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Flood-able Industrial Park

Converting a Waterfront Industrial Space into a Tidal Park. Innovative Approaches for Resilient Water Management to Address River Flooding and Sea Level Rise.

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Abstract

The thesis, conducted partially within the Erasmus+Internships programme, explores the transformation of an industrial space, specifically the Royal IHC shipyard in Kinderdijk, the Netherlands, into a resilient and sustainable tidal park.
The study analyzes the climate change adaptation plans and strategies of major cities, with a particular focus on water management in the face of sea level rise and river flooding. Special attention is given to the Netherlands, examining its history of water management, contemporary challenges, and innovative approaches. Two case studies, 'Getijdenpark' and 'Strijp-S', are analyzed to learn innovative approaches for climate adaptation and conversion strategies for industrial areas.
The comprehensive redesign project for the Royal IHC shipyard entails its conversion into a sustainable and resilient park that dynamically responds to water levels and provides additional space for rivers during high levels. The project integrates residential, working, and social-recreational areas, implementing innovative concepts for urban regeneration. It explores new methods and resilient strategies for water management, addressing the challenges posed by river flooding and rising water levels.
The aim of the thesis is to investigate and provide strategies and recommendations for sustainable urban planning and adaptation to climate change, demonstrating the potential of transforming waterfront industrial spaces into resilient environments closely connected to water.

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1. The climate challenge

Since temperatures have been reliably and consistently recorded, the decade 2010–19 was the warmest. The scientific community agrees that human activity is the primary cause of the climate crisis. In particular, it must be blamed on the use of fossil fuels and the resulting increase in greenhouse gases released into the atmosphere[1].This extra heat is causing extreme temperatures, intensifying heavy rainfall, limiting the variety of habitats for plants and animals, and decreasing sea ice and snow cover[2].

In its reports, the Intergovernmental Panel on Climate Change (IPCC) has synthesised an impressive amount of data and scientific knowledge. Through these, a more coherent image has gradually emerged. Despite the inevitable uncertainties connected to various possible future scenarios, the reports highlight the following certain points[3]:

- the combustion of coal, oil, and gas releases large amounts of carbon monoxide and other greenhouse gases. Emissions disrupt the natural cycles of these gases, causing them to accumulate in the atmosphere.
- the increase in greenhouse gases described above has an impact on the planet's energy balance. As a result, the average global temperature rises.
- in the worst-case scenario, in which greenhouse gas emissions are not significantly reduced in the following decades, temperatures will rise by an additional 3–4 °C. An increase of this magnitude would result in widespread climate change and rising sea levels.
- the effects of climate change on ecosystems and human activities will be significant. Therefore, we require climate change adaptation to manage unavoidable impacts, and mitigation to avoid the unmanageable ones.
- to have a good chance of keeping global warming below 2 °C above pre-industrial levels, three-quarters of the available fossil fuels must be left in the ground, and deforestation must be stopped.

The global average temperature (land and sea) has already risen by 1.2 °C since 1850. Regardless of future pollution levels, it is now certain to rise further in the coming decades. This is due to the long residence time of carbon dioxide in the atmosphere and the heat already stored in the oceans as a result of historical emissions. Slow processes, like sea level rise, can no longer be stopped; at best, they can be limited in the long term[4].

Increases in temperature can differ significantly from the global average, which accounts for both land and ocean areas. In limited zones or during particular seasons, the increment could be higher or lower. Global warming has not been and will not be uniform. According to the IPCC, it will be more noticeable on land than in the oceans, at the poles than in tropical areas, and in arid regions[5]. Italy, like many other countries, has already warmed by about 1.8 °C since the pre-industrial period, which is roughly

1 WWF. (2022). *Cambiamenti climatici.*

2 Dahlman L., Lindsey R. (2022). Climate Change: Global Temperature. *Climate.gov.*

3 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p.18

4 Koninklijk Nederlands Meteorologisch Instituut. (2021). *KNMI Klimaatsignaal'21. Hoe het klimaat in Nederland snel verandert*, p.21

5 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p.20

twice the global average[6].
We need to understand the gravity of climate change's potential consequences. They are already relevant today. If we do not act soon, the rise could eventually reach 4 °C or higher in the future. At that level, available studies predict the extinction of many species, significant threats to global food security, and the inability to carry out many normal human activities, such as cultivating and working outdoors in certain areas or seasons[7]. Gas emissions must be drastically reduced, and the effects of climate change that have already begun must be managed.

6 Ibid
7 Ibid, p.21

2. Plans and strategies for climate crisis adaptation

We are experiencing a new climatic condition. We are not fighting the climate; rather, we must adapt to the new conditions. The capacity to change, considering the climate, nature, and social component, is what defines sustainability in urban planning[1].
The emergency of the climate crisis necessitates a significant shift in cities' responses to global warming. It is evident that the level of commitment and, more importantly, the results achieved in the first two decades of the twenty-first century are insufficient to fulfil the objectives outlined in the Paris Agreement[2].
Something has to change in the construction and design industries as well. Buildings and infrastructure play an important role because they account for nearly 40% of energy-related CO2 emissions and have a significant impact on natural habitats. Professionals should satisfy client needs while respecting the ecological limits of our planet. Buildings, cities, and infrastructure should be conceived as parts of a larger, self-sustaining system. The knowledge and technology to start this transformation are available; what has been lacking is the collective will. To this purpose, *UK Architects Declare Climate and Biodiversity Emergency* was founded in May 2019. The participating architecture firms (including Zaha Hadid Architects, David Chipperfield Architects, and Foster + Partners) are committed to producing architecture and urban design that has a positive impact on the environment[3].
In recent decades, the focus has been on individual buildings, with the aim of making them as sustainable as possible. But in order to address the climate crisis, we must adopt a more global, territorial, and social perspective. This is reflected in the design of public spaces. Climate adaptation lies in the ability to govern the urban systems of cities and metros. We require a more comprehensive and broad-based assessment; we require urban strategies[4].
The concept of resilience in relation to socio-ecological systems can be defined by three parameters:
- the amount of perturbation that the system can absorb while remaining stable;
- the system's capacity to self-manage;
- the adaptability, or the system's ability to learn and adapt.

An urban system must be adaptable in order to be resilient. It is also critical to maintain a regional rather than a local perspective; greater system heterogeneity allows for better absorption of potential instabilities. Thus, the resilience of a complex system is not only the ability to adapt to change and remain stable; it is also the capacity to invest in the opportunities that a negative event may bring. Extreme weather conditions can lead to the redesign of existing structures, the regeneration of entire systems, and the emergence of new approaches[5].
Regardless of predictions, countries in Europe and around the world must adapt

1 Mezzi P. (2020). *Fare resilienza. Strategie per adattare città e comunità agli shock climatici e sociali, in Italia e nel mondo*, p. 57
2 Ibid, p. 28
3 Ibid, p. 33
4 Ibid, p. 43
5 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 45

their urban centres, rural landscapes, and economic systems to the new climate. Some interventions are relatively low-cost, such as information campaigns on how to ventilate the environment during the warmest periods or the development of early warning systems for heat waves. Other times very expensive projects are required, for example the construction of dams and coastal protection systems, the relocation of floodplain residents, or the expansion of retention basins to cope with droughts. Adaptation measures involving natural methods to increase site resilience are also being developed. Some of these are, for instance, the restoration of sand dunes to prevent erosion or the planting of trees on riverbanks to reduce overflows[6].

Many local governments have already begun to confront the effects of climate change and are preparing to deal with rising sea levels, hurricanes, and floods. Most of them are coastal or riverside cities. Due to their disposition, these urban areas have always had to deal with the catastrophic events that are becoming more common today. These cities have begun to design and construct resilient beaches, coastlines, squares, and neighbourhoods. More importantly, they have established a network that generates and publicises a new technical culture, best practises, investments, citizen participation, and tangible results through completely innovative urban plans and adaptation strategies[7].

The following pages illustrate some cities that were among the first to adopt urban plans and strategies to adapt to climate change, promoting projects and interventions of various scales and types. These are some of the realities that today's world must use as a model for adapting to the new climate.

6 Ibid, p. 33
7 Ibid, p. 47

New York, a resilient city-laboratory

New York City has been at the forefront of implementing policies to address climate change. The city can be thought of as an urban laboratory for resilience. Here, integrated initiatives to pursue both adaptation and mitigation were developed for the first time. This pioneering role is due to New York's geographical, economic, and climatic conditions. It is indeed highly vulnerable to extreme weather events such as heat waves, flooding, and storms[8].

New York's strategy, which is articulated in a series of programmes, plans, and projects, is one of the most complex in the international arena. Many have used the Big Apple's experience to direct their own planning and implementation of urban resilience strategies.

The first step was taken in 2007, when the municipality adopted *PlaNYC*, a long-term strategic plan entitled *A Greener, Greater New York*. The programme aimed to strengthen the economy, address climate change, and improve residents' quality of life. The plan included measures to improve the city's ageing infrastructure, the upgrading of water networks, the creation of parks, and the energy conversion of buildings, transports, and infrastructure. These decisions were supported by the creation and consultation of climate maps. It was the first time that a planning tool also included a goal for lowering greenhouse gas emissions. The climate section of the programme categorises adaptation strategies into three basic steps[9]:

- examining climate change and its impact on New York;
- evaluate potential consequences and develop interventions to adapt the most vulnerable areas;
- create a broad and comprehensive resilience-building strategy for the entire metropolis.

On October 29, 2012, Hurricane Sandy hit the American city, flooding roads, tunnels, and subways and causing more than 63 billion dollars in damage[10]. Despite this, the city had responded well to the environmental catastrophe: the re-established wetlands had helped to absorb the water, new structures with an empty ground floor had not been damaged, a significant portion of the sewage system had continued to operate, and the situation had been fully restored within five days of the storm[11]. The measures introduced turned out to be correct and had positive results. Thus, the municipality was persuaded to carry on with what had been started in 2007; the *PlaNYC* programme, later replaced by the *OneNYC*, was updated with an increased emphasis on the resilience aspects. In summary, the main goals are to lift 800,000 New Yorkers out of poverty, create new job opportunities, drastically reduce greenhouse gas emissions and unsorted waste, improve air quality, and ensure that the population most vulnerable to climate change is increasingly protected and gains resilience. The quality of the Big Apple's strategy is its ability to implement multilevel actions affecting large areas of the city[12].

A special mention goes to the winning project of the *Rebuild by Design* initiative, an

8 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 125
9 Ibid, p. 128
10 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 76
11 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 131
12 Ibid, p. 135

organisation that brings together local and federal institutions, universities, research groups, and citizens to achieve goals related to urban resilience. The architectural firm Bjarke Ingels Group presented *Big U* [Fig. 1], a project that provides continuous flood protection along Manhattan, one of the city's most vulnerable and populated areas. The lower east side will thus be transformed into a park and playground with a bike and pedestrian path[13].

Fig.1 (On the right) The *Big U* project by BIG Bjarke Ingels Group.
(Source: arquitecturaviva.com/works/proyecto-the-big-u)

13 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 77

Barcelona, world leading resilient city model[14]

Barcelona is without a doubt the European city that set the standard for how to adapt to climate change. In fact, the Catalan city was the first to address climate change. It established the *Consejo Nacional del Clima* (CNC) in 1992 to develop a mitigation plan. The first *Plan Nacional de Adaptación al Cambio Climático* (PNACC) was approved in 2006, and it was revised several times in the years that followed. The actions to increase flood resilience conceived in the plan were necessary; the city has experienced increasing rainfall in recent decades, alternating with frequent heat waves[15].

Barcelona has implemented projects such as the *Deposito de retenctión de agua de lluvia* (underground rainwater storage facility) [Fig. 2] to prepare for future water shortages and droughts. About 70,000 cubic metres of water, which enter at a rate of 50 cubic metres per second, can be stored in the facility, which was constructed beneath a shopping mall[16].

Fig.2 *Deposito de retencion de agua de lluvia Juan Mirò.*
(Source: amb.cat/s/es/web/ecologia/aigua/cicle-de-l-aigua/prevencio-d-inundacions.html)

14 In 2013, the United Nations, through the *Habitat programme*, recognised Barcelona with this title for having carried out flood resilience interventions before other cities.
15 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 148
16 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 56

The building of 15 storage facilities for collecting and storing extra rainwater, like the one described above, was funded by the programme introduced in the 1990s. Barcelona is thus able to collect 500,000 cubic metres of water during periods of heavy rainfall, which big pipes and pumping systems then distribute to the purification plants [17]. All of this is supported by a system that uses technological tools for decision-making, such as geographic information systems, mathematical calculation models, and remote-control systems. This enables knowledge of the water network and drainage systems' current conditions in real time. Thanks to this, the technical services of the water company, municipal government, city police, fire brigade, and municipal civil protection can all be coordinated[18].

The implementation of such a capable rainwater storage system is certainly commendable. However, Barcelona's real accomplishment is that it has created a successful water management system that is based on the idea of urban resilience. This required determining and evaluating risks, examining vulnerabilities, and ultimately developing an urban resilience programme[19].

17 Ibid, p. 57
18 Ibid
19 Ibid

Copenhagen, the resilient neighbourhoods

Copenhagen has always been at the forefront of sustainable development issues. The cloudburst that flooded Copenhagen in July 2011 caused nearly 1.5 euros billion in damage and threatened one of the world's most efficient capitals. This catastrophic event prompted the municipality to revise its climate plan. A true adaptation strategy, the *Copenhagen Climate Adaptation Plan*, was therefore developed in the same year. The latter provides clear operational instructions: construct barrier structures and buildings above sea level, expand the capacity of sewage systems, install rain alarm systems, waterproof basements, store rain to minimise damage, and equip basements with water pumps. The programme also includes more conventional mitigation strategies, like the development of green spaces on sealed surfaces, neighbourhood micro-parks, green roofs and walls for rainwater collection, and the use of alternative air-conditioning systems[20]. To design the plan, it was essential to carefully assess urban vulnerability to heavy rainfall using data collected over time and by the IPCC[21].
In the face of climate change, Copenhagen saw an opportunity to improve the city by implementing vegetation and water rather than concrete. The municipality intends to make public spaces into showcases of technological climate change adaptation solutions. This increases the attractiveness of neighbourhoods at a lower cost-quality ratio than infrastructure-type interventions[22].

Fig.3 Saint Kjeld's Kvarter by Tredje Natur. (Source: abitare.it/en/gallery/architecture/san-kjeld-copenhagen-first-climate-change-adapted-neighbourhood-gallery/?foto=2)

This is the context in which the regeneration of San Kjield [Fig. 3], a formerly working-class neighbourhood close to Copenhagen's harbour, begins. By adding planted areas, green dunes, bicycle paths, replacing impermeable pavement with lawns and urban parks, and elevating the pavement to catch and drain excess water, the architectural

20 Ibid, p. 58
21 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 165
22 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 60

firm Tredje Natur designed the transformation of the neighbourhood[23]. The project enhanced local biodiversity, raised citizen quality of life, and decreased air pollution and the heat island effect. The master plan has thus given the main square a strong identity, making it a recognised urban place as well as the world's first resilient urban area[24].

Another Copenhagen-based project by the SLA studio, *Soul of Norrebro* [Fig. 4], explores the topic of cloudbursts in urban settings. It involves the renovation of Hans Tavsens Park and Korsgade Avenue in Norrebro district. The project entails converting the park into a sizable natural basin that can catch and drain surplus rainwater totaling 18,000 cubic metres. The water is then discharged into the nearby Peblinge Sø river, where it is purified using phyto-purification systems[25]. Here too, the problem of heavy rainfall in urban areas is approached from a new angle; it is no longer viewed as a threat but rather as a resource and an opportunity to develop new, high-quality public spaces with the aim of implementing biological diversity, cultural exchange, and neighbourhood sociality[26].

Fig.4 The *Soul of Norrebro* project by SLA.
(Source: landezine.com/nature-based-climate-adaptation-wins-scandinavias-biggest-architecture-award/)

23 Ibid
24 Mezzi P. (2020). *Fare resilienza. Strategie per adattare città e comunità agli shock climatici e sociali, in Italia e nel mondo*, p. 62
25 Ibid, p. 67
26 Ibid

Rotterdam, living on the water

The presence of water is a historical feature of Rotterdam. Its location, in the Nieuwe Maas river's delta, has made it Europe's largest trading port. As we will see in more detail in later chapters, water has always been a dangerous resource, but the Dutch have been able to govern and exploit it fruitfully. However, climate change over the last few decades has strained this relationship because 80% of the city is below sea level. Climate change and sea-level rise simulations show Rotterdam as one of the world's most vulnerable port facilities[27].

The Dutch city is a critical area for implementing climate change policies. It has focused local planning tools since the 2000s on finding appropriate strategies and valid water management initiatives. Rotterdam wants to maintain its appeal on the social and economic fronts. To achieve this, the city introduced *Rotterdam Climate Proof* in 2008. According to the plan, the port city will be the most sustainable in the world and a pioneer in climate adaptation. It outlines three main steps in order to achieve this[28]:

- make Rotterdam a national and international hub for knowledge on climate change and water;
- obtain investments to make the city and port more attractive to inhabitants, companies, and research institutions;
- develop innovative climate adaptation strategies and projects to be used and export.

Over the years, other resilient strategies have been developed and are currently being pursued, both through planning tools and local programmes that aim to establish eco-sustainable goals through agreements between multiple stakeholders and private businesses. People are also being educated on how to design resilient spaces, use renewable energy technologies, and reduce daily consumption.

Fig.5 Floating Homes Nassauhaven by Public Domain Architects.
(Source: rotterdammakeithappen.nl/en/showcases/sustainable-floating-homes/)

27 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 158
28 Mezzi P., Pellizzaro P. (2016). *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 62

The Rotterdam approach is based on nature's ability to self-regulate. Barriers, dikes, and other systems that attempt to stem and channel water are proving ineffective in the long run. This is why the municipality has decided to prioritise slow, painstaking, space- and nature-conscious interventions[29]. Rotterdam will be mentioned several times in this thesis' discussion. The interventions of the *Getijndenpark* project and the *Room for the River* programme in particular will be presented in chapters 3 and 5, respectively.
Rotterdam, like Copenhagen, wants to increase its attractiveness by adapting to climate change. The city generally rejects cautious interventions. Instead, it offers itself as a laboratory for resilient design research and experimentation. By 2025, new construction outside the levees will be limited to adaptive buildings and floating neighbourhoods where people can live, work, and relax on the water[30] [Fig. 5]. Due to its dynamic nature and ongoing change, Rotterdam has the potential to set the standard for resilient future planning.

29 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 160
30 Ibid, p. 161

3. Water's threat: rising sea levels and pluvial floods

Water can be a very dangerous threat: it rains, floods, becomes scarce, and pollutes. It has also, however, always been an important factor in the social, economic, and cultural advancement of entire civilizations. Man has exploited and used it in a variety of ways and with a wide range of technologies to cultivate, power mills, generate energy, and transport[1]. Water is an element of separation and communication, a tool for protection and defence, a factor of aesthetic promotion, and a vital part of community sustenance.

Despite all of this, over the past century, water has frequently been perceived as a problematic factor in the development of cities. Due to climate change, managing rivers, seas, and lakes has become more difficult. The two water-related phenomena that most affect coastal and riverside cities are, in particular, rising sea levels and water system vulnerability to the new rainfall regime[2].

The global sea level has risen by about 20 cm since the beginning of the twentieth century, and this phenomenon is accelerating; in recent years, an average rate of 3.7 mm per year has been recorded. The loss of mass from the Arctic and Greenland ice caps has been the most significant contributor to this process[3].

The need to find solutions for coping with rising sea level stems from the fact that it will continue regardless of which future emissions scenario we will be in. This is due to the slow response of the oceans to the warming that has occurred thus far, as well as the melting of glaciers; these are processes with extremely long reaction times, which means that once initiated, changes cannot be reversed in the same way. As a result, even in the most optimistic future scenario (low emissions SSP1-2.6), sea level will continue to rise, increasing by 0.3–3 metres by 2300. Sea level should be in equilibrium with the climate in 10,000 years and will have risen by at least 6-7 metres when global warming peaks at 2°C[4]. Most coastal regions around the world will face pressure from rising water levels, but urban areas will experience the most stress.

Climate change has an impact on precipitation as well. Both the frequency and heaviness of rainfall are increasing. Cloudbursts are causing flooding all over the world, particularly in Italian cities. Watercourses, collection systems, and sewage lines are unable to dispose the most intense rainfall. Some anthropogenic activities, aside from the change in rainfall regime, have had an influence. These include, for example, the expansion of urbanised areas, the increase in economic activities, the progressive sealing of the soil, and the revocation of natural flood expansion zones[5].

1 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 52
2 Ibid, p. 54
3 Koninklijk Nederlands Meteorologisch Instituut. (2021). *KNMI Klimaatsignaal'21. Hoe het klimaat in Nederland snel verandert*, p. 27
4 Ibid, p. 31
5 Manigrasso M. (2019). *La città adattiva. Il grado zero dell'urban design*, p. 62

3.1 A common problem among Italy and the Netherlands

Europe is one of the hardest regions hit by the climate crisis, with average annual temperatures rising by 0.2 to 0.5 C° over the last 50 years, depending on location[1]. This trend is expected to continue, regardless of future emissions levels. The images below [Fig. 6] show the expected average temperature change under the best SSP1-2.6 (left) and worst SSP5-8.5 (right) emission scenario.

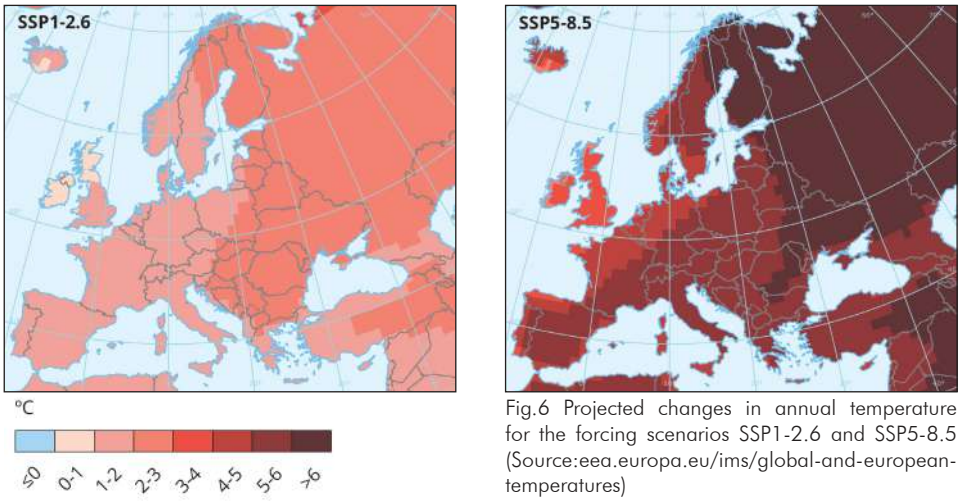


Fig.6 Projected changes in annual temperature for the forcing scenarios SSP1-2.6 and SSP5-8.5 (Source:eea.europa.eu/ims/global-and-european-temperatures)

Further temperature rises will have disastrous consequences for our cities. We must find a way to limit these changes while also adapting our urban systems to accommodate them. This thesis investigates innovative resilient solutions implemented in the Netherlands to mitigate rising sea levels and increased river flows caused by more frequent heavy rainfall. A 1 m rise in sea level is expected by 2150–2350 (low emissions scenario) or 2090–2140 (high emissions scenario)[2].
The figures [Fig. 7] illustrate the portion of land that would be flooded in the Netherlands and in Italy without barriers and dikes if sea levels rose by 1 metre as discussed previously. A failure of this magnitude is improbable, but it shows that these defence solutions alone are no longer sustainable; a different approach is thus required.
A large part of the Netherlands is under threat, while in Italy, the most vulnerable city, as one might expect, is Venice. The Dutch polders and the lagoon city are in a very similar situation; as sea level rises, they both sink due to subsidence[3]. The Venetians have always been resilient; they have adapted to high tides, and they have learned to live with them. However, the climate crisis is actually making things worse; extreme water levels are causing damage to infrastructure from foundations to bridges, navigation

1 European Environment Agency. (2022). *Global and European temperatures.*
2 Koninklijk Nederlands Meteorologisch Instituut. (2021). *KNMI Klimaatsignaal'21. Hoe het klimaat in Nederland snel verandert*, p. 30
3 Fracasso S. (2020). *Per un pugno di gradi. Da Vaia all'acqua granda: la svolta energetica per cambiare il Veneto*, p. 4

is becoming more complicated, and *acqua alta*[4] now reaches where it once did not[5]. Living in Venice will become unsustainable unless concrete steps are taken to address the issue. This is why an international exchange of innovative ideas and solutions for making cities more resilient is fundamental.

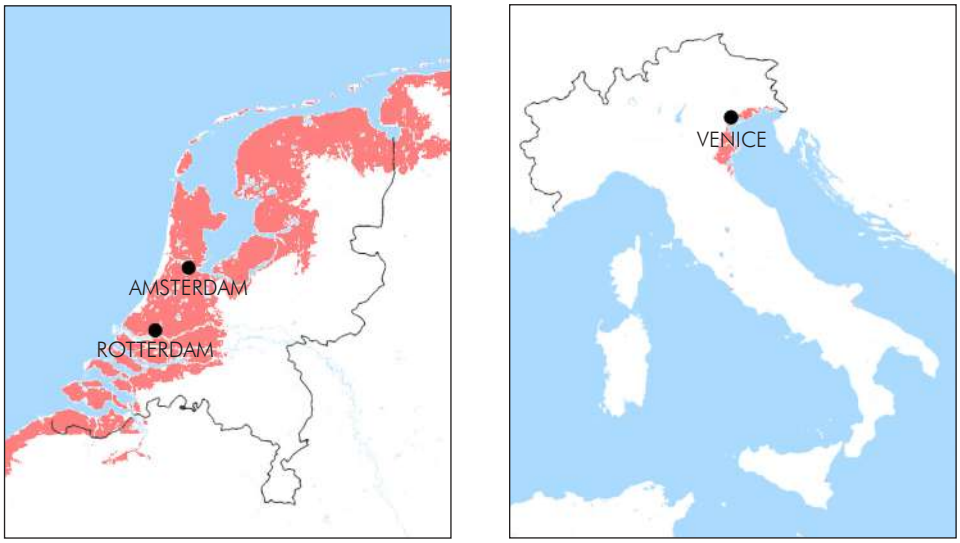


Fig.7 Projection of the portion of land that would be flooded in the Netherlands and Italy without barriers and dikes if the sea level rises by 1 metre. (Source:coastal.climatecentral.org/map/8/100.6166/13.2746/?theme=water_level&map_type=water_level_above_mhhw)

4 (lit. "high water") is the term used in Veneto, Italy for the exceptional tide peaks that occur periodically in the northern Adriatic Sea. The peaks reach their maximum in the Venetian Lagoon.

5 Pelizzaro P. (2016). Le città italiane alla sfida climatica. In Mezzi P., Pelizzaro P. *La città resiliente. Strategie e azioni di resilienza urbana in Italia e nel mondo*, p. 121-122

4. Water management in the Netherlands

The Dutch water system is complex. This is due to the fact that water management affects a wide range of social concerns, such as flood protection, navigation, nature, energy production, industry, agriculture, and recreation. It thus involves conflicts of interest and matters involving a variety of individuals and parts. Furthermore, water management policies must now address many issues related to climate change, which causes rising sea levels, modifications in river flows, and shifting rainfall patterns, with more frequent and intense downpours alternating with long periods of drought[1].
The Dutch have successfully tamed the water and made the Netherlands habitable. Behind it all, there is a significant amount of water management work that allows safe living while also continuously ensuring supply, drainage, and water quality. The climate crisis has severely harmed today's water infrastructure, and research, innovation, and the ability of water managers to collaborate, both nationally and internationally, are critical.

Fig.8 The Maeslantkering on the Nieuwe Waterweg, in South Holland, Netherlands.
(Source: beuk.eu/bestanden/artikelen/1/2779_Royal_Beuk,_Group_Travel,_DMC,_Holland_-_Rotterdam_and_Kinderdijk_-_Maeslantkering_-_Het_Keringhuis.jpg?1554389274=)

1 Rijkswaterstaat, Association of Dutch Water Authorities. (2019). *Water management in the Netherlands*, p. 9

4.1 Netherlands' geomorphology

The Netherlands is uniquely positioned on a delta formed by three major rivers (the Rhine, Meuse, and Scheldt), with nearly two-thirds of the territory below sea level. The North Sea shatters the coast from the west, while rivers bring water from the south and east, often in large quantities[1]. We can think of the Netherlands as a gateway through which water from European rivers and canals flows before entering the sea. This process is facilitated by the territory's topography, which has highlands in the south and east but is otherwise flat and below sea level [Fig. 9]. More specifically, approximately 40% of the surface is below the NAP level, with flooding affecting 59% of the land. As a result, without flood defences, approximately 60% of the country, principally the provinces of North and South Holland, would be regularly under water[2].

Determining how much land is below sea level is difficult because it varies by about 1.5 metres between low and high tide. This information can thus only be defined by comparing heights to an average sea level, defined as the *Normaal Amsterdams Peil* (NAP), of 0 metres. The altitudes in the Netherlands (and in most of Western Europe) are measured in relation to this data[3], and it will be used as a reference several times throughout the discussion of this thesis.

In order to have some control over water, the Dutch territory has been modified and made habitable through pumping stations, sluices, polders, dikes, and barriers. These grafts have resulted in a network of rivers, lakes, embanked creeks with drainage channels, urban canals, and waterways[4]. In total, 7200 km^2 of land in the Netherlands have been reclaimed, accounting for approximately 20% of the total surface area. The western part of the country is mostly composed of peat, a type of soil that becomes denser when water is extracted from it. To avoid flooding, the Dutch must continue to drain the soil, causing it to subside by 0.8 to 2 cm per year[5].

1 Rijkswaterstaat, Association of Dutch Water Authorities. (2019). *Water management in the Netherlands*, p. 9
2 Ibid, p.43
3 Netherlands insiders. (n.d). *How Much Of The Netherlands Is Below Sea Level?*
4 Rijkswaterstaat, Association of Dutch Water Authorities. (2019). *Water management in the Netherlands*, p.23
5 Netherlands insiders. (n.d). *How Much Of The Netherlands Is Below Sea Level?*

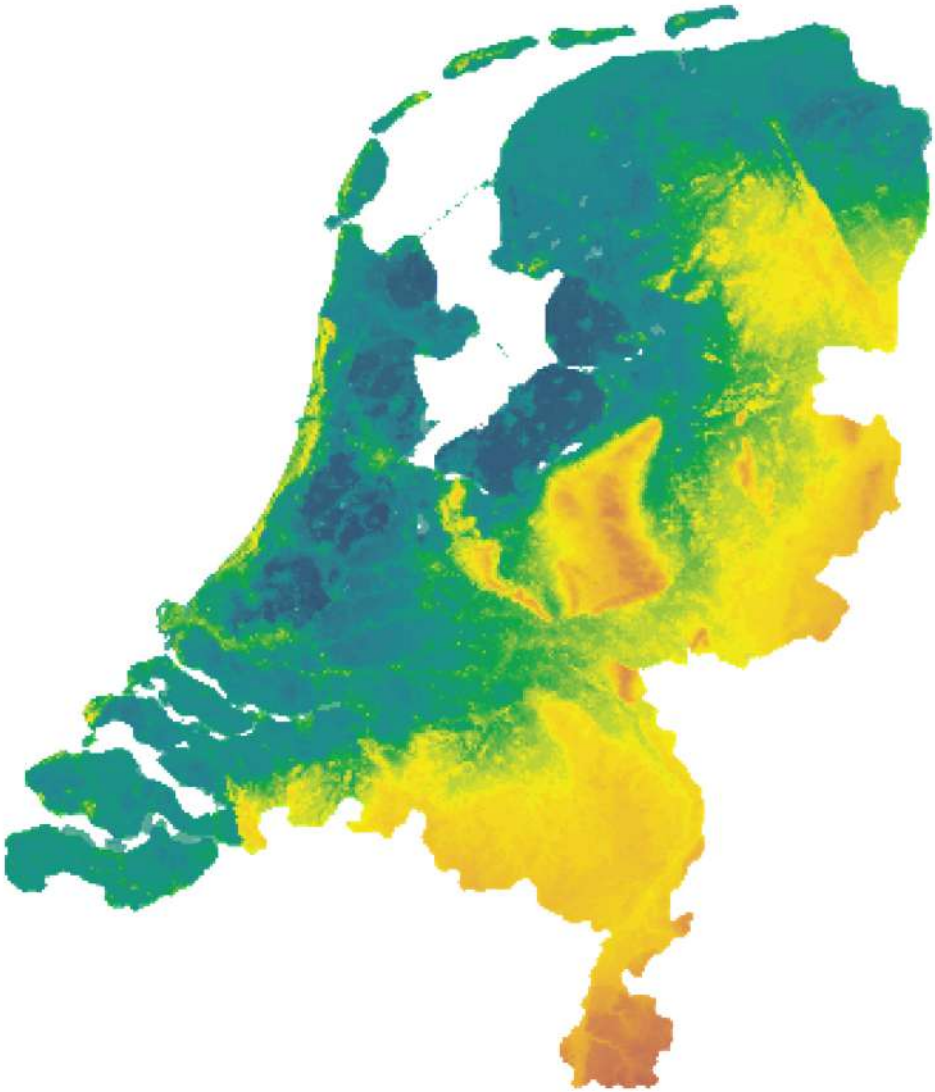


Fig.9 Current altitude file of the Netherlands. The colors of the map are self-explanatory: dark blue is land well below sea level and found in the polders in the country's western part and the IJsselmeer, dark green is land around sea level and vulnerable to flooding, light green, yellow, and orange are well above the average sea level. (Source: ahn.arcgisonline.nl/ahnviewer/)

4.2 Water management: historical perspective and contemporary issues

The first colonists to settle in the Netherlands around 5,000 years ago discovered a flat, poorly drained delta; a floodplain intersected by streams, tidal creeks, and small and large rivers. Initially, they had to build their dwellings on high ridges or artificially raised hills along these watercourses[1]. Archaeological discoveries demonstrate how, at the dawn of our era, small dams and canals were constructed to create suitable conditions for small-scale agricultural activities. Due to a lack of reliable evidence, developments that occurred after the Roman era are still unknown.

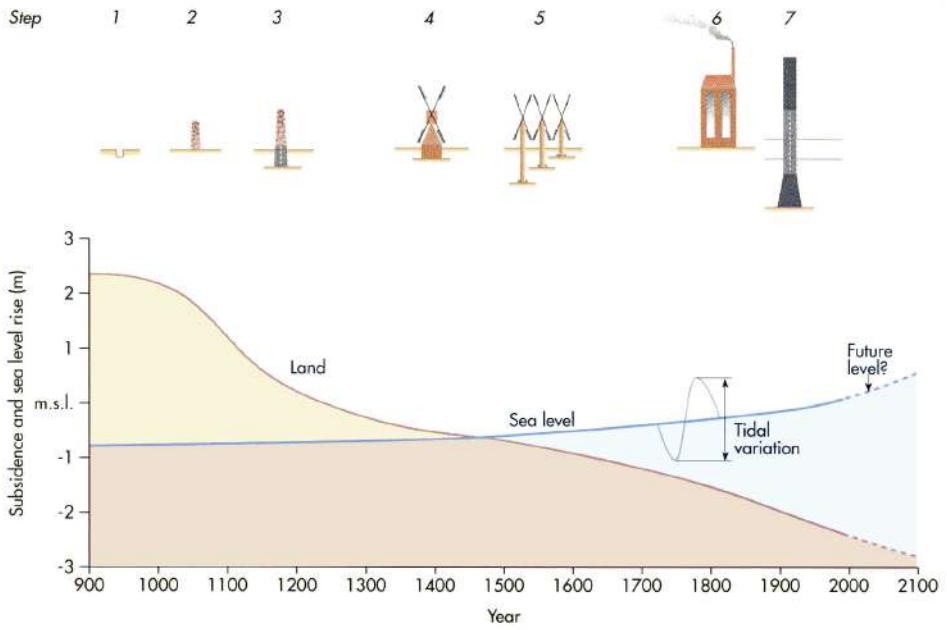


Fig.10 Stepwise response to the increasing subsidence of land and sea level rise over time .
(Source: Huisman P. (main author), Cramer W., van Ee G., Hooghart J.C., Salz H., Zuidema F.C. (1998). *Water in the Netherlands*, p.33

Around 1000 AD, Western Europe experienced a population increase, which coincided with an increase in demand for raw materials. To create more arable land, drainage ditches and trenches were dug in the boggy peat and clay soil 2/3 m below sea level to lower the water table (step 1 in Fig.10). Because of ground lowering, the residents were forced to dig more canals in order to continue farming[2]. This was the start of an irreversible process that continues to affect the Netherlands today, with land subsidence on one hand and rising sea levels on the other.
Later, during high tide, a sizable portion of the coastline area was flooded. As a

1 Huisman P. (main author), Cramer W., van Ee G., Hooghart J.C., Salz H., Zuidema F.C. (1998). *Water in the Netherlands*, p.32
2 Ibid

consequence of this, over time, levees were constructed to defend the land from the threat of the sea, and locks were built in river inlets (steps 2 and 3)[3].
In the centuries that followed, these techniques proved insufficient against the terrain's subsidence. The soil behind levees and dikes drops far below sea level, making gravity-draining the excess water impossible. This resulted in the embankment of small inland areas known as polders, where extra water was artificially removed (step 4). This type of gradual artificial drainage has become common in the Netherlands. Initially, it was done using hand and horse-drawn mills. Due to their capacity limitations, these were replaced starting in the 13th century by windmills that permitted larger-scale drainage. This invention is regarded as critical to the survival of the country[4].
In the 16th century, drainage techniques were refined to the point where shallow lakes could be drained. Certain height differences (up to 6 metres) between the former tidal inlet and the new polder even necessitated the installation of a sequence of windmills (step 5)[5].
Holland then rose to prominence as a hub for trade, business, and shipping. Substantial amounts of capital could be therefore reinvested in the development of the agriculture sector, which, when combined with the industrialization phenomenon at the beginning of the 19th century, allowed for the reclamation of large areas using steam pumping stations (step 6). The artificial release of water from the *boezems*[6] became possible as well[7].

