Climate ≈ water

Bridging the gap between adaptation strategies of climate change impacts and European water policies

PROJECT PERIODIC REPORT

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[1] Usually the contact person of the coordinator as specified in Art. 8.1. of the grant agreement

[2] The home page of the website should contain the generic European flag and the FP7 logo which are available in electronic format at the Europa website (logo of the European flag: http://europa.eu/abc/symbols/emblem/index_en.htm ; logo of the 7th FP: http://ec.europa.eu/research/fp7/index_en.cfm?pg=logos). The area of activity of the project should also be mentioned.

Summary

The Project ClimateWater (http://www.climatewater.org) is a 7th Framework Programme project of the Co-ordination and Support actions (supporting) type of 3 years duration (01 November 2008 – 31 October 2011). This summary report corresponds to the achievements of the first 18 month of the project.
The Project is co-ordinated by VITUKI (P1, H) and the Co-ordinator is Prof. Dr. Géza Jolánkai. The 10 partners are: P2 UNIDEB (H); P3 CNR-IRSA (I); P4 (USF, D); P5 GeoEcoMar (Ro); P6 Geonardo (H); P7 UVIEN (A); P8 UNILEI (UK); P9 SHMU (SK); P10 SOGREAH (F) and P11 MRA (Malta).

The Project ClimateWater's **objectives are**; the analysis and synthesis of data and information on the likely (known, assumed, expected, modelled, forecasted, predicted, estimated) water-related impacts of the changes of the climate (**WP2**) with special regard to their risk and to the urgency of preparation to combat these changes and their impacts. The Project will identify all adaptation strategies (**WP3**) that are, and could be, developed in Europe (and also globally) for handling (preventing, eliminating, combating, mitigating) the impacts of global climate changes on water resources and aquatic ecosystems, including all other water-related issues of the society and nature. Research needs (**WP4**) in the field of 'climate impact on the water cycle and water users' will be identified. The most important output of the project will be the identification of gaps (**WP5**) that would hinder the implementation of the EU water policy in combating climate impacts on water.

By the mid-term of the project we have completed **WP 2 – Analysis and synthesis of water-related climate change impacts –** by reviewing several hundred project documents, books, papers & web sites. Consequently in this report it is not possible to refer to individual literature items and the reader is kindly requested to consult the website, where the full list of all reviewed documents is found by their Work Package and their sub-headings and topics. For the same reason only some of the most critical impacts revealed by this project can be mentioned in this summary report.

One of the **major water-related impacts is flooding.** It has close relationships to its cause – the unprecedented rainfalls and rainstorms and their impacts that include loss of human life, extreme health risk and the risk of epidemics; mud avalanches and land slides, loss of properties, devastation of natural treasures and serious water quality deterioration by the so-caused extreme pollutant loads. We found that the extremity and frequency of floods are very likely to be increasing, as a result of devastating flooding of the valleys of smaller streams and creeks, where floods had not been previously experienced. Here it should be stressed that at the **time of writing this report nearly the whole of Europe has been recently subjected to the most devastating floods ever experienced**, causing loss of life and serious health risk, induced by the highest recorded rainfall events, themselves of very high intensity at many sites.

Another **major impact area is drought and water scarcity**, the severity of which is also likely to be increasing over roughly the southern half of Europe, with special concern to the Mediterranean (also in some areas where floods and excess water are also causing severe problems). Drought and water shortage result in severe losses to agriculture and in the over-exploitation of groundwater resources. This latter might add to the severity of saltwater intrusion that stems from sea level rise.

Water supply will be seriously handicapped in many regions by the shortage of surface waters and the depletion of groundwaters, exacerbated by climate change-induced increased pollution of both. The forecasted limitations in the availability of clean and fresh water could result in difficulties in achieving the goal of improved safe access to drinking water, with conflicts between different users. All the expected modifications of the climate will also have a direct effect on both groundwater quality and quantity.

Water quality will deteriorate as a consequence of temperature rise, decreased flow (lower dilution rate) and higher runoff-induced nutrient loads. These factors will affect the rates of all chemical and ecological processes, resulting in accelerated eutrophication, decreased oxygen content and the increase of pollutant concentrations. Deterioration in terms of priority pollutants (e.g. heavy metals) and also pathogens are expected with flash floods and storm runoff events. This, in turn may result in serious health risks (e.g. among bathers of natural water bodies). A very **serious health risk** is associated with the overflow of combined sewers, as a result of intensive rainstorms of increasing intensity.

Indirect impacts on drought: Apart from the direct impact of climate change on water resources (and hydrology), we were dealing with the many indirect impacts, here only major impacts; a) Environmental impacts of damages to flora, fauna, biodiversity and to nature conservation areas; wind and water erosion of soils, reduced soil quality: b) Economic impacts of drought; losses to agricultural producers, losses to crop and livestock, fisheries and to timber production; loss to the recreation and tourism industry: c) Social impacts of drought, including health effects - increased conflicts of water users; reduced quality of life (increased poverty), loss of cultural sites; recognition of institutional restraints on water use.

Impacts on agriculture: The most evident negative impacts of climate change on agriculture coming out of the review are changes in water demand and availability along with a growing risk of drought, changes in length of the growing seasons, shift of zones, changes in crop yields, increase in the magnitude of several types of soil degradation, changes in agricultural diseases and loss of arable lands due to – among others – salinization caused by sea water intrusion and increased use of irrigation. The frequencies of drought may become regular; not only in semi-arid countries. As a causal chain drought leads to further negative effects on agriculture, such as loss of crops and animal stock, loss of arable land and desertification - which already affects several countries.

Major water-related/dependent industries, such as navigation, hydropower and nuclear power generation, will be strongly impacted. Major impacts of navigation include low water levels that will reduce loading capacity of freighters and affect transport prices. Low flows will increase the number and severity of fords and the severity of bottlenecks (narrows). This might lead to the need for replacing complete fleets by smaller vessels. Increasing level and frequency of high floods also impacts navigation over much of the inland waterways of Europe. Increased costs of routine infrastructure maintenance (e.g. dredging) and renewal are expected. In marine navigation, sea level rise can cause coastal erosion, degradation of port structures, incidents of over-topping and flooding of lowlands. Impacts on hydropower generation include a forecasted 6% decrease in utilisable capacity. Power transmission lines, offshore drilling rigs and pipelines, might be damaged by flooding and by more intense storm events (the Bay of Mexico catastrophe happened at the time of writing this report). Capacity increase of the EU hydropower industry might be possible in the part of Northern Europe "becoming wetter" . Nuclear power generation might be seriously impacted by rising water temperatures of cooling water for the stations. It has been estimated that about the half of the water intake in Europe is due to industrial water demand. Thus, in drying parts of Europe all strongly water-dependent industries might be at risk and subject to economic losses.

Impacts on landuse planning and on water management, as its major framework, will be facing serious impacts of both higher floods and drought and water shortage/scarcity (considering also land-slides and mud-avalanches). The major impact is in general terms that the methods and scope of the land-use planning need to be changed to suit a better and more efficient planning of adaptation measures (within RBMP).

Impacts on nature and within nature the aquatic ecosystems will be severe, as both too much (flooding) and too little water might cause severe degradation. Depletion of oxygen, increase of pollutant concentrations, excess pollutant and nutrient loads of high floods and runoff-washoff waters all cause problems, which span from fish-kill though various phases of planktonic and macrophyte eutrophication until poisoning by a large variety of organic and inorganic micropollutants that stem from increasing runoff from urban land and industrial "brown-field" sites. These are mostly existing anthropogenic impacts that might increase with climate change.

Terrestrial ecosystems will also become heavily impacted by both too much and too little water and by the shifting of temperature zones. At global scale <u>the evapotranspiration from forests is responsible for the majority of the world's freshwater budge</u>t. Therefore climate change impact on forests and other terrestrial ecosystems <u>could be the main driver of all water related problems</u>. Changes in the form and amount of precipitation, along with associated water availability within a forest ecosystem, may directly affect bird, amphibian, and reptile communities by concentrating populations and increasing their vulnerability to parasites and pathogens, as well as intra- and inter-specific competition. With increasing temperatures and potential reductions in soil moisture, trees could become increasingly heat- and moisture-stressed, making them more susceptible to fire.

Terrestrial/aquatic ecotones are subject to severe impact of climate change, mostly because of induced shifting of the edge-community zones. Inland-water ecotones, edge community habitats of floodplain and lake-shore ecosystems, will be shifting with severe response of their flora and fauna and with unwanted exposure to invasive non-endemic species. For coastal ecotones sea level rise is seen as the major future impact. It will alter habitat conditions for present flora and fauna and open a "Pandora's box" of migrating, alien and invasive species.

In **WP3, Analysis and synthesis of methodologies of adaptation measures,** only some topics have been covered by several documents, as this work package is currently underway. Nevertheless, some very important strategies have already been identified. They concern firstly strategies to combat the **extreme hydrological consequences of climate change, floods and drought.** The recently-increasing number, and severity, of floods in Europe with their devastating consequences has forced both experts and authorities to take necessary measures. In this area they are concentrated mainly at structural measures (flood protection constructions, reservoirs, etc.); improving predictions and flood warnings; enlarging international cooperation on transnational rivers; improving information access and flood education for the public. A fairly new concern is the extreme flooding of small streams and even of creeks and rivulets in river basin headwaters. Adaptation techniques of this type must substantially reconsider hydrological and water management strategies of mountains and hills along with those of woodland and rangeland management strategies. Strategies to **fight storm-induced sea surges and rising sea water level** have also been reviewed, spanning from technical measures to detailed evacuation plans.

The second strategy is adaptation directed towards increasing frequency and extent **of droughts** in many areas in Europe, leading to shortness of sources of water – affecting practically all aspects of human activities – most directly **on agriculture**, but also on society (households**), industry, hydropower generation**, fisheries, recreation and tourism, nature conservation. The adaptation strategy in this area is divided in two basic categories: 1) efforts to **decrease water consumption** by both technical measures, pricing policy and by education to reduce water consumption by people and companies; 2) Measures within water supply include all kinds of storage, through "ecosystem services" with better soil management and other means such as as expansion of rainwater harvesting and increased storage capacity by building reservoirs (underground or covered reservoirs in areas of extremely high evaporation). Strategies reviewed for adapting **navigation** to the impacts of climate change also cover a wide range, from rebuilding infrastructures through changing fleets up to full river canalisation. Options reviewed for building of **adaptive capacities** offer considerable chances for the EU's societies to improve water management.

The revealed **strategies to combat climate change-induced water pollution** pointed to the rising importance of the control of non-point sources of pollution, which would be (are already) considerably increased by the extreme precipitation-runoff events expected.

The work on **WP 4, Identification of Research Needs,** has begun. Its main objective is to identify the research needed to fill the gap in the water-related policies of the EU to ensure the implementation of strategies to adapt to climate-change. In this context the results are (will be) included in WP5 discussed below. Some of the most relevant sub WPs are WP 4.2: Ecohydrological water and ecosystem management strategies and WP 4.3: Research into climate change-induced causes of pollution**.** Major findings so far are discussed under WP5 below. We have also recognized that there will be a need for **strengthening research** also beyond the need for identifying gaps in water-related policies. This **especially concerns floods and the related impacts of mud-avalanches, land-slides,** etc, especially in the light of the **European- (and world-) wide series of hydrological catastrophes of May-June 2010.** New research themes introduced are: WP 4.10 Research need in navigation and hydropower; WP 4.11 **Research need in flood forecasting and defence** and WP 4.12 Research need in water management.

The bulk of the work for **WP5**, **Identifying and Bridging gaps in Water-related European Policies**, is also just starting. Nevertheless some important gaps have already been identified during the processing of Project and literature documents simultaneously for all work packages. For indications only, the following most important ones are:

1) To cope with the ever-increasing impacts of drought, water pollution and flooding, an **enforceable legal EU-wide regulation of the equitable use of the quantity and quality of water resources** will be needed. Specifically, an "obligatory release flow" towards downstream countries of the river basins in concern, and the "Polluter Pays" principle for the quality assurance must be specified in scientific and legal-administrative, **enforceable**, terms! This means the complete reworking of all existing relevant EU-wide agreements, conventions and regulations on the use of water resources (which always contain an annex or footnote to ensure escaping from the assurance and implementation of these basic obligations).

2) As climate change-induced non-point source (diffuse) pollution loads seem to be a major impact on water resources, serious gaps of WFD and many relevant (agricultural, ecological) directives in dealing with NPS pollution must be eliminated.

3) A major weakness of Integrated Water Resources Management (IWRM), which is a major recommended tool of river basin management planning (RBMP), is the lack of integration of water quantity, with water quality and the state of the aquatic ecosystem. In coping with climate change impacts this integration must be ensured by reshaping the Water Framework Directive.

4) There is a series of strategies identified by many projects that are aimed at jointly applying quantity (flood) control, drought management (sustainable agriculture and water supply) and pollution control with special regard to climate-change induced diffuse pollution. The river basin wide planning of these strategies can be considered as one of the major objectives of this project and of adapting to climate change. These strategies together can be called (see references) **ecohydrological tools for planning strategies** that will have to be included in RBMP, itself the major tool of WFD. We strongly feel from our reviews to date that this tool is missing.

Content

Partners (beneficiaries) of the Climate Water Project Consortium

Beneficiary Number *	Beneficiary name	short name	Country
1	VITUKI Environmental and Water Research Institute	VITUKI	Hungary
2	University of Debrecen, Faculty of Engineering	UNIDEB	Hungary
3	Water Research Institute of the National Research Council	CNR-IRSA	Italy
4	Institute of Environmental Systems Research, University of Osnabrück	USF	Germany
5	National Institute of Marine Geology and Geo-ecology	GeoEcoMar	Romania
6	Geonardo Environmental Technologies	GEONARDO	Hungary
7	University of Vienna	UVIEN.FE	Austria
8	University of Leicester	UNILEI	United Kingdom
9	Slovak Hydrometeorological Institute	SHMU	Slovakia
10	SOGREAH Consultants	SOGREAH	France
11	Malta Resources Authority	MRA	Malta

1. Project objectives for the period

The **overall objective** of the Climate Water project is to study European and international **adaptation measures and strategies** related to **climate change impacts** and how these are taken into account in **water policies**. The project will **formulate a coherent framework** for adaptation strategies of climate change impacts on water resources, water cycling and water uses of society and nature, with special regard to those that water policy has to take into account when considering climate change impacts.

The project will **bring together** scientific and policy experiences on the existing and/or missing links between climate change and water management and will **help to -**

- **identify research needs** for climate change impacts on water cycle and resources,
- **develop and apply methodologies** for adaptation measures to climate change,
- **develop scenarios** of water demand and to potential implementation on water policies.

To meet the above-outlined **project concept** and goals, **4 specific scientific objectives** have been identified:

Objective 1 Analysis and synthesis of water-related impacts
Objective 2 Analysis and synthesis of methodologies of adaptation measures
Objective 3 Identification of research needs
Objective 4 Identifying and bridging gaps in water related European policies

The Project Climate Water focuses on studying the available (known, proved, planned or even hypothetically perceived) national and international, European and global, **adaptation measures and strategies**, which offer solutions for **alleviating and counteracting climate change impacts** on the hydrological cycle, on water resources, on the water use-related activities of societies and on the life of living things and the properties of natural objects. To this end, the project will initially **review, synthesise** and **analyse** the water-related impacts on society and nature.

In addition to compiling a comprehensive "supporting" collection of available adaptation measures and strategies, the project particularly aims to identify how climate change adaptation strategies are incorporated into **European Water Policies** (in particular the WFD), and to what extent they are capable of responding to the identified needs. Subsequently, the missing links among European Water Policies will be highlighted and **policy recommendations** will be formulated with the aim of bridging the gaps.

In this <u>period all four objectives were being met</u> <u>to various degree of completeness, proportionally to the time spent</u>, since they form also the major work packages, as follows:

WP2 ANALYSIS AND SYNTHESIS OF WATER RELATED IMPACTS.
WP3 ANALYSIS AND SYNTHESIS OF METHODOLOGIES OF ADAPTATION MEASURES
WP4 IDENTIFICATION OF RESEARCH NEEDS
WP5 IDENTIFYING AND BRIDGING GAPS IN WATER RELATED EUROPEAN POLICIES

The reports of these four work packages are contained in the following chapter and indicate the state of progress at the middle of the project time-span. There is also a report on WP 6 "Dissemination of knowledge" that describes the relevant activities of the project partners in conferences, their publications and other means of interpreting the results of the project.

2. Work progress and achievements during the period

Foreword and paying of tributes

At the time of writing this report a large part of Europe is facing **risks and dangers of the most catastrophic and devastating floods ever recorded**. Flood outflows, through large and many dike-ruptures (flood levee breaches) have inundated numerous villages, towns and cities over the whole of Middle Europe (from Serbia through Hungary, Slovakia to Poland and beyond; also many cities of the Mediterranean) and were fought by thousands or several tens of thousands of people over the dikes and in rescue teams. Human lives were lost, agriculture devastated, ecosystems and natural treasures seriously damaged. Populated places were flooded by sewage, causing serious health risks, and the danger of epidemics was also faced.

Firstly the Co-ordinator (with the support of the Consortium) wishes to pay tribute to those presently fighting the floods and to those who are helping (an unbelievably high number of people) those who lost all the possessions gained during their whole life.
Next however we, the Consortium believe that these record-breaking, repeated, rainstorms and the associated flash-floods, mud avalanches, landslides etc, are providing evidence that we are working on a very important project, in trying to define adaptation options and the policy improvement that could serve the adaptations strategies.
And beyond this evidence, many of the scientists of this consortium believe that these presently-experienced events are rather heavier than those forecasted and could – in certain items — contradict earlier predictions. Consequently we strongly believe that the determination of research need will be an even more important part of this project and should go beyond the determination of research needed to overcome policy gaps and focused on the research and monitoring need for providing better predictions.

