Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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Time to Adapt – Climate Change and the European Water Dimension
Discussion Paper: Water Resources Management

Introduction

Water management includes a broad range of activities. In these papers a differentiation is made between "**water resources management**", which denotes overarching management at river basin or coastal zone level, and "**water supply and sanitation services**" (WSS), which relates to the activities of the water industry. Although both aspects are closely linked, they will be affected in different ways by climate change, and are therefore dealt with in two separate discussion papers. The present paper addresses the issue of water resources management; the papers on WSS and on other sectors are available at www.climate-water-adaptation-berlin2007.org.

Integrated water resources management (IWRM) as defined by the Global Water Partnership is "a process which promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems." It seeks to balance human and environmental needs and to co-ordinate different users' interests.

Climate change will affect the management of water resources in many ways, and wide-ranging impacts on socio-economic development might be the result. Climate change will not only impact on the supply of water resources, but also on the use of and demand for water by different sectors and stakeholders. Integrated management approaches are thus a key prerequisite for developing adaptation strategies that take all relevant sectors and stakeholders and the complex relationships between them into account.

Climate-driven changes in water resources and impacts on water resources management

Although the impacts of climate change on water resources vary strongly between European regions, three main challenges to the management of water resources can be identified: an increase in the risk of floods along coastal zones and in river beds, a decrease in the availability of water, and a deterioration of water quality.

As a consequence of rising sea level and changing rainfall and snowmelt patterns, flood risk - including storm surges - is expected to increase. Ensuring efficient flood protection and preventing loss of lives and damage to assets in flood prone areas along rivers and coasts may thus become an even greater challenge due to climate change. Higher temperatures in winter mean that less precipitation will be falling as snow, and that snowmelt will be occurring earlier, thus changing the seasonal timing of river discharge and groundwater recharge. Combined with decreases in summer precipitation, this could increase the risk of droughts. However, due to the projected increase in the intensity of individual precipitation events, the risk of summer floods may increase at the same time.

Climate change effects, in combination with unsustainable water resources management (e.g. over-consumption and pollution) in water scarcity situations, could result in severe impacts on nature and society. Therefore, drought management in Europe will have to respond to additional challenges under a changing climate (European Commission, 2006a).

However, climate change will not just affect water quantity. Excess water or low water

levels can also have a negative impact on water quality. If the trend to an increase in the mean precipitation amount per wet day in western and northern Europe continues, this could lead to more frequent capacity overloads of urban sewer systems. Higher runoff will additionally increase pollution from diffuse sources and sedimentation, thus deteriorating water quality further. Reduced water levels, on the other hand, mean that pollutants will become less diluted. In combination with increased water temperatures and reduced dissolved oxygen levels, this could seriously affect the ecological balance of freshwater systems.

Overview on water resources and their use

The total renewable **freshwater resource** in Europe is around 3500 km^3 per year. These water resources are unevenly distributed between regions and river basins in Europe. There are areas where water is abundant, while others are already facing water stress under present climatic conditions. Today, some 20 countries, mainly in central and northern Europe (50% of Europe's population), can be considered as non-water-stressed, 9 are considered as having low water stress (32% of population; including Romania, Belgium, Denmark, Greece, Turkey, and Portugal), and four countries (18% of population; Cyprus, Malta, Italy, and Spain) are considered water-stressed (EEA 2003).

Water abstraction in Europe amounts to about 353 km^3 water per year, i.e. 10% of the total freshwater resources. On average, 33% of water abstracted is used for agriculture (mainly irrigation), 16% for urban use, 11% for industry (excluding cooling), and 40% for energy production. The shares vary strongly between countries and regions. In the Mediterranean region, the share of water abstracted for irrigation is particularly high, while in the Western European Countries, the largest percentage of abstracted water is used for cooling in energy production (EEA 2003).

Floods and droughts are a constant concern in water management. Between 1998 and 2002, Europe suffered about 100 damaging **floods**, and around 1.5% of the European population was affected (EEA 2005a). During **drought periods**, the fair allocation of water and the sustainable management of the resource represents a great challenge.

