realise themselves.

To understand how the challenges actually work and grasp the technical meaning behind them conversations were had with specialists. In the case of this project conversations with mangrove restoration experts, people from the government, policy experts and water management experts were conducted to understand the technical implications and importance of the challenges of the urban-water-soil metabolism on the coast of Paramaribo.

Pattern Deck

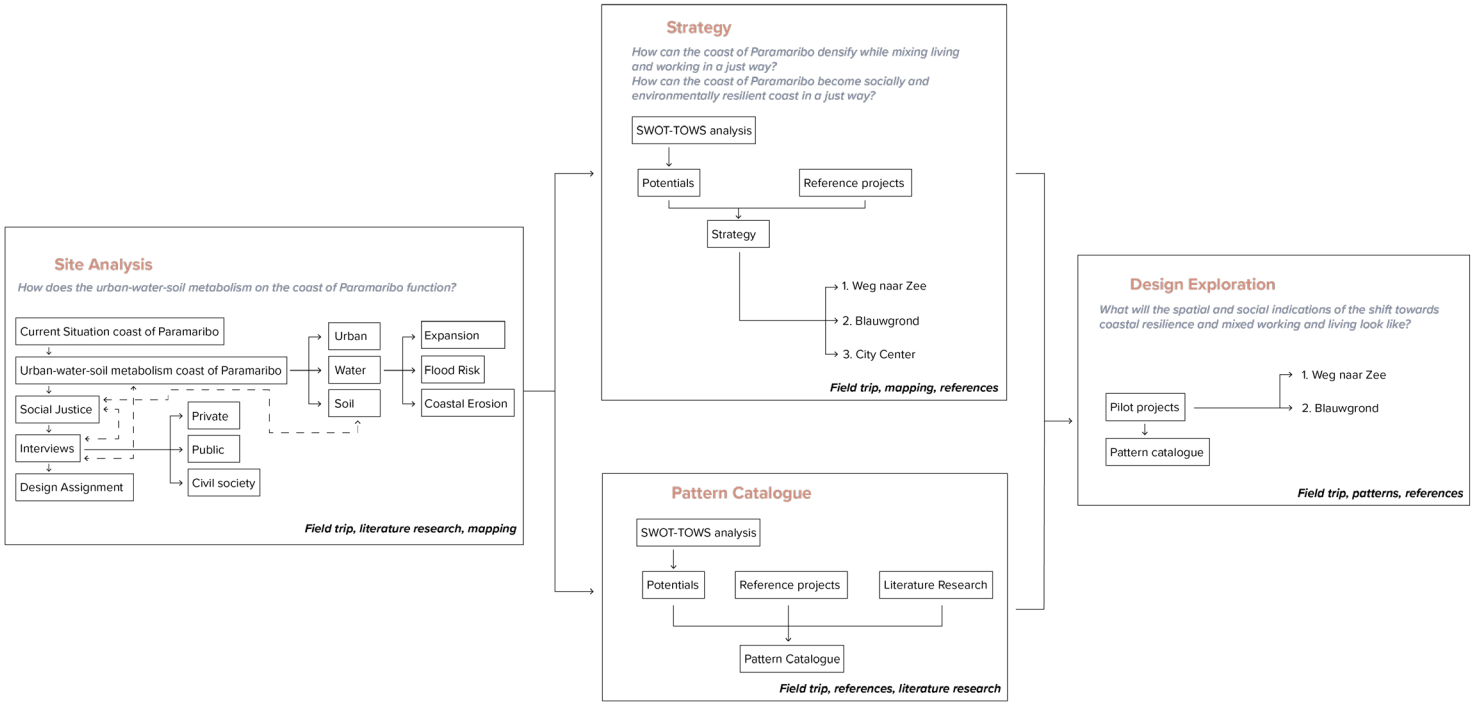
The pattern deck was created according to literature research, reference projects and conversations with the residents. Patterns are often used when the participation and input of residents are included in the design process. As this project focuses on feasibility for the residents, a pattern language is helpful. However, in Suriname pattern language is not used and is therefore not a known form of communication. In order to make the pattern language understandable for the residents the patterns were developed as a card which resulted in a pattern deck.

Spatial Strategy

The coast of Paramaribo is not the only coast dealing with the challenges of urban expansion, flood risk and coastal erosion. Developing a spatial strategy that can be transferable to other coastal cities with the same or similar parameters will make the project clear for stakeholders. With this in mind, a pattern deck is created.

Pilot project

After the spatial strategy and the pattern deck were developed a location was chosen to demonstrate how the pattern deck and the strategy combined be translated into a design.



Chapter 3 shows the spatial analysis of the coast of Paramaribo. This analysis is based on the three main systems urban, water and soil. Afterwhich the analysis is concluded by layering the three systems and looking at the current state of the urban-water-soil metabolism on the coast of Paramaribo.

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3.1 Urban

3.1.1 Urban expansion

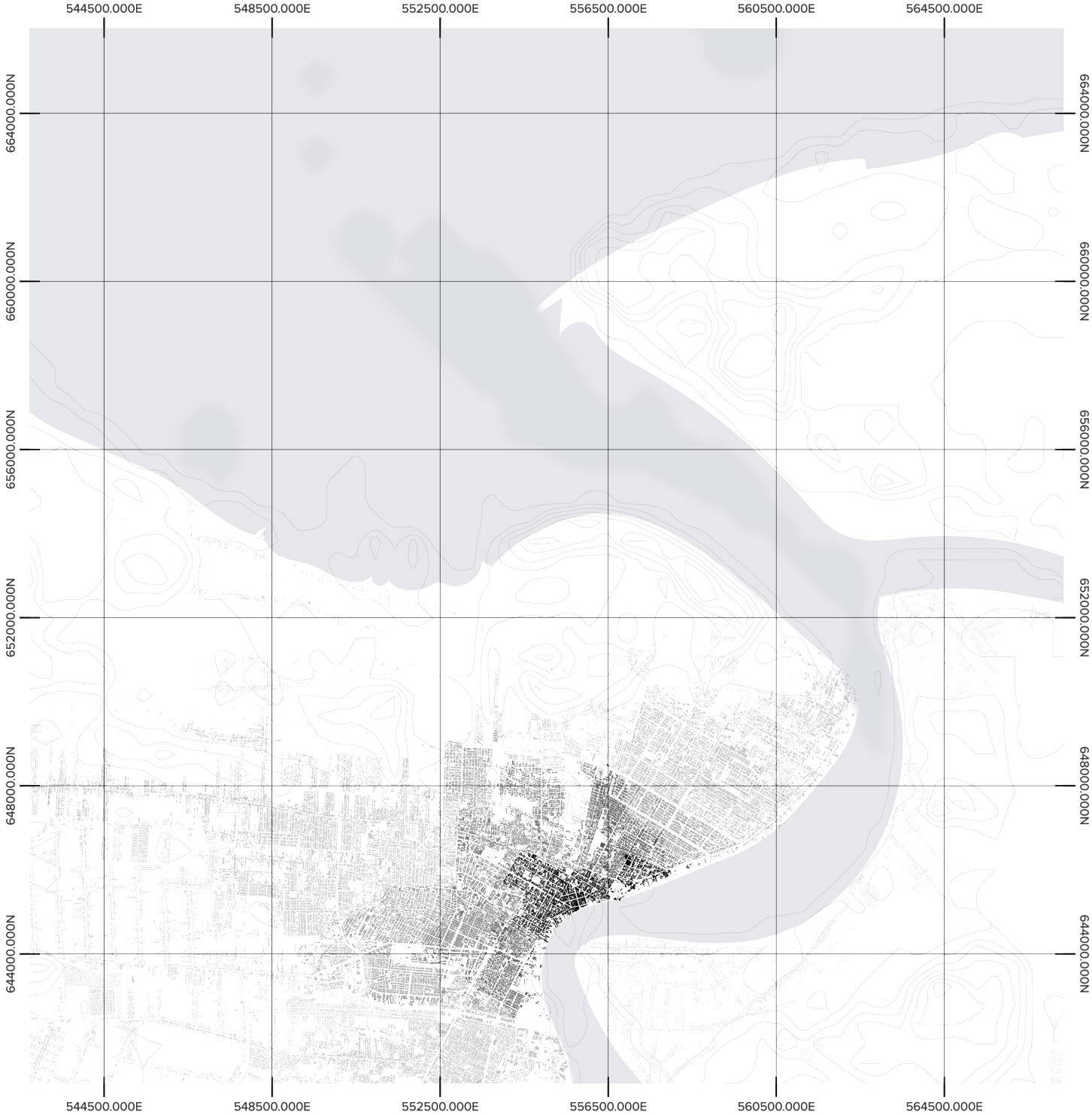
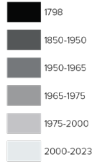
Cities already house 50% of the world’s population, and over the next few decades, this percentage is expected to climb. Coastal cities have large urban populations, and it is projected that these cities would be significantly impacted by the specific consequences of climate change (Linnekamp et al., 2011).

Paramaribo has had a steady expansion since the colonial time. The expansion happened in a structured fashion as the city was planned according to a strategy. This was because of the construction of new plantations (Claes & Debaene, 2009).

In the period 1950-1965, the expansion accelerated and nearly doubled in surface, the rate of this urban expansion was kept up in the following periods (Heirman & Coppens, 2013).

The urban expansion started off along the Suriname River and expanded mostly along this body of water. After this, the expansion moved to the west and the south, although in recent years the expansion has started to move more towards the north.

Source: QGIS, Suriname Open Street Map datapackage geofabrik, Forest (Suriname Water Resources Information System, 2018), Heirman (2019) , GEBCO Gridded Bathymetry Data Download



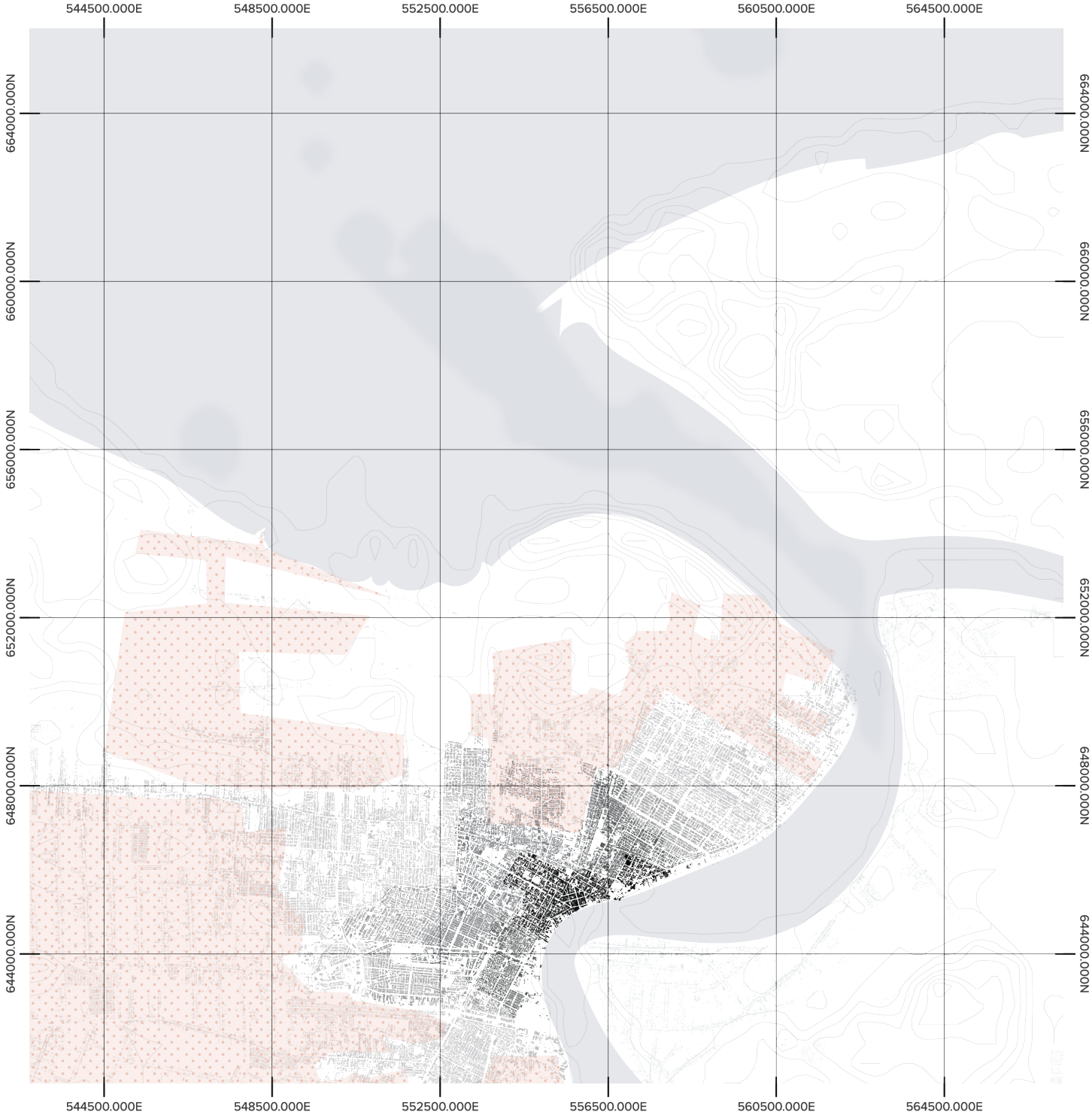
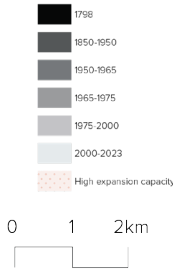
3.1 Urban

3.1.2 Prediction urban expansion

Following the urban expansion pattern Paramaribo has had through its development since the colonial period it can be said that the expansion first starts along the Suriname River before spreading more land inwards. Depending on the location of the expansion it then spreads to the west or the south.

Looking at the expansion along the coast of Paramaribo it is established that urban development is happening along the Suriname River. Following the development pattern of the city has high planning capacity west of this urbanized area.

Source: QGIS, Suriname Open Street Map datapackage geofabrik, Heirman (2019), GEBCO Gridded Bathymetry Data Download



3.1 Urban

3.1.3 Stakeholder analysis

The involved stakeholders are divided into three main sectors namely; public-, private- and civil society. The stakeholders in each of the sectors can all be addressed and assessed in the same way.

The public sector has a significant amount of power. They make the systems the other sectors revolve around and rely upon. This sector needs to be interested and convinced of the project.

The private sector has various amounts of power, depending on the individual actors within the sector. The interest in this sector is lower. Although this sector does have a lot of influence on the other sectors. When spreading awareness this sector can be of great value, but in order for this to happen awareness must first be built up for this sector.

Of all the sectors civil society has the least amount of power, this does make up for the fact they do tend to have more interest and awareness than the other sectors. The interest and power of different stakeholders among the different sectors have been assessed and a prediction has been made of how this interest and power would have to be adjusted in order for this project to be successful.

In Paramaribo, the public sector is present and has made certain systems the other sectors revolve around. Although systems in Paramaribo especially when looking at systems portraying flood prevention and action, coastal erosion and assisting residents in this are not optimal. In some cases, the systems or policies are just in the form of documents. This is due to the fact that policies need funding in order to be implemented, this is not the case in Paramaribo, and also the entire country (Suriname). More on this and the reasoning behind this

can be found in chapter 4, In conversation with paragraph 3 conversations with specialists.

Because the policies and therefore systems within the scope of this project are either non-existent or not running optimally the public sector does not have the amount of power and significance as it should. Moreover, the private sector and civil society run on the systems set in place by the public sector which then means that these two sectors are also not running optimally as they do not have a certain system to fall back on.

This means that a systemic change is needed. Be it in the public sector or not. In any case, a system is required to give the sectors a framework to fall back on. In the case of this project specifically, the focus is on proposing systemic change now and the change actually being feasible and should be able to be implemented now. Therefore, proposing a whole public sector systemic change where new policies and systems are created and implemented falls out of the scope of this project. Whereas a systemic change in the form of an organisation such as a Non-Governmental Organisation can propose a similar system. In addition to this, an NGO also provides a good base for a big systemic change and shift within the public sector in the future.

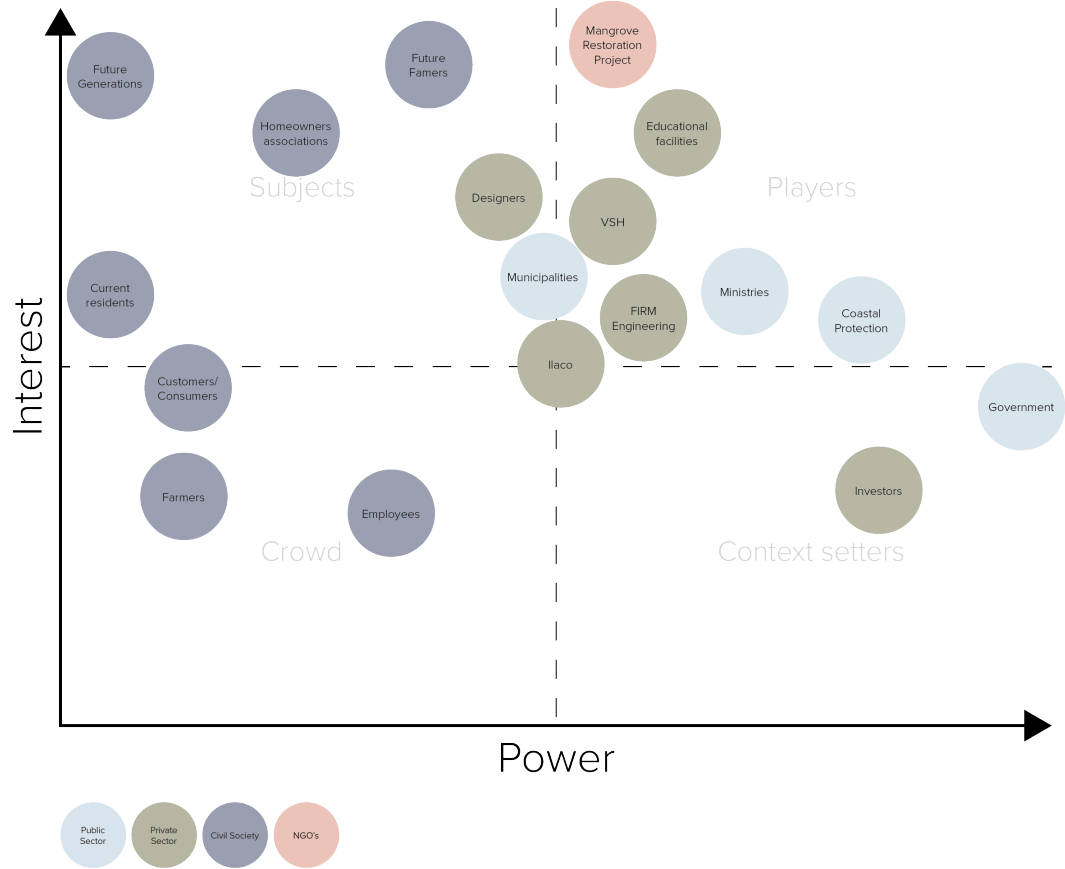


Figure 3.1 Stakeholder analysis

3.2 Water

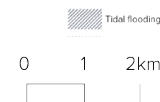
3.2.1 Tidal flood risk

Tidal flooding is flooding coming from a body of water. Looking at the coast of Paramaribo it borders 2 major bodies of water namely the Atlantic Ocean in the north and the Suriname River in the east. Now these bodies of water cause two different types of tidal flooding. In the north, the Atlantic Ocean causes coastal flooding on the coast, whereas the Suriname River in the east causes river flooding on the coast. Climate change has just exaggerated the probability of these types of floods occurring since the sea levels are rising.

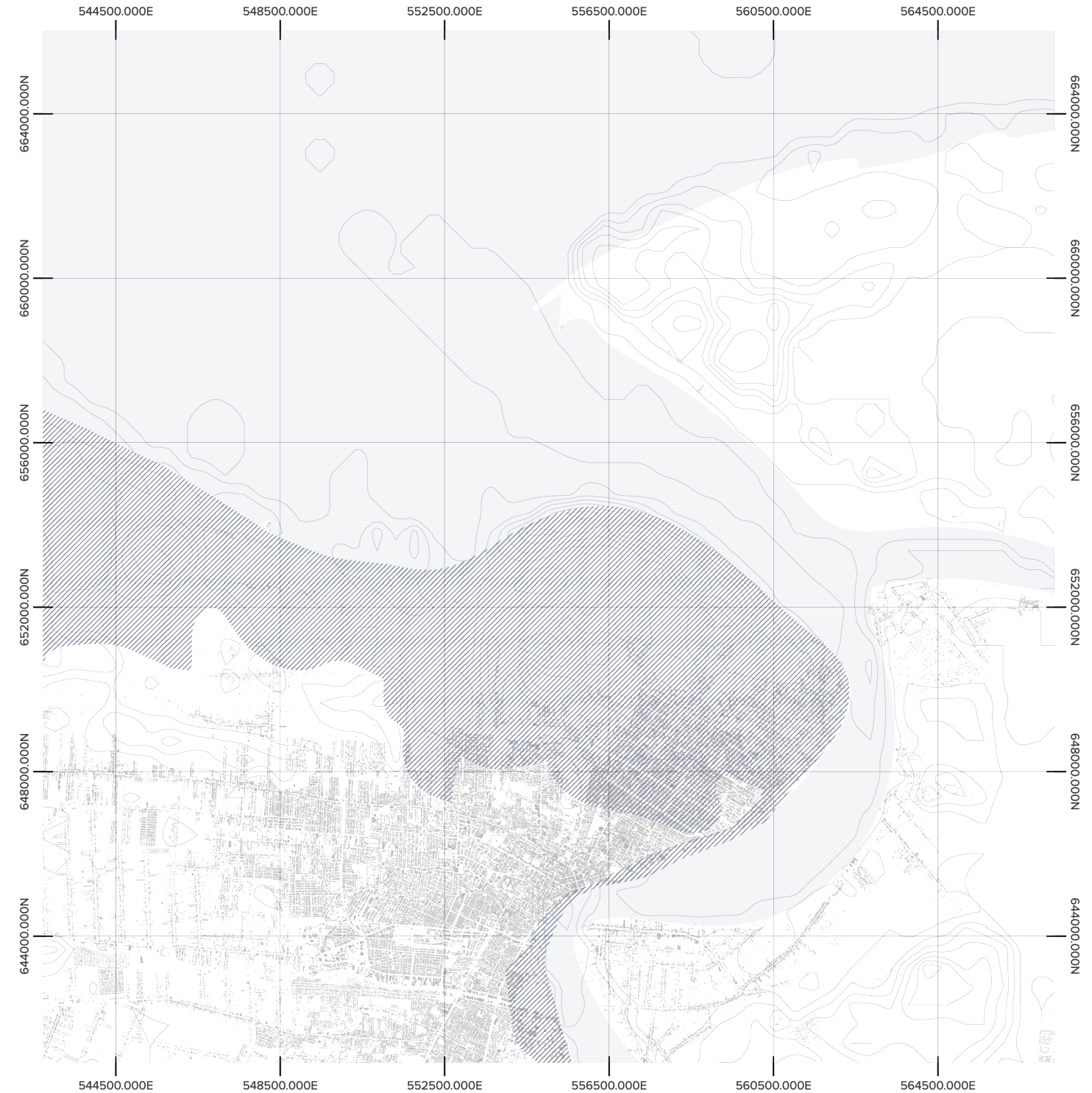
Moreover, the coast of Paramaribo is very susceptible to floods due to the land lying about 2-3 meters above sea level in most places with some areas lying about 4 meters above the sea level (Topografische kaart Suriname, hoogte, reliëf, n.d.).

Combining the parameters, low-lying land and flood risk results in the coast of Paramaribo suffering from coastal and river flooding. The flooding extends to the entire coast to almost 6 km of land inwards.

These floods have a negative effect on not only the peri-urban and sub-urban areas in the affected areas but also reap havoc on the agricultural land in Weg naar Zee.



Source: QGIS, Suriname Open Street Map datapackage geofabrik, Guzman et al., 2017b, GEBCO Gridded Bathymetry Data Download

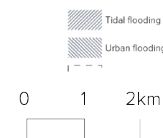
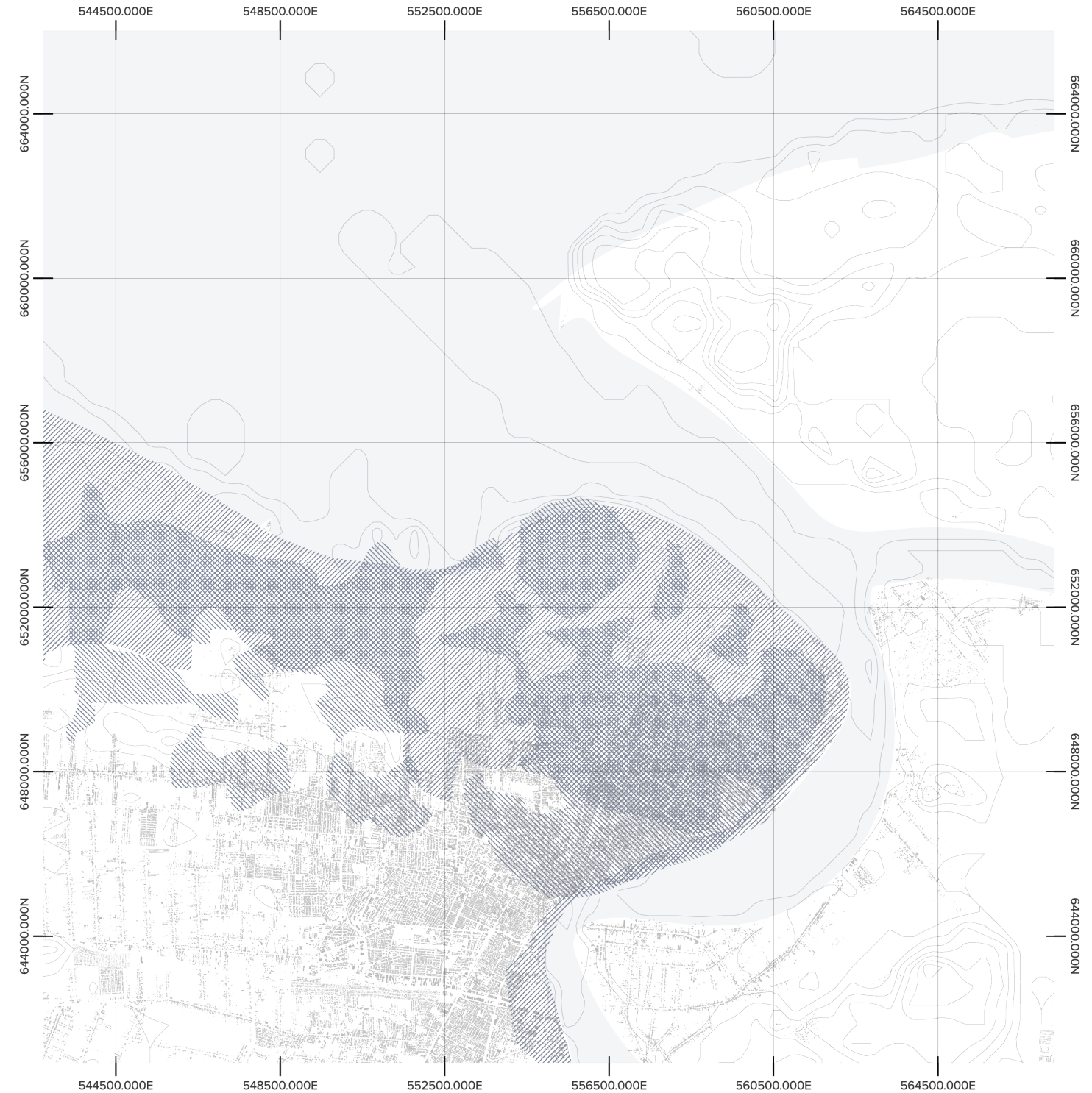


3.2 Water

3.2.2 Urban flood risk

In addition to the coastal- and river flooding the coast of Paramaribo also suffers from the effects of climate change has had on the weather. Due to climate change, the weather in Suriname has changed which has resulted in more rain in both the rainy and dry seasons. This means that there is more water coming down in the city. This has led to an increase in urban flooding.

