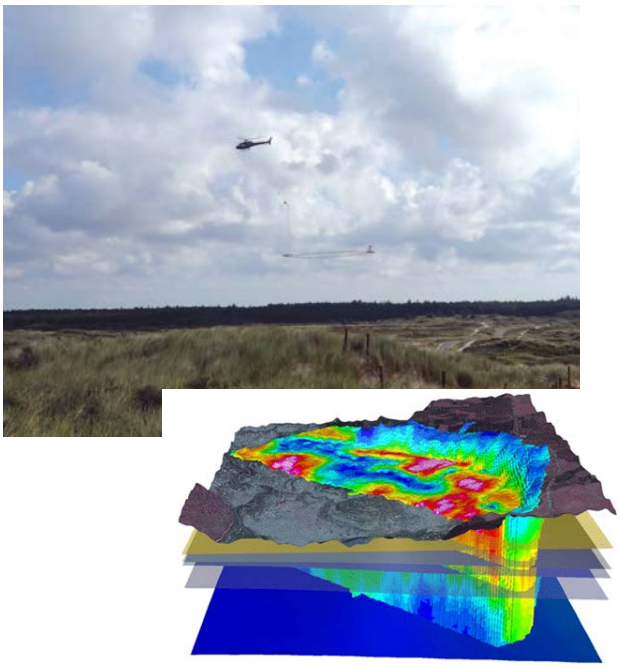
Technical Tools

and the need for innovation



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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.

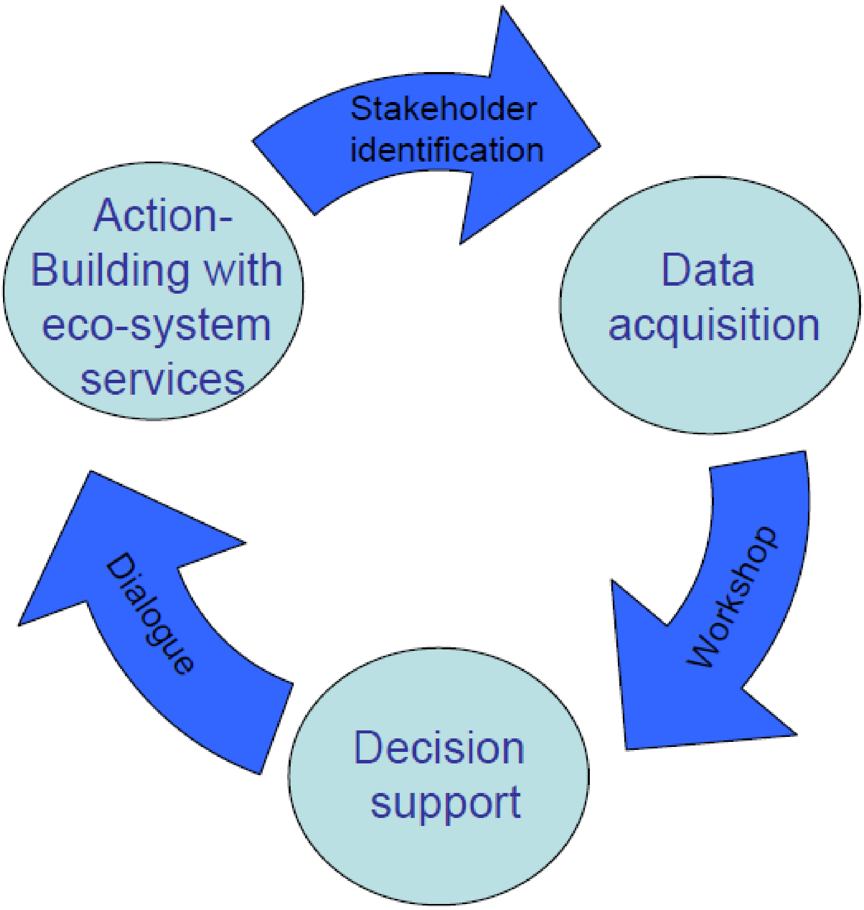

Figure 1: Steps in climate adaptation

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. The collected data can be used to give an overview of the impact today, in the future and/or can be used by modellers, construction decision support systems or can be directly published in the form of maps, logs, risk forecasts, etc.

