Climate ≈ water

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

PROJECT FINAL REPORT

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Name of the scientific representative of the project's co-ordinator, Title and Organisation:

Prof. Dr. Géza Jolánkai, VITUKI, H-1095 Budapest Kvassay J ut 1

Tel: +36 30 9927538

Fax: +36 1 2157782 (Email: jolankai.geza@vituki.hu, jolankaigeza@gmail.com)

Project website address: http://www.climatewater.org

4.1 Final publishable summary report

Executive summary

The overall objective of the ClimateWater project has been to study European and international adaptation measures and strategies related to climate change impacts and how these are taken into account in water policies.

In WP2, "Analysis and synthesis of water related climate change impacts", several hundred projects and documents were reviewed. Major impact areas are flooding, drought and water scarcity. Flooding and severe droughts are already drastically increasing in Europe. Water supply will be seriously handicapped, in many regions. Water quality will very likely deteriorate as a consequence of climate change. Impacts on agriculture are also severe with very high economic, environmental and social impacts. Major water related/dependent industries such as navigation, hydropower and nuclear power generation will be strongly impacted. Impacts on nature and within this on aquatic ecosystems, terrestrial ecosystems, terrestrial/aquatic ecotones were all identified in details.

InWP3 on adaptation measures, strategies are aimed to combat the highly increasing extreme hydrological consequences of climate change, floods and drought. A new concern is the increasing number and severity of floods in Europe with devastating consequences, the extreme flooding of small streams, even of creeks and rivulets. Strategies to fight storm induced sea surges and rising sea water level were also reviewed. The adaptation strategies can be divided into two basic categories: 1) efforts to decrease water consumption by technical measures, pricing policy and by education; 2) measures within water supply including all kinds of storage, through "ecosystem services" with better soil management and other means such as expansion of rainwater harvesting and increased storage capacity by building reservoirs. Strategies to combat climate change induced water pollution pointed to the rising importance of the control of high-runoff induced non-point sources of pollution.

In WP4 the identification of research needs, an Index for Impact Magnitude and Action Urgency was developed. The Project Partners identified research needs aimed at bridging the policy gaps, demanded basic changes in all water related policies and much more detailed monitoring of all waters and even regular field studies. A characteristic example is the Water Framework Directive and its main tool the River Basin Management Plans (RBMP). The main conclusions are that research into flood defence, drought combating and ecosystem management strategies must be strengthened.

WP5, "Identifying and bridging gaps in water related European policies", identified that a major gap of the existing water related policies stay on a general level. Some of the major documents of international organisations and larger projects aimed directly at adaptation to climate change also do not give concrete advice. Changes in the policies are often not able to follow the accelerated changes of the climate. To cope with the ever increasing impacts of drought, water pollution and flooding, an enforceable EU-wide regulatory and science based planning of the equitable use of the quantity and quality of water resources will be needed. There are basic underlying misconceptions in some directives (like the Drinking Water Directive). Policies in some cases are simply not existing (Drought, Hydropower and Navigation). **The adaptation strategies to bridge the gaps** can be divided into the following groups: a) Policy- and decision-making (on national and EU level) in Water Management to create new international legislation that will ensure fair water quality and quantity management. b) Education to adapt to the climate change created situation. c) Designing and implementing the strategies and measures of adaptation, based on field measurements: and this is what we call Ecohydrology. The Co-ordinator's final advice on this basis is to ensure ecohydrological planning of the major tool of RBMP to improve WFD and other policies, **and act as rapidly as possible**.

4.1.1 Project context and objectives

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

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

- **Identify research needs** on 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.

In view of the above-outlined **project concept** and goals, **4 specific scientific objectives** were 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**

ClimateWater has focussed 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 the climate change impacts** on the hydrological cycle, the water resources and on the water use related activities of the societies and on the life of living things and the properties of natural objects. To this end, the project has initially **reviewed, synthesised** and **analysed** the water related impacts on the society and nature.

In addition to compiling a comprehensive "supporting" collection of available adaptation measures and strategies, the project particularly aimed at identifying 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 the European Water Policies were pointed out and **policy recommendations** formulated in an aim to bridge the gaps.

New scientific approaches are needed to handle some or even many of the water-related climate change impacts and adaptation strategies. Therefore, ClimateWater has **reviewed these new fields** of water related sciences and discussed hypotheses. In doing so, it aimed to bridge the evidently existing gaps, the 'missing links' between scientific approaches and the tools offered by policy makers. **Experiences** with these policies in different parts of Europe have been taken into account with an outlook at global scale. Throughout these series of activities, ClimateWater has aimed at the **development of scenarios for adaptation measures** to climate change, identifying their potential to alleviate climate change impacts and to build them into implementation of water policies.

Since water is needed for practically all sectors of the economy, and climate impact on water will therefore hit all sectors, the project concept was based on a **multi-sectoral approach**. The main water-related climate change impact and adaptation methodology fields to be addressed have

included principally **water management** as a whole, and within this the following main **sub-categories of water management**:

- **Floods** with special regard to the recently-observed dramatically rising peaks
- **Drought** and **water scarcity** with special regard to rising trends that may occur on the same place and in the same year as the extreme floods; the problems in the Mediterranean with regards to **water stress**, problems in cities, etc. as well as other implications on water management
- **Excess water** other than floods (like inundation, mud- and snow- avalanches, hail-storms, e.g. impacts stemming from previously not experienced extreme precipitation events)
- **Hazards and risks** of water supply with special regard to Human needs (e.g. drinking water supply and industrial water supply) and to the development of scenarios of water demand, as well as impacts on water quality and health
- Identification of newly-arising **water demands** due to the need for adapting to climate changes (such as that in forestry and wildlife management)
- Impacts on **water quality** and on the state of the **aquatic ecosystem** with special regard to the fact that, according to the Water Framework Directive, this is the major policy-related issue of our times.
- Impacts on **food production** with special regard to the **supply of irrigation wat**er, the demand for which is expected to increase with climate change, and to other important agricultural water issues (soil salinisation, alklinisation)
- Impacts on **groundwater** with special regard to decreases in groundwater levels and to the decrease of groundwater recharge in the drought ridden areas of Southern Europe
- Impacts on **land-use and planning** with special regard to managing water uses and the changing water demands and also considering flood risks
- Impacts and adaptation strategies of the **coastal zones of the seas** around Europe
- Hazards of navigation on **inland waterways** (including hydropower utilisation)
- Water-related impacts on **terrestrial and aquatic ecosystems**; (including nature conservation and forestry issues)
- Impacts on water-related **recreation and tourism**

All these have included the screening type synthesising analysis of the water-impacts of climate change as well as the **existing, planned or potential adaptation measures** (as scenarios of counter action or combat). To enhance and facilitate the synthesis and screening of water impacts and adaptation measures, an index of "Impact Magnitude and Action Urgency (IMAU)" have been developed in two versions, ranking impacts and the adaptation measures in European regions, by integrating ongoing European research results, differentiating also according to major river basins of Europe.

New or novel (missing) water- and climate- related research areas/topics have included:

- **Ecohydrology**: Focussed at catchment or river basin scale (that is river basin management) and is the concept of governing hydrological processes by ecological engineering processes, in such a way as to achieve the sustainability and biodiversity of terrestrial and aquatic ecosystems. Provides the main impetus for developing the appropriate **impact-adaptation and mitigation strategies** and their scenarios.
- **Runoff induced non-point source pollution**: Although the dominating role of non-point (or unidentified) sources of pollution in the overall pollution loads of European catchments are becoming recognised, it is much less clearly perceived that the expected changes to weather

in Europe will, or might **strongly, amplify this load contribution**. Therefore this seems to be one of the research fields where much effort needs to be concentrated in the future.

- **Alternative waste- and sewage water treatment** technologies. In a climate impact-ridden water management of Europe's close future, the required adaptation and mitigation measures will almost certainly include novel or brand **new approaches to waste and sewage water handling including re-use** wherever possible. A vast literature offers an abundance of alternative tools, but their efficiency and economic feasibility are such questions that may only be answered after much more research and in the possession of knowledge on the expected climate change impacts on water resources.
- **Water stress and droughts:** Although in the drier parts of Europe abundant knowledge is available for fighting droughts and the related water stresses, there might be need for improving these technologies along with the improvement of drought monitoring and characterizing droughts with drought-indices.
- **Drinking water supply:** New or novel research topics might arise in searching adaptation measures for new sources of drinking water supply and new ways of water conveyance with less water losses than what is accepted today (quite high rates in European scale).
- **Groundwater resources:** Research into various groundwater resources and into the processes of recharge will certainly be accelerated when these resources will have an already known or assumed loss due to climate change. Climate-change related groundwater pollution and the techniques of prevention must also be a topic of new research.
- **Studies on geology** (Paleo-geology) as source of information on climate changes over recent geological time scale, including implications concerning the present situation.

Activities to achieve the above four objectives have been conducted under four major work packages throughout the 36-month project duration:

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

In addition, a horizontal work package, **WP6. Dissemination of Knowledge**, has aimed to increase the visibility of the project and the dissemination and exploitation of its results. It has run from the very beginning of the project until after its end. Substantial awareness of ClimateWater has accordingly been raised among different stakeholders through various dissemination actions such as the regularly updated ClimateWater homepage and the coverage of the project in various pertinent events. Several events have been attended by the project coordinator and the partners, where ClimateWater was presented. Stakeholders were reached through poster presentations, PowerPoint presentations as well as the project brochure and leaflets that were distributed in relevant events attended by the consortium members. In addition, the project benefited from increased coverage by various on-line and off-line media, such as blogs, newsletters and other publications. Finally, the ClimateWater Stakeholder Platform, which has been launched and maintained as an integral part of the ClimateWater website, has further reinforced stakeholder involvement and the exploitation of the project's results.

Summarizing: All the four scientific work packages were focussed at the identification of the climate change related impacts on water resources and at finding out how Europe can provide a solution for saving our water resources, their quantity, quality and the ecosystem, that is Man and

Nature together. The further aim was to identify these strategies – all possible physical and non-physical strategies and the societal implications of all the remedial actions. In trying to identify the research fields to enhance the work, we also looked at the identification of research gaps in the related policies, while focussing on recent strategies such as ecohydrology. The very final task was to help bridge these policy gaps, by reviewing all water related policies of Europe, whereas water is linked to many EU policy areas (e.g. agriculture, transport, food, etc.) as it is a cross-cutting issue. Therefore, this task was immense because we also knew that that flood, drought and ecosystem management strategies were to be included in these policies. What we did not know at setting the objective that water impacts became so drastic, and alternating, that the actions, and the finding the related financial resources will become very urgent. A brief summary of our results are found in the following chapter.

4.1.2 Main S&T results/foregrounds

Introduction

The text of this description of the main scientific and technological results of the project originates from the full scientific reports on WP2-WP5, which have been submitted as separate deliverables throughout the project's lifetime. The texts of the original authors, the partners P3, P9, P1 and P4, are not changed. Remarks or additions of the Co-ordinator are marked thus. Due to size limitations of reporting, the original conclusion texts were much curtailed.

Report on WP2: Analysis and synthesis of water related climate change impacts
Compiled by Partner 3 CNR-IRSA, Italy (with the contribution of all project partners**)**

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 (e.g. extended droughts) and decrease of water storage in snow packs, glaciers and the polar ice caps and rise of sea level.

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.

Comments of the Co-ordinator: Transition zones of Middle Europe are having a very large impact from both too much and too little precipitation. 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 is likely to be reduced. In particular, snow packs 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. Diverse climatic environments in Europe, ranging from polar conditions in the north to arid tropical conditions in the south, make a generalized prediction impossible.

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, and southern Europe) as high-intensity rainfall events (that occur even in arid regions), cause 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 because decreases in stream flows, lakes and other standing-water volumes will result in increased concentration of all contaminants. This is frequently associated with change of

temperature and lower light penetration with basic changes of the chemical and ecological process in these waters.

The health risk of the human population is being dramatically increased by the 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 also 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 forecast for the future.

The year-by-year, recently record-breaking floods of a large part of Europe, is one of 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-breaks 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 inundation 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.

Agriculture will remain the largest water consumer in the Mediterranean countries in the next few decades, with warmer and drier growing seasons resulting by 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 as a result of the use of lower water-demanding technologies.

Major impacts on inland navigation include lowered 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. Likely negative impacts on marine navigation include coastal erosion, degradation of port structures, reduction of top clearance between ships and bridges (because of thermal expansion of oceans and melting of polar ice sheets), hazards of storm surges. 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. Capacity increase of the EU hydropower industry might be possible in those parts 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 will be at risk and subject to economic losses.

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 have to be management, planning and political-administrative measures implemented before structural interventions. Only water resource managers in fact, can respond to

the combined effect of climate change, population growth (and consequences 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. Integrated water resources management must be upgraded to cope with the expectable changes of climate change impacts on water ecosystems. This is most effectively done by integrating all water engineering (hydrological and hydraulic), water quality and pollution control approaches with the needs of the aquatic, adjoining (ecotone) and terrestrial ecosystems. The integration of this approach with improved economic, social and legal-administrative frame will result in the appropriate management system, not forgetting the capacity building and learning approaches.

There is general agreement that development should build adaptive capacity, helping poor countries to become less vulnerable to the impacts of climate change, by diversifying their economies and livelihoods, increasing access to markets, education and healthcare and building social and financial safety nets.

Considering the trans-boundary extension of many climate change impacts, it is essential to integrate climate change into foreign policies in order to 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. International agreements and conventions serving for such purpose should take care of protecting downstream neighbours from the hazards of the too much, the too little and the too polluted waters crossing the transboundary stations and this should be ensured in an obligatory way and by internationally enforceable laws.

Report on WP3 and recommendations for WP4 and WP5: Analysis and synthesis of methodologies of adaptation measures, complied by SHMU P9, (SK), with the contribution of partners: P1 VITUKI (HU); P2 UNIDEB (HU); P3 CNR-IRSA (IT), P4 USF (DE); P6 Geonardo (HU); P7 UVIEN (AT); P8 UNILEI (UK); P9 SHMU (SK); P10 SOGREAH (FR) and P11 MRA (MT).

Adaptation to climate change in water management is needed now. Hydrometeorological records and climate projections provide abundant evidence that water resources are vulnerable and can be strongly impacted by climate change, with wide-ranging consequences for human societies and ecosystems. Nearly all countries are anticipated to be negatively affected. Such impacts vary greatly from region to region and include increased frequency and intensity of floods and droughts, greater water scarcity, intensified erosion, decline of glacier and snow cover, sea level rise, salinisation, impacts on water quality as well as ecosystems. Mitigation efforts have started but will take too long to show effects.

