Flooding Noordereiland
A systematic approach to alter the performance of the urban block responding to the extreme circumstances of flooding

Research Report

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A Systematic Approach to alter the Performance of the Urban Block responding to the Extreme Circumstances of Flooding

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Transitional Territories Graduation Studio
North Sea Landscapes of Coexistence
Altered Natures and the Architecture of Extremes

09/07/2019

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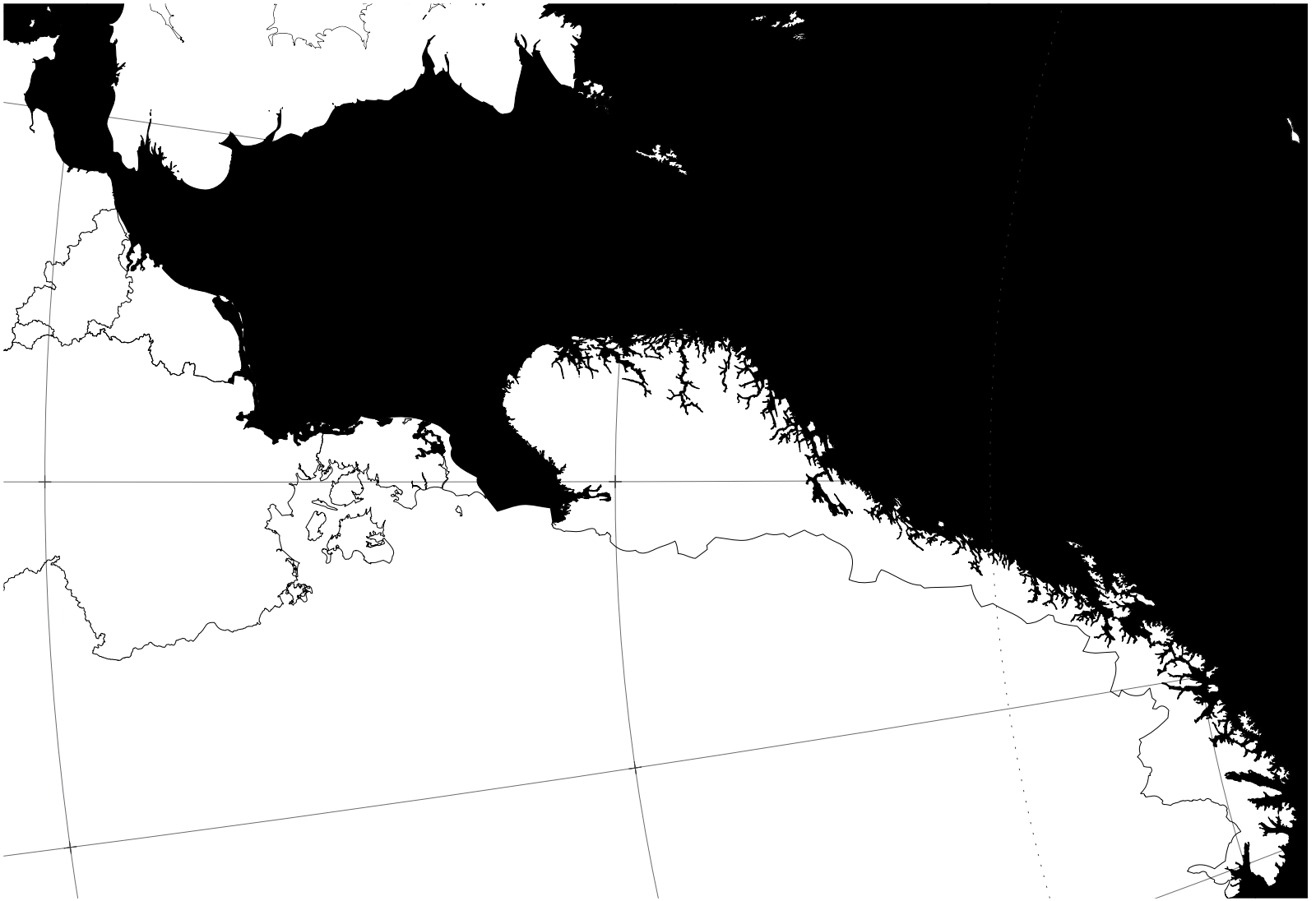
dr. ir. Taneha Kuzniecow Bacchin

The Studio's Focus

This academic year, the studio Transitional Territories, hosted by the Delta Urbanism chair, once again focussed on the extents of the North Sea. Aim of the studio collective, put together by Architecture as well as Urbanism students, was to investigate into possible altered processes in the environment of this heavily urbanised sea, with focus on spatial conflicts, which in turn would be attempted to solve in the architectural scale.



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Introduction

Climate is changing. Weather conditions are becoming more extreme; we are expecting fiercer storm surges, more intense seasonal precipitation patterns and, in some calculations, up to three meters relative sea level rise.

Especially the south coast of the North Sea will be affected the most. Particularly in the Netherlands, the coastal topography is shallow and the densely populated hinterland is just above or even under current sea level.

Rotterdam and its harbour (the biggest in Europe) is one of the lowest areas along the south coast and it is here where changes will be most apparent. The city is built in a natural river delta, which has been altered extensively in the last millennia to facilitate a desirable and safe living environment for its inhabitants. It is here, where floods would cause economic loss through damage to property and social disruption to the population.

Therefore, how to deal with rising water levels and therefore temporal floods in the urban context of Rotterdam? How is it possible to showcase the feasibility of living and creating a desirable environment in a flooded city?

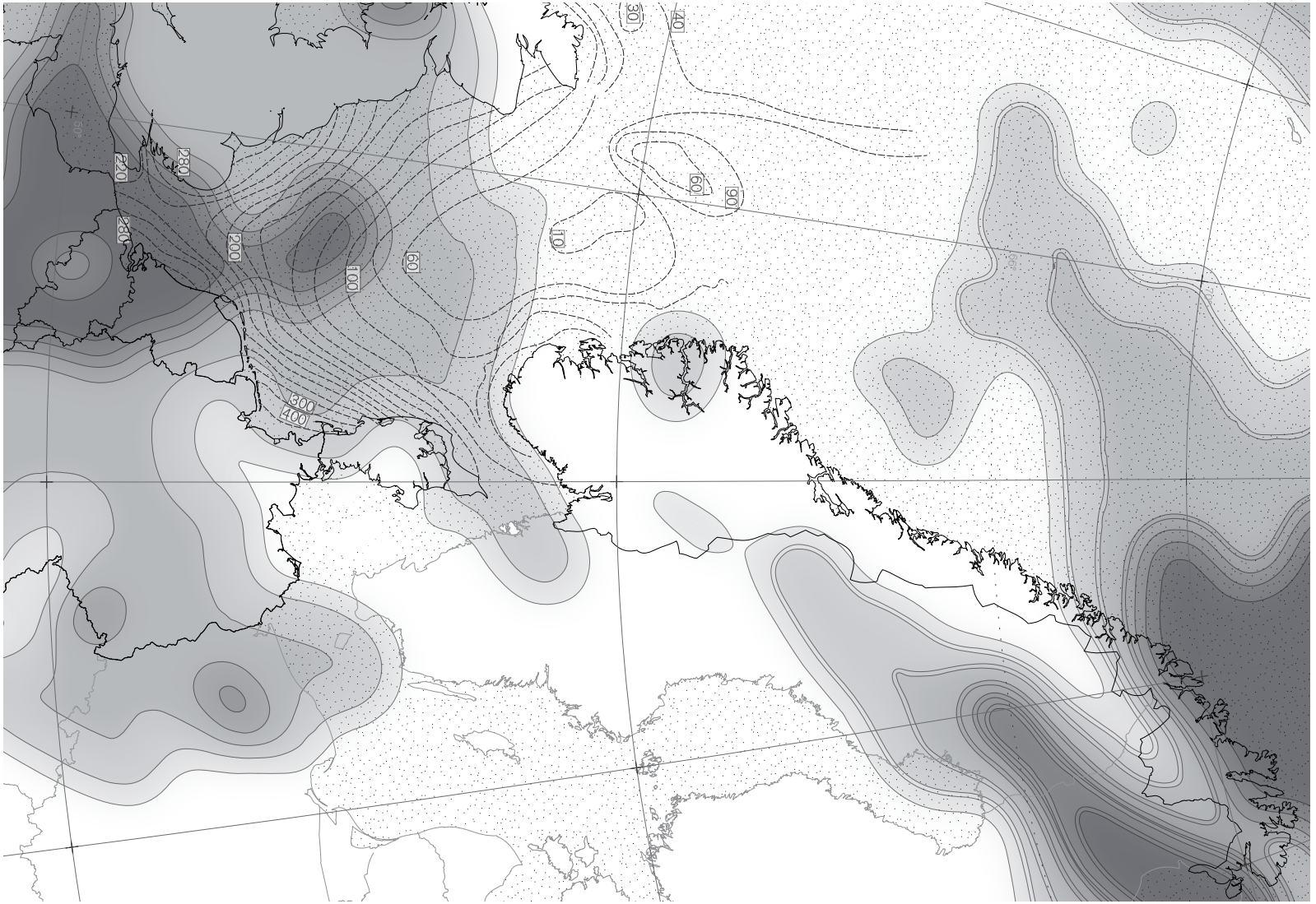
Key words: climate change, relative sea level rise, urban context, liveability

The North Sea

Storm Surge

This map represents the extreme scenario for wind speed and air pressure in the future, during winter time. The frequency of winds will increase up to 7% in North West (Martin Beniston, 2007). These conditions will create more storms along the coastal regions of Holland, Germany and Denmark, leading to storm surges, wind will push water towards the coast, it accumulate in a storm surge (Martin Beniston, 2007) and will transport moisture on northern Europe and Scandinavia. That determines the excess of precipitation over evaporation. (Hurrell, 1995; Sündermann, 1981)

