Baseline Report Delfland
Aquarius: Farmers as Water Managers Project

Information acquired for the Pilot area Midden-Delfland

Picture: Slinksloot, Midden-Delfland

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Contents

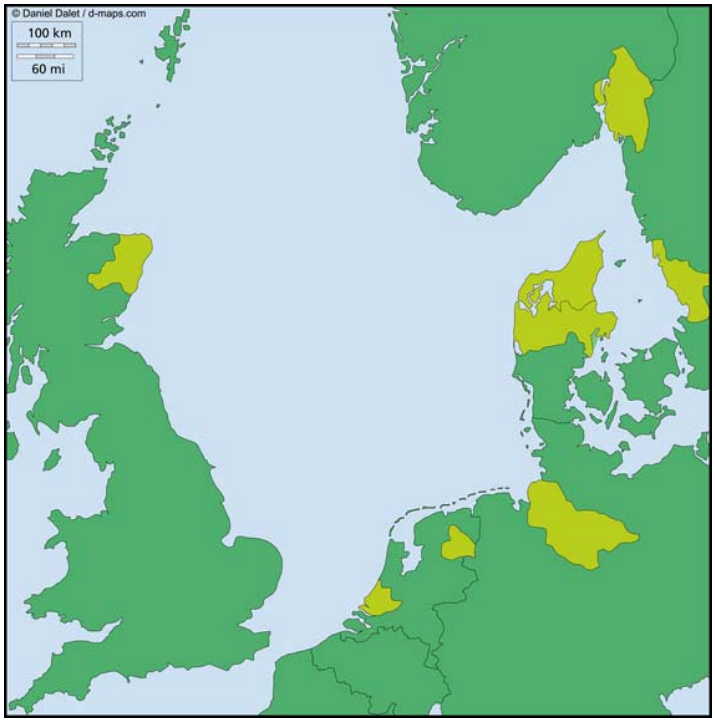
Introduction Aquarius

The Aquarius project has a common aim to find and implement sustainable, integrated land-water management through engaging with land managers.

Climate changes and stricter environmental regulations pose new opportunities for, and challenges to, farmers in the North Sea Region. Extended periods of rainfall increase erosion and input of nutrients and pathogens to water, and periods of drought hinder the ability of water to dilute diffuse inputs.

If land managers are to maintain efficient and effective agricultural production practices under these changed conditions, they must be willing to adapt their practices and manage uncertainty. This will require land managers to be involved in agreeing on the problems and taking part of action-research to create new solutions. Therefore, “Farmers as water managers” is the slogan for Aquarius.

The project involves 15 partners from seven pilot regions in six nations around the North Sea



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Purpose of the Baseline report Midden-Delfland

This report provides some selected highlights from the baseline research that has been conducted in the pilot region Midden-Delfland. The overall research process of Aquarius is a cycle of planning, negotiating, implementing, monitoring and evaluating the project. The baseline phase allows for the planning and negotiation aspects to be compared across the seven pilot regions.

The purpose of the baseline phase has been to draw together knowledge and experience from a range of sources in order to address the first aim of the project proposal of Aquarius - to 'identify common and particular constraints on farmers acting successfully as water managers'. The baseline phase therefore set out to provide a:

- Baseline description of existing land and water management and its impact on the ecosystem in the project areas
- Baseline description of the direct stakeholders, their socio-economic structures and cultural traditions in the project areas
- Baseline description of the future challenges for the farmers and the environment under changing climatic conditions.

Expert networks on the environment, economics, social, policy & legal and climatic issues set out some shared trans-national questions for each pilot region to answer. In this report you find the answers to these questions for the Midden-Delfland pilot area.

This report also formed the input of Midden-Delfland at the discussions at the transnational workshop held in Tarland on 1st – 3rd December 2009. The workshop shared information on baseline conditions, identified problems and exchanged the visions expressed by the local stakeholders for possible solutions allowing farmers to act as water managers.

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Information about the area

1. The size of the catchment

The Delfland pilot area is the local catchment 'Midden-Delfland'. Midden-Delfland is an area in south-western part of the 'Randstad'. The Randstad is situated in the western part of the Netherlands. Midden-Delfland largely consists of agricultural grassland. It is often seen as a regional park between big cities and glasshouse horticulture.

The surface of Midden-Delfland is circa 65 km^2 (6,500 ha). The villages in Midden-Delfland are Maasland, Schipluiden, Den Hoorn and 't Woudt (Figure 1).

