ONE STEP BEYOND IMPLEMENTATION OF CLIMATE ADAPTATION INNOVATIONS

EXPERIENCES FROM THE INTERREG IVB PROJECT WATERCAP

Promilleafgiftsfonden for landbrug

Colofon

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AWA
AQUARIUS Farmers as water managers
CLIWAT CLIMATE & WATER
cradle to cradle islands
diPol
CLIMATE PROOF AREAS
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

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AIMS AND CHALLENGES OF WATERCAP

I. Borowski, T.Balskilde Stoltenborg, I. Asta Wiborg, R. Johnsen

Context and aims of WaterCAP

Interreg projects unfold their high potential in building networks for exchange and innovation among European regions on thematic issues. The inter-regional effect and impact is highly recognised1 and leads to new and permanent cooperation's across borders. Interreg projects have dealt and are dealing with outstanding and urgent challenges of the European Union, e.g. innovation, energy and sustainable development. These challenges have been tackled on regional level and solutions have been created by close cooperation of project partners. The results and experiences gave evidence that the inherent potential is not limited to one part of Europe. Therefore, six Interreg project from the North Sea Region programme were brought together to exploit the full potential of their results and experiences on the climate change and the effects on the hydrological cycle.

Towards this background, the cluster project WaterCAP was established. The results from seven North Sea Region projects (Aquarius, CLIWAT, CPA, C2C islands, DiPol, SAWA) and the Baltic Sea Region project (BaltCICA) have been merged to provide on-the-ground experience to European policy makers. The clustering of these six projects to WaterCAP boosts the already existing added value by sharing and synthesising their knowledge.

One of the most tangible outcomes of this cluster project are the success stories, which are best practise examples from out each of the six North Sea Region Interreg projects. These success stories shortly explain the challenging issue and the jointly developed solution within the project. Furthermore, these success stories have been identified by the WaterCAP cluster consortium as important and innovative examples for sustainable solution approaches of climate induced problems at the hydrological cycle. It also shows that integration of technical solutions with good governance is one of the major tasks to cope with climate adaptation challenges.

How did we faced these challenges

WaterCAP combined action research and interactive meetings with both project members and policy officers of the European Commission:

- We organized interviews with policy offers from DG Regio, DG Research, DG Environment and DG Agriculture.
- We organized a workshop with European policy offers and project members to discuss the results we found in the interviews and how we could contribute to the needs of Interreg.
- We organized 4 interactive workshops with project members to collect experiences, knowledge and success stories on climate adaptation implementation, focussing on the subjects: water quality and water quantity, innovative tools, governance and policy recommendations.
- We shared our results on conferences: NSR conference in Hamburg (2011), Brussels and ECCA conference on climate adaptation.

We believe a major step in WaterCAP was the opportunity to look beyond pilots, based on the results of previous Interreg projects. In this context we discovered what innovations other regions in the North Sea Region could use. And being aware of the strengths and weaknesses of innovations, it was easier to cluster and synthesize the results. So thanks to the cluster project WaterCAP, the results of European funded projects have been set in a wider perspective.

Content and outline of this report

This report represents the experiences and knowledge developed during the WaterCAP project. It is focussing on both the clustering of the results and experiences of six thematic projects and the process on how to develop a strategy for dissemination of cluster results in the European Union. Moreover this report is meant for all professionals working on water and climate issues, interested in European projects.

The outline of the report is as follows:

- Chapter 2 gives an overview on our experiences and perspective with the European policy level and.
- Chapter 3 shows how climate change impacts water quantity and quality in the North Sea Region, based on experiences in the previous Interreg projects.
- Chapter 4 list examples of technical innovations, which have been developed in the seven Interreg projects.
- Chapter 5 describes the challenges of the governance of climate change, and practical solutions drawn from the projects.
- And last but not least the conclusions and recommendations for the interreg Secretariat are summarized.

In Appendix B you can find all the success stories drawn from the included Interreg projects. If you are inspired and want to read more, feel free to dig into the following underlying reports of WaterCAP:

- L. Jackson-Blake, K. Macleod, M. Stutter, W. Kenyon (2012). Impacts of climate change on water quantity and quality in the NSR.
- Ilke Borowski, Rolf Johnsen, Sophie Rotter (2012). *WaterCAP – Water Management in a Changing Climate, Adaptation to New Conditions and Promotion of New Strategies – Report on Tasks 2.3, 2.4. and 2.5 How can WaterCAP projects best support the European policy in the field of climate adaptation and integrated water resources management? Final Version, 30th May 2012.*


POLICE
ROAD CLOSED

2
HOW INNOVATIONS CONTRIBUTE TO THE IMPLEMENTATION OF EUROPEAN POLICY

I. Borowski, T.Balskilde Stoltenborg, I. Asta Wiborg, R. Johnsen

Introduction on European policy

The resources of the European Commission to implement their policy in the Member States can be roughly divided into legislative and financial instruments:

- Legislative instruments such as framework directives, e.g. Water Framework Directive (2000/60/EC), Flood Risk Directive (2007/60/EC);
- Financial instruments, such as:
  - Research funds, e.g. FP7,
  - Structural funds, e.g. Interreg,
  - Investment funds, e.g. TENT.

Some background and considerations on the European frameworks will be outlined in chapter 2.3. An overview of the European funding programmes is illustrated in Appendix A.

One of the missions of the European Commission is to stimulate Europe's innovative strength, which is the base for new policy as well as funding programmes like Horizon 2020, Interreg, TENT or Life+. A principal aim of the North Sea Region 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.

In this report we focus on the work of Interreg IVb regarding water and climate projects, and the conclusions and recommendations we can draw for the next Interreg V Programme.

2.2 Hot issues at European level

European policy acts as a strong driver for international and regional policy and management. Vice versa, European policy makers want to advocate regional diversity and consider it a main task of the European Commission to integrate and balance regional demands into European policy: For example, interviewees expressed their need for learning more about the policy clashes at regional level and feeding them back to European level, because they might point towards insights for improving European policy. For example, in the Aquarius project, farmers complained about policy clashes between different water policies, e.g. the Water Framework Directive and flood management, which would lead to constraints in implementing good local solutions.

According to inquiries with policy officers of the European Commission, the results of WaterCAP would be in particular appreciated if it contributed to:

- Innovation and bringing innovations into rural development programmes, to strengthening the EU.
- Economical benefits for society and for multiple sectors.
- Job creation.

This rather general perspective can be understood in the context of the on-going economic crisis. It points towards the need of the European Commission to legitimate their activities for taxpayers as well as the interest to improve the approach to sustainability and finding solutions which can support European export. During the interviews a broad list of issues was collected, on which the interviewees identified demand for action and contributions from Interreg projects[1].

1. Ilke Borowski, Rolf Johnsen, Sophie Rotter (2012). WaterCAP – Water Management in a Changing Climate, Adaptation to New Conditions and Promotion of New Strategies – Report on Tasks 2.3, 2.4. and 2.5 How can WaterCAP projects best support the European policy in the field of climate adaptation and integrated water resources management? Final Version, 30th May 2012

Essential background on European directives

There is no directive for climate adaptation

A range of European legislations covers different aspects of nature and water management and sets various goals. The environmental directives aim to introduce an approach which will result in greater protection for a vital part of our environment all over Europe. The aspect of climate change is not consistently dealt with in this legislation. This brings subsequent benefits and disadvantages, which we have to deal with in challenging climate change. These will be addressed in the following text.

What type of regulation do directives represent?

You will have to keep in mind what kind of regulation the different environmental directives represent. E.g. the Water Framework Directive (WFD) and the Habitat Directives represent two different kinds of regulation. The recommendations for implementing these two directives in the Member States, do not take these differences explicit into account. This means that the recommendations at some point favor the one way of regulating and sometimes the other, without being consequent. Especially the recommendation aiming at harmonizing the directives, in some cases takes away the flexibility for the Member State. It might be deliberately, but important to stress in case of climate adaptation challenges.

Example: Observed challenges with the WFD

This directive is, as the title underlines, a framework directive. This means that it, to a large extent, only sets the frame for the objectives for the water environment and how these objectives should be reached. But as this means that the Member States have been able to continue their tradition for water management, and the management demands a lot of restrictions, this has given rise to a lot of questions concerning comparison between the Member States. Focus has been on whether one Member State is doing more or to less compared to others. This discussion is not always right because the directive as a framework directive gives management room for each Member State. It would be more interesting for the Member States to focus on the question: is the national implementation and management sufficient to reach the environmental goals?

Is it a legislative problem on European, or national level?

When dealing with environmental problems, regulated by directives, one needs to ask why the problem still exists. There is sufficient legislation, one might think. But probably the European directive hasn't been implemented sufficiently, or the problem could be found in the national legislation. Besides the importance to base recommendations on the right premises, it is also important to consider the nature of the problem:

- Is it a crossing-border problem, e.g. dealing with inland and coastal waters and different responsible administrative bodies.
- Is it a cross-sectoral problem, e.g. dealing with river management works which touches different directives and responsibilities, or groundwater extraction in coastal areas.

Drafting and implementation regulations and its implications

The freedom to choose how to implement directives - with respect of the directive purpose - is one of the directives characteristics. The national legislation differs between Member States, due to different ways of thinking about environment and dealing with this. Therefore, for some Member States it might be easier to implement the directives and fulfill its objectives, than for others.

Problems that may occur are sometimes due to translation. The wording of the directives is mostly broad and can be interpreted differently. In translation into other languages and national legislation, miscommunication can arise. For example words which do not exist in other languages, or different terms to address the specific environmental problem. It doesn't have to be a problem as long as the purpose of the directive is fulfilled.

Another problem occurs when the implementation (including the management of the rules) doesn't fulfill the objectives set by Europe. Mostly the objectives of a directive are quite broad, to maintain flexibility for each Member State and to moderate the process of connecting to national legislation. The consequence is less focus and goals are 'weakened', and discussions arise between Member States whether or not they

fulfill the environmental objectives.
All these legal circumstances and implications have been taken into consideration in WaterCAP and in the recommendations given.

How European policy is developed and improved

According to the interviews with the European Commission, policy makers are in general strongly interested in evidence based contributions from science and research projects. But they often face the challenge that too many, not too relevant projects, compete for their attention. Moreover, the most urgent input these projects need from European officers is not addressed clearly. That is why decision makers make use of a number of strategies to cope with this situation and gather enough information to develop new policies, including:

- They listen to their peers and colleagues about projects but rarely read through articles or newsletters in full length.
- They set up their own specific research projects, delivering along the necessary timeline the relevant results.
- Consultancies are hired to analyse, review, synthesize and filter the information load.
- For the projects themselves, "project ambassadors" were suggested as one proven method. These ambassadors have a strong link to the policy level, sometimes being even part of it, and are well visible. They can support the projects to make a contribution to policy development.

Regional lessons from Interreg or research projects are considered of central importance by European policy makers. Not only for other regions to learn about, but also for European policy development to improve and adapt. In this perspective the call for specific lessons ("delivering numbers") is great, in stead of producing general lessons learned. For example, assessments of cost effectiveness and environmental resource costs were increasingly called for. Therefore the results of European projects should show how much time, money or other resources are necessary:

- for successful implementation of integrated measures,
- for participatory approaches, or
- for applying new technology.

Besides the need of research, there is an increasing need for smart innovations which can contribute to implement the European policies. So if project insights have been identified as relevant for the implementation of European policy at regional level, they are emphasized in subsidy frames or regional development programmes.

