Towards an open delta

Research and design for sustainable urban landscapes in an open Dutch Southwest Delta

July 5th, 2012

MSc Thesis by

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Colophon

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Keywords:
Delta regions
Urbanization
Paradigm shift
Working with nature
Thesis

Delta regions formed by the sedimentation and erosion of sea and river, contain the most vibrant and rich ecosystems in the world. A rich variety of flora and fauna and a fertile soil create a productive environment that sustains urbanization. The most densely populated areas as New York, Rotterdam, London and Jakarta are established in delta areas and have developed into economic and cultural capitals.

While delta regions provide the bloom of society it also possesses one of the most fragile urban environments. Events like the Dutch Watersnoodramp in 1953 and Hurricane Katrina in 2005 depict the vulnerability of the urban fabric to severe weather and changing natural processes. It is not only the presence of potential flooding, but also the subsidence of land, higher river discharge and rising sea levels that possess a threat. Flood defenses and water management are essential to sustain living and the process of urbanization in the delta.

The Dutch have a long tradition in the struggle against water. But there is a paradigm shift from fighting against water to working with nature. Many theories and philosophies that are within this new scope of working with nature, but there are no general methods or ideas on the implementation in urban or economic development. [Meyer et al., 2010]

This MSc Thesis aims to add to the discussion on future urban development in the delta and the new paradigm of working with nature by providing a more detailed impression of present plans for the Dutch Southwest Delta. The form to reach and present the detailed impression will be a research and design project. Within the framework of the graduation studio Delta Interventions, that focusses on urban and architectonic research and design in an urban delta, the project will touch the disciplines of urban design and landscape architecture. In which urban design will be the main field of this graduation project.

I want to thank you advance for reading this MSc Thesis.

N. den Besten

Figure 1. The Dutch Southwest Delta
Source(s): *Author, 2012*
Data used: *Google pictures, 2012; Google Maps, 2012*

Literature:

MEYER H., BOBBINK I. & NIJHUIS S. (Eds). (2010). *Delta urbanism: The Netherlands*. Chicago: American Planning Association.

Graduation framework

problem statement

Aftermath of the Delta Works

Keywords:
Urban Delta
Reclamation
Delta Werken
Complications
Problematics
Potentials

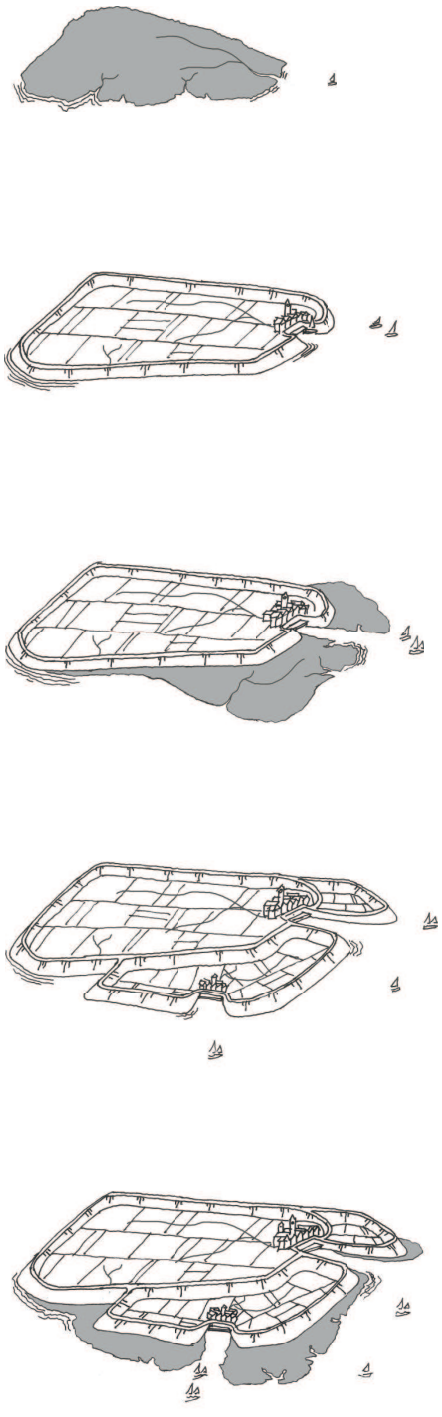

Figure 2. Urbanization of delta cities in the Dutch Southwest Delta
Source(s): *Author, 2012*

Urbanization in the Dutch Southwest Delta started with cities on sand dunes along the coast like Ouddorp and Goedereede. The fisherman's cities relied on the natural riches of the delta and the natural altitude of the dunes for protection against water. The tidal dynamics and river discharge created sand plates, called ‘slikken’, in the Dutch delta.

The invention of technology for land reclamation in the 10th century started a unique transformation in the delta (see figure 2.). Sand plates were dike-ed and pumped and became polders. Examples of early harbor cities created on the dike-ring are Ooltgensplaat and Oude Tonge. These cities were founded at the main creek of a sand plate. The polders created a condition for more sediment deposition, due to the hard edges of the dikes. Outside the dike-ring sediment cumulated and formed new sand plates. These sand plates formed the basis of a new adjacent polder and a new harbor settlement.

The latest polders date from 1930's, but technically the process came to an end in 1953 with a stop of sediment transportation in the delta. The Watersnoodramp in 1953 led to the engineering of a great and expensive water defense project that would protect the inhabitants of the Southwest Delta against probable storm surges. Shortening the Dutch coast line and closing the Dutch Southwest Delta.

However, the Delta Werken caused complications that were not predicted in time of planning and construction. Today, these problems even create the dilemma of re-opening the estuaries of the Dutch Southwest Delta. The discussions about this open delta have provided different perspectives. For example the ‘Toekomstvisie 2050’ by Stuurgroep Zuidwestelijke Delta (Committee Southwest Delta) and H+N+S Landscape Architects and ‘Hoogtij voor Laag Nederland’ by WNF. Both perspectives include a re-introduction of tidal dynamics to solve the quantitative and qualitative water problems and a revitalization of recreation, living, nature and water defense. [Programmabureau Zuidwestelijk Delta, 2009; WWF, 2010] This will also be addressed in the next chapter.

The assignment lies in solving current problematics, discovering potentials and providing solutions for complications summarized in:

Water storage
The Programmabureau Zuidwestelijke Delta provides a future perspective of sea level rise and higher river discharges of the river in 2020, 2050 and 2075. The water discharge is mainly via the Nieuwe Waterweg and Haringvliet. The committee proposes to use the water basins of the delta to store water when river discharges are high and the sea level is too high for outlet. This strategy is part of the Ruimte voor de Rivieren (Room for the River). The water storage uses a progressive scheme where the Krammer Volkerak, Grevelingen and Oosterschelde succeed each other in order of water storage (see figure 5.).

[Programmabureau Zuidwestelijk Delta, 2009]

Economic segregation
The delta cities at the coast are in general wealthier. The 'WOZ-waarde' (value of real estate) is in the municipality of Goedereede higher than in Oostflakkee (see figure 3.). Vacant houses and poor public space make this statement visible on street level (see figure 4.).

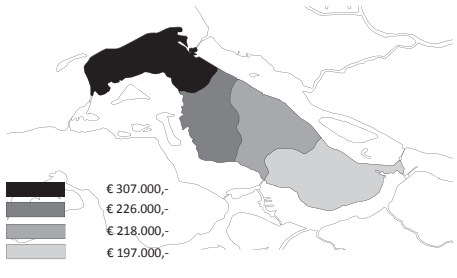

Figure 3. WOZ-values Goedereede, Dirksland, Middelharnis and Oostflakkee.
Source(s): *Author, 2012*
Data used: *Wikipedia, 2012*

Figure 4. Vacant housing in Oude Tonge
Source(s): *Author, 2012*

Environmental problems
The world-known water defenses also triggered a change in the ecological and hydraulic structure of the Dutch Southwest Delta. The water quality in the basins has changed by the level of chlorides and nutrients in the water, due to a low water flow from the sea and a high river discharge. In the Grevelingenmeer and the Oosterschelde there is a lack of nutrients and a high level of salt that causes flora and fauna to decrease. This also affects the shell-fish industry. In the Krammer Volkerak there is an abundance of nutrients and a lack of salt water that causes the growth of blue algae that prevents (water) recreation and the obtaining of irrigation water for agriculture in the surrounding islands. [Programmabureau Zuidwestelijk Delta, 2009;

WWF, 2010] With the quantitative reduction of sea water in the delta, causing less sediment deposition, and a continued process of erosion, the sand plates in the Dutch Southwest Delta are diminishing. [WWF, 2010] The quantitative and qualitative water problems have led to discussions to re-open the Dutch Southwest Delta.

Lost historic identity
Current delta cities have lost their direct relation with water due to the reclamation of land. The historic identity of a harbor city has been changed in an agricultural harbor city (this topic will be discussed in the research chapter). The inter tidal areas in the delta have disappeared and the dike functions as a hard border between two worlds: the polder and the open water [Programmabureau Zuidwestelijk Delta, 2009].

Unsafe and unattractive shipping routes
The shipping route in the hinterland of the Dutch Southwest Delta is of great importance for the economy of the Netherlands. It is one of the most navigated waters in Western Europe. Both transport and recreation ships make use of the water bodies that connect Rotterdam with Antwerp and international waters (see figure 4.). The shipping route in the Krammer Volkerak is one of the busiest recreation routes, but with the combination of numerous transport ships it is also one of the dangerous ones. Due to the dikes as hard border between the two worlds of the polder and open water, the route is also unattractive.

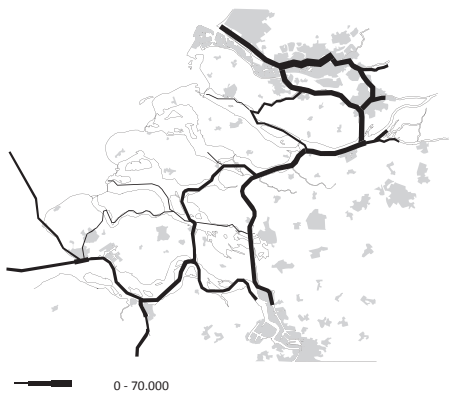

Figure 4. Shipping passages in the Dutch Southwest Delta
Source(s): *Author, 2012*
Data used: *Atlas van de Zuidwestelijke Delta, 2009*

Ecologic potential
The closed estuaries limit fish migration and the presence of a rare brackish ecology (flora and fauna diversity). A brackish ecology will also provide, next to a rich nature for diversity and recreation, new possibilities for the fishing and shell fish industry. [WNF, 2010]

Recreation potential
The hinterland of the Dutch Southwest Delta could have a higher potential for recreation. Although the current focus of recreation lies at the coast, the whole delta could become a (nature) recreation archipelago of Antwerp and Rotterdam. [Programmabureau Zuidwestelijk Delta, 2009; WWF, 2010]

Demand landscape living
There is a high demand for 'living in the landscape'. Research by Heins indicates that of all people living in cities more than 80% wants to live in a 'rural' or 'landscape' environment. With a majority that prefers a city in the vicinity of this landscape living. [Heins, 2002 in: van Dam, 2005] With Rotterdam and Antwerp as major cities, the delta is ideal for landscape living.

Fresh water management
The presence of salt water by seepage, water contaminated by blue algae and intense rainfall demands a solid fresh water management for inhabitants and agriculture on the delta islands. Especially when the delta is re-opened and salt/brackish water will affect fresh water inlets.

Re-development of water defenses
The Delta Werken protect the Dutch Southwest Delta against severe water hazard. With the re-establishing of the open delta the Delta Werken could be modified to provide tidal dynamics to occur in the water bassins, but remaining the main defense line. Or be removed and the water defense is sustained within the delta. The water defenses should be enhanced for the new situation and future climate change.

The re-establishing of natural processes in the Dutch Southwest Delta requires a re-thinking of future urbanization, identity, socio-economics, landscape, recreation, (water) safety, water management and ecology. These layers can be summarized in three inter-related layers: the urban, cultural and natural layer. The problem statement of this research and design project is described as:

"How to deal with past and future urban landscape in relation to; urban, cultural and natural layers, in a re-opened Dutch Southwest Delta?"

To research and design on this problem statement the Krammer Volkerak area is chosen as a R&D location. The Programmabureau Zuidwestelijk Delta state that the different objectives in the Dutch Southwest Delta come together in the Krammer Volkerak [Programmabureau Zuidwestelijk Delta, 2009]. This is also indicated in figure 5. The Krammer Volkerak could function as a test case or experiment for other similar locations in the Southwest Delta (see figure 6).

Literature:

HEINS, S. (2002). Rurale woonmilieus in stad en land. Plattelandsbeelden, vraag naar en aanbod van rurale woonmilieus. In: VAN DAM, F., BIJLSMA, L., VAN LEEUWEN, M. & PALSDOTTIR, H. L. (2005). *De Landstad. Landelijk wonen in de netwerkstad*. Rotterdam: NAi Publishers

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WERELD NATUUR FONDS (WWF) (2008), H*oogtij voor Laag Nederland. Werken met de natuur voor een veilige en mooie delta*. Retrieved 9 february 2012, from: http://assets.wnf.nl/downloads/wnf_haringvliet_rapport.pdf

Present problems

Water storage
- Ruimte voor de Rivieren (Room for the River) (RvR)
- Storage excessive rainwater in agricultural polder

Environmental problems
- Nutrition flows
- Oxygen levels
- Declining sand plates

Economic segregation
- Low(er) real estate value (WOZ)
- Poor(er) spatial quality

Lost historic identity
- Harbor city became a polder city
- Lost inter tidal area, between open water and the polder.

Unsafe and unattractive shipping route
- Main recreative and transport shipping routes
- Dike as poor scenery

Future potential and complications

Ecologic potential
- Brackish ecology
- Fish migration
- Addition Natura 2000

Recreation potential
- Delta as a recreation archipel for Rotterdam and Antwerp
- Eco tourism

Demand landscape living
- Rural development in landscape
- Archipel of Rotterdam & Antwerp

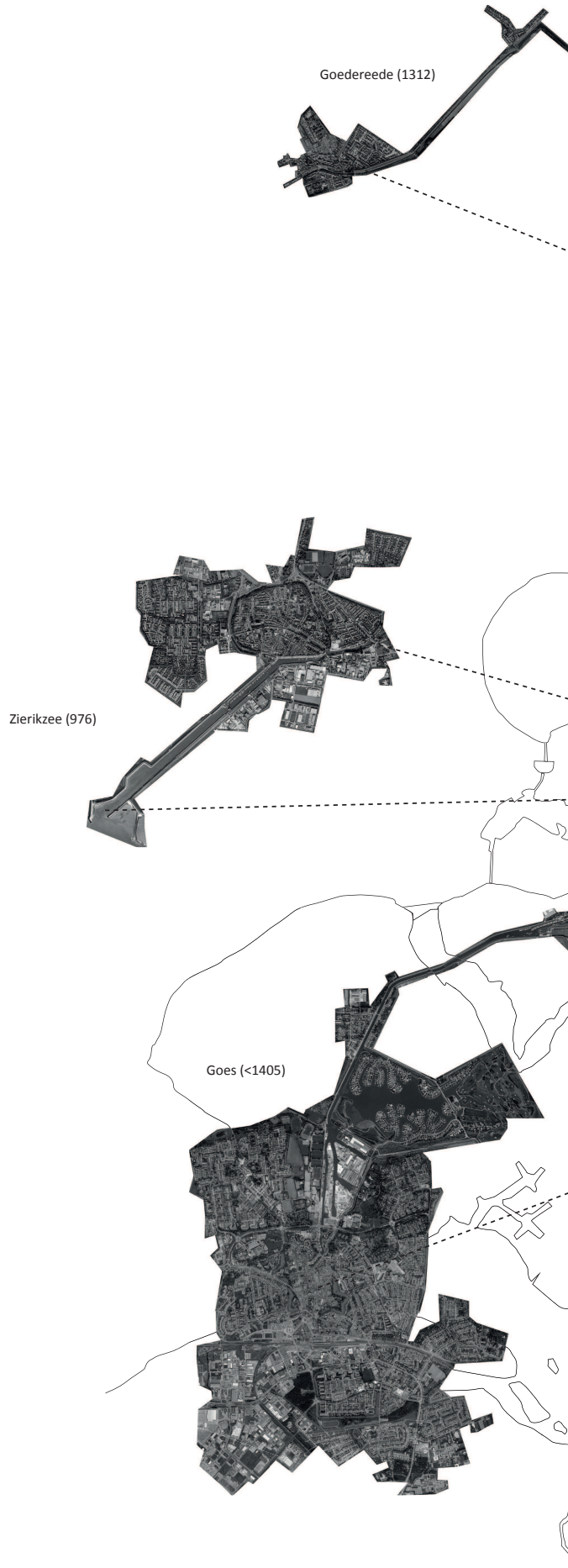
Fresh water management
- Water storage to counter salinization
- Water storager for fresh water supply

Re-development water defenses
- Enhanced defense lines
- Delta Werken

Main transport shipping routes
Fish migration
Recreation potential
Water storage in the Delta (steps) (RvR)
Delta cities with lost identity
Low oxygen level
Fresh water shortage / salinization problems
Natura 2000
Nutrition flow
Ecology transformation zones (with an open Delta)

Figure 5. Current potentials and problems in the Dutch Southwest Delta
Source(s): *Author, 2012*
Data used: *Programmabureau Zuidwestelijke Delta, 2009; WNF, 2010*


>O2
>O2
>O2
RvR
RvR
RvR


Goedereede (1312)
Zierikzee (976)
Goes (<1405)

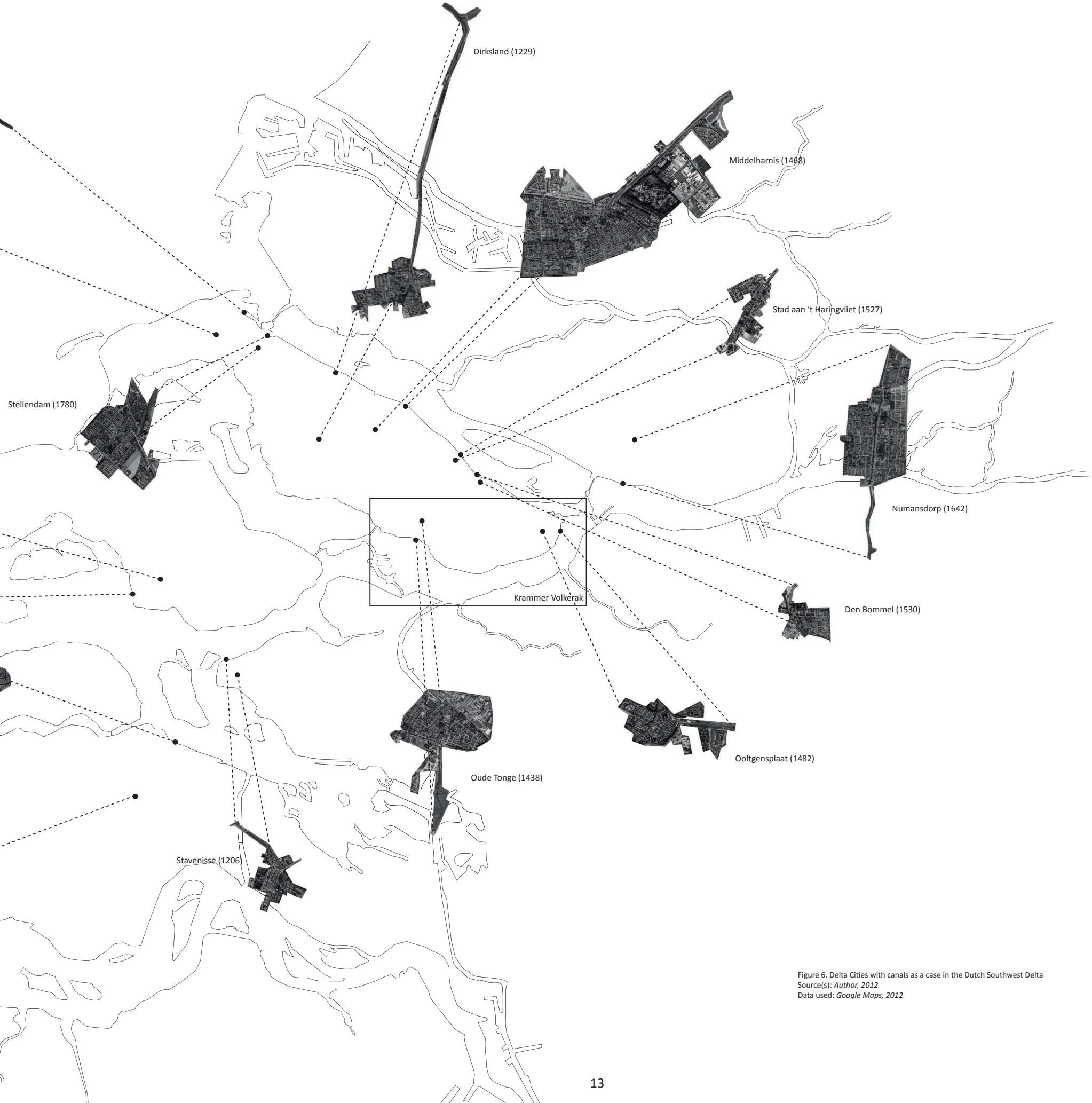


Figure 6. Delta Cities with canals as a case in the Dutch Southwest Delta
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Defining an open delta

Keywords:
Definition
Open delta
Dutch Southwest Delta
Visions
Process

The graduation project 'Towards an open delta' concerns itself with an open delta. However the open delta is vague term often related to ecology oriented plans and visions in urbanism and landscape architecture. In this short position paper I want to research different plans that refer to an open delta and take a position by defining the open delta for this graduation project. Tjallingi states that there are four different ways how people look at nature or the environment and that these are determined by their world views or basic attitudes towards nature. The four attitudes towards nature are: man as the master of nature, man as the steward of nature, man and nature as partners, and man as a participant in nature. [Tjallingii, 1996]
Working with nature can be interpreted as predominant or a more submissive relation between man and nature and everything in between. The paper will research two plans that describe the open delta: 'Toekomstbeeld Zuidwestelijke Delta 2050' by advisory committee Zuidewestelijke Delta and H+N+S Landscape architects and 'Hoogtij voor Laag Nederland by WNF.
The paragraphs will provide a brief description of the plans and a brief description per topic, relevant to urbanism and landscape architecture. A conclusion will state my position as a urban designer on the open delta, using the two plans for an open delta.

Future Southwest Delta 2050 - Zuidewestelijke Delta and H+N+S Landscape architects
The advisory committee Zuidewestelijke Delta and H+N+S Landscape architects want to restore the ecologic condition of the delta by using the Delta Werken (Delta Works) as a starting point for their vision of 2050. This vision consists of three ambitions: climate proof and safe, resilient ecology and restoring estuary dynamics, enhancing quality of living and settling environment. And will be applied in four layers: water structure, 'front-delta' (Voor delta), contact zones land and water and cities and villages.

The Delta Werken will remain as a primary water defense system, but will be adjusted to re-establish the tidal dynamics in the delta in a controlled way. The Delta Werken will be re-completed. The semi-open water defenses allow the restoration of the sedimentation, sediment erosion, water quality and a brackish ecology. In addition, the visionaries want to restore the landscape and cultural identity of the delta. Each water body will have its own identity and will be related to one and other (see figure 7). The delta cities will regain their lost relation with water by introducing contact zones between water and the city. The contact zones will contain attractive 'landelijk wonen' (living in the landscape) in the vicinity of Rotterdam. Agriculture will remain strategically important in the delta and must be conserved as large scale and monotone functional agriculture.

The possibility to control the water safety, provide ecological restoration and restore the identity of the delta summarizes the intentions of the future vision. And provide condition for living, working and recreating in the Dutch Southwest Delta (see figure 8). [Programmabureau Zuidwestelijk Delta, 2009]

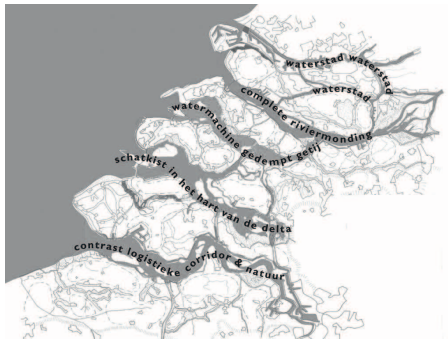


Figure 7. Identities of the delta
Source: *Programmabureau Zuidwestelijk Delta, 2009*

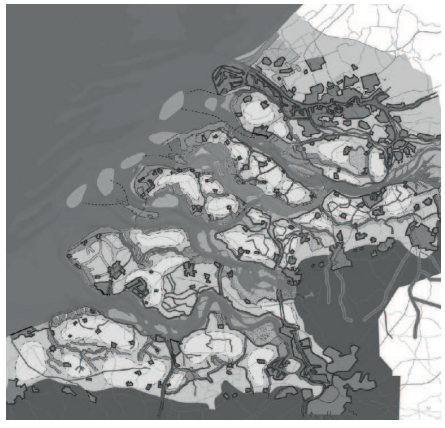


Figure 8. Plan by H+N+S Landscape architects
Source: *Programmabureau Zuidwestelijk Delta, 2009*

Ambition:
I Climate proof and safe
II Resilient ecology and restoring estuary dynamics
III Enhancing quality of living and settling environment

Duration
+ 2020 / 2050 / 2075 (study statement)

Water
+ Regulated estuary dynamics
+ 1,0 - 1,5 m fluctuation Krammer Volkerak

Water defense
+ Modified Delta Werken
+ High water storage Krammer Volkerak (RvR)
+ Upgrading dike system
+ Other water defenses in contact zone

Urbanization
+ New forms of 'landschappelijk wonen' (living in the landscape) in the contact zones (watermachine), related to R'dam
+ Connecting cities in Brabant to the delta by water
+ Relating delta cities to the water again by contact zones

Landscape
+ (Partially) restoring creek system
+ Maintaining clay/polder landscape

Agriculture
+ Exceptional agriculture
+ Aquaculture
+ Maintaining current mono-functional agriculture

Ecology
+ Nutrient Flow (regulated)
+ Sand motor
+ (Pure) Natural Landscape

Hoogtij voor Laag Nederland - WNF
With the document 'Hoogtij voor Laag Nederland' the World Nature Fund pleads for an ecologic rich delta. The ambition of the WNF/WWF is to work with nature for a flexible, safe and beautiful delta. With t he Southwest Delta is an Archipel, with an high potential for tourism and recreation (see figure 9).

The water safety in the delta is powered by dunes, dikes, inundation areas and natural processes. Sedimentation will provide a broad coastline that decreases the force of waves. The Delta Werken will be removed and replaced by new generation water defense structures. The natural and dynamic landscape that will emerge should be protected. The natural landscapes will attract people from Antwerp and Rotterdam. The open connections provide an increased connectivity of to the islands, but also to Antwerp and Rotterdam. Residential and recreation locations are built on 'terpen' (wierden) and are connected to the historical polder landscape. The landscape has adapted to the brackish conditions due to a transition period. The need for sweet water is reduced, because most of the agriculture functions have moved due to the salinization in the delta.

The open Dutch Southwest Delta will restore the brackish ecology which provides a natural, water safe, assisted by a new generation Delta Werken, and attractive landscape summarizes the vision of WNF. [WWF, 2008]

Ambition:
I Flexible delta
II Safe delta
III Beautiful delta

Duration
+ Now! (politcal statement)

Water
+ Open estuaries (open arms)
+ Unknown fluctuations

Water defense
+ No dams, but modern construction, only needed at the uttermost
+ Sand plates to break waves
+ Nature zones to provide water storage

Urbanization
+ Living locations are elevated and/or surrounded by dikes
+ Terps for living and recreation (outside the dikes) (the building tradition before the medieval diking), also on poles, flooting and resilient/water proof buildings
+ Shuttles to connect the the archipel to large cities
+ People are 'welcome' if they do not disturb nature/natural processes

Landscape
+ None.

Agriculture
+ Agriculture has moved, due to salt water, low demand of fresh water
+ Agricultural land will be flooded (regulated) to heighten the soil with sediment to prevent internal salinization.

Ecology + Nutrient Flow
+ New fauna (and flora) / Biodiversity
+ Sand motor
+ (Pure) Natural Landscape

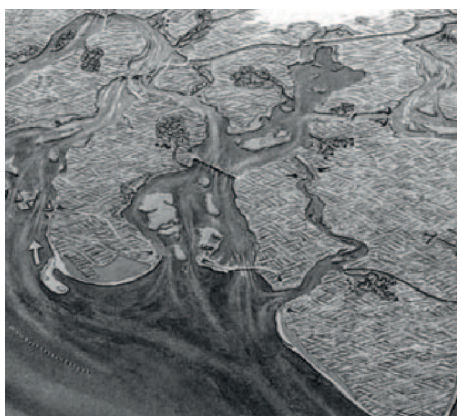


Figure 10. Hoogtij voor Laag Nederland
Source: *WWF, 2008*

The vision of the Zuid Westelijke Delta and H+N+S Landscape architects is in the different attitudes towards nature, as described by Tjallingii, an attitude of man as the steward of nature. A plan that has an attitude of nurturing the landscape, to maintain and sustain it, including agriculture. The vision of WNF is different, it refers more to an attitude of man as a partner in the perspective of nature. An open delta is beneficial for ecology and profitable for man. It is familiar to the idea of the rich delta, but without current agriculture.

In my opinion the paradigm working with the delta refers more to the vision of WNF. “Working with” implies an interactive relation between man and nature, beneficial and profitable for each actor. This does not exclude that the plan of the Zuid Westelijke Delta and H+N+S Landscape architects. A gradual transition from the position as ‘steward’ to ‘partner’ is plausible and most realistic.

My position on an open delta is that the estuaries should be completely open. The Delta Werken will be adjusted that they can be fully opened or will be replaced by a new generation water defenses, this to sustain the full potential of tidal dynamics and natural processes. This will cause the delta to have far higher fluctuations in water level than in the current condition. This provides an extreme condition, that provides excelent parameters for design.

The contact/nature zones and recreative and residential location in these zones (on terps) belong to the urban and landscape design of an open delta. Both visions contain similar visions and can enhancing and/or contributing to each other for an integral and sustainable urban landscape.

For the research and design project this means that the vision of WNF is the driving vision for the project, as an extreme and idealistic situation. But as mentioned earlier, I will therefor not exclude the vision of the Zuidwestelijke Delta. The graduation project has to include both visions and its layers, in a proces.....towards an open Dutch Southwest Delta.

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PROGRAMMA BUREAU ZUIDWESTELIJKE DELTA (2009), *Toekomstbeeld Zuidwestelijke Delta 2050*. Retrieved 10 september 2011, from: http://www.zwdelta.nl/dynamisch/bibliotheek/70_0_NL_Toekomstbeeld_def1.pdf.

TJALLINGI, S.P. (1996). *Ecological conditions: strategies and structures in environmental planning*. PhD thesis, Delft University of Technology.

WERELD NATUUR FONDS (WWF) (2008), H*oogtij voor Laag Nederland. Werken met de natuur voor een veilige en mooie delta*. Retrieved 9 february 2012, from: http://assets.wnf.nl/downloads/wnf_haringvliet_rapport.pdf

aim

Towards an open delta

Keywords:
Urban landscape
Process
Urban layer
Cultural layer
Natural layer
Dutch Southwest Delta
Open delta

The problem statement addresses that the vision of re-establishing an open Dutch Southwest Delta, generates the question how to deal with past and future urban landscape in relation to; urban, cultural and natural layers and the meaning of an open delta. Research on the open delta provided a personal position in this graduation project: the open delta should be approached as a process, including both visions of WNF and Zuidwestelijke Delta and all its layers. In order to answer the question and provide a theoretical framework for this graduation project, the main aim of this research and design project is:

"To design an urban landscape in the Krammer Volkerak area, that in a durable process provides a sustainable combination of urban, cultural and natural layers, in a re-opened Dutch Southwest Delta."

A sustainable process
This research and design project aims to be both process-oriented and sustainable. The project has to contain a plan that covers different phases that indicate the transformation of the current situation till the vision of the Zuidwestelijke Delta and till the vision of WNF. This is sustainable in the sense of providing a realistic proposal how to deal with an open delta and what value it contains if the visions cannot be realized. The aim mentions of three different layers, the urban, cultural and natural layer. To provide a sustainable plan, these layers have each their own unique characteristics that can enhance, complement and relate to other layers. Sustainability will work in this project through different scales, layers and phases, with each having its own value.

Urban layer
The urban layer provides research and design on the form of current delta cities and future urbanization in relation to water, the natural processes and the surrounding cultural and natural landscape. This research has the objective to provide background to re-design the current relationship between delta cities and the water landscape in an open Dutch Southwest Delta. Current delta cities have, due to urban development through the centuries, lost their relation with water and have transformed from a harbor city to a polder city. To restore the identity of a harbor city this graduation project aims to directly relate the city to the water. The urban layer also contains the design of a safer shipping route, a proposal to counter economic segregation and water hazard.

Cultural layer
Land reclamation created a unique polder landscape in the Dutch Southwest Delta. The cultural layer provides research and design on the polder landscape and the natural landscape, including their relation with recreation and the urban fabric. The polder landscape and open water are divided by a hard border: the dike. The inter-tidal area has disappeared and hereby the delta lost a part of its identity. This research aims to discover a new or revised relation between the polder landscape and the natural landscape. And what value it constitutes for living and recreation.

Natural layer
The discussion of re-establishing an open delta is mainly caused by environmental complications of the Delta Werken and the potential of a rare brackish ecology. Nature will play a large role in the design of the Krammer Volkerak. This research and design project aims to depict the transition of cultural or urban layers to natural layers, providing an interesting development that also symbolizes the changing paradigm of man as 'steward' of nature to a 'partner' of nature.

The impact of an open delta

Keywords:
Social relevance
Academic relevance
Urban theory
Research
Discussion

The relevance of this graduation project can be described in two perspectives; a social and an academic relevance of the research and design. The academic relevance is related to the project's addition to the body of knowledge in the form of a review paper on current urban theories, historical research and research by design. The social relevance of the graduation project relates to the current regional plans made by urban and landscape offices and the current political and social discussion it evokes.

Academic

The review paper, as described in the interlude, is included in the research chapter and deals with the theory of working with nature. This theory is often spoken off, but has no clear definition and no implementation methods. A part of this review is the theory of the resilient city that has no clear urban model [Hooimeijer, 2011]. This research by design project could add to this new urban theory by providing a design related to nature and water hazard. 'Towards the open delta' will provide a way of working with nature, not only in the resilient city theory, but also in the theory of design with nature and the economic value of nature.

This project will also research the urbanization of delta cities in the Dutch Southwest Delta and develop a possible theoretical and implementation framework for future urbanization in an open Dutch Southwest Delta. This research may add to the research of Han Mayer and others in the publication: 'Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland: 1850-2000' [Meyer et al., 2007].

Social

The social relevance of this research and design project is twofold. The vision of an open Dutch Southwest Delta provides a question on how the urban landscape will look like and what it could offer. But also the discussion on the complications and problems the open delta will cause. The first is could be idealistic, but the second is this present day discussed in the public and political domains. Although the project has an idealistic foundation, the implementation relates to the public and political stakeholders.

The visions of H+N+S Landscape Architects (in corporation with ZW Delta) and the WWF are regional plans, containing concepts and ideas on water management, safety, urbanization and ecology. But remain on a large scale. The plans do not cover the problems that can be found at smaller scales and how these new forms, identities and solution are implemented. The relevance of this graduation project is that it provides a small scale design that could speak to the imagination of politicians, civilians, and other stakeholders.

An open Dutch Southwest Delta and an open Krammer Volkerak is relevant to stakeholders in the sense of fresh water management, water safety, ecology (Natura 2000) and the identity of the urban landscape.

The delta is re-opened to solve problems that are created with a closed delta, but the years in a closed delta have provided a new way of living that is adjusted to the presence of fresh water, water safety. Summarized, the delta will solve problems, but will generate complications. This design and research will provide insights and solutions for the problems and complications as described in the problem statement that are relevant for the stakeholders in the Dutch Southwest Delta.

Literature:

HOOIMEIJER, F. (2011). *The tradition of making poldercities*. PhD Thesis, Delf University of Technology.

MEYER H., VENEMA H., VAN DEN BURG L., KROMER N. & SMITS W. (2007). *Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland: 1850-2000.* Delft: TU Delft.

Research by design methods

Keywords:
Research questions
Research methods
Design methods
Research by design

The aim: "To design an urban landscape in the Krammer Volkerak area, that in an integral process provides a sustainable combination of urban, cultural and natural layers, in a re-opened Dutch Southwest Delta." provides the main research question of this research and graduation project:

"How...to design an urban landscape in the Krammer Volkerak area, that in an integral process provides a sustainable combination of urban, cultural and natural layers, in a re-opened Dutch Southwest Delta?"

The main research question is divided in different sub research questions that will deal with the integral process and the sustainable combination of the urban, cultural and natural layer. Each research question will be accompanied by a research domain, research methods and the implementation of the methods:

Review - Paper
Review - Policy
Literature Study
Mapping
Research by Design - Sketching
Research by Design - Modelling
Expert Interview

Theory
The sub research questions on theory are:

What are current paradigms on designing in an urban delta?

Domain(s): Urban Theory
Method(s): Review - Paper
Implementation: a literature review on the paradigms 'The Resilient City', 'Design with Nature' and 'The Rich Delta', resulting in a review paper. Preliminary literature list: HOOIMEIJER F. (2011). The Tradition of making polder cities. PhD Thesis. Delft University of Technology, McHARG I. (1969). Design with Nature. New York: The Natural History Press and COSTANZE, R., (et al.) [1997]. The value of the world's ecosystem services and natural capital. Nature, 387, p. 253-260.

What is an open Dutch Southwest Delta according to Advisory Committee 'Zuidwestelijke Delta' and 'WNF'?