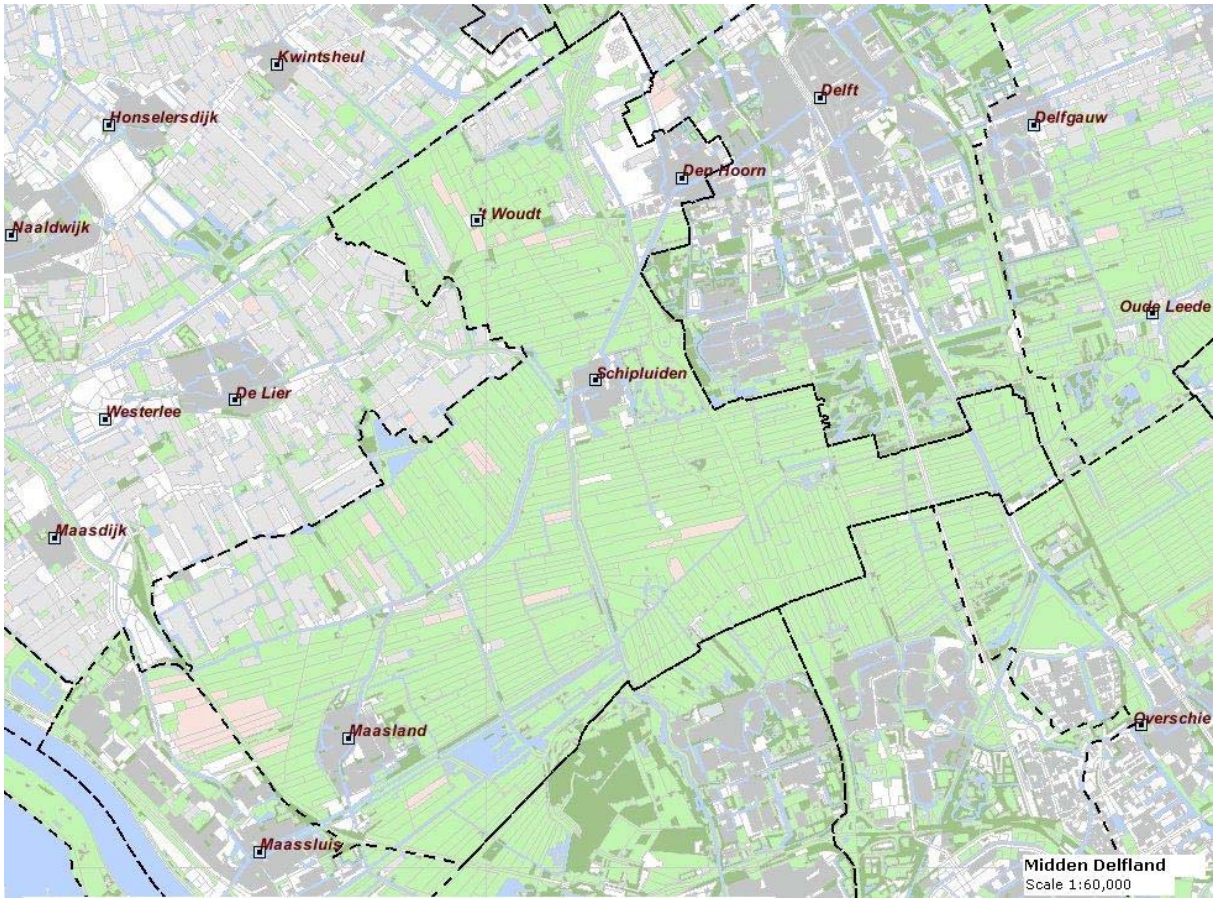

Figure 1 *In the middle: Midden-Delfland with Maasland, Schipluiden, Den Hoorn and 't Woudt.*

2. The size of subcatchment (pilot)
It is the same: 65 km^2.

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3. Topography

Midden-Delfland is characterized by an open landscape. Midden-Delfland is a historic-cultural area with the origin of agriculture as dairy farms.

The dairy farms are necessary to hold on to the open landscape. Because of them it is possible to continue the historic-cultural values in Midden-Delfland. Along with agriculture surface water in the landscape is the most important structuring factor. Surface water connects big cities - as Rotterdam and The Hague - to the rural area.

The biggest part in Midden-Delfland consists of peat-soil grassland area. The soil profile in Midden-Delfland is mainly clay and peat. Important for the barrages in Midden-Delfland are the peat dikes.

4. Land Cover & land use in catchment area

Midden-Delfland is an area with agriculture activities. Around the villages Maasland and Schipluiden there especially dairy farms established. Near Den Hoorn greenhouses are established.

't Woudt is a small village in the middle of the open landscape. Around 1/3 part of Midden-Delfland is used for recreation and appointed as nature area.

Figure 2 shows options for recreation in Midden-Delfland.

5. No. of farms/land based enterprises in the catchment area

Midden-Delfland is an area with agriculture activities (% in 2005):

- Agriculture farms: 8.30%
- Horticulture and crop farms: 8.60%
- 'Grazing cattle' 82.60%
- The rest: 0.50%

Gross of Midden-Delfland consists of dairy farms. Around 80 farms are working in the total area of Midden-Delfland. There are small numbers of greenhouses in Midden-Delfland (especially in Den Hoorn).

6. Population density in the catchment area

There live circa 17,000 people and the population density is around 369 persons per km^2 (at January 2009).

The housing density is around 140 per km^2 (at January 2008).

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7. Typical Farm Size

The average surface of dairy farms in Midden-Delfland is 30 ha. The average size of the greenhouses in Midden-Delfland is unknown.

8. No. of Ha by different branches

Around 1/3 part of the area is used for recreation and appointed as nature area. Most of the other part of Midden-Delfland is used as grassland.

The surface of the different cultivation of Midden-Delfland in 2008 is as follows (%):

- Agriculture: 18.30%
- Horticulture: 0.30%
- Greenhouse horticulture: 6.40%
- Grassland: 75.00%

9. Animal density

Unknown.

10. Employment in primary, land based sector (including self employment) out of total employment in catchment area

With the current information it is not possible to describe the situation in Midden-Delfland.

11. Primary pilot problem

The primary pilot problems are excessive water with climate change and high nutrient concentration in surface water.

12. Is the catchment similar to other catchments in country

Yes

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Figure 2 *Midden-Delfland*

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The Delfland pilot area is the local catchment 'Midden-Delfland'. This area consists of several 'polders' with al lot of ditches and a system of canals on a higher waterlevel. These canals are a part of one out of seven waterbodies Delfland is divided into according to the WFD. This waterbody is called the 'Westboezem'. In the pilot area is also another WFD-waterbody in the 'Holierhoekse- en Zouteveense polder'. The other polders are too small according tot the WFD for giving the status of WFD-waterbody.
In the southwest part of the pilot area is more influence of groundwater caused by the nearby situated river 'Nieuwe Waterweg'. This influence causes for example higher concentrations of chloride in the surface-water. Especially in the northwest part of the area the influence is shown of the losses of nutrients and pesticides by the greenhouses. Her you can find high concentrations of nutrients and incidentally extremely high concentrations of pesticides.