This should not be that big of a problem, but the water management system in Paramaribo does not have the capacity to handle this. This is due to the water management system not being maintained as it should and the water management system being out of date. This system was set up during the colonial period of Suriname which has not been updated much since the independence. In addition to this, the sluices and pumps are all still handled manually which means a lot of maintenance.



3.2 Water

3.2.3 Summary

The coast of Paramaribo has a high flood risk. Due to several different factors namely the low-lying land which increases the risk of coastal- and river flooding, this has been exaggerated by sea level rise and more precipitation due to climate change which has led to an increase in urban flooding.

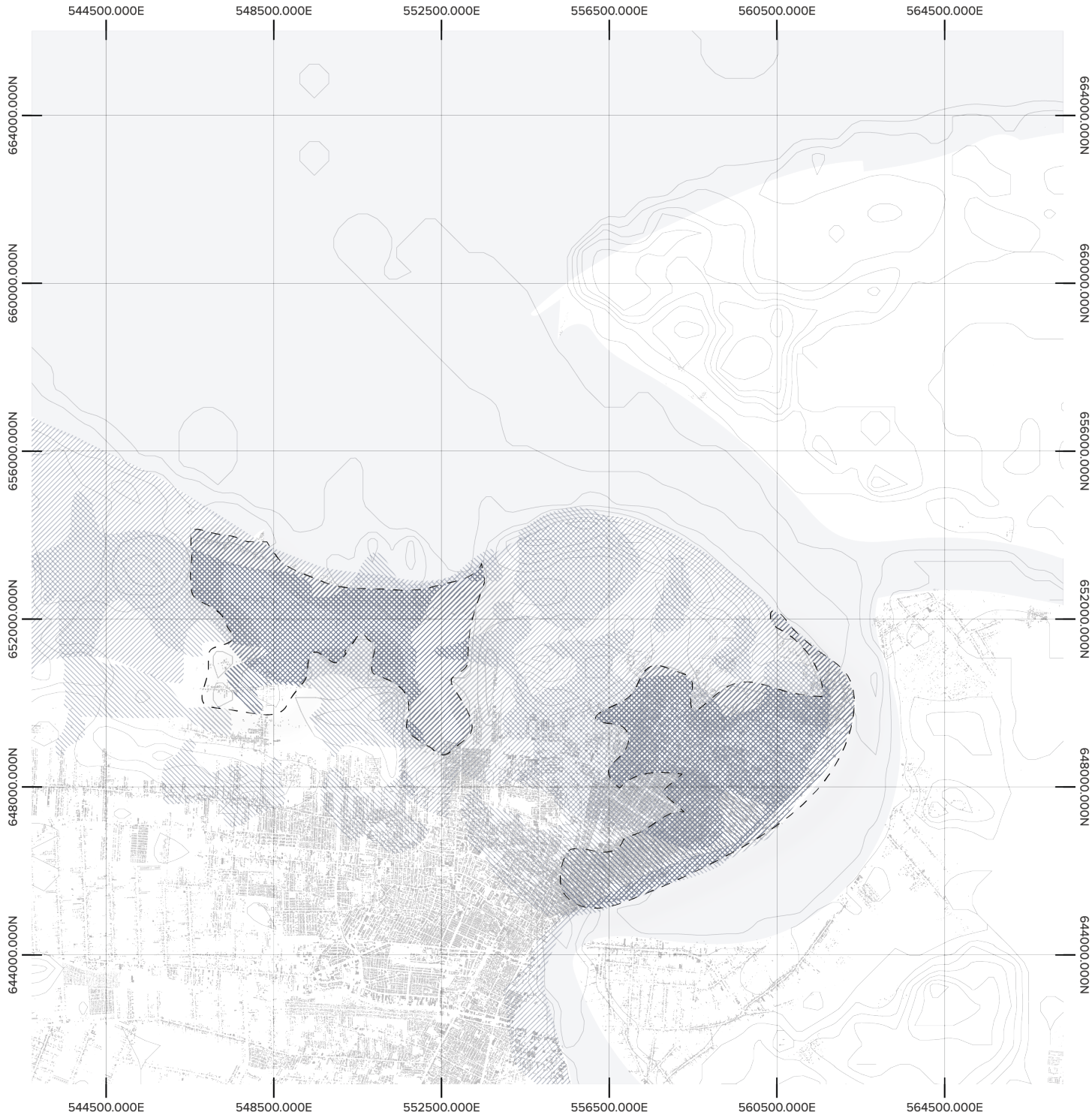
Layering these flooding types it is noticeable that the coast of Paramaribo is at high risk for flooding. Flooding originates from different sources, in the case of the coast these are, tides, sea level rise, low-lying land, and poor water management.

But how do the residents in Paramaribo cope with the floods?

According to Linnekamp et al. (2011), floods have quite a negative impact on residents, people can't go to work or school. Stress is something that residents experience more often as a repercussion of floods. Most residents experience this heightened stress because floods mean damages to their properties which coincidentally leads to more expenses. Moreover, another stress factor is the unpredictability of floods (Linnekamp et al., 2011).

The question that then presents itself follows: What are these households doing to protect their homes and or properties?

A routine measure that residents undertake is raising their properties, for the residents with lower income mud is used while residents with higher income tend to use concrete (Linnekamp et al., 2011). Preventive action against floods is an individual thing amongst the residents according to Linnekamp et al. (2011). It is curious that in case of floods, residents don't tend to contact governmental institutions in these situations (Linnekamp et al., 2011).



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3.3 Soil

3.3.2 Coastal protection

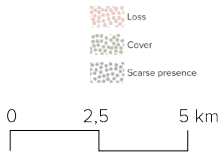
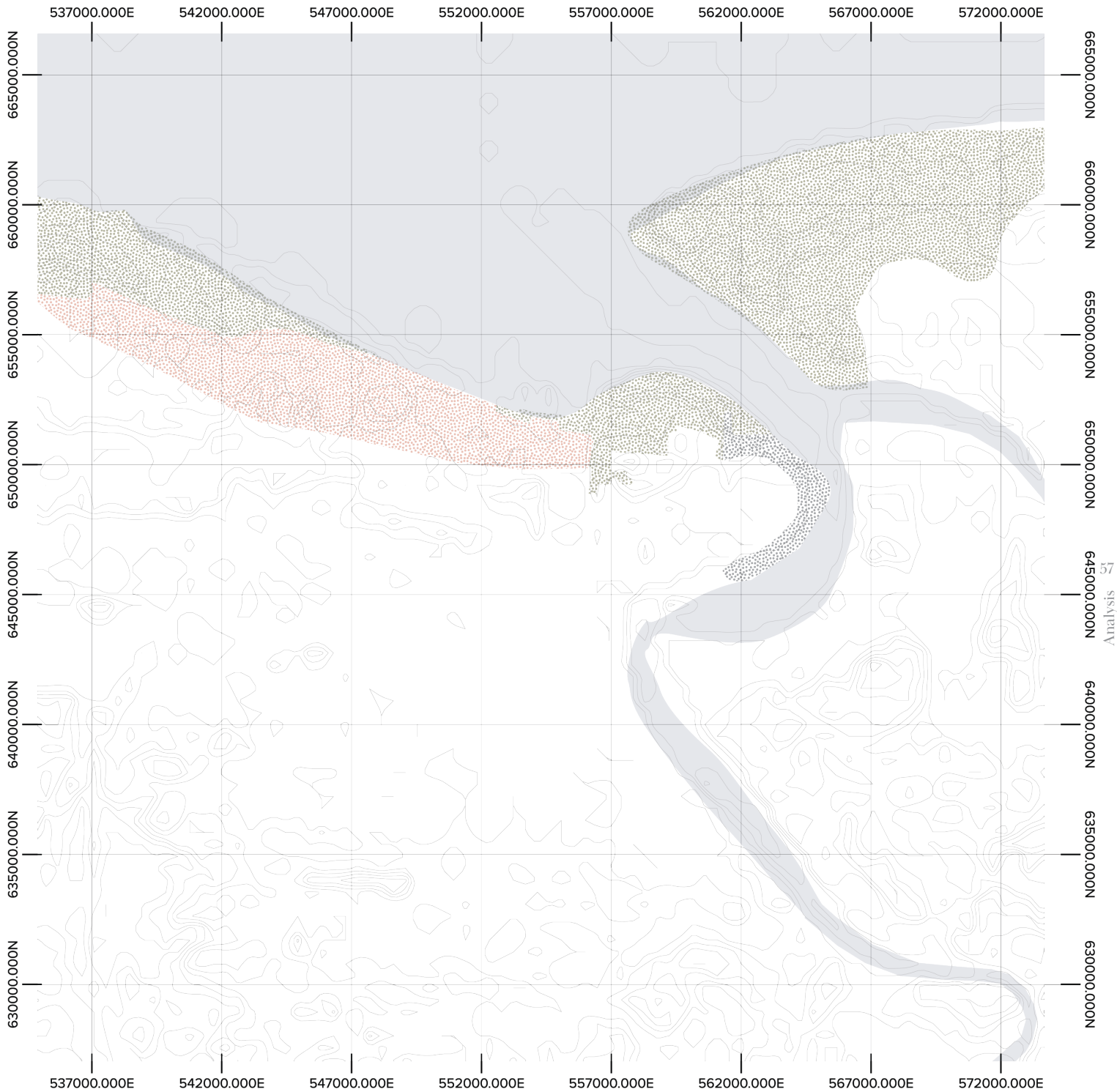
The coast of Paramaribo does have natural protection, in the form of mangrove forests. These mangrove forests used to span the entire coast of Suriname.

Mangroves are no ordinary trees, they have partly aerial roots. These roots sit beside the mudbanks and grab onto the mud in the mudbanks, therefore, adding soil to the coast. In addition to this, the mangroves are the natural habitat for several species along the coast of Paramaribo, namely shellfish. The trees grow in salty and brackish water. And are therefore known as coastal trees, mangrove forests only grow in tropical and subtropical areas as they can not withstand freezing temperatures.

In addition to this mangrove forests are meant to withstand floods. Their roots allow for the trees to withstand the daily tide changes, in the event of tidal waters the roots also slow the movement. This causes sediment to get trapped in the roots and build upon the muddy soil that they grow out of (What is a mangrove forest?, 2022).



Figure 3.2 Map of Paramaribo 1835 (Stichting Wetenschappelijk Onderzoek in de Tropen, 1973)



3.3 Soil

3.3.3 What types of mangroves can be found on the coast of Paramaribo?

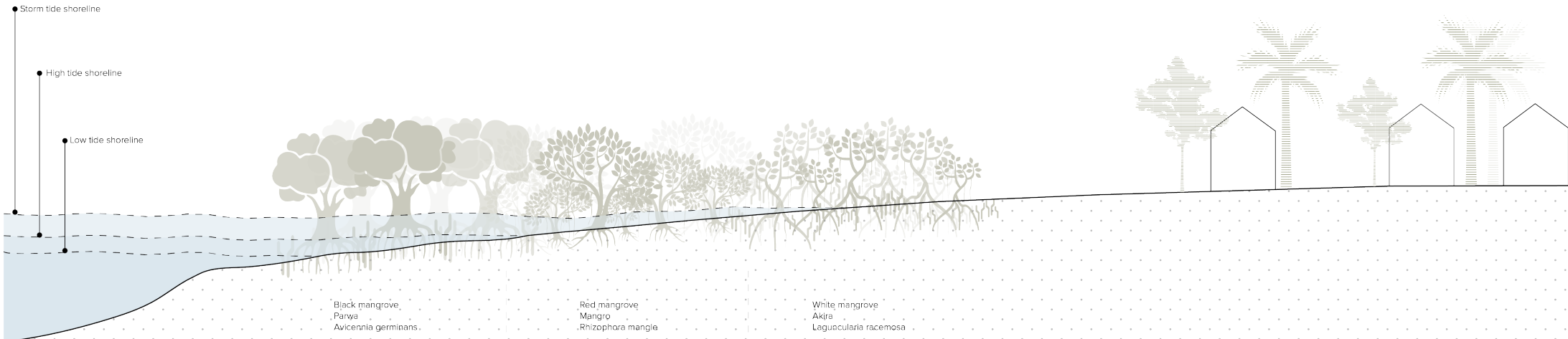
Suriname has 3 species of mangroves; black mangroves, white mangroves and red mangroves. Where the coast meets the ocean there are mostly black mangroves, these are characterized by their straight trunk with stilt roots growing out of the soil in order to breathe. The black mangroves are a pioneer for coastal protection. Where the coast meets the mouth of the Suriname River there are mostly red mangroves. These mangroves are known as widely branched out trees, the roots grow out of the lowest part of the trunk and bend where they ramify into more aerial roots. The tree ramifies until it reaches the muddy soil. As for the white mangroves which is the third species of mangroves found in Suriname, these grow in the form of shrubs or small trees (Wessels Boer, Hekking, & Schulz, 1976).



Figure 3.3. Mangrove types of Suriname, (Wessels Boer, Hekking & Schulz, 1976)

In most mangrove forests the three species all grow together with the white mangroves growing near the water, after which the black and red mangroves follow.

Since the mangrove forests have been taken out and there is quite a significant amount of sediment loss along the coast of Paramaribo. There is a mangrove rehabilitation project ongoing in Suriname. This organisation first constructs sediment trapping units in order to capture enough soil for the mangroves to grow in after which they plant black mangroves along the coast of Paramaribo. The project has been a success and is still ongoing, more on the mangrove restoration project can be found in Chapter 4.



Source: (Makowski & Finkl, 2018)

3.4 Conclusion analysis

3.4.1 Summary urban water soil metabolism along the coast of Paramaribo

In order to find the potential of the urban-water-soil metabolism on the coast of Paramaribo, a clear overview of the current state of the coast must be assessed first. After the analysis of the 3 systems urban, water and soil, a statement can be made as to the current dynamics of the urban-water-metabolism on the coast of Paramaribo. It can be concluded that the coast of Paramaribo is set to undergo urban expansion due to the predicted urban growth.

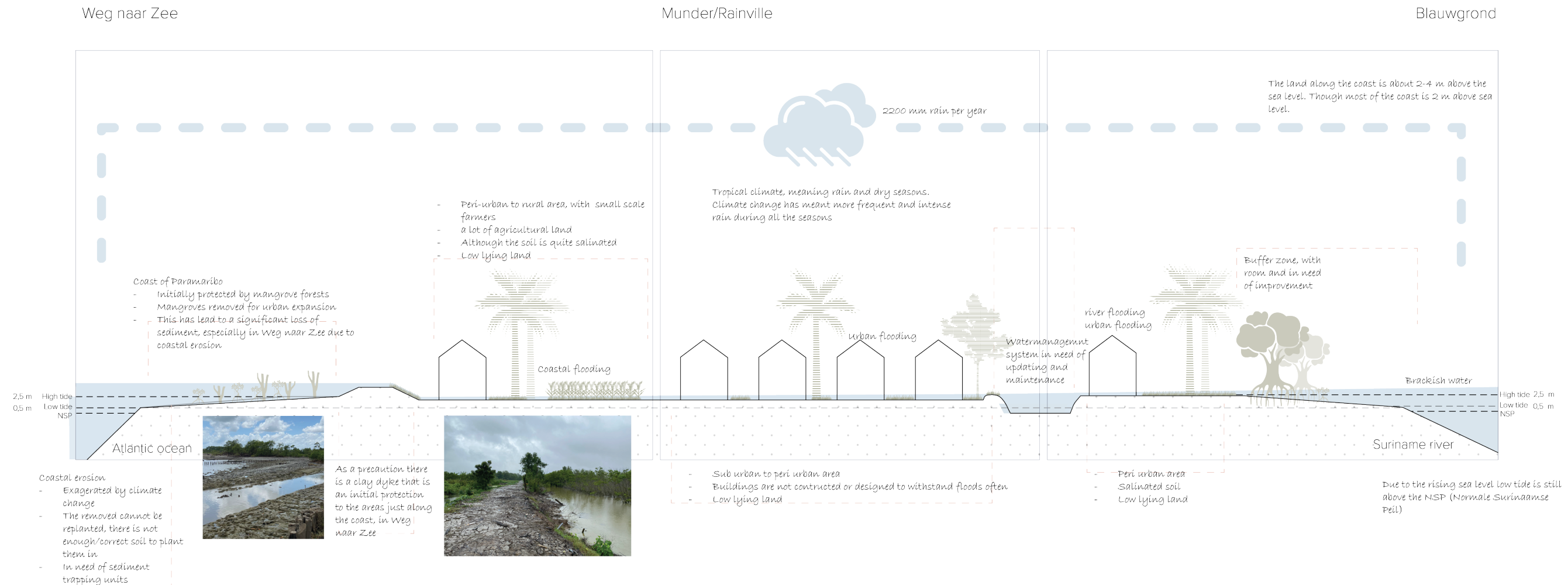
At the same time, the coast is dealing with two major challenges, flooding and coastal erosion. Now these two challenges are influencing each other. The low-lying land of the coast is a factor that causes more floods along the coast, at the same time the land keeps getting lower. This is because every time there is a flood soil gets swept away by the water. The incoming water (from either the sea or river), which are part of the reason for the floods, is not kept back from the land due to a lack of coastal protection. In the case of this study area, this is the lack

of mangrove forests. These forests were taken out in preparation for urban expansion on the coast. Because the mangroves along part of the coast were taken out the coast is not protected from the dynamic mudbanks moving along the entire coast of Suriname.

Due to the lack of protection along the coast, Paramaribo is eroding, and there is a significant loss of sediment along the coast of Paramaribo. The loss of sediment is right along the area in Paramaribo where there is quite an amount of agricultural land. The soil in this area suffers

from salinization because of the seawater coming in due to a lack of coastal protection.

Now, the residents living along the coast have to deal with floods often. At the same time, the coast needs to prepare for urban expansion, dealing with floods and coastal erosion.



3.4.2 Defining locations for the strategy

This project focuses on 3 main locations where the challenges concerning the urban-water-soil metabolism present themselves differently. The locations decided upon are established by layering the urban, water and soil analysis and defining where the biggest risk areas overlap each other. Then zoom in and look at how the challenges actually present themselves at street level to make certain that the problems present themselves differently in each of the chosen locations. The 3 locations will result in 3 strategies that can be used as examples when working in other locations (be it in Suriname or anywhere in the world) given that the location has the same or similar parameters.



Loc 1

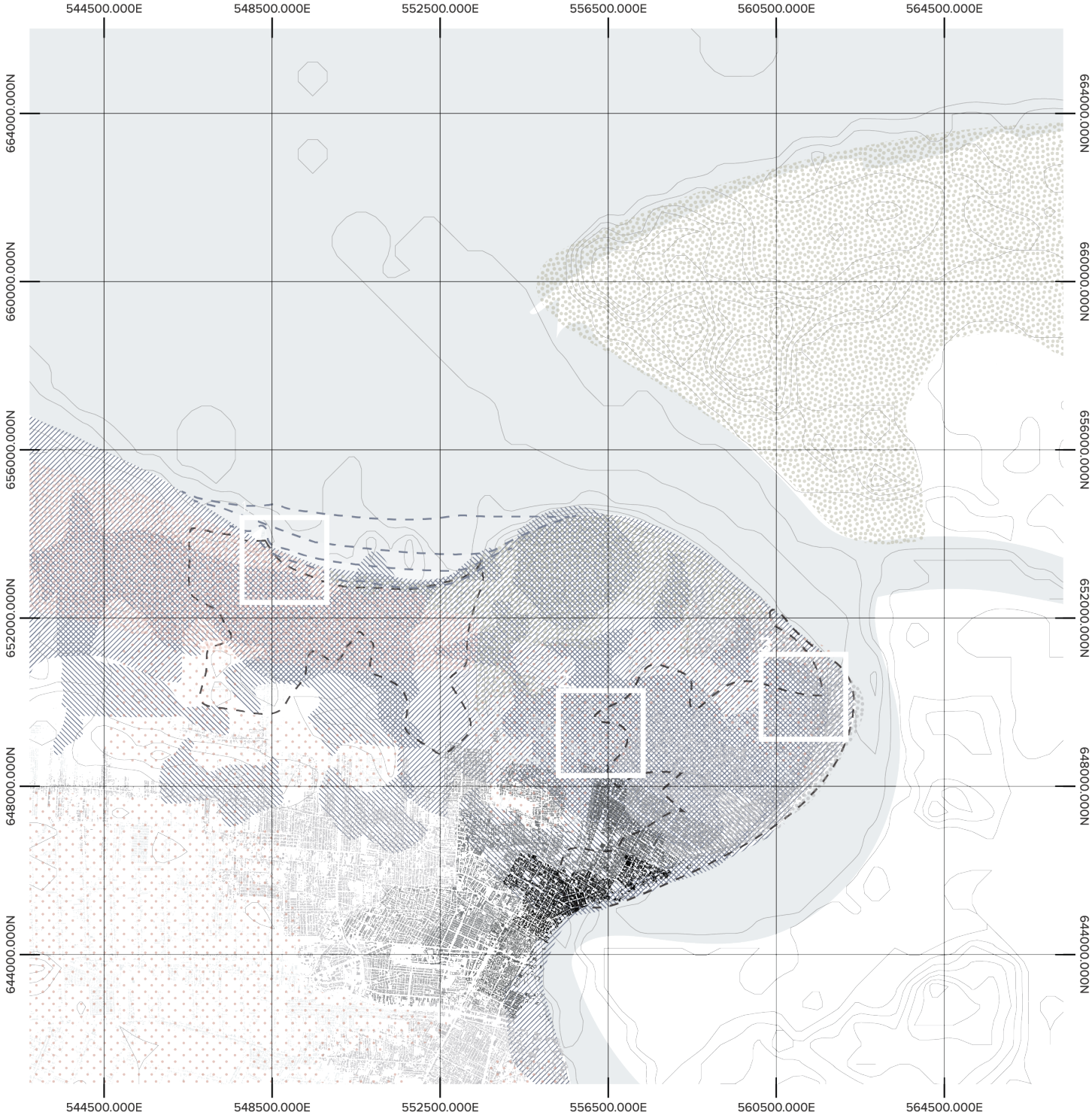
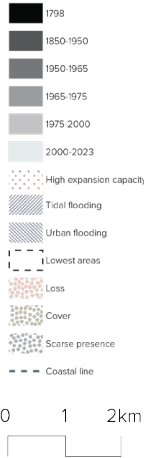


Loc 2



Loc 3

Source: QGIS, Bing



To form a better picture and understand the current situation along the coast several conversations were had with residents and experts. These conversations were conducted during the site visit. In appendix 4 an overview of the specialists consulted for this project is included.

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In conversation
with...

4.1 Conversations with residents

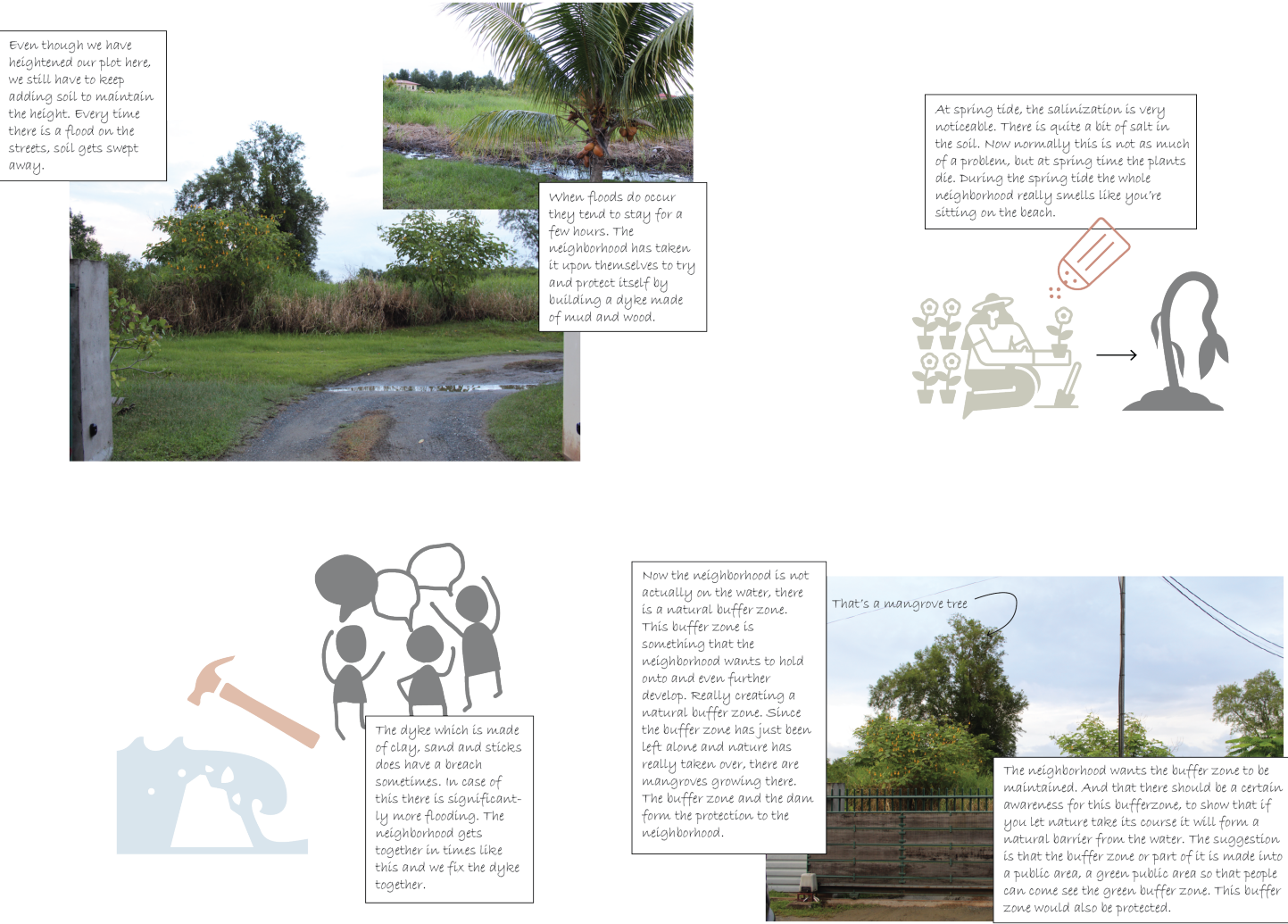
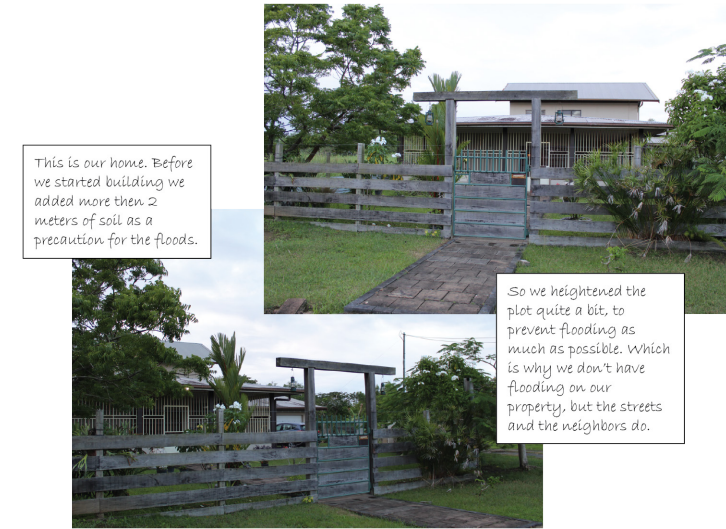
4.1.1 In conversation with a resident from Blauwgrond

This resident has resided in Blauwgrond for the past 25 years with her family. The family lives quite close to the Suriname River, with roughly 200-300 meters separating them from the river. The neighbourhood in which they live is prone to flooding, originating from the river and the water management of the area. Although the streets and the terrains of the neighbours do experience floods, the terrain of this resident does not experience floods. This is because, before they built their house they heightened their plot quite a bit. Every few years they add more soil to the plot to keep up with the floods as every flood soil gets swept away. To protect themselves from floods, which last for a few hours at a time, the neighbourhoods have taken it upon themselves to protect themselves by building a dam made out of mud and wood. This dam does work but does have a breach now and again. In the event of a breach, the neighbourhood comes together and fixes itself.

