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Climate change adaptation and mitigation strategies already in practice based on the 1st River Basin Management Plans of the EU Member States

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Table of Contents

List of Abbreviations

ASTRA	Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region
BMLFUW	The Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management
CC	climate change
DG	European Commission Directorate General
DRB	Danube River Basin
DRBMP	Danube River Basin Management Plan
EEA	European Environment Agency
EIA	Environmental Impact Assessment
EMAS	EU Eco-Management and Audit Scheme
EPA	Environment Protection Agency
FINDAPT	Assessing the adaptive capacity of the Finnish environment and society under a changing climate
FLOW-MS	Flood and Low Water Mosel / Saar Interreg project
FRMP	Flood risk management plan
GHG	greenhouse gases
GMES	Global Monitoring for Environment and Security
ICPDR	International Commission for the Protection of the Danube River
ICPR	International Commission for the Protection of the Rhine
IKSMS	International Commission for the Protection of the Moselle and Saar
IPCC	Intergovernmental Panel on Climate Change
IRBD	International River Basin District
JRC	Joint Research Centre of European Commission
KNMI	Royal Dutch Meteorological Institute
METSO	Forest Biodiversity Action Programme for Southern Finland
MS	Member states
NIEA	Northern Ireland Environment Agency
ÖWAV	Austrian Water and Waste Management Association
RBD	River basin district
RBMP	River Basin Management Plan
REFRESH	EC FP7 project 'Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems'
SEA	Strategic Environmental Assessment
SEPA	Scottish Environment Protection Agency
SILMU	The Finnish Research Programme on Climate Change
SNIFFER	Scotland & Northern Ireland Forum for Environmental Research
SOER	State of the Environment Report
VAHAVA	Project for Getting Prepared to (combat) Climate Changes in Hungary
WFD	Water Framework Directive
WSDIS	Drought Information System

Executive summary

With the statement that *"...it is unlikely that within the timeframe of the Water Framework Directive (WFD[2]) implementation (i.e. up to 2027), the effects of a climate change signal will be adequately distinguishable from other human pressures and natural variability to the extent that extensive changes in status become necessary."*, the Guidance Document on River Basin Management in a Changing Climate[9] created a balanced, temperate atmosphere around the question how to integrate climate change (CC) in the framework of water management. As a result, the consideration of CC has been introduced to the 1st River Basin Management Plans (RBMP) of Member States in a largely qualitative way, if at all. The decision whether or not to include CC issues to the plan was obviously depending on the availability of information but also on the urgency of the CC related problems involved for each country. As the projected changes in temperature and, especially, precipitation in Central Europe and Baltic countries include still large uncertainties for the coming years, Estonia and Latvia fully excluded CC issues from the RBMPs for 2009-2015 (Table 1). Also Germany where a large part of European CC research is concentrated, discussed the issues very modestly in the 1st RBMP. To overcome the uncertainty issues in water resources availability, Belgium developed, besides the basic scenario, a maximum and a minimum scenario but emphasized their equal probability. The Danube countries concluded that CC signals for the Danube river basin district (RBD) are sufficient to act beyond existing scientific uncertainties. Also in The Netherlands, a country where water management has long traditions and where the protection measures against increasing sea levels belong to national safety issues, the CC is addressed in a holistic way in a number of large scale flood protection plans and has a central position in the National Water Plan 2009-2015.

Most countries included a chapter to the 1st RBMP do describe the observed CC and its impacts to water resources management. Only in some cases (e.g. Bulgaria, Germany, and the Meuse International RBD) the CC information was scattered between several chapters or not explicitly addressed. Within the 1st RBMP UK and Ireland dedicated a separate annex or even a report on CC issues and 'climate checking' of the Programme of Measures. The 'climate checking' was aimed to ensure that the Programmes of Measures are sufficiently adaptive to future climate conditions, based on available knowledge, data and common sense. For the checking, countries had to assess whether the planned measures, especially when these measures have a long lifetime, remain effective under the likely or possible future CCs and favour measures that are robust and flexible to the uncertainty and cater for the range of potential variation related to future climate conditions. Favoured should be sustainable adaptation measures, especially those with cross-sectoral benefits, and which have the least environmental impact, including greenhouse gas emissions.

Table 1. Integration of climate change (CC) issues in the first RBMPs by countries and international RBDs analysed in the report (NE=not explicitly)

Country or International River Basin District	Format of including CC issues	CC observations and projections included	CC impacts discussed	'Climate check' of the Programme of Measures	Specific CC adaptation measures included in the current plan	Adaptation measures for lake (L), river (R) or wetland (W) ecosystems	Division of tasks between 1st, 2nd and 3rd RBM cycle
Austria	Chapter	Yes	Yes	Yes	Yes	No	NE
Belgium	Chapter	Yes	Yes	Yes	Yes	R	NE
Bulgaria	Scattered	NE	NE	NE	Yes	L	NE
Czech R.	Chapter	Yes	Yes	NE	No	R	YES
Estonia	Not incl.	No	No	No	No	No	No
Finland	Chapter	Yes	Yes	Yes	No	L	Yes
Germany	Scattered	NE	NE	No	N	No	Yes
Hungary	Chapter	Yes	Yes	NE	Yes	R W	NE
Ireland	Report	Yes	Yes	Yes	Yes	L R W	NE
Italy	Chapter	Yes	Yes	Yes	Yes	No	NE
Latvia	Not incl.	No	No	No	No	No	No
Luxembourg	Chapter	Yes	Yes	Yes	Yes	No	NE
The Netherlands	Chapter	Yes	Yes	Yes	Yes	No	Yes
UK	Annex	Yes	Yes	Yes	Yes	R W	Yes
Danube	Chapter	No	Yes	No	No	No	Yes
Rhine	Chapter	Yes	Yes	NE	Yes	R L	Yes
Elbe	Chapter	NE	NE	No	No	No	Yes
Meuse	Scattered	No	No	No	No	No	No

Most countries had carried out the 'climate checking' of their measures but the results were reported with a very different level of detail. If, for example, Ireland and Scotland presented the analysis for all measures in full detail in a table format, and England and Wales gave only one example of the screening of ability of actions to perform under future climate, then Bulgaria, Czech Republic and Hungary just mentioned the screening without providing any examples. In Luxembourg the screening of the measures was done in areas of flood risk management, low-water management and drought. In the future, an adaptation strategy to CC will be enlarged also to other areas such as water use in agriculture, energy production, and planning of future land use.

The distinction of specific CC measures from the complex of measures dealing with floods, droughts and water quality protection, is rather arbitrary. In some cases, for instance, when a link between CC and flood frequency is proven, there is a tendency to qualify all flood protection measures as CC measures and the same is valid for drought prevention and water quality protection measures. In the present report (see Annex) the measures are categorized according to the original reports and, hence, some measures which are qualified as CC measures by one country may be not mentioned by other countries which did not consider the linkage to CC strong enough. Some of the measures listed in the Annex of the present report were not directly listed as measures in the management plans, but were picked out from the text as discussing the tackling of climate impact.

Still there exist measures which address directly the CC impact, for example, the Finnish measures that aim at optimising the water level regulation schemes according to the observed and projected changes in seasonal flow patterns. Also measures presented by Austria to increase cleaning efficiency of sewage treatment plants to compensate for the lower dilution capacity in receiving waters as a consequence of low flow, and setting norms for water withdrawals for snowmaking in ski resorts where skiing season is shortened by decreasing amount of snow, are clearly addressing CC.

In the course of the present analysis, special attention was paid to **adaptation measures addressing climate impact on ecosystems**. This topic was rather scarcely presented in nine of the 18 RBMPs analysed (Table 1). As the ecosystem measures have a high profile in the REFRESH Project, all the measures found are given by countries in the following list. As the measures are translated from different languages, the wording does not pretend the full authentity of the original text and for more detail it is suggested to consult the original plans in national languages.

Czech Republic

- Revitalization of minor watercourses and small water areas in municipalities;
- Establishment and rehabilitation of riparian stands;
- Improvement of the retention capacity landscape and reduction of flood occurrence in a nature-friendly manner;
- Rehabilitation of fish ponds;

Belgium

- Maintenance of the integrity of rivers;

Bulgaria

- Maintenance of river beds to ensure the passage of the flood peak;
- Prohibition on empting small dams for fishing purposes;

Finland

- Need to leave more storage capacity for winter in the regulated lakes in southern and central Finland because of increasing winter runoff and more frequent winter floods;
- Need for lower storage capacity in spring when the snowmelt floods will disappear or be reduced;
- Need to fill the lakes in spring because of longer and sometimes also drier summers;

Hungary

- Restoration of river floodplains;
- Restoration of wetlands;

Ireland

- Actions to replace habitats lost through sea level rise or increased flooding;
- Adaptation measures addressing reduction of habitat fragmentation, protection and restoration of floodplains and wetlands at high-status sites and protected areas for water dependent habitats and species;
- Adaptation measures addressing changes to ground and surface water flow regime at high-status sites and protected areas for water dependent habitats and species;
- Adaptation measures addressing changes to erosion and sedimentation pressures at high-status sites and protected areas for water dependent habitats and species;
- Adaptation measures addressing changes to diffuse and point source nutrient loadings at high-status sites and protected areas for water dependent habitats and species;
- Adaptation measures addressing the decrease in assimilative capacity of water bodies receiving pollutant loads from point and non-point sources;
- Measures to maintain compensation flows at reduced available water resources in summer to contribute to fish migration within systems particularly around or across barriers such as weirs;

The Netherlands

- Investigate the impact of dumping sand on the beach or forebanks during sand nourishments on beach ecosystems

United Kingdom

- Increasing the resilience of ecosystems to the impacts of CC. Research such as the ‘Modelling Natural Resource Responses to Climate Change’ (MONARCH) programme, the Marine Biological Association led project ‘Marine Biodiversity and Climate Change’ and the Environment Agency led project ‘Preparing for climate change impacts on freshwater ecosystems’ (PRINCE) are helping to predict how the composition of plant and animal communities in the UK will change.
- Continue controls on importation and releases of invasive non-native species;
- Consider broadening the range of species restricted for importation;
- Develop the ‘landscape ecology approach’ to identify and protect key habitats, open up new habitats and develop and maintain wildlife corridors;
- Reduce habitat fragmentation and protect and restore areas of floodplains and wetlands;
- Map current and future climate spaces and the vulnerability and impacts for priority species and environments;

Rhine IRBD

- Enhance the re-colonization potential of species;
- Improve the connectivity of river systems;
- Creat buffer strips, which reduce nutrient loads of lakes and rivers and also offer shading of water;
- Carry out targeted investigations on the effect of CC on species.

The present report is of relevance to the 7th EU Framework Programme, Theme 6 (Environment including Climate Change) project REFRESH (Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems, Contract No.: 244121), to JRC Thematic Area 3 (Sustainable management of natural resources) foci on CC, to the European Clearing House mechanism on CC, and to the EC Blueprint on Water.

Introduction

In April 2009, the European Commission presented a White Paper[1] which sets out a framework for climate adaptation measures and policies to reduce the EU's vulnerability to the impacts of climate change (CC). The White Paper stresses the need for further measures to enhance water efficiency and to increase resilience to CC. Addressing CC requires two types of response. Firstly, the greenhouse gas (GHG) emissions should be reduced (mitigation action) and secondly adaptation action should be taken to deal with the unavoidable impacts.

CC will cause significant changes in the quality and availability of **water resources**, affecting many sectors. More than 80% of agricultural land is rain-fed and food production also depends on available water resources for irrigation. Limited water availability already poses a problem in many parts of Europe and the situation is likely to deteriorate further due to CC. Europe's high water stress areas are expected to increase from 19% today to 35% by the 2070s.

CC will increasingly drive **ecosystems including marine and freshwater ecosystems** and **biodiversity** loss, affecting individual species and significantly impacting ecosystems and their related services, on which society depends. Ecosystems play a direct role in climate regulation with peat lands, wetlands and the deep sea providing significant storage for carbon. In addition, salt marsh ecosystems and dunes provide protection against storms. Other ecosystem services will also be affected such as the provision of drinking water, food production and building materials and oceans can deteriorate through acidification. Some land use practices and planning decisions (e.g. construction on flood plains), as well as unsustainable use of the sea (e.g. overfishing) have rendered ecosystems and socioeconomic systems more vulnerable to CC and thus less capable of adapting.

The challenge for policy-makers is to understand these CC impacts and to develop and implement policies to ensure an optimal level of adaptation. **Strategies focused on managing and conserving water, land and biological resources to maintain and restore healthy, effectively functioning and CC-resilient ecosystems** are one way to deal with the impact and can also contribute to the prevention of disaster. Due to the regional variability and severity of climate impact most adaptation measures will be taken at national, regional or local level. However these measures can be supported and strengthened by an integrated and coordinated approach at EU level. The EU has a particularly strong role when the impact of CC transcends the boundaries of individual countries (e.g. river and sea basins and bio-geographic regions).

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[1] COM(2009) 147 final, 1.4.2009, 'Adapting to climate change: Towards a European framework for action'

Ecosystem services such as carbon sequestration, flood protection and protection against soil erosion are directly linked to CC and healthy ecosystems are an essential defence against some its most extreme impacts. **Regarding water**, a number of existing EU policies contributes to adaptation efforts. In particular, the **Water Framework Directive**[2] (WFD) establishes a legal framework to protect and restore clean water across Europe by 2015 and to ensure the long-term sustainable use of water. The **River Basin Management Plans** (RBMPs) due in 2009 under the Directive will take into account the impacts of CC and the next generation of plans due in 2015 should be fully climate-proofed. The second follow-up report to the Communication on water scarcity and droughts in the European Union[3] stresses that decreasing availability, declining quality, and growing demand for freshwater are creating significant challenges where CC is expected to exacerbate the situation.

WFD Article 9[4] requires Member States to ensure by 2010 that **water pricing policies** provide adequate incentives for users to use water resources efficiently. However, pricing is only one possible tool to be considered; additional measures are needed to encourage efficient use of water. Examples of the most widespread measures used in the Member States are the application of block tariffs, penalties for excessive consumption and discounts for water savings. In some southern European river basins legal measures have been adopted to also control existing groundwater extractions.

Large-scale development of economic activities such as tourism or farming could lead to over-abstraction of waters which can cause significant problems, particularly in water-scarce areas. Several activities linked to **land-use planning** are ongoing across the EU both at European and at national level:

- From 2010 Member States will have to define standards applying at farm level for compliance with existing national authorisation procedures when using water for irrigation.
- In order to avoid increased pressure on European water resources, feedstock for bioenergy should be more concentrated in northern and central parts of Europe than in the south (and particularly in water scarce regions).

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[2] Directive 2000/60/EC of the European Parliament and the Council establishing a framework for Community action on water policy, OJ L 327, 22.12.2000, p.1.

[3] COM(2010)228 final. Brussels, 18.5.2010. REPORT FROM THE COMMISSION TO THE COUNCIL AND THE EUROPEAN PARLIAMENT. Second Follow-up Report to the Communication on water scarcity and droughts in the European Union COM (2007) 414 final

[4] Pursuant to Annex VII, point A.7.2, RBMPs must include 'a report on the practical steps and measures taken to apply the principle of recovery of the costs of water use in accordance with Article 9'.

- Most Member States reported that they fully implement the Environmental Impact Assessment[5] (EIA) and Strategic Environmental Assessment[6] **(**SEA) Directives. In the case of projects significantly affecting the aquatic environment it is recommended that the assessment of water-related impacts required by Article 4 (7) WFD are incorporated in the SEA and EIA[7].
- Most **tourists** go to the areas where water scarcity and droughts are already problematic and use on average over four times[8] as much water per day as a local resident. A key challenge identified is to reduce water demand in the peak season and minimize resource use to reduce the ecological footprint and stress on water.

Rural Development Programmes are an important tool that can have a significant impact on achieving the WFD objectives. The funding of measures fostering better water management, such as the improvement of existing supply systems, leakage reduction, reuse of waste-water, soil protection, are increasingly taken into account in EU and national budgets. More information is expected on improved use of the EU and national funds in the RBMPs as only a few Member States reported the implementation of **taxation policies** that take into account water scarcity and drought issues.

Specific **Drought Management Plans** could be developed as supplements to the RBMPs. However, the delay in implementing the WFD can hamper the affected Member States in tackling water scarcity and drought problems. A guidance document on incorporating CC in the second and third river basin management cycles was adopted by the Water Directors in December 2009[9]. It includes a specific chapter on adaptation measures related to water scarcity and drought problems. Some Member States already reported that no basins with permanent scarcity are identified (Denmark, Austria, Finland, Lithuania, Belgium) but occasional, or even frequent, water stresses during summer can be expected (Denmark, Austria, Finland, Lithuania). However, others suffer permanent scarcity across the whole country

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[5] Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment, OJ L, 175, 5.7.1985, p.40.

[6] Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment, OJ L 197, 21.7.2001, p.30.

[7] CIS Guidance Document No. 20 on Exemptions, http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/documentn20_mars09pdf/_EN_1.0_&a=d.

[8] EEA Europe's Environment, The Third Assessment (2000).

[9] http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/guidance_documents/management_climatepdf/_EN_1.0_&a=d

(Malta, Cyprus) or whole river basins (Spain, Italy). Not only Mediterranean countries, but also others from central Europe reported areas with frequent water scarcity (Czech Republic) or over-exploited aquifers (France, Belgium).

In those regions where water demand still exceeds the availability of resources, despite having exhausted all possible options to reduce water demand, **new water supply infrastructures for the mitigation of drought effects** could be considered. A study carried out for the Commission in December 2008 assessing the risks and impacts of four alternative water supply options (desalination, wastewater re-use, ground-water recharge, and rainwater harvesting) revealed that it is not possible to provide an EU-wide set of best available mitigation options. The potential problems and mitigation options differ between locations and technologies – meaning that mitigation measures have to be designed to deal with local conditions.

In July 2009 an assessment[10] was finalised for the Commission showing that the introduction of **mandatory requirements on water using devices** under the extended Eco-design Directive could induce significant savings. If all domestic water using products were included, a 19.6% reduction in EU total public supply might be achieved, which would correspond to a 3.2% reduction in the total annual EU abstraction. The EU Eco-Management and Audit Scheme (EMAS)[11] is a management tool for companies and other organisations to evaluate report and improve their environmental performance. The European Environment Agency (EEA) reported that manufacturing industry uses about 11% of total freshwater abstracted across Europe, with about half used for cooling and half for processing. Water abstracted for energy production accounts for 44% of total freshwater abstraction but very little of this water is consumed in the process. There is potential for greater use of alternative water sources for energy production (cooling) as these can be less impacted by droughts[12]. For **water scarcity and drought information system throughout Europe** the indicators are being produced under the Common Implementation of the WFD in coordination with the EEA and the Joint Research Centre (JRC). The EEA has made progress in establishing a European Water Scarcity and Drought Information System (WSDIS), and the implementation of the Global Monitoring for Environment and Security (GMES) which can deliver space-based data and land monitoring services in support of water policies[13]. The EEA also produces annual figures, including data on water quantity, in the State of the Environment Report (SOER).

[10] BioIS&Cranfield university (July 2009) Study on water efficiency standards

[11] Regulation (EC) No 1221/2009,OJ L 342, 22.12.2009, p. 1.

[12] EEA Report No 2/2009, Water resources across Europe - confronting water scarcity and droughts.

[13] COM(2009) 223 final, proposal for a regulation of the European Parliament and the Council on the European Earth Observation programme (GMES) and its initial operations (2011-2013)

22 December 2009 was a milestone in European water policy. This is the date by which the implementation of the **WFD** required **RBMPs** to be adopted for all river basins across the EU. However, the Commission is concerned that implementation of the WFD in the Member States which are most affected by water scarcity is delayed (consultations on the draft RBMPs had not started by December 2009, *inter alia* in Portugal, Cyprus, Malta, Greece and in 22 out of 24 RBD in Spain). The fact that the year 2009 brought a certain degree of hydrological relief compared to the harsh situation experienced in the last few years by some of the southern European countries, does not change this conclusion. Water resources are still under increasing pressure from pollution, from over-exploitation and from CC – and even in the light of significant uncertainties about the future hydrological regime in Europe, cleaning up our waters, strengthening biodiversity, moving towards improved water efficiency and maximising water availability must all be part of the answer to these challenges. The WFD requires the Commission to publish, by 2012, a report on its implementation which will review how Member States have tackled their river basin management planning. This, together with a review of the vulnerability of environmental resources, will contribute to the Commission Blueprint for safeguarding Europe's water resources planned for 2012. It will foster a move away from a crisis management approach towards prevention and preparedness with a view to ensuring a sustainable balance between water demand and the supply of clean water, taking into account the needs of both human activities and of natural ecosystems.

River Basin Management Plans for 2009-2015

The deadline for publishing RBMPs (22.12.2009) and the deadline for reporting these plans to the Commission (22.3.2010) have expired while not all Member States have complied with the timetable[14] (Fig. 1).

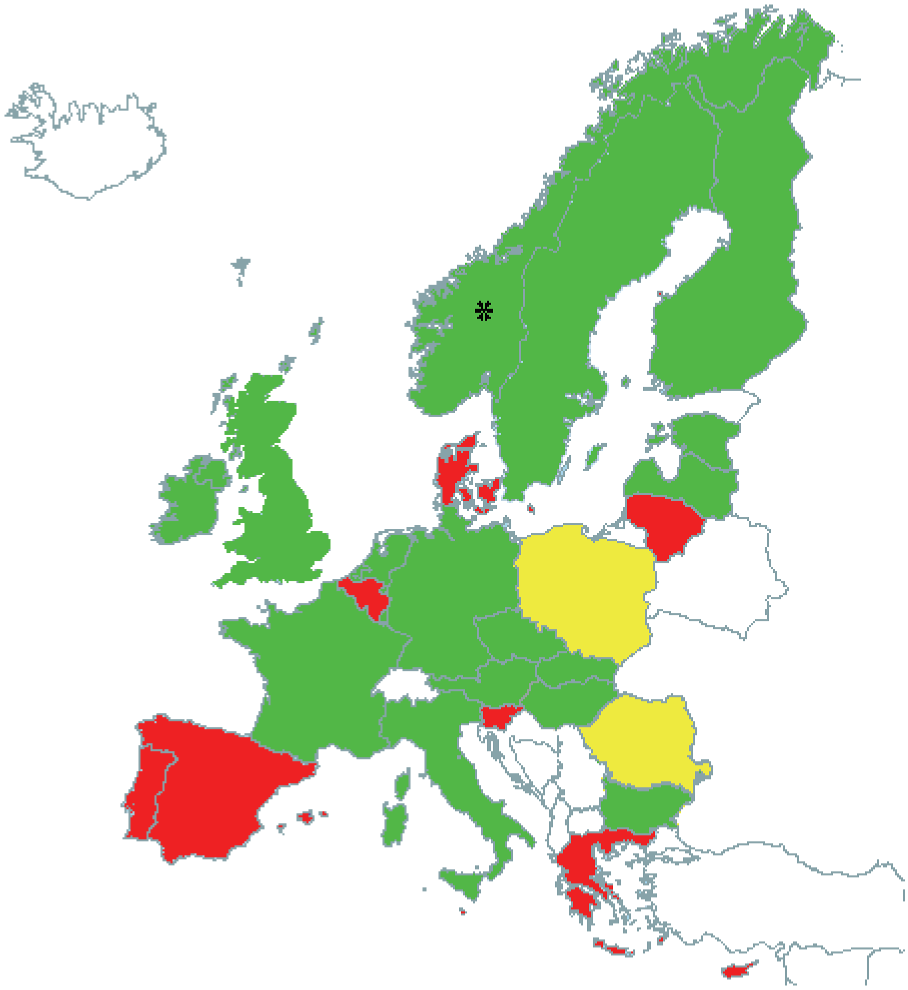


Fig. 1. *The status of consultations which are still ongoing in the different EU Member States[15] on the adoption of the River Basin Management Plans. The map downloaded from http://ec.europa.eu/environment/water/participation/map_mc/map.htm shows the status updated 30.06.2010. GREEN - River Basin Management Plans adopted, YELLOW - consultations finalised, but awaiting adoption, RED - consultation have not started or ongoing.*

[14] http://ec.europa.eu/environment/water/participation/map_mc/map.htm. Updated 30.06.2010

[15] Norway is implementing the Water Framework Directive as part of the European Economic Area Agreement, with specific timetable agreed.

Integration of climate change issues in national RBMPs

In April 2010, the “Conference on Integrated River Basin Management under the WFD – Action Programmes, Adaptation to Climate Change, Inspiration” was organized and held in Lille. The conference aimed to inspire water and river basin managers, researchers, local and national government decision-makers currently engaged in the implementation of the first RBMP and anticipating challenges of the second round of RBM planning. By voting, the participants indicated per topic, a top two or three of scientific insights and/or resulting recommendations that are considered as most important to be taken aboard in the RBM planning and execution process. The following ‘top three’ recommendations (measures) for tackling CC hazards[16] were indicated:

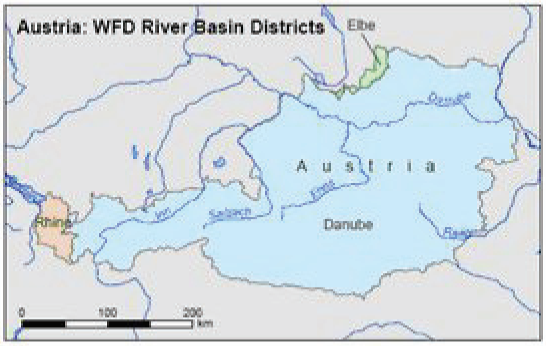
1. Use an integrated modelling approach to refine local scale projections of CC.
2. Improve our knowledge base by coupling integrated biophysical system models to socio-economic models and by subsequently feeding them with available data about the impacts of past disasters.
3. Understand and explain the different levels and sources of uncertainties and ensure the robustness in the projection/scenarios.

Presently the RBMPs are available in national languages. By early 2011, EEA and DG Environment consultant WRc consortium (www.wrcplc.co.uk) will collect extra information from the RBMPs asking a national consultant to extract information from the national RBMPs. For this process 17 templates, including one on CC impacts, have been prepared[17]. In the present overview the information on integrating CC adaptation issues into river basin planning is given first of all for countries in which RBMPs have been adopted by the Commission. For countries which continue consultations or in which consultations have not yet started, the access for files at Eionet Central Data Repository[18] is limited or missing and thus these are not included in the present overview. Within the REFRESH project we could not order professional translation of RBMPs and due to the problems of understanding some countries (France, Norway, Slovakia and Sweden) were not reviewed. As the measures are translated from different languages, the wording does not pretend the full authentity of the original text and for more detail it is suggested to consult the original RBMPs in national languages.

[16] www.sednet.org/download/JEM-WFD_beyond-Introductory-Paper.pdf
[17] Personal communication with Peter Kristensen, EEA
[18] http://cdr.eionet.europa.eu/

Austria

- Austria has three river basin districts (Danube, Elbe, Rhine), all of which are international sharing water courses with Czech Republic to the north, Germany to the north-east, Slovakia and Hungary to the east, Switzerland and Liechtenstein to the west and Slovenia to the south.
- Webpage http://wisa.lebensministerium.at/ provides all information on the implementation of the WFD.
- Consultation on the draft RBMPs has taken place between 27 April 2009 and 27 October 2009. The RBMPs were adopted 30 March 2010 and are available at http://wisa.lebensministerium.at/article/archive/13164



http://ec.europa.eu/environment/water/participation/map_mc/countries/austria_en.htm

General approach

The Austrian National Water Management Plan 2009[19] contains a special chapter (Chapter 9) which provides a concise account of current knowledge regarding the effects of CC on water and the resulting need for action. The analysis covers all important areas of water management such as floods, droughts, water quality, effects on ecosystems, agriculture, hydropower production and tourism and analyses the CC impact on management applied in these sectors. Although the division of tasks between the first and later RBM cycles is not explicitly shown, most of the tasks described imply a broader time horizon. Some of the described measures, such as the *development of norms for water abstractions for snowmaking in ski resorts* or *increasing cleaning efficiency of sewage treatment plants to compensate for the declining dilution capacity of receiving rivers*, can be considered direct CC adaptation measures.

A working group set up within the Austrian Water and Waste Management Association (ÖWAV) with the objective to gather and assess in an interdisciplinary way the significance the potential impact of CC on water management in Austria. This working group has collected results of climate models for Europe concerning Austria, analyzed the results of previous observations and discussed the likely development. The results were jointly published by BMLFUW and ÖWAV at the end of 2008 in a report titled „Auswirkungen des Klimawandels auf die Österreichische Wasserwirtschaft“ (Effects of climate change on the Austrian water management). The report suggests an increase of the annual mean air temperatures in Austria of up to 4.5 °C until the end of this century. In summer the warming would be more pronounced. The statements about the changes in precipitation are inconsistent and are complicated by the fact that the Alps are a transition area where an increase to the north and a marked decrease to the south are expected. The summer rainfall would tend to diminish while the winter snowfall should rise.