3 Ibid, p.33
4 Ibid
5 Ibid, p.34
6 body of water without a fully controlled level, used for collecting water pumped out of polders before it is discharged into a major river or sea. (source: www.wordsense.eu/boezem/)
7 Huisman P. (main author), Cramer W., van Ee G., Hooghart J.C., Salz H., Zuidema F.C. (1998). *Water in the Netherlands*, p.32

4.3 Flood defence as a technological lock

As was previously mentioned, and as can be seen in Fig. 10 on page 28, the Dutch's historical draining of the wetlands has gradually transformed into what we can now appropriately describe as a technological inhibition. The drainage of the peat and the resulting subsidence of the soil forced the continuous raising of the defences. Today, the difference in height between these and the ground exceeds 10 metres in some spots.
Following the flood of 1953, which flooded a large, relatively unpopulated area (but still caused 1800 deaths and serious damage), the Delta Commission was formed. They drew up the Delta Plan; all tidal outlets in the estuary were closed, with the exception of waterways providing access to the ports of Rotterdam and Antwerp, where the dykes were to be strengthened.
Despite these outstanding efforts, the major rivers nearly overflowed in 1993 and 1995, forcing 200,000 people to evacuate. The polders and dykes of the Netherlands are a justified source of pride around the world, but the Dutch defence system is clearly vulnerable in the long term. Flood defences are expected to fail once every 4000 to 10,000 years, according to safety standards[1]. Although there is a very small chance, there are a variety of factors to consider. Firstly, millions of people actually live several metres below sea level, which means that, in the worst-case scenario, many casualties and unimaginable economic, cultural, and social damage would occur within a few hours. Furthermore, the uncertainties associated with hydraulic and engineering calculations can result in an order of magnitude error. Statutory safety tests are limited for practical reasons and exceeding the water level is only one of the failure mechanisms[2]. We can conclude that dams' actual effectiveness is unknown.
When we consider the uncertain effects of climate change, it appears that living in the Netherlands is unsustainable in the long run. The Dutch flood defence has always relied on civil engineering structures to keep out the water that periodically regained space. This vicious circle has resulted in a real, and seemingly inevitable, technological blockade.

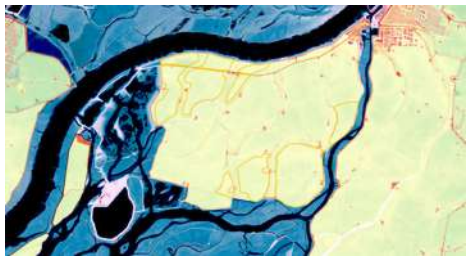
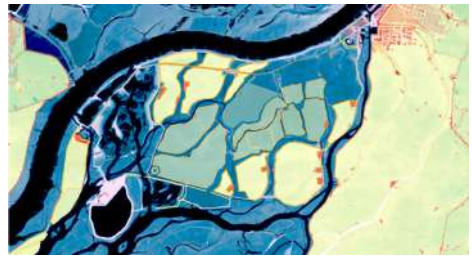
1 Wesselink A. (2007). Flood safety in the Netherlands: The Dutch response to Hurricane Katrina. *Technology in Society.*
2 Ibid

4.4 *Room for the river*, a new resilient approach

Even though the situation in the Netherlands appears critical, there is still optimism because innovative flood management concepts have been developed, which may provide a way around the current technological block. These are based on the idea of "accommodating" water rather than "controlling" it, as the engineering paradigm suggests. The implementation entails a significant redesign of the floodplain, which expands the area available to channel rivers during floods and allows processes that naturally take place in deltas[1]. The *Room for Rivers* programme [Fig. 11] originated from these principles and offered the opportunity to introduce better resilience, more water space, and increased flexibility to cope with future changes.


(Source: landezine.com/room-for-the-river-nijmegen-by-hns-landscape-architects/)


(Source: uu.nl/en/research/water-climate-and-future-deltas/storylines/flood-risk-management/integrated-flood-risk-management-in-practice/room-for-the-river)

(Source: Hobeica L., Rossano F. (2014). *Design as a negotiation platform: New deals and spatial adaptation in flood-prone areas*)

Fig.11 In order, respectively the Nijmegen floodplain, the River IJssel and the Noordwaard area before (left) and after (right) the *Room for the River* project. (Source: personal elaboration)

1 Wesselink A. (2007). Flood safety in the Netherlands: The Dutch response to Hurricane Katrina. *Technology in Society.*

Extreme water levels in the 1990s raised awareness that nature cannot be controlled and that new approaches to river management are required. These events gave a significant stimulus to the project and collaborations among different organizations. The *Room for the Rivers* programme is based on cooperation between government agencies from various disciplines and levels (national, regional, and local). It is the result of the integration and alignment of multiple watershed management objectives, including safety, transportation capacity, recreational opportunities, natural space, economic facilitation, and water supply and quality[2]. Besides that, there is a growing interest on a global scale in the sharing of cutting-edge ideas and best practises for these methodologies. They have enormous potential for application in river basins all over the world[3].

A different river configuration provides greater safety and new natural and recreational areas, but it is not always easy to accomplish. Transferring people and businesses when removing or relocating dams is one of the main issues. For this and other reasons, each river requires customization[4]. The *Room for Rivers* programme has developed several solutions, which are listed below, to give rivers more space[5].

2 Zevenbergena C., Rijkea J., van Herka S., Ludyc J., Ashleya R. (2013). *Room for the river: international relevance*, p.24.
3 Rijkswaterstaat. (n.d.). *Ruimte voor de rivieren.*
4 Ibid
5 Rijkswaterstaat. (n.d.). *Maatregelen rivierengebied.*

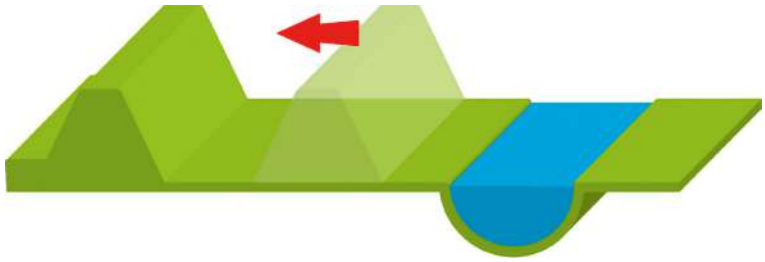


Fig.12 Dike relocation
Shift the dams inland to expand the floodplains. This provides more space for the river and more capacity to absorb water in the event of flooding.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

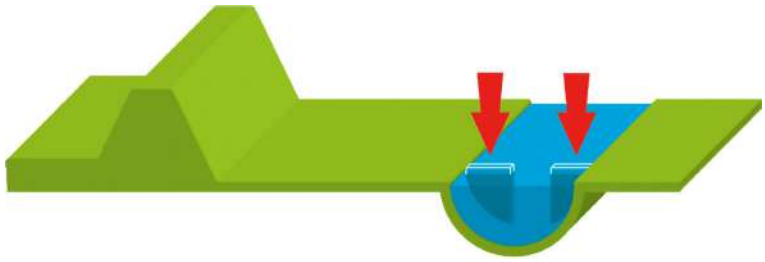


Fig.13 Lowering of perpendicular groynes and building attracting groynes
Lower a groyne (a short dam at right angles to the river) or build a longitudinal dam (parallel to the river). This makes it simpler for the water to drain.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

Fig.14 High-water channel
Drain excess water through a secondary channel. This becomes a branch of the main river, created by placing two extra dams in the landscape. By doing so, some of the water can be discharged through a different route.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

Fig.15 Removal of obstacles
Obstacles in the river, such as jetties or bridgeheads, which hinder water drainage can be removed or adapted.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

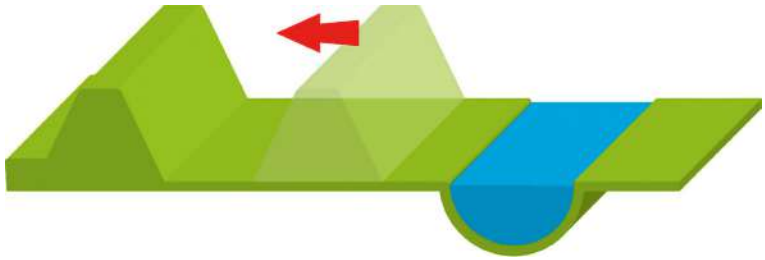


Fig.16 Depoldering
Move the dam of a polder further inland. This enables the river to flow in and out of the area during high tide. (Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

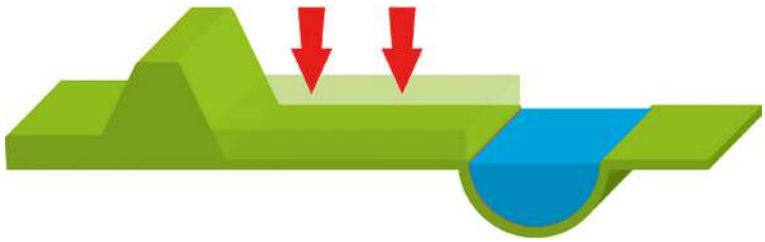


Fig.17 Lowering the flood plain
In recent centuries, flood plains have become higher due to, among other things, the deposition of sand and clay. Excavating the floodplains provides the river with more space during high water.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

Fig.18 Water retention
Temporarily storing excess water when it cannot be discharged into the sea. This can happen when, for example, storm barriers are closed.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

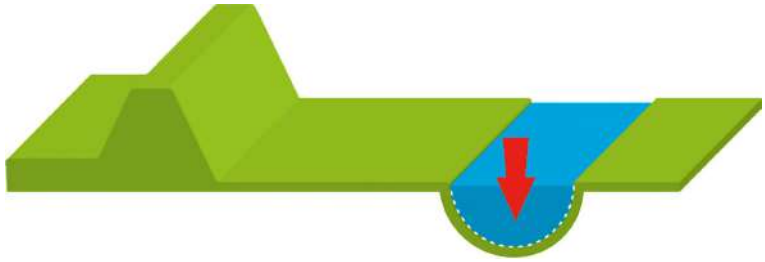


Fig.19 Deepening the summer bed
Excavate the bottom and thus lower the riverbed. By doing so, the river is deeper and there is more space for water. (Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

Fig.20 Dike improvement
If widening the river is not entirely possible due to lack of space, the dam can still be raised and improved.
(Source: rijkswaterstaat.nl/en/water/water-safety/room-for-the-rivers/measures-in-and-around-rivers)

4.5 The Rhine delta in South Holland

This essay focuses on the redevelopment of a shipyard in Kinderdijk, an UNESCO World Heritage Site situated at the intersection of the Lek and Noord rivers. The location was chosen not only for the potential transformation of the industrial area or its immense historical and cultural significance; it is indeed a symbol of water management through historical windmills. It was selected specifically because of its location on the Rhine delta in South Holland, which has been identified as one of the Dutch regions most vulnerable to flooding.

Fig. 21 illustrates the maximum water depths associated with flood defence breach scenarios. We can see that in riverine areas, large spaces flood deeply, while in the case of dam breaches along the coast, the flooded areas are generally smaller and shallower. This is due to a variety of factors:

- near the coast, any inflow through the breach has a shorter time, which usually coincides with the duration of a storm. At low tide, water can pass off in many spots, and after a storm, the outside water level drops below ground level in most locations. A storm lasts less time than high river water[1].
- the difference between water and ground level is greater along rivers than along the coast because the latter is usually in a higher position[2].
- the coastal zone is typically more compartmentalised by secondary barriers, inlet embankments, elevated roads, and railway lines than the river zone. These obstacles limit and confine flooding[3].
- generally, the river area slopes westward and downward, which facilitates easy water flow to the downstream portion[4].

1 De Bruijn K., Van Der Doef M. (2011). *Gevolgen van overstromingen - Informatie ten behoeve van het project Waterveiligheid in de 21e eeuw*, p. 27
2 Ibid
3 Ibid
4 Ibid

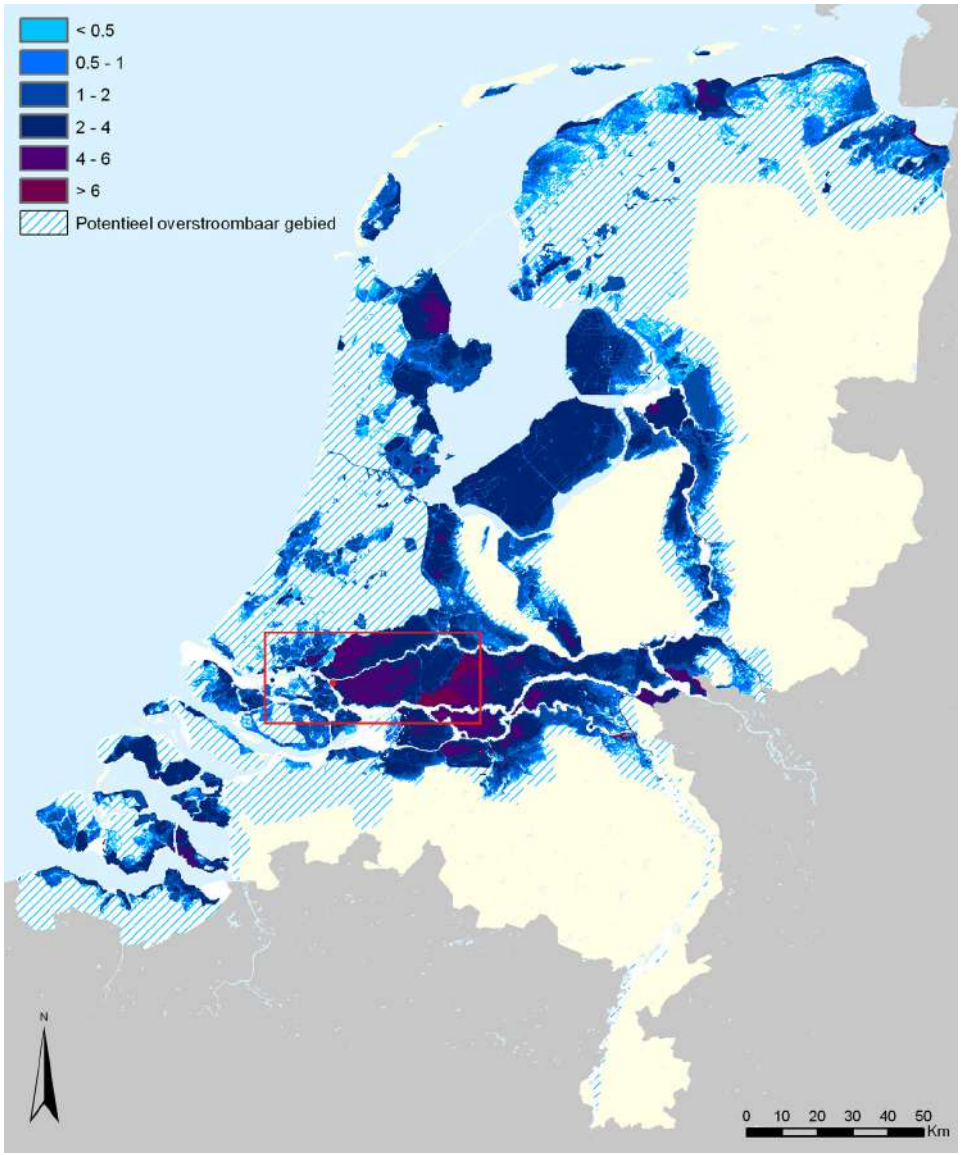


Fig.21 Maximum water depth based on the flood scenarios at test level.
(Source: De Bruijn K., Van Der Doef M. (2011). *Gevolgen van overstromingen - Informatie ten behoeve van het project Waterveiligheid in de 21e eeuw*, p. 28)

Fig. 22 depicts the dam sections where the most casualties could occur in the event of a breach. These are mainly localised in lower river areas; high damage and a high number of victims are expected here, especially in densely populated areas situated far below the water level. It should be highlighted that the number of casualties is directly related to the lack of evacuation options[5].
The project's location is shown in both images with a highlighted frame. These maps demonstrate the critical situation in which the regions on the delta of South Holland find themselves. The design solutions presented in this thesis are meant to provide innovative and resilient approaches to the problems of these still too vulnerable areas.

5 Ibid, p.32

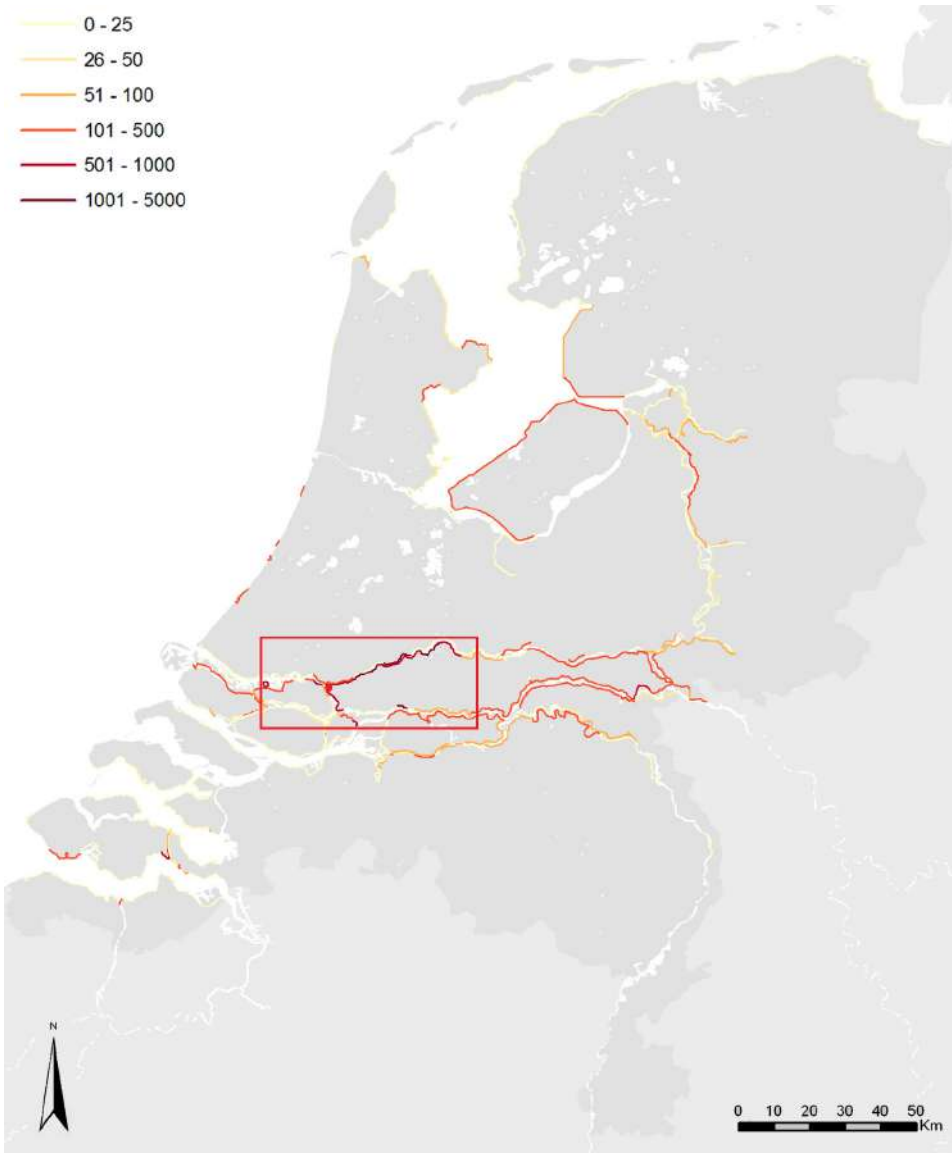


Fig.22 Casualty numbers per dyke section. (Source: De Bruijn K., Van Der Doef M. (2011). *Gevolgen van overstromingen - Informatie ten behoeve van het project Waterveiligheid in de 21e eeuw*, p. 32)

5. Getijdenpark, environmental recovery strategies

Getijndenpark is an example of landscape design aimed at making a densely populated and built-up city like Rotterdam resilient. The programme entails the creation of a tidal park (in Dutch, *Getijndenpark*) along the Nieuwe Maas delta. This combines both an engineering and a natural approach, using technological innovations to prevent flooding, reduce thermal stress, increase biodiversity, and create recreational areas. The design principles are based on natural processes and dynamics, such as sediment, vegetation, wind, and tides. The aims are to improve water systems and create opportunities for nature's development[1].
The overall project is structured over a very wide area, but the study presented here will concentrate more on the interventions in Rotterdam. The river's relationship in these densely populated areas is complex and interesting because it considers a multitude of factors that are only present in large port cities.
The *Getijndenpark* research will be useful for learning strategies and interventions for climate adaptation as well as the creation of public spaces and parks. These projects are completely innovative and, in some aspects, experimental. Despite this, their implementation is essential for developing strategies for addressing climate change and the ensuing sea level rise.

Fig.23 Artist's impression of the "Nelson Mandelapark" project in Maashaven, Rotterdam.
(Source: rotterdam.nl/nelson-mandelapark)

1 Batterink H. (2019). *Building with nature in de stad: Oplossing voor een vitale, veilige & welvarende deltastad?*, p. 2

5.1 Context

Water from Germany, France, and Switzerland flows into the sea through the Nieuwe Maas. At this point, the watercourse has grown from small streams into a massive tidal river.
The tidal park's design area is located in the delta of the Nieuwe Maas, at the end of the river ecosystem, where fresh water meets salt water from the sea. A typical brackish transition occurs here, and the river is influenced by sea dynamics; the tide is about 1.5 metres high, resulting in continuous sedimentation and erosion. Mudflats, salt marshes, plains, and tidal streams are the outcome of this process. Nevertheless, the project area in Rotterdam is upstream, and the water is mostly fresh with some brackish periods. It is, however, affected by the tide's rise and fall[1].
The study area encompasses the riverbanks in the inner city of Rotterdam, approximately limited on the east by the Van Brienenoord bridge and on the west by the municipal border with Schiedam. The study will look at the strategies adopted in all of the tidal park projects, but it will mainly focus on the locations within the urban area of Rotterdam: *Getijndenpark Nassauhaven*, *Getijndenpark Eiland Van Brienenoord*, and *Polder De Esch*.

Fig.24 The riverbanks in the inner city of Rotterdam.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.18)

1 Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p. 9

River evolution

The Nieuwe Maas estuary is highly urbanised and the natural processes of a tidal river, with all that entails, are hardly recognisable today. When we look at the 1850 map [Fig. 25], we can see that the Nieuwe Maas was still in its natural, wild state, with all of its processes, forms, and habitats. This has not been completely lost. In fact, some of these conditions are still active: the river currents, the supply of silt and food, the tidal range, and the variable conditions of brackish and fresh water.
The physical form of the area has undoubtedly changed, limiting the ability of natural processes to express themselves. The riverbed has been dredged a lot and to a uniform depth, and the banks have been transformed; they are mostly stony, steep, or even vertical. As a result, there is no sedimentation along the banks, and organisms are unable to find food, silt, or shelter. This has led to the loss of many natural habitats, and the flora and fauna that were once abundant have decreased [2].
As I will explain later, in addition to causing damage to the river ecosystem in the area, these docks prevent citizens of Rotterdam from having a living and tangible relationship with the river; they can only approach or touch the water in a few locations throughout the city, and they are deprived of possible green spaces along the Nieuwe Maas' banks.

Fig.25 Map view of Rotterdam and environs, 1850 (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.17)

2 Ibid, p. 11

Future perspective

In the coming decades, Rotterdam will grow in all respects, and this means a number of essential measures to maintain the city's high standard of living. The municipality aims for improved accessibility and a more innovative economy, but most importantly, it wants to build 50,000 new houses by 2040 [3].

More houses imply more people, which means more facilities and public space are required. People don't just want to move because of the house's appearance; they also want a pleasant living environment, which requires adequate public space. For these reasons, as well as the high demand for public spaces that already occur, the municipality of Rotterdam intends to create 20 hectares of green space[4].

The Niuewe Maas represents an opportunity to add new and unique public space in a city that is rapidly expanding; it is centrally located and close to most homes that have limited or no green space. Furthermore, river greening can contribute to the city's climate resilience as well as the transition to green mobility when combined with the construction of efficient cycle paths[5].

Therefore, the municipality plans to redesign the Nieuwe Maas's banks into a prominent and distinctive public space. The goal is to make Rotterdam even more of a river city by constructing an urban park with attractive living and working environments. The Nieuwe Maas is a critical element of the city's long-term sustainability.

Fig.26 Rotterdam adaptation strategy by De Urbanisten.
(Source: urbanisten.nl/work/rotterdam-adaptation-strategy)

3 Gemeente Rotterdam. (2019). *De Nieuwe Maas als stedelijk parklandshap levendig, aantrekkelijk en natuurlijk! Programma Rivieroevers Toekomstperspectief binnenstedelijke Nieuwe Maas*, p.2
4 Ibid
5 Ibid

5.2 What's a tidal park?

A tidal park can be described as an area along the river with tidal action where the ground level rises gradually from the river to the land[1]. In terms of design, this entails making the river more natural, enjoyable, and attractive. Its goal is to improve the relationship between water and land as well as between nature and the city, and to generate a variety of ecological, recreational, social, and economic values. It also has educational value because it shows the river's natural dynamics and its processes[2].
This complexity of values allows for multiple opportunities to be exploited and multiple targets to be linked, as well as increasing the chances of project implementation in the future; more stakeholders can be attracted, and more funding can be obtained in this way[3].
The *Getijndenpark* project aims to create the preconditions for the river's natural forces to be able to provide services and spaces that citizens can enjoy. In practical terms, this involves the establishment of a larger outpost near the Rotterdam dykes and the restoration of natural conditions in the petrified but highly dynamic environment[4]. Clearly, due to the presence of fixed structures, port activity, and buildings, it is impossible to completely restore the original landscape in a delta city. With this type of intervention, an adaptive form of water control is also pursued, which can be described through two interconnected concepts: flood and flooding risk management, which include both flooding and excess rainwater[5].
Tidal parks are relatively new, innovative, and somewhat experimental. *Getijndenpark* serves as a testing ground for the knowledge and experience required for climate resilience projects in river cities. The tidal park is a work in progress, adaptable, and will be implemented when space, government willingness, and other interested parties are available[6]. It is also a project that, by nature, will undergo stops and changes; this will happen if it interferes with the port business[7] or if water management is put at risk. Some changes can be necessary because the river's dynamics have a significant impact on a variety of activities and functions in the city[8].

1 Batterink H. (2019). *Building with nature in de stad: Oplossing voor een vitale, veilige & welvarende deltastad?*, p.14
2 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.14
3 De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.6
4 Batterink H. (2019). *Building with nature in de stad: Oplossing voor een vitale, veilige & welvarende deltastad?*, p.14
5 Ibid
6 Ibid, p.6
7 De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.6
8 Batterink H. (2019). *Building with nature in de stad: Oplossing voor een vitale, veilige & welvarende deltastad?*, p.14

Climate resilience is defined as "the ability of a system, community, or society exposed to danger to withstand, absorb, and repair the damage caused in a timely and efficient manner"[9]. But, in addition to defensive functions, resilience can take on a broader meaning if spatial functions such as recreation, agriculture, and urban planning are provided, which can lead to more sustainable choice. The ambitions and interventions of the Getijndenpark project reflect this: water retention in the soil, new forms of housing such as houseboats, ecosystem revitalization, urban renewal of old harbour sites, andcompensation for the effect of urban heat are just a few examples.

Fig.27 Artist's impression of the project in Maashaven, Rotterdam.
(Source: tauw.nl/nieuws/eerste-fase-getijdenpark-in-de-maashaven-van-start.html)

9 Ibid

5.3 Objectives

The *Getijndenpark* project, as previously stated, has a wide range of spatial, ecological, socioeconomic, and flood-prevention ambitions. This complexity ensures the involvement and financing of several groups. Eight objectives must be achieved to ensure the success of the project.

Bringing together city and nature

The *Tidal Park* program's most explicit target is to bring the city and nature closer together. As previously stated, the river is difficult to reach, if not impossible, from many parts of Rotterdam. This is due to the fact that most public quays are vertical or very steep and were built for port activity rather than as public space. As a result, the lack of recreational and ecological value is evident. The *Getijndenpark* project entails softening the banks in order to make the water more accessible, allowing natural development and granting spaces for leisure. In the longitudinal direction, it aims to create more ecological and recreational continuity. Here, citizens will be able to fish, do sports, and cycle along the bank, for example[1].

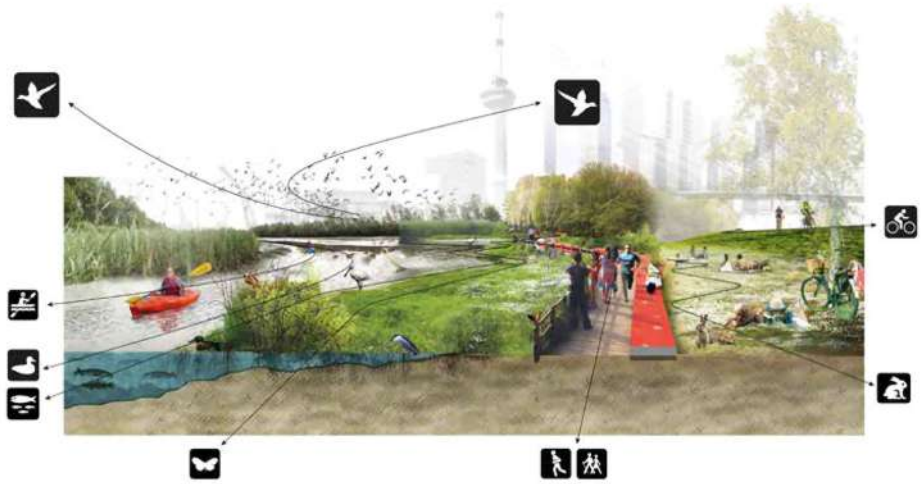


Fig.28 An impression of Getijdenpark, where nature and the city come together.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.10)

1 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.14

Increasing biodiversity

Increased biodiversity is another benefit of softening the banks and allowing nature to flourish. In the river's transverse direction, the project aims to build a series of gradients. This level system provides opportunities for the enrichment of different kinds of flora and fauna, laying the groundwork for various habitats relating to water depth. Overall, the river is enriched because it becomes a migratory route for fish and other animals in search of nutrient-rich areas or places to settle[2].

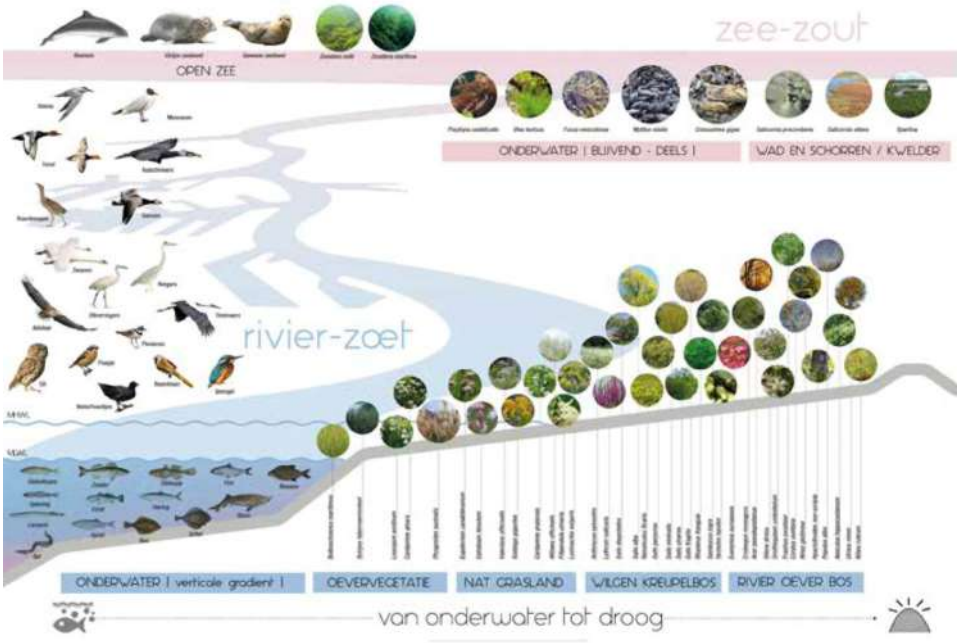


Fig.29 Flora and fauna that could benefit from the establishment of a tidal park in and around Rotterdam, from the river to the sea. (Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.10)

2 Ibid, p.17

Food production

The growth of nature along the river, as well as the increase in biodiversity, enables citizens to produce and consume local food. Different species of fish can be caught depending on the delta's location. Not only that, but the increase in green spaces also allows for the cultivation or breeding of animals in some areas. At first, it won't be possible to sell the caught fish, but that does not matter to hobby fishermen; it is the experience of being able to eat from your own river that counts[3].

Fig.30 Some illustration of riverside food experimentation and production.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.10)

3 De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.9

Base for urban development

Another fundamental aim, as previously stated, is to use the newly created areas as the basis for the large-scale urban development planned for Rotterdam. The city's demand for green public spaces is high, and *Getijndenpark* could be a real solution. Places become more appealing as a result of the development of nature, and citizens' living and working conditions improve. There is also a positive economic aspect; the tidal park increases the property values of houses near the river, and it saves money on quay maintenance in the short term[4].

Fig.31 How the Tidal Park improve the city's space and urban quality.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.11)

4 Ibid

Improving river safety

Developing a tidal park in place of the current stony, vertical dikes will help to improve flood protection. New and wider banks allow nature to prosper while also making the ditch more secure[5]. Tidal parks undoubtedly contribute to the city's climate resilience, but many more would be required to achieve a significant neutralising effect on the increasing water level, which is not always possible in urban areas[6]. As a necessary consequence, future upscaling of these solutions will be necessary.