Bodva River Flood, Hungary

French Riviera Flood

3.1 Work Package 2. Analysis and synthesis of water related climate change impacts

Preface

By the time this report was compiled, the work with WP 2 has been completed. A report on its activities has been compiled by the WP-leader Partner (P3- CNR-IRSA, Italy) on the basis of the contributions of all other partners. These latter contributions formed a hierarchy as shown below:

Level 1: Contributions from the processing of single documents such as project reports etc.

Level 2: Thematic focus documents (processing level one contributions for topics within sub-WPs; such as floods, water supply etc – shown below in the condensed report);

Level 3: Task-leader report, processing thematic focus reports falling into a task (2 decimal sub-WPs);

Level 4: Sub-WP report, processing all former level documents for the two sub-WPs (2.1 Impacts on Society and Economy; 2.2 Impacts on Nature)

All these documents (of several hundred pages) can be seen and/or downloaded on the Members Area of the homepage (www.climatewater.org) to where Project Partners and EU officials (as ordered/allowed by the Programme Officer (PO)) may have access.

The WP 2 report by Partner 3 CNR-IRSA was the first scientific deliverable of the project and was uploaded as such to the reporting EU website with all the literature references utilized for this work. These references are contained in 20 pages (and more references are included in the thematic foci). **An important decision of the Co-ordinator** stemmed from the very high number of references, namely **not to refer within the text to any of the documents processed in order to avoid non-readability of this report**. In this decision another two facts played a role:

- In many of our major findings, presented below in a condensed manner, more than one (sometimes a dozen or more) references played a role;
- Each reference and the corresponding findings can be identified by readers who consult the lower level reports, which also include the references.

In the condensed WP report below, the full WP2 report made by Partner 3 CNR-IRSA was utilized to a large extent, modified and/or expanded, by the co-ordinator taking the inputs of other partners also into consideration.

WP2.1 Water management and other water-related impacts on the society and the economy (P8, UNILEI**)**

Topic 2.1.1: Direct impacts on the life and health of the population and the wealth of the nations (P1, VITUKI)

Floods and excess water

Annual runoff will increase in the Atlantic and northern Europe and decrease in the Mediterranean, Central and Eastern Europe. It is predicted that the winter flow of central and eastern European rivers will increase, whilst their summer flows will decrease.

The winter flood risk in northern Europe will increase by 2020, whilst the risk of flash floods will increase throughout Europe and risk of snowmelt floods will shift from spring to winter.

It is not only the magnitude but frequency, timing, spatial extent and temporal duration of the floods that is also likely to change.

Sea level rise could have a variety of impacts on coastal areas in Europe including flooding, land loss, salinization of groundwater and destruction of built infrastructure and buildings, wetlands. Flooding from wind-driven storms will continue to be more significant; the extreme events of storm surges with high tides will become less frequent but more significant.

Flood-risk is projected to increase over most of Europe, with special danger to human life and property, including a serious health risk stemming from the overflow of raw sewage, dead animal carcases and similar issues.

Excess water inundations will become more severe with the growing quantity and intensity of rainstorms. The number and severity of land slides and mud-avalanches also increase with the increasing frequency and intensity of rainstorms (both are proven by events over much of Europe at the time by writing this report).

Water supply

It is well known that climate change has already caused considerable changes in water supply which will increase throughout almost all of Europe (Figure. WP2/1).

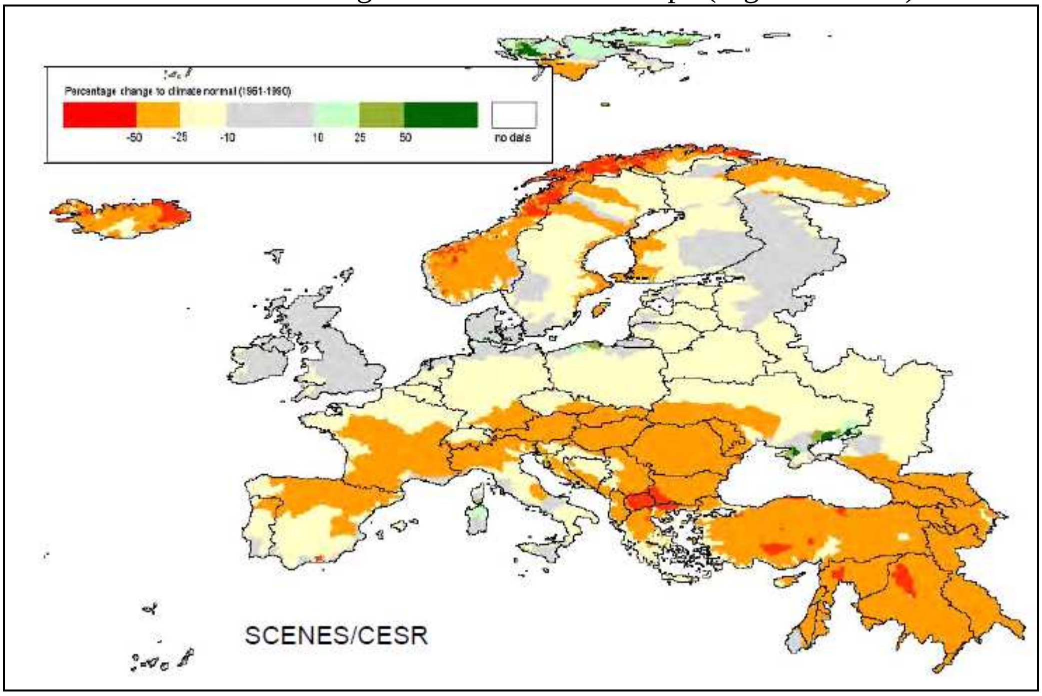


Figure WP2/1. Change in average seasonal water availability - summer (IPCM4, A2 scenario, 2050s)

To synthesize the likely impacts of Climate Change on water supply is not an easy task, mainly because of the great number of indirect impacts that are difficult to detect. An attempt in this sense is presented below:-

Higher annual runoff will be caused by increased precipitation in the high latitudes.

In contrast, some lower latitude basins may experience large reductions in runoff and increased water shortages as a result of a combination of increased evaporation and decreased precipitation.

The forecasted limitations in the availability of clean and fresh water could result in difficulties in achieving the goal of improved safe access to drinking water, with conflicts among different users.

All the expected modifications of climate will also have a direct effect on both groundwater quality and quantity.

Melting ice and the thermal expansion of oceans are the key driving factors of sea level rise. Such rising sea levels will also lead to salt water contamination of groundwater supplies, threatening the quality and quantity of freshwater access to large percentages of the population, in addition to exposing coastlines to greater erosion and flooding pressures where the majority of the human population lives.

Water quality

Temperature rise, decreased flow (lower dilution rate) and higher runoff-induced nutrient loads will affect the rates of all chemical and ecological processes, resulting in accelerated eutrophication and decreased oxygen content with the increase of pollutant concentrations.

Deterioration in terms of priority pollutants (e.g. heavy metals) and also pathogens are expected with flash-floods and storm-runoff. This, in turn may result in serious health risks (mainly among bathers of inland water bodies).

A very **serious health risk** is associated with the overflow of combined sewers following intensive rainstorms of increasing intensity (overflow of the streets of populated places by untreated sewage water is experienced in many towns over a large part of Europe at the time of writing this report).

Intensified precipitation-runoff events, including very rapid snowmelts, will shift the total load of many (if not most) of the polluting substances towards diffuse or non-point sources, thus changing the need for altered river basin management strategies (which still focus mostly on point source treatment).

Longer growing seasons, higher risk of algal blooms and increased growth of toxic cyanobacteria are expectable.

Deterioration of groundwater quality is expected due to altered precipitation and runoff conditions. Decreasing of aquifer recharge is expected in southern regions of Europe, with the lowering of the groundwater volumes and increasing pollutant concentrations. Extreme weather events can readily mobilize contaminants that have accumulated on hardened surfaces.

Coastal regions will, under drought conditions, suffer from saltwater intrusions into freshwater bodies or coastal aquifers and, as a consequence, from significant water quality deterioration and risks to water supply.

Drought and water scarcity (P9, SHMU)

Drought is well known over a large part of Middle to Southern Europe, even in places where floods and excess water also causes problems within the same year, but climate change can greatly aggravate these problems beyond the level of manageability.

Drought in itself represents a direct impact of Climate Change on water resources (and hydrology); in addition, it can be also responsible for indirect impacts. The environmental impacts of drought include:

- Damage to animal species (reduction and degradation of fish and wildlife habitat; lack of food and drinking water; greater mortality due to increased contact with agricultural producers, as animals seek food from farms and producers are less tolerant of the intrusion; disease; increased vulnerability to predation; migration and concentration; increased stress to endangered species; loss of biodiversity)
- Damage to plant communities (loss of biodiversity, loss of trees from urban landscapes, shelterbelts, wooded conservation areas).
- Increased number and severity of fires.
- Wind and water erosion of soils, reduced soil quality.
- Air quality effects (dust, pollutants).
- Visual and landscape quality (e.g.. dust, vegetative cover)

The economic impacts of drought include:

- Losses to agricultural producers (annual and perennial crop losses; damage to crop quality; income loss for farmers due to reduced crop yields; reduced productivity of cropland; insect infestation; plant disease; wildlife damage to crops; increased irrigation costs; cost of new or supplemental water resource development)

- Losses to livestock producers (reduced productivity of rangeland; reduced milk production; forced reduction of foundation stock; limitation of public lands to grazing; high cost of water for livestock; cost of new or supplemental water resource development; high livestock mortality rates; disruption of reproduction cycles; decreased stock weights; increased predation; range fires)
- Loss from timber production (wild land fires; tree disease; insect infestation; impaired productivity of forest land; direct loss of trees, especially young ones)
- Loss from fishery production (damage to fish habitat; loss of fish and other aquatic organism due to decreased flows)
- Loss for recreation and tourism industries (loss to manufactures and sellers of recreational equipment; losses related to curtailed activities e.g. hunting and fishing, bird watching, boating)

The social impacts of drought include:

- Health effects (mental and physical stress, e.g. anxiety, depression, loss of security, domestic violence; health-related low-flow problems, e.g. cross-connection contamination, diminished sewage flows, increased pollutant concentrations, reduced fire fighting capability, etc.; reductions in nutrition, e.g. high-cost food limitations, stress-related dietary deficiencies; loss of human life; public safety from forest and range fires; increased respiratory ailments; increased disease caused by wildlife concentrations)
- Increased conflicts (water user conflicts; political conflicts; management conflicts; other social conflicts, e.g. scientific, media-based)
- Reduced quality of life (increased poverty in general; population migrations; loss of aesthetic values; reduction or modification of recreational activities)
- Disruption of cultural belief systems (e.g., religious and scientific views of natural hazards)
- Re-evaluation of social values (e.g., priorities, needs, rights)
- Public dissatisfaction with government drought response
- Perceptions of inequity in relief, possibly related to socioeconomic status, ethnicity, age, gender, seniority
- Loss of cultural sites
- Increased data/information needs, coordination of dissemination activities
- Recognition of institutional restraints on water use

Topic 2.1.2 Indirect impacts on the society through direct impacts on economic activities (P9, SHMU)

Water management

Water management can be defined either as a sum of administrative-policy making/enforcing activities of the state (and/or EU) administration with the inclusion of all rules and regulations and in this case the climate change impact is that they must find new rules/policies — and should probably restructure their organisation to suit the adaptation strategies needed. Although this is a very important "impact" but this is also the major objective of WP5 and will be dealt with there! On the other hand, water management is an "umbrella name" of all technical water-related engineering activities (e.g. flood control, water supply, irrigation, navigation, hydropower), which latter have their own specified "box" among the topics. Nevertheless some important aspects of "Water management" are as follows:-

As a consequence of Climate Change, water management will have to change in a way that becomes able to cope with changes in water quantities and water quality.

Water management will also assume an increasing importance because of the shift of the total load of many polluting substances towards diffuse sources, instead of the point-sources of treatment plants.

A need is forecasted for reconsidering water management in terms of widening and deepening approaches for allocating water on a catchment basis, especially of international river basins, through openly agreed and fairly conducted procedures. This procedure should (must) end up with **enforceable legal EU-wide regulation** of the equitable use of the quantity and quality of water resources. Specifically, there should be "obligatory release flow" towards downstream countries of the river basins in concern, and the "Polluter Pays" principle for quality assurance must be specified in scientific and legal-administrative, **enforceable**, terms! Otherwise, when this is not done, there will be many countries of international river basins, forced to be satisfied with less volume and highly polluted water!!.

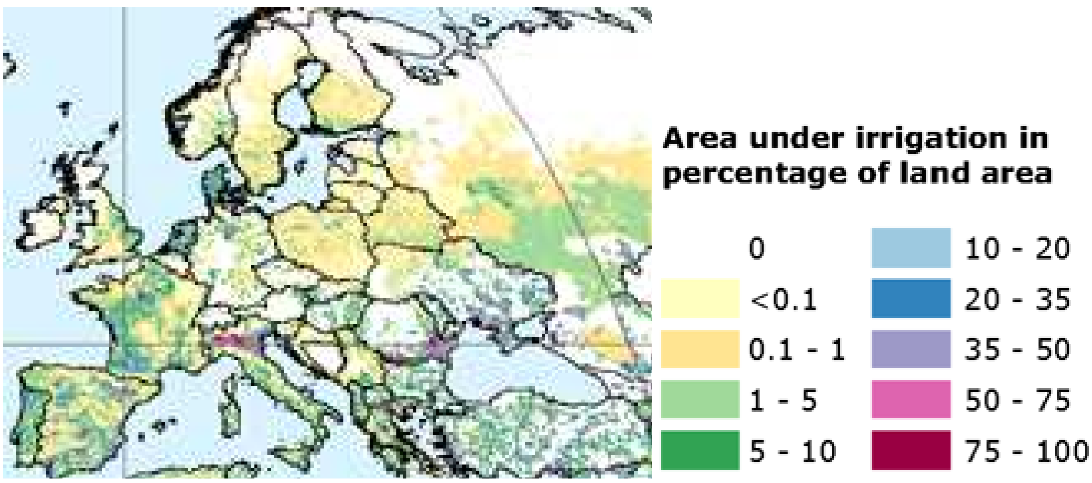
With this aim it is imperative that communication exists between the managers of river basins and scientists, allowing the application of scientific knowledge to water management itself.

Integrated Water Resources Management (IWRM) and Strategic Environmental Assessment (SEA) could be efficient tools of "climate proofing", if the techniques can overcome the serious lack of integrating water quantity, water quality and the state of the aquatic ecosystem in the management procedure.

Agriculture (P2 UNIDEB)

As often asserted, agriculture not only represents one of the most significant source of diffuse pollution in many areas of the Planet, but may, in turn, be impacted by other impact sources such as Climate Change. For example, on one hand one of the biggest pressures on water resources is agriculture and irrigation practices because agriculture accounts for approximately 30% of total water abstraction and about 55% of water use in Europe. On the other hand water scarcity as a direct impact of Climate Change is expected to be one of the biggest pressure on agriculture.

Climate Change will impact agriculture in a number of ways. The main negative impacts of climate change on agriculture are changes in water demand and availability, along with growing risk of drought, changes in length of growing season, shift of zones, changes in crop yields, increase in the magnitude of several types of soil degradation, changes in agricultural diseases and loss of arable lands due to – among others – salinization caused by sea water intrusion and increased use of irrigation. The frequencies of drought may become regular and not only in semi-arid countries. As a causal chain, drought leads to further negative effects on agriculture like loss of crops and livestock, loss of arable land and desertification, which already affects several countries.



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Because of inevitable regional differences found in the assessed impacts, results of case studies in every topic will be important in the further proceedings of this project. Also, differences between predicted and experienced impacts should be taken into consideration in the WPs following this one. Several documents define the research needs for better monitoring of experienced impacts, including downscaling and for improving predictions.

Navigation (P10, SOGREAH)

Maritime navigation (polar/non-polar) is primarily dependent on factors affected by climate change like:

- increase of the global mean sea level,
- changes in wind conditions,
- evolution of wave action,
- evolution of tidal propagation and range,
- changes of the ocean circulations and coastal hydrodynamics,
- changes of the coastal and estuarine morphology,
- changes to the frequency, spatial and temporal characteristics as well as the force of storm events (like hurricanes, tornados and surges),
- changes in the sea chemistry (e.g. salinity, pH and temperature),
- relocation of environmentally protected areas,
- changes in ice conditions,

Sea level rise and enhanced wave action can cause coastal erosion, degradation of port structures, incidents of overtopping and lowlands flooding.

Inland navigation is primarily influenced by specific changes resulting from climate change, of the hydrological characteristics in each river basin like:

- decrease or increase of the water supply in the navigable river sections/waterways (e.g. effects of the changes to snowmelt dominated basins, as well as precipitation),
- increase of more extreme hydrological conditions with more intense and long lasting high waters (floods) and low waters (droughts),
- changes of river morphology,
- changes in the efficiency of existing waterway infrastructure,
- increase of water temperature.

Low water levels reduce loading capacity and affect transport prices.
Increase in frequency of floods and storm surges could temporarily disrupt transport.
Increased variability in climate conditions is likely to lead to more unstable navigation conditions on European waters and to increased costs of routine infrastructure maintenance (e.g. dredging) and renewal.

Hydropower and nuclear power generation (P10, SOGREAH)

In general, the greatest vulnerability to climate in the hydropower industry for both planners and operators is to drought, or any event which would threaten ensuring a long-term water supply. Southern European countries, where a diminution of annual precipitation is expected, will be particularly impacted.

Global figures on the evolution of the hydropower potential predict by 2070, under a moderate scenario (A1B), that this potential will diminish by 6% at the European scale.