[19] http://wisa.lebensministerium.at/article/archive/29368/

Flood events

There is a potential possibility that heavy rain events occur more frequently, but the simulations do not show it. Also, no such trend has been observed in recent decades. In anthropogenically heavily modified rivers like the Danube, an accumulation of medium flood levels is clear, but can not be interpreted as a result of CC. Flood protection measures are planned mainly based on hydrological statistics. These calculations involve inherent uncertainties that will be tackled in the planning phase by an additional board if necessary. The impact of CC on future flood events in Austria was examined for different regions already within the BMLFUW project FLOOD Risk II (Advanced Networking and implementation strategies of the integrated flood control). For medium and large basins (>250 km²), no changes are expected that go beyond the recent uncertainties. On the other hand, a *need of action arises in small catchments for which the risk of convective heavy rainfalls (thunderstorms) has been indicated*. For these areas, a mathematical consideration of CC is not yet possible since the available climate models have too low spatial resolution to allow the necessary planning for the regional and local forecasts. In addition, there are blurred statements on a possible but hardly quantifiable increase of sediment inflow to the waters in the high alpine areas due to the rise of the permafrost boundaries and the thawing of frozen soil layer. Against this background, *the protection of the remaining retention areas becomes highly important*. It will suit to the requirements of EC Flood Directive[20] that future flood risk management plans may not include measures that increase the flood risk of other countries involved and will also *minimize the peak flow of small-scale, convective heavy rainfalls*. Should the evidence of an increase in convective heavy rainfall become stronger, *appropriate measures should be applied to mitigate the expected higher input of nutrients from the soil erosion and flooding of the dung depositories.*

Low water flows and reduced groundwater recharge

While an increase in runoff is likely in the winter months, a significant decrease in runoff is expected in many areas in the summer. Although not supported by recent observations, it is assumed that dry weather periods will become more frequent and more intense. For low rainfall regions already present in the north, east and southeast of Austria, this would result in a shortage of natural water resources. Application of *compensatory measures such as irrigation systems in agriculture* will subsequently lead to competition with the water supply and water ecology. As shown in the BMLFUW/ÖWAV 2008 report on the example of Eastern Styria, hot and dry summers like 2000 and 2003 bring about a steep drop in groundwater levels, while increasing the peak demand of water in the summer months. Many homes or businesses with private wells did not find a solution to this problem and had to

[20] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks

connect to the municipal water supply. According to the report, an up to 40% decline in the annual groundwater recharge is expected for the Eastern Styria while for the Marchfeld the decline will exceed 60%. The increase of temperature increases also the potential evaporation, which means an increasing stress of the ground water resources through the vegetation. In the low rainfall agricultural regions of Austria, in particular summer crops would be exposed to increased heat and drought stress. Well regions of low water-containing soils lying on crystalline, flysch and chalk subsoils may be increasingly affected by drought periods and its heat and drought stress in the future. An increase in agricultural irrigation demand particularly for summer crops such as maize, sugar beet and vegetables, would therefore be a logical consequence. This additional irrigation is needed in the periods of already extremely low water levels and hence the water can not be removed without serious consequences on the ecology of affected water bodies. A shift to more groundwater use is expected in the affected regions due to the lack of productive aquifers, and could in the future in some cases reduce groundwater recharge to critical levels. *In the medium and long term, more efforts will be made in the water management to solve the problems identified in the affected regions.* The selection of possible future measures ranging from *water-saving measures (particularly in the agricultural irrigation), the increase in available water supply through increased retention of water in the area, artificial groundwater recharge and storage, broader insuring of drinking water supplies by regional and interregional loop lines, measures to meet the feed requirement for livestock in dry periods, to the creation of special management plans.* In the lowest rainfall areas, quantitative and qualitative problems can be expected in the water supply, especially in small-scale supply systems. Also the demand for cooling water may increase. *For the drinking water supply a balance can be created through extended networking.* The urban water management could in some areas such as the northeastern Austria face the *need to increase cleaning efficiency of sewage treatment plants and combined sewers or discharges from storm water channels, because of the lower dilution capacity in receiving waters as a consequence of low flow and increased water temperatures.* For combined sewers both the overflows as the low discharge conditions may become more frequent. A significant decline in annual groundwater recharge could also affect the remediation of contaminated groundwater bodies, like the one in Marchfeld, which has already a long renewal time. The significantly smaller dilution would postpone the expected rehabilitation success.

Effects on hydropower production

As a result of increased evaporation the annual sum of runoff waters is reduced. By the end of the century, this reduction can amount to 12-18%. Although the winter runoff will slightly increase, the summer low water periods in the foothills of the Alps become increasingly noticeable. This means that the hydro-electric annual energy production could fall by a very uncertain value up to 3-8%. It is foreseeable that the energy production increases in winter meeting better the energy demands. Due to the thawing of frozen soil layers in the mountains, there will be an increased entry of solids into the aquatic environment. The requirements concerning the sediment budget for the operation of hydropower plants will be a future challenge.

Effects on the ecosystems

The already observed warming of water bodies, which will increase even more in the future, leads to a shift in species range along the course of a river, which is problematic especially for the rheophilic and cold-loving species. So, for example, Cyprinids will be favoured while the suitable habitats for salmon will decrease. This will affect the *derivation of reference conditions and setting the quality objectives in some water body types. These effects can be adjusted but only in the medium to long term.* Specific conclusions will be drawn from the *long-term observation of the reference benchmarking sites.* Increasing temperatures could also lead to more restricted regulations regarding thermal discharges.

Glacial retreat

Over the next forty years, the influence of melting glaciers increases the meltwater proportion in the runoff, which is negligible for the water balance of Austria, but has a significant effect for glaciated alpine basins. Between 1969 and 1997, the glaciers in Austria lost 17.1% of their area and a volume of 4.9 cubic kilometers. With the retreat of glaciers and the rise in temperatures in the high mountains, the thawing soil layers instabilize the slopes, which may give rise to rockfalls, landslides and mass movements.

Tourism

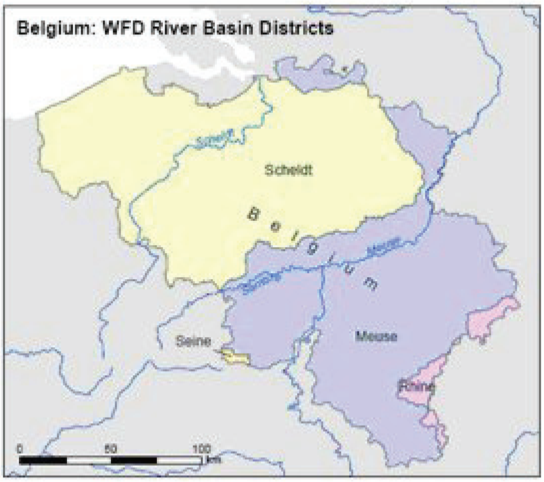
The increased temperature decreases up to 50% the proportion of snow in precipitation and moves the climate zones in the Alpine region around 400-600 meters uphill. The number of frost days and days with snow cover will decrease in the valleys. The impact on winter tourism may be compensated by snow machines only partially and only at higher altitudes. A further expansion of the snowmaking systems with more and greater snowmaking ponds is expected. This is the only way to ensure the necessary amount of snow for skiing in the future. The affected area includes the entire Alpine area of Austria, with its touristic ski areas. For water management perspective, it will be *necessary to develop norms for snowmaking reservoirs in order to avoid further deterioration of water scarcity by additional withdrawals.* In addition, *more attention has to be paid to the stability of the increasing dams and the environmentally friendly operation of the hydropower plants.*

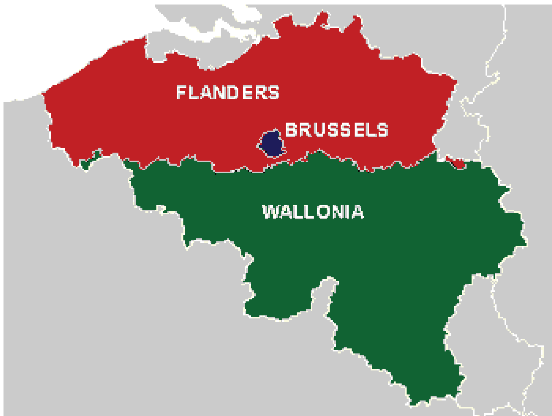
Monitoring of environmental conditions

The Alps lie between the southern Europe dominated by decreasing precipitation and northern Europe where a significant increase in the annual rainfall is forecast. In addition, because of their topography and the high spatial variance of climatic conditions, the Alps represent a kind of climate divide. The difficulties to derive sufficiently reliable results for small catchments have been recurrently noted. It is therefore *important to maintain the continuous long-term measurement network for the observation of various climate factors (such as rainfall, temperature, drainage, water temperatures, snow cover) and their impact on the water balance. It would be also necessary to ensure that it is the middle and higher elevations, for which the worse and very different impacts of CC have been projected, would be adequately monitored.* Only with sufficiently long data series, the statements and forecasts of local and regional climate models are verified. In September 2009, the Central Institute for Meteorology and Geodynamics (ZAMG) and the Technical University of Vienna started the project "Adaptation Strategies to Climate Change for Water Management of Austria”. In this project, a targeted collection and evaluation of available data and research results is carried out. The report is intended to build strategies for water management based on the principles derived from climate models.

Belgium

- Belgium belongs to 4 international river basin districts sharing water courses with the Netherlands, France, Luxemburg and Germany.
- The responsibilities for implementing the WFD in Belgium are divided between the Federal State, competent for coastal waters, and the 3 Regions (Flanders, Wallonia and Brussels-Capital Region), all three competent for rivers, lakes, transitional waters and groundwater. Consultations are organised by the Regions and the Federal State. Central webpages provides all information on the implementation of the WFD:
- Consultation on the draft RBMPs in Flanders took place between 16/12/2008 and 15/6/2009, in the Federal between 22/12/2008 and 21/08/2009. In Wallonia two consultation phases were foreseen in 2008 and 2009. Consultations have not yet started in Brussels Region.
- The information is only available in Dutch (Flanders) / French (Wallonia). Some documents (for example the draft RBMP of the Scheldt) are available in both languages. Some documents are also available in other languages German (the third official language in Belgium).





Map sources:
http://ec.europa.eu/environment/water/participation/map_mc/countries/belgium_en.htm
http://www.sociotimes.com/archives/2007/10/belgian_split_p.aspx

General approach

Since the Draft Flemish RBMPs[21] are based on integrated water management, they include also measures regarding floods and surface water quantity and availability. Hence, adaptation to CC will in this way be tackled implicitly (since the frequency of floods and droughts is expected to increase as a result of CC). To tackle the CC impacts, additional measures were included in the first RBMPs for Meuse and Shelde.

The Program of Measures in the Wallonian draft RBMP[22] does not mention explicitly any CC issues, however includes chapters on flood and drought management.

The Flemish Draft RBMPs for Meuse and Shelde list the following projected CC issues in Belgium[23]:

[21] http://www.volvanwater.be/stroomgebiedbeheerplan-maas/overzicht-download; http://www.volvanwater.be/stroomgebiedbeheerplan-schelde

[22] http://environnement.wallonie.be/directive_eau/pg/7/7.asp

1. A clear upward trend in temperature. In Europe the warming is greater in winter (+1.1°C) than in summer (+0.9°C), making the differences between seasons smaller. The annual average temperatures of 11.5°C and 11.4°C at Uccle in 2007 and 2006 were the absolute records since the start of the measurements in 1833. The projected temperature increase in the 21st century will be strong. If current trends continue, according to the projections of the Intergovernmental Panel on Climate Change (IPCC), by 2100 the climate belts in Western Europe will shift by about 500 km north.
2. The most negative effects in Europe are expected from the increased frequency and intensity of extreme events (storms, droughts, heat waves, floods).
3. There will be more precipitation. Analysis of rainfall data in the 20th century shows that in Belgium the average annual precipitation increases.
4. The changes in precipitation can not only show by changing year averages. More important in view of the potential impact are the seasonal shifts and the occurrence of extreme precipitation periods. In Belgium the increase in rainfall is mainly in the winter months. Analysis of rainfall data since 1833 shows a slight (not significant) increase in the number of days with measurable precipitation (≥ 0.1 mm/day) detectable only in spring and winter, while in summer the number of precipitation days remains constant. The number of days with heavy precipitation appears to be increasing.
5. Floods are the most common natural disaster in Europe and the number of heavy flooding both globally, and in Europe and Belgium increased significantly since 1970. The recent increase in flooding is certainly not solely attributed to CC. Overall, the impact of CC on the overall flood risk is much smaller than the changes in land use, population, etc. But with a fast rising sea level (see below), the changing rainfall pattern all over the coming decades increases the further risk of flooding.
6. Although most studies indicate only small changes in the average rainfall in summer, a stronger concentration of rain within short periods of heavy rainfall is expected. This can lead to a decline in groundwater table in periods of high water demand.
7. It is clear that the drought problem in Belgium will increase in the future to a greater extent than the flooding problem. Besides an impact on drinking water supply, CC will have a negative impact in this way on the surface water quality, navigability of rivers, availability of cooling water for power plants, and irrigation of agricultural land.

[23] A more complete description of the climate in Flanders can be found in the MIRA Background Paper on Climate Change at www.milieurapport.be

8. The Belgian coast in Ostend has seen a sea level rise to 1.7 mm per year over the period 1937-2006. Later measurements have shown in Zeebrugge and Nieuwpoort however, an average increases of sea level by 2.3 and 2.6 mm per year. Within Europe, the Netherlands and Belgium are two countries most vulnerable to flooding due to rising sea levels: more than 85% of the coastal area lies less than 5 meters above sea level. Besides the direct loss of land, threatening coastal areas, a rising sea also indirectly enhances erosion, salt water intrusion into groundwater wells, impaires operation of sewage systems in coastal cities with potential health effects, and degradation of coastal ecosystems with loss of biodiversity.

The additional measures were included in the first RBMPs for Meuse and Shelde that should take into account the impact of CC:

- *Estimate future needs in drinking water supply, wastewater treatment, and water supply for industry and agriculture*
- *Scenario development for predicted long term water quantity changes*
- *Determination of the quantitative capacity of water*

Besides the planned water storage and water conservation areas, the additional measures need to be taken to first retain water for later slow release. In order to suppress the adverse CC impacts, a maximum space for water should be created.

In formulating measures more attention should be paid to CC regarding the possible negative effects of proposed action on climate and the efficiency of the proposed measures in a changed climate.

It was mentioned that using water bodies as cooling water reservoirs will create a pressure that will increase the impacts of CC.

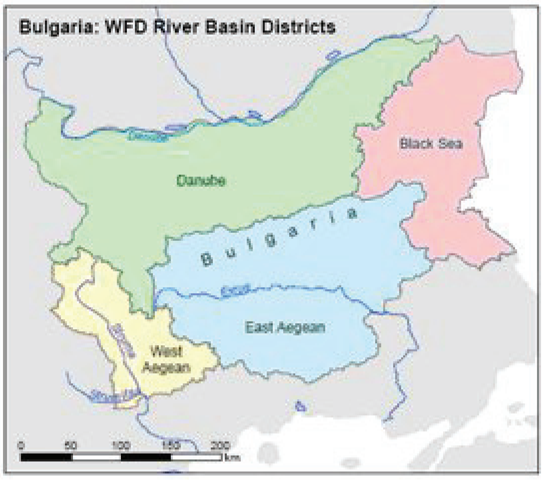
Issues of floods and droughts in the Wallonian draft RBMP[22]

Over the past decade, the Walloon Region has faced recurrent **floods** causing extensive damage, both at the population level and at the level of economic sectors. Furthermore, the types of observed events are very diverse in terms of their intensity, duration or of their extent. An action plan approved by the Walloon Government in January 2003, the PLUIES Plan includes a set of 30 concrete measures to be taken to reduce the risk of damage. One of the first action involves the *mapping of flood zones*. Followed, as examples, the *implementation of urban constraints, promoting agri-environment (hedges, headlands), maintenance of the integrity of rivers, carrying out remedial works or the local improvement of flood warning.* The draft measures proposed have been selected and prioritized based on their general effectiveness for the achievement of the objectives of the WFD, and not only on the basis of their effectiveness in the fight against flooding.

Low flows are caused by prolonged drought compounded by high temperatures. This causes a decrease in the dilution capacity of water for substances released into the aquatic environment. The concentrations of pollutants are likely to exceed the values considered as dangerous to the aquatic fauna and flora but also for the quality of drinking water. Reducing the flow and water level of rivers is often unfavorable also to the transport, degradation of organic matter, sedimentation of particles and oxygenation of the water. In times of low water, the flow of water tends to become laminar and turbulence is reduced, which prevents water from recharging properly dissolved oxygen. In addition, the solubility of oxygen decreases with increasing temperature of the water. Deoxygenation of the water is also accompanied by a general increase in pH that can lead to a rapid increase in toxic ammonia levels in the medium. The decrease in flow and alteration of water quality will modify the development of plant communities (primary producers), generally leading to an increase in algal production. The proliferation of filamentous algae can then cause potential harm of various kinds: aesthetic, physical or chemical (anoxia, overgrowing of the basin, eutrophication). At the aquatic fauna, the low water phase is often accompanied by a decrease in the number and diversity of invertebrate populations. In addition to physico-chemical degradation of stream, low flow may cause adverse physiological reactions of fish which can suffer from hyperthermia or asphyxia.

Bulgaria

- Bulgaria has 4 river basin districts (RBD), 3 of which are international sharing water courses with Greece and Turkey to the south, Romania to the north (Danube River is the border), Serbia and Former Yugoslavia Republic of Macedonia to the west and one national river basin - Black Sea RBD.
- A central webpage[24] provides all information on the implementation of the WFD.
- Consultation on the draft RBMPs were held between:
  - 22/12/2008 and 05/06/2009 in Danube RBD.
  - 05/01/2009 and 01/07/2009 in Black Sea RBD.
  - 22/12/2008 and 22/06/2009 in East Aegean RBD.
  - 20/01/2009 and 30/06/2009 in West Aegean RBD.



http://ec.europa.eu/environment/water/participation/map_mc/countries/bulgaria_en.htm

[24] http://www.moew.government.bg/manage/water.html#plan

- The information is only available in Bulgarian

The development of the water sector in Bulgaria has been guided by the national strategy[25] adopted in 2004. This strategy sets the management tasks until 2015, however, is not fully harmonised with the WFD approach.

General approach

Programmes of measures in Bulgarian RBMPs account some of the important problems that must be resolved, as desertification of land, reduced water resources, the occurrence of extreme weather events. Coming years will increase the expected likelihood of flooding, alternating with periods of drought affecting the entire water cycle. Several changes are unpredictable and have probabilistic nature, but can be mitigated through the underlying RBMP measures spelled out in detail in Section 7. The approaches and presentation formats differ slightly by the different RBDs.

In the RBMP of the Black Sea RBD[26], measures to tackle CC are not given separately but integrated in the blocks of measures dealing with effective and sustainable use of water, drinking water protection, abstraction of surface and groundwater, and water monitoring. In the latter, a specific measure calls for *conducting investigative monitoring of the effects of CC and the impact of invasive species on aquatic biota and sediments in sensitive and vulnerable areas and areas for fish and shellfish.*

In the RBMP of the East Aegian Sea RBD[27] measures relating to CC are included to flood, drought and erosion protection measures. Depending on the susceptibility to soil erosion in the watershed, afforestation activities are planned in the low-lying parts and grass growing at higher altitudes which, in addition to erosion control, will contribute and improve the hydrological characteristics of rivers. The measures are classified into Research & Monitoring, Information campaigns & training, and Administrative & Financial measures.

In the RBMP of Danube RBD[28] the register of measures included in the developed programs to protect and improve the aquatic environment is presented in Annex 7.1.1. Table 7.1.14. lists the measures addressing climate change.

RBMP of the East Aegian Sea RBD describe the measures addressing CC impacts as rising temperatures, reduction in rainfall, changes in runoff of rivers, flash floods, occurrence of droughts. The effect of CC on water ecosystems and different socioeconomic activities have not been adequately studied, but some results are already available showing problems in certain areas, mostly related to the type of so-called "Temporary rivers”. The measures aim at investigating the *manifestations of CC, determination of the affected areas and components, the effect on economic*

[25] Република България Министерски Съвет. Национална стратегия за развитие и управление на водния сектор до 2015 г. (Republic of Bulgaria Council of Ministers . National strategy for the development and management of water sector until 2015).
[26] http://www.bsbd.org/v2/bg/BSPLAN2009.html
[27] http://www.bd-ibr.org/details.php?p_id=0&id=69
[28] http://dunavbd.org/index.php?x=204

activities, and identification of indicators for monitoring and evaluation.

Measures to reduce the effects of drought and water scarcity in the East Region

STUDIES, RESEARCH, MONITORING

1. *Study on CC and its impact on climate water resources (surface and groundwater) ecosystems, ecological status, crops and hydropower. Designation of sensitive areas and Indicators.*
2. *Assess the need for water medium and long term for different economic sectors (households, agriculture farm economy and hydropower) and availability of the necessary water resources. Determination of problematic sectors and areas.*
3. *Establish a system for assessing Impact of CC, monitoring and indicators.*
4. *Assessment of the economic impact of CC on different economic sectors and development forecast scenarios in the context of CC, determining the economic Indicators.*
5. *Studies to reassess the needs of water and effective management of the resource optimization of the transferred quantities in other river basins*
6. *Development of methodology for determining the fiscal incentives for the introduction of mechanisms and practices for water efficiency.*
7. *Development of management plans water resources in drought conditions.*

INFORMATION CAMPAIGN AND TRAINING

8. *Campaigns to promote use of devices and appliances, saving water in households.*
9. *Campaigns to promote the use of irrigation methods that reduce the demand on water.*
10. *Campaigns and meetings to promote introduction of cycles and new environmentally sound technologies in industry to reduce water consumption*
11. *Campaigns to promote the cultivation of crops requiring less water.*

ADMINISTRATIVE MEASURES AND FINANCIAL MECHANISMS

12. *Limiting the use of water in drying type rivers.*
13. *Introduction of financial incentives for water saving methods in irrigation and industry.*
14. *Prohibition on withdrawal of water for energy during dry summer months.*

Measures to reduce the negative effects of flooding in the East Region

STUDIES, RESEARCH, MONITORING

1. *Thickening and modernization of the network of meteorological and hydrological monitoring to obtain more reliable data for water resources.*
2. *Filming of the topography of rivers and create a digital model of relief.*
3. *Mapping of flood zones.*
4. *Establishment of hydrological models for water management.*
5. *Identify areas threatened by flooding under different scenarios for flood height.*
6. *Development of methodology for assessing damage and assess the potential damage of flood risk areas.*
7. *Develop a project for each river basin for protection against high floods and for integration of measures to improve hydromorphological condition of wetlands to achieve the objective of good water status.*

INFORMATION CAMPAIGN AND TRAINING

8. *Establishment of an early warning system for flood risk.*
9. *Training for use of the early warning system.*
10. *Training and information campaigns for problems associated with floods.*
11. *Consulting the public on determining risk areas.*
12. *Consulting the public on development of flood prevention measures.*
13. *Informing the public regarding developed measures.*

ADMINISTRATIVE MEASURES AND FINANCIAL MECHANISMS

14. *Establishment of a mechanism to coordinate actions in cases of flood risk.*
15. *Creation of a coordination mechanism for flood occasions.*
16. *Maintenance of river beds to ensure the passage of the flood peak.*

In the RBMP of Danube RBD[29] the register of measures included in the developed programs to protect and improve the aquatic environment addresses also CC (Table 2).

[29] http://dunavbd.org/index.php?x=204

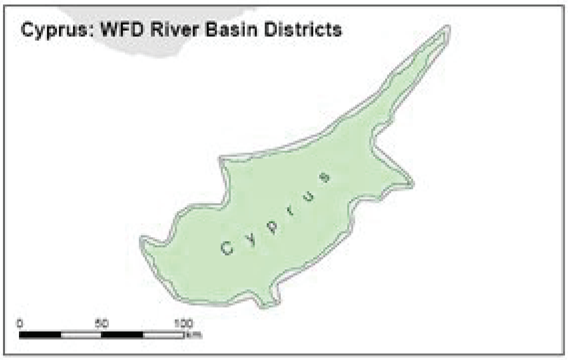
Table 2. Measures addressing climate change in the RBMP of Danube RBD Annex 7.1.1, Table 7.1.14. Each measure recorded in the register contains a unique code under which it is registered and incorporated in the developed programs to protect and achieve good status of water bodies. Code measures consist of the following abbreviations or BG1MB BG1MS, and XXX: BG - element indicating the country in case of Bulgaria 1 - Code of the Danube basin management; M (measure) - a measure; B (basic) or S (supplementary); XXX - figures indicating the sequence of the measure in the register.

Measure code	Measure	Type of measure
BG1MS053	*Additional runoff regulation*	S
BG1MS054	*Conservation or plumbing of unused drill holes*	S
BG1MS055	*Prevent overexploitation of groundwater*	S
BG1MS056	*Assessment and prediction of changes of water resources based on data from water monitoring*	S
BG1MS057	*Reforestation of clear cutting areas in water supply zones, avoiding acacia and poplar*	S
BG1MS058	*Improving forest management in water supply zones*	S
BG1MS059	*Anti-erosion measures and reduction of unused water flow*	S
BG1MS060	*Planting appropriate native tree species*	S
BG1MS061	*Prevention of forest fires*	S
BG1MS062	*Providing economical water use by building water supply systems*	S
BG1MS063	*Using economic regulators, leading to water saving in areas with a shortage of water resources*	S
BG1MS064	*Prohibition on empting small dams for fishing purposes*	S
BG1MS065	*Stimulating the economic use of water for irrigation*	S
BG1MS066	*Regular informing of the public about the state of water resources of the country at local and national level*	S
BG1MS067	*Public control over water pollution and illegal abstraction and creating "green line" phones to municipalities and regional Inspectorates of environment and water*	S
BG1MS001	*Develop fiscal incentives for the introduction of mechanisms and practices for water efficiency*	S
BG1MS003	*Reduce losses in water supply network through rehabilitation or construction of new pipelines*	S
BG1MB027	*Prohibition on issuing permits for water, where the total water use exceeds the operational resources of groundwater bodies*	B
BG1MB031	*Control permits for water (control abstraction)*	B
BG1MS006	*Regulation in the permits for water abstraction for dangerous lowering of groundwater levels*	S
BG1MS010	*Prohibition on issuing permits for water for bodies of groundwater-dependent Intermittent rivers*	S
BG1MS011	*Prohibition on issuing permits for construction of protective facilities of surface water in areas where it might significantly increase groundwater levels*	S
BG1MS012	*Construction of reservoirs to regulate the maximum (peak) flows*	S
BG1MS013	*Maintenance of water supply networks in good condition*	S

BG1MS014	*Optimization of water abstraction for industrial use through the introduction of closed cycles*	S
BG1MB039	*Control of compliance with permit conditions for water use*	B
BG1MB085	*Monitoring of surface and groundwater to assess the condition of water bodies*	B
BG1MS033	*Application of environmental standards in production processes*	S
BG1MB043	*Regulation for the permits for construction and operation of new and existing industrial installations and facilities*	B
BG1MB044	*Control over the conditions in the permits issued*	B
BG1MB080	*Regulation to assess the environmental impact assessment (EIA) of investment proposals for construction, operations and technology according to EPA*	B
BG1MB081	*Regulation to assess the need for an EIA according to EPA*	B
BG1MB082	*Control over fulfilment of the conditions of the EIA decisions*	B
BG1MB182	*Preparation of Management Plan for flood risk*	B

Cyprus

- Cyprus has 1 river basin district.
- A central webpage[30] provides all information on the implementation of the WFD.
- Consultation on the draft RBMP is being carried out between May and November 2010.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Greek



General approach

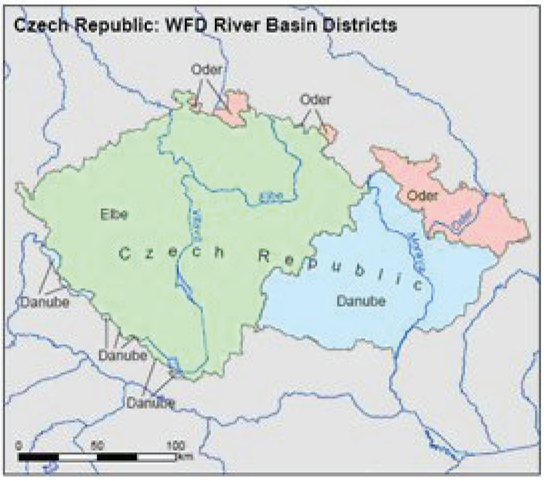
As the consultations on the adoption of the RBMP for Cyprus were still ongoing at the time of preparation of this report and the final version of the plan is not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

[30] http://www.moa.gov.cy/moa/wdd/Wdd.nsf/guide_gr/guide_gr?OpenDocument

Czech Republic

- The Czech Republic has 3 river basin districts, all of which are international sharing water courses with Poland to the north, Slovakia to the East, Austria to the south and Germany to the south-west and north-west.
- RBD Elbe is divided into 6 sub-basins:
  - River Basin Upper Vltava
  - River Basin Lower Vltava
  - River Basin Berounka
  - River Basin Upper and Middle Elbe
  - River Basin Ohre and Lower Elbe
- RBD Danube is divided into 2 sub-basins:
  - River Basin Morava
  - River Basin Thaya

- Information in Czech



- A central webpage provides all information on the implementation of the WFD: http://www.mzp.cz/cz/plany_oblasti_povodi.
- RBM plans prepared for national parts of the Elbe River Basin, the Danube River Basin and the Oder River Basin by the Ministry of the Environment in accordance with the Czech Republic Government Resolution No. 567/2007, are the basic documents for the reporting according to Article 15 of WFD. These documents are available only in Czech language. International RBMPs and plans prepared at sub-basin level will be attached as background documents.
- International part of the Elbe RBMP is also available in German version from the address: http://www.ikse-mkol.org/. International part of the Danube RBMP is also available in English version from the address: http://www.icpdr.org/participate/. International part of the Oder RBMP is also available in German version from the address: www.mkoo.eu.
- Consultation on the draft RBMPs took place between 01/07/2008 and 31/12/2008.

General approach

The Plan of Main River Basins of the Czech Republic[31], the basic strategic document notes that with the ongoing and anticipated CC the incidence and intensity of extreme hydrological phenomena, i.e., both floods and droughts, may rise. However, due to large uncertainties in predictions of CC, its impact on existing water supplies is not considered in the first round of RBMP until 2015. Although the impacts of CC may to a certain degree affect agricultural water use, it is not provided that this phenomenon would be reflected in significant adjustment needs to the use of irrigation water before 2015.

The Plan of Main River Basins of the Czech Republic was approved by the Government on 23 May 2007 Resolution No. 562nd. It is an important strategic document for planning the activities and measures and formed the basis for the RBMPs. This document sets the general objectives for protection, improvement and management of surface and groundwaters and aquatic ecosystems based on the objectives of water protection, the sustainable use of water for protection against the harmful effects of water and improving water conditions and protection of the ecological stability of the country. The document stipulates a need for an integrated approach to address the prospective needs and requirements for water, in particular with regard to the long-term prospect assuming a more distinct manifestation of the consequences of the anticipated CC.

In the long-term prospect, it is necessary to take into account CCs expected in the next fifty to hundred years that will manifest themselves in the field of water by an increased extremity of dry periods or flood situations occurrence. Pessimistic scenarios and hydrological models indicate a possible decrease of the average discharge in watercourses by as much as 40% in the perspective of the first half of the 21st century. Similar decrease is expected for the minimum flows in watercourses and for groundwater tables. Higher soil evaporation in the spring-autumn period will result in runoffs showing mainly decreasing trend. Decreasing inflows and increasing evaporation will impair the capacity of water reservoirs to safeguard and compensate water abstractions. Decreasing water flow rates and rise in water temperature will also increase the risk of higher eutrophication and impaired water quality. These changes will not manifest themselves in a leap but gradually.

