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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Keywords:
Delta regions
Urbanization
Paradigm shift
Working with nature
Thesis

Introduction

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 urbanisation. 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

Literature:


Data used: Google pictures, 2012; Google Maps, 2012
Graduation framework

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Aftermath of the Delta Works

Keywords:
Urban Delta
Reclamation
Delta Werken
Complications
Problematics
Potentials

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 ‘Hoogtijd voor Laag Nederland’ by WWF. 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.).

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.).

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;]
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 dike as hard border between the two worlds of the polder and open water, the route is also unattractive.

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 basins, 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).
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
  - Lower real estate value (WOZ)
  - Poorer 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 recreational 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 storage for fresh water supply

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

Figure 5. Current potentials and problems in the Dutch Southwest Delta
Source(s): Author, 2012
Data used: Programmbureau Zuidwestelijke Delta, 2009; WNF, 2010
Figure 6. Delta Cities with canals as a case in the Dutch Southwest Delta

Source(s): Author, 2012
Data used: Google Maps, 2012
The graduation project 'Towards an open delta' concerns itself with an open delta. However, the open delta is a 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. Tjalimgi 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. [Tjalimgi, 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 Zuidwestelijke Delta and H+N+S Landscape architects and 'Hoogtijd 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 - Zuidwestelijke Delta and H+N+S Landscape architects**

The advisory committee Zuidwestelijke 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]

**Hoogtijd voor Laag Nederland - WNF**

With the document 'Hoogtijd 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 the 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 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! (political 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, floating 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

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 excellent 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 process towards an open Dutch Southwest Delta.

Figure 10. Hoogtijd voor Laag Nederland
Source: WWF, 2008

Literature:
Towards an 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.

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.

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

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.
The impact of an open delta

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.

Keywords:
Social relevance
Academic relevance
Urban theory
Research
Discussion

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:
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

- **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

- **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.

- **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.

- **How to design the urban form of Oude Tonge and Ooltgensplaat in an open Dutch Southwest Delta, and in relation with the new inter tidal area?**

  Domain(s): Urban Design & Landscape Design
  Method(s): Research by Design - Sketching

- **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).

**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.

- **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

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

  Domain: Landscape Design
  Method(s): Mapping
  Implementation: this mapping will provide insight in the structure and characteristics of the 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.

**Cultural Layer**

The sub research questions on the cultural layer are:

- **What are the form and characteristics of the (cultural) landscape in Oostflakkee?**

  Domain: Landscape Design
  Method(s): Mapping
  Implementation: this mapping will provide insight in the structure and characteristics of the 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.
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 inventory 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.

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 theoretical framework and the research by design will be delivered and/or presented in certain products. These products can be divided into two groups: research products and design products (see figure 12). The 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 exist 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 visualizes 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.

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<td>Urban design</td>
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Figure 12. Time schedule graduation project 2011/2012
Source(s): Author, 2012
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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]. 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.

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 it is important to know the precedced 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, mitigation and adaption
Source: White, 2010
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 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 [Tjallingi, 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 14. Phasing and urban archetype**

*Source: Hooimeijer, 2011*

**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 canard, 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).

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

The city and natural processes
“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 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.

Literature list:


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.

![Height map](image1)

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

**Occupation**

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

![Occupation](image2)

Figure 19. Occupation
Source(s): Author, 2012
Data used: Top 10 Vector Map, TU Del 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 European 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

Swimming
Surfing
Waterskiing
Day recreation / camping
Birdwatching
Walking / cycling

< 50 ships
50 - 100 ships
100 - 300 ships
300 - 600 ships
> 600 ships
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 natural processes related to form. In the theory of Design with Nature this is sedimentation.

Sedimentation is an unpredictable 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 longitudinal is strongly related to the velocity of a steady turbulent open channel flow:

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

In which:
- $v$: flow velocity (m/s)
- $C$: Chezy coefficient (m$^1$/s) ~ friction coefficient
- $R$: hydraulic radius (m) ~ water depth
- $l_w$: bottom slope (m/m)

And of sediment transport:

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

In which:
- $S_{sed}$: sediment transport (kg x 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:

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

$$v_1 > v_2$$

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

The problem statement addresses that the Deposition of sediment occurs when the water depth, 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:

$$Q_1 < Q_2$$

$$A_1 < A_2$$

$$v_2 < v_1$$

With multiple objects (groynes):

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

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 (getijenslag) 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 directions (sea and river). This provides 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 ‘voorovers’ (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 creeks and overview of sedimentation in the Krammer Volkerak
Source: Author, 2012
Data used:
- 1850. Map room, TU Delft Faculty of Architecture, 2011
In the Medieval period Goeree-Overflakkee existed of a dune with the village of Ouddorp and multiple sand plates. The intertidal 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 reclaimed 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 reclaimed 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.geschiedenisvandirdikland.com, 2011; Google Maps, 2012

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Keywords:
Urbanization Delta cities
Harbor city
Polder city Phases

Source(s): Author, 2012
Data used: www.geschiedenisvandirdikland.com, 2011; Google Maps, 2012
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 ‘kerk- en- voorstraad dorpen’ [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 some historic photographs and drawings to provide some visualization. This will lead to an interpretation and description of the urbanization.
Figure 30. Schematic representation of the urbanization of Oude Tonge
Source: Author, 2012
Figure 31. Schematic representation of the urbanization of Ooltgensplaat
Source: Author, 2012
The urbanization process of the delta cities Oude Tonge and Ooltgensplaat went by seven different phases, each related to a technological or socio-economic development:

**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. Adjacent 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.

**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 accessible for ships. The harbor has a typical L-shape.

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

Around 1750 mills were constructed to provide the cities in their 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.