Domain: Urban Theory
Method(s): Review - Policy
Implementation: a literature review on current policy and vision documents of Advisory Committee 'Zuidwestelijke Delta' and 'WNF' to obtain insight in the meaning of an open delta for the Dutch Southwest Delta and the Krammer Volkerak and what research and design frameworks it provide for my graduation project. This research will also place the project into context and provide the necessary relevance of research.

Urban Layer
The sub research questions on the urban layer are:

What is the relation between delta cities, water and natural processes through the course of history?

Domain(s): Urban Design & Landscape Design
Method(s): Mapping & Literature Study
Implementation: historic mapping of the delta cities Oude Tonge and Ooltgensplaat. And literature study on delta cities. Preliminary literature list: MEYER H., VENEMA H., VAN DEN BURG L., KROMER N. & SMITS W. (2007). Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland:

How to extent the urban form of Oude Tonge and Ooltgensplaat in an open Dutch Southwest Delta, and in relation with the new inter tidal are?

Domain(s): Urban Design
Method(s): Research by Design - Sketching
Implementation: this research by design will provide the way the delta cities could be extended or grown when the natural processes in the open delta are re-established and the cities obtain their relationship with water again. The sketching will be done on transparent paper, with an A3 or A1 underlayer projecting maps of the current situation in the scales of Oostflakkee and the delta cities of Oude Tonge and Ooltgensplaat. The sketched design will be continually re-designed till the outcome is satisfactory in quality.

What is the urban and landscape composition of 'wierden' in The Netherlands and Germany?

Domain: Urban Design & Landscape Design
Method(s): Case Study
Implementation: part of the visions for an open delta, as researched in the second theory question, the 'wierden' will be a part of landscape living in the intertidal area. This case study research will provide design inspiration by discovering the characteristics of the 'wierden' in Hogebeintum (NL), Marken (NL), Niehove (NL), Hallig (DU) and Westerhever (DU).

Cultural Layer
The sub research questions on the cultural layer are:

What are the form and characteristics of the (cultural) landscape in Oosflakkee?

Domain: Landscape Design
Method(s): Mapping
Implementation: this mapping will provide insight in the structure and characteristics ofthe current polder landscape that will form a basis and/or spatial framwork for design. The maps will describe the polder structure, dike structure, historic mills and photographs.

How to design the (new) relation between the polder landscape and the intertidal area?

Domain: Landscape Design
Method(s): Research by Design - Sketching
Implementation: the current relation between polder landscape and water is the hard boundary of the dike. With the introduction of the intertidal area it is necessary to research this new relation. The sketching will be done on transparent paper, with an A3 or A1 underlayer projecting maps of the current situation in the scales of Oostflakkee.

Natural Layer
The sub research questions on the natural layer are:

What are the characteristics of a sweet and a brackish/salt landscape in a transforming delta?

Domain: Landscape Design
Method(s): Mapping
Implementation: to design the transformation from a closed delta to an open delta it is necessary to define the different ecologies. The mapping is done by collecting different photographs of soils, vegetation and animals, vizualized in the design.

How to design with the natural processes of sedimentation and erosion in an open delta?

Domain: Landscape Design
Method(s): Expert Interview, Mapping & Literature study
Implementation: interview with an expert in hydraulics, dr.ir. Bram van Prooijen of Civil Engineering on the topic of sedimentation. To obtain basic principles about sedimentation, so it can be applied in design. Historic mapping of sedimentation (coast lines) in the Krammer Volkerak and literature study to understand the process of sedimentation and what it does to nature. Preliminary literature list: PARRIAUX A. (2009). Geology: Basics for Engineers. London: CRC Press.

What is the form of the intertidal area that connects the delta cities Oude Tonge and Ooltgensplaat to open water?

Domain: Urban Design & Landscape Design
Method(s): Research by Design - Modeling & Sketching
Implementation: the intertidal area will be shaped by the natural processes. As urban designer we can manipulate these processes and form a landscape. To research an ideal form of this landscape a model will be used with sand so multiple variants can be generated. The sketching will be done on transparent paper, with an A3 or A1 underlayer projecting maps of the current situation in the scales of Oostflakkee.

The outcomes of these sub research question will answer the main research question and will be answered within an integral and sustainable process that will cover the transformation of the current delta to an open delta. Next to the research questions an inventarization of the design and research location will be done to provide general information.

The main question is researched by means of research by design as depicted in figure 11. When designing the drawings and ideas will be evaluated, reflecting on the theoretical framework. The found problems or new opportunities will be lead to additional analysis and research will provide input for multiple solutions for the design. In this phase I want to document all the different solutions to enhance the argumentation of the design. Not all solutions will add to the design, but could add to the body of knowledge. The conclusion on the theoretical framework, design and toolbox will lead to recommendation for implementation and further research.

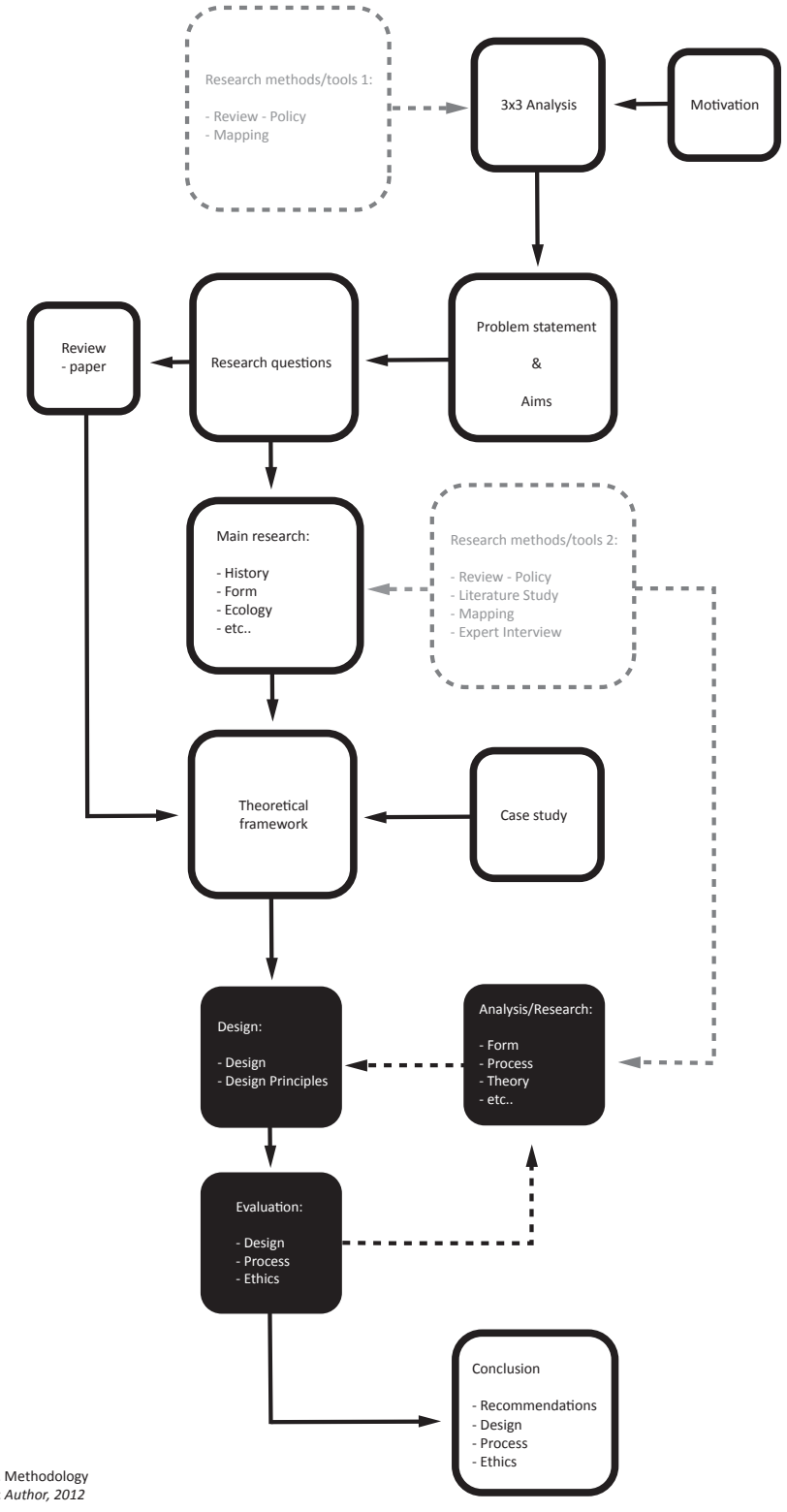

Figure 11. Methodology
Source(s): *Author, 2012*

time schedule

Graduation planning

Keywords:
Time schedule
Deliverables
Research
Design
Presentations

The theoretical framework and the research by design will be delivered and/or presentated in certain products. These products can be divided in two groups: research products and design products (see figure 12.). Tthe research products, like papers and the thesis are determined by the faculty. However, the design products are related to the nature of the chosen research and design project. This graduation project will deliver five design scales: a concept, an urban landscape plan, an urban design, a public space design and a delta design.

Concept
The concept will contain a description in text and image of the general design idea and vision related to the field of urbanism and landscape architecture.

Urban landscape plan
The urban landscape plan excist of maps on the scale of Oostflakkee and covers the Krammer Volkerak. Solutions and ideas on urbanization, water defenses, water management, ecology, recreation and shipping will be presented in a series that vizualizes an integral and sustainable process towards an open delta.

Urban design
The urban design will zoom in on the urban landscape plan and will depict a design on the scale of the delta cities Oude Tonge and/or Ooltgensplaat.

Public space design
The public space design will zoom in on the most important or characteristic spaces in the urban design.

Delta design
The delta design will take the previous design solutions and apply these at the other case locations in the Dutch Southwest Delta. This provides a clear overview of delta and is part of the conclusion of the thesis.

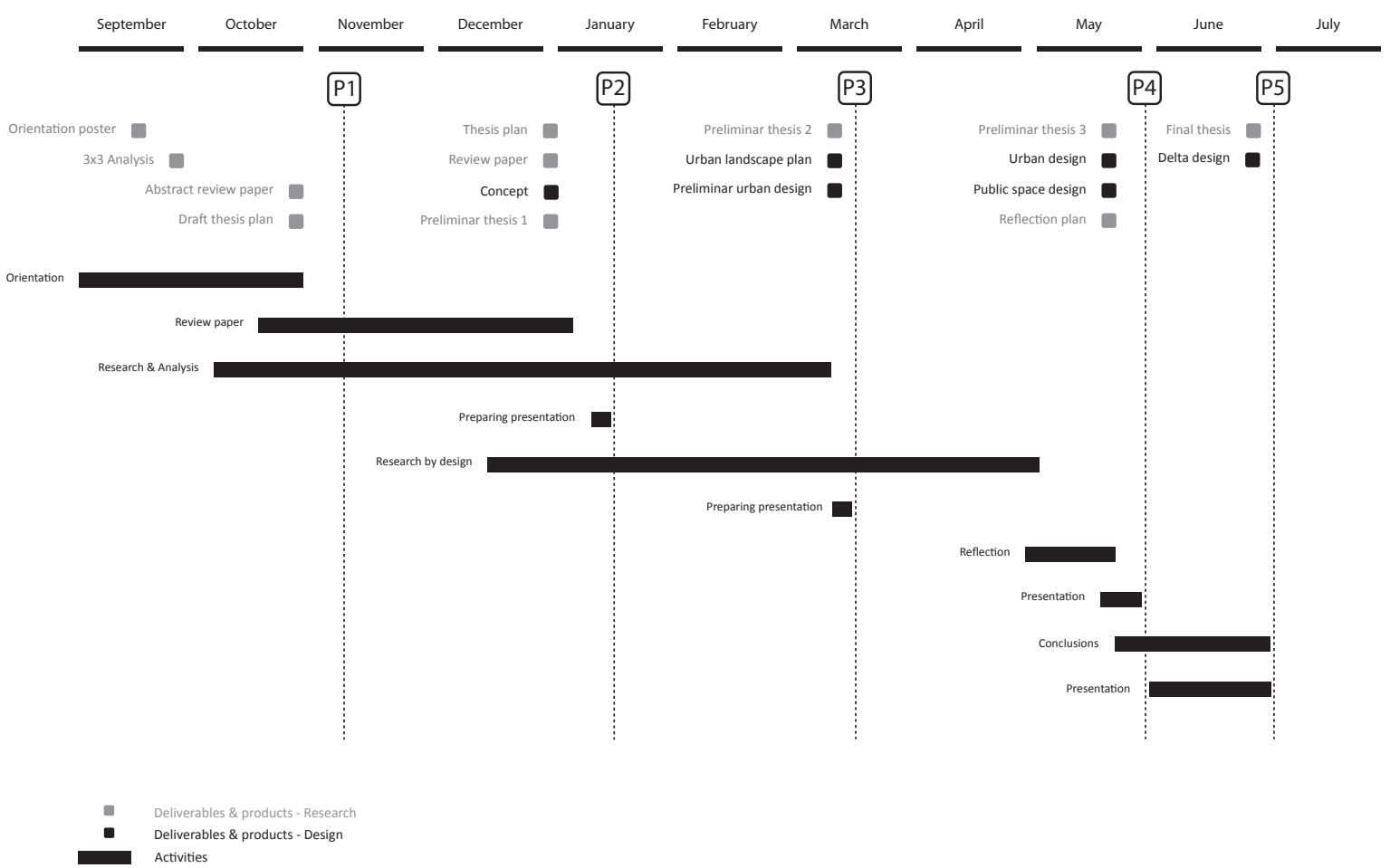

Figure 12. Time schedule graduation project 2011/2012
Source(s): *Author, 2012*

Research

review paper

Working with nature

Keywords:
Urban delta regions
Urban delta theories
Resilient city
Design with nature
Rich delta

Delta regions contain the most densely populated areas in the world it also possesses one of the most fragile urban environments. Events like the Dutch Watersnoodramp in 1953 and Hurricane Katrina in 2005 depict the vulnerability to severe weather on the urban fabric. Man's struggle against water resulted in the construction of flood defenses and the execution of water risk management.
But there is a paradigm shift from fighting against water to working with nature [Meyer et al., 2010]. There are many theories and philosophies that are within the scope of working with nature, but there are no general methods or ideas on the implementation in urban or economic development [Meyer et al., 2010]. This paper aims to find a theoretical framework for working with nature by reviewing three theories or approaches to the urban delta; the resilient city, design with nature and the rich delta.

Introduction

The context
Delta regions formed by the sedimentation and erosion of sea and river contain the most vibrant and rich ecosystems in the world. A rich variety of flora and fauna and a fertile soil create a productive environment that sustains urbanization. The most densely populated areas as New York, Rotterdam, London and Jakarta are established in delta areas and have developed in economic and cultural capitals.
While delta regions are the bloom of society it also possesses one of the most fragile urban environments. Events like the Dutch Watersnoodramp in 1953 and Hurricane Katrina in 2005 depict the vulnerability to severe weather on the urban fabric. It is not only the presence of potential flooding but also the subsidence of land, higher river discharge and rising sea levels that possess a threat. Flood defenses and water risk management are essential to sustain living and the process of urbanization in the delta.
The Dutch have a long tradition of struggling against water. But there is a paradigm shift from fighting against water to working with nature [Meyer et al., 2010]. There are many theories and philosophies that are within the scope of working with nature, but there are no general methods or ideas on the implementation in urban or economic development [Meyer et al., 2010].

The content
This paper aims to review three theories or approaches to the urban delta to find a theoretical framework for working with nature in the urban delta. This framework consists of different spatial related ideas that provide conditions for design. This review also aspires to find a relation or correlation between the different theories.
In an urban delta it is first of all necessary to put the paradigm working with nature into the perspective of the city and its protection against water. The urban archetype of a resilient city is commonly used in urbanism in relation to water but with different interpretations, explanations and implementations. Also there is no clear consensus of an urban model to sustain this idea of a resilient city [Hooimeijer, 2011]. A second perspective on working with nature in the urban delta is the theory of design with nature by McHarg. The natural processes that are linked to water have led to the present form of the delta and created spatial conditions for urbanization [McHarg, 1969].
The last and third perspective on working with nature is the rich delta that links the beneficial to environmental approach in an urban delta.

The research for this paper is done by literature review of multiple authors and will define a theoretical framework for my graduation project. By reviewing different theories about the paradigm working with nature, applied to the urban delta, there will be a clear understanding of the current paradigm, so that the research in my graduation project will add to the general body of knowledge of urbanism. It also specifies what the theories imply and what spatial conditions they provide for design.

The water resilient city

Shift of paradigms
The paradigm shift from fighting against water to working with nature started in 1970's and was accelerated with a growing awareness of climate change in the 1990's [Meyer et al., 2010]. To understand the current paradigm is it important to know the preceded paradigms and why they changed. The idea of the resilient city was as the paradigm working with nature also preceded by another urban archetype.
Hooimeijer describes in The Tradition of Making Polder Cities consecutive phases in Dutch history related to urban archetypes. Her study states five urban archetypes each related to five phases (see figure 14. on page 25). The adaptive city is close to the natural system or rules and has an integrated system of polders and urban fabric. The fertile city is where the city profits from the hydrological advances in the sense of wealth, power, defense and knowledge. The systemized city is the urban archetype of the industrial revolution with increased city density, infrastructure and social inequity. The maakbaarheid city (creatable city) differs from the first three archetypes, it has hardly any relation with the (underlying) landscape and shifts to a more social and economical urbanism and relies on technology that makes the city maakbaar (creatable). This urban archetype is followed by the resilient city. For a more in-depth description of the urban archetypes I refer to Hooimeyer's The Tradition of Making Polder Cities. [Hooimeijer, 2011]
The progression of the urban archetypes to the resilient city is caused by cultural changes in society and technological advancement [Hooimeijer, 2011]. The idea of a resilient city appeared in the same period as the growing awareness of climate change, around 1990's. This growing awareness enhanced the missing relation between the city and the landscape by pointing society to the affects of human interventions and land use in the widest sense on the global environment. The publication of Verstedelijkt Landschap (Urbanized Landscape) by Fritz Palmboom marked the change with a new historical awareness that links urbanism to landscape in the Netherlands [Hooimeijer, 2011].
Hooimeijer state that monitoring and information technology reduce the vulnerability of the city to water hazard [Hooimeijer, 2011]. The shift from the maakbaarheid city to the resilient city means a change from an engineering solution towards a more risk and vulnerability perspective of the city.

Definition of resilience
To define what the resilient city is and spatial conditions it needs to construct or design a possible urban model, it is viable to first define resilience as term.
The term resilience is rooted in ecology. Picket defines ecological resilience as: "the ability of a system to return to stability or equilibrium after a disturbance" [White, 2010, p. 96]. This definition is almost similar to Gunderson's definition of engineering resilience: "the time of return to a global equilibrium following a disturbance" [Gunderson et al., 2002 cited in Bosher, 2008, p. 12]. The difference is that Picket states that resilience is related to a system instead of only the act. Resilience is bound to a balanced context or state to return to, but is also can shift to another equilibrium. Novotny et al. states this clearly: "embracing change is the essence of resilience" [Novotny et al., 2010, p. 145]. It implies that resilience is a progressive process. Resilience is after disturbance constantly returning to a balanced state within a system, progressing from a balanced state to another balanced state.

The water resilient city
A resilient city could therefore be described as a city that constantly returns to a balanced state after a disturbance, or more specific the impact of flooding. The risk of flooding and its affects will lead to a resilient response of both mitigation and adaption (see figure 13.). The resilience to water hazard is at itself part of the paradigm of fighting against water. It reacts to water as an enemy instead of having a harmonious relationship with it. However a water resilient city is not only a city that has low hazard, exposure and vulnerability in the perspective of flood risk. It is part of a greater context.

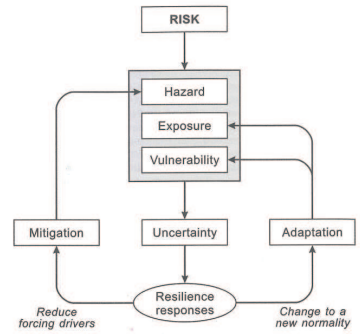

Figure 13. Risk, resilience, mittigation and adaption
Source: *White, 2010*

	Phase	Nature & defence	Anticipative	Offensive	Manipulative	Adaptive Manipulative
	Chapter title	2. Natural Power	3. The Power of Unity	4. The New Power	5. Accelerating Powers a_Machine/ b_Man/c_Flower Power	6. Adaptive Power
		AMPHIBIOUS CULTURE		LAND CULTURE		
	Year	-1500	1500-1800	1800-1890	1890-1990	1990-
Context	Marking technology	Ditch, Sluice, Mound, dike	Pre-industrial Mill	Industrial Steam	Industrial combustion engine (diesel, petrol), electricity	Post-industrial data and service society Computer
	Paradigms	Adaptation Paradigm	Fertility Paradigm	Systemization Paradigm	*Maakbaarheid* Paradigm	Resilience Paradigm
	Context	Nature over culture	Diking and reclamations	Drained lakes	Reallotment	Nature
	Society		Land of cities	Constitution	Welfare state	Globalization
	Scale		Country vs city	Birth of the national state	Stabilization of the national state	Regionalization and internationalization
Disciplinary	Urbanism	Urban development	Urban engineering	Urban engineering + landscape	Urban design (housing)	Urban design + landscape
	Skill	Craft	Experience building a body of knowledge	Knowledge development	Scientific knowledge	Multitasking, multi-functionality, governance, negotiated knowledge
		Craftsman	Military	Engineers	Specialization	Generalists
			Early Modern Period (Taverne)	Modern Period (Van der Woud)	Modernization	PostModern Period
	Focus		Rationality	Hygiene	Transparency	Sustainability and resilience
	City type		Closed city	Open city	Multistructure city	Network city
	Issue			Waste, train	Car & Stone Housing	Water/climate
	Urban Strategy		Functional adaptation	Functional concentration	Functional separation	Elastic Frameworks C2C, ecosystems
	Organization		City factory	Department of Public Works	Department of Urban Planning and Housing	Urban development Authority
Spatial Interventions	Coherence of Urban structure		Water, road and building	Water, road and building	Road and building main structure, water and green separate	Integration of black, blue and green infrastructure
	Relation to the territory	Urbanism is physical geography	Urbanism follows physical geography	Urbanism influences physical geography	Urbanism ignores physical geography	Urbanism reintroduces physical geography
	Water function	Drinking water and transport	Drainage and discharge representation	Public space	Recreation	Nature and architecture
	Relation urbanism and water	High and dry city	Peat Polder city	Pumped city	Drained city	Sustainable city
	Brown			Water supply city	Sewer/drained/ waterway city	Water cycle/ water sensitive city
	Building site preparation	Mound, dike	Encircling canal, mud	Lowering groundwater table, sand	Hydraulic filling integral filling	Partial filling
	Urban model	Mound, dune, and river cities, Dike, dam, *burcht* and coast, cape, key cities	*Boezem*, polder and fortification city	Polder city	Garden city Neighbourhood city 'Cauliflower' neighbourhood	New Dutch water city
	Urban Archetype	Adaptive city	Fertile city	Systemized city	*Maakbaarheid* city	Resilient city

Figure 14. Phasing and urban archetype
Source: *Hooimeijer, 2011*

Hooimeijer states that vulnerability in the resilient city is accepted to a certain level and technology is used to predict the risk so adaptations or mitigations can be made in the urban condition [Hooimeijer, 2011]. Infrastructure and buildings in cities are most vulnerable in the face of disasters [White, 2010].
The attitude of accepting a certain level of vulnerability is often found in traditional building traditions, mostly in developing countries. Jigyasu states that traditional technology has a remarkable capacity to adept to natural hazards, living in a harmonious relation with natural hazards instead of resisting it [Jigyasu, 2008].
Hooimeijer further describes the resilient city in the adaptive manipulation phase as: "a city in balance with water and land, connecting all scales, with an individual and a collective adaptability and making use of all the high-potential features of the other urban archetypes: flexibility, adaption, cooperation, boldness, organization, integration, consciousness, time, waterscape, water level, logic of place, water logic, landscape, social, height, water and mud." [Hooimeijer, 2011, p. 306]. The water resilient city is not only concerned with the controlled protection against flooding based on risk and costs. In the shifting paradigm from fighting against water to working with nature, the resilient city also relates closely to the environment surrounding the city and the traditions of earlier city building.

Design with nature

Attitudes towards nature
The paradigm working with nature implies an interactive relation between man and nature, and implicitly describes and relationship between the city and nature. When looking at the relation between man and nature there are many attitudes towards nature and how man can work with nature.
In his publication Ecological conditions, Tjallingi states that there are four different ways how people look at nature or the environment and that these are determined by their world views or basic attitudes towards nature. The four attitudes towards nature are: man as the master of nature, man as the steward of nature, man and nature as partners, and man as a participant in nature. [Tjallingii, 1996] Working with nature can be interpreted as predominant or a more submissive relation between man and nature and everything in between. In the current paradigm the Dutch urbanism sustains a predominant relation between man and nature. This is expressed in the (New) Delta Program where plans are made to restore nature by human interventions (see figure 15). However man as a partner of nature attains more terrain in the current paradigm, for example by the Dutch Wereld Nature Fonds (WNF) to let nature reclaim the Southwest Delta by complete restoration of the estuaries [Wereld Natuur Fonds, 2010].

Figure 15. The New Delta Program
Source(s): *Delta Committee, 2008. In Meyer et al., 2010*

Natural processes and form
In addition, Tjallingii provides a description of nature in this current paradigm: "nature, in the context of working with nature, is not seen primarily as a thing, a species or an area, but as a set of processes" [Tjallingii, 1996, p.62]. This is also stated by McHarg, and he even extends this theory by: "certainly we can dispose of the old carnard, form follows function. Form follows nothing - it is the integral with all processes" [McHarg, 1969, p. 173]. Natural processes can be divided in two directions: one of evolution and one of retrogression. In this Naturalist approach the evolving process in nature has a sense of creativity and needs to be creative, because destructiveness in nature is intolerable. [McHarg, 1969] The paradigm working with nature could therefore also be described as working with all evolving (and retrogressing) processes and form that derives from it, in nature. McHarg underpins his statement with a few examples of natural processes that occur in a delta (see figure 16).

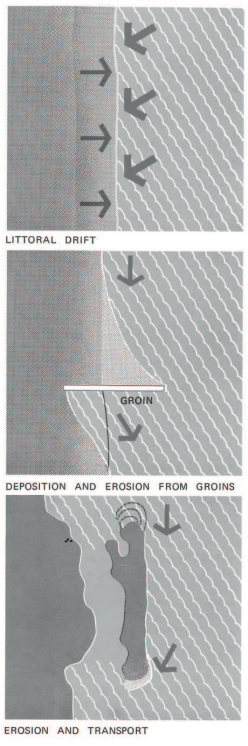

Figure 16. Sedimentation and erosion
Source(s): *McHarg, 1969*

An important natural process in the delta is the constant process of deposition and erosion of sediment in the coastal areas and estuaries. This complex and unpredictable process causes the landscape of the delta to change continually in form. In the Dutch delta the processes of erosion and sedimentation sustained the urbanization of Zeeland due to the constant reclamation of newly sedimented

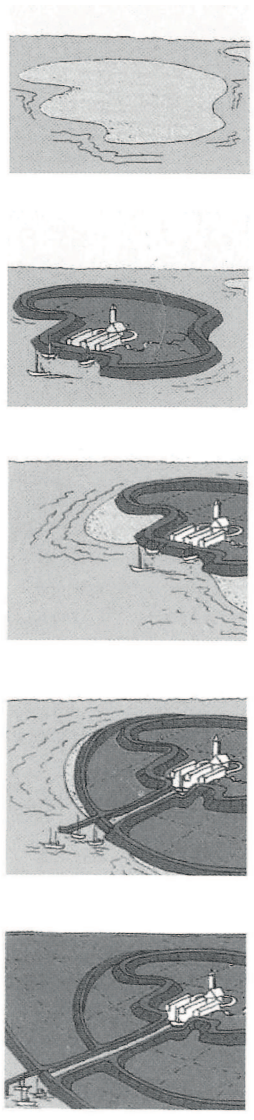

Figure 17. Urbanization in the delta
Source(s): *Bureau Alle Hosper. In Meyer et al., 2010*

The city and natural processes
"The forms of new cities are derived in largest part from an understanding and response to natural processes", states McHarg [McHarg, 1969, p. 171]. In addition to this statement: "Cities evolve as the outcome of myriad interactions between the individual choices and actions of many human agents (e.g., households, businesses, developers, and governments) and biophysical agents such as local geomorphology, climate, and natural disturbance regimes." [Alberti et al., 2003, p. 1170]. The statement of Alberti et al. describes an evolution of cities due to the interaction of man and disturbances.
White writes in Water and the City that the view on nature of McHarg a precursor is to the modern concepts and ideas of sustainability, risk, resilience and natural hazard management [White, 2010]. Alberti et al. propose in their article Integrating Humans into Ecology: "we propose that resilience in cities [..] depends on the cities' ability to simultaneously maintain ecosystem and human functions [Alberti et al., 2003, p. 1170]. Design with nature is closely related to the idea of a resilient city.

The rich delta

Value of natural processes
The rich delta is an elusive theory or idea. There is no definition of this idea, when dealing with urban design and planning in the delta. Implementation of the rich delta is often related to the value of natural processes or the natural capital that the delta possesses. This remark implies a certain relation to the paradigm of working with nature and relates to a more economic approach to the urban delta.
To understand the rich delta it is important to look at the relation between the city and the idea of value. McHarg states about the Naturalist movement: "they have concluded that within the city and its immediate hinterland certain natural processes perform work for man and thus constitute a value" [McHarg, 1969, p. 171]. He also states, more generally, that the natural processes constitute a social value, that each area has certain suitability's for specific functions or purposes, and are not always suitable for all human uses [McHarg, 1969]. Like natural processes derive into (natural) form, nature provides certain social value.

Natural capital
Social values determine some sort of form of benefit for man or the city. Costanza et al. wrote: "Ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive, directly or indirectly, from ecosystem functions" [Costanza et al., 1997, p. 253]. In their article The Value of the World's Ecosystem Services and Natural Capital they describe different goods, services and functions of an ecosystem and looked at the economic value per acre and estimated estuaries or deltas as the most valuable kind of ecosystems per acre [Costanza et al., 1997]. The rich estuaries obtain their values especially from (water) disturbance regulation, nutrient cycling, food production and recreation. This can be described as natural capital [Costanza et al., 1997].

The Rich Delta
The idea of a rich delta relates to the natural processes that constitute social value that is expressed in beneficial natural capital. The term rich delta used by academics refers primarily to the high economic value per acre of the delta ecosystem. In the paradigm shift from fighting against water to working with nature this also means a growing awareness of natural capital and the profitable environment surrounding delta cities.

Conclusion

Working with nature

The paradigm shift from fighting against water to working with nature created, based on the theories of the resilient city, design with nature and the rich delta, a shift to an increased awareness of the environment and landscape surrounding delta cities. That is expressed in a balanced, but evolving relation between city and nature. Within the context of urbanism, the idea of the resilient city forms the basis in the paradigm of working with nature, with the theory of design with nature as a precursor and the idea of a rich delta as an additive.
Although the theories relate to each other, each theory looks at the environment in a different way. The approach of the resilient city is more contextual and looks at the historic landscape, building traditions and (water) hazards. The Naturalist perspective of design with nature is more fundamental and abstract, it also relates to a more processes oriented approach. The idea of a rich delta is more beneficial and emphasizes the functionality of nature and landscape.

Graduation project

In the current paradigm of working with nature, urban design in the Dutch Southwest Delta should have a strong relation to the spatial conditions of the historical context of the landscape, building traditions, the natural processes that lead to form and the natural capital of ecosystems. The graduation project should embrace the paradigm and its spatial conditions to make the research and design relevant to add to the body of knowledge of urbanism.
When researching and designing in the Dutch Southwest Delta the urban designer has to keep in mind that urban design is bound to a set of natural processes that will continue after the construction of the project. A design project in the delta is therefore not project based but process based. A constant interaction with change called: working with nature.

Recommendations

The urban model of the resilient city is not specified [Hooimeijer, 2011]. I encourage more designers, dealing with urban deltas, to add to the discussion of the current paradigm working with nature by designing with the historical context of the landscape, building traditions, the natural processes that lead to form and the natural capital of ecosystems.
In addition, the ideas of the resilient city and the rich delta need a clear consensus to apply them more effectively. Extended research and design in the field of urbanism could bring this consensus.

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Inventarization of the Krammer Volkerak

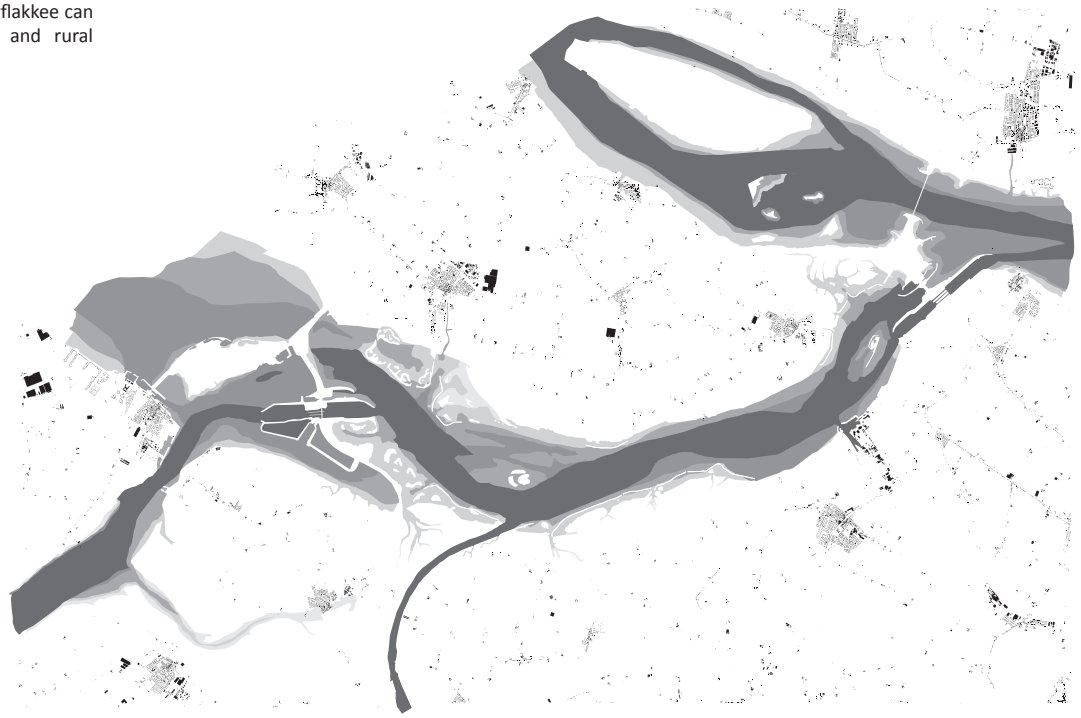
Keywords:
Height
Occupation
Governance
Natura 2000
Industry & Energy
Facilities
Recreation

Height
The governance of the Krammer Volkerak area is shown by area and dike segments.

Figure 18. Height map
Source(s): *Author, 2012*
Data used: *Height map, Ruimtelijk Kwaliteitskader Volkerak-Zoommeer, Bureau Stroming, 2012*

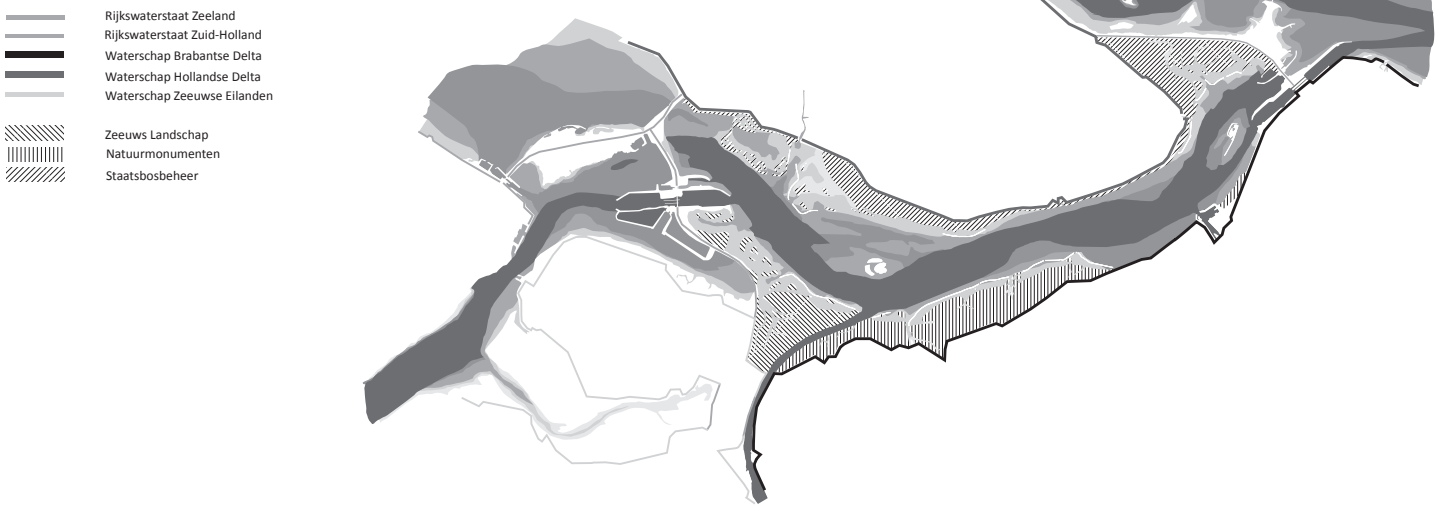
Occupation
The occupation of South East Goeree Overflakkee can be divided in village/urban occupation and rural occupation.