How European policy is being implemented

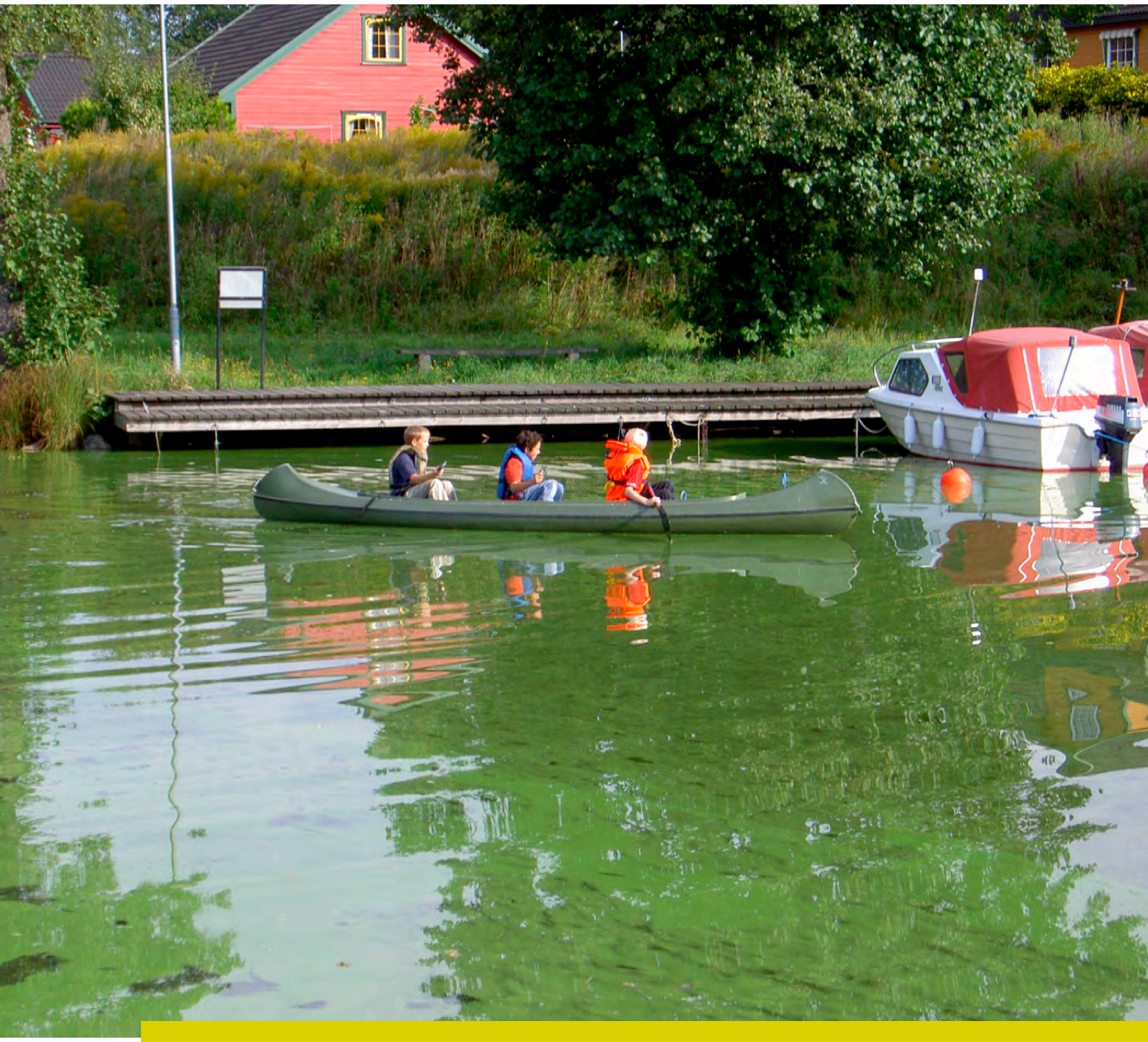
WaterCAP includes several Interreg projects, so in this paragraph we focus on the contribution of these projects to the implementation process of European policy. The experiences of project members of WaterCAP and the results of discussions with European officers point to several important contributions:

- Interreg projects can provide a good means for strengthening the relations between water management at regional and European level. This is stimulated by feeding in the results of Interreg projects to the European policy process. Not only through national representatives, but both directly addressing representatives from the regions as well as from the European Commission, actively involved in European policy processes.

- Interreg projects do have impact on local level. Water managers at local level are trapped between high ambitions to implement European and national (long term) policies and the reality of the local economy to implement solutions, sustainable or not. Interreg projects can in this context play an important role to test and demonstrate ways of implement the good examples and disseminate them to other regions. This gives the local water manager to test the innovative ideas, which could not be realized within the local short term economical frame.

3

IMPACTS OF CLIMATE CHANGE ON WATER QUANTITY AND QUALITY IN THE NORTH SEA REGION



L. Jackson-Blake, K. Macleod, M. Stutter, W. Kenyon

Introduction

The chapter summarises key learning from reviewing the cluster projects relating to climate change effects on water quantity and quality in the North Sea Region (NSR) using the DPSIR framework (Driver-Pressure-State-Impact-Response; EEA, 2003). Climate change is the considered as a 'Driver' and expected water quantity and quality issues the 'Pressures'. Developments in assessing changes in the 'State' of the environment and the likely 'Impacts' of these pressures are explored. The cluster projects primarily focused on planning, designing, implementing or testing adaptation/ mitigation measures and these are considered as 'Responses'.

Drivers: climate change in the North Sea region

Climate change projections for northern Europe indicate changes in both temperature and precipitation regimes in the future that, in some areas, will contribute to significant changes in water quantity and quality. This section makes use of the findings of CPA (WP1 Report, 2012), SAWA (Lawrence et al., 2012), Safecoast (Safecoast, 2008) and Climatewater (EEA, 2007; Bates et al., 2008) with respect to projected climate change in the NSR, with additional information from the fourth IPCC assessment report (IPCC AR4 SYR, 2007). Our evaluation suggests that change scenarios used to generate predictions about future water quantity and quality, which in turn inform water management policies and practices, lag some time behind the must cutting edge climate scenario models. Hence, handling and communicating inherent uncertainties in this complex, rapidly developing area is a key challenge for the scientific and policy communities. Despite large variability between different climate models, several consistent patterns emerge which, if realised, could impact water quantity and quality in the NSR. Whilst this review is focused on climate change impacts on water quantity and quality, other drivers will be important and may exacerbate climate-related problems, or indeed outweigh them completely.

Temperature: For all countries in the NSR, temperature is expected to rise in the future (especially in winters) by 2-3ºC by 2060, and of 3-4ºC by the 2090s (compared to baseline 1960-90), but with the possibility of greater warming in the northern half of Norway and Sweden, particularly during summer.

Precipitation: Over the period 1901-2005, observations show an increase in precipitation over land north of 30° and an increase in intensity of precipitation (IPCC AR4 WG1, 2007). Model outcomes regarding precipitation are less certain than temperature. Precipitation extremes (heavy rainfall) are expected to increase throughout the region in both summer and winter, but snowfall decreases.

Sea level rise: There is strong evidence that, after a period of little change during the last 2000 years, global sea level rose during the 20th century and is expected to rise variably across the NSR. Although highly uncertain there are likely to be associated with changes in extreme sea levels resulting from storms and storm-induced tidal surges.

Pressure: expected water quantity and quality problems

In the North Sea Region, changes in precipitation amount and intensity, increases in evapotranspiration and rising sea levels are expected to generate 'pressures' on water quantity and quality, such as flooding, drought, eutrophication and salinization. The key anticipated pressures dealt with by the projects in the cluster are shown in Table 1 and these are related to impacts studied in the projects in Table 2.

State: representing the state of the environment quantitatively

The projects developed some quantitative measures which can act as an indicator of the current and changing environmental conditions or 'states': Local-scale flood risk maps in CPA (particularly coastal and urban flood risk maps), SAWA (primarily catchment flood risk maps) and CLIWAT (urban and regional), monitoring surveys (DiPol, rainfall intensity and the delivery of heavy metals, bacterial pathogens, pesticides and PAHs), CLIWAT focused more on groundwater geophysical and chemical monitoring methods (CLIWAT) and modelling in DiPol, SAWA and CLIWAT to assess the likely impact of climate change on the water bodies.

Pressure	Likely drivers	Project	Pilot areas
» Coastal flooding & coastal erosion	» Sea level rise	» CPA	» Schouwen-Duiveland (NL), Wesermarsch (D), Eastern Scheldt (NL), TichwellMarsh (UK)
		» CLIWAT	» Fryslan mainland (NL), Zeeland (B, NL)
» Freshwater shortage (groundwater salinisation)	» Sea level rise (saltwater intrusion into aquifers) » Increased groundwater abstraction in coastal areas	» CPA	» Wesermarsch (D)
		» C2CI	» Many
		» CLIWAT	» Zeeland (B, NL), Tershelling (NL), Borkum (D), Fohr (D), Als (DK), Fryslan mainland (NL), Zeeland (B, NL), Oostende (B), Schleswig (DK, D)
» Freshwater shortage (droughts)	» Increased evapotranspiration » Increased abstraction	» CPA	» Wicken Fen; Great Fen (UK)
		» Aquarius	» Veenkoloniën (NL), IlemalJeetzel (D), Smedjeåen (S)
		» CLIWAT	» Schleswig mainland (DK, D)
» Riverine and lake flooding	» Increased precipitation » Building on floodplains	» Aquarius	» Midden-Delfland (NL), Smedjeåen (S), Tarland (UK)
		» SAWA	» Wands, Ilmenau (D); Gaula, Tana (No); Lake Vänern (S); Hunze (NL)
» Urban flooding	» Intense rainfall events » Urbanisation	» CPA	» Wesermarsch (D), Arvika (S)
		» CLIWAT	» Horsens (DK), Schleswig (DK, D)
		» SAWA	
» Diffuse pollution – nutrients	» Summer low flows » Intense rainfall events » Agricultural intensification	» Aquarius	» 7 out of 8 pilot areas
		» CLIWAT	» Egebjerg (DK)
» Urban pollution: heavy metals & other contaminants; landfill emissions	» Intense rainfall events » Increase in groundwater level » Urbanisation	» DiPol	» All (Gothenburg, Copenhagen, Oslo, Hamburg)
		» CLIWAT	» Horsens (DK), Schleswig (DK, D), Horlokke (DK), Aarhus (DK)
» Changes in lake and sea temperature and nutrient distribution; algal blooms	» Increase in air temperature » Decrease in ice cover » (Marine: changing ocean currents)	» e.g. WISER, REFRESH	
» Increase in river water temperature	» Increase in air temperature	» e.g. WISER, REFRESH	

Table 1 Summary of the main water quantity and quality-related pressures in the NSR that are anticipated as a result of climate change, and the associated projects and pilot areas that deal with them.

Impact: flooding, water shortages, eutrophication and contamination

The North Sea region is of high economic importance, with stretches of rural areas interspersed with densely populated urban areas close to coastal and estuarine zones.
There are also diverse coastal habitats, many designated as conservation areas at an international level, protected under the Birds and Habitats Directives, including land and marine-based Special Protection Areas (SPAs) and Special Areas of Conservation (SACs), which together form the Natura 2000 network. The Netherlands, for example, contains around 8,200 km2 of Ramsar-listed wetlands, and Denmark some 20,800 km2 (http://ramsar.wetlands.org). It is within this socio-economic and environmental setting that the impacts of climate change on water quantity and quality need to be assessed (Table 2).

Responses

Responses to water quantity and quality issues may be aimed at reducing the driving force or the pressure, changing the state or reducing the impact of the pressure. Table 3 provides a summary of some of the responses that are recommended, developed, implemented or evaluated within the cluster projects.

General responses such as increasing communication and education regarding water quantity/quality issues were addressed by SAWA's (e.g. sustainable education centres, taught courses regarding flooding and computer games to engage the younger community). Awareness-raising events are also important, as are the production of handbooks to guide water managers and practitioners (e.g. the CLIWAT handbook). All the cluster projects included a strong element of stakeholder involvement in the development of adaptive approaches to integrated water management, recognising that it is only through engaging with water users, managers and the wider community that sustainable solutions can be identified and successfully implemented.

Many of the cluster projects make reference to integrated water management and spatial planning strategies for the management of water resources, and one of the key aims of Aquarius is to identify and highlight some of the other benefits that may result from adopting certain water management measures (such as improvements in biodiversity or opportunities for enhancing tourism and the recreational value of an area). Indeed, in their fourth assessment report the IPCC state an expectation that the paradigm of 'Integrated Water Resources Management' will be increasingly followed around the world. This would shift water, as a resource and a habitat, into the centre of policy making and has the potential to decrease the vulnerability of freshwaters and associated ecosystems to climate change (IPCC AR4 WG2 2007).

Pressure	Possible impacts
» Coastal flooding	» Damage to property and infrastructure » Damage to agricultural land » Decrease in land fertility/areas become unsuitable for agriculture » Displacement of populations » Risk to human life » Loss of shallow intertidal habitat and associated negative ecological impact » Loss of low-lying freshwater wetland and associated negative ecological impact » Loss of areas of historical/cultural significance
» Riverine and lake flooding	» Damage to property and infrastructure » Risk to human life » Damage to agricultural land » Areas become unsuitable for agriculture
» Urban flooding	» Damage to property and infrastructure » Flux of contaminants to waterbodies
» Freshwater shortage (drought)	» Loss of wetland habitats and associated negative ecological impact » Lack of freshwater for irrigation – lower agricultural yields » Lack of freshwater for human consumption » Damage to freshwater ecosystems » Competition for water use (food, energy, aquatic/wetland ecosystems)
» Freshwater shortage - groundwater salinisation	» Shortage of freshwater for irrigation » Decrease in land fertility » Lack of freshwater for human consumption - possible negative impact on tourism » Damage to associated freshwater ecosystems
» Diffuse pollution - nutrients, bacterial-pathogens	» Eutrophication - damage to aquatic ecosystems » Restrictions on bathing
» Urban pollution: heavy metals & other contaminants	» Damage to aquatic ecosystems » Contamination of aquifers » Restrictions on bathing
» Urban pollution: landfill emissions	» Aquifer pollution - damage to drinking waters » Pollution of adjacent surface waters and damage to aquatic ecosystems
» Changes in lake temperature and nutrient structure	» Change in ecosystem structure and functioning » Toxic algal blooms more common – bathing restrictions
» Increase in river water T	» Change in ecosystem structure and functioning

Table 2 Major pressures and associated impacts in the North Sea region. Non-compliance with EU Directives can also be seen as impacts, but are not listed here, as can loss of designated status (e.g. Natura 2000 sites).

