FUTURE OF EUROPEAN WATERS

How should policies be adapted
International conference
Budapest, 23-25 March 2011

The international conference on the "Future of European Waters" was convened by the Hungarian Academy of Sciences and was held in Budapest on 24-25 March, 2011, in order to highlight critical tendencies in water issues, to overview and assess the existing programmes and to reinforce the need for an improved policy-science cooperation with a view of further development and effective implementation of proper science-based response policies and measures, respectively. It was also taken into account that the water issue was put on the political agenda of the Hungarian Presidency of the Council of the European Union during the first half of 2011. The conference was also considered as an important step in the consultation process towards the 6th World Water Forum to be held in 2012 in France as well as a contribution towards the 2012 "Blueprint to Safeguard Europe's Waters" to be produced by the European Commission. The Budapest conference offered an opportunity for the exchange of views between the representatives of the scientific and the policymaking communities.

During the plenary and the thematic sessions many critical problems were addressed and discussed in depth. Based on the keynote presentations and the lively discussion during this event, the following key conclusions and policy recommendations have been formulated by the conference participants.

Key messages and policy recommendations

1. Freshwater resources: increasing pressures and the general policy challenge

Key issues and policy recommendations (1)

1. Water is a key to development. The global water dilemma is characterized by the co-existence of many serious problems, which are associated by unfavourable global trends in terms of population growth, water uses, climate change and economic globalisation. The water crisis is threatening all of our societies, primarily those of the developing world. It should be recognized that, when it comes to water, a move towards a sustainable future requires much more concentrated efforts by all regions, countries and stakeholders than in the past.
2. New approaches are needed that should be based on regional and local conditions, institutional considerations, existing and required capacities, ownership as well as financing possibilities and needs. Implementation, assessment and enforcement of the existing and any new programmes require much more attention than in the past.
3. In the course of past decades, the developed world has demonstrated that continuous improvements of water policy and legal instruments work in practice. Specifically, one of these achievements is the EU Water Framework Directive, with its application in more than thirty countries. The related other policy and legal measures, investments and technology developments serve as an example of good practice. However, the very same countries also face many challenges. The application of water policies should be achieved in river basin-wide solutions and by taking into account global aspects of water issues.
4. It is expected that the deplorable water situation in much of the world could be improved only if national and international institutions, including the EU and the UN, further increase their efforts in water-related capacity building especially for the benefit of the

developing world. Europe has the knowledge and technology to lead that change, inter alia by assisting developing countries to short-cut historical trends of water pollution (by providing them with access to modern “ecologically-sound” technology and know-how).

Freshwater resources of our globe are practically steady. They are the same today as during the Holocene climate optimum. However, due to population growth the per capita renewable water availability has decreased from about 26 000 m³/cap/year in 1900 to 6000 m³/cap/year in 2010. If present trends prevail this figure may further diminish to 4700 m³/cap/year by 2035. In the same period water withdrawal increased at a double to triple rate of the population growth. Of the 6000 m³/cap/year about one third is estimated as an easily accessible renewable resource while the demand is approximately 1000 m³/cap/year. This implies that the potentially high global water use/supply ratio already indicates that there are many regions where physical scarcity is a serious issue due to regional variability. Estimates suggest that by 2035 approximately 30-40 % of the population will live under water scarcity. Impacts of climate variability and change will further contribute to redistributing supplies and demands alike. Water scarcity often occurs due to economic reasons, however; roughly 20 % and 40 % of the population lacks safe drinking water supply and safe sanitation, respectively, because of that. A number of further serious issues should elevate water high on the political agenda. These include urbanization and its consequences, pollution of all sorts (traditional and modern ones alike), floods, droughts, disappearing waters due to overexploitation (such as the Aral Sea, the Colorado and the Yellow rivers, ground waters in all the continents), conflicts in transboundary river basins and aquifers shared by several countries (nearly half of the world's population live in such regions) just to mention the most powerful drivers. Therefore, we must recognize that the impacts of globalisation and climate change, that are often unexpected and surprising, will have dramatic changes on water availability and use. Amongst the other global drivers virtual water transfer (via the international trade of agricultural and other products) and potential consequences of global air traffic, in contributing to the fast transfer of epidemics from one continent to the other, should also be mentioned.

The above processes demonstrate the fact that the human pressures on freshwater resources are rapidly increasing. The water footprint concept is a useful instrument to express and quantify these tendencies. The water footprint can help businesses and other water users to understand at what critical points of water use to operate better within the context of the water environment. It can provide basic information for the private sector to make water-conscious operational decisions concerning a number of issues to start reducing business risk and improve environmental sustainability. This concept could be effectively used to estimate the water footprint of the EU member states and to initiate the preparation of a common strategy to reduce it. However, in order to achieve and ensure a real benefit for the environmental sustainability of Europe's river basins, sustainable water management response strategies on a river basin scale are needed that are implementable with a joint effort of all water users. In order to reach this, the European Water Stewardship scheme provides the methodology to water users in all sectors, to define and implement such response strategies.

The fundamental question of water management today is whether to what extent the needs of nature and humans can be met now and in the future. There is no clear answer to this question and the policy challenge is huge. Although advanced technologies are available and are used to save water and to reduce pollution significantly, as demonstrated by many successful applications, water demand and withdrawal are still growing, and new pollutants emerge. Many of the problems listed above appear also in the developing world where different approaches may be appropriate. Such approaches should be based on the appropriate consideration of local socio-cultural conditions, capacities, ownership, financing possibilities

and matters of governance rather than trying to blindly transfer solutions of the industrialized world.