Figure 19. Occupation
Source(s): *Author, 2012*
Data used: *Top 10 Vector Map, TU Delft Library*



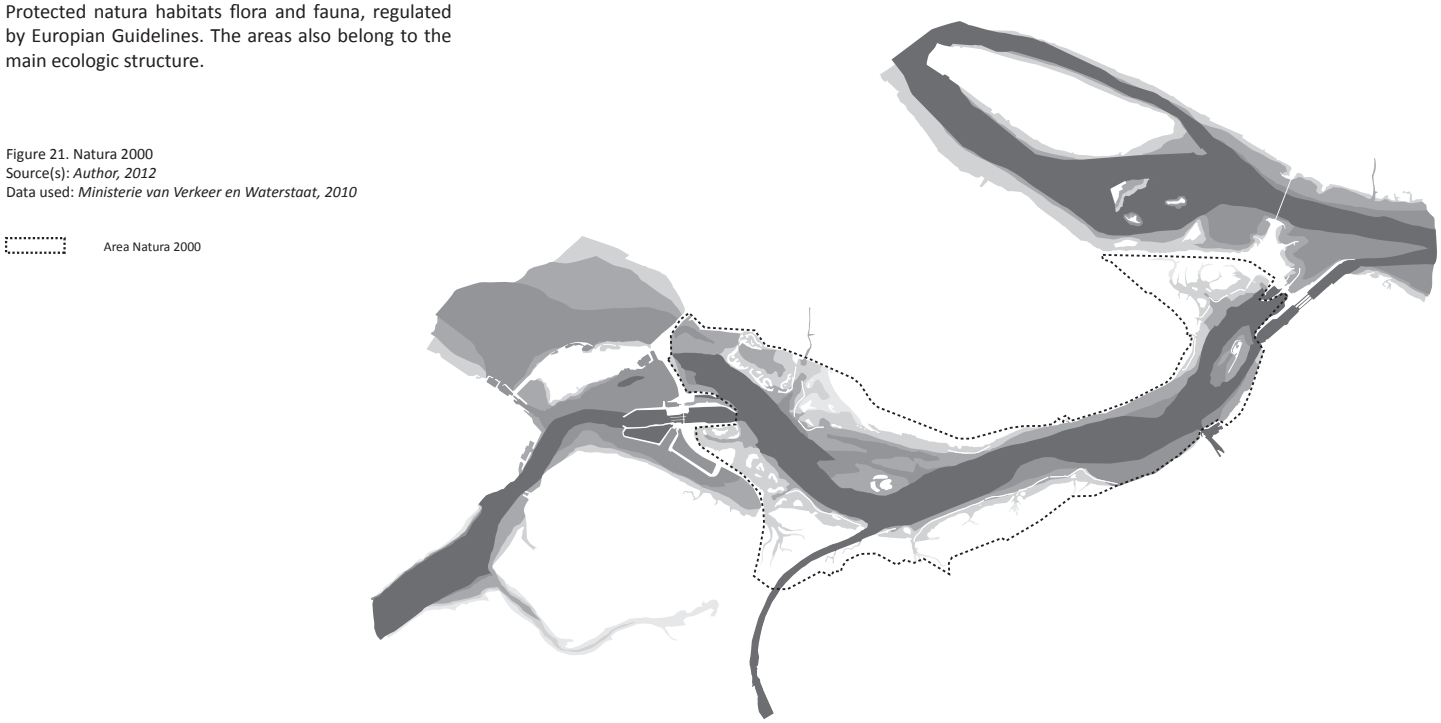
Governance
The governance of the Krammer Volkerak area is shown by area and dike segments.

Figure 20. Governance
Source(s): *Author, 2012*
Data used: *Ministerie van Verkeer en Waterstaat, 2010*



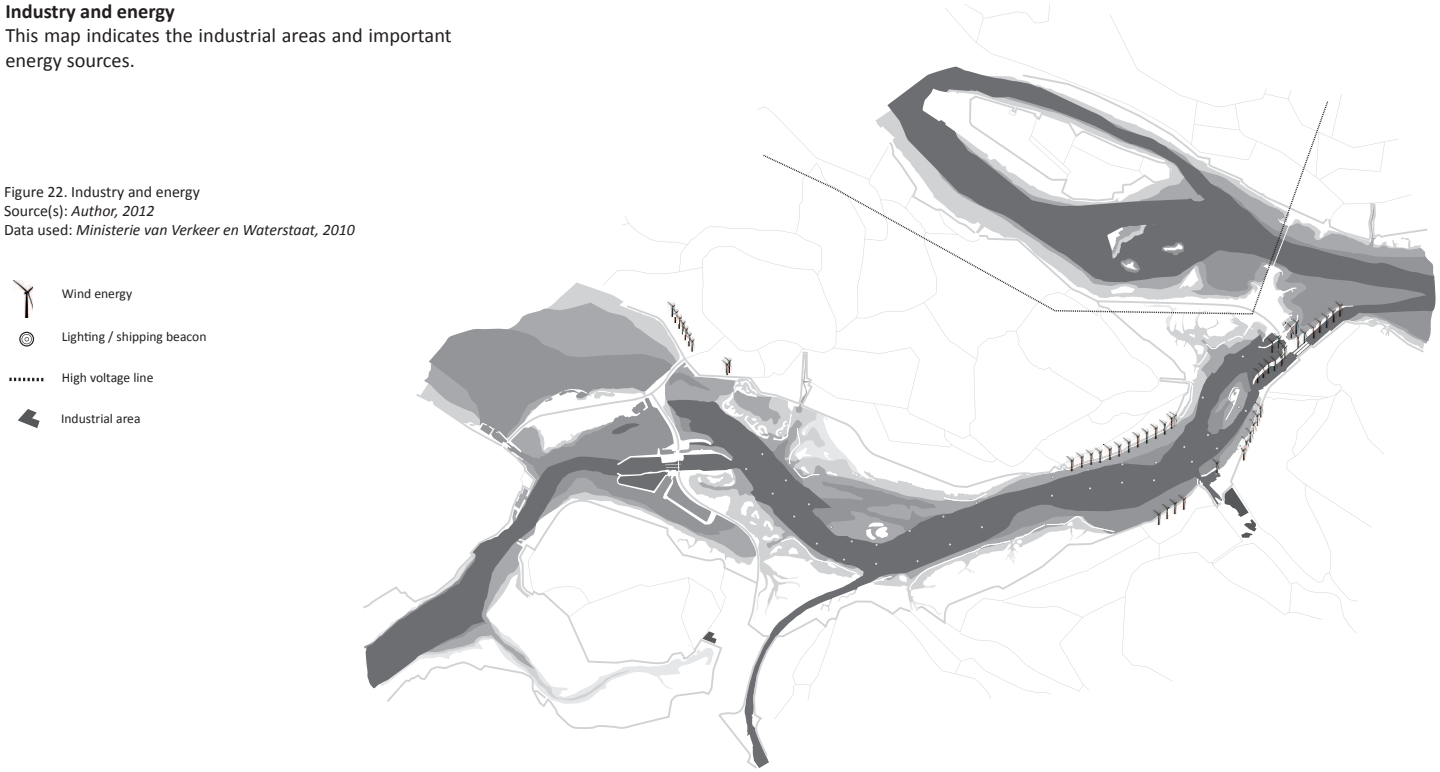
Natura 2000
Protected natura habitats flora and fauna, regulated by Europian Guidelines. The areas also belong to the main ecologic structure.

Figure 21. Natura 2000
Source(s): *Author, 2012*
Data used: *Ministerie van Verkeer en Waterstaat, 2010*



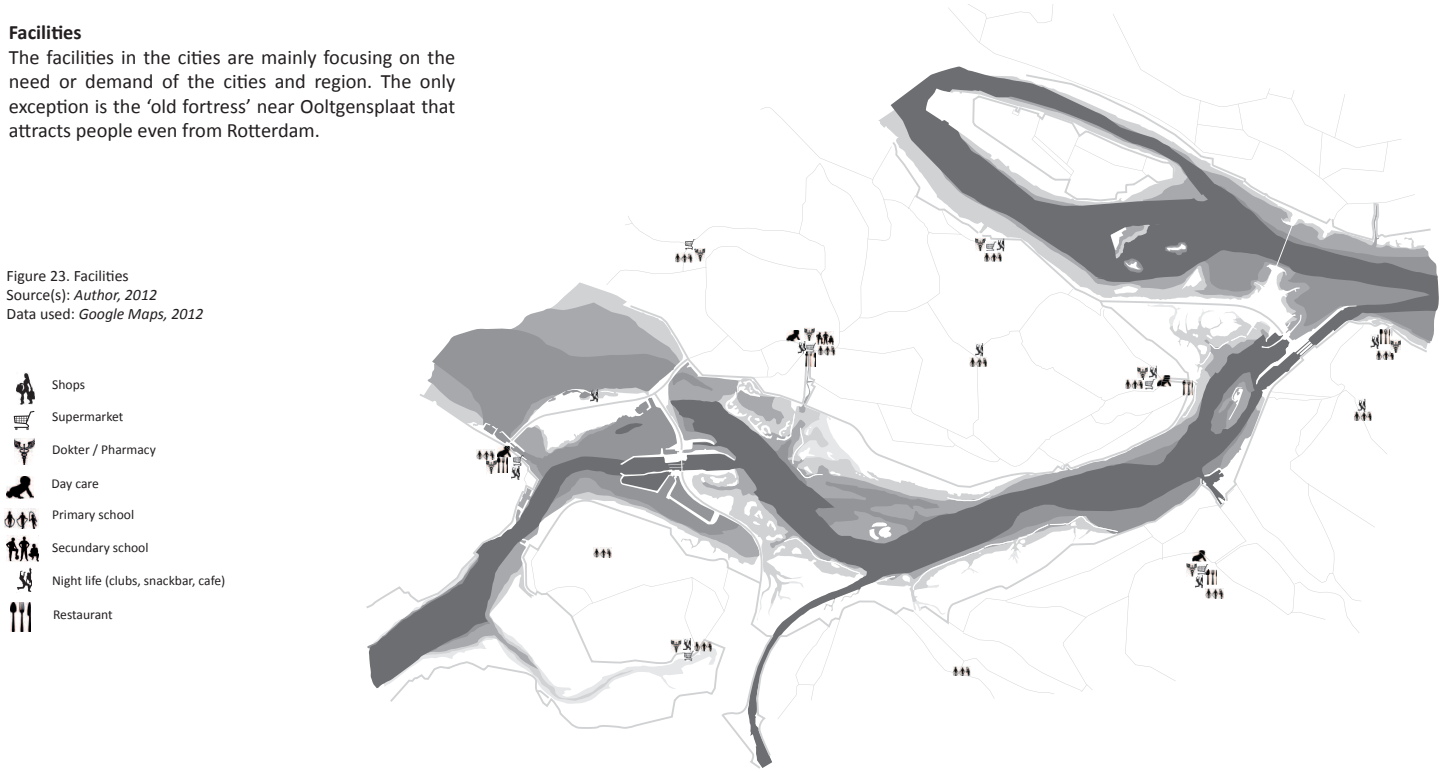
Industry and energy
This map indicates the industrial areas and important energy sources.

Figure 22. Industry and energy
Source(s): *Author, 2012*
Data used: *Ministerie van Verkeer en Waterstaat, 2010*



Facilities
The facilities in the cities are mainly focusing on the need or demand of the cities and region. The only exception is the 'old fortress' near Ooltgensplaat that attracts people even from Rotterdam.

Figure 23. Facilities
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*



Recreation
The different recreational functions are divided into activities and harbor berths.

Figure 24. Recreation
Source(s): *Author, 2012*
Data used: *Ministerie van Verkeer en Waterstaat, 2010*

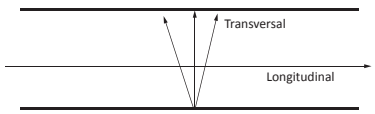
theory

Sedimentation and erosion

Keywords:
Sediment transporation
Sediment deposition
Erosion
Flow velocity

Tidal dynamics, river discharge and sedimentation are the processes that constitute the landscape of the Southwest Delta. This chapter will not deal with the biological processes of flora and fauna in the delta, but will relate to the theoretical framework discussed in the review paper, one of naturall processes related to form. In the theory of Design with Nature this is sedimentation.

Sedimentation is an unpredicatble natural process that relates to the transportation, deposition and erosion of sediment in a waterbody. The transportation of sediment is bound to the velocity of water and related to direction it flows (longitudinal or transversal on the shore line).



The longitudal is strongly related to the velocity of a steady turbulent open channel flow:

$$v = C \times \sqrt{(R \times i_w)}$$

In which:

v : flow velocity (m/s)
C : Chézy coefficient $(m^{\frac{1}{2}}/s) \sim$ friction coefficient
R : hydraulic radius $(m) \sim$ water depth
i_w : bottom slope (m/m)

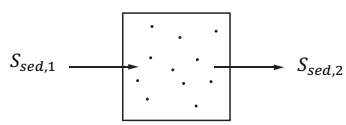
And of sediment transport:

$$S_{sed} = m \times v^n$$

In which:

S_{sed} : sediment transport $(kg \times m/s)$
m : sediment mass (kg)
v : velocity (m/s)
n : coefficient

Sediment deposition occurs when the transport of sediment into a system is larger than the transport of sediment out of a system. This means:



$$S_{sed,1} > S_{sed,2}$$

$$v_1 > v_2$$

$$C_1 \times \sqrt{(R_1 \times i_{w,1})} > C_2 \times \sqrt{(R_2 \times i_{w,2})}$$

The problem statement addresses that the Deposition of sediment occurs when the waterdepth, friction and bottom slope is reduced. The velocity of flow can also be determined by the general flow formula:

$$Q = A \times v$$

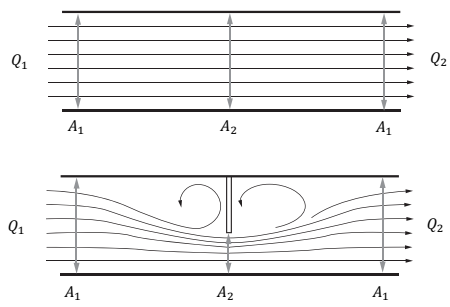
In which:

Q : flow of fluid (m^3/s)
A : flow surface (m^2)
v : flow velocity (m/s)

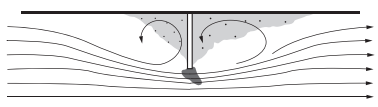
$$Q_1 = Q_2 = A_1 \times v_1 = A_2 \times v_2$$

When $A_1 > A_2$ then: $v_1 < v_2$

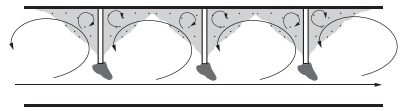
When an object is placed in a waterbody the surface of flow in the waterbody changes and increases the velocity:



AAfter the object there will be a decrease of velocity because the surface is increasing. The formula of sediment transport thus states that there will be deposition of sediment (light grey). At the point of the object where the velocity is high there will be erosion (dark grey):



With mulitple objects (groynes):



The relation between velocity, sedimentation and erosion is also visible in a meandering river:

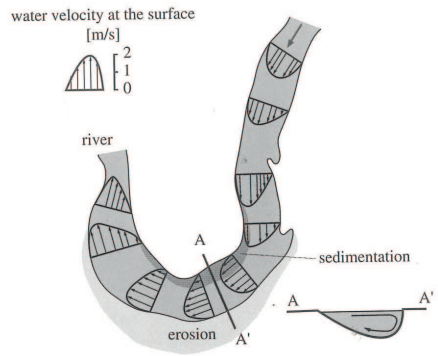


Figure 25. Sedimentation and erosion in a meandering river.
Source: *Parriaux, 2009*

This kind of sedimentation is based on the longitudinal direction of flow, but the transverse direction is different. It is related to to the nature of the wave. A tidal wave (getijdenslag) will generate a constructive process: the accretion of sediment in a waterbody. A wave created by wind will generate a destructive process: the dimishing of sediment in a waterbody.

Word of thanks:

I want to thank dr.ir. Bram van Prooijen, from the faculty of Civil Engineering (TU Delft), for his contribution to this chapter by providing a general understanding of the topic of sedimentation in the form of formulas and basic principles. Drawings in this chapter (except from Parriaux) have been made during the discussion about the topic, and later on edited by the author.

Natural processes in the Krammer Volkerak

Keywords:
Sedimentation
Creeks
Foreshores

The deposition and erosion of sediment formed the landscape in the Dutch Southwest Delta. During the course of history the delta landscape changed by these natural processes.

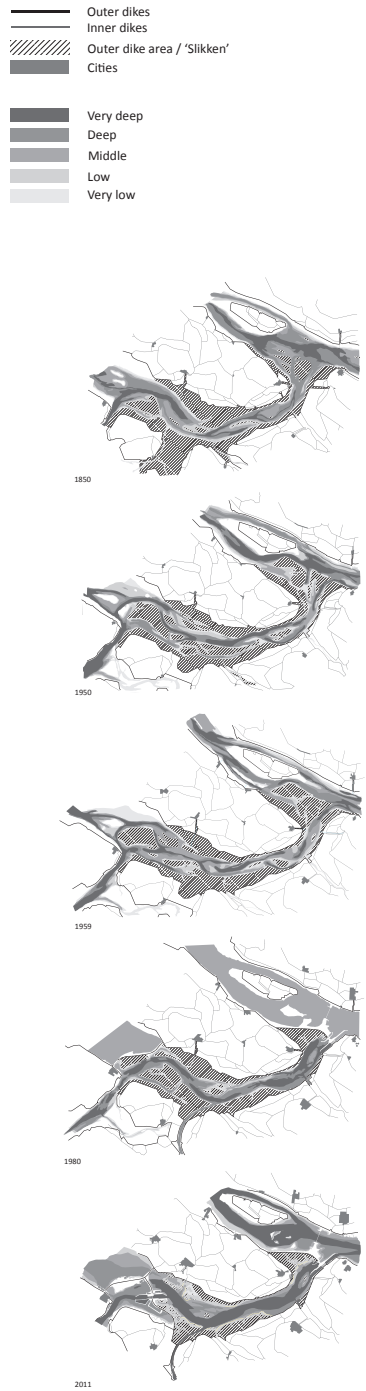
Until the construction of the Delta Werken the delta had an open connection between sea and river and sustained the sedimentation and erosion of the delta. The Krammer Volkerak has characteristics of a meandering river that flows in two direction (sea and river). This provide a particular sedimentation of both shores of the Krammer Volkerak.

After the completion of the dams the accretion of sediment stopped. The 'kreken' (creeks) remind of the open delta and the former tidal dynamics.

However, the process of erosion still continued by waves generated by wind. Diminishing the sandplates and leaving 'vooroevers' (foreshores). Although it indicates the absence of tidal dynamics it is a characteristic landscape feature of the Krammer Volkerak.

Figure 26. Foreshores and creeks.
Source: *Google Earth, 2012*

Figure 27. Historic analysis of cities and overview of sedimentation in the Krammer Volkerak
Source: *Author, 2012*
Data used: *1850. Map room, TU Delft Faculty of Architecture, 2011; 1950. - 1980. watwaswaar.nl, 2011; 2011. Bureau Stroming, 2008*



Urbanization of Oude Tonge and Ooltgensplaat

Keywords:
Urbanization
Delta cities
Harbor city
Polder city
Phases

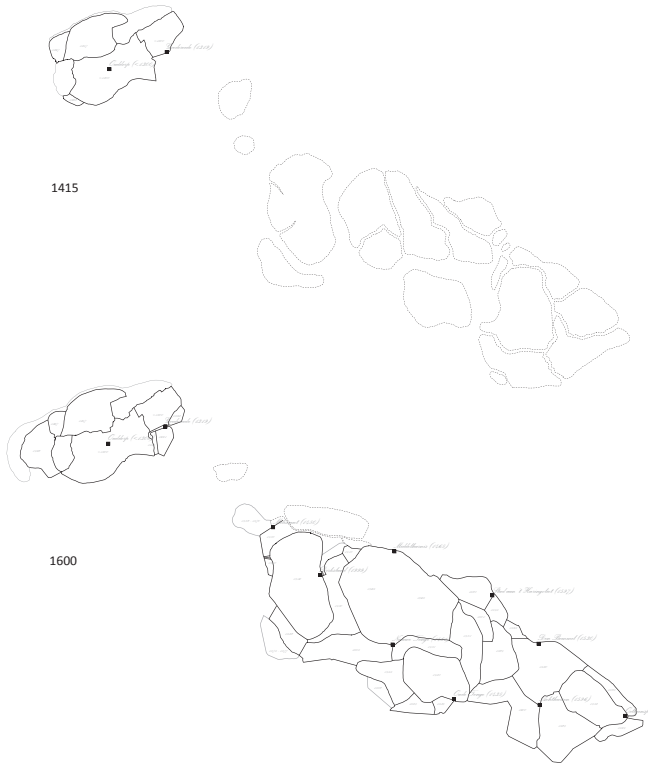
In the Medieval period Goeree Overflakkee existed of a dune with the village of Ouddorp and multiple sand plates. The inter tidal area did not contain any villages or settlements and belonged to the vagaries of natural processes. The delta was a rich fishing ground and an ideal place for trade, and thus for urbanization. The plates surrounded by a ring dike and cultivated. Villages were founded at the (main) creek of the reclamated sand plate. The creek provided water discharge of the polder and in addition kept the harbor open (from sedimentation). The accretion of sediment to the dike ring created a new sand plate that later on was reclamated and urbanized. The described process of sedimentation and reclamation is depicted in the maps below. The (livable) island of Goeree Overflakkee increased in size. Delta cities that were once on the edge of water were decades later positioned in cultivated land. Early delta cities transformed from a harbor city to a polder city.
This chapter will research the historic process of urbanization and provide the basis for the analysis of urban form in the next chapter.

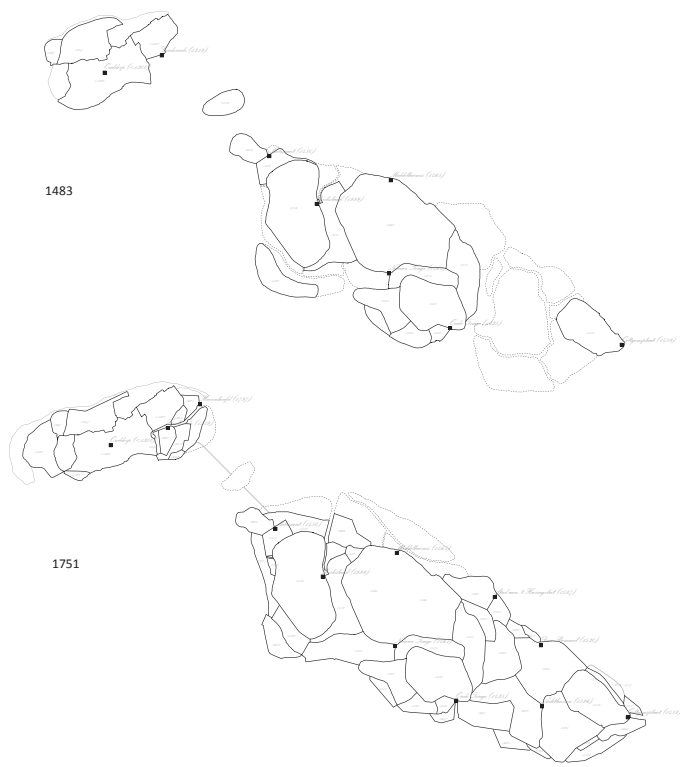
Figure 28. Urbanization of Goeree Overflakkee
Source(s): *Author, 2012*
Data used: *www.geschiedenisvandirksland.com, 2011; Google Maps, 2012*

Sand plates, "slikken"

Polders, and date of construction

Delta cities, and date of first historical mention

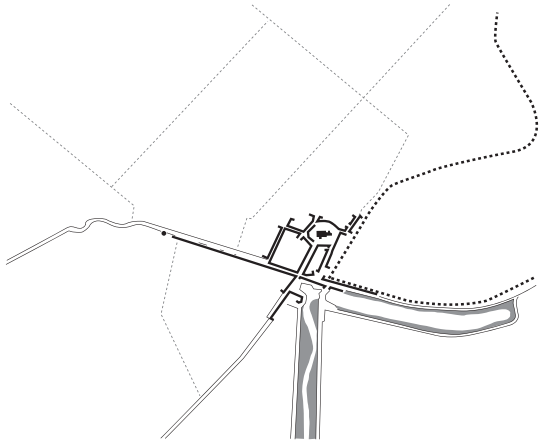


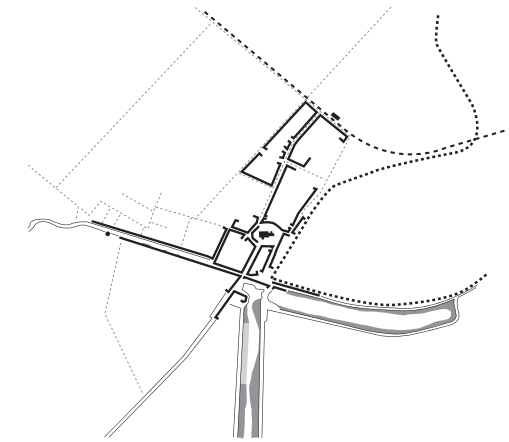


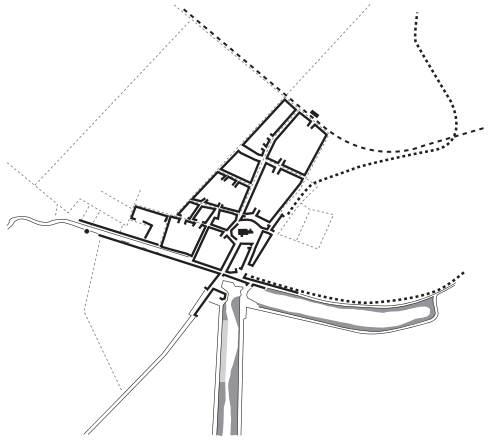
The maps in figure 29. show the urban landscape of Oude Tonge and Ooltgensplaat in 1850 and 2009. The cities and their relation with the landscape changed through the centuries. The delta cities in the Dutch Southwest Delta started as harbor cities, characterized as 'kerkring-voorstraatdorpen' [Meyer et al., 2007], but in 1850 the cities were embedded in a polder landscape. Becoming polder cities.
The urbanization between 1850 (or earlier) and 2009 has gone through different phases, triggered by different technological and socio-economic developments.

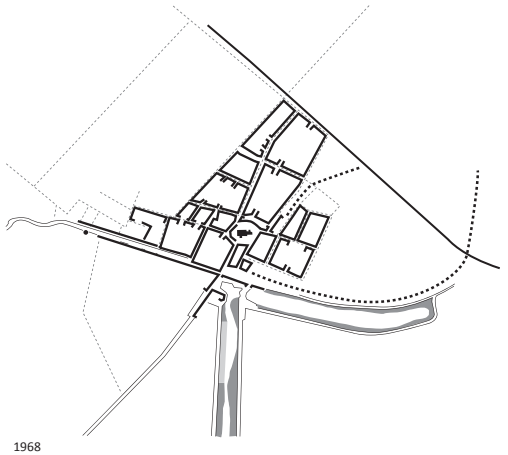
To understand this process figures 30. and 31. show a schematic representation of the urbanization of the delta cities, describing the relation between the city, harbor, church, flourmill, canal and creek, accompanied with ome historic photographs and drawings to provide some visualization. This will will lead to an interpration and description of the urbanization.

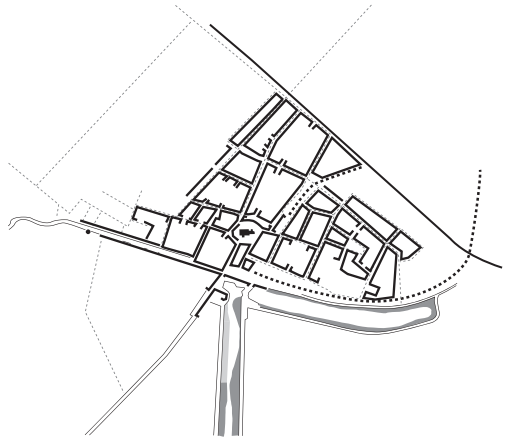
Figure 29. Oude Tonge and Ooltgensplaat in 1850 and 2009
Source: *Author, 2012*
Data used: *1850. Map room, TU Delft Faculty of Architecture, 2011; 2009. Google Maps, 2011*

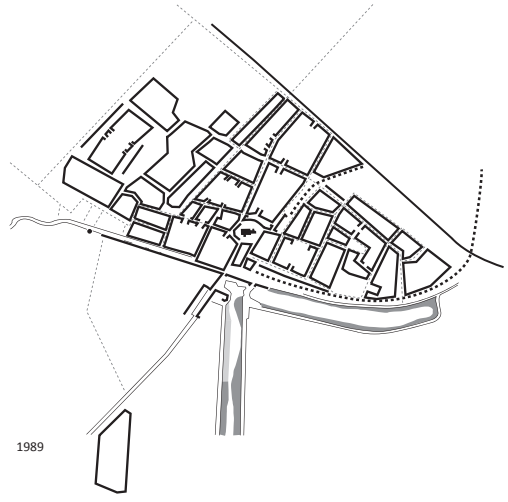


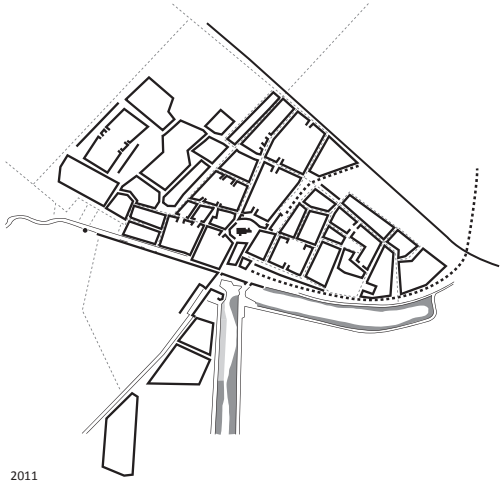












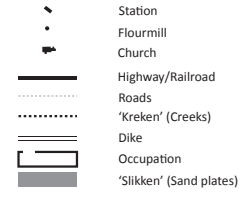
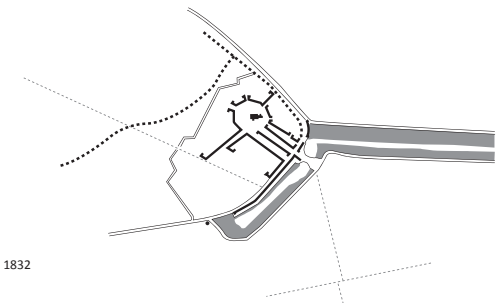
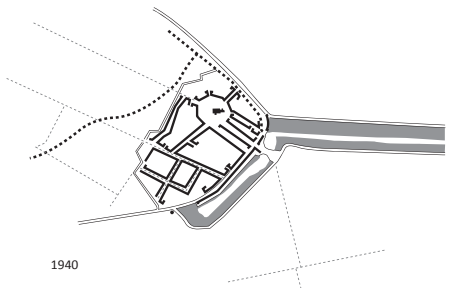


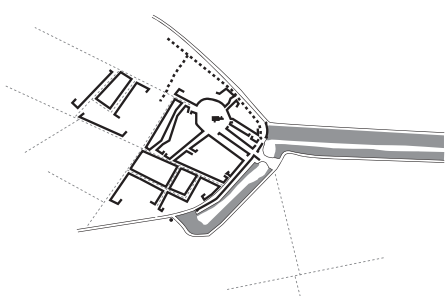
Figure 30. Schematic representation of the urbanization of Oude Tonge
Source: *Author, 2012*
Data used: *1850. Map room, TU Delft Faculty of Architecture, 2011; 1940. - 1980. watwaswaar.nl, 2011; 2011. Google Maps, 2011*



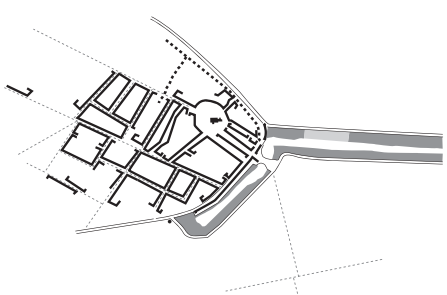
1832



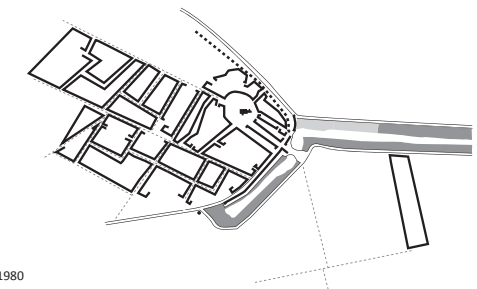
1940



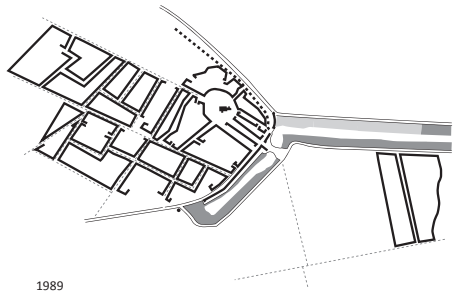
1959



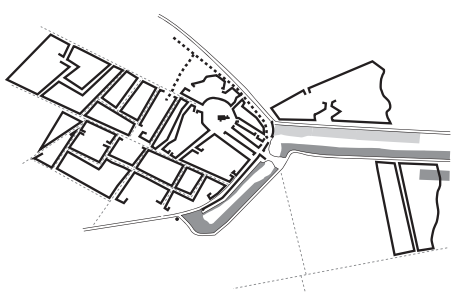
1968



1980



1989



2011

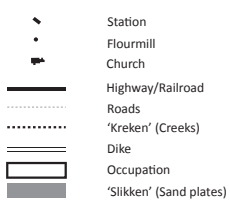


Figure 31. Schematic representation of the urbanization of Ooltgensplaat
Source: *Author, 2012*
Data used: *1850. Map room, TU Delft Faculty of Architecture, 2011; 1940. - 1980. watwaswaar.nl, 2011; 2011. Google Maps, 2011*

The urbanization process of the delta cities Oude Tonge and Ooltgensplaat went by seven different phases, each related to a technological or socio-economic developement:

Phase I - The harbor city (< 1650)
Main characteristics: kerkring-voorstraat, harbor, creek.

The ‘voorstraat’ (main street), with two parallel streets, connected the church with the harbor. Adjecent to the city is a ‘kreek’ (creek) that is used for draining the polder and in addition, the kreek sustained an open harbor by the discharge of the polder that constantly eroded the canal. In addition the church is surrounded by a ditch for water storage.

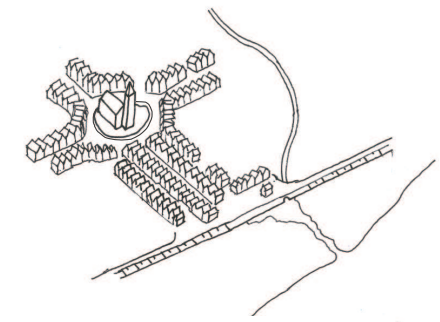


Figure 32. The harbor city
Source: *Author, 2012*

Phase II - The canal city (1650 - 1750)
Main characteristics: polder, spui, canal, kreek, harbor.

Extended land reclamation embedded the city in a polder landscape. In the ‘spui’ (drain reservoir) water was collected to flush the extended canal at low tide, so the harbor remained accesible for ships. The harbor has a typical L-shape.

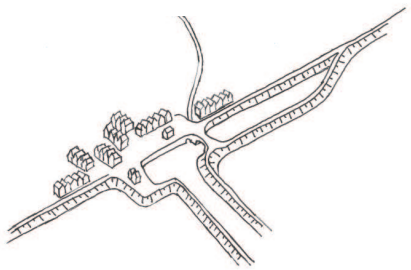


Figure 33. The canal city
Source: *Author, 2012*

Phase III - The agriculture city (1750 - 1890)
Main characteristics: flourmill, molendijk, ribbon development

Around 1750 mills were constructed to provide the cities in there own flour. The dike on which the flourmill was built often bared the name: ‘molendijk’ (mill dike) and was accompanied with ribbon development along side the dike.

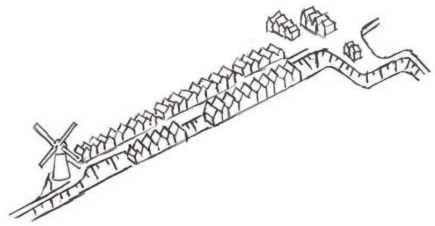


Figure 34. The agriculture city
Source: *Author, 2012*

Phase IV - The connected city (1890 - 1960)
Main characteristic: urban development near main/important infrastructure.

During the industrial revolution the delta cities started to expand to main or important infrastructure. In addition, the canal obtains an (industrial) harbor.

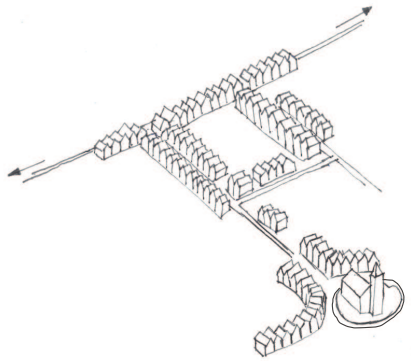


Figure 35. The connected city
Source: *Author, 2012*

Phase V - The polder city (1960 - 1980)
Main characteristic: urban development in the polder landscape

After the WWII the delta cities started to expand in the polder, and in this progressive process damming a creek. This post-war urban development followed the line composition of the polder landscape. In this period the delta cities could have lost ditch surrounding the church lost the ditch and L-shape of the harbor.

