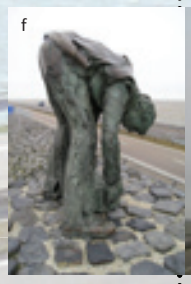
The future of an adaptive ‘Afsluitdijk’

A landscape architectonic design of a safe ‘Afsluitdijk’ that expresses the unique qualities of the site

Master Thesis Landscape Architecture
Wageningen University and Research Centre
J.C.W. (Monique) Sperling BSc



Den Oever

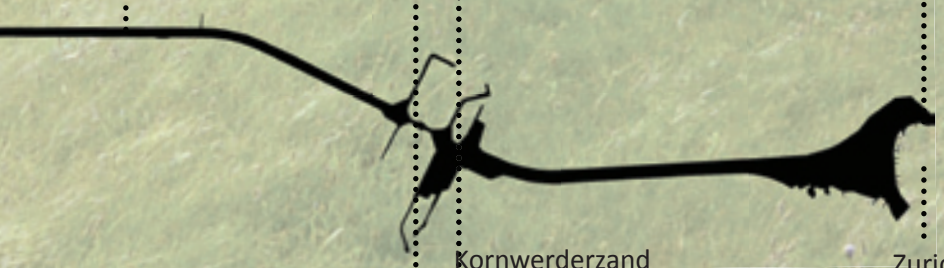
Robbenplaat

Stevin sluices

Monument
De Vlieter

Breezanddijk

Overview of ‘De Afsluitdijk’



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Major Thesis Landscape Architecture

Wageningen, January 2009

Wageningen University and Research Centre
Master Landscape Architecture & Spatial Planning
Major Thesis Landscape Architecture (LAR 80439)

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Signature Date

Examiner: Ph.D. Professor J. (Jusuck) Koh (WUR)

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Signature Date

WAGENINGEN UR
For quality of life

I. Location of ‘De Afsluitdijk’ in Europe

II. Location of ‘De Afsluitdijk’ in The Netherlands

III. Location of ‘De Afsluitdijk’ in Northern Netherlands

De dijk ligt tussen ‘t land en ’t water
Met palen en bazalt.
Hier ligt hij nu, hier ligt hij later,
Totdat de aarde valt,

Hij is gestegen uit de vloeden
Met norse langzaamheid
Hij is tot schutten en tot houden
Tot worstelen bereid

Hij ligt er met zijn taaie wieren
Gelijk een donker dier,
De wind kan langs zijn flanken gieren
Of fluiten in een kier,

Hij kan in grondzee onderduiken
Gekranst met lillend schuim –
Geen kracht kan deze kracht verbruiken
Hij staat er groot en ruim!

(J. Engelman – ‘de dijk’ in (Stuvel 1957))

INTRODUCTION

A thin long line cuts across a huge amount of water, creating a place with a unique openness and robustness. A place where you feel free, feel the sun on your face, the strong wind through your hair and smell salty air. This place is called 'De Afsluitdijk' and is situated in the northern part of the Netherlands.

This major thesis about De Afsluitdijk is the final project of my study Landscape Architecture at Wageningen University in The Netherlands. The subject of this thesis arose from a problem of international matter: the expected climate change. The basic construction of this long, almost straight line and its surroundings gave me a unique experience. The dam element is an icon that shows how 'the Dutch' are coping with the sea. During a symposium 'De Toekomst van de Afsluitdijk' (the future of 'De Afsluitdijk') organised by 'Rijkswaterstaat', my interest grew even more and various constraints became clear. I felt its uniqueness and opportunities were not given sufficient credits and the ideas not integral, because they were too much focused on one aspect.
The dam is constructed in 1932 and now, in 2008 'De Afsluitdijk' is again one of the topics where experts are talking about. About seventy years after construction safety standards are changed. According to the regulation 'Wet op de Waterkering', 'De Afsluitdijk' will be no longer sufficient to protect the hinterland against flooding in the future. The expected climate change plays a big role in the need for development. The water flow coming from European rivers increased, the traffic flow changed and sustainable energy production became an hot item (Bureau Bosch Slabbers 2000). Also according to the magazine 'De Blauwe Kamer' a landscape vision is needed because of the re-adjustment of the dam (van Tilburg 2007).

These gave reason to have a closer look at 'De Afsluitdijk' and try to come up with a design solution. This thesis shows a solution to make the dam safe again while enhancing the spatial quality.

I would like to thank in particular Ingrid Duchhart for her supervision and enthusiasm during my thesis. She encouraged me to come up with good (design) solutions and helped me to finish this major project. I am thankful for the advice, time and inspiration from Joost van de Beek and Eric Regeling of 'Rijkswaterstaat' to get a clear overview of the problems and technical conditions, Willem van Duin (Imares-Texel) for his inspiring ecological information, Klaas Kerkstra for his design suggestions and stimulating ideas, Henriëtte Otter, Maaike Bos, Gerda Lenselink of Deltares for their critical remarks on the research method, Thamar Tax for her support and review, and last but not least I would like to thank my colleague students, friends, and family for their critical listening and positive support.

Monique Sperling BSc

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SUMMARY

Climate Change (chapter 1)
The expected climate change is the point of departure for this thesis. The predicted climate change has various consequences on different scale levels. The biggest influences on the scale of 'De Afsluitdijk' are:

- A rising temperature, which results in higher North Sea and 'Waddenzee' level. The sea water level will, in comparison to 1990 rise with (scenario W+, 'KNMI' 2006):
  - 15 - 35 centimetres in 2050;
  - 35 - 85 centimetres in 2100;
  - 100 - 250 centimetres in 2300;
- a changing rainfall pattern, which results in more run off by rivers to the 'IJsselmeer' in winter and less in summer;
- more storm surges, which means more wind and higher waves, which are fiercer in comparison to waves at this moment.

Research question (chapter 2)
"In what way can a landscape design contribute to a safe 'Afsluitdijk' that expresses the unique qualities of the site?"

'De Afsluitdijk' (chapter 3)
In 1916 the Netherlands had to cope with a population growth and a dramatic flood disaster in the areas surrounding the 'Zuiderzee'. The water disaster was followed by a food shortage. Together this resulted in 1932 in the construction of 'De Afsluitdijk', which protects the hinterland against flooding and made it possible to construct new polders for agriculture. The dam has nowadays also a connection-function between the northern provinces of Holland (and to northern Europe). It is also a barrier to maintain the fresh water reservoir of the 'IJsselmeer' and transfers run off water from the 'IJsselmeer' to the 'Waddenzee'.
The dam is interesting because it is a unique architectonic construction situated in a unique landscape of water; water-scape. It is an almost straight line of 32 kilometres long, 90 meters broad and is located in the middle of the sea. The 'Waddenzee' positioned at one side and the 'IJsselmeer' at the other side. The dam 'touches' the land at the province of 'Noord-Holland' near the village 'Den Oever', and at the province of 'Friesland' near the village 'Zurich'.
The characteristic open landscape experience is unique for the Netherlands. Next to this, the dam is interesting because it became a symbolic icon of the way the Dutch are coping with water, which attracts many visitors.

Reasons to re-adjust 'De Afsluitdijk' (chapter 2)
The main function of the dam is protecting the hinterland against flooding. When the dam breaks, the hinterland will get flooded because the 'IJsselmeer' dikes are not strong and high enough (see appendix). The dam is not prepared to fulfil this function in the future because:

- Of the expected climate change the North Sea water level will rise. This results in a higher pressure on the dam from the 'Waddenzee' side;
- the expected climate change will result in a more irregular rain pattern followed by a higher run off of rivers in winter and lower in summer. The higher run off results in a higher 'IJsselmeer' water level. This means a higher pressure on the dam from the 'IJsselmeer' side;
- because of the higher run off, the dam has to transfer more water from the 'IJsselmeer' to the 'Waddenzee'. At this moment the spout capacity of the dam is too low to be able to transfer all this water. This results in an accumulation of water in the 'IJsselmeer' and rivers what can cause floods;
- more storms mean more waves and waves that are fiercer at the side of the 'Waddenzee'. The materials and dam are not strong enough to deal with this;
- this climate change results in a higher pressure on the dam from two sides. Because of this, the dam does not suffice the 'Wet op de Waterkering' (legislation about dams) anymore, so change is needed.

In addition, there are some constraints because of the construction of 'De Afsluitdijk' that can be solved. The knowledge and importance of ecology changed in comparison to 1932. This new input influences the adjustment;

- the dam is a barrier for the natural water flow from the European rivers to the North Sea. This results in an accumulation of water in the 'IJsselmeer' and rivers what can cause floods;
- the barrier separates the saline and fresh ecosystem. This is bad for ecology because there are no gradients, resulting in less biodiversity and a few habitats;
- the dam is a barrier for migrating fish. Fish migrating between their living area, the North Sea, and their breeding area in the 'IJssel'-river or further. The fish are getting lost and can not breed, resulting in less fish;
- the spouts transferring the water from the IJsselmeer to the Waddenzee result in sudden fresh water inlets. Because of this a lot of life stock of the Waddenzee is dying out or get diseases, because they suddenly get a lot of fresh water on top of them and they can not adjust to this sudden change in environment.

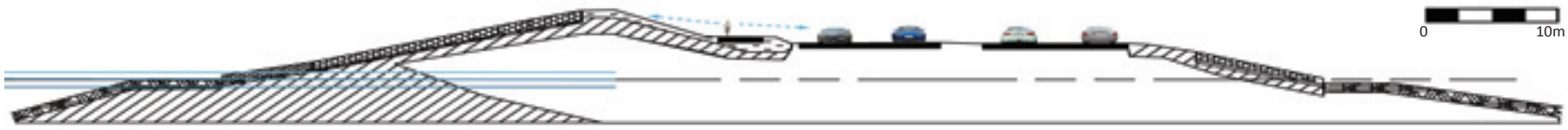
On the level of the dam itself are some constraints of perception to be solved:

- only one side of the dam, the 'IJsselmeer', can be perceived. It is impossible to see the 'Waddenzee' while driving or biking along the dam. This makes people not aware of the uniqueness of being on a dam that goes through the sea;
- while biking over the dam it becomes boring, because only the dike can be seen. The water can not be seen very well, because the highway is in-between the bicycle path and the water. The cars are passing the dam in high speed, which makes a lot of noise. This makes it also not nice to cycle along the dam.

Research method (chapter 2)
The research method comprises four phases. Figure I shows a summary of these stages. The method is not a linear, as the overview may suggest, but a cyclic process. The method is based on research by design and the design follows on the site characteristics. Sketches and drawings are made as soon as possible in the process and are later on assessed by the theoretical framework. This makes that the designer is not limited to the technical knowledge and makes the design more innovative. During the whole process my landscape architectonic vision develops and adapts to new knowledge.

Phases:

1. Orientation Phase one exists of the subject orientation. This occurs by doing a landscape analysis, site visit and visiting the symposium 'Toekomst Afsluitdijk' (future 'Afsluitdijk') organised by 'Rijkswaterstaat' on the 14th of March 2008;



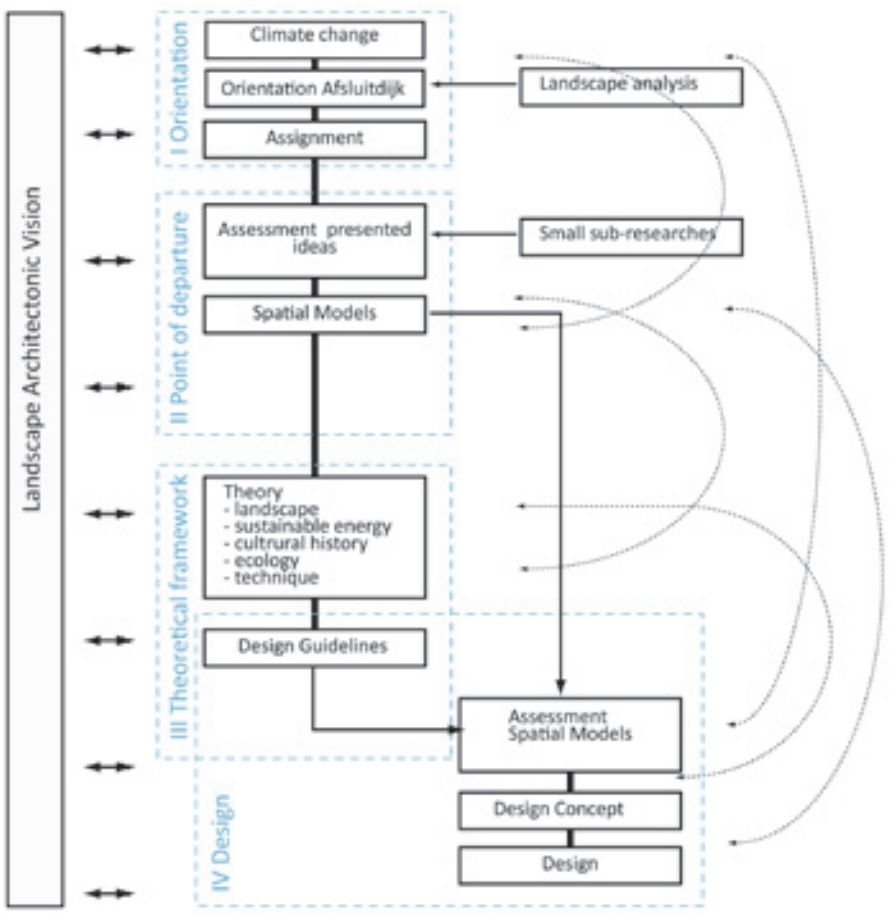
I. Current situation 'Afsluitdijk'

2. Point of Departure: In this phase, the ideas, presented at the symposium, are discussed. With the help of small sub-researches, the ideas become clearer. A brainstorm session results in intuitive sketches that give an overview of the possibilities of the site. By overlay these sketches result in spatial models;
3. Theoretical framework: This phase elaborates on the reference studies, and theories about landscape, sustainable energy, cultural history and ecology. All together they result in the design guidelines;
4. Implementation: The design guidelines are given a certain value because they do not all have the same importance. The three spatial models are assessed, resulting in one model. This model is the base for the design concept. The design and design details are explained and drawn.

Symposium (chapter 5)
About thirty ideas were presented during the symposium 'Toekomst Afsluitdijk' organised by 'Rijkswaterstaat' on the 14th of March. They were mostly focused on one aspect and not integral. During the symposium it became clear the site has potential to produce sustainable energy. The ideas could be grouped and this resulted in three spatial models:

1. raising the dam;
2. a second dam;
3. broadening the dam with a natural barrier.

Theoretical framework (chapter 6)
'De Afsluitdijk' is situated in the middle of a water-scape. This water-scape can be divided in various layers (layer model, triplex model, Lynch): relief, water, dam, and architecture.
The various theories about proportion and scale as the Golden Section, The Modulor, Anthropometry, and Visual Scale, together with theories about shape and space of McCluskey, Curdes, Wassink, and Thiel, and perception and spatial quality in general explained by Werksma, Hooimeijer, Coeterier, Ploeger, and Rooijers, lead to the spatial quality of 'De Afsluitdijk'.



II. Summary research method

Spatial quality is very difficult to define, because it is among others depending on time, space, and culture. Social processes are closely related to the definition of spatial quality. It has to do with the aesthetical value, the functionality, the relations between ecology and human activities. In short, it can be said that spatial quality is about relations, proportions and context.
The spatial quality of 'De Afsluitdijk' can be summarized as follows (Sperling, 2008):

- openness of the surroundings;
- long, thin line;
- cultural historical value, icon function;
- simple design concept with a sequence of exceptional places;
- unity in form, scale, materials, and colours;
- interaction between the technical, artificial dam element and the natural appearance of its context gives the site quality. It is the total setting what makes it special;
- contrasts as natural – artificial, fierceness – safety, dynamic – static, etcetera;
- characteristics to produce sustainable energy.

Design (chapter 7)
The three spatial models are assessed with the help of design guidelines. Spatial model 'Broaden the dam with a natural barrier' turns out to be the best model.
The design concept is based on the history and characteristics of the site. This results in a protection of the dam with salt marshes. Because of the existing trench 'Doove Balg' is it impossible to protect the whole dam with salt marshes. The salt marshes protect the western part of 'De Afsluitdijk and artificial reefs protect the eastern part (fig. 7.13 p96 and fig. 7.81 p124). The salt marshes have high ecological value and contribute also to the cleaning of the water. They filter silk out of the water so that the water can be used in the osmosis plant at 'Breezanddijk'. The brackish 'waste' water of the osmosis plant is used to make a gradient in saline to fresh water what solves the problem of the migrating fish. With a fish ladder at 'Breezanddijk', the fish can pass the dam. The brackish water is led to the fresh water inlet to be mixed with each other to solve the sudden fresh water inlets.
Further more the profile of the dam changed. The bicycle path moved to the other side of the dam (to the 'IJsselmeerside'). This made it possible to raise the dam with 2,35 meters while maintaining the highway. By moving the bicycle path the 'IJsselmeer' can be seen instead of the wall of grass and the passing cars of the highway (fig. 7.29 p102).
During the research it became clear to develop the places where the dam touches the land to strengthen the spatial quality of the dam itself. The openness of the dam is strengthened by increasing the contrast between open and enclosed. This is done by extending the forest at the 'Noord-Holland' side and adding wind turbines at the 'Friesland' side.

Main conclusion (chapter 8)
The main conclusion answers the research question of this thesis:
In what way can a design contribute to a safe 'Afsluitdijk' until 2200, which expresses the unique qualities of the site?
The content of this thesis is a research by design to adjust 'De Afsluitdijk' in a way the dam suffices the new standards of safety without losing the unique qualities of the site.
The results suggest that the hypothesis is true. By using a qualitative landscape architectonic approach, an integral design can contribute to the design of a safe 'Afsluitdijk', which is also beautiful, and is adaptive to the unpredictable climate change.
The spatial quality of the openness horizon, the long, straight, thin line, and the contrasts are expressed. The proposed design solutions strengthen each other and form a unity that fits the existing situation and context. The design shows a multifunctional 'Afsluitdijk' in which the production of sustainable energy and the increasing of ecological values are integrated with the main functions of providing safety, spouting water, and being a connection.

CHAPTER

1

Climate Change

Climate Change

The climate change is a problem of international matter, but has consequences for ‘De Afsluitdijk’. The changing climate has different consequences resulting in interesting design assignments for landscape architects. According to the Dutch government one of the biggest spatial questions of the 21st century is how the Netherlands will cope with the climate change (Platform Communication on Climate Change (PCCC) 2008). According to ‘Rijkswaterstaat’ (2008) the dam will not be able to protect the Netherlands against flooding in the future because of the expected climate change.

It is not totally clear what the consequences for ‘De Afsluitdijk’ of a change in climate will be. The ‘KNMI’ (Dutch meteorological Institute) produced different scenarios to give an overview of possible consequences. The scenarios differ from each other in average temperature rise and air circulation patterns. This chapter describes what the consequences on a global (world) and on a national scale (The Netherlands/‘De Afsluitdijk’) could be.

1.1. Global consequences

According to the IPCC (2007) climate change can be defined as:

> *Climate change 'refers to a change in the state of the climate that can be identified (e.g. using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity' (Intergovernmental Panel on Climate Change (IPCC) 2007) Topic1 p6).*

The climate is changing as long as the world is existing, but in particular at this moment people are more aware of the environment and the way they contribute to a change (Platform Communication on Climate Change (PCCC) 2008). Experts are doing research about the reasons and consequences of climate change (fig. 1.1). So far, it is not totally clear how, and in what speed the climate will change and what the consequences will be. Though it is clear that the change will affect different categories like recreation, nature, agriculture, health, etcetera. They are closely related to each other, if one is affected, the others automatically change. This means that a small change can have a big impact on different levels. Researchers do also know that a sea level change will be one of the consequences. It is not clear how much the sea level will rise or fall, but this thesis assumes that the climate change will cause a rise of the sea level. A rise is chosen because most of the experts expect a rise (N.M.J.A. Dankers, H.M.P.M. Capelle et al. 2002; Intergovernmental Panel on Climate Change (IPCC) 2007; Tol 2007; Platform Communication on Climate Change (PCCC) 2008).
This sea level rise will be a result of the rising temperature. A lot of the existing ice (onshore and glacier) will melt. Also the 'Groenlandse IJskap' is melting, which results in a higher sea level (Platform Communication on Climate Change (PCCC) 2008). A higher temperature will also effect evaporation, and run off of water. It means more rain and less snow (van Drunen 2006b), and rivers will have to cope with the transportation of more water (Platform Communication on Climate Change (PCCC) 2007). At this moment it is clear the temperature rose about 0,7 °C in the world and 1 °C in the Netherlands in the last century (Milieu en Natuur Planbureau 2005). The sea level has risen about twenty centimetres in the last centuries (Milieu en Natuur Planbureau 2005).

1.2. National consequences

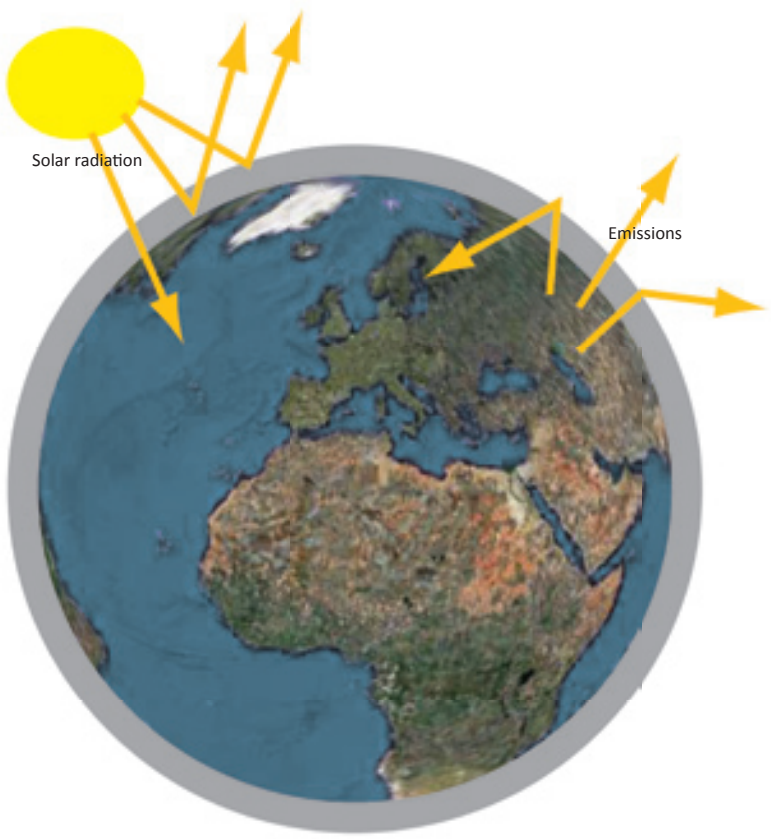
The 'KNMI' made four scenarios to get an overview of the effects of the expected climate change (KNMI 2006). This thesis takes the scenario W+ as point of departure, because 'Rijkswaterstaat' always takes this scenario when they have to deal with safety projects (Rijkswaterstaat 2008a). According to 'KNMI' (2006) the expected climate change for the Netherlands (KNMI 2006) means:

Higher temperature
All four scenarios show a temperature rise. The temperature will rise between 0,9°C to 2,3°C in winter and 0,9°C to 2,8°C in summer. These numbers are for the year 2050 in comparison to the year 1990 (fig. 1.2). (KNMI 2006)

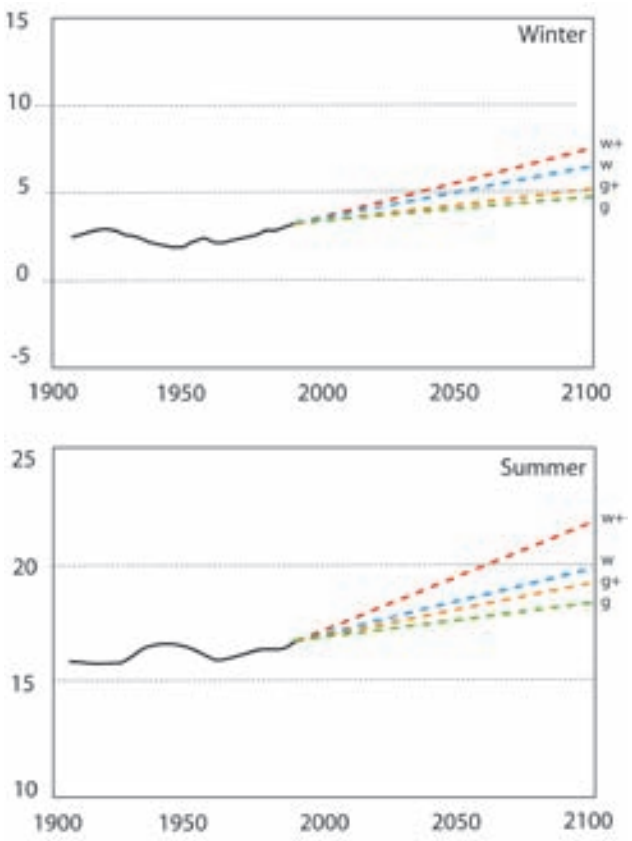
More rainfall
The yearly rainfall rose with 18% since 1906. The scenario W+ shows a rise of rainfall with +7% in winter and a decrease of rainfall in summer of -10% per degree (fig. 1.5). The decrease in summer is the result of a decrease in the amount of rainy days. All scenarios show a high average of rainfall in summer because of heavy showers. (KNMI 2006)

Shortage of fresh water
When the sea level is rising, the salty water will move up inland what will affect the fresh water (Deltacommissie 2008 2008). The soils can become brackish and in warm, dry summers a shortage of fresh water will occur (Waterbeheer 2000). Agriculture, nature, and shipping will be the dupe of this shortage.

More and stronger storms
The scenario W+ shows a small increase of the highest day average of wind speed per year. (fig. 1.4). The strength of heavy gales, especially from South West direction, increases a little bit above North West Europe (Deltacommissie 2008 2008). At this moment these occur less than once a year.
Near the Dutch coast, storm tides are happening at the moment storms come from the direction West or North. The four scenarios show a change in the amount of storms from these directions is insignificant. (KNMI 2006)



1.1. Green house effect



1.2. Expected temperature rise (degrees C) (KNMI)

Sea level rise

The Netherlands is situated in Europe and located next to the North Sea. The most important characteristic of The Netherlands is the fact that a part is situated underneath sea level. The lowest part is about 6,5 meter below mean sea level (Ronald E. Waterman, Misdorp Robbert et al. 1998). Additional to this, the Northern and the Western parts of the Netherlands are sinking (Waterbeheer 2000) a few centimetres per century (Milieu en Natuur Planbureau 2005). The sinking of the land is the result of among others:

- The Dutch way to win land from the sea (system of making polders);
- Geotectonic drifts and post glacial rebounding of Scandinavia and Scotland;
- The acquirement of gas. The area surrounding Slochteren (North Netherlands) is expected to sink about 60 centimetres until 2050 (Milieu en Natuur Planbureau 2005);
- The subsidence of peat and clay areas (Milieu en Natuur Planbureau 2005).

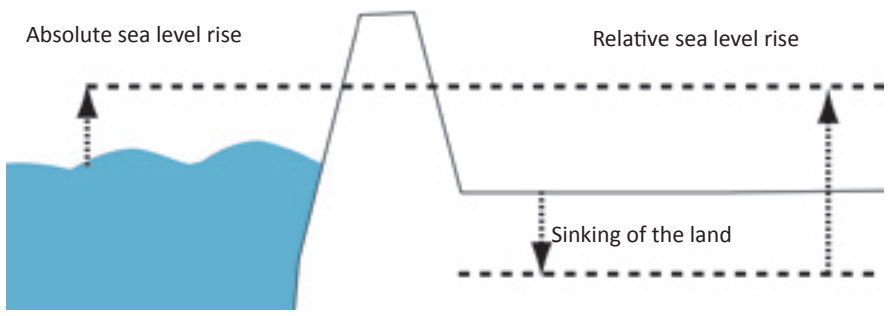
This means that the level difference between land and sea is even increasing what means a part of the sea level rise is relative (fig. 1.3)
In the lower parts of The Netherlands the relative sea level rise is even more because of subsidence of clay and peat of these parts (Platform Communication on Climate Change (PCCC) 2008).
The fact half of the Netherlands is situated below sea level has different consequences for this country. It always had and has, to live with and has to protection itself against the water. Various innovative systems help to control the water level. In the lower parts of the Netherlands the water transportation goes from polders to outlet waterways (‘boezems’), to the water outside the country. In the higher parts of the Netherlands the water flows through canals and rivers to the sea (Milieu en Natuur Planbureau 2005).
The Netherlands had to cope with extreme high water levels in rivers and seas, especially during 1993, 1995. Next to this extreme high water occurred because of a lot of rain in 1993, 1994 and 1998. This had social as well as economical impacts. Especially areas with a high density of houses are vulnerable, because of risks for people and capital. But on the other hand risks can also bring innovative ideas (Platform Communication on Climate Change (PCCC) 2008).
The last hundred of years the sea level along the Dutch coast rose with 20 centimetres compared to the Average Mean Level. The Netherlands was always threatened by storm surges, but at this moment the expected climate change is one of the aspects why the government and experts are doing research about the protection of the country even in more detail. Although experts do not know exactly what will happen in the Netherlands in the future:

- ‘The sea level rise with 20 – 110 centimetres this century’ (Milieu en Natuur Planbureau 2005);
- The sea level will change between 20 to 100 centimetres (Wetenschap, no.1, 2001 -19);
- The absolute level rises with 18 to 59 centimetres in the 21ste century in comparison with the level in 1990 (Platform Communication on Climate Change (PCCC) 2007);
- The water level in the ‘IJsselmeer’, Markermeer and the Randmeren will rise a few decimetres in 2100, according to the middle climate change model (Milieu en Natuur Planbureau 2005).
- In 2050 the absolute sea levels raise, near the Dutch coast, various from 15 to 35 centimetres (in comparison to 1990). Around 2100 the rise various between 35 to 85 centimetres. According to the scenarios the sea level rise will keep on rising to 1 – 2,5 meter in 2300 (KNMI 2006).

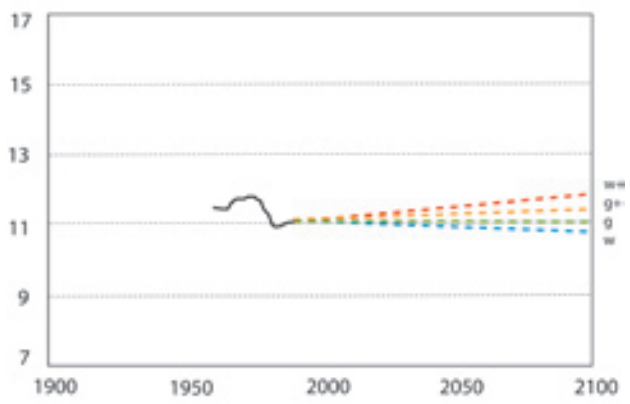
This thesis takes the scenario W+ of the ‘KNMI’ as point of departure. According to this scenario the sea water level will, in comparison to 1990) rise with (KNMI 2006):

- 15 - 35 centimetres in 2050
- 35 - 85 centimetres in 2100
- 100 - 250 centimetres in 2300

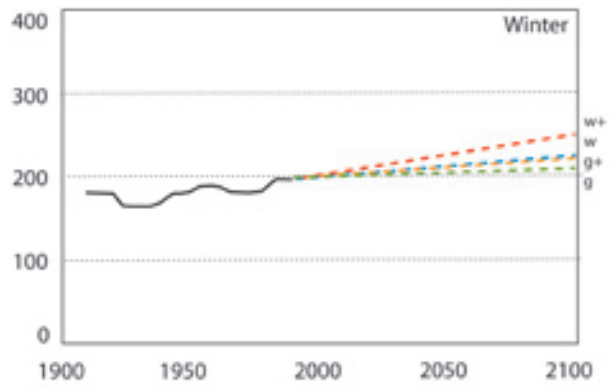
The rising sea water level results in a constantly need for sedimentation of sand. The shortage of sand along the Dutch coast is increasing because almost no sand comes from the sea and rivers anymore.
The expected sea level rise has consequences for the ‘Waddenzee’ and ‘IJsselmeer’. The ‘Deltacommissie 2008’ assumes the natural sediment transport (sandy and muddy water) of the tidal area of the ‘Waddenzee’ can keep up with a sea level rise of 30-60 cm per century. How bigger the tidal area, how bigger the sediment need is. The sea level rise should be smaller if we want to keep up in a natural way. The ‘Deltacommissie 2008’ assumes the most western parts of the ‘Waddenzee’ are the first areas that can not keep up with the sea level rise (probably around 2050-

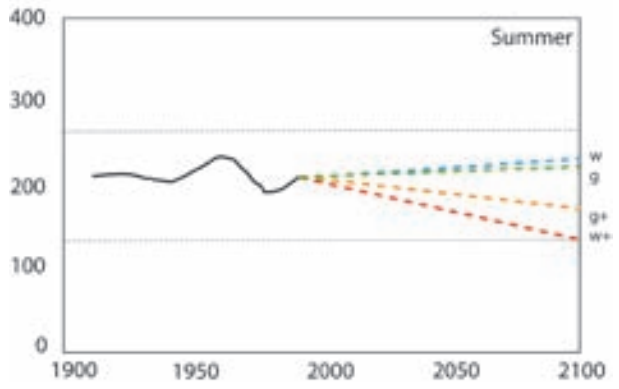


1.3. Absolute and relative sea level rise



1.4. Expected wind speed (m/s) (KNMI)





1.5. Expected rainfall (mm) (KNMI)

2050

Relative sea level rise
40 cm at most

1.6. Consequences sea level rise and changing run off rivers

Legend

- Spout by means of gravity is possible
- Shortage fresh water 'IJsselmeer'-area
- Salty sea water effects inland areas
- Salty seepage
- Increases flood chances rivers

2100

Relative sea level rise
65-130 cm at most

1.7. Consequences sea level rise and changing run off rivers

Legend

- Without a higher water level spout by means of gravity is impossible
- Shortage fresh water 'IJsselmeer'-area
- Salty sea water effects inland areas even more
- Salty seepage
- Increases flood chances rivers

2100). The result is a character change. (Deltacommissie 2008 2008).
As said before the temperature rise and changing air circulation lead to a decreasing summer run off and an increasing winter run off of the rivers. This means the water level in the 'IJsselmeer' will increase (fig. 1.6. and 1.7). In summer the average run off of the river Rhine can decrease from 1700 m3/s in the year 2008, to 700 m3/s in the year 2100. The now extreme winter run offs will be normal in the future. The calculated discharge ('maatgevende afvoer') is changing from 16.000 m3/s (2008) to 17.000-22.000 m3/s (2100). The river Maas will probably change from 3.800 m3/s to 4.200-4.600 m3/s.
Until 2050 transferring water from the 'IJsselmeer' by means of gravity to the 'Waddenzee' is possible by making use of the low water level at low tide. After 2050 taking measures, as pumping or a higher water level of the 'IJsselmeer' are needed (Deltacommissie 2008 2008).

According to various experts climate change will, on the long term, result in:

- A temperature raise (Hurk, Tank et al. 2007; Tol 2007);
- A sea level rise (N.M.J.A. Dankers, H.M.P.M. Capelle et al. 2002; Hurk, Tank et al. 2007; Intergovernmental Panel on Climate Change (IPCC) 2007; Tol 2007; Platform Communication on Climate Change (PCCC) 2008);
- Higher fluctuations of river discharges; heavier rainfall in a shorter period. More rain in winter and less in summer (Milieu en Natuur Planbureau 2005);
- A rise of the amount of rain (more raining days and more extreme periods) (Milieu en Natuur Planbureau 2005);
- A change of the storm pattern (Platform Communication on Climate Change (PCCC) 2007). Probably there will be more gales;
- A decrease of drink water use in summer (van Drunen 2006a).

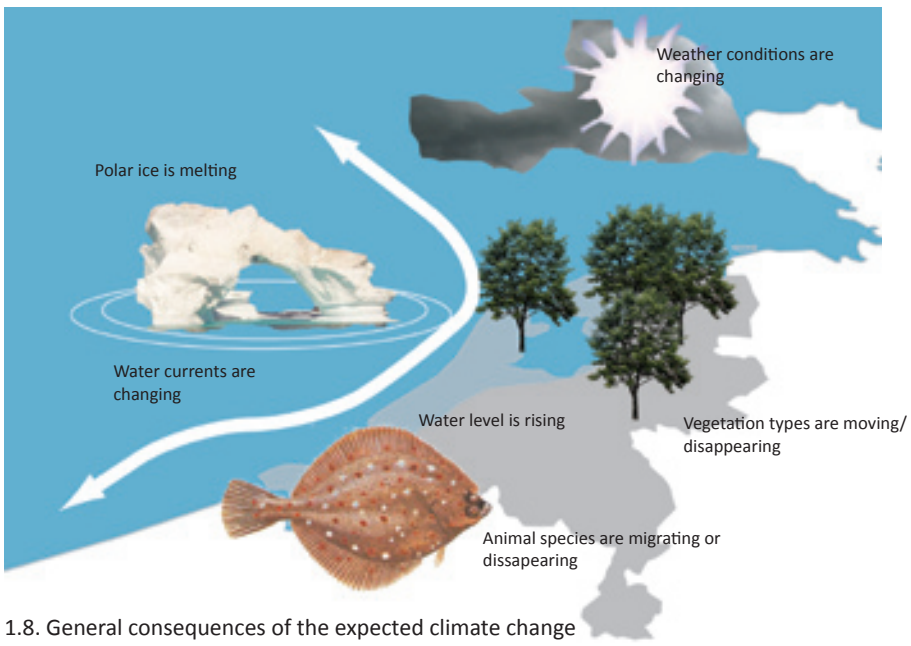
Of course the climate change has more effects. The most important once for this thesis, are mentioned above.

1.3. Adaptation and mitigation

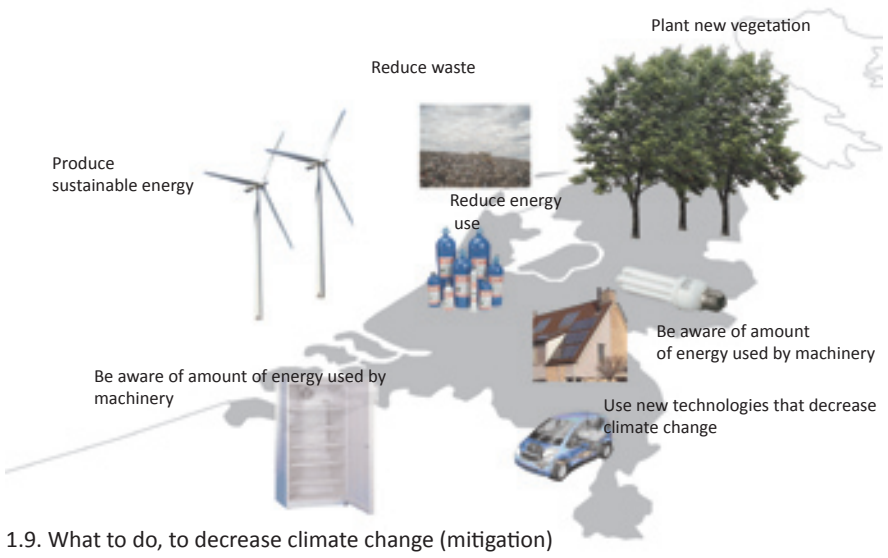
As explained in the former paragraph, the climate change has various consequences. There are different ways to deal with changes in the environment. The first way is to adapt to the change and the second one is to mitigate.

'Adaptation' means that changes are made to adjust to the climate change (Platform Communication on Climate Change (PCCC) 2008). It has effect on short term and specific location (van Drunen 2006a).
'Mitigation' means a considerably reduction of the greenhouse gas emissions. On the long term it has effect if all countries participating. (van Drunen 2006a).

Different researchers investigated the advantages and disadvantages of adaptation and mitigation. It is important to keep in mind that the sea level is reacting slowly to the atmosphere. This means that if we want to slow down the rising of the sea level it will take more effort than trying to slow down the climate change. 'Therefore, there may be few short-term coastal benefits from mitigation, while the effect of mitigation on coastal adaptation may be larger and more immediate' (Tol 2007) (Anon) (p2). 'According to scientific research is even by mitigation not possible to prevent a climate change' (van Drunen 2006a). That is why we need to do both: mitigation (fig. 1.8 and 1.9), try to make the negative consequences as less as possible and adaptation, to be prepared for changes. Mitigation and adaption are close related if the mitigation is higher this has an effect on the adaptation (this will be lower) (Tol 2007).



1.8. General consequences of the expected climate change



1.9. What to do, to decrease climate change (mitigation)

CHAPTER 2

The Assignment

The Assignment

This chapter deals with the variety of reasons, on different scale levels, to develop ‘De Afsluitdijk’. In comparison to 1932 aspects of safety, climate, ecology, water flows and traffic flows have been changed. These changes resulted in new standards and the dam will have to cope with more constraints in the future. This thesis aims to contribute to an integrated design that solves core and sub problems while expressing the existing qualities.

2.1. Reasons for adjustment

'De Afsluitdijk', constructed in 1932, is build to protect the Netherlands against flooding. Especially because of the expected climate change various regulations have been changed since 1932. One of the biggest spatial questions of the 21th century is how The Netherlands should deal with the expected climate change (Platform Communication on Climate Change (PCCC) 2008). According to 'Rijkswaterstaat' 'De Afsluitdijk' has to be adjusted to the expected climate change (Rijkswaterstaat 2007a; ANP 2008).

The dam needs adjustment because of various reasons but reason number one is safety. After the construction of 'De Afsluitdijk', safety standards changed and ideas about the environment developed (Bureau Bosch Slabbers 2000). The environment became more important (Sperling, 2008).

Different demerits are found by testing the dam on grounds of the 'Wet op de Waterkering' (fig. 2.1.) The 'Wet op de Waterkering' is a regulation that contains the protection standards of dams against flooding of the 'IJsselmeer', Markermeer, North Sea and the big rivers (Ministerie van Verkeer en Waterstaat). The original regulation has been changed because of different reasons, but mainly because of the expected climate change (Ministerie van Verkeer en Waterstaat s.a.). The dam should be higher, broader and must be renovated to adapt to the expected sea level rise (Nederlandse Omroep Stichting (NOS) 2008). When 'De Afsluitdijk'

2.1. Safety check dams

breaks, the hinterland will be flooded, because the 'IJsselmeer'dikes will not be strong enough.

On the 28th of January 2008, during an atelier session with representatives of the National Government, provinces, and municipalities, turned out opportunities are seen to realize extra ambitions (Ministerie van Verkeer en Waterstaat 2008). Experts see opportunities to solve more constraints next to the development of the main function; safety against flooding. Not only should the safety aspect be taken into account. It is important to look for a synergy between water safety and other functions like nature, recreation, landscape, infrastructure, and energy, where possible.

The unique characteristics of the location has potential to be an experimental area for the latest innovative developments for coastal defence and sustainable energy (Ministerie van Verkeer en Waterstaat 2008; SMO 2008; Ministerie van Verkeer en Waterstaat s.a.). The dam should be used to show where the Netherlands is good at: being innovative on water and land (Prof. Ir. J. Brouwer in (SMO 2008). The

2.2. Use of energy (coal, natural gas, oil) The Netherlands

'Ministerie van Verkeer en Waterstaat' (part of the government) and the province 'Noord-Holland' have decided to do research on different possible feasibilities of ambitions like innovation and sustainability (on top of the essential basic function). The production of sustainable energy is clearly seen as a big opportunity (Ministerie van Verkeer en Waterstaat 2008) and could facilitate a part of the energy need in the Netherlands (fig. 2.2).

Additional the dam has another opportunity (Ministerie van Onderwijs Cultuur en Wetenschap 2008). The dam is, and can be an icon in the future. The dam should also be attractive to tourists and recreants (IJskes 2008). New economical and social profits can help to bear the costs of adjusting 'De Afsluitdijk' into a dam that is sufficient in the future. (Ministerie van Verkeer en Waterstaat s.a.).

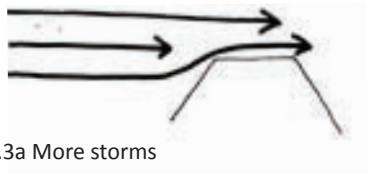
Constraints by function

This paragraph points out the variety of constraints of 'De Afsluitdijk'. Constraints are consequences of causes and most of the time causes of a higher scale level have consequences on a lower scale level. In this case the constraints are arranged to the functions of the dam, and the consequences of the construction of 'De Afsluitdijk'.

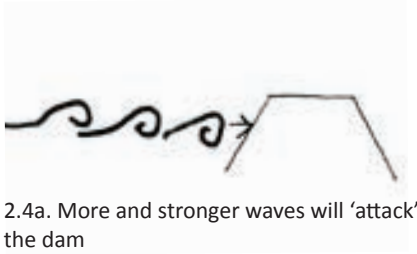
The main function of 'De Afsluitdijk' is the dam function. 'De Afsluitdijk' is constructed to protect the hinterland against flooding. The constraints caused by the construction of the dam are elaborated in paragraph 2.3.

Main function: Dam, guarantee safety against flooding

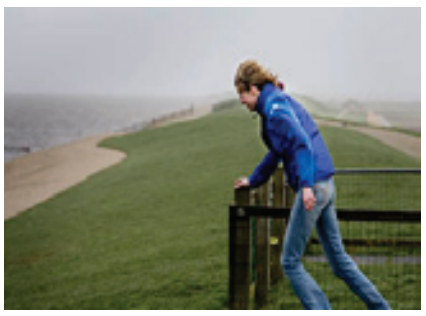
Because of the expected climate change, 'De Afsluitdijk' will have to cope with more storm surges and fierceness of the water from both sides, because of a higher water level of the 'IJsselmeer', the 'Waddenzee' and the North Sea (fig. 2.3. and 2.4.). According to the



2.3a More storms



2.4a. More and stronger waves will 'attack' the dam



2.3b. More storms

2.4b. More and stronger waves will smash against the dam

'Wet op de Waterkering' the top of the dam is about 2,5 meters too low. Additional 5% of the stone covering does not suffice the safety standards (Rijkswaterstaat 2008b).

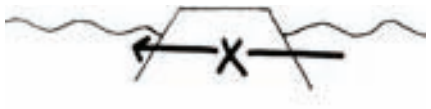
Secondary function: Spout capacity
The amount of water that comes from the rivers ('Vecht', 'IJssel', 'Eem') and hinterland is increasing (Bureau Bosch Slabbers 2000). According to the KNMI, the daily rain extremes will increase with 5-27% in 2050. In winter the amount of longer periods with a lot of rain will approximately be the same (4-14%) in 2050, but the amount can be twice as much in 2100 (Platform Communication on Climate Change (PCCC) 2007). Because of the increasing discharge of river water in winter and the increasing run off to the 'Waddenzee', the 'IJsselmeer' level will follow the run off pattern of the 'IJssel' more and more. Additional the higher water level of the 'Waddenzee' and 'IJsselmeer' are resulting in a spout capacity that is too low in comparison to the agreed water level (Consortium Sluitstuk 2008). As the maintenance will stay the same, higher fluctuations in the 'IJsselmeer' will occur (Milieu en Natuur Planbureau 2005). The spout capacity of 'De Afsluitdijk' is not enough to be able to cope with the increasing amount of water that has to be transported to the 'Waddenzee' and the North Sea. This can result in an accumulation of water in the 'IJsselmeer' and rivers what can cause floods.

Constraints because of the construction of 'De Afsluitdijk'
The construction of the dam has various positive and negative effects. This paragraph categorizes constraints in relation to effects on ecological and perception point of view.

Ecological effects
One of the disadvantages of 'De Afsluitdijk' is the barrier for ecology. The construction of the dam resulted in the 'IJsselmeer' lake with still water. More algea started to grow (Maurits 2008) and the area lost certain animal species over years. The natural water flow from the hinterland to the North Sea came to a halt (fig. 2.9). The 'IJsselmeer' turned into a fresh water lake and the 'Waddenzee' became brackish. Nowadays 'De Afsluitdijk' still is a clear division between those two ecological systems (fig. 2.10). Now there are not gradients of habitats, resulting in less biodiversity. Unfortunately the quality of the 'IJsselmeer' water is still decreasing. According to 'Rijkswaterstaat' the ecology has to be improved (Rijkswaterstaat 2007b).
Additionally the dam has different sluices that are not accessible for certain fish types, like trout and salmon (Rijkswaterstaat 2007d), which are migrating from saline to fresh water and vice versa (fig. 2.11). This

2.5a. The North Sea water level will rise (in comparison to 1990 40-85 cm in 2100): more pressure from 'Waddenzee' side

2.6. The level in the 'IJsselmeer', Markermeer and the 'Randmeren' will rise: More pressure from 'IJsselmeer' side



2.9a. Barrier for the natural water flow from the hinterland to the North Sea and vice versa. The estuary character of the 'IJsselmeer' disappeared

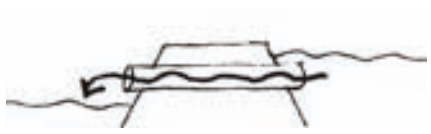
2.10a. Barrier between salty and fresh ecosystem: no gradient in habitat-types

2.5b. The North Sea water level will rise

2.6b. The 'IJsselmeer'-water level will rise

2.9b. Barrier natural water flow

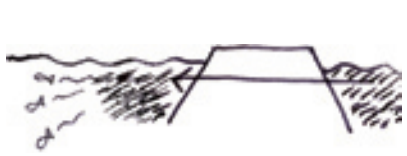
2.10b. Barrier in-between ecosystems



2.7. The water run off will be about 15% more water in 2050 than in 2008 (Rijkswaterstaat 2008a). The existing spout capacity is too low. More chance on floods

2.8. Does not suffice the conditions of the 'Wet op de Waterkering': can result in floods

2.11a. Barrier for migrating fish: certain fish types die out

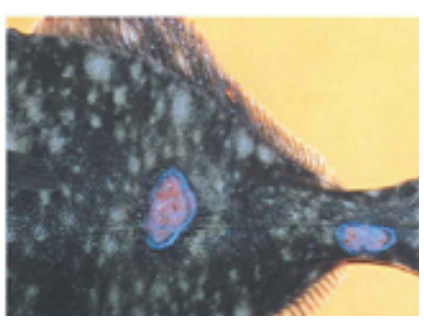


2.12a. Abrupt fresh water inlets: life stock dies out or gets deseases

2.7b. Spout capacity will be too low

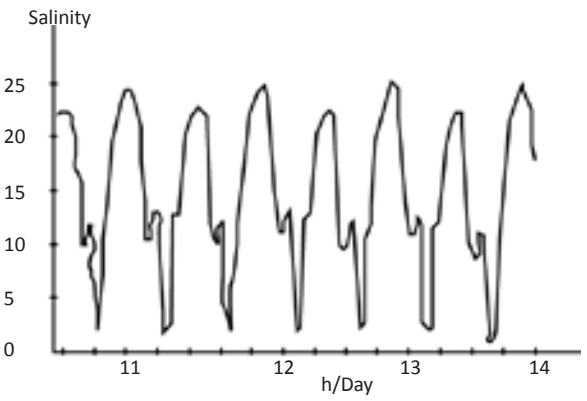
2.8b. Does not suffice 'Wet op de Waterkering'

2.11b. Fish that migrates (Salmon)



2.12b. Fish diseases

results in less fish. In the past this resulted in the end of fishery in the 'IJsselmeer'. In a convention about the protection of the Rhine of 1999 is written down the migration of fish should be possible and developed (F.G.M Hoogenboom, M.M. Gründemann et al. 2005; Rijkswaterstaat 2005).
Furthermore the sluices result in abrupt fresh water inlets into the 'Waddenzee' (fig. 2.12 and 2.13). Certain animal species can not handle this kind of sudden changes in environment and die or get diseases. An example is the Platichthys fles ('Flounder','Bot') that gets skin diseases (fig. 2.12b.) because of the abrupt fresh water inlets (Dijkema 2001).



2.13. Salinity differences over time at Lorentz-sluices

Effects for perception
The profile of the dam itself makes it impossible to experience both sides of the dam. Only the 'IJsselmeer' is visible (fig. 2.14). The 'Waddenzee' and 'IJsselmeer' are experienced as two separated lakes, as if the 'IJsselmeer' was not connected to the 'Waddenzee' in the past. The driver is not aware of the fact he is driving on top on a dam that goes through the middle of the sea.
Next to this, the cycle path is situated in-between the dam and the highway. While biking over the path, it is impossible to enjoy the 'IJsselmeer' (fig. 2.15). It becomes very boring because the path is situated in-between the dike and the highway where cars are passing by with high speed what makes a lot of noise.


2.14a. Only one side of the dam can be experienced


2.15a. The location of the bicycle path is not optimal in-between dam and highway


2.14b. Only one side of the dam can be experienced


2.15b. The location of the bicycle path is not optimal in-between dam and highway

Criteria
These constraints lead to the next criteria:

- The design should result in a dam that suffices the standards of the 'Wet op de Waterkering'. This means the dam together with its surroundings protects the hinterland against flooding until at least 2100;
- The design should result in a solution to transport more water from the 'IJsselmeer' to the 'Waddenzee';
- The design should show a way to decrease the barrier for ecology and perception;
- The design should result in a balance between conservation, adjustment, cultural history and innovation.

2.2. Research question

'De Afsluitdijk' should be developed to suffice the new requirements of the future. 'De Afsluitdijk' is safe when he protects the hinterland against flooding. This can happen in multiple ways. During a symposium about the Afsluitdijk on 14th of March 2008 multiple ideas are presented. These ideas focused, most of the time, on one aspect, and are not very integral. In my opinion it is important to develop the dam in an integral way. Ideas become stronger when they are harmonized and in balance with each other. 'De Afsluitdijk' comprises a big region with different landscape types and many different stakeholders with varied desires and demands. A landscape architect is able to come with a solution that is effective for the different stakeholders without losing the unity and qualities of the area. A landscape architect can contribute to the design of 'De Afsluitdijk'. The design can be a contribution, because the design should be an integration of technical, ecological, economical, and social input.
This thesis takes the existing qualities into account and result in a design that expresses the qualities of the site. A reconstruction of the dam should result in an enhancement of the spatial quality especially because the dikes, and its surroundings, are of special value to many people, national and international. My architectonic contribution is a solid analysis of the dam and the spatial qualities resulting in an integrated design that answers the spatial constraints mentioned in former paragraph. Furthermore this research shows a manner to use the potentials of the area in a good way. By expressing the qualities and potential, additional constraints can be solved next to the main constraint.

The main research question of this thesis is:
In what way can a landscape design[1] contribute[2] to a safe[3] 'Afsluitdijk' that expresses the unique qualities[4] of the site[5]?

[1] A design gives Spatial solutions for the constraints mentioned in this chapter.
[2] Contribution means next to the landscape architectonic approach, technical, ecological, economical and social input is needed.
[3] Safe is when the dam is able to protect the hinterland against flooding until 2200.
[4] The Unique qualities become clear during the landscape analysis.
[5] The site consists of the northern part of the province of 'Noord-Holland', De Afsluitdijk and a small part of the 'Waddenzee' and 'IJsselmeer' and a part of the province of 'Friesland'.

2.3. Hypothesis

By using a qualitative landscape-architectonic approach[1], an integral design can contribute to the design of a safe Afsluitdijk that expresses the unique qualities of the site and is adaptive to the expected climate change. By using landscape elements it is possible to adapt to the expected climate change. The potentials of the site can result in sustainable energy production in various ways, which contributes to the need for energy in a good way for the environment.

[1]A qualitative landscape architectonic approach takes the landscape as a base. It is an holistic approach to analyze the existing situation. It results in solutions that contribute to actual ordering and scale problems. And results in a sustainable design[2]
[2]A sustainable design is adaptive in many ways. It can adapt to the expected climate change and to social change.

2.4. Point of view

It is essential that The Netherlands, because of its characteristics, reacts on the expected climate change. The Netherlands is protecting itself against flooding already for many years. Because of this experience the Netherlands is coming up with innovative solutions.
I stand for protection of the existing land but up to a certain point. When the sea level keeps on rising, the dams need to be higher and higher. When the dikes become really high 'the Dutch' should leave the lower areas and move upwards to the higher areas. The criteria to be able to determine the moment to move upwards are depending on time and location. At this moment the dams should be developed to a height of 10 meters above Mean Sea Level to be able to cope with the sea level rise till 2100 (Rijkswaterstaat 2008b). In my opinion it is worth it to adapt by raising the dams, but only in combination with mitigation (reduction of the greenhouse gasses) to decrease the expected climate change as much as possible.

'De Afsluitdijk', as part of the protecting-system of dikes, needs re-adjustment to adapt to the expected climate change (Rijkswaterstaat 2007b). The dam should be able to cope with a higher water level of the 'Waddenzee' and 'IJsselmeer' together with more fierceness waves in comparison to 2008 (Rijkswaterstaat 2007b).
The renewal of 'De Afsluitdijk' should happen in a bigger context. Developing only the dam itself will not make any sense. The design for 'De Afsluitdijk' only works when the other dikes in the Netherlands are also made higher.
'De Afsluitdijk' is a dam with a future. I am convinced 'De Afsluitdijk' can develop into a beautiful dam, which protects the hinterland against flooding. In my point of view the adjustment of 'De Afsluitdijk' should happen in a way the main function, the one of protecting the hinterland against flooding, is still clear. The design should answer the safety question in a way the qualities of the site are expressed.
The openness is one of the main aspects of the spatial quality of the dam. The perception of openness can be intensified by intensifying the contrast between open and enclosed. Saving open view lines is in this case very important.
The character of the thin, straight line should be conserved. The basic, simple character should be taken into account, because this simplicity, in relation to its function and scale, gives the dam its unique experience and quality. To strengthen the perception of these qualities, contrasts like open/enclosed and natural/artificial should be intensified. Every stakeholder should be able to experience the dam optimally in their own speed. The fact the dam is situated in the middle of the sea makes it special. At this moment people can pass the dam without knowing that. Visitors should perceive the two sides of the dam to realize 'De Afsluitdijk' is a dam, and not a dike.
Additional, people should recognize that two totally different landscape types are connected. This can happen by making the perception of 'Noord-Holland' and 'Friesland' different. It should be clear where the dam starts and ends (vice versa).
I stand for an integrated design, which is better than solving the problems from an individual point of view. A landscape architectonic design for 'De Afsluitdijk' should make it possible to solve the constraints without losing the positive characteristics of the site. By using a landscape, architectonic approach the qualities and opportunities of the site can be strengthened and expressed in the design.

An integral design means the dam has various functions. They do not all have the same importance. The main design question is about safety, because the main function of 'De Afsluitdijk' is protecting the hinterland against flooding. This main design question should be answered, in a way the spatial qualities are expressed. The adjustment of 'De Afsluitdijk' should happen without harming the fresh water basin; the 'IJsselmeer', because fresh water will probably be rare in the future, because of the expected climate change. Additional it is important to maintain, and were possible to strengthen the ecological values of the site.
Afterwards the opportunities seen during the site visits and resulting form the literature study should be implemented into the design.
An example from the literature study is the opportunity to produce sustainable energy. Implementation of these opportunities should happen in a way it emphasizes the spatial qualities of the site.

To summarize, this thesis has the next order of importance:
1. Safety against flooding;
2. Spatial quality;
3. Fresh water basin;
4. Ecology;
5. Sustainable energy production;

Overview constraints

Constraints by function:

Dam
- More storms: more and stronger waves
- Higher North sea water level

→ Does not suffice the 'Wet op de Waterkering'
Chance of flooded hinterland is bigger

Spout
- Higher IJsselmeer water level: spout capacity too low

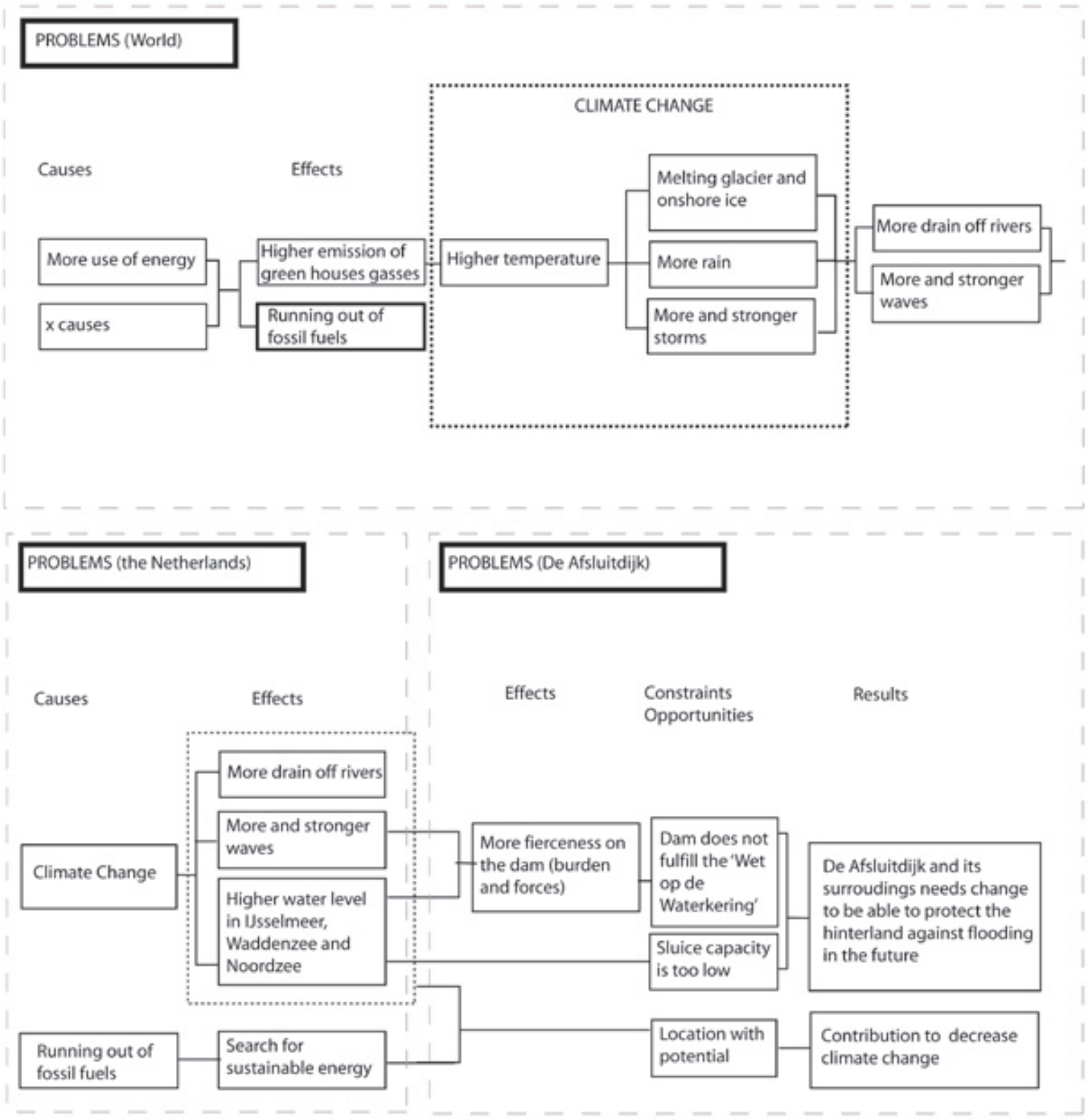
Constraints by effects :

Ecology
- Barrier natural water flow
- Abrupt fresh water inlet
- Barrier migrating fish
- Barrier fresh and saline ecosystem

→
- Chance of flooded hinterland is bigger.
- Water life stock is dying or gets diseases
- Migrating fish die out

Perception
- Only one side of the dam can be experienced
- Cyclists bike in-between a dike and a highway

→
- No one is aware of the fact they are in the middle of the sea (icon)
- The water of IJsselmeer / Waddenzee can not be experienced, what is a missed opportunity because water attracts people



2.16. Problem tree: overview of the constraints on different scale levels

Safety and sustainability should be the basis for the strategy of the next century. The designs should connect to natural processes. By using the dynamics of the sea (new) biodiversity and attractive landscapes can come into being (Deltacommissie 2008 2008).

