# Research Plan

Towards Living with Water

In search of new perspectives towards living with the increasing risk of flooding in the densifying outer dike area of the urban center of Rotterdam


J.E.H. Grevink | Architectural Engineering | 2020-2021

Under supervision of: | Delft University of Technology

Dr. F. L. Hooimeijer | Faculty of Architecture and the Built Environment

R. A. Gorny | Faculty of Architecture and the Built Environment

# Preface

After a brief topical introduction and problem statement this research plan will elaborate on the analytical and methodological aspects behind my graduation research. During my research the structure this research plan proposes will help guide me through the vast amount of resources and research methods available today. It will aid in unraveling a complex issue, into more clear and manageable parts, ultimately leading to a relevant and innovative architectural intervention.

In designing my research the Research Plan Lecture Series helped me to become aware of my own thought patterns. This made it possible for me to reflect on them in a critical way thus making adjustments when necessary in my way of thinking.

The main topic and associated problem statement has primarily come from my personal curiosity towards 'living with the increasing risk of flooding'. This in the context of the Dutch housing shortage on which the Architectural Engineering graduation studio is focusing.

To me personally, the presence of natural water has always had the ability to instantly make me feel at home anywhere around the world. The calmth of the sea regularly enables me to sort out my thoughts and think more clearly during chaotic periods. Even more, it enables me to experience the raw power of nature, the thrill while surfing along with dramatic waves but also the sometimes overwhelming panic after a small mistake.

Therefore, the unprecedented phenomenon of accelerating sea level rise and increasing risk of flooding from rivers in The Netherlands poses an interesting challenge. Especially during the next few decades when the housing shortage will lead to a vast amount of residences to be developed in the midst of a flood hazard. Being a young architect, I see it as an opportunity to combine my passion for architecture with a deeper understanding of the growing threat rising water poses to the built environment. My aim is not necessarily to solve the complex issue on my own, but rather to investigate into, and add to, the growing amount of possible architectural solutions generating resilience, which, in turn, could be implemented or used as food for thought in the near future. Also I see it as an opportunity to explore the possible qualities living with natural water could bring to everyday life, with in mind the devastating power it can bring as well.

On the one hand this personal interest provides me with a lot of curiosity towards the subject, which helps me to dive deeper into the research topic. On the other hand it also provides me with a lot of subjective assumptions and un-argued ideas solely based on my personal experience. As Andrej Radman stated in one of his lectures: *"it can be essential to rid oneself of oneself in order to be able to observe a topic in a scientific manner."* (Radman et al., 2020). Throughout my research and design process I therefore constantly try to be aware of this, sometimes unconscious, behaviour and try to train myself to think outside of my personal experience, ultimately leading up to a project based on facts, theories and experiments rather than personal interpretations.

J.E.H. Grevink

December, 2020

# Contents

# 1. Problem Statement

### Problem statement

As a result of global sea level rise worldwide articles are beginning to state: *"The Dutch Have Solutions to Rising Seas. The World Is Watching."* (Kimmelman, 2017). It seems it is assumed that Dutch water management interventions such as the Delta Works, constructed as a response to the 1953 flood disaster, are a means to avert the consequences of extreme sea level rise on the long-term. However these infrastructure projects are not designed to withstand the effects of the currently predicted increasing sea water levels and more frequently occurring extreme weather conditions (Bregman, 2020). Nevertheless, it seems self-evident to many Dutch people that the government will take responsibility for acting on time.

When the predicted acceleration in sea level rise appears to be true, the current flood defense strategy is not prepared for a shift towards the required change (Bloemen et al. 2017). This is because the required shift is limitied by current standards of society that are against certain changes. As a result, there will be an increase in both transfer costs and strategy-dependency that makes it more difficult to do the required shift. (van der Meulen, 2018). To make sure preparedness, rather than a disaster, leads development, various outcomes of increasing sea level rise and the required adjustments therefore needs to be researched and made visible for the people.

Backing up the need for a different approach is professor Kleinhans' theory stating the risk of flooding comes from lasting changes in climate, sea levels and river discharge, instead of accidental extreme weather events. Whereas occasional extreme weather events have resulted in situations of temporary 'shock', lasting climate change will result in long term 'stress' which requires a different approach. Saline water will seep underneath the costly dikes and will cause problems regarding drinking water, agriculture and nature (Kleinhans, 2018). According to Henk Ovink, Special Envoy for International Water Affairs, the biggest worldwide challenge lies in the field of availability of water, purifying water and other new applications to counteract the consequences Kleinhans describes (Ovink, 2020).

On the other hand, flood risk is also affected by the degree of vulnerability of the built environment and its inhabitants. The amount of possible victims and damage to the built environment in the event of a possible flood is of great importance in decision-making (Pieterse et al. 2009). In this way the flood risk of an already flood prone area will raise as a result of densification. Due to the national housing shortage the aim is to build 58.900 houses in the inner-city area of Rotterdam before 2030, primarily intended for starters and middle income groups (Groenemeijer et al., 2020). For various areas this results in a higher flood risk due to both the changing climate as well as densification, as this leads to an increase in vulnerability (fig. 2.1).

Ahmed Aboutaleb, Dutch politician of the Labour Party and Mayor of Rotterdam, said of the city: *"Rotterdam lies in the most vulnerable part of the Netherlands, both economically and geographically. If the water comes in, from the rivers or the sea, we can evacuate maybe 15 out of 100 people. We have no choice. We must learn to live with water."* (Kimmelman, 2017). Although dikes protect the low-lying parts of the city, also in the densifying outer dike area sensitive areas can be identified (Gemeente Rotterdam, 2014).

Seen the reduction of greenhouse gas emissions and limiting global warming is not entirely in the hands of The Netherlands alone, there has to be a plan takes into account the possibility the country will not survive. Therefore, experts warn that alternative opportunities must be explored in time (Schuttenhelm, 2019a). Especially while the rest of the world does use the Dutch approach as an example, we shouldn't sit back and solely rely on the defensive landscape that has been designed based on assumptions made in the past. Instead, we should search for new perspectives on how to live with the increasing risk of flooding, act in time, and lead by example.

**Hypothesis/objective**

The starting point for this research is based on the assumption that a new building typology can contribute to reducing the housing shortage while generating resilience instead of vulnerability to flooding. The overarching goal is to reduce the flood risk in densifying outer dike areas and contribute to a changing mindset towards living with the increasing risk of flooding. In the context of the current defensive mentality, communicating through architecture a new perception, which embraces and benefits from the qualities natural water can bring to the built environment, will ultimately aid transition through increasing awareness.

The typology will be designed as a diagram flexible to be reinterpreted and deployed in various similar physical contexts dealing with similar conditions. It will be designed to be part of a bigger network of spatial interventions and function along with other existing water management solutions. The diagrammatic design will manifest itself in the form of a detailed design for one of these locations. For the purpose of this detailed design the research will focus on experimenting with design principles rendering visible and utilizing natural water to enhance spatial qualities benefitting everyday life. The final design will be presented as an imaginative case-study and can be seen as an experimental form of research.

The New York Times

# The Dutch Have Solutions to Rising Seas. The World Is Watching.

**In the waterlogged Netherlands, climate change is considered neither a hypothetical nor a drag on the economy. Instead, it's an opportunity.**

ROTTERDAM, the Netherlands — The wind over the canal stirred up whitecaps and rattled cafe umbrellas. Rowers strained toward a finish line and spectators hugged the shore. Henk Ovink, hawkish, wiry, head shaved,

**1.1 Global relevance**, Article: *"The Dutch Have Solutions To Rising Seas. The World Is Watching."* (Kimmelman, 2017)

# 2. Theoretical Framework

As both climate change as well as urbanization of flood prone areas contribute to a rising flood risk (fig. 2.1) the question is how to meet the high demand for affordable housing while generating resilience instead of vulnerability through architectural design. In order to position the project within the current Dutch housing, and flood risk related challenges this chapter will point out the main topics the research will focus on. The resulting framework will provide leads on which the design can be developed further.

