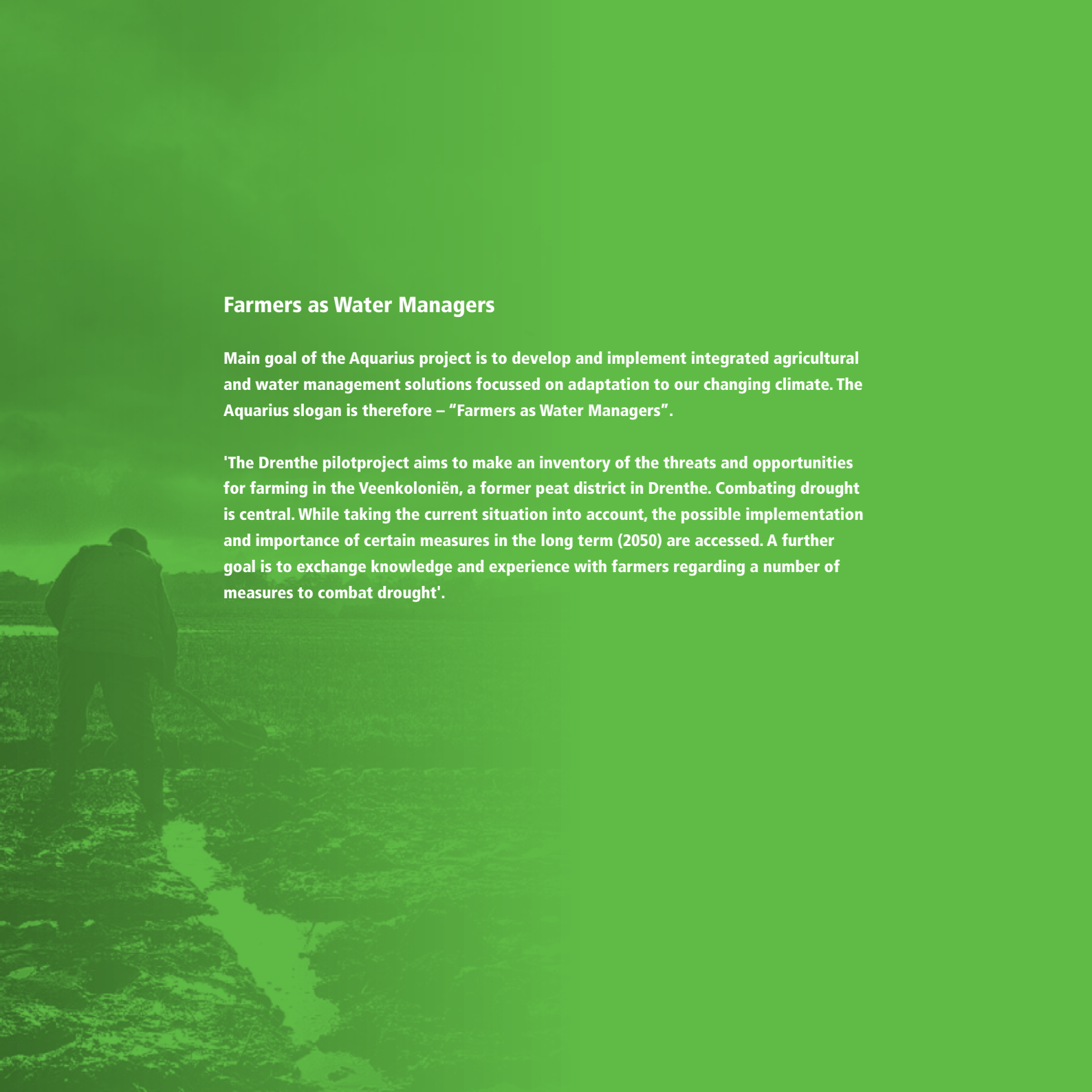
Aquarius in Drenthe
Final Report



Farmers as Water Managers

Main goal of the Aquarius project is to develop and implement integrated agricultural and water management solutions focussed on adaptation to our changing climate. The Aquarius slogan is therefore – “Farmers as Water Managers”.