Comments of the Co-ordinator: Slower than the occurrence of new and increased impacts. Therefore, it is both urgent and cost-effective to start adaptation now.

Adaptation may be costly, but it is much more cost-effective to start adaptation now since costs will be much higher once climate change effects are irreversible. Pricing mechanisms and markets can help to achieve a more efficient allocation of water resources; however equity considerations must also be taken into account. Mechanisms like insurance can play an important role.

Adaptation measures should strive to combine cost-effectiveness, environmental sustainability, cultural compatibility and social acceptance. Prioritization of adaptation measures should be based on the results of vulnerability assessments, costs and benefits assessments as well as on development objectives, stakeholder considerations and the resources available.

The need for adaptation requires a paradigm shift – thinking out of the box. This may stimulate alternative and innovative approaches. In particular it is crucial to shift from a supply-side approach to a more sustainable, "demand-led" approach to water resource management, focusing on conserving water and using it more efficiently. Implementing integrated water resources management supports climate change adaptation. Incorporating climate change effects into IWRM and fostering the implementation of IWRM will advance adaptation to climate change.

Comments of the Co-ordinator: Nevertheless IWRM should also be updated, as pointed out by several documents of ClimateWater, for example by integrating water quantity, quality and ecosystem issues in the planning and management process.

Successful adaptation will require interactions between multiple levels of government –European, national, sub-national and local – as adaptive capacity and action at one level can strengthen or weaken adaptive capacity at other levels.

Reearch must be focused in the coming decade upon efficient IWRM, based on refined methods of calculation of water sources and resources including climate change impact assessment (global climate change models that assess precipitation and temperature changes and other issues pertinent to water supply). This process requires the improvement of monitoring data (accuracy of data & automation of the whole monitoring process) for setting-up an effective integrated water resources management policy. The strict orientation of geological and hydrogeological studies aimed to clarify the conceptual model area and knowledge of hydrological, geologic, hydrogeological and soil background will be essential. Better understanding of biological processes and anthropogenic impacts on the water system, understanding the role of surface groundwater interface, retention capacity and the artificial recharge of aquifers and the dynamic synergy of resources and static water supplies will help for setting IWRM in the future.

In the field of identifying and bridging gaps in water-related European policies the effort must be focussed upon:

- Trans-national strategies to strengthen the protection and management of water in trans-boundary territories;
- Assessment of the impact of climate change upon design the global strategic adaptation measures and rules;
- International exchange of information and approaches for evaluation of point and diffuse sources of pollution, and adaptation strategies for pollution control with due concern to consequences in water quantity and quality on the European level;
- Exchange of best practices and recommendations based on the experiences gained by EU member states and the Commission within the development of the 1st River basin management plans (1st RBMPs) according to the WFD in order to support the preparation of the 2nd RBMPs.

Comments of the Co-ordinator: the actual planning of the potential outcome of climate change adaptation measures must be included in which latter since this planning is weak in the present practice of RBMP, as it was pointed out in several background documents of Project ClimateWater)

In the field of agricultural research needs a more precise identification of the forest-steppe ecotones subject to impact is closely linked to the need to determine the border-zone of changes to wetter and drier zones of Europe.

From the considerations above it can be inferred that policy makers can greatly contribute to ensure an optimal level of adaptation by developing and implementing political strategies focussing upon managing and conserving water resources and on maintaining and restoring climate change-resilient ecosystems, in this way also contributing to the prevention of disasters.

Detected range shifts are based on findings from a relatively low number of freshwater organism groups and few regions. The lack of a wider knowledge hinders predictions with regard to general responses of freshwater biodiversity to climate change and other associated anthropogenic stressors. This is not only important with regard to predicting the responses of freshwater species to both directional climate change and short-term climatic oscillations, but also when assessing the capacity of protected areas to accommodate future changes in the distributions of freshwater species.

It is critical that further research is conducted as there are few current case studies about nature conservation and consequently, major scientific challenges remain, for example to understand the quantitative link between service provision and ecosystem structure or function; to value those ecosystem services that generate benefits for which there is no obvious market price (e.g. climate regulation or species' 'existence values'), and to ensure that emphasis on service provision does not allow further biodiversity erosion from among the many scarcer species whose functional contribution is small.

Adaptation in damage prevention should be prepared on an international and national level and in a large scale, where all the different aspects can be considered, however strategies should be based on local knowledge, and it should be delivered on local level, where possible. It would be also important to consider regional differences in the national strategies.

Protection measures can be divided to structural and non-structural ones. With regard to structural measures the first aim is to focus on the consistency of existing structures, work out monitoring programmes, and carry out maintenance and improvement where necessary. When there is a need to build new defensive structures, the viability of them should be proved through extensive assessments where all possible solutions are considered. Cost-benefit analyses should be carried out for long term where climate change impacts are also accounted for. Wherever possible expensive and temporal solutions should be avoided, and environmentally sustainable solutions should be looked for (WP5), which in many cases also means relatively cheap (cost-effective) one.

Careful spatial planning should give the bases of decisions where risk assessments, risk mapping and zoning approaches are used. Land use change might be a viable solution in many cases (e.g. excess water, sea-level rise), which should be coordinated and supported by governmental bodies (e.g. local governments).

A "healthy" mixture of structural and non-structural measures could mean the "best" solution in specific cases of damage prevention and risk reduction in most cases. Therefore national/regional strategies as well as implemented solutions should be flexible, so that measures can be modified to the changing environmental and climatic conditions. A very important property of the strategies must be to increase and support resilience against changing conditions. More specifically this means, for example, that in case of a flood protection scheme, the protection could be based on several soft and hard measures. Small cascade-type reservoirs could be built on the watershed together with

afforestation programmes on hill sides and buffer zones on the edge of the rivers to increase residential time and also to hold back water for irrigation. Low-lying floodplain areas could be used as emergency reservoirs and also to improve the water balance of local areas, this way providing water for the ecosystem. These measures together could give a flexible tool where the proportions could be changed with increasing or decreasing water runoff. (These measures together are part of the basin-wide ecohydrological approach in which also the resilience of the aquatic ecosystem of wetlands will be an important part of the overall water quality and quantity management strategies of the entire basin).

Holistic approach and basin-wide integrated management will be required for riverine flood protection. Cross-sectoral communication and management will also be necessary as water management has strong effects on other fields such as agriculture and industries. Complex and innovative thinking will be a minimum requirement when dealing with issues like coastal flooding and excess water as well as avalanche hazard reduction.

In many cases the effects of natural disasters on human lives and health could be reduced through education, training, awareness raising and effective communication. Significant investments should be therefore introduced in these fields in order to further improve the effectiveness of forwarding knowledge. Education of experts of many fields, on the likely impacts of climate change is an area also undoubtedly important, so that they will be able to account for them during their work.

Research needs have been identified in most areas. One general need is the further improvement of models. This also affects the predictability of future changes in water runoff, river flows and also improves the impact assessment of specific hazards. This includes the increasing of spatial and temporal resolution of the models and the improvement of data. Implementing monitoring and data collection programmes and building of databases available for all EU states should be a key issue. Further verification of currently-available models is also necessary. Interactions of water impacts and impacts on nature (wildlife) is also a field where further studies should be carried out. Improvement of models describing impacts of avalanches, flash floods, mudflows on structures is already an important need, and it will likely gain even further importance in the future.

Adaptation to climate change should be integrated into current risk management strategies and planning processes, and not be a stand-alone issue, but part of a larger planning process. Adaptation strategies should be designed in the context of development, environment and health policies. Many of the options that can be used to reduce future vulnerability are of value in adapting to current climate and can be used to achieve other environmental and social objectives.

Strongly water-dependent industry (hydropower, thermal energy) and navigation depend on the scientific community to provide some of the answers that they need to adapt and to incorporate climate change into their decision making.

Until now, operators and planners have mainly had a reactive approach when dealing with adaptation to climate change. They have also learned from past climate experiences and made their systems more resilient, based upon these events. A lack of information on how to incorporate climate change into existing codes and guidelines is perhaps part of the reason for launching more adaptive planning aimed at safeguarding these structures.

Among practical measures in relation to WP4 and WP5, the following are important:

- Need for research on water usages, impact on the resource, adaptation to Climate Change and the conflicts which may result;

- Need for reinforced monitoring of aquatic environment (cf. WFD);
- Need for storing monitoring data in shared data bases freely available to scientists and water users;
- Need to work on the apparent conflicts between the ENR Directive, the WFD, the Habitat Directive, etc. in order to determine acceptable trade-offs;
- Need to anticipate the management of multipurpose reservoirs for future situations of water scarcity;
- Need to optimise the exploitation of multipurpose reservoir schemes and of cascades of reservoirs (**Comments of the Co-ordinator:** There is little water to store over many parts of Europe);
- Need for technology and knowledge transfer. In that respect, specific education and learning packages and modules could prove useful.

One of the biggest difficulties in adapting to climate change revolves around the uncertainty regarding climate change impacts at the local and regional level. It is also very difficult to estimate and quantify the economic effects of changes in climatic conditions. This uncertainty complicates the standardization of adaptation measures and demands a certain level of flexibility to adapt to future conditions that are not predictable today. However this uncertainty should not paralyze adaptive action.

Adaptation is already taking place, but in a piecemeal manner. A more strategic approach is needed to ensure that timely and effective adaptation measures are taken, ensuring coherency across different sectors and levels of governance. Autonomous adaptation is unlikely to be optimal because of uncertainty, imperfect information or indeed financial constraints. This means that we cannot leave adaptation efforts to individuals or businesses. In addition, some adaptation actions that are taken may increase vulnerability rather than reducing it.

Early action will bring clear economic benefits by anticipating potential damages and minimizing threats to ecosystems, human health, economic development, property and infrastructure.

The methodological approach developed in the WP for capacity building has enabled both a qualitative assessment of capacity building processes to be made and an indicative list of adaptation strategies in four major European river basins to be compiled. It seems that the mechanisms for monitoring and evaluation are the weak points of the capacity building effort in the river basins concerned. Monitoring and evaluation are the keys to improve capacity building processes, through learning from previous actions. Such learning processes should occur in a collaborative fashion, especially when both policy makers and scientists are envisioned to interact in order to achieve the overall objective of the adaptation strategy. This also seems to coincide with limited stakeholder involvement or political support. The projects seem less effective in adopting a multi-level governance perspective. It rather looks as though that the coordination of adaptation measures is dealt with in isolation, resulting in a mismatch between these levels. This suggests that a lack of vertical integration of governance levels does not *per se* coincide with a lack of horizontal integration.

Conclusions drawn by several studies indicate that modelling possibilities of diffuse or non point source (NPS) pollution loads should be also subjected to research, with due concern to the inherent shortcomings of the non-verifiable or non-calibratable, 100+ parameter conceptual "watershed" models used for the purpose (e.g. to select the most reliable one). Another conclusion supported by most of the studies referred to in this regard, is that the share of NPS source pollution in the overall

pollutant loads of river basins is rapidly increasing both with climate change induced impacts (extra heavy and very frequent, record-breaking precipitation events all over Europe) and with the enhanced treatment technologies applied at point sources (waste and sewage water outfalls) that are applied in the framework of the WFD to all EU countries. It follows from this fact that the concept of WFD and all the water-related directives and policies must be changed to pay much more attention to the control of these diffuse sources.

Much more research and field work will be needed to establish really working accidental pollution emergency warning and forecasting systems. These should include establishing the financial and administrative (policy) framework for assuring the annually-repeated monitoring and field work that would be needed for upgrading, updating and maintaining existing model systems. Certain further research into the development of respective models as planning tools will also be needed.

The most important general conclusion in the area of water quality is that the Climate Change adaptation literature – including large EU and other international summary documents –seem to forget the urgent need for pollution control adaptation strategies. In this context, much more research is needed, with due concern to the recently (2010) observed pollution incidents in Europe and elsewhere, calling for much better monitoring and field work. This serious lack also calls for the reworking of most of the water-related Directives and policies to include items that support pollution control adaptation strategies. This is of extreme urgency, as very serious health risk and ecological catastrophes call for it.

Report on WP4: Identification of research needs
Compiled by: P1, VITUKI, (H), with the contribution of all project partners

WP4.1 Index of Impact Magnitude and Action Urgency (IMAU) (P1**)**

The original idea of developing an index or indicator of the Magnitude of Impact and Urgency of Action, was that a method for the calculation of this index be accepted by all partners. On the first Rome meeting of the Project, the participants voted against the development of this index with the reasoning (Coordinator: with some correctness) that no index ever served the purpose for it was created.

Nevertheless, as the development of an index is in the Description of Work, the Programme Officer to this project, when reviewing the Mid-Term report, correctly demanded the development of such. The Consortium promised, in the rewritten mid-term report, that the following two indices will be developed:

- A simplified solution of the Co-ordinator; and
- Another substitute approach by the Partner P4 USF (Germany) – found in P4 reports on WP5.

Below are the main conclusions of the simplified method of the Co-ordinator, derived from a scoring matrix developed and filled by each Project partner. Three distinct evaluations of the matrix were made and the conclusions of two are summarized here: Some conclusions may be drawn from the Figures (see the full report). The figures illustrate quite well the major conclusions that are well known to all scientists and managers (policy makers?) who deal with climate change It is clear from these figures that among direct impacts flooding received the highest indicator value all over Europe, with the exception of South Europe, where water supply and drought are the dominating IMAU values. From the SPIDER diagram it can be concluded that high flood IMAU values are also clear, while water supply and drought dominates IMAU values of Southern Europe. The urgency of land-

use planning development is also clear. The small values for Northern Europe indicate the lack of scores for this region. A conclusion from this simplified IMAU method might be that, in spite of the simplicity, it yields the action urgency that is needed in the climate change impact fields investigated.

WP4.2: Ecohydrological water and ecosystem management strategies (P7)

The concept of ecohydrology is relatively young but nevertheless auspicious. The ecohydrology approach is an extremely useful tool for the adaptation efforts needed to combat climate change. However a meta-analysis of data indicates that there are research needs in various fields on basic understanding, e.g. of plant-water-use and on applied ecohydrology. One big issue is forests, which cover nearly 50% of Europe but several information gaps were found. Further research needs were detected for the agricultural sector, wetlands and urban environments. The two EU Directives most directly dealing with water (HD, WFD) should be urgently adapted in the light of climate change.

Research needs can be summarized as those into ecohydrology (strategies of ecology, hydrology, hydraulic construction and pollution control of point and nonpoint sources).