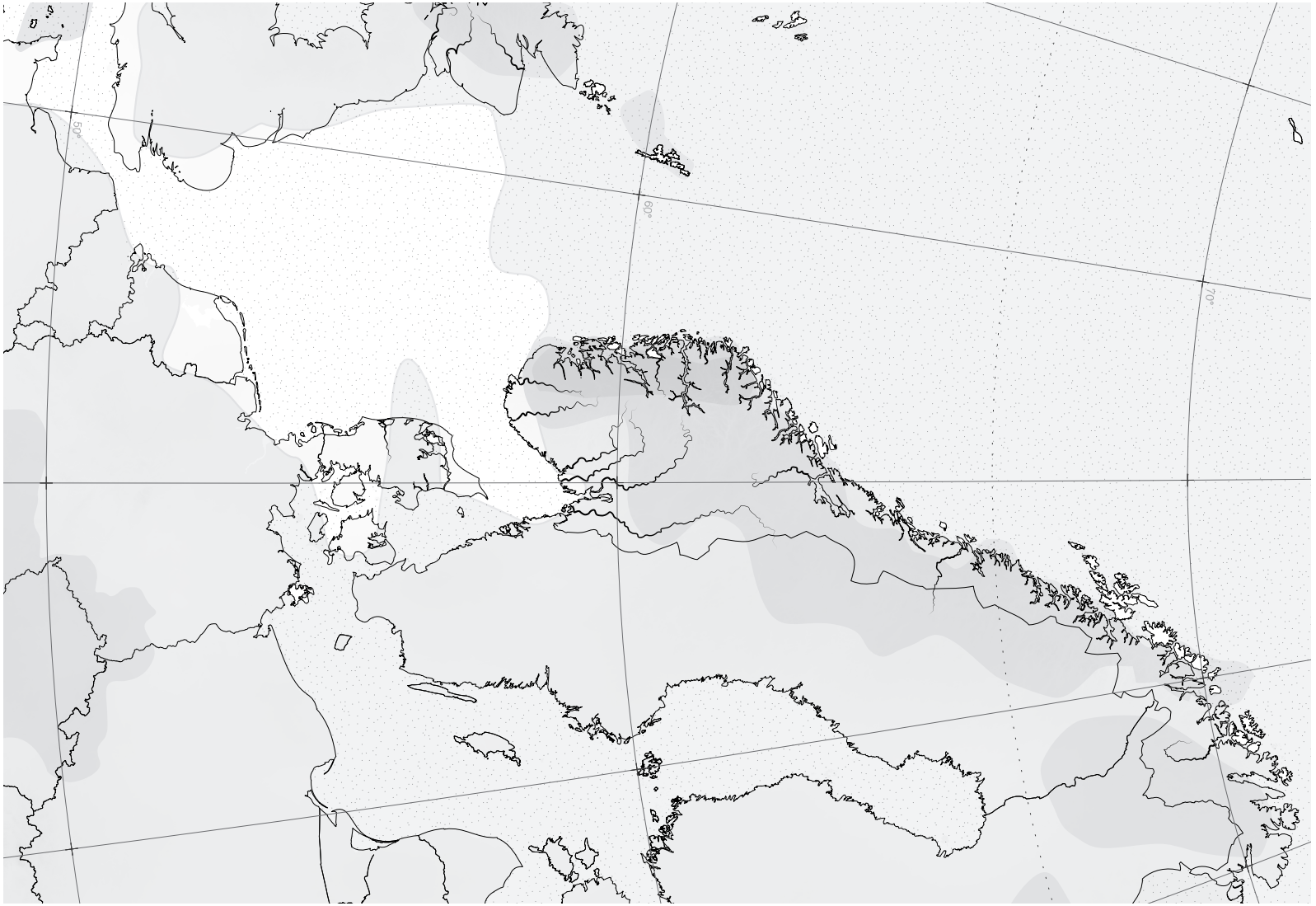
Altered Storm Surge Patterns



Summer Precipitation

The map illustrates the modelled prediction of precipitation for Summer in the North Sea region for the year 2100. Further it illustrates the change in extreme 1-day rainfall events in summer in comparison to current trends. Lastly, the map shows rivers that experience a decrease of size in their floods during the summer. In order to simplify this data has been reduced to only show which rivers experience this reduction or increase (in winter) and not the percentage.
In general
a decrease in rainfall during summer is the most likely development for the coming years. Especially, the southern regions will experience a drastic decrease. Close to the North Sea this will exacerbate the likelihood of droughts during summer and threaten the supply of drinking water. For the Northern countries this development will come with some advantages as river floods become less likely and smaller in size. Yet especially the Oslo region as well as some of the extremely northern lying parts of Norway will experience increasing rainfall also in summer. The visible divide between Scandinavia and Western Euro- pe is mirrored in the map illustrating Winter precipitation.
Sources: (Alfieri et al., 2015; Beniston, 2007; NCAR, 2004)

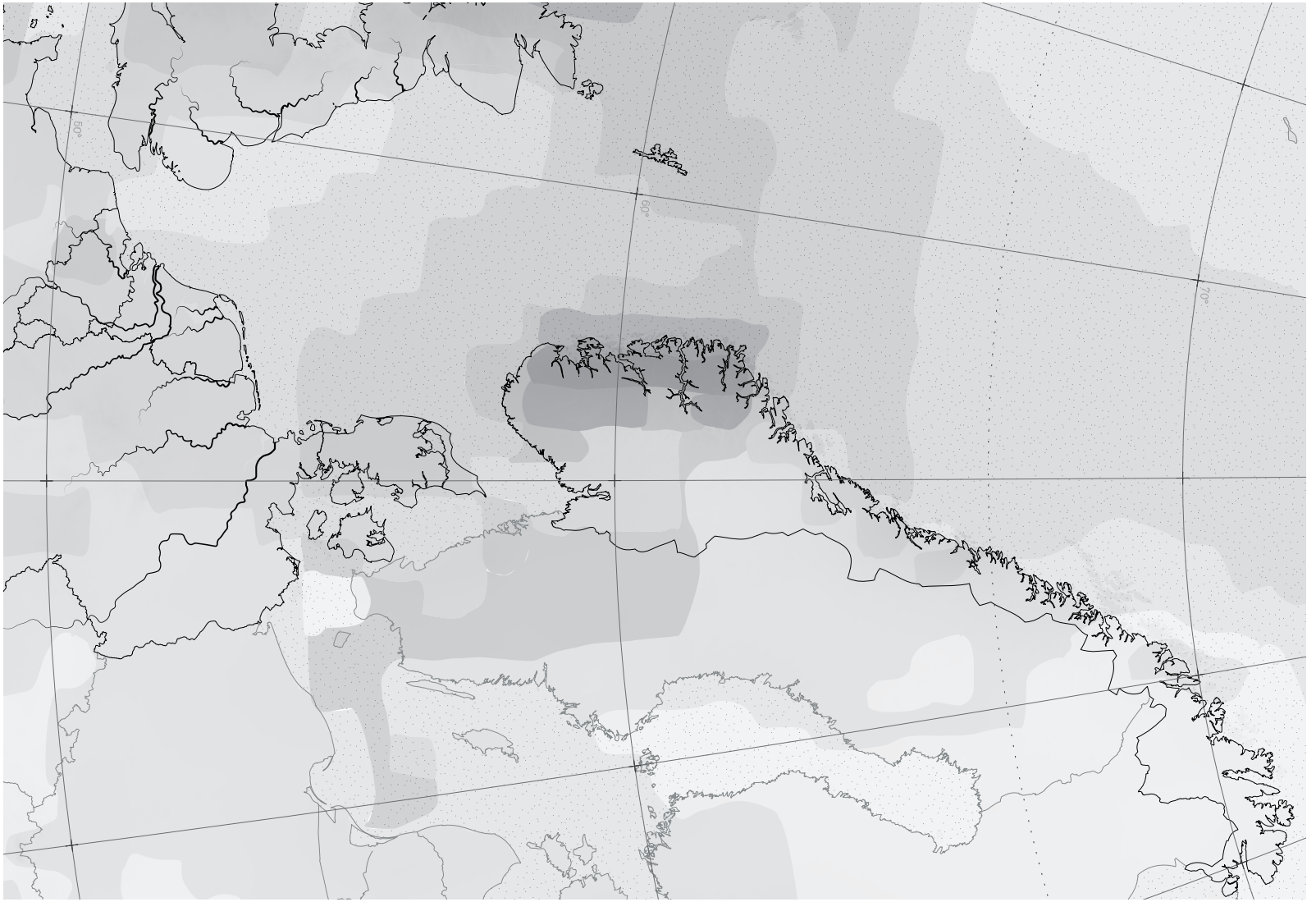
Altered Summer Precipitation Patterns



Winter Precipitation

The map illustrates the modelled prediction of precipitation for Winter in the North Sea region for the year 2100. Further it illustrates the change in extreme 5-day rainfall events in winter in comparison to cur- rent trends. Lastly, the map shows rivers that experience an increase of size in their floods during the winter. In order to simplify this data has been reduced to only show which rivers experience this surge and not the percentage of change. In general the coastal regions of the North Sea proper will experience increases in rainfall averages as well as extreme rainfall events. This is also evident on the British Isles, where especially England and more specifically Eastern Anglia will suffer from heavier rainfall and an increase in river floods. Norway, on the other hand, will see a general decrease in these rainfall events in sumemr with exclusion of the mountain ranges in the South West of the country. The visible divide between Scandinavia and Western Europe is mirrored in the map illustrating summer precipitation. As a result we see that Germany, the Netherlands, Belgium, the UK as well as Denmark will witness more extreme rainfall in Winter and more periods of precipitation drought in summer, exarcerbating the impact of water shortage and floods. Sources: (Alfieri et al., 2015; Beniston, 2007; NCAR, 2004)

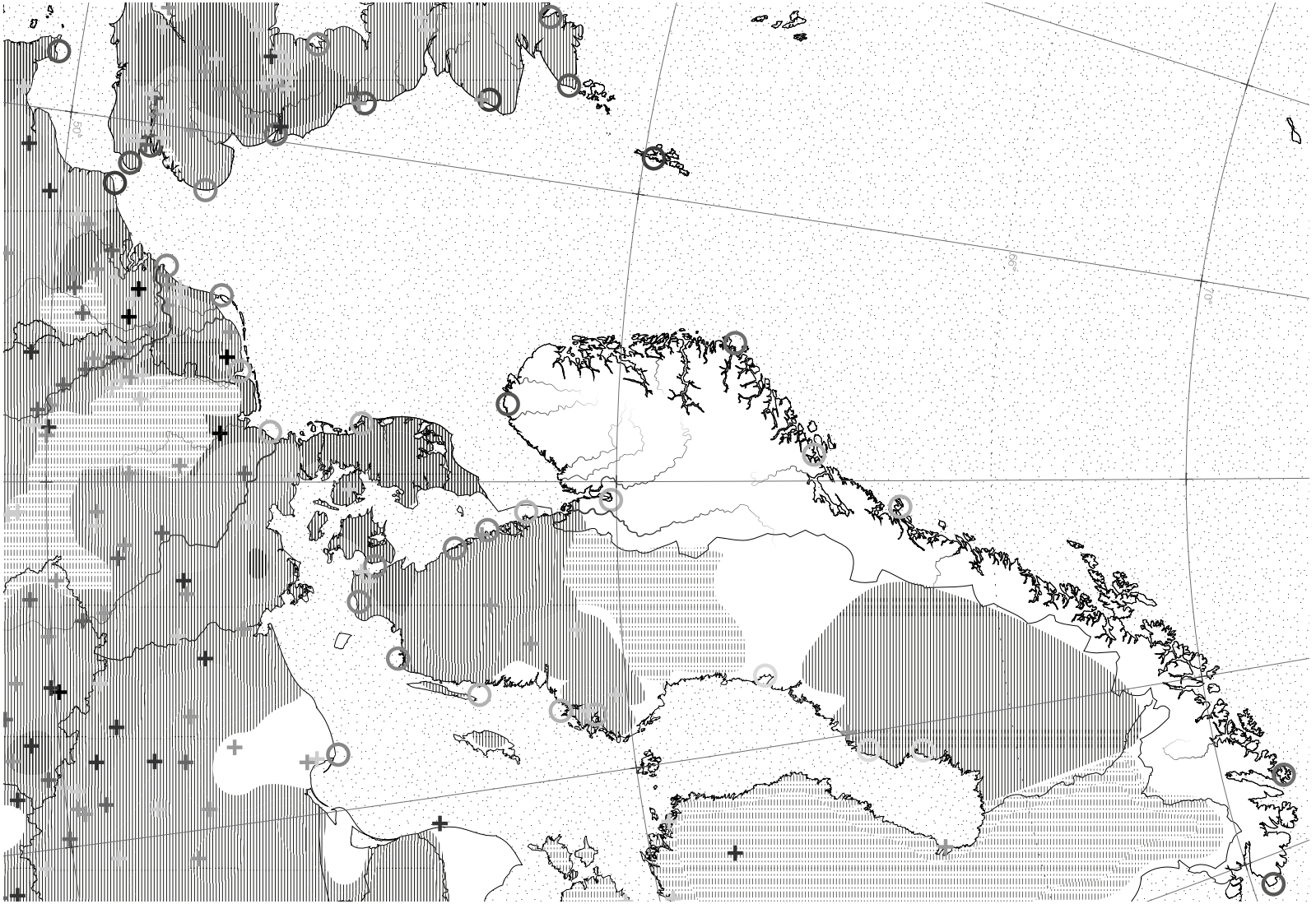
Altered Winter Precipitation Patterns



Flood Projection

This map reveals the relative change in expected annual damage between the periods of 2071 to 2100 and 1961 to 1990 as a result of flooding events under the RCP 4.5 scenario. What can be gathered from this mapping is that France, UK, Denmark, and the Netherlands will experience the most increase in annual damage, whilst Portugual, Romania, Finland, and Estonia will experience the most decrease in flooding.
Additionally, this conclusion has been correlated with other sources, that project an increase in coastal and river flooding in the same areas aforementioned, to reveal a similar pattern.