All sectors of the economy will have to adapt to the anticipated impacts of CC. However, as the CC impact estimates show considerable variability and no estimates of the expected requirements of individual sectors for water resources are known yet (in particular as regards agriculture, industry and drinking water supply), this first Plan of Main River Basins of the Czech Republic lays down a strategy based on the precaution principle. Chapter 2 of the strategic plan lists the objectives and measures in flood protection and protection against other detrimental effects of water (the issue of drought and water erosion), which are considered the climate related issues in the water management. Implementation of adaptation strategies will make sense even disregarding the link to the CC. The current climate variability, including the extreme weather phenomena, usually causes significant damages. Major effort to adapt to these phenomena, with regard to adoption of the precaution principle, may reduce these damages in a short-term perspective disregarding CCs from the long-term point of view.

Climate change related measures

1. *Landscape measures implemented in a nature-friendly manner (natural overflow, polders, watercourse channels improvements in built-up areas of municipalities);*

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[31] http://eagri.cz/public/web/en/mze/water/planning-in-the-field-of-water/plan-of-main-river-basins-cr.html

2. *Measures to optimize water regime of the landscape, to increase its retention capacity and to protect it against water erosion (especially to revitalize inappropriately regulated watercourse channels, inappropriate drainage and other interventions having adverse impacts on landscape water regime, to reduce the occurrence of adverse water erosion impacts, to reduce adverse impacts of surface runoff - infiltration zones and seeping depressed areas and flood storage rehabilitation);*
3. *Technical measures specified in the sub-programmes of the Ministry of Agriculture (Support of Flood Protection Measures with Retention, Support of Flood Protection Measures along Watercourses, Support of Increasing the Safety of Hydraulic Structures);*
4. *Torrent control in forests (Section 35 of the Act No 289/1995 on Forests, as amended*

The plan requested to complete, by the end of 2008, designation of flood plain areas along major watercourses with regard to built-up areas, in areas suitable for building on according to the general land-use planning documentation or, if necessary, also in other areas in order to determine the size of the potential flood hazard areas and subsequently to reflect this in the river basin district plans.

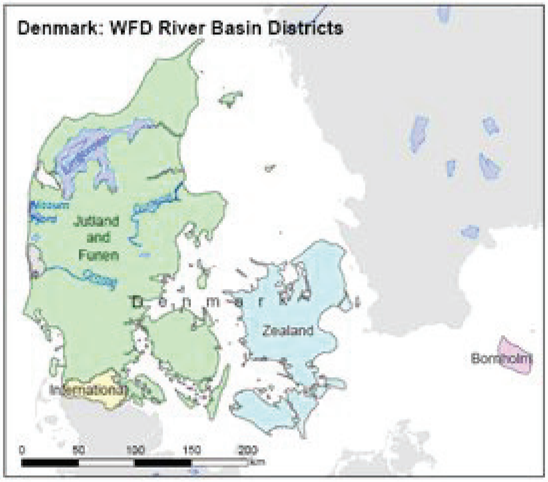
The river basin district plans will specify, in co-operation with the regional authorities, areas requiring flood protection with regard to their significance, including the standards of their protection and the areas to be used to mitigate the floods.

The plan requested to *set up a long-term programme for research of extreme hydrological phenomena, by a coordinated procedure at the level of the Ministry of the Environment, in agreement with the Ministry of Agriculture and the Ministry for Regional Development and in co-operation with universities and other expert institutions.*

The plan requested *to update by mid-2009 the existing system of area protection of localities hydrologically and morphologically suitable for surface water storage in the long-term prospect as one of the adaptation measures for the anticipated CCs in the next 50-100 years which may show in the form of an increased extremity of dry period and flood situation occurrence.*

Denmark

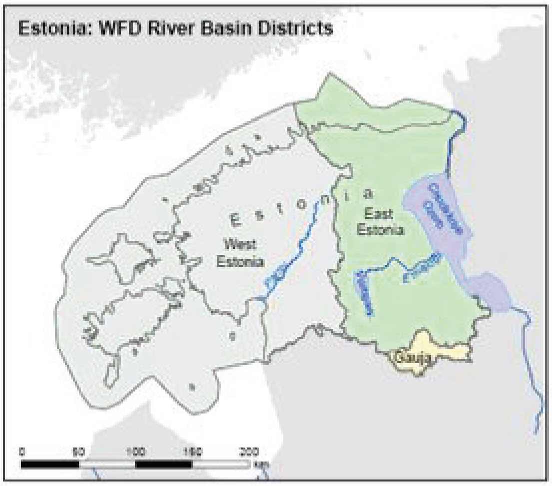
- Denmark has four river basin districts (RBD1: Jylland and Fyn, RBD2: Sjaelland, RBD3: Bornholm, RBD4: International RBD), out of which the latter is sharing water courses with Germany to the south.
- Consultation of local authorities on the draft RBMPs started on 16 January 2010. Draft RBMPs have been issued for 15 subdistricts to RBD1, and 6 subdistricts of RBD2. The draft RBMPs for consultation and more information about consultation can be found here. Consultation of the public has not yet started.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - Denmark's Ministry of Environment website dedicated to future RBMPs
    - Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Danish



General approach

As the consultations on the adoption of the RBMP for Denmark were still ongoing at the time of preparation of this report and the final version of the plan is not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Estonia



- Estonia has 3 river basin districts, out of which 2 are international sharing water courses with Russia to the east and Latvia to the south.
- A central webpage provides all information on the http://www.envir.ee/1226
- The RBMPs for East-Estonia, West-Estonia and Koiva river basins were adopted by the Government on 1 April 2010 and can be downloaded (in Estonian only) from http://www.envir.ee/vmk
- Consultation on the draft RBMPs took place between 22 December 2008 and 22 December 2009.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

General approach

Estonia has not addressed any CC issues in the first RBMP. At present, Estonian Ministry of Environment has initiated a procurement procedure (deadline 1.3.11) for a report that would give an initial overview of current scientific knowledge of observed CC impacts on water ecosystems in Estonia, assess the suitability of current monitoring programmes to detect climate signals in water bodies, and analyse the possible future impacts of projected CC on surface waters in Estonia. This information will be needed to integrate CC issues into the following rounds of RBM planning. Among climate related issues, Estonian RBMPs includes a chapter on floods.

Floods

Floods are natural phenomena, to which the inhabitants of low-lying coastal areas and major river sides are exposed for thousands of years. Estonia has the advantage that the areas of large natural floodings are mostly uninhabited or sparsely populated.

The following types of floods occur in Estonia:

- Spring floods on rivers;
- floods in the rivers and in particular their estuaries caused by intense or long-lasting rains;
- flood risk associated to breaking of reservoir dams;
- floods in densely populated and industrialized areas with insufficient storm water collection systems during intense rainfalls;
- flooding in agricultural and forest lands caused by excessive rainfall.

Since large floods categorized as natural disasters occur in rare cases, floods in Estonia have no lasting negative impact on water quality and thus there is no need for continuous state monitoring system for floods. Although the groundwater or surface water quality in the flooded areas may be significantly impaired during floods or after them (a few days to a few months), mainly for two reasons:

- floods would flush sewage systems and wastewater treatment plants (including biponds and sludge treatment fields);
- floods may flush the territories of enterprises, handling hazardous substances or keeping them in large quantities.

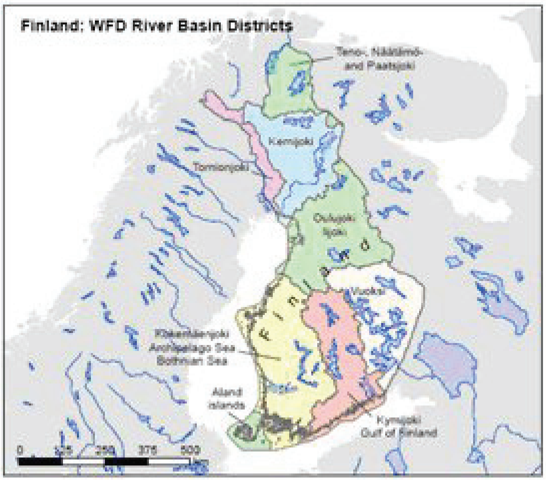
A source of hazard is the breaking of river dams that may result in human casualties and significant economic damage. Sediment transport may deteriorate water quality below the dam breakage. A river section located in the empty reservoir cannot be regarded as being in good condition.

Water levels in natural lakes are often historically regulated. Breaking of the dam will cause water level decline and the lower parts of the lake will overgrow with macrophytes. It is difficult to restore the pre-emergency state of the overgrown parts of the lake.

According to the regulation No 58 of the Estonian minister of the environment from 28.05.2004. "List of major inland water bodies with large floodplains and the estimation of their maximum flood levels" there are 9 water bodies with large floodplains in the East-Estonian river basin district. Seven of the reservoirs pose a flood risk. The areas surrounding Lake Võrtsjärv are regularly flooded. At the highest water level the flooded area reaches 57 km^2. It is impossible to avoid flood damages by constructed regulation systems. Among populated areas, periodic floods of the Emajõgi River disturb the life in Tartu city and the floods of Lake Tamula in Võru town. In Western Estonia floods cause biggest economic losses in towns Pärnu and Haapsalu. In Koiva RBD significant floods do not occur.

Finland

- Finland has 8 river basin districts, out of which 2 are international sharing water courses with Sweden to the west and Norway to the north. The Åland islands is one river basin district, with separate legislation and implementation.



  - River Vuoksi
  - River Kymijoki - Gulf of Finland
  - River Kokemäenjoki -Archipelago Sea - Bothnian Sea
  - River Oulunjoki - River Iijoki - Bothnian Bay
  - River Kemijoki
  - River Tornionjoki
  - River Tenojoki - River Paatsjoki
  - Åland
- A central webpage provides all information on the implementation of the WFD (the process has been organized upon the Regional Environmental Centres)
- RBMPs were adopted for all of Finland in December 2009. RBMPs from the mainland can be downloaded from this Finnish Environmental Administration webpage in Finnish & in Swedish. Click on Åland to download the plans from the Åland Regional government.
- Consultation on the draft RBMPs took place between 30 October 2008 and 30 April 2009, and in Åland between 22 December 2008 and 30 June 2009. Read more about consultation on the specific pages of the relevant Competent Authorities:
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Finnish and partly in Swedish

General approach

In the RBMPs Finland has declared that the information on impacts of CC on water is still inadequate and, in the short term, many other factors are clearly more important in terms of water status. In the first round of RBM planning until 2015, Finland will treat CC on general level. The aim is that measures proposed in the RBMP would promote also adaptation to CC. For this purpose, all measures have been screened regarding CC.

Climate checking of the Program of Measures

Measures have been selected in a way to guarantee their positive effect on the status of water bodies and, at the same time, they should prevent the harmful effects of CC. This requires that in the process of measure development, water systems are examined in a holistic way and that measures are adjusted, if possible, on a hydrological basis to slow down water movement in the catchment area. In a CC perspective, the measures are divided in three categories:

- measures with additional benefits in case of CC;

- measures that are neutral regarding CC;
- measures that may impair adaptation to CC.

For the bulk of measures CC is expected to be neutral and only a small portion is estimated to impair the effect of CC. They can be used to reduce the flood risk in known flood sensitive areas. Improvement of regulation systems is a water management measure and the main measure of flood protection in Finland. In the development plans of water regulation the water resources management must be coordinated with flood protection with the consideration of anticipated CC.

Information on the impacts of CC on water cycle, water pollution and restoration measures will be updated when the water management plans will be reviewed in the following round. At the same time, the needs will be specified for:

- developing monitoring programs to detect the effects;
- making changes to water bodies typology and type specific reference conditions;
- developing the knowledge base of CC to take it into account in the operational programs and to integrate it more closely with other water uses and land use planning;
- to consider CC in water management analysis at a longer time scale, for example, 40 years.

Climate change impacts and related measures

Finnish RBMPs include an analysis on the CC impact on water. It is shown that CC impacts can already be detected, but they are expected to increase substantially towards the end of the century. According to the latest climate scenarios, the mean air temperature in Finland in 2020 will be by 1.2 to 1.8°C higher than in the benchmark period of 1971-2000. By 2050, the average temperature could rise, from 2.3 to 3.7°C, and by 2080 from 3.1 to 6.2°C. Corresponding changes in precipitation are 4-6, 8-13 and 11-23 per cent. The intensity of precipitation would increase more than the average precipitation amount. By the end of the century, the maximum daily precipitation will increase 20-40% in winter and 10-30% in summer. These new scenarios do not differ significantly from those of the past; the projected precipitation growth is, however, to some extent higher, particularly for late summer.

In Finland's inland waters, CC will affect most strongly the hydrological conditions, by changing water levels and the seasonal distribution of the runoff. The annual runoff is estimated to change between -5 to +10%, depending on the river basin.

The annual runoff in southern and central Finland's lake basins is expected to diminish somewhat as a result of incleasing evaporation. In winter, increased melting of snow and rain will increase the winter floods. Similarly, spring floods are reduced when the snow cover will no longer accumulate during warm winters. Water levels in the central large lakes in winter will become winter higher than now. An increase in summer floods, particularly in small lakes, is expected as a result of the wider spread of torrential rains during summer. On the other hand, a prolonged summer season also brings the opportunity for dry summers, particularly in southern and central Finland.

Growing winter runoff and more frequent winter floods of southern and central Finland require to leave more storage capacity in the regulated lakes. In spring, the need for storage capacity will be lower when the snowmelt floods will disappear or be reduced. Because of longer and sometimes also drier summers, the lakes need to be filled in spring. In northern Finland, the storage capacity is still needed to reduce the flood risk caused by snowmelt. Lake regulation permits need to be changed. The need for change is estimated for more than half of the current 220 regulation permits.

In South and Central Finland rivers spring floods are reduced, but the reduced time of winter ice cover increases the likelihood of ice jams. Heat waves imply an increase in torrential rains and contribute to increasing summer flash floods in urban areas and small and medium-sized rivers. On the other hand, the prolongation of summers itself can exacerbate the late summer drought.

Increased flooding may also have implications for groundwater extraction, because many water supplies are located in the vicinity of flood-sensitive waters. Flood water can reach the groundwater aquifer deteriorating the drinking water quality. Groundwater purification can take a long time. Quantitative changes in low flow conditions important for water supply have not been assessed, but the lake water level scenarios suggest a prolongation and reduction of summer low flows. In these areas it may become difficult to supply water for irrigation in dryest summers.

CC effects on groundwater resources has been studied much less than the surface water impacts. Ground water levels appear to rise in winter, and will be slightly lower in late summer. The lowest water levels in summer and autumn will have a further drop. This worsening of droughts will increase risks and problems in water supply systems more dependent on groundwater. Large groundwater aquifers will be less affected by the seasonality changes in rainfall and snowmelt than smaller ones. The lowest levels in most major groundwater aquifers are encountered at the end of the dry seasons. Summer rains not often reach groundwaters and therefore are not as effective for groundwater recharge compared to the rainfall and melting in the autumn and winter when the soil is already water saturated and rain water can leach into groundwater. The groundwater quality may decline in small groundwater bodies, as reduced groundwater discharges will lead to lack of oxygen and dissolved iron, manganese and high concentrations of metals. This was an indication of drought during the years 2002-2003.

CC will increase the nutrient load in aquatic ecosystems, and thus eutrophication. Leaching increases with the increased runoff. Greatest impact are expected in southern and southwestern coastal regions of Finland. The lack of snow cover on fields is likely to increase the nutrients, phosphorus and nitrogen, leaching into running waters. Woodlands can leach more nitrogen. Also, leaching from urban areas will increase with urban floodings becoming more frequent. Increasing water temperature favours the growth of cyanobacteria deteriorating oxygen conditions in lakes and coastal waters, especially for the low flow period. Also, the bacterial count in water may increase. On the other hand, oxygen conditions may benefit from shortening of the ice cover periods.

Changes in nutrient loadings from fields since the SILMU project (The Finnish Research Programme on Climate Change) have not been assessed nationwide. According to the SILMU results, nitrogen leaching will increase considerably, especially in western and southwestern parts, but leaching of particulate phosphorus can decrease as a result of lower spring flood peaks. On the other hand, phosphorus loadings may more than double from the permanently snow-free areas during years with rainy autumn and winter. In recent years, such conditions have already often occurred in southern and central parts of Finland. Also the ASTRA project (Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region) results from Kokemäenjoki have given indications of a substantial increase of phosphorus leaching. The additional leaching due to CC depends strongly of the use of cultivation methods and plant selection. Load increase can be significantly reduced by a winter plant cover on fields, in particular on sloping fields. Changing weather conditions did not seem to have much influence on leaching of dissolved phosphorus, and the plant cover could slightly increase it. Leaching of nitrate appeared to increase, particularly in the southwestern part of Finland.

FINDAPT project (Assessing the adaptive capacity of the Finnish environment and society under a changing climate) has estimated the effects of CC in other respects the environment, people and livelihoods. CC is not expected by 2050 to pose significant health risks in the Finnish population. Biota is expected to be increasingly affected. New species enter as the native ones move northward, causing pressures on existing species and habitats. Some species of fish, particularly salmonids, may suffer from the change.

In Finland agriculture and forestry as well as heating energy consumers may benefit from CC. Hydropower production potential of existing plants would grow by 10% and the tourism industry can gain a comparative advantage at the European scale. Real estate and traffic-related construction costs would increase somewhat over the coming decades and more later. In terms of gross national product, the impact of CC has been considered relatively low. The effects of changes are still uncertain at global and national levels. The global food price increase allows for arable farming and livestock production to be increased in Finland. As a result, the nutrient loads to water bodies can increase with consequences to their ecological status. CC causing milder winters with recurrent thaw periods may hamper agriculture to achieve the objectives of load reduction.

Increase in forestry and timber production can increase loads of nutrient and suspended solids if appropriate water conservation measures are not applied. In particular, small water bodies and headwater catchments will be endangered. Improving of water protection measures simultaneously with the ongoing CC, which is likely to increase the leaching, will be a challenge. METSO Programme (Forest Biodiversity Action Programme for Southern Finland) will promote the conservation areas, which reduces the local forestry watershed loading.

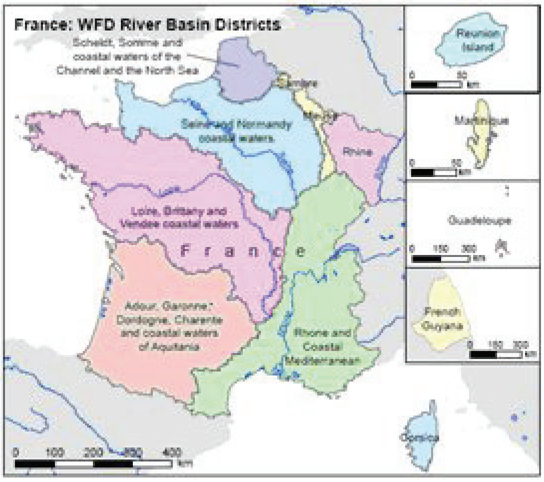
Electricity consumption is forecasted to grow over the coming years by about 1.2% per year. International emissions trading and a national energy and climate strategy put pressure on more efficient utilization of renewable resources. Energy production and efficiency will increase in the future. Pressures may arise, inter alia, more efficient use of already built hydro power plants and the construction of small hydropower systems could be increased.

Road transport is expected to increase. On the other hand, rising fuel prices may slow down the growth of traffic. *With increasing traffic volume increases the risk of accidents and groundwater protection should be strengthened.* Road administration is increasing the salting of busy roads in particular those of heavy traffic. CC will increase the incidence of zero temperature weather, and thus contributes to the need for salting.

CC impact on water supply is difficult to predict. Supposed longer and drier summers, rising temperatures and runoff reduction in spring could reduce the groundwater table, despite the abundant groundwater formation in late autumn and winter. The decline of groundwater level may affect the availability of the groundwater, but also its quality. CC due to increasing flooding may cause both surface water and groundwater quality deterioration.

France

- France has identified 12 river basin districts, out of which 4 are overseas territories. Among them six have a landborder with another European country (Rhône, Adour Garonne, Rhin-Meuse, Artois Picardie, Seine and Normandie) with Belgium, Luxemburg, Germany, Switzerland, Italy and Spain. Five are islands (Corsica, La Réunion, Martinique, Guadeloupe).



- The RBMPs (SDAGE) were adopted in December 2009 and can be downloaded for 11 River basin Districts (not Corsica) from the following page. The RNBMPs can also be downloaded directly from the following links :
    - Adour Garonne district
    - Artois Picardie district
    - Loire Bretagne district
    - Rhin-Meuse district
    - Rhône Mediterranée district
    - Corse district
    - Seine- Normandie district
    - Guadeloupe district
    - Guyane district
    - Réunion district
    - Martinique district
    - Mayotte district
- A central webpage provides all information on the implementation of the WFD.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title
- Consultations on the draft RBMPs took place in 2008 and 2009, information can be obtained from specific pages of the relevant Competent Authorities:
    - RBD Rhône Méditerranée
    - RBD Corse
    - RBD Loire Bretagne
    - RBD Rhin Meuse
    - RBD Seine Normandie
    - RBD Artois Picardie

- RBD Adour Garonne
- RBD Martinique
- RBD Guyane
- RBD Guadeloupe
- RBD Réunion
- Mayotte

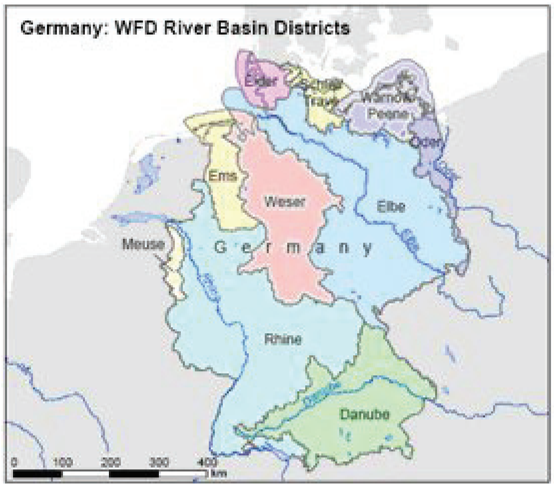
- The information is available in French except for RBD Rhin Meuse basin
    - In English
    - In Dutch
    - In German

Due to the language barrier, the French RBMPs are not reviewed in this report, except RBD Rhine and Meuse that are reviewed in the section of international RBMPs.

Germany

- Germany has 10 river basin districts, out of which 6 are international sharing water courses with Denmark to the north, Poland Czech Republic to the east, Austria, Switzerland and France to the south and south-east and Luxembourg, Belgium and the Netherlands to the west.

- Information auf Deutsch (not yet updated)



Division by River basin districts

- RBD Elbe
- RBD Weser
- RBD Rhine (The Rhine is subdivided into its Federal States :
  - Federal State of Baden Württemberg
  - Federal State of Bavaria
  - Federal State of Hessia
  - Federal State of Lower Saxony
  - Federal State of North Rhine Westphalia
  - Federal State of Rhineland Palatinate
  - Federal Statem of Saarland
  - Federal State of Thuringia
- RBD Ems
- RBD Oder
- RBD Danube
  - Federal State of Baden Württemberg
  - Federal State of Bavaria
- RBD Schlei/Trave
- RBD Eider
- RBD Warnow/Peene
- RBD Maas

Division by Federal State level

- Federal State of Baden Württemberg
- Federal State of Bavaria
- Federal State of Berlin (RBD Elbe) *(General Info to WRRL – No dedicated consultation website available)*
- Federal State of Brandenburg (RBD Elbe, Oder)
- Federal State of Bremen (RBD Weser)
- Federal State of Hamburg (RBD Elbe)
- Federal State of Hesse (RBD Rhine, Weser)
- Federal State of Lower Saxony (RBD Rhine, Ems, Elbe, Weser)
- Federal State of Mecklenburg-Western Pommerania (RBD Elbe, Schlei/Trave, Oder, Warnow/Peene)

- Federal State of North Rhine Westphalia (RBD Rhine, Ems, Maas, Weser)
- Federal State of Rhineland Palatinate (RBD Rhine)
- Federal State of Saarland (RBD Rhine)
  - http://www.saarland.de/SID-3E724395-6D481941/15545.htm
  - http://www.saarland.de/31944.htm
- Federal State of Saxony (RBD Elbe, Oder)
- Federal State of Saxony-Anhalt (RBD Elbe, Weser)
- Federal State of Schleswig-Holstein (RBD Elbe, Schlei/Trave, Eider)
- Federal State of Thuringia (RBD Elbe, Weser, Rhine)

RBMPs were adopted in December 2009, and can be downloaded from this central webpage. Consultation on the draft RBMPs took place between 22/12/2008 and 22/06/2009. Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

General approach

The LAWA - Strategy Paper on Climate Change (2010)[32], which gave an overview of observed and projected CC and its effects on water related issues in Germany, indicated the following major possible effects of CC on surface waters: lowering of water levels, drying up, change in temperature regime, increased nutrient loading, critical oxygen conditions, invasion of warm-water species, narrowing of salmonid habitats. These effects are valid for the entire country without considering regional differences. According to the WRc report[33], Germany was the only country (among 15 who responded to the questionnaire) to state that due to uncertainties about the concrete regional extent and effects of CC on water bodies, it is unlikely that the issue of CC will be included as a separate chapter in the first RBMPs. However, Germany considered possible that certain problems concerning water budget in water bodies caused by CC (e.g. water storage for different purposes, water availability for filling of fish ponds, droughts or prolonged drying periods in streams and rivers) might be addressed in particular sections of the RBMP. Impacts on ecosystem and groundwater-dependent ecological systems, increase of soil erosion might also be included.

Indeed, rather low significance is given to CC issues in the German RBMPs. For example, the Bavarian management plans for Danube and Rhine RBDs[34] analysing the significant pressures and anthropogenic impacts on the status of surface and ground water (Ch. 2), state regarding the impacts of CC: "Based on regional climate projections, a prolongation of hot dry periods can be expected for the coming decades and hence low water conditions may temporarily worsen. Currently work is going on

[32] Strategiepapier „Auswirkungen des Klimawandels auf die Wasserwirtschaft“ Bestandsaufnahme und Handlungsempfehlungen beschlossen auf der 139. LAWA-VV am 25./26. März 2010 in Dresden
[33] Nixon, S. 2008. Summary of information received from Member States on best practices and approaches for a climate check of the first Programmes of Measures. WRc Report to the Strategic Steering Group on Climate Change and Water. Version no. 2, 21 August 2008.

[34] http://www.wrrl.bayern.de/bewirtschaftungsplaene/index.htm

to gain reliable results for quantification of this statement. The possible consequences are likely of no special significance for the first reporting period of RBMPs."

Also the Eider RBMP[35] treates flood risk management and the consequences of CC in the context of future planning of water management. The task to identify future changes in water balance resulting from possible CC, to inform the water management authorities on the related quantitative and qualitative hydrological impacts, and to develop sustainable strategies in accordance with the precautionary principle, can only be planned and implemented in frames of a long-term programme. The individual work and study areas need to be checked for their technical compatibility and presented in a holistic way which takes into account the entire set of their relationships."

Greece

- Greece has 14 river basin districts, out of which 5 are international sharing water courses with Albania, Former Yugoslav Republic of Macedonia and Bulgaria to the north and Turkey to the east.
- A central webpage provides all information on the implementation of the WFD.
- The timing of consultation on the draft RBMPs has not been defined yet.
- Information in Greek

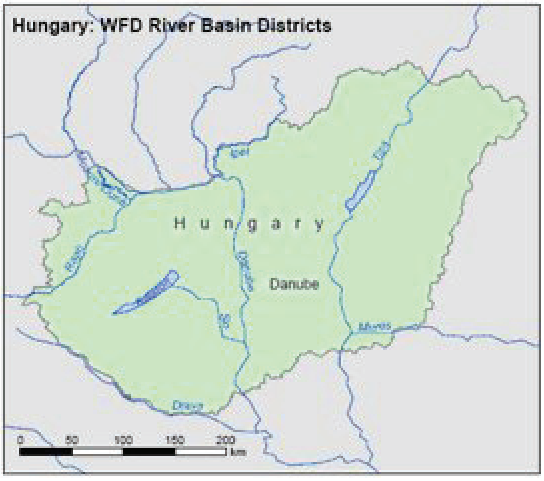
General approach

As the consultations on the adoption of the RBMP for Greece were still ongoing at the time of preparation of this report and the final version of the plan is not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

[35] http://www.wasserblick.net/servlet/is/102568/

Hungary

- Hungary has 1 RBD, which is an international water course, the Danube, shared with Slovakia to the north, Austria and Germany to the west, Croatia, Serbia, Romania, Bulgaria, Moldova and Ukraine to the south and east.
- The Hungarian RBMP was adopted early May 2010 and published on a central webpage, which provides all information on the implementation of the WFD : www.euvki.hu
- Consultation on the draft RBMPs took place between 22/12/2008 and 18/11/2009: www.vizeink.hu
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Hungarian



Hungary is divided in two by its main waterway, the Danube (Duna); other large rivers include the Tisza and Drava, while Transdanubia contains Lake Balaton, a major body of water. The largest thermal lake in the world, Lake Heviz (Heviz Spa), is located in Hungary. The second largest lake in the Pannonian Basin is the artificial Lake Tisza (Tisza-to). A recent vulnerability assessment[36] revealed the following most severe problems in the hydrology and water management area (Tables 3 & 4).

Table 3. Vulnerability assessment of the climate change effects on the hydrology and water management in Hungary[36]

Climate change impact	Vulnerability effect
Increasing climate aridity, increasing surface temperature and heat dissipation, decreasing precipitation	Less drainage and water infiltration, the annual renewable hydrological reserves decrease, water balance of lakes and ponds deteriorates, water exchange cycle slows, lakes disappear.
Increasing summer temperature, decreasing summer precipitation	Less drainage on summer, reference (August) hydro reserves decrease. The natural water reserves in lakes decrease in summer, the periods with low water level increase and lengthen. Decreasing humidity of soil, lengthened dry periods.
Melting of glaciers in countries bordering Hungary	Periods of low water level on the Danube shift from autumn months to earlier months.
Rising of winter temperature, change of winter precipitation and the proportion of rain thereof, reduction of humidity stored in snow cover	Rain related drainage increases in winter, the snow related delayed drainage comes earlier and since the proportion of rain and snow can not yet be estimated reliably, floods can come earlier, the rivers peak at higher levels, with high uncertainty, the winter precipitation increase can cause increase in infiltration, ice cover on waters can reduce.
Increasing frequency and intensity of large precipitation	Intensity and frequency of floods at inhabited area are expected to increase.