Now, as mentioned before, the neighbourhood is not actually on the water, there are about 200-300 meters of land between the neighbourhood and the river. This stretch of land is occupied by nature, with mangroves growing in various ages and types, making it a natural buffer zone. This buffer zone is something the neighbourhood wants to hold onto and develop further. The suggestion the neighbourhood has for this buffer zone is to let nature take its course so that a natural buffer zone develops.

In addition to this, the soil on their terrain is salinized, meaning that there is quite a bit of salt present in the soil. Normally this would not be a problem, but with spring tide the plants the resident plants herself (mostly flowers, shrubs and even vegetables) tend to die. The salinization is so noticeable that during spring tide the whole neighbourhood smells like you're sitting on the beach.

The neighbourhood wants the buffer zone to be maintained. And that there should be a certain awareness for this buffer zone, to show that if you let nature take its course it will form a natural barrier from the water. The suggestion is that the buffer zone or part of it is made into a public area, a green public area so that people can come see the green buffer zone. This buffer zone would also be protected.



4.1 Conversations with residents

4.1.2 In conversation with a resident from Weg naar Zee

The residents living here are a couple, their terrain stretches all the way to the sea. About 75 meters of their land have remained untouched in order to give it back to nature. When the residents first bought their land they could walk all the way to the sea and see the sea from afar, this meant that there was no coastal protection (meaning mangroves). Giving nature the room to take its course has had a positive effect on the land as the residents noticed that after a while there were mangroves growing where nature was just left alone.

The residents did try to help the natural processes by making a kind of Sediment Trapping Unit. These are frames that are partly filled with soil and then left to nature to take its course. After a while, the trapping units became overgrown and filled with soil. The units give a good base and provide enough soil for the roots of the mangrove trees to adhere to and grow strong. The result of this is a now almost 75-meter stretch of land full of mangroves. The residents have also noticed that there is land gain which means that the mangroves are indeed doing their job.

In order to protect their land the residents have made water buffers along the length of their land. The water buffers house the excess water and pump the water back into the sea.

As another layer of protection, the residents have made a big pond which also acts as a water buffer zone which lies in between the land they occupy and the land they have given back to nature.

The land is quite salinated which is why the residents tend to do their planting more land inwards and are very specific with the types of plants they cultivate. Some

fruits, for example, papaya growing near the sea has a very salty taste to them due to the amount of salt present in the soil. On the rest of their land, they use an integrated farming method.

We have quite a bit of land, that stretches all the way to the sea. About 75 meters of this land we have not touched, or tried not to touch in order to give it back to nature. This has had a positive effect on the land, when we got the land we could see the sea, but that meant that meant that we did not have any coastal protection.



We noticed that there where mangroves growing on the parts where we just let nature take its course. So we have 75 meters of our land to the sea. Now this 75 meters of land is full of mangroves and nature. We are gaining land.

To try and help the natural processes, we made a kind of Sediment Trapping Unit. We filled this partly with soil and then let nature take its course. After a while the trapping units are overgrown and form a barrier. This helps to protect our land from coastal erosion and keep a lot of water away.



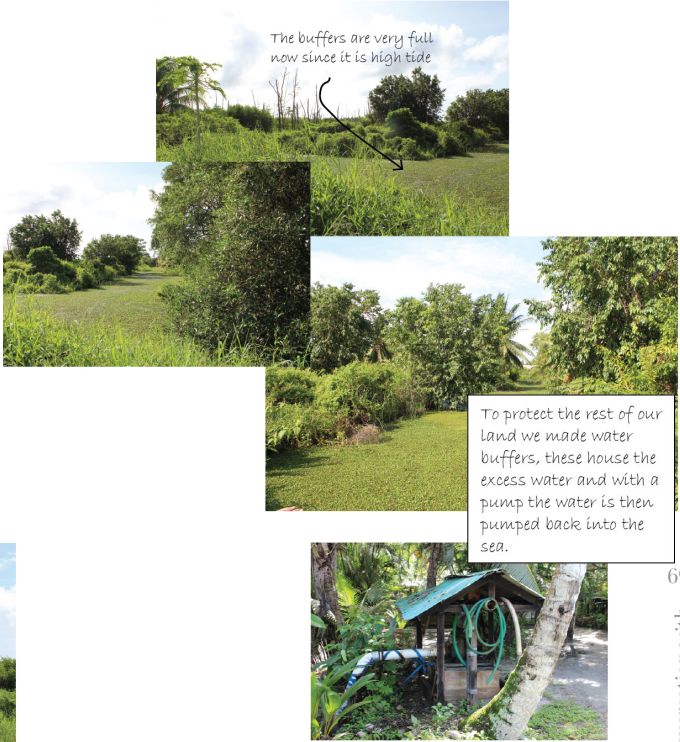
Between where we occupy our land and the area we have back to nature we make a big pond, another form of defence.



There is some salinization on our land, that is why we only plant more land inwards and we only plant certain kinds of plants. The fruits, papaya for example growing near the sea has a salty taste to it if you eat it.



The buffers are very full now since it is high tide



To protect the rest of our land we made water buffers, these house the excess water and with a pump the water is then pumped back into the sea.

4.2 Planting Mangroves

In the case of Weg naar Zee a dyke was not an option because there was and still is no money for this. Planting mangroves in Weg naar Zee is also immediately not a possibility because the coast in this location consists of hard mudbanks, everything else has eroded away. On the other hand, sediment coming from the Amazon can be collected, this can drastically reduce erosion and present the opportunity to plant mangroves. At Weg naar Zee mangrove rehabilitation requires a bit more attention. The situation in this location is different since there is no soil to plant mangroves, which means that there is not much soil for the plants to hold onto. This means that mangrove restoration in Weg naar Zee would consist of two very important steps, the first being collecting soil, this would be done with Sediment Trapping Units. The next step would be to start planting mangroves.

The coast of Suriname is a growing coast, the downside is that where the coastal system was disrupted by human activity the coast has broken down. The breakdown has been exacerbated by climate change. The coast can achieve resilience by using good techniques to collect sediment from the water that comes from the Amazon. The Sediment Trapping Units used in Weg naar Zee are made out of wallaba poles and bamboo, this makes the waves arrive less strongly, which does not stop erosion but does slow down the process quite a lot. This allows the time for the mangroves to be planted.

How old the mangrove plants need to be in order to be planted successfully depends on a few parameters; biodiversity, environment, weather conditions, climatic parameters, fresh water, rain etc. The best time to plant the mangroves is nearly 4-5 months old, at this age, the mangroves are strong enough to withstand the different conditions present along the coast. The roots must be long and strong enough to be able to breathe above ground, the plant must also have a sufficient amount of

leaves. The leaves help to collect water and secrete salt, which ensures that the rainy seasons are bridged. When planting the plants it is important to make sure that the roots are not covered all the way with soil (mud), this allows for them to breathe, once the roots start to stick out further the process goes rather fast and the mangroves can grow up to 2-3 meters high within a year. The Mangrove Rehabilitation Project plants only black mangroves which are known as Parwa in Surinamese.



Figure 4.1 Newly planted black mangroves at Weg naar Zee



Figure 4.2 Citizens planting black mangroves at Weg naar Zee



Figure 4.3 The set up of the mangrove restoration, with bamboo for the STU's



Figure 4.4 Citizens planting black mangroves at Weg naar Zee



Figure 4.5 Soil along the coast ready for mangroves to be planted

4.3 Conversations with specialists

4.3.1 Through the eyes of the government

The Ministry of Spatial Planning & Environment is suggesting that Weg naar Zee is one of the areas along the coast of Paramaribo where there should be minimal densification. Weg naar Zee is labelled as a high-risk area for both flooding and erosion, with the expected rise of the sea level these problems will only increase. The ministry can not help residents should they choose to live there since there is almost no funding to resolve these issues at the moment.

In the water management drainage system, one of the things that are currently being looked at is transforming high-risk areas into buffer zones (flooding). The water is then diverted from the high investment areas (areas where people now live and work) and in order to protect those areas, the water must be diverted somewhere. Water goes to the lowest point, what we have to do is create the buffer zones in such a way that the water is led there and then really stays there. Storage is also created here.

In the city the ministry is also looking at areas where the water can be led (buffer zones in the city), empty plots, roads, and canals (new and old) are examined. In addition to this, the ministry is looking at the roads that are less used and whether it is possible to flood them.

As for the situation at Weg naar Zee and the Mangrove project. The mangroves are good for absorbing the blow from the sea, but what they cannot absorb is that the water goes in anyway. One of the things the ministry also deals with in terms of sea level rise is that the salt water comes in (the farms). Salinization of the soil makes the soil unusable. If so, it seems useful to shift it, you won't be able to do anything there at some point. We have not yet thought of a system to remove salt water from the groundwater. The mangroves do hold back the waves

and the erosion, but what doesn't stop it is the water. A hybrid approach would be the best option to go with.



The eroded coast by Weg naar Zee, made by author (December 2022)

4.3.2 What about policies?

As of now, Suriname has no actual spatial development or design policies taken up in the law. There are documents concerning these subjects that are signed off by the government which can be seen as policies, but they are not officially taken up in the actual law. These documents can be seen as policies since they are signed off by the government, this makes these documents legal which therefore means that they can be seen as policy documents.

Even though these documents exist, it is not always possible to actually implement this. Why? Very simple, funding. Suriname is in a difficult financial state, there is not enough money to spend on this. The policy documents that exist are made because they are funded by external companies, but the funding is often not enough to make the documents and then implement them. Moreover, the documents which are signed off by the government that is currently elected are very often set aside when a new party comes into office. This means that even if a plan was being followed concerning spatial development and design this plan would be put to an end when a new party comes into office. This can be done because the documents are not taken up in the law.

However, this does not mean that spatial planning, development and design are not of importance to the government. Just like for example tackling the flooding problem and erosion problem along the coast of Paramaribo for example. The government does not take these concerns lightly, they are a high priority. Especially the flooding problem and erosion problems along the coast are high-priority examples. But, even though these things may be of high priority there is not enough money to really address these problems.



Clay dyke on the coast by Weg naar Zee, made by author (December 2022)

4.3 Conversations with specialists

4.3.3 Watermanagement Paramaribo

The water management system of Paramaribo is based on the plantation structure and has not really been changed or upgraded (meaning real systemic change) in recent years. In addition to this, the maintenance of the water management system is not as it should be. If the water management system is maintained properly and regularly, meaning that it would be operating at its full capacity, urban flooding would not be as severe as it is right now.

The solution to this would be either funding for the water management system and/or the implementation of a new policy system. A new policy would also not be able to be implemented immediately. This would mean that the residents need to protect their properties and homes themselves as far as they can. Making their homes and properties resilient would be the best option for the residents right now, this counts for existing homes and new builds.

In the future, the best solution would be to upgrade the entire water management system and try to make it as low maintenance as possible.



Man made ditch for extra capacity in the watermanagement system, made by author (December 2022)

In chapter 5 the strategy of this project is explained, starting with a conclusion of the analysis and conversations during the site visit. The pattern deck is introduced afterwhich a general strategy is explained. The collaboratory aspect of the project is introduced and explained. 3 locations are chosen for which strategies are developed with the pattern deck.

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5.1 SWOT-TOWS Analysis

The current dynamics of the urban-water-soil metabolism on the coast of Paramaribo have been analyzed, the potentials have been identified and the perspectives of the residents and some professionals have been taken into account.

The coast of Paramaribo has to deal with several challenges such as urban- and tidal flooding and coastal erosion. Moreover, the city of Paramaribo is in need of urban expansion, with most of the city already densely occupied the coast is one of the few places in the city where urban expansion is a possibility. This urban expansion on the coast will not be feasible or realistic

with the current challenges the coast faces pertaining to the water- and soil systems.

The analysis shows where urban expansion is to be expected and possible in the city of Paramaribo and how the urban- and tidal flooding and coastal erosion challenges are presenting themselves on the coast of Paramaribo. With a clear overview and understanding of the urban-water-soil challenges the coast of Paramaribo faces a deeper dive is taken into understanding and exploring different solutions. This is done by looking at the challenges of the coast through the lenses of residents and professionals.

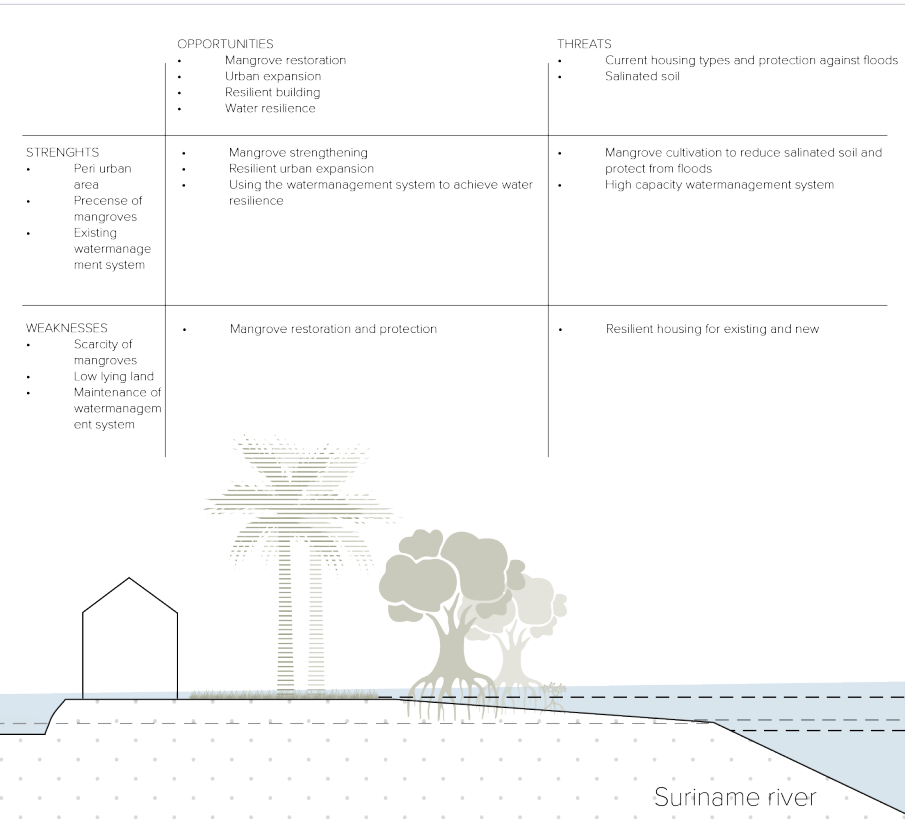
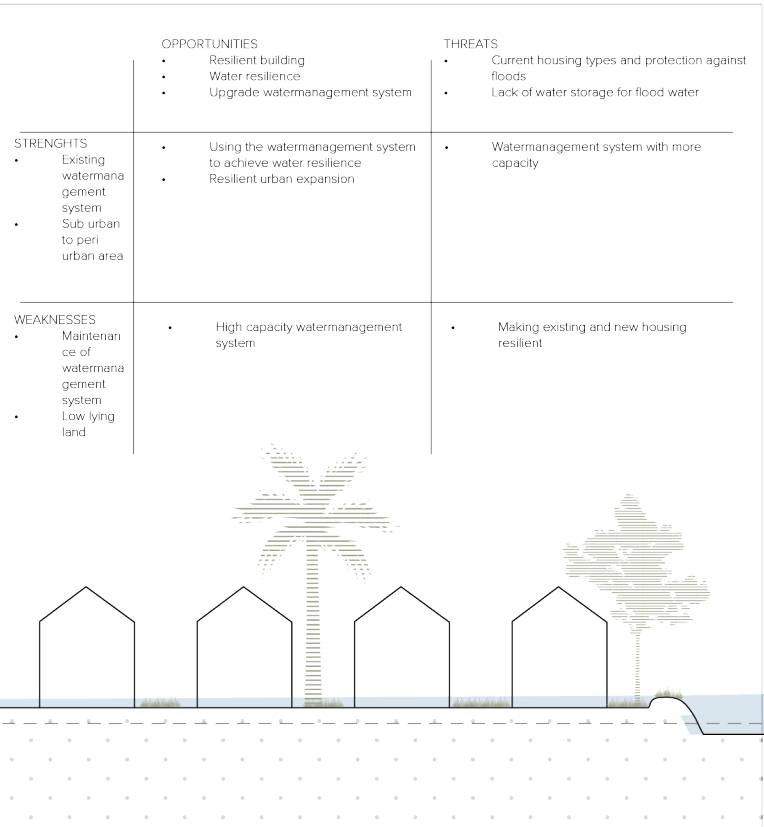
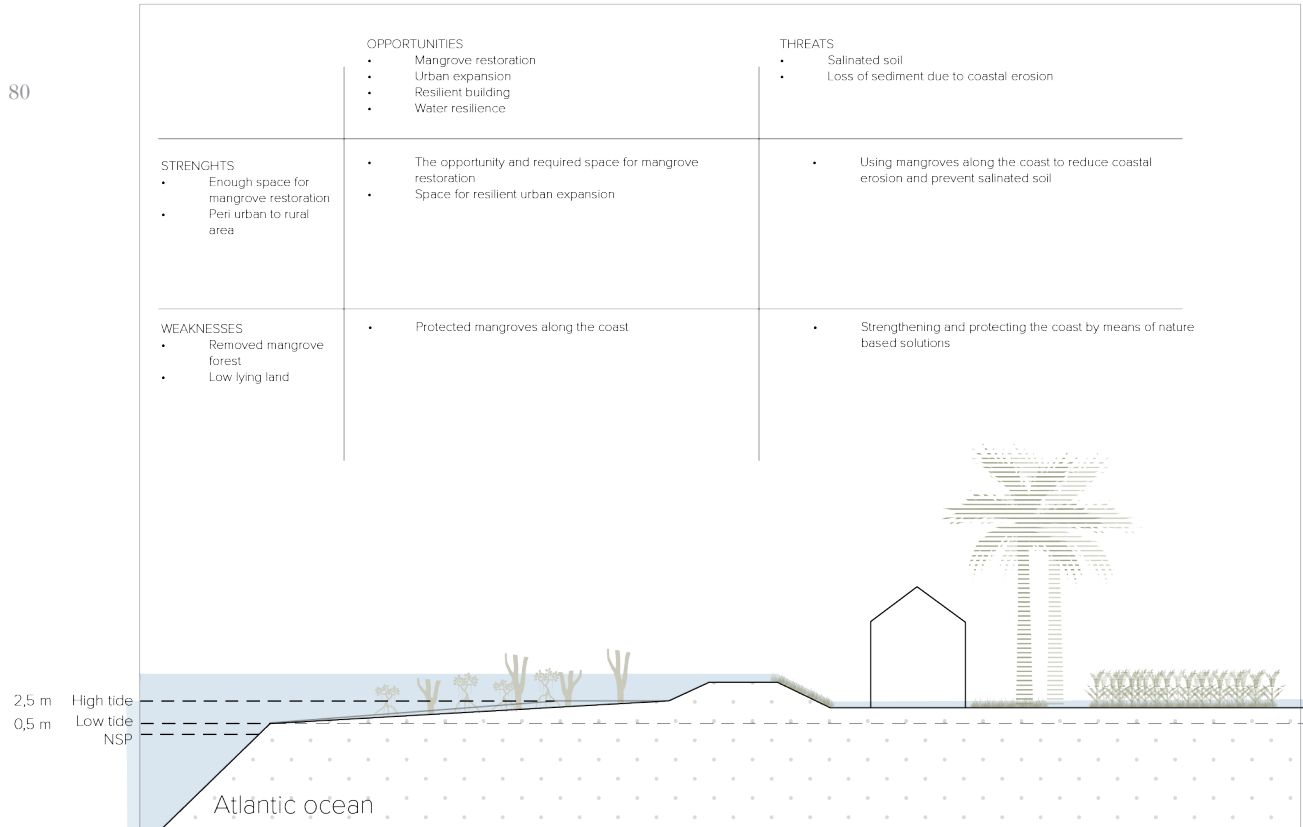
Since urban expansion is expected along the coast, these houses need to be resilient to possible flooding, since flooding is inevitable on the coast. This means that houses need to be made resilient for not only urban expansion but also the existing houses on the coast. The coast suffers from two types of flooding urban- and tidal. Urban flooding has to do with an increase in precipitation due to climate change, in addition to this the water management system in Paramaribo is not properly maintained and is in need of updating. This is the reason why the water management system is not functioning at its full capacity. The city of Paramaribo lies

very low, which makes the city more perceptible to tidal flooding. Moreover, tidal flooding is not dampened as it comes inland since there is little to no coastal protection in place. The coast of Paramaribo has had significant mangrove loss which was the natural coastal protection. Currently, mangrove restoration has started and had positive results. The mangroves can protect the coast from coastal erosion and dampen the effect of the tides coming. This means that they can reduce the effect tidal flooding can have on the coast.

Weg naar Zee

Munder/Rainville

Blauwgrond



5.2 Potentials

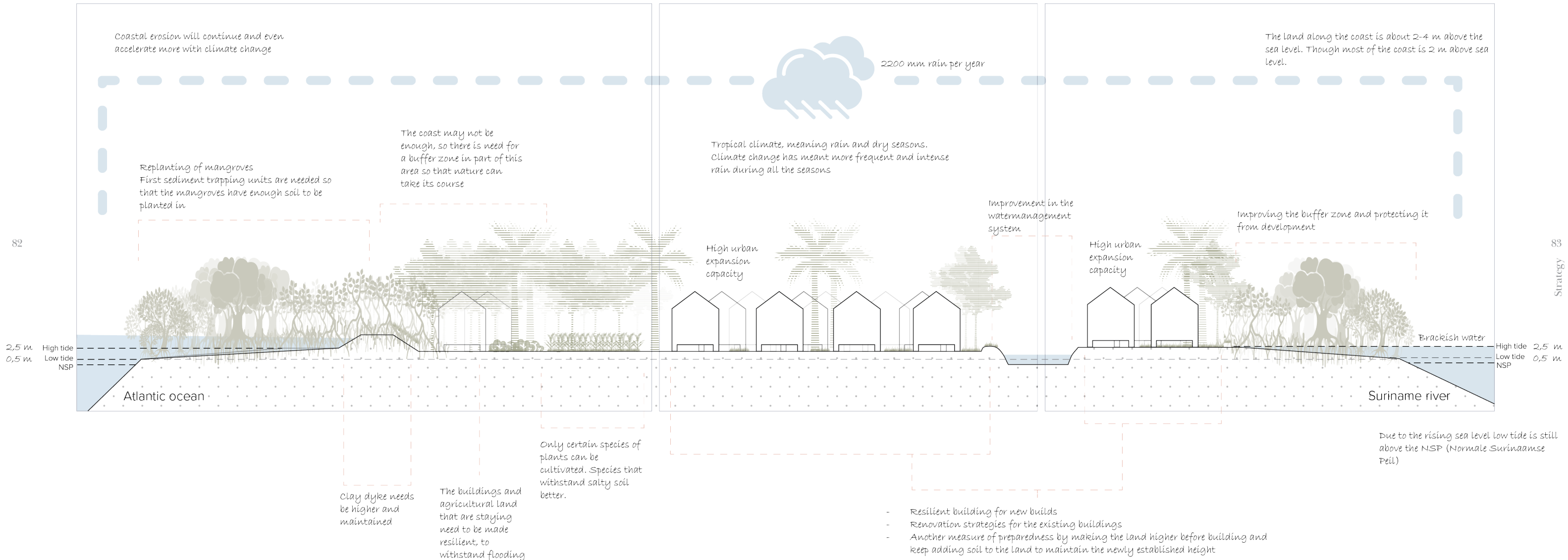
Resilient vs. Adaptable

In this case resilient would be the preferred option because resilient means creating a new normal situation that is already catered to withstand the risks in some way in case of disaster you adapt to the situation and then go back to the new "normal". Where as adaptable means that you keep the situation as it is and when disaster strikes you adapt to the situation.

Weg naar Zee

Munder/Rainville

Blauwgrond



5.3 The Pattern Deck

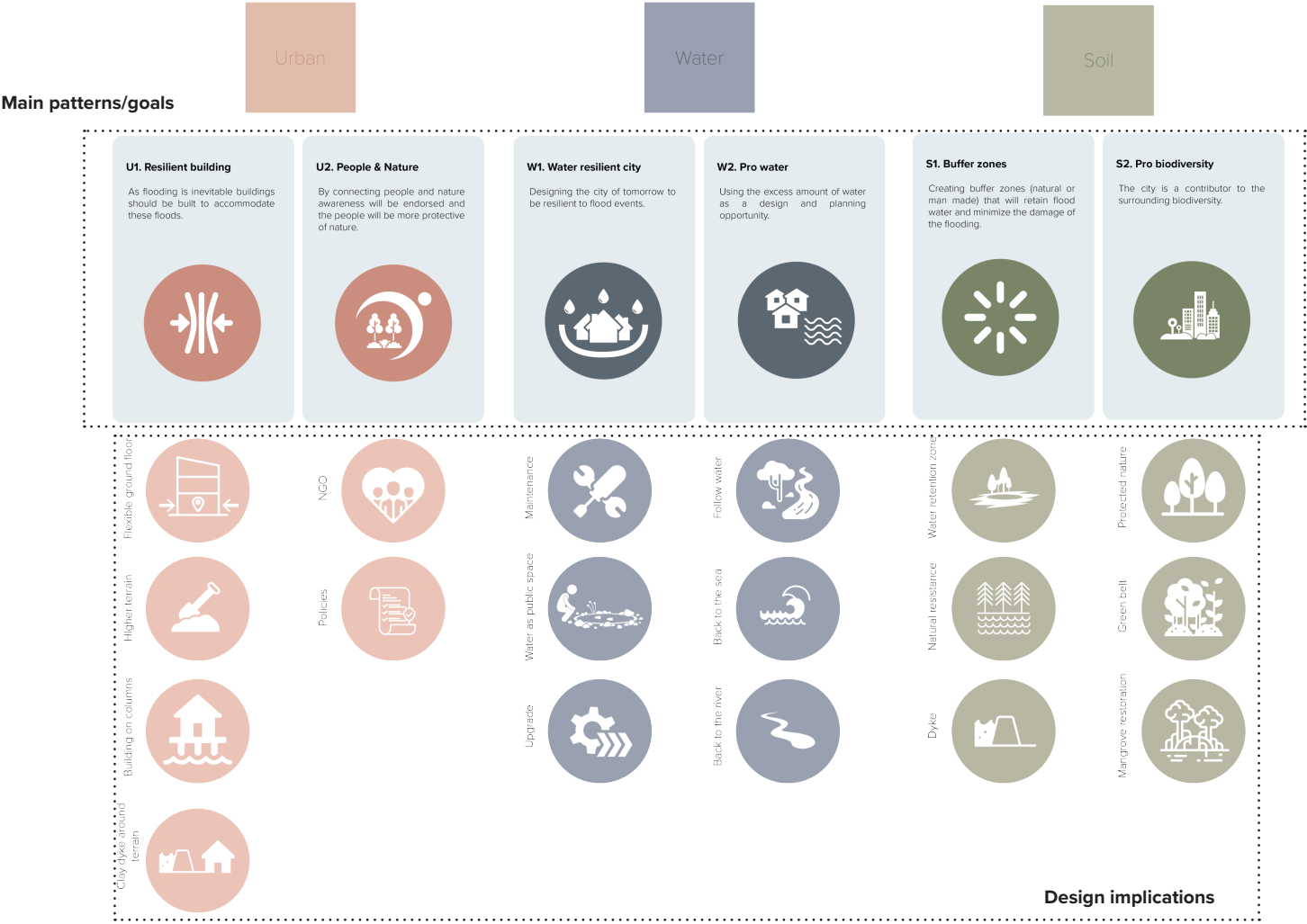
The concept of a “Pattern Language” is explained by Alexander et al. (1977) in “A pattern language: Towns, Buildings, Construction”. In the book, a so-called pattern set is designed to work together and be understandable for all the stakeholders where a town, building or construction should be included should there be a need or want for it.