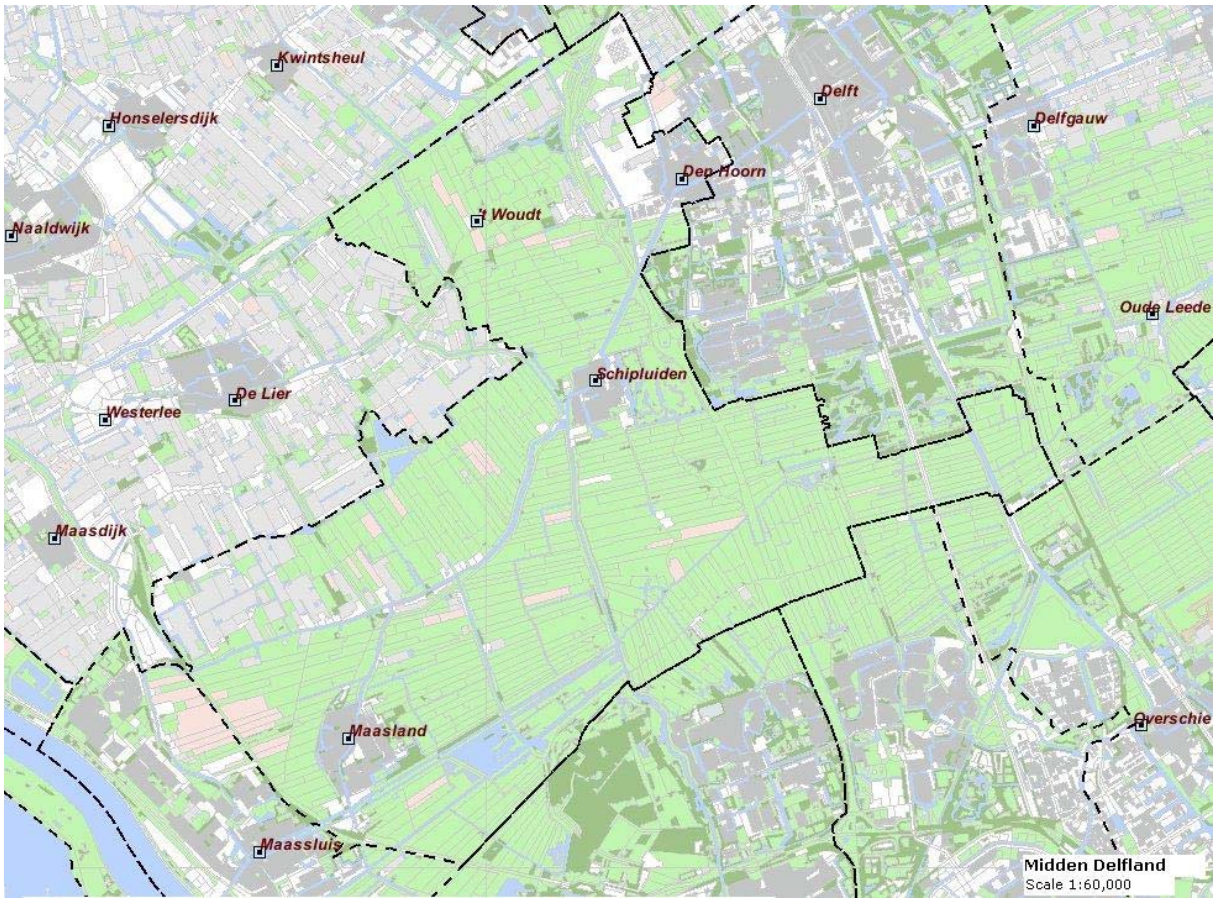

Figure 3 *Location of the pilot area.*

Type of Waterbody: Ditches and canals
The canals in this area are about 10-50 m wide en 2 m deep. The greater parts of the ditches are less then 5 m wide en about 0.5 m deep. A small number is more then 10 m wide and about 1 m deep. The rest of the ditches vary between these categories.

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Main problem: Eutrophication

The water quality in the polders, including de WFD-waterbody Holierhoekse- en Zouteveense polder, is poor due to excessive growth of green algae and duckweed. This is caused by the high concentrations of nutrients. Beside the eutrophication, there is a problem of the pesticide imidacloprid, sometimes other pesticides and the heavy metals copper and zinc.

In the canals (WFD-waterbody Westboezem) are also high concentrations of nutrients that sometimes cause excessive growth of green algae. There is not always a big bloom of algae, in spite of the high concentrations of nutrient, because the residence time of water in the canals is very short during a large part of the year. Other problems in these canals are the concentrations of pesticides, copper en zinc and that there is not enough space for macrophytes. Almost in all surface water in the pilot area the population of fish is too high and not in balance for a good ecological status.

What is the ecological status today?

The ecological status of de official WFD-waterbodies Westboezem and Holierhoekse- en Zouteveense polder is quite far from the good ecological status. This situation is almost similar in the other polders (ditches) in the pilot area.

Do you expect good ecological status by 2015?

No, but we expect a respectable improvement in water quality compared to the situation in 2005.

What is the impact and importance of agriculture?

For one of the polders, the WFD-waterbody Holierhoekse- en Zouteveense polder (figure 4), the sources of nutrient loads are analysed. The surface area of this polder is about 11,3 km^2. The results of these analyses are given in figure 5 en 6.

Figure 4 *The Holierhoekse- en Zouteveense polder.*

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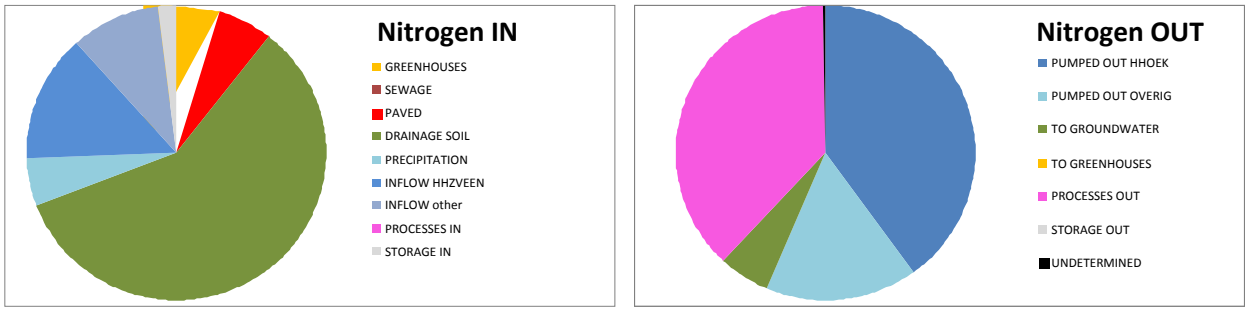
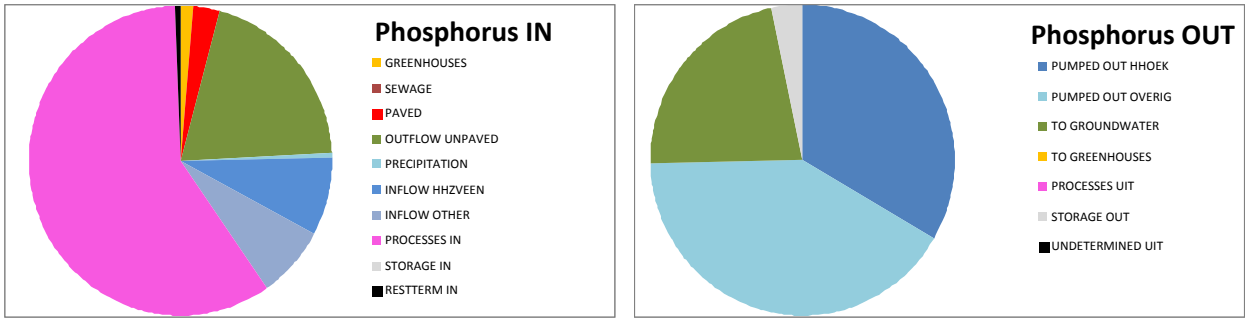


Figuur 5 *Nitrogen loads from different sources in one of the polders in the current situation (total 54 tons)*

The main source of nitrogen load, about 60%, is the drainage from the soil(green). This source is a combination of drainage of nutrients, seepage, and the release of nitrogen caused by the mineralization of peat. This source is for a part influenced by agricultural activities (dairy farms). Also the other agricultural category, de greenhouses (yellow), is responsible for about 5%. About 15% of the nitrogen load is coming into the polder with water that is used for keeping the surface water in the polder on the official water level. The largest part of nitrogen is pumped out of the polder with excessive water and via chemical processes (for example denitrification).



Figuur 6 *Phosphorus loads from different sources in one of the polders in the current situation (totaal 14 tons)*

The sediment release from the soil and mineralization of peat (pink colour) is responsible for 2/3 part of the total phosphorus load. This is also influenced by activities of the dairy farms. The greenhouses are responsible for a very small part of the phosphorus loads (1%). The largest part of phosphorus is pumped out of the polder with excessive water.

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What are the expected impacts of climate change?

Milder winters and more rainfalls with high intensity are expected. There may be a larger risk for flooding. Flooding of agricultural areas causes larger P release from the soil to the water body.