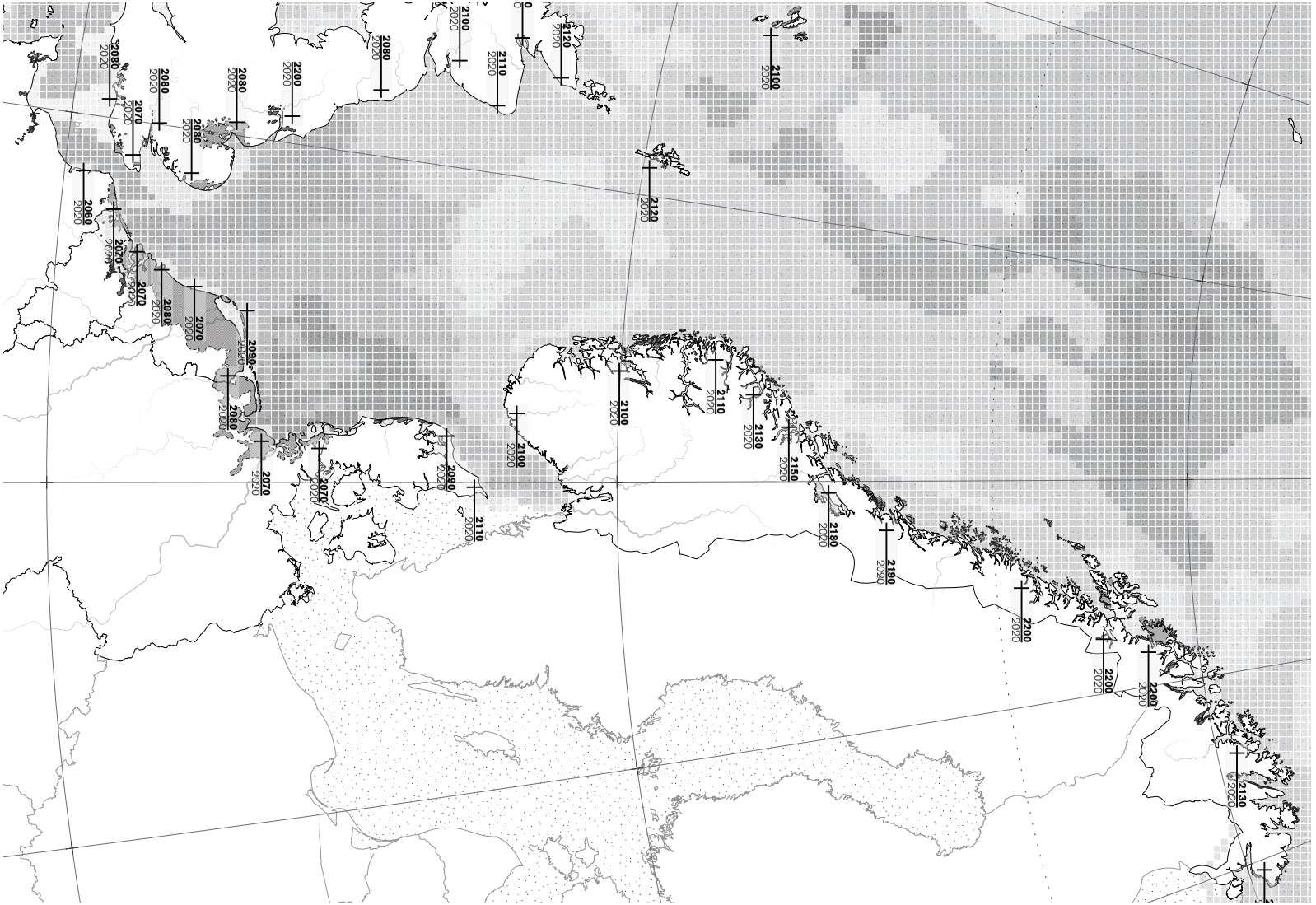
Flood Projections



Relative Sea Level Rise

This maps illustrates the extreme effect of the climate change in case of +1m sea level rise (SLR) in regard to 8.5 RCP scenario and in the absence of action. The sea projection depicts a prediction for the relative sea level rise in the period 2081-2100. The map renders the flood risk areas in the North Sea region and provides information about when those events are expected to be formalised: as extreme event (Flood) or constant condition (Sea Level Rise). In the aftermath of relative sea level rise, the huge part of the coastline shall be reconsidered in terms of water defence systems and urban strategy. The entire seascape is expected to fully reshape, where most vulnerable countries to those changes are Netherlands, Germany, Denmark, but also part of England. The increasing amount of sea water will affect many aspects of the human habitat, like for instance the entire primary sector of the economy, the appearance of the wide maritime areas etc.

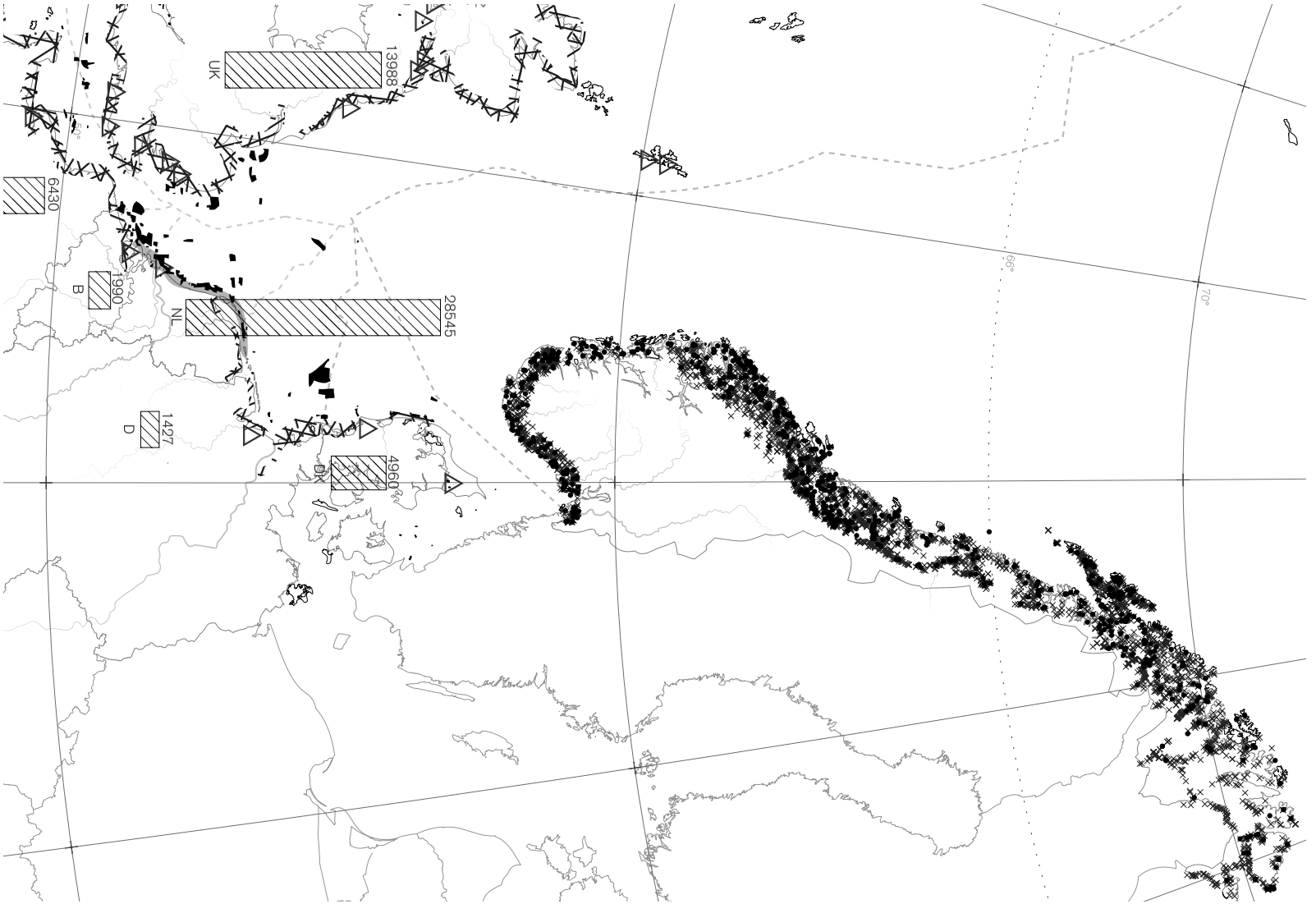
Points of Conflict due to a Relativ Sea Level Rise



Human Intervention

Artificial structures construction activities in the North Sea area. Aggregates, sand and gravel withdrawal sites in Norway indicate exis- ting and possible sites for utilizing raw materials in constructions.

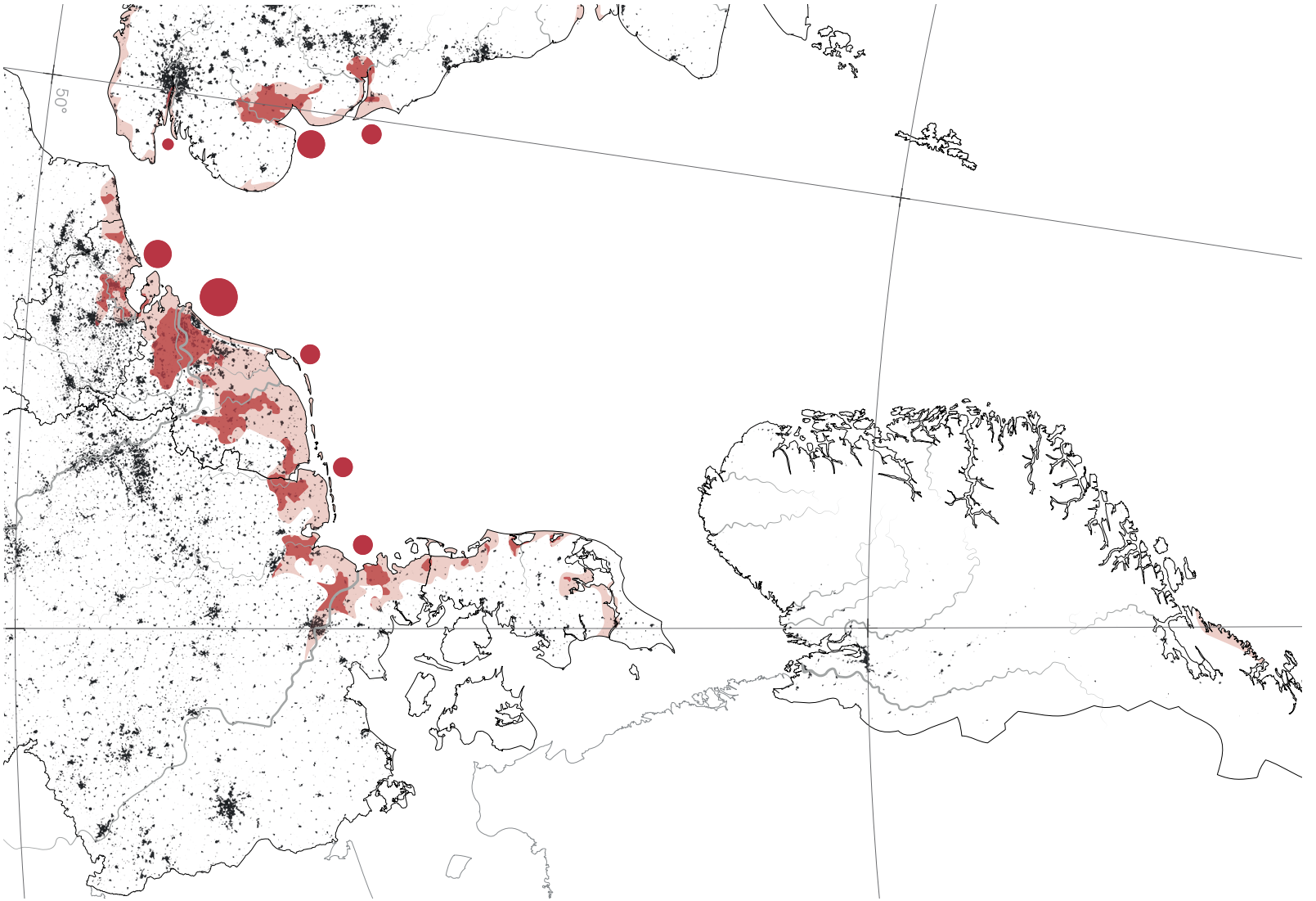
Investments in Coastal Protection per Year and Country



Risk Assessment of Flooding

Areas predicted to be in risk of flooding by rivers and the North Sea in case of 5 meter relative sea-level rise. The map demonstrates that the most vulnerable urban areas are located along the southern coasts of the North Sea; Belgium, The Netherlands, Germany, and Denmark

Hot Spots: Primary Conflict Areas due to Sea Level Rise



Rotterdam

Rotterdam

Rotterdam and its harbour (the biggest in Europe) is one of the lowest areas along the south coast and it is here where changes will be most apparent. The city is built in a natural river delta, which has been altered extensively in the last millennia to facilitate a desirable and safe living environment for its inhabitants, initiating in the 14th century with the damming of the river Rotte. A sluice was installed to secure the hinterland from flooding and convert it into habitable land. From then on, the settlement around the lock mechanism has evolved into one of the biggest urban areas in the Netherlands. It is here, where floods would cause economic loss through damage to property and social disruption to the population.

