Resilient communities

How can a spatial framework contribute to resilient flood-risk protection, while improving the living quality of communities?

Faculty of Architecture, dept. of Urbanism Graduation studio " Delta Interventions" Graduation Report: Bram Willemse - 4164733 - b.willemse@student.tudelft.nl

Colophon

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GRADUATION REPORT

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1st mentor: Anne Loes Nillesen
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PREFACE

This booklet forms the report of the graduation project in the studio of Delta Interventions at the Technical University Delft, Faculty of Architecture, department of Urbanism.
This report describes what research has been done in the graduation year and how this evolved into a strategy and urban design. The research is based on the theoretical and analytical framework of the subject, using literature and spatial analyses to define the context and strategy for the project, which later resulted in a design for the chosen location.

The subject of this graduation project is Resilient Communities; designing flood-risk protection measures that will increase the social and spatial quality of different communities, increasing the quality of live. The location chosen to develop this project is Coney Island, an urbanized peninsula located on the Atlantic coast of New York City. This area is characterized by a wide variety of communities and water related hazards.

This report describes the steps that have been taken to develop both strategy and design to research the main research question;

How can a spatial framework contribute to resilient flood-risk protection, while improving the living quality of communities?

It is divided into nine chapters. First, the context in which this graduation project is set will be described. This resulted in the problem statement and aim of the project, setting research questions that will be answered the following chapters. Then the theoretical framework will be discussed, the role of the urbanist, the contributions to the social and academic debates and the introduction of the project strategy will be explained. The third chapter will explain the methodology used in the project and the disciplines that are involved. The forth chapter will go into the analyses that have been done to understand flood-risk and the effect it has on the communities of Coney Island. The social and spatial characteristics of Coney Island are also investigated, resulting in a detailed understanding of the location and the context in which it is set. The fifth chapter will discuss two reference studies that have been done to understand how other projects deal with the relationship between ecology, flood-risk, and living quality of communities. This resulted in the sixth chapter, the framework urban design.

This adaptive framework has been worked out in an urban design on a key location, Coney Island Creek. The design uses dynamic natural processes as key instrument to phase the implementation of the interventions to cope with the uncertainty that the future brings. This will be discussed in the eight chapter. The final chapter will provide a reflection on the process, planning and product of the graduation plan. It will reflect on the last year and discuss how the strategy and design can be seen as answer to the main research question. Recommendations for further research on the subject will be given as a closing remark.

- Bram Willemse

Reading guide:

Pages with this bookmark will discuss the issues, analysis and concepts regarding flood-risk protection.

Pages with this bookmark will discuss the issues, analysis and concepts regarding the ecological quality.

Pages with this bookmark will discuss the issues, analysis and concepts regarding the quality of life within communities.

1. INTRODUCTION

Key-words

Resilient flood-risk protection; resilient communities; framework urbanism; social quality; spatial quality; eco-system based coastal defense; Coney Island

Introduction

To better understand the challenges this graduation project will deal with, the context in which it is set will be explained. Delta Interventions is an inter-disciplinary graduation studio focusing on water related issues such as flood risk management in urban delta regions (Nillesen, 2013). The project is located in the metropolitan region of New York City. In 2012, hurricane Sandy had a devastating impact on the city. The effect this hurricane had on everyday life illustrated the ineffectiveness of the flood-risk management of the United States of America. It is therefore necessary to further investigate the current flood-risk management, related water hazards and the impact flood-risk has on communities.

The flood-risk

Before discussing the flood-risk management in the United States of America, the term flood-risk needs to be defined. There are different ways to characterize flood-risk. In this graduation project, the definition given by McCharthy (McCarthy et al., 2001) will be maintained, as this is the main definition mostly used by others in the field of water-management, civil engineering and urbanism. McCharthy describes flood-risk as the probability a hazard will occur multiplied by the consequence of that hazard.

The US water management approach

All flood-risk management approaches can be evaluated on four elements; prevention, recovery, adaptation and transformation (see illustration 1) (Van Veelen, 2013). A flood-risk approach implements policies on one or more of these cornerstones. The Dutch philosophy for example is based almost entirely on the prevention of flooding. By focusing so greatly on prevention, other aspects such as recovery make out a much smaller part of the Dutch flood-risk management. In contrast to this, the United States tries to mitigate flood-risk almost entirely on recovery.

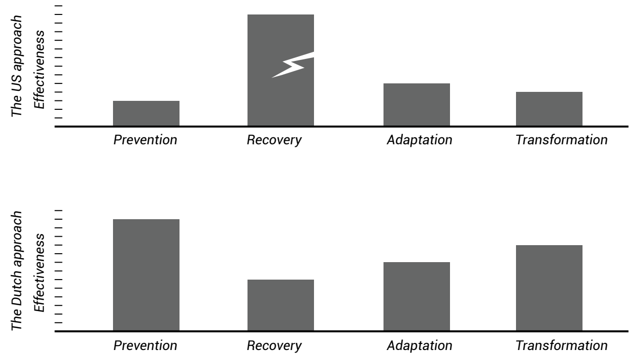


Illustration 1 Flood-risk management cornerstones

SOURCE: Image by author, 2013.

Flood-risk management in the United States is a fairly new phenomenon. The first hazard mitigation programs where taken into action in the 1960s and have since then not been changed significantly (Aets et al., 2012). The main actions the federal government implements are based on only one of the four hazard mitigation cornerstones, fast-pace recovery. Their philosophy is that by decreasing the consequence of a flooding, the impact is also smaller. To achieve this, two tools are important, detailed maps of flood prone areas and a flood insurance program, reimbursing the damage of a disaster to the inhabitants (Burby, 2002).

The maps illustrate the probability of flooding in different areas, as well as the value of the properties at risk. These maps are the fundaments of the National Flood Insurance Program (NFIP). The insurance premiums of the NFIP are based on the probability of flooding, combined with the damage a flood could inflict. These maps also help local governments set criteria for construction in flood plains. This should then result in urban activities to locate in flood-prone areas only when the benefits of doing so outweigh the private and social cost of flooding (Gornitz et al., 2002). The National Flood Insurance Program is only available for inhabitants who meet the NFIP standards. These standards are met if you have a stable income, maintain your house properly, and pay the required taxes. In theory, this approach can be an effective mechanism for dealing with flood hazards. It could promote wise use of floodplains and minimize the effects of a disaster. How the NFIP currently functions however, aggravates the effects of flood-risk (Burby, 2002).

The financial crisis that has been holding households in its grip since 2007 resulted in more than ten percent of inhabitants who live in flood-prone areas that are unable to pay their NFIP fees (Walsh, 2013). When hurricane Sandy hit the east coast of the US, hundreds of households where unable to rebuild their home and where forced to relocate (Walsh, 2013). The negative impact this selective flood-risk management has on the social quality of communities is enormous. Even if the community is rebuilt, the social cohesion that was there before has vanished, decreasing the living quality of these waterfront communities. In that sense, the current flood-risk management has a negative impact on the social quality of waterfront communities.

Combined with the increasing frequency and intensity of storms, flood-risk management in the United States is facing even greater challenges. The impact that natural hazards have upon the urban environment will increase the costs of rebuilding enormously and make this flood-risk management approach inadequate. The fact that there is still extensive development in areas with the greatest risk from flood hazards, as well as the limited results of local governments to implement appropriate hazard-mitigation measures in new constructions, increase the costs of the NFIP even more (Burby, 2002). With the uncertainty that climate change brings forth this ‘respond to’ approach will become even more vulnerable. There is need for a system that can absorb disturbance, both spatially and socially.

The effects of flood hazards on communities

With over six million buildings located within the boundaries of the hundred year floodplain, flood losses across the United States have an increasing impact on the way of life of inhabitants (Burby, 2002). The tremendous cost that natural hazards inflict upon our urban environment requires no less than rigorous changes in the flood-risk management. On a more local scale, these hazards have a devastating impact on communities, on both physical and social level. Looking at a major disaster in the last years, hurricane Sandy, the effects will still be visible for years to come. The fact that basic needs, such as food, water, electricity and mobility, where not met in the weeks after the disaster show the ineffectiveness of the current flood-risk management. Due to a strong segregated society in the United States, some social vulnerable inhabitants looted surrounding shops and supermarkets in mobs up to a hundred people (Lysiak and Dillon, 2012). Owners of these shops defended themselves against the looters, shots were fired and communities turned into a lawless free-for-all. This post-apocalyptic atmosphere could last weeks in flood prone communities. These vulnerable communities are trying to rebuild their way of life, but are now aware of the impact a disaster could have on their neighborhood.

Zooming in on an effected community the effects of a natural disaster become even more apparent. In Coney Island, one of the well-known waterfront communities of New York City, it took more than a week to bring back electricity and water. Coney Island is known for its large amusement parks and beach that attract millions of New Yorkers during the summer months. The damaged subway and freeways made it hard to enter the peninsula and Coney Island was cut off from the rest of Brooklyn. A large part of Coney Island is made up of social housing projects. These inhabitants did not have the means to evacuate the area before hurricane Sandy hit. Resulting in more than 40,000 people who were left without basic amenities such as water, electricity or food (King, 2013). In the weeks after, no police or other law enforcement was patrolling this area, resulting in a dramatic decline of public safety and social quality. A year later the main attractions are rebuild, but the amenities needed for a well-functioning community are still missing. The social housing blocks are deteriorating and some neighborhoods are victim to an increase in crime (King, 2013). The fact that basic needs, such as food, water, electricity and mobility, where not met in the weeks after hurricane Sandy, demonstrates the ineffectiveness of the current flood-risk protection management and the effects of this on a local scale. The communities on Coney Island are trying to rebuild their way of life, but are now aware what effects a disaster could have on their neighborhood. These are still communities who continue to struggle to return to normalcy (King, 2013).

Within this context the gradation project Resilient Communities is set. The ineffectiveness of the current flood-risk management is known and the inhabitants are aware that something should be done. Individual protection against flood-risk on the other hand does not protect the social qualities of a community and could disrupt communal life as well. This graduation project will position itself in this discussion and will try to develop a context-driven flood-risk protection, decreasing the consequences and the effects of water related hazards while increasing the social and spatial quality, creating resilient waterfront communities.

Illustration 2: Sea Gate community in Coney Island tried to prevent looting and theft by putting roadblocks around their neighborhood. SOURCE: Minchillo, J., 2013. http://e-arcades.com/blog/?p=1267


THANKS
MAYOR BLOOMBERG
RESIDENTS
ONLY!
U LOOT, WE SHOOT


PROBLEM STATEMENT

When describing the context of this project different problems regarding the current flood-risk protection where described. As this is a graduation project within the field of urbanism, the problems should be able to be addressed with the research and design methods learned as an urbanism student, and result in spatial interventions and/or regional strategies. What is the most pressing issue at the moment is the lack of flexibility and absorbing capacity towards future flood hazards on a local scale. As described earlier a lot of effort has been spent on rebuilding and recovering from hurricane Sandy. In the Netherlands on the other hand, a lot of money is spent on the maintenance of the high safety standards they have set themselves. That this is going to become harder over time is evident, as the rapid urbanization of flood prone areas will increase the costs to rebuild and future storms will become more frequent and more intense (Gornitz et al., 2002). The negative effect that the lack of basic amenities has on the social quality of the community is enormous and results in the deterioration of these living environments. Looking at flood protection measures built in other flood prone areas, such as New Orleans, another problem can also be found. Especially in the American context, flood protection is seen as a stand-alone problem that can be solved with technical measures (Aets et al., 2012).

Flood-risk protection measures as shown in illustrations 3 and 4 demonstrate the negative effect protection measures can have on social and spatial quality of the living environment. These measures destroy to relation between community and water, and disrupt the connection between different communities, as the flood defense is inaccessible and difficult to cross. Another important issue is the deterioration of the ecological value of the area, as hard, man-made structures could disrupt the natural dynamic processes that form the base of the ecosystems in coastal areas (Temmerman et al., 2014). So, by decreasing the flood-risk by these types of 'civil engineering' solutions, both the quality of life in communities as well as the ecological value of the coastline could be affected. It is therefore necessary to consider these three themes as inseparable before taking action.

The impact that flood-risk has on communities, on the short and long term, combined with the negative effects that flood-risk protection measures could have on the social, spatial and ecological quality of the environment are the main problems that this graduation project will be aiming to address.

Illustration 3-4: Flood-risk protection measures implemented in New Orleans. SOURCE (Royal Haskoning, 2013) http://www.royalhaskoning.com/en-GB/NewsAndDocumentation/Pages/HelpmakeNewOrleanssafer.aspx

AIM OF THE PROJECT

Location Choice

The location chosen for the gradation project is Coney Island, an urbanized peninsula located on the Atlantic coast of New York City. This area is characterized by a wide variety of communities and water related hazards. The problems described in the problem statement all occur in this area. Besides the current problems, future sea level rise will increase the intensity and frequency of storms, as well as exacerbate beach erosion and the deterioration of salt marshes (Gornitz et al., 2002), making Coney Island even more prone to flood-risk in the future. The combination of high density, current and future flood-risk issues, as well as the diverse social and spatial characteristics of the communities, make this an interesting and exemplary location for this graduation project. To test the strategic plan for Coney Island, a design was made for a crucial part of the peninsula, the Coney Island Creek. The communities around this creek are the most vulnerable to flood-risk and have the highest exposure the flooding. The ecological quality of the creek is poor, and a variety of social and spatial issues deteriorate the living quality in the surrounding communities, as will become more apparent after the analyses are discussed in the coming chapters.

Illustration 5: Coney Island in the context of the greater metropolitan area of New York City.

SOURCE: Google Maps, 2013.

RESEARCH QUESTIONS

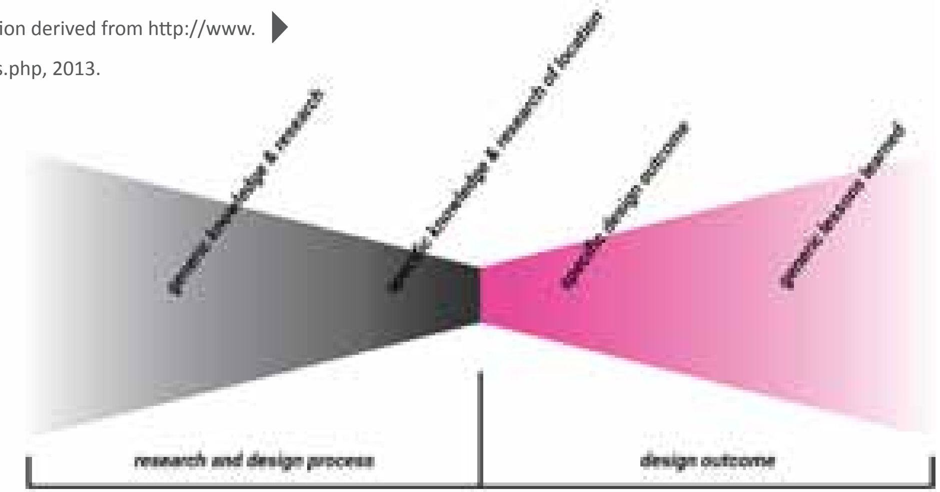
The aim of the Resilient Communities graduation project will be both a strategic plan and a spatial design on Coney Island that will decrease the flood-risk by means of spatial measures. The strategic design will focus on providing development principles on the entire peninsula, implementing a phasing plan to combine flood protection measures with ecological improvements and social and spatial measures. This strategic plan will be translated into a spatial design on a specific location on Coney Island, the Coney Island Creek. This design will show how flood risk protection measures can improve the living quality of communities, providing an answer to the main research question. In contrary to current flood-risk mitigation measures, these spatial measures will aim to increase the social and spatial quality of the different communities, increasing the overall living quality. It will investigate how flood-risk protection measures can be adapted to the diverse context of the communities on Coney Island. To acquire the knowledge needed to create such a design, a broad research on flood risk, ecology and social and spatial quality has been done. By analyzing the area of Coney Island, specific knowledge is obtained to form the base of the design proposal. Later in the graduation project, the design proposal and the specific knowledge acquired on the communities of Coney Island was investigated to discuss the lessons that were learned on this location. These generic lessons can help future developments of flood-prone communities world-wide.

The main research question that will be answered is the following:

How can a spatial framework contribute to resilient flood-risk protection, while improving the living quality of communities?

Illustration 6: Structure of research, the hourglass model.
SOURCE: Image by author, information derived from http://www.socialresearchmethods.net/strucres.php, 2013.

To answer this question the terms that it contains should be researched separately. Illustration 6 shows the basic structure of the research. First generic knowledge on the subjects is acquired. With this knowledge, focused questions on the location can be derived. These sub-research questions will be answered after each chapter of this report. After analyzing the context, a strategy and design can be made to cope with these issues. This design should be evaluated as a solution for the main research question. This design will then be reviewed in chapter 8 to obtain common principles that can be used for future developments of flood-prone communities.



The sub-research questions are the following:

1 What type of water hazards contributes to flood-risk (a), and which contributes to flood-risk of the communities of Coney Island (b)?
Methods used: Literature study, inventory, historic analysis
Discussed in chapter 4.1

2 What elements of a community make it vulnerable to flood-risk (a), and how vulnerable are the communities of Coney Island (b)?
Methods used: Literature study, data analysis
Discussed in chapter 4.1

3 What are resilient measures against flood-risk (a), and how can they be implemented in the context of Coney Island (b) ? Methods used: Reference study, spatial analysis, classification
Discussed in chapter 4.2

4 How can flood-risk protection measures increase the ecological quality of the area (a), and how could this contribute to the ecological quality of Coney Island (b)?
Methods used: Literature study, Reference study, spatial analysis
Discussed in chapter 4.2

5 What is the distinction between the communities of Coney Island?
Methods used: Spatial analysis, data analysis, historic analysis
Discussed in chapter 4.3

6 How can the spatial quality benefit from flood-risk protection measures (a), and how can they contribute to the spatial quality of Coney Island (b)?
Methods used: Reference study, spatial analysis
Discussed in chapter 6

7 What is the role of self-organization of communities to create a resilient flood-risk management system?
Methods used: Literature study, Data analysis
Discussed in chapter 7

8 What principles of the design of Coney Island can be used for future development of flood-prone communities?
Methods used: Reference study
Discussed in chapter 9
The methods that will be used to research these questions will be further described in chapter 3.1 Methodology.

2. THEORETICAL FRAMEWORK

The theoretical framework in which this graduation project is positioned is based on the relation between three terms: resilient flood-risk protection, ecological quality and the living quality of communities. With answering sub-research questions regarding these terms, shared goals and communal objectives are found. A literature review regarding the definition of these terms will be the base for further analysis of the context of Coney Island.

Resilient flood-risk protection

In literature, there is some uncertainty about the definition of the term resiliency. In this thesis plan, resiliency is defined as the 'capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function and identity' (Walker, 2004, p.17). Other authors such as Cannon, T. and Cutter, S. who have dealt with resiliency in the context of flood-risk management, also use this definition (Van Veelen, 2013). Looking at the current flood-risk management, resiliency is the necessary factor. It will create a more flexible flood-risk mitigation system that can cope with the uncertainties of climate change and sea level rise. This will result in a greater capacity to absorb the impact of hazards. A resilient flood-risk protection will both decrease the exposure to flooding, as the absorbing capacity will be greater, and will decrease the consequences of flooding, as the reorganizing capacity will decrease the vulnerability of communities (Walker et al., 2004). These two elements together will decrease the overall flood-risk for a community greatly.

Ecological quality

The dictionary defines ecology as the relationship between organisms and their environment. Ecological quality is therefore the degree to which the environment is suitable to provide the conditions needed for animal, plant or other organisms to thrive. Historically speaking, this quality of the environment used to be one of the main reasons for people to settle somewhere. In our times, the transformation of nature through urban development has resulted in disturbed ecosystems worldwide (Perysinaki, 2010). Among many other things, this lost balance between nature and culture has contributed to the rise of sea level and more frequent and intense storms. As this project will focus on mitigating flood-risk, it is only logical to also improve the ecological quality of the site, helping to restore the balance.
In this project, ecological quality will therefore be one of the three vital elements to improve.

Living quality of communities

The term living quality is a term used in many different fields. For this project, the living quality of inhabitants in communities will be defined as a combination of spatial quality and social quality. These two terms are researchable in the field of urbanism and can be changed and improved by an urban design (Gehl, 2008).
Spatial quality is a broad term. Generally speaking, spatial quality is the extent to which space satisfies the expectations of a community (Hooimeijer, 2012). These expectations are determined by the values pursued by the community itself. This means that there are different interpretations for the term, as each location has a different context. Spatial quality in that sense however, is a subjective view that is hard to measure.

In this research, spatial quality will be assessed by the matrix discussed in the book Kwaliteit in meervoud by Habiform, a knowledge network of professionals in the field of spatial quality in the Netherlands. This matrix combines the three basic principles of spatial quality with four criteria which play a role in the design of space, namely the economic, the social, the ecological and the cultural criteria (Hooimeijer et al., 2001). This matrix, shown in illustration 7, will provide an instrument to research the spatial quality of the different communities in Coney Island objectively. This will provide knowledge on how to adapt flood-risk protection measures to the needs of different communities, as well as provide information on how to phase the strategic plan for Coney Island. Later in the project, this matrix will provide a base to reflect on the design made for Coney Island Creek.

Illustration 7: The matrix to define spatial quality.
SOURCE: (Hooimeijer et al., 2001: p.35)

Social quality of the living environment is something that is difficult to define. In this graduation project the term is defined by Gehl as; ‘Social quality is the fruit of the quality and length of other types of activities than necessary activities. It occurs spontaneously when people meet in a particular place. Communal spaces in cities therefore become attractive when all activities of all types occur in combination and feed off each other’ (Gehl, 2008, p.26). In his book Life between buildings, Gehl presents a method for evaluating the social quality of a community. He also gives insight in how a design can encourage active use of outdoor space, increasing the social quality of the living environment (Gehl, 2008). During the design phase of the graduation project the methods discussed by Gehl formed the base for creating conditions to increase the social quality of communities (see chapter 7).

	Economic	*Social*	*Ecological*	*Cultural*
Functional use	x	x	x	x
Perception	x	x	x	x
Future value	x	x	x	x

The role of urbanism

In the complex and highly urbanized waterfront of today, there is a need for an integrated approach towards threats and opportunities. Urbanism could play an important role in these situations. Urbanism focuses on the integration of interests, combining social-cultural, economic and political perspectives with the spatial conditions of the location (Hooimeijer et al., 2001). These issues are intertwined and all related to the complex environment of the city. The strength of urbanism also lies in its ability to extend our understandings onto other fields, linking the performance of natural processes with engineering and urban design strategies (Perysinaki, 2010). I therefore believe that urbanism is the field of expertize needed to integrate the site specific conditions, the civil engineering solutions and political desires, improving not only the flood-risk safety, but also other much needed issues.

In the setting of this graduation project Resilient Communities, aspects such as flood-risk protection, ecological quality, spatial quality and social quality all have different demands of the environment. Urbanism can be the field that connects these terms, creating a design that takes all the elements into account. The unique aspect of our field is that we gather objective knowledge needed to understand the problems. With this knowledge, we then form our own vision on the matter, creating a design or strategy that takes these threats and opportunities into account. With this design, we try to improve not only one aspect, but a combination of them. This integrated strategy is perfectly suited to deal with the complex issues of Coney Island.

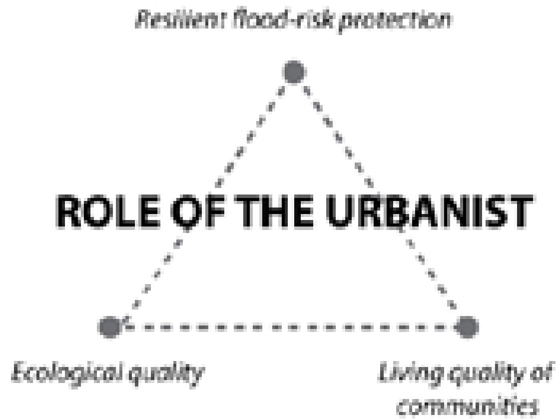


Illustration 8: The role of the urbanist, the connecting element between different fields.
SOURCE: Image by author.

SOCIAL AND ACADEMIC DEBATE

Social debate

As discussed in the introduction of this thesis plan, the current approach of rebuilding and recovering is not enough. Inhabitants are aware of the necessity to adapt to future flood hazards. The lack of thrust in the current flood-risk protection encourages communities to take action themselves (Nelson et al., 2007). The current individual flood-risk protection could however deteriorate the social and spatial quality. Illustration 9 shows the lack of connection between public and private space that occurs when people adapt to flood-risk individually.

Another problem with individual measures is that they have no coherence with other projects, have limited effect due to lack of expertize (Godschalk, 2003), and are only based on flood defense, not on other water hazards or spatial improvements. The image shown in illustration 10 portrays the willingness of inhabitants to act, but the lack of means, expertize, and integration, prevent these measures to significantly improve the situation. Residents erected a dune in front of their neighborhood as a protection against hurricane Sandy. Due to inexperience and a lack of knowledge, the wave forces pushed the sand into their homes, resulting in more damage than without these precautionary measures. In a sense, these do-it-yourself measures could even aggravate the situation or deteriorate other spatial qualities. There is therefore a need for urbanists as ourselves to integrate flood-prevention with other spatial interventions to improve community life as a whole.

The social relevance of the graduation project is twofold; there is a need to decrease the overall flood-risk of the entire communities while using these measures to improve the living quality of communities.

Illustration 9: Individual flood-risk protection. SOURCE: (FEMA, 2013) http://www.floodsmart.gov/floodsmart/pages/residential_coverage/rc_overview.jsp

Academic debate

Current strategies for flood protection are only based on spatial elements. The Urban Waterfront Adaptive Strategies of the NYC Department of City Planning developed a catalogue that identifies the range of possible strategies to increase the resilience of urban coastal areas to water hazards. This catalogue combines the geomorphology and the hazards with the desired protection measures (NYC_Planning, 2012). This location based strategy results in specific solutions for different flood-prone areas. What they do not take into account however are the ecological or social conditions. Different approaches have a different impact on the ecological, spatial and social aspects of a community.

Besides the lack of context driven solutions another discussion arose the past year. Conventional flood-risk protection measures are increasingly challenged by the unpredictability of sea level rise and its consequences. The lack of flexibility of these protection measures, as well as the costs of maintenance and improvements, become more and more untenable (Temmerman et al., 2014). A different approach, discussed in the journal Nature, argues that an ecosystem-based coastal defense can be a cost-effective and ecologically sound alternative for the current flood-risk protection (Temmerman et al., 2014). The concept however, besides small parts of the shore of the Scheldt in Belgium, has never been carried out on a large, urban scale before. This project could therefore provide knowledge on how to implement such a strategy into the urban environment.

This graduation project will help shift the current strategies from an approach focused on reducing flood-risk to a context-driven approach, addressing more issues that will help create a resilient flood-risk protection system and well-functioning communities.

Illustration 10: Flood defense gone wrong. SOURCE: (Olsen, M., 2013) http://www.telegraph.co.uk/news/picturegalleries/worldnews/9644975/Hurricane-Sandy-pictures-50-dramatic-images-of-destruction.html

3. RESEARCH STRATEGY

Methodology

To achieve the goal of creating resilient communities, an integral approach from different fields is needed. As a result the methods used to address different problems and solutions are also diverse. The methods that will be used are briefly explained below.

Literature study: By studying literature knowledge is gained on specific subjects that are related to the graduation project. By reviewing other literature about the discussed topic, forming an opinion and building a recommendation for this graduation project, it is positioned in the academic field. By learning from the experience of others, this project could build upon other literature, adding to the body of knowledge on the subject.

Data analysis: By using the existing data sets available of Coney Island, it is possible to underpin the decisions made in the project. Using hard data can also show the feasibility and relevance of certain measures. The data used in this thesis plan was derived from the Department of Urban Planning of New York City. The data is available on http://oasisnyc.com/map.ax.

Historic analysis: To understand the importance and relevance of different areas and patterns, the historical context needs to be analyzed. By overlaying historical maps, mismatches and relations can be found.

Spatial analysis: Analyzing the spatial characteristics is vital to understand the working of a community. With spatial analyses different elements can be investigated and interpreted, such as land-use, urban morphology and transportation.

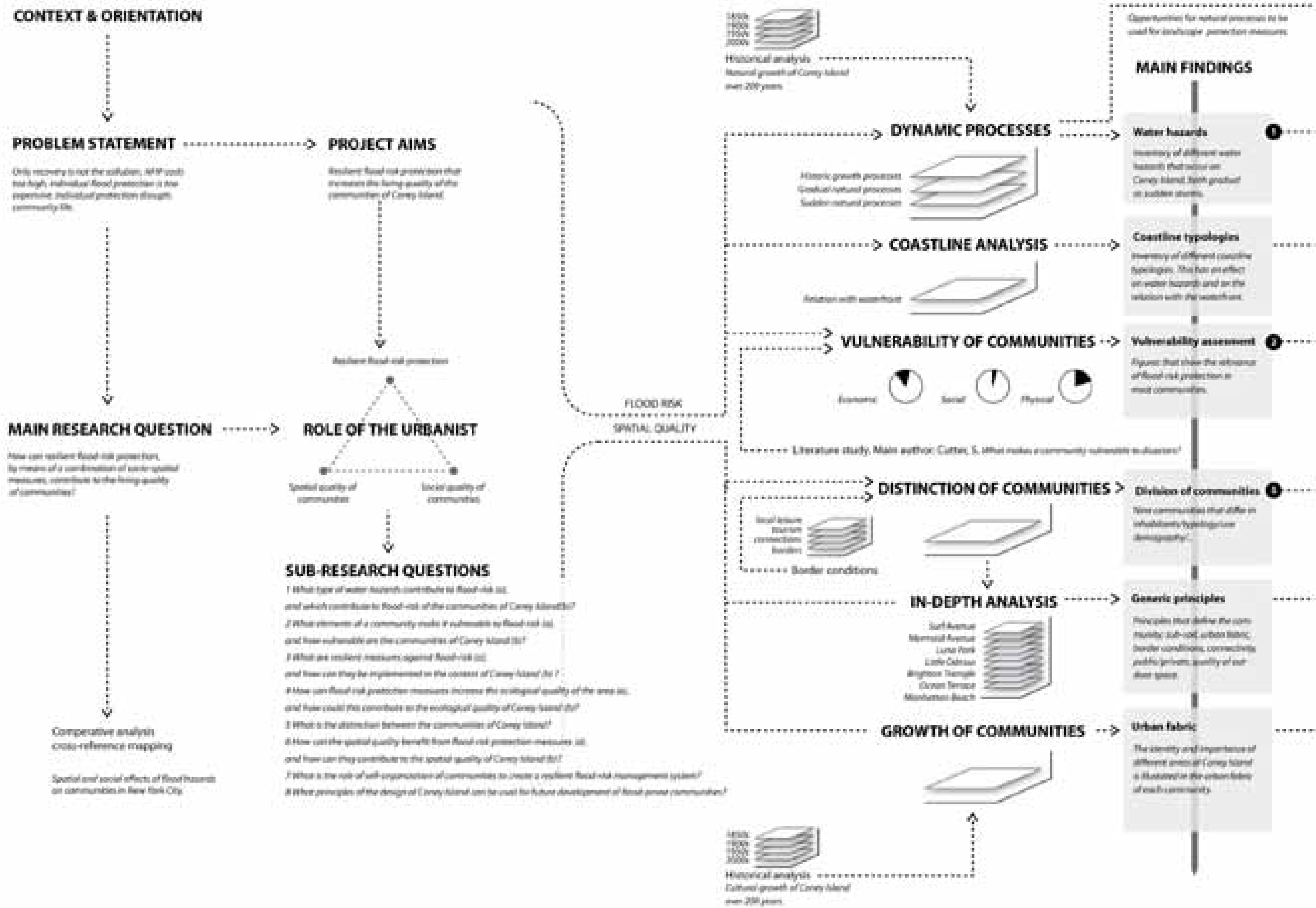
Reference study: Comparing how other locations cope with similar issues and building up an inventory of different projects. This can be used as an inspiration during the design process.

Inventory: A list compiled to give an overview on a particular subject. The types of water hazards or the flood-risk protection measures for instance.

Classification: A list as described as an inventory, but now each item has a certain arrangement. By valuing some elements higher than others, this type of list already gives an idea of what elements are most important or best suited.

The structure of the project can be divided into four parts. First the theoretical background that is needed to properly define the project aims and research questions was researched. This part was mainly reviewing literature, defining the terminology and developing a theoretical framework. With this base set, the second part consists mainly on analyzing the location specific elements. By analyzing separate elements, such as the coastline, the vulnerability, or the historic growth of communities, a better understanding of the unique elements of Coney Island was achieved. The analysis phase is divided into three parts, analyzing the flood-risk, ecological quality and the spatial quality separately. In the following chapter, each analysis will be accompanied by text explaining why this analysis was done, as well as the main findings that were achieved and an answer to the regarding sub-research question. The diagram on the next pages shows the structure of the graduation project, resulting in a spatial strategy of Coney Island and an urban design of Coney Island Creek.

Illustration 11: Parachute Jump. SOURCE: http://www.urban75.org/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Division of communities
Generic principles
Urban fabric

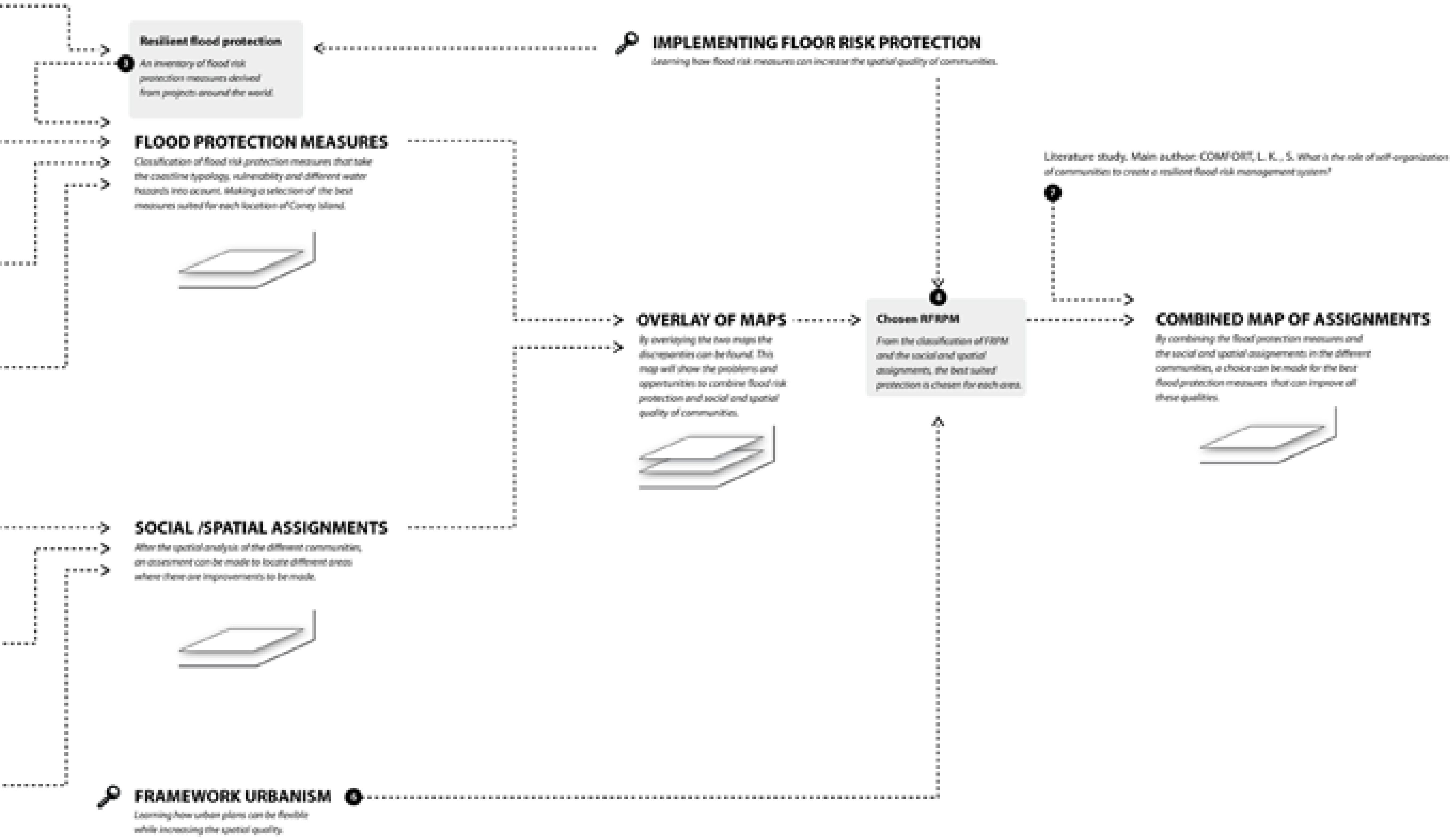


Illustration 12: The structure of the graduation project and the methods used. SOURCE: Image by author, 2013.

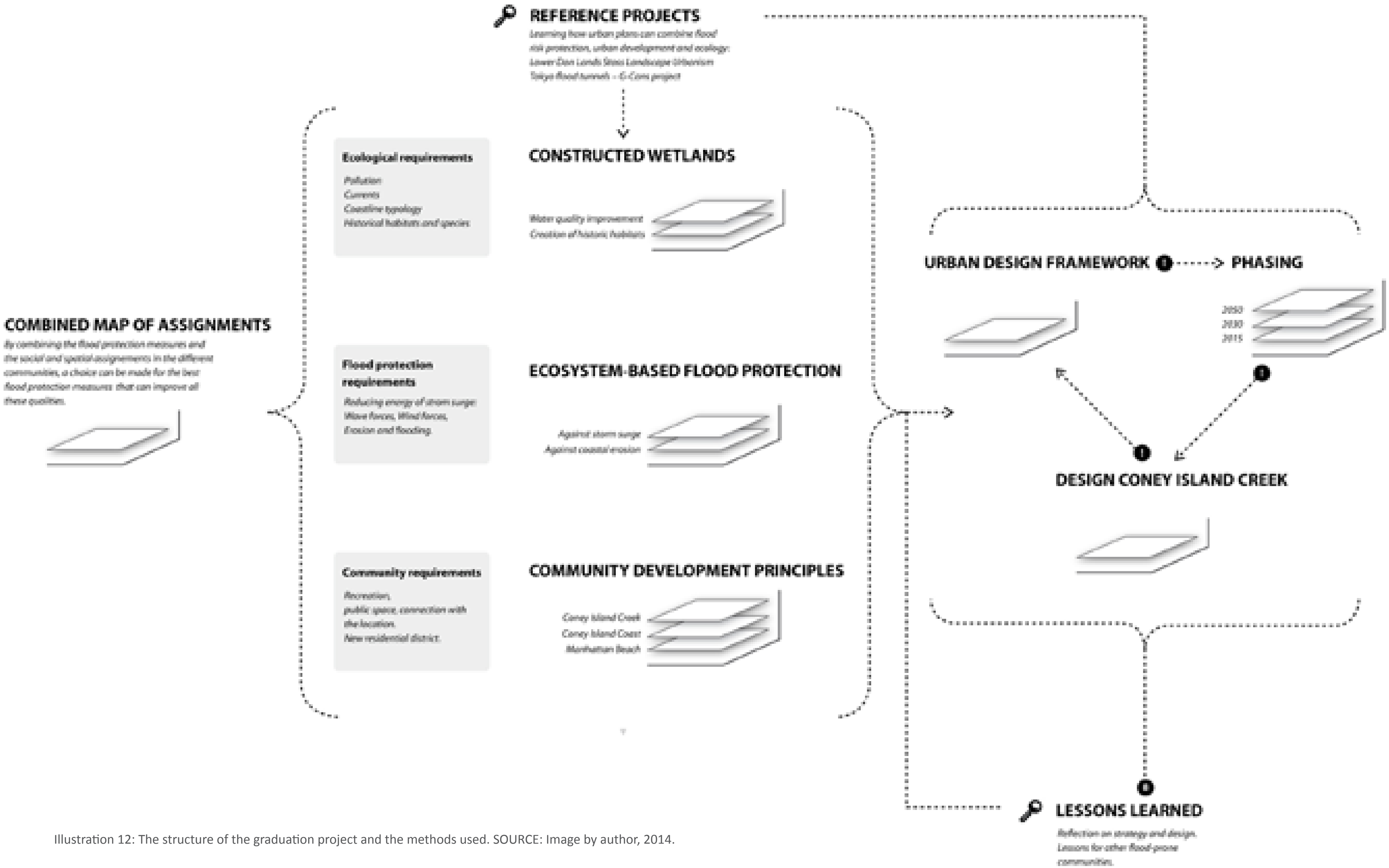


Illustration 12: The structure of the graduation project and the methods used. SOURCE: Image by author, 2014.

