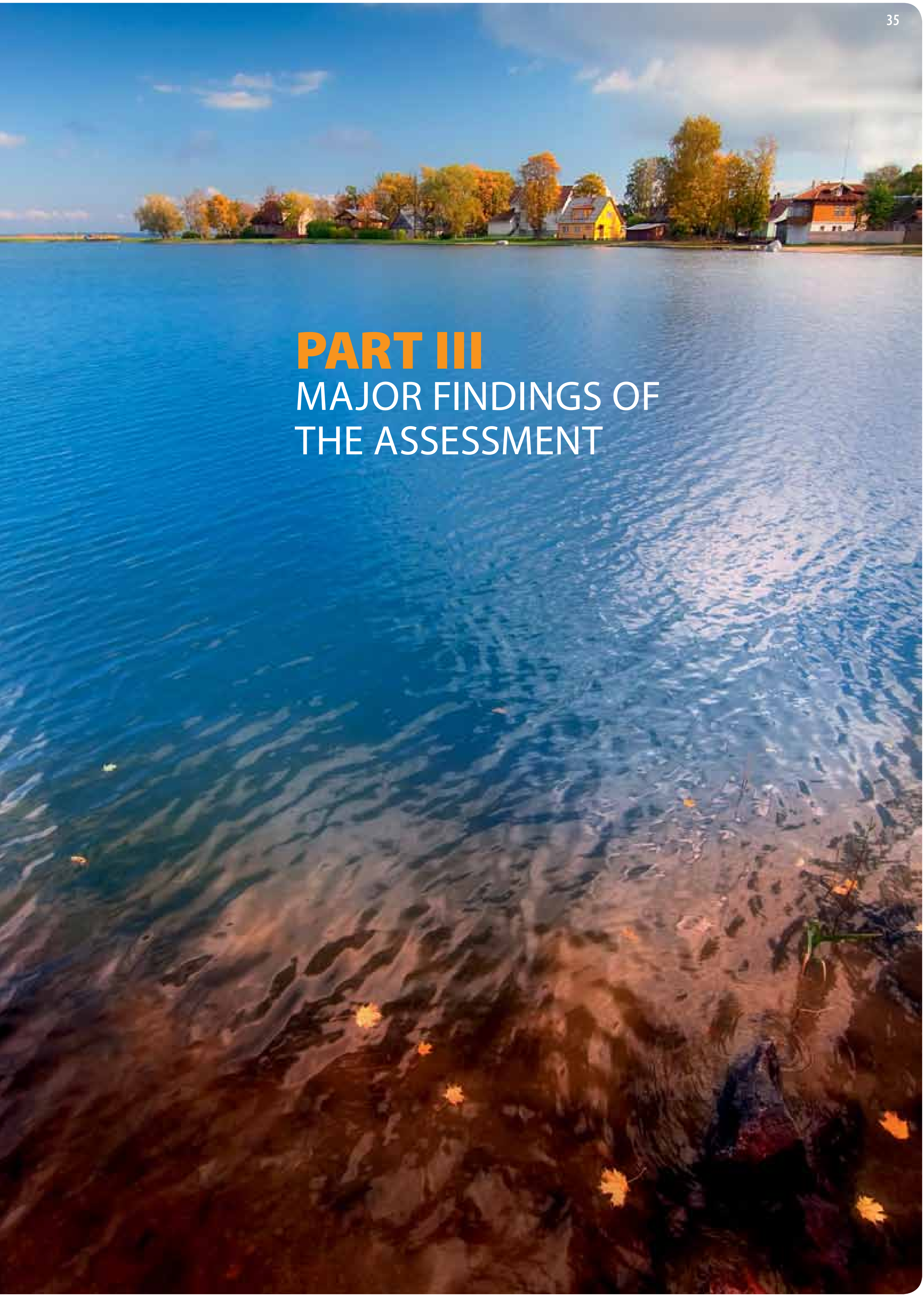


PART III
MAJOR FINDINGS OF THE ASSESSMENT

CHAPTER 1
WESTERN AND CENTRAL EUROPE

INTRODUCTION

The subregional assessment of transboundary waters in Western and Central Europe covers transboundary rivers, lakes and groundwaters shared by two or more of the following countries: Andorra, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Hungary, Ireland, Italy, Liechtenstein, Luxembourg, Netherlands, Norway, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom. The assessment of the individual transboundary surface and groundwaters in this subregion can be found in the Chapters 5, 6, 7 and 8 of Section IV (drainage basins of the Black Sea, Mediterranean Sea, North Sea and Eastern Atlantic, and Baltic Sea).

Many of these transboundary waters provide vital resources, and countries are often dependent on flows generated from outside their borders. Within this subregion, the Netherlands and Hungary are probably prime examples of this dependence.

For historical reasons, also linked to the economic development around main navigation waterways, transboundary cooperation has a long tradition in the subregion. Many bilateral, river basin and lake agreements have existed for many years; most are based on the Water Convention.[1]

The River Rhine is the most intensively used watercourse in Europe. For many centuries it has been an important shipping lane, and 800 km of the river from Rotterdam to Basel is navigable. It has also been a source of food and water, and the basis for human settlement and intensive industrial development on the banks of the Rhine and its tributaries. The River Rhine provides drinking water for 30 million of the 58 million people who live in the basin, either by direct abstraction (e.g. from Lake Constance), via riverbank filtration, or filtered through the dunes between Amsterdam and the Dutch coast.

Since its adoption in 2000, water management in the sub-region has been dominated by the WFD. Countries have transposed the WFD into their own national legislation, and have been required to follow the implementation timetable set out in the Directive. The non-member countries in the subregion, Norway and Switzerland, also implement the WFD, or pursue comparable aims in their approaches to water management.

There are many transboundary wetland areas in the subregion, which is also the most advanced in terms of transboundary cooperation in this field: in some cases, two or even three bordering countries cooperate in managing a shared wetland. Of the 13 officially designated transboundary Ramsar Sites worldwide, 6 are in Western and Central Europe. Four of these have been covered in the Second Assessment. This Assessment also includes additional Ramsar Sites which have been declared by one country, but extend into the territory of another country where they are not yet protected under Ramsar, as well as Ramsar Sites which have been designated separately on each side of the border, but without joint official designation as a transboundary wetland, enabling joint management of the ecosystem. Besides the Ramsar Sites included in this Assessment, Central and Western Europe holds more than 30 transboundary wetlands for which at least one side of the border has been designated under the Ramsar Convention. This underlines the need for transboundary cooperation, as management decisions often impact several countries, and the numerous services provided by the wetlands extend far beyond a country's boundary. In addition to protection under Ramsar, many wetland areas in the region are protected under national and EU legislation, especially under Natura 2000.

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORKS FOR TRANSBOUNDARY WATER MANAGEMENT

Under the overall umbrella of the WFD, other related legislation target specific waters, activities or groups of pollutants. The Urban Wastewater Treatment Directive[2] (UWWTD) and the Nitrates Directive[3] have both improved, and will further improve, water quality with respect to nutrients and other substances. The chemical quality of Europe's surface waters is addressed by the recently established Environmental Quality Standards Directive,[4] a daughter directive of the WFD which defines annual average and maximum allowable concentration limits for a wide range of pollutants, known as priority sub-

[1] Information on the existing agreements for transboundary water cooperation can be found in annex II.
[2] Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment.
[3] Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources.
[4] Directive 2008/105/EC of the European Parliament and of the Council of 16 December 2008 on environmental quality standards in the field of water policy, amending and subsequently repealing Council Directives 82/176/EEC, 83/513/EEC, 84/156/EEC, 84/491/EEC, 86/280/EEC and amending Directive 2000/60/EC of the European Parliament and of the Council.

stances. Another WFD daughter directive focuses on groundwater.[5] The Bathing Water Directive[6] aims to protect the health of the public using Europe's inland and coastal bathing waters. The Flood Risk Management Directive[7] aims at improving flood prevention and flood damage reduction in river basins.

As a result of the emphasis given in the WFD, the concept of IWRM in river basin districts is well established. In particular, the requirement to develop and publish, by December 2009, River Basin Management Plans (RBMP), and to establish programmes of measures by the same date, has been a strong driver for this approach. Management by river basin is now firmly established, including involvement of the public.

Moreover, Norway, although not an EU member State, introduced voluntary implementation of the WFD in selected parts of the country between 2007 and 2009. River Basin Management Plans for these sub-districts were adopted by local councils in 2009, and approved by the national government in 2010. RBMPs will be prepared for the whole of Norway between 2010 and 2015.[8]

In the past ten years, Europe has suffered more than 175 major floods. Because it was adopted later on, the EU Flood Risk Management Directive is one cycle behind the WFD. Consideration of water quality in RBMPs is therefore one cycle ahead of flooding. Clearly it would be more effective if both were considered together, and, in future, so as to promote integrated water management, the Floods Directive foresees close coordination with the WFD, even, where possible, developing combined management plans.

Thus, management of water quality and quantity is not yet fully integrated in EU legislation. As well as status, water quality is highly dependent on flow regime, and the potential changes to water quality resulting from hydromorphological alterations are not always well understood. Thus, while IWRM has brought surface water and groundwater closer together, this may be less true for quantity and quality, which are not always considered together. Sometimes, IWRM on a river basin scale is hampered by existing institutional arrangements at national level in which surface water and groundwater, and quantity and quality, are the responsibility of separate organizations.

In preparation for RBMPs under the WFD, an essential step was the identification and delineation of bodies of surface water and groundwater as management units, and their characterisation as being at risk of not achieving good status (or good potential in the case of heavily modified water bodies) by 2015. This process has been completed, throughout the subregion, for both surface waters and groundwaters.

Large river basins are formally subdivided under their RBMPs into Working Areas for detailed management planning. The Rhine, for example, has nine international and national Working Areas. Within these, pressures and impacts are different, and the corresponding management responses need to be tailored accordingly. Similarly, the Oder has six Working Areas, each containing many water bodies.

Differences in geological settings across the subregion, combined with differences in national approaches to the definition of groundwater bodies, have sometimes slowed down the process of identifying transboundary groundwater bodies. Nineteen of the twenty-seven EU member States recently provided GIS-mapped information of their groundwater bodies.[9] Of the 7,019 bodies in the database, 124 were reported as being transboundary. However, in the Scheldt International River Basin District, 42 of the 67 groundwater bodies in the basin are designated and mapped as being transboundary. In contrast, 103 groundwater bodies have been designated in the Oder Basin, some of which may be transboundary even though they have not yet been defined as such. At a national level, Slovakia identified 15 candidate transboundary groundwater bodies, and, after official bilateral negotiations, seven were confirmed by both countries. Of the 71 groundwater bodies in the the Moselle and Saar sub-basins, 26 are close to a national border.

At the same time, there are transboundary aquifers that have been jointly recognised by neighbouring countries, in some cases for many years. One with important groundwater resources is the Genevese aquifer formed of alluvial sediments along the Rhone at the outlet of Lake Geneva. This aquifer is shared by France and Switzerland, and a joint agreement for its management and protection was first signed in 1978. Other jointly agreed transboundary aquifers include, for example, those shared by Belgium and the Netherlands, Belgium and France, Austria and Hungary, Austria and Slovenia, and Spain and Portugal.

It is also important for a truly integrated management to know where groundwater and surface water are in close connection with each other, potentially affecting each other's status. For instance, on the basis of hydrogeological knowledge, ecological criteria and the presence of Natura 2000 sites, 34 groundwater bodies in the Scheldt River basin were identified as being in close connection with surface water. However, even for the well-established river basin commissions, addressing transboundary groundwaters is a new challenge.

Institutional arrangements for the management of transboundary waters must reflect the physical complexity of large basins. In the Po basin, for example, the upper part is characterised by high mountain terrain, fast streams and the large alpine lakes of Lugano, Maggiore, Como, Iseo, Idro and Garda. Surface water concerns are dominant and related mainly to the impacts of hydropower production, flooding and landslides. In the lower part, as well as the main river there are large aquifers and many individual groundwater bodies, all within the Italian part of the basin, and here the pressures come from pollution from agriculture and industry, and from abstraction for irrigation. The most important stakeholders are very different in the two parts of the basin, and the institutional framework for transboundary water management must take account of this. Similar situations characterise the Danube, Rhine and Rhone basins.

The WFD has had a major positive influence on water management and the protection of water resources in the subregion, but is not by itself a sufficient basis for transboundary cooperation. This requires specific structures and institutions. The subregion is fortunate to have well-established transboundary commissions for its largest river basins, including the Danube, Rhine, Meuse, Oder, Elbe, Moselle and Saar, and Scheldt. Some

[5] Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.
[6] Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC.
[7] Directive 2007/60/EC of the European Parliament and of the Council of 23 October 2007 on the assessment and management of flood risks.
[8] A brief description of the water resources management framework in each of the countries can be found in annex I.
[9] Groundwater GIS reference layer: submission/compilation status and evaluation. Draft report. European Environment Agency (EEA). 2011.

of these commissions have existed for more than 50 years, have long provided strong frameworks for collaboration between riparian countries, and more recently have facilitated the preparation of transboundary RBMPs and the establishment of joint monitoring programmes. In transboundary basins where international cooperation is less established and joint bodies/river commissions are less effective, implementation of the WFD has been limited to the national borders, or, at the basin level, has mostly involved the preparation of separate national plans without real coordination and cooperation.

In addition to regional frameworks such as the UNECE Water Convention or multilateral agreements and relevant river basin commissions, cooperation at bilateral and more local scale is also needed to ensure transboundary water management. In the Ems River Basin District, there is no international river basin commission, but management is overseen by a high level International Ems Management Group in which decisions are made by representatives of the responsible ministries of the Netherlands and Germany. At a lower administrative level, professionals from the Netherlands, from North Rhine-Westphalia and Lower Saxony work in the International Coordination Group Ems, which implements the decisions of the International Ems Management Group and agrees on joint implementation of WFD activities. Within the Scheldt basin, there is a separate set of agreements between the Flemish Region and the Netherlands related to the deepening, shipping, safety and nature of the Scheldt estuary, covered by the Vlaams Nederlandse Schelde Commissie.

There are good examples of formalized cooperation on transboundary wetlands, although experience shows that developing suitable transboundary institutional arrangements for major wetland sites takes considerable time. Cooperation on management of the trilateral transboundary Ramsar Site at the Morava-Dyje-Danube confluence was initiated in 1994 by NGOs in Austria, the Czech Republic and Slovakia. In 2001 a Trilateral Ramsar Platform was established by a memorandum of understanding between the environment ministries of the three countries. The Platform includes representatives of the ministries, local government, site managers and NGOs. Common goals and principles for site management plans were agreed in 2003, and a common management strategy is currently being developed. Similarly, the history of the Fertö-Hanság wetland, shared by Austria and Hungary, stretches from the original designation as a Landscape Protection Area, recognition as a site under the UNESCO Man and Biosphere Programme in the 1970s, to Ramsar designation in 1989, National Park status in the 1990s, and World Heritage site in 2001.

MONITORING OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

Monitoring in particular needs bilateral and multilateral agreements and institutional frameworks for full implementation of the requirements of the WFD and detailed cooperation at a more local scale. The WFD envisages monitoring networks with a general consistency of approach throughout the EU, and guidance has been developed under the Common Implementation Strategy to this end. Nevertheless, there is some flexibility for Member States in the establishment of monitoring programmes, and many differences remain. The issues of comparability and inter-calibration in particular provide challenges for transboundary monitoring. The difficulties of comparability may be particularly acute where countries select different biological monitoring elements and different methods for monitoring the status of surface waters.

Implementation of the WFD has often required substantial revision and improvement of national and international monitoring networks. In the Meuse Basin, for example, surveillance monitoring programmes, as required by the WFD, were established by States and regions in parallel to each other in 2005-2006 for both surface water and groundwater. These were compared by the International Meuse Commission in 2007. In the Morava Basin, joint monitoring of water quality and quantity is performed by the Czech Republic and Slovakia and by the Czech Republic and Austria several times each year, and a yearly report submitted to the relevant commissions for transboundary waters. Moreover, the Morava River Basin monitoring is part of the Danube Trans-National Monitoring Network.

Even before the adoption of the WFD, joint monitoring programmes had been developed in river basins such as the Scheldt and Meuse. In the former, a homogenous monitoring network was established for the river in 1998, with 14 measuring points between source and estuary with a four-week frequency, a harmonised sampling protocol, and inter-calibrated and fully comparable analytical methods. The results were reported jointly on a yearly basis, and were able to show improvements in water quality in several parts of the basin. To fit in better with national WFD monitoring networks, this has been augmented from 2010 by sampling from 22 more locations, and the analysis of additional parameters. Coordination of groundwater monitoring in the basin focuses in particular on the quantitative and qualitative status of the 42 groundwater bodies which belong to transboundary aquifers composed of the Carboniferous Chalk, the Brusselian sands and the coastal Flemish-Dutch alluvium. A coordinated transboundary waters monitoring programme has also been established by Spain and Portugal for the Miño/Minho Basin.

While groundwater monitoring is being enhanced, knowledge of status and trends for both quantity and quality is generally less comprehensive than for surface water. Groundwater bodies are monitored for both quantitative and chemical status. For the former, critical parameters are the volume of available groundwater resources, the amount abstracted and the groundwater levels. In the Oder Basin, as in many similar locations, complex multi-layer aquifer systems require the different levels to be separately monitored.

Many of the countries of this subregion have had national monitoring programmes for quantity and quality of surface waters and groundwater for many years. These have often produced long time series of historical data for river flows, spring discharges and groundwater levels, and for some chemical parameters such as nitrate. It is important that revisions of monitoring programmes in accordance with the WFD ensure comparability and continuity with this historical data, which has great value in relation to the assessment of climate change impacts, the effects of land use change, water quality trends, and the beneficial impacts of programmes of measures.

MAIN PROBLEMS, IMPACTS AND STATUS

Compared with some of the other subregions covered by this Assessment, water is relatively abundant and water scarcity is easier to manage in Western and Central Europe. Overall, less than 20% of the available water resources are used each year.[10]

However, water availability and populations are unevenly distributed through the subregion and within countries, and water scarcity occurs widely, especially in the southern parts of the subregion, where demand is often met by transfers from other river basins, water reuse, and desalination. However, in the rest of the subregion, large areas are also affected by water scarcity and droughts. A comparison of the impacts of droughts in the EU between 1976-1990 and 1991-2006 shows a doubling of both area and population affected.[11] As an example, the 2004/2005 hydrological year saw one of the worst droughts ever recorded in the Iberian Peninsula, with less than half of the average precipitation, much reduced river flows, a 40% reduction in hydropower generation, and a 40% decline in cereal production.[12]

Intensification of agriculture continues to be a major pressure factor. From a water quantity point of view, this is manifested in increased abstraction for irrigation, mainly in the southern countries. In the Spanish parts of the Duero and Guadiana basins, respectively 92% and 88% of water withdrawal is for agricultural use. Water abstraction for irrigation is also a major pressure factor in the Po Basin, being 80% of the total water use. Over-exploitation of groundwater has resulted in declining water levels, salt water intrusion and the drying up of wetlands. Water demand in summer for agriculture and tourism is particularly acute in the coastal regions and islands of the Mediterranean.

Groundwater abstraction is a major pressure in many parts of the sub-region. In the Scheldt Basin it is estimated that 844×10^6 m^3 of groundwater is abstracted per year, of which 581×10^6 m^3 is for drinking water supply. Groundwater abstraction for agricultural irrigation is a major pressure on the aquifers in the Tejo/Tajo Basin and elsewhere in Spain.

Hydromorphological changes disturb the natural flow and sediment regime of rivers, hinder the achievement of ecological objectives, destroy habitats for fish and other water organisms, and prevent fish migration. These structural changes take two main forms – river bed straightening and maintenance to enable water transport and prevent flooding, and the construction of transverse structures for electricity generation, flood protection, flow regulation or water supply, or combinations of these objectives. Almost all of the transboundary river basins experience hydromorphological changes as a major pressure, often extending back to the industrial development of the subregion. For many decades the Moselle and Saar have been developed as major shipping routes, and the 28 locks on the Moselle and 6 on the Saar present barriers to fish migration.

