# MAIN FINDINGS FROM **AQUARIUS**

*Farmers as water managers in the North Sea Region*

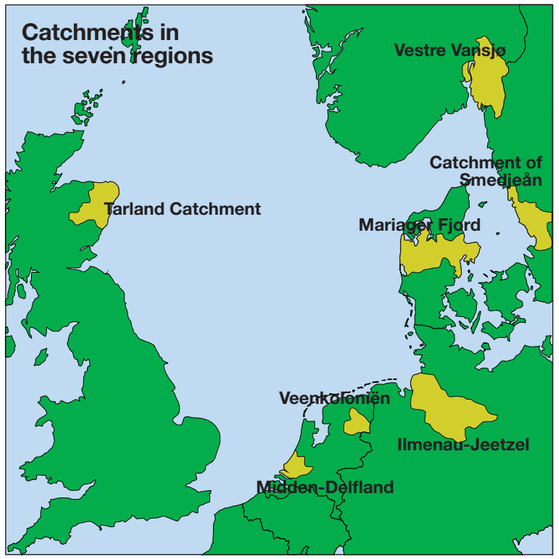


AQUARIUS

Farmers as water managers

# *The partners in Aquarius*

**The Aquarius Project consists of 15 partners from six countries with seven pilot areas around the North Sea.**







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# *Thoughts from the project manager*

BY **IRENE WIBORG**

*The Aquarius project is truly unique. An international EU project dealing with climate, water environmental, and agricultural issues has never before involved so many and so varied stakeholders in such intensive work across national borders.*

*Working on the Aquarius project is an interesting experience from which I believe many people have gained.*

*The constellation of 6 countries with representatives from the scientific world, from the national, regional and local authorities, from the agricultural advisors and from the farmers is a cocktail of interesting points of view where many preconceived understandings of matters have been challenged.*

*Questions like:*

- *What is good agricultural practice?*
- *What is a good environment?*
- *What is to the benefit of whom?*

*have been discussed over and over again. And the results of the open discussions have been very important for the many conclusions that we have reached in the project.*

*Everybody can learn from each other. But it has been an eye-opener for me that we from a Danish point of view and even from a Danish agricultural point of view have gained so much new knowledge through the project.*

*But it's not just new knowledge that we have acquired from the project – it's also 'Innovative solutions' – solutions that make a difference – although the term 'innovative solutions' is often just used as two hyped words and no more.*

*This project is creating innovative solutions because it is bringing knowledge from different countries and from different branches together. That provides new perspectives in our work. For instance the German pilot partner has found some innovative solutions on how to keep the water in the catchment, this invention were based on solutions already found in the Swedish pilot area.*

*Some solutions are already put to work, other solutions have not yet come so far. However, some of the solutions will not show their positive effect on the environment immediately. For instance it will take up to 30 years before the changes in farm practice in the catchment of Mariager Fjord have come to full effect in the water environment.*

*In this magazine we will present the main findings from our transnational Aquarius work first. Later in the magazine we will present the findings from each pilot area in more detail.*

*On www.aquarius-nsr.eu you will soon be able to download a complete report containing the findings from our three years of work in Aquarius.*

*Climate changes and stricter environmental regulations pose new opportunities and challenges for farmers in the North Sea Region. In this project we have been looking for adaptive solutions which are for the benefit of the farmers as well as for the water environment. But even more importantly we have found methods for how to find solutions which are for the benefit of all stakeholders.*

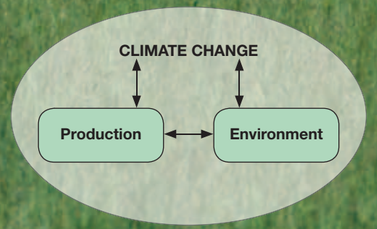
**Changed Climate – how will the North Sea Region be influenced?**

The climate is changing and in the future we will experience higher temperatures, more rainfall and more instances of extreme weather; storms, droughts, and floods. These climate changes as well as stricter environmental regulations pose new opportunities and challenges for farmers in the North Sea region.

Extended periods of rainfall increase erosion and the input of nutrients and pathogens to water. Furthermore, periods of drought hinder the water's ability to dilute diffuse inputs.

In order to maintain an efficient agricultural production and a good water environment under the changed conditions, farmers must adapt their production. This is the basis for the project Aquarius.

Within the pilot areas the problems vary greatly: water shortages, flooding, and water quality. The urgency of these problems varies as well. In the figure opposite the possibilities for farming in this changed climate are illustrated. All in all it seems like the agricultural opportunities in the North Sea region will improve with a changed climate. This is quite opposite to the conditions in many other places in the world.




The farmer has objectives for production and the environmental authorities have objectives for the environment. In a changed climate the objectives must be coordinated in cooperation. That ensures the best balance and the most cost effective solutions to the challenges.

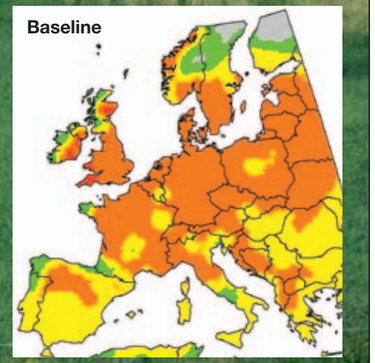
The top map (baseline) shows the calculated yield for winter wheat on clay soil today (tons per ha). The two bottom maps show the tendencies for yields in the years 2020 and 2040. The maps are based on climate scenarios generated by six different climate models.

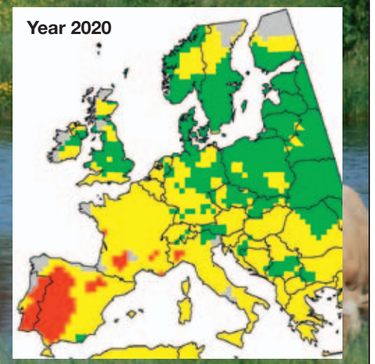
**Baseline**

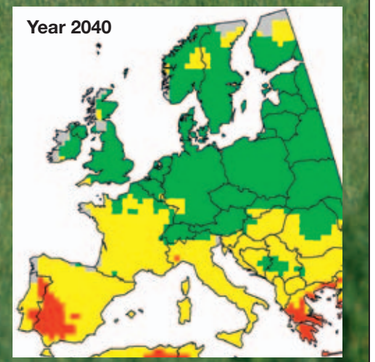
- Unsuitable
- 1-4 tons per ha
- 5-7 tons per ha
- 7-9 tons per ha
- >9 tons per ha

**Year 2020 and 2040**

- Unsuitable for cultivation
- Certain increase in yields
- Uncertain development
- Certain drop in yields




*Source:* Aarhus University, Jørgen E. Olesen, et al.



# PROCESS AND **RESULTS**

During phase A in Aquarius focus was on making a common platform for the work to be carried out in the project. We produced a baseline description of existing land and water management and its impact on the ecosystem in the project areas as well as a baseline description of direct stakeholders, their socio-economic structures and cultural traditions in the project areas. Based on these descriptions the future challenges for the farmers and the environment under changing climatic conditions was identified.

During phase B focus was on identification and description of key methods for farmers to deal with increased temperatures, nutrient losses, flooding and droughts in the future.

During phase C the opportunities for farmers to act as water managers by using new measures and techniques were identified and demonstrated at farm and catchment level.

During phase D the learnings form the project take place. This phase leads to recommendations on future land and water management planning.

**A Common Aquarius Framework for: Empowering the Farmers as Water Managers in a Changing Climate**

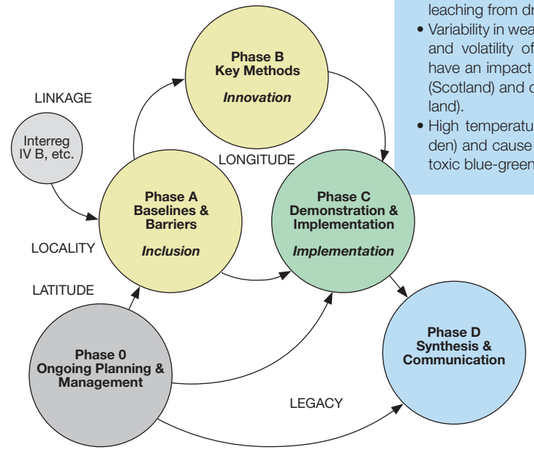



Illustration of the project process. The chart clearly shows that the process is not a linear one – the different phases interrelate. Especially phases B and C are interrelated.

## Baseline

### Climate Change in the pilot areas

As part of the baseline phase we endeavoured to identify the climate changes we expect in the North Sea Region and the expected challenges for farming in the pilots areas in the various countries.

- Precipitation trends suggest potential increased irrigation might be required (Denmark; Delfland (inlet of salinated and/or nutrient rich surface water); Drenthe; Germany; Norway; Sweden; Scotland) – this may lead to inter-regional conflict for drinking versus irrigation water (Drenthe) or downgrading of protected aquatic ecosystems (Germany) or water quality problems (Delfland)
- Warm, moist conditions in spring/summer may mean a need for more pesticides and fungicides (Denmark; Drenthe; Scotland), may create problems in accessing the land for cultivation (Denmark, Norway, Scotland) and the growth of toxic blue-green algae (Delfland)
- There may be increased salinisation due to upward salinated groundwater flows or the inlet of salinated surface water (Delfland)
- Winter floods or heavy rain may damage new crops (Germany; Sweden; Scotland), increase nutrient leaching to ground and surface waters (Denmark, Norway) and an increase of nutrient rich drainage water due to nutrients leaching from drained soils (Delfland).
- Variability in weather patterns will increase risk and volatility of profits (Germany; Drenthe), have an impact on farmer access/operations (Scotland) and on water system control (Delfland).
- High temperatures may scorch crops (Sweden) and cause health risks due to growth of toxic blue-green algae (Delfland).

## Baseline

### What was needed in order to find solutions to the challenges?

As another part of the baseline all pilots agreed on the following needs in order to find solutions to the challenges:

- The need to understand the farmer: what motivates different types of farmers and how to use the most motivated farmers to communicate with their colleagues.
- The need to understand 'good farming practice' and how any changes to the Common Agricultural Policy might have an impact on how this is defined and how farmers behave.
- The need to link climate change scenarios to farm management, despite the difference in timescales and the degree of uncertainty, and how to communicate the impacts of climate change on land-water management, not just the change in weather.
- The need to put the farmer in the wider political, social, and economic context whilst understanding their particular business and spatial circumstances; and identify the benefits of farmers acting as water managers for farmers and the wider public.
- The need to consider equity and the distribution of costs and benefits, including who pays for measures, and how much these measures might cost.
- The need to share the best way to work together, such as involving farmers in diagnosing the problem, choosing solutions, talking to other stakeholders, and sharing knowledge to help this project and form a foundation for future work.

**The problem-solution wheel**
As part of the key methods we developed technical, financial and participatory solutions. At the end of the key method phase we developed the so called 'problem-solution wheel'. It was invented in order to find the right mix of methods to ensure a good water environment and still maintain an efficient agricultural production.

We have worked with key methods in three categories:

- Technical methods
- Financial methods
- Participatory planning

It is simply not enough to handle for instance a technical issue. If the right participants are not involved and the financial issues are not in place, all efforts to find win-win solutions for the benefit of all parties will be wasted. In order to secure such win-win situations the problem-solution wheel can be used with great effect.