2.5. Research method

The research method comprises four phases. Figure 2.17 shows an overview of these stages and the appendix includes the elaborated overview. The method is not linear, as the overview may suggest, but it is a cyclic process. The method is based on research by design and the design follows out of the site characteristics. Sketches are going to be made and tested by a theoretical framework. This makes the designer not limited to the technical knowledge and makes it easier and more innovative to make a design for the year 2200. During the whole process I form my landscape architectonic vision and adapt it to new knowledge.

Phase I: Orientation
This phase exists of elaboration of the starting point of this thesis. The consequences of the expected climate change become clear and the subject orientation happens. Further more the site analysis occurs here. This analyse will be based on a landscape approach. This results in an overview of the constraints, the main research question and the hypothesis.

Phase II: Point of departure
During the symposium 'Toekomst Afsluitdijk' many individual ideas are presented (SMO 2008). The presented ideas are the point of departure for the next phase of this research. It becomes clear the site has potential to produce sustainable energy.
The sketches will be grouped into the aspects 'safety' and 'sustainable energy production'. Sub-research questions help to understand the presented ideas (see appendix). The assessment of the presented ideas takes place with the help of a (intuitive) sketch-brainstorm based on my landscape architectonic vision. The intuitive sketches give an overview of the possibilities of the site. Some of the sketches will be laid on top of each other to view possible combinations based on the landscape analysis. This results in spatial models.

Phase III: Theoretical framework
A site visit results in an overview of constraints of site scale and inspiring ideas.
Inspiring ideas come also up during a reference study at the 'Brouwersdam' and the 'Oosterscheldekering' (reference studies can be found in the appendix). These site visits in combination with my landscape architectonic vision result in my personal 'landscape architectonic opinion of 'De Afsluitdijk''.

'Landscape Theory'
The 'landscape theory' focuses on what landscape, order, proportion, scale, shape, space, and perception mean for the spatial quality of 'De Afsluitdijk'. The general theory together with my personal landscape architectonic opinion of the dam results in an overview of the spatial qualities of the site.

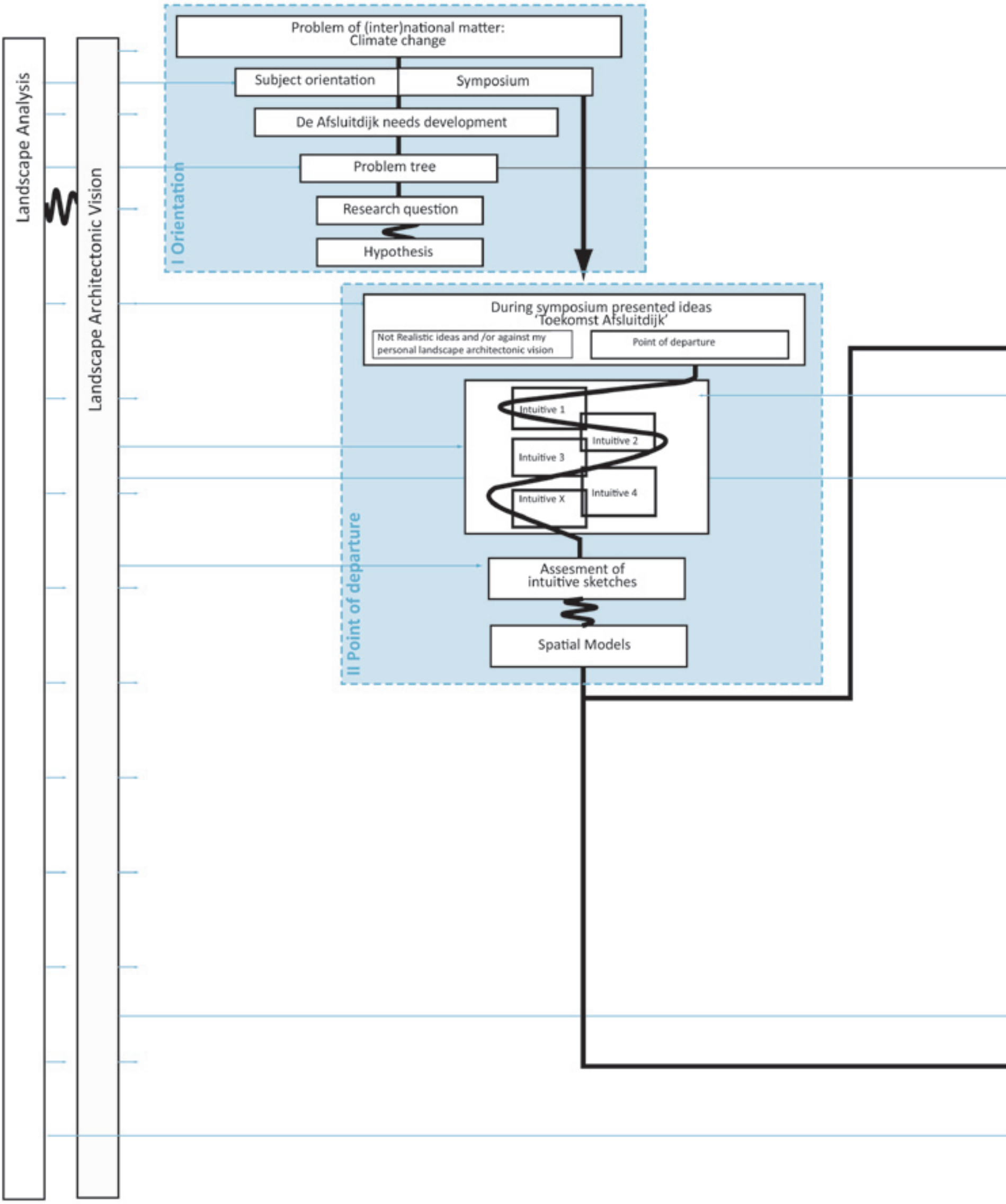
'Sustainable energy'
The 'Theoretical framework phase' also deals with the ways to produce sustainable energy at 'De Afsluitdijk'. Theory about the production of energy by osmosis, wind, wave and solar energy give knowledge to be able to implement these techniques in a landscape considered manner.

'Design Guidelines'
- The 'pre-conditions' are formed from the constraints. These are the starting points of my thesis, the main problems to be solved;
- The opportunities to produce sustainable energy, the landscape architectonic opportunities, cultural historical opportunities and ecological opportunities lead to 'ambitions';
- The 'demands' are the result of technical information.

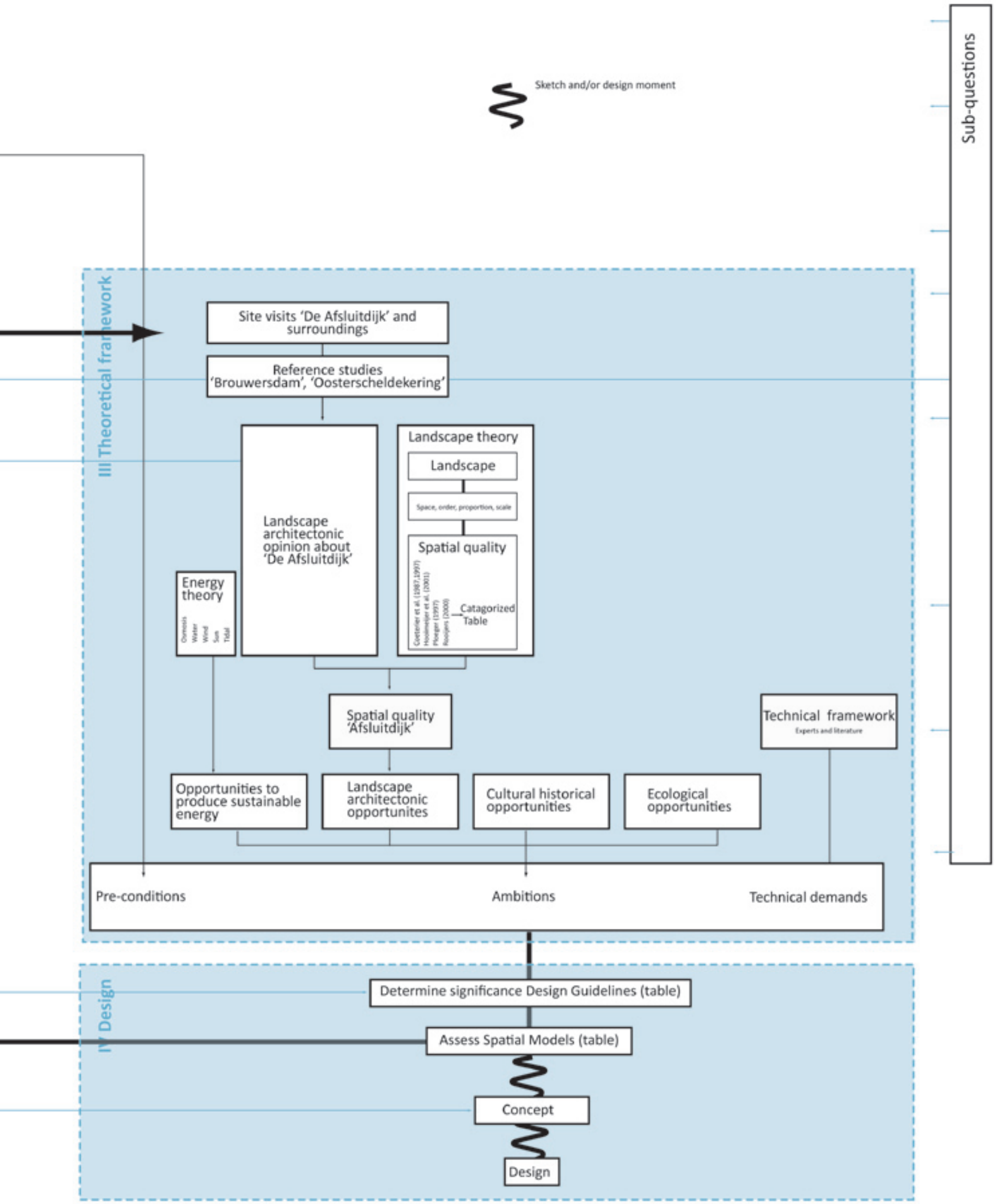
Phase IV: Implementation
The design guidelines do not have all the same importance. In this phase every guideline gets certain significance. This significance is conducted from literature study, talking to experts, my landscape architectonic opinion and knowledge about the constraints.
The next step is the assessment of the three spatial models of phase II. Model number three turns out to be the best model. This model results in a concept by taking the landscape analysis into account. The concept resulted in the design and details of the design are drawn.

2.6. Report outline

This report consists of 8 chapters. The first chapter demonstrates the consequences of the expected climate change on various scale levels. Chapter two elaborates on the assignment. The reasons for adjustment, research question, hypothesis, point of view, and the research method are explained. Chapter three introduces 'De Afsluitdijk'. The history and present of the dam are written down. Chapter four discusses the context of the dam. Europe, the provinces 'Noord-Holland' and 'Friesland', the municipalities 'Wieringen' and 'Wûnseradiel', and the 'Waddenzee' and 'IJsselmeer' are shortly described. Chapter five deals with the symposium 'Toekomst Afsluitdijk' organized by 'Rijkswaterstaat', on the 14th of March 2008. Chapter six demonstrates the theoretical framework, where theories about landscape, order, proportion, scale, shape, space, perception, and sustainable energy become clear. This chapter finishes with a conclusion about the spatial quality of 'De Afsluitdijk'. Chapter seven presents the design solutions for the various constraints mentioned in chapter two. Chapter eight shows the conclusions and finishes with the discussion.



2.16. Research method


Sketch and/or design moment
Sub-questions
III Theoretical framework
Site visits 'De Afsluitdijk' and surroundings
Reference studies 'Brouwersdam', 'Oosterscheldekering'
Landscape architectonic opinion about 'De Afsluitdijk'
Landscape theory
Landscape
Space, order, proportion, scale
Spatial quality
Catagorized Table
Energy theory
Osmosis
Water
Wind
Sun
Tidal
Spatial quality 'Afsluitdijk'
Technical framework
Experts and literature
Opportunities to produce sustainable energy
Landscape architectonic opportunites
Cultural historical opportunities
Ecological opportunities
Pre-conditions
Ambitions
Technical demands
IV Design
Determine significance Design Guidelines (table)
Assess Spatial Models (table)
Concept
Design

CHAPTER 3

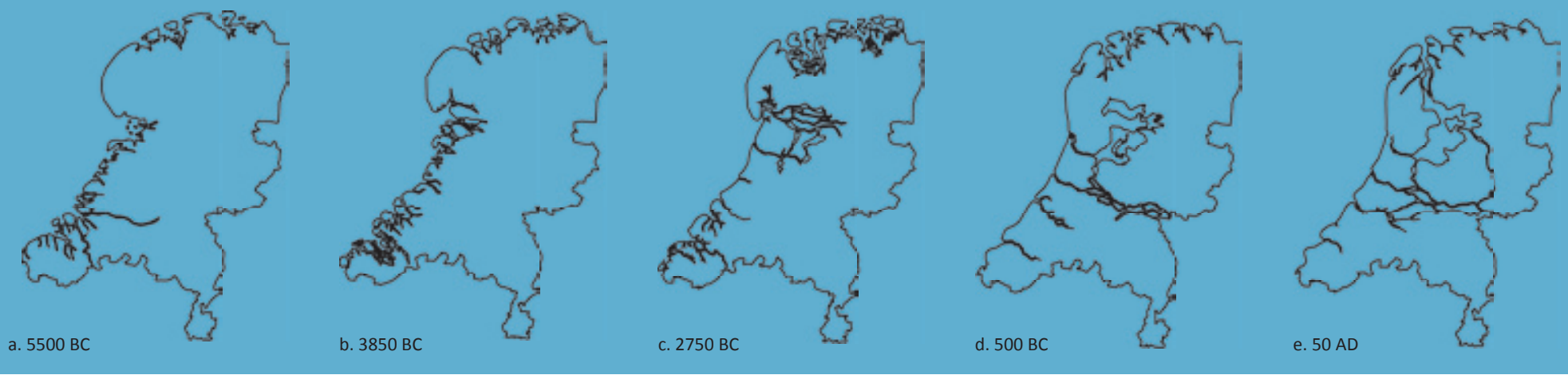
‘De Afsluitdijk’

3. ‘De Afsluitdijk’

3.1.

The Netherlands is living with, and struggling against water for many years. The Netherlands contains different types of protection against flooding. Examples are dikes, dunes, dams, sluices, groins, and knolls.
One of the most unique and characteristic dam of the Netherlands is ‘De Afsluitdijk’ (literally translation of this Dutch name: “closing dike”). This dam is constructed in 1932 to shorten the coastline. The dam is a primary dam of thirty-two kilometres long and connects the North West (Province of ‘Noord-Holland’) of the Netherlands with the North East (Province of ‘Friesland’) and vice versa.

3.2. Development of The Netherlands



3.1. History

Two millennia ago the Waddenzee and the IJsselmeer mainly consisted out of peat and clay lands. An inland fresh water lake (Almere) was situated in the middle of The Netherlands (fig. 3.2). Around 1200 the 'Zuiderzee' came into being because of the North Sea encroached on the 'Zuiderzee'-area and connected the North Sea with the lake Almere. Tides and storm surges came via the sea inlets into the Waddenzee and the 'Zuiderzee'. The greatest depths were situated in the sea inlets between the Wadden islands (40m) (Ven G.P. van de 2004).
Until 1932 the IJsselmeer (lake) was a sea arm with the name 'Zuiderzee'. Towards the South the depth, soil condition and water condition changed. The arm was saline in the northern part and fresh in the southern part, because of the rivers (like the IJssel) in the South. The area was characterised by tides, because the 'Zuiderzee' was connected to the North Sea.
The 'Zuiderzee' was not a deep sea and it was not easy to navigate. The fishers that fished at the 'Zuiderzee' had a special type of boat: with a flattened bottom. They fished for eel, anchovy, herring, flounder and smelt. The best period for the fishery on the 'Zuiderzee' was about 1900. In the 19th century the bigger ships used the 'Noordhollands Kanaal' (canal) and later on the 'Noordzeekanaal' (canal).
Hundreds of years the North Western part of The Netherlands was a wet area almost without housing and roads. The only infrastructure that existed was canals. Transportation of different products was happening by boat (sailing ship). The coastline of the 'Zuiderzee' contained many small characteristic villages with harbours. Examples are 'Stavoren', 'Workum', 'Lemmer', 'Makkum', 'Elburg', 'Monnickendam', 'Marken' and 'Huizen'. The harbours were used by fishers to trade and additional the harbour was used to construct boats and attributes. The 19th century small villages were inspiring for many artists, so the villages were well visited. The income of the fishers was not a stable fact. They lived most of the time in uncertainty and poverty. The area was focused on fishery; only at 'Marken' a few agricultural fields were situated.
The coast line contained many dikes, not all of good quality, so every once in a while a few dikes burst and the area behind the dike got flooded (Carmio 2007). Many dikes brook into parts because of a storm surge on the 13th and 14th of January 1916. The island Marken and the village Spakenburg were totally flooded. Many boats damaged the surrounding houses and harbours. The economical and emotional damage made the government decide to accomplish the ideas of Ir. Cornelis Lely (Carmio 2007). Ir. Lely was at that moment Minister of Public Works and Water Management and tabled the bill to close the 'Zuiderzee'. This 'Zuiderzeewet' (legislation) was accepted in 1918.

In 1891 Ir. Lely had the idea of a dam to protect the whole area, which was surrounding the 'Zuiderzee', from flooding. The dam would transfer the surplus of water to the Waddenzee with the help of locks. The remaining water resulted in a fresh water basin in the form of a lake. The idea was to make a dam from the province 'Noord-Holland' to 'Friesland'. This idea had various advantages:

- The coastline could be reduced from 300 to 45 km, what resulted in a safer situation and lower costs (Carmio 2007; Bakker s.a.);
- A better connection between 'Noord-Holland' and 'Friesland' could come into being;
- The whole part of 'Laag-Nederland' could be prevented against salinization (Ven G.P. van de 2004; Carmio 2007);
- The fresh water lake could be used for drinking water (Carmio 2007; Bakker s.a.);
- People could control the water level (Carmio 2007) what resulted in an improvement of drainage of the 'Zuiderzee' (Carmio 2007; Bezoekerscentrum s.a.);
- The construction of polders became more easy (Carmio 2007; Bakker s.a.);
- The new polders could be used for new functions: extra space for housing and agricultural functions (Carmio 2007);
- The construction of the polders and dam gave employment (Carmio 2007);
- An interesting sight for a lot of visitors raised (Carmio 2007; Bezoekerscentrum s.a.);

Lely was not the first person with this idea. In 1667 Stevin had the same plan, but at that moment it was not possible to construct the dike because of technical reasons:

> *'Men sal eerst de Noortzee van de zuyderzee afscheyden, dammende alle gaten van Staelduynen over Texel, Eyerlant, Vlielant, Derschellignen en Amelant, en sluytende dit aen Vrieslant. En stellen in so veel gaten sluysen, om daer deur in de Noortzee uyt te lopen, en by ebwater te losen, als genoeg is. Ende hier mee sal penbaerlic de Zuyderzee genoegsaem altoos op de laegste ebwater connen gehouden, en (deur dien men noeyt Zoutwater in laten en geduerig versch rivierwater toe vloeyen sal) mettertijd versch worden' (Stuvel 1957) p12*

Stevin tells here the 'Zuiderzee' should be enclosed by a dike, which results in a fresh water lake.

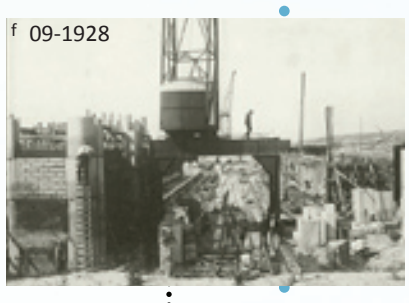
The plan (Lely) had serious consequences for the fishing industry. Compensation was awarded for the loss of income thanks to a special ''Zuiderzee' Compensatie Act' (Ven G.P. van de 2004). The ecology of the 'Zuiderzee' would change totally so that fishing would not be possible anymore. Despite these disadvantages people began the process to realise the dam, but it was not going well at the beginning. In 1901-1907 the government made a planning legislation, but at the change of the governments this legislation was deleted again. The process almost stopped in 1914 because of the First World War. The ministry of Defence was not sure about the construction of 'De Afsluitdijk', because this could give the enemy an opportunity to attack the 'Vesting Holland' from the North. The enemy could easily go from the province 'Noord-Holland' to

3.3

f. 800 AD g. 1200 AD h. 1675 AD i. 1916 AD j. 2008 AD

‘Friesland’. (Carmio 2007)
His second reason was because of the sluices. Holland contains various defence elements; one of them is the defence lines (verdedigingslinies). These are lines of bunkers and constructions like bastions. The ‘Vesting Holland’ protected the big cities of Holland, the east of the Netherlands was protected by the ‘Nieuwe Hollandse Waterlinie’ and the south was protected by the big rivers. The protection of the Netherlands was based on the element water. To protect the Netherlands during an attack of the enemy, the method of the ‘Nieuwe Hollandse Waterlinie’ (opening the sluices) was used. Water from the ‘Zuiderzee’ reached until the ‘Nieuwe Hollandse Waterlinie’. The water level would be about 40 centimetres, too much to be able to walk through and to less to be able to sail.
If the enemy would conquer ‘De Afsluitdijk’, than they would be able to open the sluices themselves and put a part of the Netherlands under water. Although these disadvantages were there, the construction of the dam started in 1930 (fig. 3.4). The Ministry of Defence agreed with the construction because of a curve in the design. The arch in the dam was an important strategic advantage of defence because the Kazematten could be constructed in prolongation of the dam what made it possible to shoot over the dam. The protection of the dam itself came at ‘Kornwerderzand’, because the sluices over there where of high importance to control the inundation water. To protect Holland against attacks from Germany the Stellingen of ‘Den Oever’ and ‘Kornwerderzand’ came into being. They where part of the protection network of the Netherlands.
In the original idea the dam was a straight line that would end up in the village Piaam, but for multiple reasons the plan changed. The construction was easier because of the presence of tidal trenches, peat soil and it led to the opportunity to construct the Lorentz sluices at ‘Kornwerderzand’ (an already existing sandbar). As said above the arch was important to protect the dam against enemies. The connection was situated a bit more to the North. (Carmio 2007)

The ‘Project ‘Zuiderzee’’ started with a dike between North-Holland and Wieringen. The first soil was thrown into the Amsteldiep (Milieu en Natuur Planbureau 2005) at the 29th of June 1928. Because of an economical bad period in the twenties, the construction was a bit delayed. The dike through the Amsteldiep was finished in 1924 (Carmio 2007).
The construction of a polder in the ‘Zuiderzee’ was also delayed.
In 1926 a trial polder was made near Andijk. After one year the Wieringermeerpolder was made and finished in 1930 (Carmio 2007).
In 1927 the construction of ‘De Afsluitdijk’ started again, and was finished on 28th of May 1932. The construction of the ‘Project ‘Zuiderzee’’ was going on at different places at the same time: From the shores of ‘Friesland’ and ‘Noord-Holland’ and from special made islands (Carmio 2007).
The completion of ‘De Afsluitdijk’ made an end to the fishery on the ‘Zuiderzee’. Many fishers resisted, because they lost their main source of income, but after the construction trade, transportation and agriculture became more important. The water in the IJsselmeer became fresh what resulted in a totally different ecosystem. When ‘De Afsluitdijk’ was finished, the name ‘Zuiderzee’ changed in ‘Ijsselmeer’ (IJssellake, named after the river ‘IJssel’).
At the beginning the plan was to gain a polder as big as the whole ‘Zuiderzee’. In 1927 the construction of the Wieringermeerpolder started and this polder was finished in 1930. The rain had to flush out all the salt and afterwards the soil could be used for living, grass fields and later on the soil could be used for agricultural functions. The ‘Noordoostpolder’ (‘Urk’ and ‘Schokland’ included) was constructed during the Second World War. The polder was finished in 1942. (Carmio 2007).
In 1950 a dike was build in the IJsselmeer at the location were later on East Flevoland is constructed. In 1953 the work stopped because of the dramatic floods in the south west of the Netherlands. People where needed to solve the different constraints over there. In the nineties it was decided not to transform the ‘Markermeer’ into a polder, because of various reasons. The main reason was because of the need for fresh water and the second reason was an ecological reason. The area was (and still is) used by many water birds as forage area.
The polders where well designed and considered. The polders appear to lend itself well to agriculture, urban development, recreation and nature conservation. From 1986 the ‘Noordoostpolder’, ‘Oost Flevoland’ and ‘Zuid Flevoland’ formed together the province of ‘Flevoland’. The first new big city was ‘Lelystad’ (named after Ing. Lely). The first inhabitants came in 1967 and in 2007 the province ‘Flevoland’ had about 365,000 inhabitants (Carmio 2007).



1891 Design plan Ir. C. Lely to enclose the 'Zuyderzee'

1916 Flooding disaster

14 June 1918
Construction of the 'Zuiderzeewet' (regulation) about the 'Zuiderzee' and surroundings

29 June 1920
First container to enclose the 'Zuiderzee' in the 'Amsteldiep'

31 July 1924
Finishing the 'Amsteldiepdijk' (dike)

1920-1926
Preparation work

March 1926
traffic allowed over the 'Amsteldiepdijk' ('Wieringen' connected with the coast)

January 1927 Starting with the construction of the dam between 'Zurich' and 'Den Oever'

1930 Polder 'Wieringermeer' is dry

28 May 1932 Last open part of 'De Afsluitdijk' is closed at the location of 'De Vlieter'

23 January 1933 'De Afsluitdijk' is finished and open for paying transport
25 September 1933 Official opening of the dam and placing of the monument by 'Maatschappij tot uitvoering van de Zuiderzeewerken'(organisation).

23 September 1954
Queen Juliana unveils the statue of Dr. Ir. Lely

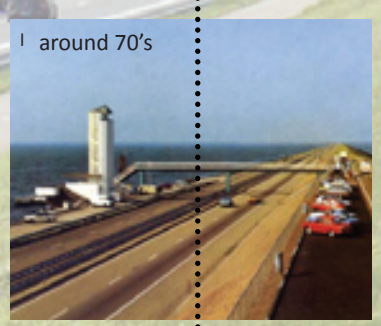
3.4. Time line of 'De Afsluitdijk'

j
end 60's

k around 60's

m 1983

l around 70's



n 2007

o 2007

p 2007

q 2008

r 2008

s 2008

1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 - 2050 - 2100

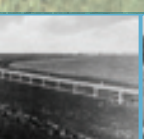
29 May 1968 The last polder 'Zuidelijk Flevopolder' is dry

1976 The road over 'De Afsluitdijk' is transformed to a highway (A7)

1982 Monument 'De Steenzetter' unveiled because of the fact 'De Afsluitdijk' is 50 years into being.

2007 Celebration 'De Afsluitdijk' is 75 years into being.

2008 New ideas to make 'De Afsluitdijk' safe against flooding again.










3.2. Present

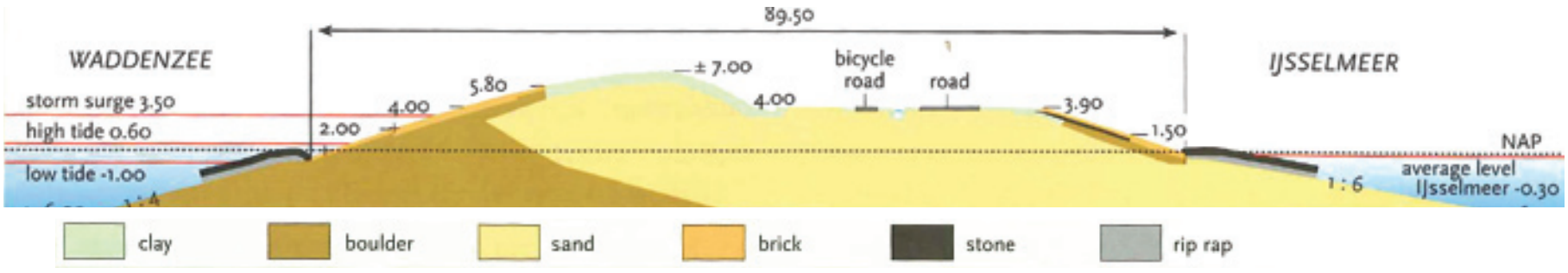
Its name presumes ‘De Afsluitdijk’ is a dike, but it is a dam.
A **dike** is a constructed elevation that protects the land behind the dike against high tide and waves. The Netherlands has two kinds of dikes: primary dikes and regional dikes. Primary dikes protect against the water from the Noordzee and big rivers like the IJssel and the Rhine. Regional dikes protect the land from inland water, like lakes and canals (Rijkswaterstaat s.a. II). According to the VanDale dictionary a dike is a dam that is situated on land and is a raised embankment of soil (Van Dale Lexicografie bv 2007).
A **dam** is, according to the dictionary Van Dale, a dam, an embankment in-between both shores. Next to this is it a connector between two elements (Van Dale Lexicografie bv 2007). A dam can be seen as a dike on both sides surrounded by water.

‘De Afsluitdijk’ is part of the Dutch coastline (fig. 3.5) and is constructed of boulder clay backed by sand and is faced with stone just below water level, on a base of boulders resting on mats of willow (Encyclopædia Britannica 2008) (fig. 3.8).
The construction of the dam shows a change in thinking about the battle against the sea. Instead of heightening the dikes, the coastline is shorted. The development of the dam together with its architecture became an icon of international fascination. It is the longest straight line of the Netherlands, what makes it an impressive construction. Moreover ‘De Afsluitdijk’ has cultural historical value (Rijkswaterstaat 2007a). ‘De Afsluitdijk’ is a landmark for the identity of the area and the history of the Netherlands. Like said before, the dam is a symbol of the struggle against the water.
The main function of the Afsluitdijk is to protect the hinterland against flooding and extreme circumstances of the Waddenzee. The name Afsluitdijk insinuates that it is a dike, but it is not. ‘De Afsluitdijk” is a dam. A dam is surrounded by water on both sides. The dam is on average 90 meters broad on water level and 7,50 - 7,80 meter above Mean Sea Level. At some places, like ‘Breezanddijk’ and a part near ‘Friesland’, the dam is at Delta height (Deltahoogte; ten meters above Mean Sea Level). This is about 3,50 meter above the highest water level ever (Bezoekerscentrum s.a.).
The secondary function of the dam is the fast connecting between ‘Noord-Holland’ and ‘Friesland’ (Carmio 2007) (fig. 3.6). The dam connects the landscapes of ‘Noord-Holland’ and ‘Friesland’. The landscape of ‘Friesland’ is of smaller scale and has more church towers that dominate the view in comparison to ‘Noord-Holland’. Both landscapes can be characterized as open and agricultural. The coastline of the Frisian IJsselmeer is various. The coastline of ‘Noord-Holland’ exists of a sudden straight border of the Wieringermeerdike and the former island Wieringen (with its rolling and small scale landscape) (Rijkswaterstaat 2005).
On top of ‘De Afsluitdijk’ the highway (A7/E22) connects national and international areas (fig. 3.7). A bicycle path connects the provinces ‘Noord-Holland’ and ‘Friesland’. On top of the dam the European hiking route E9 and the North Sea Trail are situated. The North Sea Trail is going from the coast of Portugal to the Baltic States over fifty kilometers of dams. ‘De Afsluitdijk’ is the longest with 32 kilometres (IJskes 2008).
The shape of the dam was depending on its function and technical restrictions of 1932. The shape and basic use of colours and materials is very characteristic. The constructions on top of the dam are designed by architects Roosenburg and Duduk in the style of ‘De Nieuwe Zakelijkheid’ (Rijkswaterstaat 2005).
The dam contains locks for barges and small seagoing craft at two locations: ‘Den Oever’ and ‘Kornwerderzand’. Near ‘Den Oever’ (‘Noord-Holland’) three times a part of five sluices and one lift lock. These have the name Stevinsluizen, named after Hendric Stevin, the first expert with the idea for a dam in 1667. ‘Kornwerderzand’ (‘Friesland’) has two times a part of five sluices and two lift locks: the ‘Lorentzsluizen’. Hendrik

3.5. Soft and hard coastlines

3.6. Connection between the province Noord-Holland and the North Western part of the Netherlands (Friesland, Groningen)

3.7. Connection between The Netherlands with the rest of Europe



3.8. Cross-section. A boulder clay dam was the base for the dam. Spouting sand gave the dam it shape. The dam body is covered with clay, natural stones and bricks.

Lorentz was an important professor who had a lot of knowledge about water heights, currents, and dike heights. Because of him 'De Afsluitdijk' is constructed a bit more to the North instead of straight to 'Piaam'. The lift locks contain swingbridges for cars (Carmio 2007).
The fairways between de Waddenzee and the IJsselmeer are depending on trenches as 'Visjagersgaatje' (fairway to 'Den Oever'), 'Doove Balg' (fairway 'Marsdiep' - 'Kornwerderzand') and 'Boontjes' (fairway 'Kornwerderzand' – 'Harlingen'). The amount of professional ships passing is about 10.000 per year. To maintain the trenches dredging is needed. A few places in the Waddenzee are pointed out to dump this mud (Rijkswaterstaat 2005).
'De Afsluitdijk' contains twenty-five sluices of twelve meter broad to transfer 5000 m3/s water from the IJsselmeer to the Waddenzee. The planned new sluice capacity will double this amount (Rijkswaterstaat 2008b). The sluices can be opened and closed to control the water level in the IJsselmeer. It is not always possible to transfer water from the IJsselmeer to the Waddenzee, only if the water level in the Waddenzee is lower than the level in the Ijsselmeer (low tide), because the spouting happens with the help of gravity. By opening the sluices for a small part a small amount of fishes can go from the Waddenzee to the IJsselmeer.

Tourism is one of the important economical functions of the IJsselmeer and its surroundings, especially coastal tourism. Foreign tourists see 'De Afsluitdijk' as one of the characteristic elements of the Dutch way to live with water and the struggle against it (Nederlandse Omroep Stichting (NOS) 2008). Information signs tell the visitors about 'De Afsluitdijk', ecology, etcetera. The experience of the robustness of the dike in combination with the genesis of the dam is attractive to visitors (Ministerie van Verkeer en Waterstaat). A small camping site is situated at 'Breezanddijk'.
Angling is one of the most popular forms of recreation on the Waddenzee. 45% of the fishers fish from the watersides like the harbours, at 'De Vlieter' or at 'Breezanddijk'.
Recreational shipping is also important, especially in summer. At the IJsselmeer shipping is not depending on trenches. In the Waddenzee during low tide it is depending on trenches.
The amount of passing ships was in 2005 38.3000 at 'Den Oever' (Stevinsluizen) and 45.800 at 'Kornwerderzand' (Lorentzsluizen) (Rijkswaterstaat 2008b). Ninety percent in the months May to September. In summer the waiting periods can be four hours (Rijkswaterstaat 2005).
The dam is also used for military activities. Near 'Breezanddijk' ammunition is tested. The insecure zone of this artillery range is situated into the Ijsselmeer and covers about 200 km. The testing area is 1,5 hectares. At those places the artillery is drawn up. Additional the area is used for military low height flights. The track is about 4 kilometres broad and goes from 'Breezanddijk' to 'Vliehors'' on the island 'Vlieland' (Rijkswaterstaat 2005).
Along the Afsluitdijk a few archaeological high value areas are situated. Especially in the old trenches high values are expected.
'De Afsluitdijk' contains various national monuments, but is not a monument on its own (RACM 2008) (fig. 3.9-3.14):
On the part of 'Noord-Holland':

- Stelling of 'Den Oever', complex (luchtdoelremise, kazematten, tankhindernis, machinegebouwen): still intact and recognizable defense object out of the last phase of permanent defense construction in the Netherlands. It is unique because of the concrete build construction and trenches;
- Stevin sluices: intact example of building with reinforced concrete;
- Monument of Dudok: intact monument in 'zakelijk – expressionistische' building style;
- Lichtopstand: rare coastal object of end 18th century (original from Wieringen);
- Peilschaalgebouwen: elements of the water control history at 'Den Oever'.

On the part of 'Friesland':

- Lorentz sluices: hydraulical technic and constructional typology and functional rare design of ir. D. Roosenburg;
- Duane office (Roosenburg): unique expression of landscape geographic development;
- Border pole: border 'Noord-Holland' and 'Friesland';
- Various objects of de Stelling van 'Kornwerderzand': (kazematten, open opstellingen, tankversperringen). Defence Construction from around 1930;
- Beschermd dorpsgezicht (protected villagescape) 'Kornwerderzand': sluice Construction and settlement as part of the ' 'Zuiderzee'werken'.

The next pages elaborate on the exceptional places along 'De Afsluitdijk'.

‘Den Oever’

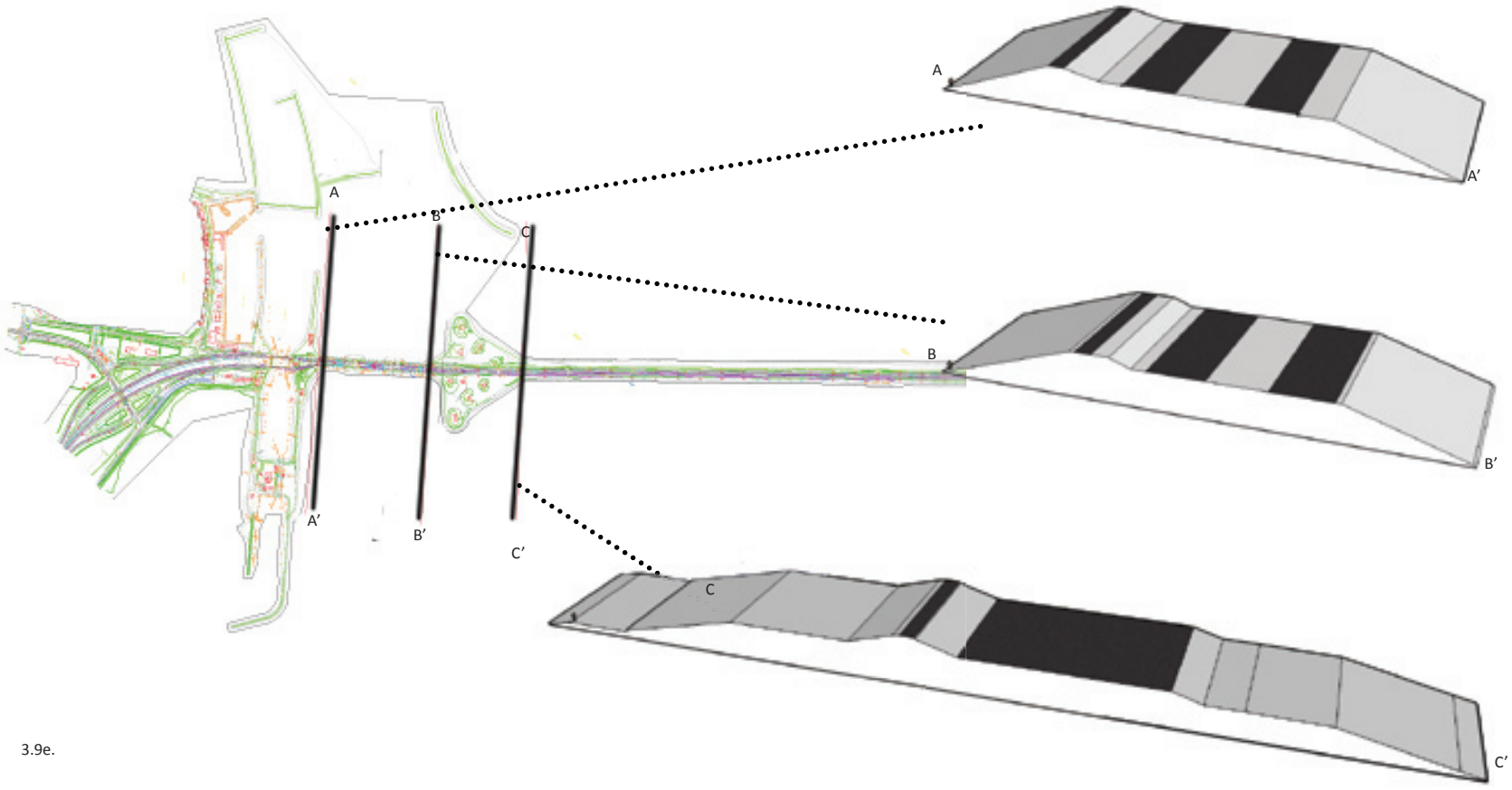

3.9a.


3.9b.


3.9c.


3.9d.

‘Den Oever’ is a small village in the province ‘Noord-Holland’. Near ‘Den Oever’ the ‘Stevin Sluices’ are situated. Every year 65.000 ships (57.000 recreational ships) pass the Lorentz and Stevin sluices (Consortium Sluitstuk 2008). Twenty-five spouts (‘Den Oever’ + ‘Kornwerderzand’)are working and transferring 5000m^3 IJsselmeer-water per second to the ‘Waddenzee’ (Rijkswaterstaat 2007d). Because of the abrupt fresh water spouts the nature along the dam is poor (IMSA 2008).
At this moment (2008) 18.900 to 24.400 Vehicles pass ‘De Afsluitdijk’ in twenty-four hours. In 2020 this numbers will be about 24.000-32.000 (a yearly increasing percentage of 4%). Improvement of the capacity is not needed till 70.000 vehicles in twenty-four hours (IMSA 2008).



3.9e.


3.9f.


3.9g.


3.9h.

‘De Vlieter’

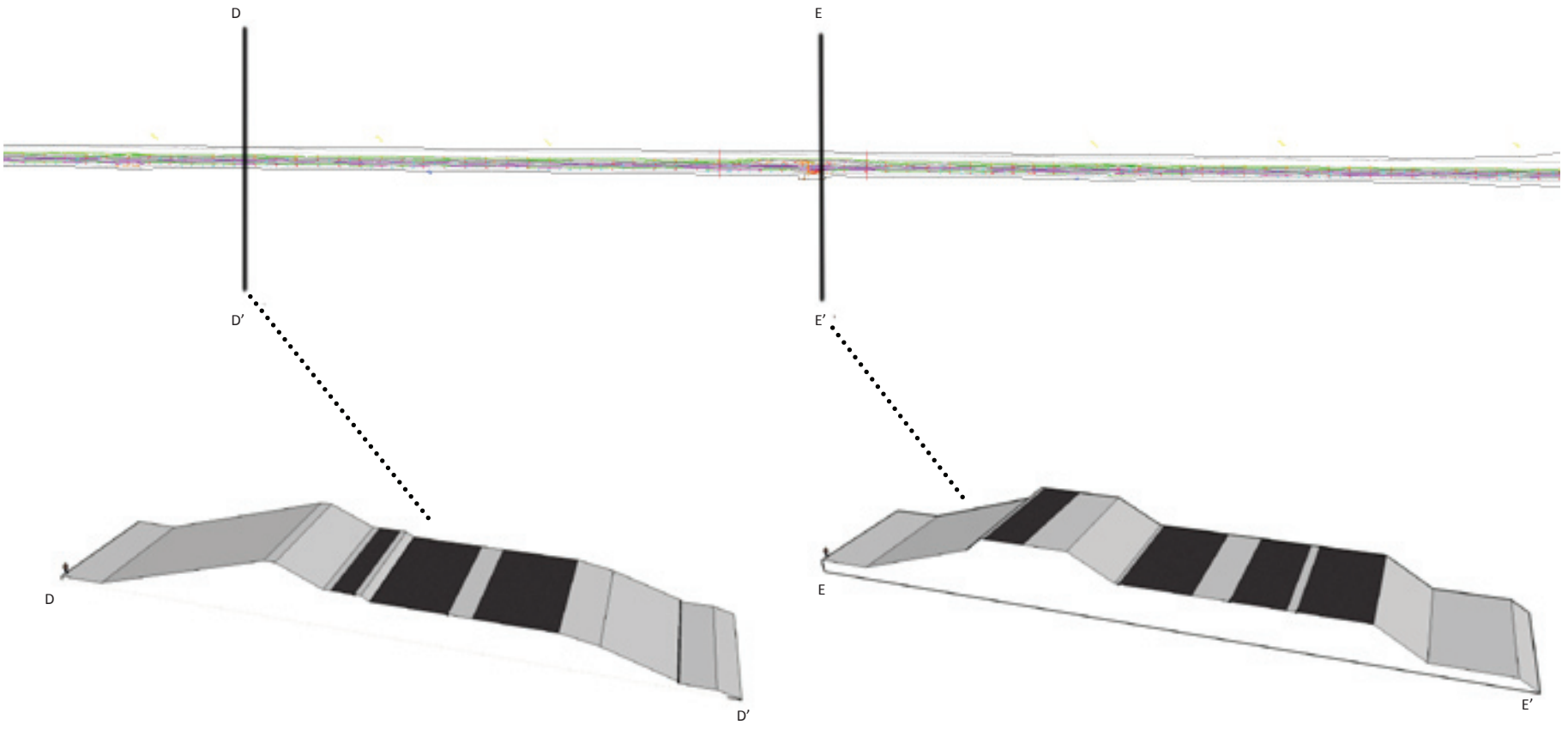

3.10a.


3.10b.


3.10c.


3.10d.

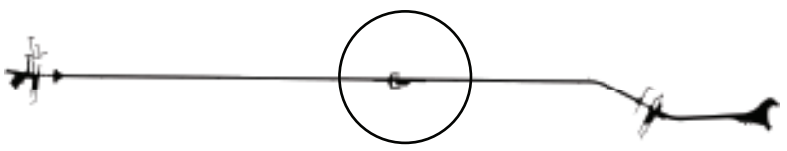
This is the location where the last gap in the dam was enclosed in 1932. Architect Dudok designed a monument in the form of a watch tower. In the tower a souvenir shop and a small catering is situated. The manager of the catering estimates 250.000-300.000 people stop to visit the monument of Dudok (Consortium Sluitstuk 2008). Twenty-two years after the finishing of ‘De Afsluitdijk’ Cornelis Lely was brought honour with a bronze statue of Marie Andriessen. Unveiled by Queen Juliana.



3.10e.


3.10f.


3.10g.



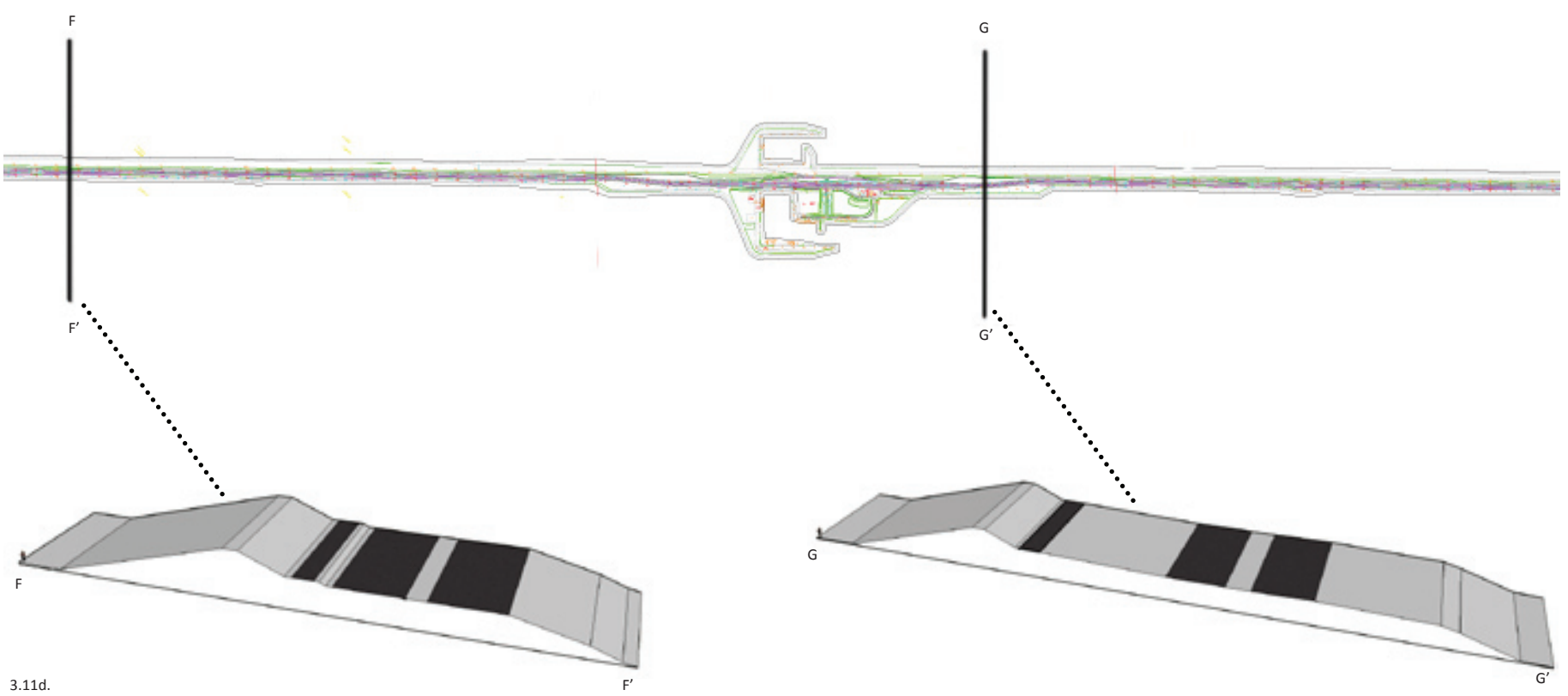
‘Breezanddijk’


3.11a.


3.11b.


3.11c.

These sluice complexes were constructed in large building pits. After the completion of the complexes these building pits were flooded and the encircling dikes removed. To construct the dikes, artificial harbours were needed to (un)load on calm water and storage osier and stone. ‘Breezand’ is such an artificial island with harbour (Ven G.P. van de 2004). The area is still in military use by the land forces and navy to test 155 mm en 25 mm ammunition. A gas station is situated over here. A camping site with site caravans, without facilities is situated on the side of the IJsselmeer.



3.11d.


3.11e.


3.11f.


3.11g.

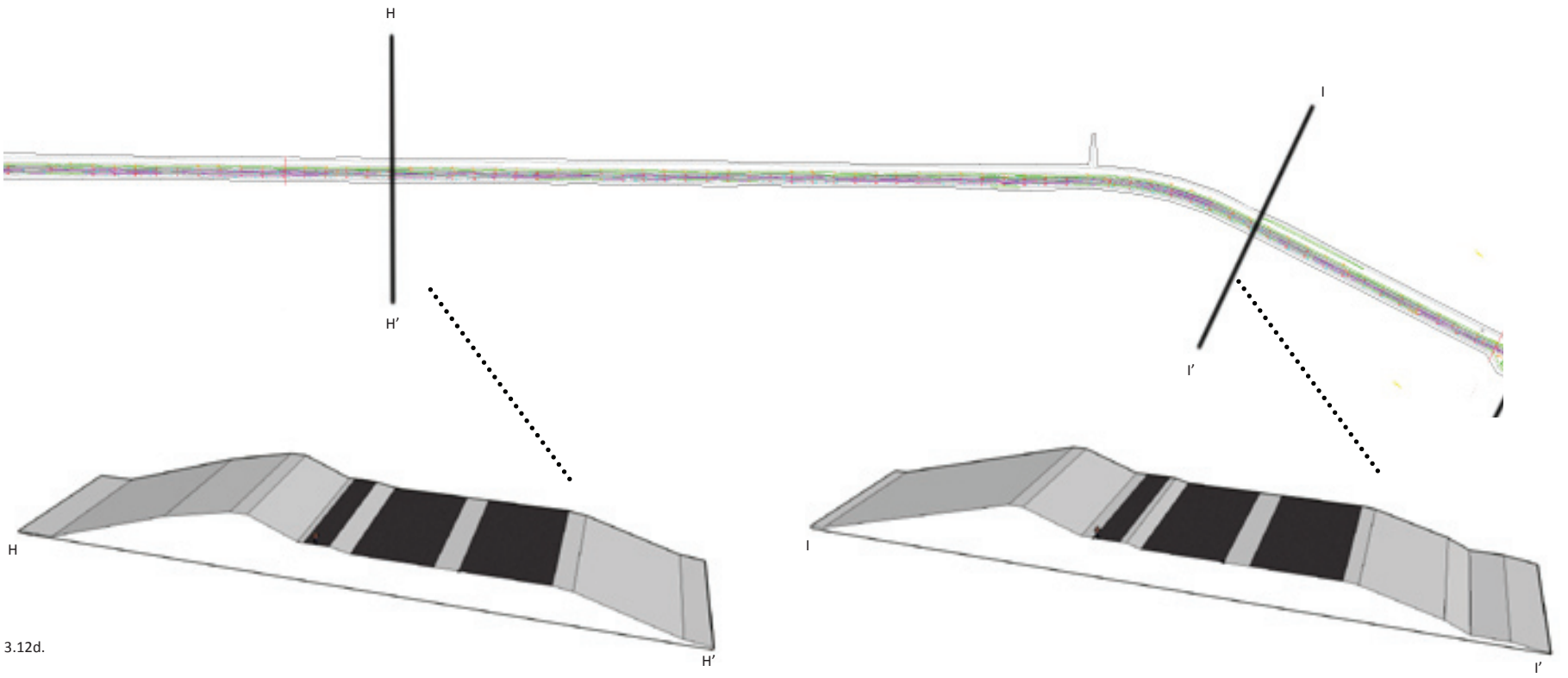
The ‘Arch’


3.12a.


3.12b.


3.12c.

In the paragraph about the history of ‘De Afsluitdijk’ is explained why this arch is constructed. At the side of the Waddenzee is a small reef placed to move the water flow from the dam.



3.12d.


3.12e.


3.12f.


3.12g.

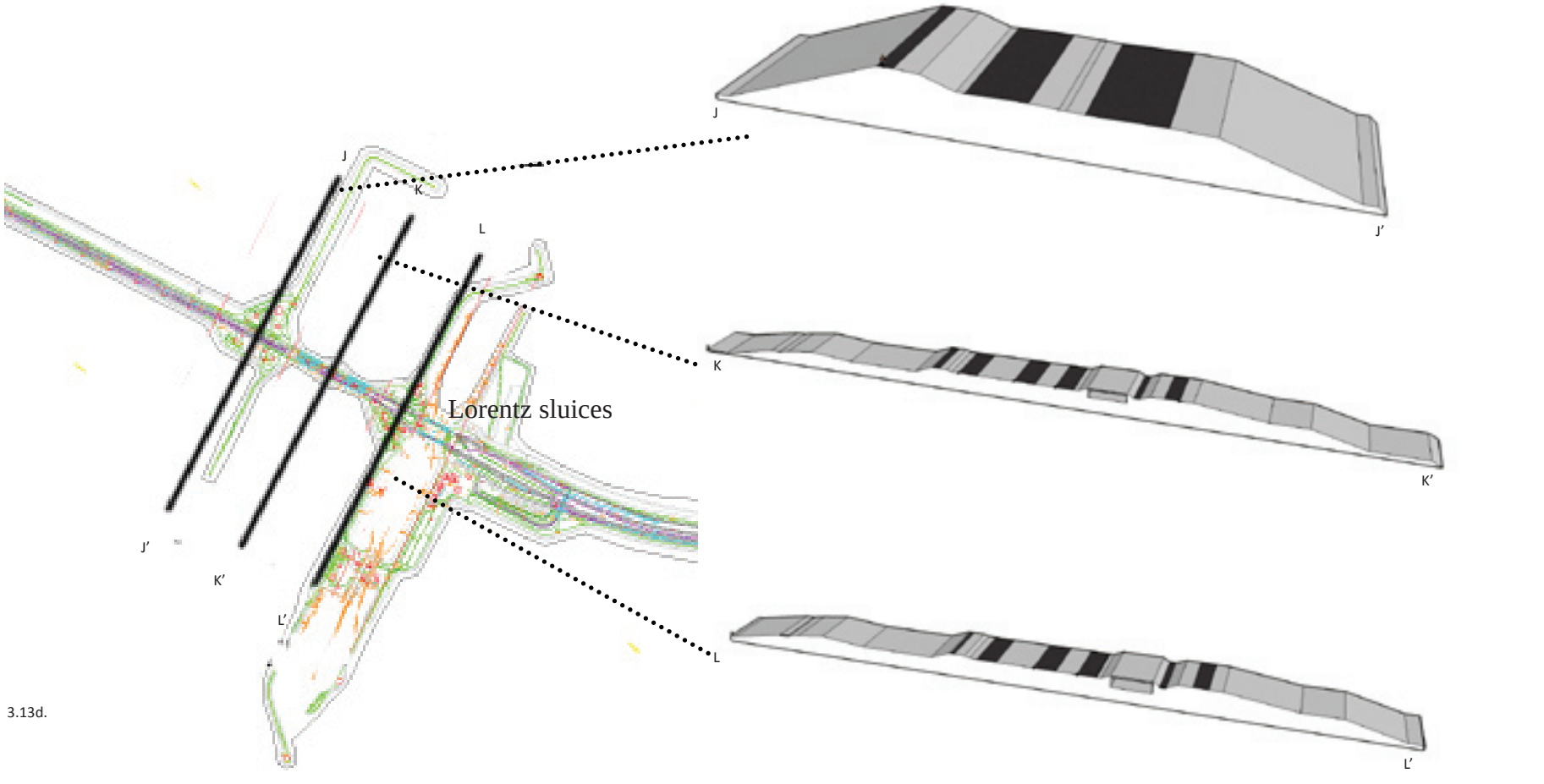
‘Kornwerderzand’


3.13a.


3.13b.


3.13c.

At ‘Kornwerderzand’ the sluice complex of Lorentz is situated. 4.000 Professional ships and 40.000 recreational ships pass the Lorentz sluices every year (IMSA 2008). The ‘Kazematten’ museum has about 12.000 visitors every year (Consortium Sluitstuk 2008). A few living houses are still located at this place and are protected monuments (‘beschermd dorpsgezicht’).



3.13d.


3.13e.


3.13f.


3.13g.

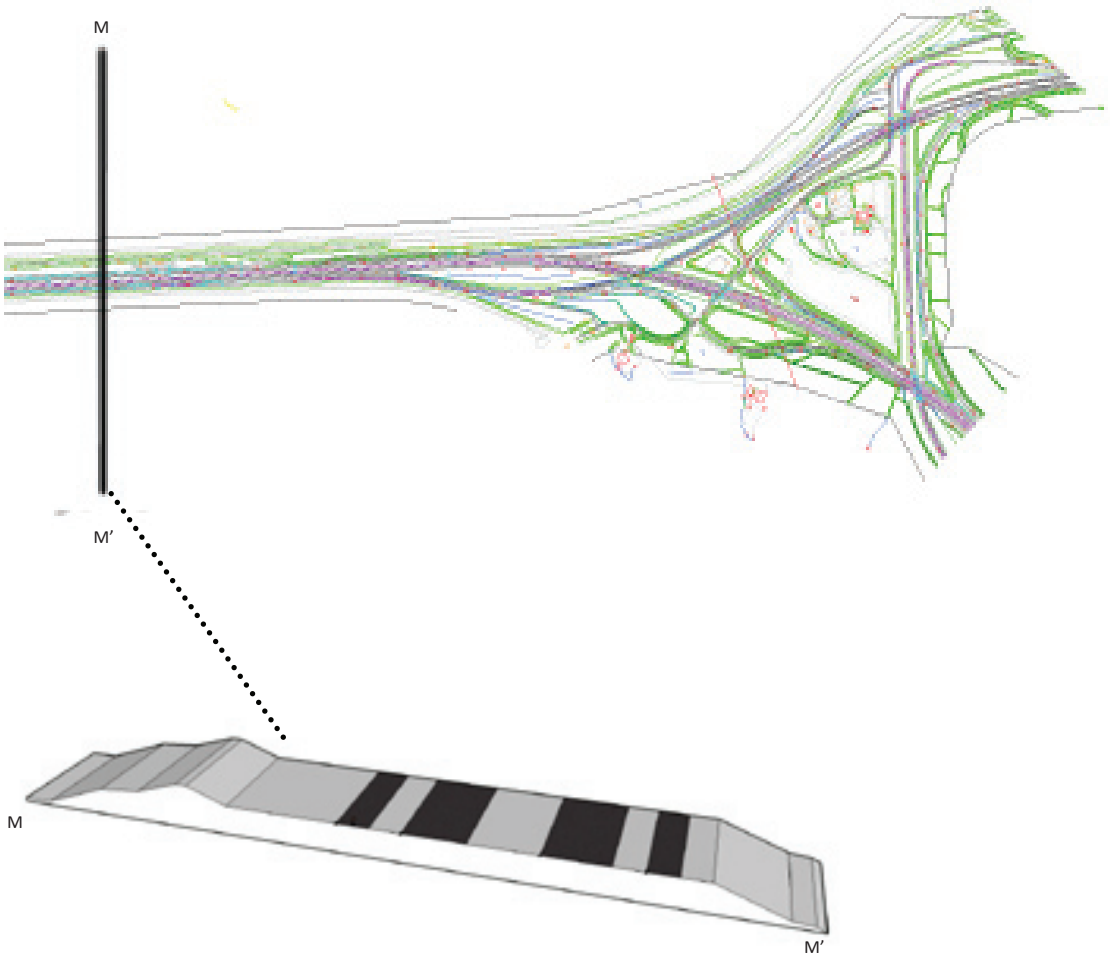
‘Zurich’


3.14a.


3.14b.


3.14c.

Zurich is a small village in ‘Friesland’. Here ‘De Afsluitdijk’ is connected to the land. The area can be characterized as an open landscape with wind turbines scattered into the landscape. At ‘the end’ of ‘De Afsluitdijk’ a restaurant with the name ‘Poort van Friesland’ is situated. In-between ‘De Afsluitdijk’ and the ‘Noordwaard’ a popular surf spot is located (Consortium Monument Afsluitdijk 2008).



3.14d.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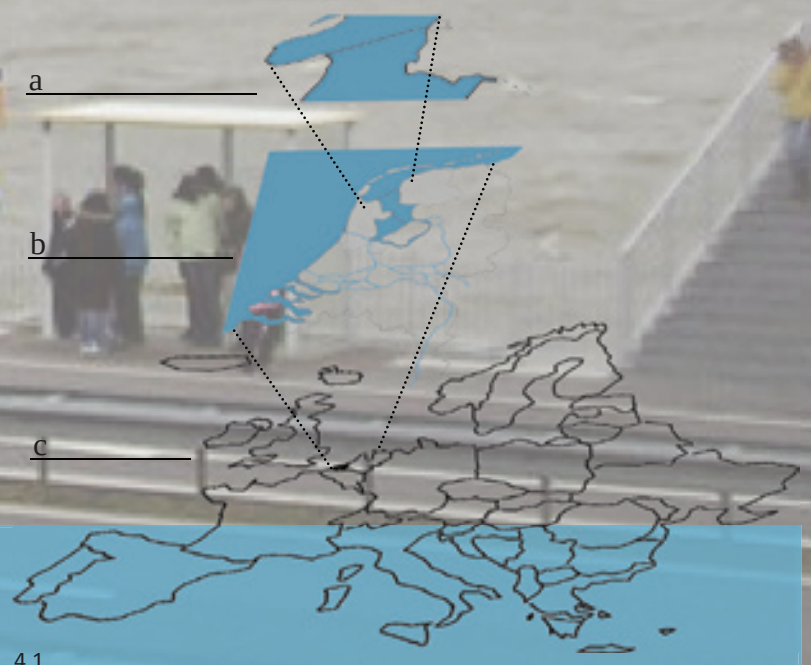
CHAPTER 4

Spatial Context



4.1

Spatial Context

The surroundings of ‘De Afsluitdijk’ influence the dam in various ways. That is why an analysis of a wider-study-area is needed. This chapter describes the landscape, which is surrounding the site of ‘De Afsluitdijk’, on different scale levels to get a broad overview. Regional considerations for specific assignments should be made integral and from a big scale perspective, because the site is part of a bigger system.
The study area of ‘De Afsluitdijk’ can be seen from different scale levels:

- Europe is the highest scale level (fig. 4.1c). On this scale the relation of the dam with the coast line of Europe becomes clear.
- On a lower scale level (fig. 4.1b) the ‘Noordzee’, ‘Waddenzee’, ‘IJsselmeer’ and rivers are interesting. The ‘Waddenzee’ and the ‘IJsselmeer’ are important, because they are in the circle of acquaintances. ‘De Afsluitdijk’ is crossing those two water landscapes, what makes them very important. Additional the provinces ‘Noord-Holland’ and ‘Friesland’ need attention.
- On the smallest level (fig. 4.1a) the areas where ‘De Afsluitdijk’ touches the land are important: ‘Wieringen’ (‘Noord-Holland’) and ‘Wûnseradiel’ (‘Friesland’).