Patterns are designed so that they can be used and applied indefinitely, with a different spatial outcome every time. The patterns include instructions, with specifications for scale and relation to each other. The relation the patterns have to each other forms intricate pattern webs that form a pattern language.

(Re)introducing co-existence aims to propose a resilient, nature-based proposal which addresses the projected urban expansion, urban- and tidal flooding and coastal erosion challenges on the coast of Paramaribo. With special attention to making the project feasible for the residents to realise themselves. The proposal will mean a systemic change where all relevant stakeholders and more importantly the residents from the beginning of the co-creation process. Therefore the possible design implications/solutions need to be understandable for all.

A pattern language in the form of a pattern deck consisting of pattern cards is designed to address urban expansion, urban- and tidal flooding and coastal erosion in a resilient way by using mostly nature-based solutions. This is the pattern deck.

The pattern deck consists of 24 patterns, divided into 3 main categories urban, water and soil. There are 6 main patterns or categories, and each of these leads to more specific design implications.

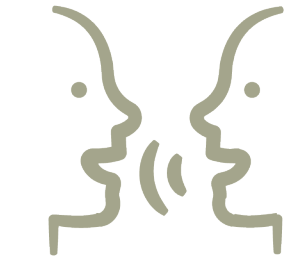


5.3.1 Developing the pattern deck

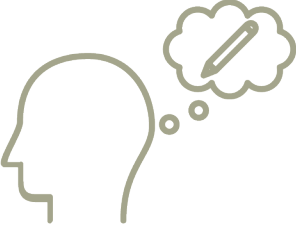
The pattern deck is developed with two main methods, conversations with residents and reference projects. During the site visit conversations were had with residents, during these conversations the residents explained various ways in which they protect their homes and properties from flooding and coastal erosion. It was also explained by the residents that certain solutions were chosen, depending on how the flooding and coastal erosion challenges presented themselves in their locations. In addition to this, the residents expressed what goal they had in mind when they chose a certain design solution for their homes and/or properties.

Furthermore, the residents were asked what they would do to protect their neighbourhoods using nature-based solutions. It was mentioned by the residents that their communities didn't experience flooding and coastal erosion problems when the natural protection along the coast was still intact. Some even took it upon themselves to let nature take its course so that the natural protection grew back on its own. With this in mind, several reference projects were consulted to translate this into patterns. In this way the main pattern deck was developed, and the pattern deck was fine-tuned by testing the deck in several workshops.

An extensive look into the patterns can be found in the "Pattern Deck", in which each pattern is explained in more detail, complete with the reference projects that inspired it. This also includes a more detailed look into the testing of the game with workshops.



Conversations with residents



Translating into design implications



Reference projects

Translating into patterns

5.3.2 Playing the game

Since there was no original pattern catalogue to consult for this study, the designs had to be created from scratch. The reference projects and a field trip for the project for which the patterns were produced brought the designs to life. The patterns were clearly defined by discussions with residents on how they solved the particular issues the project was focusing on.

Since the patterns were created as a means of communication for the locals, the field trip was essential to their creation. The purpose of the project for which the patterns were created is to propose design implications that locals can independently realize. This is another reason why it was crucial to collaborate on the project's design with the local community.

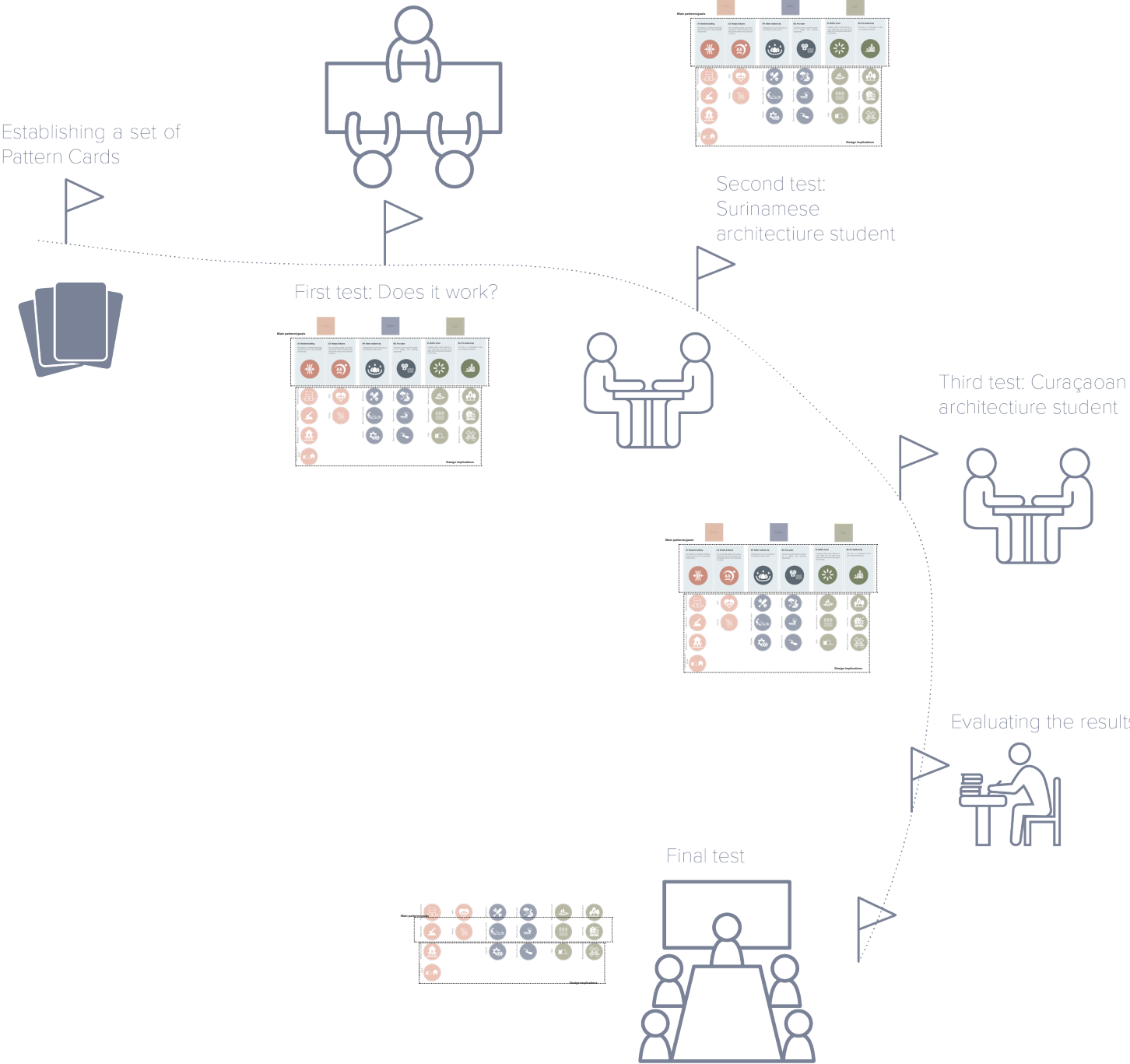
It was crucial to put the patterns to the test in order to determine whether or not they serve as a useful “tool” for the co-creation process because they were created with that goal in mind. Because playing cards are a universal language that everyone understands, the patterns were created to communicate through card games. To improve both the cards themselves and how the “game” should be played, the pattern cards, which make up the pattern deck, were tested on various audiences. Knowing how to play the game was crucial because this is how the residents would actually collaborate on the creation of the pattern deck.

The strategies and designs for the project were then developed while taking the testing results into account. In the project, the test audience took the role of the locals. In this approach, the project could demonstrate how the strategies and designs would have looked if co-creation had taken place.

In Suriname, co-creation with locals using a pattern language is not yet practised. Because of this, it was not

an option to show the residents well-known patterns. It is crucial to explain the patterns to residents in a way that they can understand because the goal of this project is to promote co-creation with them. In this method, the patterns are created for the residents as cards, while the experts can discover the patterns in the booklet the way they are used to. The patterns are supplied in the handbook together with all necessary theoretical and practical information and references, however, they are presented as cards to make them easier for the residents to utilize.

It was now time to test the pattern cards after they had been established. One Dutch citizen and one Surinamese architecture student participated in the first test. During the first two tests of the game and the pattern deck, the players were given both the main pattern goals and the design implications. This resulted in some confusion among the players since it was unclear if a certain goal and design implication can be played at the same time. It was then decided that the players would only be given the design implications when playing the game. The main pattern goals would be used by stakeholders, specialists and professionals when translating the results of the game into spatial strategies and designs. The players' suggestions led to the addition of the policy card and dyke card after the first test had begun. A Surinamese student of architecture took the second test, and a Curaçaoan student of architecture took the third. Following the tests, changes were made to the game's rules in order to get ready for the P3 test on colleagues. A big change is that the pattern deck that is presented to the players only includes the design implications. For the examination of the colleagues, a new objective was added. Which was thinking ahead in time and not only of design solutions now.



5.3.3 Results of the game

General audience

The first round of testing involved a general audience made up of a variety of people, hence the term “general audience”. The players were given a section with two objectives in mind. To make it easy to rapidly and clearly understand the situation at the place, the part was kept short yet straightforward with a SWOT analysis. There was no set time limit for finishing the game during the testing presented to the general public, but the amount of time each participant spent playing was recorded. It is also important to note that the players were handed a deck of cards that included the six primary patterns, or

goal cards.

Results

After every participant in the general audience finished their pattern game, the outcomes were all placed next to one another, evaluated, and compared. The cards that the players returned the most often were selected and placed back into the original general portion that was shown to the players. The largest and most significant lesson from this test was that the outcomes were concentrated on solving the location’s difficulties right away. Additionally, U2.1 NGO was the only card that

was played by each and every player. The six primary patterns or goal cards did cause some confusion, as their potential for being more precise than the rest of the deck has design ramifications.

Mixing of the cards is highly encouraged



Solutions must be mostly nature based



Solutions must be financially feasible for the less fortunate residents



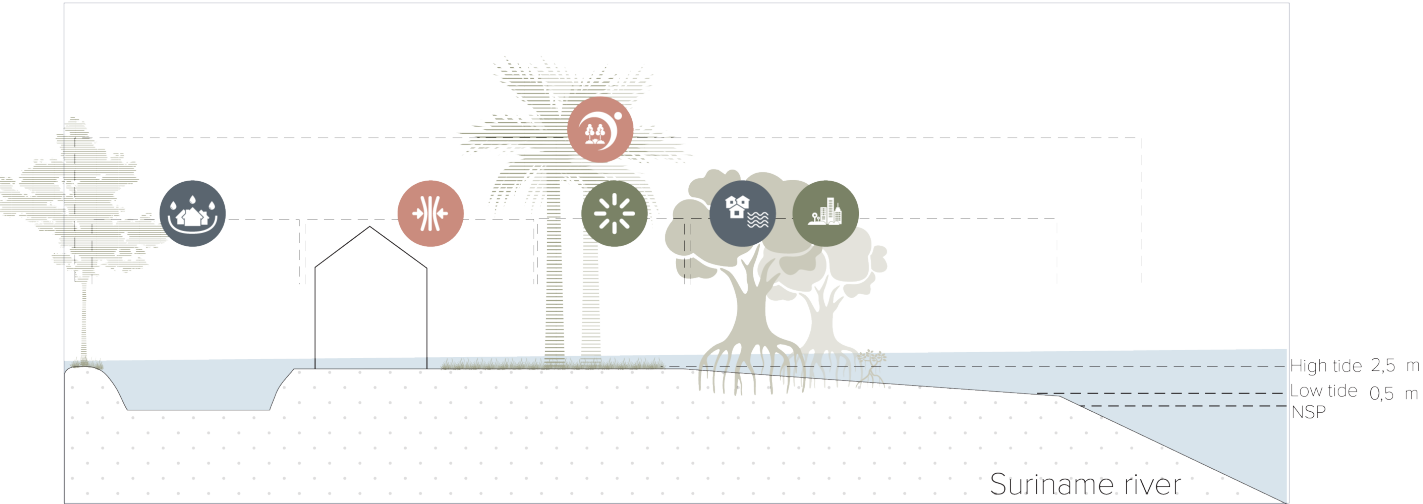
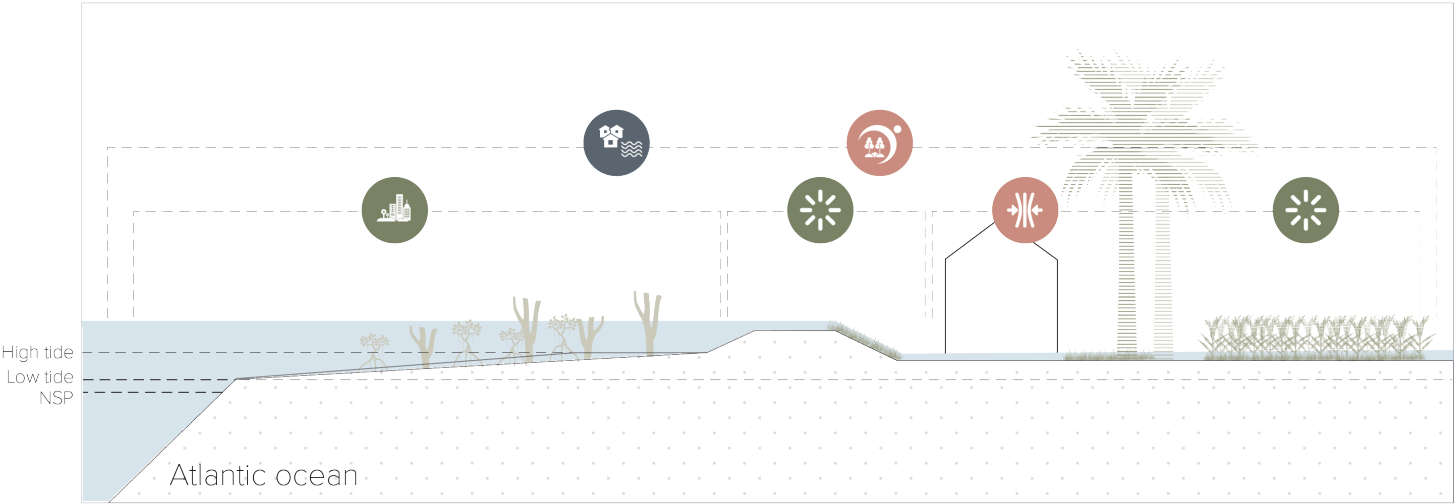
Mixing of the cards is highly encouraged



Solutions must be mostly nature based



Solutions must be financially feasible for the less fortunate residents



P3 test/Colleagues

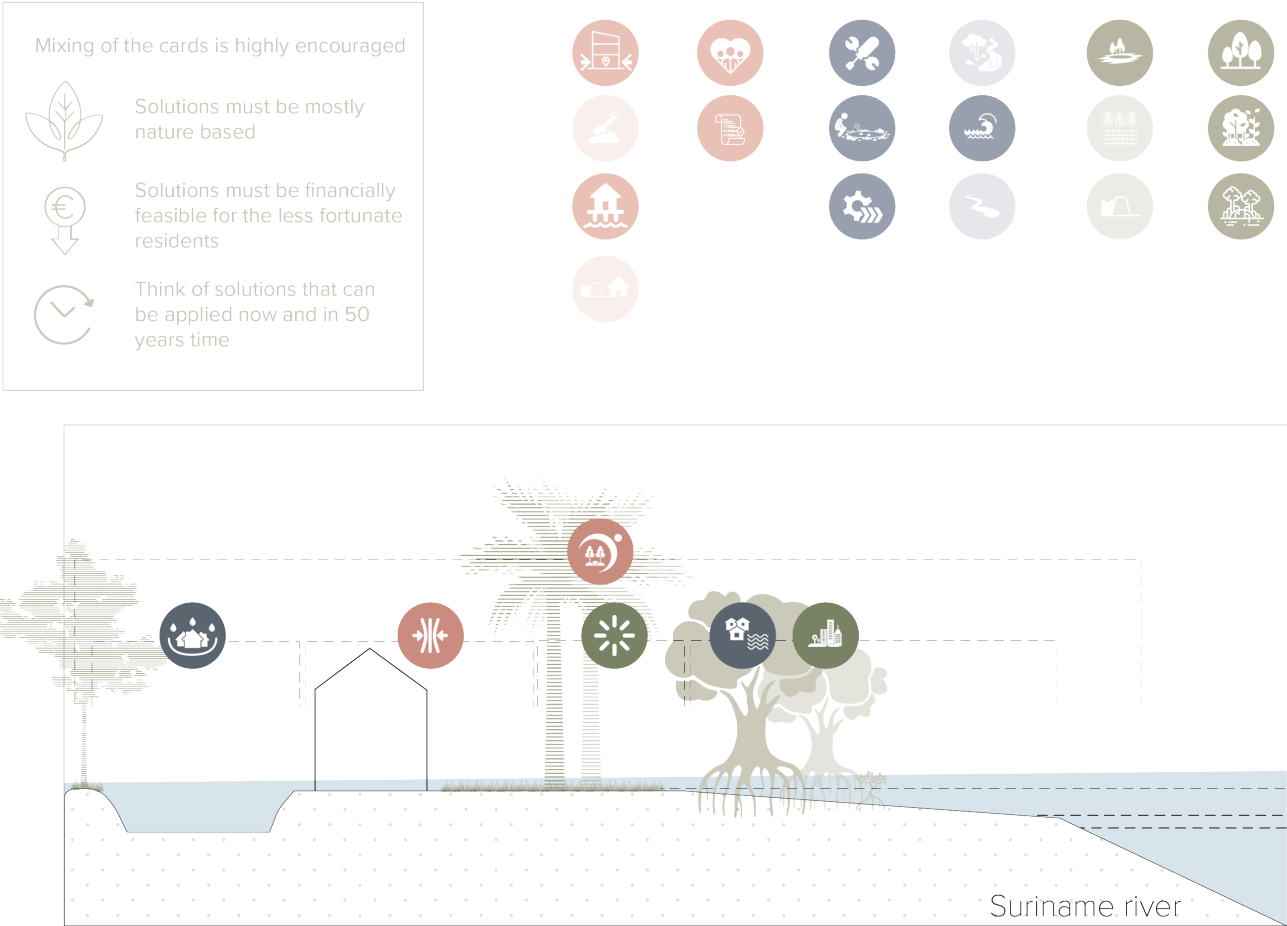
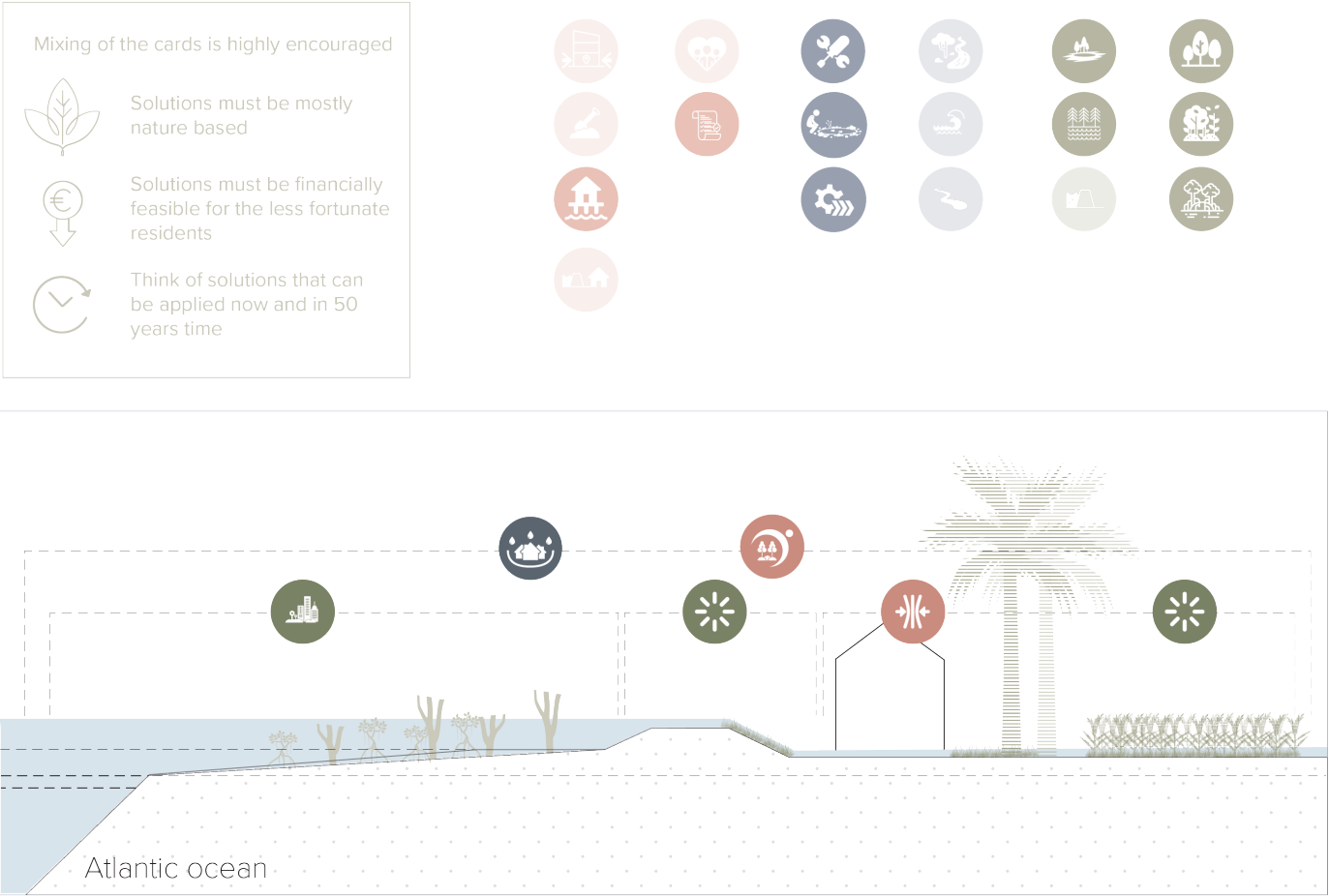
Before presenting the game to colleagues, some improvements were made keeping in mind the feedback from the general audience. Altering the deck is one of them; for this test, only design implications were provided as a pattern deck. Additionally, a specific period of time—exactly 30 minutes—was allotted. The final objective or game rule was to consider design options that could be used both now and in 50 years. The general audience’s responses were concentrated on design solutions for the present; the test for the colleagues was whether the pattern deck could be utilized to consider design

solutions for the future as well.

Results

When playing this game in the future, the results of the testing on colleagues did offer some very useful information. The first is that it takes longer than a half-hour, perhaps even closer to an hour, to play the pattern game in groups. Additionally, particularly when the game is played with a group, it could be necessary to explain each card in advance. When the game was tested on coworkers, the issue was that it was challenging to actually start the game and read the cards. This might possibly be

avoided by reading the cards together before the game begins. Additionally, when playing the game in groups, conversation is expected; therefore, the timeline should be taken into consideration, and additional time should be given.



5.4 Coastal Strategy

In order for the coast of Paramaribo to achieve resilience by way of the urban-water-soil metabolism systemic change is needed. Changes within the urban, water and soil systems, and how they function along the coast. The goal is to achieve resilience along the coast by (re) introducing co-existence amongst the 3 systems.

This future resilient system focuses on 4 main principles namely:

- 1. Boosting biodiversity
- 2. Coastal protection & strengthening
- 3. Flood resilience
- 4. Resilient housing

The design implementations that lead to the proposed strategy along the coast will differ since the challenges within the urban, water and soil systems present themselves differently. As a conclusion to the analysis, three locations were chosen where these challenges differ. (Re)introducing co-existence proposes a strategy to achieve a resilient future urban-water-soil metabolism for each of these three locations. The main principles mentioned above do apply to all the locations since they are the general principles for the entire coast.

The strategies for the three locations are designed using the outcome of the pattern deck. The results of the pattern game played during the testing phase are taken into account when proposing a strategy for the locations. The strategy for each location is thought out in phases of 5 to 10-year increments, clearly indicating the systemic change occurring in the different phases of the process.

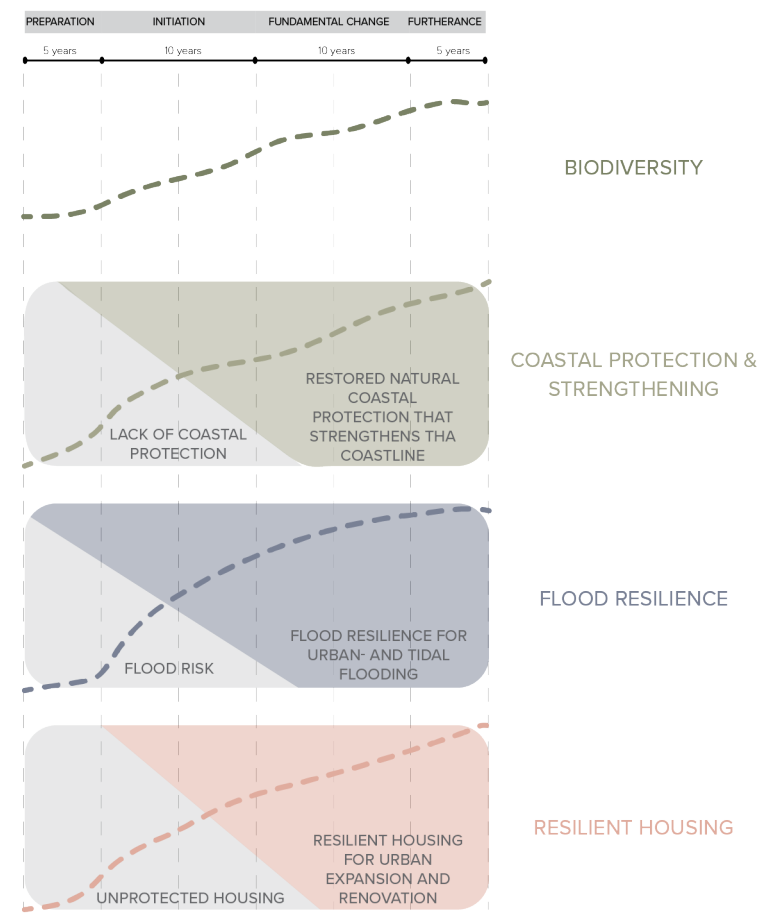
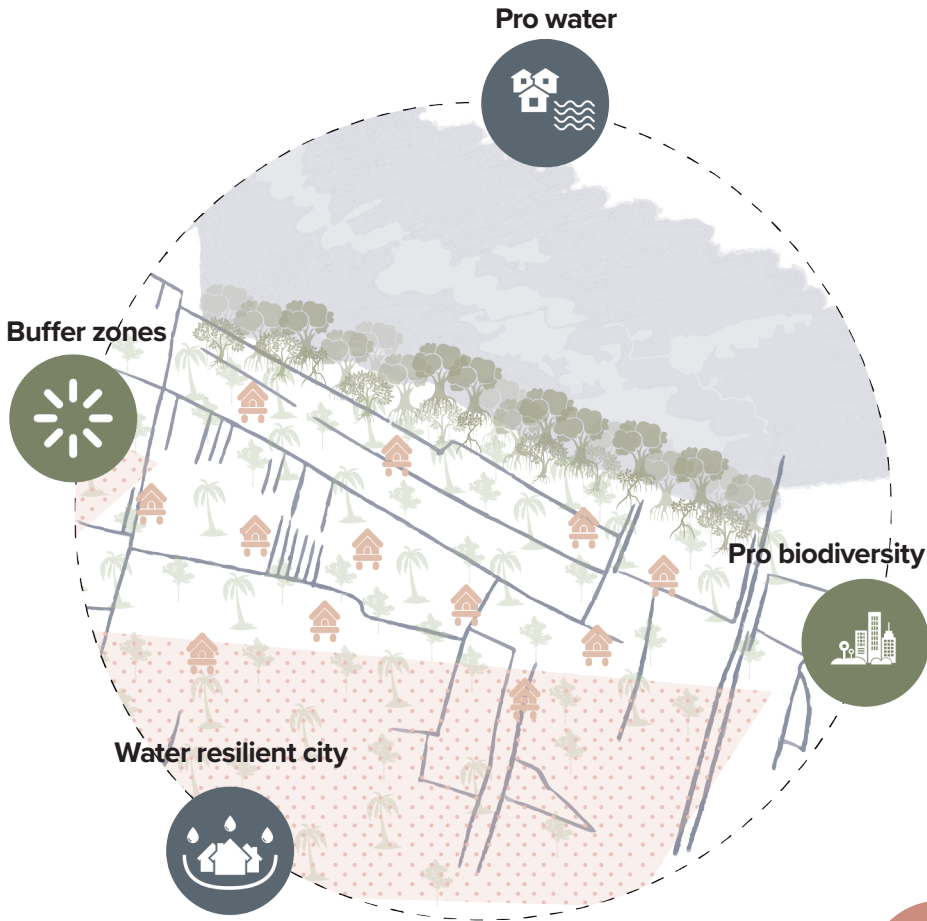


Figure 5.1 Systemic change diagram according to the timeline of the project. The diagram shows the major transitions of the different general principles.