During the last two centuries there has been a marked increase in the size and number of large storage reservoirs, and there are now more than 7,000 large dams in Europe and thousands of smaller ones.[13] Hydropower provided 16% of electricity generation in Europe in 2008, mainly in the northern and alpine countries, and mostly from large dams and reservoirs. Inland waterway transport plays an important role in the movement of goods in Europe, with more than 4,000 km of navigable waterways. 20 of the 27 Member States have inland waterways, 12 of which have interconnected transboundary networks. Thus, these major and long-established civil engineering works, in existence for many decades, mean that the original, natural state of the rivers probably cannot be known.

The importance of the resulting hydromorphological changes was recognised in the WFD by the concept of "heavily modified" water bodies. In their first characterisation of river basins under the WFD, most EU member States indicated that pressures derived from urban development, flood defence, power generation, navigation and river straightening and land drainage were important in affecting the hydromorphological status of water bodies. Four Member States, Netherlands, Belgium, Slovakia and the Czech Republic provisionally identified more than 50% of surface water bodies as being heavily modified or artificial, largely in the transboundary Rhine, Meuse and Oder Basins.[14]

In the International Oder River Basin District, 227 surface water bodies are considered to be artificial and 294 heavily modified, out of a total of 2,574. In the Scheldt, the proportion of heavily modified water bodies varies between 26% and 67% in the four riparian countries, and artificial water bodies between 12% and 33%. For the Elbe Basin, of a total of 3,896 surface water bodies, 777 are classified as artificial and 1,016 as heavily modified. Hydromorphological modifications have been even greater in the Rhine Basin, with three major phases of river regulation taking place since the 19th century. Many barrages and locks were built

[10] *Source:* Water resources across Europe: confronting water scarcity and drought. EEA Report 2/2009. EEA. 2009.
[11] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[12] *Source:* García-Hernandez and others. The outstanding 2004/05 drought in the Iberian Peninsula, Journal of Hydrometeorology, 8 (3). 2007.
[13] *Source:* Water resources across Europe: confronting water scarcity and drought. EEA Report 2/2009. EEA. 2009.
[14] *Source:* First report on the implementation of the Water Framework Directive 2000/60/EC. EC, 2007.

for power generation and shipping. The construction of dikes and bank stabilisation measures cuts the adjacent alluvial floodplains off from the dynamics of river flow and shortens and straightens the river: the Upper Rhine lost 30 km in length, together with 87% of the water meadows between Basel and Karlsruhe,[15] and 60% of its alluvial forests.

Amongst other member States, an average of 16% of surface water bodies was provisionally identified as heavily modified or artificial. In Switzerland, 46% of watercourses below 600 m altitude are heavily impacted, and in Germany only 21% of rivers, mainly in the less populated areas, remain in their natural state or are only slightly to moderately altered.[16]

These hydromorphological pressures cause changes in hydrological regime and river flows, interruption of river and habitat continuity, disconnection of the modified watercourse from the adjacent wetlands and flood plains, and changes in erosion and sediment transport. These in turn produce ecological impacts which include loss of habitat diversity, disruption of migration and introduction of exotic species via the new water connections produced by the extended canal systems. Flow regime is one of the major factors controlling ecosystem function and services in river and wetland ecosystems. The seasonal and daily flow regimes of many European rivers have been changed by the structural modifications described above.

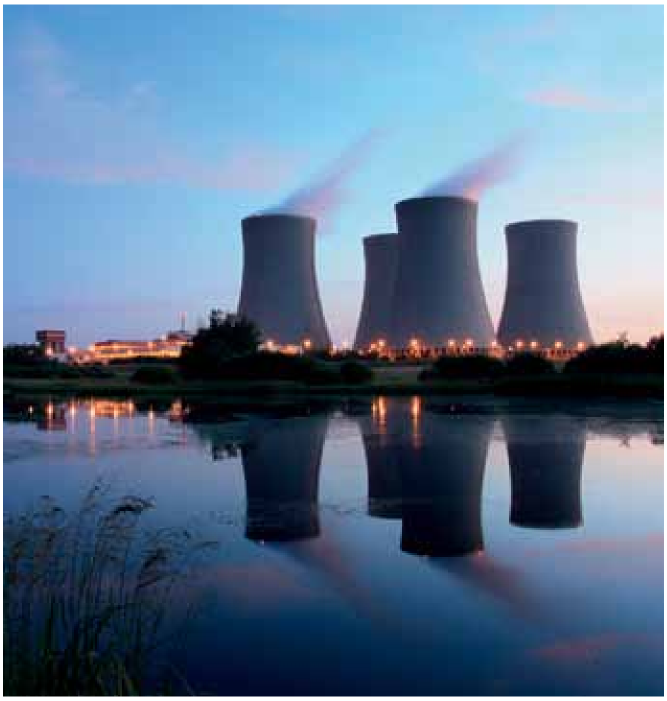
Heavy abstraction of groundwater also has a negative impact on wetlands and their ecosystems by drawing down groundwater levels and reducing the discharges of water that often support these fragile ecosystems.

Changes in land use and the planning of development can have major impacts on drainage basins. Rivers have been straightened and wetlands and floodplains drained to permit farming and urban expansion. These changes mean that rivers flow faster in narrower and deeper channels than in their natural state and floods can develop more rapidly, allowing less time for flood warnings, and reducing the capacity of floodplains to provide space for the temporary retention of flood waters.

Causes of freshwater pollution are diverse, and vary considerably in the subregion. Thus, while landfills, forestry, mining, aquaculture and unsewered sanitation can all cause local pollution it is, not surprisingly, agricultural activities, industry and the urban environment which are the dominant pressures. All of the major river basin commissions cite diffuse pollution from agriculture as a major pressure and impact. In the Po Basin, for example, 15% of the organic pollution load can be attributed to municipal sources, 52% to industrial wastewaters, and 33% to agriculture and animal husbandry. In the Elbe Basin, nutrient loading and hydromorphological changes are each reported as providing about 45% of the problems for surface waters, and point sources the remaining 10%. For groundwater, the pressures in the basin are provided dominantly by diffuse pollution from agriculture, point source pollution from old landfills and industrial sites, and abstraction for potable supply and lignite mining.

While there have been signs of improving water quality, the pressure from agriculture remains high, and diffuse pollution by nutrients and pesticides remains a major cause of poor water quality in many parts of Europe. Source apportionment studies indicate that agriculture generally provides 50- 80% of the total nitrogen load, with wastewater providing most of the remainder.[17] High applications of both mineral and organic fertiliser are used in the farming areas of Western Europe, particularly those in the Netherlands, France, Spain, Belgium, Denmark and Germany. Nitrogen application rates had increased dramatically over past decades, so that a surplus in excess of that needed by crops or grassland was transported into freshwater systems. Application rates in the subregion are now widely declining in response to the legal framework summarised above, but the time taken for pollutants to move through the hydrological cycle means that in some areas concentrations in receiving waters may still be rising, even when the source itself is diminishing. Where trend data exists, this suggests that nitrate concentrations declined between 1992 and 2008 in 30% of rivers.

Remarkable efforts have been made to reduce pollution from urban wastewaters, and municipal wastewater treatment has increasingly been installed across Europe. Implementation of the



UWWTD has not only led to a higher collection rate of wastewaters, but also driven improvements in the level of wastewater treatment over recent years. The majority of wastewater plants in Northern and Central Europe now apply tertiary treatment, although elsewhere in the EU, particularly in the south-east, the proportion of primary and secondary treatment remains higher. This has led to a reduction in discharge of nutrients, biological oxygen demand — a measure of organic pollution — and of ammonia to receiving waters. The emission of some hazardous chemicals has also been reduced.

However, the discharge of micropollutants via wastewater treatment plants and diffuse sources remains a challenge for water protection. To mitigate point-source pollution by micropollutants in Switzerland, for example, the largest wastewater treatment plants in areas of concern are to be upgraded, with a further treatment step in addition to tertiary treatment. The corresponding legal basis is currently being established.

Urban environments generate a range of pollutants, including industrial and household chemicals, metals, pharmaceutical prod-

[15] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[16] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[17] *Source:* Source apportionment of nitrogen and phosphorus inputs into the aquatic environment. EEA, 2005.

ucts, nutrients, pesticides, and pathogens from domestic premises, industrial plants and transportation networks. Contaminant transport pathways are complex and the ultimate fate of urban pollutants highly variable, depending, among other things, on the mode of wastewater collection and treatment. As an example, in some cities the sewage system is designed to also collect storm run-off from streets, roofs and other impervious surfaces. These dual systems are often long-established, and were generally designed and built for smaller populations. During storm events the flow generated can exceed the capacity of these combined sewer systems, and the excess overflows into streets and backs up into buildings. This is sometimes prevented or lessened by temporary diversion into relief drains which bypass the treatment works and discharge directly into receiving watercourses. These discharges of untreated water containing a range of pollutants can quickly deplete oxygen levels for aquatic life and cause rapid deterioration of bathing water quality.

Excessive concentrations of nitrate and phosphorus from agricultural activities and urban wastewaters are the most common causes of freshwater eutrophication. Whilst nitrate concentrations remain high, 42% of rivers with long-term time series data for phosphorus concentration – which is often the limiting factor for eutrophication – show statistically significant declines between 1992 and 2008.[18] Phosphorus concentrations have also declined since the 1990s in many lakes in Western Europe. These improvements can be attributed to controls on the use of phosphorus in detergents and enhanced nutrient removal in wastewater treatment, but the rate of improvement in water quality appears to be slowing in some rivers and lakes. Further significant declines in concentrations will have to be achieved by reduction in the smaller proportion of phosphorus pollution coming from agricultural sources.

High population densities and long industrial histories still have a profound impact on the waters of the large river basins of Western and Central Europe. In the Rhine Basin, for example, 88% of the water bodies in the main stream are classified as of not good chemical status, mainly on the basis of poly-aromatic hydrocarbons (PAH) concentrations exceeding environmental quality standards. Most groundwater bodies in the basin have good chemical status, and the causes for classification as bad status are nitrate from fertiliser applications, and intensive livestock rearing and plant protection products. Although inventories of flora and fauna reflect the improvements in water quality, the present ecological status of the Rhine shows that 4% of water bodies are classified as good, 37% as moderate, 34% as poor and 14% as bad, although the situation is expected to improve considerably by 2015.

Although reporting of RBMP by Member States is still incomplete, some 40% of surface waters and 30% of groundwaters are at risk of not achieving good status by 2015, with agricultural emissions and wastewater discharges confirmed as the most significant pressures with respect to ecological and chemical status.

Forestry, tree felling and other associated land use changes resulting in soil erosion and greater sediment loads provide pressures in some parts of the sub-region, as does mining, either from current activities, or as a legacy of closed and decommissioned mines. The legacy of past coal and iron mining remains a major pressure on surface water and groundwater in the the Moselle and Saar sub-basins, together with calcium chloride-rich discharges from the Lothringian salt industry in the lower reaches of the Meurthe tributary of the Moselle, past mining in the Ruhr and current open-cast lignite mining on the left bank of the Lower Rhine.

CLIMATE CHANGE AND ITS IMPACTS ON WATER RESOURCES

Climate change is projected to lead to significant changes in yearly and seasonal water availability. Water availability is predicted to increase generally in the north (for instance for the Torne, annual precipitation is projected to rise by 4-12%, over the next 50 years), whereas southern areas, which already suffer most from water stress, are likely to be at risk of further reductions in water availability, with increasing frequency and intensity of drought.[19]

Seasonal changes in river flows are also predicted. Higher temperatures would push the snow limit in northern and mountain regions upwards, and reduce the proportion of precipitation falling as snow. This would decrease winter retention of water and increase winter flows in rivers such as the Rhine, Rhone and Danube. The reduced snow reservoir and earlier snowmelt would reduce spring meltwater flows. There are some suggestions that more intense precipitation events might occur in spring and autumn, with fewer in the summer. Together with an expected overall decline in summer precipitation, these changes could lengthen the periods of low flow in summer, although elsewhere there are expectations of higher summer rainfall.

Both direct and indirect consequences of climate change on water quality can be anticipated. Where intensive rainfall events become stronger and more frequent, greater flushing of diffuse agricultural pollutants to both surface water and groundwater could result, and the frequency and severity of polluted urban stormflows could increase. Overall increases in annual rainfall could have the effect of diluting diffuse pollutants. Hotter and drier summers would enhance mineralisation reactions in the

[18] *Source:* The European Environment: State and outlook 2010. EEA. 2010.
[19] *Source:* Impacts of Europe's changing climate — 2008 indicator-based assessment. Joint EEA-JRC-WHO report. EEA-JRC-WHO, 2008.

soil and thereby potentially increase nitrate concentrations in water. Rising water temperatures will increase the likelihood of cyanobacterial blooms, and hotter and drier summers would deplete river flows, reduce dilution capacity and lead to higher pollutant concentrations and possibly fish deaths (temperatures above 25ºC can be fatal).

In relation to management of the Genevese transboundary aquifer, the extreme heat wave of 2003 and heavy storms of 2007 both produced high turbidity in the Arve River water. This rendered the water unsuitable for artificial recharge of groundwater, and the plant had to be closed. Thus, opposite meteorological extremes had the same practical impact, highlighting the potential implications of climate change for the control and management of artificial groundwater recharge with river water.

Climate change may also produce changes in land use, agricultural activities and cropping patterns. Rising temperatures may result in the northward extension of cultivation of a whole range of crops. Hotter and drier summers are likely to increase the demand for seasonal supplementary irrigation, both within and beyond existing irrigated lands. Modelling studies in the Guadalquivir River Basin suggested an increase in seasonal irrigation requirements of 15% to 20% by the 2050s, and even in the United Kingdom irrigation demand is likely to increase.[20] These substantial demands may be difficult to predict and plan for.

Overall, whilst potential climate change impacts will vary, with the mountain areas particularly affected, this subregion may have the greatest capacity for adaptation to climate change. Policy choices to mitigate impacts are important, and some promising efforts are already being made in several of the major transboundary basins – the Rhine, Meuse and Danube. In the Rhine Basin an expert group has been established to review the state of knowledge of climate changes so far, and their likely impacts on the water regime in the Rhine Basin. Whilst annual average run-off remains largely constant, there is a transfer of flow from summer to winter. Further work involves drafting a scenario study for the flow regime of the Rhine, and, based on results, adaptation strategies will be drafted within the ICPR. In the Meuse, an EC Interreg project is currently working with the support of the International Meuse Commission to define a common strategy for adapting to the consequences of climate change in the river basin and measures for addressing the higher discharges, less rapid drainage and consequent increased flood risk that are likely to occur. This work will also contribute to the implementation of the EU Floods Directive. For the Danube, work has also been initiated to analyse the state of knowledge on climate change and its impacts in the basin as a basis for discussing adaptation strategies.

Policy with respect to climate change adaptation is also being developed at national level. In Slovakia, for example, a national climate programme was established in 1993 to establish relevant monitoring and interpret the results in relation to possible climate change impacts on hydrological variability, agricultural production and forest ecosystems. The programme also considers and proposes adaptation measures to reduce the negative impacts of climate change on the management of land and water resources.

RESPONSES

Until recently, water management has largely been directed towards increasing supply from wells, reservoirs, water diversions and desalination. Recognising that this could not continue indefinitely, attention has turned to the management of water demand by measures such as water pricing mechanisms, reduction of water losses, water reuse and recycling, increasing the efficiency of domestic, agricultural and industrial water uses, and water saving campaigns supported by public education. Reducing water demand can bring additional benefits in decreased pollution discharges and lower energy consumption.

The potential for water saving is considerable, with estimates that water efficiency could be improved by 40% through technological improvements alone,[21] with changes in behaviour or production processes producing additional savings. At the household level, this is largely a matter of combining water-efficient installations with raising awareness. Industrial users have reduced water use by recycling, reuse, changing production processes, using more efficient technologies and reducing leakage.

The EU sixth Environment Action Programme and EU water legislation, including the WFD, aim to ensure that water abstraction is sustainable over the long term, and to promote the protection of water resources. Moreover, in 2007 the European Commission adopted a Communication "Towards Sustainable Water Management in the European Union" related to water scarcity and droughts.[22] This set out the measures needed for a water-efficient, water-saving economy, with full implementation of the WFD to include water pricing policies, and sustainable land-use planning.

The WFD requires Member States to implement water pricing policies which provide adequate incentives for using water efficiently. In practice, this usually means a combination of pricing and metering, which has been highly effective in changing consumer behaviour in many countries. Increased water prices have been a major factor in reducing public water demand in Eastern Europe, and have contributed to a desire for water saving in Western Europe.[23] To encourage efficient water use, pricing must be related to the volume of water consumed. Metering therefore plays a key role, and should be introduced for all sectors of water users, although not all countries meter the majority of water users.

In the southern part of the sub-region, agriculture is by far the dominant water use by volume abstracted from rivers and aquifers. Farmers have frequently changed to more water-intensive crops because of the high yields obtained and the high prices commanded, but agricultural users generally pay much less for water than other users. In Greece and Spain, for example, water for agriculture costs about €0.05/m^3, compared with €0.85 to €1.35/m^3 for household and industrial use.[24] If water for agriculture were paid for by volume and with the price reflecting full resource and environmental costs, farmers would respond by improving the timing of irrigation, adopting more efficient techniques such as sprinkler and drip irrigation, and changing to less water-demanding crops. In Spain, the total irrigated area has remained stable from 2002 to 2008 at 3.4 million hectares, while the area under gravity flood irrigation has decreased from

[20] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[21] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[22] Communication from the Commission to the European Parliament and the Council "Towards sustainable water management in the European Union - First stage in the implementation of the Water Framework Directive 2000/60/EC". COM(2007) 128 final. Commission of the European Communities.
[23] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.
[24] *Source:* The European Environment: State and Outlook 2010, Country Assessment — Greece. EEA. 2010.

1.4 million to just over 1 million hectares, and the area watered by drip irrigation increased from 1.1 to 1.6 million hectares. In 2006, water use for drip irrigation was 3,800 m^3/ha, compared to 6,200 m^3/ha for gravity irrigation. In some cases the savings in water achieved by more efficient irrigation have been used by farmers to irrigate larger areas of land.

Leakage of water from supply systems in parts of the subregion remains substantial, and countries face major challenges to reduce these losses. Investment in detecting and repairing leaks is important, and improvements to the construction and maintenance of water supply systems have reduced leakage losses throughout the sub-region. In the past 10 to 15 years, 30-50% reductions in leakage have been achieved in the Czech Republic, Denmark, England and Wales, Germany, Malta, the Netherlands and Spain. In the Czech Republic, Spain and the United Kingdom they are now down to 20% or below.[25] In a few countries, such as Germany and Denmark, losses are down to 10% or even lower, which is probably close to the limit of what is technically and economically feasible. Such conservation measures have significant economic and environmental benefits, delaying or avoiding additional water supply abstraction, reducing sewage generation and investment in treatment capacity, and reducing energy requirements for abstracting, treating, and transporting both clean water and wastewater.

There have been visible benefits for the protection of water resources in the last two decades, thanks to investments in wastewater treatment. These have produced measurable improvements in water quality, particularly with respect to nutrients, biochemical oxygen demand, ammonia and hazardous chemicals. Much of the early concern focussed on pollution from both active and closed industrial sources. For instance, between 1987 and 2000, measures under the Rhine Action Programme led to improvements in river water quality, recovery of the fauna, and a significant reduction in the number and severity of accidental pollution incidents.