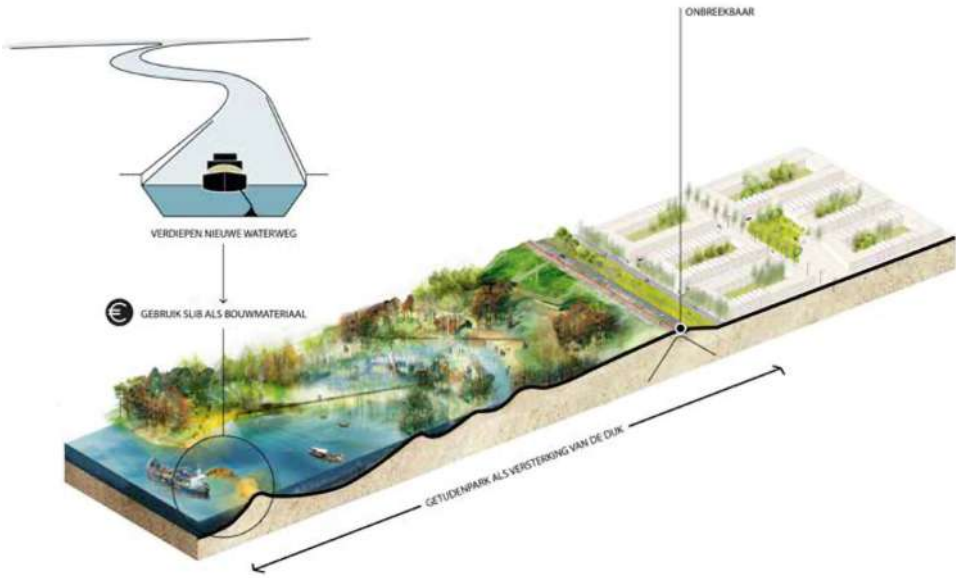


Fig.32 How the Tidal Park improves water safety.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.11)

5 Ibid
6 Batterink H. (2019). *Building with nature in de stad: Oplossing voor een vitale, veilige & welvarende deltastad?*, p.14

Recycling and experimenting

The *Getijndenpark* project fits perfectly into the logic of the circular economy; the sludge dredged to maintain the depth of the Nieuwe Maas can be reused as construction material for the tidal park. This closes a cycle that can also be extended to locations outside Rotterdam, putting it in a regional perspective. Repurposing dock rubble, cooling the city through more frequent surface water exchange in urban water structures, and using the tidal park as a test site and open-air laboratory to gain experience and knowledge in this type of intervention are other options[7].

Fig.33 Outline of the regional recycling, reuse and experimentation circuit initiated with the Tidal Park. (Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.11)

7 De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.9

Learning

Not only engineers and planners, but also citizens and children can benefit from the tidal park's educational opportunities. *Getijndenpark* has the potential to become a place where people can learn about the delta and experience the river's dynamics, as well as a play area. This can increase appreciation for nature by citizens, as it makes the tide visible and perceptible and increment their awareness of living in a delta[8].

Fig.34 Vision of the Tidal Park as a learning environment.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.10)

8 Ibid

Exposing capabilities

Showing what a tidal park can do is a long-term and global goal. The project tests a new process, technological innovations, and sophisticated design while also providing ecosystem services such as thermal stress reduction, air purification, and healthy behaviour encouragement. *Getijndenpark* has the potential to become a global model for climate resilience and improve the environment of a water-based city[9].

Fig.35 The capabilities of a tidal park.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.11)

9 Ibid

5.4 Design strategies and principles

The aspirations of the tidal park programme have been translated, during the planning phase, into six design principles to be followed in order to make *Getijndenpark* concrete and enrich the various locations along the river.

Making the transition between land and water as gradual as possible

The first principle constitutes the realisation of the tidal park itself. In order to make the transition between land and water as gradual as possible, it is necessary to redesign embankments with shallow slopes, excavate and move soil against the shore, or, where space permits, dig up the high foreshore and push the material towards the water to create a long ramp. The surface of contact between water and land is thus increased. These interventions are the project's basis and differ depending on the site's conformation. As a result, the techniques to be used in the various contexts are explored next.

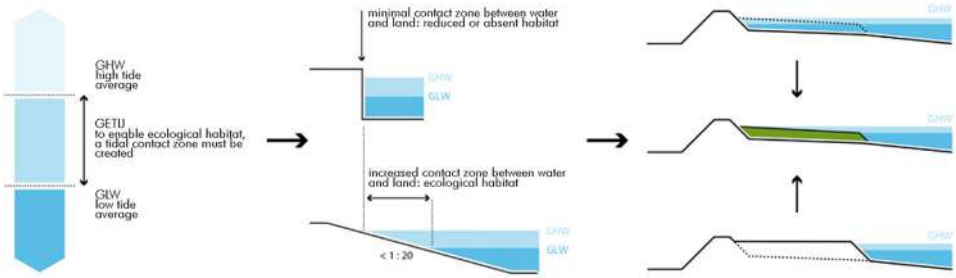


Fig.36 Maximising the sphere of influence of tidal nature by increasing the contact zone between water and land. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.42)

• in harbour docks

Tide parks in port basins are a compelling idea. This is because many harbours are managed by municipalities and, as they are progressively moved towards the sea, some basins become available for conversion. In these scenarios, it's important to keep the basin's size and scale visible, as the harbour's character must be recognisable. It's also a smart idea to extend the view from the basin's head to the river and make the water accessible[1].

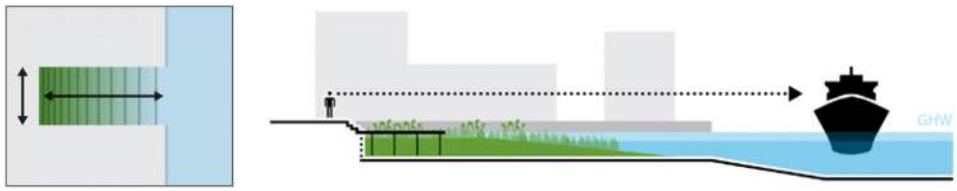


Fig.37 The harbour basin remains customisable in size and scale (on the left). The view from the head of the dock is open towards the river and the water is made accessible (on the right).
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.43)

1 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.43

• along the river

Digging along the river's banks is possible in order to widen the land-water contact zone and thus create a tidal park. An alternative could be to create a series of natural, linear pools behind the river's barrier; with a tubular connection across the dam, the water flows and these are influenced by the tide. Water access can be controlled and blocked if the level rises above a predefined level. In this way, this mechanism improves safety[2].
The length of the river is appreciable in these contexts. This feature can be used to create reserved slow-mobility paths with a view of the Nieuwe Maas. Future quayside access from both sides will open up the possibility of a pedestrian and bicycle pathway network. This would provide a continuous and high-quality spatial connection throughout the entire city[3].

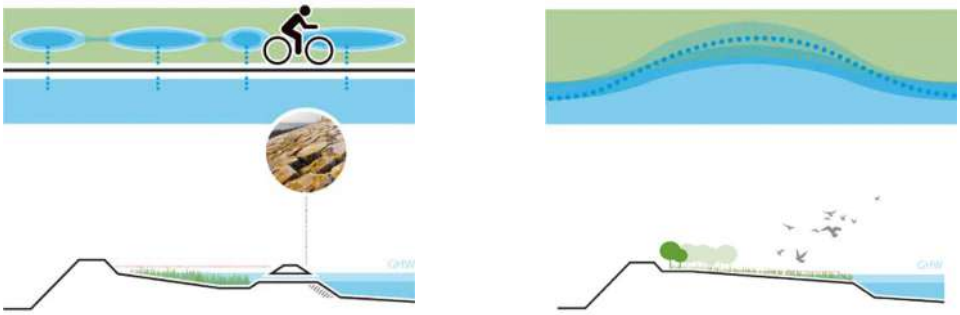


Fig.38 An extended tidal inlet along the river (on the left). A series of tide pools behind the foreshore (on the right). (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.44)

• in the inland areas

Several green areas can already be found along the Nieuwe Maas. These parks commonly have a limited number of trees, few walking paths, and poor spatial qualities. These areas could benefit from a tidal park to improve their quality and make them more interesting and stimulating for city dwellers. To accomplish this, the river and thus the tides will be brought in via a lake or a slope perpendicular to the watercourse. This will create an environment that is connected to the river but further inland, safer, and more suitable for children's playgrounds[4].

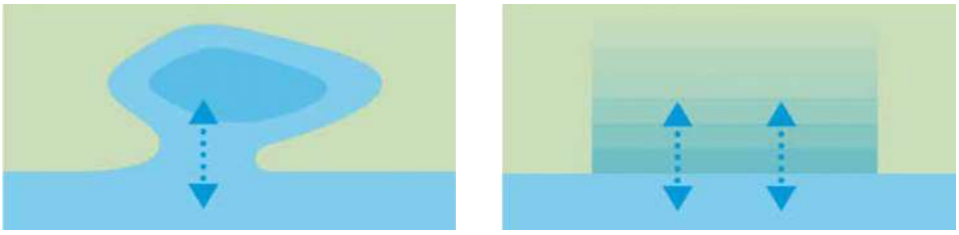


Fig.39 An enclosed pond creates a barrier for tidal environments and urban uses (on the left). A tidal slope allows the urban park to gradually 'disappear' into the water (on the right).
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.45)

2 Ibid, p.44
3 Gemeente Rotterdam. (2019). *De Nieuwe Maas als stedelijk parklandshap levendig, aantrekkelijk en natuurlijk! Programma Rivieroevers Toekomstperspectief binnenstedelijke Nieuwe Maas.*, p.24
4 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.45

• in the river's outer bend

The Nieuwe Maas meanders through Rotterdam, resulting in a number of significant bends. The river's outer curve is usually wide and offers great views of the city. The erosive effect of the river's currents and waves in the outer bend must be considered in the design. The elongated area is suitable for bicycle and pedestrian paths near the water. In addition, it also requires a hard edge to protect it from erosive action[5].

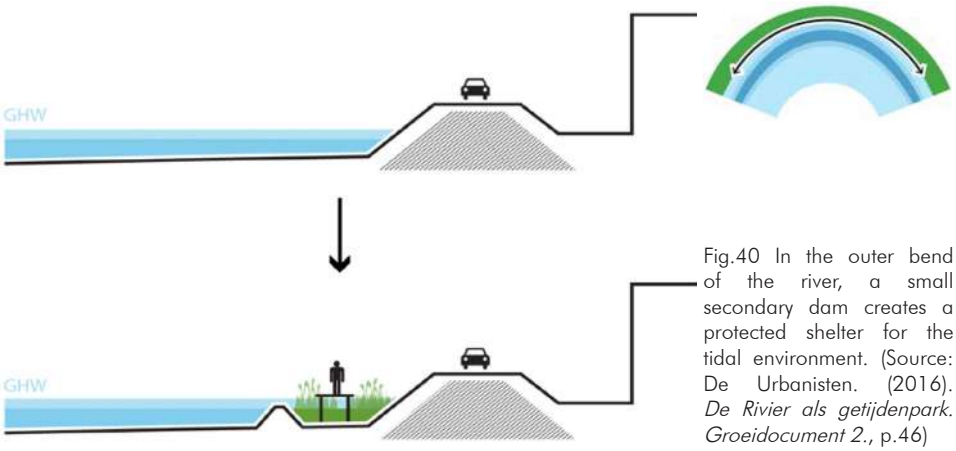


Fig.40 In the outer bend of the river, a small secondary dam creates a protected shelter for the tidal environment. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.46)

• in the river's inner bend

The inner side of the river bend has a more local character than the outer side. The view is confined to what is on the other side, and it is focused on the water. Here, a tidal park can be designed as a protected area with respect to the watercourse's cross direction. The hydrodynamics of the river in this position cause a natural sedimentation process that can be facilitated[6].

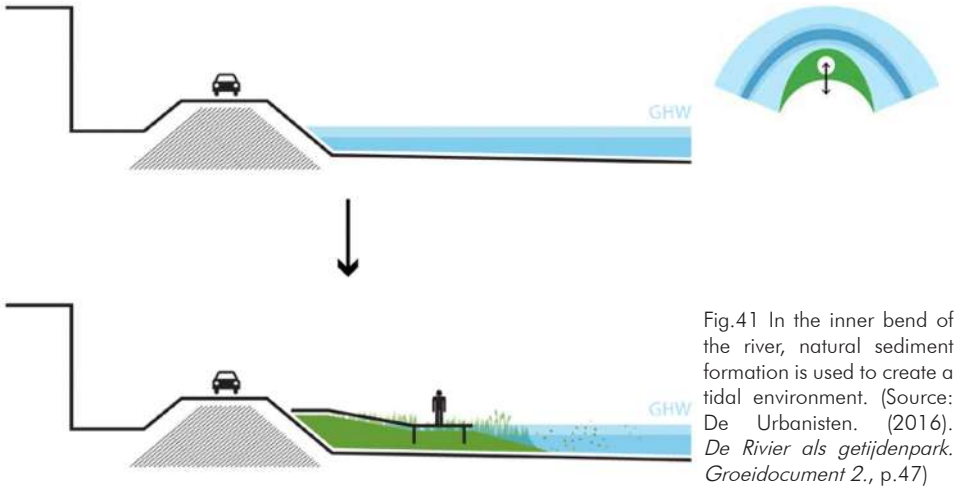


Fig.41 In the inner bend of the river, natural sediment formation is used to create a tidal environment. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.47)

5 Ibid, p.46
6 Ibid, p.47

• between the dykes

The area adjacent to the Nieuwe Maas is characterised by several inland polders; peat meadows where a tidal park could easily be designed. These spaces are free and nearly empty. The river and tides can be brought inside in a controlled manner using, for example, a flotation dam to ensure safety[7].

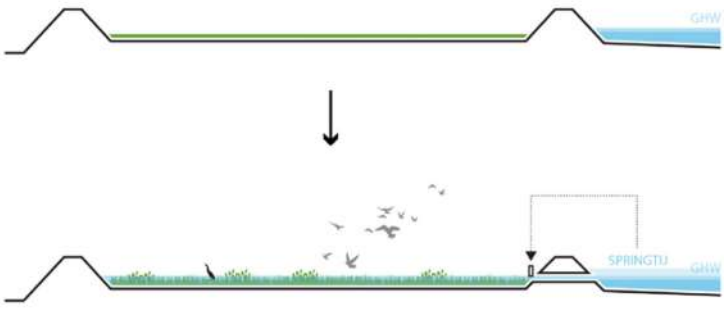


Fig.42 Transformation of the natural landscape with the creation of a tidal park. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.48)

The polders in Rotterdam are mostly located in urban areas and offer different characteristics and opportunities. Introducing tidal parks in these densely built-up places is not cost-effective; it would require a total alteration of the area. Old harbours, such as Rotterdam's Oude Haven, are an exception. A tidal park could be a useful addition to these locations. Many people live and work near these sites but are unable to perceive the river in a significant way. This is due to the hardness of the dykes, and the distance to the water is an impediment. A tidal park between the dykes would encourage people to approach the river, and along with the construction of suitable facilities, it would revitalise these unique and historic harbours[8].

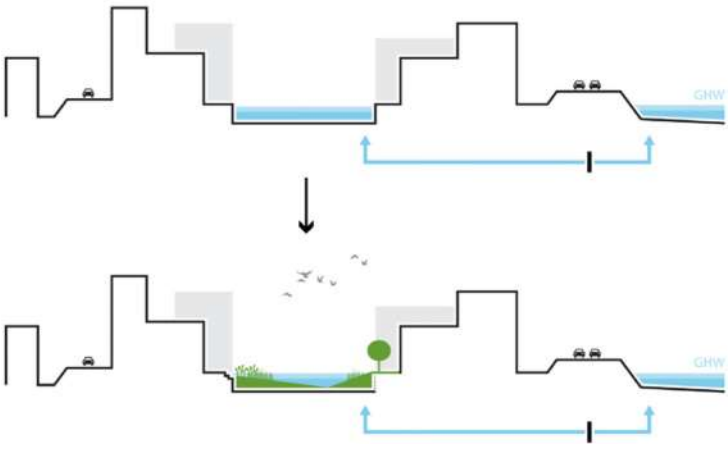


Fig.43 Transformation of the urban landscape with the creation of a tidal park. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.49)

7 Ibid, p.48
8 Ibid, p.49

• realising islands

Many people and animals visit the existing islands in Rotterdam's river, such as Brienenoord and Noordereilan. Although it will take substantial hydromorphological and hydraulic studies, as well as a considerable amount of time and money, it is worthwhile to investigate the possibility of creating new islands. The current river profile consists of raised areas against the dam, a steep slope to the bottom, and a wide central channel. The construction of a tidal island entails widening the river, excavating the banks, and pushing the released material into the water to form the island. The dams will be narrowed, but their height will be maintained or increased to ensure safety. The navigable stretch will remain the same width, and the river will have more room to expand overall[9].

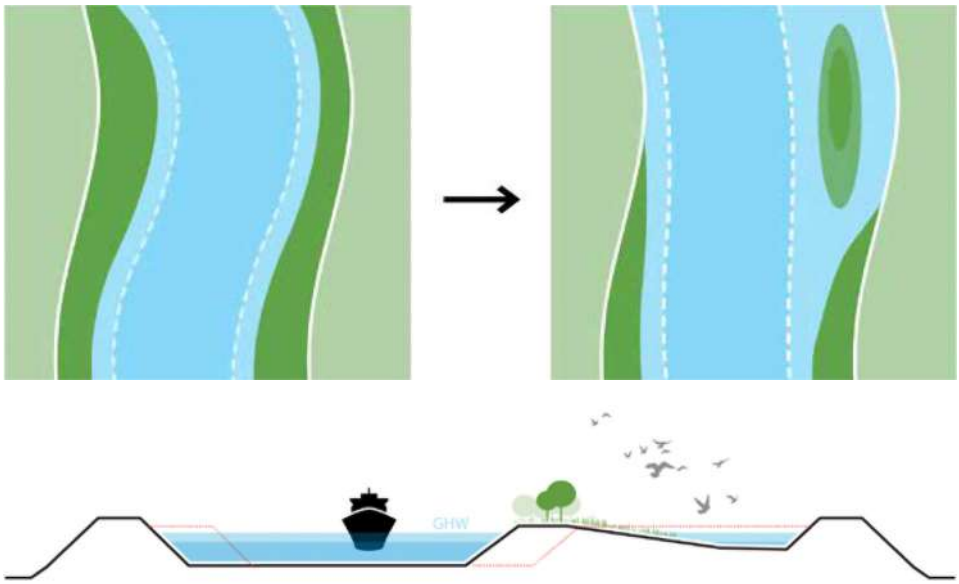


Fig.44 Shifting the shoreline creates space for an island.
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.50)

• rely on context

The above-mentioned interventions all serve the same main purpose: a more gradual transition between land and water. The different solutions for developing a tidal park are related to the various scenarios that the designer may face. The measure taken is always context-dependent. So, the examples provided above only serve as a starting point for "what is appropriate and where"[10]. This is necessary to avoid random experiments, but it does not preclude the future design of new, more appropriate forms for a tidal park.

9 Ibid, p.50
10 Ibid, p.51

Creating a well-balanced mix of nature and culture on the riverbanks

Getijndenpark design can take many configurations, some purely natural and others more cultural, utilising a wide range of intermediate forms and combinations. The type of tidal park depends on the context. A more urban layout with a more cultural design will be required in a city centre that can accommodate a higher number of users. Other areas, further from the downtown area, will have a more natural character, with artificial elements being essential and limited[11].

Fig.45 References on the rich spectrum between natural and cultural tidal park.
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.53)

As a result, there is a balanced mix of the natural and built environments, with the importance of the two parts varying depending on the location. The *Getijndenpark* project also includes additional river activities, tourist attractions, catering facilities, and temporary initiatives such as festivals[12]. To accommodate all of this, the city requires brand-new, large, and lively parks. Rotterdam can become an even more seamless fusion of city, port, and river thanks to the *Tidal Park* programme.

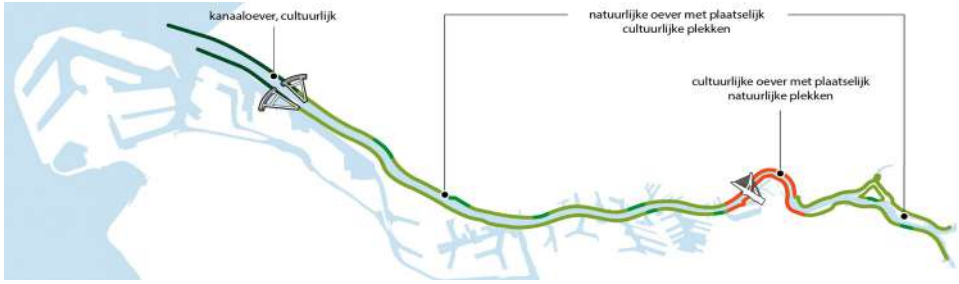


Fig.46 Localisation of natural and cultural interventions in the Tidal Park.
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.52)

11 Ibid, p.52
12 Gemeente Rotterdam. (2019). *De Nieuwe Maas als stedelijk parklandshap levendig, aantrekkelijk en natuurlijk! Programma Rivieroevers Toekomstperspectief binnenstedelijke Nieuwe Maas.*, p.41

Designing individual spots as a single system

The scale and size of the *Getijndenpark* project deserve special attention. The river landscape, with its harbour basins, is very large and requires suitable interventions. The programme must respect a double link: a relationship between the various tidal parks to reinforce the concept of the river as a whole, but also a relationship between the specific project and the specific context. To succeed in this, it was useful to identify six environments with similar spatial and landscape characteristics. Within these, the individual places are designed with coherence and in relation to each other. From the sea upstream, the following characteristic contexts can be read: the canal, the canalised river, the large-scale harbour landscape, the urban harbour landscape, the metropolitan waterfront, and the urban river[13]. The research will concentrate on Rotterdam's central area, classifiable as a metropolitan waterfront environment.

Fig.47 Identification of six environments with similar spatial and landscape characteristics in the Tidal Park. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.54)

13 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.54

Allowing and assisting nature's development

Within a relatively small region, the flora and fauna in the river's area show a wide variety of species. This is caused by the natural processes of the tides and the various gradients of fresh, salty, and brackish water, which lead to different nutrient availability and distribution. This heterogeneity must be implemented by the project in order to enrich the Nieuwe Maas with various habitats that have their own, unique natural conditions[14].

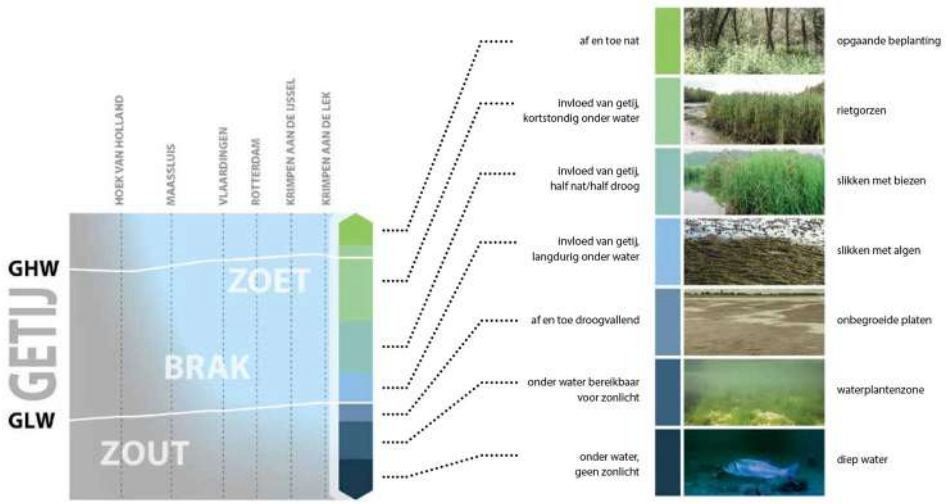


Fig.48 Distribution of flora in and around Rotterdam based on conditions and water depth. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.55)

14 Ibid, p.55

Building with nature

This principle is an extension of the previous one. As well as providing favourable conditions for the growth of nature, the *Getijndenpark* project can allow the stimulation, augmentation, and acceleration of natural processes through human interventions. In order to improve the ecological, economic, and social balance, it is also important to gain knowledge of how these measures will affect the environment. Building with nature can result in concrete, easily implemented, sustainable solutions that benefit the climate, environmental quality, and water safety[15].
Six potential solutions for tidal parks' underwater nature are outlined below. These are just a few of the configurations that can be conceived, and they include a number of concrete measures that are selected based on the area, type of dock, and its use. The examples also show which fish and organisms are most likely to live in these spots based on the measures implemented.

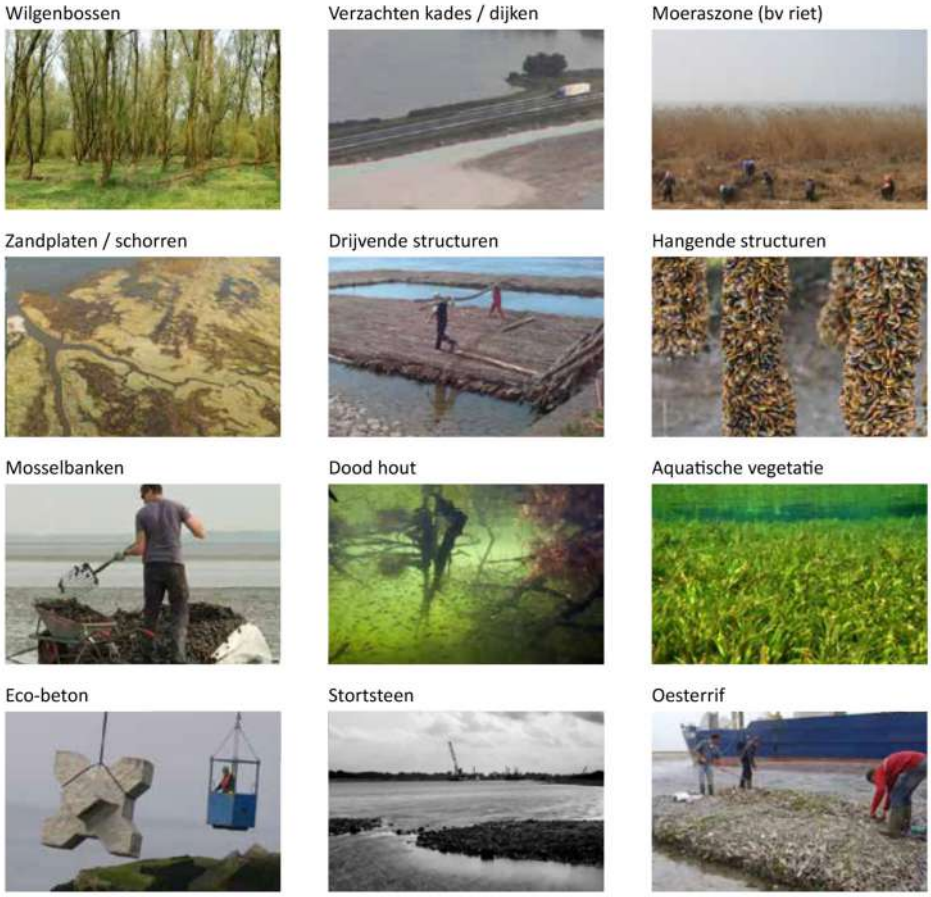


Fig.49 Reference images for the practice of "building with nature".
(Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.56)

15 Ibid, p.56

• in a harbour basin in the heart of the city

A port basin in the middle of the city has steep quays, an even, deep seabed, and a weak current. In these areas, floating bridge-like structures can be installed. On the seabed, heavier, more stable elements (like wood, artificial rocks, or rubble) keep them in place. Additionally, gabions can be fixed to the quay and filled with shells or other similar objects. Because these gutters are stable, they surface during low tide. This combination of elements provides a perfect habitat for mussels, anemones, and crabs[16].

Fig.50 A vision of interventions in a port basin in the heart of the city. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.32)

16 Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.32

• in the proximity of the port

Typically, the areas at the end of a harbour have rocky slopes and relatively flat bottoms. A shallow bank where vegetation can easily grow can be created by placing an underwater reef at a distance from the rocky slope. The gap between these can be filled with sand. If there is a flat area of land after the rocky slope, a small pool that fills at high tide and stays full afterwards can be included; the water will warm up and become an ideal habitat for small organisms and nests[17].

Fig.51 A vision of interventions in the proximity of the port. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.33)

17 Ibid, p.33

• in a non-navigable secondary canal

Gabions can be positioned transversally in a secondary channel that is relatively narrow and therefore unnavigable. This system slows the flow of the river and permits significant sedimentation up to the mean water surface. This results in the development of a muddy habitat that is ideal for benthic fish and other wildlife that inhabit the banks and can find plenty of food here[18].

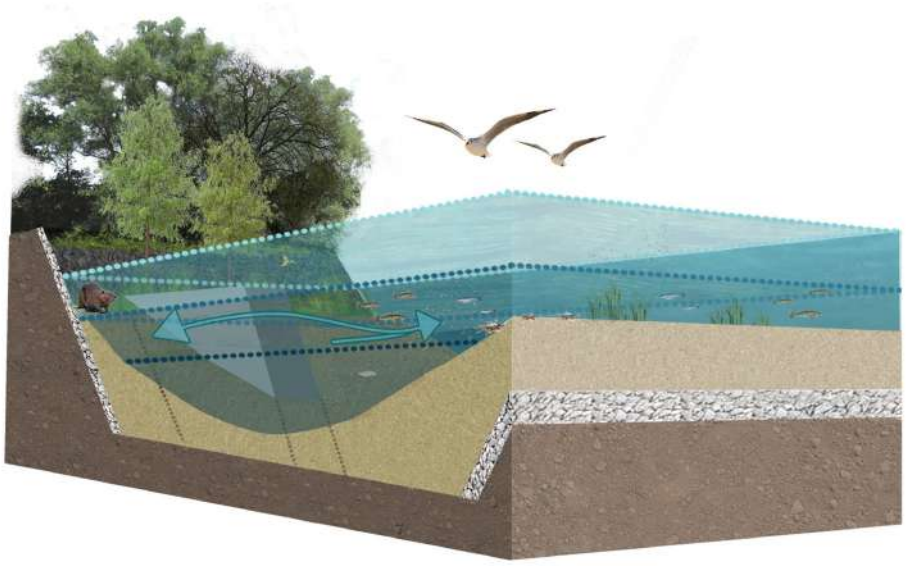


Fig.52 A vision of interventions in a non-navigable secondary canal. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.34)

18 Ibid, p.34

• in a river's inner bend

As previously mentioned, sedimentation occurs more easily in the river's inner bends than in other spots. It is possible to build a second dyke parallel to the main one in these locations, at some distance from the slope, and fill the space in between with sand or similar material. As a result, the foreshore area is affected by the tide. The main river, which is deeper, will be connected to it at high tide, while it will remain isolated at low tide. This system will develop a habitat where sedimentation is significant and natural. Eels, plaice, mullet, and saltwater trout will find food and shelter here. The juvenile fish will also attract a large number of waders[19].

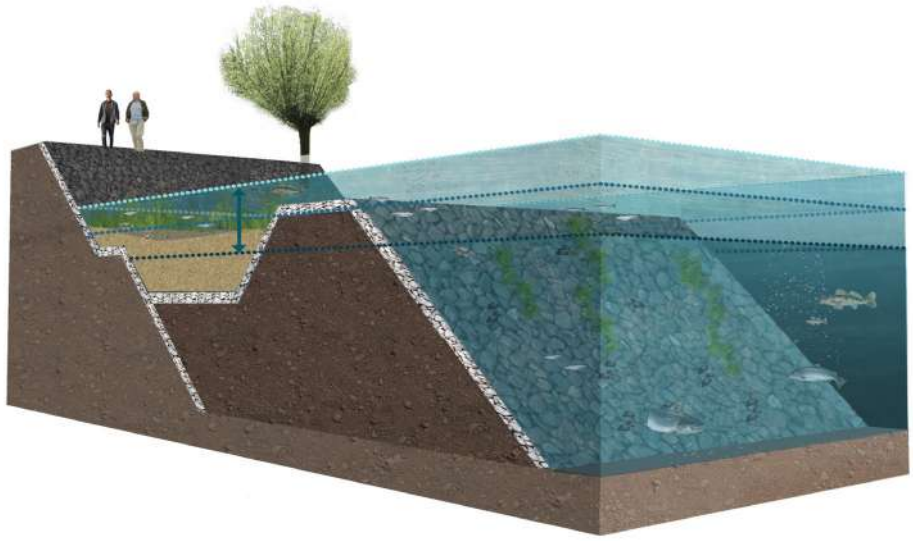


Fig.53 A vision of interventions in a river's inner bend. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.35)

19 Ibid, p.35

• in an unused port basin

It has already been discussed how to build with and for nature in a central harbour basin. However, if navigation has completely stopped in the harbour, the shallow water can be modified by installing a sandbank or simply ceasing dredging. An underwater habitat that had been lost as a result of port activities can be restored by adding structures like dead trees or artificial reefs[20].

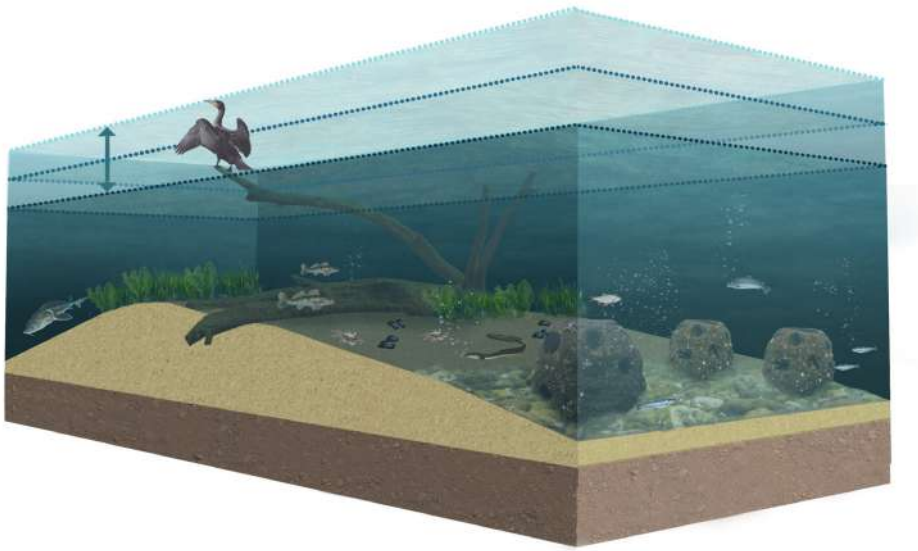


Fig.54 A vision of interventions in an unused port basin. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.36)

20 Ibid, p.36

• in a free area

A more eco-friendly quay can be built if the area is vacant or there are premises for a more radical transformation. To accomplish this, the hard banks must be removed, and the river's dynamics re-established. These will, for example, result in the formation of mudflats. Shallow banks create a gradual depth that encourages vegetation development and can accommodate more bird and fish species[21]. All of this is only possible after a detailed hydraulic study; interventions are only beneficial if they do not impact flood safety.

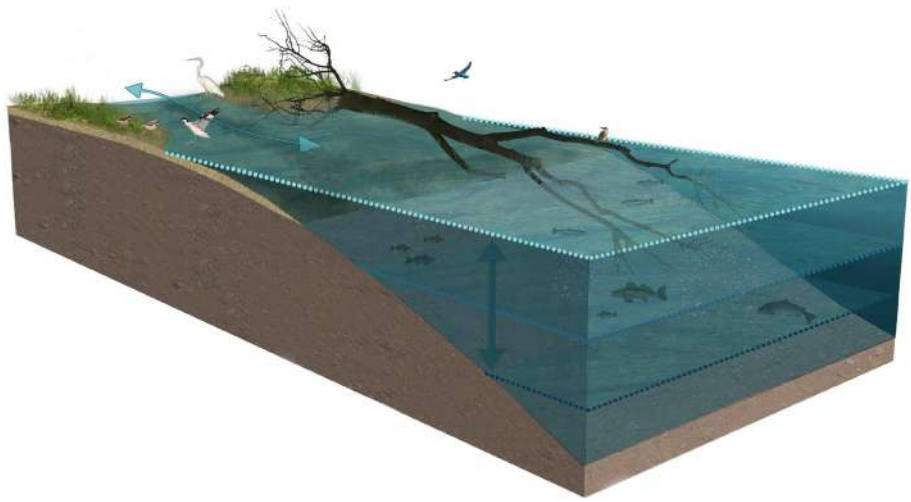


Fig.55 A vision of interventions in a free area. (Source: Herk V.J., Heukelum V.M., Wardenaar J.K. (2020). *Onderwaternatuur Rotterdam. Een analyse en typologie voor het nemen van passende maatregelen ter versterking van de onderwaternatuur van de Nieuwe Maas en de aangrenzende havens van Rotterdam*, p.37)

21 Ibid, p.37

Connecting the tidal park to its landscape context

This design principle has appeared several times on previous pages. All of the solutions presented must be chosen and adapted to the specific context. Not only that, but they must also ensure that the tidal park is clearly and legibly anchored to the landscape[22]. Here are some measures to pursue this design principle:
- exploit the dikes as pathways and incorporate them into the new green structure;
- improve the relationship between the landscape inside the dam and the river;
- use the space at the base of the dykes for natural development;
- implement recreational connections between the river and the innermost watercourses.