Pressure	Likely drivers	Pilot areas
» Coastal flooding	» Damage to property & agricultural land, risk to human life, displacement, loss of historic sites	» Develop integrated spatial planning and water management strategies to improve sea defences in a sustainable way, maximising other benefits
	» Loss of shallow intertidal habitat	» Protect intertidal areas, e.g. sand bank nourishment, oyster beds. Wetland restoration
	» Loss of low-lying freshwater wetlands	» Managed coastal realignment
» River/lake flooding	» Damage to property & agricultural land; areas become unsuitable for agriculture	» Develop adaptive flood risk management plans and strategies for their implementation
		» Creation of wetlands for water storage
		» Optimise storage capacity during floods using automated 3-weir flow regulation
		» Lake dredging
		» Develop emergency plans to deal with flood waves
		» Creation of decision support database of flood alleviation measures in the NSR; where possible, cost-benefit analysis of these measures
» Urban (pluvial) flooding	» Damage to property, flux of contaminants to waterbodies	» Assess adaptation/response needs. Design flood mitigation measures, e.g. separate sewage systems for rain water and sewage; increase of water storage in urban areas
		» New urban infrastructure; better draining of surplus groundwater and excess rainwater
		» Sustainable Urban Drainage Systems (SUDS)
» Freshwater shortage (not salinisation)	» Lack of freshwater for human consumption/ agriculture	» Water storage (small weirs), more efficient groundwater use (sprinkling, pivots)
		» More efficient water storage: Artificial ponds; encourage active recharge of groundwater
	» Loss of freshwater wetlands	» Creation of wetland using low-cost non-engineering methods
	» Flooding/GW salinisation	» Salt-resistant agriculture/aquaculture
» Groundwater salinisation	» Lack of freshwater for human consumption, agriculture and ecosystems	» Better freshwater management systems on islands and low-lying coastal areas: use/ storage of excess precipitation during wet periods of the year
		» Desalination for drinking water, storage of winter rain water for summer use, sanitation and separation of household water, purification and reuse of waste water effluent.
		» Better knowledge of island subsurface/hydrological system. Optimise water supply well configuration
		» Increase storage capacity of polders/more pumps; monitor groundwater resource
» Diffuse pollution	» Eutrophication - damage to aquatic ecosystems	» Identify technical, financial/institutional and participatory problems to achieving "farmers as water managers"
		» Restrictions on bathing
		» Diffuse pollution mitigation measures, e.g. buffer strips, fencing streams, etc.
» Pollution from urban/ industry	» Damage to aquatic ecosystems » Restrictions on bathing » Aquifer pollution - damage to drinking waters	» Ascertain contaminant sources, to target response. Monitoring or urban groundwater quality
		» Retention ponds
		» Simaclim regional relative risk ranking model - help prioritise actions & plan response
		» Water purification prior to discharge to surface water bodies
		» Landfill: evaluation and remediation if necessary (climate-proof)

Table 3 Summary of the kinds of responses recommended, developed, implemented or evaluated in the cluster projects

4
TECHNICAL INNOVATIONS CONTRIBUTING TO CLIMATE ADAPTATION

R. Johnsen

Introduction

Climate adaptation in society needs to be built on integrated thinking, sound concepts and accurate modelling. Within the WaterCAP cluster, three major factors have been identified as a way of supporting the integrated approach. In effect, the three factors are the technical tools that have been utilised in the WaterCAP projects. They are:

1. Data acquisition. The data that is collected to increase knowledge in the field of climate change and water.
2. Decision support. The systems and models that are used to increase the level of understanding and visualisation of a changed challenge and to support quality decision making.
3. Action - Building with eco system services. The construction, installation or specific action taken to prevent damage from climate change.

In between each of these steps there is a social dimension, which includes stakeholder involvement. Figure 1 shows this process.

Figure 1 Steps in climate adaptation

From challenges to solutions

The development of future integrated concepts for the management of water in urban and rural areas requires affordable and structured access to data from different sources. Decision support systems such as integrated groundwater models, irrigation systems, flood management systems and scenario modelling can be established on the basis of data directly related to flood risk, geology, flow in streams, sea level rise, changes in precipitation, infrastructure in rural and urban areas, etc. Based on these data decision support systems such as integrated groundwater models, and flood management systems, put forward a number of solutions that should be implemented.

The solutions may be to build intelligent drainage systems, develop new wetlands to store water, new pumping strategies in well sites, sand nourishment, oyster reefs or “living with water” solutions in the city. All of these new climate adaptation solutions can be grouped under the heading Action – Building with ecosystem services. The report’s appendix contains a list of success stories explaining outstanding technical examples from each of the projects involved.

Data Acquisition

Good innovative examples

Scientific data on groundwater levels, soil moisture and stream flow have been collected in the WaterCAP project. There are many examples of this data: literature searches and interviews (CPA), airborne geophysics such as SkyTEM, water table measurements, drillings and logs, the development of databases (CLIWAT), moisture sensors and testing of filters (Aquarius), flood maps (Sawa), infiltration and sewage capacity measuring (C2CI) and water quality acquisition during flood events (Dipol).

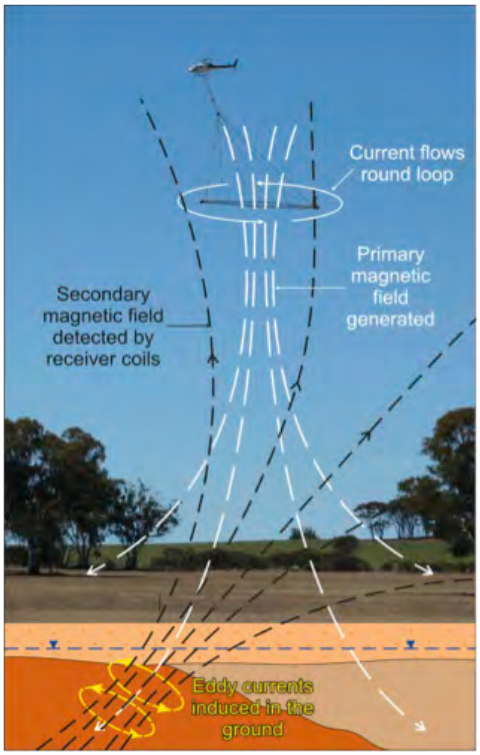


Figure 2 SkyTEM Airborne data acquisition

A good example of this innovative data acquisition is SkyTEM (CLIWAT), illustrated in figure 2. This is an airborne method of data acquisition that is highly efficient and covers a large data area without disturbing local landowners. Other methods are used to map sub-surface conditions, the extent of aquifers and salt water intrusion in coastal areas. Another innovative example is a system that involves moisture sensors that monitor soil moisture and which displays real-time information on-line, enabling landowners to irrigate crops when needed (Aquarius).
Figure 2 SkyTEM Airborne data acquisition

What needs to be further developed within this field?
Quality real-time digital data that is readily accessible on-line has to be available in the future. This means that there has to be increased focus on developing methods that collect data cost-effectively and efficiently.

Data accessibility is also of great concern. The structured knowledge about where the data is and what its contents are is an essential factor for a society as it aims to use data in the planning and prevention of damage from water and climate change. This means that the structure and visibility of data across Europe must be further developed, starting in the North Sea Region.

What will drive innovation in this field?
Being able to try new ways of working and bringing people from different sectors together is important and the EU could be a catalyst in this process. In WaterCAP, we have learned that we can create innovation by involving different sectors that are involved in water quantity/quality issues. An example of this is the use of data between different sectors.

Recommendation towards policy level
- Data is needed for sound climate change adaptation. Lack of data means that adaptation measures could be "oversized" to deliver the required security. Strong sets of data on the other hand allow more cost-effective and more precise solutions to climate adaptation and they lower uncertainty.
- More efficient and cost-effective data acquisition should be supported. Innovative ways of capturing data, for example SkyTEM, should be applied in Europe on a much broader base.
- Pilot studies – even studies that challenge mainstream ideas in science/society – should be supported by EU in order to create innovative thinking and breakthroughs. This also includes interdisciplinary work between different institutes, which enables data to be fully and effectively utilised.
- A more flexible and bolder framework should be established, which supports the really big innovative ideas, such as sensor techniques, online measuring and monitoring without a specific target. Interreg could refocus on the implementation of innovations and at the same time be very flexible. Innovation involves uncharted territory. Stage Gate models can be introduced to support projects that contribute to climate change challenges, throughout their lifetime.

Decision support

Good innovative examples

Detailed biophysical simulation models like groundwater models (Aquarius, CLIWAT, SAWA and C2CI), flooding models (CLIWAT, CPA, Aquarius, SAWA, C2CI) and water quality models (DiPol) are useful tools for raising awareness, visualising data, learning and for identifying the relevant impacts and designs and assessments of adaptation options based on forecasted climate changes (see figure 3).

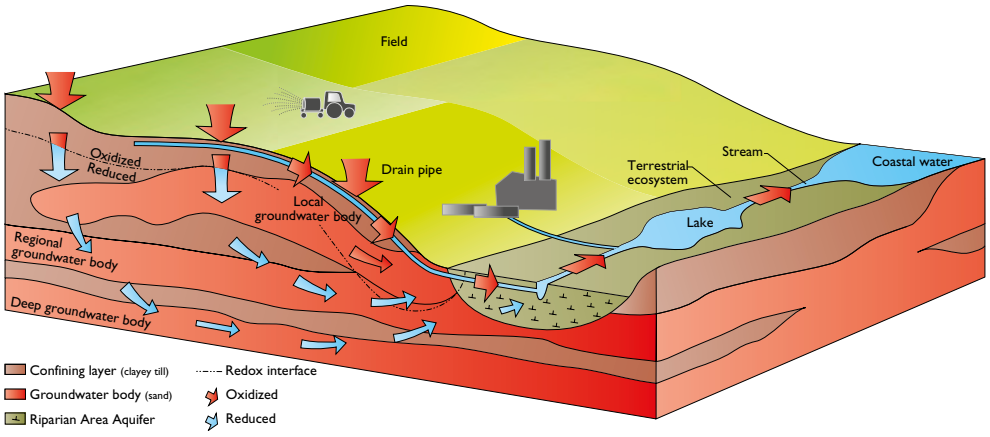


Figure 3 Modelling the effects of climate change in 3D numerical models like this example (CLIWAT)

Scenario building tools, like group model building and backcasting scenarios, are necessary complementary tools for integrated management and for identifying vulnerabilities, sensitivities and thresholds. Furthermore, scenario building tools can be useful for identifying adaptation measures and institutional barriers, and for the assessment and timing of adaptation measures, including their robustness and trade-offs (between different adaptation measures in order to adapt to and reduce risks for climate change and other drivers).

What needs to be further developed within this field?

Bio- and geophysical simulation models needs to be downscaled to a scale useful for decision-makers (farmers and water companies may/can only do something if the scale matches their stakeholder needs). Today, we are able to model at a more significant scale than we could 10 years ago. Real-time forecasting etc., and methods for communicating data (improved sensors, apps for communicating data etc.) are important for communicating model simulation results, early warnings, evacuation plans, the supply of humanitarian relief. This underlines the importance of including stakeholders in the development and utilisation of modelling and decision support tools.

Therefore, integrated water resource management approaches (integrated land use and groundwater/surface water management in rural areas and integrated infrastructure management in urban areas) are needed in order to collectively deal with surface water and groundwater management and to increase efficiency when implementing the Water Framework Directive and when adapting to climate change impacts.

What will drive innovation in this field?

Building scenario development and using integrated assessment tools (exploratory/back casting scenarios) backed up by results from fine resolution biophysical numerical models (groundwater, flooding/drought, ecological

models), expert knowledge and reliable data collection will enable strategic management of climate change impacts (and other drivers e.g. demography and economics) and adaptation measures (including uncertainties) for better climate change strategies and more resilient societies with increased adaptive capacity. We simply need to manage our water resources with less uncertainty and therefore we need reliable models on a local scale.

The models need to be related to on-line data and should be updated automatically. In addition, the decision support systems in relevant cases should be easily accessible via web services in order to be of best use for society.

Recommendation towards policy level

Bio- and geophysical simulation models (groundwater, flooding and ecological models) should be established for problem areas where there is a need for a quantitative understanding of the impacts of climate change. The EU should lay down a framework that supports better modelling at a local scale supported by on line monitoring.

Integrated and adaptive water resource management with balanced (and interacting from stakeholders) top-down (biophysical simulation models) and bottom-up approaches (scenario development, group model building and conceptual/influence diagram models) are needed in order to allow for higher order learning processes for developing contexts, changing frameworks and shaping actions.

Development with ecosystems

Good innovative examples

Building with ecosystem services is based on a more general change in approach, and has been practiced in coastal, agricultural and urban areas. The aim is to use existing natural materials and processes for sustainable protection and responses and a reduction of physical impacts on the shore-line (erosion). For example using sand and shellfish on sandy coasts, which is tested in the CPA project with oyster reefs (see figure 4). Ecosystem service can also be found in soil management. The water storage capacity could be a management aspect for farmers, in stead of draining precipitation as fast as it can. Farmers did act as water manager in the project Aquarius and this included increased awareness and responsibility for managing the whole environment. Examples of increasing wetland development and storage capacity can be found in the projects SAWA, CPA, Aquarius, C2CI Islands. Other examples of Building with ecosystems are Sustainable Urban Drainage Systems (SAWA) and reusing wastewater treatment plant effluent (C2CI Islands). These innovations have had a positive effect on the fresh water lens beneath an island.

Figure 4 Oyster reefs in the Oosterschelde (Netherlands)

What needs to be further developed within this field?

We need to increase knowledge about the limitations of using natural living materials. This includes more active feedback on the impacts of actions. There needs to be more awareness of the excellent examples from the WaterCAP projects to encourage more examples to be implemented in other areas in the North Sea Region and elsewhere. To support this change in approach, we should focus on the excellent examples and recommend that regulations are laid down which make ecosystem services more competitive. The local and regional approaches should be further developed – to fit local needs and to produce tailor-made solutions. Furthermore, there is a need for an analysis of why and how at the local level, engaged individuals or authorities initiate solutions and "build" with nature and lastly, we must share best practices.