Options for adaptation

Human activities are strongly dependent on the availability of water resources in sufficient quantity and adequate quality, while at the same time many of these activities can adversely affect the condition of the aquatic environment. Therefore, adaptation strategies that place a focus on the protection of water resources will improve the adaptive capacity of all sectors and activities that depend on water. On the other hand, an integrated approach to adaptation in water resources management requires contributions by other sectors, and the co-ordination and integration of sectoral activities.

All adaptation strategies need to be based on sound risk assessments. Both existing projections of future changes and analyses of past developments should be considered in order to identify vulnerabilities and uncertainty ranges and to build robust adaptation strategies.

Climate change impacts, in particular decreases in water availability in certain regions and seasons, are likely to lead to conflicts of interests among the users. For example, if water is scarce, water use for irrigation might conflict with minimum flow regimes needed for cooling water. Adaptation may therefore require first the prioritisation of uses and then the selection of sufficient and appropriate ways of implementation. Choices may have to be made concerning the allocation of water resources, and criteria and indicators need to be developed on the basis of which such choices can be made. Decisions should be transparent and comprehensible to the affected sectors and the general public, in order to create acceptance among them.

Adaptation strategies should also consider the costs and the benefits of each measure and of the combinations of measures. These costs and benefits should be discussed among the different users and stakeholders. The following provides a list of several adaptation measures that are available.

Technically-oriented measures

Technical adaptation can be seen as the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impacts of climate change (Levina and Tirpak, 2006). Such measures include flood protection measures (e.g. in case of more frequent or intense flooding, defence structures may be

upgraded), supply and demand measures,[1] water saving techniques (e.g. rainwater collection and greywater recycling), water storage measures, etc. In areas facing water scarcity, measures aiming to close the local water cycle and to encourage more efficient use of the available water should be developed and applied where possible.

However, before undertaking major investments in infrastructure, all available options for adapting the operation of existing structures to changed targets and boundary conditions should be exploited. Changes in management may often provide more flexible solutions and maintain more possibilities to react to further unforeseen changes in the future. In order to identify the need for alterations of management the performance of existing systems has to be analysed regularly.

Land-use related measures

There is a strong feedback link between changes in land use and water resources management. Land management has an influence on the ability of the soil to hold back precipitation or flood water: the sealing of large areas, for instance in urban centres, increases the risk of flash floods, while sustainably managed soils in agriculture or forestry may be able to store large quantities of water and thus act as a buffer during intense precipitation events.

Land use therefore plays an important role with respect to flood risk management. In some cases, holding back flood waters through technical measures may not be possible or may be too costly in the long term, and alternative strategies may be employed. In flood-prone areas along rivers where damage to infrastructure, buildings and property cannot be prevented at reasonable cost, it may be necessary or desirable to restrict building development, or even to consider resettlement to areas that are less at risk. Similarly, countries may prefer managed retreat along coastlines to building new dykes, or try to manage water levels and "live with water" instead of holding it back.

Economic measures

Economic instruments might play an important role in adaptation strategies. Firstly, economic incentives, such as water pricing policies and water trading schemes, can be used to encourage changes in consumer behaviour that lead to a more sustainable and efficient use of water and may help to reduce overall water consumption. Secondly, economic instruments can help to recover the costs of adaptation measures. They might be applied across different sectors to account for the costs of additional water use for instance by the agriculture, electricity or tourism sector.

Economic instruments might also include **payments for ecosystem services** (PES). Water-related ecosystem services can be provided through land-use related measures, for instance forestation, conservation agriculture and extensification of agricultural land use, flood plain restoration, the conversion or restoration of natural land cover, or wetlands restoration. Services delivered by such measures include flood prevention, control and mitigation; regulating runoff and water supply; improving the quality of surface waters and groundwater; withholding sediments, reducing erosion, stabilising river banks and shorelines and lowering the potential of landslides; improving water infiltration and supporting water storage in the soil; and facilitating groundwater recharge.

Payment schemes may contribute to adequately valuing these ecosystem services and to encouraging the protection of such ecosystems and their capacity to provide water-related services. Guidance for establishing PES in water management was published by the United Nations Economic Commission for Europe in 2006 (UNECE 2006).

Information measures

Information measures in combination with risk mapping and/or improved warning and preparedness systems are crucial to reduce vulnerability to climate change driven effects (e.g. flood risks). In addition, such information measures can create a higher awareness and acceptance among the public and stakeholders on the effects of climate change and the need to adapt to climate change (e.g. water saving).