This process has been given further impetus by the implementation of the UWWTD. Countries in the north and centre of the sub-region were already well provided with tertiary wastewater treatment for their urban populations. More than 96% of the 58 million inhabitants in the Rhine Basin are connected to wastewater treatment plants, and many industrial sites now have modern and comprehensive wastewater treatment facilities. In the northern countries of the sub-region, tertiary treatment has been provided for 70-80% of their populations for over twenty years, and the remaining 20% or so live in small, scattered rural communities, with small-scale sewage treatment systems or septic tanks, which are, nowadays, quite strictly regulated. With conventional substances such as nutrients and certain heavy metals largely addressed, the focus of urban wastewater treatment in these countries is increasingly shifting to address the elimination of micro pollutants. Investment in environmental measures does, therefore, pay, but continuing efforts are required. However, it can become disproportionately costly to serve the last communities in basins where most of the population are already connected to sewerage systems.

In countries in the south and centre of the subregion, the proportion of national populations connected to wastewater treatment systems has increased within the last two decades, and the proportion of plants with secondary or tertiary treatment have also increased substantially over the same period. In the Oder Basin, for example, some 500,000 and 150,000 additional people in the Polish and Czech parts, respectively, are expected to be connected to sewage systems between 2005 and 2015. Continuing investment will still be required to increase coverage, and maintain or replace ageing water supply and sanitation infrastructure. The high infrastructure costs of meeting the requirements of the UWWTD place a particular burden on new EU member States, who are therefore given more time to achieve compliance.

However, whilst implementation of the UWWTD has resulted in more of the subregion's population being provided with

[25] *Source:* The European Environment: State and Outlook 2010. EEA. 2010.

wastewater collection and treatment systems, there remains considerable scope for increased control of pollutants at source.

Agriculture remains the dominant land use in most of the large transboundary river basins, but nitrogen fertiliser applications to crops have been decreasing in recent years. This is largely driven by stricter environmental legislation such as the Nitrates Directive. Increasing demand for organic produce, the high cost of fertilisers, scientific advances in improved crop strains and modern application techniques have also played their part. In the Rhine Basin, a reduction of up to 15% in the nitrogen load from agricultural sources is targeted by 2015.

Implementation of the Nitrates Directive is likely to result in further improvements in the quality of both surfaces waters and groundwater. Ten EU member States have designated their whole territory as Nitrate Vulnerable Zones, and in the remainder substantial areas of agricultural land have been designated, overall comprising almost 40% of the area of the EU. Member States have established action programmes of measures, almost all of which incorporate a manure nitrogen application threshold of 170 kg/ha/year. Other measures in the directive include the development of comprehensive codes of good agricultural practice, and restrictions on the timing of fertiliser applications and on the types of vulnerable land to which fertilisers can be applied. However, even where full compliance is assured, sufficient improvement in water quality may not be achieved, and the beneficial impacts of the measures will take years or decades to become apparent, especially in many of the subregion's deeper groundwater systems.

For the larger river basins, restoring river hydromorphology remains a major challenge. The hydrological regimes of many wetland systems have been heavily altered in the past by the river engineering activities mentioned above, and, as a result, many of the major European rivers have been separated from their floodplains. Realising that rivers cannot be properly managed in isolation from their floodplains and without a better balance between user needs, numerous restoration projects are underway. These measures can provide greatly improved ecosystem services, encourage habitat restoration and restore biodiversity.

This is illustrated particularly by efforts to restore continuity of the Rhine, to allow improved fish migration under the "Master Plan Migratory Fish Rhine", efforts which are already showing progress. The programme will eventually re-establish spawning habitats, and improve fish passage close to the coast and at dams further up the Rhine and its major tributaries. To build up self-sustaining stocks of salmon, access must be restored to a maximum number of identified spawning and juvenile habitats in the Rhine catchment, and greater facility for upstream migration allowed. Activities to support this include work on two dams in the Upper Rhine at Strasbourg and Gerstheim by 2015 to allow access to the Elz-Dreisam system in the Black Forest, improving existing fish passages at four dams on the High Rhine and at several barriers on the navigable tributaries that are the Moselle, Main, Lahn and Neckar. Such measures are also a feature of responses in the Moselle and Saar and in the Scheldt. The Master Plan also covers the protection of lake trout in the parts of the basin beyond the natural fall of the Rhine at Schaffhausen.

Efforts to restore the ecosystems of the Upper Rhine have resulted in the transboundary French-German Upper Rhine Ramsar Site. Designation of this strip of forests and floodplains stretching 190 km from Basel to Karlsruhe in 2008 took 16 years to achieve. Management of these transboundary wetland ecosystems is led

by a tripartite intergovernmental council — the Upper Rhine Council — and facilitated by the establishment of a trans-border Rhine Park, supported by NGOs targeting sustainable tourism, salmon restoration and waterfowl. In the Swiss part of the Rhine Basin, a recently enforced amendment of Swiss water protection legislation requires restoration of the natural functions of waters and strengthening of their social benefits, along with more stringent measures to eliminate the major negative environmental effects from hydroelectric power generation.

Almost all of the pressures outlined above are present in the Raab/Rába basin, shared by Austria and Hungary, such that only two of its 30 surface water bodies are presently of good status. Specific measures to be taken include reducing regulation of the rivers, modifying the operation of barrages and constructing fish channels, providing buffer protection strips along the river, reducing nutrient loading from arable and livestock farms, and supplying additional water to the oxbow ecosystems in the flood plain close to the river. These are likely to be required through three RBMP cycles until 2027, in order to reach good status for surface water and groundwater.

Restoration measures are also important in heavily modified lowland river basins. The Wiedau River, shared between Denmark and Germany and discharging into the Wadden Sea, has been highly controlled by weirs and gates to protect it from tides and surges. During the last decade, a number of projects have been completed to make the weirs passable for migrating fish, and to return straightened and modified stretches of the river to its original meandering course.

With regard to responses, it is essential that the implementation of programmes of measures under the WFD is coordinated at the basin level. This requires transboundary agreements on the measures to be taken, political commitment to their enforcement, and sustained cooperation to monitor their effectiveness. Thus, for the Scheldt basin, a transboundary Catalogue of Measures, directed at a range of pressure factors, has been developed, in which the countries will provide comparable details of their measures. Measures are classified according to sector of human activity, the subject or source of pollution to which the measures are addressed, the environmental compartment they are directed at, and the groups of pollutants they are intended to control or reduce. At a more local level, joint lists of restoration measures are compiled under the common management strategy developed for the Morava-Dyje-Danube floodplain.

For many intensively-farmed areas, the programmes of measures developed under the Nitrates Directive will not, by themselves, necessarily be enough to restore water quality. In some countries, local, more intensively targeted measures have been developed. In the German Federal State of Baden-Württemberg, the local Agro-Environmental Programme uses a point scoring system for a range of farming actions designed to minimise nutrient pollution, and provides payments of 10 euros per hectare for each credit point.

Considerable advances have been made in providing early warning of accidental pollution. The International Warning and Alarm Plan for the Elbe was established in 1991 with five warning centres. The plan is upgraded and revised from the experience of any accidents which occur and is regularly tested, and considered a major defence against transboundary impacts of accidental pollution. Similar warning systems for river basin protection are operated by other international commissions.

Where it is particularly difficult to achieve good status by 2015, the WFD allows extensions to this deadline for reasons of technical unfeasibility or disproportionate costs of response measures, or because the local natural environment and flow regimes mean that the beneficial impacts of the measures will be very slow to appear. The first two often apply to engineering works to improve the hydromorphological conditions, and the last to nitrate pollution of groundwater. Thus, in the Meuse for example, only about 280 out of 777 surface water and 42 out of 82 groundwater bodies are expected to reach the WFD targets by 2015, and 492 surface water and 29 groundwater bodies will require deadline extensions for one or more of the reasons mentioned above.

EU member States are now beginning to establish activities related to the implementation of the Floods Directive. The lower part of the Klarälven is included in a pilot programme within the directive. In the Moselle and Saar, the Flood Action Plan, which was adopted in 1998 by the Commission and outlines activities up to 2020, will be incorporated into the flood risk planning required by the Floods Directive. The same applies to existing flood action plans or programmes in other international basins.

THE WAY AHEAD

A comprehensive range of EU legislation has been established to protect freshwater from pollution. Full compliance with this legislation would result in substantial improvements in water quality, but the extent to which these can be achieved could be constrained by several factors, not least of which is the economic costs that will need to be borne by society to achieve good status under the WFD.

Although the legislative framework is well established, long-term political and institutional commitment will be needed to achieve the desired environmental benefits. In the Elbe Basin, for example, the expected reduction in nutrient loading in the first RBMP period to 2015 is 6% for nitrogen and 9% for phosphorus. These are expected to result from measures to control nitrogen applications in excess of crop requirements, improve cultivation practices to help reduce nitrogen losses from the soil, and establish riparian buffer zones without fertiliser applications, which will encourage denitrification. Even with these measures, the basin management plan anticipates the need for slow reductions in loading until 2027, because of the issues of technical feasibility and natural conditions referred to above.

Along with the requirement for long-term commitment will come a need for regular review and updating of monitoring programmes to take account of, for example, new substances and hazards, and evaluation of the effectiveness of programmes of measures and other responses. It will be important in this process to review the lessons learned from implementation. In the Rhine Basin, for example, key lessons suggest it is important to establish priorities and tackle the important tasks first, allow for adequate public and stakeholder participation at the local level, keep things simple and concentrate on measures that are well understood. Ecological restoration is a complex process, but finding a symbol, in this case fish life, that both politicians and the public understand, has been of considerable benefit.

Other current and future driving forces could instead have negative impacts on water quantity and quality in the coming years. These include climate change impacts as well as changes in land use. Most studies predict a continuing decline in grassland cover in the countries of the EU, with the area of permanent crops remaining stable or decreasing.

However, European legislation does not always move consistently in the same direction, and implementation of the Renewable Energy Directive, for instance, is likely to result in an increase in the cultivation of biofuel crops. As it is unlikely that less food will be produced, formerly natural grassland or woodland might start to be cultivated, resulting in the release of additional carbon and nitrogen into the environment and increased use of agrochemicals. Implementation of this Directive is also likely to increase demand for hydro-electric power generation, with consequent pressures and impacts on surface water systems. Adaptation policies related to climate change and long-term energy provision need to be developed to minimise the negative impacts on freshwater systems, and hence to avoid simply transferring environmental problems between sectors.

The political changes in Europe from 1989-90 resulted in less pronounced decreases in water abstraction and consumption in Western and Central Europe than in other subregions. Nevertheless, within the Oder Basin, water consumption declined by 25-30% and, although demand has begun to recover, present water sources should meet demand at least until 2015. These economic and social changes also led to sharp declines in industrial activity and reductions in agrochemical usage, and hence pollution loading, but these are now beginning to recover and this is likely to continue.

Illegal abstraction, particularly from groundwater for agricultural use, is widespread in some countries. Addressing illegal water use presents major political challenges, and requires surveillance and fines to detect and control such activities. From 2010 the Good Agricultural and Environmental Condition framework, developed as part of the EU cross-compliance mechanisms, includes requirements for improved authorisation of water for irrigation. This should help in water management by providing a means by which member States can control illegal abstraction of groundwater by unauthorised wells.

There remains a need to strengthen the integration of European policy so that improvements in water management are not compromised by policies in other sectors, such as the EU Common Agricultural Policy and the proposed trans-European waterway network. Recent reforms of the CAP and Swiss agricultural policy have resulted in a decoupling of agricultural subsidies from production, and the introduction of cross-compliance mechanisms to help address environmental concerns. Further reform of agricultural policies is, however, required to improve water use efficiency and irrigation practices.

CHAPTER 2 SOUTH-EASTERN EUROPE

INTRODUCTION

The subregional assessment of transboundary waters in South-Eastern Europe (SEE) covers transboundary rivers, lakes and groundwaters shared by two or more of the following countries: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, Montenegro, Romania, Serbia, Slovenia, the former Yugoslav Republic of Macedonia and Turkey. The assessments of the individual transboundary surface and groundwaters in this subregion can be found in the Chapters 5 and 6 of Section IV (drainage basins of the Black Sea and of the Mediterranean Sea). The assessment of transboundary waters in SEE also contains assessment of a number of selected Ramsar Sites. Besides the assessed Ramsar Sites, there are important transboundary wetland areas elsewhere in SEE, e.g., the delta of Maritsa/Evros/Meriç River (a part of it is also a Ramsar Site), as well as important human-made wetlands, such as reservoir lakes and fish farming ponds along the Drava, Mura and smaller rivers in SEE. Very extensive river flood-plains, temporary flooded grasslands and fens provide a number of services such as water storage, groundwater replenishment and support for livestock farming and biodiversity. The transboundary lakes Ohrid and Dojran are also of great socio-economic and cultural importance. Along the Adriatic and Aegean Seas an important number of coastal lagoons, salt-pans, and river delta wetlands exist in Albania, Croatia, Greece, Montenegro and Slovenia. The same is true for the Black Sea coast of Bulgaria, Romania and Turkey.

There are 13 major transboundary rivers and four major international lakes, as well as more than 50 transboundary aquifers, in SEE. With transboundary basins covering about 90% of the area of SEE, and more than half of these being shared by three or more countries, cooperation for effective shared water resources management is of particular importance, so as to ensure the resources' protection and sustainable use.

There is an increasing understanding that cooperation on transboundary waters provides opportunities for the creation of synergies and benefits for all parties involved. There is also an increasing consensus that countries should work to create a sustainable framework for cooperation at the transboundary level that will allow for sharing these benefits. Nevertheless, there are still numerous obstacles in achieving this objective that derive from the interdependence and the potential conflicts that exist among different uses. Non-harmonized legal and institutional frameworks and varying infrastructure development and, in some cases, diverging priorities and conflicting interests among riparian countries, as well as political unrest in specific parts of the subregion, add to a complex picture.

A remarkable number of actors active in the subregion are supporting sustainable water resources management and transboundary cooperation. The role of EU, several United Nations agencies and other international organizations, as well as of donor countries and NGOs, has been important in this regard.

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORKS FOR TRANSBOUNDARY WATER MANAGEMENT

The establishment of IWRM in shared basins depends largely on the water management frameworks at the national level. In SEE, these are either under a reform process or have been through one recently. The EU *acquis communautaire* and in particular the WFD constitute the basis for this reform process both for the countries that are members of the EU and, to a certain extent, also for those that are not yet members.[1] The Stabilization and Association Process and the EU Accession Process have played an important role in calling for integration of policies and supporting water-related investments. These processes in the different

[1] Greece, Slovenia, Bulgaria and Romania are members of the EU.
Croatia has been a candidate country for EU membership since 2004. The Stabilization and Association Agreement (SAA, the contractual basis for relations between each individual country and the EU) with the EU was signed in 2001 and entered into force in 2005. Accession negotiations opened in 2005. In February 2008, the Council adopted the new Accession Partnership (AP) for the country.
Turkey is a candidate country for EU membership. Accession negotiations started in 2005. Since then, the EU provisionally closed one chapter and opened negotiations on eleven chapters. The environment chapter was opened in December 2009. In February 2008, the Council adopted a revised AP with Turkey.
The former Yugoslav Republic of Macedonia has been a candidate country for EU membership since 2005. The SAA was signed in 2001 and entered into force in 2004. In February 2008, the Council adopted the AP for the country.
Albania is a potential candidate country for EU accession. In February 2008, the Council adopted a new European partnership with Albania. The SAA was signed in 2006 and entered into force in 2009.
Bosnia and Herzegovina is a potential candidate country for EU accession. The SAA was signed in 2008 and has been ratified by the Parliament of Bosnia and Herzegovina. A new European partnership with Bosnia and Herzegovina was adopted by the Council in 2008.
Montenegro is a candidate country for EU membership. The SAA was signed in 2007 and entered into force in 2010. A European partnership with Montenegro was adopted by the Council in 2007.
Serbia is a potential candidate country for EU accession. The SAA was signed in 2008; ratification is pending. In 2008, the Council adopted the new European partnership for Serbia.

non-EU countries, and hence the reform of the water sector, have progressed at a different pace, depending on the evolving cooperation framework with the EU as well as the prevailing socio-economic situation and administrative capacities. Adoption and implementation of demanding legal instruments such as the WFD require enhanced institutional capacities, and have proved a challenging task.

Overall, the progress in lawmaking is considerable; new laws on water have been adopted or are planned to be adopted, e.g., in Albania and Serbia. Nevertheless, there are deficiencies in the area of implementation and enforcement. The reasons are manifold. In some cases, even new laws lack key elements such as definitions, precision of rights and obligations and setting of standards, and also fall short in terms of determining procedural stages. Many are framework laws and require the adoption of secondary legislation and a set of regulations; steps have been taken, but there is still a long way to go.

The overall administrative capacity is another important reason for implementation and enforcement deficiencies, despite the ongoing reforms. Overlapping competences and fragmentation of responsibilities among different institutions and management agencies often occurs and so does a lack of effective coordination among the different ministries/authorities. Insufficient human, financial and technical resources are an additional barrier. The situation becomes even more complicated when efforts are made for more decentralization and management at the local level.

The aforementioned difficulties do not come as a surprise, since the setting up of a properly functioning legal and institutional framework needs considerable time and resources to develop. Reforms have started only in the near past in an environment of transition, political instability, limited resources and often poor social cohesion. Difficulties are more evident for sectors that need major capital investments, such as those with wastewater treatment and solid waste management. It has to be kept in mind that even EU member States, although markedly ahead, are still struggling with similar challenges. Nevertheless, overall progress at the national level is evident in all non-EU countries, especially in Croatia and the former Yugoslav Republic of Macedonia, which have been candidates for membership since 2004 and 2005, respectively.

The institutional frameworks for water resources management vary. In all cases though, there is a ministry with the prime responsibility for the development and implementation of policies and the preparation of the relevant legislation. Nevertheless, responsibilities in different fields are shared by a range of institutions and authorities holding competences that touch upon water and natural resources management and environment in general.[2]

IWRM at the basin level has only partially been adopted in the countries that are not EU member States. There is a history of efforts at the level of strategic planning (strategies, action plans, etc.) and adoption of legislation providing a basic framework for management at the basin level and including provisions for integration. However, implementation and enforcement remain considerable challenges. As far as the EU members are concerned, water resources management is practised at the basin level pursuant to the WFD – River Basin Management Plans (RBMPs) being the main tools.

With regard to shared waters, the countries have pursued their management from a predominantly national perspective. The level of cooperation varies, even among different basins shared by the same two countries. In general, this has been influenced by political and socio-economic developments at the regional and national levels, evolving needs and bilateral relations. Given the limited capacity, the process of approximation to the standards of the EU in recent years has in some cases had adverse effects on transboundary cooperation. As the transposition of the EU *acquis* and the implementation of new pieces of legislation have been a priority for most of the countries, the institutional burden linked with this effort in combination with restricted human resources has often left transboundary cooperation as a lower priority.

Nevertheless, progress, although slow, has been achieved at the transboundary level. Agreements and memorandums of understanding have been signed, and joint work has been undertaken in several cases. Agreements and arrangements vary in terms of geographic coverage — covering all waters shared by contracting parties or only specific basins — as well as in terms of scope. Some concern specific issues such as protection against

natural and civic disasters, navigation, or flooding and seasonal drought. Others have a broader scope, such as water management relations and the use of waters in transboundary rivers.[3]

Setting up joint commissions to monitor and control the implementation of the agreements is not rare. Examples include the joint commissions that have been set up between Croatia and Bosnia and Herzegovina, Croatia and Slovenia, Croatia and Hungary, Croatia and Montenegro, Serbia and Romania, Serbia and Hungary and Romania and Hungary. In some recent agreements concerning specific shared river/lake basins, the role of joint bodies has been further strengthened, and while there are differences in their scope and structure, the coordination of actions for the management of the shared water body is among the main aims, while cooperative management will be an eventual aim.

Cooperation between Albania and the former Yugoslav Republic of Macedonia on Lake Ohrid was formalized through the signing of the Agreement for the Protection and Sustainable Development of Lake Ohrid and its Watershed by the Prime Ministers of the two countries in 2004. The Lake Ohrid Watershed Committee was established in 2005.