As indicated elsewhere in this document, there are many international efforts to address these problems. However, action plans are much fewer than desired and their implementation suffers from many shortcomings. This applies among others to the MDG/Water objective (to reduce by 50 % by 2015 the ratio of those who are not served by safe drinking water supply and sanitation, in comparison to 1990) or the water related objectives included in the consensus document adopted at the World Summit on Sustainable Development (1992). On the basis of our knowledge of today, given the level of political and financial commitments both in the developing world and outside, neither of these objectives will be met by the date agreed upon by governments. While public water supply will not be too far from the target, the same is not true for sanitation: for instance the present trend in Africa suggests that the goals will be met far beyond 2060. Thus an action oriented revision of the original plan is needed to avoid a catastrophic delay. The UN Conference on Sustainable Development (Rio+20) in 2012 will provide an opportunity to address this issue.

We believe that the above deplorable situation could be improved only if national and international institutions, including the EU and the UN, further increase their efforts in water-related capacity building for the benefit of the developing world. Europe has the knowledge and technology to lead that change. Appropriately designed and implemented, cooperative capacity development programmes in water science, technology transfer and above all promoting appropriate water education are key elements in achieving the required change.

2. Floods and extreme water-related events management and mitigation

Key issues and policy recommendations (2)

1. Floods and droughts are primarily natural events, which occasionally are also reinforced by certain human activities. Water managers and users must adopt policies and practices to avoid exacerbating their adverse impacts.
2. Global changes will lead to increased flood and drought damages that need to be managed by appropriate institutional measures, including integrated flood risk management based on an adaptive approach using, *inter alia*, the potential of new ICTs.
3. Economic losses from major floods have been rising considerably over recent decades and are expected to further increase in the future due to, among others, the increasing number and value of assets to be protected.
4. Effective research programmes need to be launched to develop new statistical tools for handling non-stationary hydrological time series for long-term planning and design purposes.
5. Flood hazard and risk maps have to be prepared throughout the EU in line with the Floods Directive; these should provide the basis for the development of flood management strategies.
6. Flood management strategies have to be shifted from a reactive approach towards the management of risks and have to place more emphasis on non-structural measures, such as effective real-time hydrological forecasting systems, flood zoning and insurance. These strategies should also pay more attention to ecosystem based solutions.
7. Flood management based on the Floods Directive and River Basin Management Planning under the Water Framework Directive should be a key part of integrated water resources management. Further efforts on water scarcity and drought should also play an important role.

8. Flood risk management within the context of integrated water management should be based on a participatory approach involving users, planners, policy-makers and the scientific communities.
9. Drought management is not adequately addressed in the present EU's water legislation and the consideration of this issue will be one key component of the ongoing review initiated by the European Commission.
10. In a number of countries different extreme events occurred sequentially within one year in the same region. Such events include floods and droughts, and the inundation of deep and flat areas (depressions) with no outflows. In such areas integrated solutions should be established by retaining water of excess water periods for periods of droughts and scarcity. In a broader sense, the handling of extremes should be harmonized with land uses, agriculture and nature conservation. More generally, the promotion of multi-purpose natural water retention measures (reforestation, floodplain restoration, soil management, sustainable urban drainage systems etc.) can provide cost-efficient responses to extreme events while offering additional benefits in relation to other environmental, climate and socio-economic objectives.
11. Handling of industrial accidents and extraordinary water pollution requires increased environmental awareness and security, improved permit procedures and early warning systems, emergency plans and strengthened bi-lateral and international water governance, respectively.
12. Relevant research and education programmes on national and international levels need to be mobilized and supported in order to mitigate the impacts of extreme water events. In a broader sense preparedness, including education, public awareness raising, research and capacity development, should be recognized as the key element in realizing successful management practices to deal with extreme situations.

Flooding is one of the greatest water-related environmental disasters. Annually, it affects about 500 million people and their livelihoods worldwide. The annual cost to the world economy, of flooding and other water-related disasters, is about 30 billion Euros. With the changing frequency and variability of extreme floods, due to urbanization coupled with population growth in flood-prone areas, deforestation, potential climate change and rise in sea levels, the number of people vulnerable to devastating floods worldwide is expected to rise. Disaster risk reduction actions, in a non-stationary world, will therefore increasingly be required to build up the necessary capacity to cope with floods.

Europe is not different from the rest of the world: floods result in huge economic losses, can lead to loss of life and have adverse effects on human health and the environment. Economic losses due to major floods, including devastating flash floods in certain areas, have been rising considerably over recent decades, in which the societal (urbanization), economic (increasing asset values in floodplains) and environmental (land use change) factors clearly play an important role.

There is a good reason to be concerned about increasing losses in the future as a consequence of societal and economic developments in floodplains, even if the climate did not change. Climate variability and change could, however, increase flood hazards due to increasing frequency and intensity of floods in large parts in Europe. However, estimates of the degree of changes remain highly uncertain. Without adaptation, the potential flood losses may considerably increase with a strong spatial variability across regions of Europe. The areas being subject to floods should be identified, as required by the Floods Directive for different risk scenarios, including the potential impacts of climate change. Flood hazard and risk maps

of flood-prone areas must serve as a starting point for the evaluation of flood management strategies in the future.

