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**WHITE PAPER**

**Adapting to climate change: Towards a European framework for action**

***Climate Change and Water, Coasts and Marine Issues***

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**COMMISSION STAFF WORKING DOCUMENT**  
**Climate Change and Water, Coasts and Marine Issues**

## **1. Introduction**

Over the coming decades, climate change will have a significant impact on the quantity and quality of water resources both within Europe and globally. Water is essential to life and is central to society's welfare and to sustainable economic growth. Plants, animals, natural and managed ecosystems, and human settlements are sensitive to variations in the storage, fluxes, and quality of water and will be affected by climate change.

Climate change is projected to lead to major changes in water availability across Europe with increasing water scarcity mainly in southern Europe and increasing risk of floods throughout most of the continent. At least 11% of the European population and 17% of its territory have been affected by water scarcity to date. Recent trends show a significant increase in water scarcity across Europe.

Since 1998 floods in Europe have caused some 700 deaths, the displacement of about half a million people and at least €25 billion in insured economic losses. Climate change is expected to increase the amount of EU territory exposed to water scarcity as it aggravates existing pressures on water resources from, inter alia, pollution, overuse and population increase.

The higher water temperatures and extreme weather events such as flooding and droughts will also impact upon water quality and exacerbate existing problems of pollution.

These anticipated changes to water quantity and quality will have a wide impact, and will significantly affect key socio-economic activities across a range of sectors. Biodiversity and ecosystems in large parts of Europe will also be affected.

Successful adaptation to the impacts of climate change on water will therefore depend not just on effective national and European water regulations, but also on the extent to which water management can be integrated into other sectoral policies such as agriculture and energy policies.

The oceans and seas, and Europe's coastline will also be strongly affected by climate change. Such impacts will in turn intensify impacts on water. Moreover, the ocean is responsible for our hydrologic cycles and also plays a significant role in regulating global and regional climate and moderating weather systems around the world. This is particularly the case for the climate in Europe which has one of the longest coastlines in the world and is thus strongly influenced by the oceans and seas.

Changes in the climate will mean sea level rise, increases in coastal flooding, storm intensity, and potentially changing current patterns, which in turn could further contribute to changes in climate. Thus, sea warming may result in increased stratification and changed circulation patterns of ocean currents, decrease the amount of sea ice, increase coral bleaching and mortality, and may result in pole-ward migrations of species and increased algal blooms. Ocean acidification will pose adverse effects on calcifying species such as corals, echinoderms and crustaceans.

Since the sea knows no frontiers, adaptation to climate impacts will require co-ordination on transboundary issues and a comprehensive and integrated approach to coastal and marine areas in the implementation of national and European sectoral policies having an impact in these areas.

This paper expands on the water and marine issues highlighted in the White Paper, summarising the main impacts of climate change on water and related policies and identifying the measures in place to facilitate adaptation.

## **2. Impact**

The evidence base on the impact of climate change on water is increasing. The IPCC recently published a technical report relating to climate change and water<sup>1</sup> which pointed to the abundant evidence from observational records and climate projections that freshwater resources are vulnerable and have the potential to be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems.

As well as physical impacts such as the loss of water-dependent habitats, there will also be significant economic impacts particularly in water-dependent economic sectors and social impacts resulting from the loss of provision.

In coastal and marine areas, further to physical impacts such as sea-level rise, coastal flooding, increase in severe weather, acidification, warmer water and declines in wetland areas, changes in currents and ice cover and salt water intrusion into agricultural soils, affecting marine and coastal ecosystems, including abundance and distribution patterns of species from plankton to predators, there are also considerable negative economic impacts. This is the case in fisheries, aquaculture, coastal tourism and agriculture, harbours or in key coastal and marine infrastructures, such as ports and in shipping, with a potential overall growth impediment to the economy in coastal regions and islands, due to the costs of insurance and unwillingness of investors to place assets in affected areas.