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Economic Baseline

The aim of this chapter is:

The main questions to be evaluated on the basis of the below data are:

- What are the common financial and economic related possibilities for farming within and across pilot areas?
- What are the common financial and economic related obstacles for farming within and across pilot areas?
- On that basis what are farmer's possibilities for acting as water managers under present conditions

The below data is collected through available statistics. When available regional statistics are used otherwise national statistics.

Data collected for Main branch Midden-Delfland: Milk cattle

Issue	**Data**	**Data Source / how to present**
Gross output defined as the value of production including change in stock of products produced on the holding but excluding internal transfers	Yearly reporting for past 5 years and as a 5 year average. 2004 € 202500 2005 € 220900 2006 € 230700 2007 € 301300 2008 € 282.000	Regional statistics if available Only national Compare with national statistics € 247.480,- average
Average net income for full time land based enterprise in the catchment area related to same average on a national basis; i.e. benchmark against nation Average income is	Yearly reporting for past 5 years and as a 5 year average. 2004 € 39.700 2005 € 59.400 2006 € 48.500 2007 € 96.500	Regional statistics if available Only National Compare with national statistics € 58.860, average

defined as operating profit, wage income, pension, etc. - Including self-employment Excl. change in value of the land based enterprise	2008 € 50.200	
How large pct. of part time/ hobby farmers land based enterprises comes from the land based enterprise in the catchment area related to same average on a national basis; i.e. benchmark against nation	Yearly reporting for past 5 years and as a 5 year average. Including self-employment Excl. change in value of the land based enterprise National figures: 2003 12,3% 2004 12,4% 2005 12,8% no other figures available	Regional statistics if available Compare with national statistics
Agricultural assets defined as value of the holding including land, buildings. Equipment and stock, but not financial assets	Yearly reporting for the past 5 years 2003 € 145.500 2004 € 147 000 2005 € 139 500 2006 € 145.500 2007 € 151500	Regional statistics? If not use national statistics national € 145.800,-

Net profit for land based businesses Net profit is defined as operating profit minus net interest expenditure plus general subsidies, and is as such defined as profit before remuneration	Full-time holdings in the catchment Indicate in 25 and 75 quartile group and as average Yearly reporting for the past 5 years and as a 5 year average. 2004 2005 2006 2007 2008	Regional statistics? If not use national statistics Presented in table
Net profit by branches Net profit is defined as operating profit minus net interest expenditure plus general subsidies, and is as such defined as profit before remuneration Milk cattle	Full-time holdings in the catchment Indicate in 25 and 75 quartile group and as average Yearly reporting for the past 5 years and as a 5 year average. 2004 -/- € 72.300 2005 -/- € 36.800 2006 -/- € 65.900 2007 -/- € 14.200 2008 -/- € 41.200 Indicate for the following branches: crop, animal (cattle, milk, other cattle output, pigs, poultry, fur-bearing animals, etc). forestry and others if appropriate	Average € -/- 46800

	Milk cows Average stock 66,9 z 2003 63 2004 64 2005 64,6 2006 68,2 2007 70,8 2008 70,8	
General subsidies defined as single payment scheme and other subsidies from primarily improvement schemes, like for instance subsidies for young farmers.	The past 5 years and as a 5 year average. Average € 5.964,91 figures available all subsidies whole agricultural company's 2003 € 3783,00 2004 € 4069,41 2005 € 4176,79 2006€ 6.697,85 2007 € 11.097,51 average EU subsidy milk cattle € 38.916,6 Total EU subsidy 2007 € 52.026 2003 47904	National statistics Average Pie chart

	2004 48473 2005 53060 2006 54909 2007 52026	
Part of income based on EU agri-environmental or National agri-environmental schemes incl. organic production	Uptake of agri-env schemes The past 5 years and as a 5 year average.	National statistics Pie chart
Part of property financed by Banks, mortgage, others	The past 5 years and as a 5 year average. Indicated as pct of value of property Figures are only available over the last 3 years **2005D 2006D 2007V** Savings 12.600 16.600 11.900 deprecation 39.700 41.900 46.300 Other 11.700 -3.300 16.700 Own Capital 64.000 55.200 74.900 Long borrowed capital(morgage) 36.200 25.400 42.600 Useble capital 100.200 80.600 117.500	National statistics or banks and or mortgage

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	Costs				
	Gross investments invest)		91.400	48.200	120.200
	Mutation				
	workcapital (exclusief liquide middelen)		4.200	14.400	-1.600
	w.v.	*Supply's*	*3.700*	*3.800*	*3.300*
		credits	*1.600*	*4.800*	*8.300*
		Short borrowed capital (-)	*1.000*	*-5.700*	*13.200*
	Mutatie liquide middelen		4.600	18.000	-1.100
	Totaal bestede middelen		100.200	80.600	117.500
Conditions for financing investments	General guidelines for how big of part of property which can be financed by Mortgage (pct of value of property)				Guidelines by mortgage instates and/ or banks Interest rate for environmental investments for milk based production farms Rate -0,5% lower than market rate By RABO-Bank

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Special economic conditions from banks and/or mortgage institutions, for instance interest rate if project is sustainable (green bank)?	Interest rate, or..?? Past 5 years and as a 5 year average.	Banks (Esther please specify or delete the question!) Green investment bank Rate = 0,5%- 1% lower than market rate. Tax reduce for environmental investments Between 25 and 60% = Limited: sustainable production machines/tools 2 climate change 3 reduce air pollution 4 health 5 machines and transporting methods 6 safety and security 7 biodiversity and natural investments 8 recycling and reduces of raw materials 9 waste reduction
Concluding sentence on economic conditions for farming. If possible compare regional and national statistics	The (milk) cattle (cows) is an industry under pressure. And gets a lot of subsidy compared with other agricultural branches.	Summary sentence

Sociological Baseline Questions

Introduction - why we need to know of actions, attitudes and visions of both land users, advising and authorities:

"The farmer as water manager" means that the land user needs to adopt a new land management practice. When the land user changes practice the authority needs to make some adjustments as well, since administrations act and react to the land users' actions. Therefore "the Farmer as Water Manager" is closely connected to new administrative practices. →

New practises mean new competencies for those who administrate. Just as much as we need to know what personal and social resources we can draw upon among land users in the pilot area, we need to know what organizational resources and what practices are present with the relevant authorities.

→ New practises also mean new competencies for those who advise. The primary objective of the advisory service is to inspire the land user as to which actions to take. Therefore when the land user's actions change, the advisory service has to do so as well – or the other way around.

In order to make people or organizations change their attitudes, visions and their way of acting, we need to know their present attitudes, visions and way of acting.

As to the advisory services and authorities we are primarily interested in organizations.

We need to know, what the *organisational* resources are that are brought into the project with respect to the organisations' primary functions, in this case advisory service and/or the enactment of authority.

