PIK

International Institute for Applied Systems Analysis
IIASA

ISI-MIP

IMPACTS WORLD 2013

International Conference on Climate Change Effects

CONFERENCE PROCEEDINGS

Potsdam, Germany
27-30 May 2013

SPONSORED BY THE

Federal Ministry
of Education
and Research

www.climate-impacts-2013.org

Impacts World 2013, International Conference on Climate Change Effects,
Potsdam, May 27-30

Adaptive water management in coastal areas: From climate impact assessment to decision making

Helge Bormann, Frank Ahlhorn, Thomas Klenke

Abstract—Based on the results of a participatory study focusing on the adaptation of water management to climate change at the German North Sea coast, we adress the following questions: Which information is needed for adaptive water management related decision making in coastal regions? Which information from hydrologists is suitable for decision makers in such a climate adaptation process? How should we deal with the uncertainty in the climate projections? How does selective use of available information influence the characteristics of adaptation options? Discussing these questions, we infer the necessary compromise between scientific completeness of information and the requirements on straightforwardness for decision making.

Index Terms—water management; climate adaptation; participation; use of information; uncertainty.

1 Introduction

Climate proofing the coastal water management in the North Sea region requires several subsequent actions: Providing information on expected regional hydrological change, assessing the functionality of the existing water management systems, elaborating adaptation options for future scenarios, making the decision and implementing the most suitable adaptation option. As part of this process, linking science and policy plays a crucial role (Veraart et al., 2010). Scientific projections reflecting the regional socio-ecological circumstances are required for a sound decision making, while the information provided to decision makers must be provided in a way which is suitable for non-scientists.

This contribution presents results of the EU-Interreg VIB “Climate Proof Areas” project. In the German part of the North Sea Region, water management regulates a strong seasonality in water quantity. While in winter time drainage and storage avoid flooding, in summer time watering assists guaranteeing sufficient water availability with respect to quantity and quality. In a participatory process together with representative stakeholders we analysed the efficiency of the regional water management system and developed an inventory of adaptation alternatives based on hydrological model simulations quantifying the expected impact of climate change on the regional hydrological system (Bormann et al., 2012).

During this process the question arose how different kind of information was used: experience based knowledge on the region, scientific information on climate scenarios and expected hydrological change as well as the awareness of the uncertainty inherent to all future projections.

2 Region and methodology

2.1 Regional characteristics

The Wesermarsch County (822 km²) serves as an example for many regions along the North Sea coast lying below sea level. The rural county has a population of about 92,000 people (year 2009). 95% of the area is used for agriculture (from which 90% is grassland, mainly for dairy cattle). The topography is predominantly flat (elevations between -2 m and 5 m above sea level), soils are either fine textured (marsh soils) or organic (peat). In order to safeguard the region against storm tides, dikes have been constructed for centuries and continuously heightened to reduce the risk of flooding.

The Wesermarsch County is faced with several hydrological challenges. In winter time, water has to be drained from the area to avoid flooding. In order to minimise the energy amount required for pumping, the region is drained during low tide as far as possible. Contrarily, in summer time, the region suffers from a water deficit which needs to be compensated to avoid drying out of marsh water bodies. For this purpose, fresh water from the Weser River is conveyed into the canal system of the Wesermarsch during high tide. Due to the deepening of the Weser River for shipping and the intense drainage of low-lying areas, salinisation of surface and groundwater bodies is an increasing problem. In order to regulate water surplus and deficits, a traditional water management system has been developed in the last centuries. A dense network of ditches, channels, barriers, sluices and pumping stations has been established to regulate ground- and surface water levels in the region.