Key impacts on water and coastal and marine areas include:

- The natural environment (i.e. ecosystems, biodiversity and soil). Projected changes in precipitation patterns will affect soil formation and functions. Soil as part of the soil-water-plant system is vital for land and water management. Soil organic matter drives the majority of soil functions. Any reduction can lead to a decrease in fertility and biodiversity, a loss of soil structure, reduced water retention capacity and increased risk of erosion.
- Marine ecosystems and biodiversity, already under pressure from pollution and overfishing, will be affected by warmer temperatures and acidification, with changes in species reproduction, feeding and with changes in distributions of marine organisms, more frequent algae blooms and shifts in plankton communities. Relevant marine and coastal ecosystems services may also be lost with coastal wetlands disappearing.
- Agriculture and Forestry - agriculture is highly sensitive to climate variability and weather extremes, changes in rainfall can affect soil erosion rates and soil moisture, both of which

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<sup>1</sup> <http://www.ipcc.ch/ipccreports/tp-climate-change-water.htm>

are important for crop yields. Forests have an important role in protecting water and soil resources.

- Fisheries and aquaculture – sea-level rise, glacier melting, ocean acidification and changes in precipitation, groundwater and river flows will affect wetlands, rivers, lakes and estuaries significantly, as well as coastal and offshore waters and a range of sensitive marine habitats such as coral reefs. Such changes will require adaptive measures in order to exploit opportunities and to minimise negative impacts on fisheries and aquaculture systems.
- Health - the impact of climate change on water quality and quantity is also expected to increase the risk of contamination of public water supplies. Both extreme rainfall and droughts can increase the total microbial loads in freshwater and have implications for disease outbreaks and water-quality monitoring.
- Energy - the production of electricity is strongly dependent on water, for cooling in power plants, hydropower or the production of biomass. Changes in water resources will have impacts on many types of electricity production, and may become a further threat to the reliability of electricity supply in the future.
- Infrastructure and building - intense precipitation events, increased flood risk, and sea level rise may increase the risk of infrastructure damage. The greatest impact on transportation systems will be flooding of roads, railways and transit systems. Critical coastal infrastructure, communities situated close to the coast as well as sea ports will be exposed to coastal flooding, and storms may provoke impacts on maritime transport and related infrastructure.
- Tourism - problems of water supply are becoming increasingly common in Europe's tourist areas. The island of Cyprus for example has suffered from a chronic shortage of water for a number of years where rising demand and dwindling rainfall has put pressure on limited water resources. Coastal tourism will also be affected as a consequence of accelerated coastal erosion and changes in the marine environment and marine water quality, with less fish and more frequent jelly fish and algae blooms.
- Water supply and sanitation services - climate change affects the function and operation of existing water infrastructure, including hydropower, structural flood defences, drainage and irrigation systems, as well as water management practices.

Although there is clear evidence that climate change will have a significant impact on water quantity and quality, further research is needed in order to ensure that proper decisions on adaptation can be taken. In particular, the IPCC report identified the need to improve understanding and modelling of climate changes related to the hydrological cycle and of the water-related impacts of climate change (especially with respect to water quality, aquatic ecosystems and groundwater) including their socio-economic dimensions as well as the need to develop better tools to facilitate integrated appraisals of adaptation and mitigation options across multiple water-dependent sectors. Understanding how activities that depend on climate (energy consumption, agriculture production) will change in the future requires a better understanding of ocean dynamics and of their role in accentuating or mitigating climate change.

### 3. Measures to facilitate adaptation

Adapting to these challenges created or aggravated by climate change will require an integrated approach to both water management and to the management of marine and coastal zones, including measures to mainstream adaptation into sectoral policies.

A number of existing EU policies can facilitate adaptation efforts and optimum use should be made of this legislation. The short-term adaptation measures in relation to water should therefore focus on ensuring that adaptation is fully integrated into the implementation of existing EU water legislation and policies, in particular, the development of river basin management plans under the Water Framework Directive as well as assessing the need for further measures to enhance the efficiency of water use and exploring the potential for policies and measures to boost ecosystem storage capacity for water in Europe.

Similarly for coastal and marine areas, adaptation should be integrated into key policies and legislation, including the EU Integrated Maritime Policy and its environmental pillar: the Marine Strategy Framework Directive. The Recommendation concerning Integrated Coastal Zone Management in Europe and the newly reformed Common Fisheries Policy will also have to factor in and address adaptation as a priority.

The uncertain nature of the impact of climate change on water requires a comprehensive and continuing consideration of adaptation options including both demand and supply-side measures as well as man-made (or engineered) solutions, behavioural changes and solutions provided by the natural environment.

