GRONINGEN, ADAPTATION TO CLIMATE CHANGE

Group STAAL
[Atelier Landscape Architecture & Planning - Wageningen University - 2009]

provincie groningen

WAGENINGEN UNIVERSITY
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Kennis voor Klimaat

klimaat voor ruimte

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This atelier was executed under the framework of the hotspot groningen within the “Klimaat voor Ruimte” climate changes spatial planning program.

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PREFACE *by Rudi van Etteger (tutor)*

Before you lies the result of a masters-student atelier in landscape architecture and planning. The course started on the 2nd of March and ended on the 1st of June 2009. The atelier was executed under the framework of the hotspot groningen withing the “Klimaat voor Ruimte” climate changes spatial planning program. The assignment for the students was to plan and design a future landscape for the province of Groningen that is adapted to climate change as foreseen for the period until 2100. The students worked in three phases on this subject, following a more or less classic order of inventory and analysis, envisioning and conceptualizing, designing and detailing.

Why do we run an atelier landscape architecture and planning on the impact of climate change on a regional landscape? I as a member of the staff of the landscape architecture department I do not believe in landscape architecture in terms of mere beautification. Working on relevant themes, for society as a whole and local community in particular has our specific attention. Fitting new societal needs in the landscape and researching the capacity of the landscape to deal with new functions, for example in studying the impact of climate change, is part of our desire to make our research matter. Within the field of climate change of course we then focus on the impact on the landscape. That means that we research the potential of the landscape to adapt to climate change but also evaluate this capacity against the landscape with regards to ecological and experiential values. This adaptation is not just a matter of design but needs careful planning as well and this first more interdisciplinary atelier has immediately shown us the value of that approach.

Many people worked hard to achieve this result: first and foremost the students, the tutors and many guests that contributed with their knowledge to this result. I would like to take this opportunity to thank those that have contributed to the success of the atelier, through various introductions, lectures, explanations etc. So our thanks go to Rob Roggema, Janette Bessembinder of the KNMI, Tia Hermans and Sabine van Rooij of Alterra, Wilfried Heine and Arnold Lassche of the Waterboard Hunze en Aa’s, Patrick Bogaart of the centre Water and Climate and Jannemarie de Jonge, for their thoughts, insights and knowledge.

I thank the students for their efforts in tackling the complex issues that we put before them. It is your enthusiasm that makes this work fulfilling. I thank my fellow tutor Jan van Nieuwenhuizen for his contribution to this result. Anouk Brack helped the students with their communication and group-process-skills and has in that sense made her contribution to the end result.

The memorable trip included in this course to the state of North Carolina in the US was made possible due to financial aid by the ARCADIS engineering company and subsidies related to the hotspot Groningen of the Klimaat voor Ruimte program. The students also participated financially in this adventure and thus made it possible.

The trip delivered us many insights into a similar coastal landscape that has not been so heavily altered by engineering, but is under a more sever pressure from recreational demands than the Groningen coast. It showed us the beauty of natural landscapes and their resilience in the face of climate change. It also gave us a confrontation with the American way of life in all its unsustainable facets, from the means of transport, to the lay-out of urban and rural landscapes and even in the food we ate and the way it was served. Our ecological footprint was immediately enlarged from the moment we touched American soil.

This trip was made possible and fruitful thanks to the cooperation of professors Erich Connell and Robert Chin of East Carolina University and we were delighted by the spontaneous response of professor Stanley Riggs that was able to conjure up an impromptu lecture on the geology and planning of the North Carolina Coast to a group of unannounced visitors from the Netherlands and shared his knowledge with us in the true spirit of the academic endeavour.

I hope this end result lying before you now gives a good impression of the interesting work done in the atelier.

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1. VISION

As an independent advise bureau we have a certain vision. This vision is a representation of our philosophy and attitude towards space and time. The choices we make for the different planning processes are based on this vision. Design and planning for the far future does not have the function of a blueprint plan, but it is a framework which can guide this process. By designing for this future we have to deal with a lot of uncertainties, because of this detailed end-result plans for the future are outdated the moment they are finished. Therefore we believe in creating a framework that guides future policy makers in making decisions for a landscape that is composed out of several aspects.

We strive to create a landscape for its inhabitants and for the future which is sustainable, ecological, readable, usable, functioning, narrative and aesthetically appraised. To achieve all these aspects, we apply a holistic and creative approach. This means all relevant actors and factors and their connectedness and consequences through time and space are considered. In creating new solutions, creative out-of-the-box thinking is required. You can't create without creativity.

This vision helps us visioning space through time. We believe that this vision can have a basic leading role and can contribute to solutions for a sustainable future.

2. INTRODUCTION

Groningen

Groningen is a province in the northern part of the Netherlands, with 572.706 inhabitants of which almost one third lives in the city of Groningen. Groningen is bordered by: The Waddenzee in the north, Nedersaksen (Germany) in the east, Drenthe in the south and Fryslân in the west. Three small Wadden islands are included in the province's territory: Rottumeroog, Rottumerplaat and Zuiderduintjes. The borders of the Netherlands, the province, the two water boards and the municipalities in the area are shown in figure 1.
As Groningen is a coastal province and most of it is below sea level, climate change could become an important problem.

Climate change

Climate is the average of temperature, humidity/moisture, air pressure, wind, clouds and precipitation which is by convention measured over 30 years. It is possible to speak of regional climate and global climate, in which the regional climate has more extremes than the global climate, because it is taken from a smaller area. A part of the climate is the amount in which extreme weather occurs, like heat waves, heavy rain and flooding.

The climate is not constant, it is and has always been fluctuating due to natural circumstances, like the air and water flows, solar radiation and volcanic activity. Humans also have influence on the climate and most scientists agree the main human influences are: urbanization, land use changes, green house gases and aerosols (tiny particles high in the sky, e.g. smog and air pollution). The changing climate will have major effects for the future. The climate will change the conditions for water, ecology, agriculture and energy. This could have spatial impact on different levels.

How do the inhabitants of Groningen feel about climate change? Data of the Milieu Federation of Groningen show some numbers and figures (shown in the diagrams in figure 02). The inhabitants of Groningen see climate change as the most important environmental problem. They also think that the Dutch government takes not enough measures to fight the climate problems. It is striking that the Groninger inhabitants feel more responsible for their own behaviour in relation to climate change than the national average. They come with solutions to build in a more sustainable way, and reduce the energy use by public lightning. They come up with ideas to make Groningen 'climate neutral', because only 37 % hasn't got any ideas for this while 63% does have good ideas. They came up with ideas for their house, public lightning, job or company, glasshouses, transport and street/district.

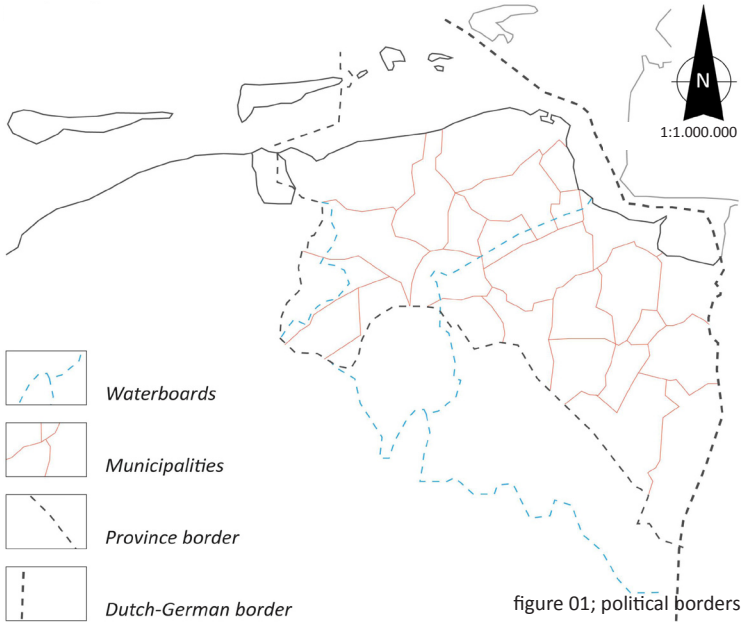


figure 01; political borders

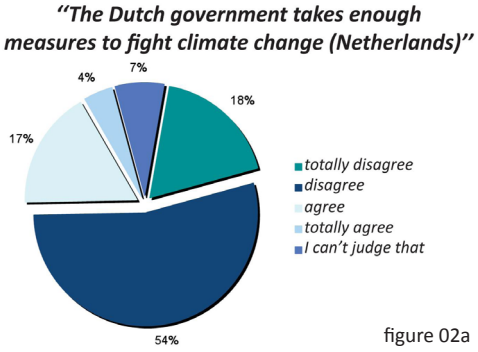


figure 02a

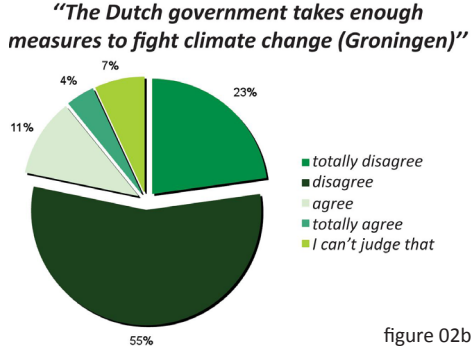


figure 02b

3. AMBITIONS

For the future of the province of Groningen, we have ambitions. These are a result of our vision applied to this province and help define what we want the future of Groningen to look like. We have defined these ambitions during a short brainstorm session in the early analysis phase of the planning and designing process. So what do we want for the future of Groningen?

Sustainable design:
Sustainability as defined by the 'World Commission on Environment and Development': 'forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs.' This is even more relevant in the context of climate change and the depletion of natural resources.

Design for safety:
As the climate is changing, the seawater level is rising, and the weather will be more extreme. This will have dramatic consequences if nothing is done, the safety of the inhabitants of Groningen will be at stake. The safety of the province on short term as well as on long term should be guaranteed. This safety can be expressed in terms of feelings (feelings of safety) and of dealing with the risks. These two aspects should both be taken into account in creating a plan for the future of this region.

Narrative design:
Every landscape has its own past and consists of many events and stories. The landscape was created by nature and by man. These local/regional qualities should be expressed and considered within the planning and designing process. By doing so, a local identity can be maintained or created. The landscape has a certain logic, which expresses its identity. Studying this logic, makes it possible to create a more legible landscape, which people can experience and feel. It is our ambition to create a landscape which is experienced positively. Aesthetics have a big share in how an environment is experienced. So creating a aesthetically positively valued landscape is important as well. Form and function should meet and balance each other.

Ecological design:
By using natural processes in landscape planning and design, a more sustainable and better functioning landscape can be achieved. Many possibilities of the landscape are not used and are unknown. Natural processes might help to enforce the coastal area. Natural resources are available on site and can be harvested. This gives opportunities for food and energy production. By doing so, some of the causes of climate change can be dealt with. For example a CO2 reduction can be achieved by using renewable energy. Furthermore costs can be reduced by using local qualities (materials, energy, food production etc.). By considering natural processes, a healthy and functioning environment can be created. Through ecological design the environmental footprint of Groningen and the interacting areas can be reduced.

Democratic design:
It is important to stay aware of the fact that planning and design process is done for a certain group of people. In the case of Groningen, there are a lot of people that are involved. By thinking from the people's perspective and allowing them to participate in the planning and design process, public acceptation can be achieved. Public awareness of climate change and its causes and consequences should be reached as well, so communication is highly important. By communicating, the public acceptation can be greater.
These topics should be included in the process. By doing so, a framework can be created which has possibilities and opportunities for developments in the short and in the long future.

PHASE ONE

ANALYSIS

4. HISTORY

There is a contrast between the open and extended landscape with the closed and introvert villages. Groningen has a differentiated landscape, divided in thirteen regions. In this chapter the history and characteristics of each region will be described shortly. Until 1438 the area was Friesian, until it was conquered by Groningen. The history of Groningen as own region starts here.

Hogeland

The name Hogeland (High land) relates to the high altitude of the land, according to the accretion of the sea. Some people say that the triangle Groningen city-Bedum-Ten Boer is not part of the Hogeland and therefore is called Lageland. This region is indeed lower than the rest of the area. It is enclosed by a sleeper dike, de Wolddike and therefore is called Innersdijken (inner dikes). The Hogeland is famous because of the sharp distinction between the social classes of 'herenboeren' and 'keuterboeren/landarbeiders'.

Eemsdelta

The Eemsdelta is the economic harbour centre around the Dollard. The Eems is a German river and runs into the Dollard and Waddenzee. This last part is called Westereems. Two important harbours in this area are the harbours of Delfzijl and Eemshaven.

Lauwersmeer

The Lauwersmeer is a manmade lake and developed by the enclosure of the Lauwerszee in 1969, before this is was a natural creek landscape. The biggest reason for damming the Lauwerszee was safety. The eastern part is military area. There is also a lot of recreation, like windsurfing and walking. In 2003 the Lauwersmeer became National Park and in 2004 the Lauwersmeer came on the third place of 'The most beautiful place of the Netherlands'. This area is liked by bird-spotters.

Reitdiepgebied

Reitdiep is a water stream from the city of Groningen (Noorderharbour) to the Lauwersmeer. Before the developing of the Eemskanaal 1876, the Reitdiep was the only open connection of Groningen with the see. After making a dike of Zoutkamp to the Nittershoek with sluices, the open connection was gone. This was finished in 1877, so the tidal influences disappeared in the city. The Reitdiep area is one of the oldest cultural landscapes in Europe. In a lot of places the old meandering river patterns are still visible.

Humsterland

This is the northern part of the Westerkwartier and is one of the oldest cultural landscapes in West Europe, already mentioned in 786/787. Before the dikes were build in 1100 A.D. Middag and Humsterland were natural islands. In 800 A.D. it was one of the densest populated areas of the Netherlands. About the year 1200 the number of storms increased and a ring dike was made around Humsterland and since 1500 Humsterland is connected to the mainland. Middag and Humsterland have as "Middag-Humsterland" the status of National Landschape and are selected for the world heritage list of UNESCO.

Waddenzee

This landscape was formed for a great part by storm tide in the 10th – 14th century, destroying peat land behind the coastal dunes. The Waddenzee is now National Park. It is an important region for nature and it is also an important recreation area where you can sport, sail or do low-tide sea-walking.

Westerwolde

The western boarder of Westerwolde is made in the 17th century, the Semslinie. By making this border the gaining of peat could start and the Kanaalstreek is developed. In Westerwolde people lived to the year 200 B.C. and it is likely that the area is populated again in 600 – 700 A.D. It was in the biggest swamp area in Western Europe: Bourtangerveen. The area around Westerwolde is a 'Esdorpenlandschap' and in the North the 'Streekdorpenlandschap'. In the nineteenth century the heath areas and peat areas in Westerwolde were mined and cultivated, so the 'Ontginningslandschap' developed.

Oldambt
Oldambt was historically an agricultural community and has a turbulent history. The Oldambt means 'The old Craft'. Around 1800 the peat areas had been exploited and the meadows changed into agricultural fields. The introduction of the potato had lead to major differences between the rich and the poor. The communist party is one of the remains of this inequality. Economically, Oldambt is not very active, their population is decreasing. To change this, the Blauwestad project was initiated. There is competition with Germany which also has very low house prices in that area. The Oldambter dialect remains relatively used. Especially near the border with Germany, the dialect remains well used.

Groninger Veenkoloniën
Until the 17th century the area was uninhabited, only on the edges turf was extracted. Groningen sent colonies of poor families to work for them to get the turf out of the soil. The workers in the area remained poor, while the surrounding cities, which property the peat soils were, got rich. The landscape changed into a landscape dominated by ribbon developments along partly filled up canals. Originally the peat swamps were inaccessible. Only in Westerwolde there was a small sand ridge which made the swamp passable.

Groningen (City)
Groningen is one of the 10 biggest cities in the Netherlands. It is a student city with 50,000 students, which is 30% of its population. It is and always was a city of commerce, strategically positioned between Drenthe and Friesland.
Groningers act in their own interest first. As they built their own city wall without permission and they chose independence for a long time before necessity made them allies to the Dutch Republic against the French. Several districts of Groningen retain their individuality of the small villages they used to be. The municipality supports this.

Westerkwartier
The Westerkwartier is one of the oldest man-made landscapes of Western-Europe. The citizens have slowly but surely won every piece of land from the sea. 800 after Christ it was even one of the most populated areas of the Netherlands.

Midden Groningen
Midden Groningen is an area with ribbon village developments on the sand ridges to the west of the area. From there the 'veenontginningen' (peat cultivation) started. Resulting these days in a low area used for agricultural fields. The area is continuing to go down due to the gas extraction in Slochteren.

Gorecht
Gorecht consists of Go, the high land on the Hondsrug and the Drentherwold which are the peat areas. Gorecht was part of Drenthe, but the prefect of the area slowly lost his position.
The city became autonomous. In 1392, the bishop of Utrecht confirmed its independency.

5. CURRENT SITUATION

This history is narrowly related to the perception of the province. Using interviews and the analysing method of Kevin Lynch a mental map is made. Furthermore, this chapter describes facts and data about the current Groningen. What kind of soils can we find here, the height of the province, numbers of inhabitants etc.

5.1 Mental map

To get more insight into the province of Groningen, we made a questionnaire to interview Groningers about their perception of the province. Unfortunately we had (too) less responses for a good overview. Besides this, we also have made a map according to the five principles of Kevin Lynch: districts, paths, landmarks, nodes and edges. By doing so, it becomes clearer what important features of the province are and where they are located. If the characteristics of an area are known, they can be emphasised, if it contributes to the identity of an area.

The final map is not a real cognitive map, because it is made with the help of factual data. Thus, it is not a product of the cognition only. This is not done for two reasons: First, there was no time and possibility to let 'Groningers' draw their own maps of the province, so it is a product of us, and not of the inhabitants. Second, our knowledge about the area is different than that of Groningen inhabitants. Our knowledge is based on data and facts acquired from our analysis and Groningen inhabitants' knowledge is based on experiences of their living in there.

By looking at the five aspects in layers above each other, their interrelationships, if present, become visible. The nodes are a result of the intersections of the main paths. The most important landmarks can be found at and near these nodes. These are areas at the north to the east of Groningen City, so these districts seem to be significant for the Groningen inhabitants. These are the most important conclusions that can be made.

5.2 Landscape

Other typical landscapes are the polders in the north, the peat area's in the east/south which have been cultivated, and the higher sandy grounds. The most typical geographic feature of the landscape is the Hondsrug. It is a ridge of sand that is mainly located in the province Drenthe and partly in the province Groningen. The ridge has a northwest-southeast orientation. At the most northern top of the Hondsrug, the city of Groningen is situated at a relative high part of the province. Some parts of the province are below the current sea level. The deep soil of the Groningen landscape consist of important fossil resources, which origin is in the continental drift.

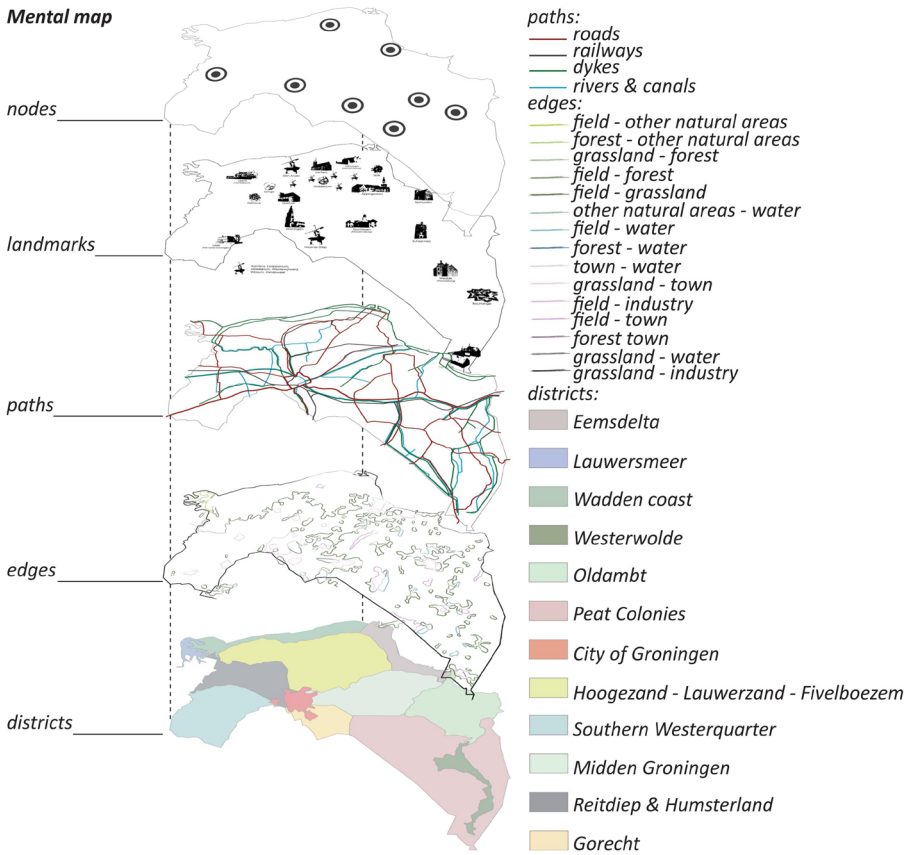


figure 03; mental map in layers

In the province of Groningen live about 572.706 people on 2400 km² land. The population density in Groningen is low compared to the 'Randstad'. On average there are 240 inhabitants/km2, this is half of the national average. Two-third of the inhabitants live in the cities: Groningen-Haren, Delfzijl-Appingendam, Hoogezand-Sappemeer, Veendam-Wildervank, Winschoten-Oude Pekela and Stadskanaal.

If we take the open water areas of the Dollard and the Wadden area into account, Groningen has twice the amount of open water as the rest of the Netherlands. In that case Groningen would have 23% nature area, because the Waddenzee an important national and natural treasure.

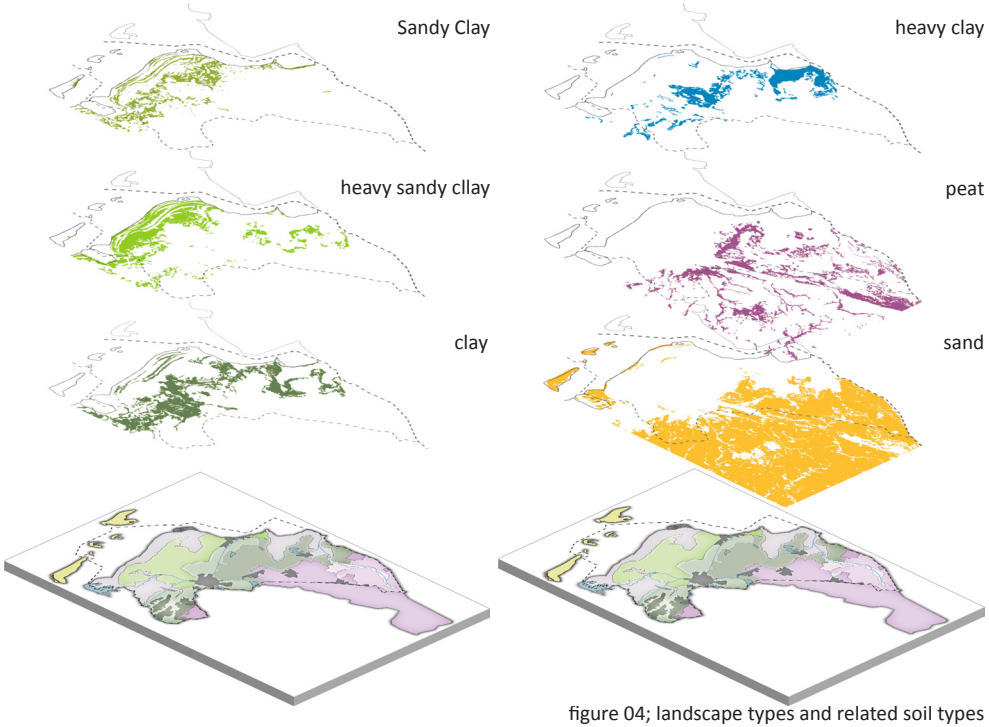


figure 04; landscape types and related soil types

If we don't take the water into account, we realize that Groningen is an agricultural province. 80% of the land is agricultural area. The largest part of agriculture is arable land. In the west are some parts that is used as livestock farming. This is not more than 15%. The arable land is used for large scale farming. Thanks to reallocation of land, the farming is done on large scale. The products are mostly grain, sugar beats and potatoes. The land use in Groningen can be summarized by the following chart:

Groningen Province: area and land use 2003

	Groningen		Netherlands	
Category	km²	%	km²	%
Built up	151	6	3289	9
Inland waters	70	3	3598	10
Forests	145	6	4841	13
Agriculture	1904	79	23041	62
Recreation	37	2	937	3
Semi-built up *)	33	1	506	1
Traffic	65	3	1143	3
Total excluding exterior water	2404	81	37354	90
Exterior water	564	19	4174	10
Grand total	2968	100	41528	100

*)Semi-built up: Land used for waste storage, storage of wrecks, burials and construction, together with other (semi-)paved areas. Source: Statistics Netherlands, Voorburg/Heerlen dated 09-03-2007

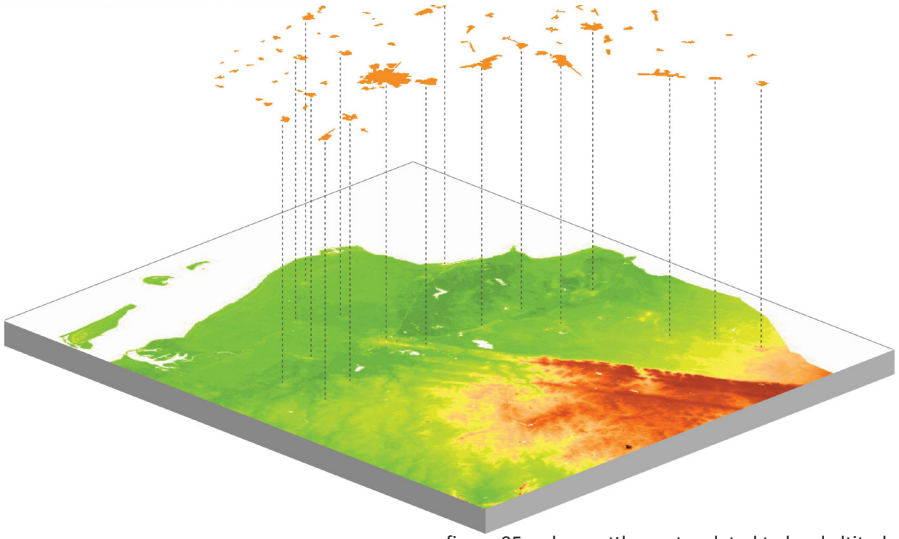


figure 05; urban settlements related to local altitude

6. LANDSCAPE TYPES

How people perceive and experience the landscape they are in, depends on many things. One of these aspects is the landscape type. Every landscape type has different characteristics which define the ambience and identity.
How people have perceived the landscape through time can be found in paintings, photos, poems and other arts. For all the eight landscape types that occur in the province of Groningen, a panorama collage containing photo's and paintings has been made to express the ambiance of the landscape.
This gives us insight in the variety of the province. It is important to take local qualities and problems into account when adapting the province to climate change. Taking certain measures can have impacts in a different way, on different scales in different landscape types.

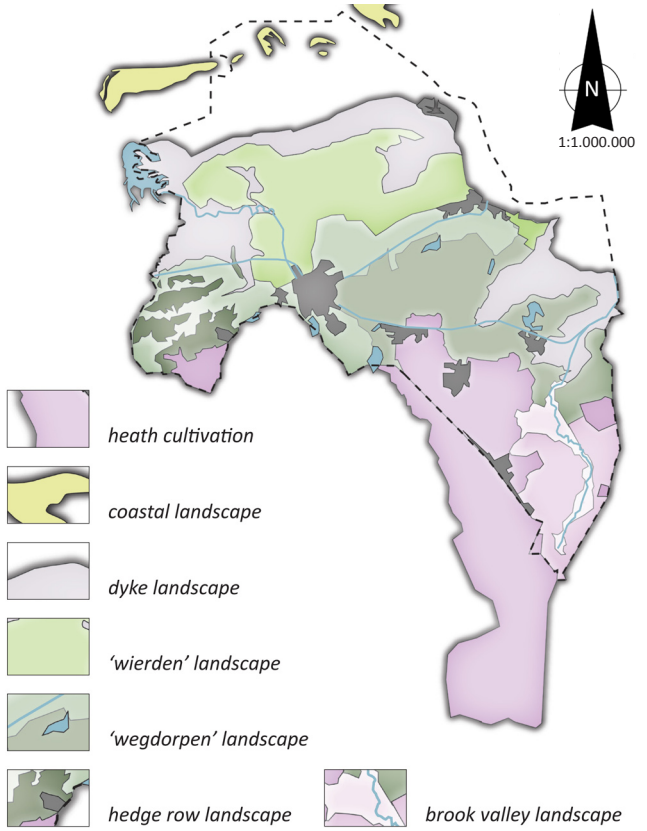


figure 06; the different landscape types in the province


Brook valley landscape


Dike landscape


Wegdorpen' landscape


Hedge row landscape


Peat Colonies landscape


'Wierden' landscape

7. DEVELOPMENTS

Now we have an overview of what is happening in Groningen at the moment, we have a better insight in how the province look like and we know something about how people think about Groningen. But what will happen in the future? This chapter tells more about the development in the region: it focuses on the influence of climate change and how policymakers react on climate change. Furthermore, you will find information about new urban and nature developments and their relation to climate change.

7.1 Climate change

The IPCC has made some scenario's for climate change in future:

1. In the most extreme case, the temperature will raise 3˚C or 4˚C in 2100. IPCC describes the world in this scenario as 'a very heterogeneous world. Regions belief in self reliance and preservation of local identities. A continuous food production results in continuously increasing population. Economic development is regionally oriented and per capita economic growth.' This causes a sea level rise of 4m in 2200.
2. In the modest case, the temperature will rise 2˚C. In this situation the world develops the same global population as at the moment, that peaks in mid-century and declines thereafter by rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. This causes a sea level rise of 2m in 2200.

On world scale, the IPCC predicts a sea level rise of 0.7m to 1.3m for Europe in 2100, but new sources predict this will be even 1.9m. We use the IPCC information for this study, because of its reliability. This sea level rise causes:

1. Negative impacts which will include increased risk of inland flash floods and more frequent coastal flooding and increased erosion (due to storminess and sea level rise).
2. On small islands, like the Wadden Islands, 'Sea level rise is expected to exacerbate inundation, storm surge, erosion and other coastal hazards, thus threatening vital infrastructure, settlements and facilities that support the livelihood of island communities'.

These predictions about climate change are in contrast with the predictions of the Royal Dutch Meteorological Institute (KNMI) for the Netherlands. They assume a sea level rise between 0.4m and 0.8m till 2100. Hereby, natural lowering of the land is taken into account, but gas exploitation and salt winnings are not. The KNMI does not say anything about economic situation in the future. The major effects within the topic water could be summarized as more precipitation and more flooding in winter and more drought (yearly water shortage of 58mm) and increase of salt penetration in surface water in summer.
In case of storms, sea levels can rise to 5 meters higher as usual. KNMI sees a decrease of these extremes, but these storms can have a great effect. At Delfzijl these heights could even be higher due to the funnel shape of the Dollard. Once every 10.000 years a surge of 6 meters occurs.

7.2 Policy

Let us zoom in at the policy about preventing climate change and adapting on climate change on different scales. The EU base their measures on the IPCC and say:

1. Reducing the emissions of greenhouse gasses (CO^2, NO_2 etc) at least 20% compared to 1990.
2. Increase the amount of sustainable energy (wind, sun and biomass) up to 20% of the total energy production.
3. Reduce the use of the energy with 20% compared with the current expectations of 2020.

For water management the European directive for Water (Kader Richtlijn Water, KRW, 2000) is decided. This agreements contain mainly topics about water quality.

Commissioned by the Dutch government, the new Delta Committee just produced new guidelines as an advise to protect against the raising water in the Netherlands. When we focus on the province of Groningen it says:

1. Along the North Sea coast:

a. A broader coastline with a balanced combination of nature develop ment / ecological processes and urban development should be built.

b. Sand should be supplied on a large scale. (The effects for the ecologi cal situation should be investigated).
2. Along the Wadden Sea area
a. Also sand should be supplied on a large scale.
b. The island polders should be protected.
3. In lake Ijssel
a. The water level should be risen for a consistent water supply.

To combat climate change, the Dutch government follows the EU guidelines (Nota “Schoon en zuinig”, 2007).
1. Reducing the emissions of greenhouse gasses (CO^2, NO_2 etc) with 30% compared to 1990.
2. Save 2% of energy in stead of 1% a year.

The province of Groningen says in the provincial plan (POP 2009-2013): “On the short term (until 2015) the province does not see the necessity of radical measurements on climate change. (…) We are open minded for new ideas. If necessary, we will take climate change into account making new plans and developments.” Besides this vision, the province has startedsome innovative research projects for example about energy landscapes (2007).

7.3 Lowering of the soil and seepage

Lowering of the soil in the Groningen region has two causes. In the first place, salt and gas extraction. Second, the drying peat leads to settling of the surface of Groningen, because of agricultural activities and extraction of fresh water. This leads to an relatively extra sea level rise.
The lowering of the soil leads to more salt seepage in the area. This brackish seepage along the coastline could have effect over a distance of tens of kilometres inland. On the one hand, this leads to a biotope with rare plant species, on the other hand it has bad effects for the agriculture along the coast. Supply of fresh water is used by farmers for the advancement of the agricultural crops. This is the reason why valuable brackish water vegetation is disappeared.
The frequent and prolonged presence of water shortage, the increase of seepage during the summer and the problems with water in the lower parts during the winter are the main effects of climate change on agriculture. The agricultural sector in Groningen should adapt on the change in weather conditions. Farmers could invest in field, plant material and technology, the agricultural sector could introduce new varieties, and the water boards could reserve more water for the farmers.

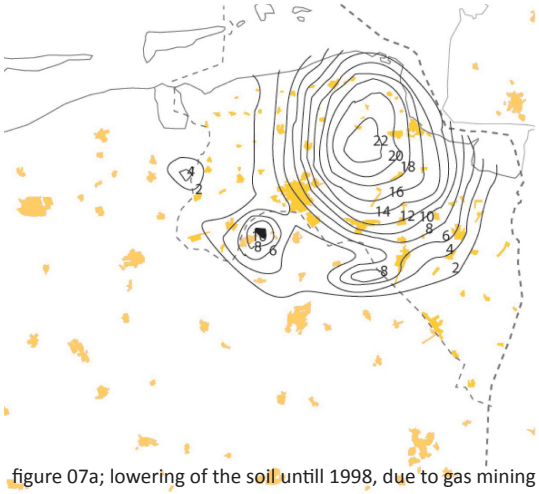


figure 07a; lowering of the soil untill 1998, due to gas mining

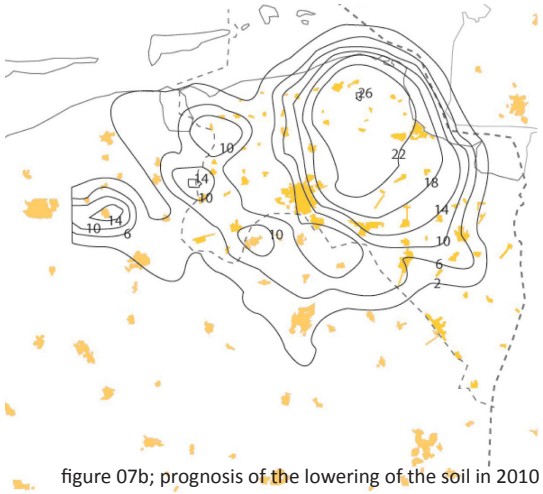


figure 07b; prognosis of the lowering of the soil in 2010

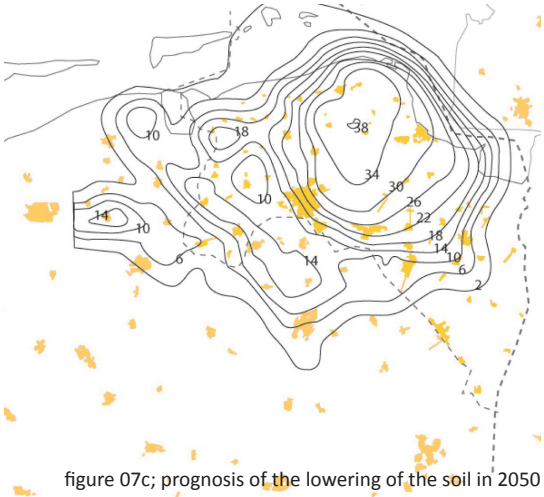


figure 07c; prognosis of the lowering of the soil in 2050

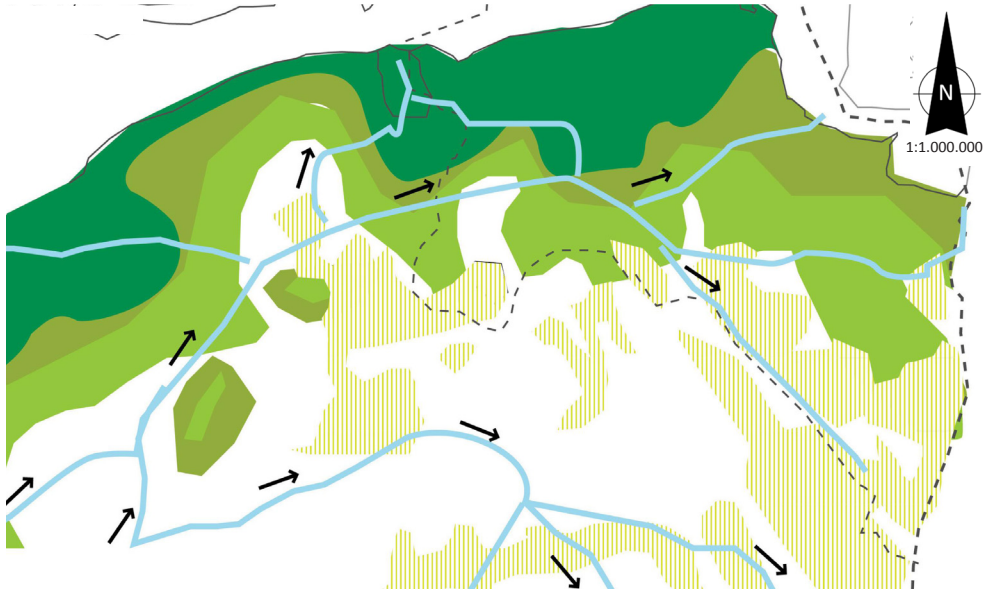


figure 08; influence of salt seepage, salinsation

7.4 Spatial plans

Of course, the province has plans not directly dealing with climate change and water management. The maps below give an overview of what is going to happen in Groningen until 2030. They can give an insight in if the adaptation to climate change already occurs, or where these plans have shortcomings.

Water management

The water boards in the region of Groningen also do not have a clear view on the consequences of climate change. They still base their policy on older dated guidelines (like the Dutch WB21). This result in measures which probably are not effective. The Hunze & Aa's water board strives to have 1300ha water retention in 2015 and 3000ha more in 2030. When we take a look at the predictions of the IPCC and the ideas of the new Delta Committee we can assume Groningen needs more retention.

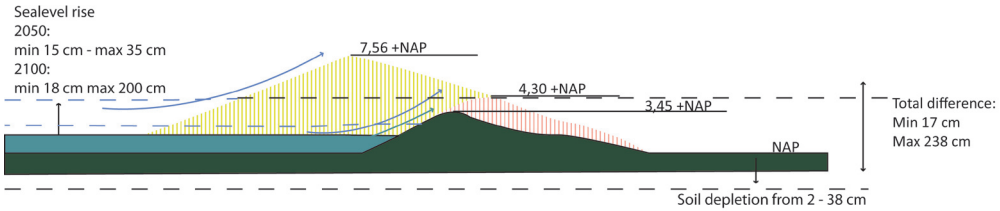


figure 09; sea level rise and the lowering of the soil

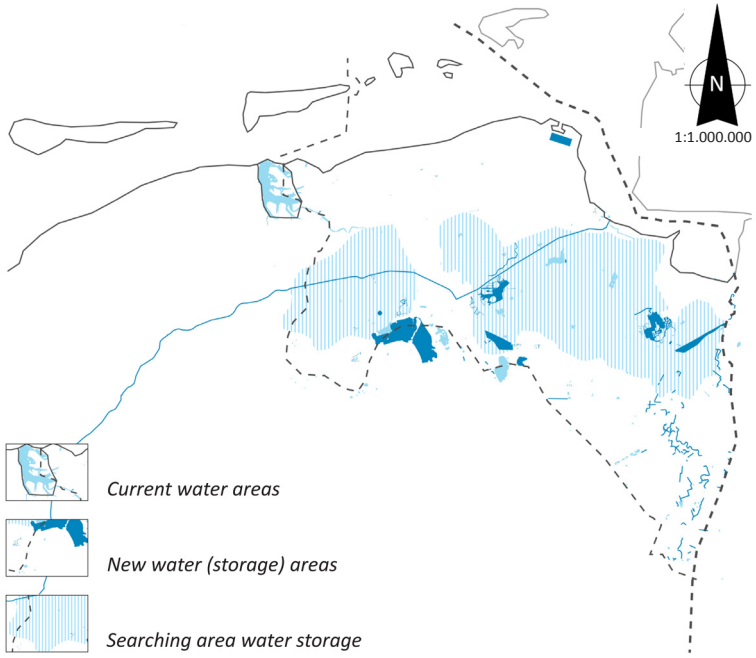


figure 10; planned development of water

Nature Development

One important plan is the realization of the Ecological Main Structure, which will be as shown in the map below.

We have to take this into account when making our plans. The parts of the EHS from which it is not sure that they will be implemented can be filled in after discussing them with the stakeholders. For designing these EMS-areas, climate change should also be taken into account. The dispersion of species could be in danger by movement of suitable habitats caused by climate change. By fragmentation, species cannot reach new habitats, and therefore not move with the suitable climate area. The accessibility of new areas determines whether the whole habitat of species will change. At a high level of fragmentation, the sustainability of species will decrease. Linking the existing habitats results in a robust ecological structure which is effective at adaptation to climate change.