Flood management strategies in the future have to be shifted from the present, predominantly piecemeal, defensive and reactive approach towards the management of risk, enhancing the ability of societies to live with floods. The attention should be focused on prevention (avoiding or limiting the development in flood prone-areas by appropriate spatial planning), protection (measures to reduce the likelihood of floods) and preparedness (providing instructions to the public in the event of flooding, such as early warning). The Floods Directive places more emphasis on non-structural measures, such as using natural floodplains as retention areas for water during floods. It should be recognized that such an approach offers a cost-effective and sustainable solution to flooding, even in the face of climate change. Nevertheless, in some cases the traditional (dikes, reservoirs) and newly developed (emergency flood reservoirs) structural measures will have no alternatives. Flood management should involve an appropriate combination of structural and non-structural measures.

Flood management strategies require an integrated approach. While the adaptation needs appear mainly at local levels, appropriate measures should be taken mainly on the catchment level. In many watersheds of Europe flood control is a transboundary issue. Flood management requires comprehensive integrated approaches amongst the various sectors of water management. It especially should be integrated with drought management through the effective use of flood waters and/or by maximising the positive aspects of floods. Flood management must place more emphasis on sustainable land use practices. The Floods Directive makes flood management a key part of River Basin Management Planning under the Water Framework Directive. Flood management should also be integrated into spatial planning and into a wider risk management system of ‘all hazards’; emergency planning and management in all relevant national or local plans.

Flood risk management within the context of integrated water resources management should be based on a participatory approach involving users, planners and policy-makers and scientific communities at all levels and should be open, transparent, inclusive and with effective communication strategies. These efforts should be supported with appropriate legislation, regulation and economic instruments as well as institutional arrangements.

Water scarcity and droughts also represent a major challenge in Europe: more than 15 % of the territory of the continent is being affected. The cost implications are huge. Drought is seriously handicapping more than half of Europe, even in areas, which are prone to flooding and flush-runoff pollution.

Drought management is not adequately addressed in the present EU's water legislation and the consideration of this issue will be one key component of the ongoing review initiated by the European Commission. The related prevention and mitigation policies are under preparation and together with the WFD should serve as a basis for development of integrated strategies covering all extremes. Such a policy should also tackle problems caused by excess waters in depressions with no outflows, that is a serious issue in a number of countries having deep flatland regions.

3. Climate change and the water cycle

Key issues and policy recommendations (3)

1. According to the IPCC assessments, climate change will have a significant influence on the global water cycle and it will impact Europe's waters in many different ways, including changing rainfall patterns, modified runoff generation mechanisms, and changing water use practices, respectively. This would make current problems even worse in the future. Improved use of scenario analyses is expected to contribute to identifying the most robust choices for both future urban and rural water management.
2. The occurrence of extreme hydrological events are expected to increase with climate change, therefore, water management policies and other sectoral policies (social, economic, spatial development, transport, agriculture etc.) need to take these into account in the planning and design procedures.
3. To assess fully the possible impacts of climate change interdisciplinary approaches and integrated modelling tools, including ecological and economical aspects, are required.
4. While there is still considerable uncertainty regarding climate change and its expected impacts, the precautionary principle should apply in developing low cost, win-win measures in order to lessen vulnerability of the society and to enhance its adaptive capacities.
5. The most serious problem is that the major planning tools for dealing with climate change are weak and not fully applicable. Therefore, the planning methodology and tools should be re-assessed in view of the expected impacts of climate change. This would need more thorough measurement and monitoring programmes, as well as, more effective provisions within an international framework. Obviously, these efforts will require more significant financial inputs for the continuing updating, calibration and verification work.
6. Preparation for adaptation to the potential impacts of climate change should be integrated into water management decisions and should be undertaken in the context of integrated land use and spatial planning.
7. Care must be taken that climate change mitigation policies and measures (e.g. increased utilisation of hydropower, inland navigation and bioenergy) do not adversely affect important water bodies and water-dependent ecosystems.

Climate change will likely result in increasingly extreme meteorological and hydro-meteorological events in several parts of the world. The incidence and severity of flooding and droughts may increase and enhance the vulnerability of nature, society and economy differently across regions. Some areas of Europe, especially in Southern and South-Eastern Europe, will probably suffer from increasing long-term water scarcity. Climate change will likely affect existing water infrastructure, such as urban water systems, hydropower, irrigation and flood defence systems. These indications are not new and the EU and its Member States have already some precautionary policies in this regard. However, it is important to refine and enhance such policies and to ensure that other policy areas are prepared to these changing environmental conditions and do not exacerbate their effects.

There are still considerable uncertainties with regard to the evolution of climate change and how it will impact on Europe's waters. It is, therefore, important that modelling the relevant processes continues to be refined, including more detailed assessments of potential impacts on different economic sectors and more robust outputs for different catchments. Lessening the adverse impacts and adapting to these changes may include a number of options. The use of scenario development and analysis is an important tool to help identify measures, which are

robust and advantageous by any conditions and, where possible, offer no-regrets solutions and win-win outcomes.

Concerning the present policy instruments in the EU (primarily the River Basin Management Planning), the most serious problem is that the major planning tools available for dealing with climate-change are weak (i.e. not sufficiently advanced) and not fully applicable.

Water management decision-making together with its implementation is a process that is not rapid and is part of a larger historical evolution. Catchment planning requires significant analysis and the measures adopted (e.g. flood defence) may take years, if not decades, to come to fruition. Identification and prioritisation of adaptation options need a comprehensive evaluation, including considerations linked to effectiveness and economic efficiency, constrains and unfavourable side-effects. It is, therefore, important for likely climate change impacts to be included in water management planning today at all levels (European, national, regional and local) of planning. Integration of adaptation into water management policy and into institutions at European and national levels is key to long-term reduction in potential vulnerability to climate change impacts. Not only will this give the necessary lead-time for measures to be implemented, it will also avoid the adoption of measures that are unnecessary or inadequate to meet the challenges of changing climate. For such an integration it is also essential that policy involves the public sector and provides relevant training and guidance tools e.g. through the European Water Stewardship scheme.

