RESILIENT DENCITY

BUILDING WITH WATER

MATTIA TINTORI
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ExploreLab19 | Research Report

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Resilient Dencity_
Building with water

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Research Report

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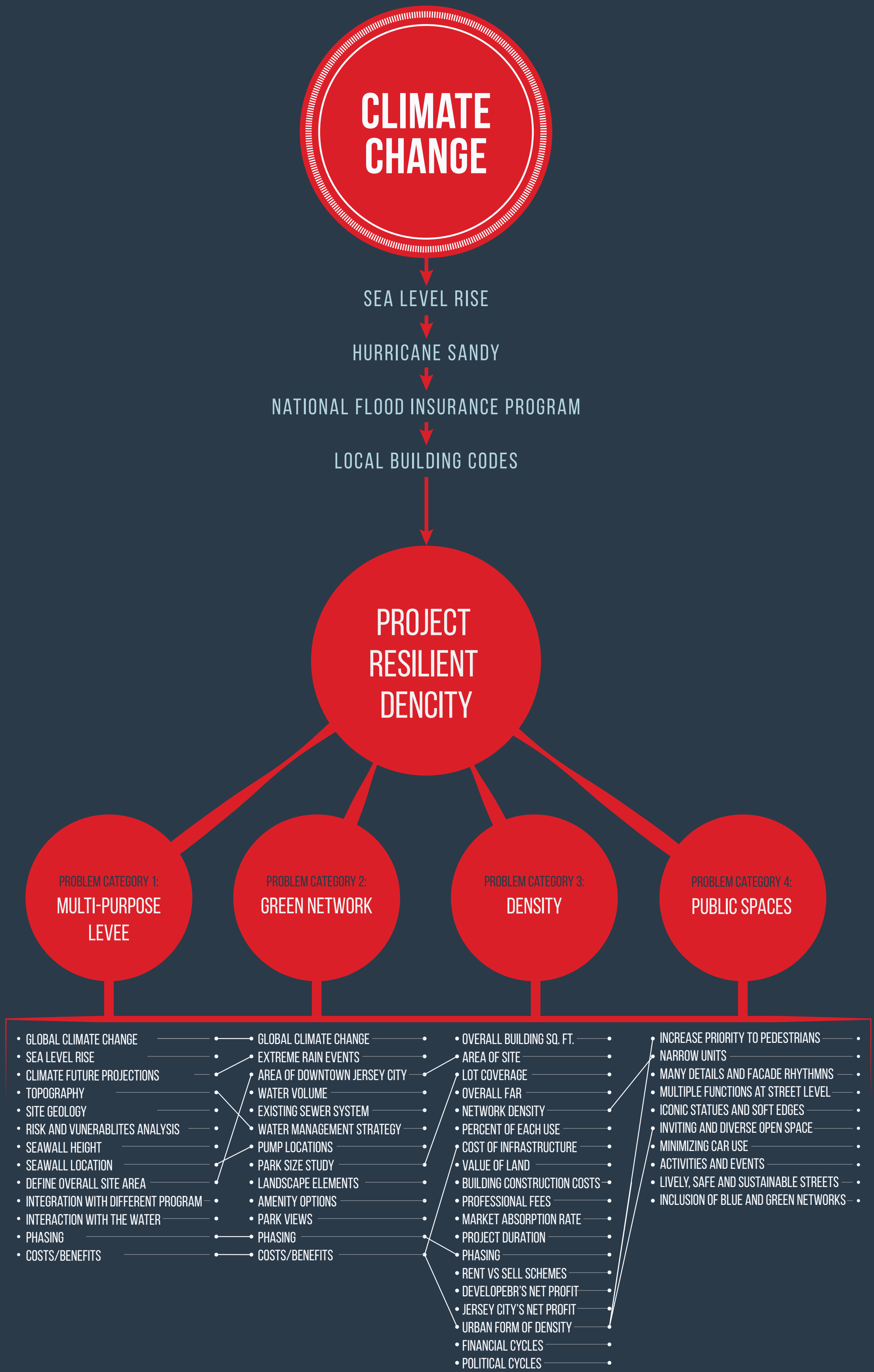
Preface

This report is part of a bigger project called **Resilient DenCity**, which is the title of a group project taking place at TU Delft and more specifically within Explore Lab 19 and it is conducted by four students:

Cosimo Conserva (Public Realm),
Matteo Ferrarese (Green Network),
Vince Marchetto (Density)
Mattia Tintori (Multi purpose flood protection).

The starting point of Resilient Dencity is global climate change and consequent sea level rise. The project aims to respond to the changing needs of our society in terms of waterfront protection and improvement focusing on Jersey City, NJ, USA waterfront. Hurricane Sandy enlighten the fact that the entire NYC metropolitan area needs improvement regarding flood defense in order to be prepared for future extreme events and climate change projected scenarios. Therefore a plan, that allows the private sector to profit as an incentive for building critical water management infrastructure, should be developed. Land reclamation from the Hudson River is then utilized to pay for the infrastructure costs, while the private sector still profits from new waterfront real estate.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1

Introduction:
Climate Change

1|

Introduction:
Climate Change

It's clear and evident that the planet we live on is changing. Our lifestyle, our habits, our culture only accelerated the rate of this change. It is internationally admitted that mankind is 95% certainly responsible of what is happening right now. For centuries, the planet has been exploited without thinking about the possible consequences and nowadays climate change is a new menace facing our world. The latest Intergovernmental Panel on Climate Change (IPCC 2013[1])[2] confirms that warming in the climate system is unequivocal, with many of the observed changes unprecedented over decades to millennia: warming of the atmosphere and the ocean, diminishing snow and ice, rising sea levels and increasing concentrations of greenhouse gases. Each of the last three decades has been successively warmer at the Earth's surface than any preceding decade since 1850.

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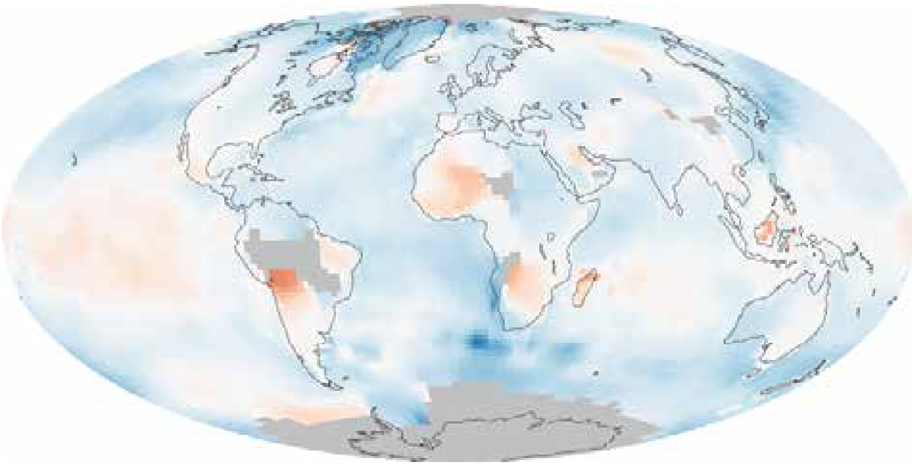
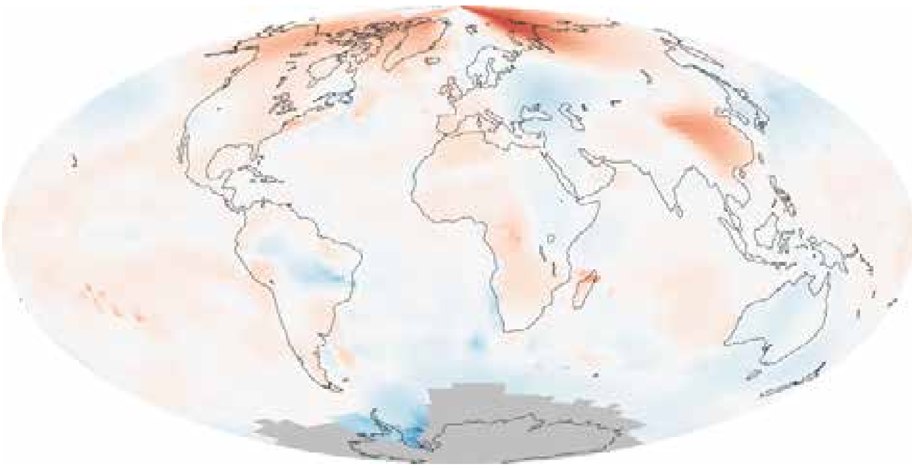
1 Allen, Bex, Boschung, Midgley, Nauels, Plattner, Qin, Stocker, Tignor, Xia, IPCC 2013: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, USA 2013

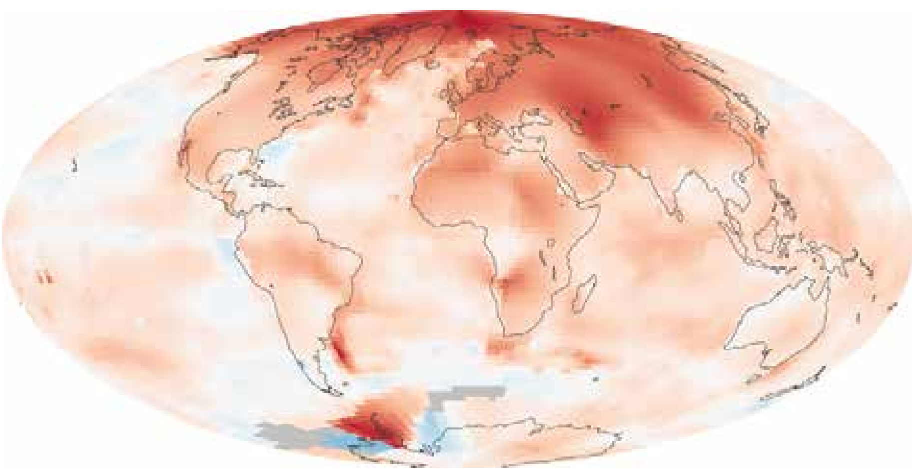
2 The Intergovernmental Panel on Climate Change (IPCC) is the leading international body for the assessment of climate change. It was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.



[1] Earth Surface Temperature Diagram. [1900-1909] © NASA



[2] Earth Surface Temperature Diagram. [1940-1949] © NASA

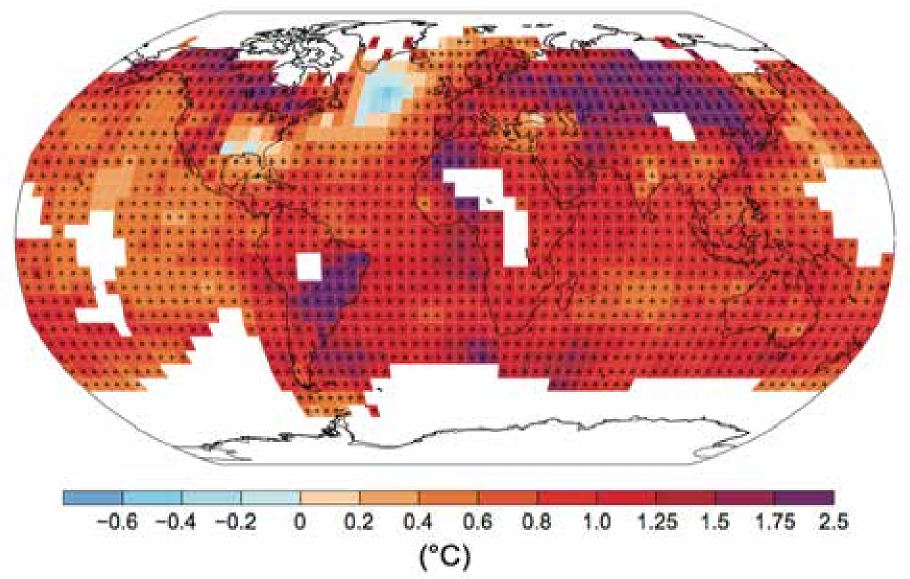


[3] Earth Surface Temperature Diagram. [2000-2009] © NASA

According to IPCC 2013:

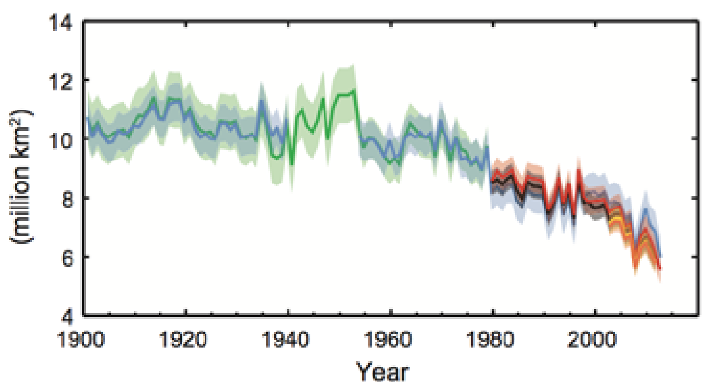
The globally averaged combined land and ocean surface temperature data as calculated by a linear trend, show a warming of 0.85 [0.65 to 1.06] °C, over the period 1880 to 2012. The total increase between the average of the 1850–1900 period and the 2003–2012 period is 0.78 [0.72 to 0.85] °C

4 Observed change in surface temperature 1901-2012 © IPCC 2013

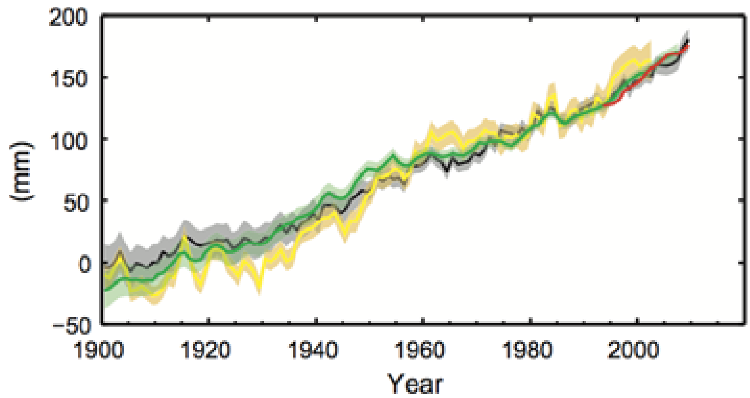


The average rate of ice loss from glaciers around the world, excluding glaciers on the periphery of the ice sheets, was very likely 226 [91 to 361] Gt yr−1 over the period 1971 to 2009, and very likely 275 [140 to 410] Gt yr−1 over the period 1993 to 2009-10.

5 Artic summer ice extent © IPCC 2013

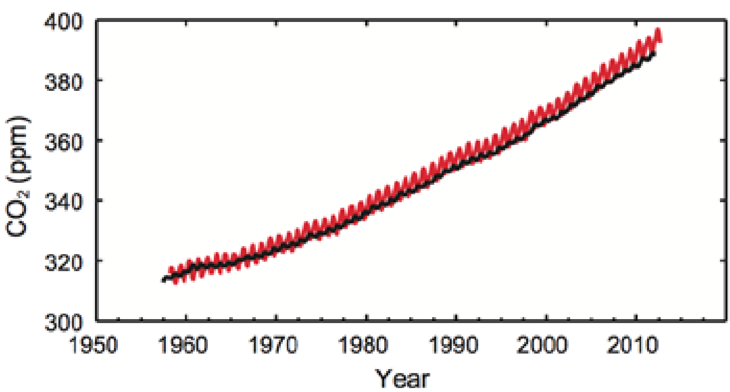


The rate of sea level rise since the mid-19th century has been larger than the mean rate during the previous two millennia (high confidence). Over the period 1901 to 2010, global mean sea level rose by 0.19 [0.17 to 0.21] m. Since the early 1970s, ocean thermal expansion and glacier mass loss from warming together explain about 75% of the observed global mean sea level rise.



[6] Global Avarage Sea Level Change © IPCC 2013

The atmospheric concentrations of carbon dioxide, methane, and nitrous oxide have increased to levels unprecedented in at least the last 800,000 years. Carbon dioxide concentrations have increased by 40% since pre-industrial times, primarily from fossil fuel emissions and secondarily from net land use change emissions. The ocean has absorbed about 30% of the emitted anthropogenic carbon dioxide, causing ocean acidification.

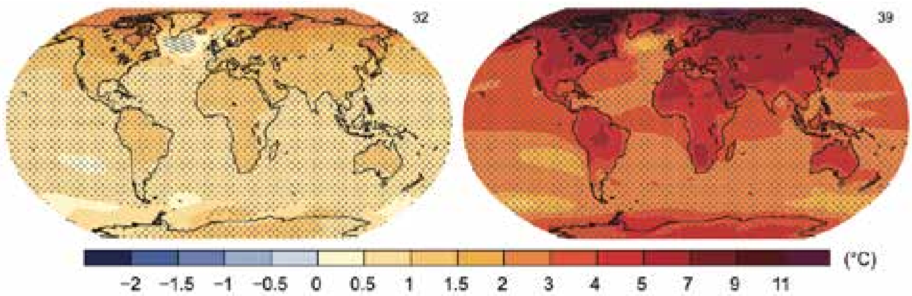


[7] Atmospheric CO_2 [ppm] © IPCC 2013

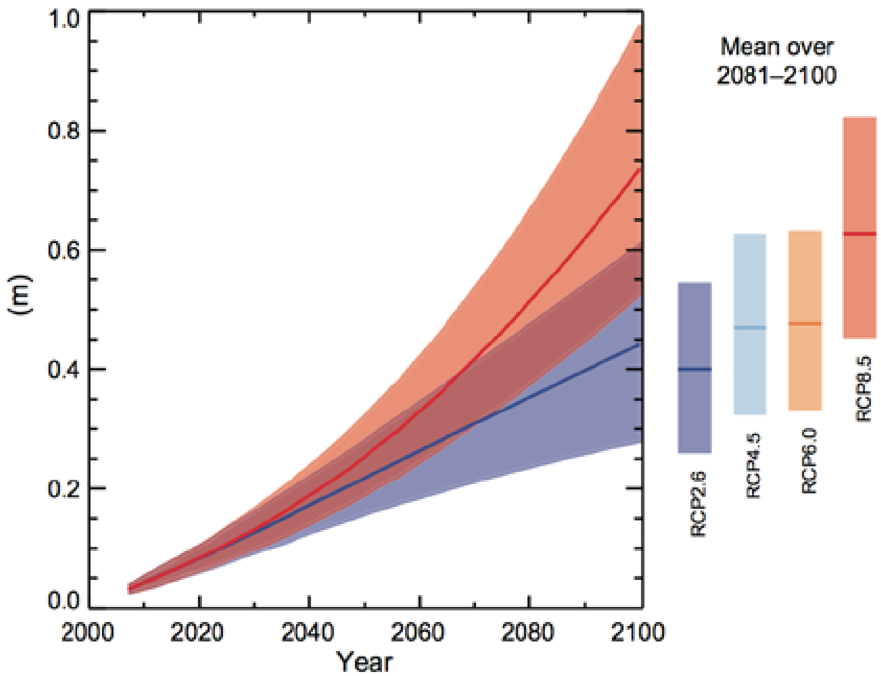
If human kind will not reconsider as soon as possible its way of living, the continued emission of greenhouse gases will cause further warming and changes in all components of the climate system. IPCC 2013 states that even if the greenhouse emissions would be stopped right now most aspects of climate change will persist for many centuries. This represents a substantial multi-century climate change commitment created by past, present and future emissions of CO_2.

IPCC 2013's projections for next decades and centuries estimate a warming from 0.3°C to 0.7°C for the period 2016–2035 and from 0.3°C to 4.8°C for 2081–2100 and a sea level rise between 0.26 and 0.82 m, taking into account different climate models.

[8] Change in average surface temperature (1986-2005 to 2081-2100) © IPCC 2013



[9] Global mean sea level rise projection for the next 100 years © IPCC 2013



At the same time, The Third National Climate Assessment (NCA[1]), released May 6th, 2014, projects a sea level rise of 1 to 4 feet by 2100 (30-120 cm).

Climate change would lead to higher temperatures, harsher storms, floods. Millions of people and some of the biggest and most populated cities around the world are threatened by this inevitable risk. Taking also into account that over half of the world's population (more than 3,5 billion people) lives within 100 km of the coast the consequences of climate change will become more and more dramatically evident and catastrophic. The future uncertainties pose special challenges, there is no "best solution", but the necessity to embrace the unexpected as expected, planning ahead to anticipate extreme events.

Even if this threat is inevitable, it could be seen from a different point of view, It could be an incentive, it could be translated into a challenge to create a better and more resilient world. The necessity to protect our world could be the starting point to develop a new idea of urban planning, protection and relationship with the natural context and its cycles. It is a positive revolution that pushes architect, urban planners and scientist to work together with a multidisciplinary approach to better understand how to integrate artificial and natural, built and unbuilt.

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1 Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, The Third National Climate Assessment, U.S. Global Change Research Program, 2014

2

Problem Statement

2|

Problem Statement

One third of U.S. population - more than 100 million people – live in coastal counties, coastal states with large areas of low-lying land are particularly vulnerable to rising seas and coastal storm surges. A sea level rise of just 2 feet [60cm] (by 2050s according to future projections) would mean that more than $1 trillion (6% of annual national GDP) of property and structures in the U.S. are at risk of inundation[1].

Sandy alone made $19 billion in damage across the New York City's metropolitan area and $68 billion of damage in total[2]. If hurricane like that were to strike New York again in the 2050s, the damage would rise to approximately $90 billion (in 2013 dollars) due to sea level rise, according to Bloomberg (2013). Dramatic events, such as hurricanes Sandy (2012) and Katrina (2005), have underlined the necessity to build and to improve flood protection systems to defend the urbanized areas from this kind of menaces.

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1 Moser, S. C. and M. Davidson (Convening Lead Authors) et al. (2013). *Coastal Zone Development and Ecosystems.* Chapter 25 in the Third National Climate Assessment

2 M. Bloomberg, P*laNYC: A Stronger, More Resilient New York* (City of New York, 2013).

[10] Sandy's destruction in New Jersey
© CNN

At National level, different organizations and teams are working to provide up-to-date researches to better understand the risk and to give future projections based on various climate models in order to provide a national database, which can be the starting point for future urban planning. The two major researches are conducted by NOAA (National Oceanic and Atmospheric Administration's) and collaborating agencies for the U.S. National Climate Assessment. These researches originate then different climate change panels which investigates the issues in detail relating them to particular areas and city. My research will take into account four different documents: NOAA Tides and Currents (2013[3]), FEMA Flood Maps (2013), New York City Panel on Climate Change 2 (NPCC2, 2013[4]) and Climate Central: NEW JERSEY AND THE SURGING SEA (April 2014[5]).

[11] Previous Page: Sandy from the space
© NASA

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3 NOAA, *Tides and currents: The battery, ny*, National Oceanic and Atmospheric Administration (2013a).

4 C. Rosenzweig and W. Solecki (Eds.), *New York City Panel on Climate Change, 2013: Climate Risk Information*, NPCC2, City of New York Special Initiative on Rebuilding and Resiliency, New York

5 Climate Central (2014). Sea level rise and coastal flood exposure: *Summary for Jersey City*, NJ. Surging Seas Risk Finder file created June 09, 2014. Retrieved from http://ssrf.climatecentral.org.s3- website-us-east-1.amazonaws.com/Buffer2/states/NJ/downloads/pdf_reports/Town/NJ_Jersey_City- report.pdf

KATRINA | 2005

[12] New Orleans after Katrina Landfall © Getty Images

[13] New Orleans' Dike Failure © Getty Images

SANDY | 2012

[14] Uptown and Bronk Subway Line station flooded during Sandy
© CNN

[15] Blackout of Lower Manhattan
© Getty Images

FLOOD

2.5

MILLION INHABITANTS IN THE NEW YORK & NEW JERSEY METROPOLITAN AREA LIVE IN THE FLOOD ZONE

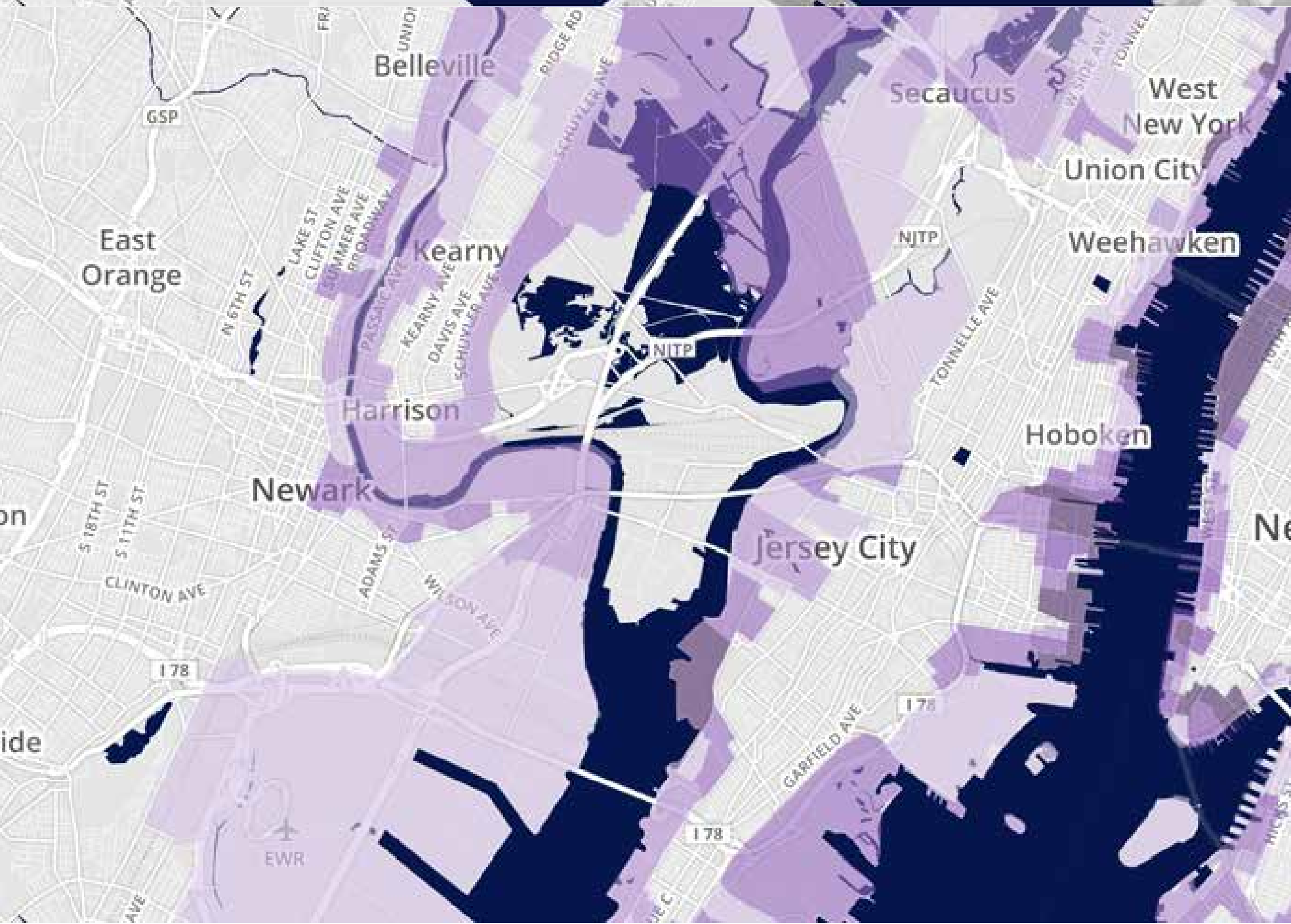
FEMA FLOOD ZONES
NEW YORK CITY/
NORTHERN NEW JERSEY REGION

FEMA Designated Flood Zones

Zone XX – 500-year
Zone A – 100-year
Zone V – 100-year

(FEMA, NOAA) *Digital Flood Data for Nassau County Unavailable ©2013


Belleville
Secaucus
West
New York
Union City
GSP
East
Orange
Kearny
NJTP
Weehawken
Harrison
Hoboken
Newark
Jersey City
CLINTON AVE
WILSON AVE
I 78
GARFIELD AVE
EWR
TONNELLE AVE
RIDGE RD
N 6TH ST
LAKE ST
CLIFTON AVE
SUMMER AVE
PASSAIC AVE
KEARNY AVE
DAVIS AVE
S 18TH ST
S 11TH ST
ADAMS ST


Belleville
Secaucus
West
New York
Union City
GSP
East
Orange
Kearny
NJTP
Weehawken
Harrison
Hoboken
Newark
Jersey City
CLINTON AVE
WILSON AVE
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GARFIELD AVE
EWR
TONNELLE AVE
RIDGE RD
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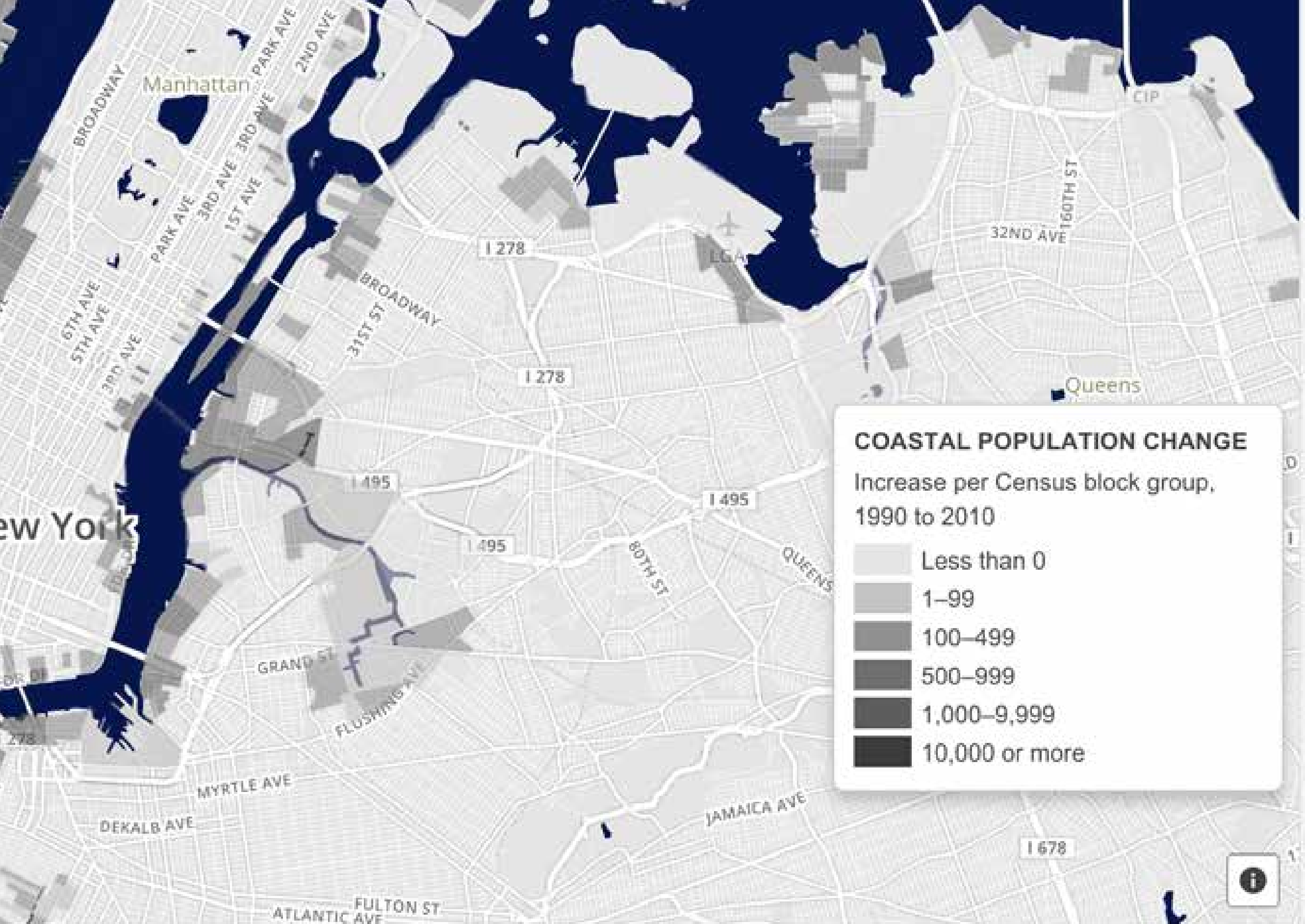
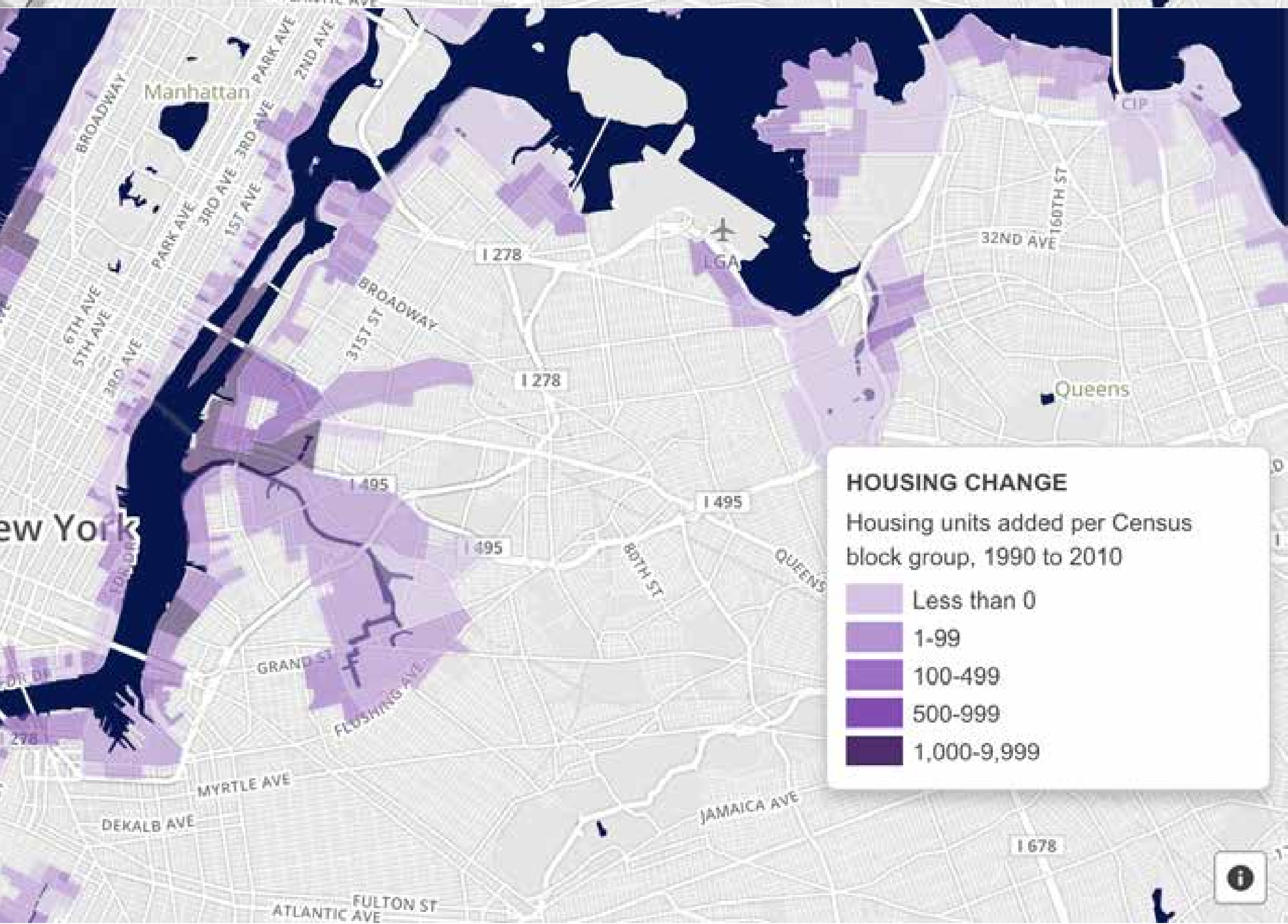

COASTAL POPULATION CHANGE
Increase per Census block group, 1990 to 2010
Less than 0
1–99
100–499
500–999
1,000–9,999
10,000 or more
Manhattan
Queens
New York
BROADWAY
PARK AVE
2ND AVE
3RD AVE
1ST AVE
6TH AVE
5TH AVE
31ST ST
I 278
I 495
I 678
80TH ST
32ND AVE
160TH ST
LGA
CIP
GRAND ST
FLUSHING AVE
MYRTLE AVE
DEKALB AVE
JAMAICA AVE
FULTON ST
ATLANTIC AVE


HOUSING CHANGE
Housing units added per Census block group, 1990 to 2010
Less than 0
1-99
100-499
500-999
1,000-9,999
Manhattan
Queens
New York
BROADWAY
PARK AVE
2ND AVE
3RD AVE
1ST AVE
6TH AVE
5TH AVE
31ST ST
I 278
I 495
I 678
80TH ST
32ND AVE
160TH ST
LGA
CIP
GRAND ST
FLUSHING AVE
MYRTLE AVE
DEKALB AVE
JAMAICA AVE
FULTON ST
ATLANTIC AVE

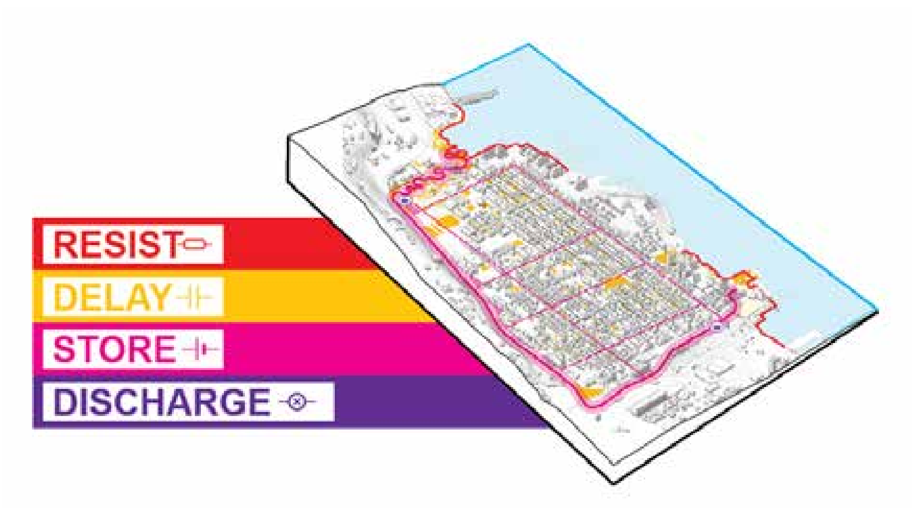
New York City's metropolitan area has already moved towards resiliency and it is starting to develop an ensemble of urban tools and climate studies to better understand the risk and face it. In 2008, Major Bloomberg, according to PlanNYC (the city's long-term sustainability plan) convened the first New York City Panel on Climate Change (NPCC1). The NPCC was made by a team of social scientist and risk management experts and it was published to inform and advise the Major and the New York Climate Change Adaptation Task Force about issues related to climate change and adaptation. After Sandy, the Major convened NPCC2 to provide up-to-date scientific information and analyses on climate risks for use in the Special Initiative for Rebuilding and Resiliency (SIRR[6]). The panel provides climate change projections, future coastal flooding maps and it makes recommendations for the projections for the 2020s, 2050s, 2080s. The City also got in contact with the best dutch experts about water management to learn from them of to face and respond to this new risk. Among them Henk Ovink, director of the office of Spatial Planning and Water Management, worked shoulder to shoulder with the American engineers and city planners to change the US point of view towards global climate change. He convinced the United States Department of Housing and Urban Development and the Presidential Hurricane Sandy Rebuilding Task Force to found an international competition as a response to Superstorm Sandy's devastation in the region[7]. **Rebuild by Design** (2013) is about innovating through community-policy solutions to protect U.S. cities that are most vulnerable to increasingly intense weather events and future uncertainties. 148 teams made up of experts in a variety of disciplines - architecture, urban design, engineering, ecology, communications - put forward ideas for rethinking development in the areas affected by Sandy. The initiative, not only was named one of the CNN's 10 Best Ideas of 2013, but it was also the starting point for the creation of a resilient area. The Danish architectural firm BIG won the competition regarding Lower Manhattan's waterfront [Fig 16, 17], while dutch architectural firm OMA was the finalist for Hoboken's waterfront [Fig 18]. No competitions have been founded to design Jersey city's coast yet, so that part of coast is now the only one not taken into account by RBD and it could become in the future the weak

6 What resiliency means within this report will be explained in chapter 18: "Resiliency"

7 Russell Shorto, *How to Think Like the Dutch in a Post-Sandy World*, http://www.nytimes.com/2014/04/13/magazine/how-to-think-like-the-dutch-in-a-post-sandy-world.html?_r=0, New York Times, April 4, 2014

[16] BIG architects presentation board for Lower Manhattan
© BIG arch

[17] BIG architects visualization of the BIG U
© BIG arch



[18] OMA's project for Hoboken
© OMA

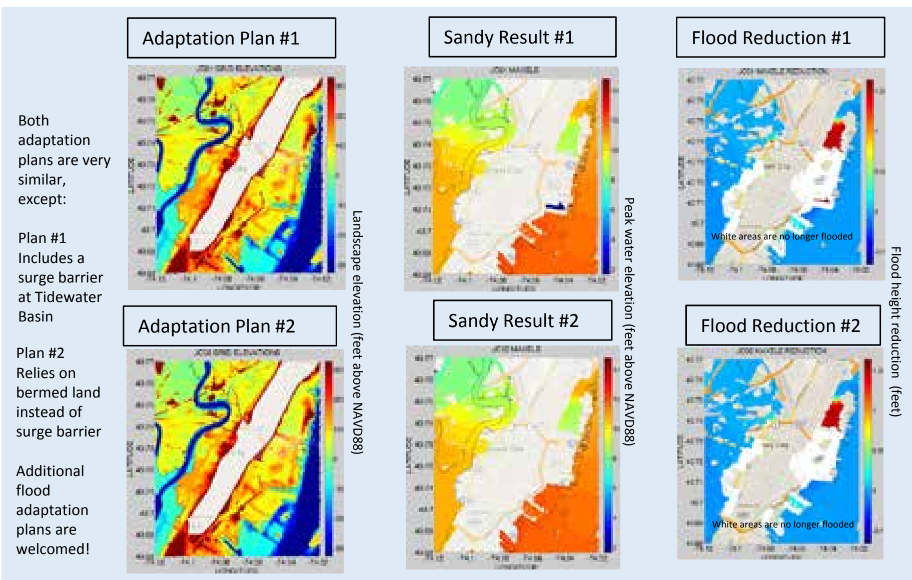
point of the entire flooding protection system. Looking at City of Jersey City official website there is a project:

"With funding from the National Oceanic and Atmospheric Administration (NOAA) Sea Grant program, the Division of City Planning has partnered with Stevens Institute of Technology's coastal flooding scientists on the Collaborative Climate Adaptation Planning For Urban Coastal Flooding Study to identify potential adaptation measures, such as levees and floodgates, and assess their ability to mitigate the impacts of coastal flooding caused by storm surge and climate change."[8]

The project proposes two different alternatives called Adaptation plan #1 and #2[9]. The only difference between them is that plan #1 includes a surge barrier at the Tidewater Basin while plan #2 relies on bermed land instead of surge barrier. The weak point of the initiative is that both tackle the risk from an engineering point of view without taking into account the public realm, the connections trough the area and the aesthetic of the final result. The concept of building walls within the city downgrades the urban quality interrupting paths, views and flow within the city's fabric.

8 http://www.cityofjerseycity.com/hedc.aspx?id=14545

9 http://www.cityofjerseycity.com/uploadedFiles/City_Government/Department_of_Housing,_Economic_Development_and_Commerce/City_Planning/charette_modelingposter_V1.pdf



[19] Adaptation Plan Presentation Board © City of Jersey City

[20] Adaptation Plan Presentation Board © City of Jersey City

Among the agencies involved there is also FEMA (Federal Emergency Management Agency) working on new flood maps, which will be finished in 2016, to provide new projections and categorize new flood areas. Regarding New Jersey State, Climate Central has published the most updated document right now taking into account both IPCC 2013 and NOAA studies. The document follows the first one released in 2012 and it is updated with new projections, climate models and revised scenarios, even if projecting future sea level is a difficult scientific challenge, not least because it will depend upon how much more carbon humans put into the atmosphere.

This panel omits the NOAA lowest scenario in this report. The lowest scenario projects this century's average rate of sea level rise as the same as last century's and lower than the average rate from the last two decades. Such an outcome seems very unlikely given projections for warming this century due to the strong observed relationship between global temperature and sea level change over the last century (Vermeer and Rahmstorf 2009). Moreover IPCC 2013's sea level projections range from 0.9 to 3.2 feet [27 to 97 cm] by 2100, but it does not include a potential rapid ice sheet breakdown scenario. NOAA's highest projection is intended to capture such a possibility, and thus the highest plausible sea level rise for the century, as an indicator of maximum risk for planning purposes. Surging Seas Risk Finder, the interactive web tool accompanying Climate Central's report, includes projections based on all four NOAA scenarios; IPCC projections; U.S. Army Corps of Engineers guidelines; semi-empirical projections developed by Vermeer and Rahmstorf (2009); and a no-global-warming scenario for comparison.

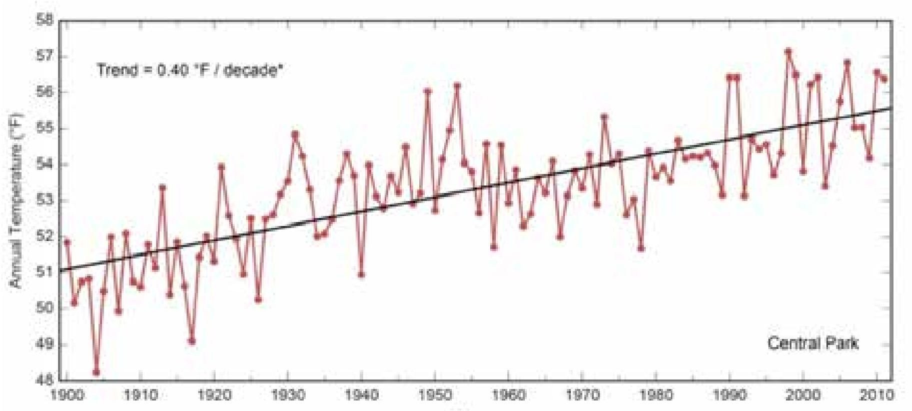
COMPARISON

According to NPCC2, future climate projections for the New York City area (100 mile land radius around Central Park) confirms the past trends and exceed them in the future.

[21] Validity Area of NPCC2
© Mattia Tintori

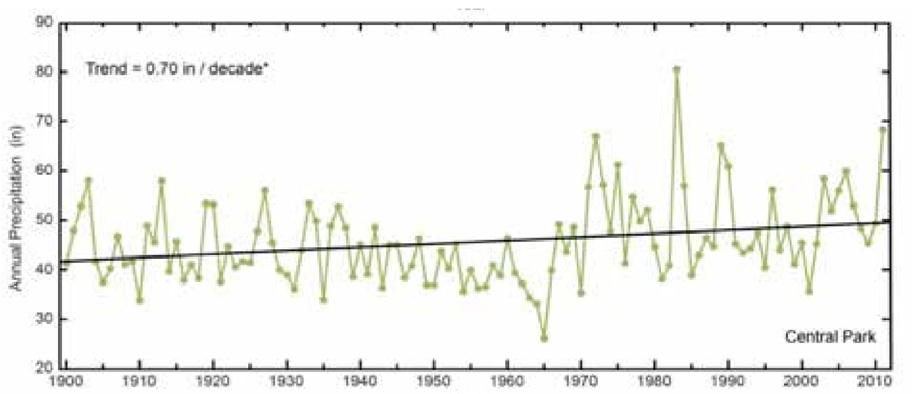
The trends show that temperature is rising steadily at a rate of 0.4 °F per decade and in the last 30 years period this increase was even faster.

22 Annual Temperature Changes © NPCC2



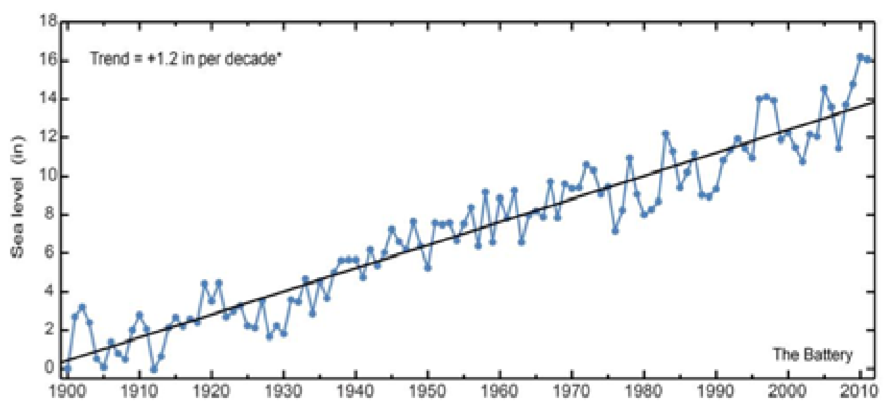
Precipitation has increased at a rate of 0.7 inches per decade and their variability has also incremented.