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Questions Authorities

Waterboard Delfland, department Policy & Research

1)	**What is the main aim of your organization as a whole?** Management of water quantity and quality of the surface water. Including management of sewage water purification plants.
2)	**What are your remits and responsibilities with respect to land use and water management?** Regional water management
3)	**What kind of tools do you apply in your rural administration in order to affect land managers' behaviour?** - Regional water policy plan - Regulations - Licenses - Stimulation subsidies. - Communication - Cooperation in research and pilot projects All related to Water and Nature conservation
4)	**In the administration, what experience do you have with direct cooperation with land users and their organizations as to the solution of environmental problems?** - project maintainance of Nature-Friendly Waterbanks with farmers (project natuurvriendelijke oevers Delfland): co-operation during 6 years. - project reducing use and loss of nutrients (starting op) Projects on a voluntary basis with groups of individual farmers and intermediate farmer organisations (LTO and Vockestaert). **What kind of cooperation? – More kinds?** **What kind of experience? - More?** - Discussions with intermediate farmer organisations about planning measures

	about water storage (anticipating on Climate change) and improving water quality (ABC-Wateropgave Delfland, KRW opgave Delfland, Waterplan Midden-Delfland).
5)	**What units within your organization have been involved?** Water quantity, water quality, policy makers, research, Finance
6)	**What educational fields are present within your unit of administration?** Water engineering, biological, ecological, Water modelling
7)	**When, as an authority, you make decisions concerning water quality, water quantity and climate change – who will be your official hearing parties?** Province, Municipals, Farmers organisation, Nature and Recreation organisations
8)	**Who may be your unofficial sparring partners with respect to decisions concerning water quality, water quantity and climate change?** Research institutes, advisory companies, union of Water Boards
9)	**I'd like you to describe your cooperation with other sections within your organization in matters concerning the pilot area.** **Who do you cooperate with?** Specialists of Water quantity and quality, EG-projects, Department of Water maintenance, accountholders pilot area, Administrators. **How do you cooperate?** Participate in internal project team or consulted as ad hoc advisors
10)	**I'd like you to describe your cooperation with other authorities in matters concerning the pilot area.** **Who do you cooperate with?** Leading Project group existing of Water Board, Municipal Midden-Delfland, Waterkader Haaglanden, Stadsgewest Haaglanden

	Ad hoc consulting Farmers organisations and Nature Boards. **How do you cooperate?** Making plans within Project group. Communicate with Farmer organisations.
11)	**How do you reckon that politicians and the political agenda have an impact on your day-to-day manoeuvring?** Politicians have expectations on concrete measures who anticipate on Water goals, Climate change and could be implemented with cooperation of local farmers.
12)	**What values are constitutive to your organization?** Improvement of Water quality, Avoiding Water problems, **Are there more important values?** Sustainable goals and measures, efficiency
13)	**What values are constitutive to your administrative unit?** See above **Are there more important values?**
14)	**Thinking of water condition objectives at local level. What are the present possibilities of farming / forestry / gardening in the pilot area?** **Do the same possibilities apply to the catchment area?** - Surface water is available for sprinkling - Maintenance of nature banks by farmers - On a voluntary basis reduce loss of nutrients by efficient use of fertilizers
15)	**Referring to land users' usage of various agri-environmental measurements and schemes, what do you think of "efficiency of means"?** To use the water more efficient we need more data and practical experience

Municipal Midden-Delfland

1)	**What is the main aim of the municipal as a whole?** Planning and maintaining local fysical planning, environment, infrastructure and landscape.
2)	**What are remits and responsibilities of the municipal with respect to land use and water management?** Maintenance of green, wide landscape in urban area. Collecting local wastewater.
3)	**What kind of tools does the municipal apply in rural administration in order to affect land managers' behaviour?** - Local fysical plan - Local Waterplan - Regulations - Licenses - Green fund for nature measures by farmers - Communication - Cooperation in research and pilot projects
4)	**In the administration, what experience does the municipal have with direct cooperation with land users and their organizations as to the solution of environmental problems?** - Setup and maintenance of Green fund Midden-Delfland. - Cooperation in projects on a voluntary basis with groups of individual farmers and intermediate farmer organisations (LTO and Vockestaert). **What kind of cooperation? – More kinds?** **What kind of experience? - More?** - Discussions with intermediate farmer organisations about fysical planning (such as: Landschapsontwikkelingsplan en Bestemmingsplan Midden-Delfland).
5)	**What units within the organization have been involved?** Fysical planning, maintenance, environment

6)	**What educational fields are present within the unit of administration of the municipal?** Civil engineering, ecological
7)	**When, as an authority, the municipal makes decisions concerning water quality, water quantity and climate change – who will be the municipals official hearing parties?** Water Board, Province, Farmers organisation, Nature and Recreation organisations
8)	**Who may be the municipals unofficial sparring partners with respect to decisions concerning water quality, water quantity and climate change?** Research institutes, advisory companies, union of Municipals
9)	**How is the cooperation with other sections within the organization in matters concerning the pilot area:** **Who does the municipal cooperate with?** Specialists environment, accountholders pilot area, Administrators. **How does the municipal cooperate?** Participate in internal project team or consulted as ad hoc advisors
10)	**I'd like you to describe your cooperation with other authorities in matters concerning the pilot area.** **Who do you cooperate with?** Participate in Project group existing of Water Board, Municipal Midden-Delfland, Waterkader Haaglanden, Stadsgewest Haaglanden Ad hoc consulting Farmers organisations and Nature Boards. **How do you cooperate?** Making plans within Project group. Communicate with Farmer organisations.
11)	**How does the municipal reckon that politicians and the political agenda have an impact on your day-to-day manoeuvring?** The pilot area should be kept open, green, with a sustainable farmer community. Politicians have expectations on concrete measures who anticipate on Water goals, Climate change and could be implemented with cooperation of local farmers.
12)	**What values are constitutive to the municipal organization?**

	Avoiding Water problems, no big lost of land due to measures. **Are there more important values?** Sustainable goals and measures, efficiency
13)	**What values are constitutive to the municipal administrative unit?** See above **Are there more important values?**
14)	**Thinking of water condition objectives at local level. What are the present possibilities of farming / forestry / gardening in the pilot area?** **Do the same possibilities apply to the catchment area?** - Surface water is available for sprinkling - Maintenance of nature banks by farmers - On a voluntary basis reduce loss of nutrients by efficient use of fertilizers
15)	**Referring to land users' usage of various agri-environmental measurements and schemes, what does the municipal think of "efficiency of means"?** To use the water more efficient we need more data and practical experience

Current legal framework

The aim of this chapter is:

To give an overview of the national regulative framework in which the pilot Midden-Delfland is situated.

Issue	**Data**	**Data Source**
Ecological policy relevant to farmers as Water Managers in a national context	National acts implementing WFD: SGBP Rijn-West Flora & fauna act	National acts
Financial support schemes/ outline directly relevant to farmers as Water mangers	Green Blue Services catalogue	National schemes
Legally binding Area Plans (National, regional, local)	National: National Water Plan Nota Fysical Plannig (Nota Ruimte) Regional: Water Plan South Holland Fysical Plan South Holland (provincial structuur visie) Water Plan Water Board Delfland Local: Landscape Development Perspective (LOP = Landschapsontwikkelingsperspectief Midden-Delfland 2025)	National, Regional, Local

Scenarios for future climate

A. Climate change in the past

1. Do you have information about climate change from the past till now

Yes, > 50 years ago

2. If yes describe effect on:

Temperature

Since 1880 the world average temperature increased with 0,6°C. Especially in the second half of the 20st century there was a strong temperature rise. The warmest years since 1860 were found in 1995, 1997, 1998, 2001, 2002 and 2003.