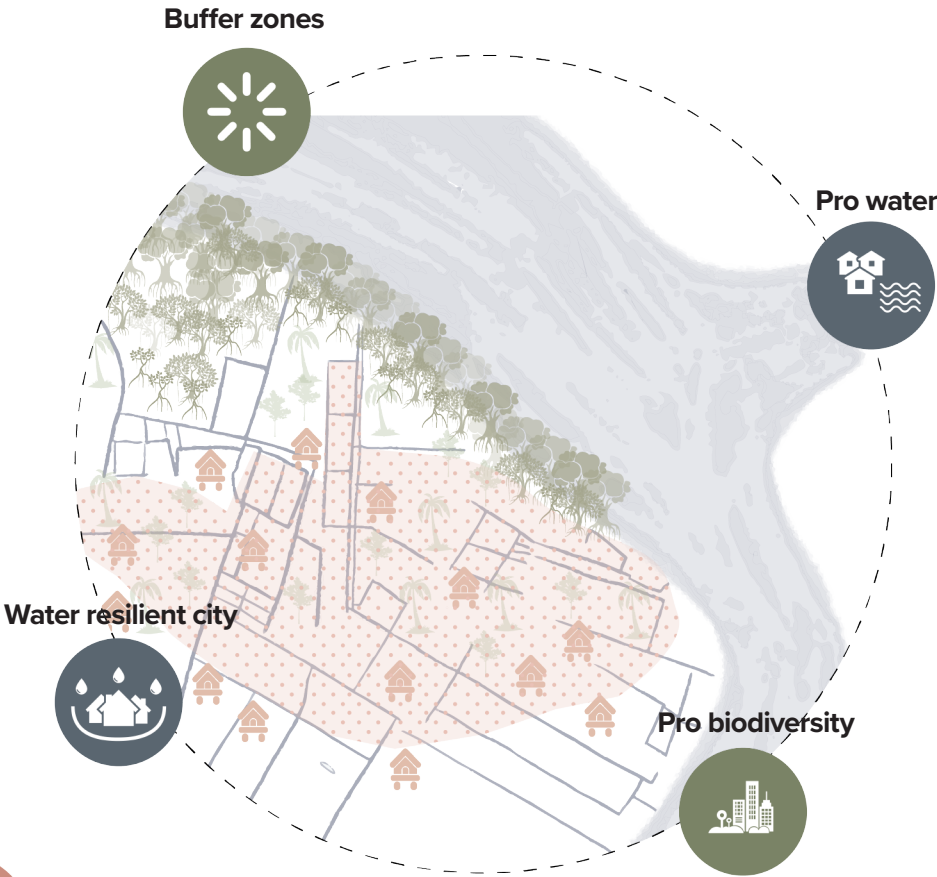
Location 1. Weg naar Zee



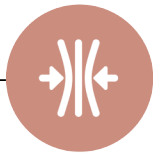
Location 2. Rainville



Location 3. Blauwgrond



People & Nature



Resilient building

5.5 Collaboration

5.5.1 Jepi Streyfeti Sungu

In order to guide and strengthen the participation of the involved stakeholders and residents, a Non-Governmental Organization is proposed - Jepi Streyfeti Sungu (JSS). This organisation embodies a system that facilitates the systemic change proposed by (Re) introducing co-existence. JSS would therefore be an organisation with full-time employees, furthermore, the organisation would unite all the participants (stakeholders and residents) according to 5 main principles.

Knowledge is a field that focuses on gaining, collecting and sharing information that stakeholders and residents can use to achieve resilience on the coast of Paramaribo. This can differ from making a house or terrain resilient to making the city or neighbourhood resilient. An important aspect of this principle is that it should act as a main database for this information and should take a conscious and continuous effort to keep evolving and adding to this database.

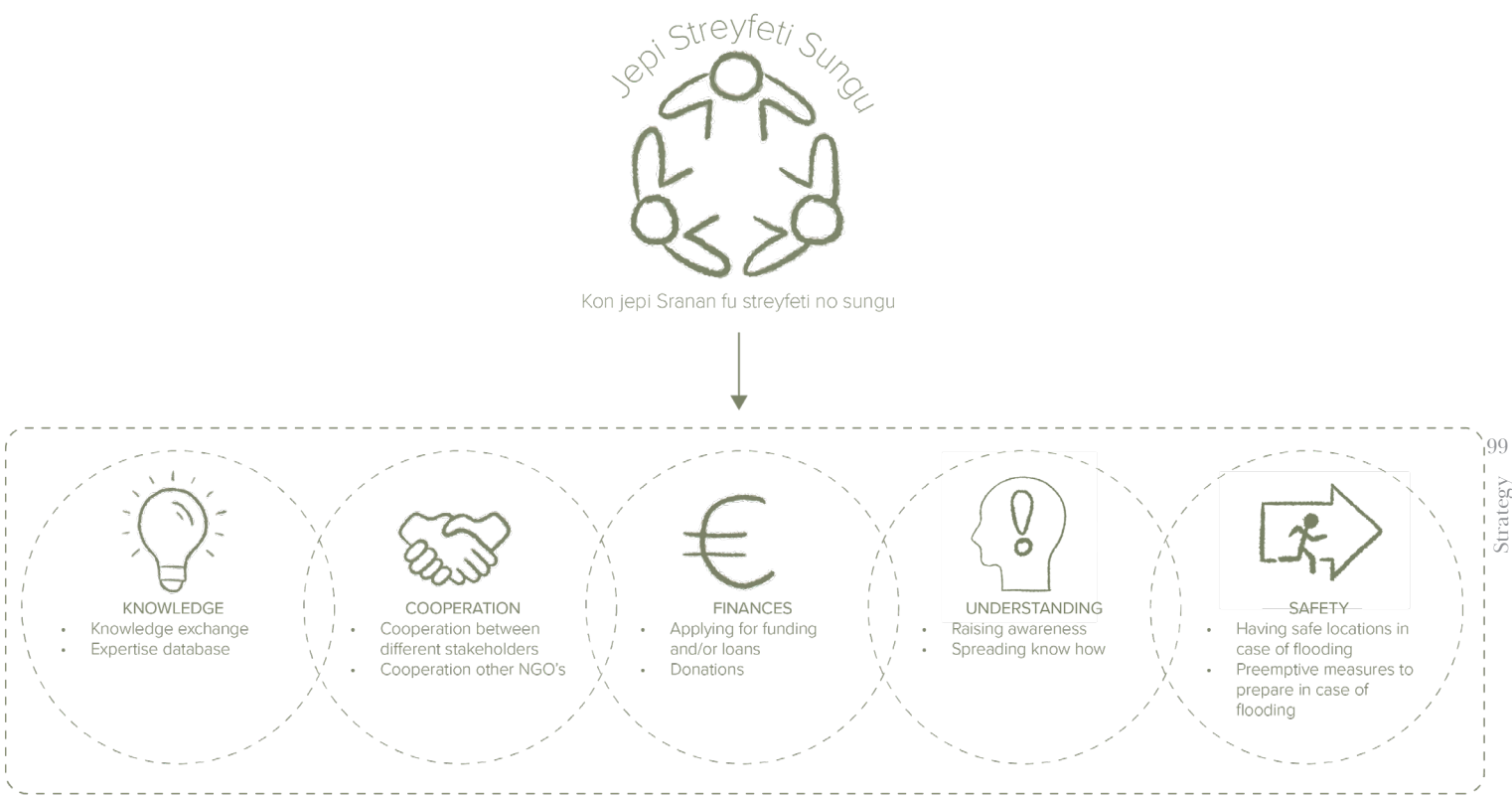
Cooperation between not only the different principles within JSS but also with external organisations. Forming a network with different stakeholders, communities and even different NGOs who have common interests. This way the different actors can help each other and more importantly learn from each other. Cooperation is a fundamental principle JSS is based on to really form a system that will endorse the systemic change proposed by (re)introducing co-existence.

Finance management would allow stakeholders and residents to apply for loans or funds. Being able to apply for loans or funds will give the residents the opportunity to still be able to achieve resilience on their terrain or house should they not have the financial means to do so themselves. Moreover, the opportunity for donations and funding from outside sources can give the opportunity

to fund research and innovation which is quite important to keep developing more methods to achieve resilience.

Understanding the current situation of the coast of Paramaribo. Raising awareness of the challenges and how the citizens and stakeholders can help. JSS is not only focused on gaining the know-how but also spreading the know-how. Sharing the information so that an understanding will develop amongst the stakeholders and residents. Also, spreading this understanding further than the coast, but to the entire city, country and beyond.

Safety is of great importance, for especially the citizens. In the event of flooding people should have a safe place to go to, a safe dry place. There should be measures set in place in the event of a flooding disaster. Should people be in need of aid there should be a system set in place for this.



5.5.2 Format of Jepi Streyfeti Sungu

The organisation, Jepi Streyfeti Sungu is composed of 5 main pillars (Kania & Kramer, 2011), these pillars all work together and form the system ended for the system change proposed by (Re)introducing co-existence.

The 5 main pillars are:

1. Coordinator

The coordinator is the main head of the organisation. This person or people oversees all the other pillars and ensures that everything runs smoothly.

2. Program

The organisation runs on a program, this program consists of goals that JSS aims to achieve in a certain timeline. The goals differ from research, getting funding, raising awareness etc. The program section of JSS ensures that the other sections remain on track with their development. They organise the entire organisation.

3. Communication

The communication section of JSS ensures continuous open communication with not only the other pillars but also with outside actors. They will actively scout new organisations to connect with. This pillar is very active in keeping the network with stakeholders and residents intact and expanding this.

4. Activities

JSS is involved in many different activities varying from designing new ways to achieve resilience for the coast, researching, awareness activities etc. Co-creation with residents occurs in this pillar.

5. Data sharing

The main goal of JSS is to share knowledge or data with stakeholders, residents and even outside actors.

JSS is the enabler of the pattern deck, the pattern deck is managed, used and even expanded by JSS. The patterns are used during the co-creation process with residents and stakeholders. Moreover, the pattern cards are used when raising awareness for the different challenges the coast of Paramaribo is coping with. Furthermore, the pattern deck is expanded by doing research and designing more ways to achieve resilience on the coast.



5.6 Strategy plan location 1. Weg naar Zee

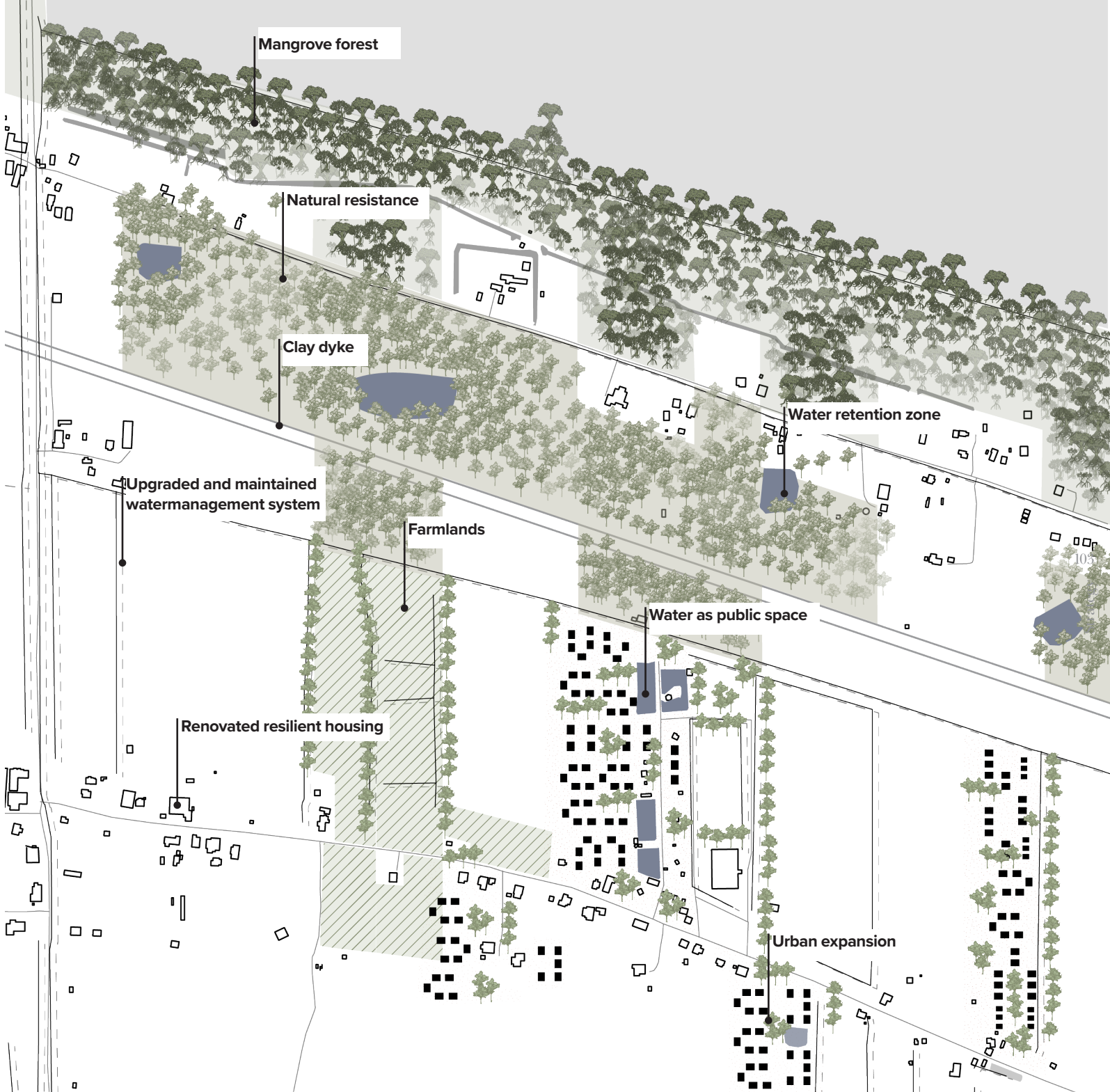
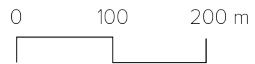
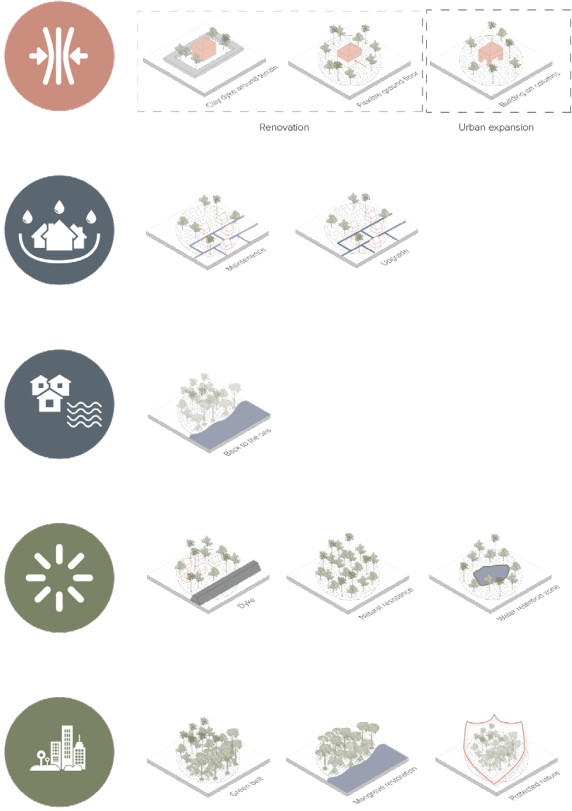
5.6.1 Protective green belt

This strategy focuses on addressing coastal erosion, tidal flooding and urban flooding in a low-lying area. For this location 1. Weg naar Zee is chosen. The main goal is to strengthen and protect the coastline and achieve flood resilience. The existing housing in the location must be made resilient and the right place for urban expansion is singled out.

For each strategy, the JSS is included to provide whatever the stakeholders and residents should need from funding to co-creation to achieve resilience, to raising awareness. The organisation is the main system for the proposed systemic change.

The strategy is based on several patterns. Starting with the urban patterns the existing housing can be made resilient with either a clay dyke around the terrain or to make the ground floor flexible so that it can be flooded. For urban expansion building on columns is proposed, in the newly expanded area the focus will not only be on creating new living opportunities for residents but also on creating new working environments. The water management of the area must be maintained regularly and upgraded. Moreover, as this location is right at the sea, the room must be given back to the sea so that nature can run its course. The natural system along the coast was disrupted when mangroves were removed in preparation for urban expansion, which lead to coastal erosion in this location. But some residents in this area bordering the sea have opted to give back some of their property to the sea and nature and to let nature run its course. This resulted in the natural restoration of mangroves on their properties. This is suggested along the coastline for this location. In addition to this, the mangrove restoration which is already in progress on this location is continued to further strengthen and protect the coastline and slow down or even prevent coastal

erosion. But mangroves do not stop the flood water from going inland, they do dampen it but do not prevent it. For this a green belt is established, the green belt consists of several patterns, mangrove restoration, natural resistance, and water retention zones. As this location is in need of multiple layers of protection against both flooding and coastal erosion it is proposed that urban expansion only takes place behind the clay dyke. The area in front of the clay dyke to the sea is made into a protective buffer zone. In addition to this, a clay dyke is proposed which is an added layer of protection. Layering these patterns will offer the layered protection that this location needs to achieve resilience against coastal erosion and flooding.



5.6.2 Timeline

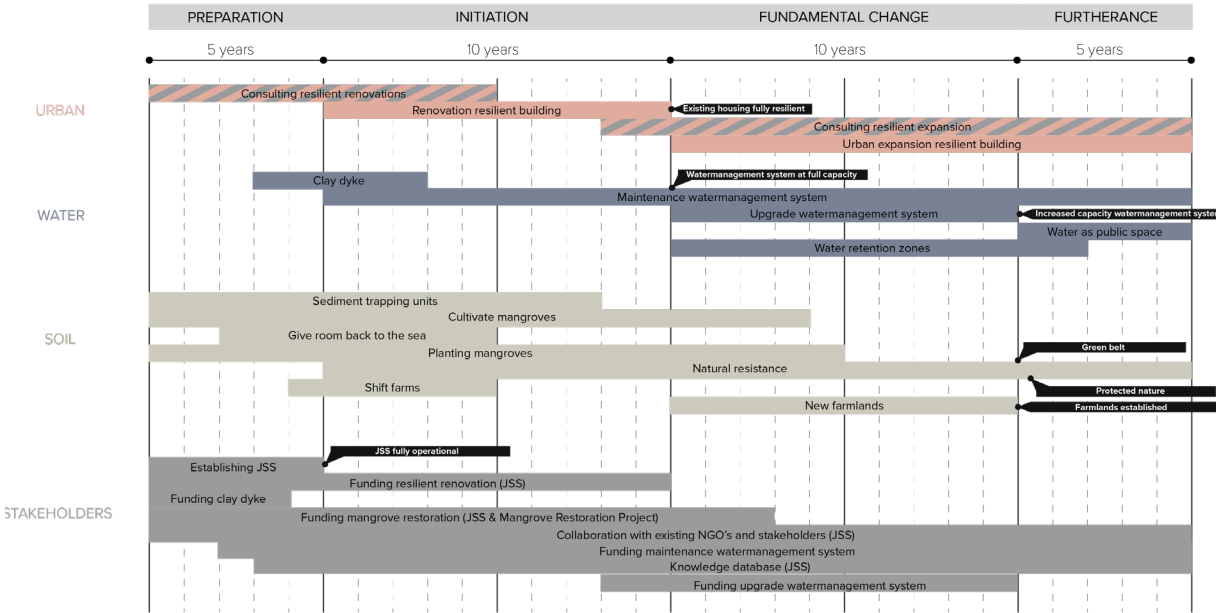
In the first phase mangrove restoration will commence, mangroves will be cultivated to be planted when they are old enough. Sediment trapping units will be made to prepare the soil for mangrove restoration. The construction of the clay dyke will start, and the room will be given back to the sea so that nature can take its course. JSS will be established and consulting will begin with stakeholders and residents to make homes resilient.

In the second phase renovating homes to be made resilient will commence, the regular maintenance of the water management system will occur, mangroves will be planted in the prepared soil along the coast and the farmlands bordering the sea will be relocated more land inwards. The natural resistance will start by planting

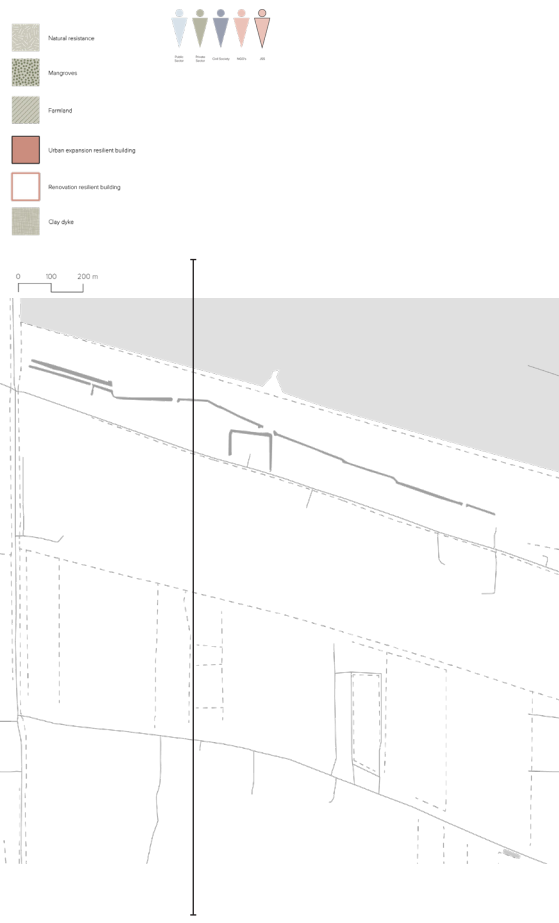
different fauna.

The third phase brings urban expansion with it behind the green belt. The green belt will be established, the water management system will be upgraded and water retention zones will be made in the natural resistance zone. New farmlands are established more land is inwards.

The final phase will introduce water as a public space in the urban expansion, protecting the green belt and further urban expansion.