13 Annual Precipitation Changes © NPCC2

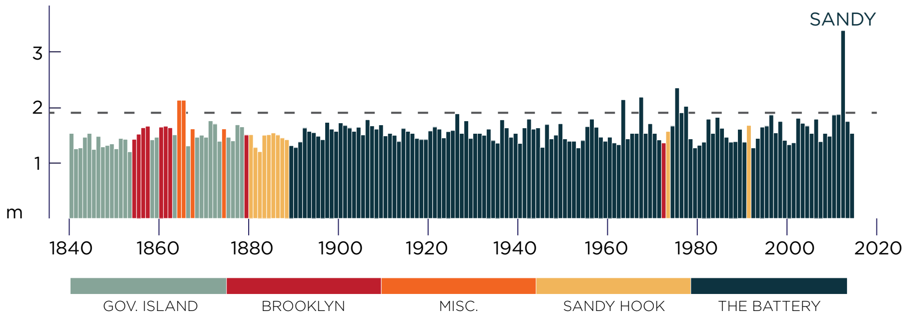


Sea level has risen approximately 1.2 inches per decade since 1900 and that value is nearly the double of the global rate of sea level rise recorded during the same period (Church and White, 2011).

23 Mean Sea Level Change © NPCC2

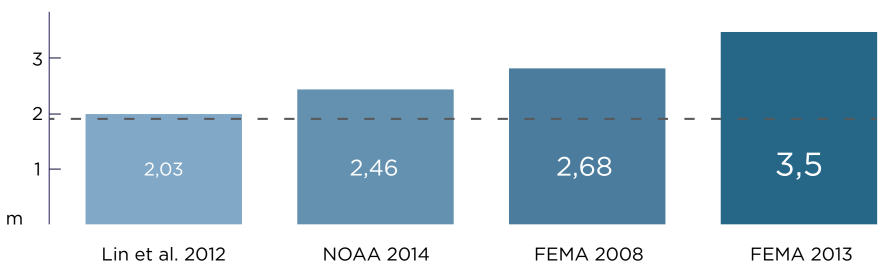


Another important diagrams that helps to understand how the situation changed over the last centuries is. It displays the annual extreme storm tide (the highest measured water level annual respect to mean sea level MSL). Before 1950, only 1 extreme event exceeded 1,9 m [6,2 ft] while after 1950, seven have.



[24] Annual extreme events for New York area © Mattia Tintori based on Noaa data

[25] Stations Location © Mattia Tintori based on Noaa data



[26] 100 yrs flood projection © Mattia Tintori

The projections for the future are even worse and they show that an intervention to face them should be done as soon as possible to prevent a real risk. It will be extremely likely to face warmer temperatures in the entire New York City area and surrounding regions with an increase by 4.0°F to 5.5°F by the 2050s and a high-estimate of 6.5°F. Regarding precipitation, the projections indicate a small increase around 20 percent more by the 2050s, while regarding sea level the model predict by the 2020s a rise between 0.3-0.6 feet [9-18cm] and by 0.9 feet [27 cm] for the high estimate. By the 2050s, the range expands to 0.6-2 feet [18-60 cm] and 2.6 feet [79 cm] for the high estimate[1].

Instead, according to the Climate Central's study, the projection is local sea level rise of 0.6-1.8 [18-54 cm] feet by 2050, and 1.9-6.3 [58-192 cm] feet by 2100, using sea level in 2012 as the baseline.

The lower numbers are the "slow" projections and correspond to NOAA's intermediate low projections. The higher numbers are the "fast" projections and correspond to NOAA's highest projections. The "medium" projections are 1.2 ft for 2050 and 3.9 ft for 2100. There is a 21 percent cumulative risk of at least one flood exceeding 6 feet by 2030, a 51 percent risk by midcentury, and a 100 percent risk by 2100. Under the Assessment's highest scenario, these chances increase to 23, 64, and 100 percent, respectively, and it is possible to compute a 99 percent risk of at least one flood exceeding 9 feet by the end of the century.

COMPARISON

It is possible to make a comparison between the two researches using the 2050 projection: they match very closely (0.6-2 feet from NPCC2 and 0.6-1.8 feet from Climate Central). The NPCC2 did not make any projections for later in the century, so midcentury makes the best point for comparison. Nevertheless, the projections given by the two analysis should be taken as indicative trend and not as a precise projection for a specific year. On the other hand, even if it is not possible to foresee exactly the right amount of rise, the trend shows a predictable

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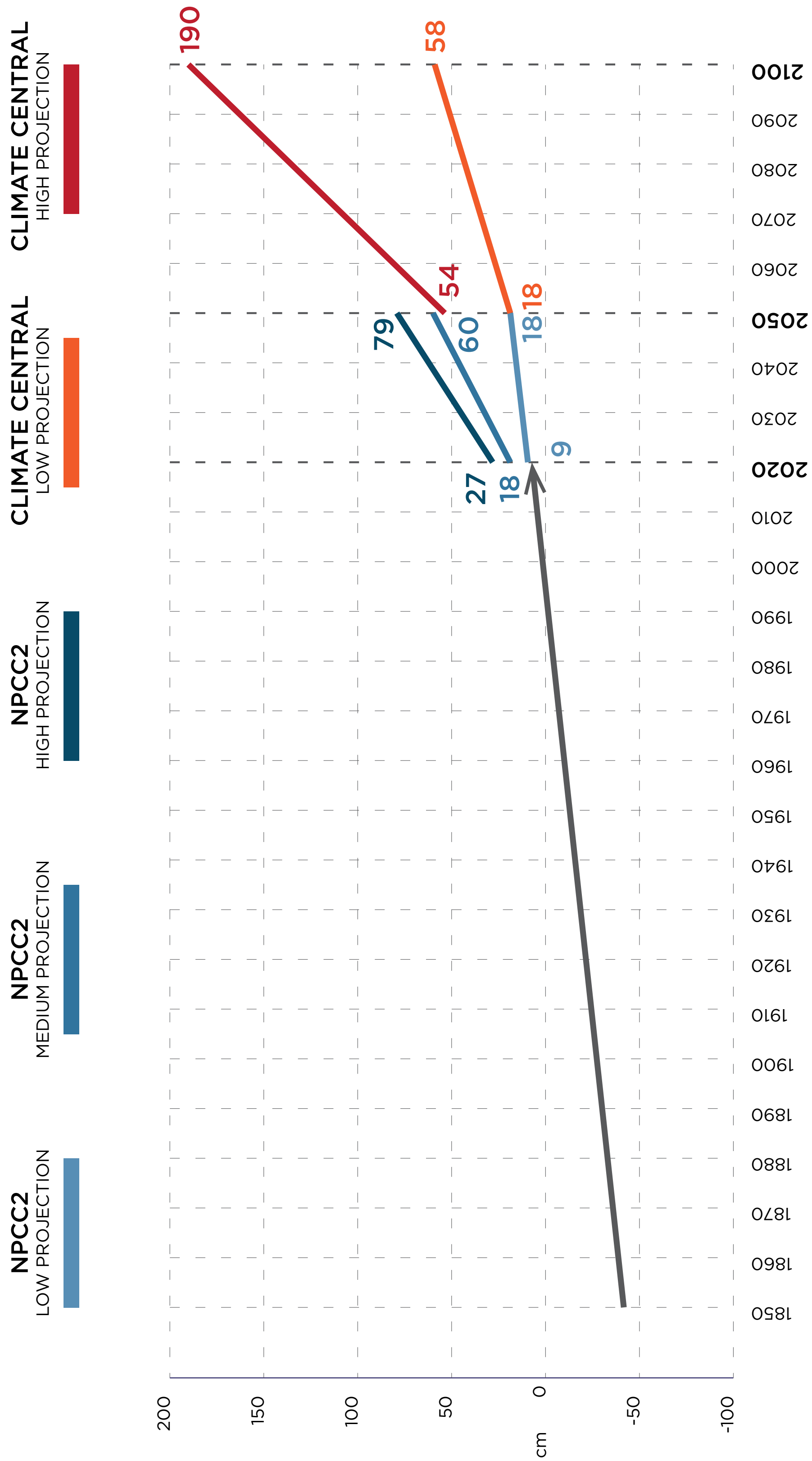
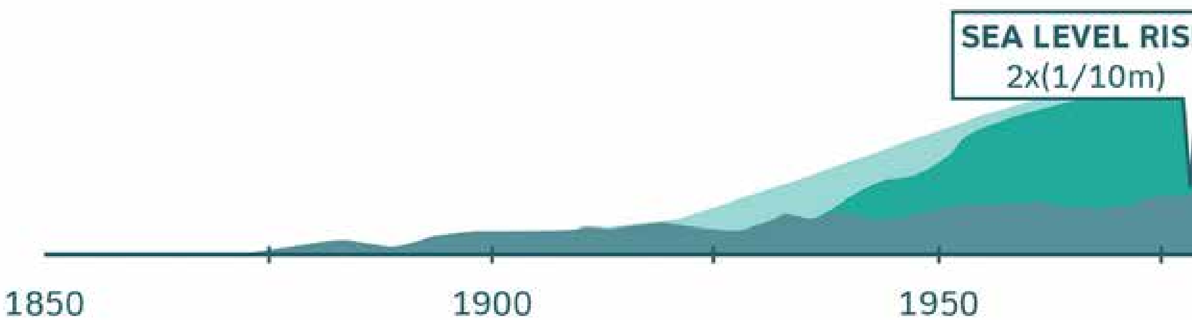
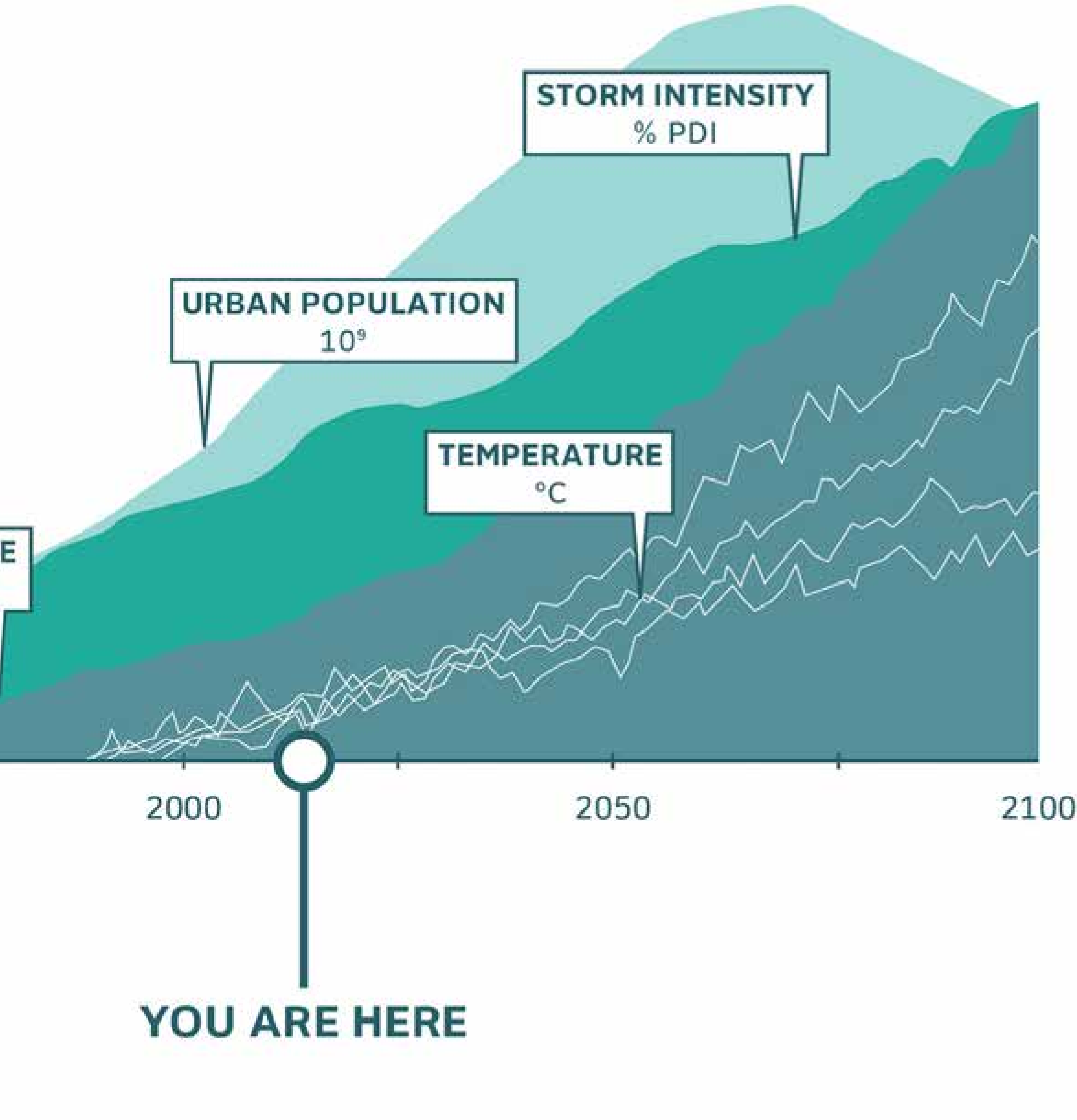
1 C. Rosenzweig and W. Solecki (Eds.), *New York City Panel on Climate Change, 2013: Climate Risk Information, NPCC2*, City of New York Special Initiative on Rebuilding and Resiliency, New York



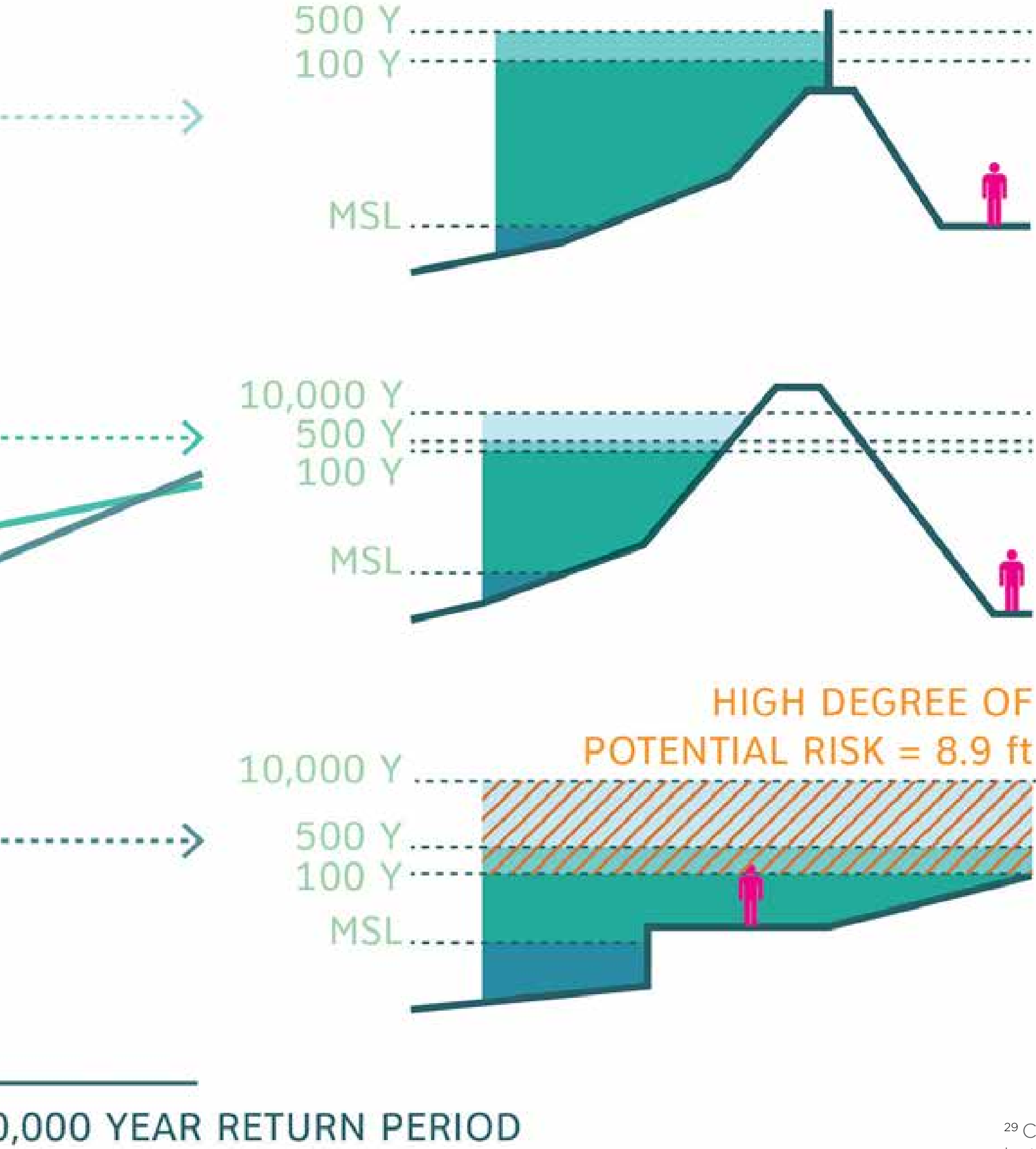
[27] MSL trends and future projections compared
© Mattia Tintori

[28] Future Climate Projections © Rebuild By Design




STORM INTENSITY
% PDI
URBAN POPULATION
10^9
TEMPERATURE
°C
E
2000
2050
2100
YOU ARE HERE


FEET FLOOD HEIGHT
MISSISSIPPI
(Niedoroda et al. 2010)
THE NETHERLANDS
(Zhong et al. 2012)
NEW YORK CITY
(Lin et al. 2012)
20
18
16
14
12
10
8
100
500
1,000



[29] Comparison between sea level rise in Mississippi, Netherlands and New York.
© Mattia Tintori

increase of the water level and that will increase the chances of extreme floods by today's standards. Future, is for definition uncertain, and so are the climate projections: another problem identified is that there is a disagreement in hazard assessment. Taking into account the 100 years flood height:

Three different agencies projects four different values, from Lin et Al's[2] low estimation till the high estimate given by FEMA, which raise its 2008's value approximately one meter. So, using FEMA 2013 estimate, it is possible to calculate that a flood reaching 11,4 feet [350 cm] above the current MSL at the Battery has today a 1% annual chance combination of storm surge and tide. But, if the sea level will rise 2 feet [60 cm] in the next decades, the flood would require 2 feet [60 cm] less to reach the same height, increasing its annual chance from 1% to 10%.

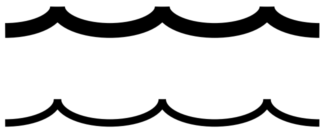
For example, using as reference value the actual 100 years flood – a flood with a 1% annual chance - sets at 11,4 feet [350 cm] above the MSL at Battery, NY. It would be enough to threaten the NYC subway system and PATH with major flooding paralyzing an important part of the City's public transportation system. More over, using the online tool provided by Climate Central study[3], it is possible to calculate the social impact and the consequences for the infrastructures. 17 km2 of land [45%], including 3 km2 of protected land would be flooded. From a social point of view, that could be translated into 54182 people [22%] threatened by the flooding. Regarding buildings and infrastructures: 27536 homes [25%], 1 hospital [50%], 50 medical facilities [26%], 13 schools [16%], 1 college [10%], 10 government buildings [20%] and 145 km of roads [34%] risks to be flooded.

These data clearly state the social vulnerability of one of the densest coast of US. There is a concrete risk that the city would be paralyzed and disconnected from its surroundings due to predicted inundation and storm surge. Infrastructures and buildings may be irreparable damaged and all the transportation grid would face huge delays or even shutdown in case of a big storm. The immense inflow to water control systems would bring to overloads and consequent combined sew-

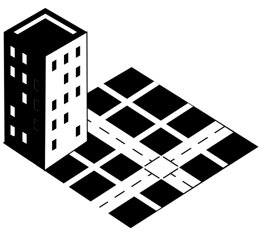
2 Ning Lin, Kerry Emanuel, Michael Oppenheimer and Erik Vanmarcke, *Physically based assessment of hurricane surge threat under climate change*, Macmillan Publishers, 14 Feb 2012. http://www.ualberta.ca/~eec/Lin_2012_NCC.pdf

3 http://ss2.climatecentral.org/?bbox=40.7790647268,-74.1156166077,40.6566920053,-74.0183784485&label=Jersey%20City#13/40.7179/-74.0670?show=satellite&level=6&pois=show

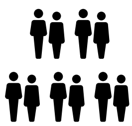
er overflows heightening the river pollution. Moreover the quality and the availability of drinking water would be reduced due to saltwater intrusion into freshwater sources. The impact of the environmental risks is likely to be higher and higher in the future and it will not be required another superstorm to cause extensive economic damage and suffering. This knowledge of weakness should lead to resilient area, future higher floods are certain, their consequences depend on the decision taken by Jersey City and all the other coastal communities.



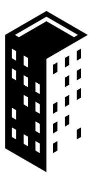
↑ **+11,4 ft**
+3,5 m



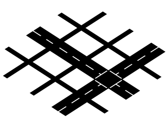
LAND 45 % [17 km2]



PEOPLE 22% [54’182]



HOMES 25% [27’536]
HOSPITAL 50% [1]
MED. FACILITIES 26% [50]
SCHOOLS 16% [13]
COLLEGE 10% [1]
GOV. BUILDINGS 20% [10]



ROADS 34 % [145 km]

3|

Project Goal

RESEARCH GOAL

The background research of studies and analysis conducted both by architectural firms and scientific associations and the assessment of the risks and hazards based on future projections will help the candidate to build a sufficient background. This background is the starting point to understand the climate problem and to find different solutions to resolve it. The aim is to join hydraulic engineering principles with architectural shapes and archetypes in order to find the best balance between technique, aesthetics and functionality. The candidate proposes to rethink the flooding protection system as a place that can host multiple functions avoiding hard engineering solutions that transform cities into fortresses totally losing the relationship between land and water. The concept is transforming an engineering product: a seawall, a bulkhead, a berm into an architectural piece. The infrastructure doesn't have to be mere protection, it has to become a center of attraction for the community with social and recreational spaces. It has to be civic, accessible for everyone, adaptable for future transformation and designed with the interaction with public in mind.

The research will join theoretical and practical aspects delivering a list of different Multi Purpose Levees that will respond to the necessity to integrate flood infrastructure with public and private sphere, recreational and green spaces and connections.

DESIGN GOAL

The design goal is divided in two different phases: phase one will be done in collaboration with the other three group mates. The first step is crucial to design an overall masterplan of the entire Jersey City's waterfront, south of Hobokme railway station till the Morris Canal, to provide the "big picture" of the project. The masterplan gives the number, the dimensions, the position and the type of buildings based on the analysis of social, historical, aesthetic, economical and sustainability aspects. It will provide the grid of the networks inside the study area: pedestrian and cycle paths, public transportation, green network, public and private spaces and the design of the flood protection system. The first step defines the character and the vision of the project and it is essential for phase two.
During phase two, the candidate selects one of the building of the masterplan related with his research topic. The architecture has to be integrated with the flood protection system and it needs to have a relation with the water. The aim is reach an successful integration between architecture and engineer to create a hybrid multifunctional building that will host a program defined by phase one and will be combined in the flood protection infrastructure.

4|

Research Question

How can I **integrate** architecture and site-based flood protection systems

to create a new **multi-purpose waterfront**

that will **protect** Jersey City and will **enhance** its public realm?

Can flood protective measure became city’s attraction?

5|

Research Methodology

The research has been divided in four different steps. The first step is analysis, background study and literature review of documents about climate change, superdikes, sea level rise projections, future scenarios, Jersey City and New York metropolitan area to build a sufficient background to face the research question. The first step is crucial to assess hazards, vulnerabilities, risks and potential of the site area (step 2). The second step focuses on the comprehension of the forces and components in play to define possible future scenarios. Third step is also directly connected with the first one and it identifies potential strategies that can be implemented in the project to achieve multi functionality in the flood defense. This step is intend as a design catalogue that can be used for every project. The last step coincides with the research goal, It is an evolution of the proposed design catalogue and it tries to schematize possible examples of interaction between flood protection and architecture that can be used in the master plan. In this step the level of detail is greater, even if the drawings are still intended as diagrams and not as construction drawings.

6|

Research Project Planning

P1:
-Introduction
-Problem Statement
-Research Question
-Research Methodology
-Research Project Planning
-Definition of Design and Research Mentor
-Definition of the sponsor

P2:
-Research part completed at 90%. The discussion with the external examiners and their comments will help me to refine and conclude it.
-Draft of the Masterplan
-Building Concept: location in the masterplan, reference projects, key design concepts, programme hosted.
-Definition of Build. Tech. mentor

P3:
-Research Completed
-Focus on the Building design: site map, plans, sections, elevations, construction details, climate integration.

P4:
-Building design completed at 90%. The comments will help me to refine and conclude the design for P5

P5:
-Research and Design Completed

7|

Plan of Approach

This project presents interconnected urban problems. The logic of the problems stems from the fact that rising sea levels and the threat of hurricanes is forcing Jersey City to upgrade its infrastructure. These critical infrastructure costs are expensive and almost impossible to pay for entirely through the public sector within the American framework. Therefore a plan, that allows the private sector to profit as an incentive for building critical water management infrastructure, should be developed. Land reclamation from the Hudson River is then utilized to pay for the infrastructure costs, while the private sector still profits from new waterfront real estate.

8|

Mentors

NIKLAAS DEBOUTTE | DESIGN MENTOR

MARK VOORENDT |RESEARCH MENTOR

ROEL VAN DE PAS |BUILDING TECH. MENTOR

9|

Sponsor

JCMUA

JERSEY CITY MUNICIPAL
UTILITIES AUTHORITY

10

Brief History of Jersey City

10|

Brief History of Jersey City

This Chapter is intended as a historical introduction to the city. Knowing the history and the evolution of Jersey City is the first step to understand the "Image of the City" today. Its artificial growth through landfilling, the relation among city / river / ocean, its industrial past are essential chapters to comprehend the strong and the weak points and how to manage them for the future.

GEOLOGICAL FOUNDATION

About 200 million years ago, the vast land piece that we call Pangea began to break up leading to the formation of the continents as we know them today. Cameron's line is the name of the edge between the North American Plate and the African one. It is a band of fractured rock over 30 meters wide and it is positioned approximately 150 meters below the earth's surface. It runs diagonally across North America running through Manhattan, the bed of the bronx river, under Roosevelt Island and finally cutting New Jersey and New York Upper Bay.
About 22,000 years ago, the last great ice sheet in North America, the Wisconsin Glaciation, moved from northwest to southeast towards New York City Region, carving the deep bed of the Hudson River. When it receded and melted, the great amount of water caused a sea level rise and flood the entire lower area of the region.

MUHHEAKUNNUK / THE HUDSON RIVER

[1] Previous page: Jersey City waterfront © Mattia Tintori

The source of the river is in the Adirondack Mountains, 500 kilometers north of the Upper Bay. Its estuarine starts from the location of today's George Washington Bridge south to the ocean and it is a mixture of salt and fresh water. The river has a strong relation with the ocean, in fact it is essentially flooded twice a day by ocean's tide that flows in an out again. Thus, the river was called Muhheakunnuk (the river that runs both way), by the first settlers, a Delaware tribe . Every and each day almost 7,5 billion cubic meters of ocean water flow up through the bay diurnally, while the fresh water of the river flows out during the low tide. This unique mixture of both fresh and salted water created a singular estuarine ecosystem.

EXPLORATION AND COLONIZATION

The first explorer that found the Upper bay was Giovanni da Verrazzano. He was a florentine adventurer sailing under French flag, who noted the presence of a large "lake" and amiable native people in 1524.
Late in 1609, the english explore Henry Hudson arrived in the region searching for the famous "North West Passage" to China and India. He followed the waterway of the river, that will be subsequently named after him, from the Upper bay. Then he reported to his sponsor, the Dutch East India Company, that he discovered a beautiful harbor, a wide river and a region promising a prosperous fur trade.
A group of Dutch settlers colonized the island of Manhattan. In 1626, Peter Minuit bought the land from the native americans and founded the city of New Amsterdam. Within 40 years the It will be conquered by the

[2] Giovanni da Verrazzano © Wikipedia

[3] Henry Hudson © Wikipedia

British, who renamed it New York. At that time, the island was a prosperous natural environment with over 330 species of birds and 170 different kinds of fish. Nowadays the 80% of the original wetlands has been erased and this ecologically rich zones no longer exists.

Shipping and maritime industries rapidly grew up in the region because of the calm water of the bay and the great width and depth of the Hudson river. The human presence started to shape the estuary through landflilling of the wetlands and the construction of piers and slips on the shoreline. As shipping flourished and the population increased, the waters became very polluted by industrial processes which dumped raw sewage directly in the sea and in the river. The problem became harsher and it completely destroyed the shellfish and oyster trade economy that had prospered in eighteenth and nineteenth century with oyster beds lining over 900 square kilometers of the estuary. Besides the mercantile purposes those mollusks were one of the natural most efficient water filtration system and their death only worsen the situation.

During 1950s, with the advent of containerized shipping, the industry moved from Manhattan and Brooklyn to New Jersey ports located on the other side of the bay. The pollution problem continued, worsen by the dumping of industrial wastes, especially polychlorinated biphenyls (PCB's) and raw sewage in the form of combined sewer overflow (CSO) outfalls, which still degrade the health of the estuary today. Moreover the wetlands have also continued to be filled and developed in the entire region.

In 1972, the government moved to do something against the pollution in the bay. The First Federal law governing water pollution passed. The Clean Water Act authorized the Environmental Protection Agency (EPA) to begin a National Estuary Program to protect, preserve and restore American Estuaries. The act stipulated that the raw sewage must be treated before being dumped in the water and this lead to a greatly improvement. The act has also worked to stop the exploit of the natural wetlands and, additionally, the United State Army Corps of Engineers (USACE) has begun a process to create "artificial" wetlands.

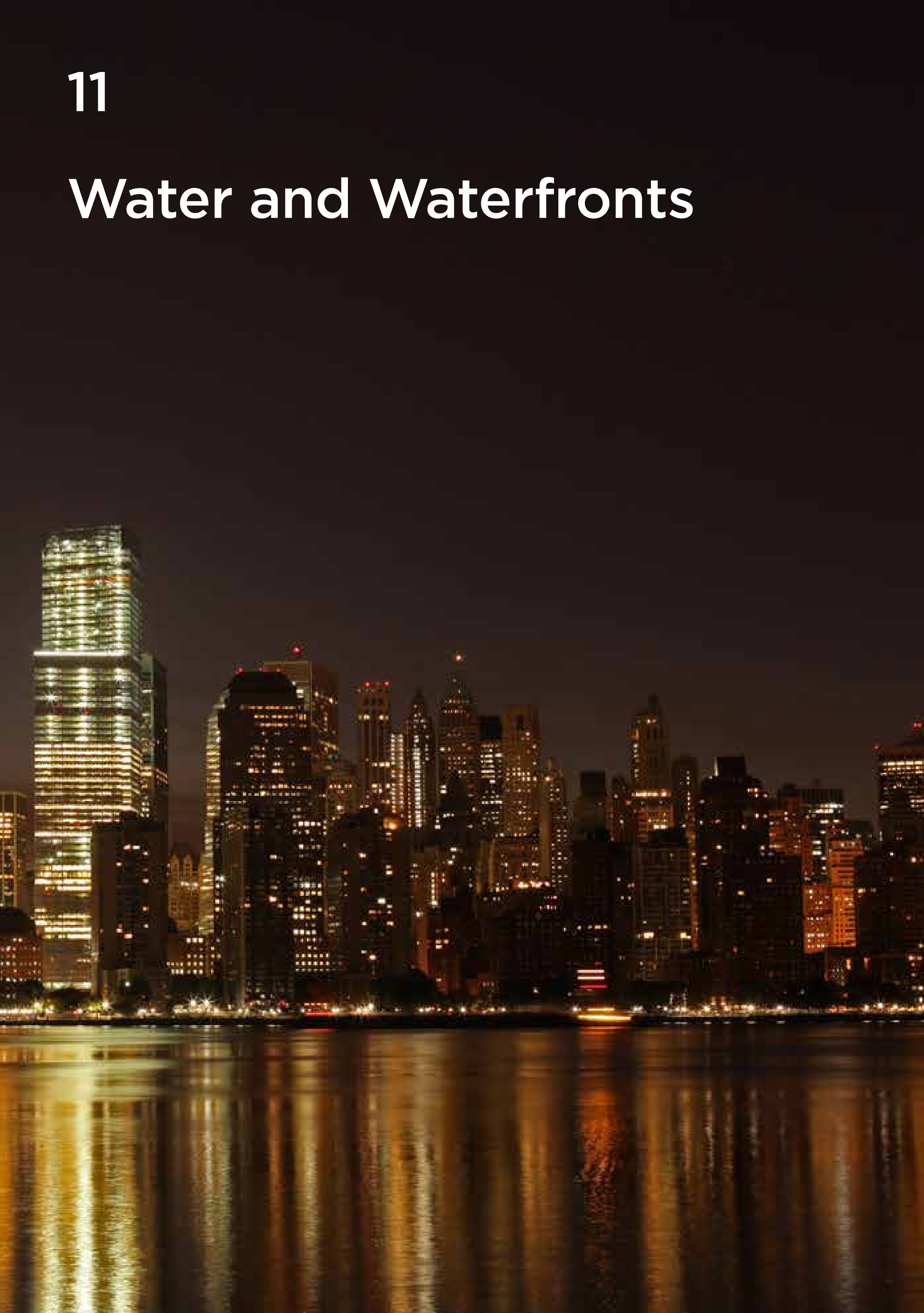
[4] Aerial of Jersey City (Paulus Hook), Manhattan. Half of JC was still underwater as tidal pools of the Hudson River. Later all filled-in by the railroads. 1853. By John Bornet. New York

[5] Jersey Central railroad yards, Morris Canal, Hudson River, Colgate Plant and the Paulus Hook neighborhood in the 1940s

Unfortunately New York Metropolitan Area, including Jersey City, does not comply with the Federal Clean Water Act standards due to the discharge of raw sewage directly into the waterways in case of combined sewer overflow during heavy rainy days. 450 CSOs are active in the Upper bay and every year over 102 billion liters of raw sewage are dumped into the water.

11

Water and Waterfronts



11|

Water and Waterfronts

This Chapter is intended to explain what water meant and means as element and symbol for our societies over time. Moreover is provided a brief explanation about how the relationship with city and water changed in the last centuries.

Water is surely the most important element for human life. It is so valuable that often it has been referred as "blue oil"[1]. A sort of duality is intrinsic in it: it is both precious: we are always struggling to conserve, clean and re-use it and, at the same time, it is an element we continue to battle with, protecting ourselves from its destructive power. Its importance as symbol of life and growth goes without saying. Water is present in every religion, literature, and art of every country. Regarding the religious world, it is sacrosanct, from the baptism of Christ in the River Jordan till the ritual immersion in the River Ganges in India. It covers about two-thirds of the earth's surface, but, besides that, only the 3 percent of it is freshwater, while the two-thirds is ice and the rest is underground. Therefore, only 1 percent of it supports life on land.[2]

Considering history and our past, water has always had an intrinsic relation with buildings and man-made constructions. From the beginning, human have founded, flourished and growth

1 Vandana Shiva, *India and the New Water Wars*, Domus, no 905 (July /August 2007), p.93

2 Zoe Ryan, *Building with Water*, Birkhaeuser, Berlin 2010.

[1] Previous page: Lower Manhattan waterfront © Mattia Tintori

[2] Hinduist in the Gange river © Getty Images

[3] "Baptism of Christ"Leonardo Da Vinci © Google

communities on deltas, rivers, lakes and coastlines. Mesopotamia was located between the luxuriant environment created by Tigris and Euphrates. Egypt has found its richness in the water of the Nile and Rome was constructed on the famous River Tiber. All over the world, for centuries the life of human kind has been deeply connected with water an its nature cycles. The biggest cities of the world have been settled and grown on water and that was one of the reason of their richness. Venice, Amsterdam, Suzhou and Birmingham became important mercantile nodes and their waterways were the veins of a worldwide water transportation system. The importance of water has not changed much: working with it, respect its natural cycles and emphasize them was important for our predecessors as it is for us today. In the 1950s NYC was the only megacity on the planet on the water's edge. In 2007, there were 14 coastal megacities that host more than 10 millions inhabitants[3]. Today, over half of the world's population (more than 3,5 billion people[4]) lives within 100 km of the coast.

3 Ibidem

4 http://www.worldometers.info/world-population/

EVOLUTION OF WATERFRONT USE

Since the start, mankind has always taken advantage of water and since technologies has permit it, he shaped the water's edge to adapt it to human uses. All the coastal communities owe their origin and prosperity to access to water, agriculture of land near waterfront and related craftsmanship, industry and trade. In the early times, industrial ports were the worldwide nodes for the movement and exchange of goods. Soon, in their surroundings an ensemble of services and functions grew to support them and waterfronts became the place where water-related and urban-based functions merged together. Cities such as New York, London, Rotterdam, Chicago, Lisbon, Cape Town became the biggest industrial ports in the 19th century. Steam power permitted to build bigger and faster boats and the waterfronts were shaped subsequently with docks, piers and warehouses. Around them, heavy industry grew strong as pollution started to do the same as result of it, making those areas uninhabitable and unsuitable for recreational activities. That was the first time when waterfront's use started to destroy the relation between the city and its water's edge. As opposite, or maybe as consequence of this lost "connection", relaxing retreats on waterfronts outside the polluted big cities became extremely fashionable for the long and short holidays of the city dwellers. Especially in Northern Europe seaside resorts grew quickly in response to the changing needs

[4] Rotterdam Port
© Telegraph

of the population that was looking for leisure time immersed in the nature. This trend kept growing also in the second half of the 19th century including Coney Island near NYC, Atlantic City near New Jersey and Montecarlo, Niche, Cannes, Capri in Europe. Things changed considerably in the second half of the 20th century as a response of transportation of cargo in standardized dimensions. This was a crucial point for what concern big cities's waterfronts. In fact, in the majority of the cases this change led to the relocation of the shipping industry in the periphery of the city due to the economical a logistical needs, leaving huge port areas and related buildings completely abandoned and damaged by toxic wastes. After that, followed the era of the "rediscovered waterfronts". Suddenly, areas that have been highly polluted and exploited came back to the city that started to recognize again the beauty of its relation with water. To reconvert the old areas and refresh the city's public image new residential, commercial, recreative and cultural developments became established all over the world. One example is Barcelona's old waterfront on the Mediterranean Sea. Like Portland or Philadelphia, the waterfront area, once taken by the shipping and the heavy industry was left abandoned and later occupied by a highway. Thanks to Mayor Maragall and to the money designated for 1992 Olympics plan, the city caught the opportunity to reconstructing itself and redesign its relation with the water's edge. The highway was buried underground and the space freed by it was used to shape

[5] A Sunday on La Grande Jatte,- Georges Seurat

[7] Beth Galì pools.
Barcelona
© Flickr

[8] Beth Galì pools.
Barcelona
© Flickr

[6] Barcelona new waterfront area © Flickr

[9] Hafen City public spaces © Flickr

[10] HafenCity © Flickr

new beaches, parks and residential buildings. Another example is given by San Francisco's coastline, which was one of the busiest area in the early 20th century till the construction of Bay bridge and the decline of ferry transportation. This led to the automobile boom and to the construction of the Embarcadero Freeway in the 1960s to improve the access to the city, but, in reality, it acted as a division between it and its water's edge. The combination of 1989 earthquake and the community opposition pushed to the transformation of the shoreline with new residential, commercial, office and flex adaptable spaces. In the late part of the 20th century the need of revitalizing waterfront achieved widespread recognition and the majority of cities moved towards it, another great example, maybe one the most recognizable in Europe, is Hamburg. The project was approved in 1997 and called Hafen City. It is located on a 157 hectare-site and it has increased the dimension of Hamburg's city centre by 40 percent, offering a new area with apartments, service business, culture, leisure, tourism and retail.

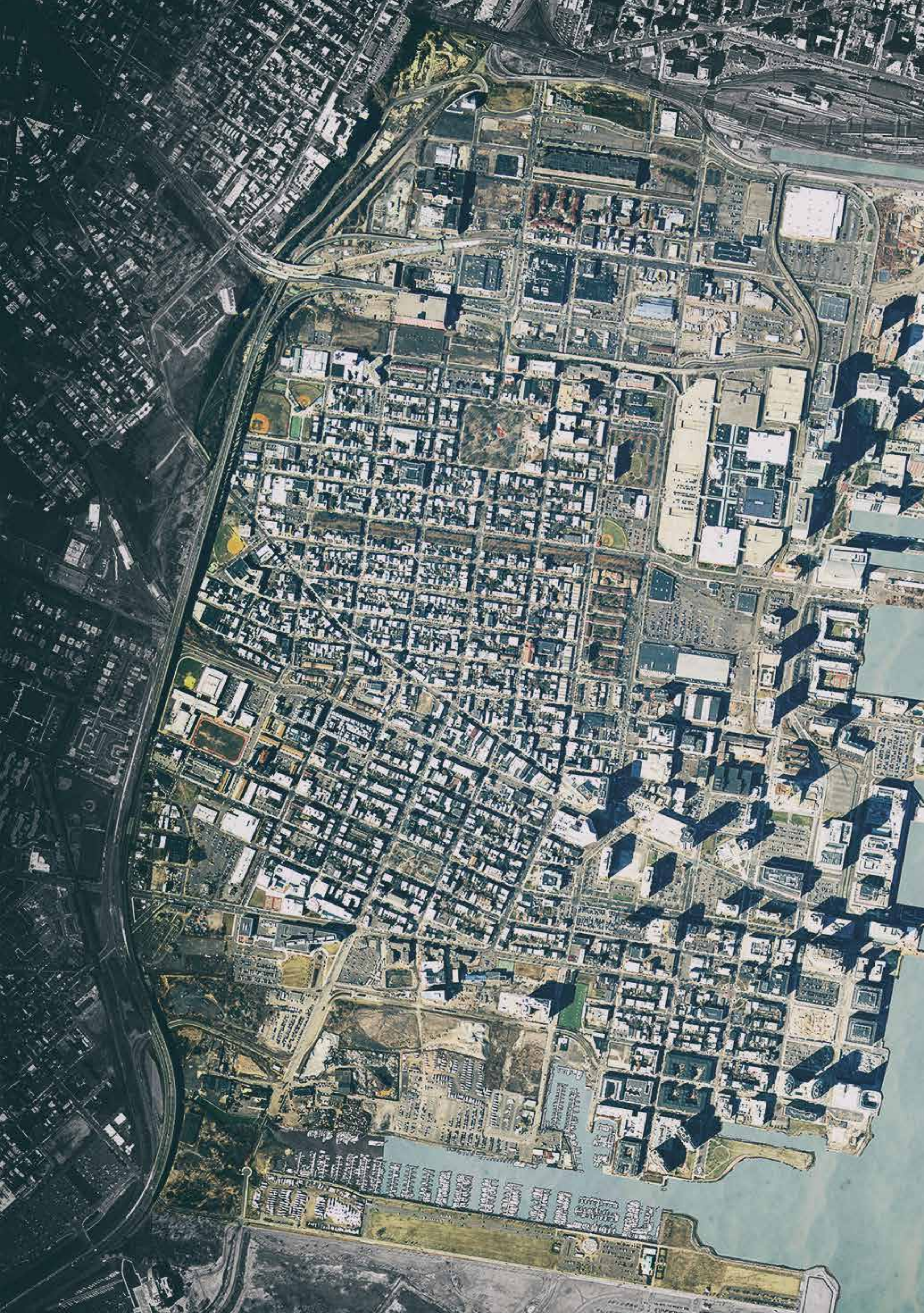
What waterfront reserve for the future then?
Which are the principles to create a successful waterfront area?

As said above: "The importance of water has not changed much: working with it, respect its natural cycles and emphasize them was important for our predecessors as it is for us today ". The face the future urban planners, architects and engineers

[11] Hafen City from above
© ArchDaily

has to learn from the mistakes and the good decision took in the past. They have to understand the legacy that every city bring with itself to enhance it in the design of the water's edge, trying to improve the connection between built environment and nature rather than building boundaries between them. At the same time, the new interventions has to fix the pollution problems of the past and avoid harmful conducts in the future. Sustainability and resiliency are the key words for the next developments. Deal with the uncertainty of the climate change and embrace the unexpected as expected defining possible scenarios. Never forget the incredible attractive power that the water has on mankind since the beginning.

[12] Hafen City
© ArchDaily



12

Site Analysis

12|

Site Analysis

"When asked for a general characterization of the city, one of the most common remarks was that it was not a whole, that it had no center, but was rather a collection of many hamlets. The question:

"What first comes to mind with the words 'Jersey City'?,"

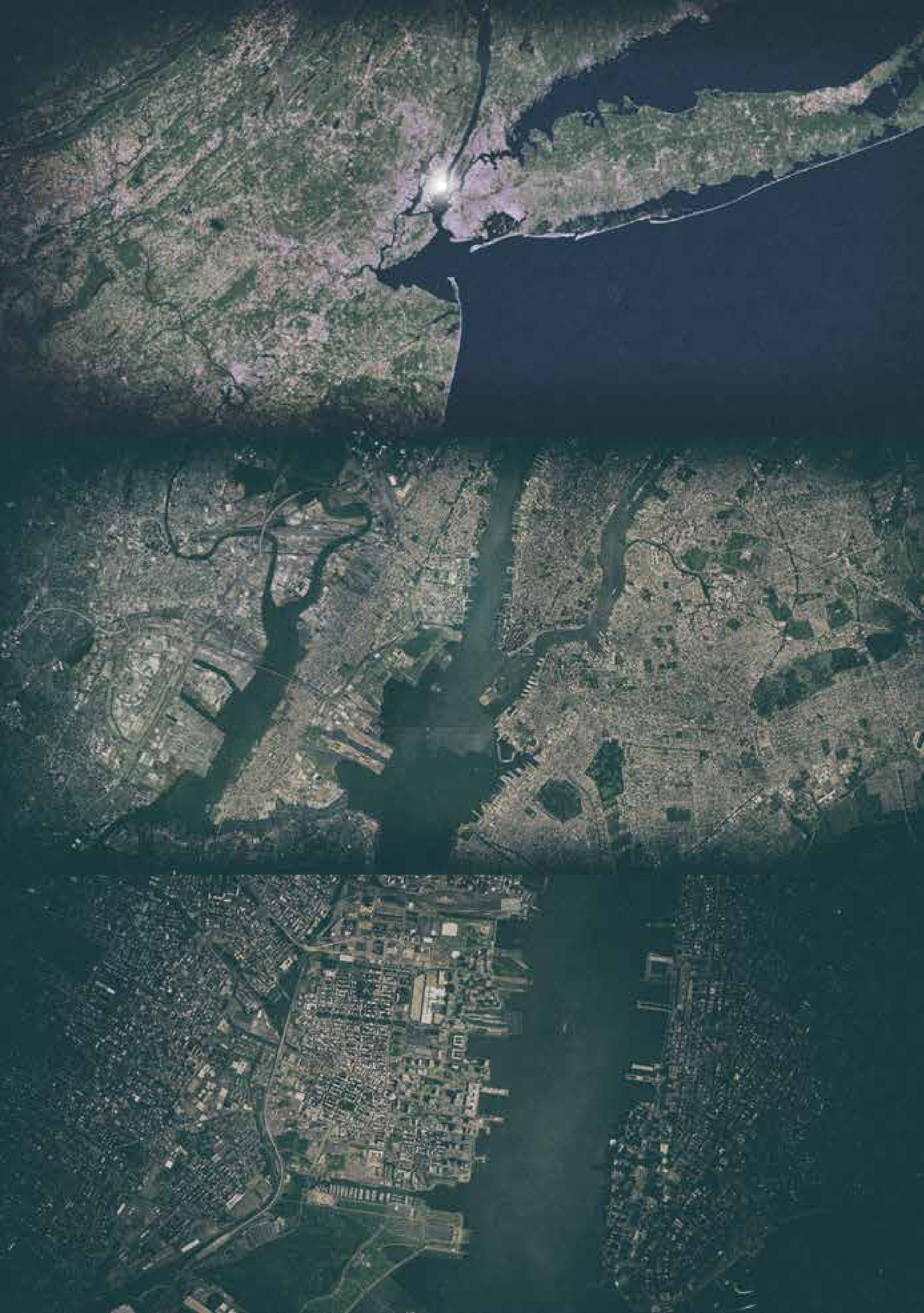
so easy to answer for Bostonians, proved to be a difficult one. Again and again, subjects repeated that "nothing special" came to mind, that the city was hard to symbolize, that it had no distinctive sections. One woman put it: This is really one of the most pitiful things about Jersey City. There isn't anything that if someone came here from a far place, that I could say:

"Oh, I want you to see this, this is so beautiful."