According to climatic predictions there should be heavier precipitations in the future in North Europe and North America as a result of Climate Change. Nevertheless seasonal shifts will certainly occur and a wider variability of the climate is probable with accentuation of extremes.

Thus not only Southern countries will have to face impacts of precipitation changes, but Northern countries too, although in a quite different and softer way. In areas with increased precipitation and runoff, dam safety may become a problem due to more frequent and intensive flooding events.

For the Alpine region, predicted changes in precipitation rates and temperature will result in enhanced snowmelt and permafrost thaw. Consequently runoff will increase in late winter and spring. On the other hand the summer season will lack water and therefore runoff will decrease.

Some documents predict that thermal/nuclear power generation plants might be affected by increases in water temperature and by water scarcity, due to their reliance on large volumes of water for cooling. The discharge of cooling water may be restricted if limit values for temperature are exceeded, which may force plant operators to work at reduced capacity or even temporarily close plants, with potentially serious consequences for energy supply. In regions with increasing water scarcity, the use of water for cooling may generally conflict with other water uses.

Furthermore, energy supply infrastructure, in particular transmission grids, might be endangered and damaged by flooding events and avalanches; transmission networks could be affected by melting of permafrost soils.

Industrial production

It has been estimated that about the half of the water intake in Europe is due to industrial water demand. Due to increased temperature, the demand for cooling water is at risk

Whilst hydropower and thermal plants are fully dependant on the quantity of water for power production, the situation is totally different for industries which use water within their processes. Improvements may considerably save water; a move in this direction has recently been observed in Northern Europe.

In the big cities of Northern Europe, water demand has diminished in recent years, not only in terms of per capita consumption, but also of total consumption. This decrease occurred for multiple reasons including more environmentally friendly behaviour by consumers, development of technology with lower water demand and increased cost of water, which has provoked efforts by consumers, particularly big consumers/industry, to reduce their consumption.

Thus, climate change will certainly have an impact on industries due to water scarcity, however industries other than power production have the capacity to adapt to a diminution of water availability.

Tourism (P11 MRA)

In Europe, climate change impacts on tourism can be both positive and negative, depending on the characteristics of the region.

The main impacts of climate change on tourism can be categorised under two main themes:

1. *Impacts on the environments sustaining tourist activities*
   Europe is generally divided into four main environments: the Mediterranean region, middle Europe, mountainous areas and Arctic regions. The main impacts in the Mediterranean region are related to increasing temperatures and rises in the sea level, making the general climate less appealing. Sea level rise will lead to the loss of beaches and lowlands. Changes in water availability will make it more difficult for these regions to sustain the water demand of tourism activities. This problem is further compounded since the demand for water supply

is highest when it is least available. In mountainous areas increasing temperatures will result in a shorter snow season and a general areal retreat of the locations adequate for skiing and winter sports.
Temperature rises in middle Europe are likely to make this region more appealing as a tourism destination since milder climates will make underexploited areas, such as freshwater lakes, more attractive. Similarly, Arctic regions are likely to experience an increase in tourism; however most of these areas are unprepared for an increase in tourist flows and this can have adverse environmental impacts.

2. *Impacts on tourist flows*
Climate change is likely to reduce the north-south tourist flow during the peak summer season due to more torrid climates in the southern regions and milder climates in the northern countries. This scenario is likely to increase tourist flow within the northern countries, but could also lead to a reversal of the north-south flow to a south-north flow. In the southern Mediterranean regions, temperature increase is likely to redistribute tourist flows, leading to an increase in tourist activity in the shoulder months.

Land use planning (P8 UNILEI**)**

The topic is closely related to the overall theme of "water management". There is, in fact, growing recognition that climate change will increase the likelihood of flooding in some areas and water shortages in other areas, and that land use planning needs to respond to this. Unfortunately, it often happens that concerns other than flood prevention/protection and water supply/conservation are given priority, with economic growth and job/housing availability, for instance, being seen more important than environmental concerns with consequential approval of land use development proposals.
Landuse planning (within River Basin Management Planning) should be one of the major strategies in adapting to climate change impacts on floods, drought, and water pollution control (see below).

WP 2.2 Water-related impacts on nature, the terrestrial and aquatic ecosystem (P7, UVIEN)

Topic 2.2.1 Impacts on aquatic ecosystems.

The large number of papers on Climate Change impacts has been synthesized in the form of tables. To draw these tables, the WFD eco-regions were assigned to their biomes as defined by Olson et al., 2001 (Fig WP 2/2).

Afterwards, with reference to each of these biomes, the WFD-quality elements (biological elements, hydro-morphological, chemical and physico-chemical elements supporting the biological elements), were considered. Successively, literature related to each of these WFD-quality elements was selected and certain contents were categorised: ▲ = increase, ▼ = decrease and R = replacement, as the example in Table WP 2/1

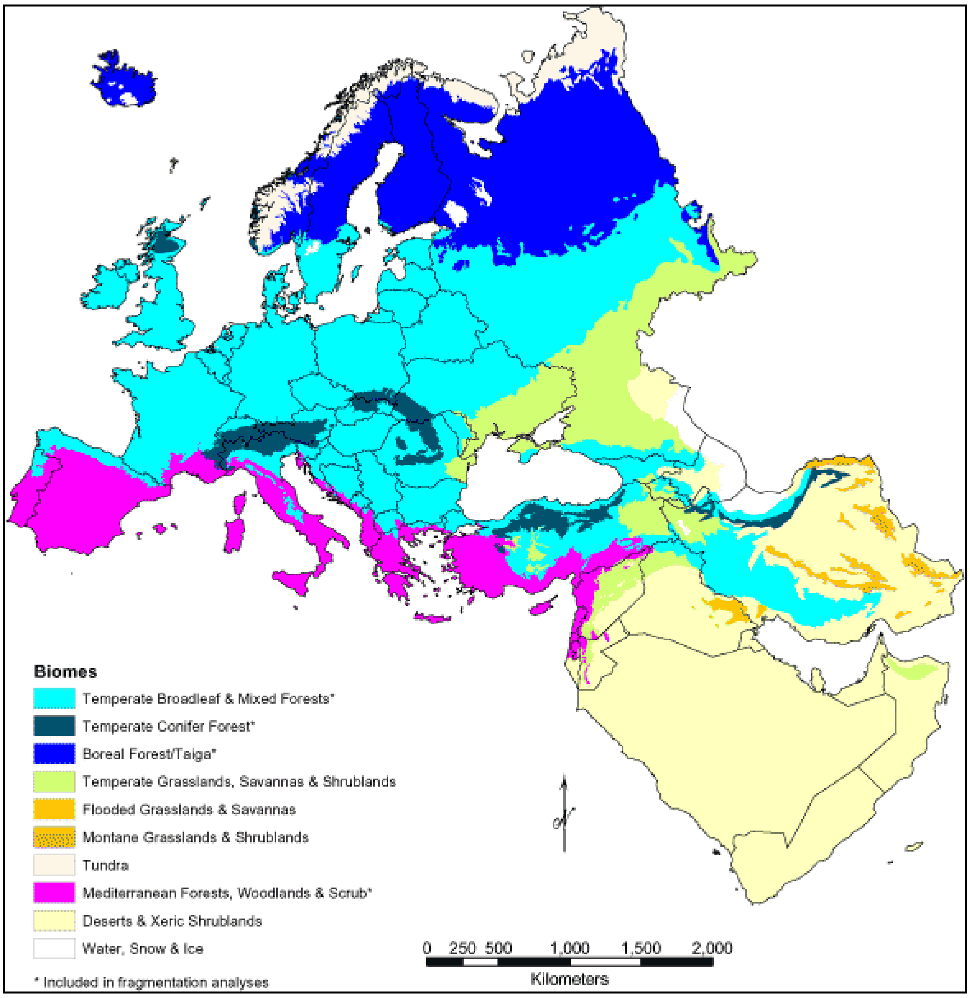


Figure WP2/ 2 European biomes after Olson et al., 2001

Biomes	Freshwater Ecoregions	Biological elements							
		phytoplankton		aquatic flora		invertebrate fauna		fish fauna	
		species composition	growth rate	species composition	growth rate	species composition	growth rate	species composition	growth rate
Mediterranean Forests	1. Iberic-Macaronesian region								
	Rivers		▲		▲	R	▲	R	
	Lakes		▲		▲		▲		
	Transitional waters								
	Coastal waters								
	3. Italy, Corsica and Malta								
	Rivers		▲		▲	R	▲	R	
	Lakes		▲		▲		▲		
	Transitional waters								
	Coastal waters								
	5. Dinaric western Balkan								
	Rivers		▲		▲	R	▲		
	Lakes		▲				▲		
	Transitional waters								
	Coastal waters								
	6. Hellenic werstern Balkan								
	Rivers		▲		▲	R	▲	R	
	Lakes		▲				▲		
	Transitional waters								
	Coastal waters								
	7. Eastern Balkan								
	Rivers		▲		▲	R	▲		
	Lakes		▲				▲		
	Transitional waters								
	Coastal waters								

Table WP2/1. Climate change impacts on biological quality elements (WFD) in the Mediterranean Forests Biome.

Topic 2.2.2 Impacts on terrestrial ecosystems (P1,VITUKI)

At global scale, evapotranspiration from forests is responsible for the majority of the world's freshwater budget. Therefore climate change impact on forests and other terrestrial ecosystems could be the main driver of all water-related problems. CC, together with changes in the atmospheric composition and in land use disturb the functioning of terrestrial ecosystems.

Increased temperature and earlier snowmelt would likely enhance summer drought stress, especially if summer precipitation is also reduced.

Weather events of the near past have already damaged the natural environment. Climate change will have an impact on the growth and yield of forests, which in turn will affect the composition of tree species and the generation rates of organic matter.

It has also been reported that a relatively small rise in temperature and a small decrease in precipitation can induce changes that have an impact on the particularly sensitive forest biocoenosis.

Changes in the form and amount of precipitation, along with associated water availability within a forest ecosystem, may directly affect bird, amphibian, and reptile communities by concentrating populations and increasing their vulnerability to parasites and pathogens, as well as intra- and inter-specific competition.

With increasing temperatures and potential reductions in soil moisture, trees could become increasingly heat- and moisture-stressed, making them more susceptible to fire. This is already one of the major problems of forests all over Southern Europe.

We have very little knowledge on the response of many species/ communities to elevated CO_2 level in the air, on evapotranspiration, and other physiological features.

Topic 2.2.3 Impacts on terrestrial-aquatic ecotones

Ecotones are characterised by specific physical and chemical characteristics, as well as by the occurrence of unique plant and animal communities with their associated biological processes.

Though ecological changes in response to Climate Change will occur everywhere, the signals will be detectable first in ecotones.

Rising temperatures will support fast-developing insect and amphibian species, but the timing of life cycles could be disrupted. Amphibian and fish reproduction fails more often in dry years and consequently organisms with poor dispersal abilities become extinct. Ground-nesting birds may be lost during floods.

For coastal ecotones the sea level rise is seen as the major upcoming impact. It alters habitat conditions for present flora and fauna and opens a Pandora's box of migrating, alien and invasive species

Conclusions for WP 2 (of WP leader P3 CNR-IRSA, changed slightly by the Co-ordinator)

The main conclusions which result from WP2 are reported below; some of these refer to the impacts of Climate Change on water resources and others to the uncertainty inherent within the tools used to forecast these impacts.

There is an overall consensus that climate change does and will affect water system dynamics through temperature changes, changes in precipitation patterns (e.g. more rainstorms) increase of evaporation (extended droughts) and decrease of water storage in snow packs, glaciers and the polar ice caps.

Water resources have strong sensitivity to even comparatively small changes in climatic characteristics for many regions of the world. This seems particularly true for the arid zones of the globe that already have difficulties with water supply and experience conflicts between different water users. Under all physiographic conditions water resources will be more sensitive to changes in precipitation than to air temperature.

The main adverse effects on water supply caused by Climate Change will occur in arid and semi-arid areas. Nevertheless, seasonal disruption might also occur in the water supplies of mountainous areas where, mainly because of increased temperature, the amount and duration of snow cover can be reduced. In particular, snow pack levels are expected to form later in the winter, accumulate in smaller quantities and melt earlier, leading to reduced summer flows. As a consequence, glaciers are expected to continue retreating, and many small glaciers might disappear entirely. The Alps are predicted to be particularly vulnerable to this consequence of Climate Change.

Predictions about hydrology are difficult in Europe however, because anthropogenic factors such as changes in land-use patterns, drainage conditions of rivers and an increasing proportion of impermeable areas, strongly influence the hydrological cycle, mixing up their effects with those of Climate Change.

Nevertheless, it is very likely that in many areas throughout Europe, precipitation will occur more frequently (as experienced during the writing of this report in the entire middle-eastern Europe) as high-intensity rainfall events, causing increased runoff and erosion, mud-avalanches, land-slides, more sediments and chemical runoff to be transported into streams and groundwater systems, impairing water quality. It is forecasted that water quality will be further impaired if decreases in water volumes and stream flows cause nutrients and contaminants to become more concentrated.

The health risk of the human population is being dramatically increased by heavier than ever rainstorms that result in overflow of combined sewers onto the streets of populated areas. Mud avalanches and land-slides associated with these record-breaking rainfalls may create catastrophic situations for downstream areas. A special associated risk is the failure of valley dams of reservoirs, the spillways of which were not designed for flush-flood runoff conditions experienced in our era (and forecasted for the future).

The year-by-year, newly record-breaking floods of a large part of Europe, is one of the largest (or the largest) water-related impacts of Climate Change. Loss of human life, high risk of epidemics and catastrophic devastation of agriculture and ecosystems are the consequences of dike-breaches and flooding of populated and other areas. Pollution of land, soil, surface and ground-water resources by nearly all contaminants found in a catchment is the evident consequence of flooding-inundating of large areas through levee-failures.

Water demand is likely to increase in some countries because of increasing irrigation, population growth and increased use of domestic appliances. With decreased water availability, because of climate change, then an imbalance of supply and demand is likely.

It is forecasted that, in the next decades, agriculture will remain the largest water consumer in the Mediterranean countries, with warmer and drier growing seasons resulting from Climate Change, creating more irrigation demand. Abstraction for the electricity sector is projected to decrease dramatically over the next 30 years as a result of continuing substitution of once-through cooling by less water-intensive cooling tower systems; industrial water use is likely to stabilise or even decrease; in Eastern Europe, urban water supply may grow significantly.

In a worst-case scenario, decrease of water availability is expected to be particularly severe in the Mediterranean regions and will be also responsible for damage to animal species (reduction, degradation of fish and wildlife habitat, lack of feed and drinking water, migration and concentration, increased stress to endangered species) and to plant communities (loss of trees, increased number and severity of fires), with significant loss of biodiversity.

There is general agreement that, to cope with impacts of such a variety, magnitude and geographical extension, there has to be management, planning and political measures implemented before structural interventions. Only water resource managers in fact, can respond to the combined effect of Climate Change, of population growth (and consequently of changes in demand) and of changes in technology, in economic, social and legislative conditions.

With this in mind, the need is reinforced, for reconsidering water management in terms of widening and deepening inclusive approaches for allocating water on a catchment basis, through openly-agreed and fairly-conducted procedures. These approaches take into consideration all classes of users, including the natural world. Besides, it has to be considered that, mainly where integrated water management systems exist, improved management may also protect water users from the effects of Climate Change at minimal costs. The integration of water management efforts at basin scale should also include the integration of the water quantity, quality and ecological aspects of water resources.

Considering the transboundary extension of many Climate Change impacts, it is suggested that integrating Climate Change into foreign policies could greatly enhance the ability and willingness of nations and of the international community to meet the challenge of minimising the impact of Climate Change upon their citizens.

3.2 WP3 Analysis and synthesis of methodologies of adaptation measures (P9, SHMU)

Preface

By the time of writing this report the work with WP 3 has entered the first phase when only some topics have been covered by several documents describing adaptation measures applied or proposed for identified Climate Change impacts.
As opposed to the practice of not referring to literatures in WP2 (due to the very high number of references, which are included in the full report of WP2), here in WP3 and (also in WP4) we refer in some items to literature what is addition to that included in the WP2 report.

WP 3.1 Adaptation strategies aimed at the water demand side (P11, MRA)

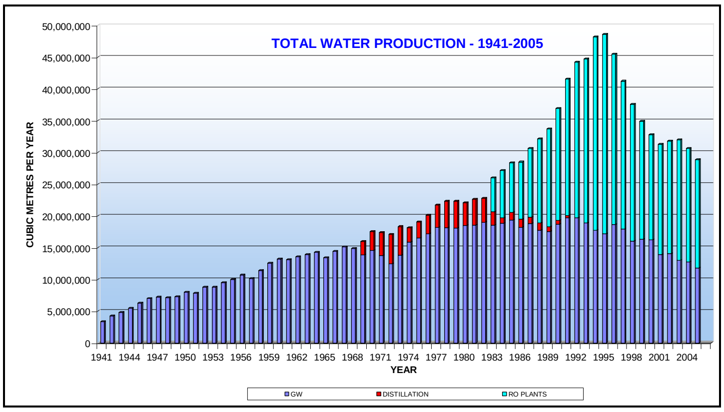
This larger group of adaptation strategies includes all adaptation activities that can reduce the excessive and unnecessary uses of water, thus reducing water demands.

People and society

In the municipal sector two main areas of action aimed at managing water demand can be identified, namely
(i) the reduction of losses in the water distribution system - system demand; and
(ii) the management of inefficient uses by the consumers - consumptive demand.

Consequently adaptation activities involve both direct and regulatory actions. The term 'direct actions' is used to describe a number of measures involving direct interventions such as leak detection and repair in the distribution system, monitoring and management of water distribution pressure and technical solutions such as fitting water efficient appliances at the point of use. On the other hand, regulatory actions are legislative and fiscal instruments (incentives and disincentives) aimed to adjust, limit or stop water uses or users who are utilizing the resource inefficiently and thus contributing to the degradation of the natural resource base. The underlying aim of such instruments should be to give the priority to the environment and water uses that have the highest social and economic value.
.
It is important to stress that the implementation of such actions should be complemented with a robust public information and education campaign, in order to ensure a wide-acceptability of the measures.