What will drive innovation in this field?

The general idea of the systems being more sustainable and supporting a circular economy will be important. Furthermore, it facilitates green growth. The farmer should be the entrepreneur, so sustainability and green growth become more profitable.

With regard to governance, development with eco systems should be given higher prioritisation on the political agenda. A solution should not only prevent impacts from climate change but also be sustainable in the specific eco system it is introduced to. This means:

- Increasing the availability of data and making access easier, and sharing information across borders;
- Implementing measures in legislation;
- Engaged local authorities and individuals driving the analysis of ecosystem services and finding solutions;
- Sharing best practices.

Recommendation towards policy level

- Make the North Sea Region an area of excellence that demonstrates climate change adaptation and development with ecosystem services on a 1:1 scale.
- The transferability of the good examples described above, to other areas in the North Sea Region is high. So Europe could be the catalyst for local initiative funding .
- Establish national or independent databases where data can be accessed.

5
GOVERNANCE OF CLIMATE CHANGE

M. Krekeler

Challenges

From a governance point of view, the nature of climate change poses several challenges to its societal regulation which make it difficult to settle the problems that are connected to its consequences. Coping with the consequences of climate change involves actors from all administrative levels and sectors. Often there is a misfit between the geographical extent of appropriate climate adaptation (e.g. a catchment area) and administrative units. Moreover, the vulnerability of stakeholders even within one single geographical area can differ widely depending on sector or specific location. All these features lead to a partly extreme fragmentation of the stakeholder landscape. Most striking is not the sheer number of actors to be involved but the wide range of possible problem perceptions and frames among stakeholders.

Insecurity regarding the consequences of climate changes is the second main challenge for any management attempt. Stakeholders tend to postpone the issue of climate adaptation with the excuse of the consequences being still vague. This is especially true for the regional and local level. Although there are widely accepted global projections for e.g. sea level rise, breaking down these results to a smaller scale is still difficult. So called “no-regret measures” contributing to societal welfare in more than climate adaptation are usually prescribed.
The long-term nature of climate change is usually named the third striking feature. Any climate governance arrangement should therefore be flexible and stable at the same time. Important in this regard is a link between a strategic and visionary approach covering the long run and short-term measures which contribute to the overall strategy and can be implemented quickly.

All those characteristics make climate adaptation a “wicked problem” that is definition of the problem and its solution is difficult, the absence of an optimal solution for all stakeholders and the complex connection of different problems with each other. Solving a problem in this context usually means to be confronted with another one as a consequence. Obviously, strictly collaborative approaches are essential in this context. Stakeholder involvement is needed to create trust and a common ground – so-called communities of practice which foster processes of social learning, i.d. the co-development of knowledge and a common problem perspective through stakeholder interaction. European directives in water management (e.g. the WFD) incorporate stakeholder collaboration as one of their main focal points.

Barriers and solutions to stakeholder involvement

Engaging in innovatively participatory projects, WaterCAP identified a range of barriers to successful stakeholder participation. A lack of resources, formal instruments („shadow of hierarchy“) and leadership can be as hindering as interferences with political processes outside the actual projects. Motivating stakeholders to participate is one of the most important and, at the same time, most challenging tasks. The fact that protagonists only take part in collaboration when they are interested in the topic makes continuous participation a heavily resource-craving activity. A clear target and outcome of the project is of paramount importance to ensure ongoing involvement of stakeholders. That concerns even the visibility of project topics. Some water management issues (e.g. tasks connected to groundwater) are hardly tangible for stakeholders. Convincing visualization concepts can be decisive here. Concerning the continuation of the project after its formal end, solutions how to keep working with the results have to be developed. Persons who are close to the decision making process have to be involved in order to not delegate the process elsewhere.

Possible participants have to be informed from the beginning (e.g. through all kind of media) and involved at a time when they can contribute. Not only is it important to ask different stakeholders for their input (by using workshops, focus groups etc.). It is decisive to really use this input in the further process, to document this for stakeholders and to give room for stakeholder-driven activities. Otherwise involved actors can be disillusioned about their possibilities to contribute and withdraw from collaboration. A consistent approach to the stakeholders and a long-term investment in the regional and European network are seen as further success factors.

Barriers for the stakeholder involvement are seen in the broad task management and the non-profitable character of unsolved long-term problems – defining middle-term mile stones appears to be more attractive. Long-term periods and return on investment are difficult to match. Possible solutions to overcome this are the thoroughly information of all stakeholders before the project starts; they should be involved at a time when they can influence the project. A leadership person who has knowledge about the project, who is in charge, who has an integrated perspective and who represents the project towards extern actors is a strong success factor. Direct communication and table talks help to name and discuss problems.

The significance of the institutional frame

Using governance terminology, we can describe participatory instruments as coordinating stakeholders by means of network building and process management. As mentioned above, societal regulation of water management under conditions of climate change is in urgent need of an elaborated collaborative network approach. However, WaterCAP experiences prove this to be a necessary but not sufficient prerequisite for effective elaboration, implementation and dissemination. Adapting stakeholder involvement and institutional framework is a crucial step if one wants to get beyond the implementation of climate adaptation innovations in pilot projects.

Representatives of the WaterCAP projects named the connection to both the market and the hierarchical mode of governance when reporting success factors from the respective project family. An innovative business model should accompany the scientific findings of a project. The focus on profit and return on investment can help to convince private as well as public stakeholders.

The European funding and financial incentives in general stimulate national and regional authorities to get their governmental body involved. In addition, challenges which are formulated in e.g. the Water Framework Directive visualize problems and are a trigger for action.

Participatory and trans-disciplinary approaches are mandatory in European programmes and legislation to get funded. The establishment of a constructive working group, the focusing on specific topics and the learning from each support the finding of innovative solutions.

A main success factor is the availability of regionalised or localised knowledge, the involvement of governmental bodies, the existence of triggers for national funding and for action and the communication between different stakeholders that work together in the whole value chain. A dedicated arena for communication and for innovative approaches supports the implementation as well as major events that “create” the momentum for action.
In order to overcome the identified barriers, more process monitoring is needed. Flexible administration structures and more flexibility regarding project planning support the activities; the national governments should enable local and regional governmental stakeholders to come up with possible solutions. Goal-oriented steering permits flexibility and serves as an incentive

6
CONCLUSIONS AND RECOMMENDATIONS

R.J.M. Franssen, B. Koehorst

The first success was collecting the wow! stories

The challenge of WaterCAP was to offer solutions for the complex process of implementing climate adaptation measures in the North Sea Region. We started our search by abstracting the successful stories of the six previous Interreg projects on water management and climate adaptation. Successful in the way the innovations could stimulate and exceed the process of climate adaptation in the North Sea Region. Stories with a wow! effect, in the way that:

- Participants were proud of the innovations they developed and enthusiastic to tell about the strengths and benefits,
- Clients and stakeholders were confident on the results,
- The Interreg secretariat could fulfill the aims and objectives regarding implementation of climate adaptation measures and innovation in the North Sea Region, following from the policy of DG Regio.

As we began to collect the successes, which are always nice to talk about, we got to know each other better. Different cultures, social and technical knowledge, scientific and practical languages and experiences found each other in transnational workshops. From there, it was a small step to reflect on the factors which could improve the innovations, in order to gain even more impact in the North Sea Region in future. What were the main challenges? What is needed from the regional and national government? And how on earth could Interreg help the regions in the last phase towards implementation? This approach definitely helped to learn from each others knowledge and experience.

The wow! stories in a nutshell

The success stories of the previous Interreg projects can be read in appendix B. They all together provide solutions for adaptive water management in relation to European frame work directives (e.g. Water Framework Directive, Natura 2000, Flood Directive), varying from small local scale to regional scale problems. The successes can be summarized in three different problem groups as a result of climate change: coastal erosion, water quality and water quantity. The wow! stories represent a set of solutions for these problems, listed in the table (page 30).

We notice some common issues while reading through the wow! stories:

- The wow! stories challenge the complexity of multifunctional land use. No coincidence, because climate changes has impact on different stakeholders, like nature, agriculture and drinking water. E.g. optimizing the water cycle on islands concerns different stakeholders.
- The wow! stories show that only integrated solutions work, based on a participatory processes. Due to conflicting interests, only solutions where stakeholders agree upon and are enthusiastic about can be implemented. E.g. Growing Coasts combines innovative building constructions with solutions that also benefit for nature.
- The wow! stories are ready for further development and/or up scaling. The organizations in WaterCAP see the opportunities and do want to proceed with these successes.
- The wow! stories needed the Interreg co-funding, because it worked as an excellent catalyst to develop and create integrated and innovative solutions.

Solutions for		Interreg project
» Water Quality	» **Water management in saline river deltas** Secures fresh water supply	» Climate Proof Areas
	» **Specific Environmental Plans** Improve water quality	» Aquarius
	» **Willow planting** Creates multiple benefits	» Aquarius
» Water Quantity	» **Multi Layer Safety** Enhances regional climate proofing	» Climate Proof Areas
	» **North European response to drought**	» Aquarius, CLIWAT, CPA
	» **Optimizing of the water cycle** Improves the groundwater regeneration	» Cradle to Cradle islands
	» **Natural flood management** Working with farmerS	» Aquarius
	» **Rain harvesting** Regional strategy for more groundwater	» Aquarius
	» **Water sensing decision system** An answer to drought	» Aquarius
» Coastal Erosion	» **Growing Coasts** Building with Nature can save drowning estuaries	» Climate Proof Areas
	» **Saving fresh groundwater** In coastal regions	» CLIWAT
» A mix of climate change problems	» **Models as decision support and management tools**	» CLIWAT
	» **Active cooperation** A great way to achieve local water management goals	» Aquarius
	» **Multifunctional wetlands** A win-win solution	» Aquarius

Table 4 List of wow! stories

Need for integrated solutions

So, all wow! stories have an integrated approach in common. We can state that climate change often results in complex, local and regional problems, which asks for these integrated solutions. Moreover there is no particular organization solely responsible in being adaptive to climate change.

We found integrated solutions by reducing fragmentation, through combining participatory cooperation and technical knowledge (e.g. Ahlhorn et al. 2010, Bormann et al. 2012). This requires close cooperation between engineers and social scientist, to translate technical solutions into understandable concepts for policy and decision makers. For example improved groundwater modeling could create a better understanding of the physical system and the impact of climate change on it. But only knowledge about groundwater models is not a solution. It needs to be combined with working in the value chain (figure 5). This stimulates organizations to act on base of new information. For example, the hydrologists in the Aquarius project worked together with farmers (clients), which are the end users in the value chain. In this approach they found solutions that took into account the business management system of the farmers. That is one of the reasons why the project succeeded. Another dimension is the translation of new information through e.g. scenario building into clear options for the decision makers. In fact the whole triangle of knowledge, clients (private) and politicians (public) should be covered to create successful integrated solutions for climate adaptation.

Figure 5 Integrated solutions for adaptive water management by working in the value chain

The wow! stories are all examples for adaptive soil and water management and working in the value chain, which is a way to create flexibility in future strategies. An example of a successful climate adaptation project is combinations of building constructions, to prevent inter tidal areas from flooding, with solutions that benefit for nature. Also in this example the private organizations were involved. Another example is the Sky-tem technique, where the university as the inventor directly worked together with the clients, such as municipality or farmers. The main benefit for clients was clear in this case: mapping an area with heli-pictures is much cheaper than modeling and installing cost-intensive and scattered monitoring systems. So in short we conclude that actors, who directly benefit in terms of business, should be incorporated in the stakeholder process to let the innovation succeed. Moreover it creates flexibility in future strategies and possibilities for further exploitation in the North Sea Region.

Need for more impact in the North Sea Region

The Interreg secretariat implements the policy of DG Regio of increasing the resilience of the regions and implement innovations. We can conclude that all the success stories resulting from the Interreg projects participating in WaterCAP, are public innovations. The wow! stories were really successful, but for the true implementation of these innovations we need to finish the innovation chain. The innovation chain, or cycle, consists of different stages and can be structured in various ways . In short, it starts from a preliminary idea, into pilots, into mapping the problem and opportunity areas and upscale the innovation. This will in the end create green growth, sustainability and a competitive region in Europe.

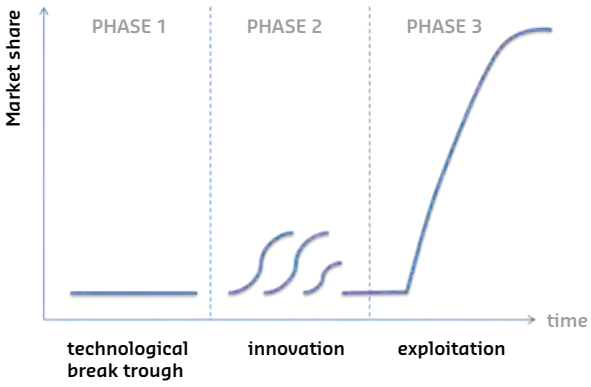


Figure 6 The innovation chain: from technical solutions, to innovations and exploitation

These phases are also illustrated in figure 6. The first phase 1 is technically oriented. In phase 2 a pilot project is being executed and the battle of standards has begun. And in the last phase 3, the dominant design will concur the market. There is a need to increase the successes to phase 3, in stead of ending smart innovations at the pilot stage, only in one specific area.