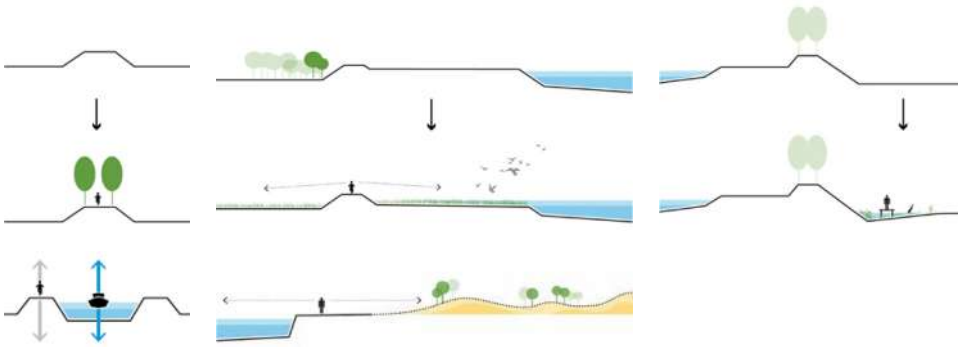


Fig.56 In order: incorporating old dam sections into the green structure, strengthening the relationship between the inner embankment landscape and the river, development of nature at the foot of the embankment, improving the recreational connection between river and inland waters, develop the boulevard at Hoek van Holland to connect with the dune area behind it. (Source: De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.57)

22 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.57

5.5 Focus on the projects

Getijdenpark Nassauhaven

A lot of new residents are moving to Rotterdam as a result of its development. This leads to a rise in demand for modern, attractive houses. Due to a lack of available building space, the municipality has begun to look at unusual locations for new residential districts, such as disused harbour sites. In this context the *Havenloft* project [Fig. 57], by Public Domain Architects, and *Getijdenpark* comes together.
18 floating homes and an eco-friendly bank have been built in Nassauhaven, a former harbour in the heart of Rotterdam[1]. The houses on the water are an intriguing solution because they use a vertical mobility system to adapt to the tide. Furthermore, they are future-proof as they are resilient to rising sea levels[2].
Architects have designed large houses. They can be finished according to the owners' wishes and needs. There is also the option of purchasing a building envelope and configuring it oneself, at one's convenience and on one's own time. The floating quarter's design also considered sustainability. The homes are built to be energy neutral. They have a solar panel base that can be extended. Heat is generated from biomass, and wastewater is treated and purified directly in the building. The weather-resistant wooden façade has a long service life, does not drip, and does not require any additional treatment. All building materials were chosen for their durability, robustness, and aesthetic appeal[3].
Living in a floating residence is an experiment that looks to the future; its occupants will be an enterprising and dynamic group of people living in close relation to nature and the water.

Fig.57 Havenloft's floating homes and the eco-friendly bank in Nassauhaven. (Source: personal elaboration)

1 De Urbanisten. (2016). *De Rivier als getijdenpark. Groeidocument 2.*, p.87
2 Public Domain Architects. (n.d.). *Floating Homes Nassauhaven, Rotterdam.*
3 Ibid

Eiland Van Brienenoord

The Eiland Van Brienenoord and the Polder de Esch, which we will discuss in the following chapter, are located on opposite banks of the same section of the Nieuwe Maas [Fig. 58]. At this point, the river curves, forming the Rotterdam entrance together with the Van Brienenoord bridge. This is where the urban area of the city gives way to the neighbouring suburban municipalities.

Fig.58 Views of Polder De Esch and Eiland van Brienenoord.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.15)

The 1.5-kilometer-long island of Brienenoord is the result of both natural development and human intervention. Sandy stretches that impeded the river's flow were moved in the 19th century, resulting in its formation. Fishing was the first economic activity on the island. Later, it was used for unloading dredged material from shipyard harbour wells[4]. The demand for parks and other open spaces has grown significantly since the 1930s. As a result, in 1944, Eiland Van Brienenoord was designated as a park with sports fields. However, the area's later development deviated from the urban plans with the construction of the IJsselmonde/Ridderkerk oil field, a metering station, an emulsion processing facility, and a crude oil facility. When the Van Brienenoord bridge was being built, one of its supporting pillars was placed in the island's eastern part, having a significant impact on the site. The WWF and the municipality of Rotterdam freed the island of fences, buildings, and garbage heaps in 2000, making it an accessible "urban jungle"[5].
Brienenoord Island is one of the few places in Rotterdam and on the river where residents can feel in touch with nature. The *Getijdenpark* project aims to increase the

4 De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.46
5 Ibid, p.47

natural value of water by creating a richer and more ideal habitat for the typical flora and fauna of a tidal park. This increases the recreational value of the area, making the surrounding neighbourhoods more appealing.
The island's strength is that it already has multiple environments [Fig. 59]. The most dynamic area is on the eastern side, where Scottish Highlanders graze. This is followed by the microculture of a plots complex nestled in a forest of wild willows. On the western side, there is a freshwater pool that serves as a habitat for toads, as well as a breakwater that juts out parallel to the riverbank[6].

Fig.59 Brienenoord Island: further differentiation of ecological and recreational areas. (Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.20)

At low tide, some parts of the island already dry up. The goal is to improve this feature in order to make the eco system more appealing to people and to broaden the variety of environments available.
The *Getijdenpark* project carried out a number of interventions on the island[7]:
- remove the fence
A large fence blocked the island's access road. Its removal produced a logical link between Eiland Van Brienenoord and the surrounding neighbourhood.
- build a pedestrian and bicycle bridge
A connecting bridge has been constructed at the island's easternmost part. There is a parking lot beneath the Van Brienenoord bridge where vehicles may be left while visiting the island on foot.
- digging
Making certain areas shallower can speed up the natural sedimentation process. More gradual banks favour animals seeking food in the transition zone between land and water. Thus, biodiversity was increased.
- lowering the quay
Lowering the quay allows for a more natural and direct inflow and outflow of river water.
- making a short tidal channel
With the addition of a brief channel at the island's head, the tidal environment has been expanded, extending the river's dynamics through water inflow and outflow.

6 Ibid, p.20
7 Ibid, p.41

Fig.60 Map of planned interventions on Eiland van Brienenoord.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.40)

Polder de Esch

Polder De Esch is located in the Nieuwe Maas' inner bend, opposite the Eiland van Brienenoord. It is a wetland nature reserve outside the dykes, hidden by ancient trees, with historical and cultural elements. Its condition is unique; it is the only polder in the region outside the dykes[8]. It is separated from the river by a dyke that formerly served as the primary flood protection structure. The protective line was lifted and relocated inland in the 1960s.

Fig.61 The pond in the centre of Polder De Esch. (Source: personal elaboration)

In the centre of the natural park is a body of water with reeds and aquatic plants [Fig. 61]. Prior to the project, the ecological value of Polder De Esch was discrete. The conversion of the polder into a tidal park has greatly increased biodiversity at the site; the idea was to allow the tide in in a controlled and discrete manner. To accomplish this, an underground connection to the river was constructed, which is regulated by a floating, lockable barrier to ensure safety [Fig. 62]. The duct was designed to allow fish, mammals, and other organisms to enter and exit on a daily basis[9].

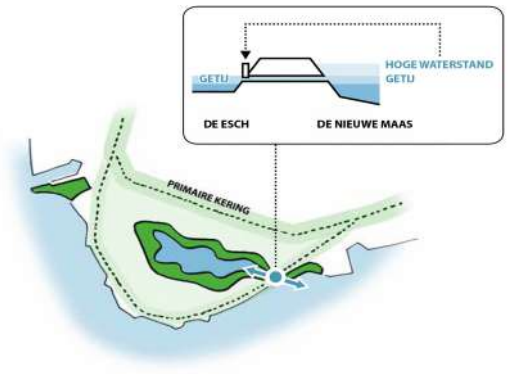


Fig.62 Introduction of the tidal park in Polder De Esch. (Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.20)

8 Ibid, p.37
9 Ibid, p.44

Today, Polder de Esch provides a more natural and "wild" alternative to Rotterdam's public parks. In order to accomplish this, in addition to the floating barrier, the *Getijdenpark* programme has promoted other interventions in the Polder de Esch[10]:

- enhancing security

The existing dam has been raised and reinforced in several places to protect the houses behind it.

- excavating

The ground can be moved in certain places to make the transition between water and land more gradual. This intervention, like that on Van Brienenoord Island, increases biodiversity.

- trim shrubs

Tall, impenetrable shrubs needed to be cut back to make the existing lake more accessible to visitors. Previously, the inner water was only accessible to the more daring. Access and walking were made possible for all citizens by clearing specific spots.

- allowing the play

The polder is now a secure place for children to play and observe the water and tides. The floating and adaptable barrier keeps the area safe.

- building platforms.

A platform on the lake allows visitors to get a close look at the water and the effects of the tides. There are also beautiful views of the river and trees from here.

Fig.63 Map of planned interventions on Polder De Esch.
(Source: De Urbanisten. (2015). *Getijdenpark Brienenoord – De Esch.*, p.42)

10 Ibid, p.43

6. Stijp-S, dismissed industrial areas recovery strategy

The conversion of Strijp-S, in Eindhoven, does not present any direct climate adaptation solutions. It is analysed here as an interesting example of industrial site transformation. Reusing existing structures rather than demolishing them and building new ones is a sustainable option that adheres to the circular economy concept[1]. Therefore, adaptive reuse can be viewed from all perspectives as a method for addressing climate change, and it should be explored and improved.
Strijp-S is one of the large industrial areas in the Netherlands undergoing transformation. It is well-known and recognised throughout the world as the former headquarters of the Philips Company. The district's conversion is a significant and elaborate case of re-design that maintains a recognisable industrial character.
The transformation that the area has undergone since 2001 is an example of adaptive reuse of industrial heritage that will be analysed within this thesis as a socially, environmentally, and economically sustainable strategy.

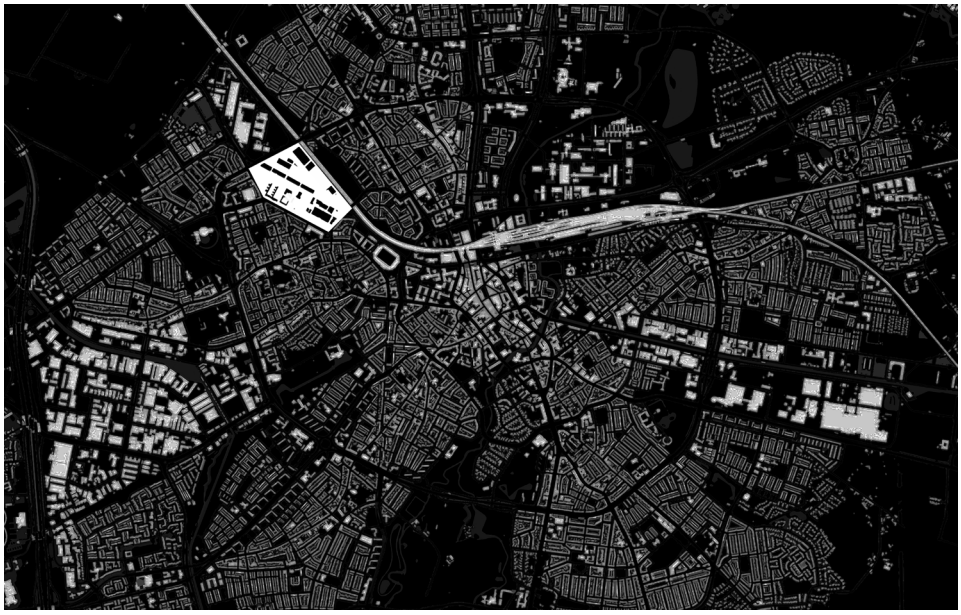


Fig.64 Map of Eindhoven with the Strijp-S area highlighted. (Source: personal elaboration)

1 Meurs P., Steenhuis M., *Reuse, Redevelop and Design. How the Dutch Deal With Heritage.*

6.1 Context

Eindhoven is situated in the Dutch province of North Brabant. The town was built at the confluence of two rivers, the Dommel and the Gender. The latter was dammed a short distance from the city centre in the 1950s, while the former still runs through it.
Strijp-S covers an area of approximately 27 hectares and is located north-west of the city centre of Eindhoven[1]. It is strategically located between the city centre and the green wedge, which is identifiable by the Philips de Jongh Park. The site is also directly served by the ring road and the railway network.

Fig.65 Aerophotogrammetry of Strij-S, highlighted, and surroundings. (Source: Google Earth)

1 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.1

6.2 History

The city's earliest days

Eindhoven was founded in the thirteenth century and rapidly expanded until the 1500s. According to old village maps, the city does not change much after this moment and plays a minor role during the late Middle Ages and the Dutch Republic[1].
Everything changed beginning in the nineteenth century. As a result of industrialization, Eindhoven and its surrounding villages have experienced rapid economic and population growth, making it one of the most important cities in the Netherlands. The construction of a new canal connecting Eindhoven to neighbouring cities in 1845 was a watershed moment. From this point forward, the city's industries receive critical input, especially in the textile, tobacco, and wood sectors[2].

The entry of the Philips company

The Philips brothers established their first light bulb factory in Emmasingel, Eindhoven, in 1891. The high availability of manpower and easy access to a large amount of rural or undeveloped land influenced the decision to settle in Eindhoven. It is clear now why the company was given nearly unrestricted positioning of industrial sites and design freedom within them[3]. Furthermore, by the end of the nineteenth century, the city already had railway connections to all of the major nearby towns[4].
It would be an understatement to say that Philips had a significant impact on the economic development of Eindhoven. Indeed, the company has done much more. It has provided "housing and social, educational, sporting, medical, and cultural facilities for its employees and their families" and also "laboratories, residential areas, schools, sports centres, playgrounds, walking parks, a library, grocery shops, drugstores […], butchers' shops, a bakery, a leisure center-theatre, and its own technology museum, the Evoluon"[5].
At the turn of the century, Philips experienced exponential growth. In the 1930s, the inner-city industrial park on Emmasingel and Mathildelaan was densely built with industrial buildings[6]. The Philips brothers quickly realised that the company needed more space to expand.

1 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.5
2 Ibid, p.20
3 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.87
4 Ibid, p.89
5 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, cit., p.28
6 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.198

Philips establishment in Strijp-S

Philips chose the Strijp-S location because of its easy rail access and proximity to the Emmasingel industrial site. The glass factory opened here in 1916 required a large amount of coal, which came primarily from the Liège mining area[7]. The industrial development centre of Eindhoven was suddenly shifted to the west side as a result of this relocation.

Following the completion of the glass factory, the site saw the rapid construction of many other buildings. A five-sided industrial complex emerged along the railroad in a relatively short period of time. The site was designed as a functional structure with wide streets and large blocks. Torenstraat was the main thoroughfare. On the northern side of this road, four buildings were connected by air bridges and pipes: three factories for the manufacture of household appliances (the SK, SAN, and SBP buildings), and the SDM building (also known as the *Veem Building*), which was built later, in 1942. Together, these structures (known as *Huge Rog*) formed a radio and, later, a television production facility. Further north, another avenue, Philitelaan, ran parallel to the railroad and led to the Bakelite factory, *Klokgebouw* (1929).

Philips' expansion was the result of a "vertical integration" strategy in which more and more semi-finished and consumable products were manufactured within the company itself[8]. The initial lack of resources resulted in the development of a complete and complex industry with a high degree of independence; everything was designed and produced internally, from raw materials to semi-finished and finished products. The company's slogan was "from the sand to the customer"[9].

The construction of the Physics Laboratory (known as *Natlab*) in 1923 exemplifies Philips' aim of attaining industrial independence. Throughout the last century, this complex has allowed the company to be at the forefront of the technology sector.

As a result, a closed industrial site with thousands of people entering and exiting every day was created. It was located between other buildings, but it was surrounded and inaccessible to non-working people. As a result, Strijp-S earned the moniker "Forbidden City"[10].

7 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.30

8 Ibid

9 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.92

10 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.31

Fig. 66 View of Strij-S, Eindhoven, in the 1960s. (Source: pin.it/12c5815)

The decline of Strijp-S

Strijp-S was densely built in 1951, after 35 years of construction and expansion. Except for the *Veem Building* (1942) and the *Glass Building* (1947), the site was mostly finished by 1930.
After the war, Strijp-S changed radically over the next 50 years as the industrial sector evolved. The construction of a new boiler room, which supplied energy to Strijp-S through an overhead coil of pipes, was relatively significant; the Leidingstraat is still visible today and is one of the most distinctive and site-identifying features. The building of this power station was the first step toward the displacement of new industrial settlements in this location[11].
During this time, the *Natlab* was also expanded. However, in 1963, an industrial district with new laboratories, which is now home to the High-Tech Campus, was founded on the city's southern border. The original glass factory was demolished the same year to make way for a ten-story office building. The first building in the *Hoge Rug* line met the same fate.
But what are the reasons for the transformation, partial demolition, and, more generally, the decline of the Strijp-S industrial area?
From a marketing perspective, the demolitions were probably necessary for economic survival. This is primarily because, since the 1960s, the concept of "integral industry" has become less convenient; the European Common Market has made it much easier for Philips to access specialised suppliers outside the company. A large portion of the domestic supply's production did stop. This was just one of several factors that contributed to Philips' restructuring and downsizing, which saw manufacturing increasingly shift to low-wage countries[12].
Many of the changes and demolitions occurred between 1951 and 2001 for practical reasons. From the post-war period onward, the economy shifts from secondary to tertiary. Buildings' functional profiles modify as work activity switches from factories to offices. This also led to an increase in the need for parking spaces[13].
Philips completely abandoned the Strijp-S site during the last major corporate reorganisation in the 1990s, shifting production to other countries and the headquarters to Amsterdam.

11 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.120
12 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.31
13 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.232

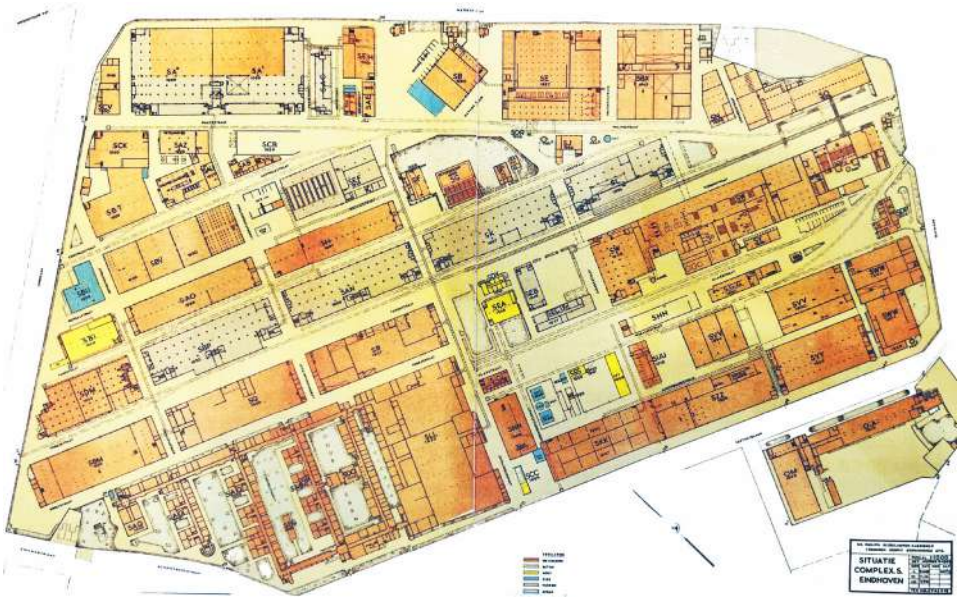


Fig.67 The Philips complex, Strijp-S, in 1953. (Source: Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.31)

Redevelopment of the industrial district

Philips donated the industrial site at Strijp-S to the municipality in 2002. The fences were removed, as well as the property line. This represented a significant opportunity for the city, which had a large public urban area connected to the centre and, further north, to the green wedge. Following that, a ten-year period was spent designing and planning a post-industrial transformation. Only a few existing buildings were saved and redeveloped[14].

In November 2002, the Rotterdam West 8 urban planning office was commissioned to carry out a preliminary urban design project [Fig. 68]. Strijp-S has become a residential and working urban area[15]. As a result, large portions of the site were demolished. This was justified by the needs arising from the conversion to civil use[16]. The majority of the southern sector between Kastanjelaan and Torenallee was torn down. *Natlab*'s northern wing has also been lost.

In general, there is a lot of interest in the area's transformation, both socially and professionally. The municipality and various development teams collaborate and have high expectations for its conversion into a "creative hub" that combines work, residences, and a variety of structures.

The value of industrial heritage has been recognised through the establishment of national and municipal monuments. Building redevelopment for new uses has become commonplace.

Although the conversion of the Eindhoven industrial site is still ongoing, it is already one of the most successful European examples. It demonstrates how industrial building preservation and reuse not only add character to a location but also have economic, cultural, social, and environmental benefits[17]. The municipality intends to increase the number of residents and jobs in Strijp-S as well as organise a lot of cultural or experimental interventions in order to make the district an appealing location on an international scale[18].

14 Ibid, p.75

15 Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.69

16 Geevers K. (2014). *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.75

17 Babalis D., Curulli I. (2018). The Philips' industrial landscape in Eindhoven. Heritage and reuse of Strijp S terrain. *Ricerche storiche*, p.73

18 Brouwers B. (2016, 7 August). Eindhoven's inner city has a lot to achieve until 2025. *Innovation Origins.*

Fig.68 Strijp-S project masterplan by West8. (Source: west8.com/projects/strijp_s/)

6.3 The urban plan

The Strijp-S development plan followed some basic principles that allowed the area to transform from an industrial site to a creative district with high economic and attractive potential. The conversion also included the direct participation of public and private stakeholders who were committed to achieving a positive outcome[1].

Fig.69 Strijp-S urban development plan.
(Source: nrpguldenfeniks.nl/upload/gulden-feniks/3/3/new_e9dc0fc9fe4b3cf3a5bba2478ef37f4c.pdf)

1 Babalis D., Curulli I. (2018). The Philips' industrial landscape in Eindhoven. Heritage and reuse of Strijp S terrain. *Ricerche storiche*, p.57

Flexibility

The Strijp-S programme does not require a detailed design to be agreed upon ahead of time. Instead, it emphasises flexibility as one of its best assets.
Furthermore, there have been no previous projects of this scale in the Netherlands. According to Trudo, "there is no script for this," and "this is what makes this process so interesting [...]; it's the compelling story of trying and experimenting, venturing and learning, driving and letting go"[2]. Indeed, the urban plan enables some leeway in terms of location and volume and allows for flexibility during implementation. Hard and soft project lines have been differentiated in the strategy. Building heights are also defined with a decisional margin[3].
One of the factors that contributed to the plan's success was its adaptability. Despite setbacks, such as the financial crisis of the 2000s, it was possible to continue the conversion through compromises and adaptations[4].
In addition to the flexibility of the plan, the flexibility of the buildings themselves is of fundamental importance [Fig. 70].

Fig.70 The units are designed to be customisable and modifiable over time. These are some of the possible flat layouts in the *Hoge Rue*'s buildings. (Source: driehoekstrijps.nl/files/25109)

2 Trudo housing association (2010). *Old buildings new ideas*, p.1
3 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.72
4 Babalis D., Curulli I. (2018). The Philips' industrial landscape in Eindhoven. Heritage and reuse of Strijp S terrain. *Ricerche storiche*, p.69

Adaptive reuse

Most of the industrial heritage present here has a monumental scale, with a reinforced concrete frame structure and free floors of considerable height, allowing them to be adapted to almost any function. Through significant investments, it is possible to reuse buildings and extend their lives indefinitely[5]. This step is fundamental because it expresses a core element of the project; preserving industrial heritage by responding dynamically to the reuse of factories, also through temporary uses and short-term leases[6]. Conserving these structures is critical not only from an economic and environmental standpoint but also from a social one. They are identifying elements of the site and part of the city's collective memory.

Fig.71 The *Radio Royaal* restaurant is housed in the *Engine Room* in Strijp-S, which has been preserved and reused. (Source: personal elaboration)

5 Trudo housing association (2010). *Old buildings new ideas*, p.16
6 Babalis D., Curulli I. (2018). The Philips' industrial landscape in Eindhoven. Heritage and reuse of Strijp S terrain. *Ricerche storiche*, p.68

New buildings

In addition to the preservation of existing buildings, the plan also requires new construction. The size of these varies, and "variations in type, architecture, materials, colour, or height within a block or line of facade"[7] are also introduced. In contrast to the old structures, there are smaller buildings arranged in intimate squares or enclosed courtyards [Fig. 72]. The result is a rich image-a labyrinth that the visitor enjoys exploring.

Fig.72 One of the residential blocks with enclosed courtyards built in Strijp-S, Eindhoven.
(Source: personal elaboration)
Fig. 73 (On the right) The *Trudo Vertical Forest*, a new residential and commercial building constructed in the heart of Strijp-S. (Source: stefanoboeriarchitetti.net/wp-content/uploads/2018/01/Stefano-Boeri-Architetti_Eindhoven-Trudo-Vertical-Forest_overall-view.jpg)

7 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.14

Mixed-use development

It is fundamental for the district's vitality that the complex house a variety of functions, as specified in the plan. Lofts, condominiums, urban villas, student apartments, and even lots for private individuals to build their own homes are all included in the project. The living function is essential in the transformation of an industrial site like this because it allows for 24-hour use and prevents it from "becoming a museum"[8].
Working is an important function as well. Strijp-S was created to work and produce. The goal is to make the space a creative industry hub for the city, focusing on start-ups and innovative businesses and offering workshops, workspaces, and places to meet and collaborate[9].
Retail shops and catering spaces are also planned to bring life to the area and attract visitors. It is not the shops and restaurants of large corporations and multinationals that characterise and distinguish the site, but rather creative companies, sophisticated solutions, and small entrepreneurs with original ideas[10].
Sport and culture are also part of the Strijp-S plan. *Dutch Design Week* and *GLOW*, Eindhoven's popular light festival, are both held here on a regular basis. Strijp-S is the home of urban sports, with areas for skaters, boulderers, and street dancers to practise and perform[11].

Fig.74 One of the buildings in Strijp-S was transformed into the largest wooden skate park in Europe. (Source: personal elaboration)

8 Trudo housing association (2010). *Old buildings new ideas*, p.17
9 Ibid
10 Ibid
11 Ibid

Sustainability

One of the plan's guiding principles is sustainability. As previously stated, the reuse of existing heritage is already part of a sustainability logic. Furthermore, special attention is paid to reducing environmental impact by pursuing energy efficiency, using environmentally friendly and energy-efficient materials, and providing as many options for separate waste collection as possible[12].

Fig.75 *Plug-in-city* is a creative community temporarily established in the centre of Strijp-s in Eindhoven. Starting with a few containers, this community of designers, architects, artists and other professionals have combined their expertise in the circular economy to build a space in the middle of Strijp- S that functions as a creative workshop, laboratory, event space and cultural centre. (Source: personal elaboration)

12 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.94

6.4 Analysis and evaluation of the transformation project

Before studying how the monumental buildings of Strijp-S have been converted, we will analyse the transformation of the site's configuration [Fig. 76], paying particular attention to the way its structure and public spaces have been treated.
A change in use is required, so areas where people can gather, perform activities, and exchange ideas must be designed. Furthermore, in these contexts, public space must be viewed as a link between different urban parts. They serve a dual purpose: on the one hand, they create internal bonds between old and new structures on the site, and on the other, they reconnect abandoned and isolated places, such as Strijp-S, to the dynamics of the city around them[1]. Indeed, as previously stated, abandoned industrial areas are typically located in strategic locations between the city centre and the surrounding urban landscape.
It is therefore necessary to depart from our common conception of public space when planning the conversion of an industrial area. Squares, avenues, and parks are often thought of as well-defined and standard, with clear boundaries and clean shapes. Such places sterilise the environment and flatten people's perceptions. Strong boundaries also hinder communication between the various city districts and with the citizenry[2].
The designer of these interventions must approach public spaces with a sense of spontaneity and transience, as these are also characteristics that distinguish industrial sites. One should not aim for a "final state in design, because new layers will always be added in the future in a continuous and endless process"[3]. To accomplish this, a system of squares, streets, and parks should be designed in industrial areas. The designer must create intermediate spaces where the public and private meet and various temporary activities can take place.

Fig.76 Strijp-S, Eindhoven. In order: 1953, current state, project. (Source: personal elaboration)

1 Curulli I. (2014). *The making and remaking of dismissed industrial sites*, p.53
2 Ibid
3 Ibid, p.54

Viability and spatial structure

How it was

Strip-S remained a closed industrial site with well-defined boundaries after the war. The railway ran along the north side of the five-sided district, which was completely fenced in. Only two road axes—Torenstraat and Apparatenstraat, which were perpendicular to each other and were recognised as the Cardo and Decumanus of Strijp-S—completely crossed the site. The four main entrances to the Philips district corresponded to these two streets[4], which ideally divided the area into four quadrants. This already demonstrates how the site was planned logically, following the lines of the railway and gas pipelines. The resulting structural scheme is formed by the intersection of two orthogonal grids, one parallel to the railway and the other parallel to *Hoge Rue*'s buildings.
All of the Strip-S buildings had a rectangular plan and were oriented along the orthogonal lines of the lot to which they belonged. Only the structures in the so-called triangular residual spaces, which is formed by the intersection of the two grid systems, were an exception.
The other internal streets were either alleys or connected to other roads. The names of the latter corresponded to the functions of the respective production units[5].
The Strijp-S structure was extremely functional. Numerous sub-functions have been formed as a result of the integrated industry concept mentioned above. This was reflected in the spatial subdivision of the site. There were various ward units, clearly distinguishable on the map, depending on their function. Each ward unit was defined by a collection of different structures that were organised according to the subprocess for which they were projected[6]. The *Hoge Rug* buildings are a perfect example of this; they were constituted by elongated floor plans linked together to accommodate the conveyor belts that ran throughout all rooms and finally delivered the products to the *Veemgebouw*. Another example is the glass products department, which includes an oven, a glass factory, warehouse buildings, and an open space for sand storage. Even the *Natlab*, which was a research facility rather than a production space, served as a separate entity in and of itself. It could be recognised by its neutral structure and facades with repeated windows[7].

What was planned and how it is now

When we examine the current configuration of the site, we can see how many of the above-mentioned features have been lost as the area has changed from the post-war period to the present.
The first feature of Strijp-S that has vanished over time, particularly since Philips' transfer, was its external closure. This was required in order to integrate the site into the city and make it accessible to citizens. The urban fabric of Strijp-S is now much more accessible and permeable; nearly all roads connect to the perimeter, allowing entry and exit from

4 Geevers K. *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.214
5 Ibid, p.128
6 Ibid, p.135
7 Ibid, p.206

the area.
The road network has undergone significant changes. The orthogonality of the system is less visible, and the streets have been enlarged. Torenstraat, which will be discussed later, and Philitelaan are two clear examples of this. Obviously, the road network had to be updated to meet modern standards. It now has to accommodate a much higher volume of traffic as well as an adequate system of cycle paths.

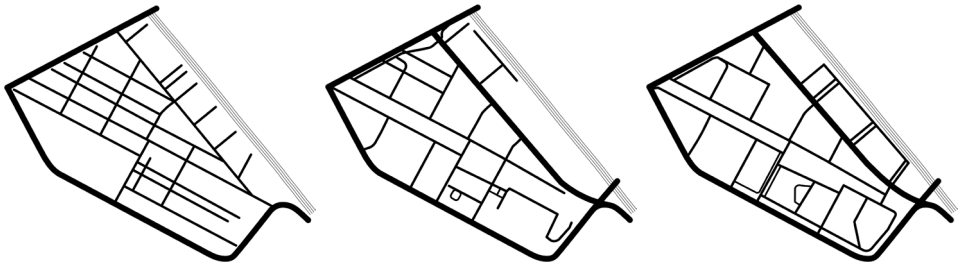


Fig.77 Road system of Strijp-S, Eindhoven. In order: 1953, current state, project.
(Source: personal elaboration)

The changes mentioned above have an effect on one's perception of the location. When comparing the current situation to that of 1953, the first thing that stands out is the decrease in building density [Fig. 78]. This, combined with the widening of the streets, has had a significant impact on the area's image. Part of the industrial atmosphere of narrow streets and long facades has been lost.
The layer per department unit that defined Strijp-S is no longer visible today. This is due to the numerous demolitions, particularly in the south-east quadrant, and the change in function that the area and buildings have undergone. As opposed to this, the West 8 project is based on the square courtyard building conglomerates that define the entire site. These complexes, which come in a variety of types and architectural styles, are divided into separate units. Each of them has a central courtyard. They refer, at least formally, to the concept of the original ward units. However, the current situation only partially reflects the plan because it has not yet been completed.

Fig.78 Building density of Strijp-S, Eindhoven. In order: 1953, current state, project.
(Source: personal elaboration)

Greenery and public spaces

How it was

As a predominantly industrial area with a high-intensity production process, it is easy to understand why Strijp-S had few public spaces. On the 1953 map, there are no well-defined squares or green spaces. The seconds, in fact, were not present at all.
There were few areas on the site that could be used for social purposes because there was a clear transition from public space to the building. The open spaces near the company canteen and on the glassworks' northeast side are an exception.
The residual spaces and streets formed an urban system that served as a public space for daily life; aside from working, people here spent their lunch breaks, went for walks, and met. Despite not being specifically designed for it, this network of secondary streets and "squares" has taken on a social function over time. Speeches, group photos, and presentations were also held here[8].

What was planned and how it is now

Both the current situation and the Strijp-S urban plan have significantly more public space. One of the primary goals of the site's transformation is to create an innovative and high-quality system of public open spaces and greenery[9].
Today, the site has a large number of pedestrian areas that connect the old and new buildings, providing places to meet, stop, and even organise events. The main square is located in the heart of Strijp-S, in the triangular lot between the *Hoge Rue* and the *Klokgebouw* buildings.
The Torenallee [Fig. 79], a 60-meter-wide green avenue that runs alongside the *Hoge Rue* complex and serves as the site's main axis, was undoubtedly the most significant intervention of the project. This open public space can be used for kiosks, recreational activities, and rest areas. It also acts as a barrier between the older Philips structures and the newer ones on the south side[10]. The *Hoge Rue*'s monumental structures are identified by this boulevard, which elevates them above other structures and emphasises their value[11]. At the municipal level, the Torenallee serves as a spatial link between the city centre and its outskirts.

Fig.79 View from the Torenallee. (Source: personal elaboration)

8 Ibid, p.210
9 Babalis D., Curulli I. (2018). The Philips' industrial landscape in Eindhoven. Heritage and reuse of Strijp S terrain. *Ricerche storiche*, p.68
10 Ibid, p.70
11 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.75

6.5 Outcomes in public spaces

Based on what has been written, I believe that the design of public spaces in Strijp-S during the redevelopment process resulted in both positive and negative outcomes. In my opinion, the plan finds a good balance between the public and private sectors, creating spaces with the right mix of conditions.

Fig.80 The central square in the heart of Strijp-S. (Source: personal elaboration)

For example, the central square between the *Hoge Rue* buildings and the *High-voltage* building [Fig. 80] has no clear boundaries and no standard shape. It is an open space with a park in front of the high-voltage building. This location has high public value because it serves as a central identification spot for Strijp-S and provides space for catering, outdoor activity, and other temporary structures. A filter is then placed between this and the *Hoge Rue* buildings. It is an "arcaded" space, with the Leidingstraat structure adding to the industrial feel. This surface is useful for pedestrian traffic, but it also serves as an outdoor space for activities on the ground floor of the *Hoge Rue* buildings. The project has implemented a very positive intervention here. Shops, exhibitions, groceries, and other amenities were placed on the ground floors of these monumental structures, allowing for continuity between different urban fabrics. From the open space, the visitor crosses the Leidingstraat, enters the buildings, and finds himself on these open-space floors full of small, different activities. The Torenallee is located on the other side and can be reached by traversing the entire ground floor. The result is a continuous flow of people through a sequence of spaces: avenue-builging-portico-square [Fig. 81].