Taking decisions today to address future possible climate events should be undertaken in the context of integrated land use planning. Building in flood prone areas and major new users of water may become more controversial in the future, therefore, appropriate measures taken today should help to avoid future problems and conflicts. Adaptation measures also offer the scope of win-win outcomes with other environmental and social objectives, such as protection of biodiversity.

Europe has committed itself to reducing greenhouse gas emissions through a variety of mitigation approaches. Some of these measures do, however, have the potential to have negative impacts on water. These include hydropower, that may substantially change river flows and ecosystems as well as bioenergy that may result in increasing pollution and/or irrigation water use. Mitigation strategies need to go in tandem with adaptation strategies. Given the inertia of the climate system, it is likely that adaptation strategies will yield gains already in the short-term. Assuming an increasing uncertainty of flows appropriate buffer capacities will likely be needed to maintain safe yield and to mitigate the impacts of extremely high flows. Therefore, more reservoir space will likely be needed in the future. That will likely imply an increased utilization of hydropower as well. As these developments are normally in the order of several years, if not decades, methods and legislation need to be further improved to mitigate the environmental impacts of such schemes. As groundwater represents nearly 90 % of the unfrozen water it is this resource that provides a huge buffer capacity against the potential vagaries of climate variability. Being a very vulnerable resource, however, groundwater needs very special attention and protection in the future.

4. Coupling agricultural and water policies

Key issues and policy recommendations (4)

1. Agriculture constitutes a major pressure on water resources, as a principal cause of non-point source pollution (nutrients, pesticides) and as a major water user for irrigation.

2. Low cost changes to agricultural practice, such as improved soil tillage practice and more efficient fertilizer applications, can have major benefits to water.
3. Technological developments for irrigation have the potential for major water savings.
4. While the Common Agricultural Policy (CAP) supports some water protection measures, it does not yet fully acknowledge the environmental damages and costs from agricultural activity.
5. Water, as a public good across the EU, needs to be integrated into the forthcoming reform of the CAP. The revised CAP must ensure that rural support is fully consistent with water-related objectives. Reform of the CAP should seek win-win opportunities for the support of rural communities alongside the objectives of the Water Framework and Habitats Directives.
6. In some cases difficult choices may need to be made on how far agriculture is sustainable, given, in particular, the potentially increasing water stress from climate variability and change.
7. The appropriateness and type of agricultural activity should be assessed and planned alongside other land and water users in an integrated spatial development perspective that parallels river basin planning. An integrated sustainable land use policy within catchments or Member States is needed, rather than a policy focused on a specific sector.

Agriculture is responsible for about 70% of the overall water consumption. To a large extent it is also responsible for a number of negative impacts on Europe's waters. Fertilizers and soil disturbance can cause pollution from nutrients and sediments, resulting in poor water quality and loss of biodiversity and amenity. Agriculture is a major source of pesticide pollution, with biodiversity impacts and high costs to the water industry supplying drinking water to consumers. Agriculture is also a major water user, in many places with dedicated irrigation systems drawing water from rivers and groundwater aquifers.

Many of these negative impacts could be controlled through simple changes in agricultural behaviour, such as how ploughing is undertaken, how pesticides are applied or what type of irrigation is used. Such changes are already or may be made compulsory under some EU legislation or be promoted through financial incentives under the Common Agricultural Policy (CAP). It is unacceptable that basic measures and practices such as these are not universally adopted across Europe.

There are also important technological innovations that have been adopted by some farmers, thus massively reducing water use. These should be more widely adopted. Where necessary, EU or Member State government support for investment in such technologies is to be encouraged. However, adoption of new technologies should not be an excuse for major expansion of irrigation in water stressed areas across the EU.

The CAP contains a number of mechanisms to deliver environmental outcomes. Extending cross-compliance obligations to encompass wider legal water objectives may be an option. However, identifying how this could be done is controversial. Under Pillar II, there are options to support farmers financially to take measures in line with certain water objectives. While these play a role, questions arise as to the appropriateness of such measures when farmers need to meet fully the objectives arising from the WFD.

The future of the CAP is currently being actively debated. It has already moved from supporting production to supporting rural development more widely. However, it should take a further step towards rural sustainability by seeking to support farmers in their protection and enhancement of public goods. Such public goods include clean and sufficient water for all

users. Where the CAP does not contribute to this objective, reform is urgently needed. It should not be the case that EU funds are seen to work against the common public interest.

The CAP, therefore, has the potential to deliver far greater outcomes regarding water, such as the specific objectives of the Water Framework and Habitats Directives, than it does now. To fail to reform the CAP to ensure that it is synergistic with EU environmental law, rather than partially antagonistic, would be a major missed opportunity and throw much of the EU decision-making process into disrepute.

However, even though good practices are adopted, agriculture still poses major threats to Europe's waters. In water stressed areas the level of water abstraction is fundamentally unsustainable. It is possible that hard choices on the future of some types of agricultural activity will need to be made, particularly with potential impacts of climate change. Equally, with a changing climate new agricultural opportunities may arise in some locations and it is important that such activities are introduced with due respect to water quality and quantity objectives.