4.1. Europe

The influence of Europe on ‘De Afsluitdijk’ and vice versa is not very big. The scale level of Europe is described here to get an overview of the coastline where the dam is part of. The coastline of Europe exists of soft and paved elements. Figure 4.2 shows ‘De Afsluitdijk’ is, because of its shape and material a unique element in the line of coastal defence. Additional the rivers starting in the mountains in Europe have big influence on the dam, because the carry away comes partly in the ‘IJsselmeer’ and has to be transported through the dam to the ‘Waddenzee’ (fig. 4.3).

4.2. ‘De Afsluitdijk’ as part of the European coast line defence

4.3. Influence drain off rivers and Waddenzee on ‘De Afsluitdijk’

4.2. Province of ‘Noord-Holland’ - ‘Wieringen’

‘Noord-Holland’ can be divided in different characteristic areas. The ‘Wieringermeerpolder’ and the former island ‘Wieringen’ are the most important ones in this thesis, because of the direct relation to ‘De Afsluitdijk’ (fig. 4.4). ‘Wieringen’ is a municipality of the province ‘Noord-Holland’. The construction of the ‘Wieringermeerpolder’ started in 1927 and was finished in 1930. The landscape here is characterised as a basic polder landscape: geometric formed fields and straight roads.
‘De Afsluitdijk’ connects to the shore of the former island ‘Wieringen’. ‘Wieringen’ was first connected to ‘Friesland’, but it moved to ‘Noord-Holland’, because of the river ‘IJsel’. Historical maps show that the island was situated on the current location around 1296 (Allan 1855). The oldest and highest parts of the island consist of boulder clay covered with sand. Far in the past the island was surrounded by peat, swamp and water areas and was very fertile. Around the tenth century ‘Wieringen’ became inhabitable. The peat was exploited for salt extraction to conserve products. After various floods the ‘Marsdiep’ came into being and the island became surrounded by water. The island protected itself against flooding by constructing dikes and new land was recaptured from the sea. The lower parts of the island became more accessible, because of the reallocation of land.
By enclosing the ‘Amsteldiep’ (1925) and the construction of the ‘Oostelijke ‘Wieringermeer’dijk’ (1930) ‘Wieringen’ was not an island anymore. In 1932 ‘De Afsluitdijk’ connects the villages ‘Den Oever’ (‘Noord-Holland’) and Zurich (‘Friesland’) (Gemeente Wieringen s.a.).
The existing landscape and history give ‘Wieringen’ a clear own identity. The characteristics of the island are still visible in the landscape although it is not an island anymore. The old island is situated higher than its surroundings and contains a high variation in slopes. The old culture is still visible in the parcellation patterns of fields, old buildings, the harbour and fishery.
In 2008 a number of 8300 people live in ‘Wieringen’. They mostly live from fishery and agriculture. The fishery is focused on capturing shrimps in coastal waters. ‘Wieringen’ is surrounded by ‘Waddenzee’, ‘IJsselmeer’ and ‘Amstelmeer’. On all sides harbours are situated for professional and recreational use. The landscape and ecological values are becoming more and more important. This is close related to recreation and tourism (Gemeente Wieringen s.a.). Rain and ground water flows from the higher to the lowest parts to the ‘Waddenzee’. The fresh water enters here the salty water. This results in a high diversity of vegetation. The lower parts of ‘Wieringen’ on the side of the ‘Waddenzee’ are important for birds (Gemeente Wieringen s.a.).
At ‘Den Oever’ the crossway of the N99 to ‘Den Helder’ and the A7 to ‘Friesland’ is situated. Busses go to Den Helder, Alkmaar, Hoorn and Leeuwarden. These connections are important because ‘Wieringen’ is situated far from economical centers. The N99 has a big impact on the landscape because it separates the former island in two parts. It disrupts the small scale landscape image, the road pattern and the pattern of settlements (Gemeente Wieringen s.a.).
The ‘Ontwikkelingsvisie’ (view about the future) focuses on the potentials for tourism. The island character should be strengthened and the ecological values conserved. The island-idea is going to be implemented by the construction of the ‘‘Wieringerrandmeer’’ and by deeping the N99. The project ‘Wieringerrandmeer’ is a project of the province ‘Noord-Holland’, ‘Wieringen’ and ‘Wieringermeer’ to make ‘Wieringen’ an island again. The will be connected to the ‘Waddenzee’, ‘Amstelmeer’ and ‘IJsselmeer’. The project should give the area a social economical impulse. An ecological area will come into being in between the ‘IJsselmeer’ and the ‘Amstelmeer’ with forest, water and reed areas. The area will be part of the ‘Provinciale Ecologische Hoofdstructuur’ (Provincial Ecological Network).

4.4. Northern part of the province of ‘Noord-Holland’

Legend ‘Wieringen’ (Noord-Holland)

- Water
- Deep water
- Existing forest
- Planned forest
- Existing vegetation
- Swamp
- Highway A7
- Regional way
- Local way
- Wind turbine
- Village
- Dike / slope (coastline)

0 1 km

4.3. Province of ‘Friesland’ – ‘Wûnseradiel’

‘Wûnseradiel’ is the municipality in the province of ‘Friesland’ where ‘De Afsluitdijk’ starts/finishes. The landscape of ‘Friesland’ can be characterized as very flat, open landscape with a lot of water. The struggle against water is visible in the landscape. The area is covered with dikes and artificial hills (‘terpen’). The hills were used to build houses on top to be safe against floods.

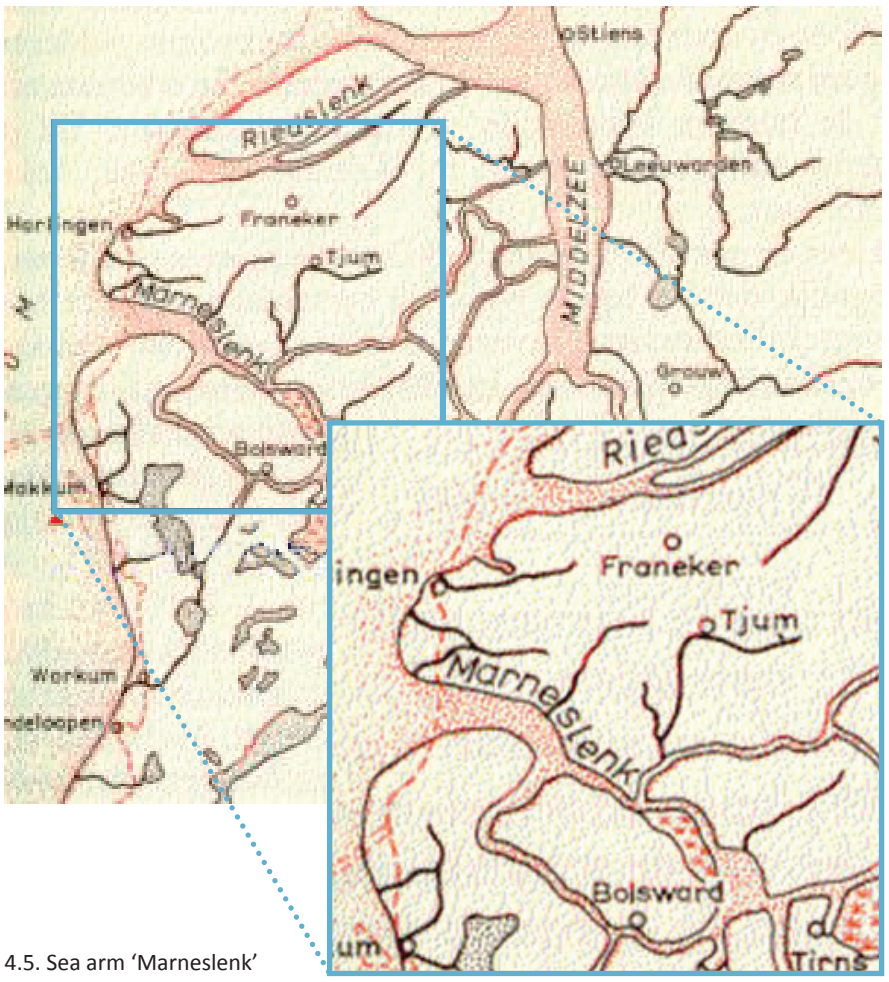
In the Riss Ice Age (180,000–130,000 years BP) ‘Wûnseradiel’ was covered by ice. The ice melted and boulder clay became visible. On top of this boulder clay sand, brought by the wind, was laid down. The sea level rose and the organic elements changed into peat. Floods covered the peat with boulder clay again.

The influence of the sea is best visible in the landscape because of the sea arm ‘Marneslenk’ (fig. 4.5). In the past people wanted to protect themselves against floods. They constructed a network of dikes (together called ‘De Gouden Halsband’) in the 11th and 12th century (fig. 4.6.).

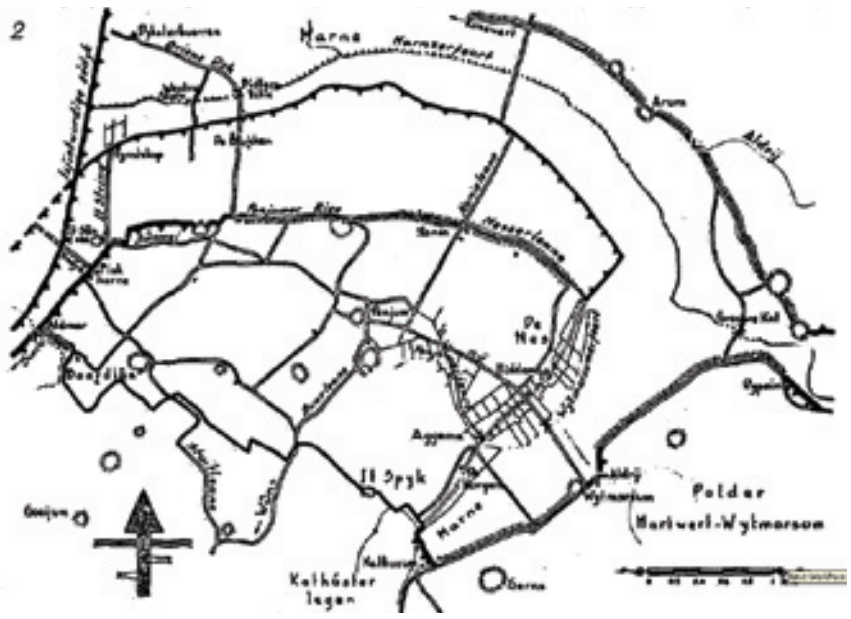
Until 1000 A.D. the northern and western parts of ‘Friesland’ existed out of mud flats. Around the 6th century A.D. the first inhabitants came to live on artificial hills, salt marshes and embankments. The salt marches were separated from each other by channels like the ‘Marneslenk’. The ‘Marneslenk’ became silted up and a new polder was constructed. The canals are still recognizable in the landscape as the lower parts. In 1863 it became clear that the dikes of the ‘Gouden Halsband’ were neglected and roads through the dikes came into being. Those mend the end of the protecting function of these dikes. In 1918 the Afsluitdijk is build to protect the hinterland against flooding. Fewer floods and dry flats resulted in extra ground.

During the Second World War (1940-1945) many fights took place at ‘Wûnseradiel’. After the war, industry and meadow areas came into being. At this moment cattle breeding and agriculture are the main land use. (Gemeente Wûnseradiel s.a.)

The highway A7 (fig. 4.7) is now crossing the landscape of ‘Friesland’ to follow its way over ‘De Afsluitdijk’ to ‘Noord-Holland’. Just before entering the dam, the highway is surrounded by a few wind turbines, scattered in the landscape. The landscape just in front of ‘De Afsluitdijk’ can be characterized as flat and open. The road system of the A7 with its exits and accesses, maintenance roads and regional roads is difficult to understand and the locations of the wind turbines do increase the disorientation, because there is no logic seen structure.



4.5. Sea arm ‘Marneslenk’



4.6. Network of dikes: ‘De Gouden Halsband’ / ‘Pinjumer Halsband’

4.7. Western part of the province of 'Friesland'

Legend 'Wûnseradiel' (Friesland)

- Water
- Deep water
- Existing vegetation
- Swamp
- Highway A7
- Regional way
- Local way
- Wind turbine
- Village
- Dike / slope (coastline)

0 1 km

4.4. The ‘Waddenzee’

The ‘Waddenzee’ is the name for a body of water that is associated with coastal wetlands positioned between a section of the North-Western coast of continental Europe and the North Sea. It is located from the northern coast of Holland (‘Den Helder’) to Denmark (‘Esjberg’). The ‘Waddenzee’ covers about 8000 km^2 in total (Rijkswaterstaat 2005). On European scale level it is the biggest and most important interconnected coastal and tidal wetland, about sixteen times bigger than the second one in row ‘Morecambe Bay’ in England (W. de Leeuw s.a.).
Holland, Germany and Denmark started to work together around 1980 to set up the ‘Trilaterale Waddenzeeplan’. The area is now well protected because of the existing botanical and geomorphologic values. Additional the area contains a big amount of protected plant and animals species of various habitat types (Rijkswaterstaat 2005).

The Dutch part of the ‘Waddenzee’ covers about 1500 km^2 and is located in-between the Islands at the Northern part of Holland, and the provinces ‘Friesland’, ‘Groningen’ and ‘Noord-Holland’ (fig. 4.8) (F.G.M Hoogenboom, M.M. Gründemann et al. 2005; Rijkswaterstaat 2005).
It is connected with the North Sea through inlets between the West Frisian Islands. Those inlets have depths of 50 meters (Encyclopædia Britannica 2008). The islands are working like barriers; sand and silk easily crush behind those islands, because most of the water is composed and shallow. This sedimentary system makes the area unique for its kind.
The Dutch ‘Waddenzee’ can be characterised as a sea with extensive tidal mud flats, salt marshes, and tidal trenches. The sand flats are mostly uncovered at low tide, intersected by deep canals. Geomorphic and biological processes are happing on big scale and undisturbed. The patterns of the sea (trenches, mud flats etc) are visible on multiple scales (fig. 4.9) (W. de Leeuw s.a.).
The high ecological value is a result of the combination of brackish, saline and fresh water. Together with the tidal identity, this area is even more interesting because of the high biodiversity these characteristics result in. The biggest part of the ‘Waddenzee’ is a protected monument and has the function of a biosphere reservation. Dunes and salt marshes are in different stages of succession. This means gradients resulting in a richness of species and multiple ecological functions. It is a place for appease, searching for food and maternity for fish, shellfish and mollusks. Additional the ‘Waddenzee’ has a rich fauna because of the soil condition. The flora and vegetation is diverse and specific. Further more the ‘Waddenzee’ area is of international meaning for migrating birds. About 10 to 12 million bird species make use of the area to fill up their fat buffer (W. de Leeuw s.a.).

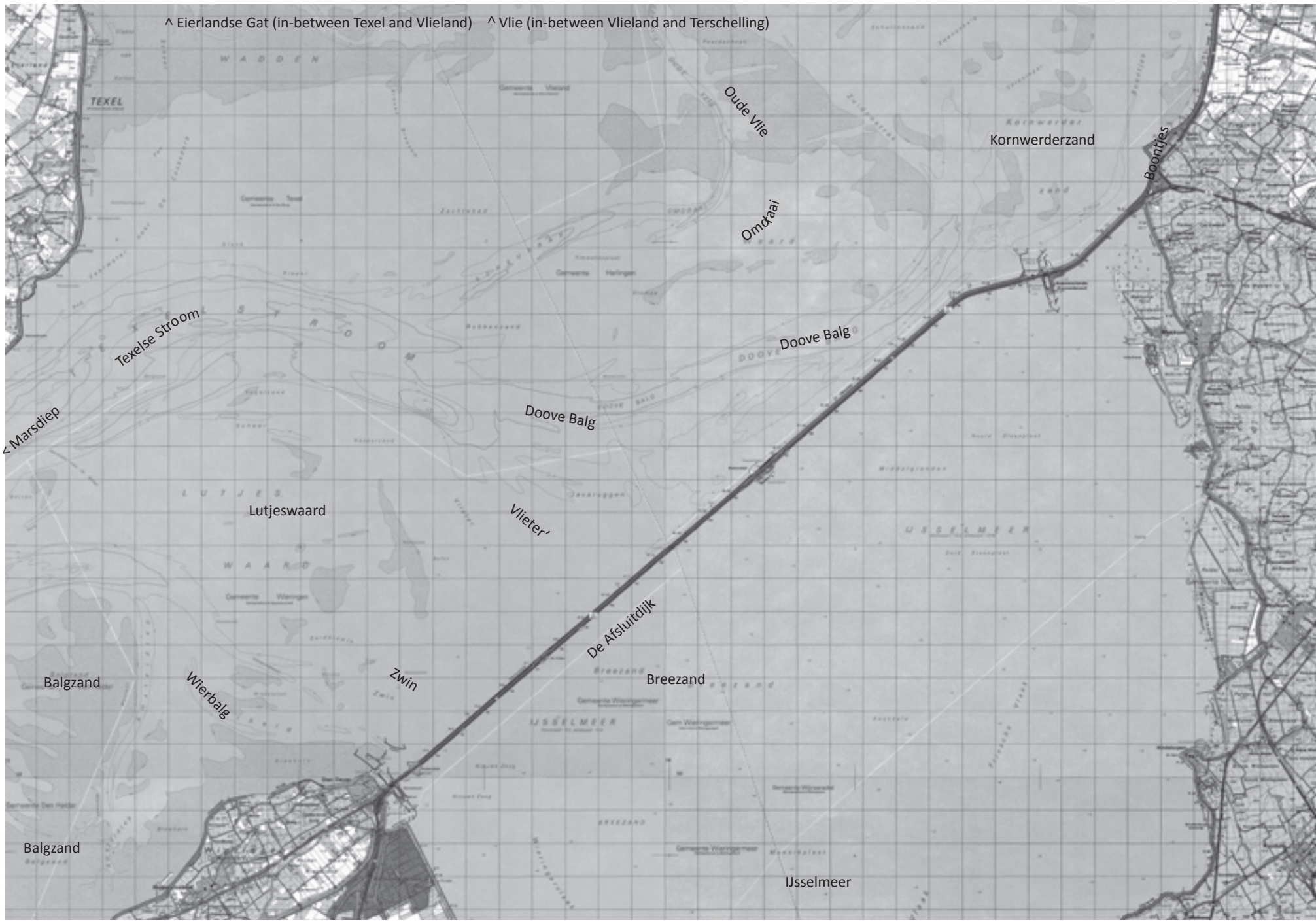
The ‘Waddenzee’ is a well protected by multiple policies. The most important ones are:

- ‘Vogel- en Habitatrichtlijn’: this regulation aims the maintenance of natural richness for birds and habitats. The ‘Habitat-regulation’ aims the conservation of biodiversity of special habitats and wild flora and fauna. The ‘Bird-regulation’ aims the conservation of birds living in natural European areas.
- World Heritage list (‘Werelderfgoedlijst’): The countries Holland, Germany and Denmark are trying to include the ‘Waddenzee’ on the list of World heritance. This list contains areas that have exceptional universal value, are unique and irreplaceable.
- ‘Nederlandse Natuurbeschermingswet’: aims to protect the scientific knowledge about the ‘Waddenzee’. ‘Natura 2000’ (part of Natuurbeschermingswet): This regulation tries to construct a European network of natural areas. The regulations protect certain types of plans and animals. (W. de Leeuw s.a.).
- ‘Staatsnatuurmonument’ (Rijkswaterstaat 2005): areas that belong to this list of monuments are of high value to the whole country on point of natural beauty or natural scientific value (Provincie Noord-Holland Holland, s.a. -182);
- ‘Structuurschema Groene Ruimte’ (Rijkswaterstaat 2005): the view of the national government is about nature and rural area is written down in this document. It aims, conservation, development and recovery of natural characteristics and values (Provinciale Milieufederaties 2007);
- PKB ‘Waddenzee’: aims for sustainable protection and development of the natural values in the ‘Waddenzee’. The protection of the unique open landscape (RIKZ 2006).

The ‘Waddenzee’ is also important because of educational and scientific point of view. Different topics and elements of the ‘Waddenzee’ are intensively investigated. This data is interesting all over the world. Research on birds that migrate over long distances can be done. Also the fact the history of the landscape, the interaction between human and nature are visible in the landscape, makes it an interesting area (W. de Leeuw s.a.).
The area of the ‘Waddenzee’ and its close surroundings is also used for recreation. The most important types are water and forest recreation, biking, hiking, and camping. Research done by Coeterier (1997a) shows qualities of respondents first thoughts: space, quiescence, virginity, grandness (‘weidsheid’), beautiful villages, different landscape types next to each other, possibility to do many different activities, richness of nature and fresh air (Coeterier J.F., Buijs A.E. et al. 1997a).

4.8. The ‘Waddenzee’

4.9. Patterns of the sea in the ‘Waddenzee’



4.10. Overview ' Waddenzee'

Future

The sea level is already rising for many years. The 'Wadden'-area is used to it and searches consciously after a balance. During a sea level rise the sedimentation of sand and silk is increasing. When the sea level rise is bigger than a certain amount the sedimentation will not be able to keep up with the sea level rise. When that occurs, the sand plates and mud plans will be situated at deeper parts and will not be flooded all the time (Waddenvereniging 2007).

The expected climate change and sea level rise influence the flora and fauna of the 'Waddenzee'. The 'Waddenzee'-water will become warmer, animals which like colder circumstances will migrate to the north and will be 'replaced' by animals which prefer warmer circumstances. Plants will bloom more early in the year, insects will disappear earlier, birds breed more early. Sand-plates and salt marshes are important areas to find food and to breed. When the salt marshes and salt planes are under water level, the situation is different resulting in less food and no breeding areas (Waddenvereniging 2007). The sub tidal planes in the Western part of the 'Waddenzee' will become even shallower (fig. 4.10). The tidal plates ('intergetijdeplaten') will probably grow with the sea level, but they will be situated a bit lower than they are at this moment. The main trench system will not change (Rijkswaterstaat 2005). When the plates follow the sea level rise, the 'Waddenzee' ecology and dynamics will not change (Rijkswaterstaat 2005). The tidal volumes of water will increase in the sea trenches 'Marsdiep', 'Eierlandsche Gat' and the 'Vlie'. The plate 'Balgzand' will follow the sea level rise and 'De Vlieter' (old stream trench, now cut by 'De Afsluitdijk') will become shallower because it will fill itself with sand. The 'Boontjes' will become narrower but will not move (Rijkswaterstaat 2005).

More saline water will move inwards and outwards from the 'Waddenzee' to the North Sea. The fresh water inlet by the 'IJssel' will increase. The salt concentration in the trench system of the 'Doove Balg', the 'Marsdiep' and the 'Texelstroom' will increase a bit. The salt concentration in the North Eastern part of 'Kornwerderzand' will decrease a bit. At this moment the salt concentration in the 'Waddenzee' vary between 200 mg Cl-/L near the sluices to 35.000 mg Cl-/L in the sea trenches (Rijkswaterstaat 2005).

A higher temperature of the water will result in an increasing algae grow and a decrease of the concentration of oxygen (Rijkswaterstaat 2005).

4.11. The ‘IJsselmeer’

4.5. The 'IJsselmeer'

The 'IJsselmeer' is the biggest fresh water lake of Western Europe (fig. 4.13.) (surface of 1130 km^2, average dept of 4,5 m) (Rijkswaterstaat 2005) and came into being after the construction of 'De Afsluitdijk' in the former sea arm 'Zuiderzee'. After the construction of 'De Afsluitdijk' large parts of the 'Zuiderzee' (3440 km^2) have been reclaimed by making polders (Encyclopædia Britannica 2008). The 'IJsselmeer' was further split into two parts by the construction of the 'Houtribdijk' ('Markerwaarddijk'), which is situated in-between 'Enkhuizen' and 'Lelystad'. The formerly brackish water has been replaced by fresh water, partly by inflow from the 'IJssel'-River, a branch of the Rhine-River (Encyclopædia Britannica 2008), the 'Overijsselse Vecht', the 'Eem' and some smaller watercourses (Rijkswaterstaat 2005) and the superfluous rainwater of the hinterland (fig. 4.12).

The 'IJsselmeer'-water has various functions: drink water reservoir, reserve shortage fairways, flushing agricultural and natural areas and cooling down water for power plants (Rijkswaterstaat 2008c). That is why it is important to maintain this fresh water reservoir.

The water of the 'IJsselmeer' is used to flush the polders with fresh water during dry periods. This source of fresh water is valuable to 'Noord-Holland', 'Zuid-Holland', and 'Friesland' during occasional summer droughts.

The water of the 'IJsselmeer' also has an ecological function. Along the Frisian coastline fallow fields (fields that are grown over), swamps (low situated meadows), and salt marshes form an ecological unity (Rijkswaterstaat 2005). Additional the area is a good forage area for birds (Ministerie van Verkeer en Waterstaat).

Next to the ecological value the 'IJsselmeer' is also important for landscape, cultural history, recreation and economics (SVBIJ s.a.). The lake is used for fishery ('Eel') and recreation like swimming and sailing.

The average length of stay of the water in the 'IJsselmeer' vary from 3,5 to 5,1 months, depending on the season. The salt concentration is below 200 mg Cl^-/L, this is about the standard for drink water (Rijkswaterstaat 2005).

The 'IJsselmeer' can expand to a water surface of 120.000 ha to store water from the rivers when it is not possible to spout from the 'IJsselmeer' to the 'Waddenzee'. It is not possible to spout during high tide; when the 'Waddenzee' has a higher water level than the 'IJsselmeer' (Bezoekerscentrum s.a.).

Future

The expected climate change results in shorter periods to spout water from the 'IJsselmeer' to the 'Waddenzee'. In winter extreme high water levels will happen more often. The average water level will rise slowly. Because of the expected sea water level rise natural areas outside the dikes will be flooded more often. This is positive for breeding birds of wet-reed-land and for certain mousse, because there is no possibility for competitors to establish themselves. For brooding births of dry areas it is a negative development. Additional the accessibility to food will decrease for certain animal species. Bare sandy plates, function as rest and sleep areas, will decrease in surface. In spring settlements of breeding birds can be flooded, because the periods of sluicing are shortened and the amounts are increased. (SVBIJ s.a.)

4.12. Location of the 'IJsselmeer' in the Netherlands

4.13. Overview 'IJsselmeer'

CHAPTER 5

Symposium

Symposium ‘Toekomst Afsluitdijk’

5.1.

This thesis takes the symposium ‘De toekomst van de Afsluitdijk’ (The future of ‘De Afsluitdijk’), organized by ‘Rijkswaterstaat’ on the 14th of March 2008, as starting point. On the 14th of March various ideas were presented by interested people and experts. These ideas are the first phase of the ‘Research Integral improvement Afsluitdijk’, a project of ‘Rijkswaterstaat’, Provinces of ‘Friesland’ and ‘Noord-Holland’ (SMO 2008). The presented ideas are elaborated in this chapter.

5.1. Presented ideas

A list of the existing ideas presented in the report 'Toekomst Afsluitdijk, resultaten van een participatieve verkenning' can be found in the appendix. About thirty ideas are presented during the symposium on the 14th of March 2008. They are mentioned below and divided in different groups (SMO 2008):

'De Afsluitdijk' with dam functions

- Soft super dam ('Zachte superdijk') by 'Deltares' and 'Imares';
- Broad under water groin ('Brede onderwatergolfbreker') by 'Royal Haskoning';
- Salt marshes and Oyster banks ('schorren en oesterbanken') by 'Delatres NIOO' e.a.;
- Dike enforcement with the material elastocoast by 'BASF' ;
- Dike enforcement with the material biogrout by 'Deltares', 'Volker Wessels';
- C-Fix Koolstofbeton (C-Fix koolstofbeton) by 'Deltares'/'Heijmans BV';
- X-blocks by 'ZUS'.

Sustainable energy production on 'De Afsluitdijk'

- Tidal turbines in 'De Afsluitdijk' by 'Teamwork technology BV, Alkyon H.C.&R';
- Osmosis by 'REDstack B.V'. e.a.

Energy production on and in the surroundings of the dam

- The Wall of solar by 'Cartesius-instituut', the 'Sun stakeholdery & W. Ockels' ;
- Road energy by 'Ooms Alenhorn Olding BV' and 'WTH vloerverwarming BV';
- Wind park (IPWA) 'E-connection';
- Valmeer by 'W. Ockels';
- Bio-offshore by 'ECN', 'TAUW BV' e.a.

Rest

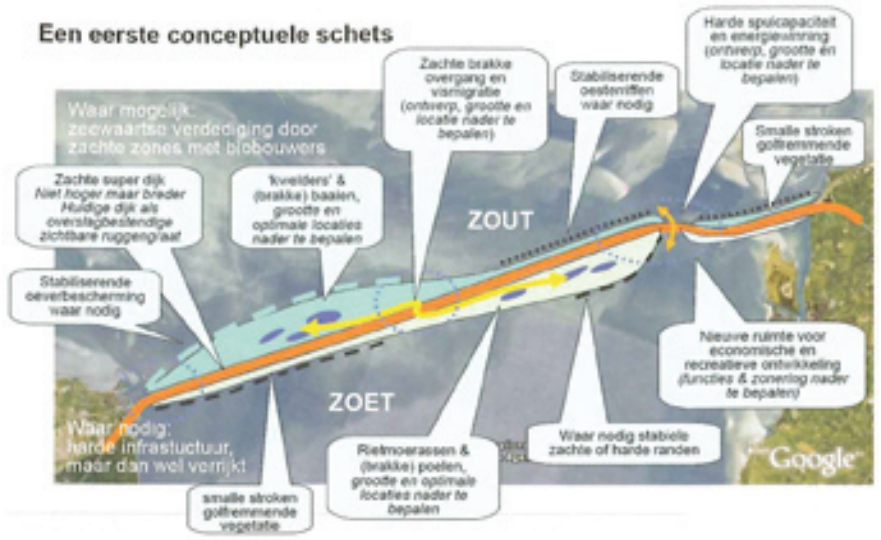
- Open the dam by 'Stichting Verantwoord Beheer IJsselmeer' (VBIJ).

5.2. Intuitive sketches

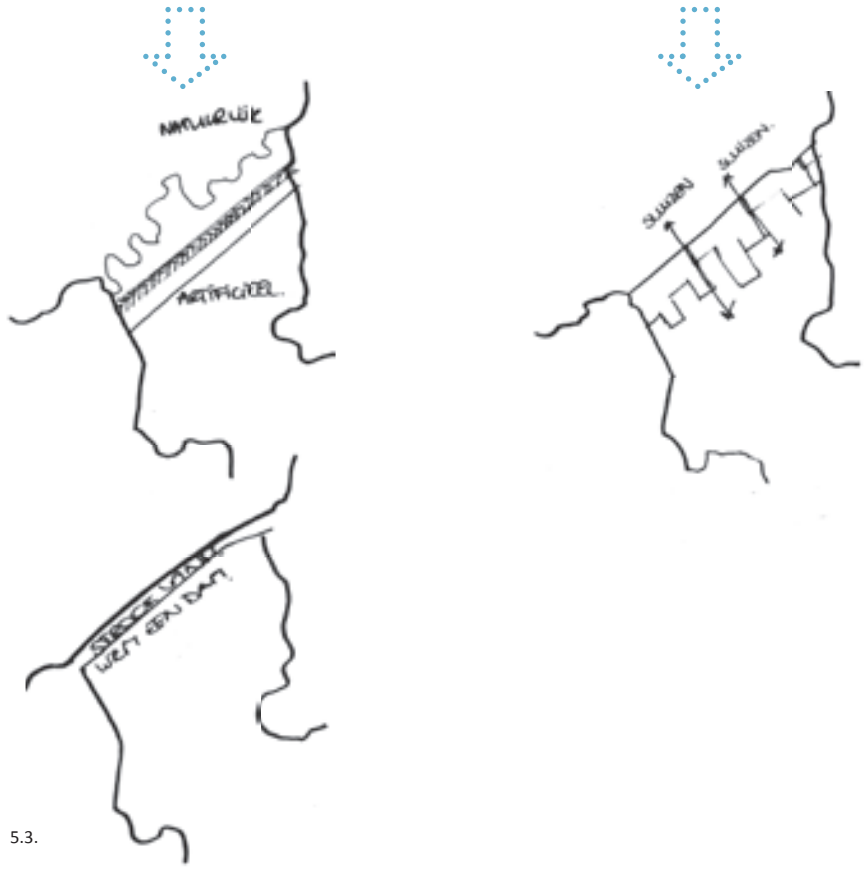
The ideas are all quite interesting for a landscape architect, but a few of them are more focused on aspects that landscape architects work with. The ideas about materials and architecture are more interesting for technical studies. The most interesting ideas for me as a landscape architect are summarized here and used as base for a brainstorm session that resulted in intuitive sketches (figure 5.3, 5.5, 5.7, 5.9, 5.11, 5.13). The steps of thinking are explained as much as possible.

Dam function

- *'Soft super dam' by Deltares and Imares (fig. 5.2.)*
  The existing dam is the base for this plan. To make the dam sufficient it is made broader and kept low as much as possible. The development of salt marshes and swaps will be stimulated. A fresh-salty gradient will be developed with tidal dynamics, this in combination with the extra spout capacity. At location where softening of the dam is not possible the dam will be made higher.



5.2. Idea of Deltares, Imares: 'Soft Super Dam'

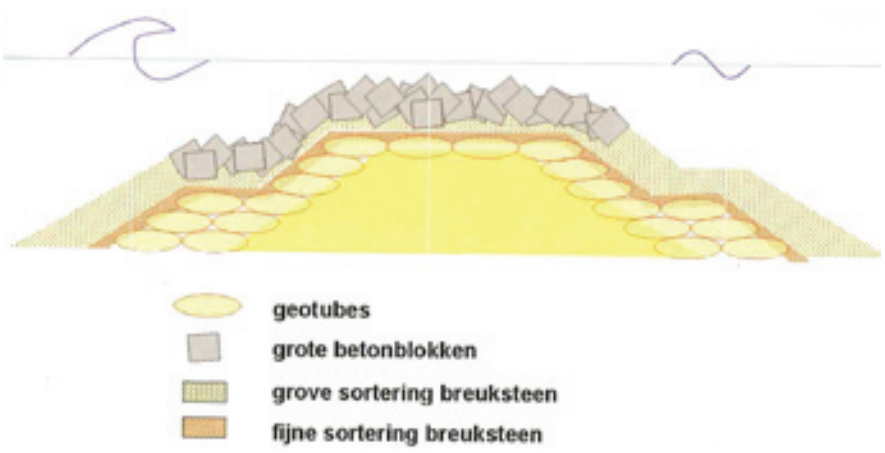


5.3.

The main idea is the salt marsh in front of the dam and the existing dam is still there.

1. What first comes up in mind is the natural barrier in front of the dam.
2. Second thought is about the contrast between this naturalness and artificial straight line.
3. The third idea is about broadening the dam.
4. Resulting in an broadening of the artificial character of the dam with the help of a 'polder-structure'
5. 'Why should there be a dam, why is it not land?' results in a zone of land along the existing dam.

- *'Broad under water groin' by Royal Haskoning (fig. 5.4)*
  The groins form a barrier for long waves because those waves are demolishing the coast. Next to this these groins can result in baizes where sandbars and salt marshes can develop. The groins are not visible from the coast because they are situated under the water level. With this artificial reef heightening the dam is not needed.
- *'Salt marshes and Oyster banks' by Deltares, NIOO e.a.*
  This is about groins and the collection of soil particles. The banks decrease the energy because the waves are made lower and the water flow is slowing down. Another advantage is that the banks can grow with the rising water level because the plants grow.

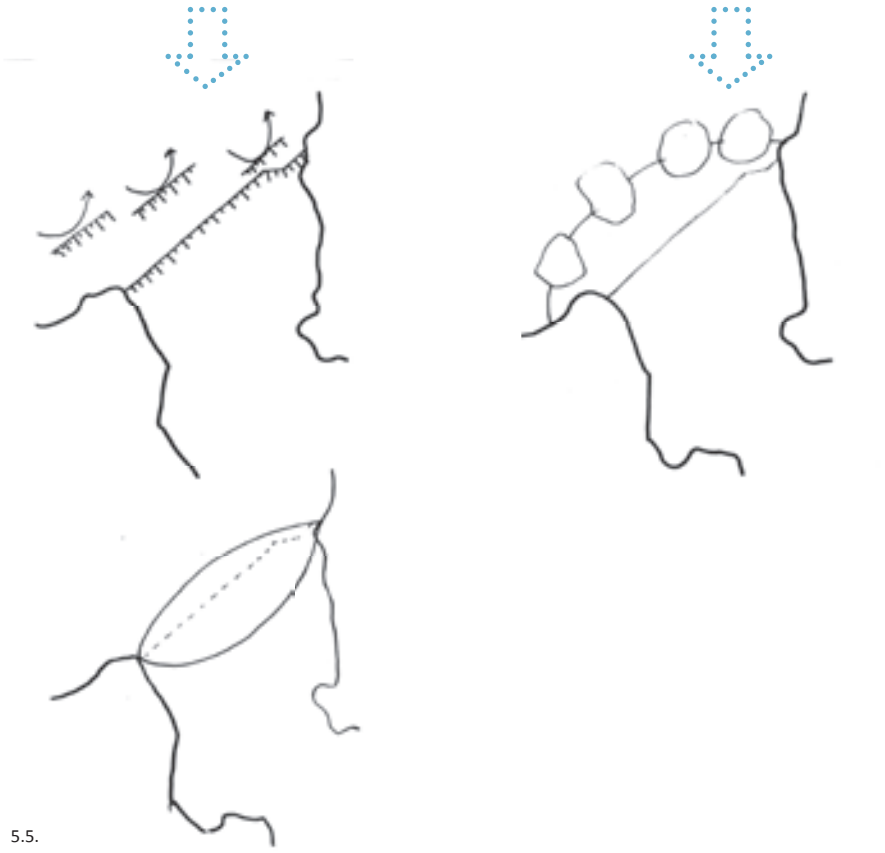


5.4. Idea of Royal Haskoning: 'broad under water groin'

Sluice function

- *'Extra sluice capacity at the location of the nod of the dam' by Rijkswaterstaat*
  The location at the West side of 'Kornwerderzand' has the most potential because the differences between high and low tide will probably be the biggest over here. Next to this the consequences for ground life are here the least and the location has the best opportunities for fishes to migrate to the IJsselmeer. And last but not least is this the best place to fit a sluice into the landscape.
- *'Naviduct Kornwerderzand' by Witteveen + Bos (fig. 5.6.)*
  The idea is to lead the road vehicles under a bridge of water. An engineered construction ('kunstwerk') situated in the link to the Wieringerrandmeer at zuiderhaven. The canal and sluice make it possible to pass the dam because of a bridge over the water.

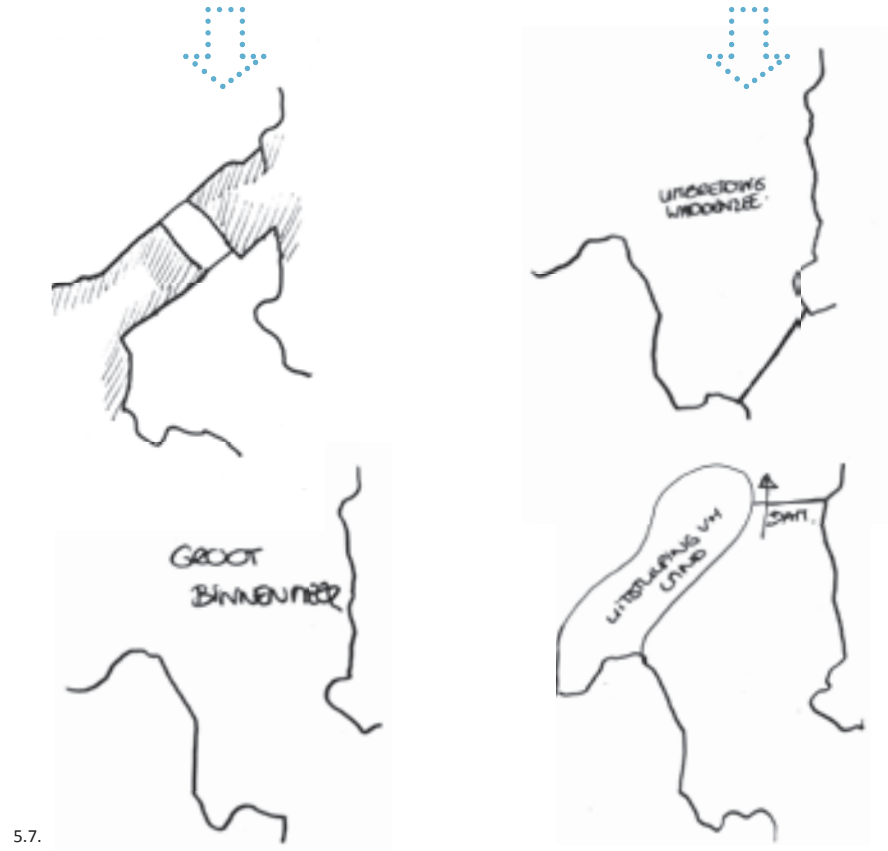
5.6. Idea of Witteveen + Bos: 'Naviduct Kornwerderzand'



5.5.

The steps of thoughts are described here:

1. Reefs in front of the Afsluitdijk that protect the dam against strong waves should be situated at the side of the North Sea and at places where the main trenches are.
2. Ships should be able to fair 'over' or 'through' the line of reefs
3. Something else could be in front of the dam to protect it against waves, like islands or another dam.



5.7.

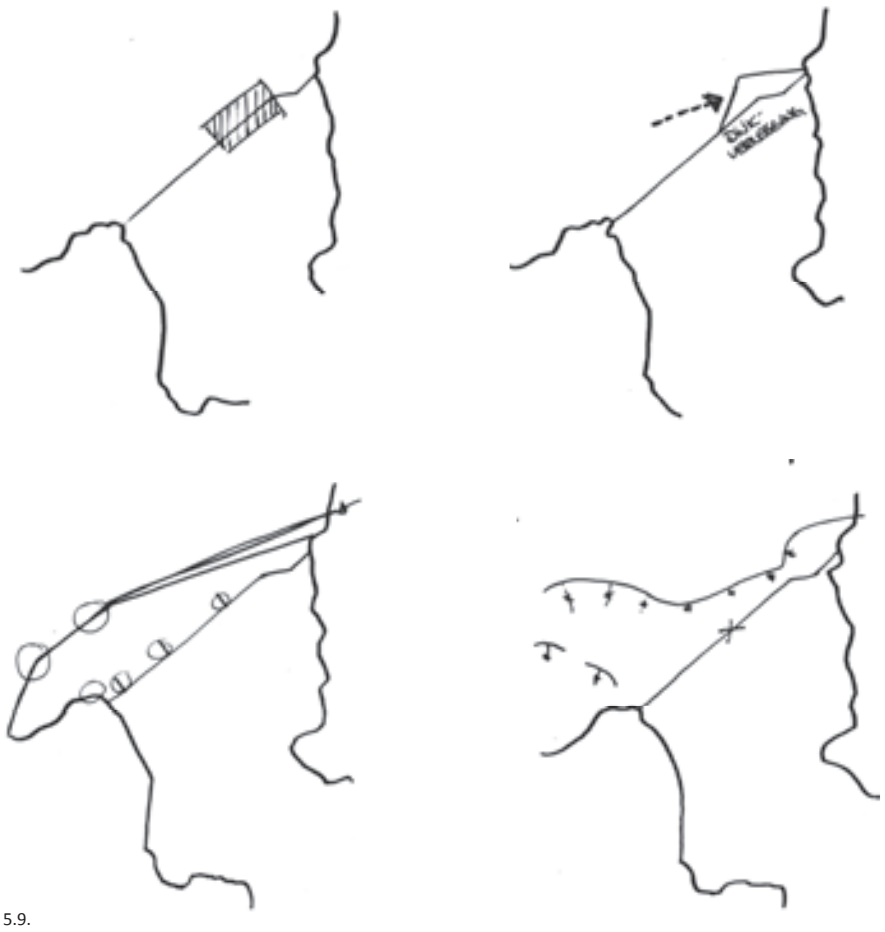
The steps of thoughts are described here:

1. Ships should be able to pass the dam
2. Ecology is important, why not moving the dam to a place so that the estuary can re-establish itself? Locate the new dam at a spot where the dam does not have to be too long (costs)
3. Why not moving the dam in-between the islands ('Waddeneilanden')? And make one big lake.
4. Why should the dam be so long, extending the land is also a possibility.
5. Ecology: Migrating fish are important, fresh water basin is important to maintain.

Sustainable energy production

- *'Tidal turbines' in 'De Afsluitdijk' by Teamwork Technology bv, Alkyon Hydraulic Consultancy & Research (fig. 5.8)*
  The fast water flows from the IJsselmeer to the Waddenzee make the dam to a location with potential to produce sustainable energy. Every sluice can contain turbines. Eighty percent of the time can energy be produced, the turbines can also help to sluice water. Fish leading systems are obliged.

5.8. Idea by Teamwork Technology bv; Alkyon Hydraulic Consultancy & Research; Tidal turbines

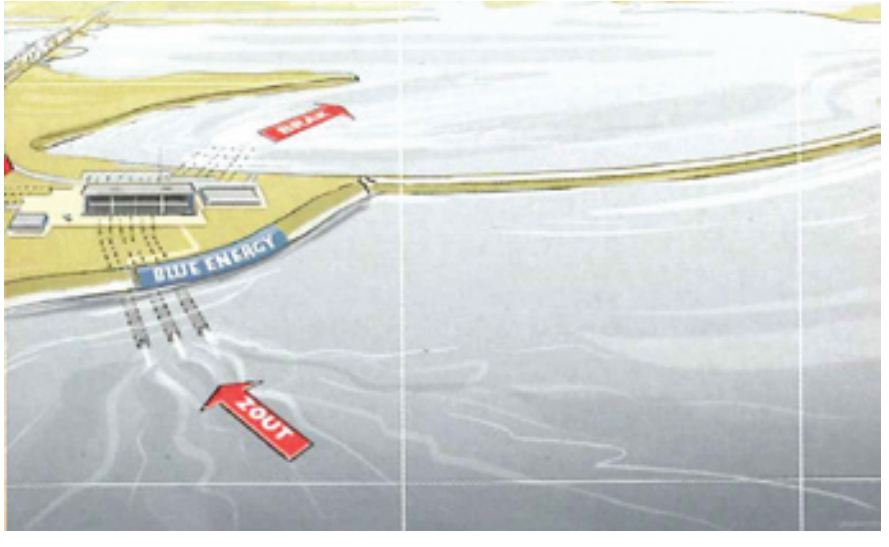


5.9.

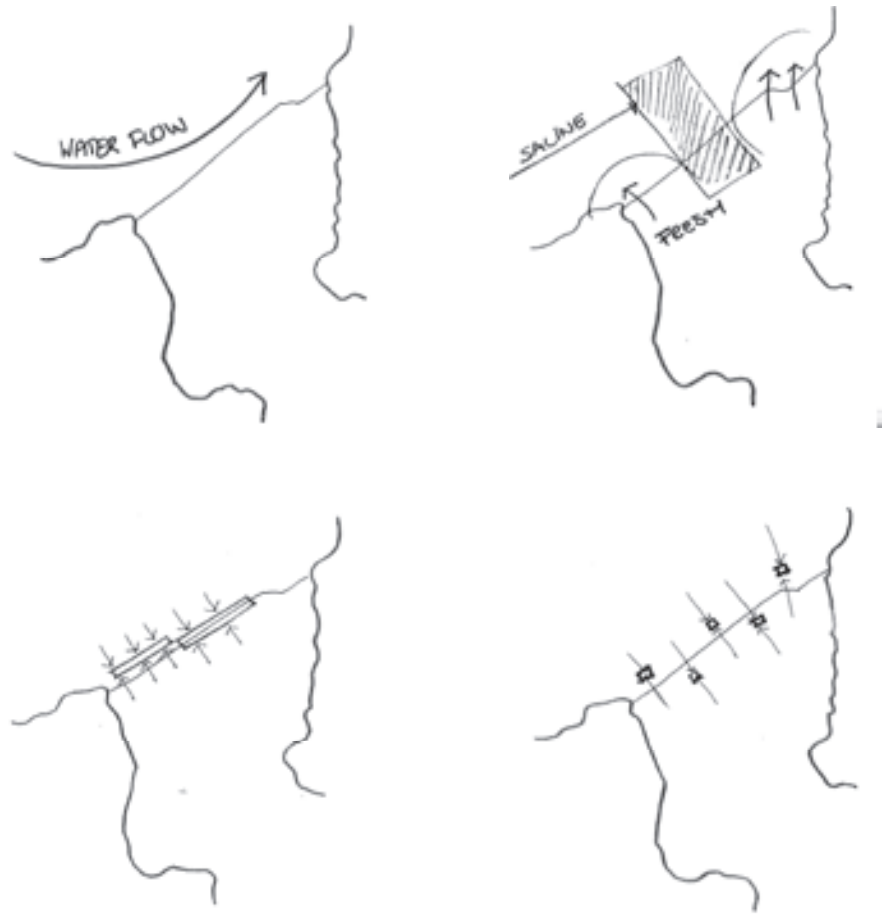
The steps of thoughts are described here:

1. The best location for a tidal turbine would be in the main trench: 'Doove Balg', because here the water flow is the fastest.
2. The dam could be moved to take advantages of the natural water flow
3. A new dam could be used to move the natural water flow away from the land and/or existing dam.

- *'Osmosis' by REDstack BV e.a. (fig. 5.10)*
  The technology has the name Reversed Electro Dialysis. Osmosis produces energy by mixture of fresh and salty water.



5.10. Idea by REDstack; blue energy: Osmosis

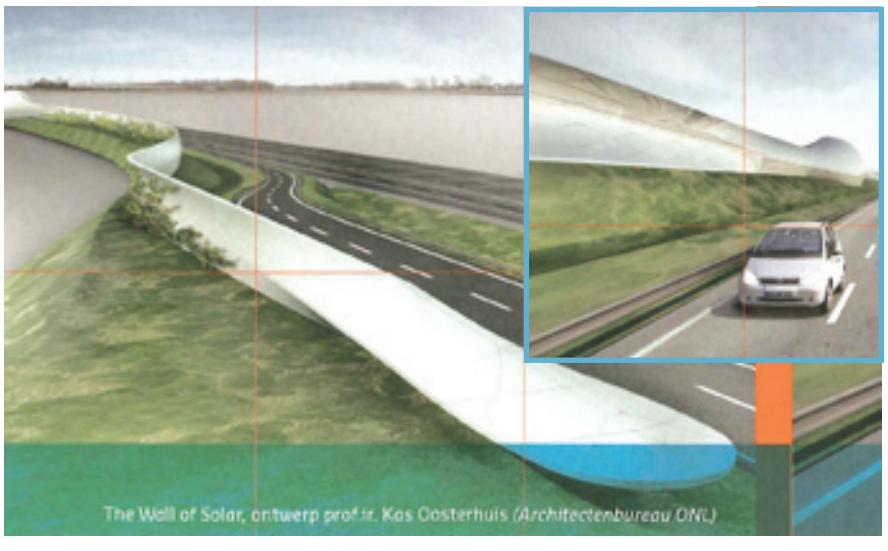


5.11.

The steps of thoughts are described here:

1. The natural water flow and characteristics are important to produce energy by osmosis.
2. The highest difference between saline and fresh water results in the highest energy production.
3. The location of an osmosis plant can be at one spot, or divided over the dam. This depends on the characteristics of the surroundings and the constructions needed for the plant.

- *'The Wall of Solar', by Cartesius-Instituut, The Sun Factory and W. Ockels (fig. 5.12)*
  Cartesius-Instituut: To construct 170.000 solar panels on the south slope of the dam. 32 km long
  Ockels: Wall of Solar: Solar wall of 6 meters high



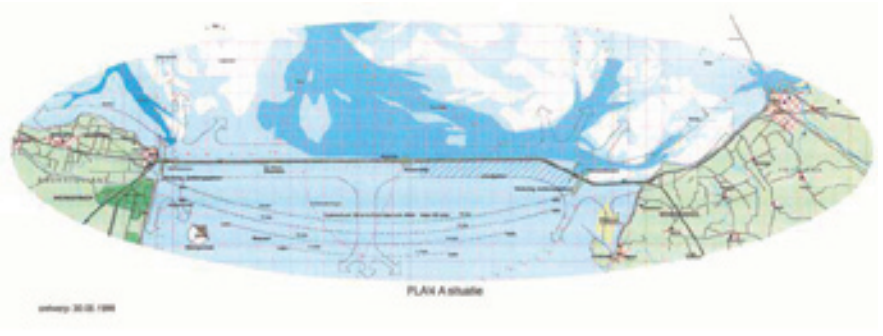
5.12. Idea by Cartesius Instituute, The Sun Factory and W. Ockels: The Wall of Solar

5.13.

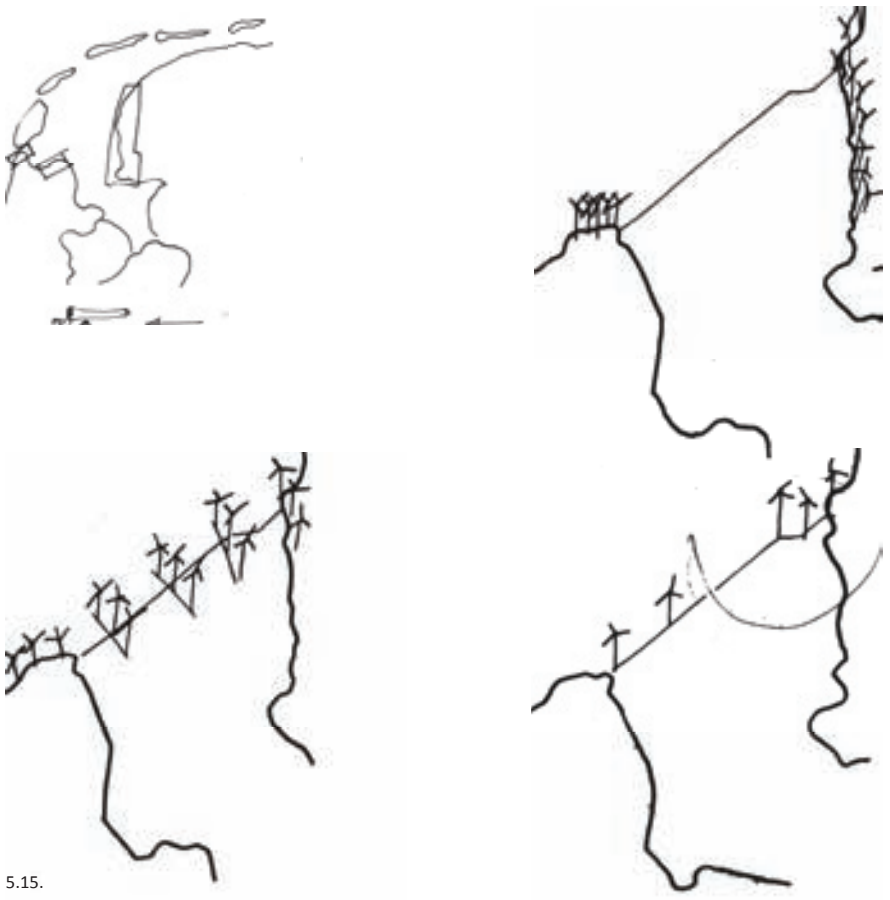
The steps of thoughts are described here:

1. The best position of the panels is to the south
2. The position of the dam can be adapted to the best position, this makes the dam also shorter (cheaper)

- *'Wind park' by 2 provinces and 4 municipalities (fig. 5.14)*
  'Interprovincial Project Wind park Afsluitdijk' (IPWA) by provinces 'Friesland' and 'Noord-Holland' and the four adjoining municipalities. 109 Wind turbines along the dam.
  Wind Park in the 'Ijsselmeer' by E-Connection Project bv: two ideas. 125 wind turbines in double row in a curved line. Another idea is wind turbines in-between buildings.



5.14. Idea by 2 provinces and 4 municipality; wind park



5.15.

The steps of thoughts are described here:

1. The best location for wind turbines is at the places where the most wind is.
2. The location of the wind turbines can be at the coastline (to maintain the openness of the dam)
3. To catch the most wind, the wind turbines can also be situated at the dam itself.
4. To emphasize the exceptional places at the dam, the wind turbines can be situated at these places. This adds a third dimensional (the height).

- *'Road energy' by Ooms Avenhorn Holding bv and WTH Vloerverwarming bv*
  It is a layer of asphalt and concrete with high warmth absorbing characteristics. Heating pipes with flowing water which transport warmth from the asphalt to deep soil layers. In winter is this heath pumped up. In winter cold water is stored to use as cooling down in summer. The asphalt can conserve on a certain temperature what result in a good road holding and no ruts.
- Bio-Offshore, production of algae to produce energy by ECN, Tauw BV e.a.
  Algae could be bred in-between the existing and a new dike.

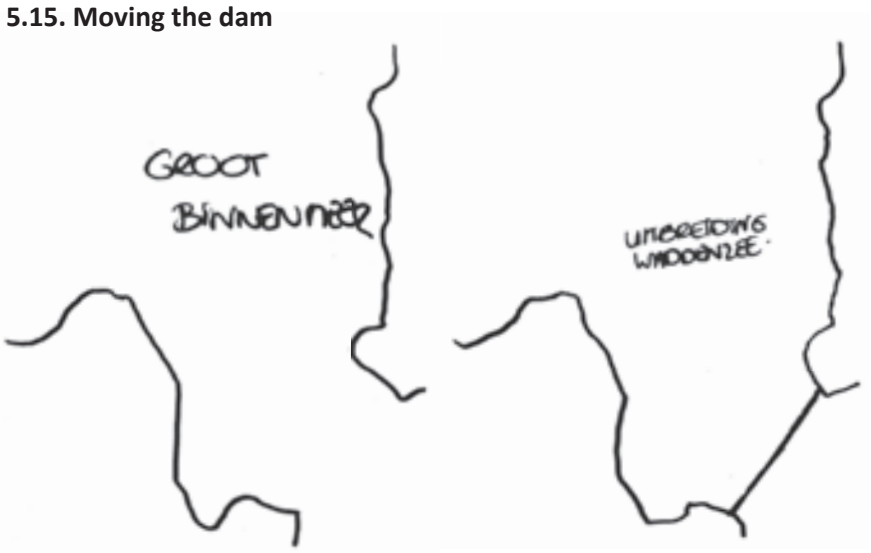
The steps of thoughts are described here:

1. Road energy can be implemented at the moment the asphalt needs renewal.
2. The production of Algae is possible when the site has the right conditions. If it can be implemented depends on the construction and how it looks like.

5.3. Grouping the sketches

As said in paragraph 2.4, safety is importance number one. As the presented ideas make clear, sustainable energy production is a big opportunity for this site. Because of the importance of safety, this aspect is taken as first point of departure. The intuitive sketches are grouped here and combined to three spatial models. This is done with my landscape architectonic vision in mind.
The assessment of the spatial models takes place in chapter 7. One of the spatial models will turn out to be the best one. With the help of the theory about spatial quality and the landscape analysis, the possibilities to implement sustainable energy production will be looked at.

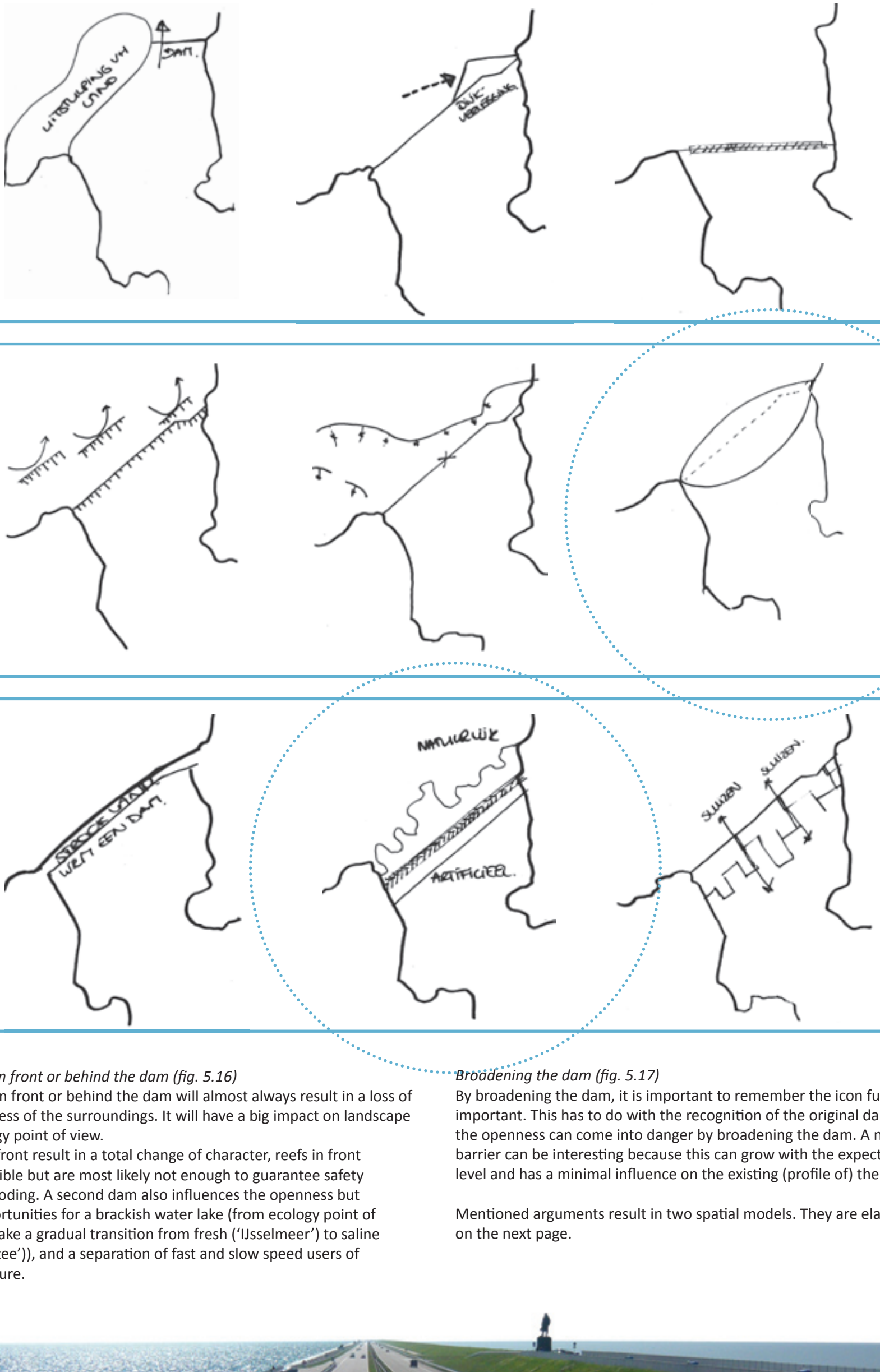
5.15. Moving the dam



5.16. Element(s) in front or behind the dam (loose from the dam)

5.17. Broaden the dam

Moving the dam (fig. 5.15)
Moving the dam to another location is not a good solution. The existing character and identity of the dam will totally disappear. The fresh water reservoir of the 'IJsselmeer' can not be maintained and the coastline becomes longer again, which means a less safe hinterland. The so well known profile, icon and connection will be gone. Additional moving the dam will be very expensive.