Through history, the morphology of the city and its relationship with water has been mainly influenced by the development of its harbour. Since the harbour has been moved out of the centre to accommodate bigger ships and therefore a demand for more space, the residential areas of the city could expand in these vacant industrial districts.

Rotterdam Greater Urban Area

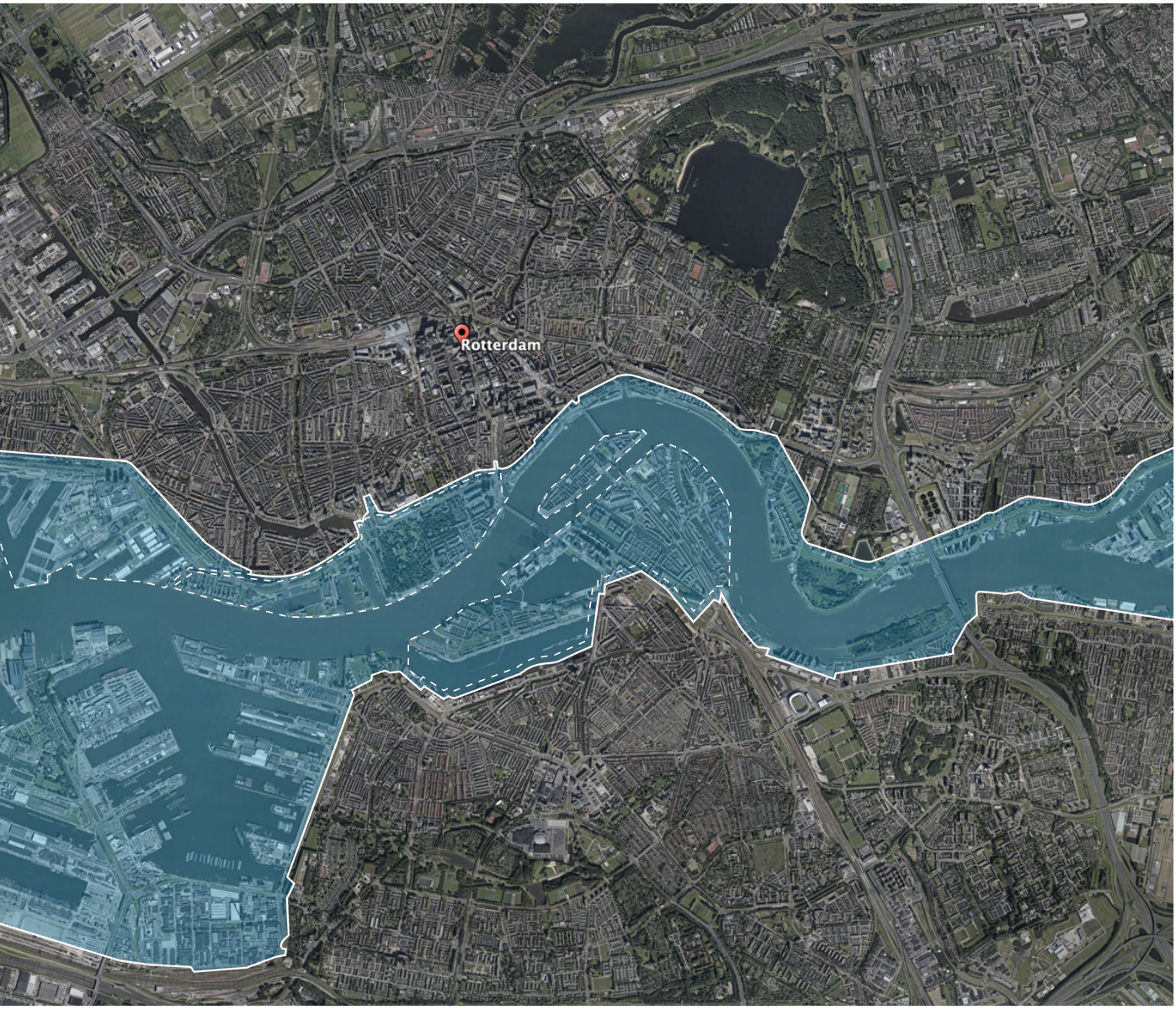

Rotterdam

1350 Dam Instalment Rotte

Outer Dike Area Rotterdam


Rotterdam

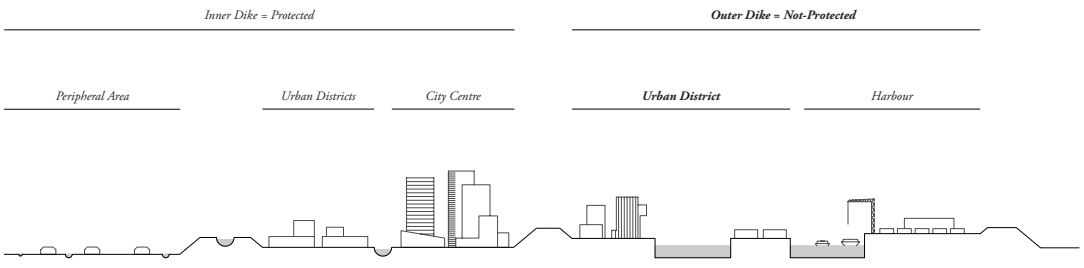
Outer Dike Residential Urban Areas


Rotterdam

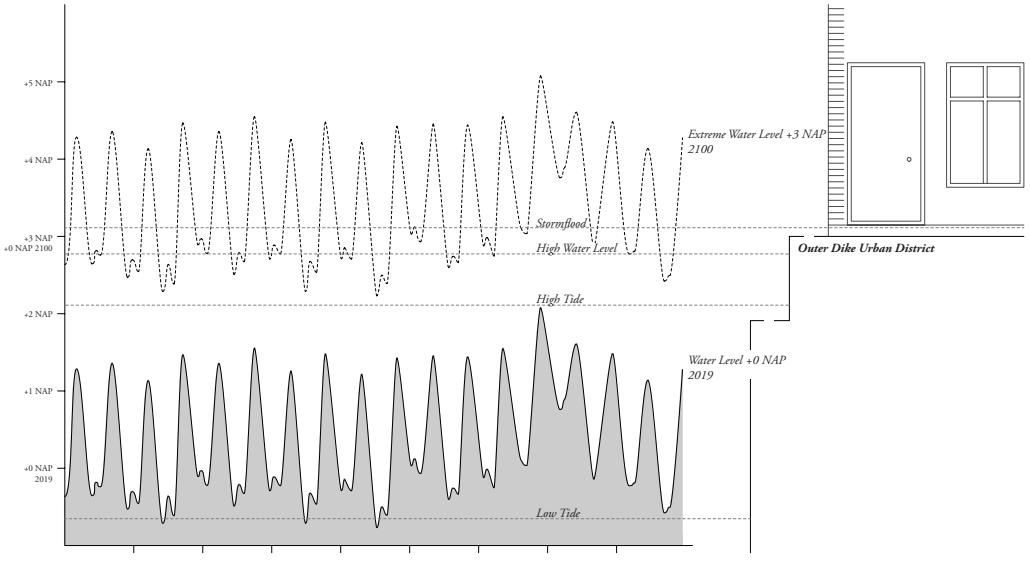
Water Managment Section Rotterdam

Altered Water Dynamics: +3m Relative Water Level

Water Managment section Rotterdam

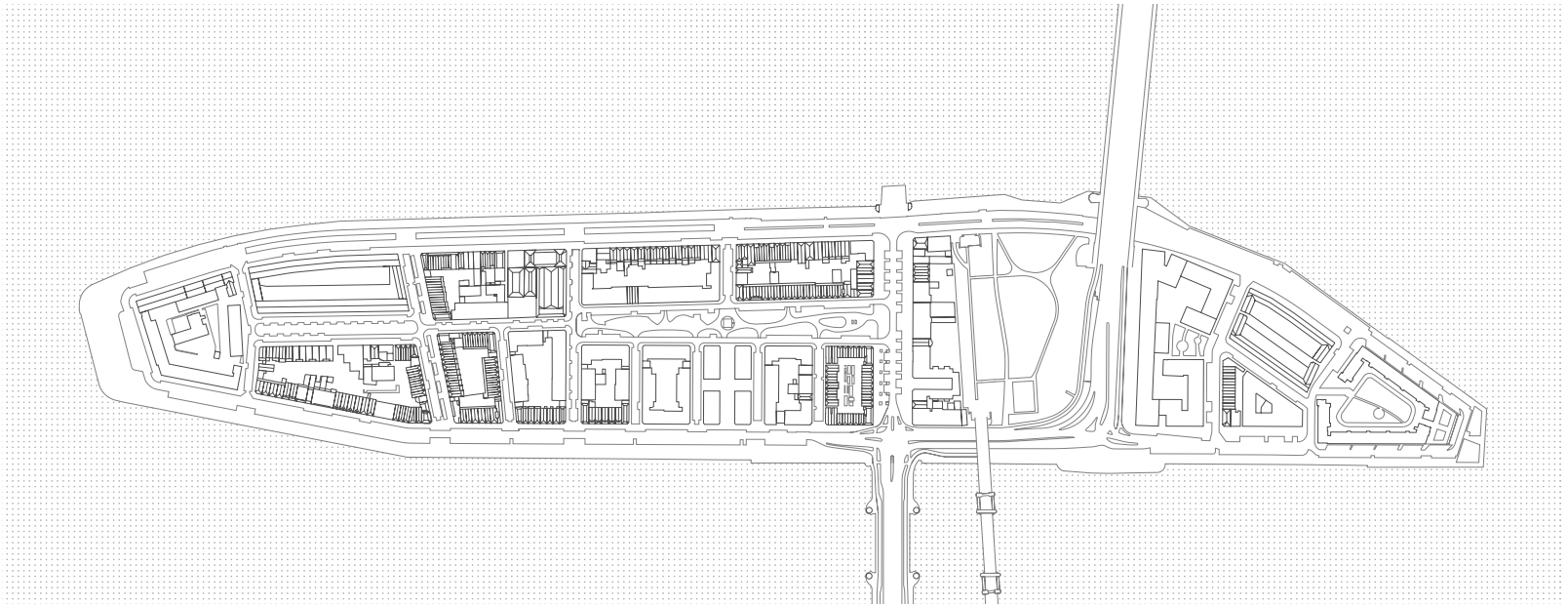


Water Dynamics Maas



Panorama Noordereiland

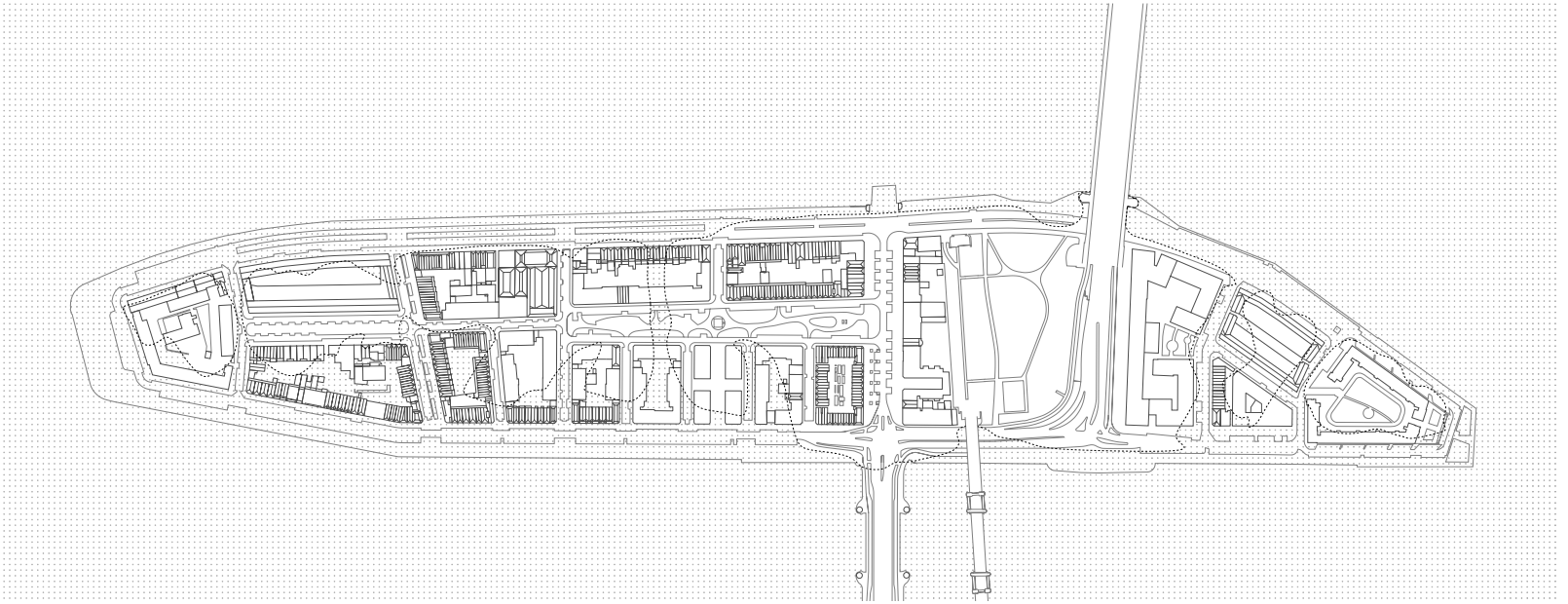
Nooordereiland Site Plan



Flooding Scenario +3m

This mapping depicts the daily flooding level with Inundation depths up to three metres, when paired with high tide. Therefore the street network and the ground floor of the existing buildings will become dysfunctional.

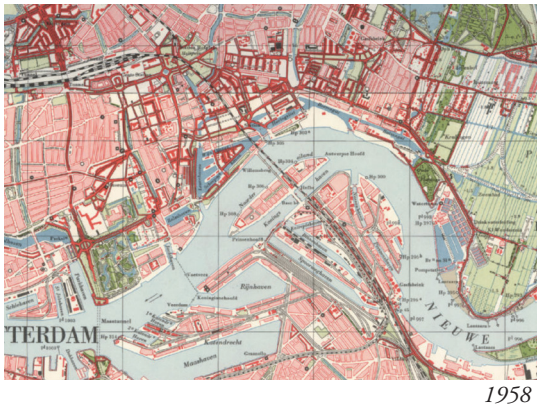
Nooordereiland Site Plan



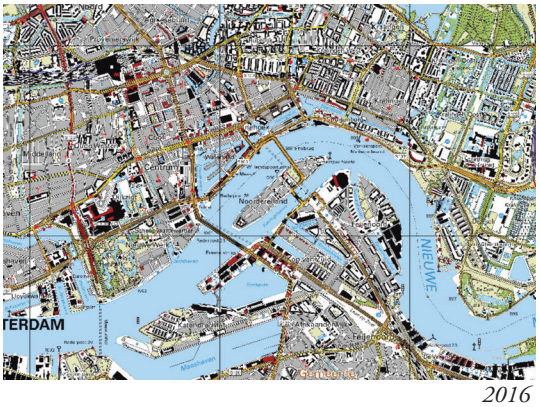
Noordereiland Site Development 1880 - 2016

1850

1907



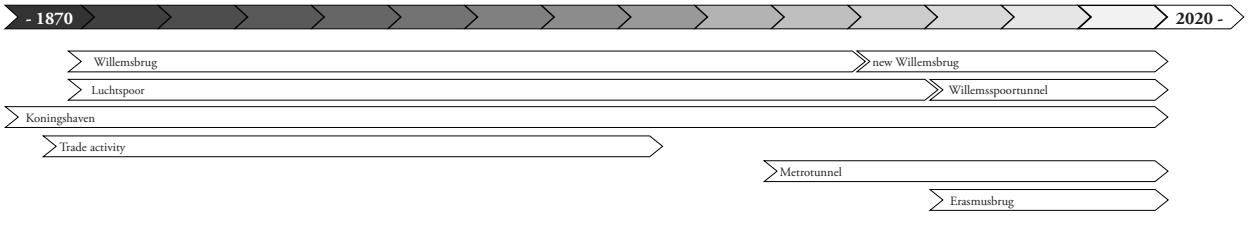
1958



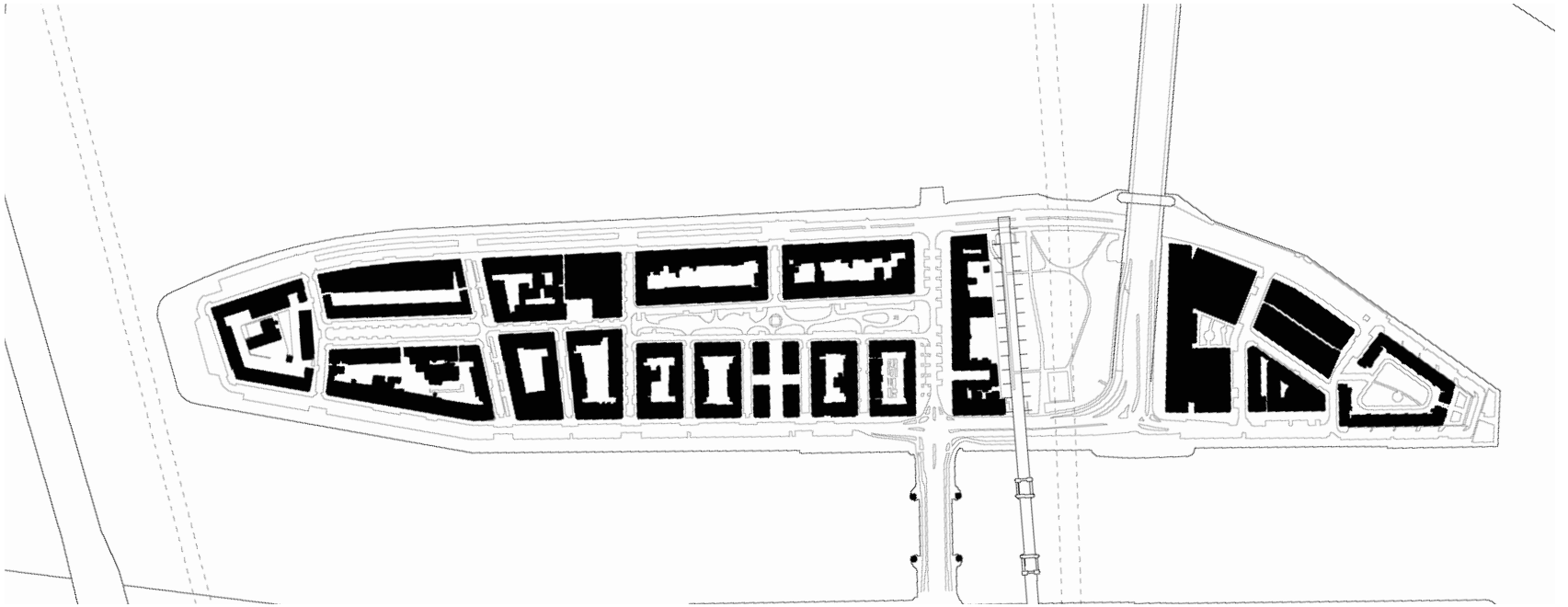
2016

Infrastructural Development "around" Noordereiland

Once the island possessed the monopole, it was the only interface between North and South Rotterdam. With the infrastructural developments in the last century, the traffic axes were re-located around the island: train and metro were tunnelled, and the Erasmusbridge now functions as the main connection between the two embankments.



Infrastructure: Development around Noordereiland



Problem Statement

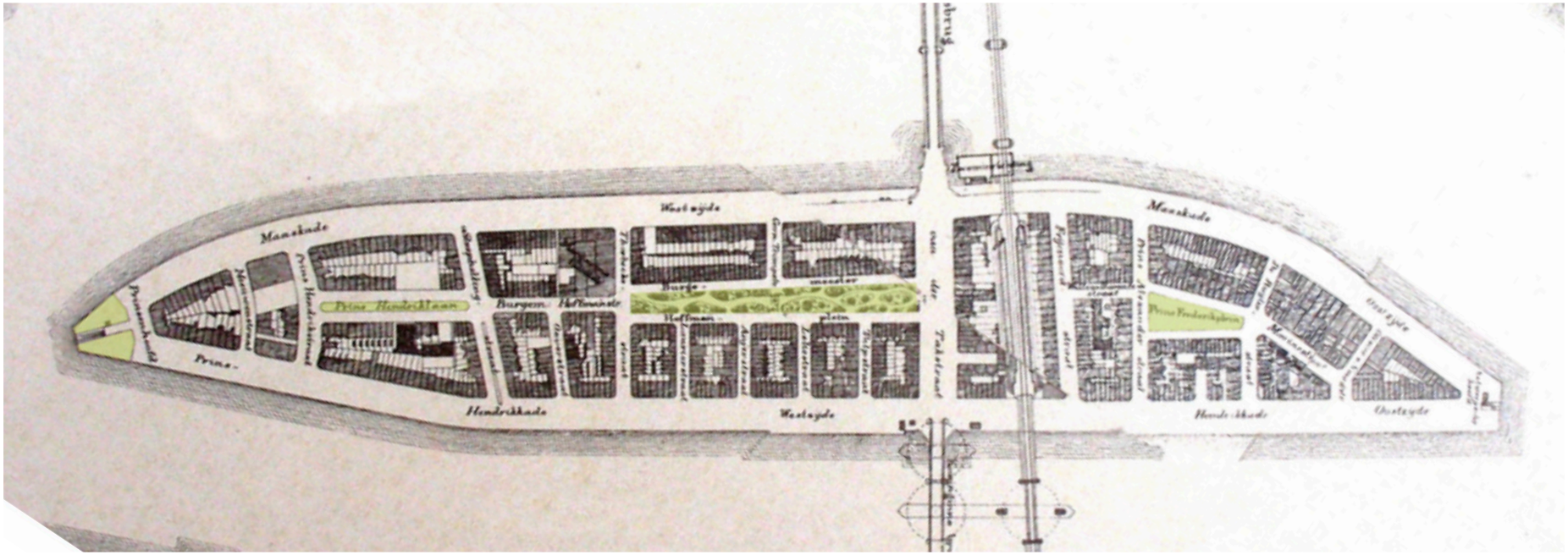
The role of Noordereiland to the city has been greatly compromised by three different strands of developments: the infrastructural negation, the social negation and the flood risk. The city island has therefore evolved from acting as a part of the city harbour and as the connector, being the southern gate to Rotterdam, to turning into a space in the transition zone between the old and the new districts.