The cross-regional and trans-border nature of river basins can have a serious cross-border impact on upstream and downstream regions. It is thus indispensable that Member States, as well as regional and local authorities cooperate on water management and ensuring sustainable and fair use of water resources. Indeed the specific nature of the issue requires coordinated action across all levels (EU, Member State, regional and local).

Particular attention should be paid to the role of green infrastructure. Healthy ecosystems preserve biodiversity and provide many valuable services such as the storage of water which in turn increase drought resilience. Green Infrastructure can play a crucial role in adaptation: protected watersheds decrease the need for man-made water treatment facilities; reforested slopes help control flooding events and landslides; protected waterways can prevent soil erosion, improve water quality, and provide wildlife habitat corridors.

#### *3.1 Integration of adaptation into the implementation of water legislation*

The **Water Framework Directive** (WFD) came into force in December 2000 and establishes a new legal framework for the protection, improvement and sustainable use of all water in Europe. It applies to rivers, canals, lakes, lochs, groundwater, wetlands, estuaries and coastal waters and requires governments to take a holistic approach to their management.

The WFD has the following key aims:

- to expand the scope of water protection to all waters, surface waters and groundwater and providing an overall framework for water management;
- to achieve "good status" for all waters by 2015;

- to provide for an integrated approach to water management based on river basins and combining emission limit values and quality standards;
- to promote sustainable water use based on a long-term protection of available water resources; and
- to provide for greater public involvement in key decisions on water management.

The best model for a single system of water management is management by river basin - the natural geographical and hydrological unit - instead of according to administrative or political boundaries. The Water Framework Directive requires a river basin management plan to be established for each river basin district (including those with cross national frontiers). The first river basin management plans are required by 22 December 2009 and must be updated every six years. This flexible management framework is well-suited to managing adaptation to the impacts of climate change as it will enable new information on the impacts of climate change and the measures necessary to adjust to be incorporated into the revised river basin management plans. The requirement under the Water Framework Directive for Member States to take a cross-sectoral approach to water management will also facilitate the necessary cross-sectoral action on adaptation and provide a framework for consideration of the relationship between the use and management of the natural environment (e.g. land) and the quality and availability of water resources. Further, the achievement of "good ecological status" for all waters as provided in the Water Framework Directive will contribute strongly to improving and maintaining biodiversity in the aquatic environment, as well as those ecosystems which rely on the aquatic environment. Work is on-going at a European level to develop by the end 2009 comprehensive guidelines and a set of tools for incorporating climate change into future river basin management plans.

The Water Framework Directive is complemented by the Floods Directive and the policy on water scarcity and droughts. These provide a more specific framework for adapting to the key water-related impacts of climate change.

The **Floods Directive** establishes a framework for the assessment and management of flood risks aimed at reducing the adverse consequences for human health, the environment, cultural heritage and economic activity associated with floods in Europe. The Directive requires Member States to assess if all water courses and coast lines are at risk from flooding, to map the flood hazards and identify assets and humans at risk in these areas and to take adequate and coordinated measures to reduce the flood risk. In line with the integrated river basin approach taken under the Water Framework Directive, the Directive also requires Member States to coordinate their flood risk management practices in shared river basins, including with third countries, and to avoid taking measures that would increase the flood risk in neighbouring countries. Co-ordination with the implementation of the WFD is required under Article 9 of the Floods Directive from the second River Basin Management Plan. The Floods Directive therefore provides a comprehensive mechanism for assessing and monitoring increased risks of flooding due to climate change and for developing appropriate adaptation approaches. The coordinated approach with the river basin management plans will ensure an overall effective approach and help avoid maladaptation measures.

Alongside an increased risk of flooding, climate change will make **water scarcity** and droughts an increasingly frequent phenomenon. In July 2007 the Commission adopted a Communication on addressing the challenge of water scarcity and droughts in the European Union setting out a number of policy options for addressing the challenge of water scarcity.

The measures identified in the Communication represent an important tool box for responding to the increased likelihood of such events due to climate change. In particular, the Communication identified the importance of moving towards a water-efficient and water-saving economy and the important roles played by water pricing and land-use planning in incentivising efficient water use.