Decision support systems such as integrated groundwater models, irrigation systems, flood management systems and other 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.

The input to the decision support systems is described in the group Data Acquisition and the results from the systems should enable the group ”Action. Building with eco system services to make new climate adaptation solutions.

Based on data directly related to geology, flow in streams, sea level rise, infrastructure in rural and urban areas etc., decision support systems such as integrated groundwater models, flood management systems, put forward a number of solutions that should be implemented.

The solutions may be to build intelligent drainage, 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 technical examples from each of the projects involved.

Data Acquisition

Good innovative examples of data acquisition methods and presentation

Scientific data on groundwater levels, soil moisture and stream flow have been collected in the cluster project. There are many examples of this data: literature searches and interviews (CPA), airborne geophysics (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).

A good example of this innovative data acquisition is SkyTEM (CLIWAT); 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 crop owners to irrigate crops when needed (Aquarius).

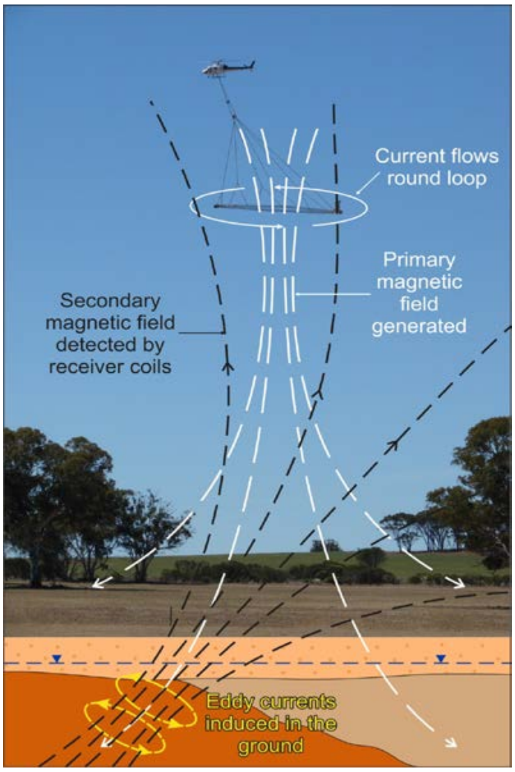

Figure 2 SkyTEM Airborne data acquisition

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.

This also means having an open approach; of actively sharing data between different parties (also private companies), for example private – public partnerships. For example, farmers will “trust” data if they are included from the very beginning of a project, when data is first collected.