Initially, the area of Noordereiland was a piece of land, belonging to the peninsula Feyenoord, located opposite of the historic city centre and shipping docks on the southern embankment of the Maas. Only a ferry connected the two sides. Due to an increasing harbour activity and a growing population, the expansion of Rotterdam towards the South seemed logical. With the excavation of the Noorderhaven (now: Koningshaven), the peninsula was divided into the remaining Feyenoord and Noordereiland to facilitate ship docks. Following, the two embankments were connected by permanent bridges. The Italian novelist Edmondo de Amicis stated in his travel-guide of the Netherlands "Holland and its People" beautifully described the perception of Rotterdam from the train, arriving from the South, crossing Noordereiland. It seemed as the gate to Rotterdam.
However, with recent infrastructural changes (re-locating the train into the Spoortunnel, crossing the island below; the digging of a Metrotunnel and the Maastunnel, which moved the main traffic axes away from the island; the construction of the Erasmusbridge, which then became the main connection between the North and the South; and finally the de-commissioning of the old bridges and the construction of a new one). These developments shifted all the traffic from going over the island, to going around. It became an infrastructural roundabout.
This phenomenon also found parallels in the city development, which followed the newly imposed axis of the Erasmusbridge. Leading also towards a social negation of the space. The newspaper "Het Vrije Volk" already fore-saw in 1961 the turn towards the negative, naming the lead article: "Island without future...".
Additionally, the apparent climate change, resulting in a relative sea level rise and more frequent flooding on particularly this exposed piece of land. This would lead to a loss in economic value, as parts of the district would be destroyed. Furthermore, the inaccessibility would affect the social acceptance, tolerating the compromised circumstances.