Urban and industrial development

Groningen also has some plans for the extension of the urban area, which will be as shown in map below. It shows that a lot of urban development is planned to be around Groningen city and also around the city of Hoogezand. The existing parts of the cities and villages are all built on the higher areas. It was hard to figure out where the existing industrial areas exactly are, because on a map they are shown as urban area. Therefore we have mentioned only the plans for new industrial areas. The new urban developments (housing and industrial) do not have a direct location with height and soil type. For example: the urban extension of Hoogezand is built on peat and near Delfzijl lots of sand was needed to heighten a planned industrial area. This could cause extra problems when the sea level raises further and further on.

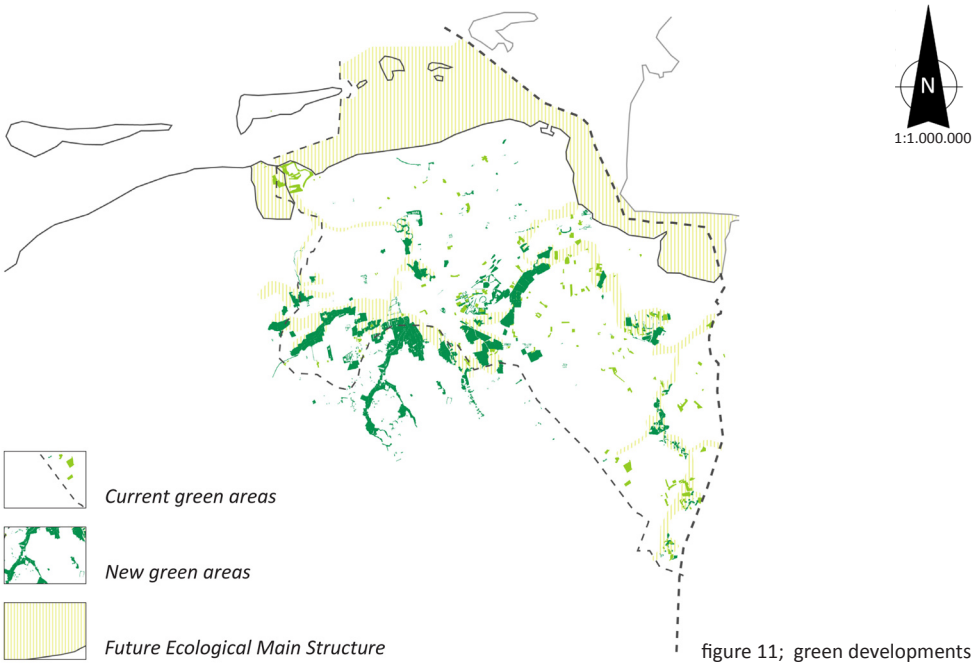


figure 11; green developments

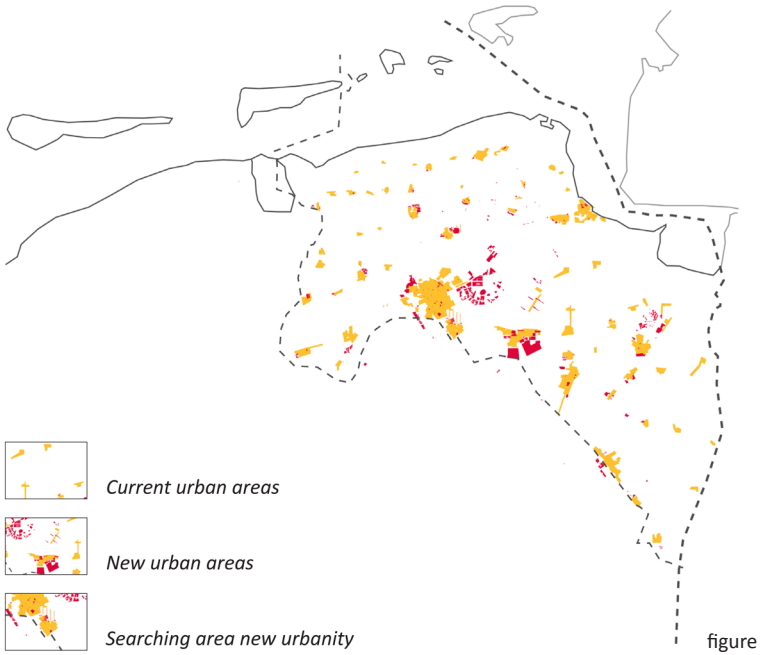


figure 12; urban developments

Infrastructure

The map below shows what the plans are for the development of new infrastructure. Especially the bigger highways will be upgraded and Meerstad will be connected with Groningen. The province has a bad public transport system outside the city because of the lack of people in the region. The new urban developments are planned near the bigger villages and cities. This are opportunities for better public transport. Furthermore climate change could indirectly cause higher prices for fuel. This could also lead to more use of public transport. The current development of new infrastructure could be in contrast with the expectations related to climate change.

Furthermore, the current electricity infrastructure has not been calculated on the large-scale introduction of durable energy sources. Development of an intelligent electricity infrastructure (smart grids) offers the answer to this problem. This technology makes it possible that the varying energy production of wind mills and solar energy can be balanced automatically with electricity consumers such as industrial installations and households.

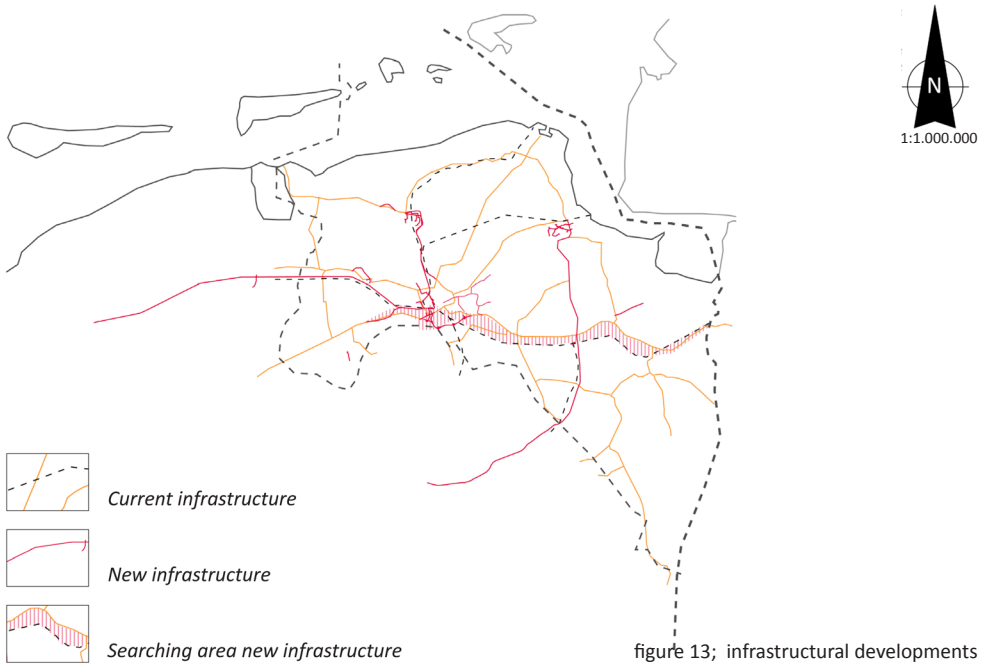


figure 13; infrastructural developments

8. CONCLUSION

A number of important conclusions can be drawn from this analysis. First of all, it has become clear that climate change is a serious issue. According to the most modest scenarios, in 2100 the average global temperature will be increased by at least 2˚C and the sea level will be at least 0,7 meter higher than it is now. Large parts of Groningen lies under sea level, so flooding risks become bigger if nothing is done. Extremes in weather will also have great consequences. Winters will become wetter and summers dryer, so it will become a necessity for this period to have more water retention areas. In 2030 the water board of Hunze en Aa has to create 4300 ha extra water retention area according to the current plans. These issues clearly point out that climate change will cause trouble and something has to be done. The interviews show that the people of Groningen are aware of this necessity. They are also willing to do something about it, so the base for adaption already exists!

When looking at the history of Groningen, some questions rise which could be important for the future. Using this backtracking, it is important to find answers on questions like: why was Groningen relatively densely populated in the past? When we look at the past we see that in earlier times development was much more dependent on the geomorphology than it is now, because technology gives a lot of opportunities that didn't exist in the past. However, there has always been a large human influence, often based on economic grounds.

Policy	*Climate measures based on*
EU: Climate Action	IPCC- measurements
The new Delta Committee	IPCC- measurements
Waterboard Hunze & Aa's	KNMI- measurements
Waterboard Noorderzijlvest	KNMI- measurements
Provinciaal Omgevings Plan 2009-2015	KNMI- measurements
Naar een energie gestuurd omgevingsplan …(2007)	IPCC- measurements

figure 14; Measurements based on the different scenarios on climate change

At the moment, the plans for the province of Groningen hardly consider climate change and adaptations for the future. The plans for the green development and the Ecological Main Structure are the most adaptive, because they offer species the opportunity to move from the south to the north. Also, places for water storage will be created, but not yet as much as necessary. It can also be interesting to look at the location of the 'boezem' systems. Are they at the right place? In which direction can they be extended? And where can extra water retention areas be created? Contrasting to the climate change policy is that many of the new urban extension are located in low peat areas (e.g. Blauwestad and extension nearby Hoogezand). These are the areas where the groundwater level will rise and causes trouble in wet periods.
Considering infrastructure, it can be useful to look at the development for a better use of public transport, which is more energy efficient than individual cars.
On the policy level, we discovered a lack of implementation of 'radical' measures. This possibly has to do with the use of different data about climate change. An overview is shown in the table and figure below.

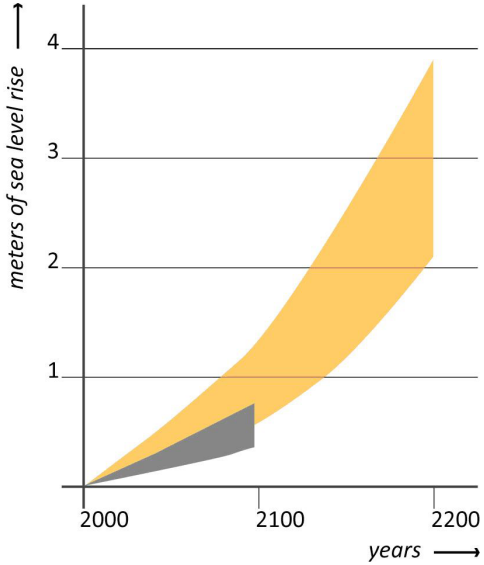


figure 15; different scenarios on climate change by IPCC (orange) and KNMI (gray)

On regional scale only Rob Roggema mentions in ‘Naar een energie gestuurd omgevingsplan voor Groningen’ the results of the IPCC as a starting point in the adaption of Groningen to climate change. For this reason the measures planned by governmental organisations follow a moderated course. The information of the IPCC is not yet implemented on lower scale.
There is a gap between international and national policy on the one hand, and provincial and local policy on the other hand. Groningen needs a policy on adaptation to climate change.

For the future, we have to take a critical look at the current land use; for example can gas winning and agriculture be continued in the way it happens now? How should the fossil resources on site be managed and what are the possibilities to harvest the natural resources? And also how can the effects of climate change be exploited in this area?

So, a lot has to be done, but we also have a lot of opportunities. If we succeed to find good answers to all these questions, Groningen can have a leading role in the adaption to climate change!

9. DISCUSSION

In our search for information on climate change, we also found information written by sceptics. This is worth to mention and it can be the case that these sceptics are right and climate change will not have such dramatic consequences as pronounced by others. Then all plans for adaptation would be for nothing. Of course, this could be the case. But what if climate change indeed will have dramatic consequences and we did not take measures, because we thought it would not be so bad? We think it is better to be prepared on the worst and hope for the best.

During the analysis we have used a lot of data on climate change in future. All organisations that produced these data of course pretend this is very ‘hard’ data, but this is very questionable. Data for the future is not ‘hard’ at all, because it consists of estimates. Therefore we need to make assumptions on certain issues

We made use of a big interview in which people from Groningen told about climate change and this pointed out that they really acknowledge the problems and want to do something about it. However, the reliability of these interviews can be questioned, because we don’t know if a representative part of the population of Groningen is interviewed or that certain people were picked to be interviewed. Also we did our own interview, but didn’t get a lot of response on it. Therefore it was more gathering our own ideas about this region. So still useful, but not objective.

This analysis only covers a small part of all the available information. On the one hand, this is because of the size restrictions, but on the other hand is the lack of time. There is such a large amount of data that can be found an read through, but the amount of time to do this is not endless. Therefore we were not able to involve all the possible information, but we tried to select the most relevant.

10. MAIN AMBITIONS FOR NEXT PHASE

Sustainable Design
When the oil and gas reserves run out, the world will adapt to new energy sources. Before all of Groningen is ready for the new system, there will be a gap where the old sources have already run out and the new energy cannot be brought to all locations of Groningen. Sustainability means making plans that are robust for future generations. Dealing with this gap is important for these generations. Actions need to be taken now!

Design for safety
Safety must be guaranteed according to our ambitions. It is immoral to leave Climate Change to chance. So 'plan for the worst and hope for the best' is our motto. Plan for the worst case scenario and hope that not all measures will be needed in the end and that the situation will not be as bad as expected.

Narrative Design
The history of Groningen tells us a story. A story of living with water by settling on the high grounds. A story of building dykes and stealing land away from the water. This fight is important for Groningen, this should be shown in our designs for the future.

Ecological Design
The possibilities that the landscape give us are not used and often not known. Our ambition is to take advantage of the possibilities that the landscape gives us. Climate Change will change our landscape. Don't just look to the problems, use the possibilities to create an ecological, aesthetically pleasing design.

Democratic Design
We strive for an inclusory approach in planning. This should not be a problem in this case. The inhabitants of Groningen have a history with water and they feel responsible for their own safety. They can provide good ideas for further development.

We want to develop a long term design in which we explain how to adapt existing systems to the new climate and in which we want to make the new sustainable landscape more energy efficient.

PHASE TWO

TOOLS AND PLANS FOR ADAPTATION

11. INTRODUCTION TO PHASE TWO

The second part of our search for a climate proof long term strategic plan for the province of Groningen consists of an assignment to come up with solutions for the raising consequences of climate change in the province of Groningen. How can Groningen adapt existing systems to cope with the new climate, how is it possible to create solutions by designing a landscape that prevents further deterioration of climate by making the new landscape more energy efficient?

But how? First, we need to brainstorm. How will people live a 100 years from now? History has shown us that a lot can change during a 100 years: since the first flight of an airplane (done by the Wright brothers in North Carolina), hundreds of airports and thousands of airplanes were created and changed the landscape and our way of life. Who expected this? Making a plan for the future contains lots of uncertainties.
Using a scenario method, we can structure our thoughts about the threats and opportunities of daily life in 2100. The basic input is the outcome of our analysis, summarised in the next chapter. For this reason, we need two themes in the axes. A detailed workout and the results of the scenarios can be found in the chapter 'shaping conceptual ideas'. The outcome the scenarios give is a starting point in what we want: 'A landscape that stimulates living with a low ecological footprint and that can deal with extreme climate change'.

How can we reach this? In first place, we should adapt to current expectations of climate change. Secondly, we should reduce our footprint. Otherwise, the temperature and sea level will get higher and higher.
By doing so, we combat climate change in the causes (reducing the footprint) and effects (adaptation to). To reach these goals, we develop tools of transition and protection. To organise and structure all the ideas, we made a differentiation between urban and rural tools, this is because these different landscape contexts ask for different measures and approaches. From these tools we derive a spatial plan. This plan is an example of how to use the tools in the Groningen landscape. Tools are connected to the landscape. The plan will show how the tools work out. We end with a description on how to use

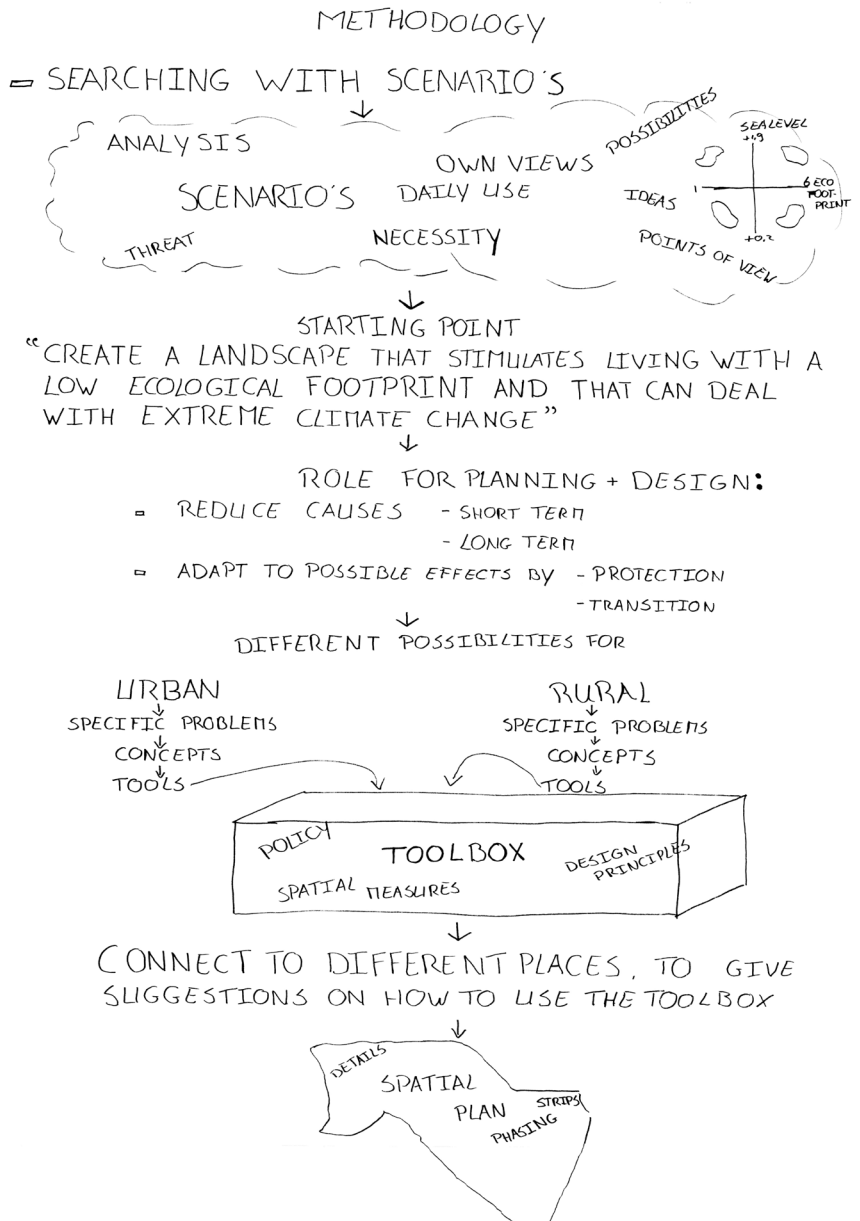


figure 16; general sketch of the plan process and the methodology

the toolbox and the spatial plan in this report, to arrive at a sustainable and safe future for Groningen.

The first phase of this project was an analysis part to analyse the problem and to search for related information. The most important outcome of this is that the problems related to climate change can be bag, are diverse, and occur on different scales. The contours of the climate change in Groningen are sketched and made clear in this phase.
A lot of models have been developed according to climate change. There is a lot of different data and there are many different stories told about climate change. The most important is, that big part of Groningen is below sea level. When the sea level rises, even a bigger part of Groningen would be flooded without the protection of the dikes. Also the surface of the province goes down by gas mining, oxidation of the peat areas and tectonic lowering. The flood risks become bigger if nothing happens. Besides this absolute and relative water level rise, another consequence of climate change is that weather extremes can occur more often. That means that we maybe have to deal with extreme drought or extreme rainfall. This could also have big consequences. Winters will become wetter and summers get dryer.
All together, the climate change has its impact on flood-defence, water management, nature development, agriculture and other forms of land use in the province of Groningen. Interviews show that people in Groningen are willing to do something about it; and this forms a base for adaptation. (mfgroningen.nl)

During the analysis step there were five design ambitions developed, which are also on the background during this second phase of the project. These were Sustainable Design, Design for Safety, Narrative Design, Ecological Design and Democratic Design. A more detailed explanation of these ambitions can be found is in the first phase of this report.

According to the assignment, the idea is to develop a long term spatial plan which explains, how to adapt existing systems to the changing climate and in which is made clear how to make the new sustainable landscape more energy efficient.
The conclusion of the analysis, which is the starting point for this second part of the plan, is that the most important issue for our case is climate change and, related to this, awareness of people (expressed by the ecological footprint). Numerical values to express these two related subjects in, are for climate change the amount of sea level rise and for expressing the awareness of people the ecological footprint that people have.

11.1 Sea level rise

The result of climate change which has most impact on the public is probably the sea level rise. There is a lot of different data about the amount of sea level rise over different time scales. According to a large group of climate experts, sea level rise will be much more than the latest IPCC-report predicts. The UN-climate report of 2007 predicted a sea level rise of 18 to 59cm before the end of this century. The latest predictions speak about 90 to 120 cm of sea-level rise in 2100. The Dutch coast will even have 30 cm extra sea level rise because of lowering of the soil. According to experts of the climate institute in Potsdam, the maximum sea-level rise could even be 1.90 m due to the quicker melting of ice on Greenland and Antarctica.

A growing group of scientists, of which some have contributed to the advice of the Delta committee, says that the IPCC-report (which will be the basis for the negotiations about the new climate treaty in Copenhagen) is too conservative and that the predictions and emission targets should be sharpened.
If nothing will be done to prevent further sea-level rise, there is a risk that the water will rise 5 to 7 m in 2300! (knmi.nl, ipcc.ch, deltacommissie.com)

The minimum scenario of the KNMI (G-scenario), predicts a sea-level rise of 15-25cm in 2100 and weather extremes will occur more often, which results in dryer summers and wetter winters (for the Netherlands). This is also the case in the most extreme scenario, but then in an even more extreme way (so even dryer summers and even wetter winters).

11.2 Ecological footprint

The ecological footprint is a measure of human demand on the Earth's ecosystems. It compares human demand with planet Earth's ecological capacity to regenerate natural resources. It represents the amount of biologically productive land and sea area needed to regenerate the resources a human population consumes and to absorb, recycle and re-use the corresponding waste. Using this assessment, it is possible to estimate how much of the Earth (or how many planet Earths) it would take to support humanity if everybody lived a given lifestyle. For 2005, humanity's total ecological footprint was estimated at 1.3 planet Earths - in other words, humanity uses ecological services 1.3 times faster than Earth can renew them. Every year, this number is recalculated - with a three year lag due to the time it takes for the UN to collect and publish all the underlying statistics.

The average hectares per person the earth can cope with is 1.7 ha. In the Netherlands for example, the global hectares per person is between the 4 or 5 hectares per person. If everyone would live like the Dutch do, this would result in a global footprint of 2.5 Earths. The United States of America for example, uses 10 hectares per person (20 football fields). This corresponds with a global footprint of 6 Earths! The footprint of developing countries is around 1 ha per person, this corresponds with 0.6 Earth. (wikipedia.nl)

With a growing population, the available hectares per person will be reduced. Looking at this in combination with the depletion of natural recourses, out conclusion is that the capitalistic, consumptive, western lifestyle should change drastically and the linear paradigm should be replaced by a cyclic one. So, concepts as cradle to cradle can give opportunities to create a more sustainable future. (footprintnetwork.org and Global Footprint Network Standards Committee, 2009)

figure 17

*An ecological footprint of 1 means that we use what the earth can handle. This equals 1.7 hectares per person on global average.
**Ecological footprint of 3 (5ha p.p) and a Sea-level rise of 0.8-1.0m in 2100

figure 17; a brainstorm

12. SHAPING CONCEPTUAL IDEAS: A BRAINSTORM

The concepts of sea level rise and ecological footprint are two concepts that individually do not give enough of a handle for design. Too much is possible, too much is unknown. Focus is needed to find:

1. the level of ecological footprint that we are aiming for during this process
2. the extremes of climate change that we will take into account during this process.

To focus our search, we did a brainstorm looking at the possible combinations of ecological footprint and climate change. These future developments are shown in the graph aside.

On the Y-axis you can find the sea level rise as an indication of the effects of climate change. The low range is 15 centimetres sea level rise, with the most positive case KNMI scenario on all climate changes, taking into account the extremes in rainfall, drought, temperature, etc. The high range is 190 centimetres sea level rise, with the worst case scenario on other climate changes. The X-axis shows the ecological footprint of the people in Groningen. On the right is a high ecological footprint, comparable with the footprint of the average American citizen, on the left an ecological footprint that will not damage the earth any further. We use the ecological footprint (as described before) as a quantifiable representation of the public awareness. We cannot change the current expectation of sea level rise for the next hundred years, but by changing our footprint, the expectations for the twenty-second century can change.

In every quadrant we did a brainstorm on what the future would hold when we followed that extreme on the axes. We used these brainstorms for our own realisation of what the effects would be on the landscape and on the way of life of the inhabitants. From these brainstorms we took one quadrant as a challenge. It is our goal to reach the vision for this brainstorm. One other quadrant showed us what could go wrong; it is a worst case, or doom, scenario that we strive to avoid in our plans.

To point out some different ways to look, we have made four scenarios. They all show the extreme within each of the four quadrants. In the annex is a more detailed description, in this text a short summary.

12.1 Four scenarios

Scenario A: This scenario has a small footprint and a high sea level rise. The overall idea is that Groningen is sustainable and preferably self-sufficient. Therefore, adaptation is needed on social and spatial scale. The use of natural/ecological processes to change Groningen will have an important role in the further development. The 10 million m3 water, that is needed for agriculture in the summer, must be stored for a longer period by smart water management and the amount of water that is used should be reduced. (Hunze en Aa) Agriculture must adapt to salt and a high water level. The nature stores CO2 and combines with other functions, so that natural process can develop. Groningen should build its houses on the higher places and there is a more sustainable and ecological transport system.

Scenario B: In this scenario there is a high footprint and a high sea level rise. This scenario is about fulfilling the needs of all people and about ‘getting what you want’. In this scenario, technology offers solutions for many problems. To prevent flooding, the dikes are upgraded. This will be expensive but no problem in this situation. The economy is an important driving force. Nature is used for economic purposes. The world is strongly influenced by humans and Groningen is dependant from other provinces and other countries. Especially for life essentials, like water and food. The energy use is not focussed on sustainable energy, therefore the gas in Groningen is an important fossil fuel to serve the expanding needs of energy. In the Waddenzee is also gas extraction and this is a search area for more gas. A nuclear power plant might be developed in Groningen, to fulfil the energy demand. The problems, which arise because of the lowering of soil, will be fought with technological measurements.

Scenario C: This scenario has a low footprint and low sea level rise. The theme is ‘connected to the earth’ and an ‘ecological way of life’. There is a big public awareness and people feel responsible for their actions. There

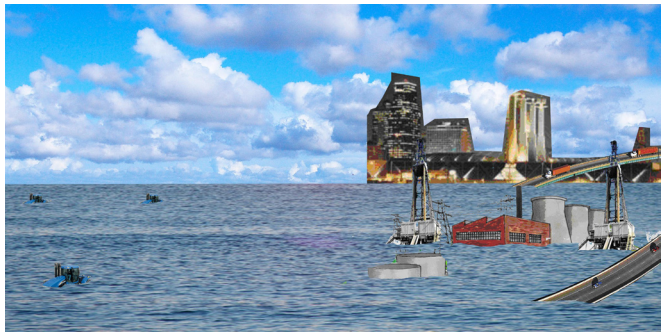
are strong political leaders with an sustainable point of view. Groningen has an biological and small scale agriculture, which produces eco-friendly food and leads to a more varied landscape. The problems around the sea dikes are dealt with, and adapted in an ecological way. Nature is combined with recreation, agriculture and education. Gas extraction is minimized and people use sustainable energy resources. The energy circle is closed. This scenario considers living in a small, self-sufficient society. The new urban developments take place on the safest location, so on the high areas. Furthermore new houses are built with more sustainable materials.

Scenario D: This scenario has a high footprint and a low sea level rise before 2100 and higher after (due to the non climate friendly behaviour of the people). The world is ruled by technology. People have solutions to fight climate change but these measures are only effective for a quite short period (only 50-75 years). Welfare and consumption develops more and more. On a longer term climate change and sea level rise could have a disastrous influence. Even more than it is assumed with the current calculations. Current gas sources are used and also new fossil fuel recourses (for example from the North Pole) are used, which result in higher production and extra pollution. Groningen will continue heightening the dikes and the agriculture will be more intensified on suitable sites. Because of this, the water amount of Lake IJssel should increase, to fulfil the water need from Groningen. Groningen will produce agricultural products for an important part of Europe and the world. Housing will be placed around the current cities, based on economic interests. Also recreation areas will be placed around the cities, combined with nature. For nature this would mean, special species with special needs almost have possibility to survive. This results in a cluster of the cities Groningen, Meerstad, Haren and Assen. The quantity and quality for individual infrastructure will increase.

When we look at the four scenarios, we can see a clear difference between A and C on the one hand and B and D on the other. However the sea level rises or not during the next hundred years, the huge ecological footprint could have negative effects on the sea level anyway. Dikes will be upgraded extremely, but the environmental awareness is still low. This causes problems when you want to prepare a region for problems that might come in the future and ask for measures on forehand. When we continue this way of life, we will probably end in a worst case scenario. Groningen and more parts of the Netherlands will be flooded by the sea or destroyed by other influences of climate change. That could mean we have to give up our land and move to higher parts elsewhere in Europe.

An example to illustrate this:
After 2100 an enormous rise of sea level will occur and the province of Groningen has not adapted to it. This means that during the past years, many investments will have taken place in the development of cities as Groningen and within the development of intensive agriculture. The land is traditionally protected, by: raising the dikes. So the 'fortification' that we live in, it is highly dependent on these dikes. What means that if the sea level continues to rise to 4 meter, we will have to evacuate because the dikes will not be able to cope with this and will break letting a great amount of water in as shown in the pictures. Here you can

figure 18; impression of the doom scenario



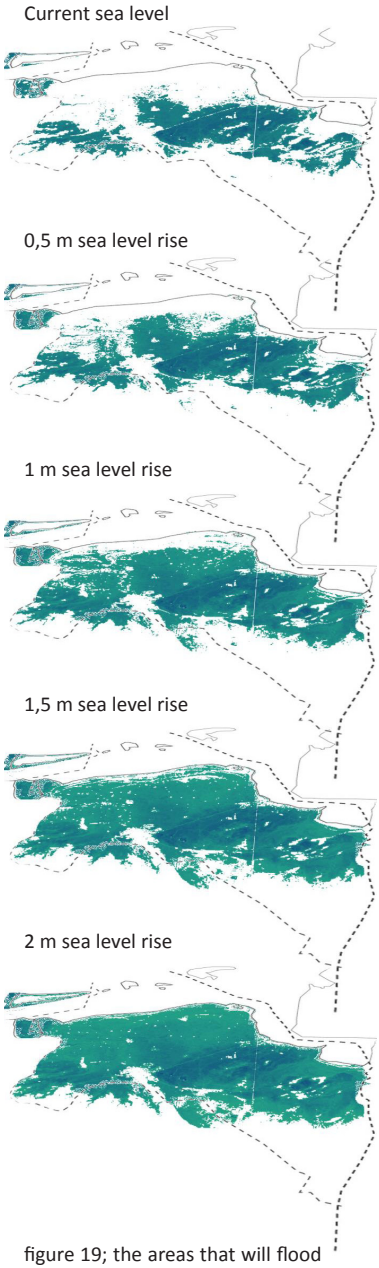


figure 19; the areas that will flood when the dikes break

see what part of Groningen will flood if the dikes break with the current sea level, and with sea level rise of 0,5 meter; 1 meter; 1,5 meter and 2 meter. So if the sea level rises higher than this, the flooding will be enormous.

Working towards spatial solutions

When the sea level rises to 4 meters we most likely will not be able to protect ourselves from the water and we will have to evacuate from Groningen to higher parts of the Netherlands or abroad.

We decided to have as a starting point that there will be climate change and we are working with the data of the most extreme scenarios of the different organizations like the IPCC or KNMI. We think it is better to prepare for the worst and hope for the best. This viewpoint for our plan for the future of Groningen stems from the ambitions we formed during our analysis. We prepare for the worst because we want to design for safety. Waiting until disasters happen does not suit that intention. By implementing these measures quickly, there is also time to work on the other ambitions. Although we cannot change the current expected sea level rise, we can adapt (to a certain extent) to these expectations. This could solve the effects of the problems.

Besides this, another solution of the problem is dealing with the causes of climate change. Taking into account the scenarios and the results of our analysis, we can conclude that we need to reduce our ecological footprint. It is our idea that a lower footprint in the end will result in a lower sea level rise on the longer term. Groningen could take a leading role in adapting to climate change, and be example for, the country, Europe or maybe even the whole world. By this, Groningen could indirectly help reducing the ecological footprint of more people.

By reducing the ecological footprint (on world scale) the further decline of planet earth and the changing of the climate can be stopped and even may be reversed. The planet might restore itself. We keep the saying 'We do not inherit the planet from our ancestors, but we borrow it from our children' in the back of our minds, because it fits very well into our ideas. By choosing the extreme climate scenario, we want to make the people aware and thoughtful of the problems that are there. Change is required; the moment for action is now! Also our motto is relevant here; 'plan for the worst, hope for the best'. We will show the possibilities for a sustainable future. The problems are huge, but we can and will challenge them.

We have looked to the following trends: International Policy, Economy, Technology and Social Acceptance.

a. In the future there will be more European integration. But also, and this is not conflicting but more a reaction to this development, there will be more regionalization. Also the participation is, and will become, more important, and the public will be more involved.
b. The economy develops into one global economy. The economy is fo cussed on scaling up and the energy prices will rise.
c. The technology is developing very fast. There is an increase of capital and these results in a rising production. The rising of technol ogy results in a shrinking employment.
d. People are not very much aware of the climate change. Some countries do pay attention to climate change and feel aresponsibil ty for their environment but most countries still (can) pay a lot more at tention to the causes of climate change. People still accept the western production process and have a consumption world as their ideal situation.

So, now we have a clear view on climate change and what the consequences could be. Because a lot is already said about the problems and consequences of climate change by several institutions as wel, we think it is time to stop talking and start designing spatial solutions. This is something that is actually pretty new; not only talk about the enormous problems and consequences, but doing a step further, work on solutions. It is very important to show how we can deal with climate change, what are the consequences of measures for the different scales in a landscape? How could they look like? We want to make this work!

13. OVER-ALL VISION: THEMES

In this first view on our spatial plan, we focus on the possible areas where the tools can be implemented in the landscape. Why are these areas useful for a certain tool? We order these tools in themes, which were showed before. This chapter also describes interventions that are useful / valid in all themes. For example: the railroad connection of Groningen is part of each strip.

13.1 Water

Coastal Defence

As a consequence of the changing climate we have to deal with sea level rise. The dikes it selves will still be high enough to defend against the sea water (the current dike is 10 meters above the current sea level, and +/- 8 meters above the expected sea level in 2100). But more important, in combination with stormy weather the high sea level causes an increased danger of surge, which could result in collapsing dikes.

To prevent against this situation, breakwaters are needed. The current coast gives us a few possibilities. First, Wadden islands can be kept in shape. Second, along the northern coast of the Netherlands a system of marshes can be expanded to reinforce the coast line.

Especially in the estuary of the Eems and the Dollard, a surge can raise the sea level 6 m above the current sea level. This is because the coastline has a funnel shape which means that the storm surge is pushed into this area, and the water accumulate in the Dollard. If this happens, the area around Delfzijl is in great danger because of this extra relative water level rise. To protect this area, a new barrier should be created in front of the Dollard.

So this coastal defence concerns measures on some distance from the mainland, and at the edge of the land; the coastline. This means that problems are fought nearby, and more far away.

Water managment

Another consequence of climate change is a changing pattern of precipitation. Longer periods of drought will lead to decline in agricultural production and in nature areas. Furthermore, rainfall becomes heavier, which results in water problems. To overcome both problems, water should be retained

figure 20; coastal defence

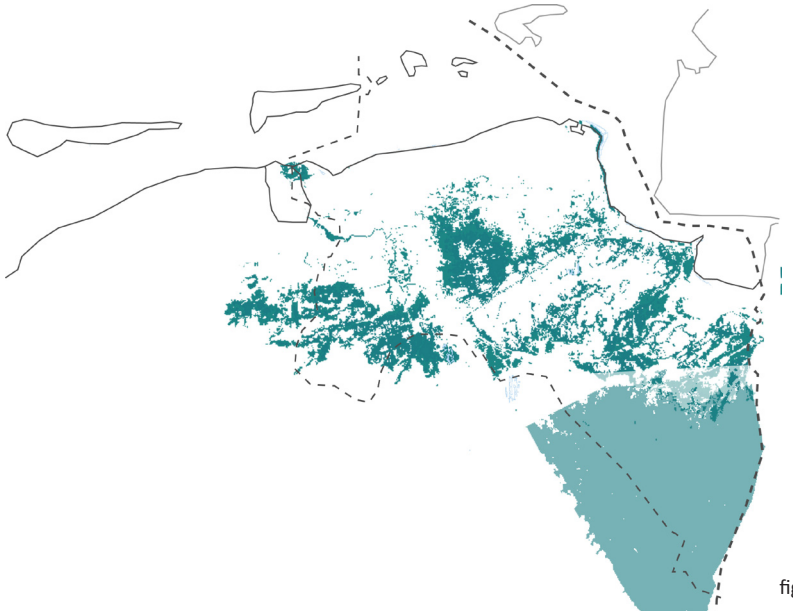


figure 21; water storage

in the province for a longer time. Logically, the lowest parts of Groningen should be used to store water because all water flows by gravity influences to this area. When the water is stored here, it can be save as well in case of drought. Also, the Peat Colonies are able to store water, although these are higher grounds; the peat can store water because it functions like a sponge. The map indicates the areas where to store the water.

13.2 Infrastructure

Transport by Trains

Overall, the use of fossil fuels should reduce because the resource will run out in the coming decades. In the current situation diesel cargo-trains drive on the following pathways:

Groningen – Rodeschool/Eemshaven-harbour
Groningen – Delfzijl
Groningen – Veendam
Groningen – Winschoten – Germany
Groningen – Leeuwarden

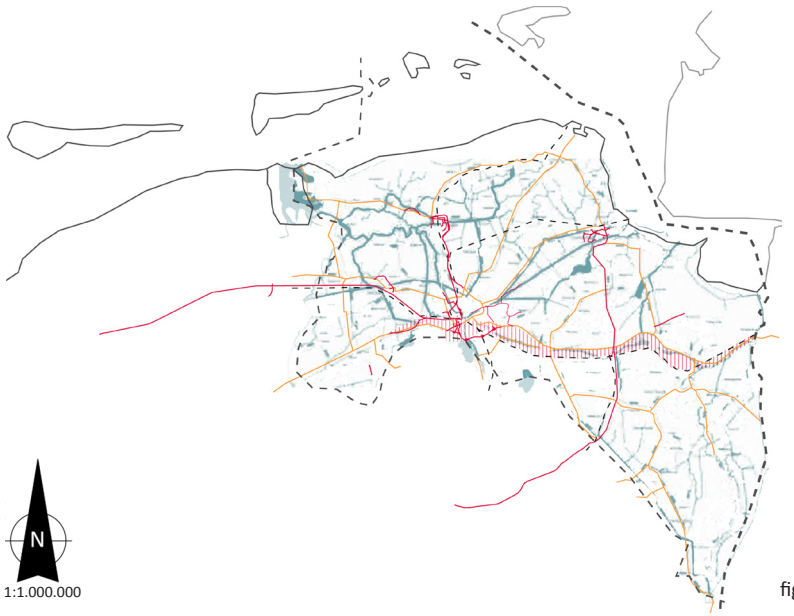


figure 23; Infrastructure

There is only one electrical train in Groningen for public transport, which runs from the city of Groningen to Zwolle. All the other trains cause a lot of CO_2-pollution because of the use of fossil fuels, which means that they contribute in the increase of our footprint. Therefore it's better to replace these trains by electrical trains in the future. Groningen will provide a lot of green energy (e.g. produced by wind-turbines) and this can be used for the trains as well.
Of course, not all routes can be transformed at once and therefore we gradually want to change this. The trains that will not immediately become electrical, will first drive on bio diesel if possible.
Besides this, the trains will run more often, to stimulate the use of public transport. So by upgrading the public transport by trains qualitative and quantitative, we can be more efficient with our energy use and stimulate the lowering of our footprint.

Transport by Cars

Gradually the concept of electrical and hybrid cars will rise and from now until 2100 more and more electrical cars can be found on the road. However, these cars need to be recharged after certain distances and therefore we want to place charging points at the current gas stations, but also at parking lots of supermarkets, working places or at central places in living areas (urban and rural).

Shipping Transport

In the current situation the canals in Groningen are almost unused, while in history they were used to exploit the peat areas and to transport the peat to the city. Especially in the peat area this canal system has a dense network, but this network has also connection with cities as Groningen, Stadskanaal, Delfzijl, Hoogezand and Nieuweschans.
In the future, these canals could get a function again. Our use of fossil fuel needs to decline and therefore transport over water could be a solution. Transport over water is efficient because of its economy of scale and has the opportunity to replace transport by trucks. Ships use relatively less energy and are cheaper in the use of labour. Flemish research says: The costs of

canal shipping are far below the costs of road transport. (Milieuprestaties van de binnenvaart in Vlaanderen, VITO, 2004)
A possible option for the use of ships could be to deliver food and other 'supermarket products' to smaller villages without supermarkets (like Veelerveen and Terwupping), and individual farms along these canals. This way of shipping is compared to the Dutch concept of the 'SRV-cars'.
The other option is to supply bars and shops in the villages and cities along the canal by boats.

13.3 Energy

Solar energy

In the toolbox the opportunity to place solar panels is also mentioned. This tool can easily be implemented in urban areas, by placing solar panels on the roofs of buildings. A short overview of an plan that can be implemented in the city of Groningen will be given below.