In comparing all the Interreg innovations we found that they tend to stop in a certain stage of the innovation cycle, at phase 2 in the figure 6. Most innovations have successfully been developed and tested for the first time in the Interreg projects. Unfortunately, after the pilot phases the project stops and the innovation cycle breaks. The most common reasons we found for this interruption of the innovation chain are:

- **Focus.** The focus in Interreg project was on developing ideas into pilots.
- **Responsibility.** The participating organizations in the pilots do not always have interest in the further development of the public innovation into market launch, because it does not fit their own responsibilities or core business of the public body.
- **Budget**. The participating members lack budget to bring the innovations one step further. Mapping the opportunities for further development is not part of the Interreg projects. And transforming the pilot products into user-friendly, appealing and high quality products neither.

- **Scope.** The participating organizations in the pilot have no particular interest in selling the results of the pilot to other regions. They have gained knowledge and solved their own problems on one location, in their own region.
- **Skills.** The participating members lack experience in developing the innovation to the next stage. They have put effort into the pilots and are engaged to brand the innovation, but are mostly technically skilled professionals in water management.

Last but not least it is not clear which locations and stakeholders suffer from which problems regarding climate change. So in fact for the North Sea Region there is no clue where to apply these successful innovations. Here, the Interreg North Sea Programme can make a big difference.

Policy recommendations

The reasons mentioned above, for not fully exploiting innovations in other regions, are comprehensible. At the same time they show the limitations of partners in Interreg projects. WaterCAP also thought about promising approaches to capture these left opportunities and repair the innovation chain, at least for the wow! stories. These recommendations for Interreg are listed here.

1. Keep the cluster projects: they fulfill an important role in economic growth

The cluster project WaterCAP was of great importance to make a step forward in implementing innovations. Now the benefits, disadvantages, strengths and weaknesses of successful Interreg pilots are transparent, which is the base of exploiting them to other regions. Moreover sharing knowledge and experiences with different scientists and organizations in a network or project setting, is the key to integrated solutions. Therefore the recommendation is to keep up the good work of cluster projects and keep the possibility of reflecting on previous Interreg work. This will help to make a step forward in economic growth and job creation in the North Sea Region.

2. Develop opportunity maps in NSR: as a bridge to successful implementation

One step beyond the implementation of climate adaptation successes is making a network analyses in the North Sea Region, to pinpoint these locations and stakeholders who can use the WaterCAP wow! stories to challenge their climate change problems. Create for example an export package for climate change adaptation in other regions. These opportunity maps and export packages can catalyze initiatives on local, regional and national level and in this way be the engine to further exploit successfully innovations in the North Sea Region. Opportunity maps could be a special focus in the Interreg V Programme.

3. Include ‘adaptive water management’ as a theme in Interreg V programme

The complex challenges and uncertainties we face due to climate change in the North Sea Region ask for integrated solutions and a mind shift from solid to flexible strategies. Adaptive water management is a theme that should be further explored, with governance as an important aspect. With integrated (ground- and surface water) models we can define the future measures to provide sufficient water, with a good quality. We should combine this knowledge with governance issues that include flexibility, such as developing scenarios with effective and efficient strategies and creating flexible arrangements with public and private partnerships.

4. Lessons learned as input for the Interreg V Programme and national policies

- Promote the incorporation of a so-called "Climate Adaptation Pre-Assessment" in plans, programmes and policies.
- When drafting new policies, remember that participatory partnerships and local commitment play a crucial role in water management. And make room for bottom-up solutions as a way to develop and implement innovations.
- Support and facilitate cooperation between stakeholders at local level. Policy should actively support the creation of catchment stakeholder groups.
- Policy should promote the use of locally generated solutions and the fact that such solutions differ due to different local biophysical and production conditions.
- Establish a unit or "innovation office" to help develop and prepare tools for the market, overcome financial barriers and develop flexible implementation strategies.
- Strengthen sustainable thinking among politicians. Support of adequate innovative and necessary solutions by decision makers. Assume more responsibility!
- Land managers perceive a conflict in policies (e.g. between flood alleviation measures and measures under the Water Framework Directive that prevent clearing vegetation from the burn). Policy makers need to provide clearer guidance.

5 Lessons learned working with farmers: policies and focus for future projects

- Policy should acknowledge and support 'farmers as water managers' more. Besides food production, farmers deliver water management services at fair prices to preserve the water environment.
- Current agri-environmental payments do not provide sufficient incentives for long-term flood management nor take a catchment approach. This should be prioritised in future funding scheme design.
- Agricultural advisors need better evidence about Natural Flood Management options in order to help engage land managers in flood alleviation.
- Water sensing decision systems are the future tool for developing a model of sustainable farming. In order to spread this innovative method and bring it to work in the dry regions there is a need for action:
  - o Provide financial support for the implementation of this innovative method.
  - o Implement legal or financial measures to motivate farmers to implement the measure.
  - o Support and develop a multi-case field study approach in a trans-boundary settings, which will promote the development of a business case.
  - o Support the execution of a thorough cost-benefit analysis.
  - o Support the development of network sharing systems to enhance communication and foster application in areas facing drought.

6. More recommendations for climate adaptation policies and focus for future projects

- Continue using islands as natural units for testing and developing water management solutions.
- Promote Building with Nature as an export product to the rest of the world.
- Promote further innovative pilots for estuarine habitats under climate change in the Oosterschelde and elsewhere in Europe.
- Consider the relevance of Building with Nature solutions to drowning tidal flats in connection with investment and research programs at national and EU level. Spread this word and highlight relevance for implementing EU directives (Bird/ Habitat, Water Framework Directive, Flood Directive) and policy developments.
- The change in groundwater systems is a hidden problem beneath our feet. New online results from the coupled groundwater models can describe future groundwater conditions, rather like weather is forecasted today. These forecasts should be available from a web portal to raise awareness of present and future conditions and challenges affecting dependent sectors.
- Increased use of multi-functional wetlands and rain harvesting in the EU should be promoted by active policy decisions. They are efficient measures in the scope of the Water Framework Directive (water quality enhancement) and the Flood Directive (mitigation of floods and droughts).
- Promote the introduction of standards which account for Multi-Layer Safety. Apply the approach in planning and policy-making of other, more vulnerable areas, and collect practical experience in learning alliance.

7
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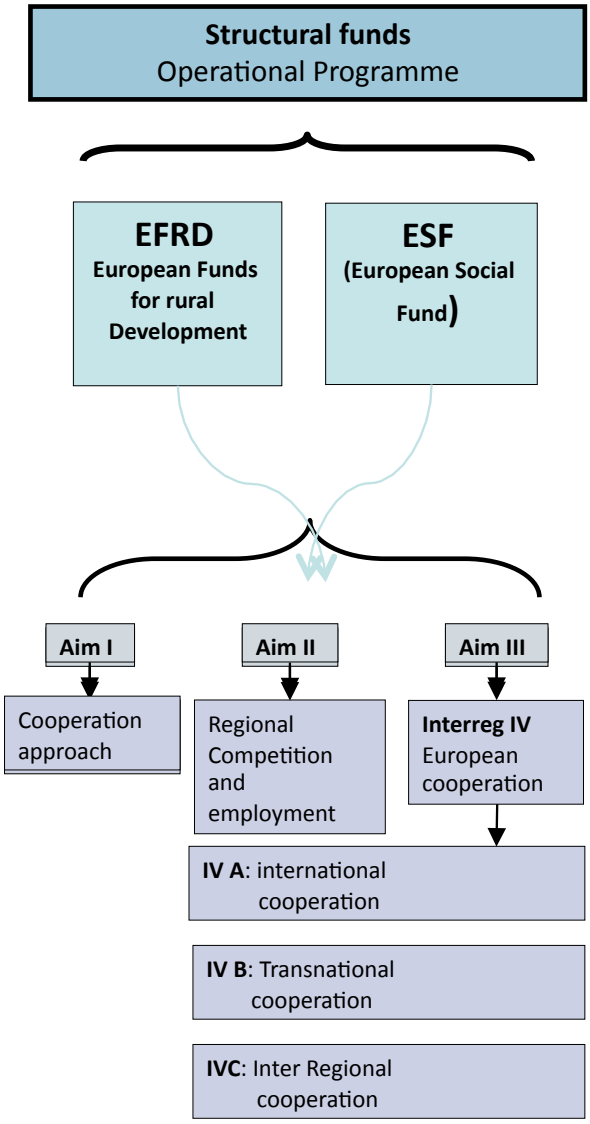
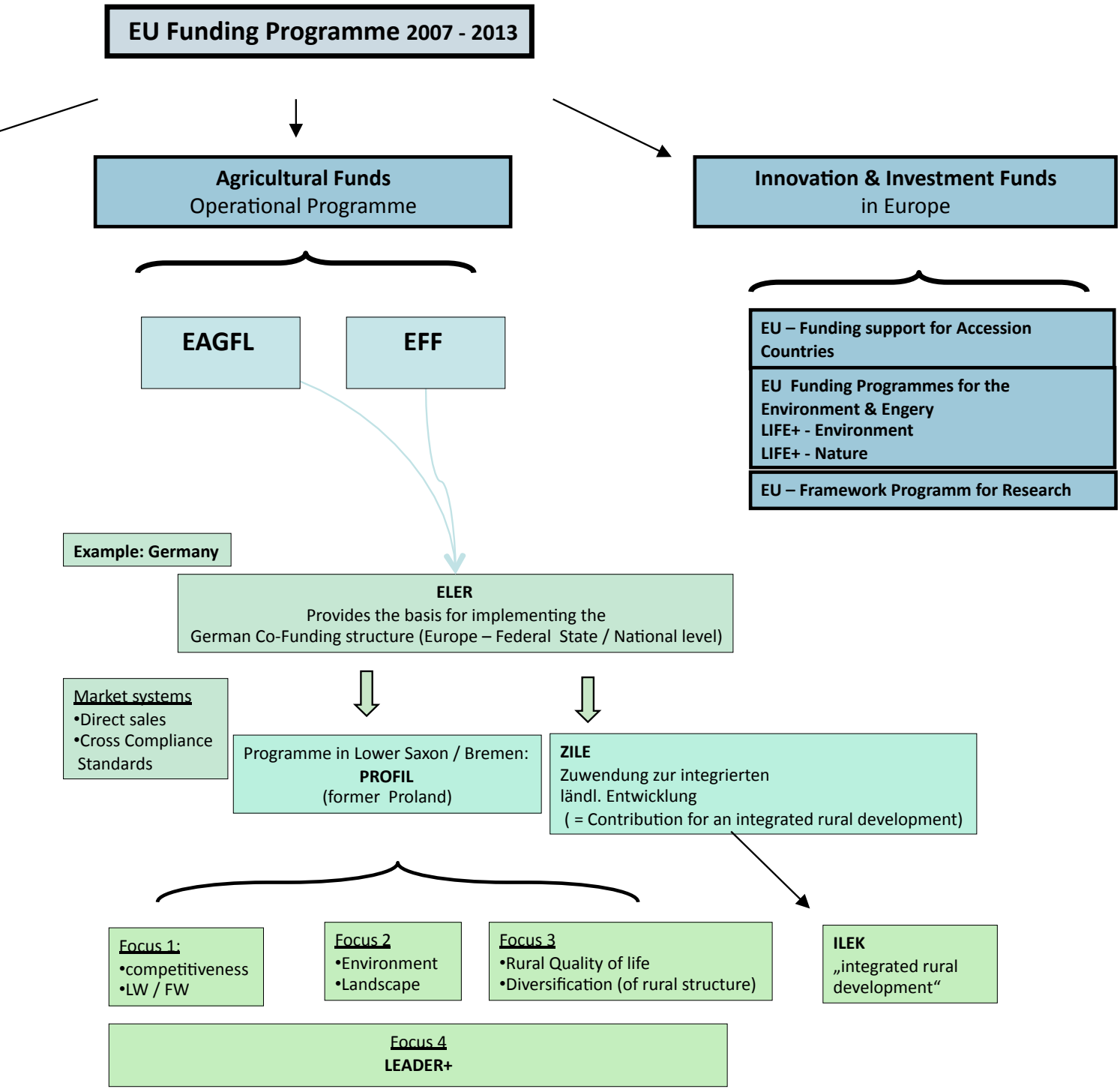
APPENDIX A
FUNDING PROGRAMMES ON EUROPEAN LEVEL

Disclaimer: This scheme gives an impression of European fundings and may not be complete.




EU Funding Programme 2007 - 2013
Agricultural Funds
Operational Programme
Innovation & Investment Funds
in Europe
EAGFL
EFF
EU – Funding support for Accession Countries
EU Funding Programmes for the Environment & Engery
LIFE+ - Environment
LIFE+ - Nature
EU – Framework Programm for Research
Example: Germany
ELER
Provides the basis for implementing the
German Co-Funding structure (Europe – Federal State / National level)
Market systems
•Direct sales
•Cross Compliance Standards
Programme in Lower Saxon / Bremen:
PROFIL
(former Proland)
ZILE
Zuwendung zur integrierten ländl. Entwicklung
(= Contribution for an integrated rural development)
Focus 1:
•competitiveness
•LW / FW
Focus 2
•Environment
•Landscape
Focus 3
•Rural Quality of life
•Diversification (of rural structure)
ILEK
„integrated rural development“
Focus 4
LEADER+

WATER MANAGEMENT IN SALINE RIVER DELTAS **SECURES FRESH WATER SUPPLY**



WaterCAP

Summary

The agricultural sector in Zeeland, located in the river delta of Rhine and Meuse, is confronted with growing impacts of freshwater shortage and salinization. The impacts of the saline groundwater in the area on the agricultural sector could, in the future be exacerbated by climate change and sea-level rise. The province of Zeeland, the water board, municipalities, as well as the agricultural sector consider a reliable freshwater supply as one of the keys for future development and sustainable growth of the region.
In Zeeland, new water management strategies and operational technologies are being developed and tested. This includes measures to improve the use of existing fresh groundwater resources and to create new freshwater reserves trough enhanced infiltration.