The most common response to the question of symbolism was nothing in the city at all, but rather the sight of the New York City skyline across the river. Much of the characteristic feeling for Jersey City seemed to be that it was a place on the edge of something else. One person put it that his two symbols were the skyline of New York, on the one side, and the Pulaski Skyway, standing for Newark, on the other. Another emphasized the sense of enclosing barriers: that to get out of Jersey City one must either go under the Hudson, or through the confusing Tonnelle traffic circle. One could hardly ask for a more dramatic, more imageable, bask location and piece of topography titan Jersey City, if one were able to build completely anew."

[1] Jersey City Localization by Bing maps © Telegraph

Kevin Lynch, Image of the City, Cambridge Massachussettes, MIT Press, 1960



“*The city with everything for industry*” that it is how Jersey City was called back in the years and this perfectly explain all the urban problems and the identity of the city that It is today. It is a city built with a big picture in mind, a canvas of singular episodes without a real fil rouge that connects them together. In the last years, its waterfront on the Hudson River has been the focus of the majority of the big development projects sponsored by the financial giants from Manhattan and the world.

It is the second biggest city in New Jersey State and it attracts business and commuters with its major air, water, rail and highway transportation arteries, abundant utilities at reasonable rates, a growing service sector and an established manufacturing base. The proximity with water and New York, the pieces of historic brick architectures, the respected healthcare and educational facilities, the vast potential for the future, make Jersey City a desirable place to live as well.

[2] View on Midtown from JC waterfront © Mattia Tintori

[3] 9-11 Monument, JC waterfront. Freedom tower and Lower Manhattan in the background © Mattia Tintori

[4] Morris Canal Marina © Mattia Tintori

[5] Morris Canal Marina © Mattia Tintori

ECONOMY

Jersey City's golden ages are passed and gone, but the city lived a new economic renaissance in the 1990s and it is still experiencing the growth trend into the 21st century. It was traditionally relying upon sectors such as transportation, shipping and distribution, and it is now focusing of what the Hudson County Chamber of Commerce calls FIRE (Finance, Insurance and Real Estate). To have an idea of the entity of the growth, we have to consider that there has been a 500 percent growth in these sectors since 1993. Moreover, since the early 1990s, higher rents, taxes and utility costs of the adjacent Manhattan pushed many New York firms to move partially or totally their offices on the other side of the Hudson River granting Jersey City the nicknames "The Sixth Borough" and "Wall Street West".

DEVELOPMENT PROJECTS

The most recent and the biggest development projects in Jersey City are located into the areas of Downtown and the Waterfront, Journal Square, the HUB at Martin Luther King, Jr. Drive, the Warehouse District Artist in Residence program, Saint Peter's College/McGinley Square Area Improvement project, residential development, and various commercial and industrial developments.

I will focus on the projects related to the waterfront area in order to understand how both public and private sector have shaped this part of the city in the last decades.

The Colgate Center, famous for its big luminescent clock crowned by the company logo, is a riverfront development project of 9 office towers, a residential building and a new ferry station connected to Manhattan. The project has a strategic importance because, at the moment, it contains two important landmarks that somehow identify and characterize the city: the big clock and the highest building on the waterfront, the Goldman Sachs Tower. Another important feature is that this project defined a financial and office district along the river and give a sort of identity of that part of the city. Unfortunately, the mono-usage of this space is also its weak point, in fact, except during the average office hours and during the weekends the area loses part of its livability and urban value. Notable ten-

[6] JC waterfront
from Battery Park
© Mattia Tintori

[7] Liberty State
Park
© Mattia Tintori

[8] Colgate Clock
© Mattia Tintori

ants of Colgate Center include Merrill Lynch; Lehman Brothers Holdings; Hartz Mountain; Essex Water-front, LLC; Lord, Abbett, and Co.; American Express Travel Related Services; National Discount Brokers; and Datek Online.

The Harborside Financial Center follows the direction set by the Colgate's project and implement the office district along the waterfront. The project is a development of five million square feet of office, commercial space, residential units (North Pier Apartments) and the Hyatt Regency Hotel. As week as the previous one it has the same weak point from the urbanist point of view. Major tenants of Harborside include Deutsche Bank, DLJdirect Holdings, TD Waterhouse, Exodus Communications, Morgan Stanley Dean Witter, Dow Jones, the American Institute for Certified Public Accountants, SunAmerica Asset Management, Garban Intercapital America, Forest Laboratories, and TradeWeb.

Besides the Hyatt, others four luxury hotels opened in the city since 2000: Candlewood suites, The Courtyard Marriott, a $60 million Hilton and a Doubletree Club Suites. All of them are located in or nearby the new development areas.

Grove Street is an important area to understand the evolution of the city, its unique location as a connection between the riverfront and the "old" and consolidated residential part of Jersey City. Recently, this area has been developed with a 306-unit luxury apartment complex with commercial and retail space (Christoper Columbus Towers).

The Newport area is also a major spot of big development in the last years. 4.3 million square feet of office space, 7000 residential units, 1200 hotel rooms and 300000 square feet of commercial space have been built between the Newport Mall and the Newport Tower (the second tallest building in the city) attraction tenants as the FDIC, Sears and JCPenney, Brown Brothers Harriman, Sterns, Filene's, First Chicago Trust, and USA Network.

Regarding residential, also the Gotham, a 220 units luxury high-rise and the Port Liberty, known as "Venice of the Hudson" are worth mention.

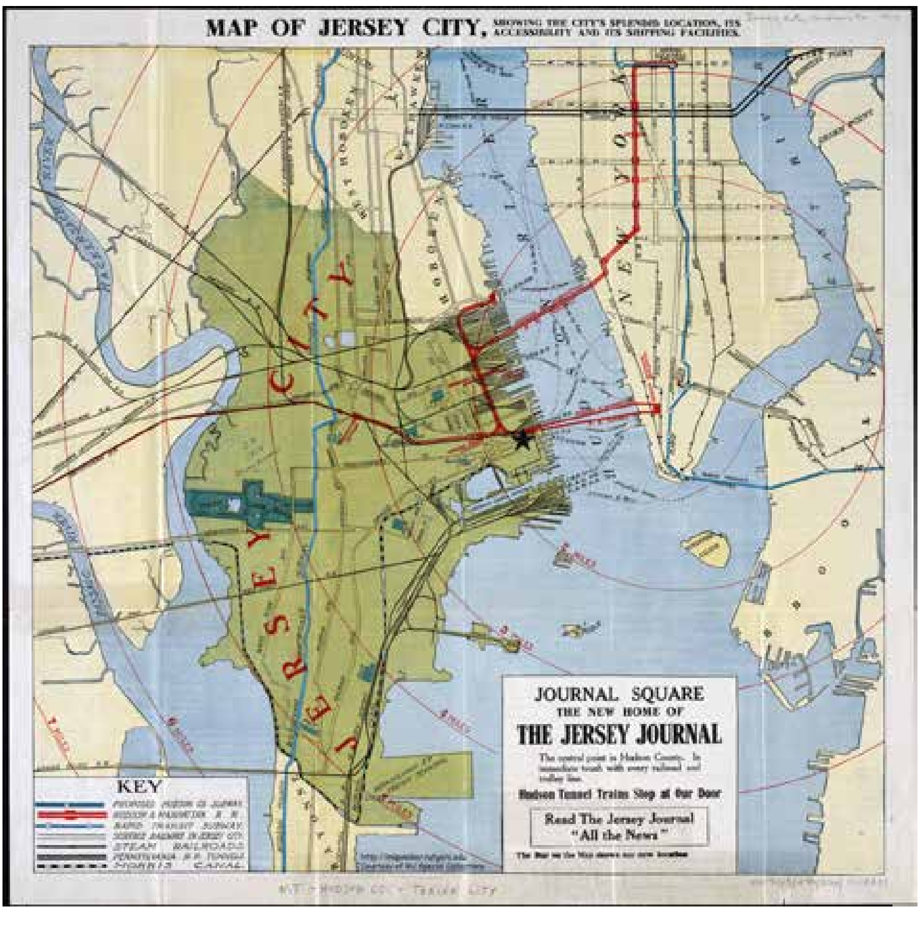
9 Harbourside Financial Center © Flickr

10 Hilton and Hyatt © Google

11 Grove st. © Flickr

SHIPPING

Even if the shipping industry is not as important as it was before, it still plays an important role in the city economy. The 11 miles of waterfront on the Hudson River are part of the Port Authority of New York City and New Jersey. The strategic position of Jersey City's port provides an excellent access to the Atlantic Ocean and its docks on the Hudson River still accommodate a large terminal for containerized shipping. Adjacent to it, there's the Greenville Yards of Conrail with truck terminals and warehousing able to host more than 100 motor carries servicing the city. Jersey City is also 10 min away from Teterboro Airport, which is the nation's busiest corporate hub. Moreover the city is close to two others airport used for carrier operations: the Port Authority Downtown Manhattan/Wall St. about five miles [8 km] away, and Newark Liberty International, about eight miles [13 km] away.



[12] Map of JC, 1910. © Rutgers Univeristy

[13] JC Historical rail
© Flickr

[14] JC waterfront
© Flickr

TRANSPORTATION

Jersey City is in a good position regarding the transportation grid, it is 13 kilometers away from Newark International Airport which offers national and international flights. It is possible to reach it by bus, train, helicopter and limousine. The City's transportation network is composed by intra- and inter- state bus lines, rapid transit, ferries, tunnels, and trains. The major transportation nodes in the city are the PATH and Light rail stations,

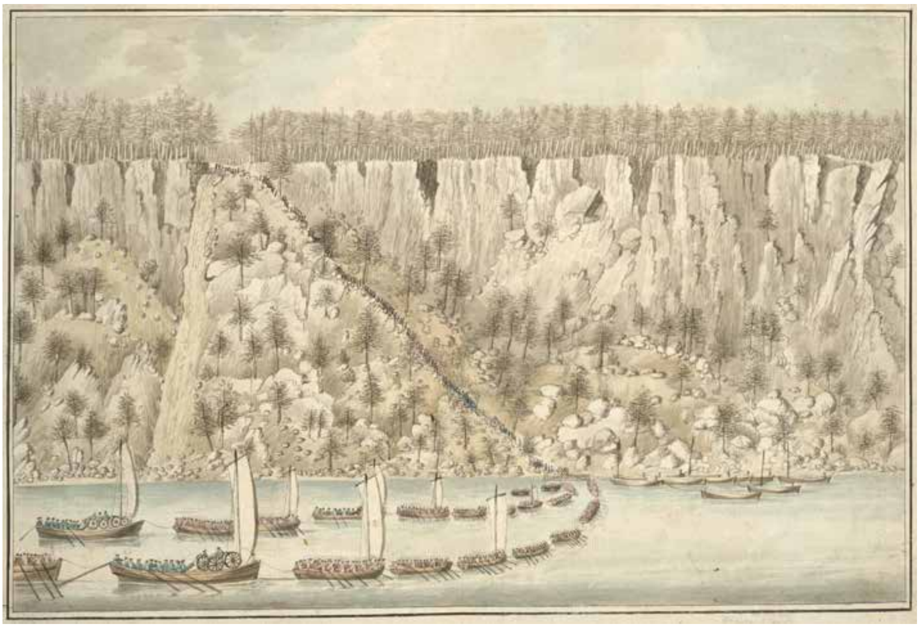
Hoboken Station and The Holland Tunnel. The PATH (Port Authority Trans Hudson) is a local train service that connects Jersey City with Manhattan, Newark, Harrison and Hoboken. The light-rail is a 20,5 miles electric powered transit service that goes from Bayonne to Ridgefield. Regarding cars, the Holland Tunnel is an underground and underwater tunnel that connects the city with Manhattan. Another efficient transportation system is composed by the ferries.

[15] Transportation
© Mattia Tintori

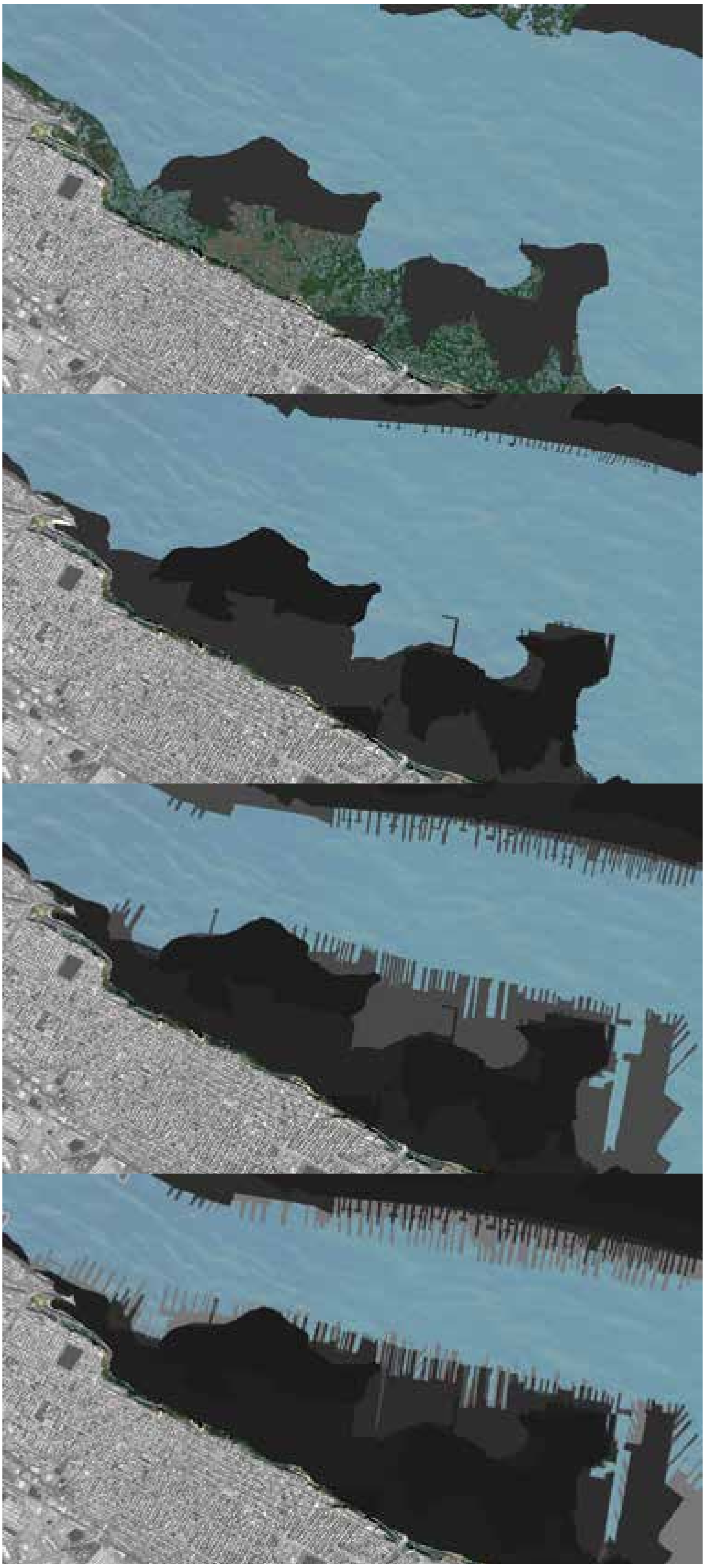
TOPOGRAPHY

Jersey city topography is characterized by the presence of a vertical cliff that cut the city in half and it is called the "Palisades". The word "palisade" derives from Latin word PALUS meaning stake. Usually the word refers to a kind of fortification made with wooden trunks positioned to create a fence. This type of defense wall was largely used in the Greek and Roman military encampments and also by the native americans as boundary of their settlements.

[16] Landing of the British forces in Jersey_Thomas Davies © Google



[17] View from the Palisades © Google



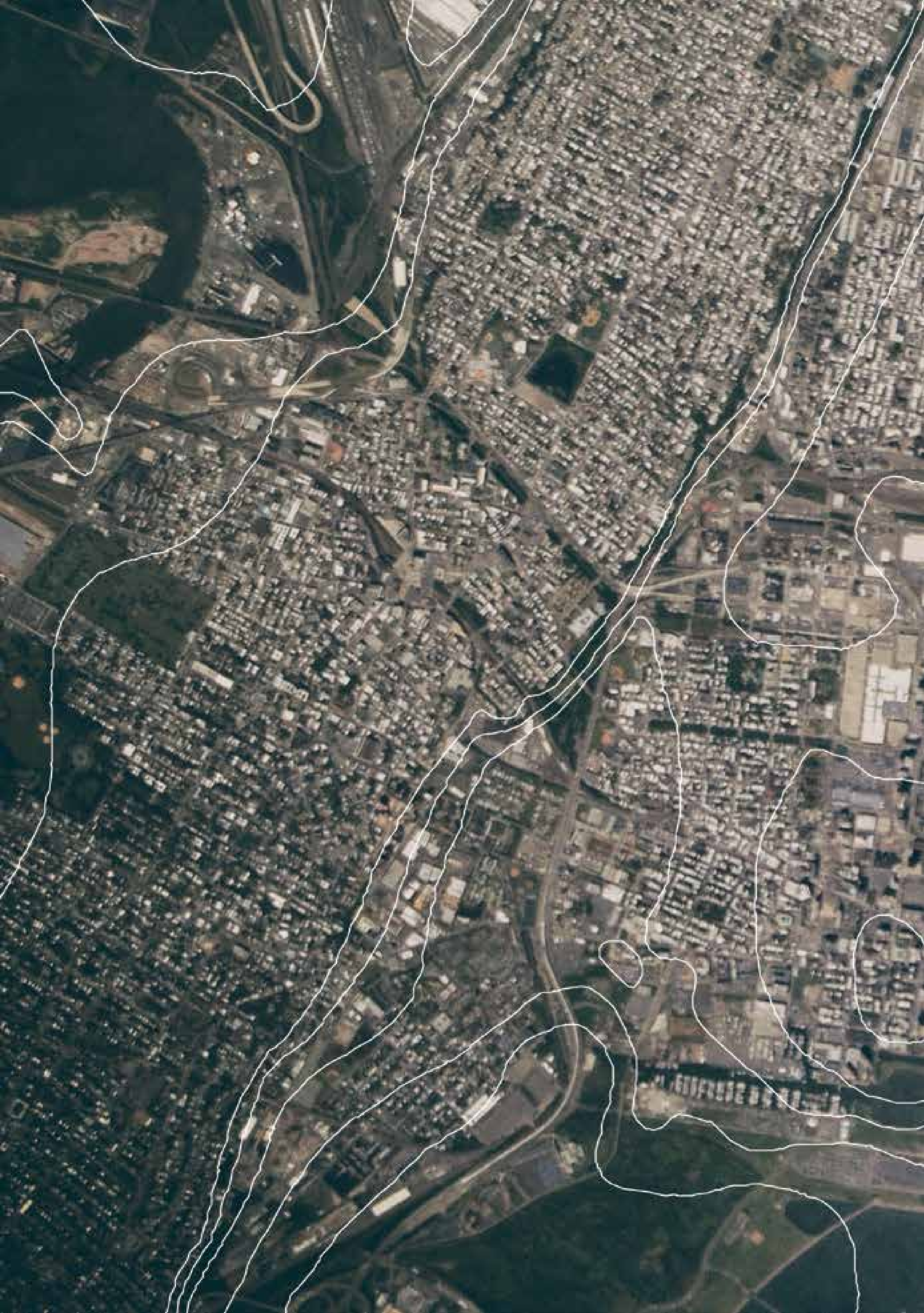
[18] Historical Landfills (1609, 1850, 1900, 1950) © Mattia Tintori

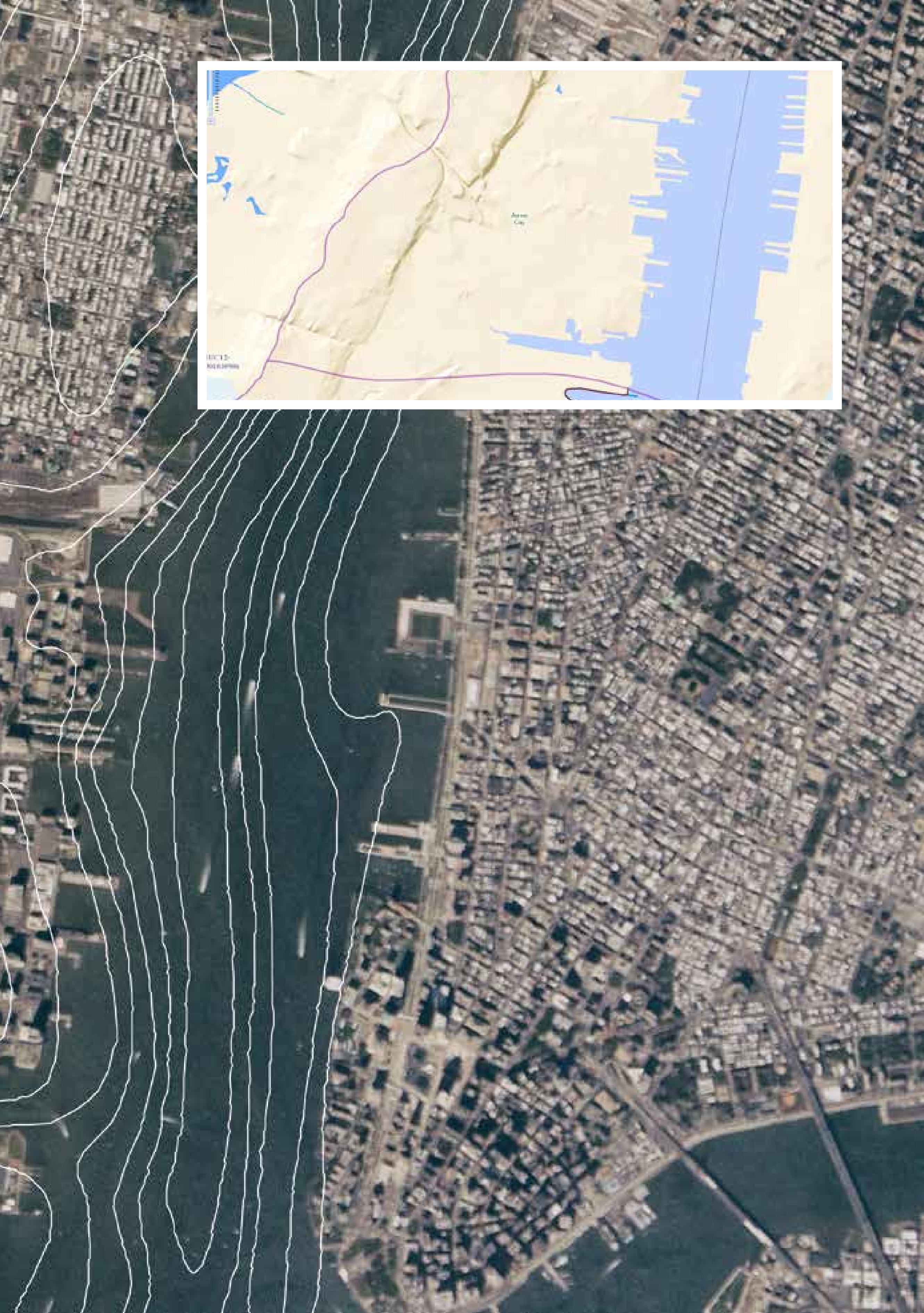
The cliff was uplifted during the Triassic period when the Pangea broke up and the molten magma intruded upward into sandstone. Over time, the sandstone layer was eroded by natural elements and the igneous formation remain. The original denizens of the area, Lenape People, called it "We-awk-en", meaning "rocks that looks like rows of trees". Regarding Jersey City, the name Palisades is perfect cause this rock cliff defend a part of the land from flooding. In fact, looking at 1609 Landfill scheme the line of the palisades is clearly visible as boundary between the inner land and the wetlands on the waterfront. Comparing this scheme with the topography map and the FEMA flood zones it is evident the protection given by the Palisades for the western part of Jersey City and moreover, the only part of the waterfront not included in the flood prone area is the higher part of the natural original wetlands. Basically the reason why Jersey City lays now in a flood zone area is derived by the continuing landfilling done over the last centuries by its residents. The inhabitants build themselves into the problem and they have to protect themselves from its threat. In fact, looking at the series of images that show how Jersey City floods we can notice that the water starts to enter from the lowest and weakest points and all of them are located on the man made landfill.

The palisades will be an important part of the project because the initial idea was to create a "circle" around Jersey City to protect it from sea level rise and the consequent flooding. In this vision the Palisades would be the natural part of this circle and the man made flood protection will be connected to them to create a "defensive wall" around the city.

[19] Digital Elevation model and 100 yrs FEMA flood area © USGS

[20] How JC floods.
From +1 ft to 10 ft
above the hight
tide line
© Climate Central





POLLUTION

As stated in the history, Jersey City and its waterways and waterbodies have a long relation with pollution. Almost nothing remains of what once was a prolific and various ecosystem. Even if in the last years the overall situation is improved, more efforts has to be put for this cause. Using GIS file provided by New Jersey State[1] and Hudson County it is evident that the ungoverned industrial past left a big scar on the territory. In the diagram are shown the known contaminated site for New Jersey state plus the chromate waste sites and the groundwater contamination areas. As shown, the site presents various type of pollution concerning both the soil and the groundwater reservoirs. For what concern the Hudson River, as explained in the history of the area, both Jersey City and New York does not comply with the Federal Clean Water Act standards due to the discharge of raw sewage directly into the waterways in case of combined sewer overflow during heavy rainy days or flooding. This issue need to be resolved for what concern the project extent and further research has to be done to understand if there is obligation of Compensatory Mitigation as stated in the Clean Water Act. As stated on the Environmental protection Agency website (EPA): For unavoidable impacts, compensatory mitigation is required to replace the loss of wetland and aquatic resource functions in the watershed. Compensatory mitigation refers to the restoration, establishment, enhancement, or in certain circumstances preservation of wetlands, streams or other aquatic resources for the purpose of offsetting unavoidable adverse impacts.

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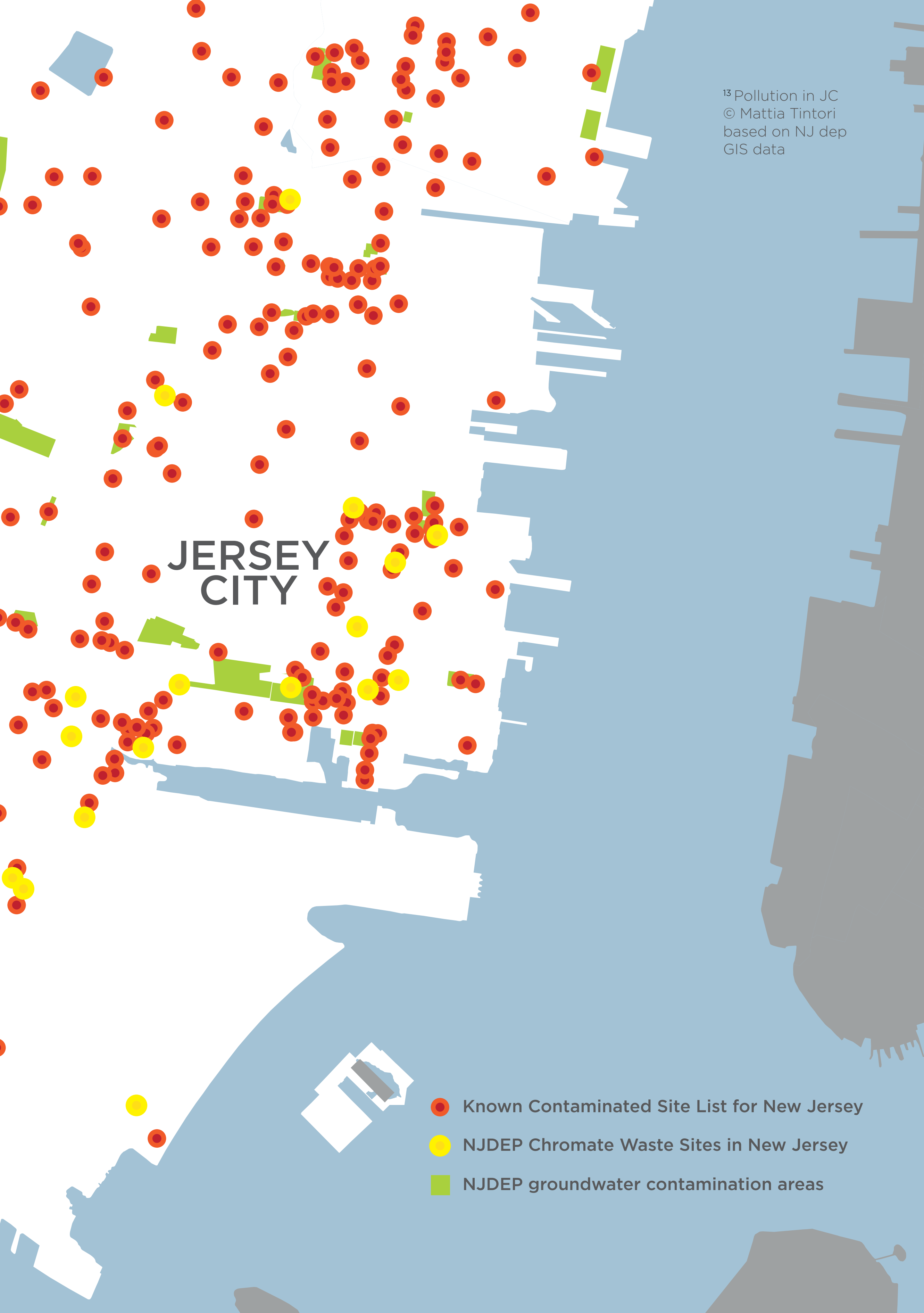
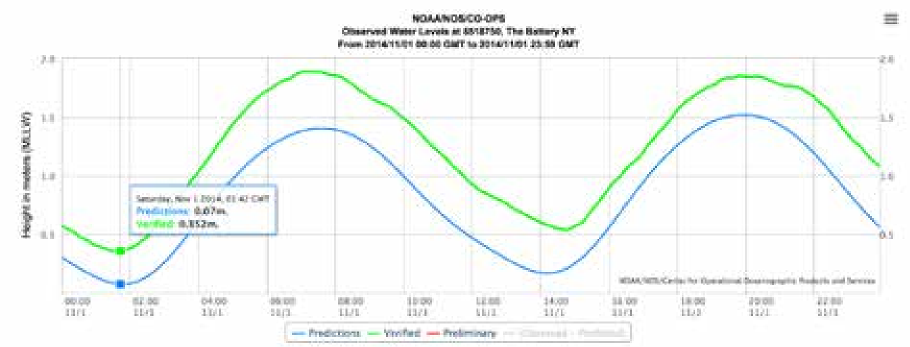
1 http://www.state.nj.us/dep/gis/lists.html


[13] Pollution in JC
© Mattia Tintori
based on NJ dep
GIS data
JERSEY
CITY
Known Contaminated Site List for New Jersey
NJDEP Chromate Waste Sites in New Jersey
NJDEP groundwater contamination areas

TIDE

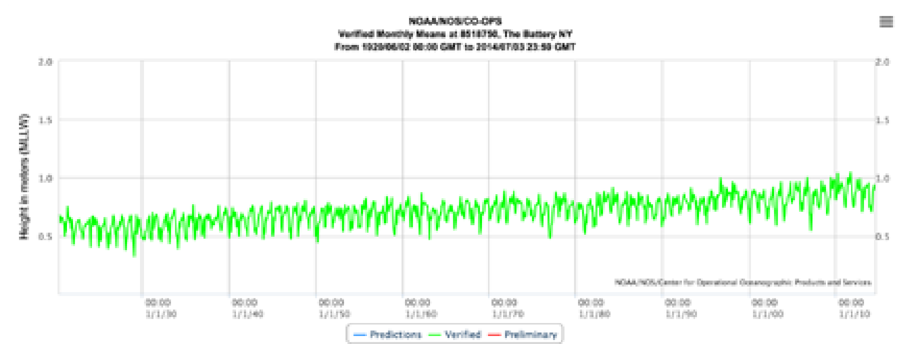
The observed water level at Battery Park (the nearest observation station) shows that the tide has two distinct highs and two distinct lows every and each day (NOAA). The diagram refers to the daily tide on 1st November 2014 and it displays two high tides for November 1st, 1,9 m at 7:36 AM, 1,85 m at 8:06 PM and two low tides of 0,35 m at 1:42 AM, 0.53 m at 2:36 PM.

[21] Daily Tide, the Battery, NY © NOAA



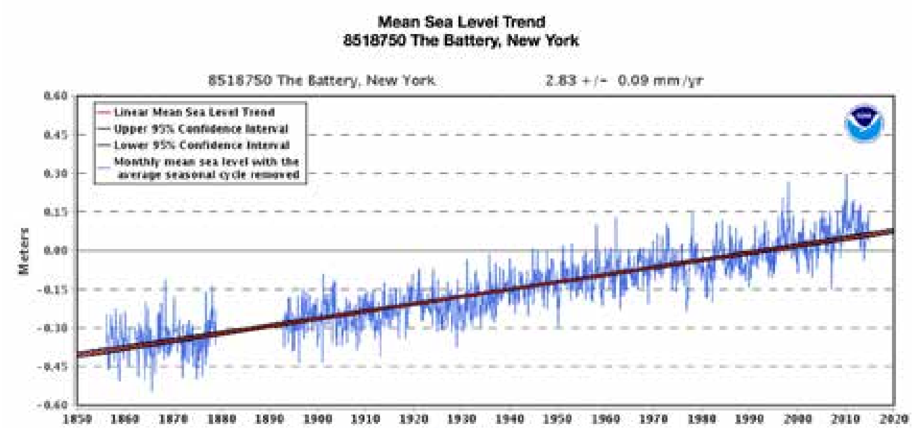
The second diagram displays how the MSL and consequently the tidal range has change from 1920 to 2014. In 1920 the average value was about 0,6 m above the MLLW and this data has increased 30 cm reaching 0,9 m in 2014. As explained in the problem statement, future projections about sea level advance a continuos rise for the next decades as also shown by the next diagram (NOAA) about the monthly mean sea level trend without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents.

[22] Verified Monthly means from 1920 to 2014, the Battery, NY © NOAA



[23] The Battery, NY
© Mattia Tintori

[13] The Battery, NY
© NYC



[24] MSL trend, the Battery, NY
© NOAA

POPULATION

According to the US Census Bureau[2], Jersey City has total population of 257345 people, 50% make and 50% female. It has a quite young population referring to the medium age value of 33,4 years old. Regarding the ethnicity, Jersey City hosts different culture, religions and ethnical groups. The white are the biggest group 34,4% of the total, followed in order by Hispanic 27,8%, Black 25,1% and Asian 25,1%. The city attracts a lot of people that comes here to live to find affordable prices and at the same time be close to New York, approximately 41% of the population (105145) are foreign born and the majority of them are from Latin America and Asia. Moreover, just the half of the population works in the city, in fact 123683 people commute very day to work with a mean travel time of 35,7 minutes.

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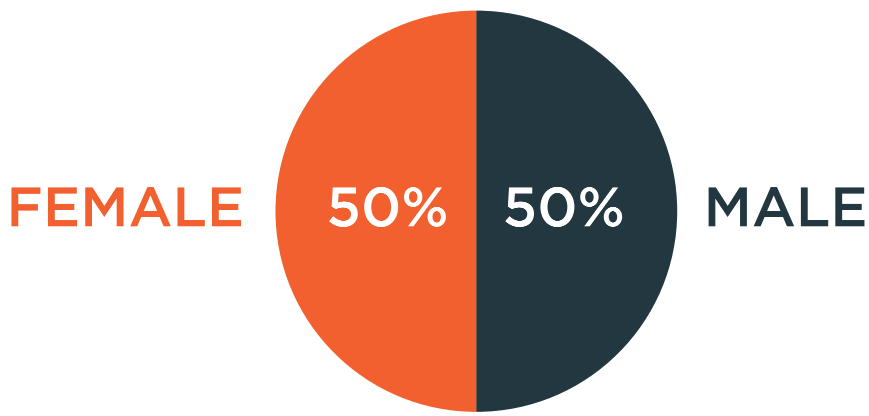
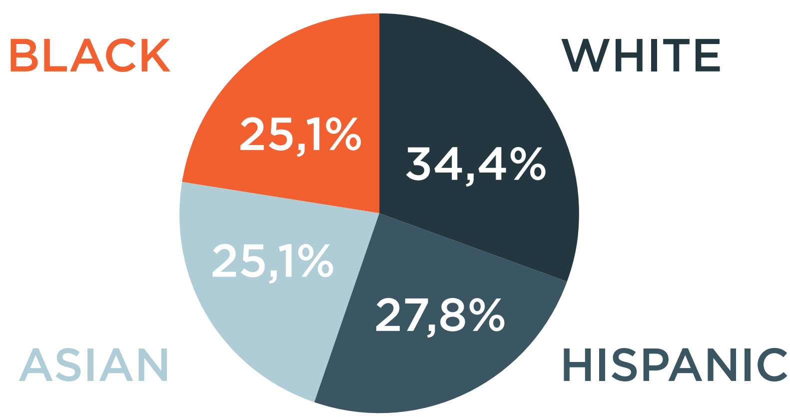
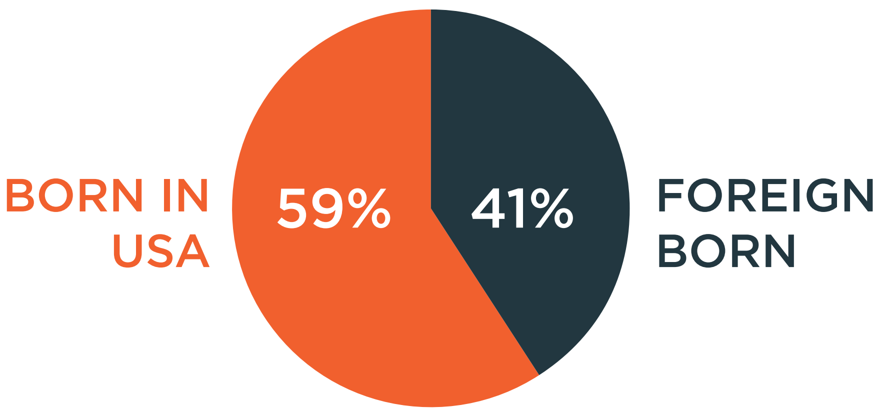
2 http://factfinder.census.gov



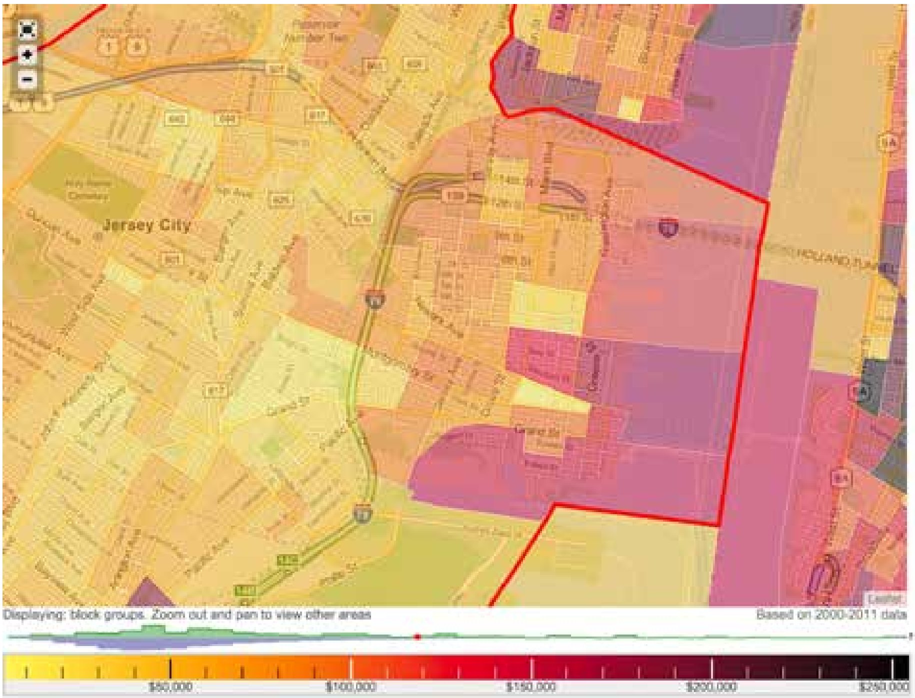




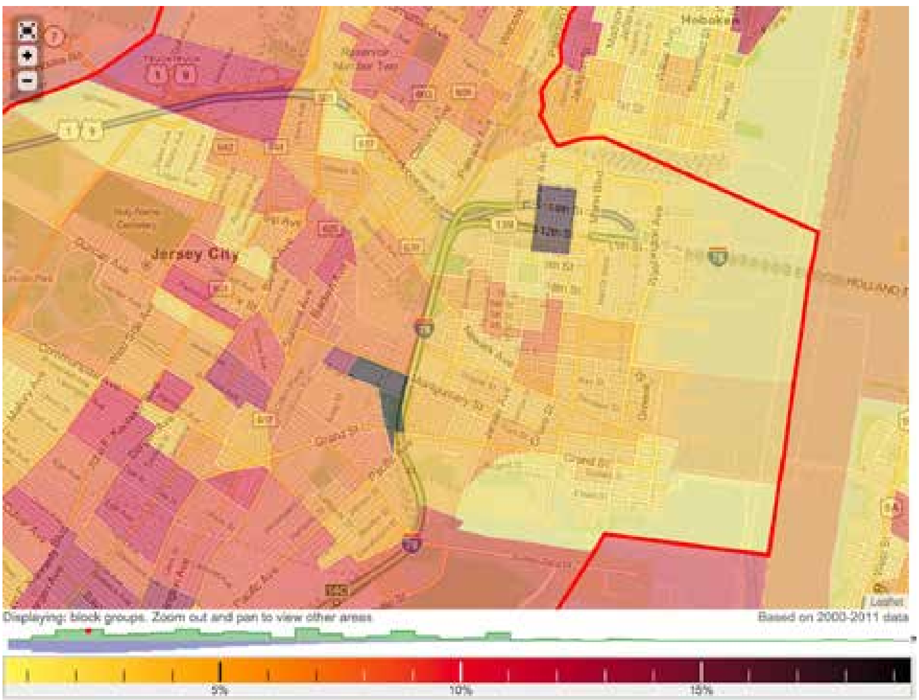
35'
MEAN
TRAVEL TIME
TO WORK

INCOME

In addition to be racially diverse, Jersey City is also economically diverse. The 25% percent of resident households had incomes below $25000 and 20% of the area's population received income support in 2011. Meanwhile, 27% of resident households had an income higher than $100000 and the Median household income is approximately $57000. An interesting outcome of this analysis is the fact that the higher incomes are located on the waterfront, where the financial and office district is.



[25] JC Income
© City Data

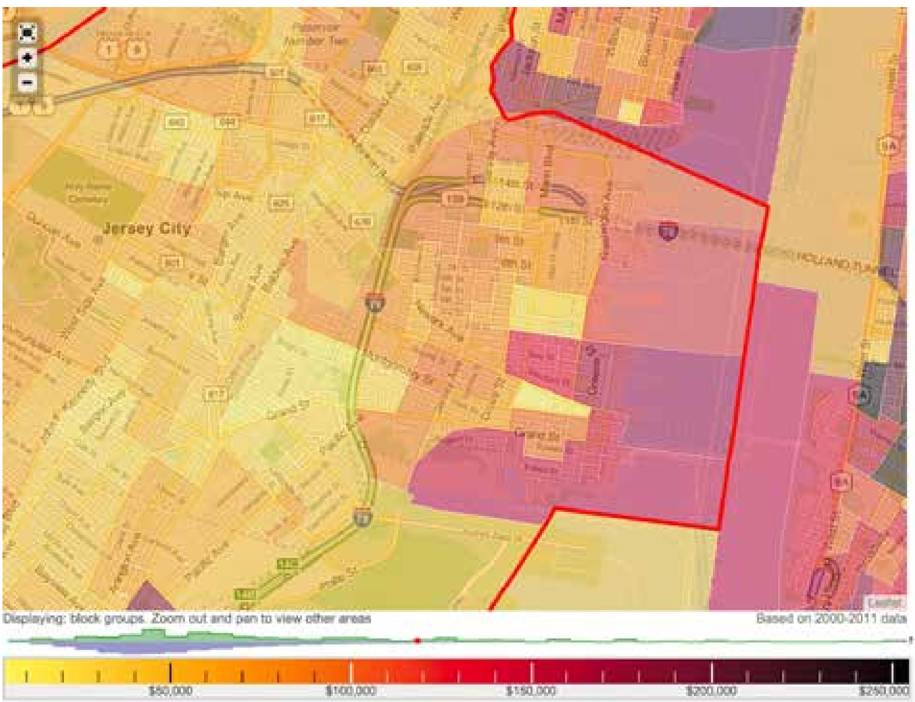


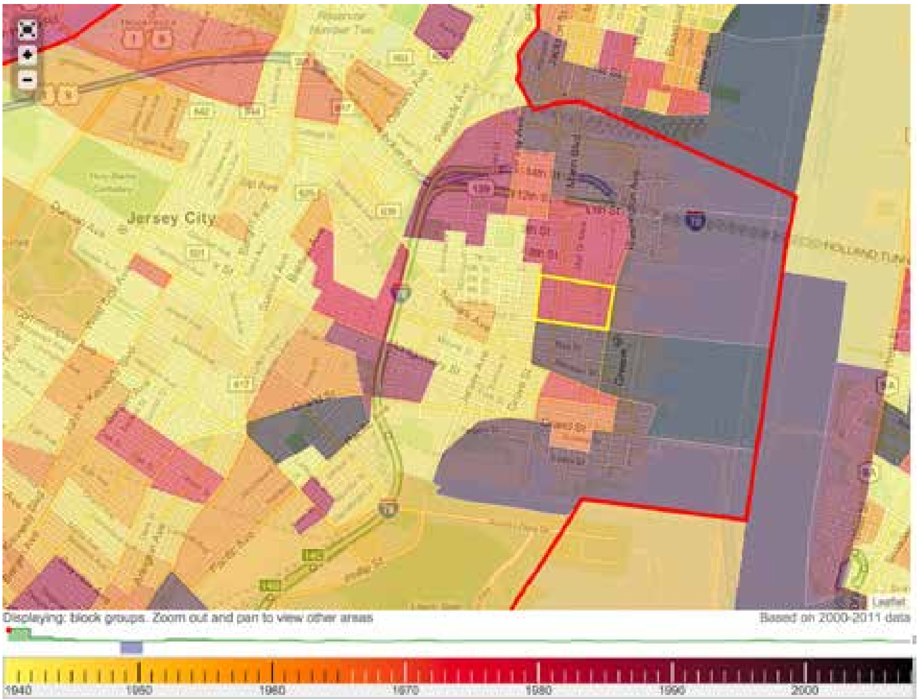
[26] JC Unemployment
© City Data

BUILDINGS VALUE

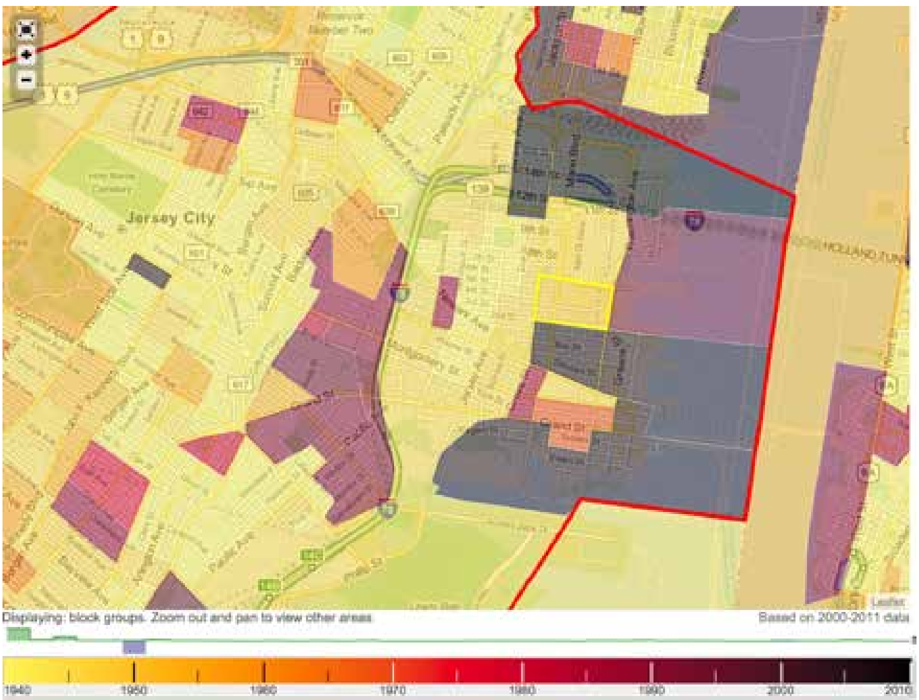
Another important outcome of the analysis is regarding the Median Building Value and the Median Year Built. The higher values and the most recent projects are obviously located on the waterfront area. There the values are higher because of the exclusivity of the location, the proximity with the water and especially the utterly beautiful view on Manhattan and the entire Upper Bay. The diagram also shows the way the city has built itself in the last year. The gradient from the back to the Hudson clearly states that the majority of the new constructions are taking place in the area near the water. The result is very important for my research cause that part of the city is also the most dangerous regarding flooding. In conclusion the goal of the project is strengthened by the need of protection of the most valuable, recent and with the highest income part of the city. As already stated, the proximity with water is both the prosperity and the threat of the waterfront areas and this diagram explains it perfectly.