[2] A brief description of the water resources management framework in each of the countries can be found in annex I.
[3] Information on the existing agreements for transboundary water cooperation can be found in annex II.

The Agreement for the Protection and Sustainable Development of the Skadar/Shkoder Lake was signed in 2008 by Montenegro and Albania. It serves, inter alia, as the legal instrument for the implementation of the joint Strategic Action Plan regarding the lake, previously agreed by the two countries. The Skadar/Shkoder Lake Commission was established in 2009.

The most successful example of transboundary cooperation in SEE is the Framework Agreement on the Sava River Basin (FASRB) between Croatia, Bosnia and Herzegovina, Serbia and Slovenia, signed in 2002 and in force since 2004. It integrates most aspects of water resources management. Three protocols to the FASRB have been signed so far, while four additional ones are in different stages of preparation. The International Sava River Basin Commission (ISRBC) has been established, with the legal status of an international organization, for the purpose of implementation of the FASRB and the realization of the following mutually agreed goals: (a) establishment of an international navigation regime on the Sava and its navigable tributaries; (b) establishment of sustainable water management; and (c) undertaking measures to prevent or limit hazards and to reduce or eliminate their adverse consequences. FASRB gives to the ISRBC the international legal capacity for making decisions in the field of navigation and providing recommendations to the countries on all other issues.

A new agreement between Romania and Serbia is under development. Informal arrangements such as in the case of the Prespa Lakes, shared by Albania, Greece and the former Yugoslav Republic of Macedonia, may also deliver results. The Prime Ministers of the three countries declared the Prespa Lakes and their catchment as "Prespa Park", the first transboundary protected area in South-Eastern Europe" in 2000. The Prespa Park Coordination Committee has been established as a non-legal entity. Work coordinated by the Committee has led, among others, to the joint preparation of a Strategic Action Plan, adopted in 2004, providing a direction for sustainable development in the basin. An official agreement on the Protection and Sustainable Development of the Prespa Park Area was signed by the Environment Ministers of the three countries and the EU Environment Commissioner in 2010, setting out detailed principles and mechanisms of transboundary cooperation.

In most of the shared basins and aquifers, however, steps such as those described for the three shared lakes and the Sava River have yet to be taken. Among the reasons are the low political prioritization of the issue, financial constraints and, in some cases, insufficient institutional capacity. Conflicting interests among countries may also be a reason. These reasons, as well as different interpretation of provisions, have also affected the implementation of legal arrangements that are in place.

Regarding transboundary aquifers, in addition to the reasons mentioned above, the currently low knowledge level adds to the difficulties of transboundary cooperation. In many cases there is lack of consensus between the countries about the extent of aquifers or even their transboundary character. The First Assessment revealed many such examples. Different positions between countries regarding the transboundary character of an aquifer, its real extent or its hydraulic connection to surface water systems also emerged in the preparations of the Second Assessment.

At the regional level, the WFD and the UNECE Water Convention are the two main frameworks that support water management and cooperation. Their consistency and complementarity represent a great asset for the subregion in terms of promoting cooperation through harmonization of policies and legal frameworks on the one hand and providing a set of sound rules and conditions for cooperation on the other.

However, the different levels of advancement in the transposition and implementation of the WFD and in the ratification to the Convention create some imbalances in many of the shared basins and prevent their application. It is a positive development that, since the First Assessment, Bosnia and Herzegovina and Serbia have acceded to the Convention and that the former Yugoslav Republic of Macedonia is preparing for accession.

MONITORING OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

The difficult conditions of the recent past in the area have had an effect also on the monitoring capacity of most of the countries. Monitoring systems have deteriorated and systematic monitoring in most of the cases have been interrupted for a period of time. Technical difficulties and limited financial resources have also reduced the availability of data and information. At present, most of the countries are in the process of improving their monitoring systems.

The non-integrated management of water resources and the lack of coordination among institutions have affected both monitoring capacity as well as at the availability of data produced. Often, responsibilities for monitoring are fragmented between different institutions. Charging for data between Government agencies and services in some cases discourages the use of all data relevant to support decision-making. The ongoing reform in the water sector is an opportunity to improve coordination between institutions involved in monitoring and assessment, and also to involve the scientific community and academia.

All countries have established a certain level of monitoring of surface waters. In general, monitoring of groundwaters is less advanced in terms of quantity, and especially in terms of quality. For many countries (particularly for non-EU countries), either quality or quantity monitoring has to be improved or still needs to be established. Some countries have jointly carried out a groundwater body characterization according to the requirements of the WFD, e.g., Austria and Slovenia characterized the Karstwasser-Vorkommen Karawanken/Karavanke aquifer.

In the EU member States, monitoring, assessment and reporting activities are mostly guided by the obligations of the different EU water-related directives, in particular the WFD. But also, for some water bodies shared by EU countries, it was reported that monitoring needs to be improved at the national level and to be improved or established at the transboundary level.

The approximation to the EU *acquis communautaire* and the transposition of the WFD also has advantages for monitoring and assessment at the transboundary level, as they bring the national systems closer together and promote harmonization.

In most transboundary basins in the subregion, information exchange is still very weak and the information produced in riparian countries is not harmonized. Joint monitoring and assessment is almost non-existent.

Nevertheless, there are positive exemptions. For example, Bosnia and Herzegovina and Croatia exchange information on the Trebišnjica/Neretva left aquifer. There is established cooperation between Hungary and Serbia regarding the exchange of harmonized information on the basis of relevant agreements.

Such agreements also exist between some of the countries that are Parties to the FASRB. The existence of the ISRBC facilitates the flow of information between countries. Serbia and Romania have established cooperation on monitoring the common sector of the Danube, and are producing harmonized information. Regarding Lake Ohrid, Albania and the former Yugoslav Republic of Macedonia have harmonized procedures for water monitoring and established joint protocols for sampling analysis and quality assurance. Efforts have started in the Prespa Basin, aiming to create a joint monitoring system to address biotic and abiotic parameters.

Certainly the most advanced example is the cooperation on monitoring under the Danube River Protection Convention. The Transnational Monitoring Network has been established to support the implementation of the Danube Convention and was revised in 2006 to ensure full compliance with the provisions of the WFD. The Network is based on national surface water monitoring networks and includes monitoring locations across the Danube (thus including the Iron Gates Reservoirs) and its main tributaries. Hence, it covers the Sava (as well as some of its main tributaries, notably the Una, the Vrbas and the Bosna), the Drava, the Tisza and the Velika Morava.

In the Maritsa/Evros/Meriç Basin, cooperation between the competent authorities of Bulgaria and Turkey has led to the establishment of four telemetry hydrometric stations in the Bulgarian part of the basin. The stations supply both countries with continuous real time data.

MAIN PROBLEMS, IMPACTS AND STATUS

Transboundary resources in the subregion commonly face numerous challenges: surface water and groundwater pollution from urban wastewater and agriculture; old, yet still operational, industrial facilities and mines; illegal wastewater discharge; and waste deposits; water scarcity; destructive floods; declines in groundwater levels; and saline water intrusion in deltas and coastal aquifers.

Regarding consumptive uses, agricultural irrigation and drinking water supply rank first by the share of total volume of water used in the basins. Water use for crop production has an important share in the waters in the Aegean Sea Basin; this can reach more than 50% in the Bulgarian part of the Maritsa/Evros/Meriç subbasin and more than 80% in the Turkish part of the Maritsa/Evros/Meriç Basin.

Domestic water supply is the main use for most of the waters in the Black Sea Basin, followed by industrial water supply, agricultural irrigation and livestock raising; the order may vary on a case-by-case basis. As an example, in the Sava River Basin and in the Iron Gates Reservoirs, drinking water supply is the main use, followed by agricultural irrigation (not taking into account the water used for hydropower production). In Somes/Szamos alluvial fan aquifer (Romanian part), drinking water supply and industry are the main groundwater uses.

Water-use efficiency in the agricultural sector is a key issue due to the unsustainable irrigation techniques used and the deficiencies in the irrigation systems. Water loss due to the degraded drinking water supply networks is also an issue for many countries, such as Bosnia and Herzegovina, Montenegro and Albania; these losses are estimated in some cases to be more than 50%.

Groundwater abstraction is a major pressure factor in many basins and aquifers, such as the Skadar/Shkoder Lake sub-basin, the North and South Banat, the North-East Backa/Danube-Tisza Interfluve and the South-Western Backa/Dunav aquifers.

Agricultural activities contribute to the chemical pollution of water resources, mainly by nitrogen and phosphorous due to use of fertilizers, and pesticides. Pressure varies among basins due to countries' specific hydrometeorological and socio-economic conditions (e.g., the need or financial capacity for agricultural irrigation), crop types and production patterns. Adverse effects on aquatic- and water-related ecosystems include the loss of biodiversity and the deterioration of ecosystems. Diffuse pollution from agriculture is reported to be an issue, inter alia, in the Sava, Mesta/Nestos, Maritsa/Evros/Meriç and Somes/Szamos Basins. Unsustainable agricultural practices exert pressure both on surface and groundwaters in the basins of Neretva and Trebišnjica, as well as in the Prespa sub-basin.

Nutrient-loading deriving from diffuse pollution and the insufficient treatment of urban wastewater has resulted in the slight eutrophication of the Skadar/Shkoder Lake. Pollution reaches the receiving seas, e.g., considerable nutrient loads get transported into the Adriatic Sea via the Drin River.

Inappropriate sanitation — insufficiently treated and/or untreated wastewater and/or improper use of septic tanks (mainly in rural areas) — as well as illegal wastewater discharges, are a major source of pollution for the river basins of the Sava, Maritsa/Evros/Meriç, Timok, Struma/Strymonas, Mesta/Nestos, Nisava and Neretva and in the Iron Gate reservoirs. Related impacts were reported for many groundwater bodies as well, e.g., in the Neretva and Trebišnjica hydrogeological basin, the Stara Planina/Salasha Montana and Tara.

Insufficiently treated and/or untreated industrial wastewaters (including illegal discharges) lead to water resources pollution by organic compounds, heavy metals and other hazardous substances. Although industrial activity has significantly declined in the Skadar/Shkoder sub-basin, unsustainable industrial wastewater management affects the quality of the lake, including sediments. Untreated industrial wastewater is a pollution source in the Ohrid, Maritsa/Evros/Meriç, Neretva, Somes/Szamos and Trebišnjica Basins for both surface and groundwater bodies. In the Sava Basin, hazardous substances pollution is reported.

Illegal waste disposal/uncontrolled dumpsites have been exerting pressures or are a potential pressure factor in a number of shared basins, impacting both surface and groundwaters. These include the Sava, Nisava, Neretva (where both municipal and industrial waste was reported), Struma/Strymonas and Mesta/Nestos Basins and the Drin River and Skadar/Shkoder Lake sub-basins.

In the Drin River Basin, impacts from mining activities are likely to still be an issue for the Drin River and Lake Ohrid and, to a lesser extent, in the Skadar/Shkoder sub-basin. In some other basins, mining activities are reported to have impacts of low intensity and of local character.

Tourism activities, in the coastal areas of basins such as the Neretva and around Lakes Ohrid, Skadar/Shkoder and Prespa, exert pressures since they periodically increase the liquid and solid waste generation as well as the water demands. Illegal construction linked with tourism is of concern, e.g., in the Drin Basin, especially in the Albanian part.

When extensive, all of the above pressures may commonly result in transboundary impacts and pollution.

Climate change has already impacted some areas and may have significant further impacts in the future. Bulgaria reported that climate change has resulted in an approximately 30% decrease in precipitation and a subsequent decrease in water resources in the Mesta/Nestos Basin and Maritsa/Evros/Meriç sub-basin over the past 20 years. According to the Intergovernmental Panel on Climate Change (IPCC), SEE is among those subregions projected to be most severely hit by climate change. Decreasing summer rainfall, decreasing average run-off and low summer flows are projected, as well as increasing frequency and severity of droughts, the risk of floods, and other extreme weather events. This is expected to result in an increased water availability/demand gap, the deterioration of water quality as a result of decreased flows, as well as other important impacts, such as damage to human health and settlements, forest fires, increasing desertification, soil degradation and loss of inhabitable and arable land and natural habitats. Economic activities depending on water will be adversely affected. This, in turn, will exacerbate the already demanding challenge of balancing competing demands among different uses — navigation, hydropower generation, agriculture, industry, tourism/recreation, etc. — at the national and transboundary levels, stemming from the multi-purpose use of basins. Additional attention should be given to water resources in such a changing environment, so as to ensure the functioning of ecosystems and the preservation of the natural capital.

In the case of transboundary aquifers, the above-mentioned issues are exacerbated by an insufficient knowledge base. This is of particular importance for karst aquifer systems. The extent and limits of karst systems, their drainage patterns and, most importantly, flow paths are little known, and the general lack of understanding of their vulnerability to anthropogenic as well as climatic stresses increases the level of difficulty of managing them and threatens their value and long-term sustainability. Their special characteristics are an additional factor of complexity when it comes to transboundary water resources management. The hydrogeological basin, encompassing the Neretva as well as the Trebišnjica and Trebižat "sinking" rivers, is a characteristic example. This basin extends across the same area as the Neretva River delta, hosting a range of socio-economic activities (e.g., human settlements, industry, hydropower generation, agriculture, tourism, recreation), as well as ecosystems of European significance. The Prespa and Ohrid Basins, which are linked through underground channels in the karst, provide an additional example, yet information about this complicated interconnection is still incomplete.

Rivers and coasts are linked through numerous hydrological and socio-economic processes. Changing patterns of land and resources use upstream result in changes in the downstream coastal zone, and consequently commonly have an effect on coastal ecosystems and economic activities. The necessary integrated approach in river basin and coastal management becomes even more challenging when it comes to transboundary basins. The Maritsa/Evros/Meriç and Neretva Basins are characteristic cases where cooperation between the riparian countries on issues related to water and land resources use patterns is necessary to alleviate adverse effects such as flooding, the alteration of geomorphology of the delta areas and salt water intrusion, as well as deterioration of soils, the quality of water and, to a certain extent, of ecosystems. Sustainability considerations have to be integrated in the development plans of the coastal areas. Unsustainable development patterns linked with agriculture and/or tourism result in the unsustainable use of water resources in water-scarce coastal areas of the Mediterranean Basin. This may exacerbate the consequences of the upstream pressures, where these exist. There are also cases in which such development patterns in coastal areas are felt outside the basin. For example, transfer of water outside Skadar/Shkoder Lake Basin is planned in Montenegro, to cover drinking water needs in the coastal areas of the country. Likewise, there are plans for water from Mesta/Nestos Basin to be used for agricultural irrigation in an adjacent river basin in Greece.

The reclamation of wetlands, uncontrolled urbanization and excessive illegal hunting and fishing have been pressure factors which, in addition to the alterations to the hydrological regimes, have caused impacts to the coastal ecosystems.

A great number of dams and associated reservoirs in the shared basins in SEE serve one or more of the following purposes: hydropower generation, irrigation, drinking and industrial water supply, flood protection and recreation. Some reservoirs, such as Iron Gates I and II in the transboundary area between Romania and Serbia, service navigational activities in addition to facilitating flood control.

Hydropower production represents a major non-consumptive use in many countries. For instance, hydropower contributes to over 90% of the energy production in Albania, while in Bosnia and Herzegovina it is an export commodity. Certain river basins are of key importance in this regard. The hydropower plants built on the Drin River in Albania produce 70% of the total hydro and thermal energy production capacity in the country. Two major dams have been constructed on the Black Drin in the former Yugoslav Republic of Macedonia. In Neretva and Trebišnjica hydrogeological basin, hydroelectric production infrastructure includes dams and underground channels for the transfer of water, including one that transfers water across the border between Bosnia and Herzegovina and Croatia, to the Dubrovnik hydropower plant. There are a number of dams in the Bulgarian part of the Maritsa/Evros/Meriç River Basin, and as many as 722 reservoirs. As far as the Sava River Basin is concerned, there are 21 dams with a reservoir capacity of over 5 million m^3. Five of them have a reservoir capacity between 161 million m^3 and 340 million m^3 (the highest (131 m) dam in Serbia, in the Drina sub-basin, has a reservoir with a capacity of 170 million m^3).

In addition to dams, the construction of water regulation structures has in many cases caused hydrological and morphological alterations with different impacts. Indicative are the destruction of parts of wetlands in lakes and deltas, the interruption of biocorridors and coastal erosion (e.g., the Drin River Basin), the interruption of river and habitat continuity and the loss of wetland areas (e.g., the Sava River Basin), the erosion of riverbeds and land as well as the decline of groundwater levels (e.g., the Neretva/Trebišnjica hydrogeological basin). In addition to altering the character of the aquatic and riparian habitats, resulting from reduced sediment transport capacity — as was reported among the main effects of the construction of Iron Gates I and II reservoirs — related sediment deposition has induced the gradual increase of high water levels upstream, reducing the safety of the existing flood protection system.

The occurrence of floods is a common extreme phenomenon, but according to IPCC 100-year floods are projected to occur less frequently in large parts of SEE. At the same time, the frequency of flash floods is likely to increase in the coming years because of the projected increased intensity of rainfall events. Detrimental socio-economic effects are felt in many basins such as the Sava, the Maritsa/Evros/Meriç and the Nisava. Extensive flood protection systems can be found in the Sava River Basin. At the same time, the Sava is a very good example in SEE of a river where some of the natural flood-plains are still intact, supporting mitigation of floods.

MANAGEMENT RESPONSES

All countries, at different paces, are making steps towards the development of basin management plans. In EU countries, the preparation of the RBMPs is mandatory and follows the relevant provisions and time frame of the WFD. In Croatia, a RBMP has been developed for the Krka River Basin as a pilot. In the former Yugoslav Republic of Macedonia, the process for the development of such plans will be initiated in the near future as part of the implementation of the newly adopted law that transposes the WFD.

The only joint transboundary management plan is the one prepared by the Sava Commission. As part of that the plan, the Sava River Basin Analysis Report was concluded and the Sava River Basin Management Plan is to be developed by end of 2011, also in accordance with the EU Floods Directive.

With regard to climate change impacts, information generated through different models needs to be downscaled to be used for planning at the basin level. Few projects are ongoing (e.g., on the Sava and Mesta/Nestos).

Specific measures are being taken or are planned for developing tools to support transboundary cooperation. One example, in the Sava Basin, is the development of a geographical information system (GIS), river information services (for the improvement of navigation safety) and a flood forecasting and early warning system, which is planned to be developed (by 2012). There is a protocol to the FASRB regarding flood protection and an Accident Emergency Warning System is in place.

One of the measures to address issues linked with agriculture (e.g., the overuse of water, nutrient and pesticide pollution) is the implementation of good agricultural practices. Countries have either reported the need for such measures or that they have been implemented. Efforts need to be continued and enhanced, or initiated where absent. Command and control measures and/or incentives with regard to the use of dangerous pesticides and fertilizers have been adopted. Nevertheless, unauthorized use of pesticides has continued in several cases.

In EU member States, the construction of wastewater collection and treatment systems for human settlements in accordance to the Urban Wastewater Treatment Directive is in progress. Efforts are also being made in non-EU countries.

Measures to address waste-disposal-related issues include the construction of solid waste management systems and facilities. Examples where such measures have been taken include the Stara Planina/Salasha Montana aquifer and the Skadar/Shkoder, the Ohrid and the Maritsa/Evros/Meriç Basins. The major challenge that the countries face in this regard is the significant level of financial resources needed. Nevertheless, in several countries, for example in Bulgaria, the municipalities have undertaken measures for the improvement of waste collection and transportation, and for shutting down unauthorized waste disposal sites.

As far as aquifers are concerned, protection zones for drinking water have been established in many cases. Nevertheless, relevant measures are reported as needing improvement for the majority of the aquifers and the efficiency of measures in place seems to vary on a case-by-case basis.