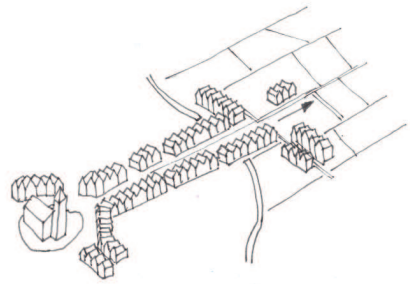


Figure 36. The polder city
Source: *Author, 2012*

Phase VI - The recreative city (1980 - 2009)
Main characteristics: recreative harbor, bungalow parcs.

The (industrial) harbor transforms into a dock for recreative ships and expands in longitudinal direction of the canal. The development of recreative housing and day recreation in nearby polders lead to the cities first expansion outside of the polder of origin.

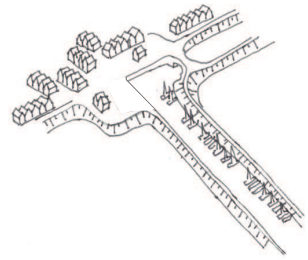


Figure 37. The recreative city
Source: *Author, 2012*

Phase VII - The expanded city (> 2009)
Main characteristics: VINEX-locations

The prelude of the recreative development extended in the development of VINEX-locations. These extensions are build in an adjecent polder, using the polder’s line composition, directed towards the water.

Figure 38. The expanded city
Source: *Author, 2012*

The alteration from a harbor city to a polder city (or expanded city) can be summarized into two transformations. First is the changed relation of the delta city with water, on a large and a small scale. And second is the relation between the city and the cultural landscape.

The delta city and water

The delta cities Oude Tonge, as others in the Dutch Southwest Delta have have lost their characteristic relation with water. The cities that once were connected with open water and an intertidal area are surrounded by a cultivated polder landscape (see figure 28.). The canal and the harbor is the only rememberance of the historic location on the water. This change is also visible in the public space, especially at Oude Tonge where water in the harbor and the 'kerkring' (church-ring) was reclamated for public space. The harbor lost its characteristic L-shape and the 'kerkring' lost its ditch (see figures 39. - 42.).

The delta city and landscape

Delta cities were founded at the main creek of a sand plate and built at the ring dike. Throught the centuries the cities developed in the polder, relating itself to the borders of infrastructure, dikes or the parcels of the polders. In this process the city crossed its own dikering, neglecting the historical context and filling in the creek to create housing and infrastructure. This process is irreversable.

The next chapter will provide a more indepth analysis of the urban form of the delta cities Oude Tonge and Ooltgensplaat and extend the argumentation of the relation between delta cities and landscape.

Figure 39. Harbor, Oude Tonge, 1910-1935
Photo by: *C. Steenbergh*
Source: *Rijksdienst voor het Cultureel Erfgoed, afdeling Gebouwd Erfgoed*
From: *www.geheugenvannederland.nl, 2012*

Figure 40. 'Oude Kerk' (Hervormd), Oude Tonge, 1910-1935
Photo by: *C. Steenbergh*
Source: *Rijksdienst voor het Cultureel Erfgoed, afdeling Gebouwd Erfgoed*
From: *www.geheugenvannederland.nl, 2012*

Figure 41. Harbor, Oude Tonge, 2012
Photo by: *N. den Besten*
Source: *Author, 2012*

Figure 42. 'Oude Kerk' (Hervormd), Oude Tonge, 2012
Photo by: *N. den Besten*
Source: *Author, 2012*

The urban form of Oude Tonge and Ooltgensplaat

Keywords:
Urban form
City Center
Infrastructure
Building typology

The urban form of Oude Tonge and Ooltgensplaat has grown significantly (see figures 45. and 46.). The first neighborhood is characterized by a 'kerk-ring-voorstraat' (church-ring-main street), the dike and infrastructure that connect the city with the polder landscape.

Figure 43. Main street and church, Ooltgensplaat, 2012
Source: *Author, 2012*

Figure 44. Harbor and church, Oude Tonge, 2012
Source: *Author, 2012*

Around 1850 the flour mills have provided a growth along the dike, called ´the molendijk´. This development continued till the WWII. At the same time the delta cities developed along the main polder infrastructure (Ooltgensplaat) or railroad (Oude Tonge).

Figure 45. Detailled growth and infrastructure of Oude Tonge
Source: *Author, 2012*
Date used: *Top 10 Vector Map, 2012; Map room, TU Delft Faculty of Architecture, 2011; watwaswaar.nl, 2011; Google Maps, 2011*

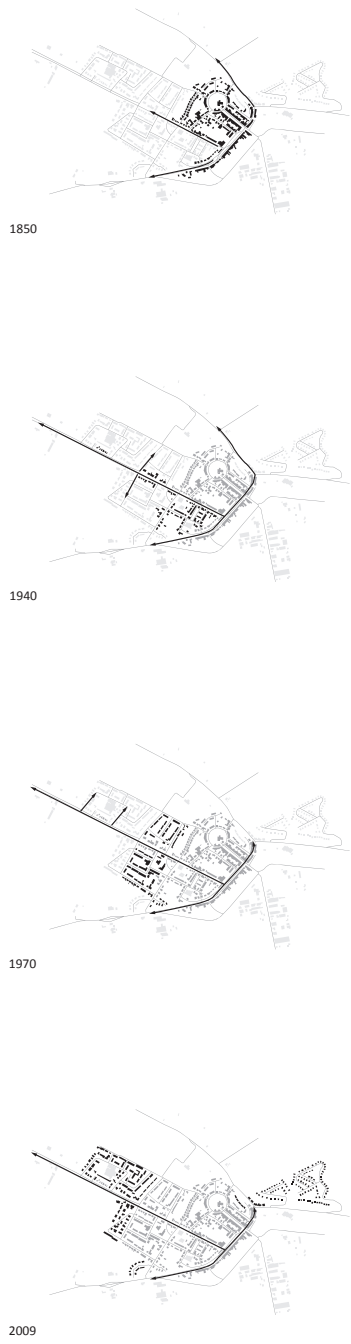
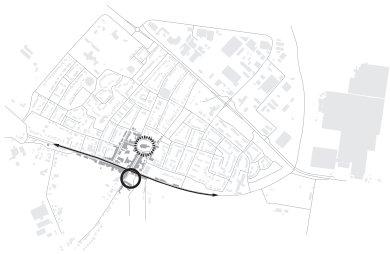
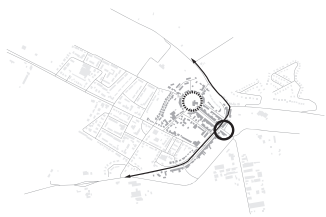


Figure 46. Detailled growth and infrastructure of Ooltgensplaat
Source: *Author, 2012*
Date used: *Top 10 Vector Map, 2012; Map room, TU Delft Faculty of Architecture, 2011; watwaswaar.nl, 2011; Google Maps, 2011*



1850

2009



1850

2009

City center
Church-ring-main street
Main infrastructure

Figure 47. Spatial transformation of Oude Tonge (Above) and Ooltgensplaat (Below)
Source: *Author, 2012*
Date used: *Top 10 Vector Map, 2012; Map room, TU Delft Faculty of Architecture, 2011; watwaswaar.nl, 2011; Google Maps, 2011*

The housing that characterized this development were labrorer or worker homes (see figures 48. and 49.).

Figure 48. Laborers' housing, Ooltgensplaat, 2012
Source: *Author, 2012*

Figure 49. Laborers' housing, Oude Tonge, 2012
Source: *Google Maps, 2012*

The urban development of Oude Tonge after the war continued by connecting te urban fabric of the housing at the dike and the housing at the railstation. In Ooltgensplaat the urban form followed the main infrastrcutural line in the polder.

Figure 50. Post-war housing, Oude Tonge, 2012
Source: *Google Maps, 2012*

When the fourth nota was in effect, VINEX-locations were build. In Oude Tonge these neighborhoods connected the main infrastrcuture line with the dike. And in Ooltgensplaat the delta city extended itself further along the main infrastructure line.

Figure 51. Vinex housing, Ooltgensplaat, 2012
Source: *Author, 2012*

The spatial transformation of Oude Tonge and Ooltgensplaat has two aspects. The transformation from dike oriented infrastructure to polder oriented infrastructure. And with this the shift of city centers.

Dike and polder oriented infrastructure
Both delta cities, Oude Tonge and Ooltgensplaat, were founded at the dike and extended in the polder landscape. The dike and the main infrastructural line formed the bases for further extension. This is also depicted in the figures 45 and 46. The maps also show a transformation in infrastructure, from a dike oriented infrastructure to a polder oriented infrastructure. The dike formed until the 1900's the main infrastructural line. Later it was the polder infrastructure that became the main infrastructural element.

Shifting city centers
As shown in figure 47., the harbor has lost its place as city center where trade, goods, daily city live and people were connected. Today (super)'markets' are placed along or near the main infrastructural elements in the urban fabric.
This is caused by the fact stated above. The harbor is not connected with the main infrastructure element. Water transport has throught the century transformed into road transport.

Figure 52. (Super)'market', Ooltgensplaat, 2012
Source: *Author, 2012*

This research can complement to the research done by Han Meyer and others, as published in the research of spatial transformations of small settlement in the western part of the Netherlands: 'Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland: 1850-2000' [Meyer et al., 2007].

In this publication of each town two sketches were made in a typological color style to vizualize the spatial transformation of the small settlements. For Oude Tonge and Ooltgensplaat the sketches are shown below.

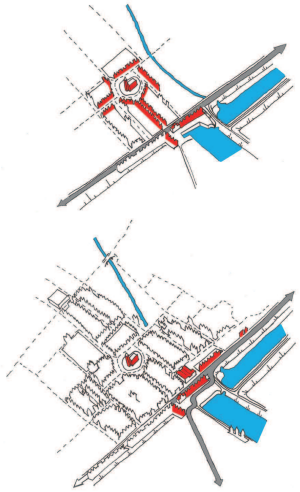


Figure 53. Spatial transformation, Oude Tonge, 1850-2009
Source: *Author, 2012*

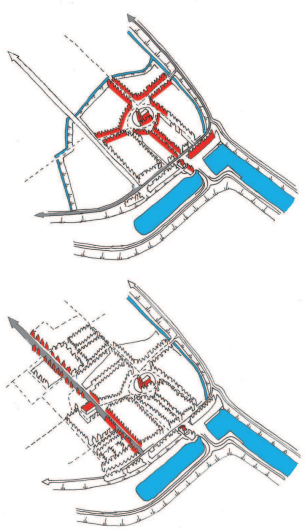


Figure 54. Spatial transformation, Ooltgensplaat, 1850-2009
Source: *Author, 2012*

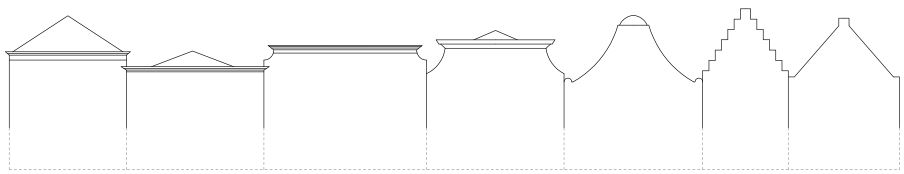
Historic housing of Oude Tonge and Ooltgensplaat

Keywords:
Historic housing
Rooftops
Window grid
Width
Flood defense

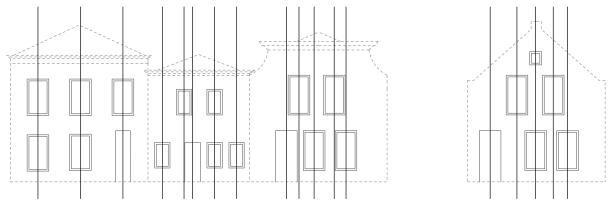
Oude Tonge and Ooltgensplaat contain historic housing, especially in the church-ring-main street, ‘molendijk’ and harbor area.

The housing are characterized by different rooftop styles, specific window grids and different building width as depicted in figure 55.. Figure 57. shows several of the unique historic houses.

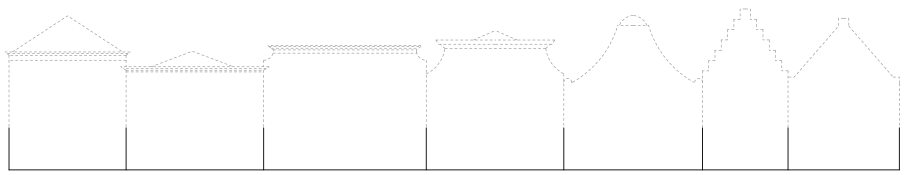
The historic buildings in the around the harbor of Oude Tonge have an integrated flood defense. The front door is elevated with 0,5m or 1,0m above street level. This solutions works also an other way, it solves also the height difference/slope of the dike.



Different rooftop typologies



3x3, 2x4, 2x3 or 1x2x3 window grid



Different width 5,5m - 10m

Figure 55. Form analysis of the historic housing
Source: *Author, 2012*

Figure 56. Flood defense integration in historic housing, Harbor Oude Tonge
Source: *Author, 2012*

Figure 57. Historic housing in Oude Tonge and Ooltgensplaat
Source: *Author, 2012*

The landscape of Southeast Goeree Overflakkee

Keywords:
Polder landscape
Flourmill
Creek

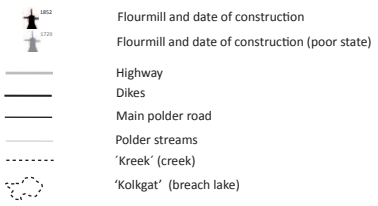
The polderlandscape of Goeree Overflakkee contains several important elements: the dikes, the main infrastructure of the dike, the creek and the flourmill. The flourmill or 'Korenmolen' is constructed around the 1750's - 1800's and is located near a dike and in the extent of a harbor. The dike is often called 'molendijk'.

The pattern of the polder landscape is rigid. It is characterized by a ring-dike that has followed the contours of former sand plates. The creek is the main drainage of rain water and the polder parcels are orientated at this creek for optimum discharge.

The landscape also indicate a 'kolkgat', or freely translated 'breach lake'. This is a result of a dike breach in the year 1953.

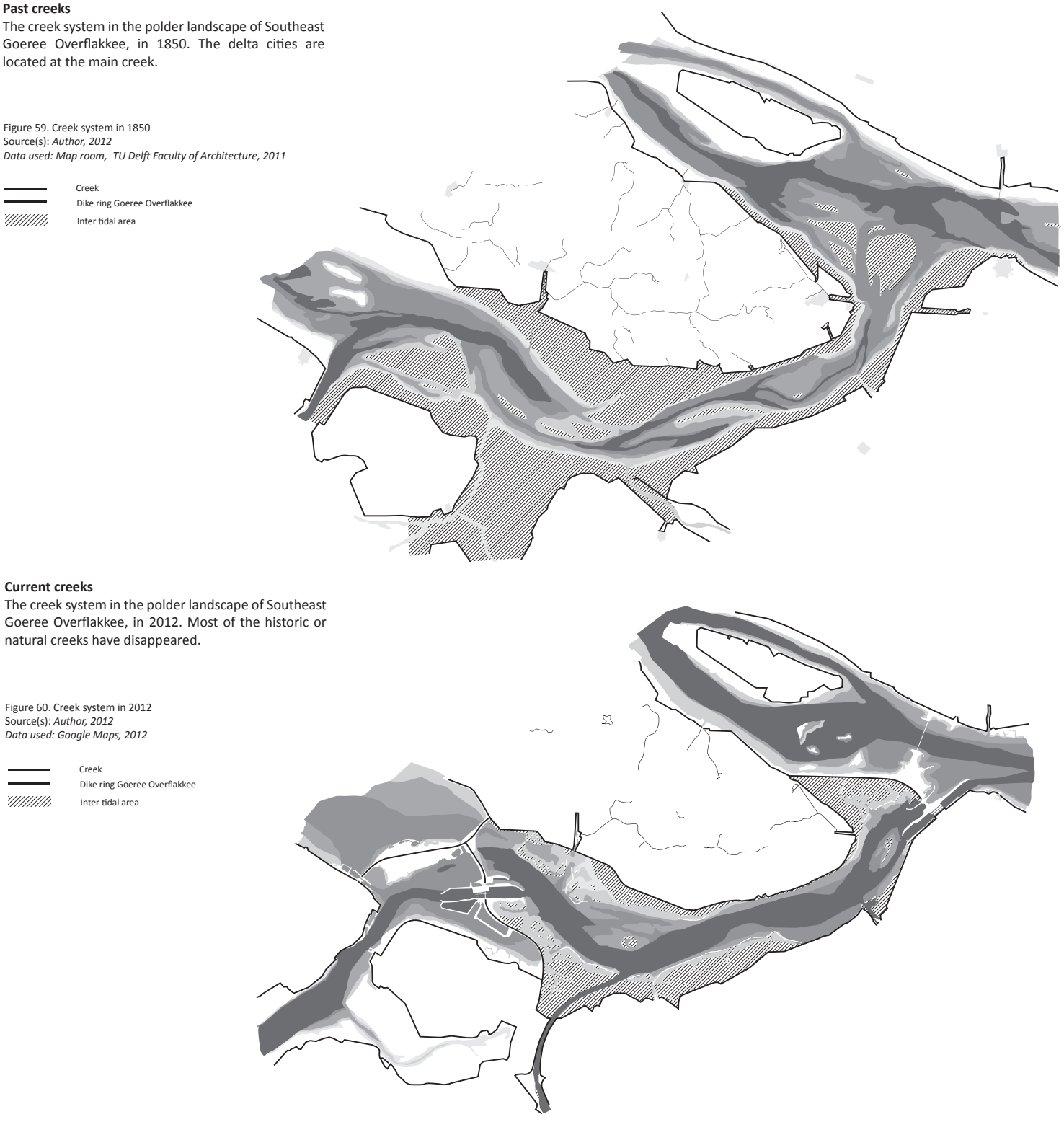
Through the centuries the landscape has lost its large and characteristic creek system. This could have to do with a lack of maintainance or the re-structering after the Watersnoodramp in 1953 when most of Oost-Flakkee was flooded.

Figure 58. Polder landscape, mills and creeks, 2012
Source(s): *Author, 2012*
Data used: *Google Maps, 2012; www.gomolens.nl, 2012; www.molens.nl, 2012*



Past creeks
The creek system in the polder landscape of Southeast Goeree Overflakkee, in 1850. The delta cities are located at the main creek.

Figure 59. Creek system in 1850
Source(s): *Author, 2012*
Data used: Map room, TU Delft Faculty of Architecture, 2011



Current creeks
The creek system in the polder landscape of Southeast Goeree Overflakkee, in 2012. Most of the historic or natural creeks have disappeared.

Figure 60. Creek system in 2012
Source(s): *Author, 2012*
Data used: Google Maps, 2012

Case Study

‘Wierden’ of the Waddenzee

Keywords:
Wierden
Terpen
Case Study

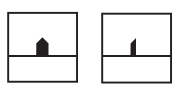
Earthern hills in the Netherlands and Germay go by different names: terpen, wierden, wuurden, worden, werden, vliedbergen, werfen (NL) and warfen, warften, wurten, wurthen, warben, wurften (DU). In the Netherlands ‘terpen’ (terps) is often used, but in this graduation project the term ‘wierden’ will be used. This has to do with the root of the word: terps refers to village or town and wierden refers to the earthern hill itself [Berendsen, 1997].

The case study on ‘wierden’ aims to obtain design inspiration for the landscape and urban composition of the ‘wierden’ in the graduation project. Acquired inspiration should contain characteristic elements or forms of vegetation, parcelation, infrastructure and the relation with water.

The cases: Hogebeintum, Niehove, Hallig(en) and Westerhever are located in the Wadden-area (northern Holland and northwestern Germany). In addition the case of Marken in the IJsselmeer. See also the figure on the right. The reason to choose this direction of study and these cases is that the majority of ‘wierden’ in the Belgium & Dutch Southwest Delta have dissappeared due to the excavation of soil. It often contained high levels of phosphorus and was used as a fertilizer for agricultural needs [Berendsen, 1997]. The ‘wierden’ in the Waddenzee area provide excellent and inspirational cases due to the different building traditions it covers, both Dutch and German. And in addition, the cases relate differently to water(hazard).

For each case a brief (historic) description will be given to relate to the context of the ‘wierde’. Also spherical impressions, reduction maps to understand the structure of the urban form and landscape, height maps and icons to describe the main features of the cases. The icons relate to:

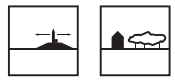
The housing type, if it is permanantly inhabited or is temporarly used for recreation.



The relation between the height of the ‘wierde’ and the maximum water level, in time of construction. Because through the course of history the context or urban landscape has changed.

The current context. If the wierde is surrounded by only vast land, by dikes or in a tidal area.

Typical characteristics of ‘wierden’. If it contains a ‘hof’ or garden (often with a pool for fresh water storage) or buildings functions as a landmark.



The conclsion of this case study will be a direction for the design of the urban form on the terps in the design project. And a summary of different characteristics and elements of ‘wierden’ that can be used in the design project.

Figure 61. The cases
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*


Hallig - Nordstrandischmoor, Schleswig-Holstein, DU
Hallig - Hooge, Schleswig-Holstein, DU
Westerhever, Schleswig-Holstein, DU
Niehove, Groningen, NL
Hogebeintum, Friesland, NL

Figure 62. Impressions Hogebeintum, NL
Source(s): *Google Pictures "Hogebeintum", 2012*
Modification: *Black & White, Photoshop*

Hogebeintum, Friesland, NL
Hogebeintum or officially Hegebeintum is one of the villages in the municipality of Ferwerderadeel in Friesland. In 600 BC, the 'wierde' of Hogebeintum was recorded to be inhabited. With a current 98 inhabitants it is a relatively small village.

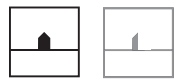
Through the centuries the height of the 'wierde' Hogebeintum has decreased by soil subsidence. However, with 8,80m +NAP it is the highest 'wierde' of the Netherlands. The earthen hill has also been excavated (1896 - 1905) in a great extense for agricultural use.

Urban composition: A 11th century Roman church is located at the center of Hogebeintum. There is a main route crossing the 'wierde' and connecting both the church and the housing. The houses are located in a random composition on the 'wierde'.

Landscape elements: The church functions as a landmark in the surroundings polder landscape. The 'wierde' has a border consisting of a hedge or fence with trees. Providing shelter for the wind.

Relation with water: The 'wierde' used to have a relation with water, but with the construction of dikes, the 'wierde' is not under affect of any waterhazard.

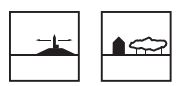
Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context:

Characteristics:



Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

Figure 63. Reduces map of Hogebeintum
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Figure 64. Height mapping of Hogebeintum
Source(s): *Author, 2012*
Data used: *www.ahn.nl, AHN v2, 2012*

Figure 65. Impressions Niehove, NL
Source(s): *Google Pictures "Niehove", 2012*
Modification: *Black & White, Photoshop*

Niehove, Groningen, NL
Niehove is a village in the municipality of Zuidhorn and inhabits 285 people. The village used to be known as 'Suxwort' or 'Suxwerd' (Zuiderwierde), the main village of the Wadden Isle Humsterland.

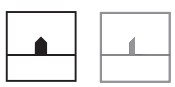
The name of Niehove refers to court (hof) that in the early Medieval Ages provided justice.

Urban composition: A 13th century church forms the center of the 'wierdendorp' that has a radial structure of infrastructure and housing. The houses are with the back to the polder landscape, pointed at the church.

Landscape elements: The church functions as a landmark in the surroundings polder landscape and is surrounded by a circular treeline.

Relation with water: The 'wierde' used to have a relation with water, but with the construction of dikes, the 'wierde' is not under affect of any waterhazard.

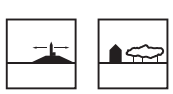
Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context

Characteristics



Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

Figure 66. Reduces map of Niehove
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

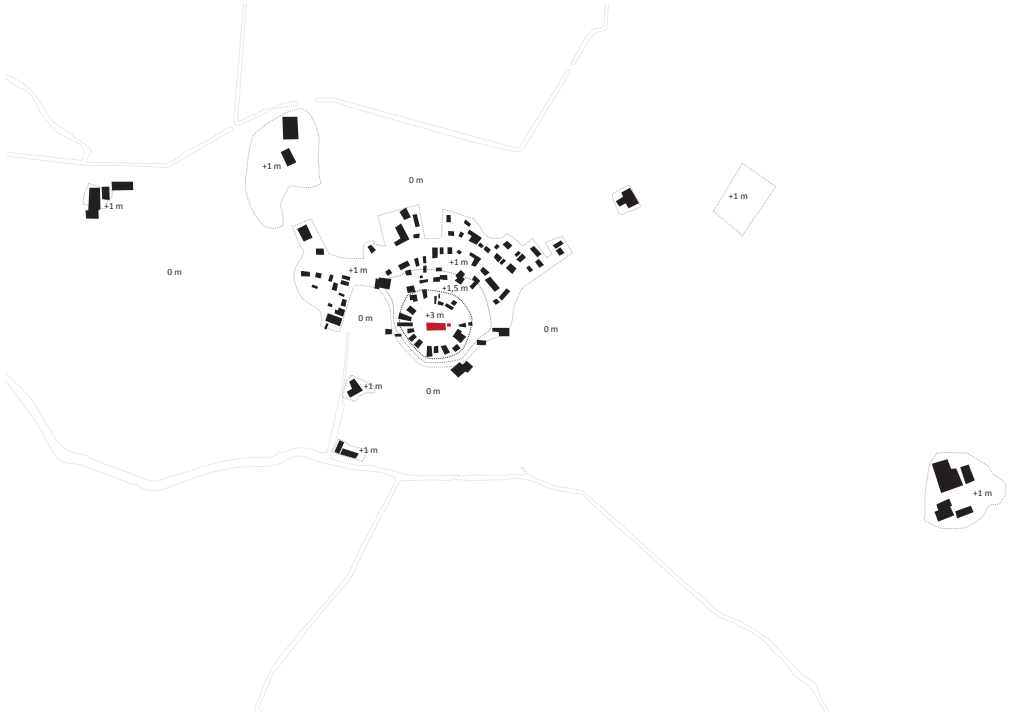


Figure 67. Height mapping of Niehove
Source(s): *Author, 2012*
Data used: *www.ahn.nl, AHN v2, 2012*

Figure 68. Impressions Hallig - Hooge, DU
Source(s): *Google Pictures "Halig Hooge", 2012*
Modification: *Black & White, Photoshop*

Hallig - Hooge, Schleswig-Holstein, DU
Hallig or Halligen consist of 10 different islands in the northern part of German Waddenzee. In the salt marshes (kwelders) livestock is kept, consisting of mainly sheep. Hallig is next to a large tourist attraction the location of summer houses on 38 'wierden' and providing home to 256 people.

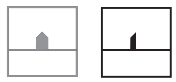
The island Hooge is one of two islands that are not directly connected to the main land and inhabits 83 people. The 'wierden'-island is nowadays surrounded by a summer dike of 1,5m.

Urban composition: Almost each house on the 'wierde' has an own connection with the surrounding infrastructure. The housing is placed randomly over the surface of the 'wierde' and oriented towards the surrounding landscape.

Landscape elements: On the 'wierde' is a community garden with a pool. The pool functions as a fresh water storage.

Relation with water: The 'wierden' of Hallig are 3 meters at maximum, not high enough for extreme storms. The housing on the 'wierden' contain an independant inner-construction of oak beams that support the roof and attic to provide a safe room during storm surges.

Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context:

Characteristics:

Figure 69. Reduces map of Halig - Hooge
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

Figure 70. Height mapping of Halig - Hooge
Source(s): *Author, 2012*

Figure 71. Impressions Hallig - Nordstrandischmoor, DU
Source(s): *Google Pictures "Hallig Nordstrandischmoor", 2012*
Modification: *Black & White, Photoshop*

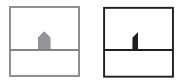
Hallig - Nordstrandischmoor, Schleswig- Holstein, DU
The island Nordstrandischmoor is one of two islands that are directly connected to the main land by a small railroad on a dam, it inhabits 18 people. The 'wierden'-island is nowadays surrounded by a summer dike of 1,5m.

Urban composition: The urban composition of Nordstrandischmoor is comparable to the one of Hooge, but a difference is found in the form of a single house on a 'wierde'.

Landscape elements: The 'wierden' on Nordstrandischmoor do not contain characteristic landscape elements. This could relate to the fact that the island floods 48 times a year and salt intrusion disables (large) vegetation from growing.

Relation with water: The 'wierden' of Hallig are 3 meters at maximum, not high enough for extreme storms. The housing on the 'wierden' contain an independant inner-construction of oak beams that support the roof and attic to provide a safe room during storm surges.

Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context:

Characteristics:

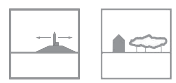


Figure 72. Reduces map of Hallig - Nordstrandischmoor
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

Figure 73. Height mapping of Hallig - Nordstrandischmoor
Source(s): *Author, 2012*

Figure 74. Impressions Westerhever, DU
Source(s): *Google Pictures "Westerhever", 2012*
Modification: *Black & White, Photoshop*

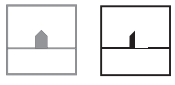
Westerhever, Schleswig-Holstein, DU
The 'wierde' at Westerhever is located at the far end of the Eiderstedt Peninsula. The salt marshes (kwelders), beaches and the characteristic lighthouse attract around 80.000 visitors a year.

Urban composition: The urban composition of Westerhever is orthogonal, almost on a grid. The two houses, former lighthouse keeper homes, are directed towards the coast.

Landscape elements: The lighthouse is a characteristic landmark in the region. The 'back' of the houses are procted against wind by a wooden fence. There is some vegetation.

Relation with water: The 'wierden' of Westerhever is just high enough to no get flooded. As shown in the picture on the left.

Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context:

Characteristics:

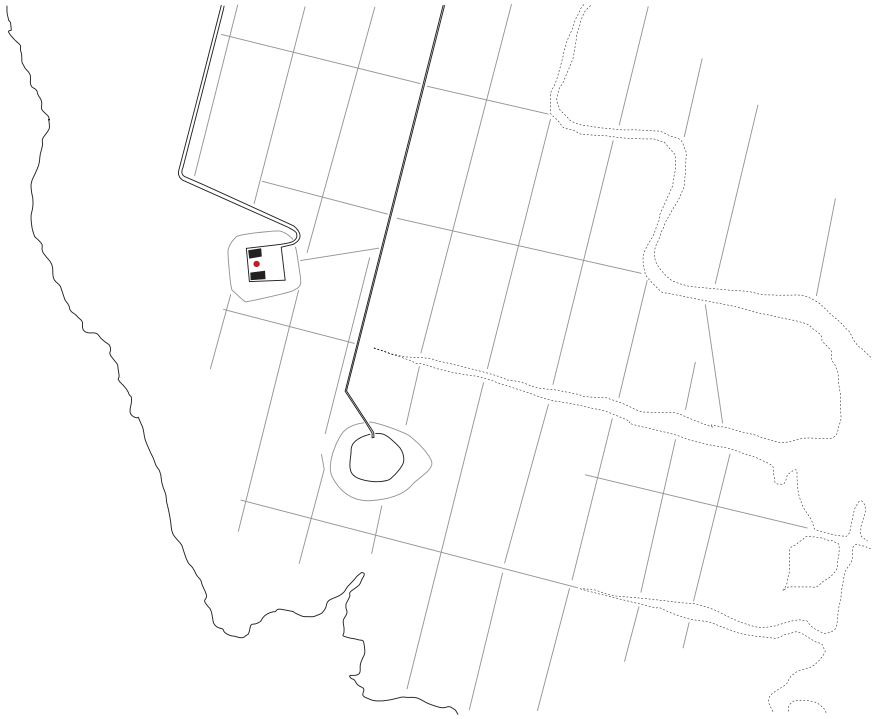


Figure 75. Reduces map of Westerhever
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

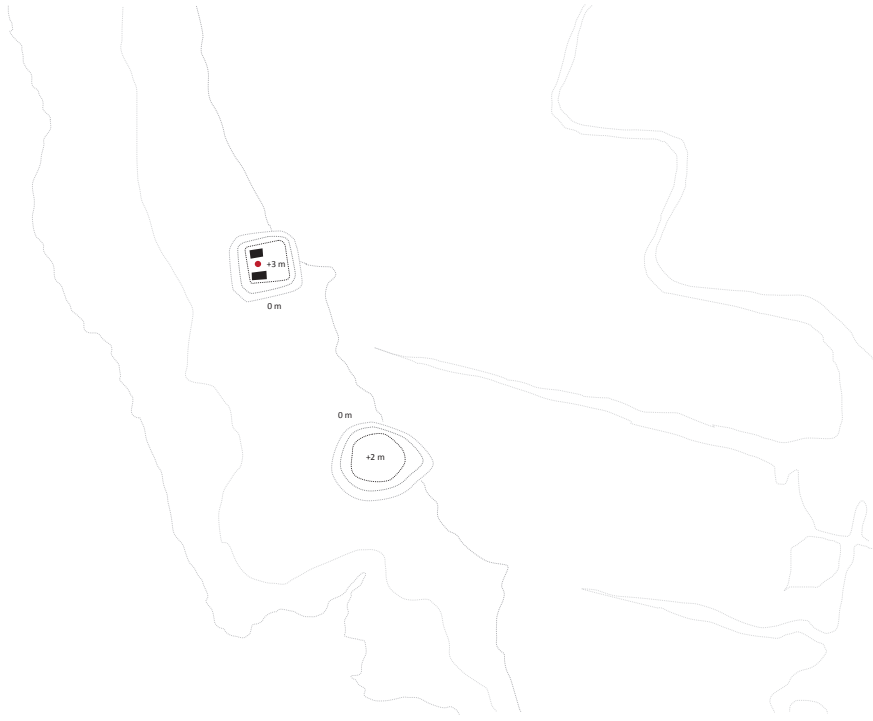


Figure 76. Height mapping of Westerhever
Source(s): *Author, 2012*

Figure 77. Marken, NL
Source(s): *Google Pictures "Marken", 2012*
Modification: *Black & White, Photoshop*

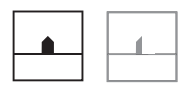
Marken, Noord-Holland , NL
The 'wierden' at Marken are located near Amsterdam, in the Markermeer. In 2004, the island was inhabited by a total of 1900 people. Marken was a former island in the 'Zuiderzee'. In 1957 it was connected to the main land by a dike. The island is a touristic area, due to the housing and traditional clothing.

Urban composition: The urban composition of the 'wierden' on Marken are similar to the ones on Hallig I. The housing is clustered on a earthern hill and oriented on the landscape. But with one or two acces routes. One of the 'wierden' is integrated with a dike.

Landscape elements: The 'wierden' on Marken do not contain characteristic landscape elements.

Relation with water: In times where the fishing industry bloomed the housing were also built on poles. But with the closing of the 'Zuiderzee' by the 'Afsluitdijk' the ground floor was transformed into an usable floor (shown in the picture on the left where stairs are connected to the first floor).

Housing type (Permanent/Recreation):



Relation flood level and terp heigth (in time of construction):

Current context:

Characteristics:

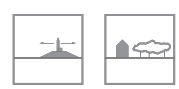


Figure 78. Reduces map of Marken
Source(s): *Author, 2012*
Data used: *Google Maps, 2012*

Roads / Courts
Water body
Parcels polder
Occupation
Landmark / Orientation point

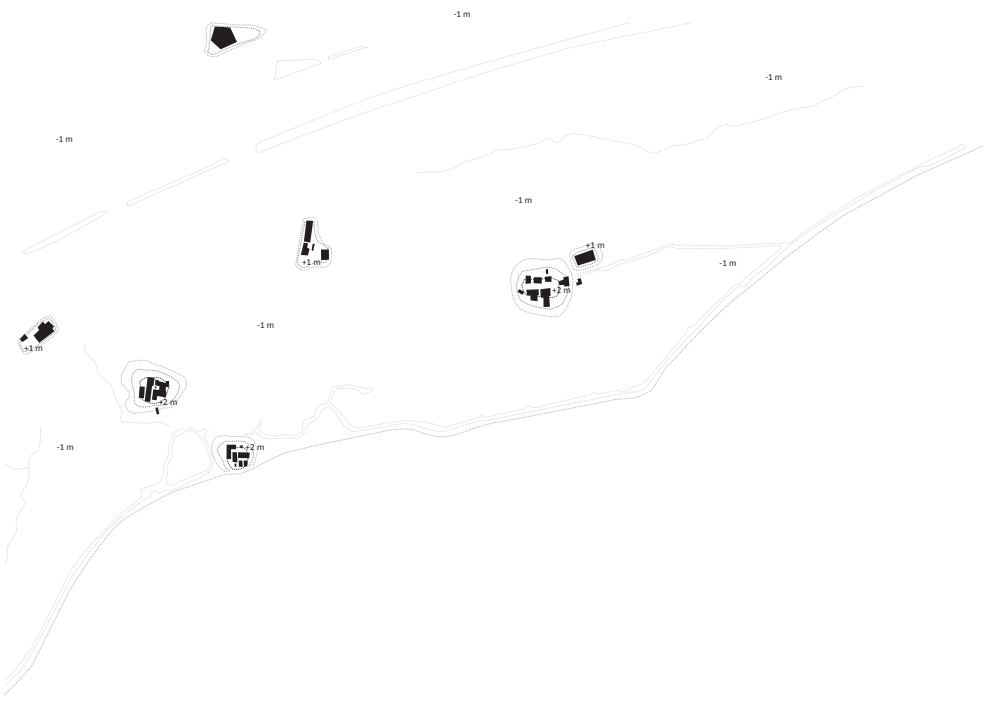


Figure 79. Height mapping of Marken
Source(s): *Author, 2012*
Date used: *www.ahn.nl, AHN v1, 2012*

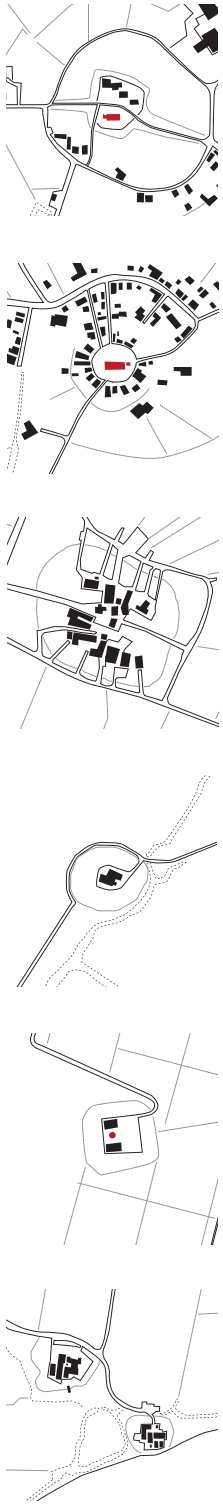


Figure 80. 6 Footprints of the urban composition of ‘wierden’.
Source(s): *Author, 2012*

Urban form
The urban form of the ‘wierden’ differs in may ways. Some have a free composition, like Hogebeintum, Hallig and Marken. Others a more organized composition like Niehove and Westerhever.