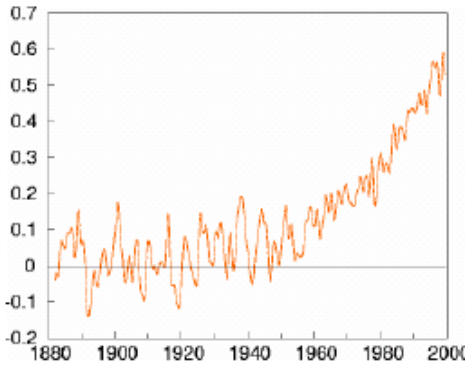

Fig.1 The world average temperature rise

In The Netherlands the average temperature rise (average over more than 10 years) is comparable to the world average temperature rise. The last decades the temperature rise was more than 1,5 * the world average temperature rise (due to changes in wind direction).

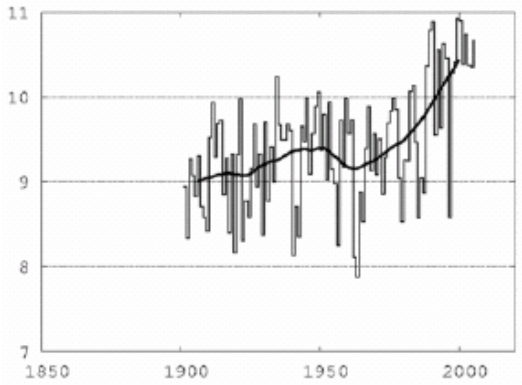

Fig. 2 The average temperature (°C) in The Netherlands (De Bilt) between 1900 and 2005.

Between 1940 and 1970 cold weather was dominating The Netherlands. The first 10 and last 30 years of the 20st century were much warmer than the world average trend. Since 1980 late winters and early springtimes became warmer due to stronger southwest winds. In the last decades (after 1975) there was an increase in warm days due to temperature rise. The last 15 years the lenght of the growing season increased with 24 days (293 days average).

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Precipitation

In the Northern Hemisphere (Northwest Europe) and The Netherlands of the 20st century the precipitation increased with 5 to 10% in average. The last 50 years in europe the rain intensity and number of days with heavy rain increased aswell.

Between 1906 and 2003 the 1-year average rainfall in the Netherlands increased with 118 mm (18%). In winter, spring, autumn and summer the total amount of rainfall increased with respectively 26%, 21%, 26% and 3%. Since 1906 the highest total amount of 10-days rainfall in winter increased with 29%.

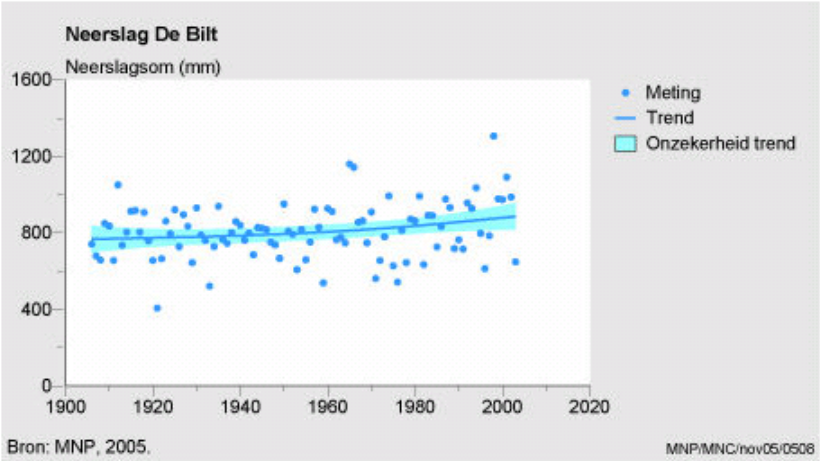

Fig. 3 Precipitation (year amount) in The Netherlands (De Bilt) between 1906

Evaporation

There is no information available yet (more research is needed).

More quantitative information: Seelevel rise

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In the last 100 years the average seelevel rise alongside the Dutch coast was about 20 cm (0,2 cm a year), due to temperature rise (causing landice to melt and oceanwater to distend). Between 1993 and 2005 the average seelevel rise alongside the Dutch coast was about 0,3 cm a year. Probably due to changes in ocean currents aswell.

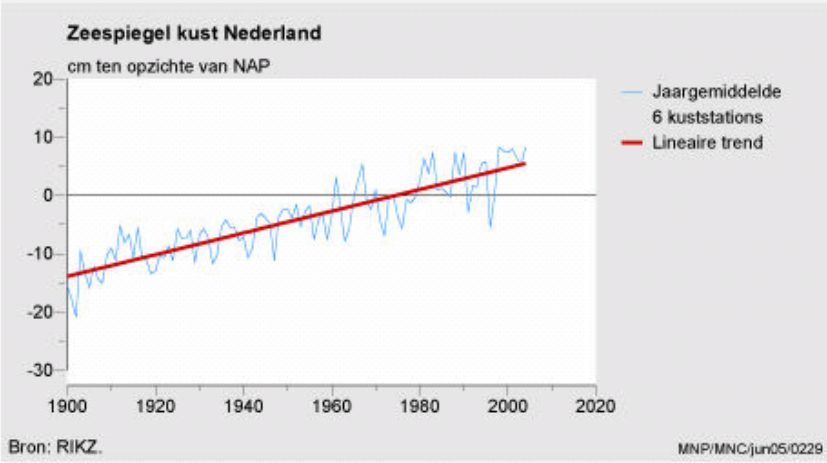

Fig 4. Average seelevel rise alongside the Dutch coast between 1900 and

The relatively seelevel rise alongside the Dutch coast is the result of seelevel rise and soil decline. The average soil decline in the Netherlands of the 20st century ranged from 0 to 0,4 cm a year.

Resume

From past (>50 years ago) till now:

- Temperature in summer is rising (increasing length of growing season);
- Temperature in winter is rising (late winter, early spring);
- Precipitation in summer is hardly rising (3%);
- Precipitation in winter is rising (october-march);
- Evaporation in summer: no information available yet (more research is needed);
- Evaporation in winter: no information available yet (more research is needed).

B. Current climate

3. Describe current climate in the pilot regionDelft

Table 1. Current climate: averages and extremes over 1971-2000 in a) the pilot area Midden-Delfland (weatherstation Rotterdam) and the Netherlands (De Bilt) and b) in 2008 in The Netherlands (De Bilt).