2.2 Participation

Since adaptation planning on regional scale must integrate local people, an integrative and participatory bottom-up process was organised to develop and agree upon regional adaptation options for the Wesermarsch. Stakeholders from regional and local organizations were invited to take part in this process. A regional stakeholder forum was established consisting of water managers, farmers, urban and regional planners, civil servants from different administrative levels, nature conservationists and scientists. They identified water management being the common focus issue. The regional forum aimed at the development of an inventory of recent water related problems, possible solutions and the identification of actors to be further integrated in this process. The stakeholders agreed upon a time horizon of adaptation planning for the year 2050. Expert interviews were carried out individually with all stakeholders in order to ensure the consideration of their institutional and personal point of views on recent and future problems, solutions and visions without being confronted to other stakeholders with different interests. The current knowledge on regional climate change and its implications on regional hydrological processes were presented to the regional forum to provide basic information for this collaborative planning process. All members of the regional forum were invited to contribute to a joint ''Wesermarsch vision 2050''.

2.3 Climate change projections

In order to assess a possible future climate change, regional climate projections of the WETTREG model (Weather Type Based Regional Climate Model; scenarios A1B, B1, A2) were used. The model generates station based time series. WETTREG is a stochastic downscaling approach determining the frequency of specific weather types from global climate models (e.g., ECHAM) to simulate station specific weather time series.

The variations among the scenarios were relatively small compared to the differences between current conditions (=base line) and the three available scenarios. Accordingly, the results of the A1B scenario were selected as input. The A1B scenario is a rather pessimistic one and describes relatively well the development of the change in global temperature since the year 2000. The investigation of time series for four climate stations around the Wesermarsch and the nine rain gauges located in the Wesermarsch revealed consistent climate trends. For the year 2050, WETTREG projected an increase in temperature of ~1 °C and an increase in winter precipitation (+25% from December to February) while summer precipitation was expected to decrease by 15% (from June to August). Similarly, average wind speed was expected to increase in winter and decrease in summer while sunshine duration was expected to increase in summer (Spekat et al., 2007).

2.4 Simulation of hydrological change

Based on the climate projections, hydrological change can be projected by applying a hydrological model. Physically based models are expected to be suited best to reproduce future hydrological conditions. The 1-D physically based model SIMULAT (Bormann, 2008) was applied to the available climate scenarios from the WETTREG model.

3 Results

3.1 Projected hydrological change

Model simulations resulted in increasing runoff rates in winter and an increasing water deficit during summer months (Bormann et al., 2012). Changes in the simulated water balance can be interpreted as changes in water volumes to be additionally drained (winter) or watered (summer), respectively. While in winter runoff generation could be expected to increase by 10 mm per month until year 2050 (scenario A1B), water deficit during summer months might increase by approximately 10 mm per month (scenario A1B). The differences among the three investigated climate scenarios were smaller than the differences between baseline and scenarios

3.2 Participation process

The inventory of recent water management related problems revealed that already today the regional water management system works at its limit. Information on (possible) hydrological change was presented to the stakeholder forum. It was used to (1) raise awareness that the amounts of water to be drained and watered might probably change in the coming decades and to (2) be able to estimate additional volumes of water to be managed by a revised water management system.

In order to consider the different sector specific views on the future, all members of the regional forum were invited to contribute to the joint ‘‘Wesermarsch vision 2050’’. During one workshop all participants were asked to describe their personal ideas on a future development of the Wesermarsch until year 2050. They expressed their interest to achieve continuity with respect to landscape, land use (agriculture), coastal protection and working conditions. Together with the information on the expected regional climate change as well as its likely effect on the hydrological cycle, the landscape vision represented the main boundary condition for the adaptation planning process.

Two focus groups developed and discussed different adaptation options for future water management, focusing on the needs of rural and urban areas. In both cases, the focus groups favoured to compose an adaptation portfolio, consisting of a set of parallel, possible adaptation measures, instead of developing a comprehensive adaptation strategy. Most of the recommended adaptation measures were based on technical solutions (e.g., dike enforcement, extension of the canal system, modernising pumps, building barriers). The proposed adaptation options, however, complied with the currently applied water management statutes of the water boards.