'The Drenthe pilotproject aims to make an inventory of the threats and opportunities for farming in the Veenkoloniën, a former peat district in Drenthe. Combating drought is central. While taking the current situation into account, the possible implementation and importance of certain measures in the long term (2050) are accessed. A further goal is to exchange knowledge and experience with farmers regarding a number of measures to combat drought'.

Contents

Introduction

In December 2008 the Interreg IVB project Aquarius started. The project focuses on the relationship between climate change, water management and the role farmers play. The agricultural sector is facing new challenges to maintain the current level of production in a changing climate while contributing to a sustainable water system at the same time. Challenges are posed by, for example, longer periods of drought, intensive precipitation, changing temperatures and increase of erosion.

Partners from 7 sub-projects in six different member countries of the North Sea Region have joined forces to realign, from various perspectives, the role of the farmer as water manager in view of changing climatic conditions.

The following partner regions participate:

Denmark	Mariager Fjord
Germany	Ilmenau-Jeetzel
Norway	Vestre Vansjø
Scotland	Tarland
Sweden	Smedjeåen
The Netherlands, Delfland	Midden-Delfland
The Netherlands, Drenthe	Veenkolonien

Set goals

We aim to achieve the following results:

- Inventory of threats and opportunities for agricultural production in the Veenkolonieën
- Current and future (2050) opportunities for sprinkling/irrigation
- Farmers' preference for measures
- Testing of measures in the field

A number of measures will be tested in the field. To facilitate these tests local water management will be adapted using sensor technology and remote controlled weirs. These 'intelligent weirs' are designed to retain water upstream in extreme situations (flooding) in order to reduce negative impacts downstream. Furthermore, a number of individual 'farmer's weirs' will be installed so that farmers can gain experience with managing water levels in their own ditches.

1 Regional Description of the Veenkolonieën

Products: The Veenkolonieën in Drenthe and Groningen (Baseline Description)
Current Ecosystem Conditions

For the international exchange of knowledge a report was written describing the pilot area of the Veenkolonieën, a former peat district in Drenthe (Regional Description of the Veenkolonieën). This report describes, in short, the local characteristics of the area including the following themes:

- Soil and water
- Recent agricultural development
- Spatial functions
- Policy

Finally, the climate issues posing the most risk for future farming, and possible adaptive measures, are included in the report.

Again, to facilitate knowledge sharing with our European partners, another document was produced describing the surface water system and the corresponding goals of the Water Framework Directive (WFD). In relation to the goals set down by the WFD eutrophication of the surface water poses a particular challenge. It is expected that by implementing normal policies the situation will gradually improve and goals will eventually be achieved. The following table shows the current and expected nitrogen and phosphate levels in the canals of the Veenkolonieën.

Water body	Present situation		Expected downward trend		Expectation after measures		Current targets	
Parameter	P	N	P	N	P	N	P	N
Canals Veenkolonieën	0,12	3,3,	0,10	3,2	0,09	2,9	0,05 - 0,10	2,0 - 2,5

Measures for combating eutrophication are not included in the Aquarius project in Drenthe.


Zimmatic

2 Links with adjacent projects

The Aquarius project is closely linked to two other projects in the region: 'Hotspot Climate and Agriculture in the North of the Netherlands' and 'Watersense'. Both projects, and their connection with Aquarius, are described below.

Hotspot Climate and Agriculture in the North of the Netherlands

Officially the Aquarius project in Drenthe is a test project within the larger project 'Hotspot Climate and Agriculture in the North of the Netherlands'. This project gathers and delivers information about the threats and opportunities for farming and the consequences for policy in the northern provinces of the country. The Veenkolonieën is one of the study areas in the region.

Within the scope of the Hotspot project an analysis was made on the influence of climate-related extremes for the most relevant agricultural sectors in the northern Netherlands, namely dairy farming, arable farming and market gardening. Adaptive measures were then explored.

Research took place in 3 phases. In the first phase the relationship between economic developments, climate scenarios and market development were studied. The results were visualized in maps showing the impact of climate change and market development on the competitiveness of the three sectors in the EU regions (Spatial Impacts of Climate and Market Changes on Agriculture in Europe, Alterra, 2008).