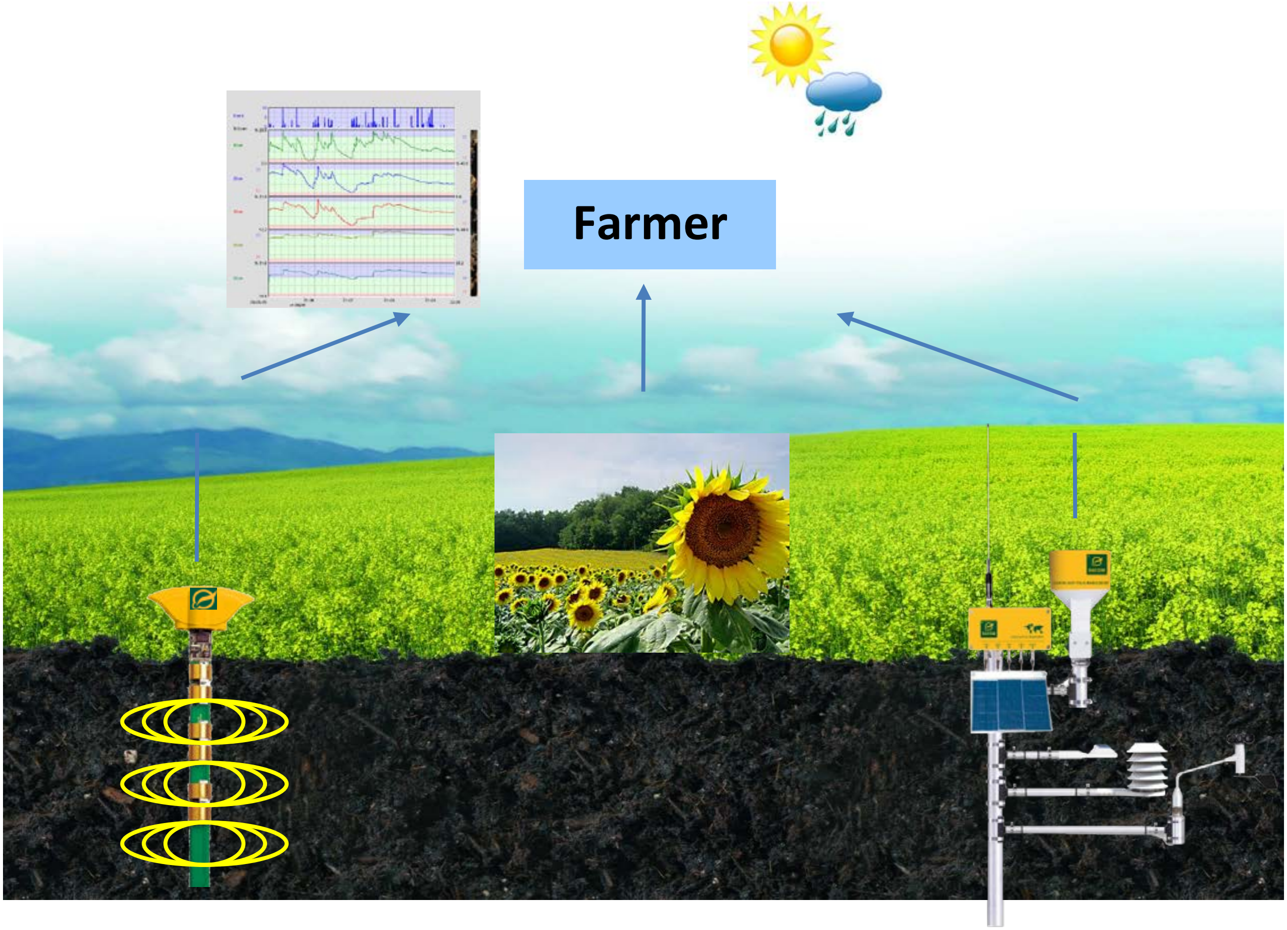

Figure 3 Water sensors and on-line monitoring of soil moisture

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.

The availability of data at the project level can be strengthened by involving the entire value chain as partners in your project (governmental bodies, knowledge institutes, associations of stakeholders, landowners and market parties). The Interreg scheme should create the ideal space for this to be realised. Today, there is a lack of private companies in the consortiums developed within the projects.

Innovative development of data collection starts by focusing on a specific challenge (e.g. saltwater intrusion in coastal waterworks). This is followed by an analysis of the entire value chain and society’s needs and demands for data collection to further define the most valuable dataset.

Recommendation towards policy level
Data is needed for sound climate change adaptation. Lack of data means that adaptation measures have to 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 create innovative thinking and breakthroughs. This also includes interdisciplinary work between different institutes, which enables data to be fully and effectively utilised.

Transnational agreements about fundamental parameters like sea level rise should be reached. This will strengthen regional planning and protection – especially in border areas.

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 too specific a target. Interreg should refocus on innovation and at the same time be very flexible. Innovation involves uncharted territory. Stage gate models can be introduced that support the projects that make real development, throughout their lifetime.

Decision support

Good innovative examples of data acquisition methods and presentation

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.

Scenario building tools (group model building and exploratory/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 tradeoffs (between different adaptation measures in order to adapt to and reduce risks for climate change and other drivers).