The impact of such measures can be quite dramatic, as is demonstrated by a practical example from Malta, where the implementation of a leakage reduction programme in the public distribution network since 1994, resulted in vastly reducing the overall municipal water demand; this in spite of a rising per capita water demand generated by an increasing standard of living.



Agriculture (P2 UNIDEB)

The main groups of adaptation methods are:

Adaptation with cropping, which includes:

- Adjusting sowing dates and crop rotation to temperature and rainfall patterns;
- Use of crop varieties, which are better suited to new weather conditions;
- Developing varieties more tolerant to heat and water stress

Adaptation by drought management, which includes:

- Decision-making tools, like climate forecasting and information sources;
- Appropriate tillage technologies;
- Reuse of irrigation water and other waste waters (with or without utilising wetlands for storage and cleanup); (Remark of the Co-ordinator: a frequently suggested technique, which is against the basic nature- and wetland conservation rules and agreements, especially in the case of waste water cleanup)

Inefficiencies must be identified and addressed. These include:

- Open reservoirs and channels which are vulnerable to water losses due to evaporation,
- The use of inefficient irrigation systems such as furrow irrigation whenever other forms of hi-tech solutions can be used;
- Improperly managed and un-maintained irrigation systems, resulting in excessive leakages and spillages of water;
- The cultivation of water inefficient crops which leads to reduced productivity for the water used;
- Irrigation plans will need to be based on careful planning and thorough assessments of their impacts.

Policy options are: Synergies need to be developed between Water, Agricultural and Development Policies. In this scenario, water utilization by the agricultural sector will be assessed and its efficient use promoted. Initial measures have already been taken through a number of Voluntary Codes in the National Codes of Good Agricultural Practice of Member States. Further measures however are needed in the short term to incentives the application of the measures outlined in these codes. Economic instruments should also gradually be introduced in order to disincentives wasteful practices. Development policies should also guide farmers towards the construction of covered, underground reservoirs (in areas with high losses by evaporation).

The maximization of crop-yield efficiency through the use of hi-tech irrigation systems should also be promoted. Fiscal incentives can be introduced within Rural Development Programmes.

Studies on ‘alternative cropping’ to determine the viability of current agricultural practices and their impact on water resources management should be carried out. These should lead to the identification of the most suitable crops in the local situation.

Industries:
There is a scope for increased water demand management, including lower production costs, increased competitiveness, lower environmental footprint (emissions).

WP 3.2 Adaptation strategies aimed at the water supply side (P9, SHMU)
There is a need for a more integrated interdisciplinary approach to adaptation and mitigation, water supply and demand.
People and society
The top priority for adaptation in the water sector should be to reduce the vulnerabilities of people and societies to shifts in hydro-meteorological trends, increased climate variability, and extreme events. A second priority should be to protect and restore ecosystems that provide critical land and water resources and services. A third should be to close the gap between water supply and demand by enhancing actions which reduce demand.
The following are examples of adaptation options that increase the resilience of people and ecosystems by improving access to water and ecosystem services in order to establish and maintain sustainable environments and livelihoods:
Increasing water supply and ecosystem services:
• Expansion of rainwater harvesting to improve rainfed cultivation and groundwater recharge
• Adoption of water transfer schemes
• Restoration of aquatic habitats and ecosystem services
• Increased storage capacity by building reservoirs
Decreasing water demand and increasing use efficiency:
• Removal of invasive non-native vegetation from riparian areas
• Improvement of water-use efficiency by water recycling
• Spread of drought-resistant crops
• Improved management of irrigated agriculture, e.g., changing the cropping calendar, crop mix, irrigation method and repair and maintenance of irrigation infrastructure
• Expanded use of economic incentives to encourage water conservation
• Improvement of urban water and sanitation infrastructure

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http://ecologic.eu/publications

Agriculture

Co-ordinator's remark: This text below is important but does not really fits to the definition of DoW for WP 3.2 Agriculture (Adaptation strategies aimed at the water supply side**)**: "*This group of strategies are focussed at the provision of various means of irrigation water (from surface reservoirs to deep confined ground waters, paying attention to the limitations relating to qualitative, quantitative and ecological aspects and the renewing rates of these resources). Fighting of droughts and water scarcity belongs also to this category*." Should be restructured in the final report.

There is a need for a more integrated interdisciplinary approach to adaptation and mitigation of water supply and demand.

Future projected trends in European agriculture include northward movement of crop suitability zones and increasing crop productivity in Northern Europe, but declining productivity and suitability in Southern Europe. This may be accompanied by a widening of water resource differences between the North and South, and an increase in extreme rainfall events and droughts.

Adaptation measures in agriculture include following groups: prevention measures, measures to improve resilience, preparation measures, response measures, recovery measures, cross compliance, rural development, water pricing, control and monitoring, water saving irrigation.

Important measures are:

- Change of sowing dates and cultivars of crops to optimize availability of water
- Continuing development of crop cultivars and crop management to optimize use of naturally occurring water
- Development of risk maps as adaptation strategy
- Minimum tillage offer opportunities for soil water retention

The Common Agriculture Policy (CAP) and the Water Framework Directive (WFD) are dealing with the protection of waters. Synergies between both policies should be strengthened. The main areas are:

CAP: cross compliance, agro-environmental schemes, rural development, diversification;

WFD: protection of waters by nutrients, pesticides; water protection zones, water saving methods, water pricing, monitoring and assessment.

Guidance provided by the UN Economic Commission for Europe will be tested on several pilot projects in countries of Balkan, Eastern Europe, Caucasus and Central Asia.

Nature conservation

Text of P8 UNILEI

There are many management options and objectives in existence for nature conservation; however, it is apparent that different adaptation strategies will be required for different situations. From the literature reviewed so far, the main adaptation measures in the area of nature conservation were identified as follows:

- The preservation and expansion of existing forests; e.g. increase tree species diversity with dryness-tolerant endemic species where declines in water availability are predicted[1].
- The prevention of habitat fragmentation and declining gene-pools[1].
- Minimise extinction of species by giving opportunities for adaptation (e.g. phenotypic plasticity, adaptive evolution or migration to suitable sites)[2].

- The improvement of forest management techniques in order to better utilise water resources[1,3].
- Avoidance of forest and wild-land fires[3].
- Rejoining of agricultural production and forestry[3].
- Wild game management[3].
- Protection of species through adequate provision of protected areas and policy[2,4].

References (for text of P8):
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WP 3.3 Damage prevention and mitigation strategies in water management (P6, Geonoardo)
As a foreword, the Consortium wishes to emphasize that the experiences with the most ***devastating floods of the period May-June 2010 in Middle Europe and in the Mediterranean might necessitate the complete reconsideration of the adaptation techniques so*** far available in the international literature. This will especially concern measures needed to provide safety for human life and means of preventing hazardous health-risk causing pollution and epidemics (due to overflowing of sewers into populated areas, and the failure of dikes). Another fairly new concern is the extreme flooding of small streams and even of creeks and rivulets. Adaptation techniques of this type must substantially reconsider hydrological and water management strategies of mountains and hills along with that of woodland and rangeland management strategies. The consortium has a feeling that we look forward to new strategies in the coming years of much higher expenses than what Member states have considered so far.

Technical adaptation strategies of combating climate change impacts include the following main categories:
Strengthening and reconstructing flood defence infrastructure is still the basic measure in flood defence. The rising of levee height alone cannot be the overall means of flood control in any river basin. Widening the flood channel by moving the flood levees might offer solution. Need for cleaning overgrown flood channels might be an option, with due concern to ecological requirements of the protection of remnants of endemic floodplain forests and other valuable ecotone vegetation.

Enhancing local storage of water and to catch water where it falls. This is a group of basic adaptation approaches. Storage as a technical means of flood control span from very small headwater reservoirs (catch basins), through almost all the means of non-point source pollution control, which are usually coupled by runoff control and water retention/infiltration techniques (terracing, strip cropping, contour-line tillage, overwinter crops, mulching, no-tillage and conservation tillage.).
This block of strategies also includes land-use, forest, and crop managements, with an emphasis on the water management of forests, and new afforestation. In urban areas this includes precipitation

and runoff control (rain water harvesting, permeable pavements, series of urban ponds and wetlands for storm-water storage).

*Flood control (attenuation) reservoirs***:** These is a group of strategies that includes all types of reservoirs (frequently multipurpose ones) spanning scale range from small headwater valley dams to the impoundments of large river dams, as they all have flood attenuation effects. A special type is the emergency reservoir, which is only filled at high floods. In larger river basins this also have the danger that excessive or over-storage of water in upstream areas can cause water shortage downstream, especially in low flow periods. For international river basins this will require the changing of water policies so as to end up with international regulations enforcing strength in sharing water resources.

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*Constructing a second flood channel and floodplain rehabilitation***:** Reclamation of floodplain wetlands and braided river systems with the opening of second flood channel can be an efficient solution. Although it is far from a very generally applicable technique, it can be very advantageous in meandering river reaches, especially on flan lands. Nevertheless, one would need special ecological considerations, with special regard to water diversion to other catchments, also mentioned in the study of EU Project 'Adam'. A special type of this approach to reclaim off-levee (e.g. sites on the protected side of the levee) flood channels and wetlands and use them as kind of emergency flood storage system coupled with other water uses (fishery, traditional pastures for grazing animals, ecotourism. etc)

Adaptation Strategies mentioned in the thematic focus on floods: (few examples only, see the details in the thematic focus)
Riverine flooding: The combination of structural (dams, dykes, reservoirs) and non-structural (early warning, spatial planning, 'living with water') flood defence strategies could be the way forward to address the increasing flood risk. Cleaning and maintenance of flood channels is also a key issue to increase the discharge capacity of rivers during floods. Basin wide international agreements should secure and regulate the water balance of the river. Adaptation strategies need the reconsideration of River Basin Management Plans (RBMP) in such a way as to follow the routes of water from the point where it falls to the point where it leaves the Basin and regulate the flows (with ecohydrological means, see under WP3 later) in such a way that all users (both Man and nature) receive sufficient shares. This approach could also help (partially) the severe inland excess water problems.
Coastal flooding: Managing coastal lowlands could be a useful strategy, as with reducing the human-induced subsidence (due to groundwater withdrawal) of these areas could reduce possible impacts. Economic analyses suggests that the optimum cost–benefit response to land loss due to sea-level rise would be widespread protection rather than abandoning populated and exposed coastal land.
A number of conferences and workshops have been oriented on this topic, for example "Floodfighters", focussed upon the following themes: enhancing protection capacities, structural

and non structural flood protection measures, know-how of participating countries, cooperation during floods. Similar were the main topics of another workshop – Climatic Change and Floods, 8 – 10 September, 2009 in Karlstad – recent developments in climate change scenarios, progress in model predictions and needs for research and development, examples from Member States on governmental and national strategies including legislation regarding climate change, best practice example from Member States, prevention and preparedness in view of climate change and its impact on floods with special regards to civil protection, cross-border cooperation related to how climate change impacts on floods, Synergies with the Water Framework Directive and contribution to the process of the work with water and climate change.

Protection against rising sea water levels and surges (P 10 SOGREAH)
Cities in low coastal lands including deltas are increasingly vulnerable to rising sea water levels and surges which often combine with river floods. This risk also combines with the ground subsidence which is often of the same order of magnitude than the absolute sea level rise. The resulting relative sea level rise is typically in the order of 10 mm per year.

In the full report of WP3 (under work) examples of recent disasters will be given. Here we only mention the most recent ones across Europe.

Recently, the Xynthia windstorm which crossed Western Europe on 26–28 February 2010 was responsible of the death of at least 51 people, with 12 more said to be missing, on the Atlantic coast of France. Most of the deaths in France occurred when a powerful storm surge topped by battering waves up to 7.5 m high, hitting at high tide, smashed though the sea wall off the coastal town of L'Aiguillon-sur-Mer.

Adaptation measures envisaged
Below only European examples are mentioned, while the full report will contain more detailed overview.
In the costal areas impacted by the Xanthia storm in France, a contradictory survey is currently on going to precisely determine the zones of extreme danger on the following criteria:

(i) where more than 1 m of submersion during the storm is expectable,
(ii) where houses are built at a distance less than 100 m behind a dyke,
(iii) where the speed of the submersion presented a danger for people.

On the basis of this survey all people living in the zones of extreme danger will be relocated.

In The Netherlands it has become recognised that, with sea level rise, it is not possible to continue “engineering as usual”. It will be too much to try to fight head on, with hard defences to protect all settled coasts. Whilst engineering protection works remain an option, it has been recognised that this should not be the only one. In recent decades, funding for maintaining dykes and other defences has fallen in Netherlands, and in a 2006 audit, at least one-quarter of these structures were not up to the Netherlands’ own standards. Faced with the reality that sea levels will continue to rise Netherlands has been forced to rethink its strategy and is now pioneering a soft approach to self-defence. The concept — called 'ecological engineering' — encompasses a variety of approaches for working with nature rather than confronting nature's forces head on. Researchers hope these techniques, including the restoration of wetlands, beaches and natural floodplains, could help deltas and coastal areas adapt to rising seas and fiercer storms. Ecological approaches are “more about adapting to what's happening, rather than fighting it”.
In Rotterdam, which is particularly vulnerable to the effects of climate change on water (precipitations, river, sea, water table rise), a brain storming exercise is on-going to make the region “climate proof”. The aim is to create a system that is sufficiently robust and that can adapt in good

time to changes as they occur, a system that is able to resist extreme conditions and continues to function. Another requirement is resilience, i.e. the system is to bounce back if ever it should unexpectedly fail. Heterogeneous teams with experts like landscape architects, town planners, water management consultants, juridical advisors, economists, etc. have been working on the elaboration of a "climate compass" which is a tool-box filled with climate adaptation measures aimed to serve project leaders and managers involved in spatial planning in areas both outside and behind the dykes. Some innovative measures were identified and proposed such as:

- Elevation of infrastructures in combination with elevated ground floors;
- Doing nothing to prevent quays from flooding in combination with the construction of wet-proof ground floors;
- Searching for location for a floating quarter;
- Reserving space in combination with stimulating the development of temporary constructions;
- Development of temporary constructions in combination with elevating entire areas.

However in the end it is not so much the specific content of the measures that is interesting for other cities; it is the elaborating process itself which is promising and which can be transposed.

General recommendations for adaptation

The case studies show that the approach of the coastal protections is gradually changing in due consideration to the fact that the sea level will continue to rise and that it will not be feasible to build always higher and stronger structural defences. Non structural approaches of coastal protections are increasingly considered as a complement to the classical structural approaches.

There is no unique response to the challenge but a tool box of possible adaptation measures, which may be valid for some time only, and may have to be replaced by others in a later stage. Adaptation shall therefore be innovative and flexible. Different types of adaptation measures might be envisaged for different areas. It will be very important to associate various stakeholders in the decision process including scientist, engineers, juridical advisors, urban planners, architects, economists, local communities, political leaders, etc.

Relocation of people seems however difficult to be avoided in areas which are or which will later be exposed to extreme danger.

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Snow and mud avalanches:

No documents on this subject have yet been processed. However it is known from the experiences of the recent years (during the project) that both avalanches have become an increasingly large problem.

In the case of snow avalanches, the Alpine countries are considering the banning of helicopter-assisted deep-snow skiing in areas not assigned for skiers, as it represents a major danger in creating snow avalanches. This has already been decided in some Alpine countries (Switzerland), but for some legal reasons it is difficult to ban. (Personal note of the Co-ordinator: it is the sport of the very rich people, and that might be an explanation of the slowing down of the introduction of this ban).

Mud avalanches are experienced as this report is written, over the entire hilly-mountainous parts of Middle-East-Europe (and also probably elsewhere). There does not seem to be any technical preventive strategy (or it would be prohibitively expensive). Legal administrative regulations must take care of the proper water management of mud-avalanche endangered places, with special care for the spillway-safety of headwater reservoirs, and erosion detention basins, etc.

Excess inland waters:

The solution to excess water problem is not so straightforward, not even technically, although farming communities might be forced to give up crop-farming in their excess water-ridden fields (for EU regulation or other purposes) and then these "wet fields" not drained anymore at large expense, could be turned into wetlands of high ecological value and of value as "eco-tourism" sites, which latter also can yield some jobs and local income. This also could be coupled with the emergency floodwater storage systems of the new flood control plan of Hungary (the Vásárhelyi Plan Update), as has been already demonstrated by some pilot projects (like that of Nagykörű). The above mentioned pilot project of Nagykörű means returning to multipurpose (ecohydrological) traditional water-and-land management techniques of the flood-prone areas. This technique is a promising solution to many climate change induced water related problems. (More detailed description with illustration is available in the Thematic Focus on floods). Nevertheless this could provide only partial solution to excess water problems of flat agricultural land, as a large percentage of cultivated land might be subject to excess water inundation causing high or total loss of harvest as it happened in May-June in 2010 over the entire flatland-part of the Carpathian basin.

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WP 3.4 Adaptation strategies of strongly water related economic activities (P10, SOGREAH)

Successful adaptation strategies have to follow a common and integrated approach that covers measures in all water-related sectors, in particular, in sectors that are strongly depending on the availability of clean and/or sufficient water, such as water supply, agriculture, electricity production, inland navigation and tourism. Such an approach will provide successful win-win solutions and avoid negative cross-sectoral feed backs of measures or non-action in one sector. It also allows to include the preservation of aquatic and other water-dependent ecosystems, which is a prerequisite for developing effective adaptation strategies.