Main Benefits

General aspects

- Increased regional self-sufficiency and reduced dependence on external freshwater supplies.
- Better awareness and understanding of the geohydrological system and effects of climate change and anthropogenic activities.

Economical aspects

- Increased turnover of farmers due to less salt or drought damage to crops.
- Decreased costs of freshwater.
- Export possibilities of innovations/solutions delta areas worldwide.

Innovative aspects

- Showcasing of different (theoretically tested) measures under real field conditions.
- Building with Nature: utilization of natural processes in engineering solutions.
- Replicating local measures provides a promising solution for a whole region.
- Efficient operational water and salt management in low-lying areas: monitoring-sensors and technologies, Airborne EM measurements.
- Replicating local measures provides a promising solution for a complete region.

Boosters for Implementation

- Knowledge of the physical system and of impacts of climate change and anthropogenic activities.
- A combination of fundamental and applied research.
- Networks between knowledge institutes, private sector, government and end-users .
- Participation of farmers.
- A joint understanding and mutual trust.

Barriers for Further Implementation

- Unclear distribution of responsibilities in freshwater supply.
- Lack of knowledge on possibilities for up scaling of local measures: socio-economical benefits and hydrological and geological possibilities.
- Conflicting interests (agriculture vs. nature).
- Physical limits in geohydrological possibilities (e.g. total amount of fresh water available during seasons).

How to Get Over Barriers

- Explore possibilities for up scaling of local measures.
- Clarify responsibilities and distribution of benefits.
- Promote participation of all parties involved.

Policy Recommendations

- Promote field-testing of measures for agricultural freshwater supply.
- Support the up scaling of proven technologies to other regions in Europe and worldwide: provide the link!
- Support cooperation and local initiatives for joint local freshwater supply solutions

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CLIMATE PROOF AREAS

ACTIVE COOPERATION
A GREAT WAY TO ACHIEVE LOCAL WATER MANAGEMENT GOALS



WaterCAP

Summary

Climate change causes flooding and water quality problems in many European areas. The Aquarius pilot in the Delft area focused on identifying opportunities for active cooperation between different stakeholders, including farmers, to hinder flooding and to reduce the deterioration of water quality by nutrient releases.

The water authority in Delfland has a long history of interaction and dialogue in the Delfland region. But active cooperation in water management requires a completely different mindset – a new way of interacting in a new setting.

Main Benefits

General aspects

Active cooperation with farmers in local water management may lead to:

- A faster realization of local water management goals.
- More than what is legally required in local water management.
- Understanding and support for the local implementation of water management measures.

Economic/job creation

Active cooperation with farmers in local water management may lead to:

- Cost savings in local water management.
- Retention of income for local farmers.
- Low investments and business risks for local farmers.
- Preservation of the agricultural area.

Innovative aspects

- Water authorities and farmers together are exploring opportunities for cooperation to preserve the agricultural area and improve the local water environment (win-win).

Boosters for Implementation

- A local intermediary, such as an agricultural nature organization, helps to work more efficiently.
- The Dutch catalogue of green-blue services, which is produced by the national government in cooperation with the regional governments, contains a long list of feasible measures and (maximum) amounts of money approved by the EC. On a local level, measures from the catalogue can be chosen and implemented.
- Visualizations are used to stimulate everyone to learn about the similarities and differences between their perceptions. Working together we can reach a collective perception of the problems and solutions at hand. The outcome of the discussions can then contribute to redeveloping and maintaining plans.

Barriers for Further Implementation

- Inadequate financial compensation discourages farmers to participate.
- The lack of a solid business case greatly reduces the chance of turning initiatives into a practical success.
- Participation of farmers requires reliability and trust.

How to Get Over Barriers

- Pay farmers a fair price for water management services.
- Make sure any financial agreement with farmers is in full legal compliance.
- Take time to reach clear agreements about mutual tasks and responsibilities at the beginning.

Policy Recommendations

- Policy should acknowledge and support 'Farmers as water managers' more. Besides food production, farmers deliver water management services at fair prices to preserve the water enviroment.
- When drafting new policies, remember that participatory partnerships play a crucial role in water management.
- Support and facilitate cooperation between stakeholders at local level.
- Make room for bottom-up solutions as a way to develop and implement innovations

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AQUARIUS
Farmers as water managers

WILLOW PLANTING
CREATES MULTIPLE BENEFITS

Summary

Climate change causes increased risk for run off of nitrogen in many European areas. In the Danish Aquarius pilot - a sub catchment to Mariager Fjord - the main focus was to identify possible win-win solutions in collaboration between different stakeholders in order to improve water quality.

Willow plantations in high risk areas of nitrogen run off can be a cost effective solution. Mapping of these high risk areas is crucial.

Main Benefits

General aspects

Growing willow can lead to:

- Improved water quality in the fjord due to less nitrogen leaching from fields.
- Reaching the municipality's climate objectives by linking local supply and demand of high energy crops for renewable energy.
- New business opportunities for farmers by becoming energy suppliers.

Economic/job creation

Growing willow can lead to:

- Reduced public costs for reaching the Water Framework Directive goals on good water quality for the fjord.
- New business opportunities for farmers as an alternative to taking arable land out of production or to restricting production conditions on arable land in general.

Innovative aspects

- By involving all primary stakeholders, optimal legal, economic and production conditions can be created for supplying energy willow as a new product to a new local market, while meeting water quality and climate objectives.

Boosters for Implementation

» An improved mapping identifying those areas where nitrogen runoff is high.

» A catchment stakeholder group where different perspectives on win-win-opportunities are represented.

Barriers for Further Implementation

» Lack of acceptance of using mapping for the identification of specific high risk areas due to a potential clash with the national implementation of the Water Framework Directive, where focus is on general regulation.

» Lack of opportunities for implementing locally generated solutions due to nationally approved methods for granting allowances.

» Lack of market-driven financing opportunities.

» Lack of innovative capacity for changing extension procedures.

» Finding solutions in collaboration requires reliability and trust between all stakeholders.

How to Get Over Barriers

Make test areas in which

» Improved mapping methods are used to identify future opportunities for Water Framework Directive implementation.

» Existing regulation is made responsive to locally generated win-win solutions.

» Innovative collaboration with banks on finding new products for private financing is being tested.

» Catchment stakeholders get time and real responsibility for reaching their goals.

Policy Recommendations

» Policy should promote the use of locally generated solutions and the fact that such solutions differ due to different local bio-physical and production conditions.

» Policy should actively support the creation of catchment stakeholder groups.

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AQUARIUS
Farmers as water managers

WATER SENSING DECISION SYSTEM

AN ANSWER TO DROUGHT

WaterCAP

Summary

European agriculture is dependent on very large reserves of freshwater. However, production is increasingly limited by summer droughts. The incidence of this water shortage problem will increase in the future with climate change (hotter, drier summers) and an increasing competition for water use (food, energy, ecology).

The answer to this is to increase water use efficiency by farmers. Water sensing decision systems use real time data from (soilmoisture) sensors combined with weather forecasts. Based on this better decisions on irrigation can be taken.

Main Benefits

General Aspects

- The introduction of water sensing at farm level targets irrigation in space and time, guided by the crop require-ments.
- Efficient irrigation results in less pressure on the freshwater supply (15-20% on water savings).

Economic/job creation

- Working with sensors creates possibilities for exporting techniques to a wide range of countries worldwide.
- Efficient water use is important for achieving optimal yields.

Innovative aspects

- Water sensing decision systems can form a sustainable solution possible for future problems of water management in intensively used agricultural areas.
- Farmers become more aware of the challenges associated with climate change.

Boosters for Implementation

» This decision support system empowers the farmer to judge efficient water use with limited investment and training.

» It makes agronomic sense and business sense for farmers.

» In joint study groups, farmers can discuss and improve the use of the system.

Barriers for Further Implementation

Climate variability makes the need for irrigation to maintain and/or increase yields in the future difficult to prove in the Dutch situation. The price of the sensors is still relatively high.

Maximum efficiency is affected by landscape soil heterogeneity (different soil moisture to plant water availability relationships).

How to Get Over Barriers

Screening and mapping should take place to identify those regions where the technique achieves maximum cost-effectiveness due to high water stress. Trials should take place in dry areas, where costs of water abstraction are high and/or there is strong competition with other water users.

The measurement of soil moisture is the beginning of a wide range of options to optimise agriculture under-water quantity and water quality restrictions.

Policy Recommendations

Water sensing decision systems are the future tool for developing a model of sustainable farming.

In order to spread this innovative method and bring it to work in the dry regions there is a need for action:

» Provide financial support for the implementation of thsi in-novative method.

» Implement legal or financial measures to motivate farmers to implement the measure.

» Support and develop a multi-case field study approach in a trans-boundary settings, which will promote the development of a business case.

» Support the execution of a thorough cost-benefit analysis.

» Support the development of network sharing systems to enhance communication and foster application in aresa facing drought.

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AQUARIUS
Farmers as water managers

RAIN HARVESTING
REGIONAL STRATEGY FOR MORE GROUNDWATER

Summary

Due to lack of precipitation many European areas are irrigated, but often there is not enough water for irrigation. In the German Aquarius pilot area "Rain Harvesting" was identified as an important method to overcome the challenge.

The idea of "Rain Harvesting" is to retain surplus water from precipitation events with help of weirs in ditches, with leak-proof storage ponds or even by using the groundwater body itself for storage.

The method is not yet fully developed, but has shown some promising results that satisfy both the EU Water Framework Directive by keeping the water in the catchment and the general need for more irrigation water.

Main Benefits

General aspects

» Rain harvesting secures water for both irrigation and local watercourses.

Economic/job creation

» Rain Harvesting can secure jobs and lead to growth in the farming sector by securing access to water.

Innovative aspects

» Rain harvesting measures could be financed by the irrigators. For this we have suggested a legal framework to rate and register the benefits for the water system.

» Measures supporting small watercourses, e.g. planting shading trees to keep down water temperature and plant growth in the water course, are identified as a win-win-solution for both the aquatic environment and the farmer. These activities can be realized or financed by farmers that irrigate while they would be "refunded" through additional irrigation water.

Boosters for Implementation

- The combination of a hydrogeological model with a riverflow-sedimentation model led to the knowledge on the interdependencies of groundwater extraction and effects on the local watercourses.
- The “Rain Harvesting” pilots were “invented” by farmers in the local project steering group and as the result of a stakeholder excursion to the Swedish pilot area.
- For development of effective strategies and measures, basic knowledge on the components of the regional waterhousehold has to be built up and researched on.
- Only with farmers’ local knowledge of soil, drainage systems and waterflow, low cost rain harvesting measures will be found.

Barriers for Further Implementation

- Ways of financing “Rain Harvesting” measures have to be developed. The irrigation community appears to be willing to invest for consolidation of sources for additional irrigation water. For this it is necessairy to develop and implement a legal framework to rate and register the benefits for the water system.

How to Get Over Barriers

- Irrigators, experts of administration and politicians have to develop a broad consciousness about the new strategies and have to develop the will to find solutions.

Policy Recommendations

- Politicians should initiate and mediate the necessary public and administrative discussion about “Rain Harvesting”.

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AQUARIUS

Farmers as water managers

GROWING COASTS
BUILDING WITH NATURE CAN SAVE DROWNING ESTUARIES

Summary

The tidal flats of North-Western Europe are highly valued for their natural beauty, productivity and role in the flood protection and local socio- economic activities. However, their existence is threatened by human interferences such as dredging for shipping, construction of dams or blocking off upstream sediment supply. Due to climate change, the rising sea-level rise adds another threat.

If we don't act now a large part of the intertidal areas will be drowned before the end of this century! Eco-innovative solutions such as Building with Nature can be the answer to this problem. In the Oosterschelde (Netherlands), sand nourishments are successfully implemented to stop erosion and artificial oyster reefs are being tried out.

These Building with Nature experiences, can form a promising solution for climate proofing, not only in drowning estuaries. It secures biodiversity, flood safety and the quality of life, while supporting the objectives of Natura 2000 and the Ramsar Convention on Wetlands.

Main Benefits

Economic/job creation

- Benefit for tourism and fishery: preservation of national nature reserve and fish stocks.
- Water safety for urban areas: saving on costs of dike management.
- Innovation for the dredging sector.

Innovative aspects

- Formation of innovative alliances and shared benefits: public and private partnerships.
- Building with Nature: using natural processes for infrastructure solutions.
- Preservation of long term safety and natural values of delicate tidal flats, with eco-innovative solutions.

Boosters for Implementation

- Broad stakeholder commitment.
- A sound business case.
- Partners in other estuaries who share comparable problems and are interested in cooperation.