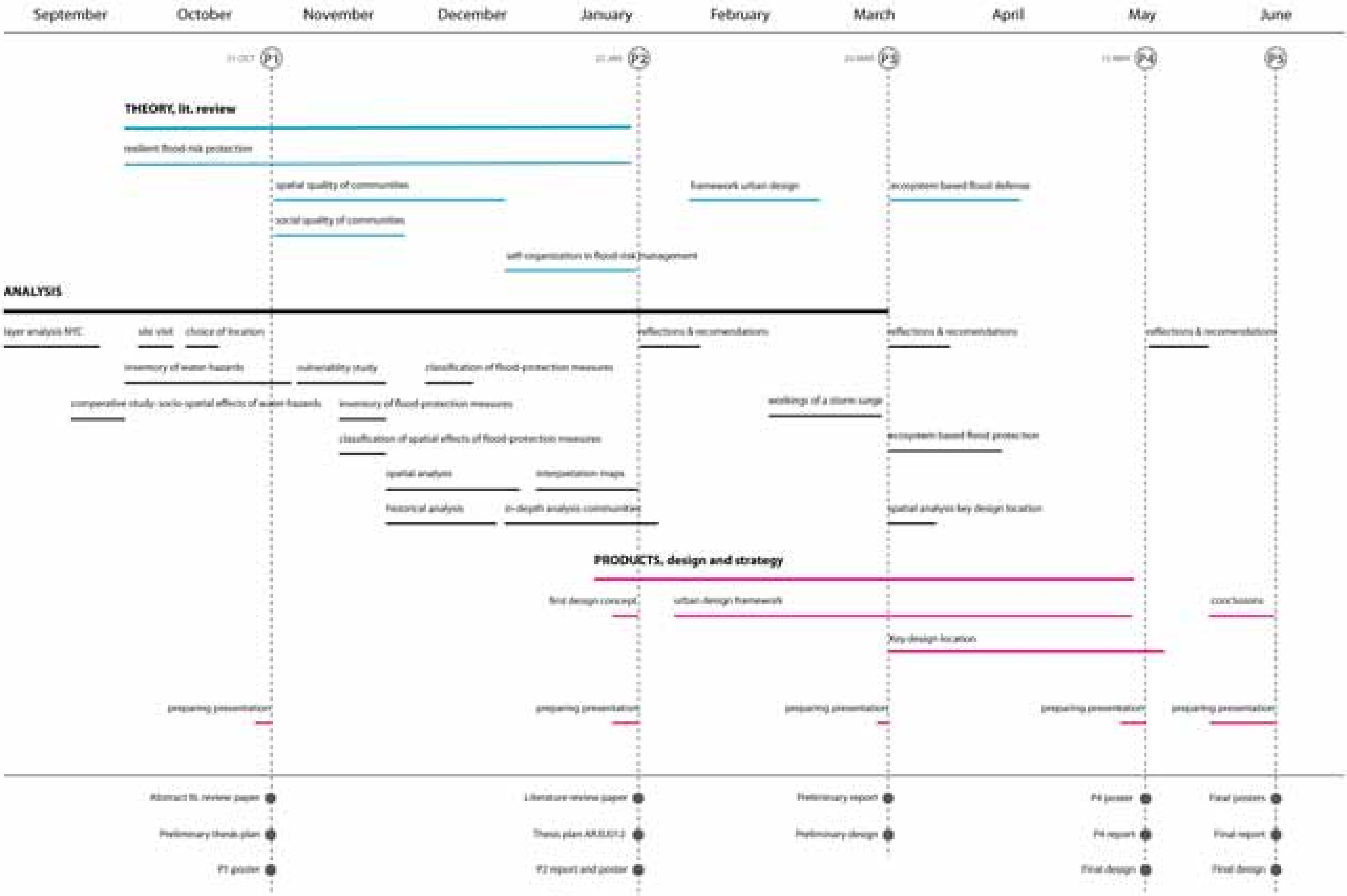
Disciplines involved

Within this project, different disciplines will come together: Urban Design, Landscape Architecture, Spatial Planning and Strategy, Civil Engineering and Sustainable Development.

Time schedule

Illustration 13: Time schedule for the graduation project

SOURCE: Image by author, 2014



September
October
November
December
January
February
March
April
May
June
P1
P2
P3
P4
P5
THEORY, lit. review
resilient flood-risk protection
spatial quality of communities
social quality of communities
self organization in flood-risk management
framework urban design
ecosystem based flood defense
ANALYSIS
layer analysis NYC
site visit
choice of location
inventory of water hazards
vulnerability study
classification of flood-protection measures
comparative study socio-spatial effects of water hazards
inventory of flood-protection measures
classification of spatial effects of flood-protection measures
spatial analysis
interpretation maps
historical analysis
in-depth analysis communities
reflections & recomendations
workings of a storm surge
ecosystem based flood protection
spatial analysis key design location
PRODUCTS, design and strategy
first design concept
urban design framework
key design location
conclusions
preparing presentation
Abstract lit. review paper
Preliminary thesis plan
P1 poster
Literature review paper
Thesis plan AR3U012
P2 report and poster
Preliminary report
Preliminary design
P4 poster
P4 report
Final design
Final poster
Final report

ANALYSIS

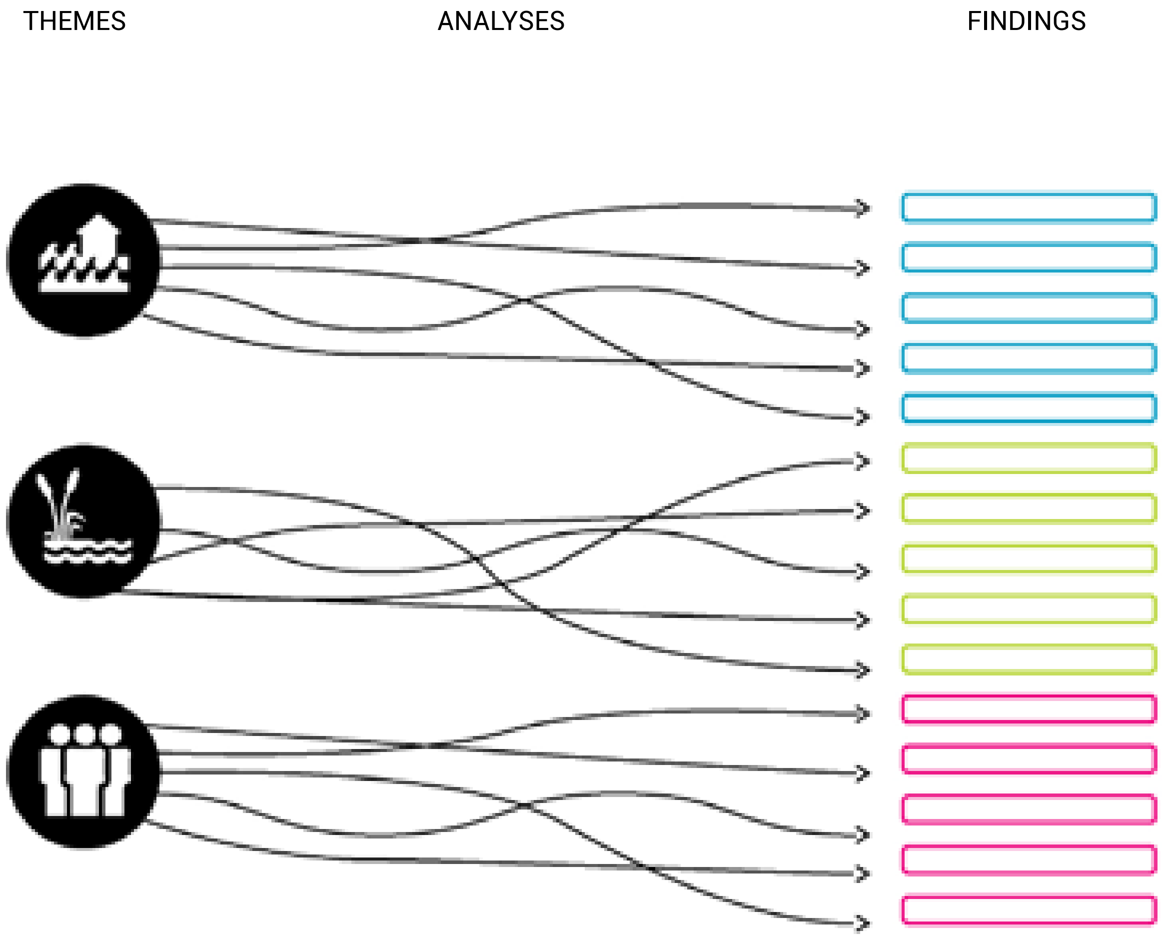


Illustration 14:Structure of the analysis. SOURCE: Image by author, 2014.

Wave forces

Erosion

Storm surge inundation

Destruction of marhslands

Tidal inundation

Pollution due to sewage outflow

4.1 FLOOD-RISK

Conditions for the graduation project, Sea Level Rise.

Sea level has been rising along the US East Coast. In New York City, the sea level rise (SLR) rate is 2.73 mm/yr (Gornitz et al., 2002). Due to the geomorphology of the location, this rate lies above the average global SLR. There are still uncertainties and discrepancies between different SLR models. But that future SLR will have a great impact on the coastal communities is a great threat. After hurricane Sandy, several projects emerged to flood proof New York City so that such a storm of the same scale could not have such large consequences. This storm however, has past, and future flood-risk mitigation should not look only to storms that already have occurred. Future flooding from combined sea level rise, storm surge, and tides will have a different frequency and intensity in the future (Gornitz et al., 2002). This will become an increasing problem over time and will also increase the flood-risk during a hurricane. As the sea level is already higher, the height of a storm surge is amplified. I therefore base the flood-risk conditions for this project on the expectations of the model used by the municipality of New York City, available at http://sealevel.climatecentral.org/surgingseas/place/states/NY. As the unpredictability increases the further we look into the future, the project will focus on the short term and middle long term (2030). Even then the predictions vary from an expected SLR of 10cm until 50cm (Gornitz et al., 2002). Because of this uncertainty, this graduation project will take the average height, a SLR of 30cm, as design condition. This will provide room for future adaptation. The main focus of the project will be the flexibility of the protection measures, rather than the height of them. This flexibility provides space for future adaptation towards threats, increasing the capacity of a system to absorb disturbance and reorganize, creating the resiliency needed in the flood-risk protection of Coney Island.

4.1 Flood risk: an inventory

As discussed in the introduction of this report there are different ways to characterize flood-risk. In this graduation project, the definition given by McCharthy (McCarthy et al., 2001) will be maintained. McCharthy describes flood-risk as the probability a hazard will occur multiplied by the consequence of that hazard. These water related hazards can be investigated separately, as different elements of hazards have a different impact on the coastline. Water related hazards can be divided in sudden and gradual hazards. Sudden hazards occur in a short period of time such as, storm surges, pluvial flooding, rapid inundation. Gradual hazards are associated with climate change, such as long-term sea level rise, pollution and shoreline erosion, and have moderate effects on everyday life. They are however, related to one another, as a long-term sea level rise and shoreline erosion will also increase the flood-risk during sudden hazards. Hurricane Sandy has shown that Coney Island is particularly vulnerable for flooding during a hurricane by a storm surge. The height of the peninsula, at the coastal side, is high enough to protect the communities behind it. As maps of the Dynamic Processes of Coney Island will illustrate, flooding occurred from the leeward side of the area, pushed in by the storm surge of the hurricane. The following chapter will explain how a storm surge works, what enhances it, and what can be done to decrease the run up of water.

Illustration 15: Inventory of flood-risks

SOURCE: Icons by author, 2013. Images from Google.

Workings of a storm surge

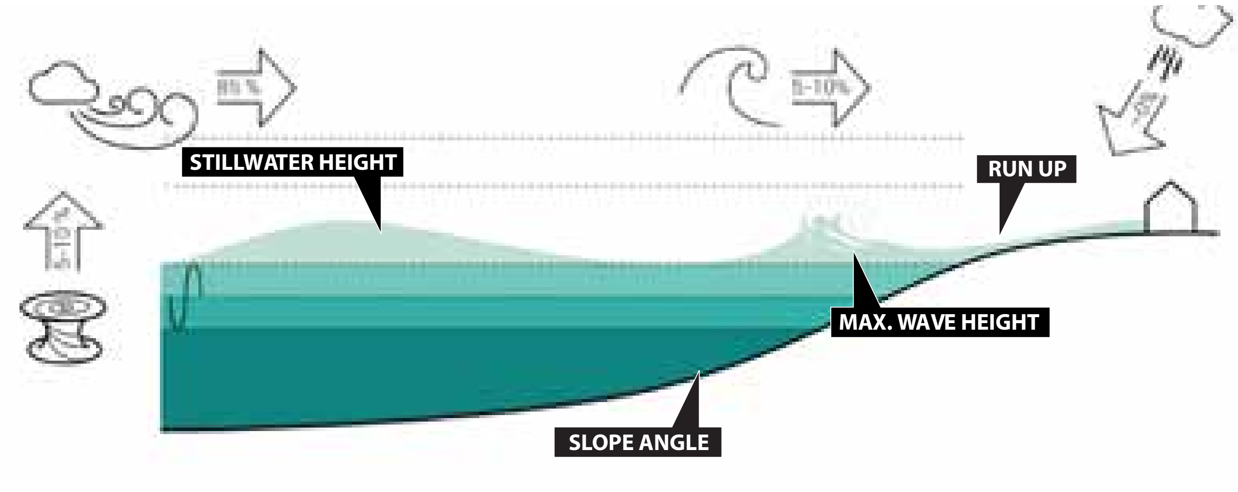
A storm surge is an offshore rise of water that occurs during a hurricane or nor'easter storms. Storm surges are primarily caused by strong winds; the wind circulation around the eye of the storm blows on the ocean surface water and raises the water. Both storm types occur in the New York region, but differ on important aspects. Nor'easters are cold-core lows that usually occur between October and April. Hurricanes are warm-core lows that happen between June and November. The difference in temperature also shows the difference in energy, warm-core storms have more energy and are more intense. Nor'easter storms are slower and have less energy. This results in lower storm surges for nor'easter storms.

A storm surge is built up when the storm is in deeper water, this rise of water level is hard to notice. Once the storm reaches shallower water, the circulation in the ocean becomes disrupted by the ocean bottom. The water can no longer go down, so it is pushed up onto land. This is called the run up of water. The energy behind the run up is so large that it can be pushed meters higher than the level of the main body of water (NOAA, 2011). As illustration 15 shows, there are three mechanisms that contribute to the energy of a storm surge. The winds piling up the water form around 85% of the energy of the surge. Waves pushing water inland in such a rate that it cannot drain off, this typically makes up 5-10% of the surges energy. The low pressure of a hurricane or nor'easter makes up only around 5-10% of the storms energy. Other aspects that increase the storm surge are the angle in which it approaches the shore, the depth and slope of the seabed.

The daily tidal fluctuation also influences the height of a storm surge. As is the case in Coney Island, the tidal range here is 1,60m every day. This makes a large difference in choosing the desired design height for the graduation project.

Illustration 16: Workings of a storm surge

SOURCE: Diagram by author, 2014.

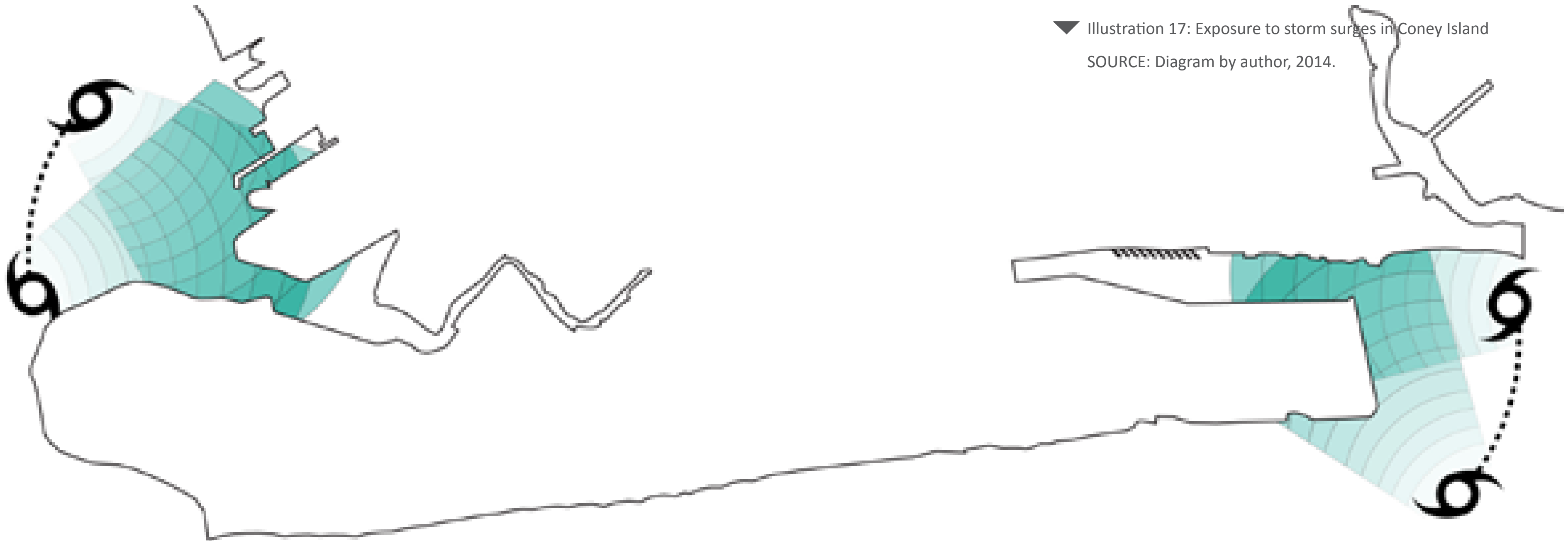


Interpretation

Comparing the two major storm systems that can occur in the New York City region, this graduation project needs to focus on decreasing the energy of a storm surge much more than heightening the coast of Coney Island. As nor'easter storms produce a much lower storm surge, the focus should lie on the much shorter but more intense storm surge of hurricanes. The buildup of energy by hurricanes is not changeable, but how this energy impacts the shore is. By changing the width, slope angle, and shape of the coastline, the energy can be deflected, absorbed or redirected.

On Coney Island, the shape of the peninsula makes the area very exposed to storm surges. As the main coastline is high enough to absorb the energy of a surge, the leeward side is not. As will become apparent in the following chapters, the northern side of Coney Island is shaped by man-made interventions and has sharp edges and corners. It also lacks proper circulation of the water as is the case by natural formed water bodies. The shape, length of the fetch, depth and coastal typology of the of Coney Island therefore act as a funnel in which the storm surge is pushed even higher, as the water cannot decrease its energy enough; the water is pushed land inward.

Illustration 17: Exposure to storm surges in Coney Island
SOURCE: Diagram by author, 2014.



Design water height in the future

To determine the design water height needed to protect Coney Island against flooding in the future, let's first look back at the effect of hurricane Sandy. Sandy struck Coney Island in two ways, directly from the coastline and through inland waterways at the leeward side. A combination of water hazards; wave forces, storm surge inundation, erosion and pollution all occurred during the storm. The communities at the most east and western edges of the peninsula where heavily impacted by wave forces directly. Even more significant though, was the inundation that occurred through the historic creeks and marshland that had been filled in decades before (NYC_ Planning, 2012). Through these routes storm surge flooding occurred. At the hurricanes peak, flooding reached a height of 2,5 meters in some places.
It is widely accepted that the future will bring even more frequent and intense storms (Gornitz et al., 2002). Coney Island needs to be prepared for storms more intense than hurricane Sandy. As hurricane Sandy was a category 1 hurricane, I believe that future improvements should at least prevent flooding of the same category storm in 2015, and a category 2 hurricane in 2030. A perspective can then be given about preventing flooding of a category 3 storm in 2050. The design water height of the storm surge will respectively be, 3 meter in 2015, 3,5 meters in 2030.

Interpretation

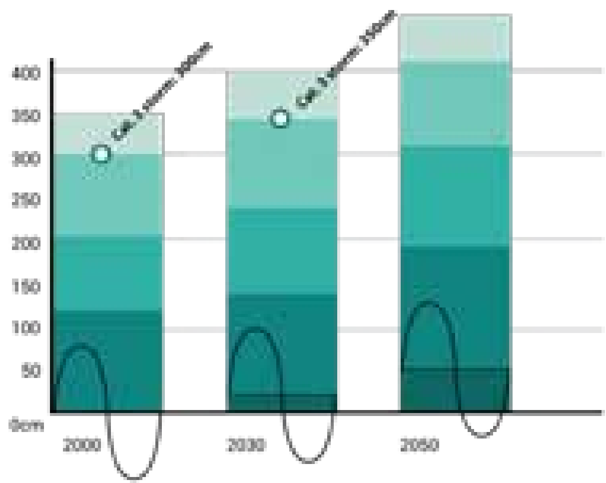
Even though the figures used to determine the design height are uncertain and the increasing intensity of a storm cannot be predicted over decades, I believe that it is important to understand what level of safety should be achieved by this graduation project. The reason for these somewhat simplistic decisions is that the most detailed predictions of 2030 and 2050 are made for the New York region (Gornitz et al., 2002, Pahl-Wostl, 2007). This means that by using these figures this graduation project can contribute to use in the academic discussion, as the predictions of both Gornitz and Pahl-Wostl will be translated into a design.

The following map illustrates the run up of a storm surge during a category 1 hurricane in 2015, and a category 2 hurricane in 2030. The information from this map is derived from the website of the municipality of New York City, (http://sealevel.climatecentral.org/surgingseas/place/states/NY). The design height against a storm surge is measured by the height of the main body of water.

! *What type of water hazards contribute to flood-risk (a), and which contribute to flood-risk of the communities of Coney Island (b)?*

Illustration 18: Exposure to storm surges in Coney Island
SOURCE: Diagram by author, 2014.

Illustration 19: Design water height in the future.
SOURCE: Diagram by author, 2014.




0
250
1000 m
Design height 2014 (1,50m)
Design height 2030 (2,00m)

Coastline typology

This series of maps was made to investigate the relation between land and water. The coastline is the first line of defense against sudden and gradual hazards. Different typologies of the coastline, and their relation towards different water hazards, need to be looked at to know where the current weaknesses are, as well as which coastlines work well. This relation is important to research, as the current and future flood-risk protection measures will have an influence on this relation.

Interpretation

The coastline of Coney Island has been divided into six different typologies; bulkheads, revetments, living shorelines, beach without protection and beach with groyne fields. Each coastline typology has a different set of qualities towards flood defense. In the map their level of protection towards certain hazards is shown. This information is derived mostly from the report Urban Waterfront Adaptive Strategies of the New York City department of Urban Planning (NYC_ Planning, 2012), but is more detailed for the use on the smaller scale of the graduation project. Noteworthy is the difference between man-made structures and natural coastlines. Man-made structures require much less space to be used as a protection measure. When the creek was filled in only a small part of the marshland remained. There also is a relation between the sub soil layer and the type of coastline. Revetments and bulkheads make up the entire coastline of the landfilled area, where natural typologies provide the relation between water and land on the sand subsoil. The areas that would be inundated by a 3 meter storm surge are protected almost entirely by man-made structures. These typologies are the weakest links in the coastline of Coney Island.

Coastline typology

Illustration 20-21: Coastline typology. SOURCE: Image by author, 2013.

Coastline height

The series of sections on the coming pages show the effect the design storm surge height of 3 meters and 3,5 meters will have on the coastline, combined with the predicted SLR of 30cm in 2030. With this knowledge, an assessment can be made on how exposed certain communities are towards flooding. This will be needed to prioritize flood-risk protection of Coney Island

Interpretation

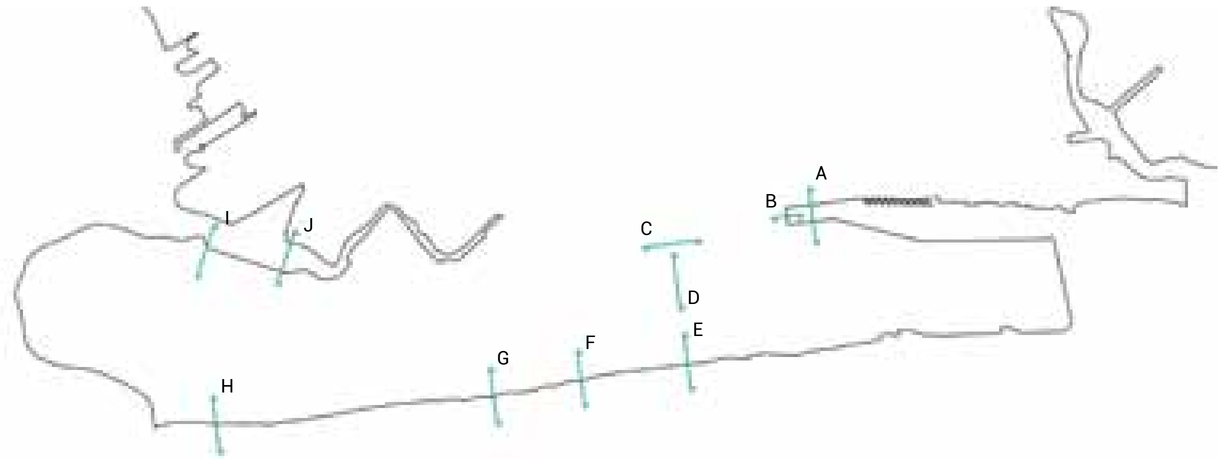
In the section is clearly visible that both Manhattan Beach as Canal Avenue are the most exposed to storm surge flooding. The height of the flooding could reach up to 2 meters, causing serious disruption of the communities. Other communities at the ocean waterfront next to the boardwalk are not flooded, but just barely. Rather than heightening the coastline at this location, the mitigation of wave forces and erosion will prove to be a more important issue to be resolved there.

This proves that, as the report from the New York City Planning Department stated (NYC_Planning, 2012), that storm surge flooding will occur not from the ocean side, but from the leeward coastline of Coney Island, where the historic creeks and marshland used to be located.

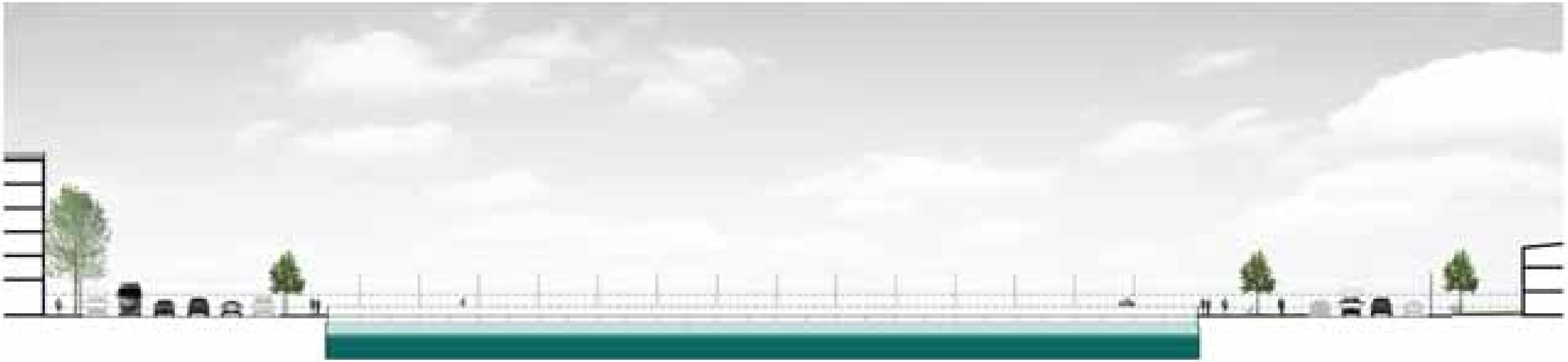
Illustration 22-31: Cross sections to analyse the flood-risk of the communities of Coney Island.

SOURCE: Diagram by author, 2014.

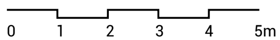
Storm surge 3,5m
Storm surge 3m
Expected water level in 2030; 0,30m.
Daily tidal fluctuation, range of 0,8m.
Current water heigth
Parked vehicles.
Road



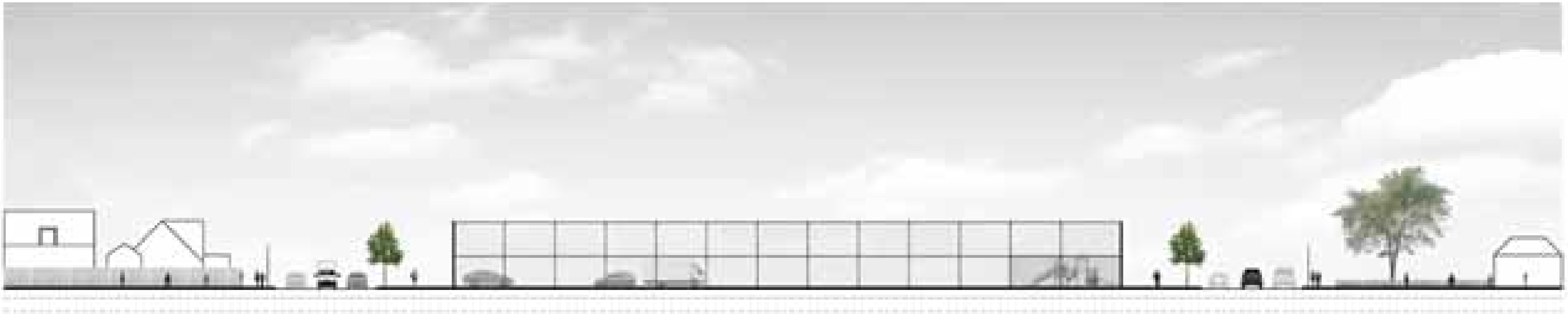
Section A, Manhattan Beach



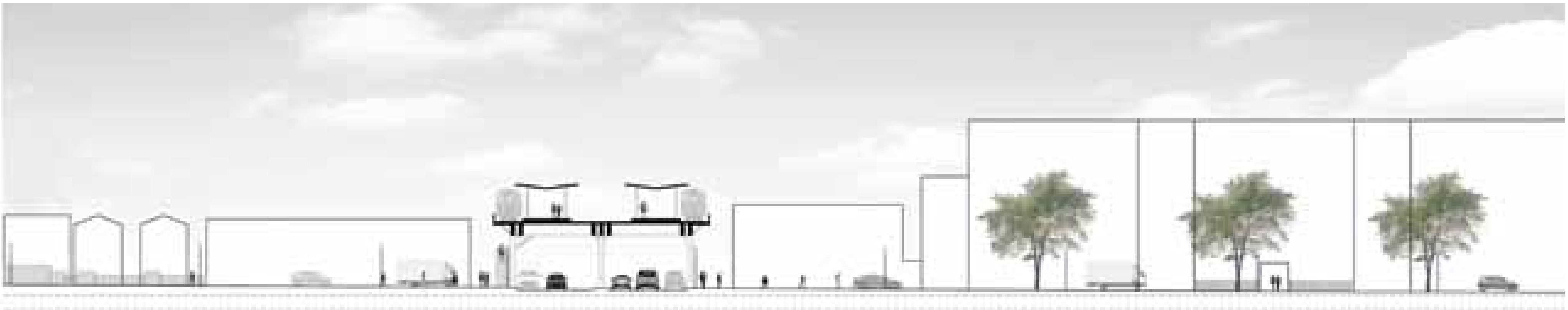
Section B, Manhattan Beach

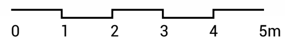


Section C, Little Odessa



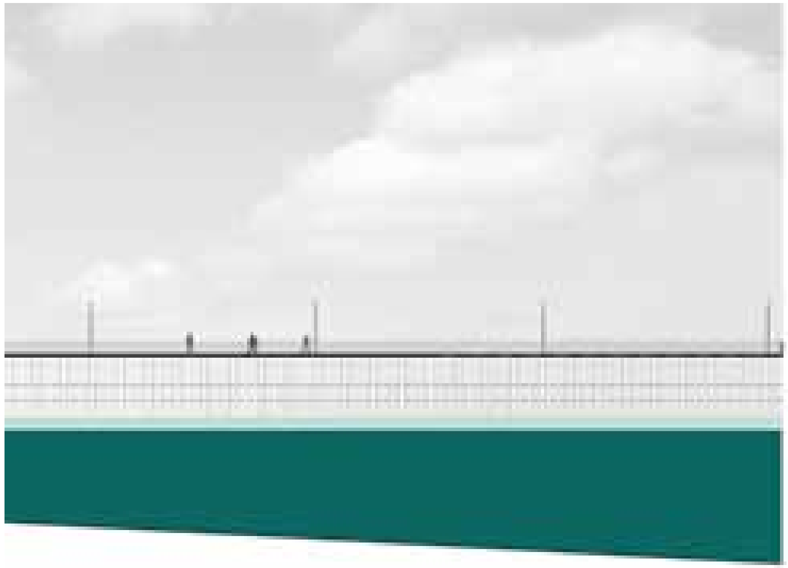
Section D, Little Odessa



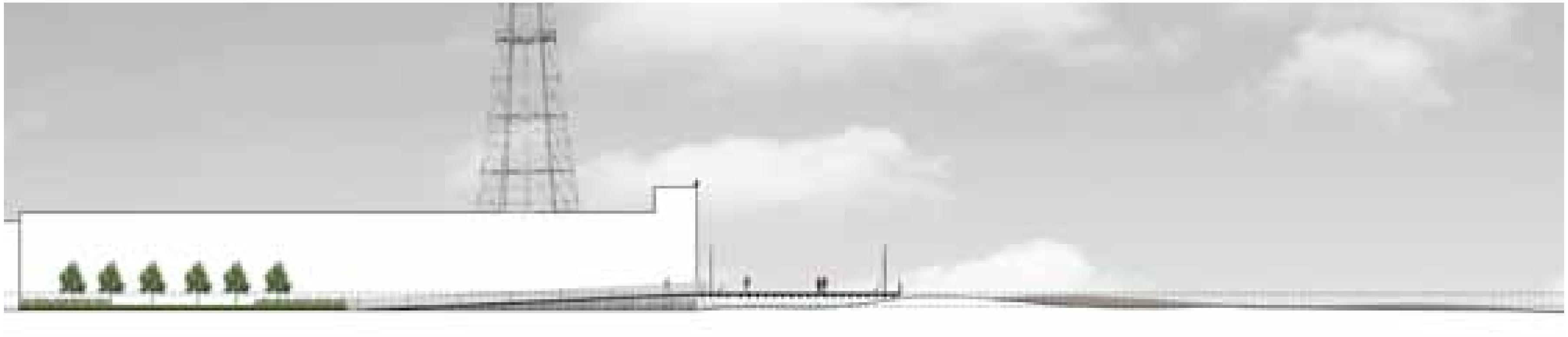


Section E, Boardwalk

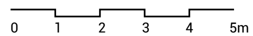
Section F, Boardwalk



Section G, Boardwalk

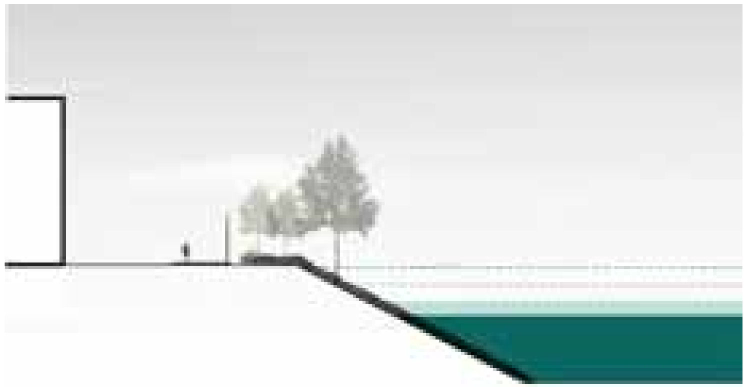


Section H, Boardwalk



Section I, Canal Avenue

Section J, Calvert Vaux Park and Mermaid Avenue



Vulnerability of communities

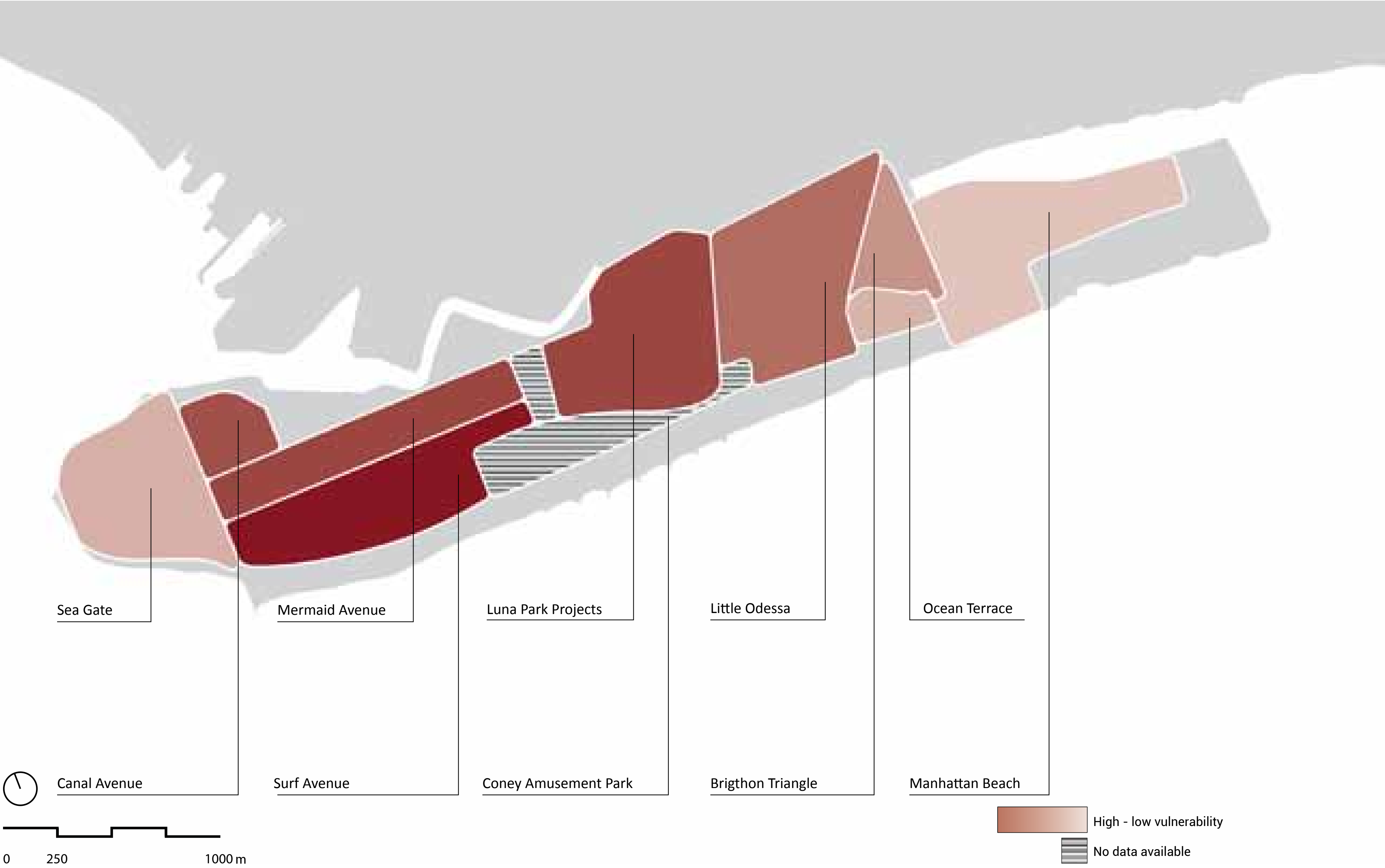
The vulnerability of the different communities on Coney Island is important to understand. As discussed earlier, flood-risk can be explained as the probability a hazard will occur multiplied by the consequence of that hazard. The probability can be decreased by flood defense measures. The consequence however, is more complex. To decrease the consequence of a hazard, the vulnerability of the inhabitants is the most important factor. In summary, vulnerability can be divided into three aspects, social, economic, and physical vulnerability (Cutter et al., 2008). The data used to analyze the vulnerability is from the New York City government. The data is available on http://oasisnyc.com/map.ax. How the distinction of the communities was made will be explained in chapter 4.2, spatial analyses. The exact data that was used for this assessment is located in appendix B.