Most important issue should be the strengthening of resilience in natural systems. A negative example is the ongoing fire suppression in North American forests that has made 180 million hectares of forests extremely vulnerable to fire. If a forest is burning, the intensity of the heat is so high that the usually fire-resistant seeds do not survive.

Comments of the Co-ordinator: As well expressed in the above conclusion by project partner P7, there exist several ecohydrological concepts or approaches. There are some American (US) approaches and there also exists a hydroecological approach in Europe, viewing only the hydraulic conditions that can support the living of certain fish types. There is an approach that wishes to use wetlands as sinks or disposal sites of sewage and waste waters, which is strongly against nature conservation concepts! The approach we discuss here and offer as a tool for solving some of the climate-change adaptation issues was developed at UNESCO in the framework of the Ecohydrological Programme (managed by myself upon my official commissioning by the Head of Science at that time), It was carried out as a kind of continuation of the ecotone programme that was also referred to above.

WP4.3: Climate change induced causes of pollution

The importance or weight of diffuse or non-point source (NPS) pollution is growing for two reasons: One is that due to WFD point sources of pollution are being rapidly eliminated (treated) all over Europe and thus the weight of non-point sources is increasing every day. The other is the climate change-induced growth of the severity on NPS runoff loads both in urban and in rural-agricultural environments. The highest ever daily precipitation and rainfall intensity, measured in many regions in Europe has caused catastrophic washing away of waste disposal sites and bursting of waste water from sewers, which becomes extremely hazardous when combined sewers are involved and untreated sewage water flows over the streets. The size of this danger can be elucidated by the example of Hungary, where 250 mm daily precipitation was measured in 2010 - one-third of the annual rainfall of that site. As emphasized by this chapter above these conditions call for very urgent counter action and the respective re-working of all water-related policies with special regard to WFD and its main tool the River Basin Management Planning. Even the results of the simplified IMAU index (Chapter 2.1 above) verify this conclusion.

WP4.4: Alternative waste and sewage water treatment and reuse technologies (P3)

Climate change is the latest cause of water scarcity and pollution that the planet has been called upon to face in the last decades. To solve these problems, wastewater managers and the public must begin to consider wastewater as a source of water that can be treated, recycled, reused and resold. Although some of these products are already derived, researchers have a long way to go to fully exploit the complete range of products that can be obtained from wastewater treatment. In addition to a way to obtain products, an improved wastewater treatment would also result in a cleaner and safer effluent. To expand wastewater reuse, public health, sanitation and environmental protection have to be given proper attention. The selection of environmentally sound technologies, which take into account the available quantity and quality of the wastewater and the requirements for the wastewater reuse are of a paramount importance. These issues are dealt with in addition to more promising methods that deserve development, are also described.

Other factors that have to be considered when decisions on water treatment and reuse have to be taken include the local conditions with reference to regulations, institutions, financial mechanisms stakeholder participation and public consensus.

The consideration of all these issues can be facilitated by incorporating innovative wastewater treatment technologies and wastewater reuse into local water management plans. Partnership with the private sector, with national and international agencies and with the community will help to build capacity and to improve efficiency during the operation of treatment plants being, in this way, extremely important in achieving the sustainable targets included in wastewater reuse plans.

WP4.5: Water stress and droughts (P2)

Climate change is predicted to reduce precipitation and increase the frequency of droughts, thus decreasing natural water resources. Areas exposed to drought and water scarcity are the most sensitive to climate change because of:

- High degrees of extraction of water resources;
- Increasing environmental water-demand; and
- Little remaining possibilities of expanding water resources.

Climate change intensifies those existing pressures that reduce good quality water resource availability and increasing water demand; both these lead to the intensification of water management conflicts. In some regions, current water uses cannot be maintained in the near-future therefore reduction of water demand and reallocation of water resources is inevitable. Limits to the socio-economic adaptation capacity of agricultural systems are limited in many regions, proven by severe damages to agriculture and to vulnerable populations. This is due to the difficulties in implementing measures effective enough to cope with long-term drought and water scarcity. Also, lack of negotiating new policies is experienced.

Higher prices enhance development of unconventional supply sources. In view of declining natural water availability and the limits to raising the amount of abstracted "conventional" water resources, reused water and desalination is going to play an increasing role. Desalination is a real option where pressures on water resources are particularly strong.

Meteorological drought may be overcome by the means of reservoirs. The degree of drought's impacts on water supply is analyzed with models which tell us the probability that a given demand

may suffer water shortages during a given time horizon, depending on streamflow variability, storage capacity and yield reliability. The probability of shortages becomes higher if reduction of average values and a change of seasonal variability are expected at the same time.

Management of the water resources system means coordinated actions in: awareness and education; investment in conservation; maintenance and improvement of facilities; establishment of rules for exchanging water rights and increasing the flexibility of the operation of regulated water resource systems with modelling.

WP4.6 Drinking water supply (P2)

Drinking water resources are indirectly saved for potable use by expanding available water resources for other purposes. In this manner cleaner resources can be saved for potable uses if other resources of worse quality are treated and used in other sectors. Water conservation also serves sustainability involving the protection of ecosystems.

The revised National Hydrological Plan (2005-2008) in Spain under the name Plan AGUA aims at making supply less dependent on climatic conditions. This follows the approach of vulnerability reduction which says that the process of sustainable development helps to reduce vulnerability to climate change. By reducing vulnerability, impacts of climate hazards are also reduced, as there is less exposure to the hazards. The program provides 3.9 billion Euros of funding for investment projects, of which a third is provided by the European Union. It aims at saving water resources amounting to 1 100 cubic hectometres annually by fostering demand management, recycling of water and encouraging efficiency in water consumption. The emphasis is on desalination, which provides about 70% of the resources generated by the program. Prices of desalinated water are provided at subsidized cost to agriculture. In view of the relatively high costs of desalination, the provision of desalinated water to agriculture risks generating inefficiencies and costs to public finances.

When choosing from options wastewater reclamation and reuse, water marketing and transfers, desalination where less costly alternatives are not available and where water prices are high must be considered. None of these can change the trend of growing water costs.

WP4.7 Groundwater (P9)

For understanding of all aspects of the water balance, with particular emphasis on detailed, continuous observations of demand-side variables (such as consumptive water use and evapotranspiration) should be realized. Better quantification of relationships between highly variable summer precipitation and recharge, improvement of understanding of snow hydrology, diagnostics of snowmelt, and runoff and soil moisture recharge when rain or snow events occur as well as better understanding of connections between surface water and groundwater.

We conclude that for the water management planning and infrastructure design, as well as for the utilizing of the existing prediction tools is strongly recommended, improved monitoring of all aspects of the water balance, with particular emphasis on detailed, continuous observations of demand-side variables such as consumptive water use and evapotranspiration. Lack of adequate groundwater data to monitor changes in areas not influenced by pumping was universally cited as a high priority for strategic monitoring investments. Monitoring of ecosystem responses and interactions between ecosystems and hydrology were assigned a high priority, especially given recent and projected ecosystem changes and their effect on evapotranspiration, runoff, and sediment transport as well as the need for strategic investment in monitoring in mountainous regions,

especially with respect to snow climatology and hydrology, given observed and predicted changes in snow hydrology and melt dates.

Although climate change has been widely recognized, research on the impacts of climate change on the groundwater system is relatively limited. The reasons may be that long historical data are required to analyze the characteristics of climate change. These data are not always available. Evaluation of the impact of climate change on groundwater is not possible only through the use of historic time-series to generate future scenarios, because previous impact studies have only provided information on change in average conditions. Also, the driving forces that cause climate changes are yet unclear. The climatic abnormality may occur frequently and last for a period of time. Even if the required data exist, uncertainty is embedded in model parameters, structure and driving force of the hydrological cycle. Predicting the long-term effect of a dynamic system is very difficult because of limitations inherent in the models, and the unpredictability of the forces that drive the earth. A physically based model of a groundwater system under possible climate change based on available data is very important to prevent the deterioration of regional water-resource problems in the future. Although uncertainties are inevitable, new response strategies in water resource management based on the model may be useful.

The investigation of the relationship between climate change and loss of fresh groundwater resources is important for understanding the characteristics of the different regions. The impact of future climatic change may be felt more severely in countries, whose economy is largely dependent on agriculture and is already under stress due to current population increase and associated demands for energy, freshwater and food. In spite of the uncertainties about the precise magnitude of climate change and its possible impacts, particularly on regional scales, measures must be taken to anticipate, prevent or minimize the causes of climate change and mitigate its adverse effects.
If the likely consequences of future changes of groundwater recharge, resulting from both climate and socio-economic change, are to be assessed, hydrogeologists must increasingly work with researchers from other disciplines, such as socio-economists, agricultural modellers and soil scientists.

WP4.8 Sustainable agricultural production in drought ridden regions (P2)

Climate change is predicted to have many kinds of impacts on agricultural ecosystems, land use, agricultural water management and agricultural ecosystems. In northern Europe climate change may pose positive impacts on agriculture such as higher crop yields and expansion of suitable areas for crop cultivation. Need for plant protection may increase in all parts of the continent. In Southern Europe the negative impacts will be dominant. Predicted water shortages and extreme weather events may cause lower harvested yields as well as loss of suitable arable land. Water shortages already cause losses in crop yields and these losses are likely to grow. The impacts of climate change on agriculture are very complex and there are interrelations among these impacts. Also there are significant differences between different regions. The many adaptation measures will build up strategies for every each region taking all these impacts - negative and positive ones as well – into consideration. It should not be forgotten to take advantage of the possible positive impacts because adaptation as a whole must be cost effective.

Adaptation to anthropogenic climate change is a new need but adaptation to new opportunities and adverse consequences of environmental changes has always been a challenge. When developing a certain strategy it must be decided which starting point we chose. Any practical guidance for policymakers must be provided not to lose time because loss of time makes the problem more and more complicated and costly. By reducing vulnerability, impacts of climate hazards are also reduced,

as there is less exposure to the hazards. When adjusting to this concept we change anthropogenic activity - both in agricultural and other sector - in a way that we reduce and mitigate all adverse impacts on the long run. Best agricultural practices along with practices of organic agriculture are already available, independently from climate change. On the other hand there is a so-called adaptation approach which says that adaptation is carried out in response to the observed and experienced impacts of climate change on society and ecosystems. These responses ensure that the vulnerability to the impacts is reduced (*Schipper, 2007*). This can be a misconception because adaptation only means to adjust to new conditions by choosing adequate techniques for production. However it may in turn ensure that less is lost each time a climate-related hazard takes place, which means risk is reduced. With reduced risk, development can be more sustainable.

To adjust to this concept uncertainty levels of projected impacts on crop productivity must be reduced. This is still a research topic of high importance, although there exist already a lot of results.

WP4.9: European research of Pleistocene and (palaeo)geology (P6)

Paleoflood hydrology. Paleo-floods & paleo-hydrology is a very relevant field indeed to the topic of climate-water relationships in Europe and in global scale. It not just helps us understand how our rivers behaved in the past but it can give bases for the improvement of the accuracy of global circulation models. Such information therefore should be gathered and the methodologies for how to apply these to everyday hydrological practice and risk assessment studies should be worked out. It is very important to gain such kind of information in order to get a better understanding of the largest possible floods under present climatic conditions and their recurrence intervals. A good example of this is a study carried out after an extremely large flood (biggest measured) occurred on the Gardone River in France. Paleo-flood study showed that there have been at least 5 floods in the last 500 years, which had a stage 1-3 m higher than the 2002 flood event had.

Conclusions for Pleistocene research. Finding analogues for present climatic conditions from the past can be a way forward to gain some information for the answer of a 'what to expect?' question as far as climate change effects on water cycle and river responses are concerned. The last interglacial is one particular area of research. Better knowledge of climatic conditions of the examined periods are naturally one target of research, while on the other hand the state of river systems can deliver important information for climate-water relationships. River system dynamics are influenced by many climatic and non-climatic factors that can have direct and indirect impacts on river systems. Obtaining better knowledge of the effects and the magnitude of these impacts would be beneficial. Studying the stratigraphic arrangement of floodplain deposits also provide valuable information on river history. This information together with, e.g., glacier behaviour of the age, can help to build up a picture of past cause and effect relationships. The use of rainfall-runoff and sediment models can also help to understand certain relationships between climate change and river behaviour, therefore their wider use should be promoted.

WP4.10: Hydropower and Navigation (P10)

Hydropower is a mature technology and technological innovation might be somewhat limited. When enlarging the scope of work to energy, the question is quite different and research is needed to develop new forms of energy, particularly renewable energies, as well as to store intermittent energy. These innovations will be needed to progressively replace fossil energies and face the future demand of energy whilst producing energy with very low greenhouse gas emissions.

Navigation is a very old mean of transportation but technological innovations are still possible and desirable. Research is needed to reduce vessel fuel consumption, to reduce water consumption in inland channels, and have navigation a very low GHG emission transportation mean.

Beyond the researches needed for technological innovations, research is needed for the maintenance and development of the infrastructures to insure that they will be able to deliver tomorrow the expected services. Research must anticipate in an uncertain context, under plausible climate change scenarios, what will be the hydrological and hydraulic conditions tomorrow. It must then propose strategies for energy and navigation to adapt to these evolving conditions. No regret strategies shall be preferred. A cost evaluation of these strategies, and the comparison with the situation of non-adaptation, shall confirm the soundness of the strategies. Research will thus provide the necessary information to the policy and decision makers to proceed.

In order to move forward with coping with climate change, it is important to create a partnership between stakeholders, government and researchers, where all parties are working towards a common goal. This type of collaboration produces results that are applicable to the industry and that can be a motor of development.

Attention shall be paid to fact that the adaptation works on infrastructures will have to be done in a more and more constrained environment. Anticipation is therefore needed and policies will be needed, duly justified by research work, to encourage virtuous strategies, to smooth the development procedures and to facilitate the acceptance of the construction works.

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, backed-up by research work, will provide successful win-win solutions and avoid negative cross-sectorial feed backs of measures or non-action in one sector. It also allows including the preservation of aquatic and other water-dependent ecosystems, which is a prerequisite for developing effective adaptation strategies.

WP4.11: Flood forecast and defence (P6)

Flood defence and forecast are heavily studied areas of hydrological, hydro-meteorological, hydraulic, environmental sciences. As there is a shift in thinking from artificial flood-protection towards more natural solutions as floodplain rejuvenation and re-widening, lowland floodplain reservoirs etc., there are new areas for research from this aspect. The risk based integrated water basin management will probably give the basis of flood protection in the future, therefore research should focus on more accurate risk assessment and loss evaluation methods and available flood disaster databases should be set up Europe wide. Further research in the effect of wetlands and floodplain forests on the floodplain hydrology should be carried out.