5. Ecosystems and water, ecological services

Key messages and recommendations (5)

1. All ecosystems require water but water-based ecosystems are especially sensitive to the quantity and quality of water. Due to various human activities the vulnerability of these ecosystems has increased worldwide with differing regional characteristics. Such ecosystems are also in danger in Europe due to formerly uncontrolled human activities (such as, for instance, flood control, intensive developments in agriculture, industry and infrastructure, spreading of alien and invasive species). The biodiversity and natural ecosystem services provided by these ecosystems have been dramatically decreased, therefore, it is necessary to prevent further degradation and fragmentation of these ecosystems and restore them as much as possible.
2. Restoration of damaged water-based ecosystems is a significant objective of WFD River Basin Management Plans (RBMPs). These plans include measures that have to be implemented in order to achieve the "good status" of water bodies belonging to water-based ecosystems.
3. Infrastructure projects must not have damaging effects on the ecological status of rivers. Modified and heavily modified water bodies have smaller buffer capacity against droughts and floods, and the provision of other ecosystem services is also reduced. The ecological effects of large infrastructure projects on rivers should be kept to a minimum and need to be offset by compensation measures that foster the objectives of the Birds and Habitat Directives as well as those of the Water Framework Directive. Comprehensive assessments must be completed of all the projects that potentially have adverse effects on river ecology. In these complex studies the cumulative effects of separate interventions need to be considered, as well.
4. Ecosystem services significantly contribute to human well-being and sustainable water management and, therefore, it is important that damaged water-based ecosystems are restored and further damages are prevented. Ensuring the sustainability of freshwater ecosystems and their services underpins efforts to achieve food and energy security, climate change adaptation and mitigation and flood protection.
5. The concept and methods should be developed and applied for measuring and harmonizing social and ecological water demands.

6. Synergies should be sought between human water uses and water demand of ecosystems by involving the public into the planning process that closely parallels with the RBMP process.
7. Quantification and evaluation methods for estimating ecosystem services are undergoing rapid development. These methodologies further should be developed and adapted to the European context. Ecosystem services should be identified and introduced into more complex social and economic approaches that include ecological principles.
8. The economic value of ecosystem services is to be integrated into all sectoral policies and instruments (economic, trade, transport, agriculture and energy), as well as into public procurement and private sector decision-making.

All ecosystems require water but water-based ecosystems are more sensitive to the quantity, quality and timing of available water than others. These ecosystems cover watercourses, standing waters, wetlands, and ecosystems depending on ground waters, transitional and coastal waters. They are important elements of the biosphere including human society. For the protection and conservation of water-dependent ecosystems and their functions it is important to integrate the relevant targets from the Strategic Plan adopted under the Convention on Biological Diversity into the sectoral policies of the EU.

Large numbers of anthropogenic drivers and pressures affect European water-based ecosystems. Drivers include energy production, storage, flood control, navigation, developments in industry and agriculture, urbanization and other infrastructural developments. Pressures are also numerous: construction of dams, weirs, ports, river diversion and regulation, irrigation, water abstraction, wastewater discharge, canalisation, shoreline protection to name but a few. Impacts are significant such as dramatic changes in hydro-morphological conditions, horizontal and longitudinal ecosystem discontinuity of water courses, disappearing floodplains, degraded shoreline ecosystems and increased chemical loads. Consequently the ecosystems are affected by fragmentation, spreading of invasive and alien species, disappearing native species, decreasing biodiversity, ecological values, changes in sediment balance, etc. One of the consequences is that it is quite difficult to find real reference water bodies (as defined by the WFD) in most parts of the EU. This situation will only get worse in the future due to potential climate change.

More efficient measures are necessary to mitigate the degradation processes. Restoration of damaged water-based ecosystems is a significant element of the River Basin Management Plans (RBMPs) required by the WFD. Ecologically sound environmental engineering methods can help in realizing the WFD's objectives. Budgetary and fiscal decisions both at EU and national levels, should secure public funds for conservation and restoration of these ecosystem services and improvement of the natural capital.

One reason why restoration is necessary is the "working power" of the water-based ecosystems. These deliver many important goods and services, such as providing clean water and food, treating man-made pollutants, controlling floods and erosion, ensuring habitats for protected species, increasing biodiversity, and many other benefits that are difficult to quantify and value at present.

One of the most important aspects of the human impacts on the water-based ecosystems is the decreasing biodiversity, disappearing native species and spreading of the alien and invasive species. With reference to the objectives of the Birds and Habitats Directives, the conservation status of many freshwater habitats and species is generally unfavourable. Although there are some variations across biogeographical regions, the situation is critical in

many regions of Europe. Due to increasing human mobility and release of species, many alien and invasive species have entered European waters. These species (plants, fish, macroscopic invertebrates, mammals and birds) are in competition with native species and often outcompete them.

The water demand by the society and the ecosystems are not prioritised: both should be met. This often requires looking for compromises. The ecological water demand is characterized by the quantity and quality of waters (together with temporal changes and dynamics) that ensure the integrity of aquatic ecosystems. The ecological water demand should also cover appropriate morphological background conditions that can effectively contribute to the desired ecological benefits. The well being of water-based ecosystems significantly affects the quantity and the quality of ecosystem services. The quantification and valuation methods to assess ecological services should be further developed.

The concept of environmental water demand, therefore, is recommended to be introduced into the European practice. Synergies should be established between human water uses and the water demand of the water-based ecosystems by involving public in the open planning process of the RBMPs.