Interpretation

This map shows the relevance to decrease the flood-risk for almost all communities. The fact that the vulnerability of most communities, such as Canal Avenue and Surf Avenue, is high means that there is a necessity to decrease the probability or consequence of flood-risk. The high vulnerability is mostly due to a high social vulnerability. When improving the social vulnerability, the consequence of flood-risk will therefore decrease. One of the main aspects to improve during this graduation project is therefore the social vulnerability. When the inhabitants of the different communities are less vulnerable, the consequence of a storm will also be less, reducing the flood-risk altogether.
One method to decrease the social vulnerability is improving the social cohesion between inhabitants (Walker et al., 2004). By increasing the social quality in communities, defined in chapter 2, this can be achieved. As an urbanist, I believe that urban design can improve the social quality of living environments. To do so, there need to be public space for people to interact, to do more than just the necessary activities. When the public space is enjoyable, people stay longer and interact. An urban design can facilitate this by creating a place where this optional activity can occur. For the design of the Coney Island Creek, discussed in chapter 7, this will be one of the most important issues to improve. On the larger scale, that of the entire Coney Island peninsula, an Urban Design Framework is a powerful tool for resolving these issues. It is particularly useful for identifying areas to integrate social characteristics with spatial interventions (McKee, 2013). A reference study on Urban Design Frameworks is shown in chapter 5. Each place has unique characteristics and potential, so the framework needs to be specifically adapted for each place. When the social cohesion within these communities is improved, the flood-risk will decrease.

! *What elements of a community make it vulnerable to flood-risk (a), and how vulnerable are the communities of Coney Island (b)?*

Illustration 32: Vulnerability assesment. SOURCE: Image by author, 2013.
Data household income and poverty value:
[Online]. Available: http://www.city-data.com/neighborhood/Canarsie-Brooklyn-NY.html [Accessed 14 November 2013].


Sea Gate
Mermaid Avenue
Luna Park Projects
Little Odessa
Ocean Terrace
Canal Avenue
Surf Avenue
Coney Amusement Park
Brigthon Triangle
Manhattan Beach
High - low vulnerability
No data available
0
250
1000 m

Flood-risk protection on Coney Island; classification

With the knowledge from the different water hazards, coastline typology, vulnerability and the flood protection measures, a classification can be made of the best suited flood-risk protection for Coney Island. This will be the first step in creating resilient communities on Coney Island. The inventory of protection measures is shown and discussed in Appendix C.

Interpretation

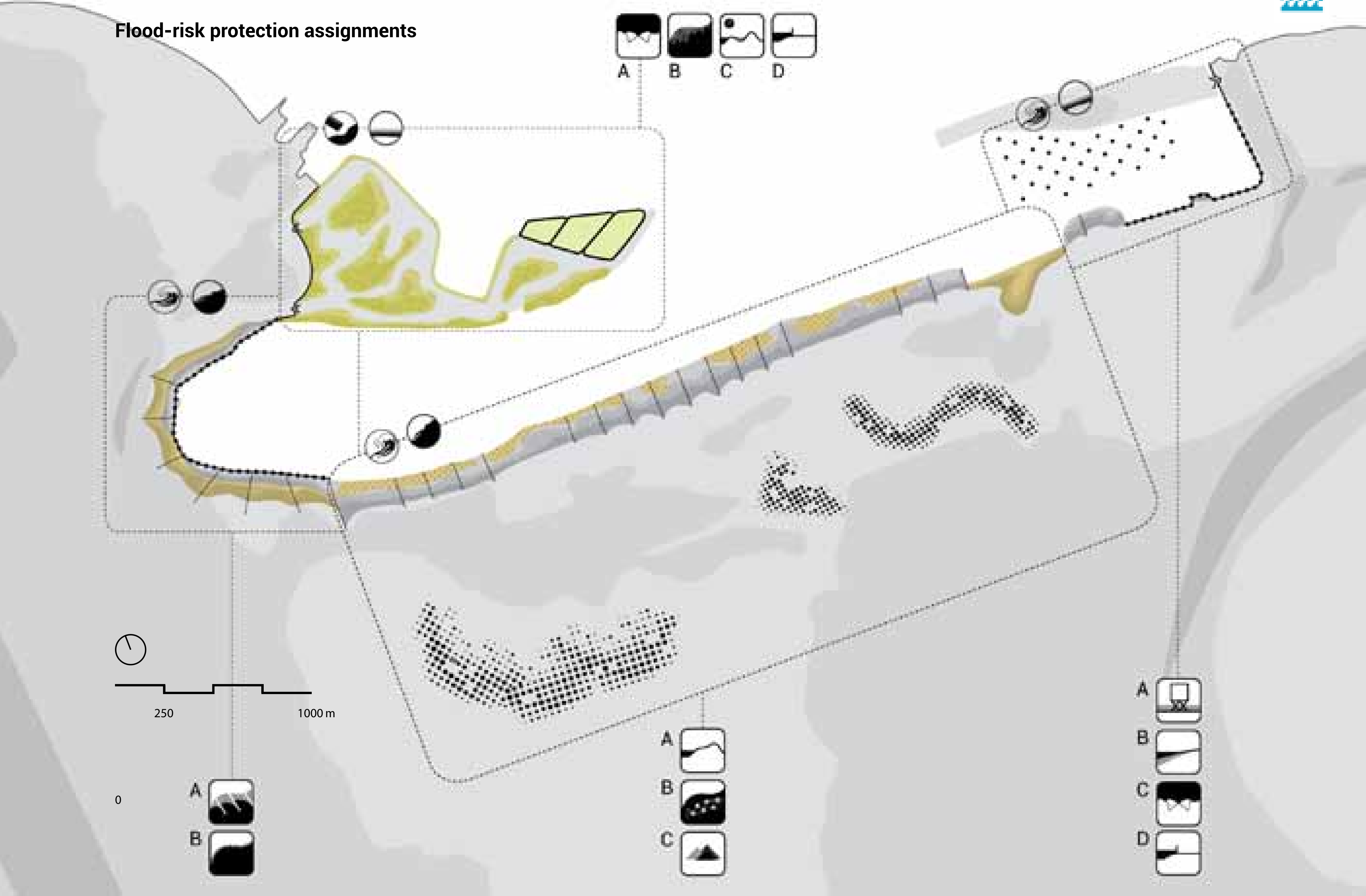
The flood-risk protection measures are classified depending on their protection against the water hazards of that location. For the Coney Island Creek for instance, storm surge inundation and pollution are the most pressing issues. By creating salt marshland, the pollution could be decreased, as salt marshes filter the water (Nelson et al., 2007). Another solution is buffering this sewage outflow in polders, so that the polluted water can be let out gradually, decreasing the impact on the environment. On the East side of Coney Island, Manhattan Beach has less space for the creation of marshlands. Here, revetments could decrease the wave forces on ocean side. On the North side, a storm surge could prevent inundation of the low lying parts. Another solution is individual protection. Manhattan Beach has a wealthy population and a low vulnerability. As illustrated in chapter 4.4, the size of the plot could facilitate own flood protection measures. The depth of the water around Coney Island is also important, when the water is deep, the expansion possibilities are small. Other protection measures, such as artificial reefs, can only be implemented in water less than 10 meters deep. By positioning the artificial reefs as shown in the map, the reefs will trap sand that is brought here by the tides from Jamaica Bay. These reefs could then mitigate the wave forces from the ocean during a storm and counteract erosion of the shoreline of Coney Island. The main stretch of coastline, where wave forces and erosion are the most important water hazards, dunes could strengthen the current beach. On the other side of the island, at Sea Gate community; groynefields could trap the erosion from the main beach to improve the protection of their own coastline.

In conclusion, using natural processes combined with man-made measures could increase the resiliency of Coney Island towards flood-risk. An example of dynamic natural processes can be used to mitigate flood-risk will be discussed in the next paragraph. A combination of both natural and man-made measures, adapted to each location, will be the best option, as most protection measures do not prevent all types of water hazards. In chapter 6 Framework Urban Design, the best suited measures according to the ecological and spatial/social assignments will be combined. Together with the phasing plan, this will form an adaptive Framework Urban Design for Coney Island.

! *What are resilient measures against flood-risk (a), and how can they be implemented in the context of Coney Island (b) ?*

Illustration 33: Flood-risk protection on location.
SOURCE: Image by author, 2014.

Flood-risk protection assignments



Eco-system based flood-risk potection

Conventional flood-risk protection, such as the construction of levees, revetments and storm surge barriers, are widely perceived as the best solution to mitigate flood-risk (Temmerman et al., 2014). These measures however are not always flexible, as their heightening and widening conflicts with other land use. Especially in urban areas, the improvement of man-made flood-risk protection measures requires the involvement of different actors and the maintenance costs are high. To keep up with the increasing flood-risk, these solutions are becoming more and more unsustainable (Nelson et al., 2007). On the other hand, the reclamation of wetlands and other coastal ecosystems has resulted in the loss of most of the natural flood defenses. This is also the case in Coney Island, as large parts of marshland where reclaimed for industrial harbor sites and a new residential area. It is no coincidence that those reclaimed parts are now the most exposed sites of the peninsula.

In recent years there is a growing interest in the potential of creating an eco-system based flood-risk protection. Compared to conventional man-made flood-risk protection, this natural protection system has the capacity to reduce storm waves and storm surges, and can keep up with the SLR by natural buildup of sediments. This last process could secure the long term effectiveness and provide the flexibly needed to create a resilient flood-risk protection system. Besides the benefits against flood-risk, the water quality could be improved(Olsson and Folke, 2004).

A successful example of this type of defense system is the Scheldt estuary in Belgium. High water levels have increased by 1,3 meters since the 1930s (Temmerman et al., 2014). More land inward the high water levels are even higher due to the reclamation of wetlands. This diminished the flood storage area and reduced the resistance to landward run up. From 2006 until the 2030s, over 4000 ha of historically reclaimed wetlands will be converted back into floodplains. The marshlands are being created by building sluices through the current levees to allow tidal flooding in the hinterland (Illustration 34).

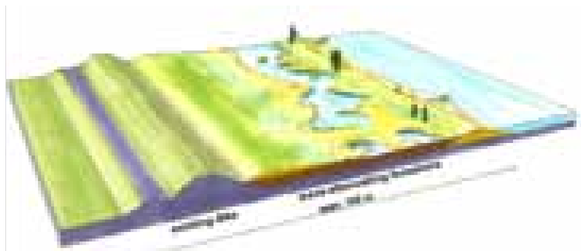


Illustration 34: Ecosystem based flood-risk protection, the Scheldt.
SOURCE : (Temmerman et al., 2014).

Important factors to take into account when construction such a defense system is the connection with the open water. This is needed for the natural accretion of sediments to naturally build up the area. Depending on the location of the defense system, the connection to fresh water is also needed. In the journal Nature, volume 504, a comparison is made to illustrate the potential and limitations of ecosystem-based coastal defense (illustration 29).

Interpretation

In summary, the creation or restoration of large coastal ecosystems could decrease wave forces, the storm surge height, the run up and accumulate sediments naturally (Temmerman et al., 2014). However, for this ecosystem to function properly, a large area of land is needed. For Coney Island, the creek would be a suitable location for this type of flood-risk protection. From a flood risk perspective, the space to function properly is there, and other issues could be resolved simultaneously. The ecological quality could also be improved, as chapter 4.2 will discuss.

Illustration 35: The potential and limitations of ecosystem-based coastal defense.

SOURCE : (Temmerman et al., 2014).

Affected variable	***Conventional protection measures***	***Ecosystem based protection***
Natural habitat	Degradation or destruction	Conservation of restoration
Sedimentation accumulation	Disturbed or stopped	Sustained
Land subsidence	Exacerbated	Counterbalanced
Storm surge propagation	Wetland reclamation reduces water storage and friction, enhance storm surge.	Wetland restoration enlarges water storage and frictional resistance
Long-term sustainability	Low, regular maintainance	High, ecoysystems are self maintaining
Cost-benefit	Moderate to high	Mostly high due to added benefits
Water quality	May degrade by accumulation of organic matter.	Improved and sustained by ecosystem
Human recreation potential	Negative perception	Positive perception
Required space	Moderate	High
Difficulty in creation defense measure	Moderate	High due to natural dynamics
Social and political acceptance	Widely accepted	Limited
Healt hazards	None	None


Gravesend
Coney Island

4.2 ECOLOGICAL ANALYSIS

To answer the main research question; "how can a spatial framework contribute to a resilient flood-risk protection, while improving the living quality of communities?", the ecological value of Coney Island needs to be analyzed. As the previous chapter discussed, natural processes could be a resilient method to mitigate flood-risk of coastal communities. These natural processes can be part of a resilient flood-risk protection system, as they will create a more flexible flood-risk mitigation system that can cope with the uncertainties of climate change and sea level rise. Historically speaking, this quality of the environment used to be one of the main reasons for people to settle somewhere. In our times, the transformation of nature through urban development has resulted in disturbed ecosystems worldwide (Perysinaki, 2010). Among many other things, this lost balance between nature and culture has contributed to the rise of sea level and more frequent and intense storms. As this project will focus on mitigating flood-risk, it is only logical to also improve the ecological quality of the site, helping to restore the balance.

This chapter will describe the historical habitats that once where the reason for settlement on Coney Island. Later on, the natural dynamic processes that have and will form Coney Island will be analyzed, showing the relation between nature and culture.

Historical habitats

Coney Island was once covered by a variety of habitats. According to the Native Species Planting Guide, a guidebook writing to help plantings in natural areas in the New York City metropolitan area, Coney Island was once covered by a variety of habitats. The largest part of Coney Island was dominated by ocean conditions and was quite monotonous, only a few trees that could stand the salt spray where present. At Coney Island Creek fresh water creeks from Brooklyn flowed into the ocean, resulting in a large diversity of conditions and wildlife. The transition between sweet and salt water, as well as the gentle slope, shallow waters and shelter from the ocean forces resulted in a flourishing ecosystem (Matsil, 2001). In illustration 30 the different habitats are shortly explained together with their respective location on the coastline compared to high tide.

1. Low salt marshland: A marsh community which occurs in sheltered, low-lying areas along the coast, in a zone from mean sea level up to mean high tide. These areas are regularly flooded by tides twice a day.
2. High salt marshland: A marsh community which occurs in sheltered, low-lying areas along the coast, in a zone from mean high tide up to the limit of spring tides. These areas are subject to periodic flooding by spring and flood tides. The high salt marsh is typically dominated by either saltmeadow cordgrass or saltgrass,
3. Maritime grassland: A grassland community that occurs on the Atlantic coast within the influence of offshore winds and salt spray. This community is usually dominated by turf-forming grasses.
4. Pine Barrens: Pine dominated forest at the coastline. Located at the edge of the coastline, in nutrient-poor grounds, affected by salt spray.
5. Tidal woodlands: A hardwood forest that occurs on mineral soils in the lowlands of river floodplains and river deltas. These sites are characterized by their flood regime; low areas are annually flooded in spring, and high areas are flooded irregularly.
6. Maritime forest: A dense forest located more upbank at the coast. Not affected by saltspray. Located near the edge of sweet and salt water.

Illustration 36: Historical map of 1830, Coney Island

SOURCE : Flickr.com

Interpretation

As the entire peninsula is densely urbanized, returning the ecological quality to what it once was is impossible. But, as shown on the historic map, the largest variety of habitats occurred there where the conditions where right, where sweet and salt water mixed, where the area was protected by ocean waves, and where the slopes where gentle. By bringing back these conditions, the large variety of the salt marsh ecosystem could be brought back.

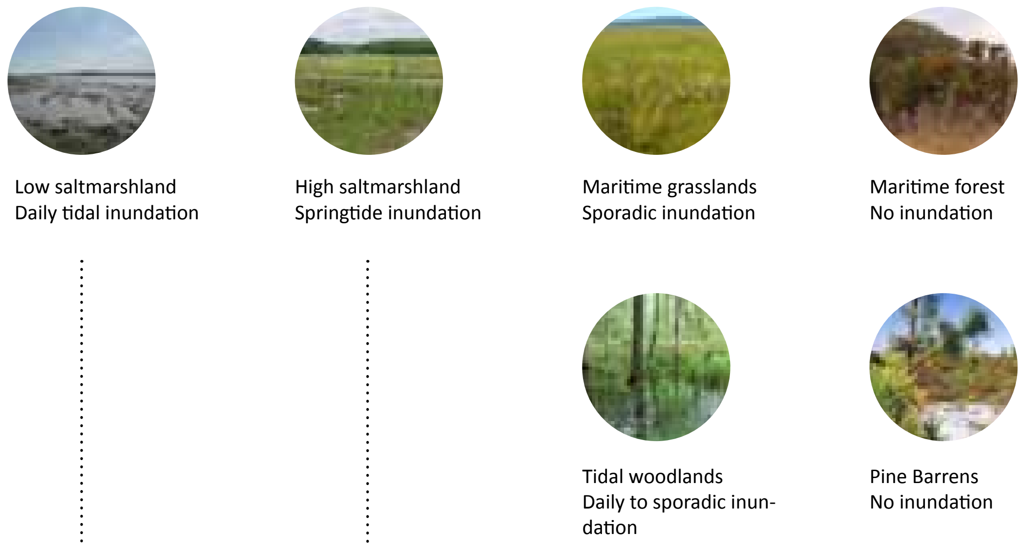
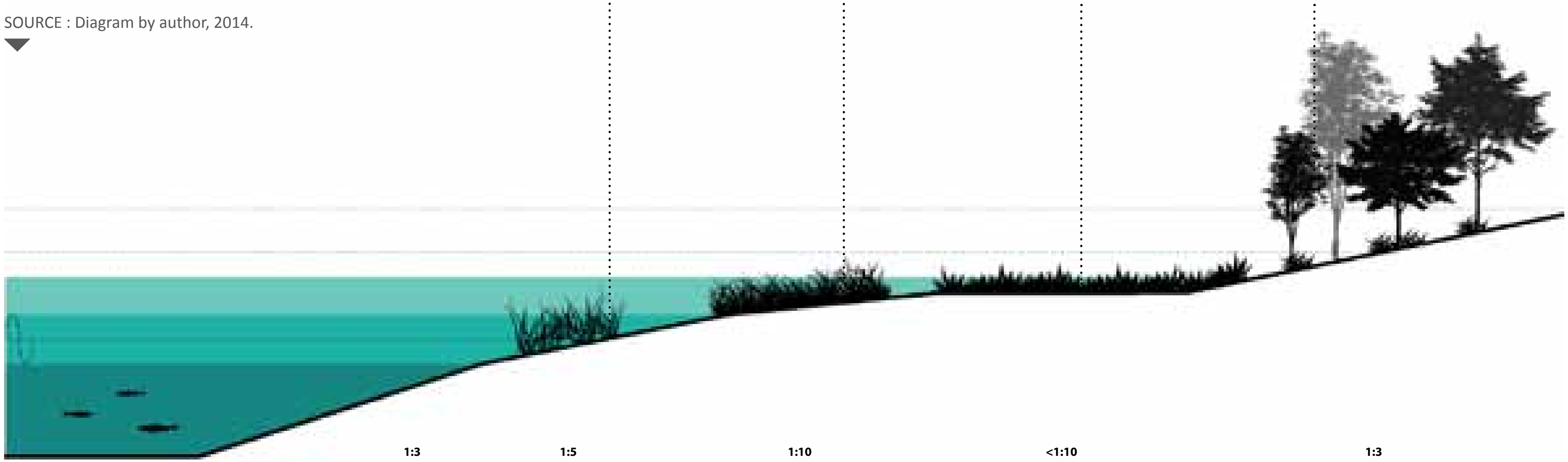


Illustration 37: Historical map of 1830, Coney Island

SOURCE : Diagram by author, 2014.



Dynamic processes of Coney Island

This series of maps is drawn to gather knowledge on the natural process that have and will shape Coney Island. As Nijhuis (2013) states on the website HowDoYouLandscape; 'The landscape can be considered as a process rather than as a result. Natural and social processes constantly change the landscape, making the dynamics of the transformation a key issue in research and design'. By acquiring this knowledge the threats and opportunities for natural processes to be used as design tool can be researched. For a more detailed analysis of the natural growth of Coney Island, appendix A can be consulted.

Interpretation of series

Coney Island, a barrier island located along the coast of Brooklyn has been formed by a continuous series of natural processes. Over time, Coney Island has always grown, nourished by the sand that eroded from other barrier island and the salt marshes of Jamaica Bay to the North East. Man-made interventions expanded Coney Island even more. The island was attached to the mainland during the 1920s landfill projects. To facilitate tourism, a boardwalk was constructed and the beach was extended towards the sea with groyne fields. From that time on, the beach needed to be replenished continuously to cope with the natural erosion, especially after major storms. The higher areas, on both East and West edges, are remnants of old dunes that used to be at the waterside. These dunes where nourished by sand that was brought up to the shore by the main ocean currents. When more sand was being dropped across the shore, Coney Island expanded towards the South. This had a significant effect on the growth of communities and the cultural significance of this area.

Looking at the gradual processes of today, we see that, due to the diminishing of salt marshes in Jamaica Bay, less natural sand suppletion of the coastline takes place. Now the coastline needs to be nourished artificially. Where natural nourishment did not take place, such as on the leeward side of the island, manmade landfill would enlarge the usable land surface. By reclaiming marshland for urbanization and industry, landfills have diminished the ecological quality of the area greatly. A relation between man-made land and inundation is noticeable, as landfill only heightened the land to just above sea level.

Another negative effect of the land reclamation is the lack of currents in these creeks. When the island became a peninsula, the water could not circulate anymore. In addition to this, combined sewage outflows in these creeks increase the pollution even more. During a storm with heavy rainfall, a combined sewage outflow discharges wastewater and storm water directly into the surface water. Combined with the lack of circulation, the Coney Island Creek is severely polluted.

These transformations, natural as well as artificial, are clearly visible in the topography of the island. When understanding the processes that formed Coney Island, a better understanding of the context and the origins of the communities is realized. The fact that Coney is now mostly urbanized means that it cannot adapt and move with the dynamic natural processes, the form of Coney Island is fixed. The fact that the main currents run parallel to the coast is an opportunity that could be used to apply natural processes in flood-risk protection measures. Sand from the East of Coney Island could be used for natural sand suppletion all along the ocean coastline. The sand that erodes from Jamaica bay could be useful to trap here as well. By trapping the sand, it can be used as natural replenishment of the coastline.

Historical natural processes

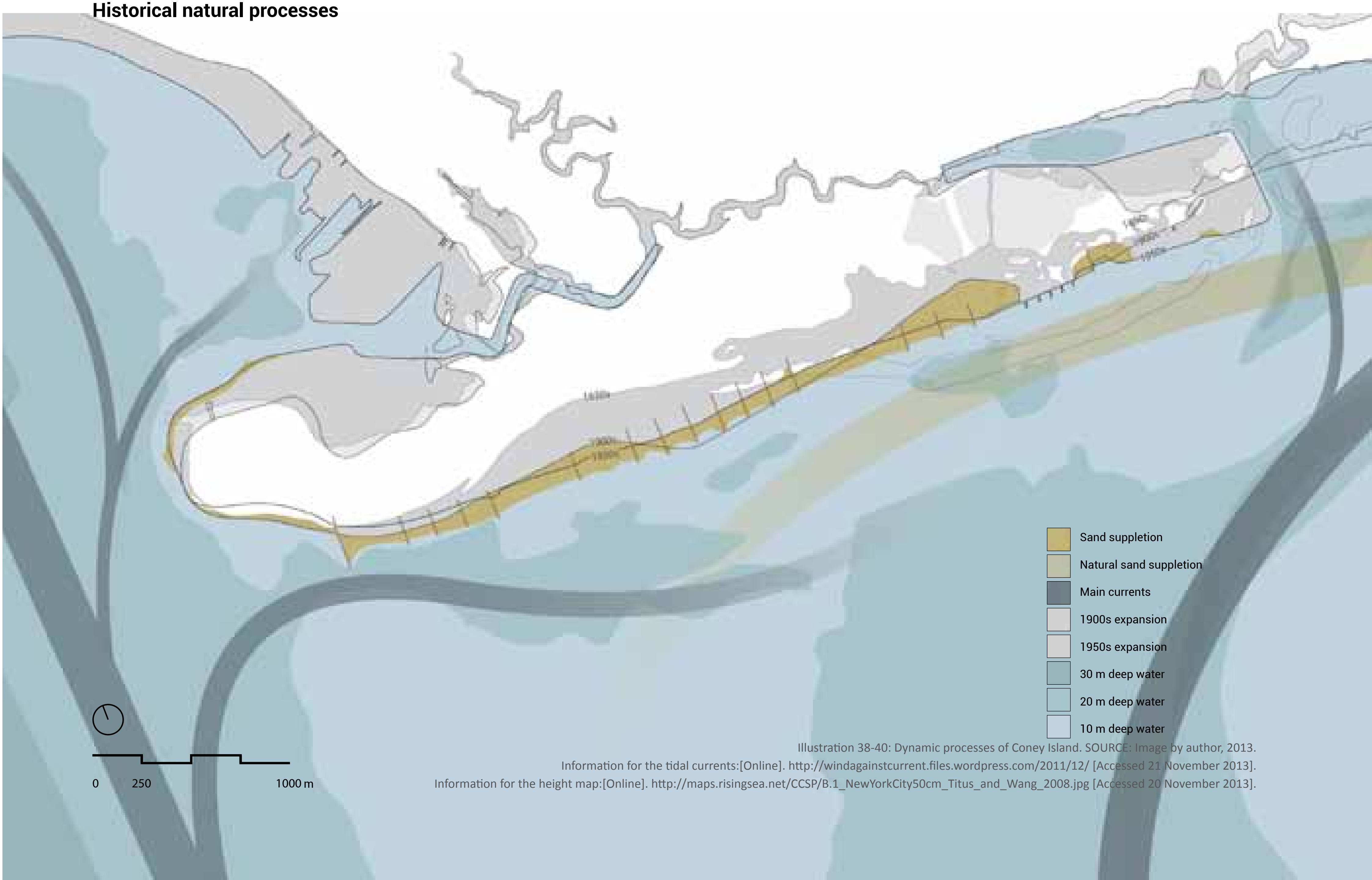
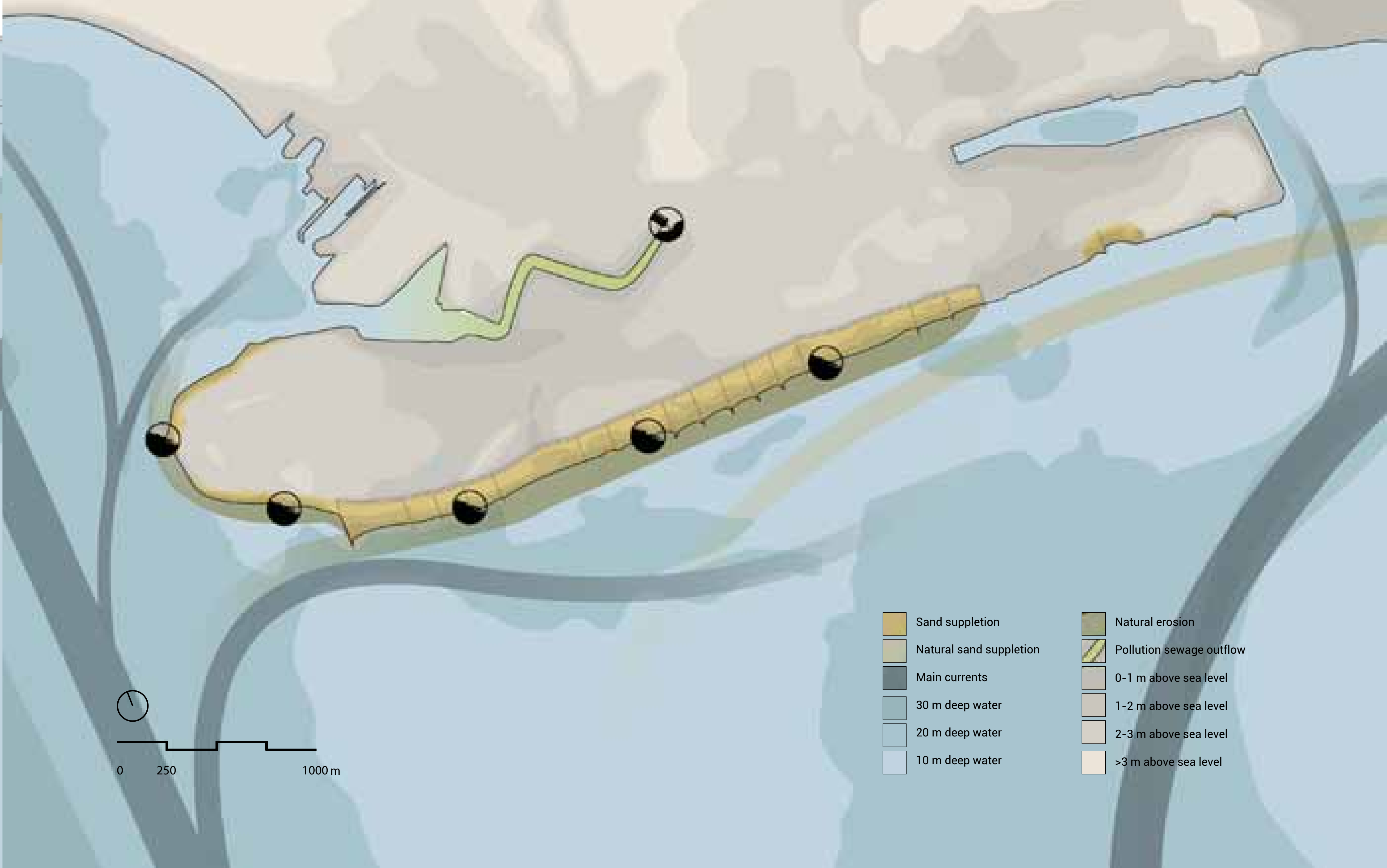
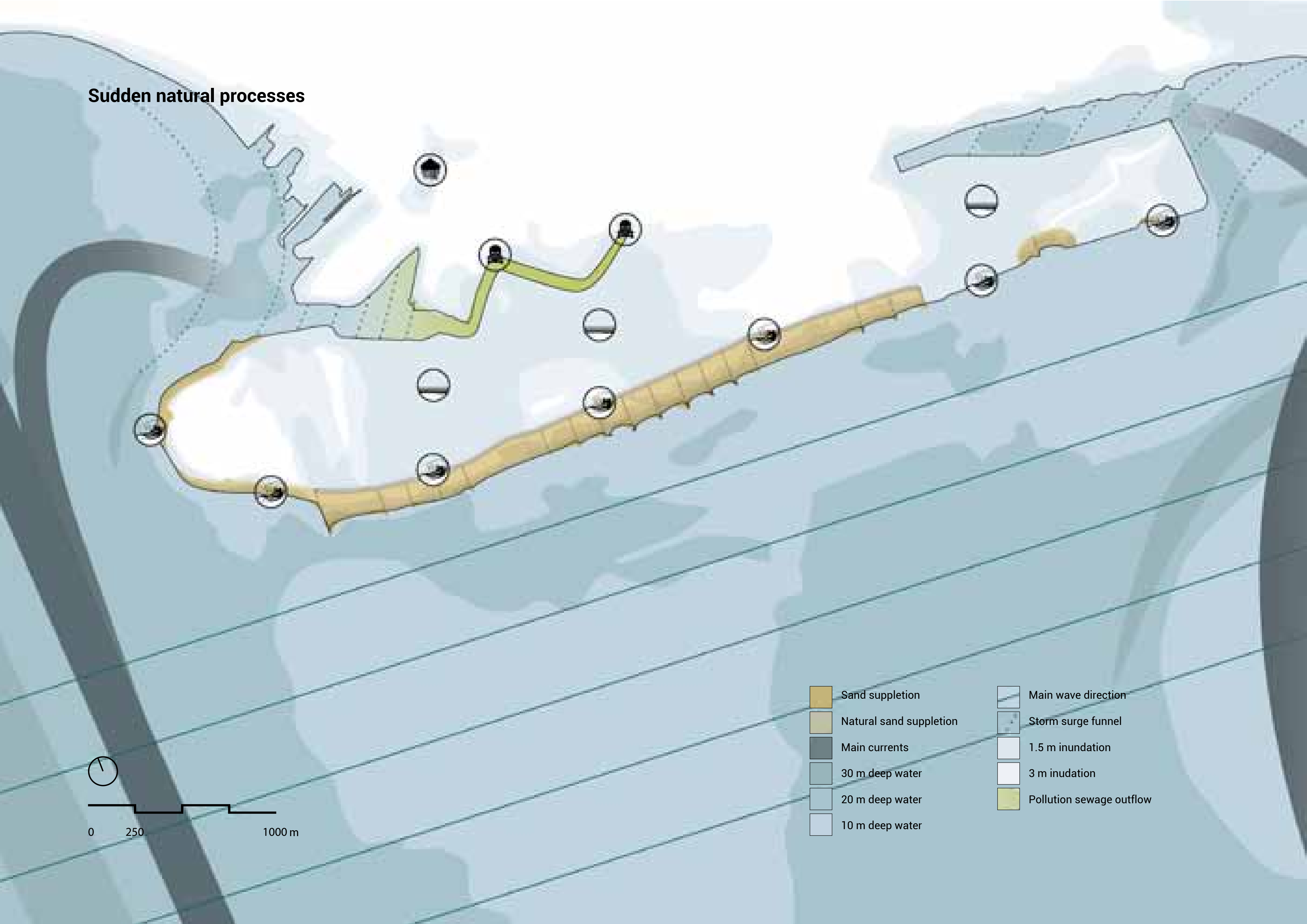


Illustration 38-40: Dynamic processes of Coney Island. SOURCE: Image by author, 2013.
Information for the tidal currents:[Online]. http://windagainstcurrent.files.wordpress.com/2011/12/ [Accessed 21 November 2013].
Information for the height map:[Online]. http://maps.risingsea.net/CCSP/B.1_NewYorkCity50cm_Titus_and_Wang_2008.jpg [Accessed 20 November 2013].

Gradual natural processes



Sudden natural processes



! *How can flood-risk protection measures increase the ecological quality of the area (a), and how could this contribute to the ecological quality of Coney Island (b)?*

4.3 SPATIAL ANALYSIS

To answer the main research question; "*how can a spatial framework contribute to a resilient flood-risk protection, while improving the living quality of communities?*", the spatial characteristics of Coney Island need to be researched. By understanding the origins of different areas and morphologies, the importance of the different urban structures can be recognized. This chapter will therefore show the interpretation of the cultural growth of the communities on Coney Island. It will explain the relation and borders between different communities and will explain how the island is used by both visitors and inhabitants. With this knowledge the social and spatial assignments to improve the living quality of Coney Island can be found.

Cultural growth of communities

As discussed, Coney Island has always been under the influence of natural processes. This was also the case for the cultural development of the area. If the historic context is understood, the urban fabric and spatial characteristics can be valued. A detailed series of maps showing the characteristics of each period can be found in appendix D.

Illustration 41 : Underneath the boardwalk.
SOURCE: Minchillo, J., 2013. http://kensinger.blogspot.nl/2009/03/coney-island

Over time, Coney Island has always been a natural refuge for the inhabitants of the ever denser New York region. As early as the 1800s, people have used this island as a place for leisure (Busá, 2010). Streets were paved and streetcars were constructed to facilitate large amounts of, mostly wealthy, people who would stay in the Victorian hotels on the coast. The infrastructure that was developed on Coney Island made it more and more accessible to other social classes as well.

In an attempt to satisfy each social class's entertainment needs, the island was split into three separate zones from east to west. The wealthy selected Manhattan Beach, the middle class chose Little Odessa, the working/poor classes were granted the central part of the island, and the underclass was left with Sea Gate (Busá, 2010). This has a direct relation to the transportation method. Manhattan Beach was secluded and only accessible by own horse carriage, as Sea Gate was only accessible by boat, which was a cheap transportation method at that time.

Illustration 42-43 : The contradiction of Coney Island

SOURCE : http://www.coneyislandcandy.ca/, 2013.

Later in the 1900s more infrastructural projects connected Coney Island and his leisure to the rest of the city. The luxury hotels disappeared, as it was able to reach the beach from Manhattan within hours. After the world fair that was held in New York in the 1930s, technical marvels were brought to the entertainment parks of Coney Island. These objects gave pleasure to the masses. The technology and leisure combined gave this place the nickname 'playground of the world'. Objects as the parachute jump, and the abundant use of electric lighting gave this place an out of this world atmosphere(Burby, 2002).

Illustration 44: Playgournd of the world.

SOURCE : http://www.coneyislandcandy.ca/, 2013.

That atmosphere changed during the 1950s.
Large parts of public beach were being used by amusement parks and the separation between public and private space was vague. To provide an open access to the main attraction, the beach and ocean, Edward Riegelmann (As Brooklyn Borough President from 1918 to 1924,) took charge of beautifying Coney Island and ensuring public access to the beach and shore through a boardwalk (Denson, 2004). This boardwalk demolished large parts of the amusement district and is still the same form and shape now as it was in the 1930s.
In 1953, when Robert Moses was running the City's Slum Clearance Committee, he rezoned large parts of land to make room for high-rise public housing projects. After this urban-renewal plans took place, and middle class houses were replaced with housing projects, the local crime rate soared, fewer people visited Coney Island, and many amusement owners abandoned their properties (Denson, 2004).

Illustration 45 : A line in the sand.

SOURCE : http://www.shorpy.com/, 2013.

What is now visible of the history of Coney Island is mostly the urban fabric. The iconic structures from the heydays of mass tourism are now dominated by large social housing projects. Large infrastructure constructions remain, only necessary for the warm summer days when inhabitants still visit Coney Island. Due to the interventions of Riegelmann by placing a barrier between the amusement and the beach, Coney Island still remains one of the only public beaches of today.

Illustration 46 : A line in the sand.

SOURCE : http://excitingny.com/, 2013.