Elements in front or behind the dam (fig. 5.16)
Elements in front or behind the dam will almost always result in a loss of the openness of the surroundings. It will have a big impact on landscape and ecology point of view.
Islands in front result in a total change of character, reefs in front are not visible but are most likely not enough to guarantee safety against flooding. A second dam also influences the openness but gives opportunities for a brackish water lake (from ecology point of view, to make a gradual transition from fresh ('IJsselmeer') to saline ('Waddenzee')), and a separation of fast and slow speed users of infrastructure.

Broadening the dam (fig. 5.17)
By broadening the dam, it is important to remember the icon function is important. This has to do with the recognition of the original dam. Also the openness can come into danger by broadening the dam. A natural barrier can be interesting because this can grow with the expected sea level and has a minimal influence on the existing (profile of) the dam.

Mentioned arguments result in two spatial models. They are elaborated on the next page.

5.4. Spatial Models

The inventory of the existing ideas presented during a symposium organized by 'Rijkwaterstaat' on the 14th of 2008 resulted in intuitive sketches. The grouping of these intuitive sketches results in two spatial models focused on safety. This paragraph explains these models, and after the 'design guidelines' (chapter 7) the models will be assessed to come up with the best model.

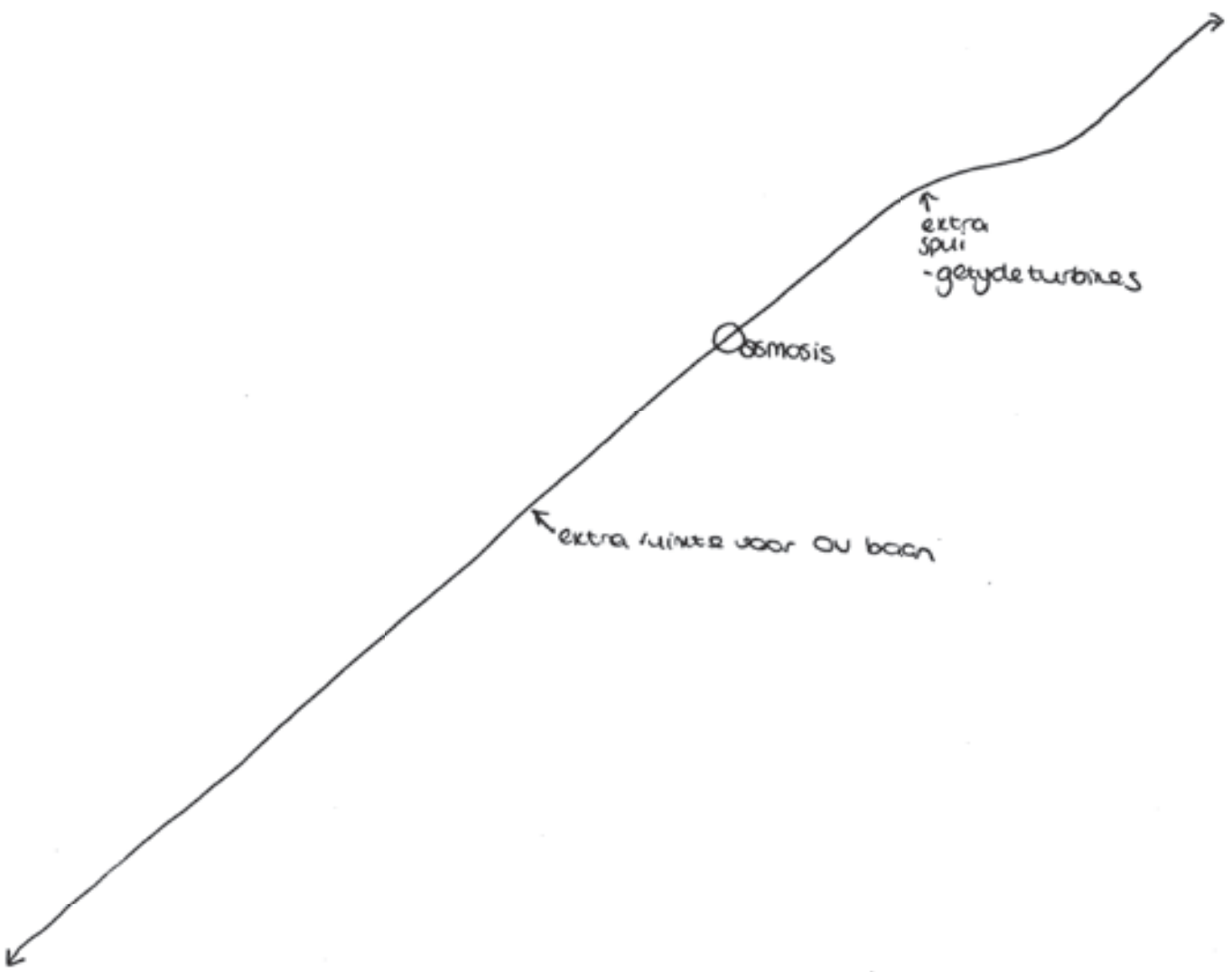
On the last page the intuitive sketches are grouped into: 'Moving the dam', 'Elements in front of the dam', and 'Broadening the dam'. It became clear 'moving the dam' is not an option. What is not mentioned during the symposium is just raising the dam. The model 'Raising the dam' is added to be assessed later on.

Model 1: Raising the dam (fig. 5.19, 5.20)

The dam will be raised with 2,5 meters to protect the hinterland against flooding. The increment of 2,5 meters is chosen because this results in a dam that is ten meters above Average Mean Level, the height of the dam should be according to the 'Wet op de Waterkering' ('Deltahoogte') [Rijkswaterstaat, 2008c -138]. By raising the dam, the dam becomes also broader (fig. 5.18). The profile stays as much as possible the same. By conserving the profile the dam keeps his (historical) character and its icon function is maintained. The disadvantage of this model is that the potentials of the area are not exploited and the spatial quality of the thinness of the line is decreasing.

5.18. Increment on top of the existing profile

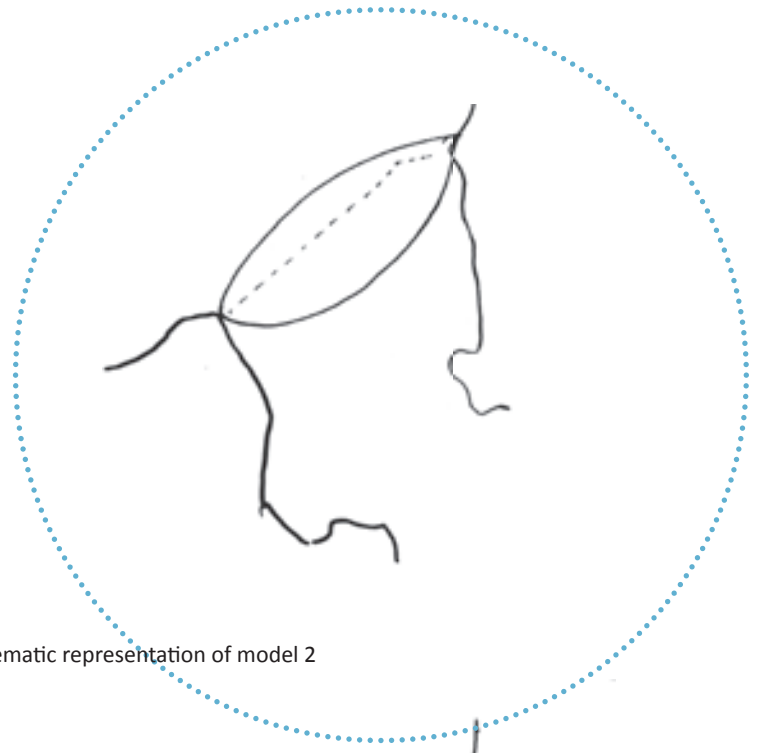
5.19. Schematic representation of model 1.



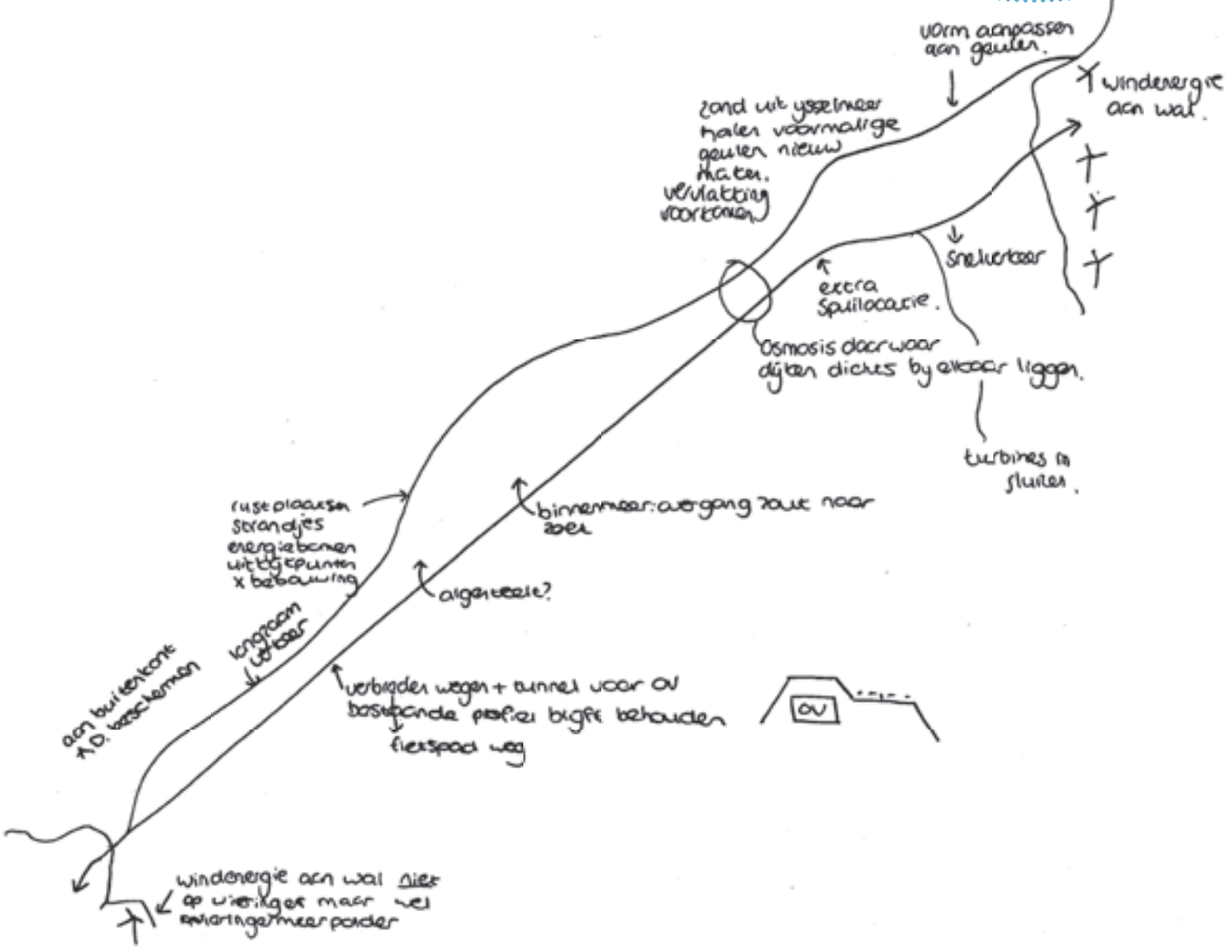
5.20. Model 1: Raising the dam

Model 2: Second dam (fig. 5.22, 5.23)
A second dam situated in the 'Waddenzee' or in the 'IJsselmeer'. This dam protects 'De Afsluitdijk' or 'De Afsluitdijk' protects the new dam (fig. 5.21). A second dam results in a lake in the middle of those two dams. This lake can be used as a brackish water lake to provide a transition from saline ('Waddenzee') to fresh ('Ijsselmeer') so that fish can migrate between their living area and their breeding area again.
The two dams can have their own function. One can be used for fast traffic and the other for slow traffic.

5.21. A second (new) dam in front of the existing dam



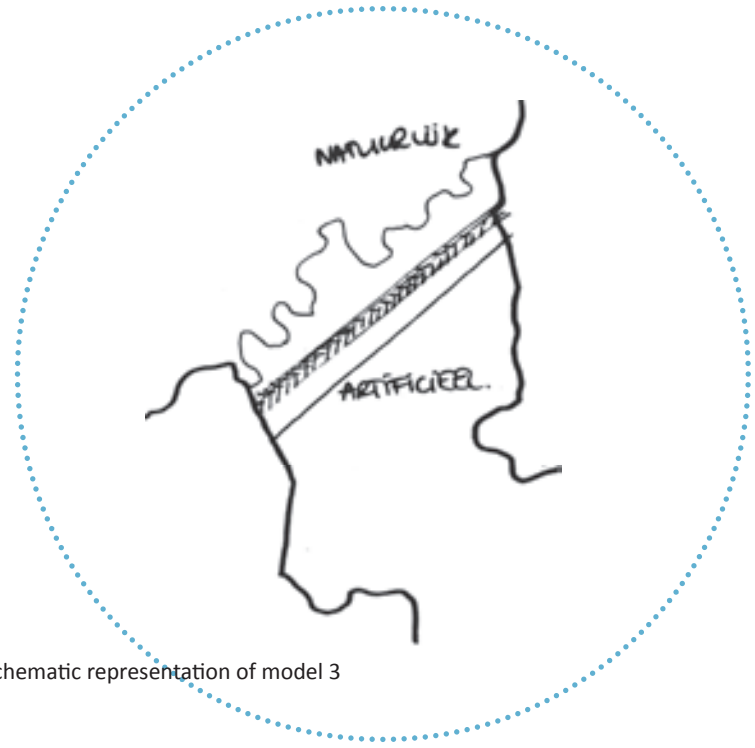
5.22. Schematic representation of model 2



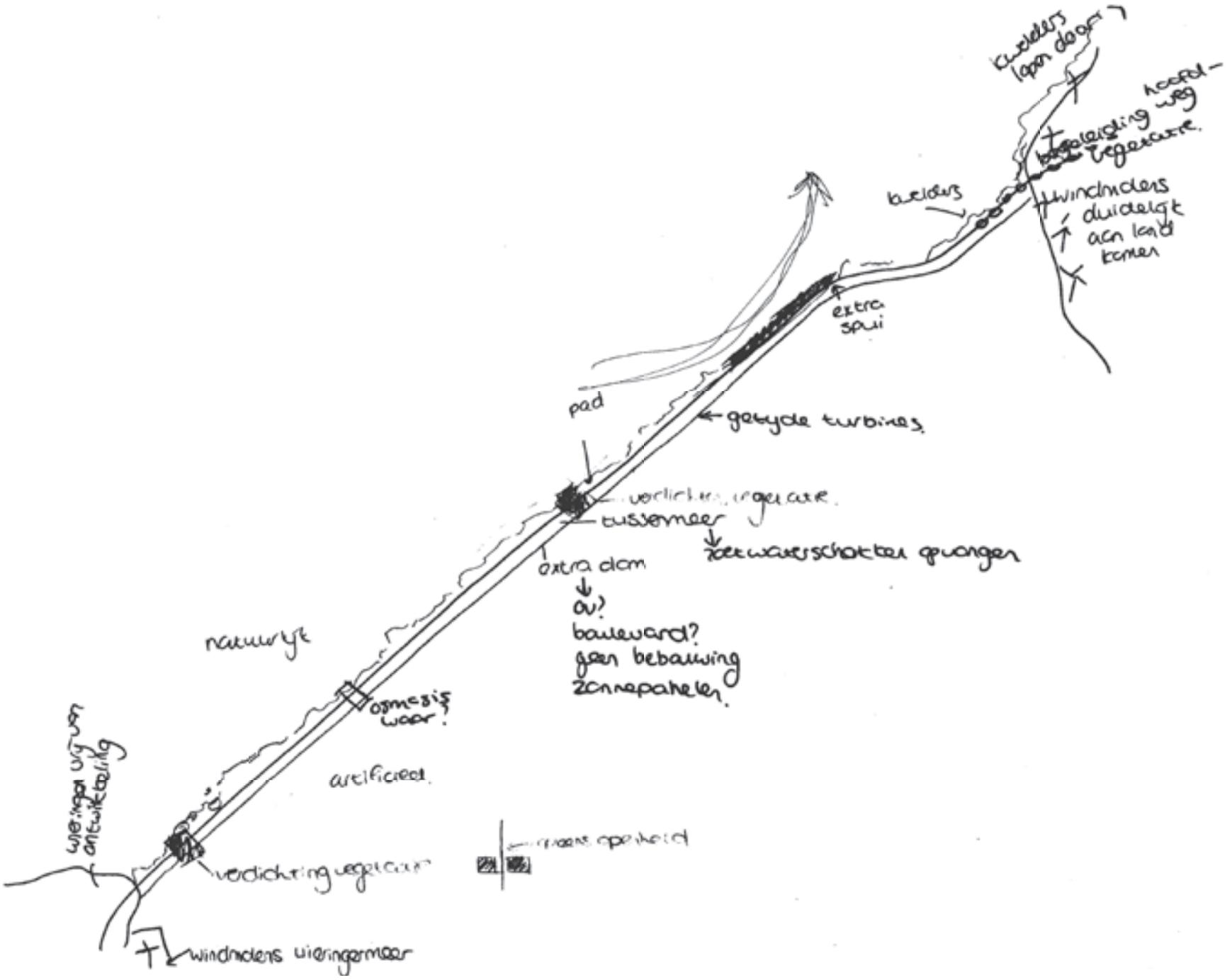
5.23. Model 2: Second dam

Model 3: Natural barrier (fig. 5.25, 5.26)
A natural barrier in de Waddenzee protects the dam against fierceness of waves (fig. 5.24). The advantages are that this natural barrier can grow with the expected sea level rise. Because the climate change is difficult to predict, this would be a nice resilient solution to cope with uncertainties.

5.24. Broadening the dam with a natural barrier



5.25. Schematic representation of model 3



5.26. Model 3: Natural barrier

The next chapter deals with the theoretical framework. Paragraph 7.2 will assess the explained models.

CHAPTER 6

Theoretical Framework

6. Spatial Quality and opportunities of ‘De Afsluitdijk’

The theoretical framework gives background information about landscape theory. These theories are needed to come up with a good design. This chapter deals with the general terminology of landscape, scale, arrangement, spatial quality, and what they mean for ‘De Afsluitdijk’.

6.1. Defining Landscape

'Landscape' is a complex word and it is difficult to formulate a definition that covers all possible angles of view (Vroom 2006). The word landscape can be divided in 'land' and 'scape'. *Land* is according to 'VanDale' a part of the world that is above water (Van Dale Lexicografie bv 2007). But land can also be seen as a territorial entity (Van Dale Lexicografie bv 2007). *Scape* can be translated as shape. The scape is 'what we see, with its meaning, and also with its stories of the past and present, which raise our expectations and emotions' (Vroom 2006) p177. The meaning and image of landscape is different for everybody, depending on age, culture, education, etcetera. This chapter shows a few ways how landscape can be seen.

Landscape is…….

- an area of land that people can see in a wink, a part of a country (Van Dale Lexicografie bv 2007) p195;
- an interaction between human and nature. This interaction is closely connected to the visible landscape elements (Vroom in (Wassink 1999));
- 'a rich source of information about our heritage' (historical geographers) (Vroom 2006) p177;
- 'a theatre, the stage of a multitude of human actions and manifestations' (architect) (Cosgrove 1993) in (Vroom 2006) p177;
- 'a scene of heroic action'(Michelangelo) (Vroom 2006) p178;
- not a scene or ecological entity, but a poetical or cultural entity, changing in the course of history' (Jackson 1984, in (Vroom 2006)) p178.

According to Coeterier (1987) every landscape definition shows (Coeterier 1987):

- The interaction between organism and the not living nature (process);
- The unity of landscape and the relation between elements to form together the whole (structure and pattern);
- The social determination of the landscape by economical and cultural processes.

These points are closely connected to the triplex model (explained later on).

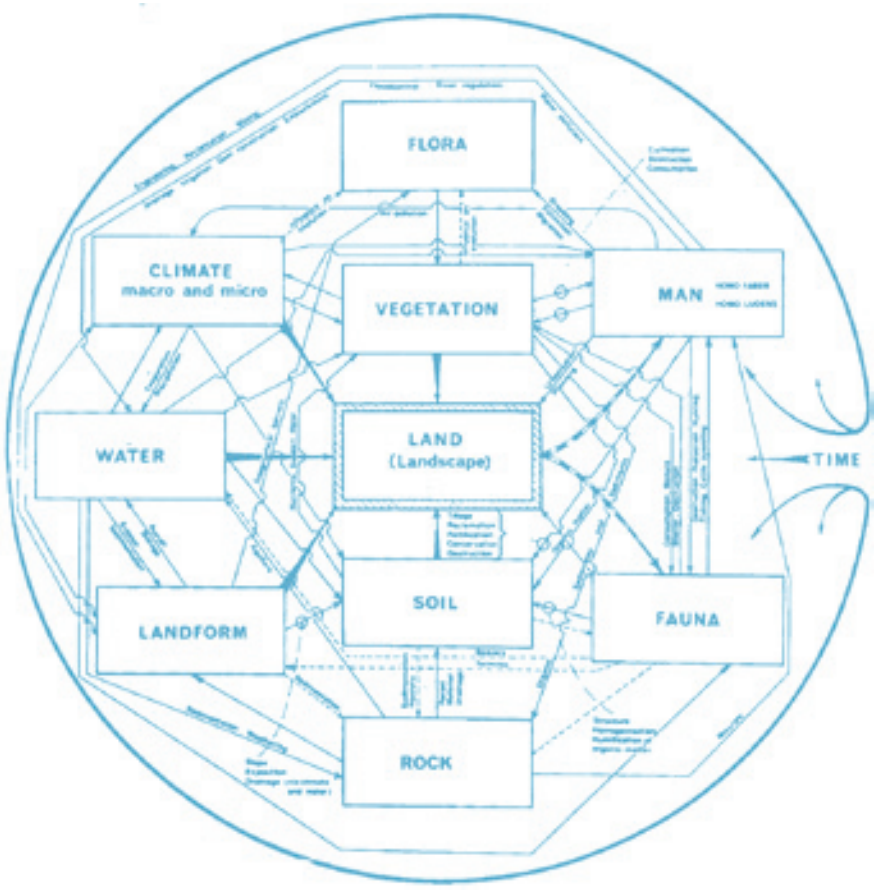
Multiple factors influence the form of the landscape. They also influence each other (fig. 6.1).
According to Kerkstra et al. (1976) the factors, that influence the shape of a landscape, can be classified in three groups (Wassink 1999):

1. A-biotic factors (climate, soil, relief, ground and surface water);
2. Biotic factors (flora, fauna);
3. Anthropogenic factors (human, soil use).

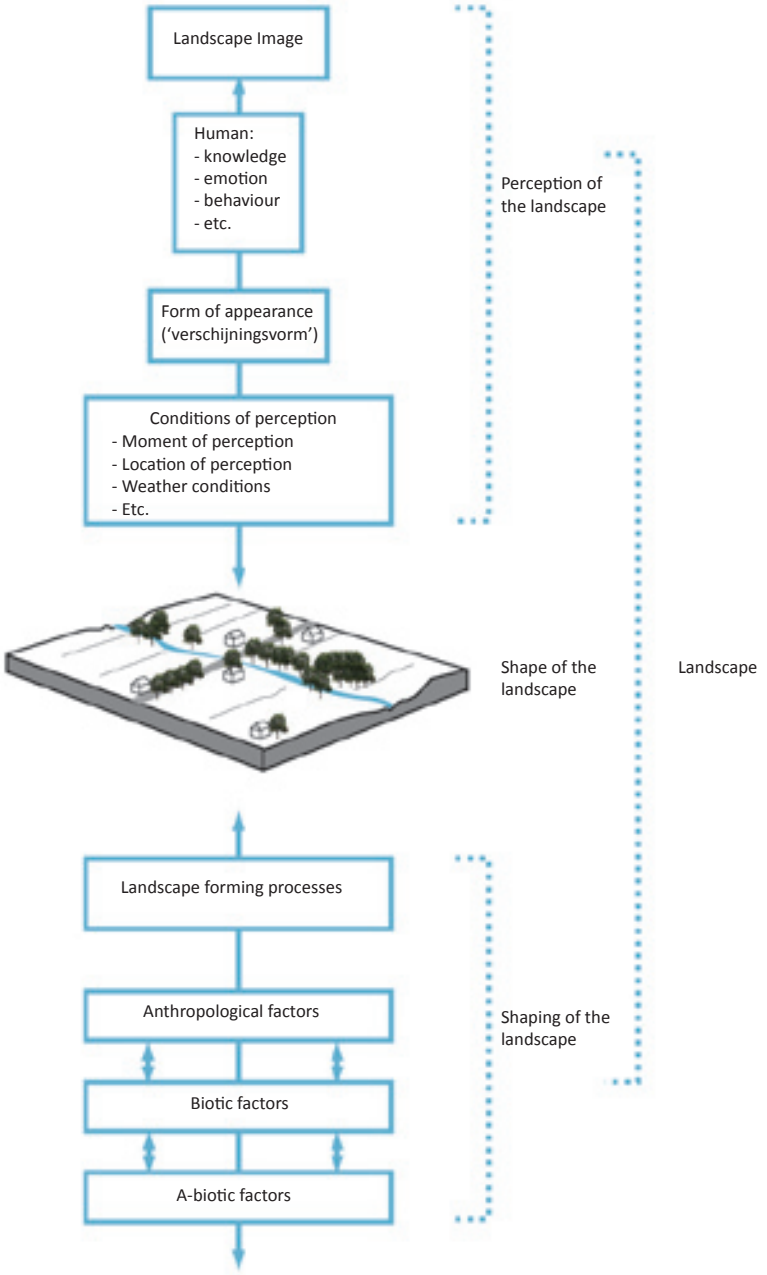
The triplex model (fig. 6.2, 6.3) sees the landscape as the sum of the three groups. The speed of the development is related to the layer. The a-biotic layer can be characterized as static, the anthropogenic layer as dynamic (Wassink 1999). The layer-model divides the landscape in other kinds of layers: field form, networks and volumes (fig. 6.4).

According to Wassink (1999) the shape of the landscape is a result of the perception and the development of the landscape. Analyzing and describing landscapes can happen in different ways (Wassink 1999) (fig. 6.2):

- *Methods focused on the 'Verschijningsvorm'*(the form of appearance) (Wassink 1999)
The perception of a form of an object is depending on multiple conditions: colour, location of the perception, direction of watching, time (in year/day) of perception, meteorological conditions, etcetera. The position of the perceiver is also important. The landscape can be analyzed from a certain (viewer) point, routes and areas (Dijkstra, 1992 in Wassink 1999).



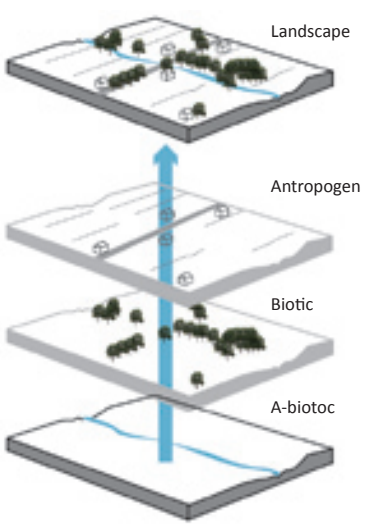
6.1. Landscape forming factors in relation to each other (Zonneveld (1979) in Zonneveld (1984))



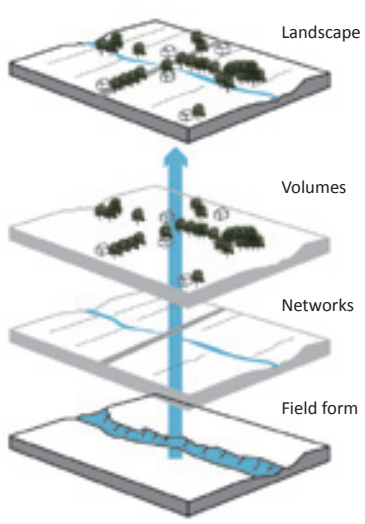
6.2. The shape of the landscape and perception of landscape

Depending on knowledge and experience, all people perceive the landscape in a different way. This influences the way people deal with the landscape, the way they structure it. According to Hoskins (1955) and Barends (2000) the history of culture can be read from the landscape (Vroom 2006).

- Methods focused on the landscape image (Wassink 1999)
The perception and assessment are important. The perception of the landscape is closely related to the visual perception. Humans select certain information depending on knowledge, emotion, behaviour, needs, norms and schemes. The selection of information results in a landscape image (Wassink 1999). Various factors influence the selection, such as the social meaning, function, history, or name. Concentration of a certain use or activity gives a place more meaning in the mind of observers.



6.3. 'Triplex-model'



6.4. Complex vertical relations exists in-between the morphologic layers.

An environmental image can be seen in three components (Lynch 1960):

1. Identity (distinction from other things, recognition as a separable entity which makes it an individual object);
2. Structure (spatial or pattern relation of the object to the observer and to other objects)
3. Meaning (to the observer, practical or emotional)

The elements of a place, which influence the perception of landscape, can be classified into five types (Lynch 1960) p47-48 (fig. 6.6):

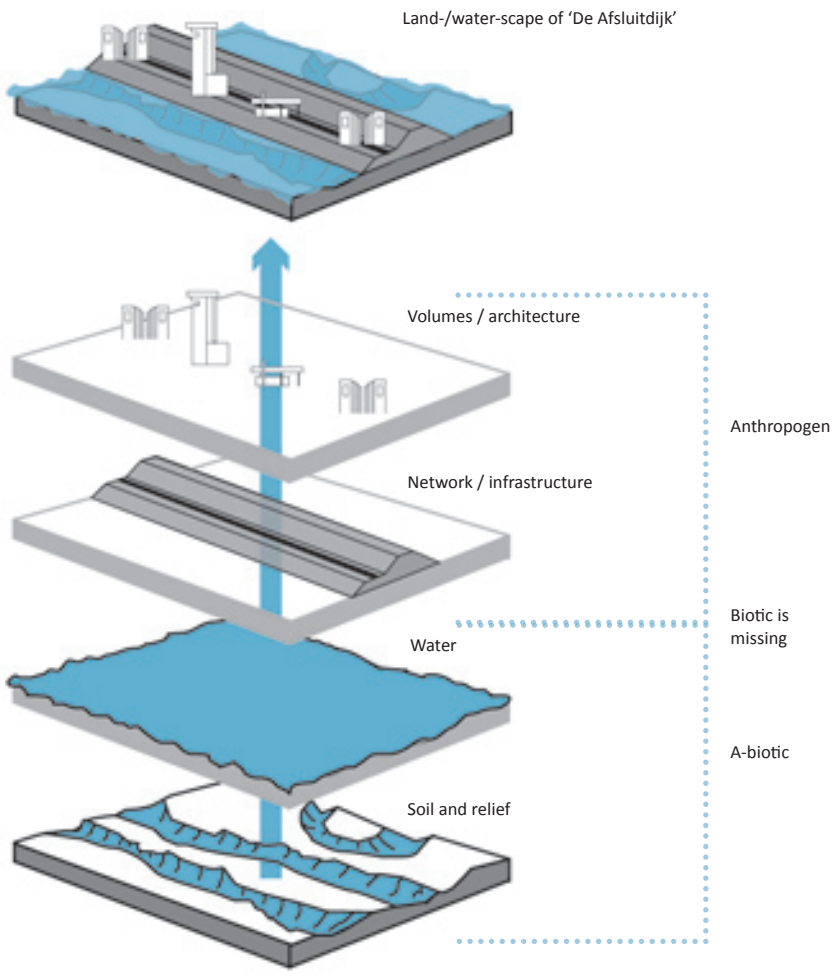
1. Paths: routes the observer takes to move. The route has a big impact on the perception of the environment.
2. Edges: linear objects which separate two or more things from each other. It can also be transparent elements that are experienced as a boundary.
3. Districts: two dimensional areas with a certain identifying character.
4. Nodes: strategic points to shift from one structure to another. Multiple identities can come together here.
5. Landmarks: objects used as reference points. They can be high and visible from far distances (regional scale) or small and different than its surroundings (site scale).

- Methods focused on the form of the landscape
An example is the method of 'landschapsbeeldkartering' of De Veer (1977). The landscape is divided into bigger unities on base of space and mass, soil use, structure, vegetation, buildings and relief.

As read, there is no clear definition of landscape because it is different for every person and also changing in time. Just a certain stage of the development of a landscape can be seen at a certain moment.
The landscape can be perceived by people because they recognize shapes. The appearance of the shape and the image of the landscape are related to the perception of the landscape.
The perception of the landscape happens in the mind of people not by seeing the individual elements, but those elements in relation to each other. How these elements are structured forms a landscape type. Paragraph 6.3 deals with shape, space and order to elaborate on this.

The water-scape of 'De Afsluitdijk'
'De Afsluitdijk' is situated in a typical 'landscape': a water-scape. The landscape of the dam exists of the exceptional places and the places where the dam 'touches' the land. The dam itself can be seen as an artificial, technical construction in a natural water-scape. Water is here, like in the rest of the Netherlands, one of the most important structuring principles for space and environment.
The water-scape of 'De Afsluitdijk' is formed by multiple factors, which also influence each other. The model below (fig. 6.5) shows how the water- and landscape are build up and how the different layers of 'De Afsluitdijk' influence each other. This model is based on the triplex and layer model (fig. 6.2-6.4)

- A-biotic layer: The a-biotic layer exists of the soil, the relief of the 'Zuiderzee' sea bed, and the water. Especially the trenches in the sea bed influenced the design of 'De Afsluitdijk'. It determined the location and the shape of the dam. The water with its water flows and waves resulted in two arches. They were needed to make the construction strong enough against the fierceness of the 'Waddenzee'.
- Biotic layer: The biotic layer is missing on 'De Afsluitdijk'. The biotic layer normally consists of living elements like vegetation. The only vegetation that can be found on the dam is grass and some weeds. Here becomes clear the design of the dam was focused on the functional aspect.



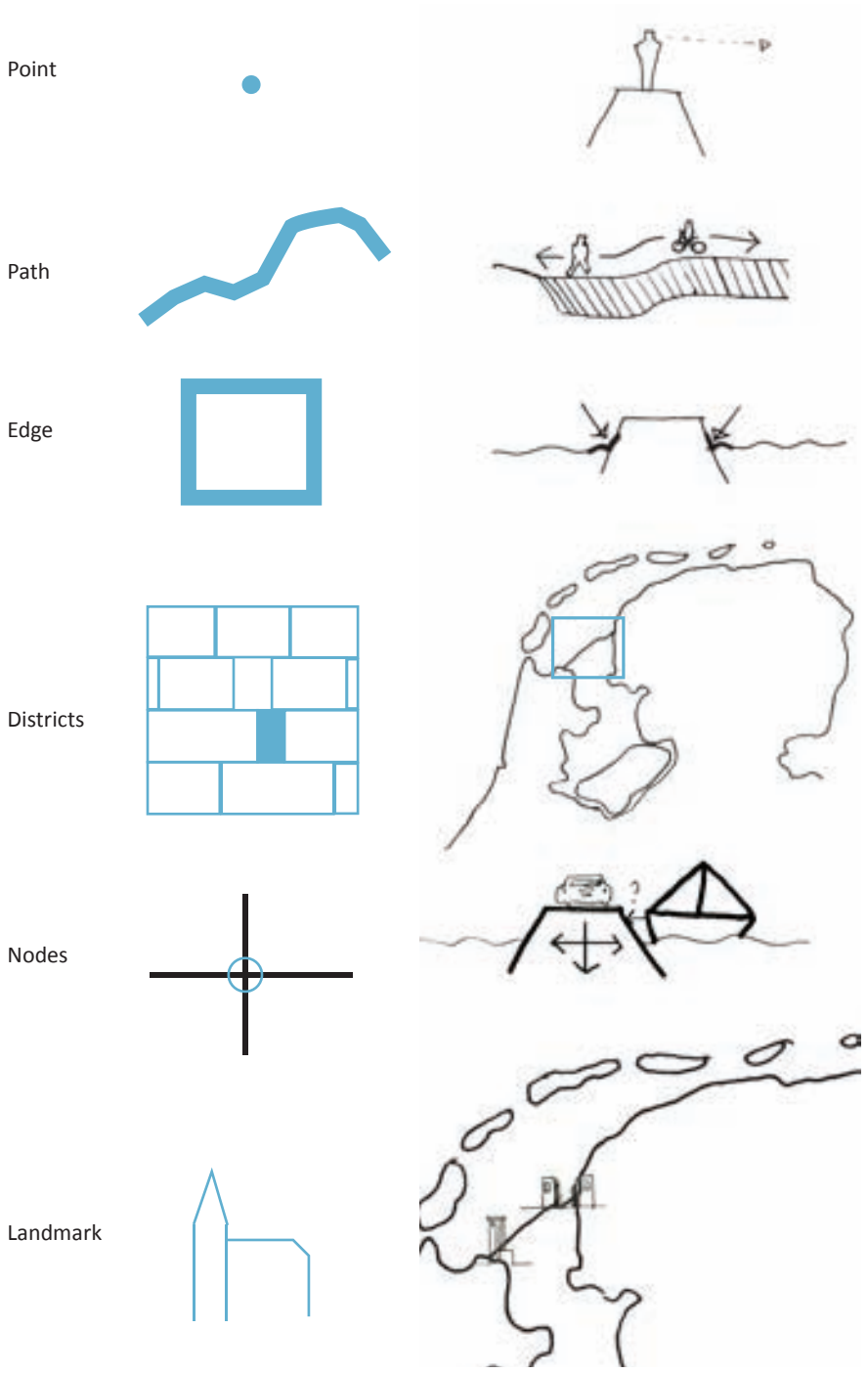
6. 5. The triplex and layer model are used as a base to analyse 'De Afsluitdijk'.

- The anthropogenic (or occupation) layer can be divided into two other layers:
    - Network layer: The network layer of the layer-model can be applied here. The main function of the dam is forming a barrier against water. ‘De Afsluitdijk’ belongs to the network of the European protecting system. The second function of the dam is connecting ‘Noord-Holland’ and ‘Friesland’. Along the dam the highway A7 and a bicycle path are situated.
    - Volume layer: The top-layer consists of architecture. The sluices, the monument, casemates, etcetera.
    - The dam, architecture;

The design of the dam is focused on the functional aspect and was restricted by finance and techniques. Although this base, the water-scape of the ‘Waddenzee’ and ‘Ijsselmeer’ together with the landscape of ‘Noord-Holland’ and ‘Friesland’ are influencing the dam. The total design shows something about the history of the dam and the Dutch culture.

The aspects of Lynch (1960) together with the triplex model give a good overview of ‘De Afsluitdijk’ in the water- and landscape. Lynch (1960) (fig. 6.6):

- Points (architecture, points to rest, standing still);
- Paths (infrastructure, moving along the dam);
- Edges (watersides);
- Districts (the whole afsluitdijk);
- Nodes (the nodes between fairways, vehicles and pedestrians/ cyclists);
- Landmark (‘De Afsluitdijk’ as a whole, the sluices on their own).



6.6. The aspects of Lynch (1960) implemented on ‘De Afsluidijk’

6.2. Arrangement

6.2.1. Order, Proportion, and Scale

'Order' is putting objects in their proper places (Vitruvius M., Morgan M.H. et al. 1960). 'Order refers not simply to geometric regularity, but rather to a condition, in which each part of a whole is properly disposed, with reference to other parts and to its purpose to produce a harmonious arrangement' (p320) (Ching 1996).

'Scale' has to do with the size of something. 'Proportion' says something about the proper relation of objects in comparison to each other or the whole. With the help of proportion a sense of order wants to be accomplished. There are different theories on proportion (Ching 1996):

- Golden section;
- Classical Orders;
- Renaissance Theories;
- Modulor;
- Ken;
- Anthropometry;
- Scale.

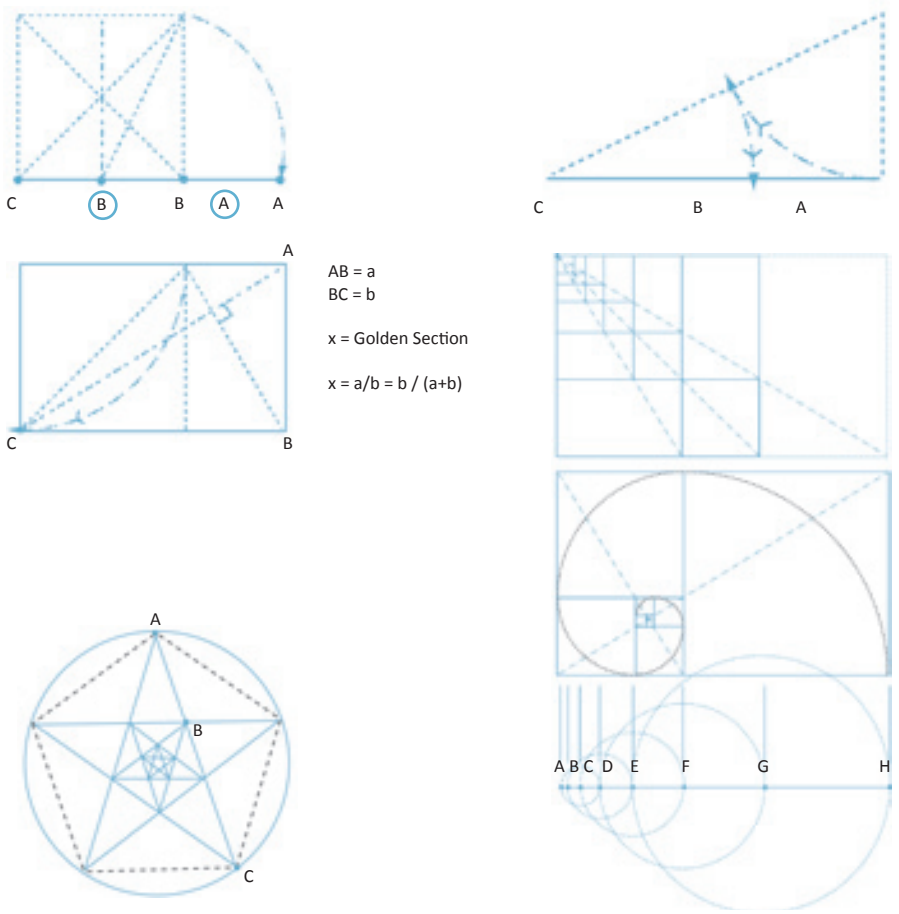
Those theories are about the aesthetic dimensions, not about functions or technical limitations. 'All its parts belong to the same family of proportions' (p.258) (Ching 1996). The result is order and harmony. A few of these proportion theories are elaborated here.

Golden Section (fig. 6.7) (Ching 1996)

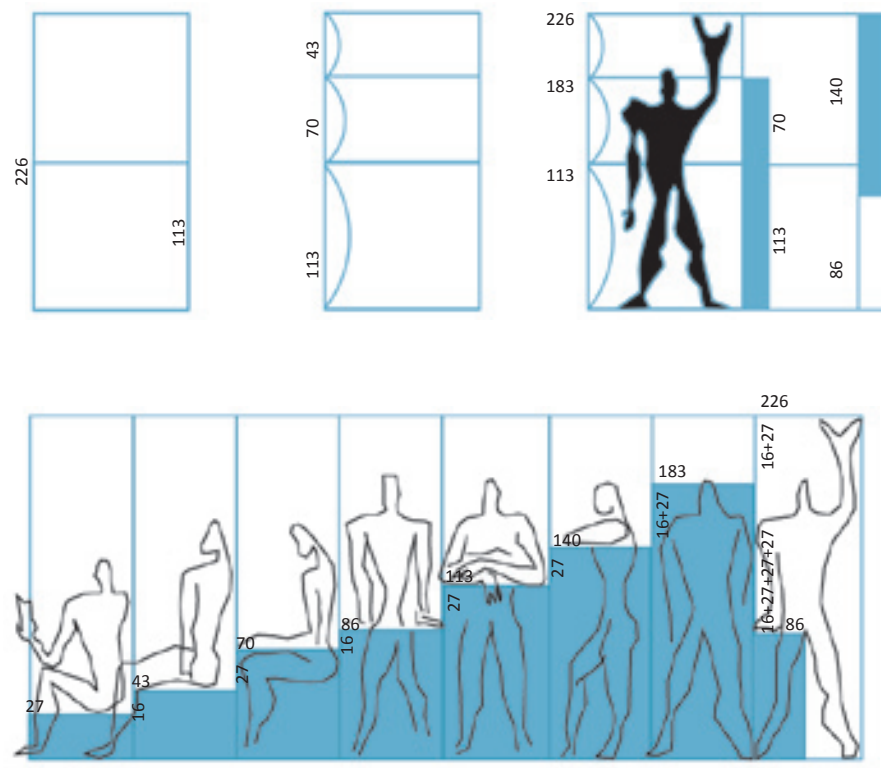
This is a Greek theory with the human proportions as base. It is used in many Greek constructions because the Greek were convinced constructions should belong to a higher universal order. 'The Golden Section can be defined as the ratio between two sections of a line, or the two dimensions of a plane figure, in which the lesser of the two is to the greater as the greater is to the sum of both.' (p286) (Ching 1996).

The Modulor (fig. 6.8) (Ching 1996)

This proportion system is developed by Le Corbusier. This system is based on the mathematic system (Golden Section and Fibonacci Series) together with the proportions of the human body. He saw the Modulor with its numbers as a way to bring the human scale into every construction.



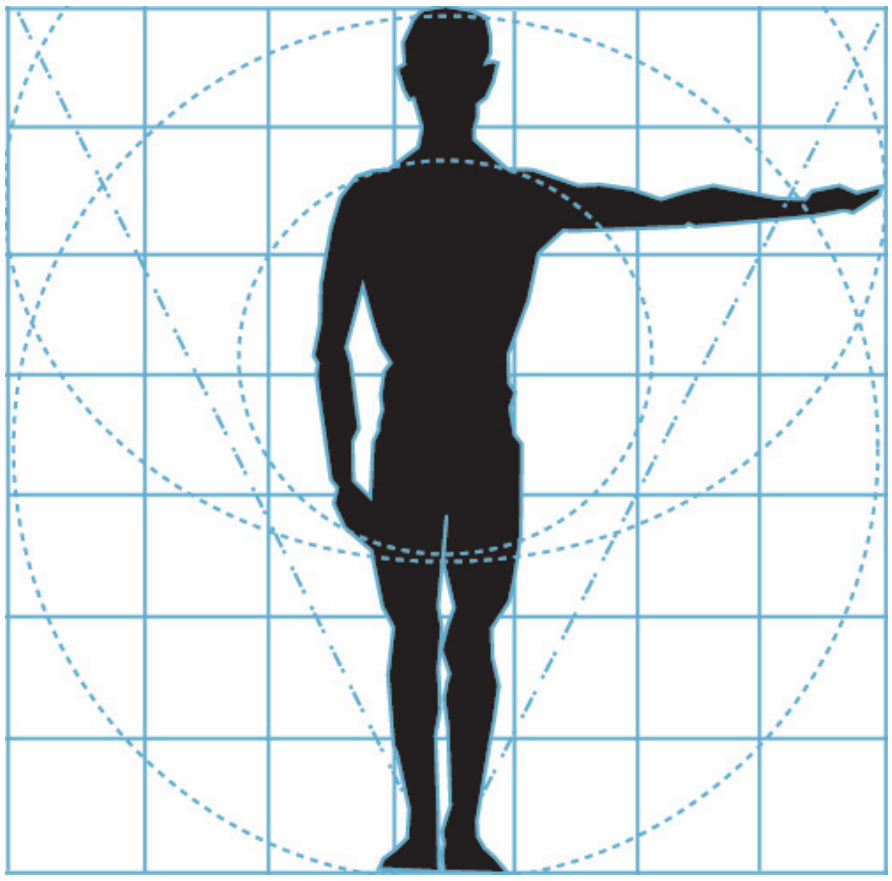
6.7. The diagram shows the additive and geometrical growth pattern based on the Golden Section.

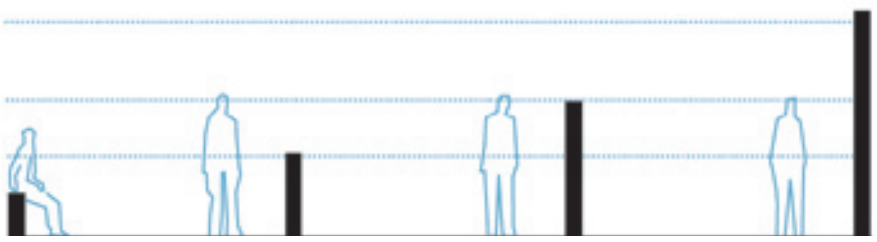


6.8. The Modulor

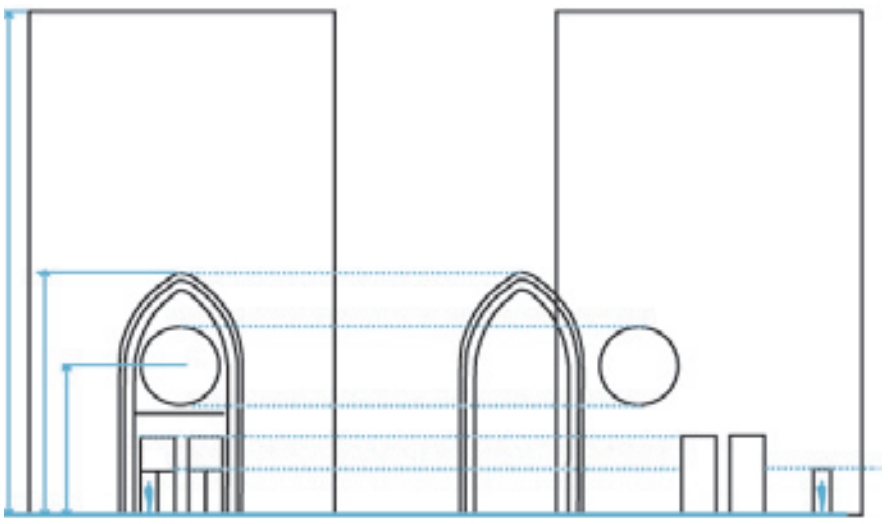
Anthropometry (fig. 6.9) (Ching 1996)
The size and proportions of the human body is used to come up with functional ratios (instead of symbolic ones). The measurements of objects are adapted for the proportions of the user (for example how far he can reach). The user of this theory should be aware of the fact our dimensions vary from individual to individual. This makes this theory not usable as an absolute measuring device.

Visual Scale (fig. 6.10) (Ching 1996)
This theory does not have to do with the object itself that much, but more with the standard sizes and the sizes of other objects standing in the surroundings of the first object.
While something is monumental and huge in scale it makes people feel small. It can give an intimating feeling. The experienced scale is depending on the shape, colour, pattern, boundaries, disposition of its openings, and the nature and scale of elements placed within it.





6.9. The size and proportions of the human body is used to com up with functional ratios



6.10. The size of an elements appears to have a relation to other elements of known to assume the size and scale.

Order, Proportion and Scale of 'De Afsluitdijk'
'Order without diversity can result in monotony or boredom; diversity without order can produce chaos'. 'A sense of unity with variety is the ideal' (p.320) (Ching 1996).
'De Afsluitdijk' can be seen as an object that has a monotonous character, but is for most people not boring. People move along the dam and see it as a beaded string (fig. 6.11): a straight line with some exceptional points connected to it. This gives the dam a clear order and makes the area clear and readable.

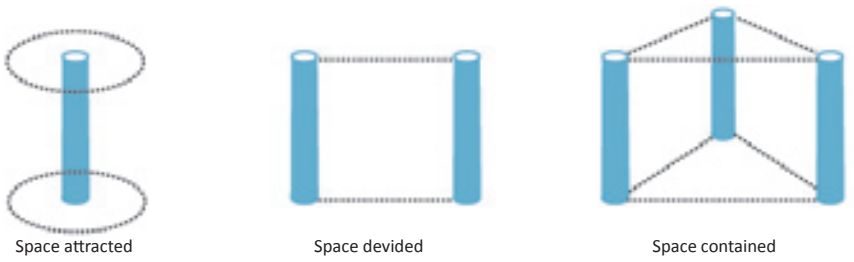
Scale has mainly to do with the size of something else. Figure 6.14 shows the comparison of 'De Afsluitdijk' with other dams and dikes at the same scale. 'De Afsluitdijk' is very thin and very straight in comparison to the other dams/bridges. This makes 'De Afsluitdijk' unique in its kind. The dam itself is about 32 kilometers long. It is a long dam, but in perception the dam is even longer because of the ratio length-broadness: 3200 m long / 90 m broad. Next to this the huge amount of water, which is surrounding the dam, is influencing the scale. This makes the dam thin, almost not there.
A person is, and feels very small when standing on the dam, because people always compare the scale of elements with their own body. The theories elaborated above, do the same, but most of the theories are seeking after the sublime. People of everyday life compare the proportion of the body just to have an idea how big something is.

6.2.2. Shape and Space
The openness and scale of 'De Afsluitdijk' has important (historical) spatial value. The perception has to do with comparison, relations and ratios. To respect the qualities of the site, knowledge about these aspects are important (Rijkswaterstaat 2008b). Not only to understand the existing but also to be able to add new elements in a right way.
The theory of Wassink (1999) compares the theory about space of Thiel (1961), Curdes (1993), and McCluskey (1985) in one table and concludes they are closely connected. This paragraph explains the theories of Thiel, Curdes, McCluskey, and Wassink.

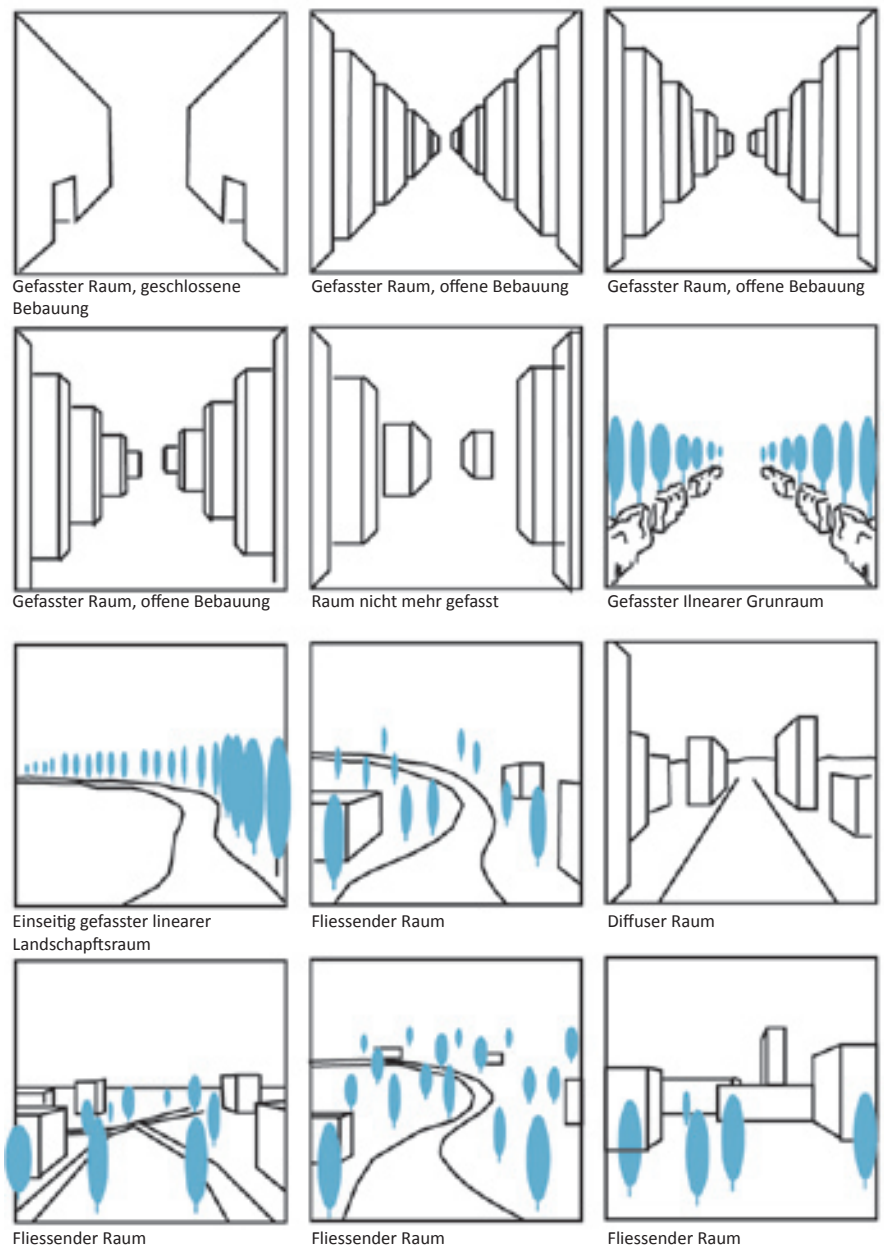
McCluskey (1985) uses three types of spaces (fig. 6.12):
- Space attracted (vertical objects mark out a space)
- Space divided (Two vertical objects, depending on distance, imply a plane what divides the space)
- Space contained (more than two vertical elements result in an outwards and inwards space)

Additional he characterizes: dynamic and static space.

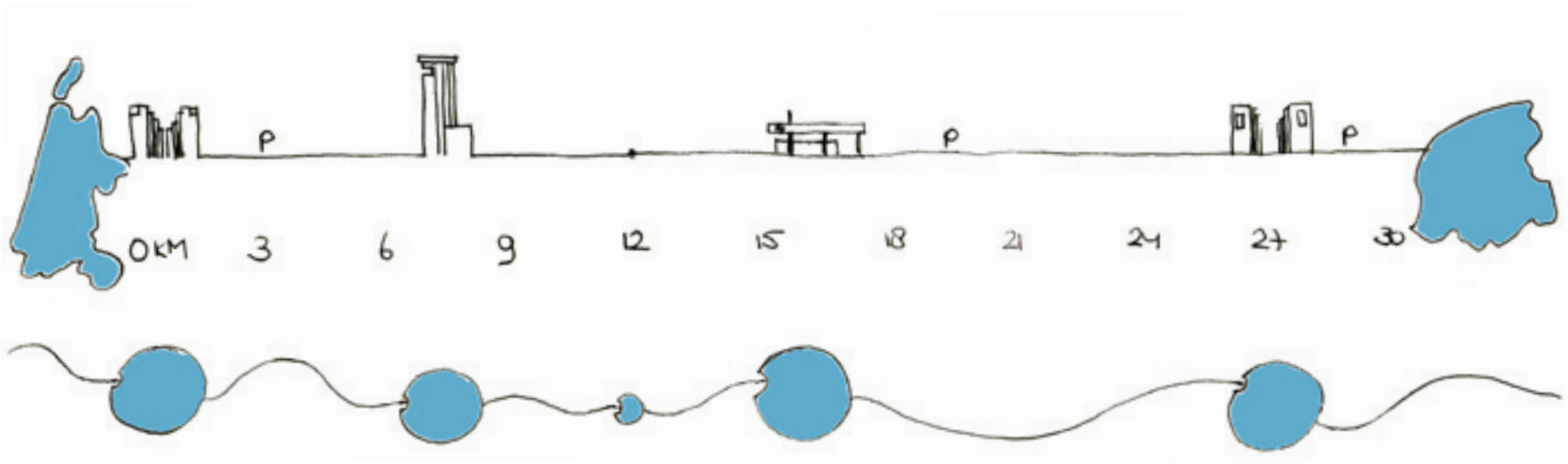
Curdes (1993) uses three types of spaces (fig. 6.13):
- Gefaβter Raum (limited space)
- Flieβender Raum (transition from Gefaβter to Diffuser Raums)
- Diffuser Raum (unlimited space)



6.12. McCluskey's three types of spaces: attracted, divided, and contained



6. 13. Three types of spaces by Curdes (1993)



6.11. 'De Afsluitdijk' as a beaded string

6.14. ‘De Afsluitdijk’ compared with other bridges and dams in the Netherlands (Deltawerken, Houtribdijk) and World (Golden Gate Bridge, San Francisco) at the same scale

According to Wassink (1999) there are two methods to see the shape of the landscape:

1. Method of the space forming elements
Shape exists of mass and is limited by space. The landscape can be analyzed by looking at the spread of landscape elements in space. This results in maps of various patterns. Landscape elements can be divided in:

- Dots (solitars, houses, etc.)
- Lines (roads, water ways, etc.)
- Planes (forests, cities, etc.)

The landscape can be divided in 3 morphologic layers (Wassink 1999):

- Site forms (basic layer, spatial result of a-biotic processes)
- Networks (landscape elements without heights and with a linear character)
- Volumes (landscape elements characterized by height and mass)

The three layers together form the landscape. Every layer has its own characteristics. In-between the layers exists complex relations.

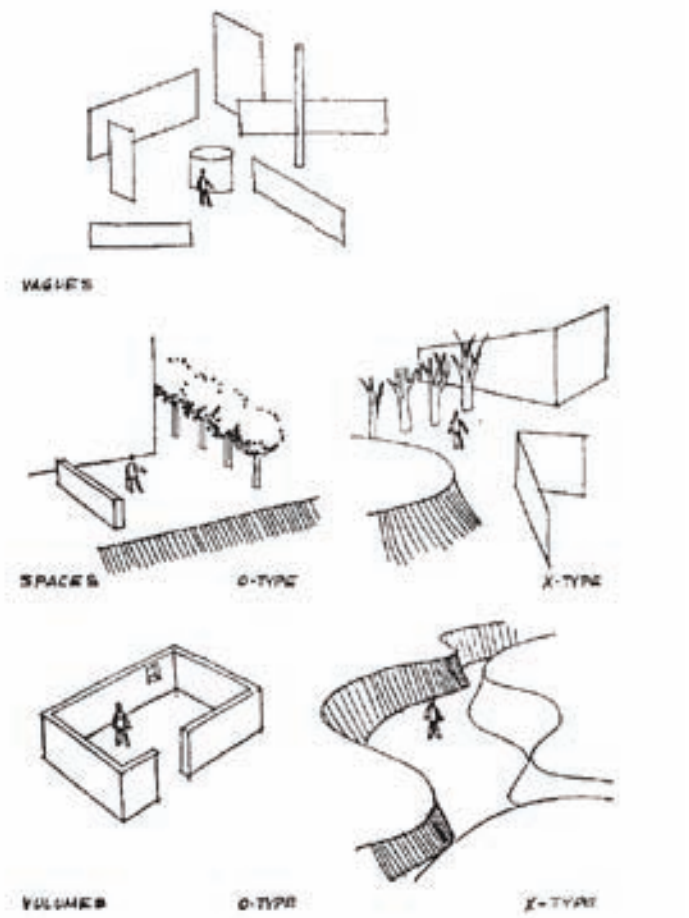
2. Method of the formed space
Shape is defined by space and limited by mass. This method is analyzing the landscape by taking the space formed by landscape elements as a base. The shape and measurement of space together with the limitation play a part in this method.
Thiel (1961) uses three types of spaces (fig. 6.15):

- Volumes (enclosed on all sides)
- Vagues (individual volumes spread at random in a continuous space)
- Spaces (transition from volumes to vagues)

Additional he characterizes: O-types (inward objects) and X-types(outwards objects).