The municipality of Groningen has a surface of 83 km2, and half of this area is really occupied by buildings, so let's say this is 40 km2. The surface which exists of roofs, when looking at this area from above, will be around 30%, so this is [0.3*40 km2 =] 12 km2.
If half of the roofs is suitable for solar panels, because the other half is facing the wrong direction or doesn't have the right roof-angle to collect the energy, a surface of [12 km2 * 0.5* 0.5 =] 3 km2 of Groningen city can be covered with solar panels.

figure 24; new energy

That solar energy provides 480 MWh/ha/year can be found in annex 3. If we multiply this by the 300 hectares [=3 km2] of suitable surface for solar panels, this gives 144,000 MWh/year that can be produced by the use of solar panels in the city of Groningen! This is [144,000/3,570,750 =] 4% of Groningen's total current electric energy use.
In the piece of text about the windmills we mentioned that one 3 MW windmill can provide enough energy for 2700 households. One 3 MW windmill produces 5190 MWh/year, so if that is enough for 2700 households, the solar panels can provide energy for (144,000/5190 * 2700 =) approximately 75 thousand households. This is 27.5 % of the total amount of households (272,445) in the province of Groningen!

Wind Energy

We want to reduce the ecological footprint of Groningen. To achieve this, we have to find sustainable ways of generating energy, instead of the use of fossil fuels. In Groningen windmills are a good opportunity to do this, because of the heavy winds along the coast. The windmills are now placed in a line of 120 meters along the coastline. We will expand these lines as shown on the map. We think this location is the most logic place to develop this new source of energy. Near the coastline, just a few housholds are settled. So there won't be too much inconvenience for the inhabitants of the whole province. Next to that, a new line of wind-turbines can function as an articulating landmark in this rational landscape of the see-clay polders which are characterised by straight lines. A line like this can articulate the border between sea and land, and makes the landscape 'readable', also from a distance. Placing the turbines in the Wadden sea isn't an option to us because it would disturb and damage the high and unique ecological values

of this estuary. To compensate the amount of windmills in the north, we will remove the windmills that are dispersed over the other parts of the province when they are worn and will not replace them by new ones.
The few households that are settled near the location of this future wind-energy line, are mostly farms. We think it would be good if farmers can profit from this new source of energy as well. Perhaps they can participate in this development, and sell the surplus provided by their 'personal turbine' as green energy to others.

The new windmills are approximately 100 meters high and the distance between two windmills should be +/- 400 meters. (home.casema.nl) If we would place them from where they are now along the whole coast, which is approximately 30 kilometres, this will result in [30,000/400 =] 75 windmills. This type of windmills we will use have a capacity of 3 MW, which means that they produce 5190 MWh/year (*annex 3)*, so all new windmills together would produce [75*5190 MWh/year =] 389,250 MWh/year.

In the area around Eemshaven are already approximately 130 windmills, which are not the newest. If these windmills are worn, we will replace them by new ones. These new windmills will also have a capacity of 3 MW, but because they are bigger, the distance in between can no longer be 120 meters, as it is now, but will also be 400 meters. This means that the number of new windmills will be approximately [120/400 * 130 =] 40. These 40 new windmills will produce [40*5190 MWh/year =] 207,600 MWh/year.
The province of Groningen already has plans for placing 88 new windmills near Eemshaven, from which 21 already have been installed. This will provide [88*5190 MWh/year =] 456,720 MWh/year. When looking at the positions of these new windmills, this will not be a problem considering the windmills we want to place. (growind.nl)

The total amount of new windmills will be [75+40+88 =] 203, which in total will produce [389,250+207,600+456,720 =] 1,053,570 MWh/year. The current electric energy consumption in Groningen is 3,570,750, so the new windmills would produce [(1,053,570/3,570,750)*100 =] 29.50% of the current electric energy use.
In January 2008 Groningen counted 272,445 households and it is known that one 3 MW windmill can provide enough energy for 2700 households, so to provide enough energy for all households in Groningen, approximately [272445/2700 ≈] 101 windmills are needed. The windmills that will be placed are thus enough to provide twice as much energy as all the households in Groningen need. (CBS.nl (2))

Blue Energy
Groningen has four spots (Nieuwe Statenzijl, Termunterzijl, Delfzijl & Lauwersmeer) that have the opportunity to generate energy out of the difference in pressure between salt and sweet water. This process is called osmose-energy and the energy potential of this process is 0.35MWh/m^3 of sweet water flowing into sea (Post et al., 2008). More than 45 million m^3 of sweet water is yearly pumped into Groningen, and has to leave the province as well some time. So using 10 million m^3 of sweet water as amount for calculations, gives a good impression of the potential of this energy source. If 10 million m3 of sweet water produces 0.35MWh/m^3, the total amount of energy produced is 3.5million MWh/year for Groningen. This is enough to fulfil the total electric energy amount of the whole province of Groningen! [is it ok to check it again? I heard one time that osmose energy is not very profitable]

Algae
Producing algaes is an excellent opportunity to produce bio fuels. As described in the tools, in future it will be possible to produce 90.000 litre / hectare / year. The production needs a large input of CO_2. to be efficient. Factories from industrial areas nearby can give their CO_2 surpluses to this algae production, so that we can achieve a more cyclic system between industry and energy. To also make the transport lines as short as possible, it is wise to place these algae-plants near the industrial areas, for example in the harbour of Delfzijl.

13.4 Housing

Taking the trend of future population development in the province of Groningen into account, new building plan are hardly needed. The population only will grow in the city of Groningen and some bigger villages. We would advice to choose locations that are situated at at least 1 meter above (the current) sea level. This will prevent possible flooding on forehand. The best locations are indicated in colour in the map.

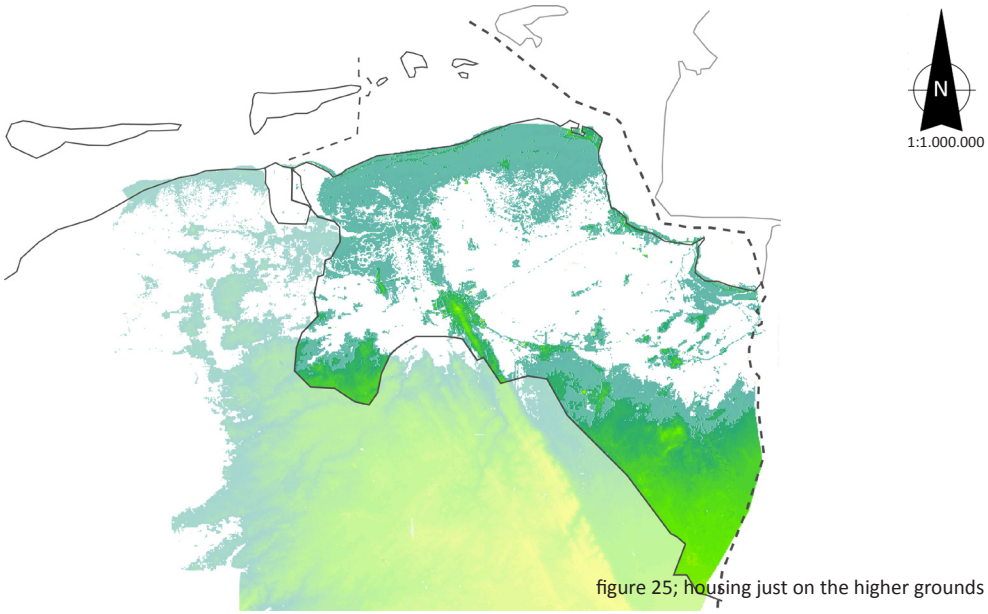


figure 25; housing just on the higher grounds

13.5 Ecology; *connect, improve and enlarge*

The ecological valuable areas in Groningen are wet and even swampy areas. The peat area, the brook valleys, and of course the Wadden sea house unique and very valuable nature. To improve and enlarge these ecological values, the toolbox tells us that these natural areas should be well-connected. Furthermore, the areas should be enlarged and the quality should be improved. There are already some plans for new nature. But if we connect this new nature with existing nature and other nature extensions in the future, we can really achieve a robust ecological main structure. In general, brook valleys in Groningen can be used as robust connections between areas as the Hondsrug the peat area, the Wadden sea, and the Lauwersmeer. As we have seen during the analysis phase, the nature areas in Groningen will get problems with drought. Stored rain water from wet periods can be used to improve the quality of nature areas by making the areas wetter. All these tools will help to adapt nature to the changing climate. Nature can also play a role in storing water, but only when this extra function won't cause disruptive problems for plant and animal species.

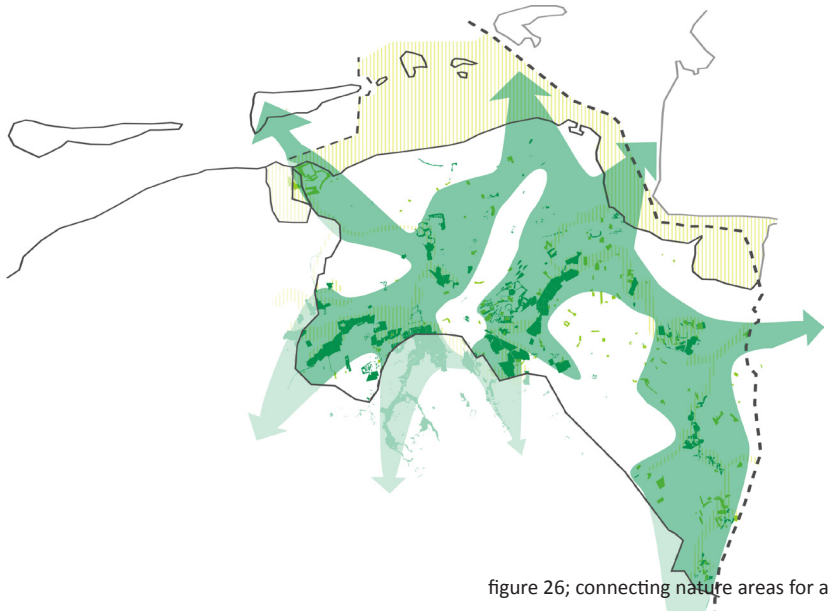


figure 26; connecting nature areas for a robust system

14. TOOLBOX; tools for urban and rural context

A spatial plan results in a single image of a possible future. Especially when designing for a scope of 90 years, it is wise to create a plan that is flexible enough to be of use in many different occasions, while still being specific enough to give a good handle to the ones that use it. The following toolbox gives both flexibility and is specific enough to be of use.

The toolbox gives an overview of the tools available to get Groningen ready for climate change. To give some order to the tools, they were divided in tools for urban and tools for rural areas. These were then divided into six themes. The separation line is not always clear, because in spatial planning, everything is related. Furthermore, urban and rural contexts have their own problems and therefore their own specific themes. Below, the division in the different themes in the toolbox are made clear.

14.1 Defining urban and rural

Rural context - 'Belonging to the countryside, something natural and simple' (van Dale). Rural is the opposite of urban in this definition. The rural areas are characterised by modesty and traditions, which is opposing artificiality (Yi-Fu Tuan, 2002). In Dutch landscape planning, the atmosphere of serenity, beauty and nature defines whether an area is 'rural' or 'urban'. In many other countries it depends on the density of inhabitants.
The rural part of The Netherlands forms about 80% of the Dutch territory. It functions as a contra-shape (contra-mal) towards the urban regions (cities). The rural exists out of agriculture, nature areas and recreational areas. The 'old rural areas' were mostly formed by agricultural activities, and agricultural buildings and small 'idyllic' houses defined its appearance. In the last four decades many people who lived in the urban areas shifted towards the rural areas. This suburbanisation caused many transformations in the rural zones. Characteristic buildings were being transformed into showy houses for the new inhabitants. Due to these changes the rural zone can now be seen more as an 'urban field'; the functional difference between urban and rural disappears (Anonymous in Vroom, 1997). It is being expected that the rural areas are more and more industrializing in the future, with some economic fundaments like scaling-up and spatial concentration of activities. (Vroom, 2005)

Urban context - 'Concerning the cities' (van Dale). From a morphological view, urban can be seen as the expression of built, structured, settled creations, as long as it is not concerning nature or agriculture. Urbanity exists mainly out of continuity of buildings. Every built area, even things like energy plants and infrastructure, are seen as urban. From this point of view, urban is often associated with pollution, stress and noise, which opposites rural characteristics as serenity and nature. It is very difficult to distinguish the difference between rural and urban, but most of the time it is defined by whether a site is characterised by agricultural activities or not. (Vroom, 2005)

There are several themes that fit in Rural or Urban. The table below shows these themes. The themes on the left side are complementary with the themes on the same row at the right side. These themes are the focus of the two groups. The themes are different enough to give a good focus for study, but there is a fuzzy area where it is unclear whether it is urban or rural; the edge of the city that forms the gradient from urban to rural.

Rural	**Urban**
Transport	Transport
Housing	Housing
Water management	Water management
Coastal defence	Micro climate
Energy	Energy

This abstract division between urban and rural is intentionally kept vague. In landscape, urban and rural context can't exist without each other, and they are very interrelated. Furthermore this encourages the urban and rural groups to keep a close eye on the research done in the other group. The vague border will make the confrontation between urban and rural more fruitful. The synergy will bring the most interesting assignments.
Next to that, it is difficult to make a strong division between urban and

rural because they are two interacting subjects. In this way the themes infrastructure and energy are compared in this explanation. The other descriptions are separate for rural and urban. In the annex we have a more detailed description of all tools and also with the more technical details. All the tools are based on the general ideas of our plan, to adapt to climate change and reduce the ecological footprint of the Groninger people.

14.2 Description of the tools

This chapter continues below with a description of each tool per subchapter. First the tools common for both urban and rural areas, then the tools, separated by theme, specific for rural or urban. Each subchapter is then divided in three parts:

1) A description of the problems within the theme;
2) The solution concepts that work as a guide towards;
3) The tools. These give possible directions towards a Climate proof Groningen within their themes.

Infrastructure in rural and urban areas

Problems

Groningen has a relatively low infrastructural connectivity compared to the rest of the Netherlands. This has to do with the relatively large distance from the 'Randstad', where a lot of (economic) activities are and with the low population density of Groningen. So the connectivity of the province has to be improved, otherwise the province will become less and less important for the Netherlands and for Europe.

Concepts

With a mission to reduce the ecological footprint of the inhabitants of Groningen, the common use of cars is a problem. The use of fossil fuels and the CO^2 emissions should shift towards the use of renewable energy sources. Our other option is alternative energy sources, because the fossil fuels are running out, so in a few decades these cars will need them. To facilitate the shift to a more sustainable transportation system, there are two challenges. The first one is the availability of green fuels (such as sunflower oil and electricity); the second is the infrastructure that is needed to distribute the fuels.

Next to cars and the infrastructure, the public transport system in Groningen could be updated and be more attractive to use.

After analyzing these problems we have some concepts to solve these problems (for rural and urban areas):

- High quality, CO^2 neutral public transport
- New sustainable/renewable fuels for personal transport
- Bundled infrastructure

Tools

a. Personal transport

- Hydrogen cars
- Electric cars
- Compressed air cars
- Solar cars
- Bio-fuels
- Cycle paths network
- Water network (boats)

Personal transportation options for people must not disappear, or be completely replaced by public transport. Personal transport gives freedom; you can go wherever you want whenever you want to. There are good alternatives which are not bad for the environment and can have the same capacity as conventional vehicles. Technique already offers multiple solutions for alternative transport options. Another way of thinking can be to completely switch back from road transport, to water-transport; especially with a higher sea level and more water in the area. If this option is realistic they will have to be investigated.

b. Public Transport
- o Light-rail
- o Maglev
- o Water network

By improving the public transport system of Groningen, without making the price for it too high, the use of it might improve as well. Public transport is more energy efficient than personal transport, therefore it should be stimulated. Besides this, it offers the opportunity for everyone (all ethnicities) to use it and to go wherever he/she wants. So it is a democratic way of transport. The future brings great technical solutions/opportunities for public transport; the Maglev train for example can reach speeds over 1000 km/h and uses magnets to reach high distances. The energy use is relatively low, because of the low friction. By connecting Groningen with other parts of the Netherlands and Europe, the role of the province might become stronger. Light rail connections might be a solution for connections between areas within the province, so smaller distance transport.

c. Digital networks
- o Mobile internet connections
- o Mobile offices
- o Digital communication (private and work)

The digital world is growing and probably will have an even greater role in the future than it has now. There will be many consequences in the way of life. For example; perhaps more people will work at home, so will need less transportation. The lives of people will not only be in the real life anymore, but also in the gigantic digital world. People might be more mobile, the whole world is connected via the digital networks. So spatially, it might have consequences as well. The exact consequences are hard to research, but considering this aspect can be useful when thinking in the future.

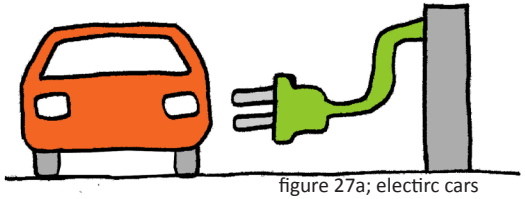


figure 27a; electirc cars

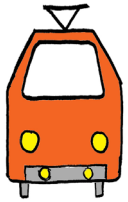


figure 27b; trams

Energy in rural and urban areas

Problems

Besides the infrastructure tools, we also have energy tools which are combined for rural and urban. 95% of all the energy in the Netherlands comes from fossil fuels. There is only enough oil (fossil fuels) for 30 to 40 years. The energy demand in 2050 might be 50% higher, compared to the current energy demand. (milieucentraal.nl) So on the one hand, the fossil resources are running out and the demand is getting higher, on the other hand. The use of fossil fuels results in high CO2 emissions. This is one of the causes of climate change and therefore for the rise of the sea level. So the solutions can be sought in reducing energy consumption and using renewable energy.

Concepts
- Be completely self-sufficient in energy production
- Stop using fossil fuels, stop CO^2 emissions, introduce more green energy types.

There are also a lot of tools to solve problems related to energy in the rural and urban areas.

Tools

a. Algae

Algae can be used for producing bio-fuel. The Volkskrant of March 28, 2009 reported that 20% of the total energy consumption of the Netherlands can be produced by algea's, if all the sewer water would be used for Algae production. According to an article published on nature.com, 1.0 ha of algae can produce 90.000 litres of bio-fuel. This is more than ten times higher than conventional bio-plant species.

b. Blue energy (sweet-salt)

Because of the difference in salt concentration between sweet and salt water, energy can be produced with reversed electro-dialyses (osmosis). The waste product is brackish water; this can be released at sea, but only in areas that can deal with brackish water when looking from ecological perspectives. The

energy potential of this process is 0.35 MWh/m³ of sweet water flowing into sea. More than 45million m³ water is pumped into Groningen, so using 10million m³ as amount for calculations, gives an impression of the potential of this energy source. This is 3.5million MWh/year for Groningen. This corresponds with the total energy consumption of all the inhabitants of Groningen! This assumption of 10million m³/year in Groningen is only 1% of the total sweet water outlet of the Netherlands. In Groningen there are four points where the water can be let out, so where a blue energy plant can be placed: Nieuwe Statenzijl, Termunterzijl, Delfzijl & Lauwersmeer. These first two options are in fact no good possibilities. Due to the process of low and high tide, there is no good possibility to use blue energy. During high tide it is impossible to drain into open water. During low tide there is no salt water at the sea side of the sluice. Another option could be to dam the Dollard, and then one big plant would be enough, perhaps. This would have big consequences on different levels in the landscape, for example the ecology.

c. Bio-mass

Using the organic waste products of agriculture and of the inhabitants of Groningen for producing energy and compost, is possible with a digestion plant. For the household waste in Groningen, the potential energy is almost 3000 MWh/year; this corresponds with the energy that one 2.0 MW windmill can produce. If the organic waste of agriculture is used, this might be higher. By separate waste collection, the role of the inhabitants becomes more active, this might help in the acceptance of alternative energy (re)sources.

d. Wind energy (turbines) – rural area

Using wind as an energy resource is a good opportunity. One windmill of 2.0 MW can produce 3460 MWh/year. A big windmill of 6.0 MW (120 m high) can produce 10 380 MWh/year. If the total energy demand of the inhabitants in Groningen would come from wind, 344 big windmills are needed. (home.casema.nl)

e. Solar energy (PV-panels) – rural area

Using solar energy is a good option for producing energy, because through the whole year this source can be harvested. Even on cloudy days this technique works. In the Netherlands, the suns' radiation power on the earth's surface is 150 Wh/m². An average PV panel can harvest 15% of this energy and there has been made a panel which can transform 41% of the solar energy into electricity. Calculation with 20% of the potential solar power results 480 MWh/year/ha. So if the total energy demand of the inhabitants in Groningen would come from PV-panels, 75km² of Groningen should be covered with solar panels. (solar4power.com, archiexpo.com, milieucentraal.nl)

f. Solar panels on tilted roofs – urban area

There are many tilted roofs in the city. By providing tilted roofs that face south with solar panels, we can provide renewable electrical energy to the city. 480 MWh/year/ha is provided. (solar4power.com) A point of attention here is the monumental buildings. These are not the most suitable places to have solar panels and a careful implementation is needed here.

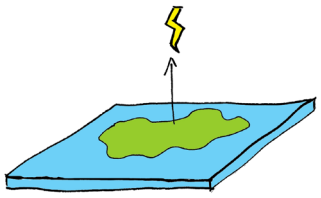
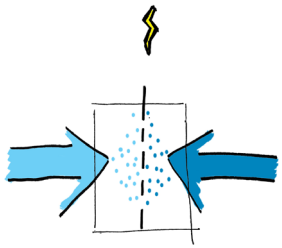
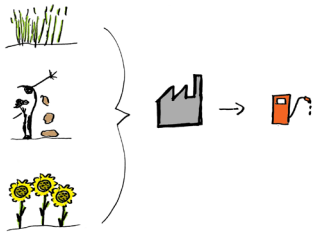


figure 28a; algae energy



28b; blue energy



28c; bio-mass energy

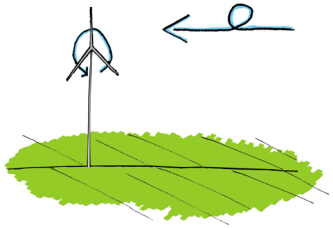
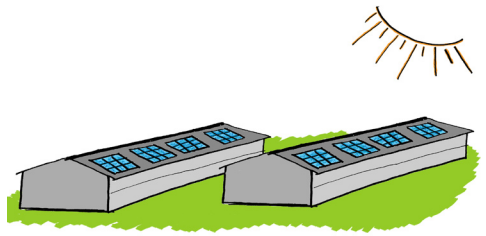


figure 29a; wind energy



29b; solar energy

g. Wind energy – urban area
Wind energy in the build environment is a possibility, although it is still being researched. Only the rural area has that much room for wind mills and in the city there can still be good possibilities for wind energy around large buildings. Examples are industrial areas and sites close to works of infrastructure (bridges, dikes, etc.). Wind-energy can be introduced close to buildings; on top or beside them, but also in a duct through a building. Furthermore they can be used between airfoil-shaped buildings. (Mertens, 2006)

h. Insulation of residential homes – urban area
Insulation will save energy no matter what the effects of climate change will be. In cold weather, the houses will stay warm easier and in warm weather the energy consumption for cooling will be less.

i. Reduction of industrial energy use – urban area
More is explained in tools for industry in urban areas.

j. Combining tools of energy (also with other functions)
Different functions can be combined. For example on a farm or house different measures can be taken, which all contribute to the use of less energy or to the use of more sustainable energy.

Agriculture in rural areas
Problems
The agriculture has a lot of influence on the environment. The diary farming discharges CO2, methane and laugh gas which contribute to the climate change. Methane gas and especially laugh gas, play an important role in the greenhouse effect (21 and 310 times as high as CO2). On the other hand, the climate change has direct effects on agriculture. For example, when extreme weather conditions will occur. Farmers´ can experience changes in precipitation and see that their land is used for water retention. Also the salinisation of the land and groundwater is related to this and causes big problems for the crop species used today. Climate change has its influence on the dispersal of diseases, which are harmful for the agricultural production and increase the ris of a failed harvest.
We can say that overall there is a surplus of dung within some parts of the Netherlands, while others have a relative shortage. There are rules made by the government concerning this. As a result of this rules the Dutch farmers started trading their dung and dungrights which causes a lot of dung transoprt. The dragging of dung trough The Netherlands also costs a lot of energy, so we see it as a problem.
Another problem is that the current way of enterprising agriculture is not sustainable and is pushed away by other land use activities.

C*oncepts*
- CO2 emmission reduction
- Adapting to salinisation
- Dealing with different water flows and amounts
- Reduce influence on the environment
- Introducing new types of agriculture

Tools
a. Reduce CO2 and reduce energy use on the farm
- o Fermentation of dung and other products
- o Use dung as fertilizer (instead of, and to stop artificial fertilizing)
- o Use wind energy
- o Use solar energy
- o Use more sustainable (building) materials

The fermentation of dung and other products (for example grass from the banks along the roads) can be done on individual or collective bases. It is a huge investment, but also increases income when the scale of this production is large enough. For a more balanced carbon cycle it is useful to only use dung as a fertilizer and to stop the artificial fertilizer.
The roofs of the farms and sheds can be used to collect solar energy and windmills could make energy for the electrical machines (for example the milking machine and maybe electrical tractors in the future). Rainwater can

be used for drinking water for the cows and for cleaning the machines. The farmers then could install a small purification machine.
Another opportunity might be choosing more sustainable materials for the farm buildings (products from the region, natural products).
b. Reduce CO2 worldwide
- Produce bio-fuel instead of fossil fuels
- Contribute to awakening people

Also farmers can contribute to the awakening of people by showing different kinds of energy cycles on the farm and educating people about the climate, the world and how we are related and use our world. For example by showing people around at the farm and make the connection clear between food growing on the land and food in the shops.

c. Pollution
- Reduce or stop the use of artificial fertilizer
- Stop use of chemical pesticides
- Search for environmental friendly solutions to fight pollution

There are a lot of solutions to fight pollution by agricultural activities which stresses the environment. Reducing or stopping the use of artificial fertilizer will lead to less emission of nitrous oxide and nitrogen. Stopping the use of chemical pesticides will have big impact, especially on the surface water. Related to this, the search for environmental friendly solutions rises. Examples of this are planning the right kind of agriculture on the right location of the land (North of the Netherlands, near to sea where insects can't fly over is suitable for crop growth) and the use of ladybirds to fight fleas.

d. Storage of sweet water
- Retention areas for rainwater and water out of the higher areas

Sweet water retention in the rural area is useful to solve water shortage in the summer and water surplus in the wet periods and besides this, the retention areas are useful to stop the underground salt water fluxes.

e. Reduce sweet water use
- Decrease water use
- Cleaning and re-use of water

f. Salinisation
- Use salt resistant crops
- Use salt resistant animals

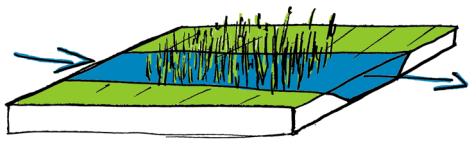


figure 30a; cleaning water with helophyte filters

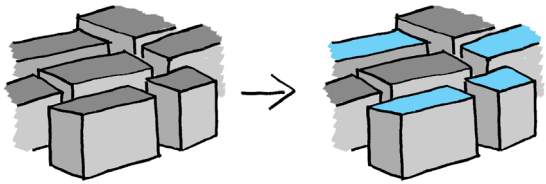


figure 30b; storing water on roofs

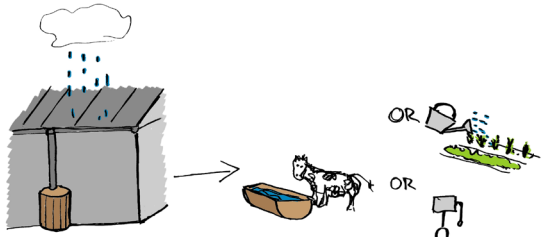


figure 30c; efficient water use and reuse of water

Housing in rural areas

Problems

Groningen contains a large amount of farms. These are all spread over the rural area, mostly outside of any villages and isolated. This results in a large flow of product transport which results in more CO2-emission and a higher ecological footprint. Currently, a trend of stopping farmers is going on in the Netherlands, and Groningen is not an exception in this trend. According to the Dutch CBS 56 percent of the agrarians is 50 years or even older, 70 percent of them does not have a successor. The changing climate also contributes to this trend but in another way. Due to the expected sea level rise more salt seepage is coming into the arable land; furthermore changing weather circumstances like drought, extreme rainfall and off-season hail cause problems for the current type of agriculture. During the last 8 years 17.5 percent of the farmers in Groningen quitted (CBS.nl (1)). This makes it more difficult to make a living out of farming and quitting becomes a more realistic option. This results in unoccupied farmer houses and there will be more during the next years if these trends will go on the next decennia.

Concepts

- Making the farms (more) self-sufficient. Small technical measures can help to reduce the external energy supply; but also being independent of, for example, the municipal sewer system.
- Search for new functions for old farms. According to the "Vijfde Nota Ruimtelijke Ordening" (Ministerie van VROM. 2004) and the "Structuurschema Groene Ruimte 2" (Ministerie van VROM. 1993) unoccupied farms could be reused for small-scaled functions.

Tools

a. Self-sufficient farms

- o agricultural waste used as energy
- o sun energy
- o wind energy
- o rain water use
- o alternative for sewer system

Agricultural waste can be used as energy supply. Dung (and urine) is in most of the cases already used as fertilizer. If there is a surplus of dung in combination with the plant waste, this could be produced into an energy resource in a digestion plant; but 4000m³ of dung is needed before this will be useful. This will also reduce the need of a connection with the municipal sewer system (which is expensive because of the wide dispersal of all the farms in Groningen)

Roofs of the farm and sheds can be used to collect sun energy. A farmer household (of 4 people) needs approximately 25 MWh/ year. Two to three PV-cells (as described earlier) could harvest the energy needed for this farm.

Small windmills produce 0.4 to 0.5 MWh / year. Compared with their larger brothers, these are not really efficient. Besides that, one windmill cannot produce enough energy to maintain a farm and the energy production fluctiates.

A person in the Netherlands uses 125-130 litres water per day. Rain water and grey water can be used and re-used for toilet flushing; this would reduce the use of water with 40 litres. For farming purposes, this water could be used for cleaning barns etc.

Choosing more sustainable materials can also contribute to a lower footprint. Examples are: materials from the region, natural products.

b. Re-allocation of farms

- o use as a house
- o use for education/art
- o social services
- o recreation/tourism

Unoccupied farms could be used as a house. Around 80% of the unoccupied farms during 1992-1999 has become a house for living purposes. Often these houses are combined with small companies at home offering different services: building and agricultural-related industry.

A few farms in the northern part of the Netherlands are used as primary schools in low-density areas. Next to that, the farms are often been used as exhibition place or atelier.

A new development is the use of farms for social services, for example as a house for elderly people, or as a psychiatric institute. This type of reallocation is new, but probably will develop in the coming years.
Recreational activities also has an opportunity in farms. The spirit of rural life can be felt in campings, restaurants and sport sites in the country side.

Water in rural areas

Problems with dikes

In our toolbox we want to be prepared for a 1.9 meter sea level rise. People might think: "Our dikes are high enough to cope with 1.9 meter extra, so what's the problem?" Well, the dikes are high enough to cope with the water in normal situations, but in case of storms Groningen can get in serious problems, because then that 1.9 meter can make the difference between water that will be kept by the dikes or water that will flood or even break the dikes. So, to be safe in future, something has to happen to prevent the cause of damage in case of storms. (Kok, M et al, 2008)

Problems with water storage

In the future precipitation and evaporation will increase, which means that in average the water balance will stay the same (Klijn et al., 2007). However, extremes will occur more often and precipitation will increase in winter (overabundance of 24-97 mm) and decrease in summer (shortage of 24-217mm) (knmi.nl). Due to this increase in rainfall and more intense rainfall, the carrying capacity of rivers and storage of water should be increased.
Besides this, an increase in precipitation will also cause higher levels of ground water, which will lead to an increase in damage to crops. It will also influence the agriculture, because the land has to be cultivated later than usual in a year.

Concepts

- Reinforce existing dikes
- Make new dikes
- Developing salt marshes
- Expand water storages

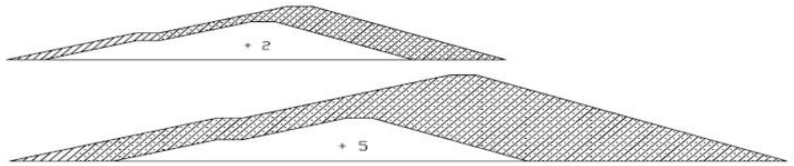
Tools

a. Reinforce dikes

To prevent land from flooding it is possible to make higher dikes, which are resistant to flooding and won't break. To make these dikes effective, it is important that there is no weak link in the ring of dikes, otherwise all the water will go through at that place and land will flood anyway.

However, when you want to raise a dike, it should also be made broader, otherwise it would loose it's strength, as shown in the figures below. The first figure also shows how much the dike should be raised (and broadened) at certain levels of sea level change.

Zeespiegelstijging [m]	Dijkverhoging [m]		Extra benodigde breedte [m]		Extra opp. [m²]	
0	Basis = 10		Basis = 80		Basis = 400	
0.5	1	1%	7	9%	73	18%
1	2	3%	14	18%	152	38%
2	4	5%	28	35%	328	82%
5	10	13%	70	88%	1000	250%



Kruinverhoging	Noordzeedijken	Westerschelde dijken
[m]	[M€/km]	[M€/km]
0,8	4,36	4,46
1,6	5,82	6,37
2,4	7,3	8,28

figure 31; costs of building sea dikes, Kok et all., 2008

b. Broaden dikes
Instead of raising the dikes, you can also broaden the dikes. These dikes are made so strong that they can not break, but only will be flooded. By letting water in the area gradually, there will not be intense and heavy flooding and also the chance on gaps is almost zero. A gap is the most dangerous, because this causes most victims and damage.
The disadvantage is that broader dikes will take a lot of space and cost a lot of money. However, these broad dikes can also be used for other purposes, like infrastructure and even housing. If you choose for this option, you should apply it to the whole shore, to prevent water from flooding through the weakest point.

c. Strengthen dikes
The principle behind this method is the same as with broadening dikes: if water gets very high, it will flood the dikes and flow into the land gradually. To make dikes stronger they need to be patch with asphalt. However, these dikes are not as strong as broadened dikes.

d. Let water in
Another option is to make artificial gaps in the dikes at certain places and create a natural flooding area over there. In this way you offer the water the opportunity to flood a certain piece of land, and prevent it from flooding another region in which it will cause a lot of damage.
The disadvantage of such a system is that the ground that will be flooded is now very fertile (and thus expensive) agricultural land and flooding will damage these fields and their crops.
The advantage is that the area that will be flooded can be used for other purposes, like nature or recreational areas.

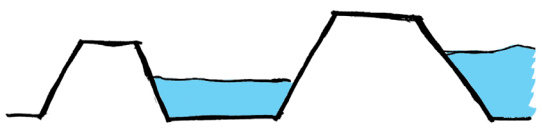


figure 32a; building a ring of extra dikes

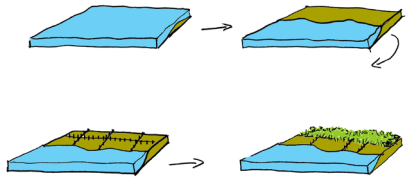


figure 32b; developing salt marshes

e. Second ring of dikes
The last option is to make a second ring of dikes. This ring can be in land, so that in case the first dike will be flooded, this dike will keep the water out. The ring can also be placed ‘outside’ the present ring of dikes. In this way it stops most of the water and the water that will flood these dikes will not be as rough anymore and causes less damage.

f. Developing salt marshes
Letting salt marshes develop on a high sand flat is also an option for coastal reinforcement. These marshes have a strong type of vegetation which catches sediment as it is deposed by the sea. This ongoing endless process makes that the marshes grow and keep reinforcing themselves. Creating large marsh areas in front of existing dikes is a sustainable and good solution for coastal defence. The marshes function as a breakwater and next to that contribute to ecological values in an area because it is a natural way of coastal reinforcement. The process can be accellerated by doing sand suppletion and the use of small wooden dams that can catch extra sediment.

g. Expand existing water storage areas
One way of dealing with the overabundance of water is to enlarge the existing water storage areas, like the ‘boezems’. In this way the extra water can be stored safely and used for other purposes. The advantage is that the place for water already exists, but it only has to be enlarged or deepened. Another option is to create new water storage areas, they could fulfil different functions, such as fighting salt seepage, breed algae for energy production, etc.

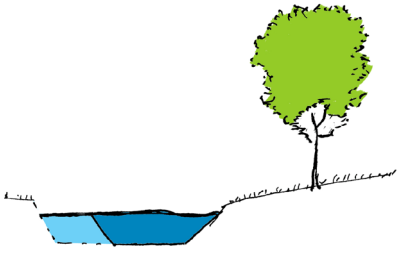
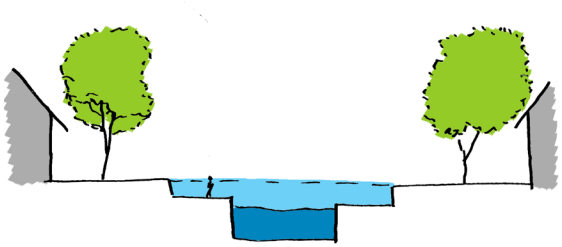


figure 33a; Storing water in canals



33b; renovating moats and canals

Nature/ecology in rural areas

Problems

Flora & fauna has difficulties in adapting to climate change, this due to the lack of connections between habitats, low habitat quality and too small habitats (this on scale of Groningen to that of Europe). As climate zones are shifting, ecosystems change. For some animals and plants it is essential to move with the shifting climate zones for survival. Nowadays it is difficult for animals to migrate and disperse, due to urbanization and its barriers. Highways, railways, new housing and more manmade objects create obstacles for species to move from the one place to another. If we want to maintain some ecological values in Groningen, it is important to overcome these barriers

Concepts

A robust ecosystem network results in a healthy and well adaptable (to climate change, extreme events etc.) ecosystem network.

Tools

a. Enlarge habitats/nature(conservation) areas

Enlarging habitats for wildlife, gives opportunities for larger amounts and more diversity of species. This is important, because a larger population has more chance for survival. For example, if a period of extreme low temperatures occurs, many animals might die, but some will survive. The larger the group, the more chance the species will maintain.

b. Connect habitats/nature (conservation) areas

Connecting nature conservation areas result in dispersion possibilities for flora and fauna. This is important for species so they can migrate to areas, if it becomes uninhabitable for them. This happens due to shifting climate zones as described earlier, or due to extreme events, like a flooding. Another reason for connecting different nature conservation areas is because this allows animals from different genetic background to breed. This is good for the genetic variation and prevents inbreeding, so the species remain healthy.

c. Improve habitat quality

If a habitat has a low ecological value, not so many species can survive; this results into a low biodiversity. This does not contribute to a robust ecological system. So diversity is important in creating healthy ecosystems. If the quality is high, less space is needed for the same effect. So combining these three tools can result in a healthy and robust ecosystem network, which is adaptable to climate change.

d. Combining ecology with other functions

Nature conservation areas can have other functions than only ecology. It can as well be used for water retention, recreation, sustainable/ecohousing, coastal defence and CO2 storage by the vegetation.

Industry in urban areas

Problems

Industry causes much pollution to the environment; CO2 and Chlorides changes the air composition. Heat coming from the factories has an effect on the micro climate and heats the water when warm water, that was used for the cooling of machines, is deposed into the rivers or seas.

Concepts

Sustainable industry through:

- Reduction of waste products from production processes
- More efficient use of energy
- Storing energy for using it later on

Tools

a. Reduction of energy use by industrial activities.

To reduce the energy needed for production processes and to reduce the amount of heat waste into the environment, factories can use energy storage methods, such as aquifers, phasing and thermo-chemical heat storage.

ECN is doing research on using heat to create air cooling, they are investigating the energy use in stationary applications and mobile applications. This could be used in industry and in cars. For cars, this would mean less energy used

for an air conditioner, because the excess engine heat can be used to cool the car.

b. City heating
Using waste heat from the industries to heat residential areas can save much energy during the winter. When there is much CO2 pollution in the air, the combination of warmth and CO2 can be used for greenhouses. Greenhouses need warmth for their plants and CO2 to make them grow better. Often there is gas burned in these greenhouses just to increase the amount of CO2 within them. (energieprojecten.nl) So, by linking these energy fluxes, a more cyclic system can be introduced to achieve a more efficient energy use and less energy is wasted.

c. Energy producing green houses
Green houses face the problem of too much heat inside during the summer. By using aquifers, excess heat from the summer can be used in winter. Cool water that was stored during the winter can cool the greenhouses in the summer. A recent design contest used this principle of aquifers to produce energy, through the difference in heat between the two aquifers. The future of greenhouses could be that they produce more energy than that they use. When they do so that energy can be used for warming houses nearby (glastuinbouw.wur.nl en intranet.wur.nl)

Housing in urban areas
Problems
The lower parts of Groningen are already below sea-level and this problem will only increase due to the mining of gas. For residential areas, this means that if the area is flooded, the force of the water will not just ruin the interior of the house, but will possibly destruct the entire building. Adaptive building will be necessary to cope with this problem in the future.
The second problem is 'urban heat'. The city is much warmer than the surrounding area, which is called the heat island effect. Due to a large amount of pavement and other kinds of stone like materials, a lot of the incoming warmth will be stored in these materials. The temperature difference between urban and rural areas can run up to 7 degrees Celcius during the day and 10 degrees during the night, even within small villages.This means that much energy is used for cooling houses. Especially, in the summer the city centres will be too hot to be comfortable, when the temperature will rise due to climate change.