**Testing key methods**
As part of the demonstration and implementation we tested the identified key methods in the pilot areas. Examples of these methods can be found in the following articles written by project participants in the pilot areas.




# *Recommendations*

At the moment we are working on extracting the synthesis of the project. The main recommendations on which all partners have agreed can be found below.

**1. Communication / involvement**
Communication between authorities, advisors and farmers is a top priority. It is also closely related to the involvement of stakeholders in issues on water management. All pilots have examples of how important communication and involvement are for win-win solutions. All relevant stakeholders need to be involved from the very beginning of the implementation process. It is also important to communicate the given objectives over and over again to all stakeholders and not lose sight of the goals during the process. Show farmers the positive effects of water management to act as incentives, through evaluations and demonstrations, and use innovative farmers as good examples.

*Example from Denmark:* Catchment groups consisting of all stakeholders seeking solutions for improved water quality – clean fjord.

*Example from Sweden:* Water Framework Directive groups. Geographical division of e.g. a catchment in order to keep groups small and efficient. Farmers irrigation groups with support from authorities. Groups of farmers invited to meetings with authorities.

*Example from Holland:* built on existing structure – the Water Boards involving stakeholders and authorities. Integrated sub – catchment plans. Organised groups of farmers – down to 12 farmers depending on the problems.

**2. Adaptation on local scale**
An important aspect is to use geographical specialisations so that local farmers and local advisors work together. Educational programme (for farmers, advisors and authorities) to spread and scale down knowledge from national or EU-level will be important.

Water management at farm level should be used as a tool to obtain a cost efficient combination of measures in areas where the water does not reach good ecological status according to the Water Framework Directive. Water management plans in the catchments must be flexible, and not general. Plans should have a firm connection to local issues.

Action should be shared by authorities and farmers on the local scale. Authorities have to promote praxis and dialogue. Which water management task that can be performed by farmers depends on the characteristics of an area. Who is responsible for water management, which water management problem needs to be solved, what are the possibilities (e.g. space, land price) of solving the problem? The answers to these questions determine the design of a water management measure, such as the flexibility, size or type of measure.

Location specific actions require that EU and national legislation allow for flexible approaches to measures.

*Example from Norway:* national rules are a maximum 70% incentive for wetland construction. This did not lead to any new wetlands being constructed. Local authorities raised the subsidies to 85% and results were reached –farmers reacted positively and wetlands were constructed.

*Example from Scotland:* Talking to farmers has shown where they perceive conflicting messages coming from the Water Framework Directive and the need to manage flooding in a changing climate. A national policy workshop has discussed this and further guidance is being developed to explain the policy interactions.

**3. Knowledge based communication**
Two way communication is as always important. Advisory organisations as well as authorities should respond to farmers' initiatives, to communication, and/or solutions to specific problems. Justifications for different measures must be well documented and scientifically sound. Preferably aims and goals should be illustrated and understandable in terms of benefits for the community and environment. Demonstration sites and other means of visualisation of concepts or goals are very important for mutual understanding.

It is also important that authorities and advisory organisations coordinate information given to farmers. Multiple and diverging messages will lead to confusion and to a lack of trust. Avoid different messages from different directives. EU directives should be checked prior to any suggested measures being implemented.

**4. Use the problem-solution wheel to verify profitability**
Influence policymakers to make environmental programs realistic, accessible and financially viable for the farmers. Measures should be cost neutral or better.

*Example from Sweden:* subsidies to farmers for constructed wetlands that can be used as an environmental tool, provide increased biodiversity, and reduce eutrophication as well as being used for irrigation by the farmer.

*Example from Scotland:* Farmers do not perceive that existing incentives are attractive for natural flood management. However, often it was not only the financial incentives that mattered – issues like maintaining ownership of the land; fit with their farming operations and the scale of the measure were also raised. Therefore, subsidies need to be considered alongside these factors.

Everybody can gain from cooperation.

*"What is lost to the water environment is lost for plant production"*

- If the farmers can hold on to the nitrogen with for instance catch crops it will benefit their production.
- If the farmers can hold on to the water during periods with excess water in the area it will benefit their production when they face draughts at other times of the year.

# CREATING **WIN-WIN** SITUATIONS IN WATER MANAGEMENT

*It is a sunny morning in the lush green area of Midden-Delfland. Water managers from six countries are listening attentively to dairy farmer Nico van Vliet, as he talks about his involvement in the maintenance of nature friendly banks. It is just one example of the Water Board Delfland working actively with farmers and other local stakeholders to tackle the challenges of water management.*

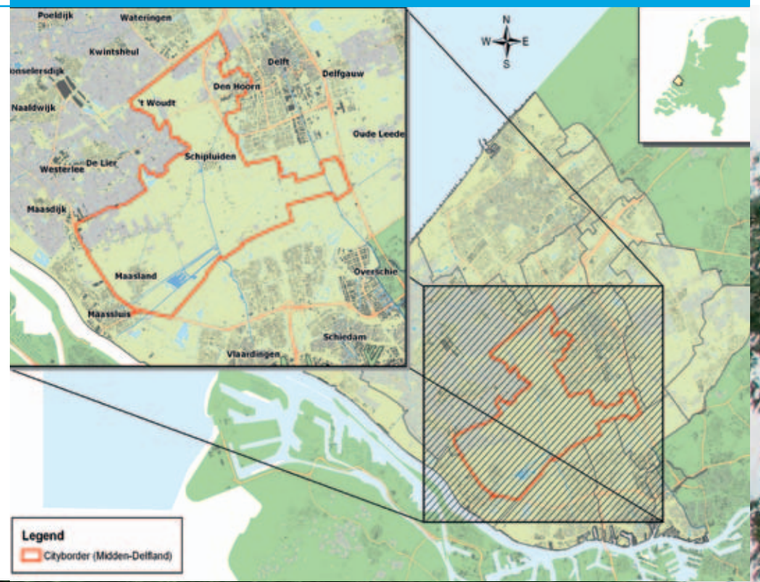
BY **MIRIAM KLAZENGA**

**Helen Hangelbroek**
Senior Policy Advisor
Water Quality,
Delfland Water Board

## The Dutch pilot area, Midden-Delfland

*Midden-Delfland is located in the 'Randstad' region of the southwestern part of the Netherlands. The area has a surface of 65 km² consisting mainly of agricultural grassland. Midden-Delfland is often seen as a green lung and cultural-historical jewel in an agricultural landscape, sandwiched between glasshouse horticulture and the urban areas of The Hague and Rotterdam. The villages in Midden-Delfland are Maasland, Schipluiden, Den Hoorn and 't Woudt.*

*Agricultural activity in Midden-Delfland is mainly dairy farming. The dairy farms also play a vital part in preserving the open character of the landscape. Historically, farmers and other residents of Midden-Delfland have a strong emotional connection with their area and tend to care deeply about preserving its historic-cultural characteristics. The main water-related problems in the area are the risk of flooding through excessive water (climate change) and deterioration of water quality caused by nutrient releases.*




As a consequence of draught the dikes become less stable. The men in the boat try whether it would help to keep dikes wet by spraying water on them.

<< There are many different interests in the project.

< The Midden-Delfland area.

> Dairy farmers Nico van Vliet (top) and Marien Boekestein (bottom)

>> Empty water buffers need to be maintained which can be done by farmers.

Operating in one of the most densely populated and built-up areas in the Nederlands, Waterboard Delfland has a long history of interaction and dialogue with different stakeholders. “Talking to farmers and other organizations isn’t new to us”, confirms Helen Hangelbroek, Project Manager for the Midden-Delfland pilot area. “The crucial difference with this project, is that instead of being on opposite sides of the table, we are exploring opportunities for active cooperation. This requires a completely different mindset. We really had to learn how to interact in this new setting.”

**Building trust**

Building mutual understanding and trust was the first crucial condition for success. Farmers, municipalities and the Water Board held many meetings to discuss how to cooperate successfully and achieve results in the pilot. During regular meetings, farmers from the pilot area were approached by the Water Board. Interested farmers were selected through interview sessions. An Executive Board member of Delfland personally visited the selected farmers to have ‘kitchen table’ negotiations about conditions for their participation. “It was a time consuming process”, says Hangelbroek. “But we learned that getting to know each other in a personal setting is a vital phase, that can’t be rushed.”

## Aquarius subprojects in the Midden-Delfland pilot area

***During the project, various subprojects were launched:***

**Domain tender green-blue services (DGBS) (see opposite page)**

An experiment intended to gain insight in the practicalities of contracting farmers for green-blue services. A farmers’ organisation itself is drawing up a polder tender for every possible green-blue service. The (fictitious) tenders include information about measures, pricing and intended implementation. Farmers also gave input about their wishes and conditions for the various green-blue services.

**Green-blue services catalogue**

The European Commission approved the Dutch green-blue catalogue in the spring of 2007. It is an aid for everyone who wishes to pay for green-blue services. The blue services were intentionally left out of the catalogue when being drawn up. Nevertheless, local governments are able to propose inclusion of additional (green-)blue services. In this subproject, Delfland examined the incorporation of (green-)blue services in the catalogue and other legal ways of cooperation.

**Management of nature friendly banks by farmers**

This subproject focused on evaluating and possible upgrading of the farmers’ management of nature friendly banks in the Midden-Delfland area. In 2009, the experiment was suspended due to the public support limiting conditions that impeded the Water Board in meeting financial requirements made by farmers. However, the experiment was successful on a practical level. It has now been followed up by the project of maintaining nature friendly banks by a farmers’ organisation.

**Social cost-benefit analysis (SCBA) open water storages Midden-Delfland**

During the realisation of the water-plan for Midden-Delfland, it became clear that construction of open water storage in the grassland polder was socially unjustifiable. To verify this conclusion, a SCBA was carried out. Alternative solutions for water storage in the open grassland of Midden-Delfland were also investigated (including possible application of green-blue services).

**Region orientated application of biomass (ROA)**

During water management Delfland has to deal with the removal of biomass (grass- and reed cuttings, ditch cleaning matter, etc.). Removal is a costly practice and the cost will increase due to the growing number of nature friendly banks. In this subproject feasibility will be examined to use the cuttings as soil improver, fertilizer and deep litter. This way, the biomass is given a useful purpose in the area, helping farmers to save money and improve the environment (water quality).

**Pilot Nutrients: agricultural operational management Midden-Delfland**

Together, farmers and Water Board Delfland prepared three lists of possible agricultural management measures tot reduce the spilling of nutrients in the water system: measures of Good Agricultural Practices; specific measures for dairy farms to invest in; and measures beyond Good Agricultural Practices and legal obligations. Measures include, for example, buffer strips, reduced fertilizer use, organic farming, constructed wetlands and new drainage techniques. The measures were assessed in group sessions with farmers and delegates of the Water Board Delfland.

**Representation of the green-blue servies**

To support and improve communication in the pilot, visual representations of green-blue services were developed with the use of input from all stakeholders. The results include pictures of a typical nature friendly bank, as well as pictures of water storage on agricultural land.