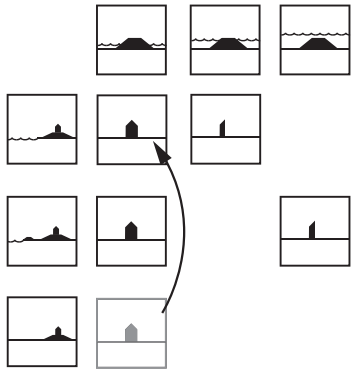
A comparison between the different forms provides or suggests a tendancy of larger settlements to contain a court-like structure with a garden (’hof’), public space or landmark in the center.

There is a strong relation between the surface of the ‘wierde’ and the amount of buildings. There is also the tendancy of tight clustering in larger settlements to efficiently use the surface of the ‘wierde’. In addition, the clustering of the housing follows the curve of the ‘wierde’.

The ‘wierden’ are founded between the early and late Medieval Ages. Traditional housing characterizes the ‘wierden’.

Housing type and water hazard
The study implies also a relation between housing type and water hazard. Larger settlements or villages with permanent occupation are built on higher ‘wierden’ (in relation to maximum water level). While smaller communities of recreation housing or larger scale summerhousing have a potential high risk of flooding.

Note: The case of Hogebeintum and Niehove depict a conflict. Their current context is not related to water. But where once related to water.



Design project
The case study provides some relevant design tools or ideas for the design of terpt in my research and design project. Summarized:

The ‘wierden’ have a court-like structure with a garden, public space or landmark.

The (larger) ‘wierden’ contain a cluster of housing following the curve and surface of the ‘wierde’. Orienteted to the surrounding landscape or inner garden, public space or landmark.

The architecture of the ‘wierde’ is traditional and context related.

Permanent occupation should have no risk of water hazard in the sense of flooding.

Recreational housing or summerhouses could have a small or large risk of water hazard in the sense of flooding.

Literature:

BERENDSEN, H.J.A. (1997). *Landschappelijk Nederland: Fysische geografie van Nederland*. Assen: Van Gorcum

Design process

Modelling

Sandbox design

Keywords:
Model
Sand
Variants
Creeks

The first design concept was to manipulate the sedimentation process to provide nature, natural water defense and to research a desirable form of landscape.

In this study model real sand was used to research form. When working with this model and thinking about the polder creeks. The idea emerged to restore the historic creeks and to connect them to the creek/canal that keeps the harbor open. With a restored sediment process, the sedimentation of the canal is also re-introduced.

When studying different variants the variant of multiple sand plates provide some tension in the design that started to look similar to the current situation in the Krammer Volkerak. This model also provided a solution to create a safer shipping route for recreation boats. By seperating them form the cargo route between Antwerp and Rotterdam.

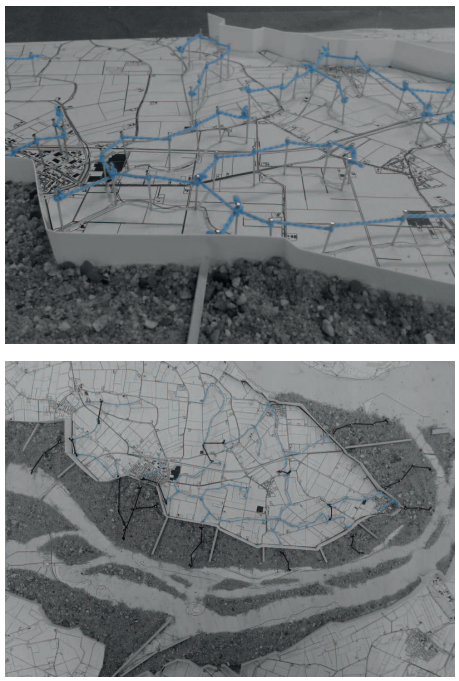


Figure 81. Final impressions sandbox model
Source(s): *Author, 2012*
Model by: *Author, 2012*

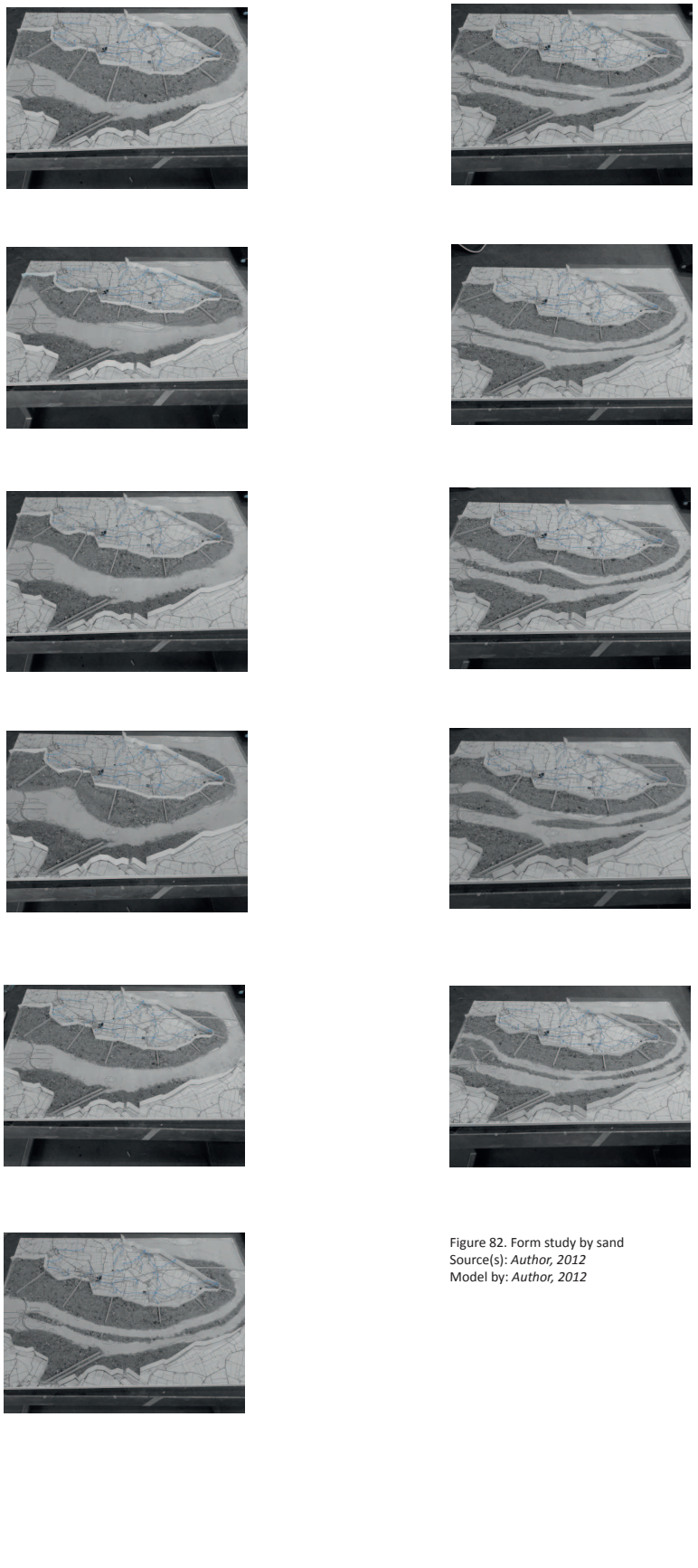


Figure 82. Form study by sand
Source(s): *Author, 2012*
Model by: *Author, 2012*

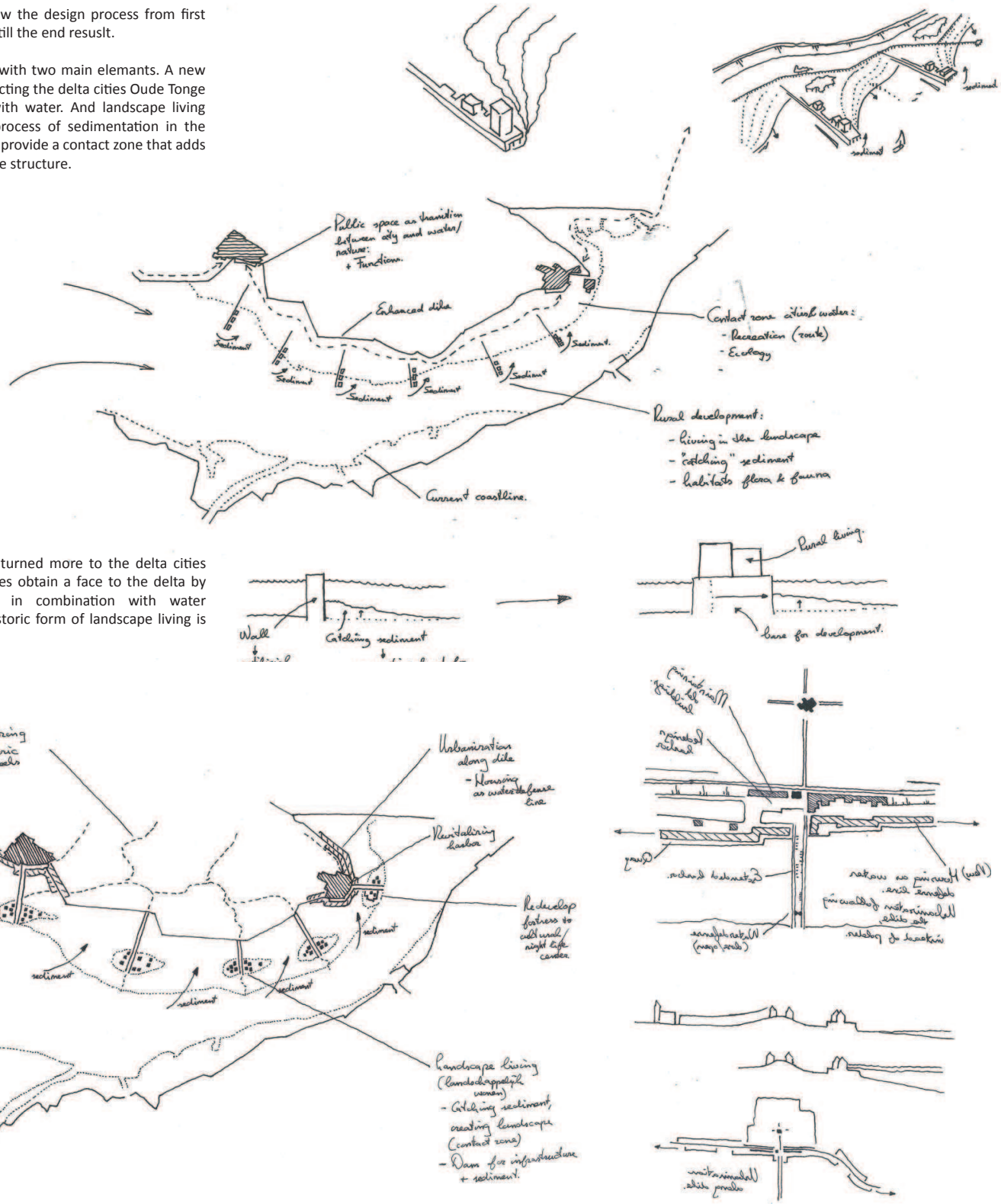
sketch process

The Thinking Hand

Keywords:
Design process
Sketches
Transparant paper
Fine liner
Form study

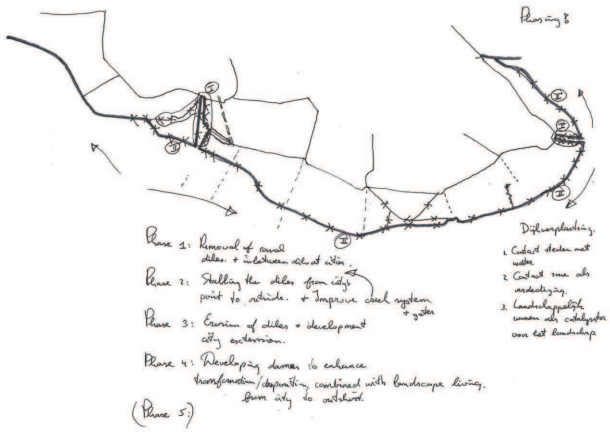
This chapter will show the design process from first concept or plan idea till the end resuslt.

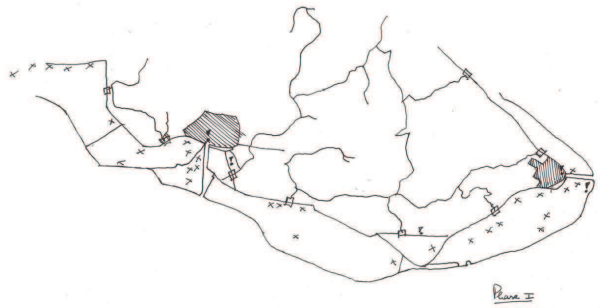
The concept started with two main elemants. A new intertidal zone connecting the delta cities Oude Tonge and Ooltgensplaat with water. And landscape living that enhances the process of sedimentation in the Krammer Volkerak to provide a contact zone that adds to the water defensive structure.

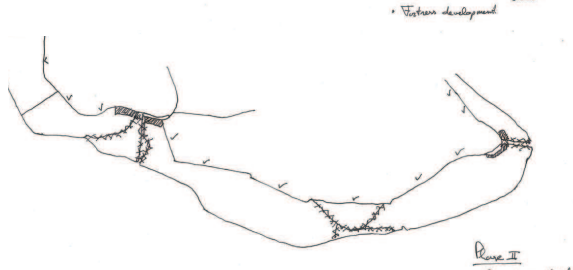


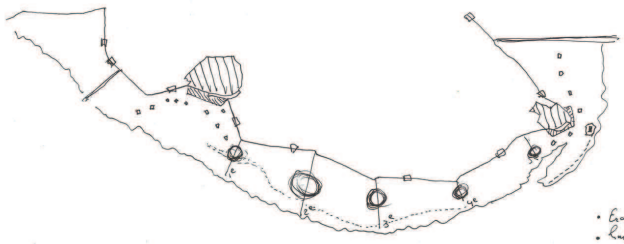
The focus of design turned more to the delta cities itself. Where the cities obtain a face to the delta by developing housing in combination with water defenses. A more historic form of landscape living is used: the “wierde”.

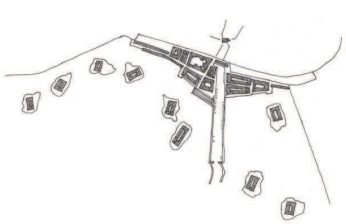
The current economic situation and political decision-making demands a phasing of a plan of this magnitude. Phasing that is flexible and provides socio-economic, natural, cultural, technical and esthetic value.

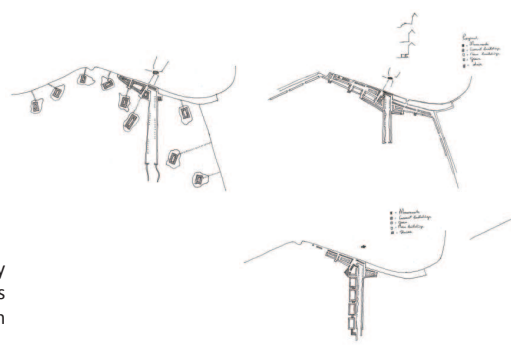






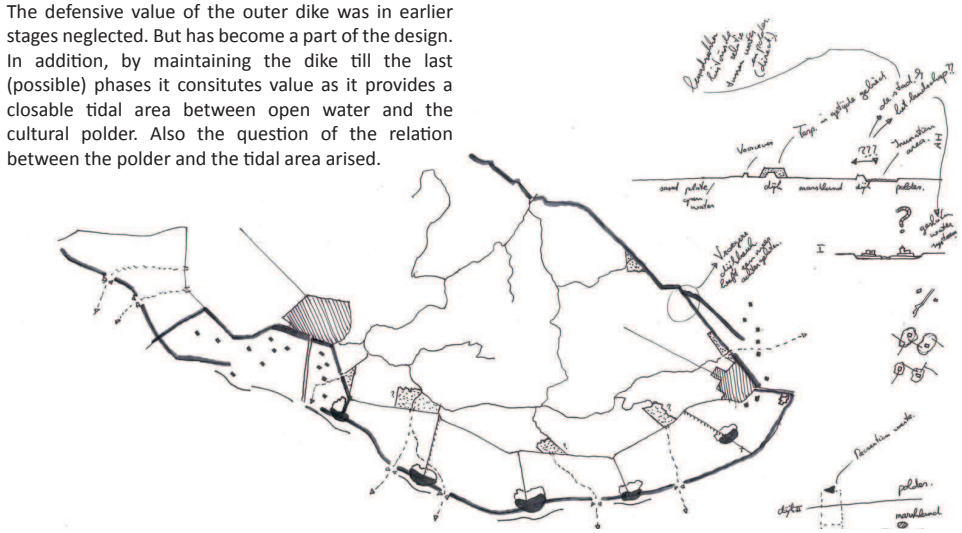




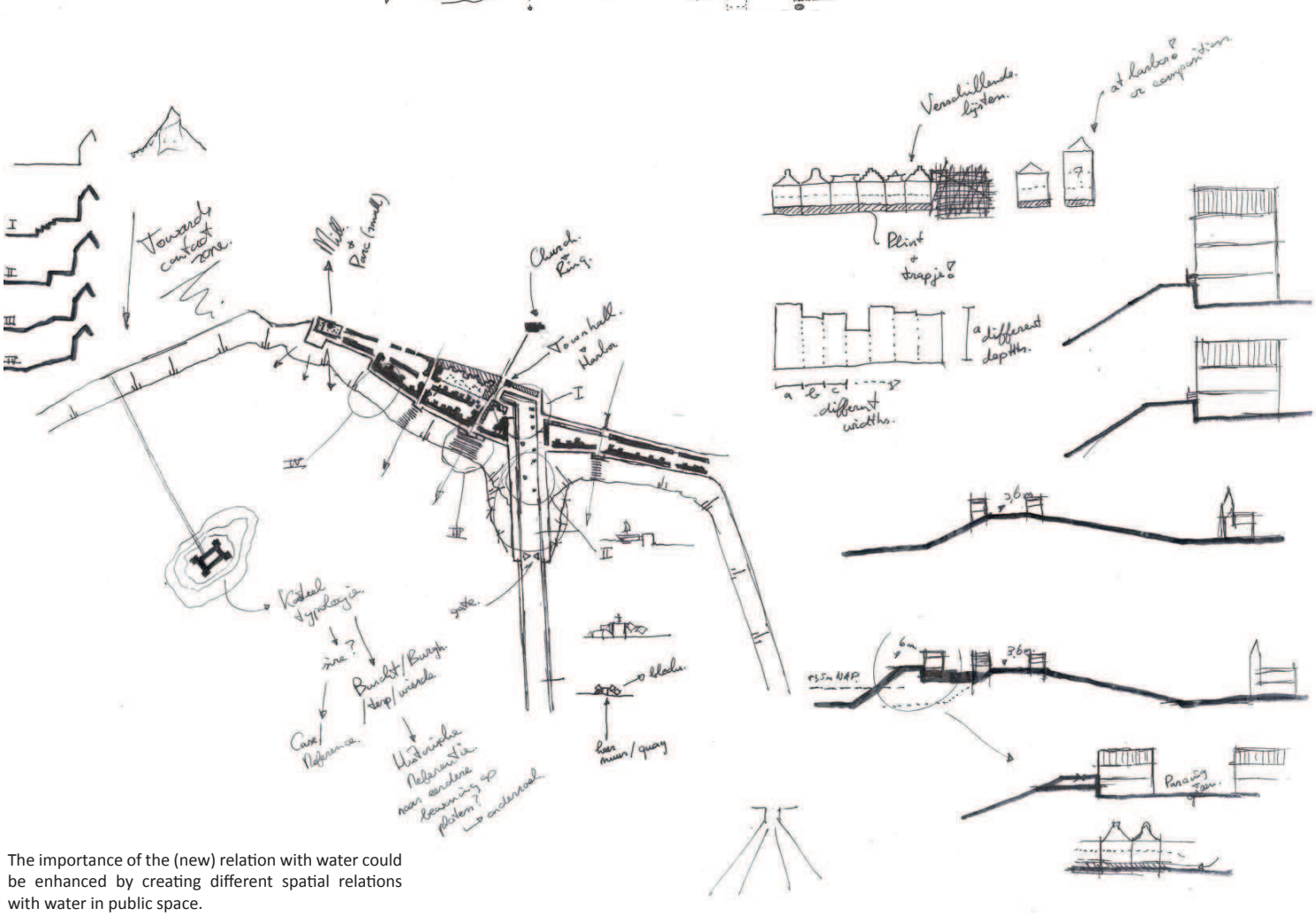


The extension of Oude Tonge was researched by different sketch variants. However a lot of sketches were made, it didn't have the right argumentation only than urban form.

The defensive value of the outer dike was in earlier stages neglected. But has become a part of the design. In addition, by maintaining the dike till the last (possible) phases it consitutes value as it provides a closable tidal area between open water and the cultural polder. Also the question of the relation between the polder and the tidal area arised.

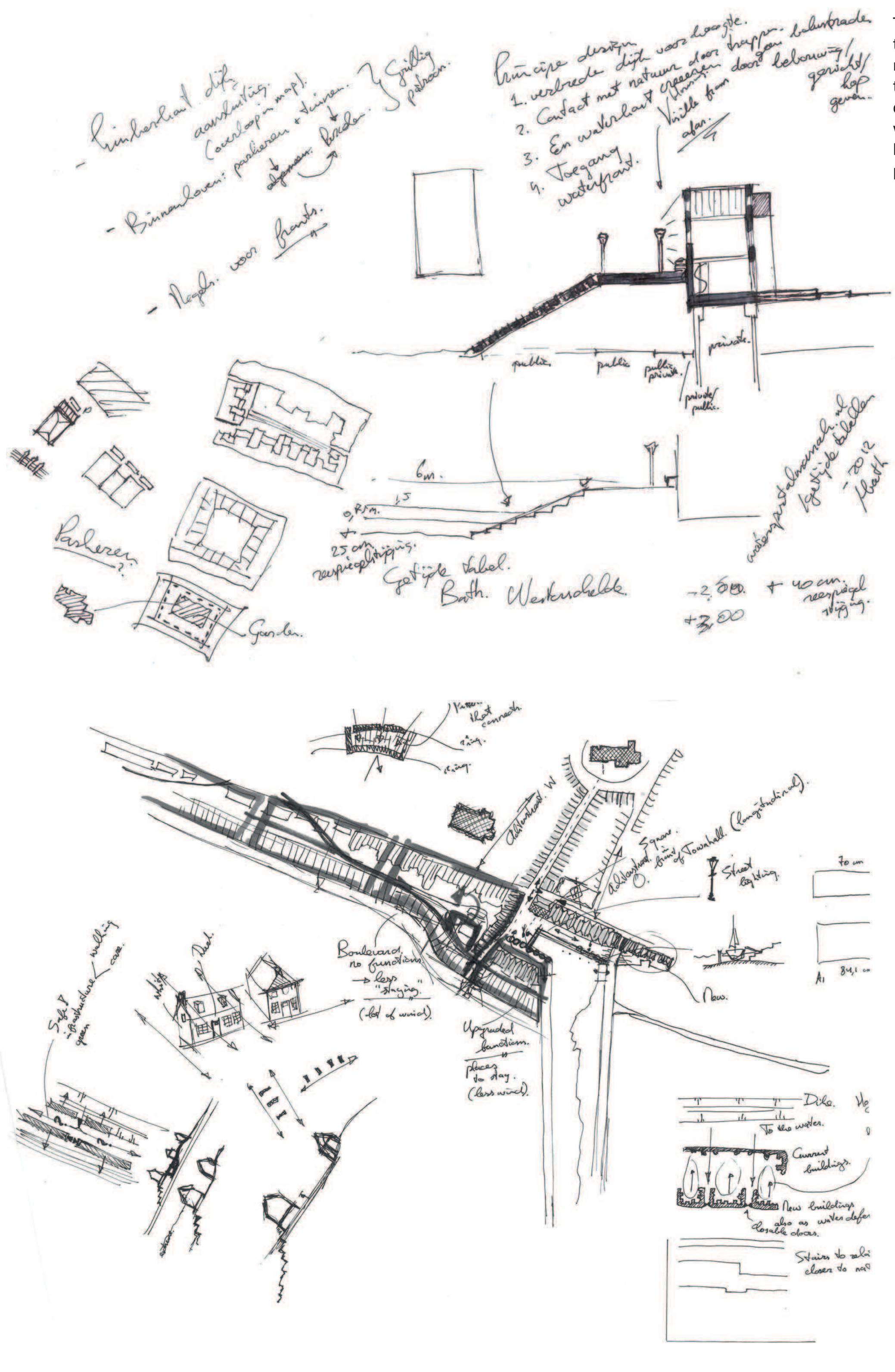


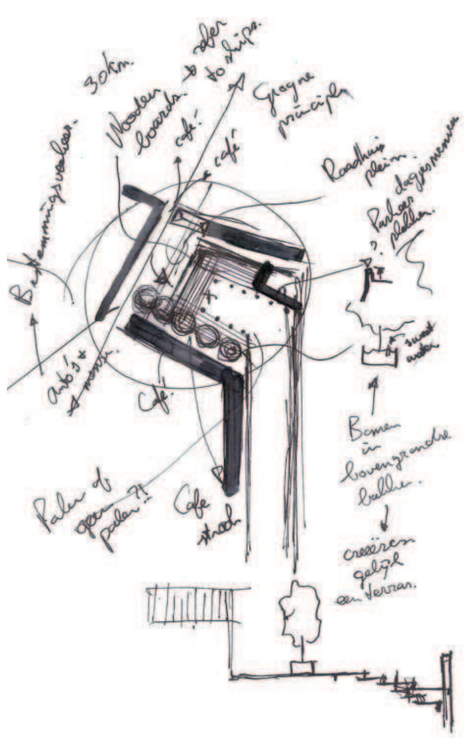
With this approach of maintaining the dike, the conceptial idea emerged to combine the extension with a stronger water defense (prepared for the future. Earlier sketches of different urban forms were not in vain and the concept is combined with these variants.

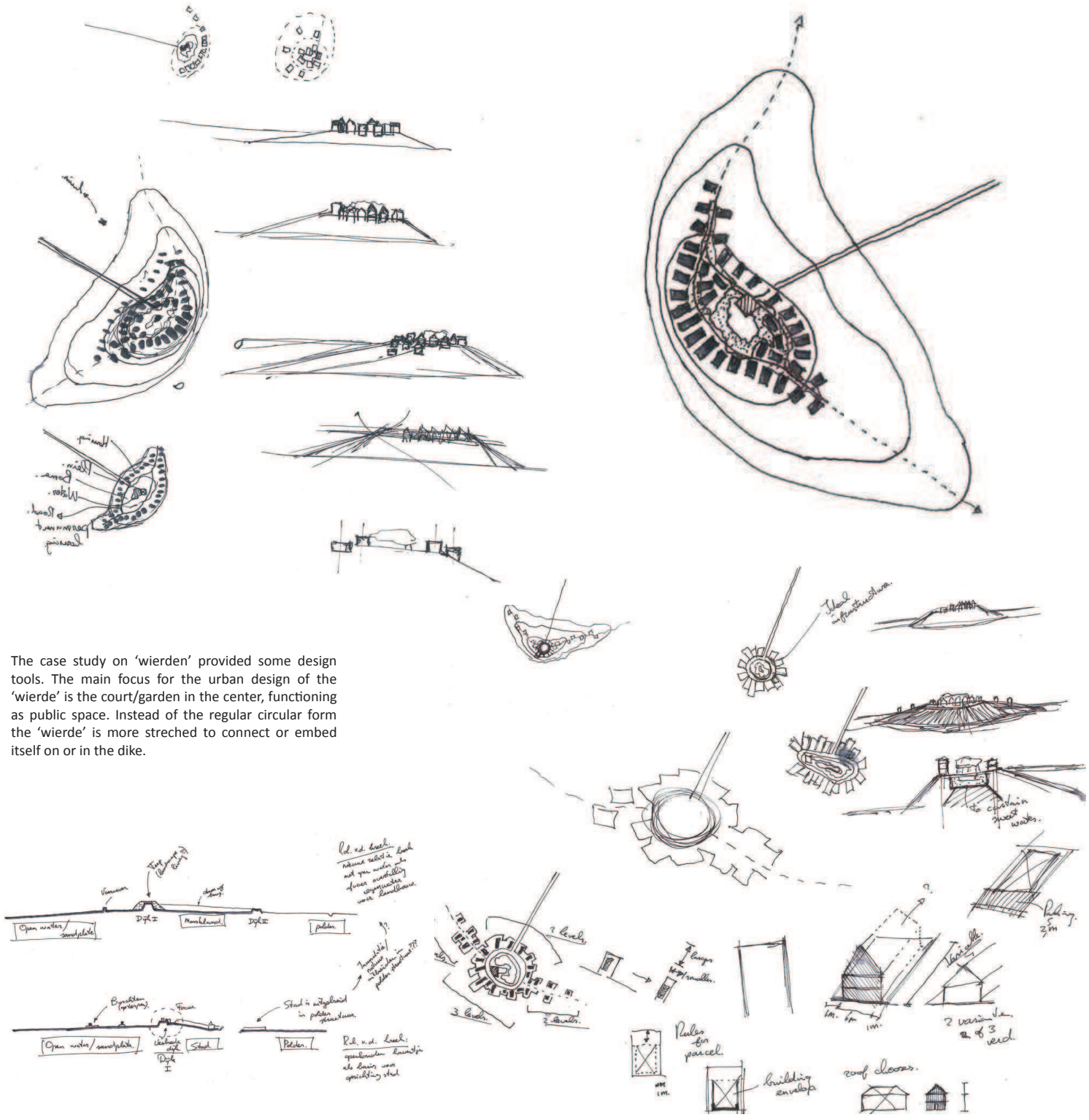


The importance of the (new) relation with water could be enhanced by creating different spatial relations with water in public space.

The urban design started to obtain shape and depth. The extension had to bridge the height difference of the old dike to the new dike. The harbor was placed more in the center of axis. Where the mainstreet of the church to the inter tidal area and the (shipping) canal come together. Also the L-Shape of the harbor was re-introduced. Not in a historic sense as a trade harbor but as a square with stairs that should bring people closer to the water.

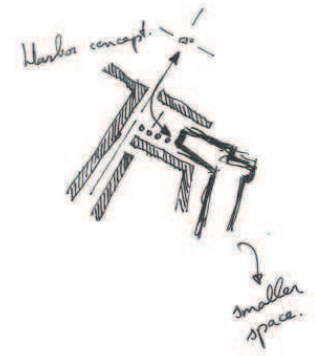


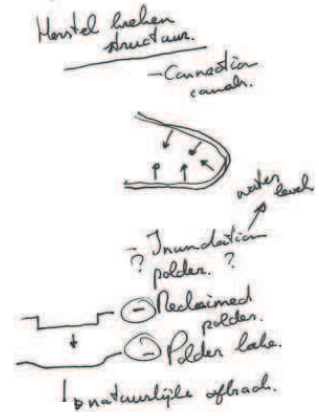


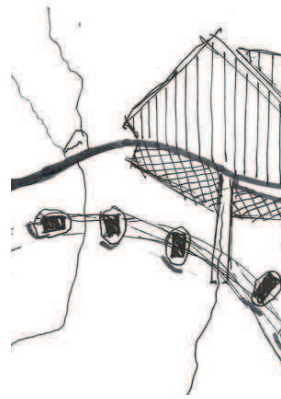


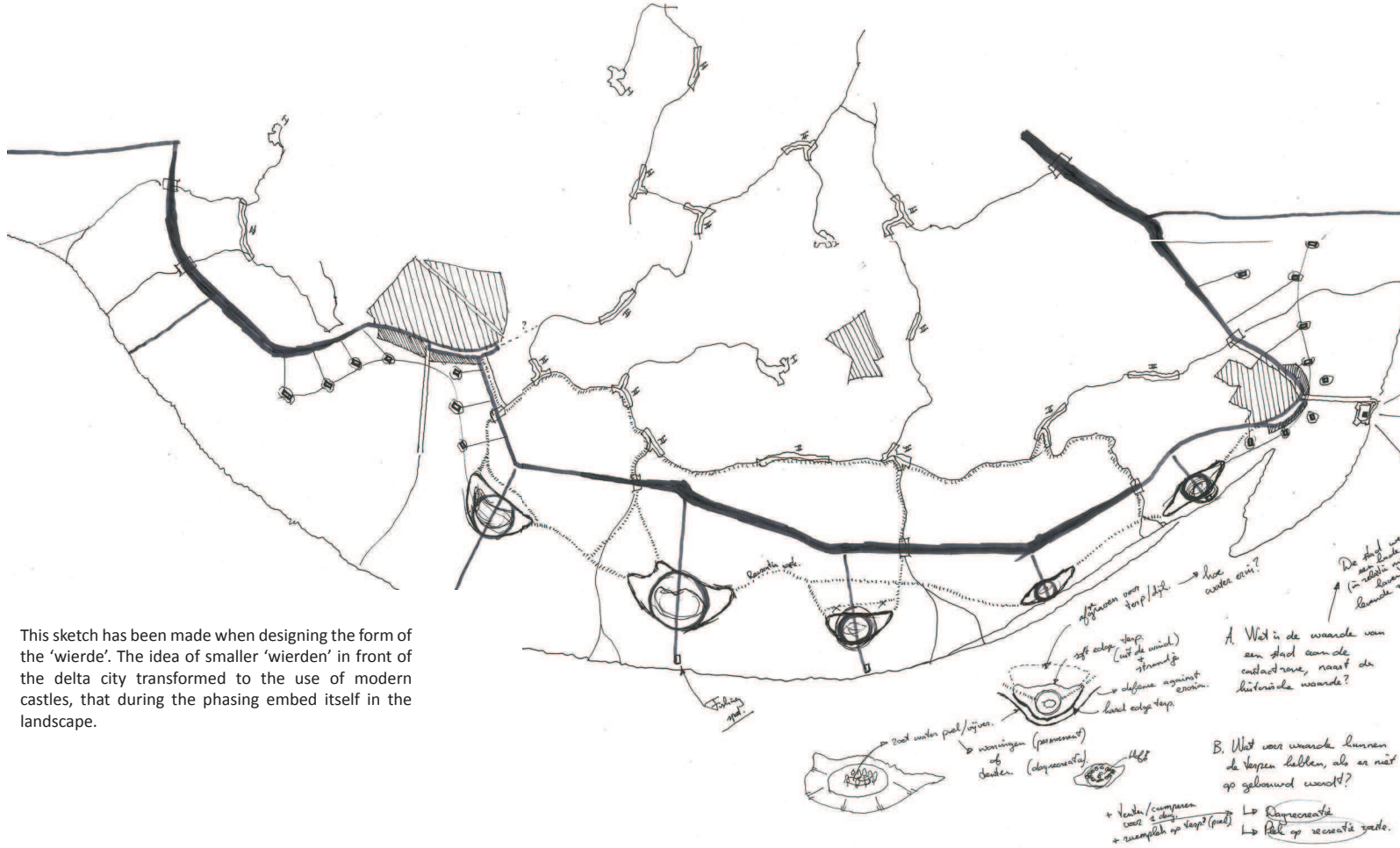
The case study on ‘wierden’ provided some design tools. The main focus for the urban design of the ‘wierde’ is the court/garden in the center, functioning as public space. Instead of the regular circular form the ‘wierde’ is more streched to connect or embed itself on or in the dike.

Agriculture deals with both fresh water shortage (internal salinization) and fresh water abundance (heavy rainfall destroys crops). To provide a solution the historic creek system is restored and expanded to store fresh water in drought and rainfall.