What lies in the future of Coney Island is uncertain. After the financial crises and the destruction after hurricane Sandy, most development plans are on hold. There is one large urban renewal plan that is still being developed, the Amusement area redevelopment plan. This plan proposes a mix of residential, commercial and leisure around the current, outdated, boardwalk park. The residential properties will be available for higher and middle income to attract new inhabitants. This brought a lot of resistance by the current inhabitants. Organized as the People's Coalition of Coney Island, they encourage the general public to see the neighborhood beyond its amusements and demand for re-investment of a portion of amusement profits in the community. As told previously, most communities in Coney Island are social vunerable and life in poor conditions. According to the Coalition, new investment should be channeled not only into new development, but also toward preservation of what already exists. 'Because beyond the rides, Coney Island is home to a low- and moderate-income community that continues to face many challenges rooted in urban poverty' (Busá, 2010).

Illustration 47 : New development. SOURCE : www.nyc.gov, 2014.

Cultural growth of communities

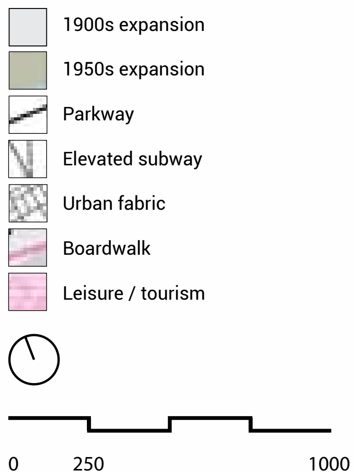


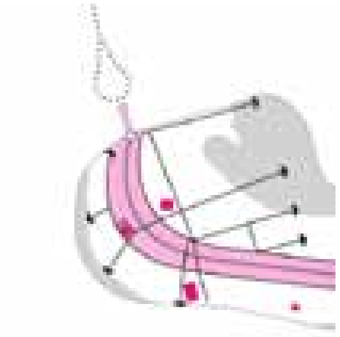
Illustration 48-51: Cultural growth of communities. SOURCE: Image by author, 2014.
Information historical maps:
1850s map: Bien, Joseph Rudolf; Vermeule, C. C.
[Online]. Available: http://seaandskyny.com/ [Accessed 12 November 2013].
1900s map: 1899 map of Coney Island, Brooklyn, New York.
[Online]. Available: http://commons.wikimedia.org/wiki/File:1879_Coney_Island.jpg [Accessed 12 November 2013].
1950s map: 1944 US Coast Survey chart, Coney Island, New York.
[Online]. http://www.thenatureofcities.com/2013/01/02/what-was-hurricane-sandy[Accessed 12 November 2013].

Cultural growth of communities

SEA GATE

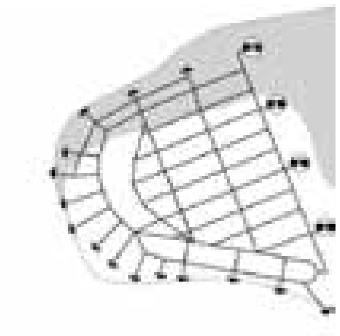
1850s

One road from pier to coast, flanked by leisure for the working class.



1900s

Railway connects Sea Gate to the rest of Coney Island, results in a new axis where leisure takes place. Fan shaped extensions towards the coastline due to expansion of shore.



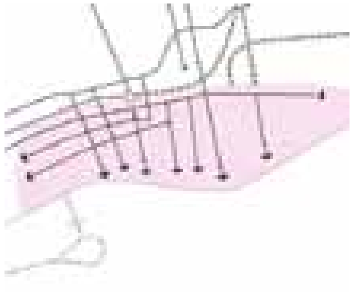
1950s

Landfill makes the urbanization of the entire area possible. Due to social housing projects, this area becomes a residential, middle class, community. Possible also due to the social housing projects is the transition towards a gated community in the 1950s.

AMUSEMENT PARK

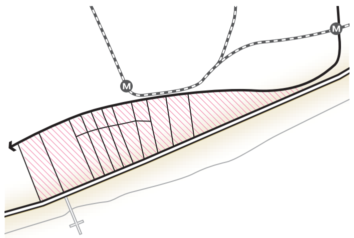
1850s

Streetcar and roads all end at the ocean, flanked by leisure.



1900s

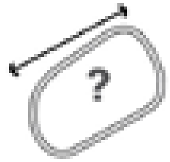
Large natural expansion of the coastline due to sedimentation. The existing roads extend towards the coastline, creating long parallel blocks.



1950s

Riegelmann boardwalk demolishes entire leisure blocks, ensuring public access of the coastline.

LITTLE ODESSA

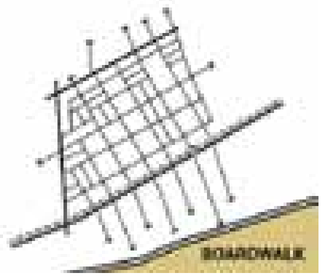


1850s

Old racetrack is abandoned in the early 1900s.

1900s

Jewish immigrants settled here during the 1900s and 1950s from the former USSR.



1950s

This immigrant enclave keeps attracting other immigrants from former soviet states densifying and expanding the community outwards. community in the 1950s.

Current use of Coney Island

This map will illustrate the different areas different people use. This map is made to understand what areas and streets are important for certain activities. The people are divided into visitors and inhabitants, as they require different amenities from the location.

Interpretation

Noticeable is the difference in North and South of Coney Island. The northern part is mostly used by inhabitants; the park is there, as well as every day functions. Visitors come here for the two main attractions, the amusement park and the beach. This is visible in the difference in width and the direction of the road. Large carparks are situated along these roads, which are mostly vacant during the cold months. Another interesting element is the lack of visibility of the coastline from the main access roads. You can image that, if you come here as a visitor, you would want to oriented yourself and see your destination as soon as possible. The park that is mainly used by inhabitants is not connected at all by foot or bicycle. A large detour needs to be made by car to visit this park. The improvement of these elements needs to be addressed in the design for Coney Island Creek.

Illustration 52: Use of Coney Island

SOURCE : image by author, 2014.


Road used by inhabitans
Every day public functions
Leisure / tourism
Point of interest
Parking used by inhabitants
Parking used by tourists
Subway station
Beach
Park
0
250
1000 m

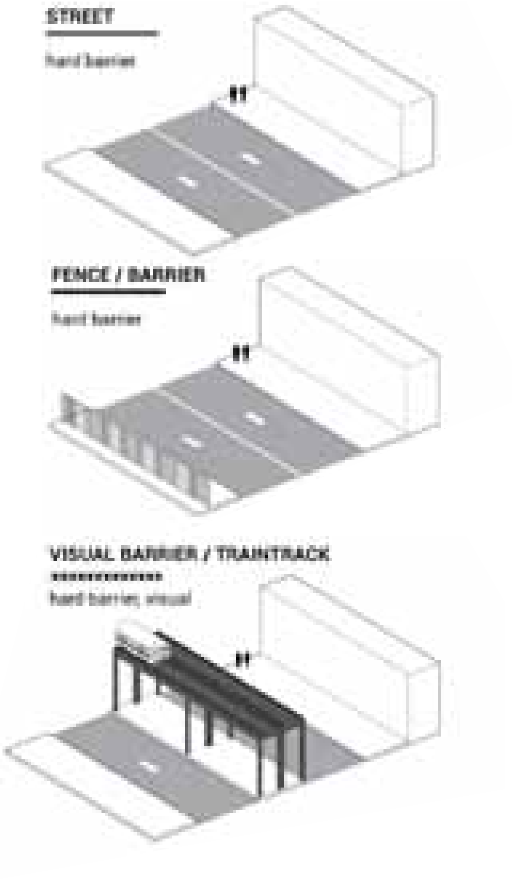
Border conditions

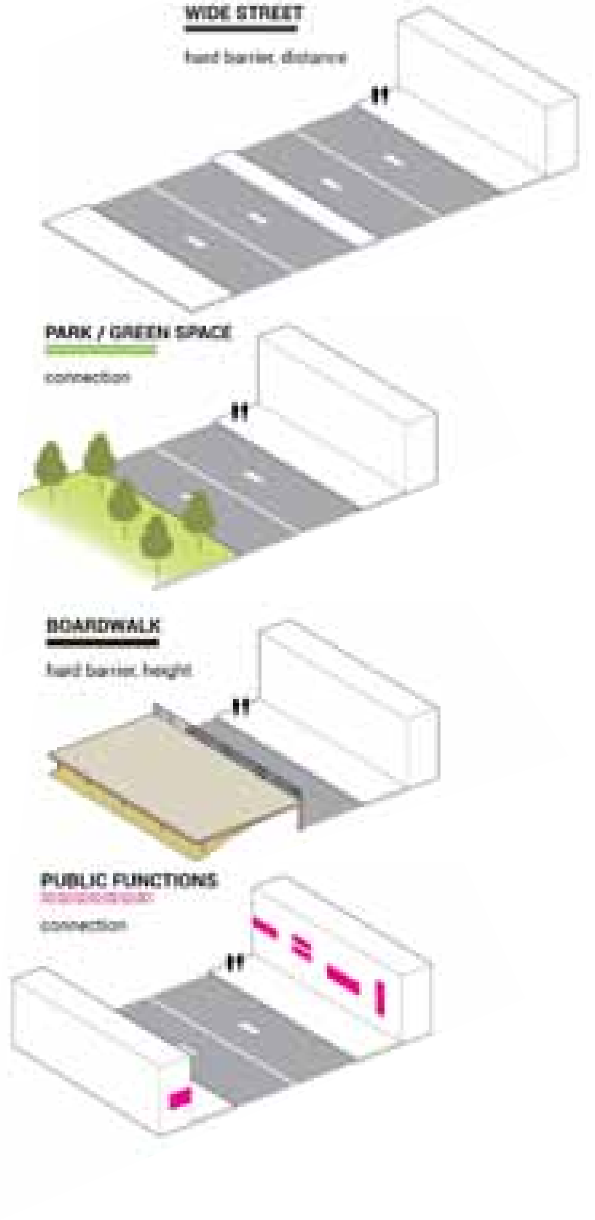
To understand the relationship between different communities, the borders between them need to be investigated. These borders are important to understand, as some will form a barrier while other can be a connecting element between them. With this knowledge, the flood-risk measures and spatial assignments will fit better in the context of the communities.

Interpretation

The borders between the communities of Coney Island are divided into seven categories. They are categorized compared to the extent that they disconnect or connect inhabitants. The parkway road that borders most of the Luna Park community for instance is a hard barrier due to the intensity of traffic and the distance to cross the road. Another border, such as the one between Mermaid Avenue and Surf Avenue is a connecting border, as there are public functions on both side of the road.
In summary, the connection between East and West Coney Island is difficult, as most borders here are hard to cross. The gated community of Ocean Terrace also disrupts this connection greatly. This has to be taken into account in the design process.

Another barrier that is less obvious is the boardwalk. The boardwalk does provide a good access to the beachside, but it disconnects the communities with the waterfront due to the height difference. This is an important aspect to take into account for the design phase.





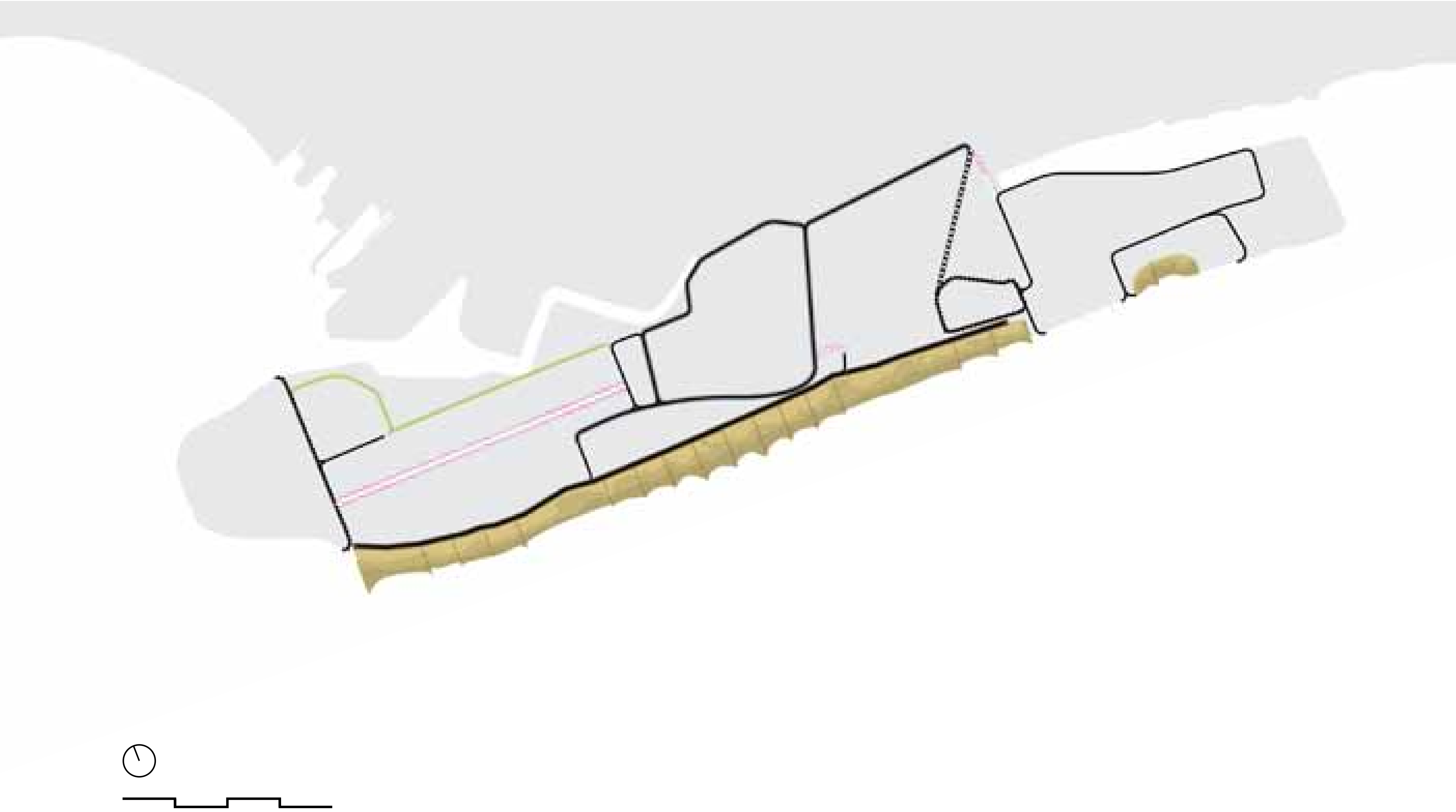
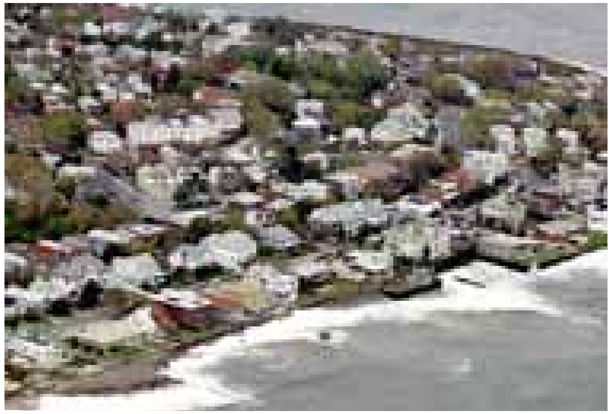


Illustration 53 : Border conditions SOURCE : image by author, 2013.


Sea Gate


Canal Avenue


Mermaid Avenue


Surf Avenue


Luna Park


Little Odessa


Ocean Terrace


Brighton Triangle


Manhattan Beach

SPATIAL ANALYSIS OF THE COMMUNITIES

This series of maps will go into the spatial characteristics of each community. Through this in-depth analysis the unique qualities of each community will be found. The information found here will lead up to detailed spatial and social assignments. This information is needed to combine flood-risk protection measures with these assignments. When understanding the threats and opportunities in every community, a spatial design such as the flood-risk protection measures, can be adapted to take these elements into account. A combination of these design assignments will form the framework urban design that will create resilient communities in Coney Island. An analysis of the main building block typology will show the relation between public and private space, as well as the relation between individual plots. This information can help in finding the atmosphere of the area. Appendix E shows the detailed findings of the analysis. The analyses lead up to an objective assessment of the spatial quality, according to the principles of discussed in the book ‘Kwaliteit in meervoud’ by Habiform, a knowledge network of professionals in the field of spatial quality in the Netherlands (Hooimeijer et al., 2001). This matrix combines the three basic principles of spatial quality with four criteria which play a role in the design of space, namely the economic, the social, the ecological and the cultural criteria. A combination of different uses of different values indicates a higher spatial quality. An example is shows in illustration 67.

Illustration 67: Example of the spatial design matrix.

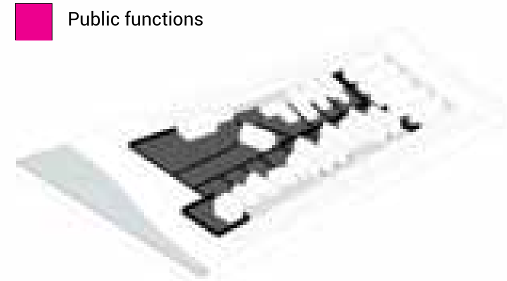
SOURCE: Hooimeijer et al., 2001.

	Economic	*Social*	*Ecological*	*Cultural*
Functional use	*Location* *Accessibility* *External effects* *Multi-purpose*	*Admittance* *Distribution* *Participation* *Choice*	*Safety* *Pollution* *Value*	
Perception	*Image* *Attractiveness*	*Inequality* *Solidarity* *Safety*	*Tranquility* *Cleanliness* *Healty*	
Future value	*Flexibility* *Agglomeration*	*Containment*	*Supply* *Ecosystems*	

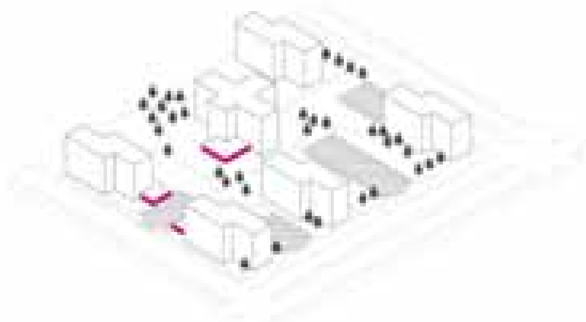
Illustration 54-66: Street view from each community.

SOURCE: Images from Google Maps, 2013.

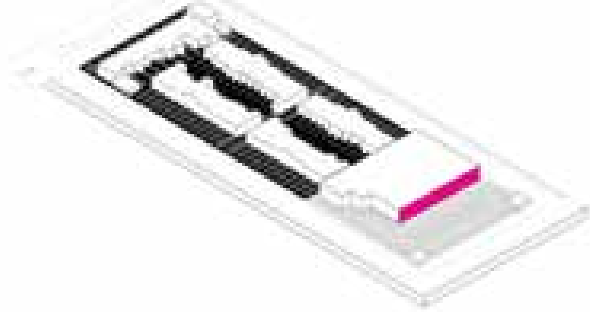
Private outdoor space
Semi private space
Public functions



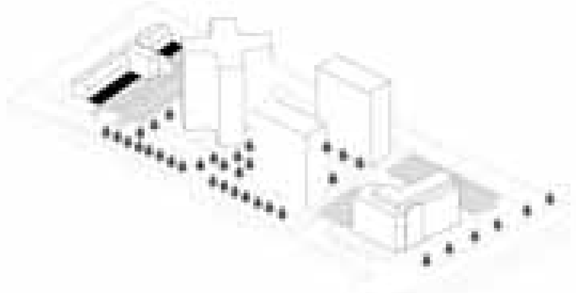
Sea Gate



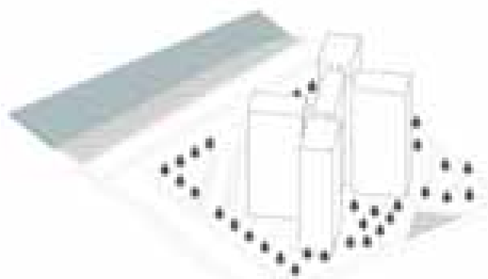
Canal Avenue



Mermaid Avenue

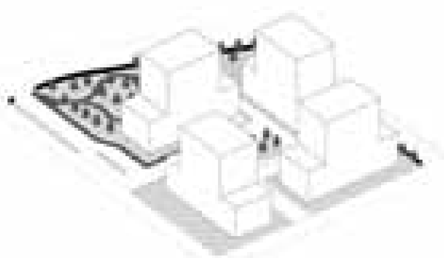


Surf Avenue



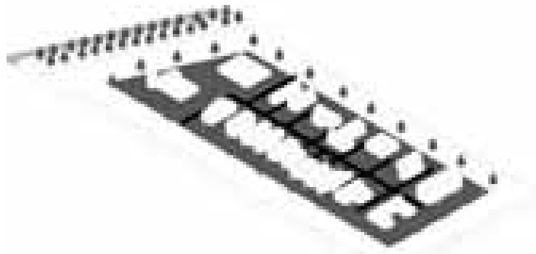
Luna Park

Little Odessa



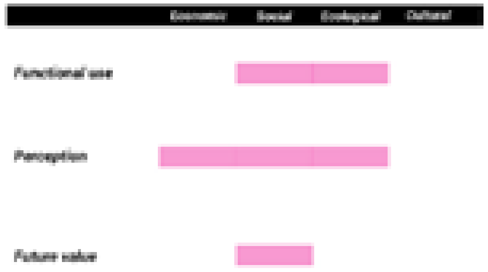
Ocean Terrace

Brighton Triangle

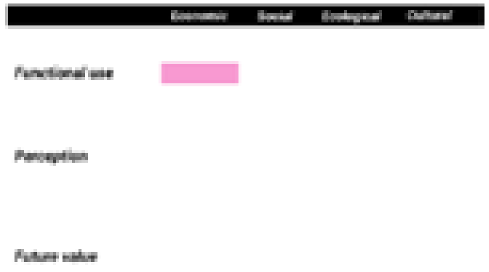


Manhattan Beach

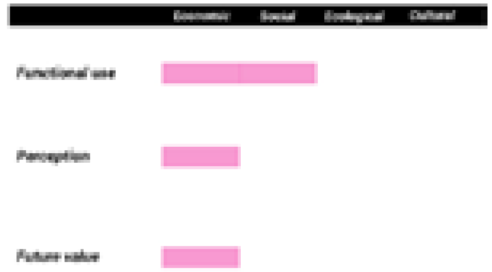
Interpretation of the spatial quality



Sea Gate



Canal Avenue



Mermaid Avenue

Surf Avenue

Luna Park

Little Odessa

Ocean Terrace

Brighton Triangle

Manhattan Beach

Interpretation

From the analysis of the different communities some areas stand out in a negative way. The communities of Mermaid Avenue, Canal Avenue and Luna Park score poorly on the spatial quality of their community. This is mostly caused by the lack of diversity, in both functions as in appearance, and the lack of social safety. The current use of the communities is poor, as well as the perception of the place. The future value is therefore also low, as there are not a lot of positive starting points to work from. Luna Park does have a positive score on economic future value, as the location towards the subway station and main access road, together with the large amount of undefined public space, does provide opportunities for renewal.

! *What is the distinction between the communities of Coney Island?*

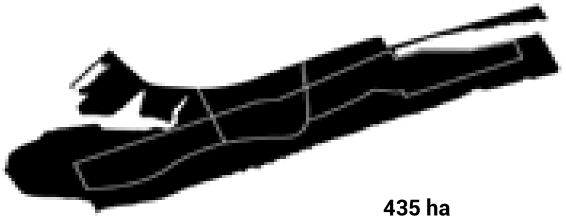
Illustration 68-93: Analysis of the spatial quality of the communities of Coney Island. SOURCE: Images by author, 2014.

5. REFERENCE STUDY

Reference studies were made to research two different relationships. The first is how the dynamic natural processes can be used to increase both the ecological quality, as well as mitigate the flood-risk. This relationship, as well as its potential and its limitations have been discussed in chapter 4.2.
Another important link in this graduation project is the relationship between ecological quality and the quality of life within communities. This also requires the use of dynamic processes within the strategy.
To cope with the uncertainty that climate change brings forth a flexible strategy is needed. This strategy needs to be able to adapt to changing conditions, it must be able to adapt to the demands and requirements that flood-risk, ecology and community life that will change over time.
An important aspect when working with these dynamic processes and changing conditions is the factor time. Natural processes have a certain rhythm and do not always coincide with the short term needs of people. This is also true for the flood-risk, which is an issue that needs to be addresses straight away, even though the chance of a storm occurring is small. As ecological quality, flood-risk also requires a long term vision that needs to be adapted overtime.
To understand how a strategic plan can deal with this uncertainty and how it can create conditions for flexible and multipurpose use of land, a reference study of two Framework Urban Design is done.
A framework urban design can be characterized as followed:

> 'Unlike a master plan, which only gives a final vision for how an area will develop, an Urban Design Framework should provide flexibility by identifying key principles rather than finite solutions. It is not a fixed view of the future nor is it a land-use report. It includes a design vision for how a place might develop and should include sufficient detail at key locations so that the vision can be tested for economic and functional viability. An Urban Design Framework should include sufficient information to allow continuous review of detailed actions within the strategic frame.' (McKee, 2013: p.7).

These reference studies were chosen to investigate the relationship between ecological quality and the social and spatial use. Both reference studies have a resemblance with Coney Island. Lower Don Lands is located former marshland that was channelized, like Coney Island Creek. Lake Ontario Park is located at the waterfront of a heavily polluted shoreline, next to urbanized area.



435 ha

270 ha

374 ha

Lower Don Lands, Stoss Landscape Urbanism. 2012
Location:
Former estuary that is now highly urbanized.
Toronto, Ontario
Cananda

Stoss Landscape Urbanism work with a systems-based approach, using natural processes as concept where possible. Their goal is use these processes within their design and ultimately, connect and encourage human engagement (Cadenasso and McGrath, 2013). The aim of the project was twofold, to improve the ecological quality of the river mouth, and to cope with the economic transformation of the area from an industrial harbor to a vacant and underused area. As is the case in Coney Island, Stoss Landscape Urbanism had to find a way to balance these conflicting human and environmental demands in a flexible way so that it remains open for future adaptation (Cadenasso and McGrath, 2013). Instead of focusing only on the needs of the expanding city, the new river mouth forms the basis for the urban design, giving it the space to function ecologically.

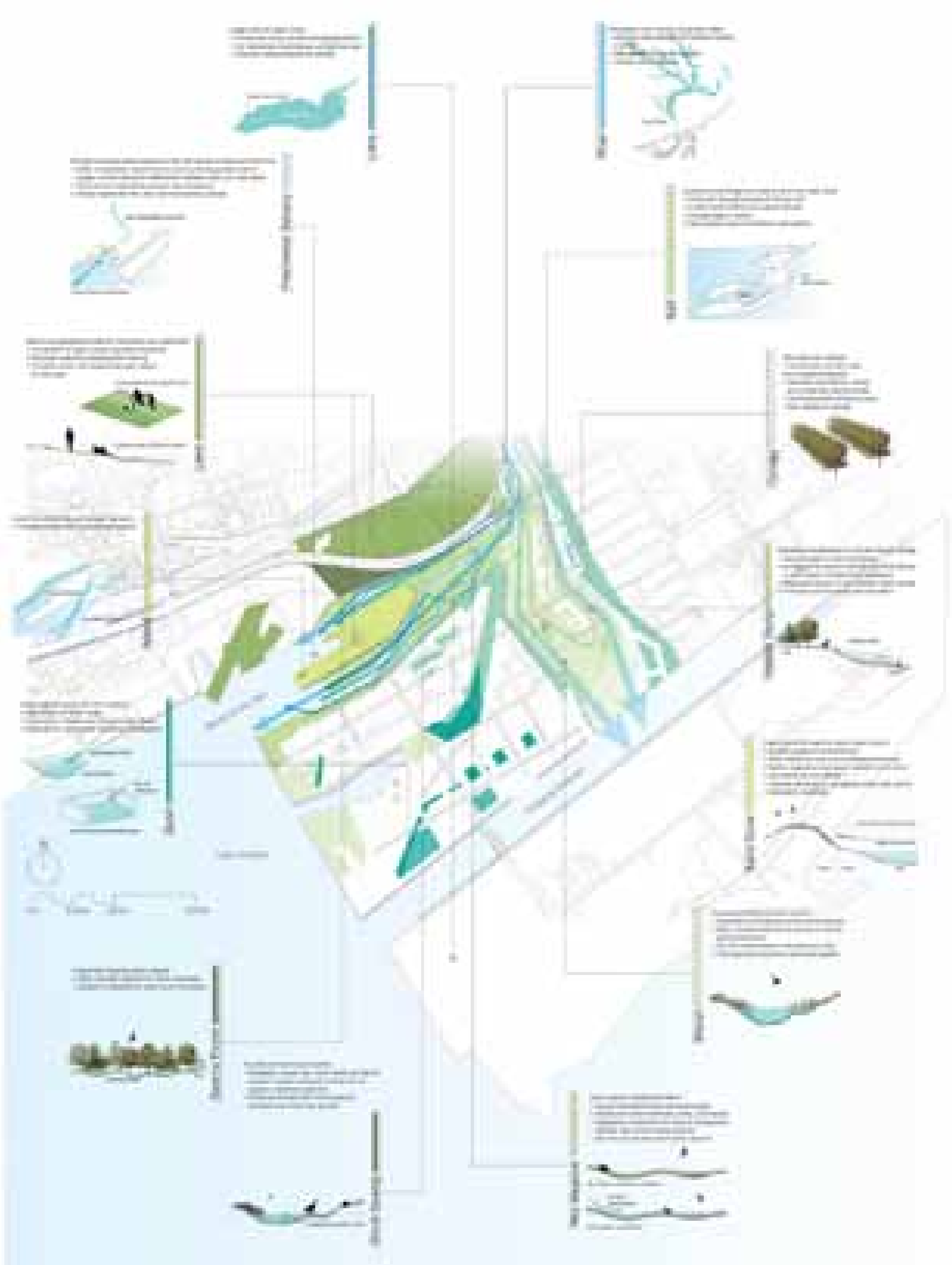


Illustration 94: Plan map of Lower Don Lands.

SOURCE: Stoss Landscape Urbanism, 2012.

The result is a design of the waterfront that creates conditions for the appearance of different habitats. These habitats require a large amount of space, but are used as the main public space for the new residential area as well. By using the land multiple ways, both goals are reached.

Illustration 95-96: Plan map of Lower Don Lands.

SOURCE: Stoss Landscape Urbanism, 2012.

Lake Ontario Park, James Corner Field Operations, 2008.
Location: Lakeshore park, at city edge
Toronto, Ontario
Canada

James Corner Field Operations aims on increasing the recreational value of the landscape and waterfront while improving its ecological quality. The proposed park will connect the distinct communities and territories of the waterfront, forming a point of refuge for the city of Toronto (Cadenasso and McGrath, 2013). The master plan can be seen as a flexible organizational tool, like a framework urban design, and tries to improve the ecological quality of the, now heavily polluted, waterfront, while increasing the recreational use of the landscape. To achieve this, the goals set are prioritized as followed. First the ecological conditions are formed, facilitated by a diversity of water depths, slopes and currents. This will facilitate the growth of different habitats. When these are formed, the recreational use of the park is set out. So will the more intense recreation be located on sites which are less ecological vulnerable. A network of pedestrian routes will link together the different recreational uses, but

will also display the diversity in ecological habitats. Connecting both ecologic demands and leisure needs in its plan.

Interpretation

For such a diverse area as Coney Island, with different threats and opportunities on social, spatial, flood-risk and ecological level, this will be a good structure to hold. The flexibility this framework strategy has, combined with a phasing plan and the identification of key action areas will be the desired strategy to be used to answer the main research question trough a design.

! How can the spatial quality benefit from flood-risk protection measures (a), and how can they contribute to the spatial quality of Coney Island (b)?

Illustration 97-99: Plan map of Lake Ontario Park.

SOURCE: James Corner Field Operations. 2008

6. FRAMEWORK URBAN DESIGN

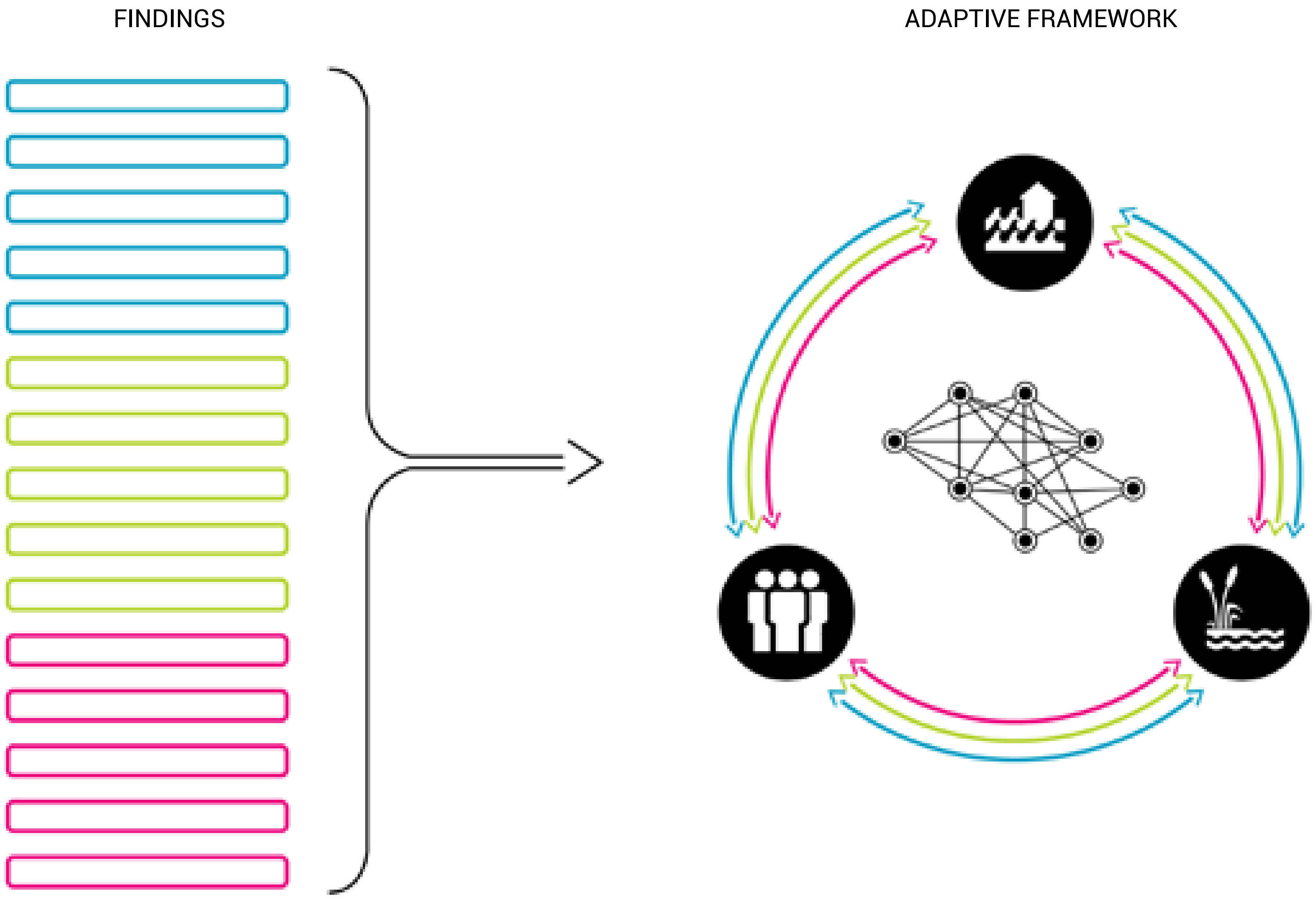


Illustration 100: Translating the requirements of flood-risk, ecology and the communities into an adaptive framework
SOURCE: Image by author, 2014.

Introduction

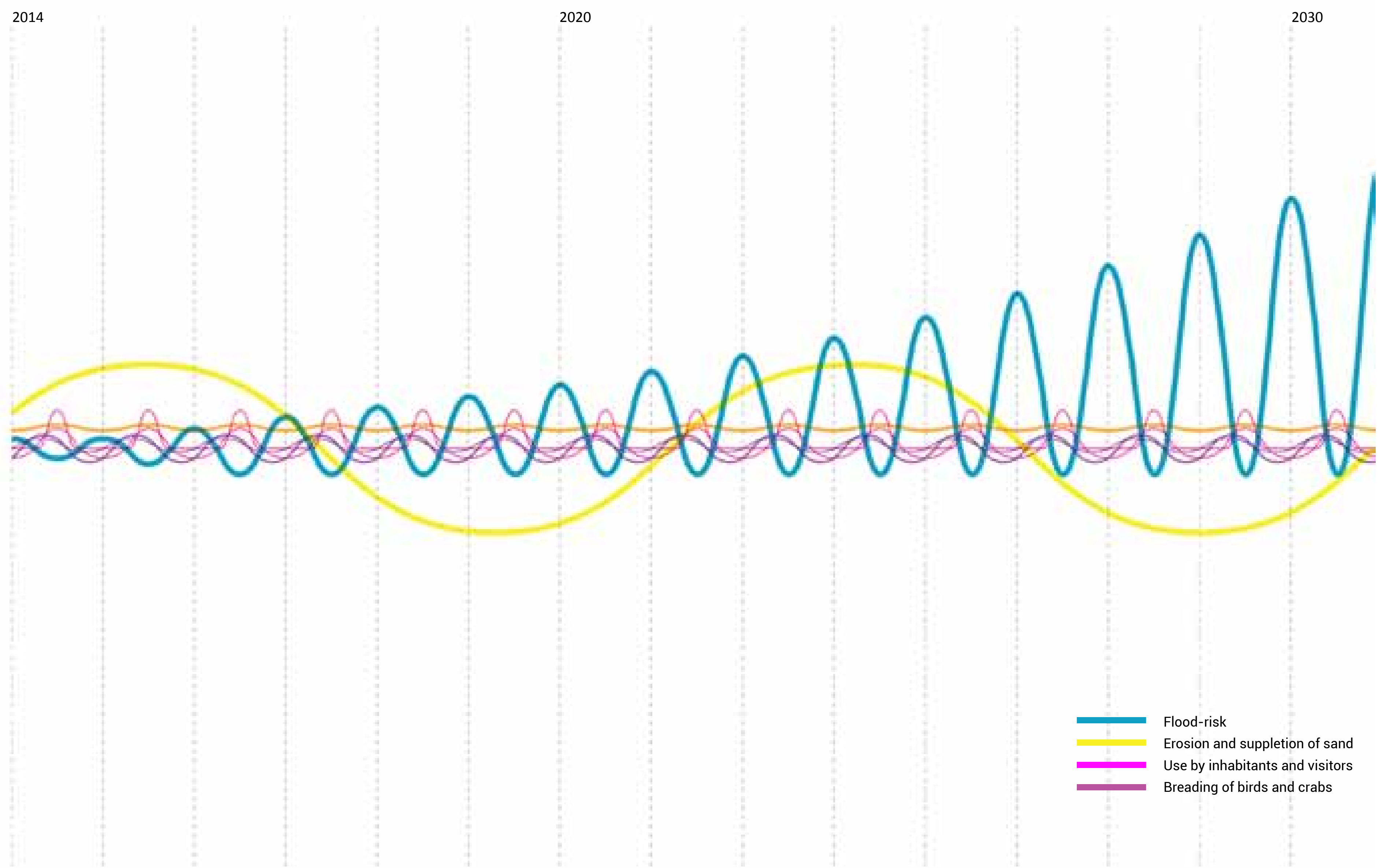
The reference study of both ecosystem based flood-risk protection, as well as the Framework Urban Design, have shown that when using dynamic processes flexibility and adaptivity are important factors to take into account. This makes the strategy resilient for future changes regarding ecology, flood-risk protection, or the needs of the communities. Another important factor is that of time, the three main themes in this graduation project all have a different timeframe and require a different amount of elaboration. The following chapter will discuss the urban design framework that will contribute to resilient flood-risk protection, while improving the living quality of communities. This strategy, combined with the translation of it into a design on a key location in chapter 7, will be evaluated as the answer the main research question: *How can a spatial framework contribute to resilient flood-risk protection, while improving the living quality of communities?*

Concept, the rhythm of Coney Island

Looking at the influence of the three themes on Coney Island during the seasons we see that the different rhythms that occur over time. The peaks in use of inhabitants as well as visitors of the public space of Coney Island are visible during summer. Other processes, such as the breading of birds and crabs near the shoreline, take place late spring. The sedimentation and erosion of sand takes place in a much slower rate. Normally, erosion takes place during the winter and autumn storms.
When looking at the rhythm of the different processes of Coney Island during a year, it would make sense to prioritize the design interventions mostly on the use of the inhabitants and visitors. But as this is a strategic plan that will be implemented during the coming fifteen years, a different timeframe is needed. The next illustration shows the rhythms of the processes during a period of fifteen years.