### Positioning

On the one hand this research focuses on the study about the practice of living with the temporality of flooding and the spatial qualities natural water can bring. The research therefore zooms in on the current Dutch defensive landscape, recent predictions and transition strategies in order to determine how a more integrative and resilient alternative can be initiated. For this it is essential to investigate into how to deal with uncertain predictions related to long-term planning practices.

On the other hand it takes into account the aim for intensified use of space in urban areas, the efficiently combining of functions and decentralization as prescribed in 'Vijfde Nota ruimtelijke ordening' (Bruinsma et al., 2018). As a result, the market driven, neoliberal building policies which partly caused the Dutch housing shortage and excluded different classes and population groups from inner-city areas. Increasingly often the functional and societal needs seem secondary to the economic importance which poses a difficult context for architectural innovation (Hulsman, 2021).

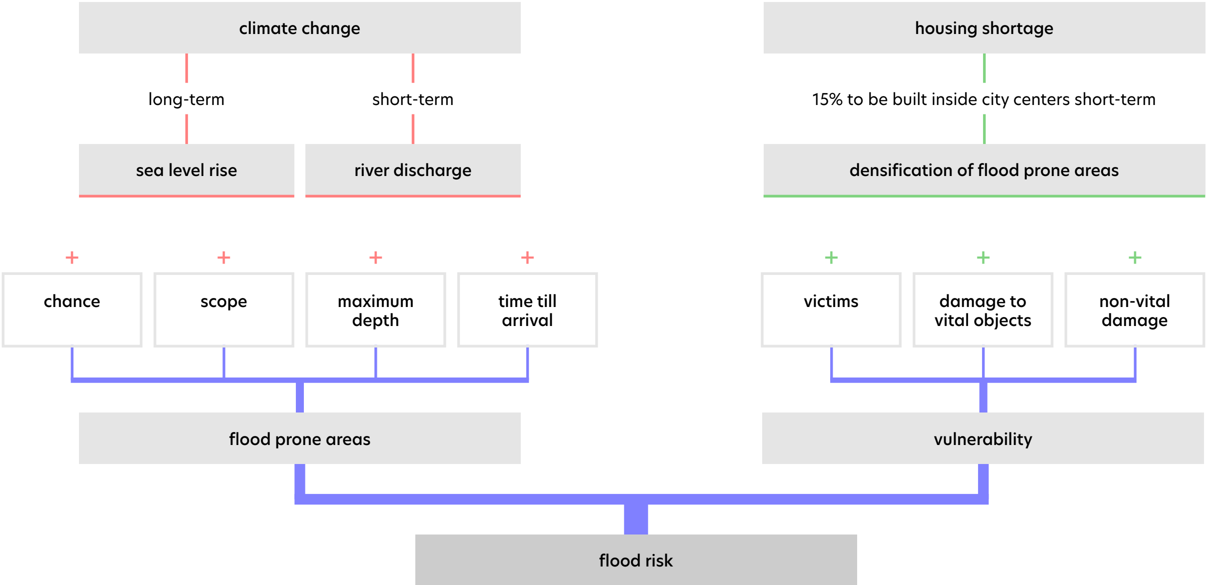
Since roughly 90% of the world's largest cities are situated on the waterfront, also outside The Netherlands it is relevant to rethink the way we utilize the open space water brings to densifying city centers. As floating urban components are less permanent and can add a variety of functions to the current mostly static grid of cities, using water as a building ground, the current space is relieved and allows for a new density (Olthuis, 2014). As the diagrammatic design will need to be tested on various sites in order to be deployable inside a bigger network of water management solutions, the in the short-term to be redeveloped inner-city ports of Rotterdam and Amsterdam will be taken as test sites. Whereas Amsterdam has to cope with a bigger need for housing, Rotterdam experiences more urgent water management issues due to its position along the river Nieuwe Maas (fig. 2.2, 2.3).

### Perspective

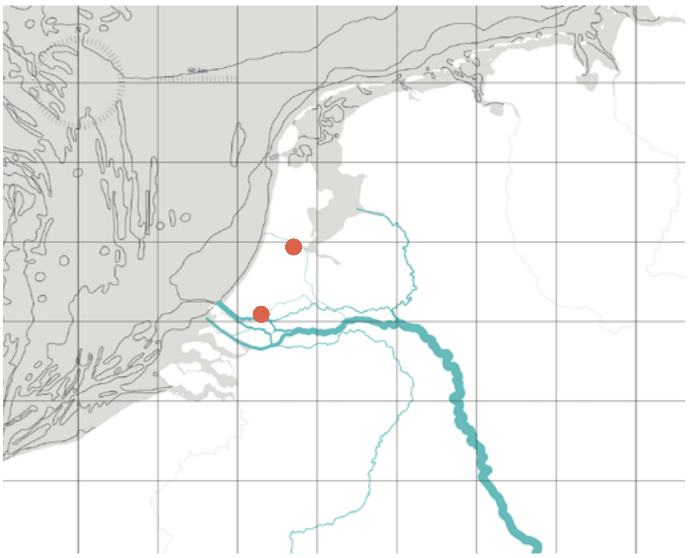
In order to understand how a transition from the current defensive landscape towards new resilient flood risk management strategies can be facilitated, the work "New Netherlands" (van der Meulen, 2018) can be used as a starting point. Van der Meulen, researcher at Urbanism TU Delft, concludes that a shift away from the current flood defenses and flood risk management is required in order for transitional approaches to be implemented. The difficulty with these transitional approaches lies in the possibility that the context will change over time.

Managing this transition therefore constantly requires influence and adjustments in governance systems and societal patterns (Rijke et al., 2012). Crucial in this transition is to emphasize on prioritizing development resulting in preparedness above responding to floods after the event (Rotmans et al., 2001). Transition management has a need for the development of a long-term perspective that takes the desired societal changes into account, to guide accelerated social innovation in the short-term, ultimately leading to changes in the societal structures which initially shaped the problem (Loorbach, 2010).

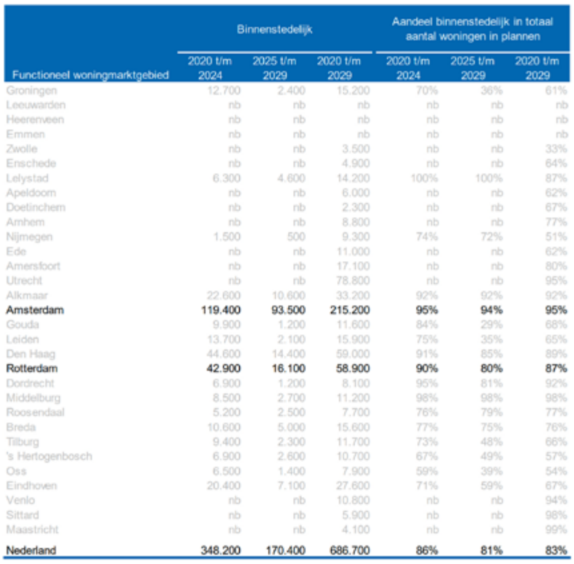
As the right approach has to be based on predictions, a well-considered response is crucial in order to avoid having to regret costly interventions in the Dutch landscape at a later stage (Haasnoot, 2018). This causes a dilemma between the need to act in time, and the need to 'wait' for reliable long-term predictions to base the proper approach on. An intervention to withstand