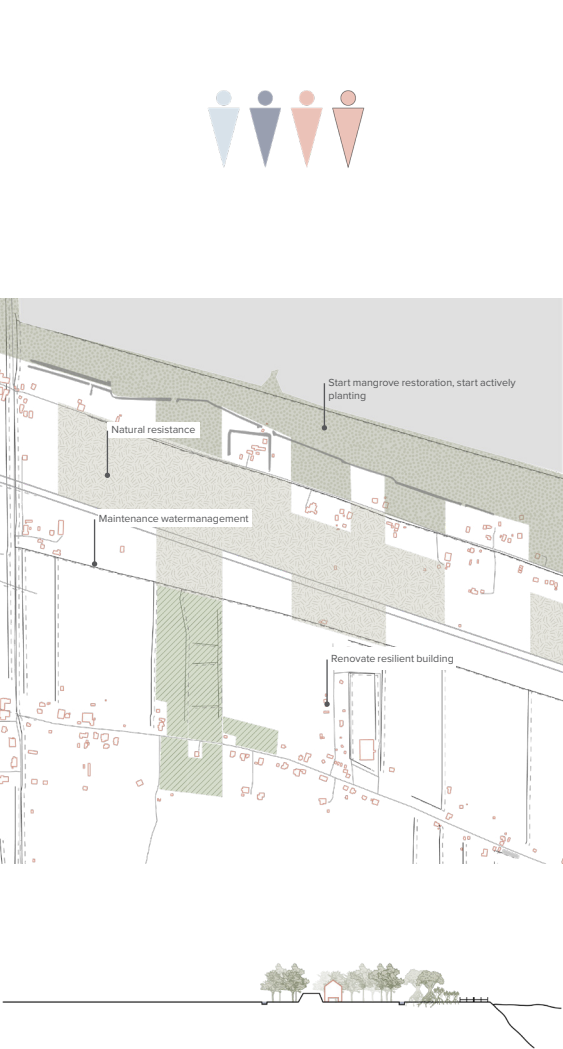
Current Situation



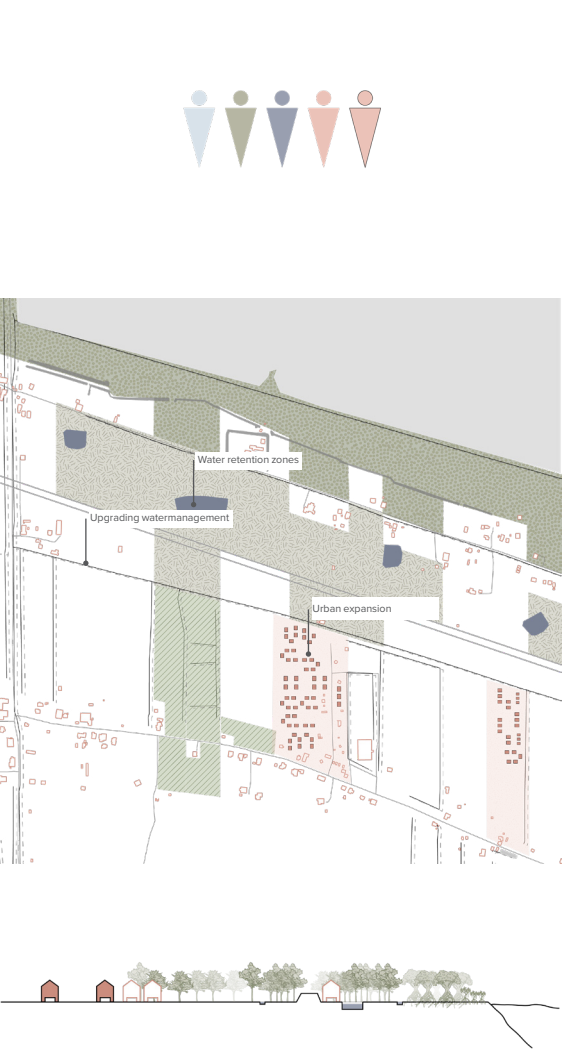
Preparation



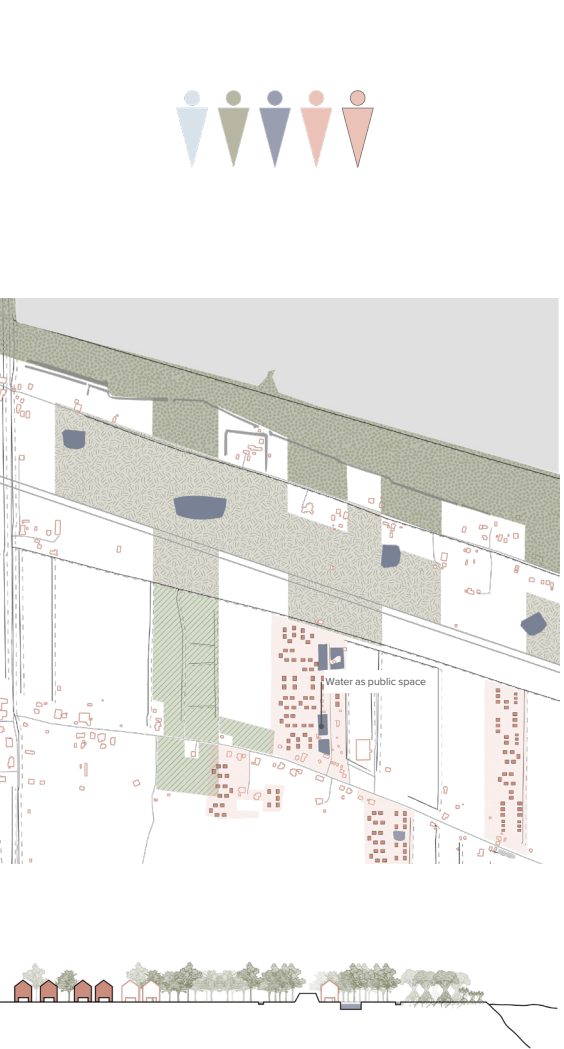
Initiation



Fundamental change



Furtherance

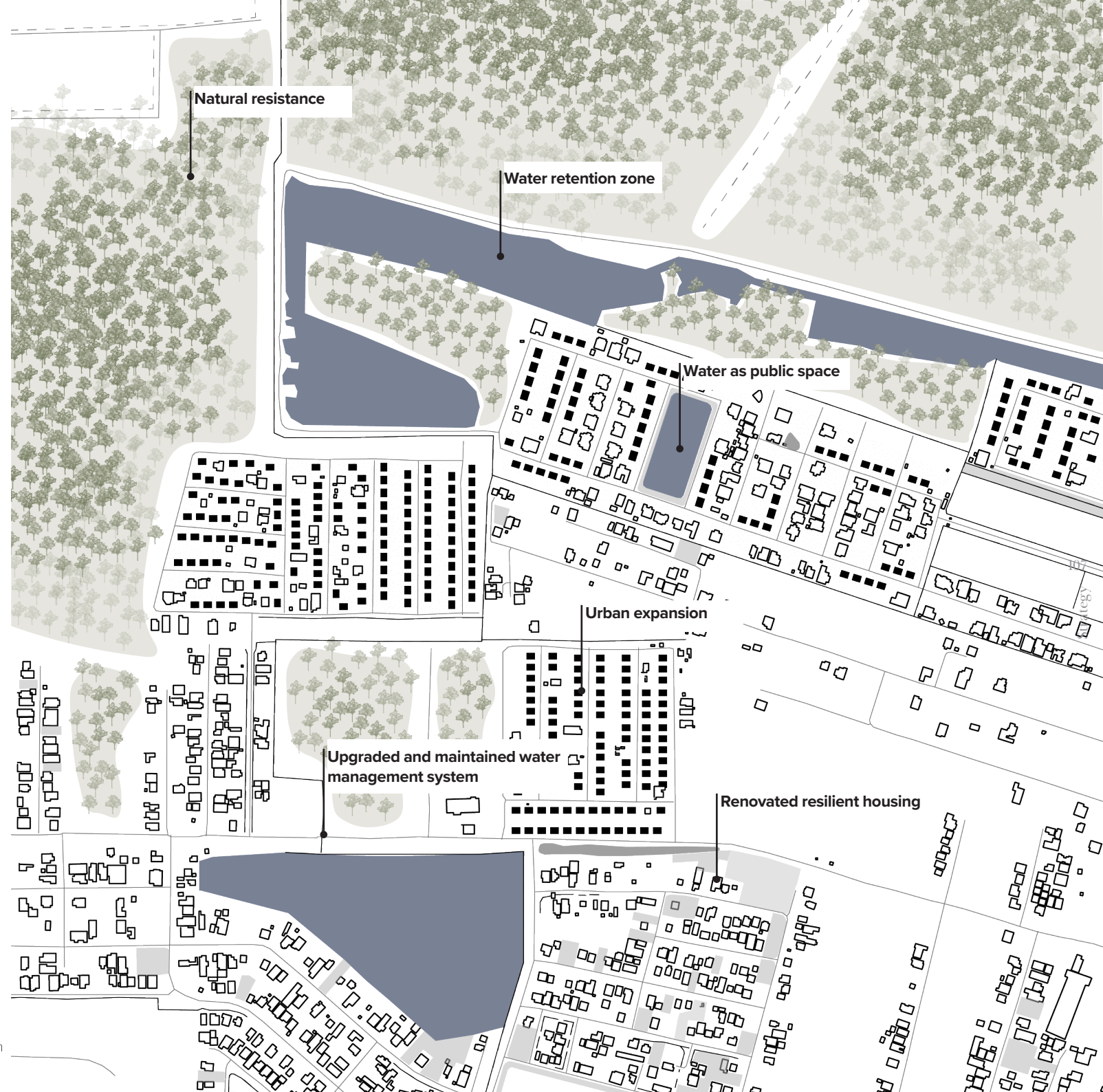
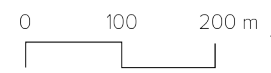
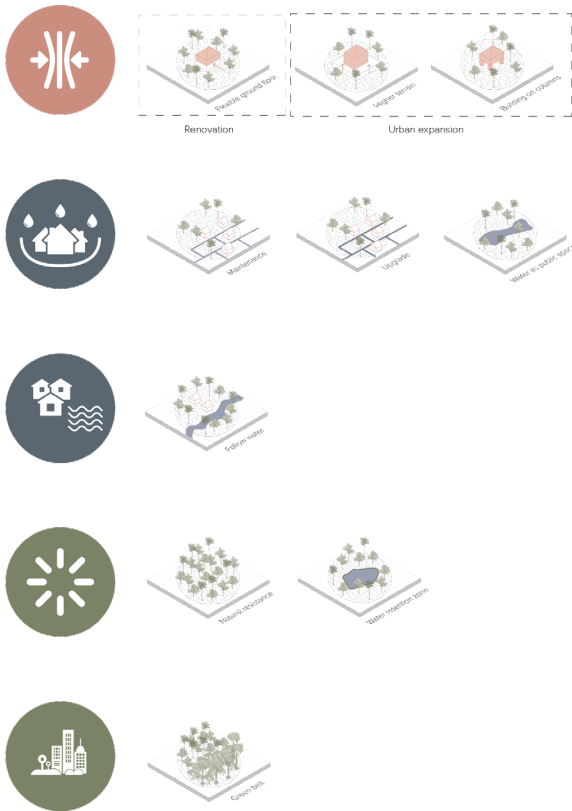


5.7 Strategy plan location 2. Rainville

5.7.1 Maximising urban expansion

This strategy focuses on urban expansion and flood resilience and expanding neighbourhoods. For this strategy location 2. Rainville is chosen, this location does lie on the coast of Paramaribo but lies a bit more land inwards.

The patterns used to design this strategy include a flexible ground floor for renovation and higher terrain and building on columns for urban expansion with the expansion being a mix of working and living. The water management system is maintained and upgraded and bodies of water are transformed into public spaces. The natural bodies of water are followed when determining the urban expansion zones. In the areas surrounding the built environment of this location untouched nature presides, this nature is turned to natural resistance, where additional fauna is planted to protect from flooding. Water retention zones are added to store access to flood water. The combination of natural resistance and water retention zones form the green belt for this area. The green belt surrounds the built areas as a form of protection against tidal flooding coming from the sea and urban flooding from surrounding neighbourhoods.



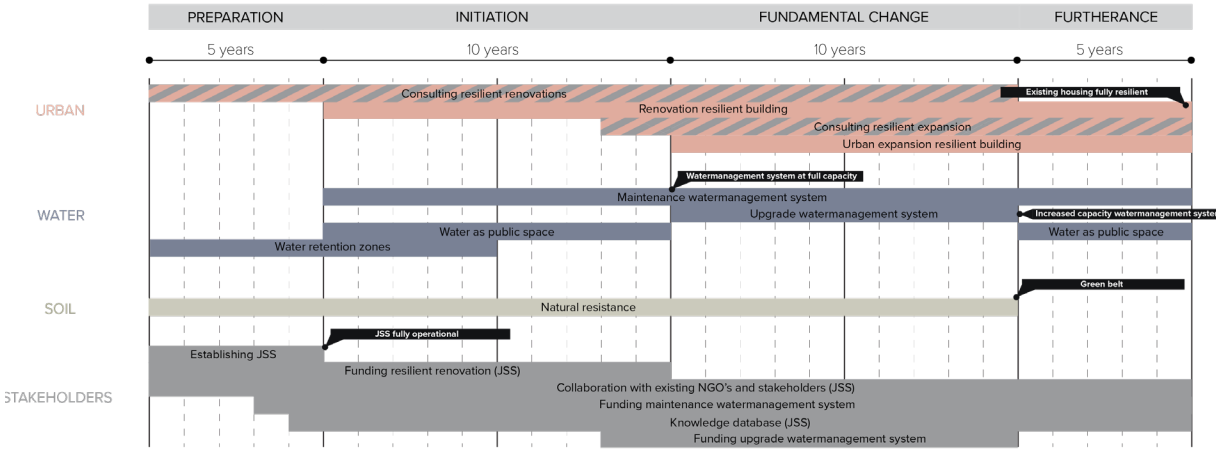
5.7.2 Timeline

In the first phase, the JSS is established and consultations with residents concerning renovating their properties start for this location, water retention zones are set to store access to flood water as well as the natural resistance.

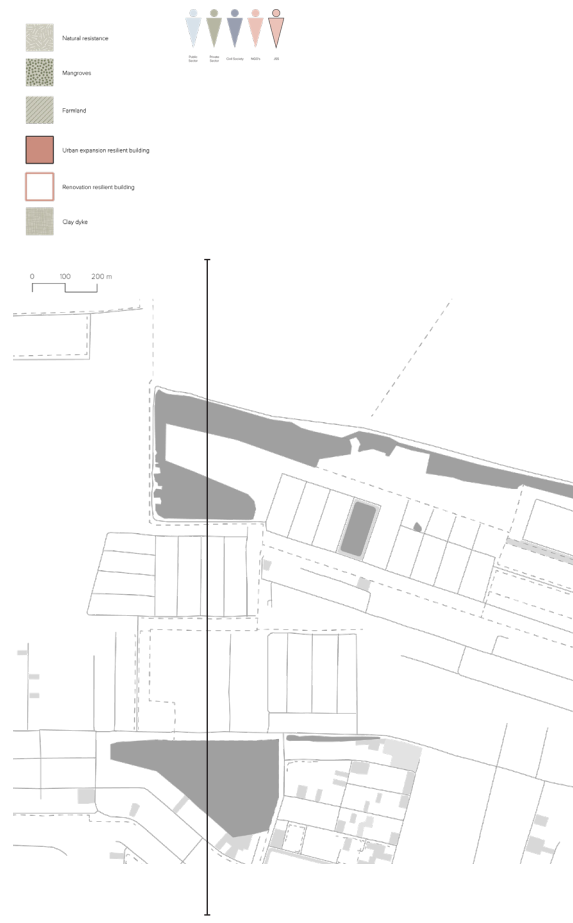
The second phase starts with the introduction of regular maintenance of the water management system as well as the renovation of properties and houses. Waterbodies in the location are made public spaces and consultation for urban expansion starts.

The third phase marks the start of urban expansion and the upgrading of the water management system. The green belt is established and functioning at high capacity. The renovation of housing is still underway.

The final phase marks new waterbodies being made into public spaces and the continuation of renovation and urban expansion.



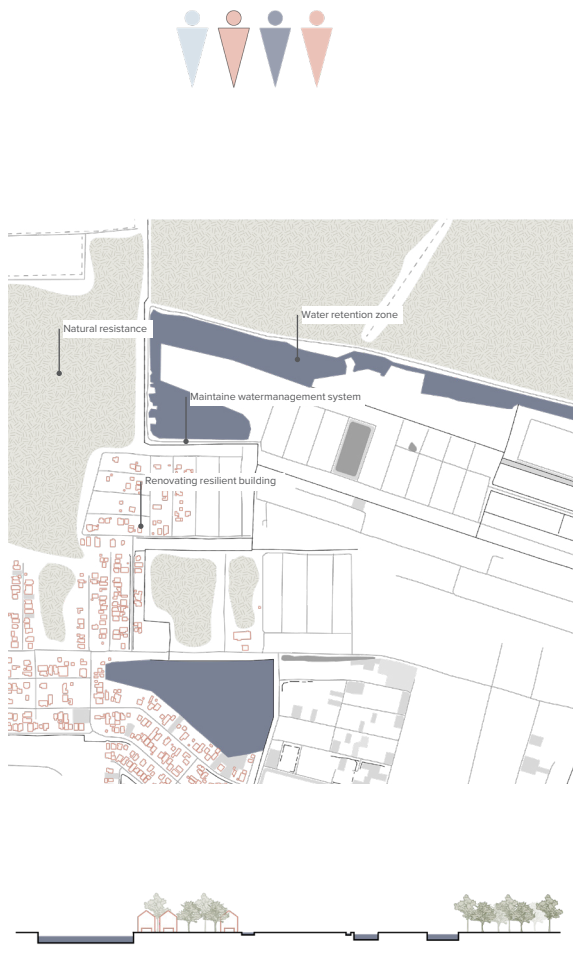
Current Situation



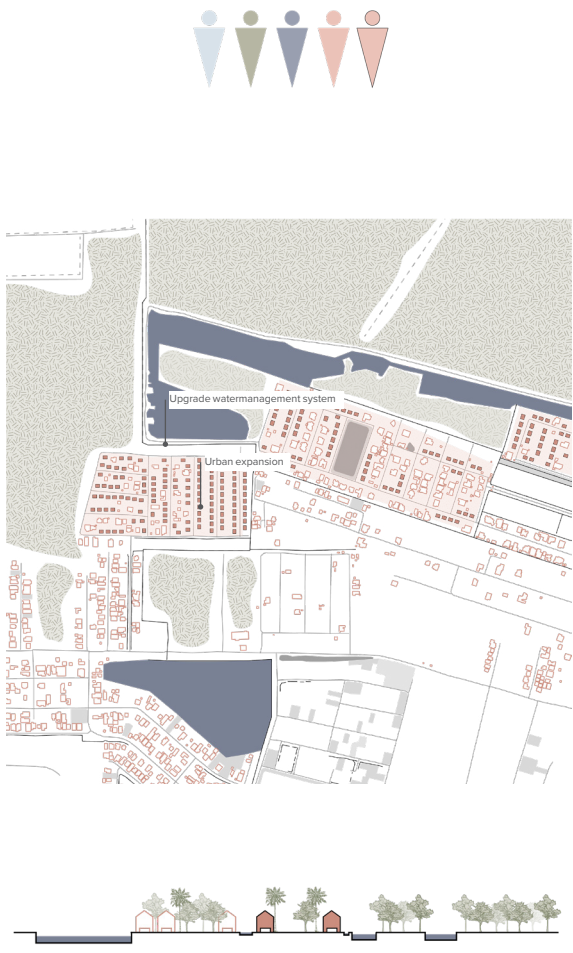
Preparation



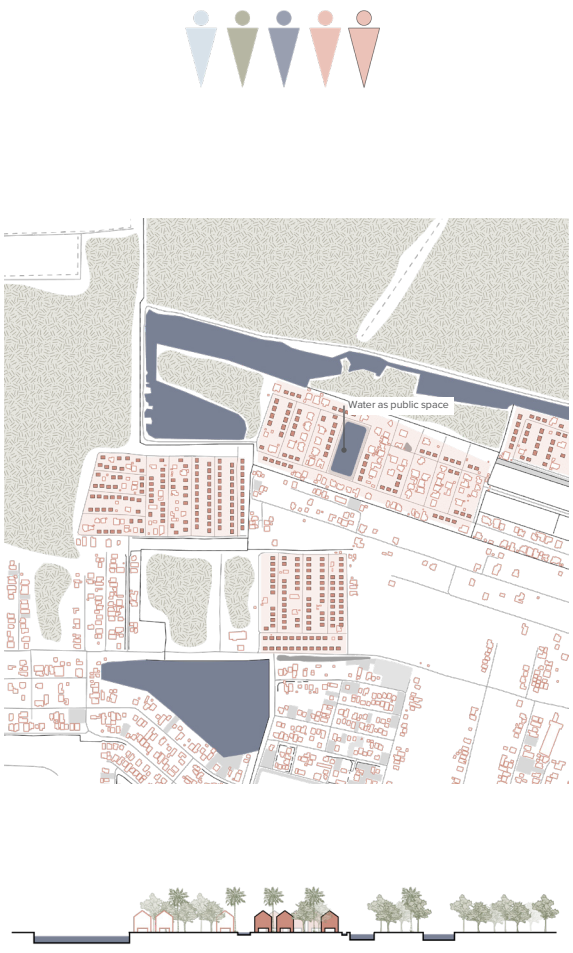
Initiation



Fundamental change



Furtherance

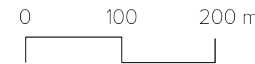
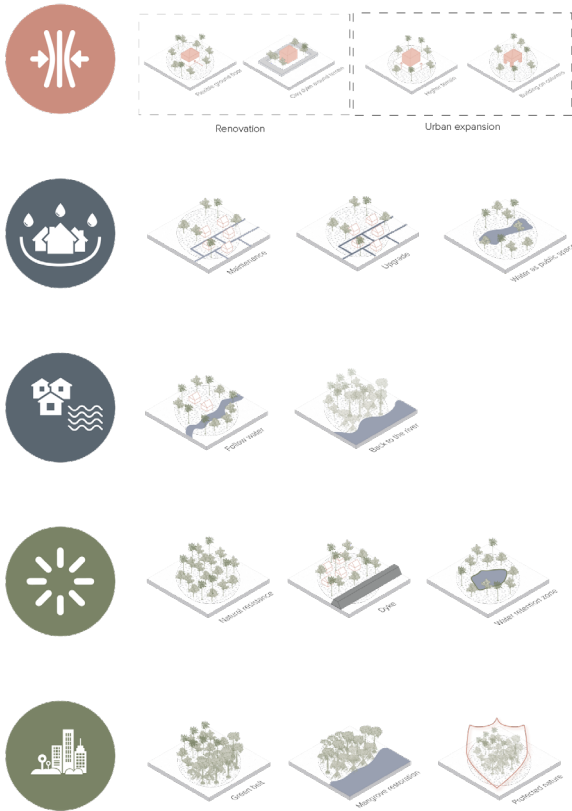


5.8 Strategy plan location 3. Blauwgrond

5.8.1 River and land in balance

This strategy focuses on tidal flooding coming from a river instead of the sea, in an area where major urban expansion is expected. The location chosen for this strategy is location 3. Blauwgrond, this location has an urban expansion, tidal flooding and urban flooding as challenges, and deteriorating mangroves along the river. In some areas, the mangroves are completely gone and in some they are scarce. In addition to this, the land here lies quite low.

The patterns used to design this strategy are flexible ground floor and dykes around the terrain for renovation properties and higher terrain as well as building on columns for urban expansion. The urban expansion will be a mix of living and working. The area has to do with urban flooding, so the water management system is maintained and upgraded to increase capacity. Water as a public space is introduced to not only create a certain environment in the area but also as a means to raise awareness amongst the residents. The natural form of the river is followed and room is given back for mangrove restoration. Surrounding natural areas has turned into natural resistance as an added layer of protection. A clay dyke is proposed as a way to keep the tidal flooding coming from the river at bay. The mangrove restoration, natural resistance and water retention zones form the green belt for this location. The green belt becomes protected to ensure that it keeps intact and is not taken down.



5.8.2 Timeline

The first phase of this strategy starts with the consultation process of making properties resilient. The mangrove restoration process starts by cultivating the plants and giving the river room. Water retention zones are established to store access water and the construction of the clay dyke starts.

In phase two the renovation process begins all the while the consultation process starts for urban expansion. Mangrove restoration is in full swing with planting and cultivating mangroves, the natural resistance areas are chosen and additional fauna is planted to strengthen

these areas for flood protection. The watermanagement system starts its regular maintenance.

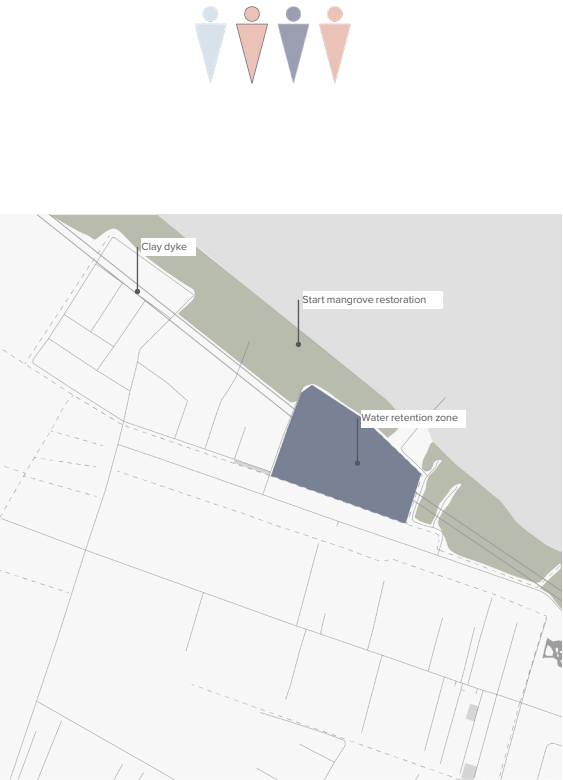
The third phase marks the start of urban expansion as well as establishing new farmlands more land inwards, and water bodies transformed into public spaces. Furthermore, establishing the green belt and the protection of it.

In the final phase, the urban expansion as well as making waterbodies into public spaces continues.

Current Situation



Preparation



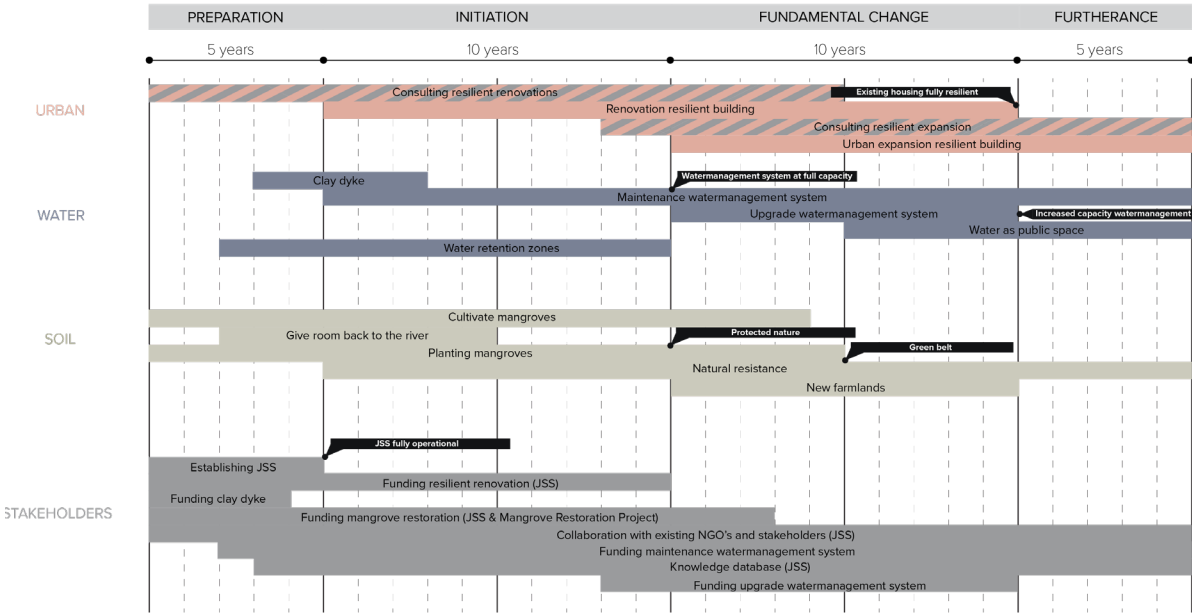
Initiation



Fundamental change



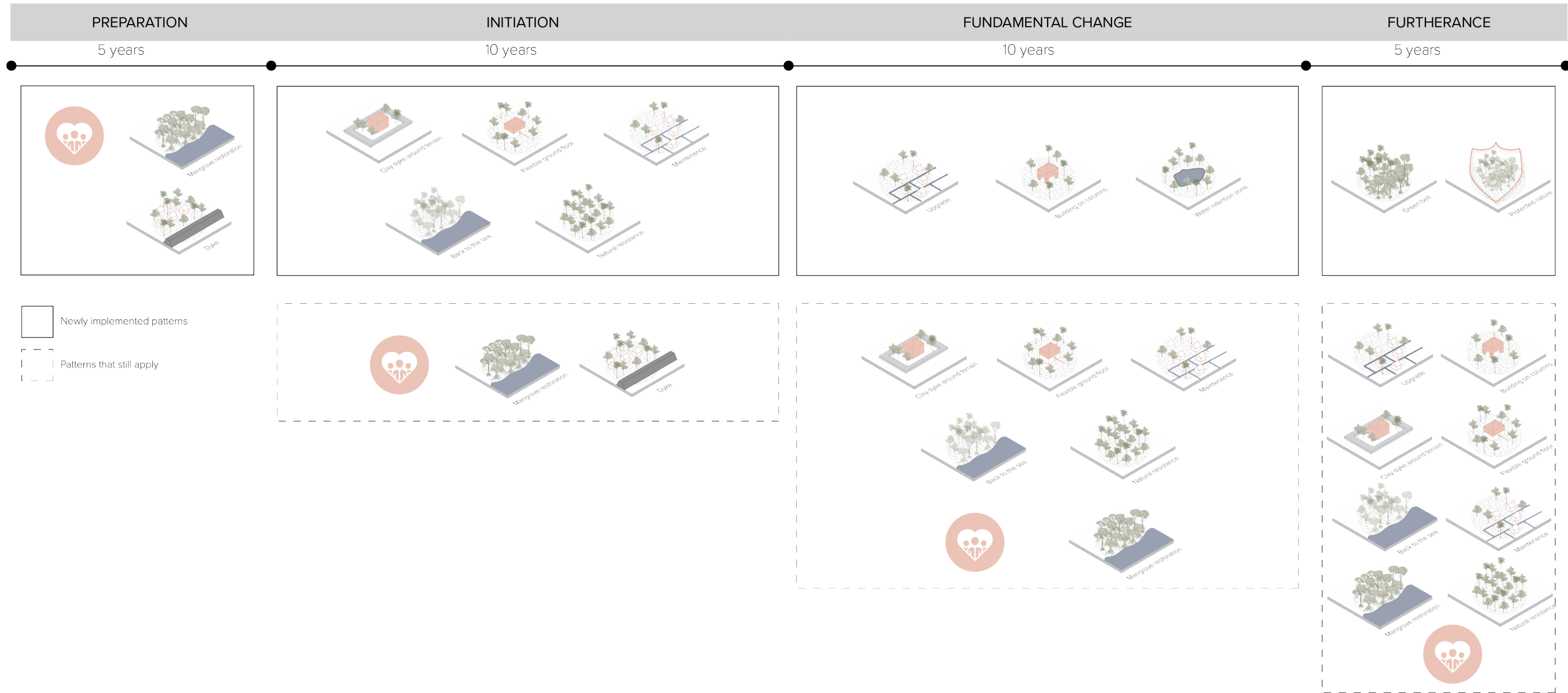
Furtherance



The possible pattern sequences are shown, which are a result of the pattern deck and the strategy. Location 1 Weg naar Zee is explained more thoroughly.