The peaks of cultural use during the summer months are much less important now. Looking at the dynamics of flood-risk, the increasing frequency and intensity of storms becomes a much more pressing issue. The same is visible for the accretion of sand. Influenced by the future storms, these peaks will become larger as well. The framework urban design needs to take these different rhythms into account and find a balance between the needs of both nature and culture (Perysinaki, 2010).

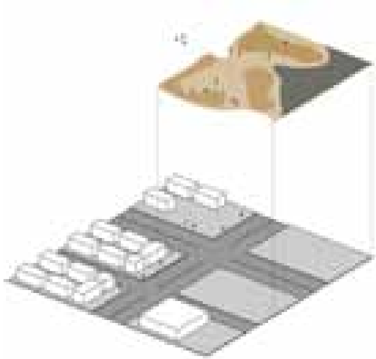
Illustration 101: The rhythm of Coney Island
SOURCE: Image by author, 2014.


2014
2020
2030
Flood-risk
Erosion and suppletion of sand
Use by inhabitants and visitors
Breading of birds and crabs

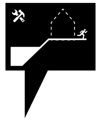
Development principles

The meet the aim of this graduation project, principles are needed that work on different scales, timeframe and themes. These principles need to be flexible in order to adapt to needs and uncertainty of the future. These development principles do need to give a certain direction towards development over time. The principles designed with these goals in mind are based on the principles described in the book series Urban Infill, from the Kent State University in Cleveland, USA (Lewis and Schwarz, 2012). They are however adapted to the specific requirements on Coney Island. These development principles define opportunities for transformation. They work on different scales and across different issues from ecology, spatial quality and the program (Lewis and Schwarz, 2012). The principles are based on both specific spatial interventions, as on processes. On the following pages, the development principles are described, showing the scale, themes, and effect these principles are aiming to achieve.

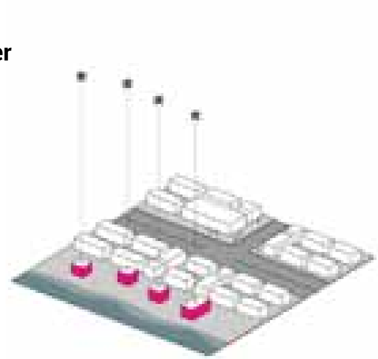
Revive



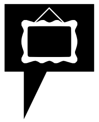
To REVIVE is to reintroduce the ecology and landscape typologies that are or were typical for that location. This can be a nature reserve, but also a public park.



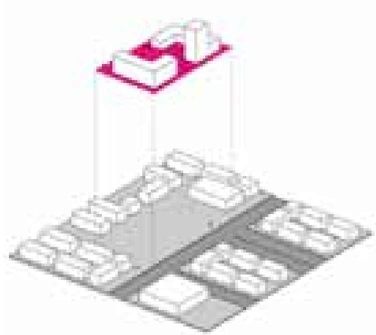
Take over



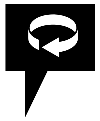
To TAKE OVER is to take over the risk of private property by taking over these most vulnerable locations through public investment. An example is the lowest lying parts at the coast to improve the flood defense.



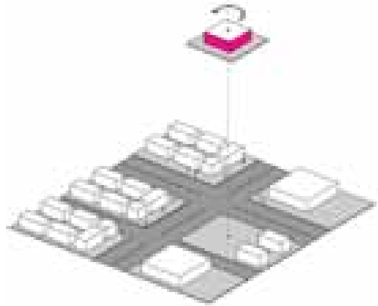
Frame



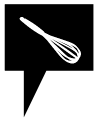
To FRAME is to define space, to use new buildings to shape the edges and focus public space.



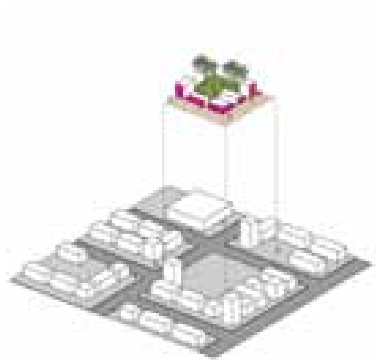
Reorient



To REORIENT is to shift the entrance of a building with a communal function towards a better location, to improve to functioning of the area.

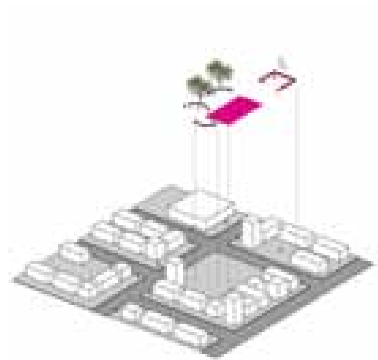


Mix



To MIX is to create places for interaction; to insert programs that connect and collect different users, and create shared spaces were a mix of activities can occur.

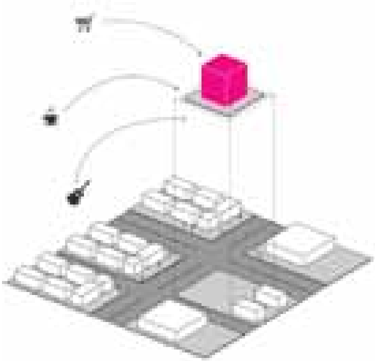
Activate



To ACTIVATE is to create place for the community, for sports and other outdoor activities. The difference between 'mix' is that these public spaces facilitate more active activities.

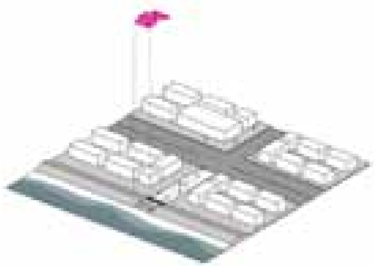
Illustration 102: Development Principles
SOURCE: Diagrams by author, 2014.
ROGERS, S. 2012. Diagrammatically, Urban Infill Volume 5., Cleveland, Cleveland Urban Design Collective.

Anchor



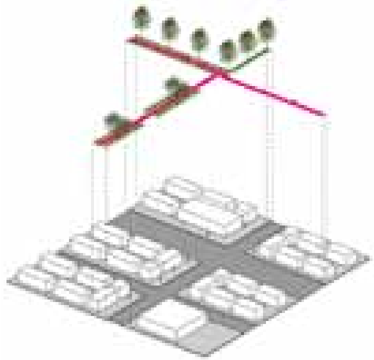
To ANCHOR is to introduce new public programs and/or buildings that serve as gathering places or reference point / landmark for inhabitants.

Visualize



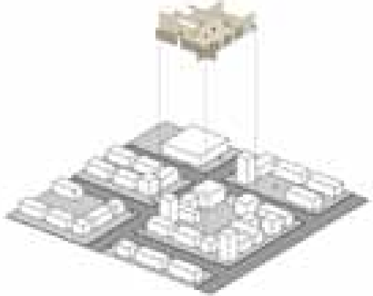
To VISUALIZE is to make the (flood) protection measures needed visible in the public space. This creates awareness by the inhabitants for the risks they face.

Link



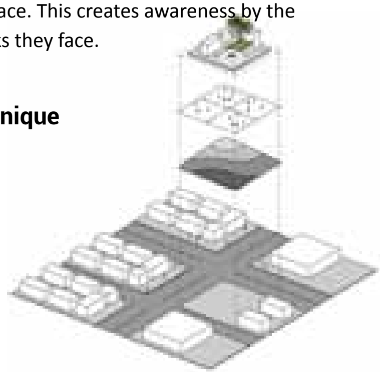
To LINK is to connect important landmarks, communities, public spaces, and amenities by creating new slow traffic networks.

Unify



To UNIFY is to create a public space that counteracts with the heterogeneity of a certain location by designing the outdoor space with serene materialization and detail.

Make unique

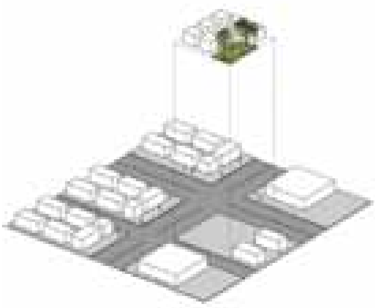


To MAKE UNIQUE is to connect the location with its context, subsoil and site specific characteristics. This strengthens the identity and quality of the public space.

Bridge

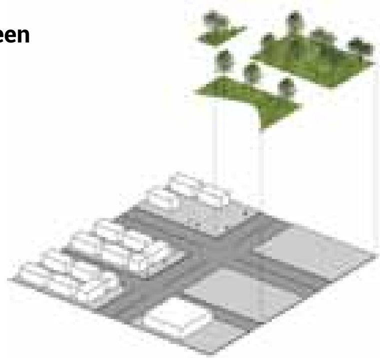
To BRIDGE is to literally or figuratively connect separated landscape elements, functions or communities.

Fill



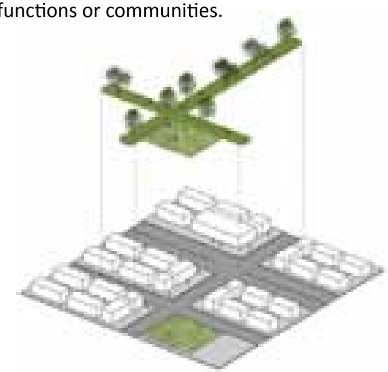
To FILL is to eliminate voids in the urban fabric by introducing new programs and buildings.

Add green



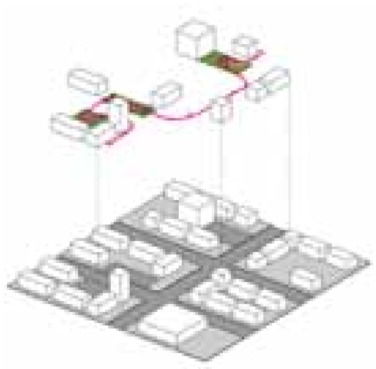
To ADD GREEN is to convert vacant land into a public space filled with trees and plants, improving the living quality of the location.

Reach



To REACH is to extend existing networks, programs or natural elements into new areas, improving the connection between them.

Thread



To THREAD is to thicken public infrastructure as a means to expand the public space into underutilized or vacant spaces.

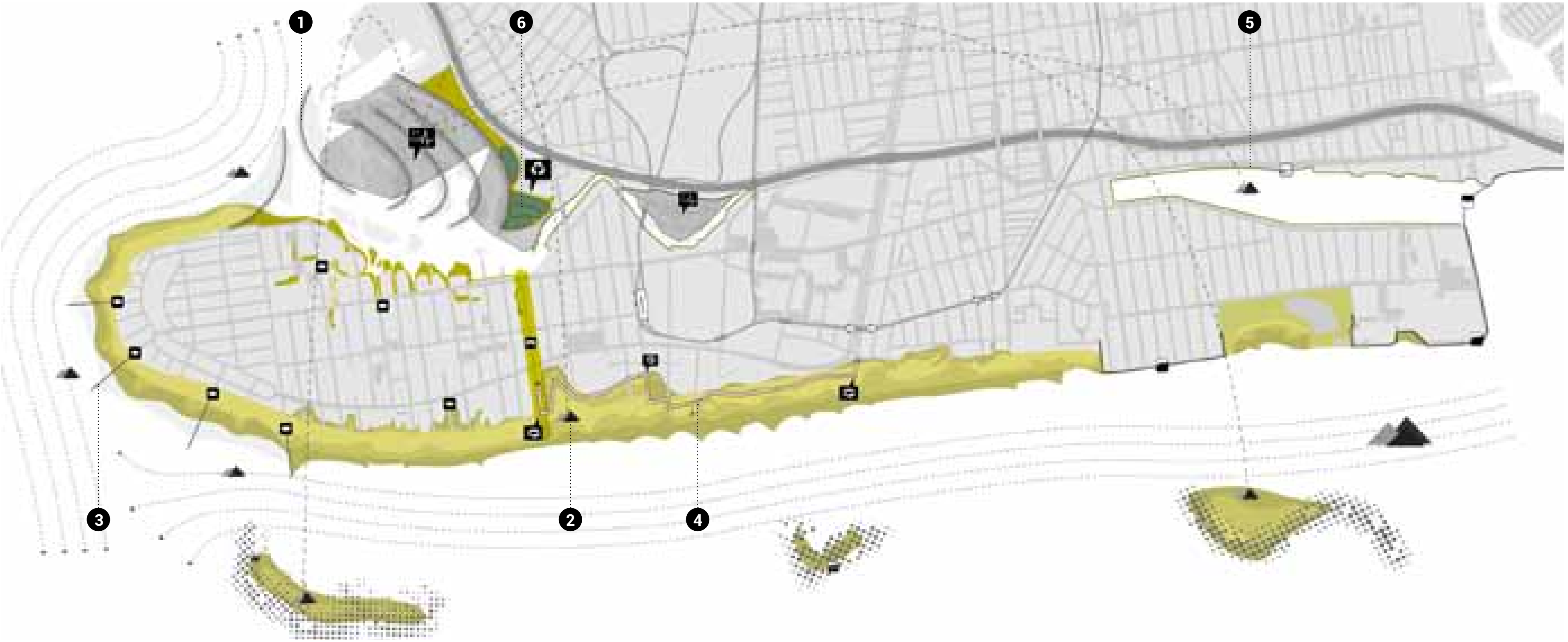
Urban Design Framework

The following series of maps shows the strategy designed for the development of Coney Island. It is divided into three phases, ending with the final phase which will aim on finding a balance between natural dynamic processes, the needs of the community, and the flood-risk protection. The text accompanying each phase will describe the most important part of the strategy regarding the three main themes.

Illustration 103: Development Principles
SOURCE: Diagrams by author, 2014.
ROGERS, S. 2012. Diagrammatically, Urban Infill Volume 5., Cleveland, Cleveland Urban Design Collective.

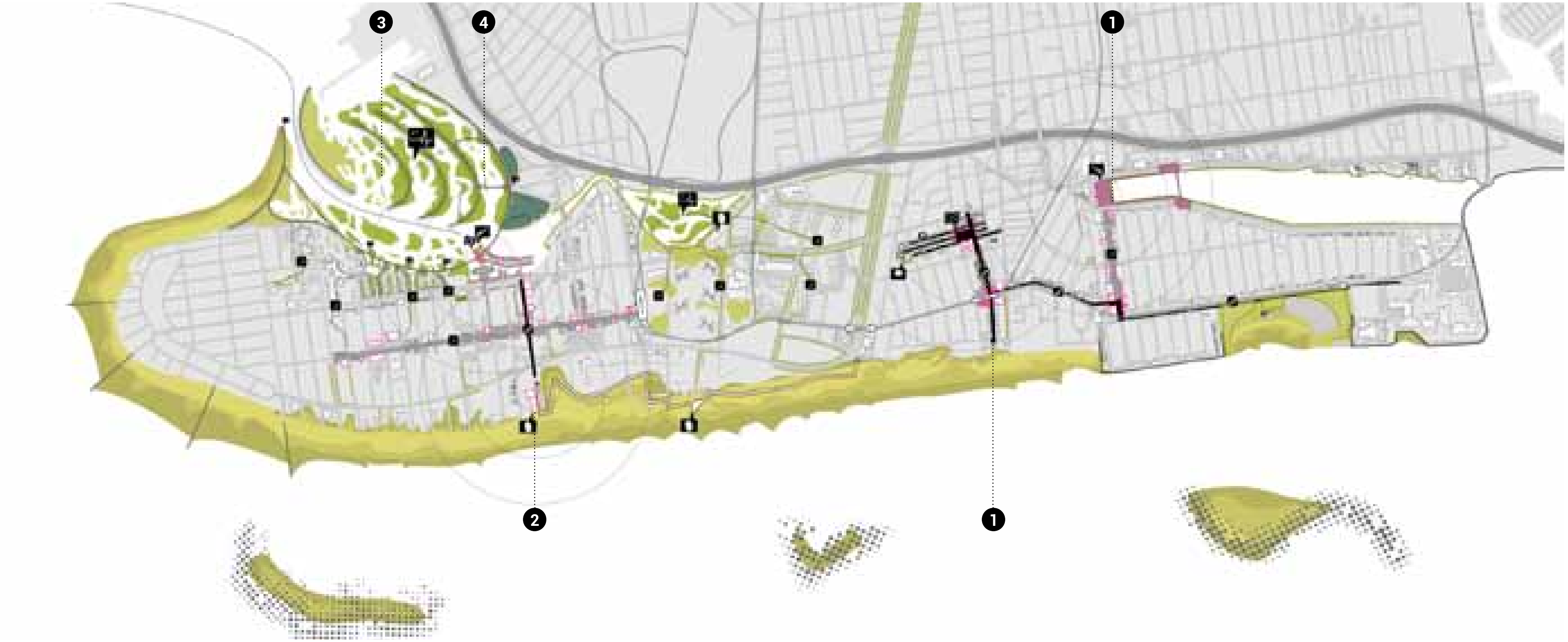
Illustration 104-106: Phasing of the Framework Urban Design
SOURCE: image by author, 2014.

Phase 1, Restoring the balance



From the analyses of flood-risk protection, ecological quality and the living quality of communities, the most pressing issue to resolve is the shape, circulation and accessibility of the park and water at Coney Island Creek. *(An import issue to still investigate is the possibility of using this sand directly, as this area used to be an industrial site 30 years ago)* First aspects to improve are the weakest links in the flood-risk protection. Revetments and a storm surge barrier will be placed around Manhattan Beach, as there is not enough space for other flood-risk protection measures. Placing ribs in this creek system, the energy of storm surges is decreased (1). By digging out over 1,200,000 m3 of sand from the park, and using the natural currents around Coney Island, the coastline can be naturally supplied onto the coastline to counter erosion (2). Groynefields at the Sea Gate community will trap the eroding sand, improving its protection against wave forces (3). The outdated boardwalk will then be reshaped to the current use of the shoreline, which is more focused around the amusement parks, instead of running all along the coast (4). The dug out sand will also be used to soften the edges of Manhattan Beach, restoring the connection between public space and waterfront (5). The combined sewage outflow from Brooklyn, as well as the storm water runoff pipes at Mermaid Avenue is replaced by a constructed wetland system (see chapter 7) and by wadi's (6).

Phase 2, Urban Interventions



With the accessibility of the ocean coastline improved, communities with a high living quality such as Little Odessa, Brighton Triangle and Manhattan Beach can reach out towards the water. By extending these communities through program, slow infrastructural elements and public space, the overall living quality of the area is improved (1). New focus points will be developed, all within walking distance of each other and the subway station to increase the use of outdoor space (2).

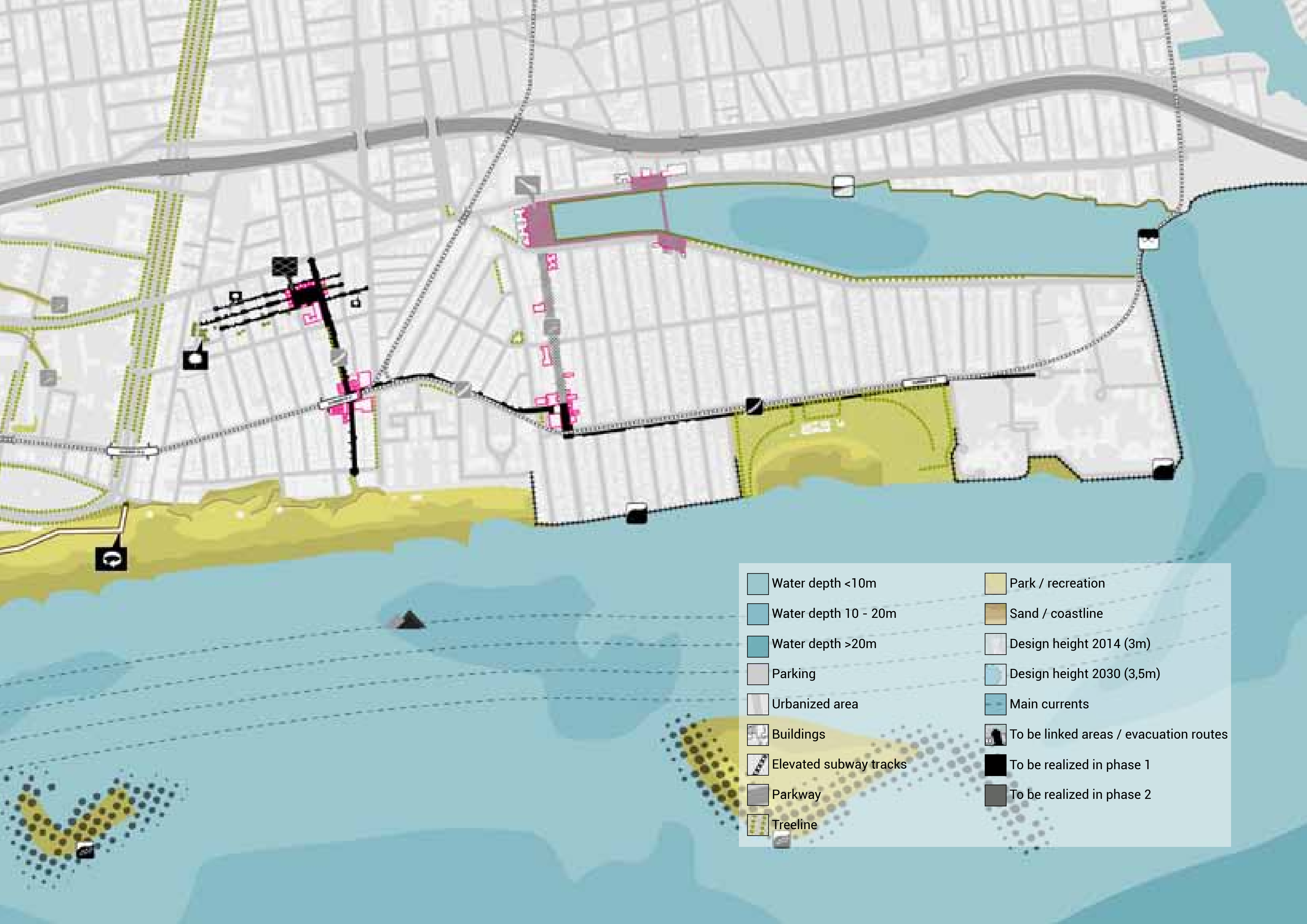
The improved water quality of Coney Island Creek facilitates the use of the waterfront. By connecting the communities of Canal Avenue and Mermaid Avenue with the salt marshland, the historic balance between nature and culture is restored (3). Due to the trapping of sediments behind the ribs at Coney Island Creek, the flood-risk protection and ecological quality is increased (4).

Phase 3, Maintaining the balance

By using the natural dynamic processes that occur around Coney Island to improve flood-risk protection, ecological quality and the living quality of communities, the system should be self-maintained (1). The gradients of sweet and salt water in Coney Island Creek create a variety of conditions, each with its diversity of habitats and trees (2). This creates an attractive leisure landscape on the once polluted and inaccessible waterfront. By creating walking paths to connect the existing communities with the landscape, a well-used park can be developed. The development of a new residential area, which will act as a connection between existing communities and the landscape can be developed (3).

URBAN DESIGN FRAMEWORK

Illustration 107: Framework Urban Design SOURCE: image by author, 2014.


Water depth <10m
Water depth 10 - 20m
Water depth >20m
Parking
Urbanized area
Buildings
Elevated subway tracks
Parkway
Treeline
Park / recreation
Sand / coastline
Design height 2014 (3m)
Design height 2030 (3,5m)
Main currents
To be linked areas / evacuation routes
To be realized in phase 1
To be realized in phase 2

IMPROVEMENTS IN THE URBAN FABRIC

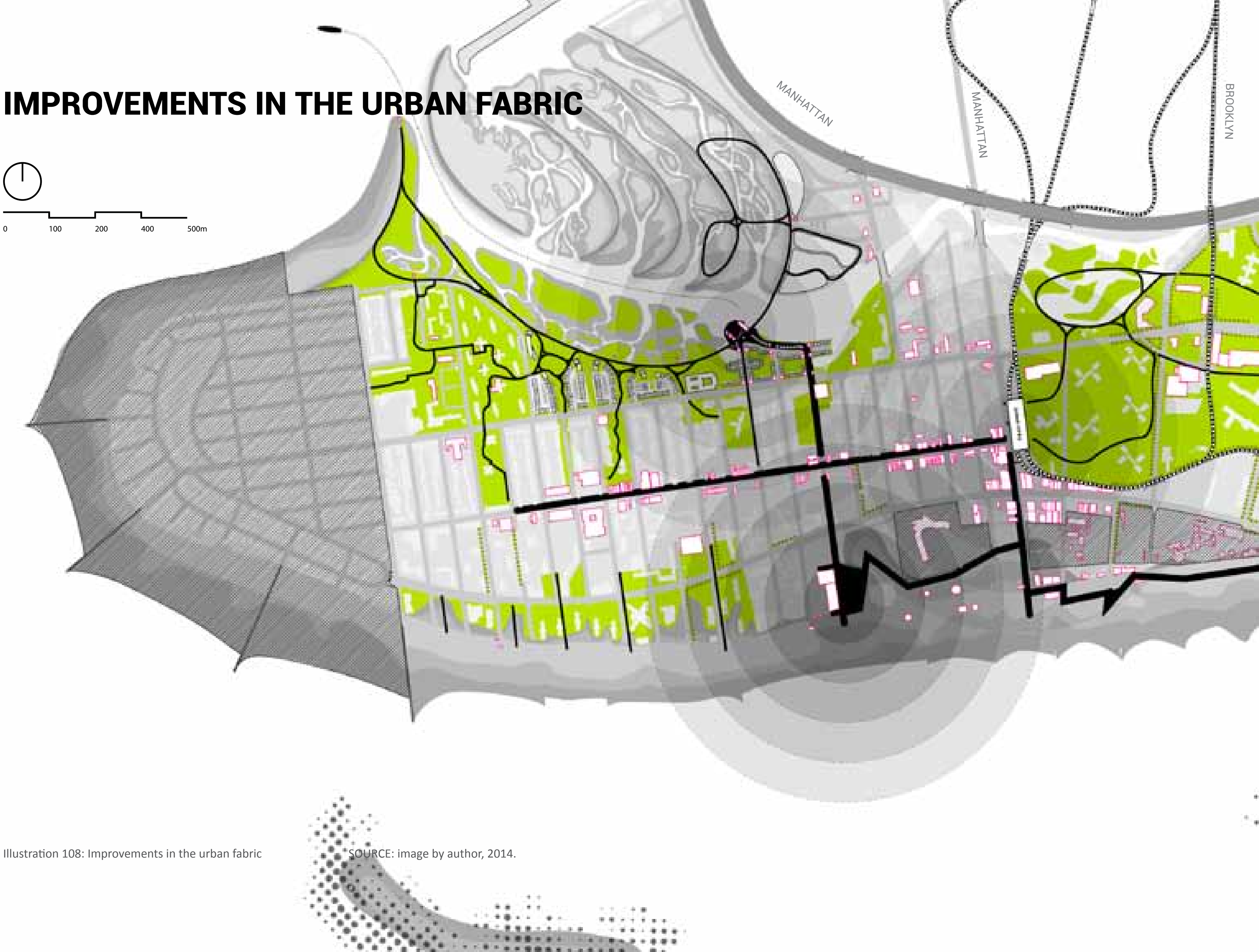


Illustration 108: Improvements in the urban fabric SOURCE: image by author, 2014.


BROOKLYN
LONG ISLAND
BROOKLYN
Inaccessible / gated communities
Strengthen connection with landscape
Public functions
Main public places
Network of improved slow traffic connections.
Improved / new center,
500 meters walking distance

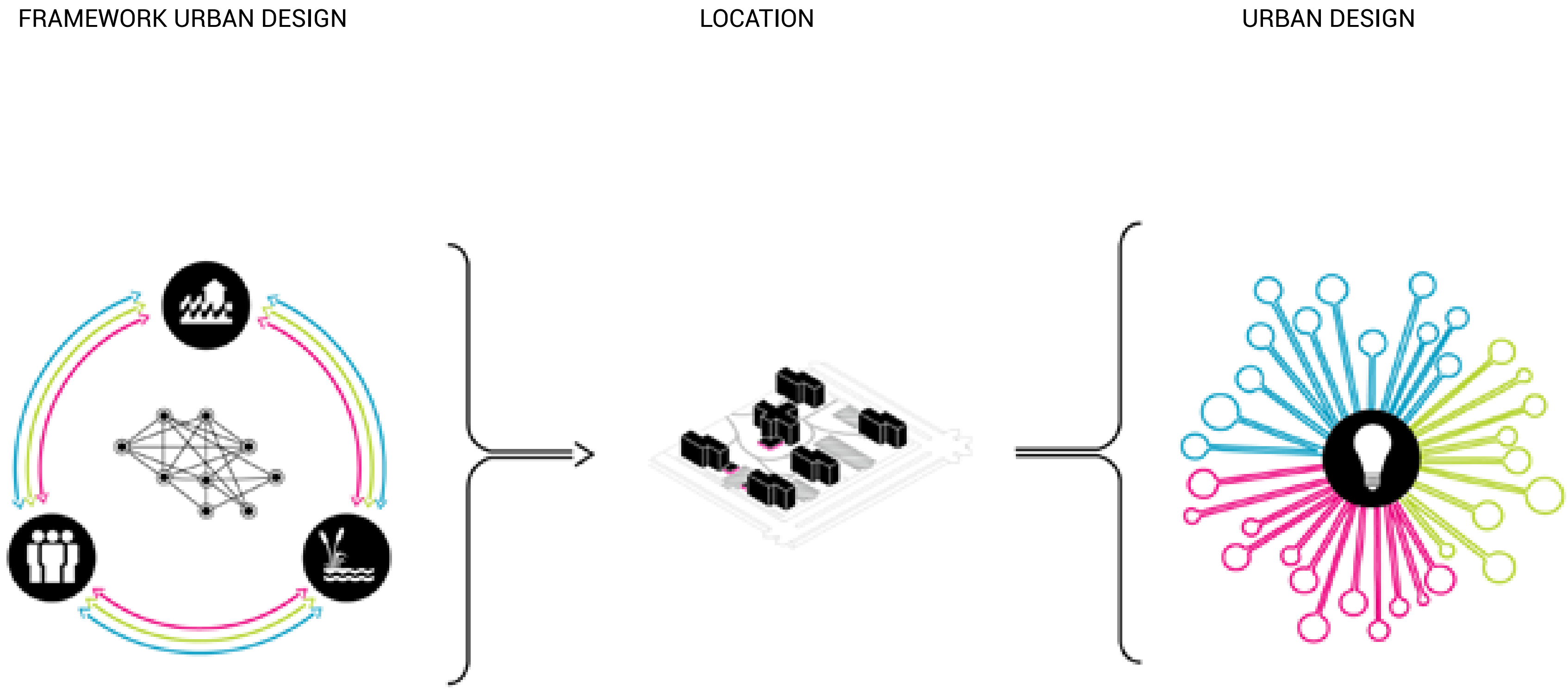


Illustration 109: Translating the adaptive framework into a design on a key location.
SOURCE: Image by author, 2014.

7. DESIGN OF CONEY ISLAND CREEK

Location choice

To test the strategic plan for Coney Island, a design was made for a crucial part of the peninsula, the Coney Island Creek. The communities around this creek are the most vulnerable to flood-risk and have the highest exposure the flooding. The ecological quality of the creek is poor, and a variety of social and spatial issues deteriorate the living quality in the surrounding communities.

The findings from the analyses done on the larger scale will provide the design with its context. From the flood-risk analysis we concluded that that storm surge flooding will occur not from the ocean side, but from the leeward coastline of Coney Island, where the historic creeks and marshland used to be located. Storm surge inundation and pollution are the most pressing issues. By creating salt marshland, the pollution could be decreased, as salt marshes filter the water (Nelson et al., 2007). From a historical perspective, the transition between sweet and salt water, as well as the gentle slope, shallow waters and shelter from the ocean forces resulted in a flourishing ecosystem (Matsil, 2001) here before the urbanization of the area. The creation or restoration of large coastal ecosystems could decrease wave forces, the storm surge height, the run up and accumulate sediments naturally (Temmerman et al., 2014). This requires a large amount of space, which is available on this location. From a community perspective there is a need for public space for people to interact, to do more than just the necessary activities. The current park that is mainly used by inhabitants is not connected at all by foot or bicycle. A large detour needs to be made by car to visit this park. When the public space is enjoyable, people stay longer and interact. An urban design can facilitate this by creating a place where this optional activity can occur.

For a more profound understanding of the area on a smaller scale, three in depth analyses are done on Coney Island Creek. With these new insights the translation of the development principles into an urban design takes place. This chapter will explain the main findings of the analysis on the three themes briefly. The final product is a design that will illustrate that this systematic approach regarding the requirements of the design resulted in a synergy of actions that is greater than the sum of their individual effects (Perysinaki, 2010). In the final chapter, a critical reflection regarding the framework urban design, combined with the design of this key location, will be held.


0
100
200
400
500m
2
1

Flood-risk protection

Looking at the map on the weakest link of the current coastline is clearly visible (1). The length of the fetch results in a large run up of storm surge. The slope, shape of the park in the north, combined with the hard edges result in a 'direct' hit at the coastline, pushing the water onto the land and into the main streets of the communities. An added threat is the combined sewage outflow (2) which is also pushed into the communities. This occurs when the sewage system cannot cope with the heavy rainfall, resulting in a discharge of pollution in the bay.

There is a need for protection measures that decrease the energy of the storm surge, so that it cannot push onto land. There are two methods to decrease the flood risk, physical and frictional resistance (Wamsley, 2010, Wamsley et al., 2012). Physical barriers are land elevations that are greater than the average sea level height, such as levees. But they do not need to be higher than the storm surge. Even 2 meters below the height of the still water, physical barriers decrease the storm surge by 30 % (Wamsley et al., 2012). The steeper the slope at the ocean side, the greater the energy loss. A series of these physical barriers would decrease the energy of a storm surge and therefore it's run up enough to be implemented as a flood-risk protection measure on this location. Added benefits of this concept is the fact that the water behind the ribs is still in connection with the main body of water, maintaining the circulation of water to prevent stagnant water and pollution. By creating a slope of 1:3 on the impact side and a gentler slope on the leeward side, the energy decreases even more. Landscape features such as wetlands also have the potential to decrease the energy of a storm surge through frictional resistance.

Water that is pushed through this vegetation slows down due to the fine maze of roots and leaves. The amount of energy loss depends on the type of vegetation, but even wetland planting below storm surge height has the potential to decrease the energy by 10% every 500 meters (Wamsley, 2010). With this information combined with basic rules of thumb this idea can be turned into a design.

Illustration 110: Flood-risk analysis.

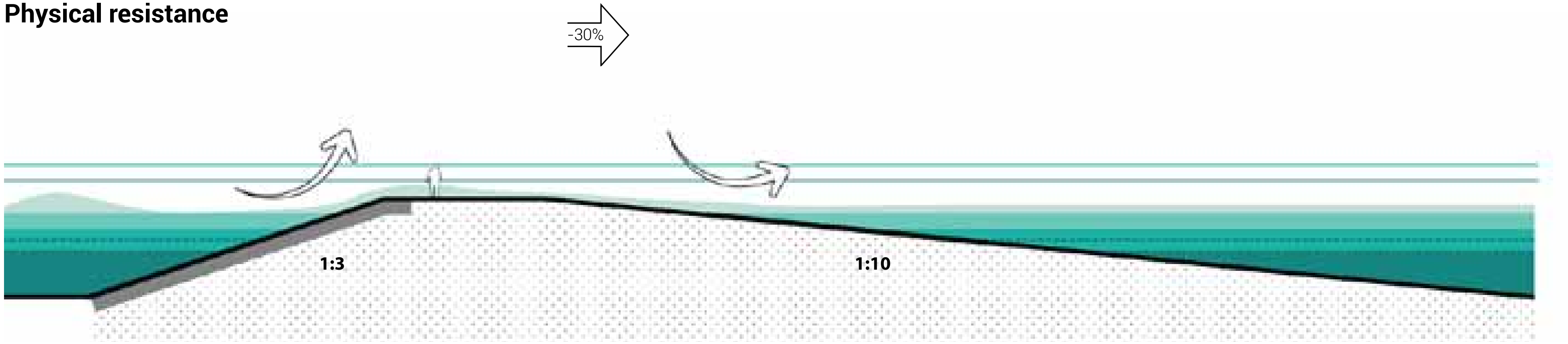
SOURCE: Image by author, 2014.