**2.1 Positioning**, Dependencies influencing flood risk, own illustration based on (Pieterse et al., 2009)

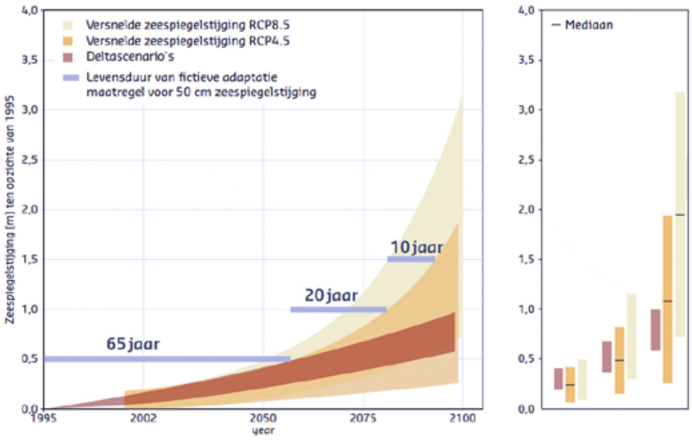


**2.2 Positioning**, The distribution of river water discharge in The Netherlands, edited from (van der Meulen, 2018)

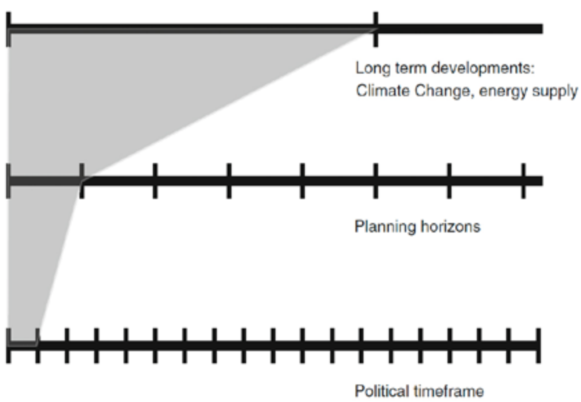


| Functioneel woningmarktgebied | Binnenstedelijk 2020 t/m 2024 | Binnenstedelijk 2025 t/m 2029 | Binnenstedelijk 2020 t/m 2029 | Aandeel binnenstedelijk in totaal aantal woningen in plannen 2020 t/m 2024 | Aandeel binnenstedelijk in totaal aantal woningen in plannen 2025 t/m 2029 | Aandeel binnenstedelijk in totaal aantal woningen in plannen 2020 t/m 2029 |
|---|---|---|---|---|---|---|
| Groningen | 12.700 | 2.400 | 15.200 | 70% | 36% | 61% |
| Leeuwarden | nb | nb | nb | nb | nb | nb |
| Heerenveen | nb | nb | nb | nb | nb | nb |
| Emmen | nb | nb | nb | nb | nb | nb |
| Zwolle | nb | nb | 3.500 | nb | nb | 33% |
| Enschede | nb | nb | 4.900 | nb | nb | 64% |
| Lelystad | 6.300 | 4.600 | 14.200 | 100% | 100% | 87% |
| Apeldoorn | nb | nb | 6.000 | nb | nb | 62% |
| Doetinchem | nb | nb | 2.300 | nb | nb | 67% |
| Arnhem | nb | nb | 8.800 | nb | nb | 77% |
| Nijmegen | 1.500 | 500 | 9.300 | 74% | 72% | 51% |
| Ede | nb | nb | 11.000 | nb | nb | 62% |
| Amersfoort | nb | nb | 17.100 | nb | nb | 80% |
| Utrecht | nb | nb | 78.800 | nb | nb | 95% |
| Alkmaar | 22.600 | 10.600 | 33.200 | 92% | 92% | 92% |
| **Amsterdam** | **119.400** | **93.500** | **215.200** | **95%** | **94%** | **95%** |
| Gouda | 9.900 | 1.200 | 11.600 | 84% | 29% | 68% |
| Leiden | 13.700 | 2.100 | 15.900 | 75% | 35% | 65% |
| Den Haag | 44.600 | 14.400 | 59.000 | 91% | 85% | 89% |
| **Rotterdam** | **42.900** | **16.100** | **58.900** | **90%** | **80%** | **87%** |
| Dordrecht | 6.900 | 1.200 | 8.100 | 95% | 81% | 92% |
| Middelburg | 8.500 | 2.700 | 11.200 | 98% | 98% | 98% |
| Roosendaal | 5.200 | 2.500 | 7.700 | 76% | 79% | 77% |
| Breda | 10.600 | 5.000 | 15.600 | 77% | 75% | 76% |
| Tilburg | 9.400 | 2.300 | 11.700 | 73% | 48% | 66% |
| 's Hertogenbosch | 6.900 | 2.600 | 10.700 | 67% | 49% | 57% |
| Oss | 6.500 | 1.400 | 7.900 | 59% | 39% | 54% |
| Eindhoven | 20.400 | 7.100 | 27.600 | 71% | 59% | 67% |
| Venlo | nb | nb | 10.800 | nb | nb | 94% |
| Sittard | nb | nb | 5.900 | nb | nb | 98% |
| Maastricht | nb | nb | 4.100 | nb | nb | 99% |
| **Nederland** | **348.200** | **170.400** | **686.700** | **86%** | **81%** | **83%** |

**2.3 Positioning**, Amount and share of inner-city plans by functional housing market area, from 2020 till 2029, edited from (Groenemeijer et al., 2020)




**2.4 Perspective**, Reduction of the functional lifespan of adaptation measures to 0.5 m sea level rise (Haasnoot, 2018)




**2.5 Perspective**, Connection between long-term and short-term (Roggema, 2012)

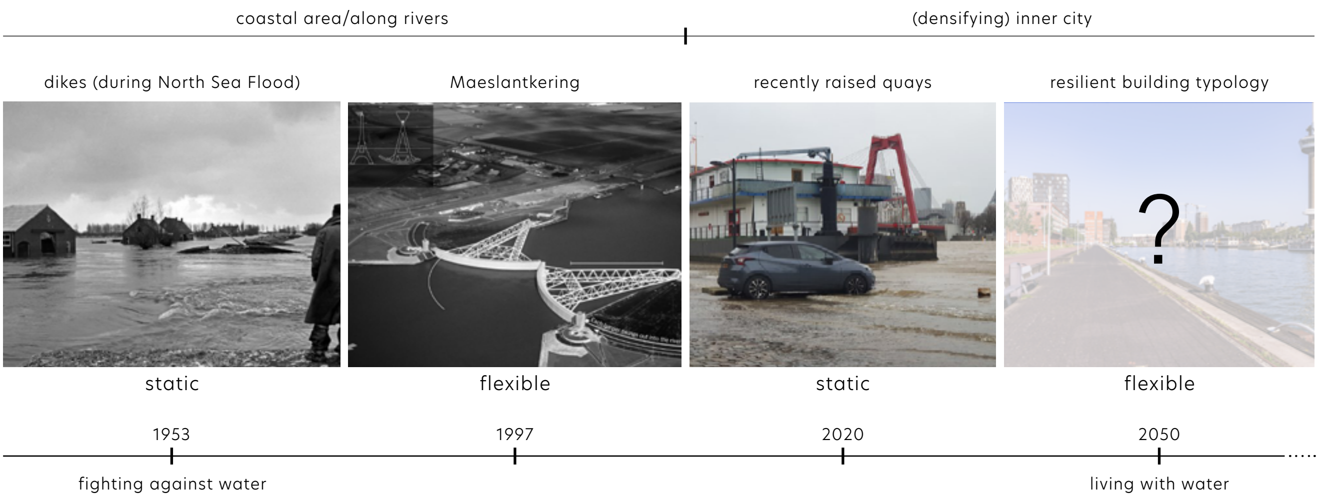
0.5 m sea level rise in 1995 was still sufficient to be able to last approx. 65 years. In 2060 the functional lifespan of this intervention has already decreased to 20 years (fig. 2.4). This means adaptation with relatively small steps is becoming increasingly difficult. Static interventions will be effective for shorter periods, which leaves little time for planning and implementation. An option would therefore be to take several larger and flexible measures instead (Haasnoot, 2018).