Flood forecast and alert systems will play an important role in flood protection and flood loss mitigation. It is a rapidly developing field of the last decades thanks to the numerical weather prediction systems. These systems however need to be further developed as their coarse spatial resolution is not adequate for accurate midterm forecasts. Ensemble prediction systems already proved their ability to reduce uncertainty, but their re-verification and re-forecast can be beneficial for statistical analysis, and for the calibration of rainfall-runoff models. Further studies are needed regarding the resolution of these models and the number of members required in ensembles. Radar measurements can play an important role in the validation of forecast systems for small catchments

and the increased accuracy of radar measurements seems to be an important area of research for mountainous areas with complicated orographic arrangements. The applicability of artificial neural networks in hydrological modelling seems to be proved but there is a need to identify the field where it can be used in everyday hydrological practice.

Report on WP5: Identifying and bridging gaps in water related European policies- Compiled by P4, USF (D) with the contribution of all partners

WP5.1: Water Framework Directive and water pollution control (P4)

Although climate change has been addressed in the text of the Water Framework Directive (2000/60/EC), it has not yet been fully considered in the draft RBMPs, both in national and international plans, unfortunately. For this reason, it is too premature to draw conclusions from the published results of the draft RBMPs or to make claims about the following issue:

- Facilitating stakeholder engagement and public consultation;
- Improving general awareness of all actors for climate change trends and impacts;
- Paving the way for more climate change related actions in 2nd/3rd cycle;
- Allowing for incorporating international, national and regional information on predictions.

However, the step-wise and cyclical approach of the WFD makes it well-suited to handle climate change. Climate change can be included in several steps of the WFD implementation, such as the characterisation and evaluation of the status of water bodies, the analysis of pressures and impacts, the economic analysis, monitoring, the design of the programmes of measures and the objective setting process. The process to include climate change in WFD implementation should be transparent and involve active engagement with all relevant stakeholders. It is important that the RBMPs take into account of the medium and long-term implications of climate change, as there is a large potential for synergies between WFD objectives and adaptation aims. On the other hand, it needs to be ensured that measures do not run counter to adaptation objectives, and that they are flexible and robust enough to be viable under changing climate conditions.

Another important remark is that WFD does not clearly enough defines the role of quantity of surface water. Outputs of various analyses related to the water scarcity, floods, climate changes show that water quality should not merely been seen as a supporting parameter for evaluation. If there is strong evidence showing that the situation at un-impacted sites changes significantly because of changed climatic conditions (and not because of other human induced pressures), reference conditions can be revised as a part of the river basin characterization review. A comprehensive and robust but reasonable and sustainable monitoring programme including reference sites is necessary to underpin such decisions. Yet, the most disturbing problem is that diffuse or non-point source pollution is practically not represented in WFD and neither in the new documents (EU Technical Report, 2009:40) that try to give account to adaptation strategies aimed at coping with climate change. Non-point source problem had been for at least a half century the largest problem and then its importance is growing because of the progress in point source treatment and because of the impact of climate change. Therefore our most important policy gap bridging advice includes the following important parts:

- Establish an ecological-hydrological (ecohydrological) approach. (see the respective chapter of the WP4 report)

- Create in RBMP a real planning methodology instead of the presently applied mostly legal-administrative approach where planning (in the ecological- or bio-engineering terms) is not included at all.
- To return to efficient monitoring that could serve the data need for the ecohydrological approach that also includes a model supported planning tool.

WP5.2: The European Flood Directive (P1)

The objective of this document is to examine whether the adaptation strategies required to reduce the impacts of climate change on floods is properly included in the Floods Directive of the European Union or not. Primarily we would like to highlight that climate change related issues are included into the Directive and it is stated that the Preliminary Flood Risk Assessments should include the impacts of climate change on the occurrence of floods. In the documents related to the Flood Risk Management Plans, however, nothing is mentioned about the need of formulating adaptation strategies in such a way as to reduce climate change impacts. It is only mentioned regarding the six yearly reviews process in which climate change impacts on floods shall be taken into account. Considering that the first review of the FRMP-s will be due in 2021, we think that this level of the requirements regarding actions is not satisfactory. It is a well-known fact that proactive actions can be very cost effective solution and so we think that the preparation against CC effects has to start with the early creation of the FRMP-s (e.g. just now in 2011). Since the issue of EFD in 2007 there have been a series of related documents issued, which seem to fill the gap what have been identified above. The European White Paper on climate change adaptation and its accompanying documents clearly presses on that the implementation of the Flood Directive has to include climate change. With regard to the methods there is a technical guidance document issued, which mentions the main choices and also recommends the robust and flexible adaptation options, which can be used in almost any cases. This document is considered as a good guidance, although we feel that the key directions of the related to adaptation methods should be included in policy documents in greater depth.

There has been a broad range of research needs identified by our analysis of literature, which can be related to the fight against climate change impacts on floods in Europe. The EFD and all relevant documents have been examined related to the objectives. The ones set on innovation and research. It is found that in general research is highlighted in all documents, but only in a general manner, without setting any obligation on Member States. We think that the inclusion of research directions and certain obligations regarding the improvement of currently available methods and technologies in flood protection, preparedness and prevention would be beneficial in many aspects. It could bring research and everyday practice closer together, from which all parties would benefit.

WP5.3: The European Water Initiative (P8)

The EU Water Initiative is basically a global approach to water-related challenges either in correlation with or independently from Climate Change impacts. As such, it may still have a significant role in Climate Change mitigation actions as this is a global phenomenon.

Also, it is the best forum to define hotspots regarding water-related inefficiencies and regions to benefit most from Climate Change impacts. During last year (2009) the EUWI working groups have, in various ways, made significant contributions towards the objectives of the EUWI, and also responded to the recommendations made at the Multi-Stakeholder Forum in August 2009. The political and strategic character of the EUWI and its objectives continue to require strong and regular political support by appropriate high-level structures within partner countries and the EU and Member States. On the EU side, this calls for greater commitment from the EU member states and

the European Commission and allocation of appropriate financial and human resources for administration, management and follow-up of the EUWI. Closer operational links are needed between the EUWI and ongoing bilateral and regional programmes supported by the Commission and the member states.

A key conclusion from all working groups is that active engagement with stakeholders throughout the process of formulating policies, strategies and work plans is essential to ensure that the activities meets articulated demands and that the results are owned and used. Looking forward, all regions are increasingly facing droughts and floods, and there is a growing demand for development of national and regional strategies for the water sector to adapt to climate change. This is expected to be one of the strategic directions of the work of the EUWI in the recent future.

The strategies/measures suggested by the EUWI working groups:

- Building resilience and adapting to climate change and variability;
- Increasing water supply services and access to sanitation to meet internationally agreed targets;
- Adopting an integrated approach to water resources management and improving water governance, including making links to other sectors;
- Improving cooperation in transboundary water development and management;
- Assessing the economic value of water and sanitation and increasing financing from all sources.

In conclusion, the direct relevance to ClimateWater is limited by geographic relevance - the focus is on Africa and the Mekong particularly; the Mediterranean and Eastern European areas only in our direct area of concern. It is focussed upon Millennium Development Goals, hence has a more limited subject area – particularly Water and Sanitation focus; not the whole water field. The research needs are also limited; to date no new findings of gaps, the emphasis is on information sharing and coordination.

The areas of interest to EUWI are areas where the concepts of increasing the ecohydrological resilience of aquatic ecosystems are under-studied and under-represented by case-studies. A major need, therefore, is clear for case-studies to show the benefits of an ecohydrological approach to improve adaptations to future climate impacts. This applies both to direct human health MDG needs - Water & Sanitation as to indirect human health MDG needs – biodiversity conservation to sustain ecosystem services.

WP5.4: Agriculture and Common Agricultural Policy (P2)

Agriculture has been identified as the major sustainable water management issue in the implementation of the Water Framework Directive (WFD), because of: Abstraction of water for irrigation accounts for 24% of total water abstraction in Europe and can be up to 80% in some southern Member-States (EEA, 2009 water resources in Europe – confronting water scarcity and droughts). the majority of the water abstracted is consumed and not returned to the water bodies (c. 70% according to the EEA); This sector has to be addressed as a priority when considering any action against water scarcity and droughts in Europe; Special focus on illegal abstraction; Current CAP offers more opportunities for sustainable water management but can also lead to adverse effects.

In some areas, ceasing irrigation could lead to land abandonment and severe economic hardship and by the end of 2011 this is what happened in many EU countries. Adopting a sustainable and efficient approach to agricultural water use is critical, therefore, not only to protect the environment but also to ensure agriculture remains profitable. The crucial roles in these policy area is to create and maintain necessary infrastructure and launch an efficient Drought Management Plan and act urgently. Achieving sustainable water resource management will require the implementation of a number of policies and practices, including:

- Water pricing would be a key mechanism to achieve more sustainable use of water across all sectors. It is also fundamental to the Water Framework Directive's requirement that the pricing of water services reflect their full costs. Now, after the serious droughts until the end of 2011 one cannot wait until appropriate water pricing has their effect. Urgent technical solutions are needed to save people and the economy.
- Ensuring that agricultural subsidies are linked to more efficient water use;
- Changing the timing of irrigation so that it closely follows crop water requirements, adopting more efficient techniques such as using sprinkler and drip irrigation systems;
- Changing crop types can reduce water demand;.
- As with other water saving approaches in agriculture, providing advice, information and education to farmers will enhance their impact significantly.

Both national and EU funds, including those disbursed under the CAP, can potentially play an important future role in financing measures to reduce agricultural water use. Finally and efficient joint drought-and-flood management mechanism will be needed to save extra waters for times when they are needed.

WP5.5: Energy and Hydropower (P10)

The EU has a global energy policy of which hydropower is an integral part. Renewable energies, including hydropower for a significant percentage, are the corner stones to satisfy the growing energy demand and, at the same time, to reduce the CO_2 emissions. Hydropower, which is highly depending on the quantity of water, will have to adapt to the impacts of climate change. However if the necessity of climate change adaptation of hydropower is stipulated in general EC policies, it is not further developed and there is no sectoral policy on the subject. This apparent gap can be well understood in due consideration of the fact that the adaptation works on river infrastructures will have to be done in a more and more constrained environment. There is a need to maximize cross-sectoral benefits and minimize negative effects across sectors. 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. Thus, when dealing with adaptation, it is necessary to think global, even more with hydropower infrastructures. This may explain why, so far, there are no sectoral adaptation policies for hydropower. This also suggests the important role that the EC should play in preparing and proposing a global policy on CC adaptation.

WP5.6: Navigation (P10)

The EU has a global transport policy of which navigation is an integral part. Rail and navigation are the corner stone of the EU strategy to reduce the congestion of roads and airports and to considerably reduce CO_2 emissions. The necessity of adaptation of transport to climate change is stipulated in the

EU transport policy but is not further developed. Same is observed in the NAIADES action programme which is the application of the EU transport policy to inland navigation.

This apparent gap can be well understood in due consideration of the fact that the adaptation works on waterways infrastructures will have to be done in a more and more constrained environment. There is a need to maximize cross-sectoral benefits and minimize negative effects across sectors. 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.

Thus, when dealing with adaptation, it is necessary to think globally, even more with waterway infrastructures. This may explain why, so far, there are no sectoral adaptation policies for waterways. This also suggests the important role that EC should play in preparing and proposing a global policy on CC adaptation.

WP5.7: Nature Conservation and Ecology (P5)

By the end of the 21st century, climate change is expected to be the main driver of biodiversity loss globally (Millennium Ecosystem Assessment, 2005). Appropriate nature conservation and management could – to some extent - help humans, through ecosystem-based approaches:

- to mitigate climate change effects
- to adapt the society to actual and projected climate changes in a timely and effective manner

Climate protection measures, such as biofuel crop production, afforestation of species rich habitats or establishing forest plantations, do not automatically contribute to biodiversity conservation.There is certainly no reason to think that the global burden of shocks is decreasing. It is also increasingly recognized that natural disasters, environmental stress, and access to resources can spark or exacerbate civil and military conflicts (UNEP 2008). Besides acting to mitigate climate change, there is little that planners, managers, and local populations can do about the incidence of natural shocks.

Comments of the Co-ordinator: It is a rather pessimistic concluding remark or quotation without looking into solution. The conclusion goes back to the 2007 IPCC report and these findings are still one of the best regarding nature conservation and ecosystems: "..The IPCC Fourth Assessment Report (2007) describes resilience as "the ability of a social or ecological system to absorb disturbances while retaining the same basic structure and ways of functioning, the capacity for self-organisation, and the capacity to adapt to stress and change". Systems that are intact and biologically healthy are likely to have a greater capacity to resist, recover from or moderate changes imposed by catastrophic or ongoing pressures".

The very last concluding remark is the following: 'The development of synergies in practice can enhance cooperation between the actors involved in Nature Conservation and Climate Change programs. Thus, a Common Strategic Framework could promote a Cohesion Policy in Nature Conservation and Climate Change related, not only to pragmatic actions, but also to research and technological development, innovation and entrepreneurship focused on 'capacity building'. 'Smart specialisation' has to be developed and complementarity has to be ensured with Europe 2020 strategy.

Thus we may conclude this issue for "bridging the gap in the relevant policies" with these sentences although it is very important to note that the bringing together of policy makers, financing agencies

and nature conservation specialists (ecologists) is now (at the end of 2011) is very urgent and no solution can wait until 2020.

WP5.8: Drinking Water Directive (P2)

The major concern of the DWD is that this Directive treats available drinking water resources as eternal and unrestrictedly available source for drinking water supply.

Comments of the Co-ordinator: It was strongly proven during the project ClimateWater that our drinking water resources are vulnerable to climate change impact and suffer from both quantity and quality problems**.**. This is a basic issue, which has to be built into the DWD directly or with proper cross-references at least to the WFD and also to the Groundwater Directive.

The most important policy gap bridging advice includes the following:

a) Integrated checking of the implementation of, and overlaps and gaps in policies relevant on this field;

   Comments of the Co-ordinator: the main directives to consider for bridging gaps are listed in Annex IV and also in the periodic report**)**

b) WFD and other water-related directives and policies must be reformed in order to pay more attention to the control of non-point sources of pollution rather than just concentrating on point sources;

c) Integrated Water Resources Management that resulted in Water Resource Management Plans that part of the River Basin Management Plan of the WFD;

d) Adaptive management approaches, decision linked research, water resource planning as part of the River Basin Management Plan of the WFD;

e) Much **improved monitoring** of all fresh water resources that provide the source of drinking water supply.