**Willingness among farmers**

Representatives from the various stakeholders explored multiple solutions for involving farmers in water management. Dairy farmer Nico van Vliet for instance, maintained two nature friendly banks adjacent to his property for a number of years. “That pilot actually went really well”, he recalls. “The financial compensation and cooperation with Delfland were great. But, since the pilot ended, it is unclear how things will move forward. The problem hinges mainly on the strict European rules and regulations. A pity, because it only makes it unnecessarily difficult to start up these kind of initiatives. Because if you ask me, it is the cheapest and most simple solution for all parties. I already manage my land anyway.” With these experiences Delfland and a farmers’ organisation are now working together in the DGBS project.

**Greater results**

Another Midden-Delfland dairy farmer, Marien Boekestein, is enthusiastic about the development of sustainable farming practices in Midden-Delfland. “Sustainable farming helps you take a critical look at your own business. Thanks to the pilot, I keep the cost low by using by-products like potato pulp instead of extra power food for my cattle. Personally, I would like to go one step further in the pilot by analysing more dairy farms. I think that on a bigger scale, we are able to achieve even greater results and win-win situations as a whole.”

**New opportunities**

The results of the pilot Midden-Delfland will be presented to the Executive Board members of Water Board Delfland. Based on this presentation and the accompanying recommendations, the Executive Board members will decide together whether green-blue services will become a part of Delfland water management policy. “The most important thing we learned during the pilot is that cooperation between area stakeholders brings many unexpected opportunities”, says Helen Hangelbroek.

## Recommendations and learnings from the Midden-Delfland pilot project

### Focus on process organization

Involving all stakeholders from the start is a vital condition for success.

### Use an intermediary

Having an intermediary in an area-related project can help work more efficiently. Make sure the intermediary (whether this is an individual or a group/organization) has sufficient knowledge about both project technicalities and general process requirements to create the right conditions for the project.

### Focus on communication

Participation of stakeholders requires reliability and trust. Mutual understanding and willingness to learn from each other is a key factor. Take time to reach clear agreements about the mutual tasks and responsibilities at the start of a project or programme.

### Identify win-win situations

Sufficient financial compensation is a strong trigger for farmers to participate. Ensuring a solid business case greatly advances the chance of turning intitiatives into a practical success.

### Make sure you have comprehensive knowledge of (European) legislation

Insufficient understanding of all the relevant (EU) laws and regulations can lead to costly and time consuming setbacks. Make sure any financial agreement with farmers and other stakeholders are in full legal compliance

### Think local and practical

In order to work in the real world, management schemes – like the Dutch catalogue green-blue services – need to match better with local characteristics and farmers’ interest as well as with water management interests.

# FARMERS ASSIST IN FLOOD **MANAGEMENT**

BY **NEIL MOIR**


**Keith Matthews**
Senior Research Scientist,
The James Hutton Institute

**Stephen McFarland**
Principal Engineer,
Aberdeenshire Council


## The Scottish pilot area, Royal Deeside, North-East Scotland

*The Tarland Burn Catchment is located in Aberdeenshire, North East Scotland, and covers an area of approximately 72km². The Tarland Catchment comprises the burn itself and a series of small tributaries that drain from the surrounding areas. The Tarland Burn is one of the major tributaries of the larger River Dee catchment, which covers an area of approximately 2,100 km². Its terrain includes farmland, upland moorland, conifer plantation, semi-natural broad leaved woodland and urban settlements.*


*Working with land managers – including farmers, factors and local agencies – has illustrated the potential for land managers to alleviate flood risk. The project has also allowed many challenges and gaps in our knowledge to be highlighted and addressed, which will inform future policy, research and practice on Natural Flood Management (NFM) throughout Scotland.*

Improving resilience to major rainfall events. Flooding of domestic and commercial properties and damage to public infrastructure is being reduced by making more space for flood water in the farming landscape of the Tarland catchment, Aberdeenshire.

<

Flood water from the Tarland Burn catchment not only has an impact on the villages of Tarland and Aboyne but contributes to flooding of the River Dee many kilometres downstream near Aberdeen.

>

The Scottish partners visit the James Hutton Institute monitoring station on the Tarland Burn

>>

Farmers, agencies and researches discuss the impacts of climate change at the Natural Flood Management Workshop held in Douneside, Tarland in January 2011.

A study is currently underway to investigate the role of farmers in managing excess water by providing land based flood alleviation measures in Royal Deeside, Aberdeenshire. The Aquarius project facilitates investigations beyond those that would normally be considered as part of assessing the feasibility of conventional flood alleviation schemes.

The work being carried out by Aberdeenshire Council, the James Hutton Institute (formally the Macaulay Institute), and Landcare North East, complements the Tarland Burn Flood Alleviation Study (TBFAS). The study aims to find a solution to flooding that affects the Aboyne and Tarland areas from the Tarland Burn during heavy rainfall. The Partners have worked with consultants Atkins to develop a hydrological model of the catchment and proposals for temporary flood storage areas.

The Aquarius project is working with land managers to evaluate and establish flood management measures that are effective but also protect business viability. The project is also exploring how temporary flood storage can offer other benefits, such as improving water quality and habitats. This has included detailed discussions with European partners on issues of financial payments/incentives, regulations and examples of good practice.

One of our findings is that little evidence exists regarding both the effectiveness of National Flood Management (NFM) interventions, and how best to finance these projects in the long term. These insights were used to inform a Scottish Government policy workshop on NFM during January 2011.

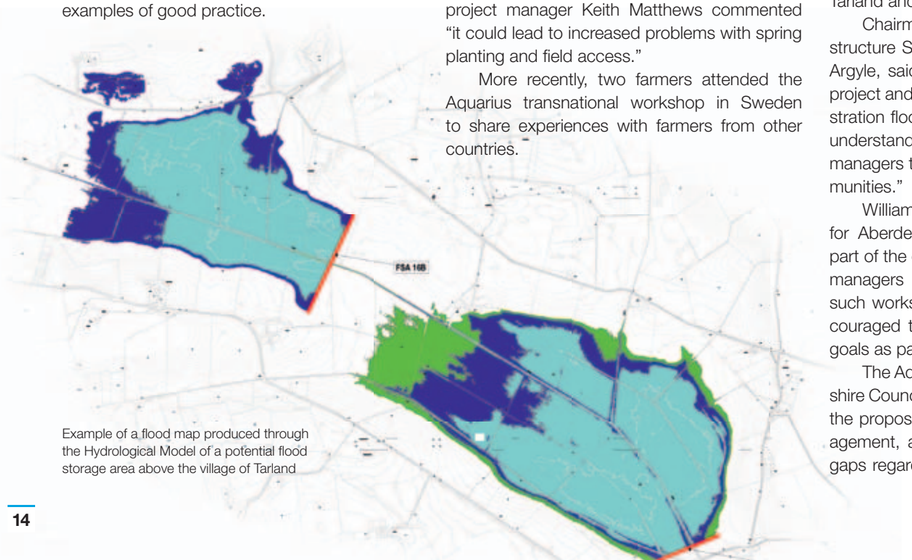
The Scottish Partnership has engaged with land managers to gauge views on climate change and the effects that flooding has had on their activities in recent years.

Flora Grigor-Taylor from Landcare North East, commented: “Although the majority of farmers did not think climate change had affected their business and so have not adjusted their farm management, approximately a third of those interviewed did feel that flooding was a major issue but their concerns are more associated with farming practice whereas the Council concern is the effect flooding has on the local settlements.”

“Some had made changes to their land management activities, including altering crop rotation cycles, changing soil management and bringing in cattle all winter.”

Research at the James Hutton Institute suggests climate change might lead to wetter springs and warmer, drier autumns. Institute project manager Keith Matthews commented “it could lead to increased problems with spring planting and field access.”

More recently, two farmers attended the Aquarius transnational workshop in Sweden to share experiences with farmers from other countries.




Example of a flood map produced through the Hydrological Model of a potential flood storage area above the village of Tarland

Farmer Andrew Robertson said: “Although the water-related problems across Aquarius are all different, the problems the farmers face all seem to be quite similar. We realise everything we do – growing crops and raising animals – has an influence on water and some things create more problems than others. We want to reduce this and be sustainable and continue in the future.”

Land manager participation is helping to focus the TBFAS. Initially, 101 potential Flood Storage Areas (FSAs) were identified and whittled down using an assessment matrix to a shortlist of sites which have the potential to alleviate the flooding in Tarland and Aboyne. The hydrological model was then used to determine the suitability and cost-effectiveness of each of the sites.

### Assessment Matrix Criteria

- Flood storage capacity and location
- Cost effectiveness of installing a measure
- Land ownership and land use
- Environmental benefits – e.g. water quality, biodiversity, amenity

Two preferred sites have now been identified as potential temporary FSAs that could hold significant volumes of water: one upstream of Tarland and one upstream of Aboyne.

Chairman of Aberdeenshire Council’s Infrastructure Services Committee, Councillor Peter Argyle, said: “A lot of work has gone into this project and we are close to identifying a demonstration flood storage area which could help us understand how to work more closely with land managers to reduce the risk of flooding to communities.”

William Murdoch, Project Team Manager for Aberdeenshire Council, added: “The main part of the current work is to establish how land managers see themselves being affected by such works, and how they can be actively encouraged to contribute to the project’s overall goals as part of their business.”

The Aquarius project is providing Aberdeenshire Council with a better understanding of how the proposed sites might impact on land management, and where there are still knowledge gaps regarding the technical, financial and participatory aspects of farmers becoming water managers.

Aquarius has transformed a technical assessment into a wider social process that empowers land managers to actively contribute to flood alleviation, while keeping land under production.

More detailed technical assessment of the preferred sites will involve further modelling to assess:

1. Flood alleviation performance and the extent of flood inundation of the fields used to store water for a range of rainfall events.
2. The footprint of different embankments designs to provide an evaluation of potential land required for the implementation of the selected FSA.
3. Investigation of the trade-offs involved in designing a flood storage scheme which is optimised for lesser events (e.g. 1:50 year event) where the land required, costs and consequences for land managers would be reduced.

Ongoing financial analysis is considering the different funding options for flood storage areas, including ownership models, maintenance issues and how funding will comply with European competition legislation. This will be fed into the evidence base for the development of the next Scottish Rural Development Programmed.

Ongoing participatory analysis is looking at how flood alleviation assessment matrices can be adapted to reflect the needs of both land managers and the local authority, which has a duty to reduce flood risk in the wider community.

The next step in the project is to construct a demonstration site for flood alleviation on productive agricultural land for completion in summer 2012. The demonstration site will allow other land managers to learn about NFM from their peers, and provide invaluable evidence about how to achieve this in a way that meets the needs of land managers.

## Recommendations and learnings from the Scottish pilot project

### Participatory

- Local knowledge from land managers was essential to identify potential flood storage sites that would not undermine business viability. Council officer input was essential to ensure the sites would provide long term flood protection, highlighting the importance of joint working.
- Greater awareness of the possible implications of climate change is needed among land managers, advisors and policy makers in a range of suitable formats.
- Different people understand ‘natural’ flood management to mean different things, which can create problems. Time should be taken to clearly define the problem and the solution.
- Agricultural advisors need better evidence about NFM options in order to help engage land managers in flood alleviation.

### Technical

- The trade-off between flood protection and impact on land management requires further modelling and analysis. Processes need to build in multiple iterations to determine optimum solutions.
- More examples of schemes to assess the cumulative effect of run-off alleviation measures are required, demonstrating to land managers that these can be adopted at acceptable cost to their operations. More post-implementation monitoring is needed in this area, and land managers can assist with this.
- Land managers can work with engineers to design measures that allow them to continue to graze or plant their fields between floods. Time and resources should be allowed for this co-design process.