Table 4. Assessment of the presently foreseen climate change related problems and their vulnerability rankings in Hungary[36]

Present problems foreseen	Vulnerability level	Climatic vulnerability
Large territories are endangered by flood. The annual flood levels and the frequency of extreme floods increase. Potential of heightening the dams is limited.	High	Melting floods: winter-spring temperature, precipitation, extreme floods: large rainfalls. Significant role of non-climatic factors (e.g. deforestation)
One-third of the country's lowlands is strongly or moderately threatened by inland inundation.	High	Spring-summer temperature, precipitation, frost. Significant role of non-climatic factors (e.g. land-use)
The Great Plain lacks utilisable surface water resources. In certain areas there is no local surface water source, the water system of the river Tisza is strongly exploited. Lack of surface water limits localisation of water demand, or latter is too strongly relying on underground water sources, thereby depleting them.	High	Drying climate: reduction of precipitation, increase of temperature (and evaporation potential). Precipitation and temperature of summer months.
The concentrated, overdriven underground water extraction results in negative water balance and ecological consequences. The danger of harmful influence on thermal waters is prevalent.	Medium	Autumn and winter precipitation, summer temperature (and evaporation). Significant role of non-climatic factors (extreme water takeout).
Conflicts arising from water level control in big lakes (Balaton), holiday resort role of the lake, lake bank's defence require smaller fluctuations; natural habitats require larger fluctuations in lake level.	High	Water level fluctuation, change in natural water resources is sensitive to interannual precipitation and temperature variance.
Unfavourable ecological conditions of surface waters, according to statistical measurements 70-80% of surface waters have unfavourable qualifications. Most critical conditions can be found in stagnant waters, or slow flowing waters and are caused by appearance of organic and dangerous contamination, nitrogen and potassium dilution and thermal waters lead-in (salt-content and temperature).	Medium	Precipitation (evaporation) and temperature of summer months. Significant role of non-climatic factors (pollutants, hydromorphological changes).
Quality of underground water is in danger, in the vicinity of settlements. Drinkable water bases are located in vulnerable geographical areas, 40% is not secured, endangering 3.5 M population.	Medium	Precipitation. Significant role of non-climatic (soil, geological attributes, hydrological relations) and anthropogenic (pollutants) factors.
Some settlements have inadequate waterworks, 35% of dwellings are not connected to communal pipeline systems, 30% of wastewater gets to receptor waters without biological treatment, 70% without grade III. treatment. Roughly 900d settlements are supplied with water not complying with EU regulations.	Low	Decisive role of non-climatic factors (financial, institutional).
Anthropogenic regulations influencing surface waters (dams, storage formulation etc.) resulted in hydromorphological changes which led to several ecological conflicts, emphasised areas are in Szigetkoz, descent of Danube's bottom, water biosphere reduction, Lake Fertő, etc.	Medium	Not well examined
Waterflows' quality and quantity from abroad are strongly influenced by foreign factors (water extraction, storage, wastewater lead-in, disastrous type of pollutions)	High	Water collecting areas beyond the country's borders. Non-climatic effects (foreign water use, wastewater lead-in, international contracts).

The report listed the following measures that need to be undertaken to adapt to CC in the fields of hydrology and aquatic ecosystems[36]:

- *Development and formulation indicator and monitoring systems to follow CC impacts on hydrology and water management, preparation of impact assessment studies*
- *Assessment of the real constraints and potential for adaptation with special regards to utilisable water reserves and flood control*
- *Development of economic water usage, higher involvement of local water assets and precipitation*
- *Repeated measuring and assessing of water restraint potentials and surface and under-surface water reserves*
- *Mandatory development of detailed CC related impact assessment for significant hydrological investments*
- *Reduction of non-climate related impacts on hydrological reserves (land use, urbanisation, settlement policy, wastewater)*
- *Quantitative and qualitative assessment of water reserves trends, as well as water demand and supply trends has to be undertaken in order to ensure the security of underground water management*
- *Assessment of CC impacts on the natural status of surface and underground waters*
- *Impact assessment for water catchment areas and development of indicator system for monitoring changes in the natural waters.*

General approach

CC issues are addressed in Chapter 11 of the Hungarian RBMP. In the first part, the observed and projected changes in Hungarian climate and the consequences of CC on water quantity and water resources quality are analysed. The second part of the chapter discusses the integration of CC adaptation in the RBMP of Hungary. In the coming decades, significant changes in temperature and precipitation can be anticipated in Hungary, potential drift of the seasons, and an increase in frequency of certain extreme weather phenomena will threaten the natural systems (including water bodies) and agricultural yields, environment, public health and quality of life. Research under the IPCC has revealed that the high biological diversity and species richness in Hungary is highly vulnerable to CC.

[36] Hungarian 5th National Communication to the UNFCCC. 2009

Climate change in Hungary

The statistical characteristics of meteorological changes show an increase in the mean temperature of 0.1°C per decade over the last 50 years and a decrease in annual precipitation of 10 mm per decade. The scientific community has agreed that human impact has played a significant role in the about 0.5°C warming that occurred in the second half of the 20th century. The most recent studies show a likely faster future increase in temperature in Hungary (around 1.5°C over the first third of the 21st century, and up to 4-6°C by the end of the century), slightly decreasing annual rainfall (in the first third of the century, 4.5% increase in winter half-year and 5% decrease within the summer semester, long-term forecasts anticipate a decrease in summer precipitation reaching 10% as assumed from the proportionality to temperature, but it is uncertain at temperature changes over 4°C), and a higher potential evaporation (the expected change 15% per °C in winter, and 10% per °C in summer). The projections are often conflicting in case of seasonal rainfall changes, however, significant changes are expected in extremes. The number of days with more than 1 mm of precipitation is expected to decline, while the number of days with more than10 mm precipitation is expected to increase (ETH regional model), the number of days with extreme amount of precipitation (over 20 mm/day) will increase most in January, while the largest, nearly 50% decline will occur in July.

CC consequences on water quantity and quality

Rising of winter temperature, change of winter precipitation and the increasing proportion of rain will reduce the humidity stored in snow cover. The surface runoff increases in winter, as the winter precipitation previously stored as snow, will drain without delay. Since the proportion of rain and snow cannot be estimated reliably, floods can come earlier, the rivers peak at higher levels and with high uncertainty. Due to the increase of winter precipitation, and increasing frequency and intensity of heavy precipitation events, the frequency of floods in inhabited areas is expected to increase endangering large territories, first of all the Cserehát area the Zemplén Mountains and the Hernád valley.

Increasing climate aridity and decreasing summer precipitation are projected to significantly reduce the volume of renewable surface water resources. Less drainage and water infiltration will decrease the annual hydrological reserves, water balance of lakes and ponds deteriorates as the water exchange cycle slows down. The size limits the filling of reservoirs in the winter period and the evaporation in summer increases the water loss. The natural water resource in lakes decreases in summer, and several of the lakes in the Great Hungarian Plain will dry up which will decrease the extent of wetland habitats and cause a loss of natural values of the country. The duration of low water periods will extend. On the Danube, periods of low water level shift from autumn months to earlier months.

The smaller amount of water will increase the sensitivity of water bodies to pollutant loads. On the other hand, sudden, rapid floods flush large quantities of pollutants and nutrients from the catchment into rivers and streams. The risk of industrial emergency events increases.

The deterioration of environmental conditions by drier weather is already observed in Danube and Tisza rivers and more water habitats, saline lakes, groundwater-dependent ecosystems become vulnerable to CC.

CC will affect groundwater quantity and quality. Due to less precipitation, higher potential evaporation and drier soil, groundwater recharge is expected to decrease. In the Great Plains the decrease will be the greatest. The Great Plain lacks utilisable surface water resources. In certain areas there is no local surface water source, the water system of the river Tisza is strongly exploited. Irrigation water demand, which is strongly relying on underground water sources, will deplete them in 50 - 100 years that would jeopardize the prospect of using a large proportion of groundwater resources for drinking water. Less water infiltration for a similar quantity of pollutants will increase the pollutant concentrations in groundwater. This effect may be offset by reducing the pollutant load.

CC is expected to affect the spatial distribution of species. The decline in biodiversity caused by water balance changes is expected to have large regional differences depending on the sensitivity of each habitat to CC. The changes occurring in water regime have different forms and degrees but in principle, affect the entire country. The nature of the change depends on the characteristics of the area. The country's highlands and hilly parts are highly vulnerable to CC-induced biodiversity losses. From this point of view, High-Bakony, Kıszegi Mountains, Vendvidék and the Northern Range are among the most vulnerable areas.

Integration of CC adaptation in the RBMP of Hungary

Based on the results of the VAHAVA project (Getting Prepared to (combat) Climate Changes in Hungary) and the last IPCC report, the **Hungarian National Climate Change Strategy** was published in 2008, which addressed a major water management issues and formulated the adaptation measures to water-related changes that were included in the **RBMP**:

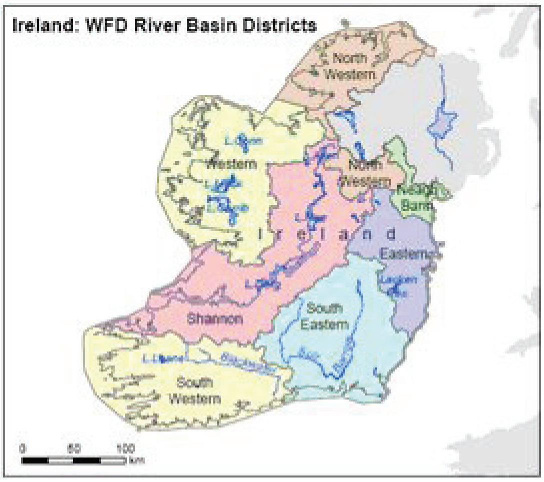
- *The absolute need to develop a new water resources management (drought tolerant plants, water-saving irrigation technologies and equipment), and apply water saving methods, and thereby increase the efficiency of water use, i.e., to ensure sustainable water use* (Chapter 8.5. and 8.6.).
- *The fast water runoff based approach should be replaced by floods retention, which appears in both the floods and droughts risk management plans and measures* (Chapter 8.2.4.).

- *Treated waste water should be kept on site* (Chapter 8.2.1.).
- *The decline of the dilution capacity due to low water in streams should be taken into account in waste water discharge into natural recipients* (Chapter 8.2.1.).
- *The flood water management must be approximated to natural regimes; the RBMP morphological measures in the floodplains should targeted at flood formation, in part, restoration of the floodplain and ecological aspects with a flexibility for the treatment of extreme floods* (Chapter 8.4.2.).
- *Restoration of wetlands. The importance of wetland habitats and forested, is currently increasingly highlighted* (Chapter 8.2.4.). *The restoration of wetland habitats must ensure their water-holding capacity, therefore, a complex water management system should be developed, for local water supply and to protect the ecosystems* (Chapter 8.7.1.).
- *The impact of CC induced low water supplies can be markedly reduced by increasing the storage capacity. The role of water storage for water resource management is expected to increase, while the construction and operating of the storage capacities must take into account the WFD ecological prescriptions* (Chapter 8.4.3).

The RBMP has a review cycle of six years that allows amendments to those measures when the knowledge on CC and its impacts become more accurate, ensuring a flexible adaptation.

Ireland

- Ireland has 7 RBDs, out of which 3 are international sharing water courses with Northern Ireland.
- The 2009-2015 RBMPs were adopted in July 2010 and are available at : http://www.wfdireland.ie/
- A central webpage provides all information on the implementation of the WFD, also, http://www.epa.ie/environment/water/, http://www.environ.ie
- Consultation on the draft RBMPs took place between 22nd December 2008 and 22nd June 2009.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Gaelic



- Read more about water management in the River basin Districts on the specific pages of the relevant Competent Authorities:

- IRBD Shannon
- RBD South Eastern
- RBD Western
- RBD Eastern
- RBD South Western
- IRBD North Western
- IRBD Neagh Bann

General approach

The CC and water issues in Ireland were summarised in a report „Draft RBMPs. Adapting the Plans to Climate Change“ published in December 2008. The report gave an overview on observed and projected CC in Ireland and described the 'climate check' procedure of the Programme of Measures.

Current CC predictions for Ireland

- The climate is warming, particularly in the summer and autumn (1.2-1.4°C in mid century, increasing up to 3.4°C towards the end of the century). The warming is greatest in the south and east of the country.
- Autumn and winter are becoming wetter: 5-10% increase in mid century, increasing 15-25% towards the end of the century. Summers are drier: 5-10% decrease for 2021-2060; 10-18% decrease towards the end of the century. Extreme rainfall events are likely to increase in frequency in autumn and winter
- The ensemble set shows slight increases in winter wind speeds (1-2%) and decreases in summer (2-3%) for 2021-2060. However, towards the end of the century there is an overall decline in speeds, particularly in summer (4-5%).
- There will be an increase in the frequency of the very intense cyclones with maximum wind speeds of more than 30 m/s; and increases in the extreme values of wind and precipitation associated with the cyclones. This will translate into an increased risk of storm damage and flooding.
- Sea temperature and sea level around Irish coastlines have been rising slowly in recent decades. Since the 1980s satellite and in situ observations show a general warming trend of 0.3-0.4°C per decade in Irish waters, mirroring temperature trends over land. However, over the Irish Sea the satellite measurements suggest a more rapid warming rate (0.6-0.7°C per decade). Rising sea levels in recent decades are primarily linked to the warming of the oceans and resulting thermal expansion of seawater, and the influx of water from melting land ice. Satellite measurements show that sea levels are rising

on average about 3.5 cm per decade around Ireland, well in excess of the ongoing isostatic adjustment of the land.

- Ocean modelling results indicate an increase in the frequency of storm surge events around Irish coastal areas. There is also a significant increase in the height of extreme surges (in excess of 1 m) along the west coasts, with most of the extreme surges occurring in wintertime.
- Modelling results suggest an amplification of the seasonal cycle across the country, with increased winter precipitation leading to a rise in winter stream flow (~10%), and the combination of increased temperature and decreased precipitation causing a reduction in summer stream flow (~30%). Change to the seasonal cycle will have an impact on water supply management and design. Increased winter flows, coupled with the predicted increase in extreme precipitation events lead to an elevated risk of flooding. This is particularly significant in the southwest of the country, and those catchments with fast response times. The decrease in summer stream flow will impact on water availability, water quality, fisheries and recreational water use.
- CC, including changes in precipitation patterns, may result in significant changes and losses for water dependent habitats and species, and biodiversity.

Climate checking of RBMP was achieved by:

- Assessing risk, due to CC, of not achieving good water status or no-deterioration in water status as a consequence of the identified pressures, such as abstraction.
- Integrating the impacts of CC when identifying and appraising the Programme of Measures and proposing appropriate adaptation of actions where necessary.
- Looking for opportunities in the monitoring programme to improve our understanding of CC trends.

Certain measures have been categorised as win-win, no-regrets, regrets, and adaptation actions.

Win-Win Solutions are robust measures in the context of CC. For example, some ecological improvements can increase water retention capacity of soil and help against increased flood risk.

No-Regret Solutions are measures that are robust and flexible enough to be viable under different climatic scenarios and thus will not be affected later by CC. Measures to reduce diffuse nutrient pollution are examples.

Regret Solutions are measures that bear a high risk of being counter-productive regarding adaptation to CC, because CC reduces effectiveness, increases costs, reduces adaptive capacity of other sectors or ecosystems, etc.

Adaptation solutions are measures specifically for adaptation to CC. Examples include designing of Sustainable Urban Drainage Systems (SUDS) and creating water storage capacities to enhance environmental flows. The majority of the actions proposed within the RBMP are identified as no regrets approaches.

Climate issues may be relatively significant for measures related to:

- protected areas and high-status sites,
- abstractions,
- physical modifications to river and marine morphology.

Considerations also arise for point-source discharges and diffuse landuse pressures such as agriculture, forestry and unsewered systems. Sensitivity for dangerous substances pressure is likely to be low.

Compared to other countries, such as Finland and UK, who also have reported the results of 'climate checking' in detail, the wording of the adaptation measures in the Irish report is different. If the other countries describe how CC affects the efficiency of measures or what additional actions should be taken to tackle the impact, the Irish measures in many cases just state that the „plan should allow for" a deterioration (Table 5).

Table 5. Examples of climate change adaptation measures in RBMPs of Ireland

Existing measure	Potential Climate Adaptation
The Nitrates Directive (91/676/EEC) Carry out monitoring surveys of water quality and agricultural practices, including studies of agricultural mini-catchments. Identify waters which are polluted or are liable to pollution and development and implement action programmes.	Actions should allow for potential washout of pollutants to surface waters during increasing rainstorms and for changes in groundwater contribution to surface waters.
Agriculture Creation of buffer strips around water bodies to prevent pollutant loss. Installation of fencing to prevent livestock access to Watercourses.	Programmes must allow for increased contamination from nutrients during less frequent but intense rainfall events.

This may leave a wrong impression as if less stringent environmental standards were requested by the adaptation measures. The message included in the adaptation measures would obviously have been more unequivocal (at least for a non-native English speaker), if instead of 'allow for' expressions like 'cope with', 'address', 'tackle' or 'consider' would have been used.

The report concluded that the Programme of Measures can be flexible and adaptable to potential future CC, in terms of temperature, storm surge, floods and droughts. In fact, many contribute to national adaptation strategies.

The analysis highlights the advantages of an integrated catchment-based approach to water management. It contributes to adaptation strategy and strengthens future science/policy link on CC and water by identifying research needs, communicating them to the research community and making best use of available research results.

Italy

- Italy has 8 RBDs, out of which 2 are international sharing water courses with France to the west, Switzerland and Austria to the north and Slovenia to the east.
- A central webpage http://www.direttivaacque.minambiente.it/distretti_idrografici.html is available to provide information on the implementation of the WFD.
- Each of the 8 RBDs consists of more than 1 region. Italy carries out a consultation process first on regional water protection plans (piani di tutela delle acque). This process will be followed by the consultation on the RBMPs on RBDlevel (piani di gestione).
- Consultation on some of the regional water protection plans is ongoing or has been completed. Read more about the regional water protection plans, which are currently available, and their consultation on the specific pages of the relevant regions:
    - Basilicata
    - Emilia Romagna
    - Lazio
    - Liguria
    - Lombardia
    - Marche
    - Piemonte
    - Sardegna
    - Toscana
    - Trento
    - Umbria
    - Valle d'Aosta
    - Veneto
- Consultation on the draft RBMPs are ongoing :
    - Eastern Alps
    - Po
    - Northern Appenines
    - Central Appenines
    - Southern Appenines
    - Sardinia
- Information in Italian

- Sicily
- Pilot RBD Serchio

- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

General approach

CC has been differently addressed in the three selected RBMPs of Italy (Po basin, Southern Apennines, and Sicily).

The Programme of Measures of the Po RBMP[37] includes a chapter (4.1.4) dedicated to CC issues. It summarises the major observed changes in the Po river basins and analyses the potential impacts. Detailed measures found in Annexes 7.9[38] and 7.10[39], will enable to address the critical issues and cope with emergencies district-wide in a systemic way.

The Programme of Measures of the Southern Apennines[40] including 7 of the 20 regions of Italy (Abruzzo, Basilicata, Calabria, Campania, Lazio, Molise, and Puglia), does not include any reference to CC, while the plan of additional measures[41] mentions only one CC related measure: the need to estimate the potential effects of CC on water resources of the basin (according to the scenario hypothesis of water shortage).

The approach in the Sicilian RBMP[42] is to assess how CC may influence the likelihood of achieving the targets set by the WFD, even if the time frame of the WFD and the first RBMP do not allow to consider any changes, to estimate possible adaptation actions and analyze how the monitoring under the RBM Plan can help to understand more thoroughly the "ground effects" of CC.

Climate change in Po RB

The events of water scarcity and flood, which occurred in the Po Basin in the last twenty years, are consistent with the predictions of the effects of global warming on the climate: increase of the frequency and intensity of natural disasters related to weather variables.

[37] Programma di misure. Autorita di Bacino del Fiume Po. Piano di Gestione del Distretto Idrographico del Fiume Po. Elaborato 7.
[38] Elenco delle misure specifiche. Autorita di Bacino del Fiume Po. Piano di Gestione del Distretto Idrographico del Fiume Po. Versione del 24 Febbraio 2010 Allegato 7.9 all'Elaborato 7.
[39] Elenco delle misure di riferimento per gli scenari e i temi chiave del Piano. Autorita di Bacino del Fiume Po. Piano di Gestione del Distretto Idrographico del Fiume Po. Versione del 24 Febbraio 2010. Allegato 7.10 all'Elaborato 7.
[40] Piano di gestione acque (Direttiva Comunitaria 2000/60/CE, D.L.vo 152/06, L. 13/09, D.L. 194/09). Relazione Generale. Allegato 16. Programma di misure. Distretto Idrografico dell'Appennino Meridionale
Autorità di Bacino Nazionale dei Fiumi Liri-Garigliano e Volturno, Febbraio 2010
[41] Piano di gestione acque (Direttiva Comunitaria 2000/60/CE, D.L.vo 152/06, L. 13/09, D.L. 194/09). Relazione Generale. Allegato 17. Misure supplementari/indirizzi, Febbraio 2010.
[42] http://www.artasicilia.it/web/pdg_web/index.html

The impacts of CC include, in addition to weather extremes, the melting of glaciers, rising sea levels and changes in productivity of crops. Other aspects, such as loss of biodiversity and ecosystem goods and services, increased risks to human health and damage to the socio-economic activities like energy production, transport, agriculture, and tourism, remain to be assessed properly.

With specific regard to the management of water resources, CC will have certainly impacts on the quality, as well as on the quantity of the resources. It is important for the RBMPs to cover the different scenarios available.

Adaptability and integration are the two key words to address the new climate conditions and the related uncertainties.

There is a general decrease of the total volume of annual rainfall, in the Po river basin, while the intensity of rainfall shows a clear upward trend. This trend is also observable on shorter time scales: from 1975 to 2007, the average annual rainfall in the Po basin decreased by 20% (Climate Conference, Rome, 2007).

The changes affect not only the precipitation but also temperature, with increasing trends recorded since mid-1800s until the end of 1900s both for minimum and maximum temperatures with a marked increase during the winter season.

The consequences of CC on biodiversity and the state of ecosystems may change the reference conditions for water bodies, introducing additional uncertainties (also due to the complexity of the impact analysis) to the effectiveness of the measures put in place by the RBM Plans, therefore changing the outcome of cost-benefit assessments.

At the European level, the instruments for CC adaptation are already in place by the Flood Directive and the proposed Marine Strategy Directive that may include impact analysis of the CC, and corresponding measures in their action plans. Many of the measures already planned for other policy areas can also act synergistically for tackling CC. In particular, the measures planned to fill the existing knowledge gaps may in future help to identify priorities and find solutions to emergencies with better established and more robust tools.

The list of specific measures for River Po RBD includes a table, which identifies 4 shared adaptation strategies to CC:

1. Planning of the district-scale water balance, with identification of critical and quantitative measures to reduce incidence and intensity and for the maintenance and / or improvement of the status of surface water bodies.
2. Extending the application of agri-environment measures of the Rural Development Plans implying further action and / or interventions aimed specifically at the WFD objectives.
3. Redefining and adapting the Programme of Measures to the CC scenarios in the Po Basin.

4. Creating resource conservation plans for the various uses for hydrographically homogeneous areas at subbasin level.

The first three of these strategies are planned to be realized in a short term while the fourth is a medium term strategy.

Southern Apennines

The Programme of Measures of the Southern Apennine area including 7 of the 20 regions of Italy (Abruzzo, Basilicata, Calabria, Campania, Lazio, Molise, and Puglia), does not include any reference to CC, while the plan of additional measures mentions only one CC related measure: the need to estimate the potential effects of CC on water resources of the basin (according to the scenario hypothesis of water shortage). The main factors affecting water resources will be the reduction in rainfall and the increased evaporation losses from the catchment.

Sicily

Sicily can be described as typically Mediterranean, characterized by long hot dry summers and short mild and rainy winters. The regional average values both of temperature and rainfall show great differences depending on the period selected and even more depending on latitude, altitude, exposition, and distance from the sea. Chapter 4.6 in the Environmental Report of the Sicilian RBMP notes that water resources in Sicily are particularly vulnerable to the effects of CC. The precipitation regime and trend in temperatures can have major impacts on the water cycle, on the balance of water bodies (including ecosystems) and economic conditions related to available water resources. The approach is to assess how CC may influence the likelihood of achieving the targets set by the WFD, even if the time frame of the WFD and the first RBMP do not allow to consider any changes, to estimate possible adaptation actions and analyze how the monitoring under the RBM Plan can help to understand more thoroughly the "ground effects" of CC.

Unfortunately, the folder including all annexes to the Sicilian RBMP was damaged and the specific measures, in case they were planned, could not be accessed.

Latvia

- Latvia has 4 RBDs, all of them are international sharing water courses – with Lithuania to the south, Byelorussia and Russia to the east and Estonia to the north.

- The 4 RBMPs were published and are available at the website of the Ministry of the Environment in Latvia and on the website of the Latvian Environment, Geology and Meteorology Centre.

- Consultation on the draft RBMPs took place between 22 December 2008 and 22 June 2009.

- Read more about consultation on the specific page of the relevant Competent Authority:
    - Information about water management in Latvia including consultation
    - RBD Daugava
    - RBD Lielupe
    - RBD Venta
    - RBD Gauja

- Key documents and links to key documents are available also in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

General approach

All four RBMPs of Latvia mention a workshop of CC researchers held on 22nd May 2009 where possible impacts of CC on river basin management in Latvia was discussed. This workshop was attended by representatives from the Latvian University, Latvian University of Agriculture, Daugavpils University, Latvian Institute of Aquatic Ecology, Ministry of Environment, and Regional Development and Local Government. However, no information is given on the outcome of these discussions nor have CC issues been integrated in the RBMPs of Latvia.

Lithuania

- Lithuania has four RBDs, all of which are international. Nemuno RBD shares water courses with Byelorussia, Kaliningrad (Russia) and Poland. The other three - Dauguvos, Ventos and Lielupės - RBDs share water courses with Latvia.
- There are different links providing information on water management issues, e.g. “Water protection aims”, “RBDs”, “RBDs Management Plans”, “RBDs Programmes of Measures” and other aspects of WFD implementation on the webpage of the Competent Authority – the Lithuanian Environmental Agency.
- Read more about consultation on the specific pages of the Lithuanian Environmental Protection Agency - ‘The role of public’.
- The draft RBMP for Neumo RBD was foreseen to be adopted by 30 July 2010.
- Consultation on the draft RBMPs and Programs of Measures of the other three RBD - Dauguvos, Ventos and Lielupes - were submitted to consultations with interested parties in May 2010 and expected to be approved by 30 September 2010.
- Key documents and links to key documents are available also centrally in the Commission’s CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Lithuanian

As the consultations on the adoption of the RBMP for Lithuania were still ongoing at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

According to the preliminary questionnaire[43] on the intentions of the Member States to include CC issues in the RBMPs, Lithuania did not know yet how much detail will be provided explaining that it depends on the findings of the relevance and severity of the impacts of CC to particular water bodies. The RBMP might contain evaluation of effects and, if they are significant, it may also contain measures that are adapted to possible CC implications. The details for adaptation measures are not known now because such actions are still pending.

[43] Nixon, S. 2008. Summary of information received from Member States on best practices and approaches for a climate check of the first Programmes of Measures. WRc Report to the Strategic Steering Group on Climate Change and Water. Version no. 2, 21 August 2008.

Luxembourg

- The territory of Luxembourg is divided between 2 RBDs Maas (70 km^2, 2.7%) and Rhine (2527 km^2, 97.3%), which are international sharing water courses with France in the southeast, Belgium in the northeast and Germany in the West.
- The RBMPs for Luxembourg were adotped in December 2009, and can be downloaded from this webpage.
- A central webpage provides all information on the implementation of the WFD.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - National level of Luxembourg
    - International Commission of Rhine
    - International Commission of the Mosel
    - International Commission of the Maas
- Information in German
- Information in French

- Consultation on the draft RBMPs took place between 22/12/2008 and 30/06/2009.
- Key documents and links to key documents are available also in CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title

General approach

Problems with water shortages and drought are not currently relevant for Luxembourg. Renaturation and the natural water management have been consistently implemented for all maintenance works in the recent years. They increase the adaptation potential of natural waters, improve habitats and biodiversity of aquatic organisms and also contribute significantly to the weakening of the peak flow in the medium flood events. The separate treatment of storm water in new development areas, either by direct introduction into water bodies or through infiltration not only reduces the loading of treatment plants with clean water, but also contributes to the reduction of flood peaks caused by the additional impermeable surfaces. Some preliminary work on adaptation to CC has been done in the Luxembourg water management in the areas of flood risk management, low-water management and drought. In the future, it is essential to plan an adaptation strategy to CC taking into account a sustainable and efficient management within the network of water users, which deals also with other areas such as agriculture, energy, and land use. The CC related water management issues in Luxembourg and the development of further adaptation srategies are presented in Chapter 6.2 of the RBMP

Problems with water shortages and drought are not currently relevant for Luxembourg. The low water and drought issues in the future will be analysed in Luxembourg adaptation strategy to CC. In high-consumption summer months, can it as maximum create technical problems for water supply.

Adaptation strategies to climate change in Rhine river basin

The background paper for the German adaptation strategy to CC refers to possible increase of annual average temperature by the year 2050 from +1.0 to +2.2 °C compared to the period from 1960-1990. That will bring about possible regional changes in precipitation from -5 to -25% in the summer months and 0 to +25% in the winter months in the same periods. It is assumed that the frequency of extreme weather conditions continue to increase. Heat records with long-lasting drought in the summer lead to both drought conditions affecting the ground water budget as well as more frequent low flow conditions in streams and rivers. The frequency of heavy precipitation events and the increase in winter precipitation with lesser proportion of snow reduces the storage of precipitation and, correspondingly, increases the probability of flooding in the winter months. If the reduction of greenhouse gas emissions has mainly an energy-economic dimension, it can be assumed that the water management will play a key role in the adaptation programs.

A current study by the International Commission for the Protection of the Rhine (ICPR) includes the Luxembourg data providing additional information on the regional climate projections in the Rhine area, and discharge conditions of the Rhine and its tributaries. A long-term cooperation has been established between the Centre de Recherche Public Gabriel Lippmann and the Water Management Administration in building up a water management data base. This research has already indicated trend shifts in precipitation amounts and frequencies. Both WFD and the EC Flood Directive[20] offer appropriate tools for the integration of climate adaptation issues in water management. The integrated management of water bodies aiming to achieve of the good status by 2015 and ensure a long-term sustainable use, is laid down in action programs and management plans for the whole river basin first time in December 2009 and will be further reviewed with a 6-year interval. The flood risk is coordinated within national flood risk management plans in the catchment areas. Luxembourg, located in the watershed between the Rhine and Maas, could build its plans upon the long-term traditions of international cooperation in the river basins of the Moselle, Rhine and Maas. The above-mentioned EU directives are integrated in the Luxembourg law of water since 2008.