[27] JC Income
© City Data





[28] Building Medi-
an Year Aparte-
mentBuilt
© City Data



[29] Building Medi-
an Year Built
© City Data

COASTAL AREA TYPOLOGY

The part of waterfront interested by our project presents only one kind of coastal area typology. The actual bulkhead headline is the result of the historical landfilling operated by the residents over time. Today, the area is characterized by a high building density achieved with high-rise commercial and residential towers. The entire shoreline has gravity bulkheads, composed by steel sheet piles used during the landfilling operations. This type of protection is really effective to retain land and avoid erosion, but they can be easily overtopped by rising waters during a storm surge event.

[30] JC waterfront bird view © Earth

[31] Holland Tunnel Ventilation Tower © Mattia Tintori

[32] Bulkhead at Liberty State Park © Mattia Tintori

13

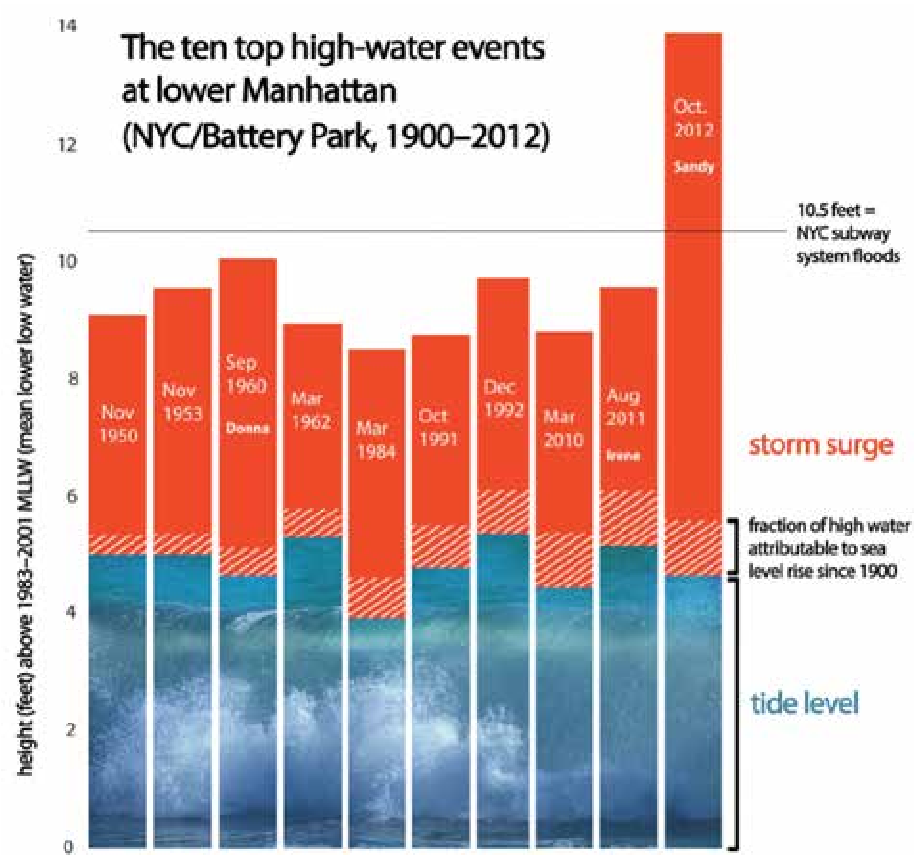
Sandy

13|

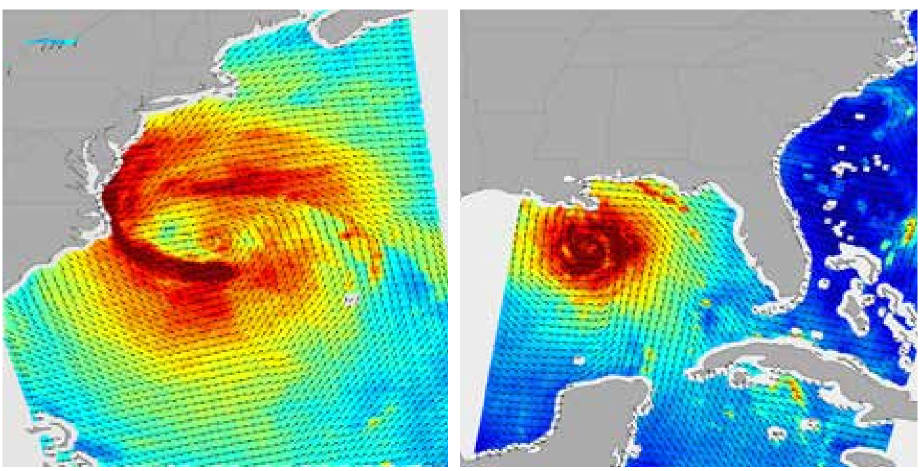
Sandy

Sandy was not an ordinary hurricane, it was a colossal meteorological event with a huge impact.
Regarding New York Metropolitan area, it was an unprecedented event, never was experienced a storm of that size, that caused so much damage and affected so many lives. As understood afterwards, an improbable set of factors came together to rise significantly its impact.

Firstly, it arrived on the evening of October 29 and it coincided with the high tide, but not a normal one, nevertheless the "spring" tide, when the moon is full and the tide is at the peak of its monthly cycle. That means that the water level was already 5 feet (approximately 150 cm) above the normal low tide line and it helped to create a massive surge of over 14 feet (430 cm) above Mean Lower Low Water at the Battery crushing the previous record of 10 feet, set by hurricane Donna in 1960. Then, there was the storm's size. When it made landfall, Sandy's tropical winds extended 1000 miles (1600 km) from end to end, which means three times the size of hurricane Katrina. Finally, there was the unusual path Sandy took towards the area and its shore. In fact most of the hurricane that reach the Northeast get close to the cost and then turn east heading out to the sea. Instead, when Sandy was coming north following the east coast of the United States it encountered a high-pressure system to the north, that block its advance and, at the same time, a low-pressure that was



[1] top ten high water events at the Battery © Noaa

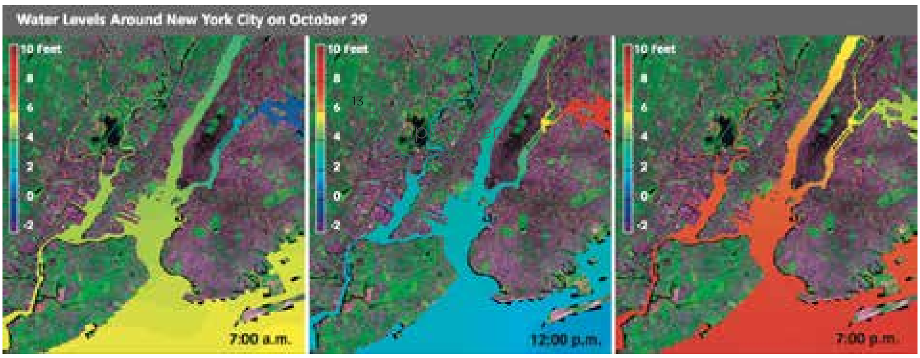


[2] Sandy and Katrina © Nasa

pushing eastwards. Pushed by these two systems, Sandy made a westwards turn and headed straight to the land as it was increasing in intensity. It came to the coasts of New York and New Jersey at a perpendicular angle and its counterclockwise winds drove the surge and the battering waves directly into the city's coastline. In a short amount of time, ocean fed bays, the bays fed rivers, the rivers fed inlets and creeks and the water rose up everywhere. Even if many storms have hit NYC metropolitan area with higher winds than Sandy's 80 miles per hour peak. As stated in "Sandy and its impact" from NYC gov website:[1]

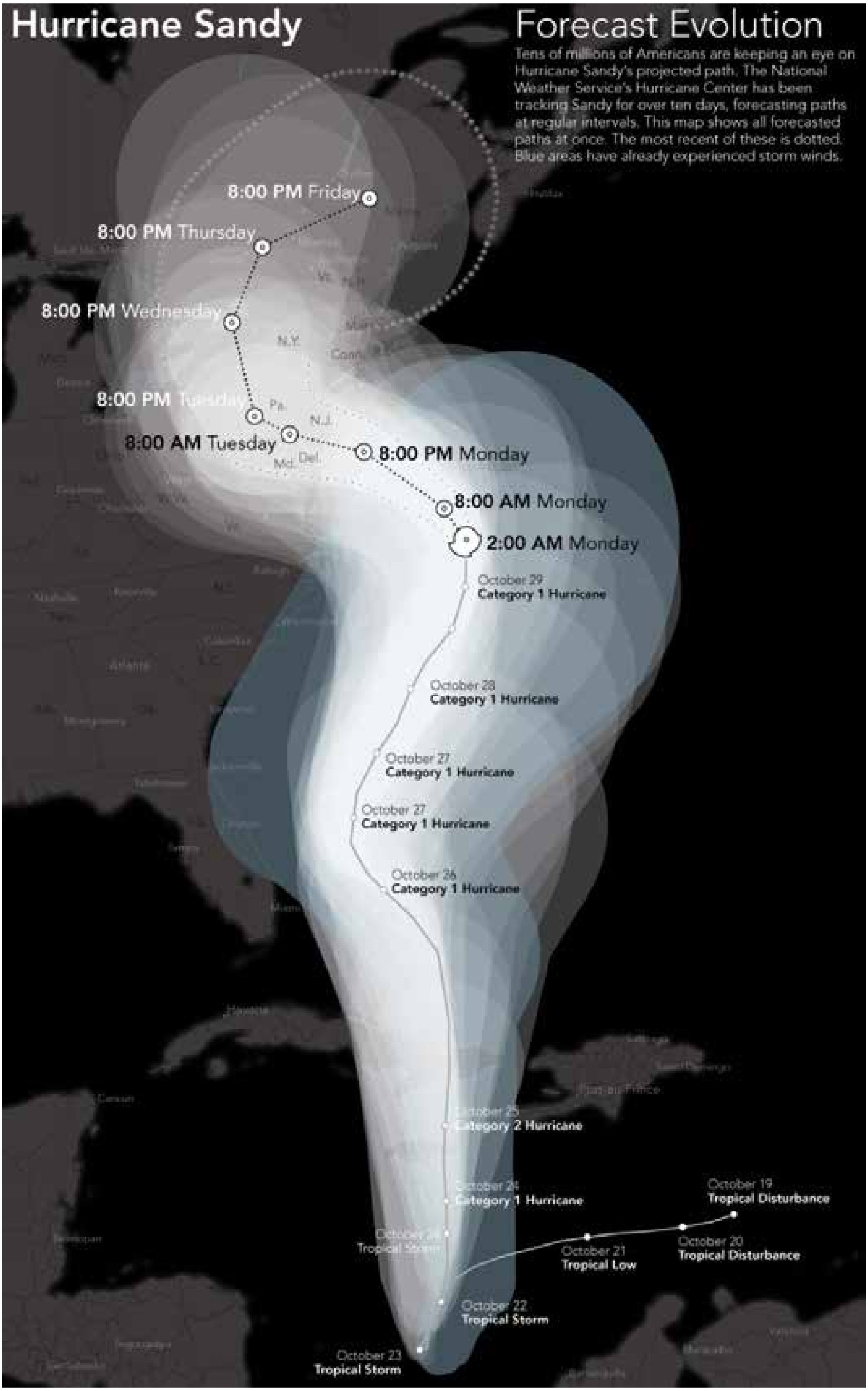
"Many storms have hit New York with higher winds than Sandy's 80-mile-per-hour peak wind gusts. Many storms have brought more rain than the half inch that Sandy dropped in parts of New York. However, Sandy's storm surge—and the devastation it caused—was unlike anything seen before. The surge, and the flooding and waves that came with it, had an enormous impact on the city."

1 Sandy and its Impact, New York City, 2012



[3] Sandy water levels on october 29
© NYC

[4] NY
© NYT


Hurricane Sandy
Forecast Evolution
Tens of millions of Americans are keeping an eye on Hurricane Sandy's projected path. The National Weather Service's Hurricane Center has been tracking Sandy for over ten days, forecasting paths at regular intervals. This map shows all forecasted paths at once. The most recent of these is dotted. Blue areas have already experienced storm winds.
8:00 PM Friday
8:00 PM Thursday
8:00 PM Wednesday
8:00 PM Tuesday
8:00 AM Tuesday
8:00 PM Monday
8:00 AM Monday
2:00 AM Monday
October 29
Category 1 Hurricane
October 28
Category 1 Hurricane
October 27
Category 1 Hurricane
October 27
Category 1 Hurricane
October 26
Category 1 Hurricane
October 25
Category 2 Hurricane
October 24
Category 1 Hurricane
October 19
Tropical Disturbance
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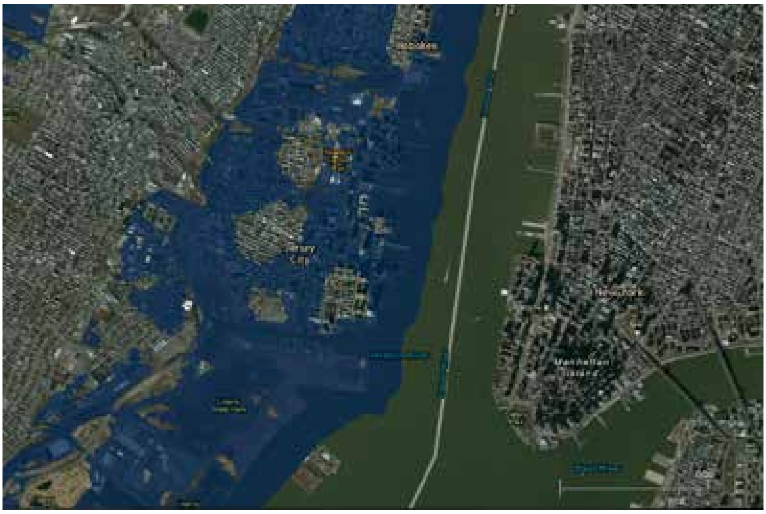
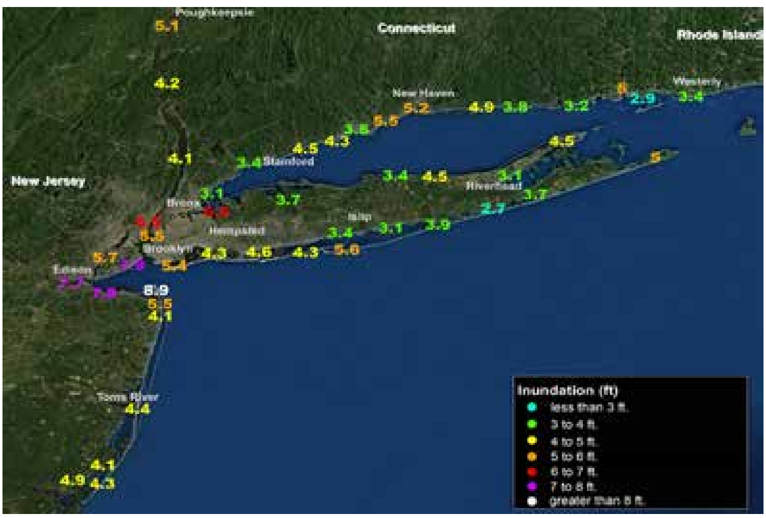


[5] Sandy Flood extent
© Stevens Institute

[6] Category 1 storm surge extent
© Stevens Institute



[7] Sandy inundation in ft at ground level
© NOAA

[8] Category 2 storm surge extent © Stevens Institute

[9] Category 3 storm surge extent © Stevens Institute

[10] Category 4 storm surge extent © Stevens Institute

COASTLINE AND WATERFRONT INFRASTRUCTURE

Sandy impacts was vast and especially the waterfront areas felted its destructive power brought by 12 feet waves, while other areas experienced only flooding. The damage to the infrastructure was extensive and the hurricane broke boardwalks, landings and terminals causing also coastal erosion when the water retreated.

BUILDINGS

The building damage was huge and various and generally severe. In some areas the floodwaters pushed houses off their foundations and destroyed walls. Elsewhere, the water filled entire basements damaging electrical and other building systems. The high-rise buildings generally bore the winds and the water, but they were rendered inhabitable cause of the damage to the equipments stored in the basement.

INSURANCE

For many residents, insurance has been one of the greatest issue after the flooding. Most of the house owners affected did not have policies adequate to cover flooding damages and part of them did not have insurance at all (almost the 50% percent). Then, more than half of the buildings damaged was outside the FEMA's 100 years floodplain, so the owners were not even aware about the risk they faced and they weren't also required to have an insurance for flooding. Regarding the ones in the flood prone area, many of them did not have any insurance, both cause they did not comply with and cause their mortgage lenders did not enforce them to.

UTILITIES

The biggest blow to city's utilities was regarding the electrical utilities cause most of the important nodes are located on the waterfront areas. More than 2 million people lost power during the storm (fig. Sandy Blackout). Generally the damaged substations were repaired in a couple of days while for the biggest ones took almost two weeks thanks to the help of thousands utility workers from other states. For days and entire weeks, there was a lack of gas and the remaining part was rationalized

[11] Damages in BK
© NYT

[12] Damages in NJ
© NYT

[13] Damages in Coney Island
© NYT

for the most important purposes as healthcare and emergency management. In fact, the storm shut down refineries, marine and pipeline deliveries and seriously damaged storage terminals. That results in four days without any kind of supply and, for almost a month the supply was limited.

TELECOMMUNICATIONS

Sandy's impact caused outages across phone, internet services, cable and wireless. The biggest outage was caused by the power loss and affected the greatest number of customers for a short-term. Another big issue caused by the power loss was the inability to charge mobile devices batteries, even if charging station were set up by cell companies in the affected areas.

TRANSPORTATION

The flooding affected a great numbers of roads, highways, railroads and airports. Meanwhile, all six East river subway tunnels connecting Manhattan with Brooklyn were also flooded such as the Steinway tunnel between Queens and Manhattan, the G train tunnel under Newtown Creek, the Long Island Railroad and Amtrak tunnel under the East River and the PATH, the Amtrak Tunnel and the Holland Tunnel under the Hudson River between New Jersey and New York. Translated in numbers, it means that 80000 ferry riders, 5.4 million of train and subway riders and 217000 commuting vehicles have been blocked by Sandy. This led the city and the task forces to implement temporary measures such as restriction for single occupant vehicles to use bridges and tunnels and the "bus bridges" to substitute the subway. Generally the normal situation has been restored after a week from Sandy's struck partly delayed by the power loss, but some elements of the entire systems remain closed much longer with repairs projected for months and years.

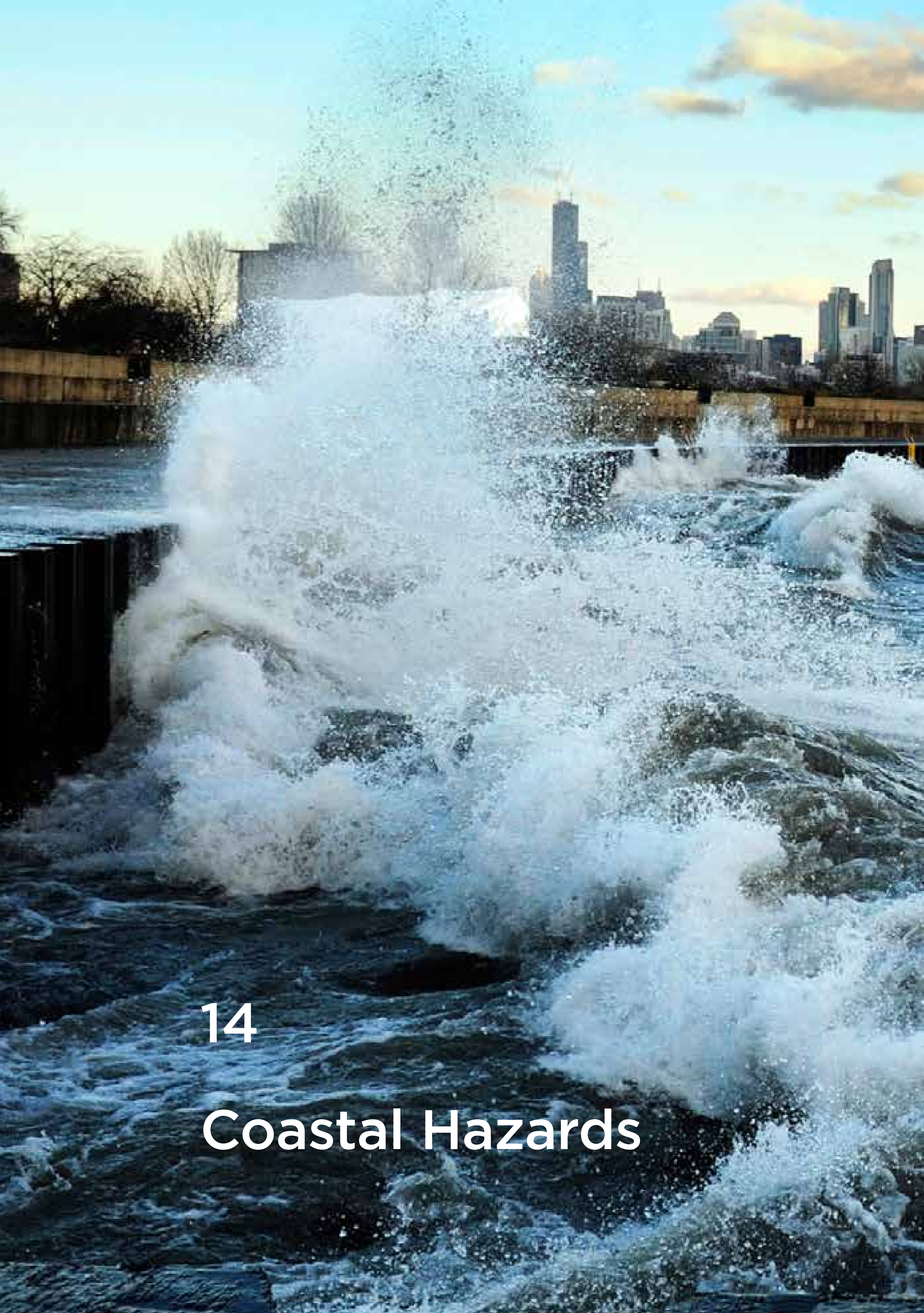
WATER AND WASTEWATER

Drinking water has been present during and after Sandy. However, in areas affected by the power loss, the pumping systems in the high rise buildings was not working leaving the residents with empty taps and no way to flush toilets. Regarding the wastewater, the storm provoked combined sewer overflow into the waterways (though quality samples has shown that the environmental impact has not been that big cause of the huge amount of water flowing from the surge).

14 Collective charger station © Flickr

15 Subway station flooded during Sandy © NYC

16 New york entrance of the Holland Tunnel © NYC



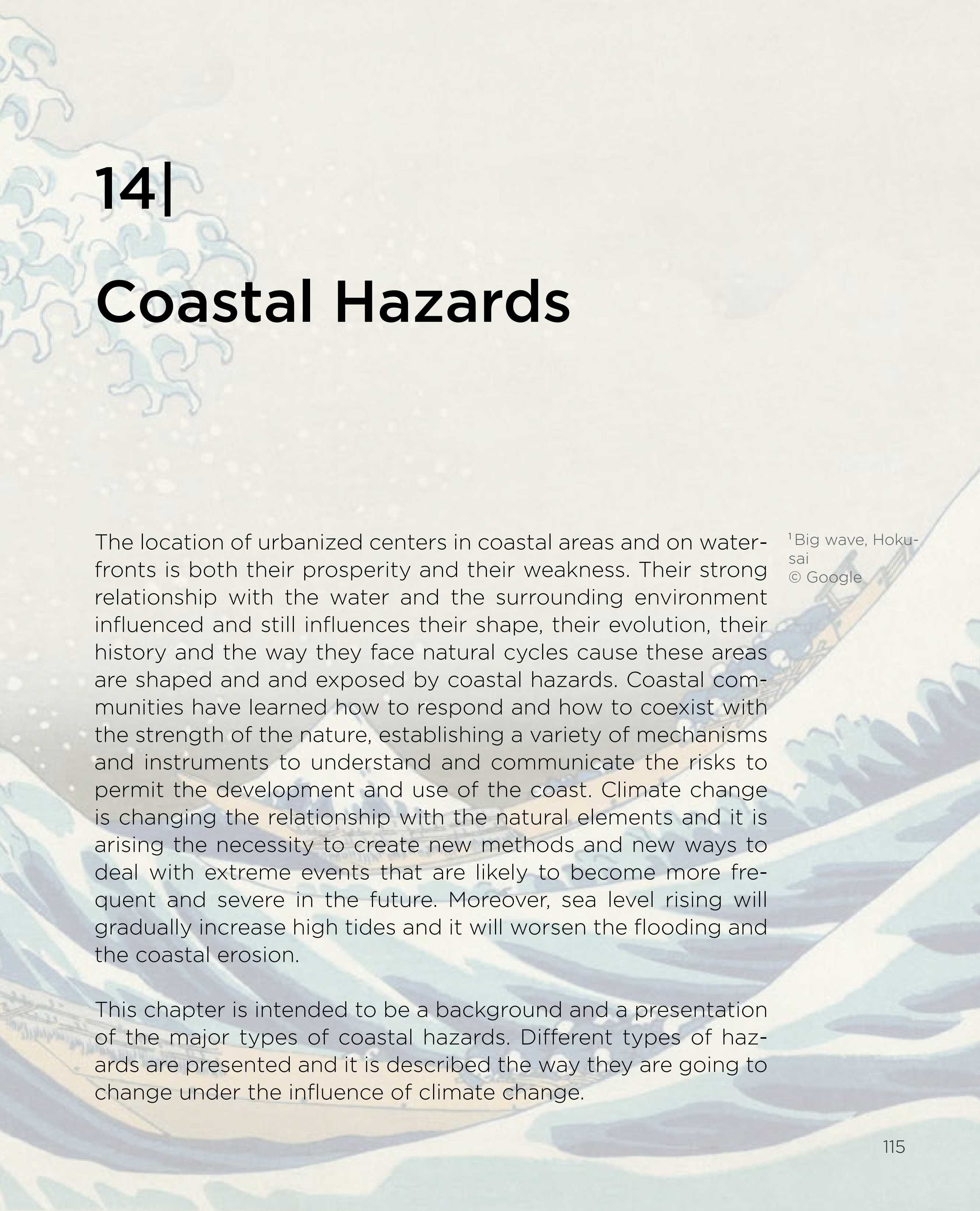
14

Coastal Hazards


冨嶽三十六景
神奈川沖
浪裏

14|

Coastal Hazards



[1] Big wave, Hokusai
© Google

The location of urbanized centers in coastal areas and on waterfronts is both their prosperity and their weakness. Their strong relationship with the water and the surrounding environment influenced and still influences their shape, their evolution, their history and the way they face natural cycles cause these areas are shaped and and exposed by coastal hazards. Coastal communities have learned how to respond and how to coexist with the strength of the nature, establishing a variety of mechanisms and instruments to understand and communicate the risks to permit the development and use of the coast. Climate change is changing the relationship with the natural elements and it is arising the necessity to create new methods and new ways to deal with extreme events that are likely to become more frequent and severe in the future. Moreover, sea level rising will gradually increase high tides and it will worsen the flooding and the coastal erosion.

This chapter is intended to be a background and a presentation of the major types of coastal hazards. Different types of hazards are presented and it is described the way they are going to change under the influence of climate change.

EVENT-BASED HAZARDS

These hazards depend on sudden events, such as earthquakes, tornadoes and coastal storms, which are the combinations of storm surge, wave action and erosion. In Jersey City and in general, New York City's metropolitan area, these kind of threat are caused by both hurricanes and Nor'easters. During Sandy, the New York Bight, the right angle shaped by Long Island and New Jersey, can act to push storm surge into the Upper Bay. Hurricanes are likely to produce harsher storms while the ones caused by Nor'easters are smaller, but more frequent. The main consequence of Storm surges is extensive flooding in the low-lying area of the city's waterfront.

According to Climate Central panel[1] and to the New York City Panel on Climate Change[2], sea level will rise in the next decades and this will results in an increased frequency and entity of coastal flooding. The 1-in-100 years flood will be higher, stronger and it will affect a bigger area. In addition, it is projected that the number of intense hurricanes is likely to increase in the entire North Atlantic Region in the future.

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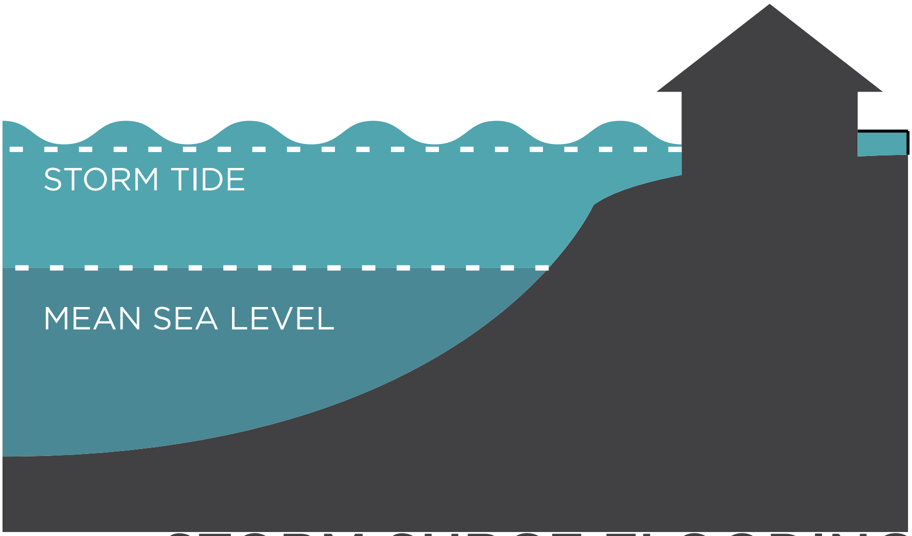
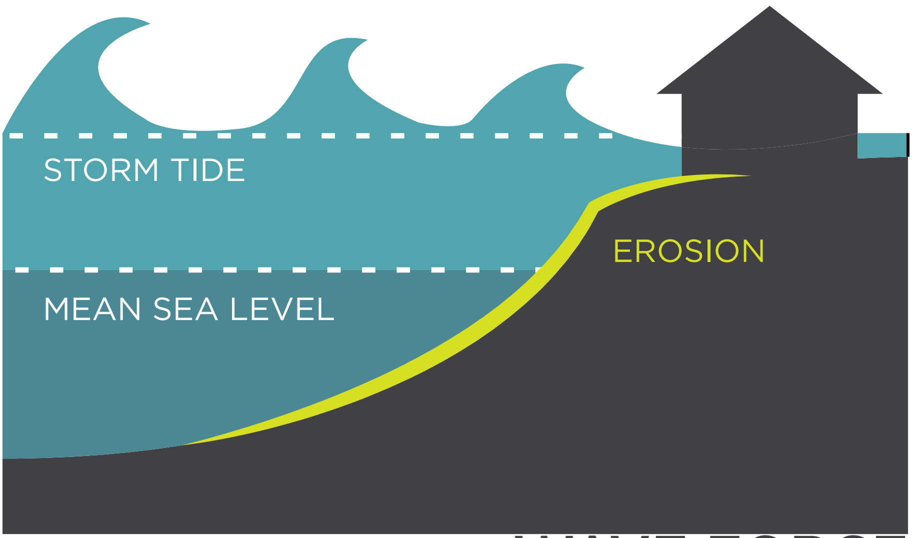
1 Climate Central (2014). Sea level rise and coastal flood exposure: Summary for Jersey City, NJ. Surging Seas Risk Finder file created June 09, 2014. Retrieved from http://ssrf.climatecentral.org.s3- website-us-east-1.amazonaws.com/Buffer2/states/NJ/downloads/pdf_reports/Town/NJ_Jersey_City- report.pdf

2 C. Rosenzweig and W. Solecki (Eds.), New York City Panel on Climate Change, 2013: Climate Risk Information, NPCC2, City of New York Special Initiative on Rebuilding and Resiliency, New York



STORM SURGE FLOODING



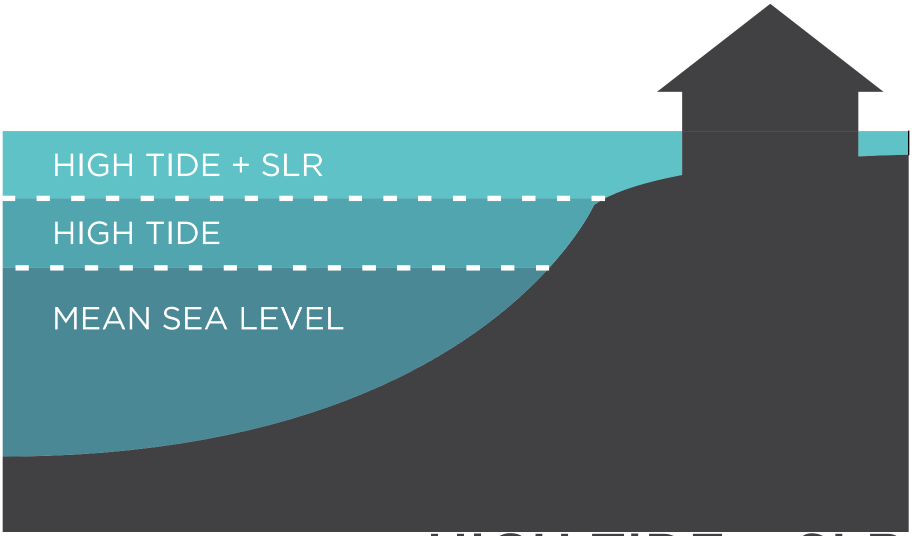
WAVE FORCE

[2] Event based hazards
© Mattia Tintori

GRADUAL HAZARDS

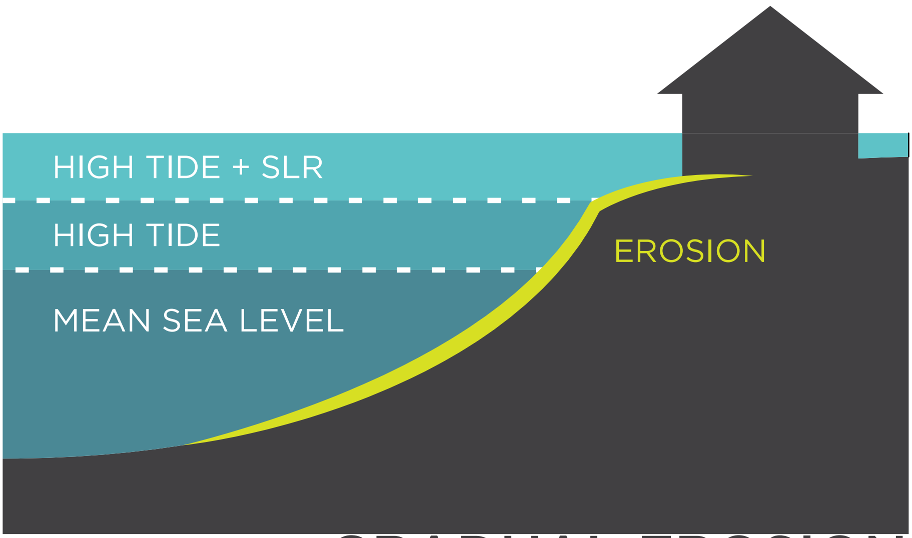
While the event-based hazards come quicker and are based on sudden events, these hazards slowly introduces themselves. This feature permit the coastal communities to be better prepared in order to deal with them, but that doesn't mean that these king of threat is less dangerous compared to the others. Coast lines have been shaped over time by winds, waves, tides, and currents and they always will be. These actions keep modifying the environment by erosion and by moving sediments.

Climate change and sea level rising are likely to affect tides and currents leading to flooding of low-lying areas by daily or monthly high tides. In areas characterized by gradual sloping shorelines such as beaches and marshes, future changes could lead to erosion and to a shifting of the high tide line landward. This shifting will results in a permanent submersion of some of the intertidal zones.



HIGH TIDE + SLR

[3] Gradual hazards
© Mattia Tintori



GRADUAL EROSION

WATER LEVELS

Sea level is not fixed, it is constantly affected by external factors that modify it during the day.
The main causes are:

1_ TIDES

Sea level is daily and monthly affected by the gravitational forces produced by the combined orbital cycles of Moon, Sun and Earth. Following specific datums that are generally used to measure tides levels:

- Mean Higher High Water (MHHW): It is the average of the higher range of the high water height of each tidal day observed over the National Tidal Datum Epoch, a 19-year period defined by the National Ocean Service as the official time segment for deriving mean values for tidal datums.

- Mean High Water (MHW): The average of all high water heights observed over the National Tidal Datum Epoch.

- Mean Sea Level (MSL): The arithmetic mean of hourly heights observed over the National Tidal Datum Epoch.

- Mean Lower Low Water (MLLW): The average of the lower low water height of each tidal day observed over the National Tidal Datum Epoch.

2_ WIND SET-UP

It is a phenomenon caused by wind stresses that can literally blow the water towards the land resulting in in an increase of the sea level and in waves that can be compared to the effect of the astronomical tide. Its effect is important regarding the sea level and it shpuld be included in the calculation of the flood protection.

3_ SHOWER GUSTS

4_ SEA LEVEL RISE

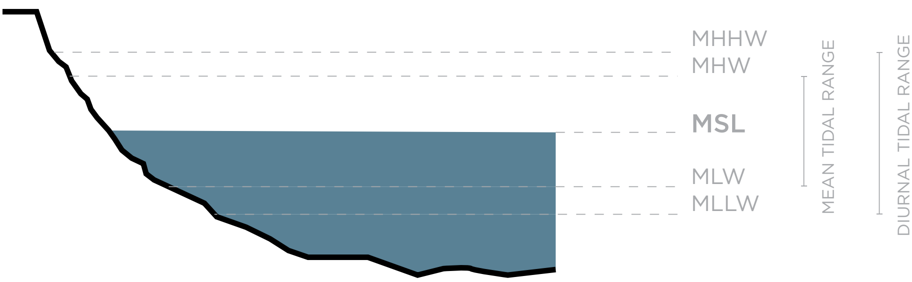
WAVES

They are the results of the motion on a water surface and they can be categorized in two main types:

- Breaking waves: waves that break because they cannot longer support themselves. It happens when that reach shallow water or when they become too steep.

- Non-Breaking waves: waves that reach the coast without breaking. They are reflected by the shoreline causing an interference between the incoming ones and the returning ones. This action results in an increase of the wave height up to 100% more.

Waves are mainly caused by : wind, ships and earth quakes.



[4] Wave at sunset
© Carreau

HURRICANE

It is the strongest type of tropical cyclone characterized by wind speeds of 74 miles per hour or higher. Usually known as hurricane in the Western hemisphere, that are also called “typhoons” or “cyclones” in the Eastern.

TROPICAL STORM

It is a type of tropical cyclone defined by winds speeds ranging from 39 to 73 miles per hour. It is also characterized by thunderstorms that produce strong winds and heavy rain. It is called tropical cause it usually originates in tropical regions of the globe.

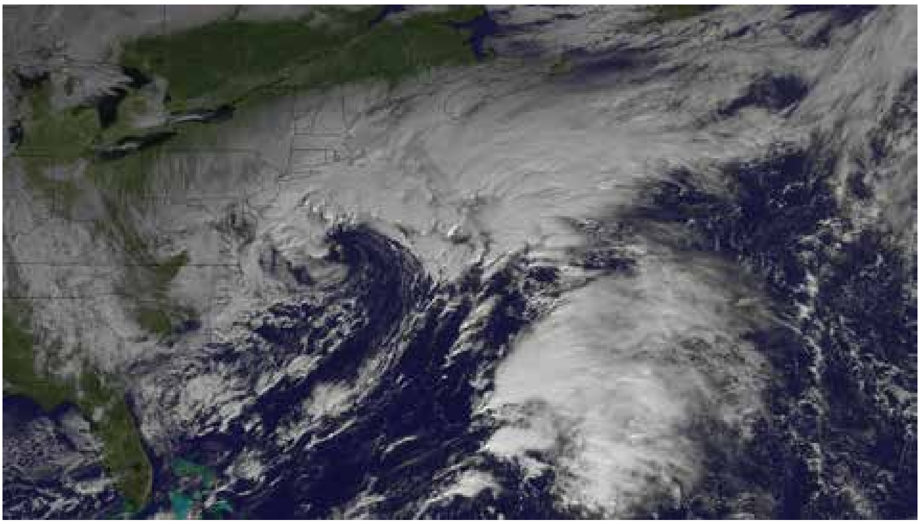
NOR’EASTER

It is a strong low-pressure climate system that typically affects Mid-Atlantic and New England states during the months of September through April, producing strong winds, heavy snow and rain, and large waves on Atlantic beaches. These storms commonly cause beach erosion and structural damage. The storm gets its name from the northeasterly winds that blow in from the ocean over coastal areas during the storm.

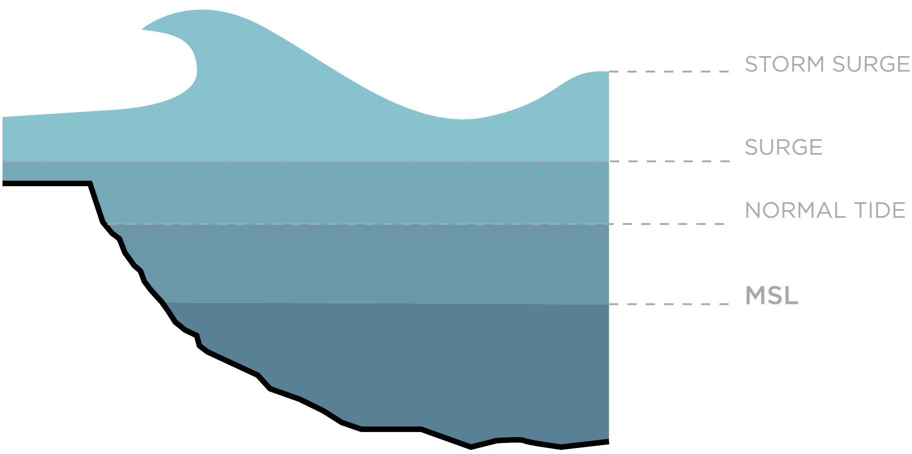
STORM SURGE

It happens when a hurricane or other strong coastal storm cause a sea level rise above the value associated with normal astronomical tides. The storm surge height is the difference between the observed storm tide and the astronomic normal tide while the storm tide is the combination of the storm surge plus the tide level. It is produced by a combination of the low pressure and the force of the wind caused by the hurricane.

5 Hurricane from above
© NASA



6 Nor'Easter from above
© NASA



15

Design Framework

15|

Design Framework

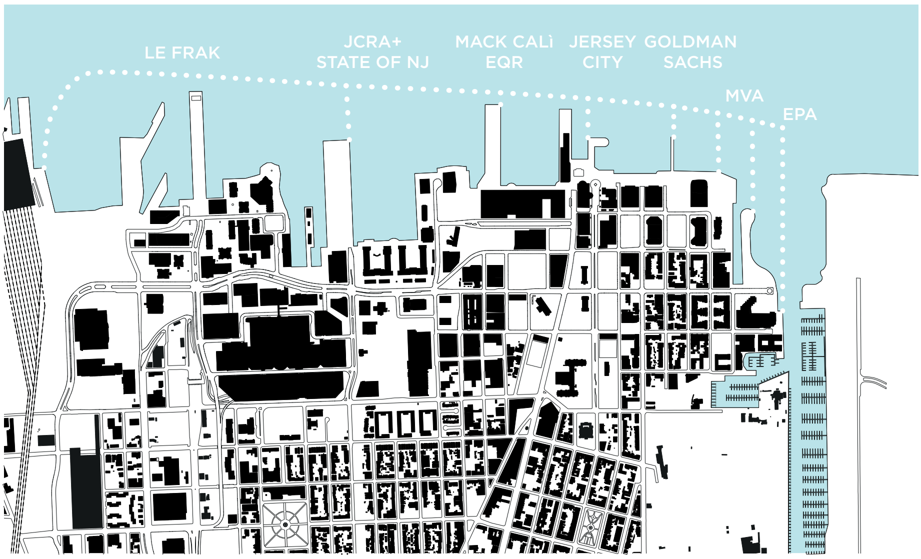
The chapter is intended as an explanation of the clients and the stakeholders that would be involved in the project. Then all the requirements and the criteria adopted are described, as well as the boundary conditions.

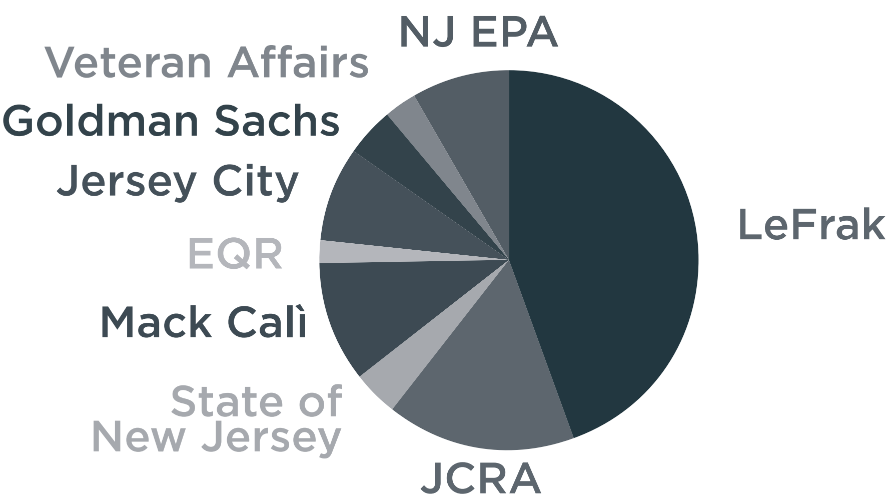
CLIENTS

This project is intended to build a new part of the city from scratch trough a huge landfill of 93 hectares [1 km^2] in the Hudson River. The site area goes from the actual bulkhead line to the pier headline positioned by the law in the Hudson River. The site is possessed by 9 different owners. As displayed by picture they are: Lefrak (44%), Jersey City Redevelopment Agency [JCRA] (16,5%), State of New Jersey (3,9%), Mack Cali (10,2%), EQR (2,1%), The City of Jersey City (8%), Goldman Sachs (3,6%), NJ Dept. of Military Affairs (3,4%) and NJ Environmental Protection Agency (8%).

The project is intended to serve both public and private clients. As explained by the diagram, the site is both owned by the City of Jersey City, other governmental institution and by private investors, mainly building developers families. More over, the need for a flood protection system involves directly the USACE (United States Army Corp of Engineers) and the Port Authority of New York and New Jersey.

[1] Clients logos
© Google





[2] Area owned in the project site compared
© Mattia tintori

PUBLIC

FEDERAL GOVERNMENT

The main client from the federal government would be the USACE. As stated on their website:
"The U.S. Army Corps of Engineers has approximately 37,000 dedicated Civilians and Soldiers delivering engineering services to customers in more than 130 countries worldwide. With environmental sustainability as a guiding principle, our disciplined Corps team is working diligently to strengthen our Nation's security by building and maintaining America's infrastructure and providing military facilities where our service members train, work and live. We are also researching and developing technology for our war fighters while protecting America's interests abroad by using our engineering expertise to promote stability and improve quality of life."
The Corp is involved in any flood defense and big infrastructure project regarding USA. They will play an important role as technical client to develop and assist in the design of the flood protection.

STATE OF NEW JERSEY

The State will be actively involved in the project, not only as higher jurisdiction compared to the City of New Jersey, but also as one of the owner of the new waterfront area.

NJ DEPT. OF MILITARY AFFAIRS AND VETERANS AFFAIR

It is a department that helps the war veterans once they come back home.

CITY OF JERSEY CITY

The City and its Council would be one of the crucial client of this project. Besides the small part of new land owned by it, only 8% of the total, the City would be highly interested in a project that would radically change the identity, the shape and the image of itself. It would be a unique opportunity to create a new vision for the future Jersey City and start to build it. It would be a great example how private and public sector together can help each other to reach the same goal.