Stated by Dutch landscape architect Rob Roggema, the best approach would be to *"navigate"* the problem (Roggema, 2012, p. 39, 40). According to Roggema spatial planning mostly focuses on relatively short-term plans in a context of predicted long-term changes (fig. 2.5). In the design process of a spatial plan, the quantitative demands determine the spatial layout and once the individual parts are embedded in the plan the future is fixed which causes problems on the long-term (Roggema, 2012). Therefore, best approach would be to determine the best possible direction towards a far-future solution, while on the go constantly adjusting the route. Therefore in order to be able to "navigate", a long-term solution must have flexibility as one of its core features.

### Change in perception

As the recent "Room for the River" project shows a shift towards deliberately 'letting flood', a more adaptive landscape is already being introduced (Rijkswaterstaat 2019). Facilitating further transition is not expected to have one fixed solution. Such a transition of an established system addresses countless interrelated problems and is expected to be only possible when initiated gradually and considered as an evolving process (van der Meulen, 2018).

In order to navigate this process the theory that design has the strength to facilitate one's imaginations and to initiate a collective behavioral change is essential (Brugmans, 2018). It is important that the current generation demands change and becomes mobilized. This can be done with the visualization of futures. (Alkemade et al., 2018). By showing a future with a convincing narrative, that informs and unites people to make complex decisions. That will result in action and opposing the resistance giving standard, architectural design has the ability to address the new complexity of a future with an increasing risk of flooding (Ovink et al., 2018). Now is the time to utilize the power and strength that design can bring in terms of communicating new perceptions (van der Meulen, 2018).



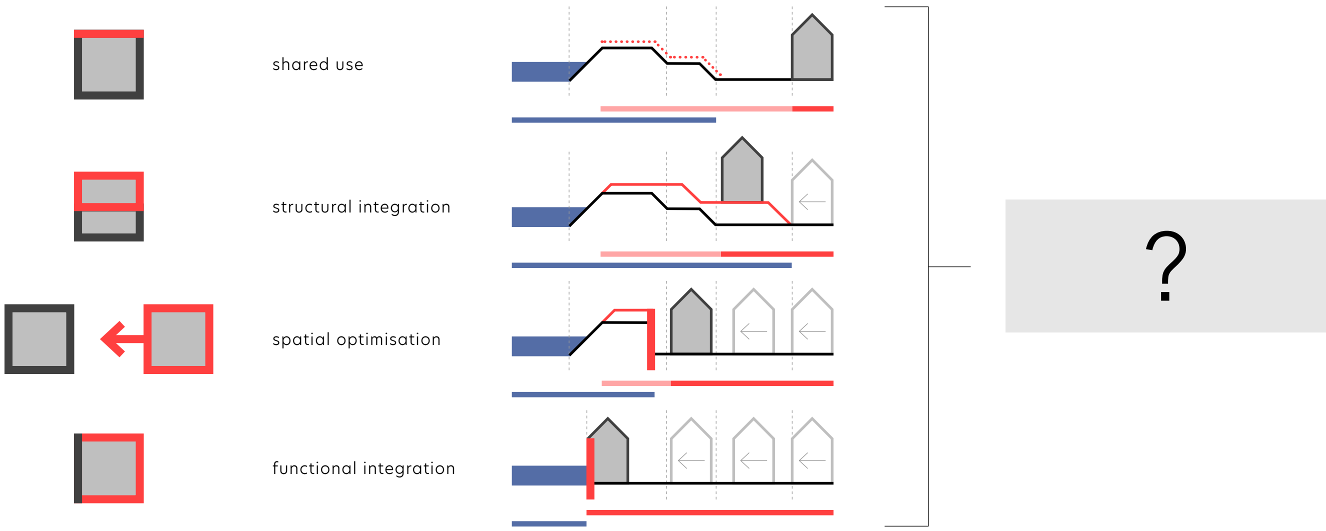

**2.6 Change in perception**, Mentality towards flood barriers after the Dutch flood disaster in 1953, own illustration based on respectively (ANP Archief, 2008), (Kimmelman, 2017), (Port of Rotterdam, 2020), own photograph Parkhaven Rotterdam, 2020

# 3. Methodology and Methods

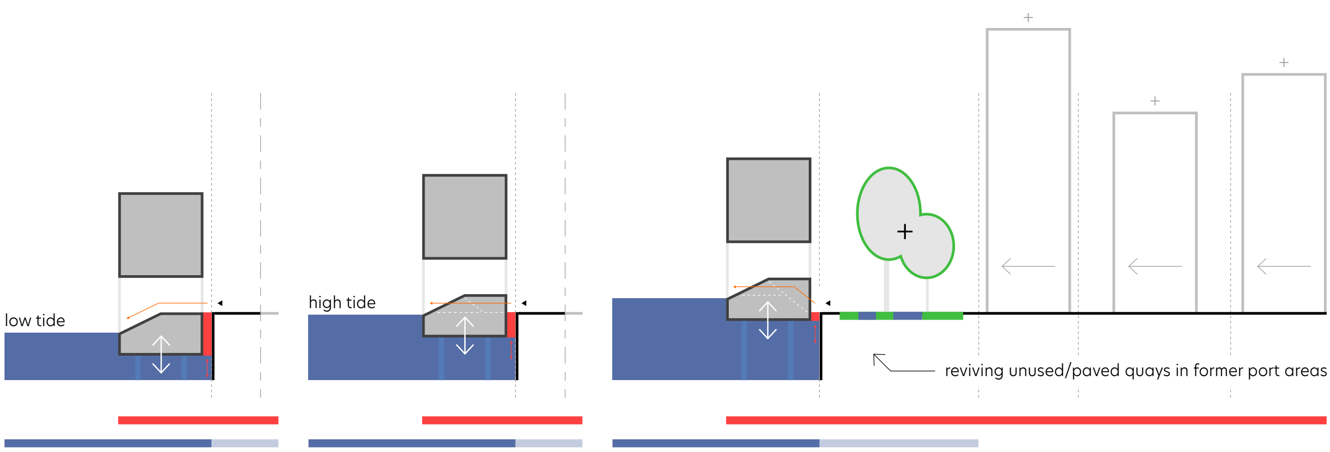
In order to gain a deeper understanding and establish the right relationships between the illustrated topics, this chapter will look into which existing architectural research methods can be applied and combined.

### Building on existing design principles

In striving towards efficient use of space in densifying urban waterfront areas, various, already implemented, integration concepts (Veelen, 2015) combined together could form a new type of building typology (fig. 3.1). Combining the principles of shared use, structural, spatial and functional integration could pose an innovative next step towards living with water in densifying urban areas (fig. 3.2). The sub questions in order to come up with workable design principles: How would a typology like this work both socially and technically? In what ways could this typology be beneficial to the densifying flood prone area behind it? What other qualities will it be able to give back to the city? How would it be implemented into the already saturated urbanizing context? What will the mandatory requirements be for the individual parts of this building typology in order to make it feasible and flexible long term?