According to Wassink (1999) the three types of Thiel, McCluskey and Curdes are closely connected. A comparison results in five space types (fig. 6.16, 6.17):

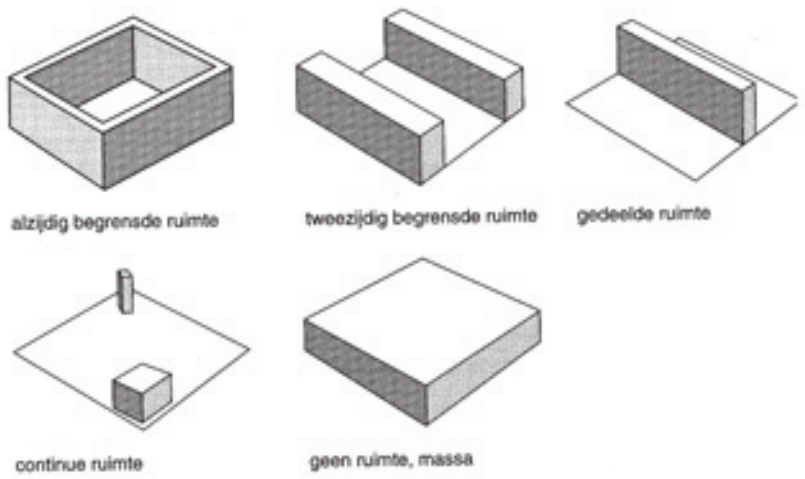
- space limited on all sides
- space limited on two sides
- separated spaces
- continuous spaces
- no space but mass



6.15. Volumes, spaces and vagues. (Thiel, 1961)

Thiel	McCluskey	Curdes
Volumes	Space contained	Gefaβter Raum
Vagues	Space attracted	Diffuser Raum
Vagues	Space divided	
x-type	Dynamic space	Gefaβter Raum Flieβender Raum
o-type	Static space	

6.16. Comparison Thiel, McCluskey and Curdes way of looking at space (Wassink 1999)



6.17. The relation between Thiel, McCluskey and Curdes by Wassink (1999)

Shape and Space of ‘De Afsluitdijk’

The shape of ‘De Afsluitdijk’ can be characterized as a straight, thin line going through a huge amount of water. The space (water) is formed by the borders of the land, but because the water covers such a big surface the borders are not visible from the dam, that is why the space seems eternal. The openness of the surrounding water is unique in The Netherlands. The open-horizon-map (fig. 6.18) shows the openness of the water is very rare. Rare aspects are mostly seen as aspects that have quality and should be maintained.

The location of the dam is a result of its function, technical and financial restrictions. The shape is a result of knowledge about water, dike enforcement, and wind flows. These reasons resulted in a construction that is very basic and functional with a shape that is easy to understand and to read. Also the constructions on top of ‘De Afsluitdijk’, designed by Dudok and Roosenburg in the style ‘Nieuwe Zakelijkheid’, are easy to understand.

The straight shape of the dam shows its main function; to protect the hinterland against flooding. The a-biotic layer (deep trenches) influenced the design, resulting in an arch in the straight line.

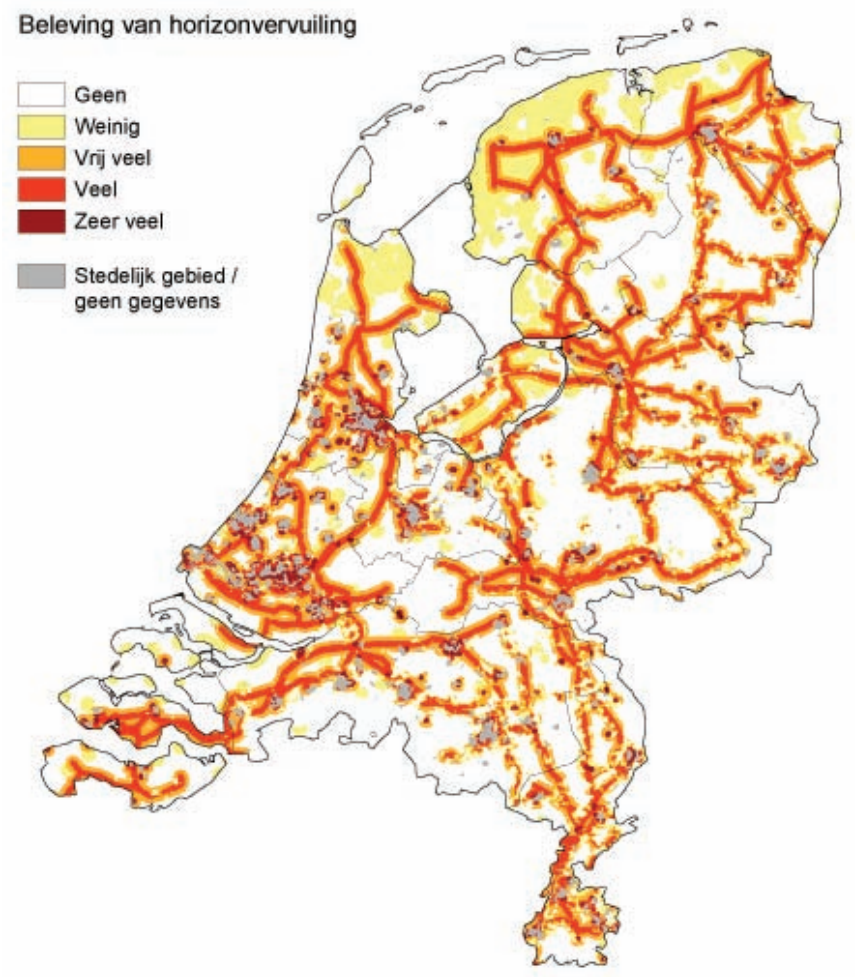
‘De Afsluitdijk’ can be seen as an object that is outwards (X-type of Thiel, 1961). The dam itself is an element and people are moving along it. People look from their position on top of the dam along the dam and over the water.

According to the method of McCluskey (1985) ‘De Afsluitdijk’ is a space dividing object. The dam divides the space of the water in two parts, but because the water is of such a big scale and the dam is such a thin line, it does not feel like a clear separation. The dividing effect has to do with the position of the viewer. When the position of the viewer is on top of the dam, the dam will not be seen as a dividing object. When the viewer is standing on the waterside, next to the dam, the dam will be seen as an wall and divides the space into two parts (fig. 6.19).

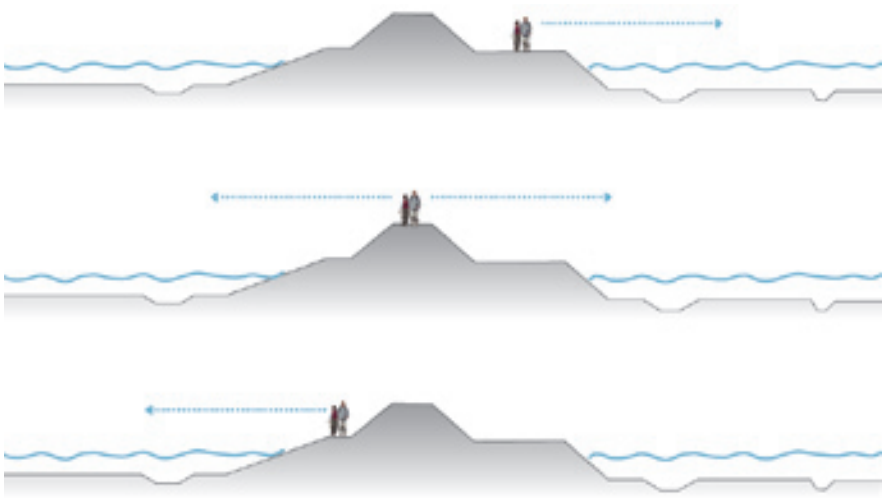
Although the dam is an X-type (Thiel), the space is very static. The borders are not changing that much because of the human fight against the sea with dikes. In contrast the ‘Waddenzee’ is dynamic because of its tidal character. Certain areas of the ‘Waddenzee’ dry up and divide the space into sub-spaces that make the space contained (McCluskey).

The nearby space of ‘De Afsluitdijk’ can be characterized as static (McCluskey). The space can also be characterized as a ‘Diffuser Raum’ (Curdes) because it is an unlimited space.

To summarize: ‘De Afsluitdijk’ lies in a static, diffuser, contained space. The dam itself can be characterized as a massive, static, space dividing object which is outwards. Depending on the position of the viewer the dam is dividing the space into two or not. The surrounding space, together with the dam itself, are a unity what gives quality to the area of the dam.



6.18. The ‘Open-horizon-disturbance-map’ shows the openness near ‘De Afsluitdijk’ is unique in ‘The Netherlands’



6.19. The position of the viewer is important for the perception of the landscape.

6.3. Spatial Quality

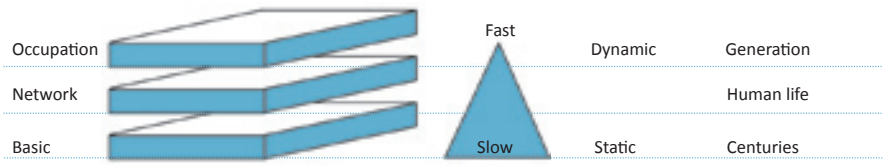
'Do not touch De Afsluitdijk' (NRC handelsblad 2008)
'De Afsluitdijk should stay the same as much as possible'
(Algemeen Dagblad 2008)
De Afsluitdijk is beautiful (Mb90 2008)

This positive character of the dam has different reasons. Why do people characterize the dam as beautiful? Why do they think the dam is so important that it should be conserved? For a designer it is important to know what the spatial quality of the site is, to be able to make, as said in the research question, a design that enhances the existing qualities. 'Spatial quality' is a definition that is widely used by many people. Everybody agrees that spatial quality is important. But how to define spatial quality is not clear. To be able to use 'spatial quality' as an instrument to design 'De Afsluitdijk', elaboration is needed.

Spatial quality is not for everybody the same, everyone describes and perceives it in its own way. There is no general definition or standard that can be used to describe spatial quality. Even if people agree on the importance of a certain aspect, the concrete translation can be different (Habiforum and Dauveliers Planadvies 2005).
According to Werksma (2003) spatial quality is accomplished when social and spatial components intensify each other. The social component can be characterized as a high dynamic society in which the meaning of time and space move all the time. The spatial component can be characterized as a layer model that explains time and space in three sections:

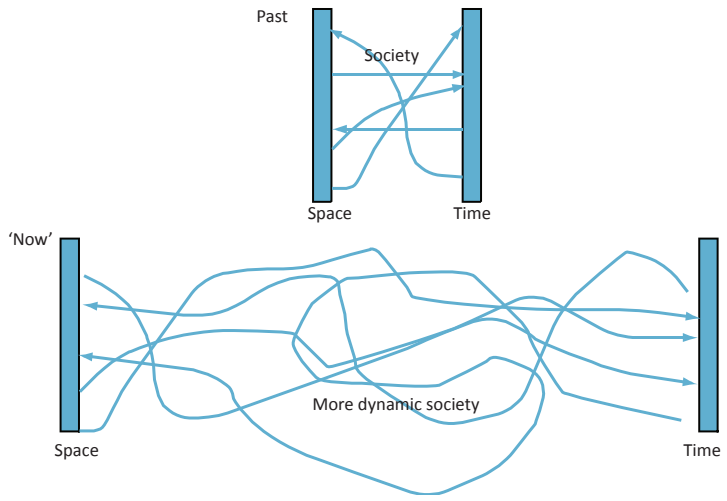
- The basic layer;
- The network layer;
- The occupation layer.

Every layer is changing, but all of them in another speed (fig. 6.20). The first layer is changing the slowest and the third layer the fastest. The effects of a change in the basic layer can become visible after many years because of the slow dynamics of the underground processes.



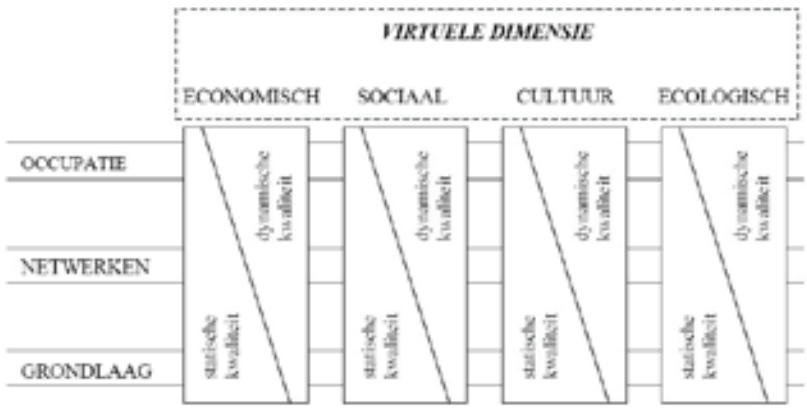
6.20. The layers are changing in different speeds

By taking the layers into account, a design becomes sustainable in a spatial way. Werkstra (2003) establishes static and dynamic qualities come into being when the social component and the layer approach strengthen each other. When connecting spatial quality to the Layer Approach it becomes clear that the changing speed of each layer influences the connection between them (Werksma 2003).
The society is not restricted to a small variation of space and time. The borders are moving outwards in time (fig. 6.21). That is why the society is becoming more dynamic in time. The meaning of space and time are depending on the borders of the society. The dynamic society is a result of the acceleration of developments (time) and an extension of the playing field (space). Everything has to be faster, better and more integral. The preference of the consumer is changing fast and the lifespan of products is small (Werksma 2003).
Jacobs (2000) poses in Hooimeijer (2001) that needs can be determined on different scale levels. The needs on higher levels determine the needs on a lower level. How lower the level how better understandable and readable. Additionally to this, the range of needs is smaller and the amount of knowledge increases when we go to a lower level. Areas can be observed on different scale, but on every level it can have a different



6.21. A society not restricted to small variation of space and time become borders are moving outwards

meaning or value. System characteristics like cohesion, variation and sustainability can be determined on every level.
In 1900 five million people lived in the Netherlands, in 2008 sixteen million. The Dutch citizen has no physical borders anymore and is part of a network society. Economical factors, like globalization, are the forces behind developments. The activities of companies and people are changing. This has consequences for the spatial settings of the Netherlands. A design is not able to catch up with the dynamics of a society, that is why a design should be flexible (Werksma 2003).
Planning of space is planning physical environment in relation to the social process. When they strengthen each other spatial quality is gained. Spatial quality is not an individual element, but it is closely related to social assessment processes. These assessment processes are changing in time and depend on the people who are involved. The assessment is depending on the vision of people about functionality and the perception of space. This makes spatial quality for every area different and closely related to the local situation (space), the moment (time) and the local standards (culture) (Werksma 2003). To make spatial quality ready for use a matrix is made (Werksma 2003). It makes the confrontation between the social and spatial component clearer. The matrix is based on the matrix of Hooimeijer (2001). (fig. 6.22.)



6.22. Static and dynamic qualities. This table shows the confrontation between the social and spataial component, but also the distinction between the amounts of dynamics in every layer. (Werksma 2003)

The ‘Nota Ruimte’ (2001) and Hooimeijer (2001) divide spatial quality in three categories (fig. 6.23):

- ‘User values’; the user value is high when people can use the area in a safe way and many functions can be integrated. Further, ‘user values’ is about adequacy, efficient use, efficient construction, efficient maintenance, coherence, accessibility and interference;
- ‘Perception values’; the perception value has to do with the experience of the surroundings, about scale and proportions, about identity and if the landscape is readable (recognizable). Spatial variation (diversity) and usefulness also belong to this category;
- ‘Future values’; the future value is about sustainability, biodiversity, robustness, flexibility, navigation effect, efficiency in time, possibility to expand and adaptation.

	Economical interests	**Social interests**	**Ecological interests**	**Cultural interests**
User value	Allocation-efficiency Approachability External effects Multi-purpose	Accessibility Distribution Participation / Involvement Choice	Safety Nuisance Dry out	Freedom of choice Diversity /variation Meeting
Perception value	Image Attraction (recreation)	Disparity / difference Sense of belonging / alliance Safety	Escape Natural	Singularity / exclusive character Beauty Contrast
Future value	Stability / flexibility Agglomeration Cumulative attraction	Surrounding / enclosure Cultures of poverty	Availability / potential of the landscape Eco-systems	Cultural heritage Integration Renewal / innovation

6.23. Spatial quality divided in three values

These categories resulted from the notions diversity, coherence and sustainability. According to Dauvellier (2000) in Hooimeijer (2001) those notions are closely related to the fundamental system notions of spatial arrangements: pattern, structure and process. These notions get meaning when they are connected to actions (form, function, time) and design (composition, integration and development). Social assessment made it possible to use these notions for discussion. This is resulted in the notions user value, perception value and future value. These values are connected to Vitruvius (60 B.C.) (Hooimeijer P., Kroon H. et al. 2001). The terms of Vitruvius’ ‘Utilitas’ (effectivity), ‘Venustas’ (beauty), and ‘Firmitas’ (sustainability) are used as a base to determine quality. These terms are converted to user value, perception value, and future value. Next to this the terms spatial diversity, economical and social functionality, cultural diversity, social justice, sustainability, attraction and human scale are used (Vroom 2006).
The study of Hooimeijer (2001) shows a way to design spatial quality. Clarifying of the term spatial quality is done by putting the notions user value, perception value and future value in a matrix together with economical, social, ecological and cultural interests. Hooimeijer (2001) emphasizes the matrix can be used as a flexible method to analyze spatial quality, but is not ‘the only truth’ (p7). The Matrix of Werksma (2003) based on Hooimeijer makes the confrontation between the social and spatial component clearer. The area in the table of ‘Perception’ in comparison to ‘Ecology’ and ‘Culture’ is the most important for a landscape architect. The area of ‘Ecology’ and ‘Social’ is used to check if the design is realistic. ‘Economical’ interest is in this thesis least important in comparison to the other interests, because the design is made from a landscape point of view.

Another way to deal with spatial quality is the division in dynamic and static quality. The spatial quality is depending on the balance between the static and dynamic qualities (Vroom 2006). The characteristics of dynamic quality are new, surprising and energetic. This kind of quality is not sustainable because new fashion, weariness and consumption result in the need for new things. The characteristics of static quality are in strong relation with the sustainable, the elements where people are used to, and the elements that are missed when they are gone (Vroom 2006). Pirsig says in Werkstra (2003) static quality is based on established values and develops to dynamic quality. Dynamic quality is liberation of the standard values and renewal of those values. To realize dynamic quality an open attitude to the future is needed and the variation in choice should be big.
According to Sijmonds (1990) in Vroom (2006) landscape architecture is working towards a design which can cope with dynamics within a sustainable, static frame work.
The terms static and dynamic qualities of Pirsig (1999) show in a clear way the problem of the term spatial quality. Phaedrus does in Pirsig (1999) an experiment. He reads four students reports aloud to students. After this, he gives them the assignment to order the student reports in quality. He also did this himself and all orders were comparable. The opinion of the students and him were almost the same. It was for the students and him clear what quality was, but they could not define it. Pirsig (1999) says in Werkstra (2003) quality is ‘a characteristic of thoughts and a judgment what is recognized by a thoughtless process. Because definitions are products of rigid, formal thinking, quality can not be defined’ (in Werkstra (2003,p 6)).
Pirsig pleads for a balance between static and dynamic quality to verify development. There should be an interaction because static quality without the dynamic quality leading to decline of the existing values. Dynamic quality without static quality results in chaotic regress. The balance always has to recover itself (fig. 6.24). Every social element (economical, social, cultural and ecological) has a static and dynamic side. This makes clear there is a distinction between the amounts of dynamics in every layer (fig. 6.22). At the places where the basic layer has no dynamic quality, the occupation layer has many dynamic qualities. The dynamics of a certain layer is the result of the balance between static and dynamic quality.

6.24. A balance between dynamic and static quality

Jacobs (2002) agrees with Werkstra that the society is dynamic in opinion, knowledge, etc. Spatial quality is not static, quality gets meaning in social processes. That is why the definition of quality is dynamic. To describe this dynamic, theories about changing social processes are needed (Assche van and Jacobs 2002). Quality is something that is right, what is good and defined inside a reality domain, a discourse. According to Bilton (1996) a discourse is ‘a body of ideas, concepts and beliefs which become established as knowledge or as an accepted world view. These ideas become a powerful framework for understanding and action in social life’ (p69) (Assche van and Jacobs 2002). According to Assche (2003) in Vroom (2006) the qualities of a landscape are not an intrinsic part of the landscape, but it comes into being because people give certain meanings, depending on the perception of the world.

Assche and Jacobs (2002) conclude spatial quality is:

- Dynamic; something that was ugly in the past can be beautiful now;
- Can be ascribed by chance; a space is interesting because you experienced something at that spot;
- Historical and contingent; depending on time and culture;
- Reactive: reacting on definitions of the past.

According to Dijkstra (2001) in Vroom (2006) architectonic quality is determined by:

- The relation between form and function;
- The relation between building and surroundings;
- The intelligibility of the architectonic concept;
- The manner of association in the concept;
- The manner of proportions.

In the Nota Landschap (1991) in Vroom (2006) landscape quality is mentioned as:

- The landscape should be of aesthetical high value;
- From ecological point of view should it function in a good way;
- It should form an economical-functional base.

The theory suggests spatial quality is a normative definition because different disciplines will look at it in a different way and time decides how spatial quality looks like. Something has quality when quality is ascribed by groups of people. Spatial quality is a social construction and comes into being after a complex interaction between personal identity, group identity, and history. Everywhere quality means something different and has everywhere to be described in another way (Assche van and Jacobs 2002). Spatial quality is subject to context and dynamics. Place, time, scale, social and cultural circumstances influence the perception of spatial quality. Additional quality is depending on an aim. To be able to describe quality, different criteria are needed (Vroom 2006).
The table of Hooimeijer gives a basic to implement spatial quality into a design by using user, perception and future value in relation to economical, social, ecological and cultural interest.

6.3.1. Perception

The theory makes clear perception is an important aspect to define spatial quality. The perception of the environment is especially in case of 'De Afsluitdijk' essential. This paragraph elaborates the aspect perception. The next paragraph relates this theory to 'De Afsluitdijk'.

The cognitive way to look at 'perception' is giving meaning to certain objects, situations and happenings. A meaning is like a filter (selection). A meaning is the result of connecting an image to a certain term. Knowledge, recognition and experience make people differentiate and focus on meaningful characteristics (Coeterier 1987). The meaning of a landscape has to do with the attachment of importance to that landscape. The interest has to do with the use of the landscape. Giving a certain value to the landscape has to do with the seeing of landscape qualities, the characteristics of the landscape that give the landscape meaning. The appreciation of landscape is also depending on social, aesthetical, ethical, symbolic and/or the frame of mind. Additional preconditions like safety, accessibility and approachability are important. Values and meanings give reference boundaries to the way an individual person perceives the environment (Coeterier 1987). Not everything has the same interest in every environment. People perceive landscapes by arranging and structuring the environment. The various elements are seen in relation to each other. The perceiver pays attention to coherence and positioning (Coeterier 1987).
The perception of the environment is hierarchic (Couterier 1997):

- Level 1: Total first impression of the landscape;
- Level 2: Qualities of unity and use (total landscape, the overview);
- Level 3: The separate qualities, like openness, historical character, naturalness, maintenance, soil and water.

There are nine qualities that determine the perception of the environment (fig. 6.25). The qualities can replenish each other. The specific combination of qualities determines the character and identity of a landscape. (Coeterier 1987; Coeterier 1997b)

Quality	**Elaboration**
Unity	A landscape can be seen like a unity, coherence between the parts. (Coeterier 1987; Coeterier 1997) Complete, intact, how is it set up.
Use	How it works.
Naturalness (Coeterier 1997)	Naturalness is depending on the knowledge of the respondent. For everybody is naturalness something else. It has to do with the impression of the environment grew organic, if it is alive, if it has an artificial character and if flora and fauna is present.
Historical character	In the research of Coeterier (1997) the respondent is asked when old and new elements go not well together. This can happen in many ways: • Between elements; • The identity of the development; • The acceleration of the development; • More scale levels: • Between landscape units or landscape parts; • Between parts of units; • Between details; • In (changing) use; • Bad maintenance; • Development phases; • Coherence of the developments; • Against the traditions
Amount of space / openness	In the research of Coeterier (1997) the respondent is asked if the landscape changed in a spatial point of view. This resulted in the next 'deelkwaliteiten': • Ratio mass-space; • 'Tearing to pieces'; • Changes in spatial composition; • Changes in the identity of borders; • Another filling-in at the same type of use; • Another type of use; • Changes in the ratio of the different parts; • Change to uniformity; • Not visual influences (railroad line, air planes).
Maintenance	
Soil and water management	
Aspects of the season	
Sensorial impressions	Colours, smells, sounds

6.25. A combination of qualities determines the character and identity of a landscape. (Couterier, 1987; Coeterier 1997)

The report of Coeterier (1997) shows two kinds of characteristics that influence spatial quality in a negative way:

- A shortage of positive qualities;
- A perception of negative developments. (To fast development and no balance between conservation and development; Bad balance between new and old; Tearing to pieces; Urbanization; Equalization and uniformity; Atmosphere; Bad implementation into the landscape; Bad policy).

The research of Coeterier (1997) shows that balance between conservation and development is important. Insertion and rejection of new developments in the existing context should happen in a right way. The term unity is closely related to this. The insertion should happen with the right measurement and amount, in the right scale and is the right position of concern.

Ploeger (1997) divides in his research the qualities about the Wadden-area in different categories. These are later on used to determine the spatial quality of 'De Afsluitdijk' (fig. 6.26):

According to Rooijers (2000) the next aspects are important for perception of beach and sea landscapes (Rooijers 2007):

- Possibilities to experience the dynamics of the natural forces: dynamics, breakers, wind, water, sand, salt on the transition from open water to dry coastal zone;
- Openness, silence and darkness;
- Experience the presence of flora and fauna: birds, fish, animals and plants (least important).

The categories of Hooimeijer (2001) can be integrated with the ones of Ploeger (1997), Coeterier (1987, 1997), Rooijers (2000) and my landscape architectonic vision. This leads to table 6.27, which shows what elements influence the spatial quality of a site. Table 6.28 relates these aspects to 'De Afsluitdijk'.

Categories	**Elaboration**
Spatial	Space, openness, extension, size, horizon
Senses	Quiescence (rust), silence, darkness
Absence of human influence	Virginity
Human influences	History (ships, villages, architecture), cultural landscapes (tuinwallen, drinkkolken), different identities of the islands
Education	Make people conscious of nature
Possibilities, challenges	Fascinating, impressive, tension of adventure, diversity, fearfulness of the water behind the dam, recreation area.
Natural processes	Autonomous tidal identity, dynamics of wind, water, cycle of seasons.
Ecological	Breeding area for fish, forage (fourageren) area
Environment	Water quality

6.26. Qualities of the 'Waddenzee' (Ploeger, 1997)

Categories	**Elaboration**
Spatial	Space, openness, extension, size, horizon, silence and darkness, singularity, escape, relax, healthy; Unity, coherence between the parts. Complete, intact. Good ratio mass-space; No uniformity, no bad visual influences (railroad line, air planes), Integration and Renewal
Sensorial impressions	Quiescence (rust), silence, darkness Colours, smells, sounds Aspects of season Beauty, feeling free
Absence of human influence	Virginity
Education	Make people conscious of nature
Possibilities, challenges	Fascinating, impressive, tension of adventure, diversity, fearfulness of the water behind the dam, recreation area. Use: how does it work. Freedom of choice, meeting points Availability of natural resources
Natural processes	Possibilities to experience the dynamics of the natural forces: dynamics, surf, wind, water, sand, salt, Autonomous tidal identity, cycle of seasons.
Ecological	Breeding area for fish, forage (fourageren) area Experience the presence of flora and fauna: birds, fish, animals and plants. Feeling safe. Availability of eco-systems
Environment	Water quality, Soil and water management, Maintenance, cleaning
Historical character	Cultural heritage History (ships, villages, architecture), cultural landscapes Traditions
Development	The identity of the development; The acceleration of the development; Coherence of the developments

6.27. The qualities of Hooimeijer (2001), Rooijers (2000) , Ploeger (1997), and Coeterier (1987, 1997) and my landscape architectonic vision together in one table.

Categories	Elaboration	Quality of 'De Afsluitdijk'	Lacking
Spatial	Space, openness, extension, size, horizon, silence and darkness, singularity, escape, relax, healthy; Unity, coherence between the parts. Complete, intact. Good ratio mass-space; No uniformity, no bad visual influences (railroad line, air planes), Integration and Renewal	The open space of the water-scape of 'De Afsluitdijk' is of such a big scale, that the space seems eternal. The borders are not visible and the horizon is free of disturbance. This, together with the thin line (ratio 3200/90 m) makes it a unique place. 'De Afsluitdijk' is very ordered, readable, structured, and clear because of the simple design. It is an almost straight, thin line with some exceptional places. Those exceptional places are related to each other and are a unity together. The unity is a result of the matching style, choice of materials and colours. The dam is uniform, what makes the concept strong.	The dam does not attract certain recreants, like cyclist, because the dam is long and very windy. The simple design can lead to 'polderblindheid'. The route of the viewer is important for the perception of the landscape. It is a missed opportunity that the 'Waddenzee' can only be experienced at a few places. Also the perception of the 'Ijsselmeer' is not optimal, because the bicycle path is situated in-between the highest part of the dam and the highway.
Sensorial impressions	Quiescence, silence, darkness Colours, smells, sounds Aspects of season Beauty, feeling free Shape	The dam is situated in the middle of the sea. The big horizon is open and a certain silence exists at this place. Only the sounds of the natural environment of the waves and wind are audible. The cars are passing by in a certain rhythm. The smell of the sea and the feeling of the weather conditions make people feel free. The seasons give divers experience, it can be very bright, silent and quiet, but also be very dark, wild and noisy. The Netherlands has only a few places where it gets dark. The influence of light is minimal at 'De Afsluitdijk'. This is one of the aspects why this site is special. The dam has two sides, literally and figurative, people are afraid of the fearfulness of the water behind the dam but on the other hand they feel safe and protected by the same dam. This gives an exiting tension. The shape and scale of the dam is unique in comparison to other dams. The experience, while comparing the huge dam surrounded by a huge amount of water, with human scale is exceptional.	The passing cars can be very noisy. You feel a bit enclosed in-between the dike and the highway while cycling
Historical character	Cultural heritage History (ships, villages, architecture), cultural landscapes Traditions	The meaning of a landscape has to do with the attachment of importance to that landscape. Almost every Dutch person knows 'De Afsluitdijk'. It is an icon that shows how we deal with water. The history adds in this case a quality to the site. The area is a cultural waterscape.	

6.28. The spatial quality of 'De Afsluitdijk'

Absence of human influence	Virginity	There is no absence of human influence in the Netherlands. The dam has an anthropogenic, technical character. The combination of the extremities the natural Waddenzee, which seems without human influence, and the so typical occupied character of the dam make it interesting.	
Education	Make people conscious of nature	When people have knowledge about a certain area they will respect and understand it more. 'De Afsluitdijk' is known by every Dutch person and even by many international people. It has a strong historical character and can be seen as an icon.	
Possibilities, challenges	Fascinating, impressive, tension of adventure, diversity, recreation area. Use: how does it work. Freedom of choice, meeting points Availability of natural resources	There are only a few places were people can go on distance from the dam. That is why those places are interesting: 'De Vlieter', the Sluices at 'Den Oever' and 'Kornwerderzand', the harbour of 'Breezanddijk', and the places where the dam connects to the land (Rijkswaterstaat 2005). De 'Waddenzee' and the 'Ijsselmeer' can be experienced at the same time. The character and identity of the dam gives opportunities to produce sustainable energy. Natural resources like wind, sun, waves and fresh and saline water are available.	
Natural processes	Possibilities to experience the dynamics of the natural forces: dynamics, surf, wind, water, sand, salt, Autonomous tidal identity, cycle of seasons.	The IJsselmeer can be experienced by passing it by car.	Experiencing both sides of the dam is almost impossible.
Ecological	Breeding area for fish, forage area. Experience the presence of flora and fauna: birds, fish, animals and plants. Feeling safe. Availability of eco-systems	Various ecosystems are available ('Waddenzee' (brackish/saline), 'Ijsselmeer' (fresh), wetlands near the coast of Friesland).	Experience ecology is minimal.
Recreation			Some picnic areas are constructed, but over there it is very windy. The recreational spots are not designed and very disorderly
Environment	Water quality, Soil and water management, Maintenance, cleaning	'De Afsluitdijk' is clean, there is no garbage laying around.	The quality of the surrounding water is reasonable. In ecological point of view it is lacking, in recreational point of view is it fine.
Development	The identity of the development; The acceleration of the development; Coherence of the developments	At this moment is the dam in balance. Earlier developments happened in symbiosis with the existing. Conservation and development is in balance.	

6.4. Sustainable energy

From the landscape analysis and the symposium (14-03-2008), organized by 'Rijkswaterstaat', becomes clear the site has potential to produce sustainable energy in various ways.
The government aims to produce 20% more sustainable energy in 2020 in comparison to 1990 in The Netherlands (Consortium Natuurlijk Afsluitdijk 2008). According to 'Rijkswaterstaat' (2008) in (IMSA 2008) the site of 'De Afsluitdijk' is, because its unique location, suitable for sun, wind, tidal and osmosis energy. This paragraph elaborates on these energy producers.

Wind energy
To achieve the aims of 20% more sustainable energy production in 2020 the government decided to implement 2.000 MW wind energy on-shores. New locations need development and existing locations need renewal according to 'Nationaal Plan van Aanpak Windernergie' by Government of VROM, EZ and LNV (2008) in (Consortium Natuurlijk Afsluitdijk 2008). Maps about the wind speed (fig. 6.29-31) show the surroundings of 'De Afsluitdijk' have the opportunity to produce wind energy.

General wind turbines with 2 or 3 blades, and a diameter of 40m, hub height of 50m, can, with optimal wind speed (wind speed 6) produce 500-750 kW. A bigger wind turbine with a rotor diameter of 60m and a hub height of 70m can produce about 1 to 1,5 MW. [DM Energietechnieken, s.a. -180].

Solar energy
As the solar radiation maps shows (fig. 6.33), the site has, in comparison to other places in the Netherlands, many sun hours per year. This, in combination with the openness of the surroundings, and the orientation of 'De Afsluitdijk' makes it an interesting sport to produce sustainable energy by solar radiation.

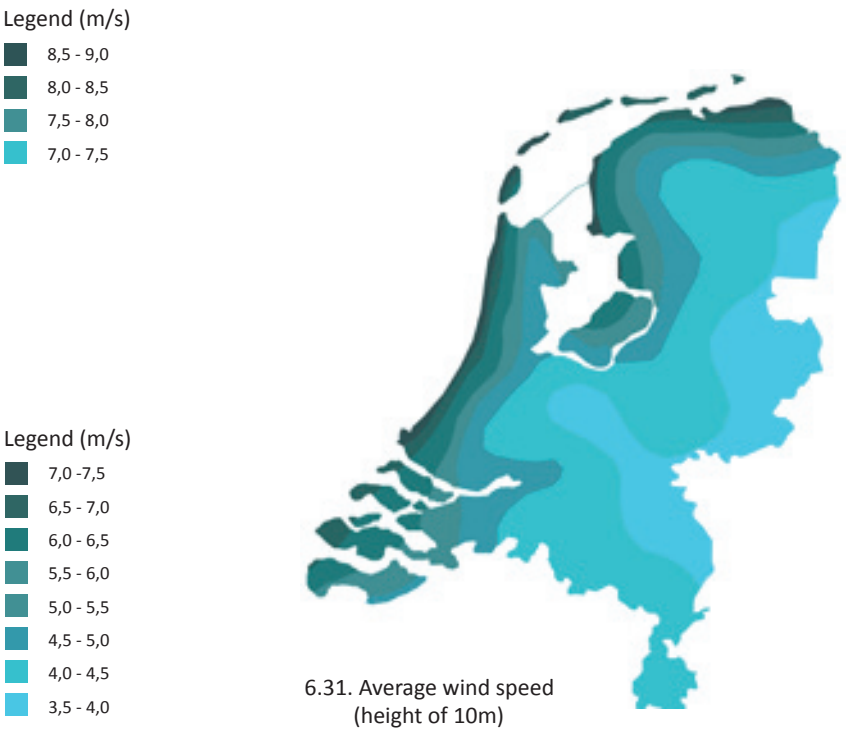
The sun is everywhere and even when it is cloudy solar panels/collectors can produce. There are two kinds of solar energy: A solar boiler produces warmth, and a solar panel produces electricity. On 'De Afsluitdijk' the second one is the most ideal because transporting warmth over a long distance means a lot of loss. The orientation is optimal when the panel is in the direction of the South. The most optimal angle of inclination is 36˚ [Witberg N., 1999 -177].

The average production of a solar panel is 100 kWh/m^2/yr [Energielijn, s.a. -181]. When solar panels are located along the whole length of 'De afsluitdijk' this would mean an energy production for 89 households for a whole year:

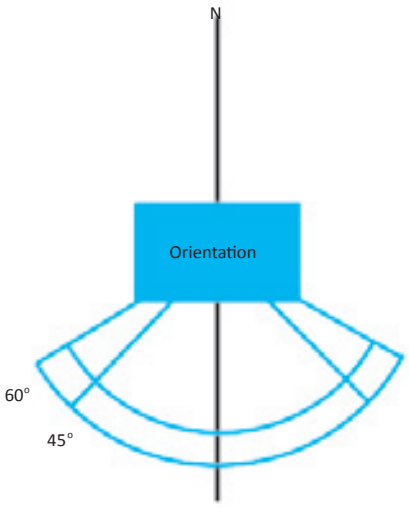
- 3200 meter x 1 m^2 = 3200 m^2
- 3200 x100 kWh/yr = 320.000 kWh/yr
- Divided by 3600 kWh (demand of one household): (320.000 kWh/yr) / 3600 kWh = 89 households.

6.29. Average Wind speed at a height of 100m: 'Noord-Holland'

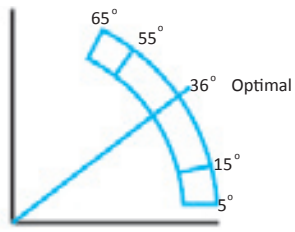
6.30. Wind speed at a height of 100m: 'Friesland'



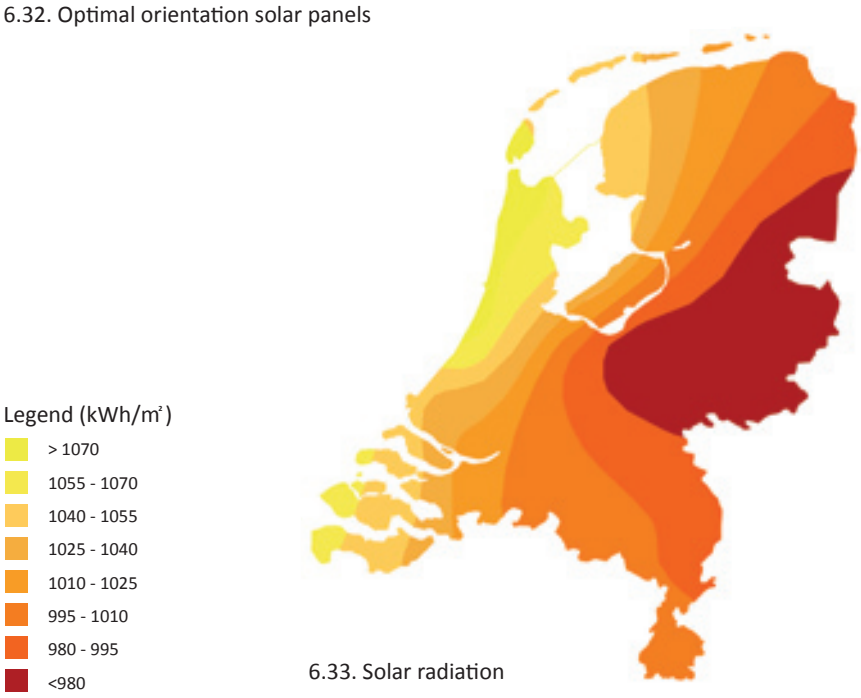
6.31. Average wind speed (height of 10m)



6.32. Optimal orientation solar panels



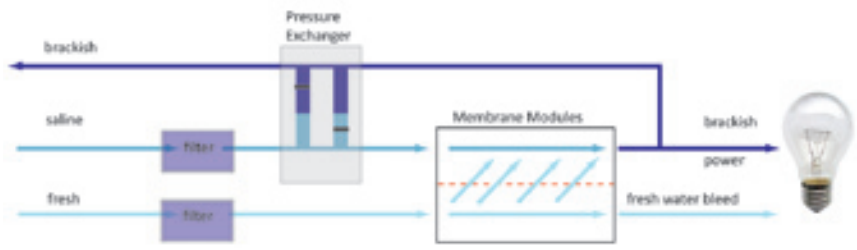
Optimal slope solar panels



6.33. Solar radiation

Osmosis
The clear barrier between saline and fresh water of the Waddenzee and IJsselmeer has big potential to produce energy by osmosis. An osmosis plant needs fresh and saline water supply to produce energy. Osmosis installations exist of piled up cells. The amount of cells and the surface of the membranes are depending on the needed voltage ('spanning') and the needed power ('vermogen'). The result is direct current, a change to alternating current is needed to make it useable (IMSA 2008).
On basis of difference in osmotic value, two manners of osmosis energy productions are possible at this moment; In Norway 'Statkraft' is working on Pressure Retarded Osmosis (PRO), in the Netherlands ' REDstack', 'WETSUS' and 'Kema' are working on Reverse ElectroDialysis (RED). Both methods are still in the development phase and commercial use will be possible from 2015 (IMSA 2008).
PRO (figure 6.34) uses the osmotic pressure difference between saline and fresh water to convert this potential energy into electricity. Fresh water flows through permeable membranes to the saline side. The difference in pressure pushes the water through a turbine what generates electricity (IMSA 2008).
RED (figure 6.35) uses the electronic potential difference between saline and fresh water. The membranes do not allow water to pass, but ions. This introduces an electron flow between cathode and anode (electricity) resulting in energy (IMSA 2008).
Both technologies can gain 1 MW per 1m^3/s fresh water. Disadvantages for RED, the membranes become chemical waste and for PRO, the membranes need chemical treatment. The RED is better is situations with lower concentration differences and big flows like sea and river water. The costs are for RED € 0,08-0,18 €/ kWh and for PRO 0,05-0,10 €/ kWh. According to (IMSA 2008) it is not possible to choose for PRO or RED at this point because both technologies are still improving.

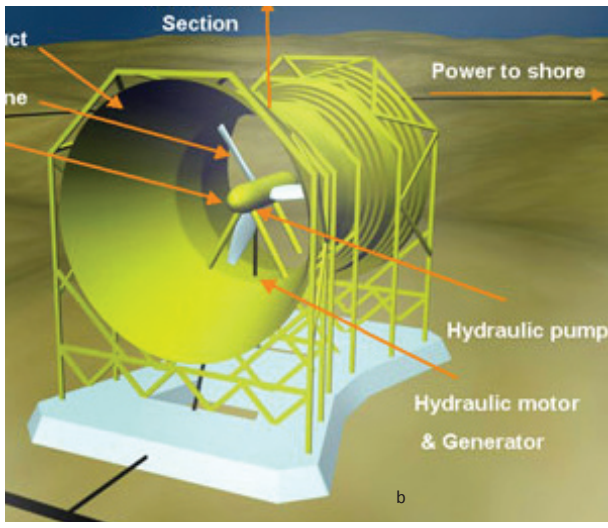
The average fresh water flow through the spouts of 'De Afsluitdijk' is 500m3/s, which can result in about 500 MW electrical power. According to REDstack (2008) the minimum outflow of 200m3/s (on base of 200 MW energy production) is enough to supply 500.000 households of energy (IMSA 2008). This is enough for the three Northern provinces [RedStack, s.a. -179; Wolff, 2008 -178].



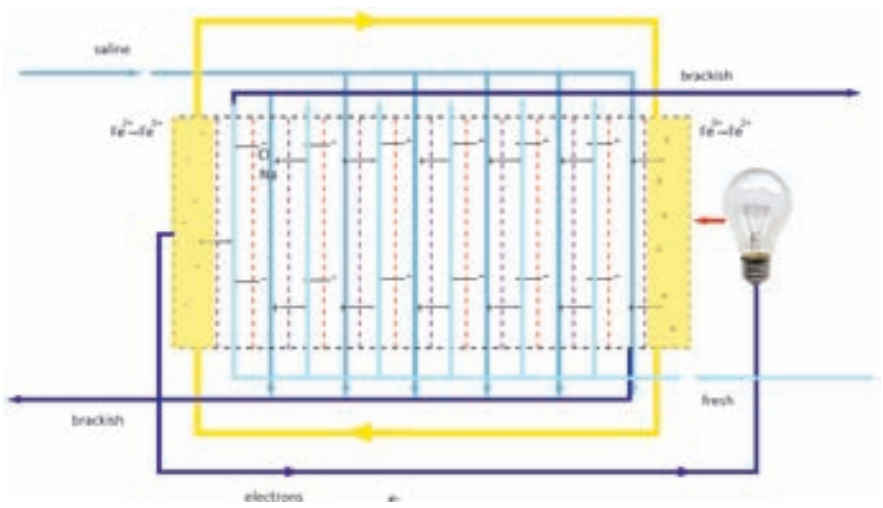
34. PRO (Pressure Retarded Osmosis)

Tidal energy
Because of the tide and the spouts, which transfer 500m^3 'IJsselmeer'-water to the 'Waddenzee' the site is interesting for tidal energy production [RedStack, s.a. -179; Wolff, 2008 -178]. With turbines placed into the water energy can be produced (fig. 6.36, 6.37) .

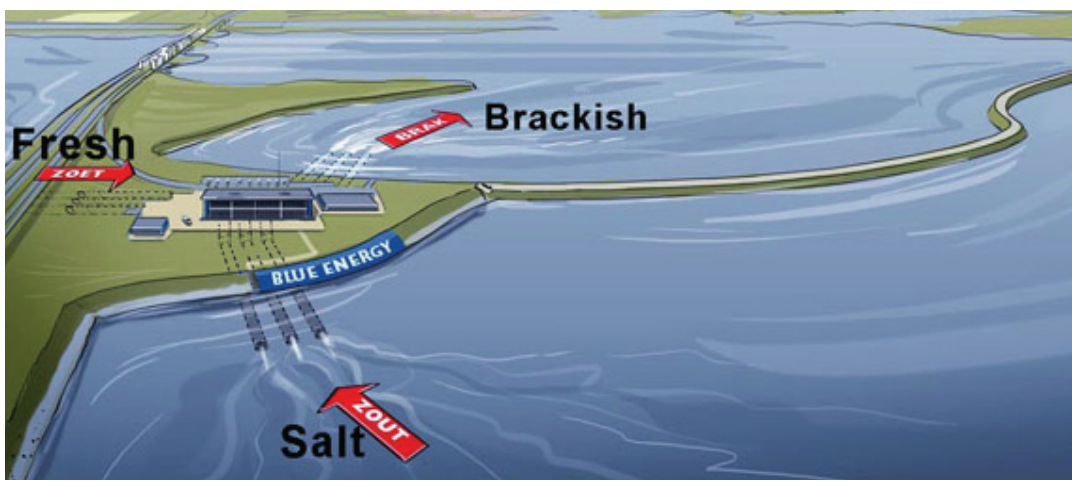
The existing sluices at 'Kornwerderzand' exist of two groups of five spouts. The sluices of 'De Oever' exist of three groups of five spouts. The twenty-five spouts are all twelve meter broad.
According to 'Teamwork Technology BV; Alkyon Hydraulic Consultancy & Research' (2008) every spout opening can contain maximal three turbines. This means 'De Afsluitdijk' can contain 75 turbines, which can produce energy for about 900 houses. The planned new spout in the arch of the dam will be as big as 'Kornwerderzand' and 'Den Oever' together [SMO, 2008 -76]. When this spot is also used, energy for 1800 houses can be produced.



6.36. Examples of tidal turbines



35. RED (Reverse ElectroDialysis)

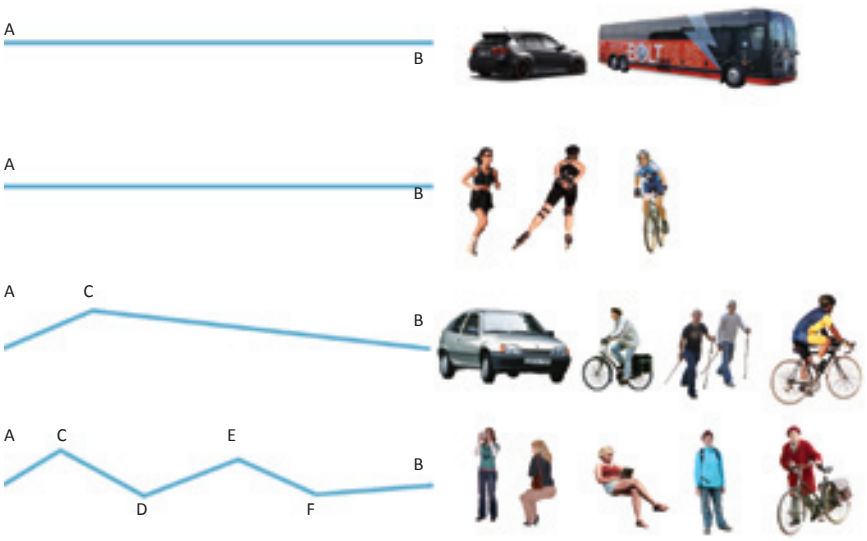


6.37. Artist impression of an osmosis plant

6.5. Conclusion: The Spatial Quality of ‘De Afsluitdijk’

This chapter describes the way the water-scape of ‘De Afsluitdijk’ is build up. The aspects order, proportion, scale, shape, space, perception and spatial quality are elaborated. During the symposium became clear sustainable energy production is a big opportunity for this site. That is why this aspect is illustrated in paragraph 6.6.
This theory forms a base to conclude what the spatial quality of ‘De Afsluitdijk is.

Spatial quality is for everybody something different, what makes it difficult to describe the spatial quality of ‘De Afsluitdijk’. The landscape theory together with my landscape architectonic view results in a description of the spatial qualities of the site: ‘De Afsluitdijk’.
In general can be said that something is ‘beautiful when things are in harmony with the surroundings, a system that fits’ (Koh 2007). Various reasons show why the total Afsluitdijk is in harmony. The dam is a unity, the architecture fits the dam and the dam fit the surroundings. ‘De Afsluitdijk’ is beautiful not only because how it looks like, but also because of its history and the story the dam tells. Articles in newspapers and forums on internet are used by people to give their opinion about the dam and its re-development. Everybody agrees the re-development should happen in the right way, but almost every change is experienced negative by society. Not only at the dam, but also in general are changes seen as negative. The high dynamics of the society makes it hard to come up with a design that fits the existing and future needs, preferences and ideas. That is why Sijmonds (1990) says in Vroom (2006) landscape architecture is working towards a design that can cope with dynamics within a sustainable, static framework. This gives the possibilities to change without harming the society, nature, and quality of the design.



6.38. Various users of ‘De Afsluitdijk’ go along the dam with their own speeds and aims from A to B

The qualities mentioned in the previous paragraphs, also occur at other places in the Netherlands, but nowhere as strong as here. The big scale results in a more intense perception. The Netherlands does not have a water-scape like this somewhere else. The dam gives the opportunity to cross the sea what results in a unique experience. The route along ‘De Afsluitdijk’ (the direction and the speed of people moving over the dam) influences the perception of people (fig. 6.38). There are only a few places were people can go on distance from the dam. That is why those places are interesting: ‘De Vlieter’, the Sluices at ‘Den Oever’ and ‘Kornwerderzand’, the harbour of ‘Breezanddijk’, and the places where the dam connects to the land (Rijkswaterstaat 2005). De ‘Waddenzee’ and the ‘IJsselmeer’ can be experienced at the same time.
The expression ‘Quantity becomes quality’ (Coeterier J.F., Buijs A.E. et al. 1997a) (p61) is true in this case. The open space of the water-scape of ‘De Afsluitdijk’ is of such a big scale, that the space seems eternal (fig. 6.39). The borders of the space are not even visible and the horizon is free of disturbance. According to Coeterier (1997a) the relation between the amount of quality and appreciation is exponential. Twice as much space on water is ten times as much appreciated. This quality is very vulnerable, because a little bit less space has already a big impact and makes the

Openness

6.39. The big scale of the water results in an experience of freedom The space is open and seems eternal. This openness is unique in ‘The Netherlands’ as the ‘open-horizon-disturbance-map’ shows

Long thin line

6.40. The long, thin, almost straight line (3200 m long, 90 m broad) results in a unique experience. The straight line seems eternal and is perceived as a thin line going through the roughness of the sea, dissapearing in the horizon.

area too standard or normal (Coeterier J.F., Buijs A.E. et al. 1997a). The combination of the openness and the long, thin line (dam) with a ratio of (3200m long / 90m broad) makes it a unique place (fig. 6.40).
The perception of environment is happening in a hierarchic order (Coeterier J.F., Buijs A.E. et al. 1997a): The first impression of the landscape has, for most people, to do with the huge measurements of the open water surface and the dam itself. People perceive the dam in its context by comparing the space with recognizable shapes and areas. The openness is one of the first perceptions in this area (not as Coeterier suggest of level 3 (paragraph 6.3.1)). During the second level of perception the dam is seen as a unity in form, colours and style with its context. The third level makes people think about the historical identity of the dam, together with the basic design.
The meaning of a landscape has to do with the attachment of importance to that landscape. Almost every Dutch person knows 'De Afsluitdijk'. When people have knowledge about a certain area they will respect and understand it more. 'De Afsluitdijk' is known by every Dutch person and even by many international people. It has a strong historical character and can be seen as an icon (fig. 6.41). It is an icon that shows how the Dutch protect themselves against water. The history adds, in this case, a quality to the site.
The design has a strong concept (fig. 6.42); it is very ordered, readable, uniform, structured, and clear. It is an almost straight, thin line with some exceptional places. Those exceptional places are related to each other and are a unity together. The unity is a result of the matching style, choice of materials and colours (fig. 6.43). The shape and scale of the dam is unique in comparison to other dams. The experience, while comparing the huge dam surrounded by a huge amount of water, with human scale is exceptional.
Next to the design, the context is unique. The dam is situated in the middle of the sea. The big horizon is open and a certain silence exists at this place. Only the sounds of the natural environment of the waves and wind are audible. The cars are passing by in a certain rhythm. The smell of the sea and the feeling of the weather conditions make people feel free. The Netherlands has only a few places where it gets dark. The influence of light is minimal at 'De Afsluitdijk'. This is one of the aspects why this site is special. Additional various ecosystems are available ('Waddenzee' (brackish/saline), 'IJsselmeer' (fresh), wetlands near the coast of Friesland). The combination of the extremities the natural Waddenzee, which seems without human influence, and the so typical occupied character of the dam make it interesting (fig. 6.44). The area of the mud flats is maybe the only place in the Netherlands where people can perceive 'jungle' nature (wilde natuur). The weather conditions and the seasons give divers experiences, it can be very bright, silent and quiet, the sea can be as a mirror reflecting the blue sky and clouds, but also be very dark, wild and noisy. Research done by Coeterier shows visitors and citizens perceive a strong feeling of space, unity, harmony, feeling of freedom and dynamics. The balance between unity & diversity, nature & culture is seen as an important aspect. Additional the fierce of the sea is impressive to people. The dam has two sides (fig. 6.45), literally and figurative, people are afraid of the fearfulness of the water behind the dam but on the other hand they feel safe and protected by the same dam. This gives an exiting tension. It gives the feeling that nature can do what it wants (Coeterier J.F., Buijs A.E. et al. 1997a).
The character and identity of the surroundings of the dam gives opportunities to produce sustainable energy (fig. 6.46). Natural resources like wind, sun, waves and fresh and saline water are available.

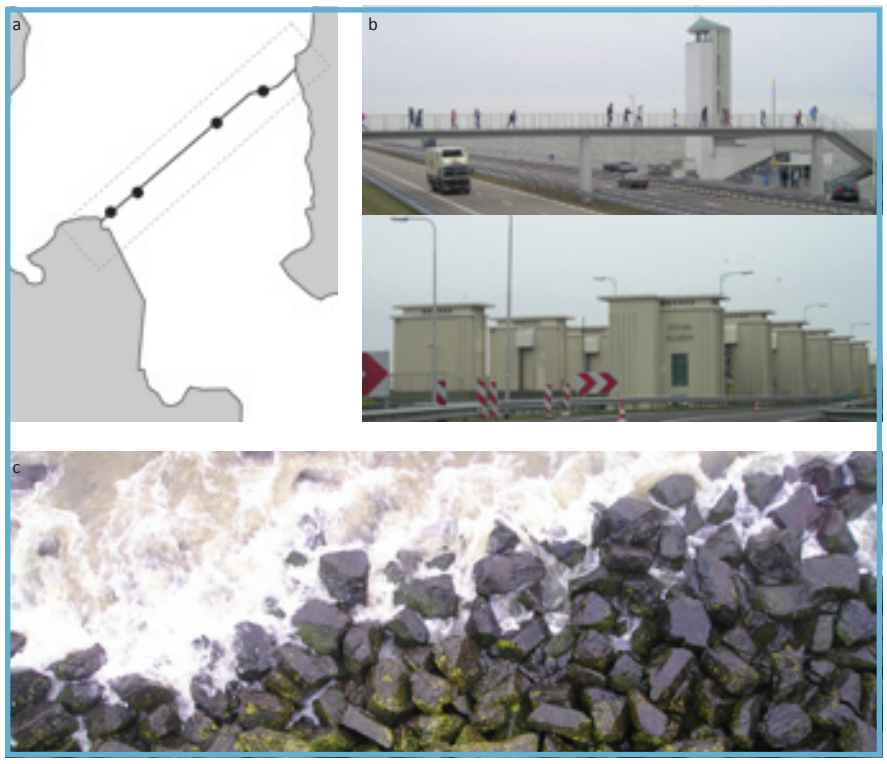
Icon

6.41. Cultural historical value. Icon about the Dutch struggle against the sea.

Simple design with exceptional places

6.42. The dam has a simple, clear design concept what is easy to read and to understand. The exceptional places are related to each other in a clear way.

Unity



6.43. Unity in rhythm, form, style, materials, and colours

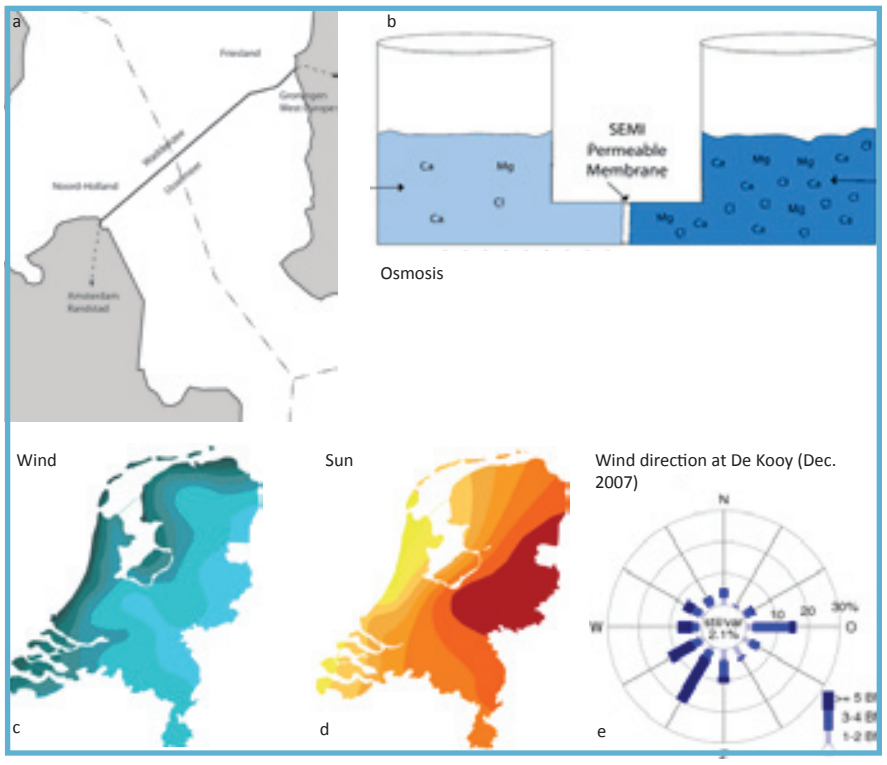
Interaction

6.44. The interaction between the technical, artificial dam-element and the natural appearance of its context is a quality. It is the total setting what makes it special.

Contrasts

6.45. Contrasts:
Natural (Waddenzee) and artificial (dam itself and the IJsselmeer)
The fierceness of the waves (Waddenzee) and the safety (dam)
The dynamics (Waddenzee) and statics (dam)
Diversity (Waddenzee) and simplicity (dam)
Variation (Waddenzee) and no variation (dam)

Sustainable energy production



6.46. Potential site to produce sustainable energy

CHAPTER 7

Design

7. Design

This first paragraph of this chapter gives an overview of the design guidelines. The second paragraph determines the significance of the described guidelines, and the assessment of the spatial models mentioned in chapter 5).
Paragraph 7.2. elaborates on the best model and explains the transition from model into spatial concept. The concept is the foundation for the final design and results from the landscape theory and my landscape architectonic view on ‘De Afsluitdijk’. The design shows spatial design solutions for the mentioned constraints (chapter 2).

7.1. Design Guidelines

Design guidelines are needed to give direction to thoughts, and to assess ideas. The design guidelines are resulting from the problems, theory, and landscape analysis.
The design guidelines are divided in 'pre-conditions', 'ambitions', and 'technical demands' (fig. 7.1).

- The 'pre-conditions' are the direct result from the mentioned constraints. The design should comply with these pre-conditions to answer the research question.
- The 'ambitions' result from three kinds of opportunities resulting from the site visits and literature study. While re-adjusting the dam, it would be nice to use these opportunities.
    - Landscape architectonic opportunities;
    - Cultural historical opportunities;
    - Ecological opportunities.
- The 'technical demands' are based on literature study and conversations with experts. The 'ambitions' focus on 'what' and the 'technical demands' on 'how'.

Pre-conditions

The main goal is designing a safe 'Afsluitdijk' that protects the hinterland against flooding. The dam should be able to fulfill its main function: barrier against water, but decrease the barrier for nature.

- Design the dam in a way the dam suffices the standards of the 'Wet op de Waterkering'. This means the dam protects the hinterland against flooding till at least 2100;
- Decreases the barrier effect of the dam. Find a solution to transport more water from the 'IJsselmeer' to the 'Waddenzee';
- Maintain the fresh water reservoir of the 'Ijsselmeer';
- Find a solution that is adaptive to climate (sea level) change.

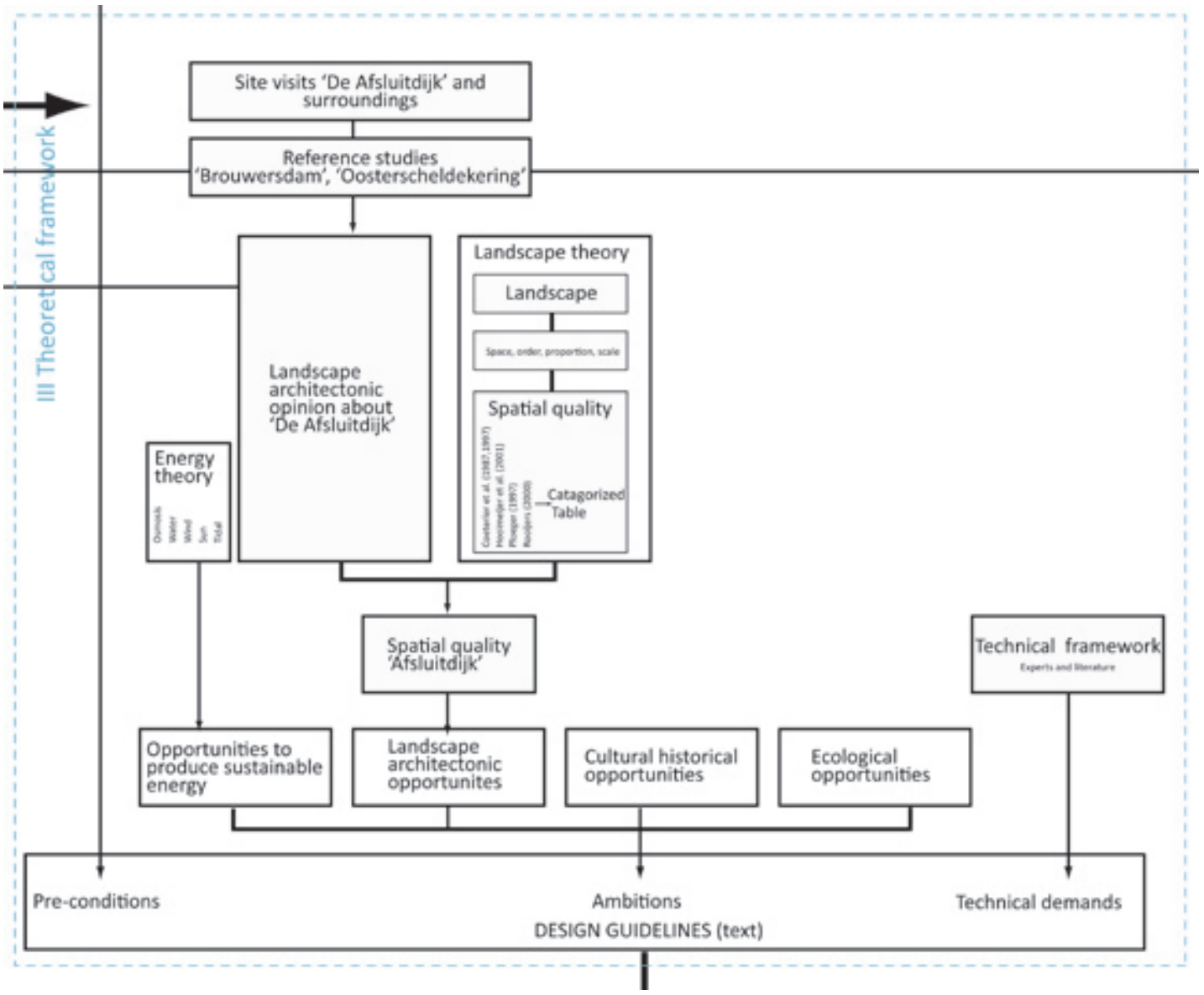
Ambitions

The 'ambitions' are the result of three kinds of opportunities (landscape architectural, culture historical, and ecological). These opportunities became clear during site visits, literature study, and the symposium ('Toekomst Afsluitdijk') visit (Rijkswaterstaat 14-03-2008). While re-adjusting the dam, it would be nice to use these opportunities.