Phase 2 focussed on researching the impacts of climate change on production, dealing mainly with extreme climatic conditions. The results of phase 2 are bundled in the report 'Klimaat en Landbouw Noord-Nederland – effecten van extremen'.
A summary of this report was made specifically for the Aquarius project (Extreme Effects, Grontmij 2010). Starch potatoes, an important product for the Veenkolonieën, are also reviewed in the report.

Phase 3 formulates adaptive strategies on a farm-management level and on a regional scale. The input received from local farmers during the so-called 'adaptation workshops' was of great value. During the workshops experts and actors looked closely together at which measures were most suitable for which areas and on what scale. In addition, a survey was carried out among farmers in the area.

Conclusions

The following conclusions are relevant for the area of the Veenkolonieën:

- The North of the Netherlands, particularly, scores well in terms of competitiveness when regarding the various scenarios. This can be explained by the combination of a high productivity per hectare and a very competitive position in the arable and dairy farming sectors. Also the area is less densely populated in comparison to the rest of the Netherlands.
- Drought and heat are climate factors to be taken into account in the Veenkolonieën.
- Farmers consider optimal water-management as the most important factor when facing dealing with the effects of climate change.

Watersense

The aim of the Watersense project is to develop decision-supporting models, using the data from a wide range of measurements, so that the available water is optimised in terms of quality and quantity. The focus is on issues with regards to starch potatoes, which is the main crop in the

Veenkolonieën. Decision-supporting software is being developed for both farmers and the water board. Within the Aquarius pilot adaptation of water infrastructure is being implemented using the Watersense software and, focussing on issues resulting from Hotspot research, the water management is being guided and adapted using sensor technology.

Conclusions

- Soil-moisture sensors are of value when trying to gain more insight into the water-balance in an area.
- The sensors are a good tool to encourage more involvement from farmers
- A first step has been made towards a decision-supporting model for groundwater quality. Direct guidance is, however, strongly dependant on the available groundwater models and these are not yet up to standard.
- An integrated control of water quality and quantity is still a step too far – the sensors need to be improved first. In theory there are opportunities there.
- Farmers can use sensors to help them decide when best to sprinkle; thereby, available water is used more efficiently.

3 Analysis of climate effects on agriculture

Description of climate effects

(Source: Extreme Effects, Grontmij 2010)

Most crops are influenced by climate change and the associated extremes in weather. Not all of the outcomes are negative - there are positive results as well. The most obvious weather extremes are that there are fewer periods of continuous rainfall and less night frosts. Continuous rainfall has been defined as a period of 21 days with at least 16 days of more than 0.5 mm of rain. If these periods occur less frequently the land is easier to toil and work on. With regards to night frost, just one extra night with more than 2 degrees frost can be enough to damage crops. Thus, a less frequent occurrence of night frost will result in less damage.

There are some weather extremes that require timely adaptive measures because they have a negative effect on cultivation or crops. Heat waves and heavy rainfall are the most frequent extremes. Heat waves can lead to drought while heavy rainfall means that crops are submerged under water, causing rot. For both extremes the solution may be found in water management.

There is an increased risk of diseases and plagues as a result of the changing climate. Winters are less severe and the combination of higher temperatures and humidity mean that diseases survive the winter and can arise in the following cultivation cycle.

Fortunately many problems can be avoided if there is good farm management. Of course this does entail being able to anticipate. For example, it is worth considering the possibility of sowing potatoes in broader ridges, just as this is done in Mexico. Grass can be sown using a more heat resistant seed mix. When building new barns and cattle sheds one should make allowances for climate- regulatory measures – this is already happening on an increasing scale.

Another way of anticipating is to change over to different crops. A number of crops have been studied with this in mind. The artichoke and sunflower are good alternatives for winter carrots and onions, for example, because of their salient tolerance and drought resistance.

Climate effects on crops

The Veenkolonieën's crop production consists of starch potatoes, sugar beets and grain. The impact of climate change on these crops is described below.