JERSEY CITY REDEVELOPMENT AGENCY

The agency was created back in 1949 as an autonomous agency

to improve the city attracting residential, commercial and industrial real estate projects. As stated on its website:
"The Agency is committed to enhancing the quality of life for all residents of Jersey City by guiding responsible development and reinvestment in all neighborhoods and communities in Jersey City." JCRA's Guiding Principles include enhancing the quality of life and improving economic and housing opportunities, building strong, viable partnerships with the community, and letting employees perform their duties in an honest, ethical manner at all times while maintaining the trust, respect and confidence of residents and our clients."

PRIVATE

LEFRAK

As stated on their website:
"LeFrak is a preeminent, family-owned property company committed to community development and long term ownership. Our principles, consistently applied, have strengthened and deepened the expertise that supports our real estate leadership."

MACK CALI

"Among the country's largest real estate investment trusts (REITs), Mack-Cali Realty Corporation is a leading owner, manager, and developer of class A real estate. The Company owns or has interests in 282 properties consisting of 266 office and office/flex properties totaling approximately 31.5 million square feet and 16 multi-family rental properties containing over 4,900 residential units, all located in the Northeast, as well as land to accommodate additional commercial, multi-family, and hotel development."

GOLDMAN SACHS

"The Goldman Sachs Group, Inc. is a leading global investment banking, securities and investment management firm that provides a wide range of financial services to a substantial and diversified client base that includes corporations, financial institutions, governments and high-net-worth individuals. Founded in 1869, the firm is headquartered in New York and maintains offices in all major financial centers around the world." They already own the highest building in Jersey City, which became sort of a land mark cause it is easily visible from Manhattan's waterfront.

STAKEHOLDERS

REGIONAL GOVERNMENTAL ORGANIZATION

INTERSTATE ENVIRONMENTAL COMMISSION

It is a commission that control the water pollution among three different states: New York, New Jersey and Connecticut. It was created in 1936 and Connecticut joined it later in 1941. Its unique importance is related to its interstate jurisdiction which make it able to mediate the conflict among the three states. In fact what distinguishes though the Commission from the agencies of its member states is the fact that the Commission is not only an intrastate regulatory and enforcement agency, but also, an interstate agency, one that can and does cross state lines. While out-of-state dischargers for example can adversely affect the waters of an IEC member state, they are beyond the reach of the agencies in the affected state, but not out of the jurisdiction of the Commission, which does not hesitate—whenever necessary, and in coordination with its member states and the US EPA—to use its enforcement and regulatory powers on both an interstate and intrastate basis.[1]

PORT AUTHORITY OF NEW YORK & NEW JERSEY

It is the responsible agency for the building, the operation and maintenance of the critical transportation between the two states. Its transportation network of aviation, rail, surface transportation and seaport facilities moves every year million of people.

STATE GOVERNMENTAL ORGANIZATION

NJ ENVIRONMENTAL PROTECTION AGENCY

It is the national agency responsible for the protection of the human health and the natural environment. The State of New Jersey is located in EPA's region 2.

NJ DEPT. OF STATE

The mission of the Department of State is to enhance the overall quality of life for New Jersey residents by advancing and supporting our State's economic vitality, cultural and historical programs and civic engagement responsibilities.

NJ DEPT. OF TRANSPORTATION

1 http://www.iec-nynjct.org

REQUIREMENTS

The requirements are usually decided by the clients and then elaborated by the architect. Since this is a thesis project, they have been selected trying to imagine what the actual clients would have ask about flood defense, density, boundaries, new identity.

FLOOD DEFENSE

HEIGHT

The height of the flood protection is selected to meet or exceed the 100 years flood value (1% annual chance) required by the law plus a 500 years flood value for the resiliency requirement. It also includes the projected sea level rise for the next 100 years. The starting value that have been taken into account to decide the height for the flood defense is the FEMA 100 years flood height which is set at 11,4 feet [3,5 m] above the MSL at the Battery, NY[1]. Although, this value refers to the actual situation and it doesn't take into account future changes and projections regarding the sea level. To include in the analysis these variables, three different projects have been selected as official references.

- 1970 USACE Rockaway Inlet Barrier: It is a project approved in 1965 by United States Congress for the design of a storm surge barrier across the Rockaway Inlet.

- Strategies for Flood Risk Reduction for Vulnerable Coastal Populations along Hudson River at Hoboken and Jersey City by Rutgers University[2]: As stated in their summary: "*Following the damage resulting from Hurricane Sandy, Rutgers University was tasked to determine the flood vulnerability of several communities across New Jersey including Hoboken and Jersey City and to develop the mitigation measures.*"

- Collaborative Climate Adaptation Planning for Urban Coastal Flooding[3]: This project has been already presented in the problem description and it is divided in two different Adap-

1 http://www.cityofjerseycity.com/uploadedFiles/City_Government/Department_of_Housing,_Economic_Development_and_Commerce/City_Planning/charette_modelingposter_V1.pdf

2 http://www.nj.gov/dep/docs/flood/final-studies/rutgers-hudson/hudson-river-study-area-flood-mitigation-final-report.pdf

3 http://www.cityofjerseycity.com/uploadedFiles/City_Government/Department_of_Housing,_Economic_Development_and_Commerce/City_Planning/Orton_SGJC_Charette_v3_noanimations.pdf

tation Plans proposed by a team composed by Philip Orton (Davidson Laboratory, Stevens Institute of Technology), Tanya Marione Stanton (Jersey City Department of City Planning), Naomi Hsu (Jersey City Department of City Planning), Jeffrey Wenger (Jersey City Department of City Planning), Douglas Greenfeld (Jersey City Department of City Planning now at North Jersey Transportation Planning Authority),Maryann Bucci Carter (Jersey City Department of City Planning), Sergey Vinogradov (Davidson Laboratory, Stevens Institute of Technology), Alan Blumberg (Davidson Laboratory, Stevens Institute of Technology), Robert Cotter (Jersey City Department of City Planning).

The USACE project is the oldest one and it refers to a situation that is almost 40 years old, although it could be updated including actual values for the sea level rise from 1970 and for the next 100 years. The height given by the USACE for their storm surge barrier back in 1970 was 18 ft [5,54m] above MSL. Taking that height and adding the sea level rise since 1970 (0,4 ft, 0,121m) the value reach 18,4 ft [5,6m]. As sea level rise value for the next 100 years, it has been selected the mean value between Climate Central Low and High Projection: 190 cm +58 cm / 2= 124 cm [4 ft]. The resulting height would be 22,4 ft [6,82m] above the MSL.

Instead, according to the report done by Rutgers University, the heights are represented in [FIG 3]. They project a 15,4 ft [4,7m] above NAVD88 for the 100 years flood plus a 2100 sea level rise of 3,1 ft [0,95 m]. They use as best estimate for the sea level rise the one made by Miller at al. 2013[4]. Based on this projection, then they argument their choice for the height:

"The range of required crest elevation for the barrier is 9 to 16 feet based upon the combination of tides, sea level rise, and storm surge. However, if wave overtopping is taken into account an additional 2 to 3 feet should be added to the design. The resulting barrier should have a crest elevation between 12 to 19 feet.[...] In this study a flood barrier is considered that includes a sheet pile bulkhead and cap base with top height 4 feet above grade and then four vertical extensions each 4 feet high combining to create a 20 feet tall barrier."

The final result is a 20 ft [6,1m] tall barrier above the top of the grade.

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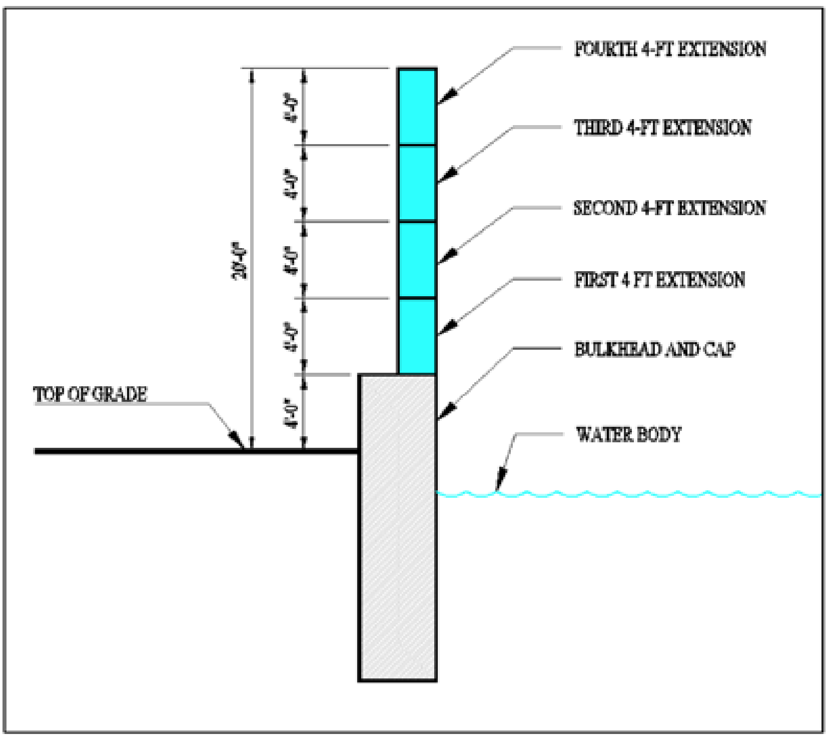
4 "A geological perspective on sea-level rise and its impacts along the U.S. mid-Atlantic coast" Kenneth G. Miller, Robert E. Kopp, Benjamin P. Horton, James V. Browning and Andrew C. Kemp, Earth's Future, Volume 1, Issue 1, December 2013

[3] Water elevations
© Rutgers

Table 2. Water Elevations Accordingly to Level of Threats, Along the Coastline of Hudson River Study Area

Level of Threat	Water Elevations (NAVD88)
10 - Year Storm	8.5 feet
50 - Year Storm	11.3 feet
100 – Year Storm	12.3 feet
100 – Year Storm + 2050 SLR	13.6 feet
100 – Year Storm + 2100 SLR	15.4 feet
2050 Sea Level Rise	1.3 feet
2100 Sea Level Rise	3.1 feet



[4] Sea wall section
© Rutgers

“Collaborative Climate Adaptation Planning for Urban Coastal Flooding” presents instead a design height of 14 ft [4,27m] above the NAVD88. Unfortunately, in the report is not specified or explained the reason of this choice. Although is possible to compare this value with the ones presented by Rutgers University and find an affinity with the 100 years flood + 2050 SLR. Probably the value proposed by the “Jersey City” design team refers to the same studies used by Rutgers University and both has used the same projection for the future, even if the final design height differs.

Furthermore, another document has been consulted in order to have one more references: “Jamaica Bay: Flood Risk Reduction System Conceptual Design” a master thesis by C.G. Siverd . Even if his project is located in Jamaica Bay, New York City, it still can be used as a reference because both our thesis uses as reference the same closest station: Battery, NY. In his final report, he also refers to USACE 1970 design and he also updates it to 2014, adding (0,4 ft, 0,121m) for the sea level rise since 1970 and the projected sea level rise for the next 100 years. Nevertheless, as value for the 2100 SLR he selected the Low projection ,instead of calculate the mean value. This choice leads to a final design height of 20,5 ft [6,24 m] above the MSL (18 ft + 0,4 ft + 2,07 ft = 20,5 ft).

CONCLUSION:

Figure 6 shows the different projected height compared to the Datums for Battery, NY. To decide the best estimate for the flood height has been decided to calculate a mean value among the different ones proposed by the documents taken into account. In this calculation, the height proposed by “Collaborative Climate Adaptation Planning for Urban Coastal Flooding” (14 ft, 4.27m above NAVD88) will not be included. Firstly, because is not explained the reason of that height in the report and secondly , because it is similar to the 100 years flood + 2050 SLR projection by Rutgers University. So, apparently, it is not included a 2100 SLR.
The final value tries to deal with the uncertanties of the future including official data regarding the sea level rise for the next 100 years. Figure 5 shows that even the Low projection from Climate Central and NPCC2 are slightly higher than the extension of the sea level rise gray line. Therefore, using a mean value between the high and the low prediction helps to ensure a certain grade of safety and, at the same time, it limits the costs.

So, the mean value is calculated among the there other ones:

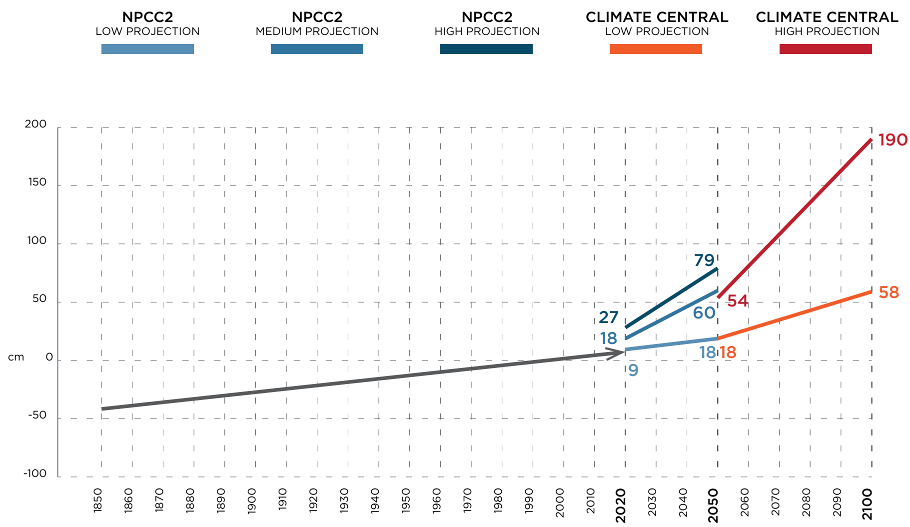
+15,4 ft [4,7m] above NAVD88
+22,4 ft [6,82m] above MSL
+20 ft [6,1m] above top of the grade

First of all, the values has to refer to the same datum, Mean sea level (MSL) has been chosen:

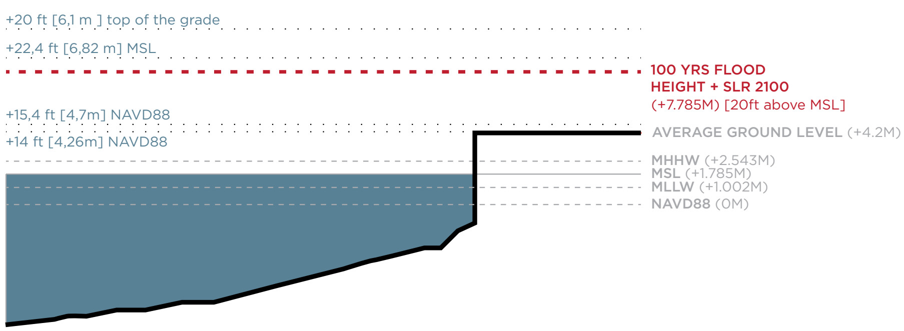
2,92 m above MSL
6,82 m above MSL
8,5 m above MSL

So:

2,92 + 6,82 + 8,5 / 3 = 6,08 m [19,94 m] approximately
20 ft [6,09 m] above the MSL.



[5] MSL past trend and projection at The Battery
© Mattia Tintori



[6] Datums and design height The Battery
© Mattia Tintori

RESILIENCY

What resiliency means within this thesis, is explained in the "Resiliency" chapter. Specifically, regarding the flood defense, resiliency refers to the capacity of the dike to withstand events beyond its design capacity. The main risk is when the flood height is catastrophically higher than the design height and the structure has to be able to resist and keep working after the hazard. Flood defense infrastructure has usually a longer life span than the one they are built for (in this case, 100 years). For this reason, the requirement is that the berm can survive an overloading with little damage or fail gradually in case the flood increases to permit the population to evacuate. The gradual failure is an important feature for what concern flood protection cause when a system face a catastrophic and fast failure, firstly the population has no time to evacuate and secondly it releases a huge amount of energy that can create a strong destructive wave. [figura overtopping]

An american example of catastrophic failure is what happened to New Orleans's dike before the landfall of Katrina in 2005. Four I-wall sections failed and a big amount of water passed through the levee and caused a bigger and stronger flood.

"*If no catastrophic breaching had occurred, the flooding and losses would have been significantly reduced, perhaps by half.*"[5]

Especially when a flood defense protects an important and densely populated city, it is required a resiliency check for an additional loading, besides the design load. For this thesis, the design storm will be 1/100 years and the resiliency check is set at 1/500 years.

Nevertheless, the values defined in this thesis are based on a simplified scheme. In fact, to determine "official values" more studies has to be held and more actions has to be taken into account as modifiers of the sea level rise. For instance, the action of the wind and the land subsidence during the life span of the flood protection have not been considered in the design height calculation due to lack of precise informations.

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5 L. Link, J. Jaeger, J. Stevenson, W. Stroupe, R. Mosher, D. Martin, J. Garster, D. Zilkoski, B. Ebersole, J. Wester- wink, et al., Performance evaluation of the new orleans and southeast louisiana hurricane protection system: Draft final report of the interagency performance evaluation task force (ipet), United States Army Corps of Engineers (USACE), vols 1e9 (2006).

[7] Wave overtopping examples
© flickr

ADAPTABILITY

It is probably one of the most crucial requirements of the project. Since there is no certainty about how the climate change will actually modify the climate patterns and components, the project is based on possible scenarios and not certified data. Therefore, the flood protection has to be adjustable at low to moderate cost to meet new requirements and in particular the sea level rise over its lifespan. Since the structure is not only a wall or a berm but an ensemble of various structures with different purposes, there are different methods to adapt it and to modify its height to face a harsher sea level rise.

Nevertheless, in this chapter, the word adaptability is not only referred to future scenarios, but also at the different situations that has to be faced in the project. In The paragraph about "Design Height" [pag. 131], the method and the references to decide the height of the flood protection has been explained. Although, it is important to keep in mind that the height value can vary depending on different factors:

SLOPE ANGLE: steep angles affect how the waves break and how the reflected ones interact with the incoming ones raising the wave height (see "Waves" pag. 121). On the other hand, gentle slopes can dissipate the water power. More gentle the slope is, lower can be the design height.

SLOPE ANGLE OF THE FORESHORE (tan α): the angle between the slope and the horizontal plane, which effect is combined with the wave steepness in a 'breaker parameter'.

SLOPE ROUGHNESS: Also the material used to build the slope affect how water and flood protection interact together. The roughness of certain materials helps to dissipate the wave energy, minimizing the water action.

INTERMEDIATE LEVELS: (see "Intermediate Levels, pag 180) The presence of a berm on the outer slope can directly affect the design height since it also dissipate the wave action. The effect is based on the width and the height of the berm.

DIRECTION OF THE WAVES: Waves perpendicular to the shoreline breaks with greater power than waves that come with different angles. This directly affects the sea level rise.

WAVE STEEPNESS: It is calculated dividing the wave height / wave length.

ALLOWABLE OVERTOPPING DISCHARGE (L/S/M): It is the allowable amount of water that can overtop the flood protection. It also influences the design height of a flood defence. The limit is determined by the effect on structural integrity and useability considerations. For instance:

Limits for overtopping for pedestrians

Trained staff, well shod and protected, expecting to get wet, overtopping flows at lower levels only, no falling jet, low danger of fall from walkway	1-10 q (l/s/m)	500 (l/m)
Aware pedestrian, clear view of the sea, not easily upset of frightened, able to tolerate getting wet, wider walkway	0.1 q (l/s/m)	20-50 (l/m)

'Wave Overtopping of Sea Defences and Related Structures: Assessment Manual', EuroTop Team, August 2007, www.overtopping-manual.com.

Limits for overtopping for vehicles

Driving at low speed, overtopping by pulsating flows at low flow depths, no falling jets, vehicles not immersed	10-50 q(l/s/m)	100- 1000 (l/m)
Driving at moderate or high speed, impulsive overtopping giving falling or high velocity jets	0.1- 0.05 q (l/s/m)	5-50 (l/m)

Limits for overtopping for property behind the defence

Significant damage or sinking of larger yachts	50 q(l/s/m)	5000 - 50000 (l/m)
Sinking small boats set 5-10 m from wall, damage to larger yachts	10 q (l/s/m)	1000- 10000 (l/m)
Building structure elements	1 q (l/s/m)	"
Damage to equipment set back 5-10m	0.4 q (l/s/m)	"

[8] New Orleans dike failure during katrina © CNN

BOUNDARY CONDITIONS

These are crucial conditions that the design must take into account to relate both to the natural features of the site and their changes over time. They include topographic and geotechnical conditions, datums for The Battery (NY) and return frequency of hurricanes.

HYDROGRAPHIC CONDITIONS

Nautical Charts of the Hudson river produced by Noaa have been used to define the height of the riverbed respect to MLLW. These data are important to draw a section of the Hudson and analyze how many cubic meters of soil are needed to make the landfill on which the dike will be developed.

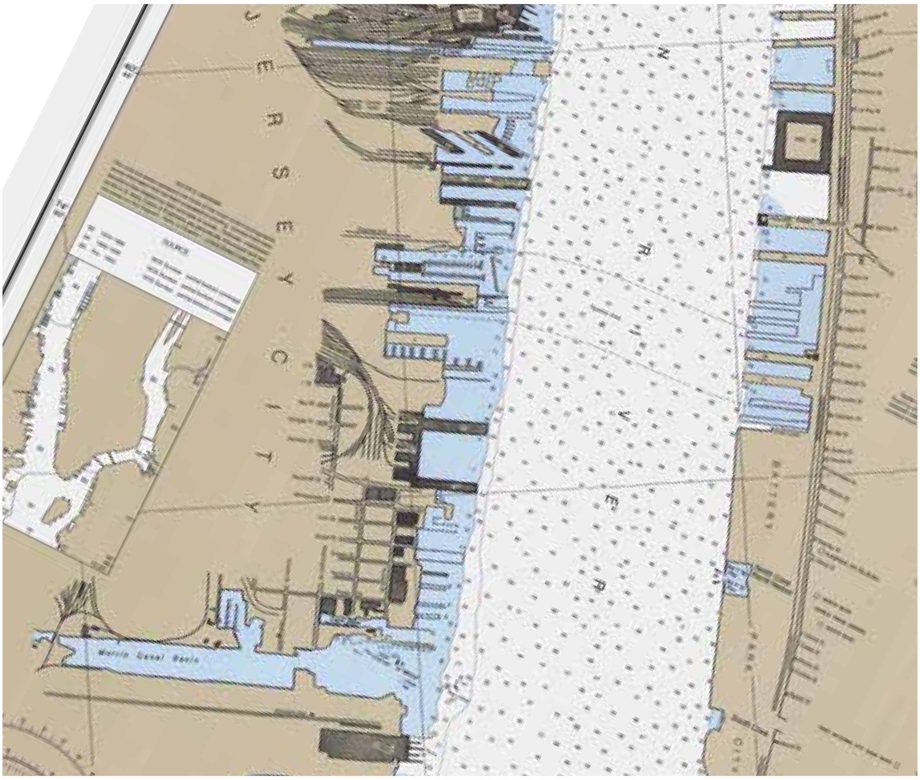
GEOTECHNICAL CONDITIONS

GIS data[1] has been collected to define the type of the bedrock soil. According to the geological map the new part of the waterfront presents two different types of stone: schist and gneiss (South green part) and serpentinite (North grey part). Both three are metamorphic rocks, which means they derived from a transformation, characterized by high temperatures and pressures (metamorphism), of existing rock types.
Schist, its name comes from the ancient Greek for "split". Schist is a rock formed by dynamic metamorphism at high temperatures and high pressures that aligns the grains of different minerals through a process called foliation.
Gneiss is similar to schist, the main difference is that in gneiss, less than 50 percent of the minerals that composed it, are aligned in thin, foliated layers while in schist the percentage is above 50.
Serpentinite is a type of metamorphic rock common beneath the oceanic crust, where it forms by the alteration of the mantle rock peridotite.

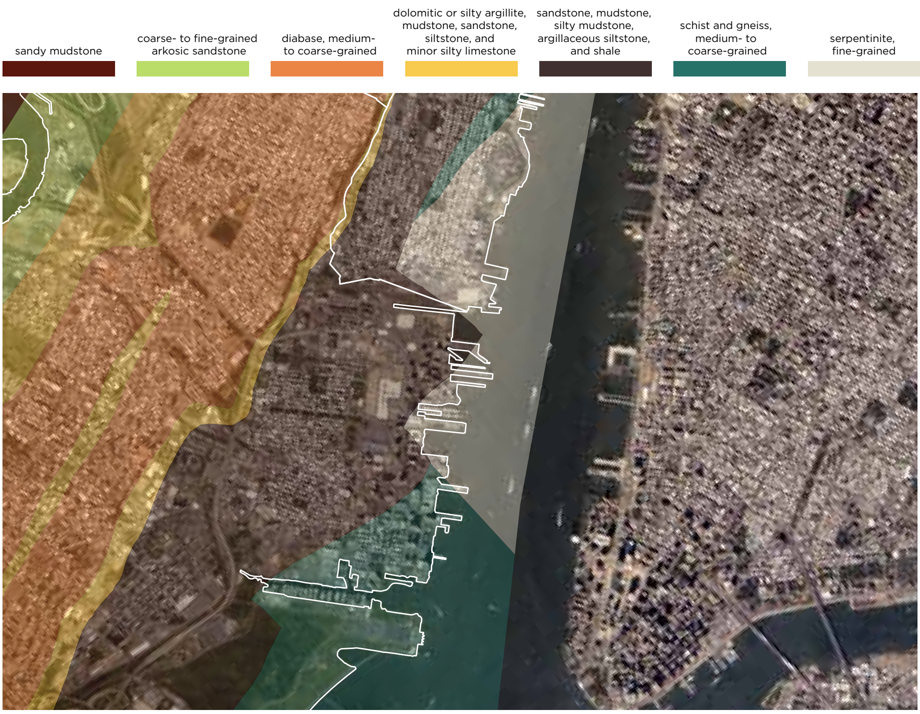
WAVE CONDITIONS

As explained in "WATER LEVELS" [pag. 120]. The action of the waves, and wind has to be taken into account to develop a more precise model to base the design on. Regarding this thesis, as discussed in "RESILIENCY" [pag. 136] these actions are not included in the calculation in order to create a simplified scheme to develop the design.

1 http://www.state.nj.us/dep/gis/lists.html



9 Nautical Map of the Hudson © NOAA



10 Bedrock © Mattia Tintori

DATUMS

As already explained in the "Coastal hazards" chapter, all the data about sea level rise and sea level in general are stated respect to a certain datum. All these values refers to a 0 line, defined NAVD88. This new datum substituted the NGVD29 accounting glacial rebounds, tectonic activities and ground-water withdrawals. NAVD88 is 0,3 meters above NGVD29 in New York area. The oceanographic station used is 8518750 The Battery, located in Battery Park, Lower Manhattan. The Battery has been chosen cause it is the nearest station to the project site and in fact, all the documents about New York and New Jersey refers to it.

The diagram shows the different tide lines referred to NAVD88:

- Mean Lower-Low Water [MLLW]: 1,002 m
- Mean Low Water [MLW]: 1,065 m
- Mean Sea Level [MSL]: 1,785 m
- Mean High Water [MHW]: 2,445 m
- Mean Higher-High Water [MHHW]: 2,543 m

RETURN FREQUENCY FOR HURRICANES

According to NPCC2[2]: *"It is unknown how the total number of tropical cyclones will change in the North Atlantic Basin. However, it is more likely than not that the number of the most intense hurricanes will increase in the North Atlantic, along with the extreme winds associated with these strong storms. As the ocean and atmosphere continue to warm, intense precipitation from hurricanes is more likely than not to increase as well. It is unknown how nor'easters in the New York City area may change in the future."*

Moreover, according to Jay et Al, 2014[3]: *"The return period for the storm surge caused by Hurricane Sandy is approximately once in 200 years and the storm tide is once in 300 years".*

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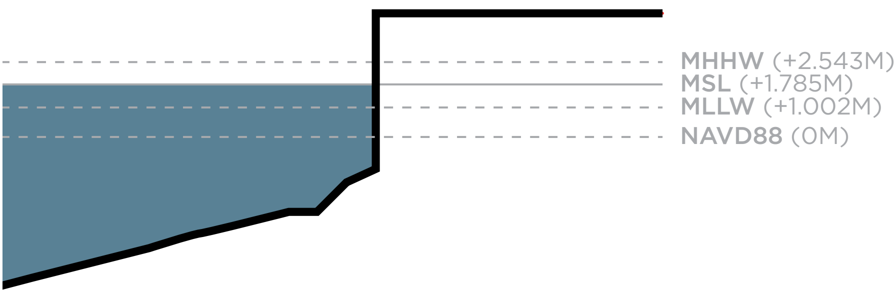
2 C. Rosenzweig and W. Solecki (Eds.), New York City Panel on Climate Change, 2013: Climate Risk Information, NPCC2, City of New York Special Initiative on Rebuilding and Resiliency, New York

3 D. Jay, S. Talke, and P. Orton, Hurricane sandy and increasing storm risk in new york harbor, 1844-2013 a perspective from noaa historical data, National Oceanic and Atmospheric Administration (NOAA) (2014).

" Localization of The Battery, NY © Mattia Tintori based on NOAA data



" DATUMS The Battery, NY © Mattia Tintori based on NOAA data


US

16

Type of Approach

16|

Type of Approach:

CURRENT APPROACH

As explained before in the site analysis, the current flood protection of Jersey City is based on the bulkhead line which is the results of the historical landfilling of the city. Bulkheads are a good land retaining and anti erosion solutions, but they are not working successfully against rising waters. In fact they can be easily overtopped by the surge exposing the city to flooding as happened during hurricane Sandy. Moreover, preliminary flood maps published by FEMA shows that this type of flood protection is not enough to protect the city. In fact the waterfront area not protected by the palisades lays for almost the half in the 100 years flood area.

Regarding the possible way to address a flood, I took into account Bosboom and Stive's "*Coastal Dynamics I: lecture notes*[1]". According to the documents there are three different approaches to address coastal erosion and flooding:

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1 J. Bosboom and M. J. Stive, Coastal Dynamics I: lecture notes CIE4305, VSSD, 2013

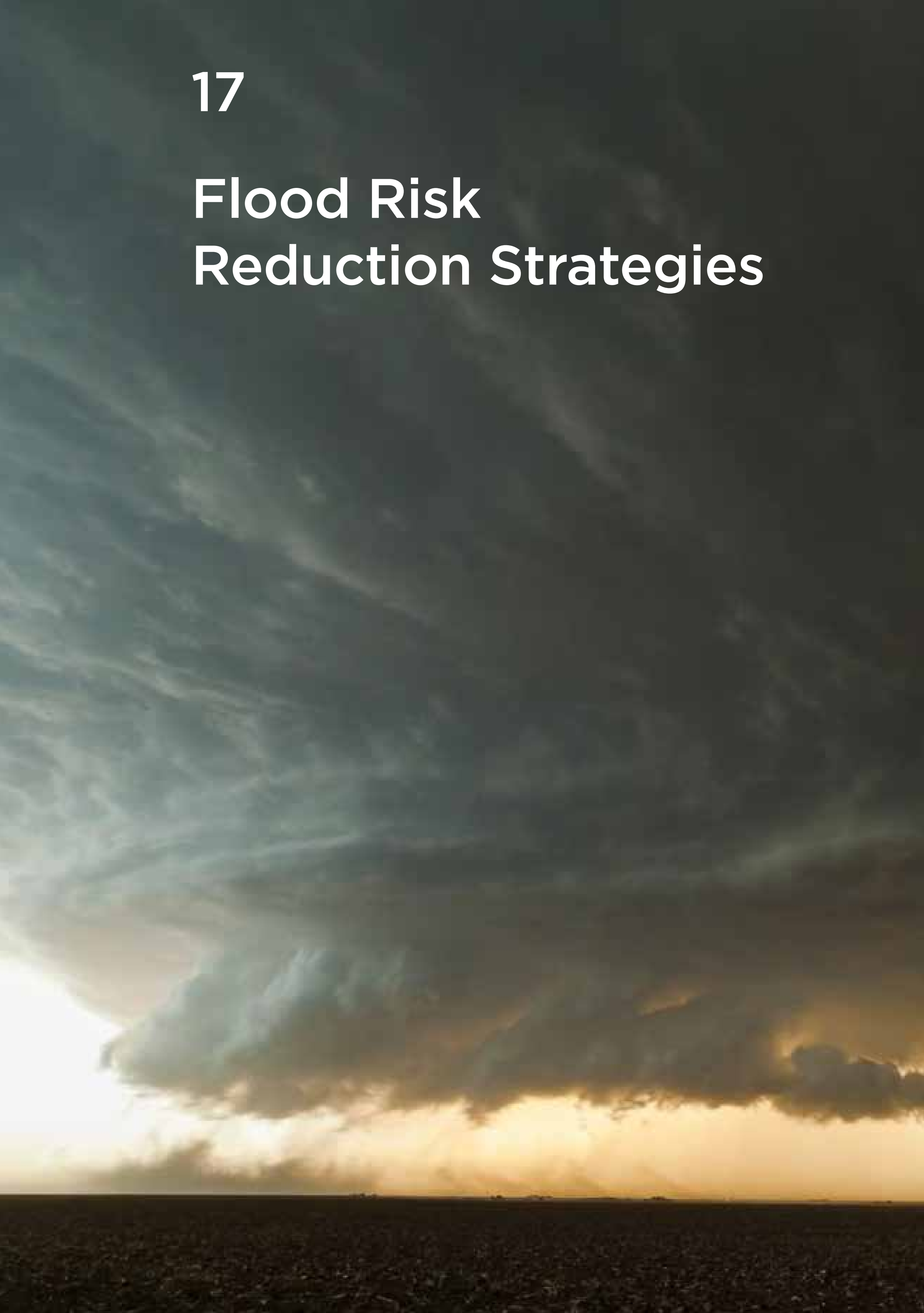
- RETREAT: evacuate permanently the entire area.
- ACCOMMODATE: adapting the infrastructure in order to prevent future flooding.
- PROTECT: designing and implementing interventions to decrease flood risk in a certain area without modifying the local infrastructure (Bosboom and Stive, 2013)

Regarding this project, the “protect” option has been chosen. Jersey City as explained in the analysis is a dense inhabited area and its current shape is the result of the evolution of the city during its history of landfilling. The relation between the city fabric and the water has been both the weak and the strong point and always will be. Looking at the city history, the proximity with the river has been the reason of the development and the growth of it. Its residents shaped it constructing land on the river to make space for their dreams. Retreat cannot be an option cause Jersey City is proud of its waterfront and is proud of its unique view on Manhattan. The City has great goals for the future and it will never leave its position. Accommodation cannot also be an option. All the bulkheads of the waterfront would be raised in order to prevent future flooding. If on one hand this solution would reduce the risk, on the hand hand it would dramatically downgrade the urban quality of the waterfront and it would block the view on the river, totally losing the relation with the water. An example of adaptation could be the project called “Adaptation Plan #1 and #2” presented in the problem statement.

Excluding the other two options, “Protect” is the only alternative. Since Jersey City has not enough money to pay for its flood protection, the idea is to join public and private sector to achieve that goal. If the city has no fund to protect itself, someone else has to. The concept is simple: the waterfront area is possessed by nine different owners and they have the right to build till the pier headline, which is an imaginary line, set by the law, in the Hudson River. The line indicates the boundary till the city can expands into the river. Following the history of landfilling, the city would extend one more time into the water creating new land on which the owner can build on. Part of the money produced by the new real estate would be the way to pay for the protection of the city. Moreover, the protection will not be pursued by hard engineering solutions, to the contrary sod infrastructure and multi purpose flood protection will be used to both make the city resilient and enhance its public realm.

17

Flood Risk Reduction Strategies



17|

Flood Risk Reduction Strategies

Comparison between NL and USA

The emergency management is ensemble of the coordinated actions, resources used and responsibilities taken to face a hazard following a comprehensive and systematic schedule before, during and after the disaster happen in order to minimize the damage and to protect the community.

It will be compared the American Emergency Management and the Dutch one. The Dutch has been selected because the Netherlands, historically, is the country par excellence regarding the flooding protection. Dutch has always been fighting against the sea and its tides and the entire nation has been conquered from it. Netherlands is always updating its flooding protection system and it is probably the only nation prepared for the climate change and the consequent sea level rise.

American Emergency Management is divided in four key phases:

- Mitigation: efforts to minimize disaster risk exposure and impact before it happen

- Preparedness: efforts to be prepared to face a certain type of threat

- Response: actions taken in order to respond a disaster that is already happened and provide relief

- Recovery: actions taken to restore the community to pre-disaster conditions.

Mitigation is one of the most important step in the energy management and often get the least attention. The first phase of mitigation is about the assessment of the risk. In this phase future projections and different scenarios have to be taken into account to be aware of the vulnerabilities and the weak points of the community. This first step demands a big effort to the government, which has to fund study and researches about the future climatic situation and then translate the informations acquired into laws and projects to reduce the risk exposure.
Preparedness is coordination during a disaster reaction. It is about continuously planning, testing, organizing, training, evaluating the plan to follow to face a disaster.
Response focuses on the immediate actions to save lives and protect properties during the disaster. It is about resolving problems and dangerous situation in a short-time through incident monitoring, urban search and rescue and logistics.
Recovery is phase into short, medium and long term and it include the development, coordination and execution of the actions to restore or rebuild the damaged buildings and to assist the affected people. It also includes the regulatory and policy measures that help the recovery phase and mitigate the effects of future disasters.

Dutch Emergency Management is divided in three different layer:

- Prevention: refers to improving flood defenses to decrease the probability of flooding (Kolen and Kok, 2013[1]).
- Land Use Planning: refers to investments in infrastructure and emergency resources (Kolen and Kok, 2013).
- Emergency management: refers to coordinated efforts by government authorities before and after a flood (Kolen and Kok, 2013).

To estimate the flood risk the Netherlands uses the equation:

Flood risk=
probability of flooding x consequences of a flood

The probability is due to natural factors and preventive measures taken by the community, while the consequences depend by the social and economic feature of the flood prone area. Once established the flood risk, a costs / benefits method is used to find the perfect balance and the optimal level of investment to reduce it to the acceptable level determined by the law.

COMPARISON

the comparison between the two different strategies underline different common points, even if the American Emergency Management is divide in four phases while the Dutch in only three. Both of them has a common first phase where all the efforts are used to reduce the probability and the entity of the flooding. Dutch "Land use planning" phase can be also seen as a mitigation action cause it refers to all the investments done to improve infrastructures and emergency resources. Dutch "Emergency Management" instead incorporates "Preparedness", "Response" and "Recovery" cause it focuses to coordinate all the efforts before and after the flood. Even the two methods seems different at first sight, they are completely superimposable. Nevertheless, the real difference lays in the

1 B. Kolen and M. Kok, An economical optimal investment strategy in a multi-layer flood risk approach, 2013

fact that Netherlands put and still putting a lot of efforts concerning the prevention and the land use planning in order to be safe and prepared to face the future changes maintaining a low level of risk within the entire nation. USA instead is not prepared to face what projected future scenarios and its Emergency management method is still based on a Fast Recovery. In fact USA use the National Flood Insurance Program (NFIP), administered by Federal Emergency Management Agency (FEMA) to reduce loss of life and damaged caused by flooding, to help flood recovery and promote and equitable distribution of costs. Unlike the other type of strategies to face flood risk, insurance provide a means for recovering financial damage after an event transferring the risk from an individual to a larger risk-sharing pool.[2]

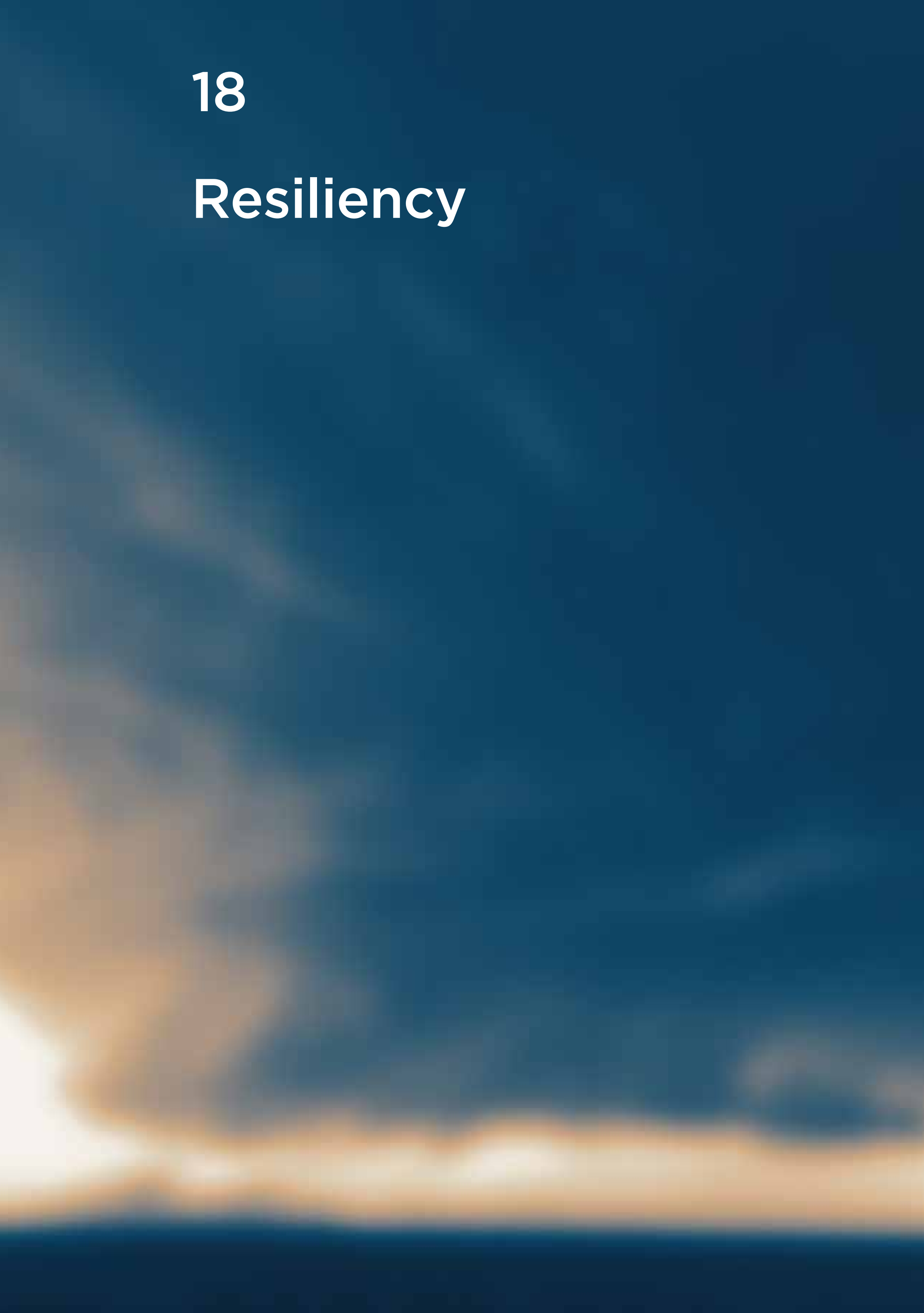
For what concern this thesis and the consequent project, the focus will be about the Mitigation / Prevention / Land Use Planning phase. The main goal is to find a way to integrate flood protection systems and architecture using a multidisciplinary approach to create something that works (engineering point of view) and at the same time could became a center of attraction for the community (architectural and social point of view).

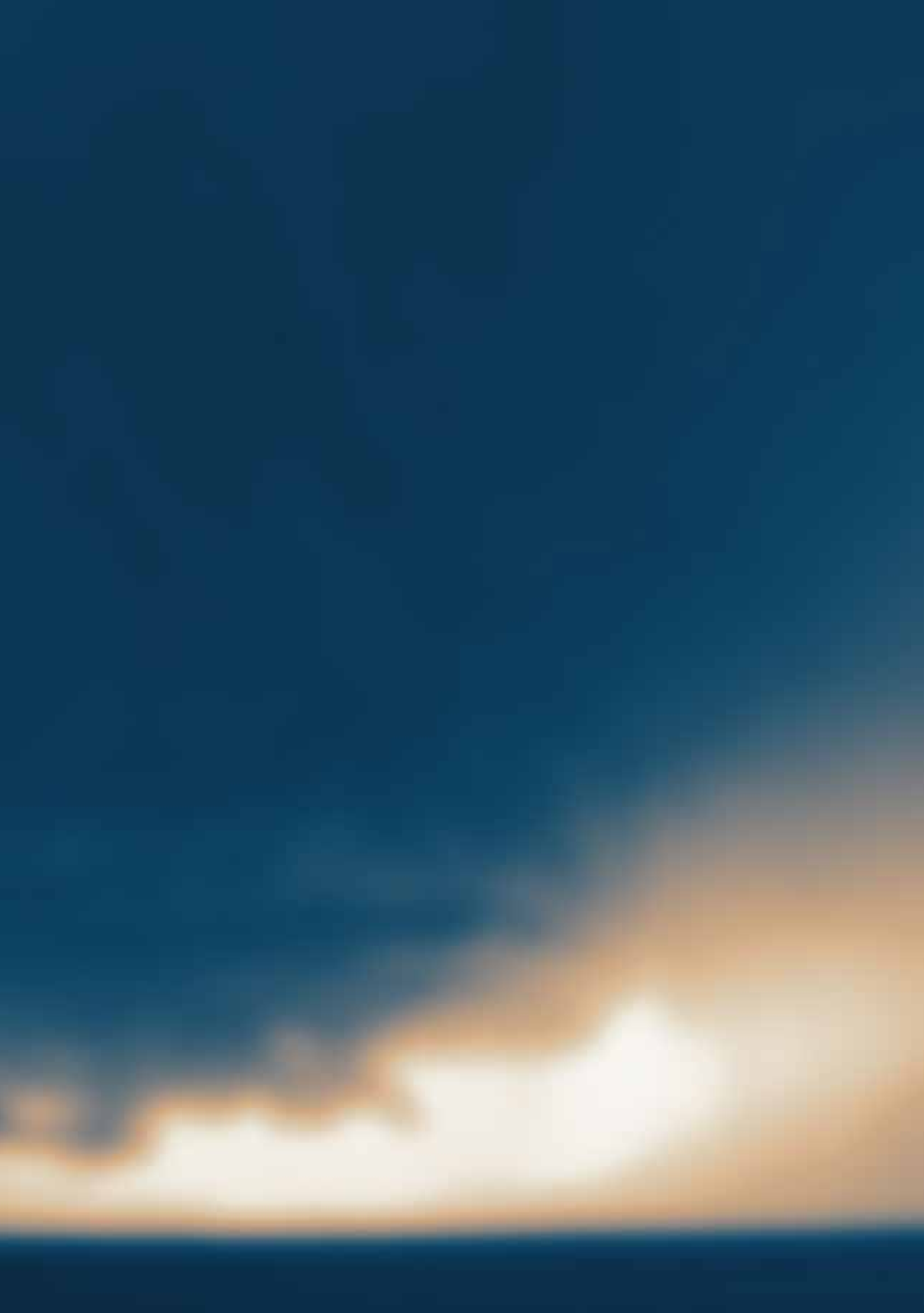
As said above, this thesis is mainly focused on the design of the flood protection and it doesn't take into account the "Emergency Management" part. To transfer this project into reality, this part has to planned as well.

2 NYC Department of City Planning, Urban Waterfront Adaptive Strategies, June 2013

18

Resiliency





18|

Resiliency

is the new black

Resilient is the new "green". In the last decade, the word green and its partner "sustainable" have been the mantra for what concerning architecture, urban planning and design marketing and publicity. These words were everywhere, they were used to describe every project and each and every product. They have been used so much and often in a wrong way that, in the end, they have lost their inner meaning. Even if the green fashion period is still alive, in the last few years a new word became the new mantra of the architectural discourse an it is: "Resilient". Suddenly we have started to speak about resilient cities, resilient plans, resilient buildings, everything became resilient and ready to face the future. For that reason I would like to specify what I mean whit "Resilient" in this thesis and with the project.

Resilience is commonly defined as the capacity to recover quickly from difficulties, toughness (Oxford Dictionary)[1]. In re-

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1 http://www.oxforddictionaries.com/definition/english/resilience?q=resiliency#resilience__7

lation to coastal hazards, resilience is the ability of a building, an area, a neighborhood, a community, a city to minimize the damage and recover as quick as possible from a coastal storm. Resilience is also the ability to understand the future and to adapt over time to changing climate risks. The meaning of resilience includes also the recognition that any risk can be totally avoid and because of that, any system or community has to develop a flexible protection plan that could work even if one of the components fail. Regarding urban planning, resilience is not only about provide coastal protection to withstand the climate events, but it also refers to the social side. The city has to maintain its livability, vibrancy, mood in the short and long term. The protection has to be one of the goal, but not the only one. Economic prosperity, job opportunity, sustainability, quality of the public realm and affordability for the residents are also important both in ordinary circumstances as week as when climate hazards occur.

19

Flood protection strategy and spatial quality

19|

Flood protection strategy and spatial quality

The following chapter is intended to motivate the decision to avoid hard engineering solutions and move towards multi purpose infrastructures in order to prevent flooding and, at the same time enhance the spatial quality of the area.