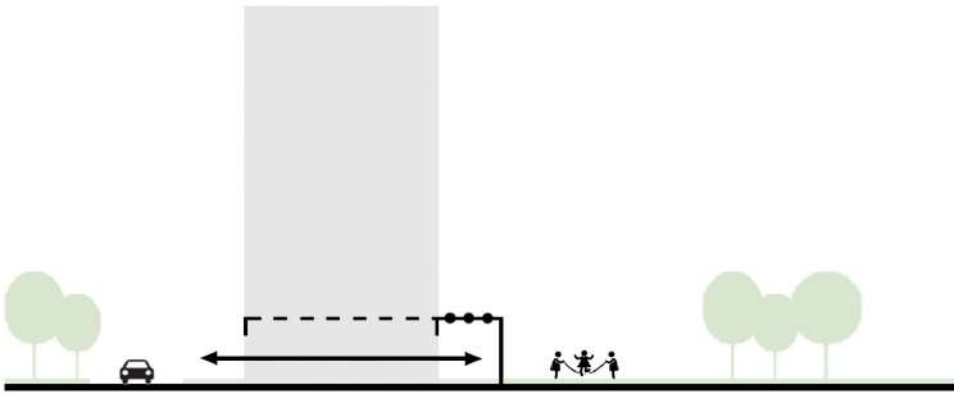


Fig.81 Explanatory scheme of the sequence of spaces: avenue-builging-portico-square.
(Source: personal elaboration)

The design of these public spaces, which overlap and create various levels of privacy, is a great outcome. Additionally, the aforementioned locations host transient activities that can change in the future.
A similar interpretation can be found in the new buildings with a central courtyard to the south. These patios [Fig. 82], which are raised above street level and almost hidden from the outside, serve as an intermediary between public and private, providing some privacy for the surrounding houses.

Fig.82 1:200 scale model of the project for Strijp-S, Eindhoven. View of the new housing with a central courtyard to the south of the area. (Source: archisign.nl/projecten/strijp_s/)

The Torenallee conversion [Fig. 83], in my opinion, was not designed with the same consideration for context. The realisation of this wide green route has altered the urban structure of Strijp-S. This new infrastructure connects the industrial site to the surrounding city, adds greenery to the district, and provides a safe cycle path. However, it is an open space in contrast to the site, which disregards the scale of the site and the size of the streets. The mistakes to avoid in the design of public spaces discussed at the beginning of the chapter are clearly visible here. Torenallee is now a typical public space that has been forcibly catapulted within the area. The boulevard struggles to connect with the surrounding structures due to its excessively marked borders.

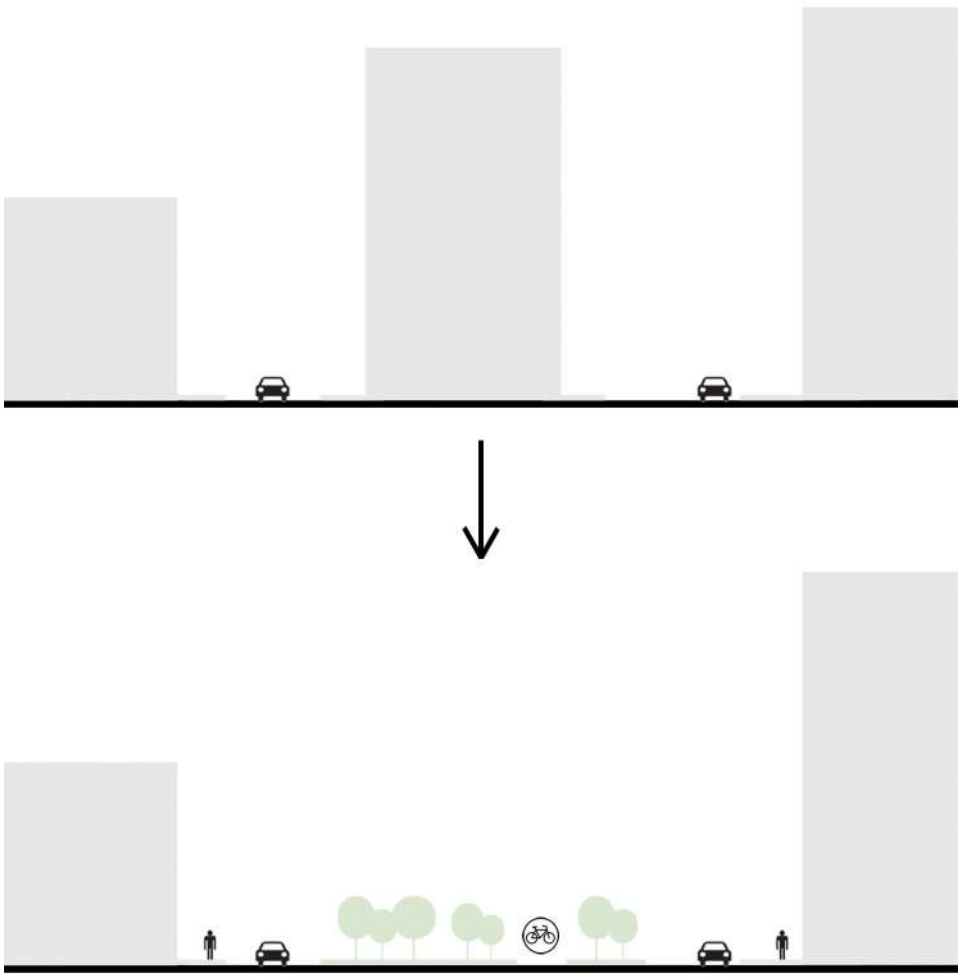


Fig.83 Explanatory scheme of the Torenallee conversion. (Source: personal elaboration)

6.6 Spatial inventory of industrial heritage in Strijp-S

This chapter will look at the conversions of the most important structures that were already present in Strijp-S prior to its redevelopment. The structures designated as protected monuments in this area are: the series of three buildings of the former *Apparatenfabriek* (SK, SAN, and SBP) that form the *Hoge Rug*; the former *Philitefabriek* (SA), now known as the *Klokgebouw*; the *Veemgebouw* (SDM); and parts of the *Natlab* (SMM, SAQ), the old physics laboratory. The *High-voltage* building (SAB), the *Engine room* (SAZ, SAU), and the Leidingstraat are marked as elements that must be preserved on the plan[1].
The monumental value of a building is determined primarily by its original intended functionality. These factories were converted into places to live, work, and host events and activities in order to develop Strijp-S into a creative hub. They were assigned a different function. This implied a different architectural meaning because they were not restored but significantly altered[2].

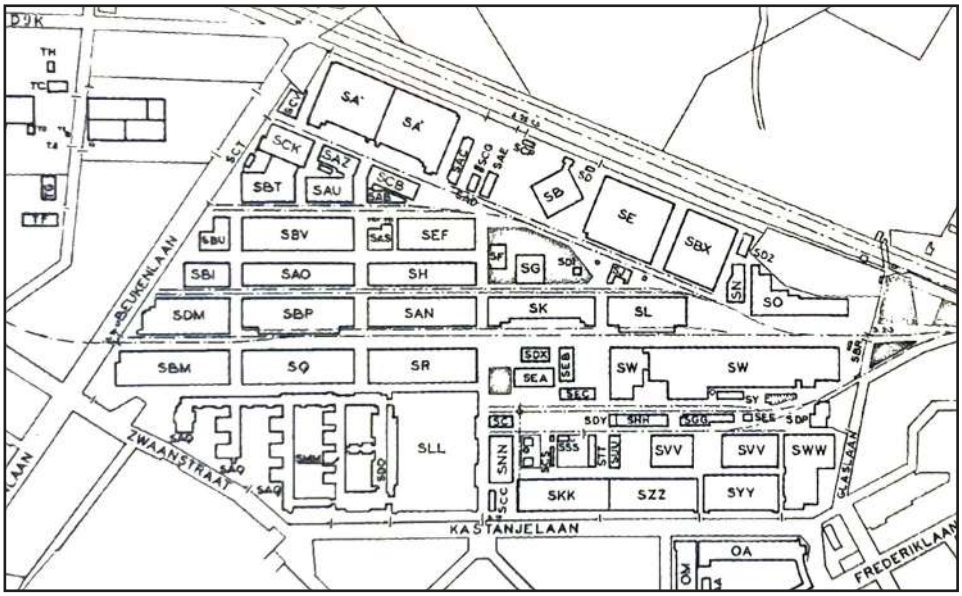


Fig.84 1947 map of Strijp-S, Eindhoven. The letter codes of the buildings refer to their locations. (Source: Abrahamse J. E., Colenbrander B., Hooff G. V., Uitterhoeve W. (2021). *Historical atlas of Eindhoven. From a small market town to the centre of the Brainport region*, p.57)

1 KuiperCompagnons. (2006). *Voorontwerp bestemmingsplan Strijp-S*, p.28
2 Ibid, p.85

Klokgebouw

The *Klokgebouw* [Fig. 85] is the only pre-war structure remaining in the nearby area of the railway. It was once a Bakelite factory and is located in the site's northernmost corner. It's a seven-story concrete structure with projections at the ends and in the middle of the south-west façade that house lifts and stairwells. On the railway side, it has two wings perpendicular to the main volume, with a single-story industrial warehouse in between. The production floors of the main block feature large windows set in a white-plastered concrete grid. The building is named after a dial with a large clock in the tower's northern corner, which is visible from afar and from the train[3].
The *Klokgebouw* now symbolises the transformation of Strijp-S, Eindhoven's creative beating heart. The former factory has been transformed into a multi-business complex with offices for business owners in the creative industries available in a range of sizes and price ranges. The ground floor has plenty of space for dance and music, as well as a professional stage for large-scale events and concerts. There are fitness rooms at the top of the building where you can exercise[4]. The large open spaces did not necessitate significant architectural modifications. The function, not the form, has changed.

Fig.85 View of the *Klokgebouw*. (Source: personal elaboration)

3 Geevers K. *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.94
4 Driehoek Strijp-S. (n.d.). *Het Klokgebouw.* www.driehoekstrijps.nl/klokgebouw

High-voltage building and Engine room

The *Engine room* and *High-voltage* building [Fig. 86] are located in the triangular plot, opposite the *Hoge Rue* buildings. The *High-voltage* building is a masonry structure with closed facades, pronounced eaves, and conveniently placed windows. The volume of the building is articulated, with a chamfered 10-meter-high main block, a vertical turret, and a low trapezoidal part on the short south-east façade. The shape was designed based on the triangular plot on which it is located[5].
The engine room is a closed volume made of masonry as well. The south-east façade is parallel to the *High-voltage* building.
Other buildings in this area were demolished after Philips' transfer. These structures, along with the thermal power station and coal warehouse, constituted the Strijp-S energy station. This was where the pipe system, the Leidingstraat, began[6].
Both buildings are now occupied by restaurant-related activities. The *High-voltage* structure houses a pub/restaurant with an adjacent terrace from which the entire square can be appreciated. The engine room has been converted into a restaurant with commercial space on the ground floor. It is now a place that retains its industrial character, with old machines, motors, and pumps still in place[7].

Fig.86 View of the *High-voltage* building. (Source: personal elaboration)

5 Geevers K. *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.95
6 Ibid
7 Driehoek Strijp-S. (n.d.). *Machinekamer.* www.driehoekstrijps.nl/machinekamer

Hoge Rue

This monumental complex stands along the Torenallee and, due to its size, dominates the entire area. It used to house the production facilities, but it is now known as *Hoge Rue*. Five buildings were originally present, but the one to the south-east and the first in the sequence were demolished. The masonry architecture, the *Veemgebouw*, and three white-concrete industrial buildings are still standing[8].
The three white factories are similar, seven-story structures. They have large windows in a concrete structure that defines the height of the production floors. The roofs are flat. A low building at the entrance is distinguishable by the curved shapes of the roof [Fig. 87] (in the first building) and the arched system (in the two southernmost factories)[9]. The six-story steel connecting bridges between these buildings, which housed the conveyor belts, are an industrial feature that has thankfully been preserved.
From west to east, the first two white buildings in the series have been converted into living lofts and workspaces. These layouts are as adaptable as possible [Fig. 70]; a cell equipped with a shower, toilet, kitchen, and storage room was designed to be moved or disassembled in a single day. As a result, the space can easily be converted from a living loft to an office or studio[10]. The ground floor, on the other hand, houses public functions to keep things lively and people coming and going. Both buildings now have a roof garden with a view of the city. Two different architects worked on the transformation of each building[11].
The last white building, the easternmost of the three, has undergone minor modifications; it was previously used as offices by Philips. Only the ground floor has been completely renovated to accommodate public functions. The old layout has been maintained on the other floors, with a few minor changes[12].

Fig.87 View of the Anton, the westernmost building. (Source: personal elaboration)

8 Geevers K. *Stedenbouwkundige waardestelling van industrieel erfgoed*, p.96
9 Ibid
10 Trudo housing association (2010). *Old buildings new ideas*, p.37-38
11 Driehoek Strijp-S. (n.d.). *Anton & Gerard.* www.driehoekstrijps.nl/lofthuren
12 Trudo housing association (2010). *Old buildings new ideas*, p.50

Veemgebouw

To the north-west, the *Veemgebouw* [Fig. 88] has nine storeys and a unique structure. It's a masonry building with horizontal windows that clearly define the floors. On the upper part of the factory, a structure diverges from the façade and forms a distinct vertical termination.
The plan defines functions that will ensure a bustle of people in this building because of its appearance and location at the entrance to Strijp-S. On the ground floor, there will be an open space dedicated to cooking and catering: space for pubs, bars, restaurants, and, most importantly, space for small entrepreneurs selling their most unique products[13]. The upper floors, which have an open layout with only columns, have been converted into private car parks and, higher up, flats and workspaces[14].

Fig.88 View of the *Veemgebouw*. (Source: personal elaboration)

13 Ibid, p.80-83
14 Driehoek Strijp-S. (n.d.). *VEEM*. www.driehoekstrijps.nl/veem

Natlab

The *Natlab* [Fig. 89] is a pavilion-style structure located to the south-west of the site, one wing of which was unfortunately demolished. As previously stated, it was originally Philips' physics laboratory. The building is unique in Strijp-S due to its traditional brick façades, large green courtyards, flat roofs, relatively low height for the area, and, above all, the auditorium projecting beyond the perimeter. Its architecture is distinct from that of the other factories on the site. The *Natlab* is important not only for its architectural qualities but also for its historical and cultural significance.
Today, the structure houses multiple functions, including a restaurant with a terrace, a cinema, and several creative workshops.
Despite its significance to the city, this structure has not been fully respected during the transformation. The already negative demolition of the east wing has given way to imposing new architecture that ignores and compresses the laboratory's scale[15]. In my opinion, the plan disregards the significance and context of the monument.

Fig.89 View of the *Natlab*. (Source: personal elaboration)

15 Curulli I. (2014). *The making and remaking of dismissed industrial sites*, p.41

Leidingstraat

The Leidingstraat [Fig. 90] is a system of above-ground pipelines that runs throughout the industrial site. It was used to transport chemicals and energy, and it stood at a height of about 5 meters. It connects the various historical buildings and gives Strijp-S its distinct industrial character.
Obviously, the system's functionality ceased when the site was abandoned. Despite the fact that it was cut and dismantled in certain sections, I believe the plan was able to use this element effectively. It is now used as an industrial pergola that spans the area and serves as a direction marker. It's been adorned with urban greenery and dynamic lighting that allude to the fluids it transported[16]. After the transformation, it became an important industrial feature. It is still historically and culturally significant today, but it now serves a new purpose; it "provides shelter from rain and sun, space for a bench, a passageway through the greenery," as well as "a directional marker, terrace, entrance, podium, shopping centre, and parasol"[17].

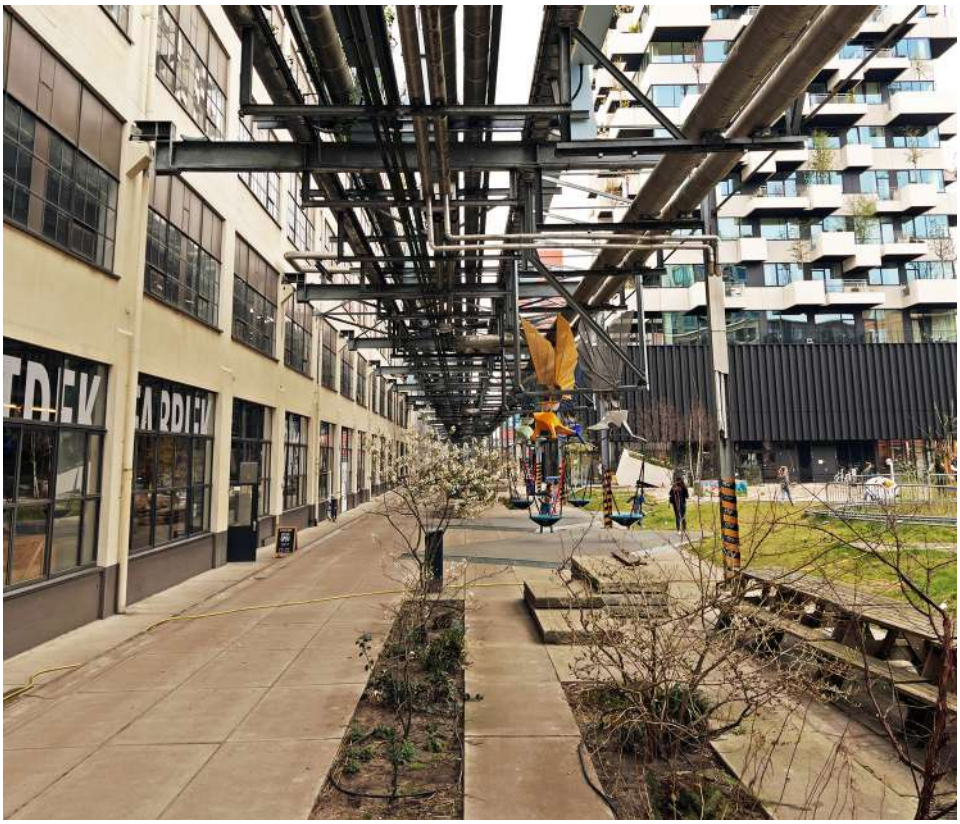


Fig.90 Different views of the Leidingstraat (above and on the right). (Source: personal elaboration)

16 Driehoek Strijp-S. (n.d.). *Leidingstraat.* www.driehoekstrijps.nl/leidingstraat
17 Trudo housing association (2010). *Old buildings new ideas*, p.129-130


Restaurant
bouwver

6.7 Industrial heritage and memory

The extent to which the reuse of industrial heritage is beneficial in economic, environmental, and social terms was discussed in previous chapters. These are all important considerations, but there is another fundamental reason for reusing abandoned industrial sites; the buildings here are intrinsically linked to the city's history and play an important role in people's memories. The industrial heritage must be preserved for what it evokes in citizens' collective memory and for the bond that these places form with the people[1].

The extent to which the reuse of industrial heritage is beneficial in economic, environmental, and social terms was discussed in previous chapters. These are all important considerations, but there is another fundamental reason for reusing abandoned industrial sites; the buildings here are intrinsically linked to the city's history and play an important role in people's memories. The industrial heritage must be preserved for what it evokes in citizens' collective memory and for the bond that these places form with the people.

The industrial building can be viewed as a text to be read in this context. Indeed, it contains many layers of history, telling the story of the building's and location's transformations, as well as decades of work, production, and innovation. It is critical to be able to read these structures, identify which elements have a strong connection to the past, and preserve and transmit them. We must also recognise that the same object can have different meanings, functions, and values for different people. Industrial artefacts are a source of meaning that designers can tap into at different levels to achieve a variety of tangible and intangible benefits[2].

The preceding does not promote industrial heritage "museumification." Rather, it emphasises the ability that a designer must have to project this type of conversion. The architect must introduce monuments and public spaces to the concept of changing over time, reliving them in the present without erasing what makes them unique.

But how does the designer accomplish all of this? We've already discussed how important it is to understand the significance of these structures in collective memory. In doing so, the designer should preserve the building's functional integrity while also allowing it to be reused by giving it a new function. This is acceptable if the adaptation of an industrial structure to a new purpose is aimed at ensuring conservation and has a minimal impact throughout the process[3].

1 Meurs P., Steenhuis M. (2017). *Reuse, Redevelop and Design. How the Dutch Deal With Heritage*, p.5
2 Curulli I. (2014). *The making and remaking of dismissed industrial sites*, p.44
3 Ibid, p.37

Strijp-S, a blurred memory

Negative emotions are commonly associated with industrial sites. They are identified with the city's grey, polluted, dangerous, and filthy outskirts, which are inhabited during the day and deserted after business hours. In addition, industrial areas have a history of difficult working and living conditions.

This isn't entirely true in the case of Strijp-S. Without a doubt, there was once a typical industrial atmosphere here, with massive buildings all looking the same. Strijp-S, on the other hand, is much more for Eindhoven residents and evokes a glorious past. Philips was very important for the progress of the city. These factories have produced the company's innovations and global discoveries. These are industries with which citizens identify and are proud. If we imagine a postcard from Eindhoven, it could very well depict the *Klokgebouw*'s clock or the Evoluon (the conference centre built by Philips).

What has been written above demonstrates how meaningful the industrial site in question was. Prior to its redevelopment, the district had a distinct place in the collective memory of the population. Has all of this been kept up? Is there still a link between the citizens and Strijp-S' glorious past in the current configuration?

"When I recently drove through the area with my father, who was born in Eindhoven, he made an interesting observation: he no longer recognised the area"[4], writes Rutger Noorlander, who then criticises the redevelopment project, claiming that the character of Strijp-S has been lost as a result of many demolitions. The area "has become almost without place; a benchmark for local identity has been broken"[5].

Many historical and distinctive elements have been lost in the transformation of Strijp-S into a creative and lively hub. As previously seen, the district's closed and "exclusive" structure was completely upended. Most of the remaining buildings have been treated like envelopes, devoid of their past and filled with a new function that struggles to communicate with the original meaning. Various industrial artefacts can still be found in street furniture and inside buildings today, but they are considered collector's items, removed from their original function, and kept only to make the place look *cool*.

From the perspective of a first-time visitor to Strijp-S, the district is fascinating and varied, making it an enjoyable place to get lost and explore. However, the industrial character of the area has been lost, and the intrinsic history of the location is no longer easily legible. During the redevelopment, many layers were cancelled.

Did Strijp-S really require all of these new modern structures, which are architecturally interesting and innovative but have little to do with the character of the area? Personally, I believe that the city's connection to the place and its history was undervalued during the conversion. The area's identity has been shattered, and we can only find fragments of it strewn about in a completely new and different context. This new configuration is still struggling to be defined. The project appears to have prioritised tourists and the needs of the creatives who now live in Strijp-S, leaving behind what defined the area and its connection to the city's history. "If you do it for the locals, the tourists will come; if you do it for the tourists, only the tourists will come"[6] is the principle that architects

4 Noorlander R. (2016, 28 August). Het karakter bij herontwikkeling Strijp-S. *Voer_*.
5 Ibid
6 Rypkema D. (2014). The economics of Heritage Conservation. In Corten J., Geurts E., Meurs P., Vermeulen R. *Heritage as an Asset for Inner-City Development. An Urban Manager's Guide book*, p.50

and designers should follow when transforming historically significant industrial areas. This way of thinking, in my opinion, was lacking in the Strijp-S redevelopment.

Outcomes of the Strijp-S conversion

Finally, I'd like to underline that Eindhoven has benefited from the Strijp-S transformation. The district, which was once entirely "off-limits" to non-workers, has evolved into an important and functional component of the city's fabric. As evidenced by the data [Fig. 91], the population of Strijp-S increased from 185 to 1790 between 2013 and 2021. A large proportion of them are young people aged 25 to 45, with 26% having international origins[7]. This is a very positive outcome for a country like the Netherlands, where space and accommodations are always in short supply.
Furthermore, the redevelopment of Strijp-S has created jobs and workspaces in innovative and creative fields. The former industrial site has effectively become Eindhoven's factory of ideas, as well as a pleasant and lively location well connected to the rest of the city. It now provides and will continue to provide services and opportunities to citizens.

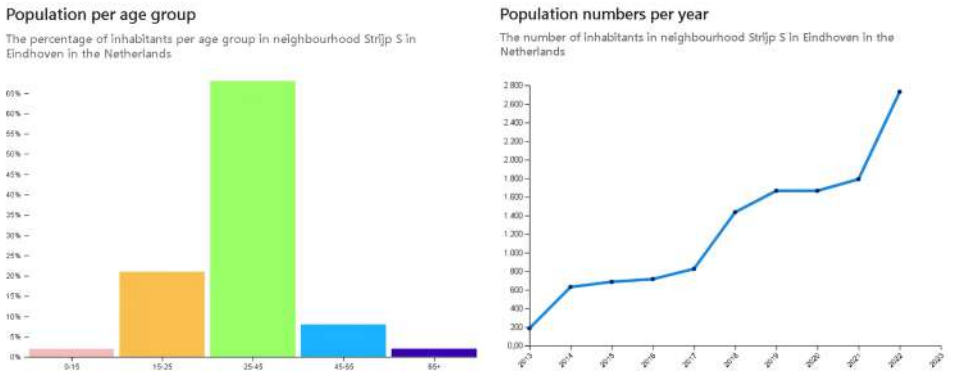


Fig.91 Number of inhabitants on 1 January 2022 by age group (on the left). The number of inhabitants in the Strijp S neighborhood, Eindhoven, for the years 2013 up to and including 2022 (on the right). (Source: allecijfers.nl/buurt/strijp-s-eindhoven/)

7 AlleCijfers. (2022). *Statistieken buurt Strijp S.* allecijfers.nl/buurt/strijp-s-eindhoven/

7. Project: “Flood-able industrial park”

The final project of this thesis focuses on the redesign of the Royal IHC shipyard in Kinderdijk, an industrial site with significant re-functionalization potential. The site was chosen primarily because of its location outside the dykes, at the confluence of two rivers with a high risk of flooding, making it an ideal candidate for a tidal park. The proximity to the UNESCO World Heritage site of the Kinderdijk windmills was also important. Furthermore, this project aims to apply the lessons learned from the two case studies, Getijdenpark and Strijp-S, which dealt with the creation of a tidal park and the redevelopment of an industrial site, respectively.

The design process began with an extensive study of climate change and adaptation plans implemented by large cities around the world. Following that, an in-depth examination of sea-level rise and flooding issues in Italy and the Netherlands, two countries that have been severely impacted by these phenomena, was conducted. The Getijdenpark and Strijp-S case studies were examined to gain a comprehensive understanding of the design principles applied to the creation of a tidal park and the redevelopment of an industrial site.

The project was divided into two distinct phases: analysis and design. The initial design process included numerous hand-drawn sketches that were later translated into final graphic representations to effectively communicate the design intent. The analysis phase began with large-scale studies of general aspects of the area, such as mobility and land use, and then gradually narrowed the focus to more specific elements and areas.

The historical evolution of the Royal IHC shipyard was given special consideration in order to identify historical elements that should be preserved. This was critical to ensuring that the redevelopment process both respected and enhanced the site’s historical value. In addition, municipal surveys were used to determine the wishes and needs of Kinderdijk residents. This information was crucial in guiding the site’s redevelopment, ensuring that the final design met the needs and aspirations of the community.

In the final project phase, a tidal park was meticulously designed to accommodate varying water levels. This innovative method enabled the development of various site configurations based on water level, resulting in a dynamic and adaptable landscape. In addition, guidelines for the reuse and redesign of preserved buildings were provided, ensuring a thoughtful and sustainable approach to the redevelopment process.

In conclusion, the final project of this thesis presents a comprehensive and well-researched approach to the redevelopment of the Royal IHC shipyard in Kinderdijk. The project offers a sustainable and innovative solution to the challenges posed by climate change, sea level rise, and flooding by drawing on lessons learned from the Getijdenpark and Strijp-S case studies and incorporating the desires and needs of the local community, while also preserving and enhancing the site’s historical and cultural significance.

SKETCHES

CORRIDOI VERDI

PROSPETTIVA 2100 → CORRIDOI VERDI IN PARCHI DELLE MAREE = SOLUZIONE IDEALE PER RETINUE

- COSTRUITO (RESIDENZIALE/COMMERCIALE)
- INDUSTRIA
- CORRIDOI VERDI (IDEE DA DIETRO PROGRAMME)
- AREE VERDI/AGRICOLE

NATIONAL PARK DE BIESBOSCH

MOBILITÀ

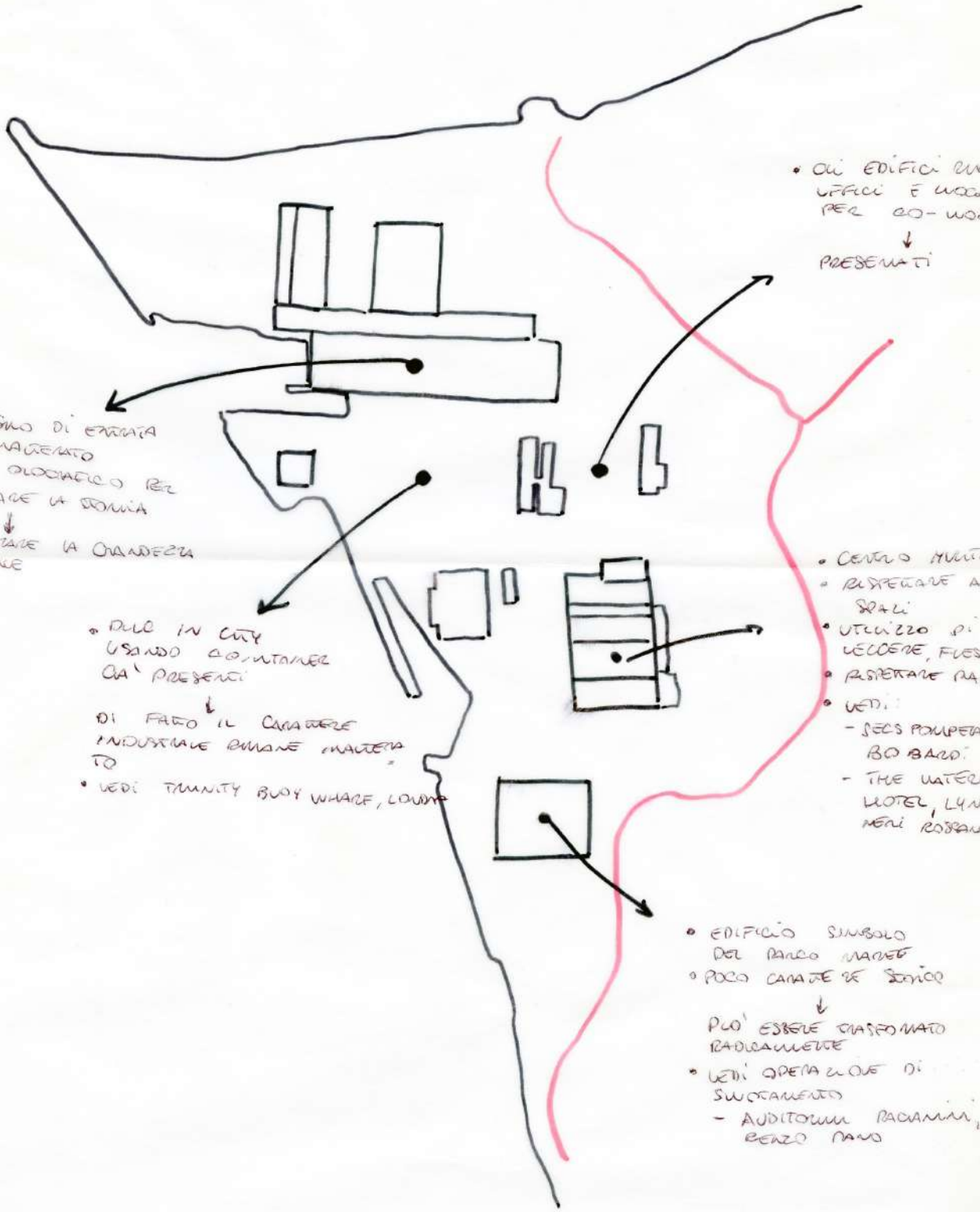
1898 VS OGQ

OGGI VS 1936

COME CONSERVO IL CARATTERE INDUSTRIALE?