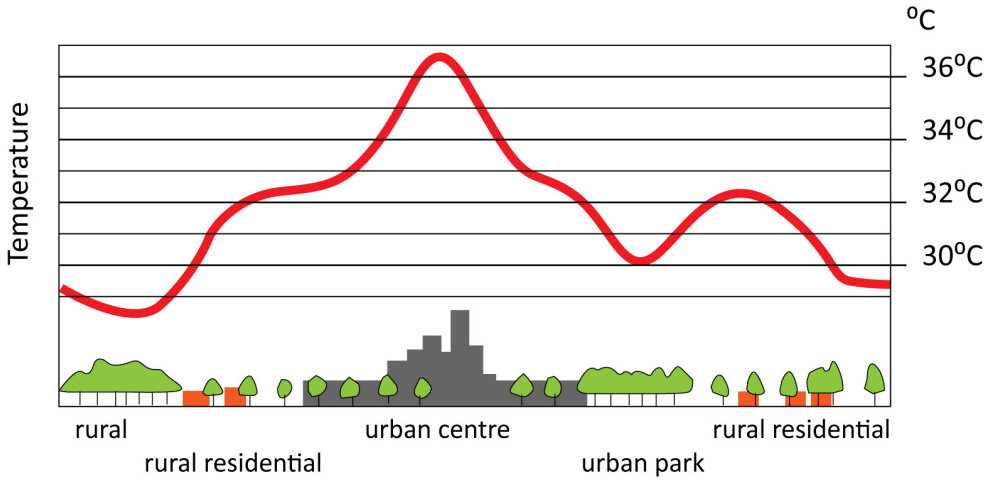


figure 34; urban-heat-island effect (source: NRCAN, 2007 & Alterra, 2008

Concepts
- Flood resistant housing when necessary
- Avoid building in risk areas
- Ventilating city
- The blue and green city

Tools
Flood resistant houses
o 'Wierden' villages
o floating houses
o houses with a dike
o houses on poles
Adapting housing areas to flooding is not always possible. Areas that are regularly flooded, but that are out of reach for heavy storm surges, can be suitable for flood resistant housing. When an area is under great threat of

storm surges living there is just to risky. There are several way to develop flood adaptive houses.
Terp villages follow the concept that has been used in the Netherlands for centuries. By creating a higher area (called terpen or wierden) to build houses on the water could not reach the houses, when the lower area was flooded. This idea is still very usefull for the flooding problems we will face because of climate change
A new cevelopment are the floating houses which are fastened to a large concrete pole. When the water rises, the house floats, but does not float away, so they are adaptive to regular flooding.
Houses with a dike around them are already commonly known and build many times before, like in the polders. For exisiting houses within an area that is in danger of flooding this is a useful solution. The dikes must keep the water out, because the houses are not ready for any water in the houses. With this solution the dike is the keyfacot, if the dike is not high or strong enough, flooding will occur and extreme water damage will be the result.
Houses on poles is an other solution, of which we saw examples in North Carolina. These houses are always higher than the surroundings thus the water can move freely below the houses. However if there is a heavy storm and surge, the poles, and thus the house, may collapse.

a. Water and green in the city for cooling
Water bassins (like canals, moats, ponds) and green (like parks, grass, trees) in th ecity are very suiteble for storing water, but can also help to fight urban heat. The perspiration and evaporation of plants and water cools the city a more pleasant environment at increased temperatures.

b. Orientation of the house toprotect from heating by the sun
- Spread houses to have enough light and space for vegetation and water
- Insulation of residential homes
- Not too many windows

If houses are too close together in the city, there is no room for plants and water.
Insulation will save energy no matter what the effects of climate change will be. In cold weather circumstances, the houses will stay warm easier and in warm weather the energy consumption for cooling will be less. New houses are already built to high standards, but older houses are not insulated that well. Subsidies might persuade house owners to update their house with better insulation.
Furthermore, windows let in the sunlight, and heats up the house. In the winter this can be pleasant. But in the summer it might get too warm inside, especially when climate change makes the summer even warmer and dryer. Insulation will help reduce the energy used to cool houses in the summer.

c. Ventilating city
Like we described even when temperature is not rising, it can be much warmer in urban environments than in rural areas. In cities, the wind is welcome to cool the environment. Corridors can be created in the city where the wind can blow through, so the stagnant heated air in the city will be cooled by winds. Next to that, if water is situated near the city, an extra cooling effect can be achieved. Water will make the wind towards the cities even cooler, which means tha the ventilating effect will be even bigger. It is an assignment to design these corridors very carefully. To heavy winds in the are not appreciated. (Alterra, 2008) (TNO, 2008)

Water in urban areas
Problems
Climate change leads towards more weather extremes. Weather extremes like heavy rainfall will lead to problems in urban areas. The water cannot infiltrate in high-dense urban areas. Especially in the lower parts of the cities there will be problems because of natural flow of rainwater towards these sides. To avoid problems, the discharge of water has to be fastened and improved. It is necessary to retain and store in the city. When this is not possible to discharge the water quickly. So, there is a need for more water retention in the cities. Implementing, more water in the city has a

positive effect on the aesthetics as well and can be used to cool down the city especially combined with wind corridors.

Concepts
o Retain, store, and discharge
o Water as city cooler
o Water as a multifunctional tool

Tools
a. Water storage in lower parts of the city
Water flows by gravity to the lower lands. These lower parts should be investigated for its suitability in temporary water retention.

b. Water next to the city
During the summer, warm eastern winds are more common. To cool the city, large ponds at the east of the city could be created to cool the wind before it enters the city.

c. Recreational areas next to canals, more space for flooding
To create more space for water storage, the capacity of existing water structures could be enlarged. Canals could get a recreational function, like the canals in Utrecht, but could be combined with more temporarily water storage.

d. Broadening of ditches
The weather extremes will result in more floodings. This tool for adaptation creates more space for storing water. Ditches can be broadened for more storing capacity.

Water on roofs
Water could be stored on roofs. It has a cooling effect on its surrounding area. The rain could be retained until the extreme rainfall ends, after that it could be discharged to other retention areas.

Recovery of canals
Historical water structures could be restored, for water retention, but also for recreation, aesthetics and cooling. More water in general has positive effect on its surroundings.

Water squares
Squares in cities could have more prominent attention towards water. Squares could have small water basins or fountains as main goal to cool down the city.

Green in urban areas
Problems
A higher temperature and more weather extremes due to climate change, can cause problems in the urban areas. The buildings, the roads and other urban functions which accommodate a nice living environment contribute to extra heating of the city.
Green in the city can reduce the temperature in the summer, to prevent a higher energy use of cooling systems. (Alterra / TNO, 2008) Next to that, when taking on the ambition of reducing the ecological footprint using green in the city can have a compensating effect.

Concepts
- Ecological urban cooling
- Breathing cities
- Micro climate

Tools
Create shade
When new buildings are being developped, more attention is required to create shade around the buildings. Planting trees helps to avoid the direct heat of the sun.

Green Roofs

- high insulating function
- absorbs solar radiation and converts this to growth energy for plants
- has a cooling effect on the surrounding area
- stores water temporarily
- reduce of CO2 concentration in the air
- increase of aesthetical values of the city

Vertical green

- insulating function
- absorbs solar radiation
- has a cooling effect on the surrounding area
- reduces CO2 concentration in the air
- increase of aesthetical values of the city

c. Wind channels through the city

The wind is a welcome factor in the city. The stagnant heated air above the city can be blown away to reduce the urban heat and energy use for cooling. Air corridors can be created in the city to guide and use the wind for city ventilation. Water near the city can help to cool the air above lakes, before it enters the city.

d. Creating parks

Two small parks have a bigger effect on improving environmental circumstances than one large park. So it is easy and clever to use all these small free spaces in a city, because it has an even bigger effect on the urban environment than one big spot. There's been research done on this in Singapore (source: Alterra rapport), that says that the cooling effect of a park can be twice or four times as big as the width of the park. By using this principle throughout the city, the heat-island-effect can easily be reduced.

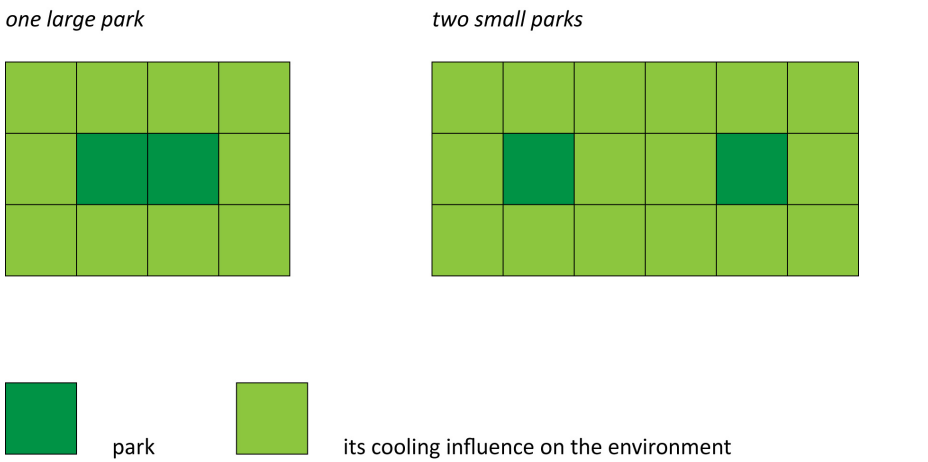


figure 35; cooling effect of one large park, or a few small parks

15. WORKING TOWARDS SPATIAL SOLUTIONS; 3 x landscape

Several landscape types can be found within the province of Groningen and these have different characteristics. Each characteristic needs its own treatment in adaptation to climate change, and each landscape type has its own chances to reduce the ecological footprint. What we try to show and emphasize with our solutions and plans is that the tools from our toolbox will have a continuously differing impact on the landscape. With respect to the different landscape types and the local qualities, we need to think about how tools can be implemented in specific areas.

Because Groningen is a large province, we summarised the characteristics of the whole province in three strips. The strips contain the different landscape types of the province where we implement the toolbox in the province of Groningen. The functions as a cross-section through the landscape and show specific problems and solutions / plans.

15.1 Three times landscape, three strips

- The Coastal-zone: Dike/Wierden landscape, the coastal large-scale rational agricultural area in the north.
- Groningen-Delfzijl strip: Wegdorp landscape, land below sea level, the peaty area between Groningen city and Delfzijl.
- The Peat Colonies: The agricultural area in the east part of Groningen between the Hondsrug and the small rivers Ruiten Aa (and Hunze?).

The tools which will be implemented in the strips could also be implemented in similar landscape outside the strips.
While the toolbox gives a wide range of possible solutions, The three strips show a possible solution, with a set of combined tools. When using this report it is important to realise that this is just one example of how the spatial implementation of the tools could look like. It is possible that you, as a user of this report have a different opinion about the tools to be used. In fact it is very likely, considering how much can change within a hundred years. These spatial plans show images of possibilities, not a blueprint plan. There are very much uncertainties, and some ideas require further research. But the intention was to come up with solutions, instead of keep on talking only about problems and consequences of climate change. However, take care to realise that this combination of tools was selected for a reason. Please, read the explanations carefully, put them in context of the time they were designed and then decide on how to proceed.

15.2 Strip 1 - The coastal zone

Introduction

The biggest villages in this region are: Middelstum, Uithuizen and Usquert. Uithuizen is the largest with approximately 5601 inhabitants. There are living a lot of people in these villages, near the coast this area is very open. Also a part of the Wadden sea estuary is included in this trip. The area north from Uithuizen consists mostly (for 80%) of arable land and of some grasslands (16%). It is a flat and open landscape with hardly any trees or shrubs. The middle part also has a lot of agricultural lands, but has more villages and also some more groups of trees. The lower part mostly consists of grasslands, with some arable land and some villages. The three main roads are the N46, the N996 and the N363. This region contains two railroads, running from the city of Groningen to Delfzijl and to the harbour Eemshaven.

Problems and opportunities

This region is interesting because of its agricultural function, with especially in the north the large parcels of very fertile land. But what is even more important is the coastal area in the north, which is very interesting in the perspective of climate change and also considering salt seepage. [dit loopt nog niet echt lekker] Furthermore, the villages offer an opportunity to show some very interesting measures in urban areas.

Implementation of the tools

In the spatial plan for this strip, we have chosen the following tools:
- sand suppletion
- marsh development
- water retention
- restoring brooks and canals,
- urban cooling,
- implementing green

Coastal reinforcement

For the coastal zone, we want to do a coastal reinforcement by creating a marsh-ridge in the sea at a distance of 1 km from the current sea dike. This ridge is partly created artificially by putting deposing sand and mud as a fundament in a strip along the coast and hold this sediment with wooden dams (in Dutch: rijshoutdammen). and by planting. After a while, typical salt marsh vegetation like common Glasswort will establish on the sand and mud flats. This vegetation will accumulatehold the sediment which is deposed by the sea when the ridge is flooded, so it will gradually grow due to the natural processes because the vegetation will continuously re-establish and

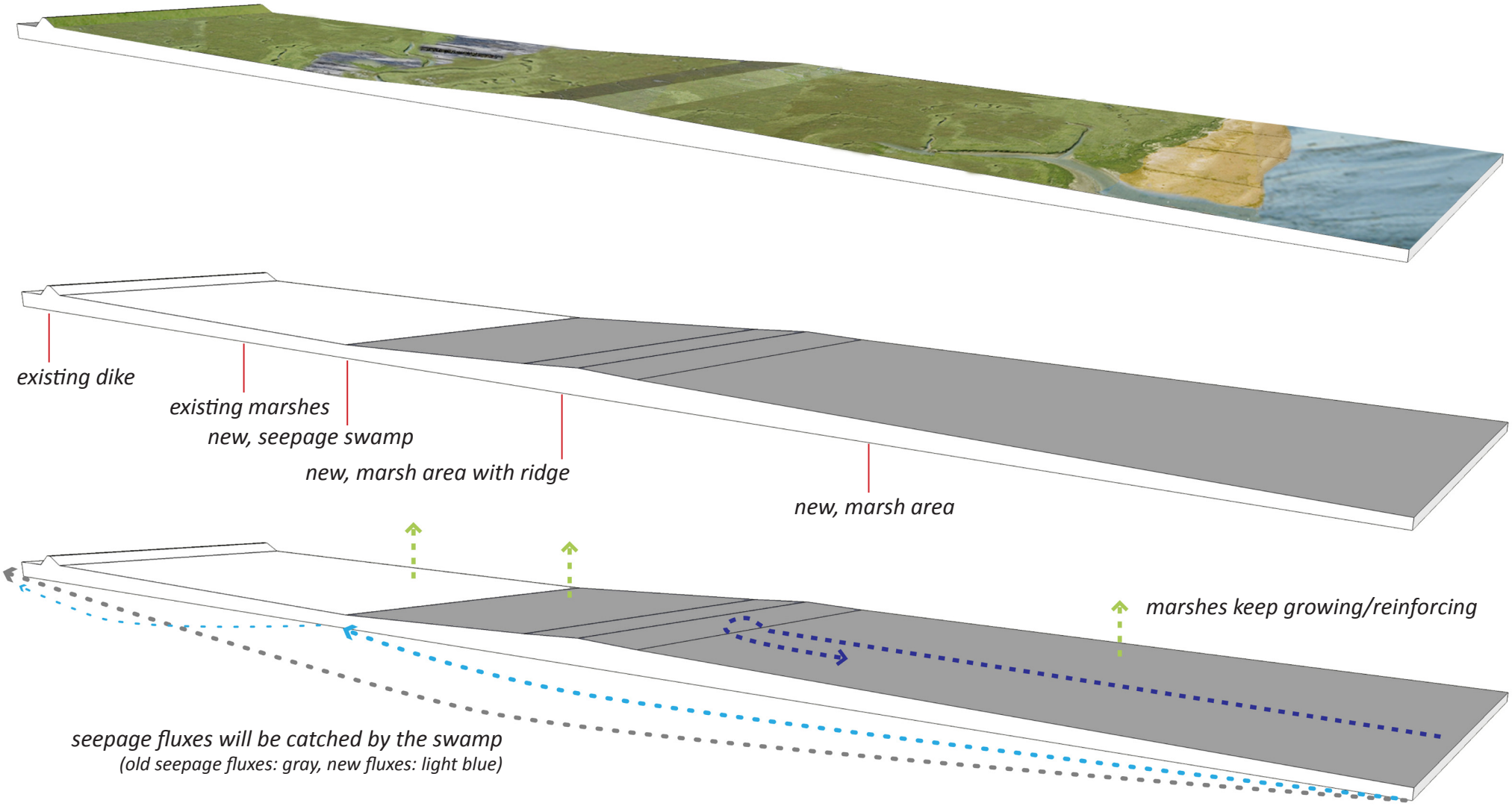


figure 36; coastal reinforcement by marsh development

reinforce itself. Even if the sea level is rising, these marshes will keep on growing and reinforce themselves. (source: 'Waddenwerken; een veilige kering die meegroeit met de zee', DHV / Wageningen Imares / Bureau Alle Hosper, 2008).
The ridge is no long closed demarcation, but is divided in strips of about one kilometre, with canals creeks of approximately 10 meter in between. With high tide, the water can flow into the area and with low tide it can get out. In this way we prevent it to be a closed system with stagnant water, with its negative effects as diseases and rotting processes. When water flows in, it is also possible to catch sediment in the area between the ridge and the dike. We want to do this with wooden dams (rijshoutdammen), with a grid of 100 meter. By doing this, a salt marsh / swamp area will develop between the current sea dike and the marsh ridge.
From the dike towards the sea, the ground level decreases from +1.5 meter NAP at the foot of the dike to -2.0 meter NAP at 500 meter towards the sea There, a swamp with some creeks is located, at the lowest point of the area between the dike and the marsh ridge. This swamp will function as well as a salt seepage swamp, in order to catch the salt seepage from the sea before it flows into the arable lands.
From the channel swamp towards the ridge, a distance of 150 meters, the ground level will increase to +1.0 meter NAP again. The ridge itself has a height of +3.5 meter NAP. From the ridge towards the sea, the ground level will decrease again to -2.0 NAP, where the level sea water is. To create this slope, we will put wooden dams north of the coast as well, which also catch the sediment and by that form a strong fundament for the whole structure.

figure 37; impression of the salt marshes in front of the current sea dike

To create this new coastal zone, first some more dams have to be created in the current salt marshes and especially in regions without salt marshes new dams have to be made to catch the sediment already. While the process of catching sediment in the zone near the dikes is going on for say 10 years, the ridge can be created. First the current sediment has to be prevented from flooding away by putting dams over there. After this, a new layer of sediment has to be put on top of this, which also has to be fixed partly with dams and partly with the marsh vegetation. When this ridge is still below sea levelhigh tide, more height can be created by dams, but when it comes above sea levelhigh tide it will not be flooded that frequent anymore.

This system is created by some artificial interventions to accelarate the natural processes, but is mostly based on natural processes systems and therefore it is not a measure that will be implemented immediately at once, but a process that will evolve gradually. This is no problem, because the sea level will also rise gradually, so the system has the time to adapt and can grow along with the sea. The end result is also a natural system that fits into the bigger picture of the coastal zone and even of the Waddenzee and its ecology, where many different altitudes are found, thanks to sedimentation and vegetation. Therefore we think this new zone is an addition for ecology,

in stead of a threat to ecology. It suits in the type of ecosystem that is already there, and will be part of it.

The system that is created in this way will effectively lower the surge, as is investigated by different engineers (DHV et al, 2008) The idea shows that the salt marshes diminish the waves in front of the Afsluitdijk. The system used for the Afsluitdijk is comparable with our system, but constructed and intended in another way.
In our plan we have two of these marsh buffers. The first one is located north of the ridge and will stop the heaviest waves; the second one is located north of the dike and will diminish the remaining waves. The existing dike is strong enough to deal with the surge if it would reach it, because its power has been diminished by the salt marshes. When the water reaches the dike it will be quite calm and for the whole dike has an asphalt coating (Google Earth, 2009) that reaches up to 5 meter could be an additional measure if needed.

When the area near the dike is formed into a solid underground, it can be used for recreational purposes, e.g. a cycle path can be created. There will be cattle on the sea dike, they can also walk on the northern side of the dike in the more salt areas. This offers farmers the opportunity to create 'presale' meat, what has its own special quality. The (salt) area between the dike and the ridge can be used for experiments with salt crops (see Annex 1 toolbox rural pg 119). For the future, the demand on these crops will rise and this area is a good place for experimenting with it.

Using the marsh-system we suggest is preferable above creating a new or heavier artificial dam or dike. We already mentioned the benefits for the ecosystem of the whole Wadden sea when using marshes, which will not be achieved when using a fully artificial dike. Next to that, by using these natural processes of sedimentation and self reinforcing systems, we can let nature do the heavy work for us. So a lot of money can be saved with this system, while when implementing new dikes bilions of Euros have to be spent.

Windmill area
In the current situation two lines of windmills are located nearby Eemshaven. They are for a part in this Coastal strip. A description of this area is in the Energy theme. Groninger people can participate in the cooperation which builds the windmills.

Infrastructure
The infrastructure will also be adapted and improved, but this will not only happen in this strip, but in the whole province of Groningen. Therefore, we have explained these plans in our theme map and text about infrastructure in our over-all vision.

Villages
The villages mentioned above are the biggest and most important villages in this region. These villages are located on higher grounds(wierden) on 1-2 meter above sea level in comparison to their close environment (Google Earth, 2009). In case of heavy rainfall water will flow out of the villages and will not cause problems by flowing into it. Most of the villages have quite some trees and shrubs in or around them, and also water areas in or just outside the town like old brooks. In case of dry and hot summers, these 'green' and 'blue' zones will provide fresh and cool air, which is especially needed in villages, because temperature is higher there and will be higher related to the climate change.
Although the heat-island-effect is at its biggest strength in big cities, small villages also cope with this phenomenon and therefore solutions are needed. In some villages these zones can be improved and/or extended, which will happen at Uithuizen (see figure 38 and 39), to make sure that with hot and dry eastern winds enough cool air is blown into the villages

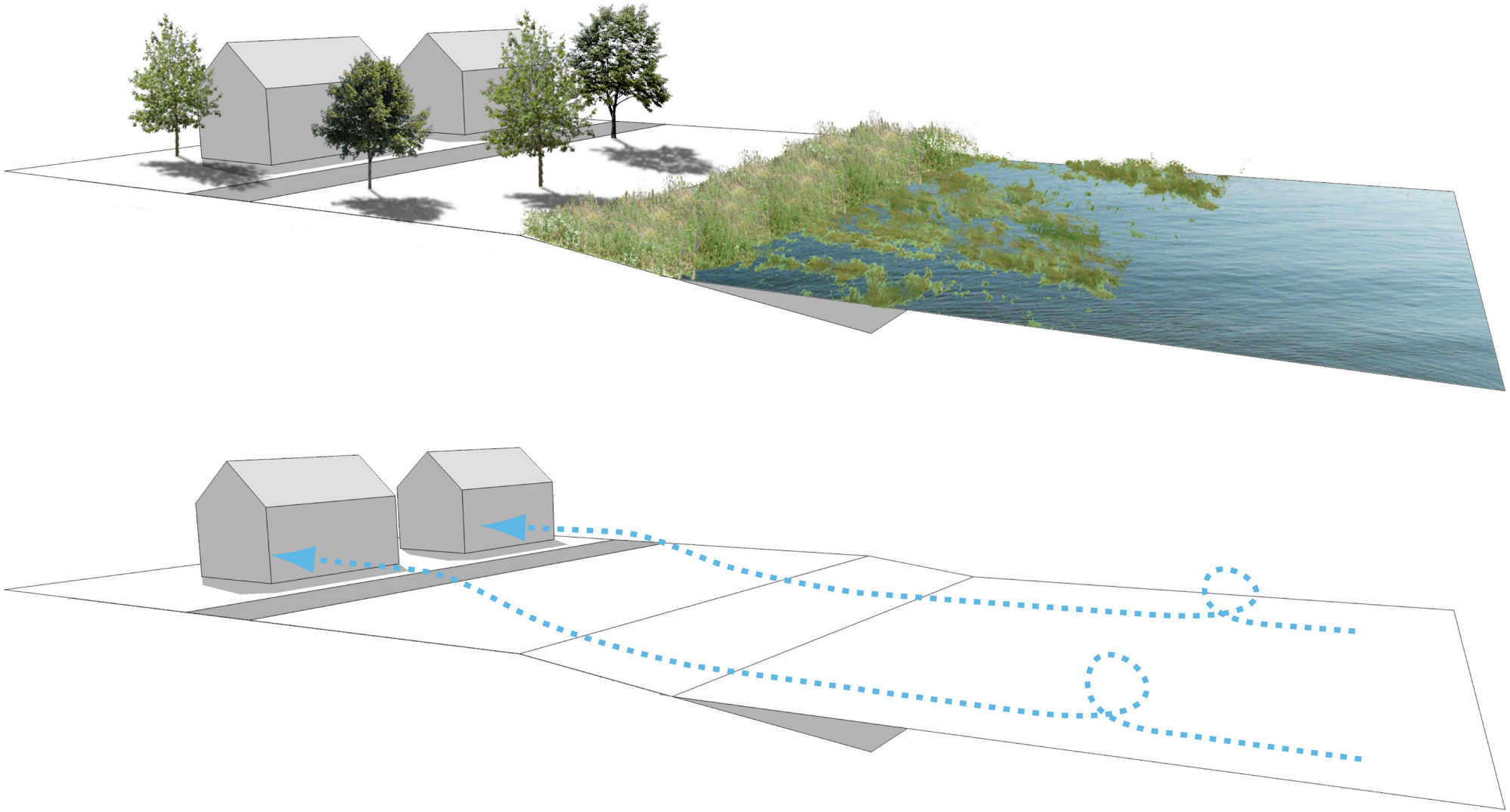


figure 38; impression of the urban edge, with the new park strip and the water area with ecological valuable banks. The water combined with wind, cools the city

Nature

The Coastal strip contains a part of the (future) route for nature. When looking at the area and its qualities, a lot of streams and small canals can be discovered, which cross the whole area. Right now these streams are very small and they have a hard border, namely the agricultural land. However, the streams offer a great opportunity to improve nature. The well known concept of the so called 'akkerrandenbeheer', the management of the banks and borders of agricultural land in a natural way, can be applied easily over here. The current streams have to be broadened and on each side of the stream a (+/- 10 m broad) zone with natural vegetation will develop in a natural way after digging away some ground to create a ecological valuable slope from the agricultural land towards the water. The channels will be connected with each other by digging some connecting canals to make sure the water does not stagnate. In this way the draining of this part of the province of Groningen will increase, what is needed when precipitation will be more intense due to climate change. And of course an ecological network will be created, by which all kind of species can migrate from one area to another along these blue-green veins. Especially in the perspective of climate change, it is important that species can move to the north, because of shifting habitats. The northern part is a very open landscape. This is a good connection zone between the inland and the sea, so we did not make that much 'akkerrandenbeheer' zones here. This new network will play an important role in that. The network is not created along the N996, because this is a busy road, and there are better and more ecological connections possible in this area, which are shown in figure 39.

Another advantage is that the streams can be used for urban cooling, by leading them along or through villages. This can be combined with the creation of parks, which will increase the process of cooling and will of course add aesthetical quality to the villages. Examples in the strips are at the east and south side of Uithuizen and Middelstum. Also a detailed cross-section is made of this tool.

At last, it can be considered to use the water streams that lead to the north to fight seepage and lead other water systems to the north as well. But this requires accurate research, and that is why it is not implemented in our plans yet.

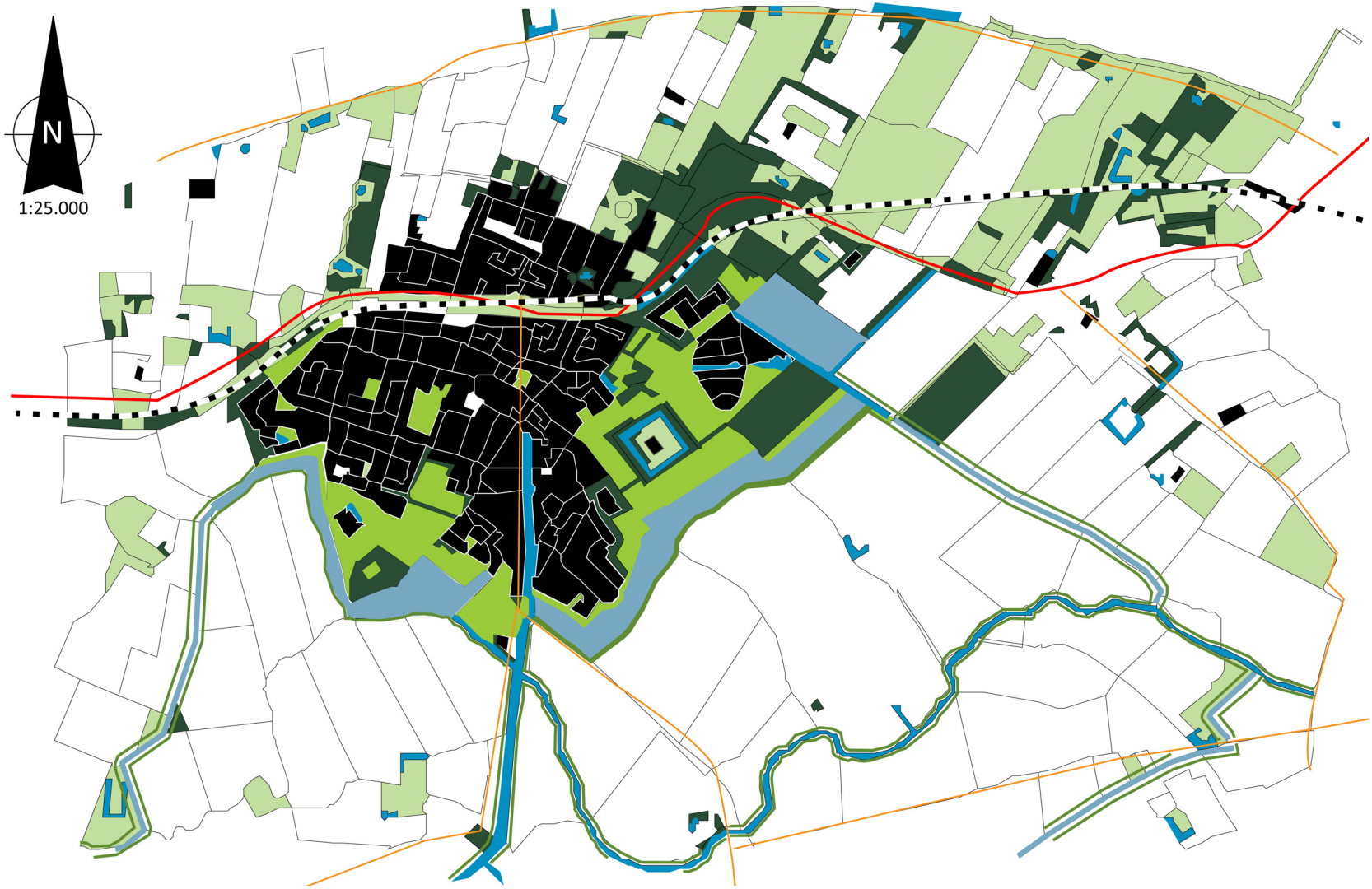


figure 39; detail map of the village of Uithuizen; the parks and water areas are linked to the ecological structure of the old streams and brooks.

15.3 Strip 2 – Groningen – Delfzijl

The second strip that was chosen extends from the city of Groningen to Delfzijl and into the Dollard. Two of the larger cities in Groningen, Groningen- city and Delfzijl are in this strip as representatives of large cities in the pProvince. The area between Groningen and Delfzijl is the lowest part of the whole province with some wet peat soils.

Problems and opportunities

The most important issue in that area is that in case of a break of the dikes in the Dollard, the entire area up to Groningen- city will be flooded. Except from the newest areas extensions of Groningen- city, Groningen the city is built above the current sea level, built mainly on a sand ridge called the Hondsrug. The low area is bounded by the higher built areas on the north and south edges of the strip. The industrial area east of Delfzijl is an important topic because sustainable industrial activitiesy in Groningen can be a leading example for the rest of the Netherlands and beyond. The Dollard is part of this strip because of the high risk of storm surges in this specific area, which could have a major impact on the whole of Groningen like we described earlier.

Within this strip there are low and wet areas, large cities and industrial areas and has to cope with surges. The strip was chosen, because of the unique combination of these elements together that all interact. Besides that, the strip is like the other strips representative for other areas in Groningen. The measures here can serve as a guideline for other areas.

We want to show our vision on protection against storm surges, transition of the agricultural area to a cope with the wetter environment and transition of industry towards ecological sustainability.

Implementation of the tools

In the spatial plan for this strip, we have chosen the following tools:

- Energy reduction industry
- Reuse of waste products industry for other purposes
- Surge protection by sand suppletion (barrier islands)
- Raising ground water level
- Making room for water storage

Groningen city

The urban tools could be implemented in the city of Groningen. The main problems in cities will be the extreme rainfall and urban heat. The city offers possibilities to reduce the ecological footprint.

The roofs of the buildings play an important role in all these aspects. Flat roofs or green roofs could partly take care of the extreme rainfall, before it flows towards lower areas. Blue en green roofs have a positive effect on it surroundings, buildings get better insulated, and in stead of absorbing heat it reflects heat. Roofs could also be placed with solar panels to produce green energy.

Other water has to be stored before it runs off. This could be done to by givinge current canals in Groningen more space and old, no longer existing canals could be dug out en revitalised (Gedempte Kattendiep, Gedempte Zuiderdiep, Rijtemakersrijge). Water can also be stored in city parks if possible.

figure 40; impression of the city of Groningen, with green roofs, vertical green, wind energy and solar energy

Building in lower area's can cause problems when floodings occur, the government should recognise that and adapt to that. New extensions of the city should be build on the higher grounds, but if build in low area there has to be extra attention towards sustainable and water rich building which is adaptive to flooding.
Green in the city improves the micro climate. The green zones between the current city districts play an important role for the city. These could be used for water retention, recreation and cooling. On street level, green improves the micro climate. Trees and vertical green can give shade, cooling and reduce the CO2 concentration. Furthermore, the aesthetical value that is added by implementing this green will also contribute to a more pleasant environment.

Low areas
The lower area of this strip faces the problem of fresh sweet water that flows towards this area from the entire province, and of the pressure from the sea. If one dike breaks, the entire area will be filled with salt sea water from the Wadden seazee. At high tide, the fresh water in the 'Boezemkanalen' can not be released into the Waddenzee because of thethere is no difference in water heightlevel. With the lowering of the soil by 'klink'caused by the oxidation of the peat and through gas extraction on the one hand and the sea level rise on the other hand, these problems will only increase. Because of the combination between these different phenomena, we can speak about an enlarged (relative) sea level rise for this area.
Because this area is this low, it is adequate suitable as a water retention area. By letting sweet water in the areas that are at the moment more than two meters below sea level, we lower the pressure of seepage from sea into the area and gain a significant amount of retention area. The extensive agriculture of the area will have to change. The ground water level will be raised in the entire area, so using machines and heavy cattle is not possible or wouldill destroy the soil and plants. Sheep and other small cattle can stay in the area, they will not destroy the land and they can help to keep the landscape open, free from trees. The solution for this area is planting sugarcane, in the first place for water purification and in the second place as production of biomass for biodiesel. This can be harvested using boats, by farmers, volunteers, municipality, or the unemployed. Not the whole area will be covered with sugarcane. Much of the wet areas will have open water or common reed. Recreation will be important in the area. Wooden footpaths through the area will have some enclosed parts where you can only see the sugarcane. Open parts let you see the open landscapes with views on the small villages to the north and south on the higher areas.


figure 41; impression of the water retention area between Groningen and Delfzijl, with possibilities for recreation

Energy is a side product of this solution. The main goal of this tool is to create a higher ecological value with fewer nutrients in the soil. The water can also be used for the production of drinking water at Delfzijl. The soils will be more pure and soil depletion by oxidation will stop. Gas extraction will then be the only reason why the soil will deplete. Finally, with a good implementation of these concepts in the landscape, the aesthetics will be good saved and improved and this can be a boost for the area on the recreational level.

Delfzijl - Termunterzijl
The Delfzijl-Termunterzijl area is heavily occupied by industry. Chemical factories and an aluminium plant are quite polluting industries, but it is industry that belongs here. From our ambitions we want our design to be

sustainable and this means finding ways to make the industry less polluting and more energy efficient. The efficiency of the factory itself is something that the factories have to invest in their selves (ecn.nl). By more efficient processes or by storing excess heat for when it is needed later on in the process. For some of the waste, there are already techniques to lower their effects, or to reuse the waste in other processes. (ecn.nl and waterforum.net)

Greenhouses must lower their CO2 pollution. By re-using the heat and pumping the CO2 waste from the aluminium factory into the greenhouses the hot water can cool down and the CO2 will partly be absorbed by the plants, reducing the amount of waste. The same concept can basically be used in algae production. The algae grow best with an optimum temperature higher than the standard temperature in the Netherlands. When also the CO2 amount is increased, the sunlight is the only limiting factor for growth. When the water comes out of the basins with the algues, the temperature of the water has decreased so much that the effects on the Wadden seazee are much less. The amount of CO2 released into the air will also decrease because the CO2 is stored into the algae. (glaskracht.nl and Stichting natuur en milieu, 2007)

Termunterzijl contains one of the few water outlets in Groningen. The

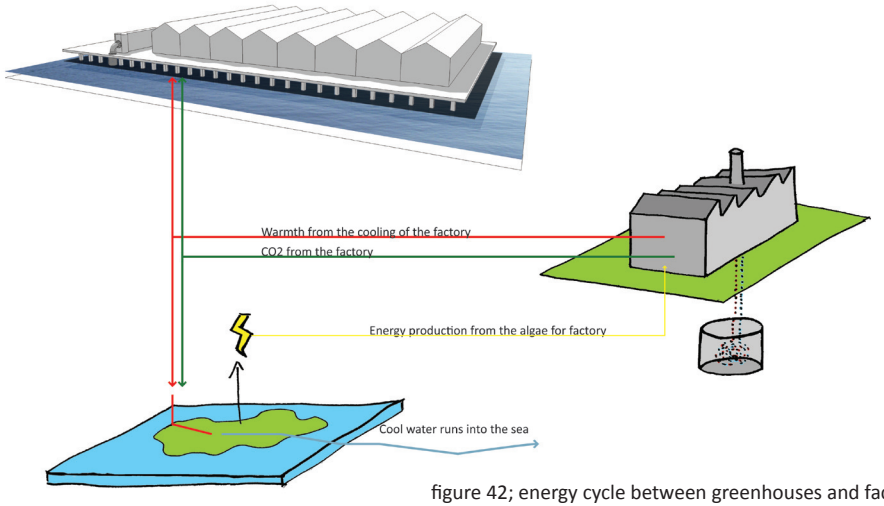


figure 42; energy cycle between greenhouses and factories

combination of fresh water and salt water from the Waddenzee has a high potential for energy production. The possibilities for this type of blue energy are even higher at the Lauwersmeer. That area is not included in one of the three strips, but we shall show the concept in this strip so that this can also be used at the Lauwersmeer. The concept of blue energy is described above, at the themes.

Dollard

The Dollard has a funnel shape, which makes storm surges even higher than in other areas. Some special protective measures are need to be taken in order to protect not only Delfzijl, but the whole inland area up to the city of Groningen. Next to that, also Germany has to deal with this problem. Therefore we recommend a joint action (both Dutch and German) to fight this problem; borders shouldn't play an important role in this.

The dikes are high enough to protect the coast from a higher sea level, but

figure 43; impression of the greenhouses at Delfzijl, there is room for educational/recreational purposes

these extra high surges rise up to 6 meters higher at the Dollard. The surge is caused because the same amount of water has to go through a smaller area. Stopping the surge is a key problem, for which serious measures need to be taken. Heightening the dikes is not an option without also broadening the dikes significantly. This means houses in e.g. Delfzijl would have to move and the harbour is also in a dangerous position. It would therefore be a more sustainable and suitable solution to make sure the surge does not reach that far into the Dollard. So the measure is taken more towards the place the problem starts.