The preliminary management plan was prepared in the years 2007 to 2009 under the EC WFD with the involvement of all stakeholders and the public. It contains costly measures in the field of sewage treatment and measures to reduce diffuse loads of pollutants from agricultural (nutrients and pesticides). To achieve the cost-effective return of water bodies into natural status and thus contributing to improved retention of water in the catchment, the renaturalisation of water bodies and the natural water management have been consistently implemented for all maintenance works in the recent years. They increase the adaptation potential of natural waters, improve habitats and biodiversity of aquatic organisms and also contribute significantly to the weakening of the peak flow in the medium flood events. The separate treatment of storm water in new development areas, either by direct introduction into water bodies or through infiltration not only reduces the loading of treatment plants with clean water, but also contributes to the reduction of flood peaks caused by the additional impermeable surfaces.

Flood risk management in a changing climate

In the area of flood protection, the Moselle river basin can serve as a pilot area when all bordering countries have improved the flood forecast and _created flood hazard maps_ according to the EC Flood Risk Management Policy showing the affected areas, potential hazards for people, environment and material assets and the particular hazard risk. Since, according to Luxembourg's Water Act, these maps can be included also in the municipal development plans (plans d'aménagement généraux, PAG), _the extremely flood prone areas will be kept free of buildings_ in future and _in areas of low hazard, buildings will be flood-adapted_. The _flood forecasting can be based on a long-standing cross-border cooperation between competent authorities with the involvement of scientific research._ The recent simulations, as well as the work on the uncertainties in the flood risk assessment carried out at the Centre de Recherche Public Gabriel Lippmann are of valuable support.

In order to support to cross-border flood protection in the basin of the Moselle and Saar regarding CC, the water management authorities have initiated a project FLOW-MS (Flood and Low Water Mosel / Saar) funded by the EU Interreg IV-A Programme. Within this project, _Flood Partnerships of communities will be founded in selected parts of the catchment area exposed to a comparable flood hazards. The aim of these partnerships is to better inform the local population of flood hazards and to improve flood protection and flood prevention._ In addition, an international support centre for flood partnerships was recently established in Trier at the Headquarters of the International Commission for the Protection of the Moselle and Saar (IKSMS) to support the affected communities during the next 5 years. In this project, _the transboundary flood forecasting system in the Moselle catchment area will be optimized, a competence center providing information and advice to communities on construction precautions will be established_, in cooperation with the University of Kaiserslautern, and _the impact of CC on high and low water conditions in the Mosel basin will be determined._

Drought and low flow management in a changing climate

Both the European White Paper on adaptation to CC and the German adaptation strategy deal besides floods also with the issues of water scarcity and drought. In that context, the communication from the European Commission „Addressing the challenge of water scarcity and droughts in the European Union"(COM (2007) 414 contributes to this issue. Regarding this, it is important to note that although drought periods, that means time-limited periods of declining water supply due to drought and extreme heat, have occurred in the Moselle basin, the Moselle region was never affected by water shortage, a condition in which more water is needed than the sustainable use of water resources can afford.

Drought periods lead to low-water situations in water bodies, which increase river temperatures and deteriorate the chemical quality of water due to the lower dilution potential with respect to discharges from sewage treatment plants. This may affect the ecological status of aquatic ecosystems. In this context, *establishing rules for the minimum residual flows at hydropower plants is of considerable importance*. This will be taken into consideration in the present structural renovation work at the Rosport hydroelectric power plant both in terms of improving the fish passes and installing an ECO FLOW turbine, which also allows to use the downstream compensation water (or residual flow) for power production.

Since the groundwater recharge occurs in the winter months from November to March, the droughts occurring in the summer months, have only an indirect influence on the supply of groundwater, which can be used for drinking purposes. The bottleneck situation in the summer of 2006 had to do with the heat wave of this summer, but was mainly due to the unsufficiency of drinking water distribution infrastructure, and due to a sequence of dry winter during which the groundwater recharge was decreased followed by a decline in spring discharge. The shortages were mainly caused by *unsustainable uses that are more common in the summer months and those which cannot and should not be considered in dimensioning of water supply infrastructure.*

Additional measures for achieving the environmental goals

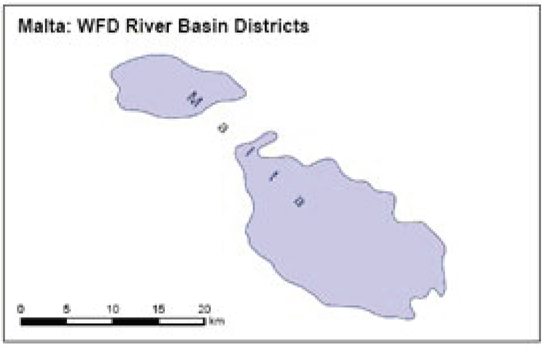
The additional measures are listed in the Annex of RBMP. In the following, some examples are pointed out:

- *Construction measures for separating storm water from the waste water.*
- *Revision of water usage rights of municipalities and industry depending on pollutant loads.*
- *Building measures for improving the water structure.*
- *Staff training on the implementation of structural measures.*
- *Codes of conduct in agriculture, governmental, municipal and private sector.*
- *Advice to farmers, municipalities and the state regarding fertilizer and pesticide use*

New development areas are planned with stormwater and sewage water separation systems and remote retention reservoirs. For the Obersauer and Rosport reservoirs, residual flow guarantees should be included in the licences for water use.

Malta

- Malta has identified 1 RBD for Malta island and Gozo island.
- A central webpage provides all information on the implementation of the WFD.
- The following WebPages provide all the information on the implementation of the WFD in Malta.
    - WCMP Malta – MEPA WCMP Malta
    - Consultation on Significant Water management Issues
    - WCMP Malta – MRA implementation of the WFD

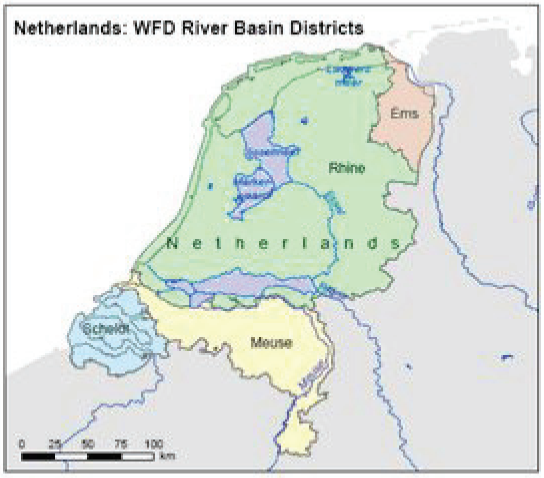


- Consultation on the draft Water Catchment Management Plan started 31 May 2010 and will continue until 31 November 2010. For information on the consultations and to download the draft plan please go to the Malta Environment & Planning Authority webpage.
- Key documents and links to key documents are available also in the CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- The information is only available in English.

As the consultations on the adoption of the RBMP for Malta were still ongoing at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

The Netherlands

- The Netherlands have 4 RBDs, out of which 4 are international sharing water courses with Belgium, France, Luxemburg, Germany.
- RBMPs were adopted in December 2009, and can be downloaded from this page !
- A central webpage provides all information on the implementation of the WFD :
  - http://www.kaderrichtlijnwater.nl/
  - http://www.nederlandleeftmetwater.nl/
- Read more about consultation on the specific pages of the relevant Competent Authorities.
- Consultation on the draft RBMPs took place between 16/12/2008 and 15/6/2009.



- Key documents and links to key documents are available also in the CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- Information in Dutch

General approach

In the Netherlands, CC and adaptation measures are explicitly integrated into the water policy agenda. The water policy objectives of the Netherlands are defined in the **first National Water Plan for the years 2009-2015**. Besides the necessary adaptations to CC, international negotiations are going on for CC mitigation by minimizing emissions of greenhouse gases. The project "Clean and Green" has these ambitious objectives. When addressing the adaptation challenge, climate-neutral measures will be sought whenever possible. The National Water Plan presents a number of specific regional water management issues for coastal areas and rivers, for Ijsselmeer, Southwestern Delta, Randstad, North Sea, Waddensee, High Netherlands, and uban areas.

Climate change projections

Climate proofing of the Netherlands is a major task, particularly for water management. Although climate has changed in all times, there is a general agreement that the climate is changing faster as a result of human activity. Since 1950 global average temperature has increase by more than 0.7 ^{o}C. In the Netherlands and a large part of Europe the observed temperature rise is twice as large as the world average.

According to the Royal Dutch Meteorological Institute (KNMI) the precise changes in the Netherlands due to global warming, are uncertain. The KNMI created in 2006 four scenarios of possible future climate around 2050 projecting a long-term sea level rise of up to 85 cm by 2100 (compared to 1990). The 2009 midterm report "Climate Change in The Netherlands, additions to the '06 KNMI scenarios ", describe the most likely CC scenarios in the Netherlands. Two tables in the National Water Plan describe the likely climate in the Netherlands around 2050 and around 2100 compared to the year 1990 according to the four 2006 KNMI climate scenarios. Besides the KNMI scenarios, the Delta Commission has done its own research. Their analysis is based on an extreme scenario with a plausible upper boundary for the global and regional rising sea levels, changing storminess in the North Sea and long term precipitation changes. Until 2050 the Delta Commission climate scenario does not exceed the bandwidth of the KNMI scenarios. For the long term, the upper limit for (relative) sea level rise in 2100 in the Delta Commission scenario is higher than in the 2006 KNMI scenarios, i.e. from 0.65 up to 1.30 meters.

Climate change impacts on water

The KNMI scenarios project an increase in air temperature, declining summer flows and increasing winter discharges in the Rhine. CC is also expected to cause prolonged periods with high precipitation in winter and intense rainfall peaks in summer. This creates a greater chance of flooding in urban and rural areas in the lower parts of The Netherlands where the storage of water in soil and polders is limited.

Global warming also leads to higher air and water temperatures and longer growing seasons. Netherlands will therefore become less suitable for certain plants and animals and more suitable for others. This has implications for agriculture, nature and landscape, which are already visible. Higher temperatures, especially in combination with drought, are also affecting water quality. The risk of algal blooms and botulism is increasing.

In the lower reaches the sea level rise together with low flows in dry periods, cause salt water intrusion further inland that would hamper the fresh water supply. Both the water demand and the water shortage are expected to increase in summer. This not only affects the water level in rivers and ditches, but also the water quality. The keywords ‘warmer’, ‘drier’ and ‘saltier’ show well the challenges that The Netherlands face.

CC requires a reconsideration of the current strategy of the fresh water and salinity control. With CC and occasional prolonged periods of drought, desiccation will need more attention. Desiccation occurs in several areas in the Netherlands and may result in loss of biodiversity. Enough fresh water with the right quality at the right time is vital for these areas.

CC adaptation issues

Although flood risk dominates the adaptation agenda in water policy, the increased risk of dry spells and water shortages is also recognised. Safety continues to be the top priority. Other goals are to avoid destruction of the considerable cultural, historical and natural value of the river landscapes.

The basic values of CC adaptation measures are their robustness and / or flexibility. A robust device or system is generally resistant to extreme events and able to meet various possible future developments. A water system is robust when it uses natural processes or uses the space. Natural systems on their own offer resistance to disruptions and have some resilience after a disturbance maintaining and restoring their function and adapting to changed conditions.

Allocating more space for water in addition to implementing technological measures is one of the guiding principles in the Duch CC adaptation programme. Instead of increasingly adapting the water systems to the human needs, they try to give more room to natural processes that would make them less dependent on technology and changing circumstances. The effects of CC, accelerated sea level rise, higher peak flows in the rivers, periods of drought or flooding and shifting ecological balance, only increase this necessity.

Water shortage and water supply

Until 2015, the existing arrangements for water policy and management in the Netherlands will be maintained. Yet, until 2015 under normal conditions with current policy, no major problems are expected. *In periods of water shortage, water will be distributed in proportion to the priority sequence to limit damage.* National priority sequence remains valid and is regionally refined. If water levels drop below a critical value, water boards can temporarily restrict withdrawals of ground and surface water and establish a watering ban.

In this planning period, it may be necessary for the government to make decisions on the long term freshwater supply and salinity control in the Netherlands for the, including infrastructures for this action. The solutions are developed in the next planning period together with the regions. The main features of this new strategy are a greater regional self sufficiency and an optimization of freshwater distribution in the main and regional water systems. These include both groundwater and surface water. Here the solutions in different areas (drinking water, agriculture, nature and shipping) should be considered and clarified in conjunction with the (spatial) implications for regional systems and functions. The relationship of the solutions with water safety and water distribution should be specifically considered.

The government believes that within the current policy frameworks steps can be already taken to **climate proof the plan by no-regret measures**. The gradual shift to crops that are less sensitive to drought and high salinity and adaptation of land use are part of this process. The alternative strategies for a sustainable and climate-proof fresh water supply for The Netherlands include social, hydrological, and technical solutions. Efficient and smarter use of available fresh water in agriculture, industry, water companies and waterways are an essential part of the new strategy. Seasonal

Storage of fresh water requires much space (more than flood storage) but it can play an important role in dry periods.

The extent to which a region is self-sufficient, can vary greatly by region depending partly on the existing land use. A good example of where self-sufficiency is given by the greenhouses where rainwater is collected in tanks and provided to crops.

The national survey will examine the possible technical measures to decrease the intrusion of salt water through the New Waterway, thus making more fresh water available for the Randstad, West-Brabant and South Holland Islands. Alternatively, if the salt water inflow through the New Waterway would be accepted, freshwater flow should be achieved through the Old Rhine, the Amsterdam-Rhine Canal and the Brabant channels. It also looks at the future role of the IJsselmeer as a strategic basin for fresh water for a large part of the Netherlands.

Flooding

In the past, heavy floodings have occurred In the Netherlands in both urban and rural areas. Increasing extreme rainfall intensities and higher amounts of precipitation caused by CC increase the flood risk. In urban areas, the area of paved surface increased dramatically in the twentieth century. More precipitation in winter leads to rising groundwater levels in high-altitude areas and results in higher risk for groundwater flooding.

The programme of the Delta Commission aims at sustainable flood protection and fresh water supply facilities, in light of expected CC, socio-economic developments and changing social attitudes. Flexibility is needed in order to be able to move on including developments in spatial planning and CC.

Prolonged and excessive rainfall in 1998 led to the establishment of the Commission on the 21st century Water management (WB21), which elaborated a three-step strategy of flood control. The whole idea is to effectuate controlled flooding, but aimed at delimiting the affected area and minimizing the flood damage. Depending on the spatial layout of the compartments, compartmentalization may have either one of the following hydraulic effects:

- detention, i.e. peak shaving;
- adding discharge capacity (sometimes with additional peak attenuation);
- adding storage capacity (in the furthest downstream areas and coastal zone).

The Netherlands' water policy (Ministry of Transport, Public Works and Water Management, 2000) recognises that in the coming years increasing water levels in the rivers and the accelerated rise in sea levels will mean that technical measures, such as raising dykes, will no longer be sufficient. A new policy of allowing more space for water is therefore being followed. Under this policy, <u>*rivers are allowed to expand into*</u>

side channels and wetland areas in order to prevent floods. Greater emphasis is also being placed on managing water levels rather than keeping the water out.

Water quality

Under additional measures of the RBMP (2009 - 2015) hundred millions of euros will be invested in the Netherlands for re-meandering rivers, construction of natural banks, and realizing fish passes for dams. Effect-oriented measures, such as buffer strips along the shores of surface waters limit the diffuse loading of nutrients. These measures will also be a major step forward to improve living conditions for animals and plants. A number of new treatment plants built in the coming years will significantly contribute to the improvement of surface water quality. Ongoing cleanup of the currently sediment rich drainage waters will be completed by 2013. Measures for the first RBMP are primarily inspired by achieving the goals of the WFD, but often contribute also to other goals of water management. Some of the measures that contribute to achieving the goals of the WFD will be not feasible to realize by 2015. This is because for example, certain large-scale measures require land to be acquired and the consultations with landowners will need more time and the cost of such measures is very high.

Sea level rise at North Sea coast

As of the 21st century, there is no doubt any longer among scientists and politicians that the temperature on earth is rising, causing various glaciers and polar caps to melt. Being a 'nether' land means that extra regulations must be taken to reassure safety from the rising North Sea. Lots of suggestions and studies are constantly being made, such as islands off the coast, raising sea dikes, wider beaches, a Second Delta Plan, etc. The Delta Committee was re-installed in September 2007 by the Dutch government to investigate how to protect the country best from CC and sea-level rising for over a century. They reported their Delta Plan, 'Working together with water', in September 2008 to the Parliament, presenting *twelve recommendations for adaptations to the Dutch coast and inland waters.* Their general recommendation is to urgently and drastically increase the safety of the Netherlands; based upon their suggestions, it will cost 1.3 to 1.9 billion euros per year up till 2050. Some of major recommendations of the Delta Committee are the following:

1 - gradually broaden the North Sea coast with sand nourishments spread out over a hundred years to allow nature to develop;

2 - gradually raise the water level in the IJsselmeer by a maximum of 1.5 meters, to insure the capability of releasing excess water without having to pump;

3 - protect the Rijn estuary region on both the sea-side and river-side with movable flood barriers;

4 - provide flood areas for excess riverwater from the Maas and Rijn in the Krammer-Volkerak, the Zoommeer, the Grevelingen and possibly the Oosterschelde;

5 - increase the lifespan of the Oosterschelde flood barrier; it is now made to work till 2075;

6 - stregthen and raise sea and river dikes;

7 - keep the Westerschelde and New Waterway open; it must also be possible to close off the New Waterway if necessary.

Further recommendations and detailed information can be found on the website http://www.deltacommissie.com/en/advies. Executing the Delta Committee's advice means supplementing of 85 million m^3 of sand per year, seven times more than in 2008. The first reactions from environmental groups and political parties were generally positive. However, there was also criticism questioning the costs per year. Are the costs for safety or do they also include new economic development. And perhaps various activities should move to safer areas instead of spending millions to keep dry feet. More discussion will come before any action takes place.

Norway

- Norway has 9 RBDs, out of which 5 are international sharing water courses with Sweden, Finland and Russia to the east.
- According to the EEA agreement, Norway will fully implement the Directive with a timelag of 9 years compared to the deadlines of the Directive. Norway has however chosen to develop 9 Pilot RBMPs in parts of each RBD in the first cycle. These plans were adopted in June 2010, and can be found on the webpage of the Ministry of Environment
- A central web page provides all information on the Implementation of the WFD in Norway.
- Consultation on the draft RBMPs took place in 2009.
- Read more on the specific pages of the relevant Competent Authorities (pages only in Norwegian):
    - Finnmark
    - Troms
    - Nordland

- Information in Norvegian

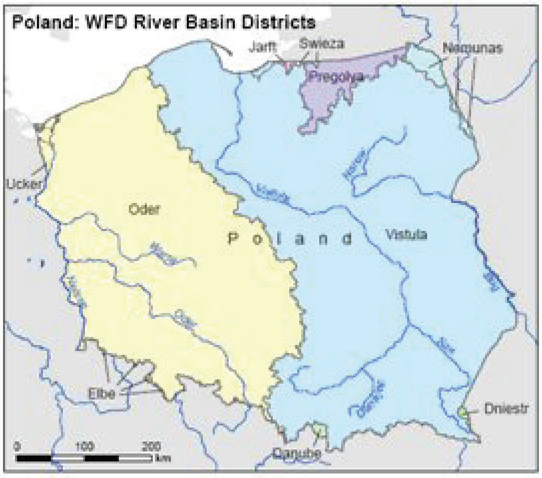
- [Trøndelag]
- [Møre and Romsdal]
- [The West (Vestlandet)]
- [The South-West (Sør-Vest)]
- [The Western-Bay (Vest-Viken)]
  - [Glomma]

- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

The Norwegian RBMP was not reviewed because of the language barrier and insufficient financial resources for this task for ordering a translation.

Poland

- Poland has 10 RBDs, out of which 8 are international sharing water courses with Russia to the north, Lithuania, Belarus, Ukraine to the east, Slovakia and Czech Republic to the south and Germany to the west.
- A central webpage provides all information on the implementation of the WFD.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
  - RWMA Gliwice (for Little Vistula and Upper Odra water regions and part of RBD Danube)
  - RWMA Krakow (for Upper Vistula water region, RBD Dniestr and part of RBD Danube)
  - RWMA Warszawa (for Central Vistula water region, RBD Pregolya, RBD Swieza, RBD Jarft and RBD Nemunas)
  - RWMA Gdansk (for Lower Vistula water region):
  - RWMA Wroclaw (for Central Odra water region without Warta and RBD Elbe)
  - RWMA Poznan (for Warta water region)
  - RWMA Szczecin (for Lower Odra water region and RBD Ucker)
- Information in Polish

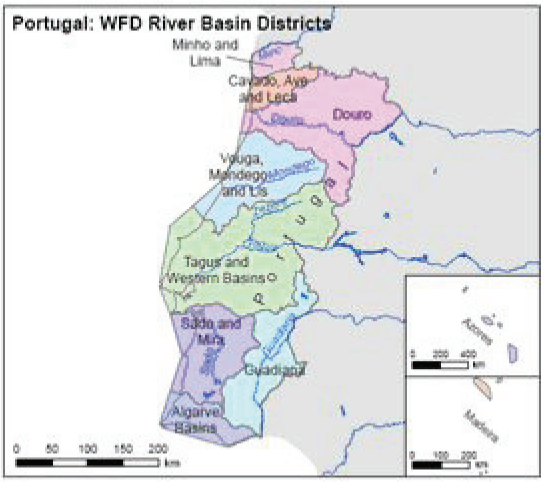


- Consultation on the draft RBMPs were planned to took place between in 2008-2009.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

As the RBMPs for Poland were still awaiting adoption at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Portugal

- Portugal has ten RBDs (eight in mainland Portugal, one in the Azores archipelago and one in Madeira archipelago), out of which four (Minho, Douro, Tejo e Guadiana) are international sharing water courses with Spain.
- A central webpage provides all information on the implementation of the WFD.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
  - ARH Norte
  - ARH Centro
  - ARH Tejo
  - ARH Alentejo
  - ARH Algarve
- Information in Portuguese

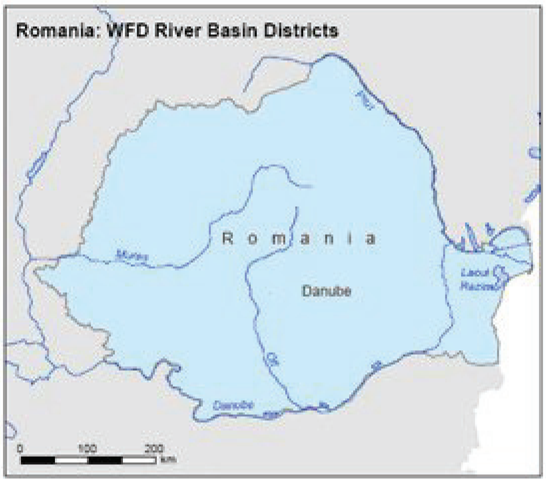


- More information is available from the Water Institute : http://www.inag.pt
- Consultation on the draft RBMPs has not started yet.
- Key documents and links to key documents are available also in the CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

As the consultations on the adoption of the RBMP for Portugal were still ongoing at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Romania

- Romania has 1 RBD, which has international sharing water courses with Serbia to the south-west, Bulgaria to the south, Hungary to the west, Ukraine to the north and Moldova to the north-east. The RBDof Romania is separated into 11 hydrographic basins.
- A central webpage provides all information on the implementation of the WFD.
- RBMPs were adopted in December 2009, and can be downloaded centrally from this webpage.
- Sub RBMPs are available for the following Romanian subbasins :
  - Somes Tisa (or this link)
  - Crisuri
  - Mures
  - Banat
  - Jiu
  - Olt
  - Arges Vedea
  - Buzau Ialomita
- Information in Romanian



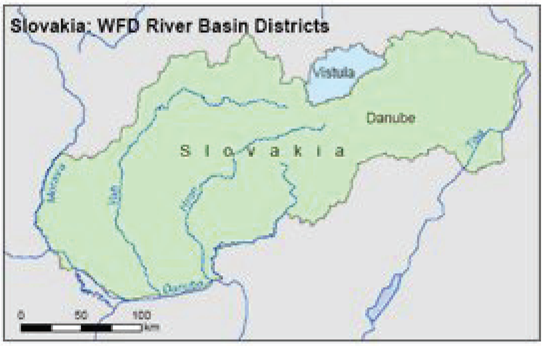
    - [Siret]
    - [Prut]
    - [Dobrogea Litoral]
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - [National Administration Apele Romane]
- The first part of the consultation on the draft RBMP was planned to take place between January 1st 2009 and June 30th 2009 and the second part between July 1st 1009 and November 15th 2009.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- The information is only available in Romanian.

> As the RBMPs for Romania were still awaiting adoption at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Slovak Republic

- Slovak Republic has 2 RBDs, out of which 2 are international sharing water courses with Austria to the west, Poland and Czech Republic to the north and Hungary to the South.
- A central webpage provides all information on the implementation of the WFD.
- The Water Management Plan (RBMP) of the Slovak Republic was approved by the Government on February 10, 2010, and is available on the web page of the Ministry of Environment of the Slovak Republic
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - RBD Danube
    - RBD Vistula

- Information in Slovak



- Consultation on the draft RBMPs took place between 23 January 2009 and 22 July 2009.
- Key documents and links to key documents are available also in the CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

> The Slovak RBMP was not reviewed because of the language barrier and insufficient financial resources for this task for ordering a translation.

Slovenia

- Slovenia has two RBDs, out of which one is international sharing water courses with Austria to the north and Hungary to the East.
- A central webpage provides all information on the implementation of the WFD.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - RBD Danube
- Information in Slovenian

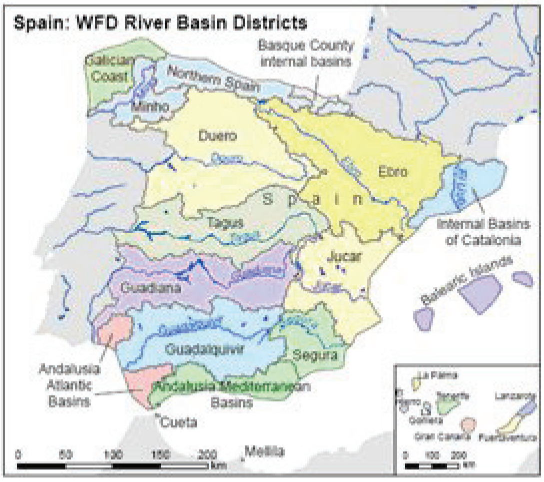
- ○ [RBD Adriatic Sea]

- A first round of consultations on draft RBMPs planned in 22.9.2009 - 22.3.2010 :
  - ○ Adriatic RBMP
  - ○ Danube RBMP
- A second consultation round on revised draft RBMPs was planned in 31 May 2010 - 31 September 2010.
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.

As the consultations on the adoption of the RBMP for Slovenia were still ongoing at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Spain

- Spain has 25 RBDs, out of which 6 are international sharing water courses with France to the northeast and Portugal to the east.
- Read more about consultation on the specific pages of the relevant Competent Authorities:
  - ○ RBD Guadalquivir
  - ○ RBD Segura
  - ○ RBD Júcar http://www.phjucar.com/consulta_pub_inic.html
  - ○ RBD Miño-Sil
  - ○ RBD Cantábrico
  - ○ RBD Duero
  - ○ RBD Tajo
  - ○ RBD Guadiana
  - ○ RBD Ebro
  - ○ RBD Galicia-Coast
  - ○ RBD Internal Basins of Basque Country
  - ○ RBD Internal Basins of Catalunya Consultations started on 15 November 2009 and more information is available here
  - ○ RBD Guadalete and Barbate - Consultations on draft plans ongoing (21.5.2010-21.11.2010) More information on consultations here !
  - ○ RBD Tinto, Odiel and Piedras - Consultations on draft plans ongoing (21.5.2010-21.11.2010) More information on consutlations here !
  - ○ RBD Mediterranean Basins of Andalucía - Consultations on draft plans ongoing (21.5.2010-21.11.2010) More information on consultations here !
  - ○ RBD Islas Baleares, consultations took place between 30.09.2008 and 30.03.2009
  - ○ RBD Islas Canarias (7 river basin districts): http://www.aguasgrancanaria.com/ http://www.aguastenerife.org/
  - ○ RBD Ceuta
  - ○ RBD Melilla
- Information in Spanish

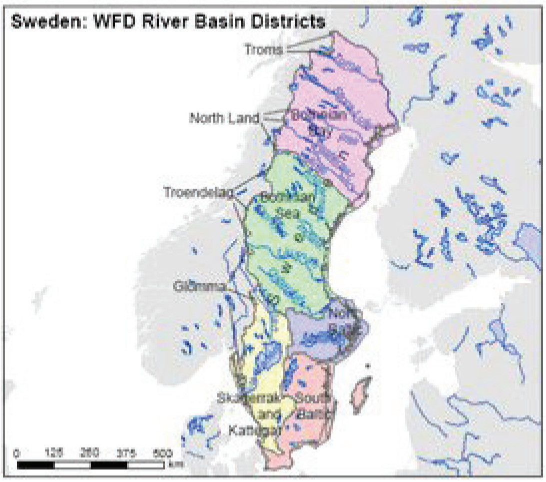


- Key documents and links to key documents are available also in the CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title.
- In general, the information is only available in Spanish; some webpages and documents can be accessed in the respective regional languages (e.g. Galician in the case of RBD Galicia-Coast and RBD Miño-Sil; Catalan and Basque in the case of Internal Basins of these Autonomous Communities). Only in rare cases are documents and webpages also available in English (e.g. Cataluña, Andalucía).

As the consultations on the adoption of the RBMP for Spain were still ongoing at the time of preparation of this report and the final version of the plan was not yet available, the integration of CC adaptation measures into the RMDP could not be analysed.