Potatoes for consumption and starch potatoes

There are a few climate factors that could form a risk for the production of the different potato sorts. An increase in periods of heavy rainfall is limited and actual measures may not be necessary. The farmer can take measures to control the impact of heat waves and for storage. If farmers need to cool the potatoes with sprinkle-irrigation during a heat wave, then certain adaptive measures will probably be required in the regional water system.

Blackleg and tuber soft rot diseases (Erwinia) are likely to become a problem as there are no measures for cultivators. More research is required into (biological) fungicides and/or resistant races. Lice, eelworms and the Colorado beetle also form a threat, and potato storage also needs attention. The climatic conditions for development of potato blight, (prolonged wet weather) occur less frequently and this means that control of the disease can be improved. Problems with wet fields and accessibility appear to have decreased slightly. This could mean that it becomes easier to decide when best to drive on the fields.

Sugar beets

Continuous warm weather in the winter period forms a possible risk factor for the cultivation of sugar beets. There are various measures which can be taken to prevent or limit the negative effects (such as a decrease in sugar content). As a result of climate change certain factors will change for the better for this crop. Extra attention may be required for the beet eelworm (Heterodera) and Cercospora leaf spot, as well as the possibility of 'new' diseases and plagues.

Unstable, wet weather conditions in September seem to be on the decrease which means sugar content could increase slightly. Rhizomania may become less of a threat. Night frosts occur less frequently and this is favourable for the young beet plants. A positive effect of climate change is that winters are generally warmer which means that the crop can be sown earlier, resulting in bigger yields. One must still be aware of the chances of night frost.

Winter grain

Possible climate risks for the cultivation of winter grain include long periods of drought in the summer months and changeable weather in the winter. Certain measures can be taken to limit or prevent the damage to yields. The negative effects of unsteady weather on yields are probably not that great. Yellow rust and other 'yellowing' diseases may form a bigger problem and this needs

attention. Continuous wet weather is less likely to occur in the future which means that access to the land during the harvest period (July - August) will probably improve.

Feedback of information with farmers

Product: Memo 'Analysis of Aquarius Survey', Grontmij 2010

To gain insight into the relevance of the determined climate effects on agriculture the results were put forward to the farmers of the Veenkolonieën during 'adaptation workshops'. During these workshops experts and actors from the area looked at which measures would be most appropriate for local implementation and at what level.

In addition, a survey was held amongst 50 local farmers in order to gauge the farmers' anticipation of increasing periods of drought and to what extent they then plan to rely on sprinkling, whether or not in combination with sensors.

Resulting from the workshops and survey it is apparent that farmers see drought and heat waves as the two main climate factors they will have to deal with in the future. Their preference lies with using traditional methods when combating drought and flooding. Surprisingly enough the farmers are also keen to use farmer's weirs and soil sensor technology. It is hard to say if this results from the sensors already being used in the area and the information given with regards to the farmer's weirs, but it is quite possible. Furthermore, an optimal water-balance is considered very important when reacting to the demands of changing climate conditions.

Combating drought in agriculture in the Veenkolonieën now and in the future (2050)

(Source: 'Aquarius: combating drought in the Veenkolonieën', Grontmij 2011)

The sand and peat soils of the Veenkolonieën are sensitive to drought. This leads to yield losses in dry years whereby the average losses through drought can be as much as 30%. At present approximately 15 million m3 of water is pumped into the Veenkolonieën from the IJssel Lake during an average summer. This water is used to maintain water levels and combat drought as well as for the operational management in factories and water level management in nature areas.

While discussing the use of IJssel Lake water it is important to take into account not just the current returns but also to make allowances for climate change. In other words, how can this water be used most efficiently? This is very relevant when gauging the need for irrigation water, now and particularly in the future. Farmers in the area have indicated that sprinkling is their best option when compensating for the effects of climate change.

The aim of this part of the Aquarius project is to do a cost-benefit analysis of sprinkling for the most common crops, on an area level (in the pilot area of the Veenkolonieën) and on a farm level, in the present situation and considering future climate scenarios. The various forms of sprinkling are also taken into account, namely the water cannon (reel installation) and the centre-pivot system.