THE WAY AHEAD

There is a great potential for sharing the benefits of transboundary waters in SEE. However, the current level of cooperation is not suited to support such development, to ensure long-term sustainability or to prevent possible negative transboundary impacts in most of the basins.

Action at the national level promoting integrated water and natural resources management is crucial, since it creates the conditions for efficient management at the transboundary level. The ongoing reforms of the water sector — which will evidently continue — can benefit cooperation. The adoption and implementation of legal instruments that fully transpose the WFD are of special importance in this regard, since they will support the harmonization of legal instruments for water management.

Until this becomes a reality, countries should use the momentum created through the reform process and go a step further. Taking into consideration the different level of the approximation process in each country, commonly agreed standards for the management of the shared basins on the basis of the WFD and international conventions may be used to specifically design rules and regulations for managing basins in a coordinated and sustainable manner, taking into consideration the specific needs and realities in each case. Lake Ohrid, where recently established joint working groups of experts are assisting in the harmonization of national legislation to support conservation and sustainable development of the Lake and its Basin, can serve as an example.

Bearing in mind the conditions in SEE, the UNECE Water Convention has a special role to play, as it offers a basis for enhanced cooperation and a common platform for EU and non-EU countries. It is a useful tool for assisting the implementation of EU water legislation by non-EU countries. Countries that have not done so yet should consider accession to the Convention.

Cooperation between riparian countries in monitoring and assessment may provide a starting point for cooperation. The establishment of harmonized monitoring approaches and data-collection methods, and eventually monitoring and information systems, would create the basis for establishing a common understanding of water quantity and quality issues and their root causes. This would facilitate more efficient collaboration and further building of trust, as well as the design of solutions on the basis of commonly agreed objectives.

Joint fact-finding exercises and analysis of the characteristics of the basins can support such a process for establishing cooperation. It may assist in the prioritization of issues at the national and transboundary levels and the basis for future managerial actions. For the EU member States, this analysis has finished or is about to finish as part of the preparation of RBMPs. Progress is varied in other countries and basins. It is of paramount importance that systematic analysis work be initiated for the basins where it is absent.

Besides exchange of information and joint analysis, other initiatives to increase trust need to be promoted to strengthen the basis for cooperation. Issues of common concern, such as transboundary flood management, also provide such opportunities.

Initiatives, supported by international actors, like the EU and UN agencies, may play an important role in facilitating cooperation. The role of donors in facilitating human and technical capacities, as well as management plan preparation and infrastructure development, is key. Regional initiatives such as those of the Petersberg Phase II/Athens Declaration Process (coordinated by Germany, Greece and the World Bank), acting in cooperation with the GEF, UNECE and UNDP, with the technical facilitation of GWP Med, help facilitate regional dialogue and capacity-building on technical issues. These enhance the benefits stemming from cooperation as well as the initiation of multi stakeholder dialogue processes between countries related to basin management, e.g., the one for the “extended” Drin River Basin.

A reference should be made to GEF, whose financing has supported cooperation and the conclusion of official bilateral cooperation arrangements for the management of natural resources in the Ohrid, Prespa and Skadar/Shkoder Lakes, with similar action planned for the Neretva River. Regarding the challenging management of transboundary aquifers, a GEF-supported process on the Dinaric Arc Aquifer System envisages the involvement of Albania, Bosnia and Herzegovina, Croatia and Montenegro (as well as Greece and Slovenia to some extent), among others, in a cooperation effort to identify appropriate management measures to be implemented at the national and transboundary levels.

The coordination of international actors, to create synergies and avoid duplication or unnecessary effort, should be a goal; this is an issue where there is room for improvement.

But in any case, actions to secure country ownership are of paramount importance. While international actors help initiate cooperation, empower institutions and establish coordination mechanisms, the responsibility falls to the riparian countries to secure the continuation of efforts and the sustainability of outcomes. A precondition for success is stronger political will with respect to cooperation in general, and transboundary waters in particular.

Stakeholder involvement is also important. Sustaining and enhancing, as appropriate, stakeholder involvement in the identification of issues and in decision-making on transboundary waters is crucial. The establishment of clear rules and procedures for public participation in decision-making, as well as systematic awareness-raising, can greatly assist.

Another critical issue is the empowerment and upgrading of the role of the joint bodies in SEE in terms of preparing and implementing plans and becoming financially sustainable.

Securing financial sustainability will be a decisive factor for the implementation of the activities towards sustainable management of the basins. In addition to the essential financing from the riparian countries, the establishment of funding mechanisms, the introduction of financing tools and the generation of new income from ecotourism and alternative activities could provide more stable and continuous financing and allow management to gradually become independent from assistance from the international community.

Development plans at the national level should balance the need for development with the need for sustainable natural resources use and environmental protection. Minimization or elimination of upstream-downstream pressures is also a factor that should be taken into account.

Dams serve as an example of a means of coping with variability and adaptation to the expected effects of climate change. Their construction is becoming an increasingly attractive solution to mitigating the impacts of extreme events (floods and droughts) and for energy security, as well as for the generation of revenue. Processes for the construction of dams are ongoing or planned in a number of transboundary river basins. The operation of the available infrastructure and planning for new infrastructure on the rivers should take into account the upstream-downstream needs and considerations, including possible negative impacts on the ecosystem services and economic activities, as well as the evolving climatic conditions.

Regarding floods, the use of better operation techniques and rules concerning the available dam infrastructure is needed to reduce their impacts. Flood prevention in transboundary basins can only be improved and flood effects mitigated through cooperation and the use of common information sources. Joint development and establishment of integrated information systems such as flood forecasting/early warning systems is essential.

Tourism is one of the sectors on which many countries rely for economic development. Lakes and parts of the shared basins (e.g., delta areas, particularly on the Adriatic Sea coast) are favourable places for such activities. The effects of related development plans that involve alternative uses for waters and water bodies on lakes-rivers-wetlands-groundwater systems need to be clearly understood before any decision is taken.

Establishing cooperative management on shared water bodies is imperative if sustainable development at the basin level is to be achieved and regional security is to be maintained. International experience suggests that, although demanding and time-consuming, cooperation yields real benefits. The Danube River Basin is an example to follow: more than half of the SEE countries are riparian countries participating in this effort, and can use the experience gained.

CHAPTER 3 EASTERN AND NORTHERN EUROPE

INTRODUCTION

The subregional assessment of transboundary waters in Eastern and Northern Europe covers transboundary rivers, lakes and groundwaters shared by two or more of the following countries: Belarus, Estonia, Finland, Hungary, Latvia, Lithuania, Norway, Poland, the Republic of Moldova, Romania, the Russian Federation, Slovakia and Ukraine. The assessment of the individual transboundary surface waters and groundwaters in this subregion can be found in Chapters 1, 5 and 8 of Section IV (drainage basins of the White Sea, Barents Sea and Kara Sea; Black Sea; and Baltic Sea).

The assessment of transboundary waters in Eastern and Northern Europe also contains an assessment of a number of selected Ramsar Sites and other wetlands of transboundary importance: the North Livonian Transboundary Ramsar Site, the Domica-Baradla Cave System, the Pasvik Nature Reserve as well as sites at Lake Peipsi, along the upper Tisza River, the Stokhid-Pripyat-Prostyr Rivers, the Lower Danube and the middle course of the Bug River. In addition to these, Eastern and Northern Europe holds a number of other important transboundary wetland areas, including numerous freshwater lakes and extensive mires connected by rivers and streams, which stretch all along the Russian, Norwegian and Finnish borders and further to the south along the Russian, Estonian, Latvian and Belarusian borders. Extensive river flood-plains, temporary flooded forests, grasslands and fens are also typical for the region, as well as coastal bays, lagoons and river deltas in the Barents, Baltic and Black Seas. The northernmost part of the region is characterized by permafrost. The numerous services provided by these wetlands extend far beyond their boundaries and range from harbouring rich and threatened biodiversity to water retention and storage as well as support to fishing, farming and various leisure activities.

The majority of the water resources in the subregion are of a transboundary nature, thus most countries are highly dependent on flows generated outside their boundaries. For example, Ukraine estimates that only a quarter of the surface water flow in the country is generated within its boundaries and more than 80% of the drinking water in the Republic of Moldova is abstracted from the Dniester River. Such interconnectedness and related vulnerability emphasize the importance of good transboundary cooperation.

There are great differences in the water resources management frameworks in EU countries and their Eastern neighbours. In EU countries, requirements for the status of water resources are defined through the environmental objectives of the WFD, which also sets the schedule of measures to be taken. In Eastern Europe — Ukraine and the Republic of Moldova stand as examples — the water resources policy emphasizes meeting the economic needs of the society. As many of the water bodies concerned are shared by EU and non-EU countries, specific implications for the implementation of WFD arise.

In the western part of the subregion, there are well functioning cooperation frameworks at the basin level, whereas in the eastern part, even if in many cases the legal basis for cooperation has been established, transboundary institutions are less effective and the level of cooperation is lower. The International Commission for the Protection of the Danube River (ICPDR) stands as a positive model for cooperation between EU and non-EU countries.

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORKS FOR TRANSBOUNDARY WATER MANAGEMENT

Most of the existing agreements for transboundary water cooperation were signed in the late 1990s or in the 2000s.[1] The Water Convention has provided the basis for such agreements. Older agreements date back mainly to the 1950s and 1960s, including the Finnish-Norwegian, Finnish-Russian and Polish-Russian agreements; the 1929 Convention between Norway and Sweden being the oldest. Currently, a number of countries are in the process of revising or have recently revised their bilateral agreements. Ukraine and the Republic of Moldova are preparing a new basin agreement on the Dniester, which foresees the establishment of a transboundary water commission. In June 2010, Romania and the Republic of Moldova entered into an agreement on the Prut. Moreover, a new intergovernmental agreement on transboundary waters between Belarus and Poland as well as Romania and Serbia are under development. Factors that have triggered revisions is the need to take into account the provisions of the WFD, the principles of integrated water resources management (IWRM) and the obligations under the Water Convention. For example, the bilateral agreement of 2003 between Romania and Hungary has a dedicated section on the harmonization of transboundary surface water and groundwater bodies according to the WFD and the Water

[1] Information on the existing agreements for transboundary water cooperation can be found in annex II.

Convention However, on some major transboundary rivers — for instance the Bug and the Dnieper — there is still neither an agreement covering the whole basin nor an established river basin commission.

Where established, transboundary water commissions promote cooperation on various issues and, in many cases, their scope and mandate have progressively expanded with time and growing trust. For example, today the Finnish-Russian transboundary water Commission deals with a broad range of management issues, including joint monitoring of pressures and water quantity/quality, joint management of water resource including joint operation of water level regulation, fisheries and threatened species. The Estonian-Russian joint commission in addition to organizing the exchange of data also defines priority directions of future work and programmes of scientific studies on the protection and sustainable use of transboundary waters. It facilitates cooperation between various actors in the basin and ensures that discussions on relevant questions are open to the public.

In a number of countries, river basin councils or similar institutions advise water management authorities on the country's or the basin's water issues. As concerns transboundary waters, Ukraine and the Republic of Moldova have the intention to invite each other's representatives to attend their basin councils meetings.

River basin councils have been established for all large river basins in Ukraine and for a few tributaries. Legislative strengthening of the status of these river basins could significantly enhance their impact on taking important management decisions. Expanding the participation in the work of councils to, for example, professionals' organizations and non-governmental organizations (NGOs) could strengthen the competence of the councils. However, costs are a limiting factor as lack of funds is already restricting the possibility to organize meetings. It is also important to include in the transboundary water agreements the interests of local populations, as Norwegian experience with indigenous peoples (the Saami) demonstrate.

Water resources management by river basins is firmly established in EU legislation. In particular, the obligation to publish by December 2009 River Basin Management Plans has been a strong driver for water management in EU member States. Eastern neighbours are also interested in the application of the provisions of the WFD. Belarus has schemes for the complex use and protection of waters, and is interested in seeing how these compare with EU River Basin Management Plans. Due to lack of resources and capacity in the eastern neighbours, the preparation of River Basin Management Plans has been mostly supported by external donors, but the implementation of the developed plans in some cases advances very slowly. For instance, a draft management plan for the Pripyat River Basin was developed in the framework of a Technical Aid to the Commonwealth of Independent States (TACIS) project, but has not been followed up.

EU countries are encouraged to jointly prepare River Basin Management Plans with the non-EU countries with which they share waters. This is not completely new; e.g., the Finnish-Norwegian Commission prepared a multiple-use plan for the Paatsjoki/Pasvik River with the involvement of the Russian authorities in the relevant process already in 1997. However, the development of River Basin Management Plans on the basis of the WFD across the EU border is not a common practice: for the non-EU countries it entails many changes in the legislation and the water management practices; and for the EU countries the risk of not respecting the deadlines of the WFD discourage a strong engagement of non-EU countries in the process.

Planning systems in the eastern neighbours of the EU are still influenced by their Soviet heritage. IWRM principles are acknowledged in these countries as important to follow, but the implementation in practice is limited. There are national institutional problems that remain to be solved and little coordination and integration between national organizations involved in the management of water resources, for example, exists between the agencies managing surface waters and groundwaters.[2] Weak institutions and legislation also make the application of IWRM difficult. Another challenge is the shortage of funding for the water sector. The Siversky Donets Basin, on which a number of international projects have supported the preparation of a river basin management plan, demonstrates the challenges.

In the Republic of Moldova, a draft of a new water law incorporating basin principles that would replace the water code of 1992 is in its final stage of agreement between sectoral ministries. The new law approximates to the EU *acquis communautaire* and the WFD. Recently, a piece of legislation for the control of wastewater discharges from municipal sources was drawn up — under the National Policy Dialogue process within the EU Water Initiative, with UNECE as key strategic partner for the IWRM component — and has been adopted; however, its implementation is difficult due to, among others, shortage of funds. A new strategy on drinking water and water management has also been prepared, but implementation has not advanced. A national strategy on waste management is currently being developed which, among others, aims to reduce impacts on water resources.

Also, the other non-EU countries of the subregion are progressively aligning their legislation to EU standards. In Ukraine, the need to introduce the principles of river basin management is reflected mainly in the Law on Environmental Protection and the Water Code.

MONITORING OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

Most of the bilateral agreements in the subregion, including the recent ones signed by countries in transition in the 2000s — e.g., Belarus-Ukraine and Belarus-Russian Federation — have among their key provisions the exchange of hydrometeorological or other monitoring data on transboundary waters. The organization of joint monitoring programmes, data collection and data management varies. Between Romania and Hungary these are organized through a joint Hydrotechnical Commission. Agreements for the exchange of data have been made also between departments and institutions dealing with hydrometeorological information, as the example of Belarus and Poland demonstrates. Even when the bilateral agreement had not been signed yet, information from water quantity and water quality surveys on the Prut River were exchanged between water authorities from the Republic of Moldova and Romania.

The establishment of joint bodies greatly facilitates the exchange of monitoring information. For instance, in the Estonian-Russian joint commission and its working groups systematic exchange of information takes place. The experience of joint monitoring on Lakes Peipsi, Lake Pihkva, Lake Lämmijärv and Narva Reservoir, based on an agreed monitoring programme, also illustrates the remaining challenges: monitoring programmes need to be

[2] A brief description of the water resources management framework in each of the countries can be found in annex I.

harmonized in some details; criteria used for assessing the situation of the water bodies need to be agreed upon; and the comparability of laboratory data needs to be continuously ensured. Lessons learned from agreements implemented over several decades show that harmonisation of monitoring and assessment practices, including laboratory analysis, can be achieved (e.g., between Finland and the Russian Federation).

The monitoring of physico-chemical determinands tends to be the prevailing practice in non-EU countries, while in EU countries, in accordance with the WFD, the classification of the status of water bodies is both based on monitoring biological determinands as well as monitoring physico-chemical and hydromorphological determinands as essential supporting elements. Biological monitoring is less developed in non-EU countries. For example, in Belarus, the Republic of Moldova and Ukraine, the surface water quality assessments are still based on the maximum allowable concentrations (MACs), defined for a range of physico-chemical parameters; however, a piece of legislation to introduce a new classification system, is under consideration by the Government of the Republic of Moldova based on the outcome of the TACIS project "Water Governance in the Western EECCA Countries" (2008–2010). It is expected that Ukraine and Belarus will follow this example as across and beyond the EU border, the different water quality systems make it difficult to compare and agree about the water quality status. For example, on the Pripyat, both Belarus and Ukraine still use their own water-quality classification systems with different sets of MACs, which complicates joint assessments of the water-quality status. In the long term, the influence of WFD will increase harmonization in the subregion.

Gaps related to low frequency of observations, lack of hydrobiological monitoring and lack of monitoring of suspended matter and bottom sediments are common problems in the non-EU countries, together with limited availability of governmental funding for renewing and maintaining monitoring equipment and laboratory devices. In some cases, funds from international projects are used to address these issues.

Another common problem, especially in non-EU countries, is the lack of coordination and data exchange between the various monitoring systems (e.g. surface waters, groundwaters, wastewater discharges, hydrometeorological monitoring, quality of waters used as a source of drinking water, recreational waters) for which different agencies in the same country are responsible. Moreover, in non-EU countries, the laboratories and data management capacity need to be strengthened from the technical and methodological point of view.

Monitoring and related reporting in the EU countries is largely set by the requirements of EU water-related directives. Preparing River Basin Management Plans jointly between EU and the neighbouring non-EU countries (e.g., Republic of Moldova and Romania) according to the WFD also influences the approach outside the EU, and the related information requirements push for collecting specific information.

Flooding is also a main problem in the subregion. Recent disastrous flooding caused by heavy rains in the Carpathians in July 2008 and in summer 2009 in rivers shared between Romania and Ukraine, and the Republic of Moldova and Ukraine reached critical dimensions, inter alia, with the discharge of the Prut reaching a record level. These events have increased awareness about the need to invest in flood prediction and cooperate with neighbouring countries in developing such systems. Ukraine is developing a flood protection system in the Dniester, Prut and Siret Basins, a part of which will be hydrometeorological monitoring, including automatic stations, in support of management decisions to reduce damage from flooding.

As an example of transboundary cooperation on monitoring, Hungary, Romania, Slovakia and Ukraine have already established a network of automatic hydrometric stations in the Carpathian region, which will be further developed over time.

However, automatic monitoring devices that are part of early warning systems require long-term commitment for continuous maintenance. Testing of the Accident Emergency Warning System (AEWS) in March 2007 on the Danube revealed that half of the stations did not react in a timely fashion.

The use of information technology in monitoring and data management is gradually increasing, introduced especially through donor-supported projects. The development of the structure and content of a pilot Geographical Information System (GIS) on the Dniester River Basin as the information basis for water management is supported in an Environment and Security Initiative (ENVSEC) project. For the Prut, a unified monitoring programme and GIS is also called for.

Networks for monitoring transboundary groundwaters are not well developed and, for example, Belarus indicates transboundary groundwater monitoring to be needed. At the same time, there are also positive examples: Lithuania has been monitoring transboundary aquifers with Poland for more than 15 years, and in 2010 groundwater monitoring was initiated based on bilateral agreement between the Lithuanian Geological Survey and the Kaliningrad Agency of Mineral Resources.

Voluntary monitoring schemes of water quality can also help in small rivers (Latvian experience).

MAIN PROBLEMS, IMPACTS AND STATUS

Although an improvement of water quality has been observed over the past decade, significant problems remain. Discharges of non-treated or insufficiently treated wastewater, municipal and industrial, still remains a major widespread pressure factor. This is particularly critical for industrial wastewaters with hazardous substances that are not treated before being discharged into surface waters or are not pre-treated before being discharged into the sewer systems.

Apart from the lack of sufficient funding for the maintenance and upgrading of industrial and/or municipal wastewater treatment plants in non-EU countries, another problem remains: the need to connect more people, particularly in rural areas and small towns, to wastewater and sanitation systems.