**3.1 Building on existing design principles**, Degrees of spatial integration, own illustration based on (Veelen, 2015)




**3.2 Building on existing design principles**, Example of a schematic proposal for a hydraulic building typology along currently vacant quays combining shared use, structural, spatial and functional integration, own illustration

**Comparative mapping**

The two test sites (fig. 3.3) will need to be analyzed in order to find similarities, contradictions and individual restrictions which can be included in the diagrammatic designs. Besides gathering data and mapping the physical context, also recent zoning plans, building plans, and flood risk related predictions, specifically aimed at these locations, will have to be clearly visualized.

The 'testability' of the two resulting diagrammatic designs then depends on both the logical coherence as well as its applicability to other sites (Groat, 2013, p. 76).

**Time-based approaches**

Instead of what we need right now, the question should be about what is needed in the far-future (Hein et al., 2020b). While keeping in mind the transition requirements and a clear overview of recent scientific predictions, how can a flexible far-future solution be determined towards which can be navigated? To set the route for future developments, various time-based approaches can be applied. The interrelated use of forecasting, backtracking and backcasting (fig. 3.4) enables to find the best solutions from history, the present and the desirable future (van den Dobbelsteen et al., 2006).

**Analysis of reference projects**

In order to distill from relevant architectural reference projects (p. 16, fig. 5.1) usable design principles in a responsible way the following questions posed by professor Carola Hein should be kept in mind: How can we use interpretations of the past to propose certain design decisions which will shape the future built environment? How to avoid findings to be based solely on personal interpretation? (Hein, 2020a). Therefore in this analysis what will be important is to explore the thoughts behind the projects, to try and understand which reasons led to its creation. In this way not the form or function will be analyzed, but the resulting capabilities, that can be redeveloped and used again (Radman et al., 2020).

**Material study**

The sustainable way of building involves the limited use of concrete which in The Netherlands is gradually more frequently being replaced by timber construction (Hulsman, 2021). In the case of the proposed hydraulic building typology this material preference gets an extra dimension as the weight of the construction will largely determine the volume. The starting point that comes with this distinction will be to use concrete if there is no other option, and to use wood where it is possible. To determine exactly where this distinction will be made material studies have to be carried out regarding buoyancy, weight, manufacturing and water resistance.

Regarding the construction the project will also utilize the 'open building' principles examined within the Architectural Engineering graduation studio in order for the project to assure flexibility and durability.

**Research by design**

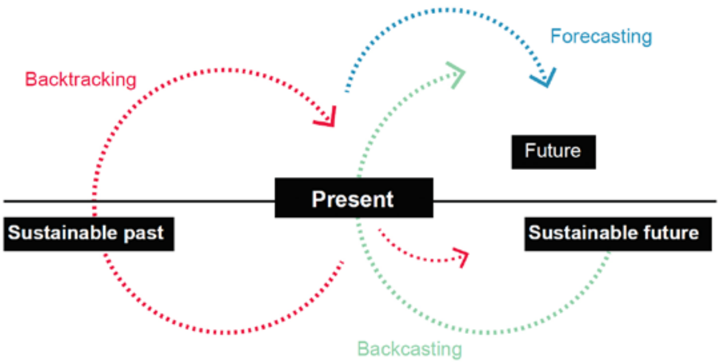
As all architecture can be seen as a form of inquiry, which takes on different manifestations in different moments in time and space, during the process there is no clear distinction between the research and design part (Mejia et al., 2020) (fig. 4.1). In order to produce new knowledge through the act of designing a back and forward process between the interconnected research and design is needed. In this way design principles resulting from research can be experimented with and tested in a site specific context. In turn, unforeseen obstacles emerging from the design process can be investigated further (Vos et al., 2013).

Posed by professor of design studies Nigel Cross the process consists of three, often unconsciously, interrelated aspects (fig. 3.5) that build on relevant first design principles as design guides in engineering (Cross, 2006). As the described problem goals are complex with no fixed solution criteria, the design process has to be transformed into a process of continuous feedback. The process needs to become reflective for it to be constantly adjusted and directed to build towards the desired future (Roggema, 2016).

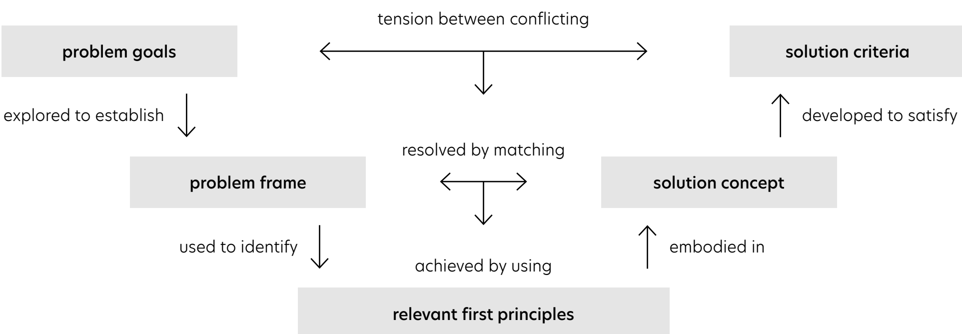
**3.3 Comparative mapping**, Short-term to be redeveloped inner-city port areas of respectively the Parkhaven/Sint Jobshaven in Rotterdam and the Coenhaven in Amsterdam, to be used as test sites, edited from Google Earth, 2020

As briefly explained by Roggema (Roggema, 2012, p. 84), the 3 methods can be described as:

- Forecasting: *"Predicting the future starting from present".*
- Backcasting: *"To define the desired future, and derive from that the steps to be taken to realise that future".*
- Backtracking: *"Going back in history to find a sustainable equilibrium, which functions as an inspiration for defining a desired future system and derive from that the steps to realize it".*

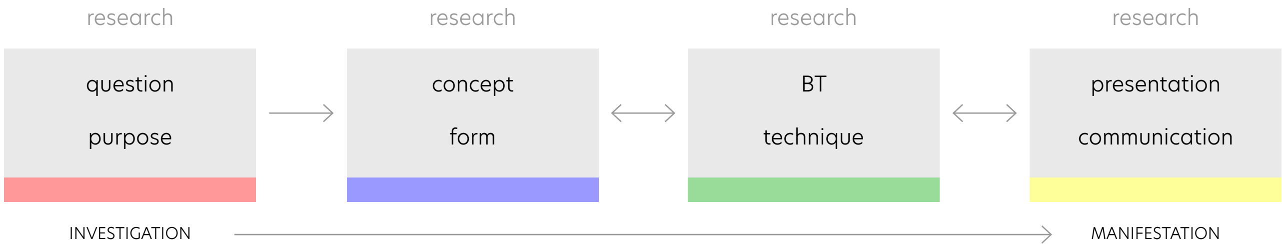



**3.4 Time-based approaches**, Graphic explanation of the forecasting, backcasting and backtracking methods, illustration by F. Lafleur edited from (van den Dobbelsteen et al., 2006), (Hooimeijer, 2016), explanation cited from (Roggema, 2012, p. 84)