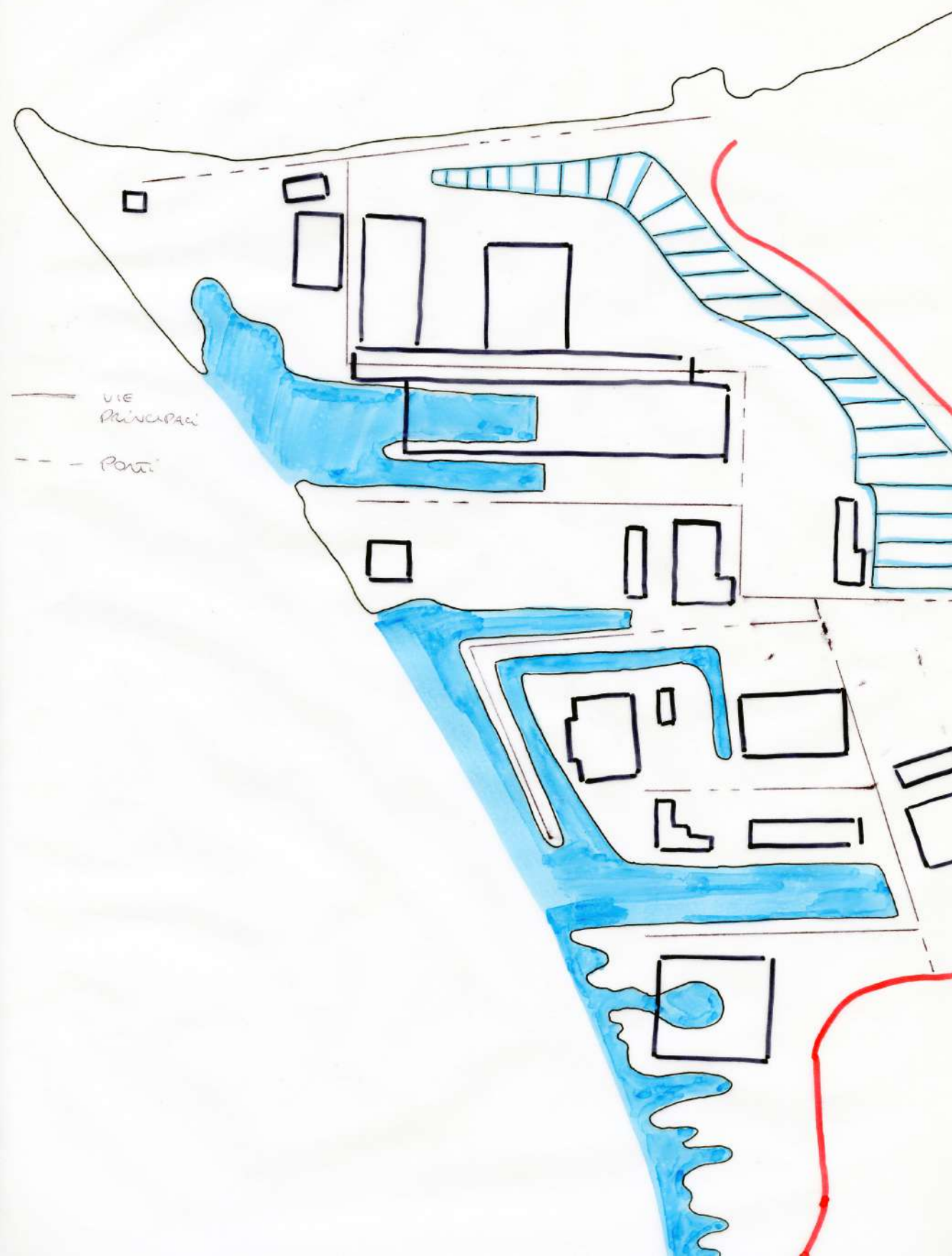
PUNTI CHIAVE:
- NON OSCURARE LA GRANDEZZA DI QUESTI SPAZI
- FLESSIBILITA' E SEMPLICITÀ LEGGERE
- CARATTERE INDUSTRIALE PRESERVATO
- RINFORZARE LA NARRATIVA DEL LUOGO

→ VEDI: - A. OLIVA, TECNO POLO OFFICINE
- MAKERS HUB MILANO



STUDIO DEGLI SCENARI IN BASE AL LIVELLO DELL'ACQUA / MARE

BASSA MAREA - SCENARIO



ALTA MAREA - SCENARIO

RIALZATO - SCENARIO

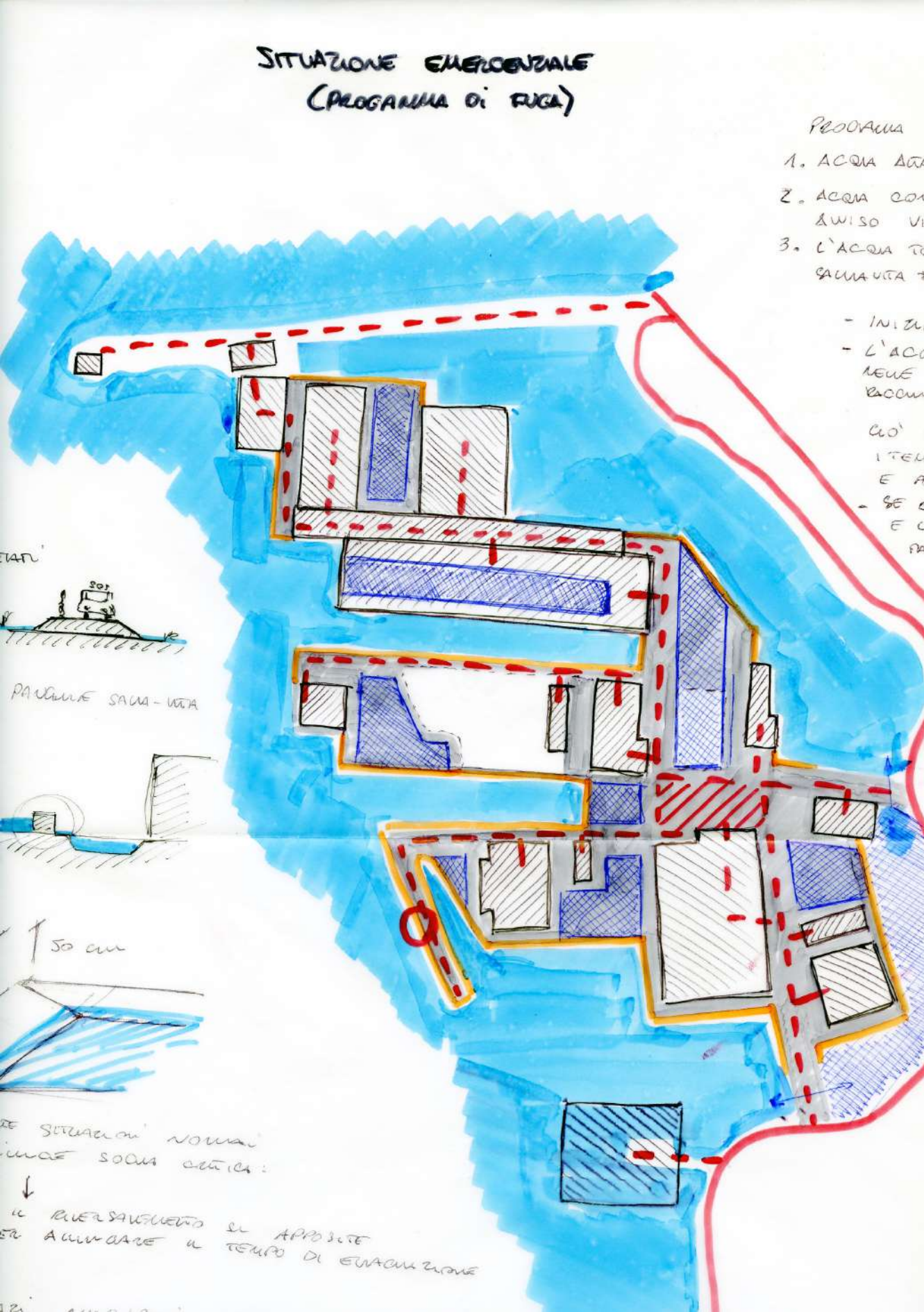
SITUAZIONE EMERGENZIALE
(PROGRAMMA DI FUGA)

PROGRAMMA

1. ACQUA ALTA
2. ACQUA CO
   AVVISO VI
3. L'ACQUA TO
   SALVAVITA

- INIZI
- L'ACQ
  NELLE
  RACCOL

QUO
ITEN
E A
- SE
  E C
  PA



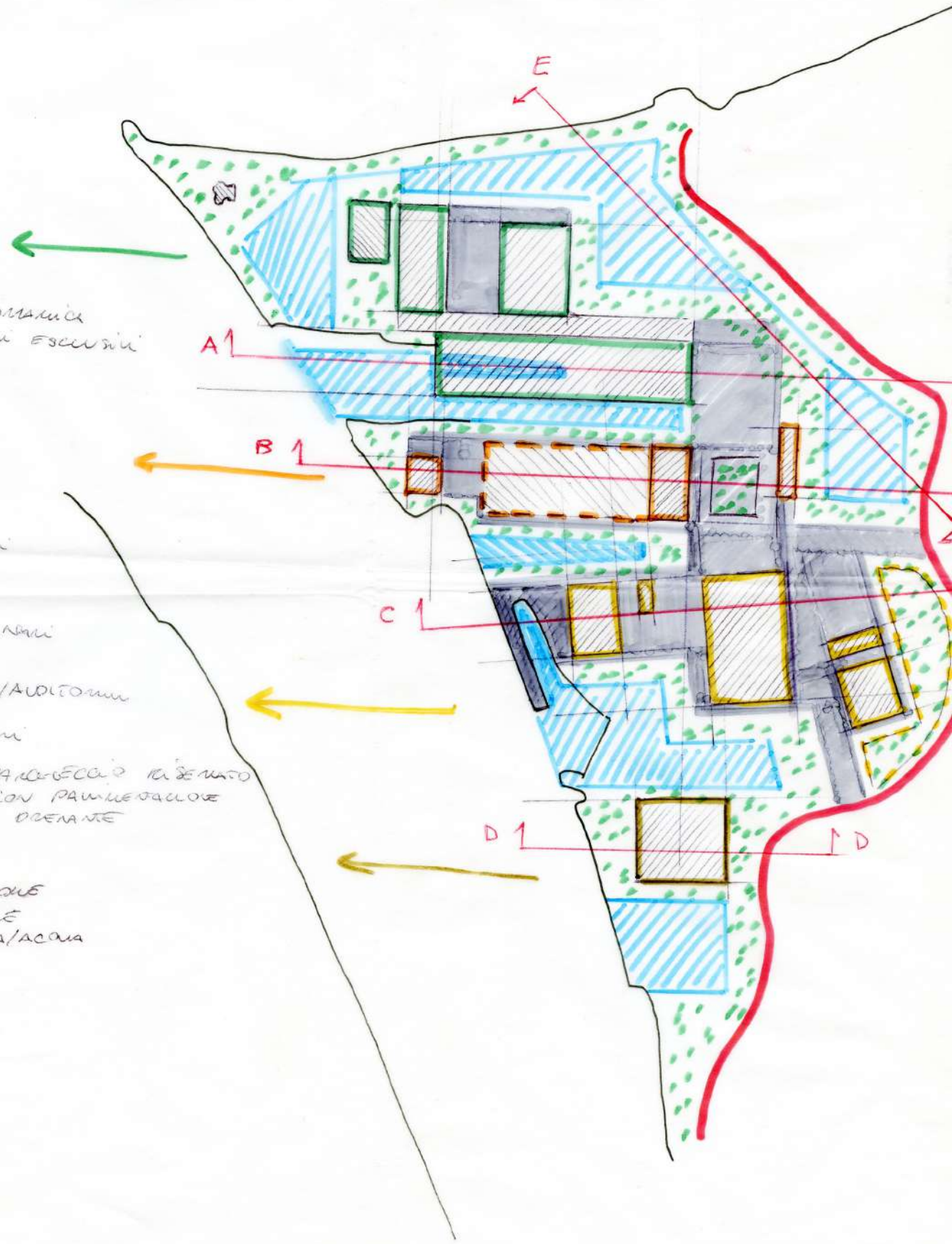
IN SITUAZIONI NORMALI
SOLUZIONE CRITICA:

↓

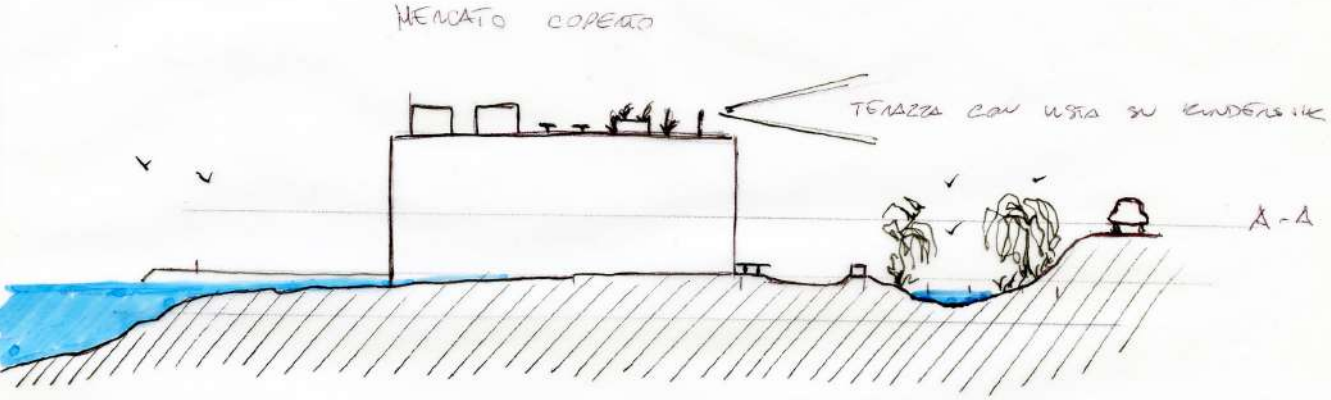
IL RIVESTIMENTO DI APPOSITE
PER ALLUNGARE IL TEMPO DI EVACUAZIONE

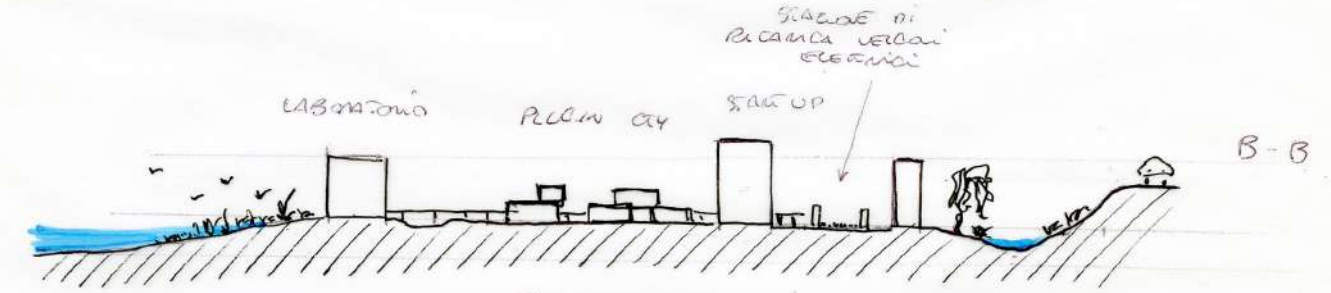
STUDIO DELLA PAVIMENTAZIONE / TERRENO

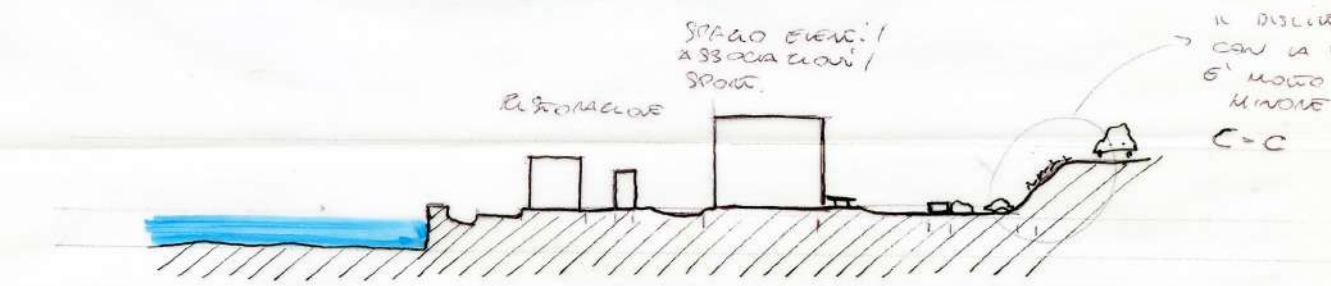
II PROPOSTA

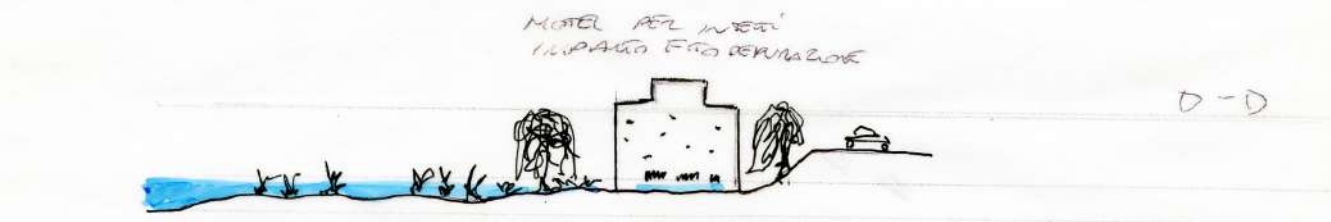


SKETCH SEZIONI AMBIENTALI





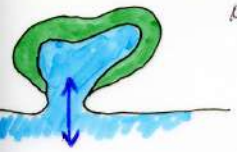




DIVERSE STRATEGIE PER IL PARCO DEL

PRINCIPIO 1C

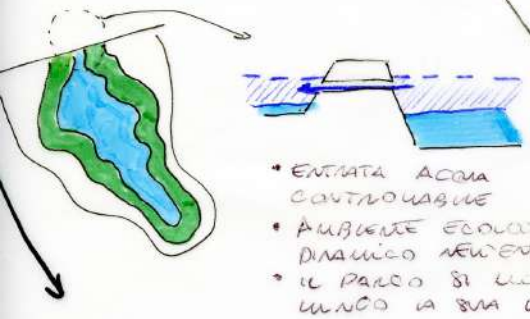
MODELLO WET HUYS TEN DONCK



VASCHE PROFONDE PER ATTRACCO TRACKER

PRINCIPIO 1F

MODELLO POLDER DE ESH



- ENTRATA ACQUA CONTROLLABILE
- AMBIENTE ECOLOGICO DINAMICO NEW ENTHOTERRA
- IL PARCO SI LEGHEREBBE MENO LA SUA VICINANZA

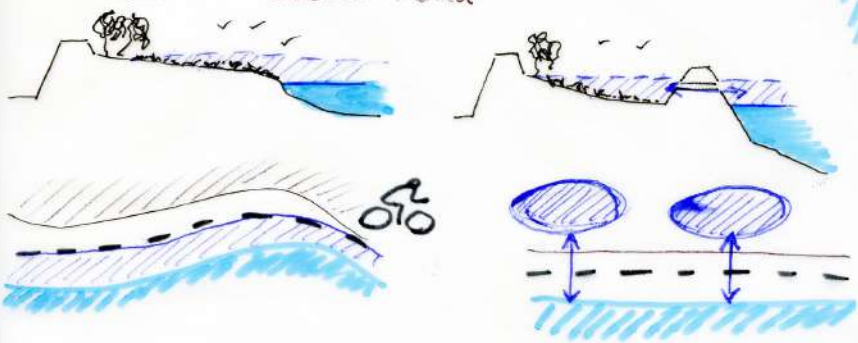
  ||

  VICINO AL FIUME → CARATTERE NATURALE, SPAZIO A FLORA E FAUNA

→ ENTHOTERRA → PARCO GIOCHI, STRUTTURE CALPESTABILI, ATTIVITÀ ACQUA RISTORAZIONE.

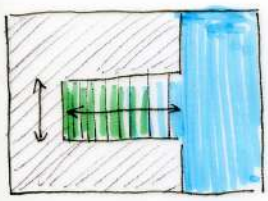
PRINCIPIO 1B

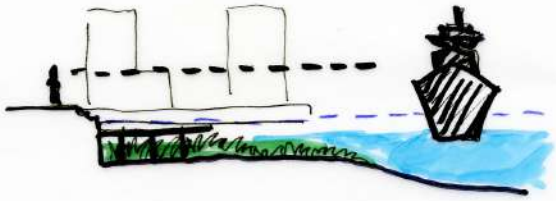
MODELLO GROENE POORT



PRINCIPIO 1A

MODELLO WILHELMINAHAVEN, KEILEHAVEN, MAASHAVEN, NASSAUHAVEN





ANALYSES


Groninga
Amsterdam
Utrecht
Rotterdam
Eindhoven


Rotterdam
Dordrecht

Green corridors

The sheet displays the green spaces differentiated into woodland, agricultural, and recreational areas. The most naturally relevant green spaces, which have important habitats for the area's flora and fauna, have also been identified. These are large parks, polders, wildlife reserves, or tidal park projects. In most cases, these green spaces are located along riverbanks.
Green corridors that have already been built, are planned, or can be designed have been derived and identified through direct study of the region and available sources. These connections run alongside the area's main road infrastructure and connect numerous nature reserves.

Green areas

Agricultural spaces

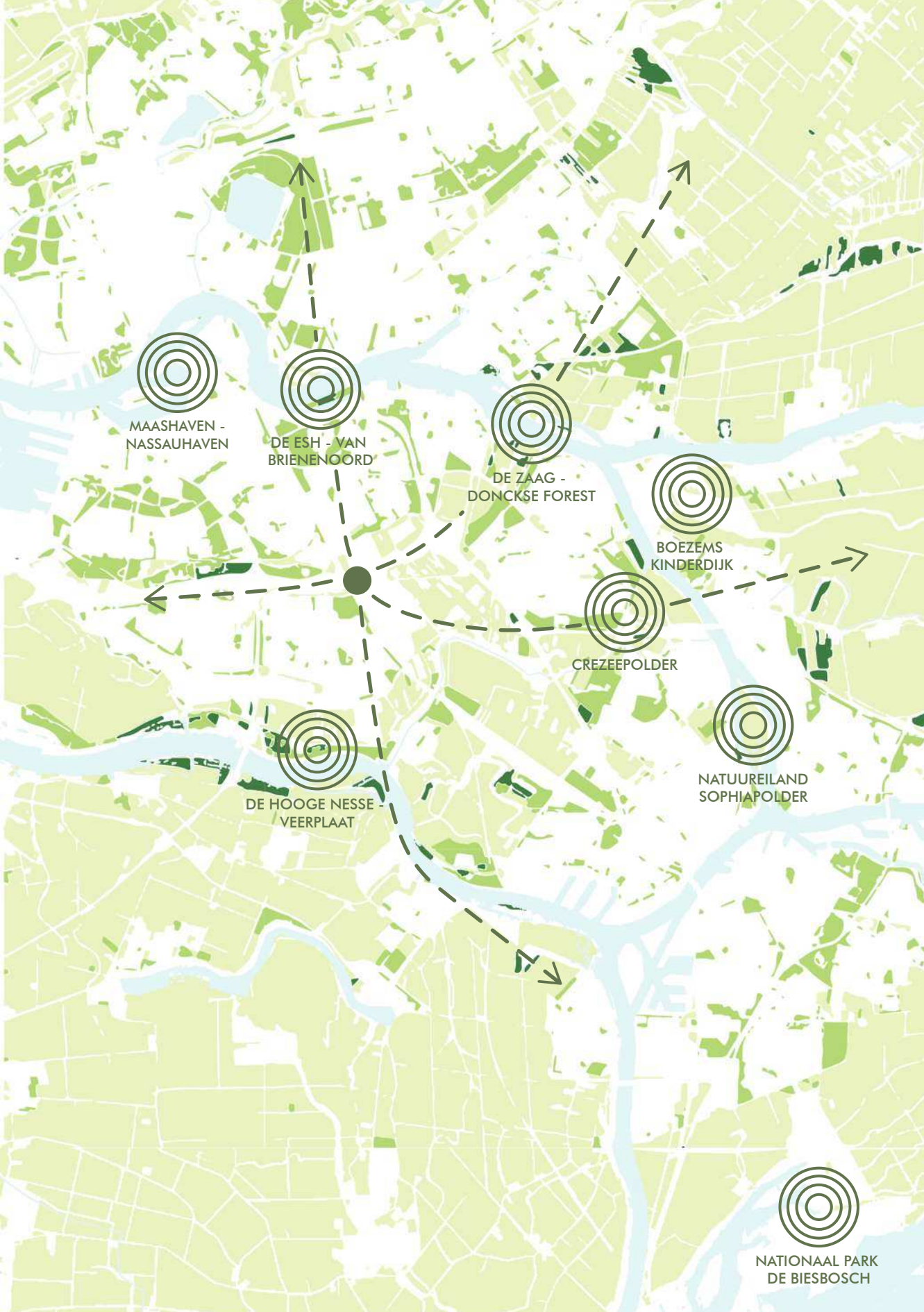
Recreational green

Wooded areas

Natural reserves, habitat parks and sustainable green projects in the Getijdenpark programme

Green corridors already realised, planned or envisaged

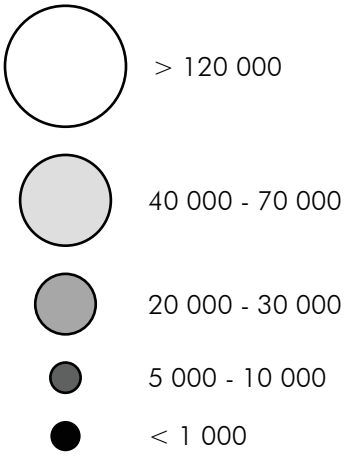
1:150 000


MAASHAVEN -
NASSAUHAVEN
DE ESH - VAN
BRIENENOORD
DE ZAAG -
DONCKSE FOREST
BOEZEMS
KINDERDIJK
CREZEEPOLDER
NATUUREILAND
SOPHIAPOLDER
DE HOOGE NESSE -
VEERPLAAT
NATIONAAL PARK
DE BIESBOSCH

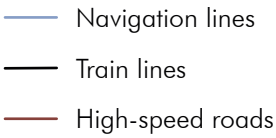
Connections

The mobility of the area was the first thing considered in the regional-level analysis phase. In particular, following maps highlights highway, rail, and sea connections. This was critical in understanding how the project site, Kinderdijk, is linked to nearby cities, especially Rotterdam, as well as how tourists and residents reach it.

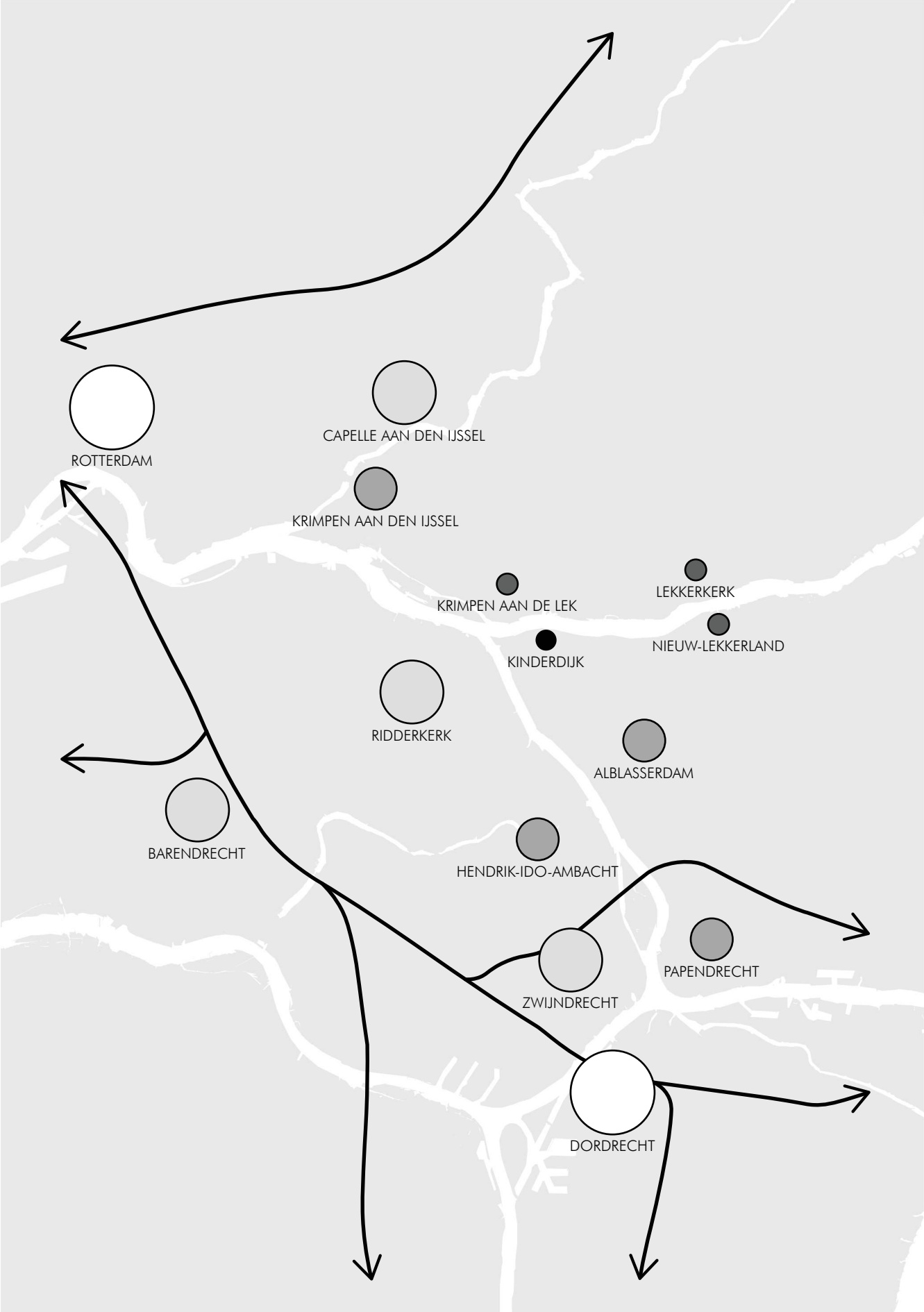
Population per municipality

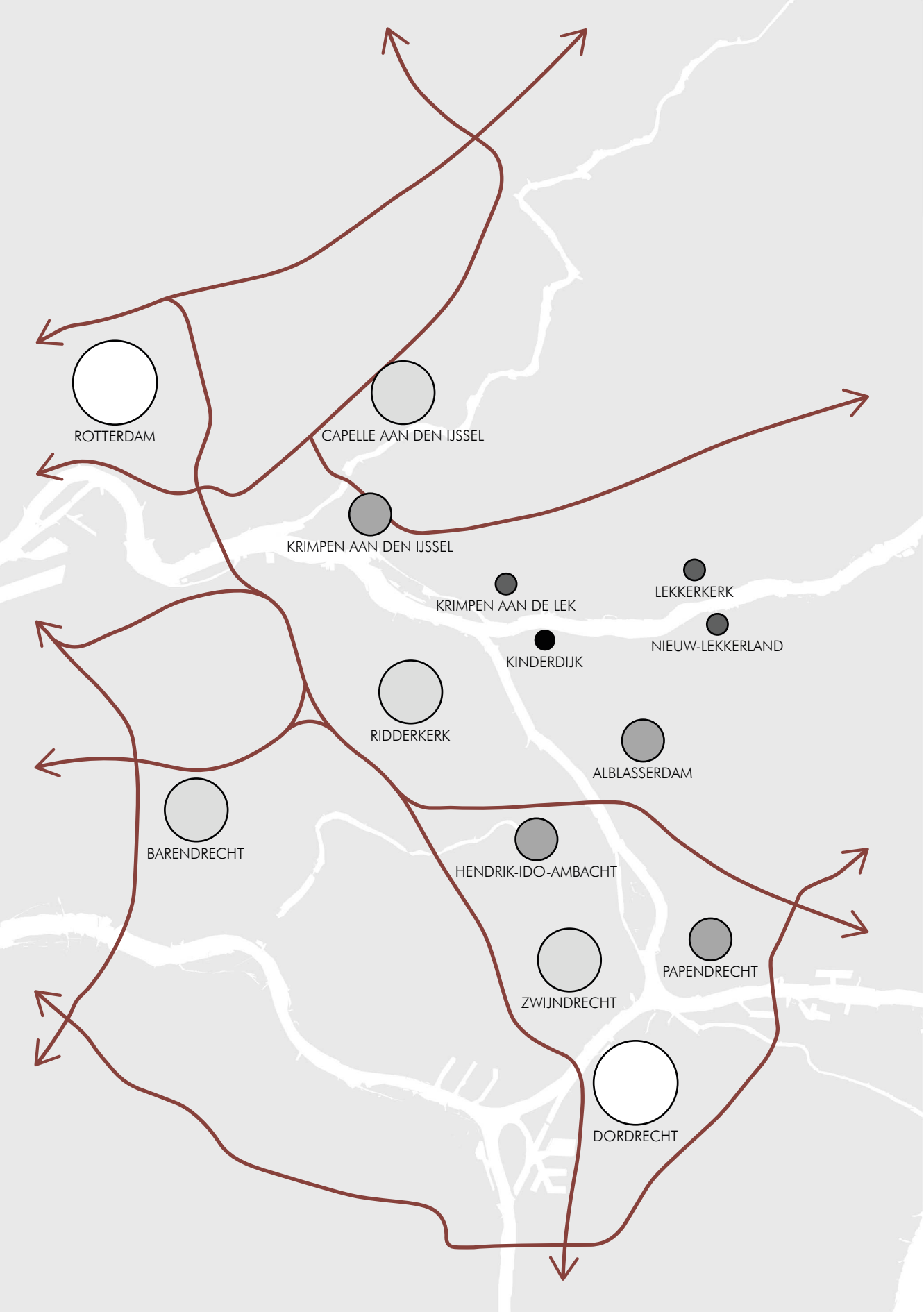


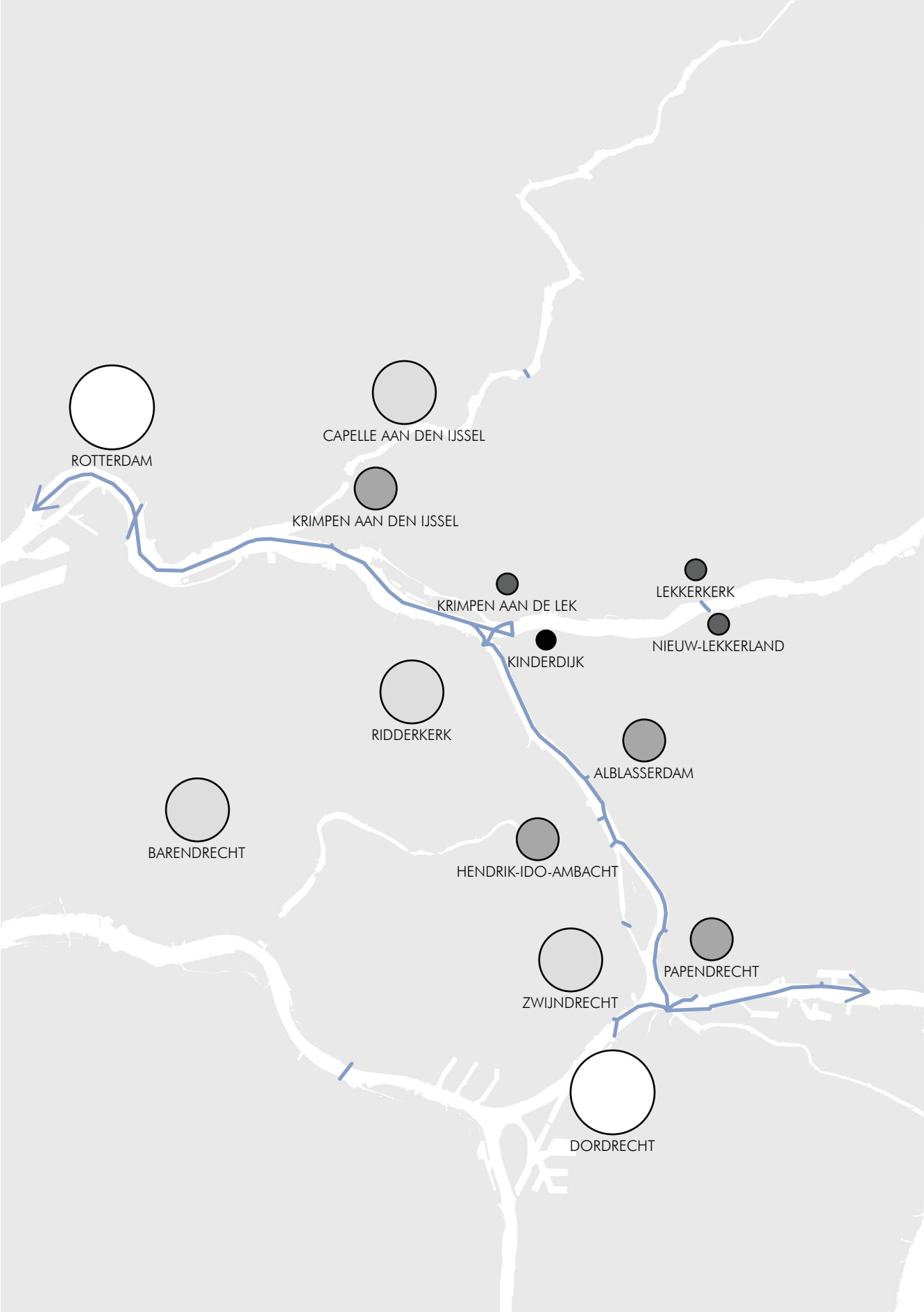
Connections



1:150 000


ROTTERDAM
CAPELLE AAN DEN IJSSEL
KRIMPEN AAN DEN IJSSEL
KRIMPEN AAN DE LEK
LEKKERKERK
NIEUW-LEKKERLAND
KINDERDIJK
RIDDERKERK
ALBLASSERDAM
BARENDRECHT
HENDRIK-IDO-AMBACHT
PAPENDRECHT
ZWIJNDRECHT
DORDRECHT


ROTTERDAM
CAPELLE AAN DEN IJSSEL
KRIMPEN AAN DEN IJSSEL
KRIMPEN AAN DE LEK
LEKKERKERK
NIEUW-LEKKERLAND
KINDERDIJK
RIDDERKERK
ALBLASSERDAM
BARENDRECHT
HENDRIK-IDO-AMBACHT
PAPENDRECHT
ZWIJNDRECHT
DORDRECHT


ROTTERDAM
CAPELLE AAN DEN IJSSEL
KRIMPEN AAN DEN IJSSEL
KRIMPEN AAN DE LEK
LEKKERKERK
NIEUW-LEKKERLAND
KINDERDIJK
RIDDERKERK
ALBLASSERDAM
BARENDRECHT
HENDRIK-IDO-AMBACHT
PAPENDRECHT
ZWIJNDRECHT
DORDRECHT

Mobility

The mobility analysis was useful in understanding how citizens and tourists travel to and from Kinderdijk. As shown on the map, there are no highways or train stations in the immediate vicinity of the project site that provide direct access to the other towns. This deficiency is offset by the presence of several daily ferry and waterbus routes that allow easy access to Rotterdam and other locations. Thus, the timetables of the ferries that can be use to travel to Kinderdijk are displayed on the pages that follow.