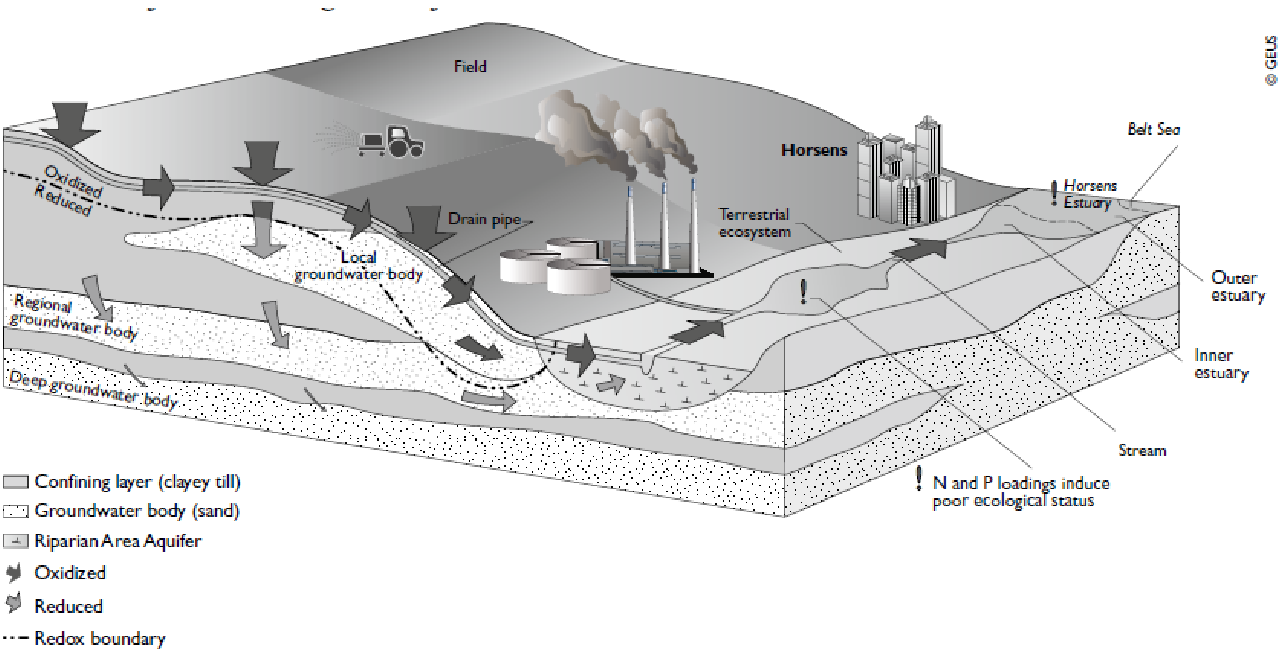

Figure 4 Modelling the effects of climate change can be done in 3D numerical models like this example (CLIWAT)

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 relevant 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. However, there is also a strong need for increasing the capacity to cope with unexpected events by building flexibility into decision making tools. This can be done by including adaptive learning and management where scenario development and conceptual models (influence diagrams, graphical models, etc.) can be useful tools, if properly backed up by bio- and geophysical modelling results, expert knowledge, the monitoring of data and local knowledge from stakeholders. 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/backcasting 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) and adaptation measures (including uncertainties) for better climate change strategies and more resilient societies (properly evaluated according to economy, biophysical indicators), 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.

The EU hould invest in approved data acquisition and monitoring (especially biophysical data and records of periods, e.g. shallow groundwater levels, runoff, flooding, sea level data, etc.) systems in order to make more reliable and timely forecasts and for reducing risk related to climate change impacts.

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 (double and triple loop learning allowing for reframing and transforming of strategies) for developing contexts, changing frameworks and shaping actions.