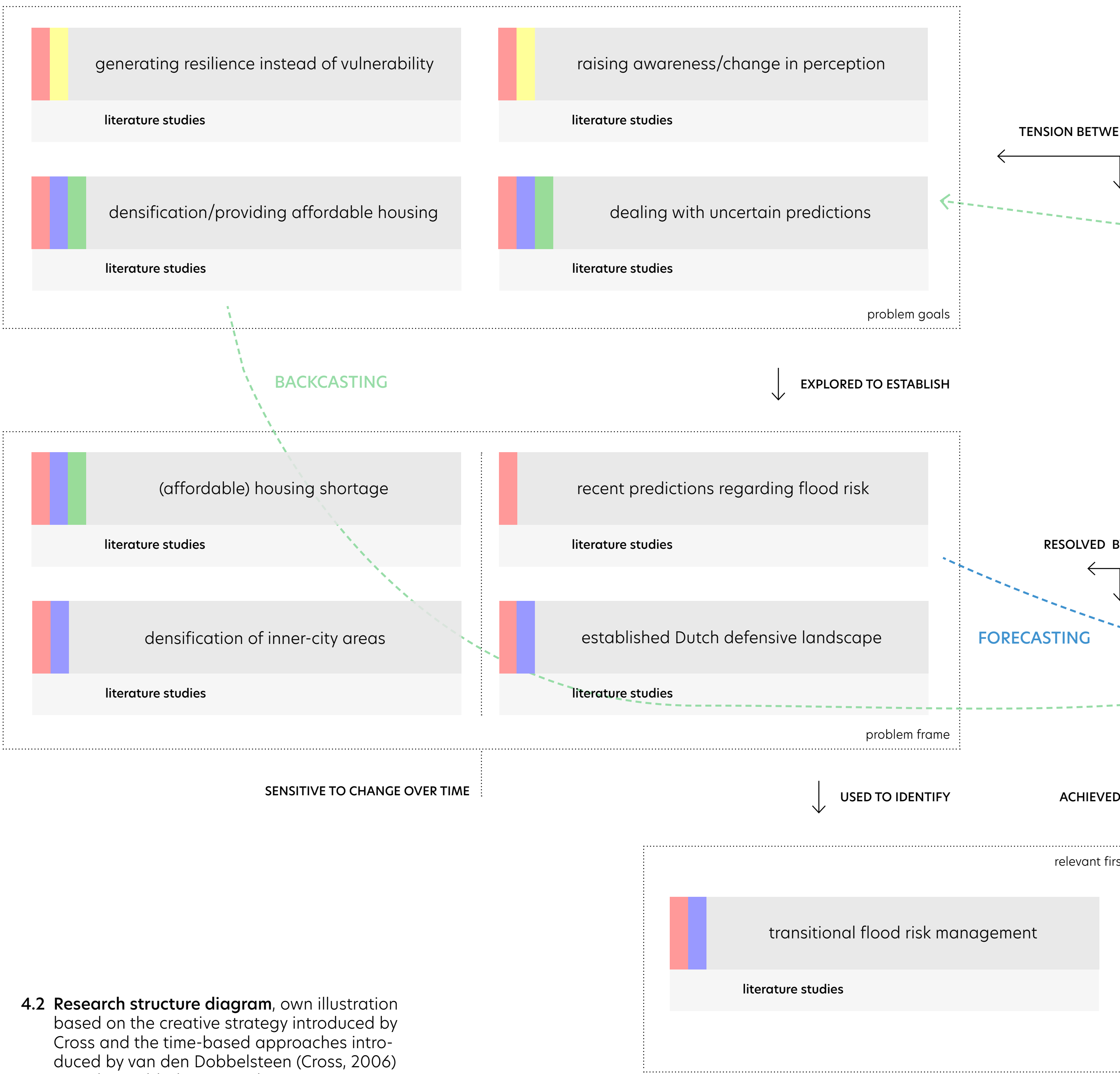



**3.5 Research by design**, Diagrammatic model of creative strategy, own illustration edited from (Cross, 2006)

# 4. Research Structure Diagram




**4.1 Research/design sequence**, own illustration based on (Mejia et al., 2020)




**4.2 Research structure diagram**, own illustration based on the creative strategy introduced by Cross and the time-based approaches introduced by van den Dobbelsteen (Cross, 2006) (van den Dobbelsteen et al., 2006)


diagrammatic design
(ensuring typology to be applicable to other sites)
topic
methods
research by design
- testing of design principles/generating feedback
- focus on widely applicable system
site-specific architectural intervention
(imaginative case study/experimental design)
topic
methods
research by design/material study
- testing of design principles/generating feedback
- experimenting with site-specific constraints
EN CONFLICTING
solution criteria
DEVELOPED TO SATISFY
introducing an innovative typology
(p. 11, fig. 3.1, 3.2)
topic
methods
building on existing design principles
- Linking previous findings
- Logical argumentation
Y MATCHING
context of (test) sites
(p. 12, fig. 3.3)
topic
methods
comparative mapping
- Parkhaven/Sint Jobshaven RTM, Coenhaven AMS
- physical context, future developments, recent predictions
hydraulic engineering
topic
methods
disciplinary analysis
- Interdisciplinary consultation/precedent study
- Material study
solution concept
BY USING
EMBODIED IN
t principles
BACKTRACKING
relevant existing design principles
(p. 16, fig. 5.1)
topic
methods
analysis of reference projects
- exploring the various thoughts behind the projects
- distilling useful capabilities to be reinvented

# 5. References | architectural reference projects


Álvaro Leite Siza, & Carlos Castanheira Architects. (2019, 24 oktober). The Building on the Water / Álvaro Siza + Carlos Castanheira. Geraadpleegd op 19 mei 2020, van https://www.archdaily.com/541173/the-building-on-the-water-alvaro-siza-carlos-castanheira

Baca Architects. (2016). The UK's first Amphibious House | Baca Architects. Geraadpleegd op 19 maart 2020, van https://www.baca.uk.com/amphibious-house.html

Barcode Architects. (2020, 25 april). MASTERPLAN RIJNHAVEN ROTTERDAM. Geraadpleegd op 5 mei 2020, van https://barcodearchitects.com/projects/masterplan-rijnhaven-rotterdam/

BIG. (2018, 13 augustus). Aarhus Harbor Bath / BIG. Geraadpleegd op 18 mei 2020, van https://www.archdaily.com/900107/aarhus-harbor-bath-big?ad_source=search&ad_medium=search_result_all

Blue Lagoon Iceland. (2019). Architecture Design Process: The Retreat at Blue Lagoon Iceland. Geraadpleegd op 22 mei 2020, van https://www.bluelagoon.com/stories/architecture-design-process-or-the-retreat-at-blue-lagoon-iceland

Cox Architecture. (2014). Brisbane Flood Resistant Terminals. Geraadpleegd op 18 maart 2020, van https://www.coxarchitecture.com.au/project/brisbane-flood-resistant-terminals/

Diller Scofidio + Renfro. (2002). Blur Building. Geraadpleegd op 19 mei 2020, van https://dsrny.com/project/blur-building

Dorte Mandrup. (2019). The Whale, Norway | Dorte Mandrup. Geraadpleegd op 22 mei 2020, van https://www.dorte-mandrup.dk/work/whale-norway

Heatherwick Studio. (2013). Heatherwick Studio | Design & Architecture | Garden Bridge. Geraadpleegd op 16 mei 2020, van http://www.heatherwick.com/projects/infrastructure/garden-bridge/

Heatherwick Studio. (2020). Heatherwick Studio | Design & Architecture | Little Island. Geraadpleegd op 12 april 2020, van http://www.heatherwick.com/projects/infrastructure/pier55/

Howarth, D. (2016, 29 juni). Christo's golden Floating Piers stretch across an Italian lake. Geraadpleegd op 19 maart 2020, van https://www.dezeen.com/2016/06/17/christo-the-floating-piers-stretch-across-lake-iseo-italy/