Comments of the Co-ordinator: it may be stated, that in trying to bridge gaps in drinking water related directives the focus should be equally on the quantity and quality of available drinking water resources. In this the protection of groundwaters must have a special care from policy makers, as in many countries this is either the only or the safest source of drinking water. The enforcement of effective usage of water by laws, incentives and penalties may be also considered. Real-time continuous monitoring of the quality and quantity of the resources are needed with the continuously updated use of forecasting models aimed at helping the daily operation of drinking water supply systems. Finding the finance for all these gap-bridging activities will be the real challenge**.**

WP5.9: Bathing Water Directive (P2)

The purpose of the Bathing Water Directive 2006/7EC is ”to preserve, protect and improve the quality of the environment and to protect human health by complementing Directive 2000/60/EC”. This new bathing water directive requests the full hydrological-hydraulic analysis of the potential sources of microbiological contamination, which is seldom carried out in sufficient detail (this is one of the gaps to bridge—not in the directives but by policy makers, bathing water operators, health authorities and financing agencies).

As stated in the original documents (of P8, P2, P1) here is actually no real gap in the policy but the serious danger of extra-large, climate change induced pollution exists. At the time of preparing the

new BWD the authors may not have been aware of major microbial pollution problems, which are (or can be) caused by Climate Change induced extreme land-runoff and especially from urban land where combined sewers may burst from drain or manhole onto streets full of sewerage water, and ending up in the neighbouring river/shoreline, close to the inland or coastal beach.

Therefore a major conclusion is that monitoring of the bathing water should take place after each "extreme rainfall event", which will need updating of the BWD. This can vary with river basin and should be defined in the locally relevant RBMP. Extreme rainfalls cannot be easily defined now. For an example of extremity we may mention a place in Hungary where one-third of the annual average rainfall occurred in 24 hours. It may also be suggested as policy-gap bridging, that inland bathing waters be closed down after each extremely large precipitation especially in cases where the outfall of a combined sewer is upstream of the bathing water site.

Another major problem of the quality of inland riverine (fluvial-or river-connected) bathing waters is the susceptible increase of the severity of accidental pollution loads. We found in Hungary that most of the largest accidental catastrophes were caused by climate-change related events, for example:

- The Cyanide catastrophe of BaiaMara/ Nagybánya of 2000, which destroyed the aquatic ecosystem down to the Danube; and
- The red slurry catastrophe of Devecser-Kolontár Hungary in October 2010.

Both are illustrated by pictures in the background documents.

We also may suggest that all monitoring activities of the EU should be reconsidered with special regard to keeping track of accidental pollution incidents. Further advice includes:

- Applying BAT should be mandatory for those technologies which may cause dangerous short term pollution incidents upstream of the site of designated bathing waters;
- Measures needed in an emergency to avoid human health risk should be considered for incorporation into the bathing water profile, cyanide technology used for extracting gold from waste heaps should be banned (the danger represented by a planned gold mine at RosiaMontana/Verespatak is illustrated in the periodic report by a simulation result of the Co-ordinator).

The major message of general validity (for all WPs) is that the existing emergency warning systems (like AEWS of ICPDR for the Danube Basin) should be continuously updated and recalibrated against new hydrological and water quality data, to enable them to give appropriate warning of sufficient lead-time.

Climate change also has an impact on the process of eutrophication and consequently increases the potential for proliferation of macro-algae and/or phytoplankton. Consequently bathing water profiles indicate a potential for cyanobacterial proliferation. Appropriate monitoring must be carried out to enable timely identification of health hazards that surely increase with climate change impacts. Parameters - compounds that might pose chronic health risks should be determined and considered for incorporation into EWSs and the monitoring of the bathing water, based on the pollution sources and impact of adverse water incidences; if the focus is on chemical and biological water quality variables, the approach may be best based on real-time continuous monitoring.

The BWD should ensure consistency with a series of water-pollution related directives:

- Water Framework Directive (Directive 2000/60/EC);

- Floods Directive (Directive 2007/60/EC);
- Nitrates Directive (Council Directive 91/676/EEC);
- Urban Waste Water Directive (Council Directive 91/271/EEC);
- IPPC Directive (Council Directive 96/61/EC);
- SEVESO II Directive (Council Directive 96/82/EC of 9 December 1996 on the control of major accident hazards involving dangerous substances extended by Directive 2003/105/EC).

WP5.10: Ground Water Directive (P11)

In general, large-scale direct impacts of climate change on water resources in Europe are quite well understood. What is still lacking for decision makers is specific knowledge on the extent to which climate change will impact flood frequency, periods of water scarcity and droughts as well as water quality at the regional and river basin level to local level. Gaps also exist on the specific impacts of climate change on all water dependent economic sectors like agriculture, hydropower, tourism, navigation or water supply and sanitation. One approach to cover this gap would be to obtain inputs from research on "scaling down" large scale scenarios and forecasts, while dealing with the remaining uncertainty of scenario outputs. Except for downscaling, scenarios and development of scenarios on climate change needs to be fostered, including more refined data with a higher resolution (e.g. regional/local scale allowing identification of specific impacts on land-use). In addition to this need for information, management approaches have to be provided which open up water policy for necessary adaptations due to knowledge gaps or upcoming new and changing information.

Comments of the Co-ordinator: As the Groundwater Directive does not contain any adaptation strategies or measures regarding the preparation for, and combating of, climate change impacts and developing resilience**,** it will be necessary to explore the possibilities to improve the related policies and measures which address climate change in an integrated manner and adjust the Groundwater Directive accordingly.

WP5.11: The Green/White Papers on Adapting to Climate Change (P4)

Forests play a major role in the storage, purification and release of water to surface bodies and subsurface aquifers. Their purification role, including that of forest soils, includes breaking down or absorbing most air pollutants carried by rain. Their soils buffer large quantities of water, reducing flooding (COM (2010) 66). There is a need for a better understanding of the relationship between forestry, water and climate change in all regions, including implications for flood management, timber production, carbon sequestration, biodiversity and other ecosystem services. Although several EU monitoring and forest classification legislation had been carried out until 2006, the EU Member States (MS) have monitored forest condition according to the "scheme of large scale and intensive monitoring. Since 2007 there is no EU legal basis for Forest condition monitoring (COM (2010) 66), but nevertheless the EU Commission, the MS and many economic operators increasingly recognize the need for more harmonized, reliable and comprehensive information on forests. While some MS may have forest information satisfying their own needs, it may not add up to information that is helpful at EU or global levels (COM (2010) 66). Competence for forest policy lies primarily with the MS under the subsidiary principle. The role of the EU is limited and designed principally to add value to national forest policies and programs by the EU proposing and possibly coordinating or supporting options for early action at EU scale. Because forests grow slowly - trees take years to regenerate, decades to grow and the final use of young stands is sometimes difficult to predict when they are established – this effort is difficult and complex and so landscape-scale long-term studies are

needed. The combined effects of climate change on forests, including shifting environmental conditions, dieback, storms and fires will be felt throughout Europe although at varying levels of intensity are likely to spread beyond their traditional boundaries (COM(2010)66). Since forestry has mainly indirect effect on both water quantity and quality, it is very complex to discover, study, model and verify their interaction in forestry. In order to assess climate-induced changes in watersheds and their ecosystems, scientists must continue to make improvements to vegetation and hydrologic models by realistically accounting for the feedbacks between land surface and the atmosphere. Ecotones are hot-spots of biodiversity and therefore they need special treatment and protection. A broad knowledge of ecotone properties was lacking, for which great deficits still exist. Ecohydrology provides means of mitigating Climate Change impacts on aquatic environments and supporting maintaining associated ecosystem services. The intrinsic combination of hydrology and ecology found in each ecohydrological approach enhances aquatic – and often also terrestrial – ecosystem resilience and resistance against Climate Change impacts, including services for human well-being. An important role in mitigating flood runoff is played by ecotones while riparian forest provides retention of flow in the active floodplain.

Comments of the Co-ordinator: Here we again would like to stress the need for EU wide legislation, which will deal with the usage of water by quantity and quality in an enforceable way. This must ensure that water is stored when flood control needs it, released when drought in downstream countries require so, and provides for the Polluter Pays Principle in an obligatory, legally-enforced way. We also wish to stress that no concrete advice for bridging the gap in the policies examined was found and neither was the urgency of action emphasized**.**

WP5.12: Drought Management (COM414) (P3)

Apart from the set up of new and more representative drought indices, together with the development of drought monitoring and early warning systems, it seems that the main lacks in the drought management legislation do not concern the scientific research in the strict sense of the term, but rather the research in the field of the legislative and institutional tools aimed at making drought management strategies more efficient.

Among these, the development of efficient linkages between the scientific and political spheres based on increased coordination to ensure that scientific results are effectively communicated to the different decision making levels and to prioritize research efforts according to policy making challenges. A further element concerns the integration of drought risk in all relevant sectoral and environmental policies affected by or contributing to drought, from water management to land use and agriculture, from energy production to tourism, also taking into consideration the protection of natural resources. Policy integration around an European drought policy might greatly help in this sense, promoting the coordinated implementation of policy instruments and measures across the above-mentioned policies, with the ultimate aim to reduce drought vulnerability.

Last, but not least, the strategy to face drought should also include an increase in public awareness and participation through, for example, educational public campaigns on drought events, their potential impacts and the planned measures. Providing information on the planned measures before their adoption, in particular, is very important to guarantee the involvement of the general public and this, in turn, greatly influences public acceptance and cooperation that are essential to make the planned measures effective.
Comments of the Co-ordinator: We may wish to suggest that drought management should be built into the RBMP (and thus into WFD) in the sense of really planning the strategies and measures of counteracting the recently (until the end of 2011) observed disastrous impacts of drought. This is to

be done in connection with flood management, and with due concern to the monitoring and field programmes needed for activating (calibrating and verifying) the planning tool they will have to use for RBMP. The financing need for doing so is also stressed along with the urgency of action for bridging these policy gaps.

Final Summary of the Co-ordinator

The objective of the project was to find the gaps in water-related EU policies, which must be bridged to avoid drastic water-impacts of climate change on Man and Nature. All Project partners identified gaps in the research field they work on. There have been many specific findings, but also some general issues. The Project ClimateWater gives advices and suggestion for making the bridge. Its major findings were as follows:

The most important general problem is that in water-related policies, insufficient emphasis is laid on field measurement and monitoring.

Another rather commonly identified gap of the existing water related policies was that if they deal (at all), with policy changes due to changing climate, they rather stay on the level of generalisation. A main gap is that many of the major documents of international organisations and larger projects aimed directly on adaptation to climate change also do not give concrete advice. (Guidance Document No 24 is an exception)

A major gap is that neither of the strategies and measures offered consider the ever-growing extremes of precipitation (thus the extremes of flood and drought!) and especially not the urgency of action. The reason is that the process of development of the strategies and measures for adaptation is slower than the changes in the climate, which was much faster than predicted 3 years ago when we started this project.

The Water Framework Directive, as the basic policy, is most criticised, along with the many related directives. The major objection against it is that it did not consider non-point pollution which has grown to an extreme health risk with changes of climate (bursting sewers, flood flushed cadavers and waste heaps of dangerous chemicals etc). Other major criticisms were aimed at RBMP, the major tool for implementing WFD. Generally it lags behind the rapid changes of the climate (although Guidance Document No 24 tries to help considerably), and do not consider the (model-based) verifiable planning for water quality and ecological changes. There are also some strong misconceptions in water policies (e.g. the Drinking Water Directive, which considers the available water resources to be eternal).

The most disturbing problem with planning and forecasting is that no working accidental emergency warning models are available; these models lack continuous updating of the data bases, also lack the calibration and verification of the water quality, ecological and hydrological sub-models of them (it can be proven by the false or rather non-existent forecasts of cyanide and red-slurry propagation. The Bathing Water Directive is also concerned).

The adaptation strategies to bridge the gaps can be divided to the following groups:

- **The strategies of policy- and decision-makers** (of state and EU administration), that is Water Management. An important part is to create **new international legislation** that will ensure that European countries would do everything to release sufficient water to downstream countries during dry periods and to reduce the risk of floods as much as they can at downstream countries during wet periods. Legislation also has to make sure that member states pay for the pollution of

waters they cause. (e.g. no ‘small-text’ amendments for escaping obligations). The legislation may need to ensure the substantially decreased use of energy and waters from all resources. **Integration of flood and drought risk in all relevant sectorial and environmental policies.**

- **The expansion of the learning or knowledge base** of the population and of all stakeholders, so as to adapt to climate change that is happening now.
- **The third group, the likely most important one in the urgent need for action** is the Environmental-Water Engineering approach. The main concept is to design and implement the strategies and measures of adaptation, based on many field measurements: and this is what we call Ecohydrology, a tool what we, P1 and several project partners (particularly P7 & P8, practiced in a number of EU projects and former TAS, PHARE etc. projects. The basis of ecohydrology is to upgrade aquatic ecosystems and their ecotones by hydrological methods, this way increasing their resistance and resilience, while in turn they will help to regulate both the quality and quantity of waters. **This strategy, proposed by the project ClimateWater, may provide through efficient landuse planning and the use of robust and simple models a tool to design the needed urgent actions.**

4.1.3 Potential impact and Dissemination and Exploitation

Climate change is now a **global challenge** for the whole world to tackle; however, at the same time, it offers an opportunity for advancing science and technology with a view to adopting better measures for sustainability. Sound adaptation and mitigation measures, especially no-regret ones, could yield socio-economic benefits in the medium- and long-term.

Evidence for **climate change and its impacts on water resources and water users** (including the ecosystems) of the Globe and, within this of Europe, is being accumulated daily. It is experienced by people, societies, and economies in the form of extreme droughts, floods, rainstorms, mud avalanches etc., occurring at the same place and in the same year, in many countries. ClimateWater has identified and analysed a vast collection of scientific and technological literature on climate change adaptation measures and strategies, and has strived to formulate a coherent framework for policy and decision makers to allow them take into account climate change in water policies. To this aim, the project has identified the needs for further research in the climate change and water field and provided specific recommendations to policy-makers to bridge the gap in water policies for climate change considerations.

Research into global climate change scenarios involves an ever-increasing number of scientists and researchers of ever widening range of disciplines. ClimateWater has utilised mainly the European part of these scenarios as inputs to the analysis and synthesis of the impacts of climate change on the water resources and water uses by the society and by the biota, the ecosystem. Thanks to the consortium members' involvement in the most relevant European investigations, direct access to the most recent research results has been possible. Similarly, this has also facilitated the involvement of key players and other relevant stakeholders in the project's activities and the dissemination and exploitation of the project's outputs.