Thus, these findings have motivated me to shift perspective on the island. Rather than seeing it as an object functioning as an infrastructural roundabout, it could be seen as an ideal urban test lab to assess possibilities of how to deal with increased flooding in an urban environment. Contrary to the modernist approach, where architectural experimentation was executed outside the urban, I want to re-introduce the experimentation back into the city.
For that, I want to draw a parallel to Coney Island, famously named "the laboratory of the Technology of the Fantastic", by Rem Koolhaas in Delirious New York. With the shift in perspective, Noordereiland can potentially become the urban laboratory for the technology of flooding.

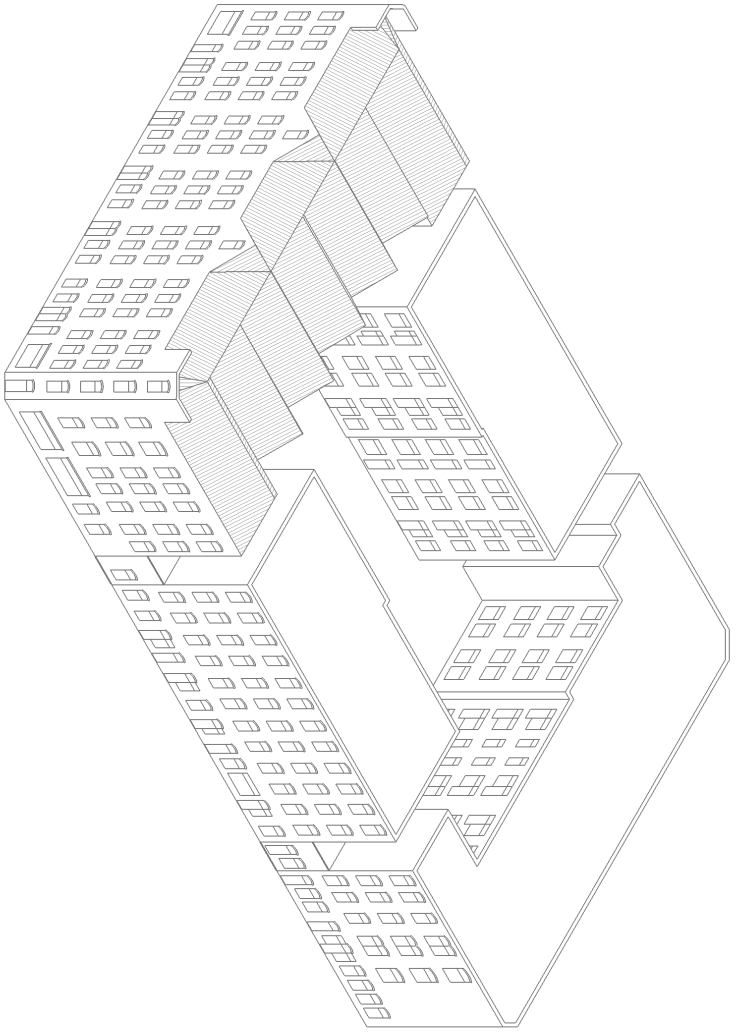
Imposed Urban Plan for Noordereiland 1880

With the digging of the Noorderhaven in 1880 and the construction of permanent bridges the island was made accessible and became an urban extension to the existing Rotterdam. The still existing block structure is representing a long lasting Dutch urban tradition of planning. Therefore I am focussing on the individual block to develop a strategy to build an experimental case study of how to dwell under these extreme circumstances.

Urban Plan Noordereiland 1880



Existing Block Axonometric View



Infrastructural Development "around" Noordereiland

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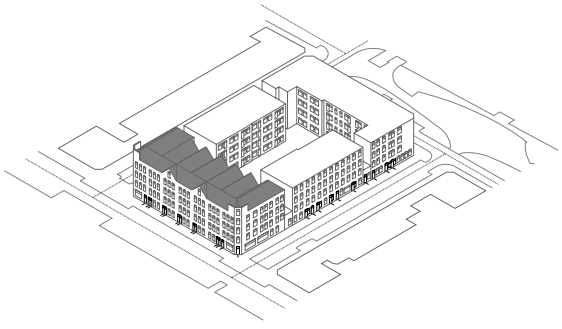
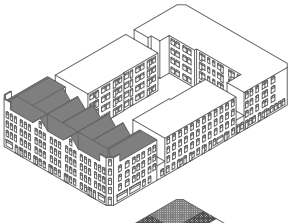
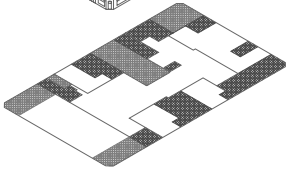
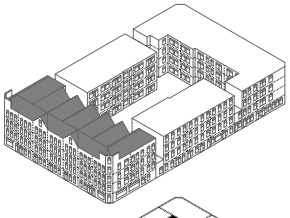
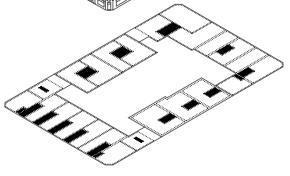
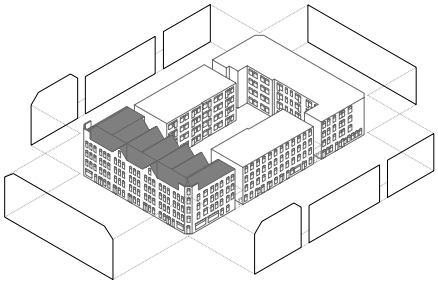


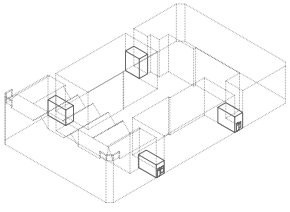








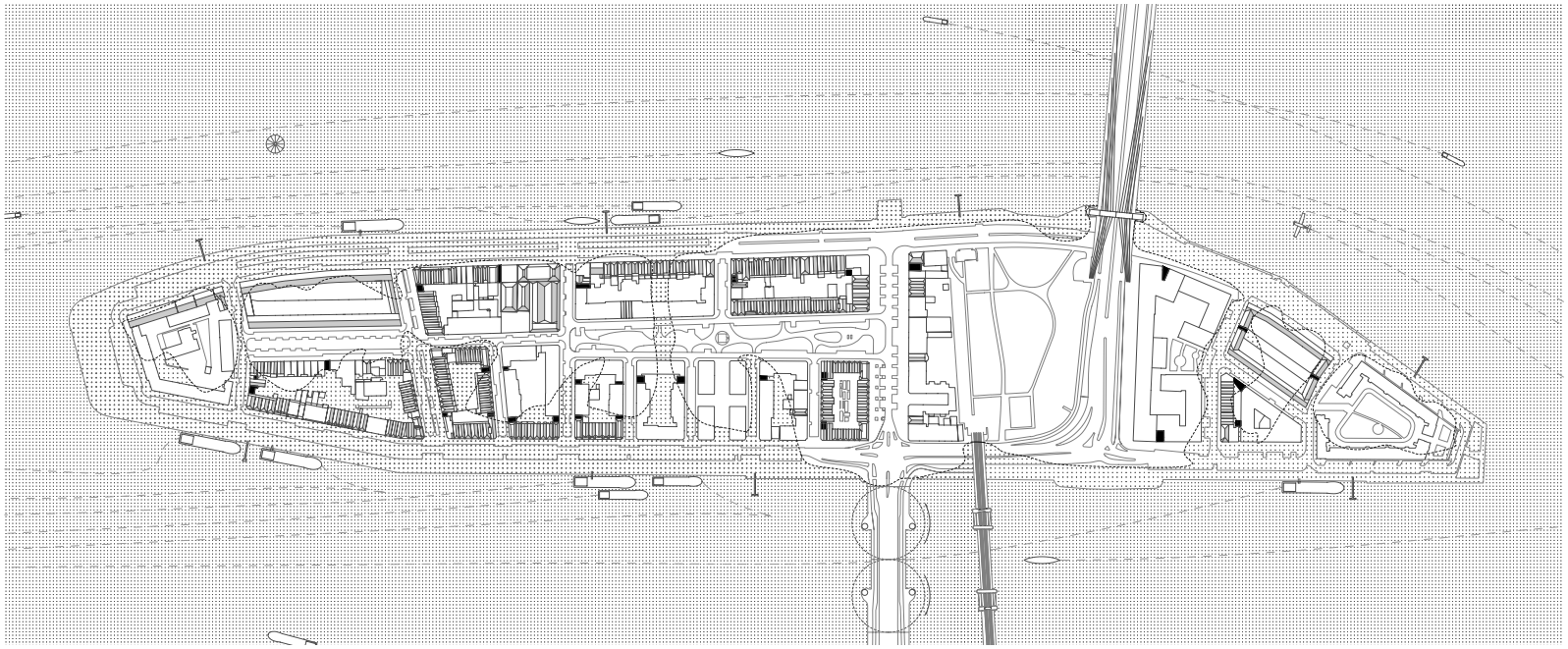




Identified “Weak Spots”

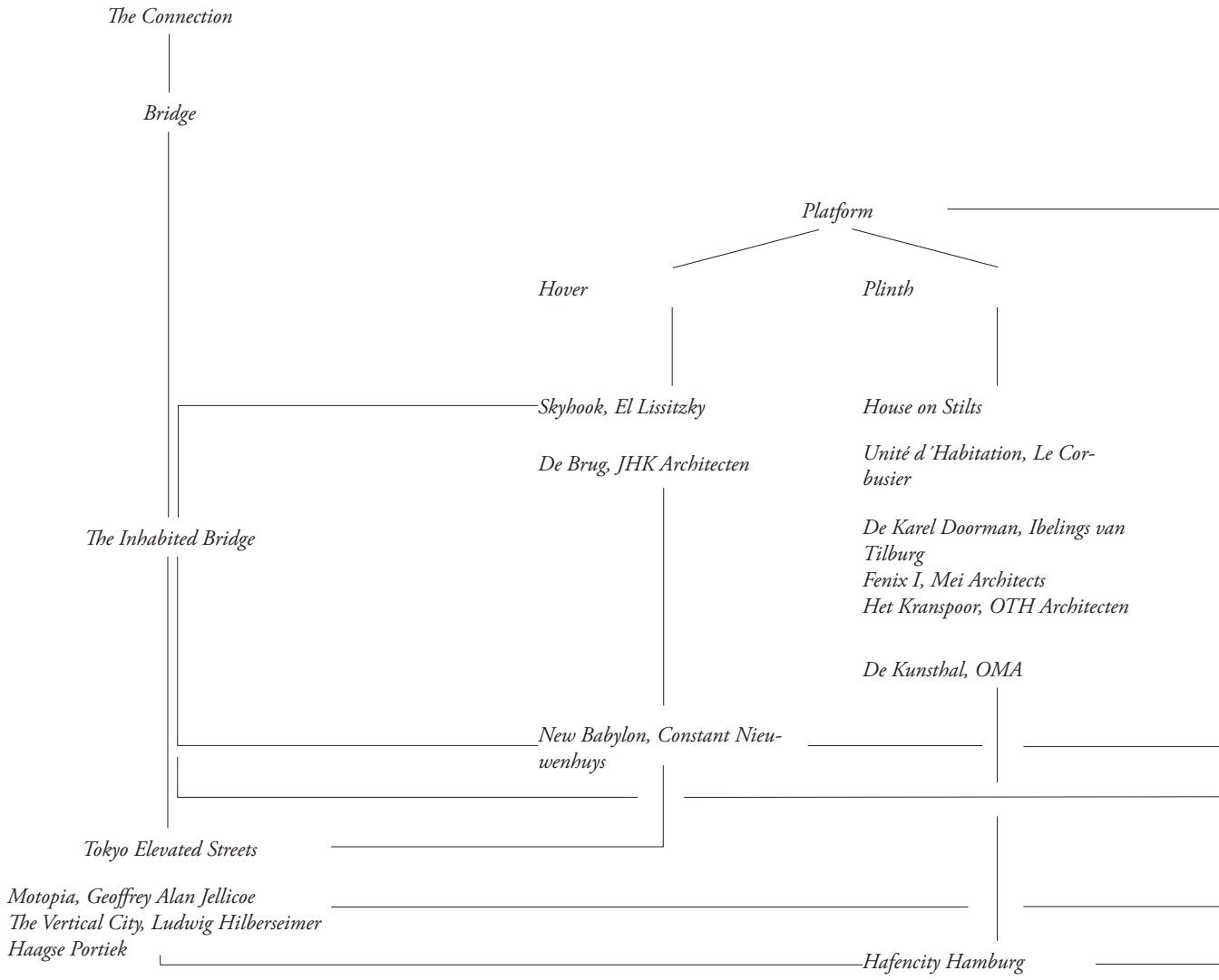
The mapped locations map the point of intervention of the project. They build the interface between the ground level and the new circulation system.