In the case of both floods and droughts, risk mapping and zoning as well as awareness-raising among stakeholders are essential to make informed decisions about prevention and mitigation measures. Insurers may be a natural partner for policy-makers in identifying and quantifying risk, communicating risk, and developing innovative risk management proposals (CEA 2006). Insurance schemes

[1] See discussion paper on water supply and sanitation.

and financial instruments may be adapted to provide for a more equitable sharing of risk.

Regulatory measures

Regulatory measures focus on the legal and institutional framework organising water resource protection and management and can be used to foster technical, economic or information measures. Further, they can be used to govern the development of other areas influencing water resources management, e.g. nature conservation and biodiversity.

Limits for adaptation

There is no doubt that an integrated concept can only be successful if all related and affected sectors are willing to contribute. In several cases interests differ among the various sectors (e.g. creation of wetlands for flood mitigation versus agricultural production), and adaptation constraints in water resources management might be limited by single-sector interests and regional conditions. However, although individual adaptation measures may conflict with single sector interests, it is in the interests of all stakeholders alike to ensure successful adaptation and preservation of precious water resources. Failure to adapt may result in economic loss to all sectors.

Appropriate strategies have to be developed to resolve conflicts between different interests, as the extent to which the conflicts can be solved will set the limits for adaptation.

Further, even if all adaptation measures are applied, the complete adaptation of water resources management to climate change is not possible due to several reasons. For instance land might be lost due to sea level rise and limitations in dyking. This limitation has to be considered, as it will increase the adaptation needs in other sectors.

Options to implement adaptation measures under the existing EU policy framework

EU Water Framework Directive

The EU Water Framework Directive (WFD)[2] obliges Member States to work towards achieving "good status" of all European waters by 2015. River basins are required to set up management plans to tackle all pressures hampering the achievement of this aim. Even if climate change is not explicitly mentioned as a pressure, the Directive provides a framework to integrate climate change adaptation measures in river basin management planning. Due to the six year planning cycle in which River Basin Management Plans (RBMP) have to be drafted and reviewed, each river basin can set short and long-term targets and related measures to be achieved in a stepwise fashion.

Article 9 of the WFD introduces water pricing as a central element. It requires the design of policies having regard to social, environmental, and economic effects, and to the geographic and climatic conditions of the region or regions affected, to address problems of water quality and quantity. This approach allows to recover costs resulting from the adaptation to climate change with some flexibility.

Including public participation and stakeholder involvement in the WFD (Article 14) allows for the balancing of various groups' interests for taking decisions on the most appropriate measures to achieve the objectives in the river basin management plan. The economic analysis requirement is intended to provide a basis for this, but it is essential that the process be open to the scrutiny of those who will be affected. This approach allows for informing on and raising awareness for effects of climate change. It further offers the opportunity to involve stakeholders and the interested public in the development of appropriate and commonly agreed adaptation measures.

In 2003, a water scarcity initiative was established under the WFD common implementation process. A first interim report on water scarcity and drought was adopted by the Water Directors in November 2006 (European Commission, 2006a). The report shows that the impacts of climate change on frequency and severity of droughts is of concern among Member States, and that the WFD is seen as an important instrument for addressing drought and water scarcity management, through the implementation of water management plans and associated programmes of measures. It also outlines how other EU and national funding and policy instruments might be used for mitigating water scarcity and drought.

[2] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for community action in the field of water policy. Official Journal L 327, p 1-72.

EU Flood Risk Management Directive

The issue of flooding as a major European concern is also addressed in the new proposal for a Directive on flood risk management.[3] This Directive could represent a powerful tool for addressing increased flood risk from climate change in Europe. The flood risk management plans required by each MS should focus particularly on prevention, protection and preparedness measures. Article 4 of the proposed Directive stipulates that projected climate change should be taken into account in the assessment of future flood risk.

The Flood Risk Management Directive, together with the WFD, would thus provide an instrument to take full account of climate change effects on flood risk, and, on the basis of the risk assessment and mapping, would encourage water managers to respond to challenges by means of an integrated management approach. The cyclic review process within both Directives allows for a long-term strategic adaptation process that is, however, flexible enough to also react to shorter term changes.