Conclusions

The most important conclusions as a result of this research are:

- The groundwater level in the pilot area decreases, on average, by approximately 0.60 m in the 2050 W+ climate scenario. Regarding the most common crops, the average profit losses as a result of drought increase in this scenario by 1.4 million Euros without sprinkling and by approximately 0.3 million Euros if sprinklers are used.
- Compared to the current situation, the area of land (with present- day crops) whereby it is economically viable to sprinkle will increase by approximately 20% by 2050.
- On the farm level the costs of using a reel installation for sprinkling are higher in comparison to the centre-pivot system. Moreover, if used more often, the reel installation is relatively more expensive than the pivot considering the higher labour and fuel costs.
- Taking extreme climate conditions into account the average costs and benefits of sprinkling are about the same in the whole area. In the drier parts the benefits of sprinkling are obviously higher than average. As a result of drought and heat waves the benefits are expected to increase more towards 2040.

4 Adaptive measures in the Drentse Monden

Product: Memo 'Results of water retention in the Veenkolonieën', Water Board 2010

Introduction (From report 2009)

Aquarius, an Interreg IVB project, is working on solutions for water shortage and flooding in the Drentse Veenkoloniën.

Water shortage is expected to cause serious problems in the predominantly agricultural area of the Veenkolonieën. With anticipatory management of water levels, using remote controlled weirs, water can be retained longer in the summer season so that the agricultural sector is less affected by drought. Additional measures for water conservation are being investigated as well as methods for more efficient water use.

Besides combating drought another aim is to control flooding in the catchment area ('boezem') during extremely wet periods in the future. To this end some 3.8 million m^3 water must be retained upstream in 2050. In the water system plan for the Veenkolonieën it has been set down that water can be retained in the existing open waters. In some situations the sides and/or tops of dams will be raised. By taking anticipatory measures the existing capacity of canals and ditches can be used optimally and remote controlled weirs will make it possible to react quickly.

Within the scope of the pilot the following activities have been implemented:

- Three weirs have been made suitable for conservation and retention by installing remote control.
- Ten small retention weirs have been placed in ditches surrounding land parcels and are operated by the farmers themselves.

Efficient water use has been stimulated by:

- Supporting the introduction of new pivot sprinkling system
- Researching groundwater as foundation for policy proposals offering more flexibility regarding the use of groundwater for sprinkling in the Veenkolonieën.

Weirs and telemetry

Between 2009-2010 an hydraulic model (SOBEK) of the canal system in the Aquarius pilot area was built (see 2.5). Using this model suitable locations were

defined for water conservation and retention with weirs. In 2010 five locations were selected for the placement of remote-controlled weirs and made suitable for water conservation and efficient water supply. The weirs are remotely controlled since 2011.

Five weirs in the pilot area were connected to a telemetry system so that the Water Board could monitor and control them from their offices. If necessary the side and/or tops of the weirs will be heightened in time.
Using a hydraulic model (SOBEK) the effects of an automated weir system on water conservation in dry periods and of water levels in the 'boezem' in extreme wet conditions were investigated. Based on the results of this model and the experiences during the pilot, decisions can be made on how to retain and conserve water on a greater scale.

The water board of Hollands Noorderkwartier was visited to exchange knowledge and learn from their experience regarding the use of weirs with a limited flow rate for water retention upstream. It appears to be true that more water can be conserved but the benefits are not large enough to solve the entire problem of a water shortage.

Ten small conservation weirs

In the higher sections of the area there are possibilities for farmers to control small local conservation weirs themselves. This type of weir is used on a large scale in the southern provinces of Limburg and Noord-Brabant and for this reason the Dommel Water Board was visited. Apparently the local farmers there are very positive about the ‘farmers’ weirs’. Water Board Peel en Maasvallei have used models to calculate that these small weirs can increase the groundwater levels by approximately 10 cm.

In 2010 five soil-humidity sensors were placed in one of the important areas for groundwater management and water levels were measured. Using these measurements, a manually controlled weir and an artificial inlet were used to optimize the water-level management.
This practical test was used to study the effects of conservation and higher water levels. The results were so positive that it was decided to expand the test to include farmers’ weirs.