Barriers for Further Implementation

- A lack of vision and courage of some stakeholders on EU level, e.g. nature conservationists, coastal zone managers.
- Cost-thinking and risk-avoidance prevails among many stakeholder groups.
- Lack of partners for upscaling and exporting to other regions.

How to Get Over Barriers

- A thorough stakeholder analysis, like in the Oosterschelde pilot.
- Identification of other regions which could benefit from the approach.
- Information campaign on Building with Nature.
- Stronger focus on benefit thinking, not on cost thinking.

Policy Recommendations

- Promote further innovative pilots for estuarine habitats under climate change in the Oosterschelde and elsewhere in Europe.
- Promote Building with Nature as an export product to the rest of the world.
- Consider the relevance of Building with Nature solutions to drowningtidal flats in connection with investment and research programs at national and EU level.
- Spread the word and highlight relevance for implementing EU directives (Bird/ Habitat, Water Framework Directive, Flood Directive) and policy developments.

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CLIMATE PROOF AREAS

SPECIFIC ENVIRONMENTAL PLANS

IMPROVE WATER QUALITY

WaterCAP

Summary

Due to poor water quality many European lakes are about to lose their function as drinking water reservoirs and recreational areas. In the Norwegian Aquarius pilot area local authorities, agricultural advisors, farmers and scientists have collaborated to reduce the phosphorus (P) loads which cause high eutrophication and toxic phytoplankton blooms in the local lake.

Thanks to specific environmental plans (e.g. buffers strips, wetlands and no soil tillage in autumn) created for each farm, the use of P-fertilization is now reduced by 75 per cent. At the same time, farmers have increased their engagement to improve water quality.

Main Benefits

General aspects

- The farmers become engaged as water managers, and they are aware of the challenges they are facing as food producers in a changing climate.
- The water quality in the western part of Lake Vansjø has been improved.

Economic/job creation

- The focus on agricultural research and field experiments has resulted in less use of fertilizers while yield and quality are maintained. This implies both better finances for the farmer and a better nutrient balance.

Innovative aspects

- The formation of local networks between authorities, agricultural advisors, farmers and scientists.
- There has been additional research on the effect of different filter materials in constructed wetlands.

Boosters for Implementation

- Individual advice resulted in an environmental plan for each farm. Local farmers were engaged in a collective action network.
- We had the opportunity to pay grants to compensate for extra costs/reduced income due to reduced tillage, buffer strips, constructed wetlands and other mitigation measures.
- The exchange of knowledge and experiences between farmers and researchers.
- Establishment of local regulations with a set of restrictions on farming practices.

Barriers for Further Implementation

- The farmers' incomes are mostly based on plant production. The value of green goods such as recreation and outdoor activities has to be payable to enable and continue-collective action for improved water quality.

How to Get Over Barriers

- Keep up the focus on individual advice, extended by field trials to ensure that the new practice with reduced tillage and reduced use of fertilizers is profitable for the farmers.
- In cases where the new practice is not profitable or affordable, the farmers need financial compensations.

Policy Recommendations

- The farmers very often struggle to make a living out of agriculture. It is harder to make farming affordable with a set of restrictions and regulations for the farming practice. It is therefore necessary to financially compensate farmers for the implementation of mitigation measures.

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AQUARIUS

Farmers as water managers

OPTIMIZATION OF THE WATER CYCLE
IMPROVES THE GROUND WATER REGENERATION

WaterCAP

Summary

The investigation of the natural water cycle on self sustaining islands regarding climate change impacts is easier that on the mainland, due to an almost closed water system. In times of increasing rates of heavy rain fall events, a rising sea level and periods of water shortage, microcosms such as islands are excellent natural laboratories to find innovative solutions for a well adapted sustainable water management.

The idea emerged to collect overloads of surface water, which put pressure not only on settlements but also on supply and disposal facilities, and drain them in a way that they can have a positive impact on ground-water regeneration. A volitional ecological side-effect is the rewetting of wetlands.

Main Benefits

General aspects

- Islands are catalysts and microcosms, on which investigations and measures can be implemented and evaluated in a limited area.
- This solution will meet and substantiate the generel desire of communities to become more environmentally sound and sustaineble.
- The management of the water cycle is optimized which has an effect on the regeneration of ground-water (fresh water lens) on the island.
- The solution is transferable to the mainland.
- This solution will support and safeguard the principles of sustainable drinking water supply.

Innovative aspects

- This solution works with nature as opposed to traditional engineering solutions. Research results can easily be implemented in practice.
- A combination of ground water regeneration and rewetting measures in one implementation process.

Boosters for Implementation

- Identify funding streams.
- Find reliable and solvent investor.

Barriers for Further Implementation

- Financial back-up, find funding or investors which are reliable for implementation.
- Commitment, the support of all involved stakeholders is essential.
- Decision makers are dependant and limited by political decision-making processes.
- Main economic drivers (e.g. tourism on islands) may be assigned a higher priority regarding investments.
- On account of uncertainties of the value and potential impacts of the developed solution to the involved parties, there is still a lack of support by the involved inhabitants.

How to Get Over Barriers

- A communication process is necessary, which is tailor-made for the specific target groups. The involved parties have to be convinced by working with different scenarios themselves. The consequences of the "doing nothing solution", as opposed to the implementation of this management system should be highlighted.
- Predictions regarding the expected impacts of climate change can also underline the urgency of the implementation. The "doing nothing solution" could cause higher investments and subsequent costs in the future and could have a negative effect on the amount of tourists.
- Building networks among important decision makers and identifying appropriate funding streams on national and international level will substantiate the process of persuasion.

Policy Recommendations

- Strengthen sustainable thinking among politicians. Support of adequate innovative and necessary solutions by decision makers. Assume more responsibility!
- Support the integration of the main economic driver of the island into groundwater management: Groundwater as tourist attraction.
- Support the combination of groundwater regeneration with other water management activities.
- Apply scenario-planning on the future groundwater situation.
- Continue using islands as natural units for testing and developing water management solutions.
- Create ownership for local projects on groundwater regeneration

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cradle to cradle islands

SAVING FRESH GROUNDWATER
IN COASTAL REGIONS

Summary

New innovative airborne mapping, online monitoring and coupled ground-watersurface water modelling are offering society new ways of managing Sea levels changes and the threat to the freshwater lens, The solutions are cost-effective on a regional scale, transferable to other EU regions and exportable worldwide.

In low-lying coastal areas, sand dunes host important freshwater lenses. These freshwater resources support surface water ecosystems, and many communities are dependent on them for drinking supplies and water for agriculture. To protect this vital resource, realistic and well-calibrated integrated groundwater models are required, which in turn rely on large amounts of high quality subsurface data.

Main Benefits

Better water management:

» Models are used to forecast hydrological conditions and the ability to extract groundwater. In this way, money can be saved and sustainable ecosystem services can be safeguarded.

» In addition, the tools and methods developed support the implementation of the Water Framework Directive and the EU white paper 'Adapting to climate change: Towards a European framework for action'.

Economy/Job creation:

» Devloping new techniques for data aquisition and SME startup of the business SkyTEM is creating jobs in the region. The company is expecting to triple the flght kilometers from 2011 to 2012.

Innovative aspects

» Smarter and faster data acquisition techniques have been developed.

» New airborne systems, for example, enable the collection of huge datasets in just a week, without disturbing ground activities, whilst online monitoring enables long distance access to large amounts of field data.

Boosters for Implementation

» A skilled project partnership allowed the development of technical methods concerning groundwater, geology and chemistry.

» Funding from the InterReg IVB programme gave the local water company the ability to use and test an uncertain method. An open minded approach from the local water company supported the implementation of new methods.

» Cooperation between institutions and countries made it possible to transfer best practice between countries in the pilot studies.

Barriers for Further Implementation

» There is a tradition of thinking in terms of national implementation and use of methods. Transnational thinking should be encouraged.

How to Get Over Barriers

» A common database and data platform would increase the possibility and efficiency of data transfer.

» Improving the conditions to work together across regions in Europe e.g. on transnational case studies will stimulate the transfer of knowledge and concrete collaboration across boarders.

» Clustering as a means of transferring methods between disciplines has been proven to be a good tool.

Policy Recommendations

» To overcome the barriers we propose the establishment of a unit or “innovation office” to help develop and prepare tools for the market, overcome financial barriers and develop implementation strategies. From the CLIWAT project an export package can be developed for climate change adaptation in other coastal regions.

» The change in groundwater systems is a hidden problem beneath our feet. New online results from the coupled groundwater models can describe future groundwater conditions, rather like weather is forecasted today. These forecasts should be available from a web portal to raise awareness of present and future conditions and challenges affecting dependent sectors.

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CLIWAT
CLIMATE & WATER

NATURAL FLOOD MANAGEMENT

WORKING WITH FARMERS

WaterCAP

Summary

Climate change causes flooding in many European areas. In the Scottish Aquarius pilot area the focus of activity was to look at working with farmers to implement flood alleviation measures through natural flood management schemes rather than the previous approach of using hard engineering methods to prevent the flooding of houses and industrial areas.

The technical solution was to create an area where flood storage and continued agricultural use could be clearly demonstrated. The solution has shown good results and can serve as inspiration for other EU countries.

Main Benefits

General aspects

- Efficient use of farm land to help protect areas at risk from flooding.
- More natural approach to creating a flood storage area. Grassing bunds rather than hard engineering measures such as rock armour.
- Fits the recommendations of the Floods Directive to use more natural flood management solutions.

Economic aspects

- The majority of the site can still be used for agricultural grazing.
- Management of the site will be minimal as land will be grazed and seed used on bunds is low maintenance grass.
- In some situations storage of water during wet conditions will provide water in times of drought.

Innovative aspects

- Improved amenity for the area with the inclusion of burnside pathway.
- Ability to include wetland areas to attract wildlife and enhance biodiversity enabling used by the local schools.

Boosters for Implementation

- Build good relationships with the landowners and have clear dialogue at all stages.
- Consultation required with other stakeholders through public meetings and open days to ensure they were informed at all stages of the project.
- Minimal loss of agricultural land in the construction of the Flood Storage Area.
- Added benefits of a path link providing better amenity for the local community.

Barriers for Further Implementation

- Land ownership and tenancy models create legal difficulties when designing long-term measures to deal with flood alleviation.
- Land managers can be nervous about committing to long-term measures given the unpredictability of markets, funding regimes and policies.
- Land managers can be nervous about the unpredictability of when the land will be flooded and the potential impact on crops or grazing.

How to Get Over Barriers

- Different understandings of 'natural' flood management. Time should be taken to clearly define the problem and the solution.
- Land managers can work with engineers to design measures that allow them to continue to graze or crop fields between floods. Time and resources should be allowed for this co-design process.
- The trade-off between flood protection and impact on land management requires detailed modeling and analysis. Technical processes need to build in multiple iterations.

Policy Recommendations

- Current agri-environmental payments do not provide sufficient incentives for long-term flood management nor take a catchment approach. This should be prioritised in future funding scheme design.
- Land managers perceive a conflict between flood alleviation measures and measures under the Water Framework Directive that prevent clearing vegetation from the burn. Policy makers need to provide clearer guidance.
- Agricultural advisors need better evidence about NFM options in order to help engage land managers in flood alleviation.

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AQUARIUS

Farmers as water managers

MULTI-FUNCTIONAL WETLANDS

A WIN-WIN SOLUTION

Summary

Construction of multi-functional wetlands is a cost-effective environmental tool that delivers multiple benefits to several levels in society. It is a good example of a win-win solution with a high potential for realizing current and future cost-efficient environmental schemes and measures.

Therefore, the multi-functional wetlands are a valuable and important measure for complying with EU directives such as the Water Framework Directives, the Nitrates Directive and the Habitat and Birds Directive.

Main Benefits

General aspects

- Nutrient retention of diffuse pollution from agriculture and recycling of nutrients.
- Drought mitigation and flood prevention.
- Increased biodiversity and habitat restoration.
- Production (e.g. biomass, fish, crayfish, ducks).
- Social benefits (e.g. hunting, fishing).

Economic/job creation

- Benefits for farmers in areas where irrigation water is limiting production and/or crop choice.
- Decreased risk of flooding and crop failure.
- New business opportunities in rural areas (e.g. fishing tourism, hunting).

Innovative aspects

- Multi-functional wetlands well developed in Sweden and have high potential for increased use in Europe.
- The Aquarius pilot showed the importance of active cooperation between different organisations.

Boosters for Implementation

A good cooperation between four important levels of organisations:

» Farmers and farmers organisations (the end users)

» Advisory organisations and consultants (disseminators and mediators)

» Authorities and decision makers (municipalities, county administrations and governmental agencies)

» Research organisations (universities and R&D institutes)

Barriers for Further Implementation

» Not all relevant organisations in society might be involved in the projects.

» The end users (farmers) are not persuaded or do not see any benefits for them even though they are involved in the projects.

» In some cases legal issues and/or administrative processes are unnecessary barriers for wetland construction.

How to Get Over Barriers

» Make sure that all relevant organisations work together from the beginning.

» Invest in key persons among the end users who act as ambassadors for the idea of multi-functional wetlands.

» Make sure that legal obstacles and the administrative processes are not hindering wetland construction unintentionally.

Policy Recommendations

» Increased use of multi-functional wetlands in the EU should be promoted by active policy decisions.

» Active promotion and information to all four levels of organization mentioned above in other EU countries.

» Create an overview of the legal and administrative processes related to the construction of wetlands.