### Financial/Institutional

- Current agri-environmental payments do not provide sufficient incentives for long-term flood management, and don’t take a catchment approach. This should be prioritised in future funding scheme design.
- Land ownership and tenancy models create legal barriers when implementing long-term measures. Equally, land managers can be nervous about committing to long-term measures given the uncertainty of markets, funding regimes and policies. Agreements need to be carefully prepared to maintain the land managers’ ‘room to manoeuvre’ while also providing the necessary surety to the flooding authority.
- Land managers perceive a conflict between flood alleviation measures and measures under the Water Framework Directive, e.g. preventing clearing vegetation from the burn and limited dredging. Policy makers, regulators and advisors need to explain how natural flood management works in practice.
- At times potential solutions are hindered by conflicting controls/regulations by different agencies. There is a need for more flexibility in the interpretation of legislation.


Spate water from the Tarland Burn at Tarland not only floods a number of local houses and businesses but also has implications for the road network.

# IMPROVED WATER QUALITY BY **COOPERATION**

*Local authorities, agricultural advisors, farmers and research scientists have collaborated to attain the target of improved water quality in the western part of lake Vansjø. The collaboration has given positive results as the water quality in the lake has improved substantially, and swimming is again safe.*

BY **ANNE FALK ØGAARD**


**Tyra Risnes**
Senior Adviser
County Governor
of Østfold

**Torbjørn Kristiansen**
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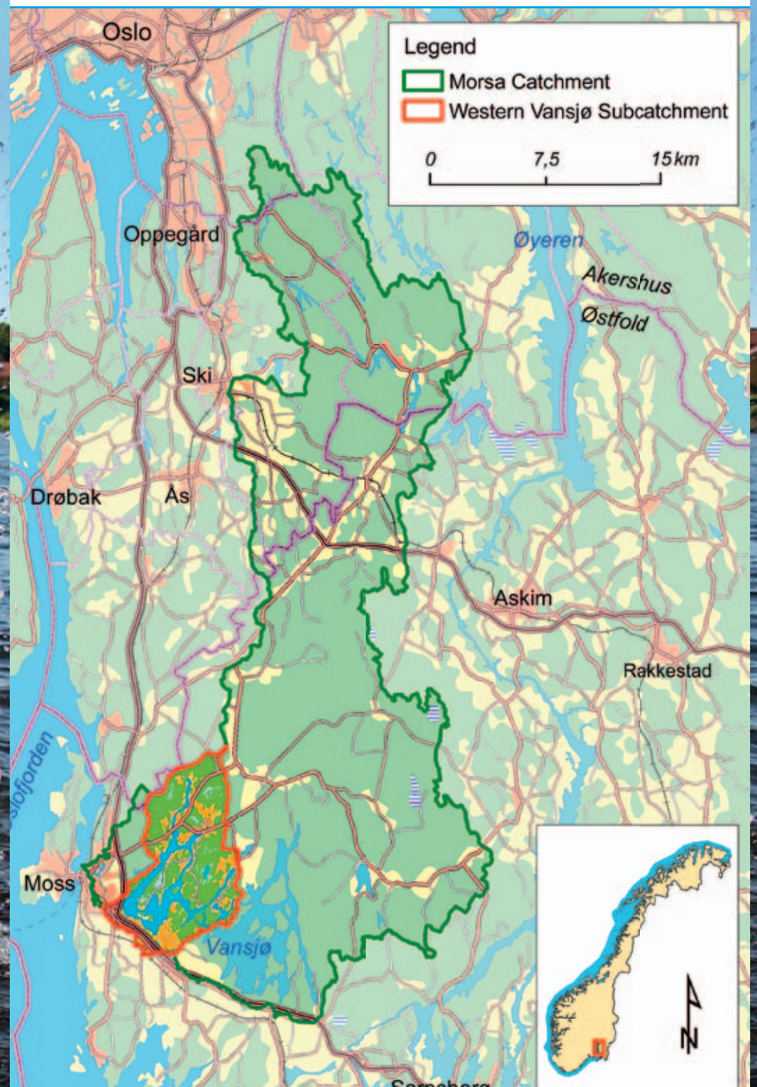
County Governor
of Østfold

**Anne Falk Øgaard**
Senior Research Scientist
Norwegian Institute for Agricultural and Environmental Research (Bioforsk)


## The Norwegian pilot area, Lake Vansjø

*The Vansjø (Morsa) catchment is located in South East Norway. The pilot area is the sub-catchment draining to the western part of lake Vansjø. The pilot area is 80 km² of which 16 % is agricultural land. Main productions are cereals, potatoes and vegetables. The western part of lake Vansjø has a very poor water quality due to algal blooms. The water quality of the lake is of great concern because it is an important recreation area for people living in the region. Large phosphorus loads to the lake is identified as the main reason for the eutrophication problems.*




After many years with swimming ban because of toxin producing cyanobacteria, the water quality in the lake has improved substantially, and swimming has again become safe.


**<**
**Reduced phosphorus fertilization**
Focus on reduced phosphorus fertilization started in meetings with farmers in 2005. Farmer contracts from 2008 gave further reduction in phosphorus fertilization.
Average phosphorus fertilization in the catchment:
2004: 22 kg phosphorus/ha
2007: 11 kg phosphorus/ha
2008: 6 kg phosphorus/ha
2010: 5 kg phosphorus/ha

**>**
**Constructed wetlands**
The farmer (and his son) as water manager. 16 small constructed wetlands have been established during the project period.

**<**
**Buffer strips**
Buffer strips with permanent grass have been established along streams and the lake.

**>**
**Research as basis for reduced phosphorus fertilization**
The field experiments were carried out in collaboration with the local extension service for agriculture, and it was demonstrated that the phosphorus fertilization could be reduced without losses of yield for both potatoes and vegetables.

Large phosphorus loads to the lake is identified as the main reason for the eutrophication problems, says Tyra Risnes. Since the phosphorus loads from point sources has become low, the main focus for further reduction in phosphorus loads to the lake is to reduce phosphorus losses from agricultural areas.

Milder winters and more high-intensity rainfall are expected. This will increase the risk of erosion and phosphorus losses from agricultural areas. Thus, mitigation measures to reduce phosphorus losses from agricultural areas will be even more important in the future.

A total of 40 farms lie entirely or partly within this catchment. There is a large production of potatoes and vegetables. This results in extra challenges when aiming at reduced phosphorus losses, because of a high phosphorus application to these crops and thereby a high content of available phosphorus in soil.

## Action plan

Substantial efforts have been made to improve the water quality during the last eleven years. The first years, the efforts showed to be insufficient to improve the water quality to a significant degree. Therefore, in collaboration with different stakeholders, an action plan for reduced phosphorus loads to the western part of lake Vansjø was worked out in 2006/2007, says Tyra Risnes. The farmers were involved through participation at meetings where all farmers were invited and through dialogue with selected farmers and with The Norwegian Farmer's Union.

As a result of this work, an integrated project funded by the Ministry of Food and Agriculture was started in 2008 in order to carry out the action plan for improving the water quality in the lake. Further, in 2009 the work in the pilot area became a part of Aquarius, whereby transnational exchange of experiences was included. In the project, local authorities, agricultural advisors, farmers and research scientists collaborate to attain the desired water quality.

## Farmer contracts to reduce phosphorus losses

The farmers are encouraged to sign a contract where they will receive a financial support for covering extra costs for committing to a set of restrictions and mitigation measures aiming at reduced phosphorus losses for a period of three years, says Tyra Risnes. Among other things, the requirements in the contracts include:

- Use of less phosphorus fertilizer than the national recommended level
- No soil cultivation during autumn
- Establishment of eight-meter wide buffer zones along open water
- Establishment of grassed waterways where there is a large risk of erosion
- Establishment of constructed wetlands where this is recommended

An agricultural advisor discussed specific challenges with each individual farmer, and the farmer was encouraged to sign the contract. An environmental plan for each farm that signed the contract was worked out by the farmer in collaboration with the agricultural extension service.

A few months after start of the project, 29 out of the 40 farmers in the catchment had signed the contract. In addition to the visit from the agricultural advisor, the basis for the high degree of participation was meetings with the farmers in the preceding years, where they were educated about the importance and effect of the mitigation measures.

## The role of research

Bioforsk – Norwegian Institute for Agricultural and Environmental Research has studied the effect of some of the implemented mitigation options and the effect of other possible mitigation options on yields and phosphorus losses. In annual meetings with the stakeholders, the research tasks were discussed, ensuring that the research aimed at answering relevant questions for the farmers and local authorities. Vegetable and potato fields pose great challenges when aiming at reducing phosphorus losses. A large part of the research activity has therefore been related to possible mitigation options on these fields, e.g. the effect of reduced phosphorus fertilization on yields and quality of the products.

The research has been important for the comprehensive reduction of phosphorus fertilization in the catchment.

## Bottle necks

In a meeting with farmers December 2010, the farmers pointed out that the requirement of no autumn tillage is an important bottle neck for continuing the contracts in the present form. No autumn tillage makes it impossible to grow winter wheat and rye and more use of herbicides is needed. Some farmers think it is difficult to succeed with spring ploughing on clay soils. If restrictions on autumn tillage are going to be continued, subsidies are still needed as spring cereals give less income compared to winter wheat.

Farmers growing vegetable and potatoes pointed out that reduced phosphorus fertilization give challenges by lack of mineral fertilizers with a lower phosphorus concentration which are suitable for these crops. Consequently, reduced phosphorus fertilization requires more work as more operations are needed to apply the different nutrients in required amounts.

## Farmers' opinions

More farmers in the pilot area agree that agriculture is one of the reasons for poor water quality and that reduced phosphorus fertilization has not reduced the grain yields. Yet, the economic benefit of reduced phosphorus fertilization is small because phosphorous fertilizer is cheap. However, farmers in the area also approve of the positive effect of their contribution to reduce the use of the world's limited mineral phosphorus resources.

The farmer contracts impose restrictions e.g. that farmers no longer can produce winter wheat, which reduces profitability for the individual farmers. Nevertheless, farmers in the area have expressed understanding for the contracts and the importance of the measures for the lake. Furthermore they have voiced willingness to take on the responsibility while stressing that all farmers must contribute, and that free-riders are not accepted.

## Recommendations and learnings from the Norwegian pilot project

### Finding solutions

Involve all stakeholders in discussions and brainstorming. This will ensure that the suggested solutions are possible to implement.

### Education of farmers

- Research based information about the importance and effect of the mitigation measures
- Show results on demonstration sites
- Involve agricultural advisors for discussing environmental challenges with individual farmers and for working out environmental plans on farm level.