It should be recognized that ecosystem services cannot be maintained without costs. Their maintenance costs generally are not covered by the beneficiaries of the services provided, as these benefits are normally public goods. Charges are also not sufficient to cover these costs. It is therefore of particular importance for the EU to direct special attention in its water policy to the importance of these services and costs associated. At the same time it is necessary to screen other sectoral policies in order to track down measures and subsidies with negative effects on water-based ecosystem services. The identified policy elements should be reformed in order to eliminate their contradictions with the EU environmental and water-management goals and ensure that public investments have no negative environmental effects. In the last decade, there were efforts to quantify and value the ecosystem services as it was done in the case of human water uses. However, this task was not solved completely and much work is still needed in the future. The quantification and valuation methods of ecosystem services (such as the payment schemes for ecosystem services or those referred to in the UNEP's report on "The Economics of Ecosystems and Biodiversity") should be further developed.

6. Challenges of the science-policy interface

Key issues and policy recommendations (6)

1. Better means of knowledge transfer between science and policy to improve evidence-based decision-making and launch more relevant water-related research are needed. Traditional dissemination activities (symposiums, conferences, media products) are important, but are not sufficient for fruitful two-way dialogues. New approaches are to be sought.
2. Detailed scientific analyses are rarely applicable as they are for decision-making. For this purpose sound aggregating, screening and interpretation of results is needed.
3. Closer cooperation with policy-makers (and other stakeholders) is needed in setting the research agenda by means of (i) increasing the use of participatory approaches in scenario development and (ii) increasing the use of conflict management approaches.
4. Development of capacities for “knowledge broker” institutes, whose tasks are: (i) to promote interaction between researchers and end users, as well as to develop capacity for evidence-based decision making, (ii) to collaborate with policy makers to identify issues for which solutions are sought; (iii) to establish access to knowledge by screening and

recognizing valuable knowledge across organizations and industries; (iv) to internalise experiences from a variety of water management actions, water industries, technology platforms; (v) to link separate knowledge pools; and (vi) to implement knowledge in new settings by combining existing knowledge in new ways.

5. At the EU level it is needed: (i) to widen the scope of European Environmental Agency (EEA) from analysing and synthesizing the state and outlook of the environment towards problem-solving assessment (technical, economic, political) and formulating the assessments to fit policy processes; (ii) to develop thematic think-tanks analysing key messages arising from research and knowledge needs for society and policy-making and (iii) to further develop the Water Information System for Europe (WISE), which is a comprehensive and shared system for water, including river basins that allows putting together the knowledge existing, the data reported and providing analysis and maps of those
6. At Member States level it is needed: (i) to increase the capacity of existing agencies/expert institutes to become better knowledge brokers, (ii) to increase the use of participatory approaches and platforms to involve national and local policy makers, scientists and end-users in the process from developing the visions and needs of research and policy through implementation (examples from SCENES and other related projects).

During past decades extremely fast development of science and technology has taken place which may significantly contribute to handling efficiently many complex water issues. For example, these developments include several areas of basic sciences, information-, bio- and nano-technologies, various advanced monitoring types, modelling, design, planning and decision support methods, and their water related applications.

In spite of all these advancements, however, significant gaps remain which hinder the utilization of our available knowledge in practice. A few important shortcomings which stem from the differing nature of science and policymaking are, among others, as follows: science is flexible, problem and discovery oriented, whilst policy is less flexible and is service and mission oriented.

Science generally aims at achieving a perfect proof by detailed, often lengthy analyses, while policy decisions should be made within given time frames, on the basis of robust, aggregated information. Handling water related problems with different kinds of uncertainties requires action-oriented science.

Science and policy-making have different natures also in terms of how to handle risks, failures and uncertainties. Science accepts probabilities (and often is based on them) and uncertainty is an inherent feature of water and environmental engineering. Data gathered on understanding hydrology, hydrobiology, water chemistry and ecology, for instance, various models are developed, but cost functions and other variables therein are all characterized by uncertainties of various degrees. Recognizing and accepting uncertainty is often in contradiction with routine decision-making, for which certainty is a fundamental parameter that allows (seemingly) easy decisions and choices to be made. This, however is a mistake, decisions taken on the basis of, say, a single scenario can easily lead to a decision failure while if at least the range of possible scenarios are known, the policy maker is in the position to evaluate the risks of various choices.

Decision-making is often a complicated and is not necessarily a transparent process of many actors, the process of which is determined by legislation and administrative structures (the permit and public procurement procedure of municipal wastewater treatment plants selection

and construction is an example). Under such circumstances the outcome can be far from what advanced technology would recommend. Here, it is sufficient to refer to many conservative and somewhat outdated municipal wastewater treatment plants constructed in the course of past two decades in the Central-Eastern European countries.

7. Water ethics

Key issues and policy recommendations (7)

1. Water ethics is a socially accepted moral code of conduct that provide guidance as to what one is supposed to do in water resources management and what one cannot do.
2. Established ethical principles should play an important role in the reconciliation of conflicts in integrated water resources management (IWRM) that are due to multiple and fundamentally different objectives. These principles play an increasing role as water crises grow.
3. Sustainable development has three principal objectives: social equity, economic efficiency and environmental sustainability of vital ecosystems. Ethical principles are to help to harmonize these and as such to mitigate the appearance of conflicts.
4. Ethical principles are also crucial in the relationship of water professionals/scientists and politicians/decision makers while jointly working on IWRM issues.
5. To ensure transparency and universal access to the right information by users, the public and the media alike is also a principal ethical issue.
6. Fundamental principles of water ethics are already established and widely known (responsibility, participation, solidarity, equity, and stewardship). These should be followed when dealing with water issues.
7. Education concerning water ethics should be conducted, starting from young people, and including professionals in every sphere of water resources decision-making and the society at large.