Adaptation measures of a structural nature cannot be implemented without launching constructive discussions with all involved parties, including political leaders, environment associations and the wider public. Experience shows that a long time period (typically 30 years) is needed to lead a structural project from its early concept, through the various levels and types of studies, until its complete achievement. If structural adaptation measures are proved to be necessary for navigation or energy sustainability, constructive discussions should begin as soon as possible and should be supported by high quality, independent, research work and consulting studies that everybody can trust.

Navigation

Successful adaptation strategies have to follow a common and integrated approach that covers measures in all water-related sectors. Navigation management and planning need to become climate-proof: the focus should be on making the right choices regarding the infrastructure, compatibility with environmental legislation including climate change, and the development of an innovative navigation fleet that can cope with future climatic conditions.

1) Inland navigation

Suggested responses are: creation of water storage, adaptation of sediment management, adaptation of vessels (reduction of draught), deepening of channels. The most efficient adaptation technique is river canalization, that is the building of series of river dams and thus eliminating the rising number of fords and navigation bottlenecks in the drying part of Europe. Nevertheless, there are serious ecological-water quality consequences, especially if the rivers remain polluted. So an adjoining adaptation strategy must be the full control of all point and non-point sources of pollution. In this case the created impoundments will still suffer some ecological changes of fish and invertebrate fauna and also in the entire flora, but the result (as experiences indicate) is a water bird sanctuary (However, strong opposition of any impoundment is likely from “green environmentalists” in such cases)

2) Maritime navigation

Increased levels of quays and of sea wall structures, stronger and higher salt water erosion resistant bridges are needed. Increased maintenance to coastal protection infrastructures will be necessary (seawalls, dunes, breakwaters). These are adaptation strategies suggested by the profession of navigation. They will conflict with other aspects of the river management and thus can only be applied with due respect for the aquatic environment through application of the WFD (for EU) and other directives and regulations.

Energy, hydropower and thermal power generation

Energy is highly dependant on water availability for transformation of mechanical energy into electrical energy (hydropower) of for cooling water (thermal power). Variation of water availability will depend on the latitude. Adaptation measures thus have to be adjusted to the specific circumstances of individual regions.

The following measures are recommended:

- Enhancing storage capacity in Alpine and south European areas
- Storage, then release of water during low flow period will be needed

- Need for research on water usages, their impact on the resource, the adaptation to Climate Change, the conflicts which may result
- Need for reinforced monitoring of aquatic environment (cf. WFD)
- Need for storing monitoring data in shared databases available to scientists and water users

Even if, as a consequence of Climate Change, the annual cumulated inflow increases (this is expected for the North of Europe) a seasonal shift and severe droughts in summer are expected. A key action in the portfolio of adaptation strategies is to increase water storage capacity to make it possible in summer to (i) continue with hydropower production, (ii) support low flow in particular for thermal power plant cooling. This supposes the enlargement of existing reservoirs and/or creation of new reservoirs. Reservoirs however, are known to generate significant impacts on water courses (e.g. morphological changes, barriers to fish migration). Such structural measures should be studied in great detail before implementation.

Among existing or planned reservoirs several have (or will have) multi-purpose objectives. In these cases the impact of climate change on hydropower is even more difficult to assess due to the many interactions and the associated constraints of the water multi-use. The assessment of the climate change impact and the adaptation measures to be proposed shall take into consideration all uses of the reservoir.

The management of cooling water demand, in particular under low flow conditions, should be made a part of the river basin management plans, and should include hydro peaking, minimum flow, reservoir management.

The adaptive capacity of alternatives for electricity generation is a key element of further development of the energy sector. Decentralised approaches and a diverse energy mix are likely to be beneficial both in terms of adaptation and mitigation on the supply side through energy efficiency, which should play a key role in national and trans-national European mitigation and adaptation policies.
The electricity sector should take into account in its planning the vulnerability of the European electricity system to intensified climate variability and water related extreme events.
The existing grid should be assessed and if necessary further developed to reduce vulnerability against climate change. Options such as decentralised electricity production and/or an interconnected “European Grid” should be considered.

Other industries

The strategy is to anticipate the need for adaptation and ensure that industrial processes with low water demand are available in due time to face situations of water deficit.

WP 3.5 Building adaptive capacities (P4, USF)

This larger group of adaptation strategies includes the regulatory, economic and institutional means of adapting to changes of water resources and water-related issues. Project partners of WP 3.5 are compiling an inventory of existing efforts to build adaptive capacity in Europe and exemplary in four European river basins. To compare the efforts they developed a framework which builds up on different aspects of building adaptive capacity.

In compliance with the WP 3.5 objective, an indicative list of efforts to build adaptive capacity implemented by ongoing and recently completed projects within a European context has been compiled. In order to highlight the key elements of these projects the list includes the following structure:

- The level of the initiating organization within the political landscape.
- The categories of efforts to build adaptive capacity as prescribed in the objectives
- The geographical scope.
- The project objectives.
- The main themes and focus points.
- The means to achieve increased adaptive capacity.
- Target groups (including level within the political landscape at which these groups reside)

This list supports a multi-level governance perspective analysis on the development and implementation of adaptation effort in major European transboundary river basins. This list includes adaptive capacity building effort in the following EU river basins: Danube, Elbe, Rhine and Guadiana and efforts to build adaptive capacity on a European scale. So far the list includes 70 projects. But most of them are focussing on a European scale. In order to come to an adequate comparison of adaption effort in the selected river basins, more representative projects are to be added to the list. The list should include 10 projects for each river basin. So far an internet survey, telephone conference with the national environmental agencies and river basin agencies, an online survey and studying of project papers has been used to gain more information. Contributions of sub-WP 3.5 partners are also envisioned.

There are six components for the comparison of adaptive capacity building efforts. These are:

1. Degree of **stakeholder participation** during the project
2. **Science-policy interaction** in transforming information into knowledge
3. Role of **communication and communication tools** in supporting science-policy interaction
4. **Multi-level governance in coordination & implementation** of the project
5. **Thematic & sectoral integration** in development & implementation of the project
6. **Monitoring & evaluation** mechanisms embedded in the project

For each of this components the efforts to build adaptive capacity that are identified in the inventory list are ranked. By comparing this and using the other parameters of the list, missing components required can be identified and further suggestions can be made for improved adaptation strategies e.g. which geographical areas (concerning the surveyed river basins) or which target groups should be taken into greater consideration in regard of building adaptive capacity.

WP 3.6 Strategies to combat climate change induced water pollution (P1, VITUKI)
No input from partners have been received so far. Consequently the text here is the opinion of the co-ordinator based mostly on his earlier projects (www.tiszariver.com) and publications (see at the end of this chapter). On the mid term workshop in Slovakia the Co-ordinator delivered a slide show presentation on this subject, which can be seen also on the project website. Main conclusions so far are as follows:
Large-many water quality impacts were identified but, the adaptation strategies of pollution control fall into three categories:

1. Dilution (which is not a solution to pollution as stated by a basic rule or rather axiom of water pollution control);
2. Tailoring waste- and sewage-water treatment technologies to the altered climate change induced situation and
3. **Application** of diffuse or non point source pollution control techniques (the BAT and very new ones). This will be the most critical issue.

<u>Dilution as an adaptation strategy for water pollution(quality) control:</u>

Although in principle not acceptable, it might be needed in serious cases of water quality deterioration. The storage volumes of reservoirs that can be used for dilution will be available for other purposes, such as fighting drought, irrigation, emergency flood storage, etc..

The dilution water provided from the Lake Tisza (Figure 3.6.1) to reduce cyanide concentrations peaks of the downstream travelling pollution wave of the BaiaMare/Nagybánya Catastrophe is also an example were dilution can really be of help.

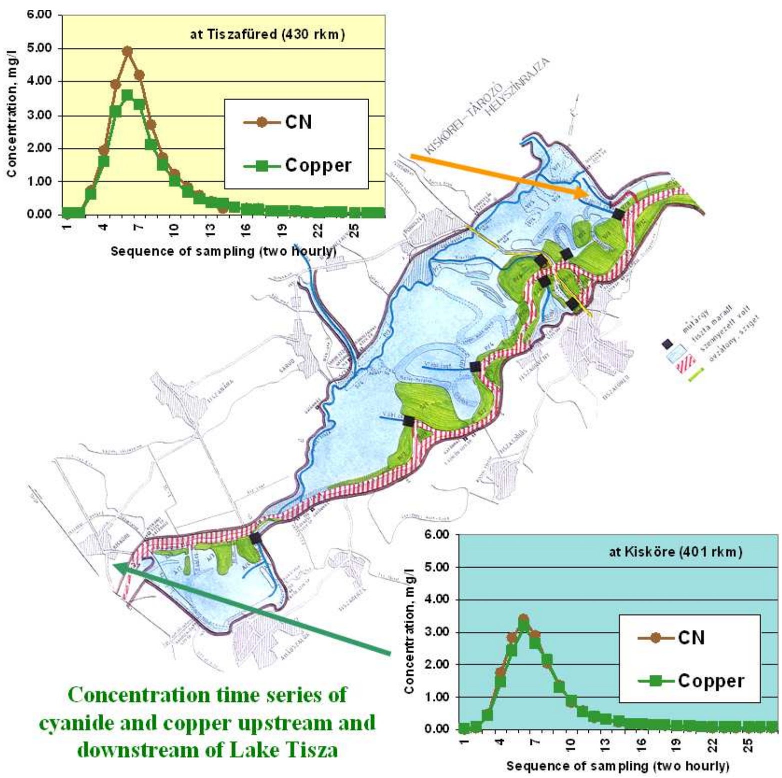

Figure 3.6.1 Impact of dilution on pollutant waves (source: the Tisza River Project:www.tiszariver.com)

<u>Tailoring waste- and sewage-water treatment technologies to the altered climate change induced situation</u>

Nearly all projects and documents analysed within Project Climate Water mention the need for upgrading wastewater treatment technologies. However, this cannot be reviewed for all possible industries. The climate impact situation and the price of water, the charge on environmental load and the penalty-incentive systems of adaptation will surely bring the required technologies. This means that technologies are already available and the non-technical legal-administrative means of adaptation shall take care for ensuring the application of the suitable ones.

A related critical issue (see also WP2) is the inadequacy of sewer systems in draining the much increased and much flashier, urban storm runoff volumes. The overflow from combined sewer systems are causing serious health risks, but separated systems also cause serious pollution and inundation problems. The technical solution is the replacing of combined systems by separate ones and/or building new much larger systems. Both are very expensive solutions

Application of diffuse or non point source pollution control techniques

A proven fact is that non-point sources represented the larger part of total annual load of water pollutants for many parameters (BOD, COD, TP, several micro-pollutants, etc.) for the last few decades. In Europe, with the success and progress of WFD-induced sewer and sewage treatment development, this contribution was and is being dramatically increased!

A further increase of non-point source diffuse pollution loads is being experienced by the impact of flashy, more fierce and intensive rainfall-runoff, which is induced by Climate Change.

Regarding diffuse source control strategies, one of the problems is that although we know the NPS control techniques and several books have been written on them (also by the Co-ordinator of this project) and even BAT is available in published guidance format, we still do not know (at design support level) their pollutant removal capacity and efficiency! This is because very few experimental data are available on real catchment-scale applications.

All the NPS techniques, together with the hydrological-hydraulic management techniques can be called Ecohydrology. We will return to this issue to also in other research chapters and finally in WP5, where ecohydrology and the related water and mass budgeting tools can be offered to bridge the “policy gap” in River Basin Management Planning (RBMP)

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Summary of adaptation strategies from the “vertical” Thematic Focus on Water Management carried out for WP2

One important reference studied can be entitled “What can be done in water management to cope with, and adapt to, climate variability and change?” and deals with adaptation. Some important findings are: 1) knowledge of water management measures is mostly available, but no “universal” adaptation approach exists. 2) The strengthening of the “precautionary principle” is important. 3) A warning on the “the irreversibility of sea level rise” is repeatedly necessary. 4) IWRM and Integrated Coastal Zone Management (ICZM) are prerequisites for adapting to climate changes. 5) Measures that enhance both ecological and human resilience in vulnerable settings are crucial for mitigating the growing risk. A whole chapter (2.4 "Coping Strategies for Dealing with Uncertainties Associated with Climate Variability and Change") of the booklet deals with adaptation and management strategies.

Another important lesson might be that the building and careful operation of reservoirs can be an efficient multi-objective adaptation strategy for many surface water uses and users (a strategy that can be the source of problems in international river basins). An important and generally valid strategy is the "enhancement of human and ecological resilience", which may also be termed as an ecohydrological strategy that can be applied on river basin level (as the same of water saving-storing land use management techniques) or at very small local level (securing the appropriate water supply of a floodplain wetland).
Overall land use management is required. Protection of the coastal areas from breaching or over-topping of sea walls during storm surges is required. A comprehensive set of adaptation strategies have been published for an international river basin of Canada and USA, which might be relevant to Northern Europe and **will be reviewed for WP3**.
Integrated Water Resources Management (IWRM) and Strategic Environmental Assessment (SEA) could be efficient tools of "climate proofing", if the technique overcomes the serious lack of integration between water quantity, water quality and the state of the aquatic ecosystem. In coping with Climate Change impacts this integration must be the major objective and this also follows from the need for fulfilling the main objectives of the Water Framework Directive.
Four basic overall management strategies, GEO-4 scenarios of UNEP, are modelled by the Project SCENES; there might be a need for reinterpreting the "sustainability first" strategy, as the most likely way out from climate-water problems.
Possible impacts on the management and planning of coastal defence decisions, suggest that effective adaptation may itself require lengthy processes of technical, legislative, and social change. The analysis of place-specific responses to climate change risks is a crucial undertaking.
The need for effective adaptation measures in the water sector and their potential impacts on adaptation and mitigation in agriculture will be greatest in Southern Europe as a result of increased production vulnerability, reduced water supply and increased demands for irrigation.

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Summary of adaptation strategies identified by the Thematic Focus on Water Quality done for WP2 :
References can be found in the thematic focus.
Control of diffuse, extreme runoff event induced, loads needs urgent development and increased attention. Management actions to control point and nonpoint source pollution and treat wastewaters discharged into the environment are the essential strategy. Future water quality will be very dependent on future human activities, including water management as the policy enforcing activity. Improved treatment of point source pollution sources are mentioned, without mentioning the need and the likely dominance of agricultural/urban diffuse loads and their treatment. Drainage basin scale water quantity (runoff control, saving rainwater where it falls) and water quality (land use management), that is IWRM or RBMP in the integrated quantitative, qualitative and ecological sense, will provide the overall solution. Measures to reduce flood risk could result in improved urban water quality via sustainable urban drainage systems. The potentially increased agricultural non-point source load impact due to the increase "growing season" needs really much more attention. Model experiences indicated that the most effective strategy in counteracting excess nutrient loads is to change land use or reduce fertiliser use, followed by water meadow creation, and atmospheric pollution controls. Overall basin wide nutrient load reduction is requested for the control of nutrient loads, along with the urgent need for intensified measurements and monitoring.

3.4 WP 4 Identification of research needs (P1, VITUKI)

WP 4.1: Research needs according to the magnitude of water-related impact and the urgency of counter action (P1, VITUKI)

The development of the index IMAU (Impact Magnitude and Action Urgency) was rejected by the Consortium on their first workshop in Rome. The reasoning (with some justifiable concern) was that index development is a huge work and no overall and general index of any type has ever worked well for the purpose they were created. Nevertheless, the partners agreed upon the request of the Co-ordinator that some type of ranking must be made, since it is referred to in the DoW in several chapters. Recently (May 2010), in the mid-term workshop in Slovakia it was decided that after the completion of WP3 (identifying all adaptation strategies) the ranking of magnitude and action urgency will be made by all partners. To aid this, Partners 5 (USF) with Partner 8 (UNILEI) offered the development of a method of evaluation and the Meeting produced a table (Figure WP4/1 below) which would be filled by all partners.

Status of WP5 on Identifying and bridging gaps in water related European policies

	Predicted	Vulnerability of	Likely timescale of
Predicted Impact of Climate Change	Magnitude of impact	recipient ecosystem	impact
upon water resources			
1			
2			
etc			

Anticipated Adaptation Strategy	Anticipated	Anticipated	Anticipated
necessary	Magnitude of	Urgency of action	Timescale of action
	startegy necessary		
1			
2			
etc			

Figure WP4/1

WP 4.2 Ecohydrological water and ecosystem management strategies (P7, UVIEN)

Text by the Co-ordinator and P8 UNILEI:

These strategies are the most important ones that could help simultaneously in the adaptation to several climate-change induced impacts. The river-basin wide controlling of flows and pollutant mass fluxes, which would be needed for adapting to many or most of the water-related climate change impacts, (floods, drought, excess waters, water pollution) can also be called the "water-environmental engineering core" of the ecohydrological approach. To this end we will shortly define this "water-environmental" engineering concept of ecohydrology (which is somewhat different from existing other definitions of this novel field of interdisciplinary water sciences):

The essence of ecohydrology is to save aquatic ecosystems by indentifying sources of degradation problems (sedimentation, excess nutrient loads, other pollutants, too little or too much flow) and find hydrological and pollution control solutions (also by modelling) to upgrading the structure, functioning and resilience of the ecosystems, while in turn the enhanced aquatic ecosystems will themselves provide means of controlling flows and water quality.

In evaluating the documents for the impact of Climate Change on water resources, ecohydrological research needs were repeatedly mentioned in the various inputs and thematic focuses of WP2. Some of these research needs are copied into this report:

Research needs from the thematic focus on Water Quality

References can be found in the thematic focus.

Research into the complex interactions of the physical (hydrological-hydraulic), chemical and biological (ecological) properties of aquatic systems should be intensified. A detailed review of climate change impact on surface water quality allows some research subjects to be subject to further research, particularly in field experiments, such as the need for research into traditional and novel drinking water technologies to cope with the substantial changes of the raw surface water quality, the causes and processes of increasing diffuse loads, temperature impacts on chemical and ecological process kinetics.