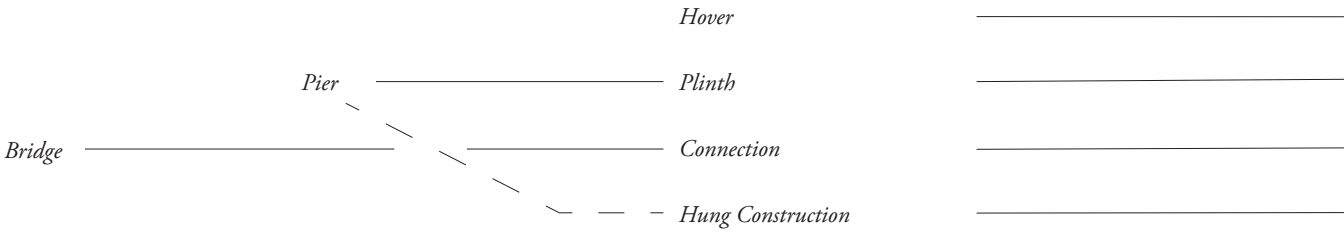
Nooordereiland Site Plan

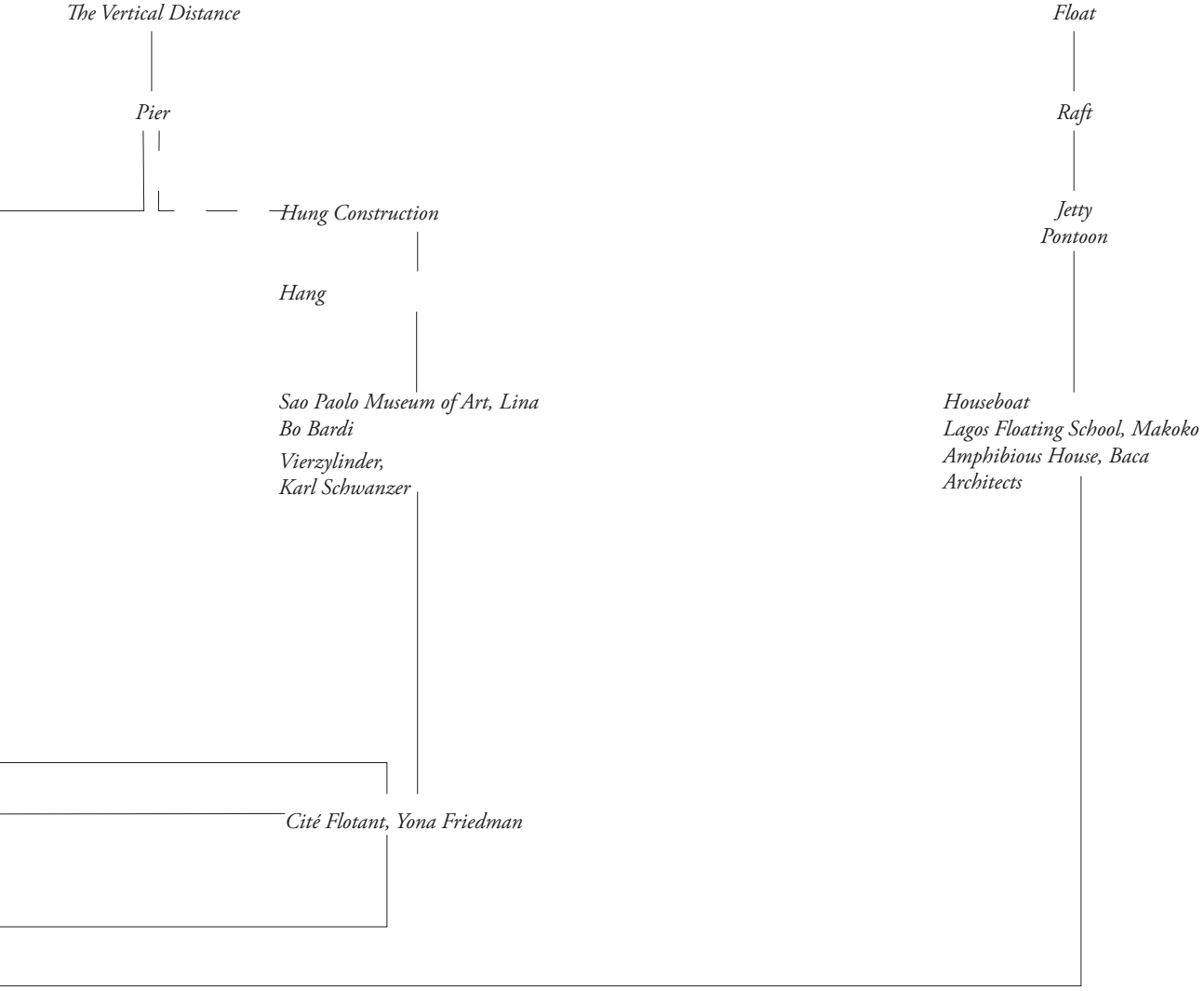


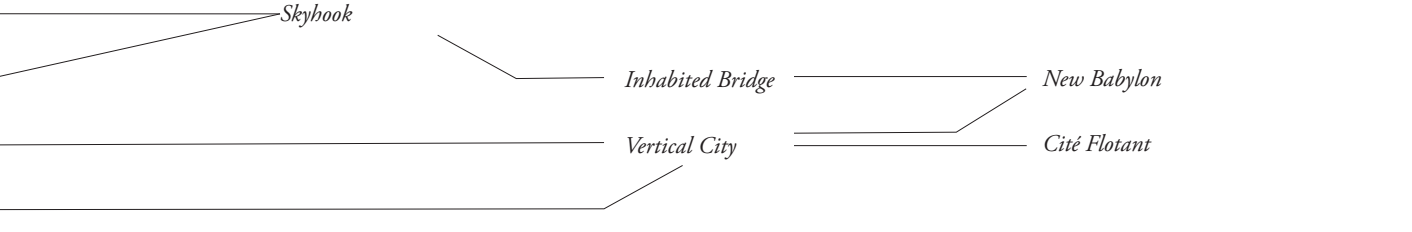
Research by Design Precedents

Building above (on/over) Water

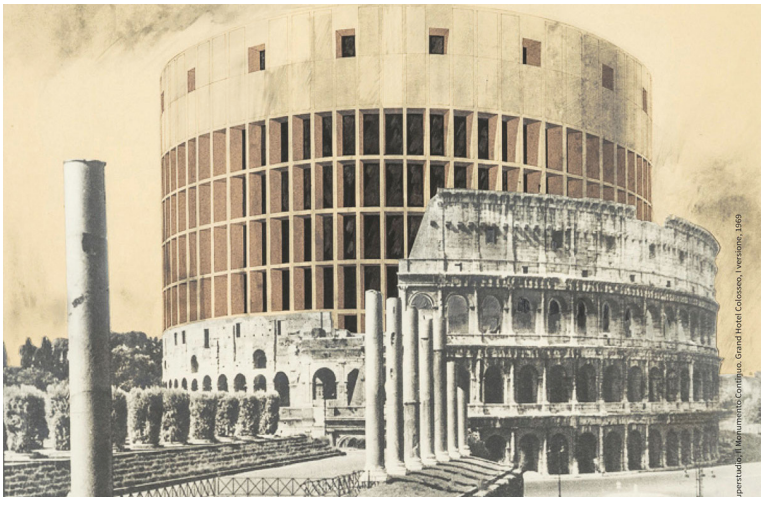





The Vertical Distance
Pier
Hung Construction
Hang
Sao Paolo Museum of Art, Lina Bo Bardi
Vierzylinder, Karl Schwanzer
Cité Flotant, Yona Friedman
Float
Raft
Jetty
Pontoon
Houseboat
Lagos Floating School, Makoko
Amphibious House, Baca Architects