Humans cannot live without water, and several painful lessons due to water scarcity, pollution or excess dictate that integrated water resources management (IWRM) has become an important prerequisite for sustainable development. Such development has three principal objectives: social equity, economic efficiency and environmental sustainability of vital ecosystems. IWRM takes into consideration the interrelationships between natural resources systems and socio-economic objectives. It also takes into account several factors outside the water sector such as national development and poverty alleviation policies. In the situation of multiple, and often fundamentally different objectives, conflicts in IWRM are unavoidable and their reconciliation should take into account established ethical principles.

Water ethics is a set of principles of appropriate conduct in the area of water resources management. In other words, water ethics provides socially accepted moral code to define what one is supposed to do in the water resources management and what are the actions one is not supposed to do and/or a standard of what harm or pain, such as damage, loss, poverty, thirst, is allowed to be inflicted upon other moral agents, including human beings. The topic of water ethics is increasingly being discussed as the water crisis intensifies and specific water policies are developed.

There is an accepted international ethical norm that human beings are entitled to access to water as a human right, as the UN General Assembly already stated in a breakthrough resolution. Equity in availability and applicability of water is an important ethical issue that has significant policy implications. Further development of water ethics should be seen as an important task to be implemented in the context of IWRM.

8. International cooperation and transboundary issues

Key issues and policy recommendations (8)

1. The global importance of water has been increasingly recognized in the course of the past two decades. The milestones of this process are the World Water Forums (the next one will be held next year in Marseille), the 2001 Bonn Freshwater Conference and the 2002 Johannesburg World Summit on Sustainable Development as well as the emphasis of this issue in the framework of the UN Millennium Development Goals (MDG). These events have set the basic principles of integrated water resources management and have led to ambitious global efforts. It is recommended that Europe and the EU play a decisive role in this process and the associated implementation.
2. Despite the substantial development of international cooperation in European water management, a number of conflicting problems indicate the need for further actions. While bilateral cooperation mechanisms are often well suited to solve such conflicts and the established dispute resolution mechanisms at bilateral, EU and international level can also be relied upon, nevertheless, more effective institutional setups and more precise legal regulations would be necessary, in particular by further developing and strengthening existing multilateral agreements.
3. Considering the increasing importance of water also in the European continent, it is proposed to strengthen the intersectoral and cross-sectoral cooperation, in particular among the EU Member States, e.g. by fully exploiting the relevant provisions of the WFD and to reinforce the European Ombudsman in water issues.
4. An international register of independent legal technical experts would support the competent tribunals (national tribunals or UN International Court) in such arbitrations, which are accepted and executed by the parties.
5. While the Water Framework Directive and the catchment-based conventions provide an important institutional framework provide for regional cooperation, Member States may face recurring bilateral problems in the management of shared water bodies. Bilateral issues should mainly be solved at a bilateral level, based on EU law, bilateral and multilateral agreements, joint monitoring and transboundary projects. Such problems should be as far as possible prevented by improving the clarity of legal texts, including both the substantive and procedural provisions.
6. Multi-lateral issues are effectively solved within an appropriate multi-lateral framework. In highly integrated regions, such as the EU, multilateral transboundary water institutions could provide an effective cooperative framework ranging from basin-wide planning all the way up to joint operational and management of the water infrastructure and institutions. In this regard, the EU-wide adoption of the relevant global UN conventions and legal instruments is recommended.
7. The importance of water should be highlighted in the context of international development cooperation, with special regard to the sustainable management of water resources, the provision of drinking water and sanitation services.

International and transboundary cooperation in water management has developed considerably in the course of past decades, particularly within the European Union. Three major vehicles are the EU legislation, bilateral agreements and international conventions. Bilateral agreements are plentiful, while there are also in place important pan-European and UN watercourse related conventions.

Within the EU the Water Framework Directive (WFD) represents a unified EU policy for sustainable use of waters and provides a consistent legal background for regulating all

activities affecting their status. The WFD is applied in 27 countries and will improve water status in neighbouring countries, thus improving the conditions to handle transboundary issues. The Floods Directive, the introduction of water issues in the Common Agricultural Policy and the Water Scarcity and Drought Communication provide for horizontal integration. The harmonised national laws assure the uniform basis for water management. Furthermore, status assessment, water uses and measures have to be harmonised in shared river basins and aquifers. This strongly coordinated administrative background together with the international conventions and bilateral cooperation has been leading to improved information exchange, prevention and decrease of water pollution and efficient management of problems with a common interest.

In spite of the many developments however, a number of unresolved conflicting problems such as damages due to accidental pollutions, discharge of other pollutants, non-negotiation of the impacts of dams and navigation, poorly coordinated flood risk management, water shortages due to diversion or disproportionate use of shared water resources, indicate the need for further actions. In fact, we have useful, but soft international conventions and virtually no juridical framework for dispute resolution. It is argued that strengthening the international cooperation, the objectives and provisions of the legal instruments, and in general, the elevation of water matters to a higher level in international decision-making are needed in the future.

The issue of transboundary cooperation should also be addressed more precisely and vigorously under EU legislation. The EU does not yet dispose of any real institutional solution to address recurring differences between the Member States. Solutions to that effect may include the strengthening of the intersectoral and cross-sectoral cooperation within the EU, the establishment a regulated mediation process or the strengthening of the position of the European Commission under the WFD to provide “good offices”.