By creating two barrier islands at the entrance to the Dollard, it is possible to break the surge. The islands can be constructed on the higher mud flats that are already situated over there. If necessary we can reinforce this fundament with some sand suppletion. The next step is to build a dike on this sand flat that functions as a storm shield. The waves break at this hard storm shield of the islands and the water that passes the islands gets more space behind the islands since they get smaller towards the back. Behind this dike, in the shelter of this storm shield, again a valuable marsh area can develop on the sand flat without further human interventions. So even though this
The surge will not have the extreme effects like it would have before. The islands are planned to be put outside of the canal, so that the ships will be able to reach both harbours of Groningen.

figure 44; impression of the barrier island with a Wadden area in front of it

figure 45a; current situation in the Wadden sea area

figure 45b; two new islands function as a barrier for storm surge and contribute to the Wadden sea system

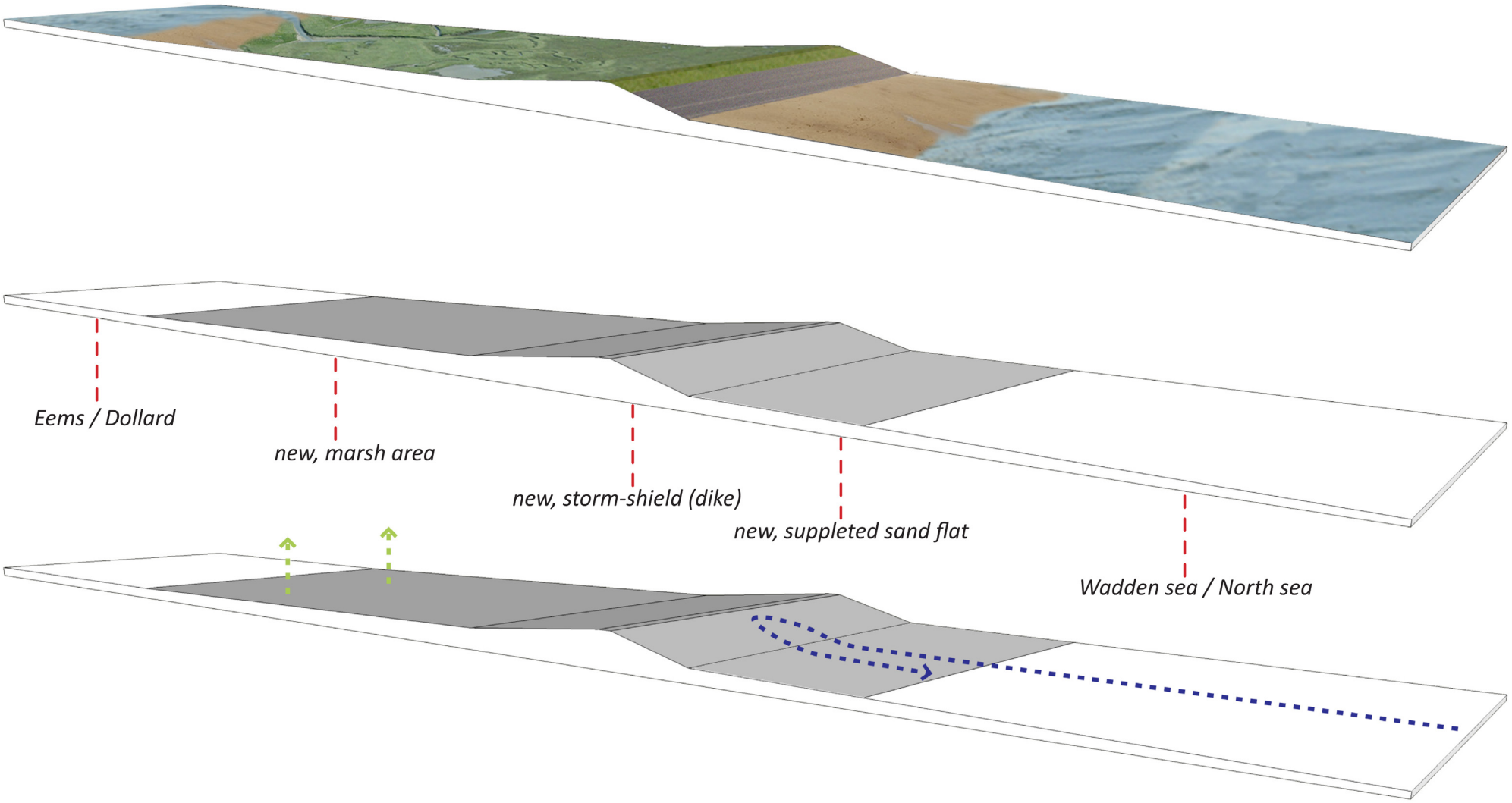


figure 46; impression of the system of the barrier islands; storm surge will be broken by the dike. Behind the dike , a marsh/mud area can develop and grow by natural processes

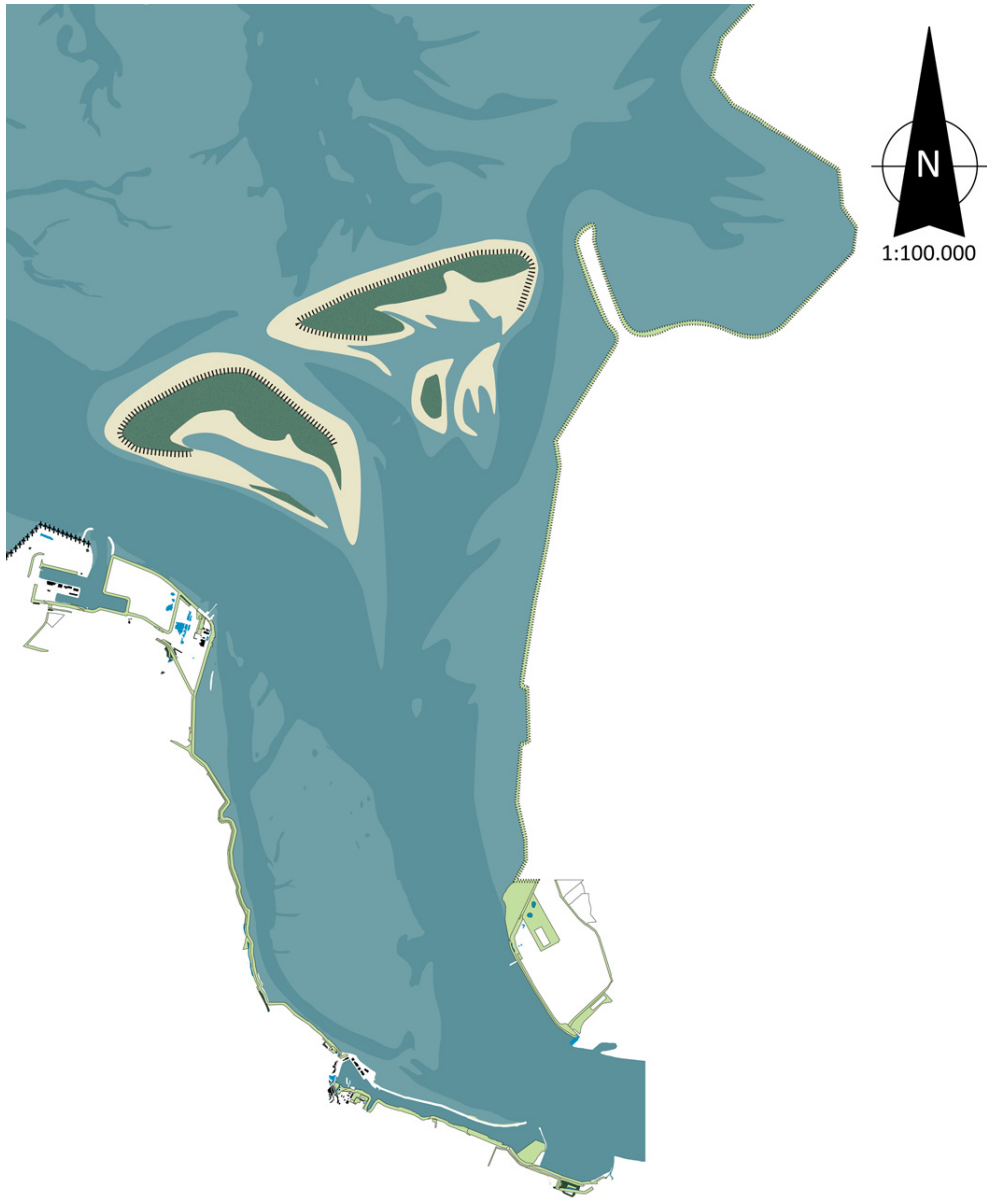


figure 47; detailed map of the barrier islands

Infrastructure

Groningen has a relatively low infrastructural connectivity compared to the rest of the Netherlands. Inhabitants are forced to use cars for transportation. To reduce the CO2 emission, public transport should be a good alternative to travel with. This can be done on different scales, Europe, the Netherlands, province of Groningen and within cities itself.

A European railway system can reduce the ecological footprint, as an alternative for plane and car travelling in Europe. A high speed train (route north) at the route Amsterdam-Groningen-Bremen has new economic and CO2 reducing potential.

Groningen already developed a plan for more public transport with a vision and implementation until 2040. The study of a framework regionrail (raamwerk regiorail) is a plan for an optimized network, for train, city tram and q-liners (fast busses). The plan consists of new rail infrastructure from Groningen-Veendam and citytrams in Groningen city. The city tram system consists of several lines.

Line 1 CS – Zernike science park
Line 2 CS – UMCG – Kardinge; extention towards wijk Lewenborg
Line 3 CS – Meerstad
Line 4 CS - Europapark
Line 5 CS - Martiniziekenhuis

These public transport systems are not developed with the goal of lowering the footprint, but with a few adjustments it perfectly fits in our vision. The public transport system should be upgraded to a system which uses green energy. Cost-benefit analysis, the benefits for CO2 reduction should not be underestimated.

15.4 Strip 3 – Peat Colonies

The third chosen area is located in the south of the province of Groningen and it includes a small part of the province of Drenthe. It starts on the high lands of the Hondsrug, continues to the north-east with peat colonies (former peat swamps), ends in the Westerwolde area with the meandering rivers Mussel Aa en Ruiten Aa and has a width of approximately 9 kilometres. It contains three landscape types: the lateral moraine of the Hondsrug, the former peat area and the brook valley landscape, which consist of mostly agricultural land and some grassland and forests. The water system is important for all the landscapes; they are all connected to the water system. Water comes from the hill, and flows through the peat soils towards the brook valley.
Within the strip the main urban area is Stadskanaal with 34.000 inhabitants (1000chancen.de), which is surrounded by the village of Nieuw-Buinen and Musselkanaal. Other larger villages are Buinen (in the south-west) and Vlagtwedde (in north-east part). The main roads are the N374, the N379, the N366, the N974 and the N976. This region does not contain any railroads (only one which goes through Stadskanaal from the north-east) but many water canals.

Problems and opportunities

This part of Groningen is different from the northern part of Groningen and unique because of the big peat colonies which extend through the whole southern part of the province. We chose this specific strip, because we want to point out the problems and solutions within these different landscapes and show how the tools in our toolbox can solve these problems.
We want to give solutions for the problems that are already there and will probably get worse due to climate change and the problems that do not exist yet, but will arise because of the climate change. Each landscape type has its own problems, but we can say that each of them has problems with water, either an overabundance or a shortage. The peat areas for example, have the problem of water shortage in summer and an overabundance during heavy rainfall. Retaining, storing and draining of water are points of interest within this area. Furthermore, the ecological footprint should be reduced. These tools could be used in this area:

- Storage of sweet water (create new water storage areas)
- retention areas for rainwater and water out of the higher areas
- Self-sufficient farms - agricultural waste used as energy (bio-mass), sun energy (solar energy: PV-panels), rain use water
- Connect and enlarge habitats/nature (conservation) areas
- Personal transport - solar cars, bio-fuels, cycle paths network, water transport network (boats)
- Develop green spaces between houses to have a cooling effect and to stimulate the growing of local products within that space
- The importance of water around the city, which can cool the city down during hot periods.

Hondsrug

In this detailed design we do not focus on the lateral moraine of the Hondsrug. The slope of the lateral moraine should be optimised for the infiltration of rain water. By this we could collect a greater amount of filtered water. This means, water should at least get the possibility to infiltrate into the Hondsrug and not end in a sewer system.

Peat area

Although clean filtered water is seeping from the Hondsrug, the main problem of the peat area is manual lowered water level for agricultural activities. For this reason, the soil is drying out, and this results in the lowering of the soils. But a lowered water level is needed for arable farming. The soil in this area is productive by the fertile combination of leftovers of peat combined with the sandy soil beneath the excavated peat. Besides this, the water in the area gets polluted by (chemical) manure used for the farming.
The area has the opportunity to store water by raising the water level. Water from the Hondsrug could be stored in the peat but in that case, the agricultural system should be changed. In the future should be focused on a locally small-scaled food production: People will have the opportunity to have their own piece of field with their own agriculture and can be self-sufficient.
One option is to make the storage in the lower part near the Hondsrug on the

east side of the river Achterste Diep. The water will flow from higher parts of the land to this point. In the canals in the agricultural area of Nieuw-Buinen the water will be filtered by helophytes and then flow to the area of the river Aa. This will be the new water system which will connect the west and east part. Along these new water connections ecology could develop. In that case new connections appear between the Hondsrug and the robust connection zone of the Ruiten-Aa. At the crossing points of the new ditches and the canals an eco-friendly passage must be created, otherwise the canals could act as a barrier for animals. The natural corridors are not only created to connect west with east, but also are also needed as connection between the north and south. The existing rivers can be the base for this.
The ditches which encounter a village or city (like Stadskanaal) could be designed as recreational route for cyclists and walkers. By creating a differentiated area, this idea also contributes to become a readable landscape.

Brook valley landscape
The problems in the brook valley landscape mainly deal with the Ecological Main Structure. It is important to allow the animals and plants to migrate and disperse. A good opportunity for the natural corridor lies along the river Aa which offers a connection through ´changing´ areas.
This area has the opportunity to become an ' ecological highway' connection through the Groningen landscape. At this moment that is still impossible, because the soils contain too much nutrients (coming from the arable land of the peat area). The absence of a natural water system (because of the arable fertilized arable lands) has its consequences for the brook valleys. Within the current situation the meanders in the rivers are straightened, so that the water can quickly flow away (to minimize the risk of flooding). Special plant species can not grow with the overdoses of nutrients and the low water level, characteristic flora and fauna even disappear. All these changes damage the originally small-scaled half open landscape of the brook valleys.

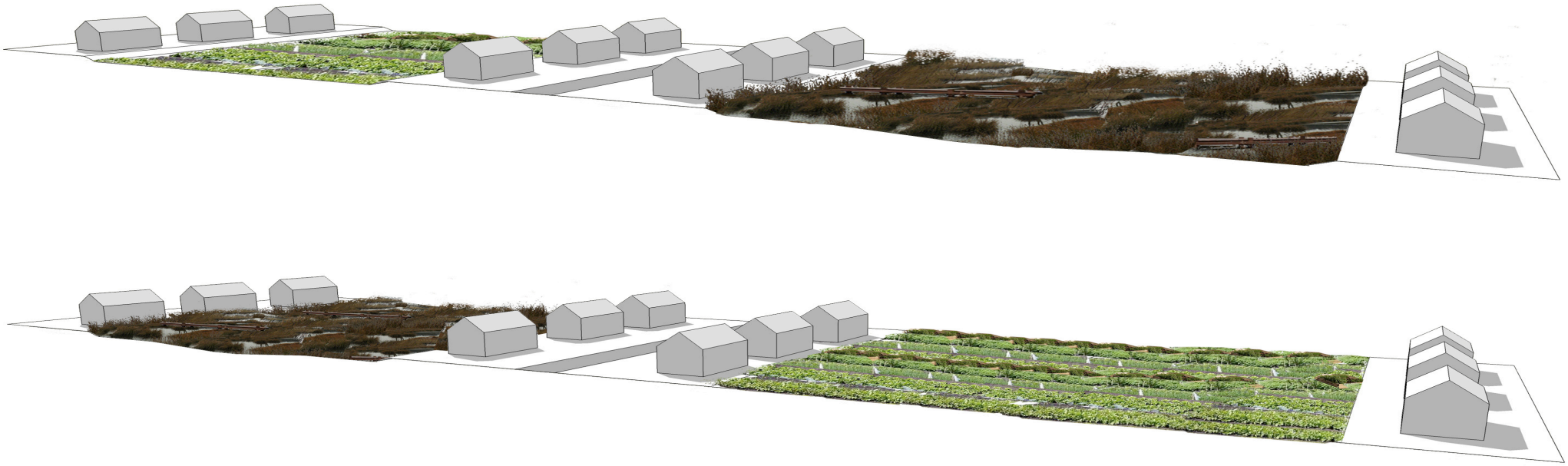


figure 48; impression of new housing areas with small scale agriculture (vegetable gardens) and peat strips. As time goes by, these two land use types can switch position

When the proposal for the peat area (as mentioned above) will be executed on a long term, the brook valley will be fed with clean water from the peat area and the Hondsrug. To keep the water clean, the run-overs of the sewage system should be disconnected from the rivers. The bottom of the river should be raised, and the river itself should be narrowed. By creating new meanders, small ponds and swampy areas along the river, the water can be retained in the area for a longer period. This gives the river his old view again: a small meandering quick-moving river with broad floodplains, with a high water level during winter and a low level during summer time.
To create an optimal EMS-corridor, dams in the river should be removed where possible. To make the water connection even better fish ladders can be implemented in the river. To complete the half open landscape new forests should be implemented on a small scale again. These can be used for recreation, but also create new opportunities for plant species and as resting place for animals. The open grassland between these forests along the rivers can be used for cattle on a small scale.

Stadskanaal
When we shift to urban areas, the problems consider heating of the towns; in our case Stadskanaal. One of the solutions can be to connect the city with the landscape. On the north-east, near the city, is a natural reservation called Veenhuizerstukken and on the east the forest of Vledderbos is situated. From the city the stream Pagediep is flowing through the landscape. To increase the cooling effect, it is possible to expand this reservation and forest with trees and small ponds (as peat area) and make the stream Pagediep more meandering, like described above for the Ruiten-Aa and Mussel-Aa. By doing this, trees can absorb heat and the water can cool the winds extra before the run into the city. In this way it will become a recreational area with a natural character that is also functional for the urban micro-climate.
At this moment, Stadskanaal is realising a pilot project “Wijken voor Water” (started in 2003) which is connected with the new housing development ‘Drentse Horn’ on the west side of Stadskanaal. This project will preserve water in urban areas in order to solve water shortage in agricultural areas.

figure 49; impression of the new housing area in the Peat Colonies

figure 50; impression of harvesting reed

During a relatively wet summer, up to 200 hectares of agricultural land can be supplied with water from the Drentse Horn. During a relatively dry summer, still 25 hectares of agricultural land can be supplied with water. Part of this idea is to redevelop the existing forest Buinerhornse Bos.
(wijkenvoorwater.nl)
This project offers a lot of examples that can be implemented around Stadskanaal. This project is in favour of water canal systems, but we chose the meandering rivers because it can offer more opportunity for water storage and flooding around them.
The project is an inspiration for further interventions around Stadskanaal. The area around the Pagediep is the lowest part directly around Stadskanaal. This could also be used as a water retention area in case the city is threatened by flooding.

figure 51; impression of the brook valley areas, a place for water retention next to recreation

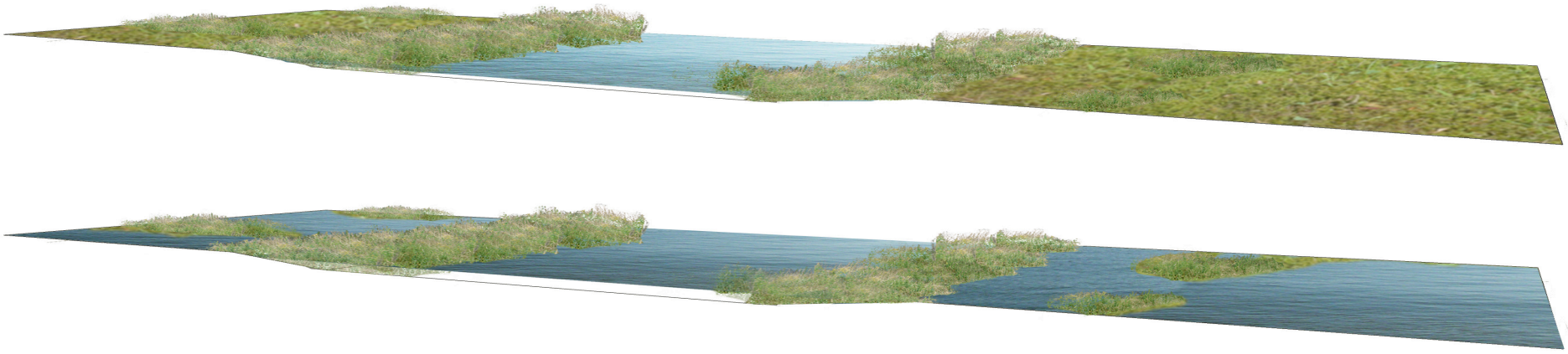


figure 52; in the brook valleys there will be more room for flooding areas

16. PHASING

Timeframe Measures
The three strips represent possible spatial solutions for parts of the province of Groningen. If anyone wants to use these plans, he will need the tools that were used to create these plans, and he will need some idea of what tool to implement at what time.

In creating the spatial plans the tools were used in a certain way, at a certain time and in a certain order. In the last previous chapter, the way the tools would can be used was already explained, but the time each tool takes from start, to achieved result, and the moment to start each tool has yet to be explained.

In the following table, the tools are explained with:
a) The deadline at which it is important to have finished the tool, because the results are necessary at that time;
b) The timeframe, which is the time it takes from the moment you start with trying to realize it, to the moment the results are there;
c) The moment to start using the tool if you want to have the results in time.

	Phasing		
Tools	Deadline	Timeframe	
Common Tools			
Public transport	2030	15 years for politics and actual building	2015
European connectivity	2030	15 years for politics and actual building	2015
- electric cars	2035	10 years to implement car charge poles, 15 years before people will buy them	2010
- biofueled cars	2045	Dependent of bio fuel production; change mind of people to actually buy the new energy, 15 years	2030
Coastal zone strip			
Coastal Reinforcement	2070, risks are so high that it has to be ready	Politics and lobbying to create consensus on the necessity of coastal reinforcement 10 years; Create sand marches, create dams on the salt marches to catch the sediment. 2 years; give marshes time to catch sediments in a natural process, 40 years; Create ridge to keep water out, 2 years; place plants on ridges to fix the sand, 1 year; Total 55 years	2015
Windmills	2025	This amount of windmills would take about 15 years to place	2010
Villages	2040	Green zone improvement, 5 years; Growth of the plants and trees takes more before they are complete and have fully functional cooling effect, 20 years. Total 25 years	2015

Groningen-Delfzijl strip			
Energy Reduction Industry	2050	Subsidise reduction measures, 10 years; Transition phase, 20 years; Total 30 years	2020
Reuse waste products industry for other purposes	2040	Purpose of area must change politically, 15 years; farmers come here to produce, installing buildings, machinery, green houses, etc. 15 years. Total 30 years	2010

surge protection barrier islands	2070	Gain political consensus, 25 years; Designing, 5 years; Implementation, 25 years; Total 55 years	2015
Production biodiesel			
- algae	2040	5 years when Reuse of waste products industry for other purposes have been realised; research must have made algae production profitable, 10 years	2025
- helophytes	2025	15 years to get farmers to switch to this type of production	2010
green in the city	2025	To get this done throughout a city as big as Groningen, 15 years	2010
water in the city	2025	Widening and reopening old canals, 15 years	2010

Peat colonies strip			
Storage sweet water	2035	Slope in filtration, heighten water level, helophyte filters, disconnect sewer turnover sytems from rivers; 20 years	2015
water in and around city EHS - connect and enlarge habitats	2040	New meanders, canals in cities, 15 years	2010
Develop green areas			
-Cooling effect	2035 (2045)	New meanders, fish ladders, remove barriers, 10 years; only after 'storage sweet water' has been realised, this can be achieved	2025
self sufficient farms			
- biomass	2025	smallSmall scaling farms - see 'cooling effect', get farms to sell locally, 5 years	2015
- solar energy	2025	Collection reservoirs for cow dung, machines for production, making it economically feasible for farmers, 10 years	2015
personal transport	2025	Change peoples mind to actually purchase it, 15 years	2010

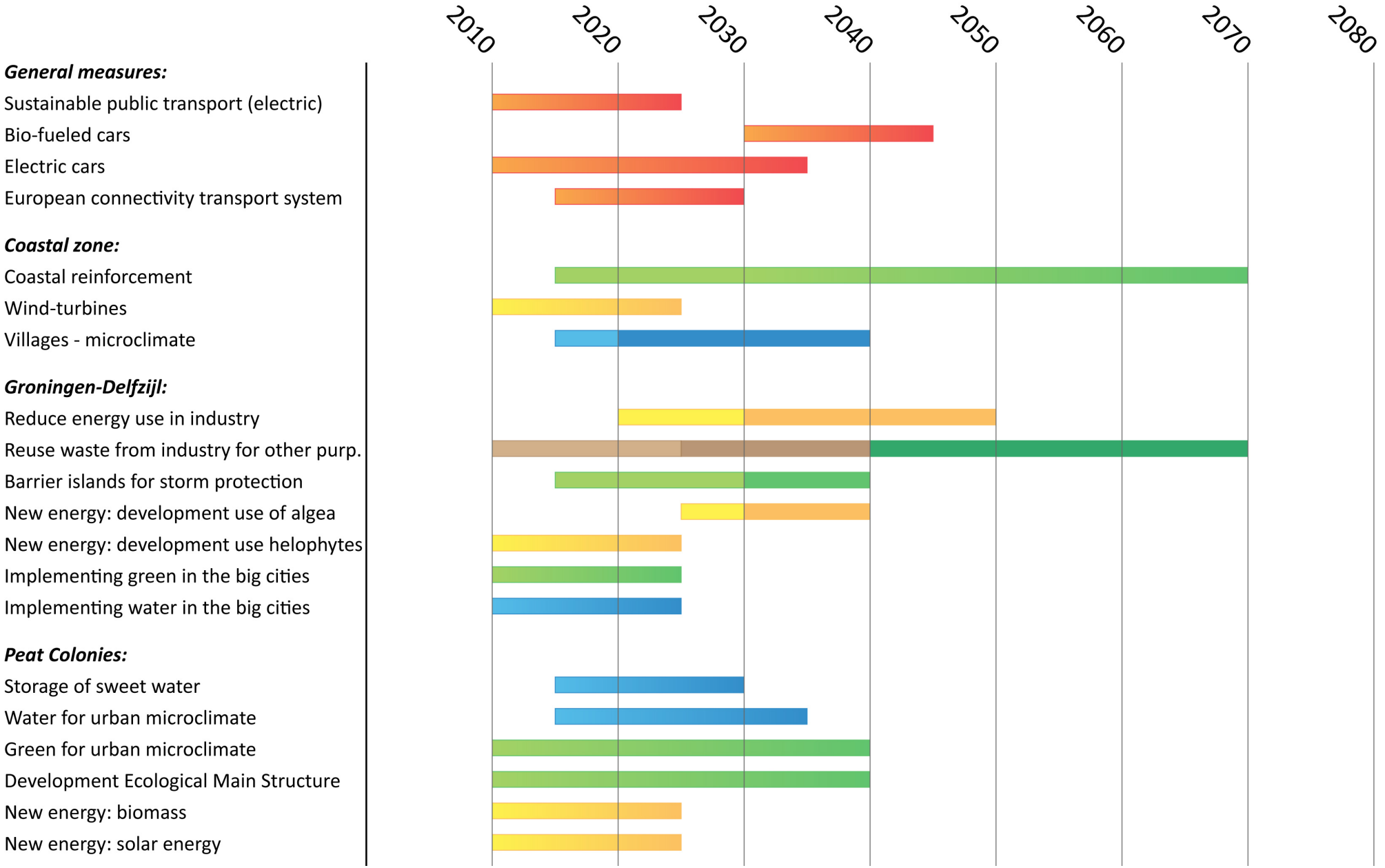


figure 53; phasing and time planning

17. CONCLUSION & DISCUSSION

It is clear that climate change is a serious issue. In 2100 the sea level can be risen by 2 meters, while a big part of the province of Groningen is already below sea level and is even getting lower due to gas extraction. Interviews with people from Groningen point out that they are willing to adapt, so nothing stands in the way for doing something.

However, a lot has to be done. We have to deal with the consequences, but also fight the causes of climate change. The main cause is the current CO2 emission, the result of our way of live, the consequences are a rising sea level, temperature rise, wetter winters and dryer summers.
We have searched for solutions for either the causes and consequences, trying to reduce the ecological footprint, adapt to higher temperatures, dryer summers and wetter winters and protect ourselves against the rising sea level.

When looking at the possible options as proposed in the toolbox and the implementation of some of them, it can be said that the current landscape in Groningen offers a lot of opportunities and qualities to reduce the ecological footprint and to adapt to climate change. We have tried to create a plan that shows first that something has to be done, but that also shows that there are a lot of possibilities of adaptation. The tools and measures are very different from each other: some measures can be easily implemented, others cost some more time because they take place on a very small scale while others cover a larger area. We have shown the implementation of some tools in certain areas. But there are a lot of tools that can be used, and many tools can be used not only in the area they are shown, but also in other areas. However, we wanted to show how the tools worked out in a specific spatial context (landscape type) with specific problems at a specific scale. We tried to show what the possibilities are and we have made this clear by using maps, calculations and other impressions. We saw it as a mission to keep the causes and consequences of climate change in mind, but not only talk about it, but actually show how to deal with it.

Our plans related to our ambitions
In the beginning some ambitions have been put forward. Having made a plan right now, it is good to reflect on these ambitions.

Sustainable design
The plans that have been made all have the label of sustainability. The over all goal is to reduce our ecological footprint, what is sustainable in itself, and all the measures are taken with the concept of sustainability in mind. New, sustainable forms of energy have been investigated to diminish the use of fossil fuels, which are not sustainable at all. Coastal defence will be organised in a way that can cope with the rising sea level for at least a hundred years. And nature is expanded and upgraded on a large scale. These are some examples of the plans, showing its sustainability.

Design for safety
In the beginning we said we wanted to “prepare for the worst and hope for the best”. The reason behind this is that it can not be afforded to take measures that will not be enough to protect the people, and it is better to take measures that can look a little bit overdone, but will definitely guarantee safety. The plans for the coastal defence, the creation of new islands, o options for water storage throughout the whole province; these are just examples that show that safety plays an important role in this plan.

Narrative design
At the start of the plan-making phase, we have made some tools. These tools were made by looking at the problems and also looking roughly at the qualities of the area and its landscape types. When deciding which tools to use in a certain situation, the characteristics and qualities of the landscape were considered first and then the tool that fitted best to these properties was applied. Also to support, upgrade or extent the local aesthetical values. Plans like the creation of ecological zones along the streams, the placing of parks and water in or near towns and the storage of water in the lowest parts and in the peat areas have been implemented. These, and many other plans, do not only offer a good solution to the problem, but also add quality

to the environment and tell the story of this landscape. A story of living with water, which is made visible again with our plans.

Ecological design

Ecological processes are the base of many plans that have been made during this project. Before making plans for the coastal reinforcement and the creation of new islands we first studied the ecological processes of the Wadden sea area. After this a design has been made that fits very well in the ecosystem and makes use of its ecological processes and benefits. Besides this, ecology is part of many of our plans, from green roofs in cities to the development of salt marshes or the regenerating of peat .

Democratic design

In the beginning of our project we asked people from Groningen about their opinion about climate change and adaptation to this and we had some results of interviews done by [bij wie ook al weer? Milieufederatie?]. The conclusion from these interviews was that the people in Groningen wanted to change and this was where the phase of plan making started.

After this, we started making plans and when doing this we took into account what the people from Groningen would like, but not by asking them, but by thinking. It would cost too much time for us nowto ask people's opinion about each plan. We think this neither is very necessary rigt now, because our aim was to show people that something has to change and to give some options for these changes. However, the democratic design is something that is important and better to implement in the future, when we will try to work out our plans and making them more concrete for final implementation. In a process like that, participation is very important. Participation might be an aspect of study in an individual research within our group in the coming period.

18. RECOMMENDATIONS

In this chapter, the content of the report is put back into perspective. All these plans were created in a timeframe of only eight weeks, by this group. We have made general calculations, done assumptions, and just skimmed some subjects that would have taken weeks to find out if we had had the time for it.
But this does not mean that our project is inaccurate and should be cast away. For projects with a time-scale of this duration, there is always suffering from uncertainties. No matter how much research is done, an expert could almost be an ordinary layman for accuracy in their predictions on this time-scale. We have made estimated guesses and did not try to predict, but to work towards a goal. We did this in such a way that in a wide spectrum of possible futures, our plan, or variations to it, can be implemented. We do feel however, that there still are several topics that need extra investigation. We can imagine that there will be continuously research on as well climate change as on the solutions for the coming problems.
We designed a toolbox and a spatial plan with a time-frame that gives room for public involvement. We also advocate their involvement in our ambitions. In the report we did not go into the topic of how to involve them, but this would be very valuable in the future.

Making the public aware
There is a 90 year timeframe for the end of the spatial plan. It seems like plenty of time to implement all the tools, but actions have to be taken right now because we already have to deal with the consequences of climate change. Even if we change our behaviour and footprint in the future, the consequences of our lifestyle in the past will be serious. And we need the time, because the public might need some convincing to make a change in the life style they are used to.
90 years is a too long period to be able to get a good view of what will happen. So it is difficult to accept that changes in life style will have to be made. The Dutch population seems more ready to do something for the environment than the American public. That was at least our conclusion after talking to North Carolina University students. The Dutch life style is already better adapted than the American life style, for there is a large difference in ecological footprint. We are happy with the way we live and do not feel like we miss anything even though we have a lower ecological footprint. Perhaps this realization can be a handle in convincing the Dutch citizens that lowering the ecological footprint will, in the end, make little difference for the quality of life. But over all, the whole world needs to rethink their habits. We, as a small country cannot fully solve this global problem of climate change. But by giving these solutions, and emphasizing that some of them are very easy to implement, Groningen (and Holland) can be an example for lowering our ecological footprint and on how to deal with climate change.

Bringing the public into the process
Besides public awareness it will be important that the public gets a say in the process as well. Our ambition is a Democratic Design, and involving the public can be a way to get a plan that will be fully realized with support of the public. Awareness is important to get the public ready to participate when given the opportunity. When the awareness is there, the question remains on how to give them that opportunity.
A great involvement in the process may mean a focus on small problems of individuals instead of a focus on the greater goal of climate change, a small involvement may have a great focus on climate change, but will not gain support from the public. A good implementation might become compromised. So where do you draw the line? How can we get maximum participation, with maximum support, with maximum usefulness for Groningen considering climate change? This will be a challenging assignment for the future as well.

PHASE THREE

DETAILED RESEARCH (summary)

19. INTRODUCTION TO PHASE THREE

In this last part of the report you will find a summary of nine individual projects on a more specific topic. After completing the first two phases, each group member started to work out one aspect from the spatial plans of the second phase. The topics worked on vary in subject and level of detail. The result is a broad deepened research that represents unique ways for adapting to climate change. Next to this summary, a full presentation is available as well in a powerpoint and/or poster presentation.

19.1 ‘The Wetlands Archipelago’ - by Jorrit Noordhuizen (landscape architecture)

In 2008 the Delta Committee (governmental institute) proposed a new policy on national water management. The lake-IJssel (located in the centre of the country) nowadays provides sweet water for big parts of the country (e.g. drinking water, agriculture). Groningen is dependent for their water supply on this lake. In the future, the Randstad will extract more water from the lake-IJssel, this means that the province of Groningen has to become more self-sufficient in their water supply. More room has to be reserved for storing water (source: Waterboard Hunze en Aa’s, 2009). Next to that, clean water is an urgent and continuous assignment as well. A lot of our wastewater is influenced by industrial and agricultural activities. Purifying it costs a lot of money and energy. How can we keep our water of a good quality, when we want to reduce our ecological footprint as well?

The problems discussed in this report occur on all scale levels. The ambition for this design is to investigate solutions for these problems on those different scales as well. The research and design focussed on the area between the cities of Groningen and Delfzijl, called the ‘Duurswold’. This area has the lowest grounds in the whole province. Many individual houses, farms and some city expandings are settled on these grounds. When thinking of for example extreme weather events (heavy rainfall, peak flows), there is a huge assignment of preventing these households from flooding. The Dutch Weather Institute (KNMI) says that due to climate change, extreme rainfall of 70 mm at one day can occur every ten years in future.

As mentioned above, there are many different assignments to work on in this area. At the one hand storing water and clean water, at the other hand adapting our urban settlements to possible flooding. The scheme on the right shows three different types of urban settlements through time. Our early ancestors build their houses on the natural high situated grounds like glacial sand ridges (period 1) to prevent their houses from flooding. Later on, especially in the northern part ot the Netherlands, people began to made artificial hills called ‘wierden’ to prevent themselves from flooding (period 2). In the last period (3), people had developped the techniques to build dikes and dams and so-called ‘polder’s. From that moment on they started to live below the sea level. But what is the next step when keeping the consequences of climate change in mind?

figure 54; the gray color indicates the lowest soils, black spots show households settled on these grounds

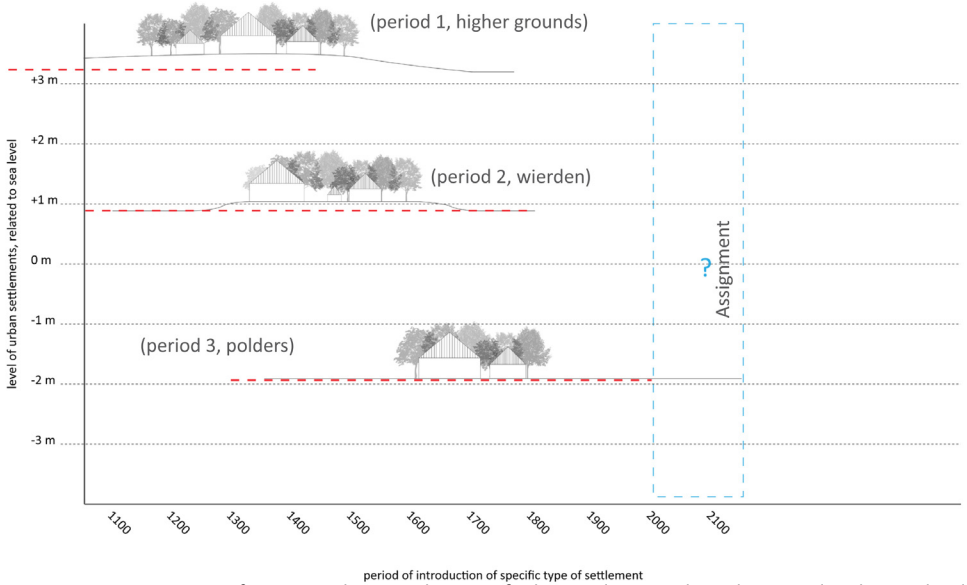


figure 55; scheme with types of urban settlements through time, related to sea level

Strategy, housing

The design proposes to use the logics of history to deal with the problems of the future. First of all, geomorphology reveals several creek ridges in the north (higher solid grounds, generated by tidal influences centuries ago). In the current situation, the ridges are not densely occupied by houses. These higher and solid creek ridges are an interesting opportunity for re-allocating housing areas if necessary due to climate change consequences.

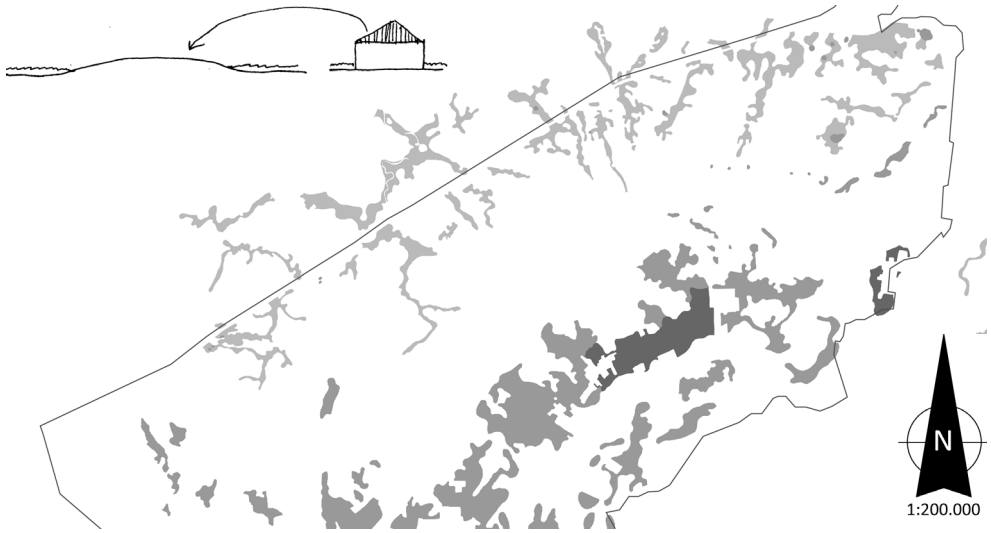


figure 56; dark grays indicates sand ridges (mostly occupied by buildings), light gray indicates creek ridges (north)

Strategy, water

A reference study of a project in Oxelosund (Sweden), showed that a wetland with helophyte filters is a very interesting solution for cleaning water. These vegetation can remove at least 50 % of polluting elements from the water, en costs almost no energy because natural processes are used. Clean water is important for the quality of life, agriculture and for a flourishing ecology.

Strategy, summary

Living on the higher creek ridges to prevent households from flooding, establishment of wetland area for water storage and purification, room for current agricultural activities of more local importance, experiencing the landscape.

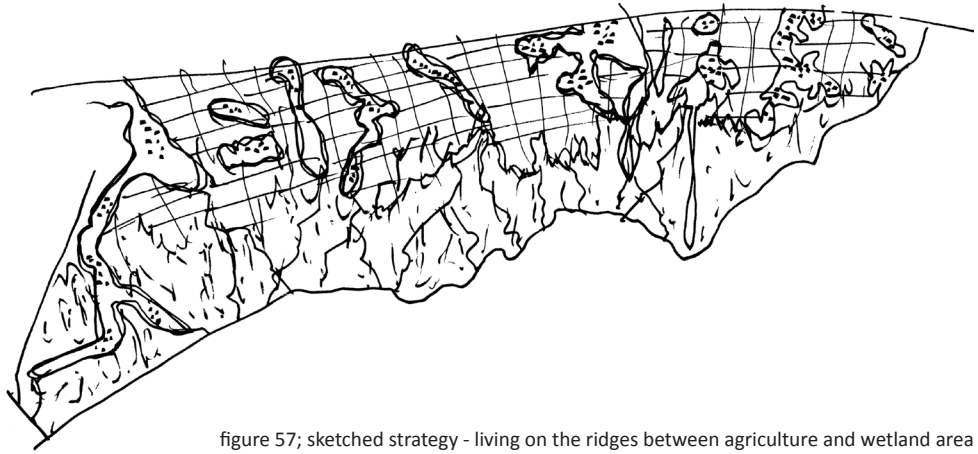


figure 57; sketched strategy - living on the ridges between agriculture and wetland area

The spatial plan proposes an ensemble of creek ridges occupied by houses, that occur like 'islands' in an open Groningen landscape. The open landscape is characterised by agricultural lands and a wetland system for purifying water poluted by agricultural activities.

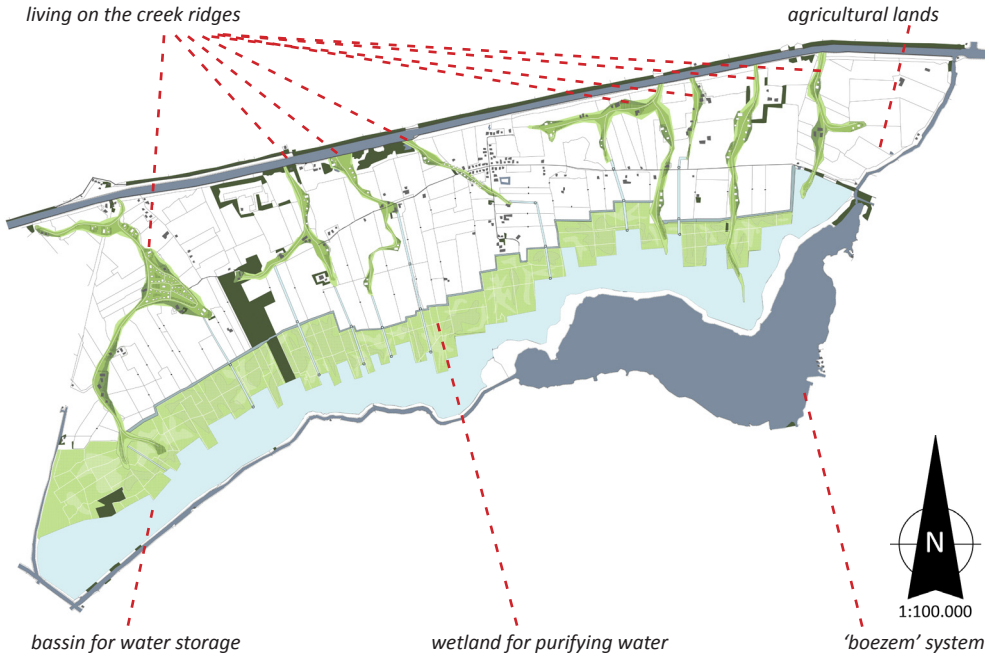


figure 58;'the wetlands archipelago'; living on the higher grounds, storing and purifying water on the low grounds

Another system

The current systems in the landscape change with this plan. First of all, the water system will change. Water that is collected in the agricultural ditches will accumulate in a canal that disperses the water through the wetland system. In several smaller bassins it will be purified. After that the cleaned water is stored in a large bassin, and will be pumped back with pumps powered by wind energy. This cycle is a continuous system that runs both visible and invisible through the landscape.