At the beginning of 2011 ten farmers’ weirs were installed in small canals and farm ditches. However, the spring of 2011 was extremely dry, meaning that the weirs could not be used for water

conservation this year. Monitoring of the weirs will continue in the coming years and this will include both the effects on the groundwater levels as well as how the farmers operate them.

Another useful idea taken from the visit to the southern provinces was that of 'steered drainage' - a new way of conserving water. As a result a test with steered drainage was started up at the PPO test farm in Rolde (Drenthe) to gain experience with this new concept in the coming years.

Encouraging efficient water use

Efficient sprinkling techniques

A test demonstration of the water and labour-saving pivot sprinkling technique has been set up and supported at 'Kompas'- the PPO test farm. Moreover, a number of farmers have visited the German partners of Aquarius who have more experience with employing the pivot system. Partly as a result of this exchange of experience, large investments have been made in pivots by farmers since 2007. Currently there are 4 centre pivots and 2 linear pivots in place on farms in the area with which a total of some 400 ha are irrigated.

Efficient planning

Soil-humidity sensors have been installed at 19 farms in the pilot area which can be used for 'made to measure' sprinkling advice. This part of the Aquarius has been undertaken in close cooperation with another project – Watersense – which developed advisory software for sprinkling and fertilizing using data accumulated in the sensors.

Farmers are pleased with the detailed information regarding moisture levels in their soil. They use this decision-supporting system choosing the right moment to irrigate, but the information is also used to optimize the planning of other activities, such as spraying and fertilizing.

Efficient use of water supplies

Currently some 80 – 90% of the water supply from the IJssel Lake remains unused in the ground. For this reason groundwater models were used to investigate the possibilities for using groundwater for sprinkling in the Veenkolonieën – without this having a negative effect on other functions in the area. Based on this a policy proposal has been submitted to the administration of the Water Board regarding a change in policy for sprinkling with groundwater in this area. Following an inquiry procedure this proposal was approved and the policy was implemented in February 2012.

5 Regional and National Communication

Communication of the Aquarius project has been in close cooperation with the Hotspot Climate and Agriculture and Watersense projects.

Communication has been focussed on a broad public:

- participating farmers
- the farming community
- regional governments
- national government and the Delta Commission in particular
- the business community

Notable communication moments:

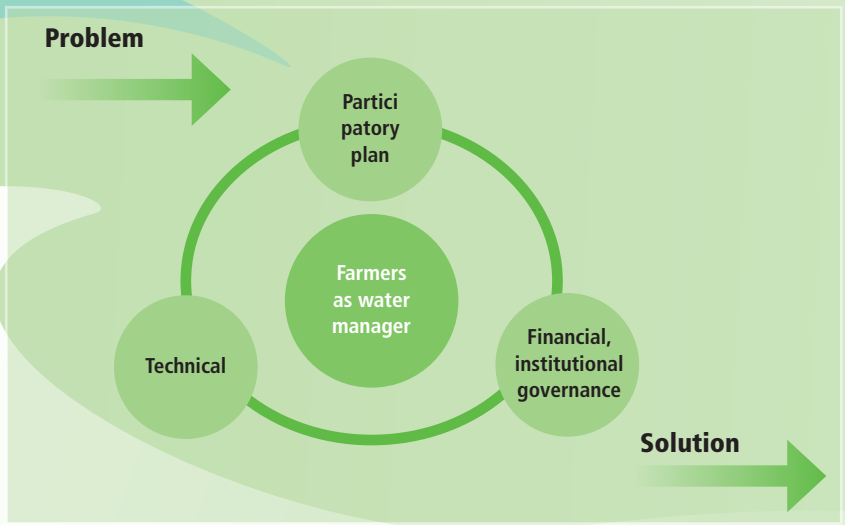
- Open Day at the Water Board Hunze en Aa's (stand, flyers)
- Information dissemination at Watersense brainstorm session
- Work visit from Polish delegation to test farm at Valthermond
- Film and presentation at COP10 on climate change in Copenhagen
- Several meetings with local growers in the pilot area
- Symposium Hotspot and Climate in Agriculture
- Grounds4Change Conference, Drenthe
- Urgenda, tour for sustainability, Drenthe
- Meeting with software developers Dacom, together with German partners
- Demonstration day for Farmers in Zeegse, Drenthe
- Visit to national Delta Commission