When someone is asked to think about flood protection, his mind usually relates to images of majestic engineering works, huge dikes and strong concrete walls. People tend to think about monumental construction often ignoring that also the waterfront boardwalk that they use everyday is a flood protection as well. When I started to write this thesis, I had the same point of view of the people I was writing about just above. My idea of flood protection was strongly related with a concept of prominence, division, a boundary that protects lives and building and at the same time, cuts off two areas denying their relation. Soon, I discovered that the best flood protection is the one that you are not able to see or distinguish from the surrounding environment. Until recently, regarding water management, the emphasis in the evaluation of the different strategies was on safety, risk mitigation, economic while less attention was usually on spatial quality and attractiveness. Nevertheless, spatial quality is a difficult and it is a subjective concept that is not easy to be quantified. According to Nillesen 2013[1], there are several methods to evaluate it: one is the Habiforummatrix[2],

1 Anne Loes Nillesen, Water-safety strategies and local-space spatial quality, Municipal Engineer, Volume 166 Issue ME1, March 2013, p.16-23

2 Hooimeijer P, Kroon H and Luttik J, Kwaliteit in Meervoud: Conceptualisering en

another is based on the involvement of quality team[3], while another one is a hybrid between the two others and it is called The Ruimtelijke Kwaliteits Toets (RKT, Spatial Quality Assessment Framework). In the latter, the assessment is done by an expert team, using a set of established criteria based on utility, attractiveness and robustness.

The important aspect of Nillesen's research is the integration, in the design process of flood defense, of new and important requirements, such as attractiveness and utility. As explained in the project goal, nowadays, flood management cannot be longer only mere protection, but it has to assimilate and incorporate other function in order to carry out multiple purposes. As stated by Peter Van Veelen[4]:

"In areas where dikes and the urbanized landscape almost merged, traditional dike reinforcement results in an undesirable claim on space, high expenses and an extended planning and realization process".

Operationalisering van Ruimtelijke Kwaliteit voor Meervoudig Ruimtegebruik (Operationalisation of Spatial Quality for Multiple Land Use). Habiforum, Raad voor Ruimtelijk, milieu en natuuronderzoek, Innovatienetwerk Groene ruimte Agrocluster (Council for Planning, Environment and Nature Research, Innovation Network Green Space and Agricultural Systems), Gouda, The Netherlands (in Dutch), 2001

3 Sijmons D, Werken met Kwaliteitsteams. Kwaliteitsteam, Ruimte voor de Rivier (Quality assurance team, Room for the River), Utrecht, The Netherlands (in Dutch), 2008

4 Veelen, P.C. van, Boer, F., Hoijink R., Schelfhout, H.A. en Haselen C.. Veilige en goed ingepaste waterkering in Rotterdam, Rotterdam-RCP. KvK026/2010

The integration between different functions can happen in various ways and the following list of degree of spatial union categorization is based upon a classification by Ellen[5] and adapted by Van Veelen[6]:

- Shared Use: Flood defense is temporarily used by another function without any modification of the basic structure

- Spatial Optimization: The shape of the flood defense is modified to create space for other structures which are not part of its structure.

- Structural Integration: An object is built on, in or under the flood defense structure, but it does not directly retain water. [super-dike]

- Functional Integration: The water retaining element of the flood defense also functions as a part of the structure with another function. (diagrammi, vddi chapter Flowscapes final Multifunctional Flood Defences final.pdf pay 7)

In conclusion, the integration between different functions regarding flood defense presents various pros: the union permits to save space in areas that are usually high-valuable for they relation with the water and the natural landscape. It permits to transform the protection in something more becoming an attraction point and enhancing the space livability. In some cases, it enhances the protection itself cause the creation of joined structure enlarges the dimension of the dike that become over dimensioned (unbreachable dike). Obviously, the integration with two or more structures with different uses has also cons: the replacement of the adjustment of some elements can be more difficult, but right and intelligent choices during the design process can avoid or minimize this issue. Another problem is the fact that the flood protection and the object could have different owners resulting in complications regarding maintenance, costs and legal issue. The division between mere protection and other function has to defined at the very beginning and the different owned has to find an agreement about finances and responsibilities in order to avoid problems in the future

5 Ellen, G.J., et. al., Multifunctioneel landgebruik als adaptatiestrategie - Puzzelen met ondernemers en beleidsmakers. Kennis voor Klimaat report number: KvK/036/2011

6 Veelen, P.C. van, Multifunctional water defenses, linking spatial development with water safety, proceedings congress Water and the City, Delft, 14-15 June 2012, to be published.

Therefore, in this thesis, three main concept will be addressed to achieve the best integration:

MULTI-FUNCTIONALITY

How can I integrate architecture and site-based flood protection systems to create a new multi-purpose waterfront that will protect Jersey City and will enhance its public realm?

Interplay between ecology, flood protection and amenity. It is a matter of demonstrating the possibilities of a new synergy between what often appears to be incompatible demands.[7]

INTERDISCIPLINARITY

The future of flood protection design, as stated in the introduction, presents a challenge that cannot be tackle by one discipline alone. It will be a mutual conditionality between urban planning, ecology, hydraulic engineer and architecture. The different point of views and expertise has to find a common ground where they can exchange ideas to enrich the entire design process and achieve a better results.

EVOLUTIONARY DESIGN

The understanding of nature and its natural cycle as starting point for a good design process. Analysis of daily and monthly tides to learn the behavior of this natural element and develop a design that respond to the various water conditions over time.

7 Martin Prominski et Al. River Space Design, Birkhaeuser, Berlin 2012.

20

Flood Defense Placement

20|

Flood Defense Placement:
"The Circle"

The placement of the dike is intended to create a Natural-Artificial circle around the city. Natural because the west part of the protection is given by the Palisades and artificial cause the rest is man-made. The idea of the circle, as a fortification around the low part of Jersey City, is developed to make the area protected even if the surroundings cities doesn't take any measure against this type of hazard. Since now, no agreements have been stipulated between Jersey City and Hoboken regarding integrated flood protection. If any decision will be taken in the future, the in land part of the dike can probably be avoided due to the connections between the two cities waterfront's protections.

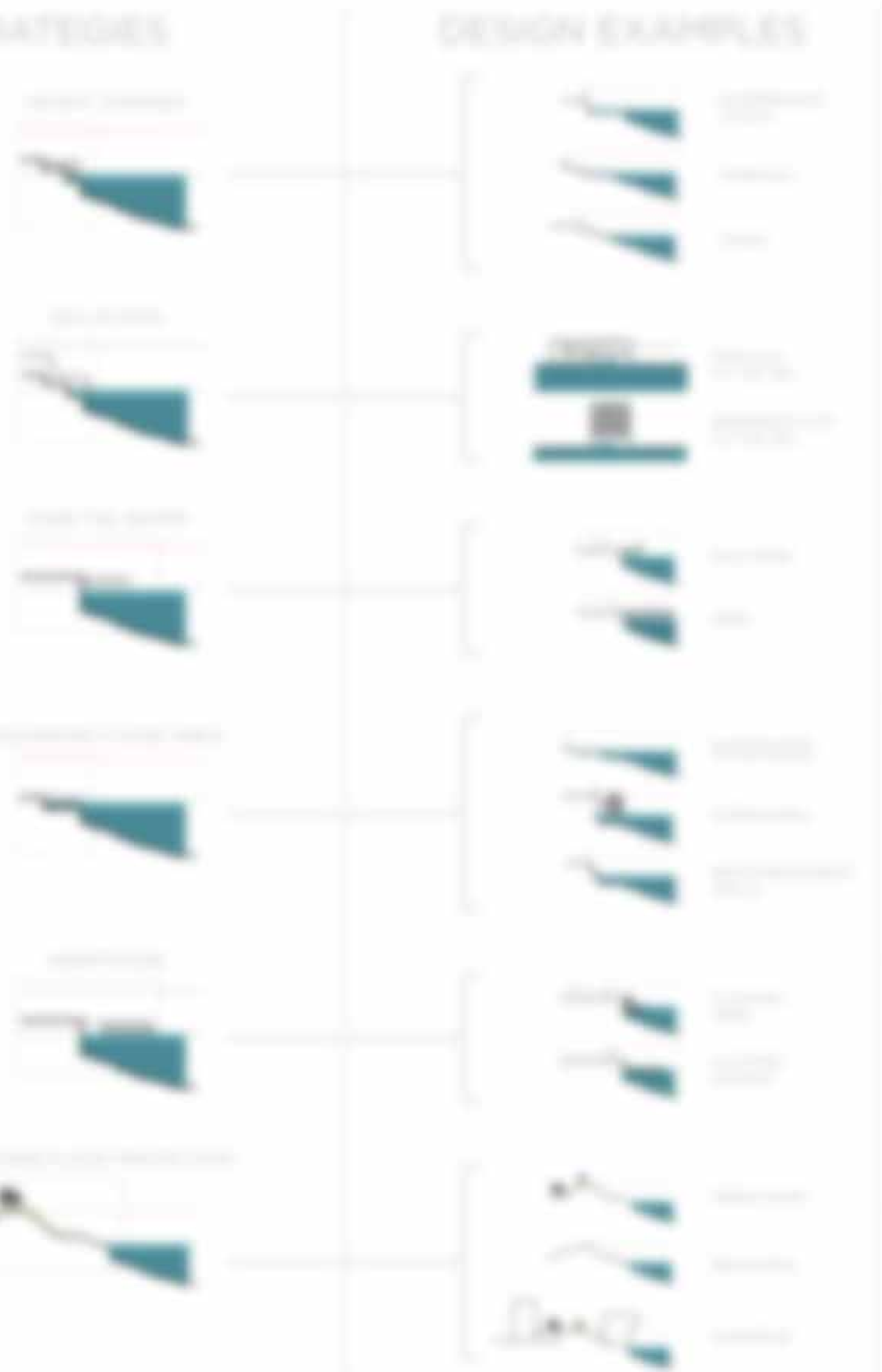
PLACEMENT

On the water's edge the profile will follow the Pier headline and then will continue both north and south on the land to reach the Palisades. As shown in the diagram, the levee line originates from the cliff near Monmouth St, then it follows the railroads and it connects to Light Rail embankment. This embankment is breached in 3 point where Jersey Av., Grove St. and Marin Av. pass through, so three flood gates are required to ensure the protection in this part. Going east the embankment keep provides the flood defense till "Target" building where it decrease in height. In this point there will be a transition from the embankment to the dike and the latter will continue reaching the levee profile on the Pier headline. It goes southwards keep following the line in the river till Morris Canal Basin. In this point, a sea gate is required to maintain the access to the marina, at the same time provide the required protection in case of flood. The seagate will be positioned in the narrowest point between the two shores to minimize the cost. Reached the opposite shore the dike will continue along the marina till I-78.


HOBOKEN

21

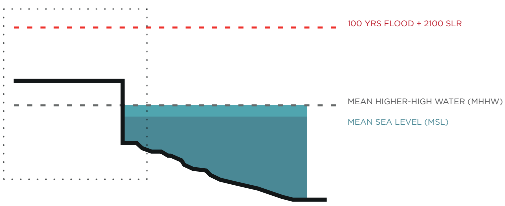
Design Catalogue


DESIGN EXAMPLES

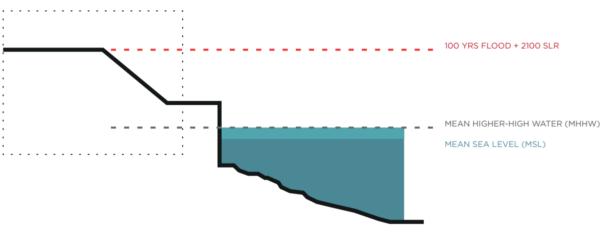
MAIN CATEGORIES

DESIGN S

TOPOGRAPHICAL MODIFICATION AND PROMENADES



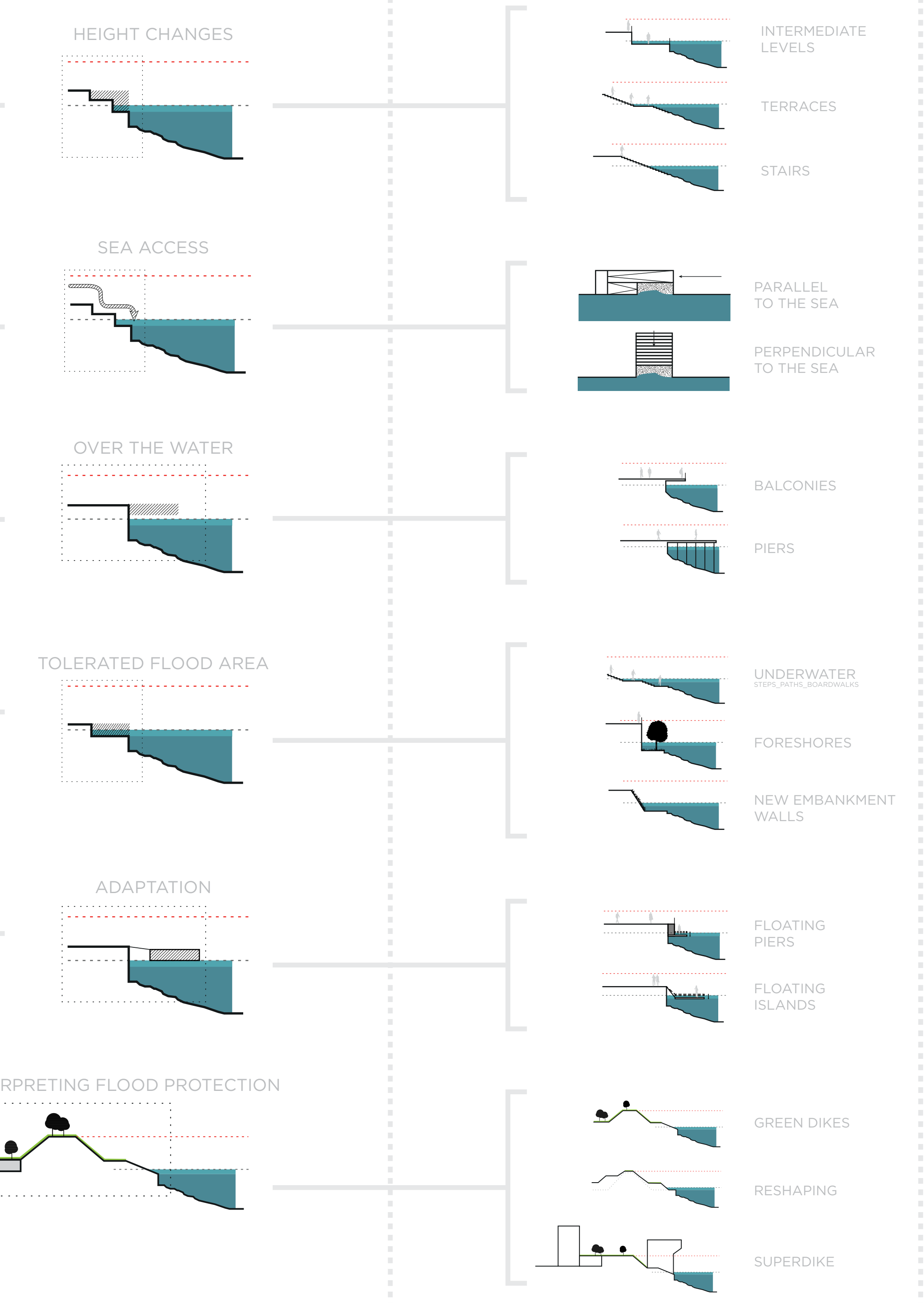
DIKE AND BERMS



INTE

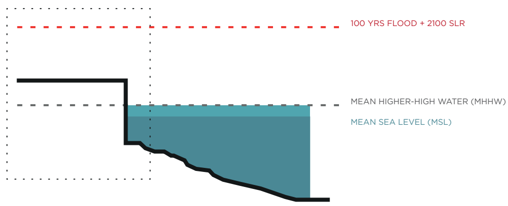
TRATEGIES

DESIGN EXAMPLES

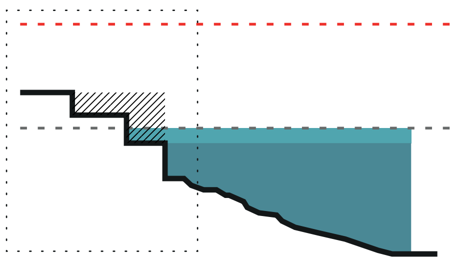


21|

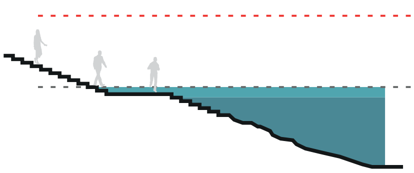
Design Catalogue:
Main Categories
Design Strategies
Design Examples



MAIN CATEGORIES
Topographical modification and Promenades



DESIGN STRATEGIES
Height Changes



DESIGN EXAMPLES
Terraces

The following design catalogue is a collection of possible designs and concepts that could be taken and use in the master plan and in future projects. The concepts are firstly divided in different "Main categories" and then in different design strategies. For each "Design Strategy" a range of different "Design examples" will be provided.

MAIN CATEGORIES

The catalogue is the result of a background research about realized and non realized project all around the world. For each and every project, the concept behind the design has been extrapolated in form of a diagram to make it more understandable and abstract (not referred to any particular site or situation). The aim was to build a comprehensible catalogue that can be used as reference regarding what are the possible ways to deal with flood protection. The catalogue is divided in two main categories:

- Topographical modification and Promenades
- Dikes and Berms

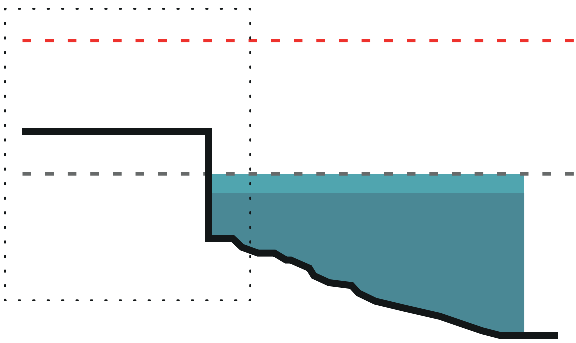
In the graphic presentation are indicated three main datums for what concerns water level: the Mean Sea Level (MSL), the Mean Higher-High Water (MHHW) and the 100 yrs Flood Height (including splash allowance).

DESIGN STRATEGIES

The design strategies explains how to respond with a particular design to water changes. They illustrate an approach or an attitude towards flooding: face it, allow it in defined areas, block it or many others. Each design strategy provides a list of different "Design examples" that follow the same approach.

DESIGN EXAMPLES

Each example is an abstraction resulted by the analysis of reference projects and displayed as a simple diagram to explain the concept and the decision taken by the designer. The catalogue does not mean to be a comprehensive guide of a totality of possible designs, but more like a list of examples that could be integrated in the master plan. Moreover, the idea to abstract every decision to single diagram helps to merge different examples together to achieve multi functionality.



This kind of interventions are focused on the waterfront area and transform it in way to create a soft and articulated edge between constructed land and water. Terraces, slopes, steps, stairs are the design elements used to create a tectonic environment that can descent gradually or more suddenly to the sea. The character of this multi layered approach is defined by the designer, but the particularity is that it is possible to create more tolerant solutions that allow flood water to reach some levels of the slope or more drastic solutions that are designed to remain dry even in case of flood. This variety of choices permits to create interesting relationship with the water and different kind of spaces based on their water permeability. Height differences can also host different programs, recreational and quiet places far from the noise of the city and with a strong connection with the water allowing different degrees of multi functionality and space use.

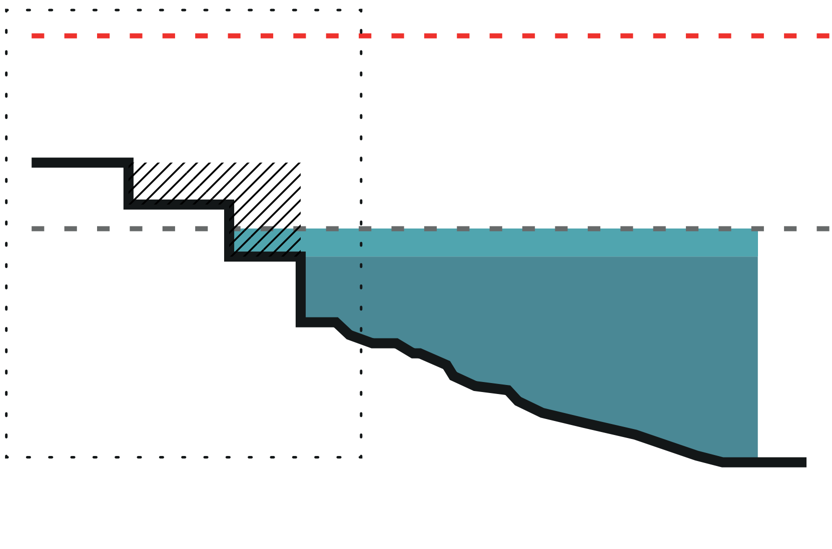
MAIN CATEGORY_1

TOPOGRAPHICAL MODIFICATION AND PROMENADES

DESIGN STRATEGY_1.1

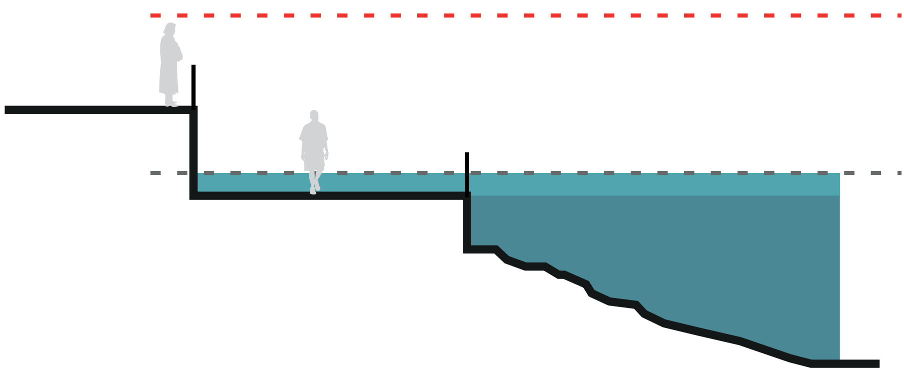
HEIGHT CHANGES

This type of design strategy is focused on the various ways to deal with altitude changes. Basically the concept is to reach the design height required for the flood protection though terraces, big steps and topographical modification of the waterfront. The flood limit shifts landwards and create a “tolerated flood area” beyond granting a direct access to the waterbody perfect for activities like canoeing or swimming. Usually the design is originated by a combination of concrete parts (waterproof) and green parts. It is important to prevent the erosion of the green parts that are exposed to the water action in way to prevent a possible failure of the system. Moreover the vegetation exposed in the “tolerated flood area” has to be selected to be resistant to saltwater and has to be differentiated, cause the height of the terraces determines the level and the frequency of the expected flood. The tectonic design of this strategy is perfect against flooding cause its shape acts like revetments resulting in wave attenuation.



DESIGN EXAMPLE_1.1.1

INTERMEDIATE LEVELS



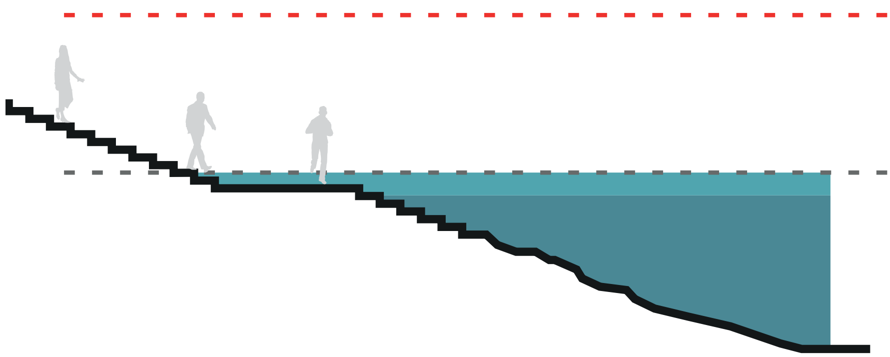
A wider intermediate level can host different programs and it is also usable for temporary activities. The width of the horizontal part defines its character, it can be a boardwalk, a place for cafe and bars, a space for playground or sport activities.

[1] Mulini beach by Studio 3LHD © Joao Morgado

[2] Proyecto de Recuperación Ambiental y Puesta en Valor del Entorno de la Fortaleza y Playa Fluvial de Goián © Pablo Gallego Picard

DESIGN EXAMPLE_1.1.2

TERRACES



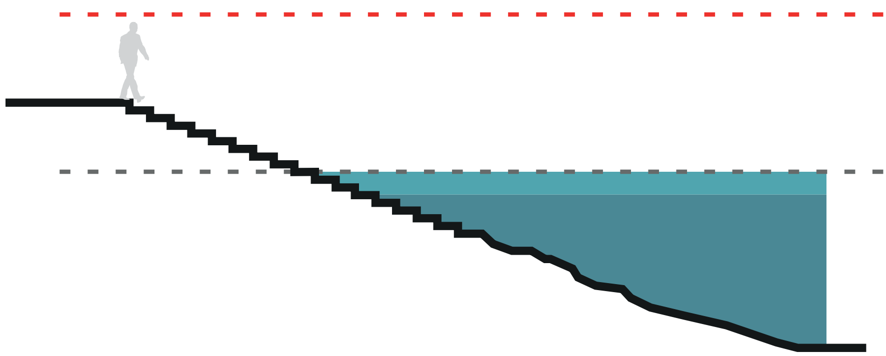
Here the transition is more gradual and create a shaded boundary between constructed land and water and permits a good access to it. The degree of transition is directly connected with the design of the terrace resulting in a steep or gentle descent to the water's edge.

[3] Rhone River Banks by In Situ Architectes Paysagistes © IN STU

[4] Ballast Point Park by McGregor+Coxall Landscape Architecture © McGregor+Coxall

DESIGN EXAMPLE_1.1.3

STAIRS



It could be seen as the steepest example of terrace. It is perfect when it is required to reach the flood protection height in a narrow space and at the same time maintain a direct access to the water. The width of the steps play an important role regarding the possible use and activities that will take place

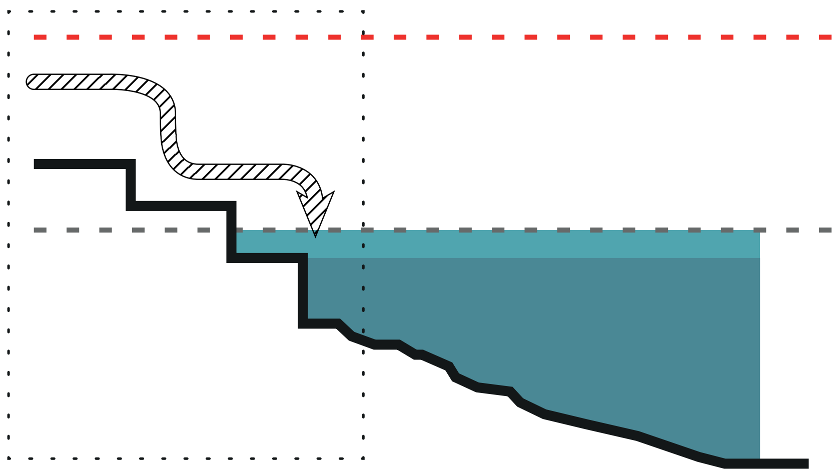
5 Maaskade Cuijk by Buro Lubbers © Buro Lubbers

6 Rhone River Banks by In Situ Architectes Paysagistes © IN STU

DESIGN STRATEGY_1.2

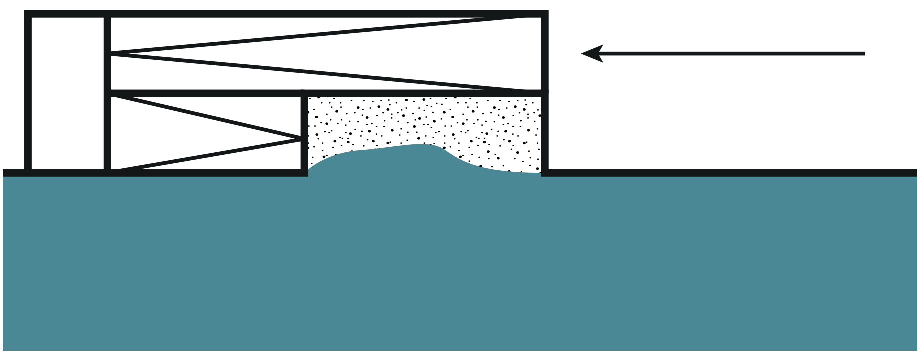
SEA ACCESS

Here the continuos vertical protection is breached in just one point to provide access to the waterbody. In this point the access is provided by ramp, terraces or stairs ending in the sea. The enter point is in direct contact with the waterbody and therefore is prone to expected flooding that may vary according to the height of the vertical elements composing the descent towards the water's edge. The quiet area created by the access point can be used for different purposes and may become a small habitat due to the relative calmness of the water.



DESIGN EXAMPLE_1.2.1

ACCESS PARALLEL TO THE SEA



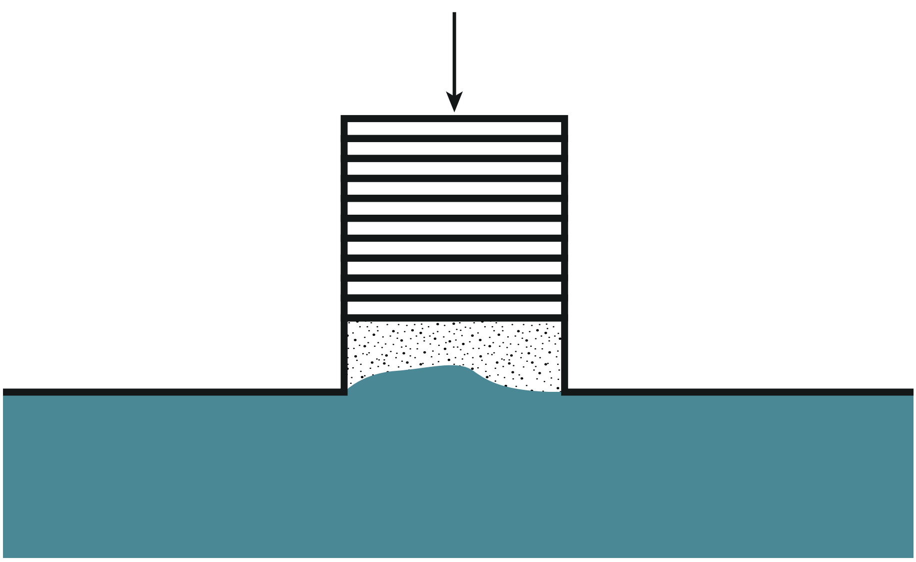
This strategy is usually used in case the height to overcome is too high and the resulting ramp positioned perpendicular to the access would be too steep. Therefore a parallel access provide the space needed to design a ramp long enough and with acceptable slope.

[7] Maaskade Cuijk by Buro Lubbers © Buro Lubbers

[8] Banks of Saône by BASE Landscape Architecture © BASE

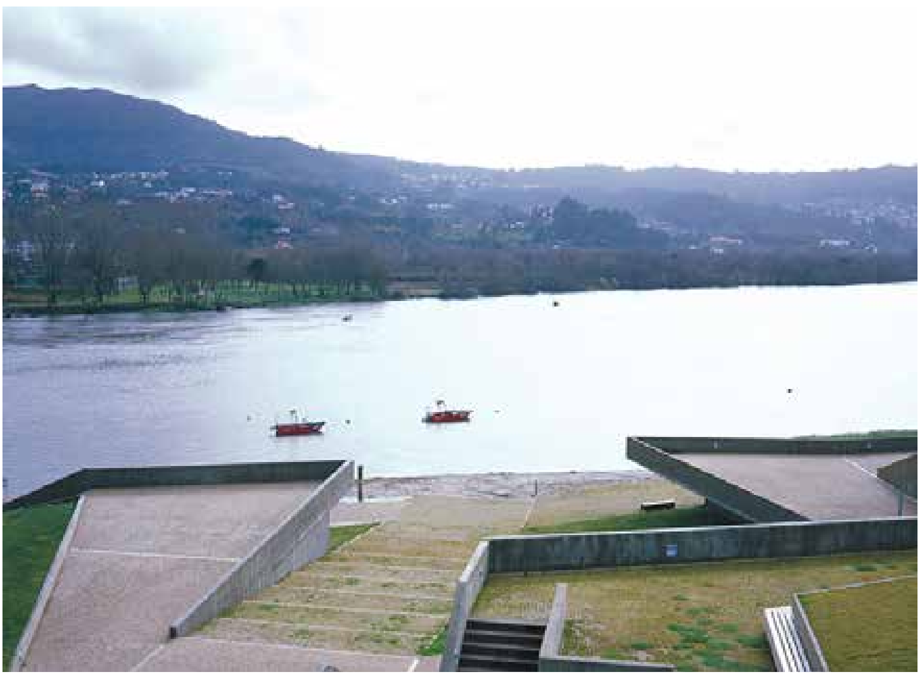
DESIGN EXAMPLE_1.2.2

ACCESS PERPENDICULAR TO THE SEA



Where there is more space usable for the access, this strategy can take place. Its character depends on the slope inclination and the length that define how the visitors approach the water's edge.

9 Wenying Lake by AECOM © AECOM

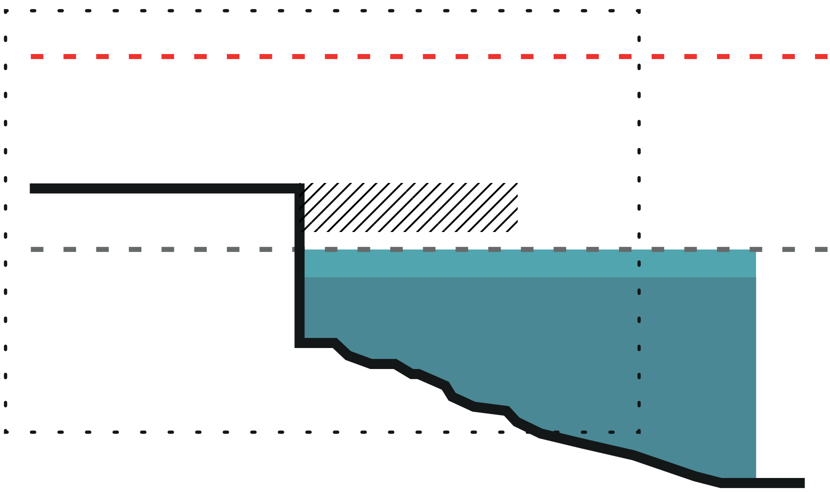


10 Proyecto de Recuperación Ambiental y Puesta en Valor del Entorno de la Fortaleza y Playa Fluvial de Goián © Pablo Gallego Picard

DESIGN STRATEGY_1.3

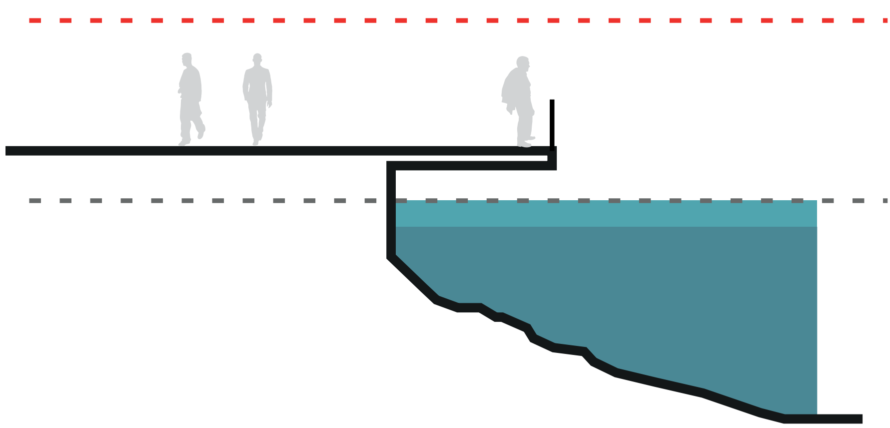
OVER THE WATER

This strategy's aim is to create a new relationship with the water and its cycle. Overhanging spaces, balconies and piers extend the promenades over the waterbody trying to create a more intimate connection with it. As for the "Height Changes" strategies the designer can decide how to integrate this structures with the natural environment and choose for flood-toleration or not. Moreover, their position requires certain precaution during the design phase, in fact they have to withstand great forces originated by the waves and the wind. Therefore, their profile and their overhang has to be planned in order to fulfill these requirements



DESIGN EXAMPLE_1.3.1

BALCONIES



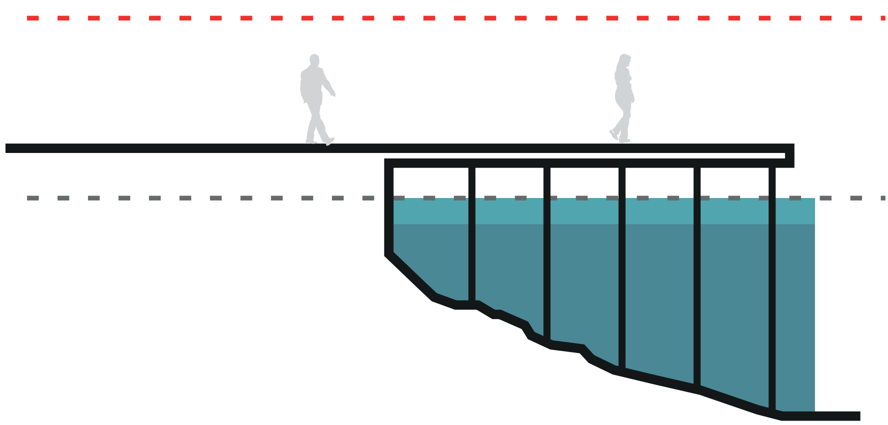
Balconies jut out into the river as fingers of a man made hand that try to catch the water in its palm. Hanging over the water-body, they provide new point of views on it and on the surrounding environment. An important part of their character is given by the design of the railing that create the boundary between the walkable part and the water itself.

[11] Prince Arthurs Landing / Thunder Bay Waterfront by Brook McIlroy
© rook McIlroy

[12] Wenying Lake by AECOM
© AECOM

DESIGN EXAMPLE_1.3.2

PIERS



Similar to the balconies, they differ from the other cause they are not hanging over the water, but they are fixed on the ground with piles or pillars.

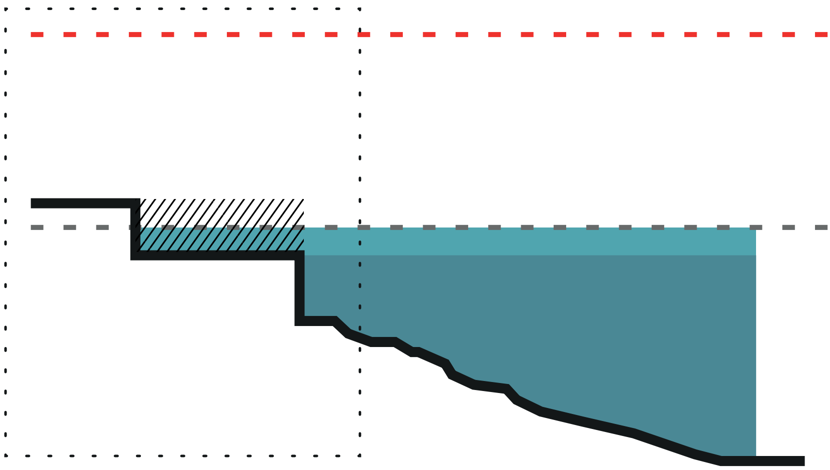
[13] Kalvebod Waves by Klar e Jds/Julien De Smedt Architects © Klar e Jds/ Julien De Smedt Architects

[14] Sjövikstorget by Thorbjörn Andersson with Sweco architects © Thorbjörn Andersson

DESIGN STRATEGY _1.4

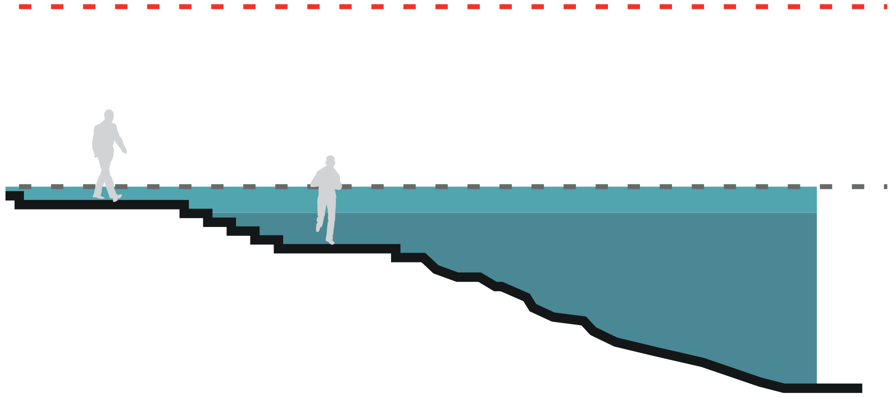
TOLERATED FLOOD AREA

This strategy focuses on a deep study of sea tides in order to create a project that can actively interact with daily and monthly sea level changes. The relation with water is the key concept behind this approach, opening up spaces even though they can be regularly flooded. Public furniture, planting and landscape interventions has to be flood resistant and the vegetation has to be choose in order to live in presence of saltwater. In this way the landscape changes accordingly to the natural water cycle offering the users different situations and set up and, at the same time, raising a certain awareness regarding tide movements.



DESIGN EXAMPLE_1.4.1

UNDERWATER STEPS / PATHS / BOARDWALKS



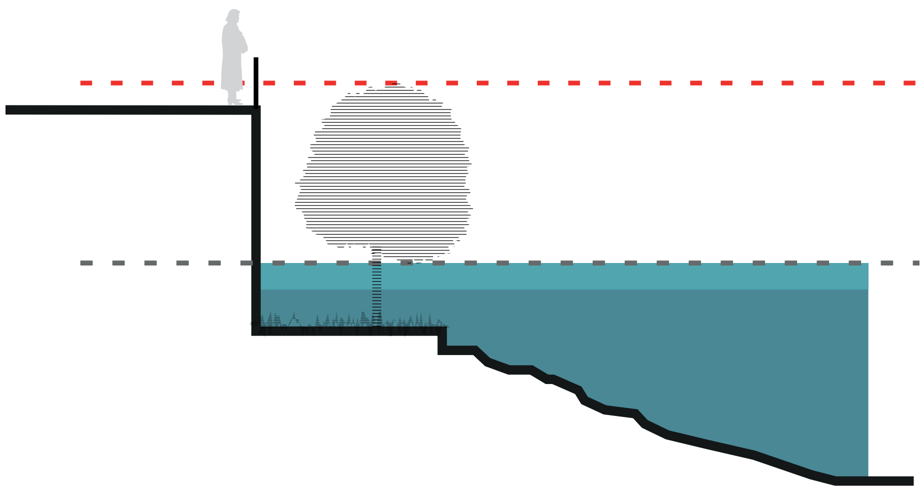
A terrace or a series of platforms whose lower steps are below the MSL and in contact with water. This permits to have different levels of interaction with the waterbody, accordingly to the tide height. The submergible spaces can host different functions and can be shaped with urban furnitures and plants.

15 Jack Evans Boat Harbour / ASPECT Studios © ASPECT Studios

16 Sea Organs by Nikola Bašić © Nikola Bašić

DESIGN EXAMPLE_1.4.2

FORESHORES



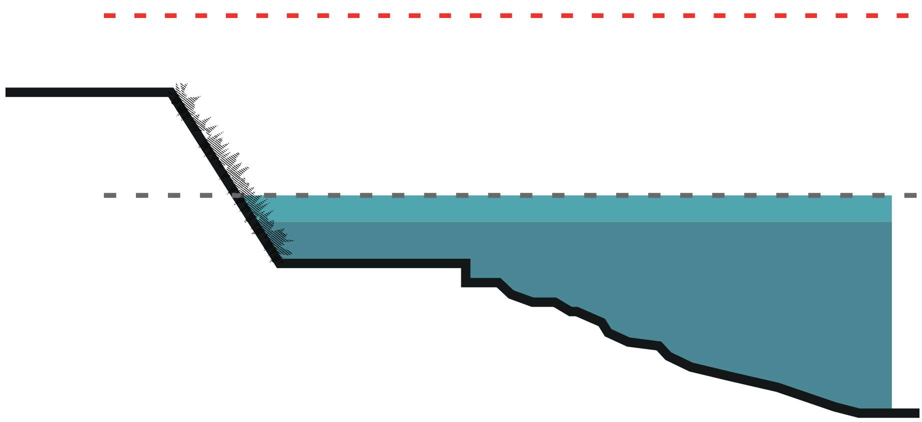
Zones along the water's edge created by depositing soil which is then planted. This creates a green colonized corridor along the boardwalk that can host different species and became a little ecological habitat.

[17] Saone riverfront
© BASE

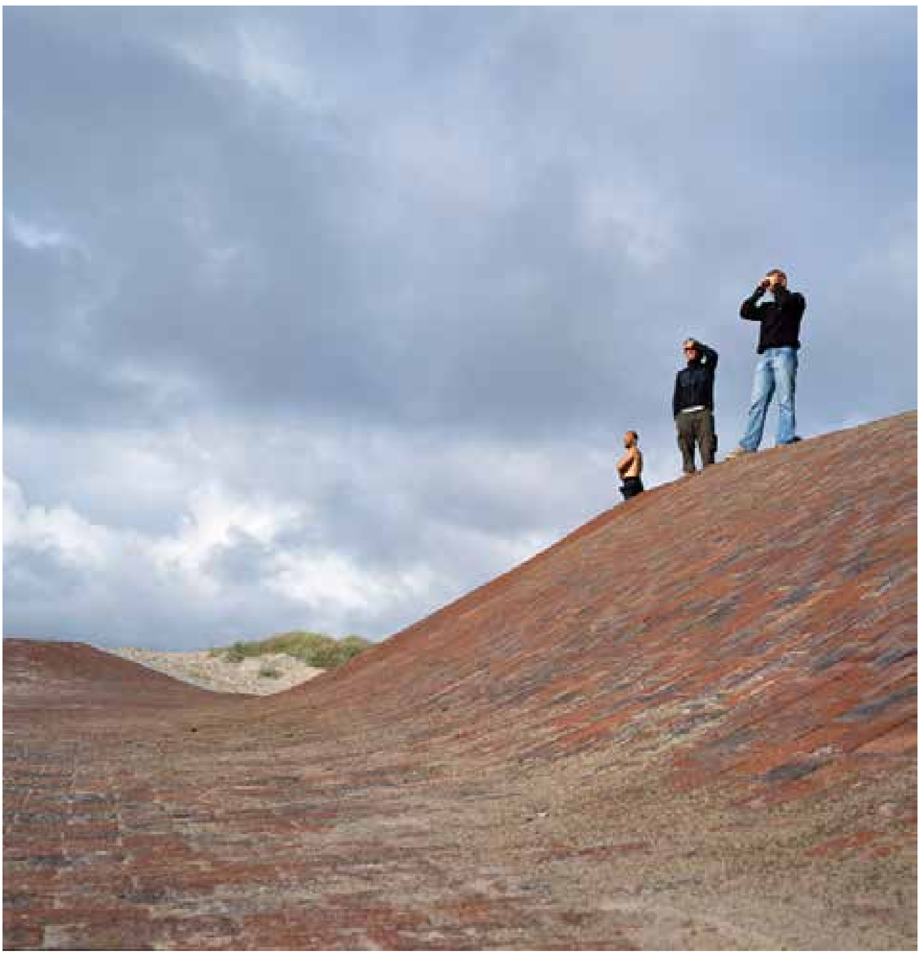
[18] Saone riverfront
© BASE

DESIGN EXAMPLE_1.4.3

NEW EMBANKMENT WALLS



When and embankment wall is reshaped or built again, it is important to choose the right material both for aesthetic and protection qualities and the right plantings. In this way, the combination between natural and artificial material can create ecological niches that can develop little habitats for different species.