The agricultural activities will have to move more to the northern part of the area. The lowest grounds (where the wetland will be situated) are no longer suitable for agriculture because they get to wet in future. Agriculture will be settled in between the ridges. Also farms can be re-located on these ridges. By doing this, agriculture can play a more local role in producing food, milk etc. Next to that, some farmers could transist their activities towards producing biomass energy by harvesting the reed from the wetland.

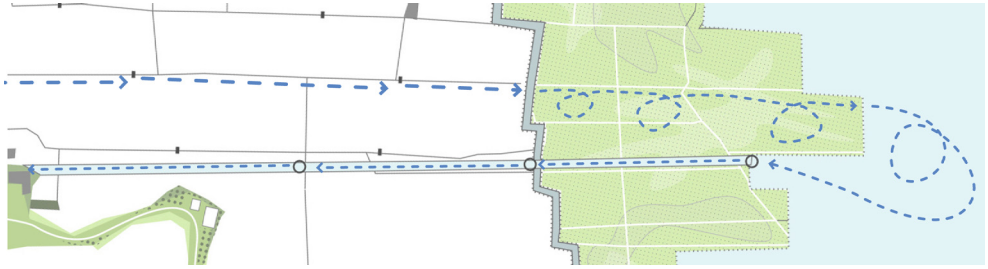


figure 59; new water system - from pasture to the wetland, to storage bassin, and back to the living area

Another landscape

This plan has serious implications for the current landscape. However, the *scale/size* of the current Groningen landscape, is one of the few landscapes in Holland that could deal with these kind of developments. Storing water claims an enormous amount of land in this small country. The Groningen landscape could be able to 'absorb' these kind of land-uses because of its empty and endless landscape.

Next to that, the future will be characterised by adding new layers (like this plan) to the landscape. Until now, the rural Dutch landscape is known by the large scale agricultural activities, initiated by post-war developments (scaling up in agriculture for preventing food crises). Like we mentioned earlier, in the future, when we have to adapt to the consequences of climate change, our landscape will change by taking this measures. This design aims to adapt to several problems and next to that, give an opportunity to experience and understand this other landscape. The future landscape could be characterised by using natural processes for adapting to climate change, with interesting ecological aesthetics to experience.

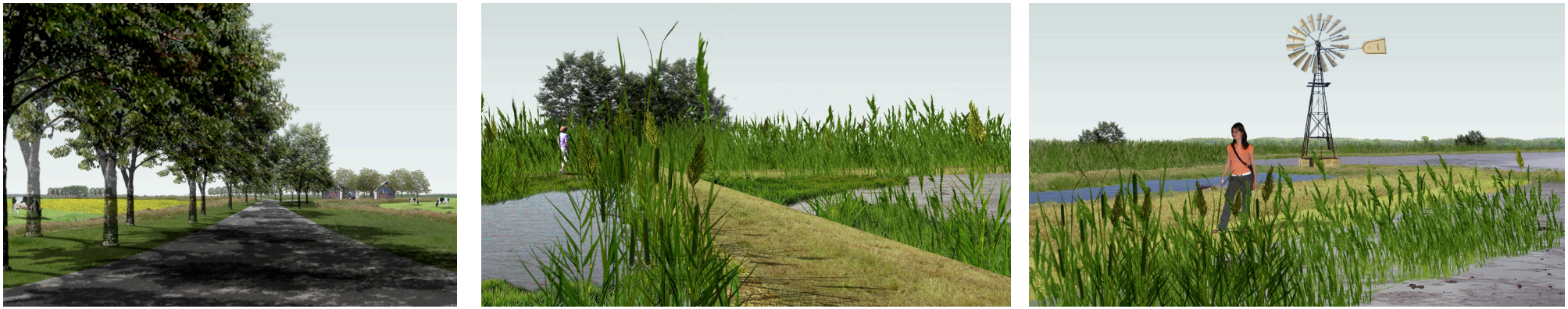


figure 60; tree-plantations articulate the shape of the creek ridges in the open field (left), the wetland can play a role for water purificantion, biomass energy and recreation (middle), wind energy pumps the clean water back (right)

19.2 Adapting phasing to public acceptance - by Maarten Verbeek (spatial planning)

Introduction

In Phase 1 of this project we created ambitions to help define what the future of Groningen should look like. Two of these ambitions were 'sustainable design' and 'Democratic Design.' In Phase 2, we decided to make 'reducing our ecological footprint' part of our main goals for this project. Among the tools we mentioned, were different sources of sustainable energy and other projects as reduction of industrial and household energy use. A few of those tools have also been used in our spatial plan for Groningen in 2100.

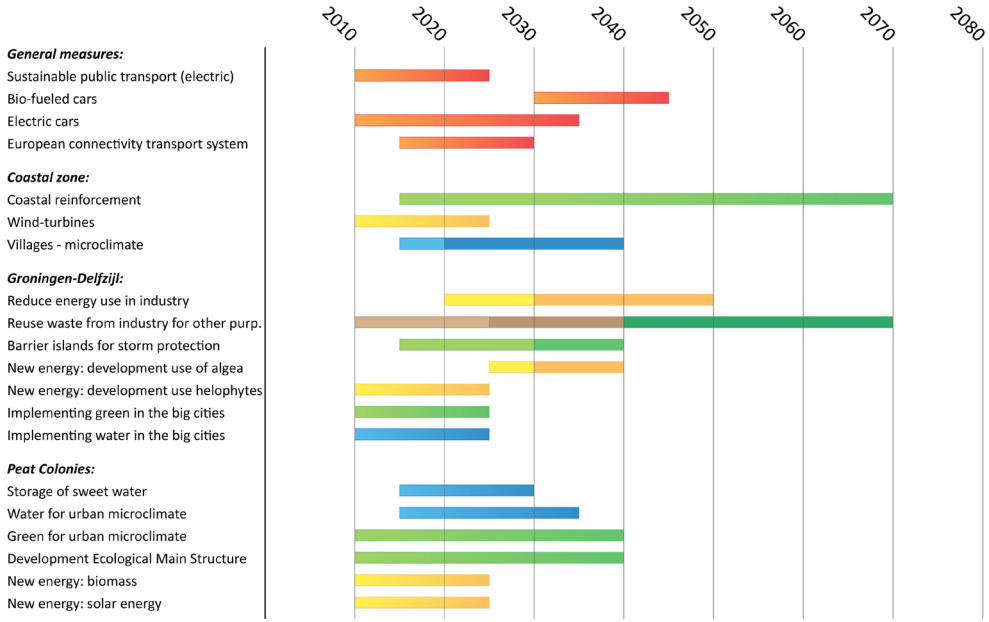
In our recommendations and conclusions we noticed that our ambition to design in a democratic way was not represented well enough in our project. However, in order to accomplish the projects that we suggested, public acceptance and support is necessary. Especially since many of these projects are very new and controversial.

The phasing that we recommended could use some refining too. Lack of time forced us to do this quickly, considering deadlines as the only condition for the phasing. Including public acceptance as a condition for phasing is a good way of refining the project.

This Chapter aims to improve the Phasing of the Group Work for maximum feasibility, by including the conditions for public acceptance.

Phasing version 1

Figure 1 shows all the tools that we used in the spatial plan at the end of phase 2, in their respective time frames. The tools that cope with new sustainable energy sources have been reviewed on the time they start and finish. This is done using information from a European project called CREATE ACCEPTANCE. This project took 27 projects on sustainable energy and compared them to see what the bottlenecks are for public acceptance. From these results conclusions were drawn considering the phasing of some of the projects. (createacceptance.net)



(Figure 61: Phasing original version)

Communication and the public

When trying to gain the support of the public, it is important to apply the right communication strategy. Raadgever (2005) gave a few rules on participation. These criteria should be used when evaluating the whole of a participatory process:

- Participants should be involved throughout all stages of the policy process (already early involvement);
- When organising citizen participation, the participants should represent the different groups in the population in a fair way (the equity dimension). For example, careful attention should be paid to the ratio male-female and actives-inactives;
- The nature and scope of the participation process should be clearly defined and participants should develop co-ownership of the process;

- The participatory process should be conducted in an independent and unbiased way;
- The process should be in some sense cost-effective to the sponsor.

However, there can be numerous reasons not to involve stakeholders in every step. Participant involvement is an indicator that suggests a good, open process. Setting it as a criterion, necessary for a good process, is too much. Too much influence by the public could lead to superficial plans. The challenge is to balance the amount of influence of the participants.

The following technique might help in coming to an overall strategy for the sustainable energy projects:

Foot-in-the-door-technique
The Foot-in-the-door-technique is a technique that involves first asking an individual to agree to a small and easily acceptable request, followed later by a larger, related request. Research has not yet found hard proof why the second larger request will be easier to accept when the smaller request precedes, but the empirical data leaves little doubt that this does in fact work. It is important that there is considerable time between the requests and a relation between the two requests is important. The individual needs to make a connection between the two. (Freedman in: Cialdini and Goldstein, 2004)

Phasing Version II
Heiskanen et al, (2007) suggests that there are differences between different views of technology, land and natural resources use, distribution of costs and benefits, and management failure. The 27 case studies knew different gradations of success. Different between technologies and different within the technologies. There are many kinds of conflicts and no one blue print methodology to achieve public acceptance.

Following the foot-in-the-door-technique, it seems logical to put all the 'new energy' projects in one campaign. The different projects need to be linked in order to receive the positive influence from the 'small requests' on the 'large requests'.

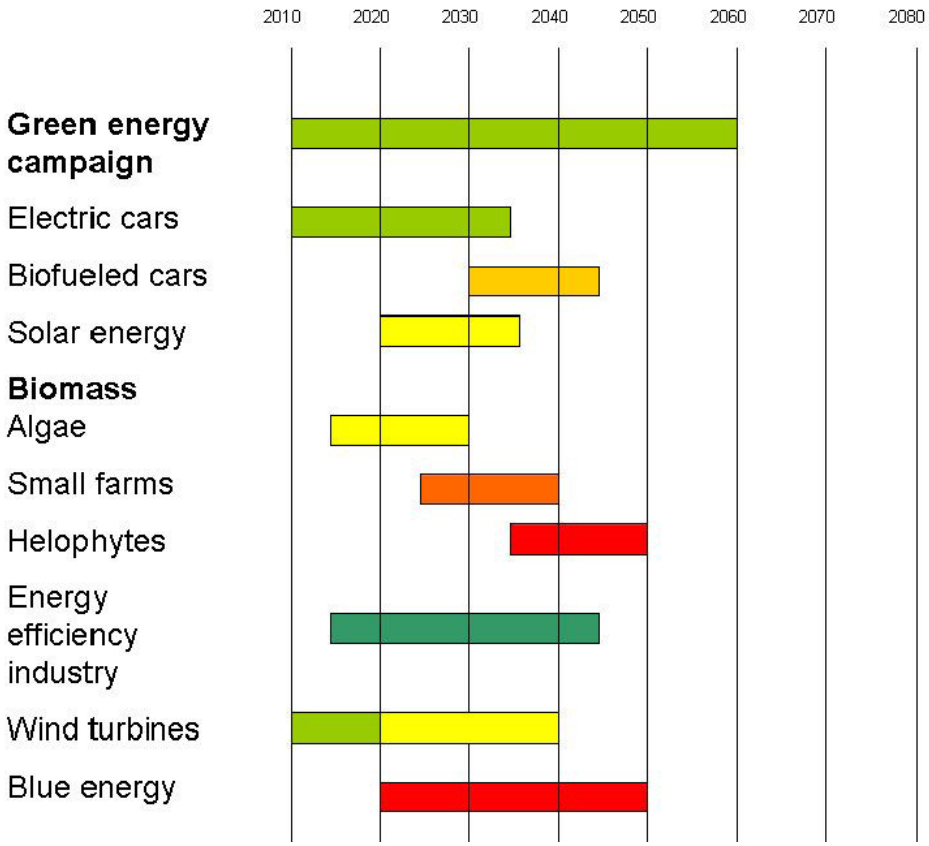


figure 62; phasing sustainable energy projects

This has lead to the new version of the phasing schedule. Above in figure 2. The colour gradients go from green, (easy to accept) to red (difficult to accept). Important is the Green Energy campaign that should start immediately and ends after all the projects have been realized. The campaign serves to link all the projects in the eyes of the public, which makes that the public finds new projects easier to accept when preceded by a successful project.
The different biomass projects do not start immediately. 'Algae production' coincides with 'energy efficiency of industry' because some industrial waste products can be used for the algae production. Bio production on farms are a choice of the farmers themselves. This is easier to accept then forced production of helophyte filters because the land becomes useless for anything else, which is why the latter will start last.
The blue energy production is a major project, that is difficult to accept, but a project in Groningen is a smaller scale then the project at Lake Ijssel. Groningen could serve as a pilot project and may in this way perhaps receive extra funding from the national government.

Conclusion
The goal of this essay was to improve the phasing of the group work for maximum feasibility, by including the conditions for public acceptance. I think the results are a step in the right direction. Be aware though that these results are the advice of one student, without the in depth knowledge of practical issues of individual projects. Use this advice and take it into account, but no advice is sound in every single situation.

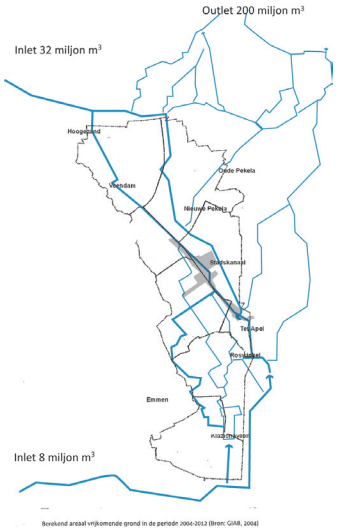
The process should be balanced in the amount of participation. Look at previous similar projects, like the ones in the CREATE ACCEPTANCE project and find your own balance.

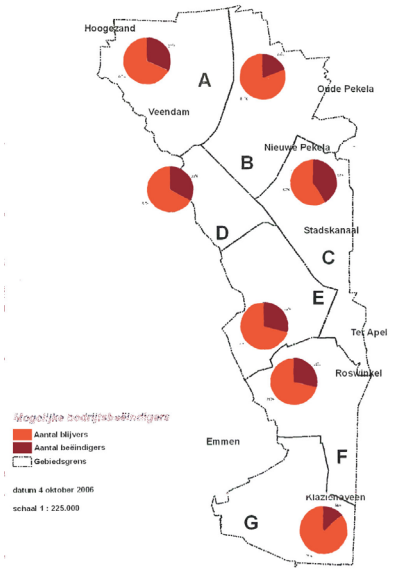
Keep in mind that if one of the projects still fails, this will mean that the association of the people with the entire campaign will be one of failure. The entire positive influence of small projects could all fall away if this happens. A good reputation, like for this campaign, takes a long time to build, but can be swept away easily.

19.3 'The New Peatcolonies - by Inge Kersten (landscape architecture)

The peat colonies are an area in the south of the province of Groningen and the north of the province of Drenthe. In the past phases it became clear that the threat from Climate change for this area does not directly come from the rising sea level, but more from extreme weather conditions.
The current land use, agriculture, requires a large amount of water, especially in summer, when there is less water available, so water is needed from other areas like the Lake IJssel. In the winter the water demand is lower while there is more water available. Which is then transported immediately out to the North sea or the lake IJssel as you can see in figure 61, 40 million cubic metres are transported from the lake IJssel into the peat colonies, while each year also 200 million cubic metres leave the peat colonies. (Source; Hunze en Aa's)
The KNMI predicts that in the future due to climate change, the extremes will be bigger, so more droughts and extreme rainfalls. Once every 10 years an amount of rain of 70 mm a day will fall. Just getting rid of that as quickly as possible and extracting water from somewhere else in the summer is not the answer, a new way of thinking is needed.
In order to create a landscape that is more robust and that can deal with a changing climate, we can learn from the past. Looking back at the history of the peat colonies we can see that the landscape did not always look the way it does now. The peat colonies used to be an enormous peat bog, which contained a large amount of water and could sustain itself. It was an area that was difficult to access, which made it a threat, but is was also a resource of water and fuel. From 1599 it became more easy to extract the peat and use it as a fuel, due to the invention of drying the peat bog itself by making canals and streams in it. This lead to a rapid extraction of the peat and created the landscape that you see these days. So in the begin of the 20th century the peat in the peat colonies was gone and a sandy soil mixed with peat was left. This made a fertile soil, which is useful for agriculture. (Source; http://www.veenkoloniaalmuseum.nl/)
The long straight plots where already developed due to the winning of peat and the canals that where dug for that, the plots where optimalised within the 20th century which results in a monotonous agricultural landscape, that we find there now.

Looking at this landscape in more detail and zooming in at the strip we chose in the second phase we can see that the current landscape is agricultural (main crops are potatoes) and the conditions of the land and water are kept to suit this agriculture. Looking at the area around Stadskanaal even closer it shows that within this agricultural land many differences are present. On the Groningen side of Stadskanaal the size of the farms is smaller and the amount of farms that end their business is the largest, while on the Drenthe side the farms are bigger and a smaller percentage of the farms end their business. (Figure 62 and 63) While doing an further analysis myself I found that the landscape is much more divers that you originally think. (Figure 64)





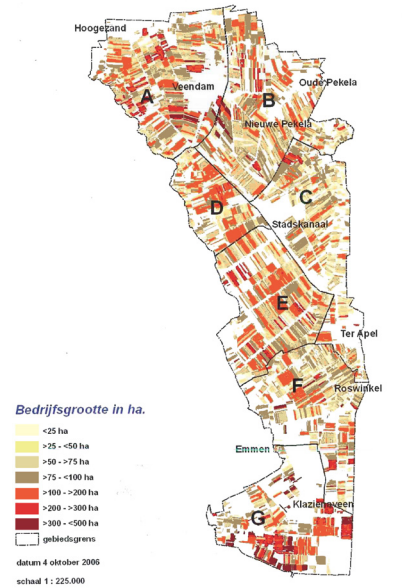


figure 63; top ; The yearly amount of water leaving and entering (from Lake IJssel) the peatcolonies
figure 64; bottom left; The percentage of farmers which end their business in the Peatcolonies
figure 65; bottom right; The size of the farms

These differences are hardly visible in the present landscape, the Mussel Aa is canalised and therefore hardly visible or used for recreation or nature and there are almost no interesting recreational routes or activities. The design challenge is to use the different landscape types in the design and make them visible and use them to create a interesting landscape.

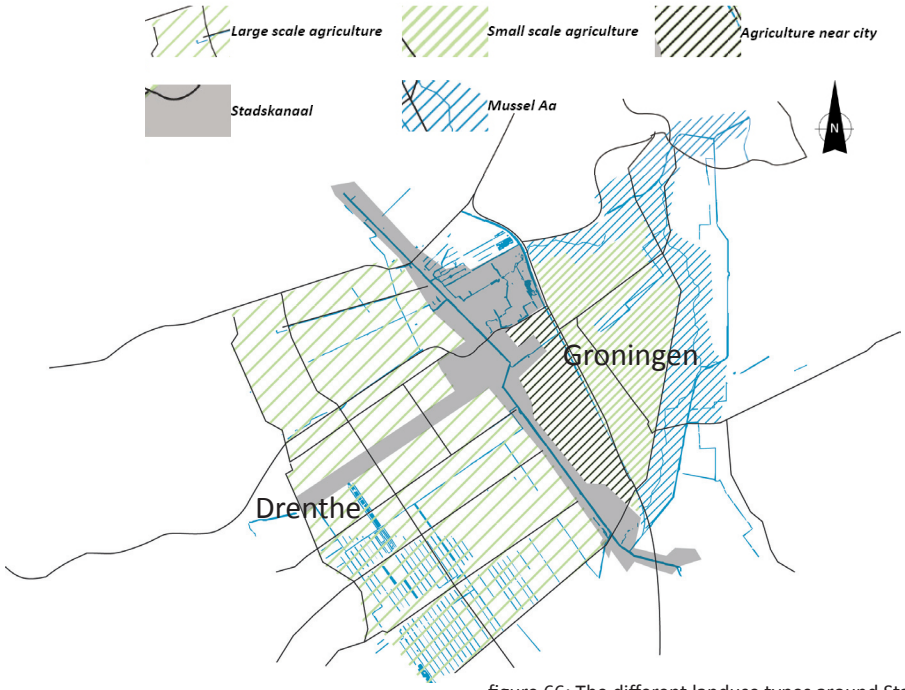


figure 66; The different landuse types around Stadskanaal

Strategy

Farming is the source of income in this area, but more and more farmers are ending their business, which means that every year almost 300 hectare becomes available for new development. In order to get more connection with the landscape and to create a landscape that can maintain itself, like the peat bogs did in the past, the brooks and ditches play an important role.

The water system leads the way for new developments, by creating meanders, natural riverbanks and temporary or permanent flood planes a more robust and divers landscape can be created. This development can

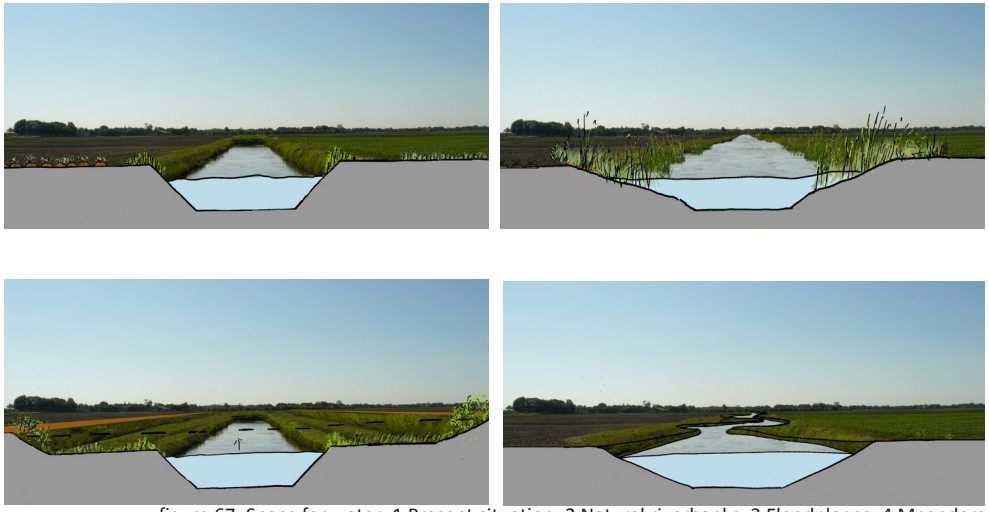


figure 67; Space for water; 1 Present situation; 2 Natural riverbanks; 3 Floodplanes; 4 Meanders

take place on its own but is more efficient if the inhabitants are involved with the development, the farmers that live in the area nowadays have to start a new or different business if this plan is developed, so their support is needed.

This new area around the mussel a creates a nice living environment along the river and makes it more accessible. The way of living that is stimulated in this area is a form of pioneering, people buy a plot on which they can build a house and a part will be for the development of the flood plane this can be a temporary, or permanent flood plane. The different possibilities are shown in figure 66

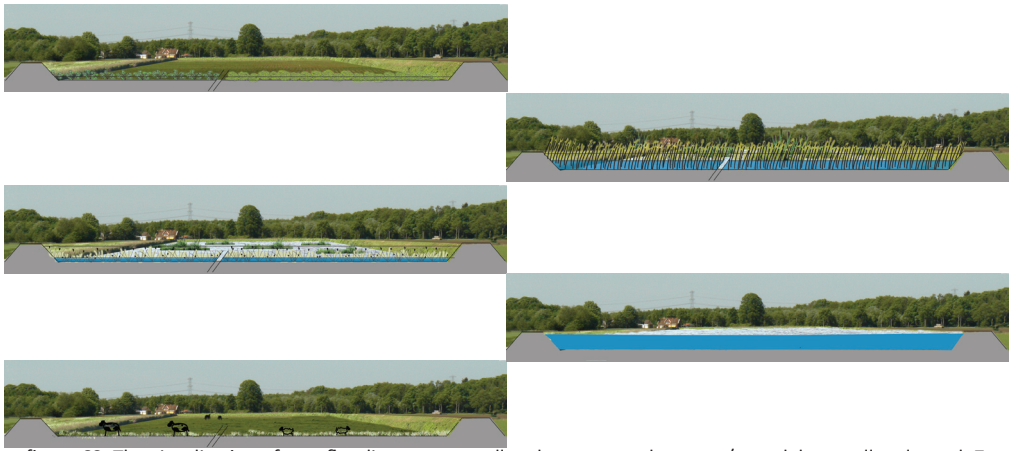


figure 68; The visualisation of new flooding areas: small scale crops, reed, swamp/peat, lake, small scale cattle7

The design

This design gives space to a new development and a new way of living people can create their own space within a given structure. (Inspiration; plan Noordwaarts by Lola landscape architects and Paul Roncken) The design gives a structure in which new water storage, agriculture, living, nature and recreation can find their own space. This will provide a system that can maintain itself and grow along with the future demands, from society or the natural systems, due to new developments or climate change. By using the landscape in this way a closed water cycle will be created and a connection with the landscape is established and in some time the self sustaining peat bog might emerge again and will function as a water buffer for the area.

The city

This system will not only be created along the rivers but is also interesting for the existing villages and cities. At the edge of stadskanaal there are many small scale farms which provide a perfect place for a new development of small scale individual agriculture. People can buy their plot (alone or with a group) and grow their own food, which creates a lower ecological footprint and a greater connection with the landscape. This can grow out in a small community which grow their crops and may sell part of their harvest to the citizens.

figure 69; Impression of the small scale urban agriculture, with individual and group initiatives

The purpose

With this design I want to give a guideline for the future and stimulate a different way of living that uses the resources that the environment gives us instead of taking the current situation for granted. The peat colonies have been an ever changing and dynamic area and it is time to make the next step.

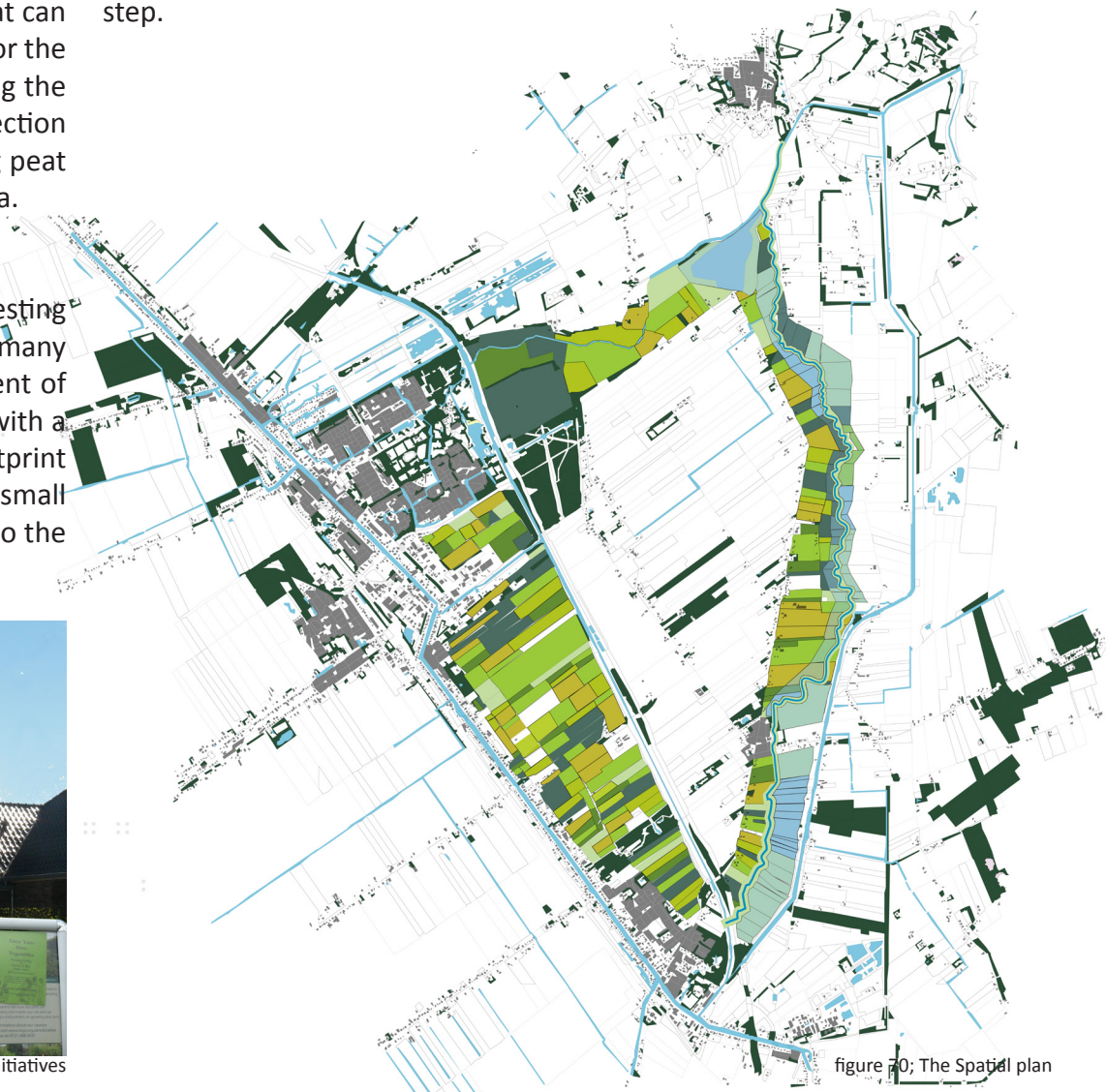


figure 70; The Spatial plan

19.4 Renewable energy production in agriculture - by Maaike Andela (spatial planning)

For the province of Groningen, group STAAL has tried to develop a climate proof, long term, strategic plan (2100) for this province. In the second phase we tried to do this by designing a toolbox, which offers solutions to climate change and to lowering the ecological footprint of the people in Groningen. Groningen can be an example for other provinces and countries. For this individual research part I tried to find a case which can be implemented in Groningen, but also in other areas. In the second phase we had the conclusion that the landscape of the province has its own logic, which expresses identity (Group STAAL, 2009). Studying this logic makes it possible to create a more legible landscape, which people can experience and feel. By looking into more detail almost ¾ of the provincial area is used by the agriculture (CBS, Landbouwtelling, 2008). The current situation in the agriculture is insecure (AgriHolland, 2009). But if we want to keep the identity of the landscape we also have to search for ways to keep the agriculture in this landscape. In this individual part I have tried to combine this problem with the problems according to climate change, especially to the problem of energy shortage and renewable energy production. By combining these two I am trying to find a win-win situation for all parties and searched for ways that our ideas of the second phase could be worked out into more detail.

There are two main problems where I focus on in this individual research. The first problem is a problem on world scale. The total energy use on world scale rises, while the fossil fuel supplies run out.

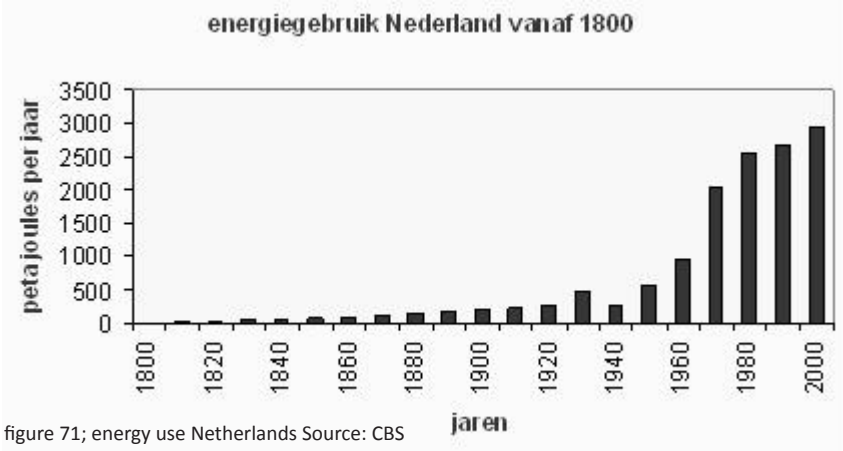


figure 71; energy use Netherlands Source: CBS

Due to the running out of fossil fuel supplies, the rising prices of fossil fuel and the negative influence on the environment (on world scale) of the use of fossil fuel, there is a need for finding more and other sustainable and renewable energy sources. There is already a small trend in this.

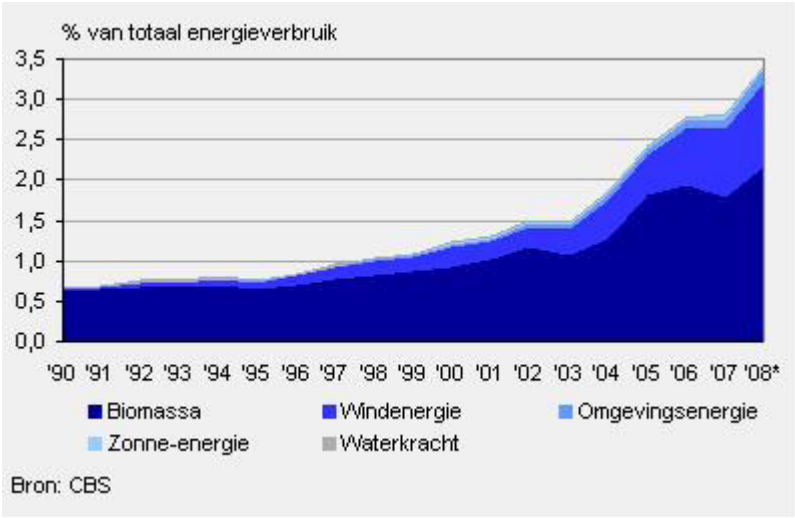


figure 72; percentage of total energy use Source: CBS

More and more renewable energy sources are developed and implemented. Group STAAL wants to stop the use of fossil fuel and wants to start with the use of renewable energy (STAAL, 2009).

The second problem, that this research is about, is the current situation of farmers. The agriculture in the Netherlands has an unsure position. Farmers try to 'keep their pants up' and this makes two general trends visible. These two trends can have big impact on the Groningen landscape, because ¾ of the total area of land is used by agriculture.

The trends are: up scaling and broadening of activities. The process of up scaling is clearly visible in the province of Groningen. The number of farmers is decreasing, while the amount of land for agricultural purposes stays the same (CBS, Landbouwtelling, 2008). This trend is also visible in the rest of the Netherlands.

One of the ways of broadening the activities is by producing renewable energy. By combining these opportunities with the problem of energy shortage a main question rises for the province of Groningen.

Is renewable energy production an attractive business for farmers in Groningen?

To find an answer to this question, I have looked to different subjects. First, what kind of different renewable energy production opportunities are there? Second, what is the political situation and stimulation towards the production of renewable energy? And third, what is the current situation?

Different renewable energy production opportunities for farmers in Groningen. There are a lot of ways in which a farmer can produce renewable energy in this province. The energy production can be for use on the farm, or production for consumers outside the farm. This first type is attractive for a farmer, because of lowering the costs for energy use. It is for example very attractive to find methods for energy production in the horticulture, because this sector uses a lot of energy, which costs a lot of money these days.
Besides producing energy for own use, a farmer can produce more energy than he can use on his farm. He can earn money by selling energy to consumers. I selected the main different ways of energy production that a farmer in the province of Groningen can think of.

Combustion Combustion (verbranding) can deliver heat or electricity. A CHP installation (combined heat and power installation) can produce heat and electricity. Electricity can be delivered to the electricity network. Waste products (for example wood and rests of plants) but also specially cultivated energy crops can be burned. With this energy you can heat for example city warming, water or milk tank, or greenhouse warming. The more efficient the system is designed and built, the more energy is produced. The systems are still getting more optimized.
Fermentation The principle of fermentation (vergisting) is producing energy by letting waste products rot. In rotting processes gasses (most important methane gas) develop and these gasses can be used. It can be added to the 'normal' gas network. Also the gas can put into the CHP and than produce heat and electricity. Rest products of fruit, vegetables, straw, dung and sludge can be used. Installations are mostly in test stadiums on farms. In the Netherlands it is compulsory to do 'co-fermentation'. This means that there has to be always a percentage of dung in the fermentation installation. You need a certain amount of rest products and dung, not transported over long distances, to make this installation profitable. Installation capacity is bigger. The 'digestaat' (rest product) can be used as artificial fertilizer.
Environmental heat This is the use of heat from soil, air and groundwater. The energy can be used for heating in winter and for cooling in summer. This is done by heat pumps and aquifers. In the Netherlands you can get the so called 'Energiepremie' (energy premium) for this. These systems are difficult to use for production of energy for consumers.
Wind energy Wind energy is the fastest growing energy source of the world. You have small scale and big scale wind energy production. Small scale windmills produce energy that can be used on the farm directly. Big scale windmills produce a lot of energy, this can be sold to an energy company and to consumers. Farmers are not allowed to use this energy on there farm. Problem of wind energy is the fluctuating amount of wind. The province of Groningen is attractive because there is a lot of wind. Enough to make a windmill profitable. Windmills are getting bigger and bigger, a general 1.5 Mw windmill can produce energy for 1000 households. A lot of municipalities don't give permission any more for a solitarily windmill, but only for clusters. According to calculations of the WWEA (World Wind Energy Association) it is possible that in 2020 at least 12 % of the total energy use can be produced by windmills (WWEA, 2009).
Solar energy For production of energy by the use of solar energy you can think of the use of solar panels, solar cells, thermal solar energy and energy roofs. Until now, the energy production by sun is only for use on the farm and not for consumers. In the 'Veenkolonien' a test is done with solar panels on the roofs of stables, but it turned out that the investments are to big to make it profitable.

Production of energy crops in the Netherlands

For the production of energy by combustion or fermentation, crops are used. The Dutch government makes a distinction between first, second and third generation bio fuel crops. First generation crops are for example maize and sugar beets. These are energy crops that compete with food crops and therefore are not profitable in the Netherlands to cultivate. Second generation crops as wood, fibres, and woody plants and third generation crops as algae's are better for use in the Netherlands but they are getting more profitable very fast. They are under construction and getting better and with higher energy amounts. In this way it can be more profitable to produce energy crops outside of the Netherlands because of the big competition with other land use activities and also with food crops.

Policy

The government made a lot of rules and goals about renewable energy. The most relevant are described in this paragraph. It started with in 1998, in Kyoto. Here the EU promised that the emission of CO2 would lower with 8 % compared to the number in 1990 and the search for sustainable energy sources should be bigger. In 2001 the European parliament accepted guidelines to double the share of sustainable energy sources in the energy production and consumption for the year 2010 (AgriHolland, 2009).

Also the different member states should take their measures. In the Netherlands the newest targets in the climate policy are: 2% energy saving each year, 20% use of sustainable energy sources in the year 2020 and 30 % lesser emission of greenhouse gasses in 2020 (related to the number 1990) (Ministry of economics, 2009). The Dutch government should also invest in research and (test) projects. The CLM (Centrum voor Landbouw en Milieu, Centre for Agriculture and Environment) in order of the ZLTO (Zuidelijke Land- en Tuinbouworganisatie, Southerly Agri- and Horticultural union) did research about the realization of the government goals by the agriculture. The found out that especially the last two goals can be realized by the agriculture. The 2 % energy saving is not as easy to implement, due to the normal and rising development of energy use.

The base to the research is that the number of cattle (pigs, chicken and cows) will stay the same. The yearly production of milk will rise with 10%. It is in the calculations that producers of energy crops get an energy subsidy. Besides this the government has also the objective to remove administrative bottlenecks which block investments in renewable energy.

Subsidy

In 2006 the MEP subsidy was stopped. In 2008 a new subsidy regulation is made, the SDE regulation (Stimuleringsregeling Duurzame Energieproductie, Stimulationregulation Renewable Energy production). With this the ministry of economics supports to produce energy with almost no weight on the environment. This subsidy is for people who want to invest in renewable energy, gas and cogeneration (combined heat and power). In the period 2007-2011 there is 326 million euro for the SDE. The SDE is the succession of the MEP, which stopped on August 18th 2006. SenterNovem is executer of this regulation.

There are also regulations which have tax advantages. For example the VAMIL (Vrije Afschrijving Milieu-Investeringen), MIA (Milieu-investeringsaftrek) and EIA (Energie-investeringsaftrek). These also can give Financial benefits for companies. In 2005 farmers produced 4.4 PJ of energy by windmills and fermentation. (Agriholland, 2009). Compared to other EU countries the Dutch farmers don't invest a lot in installations for the production of renewable energy. The exact reason for this is difficult to say now but, the regulations and stimulations play an important role in this. In the Netherlands it is not so urgent because we have our own gas supply. In literature about subsidy for farmers is often mentioned that Dutch farmers don't trust the government any more because in 2006 the MEP subsidy suddenly stopped. Farmers who had investments in renewable energy came in big financial problems than.

Conclusion

From the previous story can be concluded that there are a lot of opportunities for the agriculture to produce renewable energy. Also the market and the need (due to the upcoming shortage and rising prices of fossil fuel) for

renewable energy is growing. Besides this the government has money for financing projects for the production of renewable energy.
After seeing all this information, it seems there are big opportunities for the agriculture to produce renewable energy. In practice you can't see so much of this and farmers don't want to take big steps in this direction. By going back to the main question: "Is renewable energy production an attractive business for farmers in Groningen?" we can say that the opportunities are there, but the implementation is not so far. There are different reasons for this and these make that my conclusion on the main question is that it is, for a standard size farm, not attractive to invest in renewable energy production at the moment.

The first reason is that the government has a fluctuating policy in financing and providing of subsidy. There are a lot of farmers that don't trust the government any more. In 2006 the MEP subsidy suddenly stopped and therefore farmers who were infesting in renewable energy production methods came in financial problems. Besides this the government has made large goals, as described before, but until now don't take concrete measures to realize these goals. The second reason is that the technology is not far enough to make renewable energy production profitable at this time. The research for efficient second and third generation crops is going fast and improving.

Renewable energy production can however be profitable in some ways.
The first change is by making so called 'Agroclusters'. These are groups of farms, like an agrarian industrial area. Scale advantages will occur and make it for example attractive to build a biomass installation. For producing bio fuel it is also important to keep short distances in the transport of bio fuels and the primary products.