The majority of the bi-lateral problems should be solved in the frame of bilateral cooperation. This is the most efficient way of handling bi-lateral conflicting problems. The usual basis is a bilateral treaty, which includes all special problems of the parties, regulates the joint monitoring and data exchange, and refers to the legal background (EU compliant national laws and international conventions) to be considered. In general, it is proposed to provide an environment to reduce litigations. For this reason, a review of existing legislation is necessary. The EU, through its numerous multilateral institutions, sets a good practice for the effective management of multi-lateral issues.

In the field of international development cooperation the role of water in the implementation of the UN Millennium Development Goals should be emphasized. Water resources management and inclusive growth of developing countries are closely interrelated with sustainable development in the sectors of energy and agriculture, as well as for rural development and environmental protection. International development cooperation therefore promotes partnership with developing countries in sustainable management of water resources and provision of drinking water and sanitation services.

9. Governance and sustainable water management

Key issues and policy recommendations (9)

1. Governance is key to managing water sustainably.
2. Water related problems often originated from various sectors need to be addressed by “thinking beyond the water box”.

3. There is no general governance pattern to follow; each society should work out its own institutional system geared to local conditions.
4. Good governance is stable but still flexible enough to react to the changing environment. This should be based on careful monitoring of implementation. New member states of the EU being after the political change need to strongly focus on developing the good practice in governance.
5. Within the EU it is of utmost importance to monitor the implementation of the WFD, to draw conclusions and to disseminate good practice.
6. Participatory approach and open planning are essential for good governance that also includes conflict management and resolution.
7. Enabling environment is needed for the establishment and use of legal instruments.
8. The consequences and costs of actions as well as that of non-actions should be considered. Measures of river basin management plans need to be integrated into the local and regional development programmes, and during allocation of available funds these objectives must have a priority.
9. Europe's water infrastructure of huge value is ageing as funds are not sufficient for rehabilitation and appropriate maintenance. Good governance acting at the right time is needed to develop detailed asset management strategies, to estimate reliably depreciation values of the infrastructure and to increase tariffs accordingly to deliver investment. It is also recommended to re-think whether it is desired to maintain the present infrastructure or to move towards a sustainable concept based on closing water and material cycles, water efficiency, re-use and re-cycling, and reduction of emissions to receiving waters in the future. Such a concept should also guide the investments into new innovations and leading edge technologies, respectively.

The issues water managers face in the 21st century originate more and more from other sectors. They are basically of social, economic, political and decision making origin, and require non-traditional approaches from the perspective of water management. Therefore, it is important to look at the impact of these socio-economic activities and sectors on water, including agriculture, industry, energy production and tourism to mention a few. In other words, a comprehensive and integrated approach is needed. The water-oriented policies already recognize this need, e.g., the Water Framework Directive focuses on integrated river basin management and requires the enhancement of sectoral coordination; however, its application is still rather limited. The review of the implementation of the Directive is in progress based on the Water Framework Directive River Basin Management Plans. The need of "thinking beyond the water box" is clearly recognized. Even more efforts would be needed from the other direction, namely, as concerns the overall development policies and the policies of other relevant sectors, which are closely interlinked with water management. This approach is served e.g. by the European Water Stewardship Program, that is to work more closely together with all stakeholders in order to "open the water box" and to define sustainable water management response strategies on a river basin scale.

The review of the water related legislation started by the European Commission and it is expected that by 2012 the European Commission will publish the "Blueprint to Safeguard Europe's Waters" comprising an assessment of implementation of the existing legislation and the directions for its renewal in order to strengthen the EU's future water policy.

Water issues are much more complex in our fast changing word, than they were a few decades ago. They can only be managed if an appropriate institutional system and, more generally, an adequate governance mechanism is in place representing a framework of political, social,

economic and legal structures for the implementation of strategies and programmes. Therefore governance is of key importance at national and international level, as well.

The success of each and every plan depends on governance. A governance setting can be relatively cheap to devise and develop, but in the practice, it proves to be very difficult to set up an appropriately working system. It is generally accepted that the most crucial dilemma of today's water management is governance. Good governance is able to react to situations characterized by permanent changes, risks and uncertainties.

Every member of society is a stakeholder and is interested in water with his/her expectations, wishes and ideas. In order to channel the often conflicting interests into an outcome which corresponds to the public interest, the water sector should play an integrated role and governments should ensure that water management concepts are reflected in other sectors' policy. This requires a sophisticated system of institutions, which is missing in many countries of the world. Furthermore, governance should be present in global, regional (river basin), and country levels, ideally in harmony with each other.

Legal instruments that are adopted without providing them with an enabling environment often backfire and weaken the positive effects of others. There are good examples, however, such as the EU's Water Framework Directive.

Recently established river basin management plans give an indication that needs for investing in mitigation measures and infrastructure for achieving the "good status" are higher than willingness to allocate funds for these needs. Is should be ensured that investment needs are met and the appropriate level of willingness exists. The ongoing assessment of these plans will point out gaps in the implementation of EU water legislation and suggest solutions for improving it.

Development plans are more solid where government, private sector and civil society collaborate and follow a participatory approach. Public support and acceptance of plans makes implementation faster, more viable and long standing. In order to involve the private sector it is essential to provide an appropriate guidance on how to successfully implement the WFD requirements within a corporate water response strategy and also incentives for private water users for their contribution to this process.

There is often a dilemma of action vs. non-action. Costs and effects of "non-actions" are frequently ignored, although they might be very high. Their estimation is usually not easy especially as they are often clouded by uncertainty.

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