Research into the impact of climate change on the outcome of the changes of surface runoff pollution (e.g. diffuse) loads should be initiated as soon as possible (supported by ample field experiments), to clear the issue of “reduced diffuse loads” in drier climates against another hypothesis, which is that longer pollutant accumulation periods, associated with heavier than usual rainfall, will result in increased diffuse event-based loads also in drier climates. This could lead to stronger impact on the aquatic environment even if the annual total load will be smaller. Intensified field research associated with model development are needed to clear the impacts on the release of phosphorus from lake sediment. On the basis of the evaluation of model experiments there is an urgent research need for catchment models that could be calibrated and verified against time series of catchment monitoring station. Many more field studies would also be needed to enable the verification of model predictions. Research is needed to allow the identification of the need for determining the cause and effect relations of various eutrophication forms and with the need for field research programmes.

It should be also reported here, that the Co-ordinator was invited to the EU organized “Conference on Integrated River Basin Management under the Water Framework Directive” (26-28 April, 2010) as a “scene-setting” speaker of this conference. Title of his presentation was: **'ClimateWater' so far: impacts of climate change on water and adaptation strategies identified: an ecohydrological RBMP is needed.** The presentation can be downloaded from the homepage or form the conference website. In this, the essence of the research need for ecohydrology was formulated as

- A novel basin wide flow and pollutant budgeting tool, which could serve as the design tool for River Basin Management Planning is needed. Other than the available 100+ parameter conceptual catchment models, which cannot be calibrated.
- **Research needs can be summarized** as those into ecohydrology (strategies of ecology, hydrology, hydraulic construction and pollution control of point and nonpoint sources and the development of respective models)

References for WP 4.2

Zalewski M., Janauer G.A., Jolánkai G. (1996): Ecohydrology:- A New Paradigm for the Sustainable Use of Aquatic Resources, UNESCO, SC-96/WS-00;

Jolánkai G., Bíró I, (2001a): Basic river and lake water quality models, Computer aided learning programme on water quality modelling, (WQMCAL Version 2), (with an outlook to „ecohydrological" applications), Software and description. UNESCO IHP Documents on CD-ROM Series No.1 (http://portal.unesco.org/en/ev.php-URL_ID=39385&URL_DO=DO_TOPIC&URL_SECTION=201.html)

Jolánkai G., Bíró I (2001b): How much do we know about planning ecohydrological management actions? Proc. Int. Conf. on "The Application of Ecohydrology to Water Resources Development & Management, Venice, Italy 16-18 September, 2001;

Jolánkai G. Bíró I. (2002): How much do we know about planning ecohydrological management actions? Ecohydrology & Hydrobiology, Vol.2, No1-4, pp 321-327;

Zsuffa I.J., Pataki B., Jolánkai G (2002): Hydro-ecological revitalisation of the Gemenc floodplain in Hungary. Ecohydrology & Hydrobiology, Vol.2, No1-4, pp 127-135;

Jolánkai G., Bíró I., (2008) Nutrient budget modelling for lake and river basin restoration. In: *Ecohydrology: Processes, Models, Case Studies* (Editors: D.M. Harper, M. Zalewski, N. Pacini), CABI, Wallingford, UK, (ISBN 978-1-84593-002-8), pp 138-185

WP 4.3: Research into climate change induced causes of pollution (P8, UNILEI)

The increasing frequency and intensity of rainstorms and the accelerated melting of snow cover, will result additional pollutant loads of runoff-induced, non-point source origin. The significance of non-point source loads is rapidly increasing, with the development of sewage and waste water treatment investments (a prerequisite in complying with the Water Framework Directive). It is also a well known general conclusion of the field of water pollution control, that non-point sources have dominated the overall pollutant budgets for many parameters (particularly nutrients and many micropollutants) in practically all densely catchments of the world for many decades.

Now **the basic research need** is to define and numerically quantify how climate change has increased and is increasing these diffuse loads? This should be defined for main land use forms and for the main climate-zones of Europe.

Within this, the real problem is that the NPS loads have not been precisely known, and especially not for larger catchments. Their weight can be defined if there are sufficiently detailed monitoring immission and emission data (which is rare) to make an overall water and mass budget for the catchment of concern. Sadly, the monitoring of both sources and streams (immisson) is being drastically reduced in many EU member states (due to the false interpretation of WFD requirements & guidelines) The land-use dependent, rainfall intensity and quantity related experimental determination – formula or model – of diffuse loads is still a rarity and even less do we know about the expected efficiency of urban and even less of rural/agricultural diffuse source control techniques.

An important scientific hypothesis that requires testing is that Climate Change-induced run-off pollution loads will be increased even in those parts of Europe where the total annual precipitation and runoff will be decreasing. The reasoning for this hypothesis is that, in the longer dry periods the pollutant accumulation (due to e.g. atmospheric deposition, littering and decreased street washing) could be larger in urban areas (and perhaps also in agricultural regions), while the increased intensity and even event-quantity of rainfall will provide a much bigger run-off load. The answer to this issue is important, since the result could largely alter the adaptation strategy.

Nevertheless, many of these research needs can be fulfilled only by experimental work, which is time- and money- consuming, while in the present situation of growing Climate Change problems decision- and policy-makers need rapid answers from the science (if they care to do so!).

The most urgent and practically (financially) better suited research work probably would be the intensification of **research into a small and large-basin scale pollutant budgeting tool, that can numerically identify the weight of point and non-point sources (by tributary sub catchments) and to the improvement of the emission and immission monitoring systems** that could allow the use of such planning/modelling tools. It should be mentioned here that most of the available conceptual catchment/watershed models (there are many) are not suitable for the purpose as they use literally hundreds of built-in model parameters and coefficients in calculating runoff volumes and diffuse loads. Thus the result is not more than a scientifically very questionable speculation as far as the weight and absolute magnitude of the diffuse load is concerned.

Numerous mitigation methods have been, or are being developed to address the issue of diffuse pollution but it is widely recognised that none of them will, in themselves, solve the problem and that their efficacy is often site-specific. Research at the catchment scale is required to investigate how a suite of mitigation measures can best be integrated.

Dispersed domestic sources of phosphorus in the form of septic tanks in agricultural areas are important in terms of their ecological impact in headwaters, especially in summer, and concentrations of pollutants from this source are likely to increase with climate change. Mitigation measures that are widely applicable for rural communities and individual households across Europe are poorly developed, especially on impermeable soils.

There is a need for a more integrated approach to climate change mitigation and adaptation in so far as it affects water. This requires inter-disciplinary research that simultaneously addresses a wider range of issues than is currently normally the case.

Some management practices associated with diffuse pollution or its mitigation can have additional environmental (or other) benefits, while some can have negative influences. These are not properly understood so that a systemic evaluation of such measures can not be made. Examples include field drains that increase diffuse pollution (sediment and phosphorus) but reduce N_2O emissions. Minimum tillage can reduce erosion, and may increase carbon sequestration, but may also increase N2O emissions. Constructed wetlands reduce diffuse pollution and benefit wildlife but may also be associated with emissions of GHGs.

The potential of adding compost or digestate from anaerobic digestors (AD) to soil to improve soil structure and organic matter and reduce surface runoff and erosion has not been fully explored and warrants investigation given reductions in landfill and increased adoption of AD as a climate change mitigation measure.

The tillage of agricultural land should be fully explored; band' or 'strip' tillage across contours and the compromise between zero-till and min-till understood.

Socio-economic research into behavioural change on the part of those responsible for diffuse pollution and its control is often neglected, with the result that appropriate measures are not adopted, despite 'good science'.

WP 4.4 Research into alternative waste- and sewage water treatment and reuse technologies (P3, CNR-IRSA)

Waste discharge and wastewater treatment are sources of greenhouse gas emissions. Although carbon dioxide (CO_2) and methane (CH_4) have been the main focus in climate change calculations and discussions, the potential impact of nitrous oxide (N_2O), which is also generated from wastewater treatment plants should gain increased prominence.

Managing GHG emissions from wastewater treatment plants, including review of process models, methods for calculating carbon footprint, and identification of gaps and research needs. GHG emissions characterization with emphasis on N_2O production in nitrification/denitrification pathways is another area of focus.

Notwithstanding the recognized impact of N_2O and the acknowledged role of wastewater treatment in its generation, there are few studies that attempt to explicitly determine the impact of global wastewater treatment strategies on actual climate change indicators

The re-evaluation of waste treatment alternatives is needed because of Climate Change concerns, so that desired alternatives reduce both greenhouse gas emissions and power consumption. Anaerobic treatment is likely to be an attractive component of the alternatives. This is a biochemical process by which organic matter is decomposed by bacteria in the absence of oxygen, producing methane (CH_4) and other products. The complete mixture of this gas is called biogas. Biogas is/can be used for heating, as fuel for generators that produce electricity. The anaerobic process thus reduces the emission of CO_2 and energy consumption.

Key questions that should be asked as part of a Climate Change risk approach are "what changes in climate are expected, how will these changes impact the environment in which wastewater utilities operate, and what can and should wastewater utilities do to manage their high risk vulnerabilities"?

Essential elements of water reuse plans include the selection of categories of reuse, selection of water quality criteria for such specific reuses (in accordance with the existing regulations and guidelines), design of the treatment train providing the effluent of the required quality, and examination of overall feasibility. Unfortunately, there is little research that has so far been done on the regulation of water reuse application. While no concrete guidelines exist at this time, a number of countries have developed guidelines for specific water reuse applications which will be reviewed.

It is also important to fully review on-going research on the performance measures to develop operating strategies that meet both water quality and air quality limits.

WP 4.5 Research into water stress and droughts (Assigned to no partner)

An efficient method for maintaining moisture content is to build and/or maintain soil organic matter (SOM) across the agro-climatic regions. Elaborating the role of agricultural sector in an integrated adaptation effort at river basin level would help to solve predicted conflicts regarding water usages between different sectors. To avoid mal-adaptation it is necessary to decrease the degree of uncertainty around the linkages between Climate Change and desertification and/or desiccation.

Another important research topic could be the improvement of all kind of water storage capacities (including that of the soil) to enhance the storage of water in periods of abundance (during floods and excess water inundation) and use this water in periods of water shortage, which very frequently hits the same site that was suffering a few month earlier from too much water. This research should be accompanied by finding the gaps in the agricultural directives that might hinder the assurance of such extra storage capacities.

WP 4.6 Research into drinking water supply (P3 CNR-IRSA)

A primary goal of impacts and adaptation research is to reduce vulnerability to climate change and, as such, there is a need for studies that focus on the regions and systems considered to be most vulnerable.

Only limited research has been undertaken on the influence of the climate change upon future household water demand, which might, in turn, influence water supply. One of the basic research needs is improvements in the ability to detect water shortages farther in advance, to more precisely forecast their location, intensity, duration and to use such forecasts to inform management strategies. This would enhance water users' confidence in regional forecasts and their ability to efficiently prepare for, and adapt to, future water resource management challenges.

Furthermore, several experts point out that European guidelines to assist the sustainability of water reuse are necessary and research is needed for their most efficient implementation.

Other research needs related to water supply are :

Modelling Climate Change to reduce uncertainties:

- Climate projections need to be more accurate. In particular, better earth systems models (ESMs) will assist in reducing uncertainty in the projection of climate change in the next decades.
- Continued improvements are required in the understanding and modelling of hydrological processes at local to global scales.

The identification of means or procedures that allow the distinction (and the their interaction) between the impact of Climate Change (change in temperature and precipitation) and the impact of human interaction (land-use change and reservoir construction…etc) can be envisaged as a promising research topic.

WP 4.7 Research into groundwaters (Assigned to no partner yet, Co-ordinator's text)

Groundwater resources are and will be subject to serious depletion over the entire southern part of Europe with special regard to the Mediterranean (as revealed by many documents, see above).

Research subjects include:

What is the expectable decrease of groundwater recharge rate in the various geographical areas, climate zones and groundwater types (in order to be able to make more reliable forecasts for Climate Change scenarios and for adaptation strategies, with special regard to drinking water supply)?

Research into the expectable changes of groundwater hydraulics (direction of flow, slope of the water table, flow velocities, times of travel, etc.) with special regard to enable better forecasting of quality changes (such as salt water intrusion, or pollutant input to groundwater from excess/flood water inundations). Hydraulic models of nations and/or geographical regions (such as the Carpathian Basin) must be updated on the basis of such results, to give the support needed for adaptation strategies.

Research into the vulnerability of so far relatively safe drinking water resources (such as the karstic groundwater resources of mountainous regions) upon the recently-observed dramatic increase of daily precipitation and by the thus-induced diffuse pollution is also needed.

A straightforward adaptation strategy for improving recharge into decreasing groundwater quantity could be the use of the water available in periods of abundance (floods and other excess water). The related research subjects include 1) what technical options would be available for creating "recharge basins"? 2) What would be the risk of contaminating groundwaters by this flood-recharge and how to decrease this risk? 3) What hydrogeological research would be needed to answer the above two questions in various geographical regions?

WP 4.8 Research into sustainable agricultural production in drought ridden regions (P2, UNIDEB)

The main topics for research needs according to the review carried out for WP2 are **soil related, such as** investigating the soil resources in northern regions where arable crop yield increases can be realized, developing methods of building and maintaining SOM in soils as well as methods for pest and disease control with minimum risk to aquatic and terrestrial ecosystems. It is also a top priority issue to determine the magnitude of the CO_2 'fertilizer effect'. As **changes in water resources** pose the greatest challenges to agriculture, it is inevitable to make meteorological and, in particular, hydrological data available at the required resolution and coverage for adequate drought studies. It is necessary to determine the right way to mitigate conflicts in the most drought-affected regions.

Priority aspects are predicted trends of already-experienced or predicted impacts, to give weight to irreversible impacts, to take regional/local conditions like vulnerability into consideration, to make use of indigenous local knowledge and to find the time-frame of predicted impacts. Understanding he implementation duration of recommended adaptation methods is also necessary, as it is a relevant aspect when defining the urgency of implementing adaptation.

WP 4.9 European research of Pleistocene and (palaeo)geology (P6, Geonardo)

The objective of this analysis was to evaluate studies about the 'long', 'mid' and 'short' term temperature changes of earth, based on sediment and ice core analysis, this way providing an idea of the magnitude of temperature changes of earth surface. Strong conclusions are obviously hard to be given, as in many fields of climate analysis there is no consensus yet reached.

Figure 4.9/1 shows temperature changes of the Antarctic during the last four ice ages up till present and also the ice volume changes of the Antarctic ice sheet. According to the graphs the temperature in previous interglacials were higher than currently. The results are derived from deuterium isotopic measurements (δD) on ice cores (EPICA Community Members 2004, Petit et al. 1999).

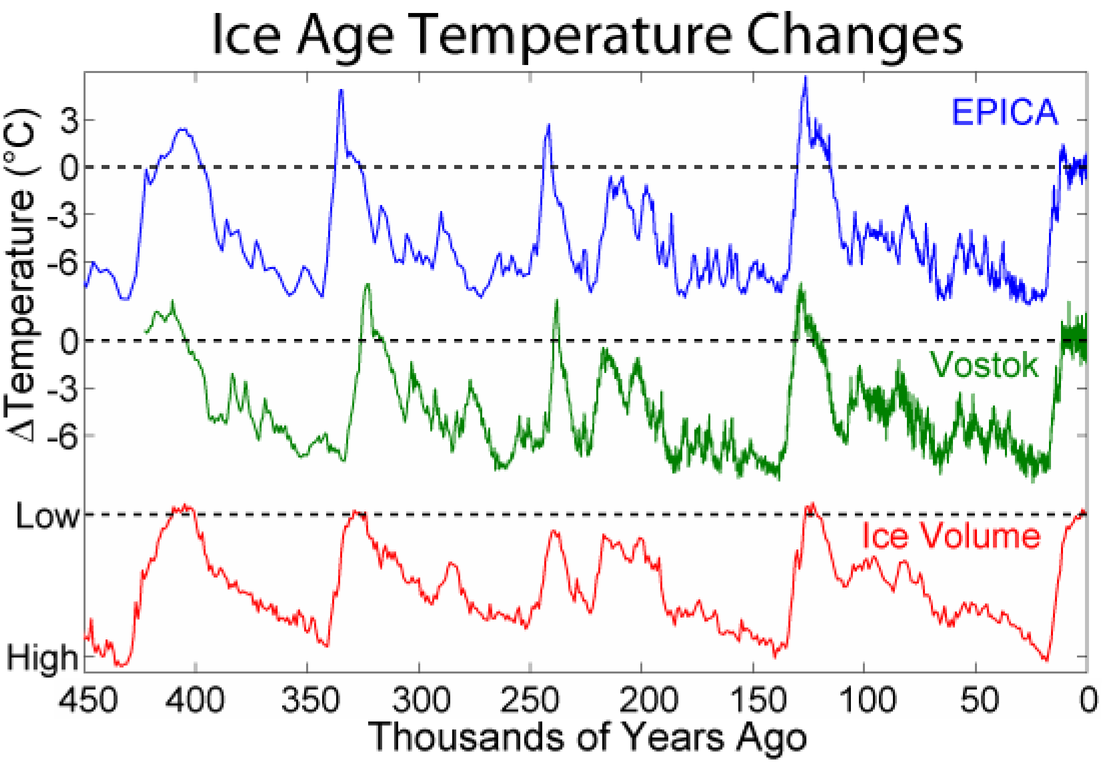

Figure 4.9/1: Ice age temperature changes; produced by Robert A. Rohde from publicly available data and is incorporated into the Global Warming Art project. Source: http://commons.wikimedia.org/wiki/File:Ice_Age_Temperature.png

The transition of glacial to interglacial 430,000 years ago shows similarities to the current interglacial in magnitude of temperature and greenhouse gases, but there are significant differences in the pattern of change. That interglacial lasted for around 28,000 years, compared to the later three interglacials and these results may forecast a long warm period from now on. On this basis we will have to consider in this project the research into paleo-history very important one.