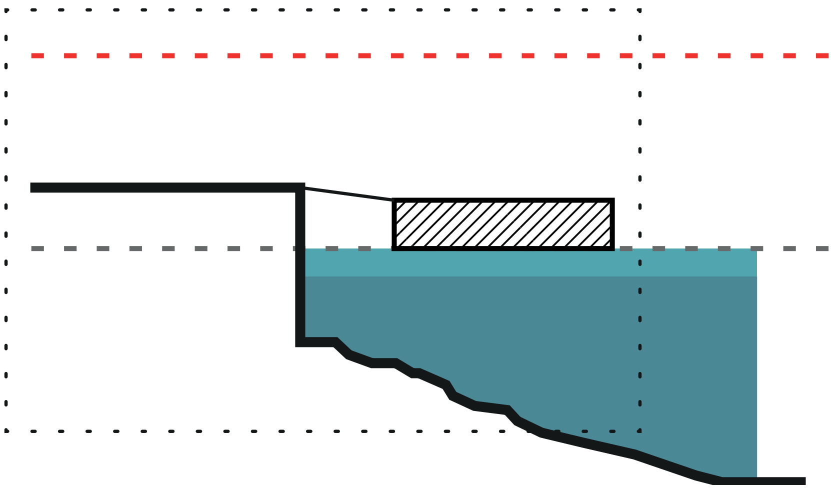


[19] Vestled by Schonherr, Carsten Juel-Christiansen and Marianne Hesselbjerg © Christina Capetillo

DESIGN STRATEGY_1.5

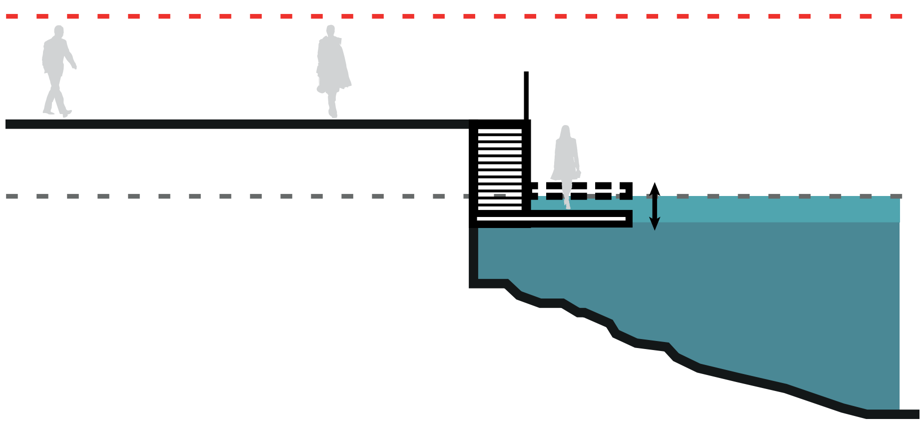
ADAPTATION

This strategy employs water floating elements that visibly rise and fall accordingly to the tides and the water's movements. Historically, the principle was used for piers, but in recent times has been used for different purposes as bathing decks, and floating islands becoming a permanent feature for many European Cities. As for the "Tolerate flood areas" this system, dependent on water movements, accentuates the people's perception about water cycle and tides. Since the elements are floating and their level is continuously changing they have to be connected to the bank by a flexible construction to allow the access.



DESIGN EXAMPLE_1.5.1

FLOATING PIERS



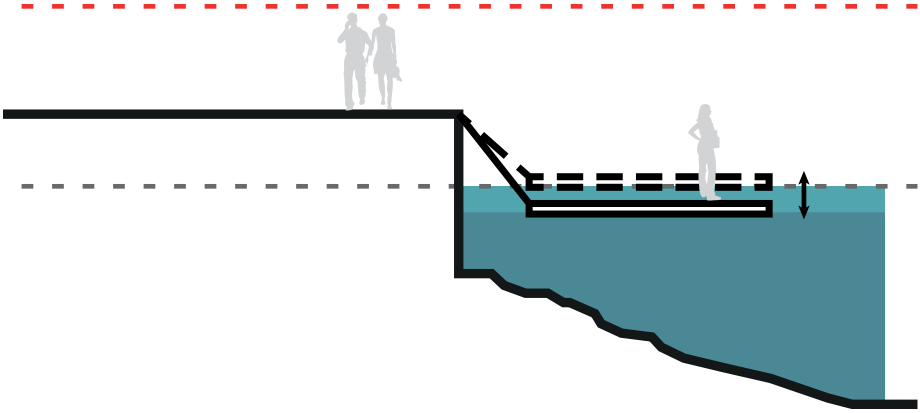
Traditionally used in the marinas for boats, the concept is adapted to be used especially for people. It creates open space on the water and it permits different level of interaction with water.

[20] The Ravelijn Bridge by RO&AD © RO&AD

[21] Hornsbergs Strandpark / Nyréns Arkitektkontor © Nyréns Arkitektkontor

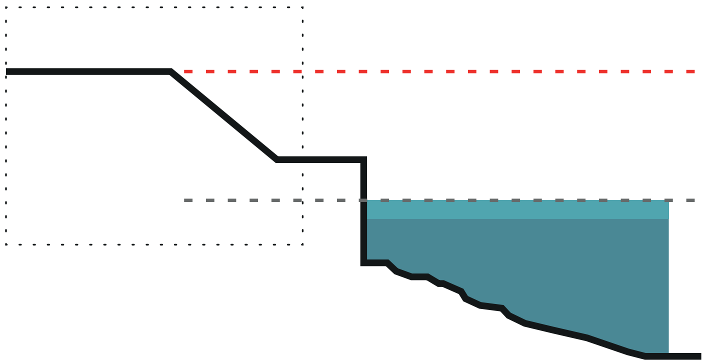
DESIGN EXAMPLE_1.5.2

FLOATING ISLANDS



Basically the same concept of the floating piers, enlarged. It directly responds to all the water's changes giving the experience really close to a boat's movement.

[22] MELBOURNE CBD WAVE POOL by Arup © Arup



Historically, dikes and flood walls are the oldest and simplest structures used to protect against flooding. Dikes are usually used outside the city where more space is available to host them, while they are substituted by vertical walls in the cities. The principal con of this kind of infrastructure is that they are basically not permeable and they tend to create a strong division between water's edge and the protected community. To avoid that it is possible to open passages trough them, but those has to be closed in case of rising water to ensure the flood protection. They can be placed both along the water or more landwards, creating a flood prone area in between. Due to their height, dikes are usually dominant presences in the landscape. For the majority of their life span they stand in the flood area, without fulfilling any other function besides flood protection. In recent years, as explained in the chapter "Flood protection strategy and spatial quality", in the design phase of these infrastructure has been included the concept of multi functionality. In fact, their dimension and their height can be used for different purpose besides the mere protection. Dikes can host building on, below or into themselves, they can be also used to create view points or topographical modifications in urban parks. There are endless possibilities to take advantage of their features to transform them into usable amenities for the community. Regarding flood protection, dikes has the important task to defend entire cities against the destructive force of water. Therefore, for their project dimension, future projections in terms of climate change has to be taken into account. Since there is no reliable predictions about what is gonna happen and when, a margin of adaptability is highly recommended in the design to allow future required modifications. For what concerns ecology, dividing a waterbody from its flood plain means intervening drastically in tide dynamics which result in losing an ecologically valuable space. However, since the majority of this structures are intended to protect urbanized areas, their presence can be employed to create green areas characterized by interesting topographical modifications that can create valuable habitat for different species and recreational areas for the residents.

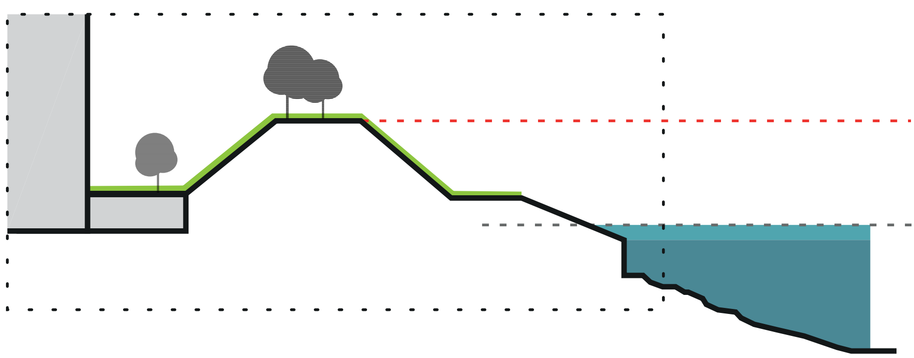
MAIN CATEGORY_2

DIKES

DESIGN STRATEGY_2.1

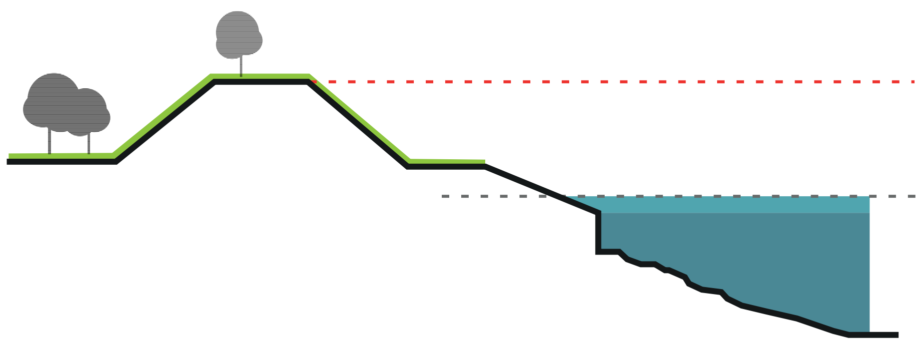
INTERPRETING FLOOD PROTECTION

Dike traditional trapezoidal form has been unaltered for centuries. It has been perfected though, to adapt to harsher flood and storm, but the study of new forms and possibilities is the next step to create new spatial arrangements within the landscape. Broadening its section can enhance its stability and protection and, at the same time, provide space that can be dedicated to other purposes. Modifying its slopes can change the relation with the water or even create new areas suitable for recreational activities or dike parks.



DESIGN EXAMPLE_2.1.1

GREEN DIKES



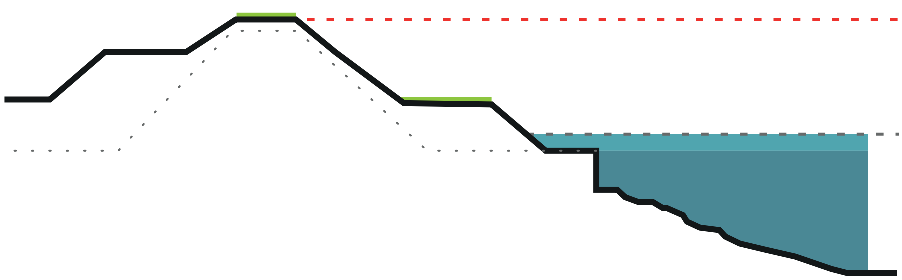
Adding green spaces or even parks to a dike creates an interesting amenity close to the water enhancing the quality of the space its possible uses. The slope and the height difference of the dike can be smartly managed to create a soft and natural landscape where flood protection and nature meet.

[24] Riverside Lünen by WBP Landscape Architects © Claudia Dreyße

[25] RheinPark Duisburg © unknown

DESIGN EXAMPLE_2.1.2

RESHAPING DIKE SECTION



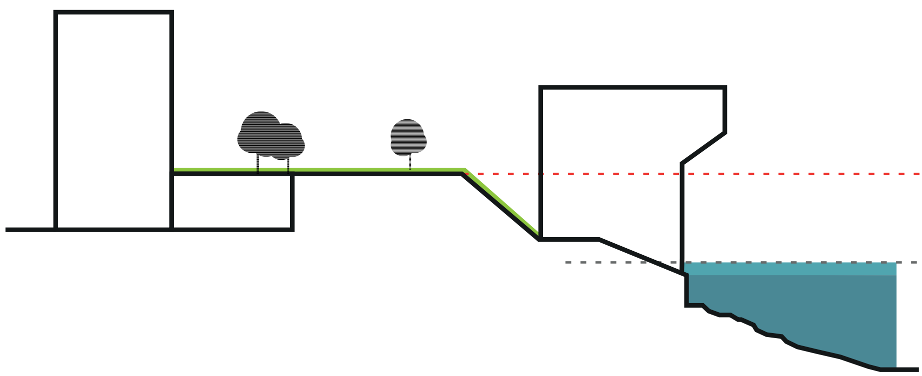
As explained in the previous design examples, dike profile is essentially determine by safety and stability consideration. Although, this profile can be modified to create different situations. Slopes can be arranged with terraces and steps, paths can shape the profit of the dike that can become more soft and natural enhancing the spatial quality of the infrastructure and transform it into a community's attraction.

[26] Sea Front-Veules-les-Roses, Atelier Ruelle © Atelier Ruelle

[27] Proyecto de Recuperación Ambiental y Puesta en Valor del Entorno de la Fortaleza y Playa Fluvial de Goián © Pablo Gallego Picard

DESIGN EXAMPLE_2.1.3

SUPERDIKES



The ultimate example of multi functionality is given by superdikes. The original profile is broadened or lift to accommodate other function, such as buildings inside the dike, on it or attached to it. Parking spaces can be host inside the levee, apartments can be on it enjoying a beautiful view on the water. In this case, the flood protection becomes bigger and wider than the requested dimension resulting in an enhanced safety (unbreachable dike).

28,29 Four Harbour Roof Park by Buro Sant en Co © Buro Sant en Co

22

Design Outcomes

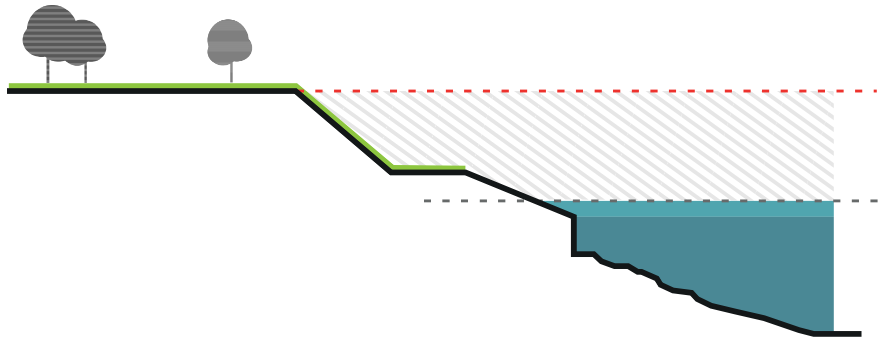
22|

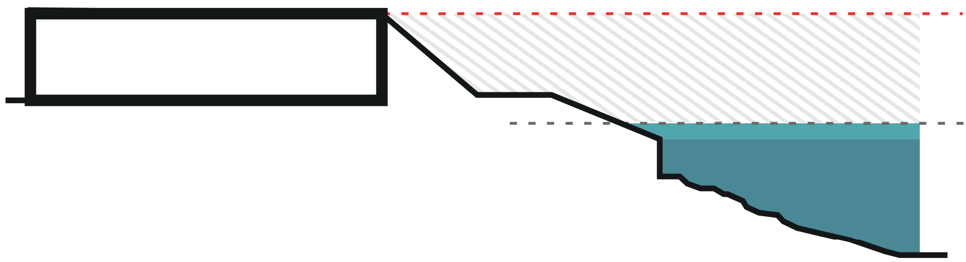
Design Outcomes

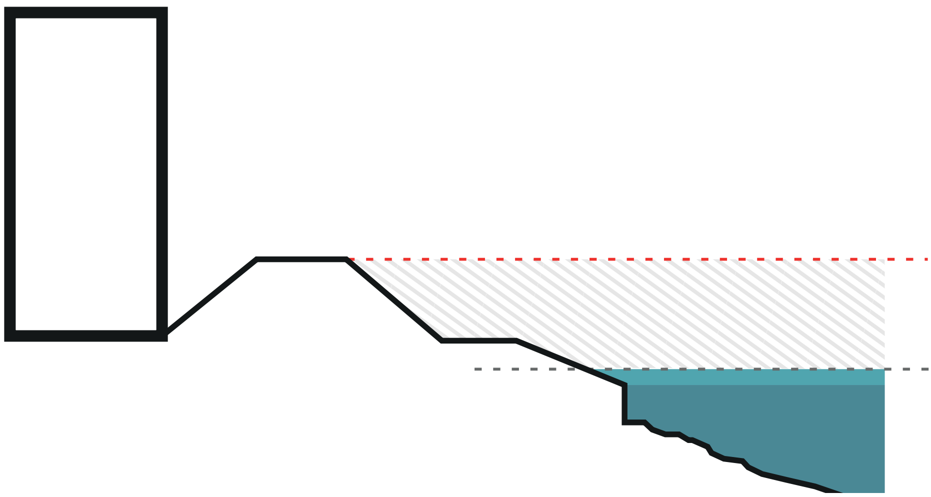
The following section is intended to define constructing diagrams for multi purposes levee in the master plan, even if any combination of the elements of the last chapter can be used in order to create every kind of flood protection and to adapt to a specific site. The concept is to join different examples from the previous chapter together, resulting in multi functional designs. This part of the report will not provide a large number of combinations due to the infinite possibilities that can be developed. More specifically, the aim is to define a list of situations where the flood protection is merged with: green spaces, building inside it, building behind it, building on it and explain how architecture and flood protection can be merged to create multifunctional spaces.

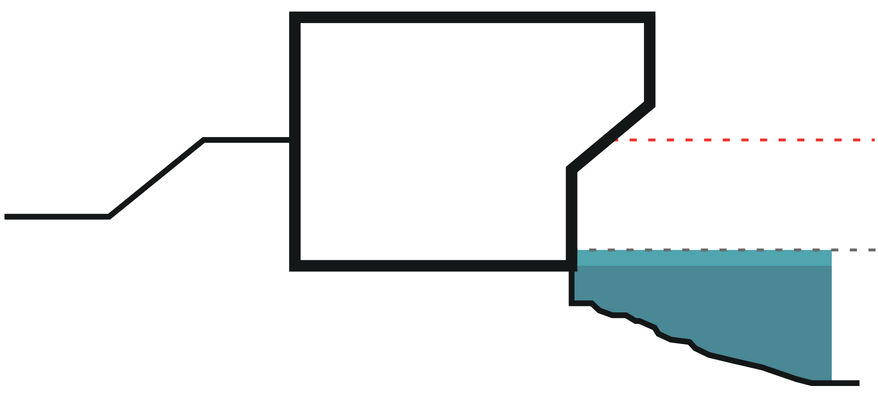
No design is related to a specific part of the site area, they are intended like a catalogue of possible integration that can be placed in the master plan accordingly to the surroundings buildings and programs selected for the different areas in order to create a connection between the dike and what is behind it. Although, the designs are not completely abstract as the diagram of the previous chapter; they meet the design requirements explained in the “Design Framework”. Therefore, the design height is based on the calculated 100 yrs flood + 2100 SLR + wave overtopping, while the design width is based on different site area situations.

As the width of the flood protection, also the height can vary in order to create different types of interaction between the city and the water. For instance, the flood tolerant part (shown in the diagram by the grey line hatch) can be enlarged to design broader beaches or portion of parks that can be flooded in certain period of the year due to the astronomical tides. As opposite that part can also be deleted and the flood protection can be used as a raised view point on the water.



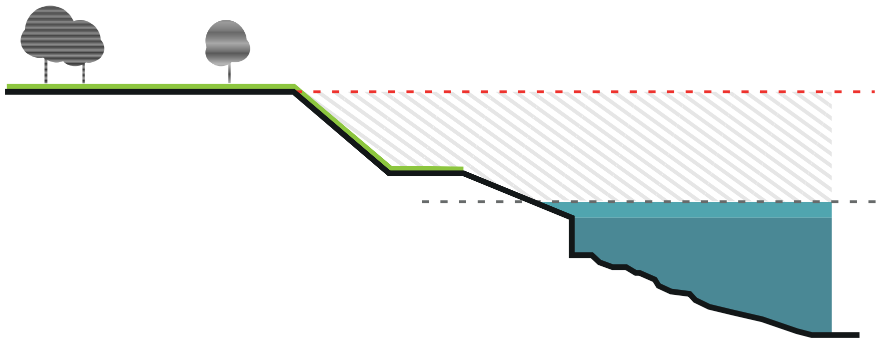






DESIGN OUTCOME 1

DIKE + GREEN AREAS



This type of integration is intended as base layer for the entire master plan. The idea is to decide first location and the width of the dike and then adapt this solution for every part of the waterfront. A green park will flow along the water's edge creating a connection along it and at the same time providing flood protection. The section of the dike can vary according to its width: narrow solution may incorporate stairs or step to overcome the height differences, while broader solution may have wider terraces or intermediate levels. It can also become a superdike raising also the entire part of city behind the dike.

As said, the result of this chapter will not be a singular perfect solution although it will be more like a design toolkit that permit to develop different outcomes.

Regarding the construction, from the bottom to the top the structure is composed by:

-COMPACTED SOIL AND EMBANKMENT: this soil is used for the landfilling operation and acts as base layer for the flood protection

-REINFORCED CONCRETE SLAB: this part is the load-bearing layer of the entire structure and it is anchored by piles to the bedrock of the Hudson river to transmit the load

-TOP PART: to develop the top part for green it has been taken as example the technology to build intensive green roof, in other words, roof gardens that can support a wide variety of plants. This kind of green roofs are obviously heavier and require more maintenance compared to extensive grass roof, due to the huge variety of trees and plants that can host. However, the use of this building technology permits to create a suspended parks that enhance the spatial quality of the space.

The solutions taken as example for the construction detail is “DAKU heavy intensive”. The system is composed, from the bottom to the top:

-Load-bearing structure

-Waterproofing membrane

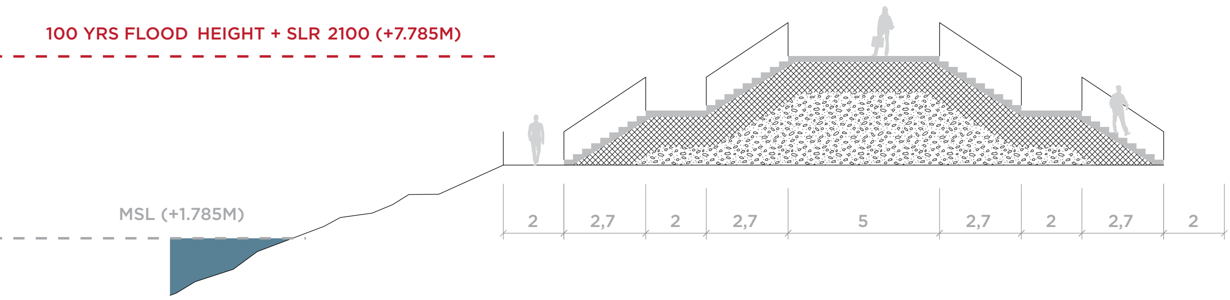
-DAKU drainage 25 (47 mm): it is layer made of expanded polystyrene. It’s used for drainage and for stockpile of water. It also protect the waterproofing layer, collecting the rainfall and giving it back to the plants through a micro evaporation and condensation process. (Thermal conductivity: 0,034 W/mK, Thermal resistance: 0,71 mK/W).

-Filter Layer: (1,45 mm) It is a geotextile filter used to divide the substrate from the drainage layer and it is made of polypropylene fibres.

-Lava Lapillus: It is a natural stone layer used to improve the drainage and the filter function of the geotextile layer. Granulometry 3-10mm.

-Growing Media

To avoid failures and erosion during the dike lifespan some precautions has to be taken. The side of the dike exposed to flood will have a thinner layer of growing media cause otherwise flood action could result in erosion of the green areas. On this side a revetment system has to be installed in order to have wave attenuation and discharge surge's power. Vegetation will have different feature accordingly if is positioned or not in the flood tolerant area. Plants located in this area has to be selected to be salt tolerant and have resilient characteristics against flood. Green areas will play an important role and their presence both will help as buffer against raising water and as water natural retention system against flash flooding.
Slope angle and slope roughness are also important cause they directly affect how water reacts when reaches the shoreline resulting in different phenomenon such as wave reflection. In this particular case the schema has been simplified in a diagrammatic way. In order to have a precise slope angle further calculation has to be done


100 YRS FLOOD HEIGHT + SLR 2100 (+7.785M)
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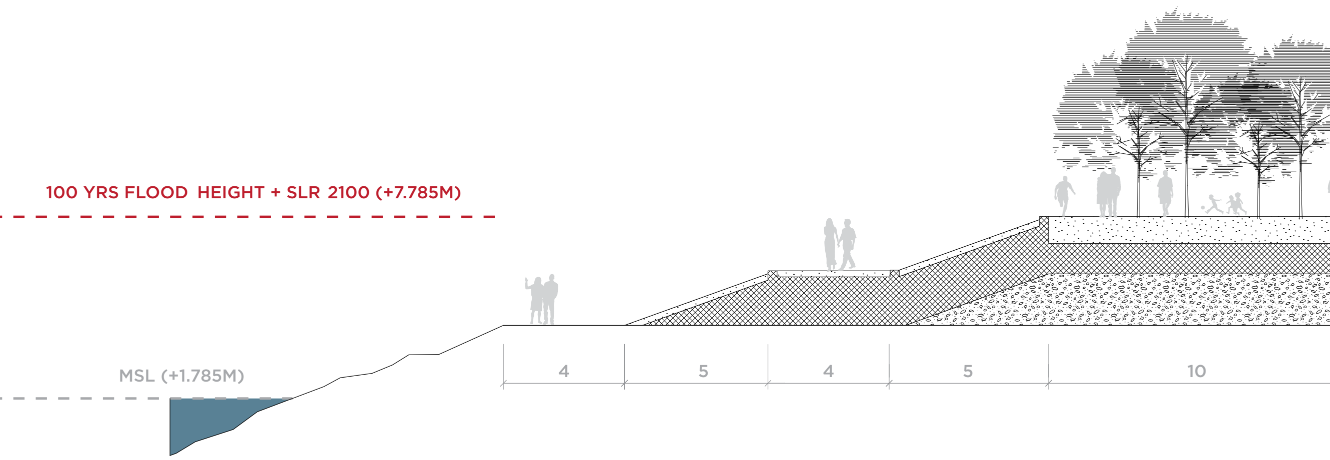
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MSL (+1.785M)
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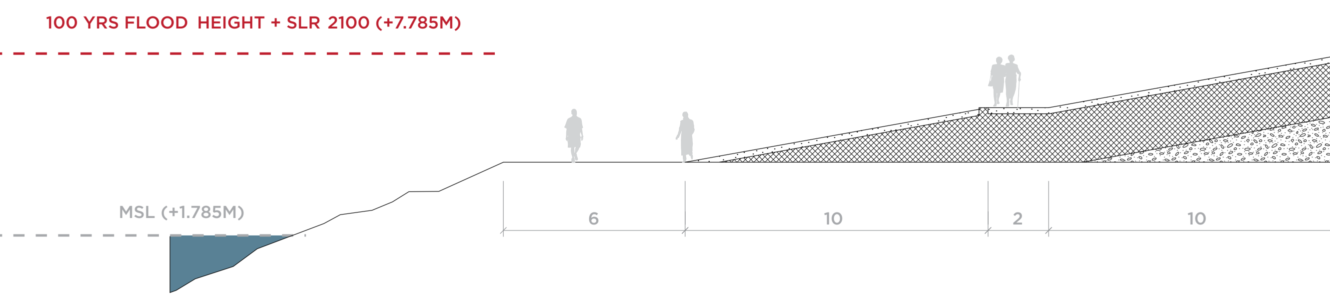
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MSL (+1.785M)
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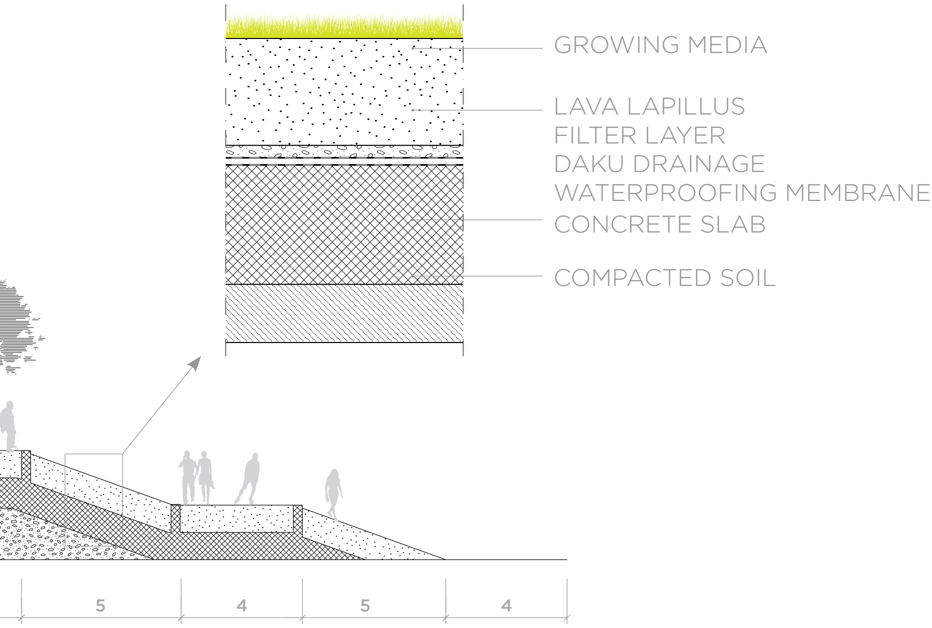
GROWING MEDIA
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DAKU DRAINAGE
WATERPROOFING MEMBRANE
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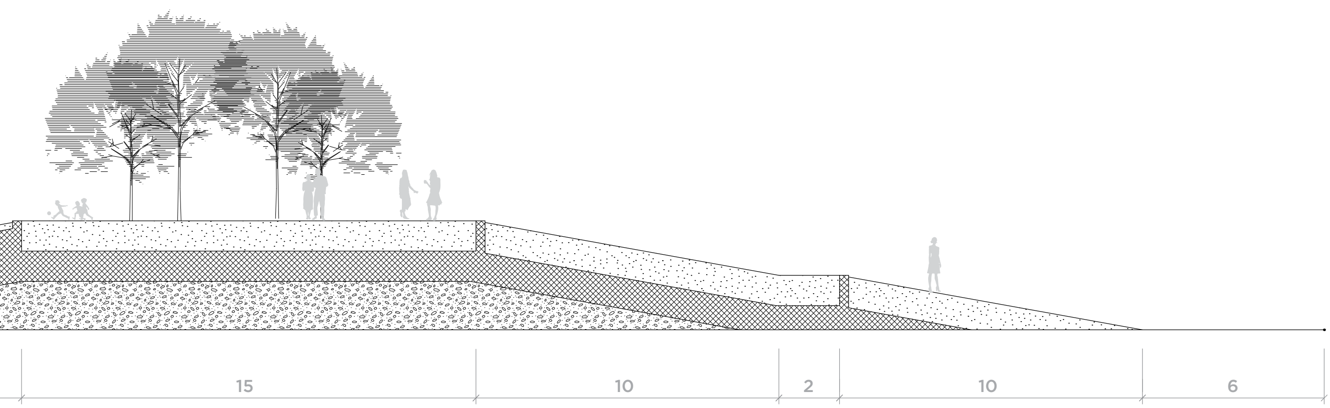
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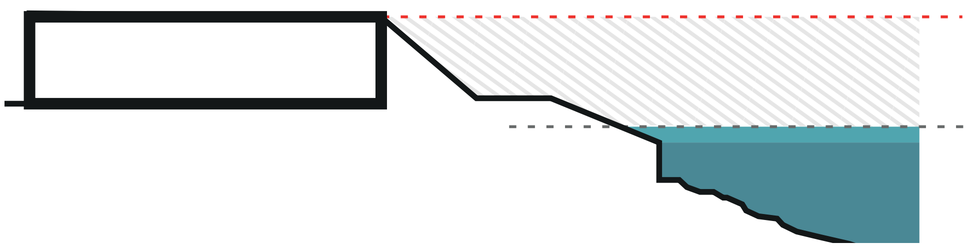
DESIGN OUTCOME 2

DIKE + BUILDING INSIDE IT



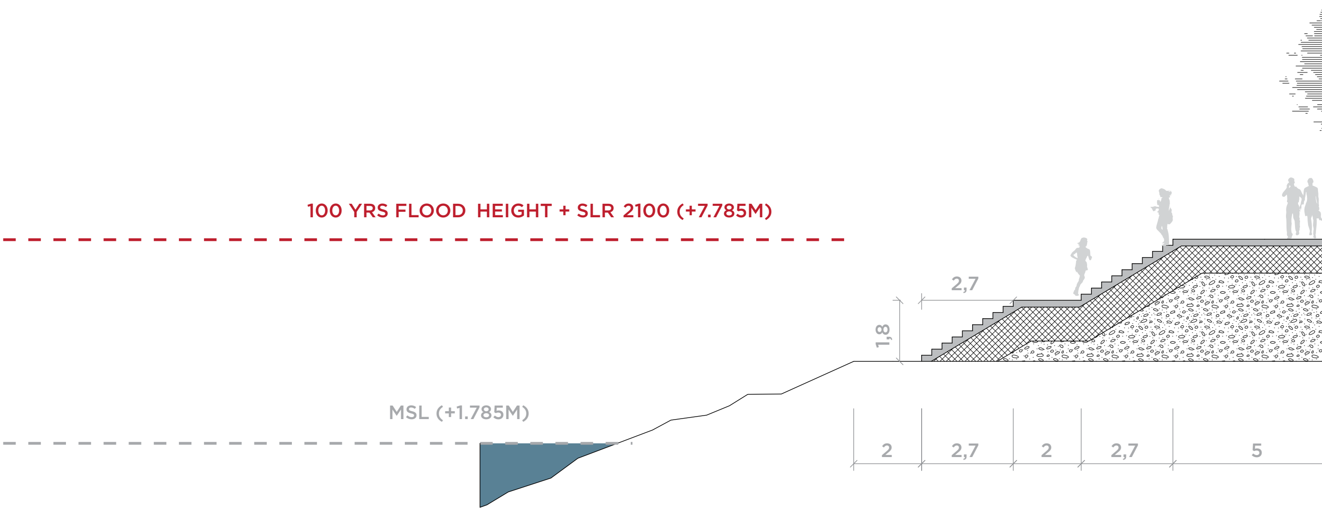
This is the first of the three different integration between flood protection and constructions. In this particular case, the building taken in account is a single story pavilion positioned inside the berm. The placement has to take advantage of the load bearing concrete slab and use it as plan roof. Therefore the building will be partly below the ground level to permit a normal height inside it. However There are different possibilities to treat this situation and they depend mostly on the placement and the relation with the green.

GREEN ROOF

The pavilion can have or not a green roof. If it has it, as said above, the load-bearing roof of the building has to connect to the concrete slab and the layers of the green roof will be the same of the park on the dike. In this case the green roof require more drainage in order to avoid excessive water load on the roof. If the roof is accessible, railings have to be installed on the edge for safety reason.

PLACEMENT

The building can be partly below the ground level or not. That depends by the internal height and different design choices. In any case the height difference respect the ground level has to be overcome with stairs or ramps. The best position is on the “dry side” of the dike, however the building can be positioned also towards the water. In this case the facade has to be water-proof and completely flood resilient.


100 YRS FLOOD HEIGHT + SLR 2100 (+7.785M)
MSL (+1.785M)
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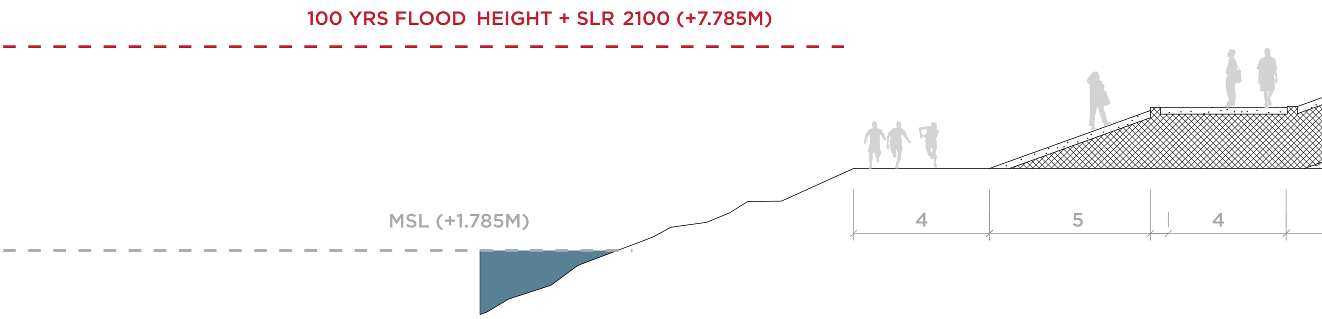
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MSL (+1.785M)
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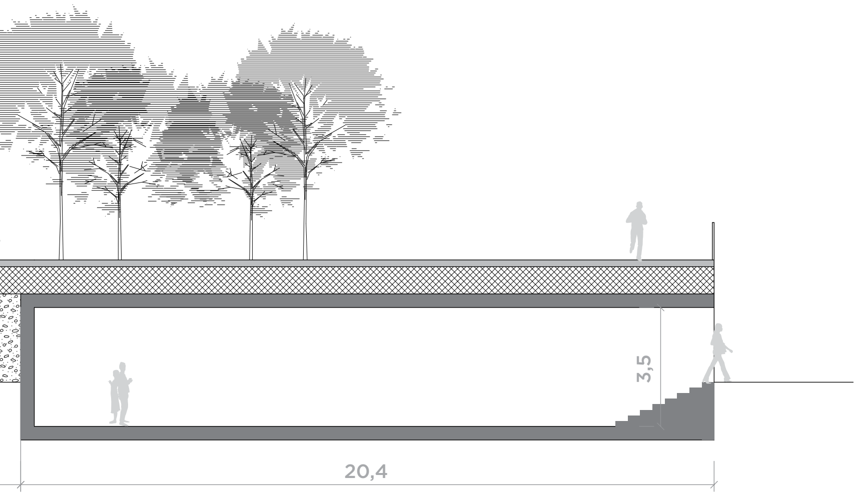
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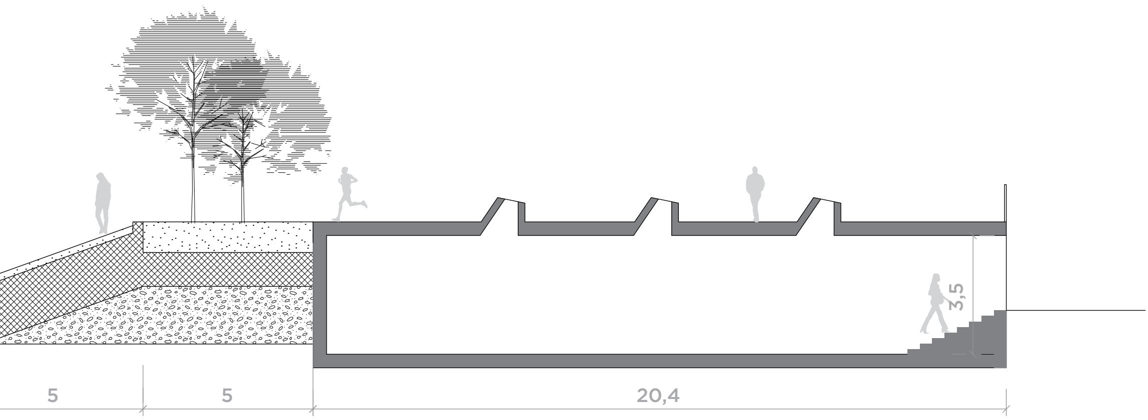
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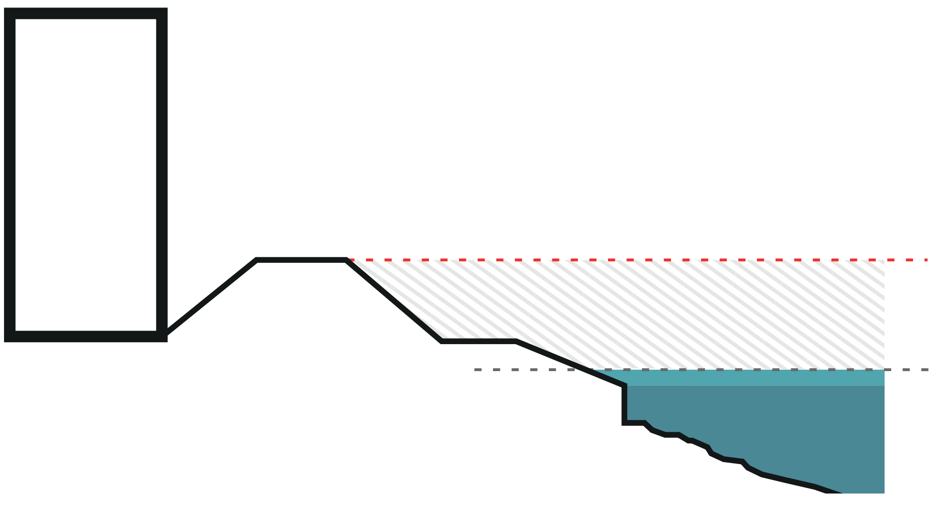
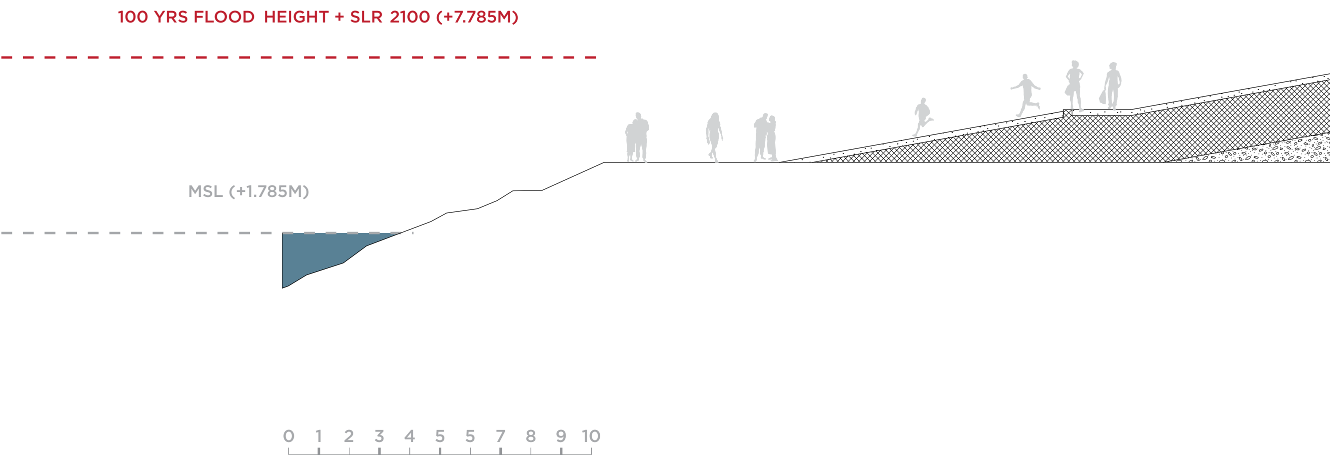
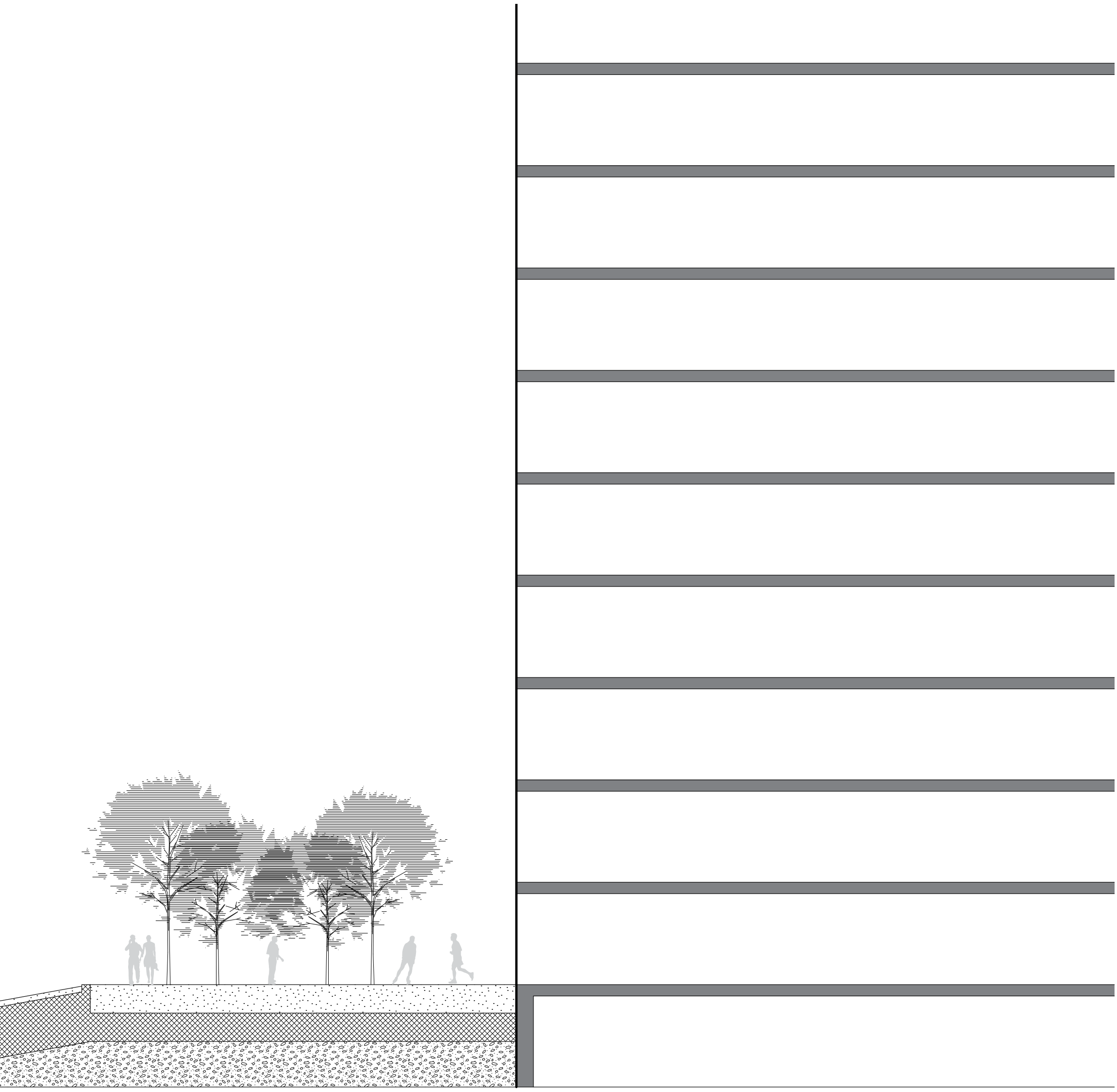
20,4

DIKE + BUILDING BEHIND IT

This strategy is indicated in case the berm will occupy the majority of the building area. In this case the building can be adjacent to it and positioned on the “dry side”. The dike height is 3,6 m above the ground floor, that means that it would overlap with the facade of the ground floor. The wall along the dike has to be design to resist to the horizontal forces of the soil and the connection between it and the top level of the dike can be treated in various way: recreational areas, green spaces, it can be connected with the programme inside the building...Endless possibilities can result from this union. For instance, the building can be connected with another construction inside the dike that can be used as parking space.