Agriculture is another pressure factor: as a significant water user it has impacts on water quantity and as user of pesticides as well as manure and/or nitrogen and phosphorus fertilizers it has impacts on the quality of surface waters or groundwaters. Draining of agricultural land has also intensified nutrient emissions from the soil into groundwaters. As concerns the assessment of the relative share of pollution from diffuse sources, some of the non-EU countries in the region still lack experience on the use of proper evaluation methods or models, which makes the development of management scenarios difficult.

Pollution by pesticides from agriculture and other hazardous substances used in industries — which can seriously damage aquatic ecosystems — is among the significant water management issues identified in the Danube Basin. The importance of pesticide use varies along the basin: in comparison with the upstream Danube countries, the level of pesticide use in the central and lower Danube countries remains relatively low. Another water management problem stems from "old" pesticides, which are not any more authorized in any of the Danube countries, but which are still present in sediments.

The identification of "heavily polluted sites", either by pesticides, oil products or other hazardous substances, and their restoration is another critical issue in transboundary and domestic water management, including its health-related aspects. The Republic of Moldova, based on the provisions of the Protocol on Water and Health, and with the assistance of Switzerland and UNECE, has in October 2010 finalized work on setting targets and target dates for IWRM, safe drinking water and adequate sanitation, which includes measures to rehabilitate polluted sites.

Agricultural pressure is often significant in basins with a large percentage of cropland, — for example, in the Somes/Szamos and Lielupe with around 50%; in the Venta with around 40%; and in the Neman, Ipel/Ipoly and Salaca with around 30%. For EU countries, which have managed to get point source pollution fairly well under control, the diffuse pollution from agriculture is becoming the main challenge. Thus, the importance of agricultural pollution and other diffuse sources as pressure factors is increasing in relative terms, as efforts for many years have focused on pollution from point sources.

Diverse industries operate in the subregion, including food processing, pulp and paper industry, chemical (e.g., oil refining), metallurgical and metal processing industries. Compared with other sectors, industry is not a big water user due to progress in water saving and rational use of water, but the industry's environmental impact depends heavily on the type of industry, the processes used and the efficiency of wastewater treatment. Heavy metals and hydrocarbons from industrial wastewater discharges are a concern in a number of basins, for instance the Siversky Donets, despite the legislation in place.

The mining industry can be a pressure factor, commonly with a local impact, for example in the Siret sub-basin, where storage facilities, including tailings dams, are located. In the Tisza and Kórós Basins, there are cadmium and copper loads from mining activities. In the territories of the Russian Federation and Ukraine in the Siversky Donets Basin, coal industry has an impact. Discharges of saline waters from mines are reported to impact on water resources, e.g., in the Vistula Basin. Ore processing also has impacts; for example nickel smelters in Pechenga, Russian Federation, cause sulphur deposition in Norway (although this has been decreasing). In the Kemijoki Basin, several new mines are in the planning phases in the Finnish territory.

Inappropriate solid waste disposal, for example at uncontrolled dumping sites, is reported to be an issue in some basins, e.g., the Daugava, Ipoly, Vah and Prut, albeit commonly of local impact.

Also hydromorphological changes impact on the biological component of the river systems. The key hydromorphological pressure components are: interruption of river and habitat continuity; disconnection of adjacent wetlands/floodplain; and hydrological alterations. The key driving forces causing river and habitat continuity interruptions in the Danube River Basin District are mainly flood protection (45%), hydropower generation (45%) and water supply (10%). A third of the channels along the main course of the Danube are either severely modified (29%) or totally modified (3%). Almost a tenth of the flood plain is totally modified. In general, the Upper Danube is hydromorphologically more altered that the downstream. In the Gauja/Koiva River, fragmentation by dams results in problems for fish migration. Systematic assessments of other major rivers would shed light on the extent of the hydromorphological changes in other parts of the subregion.

The impacts from infrastructure for hydropower generation are also an issue in many basins of the subregion. In those rivers where hydropower has been extensively developed — for example on the Dnieper, Bug's tributaries and Kemijoki — significant stretches of the river are hydromorphologically heavily altered.

Ecological changes in the Danube delta itself, including the creation of a network of canals through the delta to improve access and water circulation, and the reduction of the wetland area by the construction of agricultural polders and fishponds have reduced biodiversity, altered natural flow and sedimentation patterns, and diminished the ability of the delta to retain nutrients. This is because more of the nutrient-rich water is now washed directly through the main canals rather than being distributed through the wetlands and reed beds.

Among other anthropogenic pressures that affect wetlands are forestry operations (e.g., cutting, replacement of natural communities with monocultures). Peat extraction and associated drainage contribute to the change of hydrological processes and pose a threat to ecosystem integrity. Similar effects are caused by agricultural practices (e.g., transformation of naturally flooded meadows into cultivated lands), while intensive grazing on wet pastures leads to the degradation of natural vegetation and deterioration of the soil structure. Another extreme is the abandonment of traditional agricultural lands and subsequent overgrowing of previously open areas. A specific threat is posed by fires — in forests, on peatlands and grasslands. Unsustainable fisheries and aquaculture, hunting, berry collecting, tourism and recreation practices (including poaching, illegal dumps, etc.) contribute to the deterioration of wetland ecosystems. All together, these processes lead to degradation of valuable aquatic and terrestrial wetland biotopes and the subsequent loss of biodiversity and certain ecosystem services. Invasive plant and animal species that out-compete native ones pose another threat.

CLIMATE CHANGE AND ITS IMPACTS ON WATER RESOURCES

Concerning observed climate change, IPCC reports that mean winter precipitation increased over the period 1946–1999 across most of Northern Europe. In the future, IPCC projects summer precipitation to decrease in Eastern Europe, causing higher water stress. Northern countries are also vulnerable to climate change, although in the initial stages of warming there may be some benefits in terms of, for example, increased crop yields and forest growth. The projected impacts include increases in annual run-off in Northern Europe, and decreases in Eastern Europe. In general, annual average run-off is projected to increase in Northern Europe (north of 47°N) by approximately 5–15% up to the 2020s and by 9–22% up to the 2070s. The increase in projected run-off and lower risk of drought could benefit the fauna of aquatic systems. Groundwater recharge is likely to be reduced in Eastern Europe, with a larger reduction in valleys and lowlands. Flow seasonality (and drought risk and flood frequencies) is predicted to increase also in Eastern Europe, with higher flows in the peak flow season and either lower flows during the low-flow season or extended dry periods. In Northern Europe, IPCC predicts the risk of winter flooding to increase by 2020s and present day's 100 year floods to occur more frequently.[3]

Ukraine is a good example to highlight the impact of climate change in the subregion: the total annual precipitation is increasing over most of its territory. Within the next 30 years, climate change is predicted to cause a 15%–25% increase of the mean annual run-off in the forested northern part of Ukraine, involving an increase of winter run-off and a decrease of spring run-off. In the southern and south-eastern parts of the country, Ukraine predicts a 30%–50% decrease in the mean annual run-off, with about a half of the flow occurring during the winter months. Drought risk is expected to increase in the south of the country. Along the rivers in the Carpathians, the frequency of extreme floods is predicted to increase. Predictions of run-off change have been made for individual rivers (the Dnieper, for example). Negative impacts are expected on the water quality in the south and south-east of Ukraine.

In Latvia, compared with the reference period 1961–1990, the total annual precipitation is predicted to increase by 4%–11% in the period 2070–2100. Monthly precipitation is predicted to increase in winter and in the beginning of summer, but decrease in summer. The number of days with intensive precipitation (more than 10 mm in 24 hours) is predicted to increase by 20–100. Moreover, periods without precipitation, i.e., more than five days without rain, are expected to occur more frequently.

In the northern part of the subregion, for the area of, e.g., the Kemijoki and Teno Basins in the north of Finland, a set of climate change scenarios suggests an increase of 1.5 °C–4.0 °C in annual mean temperature and 4%–12% increase in annual precipitation in the next 50 years. Changes in seasonal flow are predicted to vary from -5% to +10%, depending on the area. In general, the frequency of spring floods may increase. Groundwater levels may increase in wintertime and decline in summer time, and groundwater quality in small groundwater bodies may be negatively affected.

No specific analysis of climate change and planning of related measures was required in the preparation of River Basin Management Plans according to the WFD. However, in some cases — thanks to the activities of, for example, river basin commissions — climate change has been taken into consideration. The Tisza River Basin Management Plan 2010 in the framework of the ICPDR stands as an example. Significant impacts from climate change on the Tisza and Danube water systems are expected, in particular reduced average water flow and increase in the frequency and intensity of extreme events, even though there are significant regional and local variations. Historical changes in land use and water management complicate the assessment of climate change impacts. Changes in water quality and ecological status are considered likely, but have not been investigated. Current practical information needs — as demonstrated by the case of the Tisza — include the quantification of the predicted impacts on water resources and a better knowledge about their spatial distribution. A number of research projects, funded in particular by the EU, aim at strengthening the knowledge base.

Monitoring of the different components of the water cycle — including evapotranspiration — for water balance studies is needed, as well as an evaluation of the changes of the hydro-

[3] Bates, B.C., Kundzewicz, Z.W. Wu, S. and Palutikof, J.P. (eds), Climate Change and Water. Technical Paper of the Intergovernmental Panel on Climate Change. IPCC Secretariat, Geneva. 2008.

logical regime through models. The necessity of strengthening interdisciplinary research of climate change impacts on water-related sectors of the economy requires coordination between different sectors and agencies. Further work is also needed to assess impacts on water uses, including those which are strongly health-related such as drinking water use and recreational use.

Many countries have developed or are in the course of developing strategies on climate change: Romania, for example, has adopted a National Strategy for Climate Change, and Hungary proceeds in this direction. In Ukraine, a draft Climate Programme has been prepared by the Ukrainian Hydrometeorological Institute, paving the way for the drawing up of a national strategy. Work is carried out by Ukraine in the framework of the National Policy Dialogue on IWRM, which so far culminated in a draft concept for the State policy on the adaptation of water management to climate change.

Efforts are also being made to address climate change-related concerns, and the need to develop intersectoral and international cooperation to this end is acknowledged. In the EU, the European Commission White Paper (2009) "Adapting to climate change: towards a European framework for action" calls for the promotion of strategies which increase the resilience to climate change, and sees also a need for the development of guidance to ensure "climate proofing" of River Basin Management Plans by 2015.

The various programmes and initiatives include, for example, a programme set up in the Paatsjoki/Pasvik River Basin, which aims to produce knowledge and information on environmental impacts for decision-making and strategies for adaptation to climate change and anthropogenic effects and which will develop assessment tools for this border region. On the Dniester and Neman River Basins, two projects on adaptation to climate change are carried out aiming to promote a basin-wide assessment of the impacts of climate change applying the UNECE Guidance on Water and Adaptation to Climate Change (2009). Evaluation of costs of adaptation and comparison of different adaptation measures is commonly further down the road for many basins, and only a few countries have seriously embarked on these aspects yet.

RESPONSES

For most of the transboundary waters in the subregion, bilateral or multilateral agreements exist. Many bilateral agreements on transboundary waters are expected to be revised, taking into account provisions of the WFD and of the Water Convention (e.g., the agreement on the Dniester, which has been under negotiation over the past few years). The studies, plans and recommendations developed by established river basin commissions demonstrate the benefits of institutionalizing the basin level cooperation.

The WFD requirements have put in motion a process towards meeting the objective of good status by 2015. EU member States have transposed the Directive in their national legislation. Preparing River Basin Management Plans has required an assessment of the situation in the basins according to a common format. Programmes of measures have been defined as stipulated in the WFD to address the main concerns identified in the Plans. However, for transboundary river basins, activities in the different riparian countries need to be further coordinated and harmonized in River Basin Management Plan(s), in particular for basins shared by EU and non-EU countries.

A positive exception is the Danube, for which a Joint Programme of Measures has been defined to address the identified Significant Water Management Issues (organic, nutrient and hazardous substances pollution and hydromorphological alterations), as well as groundwater bodies of basin-wide importance. The Programme is based on the national programmes of measures, which are to be made operational by December 2012.

Gradual rehabilitation, building and extension of sewerage systems and wastewater treatment plants is being carried out. In the EU, the Urban Wastewater Treatment Directive (Council Directive 91/271/EEC) requires collection and treatment (basically biological) of wastewater from agglomerations and sets the time frame for compliance. Many countries that acceded to the EU in 2004 and 2007 enlargements — in this subregion, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia and Romania — were granted transitional periods to comply with the Directive's requirements. The investment needed in these EU member States in order to achieve compliance with the Directive is substantial. This is illustrated by the case of Estonia, where the biggest part of the EU Cohesion Fund to fulfil environmental commitments is planned to be used for reconstruction of wastewater treatment plants and renovating relevant collection systems.

The significant investments made and infrastructure projects carried out to renovate existing wastewater treatment plants and build new ones have contributed to the reduction of pollution load to surface waters. For example, for phosphorus, nitrogen, BOD, chemical oxygen demand (COD) and suspended solids, the load to surface waters has decreased in Latvia by 10%–40% during 2004 to 2008. In Estonia, the pollution load has decreased in BOD_7 from 1992 to 2007 by 94%, in total phosphorus by 79% and in total nitrogen by 71%.

EU countries are also taking supplementary measures to reduce nutrient pollution, as demonstrated by Slovakia, where these range from legislative measures for the production of phosphorus-free detergents to the application of good agricultural practices (related to the implementation of the EU Nitrates Directive). Studies on the modelling and assessment of nutrient emissions (nitrogen and phosphorus) from point and diffuse pollution sources are also envisaged (e.g., Romania and Slovakia) as supplementary measures.

Fulfilling the requirements of the Nitrates Directive and the Urban Wastewater Treatment Directive are for EU countries the fundamental measures for reducing nutrient load at basin level. Diffuse pollution by nutrients from agriculture is addressed through, for example, specific action programmes for Nitrate Vulnerable Zones where more stringent environmental requirements for agriculture are to be applied, such as requirements to construct manure storages and prepare fertilization plans. ICPDR promotes its Best Agricultural Practices Recommendations to non-EU countries in the Danube Basin. To limit impacts on quality of water resources, vulnerability mapping for nitrate pollution from agricultural sources has been carried out (e.g., Romania).

Even though the observed improvement of water quality in the past decade in the new EU member States like Romania is partly related to reduced industrial activity, a part of the credit is given to the implementation of principles like the polluter-pays principle in environmental regulation and the transposition of the EU environmental legislation. As an example, in the Mures/Maros sub-basin, heavy metal pollution from mining has been reduced by closing some mines and by rehabilitating the wastewater treatment plants.

In order to improve the knowledge base to direct measures effectively, a number of countries are modelling flow, nutrient loads, etc. In the case of the Mures/Maros and Somes/Szamos River Basins, a need for updating existing joint models of transboundary aquifers is indicated.

Joint data collection, joint research and initiatives are also developed. For instance, Romania, Ukraine and the Republic of Moldova are cooperating in the project "Joint environmental monitoring, assessment and exchange of information for integrated management of the Danube delta region" (2010–2012), coordinated by ICPDR in cooperation with UNEP, UNECE and regional partners. A Danube Delta Sub-basin Analysis Report will be developed in the project, which is a significant step towards a Management Plan for the Danube Delta Sub-Basin according to the requirements of the WFD. A Joint Danube Delta Survey will be conducted in synergy and coordination with the joint Romanian-Ukrainian monitoring programme in the Danube, which will facilitate harmonization of monitoring systems in the delta.

Related to hydromorphological alterations, the focus of measures in the Danube River Basin District is on establishing free migration for long- and medium-distance migrant fish of the Danube and the connected lowland rivers. Deterioration of the current situation should be prevented and measures taken to improve habitats and the situation for migratory species and to support flood-plain restoration. A basin approach needs to be applied to planning any hydrotechnical measures.

The implementation of the EU Floods Directive improves preparedness as it requires EU member States to inventory flood risk zones (by 2011), to draw up flood hazard and risk maps (by 2013) and to prepare plans for flood risk management at the basin level (by 2015). The availability of EU funds for implementing protective measures (including to build infrastructure) is expected to improve flood protection in the eastern part of the subregion. Guidance by UNECE provides good examples[4] of transboundary cooperation in flood management. Related to preparedness for hydrological extremes, national strategies for flooding and drought have been prepared in most countries of the subregion.

In recognition of their outstanding values, many wetland areas are designated as protected areas under national and EU legislation, while a number of the most valuable sites also have international protection status, e.g., as Ramsar Sites, World Heritage properties and Biosphere Reserves. A bright example of transboundary cooperation specifically focused on valuable wetlands is the formal designation of Transboundary Ramsar Sites, meaning that the Ramsar Site authorities on both or all sides of the border have formally agreed to collaborate in its management. In Eastern and Northern Europe five wetland areas currently have this status: Upper Tisza Valley (Hungary, Slovakia); Domica-Baradla Cave System and related wetlands (Hungary, Slovakia); Ipoly Valley-Poiplie (Hungary, Slovakia); North Livonian mires (Estonia, Latvia); and Stokhid-Prypiat-Prostyr (Belarus, Ukraine).

The work of NGOs at basin level is constrained by limited financial resources. Real progress can be seen in bigger basins where there have been international projects. Transboundary cooperation by NGOs is further restricted by limitations to mobility (visa needs). Unfortunately, projects often do not have long-term sustainable impacts, and when the external funding is interrupted, countries are often not ready to take on the follow-up.

THE WAY AHEAD

Implementation of the WFD influences the Eastern European countries neighbouring the EU. Although they are not bound by the Directive and its deadlines, it is expected that these countries will progressively move towards the implementation of the Directive and its principles.

There are a considerable number of future infrastructure projects at different stages of planning and preparation. In the Danube River Basin District, more than hundred such projects have been reported, with more than a half related to navigation and almost a third for flood protection. These could further aggravate hydromorphological pressures.

An increase of water demand is expected, especially in the southern part of the subregion. For instance, in Romania water demand for all uses is expected to increase till 2020 (in the Mures/Maros, Siret and Prut Basins, at least) and some transboundary consultations are being undertaken about the possible consequences. Water use for public water supply is expected to increase in some basins, which may or may not have transboundary impact.

Appropriate controls regarding abstraction of fresh surface water and groundwater and impoundment of fresh surface waters (including a register or registers of water abstractions) needs to be put in place, as well as the requirements for prior authorization of such abstraction and impoundment. In line with the WFD, it must be ensured that the available groundwater resources are not exceeded by the long-term annual average rate of abstraction.

Thanks to the different protection measures that have been put in place, water quality in a number of rivers is expected to improve (e.g., including the Ipel/Ipoly, Lielupe and Vah).

However, significant water-quality problems remain. Despite the efforts made to improve treatment of wastewaters, the impact of untreated or poorly treated wastewaters will not be phased out quickly. For example, in June 2010 ICPDR estimated that in the Danube River Basin District there were 228 agglomerations with >10,000 population equivalent[5] (p.e.) still lacking wastewater treatment plants, which need to be realized by 2015, and 41 agglomerations with >10,000 p.e., which were not equipped with sewerage collecting systems and where no wastewater treatment was in place for the entire generated load.

Access to water and sanitation needs to be increased, especially in rural areas. Stepping up efforts would have beneficial impacts on public health and well-being.

[4] Transboundary Flood Risk Management: Experiences from the UNECE region. UNECE. 2009.
[5] The population equivalent is a measure of pollution representing the average organic biodegradable load per person per day.

CHAPTER 4
CAUCASUS

INTRODUCTION

The subregional assessment of transboundary waters in the Caucasus covers transboundary rivers, lakes and groundwaters shared by two or more of the following countries: Armenia, Azerbaijan, Georgia, the Islamic Republic of Iran, the Russian Federation and Turkey. The assessment of the individual transboundary surface and groundwaters in this subregion can be found in the Chapters 4 and 5 of Section IV (drainage basins of the Caspian Sea and of the Black Sea). The assessment of transboundary waters in the Caucasus also contains assessments of a number of selected Ramsar Sites and other wetlands of transboundary importance: Javakheti Wetlands area (including Lake Arpi Ramsar Site; Madatapa, Bugdasheni, Sagamo and Khanchali lakes and Kartsakhi/Aktas lake); and flood-plain marshes and fish ponds in the Araks/Aras River valley.