In particular, a separate, horizontal work package, WP6. Dissemination of Knowledge, has aimed to increase the visibility of the project and the dissemination and exploitation of its results. The objectives of WP6 were to:

- Inform a broad audience of the results of the ClimateWater project;
- Convey the relevant deliverables of the project to practitioners, scientific community and policy makers with a view to ensuring their exploitation; and
- Facilitate expert interaction and knowledge sharing on adaptation strategies of climate change impacts and European water policies.

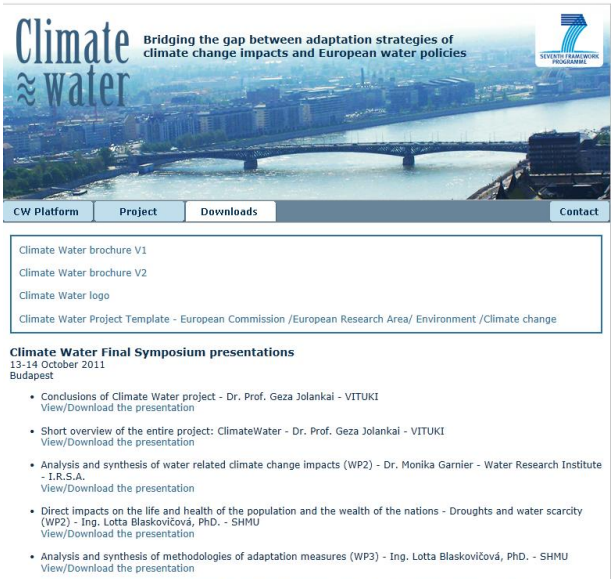
The main target group of the dissemination activities in ClimateWater were policy and decision-makers at Member States and EU level given that the project was a policy-relevant action under FP7. Nevertheless, since the scope of the project concerned a broad range of socio-economic sectors, and as such, ClimateWater was of relevance to various actors, hence, industry, scientific community and public at large were also targeted by the dissemination activities. Geonardo (P6) has led the dissemination work package, however, all partners have contributed to the dissemination activities by spreading results locally in their languages and raising awareness at the local level as well as at a European and international level.

WP6 has run from the very beginning of the project until after its end. Substantial awareness of ClimateWater among the stakeholders has been achieved through various dissemination actions such as the regularly updated ClimateWater homepage, coverage of the project in various pertinent events and the ClimateWater Stakeholder Platform, which has been developed and launched and made

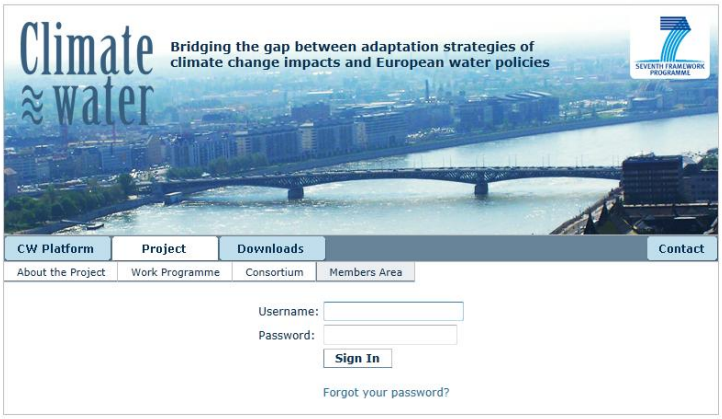
accessible through the ClimateWater homepage. Stakeholders were also reached through poster presentations, PowerPoint presentations as well as the project brochure and leaflets. In addition, the project benefited from increased coverage by various on-line and off-line media. These activities are summarised below.

A logo has been developed for ClimateWater at the very beginning of the project and used thereafter in all relevant communication and dissemination tools (see below).

The ClimateWater homepage www.climatewater.org was launched in Month 1 and has provided essential information on the project in English. Its dynamic pages have been regularly updated throughout the project's lifetime. It has also included a restricted area for the partners (Members' Area), which has been instrumental in sharing documents, the internal project results, tool-box, etc. Through its Downloads section, the consortium has made available the project outcomes, public deliverables accepted by the EC and the presentations that were made in various events and project meetings. The website has also hosted the ClimateWater Stakeholder Platform. ClimateWater website will be kept operational for a prolonged period of time after the EU funded period of the project.

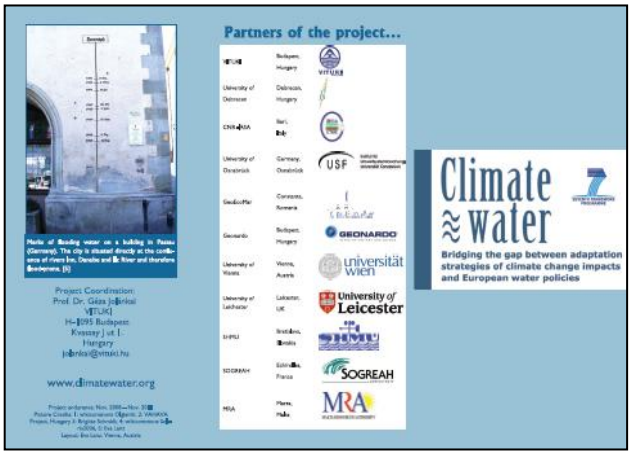


ClimateWater Homepage – Public Downloads



ClimateWater Homepage – Members' Area

ClimateWater brochure has been produced and disseminated at various events to relevant stakeholders. In line with project's progress, it has been updated – both versions are electronically downloadable on the ClimateWater homepage.



ClimateWater Brochure

ClimateWater was also covered by various media. For instance, an article on ClimateWater (Titled: *Bridge over troubled waters*) was published in the publication "International Innovation" by Research Media Ltd., whereas another article in German was published in Aqua Press International (Titled: *Gesucht: Konkrete Anpassungen an den Klimawandel / Concrete Measures for Adapting to Climate Change Needed*).

Furthermore, ClimateWater was also covered by electronic media and platforms such as online blogs (see on the next page) and a group titled ClimateWater has been established on the professional networking platform LinkedIn. This mix of online and social media tools have also helped raise awareness of the project and the dissemination of its results.

Articles on ClimateWater in scientific journals

Below, coverage of ClimateWater by an independent blog[1] on EU-funded projects, policies and related news.


EUROPA MEDIA's BLOG

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Final Climate Water Symposium

AUGUST 8, 2011

Climate water

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 is formulating a coherent framework on adaptation strategies of climate change impacts on water resources, water cycling and water uses of the society and nature with special regard to those that water policy has to take into account when considering climate change impacts.

The final symposium of Climate Water project will introduce the major results of the project, such as

- Climate change impacts on the hydrological cycle, water resources and water management reviewed for major topic categories: Impacts on the society and economy as direct impacts on life and health of the population; Indirect impacts on the society through direct impacts on economic activities; Water related impacts on nature, terrestrial and aquatic ecosystems.
- Adaptation strategies are the most important results, being reviewed in 6 major categories: water demand side, supply side, damage prevention, main water industries, adaptive capacities and control of water pollution.
- The identified research needs, where 11 very important new or novel fields are considered, such as ecohydrology. The final output is a list of advises to upgrade water-impact related EU policies, such

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ClimateWater

FEBRUARY 21, 2011

Climate water

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

Disastrous and catastrophic water related events are increasing across the world now, much worse than was forecasted by any agency or model.

Under the coordination of the VITUKI-Environmental Protection and Water Management Research Institute in Hungary, a European consortium started collaborating in 2008 in order to study European and international adaptation measures and strategies related to climate changes impacts and how these are taken into account in water policies. The partnership has formulated a coherent framework on adaptation strategies of climate change impacts on water resources, water cycling and water uses of the society.

The Project Climate Water is co-financed from the 7th Framework Programme of the European Union. It is a Co-ordination and Support action (supporting) of 3 years duration (01 November 2008 – 31 October 2011).

By the end of 2010, we at *Geonardo Environmental Technologies Ltd.* have started to build the **Climate Water Stakeholder Platform.** Those who are interested in the research results, draft documents and reports can register and get access to the Document Library.

CATEGORY CLOUD

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OUR FAVOURITE LIKS

- Brussels blog
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ClimateWater: Final Symposium, Stakeholder Platform

20/10/11 05:02

From our colleagues at Europamedia.wordpress.com

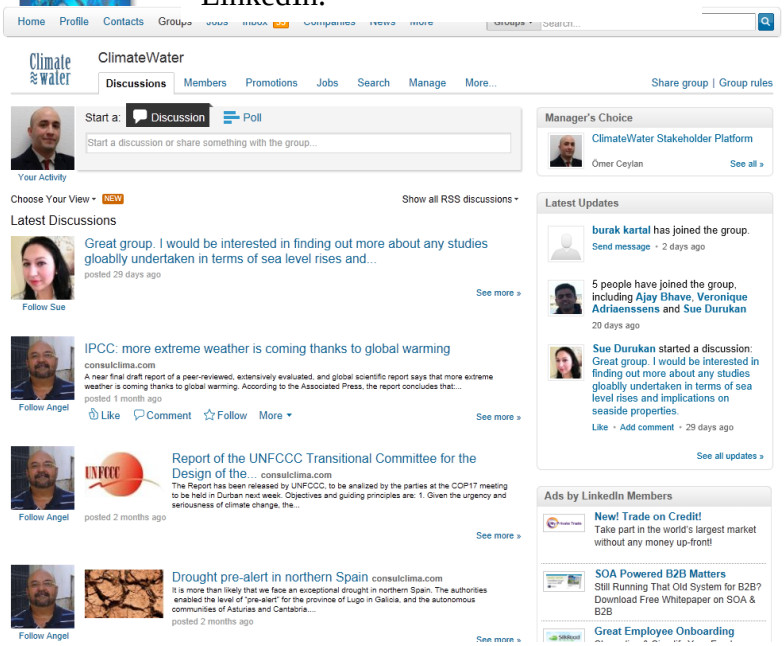
The link between climate change and water resources and the water cycle might not be so evident to all of us immediately. However, the impacts of climate change on the environment are not only the increase in the greenhouse gas emissions in the atmosphere and the change in temperatures. Due to climate change induced events, we are observing more and more frequently floods as well as water scarcity and droughts in the same year. At the sam time, several water-related sectors such as marine navigation, hydropower energy production and agricultur production are also negatively affected. Water resources and natural hydrological cycles are having quite a tough time in trying to cope with the impacts of climate change

The ClimateWater project, funded under the Seventh F (FP7) of the European Union, has addressed these issue years. Last week, ClimateWater had its final symposiu project partners from nine EU Member States (Austria, Hungary, Italy, Malta, Romania, Slovakia, United Kingdo final outputs in multiple workshops over two days. The final symposium will shortly be available on the project http://www.climatewater.org

To keep up with the discussions on this topic, do not fo online ClimateWater Stakeholder Platform! http://www.climatewater.org/register.php

Ömer

On the left, coverage of ClimateWater by the ClimateChangeWater Blog*, an independent blog on climate change and freshwater related matters. Below, ClimateWater Group[1] on the professional networking platform LinkedIn.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A near final draft report of a peer-reviewed, extensively evaluated, and global scientific report says that more extreme weather is coming thanks to global warming. According to the Associated Press, the report concludes that:...

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The Report has been released by UNFCCC, to be analized by the parties at the COP17 meeting to be held in Durban next week. Objectives and guiding principles are: 1. Given the urgency and seriousness of climate change, the...

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Manager's Choice

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[1] http://europamedia.wordpress.com/2011/02/21/climatewater/

* http://climatechangewater.org/

Throughout the project duration, **several events were attended** by the Coordinator Prof. Geza Jolankai as well as other consortium members, where ClimateWater was presented to the project's target groups (e.g. Below, Prof. Geza Jolankai's presentation at the European Commission's Research Connection 2009 Conference broadcasted at the Commission's Webcast Portal). ClimateWater also established cooperation with other projects with a view to exploiting synergies. For instance, ClimateWater Final Symposium was organised in conjunction with the training workshop of the PSI Connect project[2] – an FP7 project aiming to improve the quality and value of interactions between the science base and river basin managers and policy makers in the field of climate change impacts on river systems. Tables in Section 4.2 list all the events that the project partners have attended and presented/represented the ClimateWater project during its lifetime.

ClimateWater presentations at various events

ClimateWater Stakeholder Platform was developed and launched, and made accessible through the ClimateWater homepage. The Stakeholder Platform:

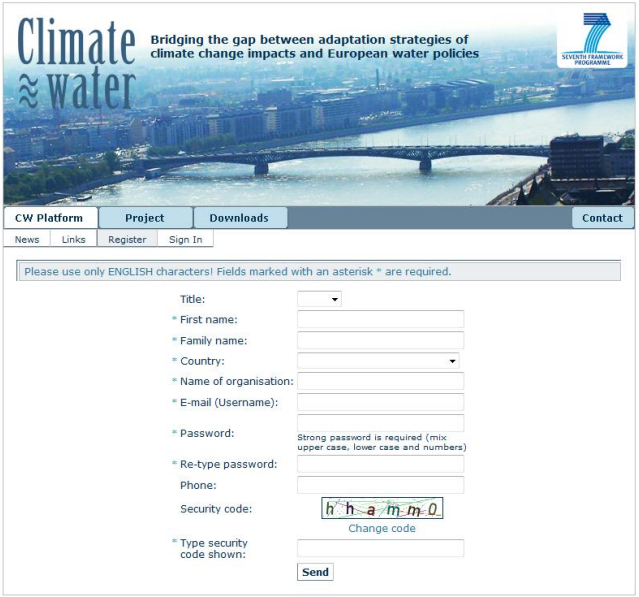
- Allows for discussions and expert interaction on adaptation strategies of climate change impacts and European water policies;
- Offers space for sharing and disseminating relevant events, documents, links, and other useful pieces of information and material; and

[2] http://www.psiconnect.eu/

- Serves as a forum, where the reviews and recommendations are accessible for policy-makers, researchers, NGOs and other stakeholders for comments.

The Platform has been developed and launched as embedded into the ClimateWater's homepage (i.e. under www.climatewater.org). All partners have been required to contribute to promoting the Platform to relevant stakeholders within their networks. A template promotional letter has thus been drafted and subsequently sent out to the target stakeholders informing them of the ClimateWater's activities, the launch of the Stakeholder Platform and the opportunities it offers.