Sweden

- Sweden has designated 5 RBDs, out of which 3 are international sharing water courses with Norway to the west and Finland to the east and north.
- Swedish RBMPs were adopted and published in December 2009, and can be found on these pages :
    - Bothnian Bay
    - Bothnian Sea
    - Skagerrak and Kattegat
    - Southern Baltic Sea
    - Northern Baltic Sea
- Consultation on the draft RBMPs took place from 1 March to 1 September 2009.
- Information on the implementation of the WFD and water management in Sweden is available on these pages :
    - The Competent Authorities (Vattenmyndigheterna)
    - Swedish Environmental Protection Agence (Naturvårdverket)
    - The Geological Survey of Sweden (Sveriges Geologiska Undersökning)
- Information in Swedish



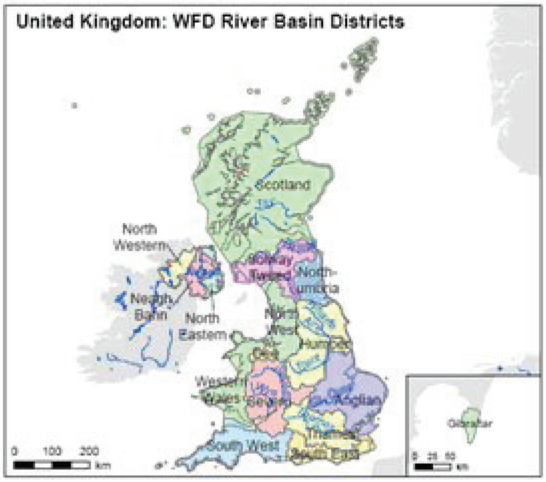
- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title
- Read more about consultation on the specific pages of the relevant Competent Authorities:
    - Bothnian Bay
    - Bothnian Sea
    - Skagerrak and Kattegatt
    - Southern Baltic Sea
    - Northern Baltic Sea

The Swedish RBMPs were not reviewed because of the language barrier and insufficient financial resources for this task for ordering a translation.

United Kingdom

- The UK has identified 16 RBDs. There are 11 in England and Wales, 3 in Scotland and 4 in Northern Ireland (including 3 international RBDs).

- RBMPs were adopted in December 2009, and can be downloaded on the following pages, which also provide all information on the implementation of the WFD:
  - England and Wales
  - Scotland: Scottish Environmental Protection Agency (SEPA)
  - Northern Ireland



- Consultation on the draft RBMPs took place between 22 December 2008 and 22 June 2009.

- Key documents and links to key documents are available also centrally in the Commission's CIRCA on line library: http://circa.europa.eu/Public/irc/env/wfd/library?l=/framework_directive/implementation_documents_1/information_consultation&vm=detailed&sb=Title

- The information is available in English and depending on the district in Welsh.

- Read more about the consultation on the specific pages of the relevant Competent Authorities:
  - Anglian RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/anglian/Intro.aspx
  - Dee RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/dee/Intro.aspx
  - Humber RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/humber/Intro.aspx
  - North West RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/northwest/Intro.aspx
  - Northumbria RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/northumbria/Intro.aspx
  - Severn RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/severn/Intro.aspx
  - Solway Tweed RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/solwaytweed/Intro.aspx
  - South East RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/southeast/Intro.aspx
  - South West RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/southwest/Intro.aspx
  - Thames RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/thames/Intro.aspx
  - Western Wales RBD: http://wfdconsultation.environment-agency.gov.uk/wfdcms/en/westernwales/Intro.aspx
  - Scotland RBD: http://www.sepa.org.uk/water/river_basin_planning/scotland.aspx
  - Solway Tweed RBD (Scotland): http://www.sepa.org.uk/water/river_basin_planning/solway_tweed.aspx
  - North Eastern
  - North Western
  - Neagh Bann
  - Shannon International RBD

General approach

The approaches how CC has been addressed in the RBMPs for England & Wales, Scotland, and Northern Ireland, and how the climate related issues have been integrated in the documents, differs slightly between environment agencies (EA, SEPA, and NIEA) and will therefore be described below in three corresponding sections.

England & Wales

The Environmental Agency has summarised the CC issues in Annex H of the RBMPs of England and Wales. The annexes for the 10 different RBDs have a similar structure but differ by chapters 3 (Summary of CC impacts) and 4 (The impact of CC on the identified pressures and the ability of measures to perform under future climate conditions) which characterize specifically each river basin district.

Projections of future climate from the UK Climate Impacts Programme ('UK Climate Projections': UKCP092,3) identify that we can expect following key changes:

- All areas of the UK get warmer, and the warming is greater in summer than in winter;
- There is little change in the amount of precipitation (rain, hail, snow etc) that falls annually, but it is likely that more of it will fall in the winter, with drier summers, for much of the UK. There is likely to be an increased incidence of very intense heavy rainfall;
- Sea levels rise, with this rise being greater in the south of the UK than the north.

CC will inevitably affect the conditions and pressures that the WFD seeks to manage in the water environment. The impact of CC on the identified pressures over the RBDs of England and Wales is given in Table 6, which shows that the CC will affect most the water abstraction, nutrient and sediment loads.

It is noted in the RBMP Annex **that CC impacts may not be strongly felt during the first river basin management cycle up to 2015 and may not be easily distinguishable from normal climatic variations. In the first cycle the Environment Agency will not attempt to incorporate CC into typologies, reference condition descriptions or default objective (including standards) and final water body objective setting.** This is because some stability is required in planning assumptions for subsequent work and because further work is required to understand what impact CC will have on underlying conditions. However, decisions and investments made during this period may have a lifetime that extends for many decades. In particular new infrastructure or modifications to existing infrastructure will last more than one cycle.

The Environment Agency's **priorities for dealing with CC in the first cycle** of implementing the WFD in England and Wales will be to:

- *consider the change in risk, due to CC, of not achieving the WFD default objectives (for example no-deterioration, good status) as a consequence of the identified pressures (for example abstraction);*
- *consider the impacts of CC when identifying and appraising actions and propose appropriate adaptation of actions where necessary;*
- *look for opportunities in the monitoring programme to improve our understanding of CC trends;*
- *consider the likely contribution of actions to future CC through their impact on emissions of greenhouse gases, and propose appropriate mitigation where necessary.*

Table 6. Summary of severity of climate change impacts on pressures in the River Basin Districts of England and Wales

Relative severity of impact of climate change on:	Anglian	Dee	Humber	Northumbria	North West	Severn	South East	South West	Thames	Western Wales
Abstraction and other artificial flow pressures	VH	VH	VH	VH	VH	VH	VH	H	VH	VH
Nutrient pressure (nitrate and phosphate)	H	H	H	H	H	H	H	**M**	H	H
Sediment pressure	H	H	H	H	H	H	H	H	H	H
Microbiology pressure	M	M	M	M	M	M	M	**M/H**	M	M
Organic pressure	M	M	M	M	M	M	M	M	M	M
Physical modification pressure	M	M	M	M	M	M	H	H	M	M
Salinity pressure	M	M	M	M	M	M	M	M	M	M
Invasive non-native species pressure	M	M	M	M	M	M	M	M	M	M
Fisheries management pressure	L/M	L/M	L/M	L/M	L/M	L/M	L/M	**H**	L/M	**M**
Acidification pressure freshwater	L	L	L	L	L	L	L	L	L	L
Acidification pressure marine	M/H	M/H	M/H	M/H	M/H	M/H	M/H		M/H	M/H
Priority hazardous substances, priority substance and specific pollutants such as pesticides	L	L	L	L	L	L	L	**L/M**	L	**M**
Temperature pressure	L	L	L	L	L	L	L	L	L	L

Further research and scoping work will be done in the first cycle of river basin management to determine if and how CC should be factored into these considerations.

There is already relevant ongoing or proposed research which will help inform our decision on these issues in the future.

The RBMP Annex H does not report in detail the impact of the programmes of actions on greenhouse gas emissions and future CC. These aspects are considered in the strategic environmental assessment reports which accompany the RBMP and in Annex E which describes how the cost of carbon was included in the economic appraisal process.

The Environment Agency has carried out a systematic screening (or 'climate check') for most of the actions which make a contribution to achieving WFD objectives to determine if and how they are likely to perform under future climate conditions – or where we need further adaptation, to seek alternatives or to develop additional actions. These adaptation options are normally referred to as win-win, no-regrets, low-regrets, and flexible/adaptive management. Actions may include more than one of these approaches. The majority of the actions proposed within this RBMP are identified as no regrets approaches. These are actions that are proposed and justified in the river basin management planning process due to current pressures. They will also bring benefits under future climatic conditions, and should, therefore, rightly be a favoured option.

RBMP Chapter 7, Annex H analyses adaptation in relation to biology and underlying conditions. It notes that work is needed to understand how changes in underlying 'natural' environmental conditions and the impacts of man-made pressures as a consequence of CC will impact on the biology in the water environment. This is needed to ensure the implementation the most cost-effective actions to meet WFD objectives, particularly those for biology. Those organisations involved in the river basin management process who have direct responsibilities for managing the natural environment need to consider the consequences of CC and the need for adaptation in the context of delivering biological outcomes. The Environment Agency, for instance, is starting to set out its **adaptation action plan for ecology and conservation**. This includes the following actions:

- Develop the 'landscape ecology approach' to identify and protect key habitats, open up new habitats and develop and maintain wildlife corridors. Reduce habitat fragmentation and protect and restore areas of floodplains and wetlands.
- Work with Natural England and Countryside Council for Wales on their review of protected area designation criteria and on managing changing conservation objectives for designated sites.
- Work with others to develop better understanding of climate space. Map current and future climate spaces and the vulnerability and impacts for priority species and environments. Develop robust case on the future ranges of key

species and how reducing current risks and adaptation actions may affect their viability.

- Target action to build environmental resilience in relation to both existing and CC pressures.
- Work with partners to identify those species and environments at greatest risk, prioritise policies and strategies for action and identify and make changes in management practices and policies that may help freshwater ecosystems and habitats to adapt to CC.
- Ensure we all build environmental resilience and restore damaged habitats to ensure salmon and trout species are to remain in existing localities. We will also seek to protect the habitat conditions for glacial relict fish species such as Char and White Fish which have little opportunity to adjust or move from their rare and isolated lake habitats and are therefore at significant risk of local extinction.

Further the Environment Agency intend to commission research to understand if, and over what timescales, the variables on which the characteristics of waterbodies are determined will change, how this could change such things as waterbody type or category and whether or how best to modify tools, analyses, and management as a consequence.

Regarding the 2nd and 3rd RBMP cycles, there seems to be a contradiction between two statements in the Annex H on CC. On the one hand it says: „Over this extended period, **towards the end of cycle two (to 2021) and through cycle three (to 2027), it is predicted that the UK's climate is likely to change significantly**. Therefore, if we all fail to take account of CC now, this could result in poor investment decisions in terms of actions and limit the extent to which we can meet WFD objectives and/or the efficiency with which we will achieve them. Further, CC could affect the predicted effectiveness of current or new actions in meeting WFD objectives (unless we all take this into account). This presents real risks for implementation and success." On the other hand, it says further:"On the basis of current scientific results, **it is not expected that,** within the timeframe of initial WFD implementation **(i.e. up to 2027)** and within the metrics used for pressure assessment, **a CC signal will be observable above natural variability** or adequately distinguishable from other human pressures at a level to cause major changes in typology or major changes at reference sites. For similar reasons, the Environment Agency will not reopen the agreed monitoring plan. However these aspects of the planning cycle will be addressed by future planning cycles." On the basis of these two statements it could be understood that **although the UK's climate is likely to change significantly by 2027, it will not cause major changes at reference sites, major changes in typology or an observable signal within the metrics used for pressure assessment.**

Scotland

The chapter overviewing the state of water environment in Scotland[44] notices that CC is already happening and further changes are unavoidable due to past and present emissions of greenhouse gases. Since 1961, average temperatures have risen in every season and in all parts of Scotland. Rainfall has increased significantly in winter, particularly in northern and western regions where winter rainfall has increased by almost 60%3. By the 2050s, average summer temperature is predicted to increase by between 1 and 4ºC. If emissions continue at their current rate, by the 2080s it may be up to 7ºC warmer. There is also likely to be a major change in rainfall patterns in Scotland, with winters becoming wetter and summers drier. Snowfall could also reduce by 60% or more in the mountains and might stop completely in other areas. The sea level in Edinburgh is projected to increase by up to as much as 18 cm by 2050 and over 39 cm by 2095.

- Higher river flows in the west and north of the Scotland RBD may help dilute pollutant discharges to rivers. However, the quantity of pollutants reaching the sea without first having been broken down in rivers may increase.
- The more intensive rainfall will make flooding more common. Management of this will depend not only on engineered flood defences but also on natural flood attenuation. The high quality of Scottish environment supports this. For example, many of the river floodplains are relatively undeveloped and their flooding helps reduce flood peaks in downstream towns and cities.
- In the drier summers, discharges of pollutants to rivers may not be adequately diluted. Higher summer temperatures will also cause lower oxygen levels. Reduced oxygen levels make surface waters less able to cope with wastes.
- Rivers that are not well-shaded by bank-side vegetation may over-heat during the extended periods of low flow, reducing oxygen levels and increasing stress on water animals. Longer periods of drought will lead to extended periods in which rivers shrink to occupy a fraction of the width of their beds. This will lead to reduced productivity and declines in the abundance of plant and animals.
- Hotter summers will also increase demands for freshwater at just the time when there is less of it that can be abstracted without impacting the ecological quality of rivers and lochs.
- CC is likely to increase storm frequency and intensity. The resulting flood flows in rivers will lead to increased erosion, particularly where river banks have been destabilised by the removal of their natural cover of trees and other

[44] The river basin management plan for the Scotland river basin district 2009–2015. Chapter 1: State of the water environment

deep rooting vegetation. The stability of the shores of our estuaries and coastal waters may also be changed by increased storminess.

- Sea level rise is also likely to engulf lower lying intertidal zones. Where there is limited space for the intertidal area to reform inland, this important habitat for marine life will be reduced in area.
- The effects of CC, such as increased sea temperature, may increase threats: some invasive non-native water plants and animals may be better able to successfully invade the water environment and become invasive.

Scottish Environment Protection Agency (SEPA) has undertaken **preliminary climate checks of the actions** needed to reduce pressures on the water environment. The results of the checks are presented in the summaries below. The assessment gives a general indication of any likely significant implications of the different on-the-ground actions in terms of:

A. Greenhouse gas emissions;
    - Will the solutions lead to an increase or decrease in greenhouse gas emissions?
    - Will the action help capture carbon in the soil or in vegetation?
    - Will the action reduce energy use in the long-term?
B. Preparing Scotland for a future climate
    - **Flood risk**
        i. Will the action increase or decrease flood risks under wetter winters, more intense rainfall and higher sea levels?
    - **Drought**
        i. Will the action help us maintain water uses in periods of drought caused by hotter, drier summers?
    - **Ecosystem services**
        i. Will the action make wildlife more or less resilient to a changed climate?
        ii. Will the action help sustain economically important water uses in a changed climate (eg fisheries, tourism, agriculture, etc)?
        iii. Will the action enable the water environment to continue to recycle our wastes under a changed climate?
C. Effectiveness under Scotland's predicted future climate.

The outcome of the check will be used to advise those taking action on whether a solution is likely to:

- contribute to meeting the challenges of CC;
- need to be designed with Scotland's future climate in mind if its effectiveness is to be maintained;
- have one or more negative effects in terms of greenhouse gas emissions or preparing Scotland for a future climate. Where such actions are necessary to achieve our objectives, we will work to ensure that their negative effects are minimised as far as possible and balanced by the overall benefits of improving the water environment.

CC will be taken into account in **drought management**.

- SEPA will develop a **national drought plan for managing abstractions** during periods of extreme low rainfall. The plan will describe the actions required of those abstracting water from the water environment, such as farmers wishing to irrigate their land. The actions will be designed to ensure the protection of the water environment whilst minimising the impact of the drought conditions on economically important activities.
- The drought management plan will be integrated with drought plans produced by Scottish Water in relation to **abstractions for drinking water supply**.
- The Scottish Government will also introduce legislation for managing abstractions during drought conditions.

Northern Ireland

The impacts of CC on the setting and delivery of WFD objectives via the River Basin Plans were discussed at a SNIFFER (Scotland & Northern Ireland Forum for Environmental Research) facilitated common workshop between Northern Ireland Environment Agency (NIEA) and Environment ProtectionAgency (EPA) in June 2009. The objectives of this workshop were:

1. To identify what we need to achieve in the first RBMP (end 2009) in relation to CC adaptation.
2. To identify what we need to do to adapt to our changing climate for the 2nd river basin plan (end of 2015)

It was agreed that the implications of CC on the WFD will be assessed and actioned in detail during the 2nd and 3rd cycle. However, the 1st RBP should flag the activity needed from 2009 to 2015 to prepare for this work:

- *<u>Data collection and collating to ensure that the knowledge base is available for implementing CC scenarios in RBMP Cycle 2.</u>*

- *Existing water quality and hydrological models need to be re-visited and verified to ensure they are fit for purpose for re- running with data from the new probalistic CC scenarios.*
- *An holistic catchment approach will be required to ensure that agriculture and land use planning, flooding and WFD all take an integrated approach in dealing with impacts of CC. This may require the establishment of a high level policy group to take joint ownership of issues and to ensure joined up working between policy makers in each department.*
- *Forthcoming regulations and guidance documents need to be climate proofed. This will include abstraction, consenting and land use policy and guidance.*
- *Development of key guidance on how to include CC scenarios when setting discharge consent limits and costing of supplementary measures taking into account the impacts on energy usage and the impacts on the environment will need to be undertaken.*
- *Evaluate the effectiveness of Invasive Species Ireland in Cycle 1.*

In Cycle 2 it will be necessary to:

- *consider CC projections for climate proofing,*
- *consider the effects of land use in the wider context to help achieve good status,*
- *consider groundwater dependent terrestrial ecosystems.*

CC planning under the RBMPs of Northern Ireland is described in Chapter 2.10 of the Register of Plans and Programmes[45]. Northern Ireland's long term approach to CC is to ensure its consideration is fully incorporated into all policy, strategy and future plans. CC considerations must be fully integrated into the river basin planning process. It may be necessary to adapt to the impacts of CC on waters but it will also be necessary to ensure that the measures that are adopted as part of the RBMP do not contribute to CC (i.e. through increased emissions) but rather contribute to CC adaptation, by for example through measures to support sustainable flood management.

The water environment is particularly vulnerable to the effects of CC, and for this reason the European Commission has identified water management as a priority area in which the impacts of CC must be taken into account. That must happen in all of the key steps of implementation including characterisation, the analysis of pressures and impacts, economic analysis, monitoring, design of the programmes of measures and

[45] Register of Plans and Programmes. North Ireland Environment Agency, December 2009. Available at: http://www.ni-environment.gov.uk/water-home/wfd/north_eastern_rbp/ne-pom.htm

the objective setting process. Fortunately, the cyclical approach of WFD implementation makes it well suited to adaptation to CC.

Temperature increases, seasonal rainfall variations, and other CCs which have been detected within the UK and Ireland, are likely to affect the existing pressures and impacts identified in the WFD Article 5 Characterisation Summary Report. In some circumstances, CC may make it more difficult to achieve WFD objectives. **It is not anticipated that CC will require significant amendments to currently planned implementation during the first cycle – it is however important that, during the first cycle CC is taken into account when implementing measures and in planning for the second cycle plans.** There is also potential for synergies between WFD objectives and CC adaptation aims. The measures in the RBMP help ensure that we firstly protect waters from deterioration due to CC and secondly take into account CC factors when developing and implementing measures to improve the water environment.

International River Basin Management Plans

A number of international River Basin Districts (Danube, Rhine, Meuse, Ems, Elbe, Scheldt, and Odra) have also published RBMPs. In the following part four of them (the international plans for Danube, Rhine, Elbe and Meuse) are analysed from the point of view how the CC issues were integrated.

The Danube River Basin District Management Plan

http://www.ramsar.org/cda/en/ramsar-news-archives-2002-new-ecological-expert/main/ramsar/1-26-45-87%5E19849_4000_0__

19 countries share the Danube River Basin (Table 7), which makes it the world's most international river basin. More than 81 million people are since centuries interconnected through the widely ramified water system of the Danube. All countries

sharing over 2,000 km² of the Danube River Basin (DRB) and the European Union are contracting parties of the ICPDR (International Commission for the Protection of the Danube River).

Table 7. Basic information on the countries in the Danube River Basin (DRB)[46]

Country	Code	Coverage in DRB (km²)	Percentage of DRB (%)	Percentage of DRB in country (%)	Population in DRB (Mio.)
Albania	AL	126	< 0.1	0.01	< 0.01
Austria*	AT	80,423	10.0	96.1	7.7
Bosnia and Herzegovina*	BA	36,636	4.6	74.9	2.9
Bulgaria*	BG	47,413	5.9	43.0	3.5
Croatia*	HR	34,965	4.4	62.5	3.1
Czech Republic*	CZ	21,688	2.9	27.5	2.8
Germany*	DE	56,184	7.0	16.8	9.4
Hungary*	HU	93,030	11.6	100.0	10.1
Italy	IT	565	< 0.1	0.2	0.02
Macedonia	MK	109	< 0.1	0.2	< 0.01
Moldova*	MD	12,834	1.6	35.6	1.1
Montenegro*, **	ME	7,075	0.9		
Poland	PL	430	< 0.1	0.1	0.04
Romania*	RO	232,193	29.0	97.4	21.7
Serbia*, **	RS	81,560	10.2		
Slovak Republic*	SK	47,084	5.9	96.0	5.2
Slovenia*	SI	16,422	2.0	81.0	1.7
Switzerland	CH	1,809	0.2	4.3	0.02
Ukraine*	UA	30,520	3.8	5.4	2.7
Total		**801,463**	**100**		**81.00**

Data in the table above is based on the Danube Basin Analysis 2005.

*) Contracting Party to the ICPDR

**) Serbia and Montenegro split into two countries in June 2006. So far no exact data on the share of the individual countries is available.

In the Danube River Basin District, all countries (including most of those not being members of the EU) have been working on their national management plan. As these plans need to be established for each river basin, the countries are also cooperating on the international level. They use the ICPDR as a platform to discuss and agree on the transboundary aspect of the management of the water resources. Jointly the countries

[46] http://www.icpdr.org/icpdr-pages/countries.htm

of the DRB have developed the Danube River Basin Management Plan (DRBMP) including measures that ensure that at least good status is reached by 2015 and thematic maps. The RBMPs has been adopted by the ICPDR on December 10 2009 and is now available. The DRBMP annexes and maps can be downloaded at http://www.icpdr.org/participate/danube_river_basin_management_plan

General approach

In the international Danube RBMP a special chapter (Ch. 8) is dedicated to flood risk management and CC. This chapter lists the general principles of integrating CC adaptation issues into river basin planning (such as the Danube basin-wide significance; step-wise implementation; addressing all Significant Water Management Issues; guiding role of scientific research; need for climate-proofing of future infrastructure projects, and inter-sectoral approach).

Within the **first cycle** of DRBMP and in the framework of the ICPDR, the Danube countries will develop an approach and strategy to ensure that the DRBMP will be followed-up by specified actions regarding CC adaptation. On this basis, **the second and third cycles** of WFD implementation in the DRB will collect and ensure more evidence, enable greater precision on the impacts of CC and will fully integrate climate issues within DRBM planning.A list of nine perceived future issues for investigation is given to be addressed in subsequent RBM cycles of the WFD.

Five concerted actions are planned to achieve synergies between river basin management and flood risk management but most of the CC issues are planned to be addressed in subsequent RBM cycles of the WFD.

Flood risk management and climate change in DRBMP

Aware of the basin-wide relevance of flood issues, the ICPDR decided to develop its flood protection policy, which was formalised by adoption of the ICPDR Action Programme on Sustainable Flood Protection in the DRB in 2004. The overall goal of the Action Programme is to achieve a long-term and sustainable approach for managing the risks of floods to protect human life and property, while encouraging conservation and improvement of water related ecosystems. The Action Programme has been designed in line with the provisions of the EU Flood Directive[20].

The river basin approach belongs to key principles of the ICPDR Action Programme on Sustainable Flood Protection in the DRB. Respecting this principle, the Action Programme stipulates that the development of the action plans for sub-basins should be based on an integrated approach, taking into account the EU WFD and its daughter directives, as well as RBMPs under the WFD at all levels. The synergy between river basin management and flood risk management in preparation of action plans for sub-basins is also emphasised in the targets of the Action Programme.

The ICPDR Action Programme on Sustainable Flood Protection in the DRB stresses that human interference into the processes of nature should be reversed as much as possible, compensated for and, in the future, prevented. The Action Programme encourages the promotion and harmonisation of changes in water policies and land-use practices, as well as environmental protection and nature conservation, in order to improve flood management and also meet the targets and measures of Integrated River Basin Management. The results of the flood action plans should be integrated into the RBMPs at an appropriate stage for information purposes. Being aware of the necessity of visualisation of the risks stemming from flood events and making this information available for the public, the Action Programme includes the recommendation for a common approach in assessment of flood-prone areas and *flood risk mapping*. The general objectives of flood maps are to increase public awareness of the areas at risk from flooding, to provide information of areas at risk to give input to spatial planning and to support management and reduction of the risk to people, property and the environment. In practical terms, the synergy between river basin management and flood risk management will be achieved through the following concerted actions:

- *Ensuring a coordinated approach in land-use planning;*
- *Reactivation of former wetlands and floodplains to achieve increased water retention along with good surface water status. As start-up actions, available data should be collected on e.g. inventory of floodplains; floodplains which are dis- or reconnected to their rivers; potential flood retention areas; future flood infrastructure projects etc.;*
- *Prevention of accidental pollution during floods affecting the storage facilities of dangerous substances;*
- *Preparation of an overview of the implementation of future measures to achieve the WFD environmental objectives while ensuring appropriate level of flood protection.*

Climate change and the DRBD

The EC Green Paper "Adapting to Climate Change in Europe – Options for EU Action" (June 2007), acknowledged that the WFD provides a consistent framework for integrated water resource management but does not directly address CC. However, the Green Paper recognised that the challenge for the EU MS will be to incorporate consideration of CC issues in the first river basin management planning cycle by 2009. This also concerns the DRB. The European Commission's White Paper on CC adaptation[1] proposes that guidance needs to be developed to ensure that the next generation of RBMPs due in 2015 are fully climate proofed, and to ensure that CC is taken into account in the implementation of the EU Floods Directive.

In preparation for the DRBMP, an international conference on CC in the Danube River Basin was held in Vienna in December 2007. The conclusions from the Conference were:

- Climate change impacts:
  - are an issue of Danube basin-wide significance;
  - will be addressed by a step-wise approach;
  - will be addressed respecting all SWMIs for the DRB;
  - will address the issues of flood protection, low water discharges, drought and land use.
- CC signals for the DRB are sufficient to act beyond existing scientific uncertainties;

- Ongoing DRB related scientific projects and their outcomes should have a guiding role. Therefore, existing DRB scientific activities are the basis for the further development of measures (see Annex 21. for a selected list of projects on CC relevant for the DRB);
- Future infrastructure projects need to be *climate proof*:
    - Holistic and coherent in their approach (linking all relevant sectors);
    - Provide flexible management tools and no regret measures.

CC in the DRB are a significant threat to the DRB environment and further actions need to be taken as a consequence. The priority at this stage is to identify eventual future pressures on the aquatic environment (see DRBMP Annex 21 for a summary on such eventual pressures) and to ensure that aquatic ecosystems are climate resilient. Furthermore, future measures implemented in the DRB, that might have additional negative impacts on water status, are to be made *climate proo*f or *no/low regret measures*.

It is clear that there is still much work needed to clearly understand the scale and magnitude of pressures and impacts, but it is obvious that there are actions that can and must be taken now and this should be a priority for the overall management of the DRB.

Following this DRBMP and in the framework of the ICPDR, the Danube countries will develop an approach and strategy to ensure that the DRBMP will be followed-up by specified actions regarding CC adaptation. On this basis, the second and third cycles of WFD implementation in the DRB will collect and ensure more evidence, enable greater precision on the impacts of CC and will fully integrate climate issues within DRBM planning. Concluding, the following list summarises the perceived future issues for investigation to be addressed in subsequent RBM cycles of the WFD:

- Ensure that monitoring systems used in the DRB have the ability to detect CC impacts on *ecological and chemical water status* as well as the effects of CC adaptation measures;
- Investigate on the effects of CCs on ecoregions, typologies and reference sites as well as proposals for solutions;
- Foster the improvement of models (climate and hydrological aspects) and of scenarios for the DRB as well as ensure the improvement regarding the presentation on climate fluctuations;
- Investigate the effects of CC on the various sectors active in the DRB and evaluate their indirect impacts on water status;
- Conduct a climate vulnerability assessment of basin ecosystems;
- Promote and apply methodologies and standards for climate-proofing infrastructure projects and integrating climate considerations into EIA and SEA procedures,
- Enhance the sharing of research information on CC in the DRB;
- Ensure that scientific information is ‘translated’ to water managers;
- Integrate all knowledge and results related to CC threats in the next DRBMP.

CC-related research projects in the Danube River Basin

(based on DRBMP Annex 21)

1. ADAM - www.adamproject.eu (Adaptation and Mitigation Strategies supporting European climate policy, 2006-2009, FP6). The ADAM project is studying, under what conditions floodplain revitalisation, land-use change and rural development reduce climate-related risks in the Hungarian Tisza River Basin. ADAM leads to a better understanding of the trade-offs and conflicts that exist between adaptation and mitigation policies. ADAM supports EU policy development in the next stage of the development of the Kyoto Protocol and informs the emergence of new adaptation strategies for Europe. CC is connected to the three main water-related problems of the Tisza region: floods, in-land water stagnation and droughts. The new water management strategy in Hungary started in 2003. The new water management plan for the Tisza River in Eastern Hungary recognised rural development and nature conservation as important objectives next to flood protection. Floodplain revitalisation and land-use change were introduced as strategies to replace or complement prevailing engineering approaches during last 150 years, dominated by river regulation, the construction of embankments and drainage that were serving mostly the interests of large-scale agriculture. Evidence so far suggests that successful adaptation requires both formal regulatory rules and informal social relations. Informal relations are crucial in strengthening autonomous adaptation and to capitalise on local traditions and experience. Formal rules can mainstream adaptation into policy cycles and are required to include adaptation in longer term planning, investment and large-scale infrastructure.

2. CECILIA www.cecilia-eu.org (Central and Eastern Europe Climate Change Impact and vulnerability Assessment, 2006-2009, FP6). The main objective of CECILIA is to deliver a CC impact and vulnerability assessment in targeted areas of Central and Eastern Europe. Emphasis is given to applications of regional climate modelling studies at a resolution of 10 km for local impact studies in key sectors of the region. The project contains studies of hydrology, water quality and water management (focusing at medium-sized river catchments and the Black Sea coast); air quality issues in urban areas (Black Triangle - a polluted region around the common borders of the Czech Republic, Poland and Germany); agriculture (crop yield, pests and diseases, carbon cycle); and forestry (management, carbon cycle). Very high resolution simulations over this region are necessary due to the presence of complex topographical and land-use features. CC impacts on large urban and industrial areas modulated by topographical and land-use effects (which can be resolved at the 10 km scale), are investigated by CECILIA. The high spatial and temporal resolution of dense national observational networks at high temporal resolution and of the CECILIA regional model experiments will uniquely feed into investigations of CC consequences for weather extremes in the region under study.