There are six major transboundary rivers and four major international lakes as well as 13 assessed transboundary aquifers in the Caucasus. By far the largest part of the subregion is covered by the basin of the Kura and its tributaries.

Natural availability of water in the Caucasus is quite variable, with abundant resources in the mountainous areas of Georgia and scarcity in Azerbaijan. Difficulties and deficiencies in water resources management aggravate problems of access to water in sufficient quantity and quality.

The Southern Caucasus countries share a common history as part of the former Soviet Union, which heavily influenced the institutional and legal setting for management of water resources, as well as their monitoring. Recent environmental protection efforts have improved water quality but the industrial and agricultural legacy of environmental degradation of the former regime has still an impact on water resources.

Past and unsolved political conflicts in the region remain a major obstacle for transboundary cooperation. A lack of trust between the countries persists, and it has thus far proven impossible to enter into formal agreements and establish effective institutional arrangements to manage most of the transboundary water resources. A number of positive steps have been taken in the direction of enhanced cooperation, mostly thanks to international assistance projects; however, a stronger political willingness to cooperate is needed to make substantial and sustainable progress.

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORKS FOR TRANSBOUNDARY WATER MANAGEMENT

IWRM is not currently applied in the Caucasus in general, but there are a number of positive developments: in many countries the water sector has undergone or is undergoing reform and new legislative water codes have been developed.

Moreover, there has been a progressive approximation towards the WFD. An important driver is the EU Neighbourhood Policy, under which Armenia, Azerbaijan and Georgia signed agreements committing themselves to bring new environmental laws closer to EU legislation and to cooperate with neighbouring countries regarding transboundary water management.

Armenia's water code of 2002 is the first in the subregion to meet this obligation. It refers to, among others, development of water basin management plans, introduced since 2005, and to an intersectoral advisory body. In Georgia, water resources are managed according to principles of territorial administration (regional units) and river basin-based management is not applied. A new water law — as a basis for reforming the 1997 water resources management system — is being drafted and will include principles of basin management. There are no river basin organizations in Turkey either, but the regional directorates of the General Directorate of State Hydraulic Works (DSI) are responsible for preparing master plans that set priorities for the development of water and land resources in the respective basins across water-related sectors.

Even if there is a lack of comprehensive IWRM plans in these countries, some steps are being progressively taken in that direction. For example, Turkey plans to initiate the preparation of a river basin management plan on the Chorokhi/Coruh River. According to draft strategic orientations of the Ministry of the Environment and Natural Resources of Georgia (2009), the development of a river basin management plan for the Georgian part of the Chorokhi Basin is scheduled for the period from 2011–2015. The Islamic Republic of Iran also reports that a comprehensive IWRM plan for the Araks/Aras Basin is under preparation.

Groundwater has a high importance in the subregion for drinking water supply, especially in rural areas. Some 80% of drinking water supplied in Georgia through centralized distribution networks is abstracted from groundwater. In addition, groundwater is also an important source of irrigation water in some areas. Nevertheless, groundwater resources in general receive little attention. Integrated management of groundwater and surface water is not occurring in the region and management of (transboundary) groundwaters is not advanced.[1]

The lack of formal cooperation between all countries in the Kura Basin, in particular the lack of a legal framework and joint body for transboundary water cooperation, is a regrettable limitation; such a development has not yet materialized despite the efforts made in various international projects, including the USAID South Caucasus Water Programme and an ENVSEC project.

The Caucasus, and in particular the Kura River Basin, has benefited from many international assistance projects. These offer opportunities but also risks of overlapping and duplication, and do not necessarily match with the countries' priorities. The institutionalization of cooperation and the creation of a joint body for transboundary water management would avoid overlapping and duplication, while also ensuring continuity and sustainability of activities and a more effective use of international funds.

Nevertheless, a few bilateral agreements and some joint commissions do exist, such as the agreements between the Islamic Republic of Iran and Armenia and the Islamic Republic of Iran and Azerbaijan or the Interstate Commission of Armenia and Turkey on the Use of the Arpaçay/Akhuryan Water Reservoir.[2]

The level of implementation of bilateral agreements, especially their water management-related clauses, remains low and activities are sporadic. For example, under the existing agreement on environmental cooperation between Georgia and Azerbaijan, no programme or actions have been developed and no official working group or intergovernmental body has been established to regularly oversee or support implementation of the agreement. Thus, the ongoing negotiations between Georgia and Azerbaijan aiming to establish an agreement and a permanent body for cooperation on IWRM are a promising step forward for the region which could provide a model for the further development of cooperation.

The status of ratification of the Water Convention is varied: Azerbaijan and the Russian Federation are Parties, while Georgia, Armenia and Turkey are not. Until the entry into force of the amendments to articles 25 and 26 to open the Convention to countries outside the UNECE region, the Islamic Republic of Iran cannot accede.[3]

Economic development is clearly the priority at the present time, and efforts to improve economic performance have influenced legislation, including environmental and water legislation. For example, in Georgia, the issuing of groundwater abstraction licences was transferred to the Ministry of Energy and Natural Resources and the requirement for an environmental impact permit is now limited to major enterprises; licences are not required by households using water for their domestic needs.

MONITORING OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

Since the break-up of the Soviet Union, monitoring and assessment declined in the Caucasus, demonstrated, for example, by a substantial decrease in the number of operational monitoring stations. Some improvement can be observed in recent years, thanks to international projects. However, there is a lack of continuity to these activities. Monitoring has suffered owing to a general lack of national funding, even if recently the situation has improved in some countries due to an increase in national environmental budgets (e.g., Armenia).

Groundwater monitoring and integration of surface and groundwater monitoring are particularly weak. In Georgia, no systematic groundwater monitoring has taken place for the past 20 years.

No (hydro)biological monitoring has been introduced in the Caucasus; however, slow progress is being made towards this, thanks to important support from EU assistance projects. Improvement in microbiological and biological monitoring is reported in Armenia and Georgia.

Water quality in lakes is not being monitored in Georgia, with the exception of checking parameters for recreational water quality.

There is no systematic control of wastewater. Self-monitoring of sewage water by enterprises has been introduced in Georgia, Armenia and Azerbaijan, but enforcement is not always strict.

A remaining Soviet influence is the still common reference to "maximum allowable concentrations of pollutants for a specific water use" (MAC) — seemingly stringent water quality standards that are difficult to comply with. Adoption and implementation of new water quality standards depends on legislation, and legislative changes are made slowly. Moreover, attachment to familiar systems and resistance to change make for slow progress in the transition from MAC values towards water quality objectives.

There are problems of quality assurance regarding data on water quality, not only in the analytics but also in the preceding chain of sampling and processing. There is no data comparability between countries, due to, among others, a lack of consistency in methods. Some international projects, such as the TACIS project "Water Governance in the Western EECCA Countries" (2008–2010), aim at a higher degree or harmonization in water quality assessment and in related parameters. The requirements of the WFD give direction to these efforts.

Monitoring of water flow has also been disrupted since the collapse of the Soviet system. There are not enough hydrometric stations (e.g., on the Kura for improving flood protection) and the riparian countries do not share them efficiently. Regular exchange of operative data, like daily water levels and weekly discharges, is missing. Early warning is also needed for hydrological extreme events and in case of accidental pollution. The recent exchanges reported between Georgian and Turkish delegations concerning establishment of early warning systems on the Chorokhi/Coruh River are a positive development.

Under the existing bilateral agreements, bilateral cooperation on monitoring is currently established between Azerbaijan and the Islamic Republic of Iran, Armenia and the Islamic Republic of Iran, Armenia and Turkey (Araks/Aras and Akhuryan/Arpaçay), Turkey and the Islamic Republic of Iran (Sarisu River), and Georgia and Turkey. While recent improvements have been achieved in the field of joint monitoring and assessment thanks to international projects, stable, long-term cooperation is missing in the Kura River Basin.

[1] A brief description of the water resources management framework in each of the countries can be found in annex I.
[2] Information on the existing agreements for transboundary water cooperation can be found in annex II.
[3] The status of ratification of selected international agreements by Caucasus countries is presented in annex III.

MAIN PROBLEMS, IMPACTS AND STATUS

Agriculture is the biggest water user in the Caucasus. In the Kura basin in Azerbaijan, some 745,000 ha are irrigated, including 300,000 ha in Azerbaijan's part of the Araks/Aras sub-basin, and more than 60% of the water withdrawn from the Kura is used for agriculture. Need for irrigation water has partly motivated building of storage capacity. In some parts of the Kura basin, agriculture and animal husbandry are the main drivers of the economy, and irrigation systems are being further developed, with substantial pressures on the water resources.

There are substantial water losses in irrigation infrastructure, with almost 30% losses in irrigation canals. In Georgia, a high share of the irrigation infrastructure consists of open, unlined channels and consequently water efficiency is low, which aggravates water scarcity problems. These will be further exacerbated by the decrease in precipitation predicted as a result of climate change and the increased abstraction. Unless effective adaptation measures are implemented to reduce the water deficit, this will impact on agriculture and might even contribute to internal displacement of populations.

Irrigation also provokes salinization of soils, especially in arid areas and where drainage is not well organized.

Diffuse pollution from agriculture, viniculture and animal husbandry, is a significant pressure factor in many basins, for example in the Alazani/Ganyh and the Akhuryan/Arpacay Basins. Agricultural pollution in irrigation return flows containing remnants of agrochemical waste, pesticides, nutrients and salts is a concern, especially for the Araks/Aras River. However, in recent years, the application of fertilizers has been relatively limited. Efforts are being made to control and reduce pollution, for instance, in Azerbaijan the Ministry of the Environment is inventorying pollution sources.

Organic and bacteriological pollution from discharge of poorly treated or untreated wastewater is a widespread problem. In particular, water quality in the Kura Basin has been severely affected. Wastewater treatment is commonly lacking for both municipal and industrial (e.g., metallurgical and rubber industry) wastewater. In Georgia, most of the wastewater treatment facilities have become non-operational and wastewater is being discharged into rivers without treatment. In the Turkish part of the Araks/Aras, urban areas are connected to sewerage networks, but few wastewater treatment plants have been set up. In rural settlements, wastewater collection is commonly lacking.

There is also room for improvement in solid waste management, as a lack of sanitary landfills is common, e.g., in municipalities in Turkey, and controlled dumpsites are reported to exert pressure on water quality, too. Pollution from illegal landfills is also a concern in Georgia and Azerbaijan.

Mining of especially copper but also other commodities results in heavy metal pollution due to acid mine drainage from tailing dams. The affected basins include — among others — the Debed/Debeda and Voghji/Ohchu basins. Wastewater from the ore enrichment and processing industry is also an important pressure factor. However, the significance of mining as a pressure factor has substantially decreased in the last 20 years in some sub-basins. With the exception of major accidents, its influence in most cases remains geographically limited.

Water-related development projects are seen as the key for socio-economic development, for example, in the Araks/Aras basin by Turkey. The existing and planned infrastructures include weirs, dams, hydropower plants and related structures for electricity generation, as well as constructions for irrigation and water supply purposes. There is concern that the existing and planned hydropower stations will result in changes in natural river flow regime, river dynamics and morphology. The Islamic Republic of Iran and Armenia are studying the possibility of building a common hydropower plant on the Araks/Aras River. In recent years, hydropower has been developed in the Turkish part of the Chorokhi/Coruh basin, where two hydropower stations are operational at present. These are part of a scheme involving 10 planned hydropower projects along the main river in a cascade style. The last one of the Lower Coruh projects is under construction. The Middle Coruh projects are in final design stage and investment programme, and the Upper Coruh projects are in different planning stages. This intense development raises concerns of transboundary impacts. To avoid straining relations between co-riparians and to ensure sustainability of use of the water resources, ecological flows have to be considered.

Flow regulation affects sediment transport, with reduction of sediments leading to washing away in the coastal zone. Moreover, sediment loads are also influenced by the dynamics of land cover/land use: deforestation makes lands more vulnerable to erosion. Erosion of river banks is reported in several basins. sand extraction is also being carried out, and international standards are being called for in that area, while on the Kura River sedimentation is a problem, as it blocks water flow, especially during periods of low water levels in the river.

Due to topography, climate conditions and a dense network of rivers in certain areas, natural disasters like landslides, mudflows, floods and avalanches are frequent in Georgia where the number of floods, including flash floods, seems to have increased in the period from 1961 to 2008. Due to its extensive lowland areas, Azerbaijan is particularly exposed to risks from flooding.

Natural disasters (landslides, earthquakes) and their potential consequences, including on industrial facilities with the risk of accidental industrial pollution (for instance from tailing dams or oil pipelines) are perceived as common and significant problems in the region and offer an area for transboundary cooperation.

The drying up of rivers threatens ecological continuity. For instance, the Iori/Gabirri River dries up in summer in dry years as result of intensive water abstraction. In the Alazani/Ganyh, reduction of (groundwater) baseflow has been reported. Over-abstraction of groundwater resources without regulation is a problem in the region.

Ecological flows are not considered. Flow regulation and anthropogenic impacts on water quality affect water-related ecosystems. There are two outstanding transboundary wetland areas: the Javakheti plateau with its numerous lakes and marshy wetlands, and the fishponds and flood-plain marshes in the Aras/Araks River valley. The Caucasus is among the planet's 34 most diverse and endangered areas identified by Conservation International and is included in the WWF list of Global 200 Ecoregions for its outstanding biodiversity. Currently, seven Ramsar Sites are designated in the Caucasus. Transboundary Ramsar Sites have not yet been designated. Apart from the two wetland areas mentioned above, other important transboundary wetland ecosystems include areas in the coastal zones of the Black Sea and the Caspian Sea, as well as the Terek, Sulak, Samur and Kura Rivers and their related, remaining flood-plain wetlands. The waters of these river and lake drainage systems provide important resources for domestic water use, hydropower generation and agricultural irrigation — especially in Armenia, Azerbaijan and Georgia. However, the same wetland ecosystems are also providing important services for human well-being, livelihoods and economies, such as recreation, fisheries, hunting and livestock farming, and harbour a rich biodiversity which depends on them.

Overfishing is a concern in the Kura Basin, where fishing is an important source of income for riparian communities. Instances of illegal fishing occur, in which unsustainable harvesting methods are being used that threaten fish populations.

CLIMATE CHANGE AND ITS IMPACTS ON WATER RESOURCES

In Armenia, summer temperatures have increased by 1 °C during the period 1935–2007, whereas the increase in winter is not statistically significant. Climate change forecasts for Armenia show a significant and consistent increase in temperatures projected for the three time horizons — 2030, 2070 and 2100 — with maximal increase in summer season. The central and western regions of Armenia are expected to experience more warming than the rest of the country. Air temperature is expected to increase by about 1 °C by 2030, with an approximately 3% decrease in precipitation. The predicted reduction in the amount of precipitation (rain and snow) varies somewhat by area/basin: for example for Akhuryan/Arpaçhay it is 7% to 10%; for Voghji/Ohchu, 3% to 5%; and for Agstev/Agstafachai 3% to 4%. A decrease of 5% to 10% is predicted in run-off in the area of Agstev/Agstafachai, 8% to 10% in Vorotan/Bargushad and 2% to 3% in Voghji/Ohchu. A decrease in groundwater levels is also predicted. Armenia's vulnerability to climate change is linked to the importance of the agriculture sector — highly dependent on irrigation from rivers — for the economy: it accounts for 20% of GDP in direct agricultural production and an additional 10% in food manufacturing.

Despite uncertainty, long-term forecasts of most global climate models show about 5% decrease in precipitation on the territory of Georgia, with strong inter-seasonal variability. In Eastern Georgia the predicted decrease of summer precipitation will increase the frequencies of drought and accelerate the desertification process. The decrease of run-off is predicted for two major rivers of eastern Georgia, the Iori/Gabirri and Alazani/Ganyh, with potential impact on irrigated agriculture and drinking water supply.

In Azerbaijan, a decrease of 15% in both run-off and groundwater recharge is expected within the next 50 years due to the predicted increase of air temperature by 2 °C to 3 °C. Groundwater recharge is also influenced by reduced surface water flow. The influence of reduced run-off, as well as decreased quality of both surface water and groundwater in the Kura basin, is assessed as very negative. In the western part of the country, the impact of reduced groundwater recharge is predicted to be very negative. In general, the coastal zone, lowlands and deserts are rated as most vulnerable to climate change. Implemented or planned adaptation mainly relate to technical flood protection, restriction of development in risk areas, improving flood forecasting and monitoring, technical measures to increase supply of water (for drought/low flow protection), application of economic instruments and improvement of existing coastal infrastructure.

During the preparation process for their Second National Communications under the UNFCCC, Armenia, Azerbaijan and Georgia performed several runs of the PRECIS (Providing REgional Climates for Impacts Studies) Regional Climate Model for different socio-economic scenarios and two Global Climate Models (HadAM3P and ECHAM4),[4] to evaluate future climate in the Caucasus region. Towards this end, the countries cooperated by exchanging data and each country validated the baseline data obtained for their territory and used it for climate scenarios and climate change impact assessment studies. Further work on compilation of future climate scenarios and agreement about them at the regional level is being carried out in the framework of the Regional Climate Change Study for the South Caucasus Region financed by ENVSEC.

In the Iranian part of the Araks/Aras basin, average annual temperature is predicted to increase by 1.5 °C to 2 °C by 2050. A reduction of 3% in precipitation is expected. The impacts on land use and cropping patterns and on irrigation needs are expected to be considerable.

For the part of the Araks/Aras that is in Turkish territory, Turkey predicts a decrease of 10% to 20% in precipitation by 2070–2100, and increased seasonal variability of precipitation. A decrease of 10% to 20% in run-off is predicted, also with increased variability. A decrease of groundwater levels is predicted too, with negative effects on groundwater quality. Both consumptive and non-consumptive water uses are foreseen to increase in the Turkish part of the Araks/Aras. But the trends are not uniform, as, for example, in the basin of the Chorokhi/Coruh a comparable increase in precipitation is expected and consequently groundwater levels are expected to rise.

So far adaptation to climate change has been limited to some studies and actual adaptation measures are mostly only starting to be considered. Turkey has developed a "National Climate Change Strategy" (2009), but the actual planning of measures lies ahead. The Islamic Republic of Iran has also been developing its national plan for coping with climate change.

[4] Turkey, the Russian Federation and the Islamic Republic of Iran were also involved in this regional implementation process, which was organized and directed operationally by the Hadley Centre for Climate Prediction and Research in the United Kingdom.

In general, little has so far been done to downscale potential climate change impacts. More comprehensive and collaborative study of effects of climate change is needed. Due to the data and modelling intensiveness of the related work, as well as the large geographical scope, the countries in the Caucasus could greatly benefit from cooperation, sharing data and comparing results. Furthermore, agreement about the basis and assumptions behind the predictions about climate variability and change would help form a uniform picture of the water resources future in the Caucasus.

RESPONSES

Despite the current tendency of weakening environmental protection requirements in order to prioritize economic development and some cuts in funding, environmental regulation is evolving. For instance the adoption of the water code of Armenia marks the way for some progressive legislation in the field of water. However, good legislation alone will not solve water problems; such legislation will also need to be enforced and institutional reforms — at times painful — need to follow to ensure the necessary structures. International frameworks, like progressive approximation to EU directives and accession to the UNECE Water Convention, offer elements for developing instruments for water policy.