Design height 2014 (3,00m)

Design height 2030 (3,50m)

Storm surge funnel

Physical resistance



Frictional risistance

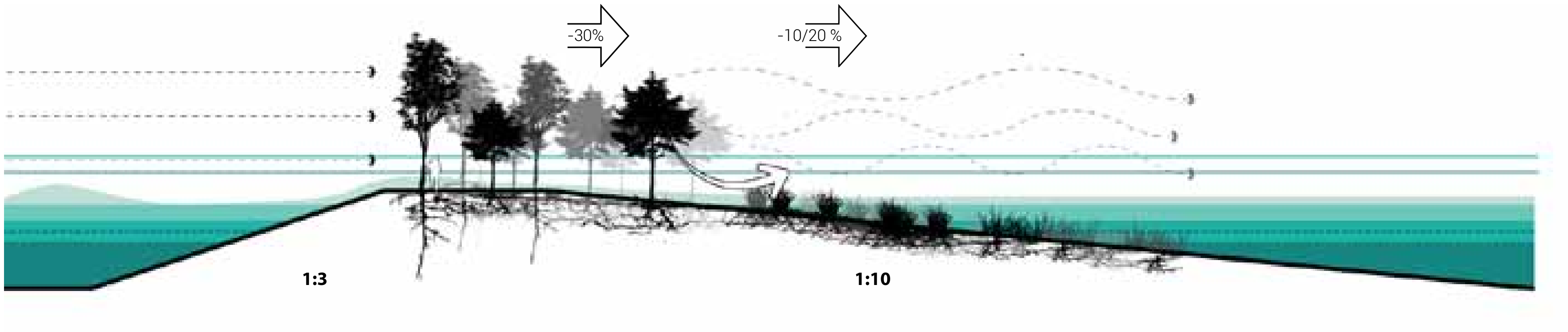
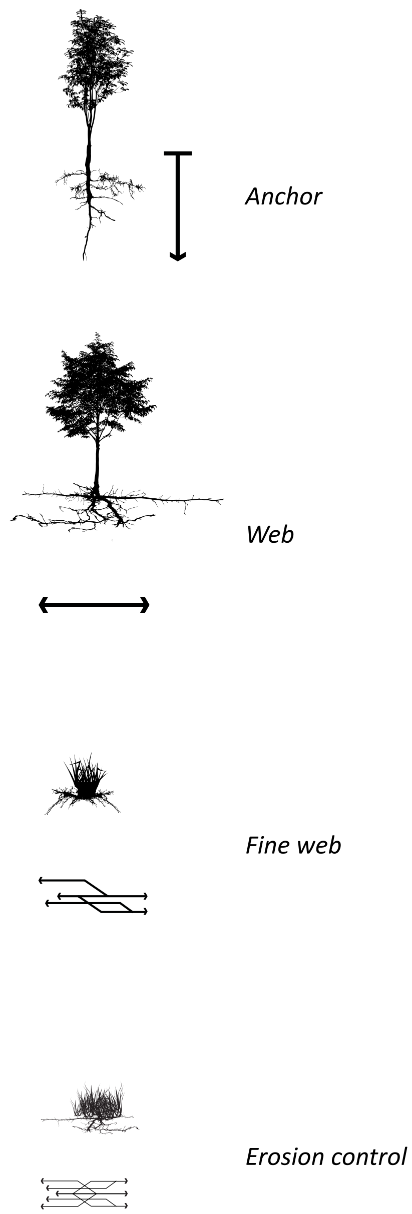


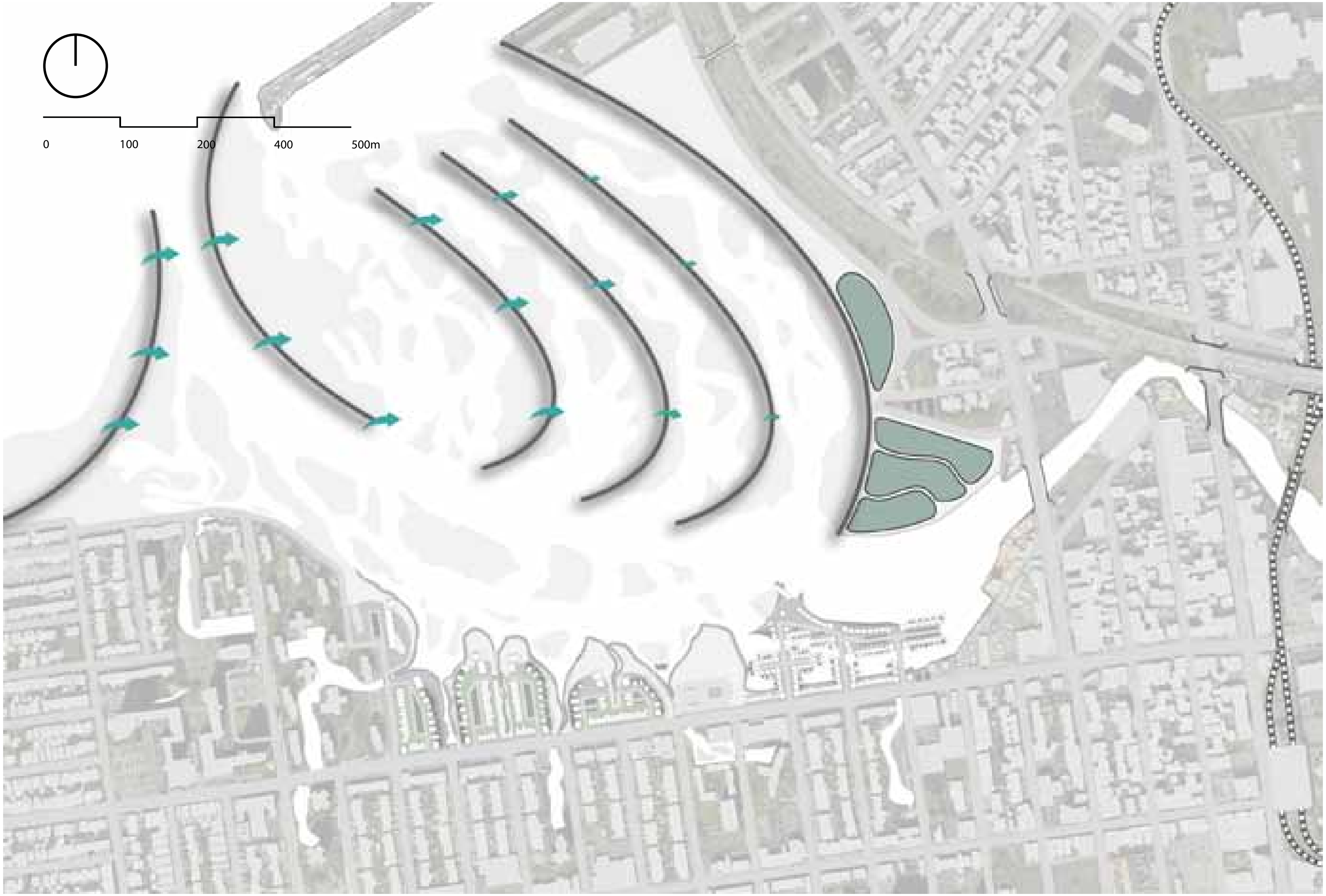
Illustration 111: Concept of the flood-risk protection of Coney Island Creek SOURCE: image by author, 2014.

Concept

For Coney Island Creek a series of physical barriers are needed to decrease the energy enough to prevent flooding. The side that is hit by a storm surge directly needs to be steep, 1:3, and protected by a hard material such as concrete (see illustration). The leeward side will have a more gently slope, 1:10 to provide different conditions regarding the tidal range. As a storm surge consists of different types of water hazards different types of vegetation are needed. At the impact side of the ribs, trees with deep roots are needed. These plants act as an anchor to prevent other plants to be pulled out by the immense energy of a storm surge. Behind this first line of defense, trees with roots as a web structure are needed to hold the sand in place. Even lower, affected by the salt water, reeds create an ever finer web against erosion. By placing multiple barriers and shaping them in a curve, the fetch is reduced as well, decreasing the run-up of the storm surge. The height of these barriers slightly increases the more they are positions towards the mainland. The first three barriers are 1,5 meters above average sea level, making them 1,5 to 2 meters below the design water height of a storm surge. Over wash of salt and sand will take place here regularly, needed for the ecological conditions for various habitats. The last barrier is 4,5 meters above average sea level, a half meter above the land behind it and 1,5 to 1 meters above the design water height (see illustration). Compared to conventional flood-risk protection, these ‘ribs’ will not destroy the open character of the landscape. The added benefits from an ecological perspective and the living quality of communities make this design solution improve certain aspects on all three themes needed to improve the overall living quality of the communities.

As I am not a civil engineer or ecologist, I do not exactly know what impact these man-made ribs have on either floor-risk or ecology quality. What I can presume however is that the ecological quality will greatly be improved compared to the existing situation, as the circulation of water, as well as the hard edges of the bay are transformed into natural banks and a larger connection to the ocean. Regarding the flood-risk protection, I can estimate that a combination of both physical and frictional resistance does have the possibility to be enough as a protection measure against flooding by storm surges.




0
100
200
400
500m

By combining information from different articles regarding the subject of the last years (Wamsley, 2010, Wamsley et al., 2012, Temmerman et al., 2014) rules of thumb can be derived. As this type of defense measure is never implemented on such type of shoreline or scale, only a rough estimate can be made. As stated earlier, physical barriers, even 2 meters below a storm surge, have the potential to decrease the energy of a storm surge by 30%, if the slope angle is great enough. The potential of frictional resistance can vary from 10 to 20%, in relation to the width of the planting, vegetation type and variety of species. At least 500 meters of land above average sea level is required to create conditions for the growth of different types of plants. If these conditions are met, 10% of the storm surge can be decreased (Wamsley et al., 2012). Another 10% energy loss can be achieved every 50 meters of trees in the path of the storm surge.
These estimates could of course vary greatly due to the difference in density of planting, height differences, direction of the wind, storm intensity and other variables. With these rough estimates however, a simple formula combining the discussed rules of thumb could be made. This formula will result in a prediction of the effectiveness of the flood-risk protection in the three discussed phases, 2015, 1015-2030, and after 2030. For these phases protection against a storm surge of respectively 3,00m, 3,50m and 4,00m is needed.

Formula

$$s * (100\% \; -p)^{n} * (100\% - f_{plants})^{Wland / 500} * (100\% - f_{trees})^{Wforest / 50} = h$$

Variables;
s = Storm surge height at impact in meters (3,00m in 2015, 3,50m in 2015-2030, and 4,00m after 2030)
p = percentage of energy loss due to physical resistance (30%)
n = number of ribs in between storm surge and communities.
fplants = percentage of energy loss due to plants (10%)
wland= width of land above average sea level in meters
ftrees = percentage of energy loss due to plants (10%)
wforest = width of forest in meters.
h = height of surge after protection measures in meters

As discussed earlier ecosystem based flood-risk protection rely on natural processes that will increase the protection over time. One large investment, the placement of the ribs, needs to be done and dynamic natural processes will gradually build up the defense. At the end of this chapter, the phasing will be discussed and the design will be tested on its flood-risk protection with the described formula.

Illustration 112: Flood-risk protection design
SOURCE: Image by author, 2014.

Overflow of storm surge that reduces the energy

Physical resistance due to ‘ribs’


0
100
200
400
500m
60.000 m3
18.500 m3
1
4.500 m3
1.500 m3
2.000 m3
1.800 m3
3.500 m3

Ecological quality

The Coney Island Creek is no longer a natural feature. The watershed drainage area is highly urbanized and the entire creek has been channelized, flanked with revetments and bulkhead (NYC_Planning, 2010). The lack of circulation decreases the ecological quality. Combined sewage outflow together with storm water runoff pipes pollute the water even more. The most northern part of the creek (1) is filled with countless obstructions such as ship wrecks and construction debris. The increase in population and the urbanization of the surrounding land has resulted in an increase in annual runoff to the Coney Island Creek. Natural response mechanism such as tidal marshland and buffer zones that might have helped to absorb the hydraulic load have been destroyed and natural streams have been replaced by piping (NYC_Planning, 2010). The only source of fresh water that flows into the creek is therefore polluted. These conditions, the water quality, lack of fresh water, hard coastline and shape of the bay result in an unsustainable environment for habitats to evolve. As a result, the communities of Coney Island have retreated from the coastline and the waterfront is inaccessible.

To understand what choice of action is needed to improve the ecological quality of the water and with that, decrease flood-risk and increase the living quality, the amount and characteristics of the pollution has to be understood. The map on the previous page shows the amount of sewage outflow that occurs during a peak period of time, 5 days (NYC_Planning, 2010). This information is derived from the average outflow of a year (approximately 290 million gallons of CSO and 1,487 million gallons of urban stormwater) in relation to the average amount of rainfall each year (1136 mm of rain) (NYC_ Planning, 2012). From the meteorological institute New York City the peak rainfall over a period 5 days was found. By dividing the amount of rainfall during a year (1136mm) with that during a peak period of 5 days (229.40mm) an estimation of the percentage of CSO and urban stormwater that flows into the Coney Island Creek could be calculated. The ratio between the discharge volumes of the different pipes was found through a study done by the municipality of New York regarding CSO's in 2010 (NYC_Planning, 2010) and can be found in appendix F.
The difference between the smaller storm water pipes that serve Coney Island and the two large pipes that serve a large part of Brooklyn is visible.

Both require a different action. I believe the goal should be to improve the water into swim water quality, as the waterfront can provide even more added benefits to the communities. In that way, fish, clams and other fauna is safe to consume as well. By understanding the characteristic of the discharges of both combined sewer outflow as well as storm water outflow a choice of improvement measures can be made.

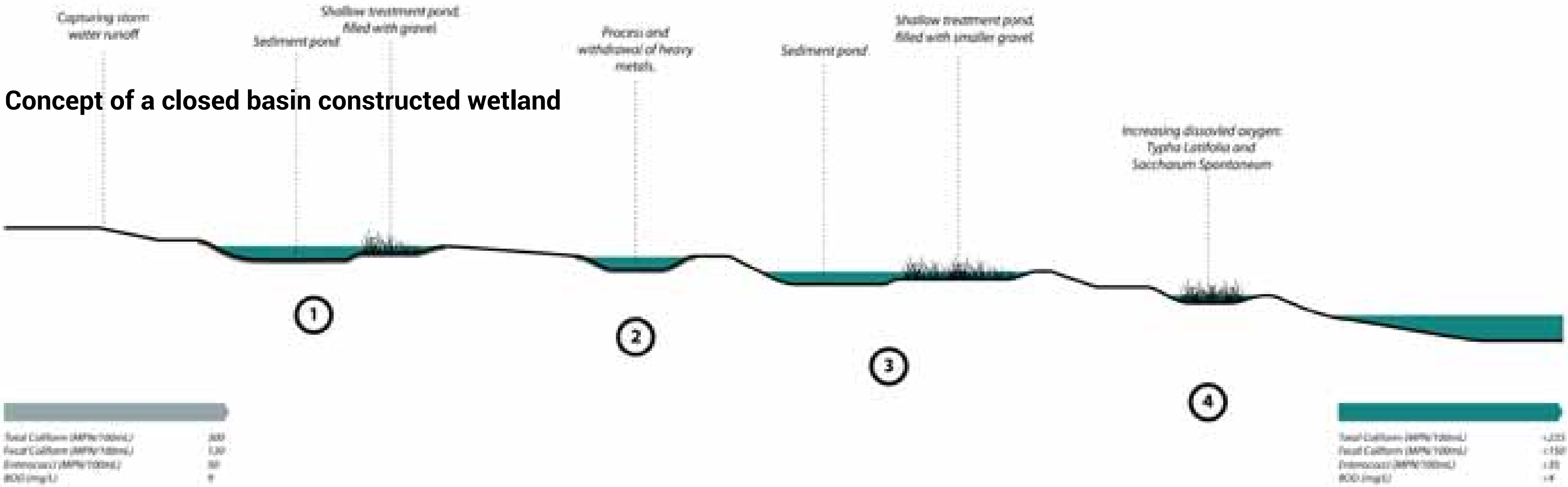
The current water in Coney Island Creek is severely polluted. It is classified as a class five water body and was almost labeled as a superfunds site by the U.S. Environmental Protection Agency (EPA). With information gathered in 2004, the EPA determined the amount of pollution within the water. This information is shown in the table below.

◀ Illustration 113: Ecological quality analysis.
SOURCE: Image by author, 2014.

Combined Sewage Outflow (CSO)

Stormwater runoff

Concept of a closed basin constructed wetland



Concept of a free flowing constructed wetland

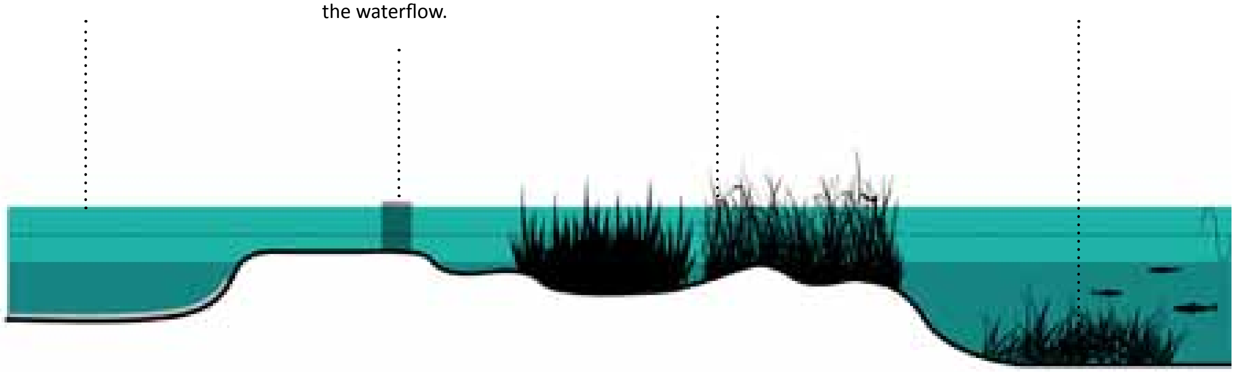


Illustration 114: Concept of the living filters within Coney Island Creek SOURCE: image by author, 2014.

Pollution	Current quality (class 5)	Desired quality (class 3)
Total Coliform (MPN/100mL)	300	<235
Fecal Coliform (MPN/100mL)	120	<150
Enterococci (MPN/100mL)	50	<35
BOD (mg/L)	9	<4

The MPN stands for 'Most Probable Number' and refers to a method that determines the approximate number of viable cells in a given volume of sample. For example: 50 MPN/100 mL means that the Most Probable Number of viable cells in 100 mL of sample is 50. To improve the water quality so it is safe to be used recreationally it needs to be improved towards a class three water body.

Fecal coliforms are bacteria that are routinely used as an indicator of sewage pollution in water and as an indicator of the human health risk (NYC_ Planning, 2010). Unlike the general coliform group, enterococci are almost exclusively of fecal origin and their presence is thus an effective confirmation of fecal contamination. Most strains of enterococci are harmless, but some can cause serious illness in humans.

The acceptable amount of this bacteria are therefore very low, only 35 per 100ml of salt water (NYC_ Planning, 2010).

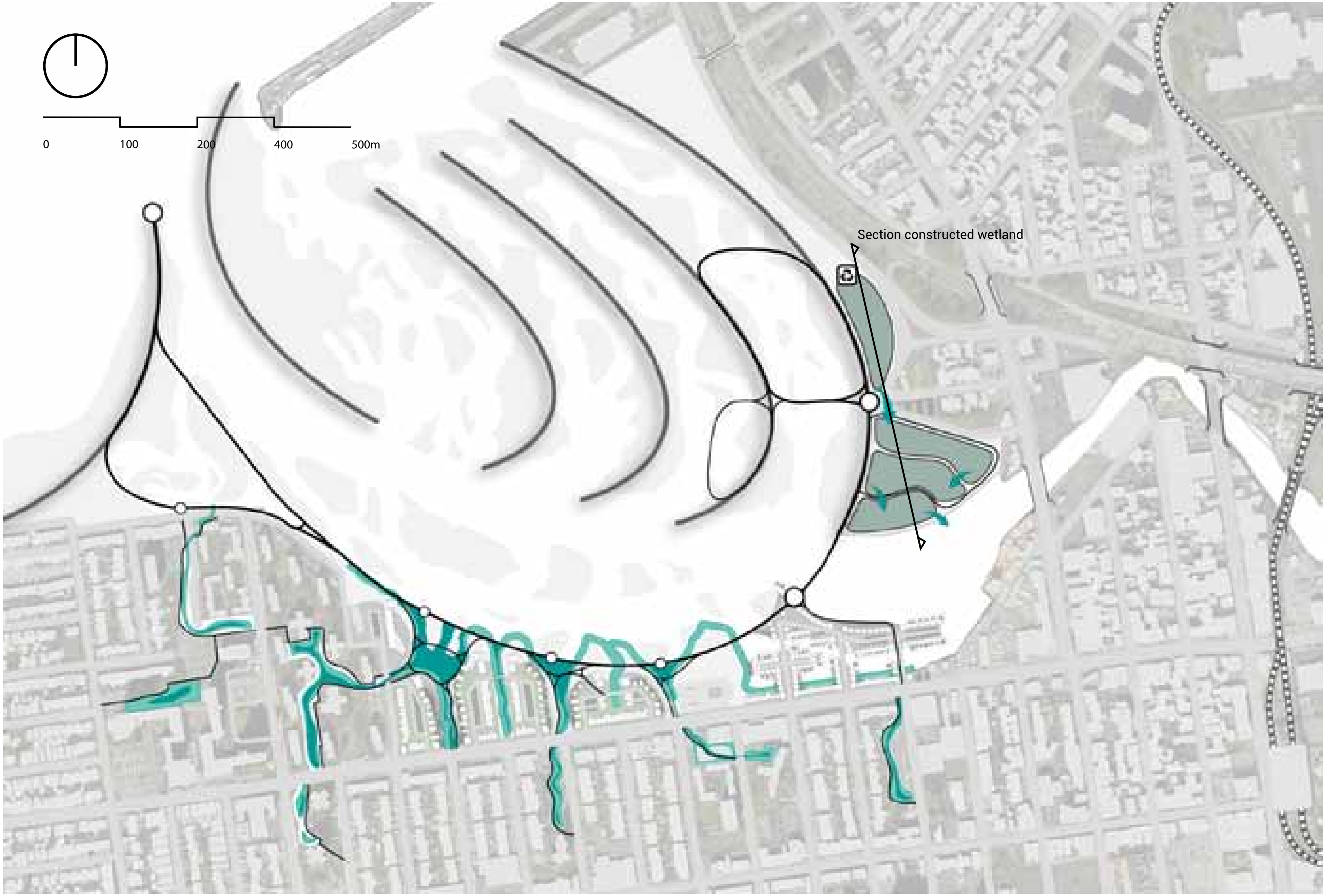
BOD stands for Biological Oxygen Demand and is a measure of the oxygen required for the decomposition of organic matter and the oxidation of inorganics such as sulfide. A high BOD therefore means that a lot of oxygen is needed to filter the pollution out of the water (Dordio, 2013). Typically, unpolluted surface waters have a BOD value of 2mg/l or less. In Coney Island Creek, this value is almost five times higher. To increase the water quality to a class three water body, a BOD level lower than four is needed. Plants species such as common rood and duckweed, plants that are regularly under water, are best suited to decrease the BOD value.

Next to these pollutants, a variety of heavy metals caused by ship wrecks and construction debris deplete the water quality. On pages 112 and 113, a catalogue of the desired plant species is shown.

Concept

A combination of fresh and salt water is needed for this ecosystem based flood-risk protection to function properly. This way, a variety of plants and habitats is achieved. Wetlands are the most desired option to be used as filter to improve the ecological quality of the area. As runoff and surface water pass through, wetlands remove or transform pollutants through physical, chemical, and biological processes. This strategy is widely used in the United States of America. Examples as the Clayton County constructed wetland system shows that CSO pollution can be filtered using natural processes.

To filter the combined sewage outflow from Brooklyn it is not possible to construct only an open wetland (Dordio, 2013). The water that comes out of the pipes from Brooklyn to the north is severely polluted; the water needs to be detained longer. A constructed wetland system consisting of different basins is the best solution for this severely polluted water (Dordio, 2013). The benefit of this type of constructed wetland is that it is not necessary to have a continuous flow of water coming into the


0
100
200
400
500m
Section constructed wetland

system. As the basins are connected by weirs they will never dry out completely. Over time, water from Coney Island Creek itself could even be pumped up to the first sediment pond, to improve the water quality even more. The effects of the hydraulic retention due to the weirs are very simple. The longer the wastewater remains in the system, the longer bacteria remain exposed to unfavorable conditions and the better the water quality will be. The minimum retention time is around the four days (Dordio, 2013). After five days the combined sewage outflow and storm water runoff is filtered enough to enter the surface water of Coney Island Creek.

The free flowing constructed wetland

The storm water runoff from Coney Island itself can be filtered by the use of a free flowing constructed wetland system. Rows of submerged vegetation, reeds and rocks filter pollution out of the water. The species of plants needed to construct such a living filter are shown on the following pages. Free-surface constructed wetland, low maintenance costs. The added benefit from this type of constructed wetland is its ability to filter the main body of water as well. If there is no storm water runoff, the tides bring water from the creek itself into the system as well.

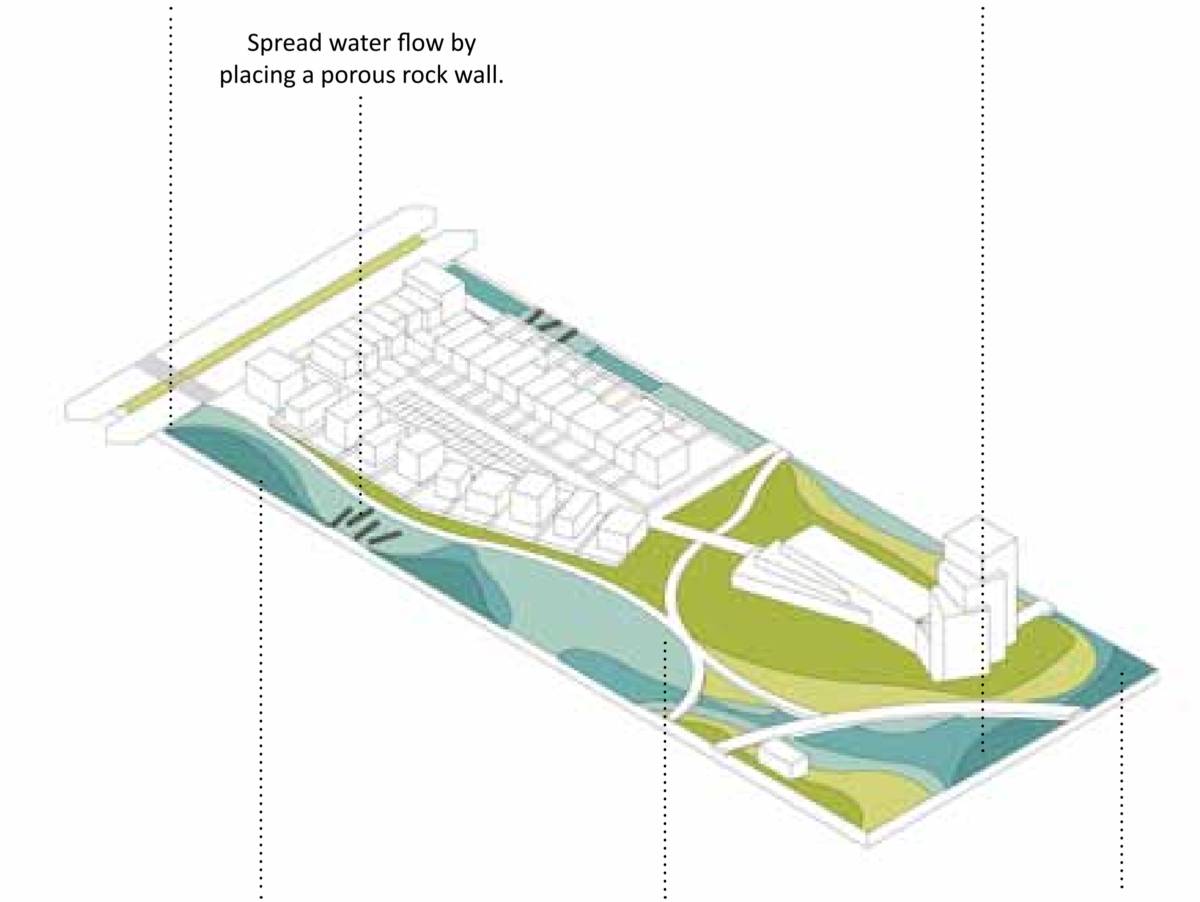
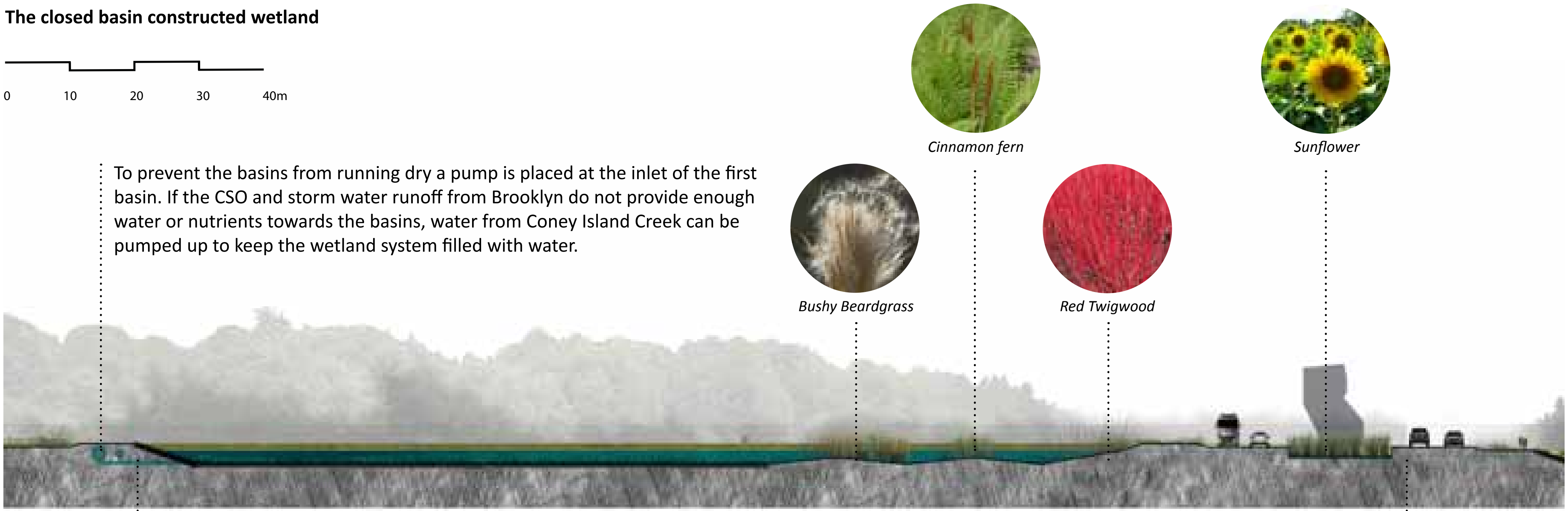


Illustration 115-116: Design of the living filters within Coney Island Creek SOURCE: image by author, 2014.

The closed basin constructed wetland



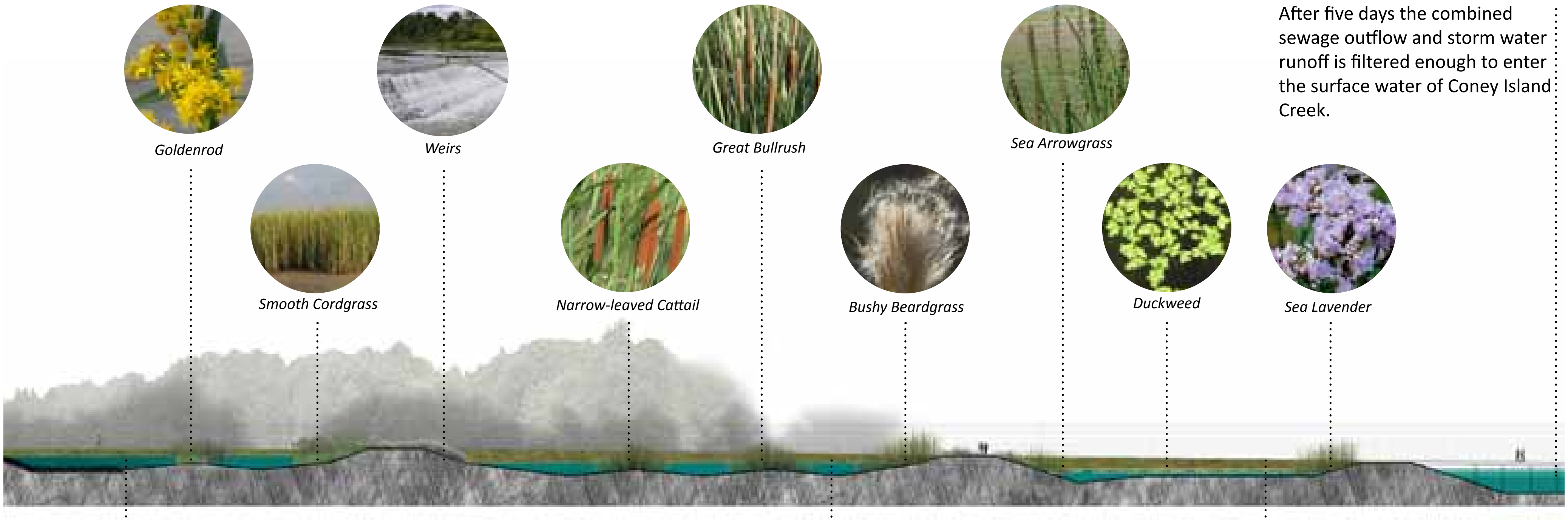
To prevent the basins from running dry a pump is placed at the inlet of the first basin. If the CSO and storm water runoff from Brooklyn do not provide enough water or nutrients towards the basins, water from Coney Island Creek can be pumped up to keep the wetland system filled with water.

Basin 1: Combined sewage outflow and storm water runoff from Brooklyn is collected in the first basin. The bottom of this basin in filled with gravel to trap the largest sediments. At the end of the basin, rows of vegetation and shallow water filter the first pollution from the water.

Basin 2: A small, dense basin filled entirely with sunflowers to filter the most heavy metals out of the water.

Illustration 117: Cross section of the closed basin constructed wetland SOURCE: image by author, 2014.

After five days the combined sewage outflow and storm water runoff is filtered enough to enter the surface water of Coney Island Creek.



Basin 3: From the second basin the water is aerated through a weir and enters the third basin. More dense gravel filters the sediments out of the water here. A variety of plants extract the fecal coliform, enterococci, ammonia and heavy metals out of the water later in the basin. To ensure a good flow of the water through the system, each higher part of the basin consists only of one variety of plants. This uniformity ensures a good flow of water through the basins (Dordio, 2013).

Basin 4: This basin also consists of a variety of plants extract the fecal coliform, enterococci, ammonia and heavy metals out of the water later in the basin.

Basin 5: This last basin consists only of floating plant species. These plants aerate the water to increase the BOD value, increasing the ecological quality of the water before it enters the Coney Island Creek.

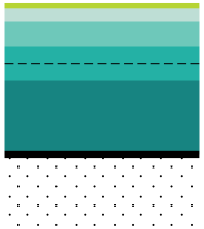

0
100
200
400
500m

Ecological quality, habitats

By placing the ribs into the bay, the currents will be decreased and sediments could pile up behind the ribs. Together with the mix of sweet and salt water, different conditions will facilitate the growth of different habitats.

Nature reserve

Walking paths



Ideal conditions for plant in relation to the water height.

Above spring tide (less than 100 days under water)

Spring tide (more than 100 days under water)

High tide (daily under water)

Low tide (less than 100 days dry)

Subtidal channel (always under water)

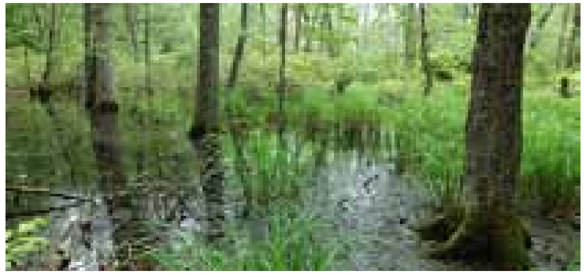
Illustration 118: Ecological quality design.
SOURCE: Image by author, 2014.

Low saltmarhsland

High saltmarhsland

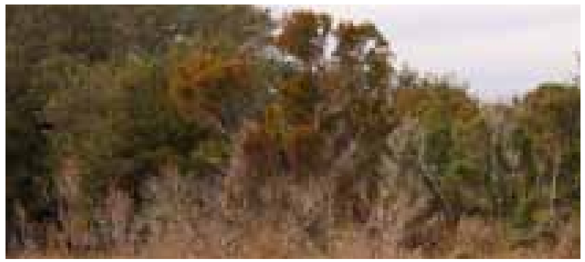
Maritime grasslands

Tidal woodlands



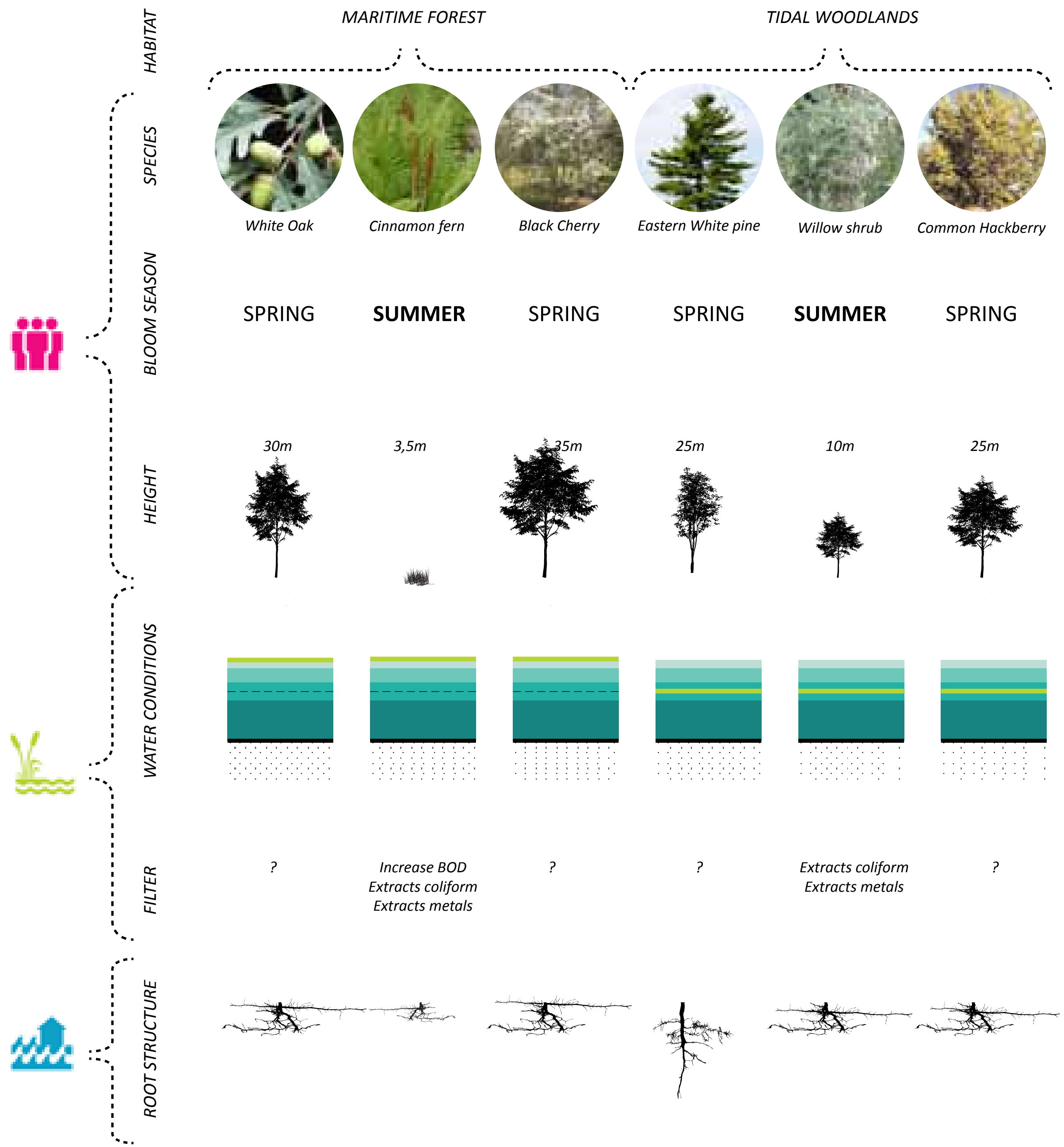
Pine Barrens

Maritime forest



Catalogue of plants

Spatial measures need to improve various aspects on different themes. By looking at the characteristics of certain plant species a choice was made to implement those species that work on more levels. All species chosen are based on the Native Species Planting Guide for the New York region (Matsil, 2001). Protection against flood-risk can be improved due to their root structure, aesthetics values such as height and blooming period can increase the attractiveness of the area, and their filtering capacity can improve the ecological quality. The filtering quality of species regarding coliform, heavy metals and its ability to decrease the BOD were also investigated. Their physical appearance, blooming period and height contribute to certain special qualities as intimacy or visual diversity. By using the potential of different plants species, the aim of the graduation project is strengthened. The following catalogue will show the most important plants desired in the Coney Island Creek.
Off course, a large variety of plant species will grow here. For the graduation project however, these plant and tree species are the most important, as they work on different levels as filter, frictional resistance, and recreational use.