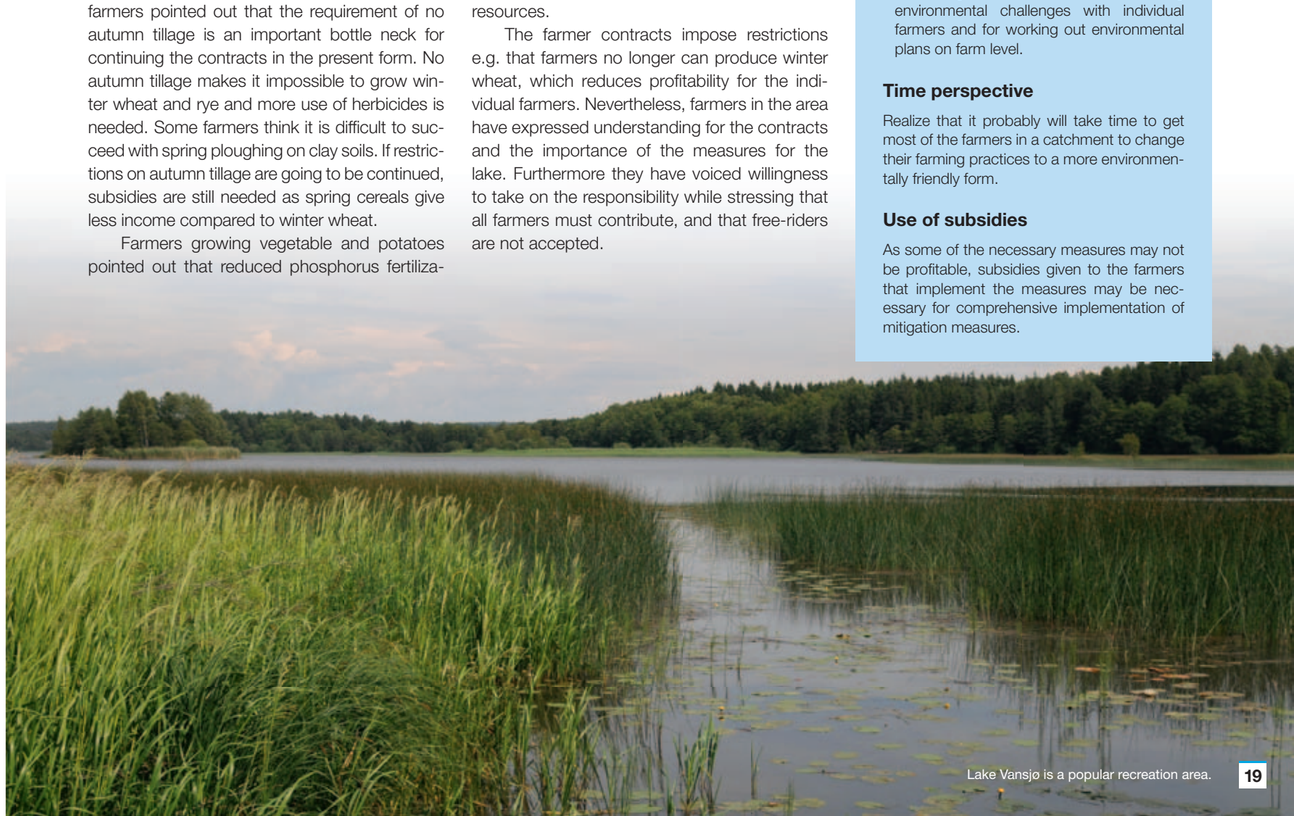
### Time perspective

Realize that it probably will take time to get most of the farmers in a catchment to change their farming practices to a more environmentally friendly form.

### Use of subsidies

As some of the necessary measures may not be profitable, subsidies given to the farmers that implement the measures may be necessary for comprehensive implementation of mitigation measures.

The western part of lake Vansjø has a very poor water quality due to algae blooms.



Lake Vansjø is a popular recreation area.

# FARM WATER MANAGEMENT PLANS – A NEW **APPROACH**

*Water management plans at farm level can be an important tool to combat the negative effects of climate change in Sweden. These plans must be locally adapted to produce cost effective combinations of measures that secure targets of production as well as of water quality in the area. This future path is recommended by the Swedish pilot group of AQUARIUS.*

BY **MONICA KLING**

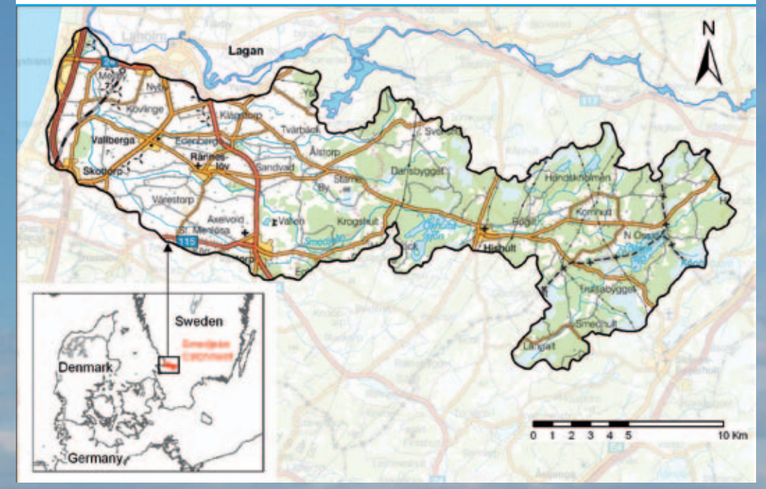

**John Strand**
Advisor.
The Rural Economy and Agriculture Society.

**Arne Joelsson**
Agronomist.
The County Board of Halland


## The Swedish pilot area, River Smedjeån catchment

*River Smedjeån catchment on the Swedish west coast is the Swedish pilot area (277 km²). Agriculture is the dominant land use on the coastal plain (43 % of total). The upland consists of forests, bogs and a few lakes. Annual periods of drought and shortages of irrigation water is a large problem in the area. Flooding of arable land is another problem leading to loss of production, although not annually occurring.*

*Eutrophication of the coastal water (Laholm Bay) has led to algal blooms and oxygen deficit. In the river eutrophication has led to a deterioration of the aquatic habitats and low biodiversity in intensively farmed area. The acidification of land and water in the upland area and eutrophication in the lower part, together with hydromorphological changes, constitute the main pressures on the water bodies*




Demonstration of windmill pumps for irrigation and biodiversity wetlands to the German project partners.

*“A water management plan at my farm is an important foundation for my plant production planning. The importance of water management is increasing.”*

*Henrik Olsson*

**<<**
Henrik Olsson, a pilot farmer in the Aquarius project, regulates his constructed wetland.

**<**
Local meteorological stations can be used to determine irrigation.

**>**
Flooding situation in June 2007, an extreme event occurring once every 30-40 year. The flooding 2007 was the main reason for the choice of River Smedjeån as the pilot catchment for the Aquarius project. But in spite of the flooding situations, drought is the main problem for the farmers in the area.

Climate change, also in the short run, will lead to loss of production in agriculture as a result of both flooding and shortages of irrigation water. Increased nitrogen leaching, erosion and phosphorus losses are other consequences which will result in difficulties to reach the EU goals of water quality in the Water Framework Directive, WFD.

“In Sweden today there is a lack of general hydrological knowledge to combat climate change. We realise that further strategies on this issue must be locally adapted”, says John Strand, project coordinator for the Swedish partners.

A key factor is the active participation of the farmers to look into the irrigation needs and capacity, and in the long run find technical solutions to reach both production and water quality goals. The project group consider that additional to farm water plans, controlled flood areas/wetlands need to be set aside in order to avoid damage by flooding in more important economic areas.

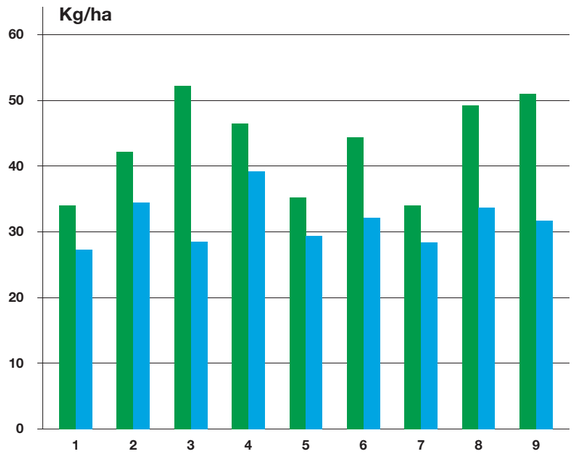
“Measures must however be addressed not only to farmers but also to other stakeholders such as NGOs, municipalities, regional and national authorities with the ambition to reach a broad acceptance”, says John Strand.

**Water abundance and deficiency**

The pilot area has already experienced extreme weather situations. In June 2007 there was a severe flooding, followed by a drought period of six weeks in the summer of 2008.

Due to climate change there are general expectations of more precipitation during autumns and winters, as well as more droughts in the summers. During summer the need for irrigation increases, whereas concurrently the water level in the river may decrease to hazardous levels for the salmon fry.

“The River Smedjeån is the main water resource for irrigation in the farming district. In extreme weather conditions it will be more difficult to reach the water quality goals than it is today. Both flooding and drought lead to increased nitrogen leaching, erosion and phosphorus losses”, says John Strand.




Estimated nitrogen leaching from arable land on nine representative pilot farms – current situation (green) and adapted farm practices (blue).

**A water management plan for each farm**

An important sub-project in the pilot area has been the production of water management plans at farm level. Nine randomly chosen farmers have participated with the aim to find technical solutions to reach the water quality goals, and to investigate the irrigation needs and capacity. Measures regarding fertilisers, catch crops, tilling, irrigation, constructed wetlands, etc. were compiled in a ‘water management plan’ for each of the nine farms.

There were large differences between the farms, as seen in the diagram. The main nitrogen leaching from the different farms can be reduced by between 4 and 23 kg nitrogen per hectare a year. In total it amounts to about 14 tons of nitrogen annually from the 1,500 hectare, if all known measures are applied.

“But if phosphorus fertilisation is to be kept within official guidelines, about 15,000 tons of slurry manure must be transported to other areas. Some of the measures are not economically feasible for farmers and need outside financing in order to be carried out”, says Arne Joelsson, project partner from the County Board of Halland.

One of the pilot farmers, Gösta Paulsson, produces 23,000 growing-fattening pigs per year.

“Animal manure is an important nutrient resource but can also be used as raw material for gas production. We are now constructing a biogas plant for production of heat and electricity. Separation of manure and ‘export’ of the solid material with high phosphorus content is under discussion”, he says.

The farmers’ attitudes towards wetland construction are mainly based on economic considerations, and they will use wetlands both as nutrient traps and as irrigation ponds. They also consider that their role as water managers must have a catchment based perspective, and not only a farm level view. To prevent flooding damages and to reach an agreement on irrigation water apportionment there is a need for cooperation at catchment level.

**Awareness, cooperation and participation**

Members of the Swedish pilot group have communicated project issues in different forms and activities with the farmers in the area.

“The full-time farmers are aware of the situation and accept that they have to adapt their agricultural practices to the coming changes. They want to maintain their farms and properties in good and sustainable conditions including drainage and irrigation systems”, says Arne Joelsson.

A catchment based irrigation group of farmers has recently been established with the aim to deal with the allocation of irrigation water from the river, and to apply for a joint license for abstraction of irrigation water. There is also a cooperation between authorities, advisors and farmers in the local water management, for example constructing wetlands and ponds as buffers and storage basins for irrigation. A thorough hydrological investigation of the catchment area has been performed within the project. This provided important information on how to manage the water resource regarding storage capacity.

“We have actively involved the farmers in the project. Local meteorological stations hosted by farmers have been useful in calculating water flow, predicting flood risks as well as changes in soil water during dry periods. The farmers have shown great interest in the hydrological studies and are suggested to take over the equipment to get data for their own planning, irrigation and water management”, says Arne Joelsson.