Landscape architectonic opportunities

While designing the dam, the spatial qualities of the site should be taken into account. It is the profession of a landscape architect to deal with spatial quality, to make a design that fits its context and expresses or enhances the existing qualities.

- Enhance the straight, thin, long line-character of the dam;
- Intensify the perception of the openness of the water;
- Make it possible to experience both sides of the dam;
- Design in an integral way without losing the spatial and architectonic unity.
- Maintain the balance between the different elements and the dam itself;
- Maintain the sequence of exceptional points;
- Enhance the contrasts:
    - Natural – Artificial;
    - Fierceness – Safety;
    - Open – Enclosed;
    - Water – Land;
- Maintain of the simple, basic, readable, anthropogenic, technical character of the dam;
- Move the bicycle path to a better location.



7.1. The design guidelines consist of ambitions, opportunities and demands

- Strengthen the perception of water, nature, weather conditions, openness, and character of the dam;
- Fit into its context. The re-adjustments should join the existing;
- Create a clear entrance to the two different landscape types of 'Noord-Holland' and 'Friesland'. The visitor should be aware of the variety in surroundings;
- Make it multi-functional. The dam should be suitable for the variety of users. The area is suitable to different kinds of users, because of its unique situation and location. Various functions can be connected.
- Use the opportunities of the site: sun/wind/fresh-saline/etcetera to produce sustainable energy (fig. 7.2, 7.3);

Cultural historical opportunities
The cultural historical opportunities result from literature study and the visit of the symposium 'Toekomst Afsluitdijk' organized by 'Rijkswaterstaat' (14-03-2008).

- Respect the multiple monuments of 'De Afsluitdijk' (Rijkswaterstaat 2008c);
- Conserve the spatial and visual unity between all elements and the dam itself (RACM 2007);
- Respect the openness of the landscape (RACM 2007; RACM 2008);
- Respect the uniform, consistent design of shape, colour, material and organisation (RACM 2007);
- Extend the continuous profile and unity in material use (RACM 2007);
- Extend the strong utilitarian and civil technical character (RACM 2007);
- Respect the line shape and scale of the dam (RACM 2008);
- Conserve the spatial unity of the line of defence ('verdedigingslinies') (RACM 2008);
- Conserve archaeological remains (RACM 2008);
- Take the current location choices of the track, the sluices, the former working islands and the defence constructions into account (RACM 2007);
- Enhance the icon function of the struggle against water (Rijkswaterstaat 2008c);
- Protect 'dorpsgezicht' 'Kornwerderzand' (Rijkswaterstaat 2008c).

Ecological opportunities
The ecological conditions follow from literature study and talking with ecologists. It is important that the design takes the environment into account (Rijkswaterstaat 2008c).

- Enhance the robustness of the ecosystem 'Waddenzee' and 'IJsselmeer' by means of (Woudstra 2008):
    - enhancing of the characteristic habitats like salt marshes, mussel areas, sea grass fields;
    - enhancing the quality and quantity of animal species, like space for certain kind of animals;
- Create a gradual connection between the ecosystems of the 'Waddenzee' and the 'IJsselmeer' (fresh and salty water)

7.2. Average wind speed

7.3. Average solar radiation

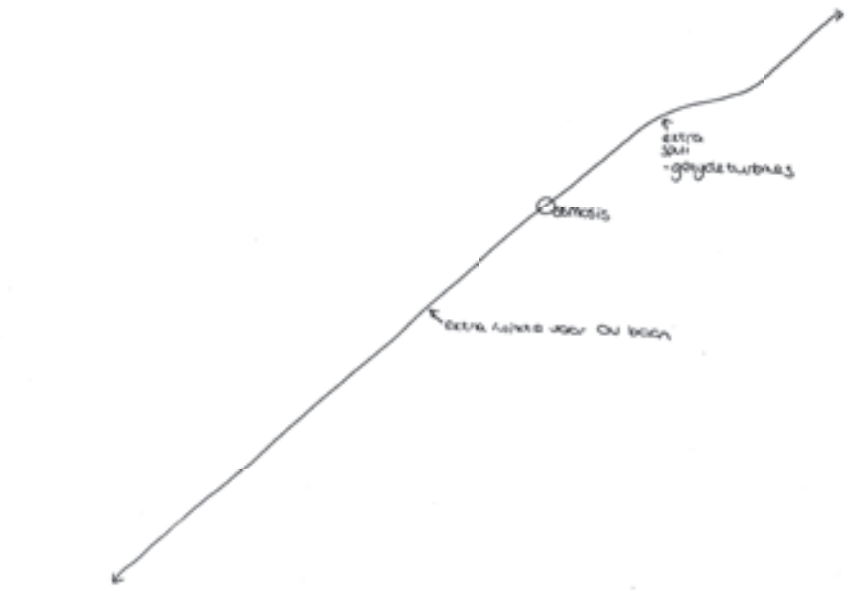
(Woudstra 2008);
- Use ecological processes as much as possible to realize the idea (building with nature) (Woudstra 2008);
- Conserve or enhance the water quality of the 'Waddenzee' and 'IJsselmeer' (Woudstra 2008):
    - Like decreasing the abrupt fresh water inlets into the brackish water system (Waddenzee);
- Take the existing sedimentation and erosion processes into account (Woudstra 2008);
- Enhance or increase the biodiversity of the 'Waddenzee' and 'IJsselmeer' ecosystems;
- Create shallows, more deep parts and shelter areas (Woudstra 2008);
- Take the consequences of sediment winning into account (Woudstra 2008);
- Take the consequences of new functions for the ecosystems into account (Woudstra 2008)
- Conserve the quality and quantity of the fresh water reservoir of the 'IJsselmeer';
- Solve the abruptness of the fresh water inlets;
- Take the various regulations into account (Natura 2000, EHS, Vogel- en habitatrichtlijn, Beschermingswet flora en faunawet, etcetera) (Rijkswaterstaat 2008b).

Technical demands
The literature study and conversations with experts lead to technical demands. If the design does not answer these criteria, the design will not work.

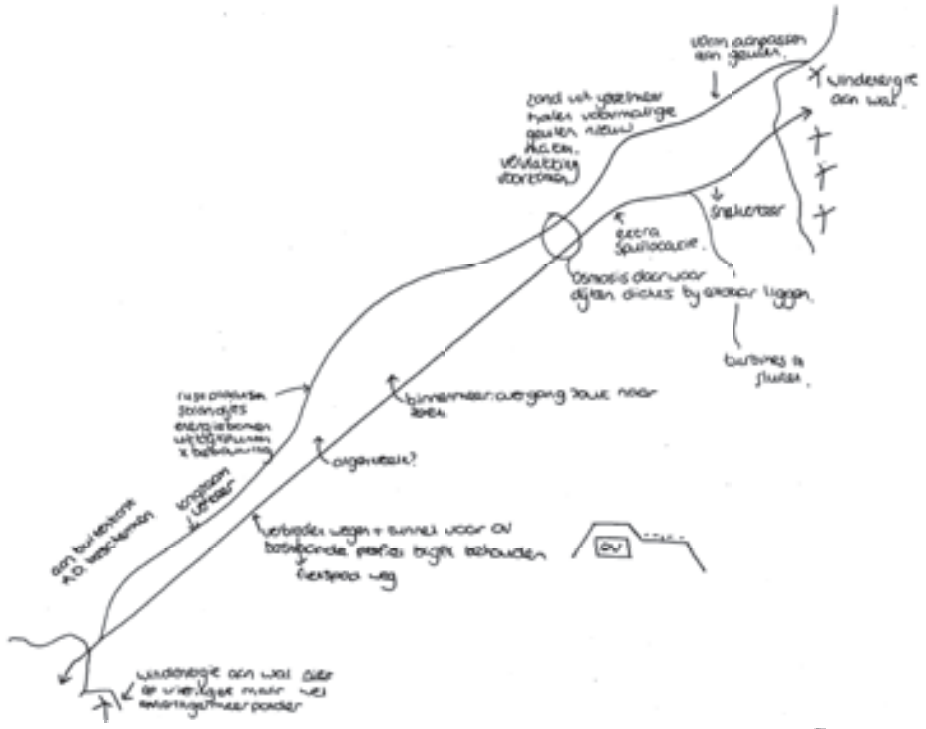
Safety
- The crown of the dam in the general profile is too low according to 'toetspoor hoogte' (Rijkswaterstaat 2008b). The crown should be raised up to 10 m +N.A.P. The result is that the water that is going over the dam ('overslag') is brought back with an amount of 5- 10 l/s/m (Regeling 2008);
- 5% of the cover of stone material on the side of the Waddenzee does not suffice (Rijkswaterstaat 2008b).
- When the dam is raised with sand and clay the slope can not be steeper than 1:4 ('Waddenzee') and 1:3 ('IJsselmeer') (Regeling 2008).
- A maintenance path/zone is needed on top or along the inside and outside of the slopes (Regeling 2008). It should be possible to inspect and to maintain the dam (Rijkswaterstaat 2008b; Rijkswaterstaat 2008c)
- It should be possible to reinforce the dam later on (Rijkswaterstaat 2008b).

Technical information:
- It should be possible to carry off fresh water (water quantity) from the 'IJsselmeer' to the 'Waddenzee' (Rijkswaterstaat 2008c). The extra sluice capacity will be situated in the nod of the dam (Rijkswaterstaat 2008b);
- Use the W+ KNMI scenario of 2006 for safety guides. Looking at the year 2100 (Rijkswaterstaat 2008b):
    - An absolute Waddenzee water level raise in a range of 0.40 to 0.85 meter in 2100;
    - The extra sluice capacity is able to conserve the existing 'IJsselmeer'-water level till 2050;
    - It is possible to spout by means of gravity till 2050, although a sea level rise of 0,25 meter. Afterwards the scenario 'meestijgen met de zeespiegel' will be used.
- Take the lowering of the absolute ground level around 'De Afsluitdijk' into account. This will be about -0,10 meter per century (Rijkswaterstaat 2008b).
- Take the different numbers into account. Example: The needed

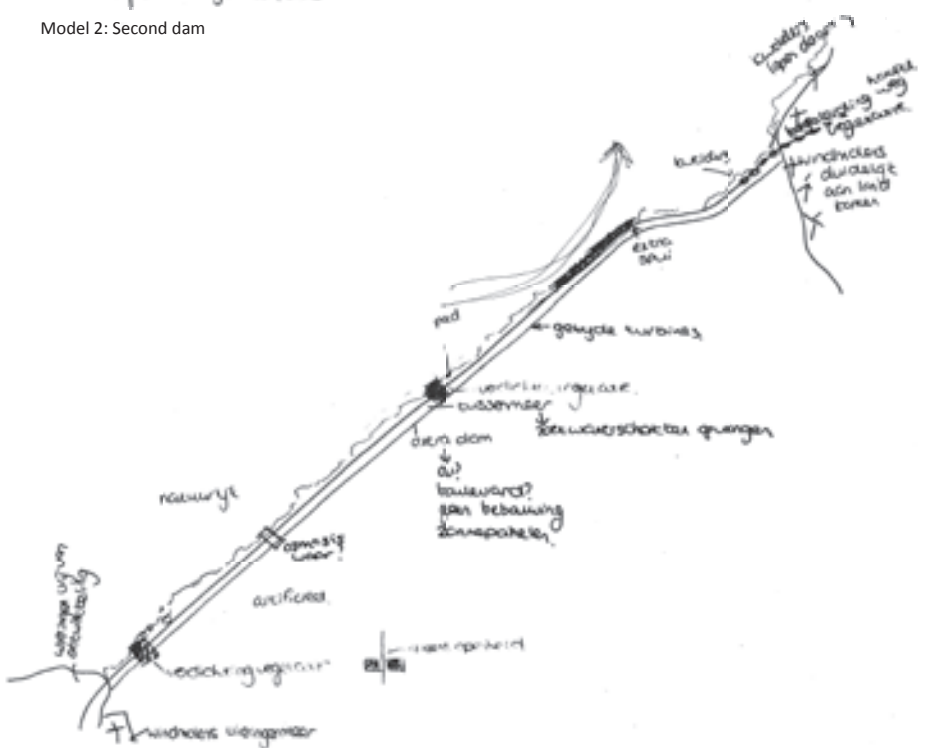
broadening is about 30 meter (Regeling 2008). According to Tanis the dam should be broadened with 18 meters when the sea level rises with 60 centimeter (Maurits 2008);
- At the side of the Waddenzee the hydraulic norm is 1:10.000, at the side of the 'IJsselmeer' a norm does not exist, but 'Rijkswaterstaat' advises to use 1:10.000 (Rijkswaterstaat 2008b; Rijkswaterstaat 2008c). Now it is ones every 1430 years (Maurits 2008);
- The prognosis about the intensity of the traffic (Rijkswaterstaat 2008b):
    - Now ca. 19.000 vehicles per twenty-four hours
    - 2020 ca. 30.000 vehicles per twenty-four hours
    - An annual growth of 4%
- In 2008 is the maximum speed at the A7 on the constructions (sluices) 70 km/h. When improvement of the dam or constructions is needed, a new road profile should be designed with the next conditions (Rijkswaterstaat 2008b):
    - 2 x 2 driving lanes of 120 km/h.
    - Cycle tracks for two directions
    - Separation of cycle tracks and road through a barrier.
    - No increasing waiting periods at crossing of road and shipping traffic
- Public transport: at least the same amount of bus stops. For the basic function a spatial reservation for public transport is not needed (Rijkswaterstaat 2008b).



Model 1: Raising dam



Model 2: Second dam



Model 3: Natural barrier

7.2. Signification Guidelines and Assessment Spatial Models

Table 7.5 gives an overview of the various design guidelines mentioned in the previous paragraph. They do not all have the same importance. Based on my landscape architectonic vision and knowledge about 'De Afsluitdijk', the guidelines are given values from I (least) to V (most significant), and the models are given grades with pluses and minuses. As explained in the second chapter, this thesis uses the next order of importance:

1. Safety against flooding;
2. Spatial quality;
3. Fresh water basin;
4. Ecology;
5. Sustainable energy production;

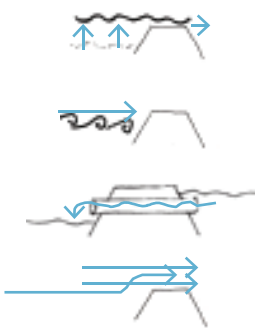
Although 'spatial model 3: natural barrier', is not the safest one (table 7.5), in combination with the other aspects like ecology, cultural history, sustainable energy, etcetera, it turns out to be the best model. The red and green circles show the extreme high or low points. It becomes clear that 'Model 1: raising the dam', is not the best because it is not taking the exiting characteristics and opportunities into account. 'Model 2: second dam', has less points because it scores low at points that have a high significance-value (like openness and spatial quality).

Significance of assessment-aspect	
I	Least important
II	Not that important
III	Average
IV	Important
V	Very important
---	The development is bad for the existing situation
--	The existing situation is decreasing
-	The existing situation does not change (zero points)
+	The existing situation improves a little bit
++	The existing situation improves
+++	The existing situation improves optimal

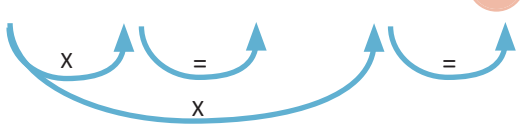
More than +9 points

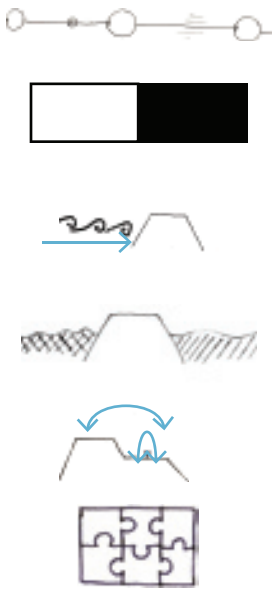
Less than -9 points

7.4. Spatial models of chapter 5



Guidelines	Elaboration	Value	Spatial model 1 Raising the dam	Total	Spatial Model 2 Second dam	Total	Spatial Model 3 Natural barrier	Total
Pre-conditions								
Protection	Against flooding (water heights)	V	+++	15	+++	15	++	10
Protection	Dealing with fierceness of waves	V	+++	15	++	10	++	10
Barrier	Barrier effect (natural water flow)	V	-	0	---	-15	-	-5
Protection	Against wind (by passing the dam)	II	-	0	++	4	-	0
Fresh water bassin	Drinking water	V	+++	15	+++	15	+++	15
Ambitions								
Fitting context	Using the unique location and characteristics of the	V	-	0	+	5	+++	15
Sustainable energy production	Contribution decrease climate change	V	-	0	-	0	-	0
	Osmosis	V	+	5	---	-15	+	5
	Sun	V	+	5	++	10	+	5
	Wind	V	+	5	-	0	0	-
	Waves	IV	+	4	+	4	+	4
	Gravity	III	-	0	+++	9	_	0
Experience Weather conditions	Sun	IV	-	0	-	0	-	0
Experience Weather conditions	Wind	IV	+	4	-	0	+	4
Experience Weather conditions	Waves	IV	-	0	-	0	+	4
Experience Weather conditions	Rainfall	IV	-	0	-	0	-	0
Multifunctional	Connection of the functions: dam-recreation-energy production	III	-	0	+	3	+++	9
Location bicycle path	View and noise	III	-	0	+++	9	++	6
Clear difference in landscape types	Friesland - Noord-Holland	III	-	0	-	0	-	0
Entrance	Friesland - Noord-Holland	III	-	0	-	0	-	0
De Afsluitdijk as an unity	De afsluitdijk is one element	IV	-	0	--	-8	+	4
Flexible design	Able to adapt to changes in climate	V	-	0	+	5	+++	15
Various users	Pedestrian	I	-	0	++	2	++	2
Various users	Cyclist/skater	IV	-	0	+++	12	-	0
Various users	Vehicles	V	-	0	++	5	-	0
Ambitions Spatial Quality								
Perception	Line (straight)	V	+++	15	---	-15	-	0
Perception	Openness	V	+++	15	---	-15	-	0
Perception	Both sides of the dam	III	-	0	+	3	++	6
Balance elements and dam itself	Unity	V	-	0	--	-10	+	5



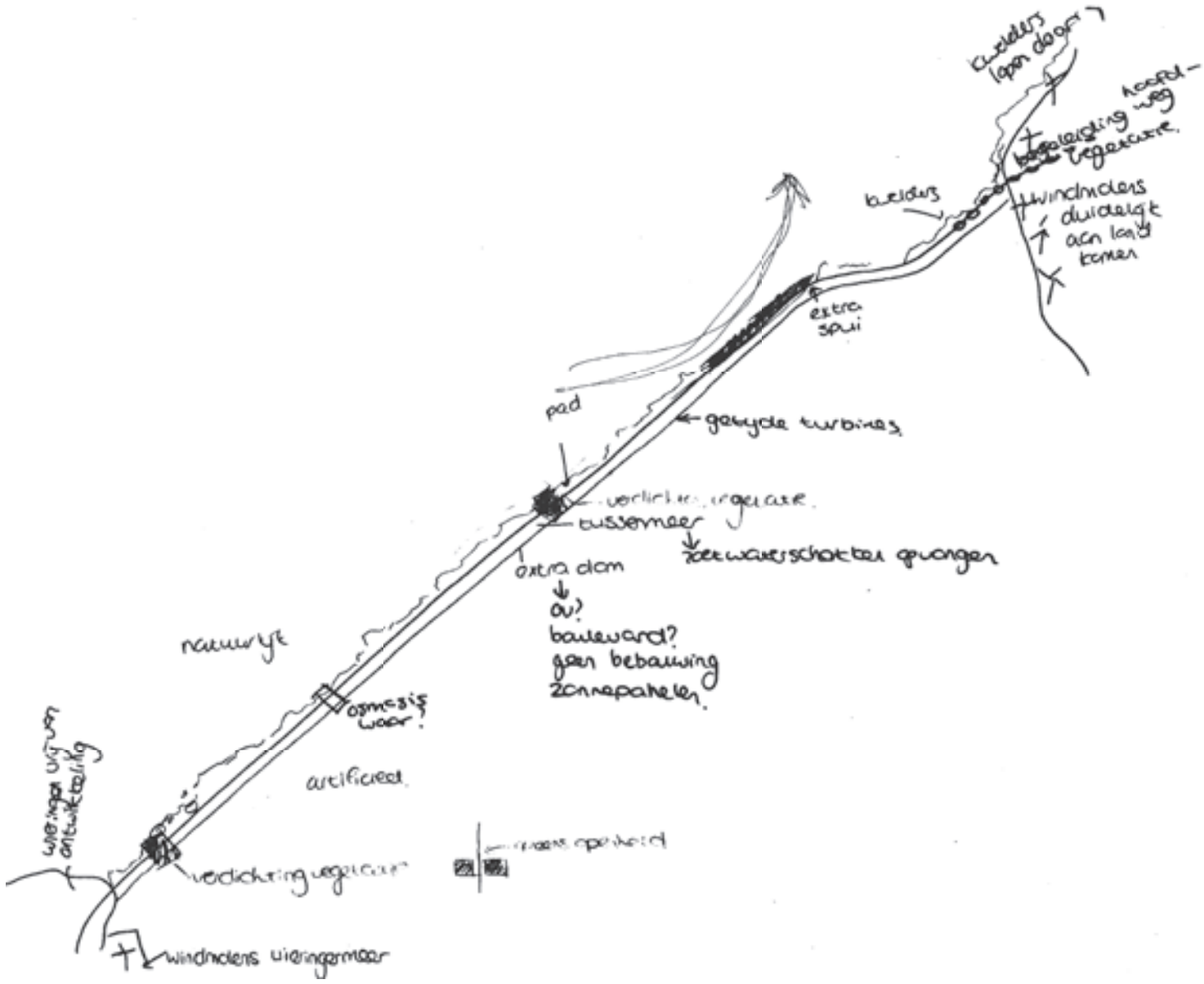


Perception	Sequence of exceptional places	IV	+++	12	+	4	-	0
Contrasts	Open-Enclosed	IV	-	0	--	-8	-	0
Contrasts	Artificial - Natural	III	-	0	-	-3	+++	9
Contrasts	Fierceness- Safety	IV	+++	12	++	8	+	4
Contrasts	Water-Land	III	+	3	--	-6	--	-6
Contrasts	Waddenzee - IJsselmeer	III	-	0	--	-6	+++	9
Maintain Character	Basic, anthropogenic, technical, uniform, consistent design	IV	+++	12	+	4	-	0
Fitting context	Location / form / readability	IV	+	4	--	8	+++	12
Ambitions cultural history								
Respect	Monuments	III	--	-6	-	0	--	-6
Spatial and visual unity	elements - dam	III	+	3	+	3	+	3
	Material use	II	-	0	-	0	+	2
Icon	Known by all Dutch as icon for safety against flooding	V	+	5	--	-10	+	5
Respect	sluices, defence constructions, dorpsgezicht Kornwerderzand	V	-	0	-	0	-	0
Ambitions ecology								
Enhancing characteristic habitats	Ecosystems and biodiversity	IV	-	0	---	-12	+++	12
Gradually connection between ecosystems	Fresh - Saline	V	---	-15	+++	15	++	10
Gradually connection between ecosystems	Fresh water inlet	IV	---	-12	+++	12	++	8
Use of ecological processes	To realize the idea	II	---	-6	---	-6	++	4
Quality IJsselmeer	Fresh water reservoir	V	+++	15	+++	15	+++	15
Take existing sedimentation and erosion processes into account		IV	-	0	---	-12	+	4
Enhance or increase biodiversity	Create shallow, more deep parts and shelter areas	II	-	0	+	2	+++	6
Technical demands								
Taking into account	W+ Scenario KNMI (climate change)	V	+++	15	+++	15	++	10
	Carry off fresh water	V	+	5	+	5	+	5
Crown reaised to 10 m +NAP		III	+++	9	--	-6	+	3
Cover of stone materials is able to deal with water going over the dam		III	+++	9	+++	9	+	3
Slopes are not more steep than 1:4		IV	+	4	+	4	+	4
Possibility for maintenance paths		IV	+	4	+	4	+	4
Possibility to reinforce the dam later on		V	+++	15	+++	15	+++	15
Total points concepts:			+ o -		+ o -		+ o -	
			Total:	186		87		249

Spatial model 3 (fig. 7.4, 7.6) turns out to be the best one with 249 points. It scores high (>9) on the next aspects (green circles):

- Safety against flooding;
- Dealing with fierceness of waves;
- Maintaining the fresh water basin;
- Fitting its context; using the unique location and characteristics of the dam for new functions;
- Multifunctional;
- Flexible design: Adaptive to changes in climate/sea level;
- Contrast: Artificial / natural
- Contrast: 'IJsselmeer'/ 'Waddenzee'
- Readability
- Maintaining / enhancing characteristic habitats: Ecosystems and biodiversity
- Gradually transition between saline and fresh ecosystem;
- Maintains the quality of the 'IJsselmeer';
- Takes the consequences of KNMI-scenario W+ into account;
- Possibility to reinforce later on.

The next paragraph deals with the elaboration and visualization of this natural barrier.



7.6. Spatial model 3: A 'natural' barrier in 'De Waddenzee' to protect 'De Afsluitdijk' against fierceness of waves and, which can grow with the expected sea level rise, turns out to be the best model

7.3. Design Objectives and Concept

Spatial model 3: 'Natural barrier' turns out to be the best model for the site of 'De Afsluitdijk'. This paragraph elaborates on what the natural barrier exactly is and how it looks like. The natural barrier should answer a few conditions (resulting from the (high valued) design guidelines and knowledge about the site):

- The natural barrier shout protect the dam against the higher water level of the 'Waddenzee' and the more fierceness of the waves (fig. 7.7);
- The natural barrier should be adaptive to the expected climate change. It should be able to grow with the expected sea level rise (fig. 7.8);
- To get the clearest contrast between naturalness and artificialness and to get an area of high ecological value, the barrier should build itself up in a natural way as much as possible by using the potential characteristics of the site (natural dynamical water flows, tide, trenches, waves, etcetera) (fig. 7.8);
- The natural barrier should not bring the fresh water reservoir of the 'IJsselmeer' into danger.
- The natural barrier should not decrease the spatial quality. The spatial quality of the site results in the characteristic and identity of the dam. The most important spatial quality is the thinness of the straight line (fig. 7.9) through the huge open water (fig. 7.10). This quality should be strengthened where possible;
- The natural barrier should not minimize the unique characteristics and opportunities of the site: The saline/fresh water, wind speed, fierceness of waves, sun hours and tide (paragraph 6.4), can be used to produce sustainable energy.

Summary constraints

Constraints by function:

Dam

- More storms: more and stronger waves
- Higher North sea water level

→ Does not suffice the 'Wet op de Waterkering'
Chance of flooded hinterland is bigger

Spout

- Higher IJsselmeer water level: spout capacity too low

Constraints by effects :

Ecology

- Barrier natural water flow
- Abrupt fresh water inlet
- Barrier migrating fish
- Barrier fresh and saline ecosystem

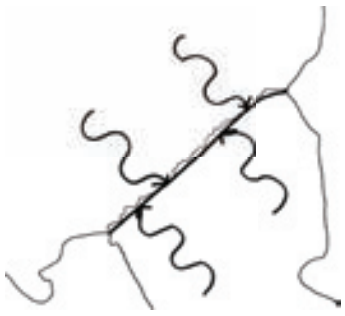
→
- Chance of flooded hinterland is bigger.
- Water life stock is dying or gets disseases
- Migrating fish die out

Perception

- Only one side of the dam can be experienced
- Cyclists bike in-between a dike and a highway

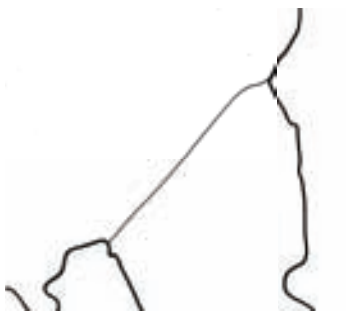
→
- No one is aware of the fact they are in the middle of the sea (icon)
- The water of IJsselmeer / Waddenzee can not be experienced, what is a missed opportunity because water attracts people

By developing these design objectives (fig. 7.11), several constraints are solved and a variety of ambitions are implemented. It provides a framework that adapts to changes in climate, society and techniques.



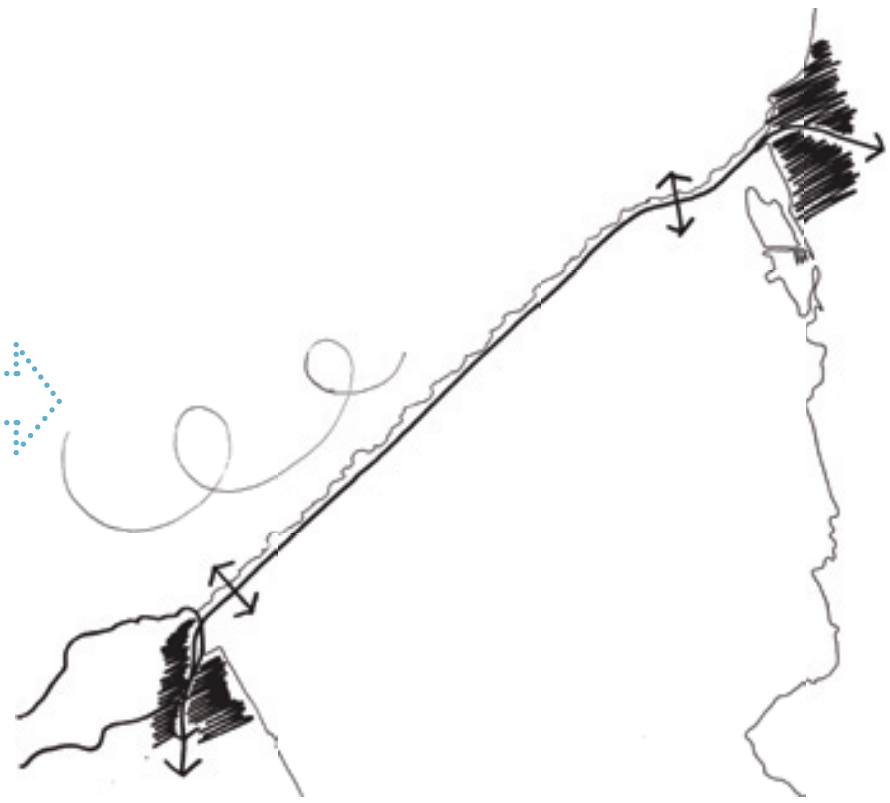
7.7 Protect against higher water levels and fierceness of waves

7.8. Build up naturally by using the dynamics of the area



7.9. Maintain the thin, straight line

7.10. Strengthen the contrast of the huge open water and the land



7.11. Landscape design objectives together

Concept (fig. 7.12)

Salt marshes protect the western part of ‘De Afsluitdijk’. The salt marshes decrease the fierceness of the waves and grow with the expected sea level rise. The dynamics of the area (tide and waves) are still visible in the landscape. ‘

Reefs, situated just below average high tide, protect the eastern part of the dam against the fierceness of waves.

To make the dam safe enough, the total dam is raised with 2,35 meter.

I assume the new extra spout together with the osmosis plant will take care of the extra run off of the rivers. Until 2050, low tide is used to spout and after 2050 pumping is needed or the ‘IJselmeer water level has to be higher.

The potential of the area (combination of fresh and saline water) is used. I assume the highest difference in salt-concentration is at ‘Breezanddijk. At ‘Breezanddijk’ an osmosis institute is situated.

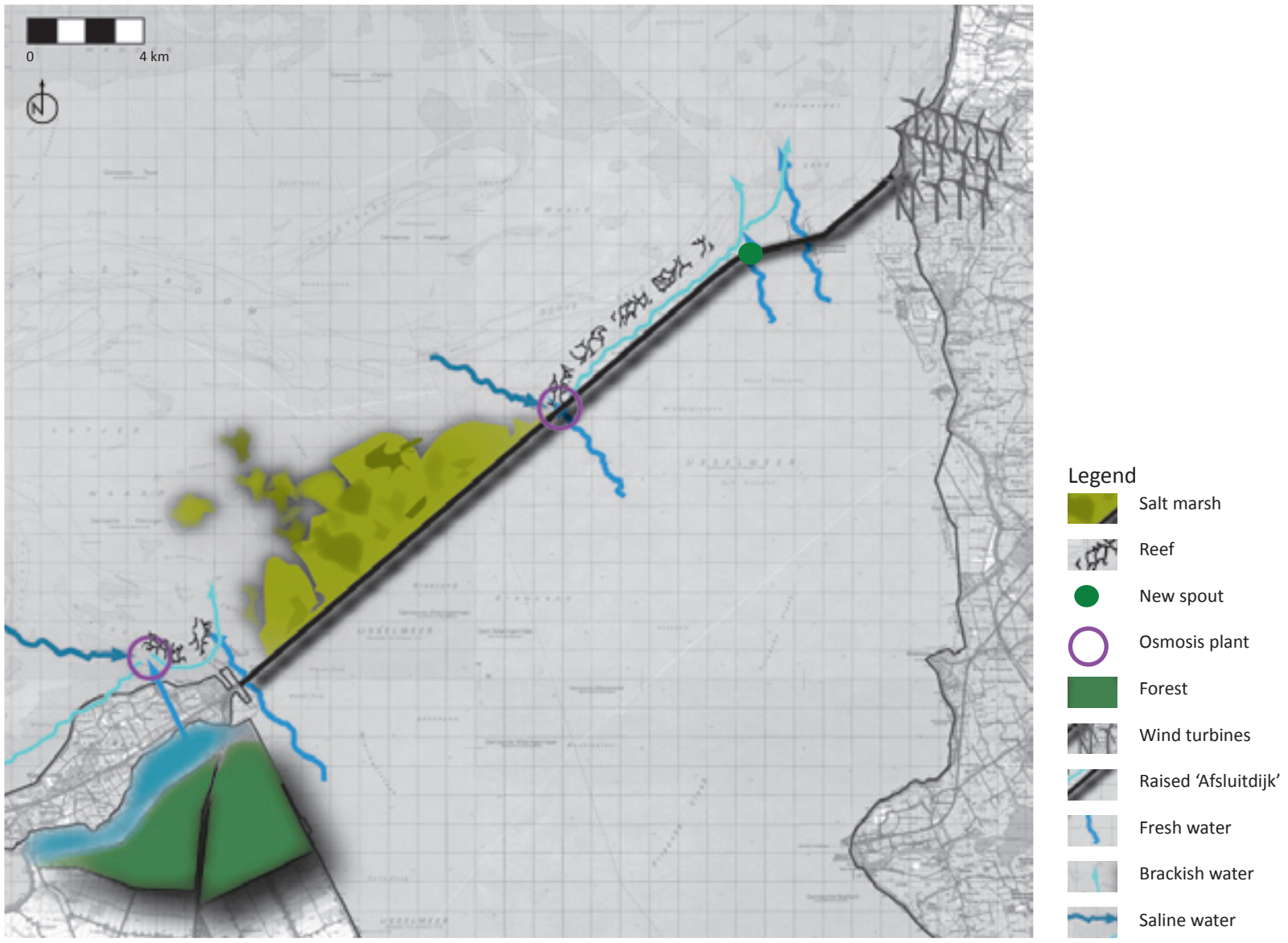
The brackish water, what is the ‘waste’ of the osmosis institute (‘Breezanddijk’ and ‘Wieringen’), mixes with the fresh water, spouted from the ‘IJsselmeer’ to the ‘Waddenzee’ (Stevin Sluices, Lorentz sluices, new spout) what is better in ecological point of view.

The reefs’ main function is protecting the dam. The second function is leading the brackish water to the spouts.

The dynamics of the site are more clear to visitors, because of the salt marshes and reefs. The salt marshes flood every now and than and the reefs are visible during low tide, but not during high tide.

The contrast between land (enclosed) and water (open) is emphasized by using landscape specific elements of ‘Noord-Holland’ (fig. 4.4) and Friesland (fig. 4.7) to make mass. At ‘Noord-Holland’ forest is used and at ‘Friesland’ the high raised elements; wind turbines.
While driving along the A7, the driver experiences a ‘wow-effect’ because the open landscape arises abrupt after passing the enclosed (forest/ wind turbine) landscape.

The contrast between the naturalness of the ‘Waddenzee’ and the artificialness of the dam is strengthened by the natural dynamic mud flats and the geometrical profile of the dam.



7.12. Concept

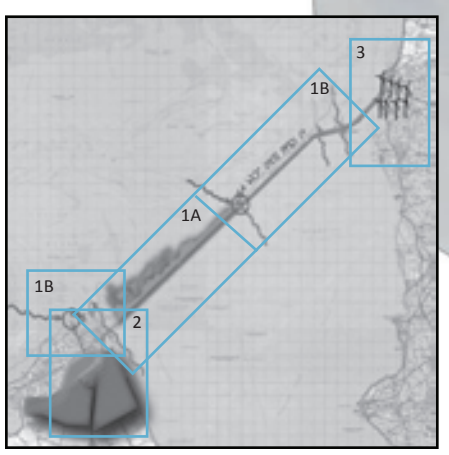
7.4. Design ‘Afsluitdijk’

The next paragraphs explain how the concept transforms into the design. The image on this page gives an overview of the total design. To explain the design the site is split into three areas:

1. ‘De Afsluitdijk’
2. ‘Den Oever’
3. ‘Friesland’

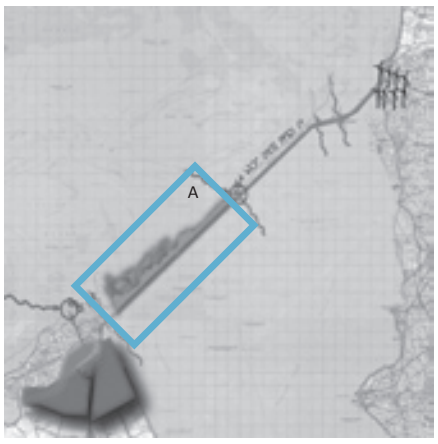
The next pages elaborate on these three areas.

7.13. Design



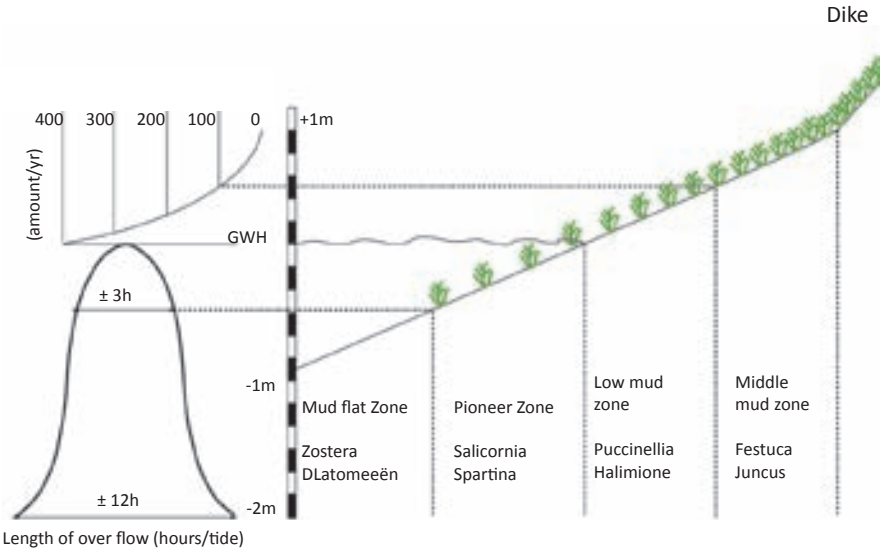

0
1 km
Legend ‘De Afsluitdijk’
‘Afsluitdijk’ (A7)
Water
(‘IJsselmeer’, ‘Waddenzee’)
Water planned
(‘Wieringerrandmeer’)
Salt marsh
Reef
Wicker dams
Brackish marsh
Saline marsh
Fresh marsh
Forest (existing)
Forest (planned)
Forest (proposed)
Village
Regional road
Wind turbine
Osmosis plant
Tubes for osmosis

Western part of 'De Afsluitdijk' – Salt marshes



7.14. Western part 'Afsluitdijk'

7.15. Current situation



7.17. Zoning and inundation frequency (based on Erchinger, 1985).

Development of salt marshes

Salt marches (fig. 7.20) come into being on tidal plates that have enough height, are protected against waves and currents, and have enough sediment, plant or seed supply. Because of an interaction between physical and biological processes the tidal planes can develop to a salt marsh above average high tide with a salty plants vegetation. In this phase geomorphologic patterns of creeks, river banks ('oeverwallen') and lower parts ('kommen') are formed. Salt marshes are always situated at places where the tide can reach them. Figure 7.17 show salt marshes can follow the sea level rise and sinking of the land, because of a combination of natural silting up and vegetation growth. The area can be characterized as a place with sedimentation and erosion.

Vegetation is an important element of the development of salt marshes (fig. 7.18, 7.19). The most important pioneer is 'Salicornia Spartina' ('Zeekraal') of one year old. This plant grows a few decimeters below average high water level ('GHW'). The pioneer stage is the most fragile, because this stage exists of a vegetation-cover of one year old plants. Also 'Eda maritima'('Klein Schorrekruid') is located in the lower parts. 'Salicornia Spartina' facilitates the development of 'Puccinellia maritim' ('Gewoon Kweldergras') (K.S. Dijkema, A. Nicolai et al. 2007b)

Around the average high water level, the older 'Puccinellia maritim' is covering the ground enough to (S. Dijkema, W.E. van Duin et al. 2007a):

- Silt up;
- Develop a creek system. A better drainage improves the succession to the next vegetation types;
- Decrease erosion of the young salt marshes.

'Zostera marina' ('Groot Zeegras') is in The Netherlands part of the 'Waddenzee' almost disappeared. Before the construction of the 'landaanwinningswerken' (getting land from the sea) in 1935 'Zostera' was growing over there. After finishing the maintenance in the outer parts (1986) the sea grass came back in the area (K.S. Dijkema, A. Nicolai et al. 2007b).

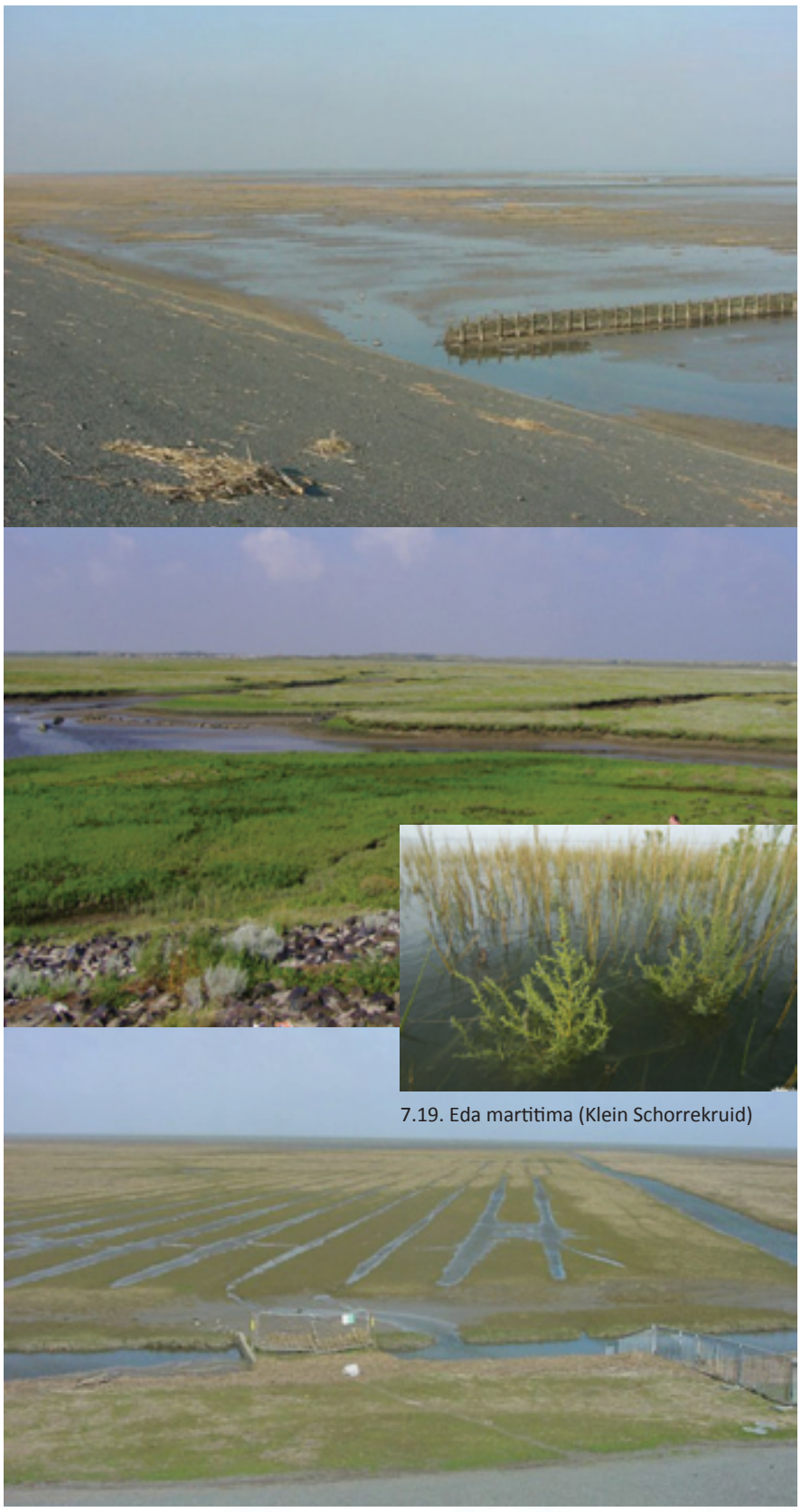
7.16. Impression salt marsh

7.18a. Zostera marina (Groot Zeegras)

7.18b. Salicornia Spartina (Zeekraal)

7.18c. Puccinellia Halimione
(Gewoon Kweldergras)

7.18d. Festuca juncifolia
(Duinzwenkgras)



7.19. Eda martitima (Klein Schorrekruid)

The vegetation stimulates the establishment of silt. Less floods means less silting up. The silting up depends on the frequency of flooding. The tidal water transports sediments over the salt marsh. The silting up decreases with the height and distance to creeks. At places where vegetation is situated the sedimentation of silt is the highest. At open places the water flow is concentrated resulting in less silting up or even erosion (new creeks). The creek system is important for the transportation of water, but also for the transportation of sediments and nutrients. The creeks are meandering because of erosion in the outer bends and sedimentation of the inner bends. In the pioneer stage the creeks are broad and shallow, in later stage they are small, deep and narrow. The pattern and concentration depends on the tide, water flow speed, soil type and salt mars morphology. At sandy salt marshes the creeks are in low density. (S. Dijkema, W.E. van Duin et al. 2007a)
Next to the surface of salt marshes, the quality of vegetation is important. Because of silting up, the zone changes from low, middle to a high zone. A difference in silting up between the pioneers zone and salt marsh can result in cliff erosion. A solution for cliff erosion is protecting the area against waves and water flows with sustainable 'wicker dams' (fig. 7.21): wood of 'Picea abies' ('Fijnspar'), 'Pseudotsuga menziesii' ('Douglas') and/or 'Picea sitchensis' ('Sitkaspar'). (S. Dijkema, W.E. van Duin et al. 2007a). 'Wicker dams' are dams that consist of piles, situated next to each other.

The vegetation is changing by succession because of the height (fig. 7.17). The end of the succession is the phase of climax. When this is happening the vegetation is less divers and the climax types will dominate the area. The biodiversity for birds and invertebrate animals is decreasing with the development of the salt marsh. Graze bare can postpone the development of the climax phase. This can occur by goose, rabbits and cattle. Intensive grazing can conserve a salt marsh in a young stage with not much vegetation types.
Bare grazing decreases the development of the vegetation but not the rising of the ground level. The grazing results in crushing under the feet, and grazing bare of vegetation, a dryer, compact, salty soil, and a higher biodiversity. (K.S. Dijkema, A. Nicolai et al. 2007b)

7.20. Impressions of salt marshes

7.21. Wicker dams (Rijshoutdammen) result in a more quiet water

7.22. Recreation on the salt marsh

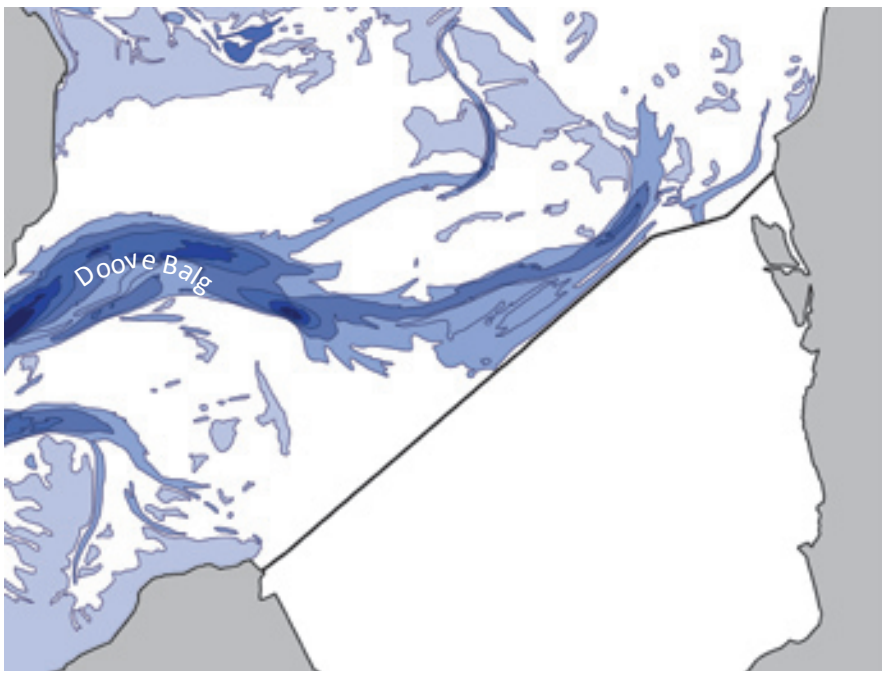
Salt marshes at the 'Waddenzee'
On international scale salt marshes are high valued nature. Additional they can function as a natural foreshore for sea dikes. A high foreshore decreases the heights of waves and how high the wave smashes against the dike. In Germany and Denmark salt marshes are used as part of the sea barrier (Anon. 2003; Hofstede 2003 in (S. Dijkema, W.E. van Duin et al. 2007a)).
The Dutch government says about the report of the 'Adviesgroep Waddeenzeebeleid': stimulating new salt marshes should be happening because of the safety of the hinterland (S. Dijkema, W.E. van Duin et al. 2007a)p36. The shallow parts at the West of 'De Afsluitdijk' are suitable to construct a bank that can add a salt marsh biotope (S. Dijkema, W.E. van Duin et al. 2007a) p3.
The aims of the 'PKB-Waddenzee' and the 'Trilateral Targets' between Denmark, Germany and The Netherlands (see chapter 4) can be reached by (S. Dijkema, W.E. van Duin et al. 2007a):

- A bigger amount of natural salt marshes;
- A bigger surface of natural morphological and dynamic salt marshes;
- An improved natural vegetation structure of artificial salt marshes reflecting the geomorphologic condition of the habitat;
- Improved situations for migrating and brooding birds.

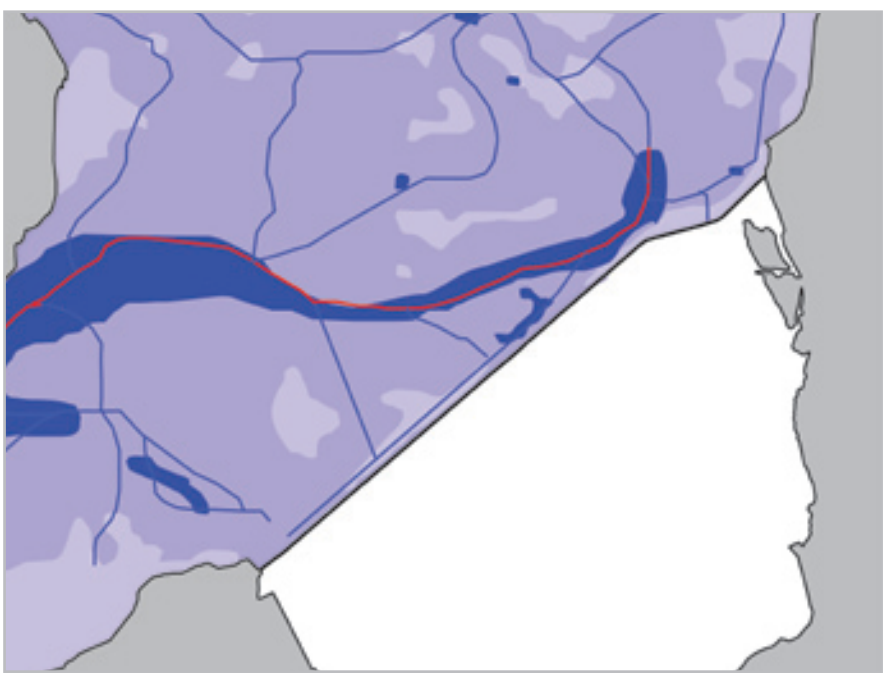
There are two reasons why the western part of the 'Waddenzee' does not contain salt marshes any more (Dijkema 2001; S. Dijkema, W.E. van Duin et al. 2007a):

1. Salt marshes and water surfaces are diked in ('Anna Paulownapoler', 'Waard-Nieuwland', and 'Prins Hendrikpolder', etc.). Almost no high situated planes remained, so growth was not possible.
2. The geomorphologic character of the eastern 'Waddenzee' changed. This area has a small tidal amplitude, big influence of wind waves and the construction of 'De Afsluitdijk'. This resulted in a higher average high water level and a shortage of sediment.

But with the help of people semi-natural salt marshes can come into being again. The amount of sedimentation in the 'Waddenzee' is high enough (Duin 2008). The proposed salt marshes protect 'De Afsluitdijk' against the fierceness of the waves. The advantage of salt marshes is that they grow with the expected sea level rise. It is not possible to implement this idea to the whole northern part of the dam because of the existing trench: 'Doove Balg' (fig. 7.23). This trench consists of strong waves and high speed water flows (fig. 7.24).
According to 'van Duin' (2008) salt marshes should be at least a few hundreds of meters broad to be safe against flooding. Further research on this is needed. According to Dijkema (2005) a salt marsh should have a minimal surface of 500 ha because of the fragility of small locations, conservation of the biodiversity and to make the cycle of development possible. (S. Dijkema, W.E. van Duin et al. 2007a). For the spatial quality it is better to broaden the salt marshes. It should not look like a broadened dam, but as a straight high dam with salt marshes next to it.



7.23. Depths (m), the main trench 'Doove Balg' is clearly visible

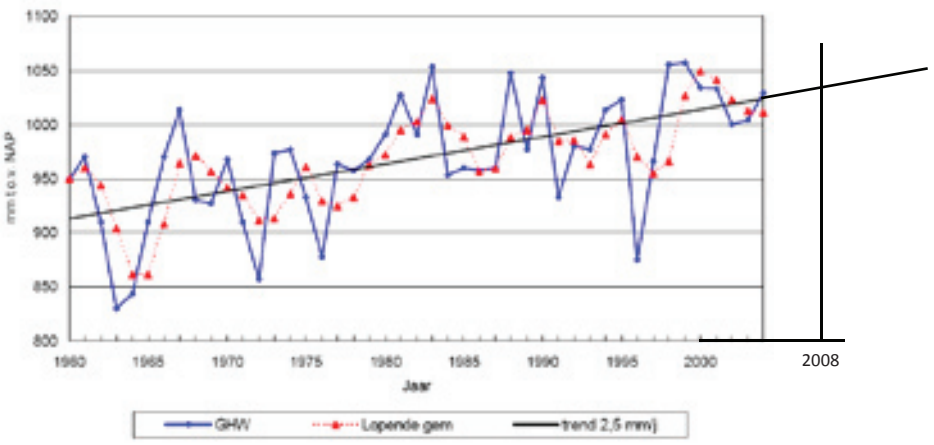


7.24. Fairways and speed of water in the Waddenzee

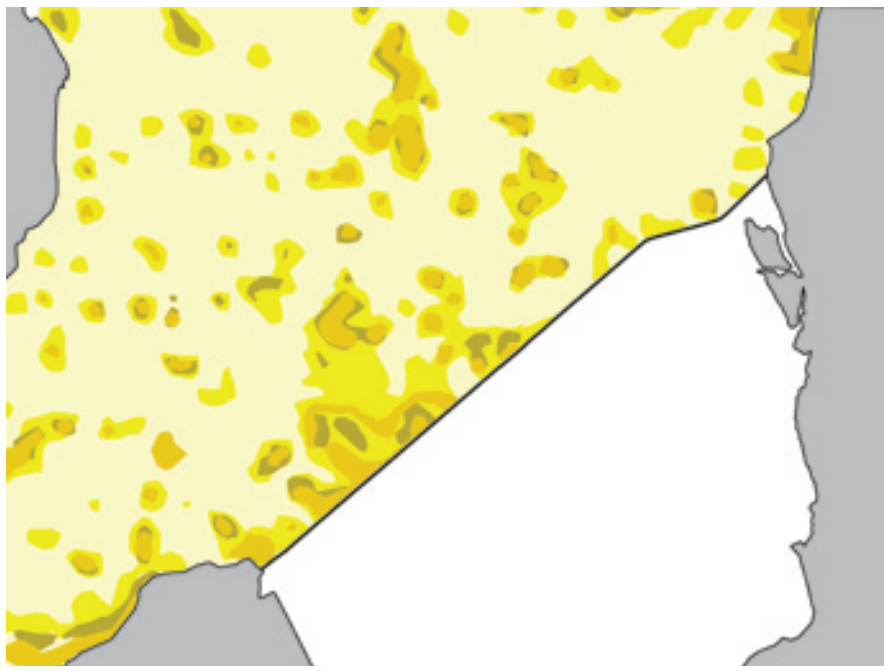
The highest and most silty parts of the western ‘Waddenzee’ are used for the development of new salt marshes (fig. 7.25). The height of the salt marsh is around GHW (Average high water level, fig. 7.17, 7.26). ‘Waste’-materials of other developments are used to build up the salt marsh. Where possible, materials of the area itself are used (fig. 7.27):

- The fairways of the harbours surrounding the ‘Waddenzee’ and ‘Eems’ are dredged. The mud is normally dumped back elsewhere in the ‘Waddenzee’ (InterWad projectteam 2008). In 2005 the amounts of mud where: ‘Marsdiep’ 213,601 m^3, ‘Vlie’ 264,153 m^3, and ‘Friesche Zeegat’ 47,380 m^3 (525,134m3 in total) (InterWad projectteam 2007).
- Also the construction of the ‘Wieringerrandmeer’ will result in a lot of materials that can help to construct a base for a salt marsh.
- Furthermore bringing up sand (‘zandsupspletie’) to the beaches of ‘Zeeland’, ‘Zuid-Holland’, and ‘Friesland’ will result in a natural flow of sand to the North. When possible the area should be build up with as much as possible with materials of the area.

The salt marshes are made with the help of ’wicker dams’. Test areas are needed to find out where to place the wicker dams exactly. It is known that wicker dams protect the area behind against the fierceness of waves. This makes it possible for materials to sink. This sedimentation is the beginning of the salt marsh. Later on the salt-marsh-vegetation will establish itself in a natural way. How the climate will change is very uncertain. That is why test areas and monitoring is needed. When the sea level rises faster than the salt marsh, more wickers dams can be placed, more sand can be put into the water and seeds can be dispersed.



7.26. Mean High Water level of the ‘Waddenzee’ in 2008: 1040 mm in comparison to Average Mean. This is the height at which the salt marsh is above water level (see figure 17).



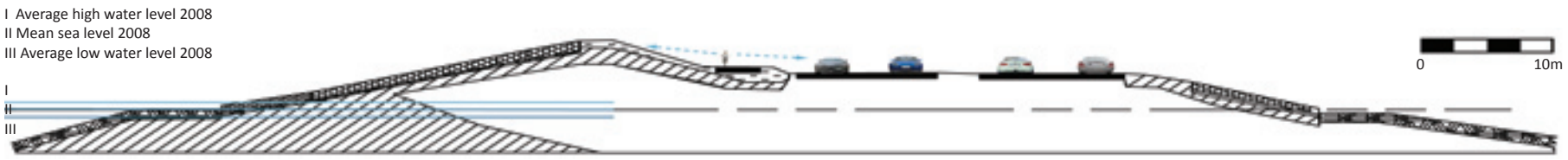
7.25. Percentage of silt

7.27. Materials like sand / silt from ‘Markermeer’, ‘Wieringerrandmeer’, fair ways and ‘Eems’ can be moved to ‘De Afsluitdijk’. Because of the supspletion at the coast of the provinces ‘Zeeland’, ‘Zuid-Holland’ and ‘Noord-Holland’ will sand naturally move to the North

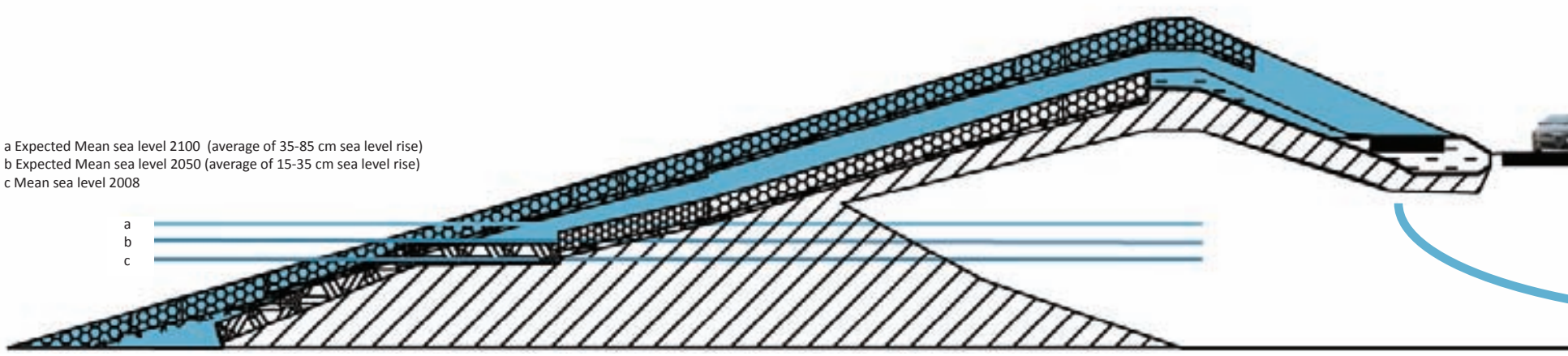
Salt marshes along 'De Afsluitdijk'
Previous text explains why it is impossible to protect the whole 'Afsluitdijk' with salt marshes. Figure 7.30 gives an overview how salt marshes along the western part of the dam can look like.
The salt marshes are decreasing the fierceness of the waves and can grow with the expected sea level rise. They also have a high biodiversity (fig. 7.40). Furthermore they filter silt out of the water, which makes it cleaner. This silt is used to grow higher and higher. The cleaner water is useful for the osmosis plant at 'Breezanddijk'. The water that goes into the plant needs cleaning first. Because of the salt marshes less cleaning (or no cleaning) is needed. The new salt marshes are also used for recreational purposes. A strolling path (fig. 7.32) makes it possible to stroll through the salt marsh area and perceive the 'other' side of the dam; the 'Waddenzee'-side. The weather conditions and dynamics of the area can be felt and seen.