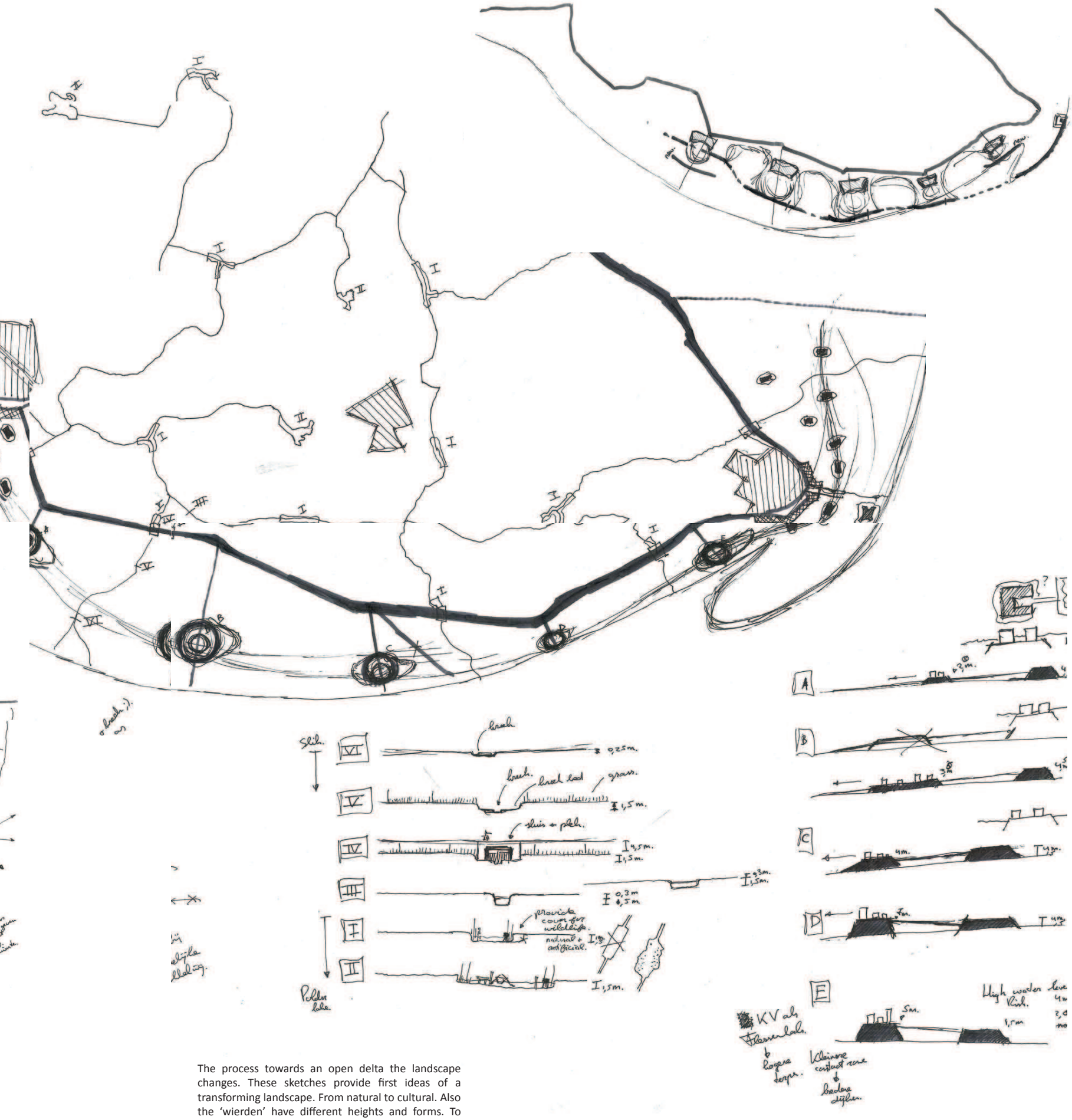








This sketch has been made when designing the form of the ‘wierde’. The idea of smaller ‘wierden’ in front of the delta city transformed to the use of modern castles, that during the phasing embed itself in the landscape.



The process towards an open delta the landscape changes. These sketches provide first ideas of a transforming landscape. From natural to cultural. Also the ‘wierden’ have different heights and forms. To relate differently to water.

Design

introduction

Designing a possible open delta

Keywords:
Delta design
Urban landscape
Urban form
Urban design
Public space
Vizualizations

The design of the urban landscape of the Krammer Volkerak is made in different scales and different phases. The design is not a difinive proposal but a possible future for the Krammer Volkerak in an open Dutch Southwest Delta.

The design is divided into two topics. The phasing of the urban landscape plan with vizualizations and sections. And the urban design covering the urban extension and the design of the ‘wierde’.

The next chapter provides the 10 different phases towards an open delta in which the value of the phase, the timeline, any water level fluctuations and a brief description. The phases are also linked to the problems icons or statements of the problem statement chapter in the graduation framework.

The section, accompanied with photoshop vizualization, provide an possible impression of an open delta. Indicating how it looks like and the value that it constitutes.

This is followed by the urban design of the urban extension of Oude Tonge. Explaining the concept and showing the design in maps and sections. In which especially the relationship between the urban space and water is important.

After the urban extension, the design of the ‘wierde’ is displayed. The design is based on the case study research on ‘wierden’ and implements some characteristic elements found in that research.

urban landscape plan

A sustainable process towards an open delta

Keywords:
Plan phasing
Sustainable process
Open delta
Krammer Volkerak

Phase I
Current situation
Goeree Overflakkee
Oude Tonge
Ooltgensplaat
Krammer Volkerak

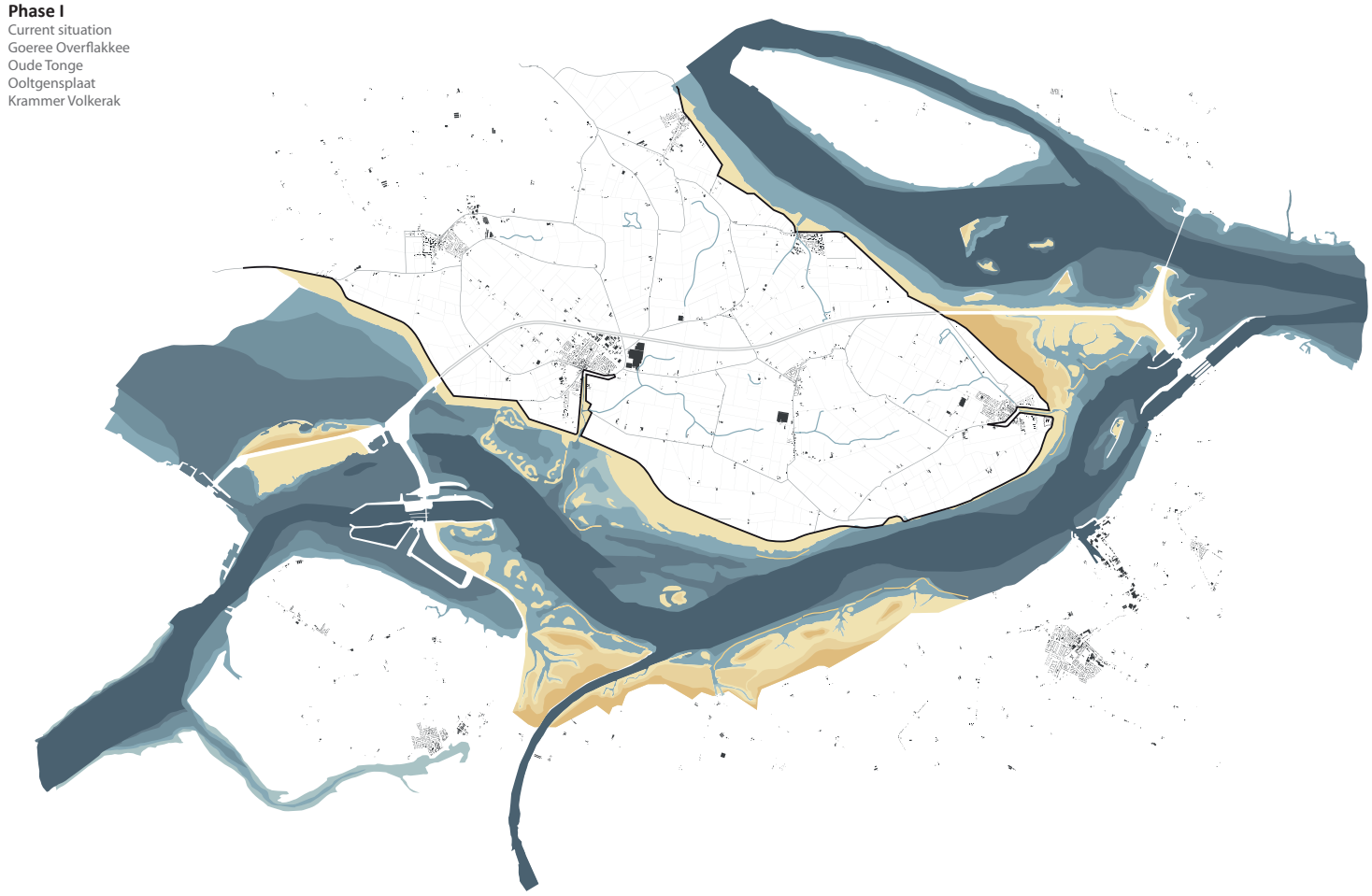


Figure 83. Phase I
Source(s): *Author , 2012*

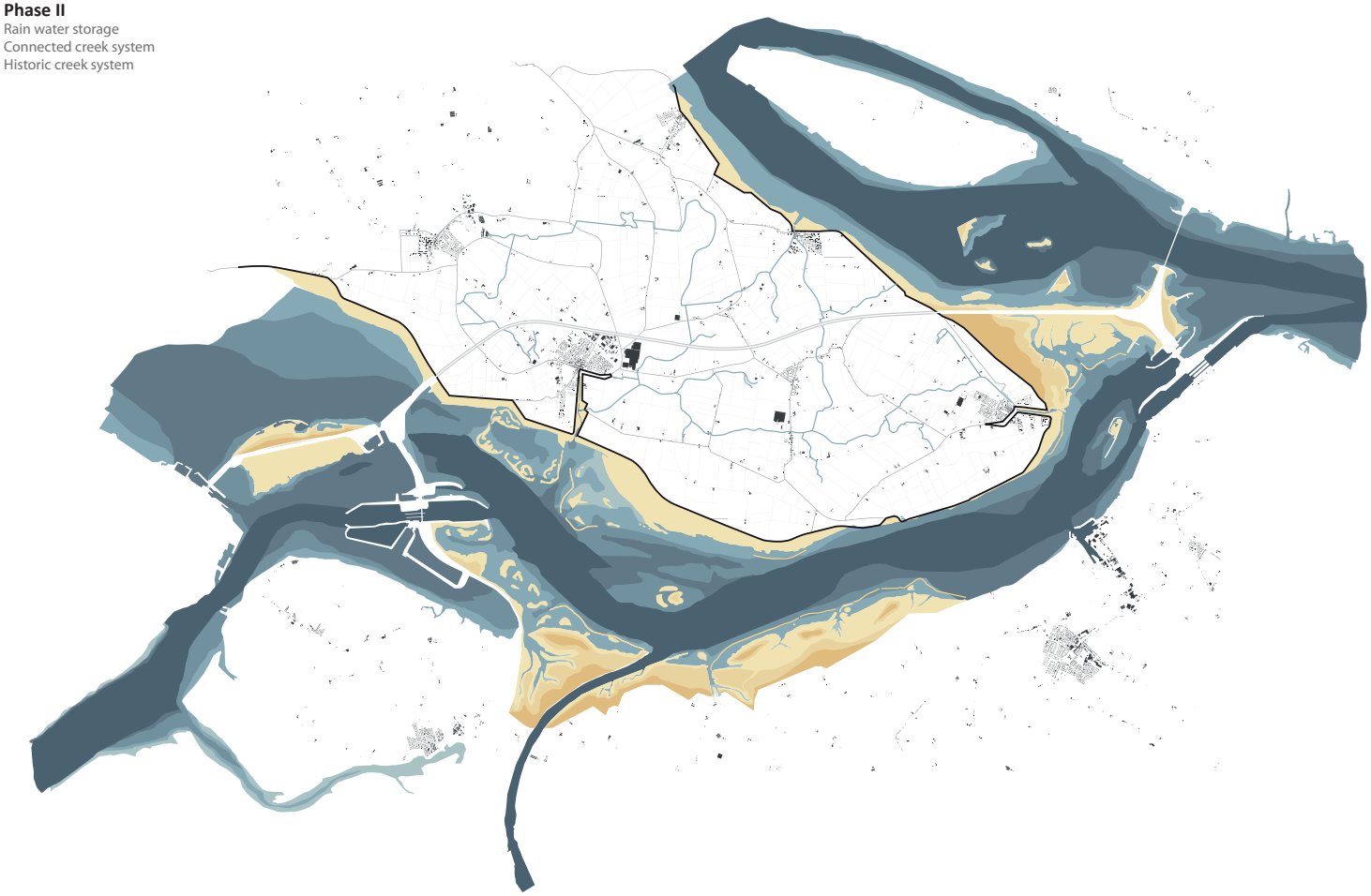
Phase I shows the current situation and context of the Krammer Volkerak. The Krammer Volkerak is characterized by the absence of tidal dynamics, fresh water, 'vooroevers', Delta Works, the delta cities Oude Tonge and Ooltgensplaat and its history.

The transformation of the Krammer Volkerak to an open water body has to trigger a better water quality, e renewed relationship of delta cities with water, providing a plan to strengthen the socio-economic condition of the delta cities, developing a rare brackish ecology to sustain flora and fauna.

The process of this transformation is an integral approach that leads to a sustainable combination of the urban, cultural and natural layers. This approach of working with nature is innovative. It also shows a transformation of cultural landscape to natural landscape.

The phasing is not one that has to be fully completed. As each phase constitutes value, the phasing can be interrupted for political or econimical reasons, and still be a valuable plan. The phasing could also be changed in order.

Phase II
Rain water storage
Connected creek system
Historic creek system



2015
Now
0 m
ZW Delta
1,0 - 1,5 m
WNF
6,0 - 6,8 m

Figure 84. Phase II
Source(s): *Author , 2012*

Highway
Water defense line - dike
Water gate
Occupation
Outer dike area
Creek
Water storage - polder
Waterdepth - very deep
Waterdepth - deep
Waterdepth - middle
Waterdepth - low
Waterdepth - very low
Birdspotting
'Wierde'
Modern castles/'wierden'

Rain storms occur more often and the discharge and storage of this rain water is lacking on the island of Goeree Overflakkee, resulting in lost of crops due to high groundwater levels in an already wet environment. To provide waterstorage and rain water discharge on the island the historic creek network is restored and connected to each other.

This will provide the farmers and agricultural businesses protection for their crops. In addition, with a possible re-establishing of an open delta, the sedimentation process will re-occur in the Krammer Volkerak. High discharge is also benificial to keep the harbor and the canal open.

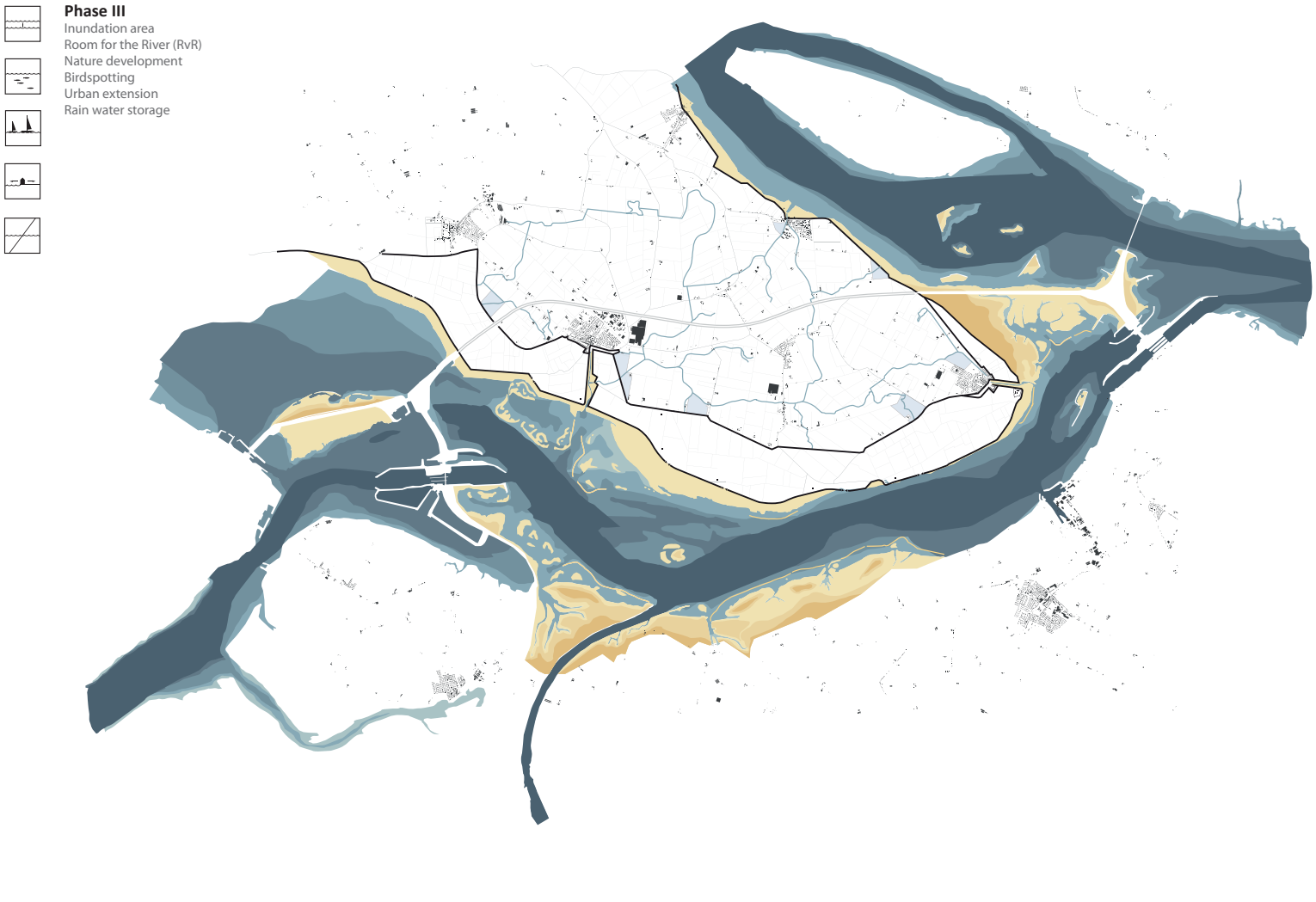


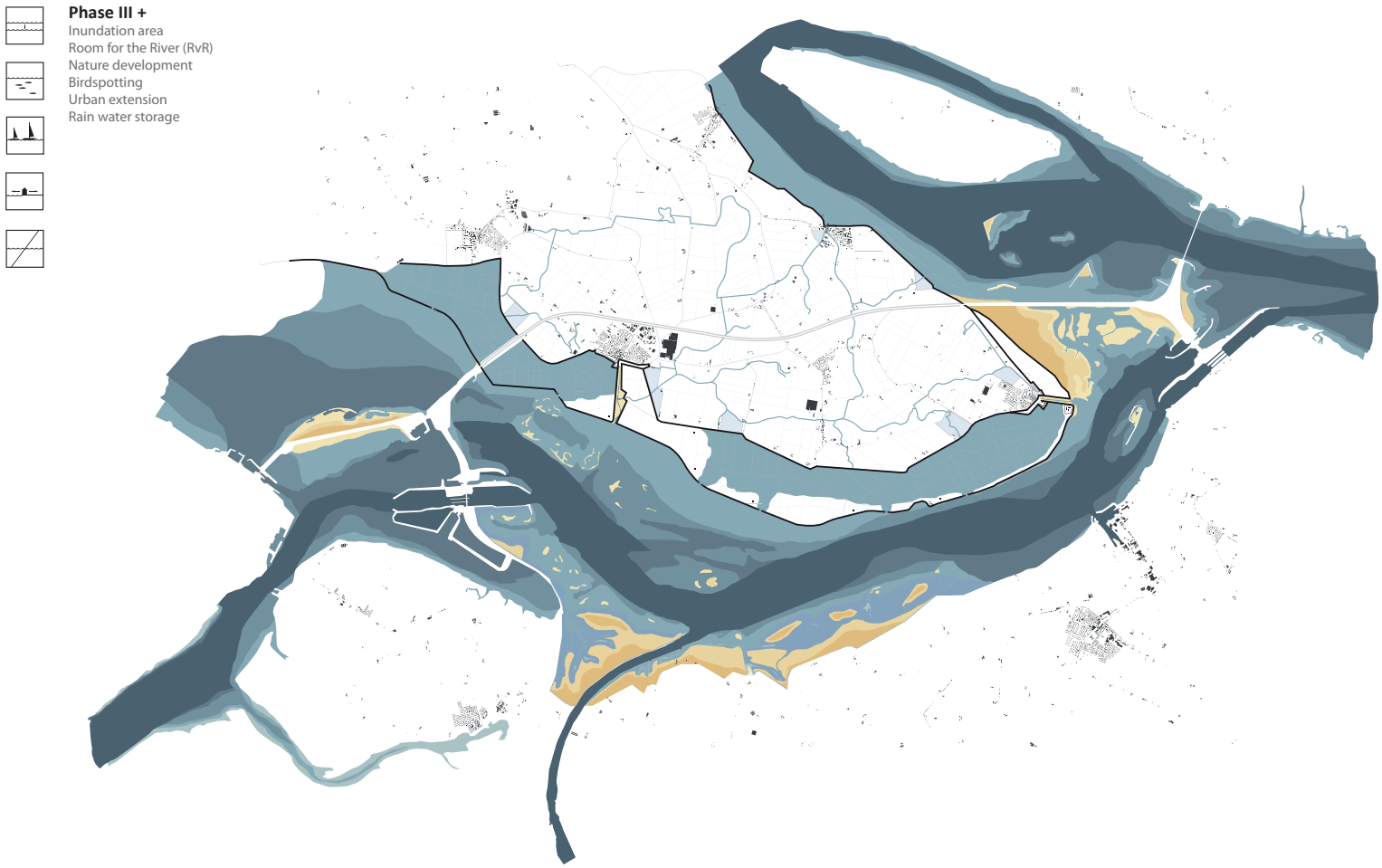
Figure 85. Phase III
Source(s): *Author , 2012*

The Krammer Volkerak becomes a part of the program Room for the River (RvR) by developing an inundation area. Although the frequency of flooding will be low, the area will without housing. And assigned for nature development. This can be related to a closely related project in Zuid Holland: Tiengemeten (Natuur-monumenten), where a part of the inner dike area is given back to nature.

The inundation area will also be an addition to the Natura 2000 areas (protected bird areas by the Europian Union). Nature development will attract ecotourists as birdspotters, researchers and recreants.

The creek network is also expanding with inundation areas. These areas will provide waterstorage and will increase in number with time (or phasing) to demand that is necessary. The water storage in the polder will also transform from a more cultural character to a natural one (see sections and vizualizations in the next chapter), combining water storage with nature development. As the inundation area (RvR) follows the polderstructure so will the inundation areas in the polder itself.

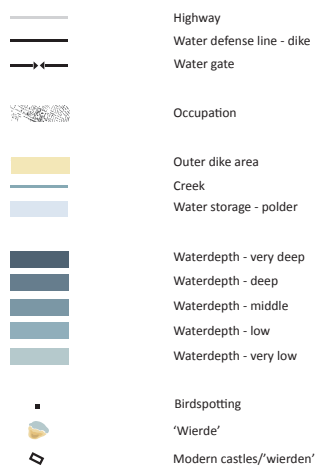
When the area is inundated not the whole surface of the area will be flooded. On this dry grounds birdspot towers will be placed. It also provides a differentiated landscape



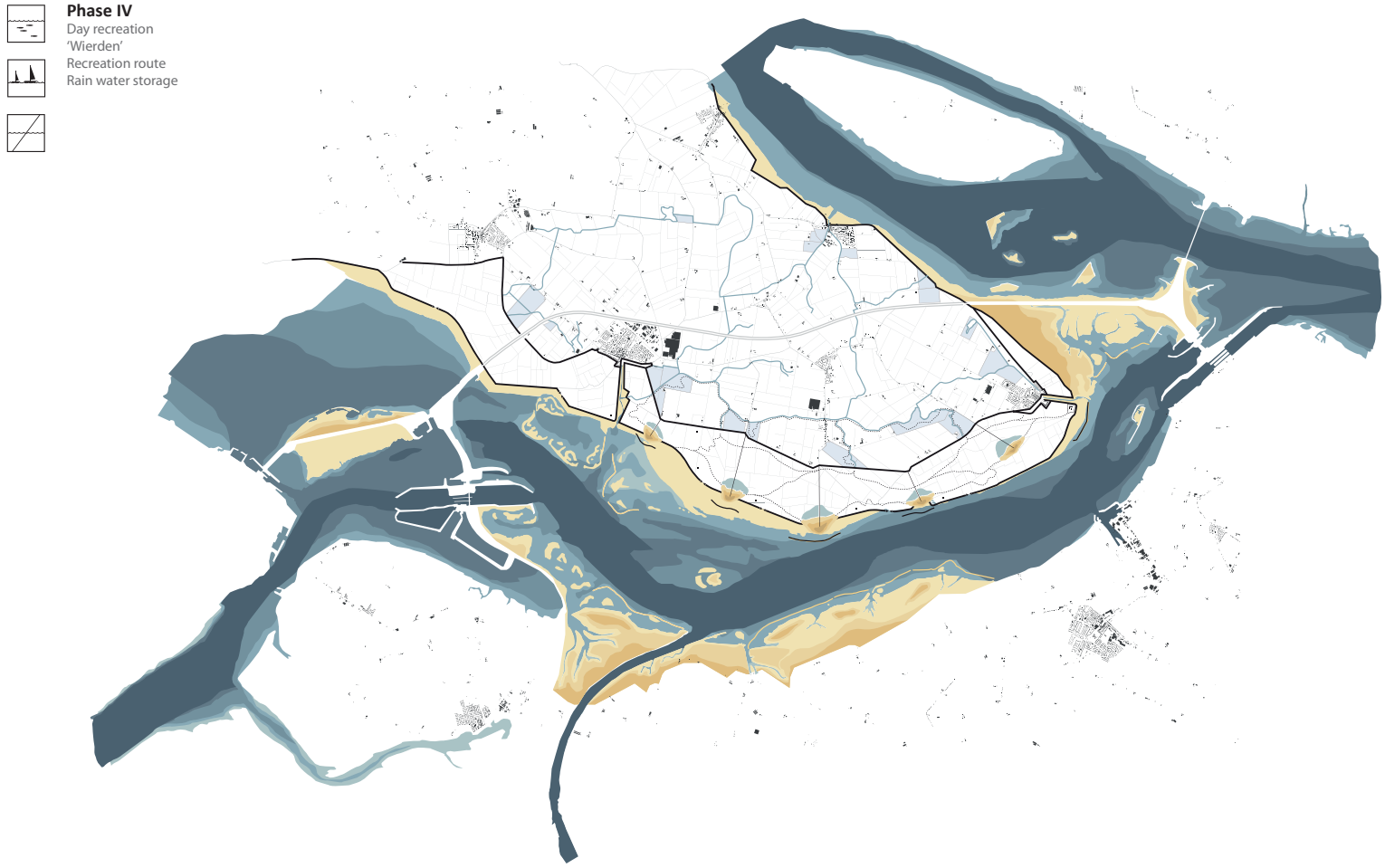
With the inundation area the delta cities Oude Tonge and Ooltgensplaat obtained a (new) relation with water and nature.

The socio-econimic condition of Oude Tonge and Ooltgensplaat is improved by the eco-tourism in the inundation area and the development of an urban extension that also will relate the delta city to the inundation area. The urban expansion is integrated with a new and higher dike (from 3m to 6m). People will be provided with building plots to stimulate public initiative and an attractive environment.

Figure 86. Phase III +
Source(s): *Author , 2012*



Phase IV
Day recreation
'Wierden'
Recreation route
Rain water storage



2040

Now
0 m

ZW Delta
1,0 - 1,5 m

WNF
6,0 - 6,8 m

Figure 87. Phase IV
Source(s): *Author , 2012*

The inundation area transforms not only in a natural area, but also in a recreative area. Large 'wierden' or 'terps' and a recreation route provide the locations for day recreation.

The recreation route showcases the transforming landscape in the inundation area and the polder area. The route also connects to the delta cities and the 'wierden'. The 'wierden' provide a place for 1-day-camping and regular camping. The pool adjacent to the earthen hill is the result of excavation and will be used for swimming and water recreation.

Highway
Water defense line - dike
Water gate

Occupation

Outer dike area
Creek
Water storage - polder

Waterdepth - very deep
Waterdepth - deep
Waterdepth - middle
Waterdepth - low
Waterdepth - very low

Birdspotting
'Wierde'
Modern castles/'wierden'

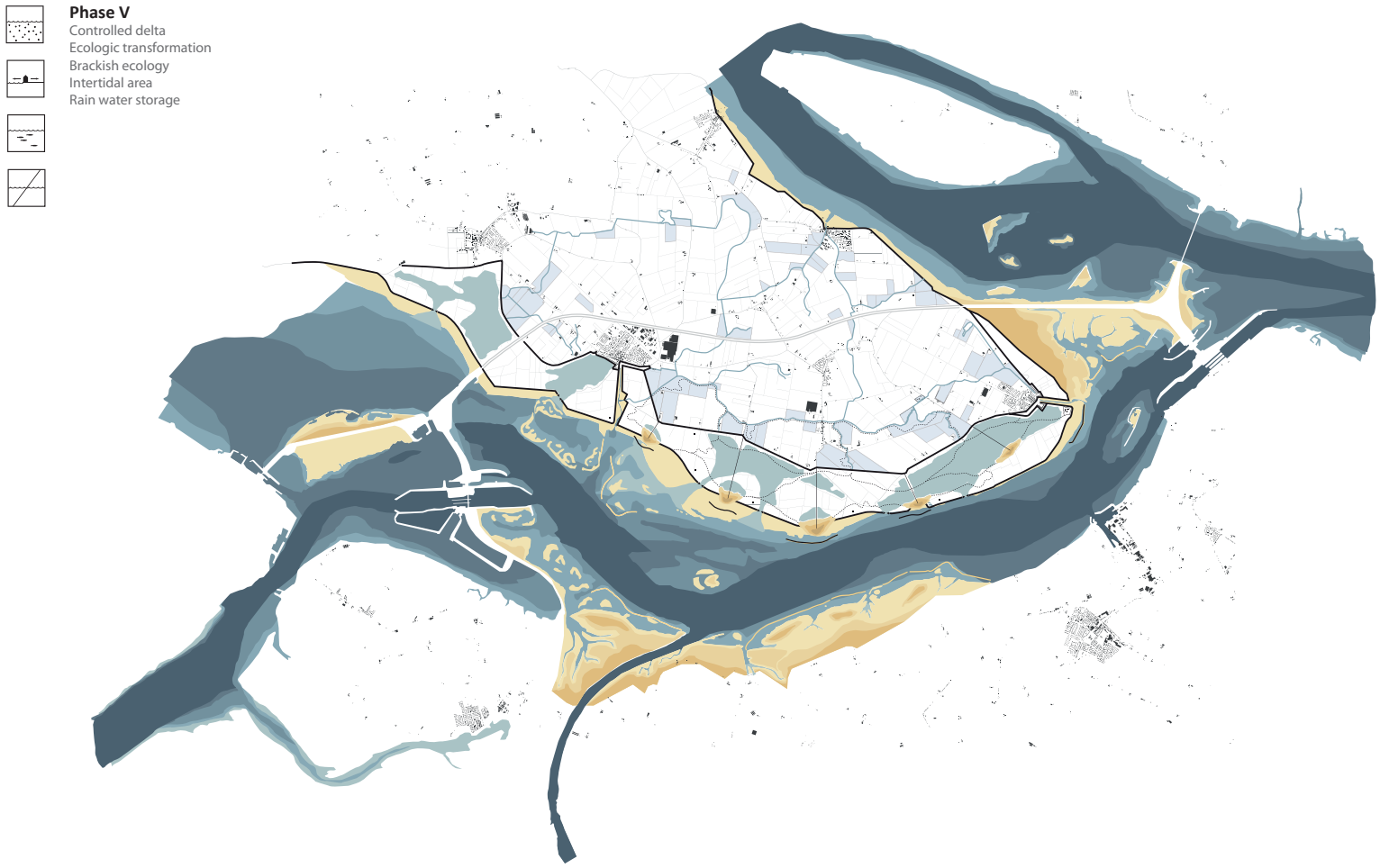


Figure 88. Phase V
Source(s): *Author , 2012*

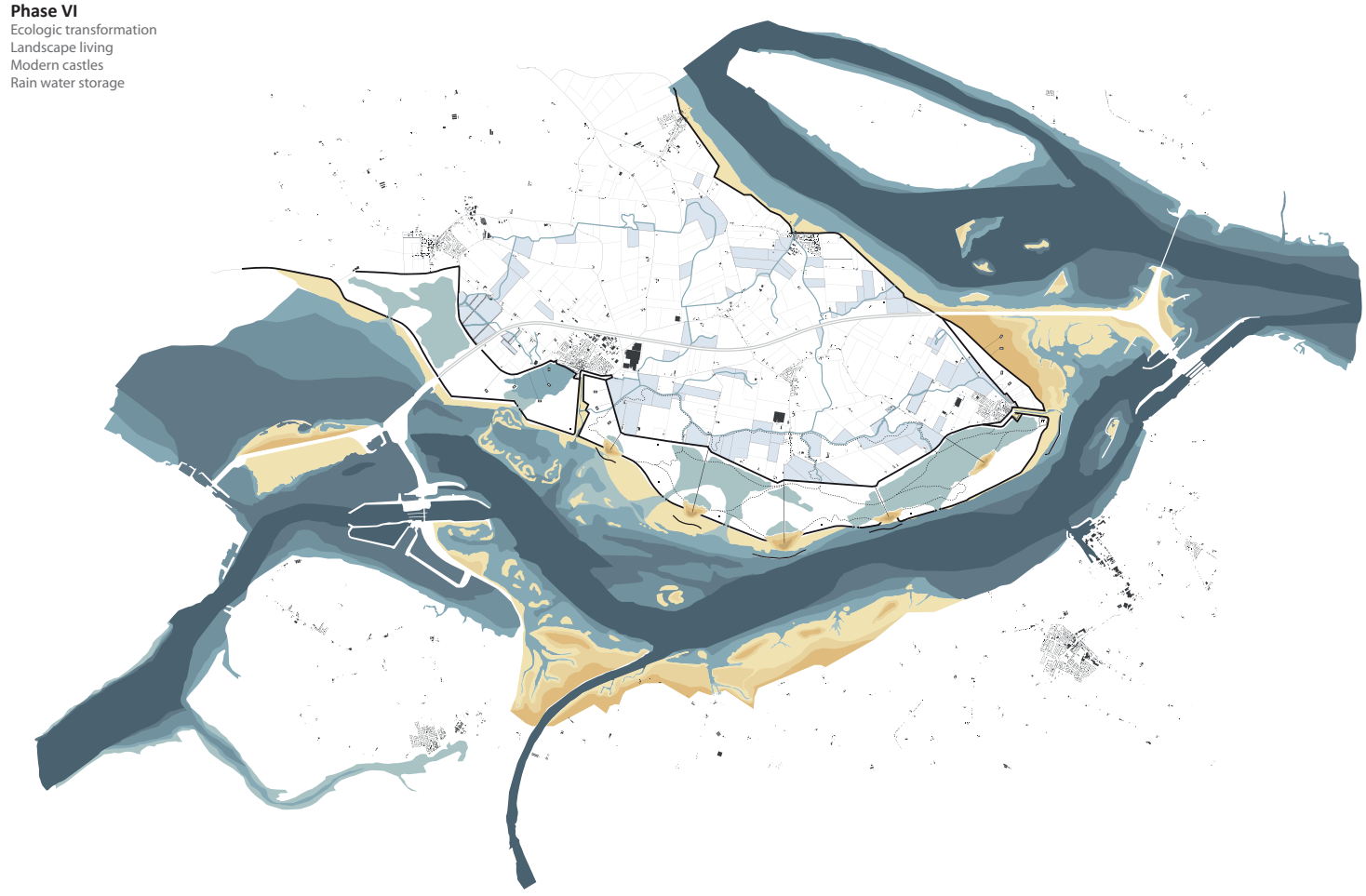
The Dutch Southwest Delta is re-opened as part of the plan of ZW Delta and H+N+S Landscape architects. Tidal dynamics are restored and will provide a water level difference of 1,0m to 1,5m.

The watergates built to let the area be inundated will now be set open to establish an ecologic transformation in the inundation area or intertidal area. The open delta in this phase is a controlled delta, where the (modified) Delta Works still provide water defense against the sea.

With the re-opening of the delta the water in the Krammer Volkerak becomes salt/brackish and the problematics with algae will be solved.

The delta cities Oude Tonge and Ooltgensplaat are now related to an intertidal area, although it is controlled and not in its full state.