Reference for WP 4.9

EPICA community members (2004) Eight glacial cycles from an Antarctic ice core, *Nature* 429:6992, 623-628, doi:10.1038/nature02599.

WP 4.10 Research need in navigation and Hydropower (P10 SOGREAH)

Navigation

The White Paper of the EU makes it clear that research needs are huge, particularly on the definition of the adaptation measures. Documents from the Commission already exist which provide detailed information on research needs. Coordination and sharing of information and research results between the Member States are also needed.

The changing world in which we enter, as a result of Climate Change, will soon necessitate new projects for implementing mitigation and adaptation measures for infrastructure. These projects, which are and will be vital for mankind, must be carried out in a dispassionate climate. Research work carried out by independent researchers, transparent consulting studies carried out by independent companies, and constructive discussions with all parties, are and will be the conditions for implementing these vital projects.

Hydropower and thermal plants

The hydropower industry depends on the scientific community to provide some of the answers they need to adapt and to incorporate climate change into decision making. Research institutions will be called upon to play a greater role in providing the science to answer their climate-related concerns, and also in facilitating adaptation for the industry.

Water resource scarcity and water temperature increase might jeopardise thermal plants' operation in summer when electrical energy will be more needed, particularly to meet air conditioning demands. Water resource and water temperature management issues are thus challenging subjects of research and of application studies at catchment scale.

WP 4.11 Research need in flood forecasting and defence (P6 GEONARDO)

Summary of research needs identified in the thematic focus on floods**:**

The references are those of the TF on Floods and also in the reference list of the Report of WP2

Further research and modelling of precipitation and runoff over Europe with adequate spatial resolution and proper downscaling methods of GCM results would be very important.

Ensemble regional climate model (RCM) runs have proved to be more accurate than single runs on several research projects, therefore it should be a widely accepted method for modelling complicated weather related events. There are still large uncertainties around the rainfall-runoff models, so the parameterisation and their structure should be carefully revised.

It will be also important to continue with research on wetland response to sea-level rise at a range of scales, from local to regional/global, as well as an improved understanding of the linkage between these different scales. At the global scale, improved spatial resolution of coastal typology and the distribution of coastal population would be particularly useful, combined with data on additional factors such as sediment availability.

When people ask the question "what are the impacts of the changing climate on floods?", the real question behind it is "how big a risk does it mean to human lives and properties?" Therefore, proper flood risk estimation methods and additional modelling capacities must be developed as a matter of urgency. For the evaluation of such methods the proper estimation of the extent of 'real' flood damage and the continent-wide collection of flood damage data should be organized.

Research into the best combination of structural and non-structural strategies in reducing flood peaks is one urgent field; another is associated with risk analysis. Research into the causes of the occurrence of record-breaking annual floods in Middle-East Europe, other than Climate Change (such as the absence of precipitation coincidences in various sub-catchment basins, and silting of flood channels) should also be strengthened.

The spatial and elevational complexities of the Alpine area and their effects on meteorological variables, demands scenarios and models with a high spatial and temporal resolution for hydrological impact assessment.

Changes in evapotranspiration play an important role in the estimates of low flows. For a sound estimation of future changes in evapotranspiration, the effect of increased atmospheric CO_2 concentrations on the transpiration by vegetation should be better understood. In addition, the effect of land use changes and re-naturalisation should be further considered.

Future research on impact assessments should focus at integrated approaches, especially links between climate, hydrological and ecosystem models. Research should also aim at the evaluation of strategies to sustain and improve development of the river and its basin in a changing environment. This type of research (into ecosystem models) could enhance the adaptation strategies to excess water problems, agriculture and forestry.

WP 4.12 Research need in water management

Below is a summary *of research needs copied from the thematic focus on water management* (in among the vertical WP2 documents). The references can be found in the referred thematic focus

There is no research need in water management as a whole, with the exception of research aimed at finding the most suitable structure (possible a kind of flexibly-changeable mixture of top-down and bottom-up approaches) of the centralized and non-centralized state administrations to cope with the changed tasks of technical and non technical adaptation measures. On the other hand, many research subjects were defined for various elements of water management (e.g. flood defence, water supply) that are discussed there in the respective topics of WP2 and WP3. Some references specify research needs, stating that the need for research on the vulnerability of society and ecosystems to Climate Change impacts is felt by many countries, particularly in the water sector. Complete reworking of models and of monitoring systems to suit more precise information for enhanced management is also mentioned by many studies. There are well established and developed techniques, such as IWRM and EIA, which should be re-established by appropriate research efforts to became real planning tools. This would improve them from their present role as excessively complicated administrative-legal tools without much concern to the quantitative numerical assessment of the quality and quantity of water resources and of the state of the aquatic ecosystem upon the planned strategies. More comprehensive representation of agriculture in climate models should allow more robust quantification. More detailed information is also needed in order to accurately simulating the impacts of partial land use change on climate.

3.5 WP5 Identifying and bridging gaps in water related European policies (P4 USF)

Foreword

The consortium has sought to process literature/project/internet documents in such a way that the evaluation of the document was started simultaneously for all the 4 scientific work packages (WP2-WP5), so as to accelerate the work and to integrate the knowledge to end up with utilisable inputs to WP5. This was called the "vertical" processing of documents for which a template was worked out (see also Chapter 5 on Project management). Several partners followed this vertical processing scheme. In this way many inputs to WP5 on research gaps in water-related directives have already been gathered. (a sample is provided in Annex I to WP5.).

As will be seen below the WP leader P4 USF has chosen another approach that looks well designed and may be very efficient if all the partners will strictly follow the guidance rules provided for the application of this method. The Co-ordinator wishes the good performance of this methodology and will encourage all the partners to follow it.

Nevertheless the Co-ordinator is also determined to ensure the use and utilisation of the policy-gap related findings of the "vertical method".

Approach to WP5 by work package leader

The purpose of WP 5 is to integrate WP 2 and WP 3 according to its main water related EU policies. This includes, according to the Annex I of the Grand Agreement, an analysis of the 12 main water related European policies:

- WP 5.1: Water Framework Directive (P4, USF)
- WP 5.2: European Flood Directive (P1, VITUKI)
- WP 5.3: European Water Initiative (P8, UNILEI)
- WP 5.4: Agriculture (P2, UNIDEB)
- WP 5.5: Energy (P10, SOGREAH)
- WP 5.6: Navigation (P11, MRA)
- WP 5.7: Nature conservation and ecology (P5, GeoEcoMar)
- WP 5.8: Drinking Water Directive (P2, UNIDEB)
- WP 5.9: Bathing Water Directive (P2, UNIDEB)
- WP 5.10: Green Groundwater directive (P11, MRA)
- WP 5.11: White Paper - Adapting to climate change in Europe (P4, USF)
- WP 5.12: EU Communication (COM (2007) 414 final) on addressing the challenge of water scarcity and droughts in the European Union (P3, CNR-IRSA)

For a successful integration of WP 2 and 3 into WP 5, a coherent framework has been developed to analyze adaptation to climate change at the concept of the science-policy interface in a European context. It aims to provide insight into how the EU water-related policies can be improved, by focussing on the following important issues:

(1) What are the most severe impacts and which impacts should be addressed first (outcome of WP 2)?
(2) What are the most urgent adaptation strategies (outcome of WP 3)?
(3) Are these adaptation strategies comprehensively addressed in the policies (is there consistency regarding the different policies)?
(4) Which measures should be taken to improve or enhance the existing adaptation strategies?

To answer question (1) and (2) different criteria were introduced which shall be used to rank to severity of impacts and following to this the urgency of the development and implementation of adequate adaptation strategies.

Ranking of Impacts

The criteria for ranking the severity of the impacts of climate change are shown in the following table. The table shall be filled by the Project partners, who are dealing with the impacts in WP 2.

Thematic Groups	Predicted Impact of Climate Change upon water resources	(1) Predicted Magnitude of impact (Scale 1-5)	(2) Resilience of recipient ecosystem (Scale 1-5)	(3) Resilience of recipient socio-economic system (Scale 1-5)	(4) Likely timescale of impact (Scale 1-3)	Sum
2.1.1 Direct impacts						
Floods (P6)	e.g. Coastal flooding	e.g. 4	e.g. 1	e.g. 5	e.g. 4	14
	e.g. Inundiation					
	...					
Water supply (P3)						
Water quality (P1)						
Excess waters (P2)						
Drought (P9)						
etc						

<u>Guidelines for using the table:</u>

The table of impacts, which is one output of WP 2, will be filled by all project partners. The different criteria for assessing the severity of the impact are specified below. Next, the partners should use these criteria for assessing which number is to be ticked when scaling the severity of the impacts in the columns of the table:

(1) Predicted magnitude of the impact: Scale 1-5 (1 indicates the lowest, 5 the highest possible impact)

1: Impact appears regional and effects only part of socio-economical and ecological system.

2: Impact appears regional and has strong influence on either ecological or socio-ecological system (strong impact: ecosystem or socio-ecological system can not recover in less than one year, or impact appears so often that recovering is not possible).

3: Impact appears regional and has strong impact on both: ecological and socio-ecological system

4: Impact appears area wide over northern central or southern Europe and has strong impact on ecological or socioeconomic systems.

5: Impact appears area wide over northern central or southern Europe and has strong impact on both ecological and socio-economic system.

(2) Resilience of the ecosystem (without adaptation) (Scale 1-5) (1 indicates the lowest, 5 the highest possible impact)

1: Ecosystem is expected to be able to recover easily (less then one year) from the expected impact.
2: Ecosystem is expected to be able to recover (recovery period one year or longer) from expected impact.
3: Ecosystem is expected to be able to migrate to colder places.
4: Ecosystem is expected to be able to migrate, if migration corridors are build by human.
5: Ecosystem can not recover or migrate from impact.

(3) Resilience of the socio-ecological system (Scale 1-5) (1 indicates the lowest, 5 the highest possible impact)

1: Socio-economic system is expected to be able to recover easily/ autonomic (less then half a year) from the expected impact few economic sectors and few aspects of social life will be affected
2: Socio-economic system is expected to be able to recover autonomic (recovery period half a year or longer) from expected impact
3: Socio-economic system is expected to be able to recover but needs help from outside the system (other not affected countries)
4: Some sectors of socio-economic system (e.g. agriculture, building) can not persist in the historic/actual geographical region (without adaptation)
5: Socio-economic system can not recover or adapt to impact in the historical/actual geographical region (e.g. shipping, construction in floodplains)

(4) Likely timescale of the impact (5 indicates earliest and most certain occurrence of the impact, 1 indicates the latest and most uncertain arising/developing impact)

1: The impact arises most likely by the end of the century and can possibly be stopped by mitigation of Climate Change.
2: The impact arises most likely by the end or middle of the century and cannot be stopped by mitigation of Climate Change.
3: The impact arises most likely by the middle of the century and cannot be stopped by mitigation.
4: The timeframe of the expected impact is highly uncertain it could also occur in the next 20 Years or sooner.
5: The impact arises at least most likely within the next 20 Years or sooner.

The presented criteria and scaling will provide a coherent framework to assess the severity of the impacts. The added value of this framework is the labelling of the impacts (column 2). It can be used later on to comply with the description of the adaptation strategies (a column concerning the benefit of the presented adaptation strategy in regard to the impact will be included). The framework for the assessment of adaptation strategies will also contain columns with all impacts, so that adaptation strategies can be related to the impacts.

Ranking of adaptation strategies

The provision of a framework for the ranking of urgency of adaptation strategies is an important element of WP 5. It will build up on the Table for the ranking of impacts. The Table will provide input for the comparison of adaptation strategies that are known in science and adaptation strategies that are mentioned in the policy documents. An important requirement for the detection of policy gaps is to structure the outcomes of WP 3.

A framework for the ranking of urgency of adaptation strategies is an important element of WP 5. Its purpose is to detect policy gaps on the backdrop of ongoing or recently completed adaptation effort. It does so, by using the ranking table of impacts as reference. The initial point of departure of the framework was to embrace a learning approach to aligning policy gaps and research needs from WP 4. However, this learning approach is considered beyond the scope of the project. The framework makes a clear distinction between strategy and measures in order to have a consistent comparison of adaptation effort. This also allows for an appropriate labelling of adaptation strategies.

Questions (as mentioned above) are:

(1) What are the most urgent adaptation strategies, as indicated in WP 3?
(2) Are these adaptation strategies comprehensively addressed in the policies (is there consistency regarding the different policies)?
(3) Which measures should be taken to improve or enhance the existing adaptation strategies?

For answering question (1) one needs to distinguish adaptation strategy from an adaptation measure. An **adaptation strategy** refers to an overall and higher basic goal with an idea of how to reach this. The definition of an overall goal is of special importance for the development of an adaptation strategy. By comparison, an **Adaptation measures** is a specific action to reach this overall goal. An example for an Adaptation strategy to climate change in the field of water would be the enforcement of the resilience of people living in flood prone in areas. Compared to this an adaptation measure (*or element*) of this strategy would be to adapt the type of construction of dwellings (construction without cellars or construction of swimming houses).

The distinction between strategy and measure is needed in this Project especially in WP 5. Without clear definitions, too many stand-alone measures to adapt to climate change needs to be reviewed. The diversity of adaptation measures is on the one hand just too encyclopedic and on the other hand there is a need to adjust the individual adaptation measures. Adaptation of infrastructure to the local conditions, for instance cannot be realized by European policies. The task of European Policies like the ones surveyed in WP 5 is to offer strategies or direction for the development of adaptation to climate change. The aim of the project is to investigate whether the current efforts in doing this are sufficient or if there is need for improvement of the adaptation strategies. Hence, to detect policy gaps.

The following table supports the distinction between measures and strategies, recommended to be used by all Partners of WP 3. By doing so, Partners of WP 5 will be provided with a clear overview of existing adaptation strategies and also some examples of measures that can be referred to the strategies (column 3). The labelling (column 2) supports a comparison of the work of the different Partners, who are surveying the different policies in the sub-work packages. By using the same labels for the adaptation strategies they can make sure that they are talking about the same strategy and identify coherency or missing coherency between the policies. The table provides the framework for all this as presented below. A detailed explanation of the criteria follows after the table.

Anticipated Adaptation Strategy necessary (WP 3)	Name/ labeling	Key Elements/ Examples for measures that can be related to this strategies	Does adaptation strategy help to tackle most severe impacts (scale 1-3 double weighting?)	Could further human development restrict the possibilities of the strategy (e.g. building in floodplains) (scale 1-3)	Anticipated Timescale of action (How time consuming is the implementation of the strategy compared to timescale of impact (scale 1-3)	Adaptation Strategy is useful to mitigate the Impacts:			
						coastal flooding	inun-dation	etc.	
Severity of impact according point system used in Impacts-table 1 (scale 4-18)						e.g. 14			
3.1 Demand side									
People and society	Enhance Resistance	e.g. adaptive construction of buildings				X			
	Escape the impact								
	Enhance Resilience	e.g. insurance							
Agriculture	...								
	...								
	...								
Industries	...								
3.2 Supply side etc									
People and society									
Agriculture									
etc. (see task matrix)			...						

To scale the criteria as shown in column 5-6 of the table, the following suggestions are made:

Column 5: Does adaptation strategy help to tackle most severe impacts (scale 1-3 double weighting?)
1: According to the ranking of impacts the adaptation strategy helps to combat impact with a severity of 4-7 points
2: According to the ranking of impacts the adaptation strategy helps to combat impact with a severity of 7-10 points
3: According to the ranking of impacts the adaptation strategy helps to combat impact with a severity of 10-18 points

Could further human development restrict the possibilities of the strategy (e.g. building in floodplains)
1: No the adaptation strategy can be implemented independently.
2: Adaptation strategy can be restricted partly by human development.
3: Difficulty of implementation grows by further development (e.g. settlement in floodplains).

Anticipated Timescale of action (How time consuming is the implementation of the strategy compared to timescale of impact)
1: Impact appears in next 50-100 years and adaptation strategy can be implemented easy less then one year.
2: Impact appears in next 50-100 years and adaptation strategy takes at least some years.
3: Impact will appear during next 20 years or is highly uncertain and adaptation strategy takes at least some years.

Screening of policy documents

Subsequent to the filling of the tables a screening of policy documents by all partners of WP 5 can begin. The project partners are requested to use the table adaptation strategies to identify policy gaps. Key Questions are:

- Which adaptation strategies are already or partly included in the policy documents?
- Do the policies contain whole strategies or just loose/sporadic measures (distinction between strategy and measure gets important again)?
- Which adaptation strategies that are described in the table are left out in the policies?
- Is there alignment between the adaptation strategies in the different policies?

To structure the outcomes of this
Each sub-WP leader on water related EU policy has to screen the adaptation strategies reviewed in the sub WP 3:
•WP 3.1 Adaptation strategies aimed at the water demand side (P11, MRA)
•WP 3.2 Adaptation strategies aimed at the water supply side (P9, SHMU)
•WP 3.3 Damage prevention and mitigation strategies in water management (P10, SOGREAH)
•WP 3.4 Adaptation strategies of strongly water related economic activities (P3, CNR-IRSA)
•WP 3.5 Building adaptive capacities (P4, USF)
•WP 3.6 Strategies to combat climate change induced water pollution (P1, VITUKI)

Sub-WP leader on water related EU policy has to screen the relevant adaptation strategies reviewed in the sub WP 3:

WP 5.1 Water Framework Directive (+ water pollution control) (P4 USF)

Work so far done by (P4) USF refers to a review of research needs and statements about climate change adaptation stated in 10 River Basin Management Plans (RBMP). The river basins in question are:

- Guadiana Adour-Garonne
- Ebro Rhône
- Rhine Seine
- Elbe Shannon
- Danube Scottish

They RBMPs have been reviewed against the backdrop of WP 3 and the screening results have been structured according to the Climate Water vertically oriented template for processing and evaluating documents. The evaluation of the RBMPs has been based on the following criteria: (1) the proposed adaptation strategies and measures to climate change in relation to the EU WFD, (2) the policy implications of these adaptation strategies for existing national water policies and (3) the research needs or knowledge gaps to be bridged. To this end, the latest but often Draft versions of the RBMPs made available at the website of the corresponding River Basin Management Authority have been consulted. For the evaluation of the French and Spanish RBMPs, online translation application has been utilized.