		1971-2000		2008
Normals		**Rotterdam**	**De Bilt**	**De Bilt**
Temperature (year)	Average	10°C	9,8°C	10,6°C
	Winter *	3,8°C	3,3°C	5,1°C
	Summer **	16,5°C	16,6°C	17,3°C
Precipitation (sum)	Average	815,5 mm	795 mm	881 mm
	Winter	193 mm	193 mm	212 mm
	Summer	205,2 mm	200 mm	280 mm
Evaporation (sum)	Average	n.i.	542,7 mm	?
	Winter	n.i.	29,2 mm	?
	Summer	n.i.	258,4 mm	?
Extremes				
Temperature >=30°C	Year	2 days	3 days	1 day
	Summer	2 days	3 days	1 day
Temperature <=-10°C	Year	2 days	3 days	0 days
	Winter	2 days	3 days	0 days
Drought	Year	151 days	109 days	?
	Winter	32 days	21 days	?
	Summer	44 days	33 days	?
Precipitation >=10 mm	Year	5 days	5 days	?
	Winter	6 days	6 days	?
	Summer	21 days	22 days	?
Snowfall	Year	23 days	25 days	0 days
	Winter	15 days	17 days	0 days

n.i. = no information available; ? = more research is needed.

* Winter: December, January, February. ** Summer: June, July, August;

- 2008: the 12th warm year in line and the 9th warm year since 1901;
- Winter 2007/2008: Very warm, very sunny and the normal amount of precipitation;
- Summer 2008: Wet, warm and the normal amount of sunshine.

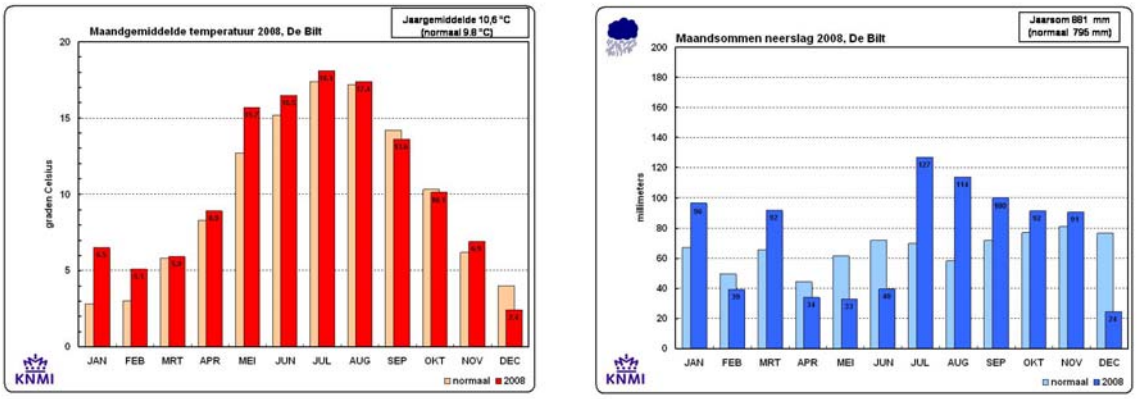

Fig 5. Temperature (average/month) and precipitation (sum/month) in The Netherlands (De Bilt) in 2008.

4. Describe the effect of the current climate on the pilot area Midden-Delfland

Climat scenario's in 2050 are incorporated in the modelstudies on waterproblems in Midden-Delfland; waterproblems in terms of too much water. The results of these modelstudies are taken into account in the todays watermagement activities in Midden-Delfland. For example, the construction of extra waterstorage or the change in dimensions of dikes.

C. Climate change

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5. *Describe the Dutch climate scenario's*

Dutch Climate scenario's related to IPCC

The climate scenario's for the Netherlands are based on the simulations of global climate models for the 4th Assesment Report of the Intergovernmental Panel Climate Change (IPCC). Based on the IPCC-results are region specific scenario's developed for seelevel rise in the eastern part of the Atlantic Ocean and windspeed in the Noordzee area. The two key-variables are: world average air temperature and western air circulation patterns. This resulted in 4 different Dutch climate scenario's concerning precipitation, temperature and evaporation potential. The climate scenario's are: Moderate (G), Moderate+ (G+), Warm (W) and Warm+ (W+). They differ in: 1) world average temperature rise (1°C or 2°C) between 1990 and 2050 and 2) change in West-European air circulation patterns.

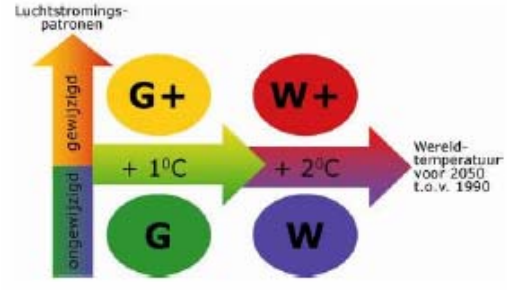

Fig 6. The position of the Dutch climate

Dutch climate scenario's in 2050

Table 2. Dutch climate scenario's in 2050 compared to 1990.

2050		**G**	**G+**	**W**	**W+**
World average temperature rise		+1°C	+1°C	+2°C	+2°C
Change in West-European air circulation patterns		No	Yes	No	Yes
Winter	Average temperature	+0,9°C	+1,1°C	+1,8°C	+2,3°C
	Coldest day/year	+1°C	+1,5°C	+2,1°C	+2,9°C
	Average precipitation	+4%	+7%	+7%	+14%
	Number of rainy days (≥0,1 mm)	+0%	+1%	+0%	+2%
	Exceeding the 10-days total rainfall amount	+4%	+6%	+8%	+12%

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	Highest day average windspeed/year	+0%	+2%	-1%	+4%
Summer	Average temperature	+0,9°C	+1,4°C	+1,7°C	+2,8°C
	Warmest day/year	+1°C	+1,9°C	+2,1°C	+3,8°C
	Average precipitation	+3%	-10%	+6%	-19%
	Number of rainy days (≥0,1 mm)	-2%	-10%	-3%	-19%
	Exceeding the 10-days total rainfall amount	+3%	+5%	+27%	+10%
	Evaporation potential	+3%	+8%	+7%	+15%
Seelevel	Absolute rise	15-25 cm	15-25 cm	20-25 cm	20-35 cm

Resume

- Dutch climate scenario's are related to Moderate rise in temperature:1°C or 2°C;
- The climate change is calculated for the national scale;
- The average temperature in summer will change between +0,9 to +2,3°C;
- The average temperature in winter will change between +0,9 to +2,8°C;
- The average precipitation in summer will change between +3 to -19%;
- The average precipitation in winter will change between + 4 to +14%;
- The average evaporation in summer will change between +3 to +15%;
- There will be no (change in) evaporation in winter.

6. Describe climat scenario's for the pilot area Midden-Delfland

The climate scenario's for the pilot area Midden-Delfland are based on the general trends in the Dutch climate scenario's. Probabilities (estimations by expert judgement) have been ascribed to the Dutch climate trends.