**Hopeful future perspectives**

The Swedish pilot group sees the project outcomes so far as very positive. They hope that the results will lead to a change of views and function as a guide on how to consider problems and values in catchments similar to the River Smedjeån in the future.

“We can already give some detailed recommendations based on the project. Most important is that the problems within a catchment must be considered from a holistic perspective, whereas solutions and measures must be locally adapted and individually accepted”, John Strand sums up.

## Recommendations and learnings from the Swedish pilot project

### Recommendations on hydrology and legal matters

- Controlled flood areas should be set aside in order to avoid damage by flooding in other more important areas. Upstream water storage can only marginally reduce the flooding problems on the coastal plain.
- Downstream effects of various measures, e.g. flood regulation must be considered to a larger extent.
- The legal aspects of all water activities – needs of irrigation, flooding situations, water quality, and biodiversity – must in the future be considered to a larger extent. The land owner must be considered as an important stakeholder in the process.

### Recommendations on water quality and biodiversity

- Water management plans at farm level, including wetland/irrigation pond construction, should be used as a tool to obtain a cost effective combination of measures in areas where the water does not reach good ecological status in accordance with the Water Framework Directive.

### General recommendations to water managers

- Support establishment of local groups handling water management issues and measures to tackle the changes in climate conditions, e.g. stream-, river- or irrigation groups.
- Inform farmers about possible use of data from their own meteorological stations (cheap and easy to use) to determine soil water conditions and irrigation needs.
- Show farmers the positive effects of water management actions (e.g. wetland construction) through evaluations and demonstrations.
- Evaluate wetland advisory programs and update previous shown interests from farmers, as conditions can alter quickly. Handle applications for wetland construction faster.

### Structural perspectives

Some of the water issues have structural reasons and are not possible to tackle at the local level with current policy instruments. New legal and financial instruments, with applicability to the coming climatic situation, have to be developed. Therefore our recommendations need to be addressed to stakeholders at different levels, like municipalities, water boards, regional and national authorities.

The pilot area is a potato district with a high irrigation need.

# COOPERATION IS THE WAY TO ACHIEVE **RESULTS**

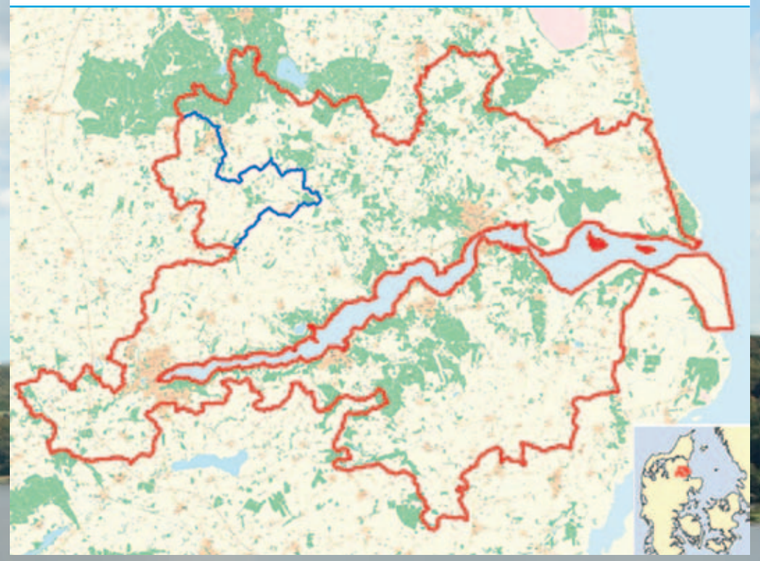
*Targeted efforts to create a common understanding within a group of farmers, advisors, and representatives from the authorities bear fruit in the Danish pilot area. The efforts are expected to lead to a row of initiatives that will effectively reduce the amount of nitrogen leaching into the vulnerable Mariager Fjord without affecting agricultural production in the area.*

BY **TROELS PRÆST ANDERSEN**

**Irene Wiborg**
Project Manager.
Knowledge Centre
for Agriculture

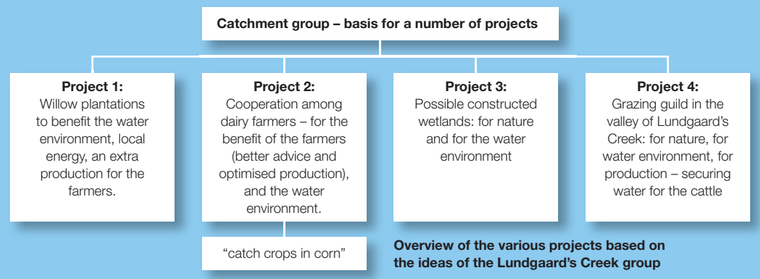
## The Danish pilot area, Mariager Fjord

*Mariager Fjord is a highly eutrophic fjord with a very high production of algae, low secchi depth and extensive oxygen deficiency. The main problem of the fiord is eutrophication due to the high loading of nitrogen and phosphorus from the catchment area. The agricultural losses of nutrients are highly dependent on climate, and thus climate changes will have a strong influence on losses. In general, higher losses of nutrients can be expected if there are no changes in current agricultural practices.*



The red line indicates the catchment area and the blue line shows the sub catchment Lundgaard's Creek.

The pilot projects in the catchment area will improve the water quality in Mariager Fjord.




**Overview of the various projects based on the ideas of the Lundgaard's Creek group**

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Authority representative:
Illustrating nutrient leaching on location for farmers.

>

Excursion to a constructed wetland in Sweden.

**Facts:**
The Danish Ministry of the Environment, Nature Agency Aalborg is a partner in the Danish pilot. The contribution to the Danish pilot is in cooperation with the Danish consulting firm NIRAS to develop a method which - from general data - is able to describe the pathways of nitrogen leaching from fields to surface waters. With this description we hope to be able to locate which fields are contributing the most with nitrogen to the surface waters.

A close and trusting cooperation between farmers, authorities, and advisors is important for finding effective solutions that benefit the environment, the climate, and farming. This is one of the main conclusions from the Danish pilot area.

Project Manager Irene Wiborg from Knowledge Centre for Agriculture sums it up like this: "Innovative and cost effective solutions to solve the challenges of for instance nitrogen leaching can best be found when a common agreement to cooperate has been established".

But how do you reach a common understanding and cooperation in a group of diverse people?

"We didn't know the answer to that question before we started this pilot project. But after thorough studies carried out by among others a sociologist, who has been following the group's work, we have come closer to the answer."

### Trust leads to win-win situations

According to Irene Wiborg it is a crucial condition for creating a well functioning group where the members feel comfortable that all participants have a joint and concrete understanding of the present challenge. It was very effective when the farmers and other participants in the group went on a field trip and thereby got a common understanding of the environmental problems. In this case the use of an infrared camera made everybody able to see from which areas the water and thereby nitrogen ran into the creek. This common understanding of the challenges removed many of the possible prejudices and helped the group members work in the same direction in the search for solutions. Another way of creating trust is through the creation and acceptance of common rules for the cooperation.

The Danish pilot group, Lundgaard's Creek Group, consists of members with different backgrounds and outlooks. "It became clear to us that we couldn't just put a group of people in a room for a meeting and expect them to solve complex environmental and climate related problems without giving them the time to get to know each other. It was an advantage for us that we had decided to have an impartial mediator in the group – especially when the discussions hit the rough seas", says Irene Wiborg.

When the group members had had time to get to know each other, had established a common understanding of the challenges of nitrogen leaching, and agreed on a set of clear rules to work by, the participants began to trust and sympathise with one another. And they began to look for project models that would benefit all participants.

"The group members started thinking of ideas that could reduce nitrogen leaching, generate a basis for income for the agricultural advisory services and make farm production more effective in order to fulfil EU objectives in a changing climate. In other words they tried to find effective win-win solutions, which – as shown in figure 1 – benefit everyone and are thus relatively easy to turn into reality on a voluntary basis", says Irene Wiborg.

In fact the Lundgaard's Creek Group has developed ideas that are about to lead to several win-win projects. These projects are as diverse as: advisory cooperation among dairy farmers, constructed wetlands, a grazing guild and planting of willow.

### Great perspectives in willow

One of the projects by the Lundgaard's Creek Group has added the growing of willow to the agenda. Through investigations and desk research the group has reached the conclusion that many different stakeholders can achieve a number of benefits from growing willow on a larger scale.

"The environmental gains from growing willow are self-evident", says Project Manager Irene Wiborg from Knowledge Centre for Agriculture.

Willow ensures significantly less nitrogen leaching and contributes to reducing the need for pesticides. According to the national authorities, growing willow will support the process of achieving the objectives for Mariager Fjord as described in the Water Framework and Habitat Di-rectives.

Farmers too perceive the reduction of nitrogen leaching as important. The decrease in nitrogen leaching is an acknowledged essential parameter in order for them to develop their farms as it allows room for a continued expansion of their production. Growing willow has an added value to the farmers in the area, since they become energy suppliers and gain an alternative source of income.

"The price of woodchips has now reached a level where it is competitive compared to cereals", adds Special Advisor Flemming Gertz from Knowledge Centre for Agriculture.

The local advisory service is positive towards this new type of farming and would be pleased to see it evolve further. They are working to develop their advising in order to handle the logistics of harvesting and planting the cuttings.

"Willow is a crop with a positive growth potential. Heating stations are already using biomass in their production and more examples of the use of biomass are added regularly," says Mads Vinther from the local advisory service, Agri Nord.

The local municipality is quite pleased with farmers, who – with respect for their neighbours and the landscape – want to grow willow. Growing willow contributes positively to achieving the climate objectives as formulated by the municipality of Mariager Fjord. According to biologist Søren Bek from the municipality of Mariager Fjord these objectives include an increase in the proportion of energy derived from sustainable sources and securing an environmentally friendly locally based energy supply.

"Furthermore, growing willow provides a lower level of nitrogen leaching than traditional crops, and this will improve the water quality in our marine habitats", Søren Bek points out.

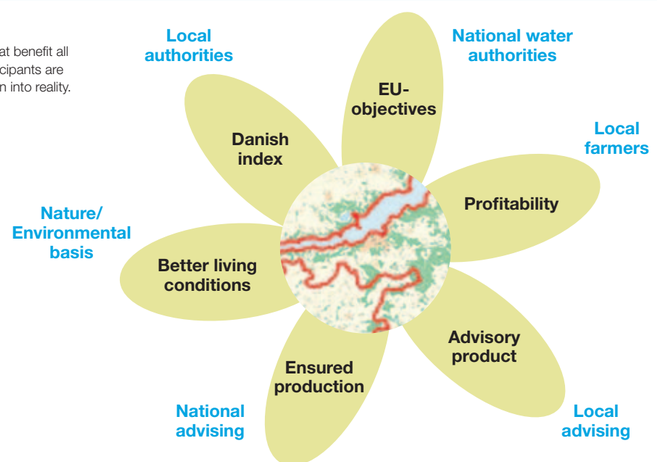
### Good opportunities

When the projects initiated by the Lundgaard's Creek Group ends there are great opportunities for using the knowledge and learnings achieved.