EU Marine Strategy

The European Commission is currently developing a European Maritime Policy. A Green Paper (European Commission, 2006b) was published in June 2006. The environmental pillar of this policy is represented by the Marine Strategy, which was launched in 2005 and consists of the Thematic Strategy on the Protection and Conservation of the Marine Environment, and of a Directive Proposal.[4]

The aim of the Marine Strategy is to achieve good environmental status of the EU's marine waters by 2021, and to protect the resource base upon which marine-related economic and social activities depend. The policy process is similar to that of the WFD. The Marine Strategy identifies climate change as one of the main pressures on the marine environment. The protection of the marine environment should be flexible enough to allow for an adaptation to changing pressures and impacts, which may for instance be caused by climate change. While not specifying measures to address adaptation to climate change explicitly, the Marine Strategy provides a broad framework that creates favourable opportunities for effective adaptation policies.

The Commission Green Paper on Maritime Policy makes clear statements as to the challenges that will have to be addressed. It emphasises that adaptation strategies, including the organisation of sea defence, will be required to manage risks for coastal and offshore infrastructure resulting from sea level rise, increased flooding and storm surges. It also mentions that Mediterranean coastal zones are likely to be affected by changing precipitation patterns, and that an increased need for desalinisation may result from this.

Conclusions and key issues

Adapting water resources management to climate change impacts requires change in management practices, land use and technology developments, so as to ensure sustainable water management. It requires the further protection of current water resources as well as the revitalisation of declined ecosystems.

The WFD and the Marine Strategy provide a valuable framework for adaptation. Both call for an integrated and strategic planning approach that provides the unique chance to include adaptation measures in water resources management, both in the short and in the long term. The proposed flood risk management directive could be a central element for raising awareness about the risks and vulnerability resulting from flooding.

Generally, adaptation of the management of European water resources should be based on the approaches of integrated water resources management (IWRM) and integrated coastal zone management (ICZM). However, the possibilities of adaptation by water resources management are limited. Therefore, successful adaptation strategies have to include additional measures in water-related sectors, in particular those that are important as users and consumers of water resources, such as agriculture, electricity, navigation and tourism.[5] The contributions from the different sectors should be co-ordinated in overarching and integrative strategies in order to avoid conflicts and create synergies. Water pricing and

[3] Proposal for a Directive of the European Parliament and of the Council on the on the assessment and management of floods. COM(2006) 15 final, Brussels, 18.01.2006.

[4] Proposal for a Directive of the European Parliament and of the Council establishing a Framework for Community Action in the field of Marine Environmental Policy (Marine Strategy Directive), COM(2005) 505 final, Brussels, 24.10.2005.

[5] See discussion papers for these sectors.

economic instruments as required by the WFD could be widely applied to recover the costs, including ecological costs, of coping with and adapting to climate change impacts in different sectors, and to ensure that these costs are shared fairly between users, providers and polluters.

In this context, an improved co-operation and participation of relevant stakeholders is necessary to deliver commonly acceptable and cost-effective solutions.

At policy level, potential conflicts between sector policies and adaptation needs should be identified, and efforts should be made to make different policies consistent with each other and compatible with adaptation.

Key questions[6]

1. **Impacts and vulnerability**: Which changes in water resources driven by climate change will pose the greatest challenges to water resources management in European river basins and along European coasts?
2. **Adaptation options**: Which adaptation options are available? What examples for successful implementation of adaptation measures exist across the EU? How should decisions be made on the selection of measures to be implemented? How can the long-term impacts of climate change be included in today's planning?
3. **Policy action**: What could be gained from co-ordinating and implementing adaptation at EU level? How could EU policies, in particular the WFD, support adaptation? How can the EU ensure that climate change issues are being incorporated into existing and future policies and their implementation?
4. **Integration of sectors**: How can effective integration of all relevant actors and the successful co-ordination of sectoral adaptation measures be ensured? How can conflicts of interest be resolved, and which criteria should be used to make decisions on the allocation of scarce water resources?
5. **Research needs**: Which knowledge gaps exist with regard to impacts, vulnerability and adaptation options?

[6] For further issues for discussion, please see also the discussion paper on water supply and sanitation.

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