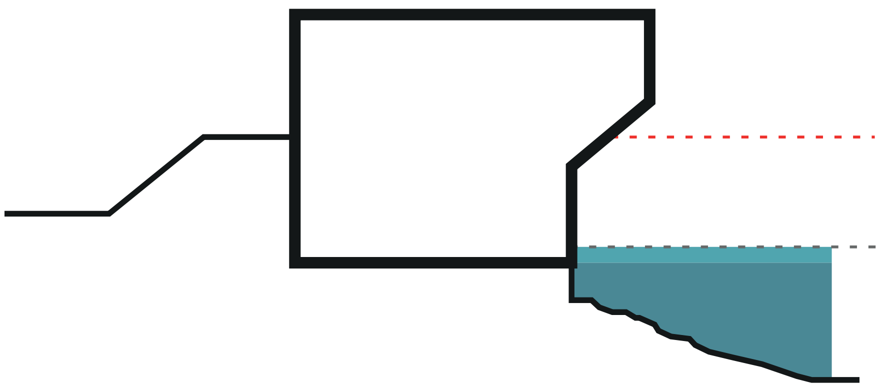

100 YRS FLOOD HEIGHT + SLR 2100 (+7.785M)
MSL (+1.785M)
0 1 2 3 4 5 5 7 8 9 10

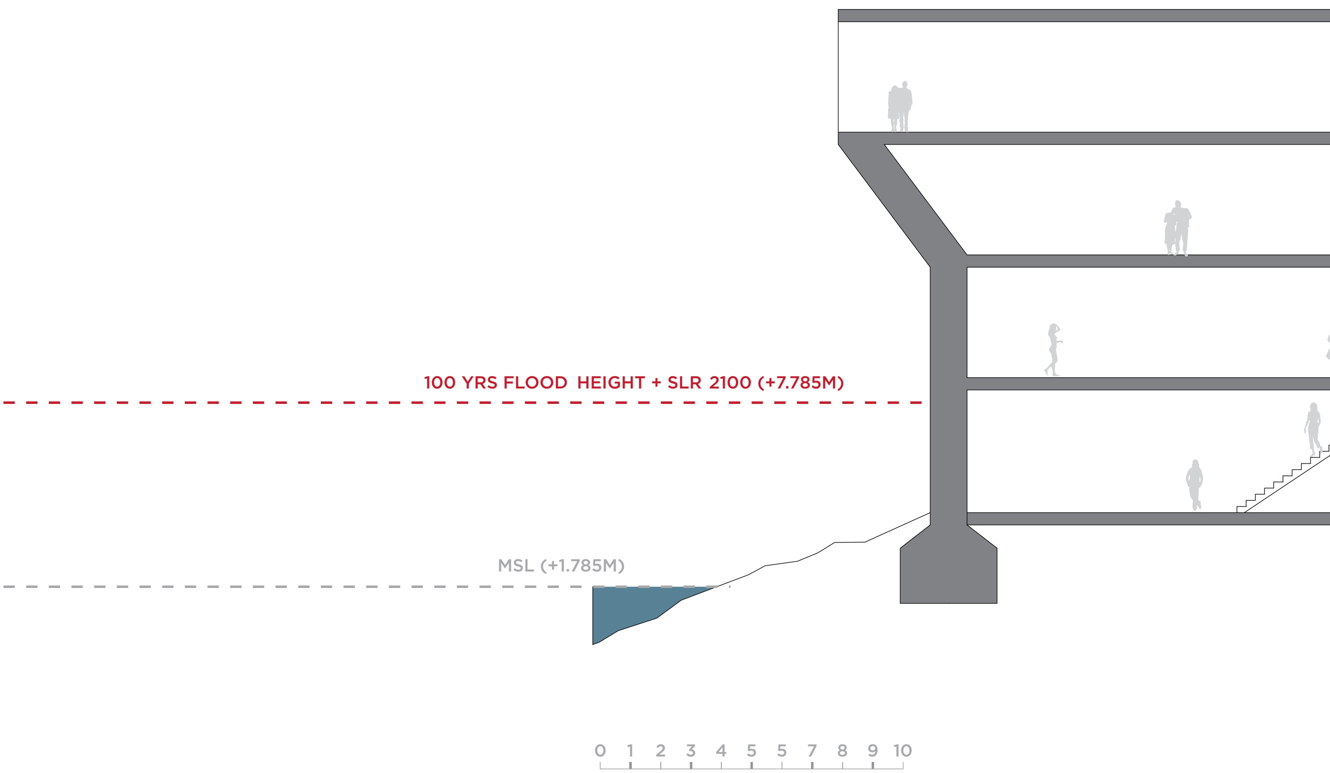


DESIGN OUTCOME 4

DIKE + BUILDING ON IT

This strategy is indicated in case the berm will occupy the majority of the building area. In this case the building can be adjacent to it and positioned on the “dry side”. The dike height is 3,6 m above the ground floor, that means that it would overlap with the facade of the ground floor. The wall along the dike has to be design to resist to the horizontal forces of the soil and the connection between it and the top level of the dike can be treated in various way: recreational areas, green spaces, it can be connected with the programme inside the building...Endless possibilities can result from this union. For instance, the building can be connected with another construction inside the dike that can be used as parking space.




100 YRS FLOOD HEIGHT + SLR 2100 (+7.785M)
MSL (+1.785M)
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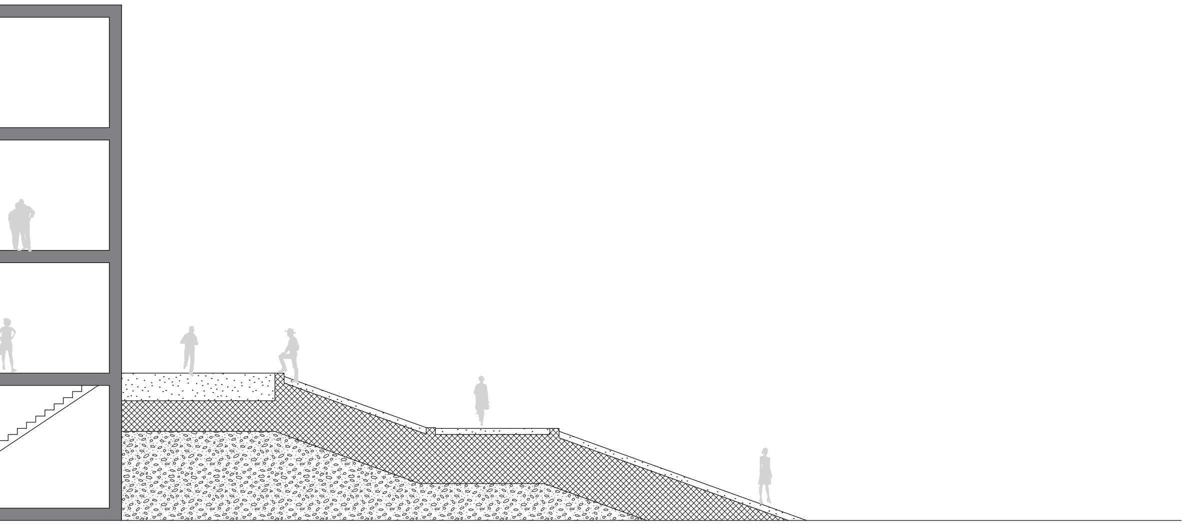


23

Reflections

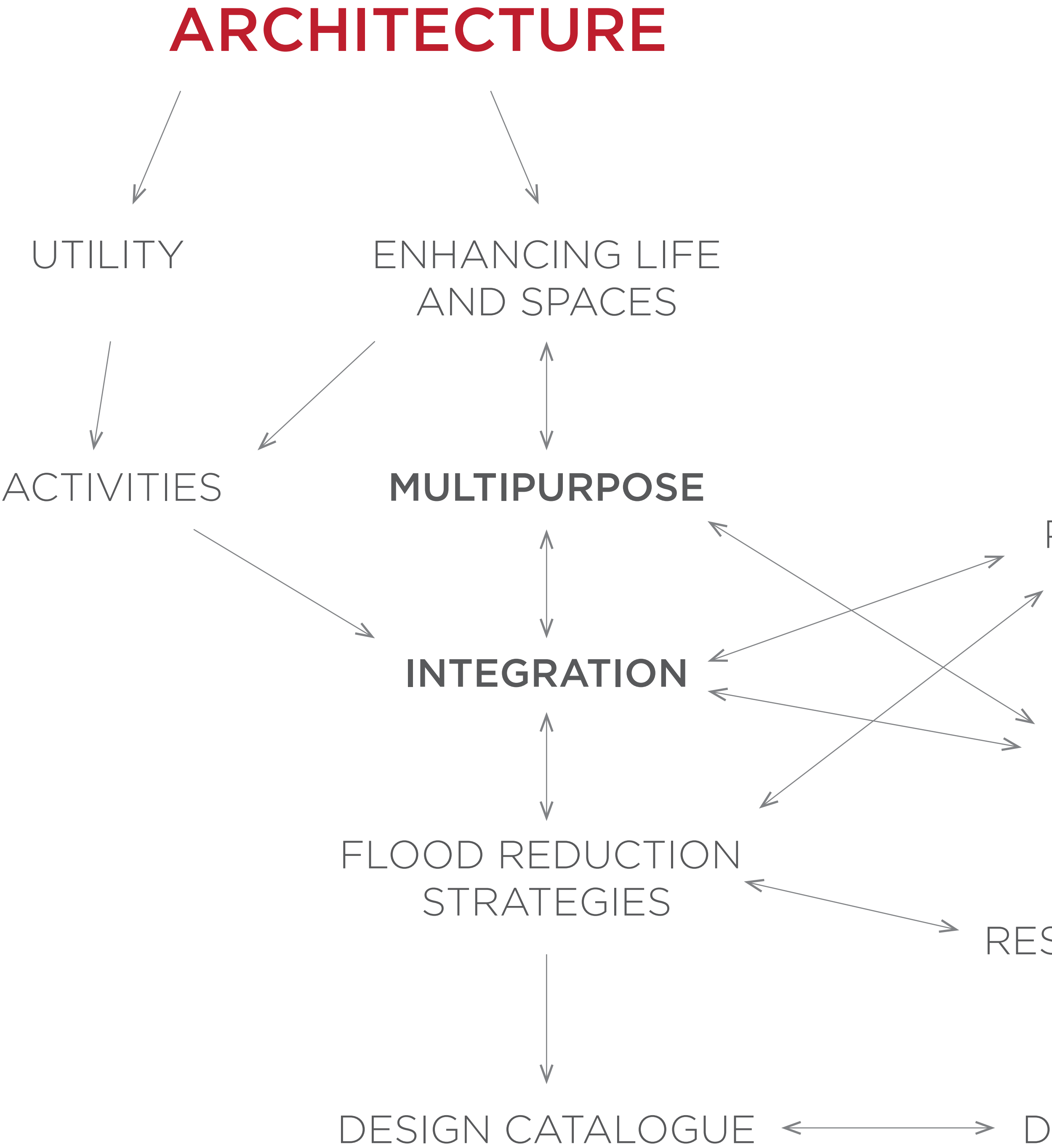
23|

Reflections

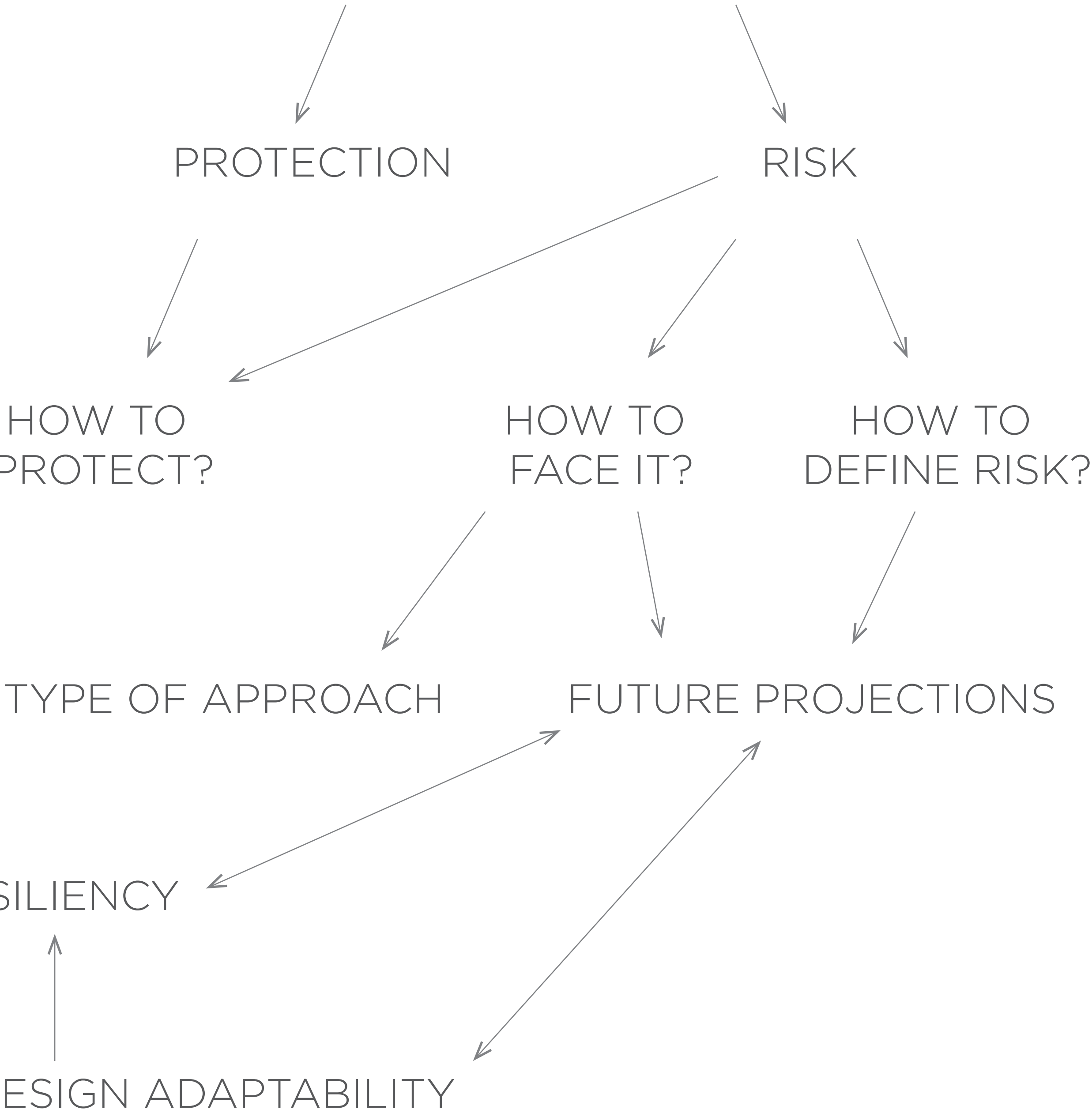
ON RESEARCH

As every fascination, at the very beginning, it was very irrational and evanescent. The idea was already there, in my mind, but the path I should follow was still unclear. The first part of my research has been a long way to collect a huge amount of information to create map in my mind about what I wanted to achieve and how, but when I was doing so, I figured out that I was wasting a lot of time and most of my researches were ending without any considerable result. The biggest difficulty was to deal with an argument that was totally new for me and try, at the same time, to join it with my architectural experience. I had no idea what was the best framework to follow to create the best union between something technical as the flood protection is and something more romantic and poetic as architecture is. Therefore, I decided to put my doubts and my ideas on paper, trying to figure out what were the information that I needed to collect and what was the best way to analyze my fascination. The making of this diagram was a very crucial step to investigate my idea. To face such a wide theme, I broke it in different subproblem and in subquestions connected together. This chart helped me to look at it from a totally different point of view. What was for me unclear and too wide became suddenly crystalline and neat. Diagrammatically, the tree diagram I made was perfect to understand all the arguments that were connected and what was the order I should follow to arrive at the answers I was looking for. As shown in the diagram, I had to connect two main themes: architecture and flood protection. Breaking them in sub-themes directly shown which were the common points and which were the most important aspects of this connection. Then, I had a path to follow, I knew which where the points that had to be integrated and I had also a hierarchy of the arguments I had to investigate.

The results of the research is at the same time a look at the past: how the cities lived their relationship with the water throughout the history, how they tried to manage its power and maintain its beauty; and a look at the future: how can we reinvent this relationship and how we can protect coastal cities while enhancing their public realm.
The research wants to be directly related with the specific site decided by my work team, but, at the same time, it also provides general design solutions (Design Catalogue) that could be used in another projects.
My report is intended as part of a bigger project, composed by four researches developed by my design team (see "Preface"). This project is called "Resilient Density" and it is currently develop within Explore Lab 19. It is composed by my research [BUILDING WITH WATER], Vince Marchetto's research [SMART BLOCKS], Cosimo Conserva's research [JERSEY CITY WATERFRONT TOWARDS A HUMAN PUBLIC REALM] and Matteo Ferrarese's report [GREEN NETWORKS].


ARCHITECTURE
UTILITY
ENHANCING LIFE AND SPACES
ACTIVITIES
MULTIPURPOSE
INTEGRATION
FLOOD REDUCTION STRATEGIES
DESIGN CATALOGUE

FLOOD PROTECTION



ON DESIGN

Once the research was completed, I had to materialize what I learned and understood into shapes and architectural products. Our four researches on four main themes [Multipurpose flood protection, Green Networks, Public Realm and Density] were intended as the starting point to develop a masterplan for the new waterfront of Jersey City. Through them we built a knowledge background that helped us to design the masterplan. Every and each one of the design team is intended as an expert in his research field and the four expertise together permits to base the design decisions on concrete data and different design toolkits.

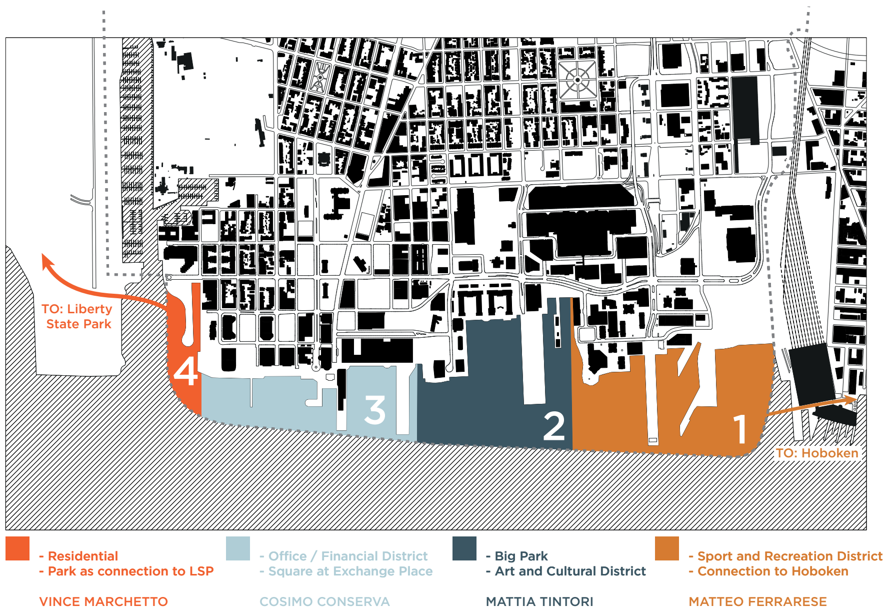
It was clear from the beginning that this kind of project needed a multidisciplinary approach that has been satisfied through the division of the expertise requested among the team members [urbanism, hydraulic engineer and landscape architecture]. Every and each team members brought into the urban design its experience and what he learnt. The division of the work was a good idea because it permitted to deepen each urban issue in a sufficient way to face such a big design with the right skills to support every decision. The team work helped to develop a better masterplan in a shorter period than it would required if the project was carried on by one single student.

However the masterplan developed by us was only the first phase of the design and it was the only phase done by the entire group together.
The second phase presented a shift in the scale of the project: every team member selected a different district in the masterplan as personal project site. Every and each district was characterized by different features and it was directly connected to the building that the team members decided to design. Each building becomes the new landmark of its district and it influences both the identity and the character of its neighborhood. However the masterplan is designed in such a way that every part of it it is interconnected and gradually shades in the close ones to avoid borders that would have ruin the urban quality of the project.

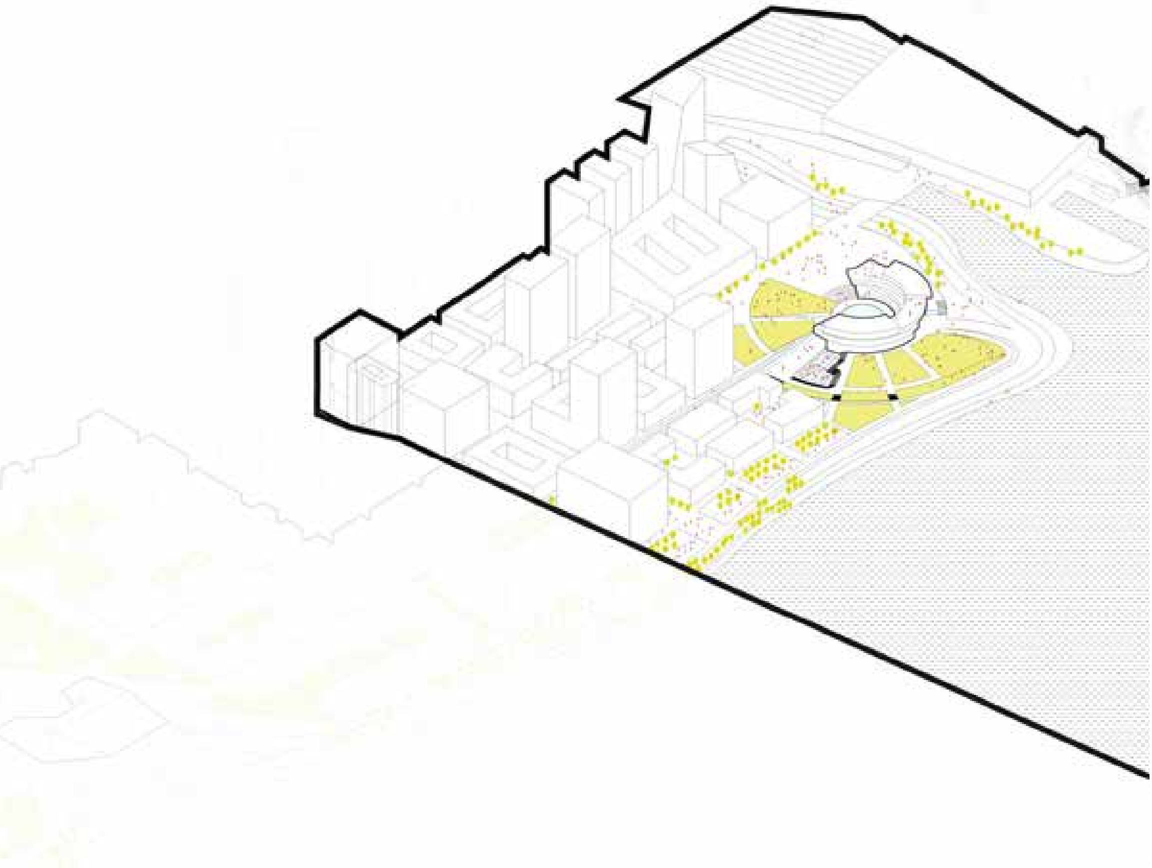
The selection of the districts has been evaluated on different factors: existing programme in the context, existing landmarks, existing nodes and type of function we wanted to develop in the new urban expansion.

-District 1 [Matteo Ferrrarese]
-District 2 [Mattia Tintori]
-District 3 [Cosimo Conserva]
-District 4 [Vince Marchetto]

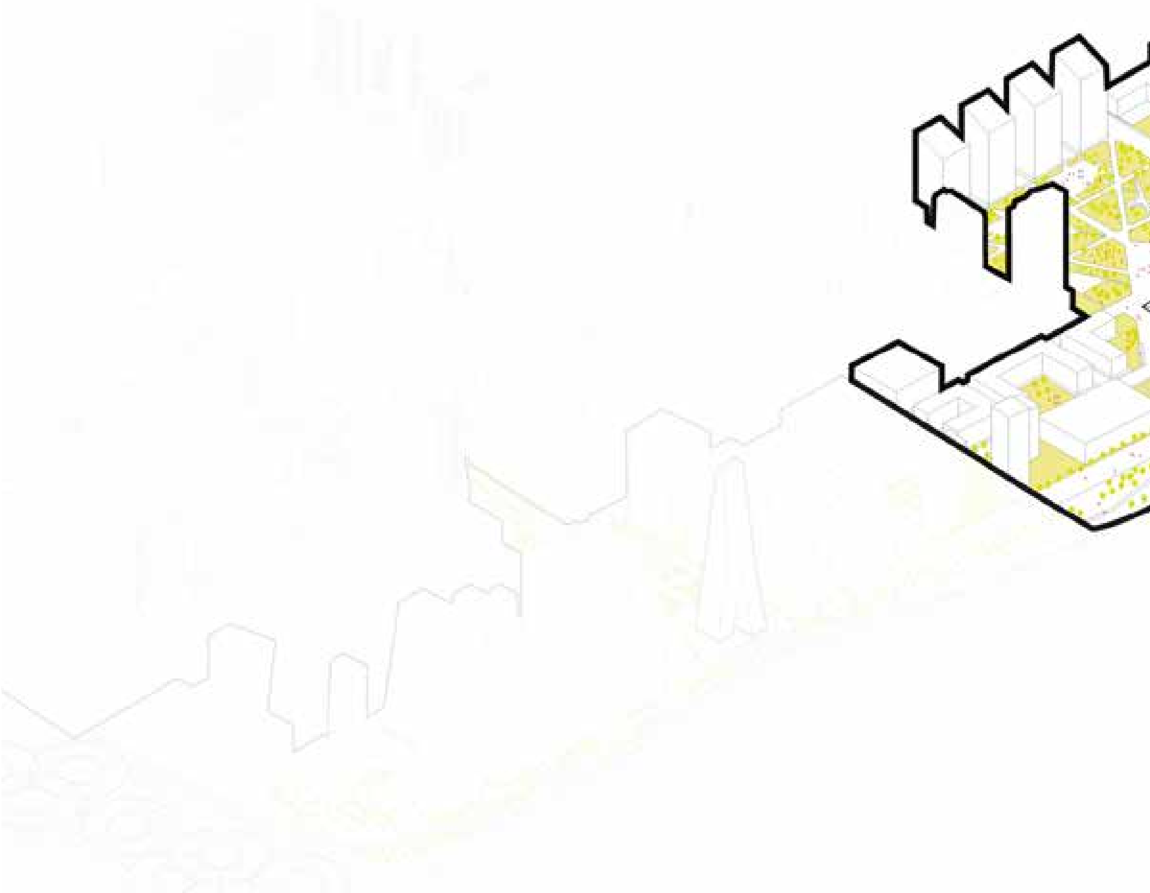
I selected District number 2 for my building to transform it in the Art and Cultural district.
I chose it cause of its proximity to and old factory that it's going to be reconverted into an "art factory". The project is to create ateliers for different type of artists. The cheap rents and the closeness to both Manhattan and Brooklyn will be crucial in the success of that reconversion. My intervention is then integrated in this future projection as place to exhibit the art produced by the artist that will move to Jersey City. The idea is to create a flexible space that can host different types of art (sculptures, interactive performances, photographs, paintings, projections...) connected to the urban fabrics and its surroundings. The choice of the programme is both top down and bottom up at the same time since it is both related to future transformation of the city that are already taking place and to a vision expressed in the masterplan hat wants to make Jersey City resilient while enhancing its public realm.



DISTRICT 1
SPORT AND RECREATION



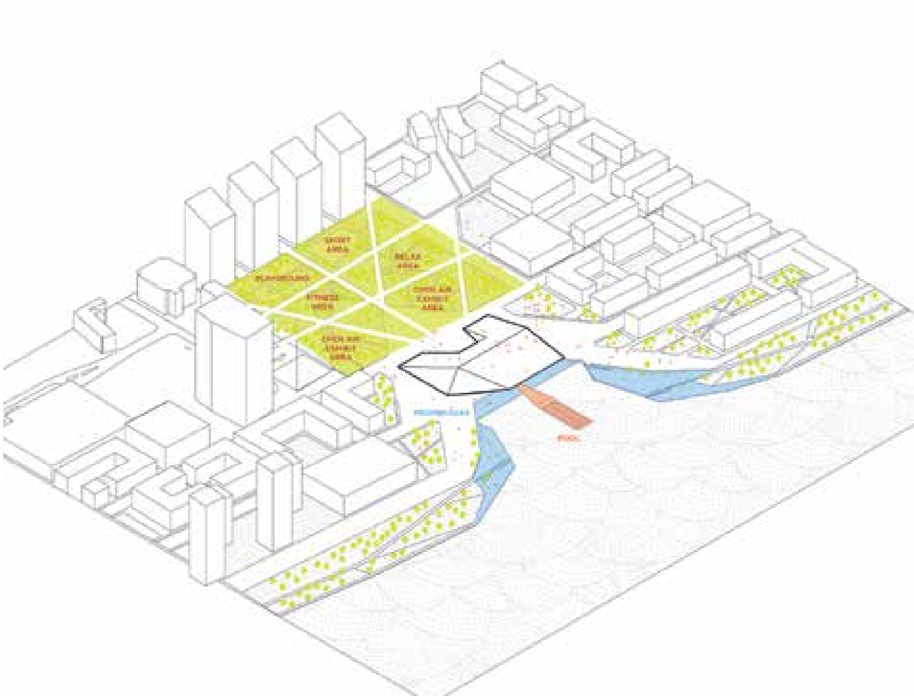
DISTRICT 2
ART AND CULTURE

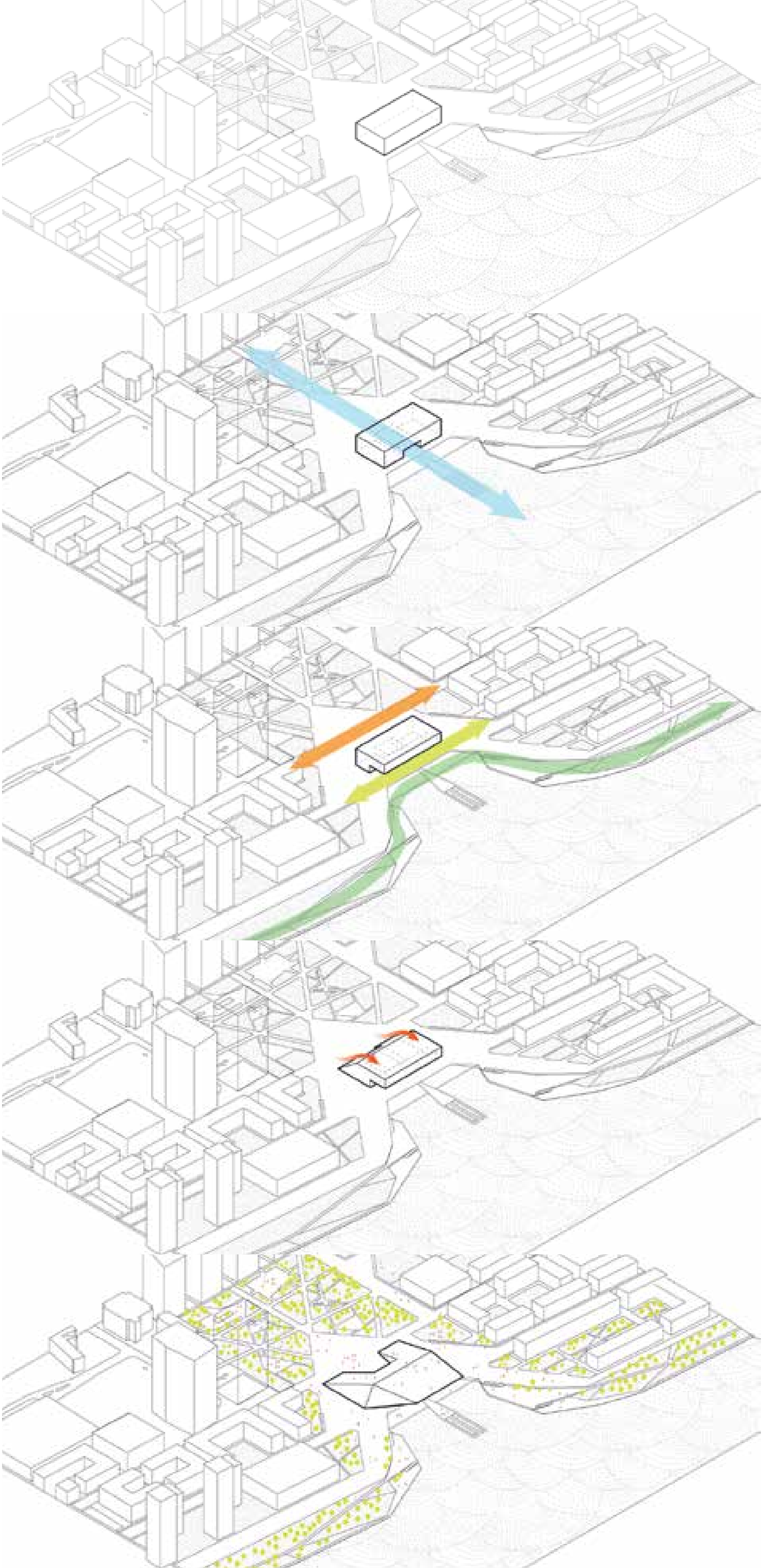


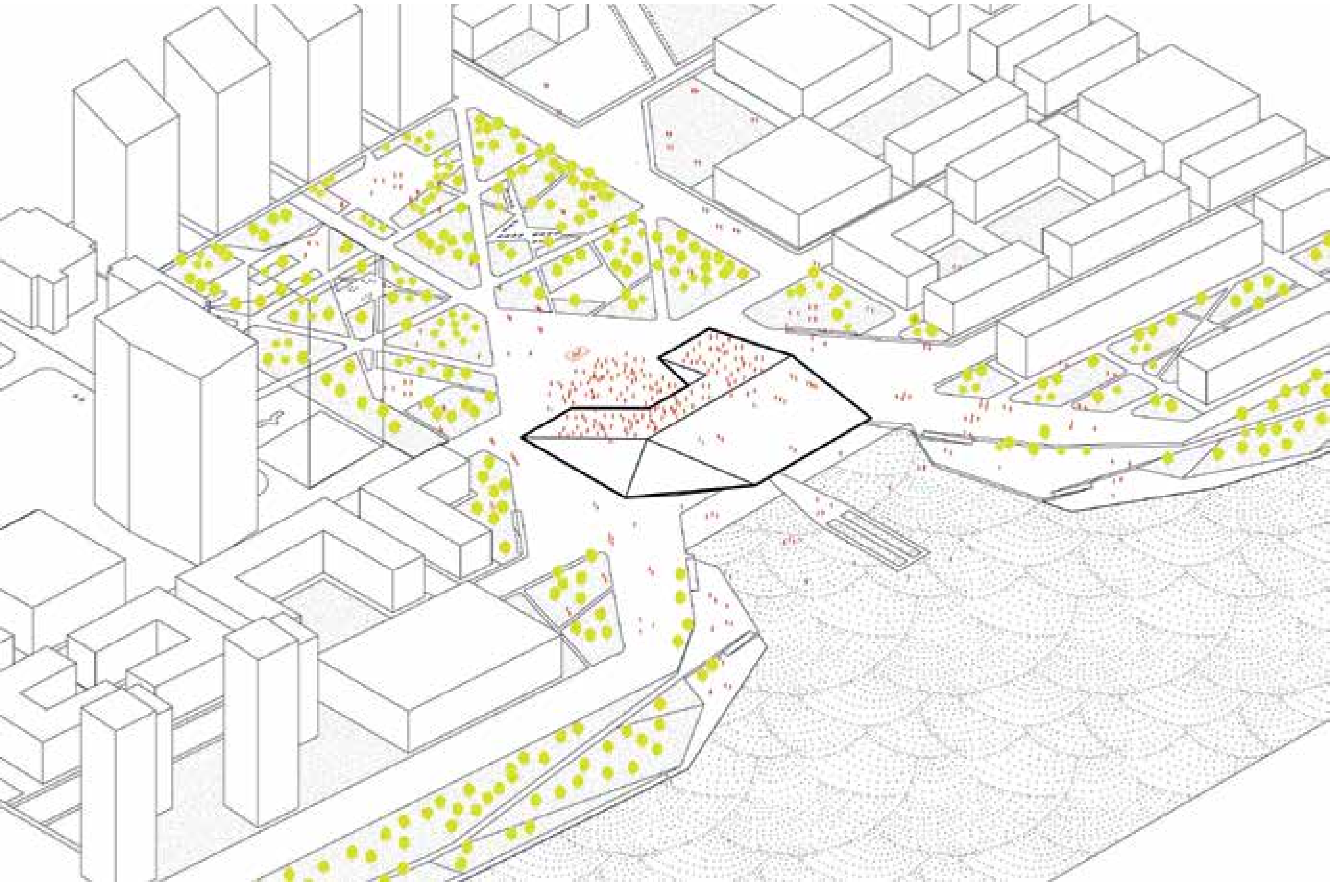
DISTRICT 3
OFFICE AND FINANCE

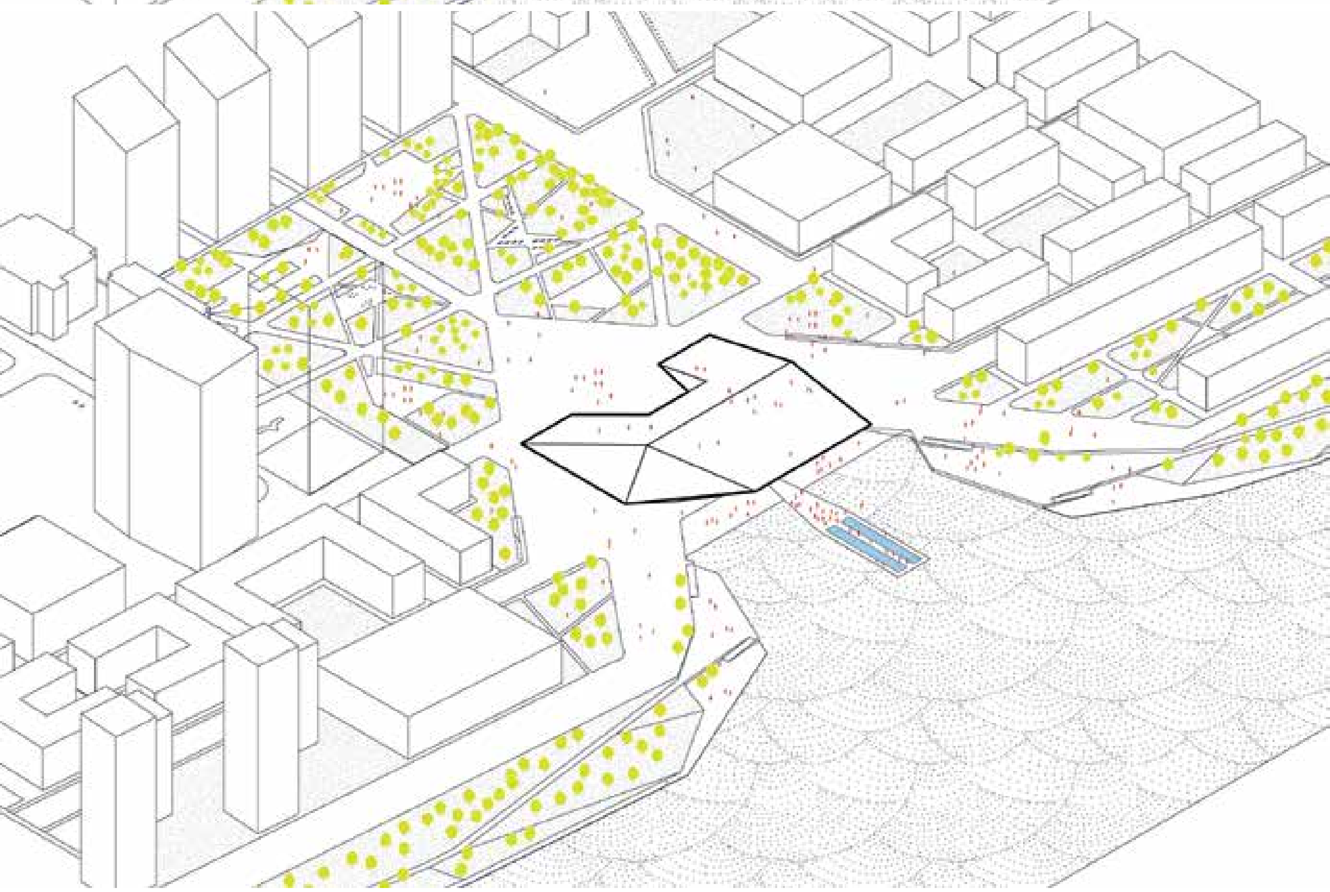
DISTRICT 4
DWELLING

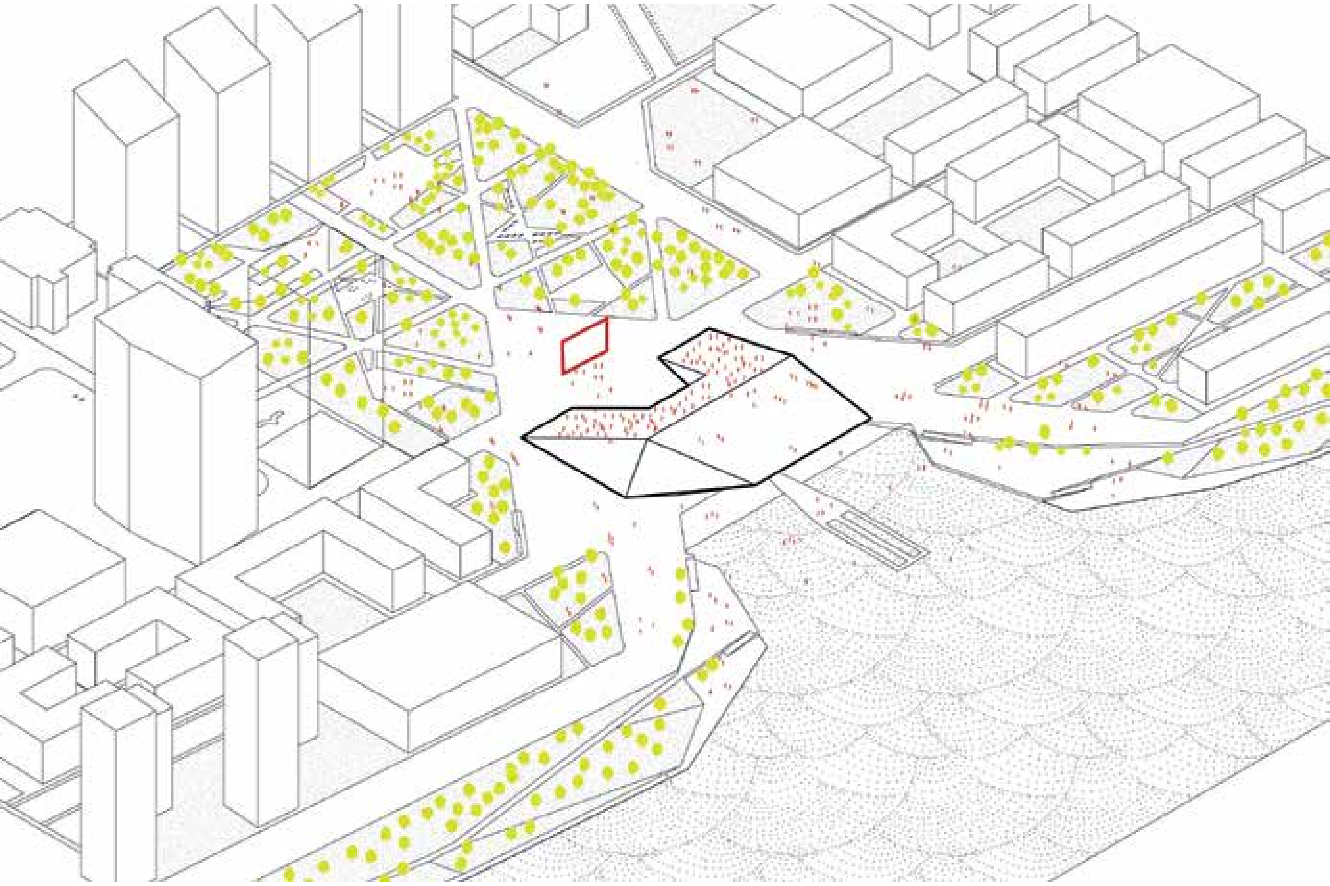
The building is placed in a specific part of District 2. It is a kind of a corridor (see site plan on the right) perpendicular to the waterfront that starts at the boundary with the existing context and extends towards the shoreline crossing the three traversal connections designed in the masterplan (commercial street, green network and dike). The site is selected in order to give the building the opportunity to take over the urban fabric of the new masterplan influencing a big area around itself. The aim is to create a system of urban spaces (from the context to the river: park, open plaza, museum, covered plaza, beach, promenade and pools) that works together with the construction to create different functions. The shape reflects this decision allowing various interactions with the surroundings and influencing them in disparate ways. The evolution of the shape is explained in the diagrams in the next pages. The museum stands as a mysterious monolithic object. Its form is totally different from the context to create a break with its style and to stand out in the urban fabric. The entire design is an ensemble of different public spaces that work together as one element. Every space is connected to the other by various kind of relations that change according to the different season of the year. This new part of that city becomes then a special point of attraction that offers a wide range of activities (sports, culture, leisure...). A new hub on the waterfront, a new landmark that shapes the identity of the new Jersey City. Something recognizable from Manhattan, something that would bring the New Yorkers on the other side of the Hudson River.

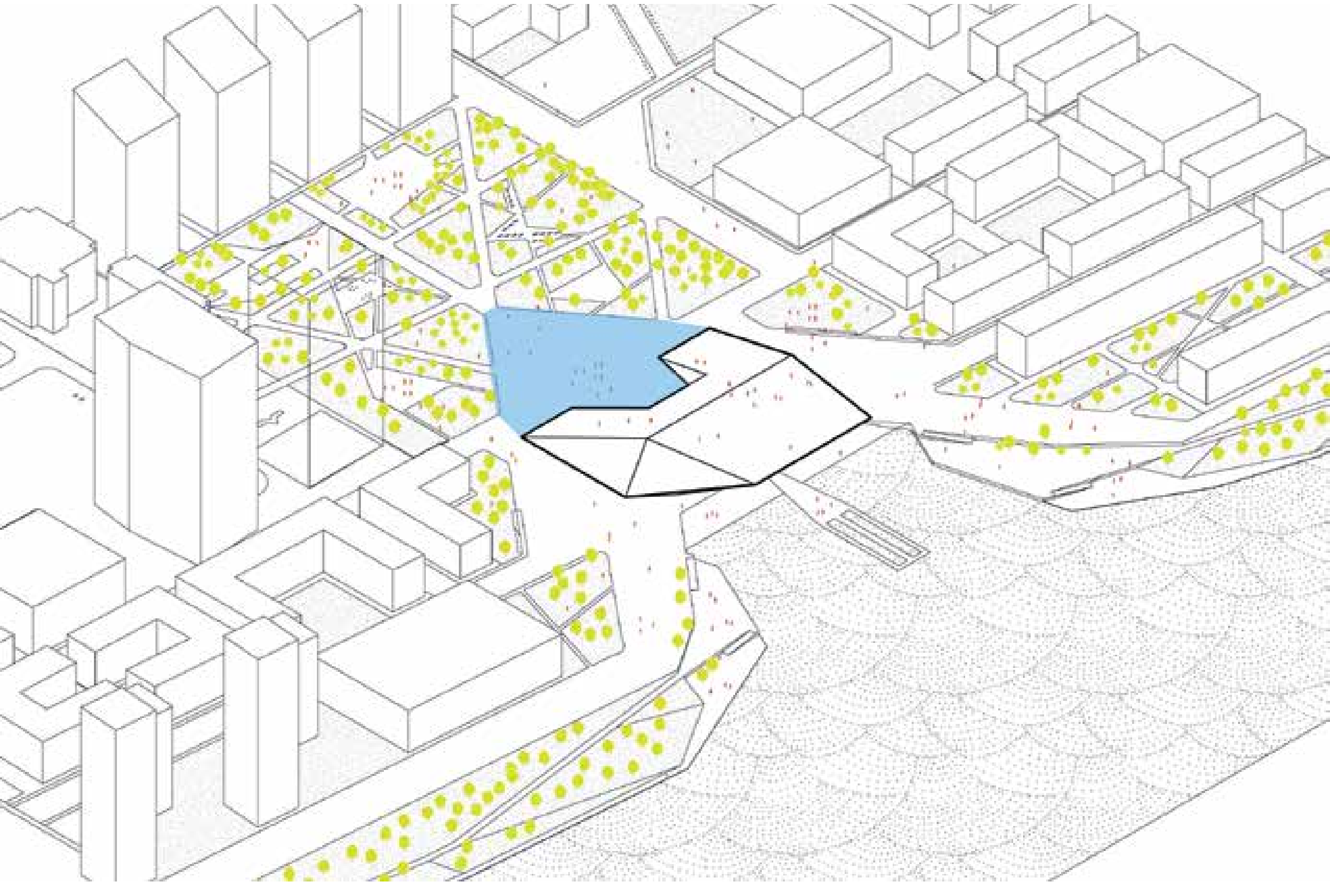












THE RELATIONSHIP BETWEEN THE PROJECT AND THE WIDER SOCIAL CONTEXT

As already explained in the "Introduction" and in the "Problem Statement", nowadays the theme of Resiliency of the Coastal Cities is one of the most discussed in the architectural debate. As I wrote in the beginning of this report:

" It's clear and evident that the planet we live on is changing. Our lifestyle, our habits, our culture only accelerated the rate of this change. It is internationally admitted that mankind is 95% certainly responsible of what is happening right now. For centuries, the planet has been exploited without thinking about the possible consequences and nowadays climate change is a new menace facing our world. Climate change would lead to higher temperatures, harsher storms, floods. Millions of people and some of the biggest and most populated cities around the world are threatened by this inevitable risk. Taking also into account that over half of the world's population lives within 100 km of the coast the consequences of climate change will become more and more dramatically evident and catastrophic. The future uncertainties pose special challenges , there is no "best solution", but the necessity to embrace the unexpected as expected, planning ahead to anticipate extreme events."

Every time I read again this part I always focus on the part where it says that half of the world's population lives within 100 km of the coast. That sentence alone can simply explain the strong relation between my project and the social context. The menace derived by climate change and consequent sea level rise is underlining the fact that need to think about the future of our cities, that we have to rethink how cities and water are related, how they interact and how they will interact in the future. The future is based on a multidisciplinary approach of different experts that work together to achieve the same goal. Engineers, architects, urbanists have to sum up their experiences and their efforts to yearn for a greater result. We followed the same approach on a way smaller scale and we worked as a design team to achieve this result. We have built our experience through the research and we have been helped by valid mentors to give a shape to our fascination.
When I look at the great impact that a competition as "Rebuild by Design" (see Problem Statement) had and still have on the architectural and non architectural debate, I can really understand how the theme that I followed is valid today, as it would be in the future and I deeply hope that this can be the starting point of something bigger than a graduation project.

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