3. CIRCLE www.circle-era.net (Climate Impact Research Co-ordination for a Larger Europe, 2006-2009, FP6). Different regions face different problems: in low-lying coastal areas, researchers are looking at the effects of rising sea levels, while in high mountain areas, melting glaciers that increase the risk of mass movements will attract attention. Some institutes are carrying out numerical modelling of climate patterns, while others are looking at the social and economic impact of change. Coordinated information about these national research programmes will enable partners to learn from each other, and avoid duplication. CIRCLE involves the activities to integrate what is already being done at the national level and to take it forward as a unified effort.

4. CLAVIER www.clavier-eu.org (Climate Change and Variability: Impact on Central and Eastern Europe, 2006-2009, FP6). CLAVIER studied ongoing and future CCs in Hungary, Romania, and Bulgaria based on existing data and very detailed climate projections in order to fulfill the needs of local and regional impact assessment. Researchers from 6 countries and various disciplines studied linkages between CC and its impact on weather patterns, air pollution, extreme events and water resources. An evaluation of the economic impact on agriculture, tourism, energy supply and the public sector was made.

5. ENSEMBLES ensembles-eu.metoffice.com (Climate change and its impacts at seasonal, decadal and centennial timescales 2004-2009, FP6). ENSEMBLES results show how the impacts resulting from these CCs, including changes in means, variability and extremes, affect all the systems and sectors studied. Examples include impacts on health, water resources, agriculture, energy supply and demand, and fire and pest risks to forests. ENSEMBLES results include, for the first time, multi-model climate projections for a greenhouse gas mitigation scenario leading to emissions and temperature stabilisation in line with European policy aims. The results have been used as a basis for a set of new tools and datasets for informing potential users about present and future climate, and have been linked to new techniques for assessing the impacts of CC in Europe in terms of risk.Developed online models include a consistent treatment of carbon, water and energy cycle feedbacks that can be exploited, for example, to analyse potential unintended consequences of measures designed for climate mitigation.

6. GLOCHAMORE http://mri.scnatweb.ch/projects/glochamore/ (Global Change in Mountain Regions, Specific Support Action of FP6, 2003-2005). The project aimed at the development of a state-of-the art integrated and implementable research strategy to gain a better understanding of the causes and consequences of

global change in a selection of 28 UNESCO Mountain Biosphere Reserves (MBRs) around the world. Mountain ecosystems provide a wide variety of useful services that enhance human welfare. These ecosystems are under enormous pressure from the growing demands placed on them by human economies for inputs (e.g., fresh water, fiber, soil fertility) as well as pressure on the capacity of these systems to assimilate waste. Future sustainable development and forward-looking policy will depend upon accurate assessment of ecosystem services so that well informed choices for mitigation and adaptation to CC can be made.

7. MICE - http://www.cru.uea.ac.uk/projects/mps/html/mice.html (Modelling the Impact of Climate Extremes, 2002-2004, FP5, Hanson et al. 2007)[47]. The research programme was based around three broad objectives – climate model evaluation, assessment of future changes in the occurrence of extremes, and the assessment of impacts of changes in extremes on six activity sectors – agriculture, commercial and natural forestry, energy use, water resources, tourism and civil protection/insurance. Focusing on two examples, changes in precipitation intensity and the length of the summer drought in Europe, MICE highlights the future behaviour of different weather and climate extremes. The regional climate model shows a coherent spatial pattern of future change in precipitation intensity with increases in the number of intense rainfall events across Northern Europe and decreases across Southern Europe. An examination of the length of the European summer drought season confirms this behaviour indicating that the number of dry days may increase in the future, particularly in the Mediterranean region. On the impacts side, MICE highlights the results produced from the modeling of energy consumption in the Mediterranean and in Finland and the expert-judgement approach applied to summer tourism in the Mediterranean. In the future it is expected that energy consumption in the Mediterranean will increase by between 15–55% in August in Italy in the 2080s relative to the baseline period. Electricity consumption in Finland follows a similar cycle of decreasing wintertime and increasing summertime but in this case the changes are not as marked as in Italy. Mediterranean tourism is expected to expand during the shoulder seasons of spring and autumn with a decline in summertime activities.

8. PRUDENCE http://prudence.dmi.dk/ (Prediction of Regional scenarios and Uncertainties for Defining European Climate risks and effects, 2001-2004, FP5)[48]

The specific objectives of PRUDENCE were to:

1. Design and execute a large set of 30-year simulations for Europe using high resolution climate models, assuming consistent scenarios of greenhouse gas and aerosol emissions and agreed model boundary conditions;

2. Evaluate and intercompare the performance of these climate models in representing 1961–1990 observed climate in Europe;

[47] Hanson, C.E., J.P. Palutikof, M.T.J. Livermore, L. Barring, M. Bindi, J. Corte-Real, R. Duaro, C. Giannakopoulos, T. Holt, Z. Kundzewicz, G. Leckebusch, M. Radziejewski, J. Santos, P. Schlyter, M. Schwarb, I. Stjernquist, U. Ulbrich, 2007. Modelling the Impact of Climate Extremes: An overview of the MICE Project, Climatic Change, 81:163–177.

3. Examine and intercompare high resolution climate projections for 2071–2100;

4. Characterise the uncertainties in projections attributable to model formulation and natural/internal climate variability;

5. Assess the changing risk of physically and economically important extreme weather events such as flooding, wind storms and heat waves, by providing a more robust multi-model estimation of the likelihood and magnitude of such changes and bystudying their potential impacts;

6. Investigate the added value (compared to conventional approaches) of applying high resolution climate scenarios for assessing the potential impacts of CC on, inter alia, ecosystems, agriculture, human health and water resources, at a range of spatial and temporal scales in Europe, and assess the additional uncertainties linked to such impact projections;

7. Identify socio-economic and policy related issues which could usefully be informed by these new scenarios;

8. Disseminate the results of PRUDENCE widely, in particular by means of a project summary aimed at policy makers and non-technical interested parties.

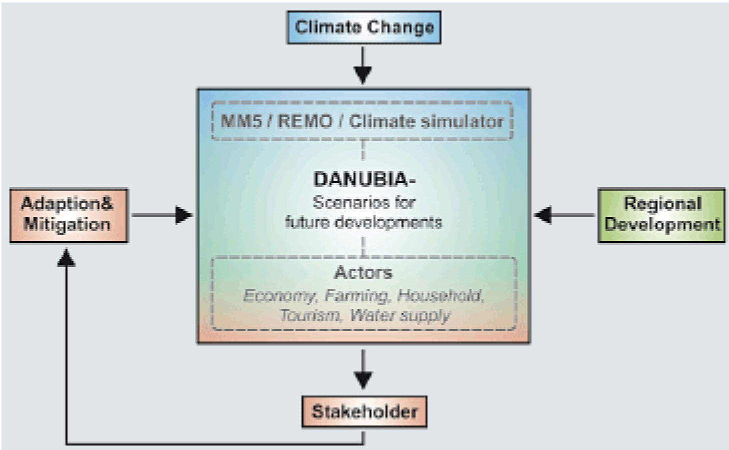
PRUDENCE joined with two other related EC-funded projects to form the PRUDENCE-STARDEX-MICE cluster.

9. STARDEX www.cru.uea.ac.uk/projects/stardex (Statistical and Regional dynamical Downscaling of Extremes for European regions). STARDEX has developed improved statistical downscaling methods which have been rigorously evaluated and inter-compared using robustness, application and performance criteria. The most robust of these methods have been used to construct scenarios of extremes for 2070-2100 for the A2 and B2 emissions scenarios for the STARDEX case-study regions and Europe as a whole. Much of the STARDEX work has most direct relevance to developers and users of climate scenarios, which provide the essential basis for all assessments of the environmental and socio-economic impacts of CC.

10. GLOWA-Danube www.glowa-danube.de (Impact of Global Change on the Upper Danube, 2001-2010).The aim of GLOWA-Danube is to investigate with different scenarios the impact of change in climate, population and land use on the water resources of the Upper Danube and to develop and evaluate regional adaptation strategies. For this purpose the decision support system DANUBIA was successfully set up. DANUBIA is a coupled simulation model including model components for natural science as well as socio-economic processes and their interactions. DANUBIA uses results of regional climate models for CC predictions, physical and physiological

[48] Christensen JH, Carter TR, Rummukainen M, Amanatidis G (2007) Evaluating the performance and utility of regional models: the PRUDENCE project. Clim Change 81:1–6.

components to describe natural processes (hydrology, hydro-geology, plant physiology, yield, and glaciology). For the simulation in the included sectors (farming, economy, water supply companies, private households and tourism) DANUBIA uses deep multi-actors models which represent the decisions of the involved actors based on the structure of societies, their framework as well as their interests. DANUBIA was successfully validated with comprehensive data sets of the years 1970-2005 and will be made available as "Open Source" in 2010 for serving decision makers from policy, economy, and administration as tool for a foresighted planning of water resources against the background of Global Change. DANUBIA is applied to the RBMP of the Upper Danube watershed



Model of the scenario-based decision support system DANUBIA

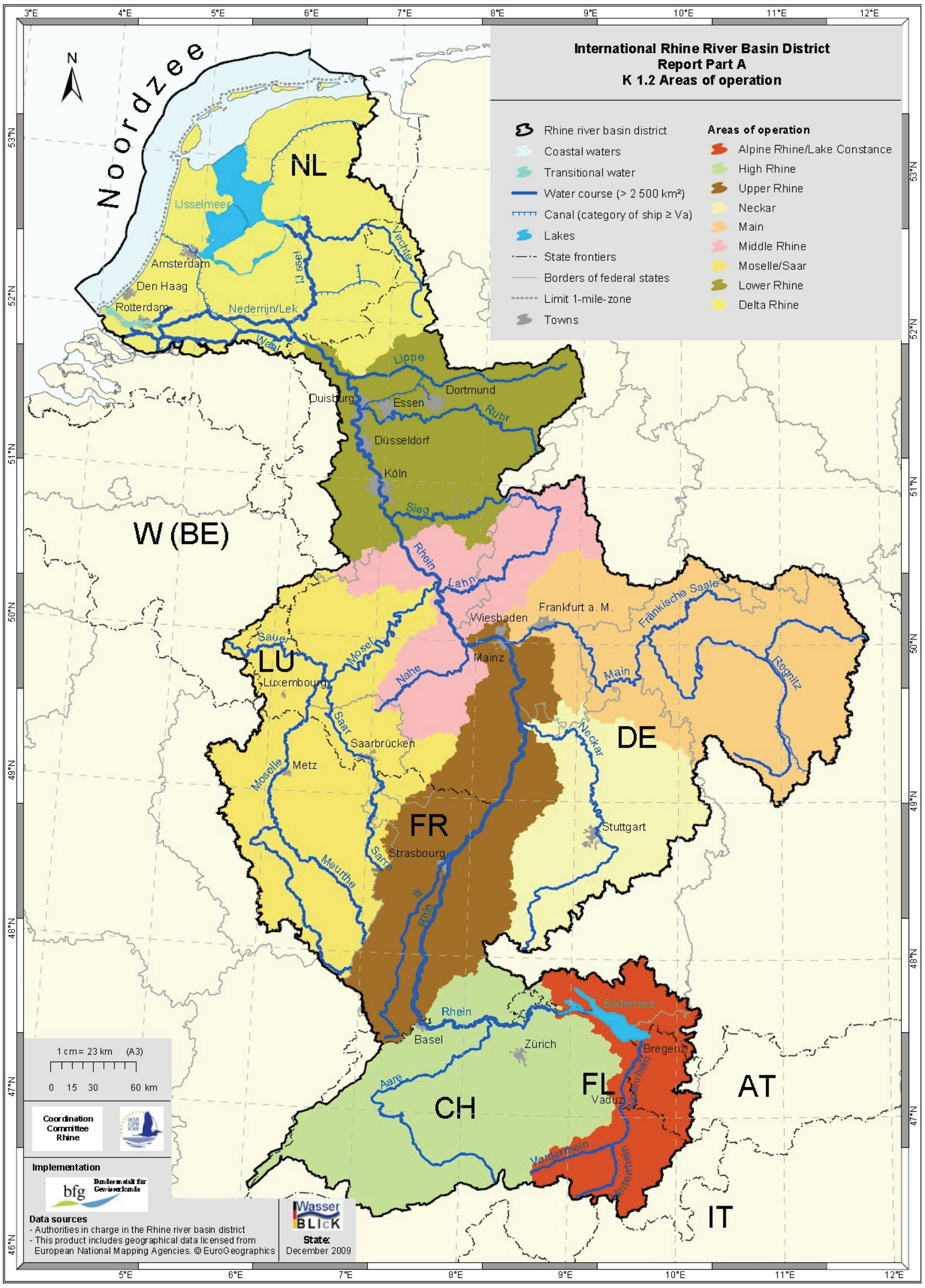
International River Basin District Rhine

Nine countries are the members of the **International Commission for the Protection of the Rhine (ICPR)**: Switzerland, France, Germany, Luxemburg, Netherlands, Austria, Liechtenstein, the Belgian region of Wallonia and Italy. Focal points of work are sustainable development of the Rhine, its alluvial areas and the good state of all waters in the watershed. Since 1950, representatives of the governments of the states concerned jointly draft recommendations for programmes of measures within the ICPR which are implemented and financed by the individual countries. The ICPR coordinates this work and discusses its results. Currently, work is focusing on the following objectives and tasks:

- Improvement of the chemical and ecological state of the Rhine by sustainably developing the ecosystem and uses of Rhine water, taking into account the relief of the North Sea.
- Comprehensive flood prevention and protection taking into account ecological requirements;
- Support of the co-ordinated implementation of European regulations, such as the WFD and the Floods directive in the watershed of the Rhine.

Work is done in coordination with representatives of associations interested, economy, local authorities whose work is related to the river and other international commissions working in the Rhine watershed. The work of the Commission is supported by a secretariat located in Koblenz.

The IRBD Rhine areas of operation (http://www.iksr.org/index.php?id=240&L=3):



RBMP for Rhine is a result of international coordination in the river basin district. All states have agreed to the international part of the management plan. It consists of a text part and maps, which may be downloaded from the following websites:

- http://www.iksr.org/bewirtschaftungsplan

- http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Inventory_Parts/bwp_endversion-en_komplett.pdf
- http://www.iksr.org/fileadmin/user_upload/Dokumente_en/Inventory_Parts/bwp_kurzfassung-en.pdf

General approach

In the general report[49] aspects of CC are discussed in Chapter 6.3 under the Economic analysis. More insight to the climate check of the programmes of measures is given in the reports from the various Areas of Operation. For the **first management period until 2015**, no significant effects of CC are still expected which would require specific measures to be taken. In order to enable a wider consideration of the impact of CC in the **second management plan**, targeted investigations are necessary in a number of fields such as the effect of CC on species; adjustment of the monitoring program to integrate CC effects; revision of climate scenarios; improving hydrological simulation models; identification of knowledge gaps.

Climate change in the Rhine catchment

According to the report by the expert group (KLIMA)[50], during the past 100 years, air temperature in the Rhine catchment has risen both in winter (by approx. 1.0°C to 1.6°C) and in summer (approx. 0.6°C to 1.1°C). This results in an annual average rise in temperature in the Rhine catchment area about 0.5°C to 1.2°C, which is in the same order of magnitude as the mean global rise in temperature of up to approx. 0.9°C per 100 years. With rising temperatures, glaciers are retreating in the Alps. In the Rhine catchment area, temperature and precipitation monitoring data already now indicate CC. Due to rising temperatures and increased precipitation and little snow storage in winter, the monthly average runoff data for the entire Rhine catchment area in the winter half-year are higher than what they used to be. At the same time, maximum runoff in winter is rising, while average runoff in summer is falling. The annual average runoff remains constant. Natural water temperature is governed by the same factors of influence as air temperature. Thus, CC has also contributed to a rise in water temperature by about 1°C to 2.5°C in the Rhine. But water temperature is also influenced by factors such as discharge of cooling water and urbanisation.

Climate projections show that, during the coming 50 to 100 years, the sum of winter precipitation will increase, while that of summer precipitation will fall. With regional variations, the trends for air temperatures indicate a rise in winter and summer air temperature by 1.1 to 2.8°C by 2050. For the period until 2050, most of the hydrological model results using climate projections show a distinct increase of the average runoff in the winter half-year and a decrease of the average runoff in the

[49] Internationally Coordinated Management Plan for the International River Basin District of the Rhine December 2009. International Commission for the Protection of the Rhine (ICBR)

[50] Analysis of the state of knowledge on climate changes so far and on the impact of climate changes on the water regime in the Rhine catchment area; 2009, Koblenz, ICPR – Technical Report No. 174 http://www.iksr.org/index.php?id=190&tx_ttnews[pointer]=2&tx_ttnews[tt_news]=467&tx_ttnews[backPid]=128&L=3&cHash=269b689b907d27e75b2a41c1beda0ef6

summer half-year. After the KLIMA expert group has evaluated literature on the CC in the Rhine catchment area in the first step, the work continues:

- In a second working step, the KLIMA expert group will draft a scenario study to be accomplished by 2010, which will establish common consistent scenarios for climate and runoff in the international catchment and include temperature developments of Rhine water by 2050 (in all, analysis of climate scenarios until 2100).
- The objective of the 3rd working step is to estimate the effects of possible CCs on the water household in order to assess future development (knowledge of possible extreme values: floods and draughts) and on the water temperature of the Rhine (extreme values, seasonal variations, long term developments).
- In a fourth working step beginning after 2010, the ICPR will develop internationally coordinated interdisciplinary adjustment strategies for the use of water quantity and for aspects of water quality and ecology. These strategies may become part of the second international management plan for the IRBD Rhine.

Climate change impacts in the Rhine catchment

CC may impact flood protection, drinking water production, industrial activities, agriculture and nature. In the long run, the increase in temperature will lead to rising sea levels. Additionally, modifications of the marine habitat which are presumably caused by CC might have a negative impact on the population of the European eel, which stocks have diminished considerably. High temperatures in summer ($\geq$ 25°C water temperature) may be a stress factor for migratory fish and imply an increased risk of infections and a temporary interruption of upstream migration.

Invasive species are ecdemic animal species from other regions. Among others, numerous species from the Black Sea region which have immigrated through the Main- Danube-Canal since 1992 are found in the Rhine. Often, these invasive species settle in the main stream and in tributaries in considerable biomasses and, attached to vessels, they even spread upstream - often at the expense of the indigenous fauna. In some part, anthropogenic influences such as increased water temperature, hydraulic engineering measures and substances present in the water favour their development.

The report from the **Delta Rhine Area of Operation**[51] analyses the climate impacts on various water categories in more detail (Table 8). The **climate check of the Programme of Measures** in the Delta Rhine Area of Operation showed that despite great uncertainties about the extent of CC, there are many no-regret measures and options that are useful, no matter how the climate will be in the future. This has been seen during the heat waves and drought of recent years. Almost none of the WFD

[51] Internationaler Bewirtschaftungsplan 2009 – 2015. Bearbeitungsgebiet Deltarhein

measures showed any reduction of effectiveness resulting from the CC, most of the measures were neutral regarding CC (no significant change in effectiveness), some even increased their effectiveness (win-win situations).

Table 8 (7-1. in the report from the Delta Rhine Area of Operation[51]). Assessment of the sensitivity of water types over charges which are exacerbated by CC. 1- not significant; 2- sensitivity is not high and strongly dependent on local conditions; 3- sensitive in places; 4 - almost always sensitive.

Pressure	**Water category**				
	Lakes	**Rivers**	**Coastal waters**	**Transitional waters**	**Groundwater**
Eutrophication	4	2	3	3	3
Salinization	3	3	1	1	3
Water level regulation	3	1	1	3	2
Runoff dynamics	1	3	1	3	1
Passage constraints	2	4	1	3	1
Thermal stress	2	3	1	2	1

Measures that improve the structure of water bodies in a way to *enhance the re-colonization potential of species* prove to be robust also to pressures of CC. In this context also measures that *improve the connectivity of river systems* are important as they flatten the runoff peak. The impact of CC will be further toned down by measures against eutrophication, such as *buffer strips, which reduce nutrient loads of lakes and rivers and also offer shading of water.* Other win-win situations are related to actions which help to achieve the Natura 2000 targets or contribute to other functions of water systems such as bathing or drinking water supply. Many policies are flexible, that means, they can be adjusted on the basis of advancing knowledge regarding the speed and extent of CC.

According to a general assessment, the impacts of CC will affect the measures of the management plans. For the **first management period until 2015**, according to current information, no significant effects of CC would require specific measures to be taken. In order to enable a wider consideration of the impact of CC in the **second management plan**, targeted investigations in Germany and in the Netherlands are necessary in a number of fields such as

- *the effect of CC on species,*
- *adjustment of the monitoring program to integrate CC effects,*
- *revision of climate scenarios,*
- *improving hydrological simulation models,*
- *identification of knowledge gaps.*

International River Basin District Elbe

The transnational Elbe River basin is one of the major central European catchments. It covers large areas of the Czech Republic and Eastern and Northern Germany. Minor areas of the head waters are located in Austria and Poland. The catchment area is 148,268 km² and the total length of the river is 1,091 km.

Hydrometheorological Institute, ICPER, BfG, Czech (source of figure)

The Elbe river basin experiences a wide range of flood issues that are typical for Europe. In the mountainous regions, the flooding processes are characterised by high intensity flash flood events. The lowlands suffer from flooding of the tributaries and the Elbe River itself, which are slower in response to the rainfall but result in very large inundation volumes. An extreme flood event in August 2002, which resulted in damages of more than €12 Billion[52], highlighted shortcomings in the existing flood protection provided in the basin. Lessons learnt from this and other events assist in the development of future flood risk management strategies.

[52] http://www.floodsite.net/html/pilot_site_elbe.htm

Under the **International Commission for the Protection of the Elbe River,** Germany, Czech Republic, Poland and Austria have jointly developed an international RBPM[53] for the Elbe River for the period until 2015 (http://www.ikse-mkol.org/index.php?id=513&L=2). This plan sets the goals to achieve the good status of surface waters and groundwater, and summarizes the necessary measures.

General approach

CC issues are mentioned in the chapter on Economic Analysis and in the summary of the Programme of Measures. The report concludes that CC impact on water related issues is still hardly quantifiable during the first river basin management cycle, but the effects of CC for the further planning of measures must be considered. It is suggested that the issue of CC and the identification of trends in particular should get greater attention and become an important subject of the future water management.

The occurrence of both hydrological extreme events, the extreme floods and the unusual periods of low water due to extreme droughts, should be taken into account in the Elbe catchment. If the climatic trends will continue according to the adopted scenarios, a more frequent occurrence of these hydrological extreme events is expected in the future. The effects of CC are currently difficult to estimate. Depending on the region and season, the rainfall may either increase or decrease. Also the probability of both the heavy precipitation events and, at the same time, the dry spells is likely to increase. In most impacted regions, this could raise the cost of water supply.

The amount of water consumption for agriculture in the Czech part of the Elbe river basin is particularly influenced by withdrawals for irrigation. The gradual increase in the trend of irrigation water use can be attributed to the need to cover the moisture deficits rather than the change in pricing policy. To a certain degree, this change may also be linked with CC although it is hardly quantifiable. In the German part of the Elbe river basin, no significant changes in water withdrawals for agriculture are expected. However, changes could be triggered by the impacts of CC. This possibility must be observed.

The measures will contribute significantly to achieving the objectives of the WFD. While implementing the measures, the integration of other sectors, such as energy, transport, agriculture, fisheries, regional development and tourism is required. Predictable effects of CCs for the further planning of measures must be considered. It is suggested that the issue of CC and the identification of trends in particular should

[53] INTERNATIONALER BEWIRTSCHAFTUNGSPLAN FÜR DIE FLUSSGEBIETSEINHEIT ELBE
nach Artikel 13 der Richtlinie 2000/60/EG des Europäischen Parlaments und des Rates vom 23. Oktober 2000 zur Schaffung eines Ordnungsrahmens für Maßnahmen der Gemeinschaft im Bereich der Wasserpolitik. TEIL A, 2009. Fachliche Bearbeitung und Redaktion: Internationale Kommission zum Schutz der Elbe (IKSE)

get greater attention and become an important subject of the future water management. In the future, medium and long term adaptation strategies to CC will play an important role in the selection and implementation of measures. First scientific results on CC impacts in the Elbe river basin were already considered in the selection of measures for the first management plan.

International River Basin District Meuse

The River Meuse (Latin Mosa, Flemish Maes, Dutch Maas) and its tributaries, the associated ground waters, transitional waters and the coastal waters constitute the Meuse International RBD (IRBD). The IRBD includes five Member States of the European Union (France, Luxembourg, Belgium, Germany, Netherlands). Most of the basin area (36.000 km^2) is in Wallonia (12.000 km^2), followed by France (9.000 km^2), the Netherlands (8000 km^2), Germany (2000 km^2), Flanders (2000 km^2) and Luxembourg (some km^2). An international agreement was signed in 2002 in Ghent about the management of the river. An International Commission on the Meuse has the responsibility of the implementation of the treaty. The costs of this Commission are met by all these countries, in proportion of their own territory into the basin of the Meuse: The Netherlands and Wallonia 30%, France 15%, Germany 14.5%, Flanders 5%, Brussels 4.5%, Kingdom of Belgium and Luxemburg 0.5%. The Commission coordinates internationally the implementation the WFD and other topics, such as flood protection in the Meuse IRBD. The countries and regions thus have the task to prepare and agree on regional water management measures within the Meuse IRBD, to achieve the good status of waters in the light of CC. RBMPs for IRBD Meuse are published in French, Dutch and German.

General approach

The RBMP for Meuse IRBD[54] does not include any special chapter on CC but mentions CC issues in the chapters on floods and droughts. The development of adaptation strategies for high- and low-water conditions in the Meuse IRBD is the subject of an Interreg IVb project. This project - AMICE - Adaptation of the Meuse to the impacts of climate evolutions[55] - runs from May 2009 to June 2013. The issue of temperature will be worked out in more detail in the work program of the International Meuse Commission, which could result in new measures in the next round of the management plans.

Floods management

Regarding floods, all states and regions combine the requirements of the EC Flood Directive[20] with the requirements of the WFD to recover natural and possibly create new water retention facilities, taking into account the requirements for environmentally friendly design. With the entry of the Flood Directive into force on 26 November 2007, all states and regions have now a common basis to reduce flood-related adverse effects on human health, environment, cultural heritage, and economic activity. The aim of the Flood Directive involves, among other things, a cross-border coordinated flood risk management in river basins, including coastal areas. By 2015, the flood risk management plans (FRMP) of the countries/regions should be created taking into account its compatibility with the WFD RBMPs. Until now, states and regions have set their flood risk management measures according to state, regional and local plans following the valid environmental laws. The aim is to avoid any adverse impact of the safeguard measures on the environment. In the future, the states and regions in the Meuse IRBD can create an overarching international FRMP or a coordinated set of plans given that the aims and actions in this plan (or plans) should be harmonized with the provisions of the WFD.

CC will affect the water balance. Extreme weather conditions (heavy rain with much larger amounts of water in shorter time intervals, heat waves and drought, water shortage, etc.) justify the control measures against flood risks that should ensure the ecological and other services of the surface waters. The development of adaptation strategies for high- and low-water conditions in the Meuse IRBD is the subject of an Interreg IVb project. This project AMICE (Adaptation of the Meuse to the impacts of climate evolutions) runs from May 2009 to June 2013. The countries and regions thus have the task to prepare and agree on regional water management measures within the Meuse IRBD, to acchieve the good status of waters in the light of CC.

[54] http://www.cipm-icbm.be/page.asp?id=51&langue=DE
[55] http://www.amice-project.eu/en/

Drought management

For a sustainable management and to counteract the effects of drought, the states and regions foresee a need to reduction of water withdrawals from surface water of the Meuse and to influence human behavior towards more economic water use.During a water shortage that eventually will be aggravated by CC, a need for actions may arise that should be agreed at the Meuse IRBD level to guarantee the drinking water supply, the water demand from the agriculture, industry and transport, and the structure and functioning of aquatic ecosystems.

Sustainable water management at the level of Meuse IRBD will require political and individual measures in the entire basin of the Meuse, to protect the natural environment, human resources and consume less water in production processes. CC and water temperature should be more considered in the future. The issue of temperature will be worked out in more detail in the work program of the International Meuse Commission, which could result in new measures in the next round of the management plans.

The project AMICE report[56] on the analysis of CC, high-flows and low-flows scenarios on the Meuse basin pointed out the following issues:

1. Several global and regional CC models used in the studies all give quite clear trends for the Mediterranean region and the Scandinavian but not for the Meuse basin which lies between these two regions and, depending on the models used, the Meuse basin gets dryer or has increased precipitation.
2. Due to the high uncertainty of climate models whether the future will be drier or wetter, the AMICE partners decided to study the possible evolutions of the basin's climate: a wet one and a dry one. However most models indicate a drier summer. And most models in the Rhine catchment say that winters will be wetter. The scenarios proposed by the AMICE partners are plausible scenarios: they are not much different from the trends used in other climate impacts studies.
3. However, it does not mean that the wet or dry climate scenario will indeed happen. The water managers and decision makers should be very aware that our results only represent two possible future climate trends, without any absolute certainty on which climate will occur.
4. A bibliographic study showed that there is no climate database ready to use for the AMICE project because they do not cover the whole basin or need a bias correction or the results of CC studies are generally too heterogeneous and sporadic to be used at the scale of the whole Meuse basin.

[56] Analysis of climate change, high- flows and low- flows scenarios on the Meuse basin. WP1 report, Action 3.

5. Hydrological studies are difficult to use and generally do not use the same impact variables which makes them difficult to compare. Time slices used in former studies are also different.
6. The easiest solution for the AMICE project was to create new climate and hydrological scenarios, because these do not exist for the whole Meuse basin, and because the Meuse Commission pointed out the need for common scenarios.