Phase VI
Ecologic transformation
Landscape living
Modern castles
Rain water storage



2055

Now
0 m

ZW Delta
1,0 - 1,5 m

WNF
6,0 - 6,8 m

Figure 89. Phase VI
Source(s): *Author , 2012*

Highway
Water defense line - dike
Water gate

Occupation

Outer dike area
Creek
Water storage - polder

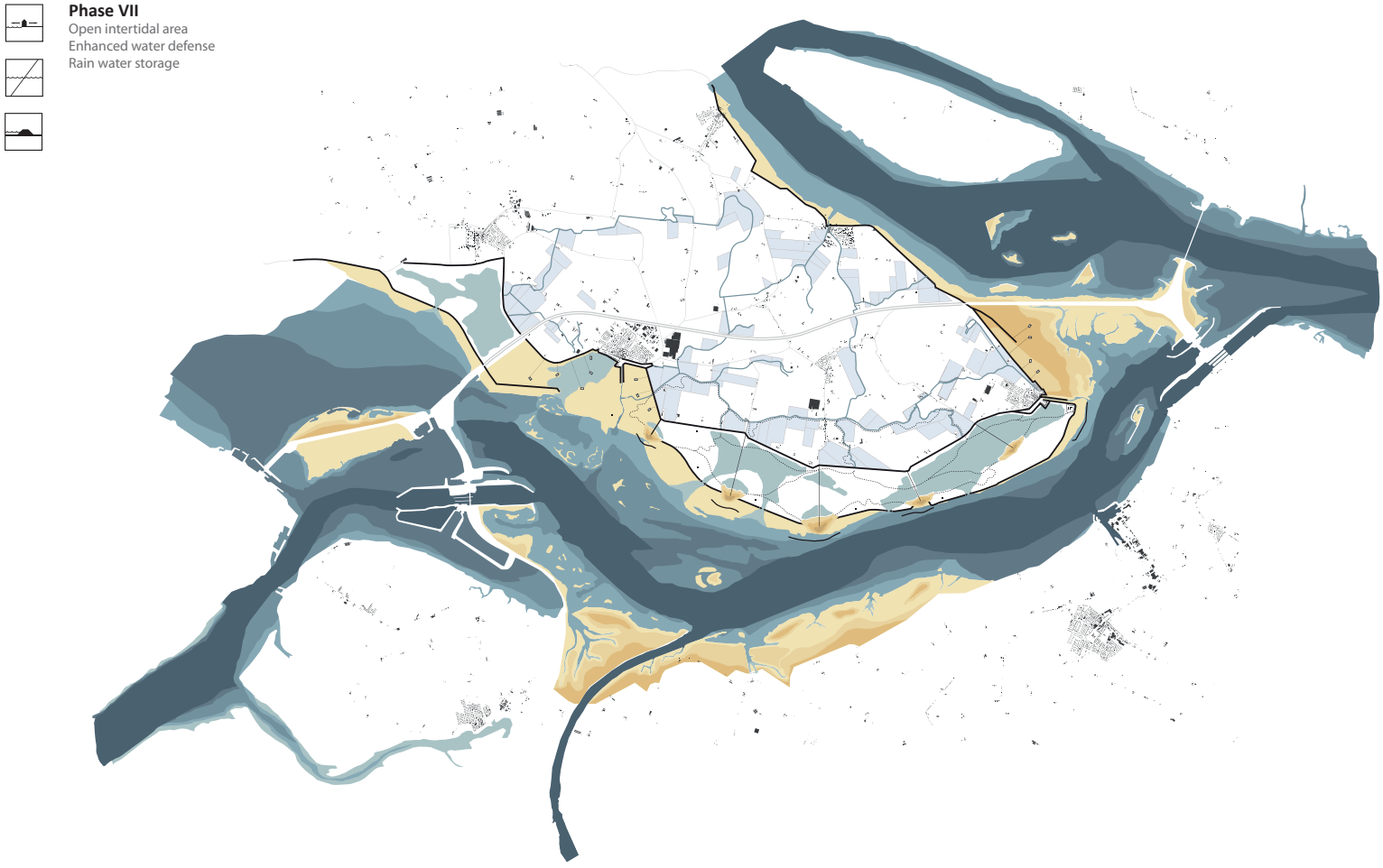
Waterdepth - very deep
Waterdepth - deep
Waterdepth - middle
Waterdepth - low
Waterdepth - very low

Birdspotting
'Wierde'
Modern castles/'wierden'

The ecologic transformation from a fresh water ecology to a brackish ecology continues as the expansion of the water storage areas in the polder. These fresh water storage areas will also counter the internal salinization of the polder by providing pressure on the brackish groundwater.

The dynamic landscape of the intertidal area provides an ideal location for attractive living or landscape living. In the vicinity of the delta cities Oude Tonge and Ooltgensplaat modern castles will be built that in time embeds itself in the landscape.

Phase VII
Open intertidal area
Enhanced water defense
Rain water storage



2065

Now
↕0 m

ZW Delta
↕1,0 - 1,5 m

WNF
↕6,0 - 6,8 m

Figure 90. Phase VII
Source(s): *Author , 2012*

Highway
Water defense line - dike
Water gate

Occupation

Outer dike area
Creek
Water storage - polder

Waterdepth - very deep
Waterdepth - deep
Waterdepth - middle
Waterdepth - low
Waterdepth - very low

Birdspotting
'Wierde'
Modern castles/'wierden'

The relation between open water, intertidal area and delta cities is restored. The city has, as in the past, a direct relationship with water.

In this transformation the (old) water defenses on the island will be enhanced and a more attractive environment for living will be created.

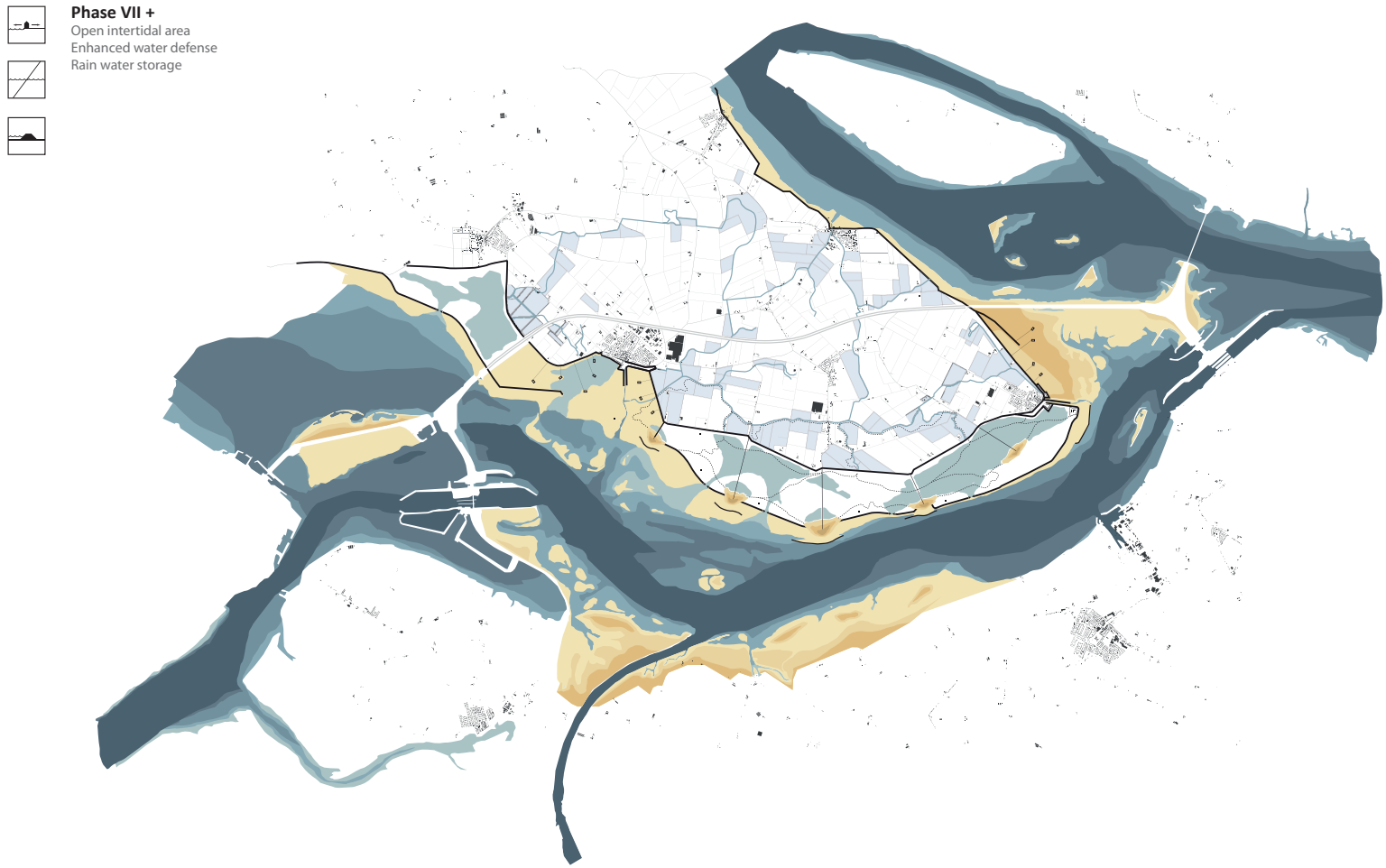


Figure 91. Phase VII +
Source(s): *Author , 2012*

Figure 92. Phase VII -
Source(s): *Author , 2012*

Highway
Water defense line - dike
Water gate

Occupation

Outer dike area
Creek
Water storage - polder

Waterdepth - very deep
Waterdepth - deep
Waterdepth - middle
Waterdepth - low
Waterdepth - very low

Birdspotting
'Wierde'
Modern castles/'wierden'

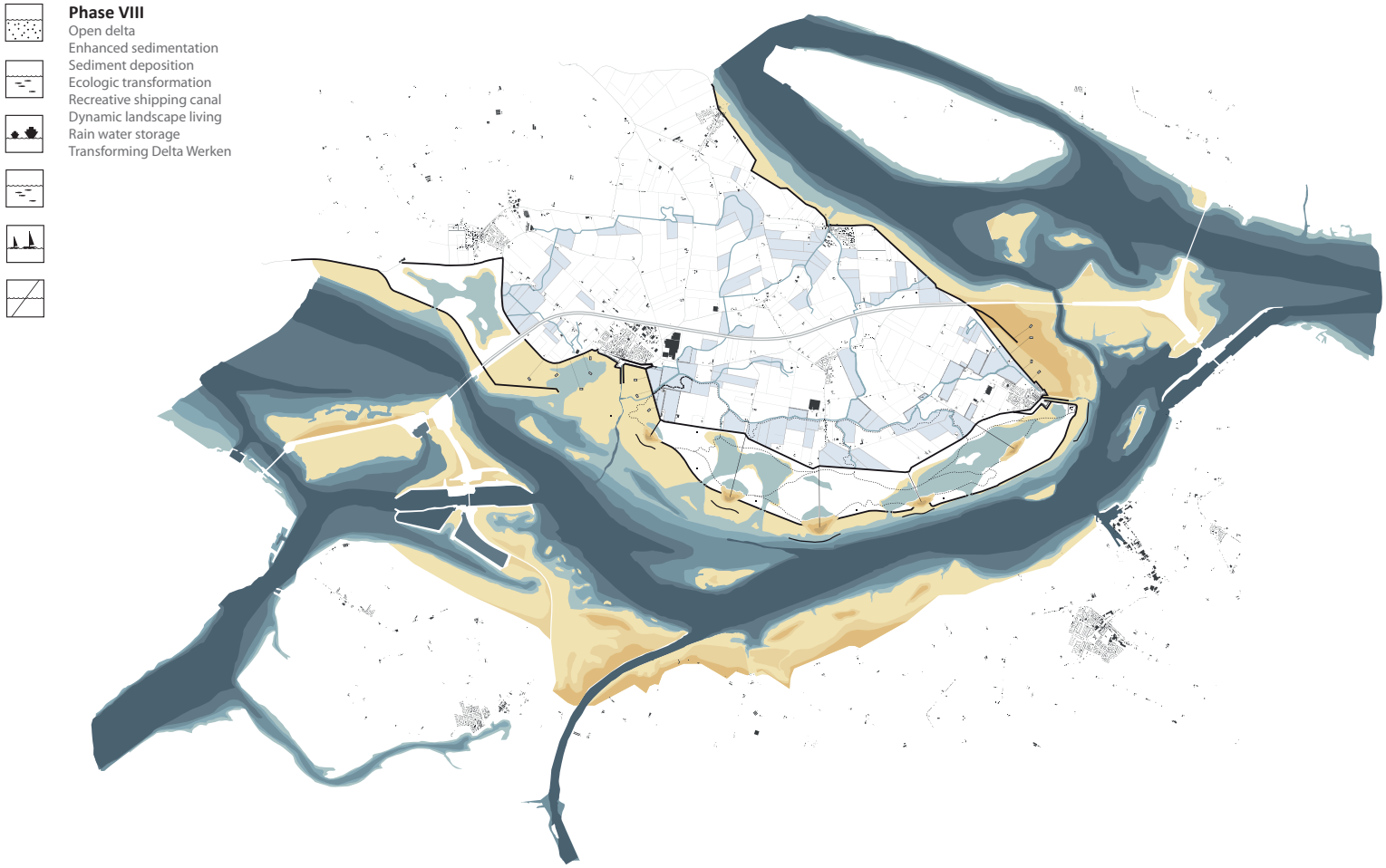


Figure 93. Phase VIII
Source(s): *Author , 2012*

The Dutch Southwest Delta is completely open. With a fully open delta, the sedimentation process is fully re-established. The defensive function of the Delta Works has made way for the embediment of nature and sediment. The tidal dynamic has a fluctuation of 6,0m to 6,8m (3,0m to 3,4m above NAP) (Bath, The Netherlands is used as reference for this fluctuation).

The fresh water storage on Goeree Overflakkee is essential.

The hard edge between open water and the dike has become more soft and has become an attractive shipping route. A canal is created to provide a more direct connection with the northern side of the island.

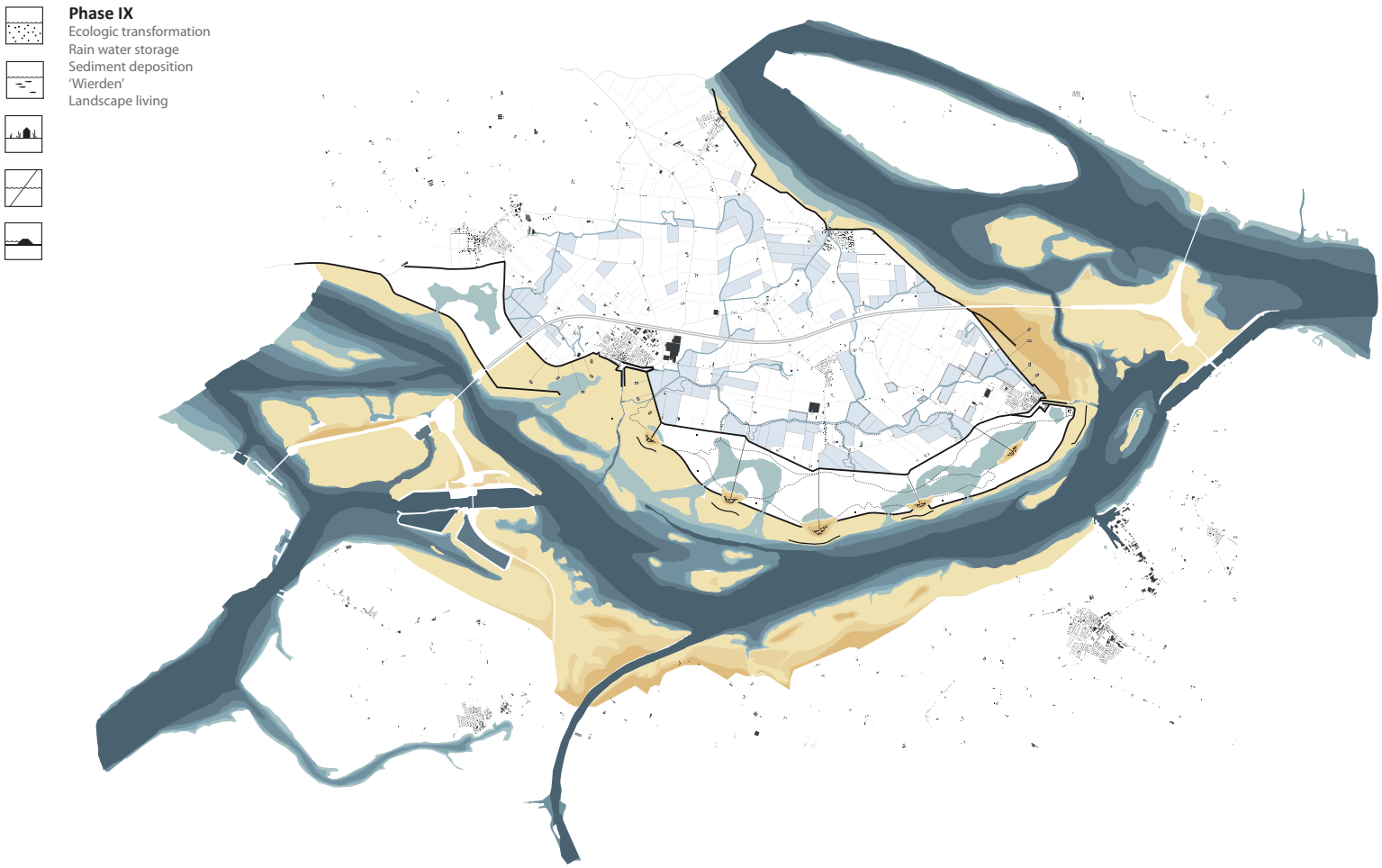


Figure 94. Phase IX
Source(s): *Author , 2012*

The 'wierden' are developed as potential locations for landscape living. As the urban extension of the delta cities, the housing on the 'wierden' is part of a public initiative.

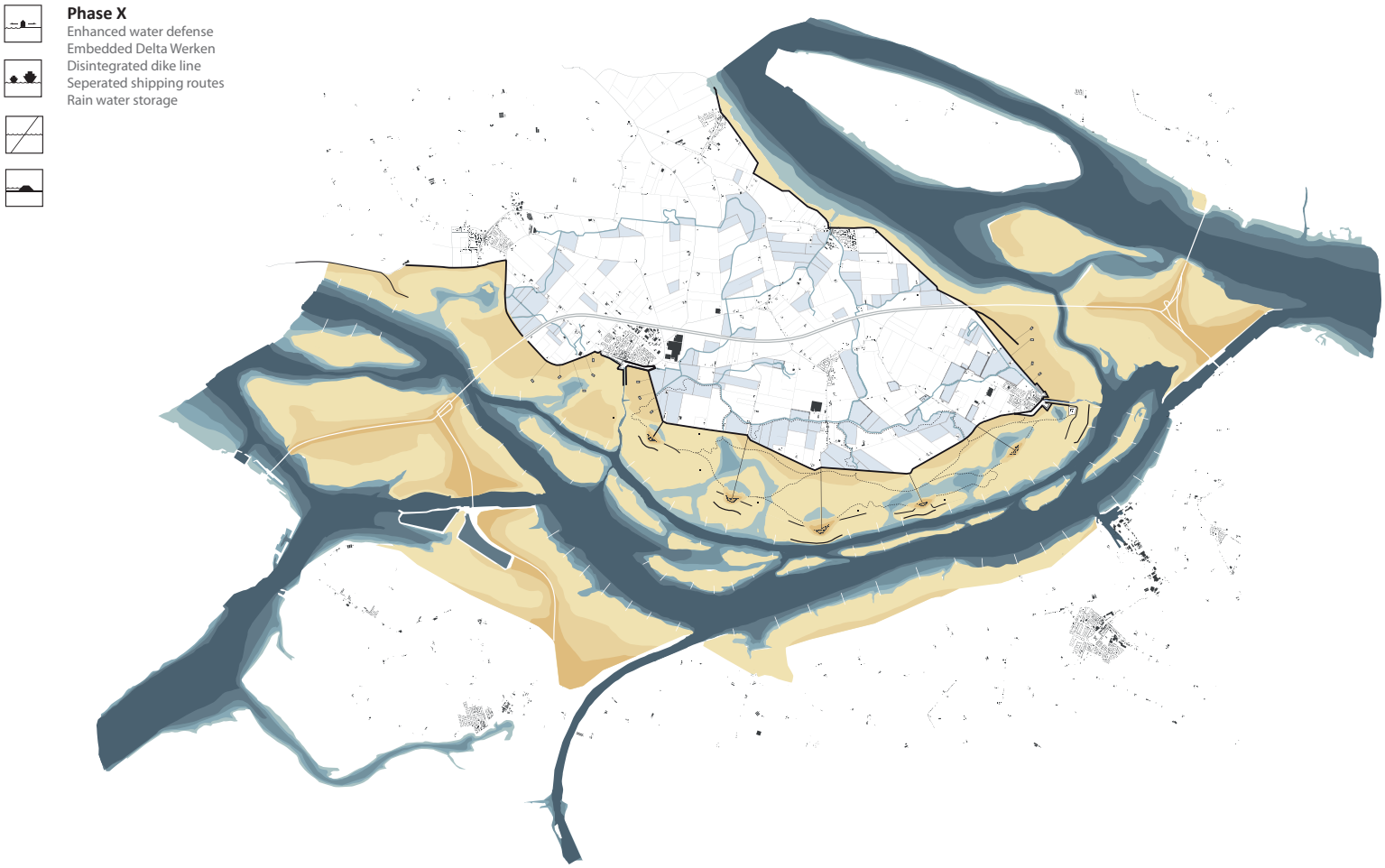


Figure 95. Phase X
Source(s): *Author , 2012*

The vision of WNF to have natural water defenses, landscape living are integrated in this last phase.

The sedimentation in the Krammer Volkerak continued. But with increased sedimentation there is a threat of silting up the area that unables shipping and decreasing water storage. To maintain an open shipping route groynes are used to narrow the shipping lane, providing a stable and high waterspeed that can transport sediment.

With manipulating the waterflow, islands are created that seperate cargo and recreation shipping in the Krammer Volkerak.

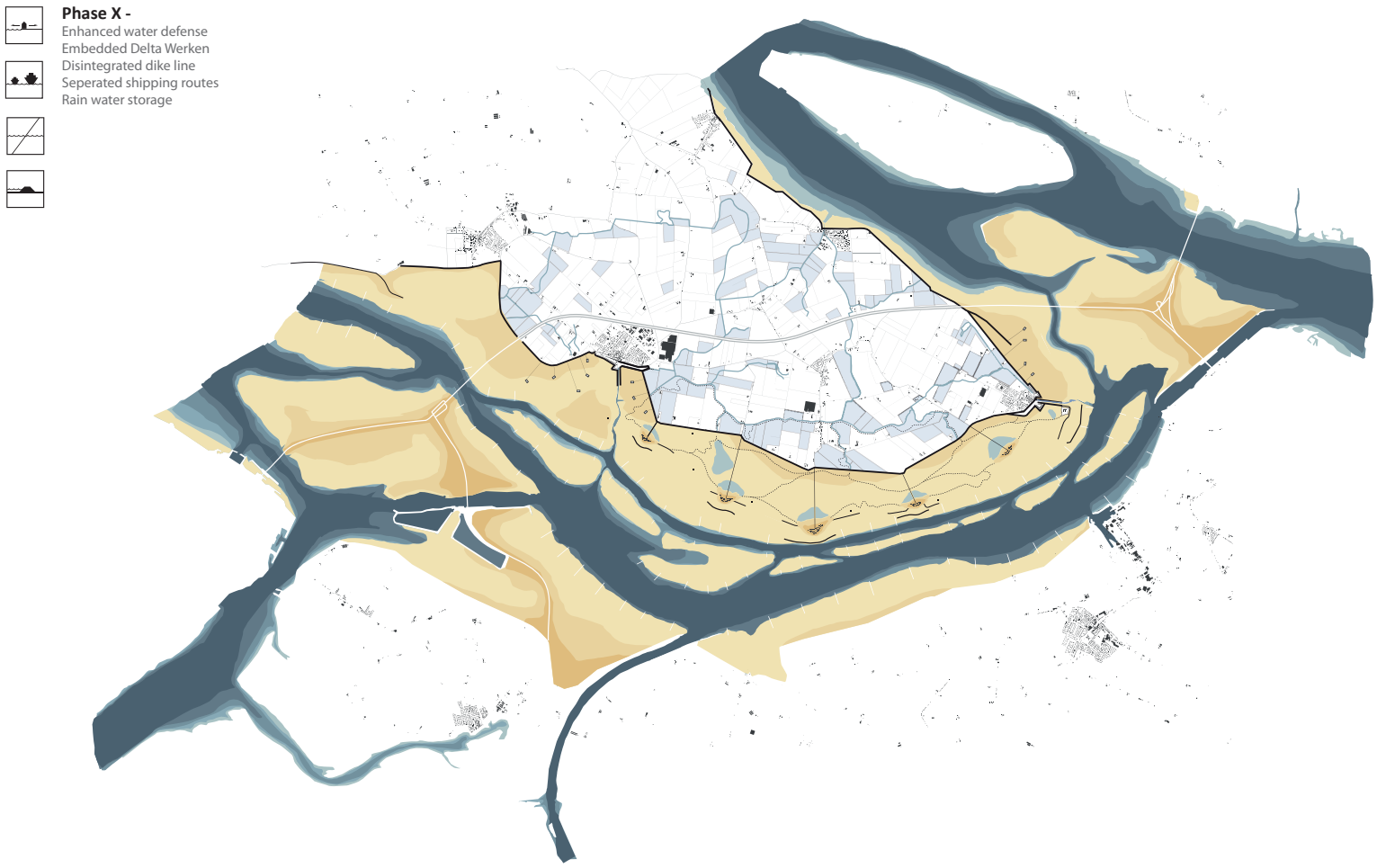


Figure 96. Phase X +
Source(s): *Author , 2012*

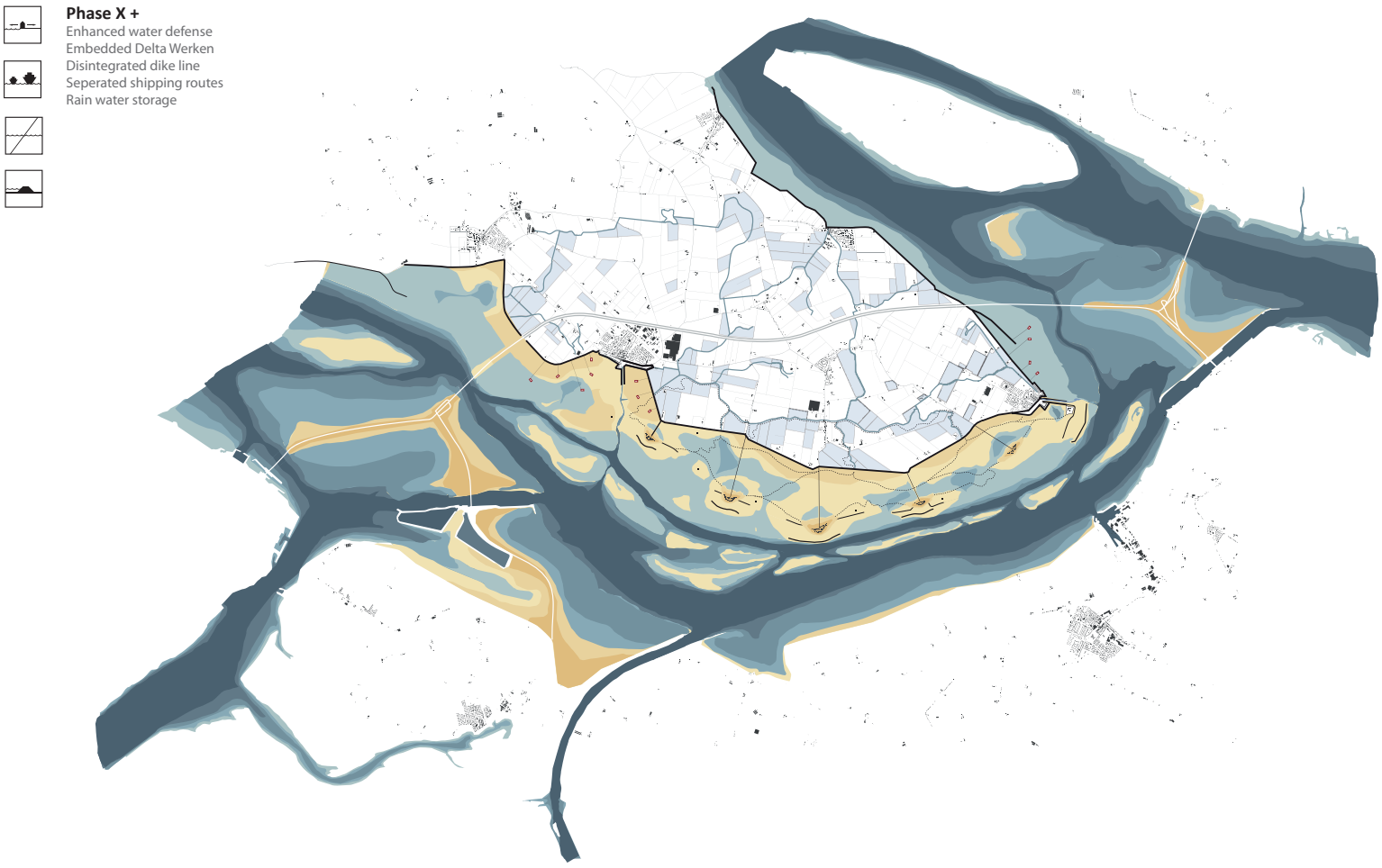
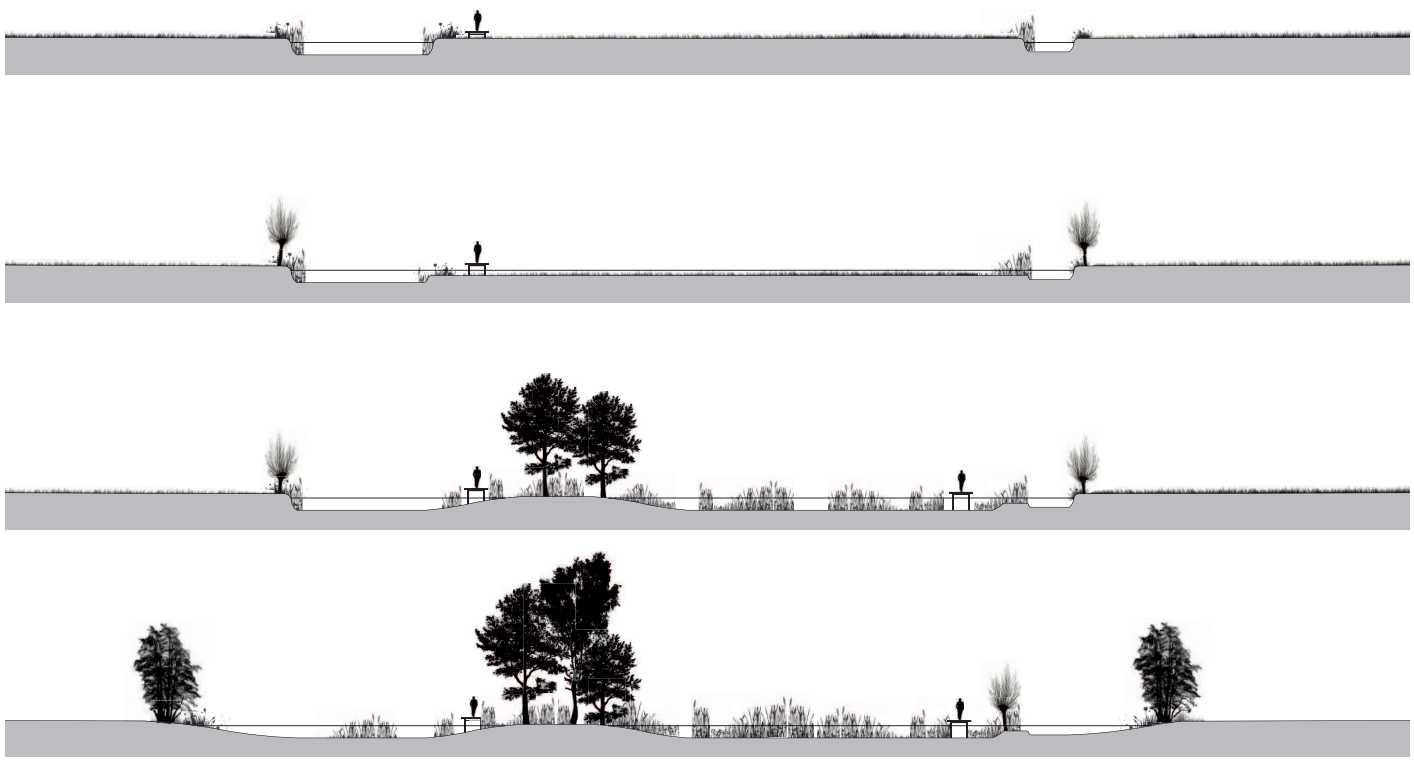


Figure 97. Phase X -
Source(s): *Author , 2012*

Transformation of a delta landscape

Keywords:
Transformation
Creek
Dike
Urban landscape
Vizualizations



'Koninginnenkruid'
Eupatorium Cannabinum

'Duinriet'
Calamagrostis Epigejos

'Schietwilg'
Salix Alba

'Zachte Berk'
Betula Pubescens

'Ratelpopulier'
Populus Tremula

'Knotwilg'
Salix Alba

Figure 98. Transformation of a creek
Source: *Author, 2012*
Pictures: *Google Pictures, 2012, tree or plant name*

The landscape in the Dutch Southwest Delta changes and expresses itself in space and form. The transformation of the urban landscape in the Krammer Volkerak area is characterized by the gradual change from cultural (man made) to natural (left to nature). Relating to the relativly new paradigm, working with nature.

Main elements of the phasing such as the creek network, the dikes, the intertidal area and urban form are design and shown in this chapter. The names of flora are provided with Dutch and Latin terms.

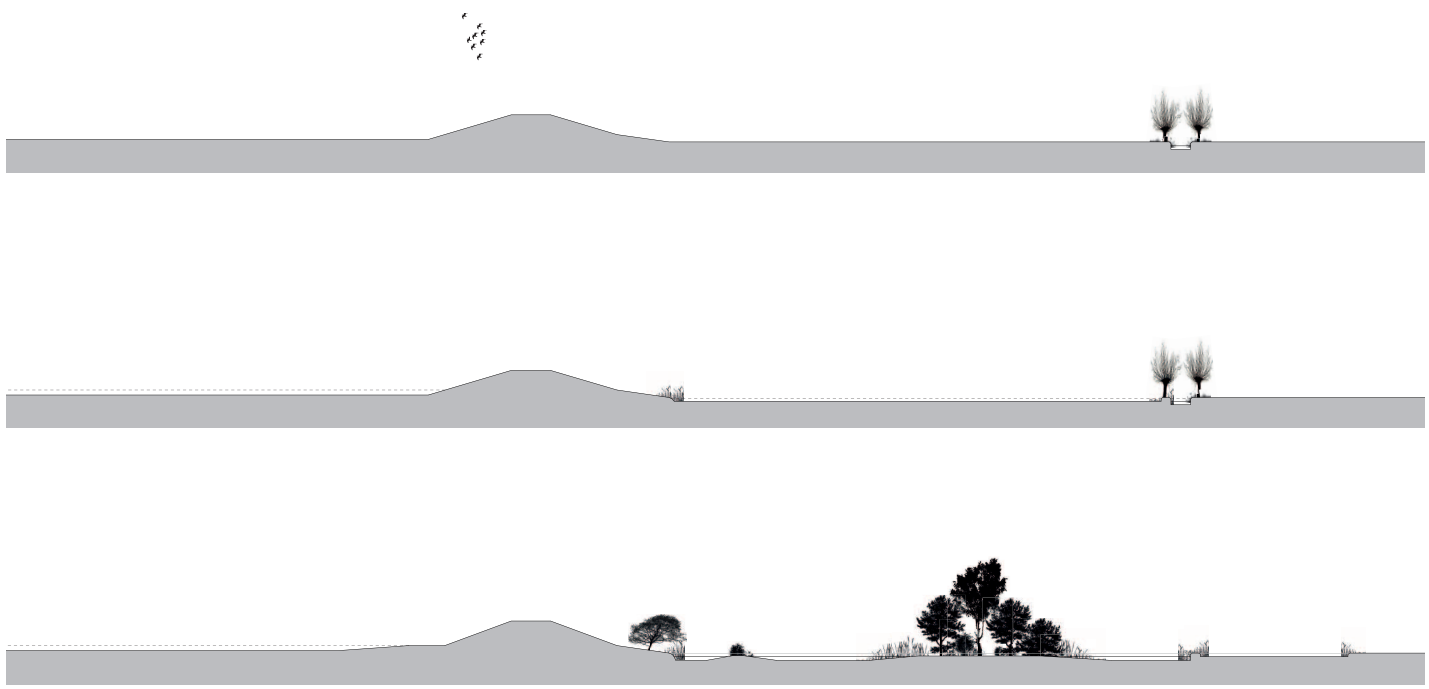
The transformation of the creek and the creek network is shown in figure 98.. The first stage is the current situation with creek and polder ditch. In the following stage the polder is lowered to provide water storage for (fresh) rain water. In the next phases the inundation polder is given back to nature in which hard edges become soft and flora and fauna find residence.

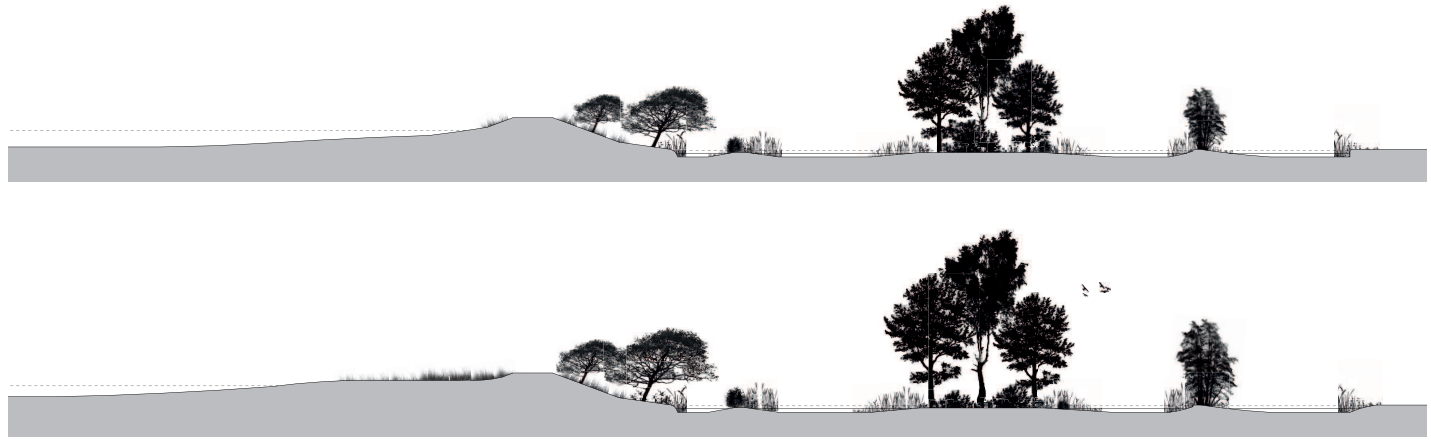
The current dike system functions as a hard border between open water and polder landscape. During the process towards an (fully) open delta the dike becomes more integrated into a natural landscape. See figure 99..