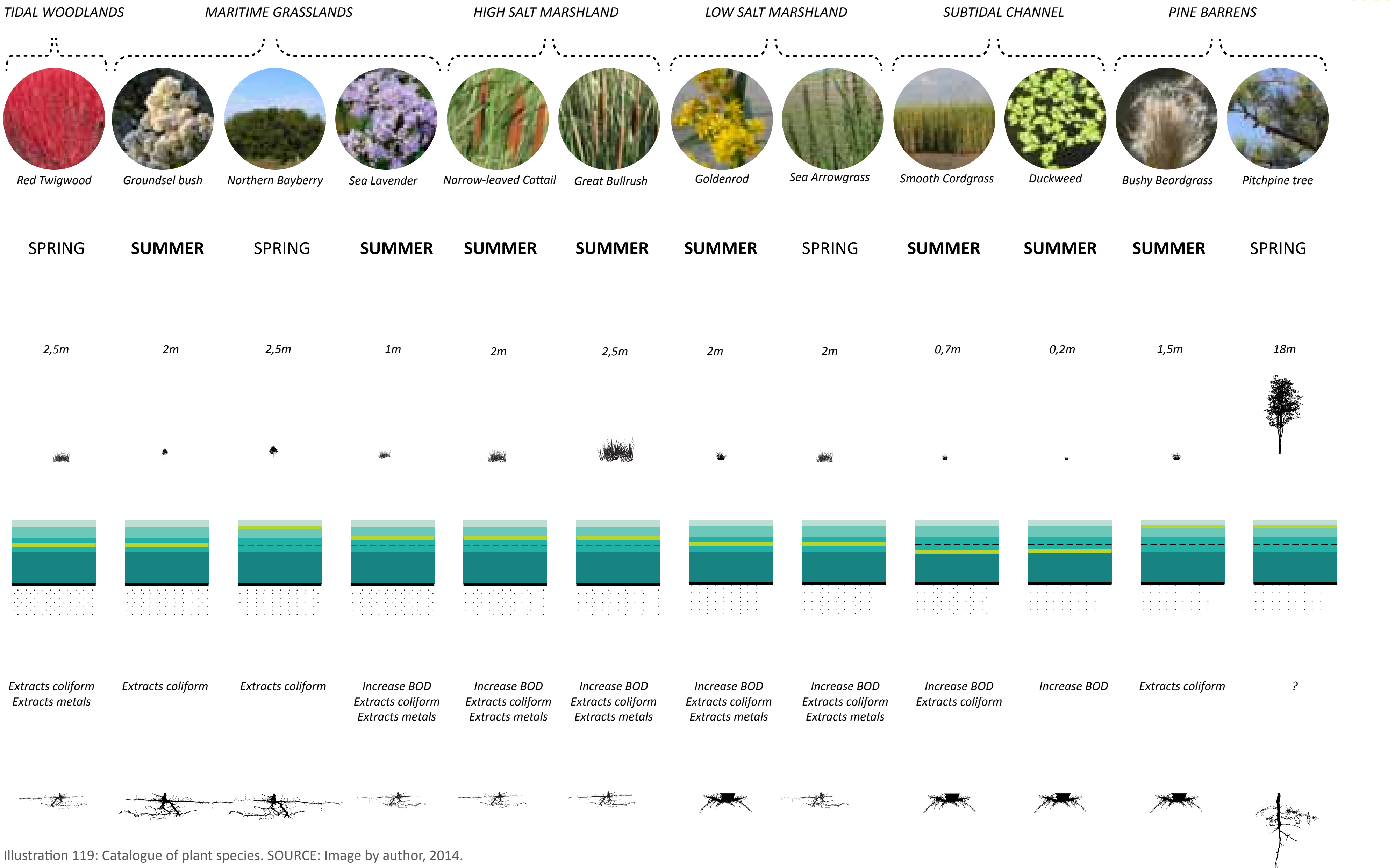


Illustration 119: Catalogue of plant species. SOURCE: Image by author, 2014.

Information from DORDIO, A., PALACE-CARVALHO, A. J., PINTO, A. 2013. Wetlands: Water “living filters”? , University of Évora. MATSIL, M. A. 2001. Native Species Planting Guide, New York, The Arsenal. WAMSLEY, T., CIALONE, M., SMITH, J., ATKINSON, J., ROSATI, J., ATKINSON, J., CIALONE, M., GRZEGORZEWSKI, A., DRESBACK, K., KOLAR, R. & WESTERINK, J. 2012. Influence of wetland degradation on surge. Nature, 500, 12.

Lack of connections between communities.

Voids in the urban fabric.

Disconnection towards waterfront.

Main street ,backbone between the communities.

View towards the parachute jump at the ocean.

Underused and undefined public space.

Quality of life within the communities.

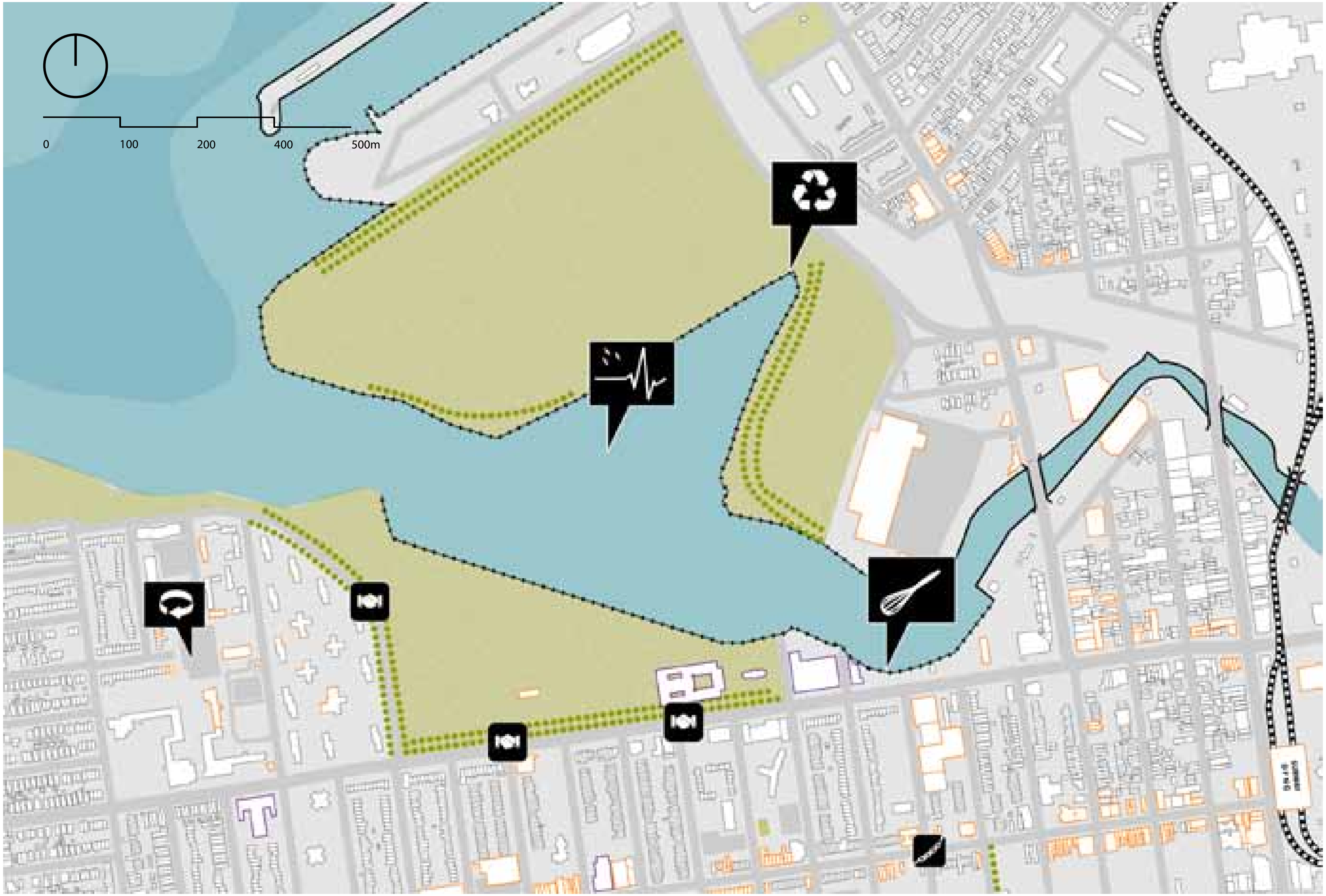
As discussed in the chapters 4.2, 4.3 and 4.4, the communities around Coney Island Creek such as Mermaid Avenue and Canal Avenue are defined as the most vulnerable communities towards flood-risk and lack certain spatial characteristics. The most pressing issues in the communities around Coney Island Creek are the lack of coherence and connection between public spaces, the underused and undefined public spaces, and the voids in the urban fabric formed by large parking lots that are only needed during summer months. The subway station is well connected towards the main shopping street, and functions as the backbone of the community. The development principles discussed in the previous chapter and should now be translated into an urban design. The actions proposed from both flood-risk and ecological perspective should also improve the social and / or spatial quality of the communities. In that way, spatial measures can increase issues on all three levels. The following pages will discuss the actions taken to integrate the three themes into an urban design and show how it will improve the living quality of communities.

As this is a project with a time span of 15 years, it is important to look beyond this timeframe so the project can facilitate future demands too. As discussed earlier, plans are made to renew some areas of Coney Island in the hope to attract more wealthy inhabitants. This has led to protests under the current inhabitants, as they feel they are being forced to relocate to areas further from the city. Inhabitants themselves united and developed a counter proposal under the name CLEAR, Community and Labor Empowerment Alliance for Redevelopment. This bottom up approach focusses on the needs of the existing communities, instead of designing a new (gated) community within the peninsula. This approach would not only add any quality to the existing conditions, but could even decrease the quality of the surroundings. The discrepancy between the old, vulnerable and poor communities and the newly proposed high rise apartments will only decrease the social cohesion within Coney Island. Decreasing the social cohesion between these communities will increase the consequences of a flood, as inhabitants have less connections with each other and feel less solidarity for one another (Walker et al., 2004). The current inhabitants are suggesting a shift from the rigid differences between the communities on Coney Island and ask for a more diverse house supply (Busá, 2010). In total, over 5000 new dwellings are needed in the next 10 years (Busá, 2010). The lack of an adequate amount of affordable housing to the existing residents of Coney Island could increase the segregation between wealth and poor even more, deteriorating the living quality of communities.

By connecting the future needs of the community with needs of the existing communities, the potential of synergy at the Coney Island Creek, where flood-risk, ecology and spatial assignments overlap could truly be exploited.

Illustration 120: Current situation in Coney Island.

SOURCE: Images from Google MAps, 2014.


0
100
200
400
500m

The following list describes the requirements set for the new waterfront design.

Facilitate growth of the current inhabitants, 50% of new housing should facilitate them.

Create an active waterfront that is easily accessible from the existing communities.

Public space that facilitates optional and social activities (Gehl, 2008).

Human scale around the walking routes and public spaces.

Attracting public functions at the waterfront that are visible from a distance.

A social node easily walkable between the subway station and the amusement park.

A ferry terminal to better connect the communities with the rest of the city.

New leisure functions around the newly accessible and clean waterfront.

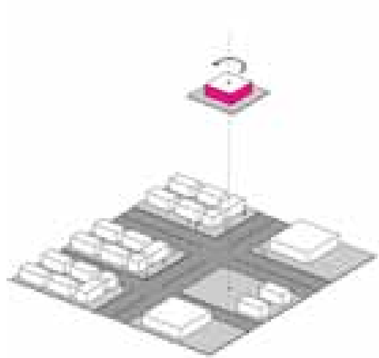
The design should connect Canal Avenue and Mermaid Avenue with the waterfront.

Transforming underused public green into a high quality park.

The design should form as a transition between old and new communities.

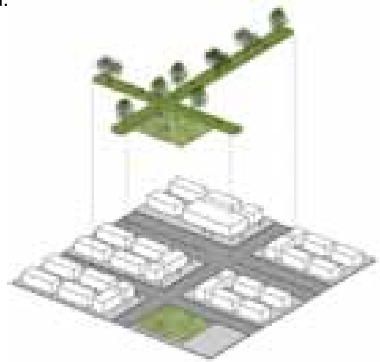
A mixed residential area, with affordable housing for existing residence, mixed with housing for higher income, could for instance increase the livability of the area.

Link



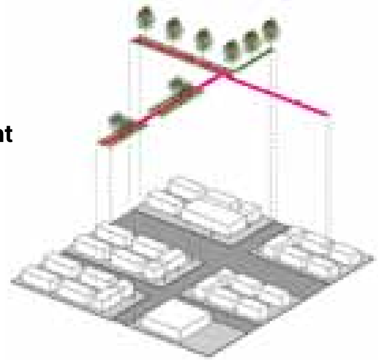
To REORIENT is to shift the entrance of a building with a communal function towards a better location, to improve to functioning of the area.

Reach



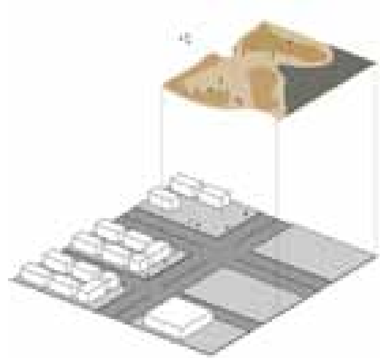
To REACH is to extend existing networks, programs or natural elements into new areas, improving the connection between them.

Reorient



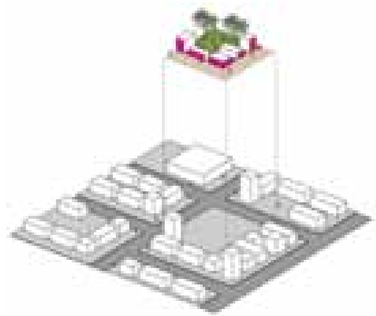
To LINK is to connect important landmarks, communities, public spaces, and amenities by creating new slow traffic networks.

Revive



To REVIVE is to reintroduce the ecology and landscape typologies that are or were typical for that location. This can be a nature reserve, but also a public park.

Mix



To MIX is to create places for interaction; to insert programs that connect and collect different users, and create shared spaces were a mix of activities can occur.

- Vacant plot
- Amenities for the community
- Touristic functions
- Park / green public space
- Bulkheads
- Revetments


0
100
200
400
500m

Creating an attractive waterfront

How the urban design will benefit the everyday life of inhabitants will be discussed in the following pages.

The map on the left shows the planned social nodes within the design. As can be seen, these social nodes are positioned on the waterfront, reconnecting nature and culture. The placed free flowing constructed wetlands that serve as ecological filters for storm water runoff from both Canal Avenue as Mermaid Avenue provide a green network towards the waterfront. As the accessibility by car of the new residential area is placed within the building blocks, the green corridors are only accessible for walking and cycling. This will provide an attractive and peaceful green route, connecting existing communities with each other and the waterfront. At the end of these routes, communal pavilions are placed. These pavilions will be differentiated according to the needs of the communities and the possibilities of landscape. Proposed is to show the relationship with the waterfront at each pavilion differently. As the tidal range in the Coney Island Creek is 1,6 meters, the dynamic landscape can play an important role. Floating pavilions, pile buildings or half submerged buildings (Nillesen and Singelenberg, 2011) could form the relationship between man and nature. As there is need for a connection with Manhattan for visitors during the summer, as well as commuters from Coney Island, a ferry terminal is located at the tip of the urban waterfront. This area will become the main node within the network, only 500 meters away from both subway station and amusement park. This makes the new social node easily walkable and well connected to the other main nodes of Coney Island.

The functions and use of the social nodes as gathering points for the inhabitants is discussed on the following page.

Illustration 121: Social nodes
SOURCE: Image by author, 2014.

Public functions

Recreational routes

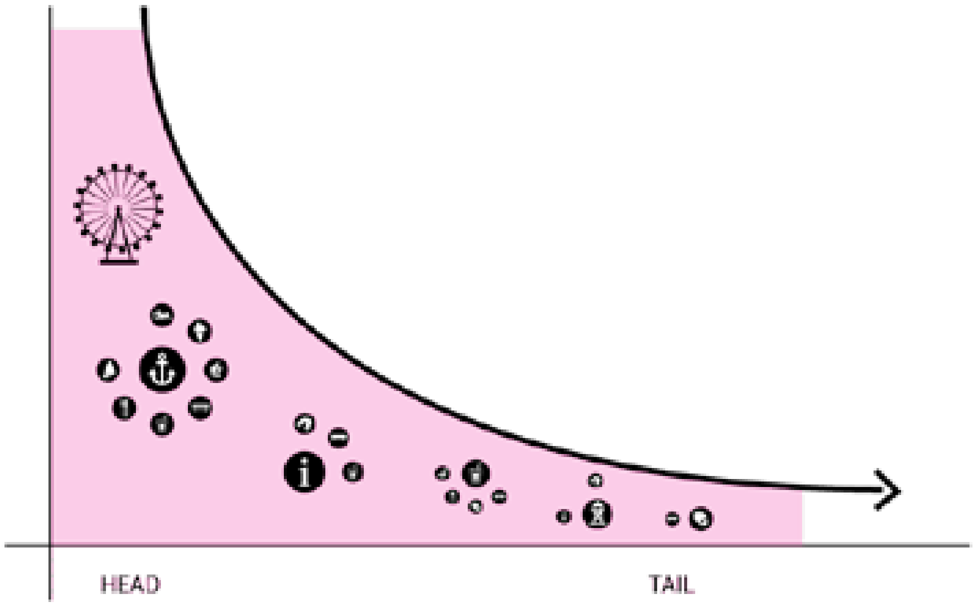
Ferry route

Proposed social nodes


0
100
200
400
500m
6 min
6 min
6 min
6 min
6 min

Leisure landscape

To facilitate an active use of the entire waterfront, differentiation between the social nodes is needed. A method to diversify the different nodes is the Long tail method. This method is used in the recreational sector to benefit from one main attractor by creating multiple niches around it. As the diagram shows, this could be useful to apply on Coney Island. As these smaller centers could never compete with the larger entertainment areas of the ocean waterfront and the amusement park, the new urban waterfront and smaller community nodes could benefit from the main attractor. As each node is only 6 minutes walking away an active use of the waterfront is stimulated (Gehl, 2008). By providing an attractive connection between them, the entire area could function as one recreation area. This could then stimulate the involvement of inhabitants to connect their shop or other public function to create a total leisure landscape.



- Observation deck / bird watching
- Viewing point
- Swimming area
- Outdoor sport activities
- Watersports
- Kayak rental
- Information point / explanation constructed wetlands
- Harbor / marina
- Sailboat rental
- Restaurants
- Café
- Street venders carts
- Resting point
- Coney Island amusement park

Illustration 122: Leisure landscape
SOURCE: Image by author, 2014.

Illustration 123: The Long Tail of Coney Island
SOURCE: Image by author, 2014.


SW-wind

Quality of life of the communities

Besides the accessibility, diversity and attractiveness of the public space, the physical conditions such as wind, sun and human scale are important. When these physical conditions are met, a space can transform into a well-used public place (Gehl, 2008).

As the climatic conditions in New York are similar to those in the Netherlands, a public space where people would stay needs to be out of the wind and in the sun. This creates an enjoyable environment. The main wind direction in New York comes from the coast, the South West. By placing the highest buildings on this side of the public spaces, the space will be in the shelter of the wind. By investigating the shadows the buildings cast during the spring, summer and autumn the social nodes can be placed in such a way that the sun will not be blocked. In the map on the previous page the shadows cast in these seasons during the afternoon is shown. We can see that the proposed pavilions next to the main boulevard will always be in the sun and out of the wind. This will result in a pleasant environment for people to stay and increase the living quality of the communities.

As discussed in the first chapter of this report, the definition of social quality of Gehl will be used in the graduation project. Gehl defines social quality as; 'Social quality is the fruit of the quality and length of other types of activities than necessary activities. It occurs spontaneously when people meet in a particular place. Communal spaces in cities therefore become attractive when all activities of all types occur in combination and feed off each other' (Gehl, 2008, p.26). As these social nodes will form the connection between the communities, waterfront and ferry terminal, this area will always be used in everyday activities. Because of the favorable exterior conditions, in other words; public space out of the wind and in the sun, optional activities will occur here too. This category of conditions includes activities such as talking, taking a breath of fresh air or walking the dog. When the quality of the outdoor area is good, optional actives will occur with increasing frequency (Gehl, 2008). The mix of activities that will occur then will create a high quality public space, truly becoming the social node within the communities.

If activities and people are assembled, it is possible for individual events to stimulate one another. As each social node is connected to a particular community, this place could increase the cohesion and involvement of the inhabitants. This combination, of spatial and social quality, will create an attractive and well used space.

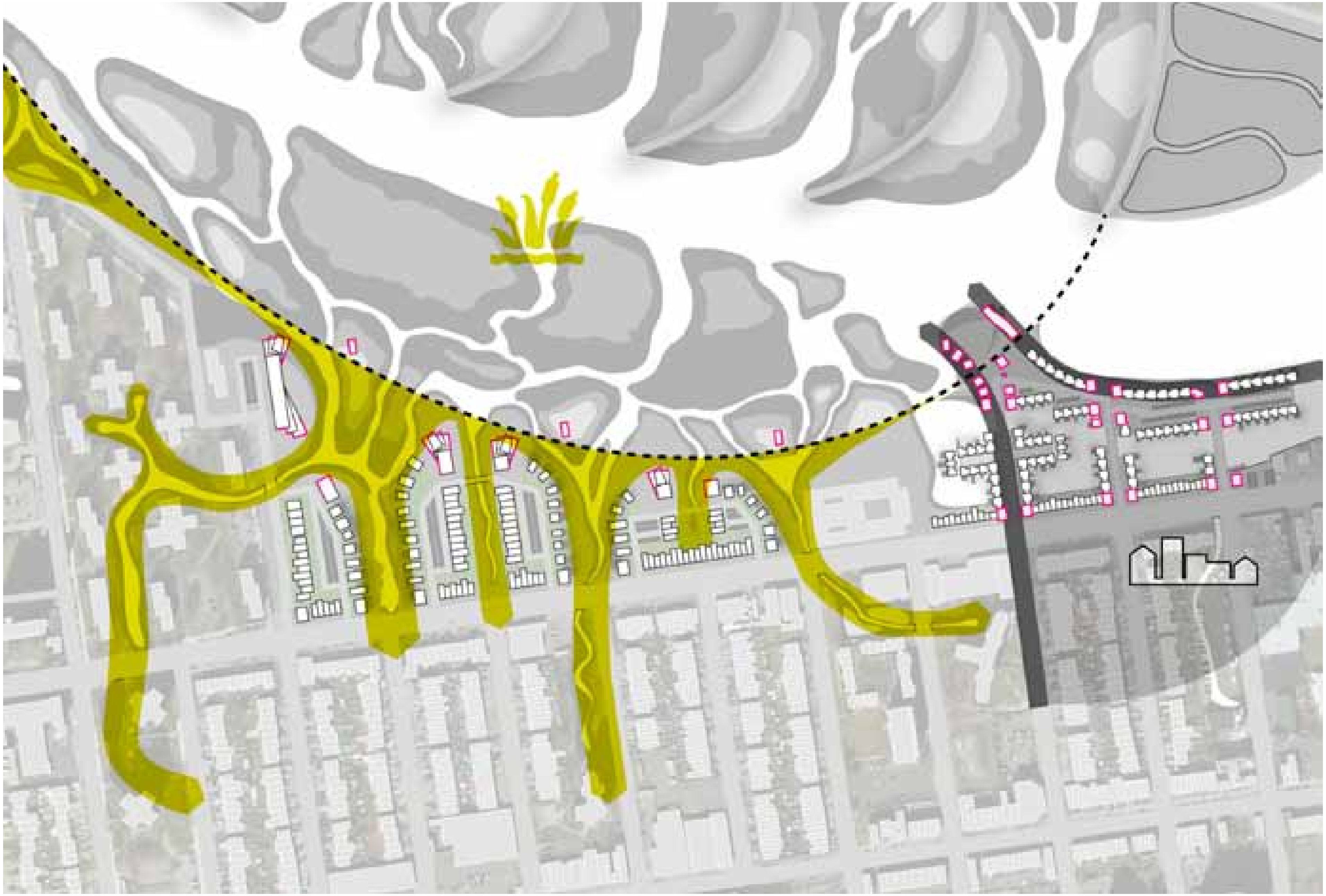
Illustration 124: Sunlight study
SOURCE: Image by author, 2014.

Shadow at a summer afternoon

Shadow at a spring afternoon

Shadow at a autumn afternoon

Public functions



Composition

The concept of the design is twofold. The mix residential area will become the edge of the communities with the waterfront. It will form a transition between urban and nature and should be shaped accordingly. On the following pages, a step by step transformation from the typical Coney Island building block to a new waterfront will be discussed. The main node should act like an extension of the city into the marshland. As the proposed functions will be of a more intense nature than the other nodes, an urbanized atmosphere is proposed. In contrary to the residential area, the border between city and nature will be hard; the buildings are placed directly into the water. The two main (east to west and north to south lines) of the typical New York grid will deform towards the waterfront, forming the transition. At the tip of this area the main public functions are located, sticking out into the natural landscape.

The main walking path that connects the different areas will become the border between city and nature. The only objects on the other side are public functions. Each of these public functions will form a different relationship between building and water. The buildings could float in the water, be placed on piles or be half submerged. This relationship with the dynamics of the water will connect the communities with the identity of the landscape even more. Due to the concave shape of the path, these public spaces will be clearly visible from the entire area.
To discuss the aesthetic value of the urban design, it is important to look at the design on eye level. Impressions have been made to illustrate this. These impressions can be found on the following pages.

Illustration 125: Compostion concept
SOURCE: Image by author, 2014.

Illustration 126: Impression of the urban waterfront
SOURCE: Image by author, 2014.


1

1. View towards the main social node, the extension of the city towards the marshland.

Flood-risk protection ribs are overgrown with plants .

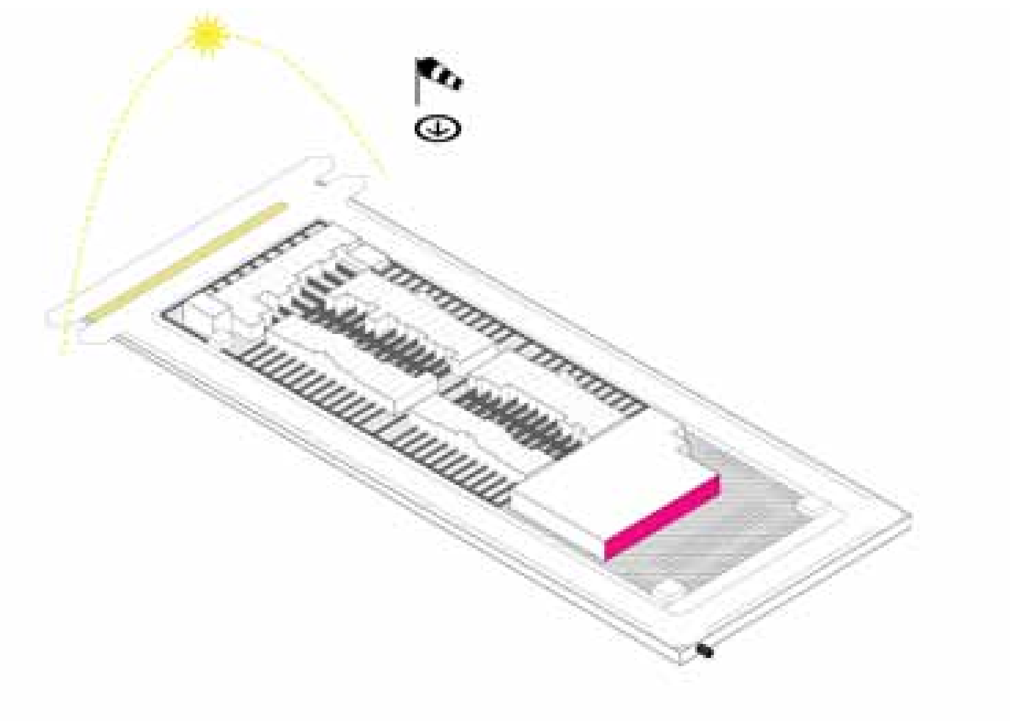
Ferry terminal towards Manhattan.

Variety of water related leisure.

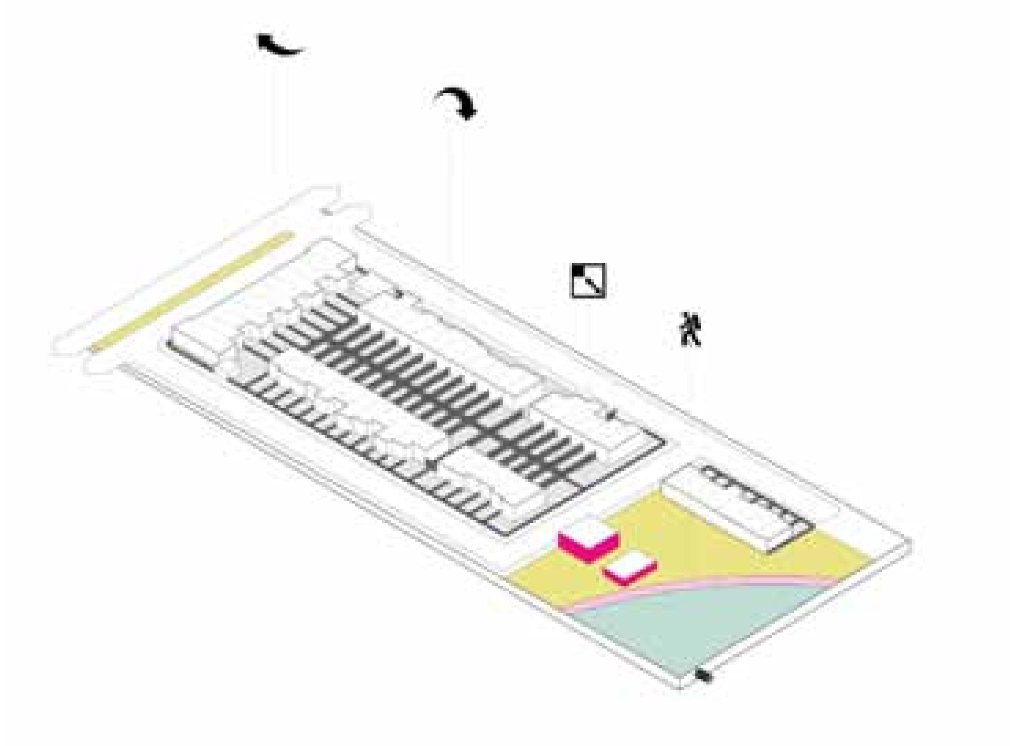
Difference in pavement creates places to stay.

3
2

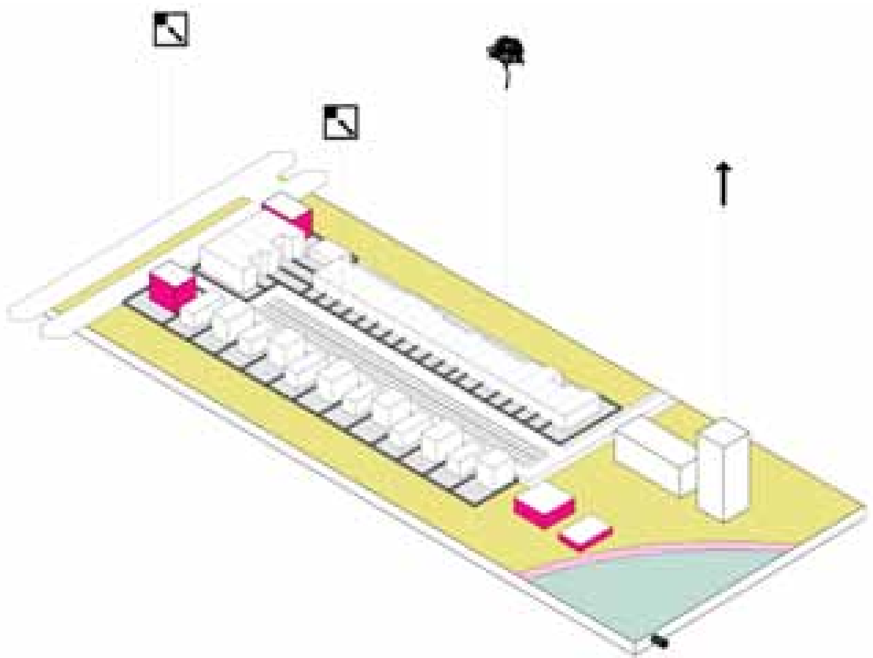
Transformation of the typical Coney Island block.



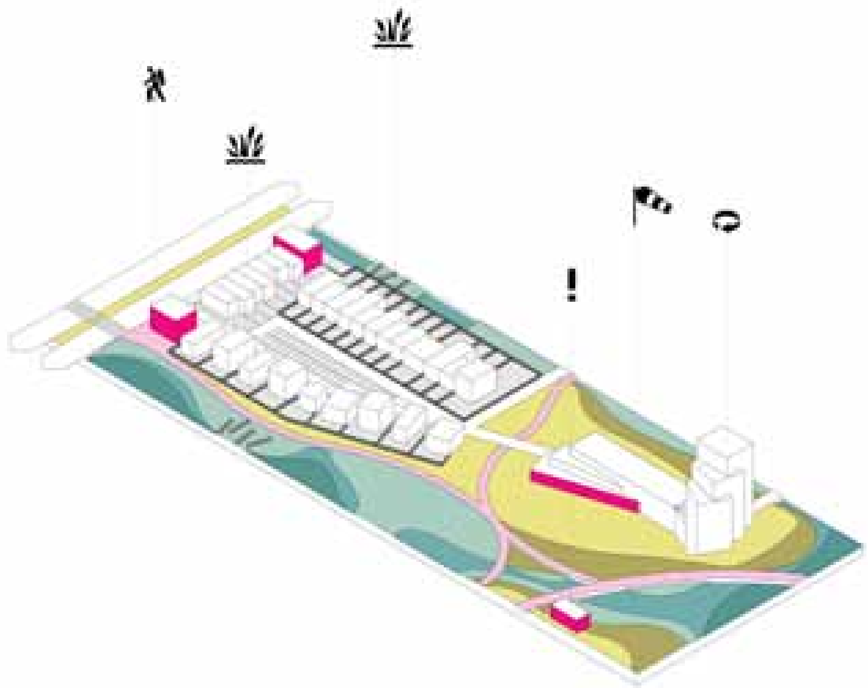
Physical conditions of the typical urban block of Coney Island. The buildings are orientated east to west. The main wind direction is from the south west.



Adding new public functions at the ends of the main direction. Instead of differentiation at the inside of the building block. The public side of the buildings will stand out, showing the individual housing.



By using the inner side of the building block as access route, the outer area of the block will be transformed into green public space. This will increase the living quality of the inhabitants as provide an enjoyable walking route towards the waterfront. By enlarging the buildings at the edges of the block and providing space for public functions, the entrance is accentuated.



By adding living filters in the green entrances, the storm water runoff from nearby areas can be filters before entering Coney Island Creek. an accent will be created at the waterfront, proving a gentle transition between the high-rise of Canal Avenue and the new urban center. The buildings are shaped in such a way that the human scale of the public space is kept intact, creating an enjoyable space to stay.

The social node of the communities is located in the extension of the main access route. The housing is differentiated to accommodate a mix of inhabitants. At the edge between public and private space, height difference and reed will provide the needed privacy.

Illustration 127: Transformation of the Coney Island urban block.
SOURCE: Image by author, 2014.

Illustration 128-129: Impression of the urban waterfront.
SOURCE: Image by author, 2014.

2. View from the new green connection towards the waterfront.

Free flowing constructed wetland filter storm water runoff.

Public functions visible from the existing communities.

Improved water quality increases the recreational value of the waterfront.

Height accent in line with existing urban fabric.

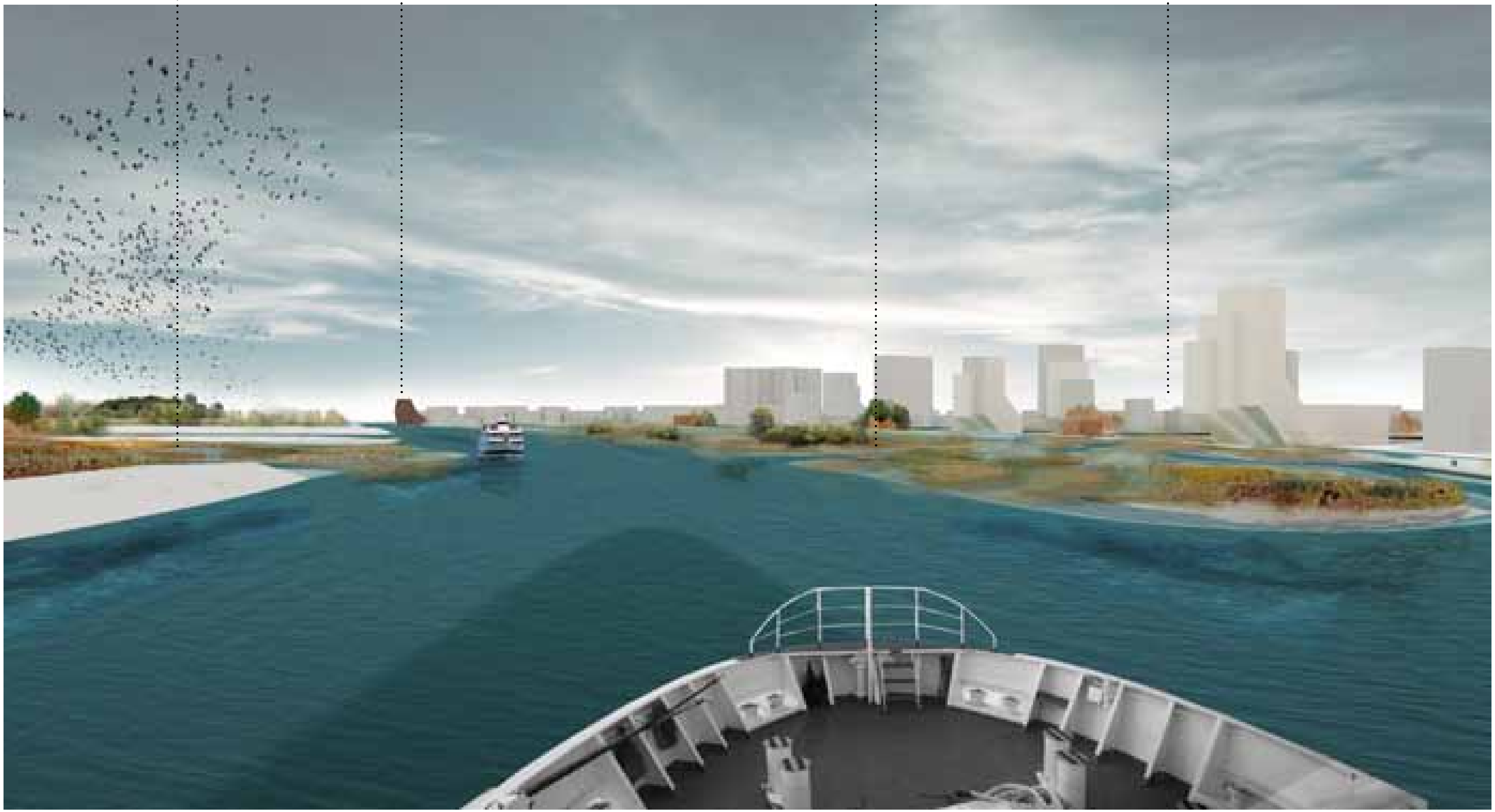
3. View towards the ferry terminal from the channel.