Lola Landscape Architects. (2018). Oostenburg Plot 3. Geraadpleegd op 12 april 2020, van https://lola.land/projecten.php?id=106

Marlies Rohmer Architects & Urbanists. (2011). » Floating Houses IJburg. Geraadpleegd op 20 maart 2020, van http://www.rohmer.nl/en/project/waterwoningen-ijburg/

Marshall Blecher & Studio Fokstrot. (2020). Copenhagen Islands. Geraadpleegd op 16 mei 2020, van https://www.copenhagenislands.com/

MVRDV. (2020, 18 maart). MVRDV - Tainan Spring. Geraadpleegd op 16 mei 2020, van https://www.mvrdv.nl/projects/272/tainan-axis

Powerhouse Company. (2020). Powerhouse Company - Floating Office Rotterdam (FOR). Geraadpleegd op 20 mei 2020, van https://www.powerhouse-company.com/for-office

Precht. (2020). Austrian Expo Pavilion 2020. Geraadpleegd op 22 mei 2020, van https://www.precht.at/austrian-expo-pavilion-2020/

RO&AD. (2011). Moses Bridge. Geraadpleegd op 18 maart 2020, van https://www.ro-ad.org/projecten/moses-bridge/

SLA. (2016). SLA :: Hans Tavsens Park and Korsgade. Geraadpleegd op 19 maart 2020, van https://www.sla.dk/en/projects/hanstavsenspark/

Snøhetta. (2018). Svart. Geraadpleegd op 20 mei 2020, van https://snohetta.com/projects/366-svart

Snøhetta. (2019). "Under" – Europe's First Underwater Restaurant. Geraadpleegd op 18 mei 2020, van https://snohetta.com/project/428-under-europes-first-underwater-restaurant

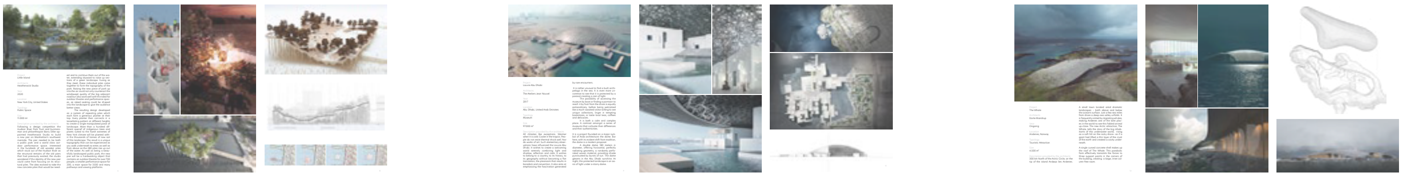
Souza, E. (2017, 14 september). These Stunning Photos Commemorate the 50th Anniversary of Alvaro Siza's Pool On

The Beach. Geraadpleegd op 18 mei 2020, van https://www.archdaily.com/796767/these-stunning-photos-commemorate-the-50th-anniversary-of-alvaro-sizas-pool-on-the-beach

Quirk, V. (2017, 14 september). The BIG U: BIG's New York City Vision for "Rebuild by Design". Geraadpleegd op 16 april 2020, van https://www.archdaily.com/493406/the-big-u-big-s-new-york-city-vision-for-rebuild-by-design

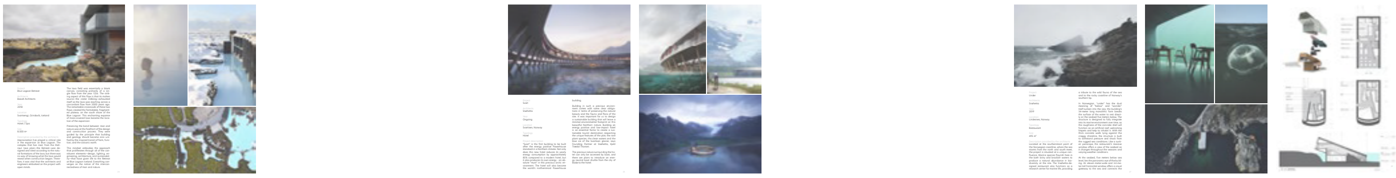
The Ateliers Jean Nouvel. (2017). Louvre Abu Dhabi. Geraadpleegd op 12 mei 2020, van http://www.jeannouvel.com/en/projects/louvre-abou-dhabi-3/

## Cultural



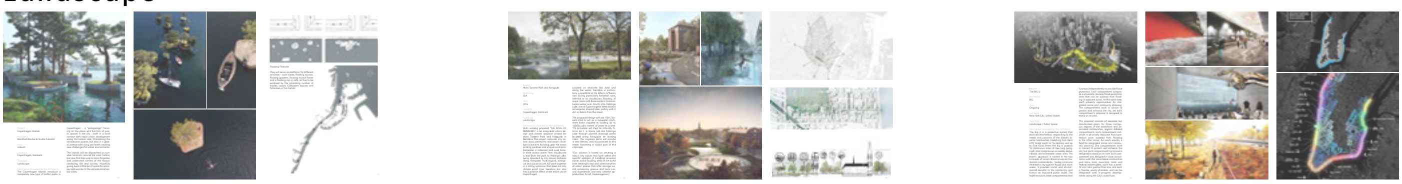
## Experimental

## Hospitality

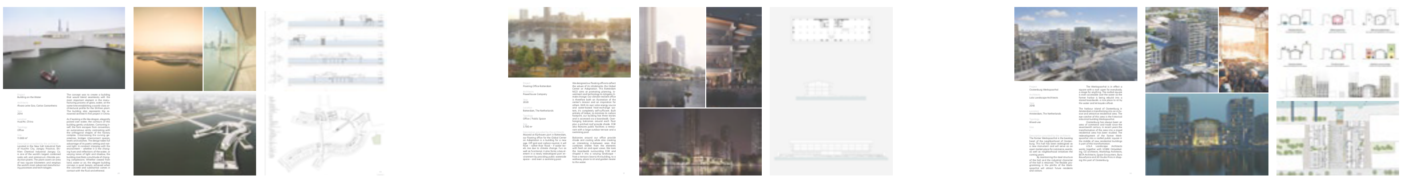


## Infrastructure

## Landscape



## Commercial



## Public

## Residential

**5.1 Architectural reference projects**, curated collection of 24 contemporary (mostly) built architecture projects, on various scales and typologies, with a strong emphasis on enhancing life through the use of natural water features, own edit (Sources: p. 18)

# 5. References | research plan


Alkemade, F., Broeck, L. van, Declerck, J. (2018). The Missing Link: curator statement. In G. Brugmans (Ed.) Our future in the delta, the delta of the future, 26-41, Rotterdam, The Netherlands: International Architecture Biennale Rotterdam.

ANP Archief. (2008). Co Zeylemaker. Geraadpleegd van https://www.anp-archief.nl/page/1188/co-zeylemaker

Bloemen, P., Reeder, T., Zevenbergen, C., Rijke, J., & Kingsborough, A. (2017). Lessons learned from applying adaptation pathways in flood risk management and challenges for the further development of this approach. Springer Complete Journals. https://doi.org/10.1007/s11027-017-9773-9

Bregman, R. (2020). Het water komt. Geraadpleegd van https://decorrespondent.nl/hetwaterkomt

Brugmans, G. (2018). Our future in the delta, the delta of the future, 26 - 41, Rotterdam, The Netherlands: International Architecture Biennale Rotterdam.