**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.

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

Afer 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.

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

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.

**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 adjacent polder, using the polder’s line composition, directed towards the water.
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 remembrance 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 reclaimed 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 bordering, neglecting the historical context and filling in the creek to create housing and infrastructure. This process is irreversible.

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.
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.

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

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

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

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 through the century transformed into road transport.
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 visualize the spatial transformation of the small settlements. For Oude Tonge and Ooltgensplaat the sketches are shown below.
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.

Keywords: Historic housing, Rooftops, Window grid, Width, Flood defense

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 polder landscape 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-structuring after the Watersnoodramp in 1953 when most of Oost-Flakkee was flooded.

Figure 58. Polder landscape, mills and creeks, 2012
Source(s): Author, 2012
Past creeks
The creek system in the polder landscape of Southeast Goeree Overflakkkee, in 1850. The delta cities are located at the main creek.

Current creeks
The creek system in the polder landscape of Southeast Goeree Overflakkkee, in 2012. Most of the historic or natural creeks have disappeared.
Earthen hills in the Netherlands and Germany go by different names: terpen, wierden, worden, wierden, vliedbergen, werfen (NL) and warfen, warften, wurten, würtchen, 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 earthen 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 disappeared 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 Waddenze 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 permanently inhabited or is temporarily 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.
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 extent 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.
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
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 ‘wierendorp’ 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.

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**Figure 65. Impressions Niehove, NL**
Source(s): Google Pictures “Niehove”, 2012
Modification: Black & White, Photoshop
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
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 height (in time of construction):

Current context:

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

Figure 70. Height mapping of Halig - Hooge
Source(s): Author, 2012
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.
Figure 72. Reduced map of Hallig - Nordstrandischmoor
Source(s): Author, 2012
Data used: Google Maps, 2012

Figure 73. Height mapping of Hallig - Nordstrandischmoor
Source(s): Author, 2012
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 protected 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 height (in time of construction):

Current context:

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

Figure 76. Height mapping of Westerhever
Source(s): Author, 2012
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 mainland 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 earthen hill and oriented on the landscape. But with one or two access 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 height (in time of construction):

Current context:

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

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

The urban form of the ‘wierden’ differs in many 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 tendency 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 tendency 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’.

Orientated 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:

Design process

modelling
Sandbox design

sketch process
The Thinking Hand
Sandbox design

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 separating them form the cargo route between Antwerp and Rotterdam.
This chapter will show the design process from first concept or plan idea till the end result.

The concept started with two main elements. 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 constitutes 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 conceptual 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 stretched 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 ‘vierden’ have different heights and forms. To relate differently to water.
Designing a possible open delta

The design of the urban landscape of the Krammer Volkerak is made in different scales and different phases. The design is not a definite 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 visualizations 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 visualizations, 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.
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, a 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 economical reasons, and still be a valuable plan. The phasing could also be changed in order.
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 water storage 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 beneficial to keep the harbor and the canal open.
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 (Natuurmonumenten), 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 European 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 visualizations 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-economic 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.
The inundation area transforms not only in a natural area, but also in a recreative area. Large ‘vierden’ 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 ‘vierden’. The ‘vierden’ 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.
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.
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.

Figure 89. Phase VI
Source(s): Author, 2012
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.
Phase VII +
Open intertidal area
Enhanced water defense
Rain water storage

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

Highway
Water defense line - dike
Water gate

Occupation

Outer dike area
Creek
Water storage - polder

Water depth - very deep
Water depth - deep
Water depth - middle
Water depth - low

Bird spotting
‘Wierde’
Modern castles/‘wierden’
Figure 92. Phase VII -
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 embedment 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.
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 94. Phase IX
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 enables 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 separate cargo and recreation shipping in the Krammer Volkerak.
Figure 96: Phase X
Source(s): Author, 2012

- Enhanced water defense
- Embedded Delta Werken
- Disintegrated dike line
- Separated shipping routes
- Rainwater storage

- Occupation

- Outer dike area

- Creek

- Water depth - very deep
- Water depth - deep
- Water depth - middle
- Water depth - low
- Water depth - very low

- Bird spotting
- "Wierde"
- Modern castles/"wierden"
Figure 97. Phase X +
Enhanced water defense
Embedded Delta Werken
Disintegrated dike line
Separated shipping routes
Rain water storage

- Occupation
- Outer dike area
- Creek
- Water storage - polder
- Waterdepth: very deep
- Waterdepth: deep
- Waterdepth: middle
- Waterdepth: low
- Waterdepth: very low

Highway
Water defense line - dike
Water gate

Figure 97. Phase X +
Source(s): Author, 2012
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 relatively 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 occurring 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.
Figure 99. Transformation of a dike
Source: Author, 2012
Pictures: Google Pictures, 2012, tree or plant name
Figure 100: Transformation of a dike
Source: Author, 2012
Pictures: Google Pictures, 2012, tree or plant name
Figure 101. Transformation of a delta city's relation with nature
Source: Author, 2012
Pictures: Google Pictures, 2012, tree or plant name
Figure 102. Visualization of a transforming creek system
Source: Author, 2012
Figure 103: Visualization of a transforming polder (intertidal area)
Source: Author, 2012
Figure 104. Visualization of a transforming urban landscape
Source: Author, 2012
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 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/7264/6997897527_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
The ‘wierden’ of the Krammer Volkerak

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/vegetation 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
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Figure 117. Visualization 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 development 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 constitutes 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
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 enduring 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 '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+H+S Landscape architects and the WNF of an 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.

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

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

The 'Projectdossier Meerlaagse Veiligheid', by the 'Delta programma', 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
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 relatively 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 developed for design in the delta in general.

Literature:

Word of thanks

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Literature