Table 3. Climate trends en probabilities for the pilot area Midden-Delfland

Climate trend	**Probability**	**Probability in %**
Seelevel rise	Most likely	> 90

Temperature rise	Most likely	> 90
Decrease in number of very cold days (frost)	Most likely	> 90
Increasing evaporation in summer	Most likely	> 90
Increase in heat wave	Most likely	> 90
Increase in winter precipitation (average)	Likely	66 - 90
More rain and an increase in extreme rainfall or a decrease in snowfall in winter	Most likely	> 90
Decrease in summer precipitation	Likely	66 - 90
Increase in summer rain intensity	Likely	66 - 99
Increase in windspeed during storm events	Fifty-fifty	33 - 66
Change in wind direct or patterns	Fifty-fifty	33 - 66

The following indirect climate variables should be considered:

- increase in surface water level and watertransport of rivers in winter;

- decrease in watertransport of rivers in summer;

- decrease in surface- and groundwater level in summer;

- increase in precipitation due to warm seawater in autumn.

7. *What is the impact of climate change on water management in the pilot area Midden-Delfland (waterquality and -quantity)*

The impact of climate change on water management in the pilot area Midden-Delfland concerns watersafety, waterquantity, waterquality and waste water purification. Here we focus on waterquantity and -quality. For information about the impact of climate change on watersafety and waste water purification is refered to table 4. Extra information is available, if needed.

<u>Waterquantity: too much</u>

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- Surfacewater problems:
    - Growing probability of high waterlevels due to heavy rain;
    - More flooding in the urban areas (drainage water and surfacewater);
- Waterlevel control problems:
    - Increasing number of days with a strong westwind;
    - The polder area need to be drained more often and over an increasing difference in waterlevel due to seelevel rise and increasing watertransport of rivers;
- Groundwater problems:
    - Groundwater rise all year round;
    - More pressure on upward groundwater flows in undrained river zones;
    - Increasing transport of drained groundwater to surfacewatersystems in drained river zones;
    - Increasing structural groundwater problems in urban areas due to relatively large distances between ditches, the absence of a drainagesystem or a bad contruction or maintenance of the drainagesystem;
    - Possible formation of watersources in areas with a thin upperground layer.

Waterquantity: too little

- Watershortage:
    - More need for constant waterlevel control and surfacewater refreshing;
    - Decrease in freshwater supply due to the import of surfacewater that is influenced by seawater (salinated surfacewater);
- Surface waterlevel control:
    - Lowering surface waterlevels;
    - More plant growth;
    - More floating garbage close to waterstructures;
    - Less availability of cooling water (for hydraulic engines) due to higher riverwater temperatures;
- Groundwater shortage:
    - Lower groundwater levels causing a descente of the upper groundlayer, damage to foundations, agricultural damage, etc.;
    - Descente of the deeper soillayer due to higher decomposition rates of organic matter;

Waterquality: surfacewater

- Higher amounts of nutrients and chloride in the watersystem, due to strong upward groundwater flows, higher decomposition rates of peat-soil, higher amounts of drainage water, waterreduction by evaporation, watersupply of bad waterquality, higher influxes of nutrients, etc.;
- Increase in denitrification rates;
- Oxygen-poor water becomes more likely;
- The appearance of exotics and plaques;
- Watertemperature rise causing turbidity, growth of alges and duck-weed;
- More plant growth and increasing growth rates causing a higher maintenance frequency;
- Accumulation of (organic) pollutants, etc.

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Waterquality: ecology

- Higher risk of botulism and mortality of waterbirds;
- Higher growth rates of alges causing bad conditions for waterplants and fauna;
- Dessication of (parts of) the watersystem causing the loss of rare species;
- Change in composition of species;
- Extinction of species

Waterquality: groundwater

- Europhication of upper groundwater due to higher decomposition rates of organic matter;
- Higher amounts of nutrients and chloride in the groundwatersystem due to strong upward groundwater flows,

Resume

Table 4. The impact of climate change on water management in the pilot area Midden-Delfland.

Impact of climate change	**Water management**	**Effect on**
Seelevel rise	-	- River + polder dikes - Waterquality & Ecologie - Deeper groundwater + salination
Temperature rise	-	- Watersupply + drought - Emissions, waterpurification systems, water drainage systems - Waterquality & Ecologie - Deeper groundwater
Decrease in number of very cold days (frost)	-	- Waterquality

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Increasing evaporation in summer	-	- Polder dikes - Watersupply + drought - Emissions - Waterquality & Ecologie - Deeper groundwater + salination - Upperground waterquality - Soil decline + stability
Increase in heat wave	-	- Polder dikes - Waterquality & Ecologie - Soil decline + stability
Increase in winter precipitation (average)	-	- River dikes + polder dikes - Waterquantity + waterlevel control - Emissions, waterpurification systems, water drainage systems - Waterquality & Ecologie - Deeper groundwater - Upperground waterquality - Soil decline + stability
More rain and an increase in extreme rainfall or a decrease in snowfall in winter	-	- Polder dikes - Waterquantity + waterlevel control - Emissions, waterpurification systems, water drainage systems - Waterquality & Ecologie
Decrease in summer precipitation	-	- Polder dikes - Watersupply + drought - Emissions - Waterquality & Ecologie - Deeper groundwater + salination

		- Upperground waterquality - Soil decline + stability
Increase in summer rain intensity	-	- Polder dikes - Waterquantity + waterlevel control - Emissions, waterpurification systems, water drainage systems - Waterquality & Ecologie - Deeper groundwater - Upper groundwater quality - Soil decline + stability
Increase in windspeed during storm events	-	- River dikes + polder dikes
Change in wind direction or patterns	-	- Polder dikes

- = negative impact.

8. What is the impact of climate change on farmers in the pilot area Midden-Delfland

In the pilot area Midden-Delfland agriculture is mainly represented by grass used by Dairy farms. Just a very small part of the pilot area is in use for glass culture.

The impact of climate change (temperature rise, increasing evaporation in summer, decrease in summer precipitation, seelevel rise, increase in winter precipitation, increase in summer rain intensity) on farmers is:

- Agricultural damage by salination of surfacewater and watersources;
- Need for more fresh water to prevent internal salination and watershortages.
- Deterioration of the surfacewater quality due to changing groundwater levels causing mobilisation of nutrients (phosphorus) and pollutants (heavy metals).

Table 5. The impact of climate change on farmers in the pilot area Midden-Delfland.

Impact of climate change	Grass (Dairy farms)	Glass culture
Seelevel rise	-	-
Temperature rise	-	-
Decrease in number of very cold days (frost)	n.i.	n.i.
Increasing evaporation in summer	-	-
Increase in heat wave	n.i.	n.i.
Increase in winter precipitation (average)	n.i.	n.i.
More rain and an increase in extreme rainfall or a decrease in snowfall in winter	n.i.	n.i.
Decrease in summer precipitation	-	-
Increase in summer rain intensity	-	-
Increase in windspeed during storm events	n.i.	n.i.
Change in wind direction or patterns	n.i.	n.i.

n.i. = no information. This may be considered as there is no agricultural impact known yet (0);

- = negative impact

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