1:20 000


Krimpen a/d Lek
Hoofdstraat
Kinderdijk
Molenkade
Ridderkerk
De Schans

21

Rotterdam Erasmusbrug — 21 — 21 — Kinderdijk Molenkade

Summer timetable (April - October)

Rotterdam Erasmusbrug	Kinderdijk Molenkade	Kinderdijk Molenkade	Rotterdam Erasmusbrug
Departure	Arrival	Departure	Arrival
Monday - Sunday			
9:04 9:49 10:34 11:19 12:04	9:38 10:23 11:08 11:53 12:38	9:41 10:26 11:11 11:56 12:41	10:15 11:00 11:45 12:30 13:15
Sailing frequency: every 45 minutes			
16:34 17:09	17:08 17:53	17:11 17:56	17:45 18:30

21

Rotterdam Erasmusbrug — 21 — 21 — Kinderdijk Molenkade

Summer timetable (April - October)

Rotterdam Erasmusbrug	Kinderdijk Molenkade	Kinderdijk Molenkade	Rotterdam Erasmusbrug
Departure	Arrival	Departure	Arrival
Monday - Sunday			
9:04 10:34 12:04 13:34 15:04	9:38 10:08 12:38 14:08 15:38	9:41 11:11 12:41 14:11 15:41	10:15 11:45 13:15 14:45 16:15

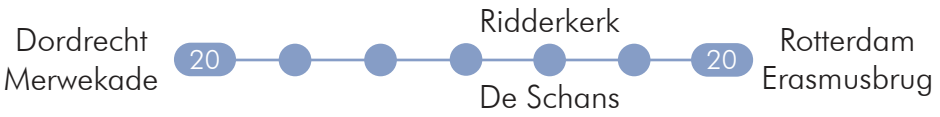
Driehoeksveer

Ridderkerk De Schans — Krimpen a/d Lek Hoofdstraat — Kinderdijk Molenkade

Ridderkerk De Schans	Krimpen a/d Lek Hoofdstraat	Kinderdijk Molenkade	Ridderkerk De Schans	Krimpen a/d Lek Hoofdstraat	Kinderdijk Molenkade
Departure	Departure	Departure	Departure	Departure	Departure
Monday - Friday			Saturday, Sunday and on holidays		
	6:35	6:30			10:45
6:47	6:55	7:00	11:00	11:10	11:15
7:10	7:20	7:30	11:30	11:40	11:45
7:50	8:00	8:05	12:00	12:10	12:15
8:30	8:40	8:45	12:30	12:40	12:45
9:00	9:07	9:12	13:00	13:10	13:15
		10:15*	13:30	13:40	13:45
10:30*	10:40*	10:45*	14:00	14:10	14:15
11:00*	11:10*	11:15*	14:30	14:40	14:45
11:30*	11:40*	11:45*	15:00	15:10	15:15
12:00*	12:10	12:15	15:30	15:40	15:45
12:30	12:40	12:45	16:00	16:10	16:15
13:00	13:10	13:15	16:30	16:40*	16:45*
13:30	13:40	13:45	17:00*	17:10*	17:15*
14:00	14:10	14:15	17:30*		
14:30	14:40	14:45			
15:00	15:14	15:05			
15:30	15:44	15:35			
16:00	16:14	16:05			
16:30	16:44	16:35			
17:00	17:14	17:05			
17:30	17:44	17:05			
18:00					

*Only from 5 May till 30 September

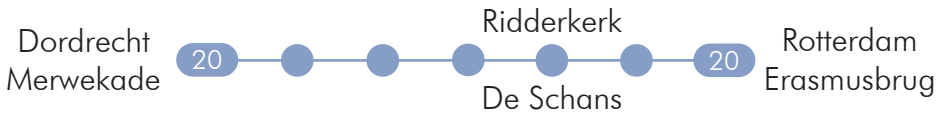
20



Summer timetable (April - October)

Dordrecht Merwekade	Ridderkerk De Schans	Rotterdam Erasmusbrug	Rotterdam Erasmusbrug	Ridderkerk De Schans	Dordrecht Merwekade
Departure	Departure	Arrival	Departure	Departure	Arrival
Monday - Friday					
6:00 6:30 7:00 7:30 7:45 8:00	6:26 6:56 7:26 7:56 8:11 8:26	6:58 7:28 7:58 8:28 8:43 8:58	7:00 7:30 8:00 8:30 9:00	7:30 8:00 8:30 9:00 9:30	7:58 8:28 8:58 9:28 9:58
Sailing frequency: 2 times an hour, every 30 minutes					
20:00 20:30	20:26 20:56	20:58 21:28	20:30 21:00	21:00 21:30	21:28 21:58
Saturday					
7:00 7:30 7:45 8:00	7:26 7:56 8:11 8:26	7:58 8:28 8:43 8:58	8:00 8:30 9:00	8:30 9:00 9:30	8:58 9:28 9:58
Sailing frequency: 2 times an hour, every 30 minutes					
19:30	19:56	20:28	19:30 20:00	20:00 20:30	20:28 20:58
Sunday					
7:45 8:00	8:11 8:26	8:43 8:58	9:00	9:30	9:58
Sailing frequency: 2 times an hour, every 30 minutes					
18:30	18:56	19:28	18:30 19:00	19:00 19:30	19:28 19:58

20



Winter timetable (October - April)

Dordrecht Merwekade	Ridderkerk De Schans	Rotterdam Erasmusbrug	Rotterdam Erasmusbrug	Ridderkerk De Schans	Dordrecht Merwekade
Departure	Departure	Arrival	Departure	Departure	Arrival
Monday - Friday					
6:00 6:30 7:00 7:30 7:45 8:00	6:26 6:56 7:26 7:56 8:11 8:26	6:58 7:28 7:58 8:28 8:43 8:58	7:00 7:30 8:00 8:30 9:00	7:30 8:00 8:30 9:00 9:30	7:58 8:28 8:58 9:28 9:58
Sailing frequency: 2 times an hour, every 30 minutes					
20:00 20:30	20:26 20:56	20:58 21:28	20:30 21:00	21:00 21:30	21:28 21:58
Saturday					
7:00 7:30 8:00	7:26 7:56 8:26	7:58 8:28 8:58	8:00 8:30	8:30 9:00	8:58 9:28
Sailing frequency: 2 times an hour, every 30 minutes					
19:30	19:56	20:28	19:30 20:00	20:00 20:30	20:28 20:58
Sunday					
8:00 8:30	8:26 8:26	8:43 8:58	9:00	9:30	9:58
Sailing frequency: 2 times an hour, every 30 minutes					
18:00	18:26	18:58	18:00 19:00	18:30 19:30	18:58 19:58

Development of a tidal park

As discussed in Chapter 5, in order for the Getijdenpark project to have a significant impact on water safety, the conversion of spaces into tide parks must cover much larger areas than those considered so far.
The study of a potential tidal park expansion around Kinderdijk is shown in the following page. The map categorises the areas outside the main dykes based on the difficulty and amount of work required to convert them into tidal spaces that can accommodate water. The study is primarily based on the number of structures and land use in the area. A nature reserve, for example, is much easier to convert into a tidal park than an industrial site because fewer factors and elements must be considered in the design.

Areas conversion

Easy implementation

Requires substantial work and planning

Requires a lot of work and a redesign of many elements

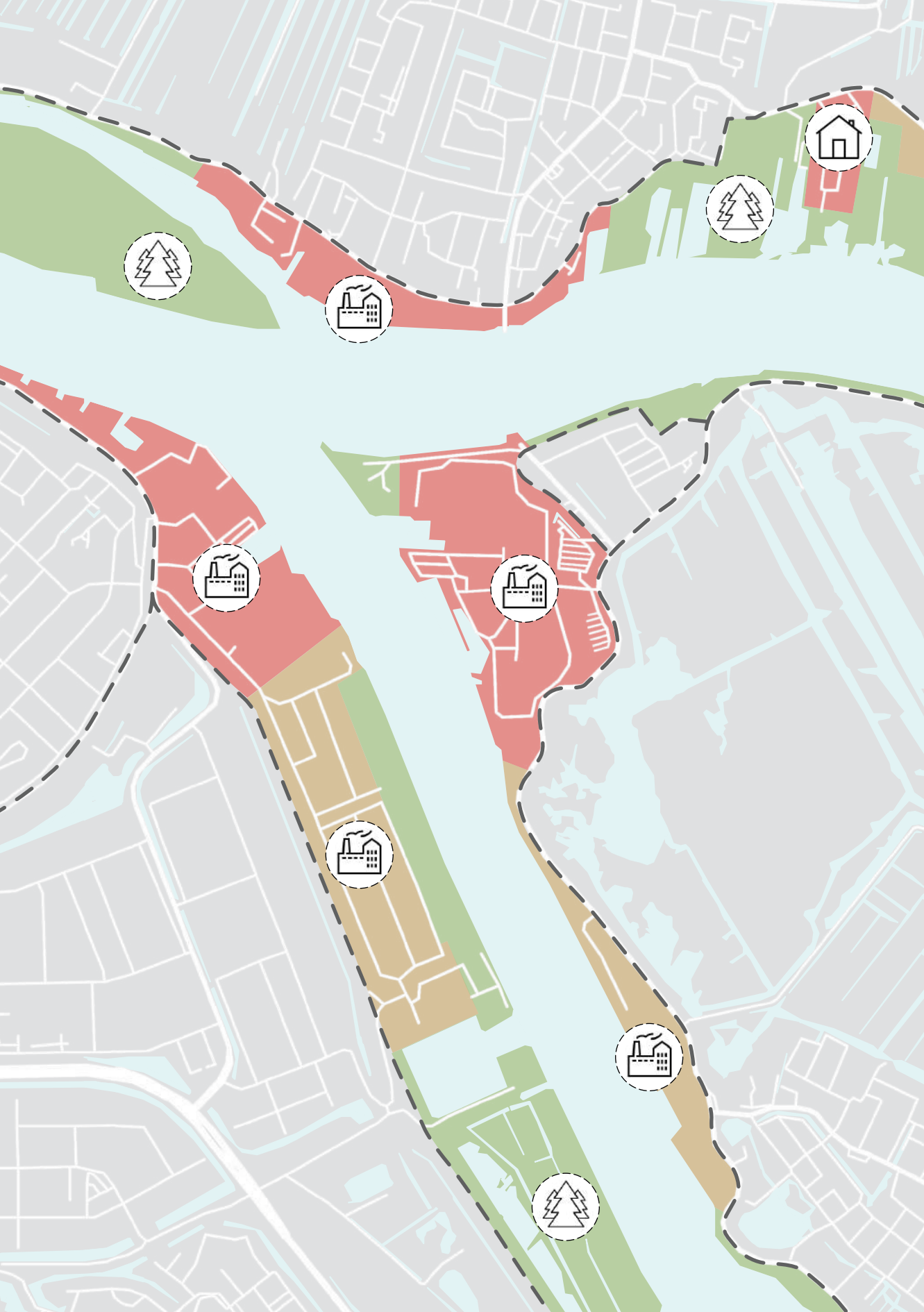

Green area


Industrial site


Residential area

Main dyke


1:20 000



Land use

Land use was one of the first local-scale analyses conducted. This was helpful to gain a thorough understanding of the space surrounding the project area, allowing to determine the needs and how to transform the Kinderdijk shipyard.
The map clearly shows the alternation of industrial and corporate spaces along the river's banks. In the hinterland, which is mostly agricultural, there are residential neighbourhoods that coincide with the cities.

1:20 000

Building functions

These pages depict the functionality of the Royal IHC shipyard's main buildings and spaces.
Almost all of the buildings are immediately apparent to be inaccessible without authorization and without the proper personal protective equipment. Other facilities in the area include a restaurant, offices, and classrooms/laboratories for teaching. This information allows one to identify which buildings are easily adaptable to a different function, whether it is similar or not.

Personal protective equipment obliged

(O) Offices

(P) Parking

(S) Ship's hall

(R) Preprocessing hall

(T) Training building

(M) Machine factory

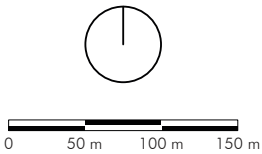
(A) Assembly hall

(Q) Finishing quay

(I) IHC Metal

(W) Working site

(L) Porter/Company restaurant




T
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On-site visit

1

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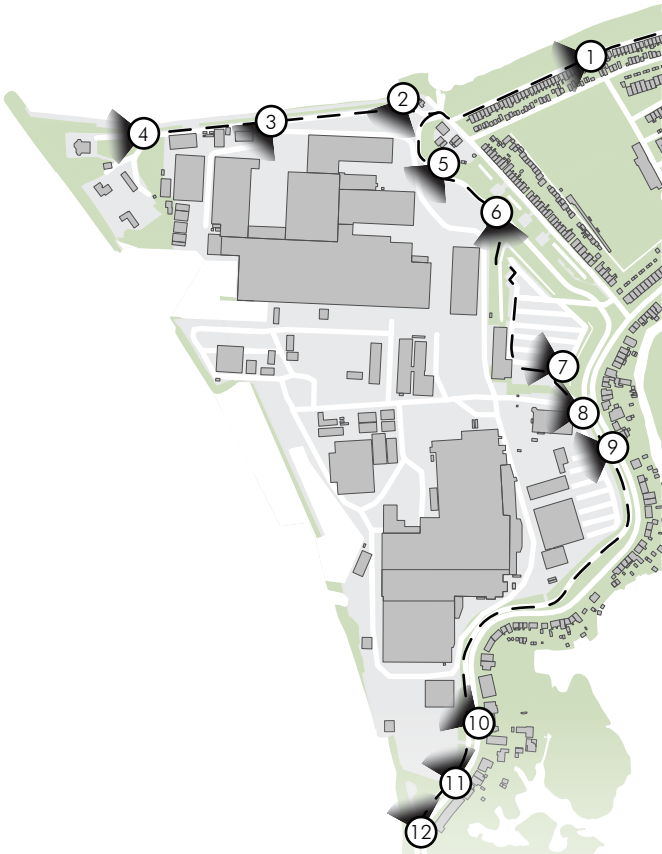
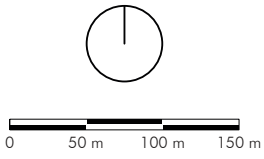


Site's historical evolution

Before planning the conversion of the Royal IHC shipyard in Kinderdijk, careful research and a study of the site's historical development since the nineteenth century were conducted.
First, historical maps of the site were collected from 1815 to the present day, which were then studied and translated into the images shown on the following pages. This process summarised the most important stages in the area's evolution, from a simple natural terrain at the confluence of two rivers to an agro-cultural area, and finally to a modern shipyard.
In order to better understand the historical periods and relate them to the corresponding maps, a collection of archived historical photographs was also incorporated.
This phase was essential to the design. From this, it was clear which buildings and elements have historical significance in the collective memory of the citizens and, as a result, need to be preserved with more carefully. Furthermore, the ground modification required for the creation of a tidal park in this area partially re-proposed previously observed land configurations.



1815

1858

1898

1936

1920

(Source:https://upload.wikimedia.org/wikipedia/commons/8/82/-NIMH_-_2011_-_0466_-_Aerial_photograph_of_Kinderdijk%2C_The_Netherlands_-_1920_-_1940.jpg)

1928

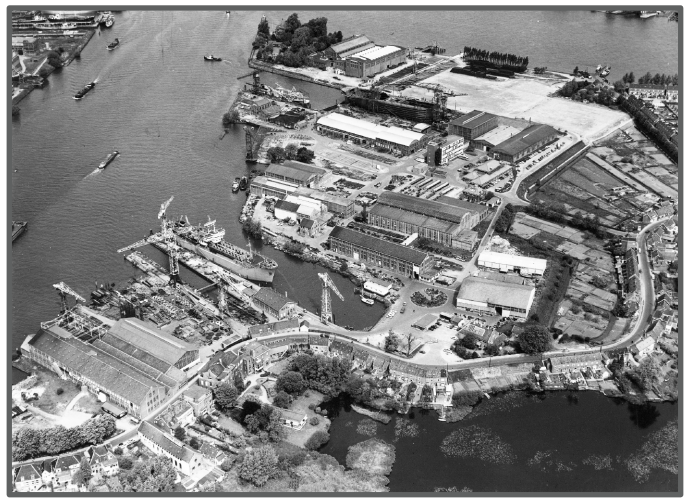
(Source: www.willemsmithistorie.nl/images/kinderdijksmitzn1928.jpg)

1937

(Source: www.regionaalarchiefdordrecht.nl/)

1969

1964

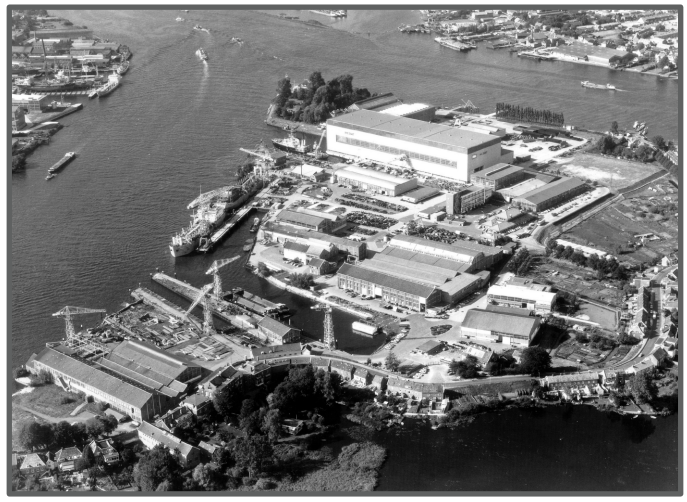


(Source: www.willemsmithistorie.nl/images/Kinderdijkzondercentrale.jpg)

1966

(Source:beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=large/8/0/552_801134.jpg)

1979



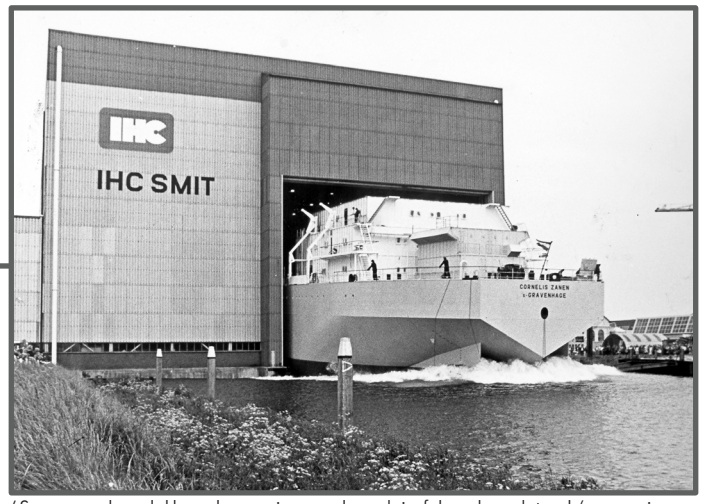
(Source:beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=webpics/8/0/552_801131.jpg)

1998

1981

(Source:beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=webpics/3/0/552_305430.jpg)

1982



(Source:beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=webpics/3/0/552_305431.jpg)

1989

(Source:beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=webpics/8/0/552_801132.jpg)

2022

2011

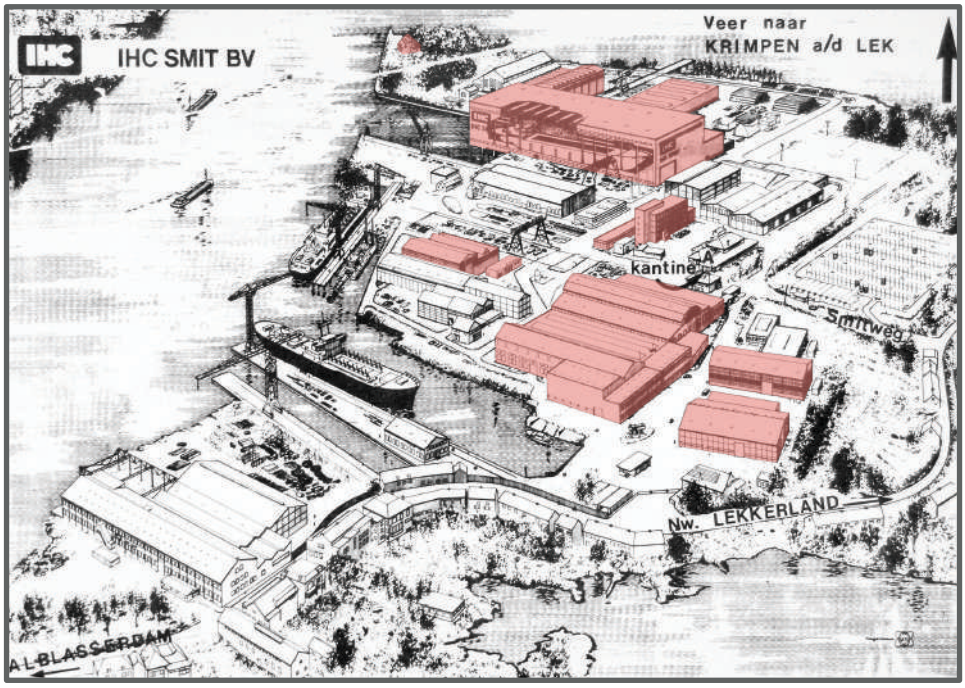
(Source: www.willemsmithistorie.nl/images/Kinderdijkvandaagdedagkl.jpg)

2022

(Source: www.google.it/maps/)

Identification of historical testimonial value

It was possible to distinguish the historical importance of some buildings over others through the reconstruction of the historical stages of the Kinderdijk shipyard using maps and archive photos.
The illustration below depicts the site's situation in 1979. By studying the historical development and comparing it to the current configuration, it was possible to identify those buildings that should be preserved more carefully, as they identify the industrial and historical character of the site. These are highlighted in the image below.
The buildings in question are not the only ones to be preserved in the project; other structures were considered to be retained rather than demolished because they can be easily reconverted and adapted to other functions (e.g. offices, classrooms, large industrial spaces).
Historical significance is not only visible in buildings. Other elements have been restored or recalled in the design of the tidal park. In the new configuration, for example, a system of canals to the north-east is created, with a shape that clearly recalls the agricultural ditches visible on maps from the nineteenth century to the 1970s. The recovery of the jetties pays homage to the location and forms of the past, as does the southern coastline, which is as jagged and "natural" as it was in the second half of the nineteenth century.



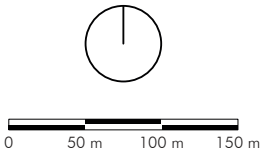
(Source: beeldbank.regionaalarchiefdordrecht.nl/serveimage.cfm?file=webpics/1/0/552_100188.jpg)

Water depth with intense precipitation

This analysis summarises heavy rainfall data in the project area. In particular, the average water depth at the locations where it builds up as a result of heavy rainfall (1:100 years) is displayed.
A thoughtful design of the tidal park was made possible by this study and careful observation of the elevation of the terrain. Understanding where water tends to collect during periods of heavy rainfall was particularly helpful for accomodate or redirecting it to other areas.

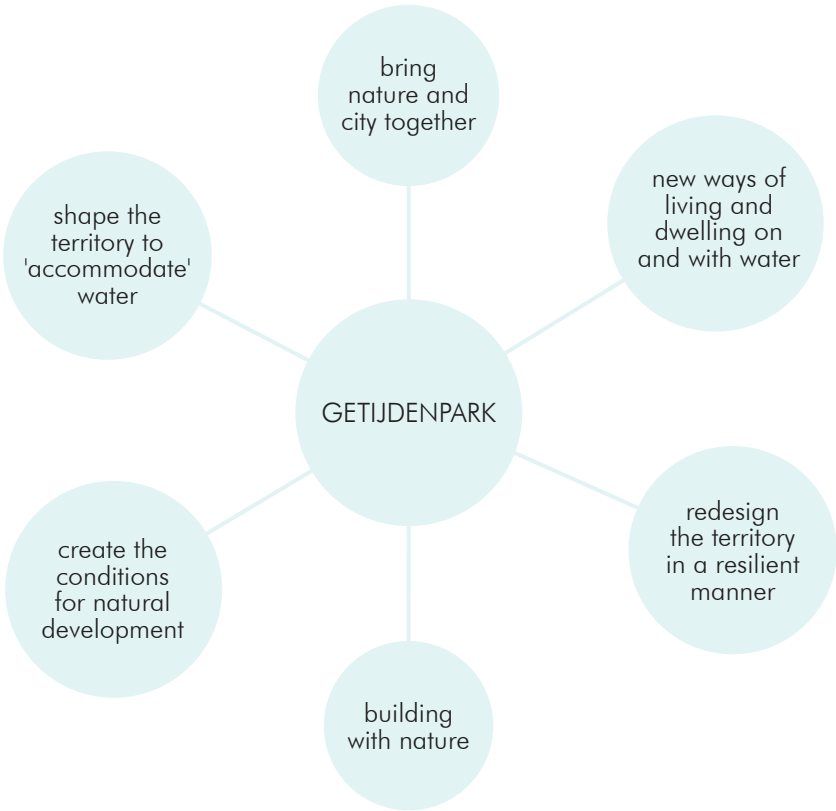
Water depth with intense precipitation - 1:100 years

- 5 - 15 cm
- 15 - 20 cm
- 20 - 30 cm
- > 30 cm

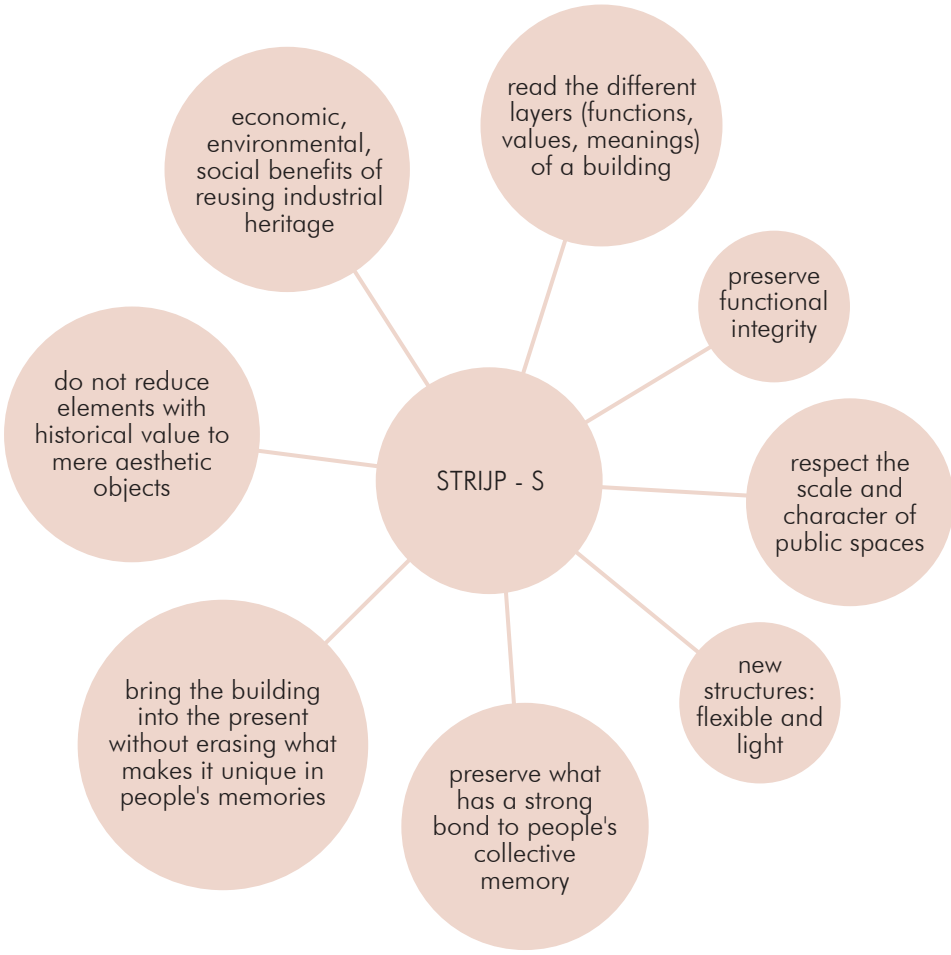


Case study learnings

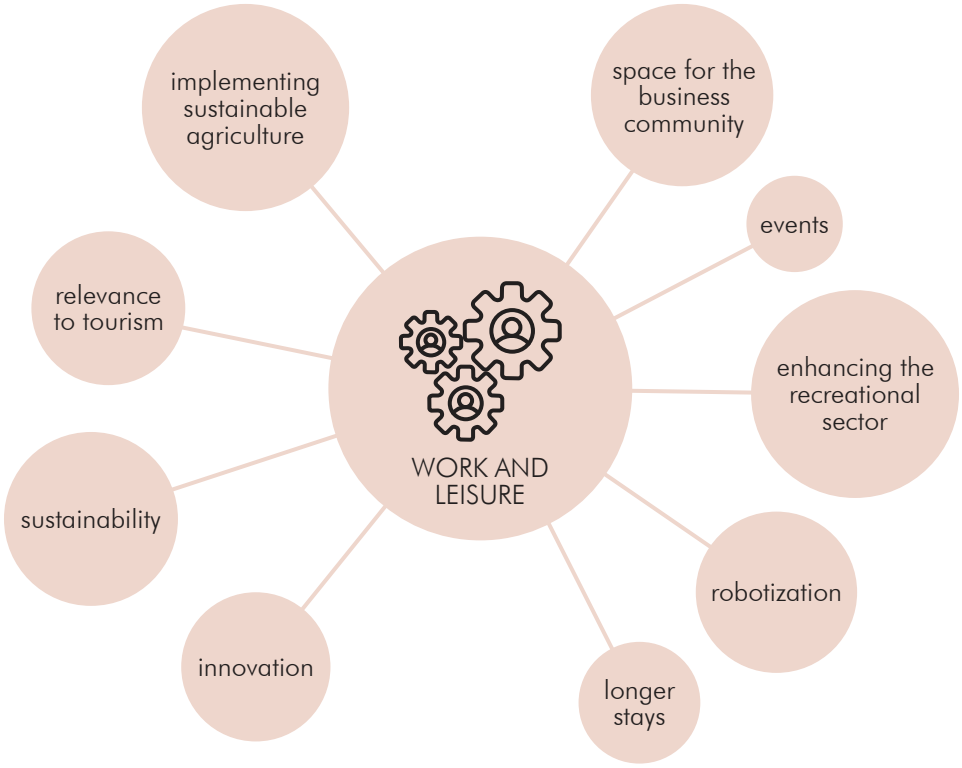
Insights gained from the analysis of two distinct urban case studies: Getijdenpark in Rotterdam and Strijp-S in Eindhoven are presented here.
These lessons, extrapolated from the in-depth analysis of Getijdenpark and Strijp-S, will serve as guiding principles for the redesign of the Royal IHC shipyard in Kinderdijk.
Located in the heart of Rotterdam, Getijdenpark is an example of the innovative convergence of advanced engineering and coexistence with the natural environment. It represents a comprehensive approach to urban development, making sustainability, resilience and the relationship with natural forces its core principles. The lessons learnt from the Getijdenpark study are manifold and significantly influence the landscape design perspective:

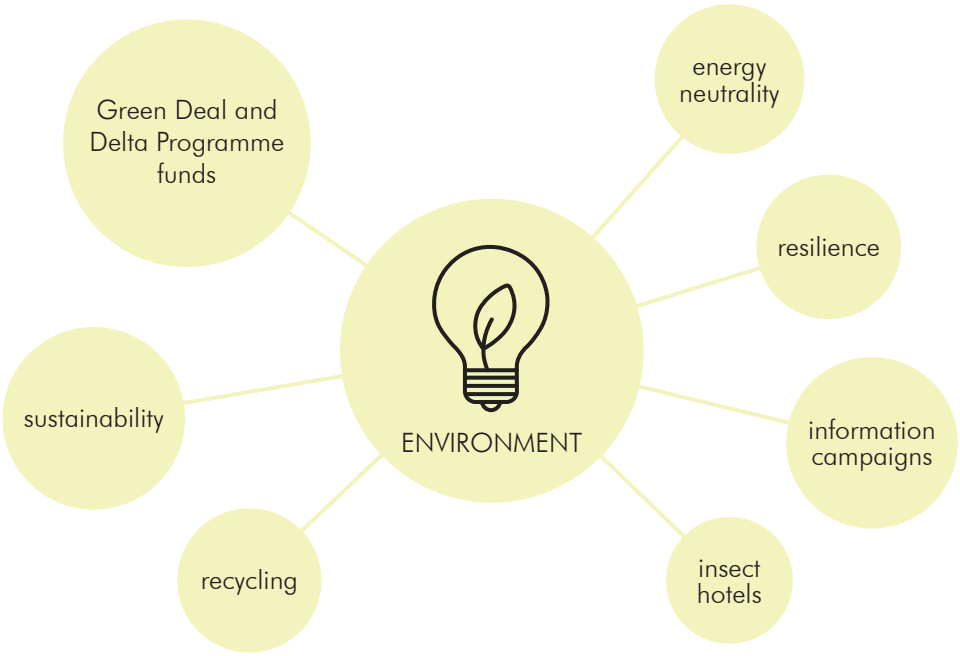


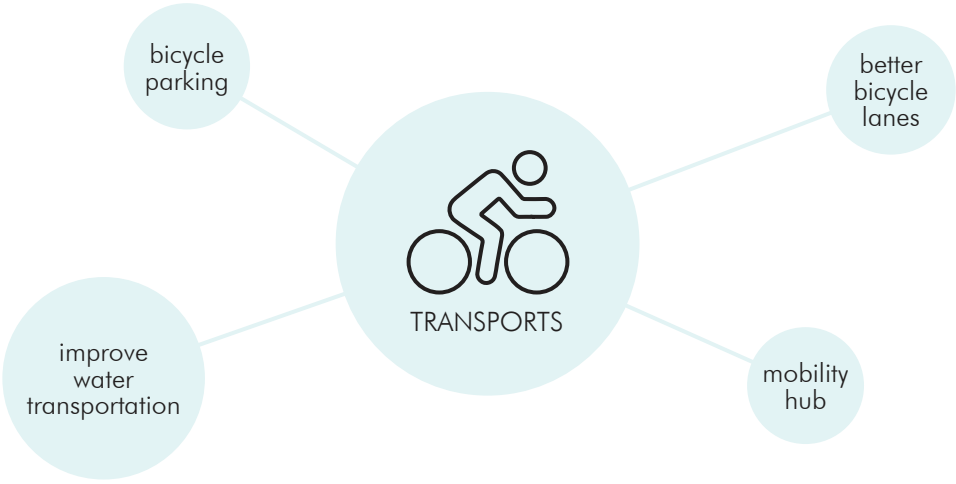
Strijp-S, located in Eindhoven, presents a distinct aspect of urban transformation focusing on the adaptive reuse of industrial heritage, giving a new function to buildings of the past. While not directly addressing climate adaptation, the project incorporates the principles of sustainability, circular economy and cultural/urban heritage conservation. The lessons learnt from Strijp-S offer insights into urban design beyond its historical context:

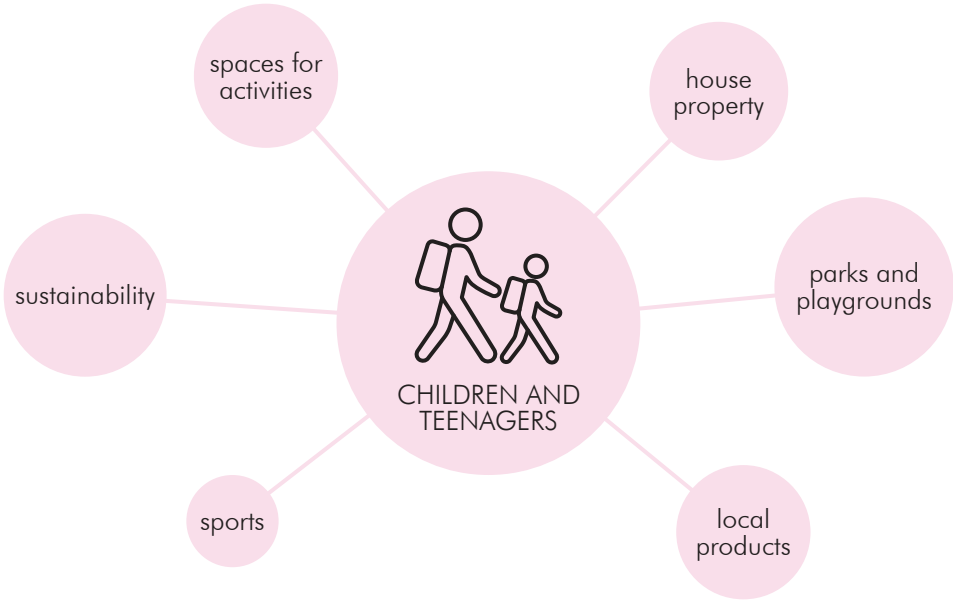


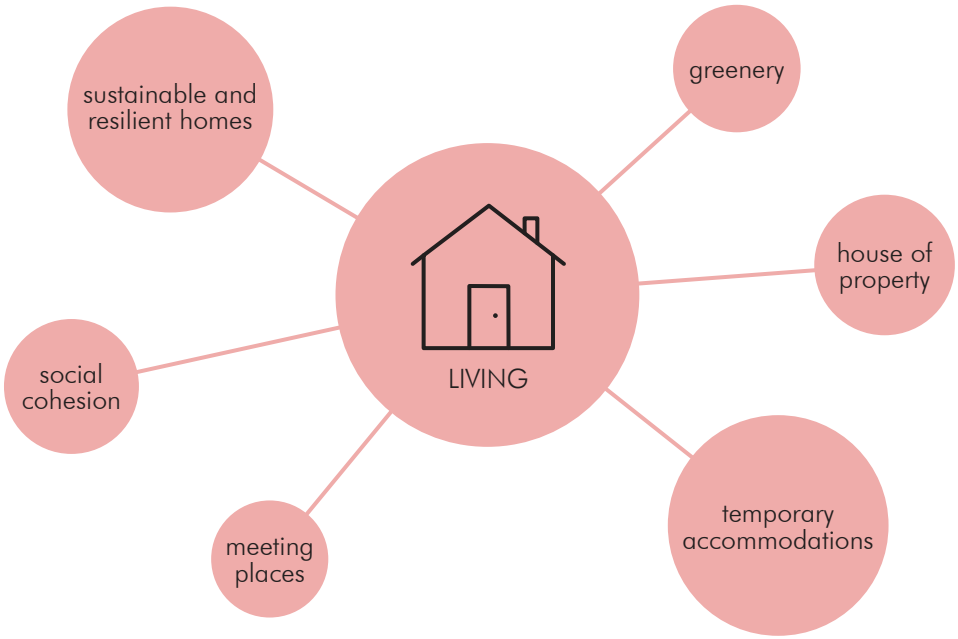
On the following pages, we summarise the needs and innovative proposals expressed by the residents of Molenlanden, the municipality to which Kinderdijk belongs. For a clearer and more careful study, the citizens' aspirations have been organised into distinct macro-themes, covering areas such as work and leisure, environment, transport, children and adolescents and life. These thematic insights are presented below through illustrative diagrams.
This collection of contributions has been instrumental in understanding the intricate fabric of community needs. Moreover, it provided a solid basis for a collaborative form of participatory planning, fostering alignment with the shared visions of the municipality's residents. It is worth emphasising that this participatory approach proved particularly valuable during the planning stages of the shipyard redevelopment, fostering informed decision-making processes.