This process is also occuring on the outerdike, figure 100.. In the last phases, the 'wierde' will provide an attractive environment for landscape living.

The urban extension and the modern castles are related to the water and nature. In the process of letting nature take over the intertidal or inundation area the urban design will be more embedded into the landscape, relating to the historic relation of the delta city with water and nature.

Figures 102. till 107. depict impressions of this process and how an open delta could look like.





‘Engels Slijkgras’
Spartina Anglica

‘Zeekraal’
Salicomia Brachystachya

‘Strandkweek’
Elymus Athericus

‘Zeeaster’
Aster Tripolium

‘Meidoorn’
Crataegus Monogyna

‘Koninginnenkruid’
Eupatorium Cannabinum

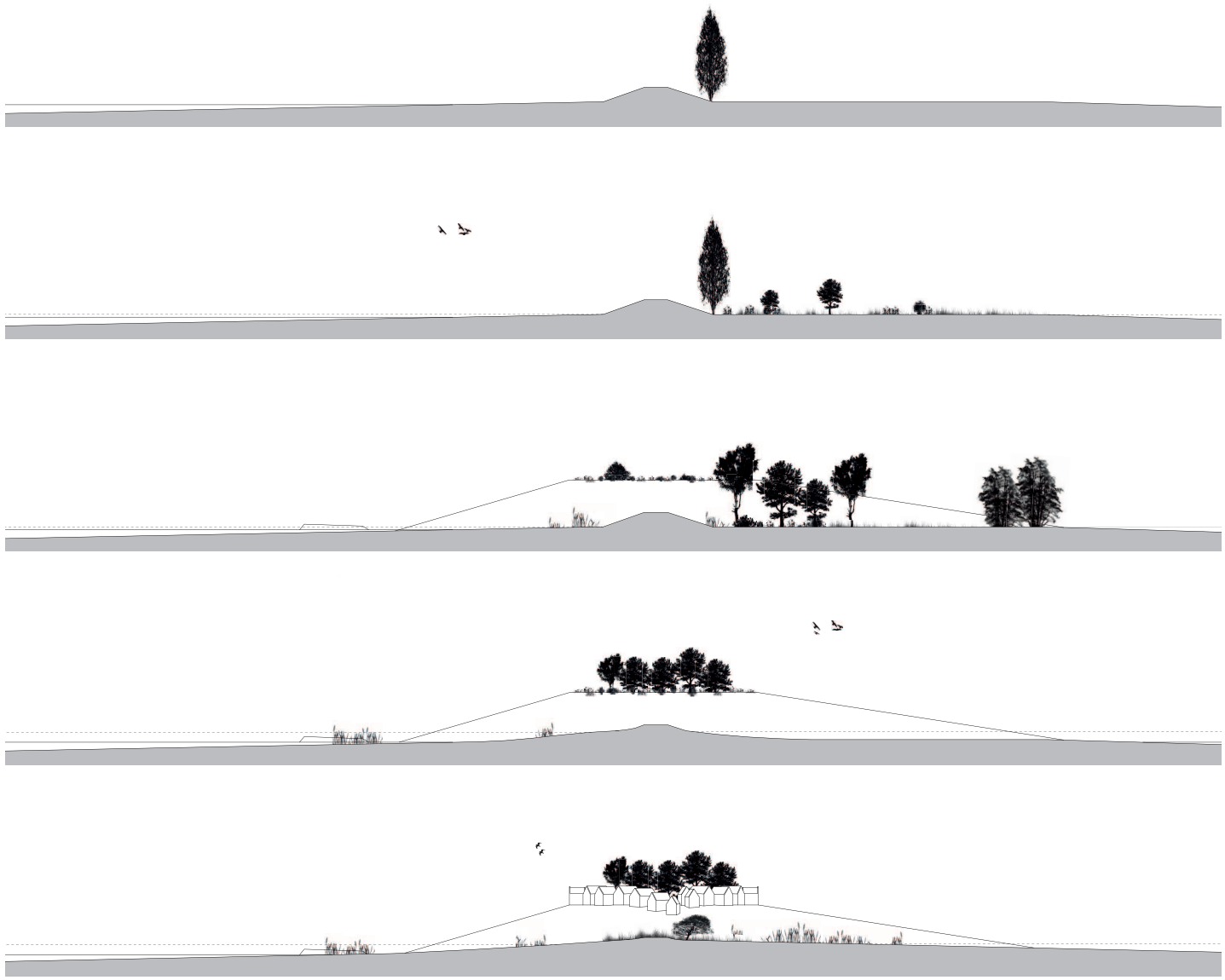
‘Duinriet’
Calamagrostis Epigejos

‘Schietwilg’
Salix Alba

‘Zachte Berk’
Betula Pubescens

‘Ratelpopulier’
Populus Tremula

Figure 99. Transformation of a dike
Source: *Author, 2012*
Pictures: *Google Pictures, 2012, tree or plant name*



‘Engels Slijkgras’
Spartina Anglica

‘Zeekraal’
Salicomia Brachystachya

‘Strandkweek’
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‘Zeeaster’
Aster Tripolium

‘Meidoorn’
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‘Koninginnenkruid’
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‘Duinriet’
Calamagrostis Epigejos

‘Schietwilg’
Salix Alba

‘Zachte Berk’
Betula Pubescens

‘Ratelpopulier’
Populus Tremula

Figure 100. Transformation of a dike
Source: *Author, 2012*
Pictures: *Google Pictures, 2012, tree or plant name*

'Engels Slijkgras'
Spartina Anglica

'Zeekraal'
Salicomia Brachystachya

'Strandkweek'
Elymus Athericus

'Zeeaster'
Aster Tripolium

'Meidoorn'
Crataegus Monogyna

'Zachte Berk'
Betula Pubescens

'Ratelpopulier'
Populus Tremula

Figure 101. Transformation of a delta city's relation with nature
Source: *Author, 2012*
Pictures: *Google Pictures, 2012, tree or plant name*

Figure 102. Vizualization of a transforming creek system
Source: *Author, 2012*

Figure 103. Vizualization of a transforming polder (intertidal area)
Source: *Author, 2012*

Figure 104. Vizualization of a transforming urban landscape
Source: *Author, 2012*

Figure 105. Vizualization of a natural inundation area
Source: *Author, 2012*

Figure 106. Vizualization from the ‘wierde’ to the pool
Source: *Author, 2012*

Figure 107. Vizualization of a transforming urban landscape
Source: *Author, 2012*

Design for a delta city

Keywords:
Delta city
Oude Tonge
Urban form

The urban extension of Oude Tonge provides a (new) relation(s) with the intertidal area, a housing project that demands public initiative and improved public space.

The concept for the urban extension is to combine an enhanced water defense with a re-vitalized harbor. The new housing are a face to the intertidal area and the promenade a recreative walking route for the inhabitants of Oude Tonge. The harbor is the spindle between the main street (from the church ring) to the intertidal area and the ship canal (to the harbor). The L-shape in the harbor re-introduces the characteristic and historic shape but has a touch to it. Instead of a quay the harbor is designed as a public space where people on a small scale can relate to water. The stairs leading to the water bridges the height difference of the square and the water.

The newly built housing is provide by public initiative. People are provided with a building plot and free in their design proving that they refer to the historic buildings in the direct surroundings and will not reach higher that 3 floors (including ground level). An example of buildings related to historic architecture are shown in figure 113. and 114.

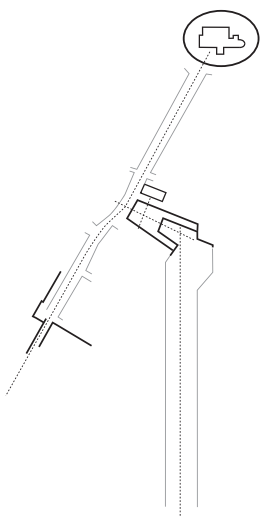


Figure 108. Harbor as pivot point between two axis (dock and main street)
Source: *Author, 2012*

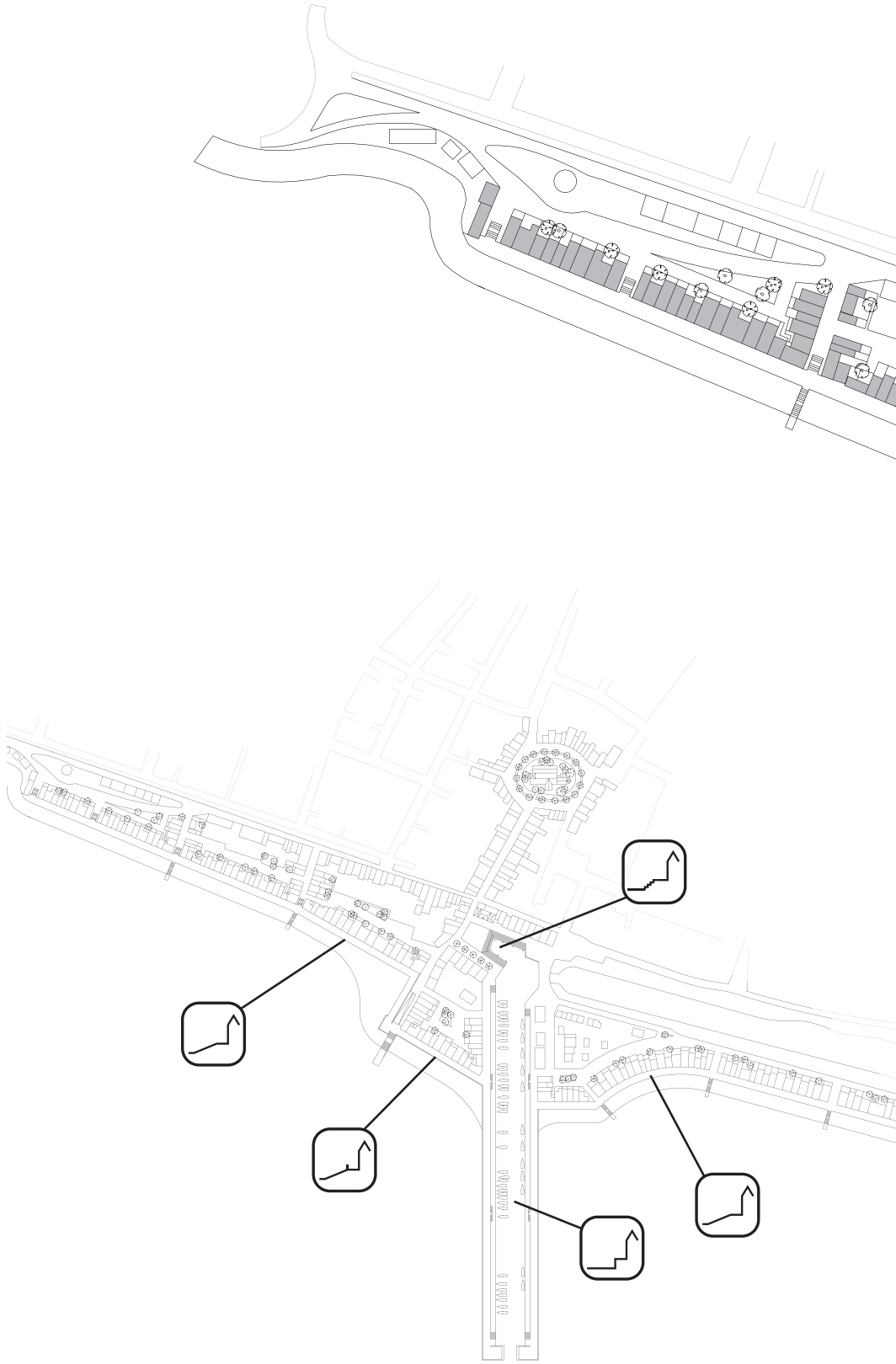


Figure 109. Different relations of public space with the intertidal area
Source: *Author, 2012*

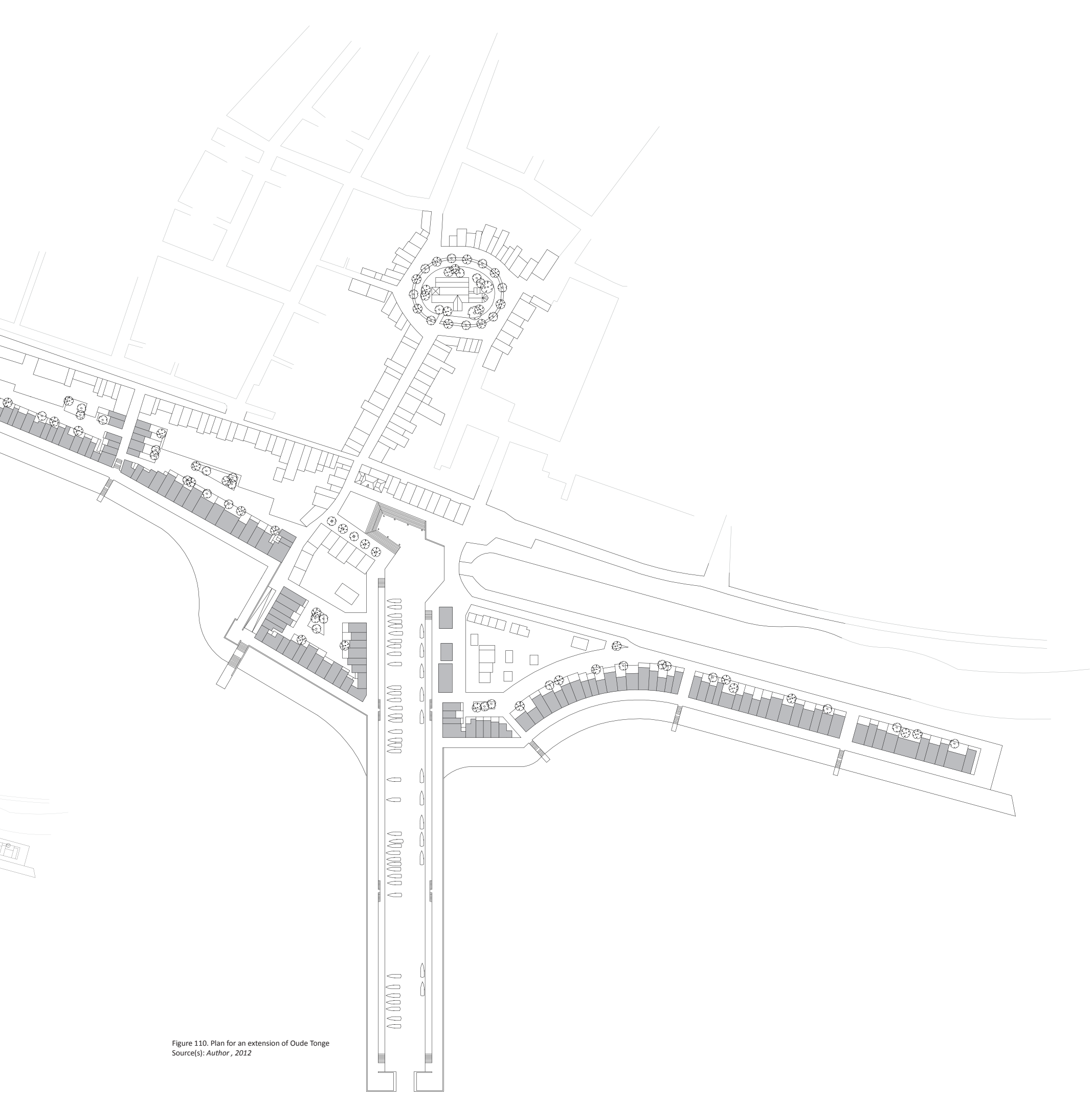


Figure 110. Plan for an extension of Oude Tonge
Source(s): *Author , 2012*

Figure 111. Section from church-ring to inter tidal area, Oude Tonge
Source(s): *Author , 2012*

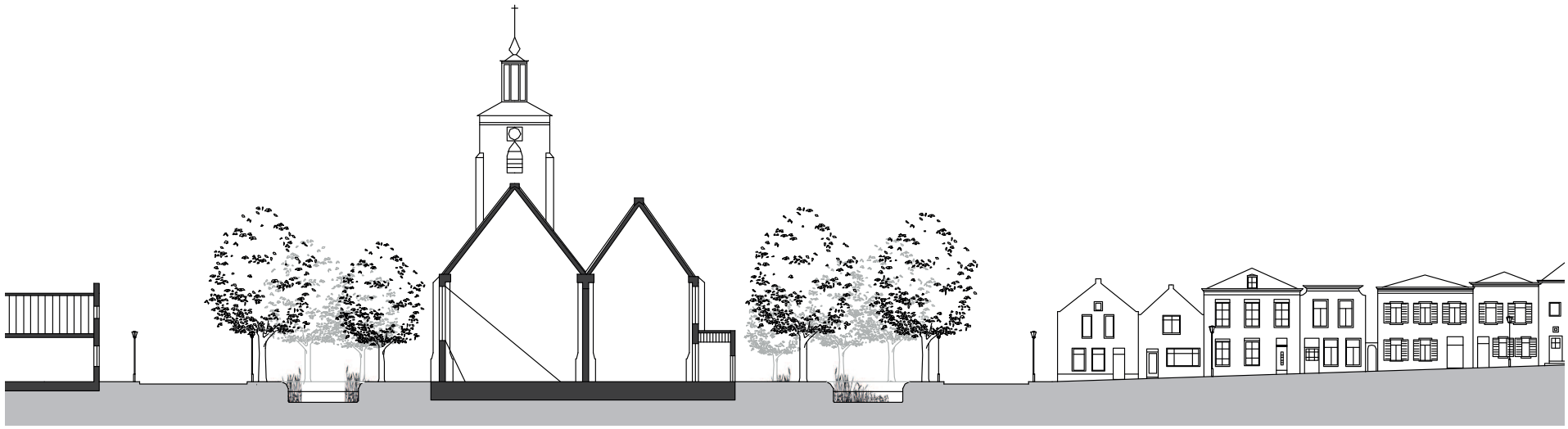


Figure 112. Section of the church-ring, Oude Tonge
Source(s): *Author , 2012*

Figure 113. Reference modern 'grachtenpanden', Amersfoort, Vathorst (left)
Source(s): *http://farm8.staticflickr.com/7264/69978 97527_91c3d6d36b_z.jpg, 2012*

Figure 114. Reference modern 'grachtenpanden', Amsterdam, Borneo Eiland (right)
Source(s): *http://static.panoramio.com/photos/original/14539498.jpg, 2012*

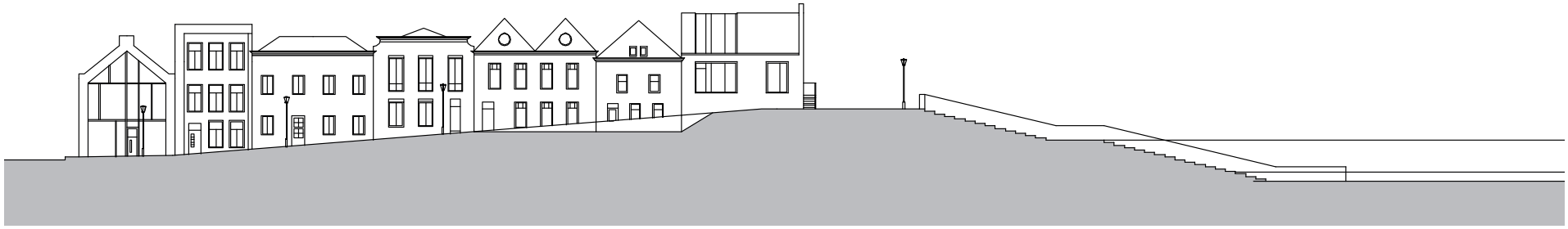


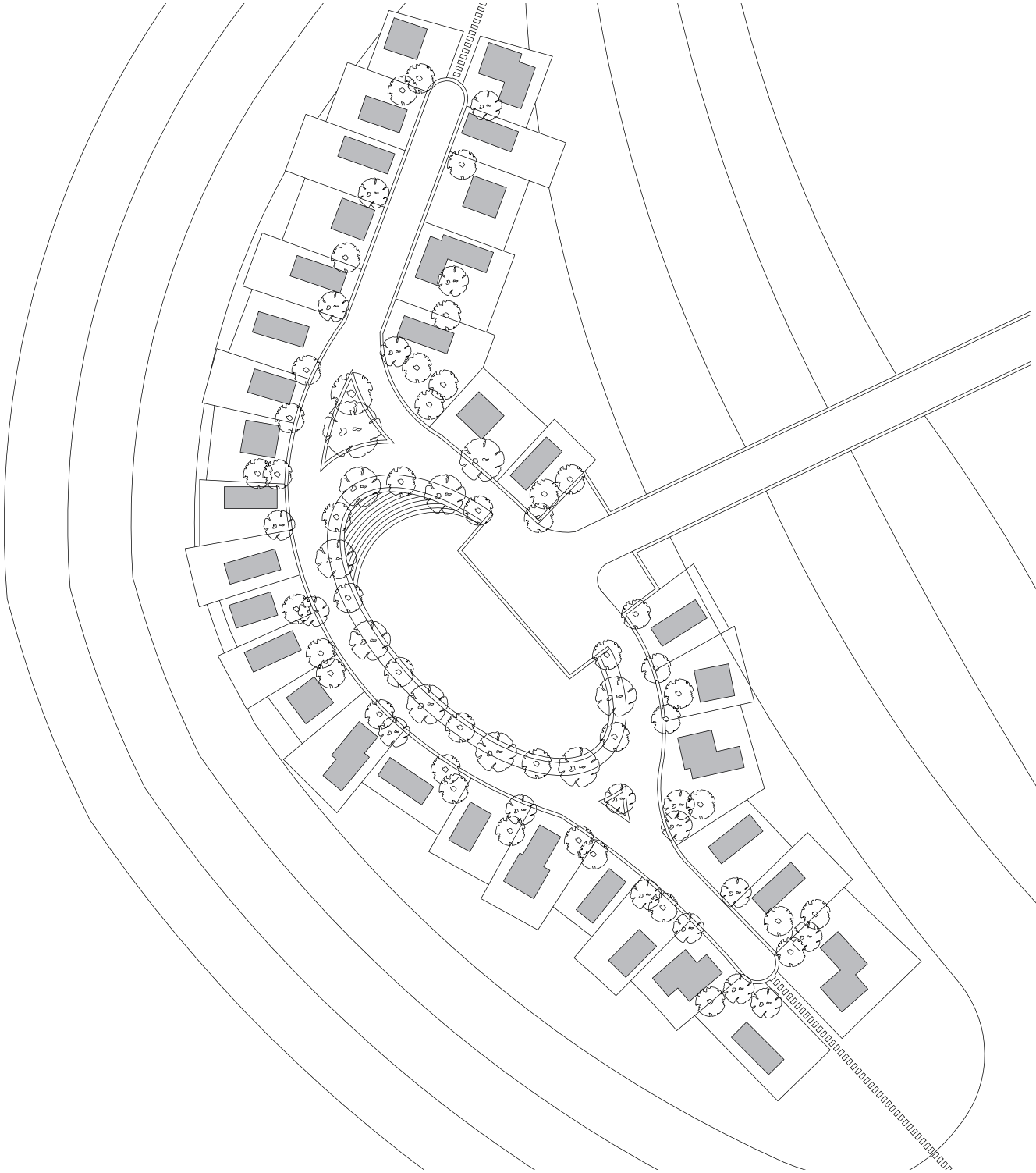
Figure 115. Section of the new dike, Oude Tonge
Source(s): *Author , 2012*

Figure 115. Section of the harbor, Oude Tonge
Source(s): *Author , 2012*

urban design

The ‘wierden’ of the Krammer Volkerak

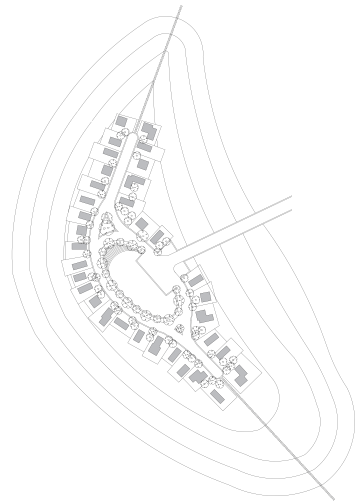
Keywords:
Wierde
Pool



The design of landscape living on the Wierde is based on the case study research on ‘wierden’ of the Waddenzee. The form is not circular but is stretched to embed itself in the dike, the parcels follow this form. The pool and the garden/vegation in the middle of the ‘wierde’ are characteristics that are used to relate to the study and ‘wierden’ in general.

As the housing in the urban extension, building plots are provided for public initiative.

Figure 116. Plan for ‘Wierde of Krammer Volkerak’
Source(s): *Author , 2012*



Epilogue

Figure 117. Vizualization of an open Dutch Southwest Delta
Source: *Author, 2012*

The Dutch Southwest Delta as an open delta

Keywords:
Krammer Volkerak
Cases
Dutch Southwest Delta
Open delta

The aim of the research and design project is: *"To design an urban landscape in the Krammer Volkerak area, that in a durable process provides a sustainable combination of urban, cultural and natural layers, in a re-opened Dutch Southwest Delta."*
The design of an urban extensions for Oude Tonge, in relation with the surrounding landscape, provides improved socio-economic conditions for the delta city in a way of public initiative and (eco) recreation. The creeks transform from hard edged cultural elements to a natural embedded elements providing (fresh) water storage and nature development. But relating to the cultural lines and structures of Goeree Overflakkee. The dikes and Delta Works transform from a hard border to a des-integrated element in nature. Providing nature developement and natural water defense. The re-established process of sedimentation is partly manipulated to maintain open shipping routes.
These design and research results as presented in drawings deliver a sustainable urban landscape in the Krammer Volkerak that constitute value during whole the process. An impression of an open Dutch Southwest Delta is shown in figure 117..

The design of a sustainable urban landscape in the Krammer Volkerak area functions as a complex design case that can be applied to other areas and delta cities in an open Dutch Southwest Delta. See figure 118.. This provides the feedback on the relevance of the graduation project and the possible application in a broader context.

The conclusion of this project is that the paradigm of working with nature consitutes value and the transformation of the urban landscape from cultural to more natural possesses opportunities for the socio-economic conditions of delta cities, nature and recreation. This research and design does not provide a solid phasing that is completed with the realization of the last phase. It aims to provide value, functionality and completeness in each stage.

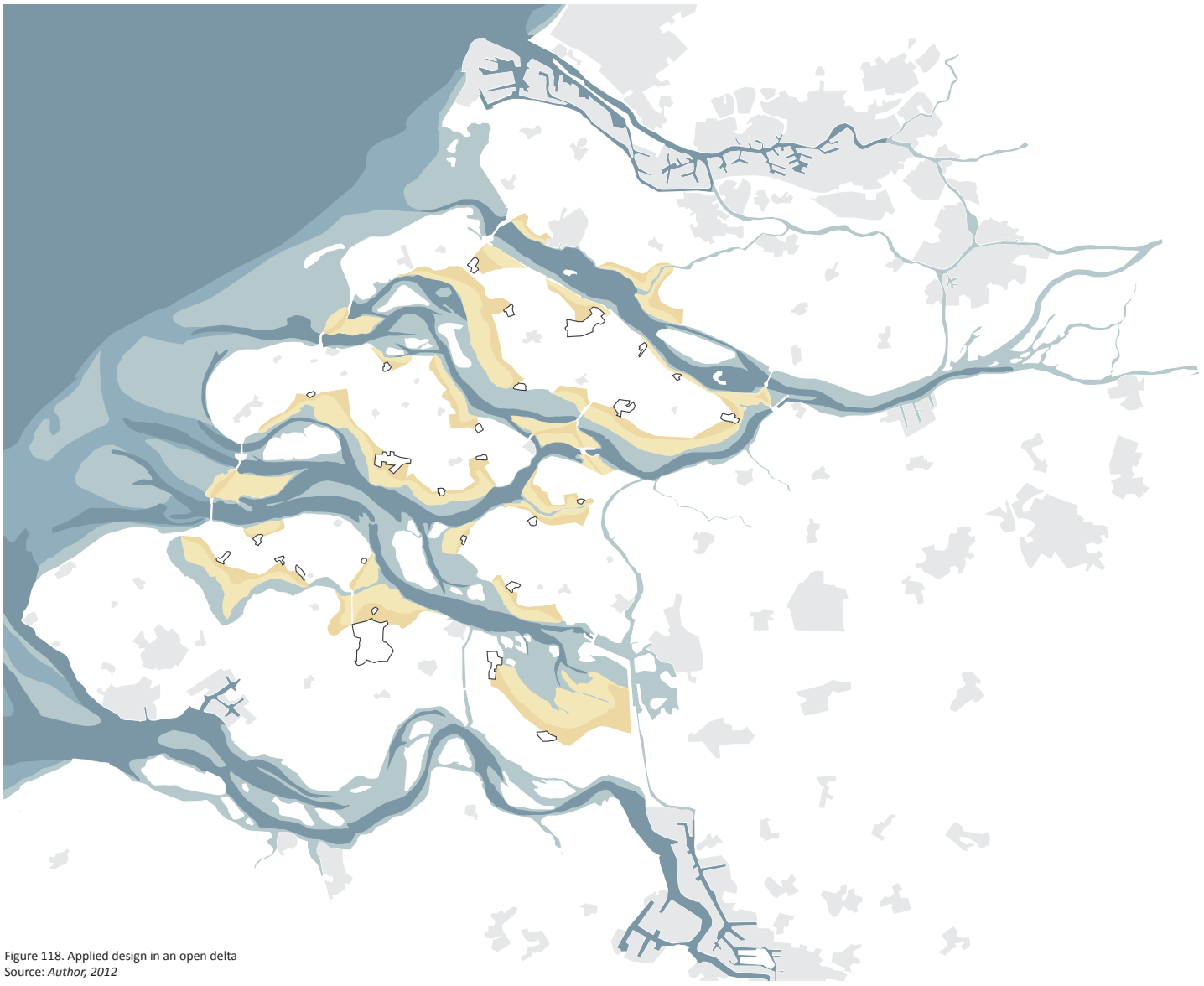


Figure 118. Applied design in an open delta
Source: *Author, 2012*

P5 reflection

Keywords:
Research by design
Studio theme
Social relevance
Academic relevance

The research and design done in this graduation project provided a more detailed implementation and visualization of an urban landscape in an open Dutch Southwest Delta. This chapter contains a reflection on the relationship between research and design in this project, the affiliation of the theme of the studio and the nature of the project and the relation between the project and the wider social and academic context.

Research and design

The historic research, form analysis and literature studies formed a framework for design. The research by design, that followed the framework, provided reflections and decisions for an identity, form and solution of an urban landscape in an open Dutch Southwest Delta. The relation between research and design will be further elaborated in the period between the P4 and P5, especially on the design process and what it means for the research on an open delta.

The research on an open delta also implied the research on the processes sedimentation and erosion. However, this civil engineering topic is complicated and as nature difficult to predict. The research in this graduation project provides the basic principles of these natural processes. The sedimentation process as indicated in the design is based on these principles and assumptions. The design project depicts in this topic a possible situation that is not fully based on exact science.

The theme of the studio

The website of the graduation studio 'Delta Interventions' state: "Delta interventions is an interdisciplinary studio in which architects, civil engineers, urban and landscape designers will collaborate. Within this studio the students will be challenged to find innovative and endurable build interventions, on a wide variety of scales that will transform and strengthen the identity of the Delta." [Delta Interventions Graduation Studio, 2012]

The research and design in this graduation project is oriented at the identity of the delta cities Oude Tonge and Ooltgensplaat. Research on the history and urban form of the city provided the basis for urban design. The identity is also related to delta landscape. The transformation from a 'closed' to an 'open' delta provided a question how the (new) relation between the polder landscape and open water can add to the identity of an open Dutch Southwest Delta. The project provides an answer with design that contains different layers from the design of an urban landscape to public space. And is in terms of design both innovative and sustainable. The graduation project reflects the theme of the studio and what it aims to accomplish.

The wider social context

The research and design project relates to the social context in different aspects. The aspects of the -sion on the open delta, the creation of recreational value for the delta cities and the addition to the 'Projectdossier Meerlaagse Veiligheid'.

The graduation project 'Towards an open delta' relates to the visions developed by 'Zuidwestelijke Delta', H+N+S Landscape architects and the WNF of an open delta.

Figure 119. Hoogtij voor Laag Nederland
Source: *WWF, 2008*

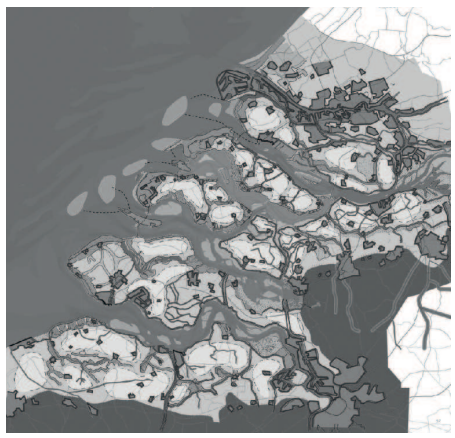


Figure 120. Plan by H+N+S Landscape architects
Source: *Programmabureau Zuidwestelijk Delta, 2009*

These regional plans do not cover the problems that can be found at smaller scales and how the new forms, identities and solution proposed by these organizations are implemented. The social relevance of this graduation project is that it provides research on complications and new solutions that an open delta provides and a small(er) scale design that can speak to the imagination of politicians, civilians, and other stakeholders by visualizing a possible future urban landscape of the Krammer Volkerak. It adds to the discussion on the open delta.

In addition it also provides a vision how to constitute value to a slowly shrinking area in the Dutch Southwest Delta by generating an attractive environment and spatial quality with nature.

Figure 121. Vacant housing in Oude Tonge
Source(s): *Author, 2012*

The delta cities on Oostflakkee have the lowest WOZ-waarde of Goeree Overflakkee and in which recreation provides a revitalization of the local economy.

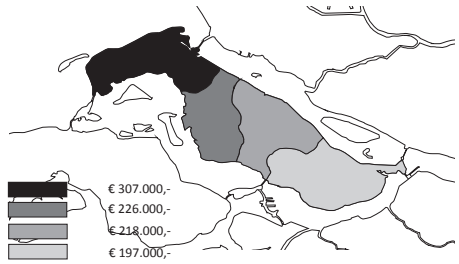


Figure 122. WOZ-values Goedereede, Dirksland, Middelharnis and Oostflakkee.
Source(s): *Author, 2012*
Data used: *Wikipedia, 2012*

Instead of a poor hinterland, the Krammer Volkerak can play an important role as a recreative and green archipelago for the metropolitan regions of Rotterdam and Antwerp.

The 'Projectdossier Meerlaagse Veiligheid', by the 'Deltaprogramma', states three consecutive layers of water safety: prevention, sustainable spatial layout and disaster control (see figure on the next page).

The design of an urban landscape in the Krammer Volkerak consists of different phases constituting solutions for the layers of prevention and the sustainable layout. In this way the project provides solutions of this concept, applied to the Krammer Volkerak and

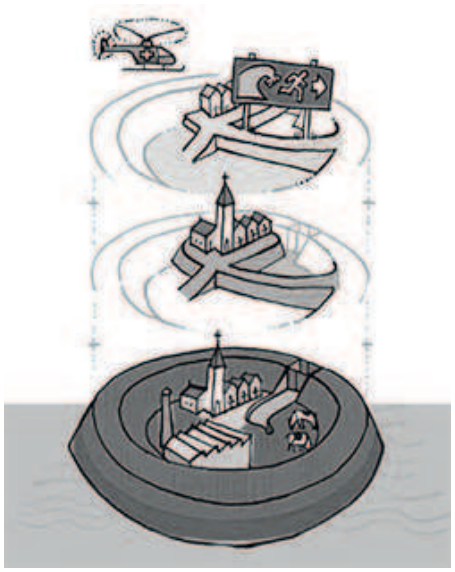


Figure 123. ‘Meerlaagseveiligheid’
Source: *Deltaprogramma, 2008,* from:
www.deltaproof.nl, 2012

Literature:

DELTA INTERVENTIONS GRADUATION STUDIO (2012). Retrieved May 14, 2012, from: www.deltainterventions.com.

MEYER H., VENEMA H., VAN DEN BURG L., KROMER N. & SMITS W. (2007). *Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland: 1850-2000.* Delft: TU Delft.

The research and design done in this graduation project provided a more detailed implementation and visualization of an urban landscape in an open Dutch Southwest Delta. This chapter contains a reflection on the relationship between research and design in this project, the affiliation of the theme of the studio and the nature of the project and the relation between the project and the wider social and academic context.

The wider academic context

The graduation researched the history, urban form and the spatial transformation of the delta cities Oude Tonge and Ooltgensplaat in the Dutch Southwest Delta. This research can add to the research of Han Mayer and others in the publication: 'Ruimtelijke Transformaties in Kleine Nederzettingen West Nederland: 1850-2000' [Meyer et al., 2007]. This publication analyzes small cities in the western part of the Netherlands on the topics of history, urban form and spatial transformation.

Recommendations

The paradigm working with nature is relativly new in urban design. I would encourage to work more with this attitude, especially when projects, design or research, are related to water. Furthermore I would encourage engineers or students to research the process of sedimentation in an open delta, that more scientific and spatial tools will be developd for design in the delta in general.

Word of thanks

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Literature

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