» Promote the use of multi-functional wetlands as an efficient measure in scope of the Water Framework Directive (water quality enhancement) and the Flood Directive (mitigation of floods and droughts).

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AQUARIUS
Farmers as water managers

NORTH EUROPEAN RESPONSE **TO DROUGHT**

WaterCAP - a cluster project

The WaterCAP cluster project partners have utilised and developed technical tools to improve the availability of fresh water resources. In addition, the results will reduce human vulnerability to climate change and improve flexibility in adaptation to climate change.

The technical systems and method are:

» Soil mapping system. Locates aquifers and measures salinisation levels. Results in better water management and prevents overexploitation and salinisation.

» Water management decision-making system. Monitors soil moisture in advance of irrigation.

» The systems are used in combination and the resulting actions are organised and implemented in cooperation with stakeholders. This improves the understanding of the significance of the scarcity of water, for example in the Mediterranean region and strengthens resilience to drought.

The tools and method support the implementation of the EU Water Framework Directive and the EU white paper ‘Adapting to climate change: Towards a European framework for action’.

WaterCAP

Soil mapping locating aquifers and measuring salinisation levels

Sea levels are rising and are threatening freshwater lenses; the beating hearts of freshwater supplies and dependent ecosystems in coastal regions. New innovative airborne mapping, and online monitoring systems, coupled with groundwater-surface water modelling systems are offering communities new ways of dealing with climate change challenges. The solutions are cost-effective on a regional scale, transferable to other EU regions and exportable worldwide.

The WaterCAP cluster project partners have utilised better and faster data acquisition techniques. For example, new airborne systems that enable the collection of huge datasets in just a week, without disturbing ground activities, while online monitoring enables long-distance access to large amounts of field data.

Models tested on the Wadden Islands (The Netherlands, Germany and Denmark), are being used to forecast hydrological conditions and groundwater extraction capability. In this way, money can be saved and sustainable ecosystem services can be safeguarded.

Additionally, saltwater intrusion in aquifers will be accurately mapped using the Airborne Geophysical TEM system. This is crucial information because by knowing the exact location of the saltwater-freshwater boundary, the effects of water extraction in drought periods can be preciously modelled to prevent up coning of saline water and thus avoid salinisation of the aquifers (in Australia, local areas are currently struggling with salinisation of the coastal aquifers due to extensive water extraction in drought periods. The Airborne geophysical TEM system is currently being used in these areas to improve water management).

» The modelling will reduce uncertainty within water management and ensure optimal decision-making because the long-term effects of extraction can be predicted (even by taking different drought scenarios into account).
» Better information on the availability of water.
» Predictions of the effects of different drought scenarios through hydrological modelling.
» A system that improves the ability to manage groundwater in a sustainable way and reduces energy consumption.
» Better water management because water can be used where it is most needed; as defined between the users.

Water Sensing System

A sensor measures soil moisture in the topsoil at different depths. The farmer can see the updated data online, so he knows exactly how much moisture is available for the crops in the field at different depths in the soil. This knowledge is combined with local weather station information (precipitation and evaporation data). In addition, the data is combined with the geological characterisation of the fields and their soil types. At this level, the farmer can see how the weather impacts the soil moisture.

Crops have different water requirements in relation to plant species, season and the growth stage of the crop. Combining all of the above information means that the farmer knows if his crops require water during each dry period and whether he has to irrigate his fields immediately or if he can wait for a few more days. The system has been tested within the WaterCAP cluster project in an area with starch potatoes, sandy soils and during a water shortage period in summer (North Eastern part of The Netherlands). About 40 farmers have used the system. The system has also been used outside Europe (Egypt, Tunisia, Kingdom of Saudi Arabia, South Africa) and on small scale EU pilot projects in Spain and Cyprus (DESIRAS)

Advantages of the water sensing system:

The introduction of water sensing systems at farm level can target real-time irrigation requirements for a specific field, based on crop requirements.

» Saves the farmer money because he will only irrigate where and when irrigation is required.
» Saves energy.
» Efficient irrigation reduces demand on the freshwater supply (water consumption reduced by 15–20%).
» In the pilot projects in Spain and Cyprus, water consumption was reduced by up to 50%.
» Farmers become more aware of water management and the ways they (can) influence water system.
» Knowledge about soil moisture is also an important factor in making more efficient use of fertilisers.

Integration of the systems

By combining the two systems described above, we are able to improve results and use data more efficiently. The Airborne geophysical TEM system provides detailed mapping of the near-surface geology, i.e. the distribution of clay and sand in the top 10 m of the soil. This information is crucial for farmers in their efforts to irrigate (and fertilise) cost-effectively and it is valuable information for determining where water sensors should be located and thus helps to optimise water sensing systems.

» By knowing the heterogeneity of the top soil the number of water sensors required can be reduced.

» Better use of the water (by the farmers) in combination with information about the availability of water will hopefully trigger other users to seek more efficient ways to use water in the long term.

The combined systems reduce vulnerability to drought, increase water availability, increase water use efficiency and reduce energy consumption.

Implementation

The implementation of the systems needs to follow a certain strategy and plan. The diagram below shows how the systems are integrated in an area/country:

1. Mapping of groundwater aquifer and soil layer and Analysis of current water irrigation system.
2. Stakeholder analysis and force field analysis to integrate local expertise on hot spots, data challenges and expected management developments.
3. Workshop: Kick-off and start-up

» Visualisation of the status-quo upper soil layer and water management system.

» Joint and integrated problem definition and analysis.

» Presentation of the systems used by WaterCAP: Airborne geophysical TEM system and the Water Sensing Decision System (WSDS).

» Identification of urgent water management problems and regions (pilot areas).

» Development of an experimental set-up for the identified pilot areas.

» Joint development of an observation and monitoring system.

4. Monitoring by Airborne Geophysical TEM system and data collection for the WSDS.
5. Stakeholder dialogue

» To identify the pros and cons of the system and its management, improvement

6. Workshop: Evaluation and Transfer

» Presentation of monitoring results.

» Presentation of experiences (pros and cons of the relevant stakeholders).

» Joint evaluation step: How to proceed? What has to be improved (communication process, methods, experimental set-up, etc.)? What were the benefits?

» Joint discussion: Are results transferable to other Mediterranean regions?

Key success factors

» Farmers take responsibility and ownership of the water management system. Local water supply companies and communities use the modelling in the management and regulation of water supply and consumption.

Costs

» Water sensing system and associated equipment, €2,000

» Data analyses, €550 per annum.

» Mapping subsurface and locating aquifers and salinisation, €5,000 per km2.

» Time required to implement mapping, install sensors and involve stakeholder is about one year.

Threats

The water management system may be too technical and farmers may feel that they are not qualified to use it or are unable to keep it operating.

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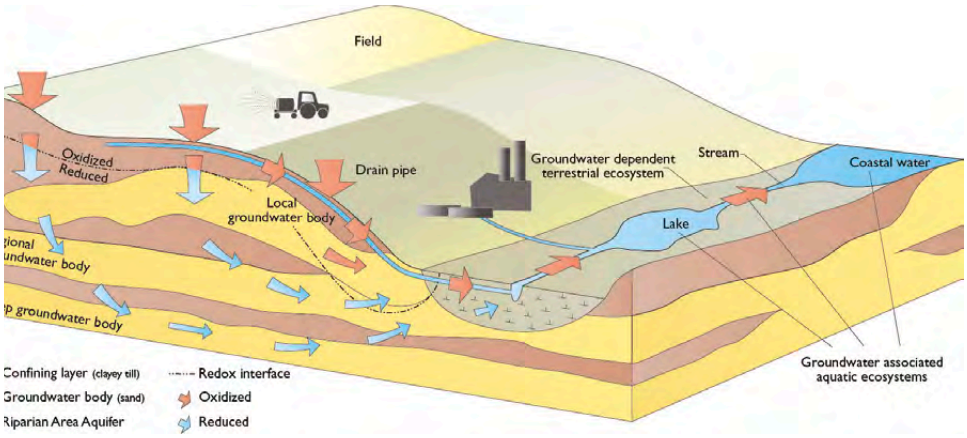
Farmers as water managers

CLIWAT
CLIMATE & WATER

CLIMATE PROOF AREAS

MODELS AS DECISION SUPPORT **AND MANAGEMENT TOOLS**



Summary

Physically distributed and coupled groundwater-surface water modelling on local and regional scales is a strong tool for decision making and climate change impact assessments on a multi-disciplinary background. Scenario building tools such as conceptual models (see figure above) and coupled groundwater-surface water- and salt water intrusion models are necessary complementary tools for integrated water resources management and climate change impact assessments. This includes assessments of groundwater quantitative and chemical status and threshold values according to the Water Framework and Groundwater directives. Further scenario building tools can be useful for identifying adaptation measures and institutional barriers, and for assessment and timing of adaptation measures including their implementation uncertainty, robustness and tradeoffs.

Models applied on e.g. the Wadden islands, are used to forecast hydrological conditions, sea water intrusion and the ability to extract fresh groundwater for water supply in a future climate. Furthermore, they were used to assess groundwater threshold values and chemical status, and possible nutrient management options based on the ecological status of associated surface and coastal waters. In this way, cost-efficient measures can be planned and sustainable ecosystem services can be safeguarded.

What enabled implementation?

- Model building on a hierachi of scales depending on the purpose of the model. Local scale issues calls for more detailed local scale models.
- Reliable parameters based on documented measurement techniques are vital data for the models.
- Cooperation between institutions and countries made it possible to transfer best practice between countries and combine results from a large range of different methods in the pilot studies.

What were the barriers to model implementation?

Easy access to accurate and high quality data collected in model areas are cornerstones of the quality and reliability of any model. Examples of on-line data sharing and visualisation from all CLIWAT pilot areas can be found in the lower part of the first page of the CLIWAT website through the link “online Geomodels”. Data for models can have more than one purpose and can here be evaluated by stakeholders and visualised interactively. The sharing must be done through a common database. Such data sharing and visualisation possibilities is not yet generally available in Europe and transferability is therefore not as smooth as possible. In addition the formats of data are not completely compatible. Online data sharing and visualisation of geological, geophysical and geochemical data like demonstrated on the CLIWAT website should be continuously developed and improved.

Modeling the impacts of projected climate change on groundwater and dependent terrestrial and aquatic ecosystems can be done in 3D numerical models illustrated by the conceptual model above . Read more about the application of conceptual and numerical models e.g. for assessment of seawater intrusion at higher sea levels, flooding and climate change impacts on groundwater and aquatic ecosystems etc. in the CLIWAT Handbook, the CLIWAT special issue of Hydrology and Earth System Sciences (http://www.hydrol-earth-syst-sci.net/special_issue149.html) and in the CLIWAT newsletter #5 of June 2011.

How to overcome the barriers?

- Sampling of the right data and efficient data exchange and visualitation is important.
- A common database and data platform would increase the possibility and efficiency of data transfer.
- Improving the conditions for working together across regions in Europe e.g. on transnational case studies will stimulate the transfer of knowledge and concrete collaboration across boarders.
- Clustering as a means of transferring methods between disciplines has been proven to be a good tool. Facilitations and workshops are good but rather costly. An increase in the use of virtual meetings would bring down the time spent on travelling and increase the potential for meetings.
- Increase in open-mindedness and education within institutions, to promote the uptake of new methods.
- Building administrative and political decisions on a sound scientific basis gathered in models should be supported by the political decision makers across Europe.
- By modelling it is possible to include uncertainty, scale issues, sensitivity and thresholds in the decision making.

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MULTILAYER SAFETY CONCEPT
ENHANCES REGIONAL CLIMATE PROOFING

Summary

The traditional approach to generate flood safety in the Netherlands is to construct physical defense
structures, such as dikes or storm surge barriers. Triggered by the expected impacts of climate change, however, there is a growing attention for combined strategies which can improve the effectiveness, while reducing the costs of flood safety on regional level: the Multi Layer Safety (MLS) concept.

MLS approaches flood safety in three levels:
1. Flood prevention (water defense structures).
2. Sustainable, water proof, spatial planning.
3. Crisis management in case of flooding

On the Dutch island of Schouwen-Duiveland, the implementation of the MLS concept has lead to new, practical options for measures to enhance regional climate adaptation.

Main Benefits

General aspects

- Enhanced flood safety.
- Increased awareness of evacuation routes in case of flooding.

Economic/job creation

- Coordinated flood safety investments.
- Avoidance of casualties and reduction of damage costs.

Innovative aspects

- A more integrated approach to climate adaptation.
- A better coordination of flood prevention, crisis management and infrastructure investments.

Boosters for Implementation

» Connection of policy frameworks on EU-level, such as the Flood Directive and the White Paper on Climate Adaptation

» More broad application, also in other regions

Barriers for Further Implementation

» A mentality change is necessary, since the traditional approach to flood safety is being challenged.

» Legal obligations fail to account for multi layer flood safety (No legal standards for flood safety through spatial planning and crisis management).

How to Get Over Barriers

» Communication and awareness building.

» Collect experience from other case studies implementing the concept.

» Legal standards to incorporate flood safety through spatial planning and crisis management (e.g. standards to be based on casualties and damage, standards for every layer, etc).

Policy Recommendations

» Promote the incorporation of a so-called "Climate Adaptation Pre-Assessment" in plans, programmes and policies.

» Promote the introduction of standards which account for multi-layer safety.

» Apply the approach in planning and policy-making of other, more vulnerable areas, and collect practical experience in learning alliance.

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