A general conclusion is that in the most – eight out of ten – screened documents, climate change is considered to a varying extent. The exceptions are the Draft RBMP of the Seine-Normandy where climate change is mentioned only once in 235 pages in the Annex and the Program of measures of the Rhone. Compared to this the awareness of Climate change in the Adour-Garonne is extensive. Management of water quantity in the perspective of climate change is one of six fundamental orientations and adaptation measures to cope with quantity changes are described in the Annex.

However, referring to the public awareness of climate change and the uncertainties climate change impose on current water management, the extent to which stakeholder or public participation aiming at well-informed decision making appears in the RBMPs varies considerably. Only in the case of the Shannon and Elbe RBMPs, participation has been explicitly mentioned.

To conclude, each RBMP includes a ‘programme of measures’, though the measures proposed are not always explicitly articulated or referred to as adaptation measures to climate change as such. In some cases, they could be interpreted as mitigation or even precautionary measures, aiming at the reduction of climate change and/or human-induced impacts on ecosystems. Additionally, in the RBMP, the policy implications of the proposed adaptation strategies and measures for current national water policies are not always clearly described or in some cases missing, though it is expected that the reform of national water policies will be in line with the EU WFD and other European Water Policies. This lack of clarity or inclusion of policy implications can be explained by the fact that all the RBMPs screened have still the status of a draft. Nevertheless, further insight into this policy reform at the national level, including the contribution of bridging apparent knowledge gaps and fulfilling research needs to this process, is still required, in order to obtain a better understanding of the key factors enabling or impeding this process of reform.

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Annex I to WP 5 Policy gaps identified so far in “thematic focus reports”

<u>From Thematic Focus on Water Management</u>
The major weakness of Integrated Water Resources Management (IWRM) is the lack of integrating water quantity with water quality and the state of the aquatic ecosystem. In coping with Climate Change impacts this integration must be the major objective and this also follows from the need for fulfilling the main objectives of the Water Framework Directive. The integration with the processes of the society and economy are also important objectives, but most of them are also included (as technically available options) in the integrated qualitative, quantitative and ecological management of water resources.
Very similar might be the case with Strategic Environmental Impact Assessment (SAE). Assuming that SAE relies on the practice and experiences with the EIA processes, one would find that in practice EIA becomes a legal-administrative procedure (a tool of politicians and decision makers) without caring for the essence of the concept, the assessment that is the numerical calculation of the qualitative and quantitative environmental impacts of various planned strategies.

The need for increased hydropower generation is very important. Nevertheless a great opposition of all green movements can be expected as there will certainly be some highly negative ecological impacts of the water storage (river dams) and a series of positive impacts (stemming from the increase of water availability). In this context there should be a world/EU-wide programme for resolving the conflicts of supporters and opponents of river dams (needed also for many purposes such as navigation, irrigation, flood control), with as much scientific evidence of the related ecological damages of both solutions, as possible. The strong reshaping of many directives including the WFD to make suitable and supporting for this much needed concept is highly desirable.

Water management can be defined either as a sum of administrative-policy making/enforcing activities of the state (or EU) administration with the inclusion of all rules and regulations. In this case of climate change impact, they must find new rules – policies – and should probably restructure their organisation to suit the adaptation strategies needed. Although this is a very important "impact" it is the major objective of WP5 and will be expanded in the forthcoming months. On the other hand, water management is the "umbrella name" of all technical water-related engineering activities (e.g. flood control, water supply, irrigation, navigation, hydropower), which latter have their own specified "box" among the topics. Therefore here in this "impact" we include the findings of studies of larger river basins (where evidently nearly all "water management" issues occur), or special other topics that cover many water management type activities, like land-use planning. Most references processed for the Thematic Focus for Water Management deal also with policy issues and will be reworked when dealing with WP 5 e.g. with the bridging of policy gaps.

From Thematic Focus on Water Quality

The River Basin Management Planning methodology (RBMP of WFD) should probably be restructured with due concern to Integrated Water Resources Management (IWRM), in the sense that water quality, quantity and ecological management concepts must be integrated at the level of assuring complete control of all point and diffuse sources of pollution, all land use practices and all hydrological runoff control measures in such a way that a decision support planning tool (e.g. modelling) helps this planning. There is a need for changing WFD policy towards non-point sources and their control techniques (still in "baby shoes" in terms of knowledge on their efficiency). Development of catchment models to support RBMP in all European catchments are much needed. For the basin wide reduction of nutrient loads of large basins (mentioned in several reports of projects of large international river basins) a proper planning tool is needed, which quantifies water and nutrient fluxes through the entire basin and through social and natural systems.

The challenge for policy-makers is to understand these climate change 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 climate change-resilient ecosystems are one way to deal with the impact. This is just one more proof for the need of basin-wide united ecological-hydrological (ecohydrological) adaptation strategies that can strengthen aquatic and terrestrial ecosystems (and their resilience), which can further assure the better and multipurpose us of remaining water resources.

Regarding water, a number of existing EU policies contributes to adaptation efforts. In particular, the Water Framework Directive 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 under the Directive will take into account the impacts of climate change and the next generation of plans due in 2015 should be fully climate-proofed. In addition, climate change must also be properly integrated in the implementation of the Floods Directive.

For water scarcity, the Commission will assess the need to further regulate the standards of water using equipment and water performance in agriculture, households and buildings. When reviewing in 2012 the implementation of the Water Framework Directive and the Water Scarcity and Droughts strategy, options for boosting the water storage capacity of ecosystems to increase drought resilience and reduce flood risks should be evaluated. It will be necessary to explore the possibilities to improve policies and develop measures which address biodiversity loss and climate change in an integrated manner to fully exploit co-benefits and avoid ecosystem feedbacks that accelerate global warming and to develop guidelines and a set of tools (guidance and exchange of best practices) to ensure that the River Basin Management Plans (RBMP) are climate-proofed and ensure that climate change is taken into account in the implementation of the Floods Directive.

3.6 WP 6 Dissemination of knowledge

Dissemination activities of Géza Jolánkai the Co-ordinator during the ClimateWater project (until Mid-term):

Planned/actual Dates	*Type*	*Type of audience*	*Countries addressed*	*Size of audience*	*Partner responsible /involved*
7-8 May 2009	Prague, Conference	Researcher/Policy maker	**All EU countries**	appr.1200	P1,/P2
22-23 October 2009	Paris, Conference	Researcher/Policy maker	**All EU countries**	appr 200	P1 (with P3, P4, and P9 also participating)
29 Nov 2009	Information day, Budapest	Broad, EU project interested	**Hungary**	Appr 80	P1/P2
26-28 April 2010	Lille, Conference	Researcher/Policy maker		appr. 250	P1
19 May 2010	Strasbourg EP speech	MPs	See description below		
December 2009	Book on Water pollution control	Researchers, teachers. Students (policy makers?)	n.a (Hungarian readers only)	Broad scientific and stakeholder public	P2 (P1)

Prague: "**Research Connection 2009 Conference"** (7-8 May 2009). Prof. G Jolánkai (Co-ordinator of ClimateWater, P1 VITUKI) participated in this EU conference as invited speaker (with costs paid by EU) to speak about the lessons learned in organizing and conducting EU projects. Title of his presentation was: „On EU founded water-environmental Projects:-How to plan them? how to get them? how to make them? How to use the results? What's coming up.”. Among the number of other projects the **recent activities and website of ClimateWater** (just having been started that time) were presented. The presentation is available on the ClimateWater Proejct website.

Paris: Conference of the title **“Implementation of the WFD in a context of adaptation to climate change”** (22 – 23 October 2009). Prof. G Jolánkai (Co-ordinator of ClimateWater, P1 VITUKI) participated in this EU conference as invited speaker (with costs to be reimbursed by EU). Title of his presentation was: Presentation of main outcomes of the ongoing project ClimateWater: research needs identified for bringing the policy gap in WFD implementation. This important WFD conference were utilised also as a venue for the meeting of the Work Package Leaders of the Project ClimateWater. Presentation was uploaded to the home-page. Minutes of the meeting was also available for aiding the progress of the project.

Budapest, The “National Office for Research and Technology” of Hungary (NKTH) has organized an information day related to EU projects. G. Jolánkai of P1 and P2, as past and present leader-participant of larger projects, was invited speaker to focus on FP (7) projects. The Presentation of the Prague conference was repeated with extended information (in Hungarian) on the Project ClimateWater.

Lille: "Conference on Integrated River Basin Management under the Water Framework Directive" (26-28 April, 2010). G. Jolánkai (Co-ordinator of ClimateWater) was invited "scene-setting" speaker of this conference. Title of his presentation was: 'ClimateWater' so far: impacts of climate change on water and adaptation strategies identified: an ecohydrological RBMP is needed. The Conference website is : http://www.wfdlille2010.org, from where all presentations are accessible. Conference proceedings are also planned but the publication is foreseen in the next year only (deadline for paper submission is 15 July 2010. Multiauthor paper of Hungarian participants – P1,P2 and P6— is being written)

Strasbourg: Cristina Gutierrez-Cortines, Member of the European Parliament as the Chair of the subgroup "Water" of the Intergroup on "Climate Change, Biodiversity and Sustainable Development" **invited Géza Jolánkai** to be a speaker to the meeting entitled "Water and climate change: a panoramic view of the problem and the solutions" to make a presentation on the results of the ClimateWater Project on the 21st of April, 20010. He was requested to submit, previously, the presentation. The EP meeting was cancelled due to the air-traffic blockage caused by the volcanic eruption. The meeting was later held and G Jolánkai, although could not be present, gave permission to use the slide-show on ClimateWater as sent, The organizers thanked this offer and used the presentation (to the knowledge of the Co-ordinator), The presentation is available on the project homepage.

Book on water pollution control: A multi-author Hungarian book of the title "Vízkészletvédelem: A Vízminőség védelem aktuális kérdései" (418 pages) (in translation: **Protection of Water Resources: Actual issues of water pollution control**), was published in December 2009. In this book Geza Jolánkai is co-author of 2 chapters and contributor to many other ones. The ClimateWater Project is mentioned in several chapters.

Partner 8, (UNILEI), is responsible for the development of short films which will bring the findings of the Work Packages to a European Audiences. There will be 3 films, focussing upon the details of a single European basin (UK), a European perspective from a Mediterranean basin with a south->north gradient-approach and thirdly, a global approach illustrating extremes which place the likely European experiences in context. Work has already started on all three, examining existing footage and collecting new.

3. Deliverables and milestones tables

Deliverables (excluding the periodic and final reports)

TABLE 1. DELIVERABLES[3]

Del. no.	Deliverable name	WP no.	Lead beneficiary	Nature	Dissemination level	Delivery date from Annex I (proj month)	Delivered Yes/No	Actual / Forecast delivery date	Comments
D 6.1	Project homepage	WP6	P6	O	PU	Month 1	Yes		www.climatewater.org
D 1.1	Project toolbox	WP1	P1	O	PP	Month2	Yes		With the help of P6
D 6.2	Platform for Stakeholder Interaction	WP6	P6	O	PU	Month8	No	Month 24	Consortium decision to wait for results of stakeholder interest (e.g Full results in adaptation strategies)
D 2.1	Report on water-related impacts	WP2	P3	R	PU	Month 17	Yes		

[3] For Security Projects the template for the deliverables list in Annex A1 has to be used.

Milestones

TABLE 2. MILESTONES							
Milestone No.	Milestone name	Work package no	Lead beneficiary	Delivery date from Annex I	Achieved Yes/No	Actual / Forecast achievement date	Comments
1	Kick-off meeting	All Wps.	P1	Month 1	Yes		Minutes on homepage
2	Home page launched	All WPs	P6	Month 1	Yes		
3	Platform launched	All WPs	P6	Month 8	No	Month 24	Consortium decision to wait for results of stakeholder interest
4	First interim meeting	WP 2-5	P3	Month 12	Yes	Made earlier in Month 8	Consortium decision to accelerate progress

4. Project management

Basic means of project management

Apart from the nearly continuous digital-electronic-telephone-skype, etc. contact and the frequent (weekly-bi-weekly) electronic mail instructions the basic means of the project management was the use of the special "tool-box", which was created on the Members Area of the Project homepage by the Co-ordinator in co-operation with the home-page operator P6 Geonardo. For illustration the opening-page of this management-tool is shown in Figure 5.1 below

Figure 5.1 First page of the management oriented home-page tool box

The partners of the Consortium are requested to upload their contributions (result of their work) to the respective directory (e.g. WP2-WP6 and their sub-wps and topics) and the Co-ordinator immediately receives a "folder-log" message to his e-mail address on the uploaded document. In this way **the progress of work of the project was monitored by the Co-ordinator on daily basis**. This also allowed the very detailed evaluation of the performance of each partner and the progress of work in each WP. On this basis the Co-ordinator produced internal (confidential) documents, an example of which will be shown below.

Another special management attempt of the Co-ordinator was to induce the processing of literature/project/internet documents in such a way that the evaluation of the document is done simultaneously for all the 4 scientific WPs (WP2-WP5) so as to accelerate the work, which anyway relays on the overlapping-simultaneous or even feed-back-loop type processing of the four WPs (see "B 1.2.2 Timing of work packages and their components" on page 17 of Annex I, the DoW of the contract). The Co-ordinator created a special template for processing documents in this way, which was called "vertically oriented template. (see an illustration below). As the template clearly shows all the four main WPs are well represented.

ClimateWater: Vertically oriented template for processing/evaluating documents	
Basic information	
Title of the project/paper/chapter etc.	Reference (web page, book):
WP, sub WP, task concerned	Name and institute of the person, who evaluates the project/paper:
Notes on the evaluated project, book, chapter, etc:	
Evaluation of the project/paper	
No. 1	
Statement on impacts: Remarks:	
Adaptation strategy mentioned: Remarks:	
Research needs: Remarks:	
Policy implication: Remarks:	
No. 2	

Figure 5.2 Illustration of the vertical template of document processing

This "vertical processing" of documents was followed by many of the partners, and this yielded for the present report of the middle of the project life-span sufficient inputs to enable the coordinator to declare timely-progress of the project.

There were some other means of accelerating the progress of the project and among these the extra non-planned workshop of WP leaders was one example as described below.

Non-planned workshop of the WP leaders

In 22-23 September 2009, the Co-ordinator convened (with the written approval of the Programme Officer) a WP leader workshop at the European Workshop on implementation of the WFD in a context of adaptation to climate change, which were organized by the French Ministry for Ecology, Energy and the Sustainable Development of the Seas. The Co-ordinator was an invited speaker (with coverage of travel and accommodation expenses). The workshop of the WP leaders proved to be effective (Minutes of the meeting are on the homepage). The title of the presentation of the Co-ordinator was „Presentation **of main outcomes of the ongoing project ClimateWater: research needs identified for bringing the policy gap in WFD implementation**". The WP leaders and thus the consortium had access to a large number of interesting presentations. Within this there was one of outstanding importance (received from the EU DG environment's representative Mr Balazs Horvath), as it

Internal progress evaluation and instructions by the end of 2009

The co-ordinator applied a special management tool to enhance progress and secure the timely reporting/implementation. This was a confidential internal document of detailed progress evaluation by partners and also by WPs and topics and relevant instructions circulated on the end of 2009.

Similar although less detailed instructions were sent. In critical cases, the Co-ordinator had direct contacts (also by phone) with the respective partners.

List of project meetings:
Kick-off meeting in Budapest: 17-18 November 2008 in Budapest

First progress meeting in Rome, 13-15 May 2009, in headquarters of P3 CNR
This meeting was convened, upon general agreement of the Consortium, earlier that planned in order accelerate progress in WP2. The coordinator believes this meeting and the timing-schedule agreed on it, was really accelerating progress of WP2, for which the report was produced in time.

Meeting of WP Leaders in Paris, 22-23 September 2009
With the agreement of the Programme Officer for ClimateWater the Co-ordinator utilized this important climate change and EU-WFD oriented conference for a task leader meeting to accelerate work and to gain important and fresh knowledge on the subject we are dealing with. See more details above.

Mid-term meeting in Slovakia 26-28 May 2010, organized by P9, SHMU

Participants of the Mid-term Workshop in Slovakia 26-28 May, 2010

Participants from left to right are: Gyongyi Ruzsa (P5, GeoEcoMar, Ro); Eva Lanz (P7, UVIEN, A), Victoria Robinson and Chris Stoate (P8, UNILEI, UK); Lea Kammermeier (P4, USF, D); David Harper (P8, UNILEI, UK); Monica Garnier (P3, CNR-IRSA, I); Géza Jolánkai (P1, VITUKI, H, the Co-ordinator); Beata Pataki (P1 and P2, VITUKI and UNIDEB, H); Gabriella Hancz (P2, UNIDEB, H); Monika Mandoki (P1, VITUKI, H); Lotta Blaskovicova (P9, SHMU, the host); Georg Janauer and Norbert Exler (P7, UVIEN, A); Manuel Sapiano (P11, MRA, Malta); Jean-Luc Rahuel (P10, SOGREAH, France); Michael Schembri (P11, MRA, Malta); Marian-Traian Gomoiu (P5, GeoEcoMar, Ro).
Remark: There were other participants, who left earlier than the photo was taken at the end of the workshop (e.g. Gabriella Lovász and Zsolt Jolankai, P6 Geonardo, H, and several Slovak participants)