Development with ecosystems

Good innovative examples of data acquisition methods and presentation

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 – for example, using sand and shellfish (oyster reefs, blue shells etc.) on sandy coasts (CPA); the farmer acting as a water manager (Aquarius), including increased awareness and responsibility for managing the whole environment; increasing wetland development and storage capacity (SAWA, CPA, Aquarius, C2CI); Sustainable Urban Drainage Systems (SAWA) and reusing wastewater treatment plant effluent (C2CI).

Figure 5 An example of development with eco system services: Oyster reef

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 facilitiates green growth:

- The farmer should be the entrepreneur, so sustainability and green growth become more profitable

With regards 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.
- Be a catalyst for local initiative funding (from the EU)
- Establish national/independent databases where data can be accessed

Appendix

Project	Data collection and presentation	Decision support	Eco system services
CPA	Data acquisition	Model based scenario building (also socio economical)	Building with nature (sand nourishment, oyster banks)
CPA	GIS tools	Integrated management	Development of wetlands
CPA	Litterature search	Soil functional assessment	Water storage in urban areas; sewage separation
CPA	Interviews		Creation of new wetlands
Aquarius	Monitoring soil moisture	Building model to support the management and distribution of fertiliser	Regain watering access for farmers whilst minimizing negative impacts on WQ
Aquarius	Testing P filters to reduce P delivery to stream (and ultimately lake) from sediment. In conjunction with other measures (reduce P fertilization, decreased tillage)	Translation of effect of climate change to crop production (effects of extremes)	Water storage (small weirs; ponds), more efficient GW use (sprinkling), efficient irrigation techniques (pivots), artificial GW recharge
Aquarius		Basic flood inundation models- criticized by farmers	Creation of wetlands: site inventories, support for farmers during application process, participatory problem solving to establish demonstration sites
Aquarius			Construction of 'nature friendly banks', maintained by farmers rather than Water Board
CLIWAT	Test and develop geophysical data aquisition,	Improving the geological model setup	Infiltration and groundwater level management in polder areas
CLIWAT	monitoring water table	Integrated groundwater surface water models	Designed pump strategy for remediation of contaminants
CLIWAT	Chemical methods to better describe the subsurface	Develop and apply models to evaluate the likely effects of climate change on groundwater quantity and quality. Identified model/data deficiencies	
CLIWAT	Monitoring surveys in towns and countryside; On line measurements		
CLIWAT	Development of database for public use		
CLIWAT	Airborne geophysical methods		
CLIWAT	Regional thematic maps of changes in sea level, groundwater recharge, groundwater tables, catchment areas of waterworks.		
SAWA	Development of flood risk maps for pilot basins	Development of adaptive flood risk management plans in pilot areas.	Sustainable Urban Drainage Systems (SUDS)
SAWA	Development of regional flood risk maps	Adaptive strategies and cost effectiveness for implementation of flood risk management plans	Effectiveness and EIA of lake dredging
SAWA	Optimising storage capacity during floods using automated 3-weir flow regulation	Optimising storage capacity during floods using automated 3-weir flow regulation	Assess efficiency of emergency plan to deal with flood waves
SAWA		water management – flood forecasting system, focus on emergency response and temporary measures during peak discharge.	Install 1700 ha storage basin, combined with nature reserve.
C2CI (Water)	Checking of possibilities for the reduction of sealed areas	Building scenario models (3D models) to predict climate change effects	Desalination for drinking water
C2CI (Water)	Checking of infiltration or irrigation possibilities / areas of the surface water		Storage of winter rain for use in summer
C2CI (Water)	Checking of the OOWV sewer systems in terms of leakage, to reduce sewer infiltration water loads in the water treatment plant		Sanitation and separation of household water
C2CI (Water)	Checking of the soil in terms contaminations by leakages		Purification and reuse of waste water treatment plant effluent
C2CI (Water)	Survey of drainage, ditches and piping		
(DiPol)	Water quality data aquisition during flood events		Simaclim. A sensitivity tool relative risk rank model. To support managers prioritizing in actions & plan response
(DiPol)			Scremotox. Tool for North Sea Wide Assessment of relative contributions of diffuse pollution sources to water quality