Raising the dam
The salt marshes decrease the fierceness of waves and grow with the sea level rise, but with extreme storm surges the water can wash away a big part of the salt marsh. To make 'De Afsluitdijk' totally safe the profile is heightened with 2,35 meter. This means the dam also becomes broader. The 2,35 meter results from the most cost efficient way to raise the dam (fig.7.29): raising the highest part. This is the most cost efficient, because the highway can be conserved. The 2,35 m is the maximal height that can be reached with the same slope and without moving the highway. When it is in the future necessary to raise the dam even more, the highway has to move or another slope needs to be implemented, but assumed is that this will not happen before 2200. Further more the highest part of the dam is covered with basalt blocks, which makes it possible that water goes over the dam during storm surges, without harming the dam too much ('overslagdijk').

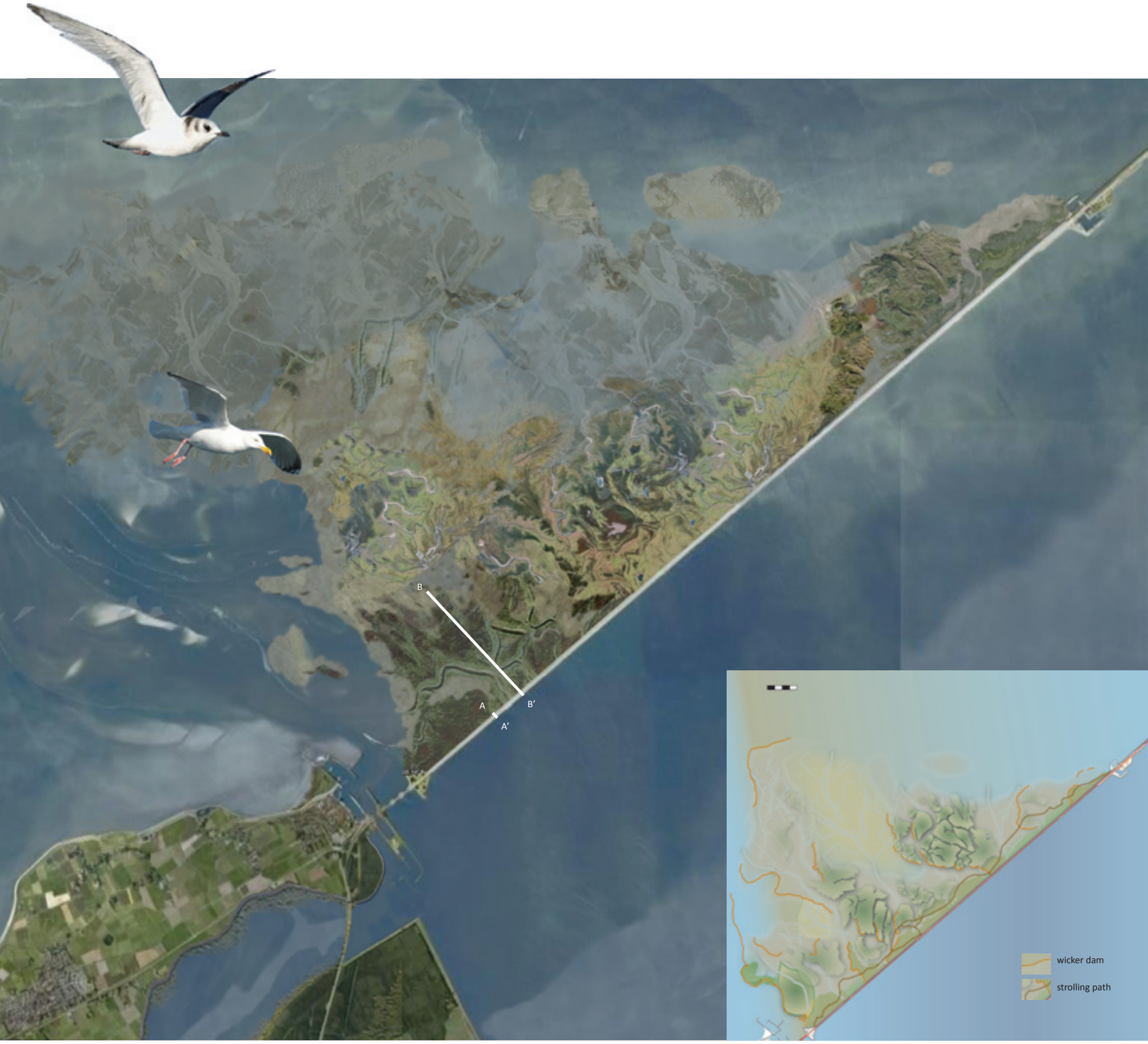
In the current situation (fig. 7.28) the existing bicycle path is situated in-between the highest part of the dam and the highway. Proposed is to move the bicycle path to the other side of the highway, to the side of the 'IJsselmeer'.
By moving the bicycle path (fig. 7.29, 7.33), two constraints are solved. One of safety: it makes it possible to rise (broaden) the dam, and one of the perception: in makes it possible to experience the lake, instead of a 'wall' (dam). Further the cyclists have less nuisance of the noise of the passing cars of the highway.
By moving the bicycle path, the cyclists are coping with more wind, because they are not cycling behind the dam anymore. To protect them against weather conditions and (the noise) of the cars, a higher part is



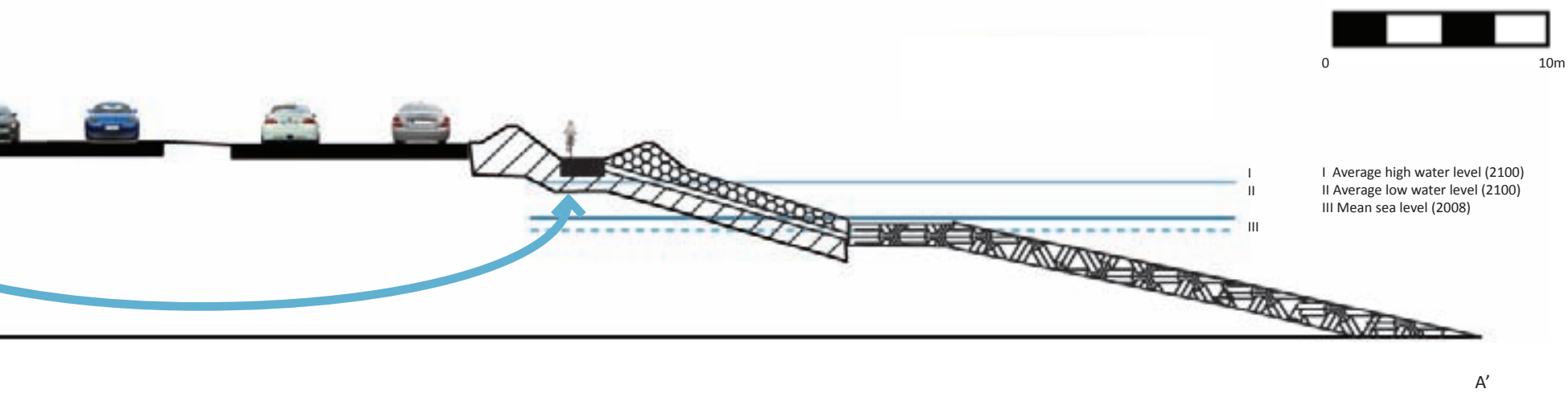
7.28. Current situation



7.29. Proposed situation: the dam is raised with 2,35 meters and the bicycle path moved to the other side of the dam



7.30. Salt marshes along the Western part of ‘De Afsluitdijk’



7.31. Impression of the salt marsh area next to ‘De Afsluitdijk’ in 2200

7.32. Impression of strolling over the salt marshes

constructed in-between the highway and the bicycle path. Because of this, the recreant will focus more on the ‘IJsselmeer’.

The higher part, next to the bicycle path, has potential to place solar panels to produce energy. By constructing slope of the increment in the most optimal angle for solar panels: 36 degrees, they can produce about 320 MW (enough for about 90 households for a year).

The ‘Deltacommissie 2008’ recommends to higher the IJsselmeer water level with 1,5 meters to ensure enough fresh water in the expected dry summers of the future (Deltacommissie 2008 2008). This means a lot of adaptation in the villages surrounding the IJsselmeer. All dikes have to be higher and harbours have to adjust to the higher water level. The design proposes to spout with the help of gravity till 2050 and afterwards pumping. However the design is flexible, when the government decides to raise the water level of the IJsselmeer with 1,5 meter and not to pump, the profile is still safe for passing people.

Strolling
A strolling path (fig. 7.32) makes it possible to stroll through the salt marsh area and perceive the ‘other’ side of the dam; the ‘Waddenzee’-side. The weather conditions and dynamics of the area can be felt and seen. The path is made of natural materials, which can decline. When people use the path more often, the path will stay into being. Fencing is not needed, because people will not go very far into the area, because the dam is their orientation point. Further into the area the area gets too wet to be attractive for people to go in. The path leads from ‘Den Oever’, via ‘de Vlieter‘ (monument) to ‘Breezanddijk’. At ‘Den Oever’ people can enjoy the village, at the Monument people can climb the viewing tower and have a drink in the small cafeteria. At ‘Breezanddijk’ the osmosis plant is open for public and has and educational character. It makes people aware of the forces of the nature, but also about their living styles.

Phases of the development of the salt marsh
Figures 7.34 to 7.39 show an indication of the different development stages of the salt marshes. These stages are not very predictable and adaptation to the existing situation is needed. When seen the salt marsh is not growing fast enough, sand can be added. When seen the vegetation does not establish fast enough seeds can be spread.

7.33. impression of the moved icylce path at the ‘IJsselmeer’ side with solar panels to produce energy

1 7.34. Current situation 2008

2 7.35. impression situation 2025

3 7.36. Impression situation 2050

4 7.37. Impression situation 2100

5 7.38. Impression situation 2150

6 7.39. Impression situation 2200

B (page 103)

‘Drieteenmeeuw’
‘Rissa tridactyla’

‘Kleine Mantelmeeuw’
‘Larus fuscus’

‘Schol’
‘Pleuronectus platessa’

‘Kwelder springer’
‘Orchestia gammarellus’

‘Wadslakje’
‘Hydrobia ulvae’

‘Tureluur’
‘Tringa totanus’

‘Kluut’
‘Recurvirostra avosetta’

‘Groot Zeegras’
‘Zostera marina’

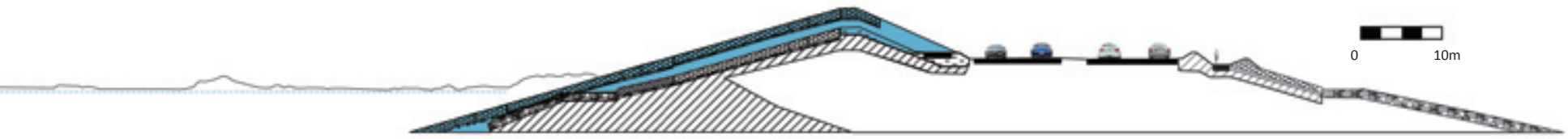
‘Klein Zeegras’
‘Zostera’

‘Klein Schorrekruid’
‘Suaeda maritima’

‘Kortarige Zeekraal’
‘Salicornia europaea’

‘Gewoon Kweldergras’
‘Puccinellia martima’

7.40 Cross section salt marsh and flora and fauna of the salt marsh



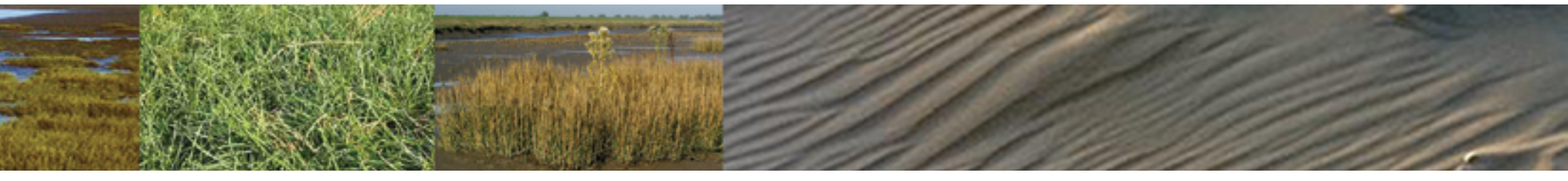
B’

‘Drieteenmeeuw’
‘Rissa tridactyla’

‘Zilvermeeuw’
‘Larus argentatus’

‘Rotgans’
‘Branta bernicla’

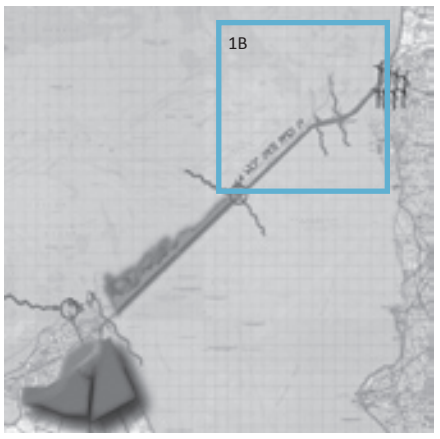
Human
‘Homo sapiens’



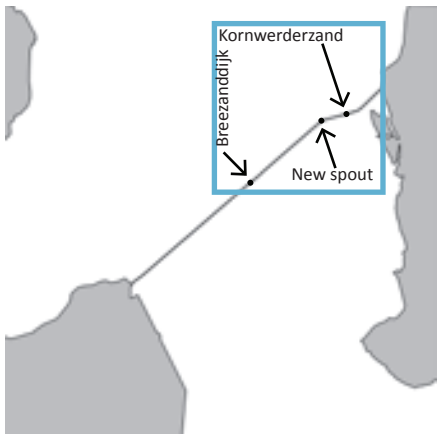
‘Rood Zwenkgras’
‘ Festuca rubra’

‘Engels Slijkgras’
‘Spartina anglica’

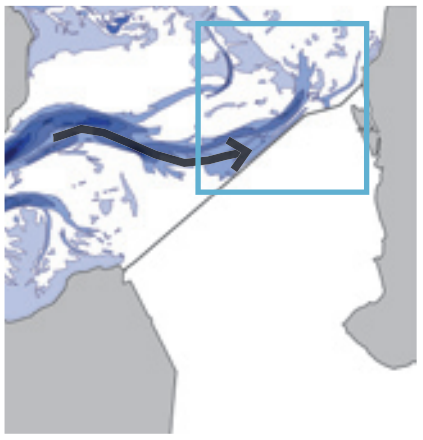
Eastern part of ‘De Afsluitdijk’ - Osmosis and reefs



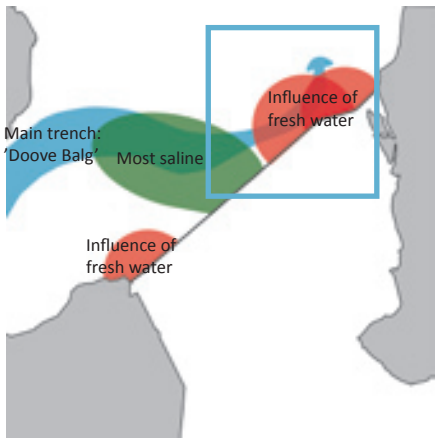
7,41. Eastern part of ‘De Afsluitdijk’



7.42. Current situation eastern part of ‘De Afsluitdijk’ (1B)



7.43. Current water flow ‘Doove Balg’



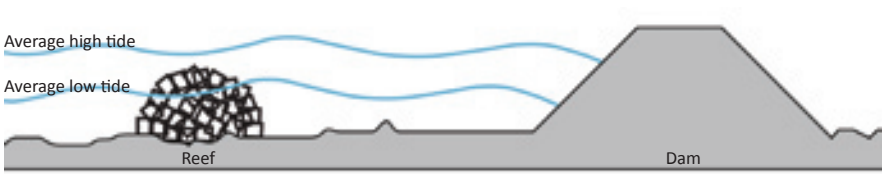
7.44. Assumption concentration fresh - saline water. The fresh water from the ‘IJsselmeer’ passing the sluices influences the concentration in the ‘Waddenzee’

It is impossible to protect the whole length of ‘De Afsluitdijk’ with salt marshes, because of the existing trench ‘Doove Balg’ (fig. 7.43). Through this trench water flows with high speed and contains waves with much energy.
As the concept explains in paragraph 7.3 the reefs are protecting the eastern part of ‘De Afsluitdijk’.

Reefs
Reefs (situated at about 200 meters from the dam) decrease the fierceness of the waves (fig. 7.46). They are build up with basalt blocks and have a semi-natural look and add new habitats to the existing situation, because various elements sediment behind the reefs (fig. 7.55). This results in deeper and shallower areas what makes it interesting for ecology.
The reefs will reduce the fierceness of the waves, but this is probably not enough to ensure safety against flooding. The design proposes to raise ‘De Afsluitdijk’ with 2,35 meters, by moving the bicycle path to the side of the ‘IJsselmeer’ (explained in fig. 7.29).
The reefs will be about 30 cm above Average Low tide; they are visible during low tide and invisible during high tide (fig. 7.45). The dynamic tidal character of the site becomes clearer to the visitor.

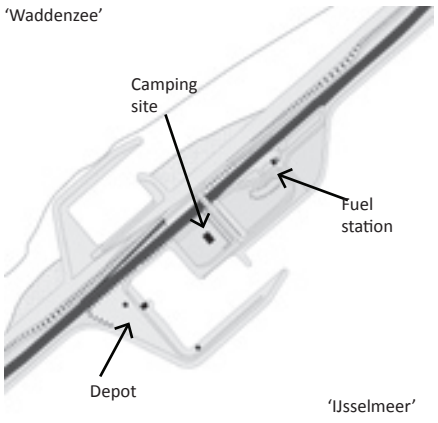
Sustainable energy production by osmosis
Paragraph 6.4. explains how fresh and saline water can result in sustainable energy production. To get the highest amount of energy, the osmosis plant should be situated as near as possible to the highest (saline) AND lowest salt concentration (fresh). Figure 7.44 shows at what place the ‘Waddenzee’ is the most saline and the ‘IJsselmeer’ is the most fresh: in the middle of ‘De Afsluitdijk’. At the sides of ‘Noord-Holland’ and ‘Friesland’ (‘Waddenzee’ side), the water is least saline because of the influence of the two sluices: Lorentz and Stevin.

‘Breezanddijk’, the former working island, is situated in the middle of ‘De Afsluitdijk’. The figures 7.42, 7.47 show the current situation. At this moment ‘Breezanddijk’ contains a fuel station and a camping site. Next to this, some space is used for recreation: picnicking, mostly used by people with mobile homes. There is a bridge what makes it possible to go from one side, to the other side of ‘De Afsluitdijk’. There is a big space free of use. At this place an osmosis plant is proposed.
The osmosis plant is producing sustainable energy, but the waste of osmosis is brackish water. Fresh and saline water go in, and brackish water comes out (fig. 7.48) (IMSA 2008).
The osmosis plant at ‘Breezanddijk’ is also an educational and innovative site for visitors. The osmosis is concentrated in one building. According to REDstack (2008) one big central installation has not that many advantages in comparison to scattered modules over the length of the dam. The modules can be constructed into the core of the dam or under the water surface.
The average fresh water flow through the spouts of ‘De Afsluitdijk’ is 500m^3/s, which can result in about 500 MW electrical power. According to REDstack (2008) the minimum outflow of 200m^3/s (on base of 200 MW energy production) is enough to supply 500.000 households of energy (IMSA 2008). This is enough for the three Northern provinces [RedStack, s.a. -179; Wolff, 2008 -178]. When the fresh water supply is lacking (for example in summer) the production has to be stopped (Consortium Natuurlijk Afsluitdijk 2008).

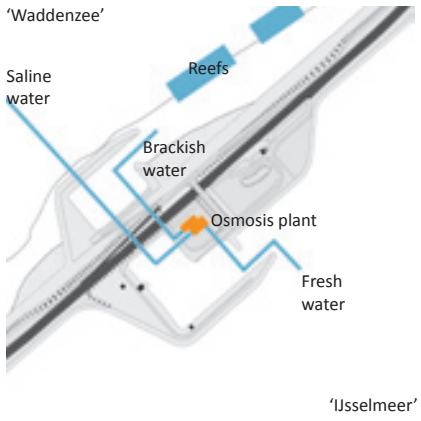


7.45. Height of reefs

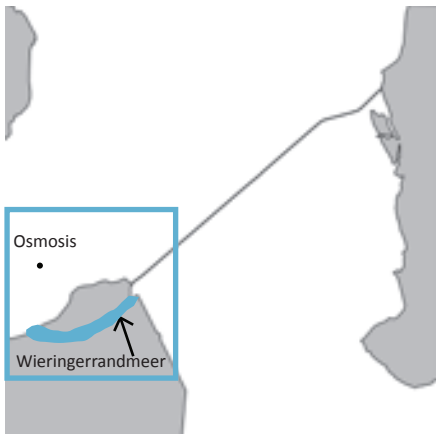
7.46. Reefs decrease fierceness of waves



7.47. Current situation ‘Breezanddijk’



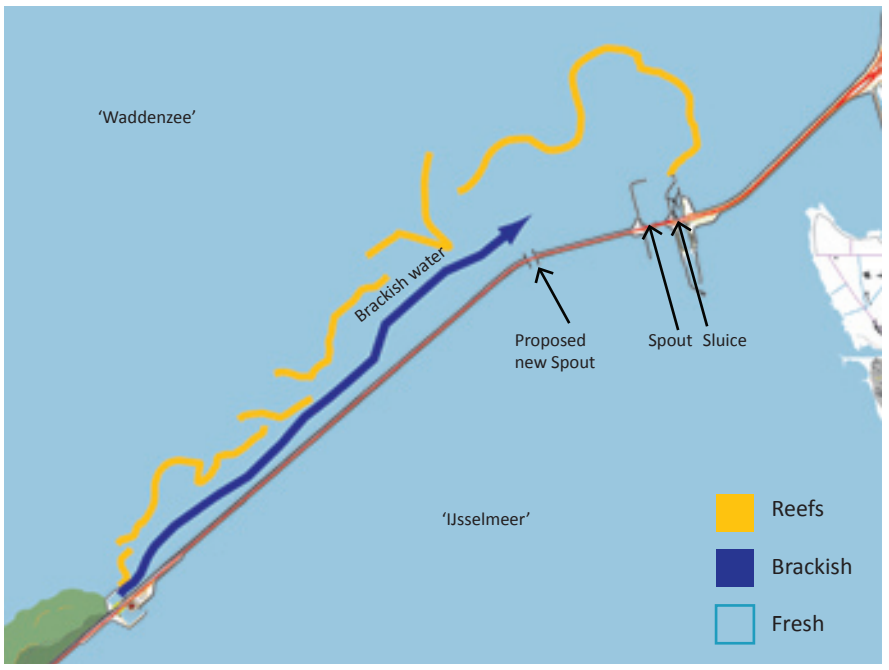
7.48. Proposed osmosis plant at ‘Breezanddijk’



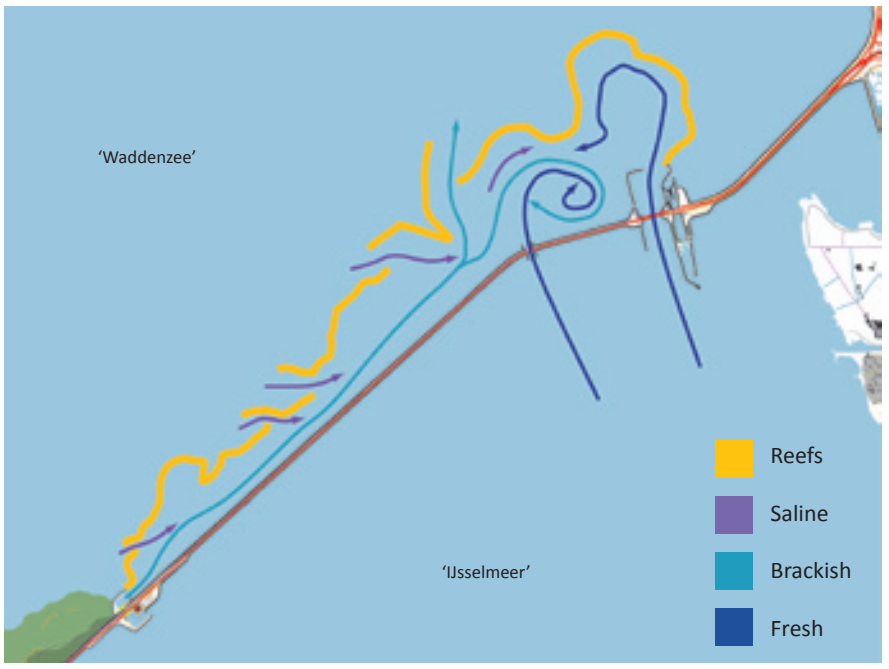
7.49. Osmosis near ‘Wieringen’

Solving the main ecological problem
One of the main ecological problems of ‘De Afsluitdijk’ is the fact that the dam is a barrier in-between the saline and fresh water ecosystem. When it is low tide, a sudden fresh water flow comes from the ‘IJsselmeer’ into the ‘Waddenzee’ and many animals die out or get (skin) diseases.
This design uses the brackish-water-‘waste’ of the osmosis plant to solve the abrupt fresh water inlets.

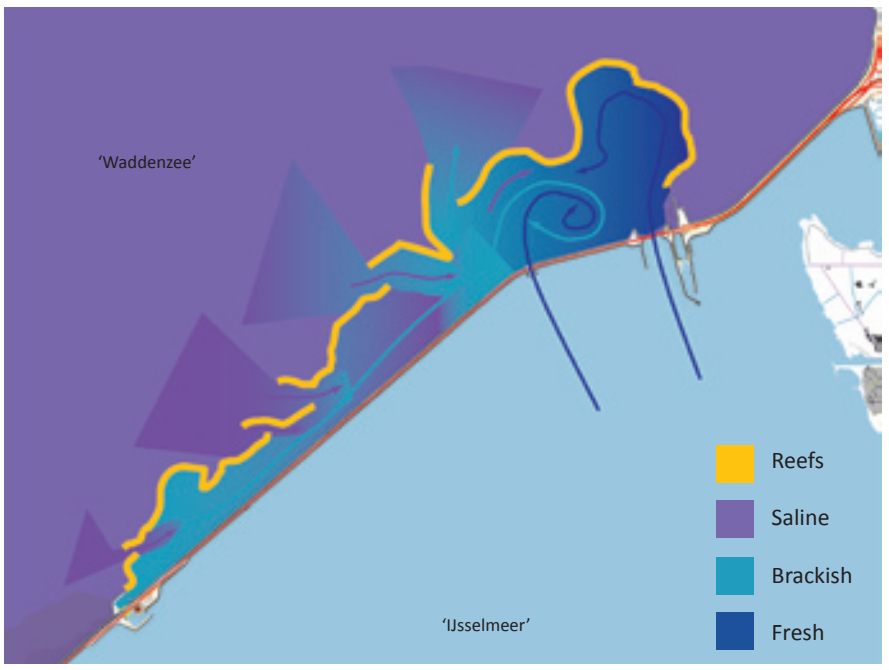
The brackish water from the osmosis plant at ‘Breezanddijk’, is lead along the northern part of ‘De Afsluitdijk’ to the spout with the help of the reefs (fig. 7.50). The brackish waste water of the osmosis plant is mixed with the fresh water of the spout near the arch and ‘Kornwerderzand’ (fig. 7.51). The water is mixed to decrease the difference between saline and fresh water.
The reefs decrease not only the fierceness of the waves, but also lead the water to the spouts. The reefs are situated just below Average Low Tide, which makes them function optimal when it is low tide, and the spouts are opening to spout with the help of gravity from the ‘IJsselmeer’ to the ‘Waddenzee’.
To move the water from West to East, the natural water flow of the ‘Doove Balg’ is used. The reefs are intersected with small gaps where saline water of the flow ‘pushes’ against the brackish water (fig. 7.51). A part of the ‘Doove Balg’-water mixes with the brackish water and makes the water flow in eastern direction. Near the spout the brackish water is mixed with the fresh water of the ‘IJsselmeer’. The mixed water flows a bit back in eastern direction and ‘escapes’ to the main trench (‘Doove Balg’) again. Here it is mixes for the last time with saline water.



7.50. The reefs guide the brackish water from ‘Breezanddijk’ to the spouts



7.51. Saline water flows through the gabs in-between the reefs and ‘pushes’ the brackish water flow to the spouts, where fresh water is mixed with the brackish water.

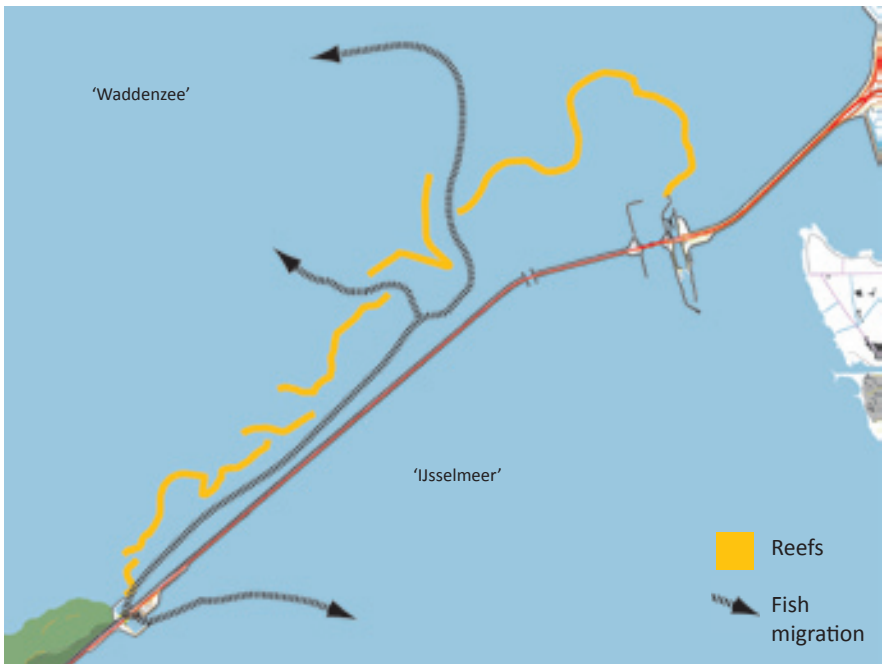


7.52. Gradient from fresh to saline

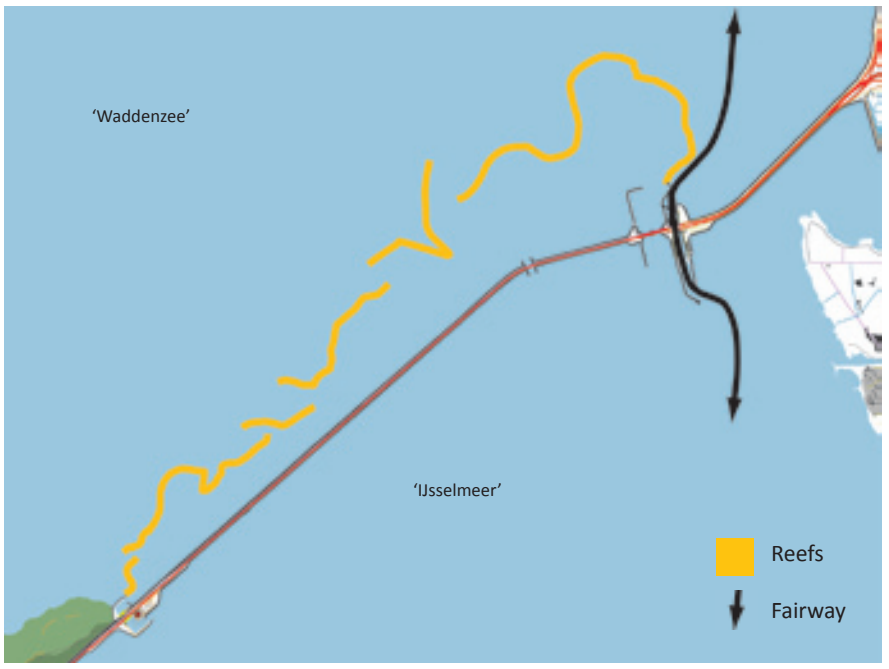
By doing this, a gradient from saline to fresh and vice versa, comes into being (fig. 7.52). The gradient between saline and fresh water is used by fish to migrate from the 'Waddenzee' to the river 'IJssel' or further to Germany (and vice versa). The fish go at 'Breezanddijk' through a fish ladder. According to van Duin (2008), the fish have no problem to swim in opposite direction of the water flow, and they will find the brackish water flow, and know to swim in what direction (fig. 7.53).
Behind the reefs various ecosystems come into being, because of sedimentation behind the reefs in the saline, brackish, and fresh part of the zone (inside and outside) (fig. 7.55). The fresh ecosystem is dominated by 'Phragmites australis' ('reed'), and saline ecosystem by 'Puccinellia martima'. This different kind of vegetation attracts a big range of animal-types.

Tidal energy
By making use of the water flows from the 'IJsselmeer' to the 'Waddenzee' during spouting, energy is produced. This flow moves tidal turbines in the tidal gaps resulting in sustainable energy. These tidal turbines are protected that fish can not swim into the turbines. In chapter 6 is explained turbines in 'De Afsluitdijk' can produce energy for 1800 houses. Additional the turbines can be used to pump water to the 'Waddenzee' when this is needed [SMO, 2008 -76].

Osmosis near 'Wieringen' (fig. 7.49, 7.64)
An extra osmosis plant is proposed in the 'Waddenzee' at the Northern part of 'Wieringen' to solve the sudden fresh water inlet of the spouts near 'Den Oever'. This place also has potential, because the water from the trenches (South of Texel): 'Texelse stroom' and 'Vissersgaatje' are really saline. The fresh water comes from the planned 'Wieringerrandmeer'. The water is transferred by tubes to the plant. This plant is situated under water level, concentrated at one spot. This disadvantage of this idea is that fresh water has to come from far away. But the advantage is the salt concentration at this spot is the highest. Calculations have to be done to find out if this osmosis plant is efficient and contributes to a better situation for migrating fish.

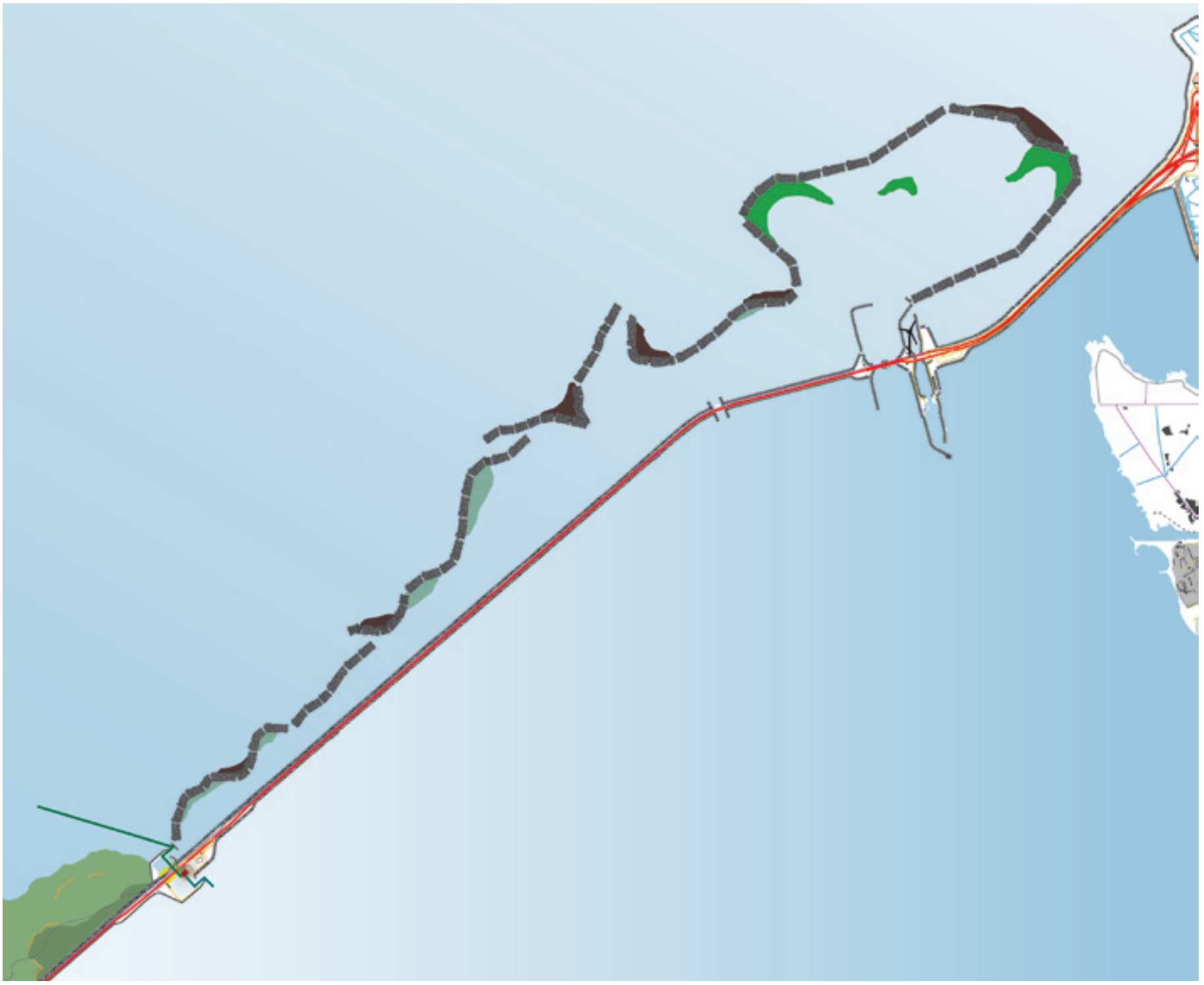


7.53. Fish migrate between 'Waddenzee' to 'IJsselmeer' and further



7.54. The fair way for ships is maintained

7.55. Various ecosystems come into being



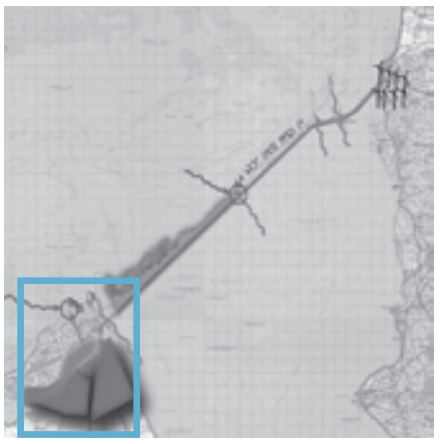
7.56. Design reefs at the side of the ‘Waddenzee’ to protect the dam against the fierceness of the waves and to lead the brackish water to the spouts.

Legend ‘Reefs’ along ‘De Afsluitdijk’

- Water
- Deep water
- Salt marsh
- Reef
- Wicker dams
- Osmosis plant
- Tubes for osmosis
- Brackish marsh
- Saline marsh
- Fresh marsh
- Village
- Slope of ‘Afsluitdijk’
- A7

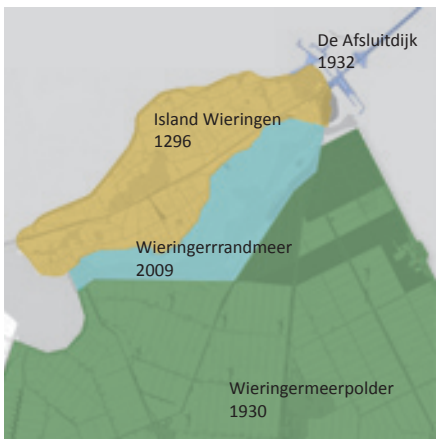
0 1 km

Province of ‘Noord-Holland’ - ‘Den Oever’

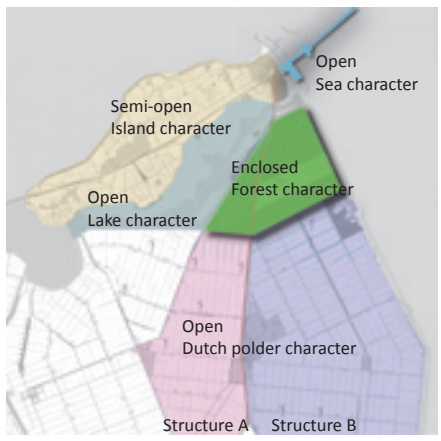


7.57. Northern part of ‘Noord-Holland’: ‘Den Oever’

7.58. Current and planned situation



7.59. Historical periods are visible in the landscape



7.60. Sequence of open and enclosed

Current and planned situation
As explained in the concept (fig. 6.12) it is needed to take the surrounding areas of ‘De Afsluitdijk’ into account to strengthen and emphasis the spatial qualities. The contrast between the land and the water is strengthened by implementing mass at land (fig. 7.63).

The Northern part of ‘Noord-Holland’ can be divided into four different areas with their own identity. These identities are the result of history and atmosphere (fig. 7.59).

1. ‘De Afsluitdijk’.
   ‘De Afsluitdijk’ is constructed in 1932. It has a special atmosphere because it is situated in the middle of the sea. The long, almost straight line, going through a huge openness is unique in the Netherlands.
2. The island ‘Wieringen’
   The island ‘Wieringen’ is located at this spot from 1296. The island consists of smaller scale agricultural fields and is the highest part of the area.
3. The proposed ‘Wieringerrandmeer’
   The planned ‘Wieringerrandmeer’ will come into being in 2009. It is a lake what emphasis the island character of ‘Wieringen’. The lake will have recreational functions and connects the ‘IJsselmeer’ with the ‘Amstelmeer’.
4. The ‘Wieringermeerpolder’
   The ‘Wieringermeerpolder’ came into being in 1930. It has a typical Dutch polder character. The polder is very open, with long view sheds. It has a strong geometrical structure and the farms are situated in a sequence along the roads. The Northern part of the polder is enclosed because of the existing forest.

Design
The design strengthens the characteristic identity of the areas and emphasis the fact they are developed in different eras (fig. 7.60).

The openness of ‘De Afsluitdijk’ is strengthened by making mass at land. As explained in former paragraph, the Northern part of the ‘Wieringermeerpolder’ contains forest. The design proposes to enlarge this forest to make more mass. The shape of the forest is connected to the existing landscape structure. While driving over the A7 from Amsterdam to Leeuwarden the sequence of open and enclose becomes clear (fig. 7.61, 7.65-7.67) and the sudden openness of ‘De Afsluitdijk’ is overwhelming.

The design proposed to change the planned ‘Wieringerrandmeer’ to strengthen the island character of ‘Wieringen’ even more (fig. 7.64).

1. Broaden the entrance to the ‘Wieringerrandmeer’ (fig. 7.64 no. 1). Instead of driving over a small ditch, the driver is aware of the fact he is driving over water to the island ‘Wieringen’. In addition ‘De Afsluitdijk’ is introduced, because he is able to see a small part of ‘De Afsluitdijk’ already.
2. Add an extra part of forest to the planned forest to connect to the existing landscape structure of the ‘Wieringermeerpolder’ (fig. 7.64 no. 2).

To ‘finish’ the shape of the island ‘Wieringen’, to make border of enclosed land and open water more clear, and to dramatic the wow-effect of openness, a new part of forest is proposed (fig. 7.64 no. 3).

The ‘IJsselmeer’-dikes are raised to guarantee total safety and to introduce ‘De Afsluitdijk’ more early (fig. 7.64 no. 4). Everybody knows that behind a high dike, the water is situated. The ‘IJsselmeer’ dike is a line that is surrounding the whole lake. This dike can be seen as a landmark to increase the orientation in the area. While driving on the A7 from ‘Amsterdam’ to ‘Friesland’ the dike is visible in the ‘Wieringermeerpolder’, but also through the forest (fig. 7.62). The visitors are aware of the fact they are nearing the ‘IJsselmeer’ with ‘De Afsluitdijk’.

7.61. Sequence of open and enclosed and the abrupt transition to the openness of ‘De Afsluitdijk’

7.62. View on dike and island Wieringen

7.63. Sequence from enclosed to open to enclosed

7.64. Design Northern part of the province of ‘Noord-Holland’: ‘Den Oever’

Legend ‘Den Oever’ (Noord-Holland)

- Water
- Deep water
- Existing forest
- Proposed forest
- Existing vegetation
- Planned forest
- Proposed osmosis plant
- Proposed raised dike
- Highway A7
- Regional way
- Local way
- Wind turbine
- Village

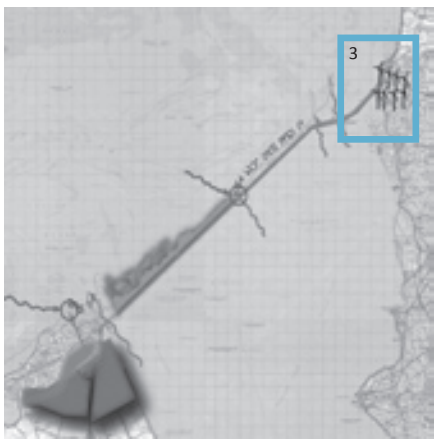
0 1 km

7.65. Impression of the proposed situation

7.66. Impression of the proposed situation (driving from open to enclosed to open)

7.67. While driving along the A7, from ‘Amsterdam’ to ‘Friesland’, the driver is led to ‘De Afsluidijk’.
From the openness of the ‘Wieringermeerpolder’-landscape (C) with its geometric structure, further to an abrupt landscape-change of mass of forest (B).
Behind the forest, the island ‘Wieringen’ is visible over the ‘Wieringerrandmeer’, clearly separated from the rest of the land. The driver drives over the water to the island.
The village ‘Den Oever’ forms, together with the forest the last mass of the land, and then the driver drives through an overwhelming openness (C).
Suddenly the openness of the ‘IJsselmeer’ and possibility to see the horizon are there.

Province of ‘Friesland’ - Zurich



7.67. Current situation Zurich

7.68. Twenty-two existing wind turbines

7.69. Infrastructure is chaotic, not orderly. The highway needs guidance to improve orientation

7.70. The direction of the grid is based on the direction of dam, coastline and highway

As elaborated in the previous paragraph, the spatial quality of ‘De Afsluitdijk’ can be strengthened by taking the two areas, where the dam touches the land, into account. The openness of the dam is strengthened by providing an enclosed experience at the provinces ‘Noord-Holland’ and ‘Friesland’.
This paragraph explains the design for the northern part of ‘Friesland’.

Current situation
The municipality where the dam touches the land at ‘Friesland’ is called ‘Wûnseradiel’. This place does already have twenty-two small wind turbines (fig. 7.68). Some of them are with two wings and others with three. They seem randomly scattered into the landscape.

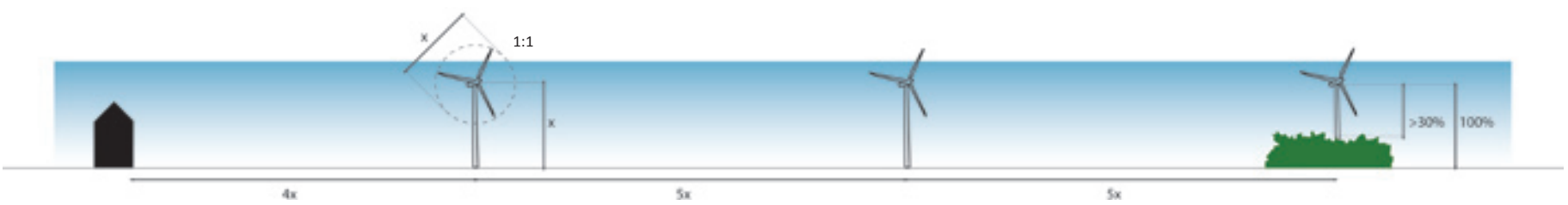
Design
The existing raising elements of ‘Wûnseradiel’ result in the use of wind turbines to give people the enclosed perception. A wind turbine park can form a kind of ‘roof’ on top of the perceiver, which leads to an enclosed experience. By reorganizing the scattered wind turbines new qualities can be added to the area. The new wind park provides more energy. By using one type of wind turbine the park has a softer attitude and, last but not least, the spatial quality of the dam is strengthened. While driving over the highway A7, the driver perceives the open landscape of Friesland first, than he feels the enclosed experience of the wind park (because of the roof formed by the wind turbines), and than he perceives an overwhelming openness on ‘De Afsluitdijk’.

Implementing wind turbines at ‘Wûnseradiel’
The landscape based design strategy in ‘Landscape and Wind Park’ leads to turbines, which are best implementable in this landscape (Heersche J., Nagtegaal L. et al. 2006) p221-230 (fig. 7.71):

Step 1: Location choice
The location is large enough and the interference with large objects is minimized. The density houses is very low in the area. The distance between wind turbines and houses should be at least four times hub height of the turbines (fig. 7.71). The location does not contain power pylons or other wind parks. The only rising elements are dikes, vegetation, buildings. There will be no interference because these elements are very low so that they do not have to be taken into account.

Step 2: Landscape characteristics
The size of the wind turbines is adjusted to the height of the rising elements like vegetation and the visibility. The amount of mass surrounding the wind park has a big influence on the visibility of the wind park. The area of ‘Friesland’ can be considered as open. This results in a large view shed. ‘It is advised to place eighty meter high turbines in landscapes with a large view shed’ . ‘To get a 1:1 proportion the rotor diameter should be eighty meters as well’. (Heersche J., Nagtegaal L. et al. 2006) p223. shows the landscape elements do not influence the turbines and vice versa. This means the ‘open composition type’ can be used. An ‘open composition type’ means that the heights of the turbines do not have to be adjusted to the height of the rising elements.
At the location of the restaurant, there is some vegetation; this means the rotor diameter should be adjusted to the height of the planting. ‘The uncovered part of the tower should be around a percentage of thirty’ (Heersche J., Nagtegaal L. et al. 2006) p223.

Step 3: Ground plane
This step is considering the functional characteristics of the park like maintenance paths. This thesis does not elaborate on this step.



7.71. Design principles wind turbines. Step 2 results in a hub height of 80m and a distance in between turbines and houses (4 x 80 m) 320 m. ‘The minimal distance between the turbines within a wind park is usually five times the rotor diameter’ [Heersche J., 2006 -160]p225.

Step 4: Context and viewers
The main route, the highway A7, has a big impact on the way people perceive the wind park. The views are long and a regular lay-out of the wind turbines will be readable because people can distinguish separate lines. ‘A rectangular grid will be best recognized when lines within the grid are located perpendicular to the route’ (Heersche J., Nagtegaal L. et al. 2006)p227.
The sizes of houses and farms that are not surrounded by vegetation will be minimized by the turbines. ‘Turbines behind unplanted settlements will change characteristic views dramatically’ (Heersche J., Nagtegaal L. et al. 2006)p227. That is why is chosen to plant some vegetation around some of the existing farms.
The amount of wind turbines depends on the size of the location, desired composition type and/or the energy need. Uniformity within the wind park can be created with a regular composition.

Step 5: Design
This step is to give the wind park its own identity.
The wind park is used as an orientation point. The wind park marks where the land stops and the water with ‘De Afsluitdijk’ begins. Additional is it used as a gate function for the province of ‘Friesland’.

The turbines are situated in a regular composition to give the park the most mass (fig. 7.77). The direction of this grid is the result of the existing coastline and direction of ‘De Afsluitdijk’ (fig. 7.70). The border of a regular composition is also less diffuse in comparison to an irregular pattern. To make the border between land and water more clear a sudden, straight border is proposed. The coastline should be visible from ‘De Afsluitdijk’ and the highway is guided by wind turbines (fig. 7.72, 7.73. 7.75, 7.76).
Because the infrastructure is chaotic and orientation is difficult (fig. 7.69), the turbines ‘guide’ the driver to ‘De Afsluitdijk’. The wind park is working as an orientation point. It is clear where the water ends and the land starts, and vice versa.

To exclude the minimization effect of turbines on houses that are not surrounded by vegetation, planting is added. The rule more than thirty percent of the hub height should be clear of planting results in trees with a maximal height of 27 meters (fig. 7.71).

Although ‘Step 2’ results in wind turbines with a hub height of 80 meters, they are difficult to implement, because of the existing dwellings. The maps in appendix V show the needed distance (blue circles) between turbines (hub height of 80m, 60m, 40m) and houses, based on figure 7.71. The maps show that also wind turbines of 80 or 60 meters are difficult to implement, because of the existing dwellings.

As said before, wind turbines are proposed to strengthen the spatial quality of the openness of ‘De Afsluitdijk’. Wind turbines can form a kind of roof. This ‘roof’ makes people feel more enclosed (fig. 7.78-7.80). Wind turbines with a lower hub height result in a more enclosed experience. This, in combination with the fact that the grid is more visible when the turbines stand closer to each other, results in wind turbines of 40 meters. The landscape based design strategy of Heersche (2006) results in 160 meters between the turbines and dwellings and 200 meters between the turbines within the wind park. This results in 54 new wind turbines, which produce energy for about 34.000 families for a whole year for (see for calculations and assumptions the frame below).

Calculations are based on:
A turbine of 850 kW, rotor diameter of 52 m, hub height of 40m, located at Frisian coast, produces 2.300.000 kWh / yr. This is enough for the energy need of a whole year of 700 families (NRG 2005).

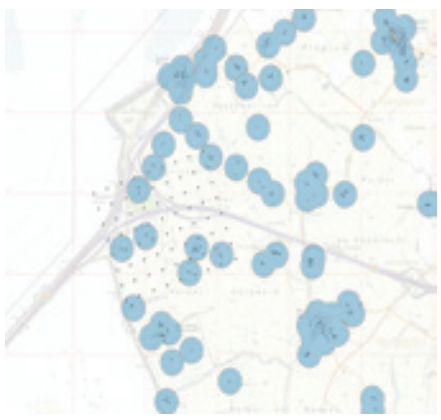
Calculation 1 (based on 3600 kWh / family/yr):
- 54 turbines x 2.300.000 kWh/yr = 124.200.000 kWh /yr,
- 124.200.000 kWh / 3600 kWh per family = 34.500 families

Calculation 2 (based on 1 turbine produces for 700 families/yr):
- 54 turbines x 700 families = 37.800 families

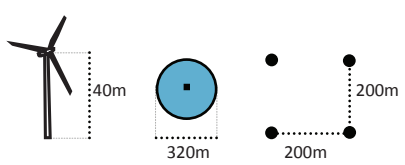
The turbines used in the design have a smaller rotor diameter. The assumption is the turbines in the design provide 36.150 families a

7.72. Coming from the land, through the mass of turbines suddenly in the openness of the Waddenzee/IJsselmeer

7.73. Coming from the dam, the location of the land becomes clear because of the clear line of wind turbines



7.74. Wind turbines with a hub height of 40m



7.75. Impression of wind turbines at the end of ‘De Afsluitdijk’

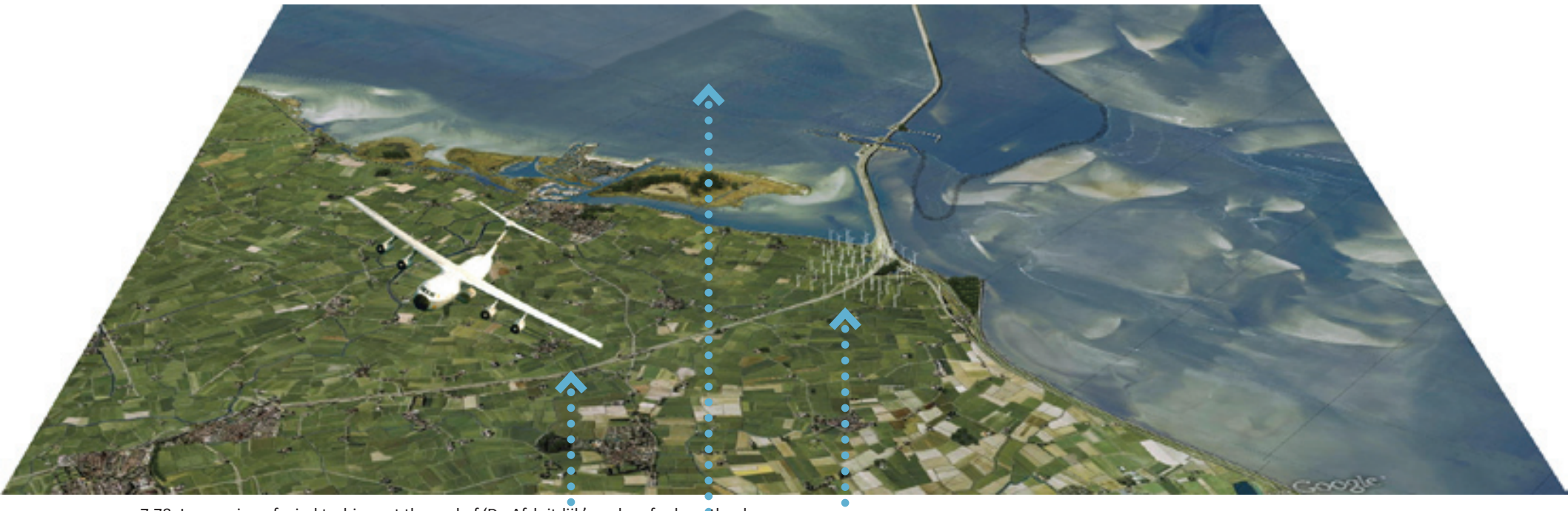
Current situation

7.76. Impression of wind turbines at the end of ‘De Afsluitdijk’ and reefs along the dam

7.77. Legend Zurich (Friesland)

- Water
- Deep water
- Existing forest
- Proposed forest
- Highway A7
- Regional way
- Local way
- Swamp
- Wind turbine
- Village
- Dike / steep slope

0 1 km



7.78. Impression of wind turbines at the end of ‘De Afsluitdijk’ and reefs along the dam

7.79. Impression of the sequence of open to semi-enclosed to open from ‘De Afsluitdijk’ to ‘Friesland’

7.80. Impression of birds eye view at the wind turbines as a block of art in the landscape

7.81. Overview total design

0 1 km

Stages of development

The impression on this page gives an overview of the total design. This paragraph explains the different stages to develop the site.

1. Start testing how salt marshes will develop in the western part of the ‘Waddenzee’
   Start testing and improving osmosis and solar panels for the site of ‘De Afsluitdijk’.
2. Move the bicycle path to the other side of ‘De Afsluitdijk’ to make space for the increment on top of the dam;
3. Raise the ‘De Afsluitdijk’ with 2,35 meters to ensure safety for the first years;
4. Help nature by making the first step of the development of salt marshes (fig. 7.34-7.39). Place wicker dams at places where the sand should stay. Start adding boulder clay in the ‘Waddenzee’ and place sand on top (at average water level ‘gemiddelde hoogtelijn’). Maybe boulder clay is only at the borders of the salt marsh needed. The boulder clay washes not that easily away and the sand is needed for the vegetation to grow. Let nature do the rest of the work. When needed make some drainage canals.
5. As said, the way of the salt marshes develop is not very predictable and adaptation to the changing situation is needed. Monitoring is always needed. When seen the salt marsh is not growing fast enough, sand can be added. When seen the vegetation does not establish fast enough seeds can be spread. When vegetation grows to fast, cattle can graze bare.
6. At the same time with the salt marshes, the reefs can be added by putting boulder blocks on top of each other starting at ‘Breezanddijk’, working to ‘Kornwerderzand’. ‘De Afsluitdijk’ suffers at this spot the most from the fierceness of waves, because of the ‘Doove Balg’;
7. At the same time with the development of the salt marshes and reefs, the dikes surrounding ‘Noord-Holland’ and ‘Friesland’ should be adapted to the new standards of safety;
8. Start deepen the new fairway near ’Kornwerderzand’ (for ships that pass the sluices);
9. Construct the osmosis plant and fish ladders at ‘Breezanddijk’;
10. Construct the ‘Wieringerrandmeer’ and place an osmosis plant at the northern part of ‘Wieringen’;
11. Remove the decrepit wind turbines and place new ones at ‘Friesland’
12. Extend the forest near ‘Den Oever’

Some of the stages can start already when the other stage has not finished yet.

CHAPTER 8

Conclusion and Discussion

Conclusion and Discussion

This chapter gives the conclusions of the different parts of this thesis. The end of this chapter discusses the process and final design.

Conclusion

This research results in various conclusions. This paragraph starts with concluding what constraints, concerning 'De Afsluitdijk', can be solved with the contribution of a landscape architect. These constraints are followed by the conclusions diverted from the symposium 'Toekomst Afsluitdijk'. The next part discusses the theoretical framework, which lead to a concluding overview of the spatial quality and opportunities of the site. After that, the design results are elaborated. This paragraph finishes with the main conclusion of this thesis.

Constraints

It turns out that the constraints concerning 'De Afsluitdijk' are the result of various aspects that are divided into constraints regarding the function, and constraints regarding the effects of the construction of the dam.

'De Afsluitdijk' is not able to fulfil its main function, being a dam to protect the hinterland against flooding, because of the expected climate change. The combination of more and stronger waves, and the predicted water level rise of the 'Waddenzee', results in a higher pressure on the dam from the 'Waddenzee' side. Further more the 'IJsselmeer' water level will rise, which causes a pressure from the 'IJsselmeer' side of the dam. This pressure can be solved by spouting water to the 'Waddenzee', but the present spout capacity of the dam is too low. Because of the pressure from two sides, the dam does not suffice the 'Wet op de Waterkering' anymore, which makes the chance of flooded hinterland bigger. The dam needs adjustment to guarantee safety against flooding again.

In comparison to 1932, new knowledge and other priorities make new design aspects important. That is why negative effects of the construction of the dam are seen these days. Ecology is currently an important aspect, which was not that important in the thirties. The dam function was the most important, and for example perception was also not taken into account.

At the present time the dam is, from ecology point of view, seen as a barrier. The natural water flow is brought to a halt, and fish are not able to migrate anymore. 'De Afsluitdijk' is a barrier in-between the fresh ecosystem of the 'IJsselmeer' and the saline ecosystem of the 'Waddenzee'. Gradients from fresh to saline do not exist. Further more the abrupt fresh water inlets into the 'Waddenzee' results in dying out and diseases among sea animals.

From the perception point of view the fact that only the 'IJsselmeer' can be seen while passing the dam and the location of the bicycle path in-between the dam and the highway are seen as negative effects.

Symposium 'Toekomst Afsluitdijk'

During the symposium 'Toekomst Afsluitdijk', organized by 'Rijkswaterstaat' on the 14th of March 2008, various ideas about the future of 'De Afsluitdijk' are presented.

From these presentations I can conclude that the presented ideas were mainly focused on one aspect and not made from an integral point of view. Safety was the main aspect and beauty was not getting enough attention. In addition the plans paid a lot of attention to the dam itself, but not that much to the spatial context of the dam. Next to this, the plans were mostly about technical solutions, which were mostly not adaptive to the climate change, and could be located everywhere. They were not specific for the site.

Diverted from the symposium I can conclude a better, integral landscape based design for 'De Afsluitdijk' can contribute to a safe adaptive 'Afsluitdijk'. A landscape architect is able to come up with design solutions that fit the context and are a unity. By using landscape elements the spatial quality can be increased and the solution can be adaptive. The constraint concerning the spout capacity is a technical problem, which is not to solve by a landscape architect.