ClimateWater Stakeholder Platform is open to all interested users, yet following a registration process to ensure security and to be able to moderate individual activities. Once a potential user submits a registration form, the Platform administrator receives a notification and approves the user to access the Platform.



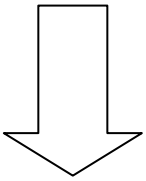
A user registered at the Platform can view content on the Platform as well as contribute to content by uploading relevant (i) News; (ii) Events; (iii) Documents; and (iv) Other type of material. The uploading process involves two steps: (1) Selecting the category of the material to be uploaded; and (2) Providing details on the material to be uploaded.

Figure on the next page shows the uploading process on the ClimateWater Platform.

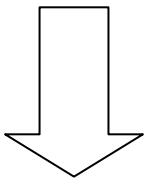
Information on the uploaded material is automatically received by the Platform administrator, who can decide to reject the inclusion of the material if of inappropriate/irrelevant content.

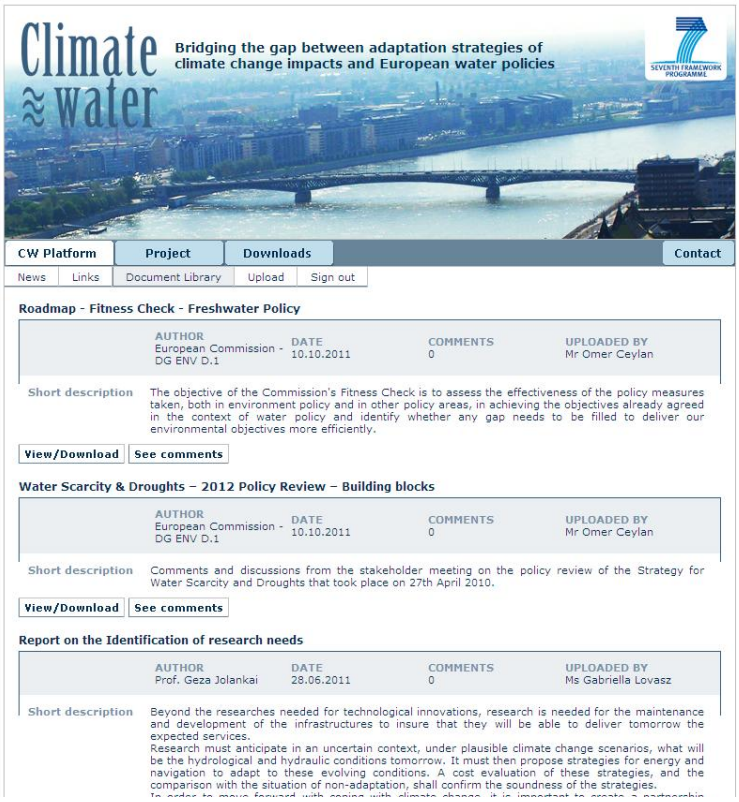
Around 100 users have to date registered at the ClimateWater Stakeholder platform. These users represent different types of organisations including universities, research institutes, industry including small and medium-sized enterprises (SMEs), public bodies including governmental agencies, and umbrella/stakeholder organisations. The organisations are also diverse in terms of geographical representation – not only EU Member States are represented, but the platform has also registered users from outside the EU, who has interest on climate change and water management issues.

Select the category of material to upload



Provide details on the material to upload and upload the actual material (e.g. document)





The uploaded material is published on the Platform.

4.2 Use and dissemination of foreground

Section A (public)

TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS, STARTING WITH THE MOST IMPORTANT ONES										
No.	**Title**	**Main author**	**Title of the periodical or the series**	**Number, date or frequency**	**Publisher**	**Place of publication**	**Year of publication**	**Relevant pages**	**Permanent identifiers (if available)**	**Is/Will open access provided to this publication?**
1	Nutrient budget modelling for lake and river basin restoration	Jolánkai, G., Bíró I	Ecohydrology: Processes, Models, Case Studies	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 18-30	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes
2	Linking Biological and Physical Processes at the River Basin Scale: the Origins, Scientific Background and Scope of Ecohydrology	M. Zalewski, D.M. Harper, B. Demars, G. Jolánkai, G. Crosa, G.A. Janauer and N. Pacini	Ecohydrology: Processes, Models, Case Studies (Book)	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 1-17	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes
3	Patterns and Processes in the Catchment	D. Gutknecht, G. Jolánkai and K. Skinner	Ecohydrology: Processes, Models, Case Studies (Book)	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 18-29	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes

4	Nutrient Processes and Consequences	N. Pacini, D.M. Harper, V. Ittekot, C. Humborg and L. Rahm	Ecohydrology: Processes, Models, Case Studies (Book)	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 30-44	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes
5	Lotic Vegetation Processes	G.A. Janauer and G. Jolánkai	Ecohydrology: Processes, Models, Case Studies (Book)	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 46-61	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes
6	Ecohydrological Analysis of Tropical River Basin Development Schemes in Africa	N. Pacini and D.M. Harper	Ecohydrology: Processes, Models, Case Studies (Book)	ISBN 978-1-84593-002-8	CABI, Wallingford, UK	Wallingford, UK	2008	pp. 223-246	http://www.ebook3000.com/Ecohydrology--Processes--Models-and-Case-Studies_40525.html	Yes
7	Szennyeződés terjedési folyamatok modellezése felszíni vizekben	Jolánkai, G.	Protection of Water Resources: Actual issues of water pollution control (In Hungarian: Vízkészletvédelem: A Vízminőség védelem aktuális kérdései)	ISBN 978-963-9988-00-2	Bíbor Kiadó	Miskolc, Hungary	2009	pp. 325-349	NA	No
8	Bridge over troubled waters	Jolánkai, G.	International Innovation - Environment	Issue 1	Research-Media Ltd.	Bristol, UK	2011	pp. 42-45	NA	Yes

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
No.	**Type of activities**	**Main leader**	**Title**	**Date**	**Place**	**Type of audience**	**Size of audience**	**Countries addressed**
1	Web	P6	ClimateWater Homepage	1 December 2008	NA	All	NA	Global
2	Conference	P1	Research Connection 2009 Conference	7-8 May 2009	Prague, Czech Republic	Scientific Community, Policy makers	~1200	All EU Member States and other third countries
3	Poster	P2	Technological science in the North-Alföld Region	20 May 2009	Mezőtúr, Hungary	Scientific Community, Policy Makers	NA	Hungary
4	Conference	P3	Round Table on manure management	27 May 2009	Naples, Italy	Scientific Community, Policy makers	~100	Italy
5	Conference	P1 (with P3, P4, and P9 also participating)	Implementation of the WFD in a context of adaptation to climate change	22-23 October 2009	Paris, France	Scientific Community, Policy makers	~ 200	All EU countries
6	Conference	P1	Info Day organised by "National Office for Research and Technology" of Hungary (NKTH) / On EU-funded water-environmental Projects	29 Nov 2009	Budapest, Hungary	Scientific Community, Policy makers	~ 80	Hungary and other EU countries
7	Conference	P1	Conference on Integrated River Basin	26-28 April 2010	Lille, France	Scientific Community,	~ 250	All EU countries

			Management under the Water Framework Directive			Policy makers		
8	Presentation	P9	Annual statement of SHMU activities 2009	12 May 2010	Bratislava, Slovak Republic	Scientific Community, Public	~ 100	Slovakia
9	Conference	P1	European Parliament meeting titled "Water and climate change: a panoramic view of the problem and the solutions"[3]	19 May 2010	Strasbourg, France	Policy Makers	NA	All EU
10	Conference	P8	Ecohydrology as a means of bridging the gap between adaptation strategies of climate change impacts and European water policies	9-11 September 2010	Zakopane, Poland	Scientific Community, Policy Makers	75	All EU
11	Conference	P4	Backcasting future visions on adaptation to floods and droughts	29 Sep- 1 Oct 2010	Rotterdam, the Netherlands	Scientific Community, Policy Makers	~ 50	International
12	Flyers	P6	ClimateWater Brochure	28 October 2010	NA	All	NA	Global
13	Conference	P1	Water related impacts of climate change and the adaptation strategies to cope with them: interim results of the project "ClimateWater": In: Proc. Int. Conf. "Building Services, Mechanical and	14-15 October 2010	Debrecen, Hungary	Scientific Community	NA	EU

[3] 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).

			Building Industry Days"					
14	Poster	P9	Conference Hydrologic Days	25-27 October 2010	Hradec Králové, Czech Republic	Scientific Community	~ 200	Slovak Republic, Czech Republic
15	Web	P6	ClimateWater Stakeholder Platform	1 December 2010	NA	All	NA	Global
16	Publication	P7	Gesucht: Konkrete Anpassungen an den Klimawandel / Concrete Measures for Adapting to Climate Change Needed.	December 2010	Vienna, Austria	Scientific Community, Policy Makers	~ 8000	EU
17	Workshop	P9	Reducing vulnerability to extreme floods and climate change in the Dniester basin	2-4 March 2011	Bratislava, Slovakia	Scientific Community	~ 20	Slovakia, Ukraine, Moldova
18	Conference	P10	Future of European Waters / "Insight of ClimateWater project activity: adaptation of navigation and hydropower to climate change"	23-25 March 2011	Budapest, Hungary	Scientific Community, Policy Makers	~ 60	All EU
19	Presentations	P1	Climate Change and WFD in the light of the results so far of the Project ClimateWater, Abstract and Conclusions of the slide show Presentation of the same title, Int. Conf. Future of European Waters	23-25 March 2011	Budapest, Hungary	Scientific Community, Policy makers	~ 60	EU
20	Presentation	P9	Annual statement of	30 May 2011	Bratislava,	Scientific	~ 100	Slovakia

			SHMU activities 2010		Slovak Republic	Community, Public		
21	Poster	P2	MedCLIVAR Final Conference Mediterranean Climate: From Past to Future	6-9 June 2011	Lecce, Italy	Scientific Community	NA	All EU
22	Conference	P8	SEFS 7 - European Freshwater Sciences / "Linking habitats to invertebrates for climate change adaptation in running waters: biological traits, taxonomic composition and diversity"	27 June - 1 July 2011	Girona, Spain	Scientific Community	~ 350	All EU
23	Workshop	P9	Neman pilot project on river basin management and climate change adaptation	3-4 August 2011	Bratislava, Slovakia	Scientific Community	~ 25	Slovakia, Russia, Belarus, Lithuania
24	Conference	P5	The 3rd Aquatic Biodiversity International Conference / "Aquatic biodiversity and climate change challenges"	4-7 October 2011	Sibiu, Romania	Scientific Community, Policy Makers	200	International
25	Conference	P5	"Anthropogenic Impact on the biodiversity in the Black Sea Area" / Marine biodiversity and climate change challenges	21-22 October 2011	Constanța, Romania	Scientific Community	200	International

Section B (Confidential or public: confidential information to be marked clearly)

Part B1

Not applicable.

Part B2

Type of Exploitable Foreground	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application	Timetable, commercial or any other use	Patents or other IPR exploitation (licences)	Owner & Other Beneficiary(s) involved
General advancement of knowledge	Recommendations for measures and strategies to bridge the gaps in water and climate change related policies	No	NA	Forecasts of climate change impacts New research fields identified Recommendations for water policy	Environment, Energy, Agriculture, Maritime, Health, Industry, etc. (nearly all sectors)	NA	NA	All beneficiaries

Exploitable Foreground in ClimateWater

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

- Purpose: In WP2, the aim was to identify the worsening of the water-impacts of the change of the climate in all fields with special regard to Floods, Drought, Ecosystem degradation and Water quality deterioration. It was also identified that the impacts are accelerating in comparison to earlier forecasts.
- How the foreground might be exploited, when and by whom: By taking notes of the findings of this work package (see www.climatewater.org). The potential users include: Climate change experts and scientists (those dealing with impact forecast); Water managers of all management levels (including those of water quality); Ecologists; Health Authorities, Agricultural authorities, etc.
- IPR exploitable measures taken or intended: NA
- Further research needs: Further research needs are mentioned here in many respects, especially in the field of making better and more detailed impact forecasts of water related climate change impacts, mentioning that a separate chapter is dealing with research needs (WP4).
- Potential/expected impact: The WP2 leader P3 and the Co-ordinator expect that there could be a considerable impact on all those scientists and researchers who deal with climate change impacts. Even policy and decision makers may be very interested. A quantitative impact may be the estimation of financial input (at all-European scale) that would be needed to improve impact forecasting, with special regard to the now (end of 2011) accelerating impacts.

Work Package 3: Analysis and synthesis of methodologies of adaptation measures

- Purpose: In WP 3, we aimed at identifying **adaptation strategies** developed in Europe and also globally for handling (preventing, eliminating, combating, mitigating) the impacts of global climate changes on water resources and aquatic ecosystems. All structural and non-structural strategies were reviewed. Six major sub-WPs have dealt with them.
- How the foreground might be exploited, when and by whom: The major exploitable foreground is that apart from supporting all non structural, no-regret, capacity building (learning), social, insurance technological etc strategies and measures **the main emphasis is to be laid on finding the concrete damage prevention strategies**, those of for saving water quantity, water quality in an ecologically sustainable manner. A special advice was to store water whenever possible (in Middle and South Europe). With special regard to making plans for it (e.g. in an appropriately changed RBMP). Exploitation may be by taking notes of the findings of this work package (see homepage -- www.climatewater.org -- that will be maintained for a sufficiently long period of time). The potential users include: Climate change experts and scientists (those dealing with adaptation strategies and measures); especially interested may be **water managers of all management levels** of all nations of the EU (including those of water quality) and of sectors of all water users; Health and Agricultural authorities may also be special users of the foreground.
- IPR exploitable measures taken or intended: NA
- Further research needs: This WP is especially intended to support the adjoining two WPs (W4 on research needs and WP5, on bridging water related policy gaps). Main research needs are those of the scientific fields discussed (each of the partners found it necessary in their fields); Those to find the best suitable strategies and measures of adaptation and those to identify the policy gaps in the 12 major policy groups we were dealing with.
- Potential/expected impact: This WP is expected to provide a well-defined framework on the adaptation strategies to handle climate change impacts on water. It provided a list of needed

adaptation measures (preparedness, damage prevention and mitigation, defence, control and combat, etc.) and strategies to be applied.