6 International Context

The role of farmers as water managers in relation to a changing climate has been looked at closely in the various Aquarius pilot areas. The implications of climate change are different for each region but in the main the following distinctions can be made:

- More drought : Drenthe, Germany and Sweden (to a lesser extent)
- Flooding: Scotland, Delft
- More eutrophication: Denmark, Norway, Sweden and Delft (to a lesser extent)

The project partners also looked at the way in which farmers adapt to the changing climate. A method has been developed (see problem-solution wheel below) whereby a problem is approached by regarding the not just the technical and financial issues but also the participatory role of all parties involved. The various pilot regions have each developed different methods further and tested these.



Subsequently an inventory was made of the ways in which farmers can influence water management issues. This has resulted in a number of recommendations.

Recommendations

From the very start all stakeholders should be involved in the implementation of a project. It is important to clarify the effects of the proposed measures with the farmers and using demonstration farms and pilots is, therefore, highly recommended. Farmers who are frontrunners in the sector are valuable for spreading the message amongst colleague farmers. Excursions with local farmers to other regions where new techniques are being used have also proved to be a very worthwhile experience.

Adaptation on the local scale

The farmers' involvement is even greater if the issues being dealt with are also locally recognisable. If, in this way, it is illustrated that cost effective solutions for water management at farm-level can be found for local problems then there will be more support. Adaptation on a local level could, for example, be implemented in the catchment area.

The following questions are then relevant:

- Which water-related tasks can be carried out by farmers;
- Who is currently responsible for water management;
- Which problems need to be solved;
- What are the possible technical solutions?

European and national regulations form a point for concern as they make it more difficult to set in farmers flexibly for water management issues.

Knowledge-based communication

Governments authorities should be aware that 'top down' communication is not always the way. Farmers with new initiatives must be given the opportunity to air their views. Moreover, it is important to document the possible results that can be achieved – visualization is a useful tool to catch the interest of others. It is also crucial that government representatives and advisors spread the same message.

Use the 'problem – solution wheel' and ensure that the measures to be taken are profitable and involving all appropriate partners from an early stage.

7 Conclusions

Effects of Climate Change

The research results indicate that the pilot area in the Veenkolonieën is sensitive to dry periods. As a result of climate change long periods of drought and heat waves are anticipated. The negative effects of such weather conditions could be even more extreme as a result of the area's dependence on water from the Ijssel Lake. It is expected that there will be less, rather than more, water available from this lake in the future. Flooding is likely to be less of a problem in the Veenkolonieën, although intense precipitation could lead to an increase in nutrient washout. As yet this is not considered to be a real issue in the area – the influence on the Zuidlaardermeer (lake) is probably of more consequence.

Farmers as water managers

The farmers in the area believe optimal water management to be the most significant factor when combating the challenges posed by climate change. On a farm level this means that sprinkling is likely to needed more often, although the benefits do not yet weigh up against the costs. Research carried out by the Grontmij has shown that the cost-benefit ratio will alter in the future as a result of changing climate conditions.

In terms of cost-benefit analyses, the Watersense project arrived at a similar conclusion. The differences between irrigated and non-irrigated land parcels are minimal. When deciding to irrigate the farmers were able to use the 'decision-supporting' sensor system to measure soil moisture. They found this to be a helpful tool, giving a much better representation of the actual situation. Knowledge and experience have been greatly improved in this regard.

Besides irrigation to combat drought the farmers are also interested in using the so-called farmers' weirs to control levels in their own water systems.

The Water Board Hunze en Aas

Optimal water management also requires an alert response from the water board Hunze en Aas with regards to controlling water levels in the area. The use of remote controlled weirs can be of added value. Besides surface water the use of groundwater could also be of importance in periods of drought. To this end the regulations on groundwater use for irrigation have been adapted – with every consideration for the effects on other functions in the area. These effects proved to be limited. Even if there is less precipitation in the future the effects will remain limited and any shortages in the summer period will be filled by the following winter.

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The Interreg IVB North Sea Region Programme

Investing in the future by working together for a sustainable and competitive region