Spatial Qualities and opportunities of 'De Afsluitdijk'

The spatial qualities of 'De Afsluitdijk' result from the landscape analysis in combination with the theoretical framework.

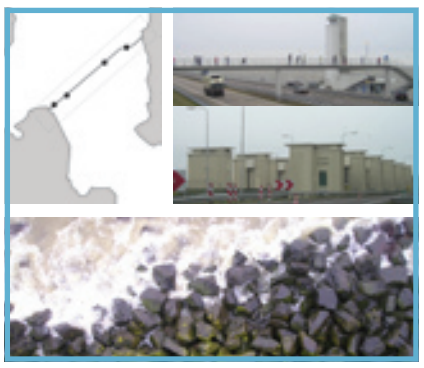
- Long, thin line: The long, thin, almost straight line (3200 m long and 90 m broad), results in a unique perception. The straight line seems eternal and is perceived as a thin line going through the roughness of the sea, disappearing in the horizon.
- Openness: The big scale of the water results in an experience of freedom. The space is open and seems eternal. The openness is unique in 'The Netherlands'. The area of 'De Afsluitdijk' does not have any disturbance. That makes it such a special place.
- Simple design with exceptional places: The dam has a simple, clear design concept, which is easy to read and to understand. The exceptional places are related to each other in a sequence.
- Unity in design: The 'De Afsluitdijk' is a unity in rhythm, form, style, materials, and colours.
- Contrasts: The site is interesting because of its contrasts:
    - the natural 'Waddenzee' and the artificial 'Afsluitdijk';
    - the fierceness of the sea and at the other hand the safety of the dam;
    - the dynamics of 'Waddenzee' against the static 'Afsluitdijk';
    - the diversity of the 'Waddenzee' and the simplicity of the 'Afsluitdijk'.
- Interaction: The combination of extremities like the natural 'Waddenzee', which seems without human influence, and the so typical occupied character of the dam makes it interesting. The interaction between the technical, artificial dam element and the natural appearance of its context gives the site quality. It is the total setting what makes it special.

Long thin line

Openness

Simple design with exceptional places

Unity



8.1 Overview of the spatial quality and opportunities of 'De Afsluitdijk'

Additional qualities and opportunities of ‘De Afsluitdijk’ are:

- Cultural historical value: Almost every Dutch person knows ‘De Afsluitdijk’ as an icon about the Dutch struggle against water and the knowledge and technical capability to construct a dam in the middle of the sea in 1932;
- Opportunity to produce sustainable energy: The site has quality in the field of sustainable energy production. There is, in comparison to other places in the Netherlands, a lot of wind and sun, but especially the fact fresh and saline water are founded here next to each other, is a big opportunity. Not only to produce energy, but also to be innovative by producing sustainable energy with difference between saline and fresh water.

Design

The spatial quality of the site and my landscape architectonic vision about ‘De Afsluitdijk’results in an overview of the most important aspects to take into account:

- protecting against high water levels;
- protecting against the fierceness of the waves;
- decreasing the ecological barrier effect;
- conserving the fresh water basin of the ‘IJsselmeer’;
- using the unique location and characteristics (to implement new functions);
- adapting to the expected climate change;
- taking the various users into account;
- conserving or strengthen the spatial quality (straight, thin line, openness, etcetera);
- conserving or strengthen the unity of the site;
- conserving the icon character;
- conserving the monuments;
- increasing the carry off of the river water to the North Sea;
- keeping the option open to reinforce the dam later on.

This design solves the various constraints in a manner the qualities and opportunities of the site are strengthened and used:
The dam suffices the new standards of safety against flooding because of the proposed salt marshes, the reefs, and the increment of 2,35 meters on top of the dam. The salt marshes and reefs protect the dam by decreasing the fierceness of the waves. The salt marshes can grow with the expected sea level and the reefs can be heightened later on. This in combination with the increment of boulder blocks makes the dam also safe against the rising sea level and makes the chance of flooding much smaller.
The plan assumes the new spout capacity together with the osmosis plant take care of the extra run off by rivers by transferring water from the ‘IJsselmeer’ to the ‘Waddenzee’. In comparison to the situation at this moment, the water can be transported easier to the North Sea, which decreases the chance of flooded hinterland.

The ‘Afsluitdijk’ maintains its barrier function of being a border in-between the saline ‘Waddenzee’ and the fresh water basin of the ‘IJsselmeer’, which is important for drinking water, flushing agricultural fields, etcetera. Although the dam is still a barrier, the ecological connection improves. The abrupt fresh water inlets are less abrupt because the brackish ‘waste’ water of the osmosis plant at ‘Breezanddijk’ is used. The brackish water is led along the dam and reefs to be mixed with the fresh water coming out of the spouts (from the ‘IJsselmeer’). Sea animals do not die out or get skin diseases anymore. A gradient from fresh to saline water comes into being and migrating fish use this gradient to swim from the ‘Waddenzee’ to the ‘IJsselmeer’ and vice versa. This makes it possible for them to breed in the fresh water rivers and live in the saline seas. This increases the migrating fish population and prevents certain fish types from dying out.
The profile of the dam is changed to be able to raise the dam. The bicycle path is moved to the other side of the highway. This makes it possible to view the ‘IJsselmeer’ and weather conditions more and to place solar panels along the dam. The cyclist can focus on the landscape instead of the highway. In addition, the passing people are more aware of the fact they are travelling over a dam, which is situated in the middle of the sea. Also the strolling path over the salt marshes contributes to this perception. The conquest of the sea and the icon character become clearer.

The design expresses the spatial qualities of the dam and utilizes the opportunities:
The long, thin line is conserved. The ‘Afsluitdijk’ does not look like a broadened dam, but as a dam with salt marshes next to it, because the salt marshes are low in comparison to the raised dam. ‘De Afsluitdijk’ goes as a string through the area and the main direction (from ‘Friesland’ to ‘Noord-Holland’ and vice versa) is clear. Also the openness is maintained by using salt marshes to make the dam safe. They are low and the horizon is kept fee of disturbance. The intervention of the reefs maintains also the openness. The reefs are situated just a little bit higher than low tide, which makes them invisible during high tide, and visible during low tide. The openness is strengthened by making the contrast between open and enclosed bigger. By proposing mass at ‘Noord-Holland’ (forest) and at ‘Friesland’ (wind turbines) the ‘wow’-effect of the openness of the ‘IJsselmeer’ increases.
The contrasts of the site are strengthened by the natural, dynamic salt marshes at one side and the conservation of the artificial, static dam with its simple clear design concept at the other side. The contrast between the feeling of fear of the water and the feeling of safety decreased, because the fierceness of the waves is not visible anymore. This is in my opinion a negative aspect of this design. The weather conditions can be experienced because of the stroll path in the salt marshes. People are aware of nature and protection system.
The profile of the dam does not change that much, only the highest part

Contrasts

Interaction

Icon

Sustainable energy production

is raised and the bicycle path moved to the other side. The shape is still recognizable and the historical icon character is the same as before. The exceptional places are not changed because they are situated at higher spots and influence the character of the dam.
The existing and new interventions form a unity. The solutions are based on the existing landscape and characteristics so that they fit together into the context.

The opportunities of the site are used. The high wind speed and the amount of solar radiation are used by implementing wind turbines and solar panels. The fresh and saline water located next to each other is exploited by producing sustainable energy by osmosis. The salt marshes filter silt out of the water to make it clean for the osmosis plant.

The design produces energy for about 538.000 households (demand of 3600 kWh/yr/household):

Solar:	90 households
Osmosis:	500,000 households
Tidal:	1,800 households
Wind:	36,150 households
	+
	538,040 households

Main conclusion
The main conclusion answers the research question of this thesis:

In what way can a landscape design contribute to a safe 'Afsluitdijk' until 2200, which expresses the unique qualities of the site?

The content of this thesis is a research by design to adjust 'De Afsluitdijk' in a way the dam suffices the new standards of safety without losing the unique qualities of the site.
The results suggest that the hypothesis is true. By using a qualitative landscape architectonic approach, an integral design can contribute to the design of a safe 'Afsluitdijk', which is also beautiful, and is adaptive to the unpredictable climate change. This makes this design better than the presented ideas on the symposium 'Toekomst Afsluitdijk'.
The spatial quality of the openness horizon, the long, straight, thin line, and the contrasts are expressed. The proposed design solutions strengthen each other and form a unity that fits the existing situation and context. The design shows a multifunctional 'Afsluitdijk' in which the production of sustainable energy and the increasing of ecological values are integrated with the main functions of providing safety, spouting water, and being a connection.

8.2. Overview of the integral design of an adaptive, safe 'Afsluitdijk' that expresses the unique qualities of the site

Discussion

The Object

'De Afsluitdijk' is an object with many aspects. For me, as student landscape architecture it was difficult to focus on the landscape aspects, because the others are also very interesting. By talking to experts, logical reasoning, and assumptions the technical, ecological, hydrological and cultural historical aspects are covered as much as possible, but more research on these aspects is needed. For me it was very interesting to get more knowledge about the technique and ecology of the dam and site.
A landscape architect should not avoid dealing with other fields of study, especially because it is one of our strongest points to integrate different kinds of knowledge to one spatial design. It would have been nice to have more time to dive more into the ecological field to be able to strengthen the design even more.

The research method

The 'Orientation phase' went well. It was very interesting that 'Rijkswaterstaat' was organizing the symposium 'Toekomst Afsluitdijk'.
The describing of the constraints was not very easy, because it was difficult to group them. Some of the constraints were regarding the main function, others regarding the secondary functions, and others were concerning the effects of the dam.
During the 'Point of departure phase' it was not always clear how to deal with the presented ideas, and to come up with new innovative ideas.
After the symposium 'Toekomst Afsluitdijk' on the 14th of March 2008 I decided not to read the new reports anymore till the end of the thesis, to avoid getting influenced by ideas of others. This was a good decision. At the end of my research these reports gave me some extra information and technical background to explain my design.
It was difficult to describe why I selected certain presented ideas as a base for my own design. Furthermore the brainstorm session ended up with sketches that were a mix of presented ideas and my own ideas. This made it for other people difficult to understand my way of thinking and decisions.
At first I thought the spatial models had to much focus on the safety aspect, but later on, this turned out well.
The phase of the 'Theoretical framework' went well, but the reference study was not entirely used at its full potential. It gave me knowledge about the experience of weather conditions, perception of proportions, and the relation between the water and the bridge/dam, but it could have been more focused on exact measurements.
Furthermore it was very difficult to group the design guidelines, because the definition of words resulted sometimes in confusion. Maybe this grouping had to much focus on the way of thinking instead of on the clearest way to describe the process.
The 'Design Phase' started with the determination of the significance of the guidelines and assessment of the spatial models. The guidelines were given values depending on their importance. This determination is quite subjective and could have done in a more objective way. The models were given points depending on the extent they improved the current situation. The landscape analysis and landscape architectonic vision were used as a base. The points of the models are given in comparison to each other. Also this was partly subjective, but at the other hand I am also convinced that a landscape architect has enough knowledge and experience to be able to give values to guidelines and models.
Giving guidelines a higher rate of importance is needed to come up with the best solutions for the most important constraints. It was an important process step to find out, which aspects were the most important for me as landscape architect. It was a good way to compare the models, but when I should redo it, I would not use so many pluses and minuses. Because it is not very objective one minus, zero, and plus would be enough.

Design

The design part of 'Den Oever' was not very strong. The design concept of strengthening the contrast between open and enclosed was strong, but the area of 'Den Oever' was complicated (and interesting) because different landscape types of different eras came together here. For this thesis it was not possible to focus more on this design, but it would have made it better.
I am very pleased over the design part of 'De Afsluitdijk'. The salt marshes are a good adaptive landscape based solution, although more research is needed. A lot of information does not exist yet, what made it difficult to design.
The missing knowledge about water flows, speeds, and directions of the future made it difficult to come up with a good design for the reefs. Also missing knowledge about the mixing of fresh and saline water made it difficult to give the right measures.
The idea of wind turbines is very interesting, but difficult to convince people to re-organise and interchange existing wind turbines with new types of wind turbines. So this can only happen when the existing wind turbines are decrepit.

To verify the assumptions and strengthen the design more research is needed on:

- the construction of salt marshes in the western part of the 'Waddenzee';
- the exact location of the wicker dams to guarantee enough safety;
- the way the salt marshes at 'De Afsluitdijk' will react on sea level changes;
- filtering sand out of the water by salt marshes to make it clean to use in the osmosis plant;
- the fierceness of the waves and the way the salt marshes react on this;
- the amount of water that has to be transported from the 'IJsselmeer' to the 'Waddenzee' and if the new spout and osmosis plant are able to handle this amount;
- the efficiency of osmosis at 'De Afsluitdijk';
- the influence (reach) of the fresh water near the spouts, to be able to determine the best location for the osmosis plant;
- Future changes of water flows (speed and direction), to transfer the brackish water to the spouts and the salt concentration for the osmosis process;
- the mixing of fresh and saline water in combination with migrating fish;
- the distance of the reefs regarding 'De Afsluitdijk';
- Length of the gabs in the reefs;
- the opportunities and possibilities for recreation and education without losing the spatial quality.

References and List of figures

References and List of figures

This chapter gives an overview of the used references. The first part focuses on the references of the text and the second part on the references of the used figures.

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Chapter 7: Design
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7.13 Based on: Google Earth (2008)
7.14-15 Topografische Dienst Kadaster (2003). 14 Oost Medemblik. Topografische kaart van Nederland 1:50.000. Emmen, TD
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c. Natuurpunt (2004) http://www.scheldeschorren.be/cms/uploads/images/gewoon-kweldergras-02.jpg [23-10-08]
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7.23-25 Based on: Watlas http://mapserver.waddenzee.nl/geoviewer/watlas/geoview.htm?/cgi-bin/mapserv?map=/export/www/mapserver/html/geoviewer/ [15-04-08]
7.26 Based on: van Duin, W., Dijkema, K. (s.a.) Kwelderontwikkeling en zeespiegelstijging, Alterra, Texel
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7.41 Based on: Topografsiche Dienst Kadaster (1999). 9 Oost Den Helder (1999), 10 West Sneek (2003), 14 Oost Medemblik (2003). Topografische kaart van Nederland. 1:50.000. Emmen, TD
7.42 Sperling, J.C.W. (2008)
7.43-44 Based on: Watlas http://mapserver.waddenzee.nl/geoviewer/watlas/geoview.htm?/cgi-bin/mapserv?map=/export/www/mapserver/html/geoviewer/ [15-04-08]
7.45-46 Sperling, J.C.W. (2008)
7.47-48 Based on: digital topografische kaart 1:10.000
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7.63-64 Sperling, J.C.W. (2008)
7.65-66 Based on: Google earth (2008)
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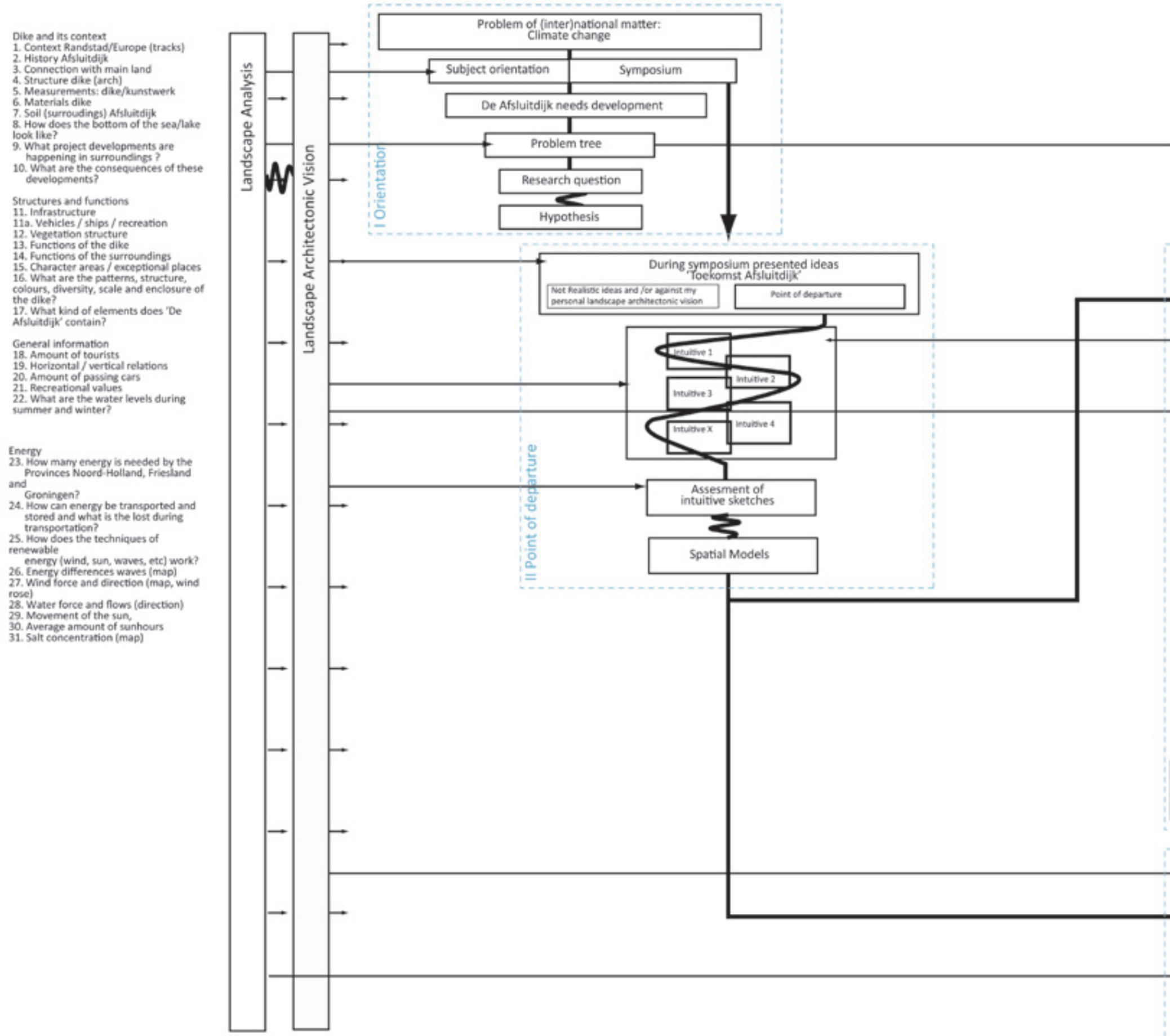
Chapter 8 Conclusion and discussion
8.1-2 Sperling, J.C.W. (2008)

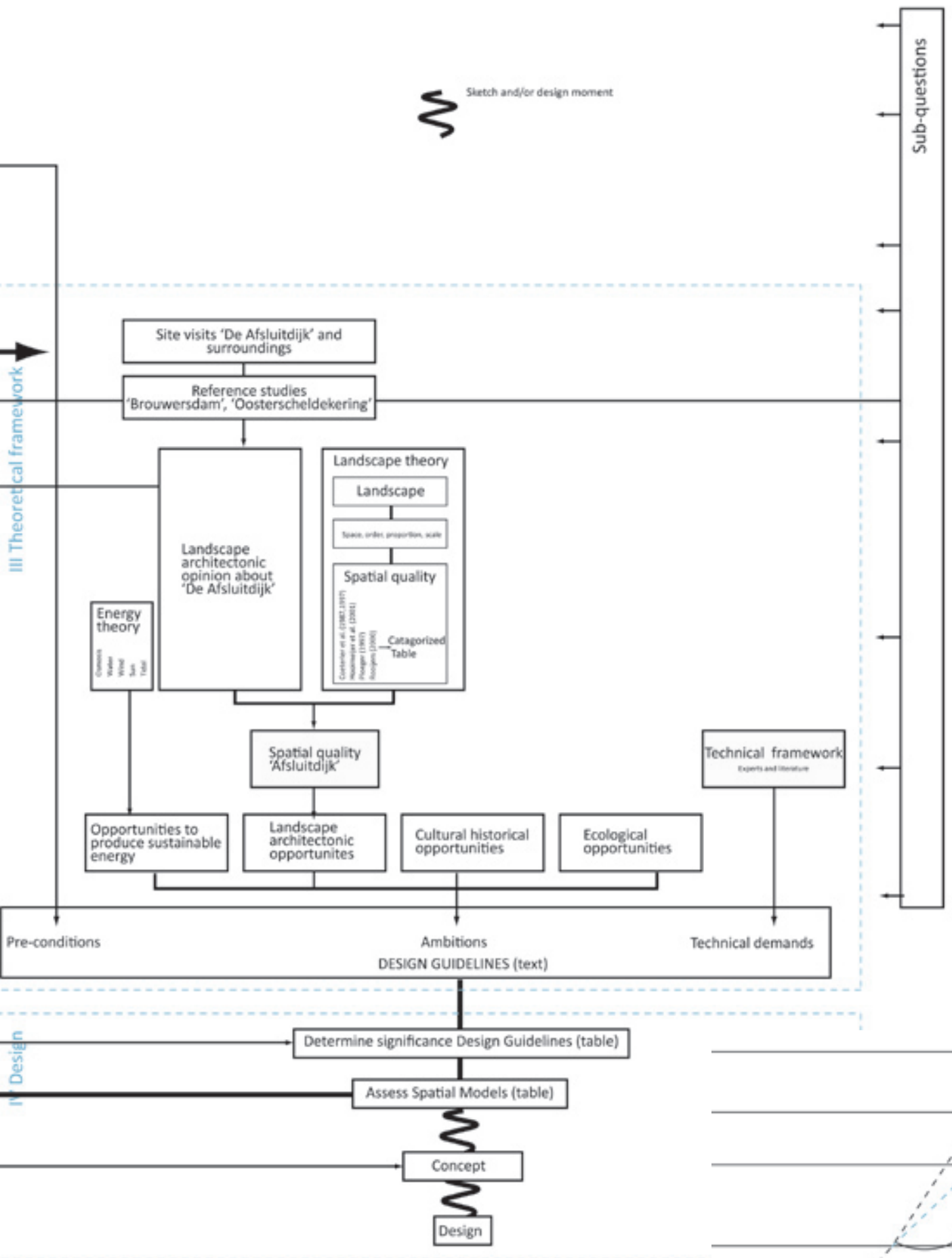
Appendix

Appendix

I Working method, including sub-researches and questions
II Presented ideas during symposium ‘Toekomst Afsluitdijk’
III ‘Afsluitdijk’; panoramas and cross sections
IV Dikes and dams that do not suffice the ‘Wet op de Waterkering’
V Implementation of wind turbines in ‘Wûnseradiel’
VI Reference studies: ‘Brouwersdam’ and ‘Deltawerken’

I Working method including sub-researches and questions





Sketch and/or design moment

Sub-questions

I Climate Change
1. How will the climate change (rainfall, storms, temperature, sun, wind, etc.) ?
2. What is the prognosis for the sea water level in the future till 2100?
3. Kyoto protocol
4. What says the 'Wet op de Waterkering' about the Afsluitdijk?

II Symposium
1. What are the most important reasons to develop 'De Afsluitdijk'?
2. What is the point to defend Holland from the sea instead of just let it happen?
1. What are the existing ideas?
1a. What are the ideas about making the dam sufficient till 2050?
1b. What are the ideas about sustainable energy?
1c. What are the other ideas about? (group)
2. What is the minimal height of the dam to be sufficient till 2050?

III. Explicate personal vision, basis for assessment
1. What ideas are interesting for me as landscape architect
2. Which ideas are not realistic or against my landscape architectonic vision

IV. Sketches: every sketch results in an answer to the next question: What is at this moment the best type and location?

Sketch 1: Safety
1. What are the existing ideas about sufficiency?
2. What are the consequences for the landscape, ecology, perception, etc?
3. What is at this moment the best solution from landscape point of view?

Sketch 2: Wave energy
1. What are the existing ideas about types of wave energy production?
2. What are the spatial impacts of these types?
2. How many energy can one wave produce?
3. Where can the most energy be produced?
4. How does the dike look at those places?
5. How is the wave energy connected to the wind speed/direction?
6. How does the water flow?

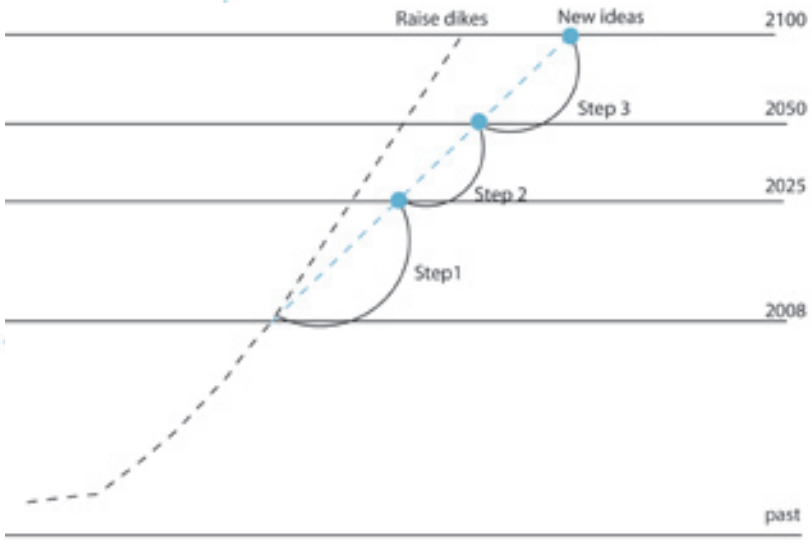
Sketch 3: Wind energy
1. What are the existing ideas about types of wind energy production?
2. How many energy does every type produce?
3. What is the spatial impact of these types?
4. What is the average wind speed and how is this devided over the whole year?
5. What is writen before about wind energy production at the Afsluitdijk?

Sketch 4: Solar energy
1. What are the existing ideas about types of solar energy production?
2. How many energy does every type produce?
3. What is the spatial impact of these types?
4. What is the average sun intensity and how is this devided over the whole year?

Sketch 5: Osmosis energy
1. What are the existing ideas about types of osmosis energy production?
2. How many energy does every type produce and how does it work?
3. What is the spatial impact of these types?
4. What kind of water does the production need?

V. Perception
1. How do people perceive the dam and how do I get most perception?
2. Sight lines

VI. Ecology
1. What are the consequences for the Waddenzee of a higher sea level?
2. What are the consequences of fresh water in the Waddenzee?
3. What are the consequences of salty / brackish water in the IJsselmeer?
4. What kind of animals live in the surroundings of the dike?
5. What kind of consequences does changes have for these animals?
6. What kind of animals/plants use the Afsluitdijk (staying or breeding)
7. What kind of restrictions are effective in this area?
8. How to develop the ecological water zone and the connection between brackish and fresh water The fresh water reservoir function of the Ijsselmeer should taken into account (Rijkswaterstaat 2007a);
9. What ecological values does the area have?



past

The design method is based on research by design. The design raised from the (landscape) analysis. The dam is not made safe by simply raising the existing dike, but new ideas came up. The idea how 'De Afsluitdijk' should look like in the future of 2100 is clear. To reach this goal back casting is needed. The design is build up in a few steps or phases. Additional it becomes clear what kind of techniques still need development to be able to reach the goal.

II Presented ideas during symposium ‘Toekomst Afsluitdijk’

Ideas presented in the report ‘Toekomst Afsluitdijk, resultaten van een participatieve verkenning’

Morphology of ‘De Afsluitdijk’
- Make the dam higher with soils and the road goes through a tunnel [Institute SMO, 2007 -10];
- New sluice at Den Oever and/or Kornwerderzand’[Institute SMO, 2007 -10];
- New sluice and naviduct at Kornwerderzand [Institute SMO, 2007 -10];
- Extra sluice at the nod of the dam [Institute SMO, 2007 -10].

Connection
- Aqua Planning Train (Bearnd Hylkema) [SMO, 2008 -76];
- Train connection by Fermo and Bausch [Institute SMO, 2007 -10];
- Aqueduct by Eisma [Institute SMO, 2007 -10];
- Super bus from Hoorn to Leeuwarden by Ockels [Institute SMO, 2007 -10].

Building with nature
- Brackish water zone in the Waddenzee [Institute SMO, 2007 -10];
- Brackish water zone in the IJsselmeer (like Plan Waterlely) [Institute SMO, 2007 -10];
- Wetlands in the IJsselmeer by van Dieren [Institute SMO, 2007 -10];
- Open the dam by Stichting Verantwoord Beheer IJsselmeer (VBIJ) [Institute SMO, 2007 -10].

Sustainable energy production
- Interprovincial Wind Park project Afsluitdijk (IPWA) by the Provinces Friesland, Noord-Holland and 4 municipalities [Institute SMO, 2007 -10];
- Osmosis, Blue Energy by Redstack [Institute SMO, 2007 -10];
- Plan Waterlely by Alkyon Hydraulic consultancy & Research [Institute SMO, 2007 -10];
- Solar panels by Cartesius Institute [Institute SMO, 2007 -10].

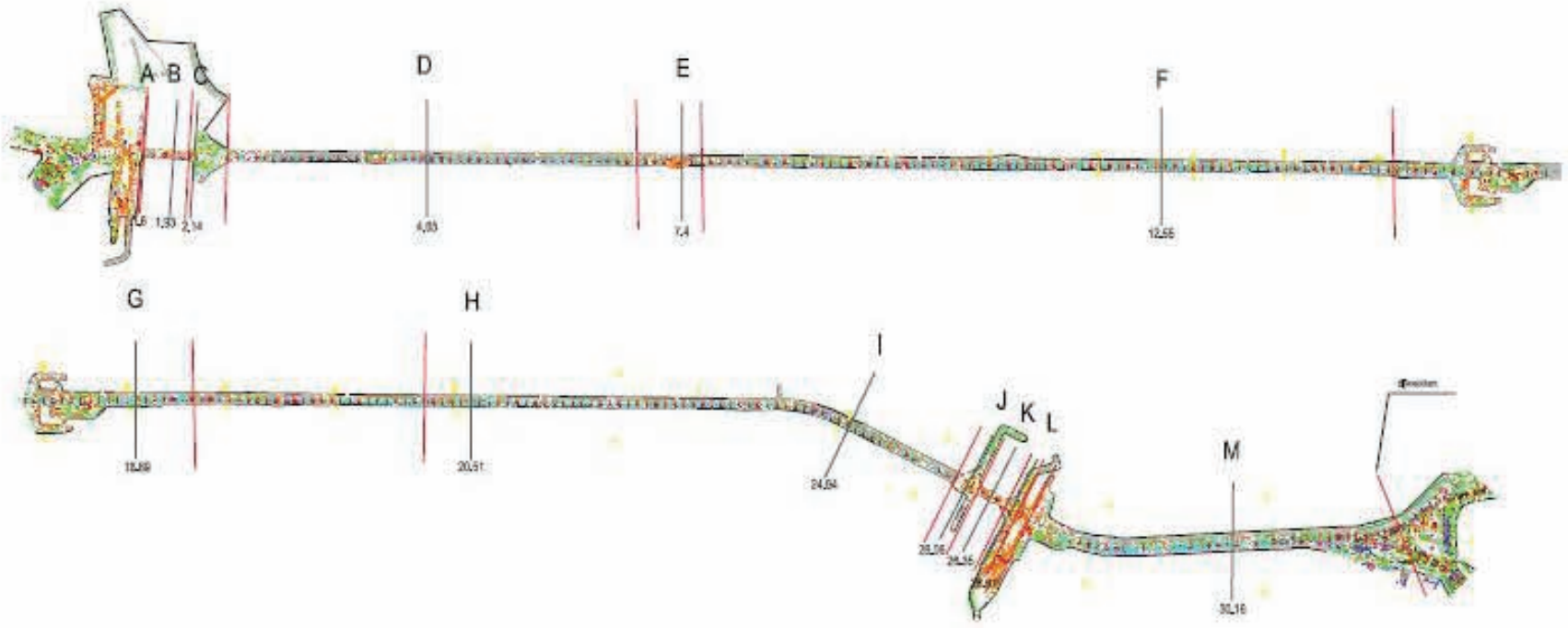
Architecture
- The stil(l) Afsluitdijk by NRJ Architecten [Institute SMO, 2007 -10];
- Maritiem network by Monolab [Institute SMO, 2007 -10];
- Vision for the future by ZUS [Institute SMO, 2007 -10];
- Dwelling at the dam by Crowel, Dobbelsteen, Jansma [Institute SMO, 2007 -10];
- Floating construction by firma Ooms, DeltaSync [SMO, 2008 -76];
- Sail building by ALT-M Architecten BNA [SMO, 2008 -76]

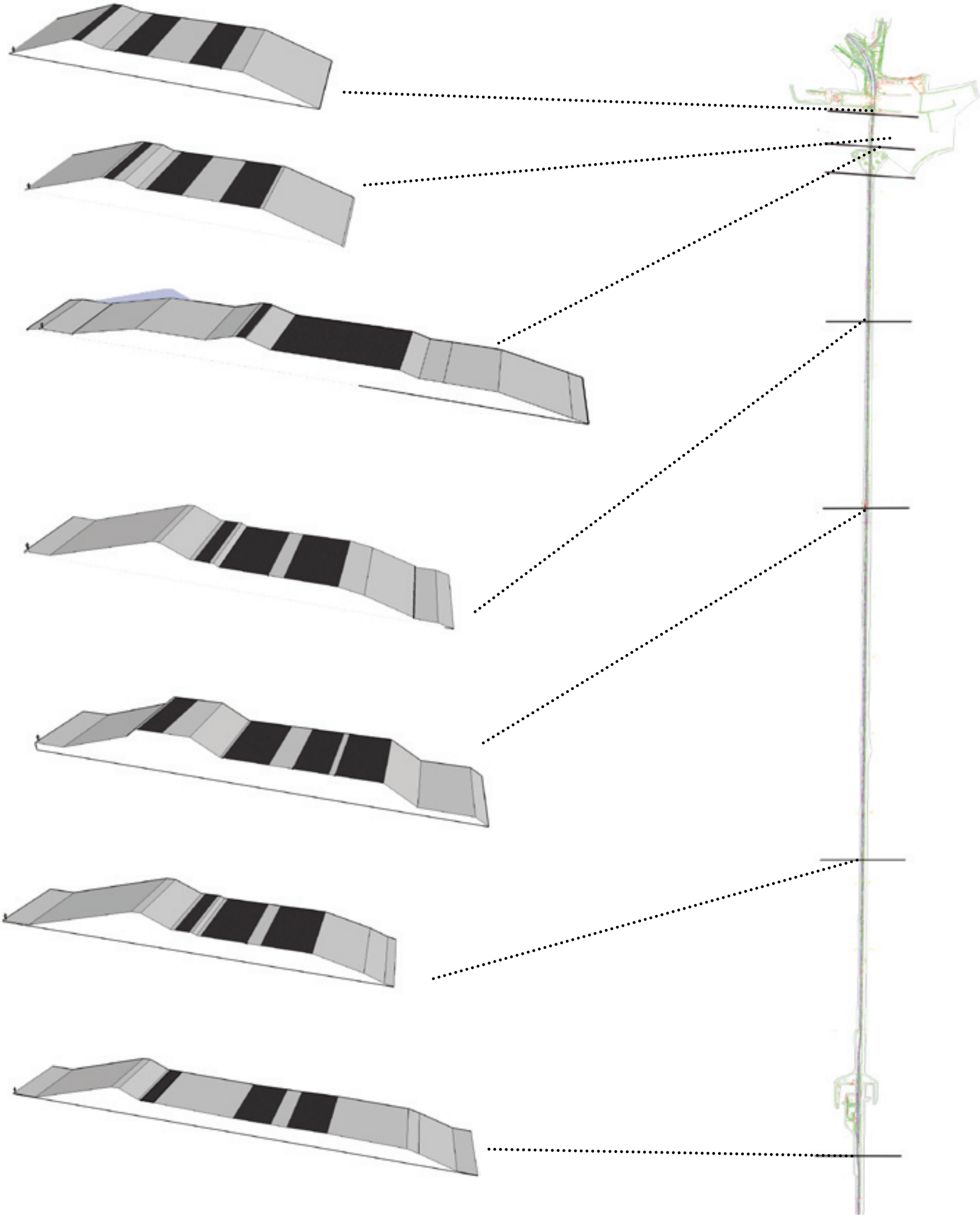
Tourism, recreation and perception
- Aqua-Citadelta by R. de Hoop [SMO, 2008 -76];
- Brundtland centrum by S. Jansen, H. Kroes, H. Seijnen, H. Brezet [SMO, 2008 -76];
- Drive-in theater performances on the dam by K. Botman, P. Stellingwerf [SMO, 2008 -76];
- Paviljoen at the Monument by ANWB ‘Een dijk van een attractie, 2006’ [Institute SMO, 2007 -10];
- Quality improvement camping Breezanddijk [Institute SMO, 2007 -10];
- Construction marina Breezanddijk [Institute SMO, 2007 -10];
- Cycling track at side of the Waddenzee [Institute SMO, 2007 -10].

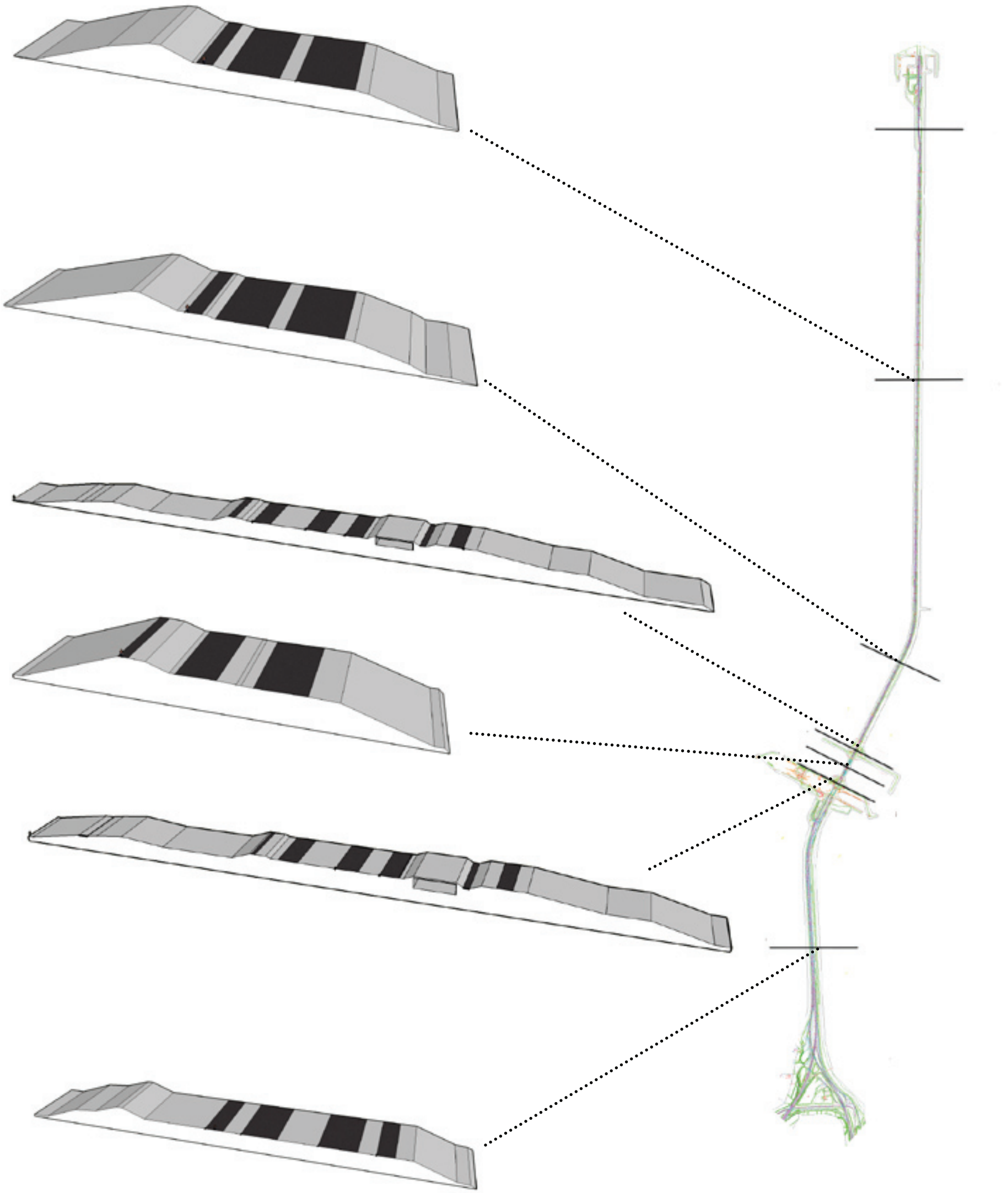
Entrance gate to Noord-Holland and Friesland
- Landscape dwellings in association with Volker Wessels [SMO, 2008 -76];
- Salty perception at the entrance gates [SMO, 2008 -76];
- New monument at Zurich [SMO, 2008 -76];
- Friese gate by Hanshan Roebers and ANWB/Vandertuuk [SMO, 2008 -76].
- Gate of Friesland Kornwerderzand ANWB ‘Een dijk van een attractie, 2006’ [Institute SMO, 2007 -10];

Integrated plans
- ‘Natuurlijk Afsluitdijk’ by W. Ockels
- Plan Waterlely by Hydraulic Consultant & Research
- Nieuwe dijk ten behoeve van aanleg Breezandmeer by A. Vrijburcht

III Afsluitdijk and cross sections

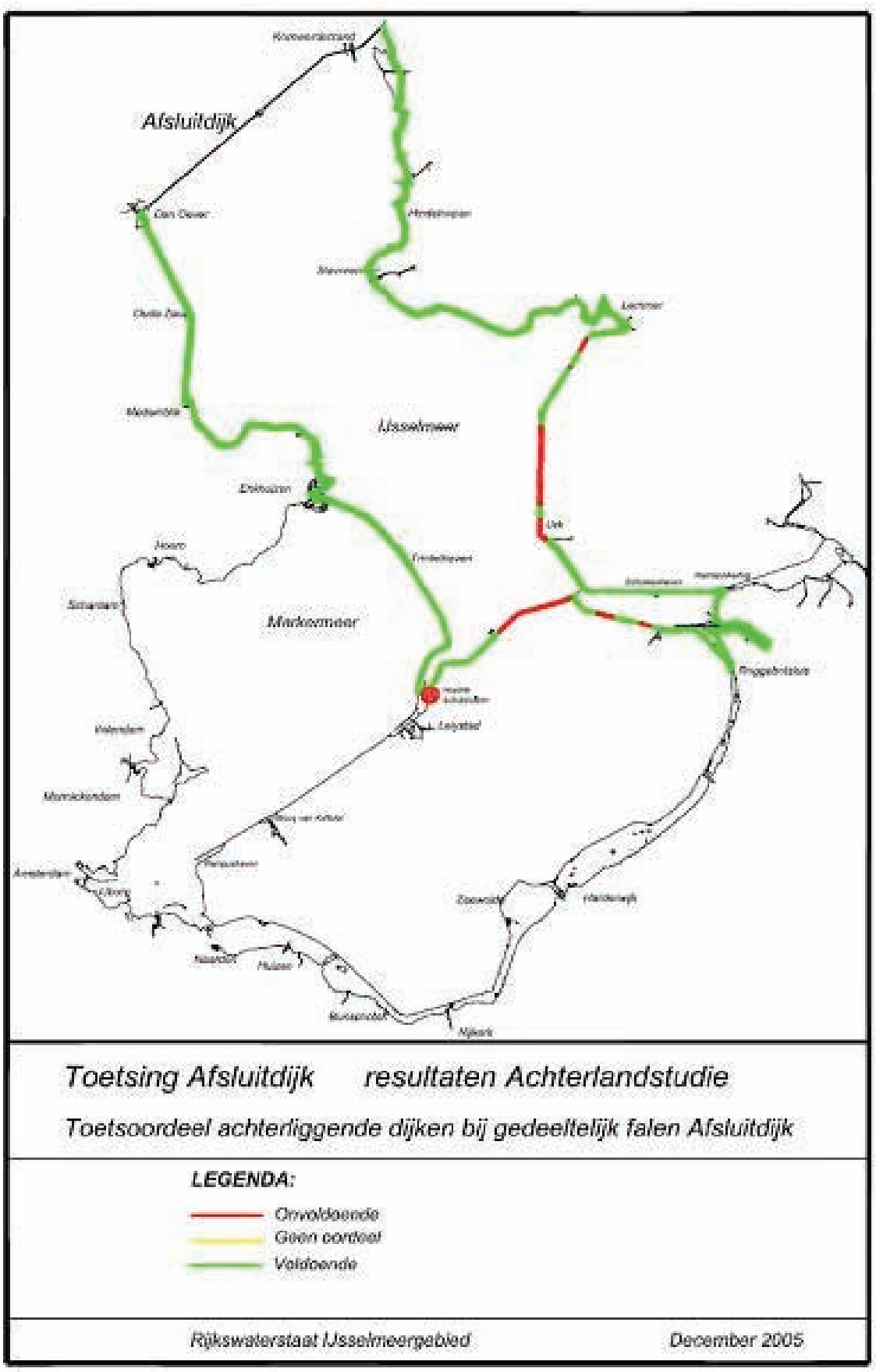




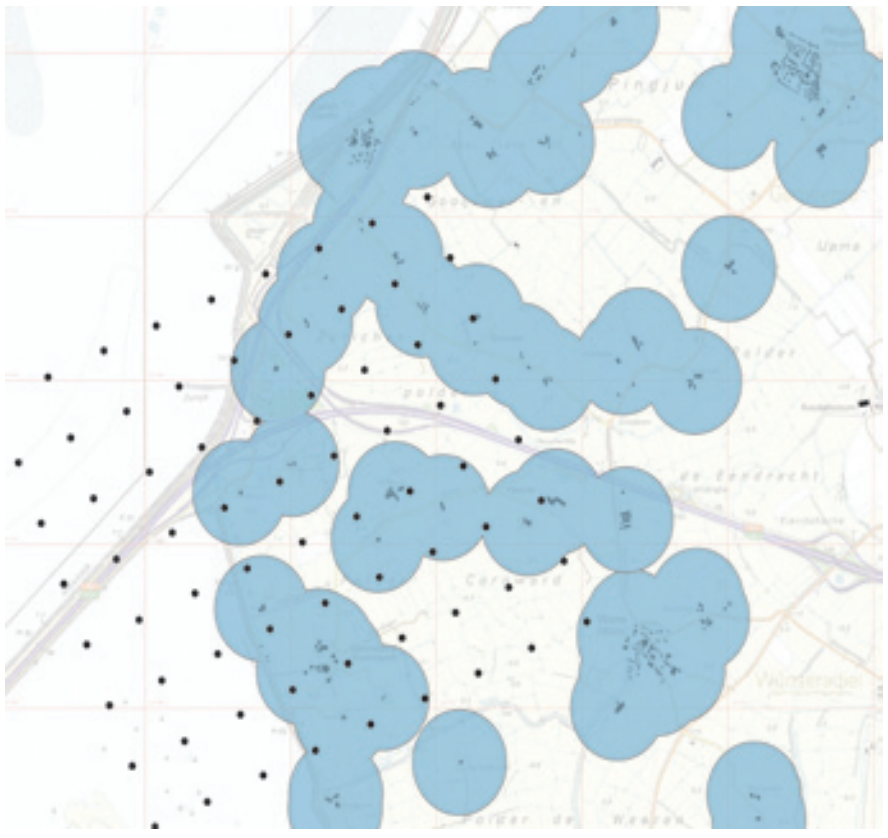


IV Dikes and dams that do not suffice the standards of the ‘Wet op de Waterkering’

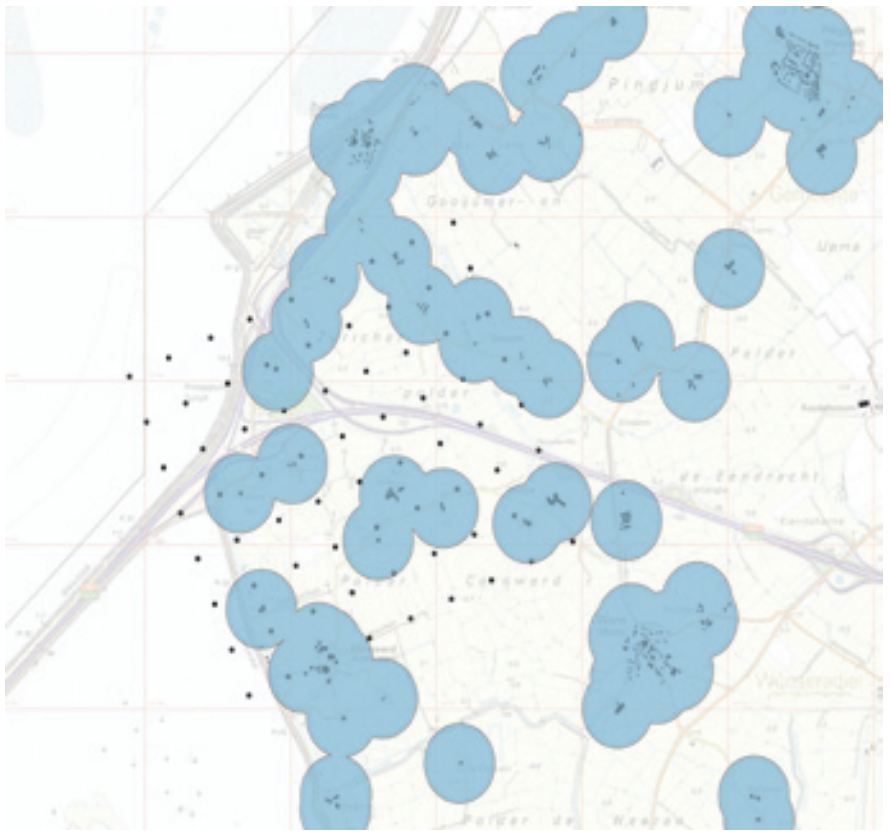
Bij de toetsing inn 2005 is gebleken dat de Afsluitdijk, inclusief de twee spuisuizen en de twee schtutsluizen op veel cirteria niet voldoen aan de 1/10.000 veiligheidsnorm. In de toekomst komt daar nog het effect van klimaatverandering bij, wat zich uit in een mogelijk forese zeespiegelrijzing en zwaardere golfaanval en in hogere afvoeren vanuit het IJsselmeer.



V Implementation of wind turbines in ‘Wûnseradiel’



Wind turbines with a hub height of 80m



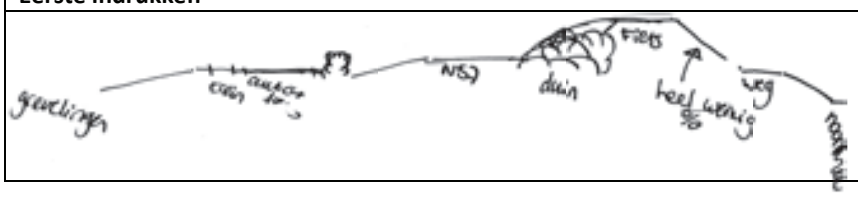
Wind turbines with a hub height of 60m

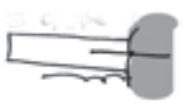
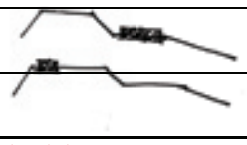
The maps show the needed distance (blue circles) between turbines (hub height of 80m, 60m, 40m) and houses. The maps show that also wind turbines of 80 or 60 meters are difficult to implement, because of the existing dwellings.

Existing high raised elements (dikes, buildings, vegetation). An open landscape with a large view shed.

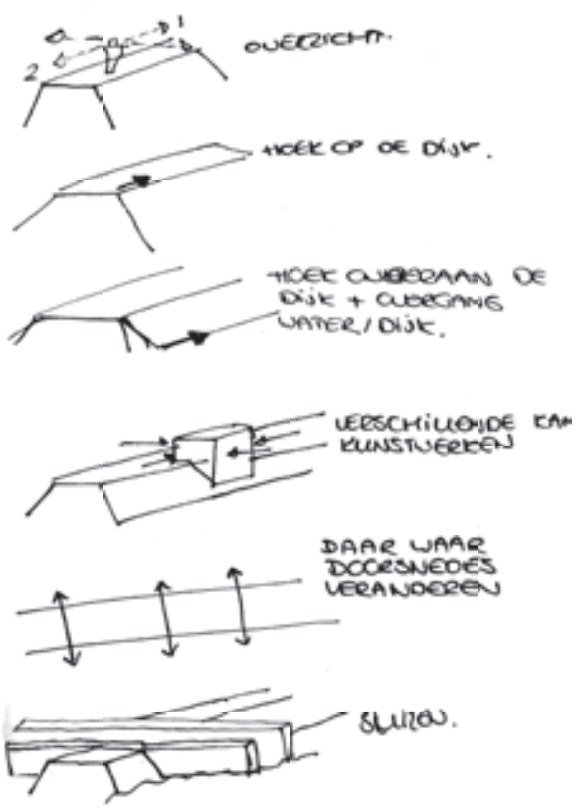
VI Reference studies: ‘Brouwersdam’ and ‘Deltawerken’

Referentiestudie Brouwersdam
Datum: 28-06-2008
Weersomstandigheden: Zonnig
Voor schetsen zie schetsboek

Eerste indrukken


Context	
Hoe is de aansluiting met het vast land? Noordzijde Rijdt letterlijk het duingebied in, opeens in de openheid en beton	Zuidzijde
Welke landschapselementen zijn gebruikt?	Helmgras / duinlandschap
Wat voor soort vegetatie staat er?	Duinvegetatie, helm + duindoorn
Hoe ziet de vegetatie eruit? (kwaliteit)	Goed redelijk veel, niet aangetast door zout
Waar staat vegetatie?	Kaartje Begin, eind, tussendoor op werkeilanden
Duurzame energie.	
Wordt er duurzame energie opgewekt?	Nee
Wat voor soort duurzame energie?	-
Waar zijn deze gesitueerd?	Kaartje -
Materiaal en kleur	
Wat voor materialen en kleuren zijn er gebruikt	
 Weg Fietspad Kunstwerken Pilaren Brug	Beton, asfalt, donker grijs Kinderkoppen _donker grijs/zwart Basalt blokken zwart en grijs Rood asfalt Grijs beton - -
Infrastructuur	
Waar is de weg gesitueerd ten opzichte van de dam?	
Is er een fietspad en wat is de locatie ten opzichte van andere elementen?	
Wat is de maximale snelheid en is deze overal gelijk	60 km/h overal gelijk
Hoeveel banen bevat de weg en zijn deze van elkaar gescheiden?	2
Kun je gemakkelijk van de weg af?	Overal, iedereen doet het, maar niet toegestaan, want is doorgetrokken lijn.
Zijn er parkeerplaatsen?	Overal
Hoe zien de op- en afritten eruit?	Iedereen rijdt er overal op en af, maar absoluut geen chaos, maar er zijn afritten getekend op het asfalt door middel van witte strepen
Waar kunnen voetgangers komen?	Overal, geen apart deel voor voetgangers, dus niet overal even veilig
Kun je bij het water komen?	Kan overal bij het water komen, mits goed ter been.
Verkeer	
Wordt het verkeer geregeld met verkeerslichten?	Nee
Slagbomen?	Ja, gaan dicht met slecht weer
Is de dam verlicht?	Nee
Zijn er bushaltes? Hoeveel? Waar?	Nee, wel bij Port Zelande, aan de kant van de Grevelingen, niet aan de Noordzeekant.
Hoe zien de verkeersborden eruit?	Normaal, weinig verkeersborden
Kun je makkelijk ‘keren’?	Ja, want kan overal de weg op en af
Beleving	
Is het water te beleven	Ja, maar met de auto kan alleen de Noordzee worden gezien, je hebt geen idee dat het Grevelingen aan de andere zijde ligt.

Take photos at the next places :

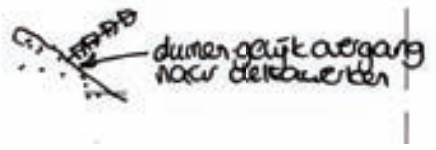


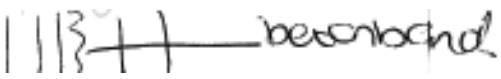
	Grevelingen dan de andere zijde ligt
Zijn er verschillen te beleven tussen de Noordzee en de zeearm? Noordzee Openheid	 Arm Meer Meer besloten door de eilanden die in het Grevelingen liggen, met 'hoge' opgaande begroeiing, de horizon is niet vrij.
Wat zie je van de kusten? Noord Strand en duinen	 Zuid Strand en duinen
Zijn er oriëntatiepunten? (landmarks) Waar (kaartje)?	Nee
Hoe is de oriëntatie in het algemeen?	Goed, je wordt geleid door beton en asfalt
Hoe wordt de sequentie van de kunstwerken ervaren.	Er is maar 1 paar sluizen
Wat zie je als je over de weg beweegt?	Zee (en duinen)
Hoe transparant wordt de dam ervaren? (vanaf de dam)?	Erg transparant, jammer dat je niet gelijk het Grevelingen ziet.
Hoe transparant wordt de dam ervaren? (vanaf de kust)?	Transparant
Is er een duidelijke overgang waarneembaar van het ene naar het andere eiland?	Ja, duinvorming
Kun je de dam ook vanuit een ander punt zien? Zo ja vanaf waar?	Ja, vanaf strand (en zee natuurlijk)
Worden de weersomstandigheden ervaren?	Fietsen, wandelen: wind, vooral omdat fietspad bovenop de dam ligt. Auto: niets
Afmetingen en verhoudingen	
Hoe hoog is de rijbaan ten opzichte van het water	Ong. 10m
Hoe wordt de maat van de route ervaren?	Groot, asfalt
Hoe worden de maten van de kunstwerken ervaren?	-
Wat is de afstand tussen de kunstwerken?	-
Kunstwerken	
Hoe zien de kunstwerken er uit?	
Zijn de kunstwerken open voor publiek?	Nee
Zijn er monumenten? Waar?	Nee
Wat voor voorzieningen zijn er? (picknickbanken, prullebakken e.d.)	Prullebakken, iedereen blijft in de auto zitten
Hoe zien de gebouwen op de dam eruit? (sluisbeheer e.d.)	Geen gebouwen, behalve sluizen
Veiligheid	
Wat is er gedaan aan de veiligheid van de gebruikers? Bv hekken e.d.	Geen
Informatievoorziening	
Zijn er informatieborden?	Nee
Is er een bezoekerscentrum?	Ja, maar ver van de dam weg, meer gericht op het Grevelingen
Is er een eetgelegenheid	Frietkarren
Recreatievoorzieningen	
Wat voor recreatievoorzieningen zijn er?	Fietspad, bij Port Zelande watersporten
Wat voor activiteiten gebeuren er?	Watersporten, voornamelijk kite-surfen
Is er parkeergelegenheid	Veel, overal waar asfalt ligt.

Referentiestudie Deltawerken
Datum: 27-06-08
Weersomstandigheden: zonnig, windkracht 6
Voor schetsen zie schetsboek

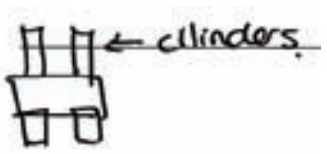
Eerste indrukken
Natuurlijker dan Afsluitdijk omdat je uit de duinen komt. De pilaren worden op de fiets niet als een muur ervaren. Goede relatie tussen zee en meer Kleinere delen van het geheel Glooiing in pilaren maakt het minder strak Pilaren hebben een opgaand (derde) dimensie

Context	
Hoe is de aansluiting met het vast land? Noordzijde Langzame overgang van duinen naar brug	Zuidzijde Redelijk strakke overgang van land naar brug, duinen, dan gelijk overgang naar deltawerken.
Welke landschapselementen zijn gebruikt?	Geen
Wat voor soort vegetatie staat er?	Aanlandingspunten, grassoorten, kruiden, boterbloemassociatie?
Hoe ziet de vegetatie eruit? (kwaliteit)	Gras, groen
Waar staat vegetatie?	Kaartje Aanlandingspunten = gras en duin Eilanden = duinvegetatie
Duurzame energie.	
Wordt er duurzame energie opgewekt?	Ja
Wat voor soort duurzame energie?	Windmolens met 2 en 3 wieken
Waar zijn deze gesitueerd?	Kaartje zie topkaart 1:25000
Materiaal en kleur	
Wat voor materialen zijn er gebruikt	
Weg	Asfalt
Fietspad	Asfalt
Kunstwerken	Wit beton
Pilaren	Beton
Brug	Beton
Welke kleuren zijn er gebruikt	
Weg	Donker grijs
Fietspad	Donker grijs
Kunstwerken	Wit
Pilaren	Wit
Brug	Wit
Infrastructuur	
Waar is de weg gesitueerd ten opzichte van de dam?	Midden
Is er een fietspad en wat is de locatie ten opzichte van andere elementen?	
Wat is de maximale snelheid en is deze overal gelijk	100 km/h, nu 70 km/h ivm wegwerkzaamheden
Hoeveel banen bevat de weg en zijn deze van elkaar gescheiden?	4
Kun je makkelijk van de weg af?	Op de eilanden wel
Zijn er parkeerplaatsen?	Op de eilanden, bij Neeltje Jans = betalen
Hoe zien de op- en afritten eruit?	Overzichtelijk
Waar kunnen voetgangers komen?	Op de fietspaden
Kun je bij het water komen?	Nee! Op eilanden enkele strandjes
Verkeer	
Wordt het verkeer geregeld met verkeerslichten?	Ja
Slagbomen?	Ja
Is de dam verlicht?	Ja: hoge lantaarnpalen
Zijn er bushaltes? Hoeveel? Waar?	Ja





Hoe zien de verkeersborden eruit?	Normaal, redelijke hoeveelheid om te kunnen bevatten
Kun je gemakkelijk 'keren'?	Ja, op de eilanden en deze liggen op korte afstand van elkaar
Beleving	
Is het water te beleven	Vanaf de fiets goed, vanuit de auto verschillend
Zijn er verschillen te beleven tussen de Noordzee en de zeearm? Noordzee Wild, blauw Omdat je zo ver kan kijken is het beleefbaar (door de hoge positie van de kijker). Eerste deel van het water zie je niet.	Arm Groenig
Wat zie je van de kusten?	
kust)?	
Is er een duidelijke overgang waarneembaar van het ene naar het andere eiland?	Ja:
Kun je de dam ook vanuit een ander punt zien? Zo ja vanaf waar?	Vanaf ver
Worden de weersomstandigheden ervaren?	Wind: vooral de wind = voelen en zien van de golven (wild-heid) Fietspad is aan zeezijde.
Afmetingen en verhoudingen	
Hoe hoog is de rijbaan ten opzichte van het water	Ong. 10-30 meter
Hoe wordt de maat van de route ervaren?	Kort, je rijdt echt van eiland naar eiland
Hoe worden de maten van de kunstwerken ervaren?	Ong. 10 meter boven de weg, groot
Wat is de afstand tussen de kunstwerken?	Ong. 20 meter
Kunstwerken	
Hoe zien de kunstwerken er uit?	Groot
Zijn de kunstwerken open voor publiek?	Nee, alleen rondleidingen
Zijn er monumenten? Waar?	Aan het begin, noordzijde, staat een beeld: 'golf'
Wat voor voorzieningen zijn er? (picknickbanken, prullebakken e.d.)	Geen
Hoe zien de gebouwen op de dam eruit? (sluisbeheer e.d.)	RWS = blokkerig, grijs. Neetlje Jans= transparant, Glooiend, gaat op in zee, duinlandschap, blauw. RWS past bij kunstwerken, Neeltje Jans meer bij landschap.
Veiligheid	
Wat is er gedaan aan de veiligheid van de gebruikers? Bv hekken e.d.	Lage hekken van ongeveer 1,20 meter hoog, veel waarschuwingsborden, veel verboden toegang
Informatievoorziening	
Zijn er informatieborden?	Ja, ook op rare, niet toegankelijke plekken
Is er een bezoekerscentrum?	Ja, Neeltje Jans = entree
Is er een eetgelegenheid	Ja, Neeltje Jans = entree



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Pages:
157

Printing office:
ABT Repro, Velp