The Commission reviewed progress towards addressing water scarcity and droughts in December 2008<sup>2</sup> and will conduct an annual European assessment of water scarcity and droughts making it possible to monitor changes across Europe and to identify where further action is needed in response to climate change. In addition, a review of the strategy for water scarcity and droughts is planned for 2012.

### ***3.2 Integration of adaptation into existing marine and coastal zone legislation***

Climate change will have a particular impact on the marine environment and coastal zones, with consequent impacts on maritime activities. The EU Integrated Maritime Policy provides a comprehensive framework for addressing maritime activities from a cross-sectoral perspective. This facilitates the integration of adaptation efforts for coastal and marine areas into specific policies. In this context, the Commission acknowledged in its Blue Paper<sup>3</sup> that risk management may impact heavily on the budget and economy of coastal zones in the future and indicated support for adaptation related to maritime activities, the marine environment, coastal zones and islands.

The **Marine Strategy Framework Directive**, the environmental pillar of the Integrated Maritime Policy aims at protecting more effectively the marine environment across Europe. It requires the EU's marine waters to achieve good environmental status by 2020. This will protect the resource base upon which marine-related economic and social activities depend.

The Marine Strategy Framework Directive establishes European Marine Regions on the basis of geographical and environmental criteria. Member States (in cooperation with other Member States and non-EU countries within a marine region) are required to develop strategies for their marine waters containing a detailed assessment of the state of the environment, a definition of "good environmental status" at regional level (wherever possible) and the establishment of clear environmental targets and monitoring programmes. The first elements of marine strategies are due by 2012 and are required to be updated every 6 years.

As with the Water Framework Directive, the Marine Strategy Framework Directive can facilitate adaptation by ensuring that climate change considerations are incorporated into marine strategies and by providing a mechanism for regular updating to take account of new information. The flexible and adaptive approach of the Marine Strategy Framework Directive as well as the reliance on Marine Regions and Sub-Regions as management units should allow for a flexible adaptation to the specific impacts of Climate Change at regional level. The achievement of 'good environmental status' of Europe's marine environment under the Marine Strategy will, as in the case of 'good ecological status' for the Water Framework Directive, prevent a deterioration in the quality of the marine environment as a result of climate change.

Europe's **coastal zones** are of strategic importance to the European Union. They are home to a considerable percentage of European citizens, a major source of food and raw materials, a

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<sup>2</sup> COM(2007) 414, 18.7.2007.

<sup>3</sup> 'An Integrated Maritime Policy for the European Union', COM(2007) 575 final.

vital link for transport and trade, the location of some of our most valuable habitats, and the favoured destination for leisure time. However, due to climate impacts, these zones are facing increasing environmental, economic and social problems. The inter-connection between land and sea makes effective and integrated coastal and maritime management essential. The Commission has highlighted the need for better integrated coastal zone management. In this context, there is a need to follow up on the Roadmap on Maritime Spatial Planning.

The Recommendation concerning Integrated Coastal Zone Management in Europe provides for Member States to take a strategic approach to the management of their coastal zones, based on, inter alia, recognition of the threat to coastal zones posed by climate change and the dangers entailed by the rise in sea level and the increasing frequency and violence of storms. The EU ICZM Recommendation lists eight principles on which coastal zone management should be based. These include integration across sectors and levels of governance, as well as a participatory and knowledge-based approach. Given the cross-border nature of many coastal processes, coordination and cooperation with neighbouring countries and in a regional sea context are also needed.

The Commission's communication of June 2007 evaluates the progress towards integrated coastal zone management in Europe and identifies and promotes measures to remedy the deterioration and to improve the overall situation in Europe's coastal zones. This identified adaptation to climate change as a priority theme for further promotion of ICZM.

A more coherent and integrated approach to coastal planning and management via integrated coastal zone management will assist adaptation efforts. The multi-disciplinary, interactive approach which underpins ICZM provides the flexible and multi-sectoral basis needed for developing effective adaptation measures. To support the implementation of ICZM, opportunities are offered especially through the EU's Cohesion Policy, Fisheries Fund and as part of the EU's Research Framework Programme.

In order to ensure a coordinated and integrated approach to adaptation in coastal and marine areas, taking into account trans-boundary issues, the Commission will develop guidelines on adaptation in coastal and marine areas.