Also it can be a changed to compare the agricultural activities on a farm with other land use functions. For example production of heat in a bio-fermentation installation for the supply of electricity and heat in a residential area.

A good example of this is the far Nij Bosma Zathe, near Leeuwarden, where 110-120 cows produce energy for 800 houses in the new residential area of the city (Mik, 2003). Combination with other land use activities is attractive, because of the big pressure on the land of other land use functions. The land in the Netherlands is intensively used and there are a lot of claims on the land in the next decennia (housing, infrastructure, recreation, nature and safety area for the river streams). Also it is an opportunity to take part in a project, for example 'Energy Valley'. You can get subsidy but you also take a risk. These are mostly pilot projects. The developments in making energy crops are going fast. Mostly the second and third generation crops come in the picture. When driving on bio fuel becomes more important also the production of energy crops will be more profitable (LTO, 2009). In realizing the goals of the government on world, European, Dutch and Groningen scale the agriculture can play an important role but not without support of the government. This has to be support in knowledge and money. The Groninger agriculture can take a leading role in the production of renewable energy and be an example for the rest of the Netherlands. Besides this the agriculture can stop the negative image of producer of a lot of harmful gasses and waste products. A clear more year policy is needed for this, to give investors enough safety (Annevelink, E. et al, 2006).

Continuation
For this individual part of the research we had about three weeks. There was a lot of information available but also a lot of nonsense written about renewable energy production by farmers. It was hard to find the usable information in this research. But during the process I found out that it is also a very interesting subject with a lot of uncertainties, so a lot of research is still needed after this. I have made some questions to go on with, for example in an MSc thesis.
- How can agro clusters be realized in the landscape?
- What are the possibilities for combinations with other land use functions?
- How can the government realize the implementation of their goals?
- What is the difference in the policy of European countries, which leads to differences in investments in renewable energy production?

19.5 Safety living for people and animals around the river Ruiten AA - by Jana Demuthova (landscape architecture)

Introduction

The area for detailed plan is situated in south-east part of province Groningen, near to German border. It is specified with 13 km long (straight) river Ruiten Aa and its surrounding (formally ´brook valley landscape´); it extends from Vlagtwedde (in the north) to small village Ter Wisch (in the south). The whole chosen area has approximately 7.730 ha.

The main problem within this area is overabundance during heavy rainfalls (in spring, autumn and winter) or a shortage of water (in summer). The second problem is rising temperature and with this is connected shifting of the climate zones, thus the ecosystems are changing too. The solutions for these problems can be in the water storage and in creating of the ecological main structure for fauna and flora. The detailed plan is divided into several characteristics of the solved area.

Agricultural landscape

The agriculture covers the most area. It is typical with arable fields (´essen´) with high potential of nutrients and moisture, which were created by farmers many years. In the past, it was dry and poor area but the human made land fertile with dark soils. The mixture of topmost from peat areas and the excretions of the cattle and sheep, which were pasture on it whole night, were added in this area; this made it fertile. The arable lands are now very valued because these layers can fix needed amount of water for growing the crops.

In my plan I do not create new agricultural fields but I illustrate where are the best areas where can be develop further because I need the real arguments for farmers why I use their fields for other purposes. As a based material I took the historical map and map of soils of province Groningen. As I mentioned before, on the historical map it can be found these fertile arable fields. On these areas are very good ´dikke´ soils (specific for ´essen´) and quite good ´humuspodzol´ soils. These fields are near to stream of the Ruiten Aa, so they can be easy supply with the water. Thus, they are good opportunity for farming. Other suitable area for developing of agriculture is on the west from the wood Westerwolde, where are peat soils. Here can be implement the system of agriculture from the detailed plan around the Stadskanaal (self-sufficient farms).

Water system

This area is characterized with main river Ruiten Aa and the system of canals where the water flows from the river. In the past, the river has natural meandering stream but later it was change by man for purpose of agriculture and now it is more narrowed.

The opportunity for solving of the problem with water storage is to make in lower parts of brook valley the river more meandering, create new small ponds and floodplains on the places where it is possible. The floodplains can be flooded during the periods of heavy rains. Thus, they can create small temporary areas for water storage. This will give to the river Ruiten Aa an old view and also it can helps to farmers with problems with water. It is also possible to build the streams on the places where are the soils which appears only near to the river. First locality is on the west side of the river near the village Jipsinghuizen and second on the east side of the river near

figure 73 ; current landscape near the river Ruiten Aa

figure 74; current housing and agricultural fields near the river Ruiten Aa

the big village Sellingen. The developing of the new water system should be started immediately, that means not later than in 2015 because the water is wild element and this process will take a lot of time.

Forests and meadows (ecological corridor)

The whole natural areas cover the 1.900 ha of the area (ruitenaa.nl). The most important is natural wood area Westerwolde, situated in the highest parts on the sandy grounds.

In my plan I commend to create the ecological corridor on the west side of the river Ruiten Aa, that means enlargement of Westerwolde to the north and the south. On this side of the river are some smaller areas of forests which can help to create an ecological main structure. The new forests will be plant on areas where the country does not loose the character (e.g. the people can see the openness as it was; on the places next to existing forests). In the south, where the river Ruiten Aa crosses the main road, it is needed to build the underpass under the road in the width 7 – 25 m (repositories. cdlib.org). With creating new forests and meadows I ensure for animals and plants space for living and surviving, but it can be also an attractive place for recreation for people.

At the beginning of creating the ecological main structure the forests will be plant like the ´stepping stones´ which will be later connected with the meadows. It is better to make a phasing in this case, that means not to take whole agricultural fields for the corridor, but at first plant the trees and than the meadows. The minimum wide should be 300 – 500 m because the biggest animal, which appears here, is the roe (repositories.cdlib.org).

Housing and paths

The brook valley landscape has the rural character. There are some bigger villages and many houses are built along the roads or they are straggly in the landscape (as farms). Some houses are near to river stream and there is risk of flooding. In this plan I want to recommend where are the best places, where to build the houses in the future. Thus, I take into account the altitude of the land (the higher parts; from 7 to 9 m above); in these localities are good possibilities for developing the habitation. There can be developed houses along the roads or as groups in the agriculture fields (peat colonies) or in the forests. Existing network of paths is quite dense, especially the small roads and paths for bikes, but they are not very used. The most used are the main roads and one of them is going along the river Ruiten Aa. For conservation of natural character of the area, the new paths can be built only in new forests and meadows for developing of tourism; that means the paths for bikes. Choosing this area and making a detailed plan I wanted to show that it is possible to change current use of the different landscapes and to adapt them to climate change (possibility for developing new areas for water storage and enlarging of the forests).

figure 75; illustration of floodplains on the river Ruiten Aa

figure 76; illustration of re-meandered river Ruiten Aa

As a group STAAL we formulated five ambitions and I would like to reflect on them.

Ecological design: The re-meandering of the river and process of the flooding (floodplains) are issues which can bring the natural view of the place. By creating the ecological main structure, the animals and plants can move more free and increase their numbers.

Democratic design: I was not successful to reach the democratic design because there was not enough time to talk with people, especially with farmers. Thus now, it is very important to make more interviews and more detailed analysis of the area (visit all the recommended areas). Sustainable design: According to the solving of the problem with the climate change I created the areas where can be stored water for some period of the time (floodplains, small ponds and meanders of the river) and I show possibility for building the self-sufficient farms which can help with the problem of the high ecological footprint.

Design for safety: In the future, it can appear the danger from flooding. For prevention, it can be used the floodplains, for instance, there will be a big amount of water in the stream; and I recommended build the houses on the highest points. For safety for fauna and flora I created the ecological corridor.

Narrative design: It was taken into account the historical value of the land (´essen´) and the soils for marking the best fields for agriculture and also giving the old meanders to the river.

figure 77; illustration of creating of the ecological main structure near the river Ruiten Aa

Figure 78; Map of the detailed plan; brook valley landscape of the river Ruiten Aa

19.6 Realizing parks against urban heat in Groningen - by Peter Davids (spatial planning)

Introduction

During eight weeks, Group Staal produced a climate proof vision for the future of the province of Groningen. One of the results is a tool to use urban green and parks to control the microclimate and urban heat (see figure 27) and cool cities like Groningen. Alterra (2008) explained in a figure that several smaller parks were more effective than one bigger park. So in general, cities probably need more small parks. (see figure: 28). But in the Alterra report clear data about size and effectiveness over distance were missing. In this small research I want to take a look at this in more detail and find out how urban green can control the urban climate in the city of Groningen.

A quick scan of the useful literature shows us, microclimate is a complex phenomena. The influence of green in an urban area is complex as well. In general, green spaces can influence the urban weather. All kind of parameters have a role in this process: the wind, different types of vegetation, the density of the city, size of green areas, the quantity of parks in an urban area etc. I would like to focus on the last two themes.

Urban climate and urban heat

To find out how a green structure could function to beat urban heat islands in Groningen, we first need to now more about the urban climate. Taha (1997) describes the urban climate as "the change in atmospheric characteristics caused by the influence of the city and the activity of its inhabitant" (H. Taha, 1997). Different weather conditions, urban thermo physical and geometrical characteristics, moisture and heat sources in a city are important causes of fluxing in temperature.

Changing's in the urban climate can lead to significantly warmer areas compared to its surroundings. This is called the urban heat island effect. The enhancing of the urban heat island effect is mainly the result of changing's in the radiation balance. All the dark pavement and asphalting in the cities results in extra heat absorption. More absorption results in a decreasing albedo.

The role of vegetation

Besides the heating by a small albedo ratio and the antropogenic heating, the city becomes cooler by the effect of green spaces. This effect of vegetation to its surroundings is diverse and complex. Vegetation can filter certain pollutants, affects wind, temperature, moisture and precipitation regime of urban areas, but can also enhance the urban heat effect by reducing the wind speed in a city. The effect of vegetation on temperature and humidity are closely related.

Cooling by parks or other forms of urban green affects 1) the park itself, 2) the surrounding of buildings and also indoor, and 3) the environment around the park. But how?

The effects of plants around buildings are diverse. Givoni (1990) describes:

- Shading: "Trees with high canopy and pergolas near walls and windows provide shade and reduce the solar heat gain with relatively small blockage of the wind"
- Insulation combined with shading: "Vines climbing over walls and high shrubs next to the walls, while providing shade, also reduce appreciably the wind speed next to the walls".
- Ground cover by plants around a building reduces the reflected solar radiation

Besides this, there is the effect of cooling in whole neighbourhoods. Mainly, the effects of evapotranspiration from the soil and transpiration from the leaves are important for the cooling effect on this scale level. Urban area have, compared to rural areas, more runoff. This runoff water drains relatively quick away into the sewerage. Less water comes in contact with the surface for evapotranspiration. A lower evapotranspiration rate is an important factor in increasing temperature in urban areas. Trees increase the evapotranspiration rate. The wind carries the cool air from the park.

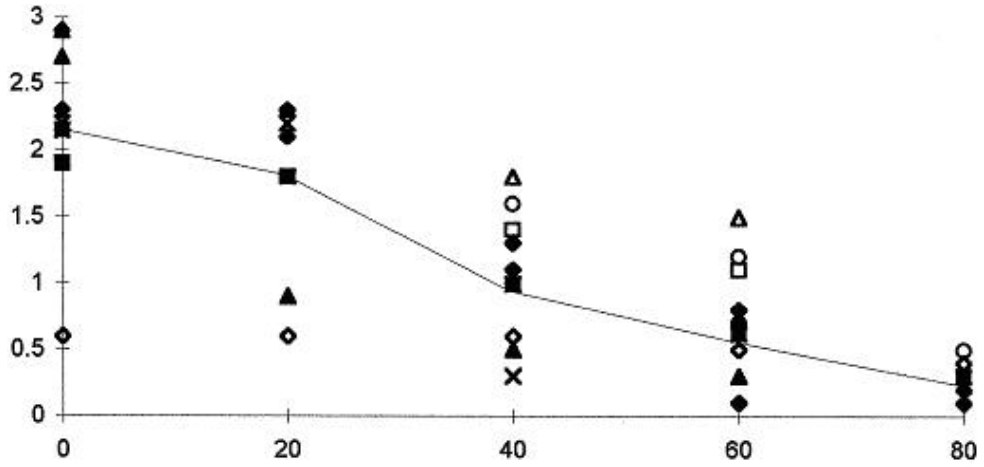


figure 79; correlation cooling effect/distance

This figure shows the correlation between distance in m(X-axe) and cooling effect in °C (Y-axe) in the research of Shashua-Bar and Hoffman in Tel Aviv. Until 1°C the results are significant.

Shashua-Bar and Hoffman studied small green sites in Tel Aviv having only a width of 20 up to 60 m. “On the average, the cooling effect is 2.15 °C at the boundary and drops to less than 0.5 °C at a distance of 80m.” (Shashua-Bar & Hoffman, 2000) This is the base for our research in Groningen.

Groningen

The green dots in the map below show an overview of the current parks in Groningen. According to Shashua-Bar and Hoffman the effect until 40-50 m is significant. This is the base of the map. A circle is drawn around the centre of the park with a radius of 50m. Each circle shows per park how far the cooling effect of 1 °C can reach. Not the whole city is covered by green circles. But, besides all parks in the analysed area, most of the streets have some single trees or rows of trees. But still there are places where trees are missing, and the park cooling effect does not reach the area in case.

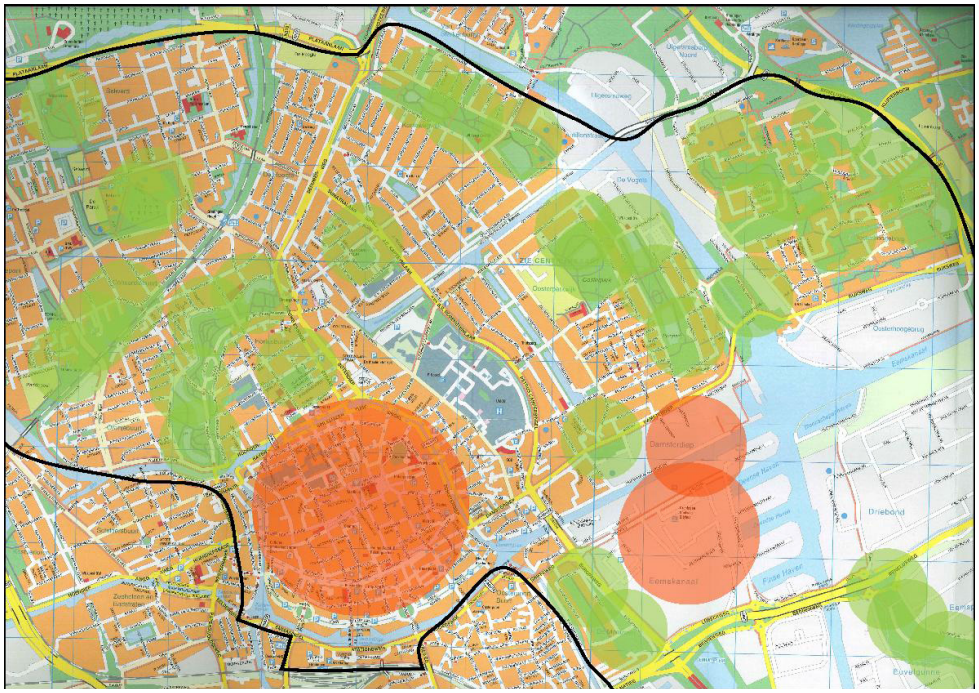


figure 80; parks in Groningen

If we follow the results of Shashua-Bar and Hoffman, we can assume these areas are not cooled enough by urban green. In these ‘red spots’ (see map) locations should be chosen for new urban green. In the inner city, greening the roofs and walls of the buildings in the narrow streets could be an opportunity. This results in more sun refection in the streets, and more shading and insulation of the buildings. At the huge building domains of the shopping malls the big area of parking lots give the opportunity to green the areas.

Conclusion & discussion

Micro climate is complex. The city climate gets influenced by an endless list of parameters. We mentioned different weather conditions, urban thermo physical and geometrical characteristics, moisture and heat sources in a city are important causes of fluxing in temperature and so on. The urban heat effect is the most obvious result of compared to the rural landscape. Urban green has in general a positive effect on urban heat in the city: it can reduce temperature up to 4^{o}C. In the opposite of that, the temperature can raise by urban vegetation: trees can block the cooling effect of wind. Furthermore we need to mention the close relation between the cooling effect of vegetation and humidity. In general, the extra humidity, caused by the evapotranspiration of trees result in the cooling effect of the city. We can discuss whether the extra humidity has a good influence or not: although the temperature lowers, the windchill factor (how the temperature is experienced) can raise. Most people appreciate a relatively high temperature in combination with a dry air, but do not like a low temperature with high humidity. Givoni (1990) is the only one making a distinction in the use of urban vegetation in dry hot areas and dry humid areas. For the Netherlands, a humid and hot area, he describes: " Because of the high humidity characterizing these places, some wind speed in the park area is very important for comfort. In planning the planting in public parks, as well as in designing the landscape around private homes, minimizing wind blockage should be therefore one of the major considerations. The climatic objectives in planning urban open 'green' areas in hot, humid regions (parks, playing grounds, etc.), should be to provide shade for the users of these areas; to minimize blockage of the wind within the open spaces; to improve the ventilation conditions in the builtup areas around the open spaces; and to minimize floods in the more sensitive urban areas". This is partly in contrast to our earlier results. So, more research to vegetation and urban heat in relation to the humidity should be done.

Planning and designing to beat urban heat is even more complex. Shashua-Bar and Hoffman give in the cited literature some clear numerical values: parks of 20 to 60m width can have a significant cooling effect of 1-2^{o}C in the first 50m from the park border. They also emphasise the small correlation between dimension of a park, the cooling effect and the distance the effect can reach. In the city of Groningen we can see the this cooling effect is already reached in big parts of the city. To find this out, we did not take the cooling effect of water into account. When we should take this also into account, the cooling effect would probably reach even further. Groningen is already a green city, especially compared to the city where research by Shashua-Bar and Hoffman, Givoni, Taha and the other is done.

Now we can ask ourselves if the willing to control the urban heat should be the main reason to organise a new structure of urban green in a city. I think not. But urban vegetation does not only affects the urban microclimate. In addition to that, urban vegetation can also affect air pollution, reduce noise, is good for health, has a positive effect on social activities and of course it has an aesthetic value. Beating the urban heat islands should be a new in the list of arguments to create more space for urban green.

19.7 Salt agriculture - by Sjoerd Haitsma (spatial planning)

Introduction and problem statement
In our plan to adapt Groningen to climate change, we have offered a toolbox with several solutions to problems in Groningen. One of the options in this toolbox was the option for salt agriculture. Agriculture is an important activity in Groningen, especially in the northern part, where 80% of the land is agricultural land. Therefore, this paper wants to take a closer look at the adaptation of agriculture in Groningen to climate change, especially in the perspective of salt agriculture.

Groningen is a province that is bordered by the sea and is influenced by the salt sea water. Especially in the northern part, the soil is getting saltier due to salt seepage. This salinisation of the soil is not an issue that plays a role in Groningen only, but something that happens worldwide. According to Szabolics (1989) 954,8 million hectares of the earths land surface are influenced by salt; at a lot of places, surface water and ground water get saltier all the time and salt deserts evolve.
This salinisation is accelerated by the consequences of climate change: some areas will get flooded with salt water, salt seepage will increase because of increasing pressure of salt water and at last, the decreasing precipitation in summer means that there is less rain that can flow away the salt in the soil. If nothing is done about this salinisation, the consequence for the province of Groningen is that within the coming 10-20 year an area of 20,000 hectares will be that salt that hardly any agriculture can take place there anymore (Aendekerk, 2007).

Right now, people do a lot to fight salinisation, so that soils can still remain usable for agriculture or other functions. This happens most of the times by using sweet water to wash of the salt. However, sweet water is scarce and water shortage is expected all around the world (Schaik, 2007-I).
Contesting salinisation by using sweet water is thus not a sustainable way to fight salinisation and besides this, it is quite expensive. Therefore it is interesting to consider a new way of thinking, which tries to use the salt areas in stead of fighting them with sweet water or just let them be derelict pieces of land. This offers a great opportunity.

If we find a way to use the salt areas in a positive way, we can use a lot of extra land that was not used for agriculture until now, and we can keep using land that will otherwise become useless for agriculture. Therefore, the goal of this paper is to explore the opportunities to adapt agriculture to salinisation, mostly by looking at the possibilities considering crops that are able to deal with salt conditions. It also wants to look at how this shift in agriculture can be implemented spatially.

Agriculture in Groningen - possibilities
The strength of agriculture in the Netherlands lies not in mass production, but in the improved knowledge on the cultivation and improvement of different crops. Farmers and research centres try to create the best crops and these crops are then exported to other countries, where they can be grown on large scale. In this way, many countries are dependant on the Netherlands for their high quality seedlings (U.Hiddema, board member of LTO-Noord, personal announcement, 1st of May 2009).
As described above, a lot of agricultural land will no longer be suitable for normal agriculture and this part of the current market will thus disappear. If one wants to try to keep using these lands for agriculture, this asks for a new market, where products or seedlings that could be produced on salt grounds have to be offered. The need to use as much agricultural land as possible and to diminish the loose of it as much as possible is underlined by the OECD (2003), saying that the demand for food will increase in the future.
There are several crops that can be used to grow on salt ground and these crops are extensively discussed in the individual essay. The most interesting salt tolerant crops are: Beet, cabbage, celery, spelt, barley, asparagus, glasswort and aster. The first are crops that could be grown on large scale, the last two are crops that can be sold as regional speciality.

Market for salt crops
In the Netherlands, an amount of 75,000 to 120,000 kg of sea vegetables is yearly sold. This is however very dependent from the seasons and heavily influenced by foreign markets, especially because of the harvesting from the wild growing plants. (Schaik, 2007-I). If we can produce more salt crops in

the Netherlands, less has to be imported from other countries and costs will decrease (Oosten & Wilt, 2000).
The market for some crops already exists, because they look like crops that are currently grown. However, before new crops can be grown and sold, they first have to be approved by the Commission for New Food (Commissie Nieuwe Voedingsmiddelen). But if they approve them, these crops can be sold easily.
The salt tolerant crops that do not look like currently used crops can cover a complete niche market. In comparison to normal vegetables, salt vegetables have a relatively high market value, mostly because of the exclusivity. However, high prices are needed to compensate for the high production costs. Harvesting can be improved by developing special machines and by genetically improving the plants. However, first the market has to be expanded, because otherwise prices will increase as consequence of the overproduction of the current market.

Implementation - process
Farmers first have to be shown that salt agriculture is very promising, which can happen by using LTO [Agricultural Organisation (LTO, 2009)] and Agrarisch Dagblad [Agricultural Newspaper (AGD, 2009)], for example. However, knowing about it and really implementing it are two very different things. To take the step from knowing to doing, some other organisations can be helpful, like HZPC (2009) and SPNA (2009). Subsidies can also help in the implementation. Farmers do not benefit directly by using less sweet water, because costs for sweet water are divided on the whole area of the water board, and therefore it is not directly profitable for them to switch to salt tolerant crops. If farmers then decrease the use of sweet water, they should also share in the benefits of this, which can happen by subsidising salt agriculture and thus individual farmers.

Implementation - spatially
Right now all the available land for agriculture is used for the 'normal' crops. Farmers can easily take a small part of their land and plant salt tolerant vegetation there, just to look how it works. For this, areas that are situated at high distance of the sweet water inlet and as a consequence of that still have high salt concentration of the soil, are very suitable. On these areas, production of normal crops will be less due to salt, and salt tolerant crops can be a good solution.
A lot of salt tolerant crops do not have to be grown on salt soils, but can also grown on normal soil. However, there are also some crops that grow better on salt soils and do not grow that well on 'normal' soils. To experiment with these crops, the salt marshes behind the sea dike are very intersting. Right now these salt marshes are not very large and they are not yet used for agricultural purposes. In Fryslân however are some areas where the area behind the dike is quite large and there these areas are used to graze cattle (Schaik, 2007-II).
Our plans for coastal defence in Groningen aim at an enlargement of the salt marshes, so in future, they will look like these in Fryslân. These salt marshes would be the ideal area to experiment with salt crops, if we leave the current laws considering the Wadden area (e.g. the Birds and habitat directive and the Law on flora and fauna) out of account. If some salt crops, that could possibly occur there naturally, are grown there, the land is used in a way that is more useful for agrarians than it is now, and in a way that corresponds for a large part with the natural situation. Crops that can be used in such a system and already grow there by themselves are Glasswort and Sea aster (Schaik, 2007-I).

When farmers are convinced about the chances of some salt crops and they want to grow them on larger scale, larger pieces of land could be used for these crops and drainage can also be adapted to this, because these pieces of land do not have to be drained by sweet water. It is possible to have a field of salt vegetation next to, for example, a field of potatoes. If they are separated by a ditch and drainage is well, the salt water will not have any influence on the normal crops (Diepen et al., 2008).

Discussion and conclusion

Before the mentioned crops are ready to be taken into production, further development should take place, to improve salt tolerance and production rate. This has to happen at research centres, like Wageningen UR and test farms, but farmers can also play a role in this themselves.

What is remarkable about the list of crops is that the potato is not mentioned at all, while this is probably the most interesting crop for the farmers in the northern part of Groningen, because this is the crop that is nowadays grown mostly in Groningen. It would be wise if research would take place on how to adapt potatoes to that. Some, already existing, wild species of potatoes that are already salt tolerant can give a handle for further research and improvement.

It is important to have a broad range of crops that could be grown on salt grounds before stopping to fight the salinisation of the soil and switch to salt crops. When one crop then turns out to be not very profitable during a certain period, the farmer can no longer switch to another, 'normal' crop, and has to have other salt tolerant crops as back-up.

In the Netherlands, spatial planning has divided most of the land on its function: a certain area for nature, another area for agriculture and an area for housing. When these functions are mixed up as mentioned above, problems can emerge, especially according to certain rules and laws that are applied to a special function. To solve these problems, one should think about redefining the functions (and related to this: rules and laws) for the area of the salt marshes, and perhaps the opportunities mentioned in this paper can help in this process!

Looking back to the results, it can be concluded that there are a lot of opportunities for salt crops. The crops that have the most potential to be used in the northern part of Groningen are beet, cabbage, barley and spelt. These are all crops that can be grown on large scale and thus fit in the system of current system agriculture in northern Groningen. Furthermore, they can replace current species and therefore the market for these crops already exists. Because they look like current crops, they can also be harvested in the same way, which means that the machines used for harvesting current crops can also be used for these new crops. Some crops, like barley, can be harvested in different seasons and are therefore interesting, because labour intensity in the busy months can be decreased in this way.
Crops as Glasswort and Aster are also interesting, but these crops are not suitable for production on large scale and should thus be produced as regional specialty.

Groningen offers interesting ways to implement these salt crops spatially. First, farmers have to get to know these crops and its success and then they have to be triggered to experiment with them. Current agricultural organisations and newspapers can play an important role in this process. Once the farmers are ready to implement the salt crops, this can happen very gradually. They can first grow them on very small scale, as a test. When this works, these crops can be grown on larger scale.

This paper has shown that it surely is possible to adapt agriculture to climate change. Salt agriculture can decrease the unsustainable waste of sweet water and offers a way to make advantageous use of land that would otherwise be useless for food production. This is very promising in a world where the demand for food is still increasing.

19.8 Healty industries - by Joppe Veul (landscape architecture)

The following three pages are a summary of the work done in the individual part of the masters atelier 2009, by Joppe Veul. An attempt has been made to illustrate this work as good as possible, it is not a replacement of the posters, but should be concidered as an insight in the basic ideas. Enjoy the reading of it.

Location

The location for this design is put in a red box. This industrial site was planned for greenhouses, algae growth and this all in a closed system. So waste becomes energy again. I was so inspired by these idea's, so I researched it further.

Motivations

Industries have great potentials for reducing the ecological footprint, because of the great amounts of energy and materials going out. So making advantage of the industrial waste streams seems to be a possible and plausible solution. Another reason for making a design for a industrial site, is because more industrial activities are easily implemented, the industrial landscape allows this, one other challenge is to make a landscape that has an aesthetic value as well. The industrial site at Delfzijl is particularly interesting, because; 1) The drainage canals pass this area, so water retention is possible here. 2) Heavy industries are located here, so many waste streams can be used. 3) Enough space is available for new developments. 4) All the required infrastructure is already on site. 5) Delfzijl has many inhabitants, which produce a lot of waste, which can be used. Besides this, they also consume, so the distances are reduces. 6) Meerstad and Groningen are nearby, so their waste streams can be used in the process as well. Transport costs can be limited in this way as well.

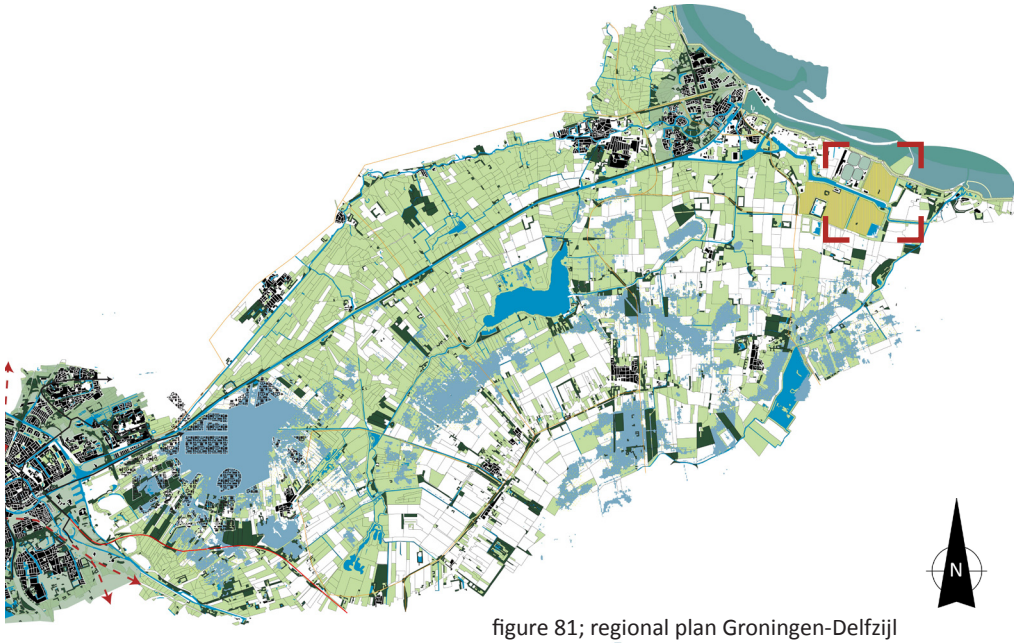


figure 81; regional plan Groningen-Delfzijl

Infrastructure (railroads, roads, canals) on the industrial site

Wind turbine park at Delfzijl

View on the edge of the industry of Delfzijl

Ambitions

The main goals which should be thought of in the design, are reducing the ecological footprint, to prevent further climate change and depletion of natural resources, and provide safety for the extreme climate change scenario. Through these goals the ambitions have been defined.

1) Closed cycles
2) Functioning production landscape
3) Water retention possibilities
4) (industrial) Aesthetics
5) Showing processes
6) Create an inspiring industrial landscape

Never ending cycle of waste

The in- and output of the systems have been structured in table 2. It is a simplified overview of the streams. Waste will be treated in several ways. The outcome of this process is energy and food. After consumption, it becomes waste again. The only way this process might end, is if people stop producing waste, which will never happen. There is no such thing as waste!

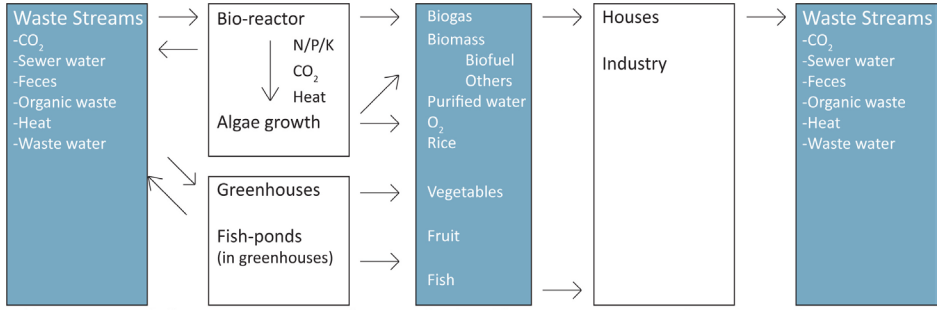
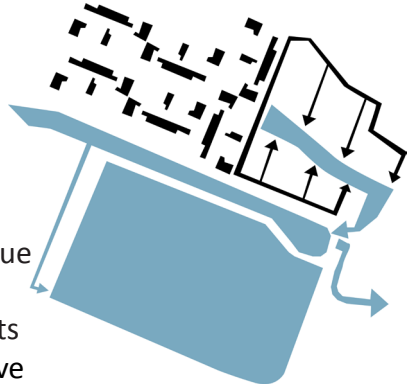


Table 2. Re-use of all waste streams, waste becomes food, and becomes waste again. This cycle is endless..

Water system

The industrial site is located next to the main water system, and nearby the sea. If there is too much water, it can be stored in the basin first, instead of letting it into the sea. This way it can be used when there is a water shortage. Polluted water from the industries are filtered by the algae, after purification, it can be brought back into the system, or stored in the basin. 5.000.000m³ water can be stored, so in extreme situations, water can be stored, or pumped back in the system. Besides this, the cooling water from the industries can be used for heating the greenhouses and the algae. In this way heat is recycled.

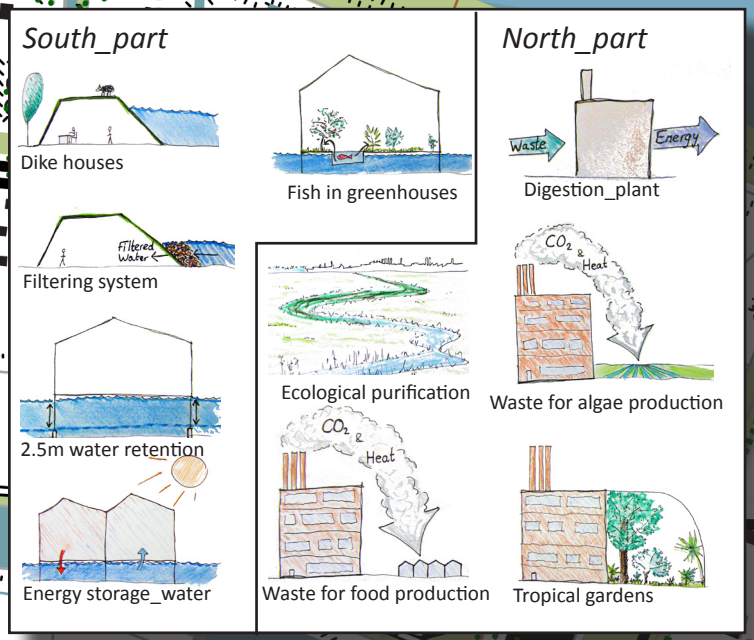


Conclusions

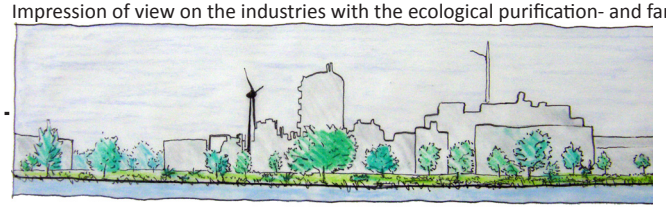
•All ambitions have been achieved
-all cycles are closed
-landscape is highly productive
-5million m³ water can be stored
-the industrial character has an aesthetic value
-processes have been made vissible
•Waste can be used to produce new products
•Algae and greenhouses are highly productive
•Closed systems are efficient and can increase the productivity
•A new way of thinking is required in the industries
•Using biological processes to reach a higher production and to re-use materials can be highly efficient
•Industries can support a healthy and sustainable lifestyle

SUBJECT	ALGAE BIOMASS	BIO-REACTOR	WIND TURBINES	GREENHOUSES	ALGAE WATER PURIFIER	TOTAL	COMPARISON
TOTAL	€1.200.000/ha/year x 100ha €120.000.000/year total	137MWh/year electric energy 137MWh/year heating energy €41.100/year	189216MWh/year 30518 households €28.350.000/year	At least 105.000 people can be fed on fruits, vegetables and fish	Save €500.000 on treatment Save €4.504.500 on drink water costs (if Delfzijl uses the system as well)	€153.395.600/year (on 300ha of land) €511.319/ha/year	€2600/ha/year on conventional crops can be made

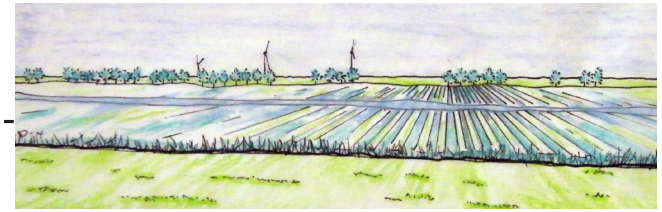
Table 3. Calculation of potential production expressed in euro's



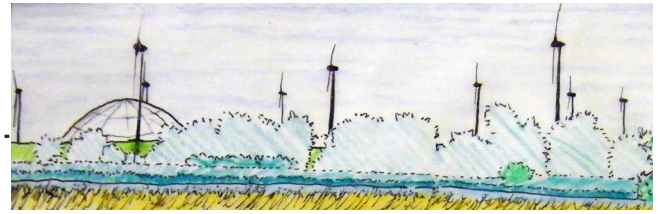
Impression of view on the industries with the ecological purification- and farm system.



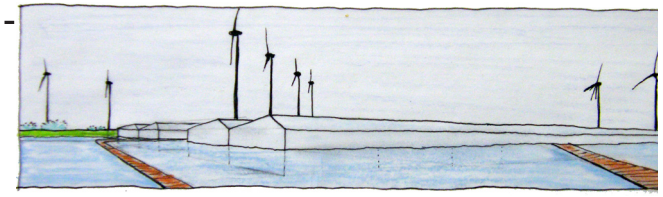
Impression of view to the north (from the road), on the algae and the sea dike.



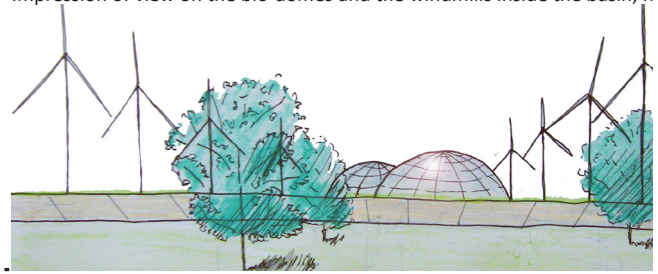
Impression of view from the west on the windmills and the center dome.



Impression of view on the greenhouses and the windmills inside the basin.



Impression of view on the bio-domes and the windmills inside the basin, from the road.



19.9 Solar energy in planning and urban design - by Rolf Willems (spatial planning)

Introduction

The subject of the thirth inividual part of this atelier is about the sun as a sustainable energy source in planning and urban design. The theory of trias energetica, a concept that helps to a achieve a sustainable future is applied on Meerstad, an urban extension of the city Groningen.

The objective of this study is a further development of the current plans for Meerstad, by means of sustainable (urban)design which applies the sun as main energy source. First the theory of trias energetica and sustainable urban design wil be discussed. Than the sustainable intentions of meerstad will come up. The next step is to evaluate the planning process and problems come into sight. The next step are new measures to optimize the current implementation of sustainable design. This gives Meerstad new input to reach the intentions of an energy neutral city.

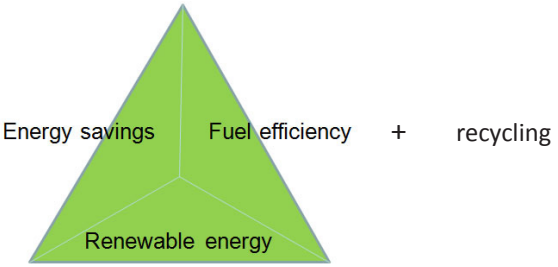
The energy sector in the Netherlands is dependent of fossil fuels. The shift from fossil fuels to sustainable ways of producing energy will be necessary if we want to reduce the ecological footprint in Groningen. A second argument is that in the coming future, the natural resources of gas in Groningen will run out. The policy of Groningen is to create an energy neutral province in 2025 in combination with a good living environment for everybody now, and in the future (routekaart energie neutraal). The shift towards a more energy neutral living environment can be implemented in new development of housing area's. In this case Meerstad, a new urban extension at the east side of Groningen with the size of 2300 hectares which contains 10.000 houses.

Theory

The starting point of sustainable building is summarized is the theory of trias energetica, developed by TU Delft (C. Duijvestein). When trias energetica is implemented in sustainable building, the building itself produces as much energy as it use (senternovem). When this theory will be implemented to increase the use of renewable energy in the building sector, three steps has to be taken.

1. Limit the energy demand through energy saving measures
2. Use renewable energy sources
3. Use fossil fuels as efficient as possible

   A futher improvement of sustainable living environment can be reached through a
4. Re-use of waste producs (Andy van den Dobbelsteen, TUDelft)



Some measure can be taken on a local scale within the building itself. Like isolation of roof, walls, floor and windows, a geothermal heat pump and a closed ventilation circuit for regeneration of heat.

The link of urban planning and sustainability is on a higher scale. For a optimal use of renewable fuels, houses should be oriented towards the south, the most optimal orientation to capture the light and warmth of the sun. The sun can be used for several objectives, which can be summarized in passive, active and photovoltaic solar energy use. *Passive solar energy* means a optimal utilization of solar energy without intermediation of mechanical systems. The building is designed to capture, retain and distribute sunlight and sun heat. The south is an optimal orientation to receive the light and heat of the sun. Smart building saves 65 % of regular new built house and 90 % of existing houses. In *active thermic solar energy*, solar collectors captures the energy of the sun. The direct and diffuse sunlight can be used to produce hot water, which is transported towards a storage unit. The hot water can be used for heating the house or for personal use. *Active photovoltaic energy* (PV) uses solarcells to transform sunlight for production of electricity . They are not to be confused with solar collectors. Several solarcells combined forms an solarpanel, also called a PV-panel (Thomas R. 2003).