4 Information related issues

Data from regional climate projections and hydrological simulations in combination with participatory planning action enable to answer to four questions being crucial with respect to future good practice in adaptive water management.

Which information is needed for adaptive water management related decision making in coastal regions?

Adaptive water management in terms of climate adaptation requires detailed regional scale information on climate change and its hydrological implications. However, such information is not necessarily available for every region. In addition, specific knowledge on recent regional challenges and problems is urgently needed in order to be able to assess the impact of changing boundary conditions on the existing water management system.

Which information from hydrologists is suitable for decision makers in a climate adaptation process focussing water management needs?

Adaptation to climate change in requires attention and action by people who have not explicitly considered climate (change) in their past decisions (Füssel, 2007). Therefore, regional projections on climate and hydrology should be translated into self-explanatory information such as changes in water balance (volumes, water levels) or sea level rise.

How should we deal with the uncertainty in the climate projections?

Dealing with uncertainty implies to synchronise the necessity to provide a band width of possible futures due to its unknown character and the tendency of stakeholders to stick to one scenario (Veraart et al., 2010), to be interpreted as a “best guess”. In our case, this problem was partly solved by the selection of a distinct time horizon (year 2050) resulting in a similar signal of all scenarios. This decision excluded considering the uncertainty as an excuse for not taking (innovative) action. However, stakeholders expected the scientists to provide fixed “numbers” describing the regional climate change and its impacts.

How does selective use of available information influence the characteristics of suggested adaptation options?

The stakeholders used the available information according to the regional water managers’ attitude to protect against design events, to implement directives, and to act according to the statutes of the water boards. Accordingly, stakeholders selectively perceived and used information which was consistent with traditional thinking (e.g., in terms of the landscape vision 2050) and opted for traditional water management solutions.

5 Conclusion

Based on the results of the "Climate Proof Areas" project we conclude that a successful climate change adaptation requires a participatory bottom-up process in order to raise awareness and acceptance. The essential knowledge on regional climate change must be linked to specific knowledge on resp. of the region and its actors. Knowledge on predictive uncertainty should be processed according to stakeholders' way of thinking. The choice of an (adequate) time horizon thereby affects the degree of flexibility in the proposed solutions. We observed that available information is used selectively according to the stakeholders' attitude. Therefore, stakeholders have to share their knowledge and to come to a mutual understanding which can be realised by social learning in a regional forum, as part of collaborative planning process. It became obvious that successful participation requires confidence among all participants. Hence time matters, participation should be part of the adaptation from an early stage in the adaptation process onwards.

6 References

Bormann, H., 2008. Sensitivity of a regionally applied soil vegetation atmosphere scheme to input data resolution and data classification. J. Hydrol. 351, 154–169.

Bormann, H. et al., 2012. Adaptation of water management to regional climate change in a coastal region – Hydrological change vs. community perception and strategies. Jounal of Hydrology, 454-455, 64-75.

Füssel, H.M., 2007. Adaptation planning for climate change: concepts, assessment approaches, and key lessons. Sustain. Sci. 2, 265–275.

Spekat, A., et al., 2007. Neuentwicklung von regional hoch aufgelösten Wetterlagen für Deutschland und Bereitstellung regionaler Klimaszenarios auf der Basis von globalen Klimasimulationen mit dem Regionalisierungsmodell WETTREG auf der Basis von globalen Klimasimulationen mit ECHAM5/MPI-OM T63L31 2010 bis 2100 für die SRESSzenarios B1, A1B und A2. Forschungsprojekt im Auftrag des Umweltbundesamtes, FuE-Vorhaben, Förderkennzeichen 204 (41), 138.

Veraart, J.A., et al., 2010. Climate change impacts on water management and adaptation strategies in The Netherlands: stakeholder and scientific expert judgements. J. Environ. Plann. Policy Manage. 12 (2), 179–200.