Green Deal and Delta Programme funds
energy neutrality
resilience
sustainability
ENVIRONMENT
information campaigns
recycling
insect hotels


bicycle parking
better bicycle lanes
improve water transportation
TRANSPORTS
mobility hub

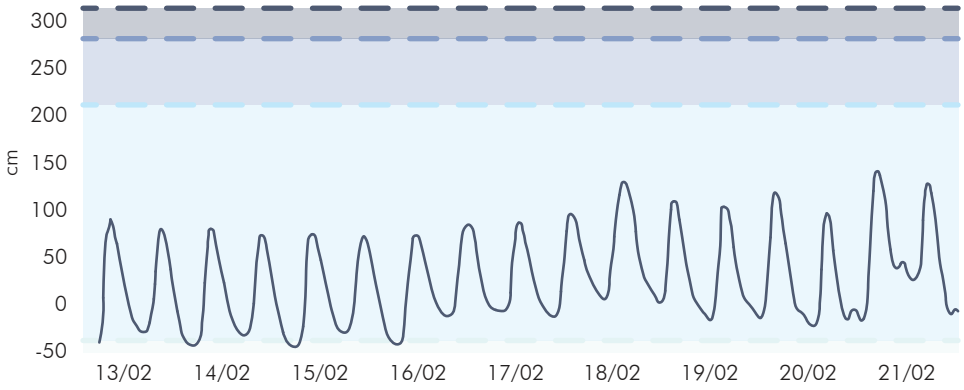

spaces for activities
house property
sustainability
parks and playgrounds
CHILDREN AND TEENAGERS
sports
local products


sustainable and resilient homes
greenery
house of property
social cohesion
LIVING
meeting places
temporary accommodations

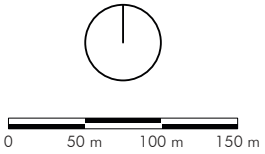
PROJECT

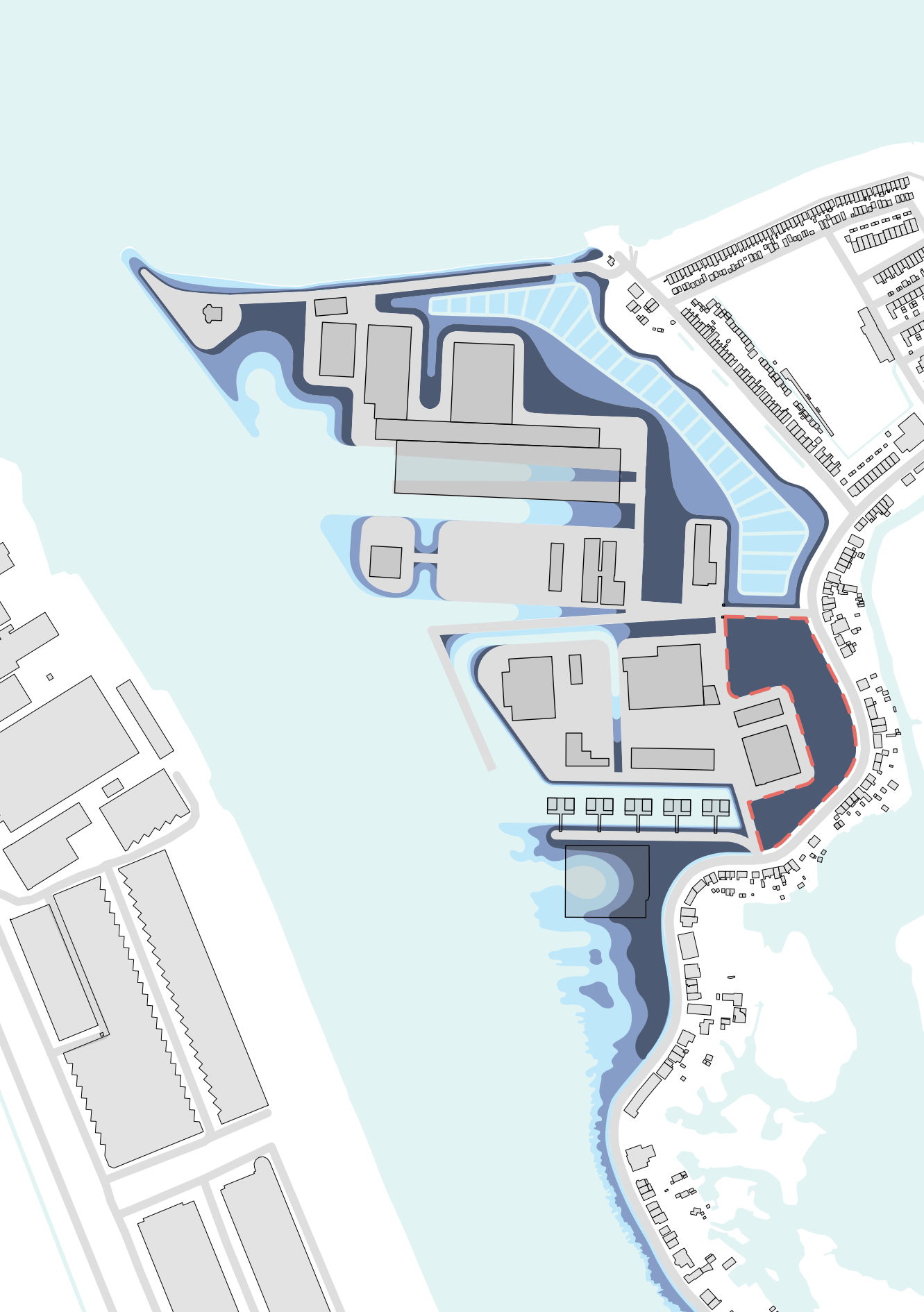
Water-level scenarios

The configurations that the project can take depending on the water level are shown on the opposite page. With a total redesign of the terrain, it was possible to design a tidal park that allows people to observe and experience the influence of water and tides.
The river tide repeats itself approximately twice a day in this area; the high tide peak occurs on average every 12 hours, as does the low tide peak, which is staggered by just over 6 hours. The average height difference between the two is roughly 110 cm.
The surface water level is measured in centimetres in comparison to the normal Amsterdam level (NAP). The measuring point taken in consideration for Kinderdijk is in Krimpen a/d Lek. The figure below shows, as an example, the development of the water level from 13 to 21 February 2023 (source: waterinfo.rws.nl/#!/thema/Waterbeheer/). The different configurations are shown separately on the following pages based on the identified limits.



Low water level (< -40 cm)
Normal water level (-40 to 210 cm)
Slightly high water level (210 to 280 cm)
High water level (280 to 310 cm)
Extreme water level (> 310 cm)
Impervious surface
Natural surface
Permeable paving
Lockable water passage



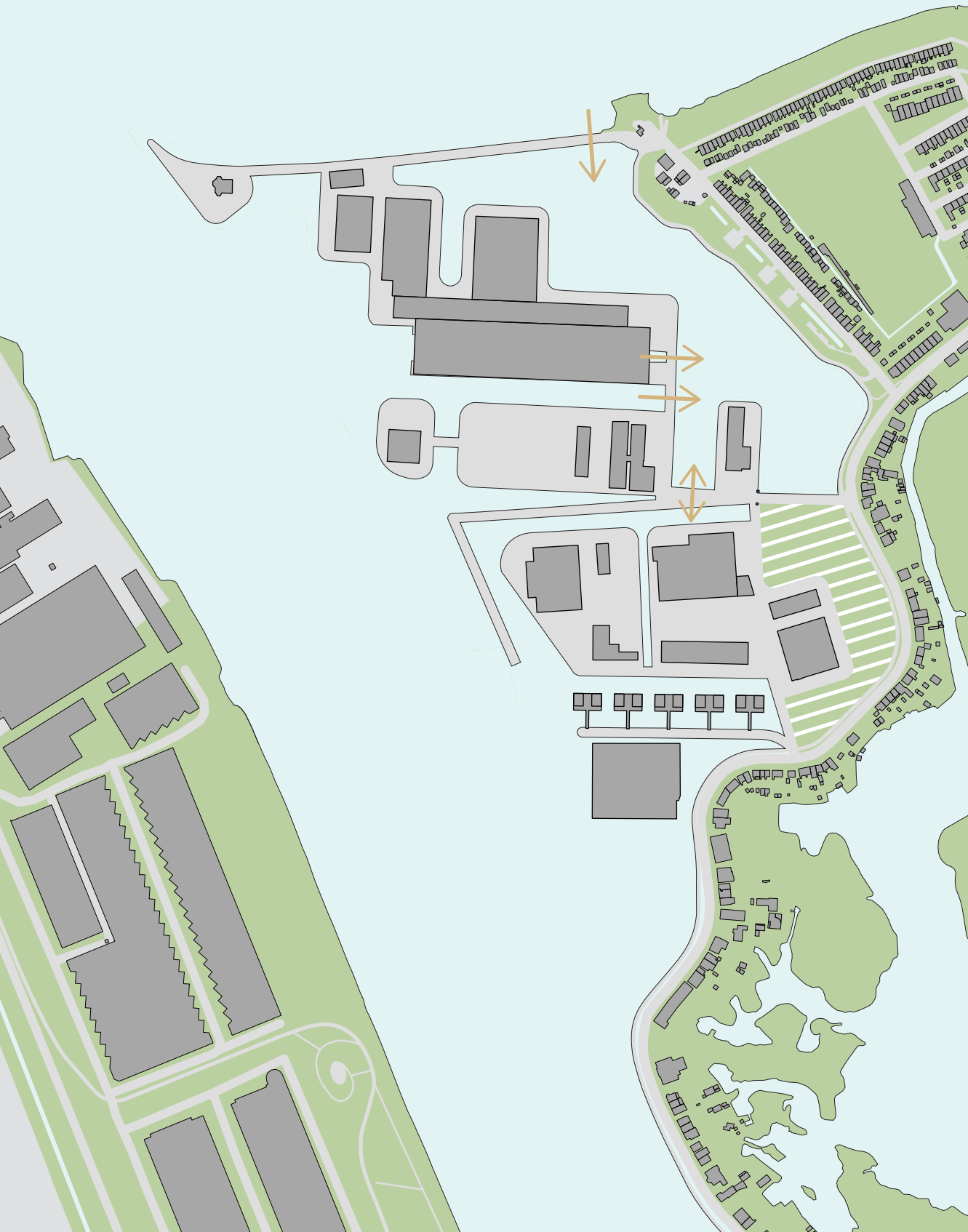


Low water level (< -40 cm)

Normal water level (-40 to 210 cm)

Slightly high water level (210 to 280 cm)

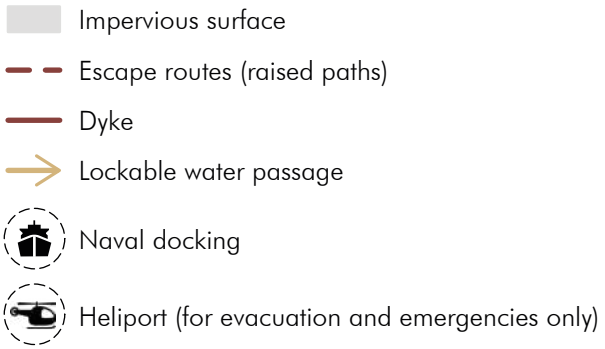
High water level (280 to 310 cm)

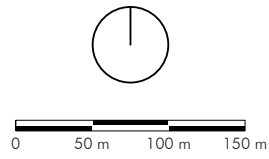


Water-level management and evacuation plan

Living on water also requires special attention, especially in areas such as these, which are prone to flooding. The map below shows escape routes in an emergency when the water reaches a level of 310 cm. It also summarises a brief regulation to be followed to maintain safety in the project area and the steps to be taken in the event of an emergency.

1. Training
Citizens and employees who regularly visit the site receive training in how to act in case of an emergency and in how to live with water consciously and safely.
2. Visual signs
There are lights that change colour on top of the tallest buildings on the site. Each colour is associated with a different water level, so people are always updated.
3. High water level
People on the site and in the vicinity receive an alert text message when the water level becomes high (from 280 cm). The latter also requests the removal of cars from the floodable car park. The message is repeated by loudspeakers.
4. Extreme water level
Gates are opened to flood the floodable car park when the water reaches the 300 cm threshold. Preparation is made for a possible evacuation.
5. Evacuation
Evacuation only takes place if the water continues to rise. In this case, people will be alerted by an audible alarm and will be channelled via the raised escape routes to the dam, the ship dock or the heliport in safety.





Extreme water level (> 310 cm)

Design principles for a tidal park

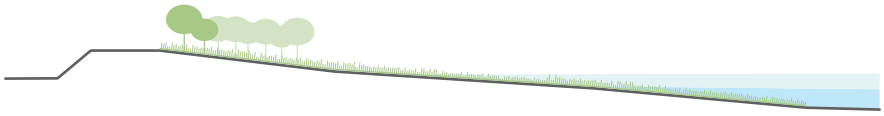
These pages depict the design strategies adopted in the creation of a tidal park at the site in question. Making the transition between land and water as smooth as possible is the guiding principle. The design decisions change depending on the context, as discussed in chapter 5.1.4. (Getijdenpark case study).

Along the river

Dig to widen the contact zone between land and water and thus create a tidal park. The length of the river can also be exploited to create paths for slow mobility with a view of the water.

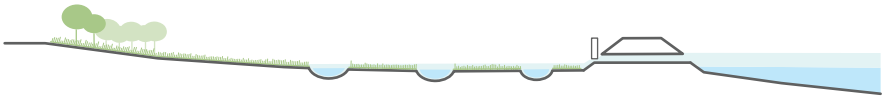
In inland areas

Bringing in the river and thus the tides in the form of a lake or a slope perpendicular to the watercourse. This creates an environment that is connected to the river, but further inland from it and safer, thus suitable for children's playgrounds and alike.



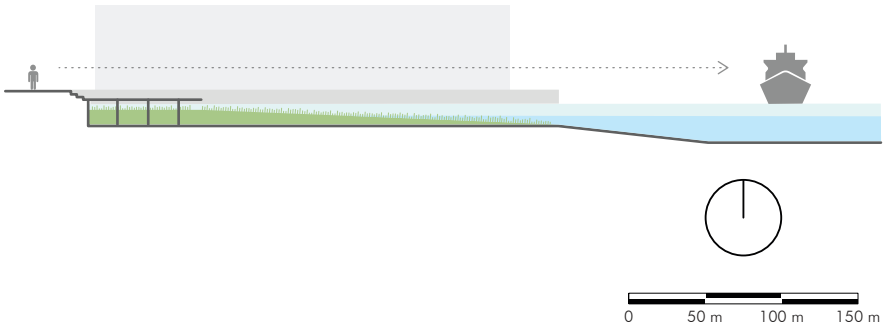
Between the dykes

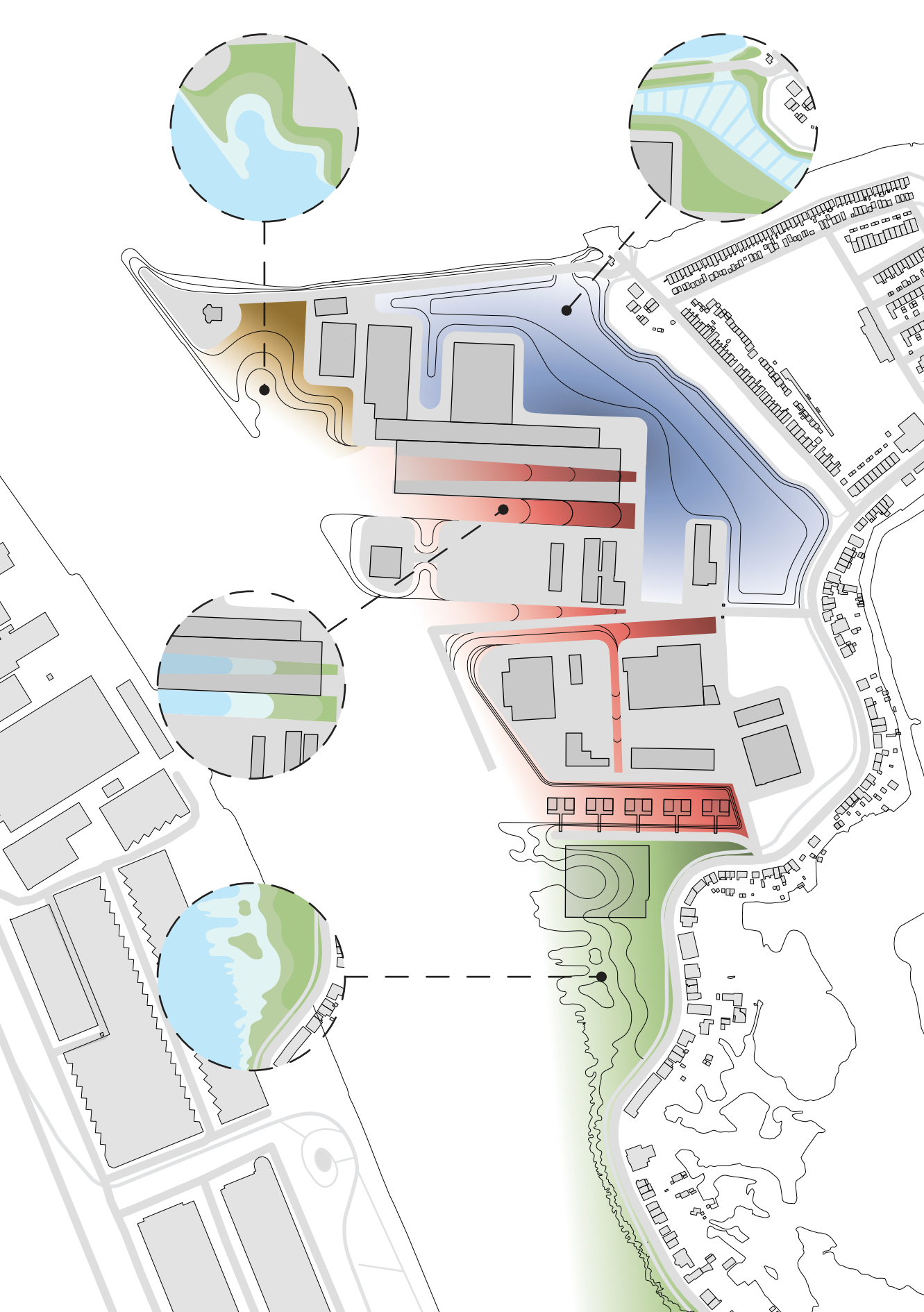
It is possible to let in the river and tides in a controlled manner with a flotation dam that guarantees safety.



In harbour basins

Maintain the size and scale of the dock in a tangible way as the harbour character must be recognisable. Open the view from the head of the basin towards the river and make the water accessible.





Refunctionalization

Ship's hall

- covered market selling regional goods
- holographic show to narrate and visualise the greatness of ships
- traditional restaurants
- rooftop terrace with suites for exclusive stays
- courses and urban manufactoring

Working site

- workspaces and offices for start-ups and businesses
- laboratories
- coworking and smart-working spaces and stations
- temporary and micro-housing

Machine factory

- event and exhibition space
- auditorium
- sports facilities
- catering area
- garage (for residents and workers only)

Floating houses

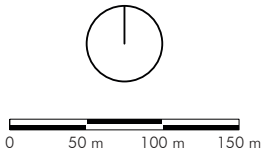
- ten floating houses

Assembly hall

- insect hotel
- phytodepuration system
- vertical greenhouse
- new site icon: industrial shed surrounded by nature and water

P Car park (permeable pavement)

Naval docking




P

Design references

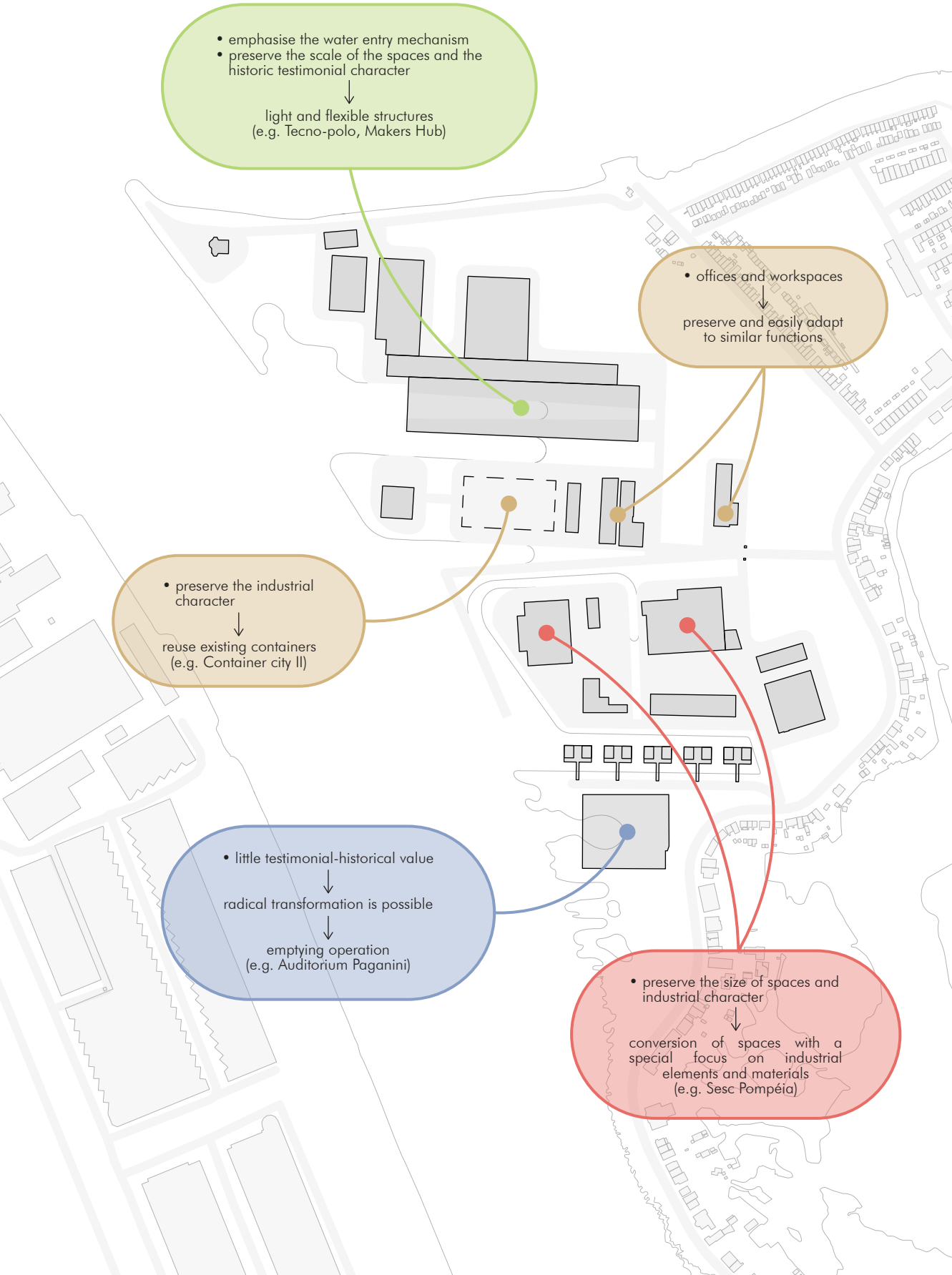
MAKERS HUB, MILAN

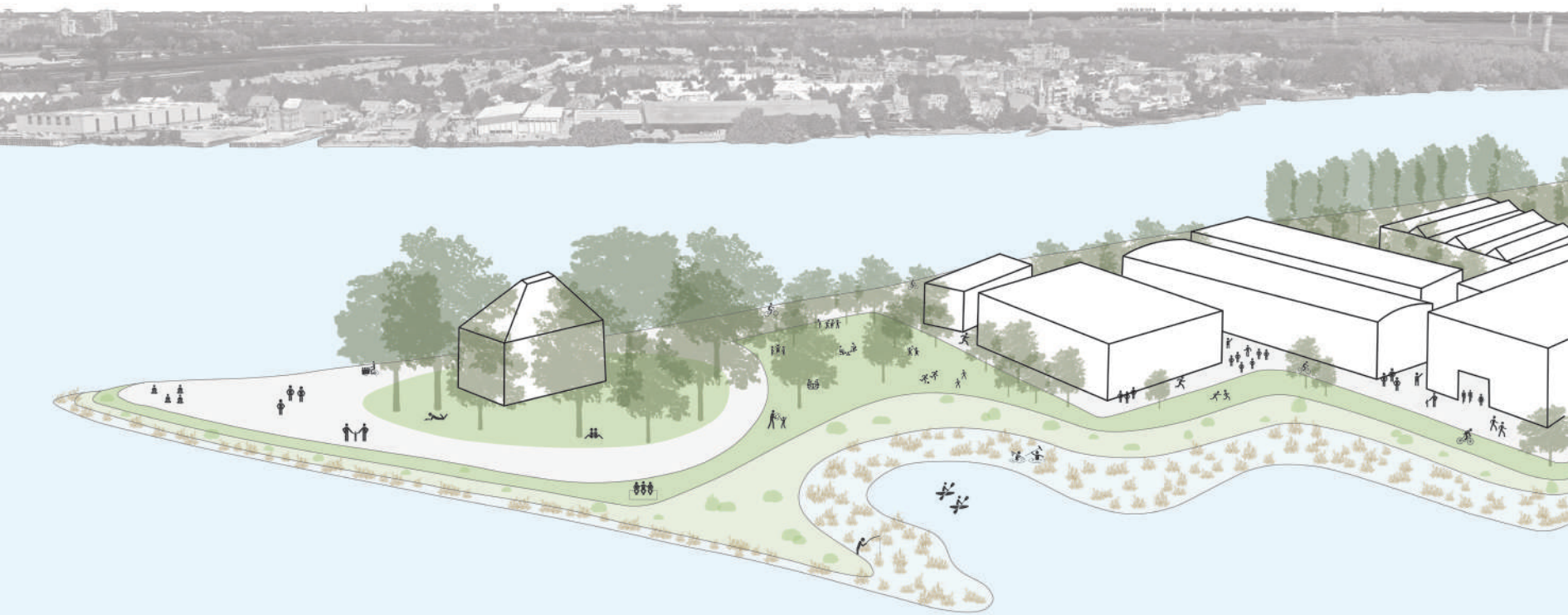
SESC POMPÉIA, SÃO PAUL

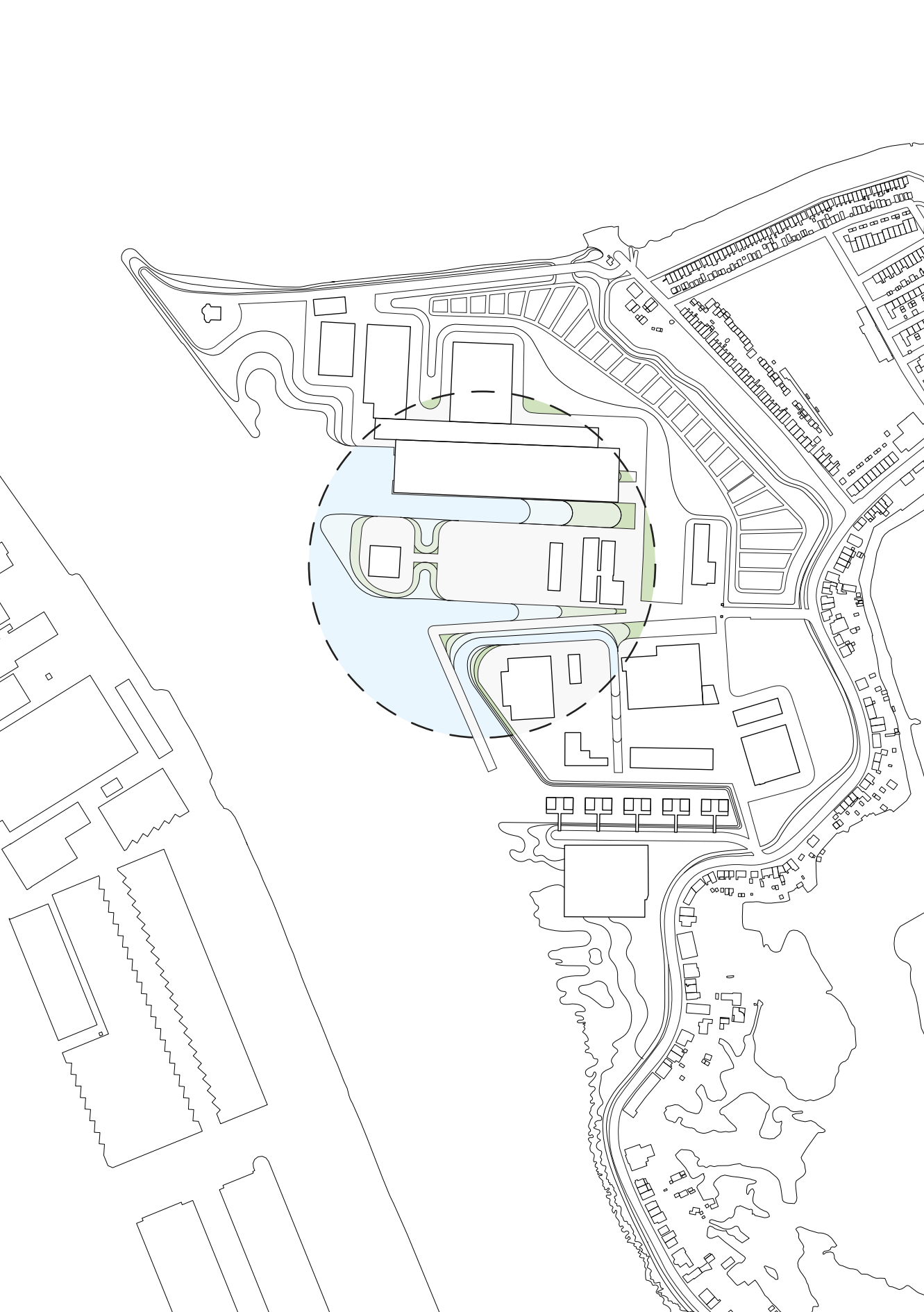
CONTAINER CITY II, LONDON

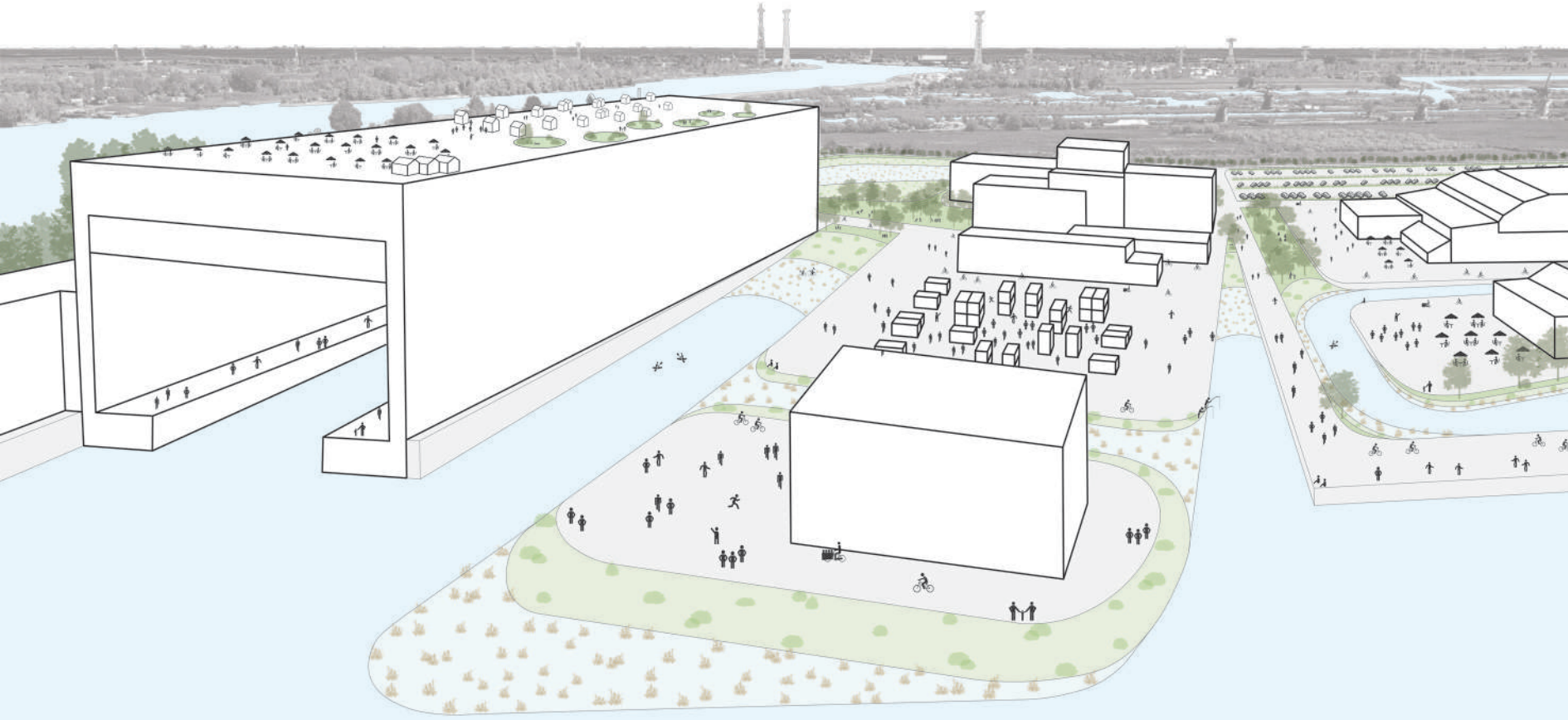
AUDITORIUM PAGANINI, PARMA

TECNO-POLO, REGGIO EMILIA


• emphasise the water entry mechanism
• preserve the scale of the spaces and the historic testimonial character
↓
light and flexible structures
(e.g. Tecno-polo, Makers Hub)
• offices and workspaces
↓
preserve and easily adapt to similar functions
• preserve the industrial character
↓
reuse existing containers
(e.g. Container city II)
• little testimonial-historical value
↓
radical transformation is possible
↓
emptying operation
(e.g. Auditorium Paganini)
• preserve the size of spaces and industrial character
↓
conversion of spaces with a special focus on industrial elements and materials
(e.g. Sesc Pompéia)







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Finally, I would like to express my sincere appreciation to the University of Padova and the Eindhoven University of Technology for offering me the opportunity to pursue my passion for research and learning.
These people and institutions have not only enriched my academic experience, but have also shaped my future aspirations. Their support has been a constant source of inspiration and motivation.

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