Urban design

Passive solar energy, solar collectors and PV-panels all need a solar orientated design. The urban plan has an important task in south orientated design. If the structure is not southwards orientated, the architect on local scale can not design with an optimal use of solar energy. A tool for optimal solar orientation is to orientate the main access roads south-northwards or east-westwards. A high gain of solar energy can be accomplished if the east-west streets have dense rows of houses(1). Nort oriented houses can get deep parcels, so the sun can enter the garden (2). At the head of the city blocks and at north south streets it the optimal solution is detached or duplex houses with broad parcels, to enable the sun shine at the flank of the house(1) Nationaal DuboCentrum (1999).

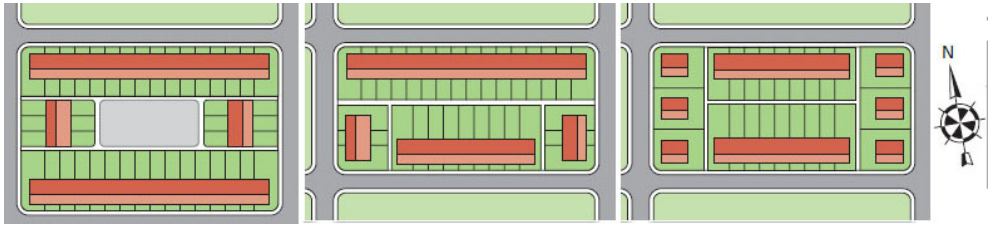


Figure 82: three different forms of solar orientation(Nationaal DuboCentrum, 1999)

Groningen

Groningen invests a lot time and money in a city that is energy neutral in 2025. They recon their responsibility to create a better world (Routekaart Energieneutraal+ 2025). In a energy-ladder, several themes are distinguished to make a guideline to implement this vision. The themes are Space & Climate, Living, Sustainable mobility, Industry & Labor and Municipal Organization. The vision of a sustainable Groningen recurs in many documents and policies.

Meerstad is the first large project in Groningen where the policy can be implemented since the vision of a energy neutral city has become official in December 2007. The bureau Meerstad invests in sustainable energy production within this new city extension. Research has been done to select one of the competing energy producing methods.

Although the passive and active solar energy production get's high credit, other measures are preferred. The lake of Meerstad contains heat, which can be extracted to heat the houses. The strong connection between the energy producing lake and the houses gives Meerstad character, like the 'city of the sun' does in Heerhugowaard. Heat from the lake has an explicit relation with the site, and is unique in it's kind. Although the sun has a high potential to decrease the EPC, but is not chosen for large scale implementation (Ecofys, 2005). The intention is te create an energy neutral area. From my perspective, energy neutal building in not enough. The energy neutrality is restricting the changes for an energy producing living environment which new built large scale settlements have. Because we still have possibilities of fossil/cheaper energy right now, new houses are not optimal oriented towards the south. The trust is still in gas or other forms of cheap energy to reach the break even point. New built area's should not work towards a break even point. In new plans like Meerstad, it is easy to implement energy sufficiency en energy production. Older area's are much harder to adapt for energy savings and production. Investments in the production of energy in new area's means less adaptation in area's which are harder to adapt.

If the production of energy with the use of solar panels is not economic profitable right now, it will be in the future. Sustainability is about leaving options open for the future. Orientate the buildings towards the south for use of passive solar energy, and make buildings easily adaptable for use of active solar energy. The scope of planning in the energy plan for Meerstad is thirty years, and that might be to small. The long term sustainability is underestimated, the potential of the sun in the long future has to be recognized. Structures of cities almost never change, the orientation of houses/ buildings/ roads often remains the same while the function of the location might change. The structure/ orientation sets the boundaries for solar use in the city. The zoning plan is an important feature to steer the future for solar energy in the right way. This tool should not be underestimated by the spatial planners among us.

Process

Depending of different factors choices have to be made more early or later on in the process. A lot of these moment of choice correspond with the scale level in which is made. Decisions which have to be implemented in a large area, have to be made in an early stage. Later on in the process the fine-tuning on a local scale can take place. Sometimes it is the other way around, the design on a small scale can demand measures on a high scale.

If people want to implement the terms of sustainable design, it needs orientation towards the sun, which can be achieved through a south orientated design. The architect working on a small scale needs a urban plan which contains sun orientated building blocks. If sustainable design is implemented from the start, the process becomes much easier than if it is tried afterwards. An optimal plan is often only possible when it is an integrated design through all different levels. Once the design is translated towards a zoning plan and is approved by the government, it takes a lot of time and energy to repeat the process for optimal solar orientation. And at a certain moment this process is irreversible, and only small scale sustainable interventions are possible.

Recommendations

The process of implementation of sustainable design can be optimized. To help the government with integral development from the start of a process, a checkpoint will be introduced. This sustainable checkpoint helps the implementation of sustainability in an early stage of spatial plans and projects. The actual check will take place when the plan is fully designed, but can be used as an inspiration in an early stage of the process. Existing list of measures, like the national package of sustainable building (nationaal pakket duurzaam bouwen) , can be applied in a stronger form. The checkpoint can be a tool to measure if a spatial plan has got sustainable quality. The *National Package Sustainable Building* contains a list off measures which are fixed or variable. Several environmental theme's are listed, like energy, indoor environment, materials, outdoor environment, water and miscellaneous items. In stead of only implementing the fixed measures, additional measures can be made obligatory. To stimulate energy production in stead of energy neutrality *New certifications* have to be introduced. The current energy saving certification like EPC and EPL, can be broadened to a system which contains both energy savings as energy production. It can help municipalities not only be energy efficient, but also have a tool to measure how much green energy is produced. A *stakeholder chart* prevents good plans for bad or incomplete implementation which can result missing the initial goal. The government have to check their responsibilities and task, but has also the responsibilities to pont out the attention of other stakeholders which have to put their responsibilities into practice. A clear list of the task can prevent misunderstandings. The *zoning plan* plan can be checked for sustainability. Are all constraints and demands of the national package and certifications translated into the zoning map and it's annex.

Conclusion

The sun has got an high potential for sustainable energy production in urban design and planning. The sun can be used in a passive way for heating buildings, the technique and cost are fully developed and ready for implementation. A active form of solar use which produces energy is at this moment only profitable with subsidies. Sustainable development accommodates the needs of the current generation, without restricting the possibilities in fulfilling the needs of future generations. If the current generation does not need active solar energy because of other good alternatives (like Meerstad) the first part of this definition is correct for Meerstad. The second part is not implemented, the current plans are not orientated towards the sun, which is restricting the possibilities for passive or active solar energy use in the future.

Implementation of solar use from the start of the project is crucial for actual use on site. A sustainable checkpoit can help this integration. Spatial planners and urban/landscape architects can apply different toolt to practice sustainable design, like in a zoning plan. The sun is powerfull and offers great opportunities for Groningen and the rest of the world!

Design

Meerstad has already got a zoning plan, but this is large scale and has got only information of the global location and size of the several districts. The zoning plan on a large scale can contain information which has to be processed in the design of the districts. The development of the other districts of Meerstad (other than the already developed area 1: meeroevers) can pay more attention to solar orientation. The design has a strong connection with the landscape, the original parcel orientation can be linked with the solar orientation.

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‘We do not inherit the Earth from our Ancestors,
we borrow it from our Children’

Anonymus, indigenous expression

21. COLOPHON

The project ‘Groningen, adaptation to climate change’ is part of the Atelier Landscape Architecture and Planning, a compulsory course in the Master education Landscape Architecture and Planning at Wageningen University, The Netherlands. This report is next to a presentation by printed posters and powerpoint, the outcome of three months of working this project.

A report by Group STAAL, 2009
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GROUP STAAL

ANNEX

ANNEX 1a; TOOLBOX (general)

INFRASTRUCTURE

Problems

Groningen has a relatively low infrastructural connectivity compared to the rest of the Netherlands, because of the relative large distance from the 'Randstad', the economic centre of the Netherlands, and with the low population density of Groningen. If the connectivity of the province isn't improved, the province will become less and less important for the Netherlands and for Europe.

With a mission to reduce the ecological footprint of the inhabitants of Groningen, the common use of cars is a problem. The use of fossil fuels and the CO^2 emissions should shift towards the use of renewable energy sources. An other option is the use of alternative energy sources, because the fossil fuels are running out, within a few decades all cars will need them. To facilitate the shift to a more sustainable transportation system, there are two challenges. The first one is the availability of green fuels; the second is the infrastructure that is needed to distribute the fuels.
Next to cars and the infrastructure, the public transport system in Groningen could be updated and be more attractive to use.

Concepts for rural and urban areas:

>High quality,
CO^2 neutral public transport
>New sustainable/renewable fuels for personal transport
>Bundled infrastructure

Tools:

Personal transport
- Hydrogen cars
- Electric cars
- Compressed air cars
- Solar cars
- Bio-fuels
- Cycle paths network
- Water network (boats)

Personal transportation options for people must not disappear or be completely replaced by public transport. Personal transport gives freedom; you can go wherever you want whenever you want to. There are alternatives which do not harm the environment and can have the same capacity as conventional vehicles. Technique already offers multiple solutions for alternative transport options. Another way of thinking can be to completely switch from road transport, back to water-transport; especially with a higher sea-level and more water in the area. Further investigation is needed to see if this option is realistic.

Public Transport
- Light-rail
- Maglev

By improving the public transport system of Groningen without making the price for it too high, the use of it might improve as well. Public transport is more energy efficient than personal transport, therefore it should be stimulated. Besides this, it offers the opportunity for everyone (all ethnicities) to use it and to go wherever he/she wants. So it is a democratic way of transport. The future brings great technical solutions/opportunities for public transport; the Maglev train for example can reach speeds over 1000 km/h by using magnets. The energy use is relatively low, because of the low friction. By connecting Groningen with other parts of the Netherlands and Europe, the role of the province might become more significant. Light rail connections might be a solution for connections between areas within the province, so smaller distance transport.

Digital networks
The digital world is growing and probably will have an even greater role in the future than is has now. There will be many consequences in the way of living. For example; perhaps more people will work at home, so will need less transportation. The lives of people will not only be in the real life anymore, but also in the gigantic digital world. So spatially it might have consequences as well. The exact consequences are hard to research, but considering this can be useful in the future.

ENERGY

Problems

95% of all the energy in the Netherlands comes from fossil fuels. There is only enough oil (fossil fuels) for 30 to 40 years. The energy demand might be 50% higher than now in 2050. So on one hand, the fossil resources are running empty and the demand is getting higher, on the other hand the use of fossil fuels results in CO2 emissions. This is one of the causes of climate change and therefore for the rising of the sea level. The solutions can be sought in reducing energy consumption and using renewable energy.

Concepts for rural and urban areas:

>Be completely self-sufficient in energy production
>Stop using fossil fuels, stop high CO^2 emissions

Tools:

Algae's
Algae's can be used for producing energy in the form of bio-fuel. According the Volkskrant of March 28, 2009 20% of the total energy consumption of the Netherlands can be produces, if all the sewer water would be used for Algae production. According to an article published on www.nature.com.
1.0 ha of algae's can produce 90 000 liters of bio-fuel. This is more than 10times higher than conventional bio-plant species.

Blue energy (sweet-salt)
Because of the difference in salt concentration between sweet and salt water, energy can be produced with reversed electro-dialyses (osmosis). The waste product is brackish water; this can be released in sea. The energy potential of this process is 0.35 MWh/m^3 of sweet water flowing into sea. More than 45million m^3 water is pumped into Groningen, so using 10million m^3 as amount for calculations, gives an impression of the potential of this energy source. This is 3.5million MWh/year for Groningen. This corresponds with the total energy consumption of the inhabitants of Groningen! This assumption of 10million m^3/year in Groningen is only 1% of the total sweet water outlet of the Netherlands. In Groningen there are four points where the water can be let out, so where a blue energy plant can be placed: Nieuwe Statenzijl, Termunterzijl, Delfzijl & Lauwersmeer. These first two options are not good options, because of the process of low and tide, there is no good possibility to use blue energy. During high tide it is impossible to drain into open water. During low tide there is no salt water at the see side of the sluice. Another option could be to dam the Dollard, and then one big plant would be enough, perhaps.

Bio-mass
Using the organic waste products of agriculture and of the inhabitants of Groningen for producing energy and compost is possible with a digestion plant. For the household waste in Groningen, the potential energy is almost 3000 MWh/year; this corresponds with the energy one 2.0 MW windmill can produce. If the organic waste of agriculture is used, this might be higher. By separate waste collection, the role of the inhabitants becomes more active, this might help in the acceptance of alternative energy (re)sources.

Wind energy (turbines) - rural
Using wind as an energy resource is a good opportunity. One windmill of 2.0 MW can produce 3460 MWh/year. A big windmill of 6.0 MW (120 m high) can produce 10 380 MWh/year. If the total energy demand of the inhabitants in Groningen would come from wind, 344 big windmills are needed.

Tools:

Solar energy (PV-panels) - rural
Using solar energy is a good option for producing energy, because through the whole year this source can be harvested. Even on cloudy days this technique works. In the Netherlands, the suns' radiation power on the earth's surface is 150 Wh/m². An average PV panel can harvest 15% of this energy and there has been made a panel which can transform 41% of the solar energy into electricity. Calculation with 20% of the potential solar power results 480 MWh/year/ha. So if the total energy demand of the inhabitants in Groningen would come from PV-panels, 75km² of Groningen should be covered with solar panels.

Solar panels on tilted roofs - urban
There are many tilted roofs in the city. By providing tilted roofs that face south with solar panels, we can provide renewable electrical energy to the city. 480 MWh/year/ha is provided.

Wind energy - urban
Wind energy in the build environment is a possibility. Only the rural area has so much room for wind mills and in the city there can still be good possibilities for wind energy around large buildings. Examples are industrial areas and sites close to works of infrastructure (bridges, dikes, etc.). They can be used close to buildings; on top or beside them, but also in a duct through a building. They can also be used between airfoil-shaped buildings.

Insulation of residential homes - urban
Insulation will save energy no matter what the effects of climate change will be. In cold weather, the houses will stay warm easier and in warm weather the energy consumption for cooling will be less.

Reduction of industrial energy use - urban
More is explained in tools for industry in urban areas.

ANNEX 1b; TOOLBOX (rural)

AGRICULTURE

Problems

The agriculture has a lot of influence on the environment. The diary farming discharges CO2 and especially methane and laugh gas witch contributes to the climate change. Methane gas and especially laugh gas play an important role because of their important role by greenhouse effects (21 and 310 times as high as CO2). On the other hand the climate change has direct effects on the agriculture. For example, by the extreme weather conditions that will appear. Farmers´ experience, for example, changes in precipitation and see that there land is used for water retention. Also the saltification of the land and groundwater is related to this and causes big problems for the today species. Climate change has also its influence on the spreading of diseases.
In the agriculture there is a big surplus of dung in some areas. There are rules made about the government by this. As a result there is trade in dung, but the dragging of dung trough The Netherlands also costs a lot of energy.
Another problem is that the current agriculture is not sustainable and is pushed away by other land use activities.

Concepts:

>CO2 reduction
>Adopting to saltification
>Dealing with different water flows and amounts
>Reduce influence on the environment
>New types of agriculture

Tools:

Reduce CO2 and reduce energy use on the farm

a) Fermentation of dung and other products
b) Reduce number of cattle
c) Use dung as fertilizer (instead and to stop artificial fertilizer)
d) Use wind energy
e) Use solar energy
f) Use more sustainable (building) materials

The fermentation of dung and other products (for example grass from the borders along the roads) can be done on individual or collective base. It is a high investment but also tends extra income when the scale is big enough. Also reducing the number of cattle will offer a solution for the dung problems. For a more balanced carbon cycle it is useful to only use dung as a fertilizer and to stop the artificial fertilizer.
The roofs of the farm and sheds can be used to harvest sun energy and windmills could make energy for the electrical machines (for example the milk machine and maybe electrical tractors in the future). Rainwater can be used for drinking water for the cows and for cleaning the machines.
An other opportunity can be choosing more sustainable materials for the farm buildings (products from the region, natural products).

Reduce CO2 worldwide

a) Produce bio-fuel
b) Contribute to awakening people

Also farmers can contribute to awakening of people by showing different kinds of energy cycles on the farm and educate people about the climate, world and how we are related and use the world.

Pollution

a) Reduce or stop the use of artificial fertilizer
b) Stop use of chemical pesticides
c) Search for environmental friendly solutions

There are a lot of solutions to fight pollution which stresses the environment. Reducing or stop the use of artificial fertilizer will lead to less emission of N2O and N. Stopping the use of chemical pesticides will have big impact, especially on the surface water. Related to this, the search for environmental friendly solutions rises. Examples of this are planning the right kind of agriculture on the right location of the land (North of the Netherlands, near to sea where insects can't fly over is useful for crop growth) and the use of ladybirds to fight fleas.

Tools:

Storage of sweet water

a) Retention areas for rainwater and water out of the higher areas

Sweet water retention in the rural area is useful to solve water shortage in the summer and water surplus in the wet periods and besides this the retention areas are useful to stop the underground salt water flows.

Reduce sweet water use

a) Decrease water use

b) Cleaning and re-use of water

Saltification

a) Use salt resistant crops

Plants to eat:

- Glasswort (‘zeekraal’)
- Zeebiet
- Zeekool
- Zeeaster
- Schorrekruid
- Sea lavender
- Spelt
- Potato
- Beets

Filament plants:

- Hemp
- Nettles

HOUSING

Problems

Groningen contains a large amount of farms. These are all spread over the rural area, mostly outside of any villages and located far from each other. This results in a large amount of transport of delivered products and products that have to be removed.
In the whole of whole, a trend of stopping farmers is going on. Groningen is not an exception in this trend. According to the Dutch CBS 56% of the agrarians is 50 years of even older. 70% per cent of them do not have a successor. The changing climate also contributes to this trend. Due to the expected sea level rise more seepage is coming into the arable land; furthermore changing weather circumstances like drought, extreme rainfall and off-season hail. During the last 8 years 17.5% of the farmers in Groningen stopped (bron: CBS). This results in unoccupied farmer houses. And this trend will go on the next decennia.

Concepts:

> Making the farms (more) self-sufficient. Small technical measures can help to reduce the external energy supply; but also being independent of, for example, the municipal sewer system.

> Using new functions for stopped farms. According to the "Vijfde Nota Ruimtelijke Ordening" and the "Structuurschema Groene Ruimte 2" unoccupied farms could be reused for small-scaled functions.

Tools:

Self-sufficient farms
a) agricultural waste used as energy
b) sun energy
c) wind energy
d) rain water use
e) alternative for sewer system

Agricultural waste can be used as energy supply. Dung (and urine) is (are) in most of the cases already used as fertilizer. If there is a surplus of dung in combination with the plant waste, this could be produced into an energy resource in a digestion plant; but 4000m³ of dung is needed before this will be useful. This will also reduce the need of a connection with the municipal sewer system (which is expensive because of the dispersal of all the farms in Groningen) . Roofs of the farm and sheds can be used to harvest sun energy. A farmer household (of 4 people) needs approximately 25 MWh/ year. Two to three PV-cells (as described earlier) could harvest the energy needed for this farm. Small windmills produce 0.4 to 0.5 MWh / year. Compared with their larger brothers, these are not really efficient. Besides that, one windmill cannot produce enough energy to maintain a farm. A person in the Netherlands uses 125-130 litres water per day. Rain water and grey water can be used and reused for toilet flushing; this would reduce the use of water with 40 litres. For farming purposes, this water could be used for cleaning barns etc. Choosing more sustainable materials can also contribute to a lower footprint. Examples are: materials from the region, natural products.

Re-allocation of farms
a) used as a house
b) used for education/art
c) social services
d) recreation/tourism

Unoccupied farms could be used as a house. Around 80% of the unoccupied farms during 1992-1999 is become a house for living purposes. Often these houses are combined with small companies at home offering different services: building and agricultural-related industry
A few farms in the northern part of the Netherlands is used a primary school in low-dense areas. It is more usual to use the farms as exhibition place or atelier.
A new development is the use of farms for social services, for example as a house for elderly people, or as a psychiatric institute. This development is new, but probably will develop coming years. Recreational activities also have an opportunity in farms. The spirit of rural life can be felt in restaurants and sport sites at the country side.

WATER MANAGEMENT

Problems

Coastal areas
In our toolbox we want to be prepared on a 1.9 meter sea level rise. People might think: "Our dikes are high enough to cope with 1.9 meter extra, so what's the problem?" Well, the dikes are high enough to cope with the water in normal situations, but in case of storms Groningen can get serious problems, because then that 1.9 meter can make the difference between water that will be kept by the dikes or water that will flood or even break the dikes.
So, to be safe in future, something has to happen to prevent the cause of damage in case of storms. (Delta committee, Polderconcept)

Water storage
In future precipitation and evaporation will increase, which means that in average the water balance will stay the same (Klijn et al., 2007). However, extremes will occur more often and precipitation will increase in winter (overabundance of 24-97 mm) and decrease in summer (shortage of 24-217mm) (KNMI,…). Due to this increase in rainfall and more intense rainfall, the carrying of and storage of water should be increased.
Besides this, an increase in precipitation will also cause higher levels of ground water, which will lead to an increase in damage to crops. It will also influence the agriculture, because the land can be worked later in the year.

Concepts:

>Adapt existing dikes
>Make new dikes
>Create another system
>Expand water storages
>Create new water storages

Tools:

Heighten dikes
To prevent land from flooding it is possible to make higher dikes, which are resistant to flooding and won't break. To make these dikes effective, it is important that there is no weak link in the ring of dikes, otherwise all the water would go through that place and the land will flood anyway.
However, when you want to raise a dike, it should also be made broader, otherwise it would loose it's strength. The figures on page 45 show how much the dike should be raised (and broadened) at certain levels of sea level change. The costs for raising dikes are shown in these figures as well.

Broaden dikes
Instead of raising the dikes, you can also broaden the dikes. These dikes are made that strong that they can not break, but only will be flooded. By letting water in the area gradually, there will not be intense and heavy flooding and also the chance on gaps is almost zero. And a gap is the most dangerous, because this causes most victims and most damage.
The disadvantage is that broader dikes will take a lot of space and cost a lot. However, these broad dikes can also be used for other purposes, like infrastructure and even housing. If you choose for this option, you should apply it to the whole shore, to prevent water from flooding through the weakest point. An additional measure could be to strengthen dikes with asphalt as well.

Second ring of dikes
The last option considering dikes is to make a second ring of dikes. This ring can be in land, so that in case the first dike will be flooded, this dike will keep the water out. But it can also be placed 'outside' the present ring of dikes. In this way it stops most of the water and the water that will flood these dikes will not be as wild anymore and cause less damage. Also, if water is stopped by the first ring, seepage will be less in the land behind the 'real' dikes.

Building marshes
Letting marshes develop on a high sand flat is also an option for coastal reinforcement. These marshes have a strong type of vegetation which catches sediment as it is deposed by the sea. This ongoing endless process makes that the marshes grow and keep reinforcing themselves. Creating large marsh areas in front of existing dikes is a sustainable and good solution for coastal defence.

Expand existing water storage areas
One way of dealing with the overabundance of water is to enlarge the existing water storage areas, like the 'boezems'. In this way the extra water can be stored in a safe way and used for other purposes. The figure below shows where the existing water storage areas are (figure.. kaartje met waterberging).The advantage is that the place for water already exists, but it only has to be enlarged or deepened.

NATURE / ECOLOGY

Problems

Flora & fauna has difficulties in adapting to climate change, this due to the lack of connections between habitats, low habitat quality and too small habitats (this on scale of Groningen to that of Europe). As climate zones are shifting, ecology changes as well. For some animals and plants it is essential to move with the shifting climate zones for survival. Nowadays it is difficult for animals to migrate, due to urbanization and the barriers that come with it. Highways, railways, new housing and more manmade objects create obstacles for species to move from the one place to another. If we want to maintain some ecological values in Groningen, it is important to do something about it.

Concepts:

> Robust ecosystem network
A robust ecosystem network might result in a healthy and well adaptable (to climate change, extreme events etc.) ecosystem network.

Tools:

Enlarge habitats/nature(conservation) areas
Enlarging habitats for wildlife, gives opportunities for larger amounts of species and animals. This is important, because a larger group has more survival possibilities. For example, if a period of extreme low temperatures occurs, many animals might dye, but some will survive. The larger the group, the more chance the species will maintain.

Connect habitats/nature (conservation) areas
Connecting nature conservation areas result in migration possibilities for flora and fauna. This is important for species so they can migrate to areas if it becomes uninhabitable for them. This can be due to shifting climate zones as described earlier, or due to extreme events, like a flooding. Another reason for connecting different nature conservation areas is because this allows animals from different genetic background to breed. This is good for the genetic variation and prevents incest, so the species remain healthy.

Improve habitat quality
If the quality of the habitat is of low ecological value, not so many species can survive; this results into a low biodiversity. This does not contribute to a robust ecological system. So diversity is important in creating a healthy ecosystem. If the quality is high, less space is needed for the same effect. So combining these three tools can result in a healthy and robust ecosystem network, which is adaptable to climate change.

Combining ecology with other functions
Nature conservation areas can have other functions than only ecology. It can as well be used for water retention, recreation, housing, safety (against the sea) and CO2 storage.

ANNEX 1c; TOOLBOX (urban)

INDUSTRY

Problems

Industry delivers much pollution to the environment. CO2 and Chlorides changes the air composition, heat has an effect on the micro climate and heats the water when cooling water is dumped into the rivers or seas.

Concepts:

> Sustainable industry through:
- Reduction of waste
- Better handling of energy consumption
- Storing of energy for later use

Tools:

Reduction of industrial energy use
To reduce the energy needed and to reduce the amount of heat waste into the environment, the industry can use energy storage methods, such as aquifers, phasing and thermo-chemical heat storage.

ECN is doing research on using heat to create cold. They are looking at stationary applications and mobile applications. This could be used in industry and in cars as well if developed. For cars this would mean less energy used by an air conditioner, because the excess engine heat can be used to cool the car. At the moment that the engine is not yet heated, the need for cooling of the interior is most needed. This system would have to be combined with energy storage.

City heating
Delivering waste heat to residential areas can save much energy during the winter. When there is also much CO2 pollution in the air, the combination can be used to provide green houses. Green houses need warmth for their plants and CO2 to make them grow better. Often there is gas burned just for the CO2.
(http://www.energieprojecten.nl/print_ocap.htm)

Energy producing green houses
Green houses face the problem of too much heat during the summer. Using aquifers excess heat from the summer can be used in winter, during the summer cool water stored during winter can cool the green houses. A recent Design contest used this principle of aquifers to even produce energy, through the difference in heat between the two aquifers. The future of greenhouses could be that they produce more energy than that they use.
(http://www.glastuinbouw.wur.nl/NL/expertise/kasontwerpenmaterialen/innovaties/zowakas/;
http://www.intranet.wur.nl/nl/home/news/Pages/Energieproducerendekassenofficieelgeopend.aspx)

HOUSING

Problems

The lower parts of Groningen are already below sea-level and this problem will only increase. For residential areas this means that if there is a flooding of the area, the force of the water will not just ruin the interior of the house, but will wash away the entire building. Adaptive building will be necessary to cope with this problem in the future.
The second problem is 'urban heat'. The city is much warmer than the surrounding area. This means that much energy is used for cooling houses. Also, in the summer the city centers will be too hot to be comfortably.

Concepts:

> Flood resistant housing when necessary
> Avoid building in risk areas
> Ventilating city
> The blue and green city

Tools:

Flood resistant houses
a) Terp villages
b) floating houses
c) houses with a dyke
d) houses on poles
When houses are built in areas that are regularly flooded, without a large force behind the water, resistant houses can be built. When the force is great, the risk is too high to build there. Terp villages follow the concept that has been used in the Netherlands for centuries. Build a higher area to build houses on. The water will not reach the houses. Floating houses are fastened to a large concrete pole. When the water raises the house floats, but does not float away. They are useful for regular flooding. Houses with a dike have been already used many times before. A dike can protect houses that are already there easily. The dikes must keep the water out, because the houses are not ready for any water in the houses. If a dike breaks the houses will be washed away. If the dike is not high enough, water damage will occur. Houses on poles do not have to float because they are always higher than the surroundings. The water can come freely below the houses, but if there is a high force behind the water, the poles, and thus the house, may collapse.

Water and green in the city for cooling
Water and green are good water buffers, but can also help against urban heat. The perspiration and evaporation of plants and water cools the city in the summer and make the city more pleasant to be in. Lanes can be created in the city where the wind can blow through, so the stagnant heated air above the city will move away from the city. Water near the city can help because the cool air above lakes can blow into the city to cool it.

House orientation to protect from the sun
a) Spread houses for enough light and space for vegetation and water
b) Insulation of residential homes
c) Not too many windows
If houses are too close together in the city, there is no room for plants and water. Insulation will save energy no matter what the effects of climate change will be. In cold weather, the houses will stay warm easier and in warm weather the energy consumption for cooling will be less. New houses are already built to high standards, but older houses are not insulated well. Subsidies might persuade house owners to update their house with better insulation. Windows let in the sunlight, and heats up the house. In the winter this can be nice. In the summer this is too much, especially when climate change makes the summer even warmer and dryer. This tool will help reduce the energy used to cool houses in the summer.

WATER

Problems

Climate changes leads towards more weather extremes. Weather extremes like heavy rainfall will lead to problems in urban areas. The water cannot infiltrate in high dense urban areas. Especially in lower parts of the cities will have problems because of natural flow of rainwater. To avoid problems, the discharge rate has to be reduced. Retain, store and discharge of water should be implemented in a more extreme form.
More water in the city has also a positive effect on the aesthetics and can be used to cool down the city.

Concepts:

> Retain, store, and discharge
> Water as city cooler
> Water as a multifunctional tool

Tools:

Water storage in lower parts of the city
Water flows by gravity to the lower lands. These lower parts should be investigated for its suitability in temporal water retention.

Water next to the city
During the summer, eastern winds are more common. To cool the city, large ponds at the east of the city could be created to cool the wind before it enters the city.

Recreational area next to canal, more space for flooding
To create more space for storage of water, the capacity of existing water structures could be enlarged. Canals could get a recreational function, like the canals in Utrecht, but could be combined with more temporarily water storage.

Water roofs
Water could be stored on roofs. It has a cooling effect on its surrounding area. The rain could be retained until the extreme rainfall is finished, after that it could be discharged to other retention areas.

Recovery canals
Historic water structures could be restored, for water retention, but also for recreation, aesthetics and cooling. More water in general has positive effect on its surroundings.

Water square
Squares in cities should have more prominent attention towards water. Squires could have small water basins or fountains as main goal to cool down the city.

GREEN

Problems

Climate change, a higher temperature and more weather extremes can cause problems in the urban areas. The buildings, the roads and other urban functions which accommodate a nice living environment enlarges the heat in the city. The surfaces in the city like concrete and asphalt, absorbs heat rather than reflect. This could lead to urban heat islands, an overall higher temperature rise in high dense areas.
Green in the city could reduce the temperature in the summer, to prevent a higher energy use of cooling systems. This main goal to reduce the ecological footprint using green in the city has also positive side effects.

Concepts:

> Ecological urban cooling
> Breathing cities
> Micro climate

Tools:

Create shade
When placing building, give extra attention for creating shade in and around the building - plant trees to avoid the direct heat of the sun.

Green Roofs
a) high isolating function
b) absorbs solar radiation and converts this to growth energy for plants
c) has a cooling effect on the surrounding area
d) houdt water vast voordat het afvloeit
e) reduce of CO2 concentration

Vertical green
a) isolating function
b) absorbs solar radiation
c) has a cooling effect on the surrounding area
d) reduces CO2 concentration
e) increase of esthetic value

ANNEX 2; SCENARIOS

Scenario A: Small footprint: sustainable and self sufficient

Characteristics
Low Footprint
High sea level rise

Water management	When climate changes, fresh water will be more important. Groningen 'imports' a lot of water from the lake Ijssel. This has to change, Groningen should be less dependent of the lake IJssel. The water must be retained for a longer period by better water management. At least 10 million m^3 water has to be stored within Groningen. The need of water could also be reduced. Households should reduce their water use. To be more efficient with water, there could be better separation between drinking water and other sweet water for households.
Agriculture	To reduce the footprint, agriculture in the northern part of Groningen should not adapt to seepage. In stead, Groningen must use is. The current crops need a lot of fresh water. The technology exists to change crops which are capable to deal with a higher level of salanisation.
Ecology	More and better nature could be used for adaptation on climate change. The spatial quality will grow, the amount of CO2 could be reduced, and it can be combined with other functions like recreation of water storage. Building an ecological network gives species the opportunity to move along with shifting ecosystems. The species can move with the climate change. Nature could be used to adapt to climate change. Ecological processes like sedimentation near the coast can help strengthening the safety in Groningen, or make people more aware of nature, how it works, and that nature is good. Groningen will develop en adapt the nature for ecological an recreational purposes. People can get closer to nature, and see the beauty.
Economy	Groningen should use it's qualities and produce for it's self, large scale importation of goods should be prevented. Groningen could in more self sufficient, within a regional economy, which doesn't depend on polluting import but can produce in a clean way. People buy regional products and eat more products of the season. Self sufficiency could attract people from other provinces and inspire them to change their way of living. Durable energy also reduce the ecological footprint, and gives a boost to self sufficiency. Wind, water, sun and bio fuel will take the place of fossil fuels.
Living	In the parts of Groningen below sea level should not be built. Living area's will be placed on the higher southern part of Groningen. The low area's will be used for recreation and water storage. Backtracking to the wierden, and projecting it to the current situation, Groningen should build on safe (high) places.
Infrastructure	A well organized public transport system will help reduce the use of cars and other polluting vehicles. The transport system should not only be developed in the province itself, railways should be implemented in a larger scale within the whole Netherlands or even Europe. On a smaller scale, city trams could be introduced to get the public transport system to a higher level.

Scenario B - Groningen – living on the max - 'getting what you want'

Characteristics
High Footprint
High sea level rise

Water management	In this scenario we use a lot of water from other regions; e.g. the Ijssel Lake to fight the seepage and to diminish the salt water penetration. It comes into Groningen from the south (south-east) and is leaded towards the northern regions. To prevent flooding, we want to upgrade dikes extremely and go for safety above all. In this scenario, technology offers solutions for a lot of problems, what is expensive. But in fact, that is no problem.
Agriculture	Agriculture is not as important any more, see economy.
Ecology	Nature is used for economic purposes, such as tourism, not for the natural value on its own. It is strongly influenced by humans and a lot of 'greenery' is used in urban areas and industrial areas.
Economy	Economy is an important driving force in this scenario and a lot of attention is paid to it. In this scenario, Groningen is very dependant from other provinces and other countries, especially for a lot of necessary matters for living, like water and food. Agriculture is not that important anymore, but housing, knowledge and industry is getting more significant. These activities can find place wherever people want (to). Building is not only restricted to the higher areas but (thanks to technology) can also take place in lower areas. The energy used is non sustainable energy. All the gas in Groningen is extracted and the whole Wadden Sea is searched for more gas. The problems, which arise because of the lowering of soil, will be fought with technological measurements. Furthermore, a nuclear power plant will be developed in Groningen, to fulfill the energy demand.
Living	Blauwe Stad and Meerstad are important housing areas for all the rich people that will be attracted to Groningen, thanks to the new knowledge and industry. These areas are attractive because of all the water and nature what exist here. Also, bungalow parks are developed around the Lauwersmeer and people have the opportunity to buy a second house in the province of Groningen.
Infrastructure	Infrastructure is focused on the economical areas.

Scenario C – Connecting to the earth - Ecological Way of living

Characteristics
Low Footprint
Low sea level rise

Water management	The people are aware of their water use and search for a sustainable solution for the water problems. In the north, land is in connection with the sea and under influence of tides and brackish water. In this way the protection against flooding will grow along with the sea and a self-sustaining way of protecting is created.
Agriculture	Groningen has an ecological and small scale agriculture, which produces eco-friendly food. A differentiated agricultural production (as a consequence of local way of living) leads to more variation within landscape.
Ecology	The processes around the sea dikes are dealt with and adapted to in an ecological way. In the natural environment recreation can take place, which is combined with agriculture and education.
Economy	People life in a small, self sufficient society.
Living	In this scenario strong political leaders change the way of thinking when we speak in terms of world scale. People realise that if they start changing now, they can still change the world. They know that now is the time to take responsibility for their actions. The new urban developments take place on the safest location, so on the high areas. Furthermore new houses are built with more sustainable materials. Gas extraction is minimized and people search for other (sustainable) energy resources, like solar energy and wind energy. In this way the energy circle is closed. Also, a lot of recycling of all kind takes place.
Infrastructure	The infrastructure is focused on the regional scale.

Scenario D - Living on the edge

Characteristics
High Footprint
Low sea level rise and after 2100 high (due to way of living)

Water management	Groningen will continue heightening the dikes. Water will cause a lot of problems. See also agriculture.
Agriculture	Groningen will develop as a further intensified agricultural society. This means, more water is needed in the area, the dependency of Lake IJssel will increase. Finally, Groningen will produce agricultural products for a important part of Europe.
Ecology	Nature areas are used for recreational purposes. These areas are located in the direct surroundings of the cities. For nature this would mean, for special species with special needs almost has no possibility to survive.
Economy	Housing will be placed around the current cities. These is mainly based on economic interests. The recreation area will also be placed directly around the cities. For Groningen, this result in a cluster of the cities Groningen, Meerstad, Haren and Assen. The quantity and quality for individual infrastructure will increase. Technological solutions leads to more extraction of gas in Groningen. For these reason, the sinking of the soil continues.
Living	The world is more and more ruled by technology. The world population increases. People think the world can be adapted by new techniques in case of climate change, but the solutions are only effective for a quite short term (only 50-75 years). Welfare and consumption develops more and more. On a longer term the climate change and sea level rise could have an disastrous influence. Even more than is assumed with the current calculations. New fossil fuel recourses (for example form the north pole) are used, business goes further as usual, which result in higher production and extra pollution.
Infrastructure	A lot of new roads are needed for all the new cars the people are buying.

ANNEX 3a; CALCULATIONS CONSUMPTION

Groningen			
houses	250000		cbs
people/household	2.3		cbs
total population	575000		cbs
Area (km2)	2968		cbs
*water	634		
*built env.			
*rural			
*etc.			

Energy consumption/year (Mwh)	per capita	groningen (575000people)	source
Natural Gas (Mwh)	17	9775000	environmental change institute
Electricity (Mwh)	6.21	3570750	environmental change institute
*Heating	0.11	63250	environmental change institute
*water boiling	0.97	557750	environmental change institute
*cooking	0.27	155250	environmental change institute
*appliances	4.86	2794500	environmental change institute
TOTAL	29.42	16916500	

Water consumption (liter/year)	per capita	groningen (575000people)	source
Bath/shower	14965	8604875000	Castelano, 2006
Washing basin	1168	671600000	Castelano, 2007
Toilet flush	14600	8395000000	Castelano, 2008
Laundry	7300	4197500000	Castelano, 2009
Dishwashing	3212	1846900000	Castelano, 2010
Food preperation	657	377775000	Castelano, 2011
Drinking water	730	419750000	Castelano, 2012
TOTAL	42632	24513400000	

Food consumption (kg/year)	per capita	(575000people)	source
Potatoes	41.6	23920000	Health concil of the Netherlands, 2006
Bread	49.2	28290000	Health concil of the Netherlands, 2006
Alcoholic drinks	58	33350000	Health concil of the Netherlands, 2006
Eggs	5.1	2932500	Health concil of the Netherlands, 2006
Fruit	38.3	22022500	Health concil of the Netherlands, 2006
Cake/biscuits	15	8625000	Health concil of the Netherlands, 2006
Ceral	16.1	9257500	Health concil of the Netherlands, 2006
Vegetables	44.9	25817500	Health concil of the Netherlands, 2006
Cheese	9.9	5692500	Health concil of the Netherlands, 2006
Milk/dairy	139.8	80385000	Health concil of the Netherlands, 2006
Nuts, Seeds, Snacks	10.6	6095000	Health concil of the Netherlands, 2006
Legumes	1.8	1035000	Health concil of the Netherlands, 2006
Fats, oils	17.5	10062500	Health concil of the Netherlands, 2006
Fish	3.7	2127500	Health concil of the Netherlands, 2006
Meat/Poultry	39.8	22885000	Health concil of the Netherlands, 2006
TOTAL	491.3	282497500	

ANNEX 3b; CALCULATIONS PRODUCTION

POTENTIALS			
Primary resources Mwh/ha/jaar			**source**
Potential solar energy groningen		2400	Mathias Loster, 2006
Solar energy PV (20%)		480	Own calculation
Wind turbines (6MW)		415.2	
Wind turbines (2MW)		137.016	
Geo-thermal		?	
Algaes	90000 liter biodiesel	100000€/ha	http://www.nature.com/nature/journal/v447/n7144/full/447520a.html
Sweat-salt energy	0,35MJ/m³ flowing sweet water		
Secundary resources	per capita	**groningen**	source
Human feces (kg)	60	34500000	http://www.deatech.com/natural/waste/toilet.html
Human urine	500	287500000	urine to be used as fertilizer
Organic household waste	88	50600000	http://www.senternovem.nl
Grey water (from sink and shower etc.)	33325	19161875000	
Animal waste	?		maybe not relevant. Use for fertilizing land
Greenhouse waste	?		
Agriculture waste	?		
Energy production in 1 year	**0.0050912**	**2927.44**	**(human feces+organic household waste)**
1kg organic waste = ,0000344MWh	**DIGESTION PLANT**		note: 70degree in plant,can be used for heating of houses

windmolens van 1 tot 10MW	1 windturbine nu = 2MW 1grote turbine nu=6MW (130m hoogte + 60mbladen=200m)	http://www.solar4power.com/solar-power-basics.html http://www.archiexpo.com/prod/helios-technology
10MW=17300MWh/jaar	3460mwh/jaar	http://www.milieucentraal.nl/pagina?onderwerp=Zonnepanelen http://www.lowtechmagazine.be/2007/01/watt.html
1MW=1730Mwh/jaar	4 grote turbines/km2	http://home.casema.nl/bakker1624/windenergie.htm

sun provides 1000 Wh per m² = 1 kWh/m² (1 hour sun in groningen)		
20%= .20kWh/m2	1600zonne uren per jaar (knmi)	**32Mwh/m2/jaar**
3E+06	3200MWh/ha/jaar	this is calculated with PV-cells which can transform 20% of the potention to electric energy. Also only the full
sun provindes 150Wh/m2=0.15kwh/m2	Mathias Loster, 2006	sun hours are used, while the can also provide energy
20%=0.03kwh/m2	1600zonne uren per jaar (knmi)	with cloudy weather