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6.1 Pattern sequence location 1. Weg naar Zee

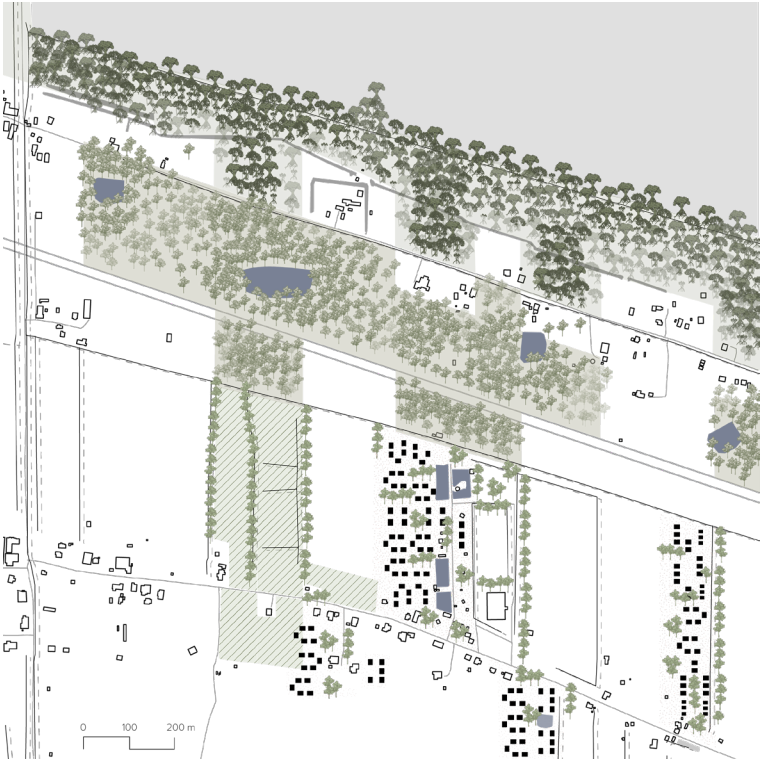


6.1.1 Concept of the design

The design for the location Weg naar Zee is approached by making a buffer zone along the sea; this buffer zone will act as protection from both the coastal erosion and tidal flooding of this area. Therefore, the buffer zone consists of 2 important components, mangrove restoration and natural resistance. This buffer zone is made out of 2 layers of nature-based solutions forming a green belt.



Figure 6.1 Bordeaux Parc Aux Angéliques by Michel Desvigne Paysagiste (BORDEAUX Parc aux Angéliques I MDP, 2012)



The form of the green belt is inspired by “Bordeaux Parc Aux Angéliques” by Michel Desvigne Paysagiste (BORDEAUX Parc aux Angéliques I MDP, 2012). The concept behind this project is forming a grid, made out of horizontal and vertical lines. These lines are determined by following the lines formed by the roads and waterways. The grid was then used to disperse the several functions included in the project. The formed grid gives a certain order to the design.

The same approach was taken for (re)introducing co-existence, a grid was formed following the roads and waterways of the area. With the grid established several functions were organised within this grid, the dispersing of the functioning also followed the current functionality of the area. With the functions of the area organised within the grid, the shape of the green belt and the urban expansion take form. As the green belt acts as a protective buffer zone it is opted to have urban expansion behind it. Moreover, the green belt includes a clay dyke, this clay dyke also follows the established grid.

The next step was to determine the density of the vegetation in the green belt, this was done by varying the density of different boxes of the grid.

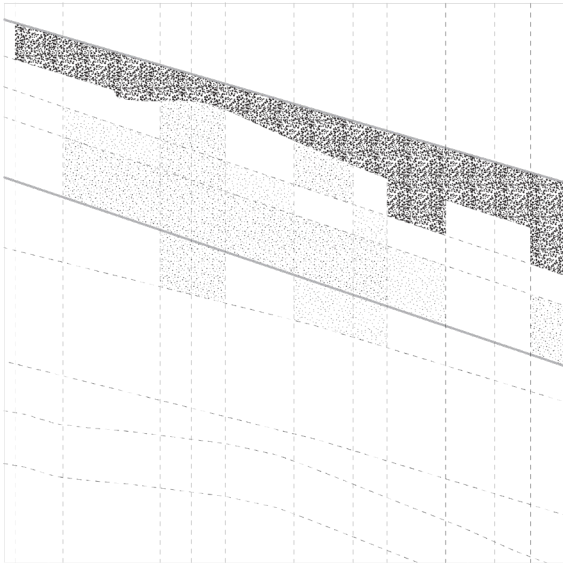
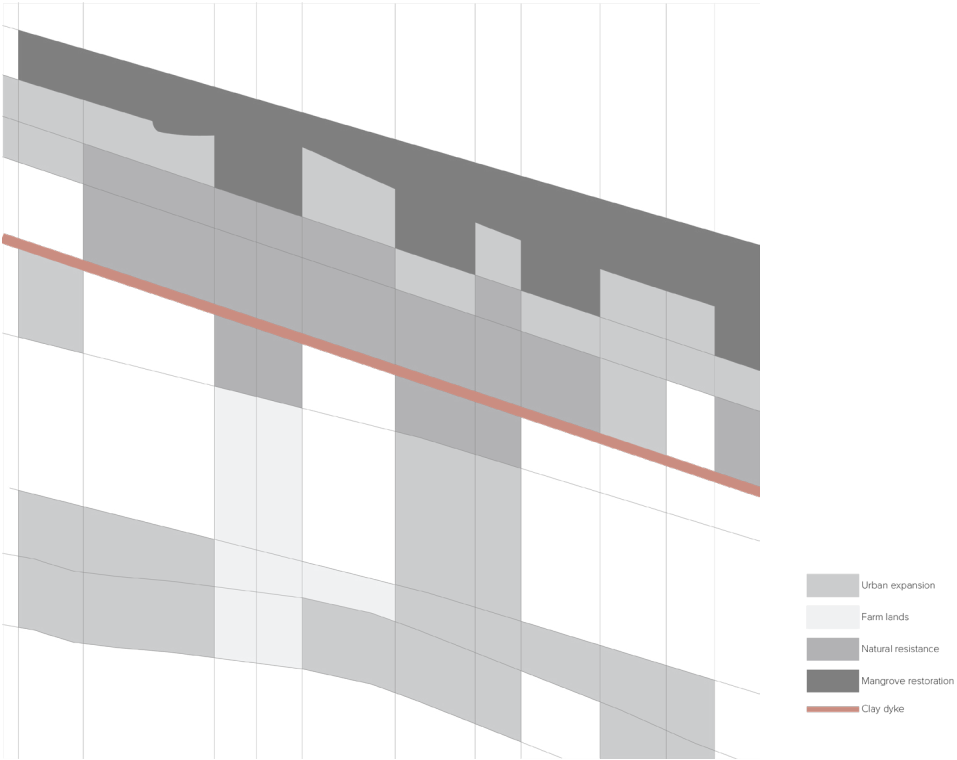
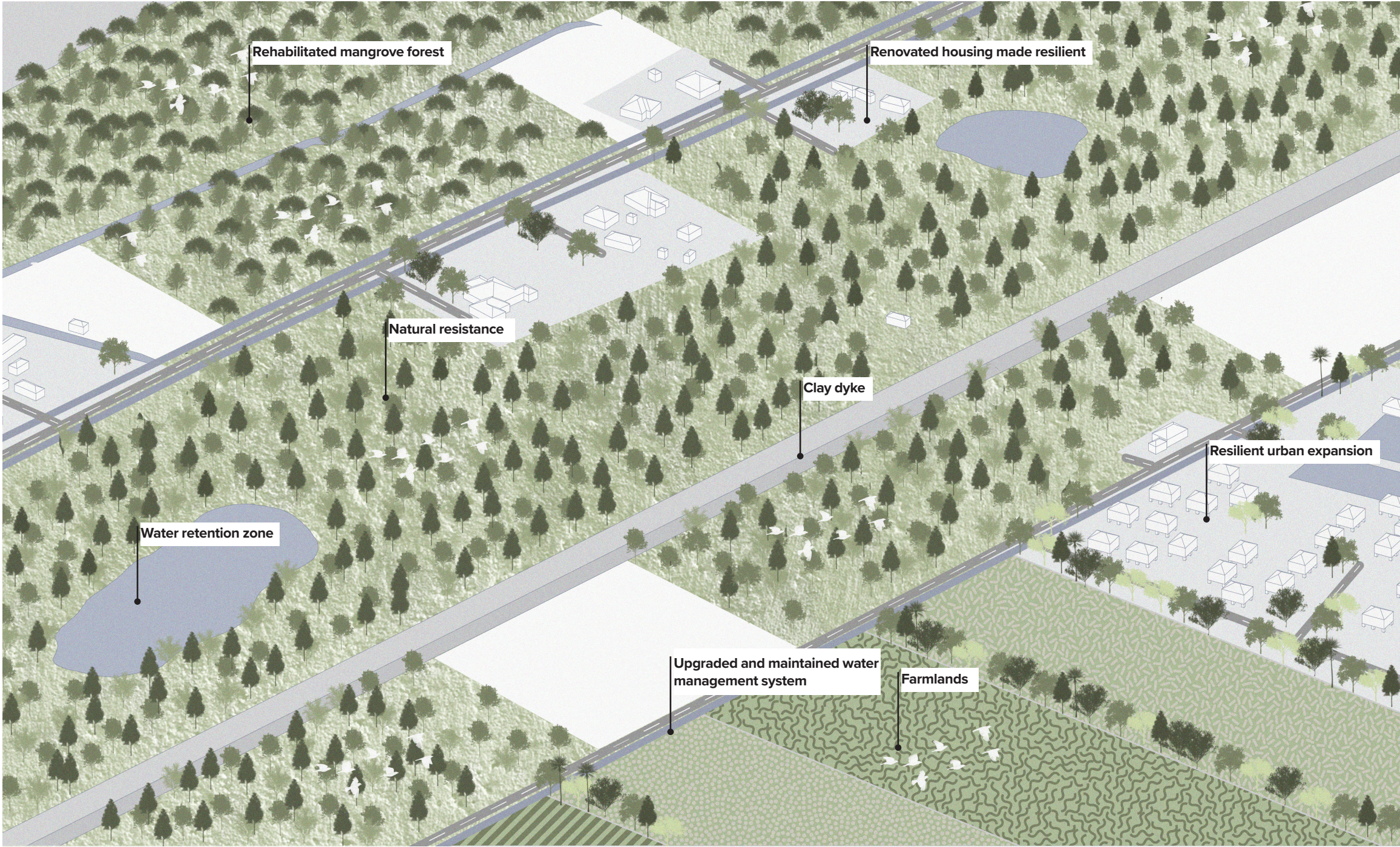


Figure 6.2 Grid with the different densities of the green belt

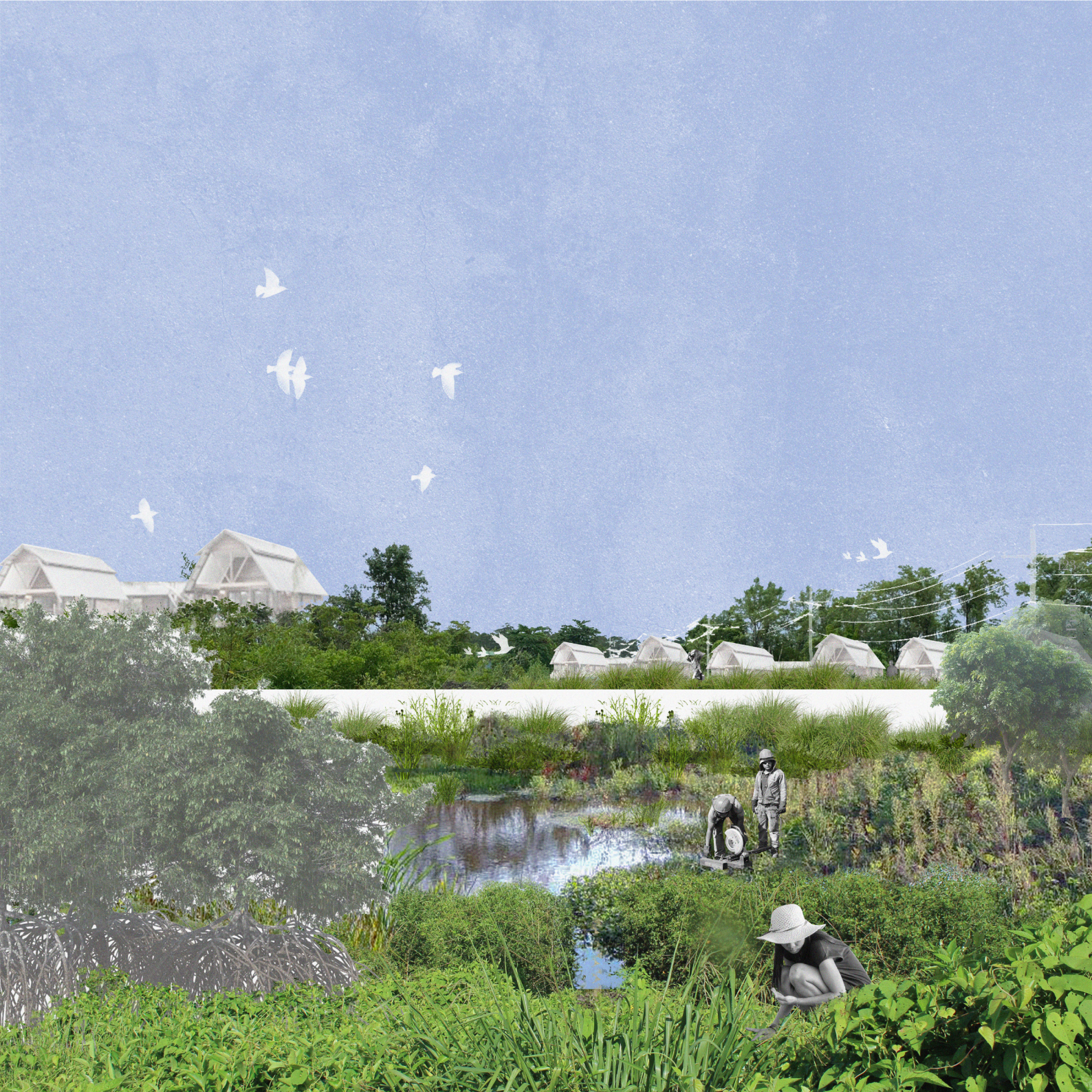


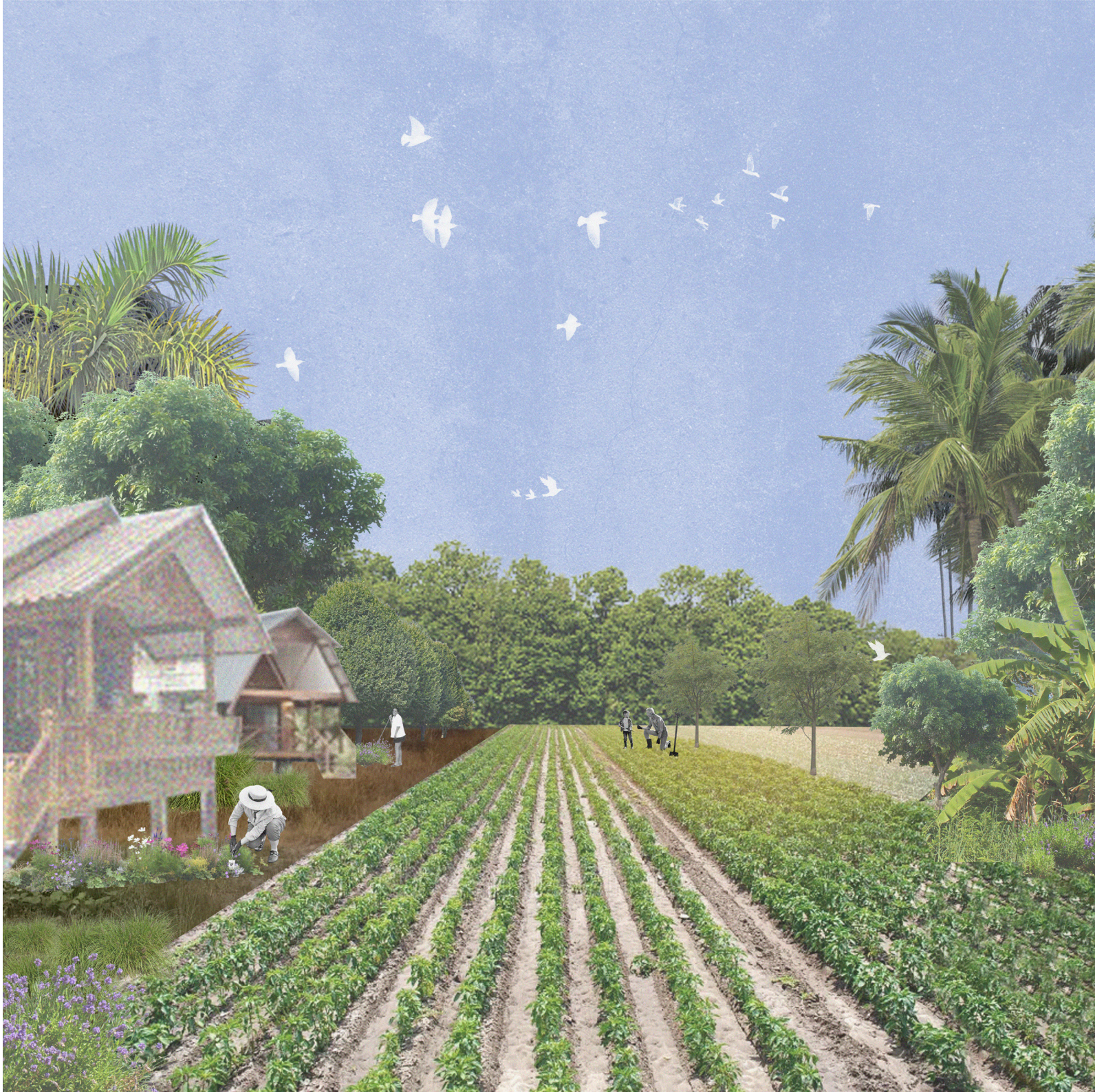
6.1.2 Axonometry Weg naar Zee

Looking at this section of Weg naar Zee, the green belt is clear, with the mangrove restoration, natural resistance, water retention zones and clay dyke shown. The grid, which is the concept of the design, can also be seen. The urban expansion behind the green belt is shown in addition to the establishment of the transitioned farmlands.

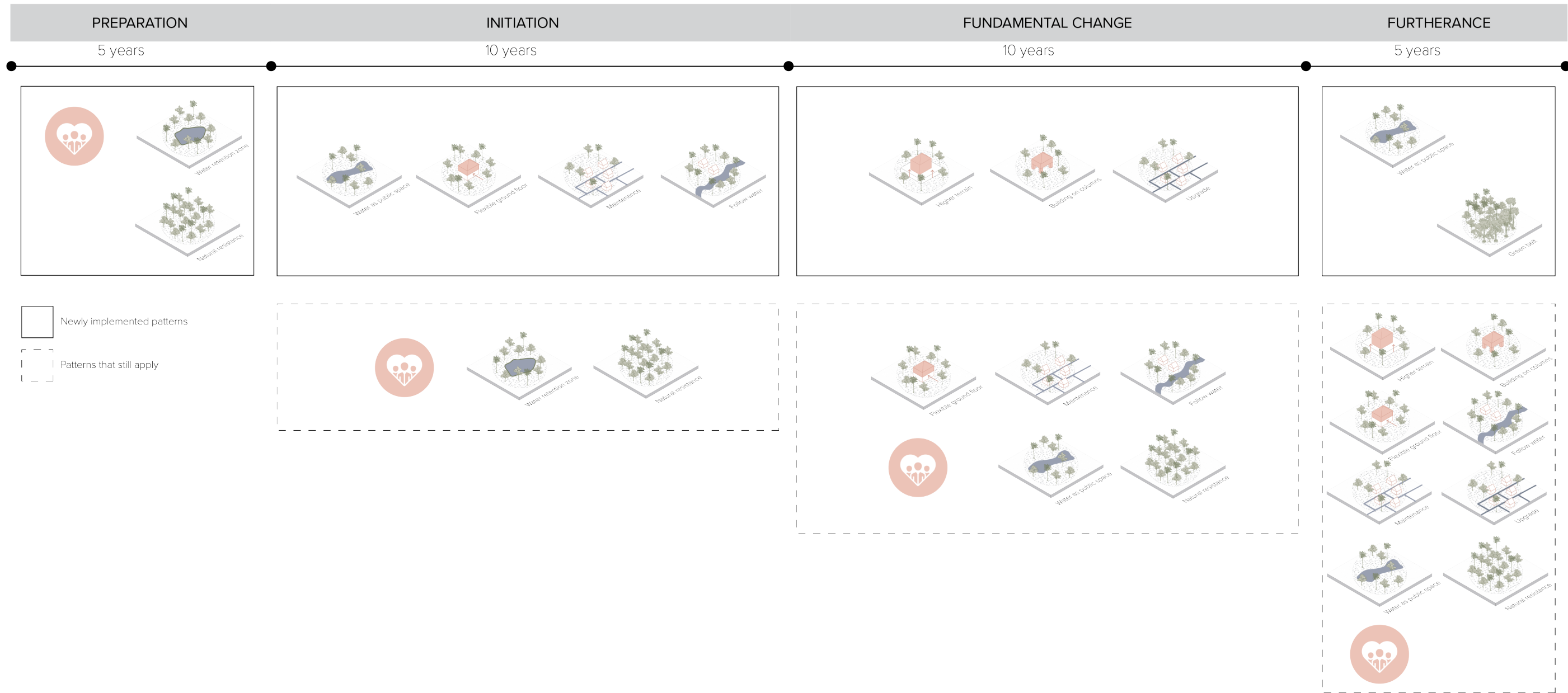


6.1.3 Spatial quality Weg naar Zee

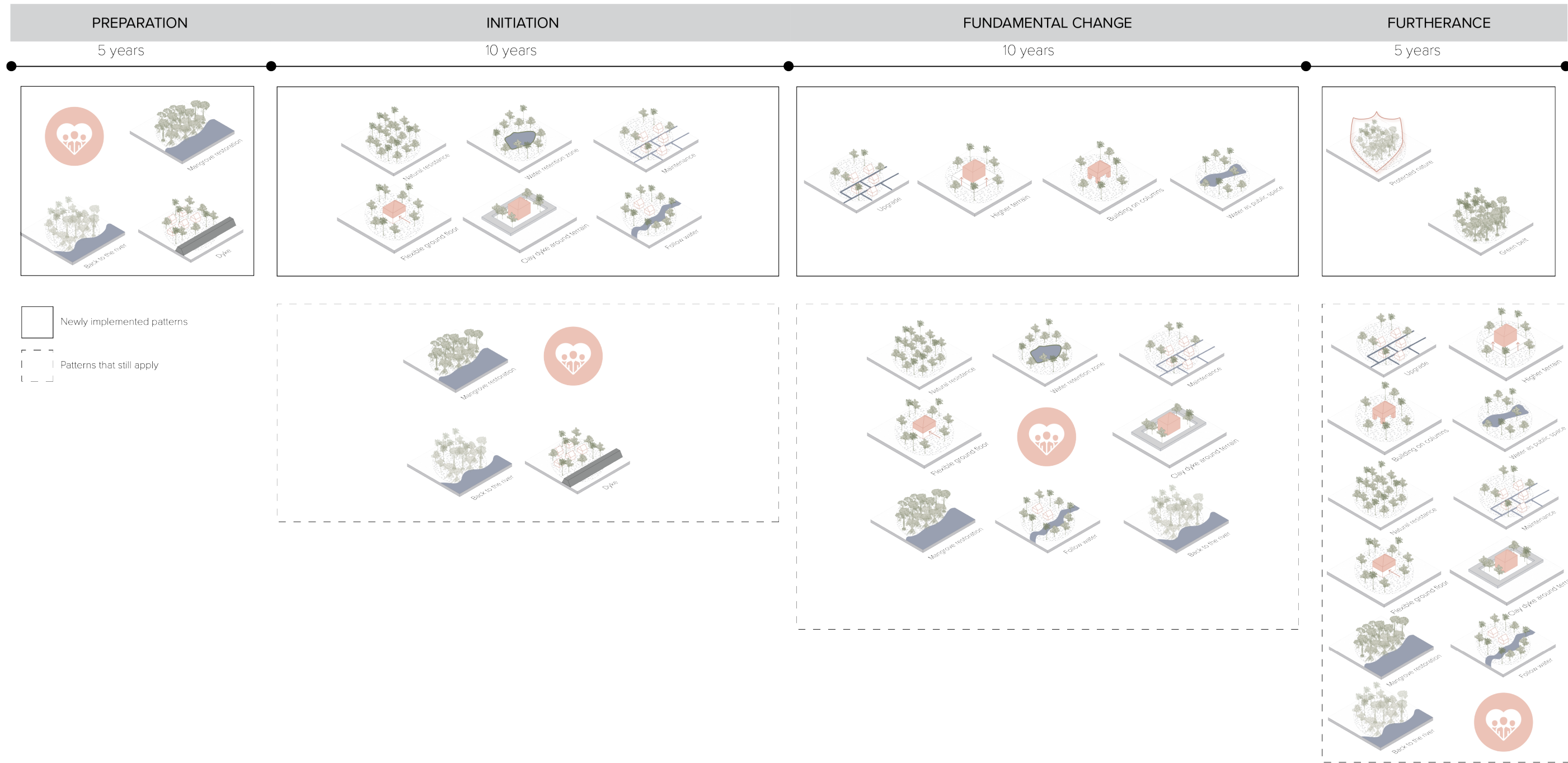




6.2 Pattern sequence location 2. Rainville



6.3 Pattern sequence location 3. Blauwgrond



This last chapter discusses the project, takes a look back at the assessment established in chapter 2 and answers the sub research questions and main research question.

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Discussion & Conclusion

7.1 Discussion

Expectations

The proposed strategies and designs (re)introducing co-existence suggests will have a big impact on the dynamics of the current urban-water-soil metabolism on the coast of Paramaribo. In the analysis of this project, the current urban-water metabolism was researched and it was determined that each of the systems, urban, water and soil present themselves as challenges along the coast. (re)introducing co-existence addresses each of these challenges and aims to propose design implementations that will improve the dynamics of the urban-water-soil metabolism to achieve a resilient coast. This is done by 3 proposed strategies in 3 specific locations based on how the challenges present themselves in these 3 areas. The strategies are based on 4 phases, the effectiveness of the strategies depends on the successful execution and completion of the previous phase. Each phase lays the foundation needed for the next to be successful, with the biggest systemic change proposed in phase 3 fundamental change.

However, the success of these strategies can be affected by natural disasters. For example, at the end of April Paramaribo experienced heavy rainfall. The rainfall was the mark of the beginning of the big rain period, although there was significantly more precipitation in comparison to previous years. As a result of this extreme heavy rainfall even areas that were not usually flooded became flooded. Should such an event occur during the execution of the strategy this could have a negative effect on the success of the strategy. Take the mangrove restoration for example, if there is suddenly heavy extreme rainfall when the mangrove plants are just planted and are not strong enough to withstand so much water and rain they could be swept away, this would mean having to start over. The solution to this would be looking into periods when these natural disasters would most likely occur and planning the phasing of the strategy around this.

Moreover, establishing Jepi Streyfeti Sungu (JSS) and making sure that this Non-Governmental Organisation runs properly and is set up with all the principles and pillars set in place is very important to the success of (re) introducing co-existence. Collaboration and networking also play an important role in this since this would bring in the funding JSS would need to remain operational.

Social Justice

The systemic change (re)introducing co-existence proposes focuses on making the implementation realisable for all residents. With this in mind, JSS was established. One of the goals of this organisation is to strive for equality on different scales.

JSS is not only meant for funding but also for bringing people, stakeholders and sectors together and promoting collaboration and networking. The proposed resilient coast and JSS allow for new jobs in the newly introduced resilient sector and proposed organisation, JSS. These new jobs are spread out in many different types on many different levels.