Work Package 4: Identification of Research Needs

- Purpose: In WP4, the objective was to identify the research gaps in the topics discussed in WP2 and WP3, which also means that the missing links between research results in the field of climate change and of water management should be identified. The main purpose is to aid the development of adaptation measures and strategies that can fill the gap in water related EU policies. NB: Nearly all policies of all sectors are some way related to water resources and their uses.
- How the foreground might be exploited, when and by whom: Major foregrounds are that research needs to be carried out relate to improving forecasting of water related damages, improving the monitoring needed for the concrete planning of counter measures and strategies for helping the development of a renewed RBMP. Exploitation may be by taking notes of the findings of this work package (see www.climatewater.org). The potential users include: Climate change experts and scientists (those dealing with research into adaptation strategies and measures); Especially interested may be **water managers of all management levels** of all nations of the EU (including those of water quality) and of sectors of all water users; Agricultural and health authorities may also be special users of the foreground, along with those of energy management and navigation, and all sectors dealing with water.
- IPR exploitable measures taken or intended: NA
- Further research needs: Further research is needed in all water related scientific fields. Research activities mentioned above are urgently needed in all water related fields. A special requirement is to find the financial sources to support the required research with special regard to field measurements that were abandoned in many EU countries.
- Potential/expected impact: The expected impact may be large if scientists and stakeholders (especially decision makers of all policy levels and sectors along with financing agencies) take the Magnitude of Impacts and the Urgency of Action (expressed also by the results of our research into the development of IMAU index) as a serious warning. Quantification is not possible but the impact may change entirely the approach to handle water related climate changes.

Work Package 5: Identifying and bridging gaps in water related European policies

- Purpose: In WP 5, the objective was to describe the strategies and measures aimed at bridging the gaps defined in the topics of work packages WP2, WP3 and WP4. The main purpose is to aid the development of adaptation measures and strategies that can fill the gap in water related EU policies. Remark: Nearly all policies of all sectors are some way related to water resources and their uses.
- How the foreground might be exploited, when and by whom: Major foregrounds are detailed description of the strategies of measures, which are needed for inclusion in water related European policies to save our water resources from the impacts of the changing climate. Exploitation may be by taking notes of the findings of this work package (see www.climatewater.org). The potential users include: Policy and decision makers, plus climate change experts and scientists (those who can help the policy makers to understand the strategies and measures, they need to include); **All policy and decision makers related to the Water Framework Directive** should be the main users of the foreground including the **related financing agencies**. Especially interested may be **water managers of all management levels** of all nations of the EU including those of **floods, drought and water quality**;

Authorities dealing **with nature conservation and ecosystem protection** should also be major users of the foreground**. Agricultural** and **health authorities** may also be special users of the foreground. All other authorities of water uses such as **Hydropower** generation and the Energy sector as a whole including the **Atomic Energy production** (using much water for cooling) must be interested in using the results, the foreground.. Authorities dealing **with navigation** can also can use the foregrounds. **Bathing water operators** and health authorities responsible for bathing waters can also exploit the results.

- IPR exploitable measures taken or intended: NA.
- Further research needs: Further research is needed in all water related scientific fields. Research activities mentioned above are urgently needed in all water related fields and many also for identifying new strategies and measures. A special requirement is **to find the financial sources to support the required research** with special regard to improve monitoring and field measurements that were much reduced in many EU countries.
- Potential/expected impact: The expectable impact may be large if stakeholders, especially decision makers of all policy levels and sectors along with financing agencies take the **Magnitude of Impacts and the Urgency of Action** (expressed also by the results of our research into the development of IMAU index) as a serious warning. Two different approaches to this index can be seen on the web page referred to above. Quantification is not possible but **the impact may change entirely the approach to handle water related climate changes in all water related policies.**

4.3 Report on societal implications

A General Information *(completed automatically when **Grant Agreement number** is entered.*	
Grant Agreement Number:	211894
Title of Project:	Bridging the Gap between Adaptation Strategies of Climate Change Impacts and European Water Policies (ClimateWater)
Name and Title of Coordinator:	Prof. Dr. Géza Jolánkai

B Ethics	
1. Did your project undergo an Ethics Review (and/or Screening)? • If Yes: have you described the progress of compliance with the relevant Ethics Review/Screening Requirements in the frame of the periodic/final project reports? Special Reminder: the progress of compliance with the Ethics Review/Screening Requirements should be described in the Period/Final Project Reports under the Section 3.2.2 *'Work Progress and Achievements'*	***No***
2. Please indicate whether your project involved any of the following issues (tick box) :	
RESEARCH ON HUMANS	
• Did the project involve children?	
• Did the project involve patients?	
• Did the project involve persons not able to give consent?	
• Did the project involve adult healthy volunteers?	
• Did the project involve Human genetic material?	
• Did the project involve Human biological samples?	
• Did the project involve Human data collection?	
RESEARCH ON HUMAN EMBRYO/FOETUS	
• Did the project involve Human Embryos?	
• Did the project involve Human Foetal Tissue / Cells?	
• Did the project involve Human Embryonic Stem Cells (hESCs)?	
• Did the project on human Embryonic Stem Cells involve cells in culture?	
• Did the project on human Embryonic Stem Cells involve the derivation of cells from Embryos?	
PRIVACY	
• Did the project involve processing of genetic information or personal data (eg. health, sexual lifestyle, ethnicity, political opinion, religious or philosophical conviction)?	
• Did the project involve tracking the location or observation of people?	
RESEARCH ON ANIMALS	
• Did the project involve research on animals?	
• Were those animals transgenic small laboratory animals?	
• Were those animals transgenic farm animals?	
• Were those animals cloned farm animals?	
• Were those animals non-human primates?	
RESEARCH INVOLVING DEVELOPING COUNTRIES	
• Did the project involve the use of local resources (genetic, animal, plant etc)?	
• Was the project of benefit to local community (capacity building, access to healthcare, education etc)?	

DUAL USE	
• Research having direct military use	
• Research having the potential for terrorist abuse	

C Workforce Statistics

3. Workforce statistics for the project: Please indicate in the table below the number of people who worked on the project (on a headcount basis).

Type of Position	Number of Women	Number of Men
Scientific Coordinator		1
Work package leaders	3	3
Experienced researchers (i.e. PhD holders)	11	14
PhD Students	6	3
Other	15	10

4. How many additional researchers (in companies and universities) were recruited specifically for this project?	**5**
Of which, indicate the number of men:	3

D Gender Aspects

5. Did you carry out specific Gender Equality Actions under the project?

○ Yes
X No

6. Which of the following actions did you carry out and how effective were they?

	Not at all effective				Very effective
❑ Design and implement an equal opportunity policy	○	○	○	○	○
❑ Set targets to achieve a gender balance in the workforce	○	○	○	○	○
❑ Organise conferences and workshops on gender	○	○	○	○	○
❑ Actions to improve work-life balance	○	○	○	○	○

○ Other:

7. Was there a gender dimension associated with the research content – i.e. wherever people were the focus of the research as, for example, consumers, users, patients or in trials, was the issue of gender considered and addressed?

○ Yes- please specify

X No

E Synergies with Science Education

8. Did your project involve working with students and/or school pupils (e.g. open days, participation in science festivals and events, prizes/competitions or joint projects)?

○ Yes- please specify

X No

9. Did the project generate any science education material (e.g. kits, websites, explanatory booklets, DVDs)?

○ Yes- please specify

X No

F Interdisciplinarity

10. Which disciplines (see list below) are involved in your project?

○ Main discipline: 1.4
○ Associated discipline: ○ Associated discipline:

G Engaging with Civil society and policy makers

11a Did your project engage with societal actors beyond the research community? *(if 'No', go to Question 14)*

X Yes
○ No

11b If yes, did you engage with citizens (citizens' panels / juries) or organised civil society (NGOs, patients' groups etc.)?

○ No
○ Yes- in determining what research should be performed

X Yes - in implementing the research
X Yes, in communicating /disseminating / using the results of the project

11c In doing so, did your project involve actors whose role is mainly to organise the dialogue with citizens and organised civil society (e.g. professional mediator; communication company, science museums)?	○ X	Yes No

12. Did you engage with government / public bodies or policy makers (including international organisations)

- ○ No
- ○ Yes- in framing the research agenda
- ○ Yes - in implementing the research agenda
- X Yes, in communicating /disseminating / using the results of the project

13a Will the project generate outputs (expertise or scientific advice) which could be used by policy makers?

- X Yes – as a **primary** objective (please indicate areas below- multiple answers possible)
- ○ Yes – as a **secondary** objective (please indicate areas below - multiple answer possible)
- ○ No

13b If Yes, in which fields?

Agriculture X		Energy X		Human rights	
Audiovisual and Media		Enlargement		Information Society	
Budget		Enterprise		Institutional affairs	
Competition		Environment X		Internal Market	
Consumers		External Relations		Justice, freedom and security	
Culture		External Trade		Public Health	
Customs		Fisheries and Maritime Affairs X		Regional Policy X	
Development Economic and Monetary Affairs		Food Safety		Research and Innovation X	
		Foreign and Security Policy		Space	
Education, Training, Youth		Fraud		Taxation	
Employment and Social Affairs		Humanitarian aid		Transport X	

13c If Yes, at which level?

- X Local / regional levels
- X National level
- X European level
- X International level

H Use and dissemination

14. How many Articles were published/accepted for publication in peer-reviewed journals?	**8**
To how many of these is open access provided?	**6**
How many of these are published in open access journals?	**6**
How many of these are published in open repositories?	
To how many of these is open access not provided?	**2**
Please check all applicable reasons for not providing open access:	
X publisher's licensing agreement would not permit publishing in a repository ❑ no suitable repository available ❑ no suitable open access journal available ❑ no funds available to publish in an open access journal ❑ lack of time and resources ❑ lack of information on open access ❑ other: ……	

15. How many new patent applications ('priority filings') have been made? *("Technologically unique": multiple applications for the same invention in different jurisdictions should be counted as just one application of grant).*		**None**
16. Indicate how many of the following Intellectual Property Rights were applied for (give number in each box).	Trademark	**-**
	Registered design	**-**
	Other	**-**
17. How many spin-off companies were created / are planned as a direct result of the project?		**None**
Indicate the approximate number of additional jobs in these companies:		**-**

18. Please indicate whether your project has a potential impact on employment, in comparison with the situation before your project:

❑	Increase in employment, or	❑	In small & medium-sized enterprises
❑	Safeguard employment, or	❑	In large companies
❑	Decrease in employment,	X	None of the above / not relevant to the project
❑	Difficult to estimate / not possible to quantify		

19. For your project partnership please estimate the employment effect resulting directly from your participation in Full Time Equivalent (*FTE = one person working fulltime for a year*) jobs:	*Indicate figure:*
Difficult to estimate / not possible to quantify	X

I Media and Communication to the general public

20. As part of the project, were any of the beneficiaries professionals in communication or media relations?

○ Yes X No

21. As part of the project, have any beneficiaries received professional media / communication training / advice to improve communication with the general public?

○ Yes X No

22 Which of the following have been used to communicate information about your project to the general public, or have resulted from your project?

❑	Press Release	☒	Coverage in specialist press
☒	Media briefing	❑	Coverage in general (non-specialist) press
❑	TV coverage / report	❑	Coverage in national press
❑	Radio coverage / report	❑	Coverage in international press
☒	Brochures /posters / flyers	☒	Website for the general public / internet
❑	DVD /Film /Multimedia	❑	Event targeting general public (festival, conference, exhibition, science café)

23 In which languages are the information products for the general public produced?

❑	Language of the coordinator	☒	English
❑	Other language(s)		

***Question F-10*:** Classification of Scientific Disciplines according to the Frascati Manual 2002 (Proposed Standard Practice for Surveys on Research and Experimental Development, OECD 2002):

FIELDS OF SCIENCE AND TECHNOLOGY

1. NATURAL SCIENCES

1.1 Mathematics and computer sciences [mathematics and other allied fields: computer sciences and other allied subjects (software development only; hardware development should be classified in the engineering fields)]

1.2 Physical sciences (astronomy and space sciences, physics and other allied subjects)

1.3 Chemical sciences (chemistry, other allied subjects)

1.4 Earth and related environmental sciences (geology, geophysics, mineralogy, physical geography and other geosciences, meteorology and other atmospheric sciences including climatic research, oceanography, vulcanology, palaeoecology, other allied sciences)

1.5 Biological sciences (biology, botany, bacteriology, microbiology, zoology, entomology, genetics, biochemistry, biophysics, other allied sciences, excluding clinical and veterinary sciences)

2 ENGINEERING AND TECHNOLOGY

2.1 Civil engineering (architecture engineering, building science and engineering, construction engineering, municipal and structural engineering and other allied subjects)

2.2 Electrical engineering, electronics [electrical engineering, electronics, communication engineering and systems, computer engineering (hardware only) and other allied subjects]

2.3. Other engineering sciences (such as chemical, aeronautical and space, mechanical, metallurgical and materials engineering, and their specialised subdivisions; forest products; applied sciences such as geodesy, industrial chemistry, etc.; the science and technology of food production; specialised technologies of interdisciplinary fields, e.g. systems analysis, metallurgy, mining, textile technology and other applied subjects)

3. MEDICAL SCIENCES

3.1 Basic medicine (anatomy, cytology, physiology, genetics, pharmacy, pharmacology, toxicology, immunology and immunohaematology, clinical chemistry, clinical microbiology, pathology)

3.2 Clinical medicine (anaesthesiology, paediatrics, obstetrics and gynaecology, internal medicine, surgery, dentistry, neurology, psychiatry, radiology, therapeutics, otorhinolaryngology, ophthalmology)

3.3 Health sciences (public health services, social medicine, hygiene, nursing, epidemiology)

4. AGRICULTURAL SCIENCES

4.1 Agriculture, forestry, fisheries and allied sciences (agronomy, animal husbandry, fisheries, forestry, horticulture, other allied subjects)

4.2 Veterinary medicine

5. SOCIAL SCIENCES

5.1 Psychology

5.2 Economics

5.3 Educational sciences (education and training and other allied subjects)

5.4 Other social sciences [anthropology (social and cultural) and ethnology, demography, geography (human, economic and social), town and country planning, management, law, linguistics, political sciences, sociology, organisation and methods, miscellaneous social sciences and interdisciplinary , methodological and historical S1T activities relating to subjects in this group. Physical anthropology, physical geography and psychophysiology should normally be classified with the natural sciences].

6. HUMANITIES

6.1 History (history, prehistory and history, together with auxiliary historical disciplines such as archaeology, numismatics, palaeography, genealogy, etc.)

6.2 Languages and literature (ancient and modern)

6.3 Other humanities [philosophy (including the history of science and technology) arts, history of art, art criticism, painting, sculpture, musicology, dramatic art excluding artistic "research" of any kind, religion, theology, other fields and subjects pertaining to the humanities, methodological, historical and other S1T activities relating to the subjects in this group]