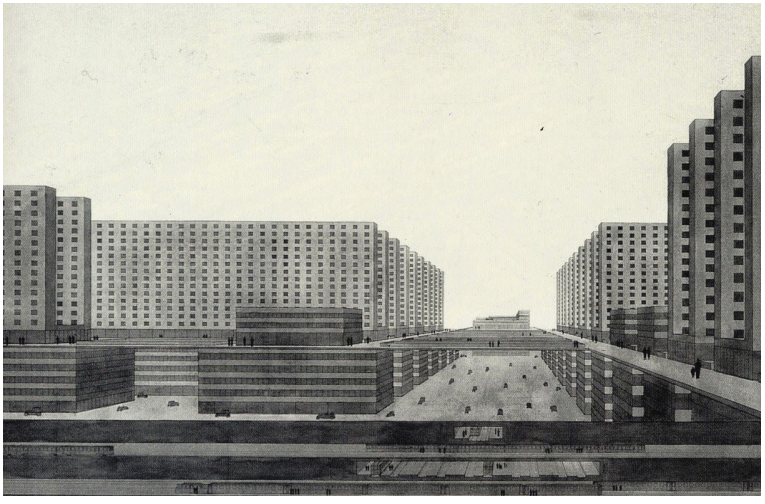

Skyhook
Inhabited Bridge
Vertical City
New Babylon
Cité Flotant

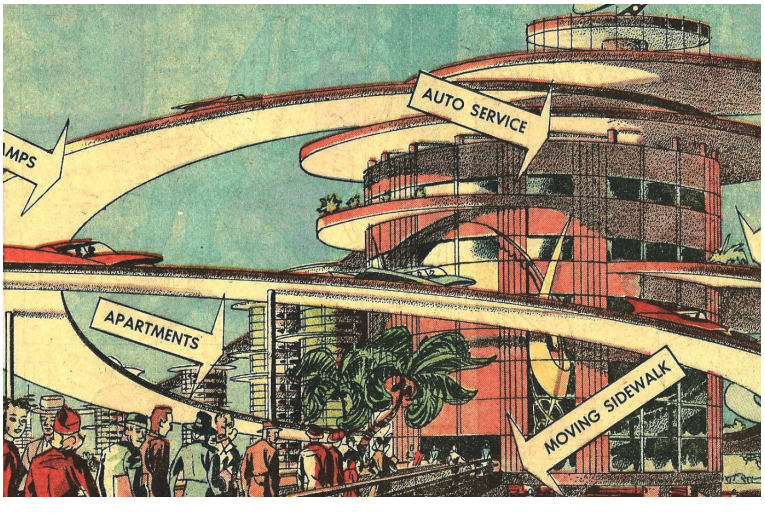
Precedents: Superimposition

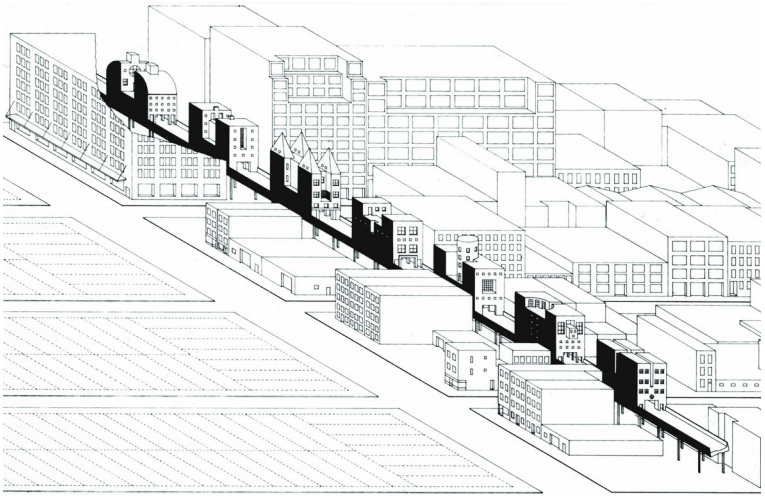


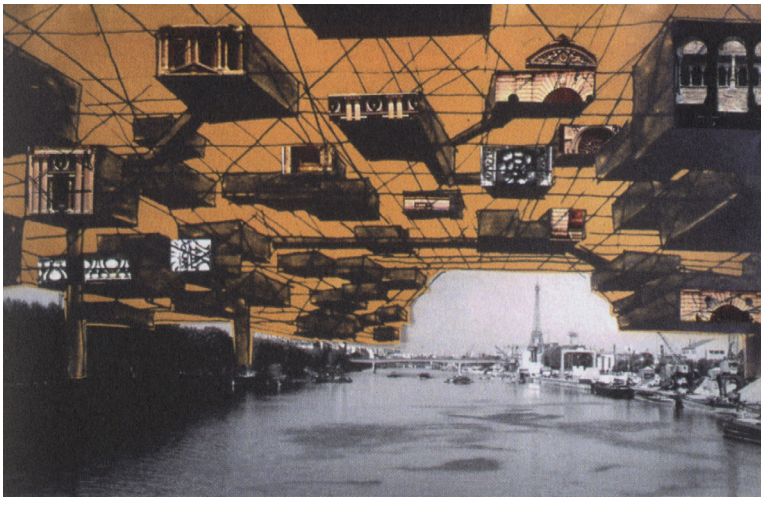
Superstudio, Il Monumento Continuo, Grand Hotel Coliseo, I versione, 1969

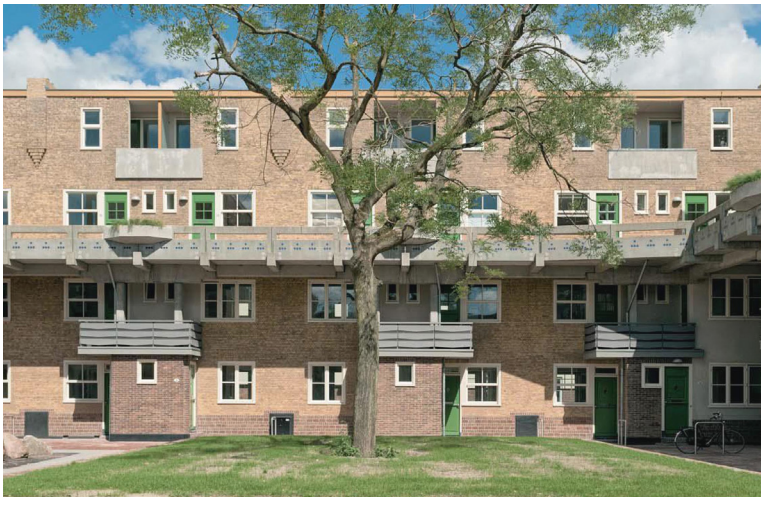
Precedents: Layer




AUTO SERVICE
APARTMENTS
MOVING SIDEWALK







Research Question

In the course of the research I limited myself to the scale of the urban block, a generic building element, defining the Dutch city. As in most of the parts of Rotterdam and other cities in the Netherlands (and Europe for that matter), Noordereiland is also put together by a number of blocks, which form the conglomerate of the district. From the initial urban concept for the island in the 1880s, the division into blocks has remained unchanged.

Therefore, aim of Noordereiland as an experimtal laboratory was for me to find a correlation between the morphology of the urban block and the exterior influence of flooding. The question arose:

How to transform the existing systematic of the Dutch block into a new generation block, which is able to cope with flooding? How is it able to maintain the block under those circumstances?

In that, the process of analysing precedents demonstrated itself as most valuable, understanding their systematics and what aspects could aid the block as a whole to be transformed. Important to me was not the single unit, but the whole system of the block.
I divided my precedents into three categories according to axes: site specific (Dutch) - non site specific and coherent (flooding) and non coherent. My categories were as follows: site specific - coherent, non site specific - coherent, non site specific - non coherent.
As stated, the accessibility of the block system became the most pressing question to answer. To escape the flooding danger, the gaining of distance to the building structure became essential. Therefore, I aimed my quest into finding possibilities of how to convert the now planar street level into a vertical one.

Position Paper

On Forms of Living

On Forms of Living

Resistance or Acceptance

As one of the effects of climate change, the relative sea level rise is turning out to be the most threatening factor for populated coastal urban areas. The force of water is increasingly working against the growth patterns of these cities and from time to time infiltrating into residential areas, causing negative social and financial effects on the population, sometimes even casualties. It is here, where we as spatial planners have to ask ourselves how to handle this conundrum in the decades to come: either offering resistance by increasing the size of existing flood defences and instalment of new ones, maintaining the same mentality from centuries past, or investigating in possible solutions to accept more frequent, almost usual inundation by controlled mechanisms and different ways of constructing.

In recent years, it has become more and more evident that our climate is changing. Scholars are agreeing that the mean temperature rise will affect our weather conditions; they are becoming extreme. We are expecting more precipitation in winter, less in summer and fiercer and more frequent storm surges. Most significantly, due to the melting ice caps of the Arctic and Antarctic some scholars estimate a relative sea level rise of up to three meters until 2100 (Dewi Le Bars et al, 2017).

Hence, coastal areas are especially threatened by the changing water circumstances. Higher water levels will change the shape of the coast. It is here, where the effects of climate change will be most noticeable. As currently about 40 % of the world's population lives within 100 km of the coast (Percentage of total population living in coastal areas), the rising sea level will influence on how living-patterns in those areas will be influenced in the next 80 years.

Historically, residing close to the water has always been a great advantage. The possibility of naval trade has motivated humans ever since to settle next to the sea. Furthermore, fertile grounds in delta areas spurred agricultural productivity. Resulting, those areas created desirable living situations, profiting from the proximity to the sea, both aspects, on which the cities of nowadays are built upon. However, the dynamic nature of river deltas caused unpredictable floods in these areas. To allow a safe environment to live in, humans have built flood defences in forms of dams, dykes, levees and sluices to be able to control the water by reclaiming land and then preventing it from inundation. A 1000 year long development in technology has enabled to defend against flooding by not only damming off, but also gaining and reclaiming land by means of landfills and pumping, allowing to build into the water by expanding ever-dry ground.
In that, the natural dynamics of some river deltas has been enormously manipulated to predominantly establish a hard border between land and water. This rigid edge condition has enabled the initially small harbour settlements to grow into vast urban and densely populated zones.

This rigid edge condition meant also, that it allowed cities to be built up right to the limit of the water, and profiting from its proximity. However, it turned out to be a balancing act, giving the water no space to go when levels are high and risking occasional floods. Through the relative sea level rise, therefore, the established limit between land and water is being challenged. The effects of climate change demonstrate the disparity between the hard, man-made protection of the land, which is a static piece of construction, and the dynamics of water with diurnal tidal movement, storms locally rising water levels and a rising sea level. One can see, that there are two opposite forces moving towards each other: urban developments and water. It seems, that the act of reclaiming land from water is slowly coming to an end, and turned into the opposite direction.

On Forms of Living

Resistance or Acceptance

Resistance

Looking back, humans have, in its essence, always kept the same mentality from the emerging of water management about a millennium ago until now: Constructing a hard border towards the water to protect the hinterland from flooding. The separation of land and water was done by constructing protection mechanism like dams, dykes and levees. These defence measures are undertaken to just cope with the current water level, as still floods of different severity occur. The North Sea flood of 1953, for example, caused around 1800 casualties in Zeeland, a sparsely populated province in the south-west Netherlands (Britannica, 2019). The reaction was the instalment of the Deltaworks, a series of flood protection mechanisms, to protect the low lying delta regions of the country. Furthermore, it includes storm surge barriers, which are close-able dams, which can cut off incoming sea water into the delta. These were imposed to still maintain an open river outlet for the harbour most of the time, as they only close in case of an emergency.

On the one hand, this act created dry and safe land to populate close to the coast to establish a short connection to the sea, hence the harbour. This link was of essence to the city to grow with the profits of the trade activity. Protecting the hinterland by means of dams and dykes has been a known technology for about a 1000 years, which means, that we are already acquainted with construction knowledge. Therefore, the existing constructions offer a foundation to build upon, when increasing the height of the dams gradually with the rising sea level. Hence, the historic substance stays the same with no need to adapt strategies.

However, resisting the water by containing it with a static border will always bear the chance of it failing. In the eventuality, that one construction malfunctions, like in 1953, the hinterland is lost to the water, which causes social disruption and economic loss. Furthermore, the instalment of sea defences are always of bigger scale. In the case of the Deltaworks, and generally water-protection in the Netherlands, this is a matter of the responsibility of the state. Huge investments, regional scale and long-term planning make it impossible for the individual to get involved into the process, which bears the danger of losing awareness of the threat.

Acceptance

Although humans have always tried to contain water as securely as possible, and when speaking of the Netherlands, floods are occurring very rarely, there is and will always be the chance of a system-failure. As mentioned, the now established hard border will not be sufficient in the future altered state and outdated soon. However, if it fails, the consequences are tremendous. The fear of failure calls for a flexible set of defence strategies, which can grow and react with changing circumstances. With the expiry of current measures there will come the possibility to transform the system: from resistance to acceptance.

Resolving the static border and turning them into flexible zones can create different layers or steps of flooding. Accepting the occasional, but controlled flooding of the city bears the possibility to establish not only an adaptable and therefore future-proof system, but also a more secure one. However, the existing structures are not redundant, and build the basis of the system, hence the first layer.

Contrary to maintaining a strict separation between and and water, which is large-scale, cost- and time-intensive, the mentality of building with the water can also function down

to the individual level. I see the possibility, that individuals, neighbourhoods and districts can decide on a set of measures for themselves, making it already a flexible decision making process.

However being a more individualistic and small-scale approach compared to resisting, it also depends on much more factors how to handle the particular circumstances. Influencing factors are, for example, the density of population, economic value, topography of the region, geology, existing building substance and flood defences. As opposed to this, building dams and dykes is universally applicable.

Conclusion

Residing close to the coast, especially in river deltas, has been and will always be an attractive area to settle. These locations offered ideal circumstances for harbours and agriculture. However, the dynamics of the river delta and occasional floods has motivated men to establish a separation between water and land, creating the possibility to expand land and ensure its dryness. Their mentality followed the principle of resisting the water by constructing flood defences like dams and dykes, building rigid borders to protect the land. Although proving itself as a successful strategy most of the time, in the eventuality of failure, the effects always were horrific. Under current climate developments, with the estimation of up to three metres sea level rise and more frequent and heavier storm surges, the current static flood defences will be threatened to break soon, if not maintained properly and raised.

However, in contrast to resisting the water, a change of thinking by accepting regular inundation has the chance to be the essence of a future-proof system. I see the advantage of a stacked flood defence system in different layers, and small-scale measures to control the water in a softer and therefore more forgiving, hence safer and more adaptable manner. Since there is little knowledge and only a limited amount of examples nowadays, it must be our responsibility as spatial planners to think of solutions from urban to the individual building scale to think of converted forms of living to be able to tackle the inevitable incoming water.

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