Annex. CC adaptation measures from analysed RBMPs

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
1	A.1	Construction and refurbishment of wastewater treatment plants and sewerage systems in conurbations with more than 2,000 PE	Measures for protection of water as a component of the environment	CZ		[1]
2	A.2	Construction and refurbishment of waste water treatment plants and sewerage systems in conurbations with up to 2,000 PE in areas requiring special protection	Measures for protection of water as a component of the environment	CZ		[1]
3	A.3	Construction and refurbishment of waste water treatment plants and sewerage systems in municipalities with up to 2,000 PE	Measures for protection of water as a component of the environment	CZ		[1]
4	A.4	Technical measures regarding industrial polluters (removal of especially dangerous harmful substances)	Measures for protection of water as a component of the environment	CZ		[1]
5	A.5	Revitalization of minor watercourses and small areas in municipalities	Measures for protection of water as a component of the environment	CZ		[1]
6	A.6	Old environmental loads	Measures for protection of water as a component of the environment	CZ		[1]
7	A.7	Revitalization of watercourses and inappropriate drainage, improvement of watercourse passability	Measures for protection of water as a component of the environment	CZ		[1]
8	A.8	Implementation of land consolidation measures and comprehensive land consolidation measures (erosion reduction, improvement of the ecological stability of landscape)	Measures for protection of water as a component of the environment	CZ		[1]
9	A.9	Riparian stand establishment and rehabilitation	Measures for protection of water as a component of the environment	CZ		[1]
10	A.10	Grassing of arable land, in particular along watercourses	Measures for protection of water as a component of the environment	CZ		[1]
11	A.11	Improvement of tree species and spatial composition of forests in especially protected areas	Measures for protection of water as a component of the environment	CZ		[1]
12	A.12	Afforestation of farmland	Measures for protection of water as a component of the environment	CZ		[1]
13	A.13	Improvement of tree species composition of forest stand	Measures for protection of water as a component of the environment	CZ		[1]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
14	A.14	Technical and biological measures to reduce euthropication of surface water	Measures for protection of water as a component of the environment	CZ		[1]
15	A.15	Grassland management	Measures for protection of water as a component of the environment	CZ		[1]
16	A.16	Complex monitoring, identification and assessment of the status of water quality and quantity (Complex monitoring of water)	Measures for protection of water as a component of the environment	CZ		[1]
17	A.17	Environmental educational programmes and provision of environmental consulting	Measures for protection of water as a component of the environment	CZ		[1]
18	A.18	Improvement of human resources potential in the field of agriculture (landscape maintenance and protection of the environment, soil erosion, water pollution, improvement of biodiversity etc.)	Measures for protection of water as a component of the environment	CZ		[1]
19	A.19	Reduction of surface water and groundwater pollution from agricultural sources	Measures for protection of water as a component of the environment	CZ		[1]
20	B.1	Measures to reduce runoff from the watershed	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
21	B.2	Building of polders larger than 50 thousand square meters	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
22	B.3	Regulation of watercourse channels in municipal built-up areas in a nature-friendly manner	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
23	B.4	Improvement of landscape retention capacity and reduction of flood occurrence in a nature-friendly manner	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
24	B.5	Erosion protection and reduction of adverse impacts of surface water runoff	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
25	B.6	Flood protection measures with retention	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
26	B.7	Flood protection measures along watercourses	Measures for flood protection and protection against	CZ		[1]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
			other detrimental effects of water			
27	B.8	Improvement of safety of hydraulic structures	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
28	B.9	Studies on rainfall-runoff conditions and specification of flood plain areas	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
29	B.10	Fish ponds rehabilitation, refurbishment, and sludge removal, and construction of water reservoirs	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
30	B.11	Flood protection measures implemented as a part of land consolidation	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
31	B.12	Implementation of precautionary flood protection measures on minor watercourses and in their basins and erosion protection measures on forest land, repairs of bank scours, erosion scours and damming, stabilization of ravines on land designed to play the role of a forest.	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
32	B.13	Development and modernization of information systems of the flood forecasting and warning service	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
33	B.14	Support of processing the mapping data about flood hazard and flood risk	Measures for flood protection and protection against other detrimental effects of water	CZ		[1]
34	C.1	Construction and rehabilitation of water treatment plants and drinking water resources in municipalities with more than 2,000 inhabitants	Measures in the field of water services	CZ		[1]
35	C.2	Construction and rehabilitation of water conduits and water distribution networks in conurbations with more than 2,000 inhabitants	Measures in the field of water services	CZ		[1]
36	C.3	Construction and rehabilitation of water treatment plants and drinking water resources, and construction and rehabilitation of water conduits and water distribution networks in conurbations with up to 2 000 inhabitants in areas requiring special protection	Measures in the field of water services	CZ		[1]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
37	C.4	Construction and rehabilitation of drinking water supply systems in municipalities with up to 2,000 inhabitants	Measures in the field of water services	CZ		[1]
38	C.5	Prospecting for and exploiting new groundwater resources to supply water to the population	Measures in the field of water services	CZ		[1]
39	C.6	Geological and hydrogeological works for the purpose of re-evaluating the groundwater resources for water supply to the population	Measures in the field of water services	CZ		[1]
40	C.7	Prospecting for, survey and assessment of the possibilities of controlled groundwater recharge by surface water (artificial groundwater recharge) from watercourses or reservoirs	Measures in the field of water services	CZ		[1]
41		Need of action arises in small catchments for which the risk of convective heavy rainfalls (thunderstorms) has been indicated	Medium and long term measures in the affected regions	AT		[2]
42		Protection of the remaining retention areas to minimize the peak flow of small-scale, convective heavy rainfalls.	Medium and long term measures in the affected regions	AT		[2]
43		Appropriate measures to mitigate the expected higher input of nutrients from the soil erosion and flooding of the dung depositories	Medium and long term measures in the affected regions	AT		[2]
44		Compensatory measures - such as irrigation systems	Medium and long term measures in the affected regions	AT		[2]
45		Water-saving measures (particularly in the agricultural irrigation)	Medium and long term measures in the affected regions	AT		[2]
46		Increase in available water supply through increased retention of water in the area	Medium and long term measures in the affected regions	AT		[2]
47		Artificial groundwater recharge and storage	Medium and long term measures in the affected regions	AT		[2]
48		Broader insuring of drinking water supplies by regional and interregional loop lines	Medium and long term measures in the affected regions	AT		[2]
49		Measures to meet the feed requirement for livestock in dry periods	Medium and long term measures in the affected regions	AT		[2]
50		Creation of special management plans	Medium and long term measures in the affected regions	AT		[2]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
51		Need to increase cleaning efficiency of sewage treatment plants and combined sewers or discharges from storm water channels, because of the lower dilution capacity in receiving waters as a consequence of low flow and increased water temperatures	Medium and long term measures in the affected regions	AT		[2]
52		Adjusting reference conditions and setting the quality objectives in some water body types.	Medium and long term measures in the affected regions	AT		[2]
53		Develop norms for snowmaking reservoirs in order to avoid further deterioration of water scarcity by additional withdrawals.	Medium and long term measures in the affected regions	AT		[2]
54		More attention has to be paid to the stability of the increasing dams and the environmentally friendly operation of the plants.	Medium and long term measures in the affected regions	AT		[2]
55		Maintain the continuous long-term measurement network for the observation of various climate factors (such as rainfall, temperature, drainage, water temperatures, snow cover, ...) and their impact on the water balance.		BE		[3]
56		Ensure that it is the middle and higher elevations, for which the worse and very different impacts of climate change have been projected, would be adequately monitored.		BE		[3]
57	3_027	Estimate future needs in drinking water supply, greywater treatment, and water supply for industry and agriculture (taking into account the impact of Climate Change)	Additional measures to tackle climate change	BE		[3]
58	3_032	Scenario development for predicted long term water quantity changes (taking into account the effects of climate change) (analogous to 5A_007)	Additional measures to tackle climate change	BE		[3]
59	3_041	Determination of the quantitative capacity of water (taking into account the impact of climate change)	Additional measures to tackle climate change	BE		[3]
60		Additional measures to first retain water for later slow release	Additional measures to tackle climate change	BE		[3]
61		Mapping of flood zones	Flood measures	BE		[4]
62		Implementation of urban constraints, promoting agri-environment (hedges, headlands, ...)	Flood measures	BE		[4]
63		Maintenance of the integrity of rivers	Flood measures	BE		[4]
64		Remedial works or local improvement of the flood warning system.	Flood measures	BE		[4]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
65		Conduct investigative monitoring of the effects of climate change and the impact of invasive species on aquatic biota and sediments in sensitive and vulnerable areas and areas for fish and shellfish.		BG		[6]
66		Study on climate change and its impact on climate water resources (surface and groundwater) ecosystems, ecological status, crops and hydropower. Designation of sensitive areas and Indicators	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
67		Assess the need for water medium and long term for different economic sectors (households, agriculture farm economy and hydropower) and availability of the necessary water resources. Determination of problematic sectors and areas.	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
68		Establish a system for assessing Impact of climate change, monitoring and indicators.	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
69		Assessment of the economic impact of climate change on different economic sectors and development forecasts scenarios in the context of climate change, determining the economic Indicators.	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
70		Studies to reassess the needs of water and effective management of the resource optimization of the transferred quantities in other river basins	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
71		Development of methodology for determining the fiscal incentives for the introduction of mechanisms and practices for water efficiency.	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
72		Development of management plans water resources in drought conditions	Measures to reduce the effects of drought and water scarcity in the East Region	BG		[5]
73		Thickening and modernization of the network meteorological and hydrological monitoring to obtain more and more reliable data for water resource	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
74		Filming of the topography of rivers and create a digital model of relief	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
75		Mapping of flood zones	Measures to reduce the negative effects of flooding in the East Region	BG		[5]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
76		Establishment of hydrological models for water management	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
77		Identify areas threatened by flooding under different scenarios for flood height.	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
78		Development of methodology for assessing damage and assess the potential damage of flood risk areas	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
79		Develop a project for each river basin for protection against high floods and for integration of measures to improve hydromorphological condition of wetlands to achieve the objective of good water status	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
80		Establishment of an early warning system for flood risk	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
81		Training for use of the early warning system	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
82		Training and information campaigns for problems associated with floods	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
83		Consulting the public on determining risk areas	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
84		Consulting the public on development of flood prevention measures	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
85		Informing the public regarding developed measures	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
86		Establishment of a mechanism to coordinate actions in cases of flood risk.	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
87		Creation of a coordination mechanism for flood occasions	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
88		Maintenance of river beds to ensure the passage of the flood peak.	Measures to reduce the negative effects of flooding in the East Region	BG		[5]
89	BG1MS053	Additional runoff regulation	Supplementary measure addressing climate change	BG		[7]
90	BG1MS054	Conservation or plumbing of unused drill holes	Supplementary measure addressing	BG		[7]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
			climate change			
91	BG1MS0 55	Prevent overexploitation of groundwater	Supplementary measure addressing climate change	BG		[7]
92	BG1MS0 56	Assessment and prediction of changes of water resources based on data from water monitoring	Supplementary measure addressing climate change	BG		[7]
93	BG1MS0 57	Reforestation of clear cutting areas in water supply zones, avoiding acacia and poplar	Supplementary measure addressing climate change	BG		[7]
94	BG1MS0 58	Improving forest management in water supply zones	Supplementary measure addressing climate change	BG		[7]
95	BG1MS0 59	Anti-erosion measures and reduction of unused water flow	Supplementary measure addressing climate change	BG		[7]
96	BG1MS0 60	Planting appropriate native tree species	Supplementary measure addressing climate change	BG		[7]
97	BG1MS0 61	Prevention of forest fires	Supplementary measure addressing climate change	BG		[7]
98	BG1MS0 62	Providing economical water use by building water supply systems	Supplementary measure addressing climate change	BG		[7]
99	BG1MS0 63	Using economic regulators, leading to water saving in areas with a shortage of water resources	Supplementary measure addressing climate change	BG		[7]
100	BG1MS0 64	Prohibition on empting small dams for fishing purposes	Supplementary measure addressing climate change	BG		[7]
101	BG1MS0 65	Stimulating the economic use of water for irrigation	Supplementary measure addressing climate change	BG		[7]
102	BG1MS0 66	Regular informing of the public about the state of water resources of the country at local and national level	Supplementary measure addressing climate change	BG		[7]
103	BG1MS0 67	Public control over water pollution and illegal abstraction and creating “green line” phones to municipalities and regional Inspectorates of environment and water	Supplementary measure addressing climate change	BG		[7]
105	BG1MS0 01	Develop fiscal incentives for the introduction of mechanisms and practices for water efficiency	Supplementary measure addressing climate change	BG		[7]
106	BG1MS0 03	Reduce losses in water supply network through rehabilitation or construction of new pipelines	Supplementary measure addressing climate change	BG		[7]
107	BG1MB0 27	Prohibition on issuing permits for water, where the total water use exceeds the operational resources of groundwater bodies	Basic measure addressing climate change	BG		[7]
108	BG1MB0 31	Control permits for water (control abstraction)	Basic measure addressing climate change	BG		[7]

No.	Original ID code	Measure	Original type of measure	Country	Comment	Source
109	BG1MS006	Regulation in the permits for water abstraction for dangerous lowering of groundwater levels	Supplementary measure addressing climate change	BG		[7]
110	BG1MS010	Prohibition on issuing permits for water for bodies of groundwater-dependent Intermittent rivers	Supplementary measure addressing climate change	BG		[7]
111	BG1MS011	Prohibition on issuing permits for construction of protective facilities of surface water in areas where it might significantly increase groundwater levels	Supplementary measure addressing climate change	BG		[7]
112	BG1MS012	Construction of reservoirs to regulate the maximum (peak) flows	Supplementary measure addressing climate change	BG		[7]
113	BG1MS013	Maintenance of water supply networks in good condition	Supplementary measure addressing climate change	BG		[7]
114	BG1MS014	Optimization of water abstraction for industrial use through the introduction of closed cycles	Supplementary measure addressing climate change	BG		[7]
115	BG1MB039	Control of compliance with permit conditions for water use	Basic measure addressing climate change	BG		[7]
116	BG1MB085	Monitoring of surface and groundwater to assess the condition of water bodies	Basic measure addressing climate change	BG		[7]
117	BG1MS033	Application of environmental standards in production processes	Supplementary measure addressing climate change	BG		[7]
118	BG1MB043	Regulation for the permits for construction and operation of new and existing industrial installations and facilities	Basic measure addressing climate change	BG		[7]
119	BG1MB044	Control over the conditions in the permits issued	Basic measure addressing climate change	BG		[7]
120	BG1MB080	Regulation to assess the environmental impact assessment (EIA) of investment proposals for construction, operations and technology according to EPA	Basic measure addressing climate change	BG		[7]
121	BG1MB081	Regulation to assess the need for an EIA according to EPA	Basic measure addressing climate change	BG		[7]
122	BG1MB082	Control over fulfilment of the conditions of the EIA decisions	Basic measure addressing climate change	BG		[7]
123	BG1MB182	Preparation of Management Plan for flood risk	Basic measure addressing climate change	BG		[7]
124		Need to leave more storage capacity for winter in the regulated lakes in southern and central Finland because of increasing winter runoff and more frequent winter floods	Measures to tackle climate change impacts	FI		[8]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
125		Need for lower storage capacity in spring when the snowmelt floods will disappear or be reduced	Measures to tackle climate change impacts	FI		[8]
126		Need to fill the lakes in spring because of longer and sometimes also drier summers	Measures to tackle climate change impacts	FI		[8]
127		Continuing need for the storage capacity in northern Finland to reduce the flood risk caused by snowmelt	Measures to tackle climate change impacts	FI		[8]
128		Need to change more than half of the current 220 lake regulation permits	Measures to tackle climate change impacts	FI		[8]
129		With increasing traffic volume increases the risk of accidents and groundwater protection should be strengthened	Measures to tackle climate change impacts	FI		[8]
130		Creating flood hazard maps		LU		[9]
131		Keeping the extremely flood prone areas free of buildings		LU		[9]
132		Flood-adaptation of buildings in areas of low flood hazard		LU		[9]
133		Basing flood forecasting on a long-term cross-border cooperation between competent authorities with the involvement of scientific research.		LU		[9]
134		Foundation of Flood Partnerships of communities exposed to a comparable flood hazards with the aim to better inform the local population of flood hazards and to improve flood protection and flood prevention.		LU		[9]
135		Optimizing the transboundary flood forecasting system in the Moselle catchment area		LU		[9]
136		Establishment of a competence center providing information and advice to communities on construction precautions		LU		[9]
137		Determine the impact of climate change on high and low water conditions in the Mosel basin.		LU		[9]
138		Establishment of rules for the minimum residual flows at hydropower plants		LU		[9]
139		Limit unsustainable water uses that are more common in the summer months and those which cannot and should not be considered in dimensioning of water supply infrastructure.		LU		[9]
140		Planning new development areas with stormwater and sewage water separation systems and remote retention reservoirs		LU		[9]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
141		Development and formulation indicator and monitoring systems to follow climate change impacts on hydrology and water management, preparation of impact assessment studies	Measures to tackle climate change impacts	HU		[10]
142		Assessment of the real constraints and potential for adaptation with special regards to utilisable water reserves and flood control	Measures to tackle climate change impacts	HU		[10]
143		Development of economic water usage, higher involvement of local water assets and precipitation	Measures to tackle climate change impacts	HU		[10]
144		Repeated measuring and assessing of water restraint potentials and surface and under-surface water reserves	Measures to tackle climate change impacts	HU		[10]
145		Mandatory development of detailed climate change related impact assessment for significant hydrological investments	Measures to tackle climate change impacts	HU		[10]
146		Reduction of non-climate related impacts on hydrological reserves (land use, urbanisation, settlement policy, wastewater)	Measures to tackle climate change impacts	HU		[10]
147		Quantitative and qualitative assessment of water reserves trends, as well as water demand and supply trends has to be undertaken in order to ensure the security of underground water management	Measures to tackle climate change impacts	HU		[10]
148		Assessment of climate change impacts on the natural status of surface and underground waters	Measures to tackle climate change impacts	HU		[10]
149		Impact assessment for water catchment areas and development of indicator system for monitoring changes in the natural waters.	Measures to tackle climate change impacts	HU		[10]
150		The absolute need for a new water resources management (drought tolerant plants, water-saving irrigation technologies and equipment), to develop and apply water saving methods, and thereby increase the efficiency of water use, i.e., to ensure sustainable water use (Chapter 8.5. and 8.6.).	Measures to tackle climate change impacts	HU		[11]
151		The fast water runoff based approach should be replaced by rainfall floods retention, which appears in both the floods and droughts risk management plans and measures, (Chapter 8.2.4.).	Measures to tackle climate change impacts	HU		[11]
152		Treated waste water should be kept on site (Chapter 8.2.1.).	Measures to tackle climate change impacts	HU		[11]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
153		The decline of the dilution capacity due to low water in streams should be taken into account in waste water discharge into natural recipients (Chapter 8.2.1.).	Measures to tackle climate change impacts	HU		[11]
154		The flood water management must be approximated to natural regimes; the RBMP morphological measures in the floodplains should targeted at flood formation, in part, restoration of the floodplain and ecological aspects with a flexibility for the treatment of extreme floods (Chapter 8.4.2.);	Measures to tackle climate change impacts	HU		[11]
155		Restoration of wetlands. The importance of wetland habitats and forested, is currently increasingly highlighted (Chapter 8.2.4.). The restoration of wetland habitats must ensure their water-holding capacity, therefore, a complex water management system should be developed, for local water supply and to protect the ecosystems (Chapter 8.7.1.);	Measures to tackle climate change impacts	HU		[11]
156		The impact of climate change induced low water supplies can be markedly reduced by increasing the storage capacity. The role of water storage for water resource management is expected to increase, while the construction and operating of the storage capacities must take into account the WFD ecological prescriptions. (Chapter 8.4.3)	Measures to tackle climate change impacts	HU		[11]
157		Altered abstraction timing	Protection of biodiversity	IE	Win-win	[12]
158		Create buffers around water bodies	Improved soil and subsoil water retention, reduced flood risk	IE	Win-win	[12]
159		Connection of unsewered wastewater discharges to municipal system in selected areas where assimilative capacity is available during low flow	Reduced spatial risk during severe droughts	IE	Win-win	[12]
160		Water conservation measures	Adaptation to droughts	IE	Win-win	[12]
161		Actions may be required to replace habitat lost through sea level rise or increased flooding	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
162		Projects should assess impacts in the context of climate change.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
163		Make provision for pre-treatment requirements for industrial wastewater entering the collection systems and treatment plants considering the potentially reduced assimilative capacity in rivers in summer	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
164		Monitor changes in hydrological pressures and review and adjust abstractions and other pressures which reduce groundwater levels in protected areas for groundwater dependent and/or supported habitats and species.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
165		Actions to reduce erosion and sedimentation pressures should be able to meet increased risk of extreme events. Consider potential for habitat creation in managed retreat from rising sea level	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
166		Increase the efficiency of water use in the context of reducing river low flows in summer, supported by metering, leakage control and potential water harvesting.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
167		Adaptation measures addressing reduction of habitat fragmentation, protection and restoration of floodplains and wetlands at high-status sites and protected areas for water dependent habitats and species	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
168		Adaptation measures addressing changes to ground and surface water flow regime at high-status sites and protected areas for water dependent habitats and species	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
169		Adaptation measures addressing changes to erosion and sedimentation pressures at high-status sites and protected areas for water dependent habitats and species	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
170		Adaptation measures addressing changes to diffuse and point source nutrient loadings at high-status sites and protected areas for water dependent habitats and species	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
171		Addressed the decrease in assimilative capacity of water bodies receiving pollutant loads from point and non-point sources.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
172		Prepare for certain physical modifications in addition to the 'soft' flood management systems under 'Catchment Flood Risk Management Plans', in order to manage extreme events, rising sea levels and storm surges.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions. This could threaten achieving not only good status but also good potential in water bodies designated as heavily modified water bodies.	[12]
173		Measures to maintain compensation flows at reduced available water resources in summer to contribute to fish migration within systems particularly around or across barriers such as weirs.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
174		Water capturing during peak flows of extreme rainfall events, and off-channel storage to reduce flood hazard and increase storage infrastructure.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
175		Consider the need for additional storage infrastructure to compensate for seasonal impacts of climate change on river flows.	Adaptation actions addressing climate change impacts	IE	Adaptation solutions	[12]
176		Planning of the district-scale water balance, with identification of critical and quantitative measures to reduce incidence and intensity and for the maintenance and / or improvement of the status of surface water bodies	Shared strategies of adaptation to climate change	IT	Due in short time	[13]
177	A.1-08-b003, D.1-08-b003, E.1-08-b003	Extending the application of agri-environment measures of the Rural Development Plans imlying further action and / or interventions aimed specifically at the WFD objectives	Regional and sectoral planning, Economic instruments	IT	Due in short time	[13]
178	E.1-08-b122	Redefining and adapting the Programme of Measures to the climate change scenarios in the Po Basin	Regional and sectoral planning	IT	Due in short time	[13]
179		Creating resource conservation plans for the various uses for hydrographically homogeneous areas at subbasin level		IT	Due in medium time	[13]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
180	E.1-08-a093	Downscaling of the global and European climate scenarios to the Po river basin and evaluation of the impacts on the current measures for flood protection and water resources management	Research and development	IT		[14]
181	D.3-08-b123	Development of a support tool for the simulation of scenarios water use in agriculture and alignment of agro-meteorological forecasts with the management of water resources	Research and development	IT		[14]
182	D.3-08-b124	Advancing knowledge on the relationships between climatic variations and mechanisms of groundwater circulation	Research and development	IT		[14]
183	E.1-08-b125	Accelerate the implementation of strategies to climate change, as adjusted for Po basin	Economic instruments	IT		[14]
184	D.1-08-c001	Measures defined on the basis of monitoring the progress and effectiveness of the RBM Plan and the results of monitoring carried out for the ongoing SEA	Regional and sectoral planning	IT		[14]
185		Estimate the potential effects of climate change on water resources of the basin (according to the scenario hypothesis of water shortage). The main factors affecting water resources will be the reduction in rainfall and the increased evaporation losses from the catchment.	Additional measures	IT		[15]
186		Increase the resilience of ecosystems to the impacts of climate change		GB		[18]
187		Continue controls on importation and releases of invasive non-native species.		GB		[18]
188		Consider broadening the range of species restricted for importation		GB		[18]
189		Develop the ‘landscape ecology approach’ to identify and protect key habitats, open up new habitats and develop and maintain wildlife corridors. Reduce habitat fragmentation and protect and restore areas of floodplains and wetlands.		GB		[18]
190		Map current and future climate spaces and the vulnerability and impacts for priority species and environments.		GB		[18]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
191		Reduce water demand	Action to reduce pressures from irrigation abstractions	GB	Action expected to be resilient and flexible as climate changes	[16]
192		Change timing of abstraction	Action to reduce pressures from irrigation abstractions	GB	Action expected to be resilient and flexible as climate changes	[16]
193		Provide water supply from other sources	Action to reduce pressures from irrigation abstractions	GB	Action expected to be resilient and flexible as climate changes	[16]
194		Control pollution load at source	Action to reduce pollution from diffuse agricultural sources	GB	Action expected to be resilient as climate changes	[16]
195		Capture polluted runoff from steadings (eg in constructed farm wetlands);	Action to reduce pollution from diffuse agricultural sources	GB	May need to design for future climate (eg higher sea levels; more intense rainfall)	[16]
196		Reduce pollutant content of sewage at source	Action to reduce pollution from sewage discharges	GB	Action expected to be resilient as climate changes	[16]
197		Improve sewer network; increase treatment	Action to reduce pollution from sewage discharges	GB	Action expected to be resilient as climate changes	[16]
198		Separate out rainwater run-off	Action to reduce pollution from sewage discharges	GB	May need to design for future climate (eg higher sea levels; more intense rainfall)	[16]
199		Reduced inputs into surface waters from land contaminated by mine spoil tips	Pollution reduction from past mining activities	GB	May need to design for future climate (eg higher sea levels; more intense rainfall)	[16]
200		Treat discharges from abandoned mines	Pollution reduction from past mining activities	GB	Action expected to be resilient	[16]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
					as climate changes	
201		Sustainable urban drainage systems	Action to reduce urban diffuse pollution	GB	May need to design for future climate (eg higher sea levels; more intense rainfall)	[16]
202		Treat highly polluting urban discharges	Action to reduce urban diffuse pollution	GB	Action expected to be resilient and flexible as climate changes	[16]
203		Reduce inputs into drains	Action to reduce urban diffuse pollution	GB	Action expected to be resilient as climate changes	[16]
204		Reduce inputs of nutrients into lochs	Action to reduce pollution from aquaculture sources	GB	Action expected to be resilient as climate changes	[16]
205		Control sea lice infestations at marine cage sites	Action to reduce pollution from aquaculture sources	GB	Action expected to be resilient as climate changes	[16]
206		Provide improved river flows by integrated operation of scheme; changing pattern of abstraction	Action to reduce pressures from hydropower schemes on water flows and levels	GB	Action expected to be resilient as climate changes	[16]
207		Provide improved river flows by reducing net abstraction	Action to reduce pressures from hydropower schemes on water flows and levels	GB	Action expected to be resilient as climate changes	[16]
208		Reduce leakage rates in water supply network	Action to reduce pressures from drinking water supply on water flows and levels	GB	May need to be supplement ed due to increased demand	[16]
209		Increase water use efficiency	Action to reduce pressures from drinking water supply on water flows and levels	GB	May need to be supplement ed due to increased demand	[16]
210		Increase supply capacity	Action to reduce pressures from drinking water supply on water flows and levels	GB	May need to design for changed rainfall pattern and increased demand	[16]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
211		Improve bank and shore vegetation	Action to reduce pressures on bank and shore vegetation	GB	May need to design for changed rainfall pattern and increased demand	[16]
212		Re-engineer more natural bed and bank features (eg recreate meanders in straightened rivers)	Actions to reduce engineering pressures	GB	Action expected to be resilient as climate changes	[16]
213		Modify, reduce or cease maintenance works (eg dredging)	Actions to reduce engineering pressures	GB	Action expected to be resilient as climate changes	[16]
214		Move embankments further away from banks and shores; reduce pressures from hard engineering structures on beds, banks and shores (eg improve design, use softer engineering techniques, remove)	Actions to reduce engineering pressures	GB	Action expected to be resilient as climate changes	[16]
215		Install fish passes	Action to ensure fish passage at existing barriers	GB	Action expected to be resilient as climate changes	[16]
216		Remove nonoperational dams, weirs and other structures	Action to ensure fish passage at existing barriers	GB	Action expected to be resilient as climate changes	[16]
217		Exploration of the impact on climate change and drought on drought-sensitive nature and including the results in the national survey of fresh water		NL		[17]
218		Exploration of the impact on climate change on water transport		NL		[17]
219		Exploration of the impact on climate change on drinking water supply		NL		[17]
220		Gradually broaden the North Sea coast with sand nourishments spread out over a hundred years to allow nature to develop		NL		[17]
221		Gradually raise the water level in the IJsselmeer by a maximum of 1.5 meters, to insure the capability of releasing excess water without having to pump		NL		[17]
222		Protect the Rijn estuary region on both the sea-side and river-side with movable flood barriers		NL		[17]

No.	Original ID code	Measure	Original type of measure	Count-ry	Comment	Source
223		Provide flood areas for excess riverwater from the Maas and Rijn in the Krammer-Volkerak, the Zoommeer, the Grevelingen and possibly the Oosterschelde		NL		[17]
224		Increase the lifespan of the Oosterschelde flood barrier; it is now made to work till 2075		NL		[17]
225		Strengthen and raise sea and river dikes		NL		[17]
226		Keep the Westerschelde and New Waterway open		NL		[17]
227		Investigate the impact of dumping sand on the beach or forebanks during sand nourishments on beach ecosystems		NL		[17]
228		Enhance the re-colonization potential of species;		Rhine IRBD		[19]
229		Improve the connectivity of river systems;		Rhine IRBD		[19]
230		Creat buffer strips, which reduce nutrient loads of lakes and rivers and also offer shading of water;		Rhine IRBD		[19]
231		Carry out targeted investigations on the effect of climate change on species.		Rhine IRBD		[19]

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Abstract
The decision whether or not to include climate change (CC) issues into the 1st River Basin Management Plans (RBMP) was depending on the availability of information and on the urgency of the CC related problems involved for each country. Most countries included a chapter to the 1st RBMP do describe the observed CC and its impacts to water resources management and carried out the 'climate checking' of their programs of measures but the results were reported with a very different level of detail. The distinction of specific CC measures from the complex of measures dealing with floods, droughts and water quality protection, was rather arbitrary. In the Annex of present report the measures are categorized according to the original reports and, hence, some measures which are qualified as CC measures by one country may be not mentioned by other countries which did not consider the linkage to CC strong enough. Some of the measures in the Annex were not directly listed as measures in the management plans, but were picked out from the text discussing the tackling of climate impact. In present analysis, special attention was paid to adaptation measures addressing climate impact on ecosystems. This topic was rather scarcely presented in nine of the 18 RBMPs analysed. As the measures are translated from different languages, the wording does not pretend the full authenticity of the original text and for more detail it is suggested to consult the original plans in national languages. The present report is of relevance to the 7th EU Framework Programme, Theme 6 (Environment including Climate Change) project REFRESH (Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems, Contract No.: 244121), to JRC Thematic Area 3 (Sustainable management of natural resources) foci on CC, to the European Clearing House mechanism on CC, and to the EC Blueprint on Water.

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