(Re)introducing co-existence proposed the strengthening and boosting of the biodiversity along the coast, this will not only have positive effects on the existing biodiversity and create spaces for biotopes, but it will also add to the strengthening of the coast.

Importance

(Re)introducing co-existence does not only aim to propose strategies and designs to achieve coastal resilience on the coast of Paramaribo. It provides a base and starts for further development on resilience to flooding and coastal erosion in not only Paramaribo but in

the whole country of Suriname, also extending past the country into locations in similar conditions. This project could be an example of this.

Moreover, this project can be the beginning of bigger systemic change for the coast of Paramaribo. Making the coast resilient opens doors to transforming the coast further and possibly introducing more economies into it. The design of a process

The main aim of this project is the design of a co-creation process in which the residents and stakeholders would be actively involved in the spatial design process of their neighbourhoods, properties and houses. An NGO was proposed that would be the instrument of connecting with the residents and stakeholders, the organisation would guide and help them to make their homes and properties flood-resilient and protect them from coastal erosion. In addition to this, the organisation would also provide financial support in case the residents are in need of it. The goal of the organisation is to offer the residents different design solutions and get their opinion on the best course of action by playing a game with them in which the possible design solutions are offered to the residents in the form of pattern playing cards. The residents play the game and with that suggest a certain design solution for their neighborhood or properties. In order to strive that all residents would be able to realise these design solutions on their homes and or properties, financial support would be offered in the case that the residents need financial support. In this way, it would be avoided that residents who are financially less well off are limited in how they can protect their homes and properties.

This concept was mentioned to a Surinamese specialist who is an urban designer and planner and is involved in the public- and private sectors.

“It is a very good way to raise awareness and also to bring about participation among the residents. Ultimately, it’s about continuity, and you can only create that if the local residents themselves take on the responsibility of management and maintenance, and therefore don’t wait for an organization to do that for them. But remember you also want them to become financially independent themselves by stimulating them to develop economic activities in their community, then I am thinking of urban agriculture projects, craft and art projects etc... The residents will have to participate from start to finish, also and above all in the decisions that are made. Give them the idea that it is their project and not that of the NGO or financier...”

For the success, continuity and further development of JSS, it is important that residents have a certain sense of awareness and responsibility for their surroundings. The NGO should not be the reason why residents have a certain sense of awareness, it can be the instigating instrument for awareness and change, but the initiative passion should lie within the residents themselves. Having this sense of awareness and responsibility can also spark the means for further development of the coast.

Recommendations

Systemic governmental change, coming up with a governmental system, introducing policies and coming up with a masterplan for Paramaribo.

What after this project? How can the coast further develop even into different sectors? Can the coast introduce new economies? What would this look like, with a collaboration with different stakeholders?

Looking more deeply into disasters and what kind of effect they can have. Coming up with contingency plans in the case of a natural disaster.

On the functioning and inner working of JSS and its integration into the network of organisations that is already there. The funding this organisation would need to be up and running.

Looking into the specifics of creating the green belt and what a process like that would look like. This would most likely be interdisciplinary.

What if, when proposing the green belt along the coast, it is also proposed that all the residents living within the area of the green belt would need to move? What would this mean for the residents? What systems would need to be set in place for this to be realised?

What would need to happen for JSS to be the “foundation” of introducing a governmental system? What kind of transitional change would this bring with it?

The further development of the coast. Introducing new sectors and what this would mean for both governmental systems and spatial planning and design.



Banana trees growing on the salinated soil on the coast of Paramaribo near Weg naar Zee, made by author (December 2022)

7.2 Assessment

In Chapter 2. Theory & Method (Re)introducing co-existence set certain goals according to the Sustainable Development Goals from the United Nations. Now, at the end of the project, the set goals are assessed to determine whether these goals are achieved and in what way.



Reduced Inequalities

UN Goal: Reduce inequality within and among countries. A main goal of (Re)introducing co-existence is to obtain equality in the extent of how the residents and stakeholders are able to cope with the flood and coastal erosion problems. In order to get a sense of equality it is important that every resident and stakeholder is heard and aware of these problems. And that an active effort is taken to make sure that all residents can make their homes resilient against flooding and coastal erosion. To achieve this a Non-Governmental Organisation is proposed that promotes funding, research, realisation, communication and collaboration on this front. This organisation aims to make sure that the rights and wishes of the stakeholders are all heard and taken into account equally. To this extent, JSS was set up.



Sustainable cities and Communities

UN Goal: Make cities and human settlements inclusive, safe, resilient and sustainable. The current living environments along the coast are improved to achieve resilience against the effects of flooding and coastal erosion. In addition to this the coast will undergo urban expansion, (Re)introducing co-existence aspires to create a resilient coast in which this urban expansion can be realised. These new living environments are designed to be resilient to the effects of flooding and coastal erosion.



Climate Action

UN Goal: Take urgent action to combat climate change and its impacts. The effects climate change has had on the coast of Paramaribo are causing an unpleasant living environment for the residents currently living there and proposing an unsuitable living environment for urban expansion. (Re)introducing co-existence addresses the effects climate change has had on the coast and aims to solve these challenges with nature-based solutions to minimise the further negative impact on the climate. With the newly proposed strategies along the coast resilience is achieved as to the effects of climate change moreover, the biodiversity is boosted by the rehabilitation of mangroves along the coast.



Life on land

UN Goal: Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss. With the rehabilitation of mangrove forests along the coast as well as the establishment of natural resistance forests, green belts are formed that strengthen biodiversity and prevent coastal erosion. The rehabilitated mangrove forests can even cause land gain. The green belt is protected which in turn forms protected pleasant habitats for species.



Partnerships for goals

UN Goal: Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development. JSS is a Non-Governmental organisation of which one of its main principles is the continuous and constant collaboration between stakeholders and residents. Furthermore, the organisation also promotes collaboration with outside organisations and stakeholders to further strengthen collaboration and establish a network.

7.3 Conclusion

The aspiration of (Re)introducing Co-existence was to devise a spatial strategy for the coast of Paramaribo that addresses the flood problems, coastal erosion and the need for urban expansion. To do this, a main question was formulated at the beginning of this project **“How can an insight into the urban-water-soil metabolism develop a more socially and environmentally resilient coast in Paramaribo?”**. In order to answer this main question several sub-questions were formulated.

The first question is **“How does the urban-water-soil metabolism on the coast of Paramaribo function?”**

The analysis on the coast of Paramaribo was specified on the workings of 3 systems; urban, water and soil. It was concluded that there is a need for urban expansion in Paramaribo and that with the growth pattern urban expansion has taken on through the years urban expansion is to be expected on the coast of Paramaribo. Furthermore, looking into the next system, water, it was concluded that the coast of Paramaribo copes with 2 types of flooding. Tidal- and urban flooding, these two types of flooding have different origins. Tidal flooding, or flooding coming from bodies of water, is a common occurrence for the entire coast. The coast is very perceptible for this type of flooding since the land is very low-lying, the rising of the sea level has only aggravated this, which leads to tidal floodings happening more often. As for urban flooding, this is flooding coming from the poor watermanagement system in Paramaribo, this type of flooding is caused by an increase in the amount of precipitation coming down each year. Climate change has played a big role in this and has just expedited matters concerning this. To be more specific, the watermanagement system is not functioning at its full capacity due to a lack of maintenance. In addition to this, the watermanagement system has not been upgraded in many years and is in dire need of this. Now, onto

the last system, soil. The coast of Paramaribo has dealt with a significant loss of land, the reasoning behind this is coastal erosion. The coast is part of an interesting dynamic coastal system in which mudbanks are moving along making the probability of losing land bigger. This would not be a problem if there was some sort of coastal protection present, in the case of the coast of Paramaribi this would be natural protection in the form of mangroves. These mangroves were taken out in anticipation of urban expansion many years ago, leaving the coast without protection in some areas causing coastal erosion and significant land loss, especially in Weg naar Zee.

The three systems come together and function together along the coast in the following way: Due to a lack of coastal protection there is a significant amount of land loss, in addition to this the flood water coming from the sea is not dampened in any way causing more intense tidal flooding. In addition to this, the coast copes with urban flooding due to a lack of maintenance and the need for upgrading the watermanagement system. These conditions make the coast a difficult place to live as residents have to cope with often repeated floodings and loss of land. Moreover, the city of Paramaribo is in need of urban expansion, with the expansion expected and most probable along the coast. The urban-water-soil metabolism along the coast is not functioning to the best advantage of the residents, future residents and the delicate environmental dynamics.

The next question to consider is **“How can the coast of Paramaribo expand while mixing living and working in a just way?”**. With the transition and systemic change (Re)introducing co-existence is proposing for the coast in order to achieve a resilient coast, a new sector is introduced focussed on making the coast resilient. This new sector brings with it new jobs differing in many

different scales. In addition to this, a Non-Governmental Organisation is proposed Jepi Streyfeti Sungu, which forms a network and is systemic as substantiation for the systemic change. In the urban expansion there is a focus on mixing working and living, therefore also offering jobs in the new neighbourhoods proposed by this project.

This leads to the next question **“How can the coast of Paramaribo become socially and environmentally resilient in a just way?”**. Starting with environmental resilience, the coast can achieve this by choosing design implications that are nature-based. The coast aims to become resilient by using mostly nature-based solutions. In this manner, the coast is strengthened and protected by forming a green belt. This green belt consists of mangrove restoration and natural resistance. Another layer of resilience is clay dykes. These design implications are all nature-based, therefore not only making the coast resilient but also adding to the biodiversity along the coast and being a booster for this. Forming better and proper biotopes for many different species.

The coast can become socially resilient in a just way by ensuring that all resident should have the opportunity to achieve resilience, no matter their station or financial situation. For this purpose Jepi Streyfeti Sungu was initiated, residents can come to this organisation for funding, loans and consultation as to how to make their properties resilient to flooding and coastal erosion.

The last sub-question is **“What will the spatial and social indicators of the shift towards coastal resilience and mixing working and living mean?”**. The new neighbourhoods, which are the products of the urban expansion will be a mix of working and living. The urban expansion will take place in certain strategic areas,

encompassed in green belts to protect these new areas and make them resilient. The buildings in these areas will all be designed and built to be resilient to flooding, giving the new neighbourhoods a whole new look. The expansion areas are always next to or combined with existing neighbourhoods. The existing neighbourhoods are also made resilient through renovation. The coast is strengthened with a green belt consistent with mangrove forests and natural resistance. Creating a buffer zone, in this buffer zone there is no urban expansion. The green belt along the coast will also be a strengthening of the biodiversity along the coast.

The specific design implications used for different areas along the coast are formed by the pattern language. The pattern language is used as a communication and co-creation tool by the JSS for all relevant stakeholders and residents in order to achieve a resilient coast.

With this information, the main question can be answered: **“How can an insight into the urban-water-soil metabolism develop a more socially and environmentally resilient coast in Paramaribo?”**

In order to (re)introduce co-existence between the urban, water and soil systems along the coast of Paramaribo several measures are taken. Firstly, the coast is strengthened by rehabilitating the removed mangrove forests protecting the coast from coastal erosion and dampening the tidal floods coming in from the sea and river. The mangrove forests also give the opportunity to add back land that was lost during the coastal erosion process. Secondly, the water management system is properly maintained and upgraded to maximise the capacity, reducing the number of urban floods along the coast. But, with climate change, the rising sea levels and the low-lying land along the entire coast floods are inevitable. Therefore, floods can not be prevented they are expected. The coast, therefore, strives to be resilient, preparing for these events in the design and planning and being able to adapt to these. In this manner the buildings are all made resilient by renovation, how this is done depends on the building and the situation. As the coast is expected to undergo urban expansion, the expansion will be completely designed to be resilient, giving the new neighbourhoods a completely new look and feel. These new neighbourhoods will also include a mixed working and living environment. Creating a water-resilient coast. Moreover, a green belt will be developed along the coast, this green belt will protect the coast from coastal erosion and flooding. In addition to this, the green belt is a boost to the coastal biodiversity and gives the opportunity for new biotopes to be created attracting more species which in turn will strengthen the green belt even further. To ensure that this happens, the green belt will be a protected area where no urban expansion

will take place, the proper and continuous functioning of the green belt will ensure coastal protection from tidal flooding and coastal erosion. The green belt will also include dykes placed in strategic places as an added layer of protection, these dykes are clay.

This strategic change is supported by a Non-Governmental Organisation Jépi Streyfeti Sungu, which will ensure proper communication, collaboration, research and co-creation between the relevant stakeholders and residents. The organisation will also ensure equality in the sense that each and every resident should be able to make their properties and homes resilient, JSS supports this by offering funding and loans to residents should they need it. Moreover, JSS offers consultations with residents to make their homes and properties resilient using a co-creation process using a pattern deck specifically designed for this purpose.

To sum things up, by making the coast of Paramaribo resilient the co-existence of the urban-water-soil metabolism will be (re)introduced.



Restored mangroves behind a man made pond, made by author (December 2022)

7.4 Reflection

Methodology

The educational projects I have done in the past have had a different approach, site visits were done in the beginning phase of the projects, even before any other analysis was done. This meant that when you go on the actual site visit you are not looking for specific things and are not paying attention to something specific. You are looking at the site very open-mindedly and keeping an eye out for anything and everything. For this project, this was not the case. The experience here was the exact opposite. Before the site visit, there was literature research, mapping etc., that took place. This meant that when going on the site visit I knew what I wanted to pay attention to and what I was looking for specifically. Besides this, the site visit played a crucial part in finalizing the analytical phase of the project and also in forming the bridge from the analysis to the strategy. In the case of this project, the site visit was used to complete the picture, whereas for previous projects the site visit was used to give an idea before even starting the analysis.

But which approach is better? I would say that the approach I took with this project was better since I am Surinamese and I live and grew up in the study area I already had a good idea of the site before doing the analysis, going back to the site after doing literature research and mapping provided me with the perfect setting to go back and look at specific things I wanted to focus on with this project.

In addition, the site visit after the analysis provided a good bridge from the analysis to the strategy since I had the opportunity to have conversations with residents and specialists which had a big impact on making a strategy for the coast of Paramaribo.

Research & Design

This project focuses on different scales and general strategies are formulated as a result of the pattern game. These general strategies are then defined further by using the patterns to translate the general strategy into a more specific strategy for each location. Then one location is chosen and translated into a design to demonstrate how the combination of the patterns and the strategy together can form a design. Strategies are developed on bigger scales and their design implementations are demonstrated on a smaller scale showing not only that the project works on different scales but that the different scales affect each other.

This project had a different approach than previous educational projects I have worked on. The approach was usually based on a pre-made frame based on the available information of the site and the planned outcome. This was not the case for this project, firstly because graduation projects are not based on certain products that need to be produced for the outcome of the project. This depends on the project, I can imagine what I want the outcome of my project to be.

Secondly, my site does not have much information available when it comes to maps, peer-reviewed literature, policies, visions, masterplans etc. There was not much to go off on, which had positive and negative repercussions. Starting with the negatives, when there is little to no accurate and updated information available it makes it all the more difficult to paint a picture of the site, to give an idea of what is going on, how the systems are functioning, what they are based on etc. On the bright side, because there are little to no policies or regional planning documents this opens up the playing field and means that when proposing a strategy for this project there are no constrictions.

Design of a process

The main aim of this project is to design of a co-creation process where the opinions of the residents and stakeholders and taken into account and used during the strategic plan and design. The role of the urban designer and planner in a process like this and in designing a process like this is that a system is created that is developed specifically to propose a spatial design that takes the opinions of the stakeholders and residents into account. It is important for urban designers and planners to realise that when designing, we are designing for the people, the residents. The residents have a perspective on the area that designers do not have. Combining the perspectives of the residents, stakeholders and designers would result in a design that encompasses the perspectives of all the involved parties and therefore results in a design that is a representation of the professionals and the residents.

Systemic change

This project proposes a new system and approach for flood prevention and protecting the coast from erosion. The strategy is focused on right now, making a change right now. Action is taken immediately to help the inhabitants against these challenges and provides a good base to further develop the project in the future.

Pattern Language

A pattern language is developed to give an overview of the different goals and the design implications needed to achieve these goals. When making the pattern language it was important to keep in mind to make it user-friendly. The residents of Suriname and by extension, Paramaribo are not familiar with pattern language in general. To

make a pattern language and just give it to a theme could be confusing and not user-friendly, which is exactly the opposite of the goal of making a pattern language in the first place. The challenge was to find a way to communicate the patterns in a way that they are familiar with and can use easily. For this reason, the patterns were made in the form of playing cards. Card games are common in Paramaribo, everyone knows how to play them every one is familiar with them. So making the patterns in the form of playing cards is speaking to them in a language that they understand.

Societal relevance

This project focuses on how to tackle the challenges climate change has brought with it, which in the case of this project are flooding and coastal erosion, with special attention to the effect that these challenges and the repercussions of these challenges have had and still have on the citizens living on the coast of Paramaribo. In addition to this, the project focuses on feasibility. Suriname is in an economic dip, many residents do not have the money to make their homes and properties resilient. The project focuses on how it can be made possible for the residents to be able to do this and do this themselves since they do not have the privilege of falling back on a system that is able to help them.

Transferability

(Re)introducing co-existence gives possible design solutions based on specific parameters originating from the current dynamics of the location and the scope of the project. The parameters can however be found in other projects, with similar locations or a similar project focus. The pattern language created for this project is also

transferable to other projects, it is even suggested that this pattern language is expanded for another project with similar parameters.

Limitations and Ethical Considerations

The people residing on the coast of Paramaribo differ in situation, specifically financial standing and living conditions. (Re)introducing co-existence focuses on strategies for 3 specific locations where the main challenges of the project present themselves differently. When coming up with design proposals for each of these locations the situation of the residents is taken into consideration. The aim of each of the designs was to make the design feasible for the residents to realise themselves. With this in mind the pattern language was developed, making the patterns tools that can be used by stakeholders and residents to encourage a co-creation process during the development of the design. Setting a system in place that will be able to fund or offer loans so that residents can afford to make their properties resilient was also a big part of this.

Personal experience

This project was a completely different experience for me as this was the first project I have done in a location I have lived in. I wanted to do a project in my country, a location very close to my heart, where I could approach the project not only as a designer/planner but also as a resident. I had not had that experience before. Usually in projects, I would get to know the location through research, analysis and site visits. With this project I was looking at a location I have known all my life, but through a different lens.

The approach to the project and the initial research were eye-opening, up until this project I was used to doing projects on locations where information was available in abundant measure. This was not the case for the location. The entire process of this project has taught me to be able to design and plan when a limited amount of information is available for a location. This was a very important lesson for me to learn as this will certainly not be the last time that this will happen. As a designer or planner, I should be able to do a project with as much information or data as is available, we should not only be reliant on information to be able to do a project.



Young mangroves and dead mangroves together on the coast of Paramaribo, made by author (December 2022)

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Appendix

1. P1 POSTER

RE-INTRODUCING COEXISTENCE

UNFOLDING THE WATER-SOIL-URBAN METABOLISM ON THE COAST OF PARAMARIBO

Nicole Chang
MSc Architecture, Urbanism and Building Sciences
Urbanism Track
Metropolitan Ecologies of Place
First Mentor: dr. Cecilia Furlan
PI
4-11-2022

Can an insight into the water-soil-urban metabolism help to develop a more resilient coast in Paramaribo?

- How does the water-soil-urban metabolism flow work on the coast of Paramaribo?

- How can the coast of Paramaribo become flood adaptable?

- How can Paramaribo expand while mixing living and working?

- What will the spatial and social indications be of the shift towards flood adaptation and mixed working and living mean?

- How can this transformation effect everyone in a just way?

Water

Flood risk index
Suriname as of 2022

Precipitation

Soil

Receding coastline

Urban

Population

Metabolism

1. Coastal - Rural

2. Coastal - Urbanized

3. Inland - Urbanized

METHODS

- In depth analysis of the zoom in locations
- Cross referencing with case studies
- Socio-economic analysis and research (with interviews)
- Research by design

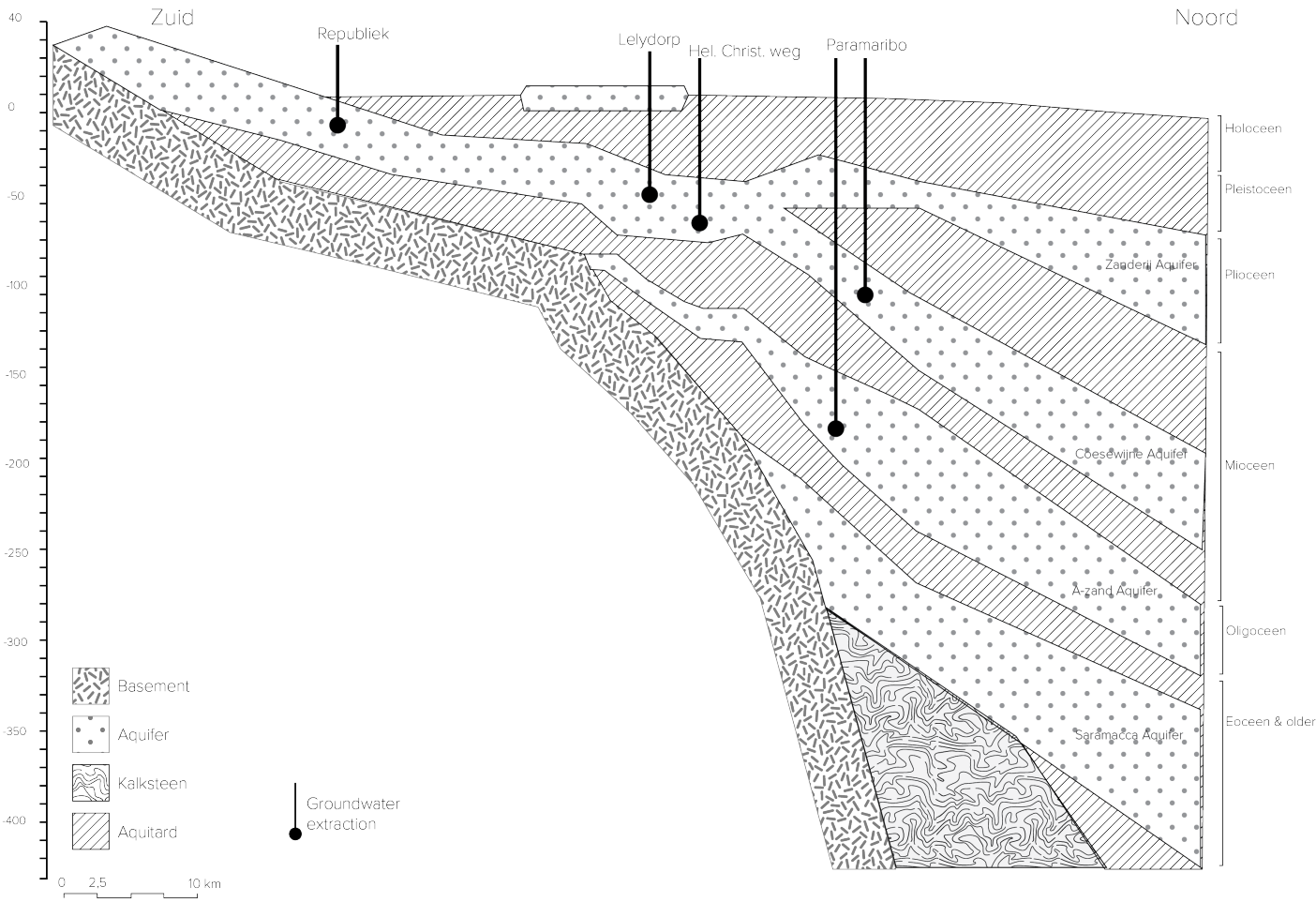
KEY LITERATURE

Living in the mangroves Bairro dos Pescadores

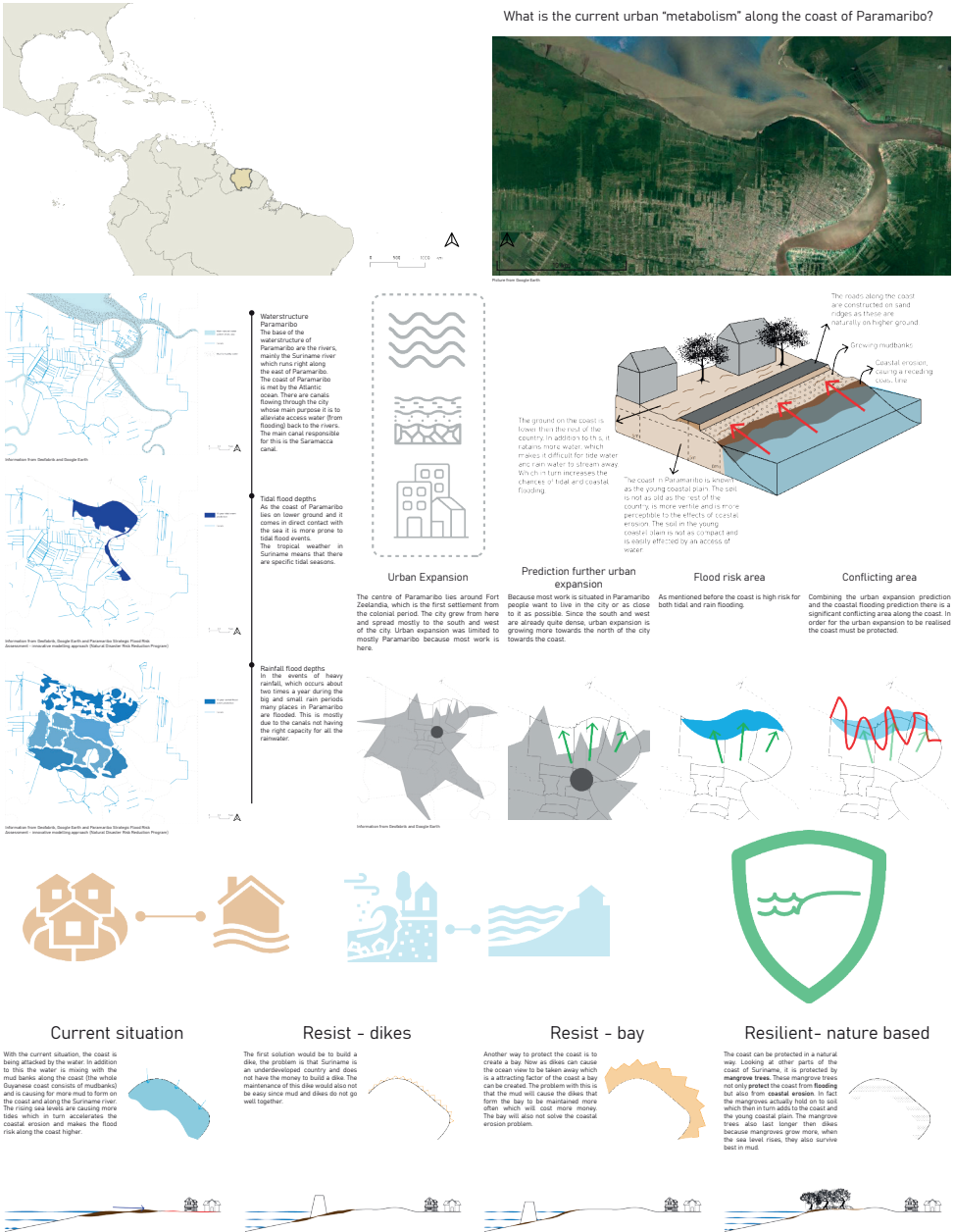
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2. SOIL SECTION COAST OF PARAMARIBO



UNFOLDING THE WATER-SOIL-URBAN NEXUS ALONG THE COAST OF PARAMARIBO



Specialist	Occupation
Specialist 1. Hydrologist, expert in mangrove restoration.	Professor at Anton de Kom University, Paramaribo Suriname. Mangrove Restoration Project Suriname
Specialist 2. Urbanist	Urban Planner & Designer working for both private- and public sector
Specialist 3. Lawyer	Lawyer working in both private and public sector
Specialist 4. Managing Engineer	Engineer working in private sector, with influence in the public sector