"It means very much to us that through this project we are able to show the Danish politicians that it is possible to have profitable farms in a way that actually benefits the environment and helps Denmark comply with international rules and legislation. This being done without even costing neither the state nor the farmers a fortune", says Irene Wiborg.

According to the project manager it is especially important that the learnings on how to establish an effective cooperation are disseminated to the whole country.

*Figure 1*
Solutions that benefit all project participants are easier to turn into reality.




## Recommendations and learnings from the Danish pilot project

### On the process issue all stakeholders recommend

- That the catchment group deals with a limited and well defined area to which all stakeholders have a relation, for instance the catchment to a creek like Lundgaard's Creek.
- That the group should include stakeholders who have a role in the use and the management of the area. In the Lundgaard's Creek group this means at least representatives from the land owners and the authorities.
- That it is important to achieve a common and visualized understanding of the N-problem based on scientific knowledge and data.

*The most important issue for the farmers:*
Special recommendation from the farmers around Lundgaard's Creek: They want to be involved in finding solutions that are neutral to or benefit their income.

*The most important issue for the water authority*
Special recommendation from the municipality in the area: Find new solutions which are to the benefit of Mariager Fjord, are in accordance with the legal obligations, and good for the local farm business.

*The most important issue for the farm advisors*
Special recommendation from the advisors in the Lundgaard's Creek area: have a non-biased advisor in the group. It gives the advisor a possibility to mediate and establish trust which leads to new solutions that all members can support – for instance the grazing guild.

### On technical issues all stakeholders recommend

- To use catch crops in cereals in order to minimize the nitrogen run-off
- Models are verified. For instance by measuring nitrogen content in water.

### On financial issues all stakeholders recommend

- That it is important to find market based business cases to the benefit of the farmers and to the benefit of the water environment in the Lundgaard's Creek area. Cases in this form are more sustainable and longer-lasting than supported initiatives.

Willow plantations benefit many stakeholders apart from the environment: farmers, authorities and the local advisory services.

**Facts about the Lundgaard's creek group**
*Members:* 3 farmers, 2 agricultural advisors from Agri Nord, 1 representative from the municipality, 2 representatives from the Danish Nature Agency, various specialists from Knowledge Centre for Agriculture, one of which acts as group secretary. The group was formed in January 2010. The purpose of the group is to ensure that initiatives are taken and carried out in the catchment area of Lundgaard's Creek. These initiatives must contribute to showing how effective and profi table farming can go hand in hand with creating and maintaining a good water environment in the whole catchment.

# SMOOTH **SMARTLY** THE WAY FOR WATER

*This is the slogan of the German AQUARIUS pilot project, which expresses the need to find new ways to deal with the expected water shortages due to climate changes in agricultural areas.*

BY **RAINER BEHRENS**

Irrigation is necessary to obtain an optimal yield.


**Elisabeth Schulz**
Agrarian Engineer.
Landwirtschaftskammer
Niedersachsen
Uelzen

**Rainer Behrens**
Agrarian Engineer.
Landwirtschaftskammer
Niedersachsen
Uelzen


## The German pilot area, Lüneburg Heath

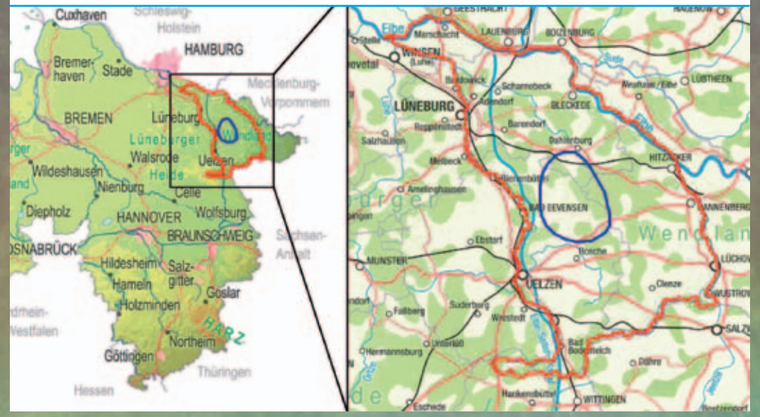
*Lüneburg Heath is in the northeastern area of the state Lower Saxony (map 1) and is a unique man-made environment. 58% of this region is used for farming and 90% of the crop land is irrigated. This makes the region one of the most intensively used regions for agriculture in Germany.*

*Due to its location the climate is sub continental and light soils have a high rate of water permeability.*

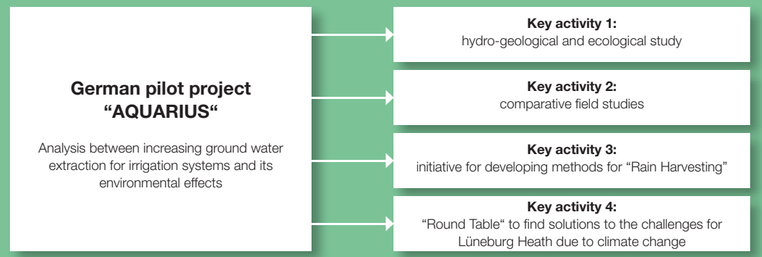
*Hence, for 3 generations farmers have been using ground water for irrigation in dry periods which guarantees the amount and quality of fruit. At the same time irrigation helps to supply crops with nutrients and prevents it from flowing into the ground water body.*

*The quantity of groundwater in eastern Lüneburg Heath is great. Due to the shere amount of ground water in the region, flow conditions of heath creeks are currently rather balanced.*

*Under the conditions of climate change irrigation systems will become more essential for farmers.*




The red line is the project area (2 Groundwaterbodies Ilmenau East and Jeetzel West), the black line the detailed modelling area




**<**
*Figure 1:* German pilot project “AQUARIUS” and its key activities 1-4.

**>**
The Round Table of Stakeholders on excursion.

**>>**
Circular irrigation machine with precision steering equipment at each single nozzle.

In light of these challenges the project „AQUARIUS – Smartly Smooth the Way for Water“ was formed. The aim of this project is to save vital regional development for the future. This means that the ground water body and the flow conditions of creeks should be protected while farmers have enough water. Until now there has been a balance between the needs of the local creeks for water during the summer and the needs of farmers for irrigation water. With changing climatic conditions plants will need more water because of the heat and at the same time less rainfall is expected during spring and summer. Today farmers already find themselves spending more money and time on pumping ground water and more hard labour on irrigating crops to save them from failing.

The Chamber of Agriculture of Lower Saxony is the German project partner and gets financial support of the Ministry of Environment of Lower Saxony. They want to figure out, whether and how it is possible to increase the extraction of ground water without endangering creeks. Furthermore the project is focused on enhancement of water efficiency and on further development in water consulting for farmers.

**Four key activities**

To tackle the future challenges, the project is divided into four different key activities (figure 1).

**1.** The first key activity includes a hydro-geological and an ecological study to obtain better knowledge on how the groundwater household, the surface water-supply and the groundwater-depending biotopes are connected.

“We don’t know enough about the relations of the watercourses and the groundwater bodies. In some parts of our pilot we supposed local upper groundwater bodies recharging the watercourses” Elisabeth Schulz from the Chamber of Agriculture and project coordinator of AQUARIUS in Germany explained.

The schematic figure (2) below illustrates the connection between different groundwater bodies and the water courses.

**2.** The second key activity comprises comparative field studies at different experimental fields. The performance of different farming methods and the irrigation system will be tested. These experiments are expected to provide additional knowledge to further improvements of water-efficiency and irrigation systems. The Chambers project partner von Thünen-Institut in Braunschweig is testing innovative ‘precision irrigation’ with the help of innovative large scale circular irrigation machines, which is shown in figure 5.

Figure (3) shows a testing field with different earnings, depending on soils conditions. This information will be bases for precising irrigation quantity.

**3.** In the third package initiatives to hold back the winter’s rainfall from running into rivers and finally into the North Sea are started and discussed with farmers, irrigation boards and water-authorities. Farmers are the ones, who know ‘their’ wet spots and ‘their’ surplus water best. So the vision of these measures summarised as ‘Rain Harvesting’ and developed in the AQUARIUS-project is that surplus water from (winter-) rainfalls is retained or collected. It could be held back in the fields and ditches, where the landscape gives a chance to do so, in order to retard the start of the irrigation in dry periods. Or it could be pumped to waterproof storage ponds to be used during the next drought. The farmers and irrigation boards at the local level know best possible spots where this could be done.

Elisabeth Schulz is optimistic: “We want to modify drainages to interrupt the water flow into ditches and rivers and to use this water for an increasing leakage. That could be realized in autumn 2011. Perhaps it will be a good example for other farmers”.

**4.** The last key activity includes a ‘Round Table’. From the beginning of AQUARIUS this Table of ‘Smootheners’ (Stakeholders) was installed. The aim has been to find cooperative solutions to cope with the challenges of climate change the Lüneburg Heath is exposed to. The basic idea is that farmers will be very creative, effective and willing to invest if they have the chance to support their future need for irrigation water with long lasting investments or activities. The necessary schemes to give and leave the profit of such measures at the farmers or irrigation boards have been discussed at different administrative levels during the project.

Therefore the round table is composed of some farmers, members of the local and regional irrigation boards, the water-authorities of the counties and some specialists of hydrology and ecology. Excursions are held to improve the contact between these stakeholders and illustrate local problems from different point of views.

Networking plays an important role in the AQUARIUS-project. It is necessary to make stakeholders aware of changing conditions. It provokes a confrontation between conflicting parties, initialises discussions and establishes understanding. Networking happens on different levels:

1. ‘Smoothener group’ as a round-table of stakeholders.
2. ‘Expert group’ for assisting the hydro-geological and ecological studies.
3. ‘Political group’ honouring system.
4. International AQUARIUS-Network with other pilots
5. Other national projects

Farmer H.-G. Schenk is one of the members of the round table: “The Aquarius project is already proving very successful and shows very clearly that the exchange of knowledge between farmers, authorities and organisations across borders is vital, when it comes to solving the problems that farmers from different countries are dealing with now and in future”.

This shows the necessity of transnational exchanges between farmers from different nations with nearly the same problems of farming. Therefore some bilateral exchanges with farmers from the Netherlands and from Sweden imparted new impressions and helped to produce new ideas for using in their own region.

*Figure 2:* Interaction between groundwater and other water levels above.

**A Grundwasseranschluss** **B schwebende Stockwerke**

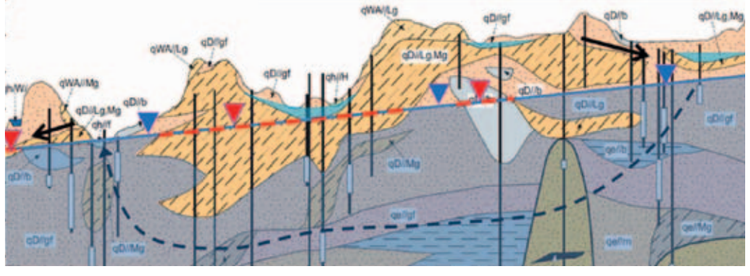



*Figure 3:* Testing field in Uelzen with variable earnings from 33,8 to 68,4 dt/ha.


## Recommendations and learnings from the German pilot project

### Hydrological

- Initiate an additional hydrogeoloical study for the southern part of the critical area (Süd-Drawehn), as conclusions are only valid for areas with floating aquifers.
- Only Extract water from the lower aquifer (which is opposed to recent policy).
- Only measures on the surface – like those to increase seepage – when active support of biotopes and creeks depending on the upper floating aquifer, is intended.