Bruinsma, F., & Koomen, E., VU Amsterdam. (2018, september). Ruimtelijke ordening in Nederland. https://research.vu.nl/files/68771923/Ruimtelijke_ordening_in_Nederland_25sept2018.pdf

Cross, N. (2006). Designerly Ways of Knowing. Springer Publishing. https://link-springer-com.tudelft.idm.oclc.org/book/10.1007%2F1-84628-301-9#about

Gemeente Rotterdam. (2014). Delta Rotterdam; Connecting Water with Opportunities. Geraadpleegd van https://ww-w.010duurzamestad.nl/pers/publicaties/RCI_Delta_Magazine_NL_website.pdf

Groenemeijer, L., & van der Lelij, M., Ministerie Binnenlandse Zaken en Koninkrijksrelaties (2020). Inventarisatie Plan-capaciteit April 2020. https://www.rijksoverheid.nl/documenten/rapporten/2020/06/05/inventarisatie-plancapacite-it-april-2020

Groat, L. N., & Wang, D. (2013). Architectural Research Methods (2de editie). Wiley.

Haasnoot, M. (2018). Mogelijke gevolgen van versnelde zeespiegelstijging voor het Deltaprogramma. Geraadpleegd van https://www.deltares.nl/app/uploads/2018/08/Deltares_Mogelijke-gevolgen-van-versnelde-zeespiegelstijging-voor-het-Deltaprogramma.pdf

Hein, C. (2020a, 17 september). Lecture 2: Creating the Past to Design the Future [Presentatieslides]. brightspace.tudelft.nl. https://brightspace.tudelft.nl/d2l/le/content/278709/viewContent/1970600/View

Hein, C., & Baciu, D. (2020b, 22 oktober). Masterclass 3: "What-if.." workshop: Sustainability: Future designs of the past [Presentatieslides]. brightspace.tudelft.nl. https://brightspace.tudelft.nl/d2l/le/content/278709/viewContent/1997503/View

Hooimeijer, F. L., Bacchin, T., & LaFleur, F. (2016, september). Intelligent SUBsurface Quality: Intelligent use of subsur-face infrastructure for surface quality. https://repository.tudelft.nl/islandora/object/uuid:6eff83a8-d0c6-438e-aa42-0dbd03835ac9

Hulsman, B. (2021, 3 januari). In de post-coronastad leven we dicht op elkaar, maar met veel groen om ons heen. NRC. https://www.nrc.nl/nieuws/2021/01/04/in-de-post-coronastad-leven-we-dicht-op-elkaar-maar-met-veel-groen-om-ons-heen-a4026021

Kimmelman, M. (2017, 15 juni). The Dutch Have Solutions to Rising Seas. The World Is Watching. Geraadpleegd op 17 april 2020, van https://www.nytimes.com/interactive/2017/06/15/world/europe/climate-change-rotterdam.html?-searchResultPosition=1

Kleinhans, M. (2018, 6 december). Hogere dijken beschermen ons niet tegen water. Geraadpleegd op 12 mei 2020, van https://www.uu.nl/nieuws/hogere-dijken-beschermen-ons-niet-tegen-water

Loorbach, D.A. (2010). Transition Management for Sustainable Development: A Prescriptive, Complexity-Based Gover-nance Framework. Governance, 23 (1) , 161 - 183.

Mejia, J., & Gorny, R. (2020). Masterclass 1: Analysis ad Synthesis [Presentatieslides]. brightspace.tudelft.nl. https://brightspace.tudelft.nl/d2l/le/content/278709/viewContent/1991679/View

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2020, 15 juni). Staat van de woningmarkt 2020. Nieuws-bericht | Rijksoverheid.nl. https://www.rijksoverheid.nl/actueel/nieuws/2020/06/15/staat-van-de-woningmarkt-2020

Olthuis, K. (2014, 23 oktober ). Top 10 trends towards floating cities: Koen Olthuis at TEDxVilnius. Geraadpleegd van https://www.youtube.com/watch?v=IqmmuIbchvU

Ovink, H. (2020, 19 maart). "We hebben nog te veel domme infrastructuur". Geraadpleegd van https://fd.nl/fu-tures/1337757/we-hebben-nog-te-veel-domme-infrastructuur

Ovink, H., Boeijenga, J. (2018). Too Big. Rebuild by Design: A Transformative Approach to Climate Change. Rotterdam, The Netherlands: nai010 publishers.

Pieterse, N., Knoop, J., Pols, L., & Tennekes, J. (2009). Overstromingsrisicozonering in Nederland; Hoe in de ruimtelijke ordening met overstromingsrisico's kan worden omgegaanOverstromingsrisicozonering in Nederland Hoe in de ruimtelijke ordening met overstromingsrisico's kan worden omgegaan. Planbureau voor de Leefomgeving. https://www.pbl.nl/sites/default/files/downloads/overstromingsrisicozonering_in_nederland_webpdf.pdf

Port of Rotterdam. (2020, maart 2). Nieuw kadedeel voor Noordereiland. Haven van Rotterdam. https://www.portofrotterdam.com/nl/havenkrant/havenkrant-38/nieuw-kadedeel-voor-noordereiland

Radman, A., Sohn, H., Kousoulas, S., & Havik, K. (2020, 8 oktober). How-To Tutorial 3: Theory [Presentatieslides]. brightspace.tudelft.nl. https://brightspace.tudelft.nl/d2l/le/content/278709/viewContent/1985760/View

Rijke, J., Herk, S. van, Zevenbergen, C., Ashley, R. (2012). Room for the River: delivering integrated river basin management in the Netherlands. International Journal of River Basin Management, 10 (4) , 369 - 382.

Rijkswaterstaat. (2019, 25 oktober). Room for the River. Geraadpleegd van https://www.rijkswaterstaat.nl/english/about-us/gems-of-rijkswaterstaat/room-for-the-river/index.aspx

Roggema, R. (2012). Swarming landscapes : the art of designing for climate adaptation (Vol. 48) [E-book]. Springer. https://link-springer-com.tudelft.idm.oclc.org/book/10.1007%2F978-94-007-4378-6

Roggema, R. (2016). Research by Design: Proposition for a Methodological Approach. Urban Science, 1(1), 2. https://www.researchgate.net/publication/308037775_Research_by_Design_Proposition_for_a_Methodological_Approach

Rotmans, J., Kemp, R., Asselt, M. van (2001). More evolution than revolution, Transition management in public policy. Foresight, 3 (1) , 15 - 31.

Schuttenhelm, R. (2019, 9 september). In face of rising sea levels the Netherlands 'must consider controlled withdrawal'. Geraadpleegd op 12 maart 2020, van https://www.vn.nl/rising-sea-levels-netherlands/

van den Dobbelsteen, A., Roggema, R., Stegenga, K., & Slabbers, S. (2006). Using the full potential: Regional planning based on local potentials and exergy. Management of Natural Resources, Sustainable Development and Ecological Hazards, 177–186. https://www.researchgate.net/publication/242288663_Using_the_Full_Potential_-_Regional_planning_based_on_local_potentials_and_exergy

van der Meulen, G. J. M. (2018). New Netherlands. Geraadpleegd van https://repository.tudelft.nl/islandora/object/uuid%3A9b260eae-9ad6-43cd-9fcb-c007240f8bbe

Veelen, P. C. van , Voorendt, M. Z., and Zwet, C. van der (2015). Research in Urbanism Series Vol. III 'Flowscapes', chapter Design challenges of multifunctional flood defences. A comparative approach to assess spatial and structural integration. IOS Press, under the imprint Delft University Press.

Vos, E., & Walsche, J. (2013). Research by Design - A Research and Teaching Concept. In Theory by Design (1ste editie, pp. 335–342). Amsterdam University Press. https://ebookcentral-proquest-com.tudelft.idm.oclc.org/lib/delft/reader.action?docID=3115819