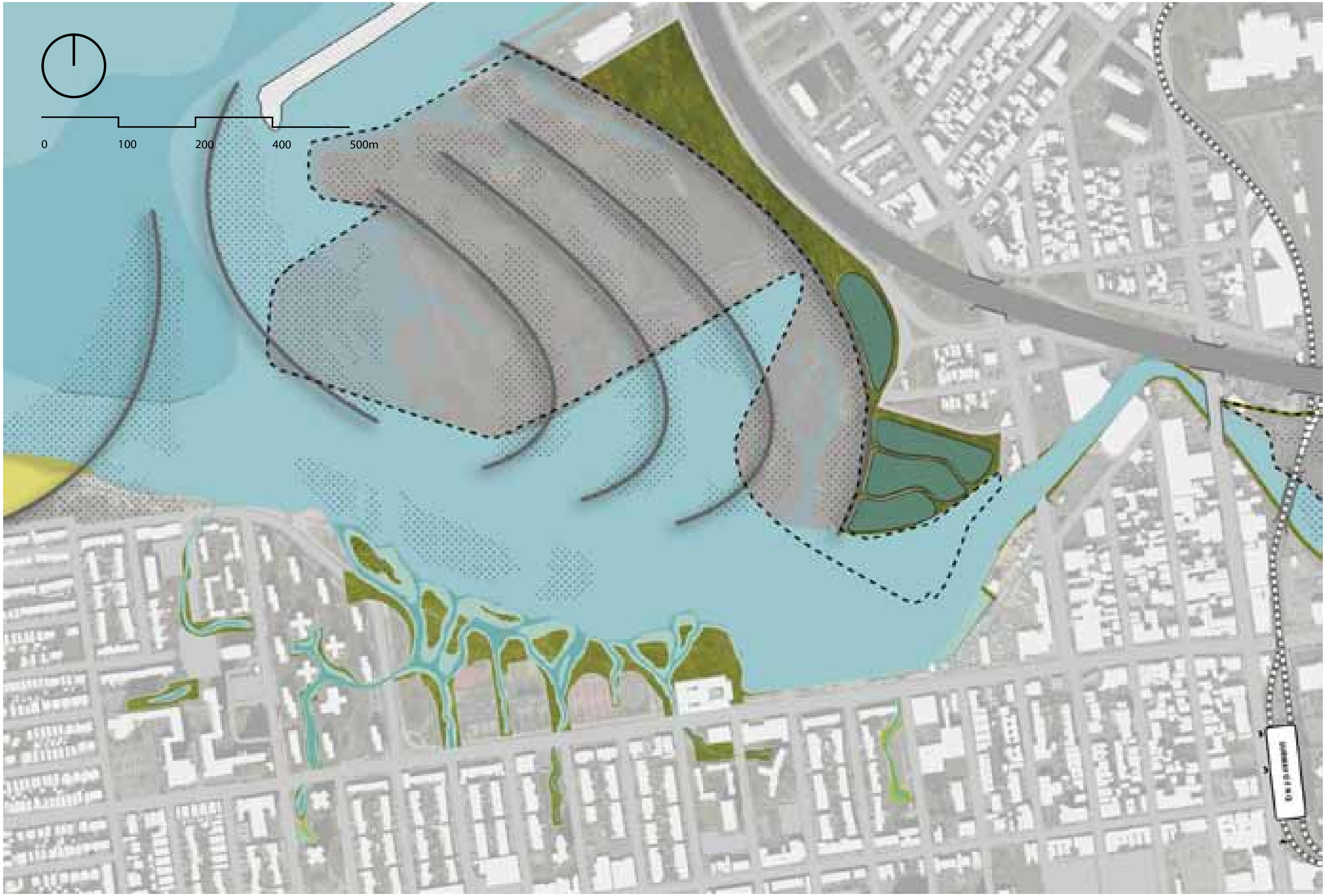
Ferry terminal extends into the marshlands.

Constructed wetlands form the connection towards the communities.

Nature reserve inaccessible for the public.

Differentiation of the public functions around the waterfront.




0
100
200
400
500m

8. PHASING THROUGH NATURAL DYNAMIC PROCESSES

$$3 * (100\% - 30\%)^{4} * (100\% \; -10\%)^{0 / 500} * (100\% - 10\%)^{0 / 50} = 0{,}72$$

One of the most important aspects of the graduation project is dealing with the increasing intensity and uncertainty of future storms. Around the world we can see different approaches towards this uncertainty. Aspects such as the costs of the protection measures, value of the assets at risks, and the vulnerability of the inhabitants play an important role in the choice of approach (McCarthy et al., 2001). An example where the flexibility to adapt towards the future was neglected is Hafencity in Hamburg. This large project that combines urban development with flood-risk protection was based on flood-risk figures that were estimated too low. As the design did not incorporate possibilities to adapt to future hazards, large investments need to be made to prevent flooding of this area in the future. To deal with the uncertainty that the future brings most approaches over dimension the protection measures. In this way, even if the predictions were incorrect, the protection measures are still effective. This approach however, results in higher costs, increased maintenance or a decrease in the spatial or social quality of the environment.
The importance to focus on the flexibility of the protection measures, so they can be adapt towards the needs in the future is therefore extremely important. By using the natural processes that occur around Coney Island as a base for further development, the project already incorporates certain flexibility by using these dynamics. The following pages will show the natural phasing that will increase the flexibility of the project, as well as the opportunities this brings forth. As discussed earlier, the water design heights are 3 meters in 2015 and 3,50 in 2030.

2015: Restoring the natural processes.

The most important aspects to improve right away are the ecological quality of the bay and the flood risk the area faces. By digging out the underused park the shape of the bay is changed, resulting in a better circulation of the water. The ribs placed in the bay will create physical resistance against a storm surge and trap sediment behind them. The trapping of sediment will result in new land that will provide different conditions for habitats to grow.
To filter the pollution from the bay free flowing constructed wetlands are placed at the coastline of Mermaid and Canal Avenue. Storm water runoff from these communities will be filtered here before entering the creek. The combined sewage outflow from Brooklyn will be filtered in the closed basin constructed wetland. These two types of living filters will increase the water quality in the creek over time. The combination of sweet and salt water and the improved water quality create the right conditions for plant species to grow.
From the storm surge formula, explained in the previous chapter, the effectiveness of the protection measures can be estimated. The physical resistance due to the placed ribs will decrease the energy of the storm surge by 30% each rib. This means that at the end of the creek, the storm surge of three meters will be decreased to 70cm. This means that the storm surge cannot run up onto land and that the area is protected against flooding.

- Existing buildings
- Closed wetland filter
- Free flowing wetland filter
- Flood-risk protection ribs
- Sediment trapping
- Current coastline
- Public functions
- New residential waterfront
- Walking paths

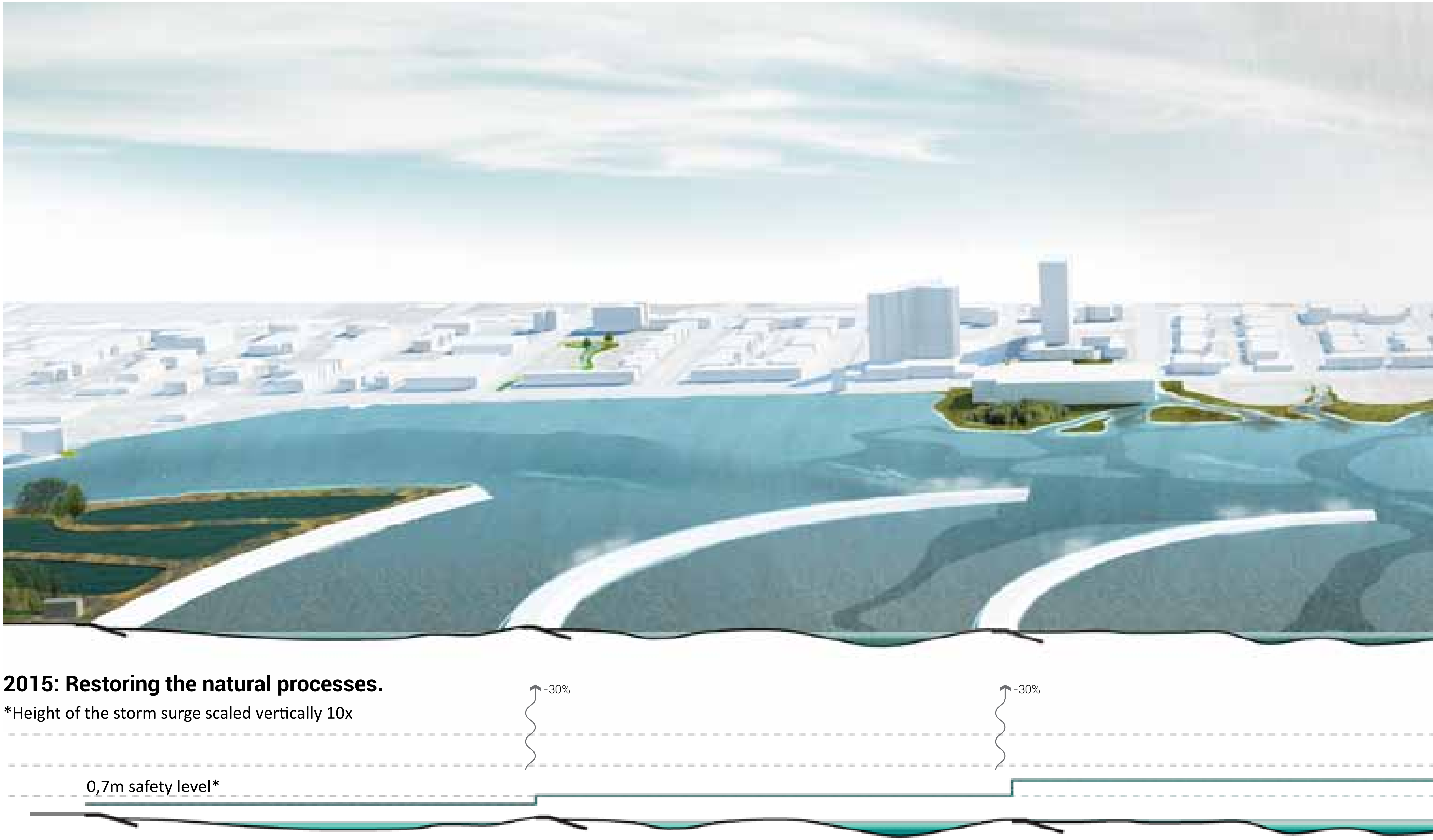
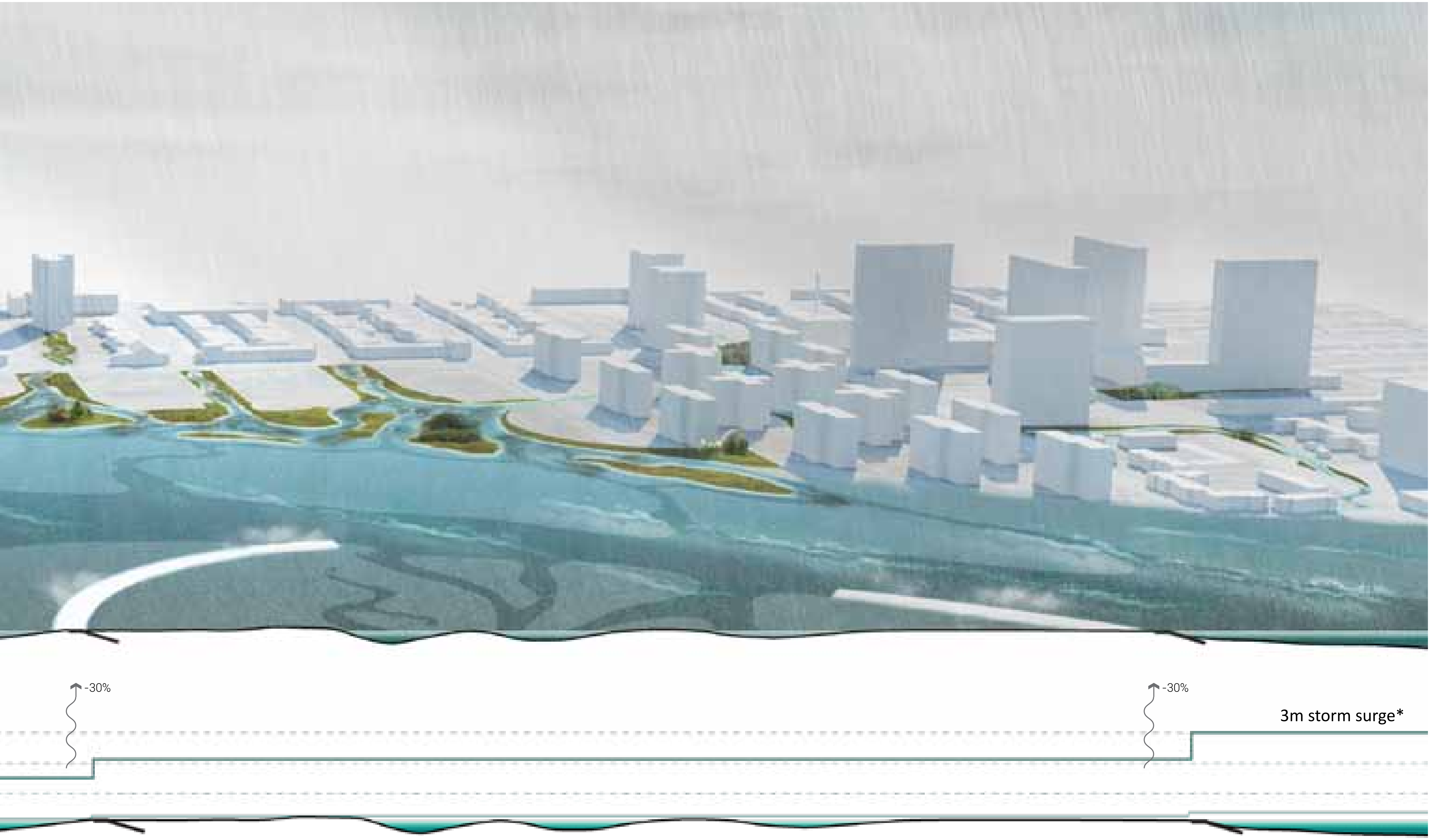


Illustration 131: Impression of the first phase of the transformation of Coney Island Creek. SOURCE: Image by author, 2014.



-30%
-30%
3m storm surge*


0
100
200
400
500m

$$3.5 * (100\% - 30\%)^4 * (100\% \; -10\%)^{650 / 500} * (100\% \; -10\%)^{0 / 50} = 0,73$$

2015-2030: Urban interventions.

The sediments that have settled behind the ribs have created different islands. The height difference of this land in relation to the tidal range of the water creates a variety of different habitats for different species of plants to grow. First the early adapters such as reeds, salt water plants and pine barrens will start to grow. These plants will already decrease the storm surge energy with 10% every 500 meters of land (Wamsley et al., 2012) and decrease the erosion due to the fine web of roots. When the water quality of the creek is improved from class five towards a class three water body the waterfront can be used recreationally. The quality of the outdoor space is improved as people can access and use the waterfront. The waterfront will be connected with the communities by walking and cycling paths along the open wetland filter. The main social node can be developed to improve the accessibility from Manhattan.

The added frictional resistance will improve the flood-risk protection over time. Even though the storm surge design height in 2030 is 3,50 meters the water height after the protection measures will still be around the 70 centimeters. The dynamic processes increase the flood-risk protection naturally.

Variables;
s = Storm surge height at impact in meters, 3.5 meters.
p = percentage of energy loss due to physical resistance, 30%.
n = number of ribs in between storm surge and communities, 4.
fplants = percentage of energy loss due to plants, 10%
wland= width of land above average sea level in meters, 650 meters
ftrees = percentage of energy loss due to plants, 10%
wforest = width of forest in meters, 0 meters.
h = height of surge after protection measures in meters, 0.73 meters.

Illustration 132: Urban interventions.
SOURCE: Image by author, 2014.

- Existing buildings
- Closed wetland filter
- Free flowing wetland filter
- Flood-risk protection ribs
- Sediment trapping
- Current coastline
- Public functions
- New residential waterfront
- Walking paths

2015-2030: Urban interventions.

*Height of the storm surge scaled vertically 10x

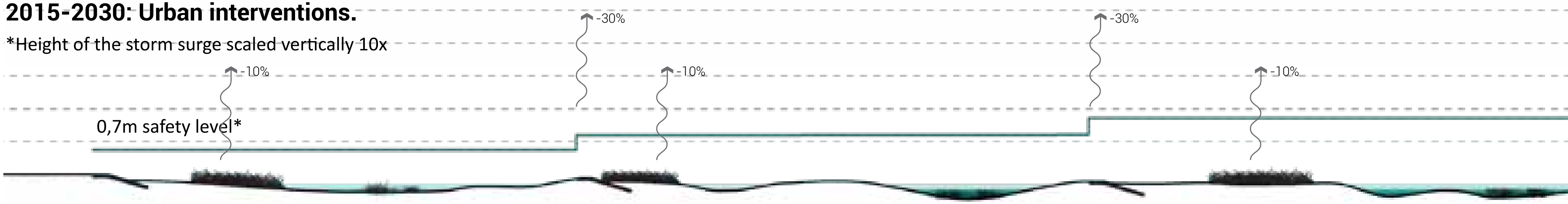
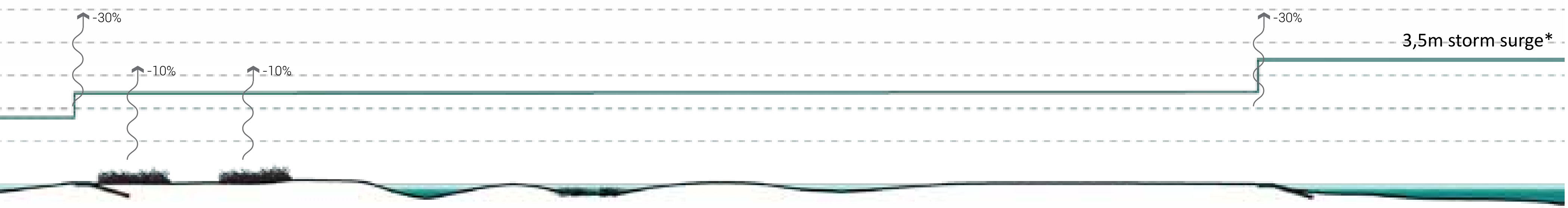


Illustration 133: Impression of the second phase of the transformation of Coney Island Creek. SOURCE: Image by author, 2014.


-30%
-10%
-10%
-30%
3,5m storm surge*


0
100
200
400
500m

$$0.7 / \{ (100\% \;\; -30\%)^{4} * (100\% \;\; -10\%)^{650 / 500} * (100\% \;\; -10\%)^{100 / 50} \} = 4$$

>2030: Maintaining the balance.

Over time, the different habitats and succession of plants will create the right conditions for trees to grow. Trees will increase the frictional resistance against storm surges with 10% every 50 meters (Wamsley, 2010). When there is need for more housing in Coney Island the new waterfront can be developed. This new residential area needs to have a large variety in the housing typology so that the demands of both existing inhabitants and new residents will be met. New public functions around the social nodes will increase the quality of the public spaces even more. The added frictional resistance will increase the flood-risk protection even more as well. Both storm surge heights after the protection measures of 2015 and 2030 are around the 0.7 meters. If we aim for the same safety level in 2030, a water height behind the protection measures of 0.7 meters, the formula can be used to find the height of the storms surge that can be protected for. The storm surge height will be the variable to find, with 0.7 meters as given safety level. Due to the added frictional resistance of the 100 meters of trees the storm surge that can be protected for is 4 meters.

Key in this phase is to maintain the balance between the natural processes. The sub tidal channels behind the ribs need to be dredged out regularly to create as much height difference to maintain the physical resistance against storm surges. The use of natural processes increases the flexibility of the design towards future needs and demands and the maintenance costs of this type of flood-risk defense will be much less compared to conventional protection measures. In the end, by using natural processes, a synergy between flood-risk protection, ecological quality and the quality of life within the communities can be made.

Illustration 134: Maintaining the balance.

SOURCE: Image by author, 2014.

Variables;

h = height of surge after protection measures in meters, 0.7 meters.

p = percentage of energy loss due to physical resistance, 30%.

n = number of ribs in between storm surge and communities, 4.

fplants = percentage of energy loss due to plants, 10%

wland= width of land above average sea level in meters, 650 meters

ftrees = percentage of energy loss due to plants, 10%

wforest = width of forest in meters, 100 meters.

s = Storm surge height at impact in meters, 4 meters.

- Existing buildings
- Closed wetland filter
- Free flowing wetland filter
- Flood-risk protection ribs
- Sediment trapping
- Current coastline
- Public functions
- New residential waterfront
- Walking paths

>2030: Maintaining the balance.

*Height of the storm surge scaled vertically 10x

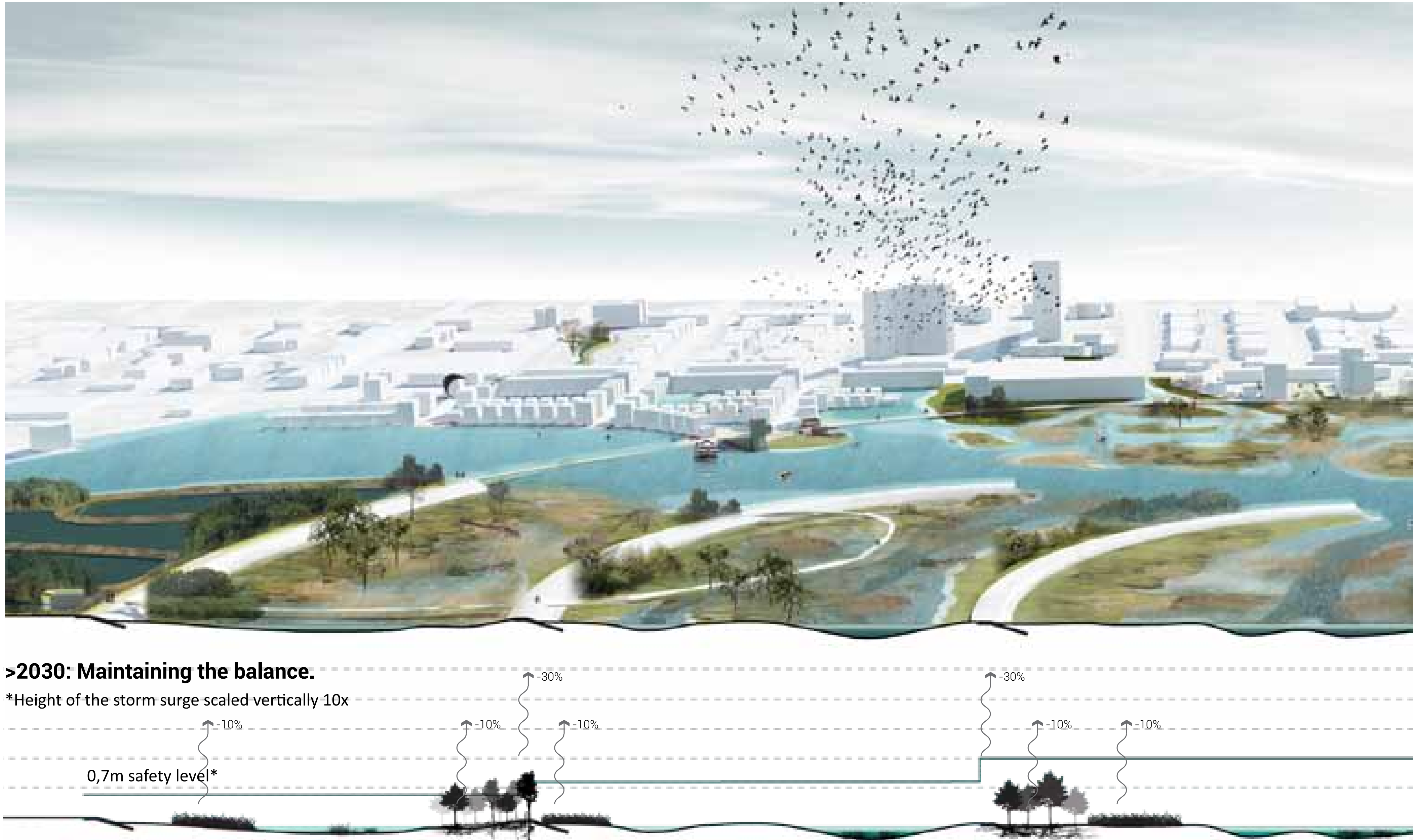
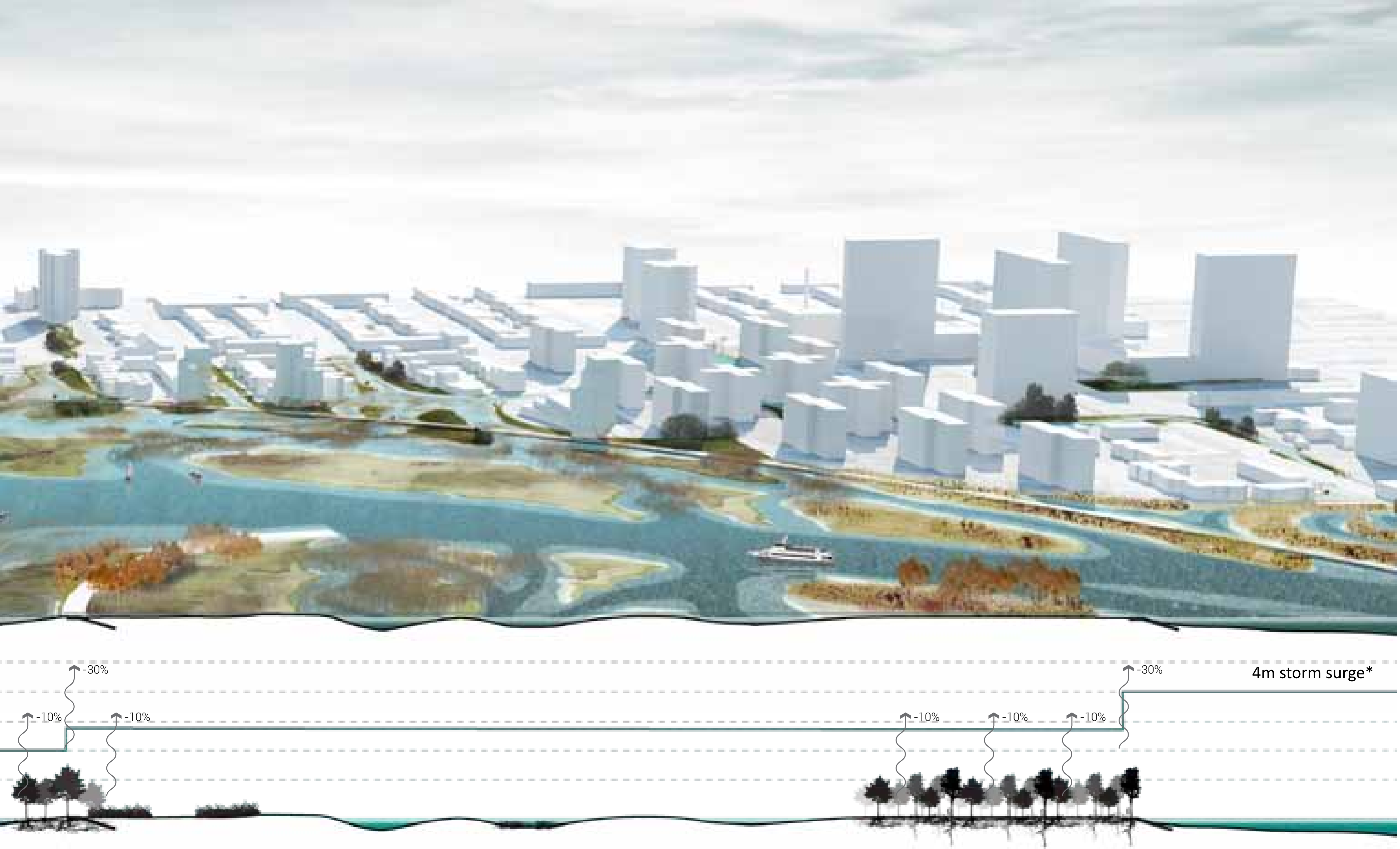


Illustration 135: Impression of the final phase of the transformation of Coney Island Creek. SOURCE: Image by author, 2014.



-30%
-10%
-10%
-10%
-10%
-10%
-30%
4m storm surge*

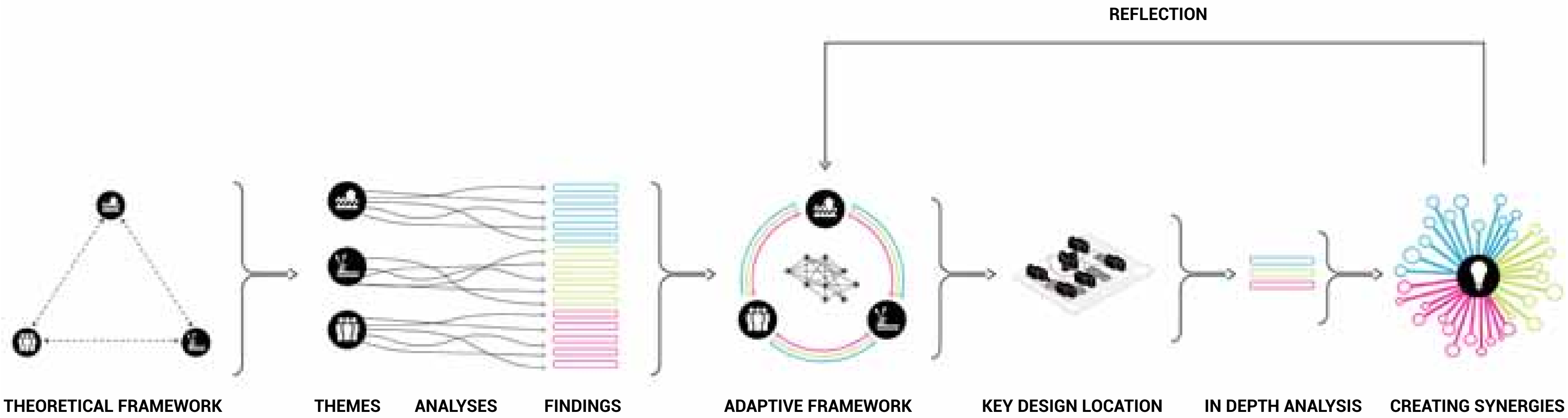
REFLECTION

The final chapter of this graduation plan will discuss the results of the graduation project in the studio of Delta Interventions at the Technical University Delft, Faculty of Architecture, department of Urbanism. In the following paragraphs, the answer to the main research question, recommendations for future research and the relevance of the project for other flood-prone communities worldwide will be discussed. The planning and process of the graduation project will be addressed after.
The main research question this graduation project dealt with is: How can a spatial framework contribute to a resilient flood-risk protection, while improving the living quality of communities?
Looking at other waterfront communities the relevance of this graduation project is apparent. Rapid urbanization of flood prone areas will increase the costs to rebuild and future storms will become more frequent and more intense. That this is going to become harder over time is evident. Flood-risk defense needs to adapt to the context in which it is located to truly create resilient communities. Conventional flood-risk defense measures do not have the flexibility to adapt to future changes in demands. A reference study on both ecosystem based flood-risk protection, as well as on framework urban designs, have shown that when using dynamic natural processes, flexibility and adaptivity within a strategy are possible. This makes the strategy resilient for future changes regarding ecology, flood-risk protection, and the needs of the communities. Another important factor is that of time, the three main themes in this graduation project all have a different timeframe and require a different amount of elaboration. By researching the three themes on both large and local scale, the relationship between different requirements and actions where found that could greatly benefit each other. The most remarkable finding of the graduation project was the use of natural dynamic processes as starting point in creating resilient communities. By reintroduction the historical ecosystems of the location, natural phasing of erosion and suppletion, combined with the ecological benefits and recreational use of the area are achieved. The added benefits of flood-risk protection by using ecosystem based flood-risk defense therefore improve the living quality of communities. The strategic framework designed for Coney Island shows the relationships between flood-risk protection and social and spatial quality. The translation of the strategy in an urban design for Coney Island Creek shows that it is possible to create synergies between flood-risk protection, ecological values and other important urban functions, serving as vital element for the needs within the communities.

As the design of Coney Island Creek shows, a spatial framework can contribute to a resilient flood-risk protection and improve the living quality of communities. Aspects as the adaptivity and flexibility of the strategy, addressing issues of multiple themes within the strategy, and a good understanding of using natural dynamic processes in the phasing, have proven to be the most important elements that need to be taken into account.

In the last years, different articles where writen about this subject (Temmerman et al., 2014, Wamsley et al., 2012, Cadenasso and McGrath, 2013), but this strategy is never implemented in an urbanized setting. The graduation project could provide support on the use of reintroducing ecosystems as flood-risk protection in urbanized areas. It will therefore help to shift the current strategies from an approach focused on only reducing flood-risk to a context driven approach, addressing more issues and seizing more opportunities. As 'Delta Urbanism' focusses on new approaches for design and planning of urbanized delta areas, this graduation project fits well within this theme.

An important remark is the inability to truly prove this design. The lack of detailed research that has been done on the subject as well as the lack of reference projects is the main reason for this. The flood-risk protection measures implemented on Coney Island Creek are based on broad estimates described in various articles (Wamsley, 2010, Wamsley et al., 2012) and would need more input from other fields of work such as biology and civil engineering. The lack of specific requirements is caused by the large amount of variables when working with nature (Jonkman, 2013). As discussed, the shape and slope of the bay, type of vegetation, height of land and shape of coastline, combined with the variables of the storm surge; direction, energy, angle, temperature and so on, all contribute to the flood hazard (Wamsley, 2010, Wamsley et al., 2012).



Process

For a spatial framework to contribute to resilient flood-risk protection, while improving the living quality of communities, specific knowledge is needed on the requirements of ecology, community and flood-risk. The relationship between the terms was investigated with different sub-research questions, focusing on how the one could improve the other. To translate the strategic plan into a design on a key location, a more in depth research was needed. As both the strategy and the design are a translation of the requirements found through analysis, research and design can be seen as inseparable parts of the graduation project.

Other flood-prone communities could benefit from this graduation plan by the methods used to come to the strategy and design. The design is a translation of the needs and requirements of flood-risk, ecology and communities, found by analyzing the location, literature research and reference studies. The research structure, shown above, could prove to be an important method to come to a context driven design that will combine resilient flood-risk protection with the living quality of communities. This structure combines generic knowledge on the themes into specific knowledge on the location. This forms the base for the adaptive strategic plan. Development principles define opportunities for transformation. They work on different scales and across different issues from ecology, spatial quality and the program. A design on a key location of the strategy will show the translation of these development principles, showing the aesthetic value of the proposed plan.

Planning

Translating the research had, like most design processes, its ups and downs. As analyses can be planned and structured, a design processes cannot. By adding a more in depth research on the key design location of Coney Island Creek, new grips on answering the main research question was found. A new article in Nature, Ecosystem-based coastal defense in the face of global change (Temmerman et al., 2014), provided important insight on the potential and limitations of ecosystems and flood-risk protection. This article helped focus the design on the three discussed terms greatly.

Illustration 136: Research structure
SOURCE: Image by author, 2014.

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Colophon

Resilient communities
How a spatial framework can contribute to resilient flood-risk protection, while improving the living quality of communities.
GRADUATION REPORT

Bram Willemse
Student ID 4164733

1st mentor: Anne Loes Nillesen
2nd mentor: Steffen Nijhuis
External examiner: G.J.Hordijk

Department of Urbanism
Faculty of Architecture
TU Delft

Date: 17 June, 2014.

Colophon

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How a spatial framework can contribute to resilient flood-risk protection, while improving the living quality of communities.
GRADUATION REPORT

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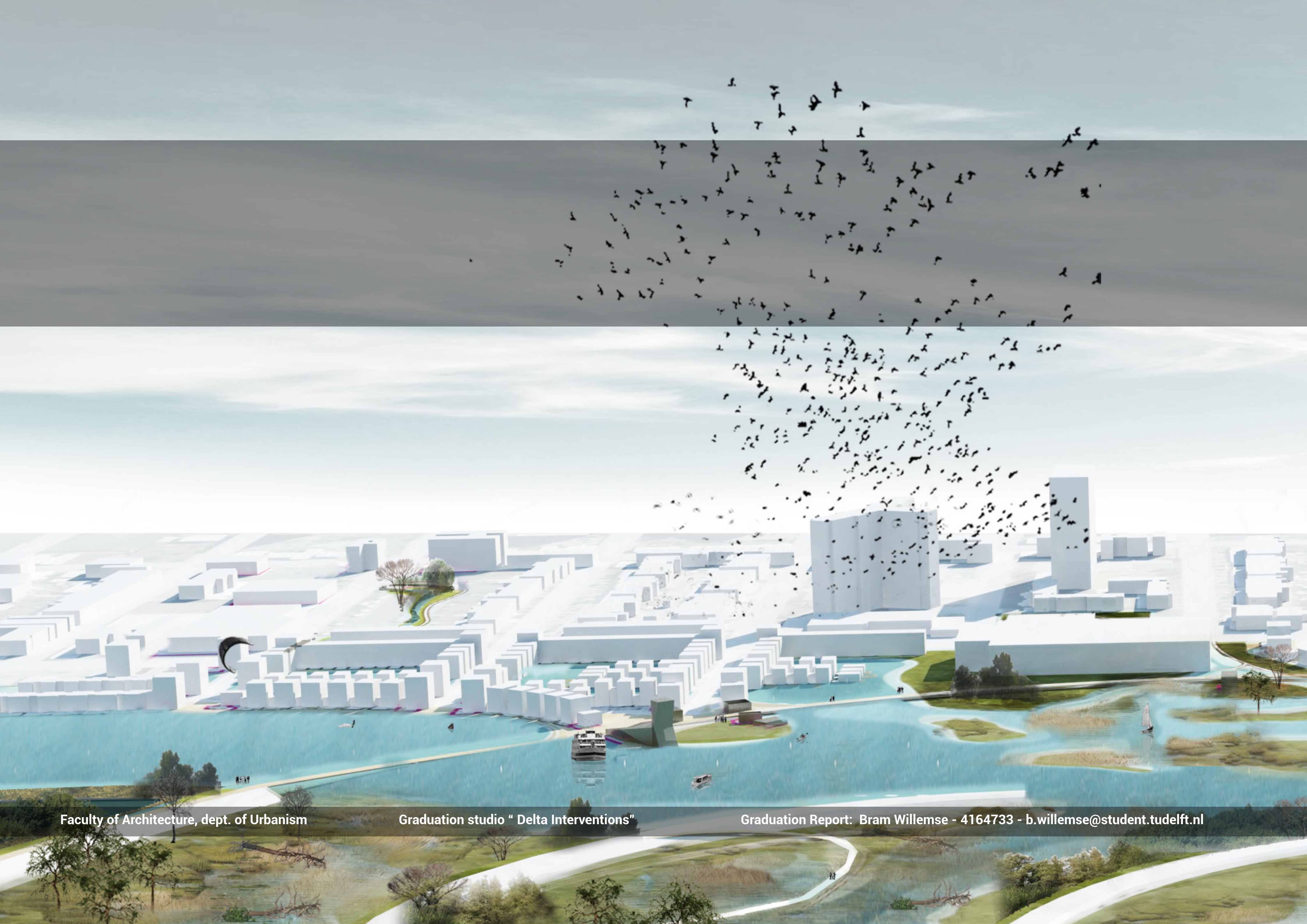

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Graduation studio “ Delta Interventions”

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