### Limnological / Good Status of Creeks / Biodiversity

- The quality of the creeks’ beds has to be improved dramatically before the benefits and problems of more or less water flow can become effective. Beds need to be reconstructed to support faster run off with more erosive power in the summertime by constructing ‘summer-beds’ (lying in the larger winter-bed to tackle flooding situations).
- Additional research about the fauna of the dry – falling upper parts is necessary. This shall be done through the last year of AQUARIUS. In order to retain WFD-effective measures it has to be clear, what the good state is (i.e. naturally falling dry or not).

### Participatory / Structural / Legal

- The assessment of the effectiveness of measures for upstream creeks or / and for groundwater quantity has to be continued.
- Additional research on the fauna of the dry falling parts of the creeks has to be done to evaluate, if measures to increase the summer base flow are helpful (i. e. determine a definition of the good state of dry falling sections).
- A political-administrative strategy should be decided by the water authority, if measures and benefits are better to be balanced on a large scale or on a local scale (or a mixture).
- Measures should be promoted by the water authority via
  - supportive examination,
  - only low-cost / no-cost obligations and by
  - defining ‘exchangerates’ of measures to additional water allowances.
- A local frame should be installed which will allow compensation-‘deals’ between environmental authority (water, nature) and irrigation boards. For example a farmer, who gives land for a buffer strip, could be ‘paid’ with additional water extraction permits.

### Irrigation

- Investment programs and a legal framework should encourage farmers to install measures to retain water (for example with weirs in ditches) or to collect water (winter flow, drainage).
- Research on farming methods for more economically effective uses of rainfall and irrigation water should be continued after all.
- Research on plant-physiological steering of irrigation should be extended (i. e. improve identification of growing phases, during which water is of high impact for the final yield and other phases with lower damage through a lack of water)

### Other

- Develop further going information strategies.
- Carryout research on public opinion (at regional and at national level) and evaluate need for and difficulties of advanced information concepts.

# FARMERS HAVE A NATURAL ABILITY TO **ADAPT**

*Farmers in Drenthe are working together with the regional authorities and water board to face the challenges resulting from climate change. Drought is an issue and the partners' integral strategy focuses on technical solutions for water retention and efficient irrigation. Researchers also predict that climate change could have a negative influence on crop growth and production in the future.*

BY **DEIRDRE BUIST**

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Hydrologist

## The Dutch pilot area, Drenthe

*The pilot area 'De Monden' in Drenthe (The Netherlands) is part of the catchment area Veenkoloniën. The Veenkolonien is part of a much bigger catchment area of the river Ems. The Pilot area is 160 km² and lies at about 5-10 m above NAP (Normal Amsterdam Water Level).*

*The Veenkoloniën is a former high-moor bog area. From the 16th till the early 20th century all the peat was reclaimed. A detailed network of straight canals was created to drain the area and enable transportation.This dense network of canals is still present. At the moment the area is mainly flat and sandy and used for agriculture. Farming is mainly arable (80%) with some grazing (18%). Averages for crops grown (2005) are as follows: starch potatos 47%, sugar beets 19%, grain 28% and green maize (fodder) 6%.*


*Because of the sandy soils of the Veenkolonieën is relatively susceptible to drought. Like most of the north of the Netherlands, during summer the area depends to a great extent on the IJssel Lake (IJsselmeer) for its water. It is expected that water from the IJssel Lake will become increasingly scarce as a result of climate change. The Aquarius pilot project in Drenthe is a joint venture between farmers and authorities and combines research, technology and practical experience in search of solutions.*

Pivots are a solution for efficient sprinkling on large scale farms at Valthermond, Drenthe.

**<<**
Water conservation with small farmer-operated weirs.

**<**
Irrigation (pivot head).

**>**
Visit to the test farm in Valthermond, Drenthe.

**>>**
Farmers exchange with German colleagues.

Project manager Ben van Os and policy advisor Rinke van Veen from the Province of Drenthe reflect, together with Jan den Besten from the Water board Hunze en Aa's, on what the Aquarius pilot project has achieved in their region. Ben's first observation is noteworthy. "We've witnessed a growing awareness amongst the farmers in our region and their natural ability to adapt", he says.

**Cooperation is the key**

The Drenthe partners in Aquarius want to find solutions for drought problems in the Veenkoloniën. "Efficient water use can be achieved by using soil moisture sensors that are connected to a decision support system' according to Jan den Besten of the Water Board Hunze en Aa's. The pilot project is closely linked to two other projects; 'Hotspot Climate and Agriculture in the North of the Netherlands' and 'Watersense'. Hotspot has researched the opportunities and challenges for agriculture as a result of climate change in the three Dutch provinces and studied the consequences for related agricultural policy. The Watersense project has developed decision-supporting models for more effective irrigation and water-level control. Jan den Besten and Rinke van Veen (Province of Drenthe) have been working closely togetherwith all parties and they are both enthusiastic about the collaboration. 'The research results and decision-supporting models are of great value", they say.

Within the Aquarius project this information has been used in the pilot area of the Veenkolonieën and the necessary infrastructure has been introduced in the field. Farmers have installed retention weirs and existing larger weirs have been fitted with a remote control system. Water conservation and more efficient irrigation techniques have been introduced and the policies for groundwater use have been adapted. More groundwater can be used for irrigation. In this way the existing reserves in the area are used optimally.

**Farmers are keen water managers**

During the initial phase of the project some 50 farmers in the region were asked to fill in a questionnaire in order to get an overview of how farmers see the challenges of drought and their attitudes towards irrigation. Results showed that the farmers, although preferring traditional methods for dealing with drought and flooding, were surprisingly keen to try something new and to use the so-called 'farmer's weirs' and sensors as a new measure.

Rinke remarks that the tests and experiments have resulted in regular contact between the farmers involved and all the other stakeholders. Workshops, crop-growers meetings and field trips were organised to encourage involvement. "We also organised a farmer's exchange visit to our German partner's region to share knowledge and experience. This was very worthwhile", he tells us.

During three growing seasons the participating farmers used soil moisture sensors to optimize their irrigation planning. All these project activities have led to farmers thinking more about optimizing the water management in their fields. Jan is pleased with the results. "There has also been a gradual increase in the number of large scale energy and labour saving pivots for sprinkling in the area", he tells us. "Some farmers even bought neighbouring plots to get the optimal area of land for a central pivot – and small weirs are being used for water conservation". Besides quantitative water management, ideas have also been developed regarding the use of nitrogen. Controlled application in combination with optimal irrigation is expected to reduce the leaching of nitrogen.

**Influencing change**

The climate is changing, farmers are adapting, but has anything been influenced by this project? What has happened on the policy level, for example? Jan confirms that a groundwater model study has been completed which will provide the basis for the water board's latest policy amendments regarding groundwater extraction. "We expect this new policy to be official in February 2012", he says.

The farmers' participation in the Aquarius pilot project in the Veenkoloniën has shown the importance of their role when developing a strategy regarding water and climate-related issues. The use of innovative measures for efficient water usage in farming has been put sturdily on the regional agenda for the new European agricultural policy.

The technical experiments in Drenthe have also drawn attention on a national level, according to Ben van Os. "Most notable is the interest shown by the Delta Freshwater Programme which is developing the future Dutch strategy for freshwater facilities", he adds.

So, what about the international aspect of Aquarius? What has been learned from the other partners? All three are excited by what the cooperation has brought. "We've learned a lot from our partners in the North Sea region and have seen, for example, how Denmark and Sweden tackle the problems of nitrate, how Germany is dealing with drought and how Scotland approaches the relationship between farmers and authorities", Rinke sums up.

**A turning point**

Until now the total possible impacts of climate change on agriculture were not generally known. Thanks to the Hotspot study more information is available and we have reached a turning point. There is now a clear willingness from all parties in the sector to work together with government bodies and water boards. "Valuable insights have been gained but we still don't have all the answers" according to the project manager. "For example, under the influence of higher temperatures and humidity, the increase of pests and diseases could become a pressing issue. Optimal plant nutrition and good operational hygiene will help preventively but more practical experience is needed".

Nobody knows what the future will bring but the Province of Drenthe, Water Board Hunze en Aa's and the Farmers' Association for the North of the Netherlands will continue their close collaboration with farmers in the area – and with their network in the North Sea Region. One last quote from Ben van Os: "Being prepared is half the battle – together we're strong!"

The pilot area in Drenthe is part of the catchment area 'The Veenkoloniën' which is a former high-moor bog area.

## Recommendations and learnings from the Drenthe pilot project

- Support the farmers with the introduction of new techniques.
- Use a research farm for demonstrations and discussion meetings about techniques.
- Encourage innovative farmers to introduce new techniques.
- There should be an advantage for the farmer (higher yield, lower costs);

- Water management on a farm should be part of sustainable farming and the greening of the CAP

- Advice on irrigation should be easily accessible via internet.

### Improve knowledge on:

- Profitability of irrigation / water conservation;
- Alternative crops;
- Present and future climate conditions;
- Further developments of soil sensors:
- The influence of climate change on diseases and plagues

### Learnings

- Adaptation can be difficult within the sphere of current farm management;
- We need to learn more about the influence of climate change on diseases and plagues and do more in depth research into adaptive measures;
- Investing in good soil structure is an important measure when adapting to climate change;
- Choosing the most suitable crop varieties can offer positive results;
- Cooperation and fine tuning between water authorities and farmers on sustainable water usage is necessary;
- Introducing new races could make arable farming more resistant to the influences of climate change;
- Governments must stimulate and facilitate the transition to new crops;
- There is an evident willingness from the agricultural sector to work together with the government bodies on a long term agenda.

# *Aquarius is partly funded by The Interreg IVB North Sea Region Programme*

**The North Sea Region Programme 2007-2013 works with cutting edge policy areas in regional development through transnational projects.**

A principal objective of the Programme is to expand the scope of territorial cooperation and focus on high quality projects in innovation, the environment, accessibility, and sustainable and competitive communities.

The 2007-2013 Programme connects regions from seven countries around the North Sea, incorporating policy level planning and the long lasting and tangible effects of projects. These are the foundations of the future transnational projects, which will create added value to partner regions and beyond.

The aim of the programme is to make the North Sea Region a better place in which to live, work, and invest.

For more information about the programme visit www.northsearegion.eu

**Main beneficiaries in Aquarius:**

1. Knowledge Centre for Agriculture, Denmark
2. Danish Nature Agency, Aalborg, Denmark
3. Landwirtschaftskammer Niedersachsen, Germany
4. Hoogheemraadschap van Delfland, Netherlands
5. Provincie Drenthe, Netherlands
6. Waterschap Hunze en Aa's, Netherlands
7. County Governor of Østfold, Norway
8. Bioforsk Institute, Norway
9. Aberdeenshire Council, Scotland
10. The James Hutton Institute, Scotland
11. County administration of Halland, Sweden
12. Halmstad University, Sweden
13. Rural Economy and Agricultural Society of Halland, Sweden
14. Municipality of Laholm, Sweden
15. Regional Development Council, Halmstad, Sweden

European Union The European Regional Development Fund

The Interreg IVB North Sea Region Programme

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

AQUARIUS

Farmers as water managers