Even if investment in wastewater treatment is still insufficient, some measures are reported to address the discharges of untreated or insufficiently treated wastewater, which is one of the most pressing problems. In Georgia, a national programme has been set up to rehabilitate the wastewater treatment infrastructure, with planned completion of works by 2020. Pressures on water quality from municipal and industrial wastewater are expected to decrease in Turkey as a result of the construction of wastewater treatment plants. For instance, preliminary work for wastewater collection and treatment plants for Artvin and Bayburt cities have been prepared to reduce pollution in the Turkish part of the Chorokhi/Coruh Basin. The Urban Wastewater Treatment regulation adopted by Turkey in 2006 is providing the necessary basis to address the issue.

In Georgia, there is an environmental impact assessment process for large enterprises in sectors such as metallurgy, chemical industry, hydropower and heat generation plants. According to its strategy for 2009 and 2010, the Environmental Inspection Service of Georgia is moving towards gradually adopting a zero tolerance approach towards violations. Strengthening of enforcement and inspection has already led to a reduction in violations of discharge regulations.

In addition to the above-mentioned urban wastewater regulation, in the recent years Turkey has adopted a series of other regulations in the framework of the Turkish Environmental Law addressing water pollution control regulation, hazardous waste control, soil pollution control, protection of waters against agricultural-based nitrate pollution and control of pollution caused by certain substances discharged into the aquatic environment. Regulations on environmental impact assessment and on solid waste control had already been adopted in the early 1990s.

No flood zone mapping has been systematically carried out since the Soviet era. In Azerbaijan, which suffers from flooding the most, the capacity to generate accurate and useful flood forecasts is hampered by a general lack of information, together with outdated technologies, equipment and approaches.

New environmental regulations (e.g., Lake Sevan law, Iranian legislation) and investments by operators are expected to reduce impacts on water resources from mining activities. Technological improvement of mining practices also reduces the related loading: for example, the Islamic Republic of Iran has gained experience in controlling pollution from copper mines by developing closed-water circulation in the processes.

There is interest in encouraging the use of economic instruments, for example in Georgia.

THE WAY AHEAD

Economic development and population increases are likely to increase water use, both consumptive and non-consumptive. Georgia predicts that, compared with the situation in 2008, its withdrawal of water from the Kura will increase by approximately 20% by 2015, with withdrawal from the Alazani/Ganyh sub-basin increasing by 10% and from the Iori/Gabirri by 3%. Economic development is clearly the priority for countries in the region, but it should be ensured that neglect of the quality of water resources and of the environment in general does not compromise opportunities in the future.

Water scarcity experienced downstream (and seasonally/periodically elsewhere) calls for improving water management in general, increasing irrigation efficiency and the application of water saving measures, as well as the conjunctive use of water, including reuse of drainage and return waters. Controlling the use of pesticides and fertilizers and diffuse pollution from agricultural lands would not only reduce harmful effects on water quality in rivers, but also improve the reuse potential of the return waters.

While the needs for capacity-building and for strengthening water management institutions are considerable, there is also valuable experience and competence to share in the region. For example, the Islamic Republic of Iran has indicated willingness to share experience with regard to reducing copper mining pollution.

There is also the need to strengthen the knowledge base on the impacts of climate change, including through cooperation. Agreement about the models to be used and selection of a common scenario or set of scenarios on which to base the modelling supports the development of a common understanding, building ground for joint or coordinated adaptation strategies.

Coordination and finding synergies in the activities supported by different donors is crucial. Donors should also ensure that their interventions respond to the priority needs of Caucasian countries and that there is commitment to follow up on the funded activities at the national level, especially in monitoring and assessment, where sustained investment and continuity are necessary to monitor the effectiveness of interventions and to detect trends. At the same time, recipient countries have to take responsibility for the follow-up beyond individual project life.

Above all, increased political commitment to transboundary cooperation is needed to improve the institutional framework and the management of transboundary water resources. The technical cooperation established under various projects should evolve in a more long-term, sustainable framework for cooperation to be able to tackle the variety and complexity of challenges for water resources.

CHAPTER 5
CENTRAL ASIA

INTRODUCTION

The subregional assessment of transboundary waters in Central Asia covers transboundary rivers, lakes and groundwaters shared by two or more of the following countries: Afghanistan, China, the Islamic Republic of Iran, Kazakhstan, Kyrgyzstan, Mongolia, the Russian Federation, Tajikistan, Turkmenistan and Uzbekistan. The assessment of the individual transboundary surface and groundwaters in this subregion can be found in Chapters 1, 2, 3 and 4 of Section IV (drainage basins of the White Sea, Barents Sea and Kara Sea; of the Sea of Okhotsk and Sea of Japan; drainage basin of the Aral Sea and other transboundary waters in Central Asia; and drainage basin of the Caspian Sea). The assessment of transboundary waters in Central Asia also contains an assessment of a number of selected Ramsar Sites and other wetlands of transboundary importance with different transboundary settings: the Gomishan Lagoon, the Aydar-Arnasay Lakes system, the Tobol-Ishim Forest-steppe, the Xingkai Lake National Nature Reserve, Lake Khanka, the complex of Daurian Wetlands and the Ili Delta.

Water resources in Central Asia are predominantly of a transboundary nature. Most of the region's surface water resources are generated in the mountains of the upstream countries Kyrgyzstan, Tajikistan and Afghanistan, eventually feeding Central Asia's two major rivers, the Syr Darya and the Amu Darya, which flow though the downstream countries Kazakhstan, Turkmenistan and Uzbekistan, and are a part of the Aral Sea Basin.

Central Asia's water resources are of critical importance to the region's economy, people and environment. Due to the arid regional climate, irrigation water is an indispensable input for agricultural production. An estimated 22 million people depend directly or indirectly on irrigated agriculture in Tajikistan, Turkmenistan and Uzbekistan. Water is also important for energy production: hydropower energy covers more than 90% of total electricity needs in Kyrgyzstan and Tajikistan and is also an export commodity.

The competing demands of agriculture in downstream countries and hydropower generation in upstream countries fuel serious political disputes in Central Asia, putting water at the heart of regional security and stability. The sensitivity of the topic is shown by the tendency for ministries of foreign affairs to be increasingly involved in transboundary water issues in Central Asian countries.

The population in the Aral Sea Basin has more than doubled from 1960 to 2008, to almost 60 million, increasing the pressure on water resources. In particular, population growth in some urban centres of the Central Asian region has been rapid in the past 20 years. South-west Uzbekistan, the Fergana Valley, southern Tajikistan (notably the Vakhsh Valley), and northern Afghanistan, for example, are densely populated zones in Central Asia. Since the break-up of the Soviet Union, national legal systems and governance structures in the Central Asian Republics have evolved to become quite different. Also the level of economic development of the different countries is highly diverse.

LEGAL, POLICY AND INSTITUTIONAL FRAMEWORKS FOR TRANSBOUNDARY WATER MANAGEMENT

Regional cooperation to manage shared water resources, in particular for the two main rivers, Amu Darya and Syr Darya, became urgent after the Central Asian former Soviet republics became independent in 1991. The legal framework for this regional cooperation was put into place in the early 1990s, immediately after the break-up of the Soviet Union. It is increasingly considered that this legal framework, building on the Soviet-era allocation of water, has become largely outdated, resulting in generally poor implementation, and therefore requiring improvement. During the past few years, the agreed arrangements on water allocation have not been fully implemented or it has proven impossible to agree on water allocation. A limitation is linked to the fact that the energy sector (hydropower, more precisely) is not addressed by the existing regional organizations engaged in water management cooperation.

Finding sustainable long-term solutions for balancing different needs and uses of water resources, including irrigation, human consumption, the generation of electricity and the protection of fragile natural environments, has proved to be a difficult task. At present a holistic, rational and equitable approach to the use of transboundary water resources supported by all countries is lacking. This has resulted not only in tensions and suspicions over water allocation and energy generation, but also in social and economic problems, as well as environmental degradation.

Key principles of IWRM like the basin approach are not appropriately reflected in the existing agreements, despite the effort to establish basin-level structures for the main basins, the Amu Darya and Syr Darya. Cooperation largely focuses on water sharing and allocation according to Soviet practices, while cooperation on water quality or water-related ecosystems is almost non-existent.

The current legal framework for transboundary cooperation includes both binding instruments and various semi-formal agreements and documents. In addition to regional agreements which are general in nature, there are a number of bilateral and some trilateral agreements on specific issues or watercourses, most of them from the 1990s.[1] One of the shortcomings of the existing legal framework is the insufficient links between the various legal instruments. Many of the agreements focus on water sharing and water allocation, but implementation is often poor — the agreement on the Chu and Talas Rivers between Kazakhstan and Kyrgyzstan focusing on the joint financing and use of certain dams and canals being one of the few positive exceptions. Moreover, Afghanistan has not signed water management agreements with its neighbours downstream.

The basic agreement concerning transboundary waters in the region is the Agreement on Cooperation in Joint Management of Use and Protection of Water Resources of Interstate Sources signed in 1992 by Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan and Turkmenistan. Under this agreement, countries confirmed the principles for water allocation as developed under the Soviet Union.

Based on the 1998 intergovernmental agreement signed by the countries sharing the Syr Darya, Protocols were signed annually (from 1999 to 2003) on the use of water and energy resources of the Naryn-Syr Darya cascade of reservoirs, depending on the dryness of the year. However implementation of the protocols was often weak. Since 2004, Uzbekistan has preferred to negotiate bilaterally with the countries of the Aral Sea Basin, including on the Syr Darya. With the support of the Asian Development Bank, a draft agreement on the Syr Darya was developed in 2005, but its finalization and adoption are still pending.

In some cases, the implementation of agreements signed by the Soviet Union has continued after the break-up; for example, Turkmenistan has continued implementing the agreements on the Tejen/Harirud with the Islamic Republic of Iran. Only fairly recently, in 1999, a new agreement was signed for the construction and management of the Dosti Dam on the Tejen/Harirud River.

The most recently signed bilateral agreements in the subregion are the ones concerning the rational use and protection of transboundary waters between the Russian Federation and China (2008), and the one on the protection of water quality of transboundary rivers between Kazakhstan and China (2011). Even though it is positive that attention is paid to water quality issues, it is not ideal that these issues are separated from other water management issues under a separate Kazakh-Chinese agreement.

The main institution at the regional level is the International Fund for Saving the Aral Sea (IFAS) led by the Presidents of the five Central Asian countries. The Executive Committee of the International Fund for Saving the Aral Sea (EC-IFAS; established 1993); the Inter-State Commission for Water Coordination (ICWC; established in 1992); and the Inter-State Commission for Sustainable Development (ICSD; established 1994); operate relatively independently of each other although they are all part of IFAS. The Amu Darya and Syr Darya Basin Water Organizations (BWOs) were established as executive bodies of the ICWC, but their influence in terms of water management does not cover the upper part of the respective basins.

Kazakhstan, Uzbekistan and the Russian Federation are Parties to the UNECE Water Convention. Until the entry into force of the amendments to articles 25 and 26 to open the Convention to countries outside the UNECE region, Afghanistan, China, the Islamic Republic of Iran and Mongolia cannot accede to the Convention.[2] Kazakhstan, the Russian Federation and Turkmenistan have ratified the Framework Convention for the Protection of the Marine Environment of the Caspian Sea. In general, however, the countries do not have a common legal framework and show a different understanding of the international water law, its principles and obligations.

The 2006 Framework Convention for the Protection of the Environment for Sustainable Development in Central Asia is an attempt to provide a legal basis for cooperation between Central Asian States on a broad range of environmental issues — among them sustainable use of water resources. The Convention has not been signed by all the Central Asian countries. Once the Convention enters into force, a secretariat will be set up to support the implementation of the Convention, but it is not clear how it would interact with other regional organizations such as IFAS and ICWC.

Kazakhstan and the Russian Federation, China and the Russian Federation, Kazakhstan and China, as well as Mongolia and the Russian Federation, have established joint commissions on transboundary waters. The Commission of the Republic of Kazakhstan and the Kyrgyz Republic on the Use of Water Management Facilities of Intergovernmental Status on the Rivers Chu and Talas (Chu-Talas Commission; established in 2006) is an example of a functioning joint body under a bilateral agreement. According to this agreement, Kyrgyzstan has a right to compensation from Kazakhstan for a share of expenses incurred to ensure the safe and reliable exploitation of specified water management facilities. Over the years, the cooperation in the framework of the Chu-Talas Commission has expanded; in 2009, it was extended to cover more facilities (the ratification by the countries is still pending). Such a model has been evoked as a means for downstream countries to participate in managing dams and other hydraulic facilities, the operation regime of which is commonly a source of tension.

With regard to the Ili and the Irtysh, it is a shortcoming that there is no permanent executive body of the Kazakh-Chinese or Kazakh-Russian Joint Commission.

During the past decade, national water legislation and organization of water resources management have been reformed in many countries of the region and this development continues.[3] For example, the 2003 Water Code of Kazakhstan introduced the principle of basin management and opened up the possibility for the various governmental and non-governmental entities involved in water management or water use, such as water users' associations or water-related NGOs, to be consulted before decisions are taken.

The Water Code of Kyrgyzstan of 2005 also establishes principles for an integrated approach to water resources management and includes basin management plans for the development, use and protection of water resources. A National Water Council with the task of coordinating activities on the water sector was established in 2006 in accordance with the Water Code, however it has not met yet. Moreover, the switch to a parliamentary form of government has led to a review of the earlier plans.

The principle of water basin management is also reflected in the legislation of Uzbekistan, where basin water administrations have been established since 2003.

[1] Information on the existing agreements for transboundary water cooperation can be found in annex II.
[2] The status of ratification of selected international agreements relevant to transboundary water management is presented in annex III.
[3] A brief description of the water resources management framework in each of the countries can be found in annex I.

It is expected that as an outcome of the reform of the water sector in Tajikistan, water management will be transferred from administrative units to river basin authorities, which should be created during 2011–2013. Afghanistan is also taking initial steps towards the basin approach, with the establishment of River Basin and Sub-Basin Agencies. The Water High Council of Afghanistan and its secretariat is reviewing the Water Law and working on a transboundary water policy.

Despite the legal developments and policy reform, implementation remains limited or has progressed slowly, affected by, e.g., lack of resources and weakness of institutions. Another major obstacle for an integrated approach to water resources management is the frequent lack of intersectoral coordination. The water management in some of the countries falls under the competence of one sectoral ministry, e.g., the ministry of agriculture in Kazakhstan, the ministry of agriculture and water management in Uzbekistan, focusing on water quantity issues in the interest of irrigation, or the ministry of energy, e.g., in the Islamic Republic of Iran. At the same time, effective structures and mechanisms for inter-agency cooperation do not exist.

A positive development is the setting up of basin councils to facilitate participation of all the concerned stakeholders. At the national level, advisory basin councils have been set up already in Kazakhstan and on the Talas in 2009 in Kyrgyzstan. Kyrgyzstan is expecting to complete the establishment of river basin management authorities and basin councils required by the Water Code in 2011. Establishment of an Inter-State Chu Talas Basin Council has been proposed and a concept for it developed. Mongolia established basin councils for the Eroo River in 2007 and for the Tuul River in 2010, with the support of a project for strengthening IWRM in the country. However further efforts are needed in this area and, where established, councils need to be strengthened to function properly.

Water users' associations have been established in many countries of the region, in particular, in Kyrgyzstan, Tajikistan and Uzbekistan, with the responsibility for the maintenance and operation of irrigation networks, but also for water supply in rural communities. Afghanistan is also making preparations for their establishment. The emergence of the water user cooperatives illustrates a shift to a more decentralized operation of irrigation facilities, an important step in reforming the irrigation and agriculture sectors.

In practice, in natural resources (including water) management, the local administrative units, like *akims* in Kazakhstan, may not be consistent in their approach and may lack resources for inspection, etc.

The low attention to groundwater in overall water management is partly explained by the responsibility for aquifer resources and their identification lying with the agencies for geology and mineral resources. It may also reflect a low awareness about the role played by groundwater resources, even though groundwater is locally very important in some areas. In Kazakhstan, positively, a comprehensive review of transboundary aquifers has been carried out.

Strengthening or even maintaining the capacity of personnel in water-related administration and services is a challenge, as many qualified experts seek to work in the private sector due to the low level of remuneration of public officers.

MONITORING OF TRANSBOUNDARY RIVERS, LAKES AND GROUNDWATERS

Limited monitoring and assessment data, data which is often not reliable and lack of data on uses and needs are common problems in Central Asian countries. The situation is particularly severe in Afghanistan.

Exchange of data is also very limited. The Central Asian Regional Water Information Base Project (CAREWIB) database, maintained by the Scientific Information Centre of ICWC, is a recent effort to make information on water resources openly and readily accessible to all the countries in Central Asia, even if access to this information system is differentiated among users with different levels of accessibility of data. However, not all countries are comfortable with this information system being developed and centrally situated in another country.

Flow data up to 1990 is commonly quoted for rivers, indicating a lack of recent data or a difficulty to obtain information. After 1991, hydrological monitoring drastically decreased. For example, on the Chu and its tributaries, the number of hydrological monitoring stations has decreased by more than two thirds since the 1970s. Similarly, of some 100 hydrological monitoring stations on Kyrgyz territory within the Syr Darya Basin in 1980, currently 28 are operational. A lack of material and equipment, and the not infrequently poor condition of the existing monitoring stations, also poses problems. Such reduction of flow monitoring complicates evaluating the impact of withdrawals and diversions, and the lack of continuity is also a constraint to assessing long-term change — i.e., climatic variability and change.

Nevertheless, the situation has been improved in, for example, Kazakhstan over the past seven years. This includes the establishment of new monitoring stations on the rivers shared by Kazakhstan and China. In its national Water Resources Development Plan, Afghanistan gives a special priority to rehabilitation of its hydrometric network. Use of satellite remote sensing is to some degree a means of compensating for reduced in situ monitoring, but still requires ground truth observations for validation.

Bilateral and multilateral donors — among others, the World Bank and Switzerland — have supported monitoring and assessment projects and data/information management, at regional and national levels. The challenge is how to sustain the monitoring beyond the life of the projects.

While in general data and information exchange needs improvement, more regularity, continuity, transparency and structure, there are some positive exceptions. For instance, there is regular joint water quality monitoring between the Russian Federation and China and the Russian Federation and Kazakhstan. Between the national hydrometeorological services of the Central Asian Republics data exchange (also partly on water quality) is working, but a wider dissemination is needed. Where a bilateral commission functions, like the Joint Commission of Transboundary Waters between Mongolia and the Russian Federation, an appropriate framework for data exchange exists: information on discharge, regime, quality monitoring results and flood and emergency situations is exchanged in the joint Mongolian-Russian Working Group. An important task of the Chu-Talas Commission is to make improved water quantity measurements available to both Kyrgyzstan and Kazakhstan.

Water quality is monitored less than water quantity. The overall water quality is reported in the Russian Federation and Central Asian Republics using a water pollution index which is defined on the basis of the ratios of measured values and the maximum allowable concentration of the water-quality parameters. Monitoring of suspended solids is limited, despite its relevance considering erosion problems and accumulation of sediment in reservoirs.

A lack of effective, sustainable groundwater monitoring programmes in most countries in the region is an obstacle to the assessment of the quality and quantity of groundwater resources in the transboundary aquifers. Data on transboundary aquifers is not exchanged, and in many of the countries knowledge in this area is at a relatively low level.

Monitoring of glaciers and snow cover — the source of most of Central Asia's rivers — is quite fragmented in the subregion as it is carried out by different organizations in different countries. The costly expeditions that have been important for glacier volume estimations have been drastically reduced and attempts are made to fill gaps through other means such as remote sensing.

MAIN PROBLEMS, IMPACTS AND STATUS

The major challenge in Central Asia is to agree on how to use the available water resources taking into account the interest of all countries and of the water-dependent ecosystems. The main issue is the conflict between water use for hydropower generation and for irrigation. While upstream countries like Kyrgyzstan and Tajikistan prioritize water use for energy production, therefore mainly in winter when it is most needed, the peak of water demand in the downstream countries for irrigation and agricultural production is in summer, during the height of the growing season.

The subregion's critical dependence on water resources is illustrated by the 2008-2009 crisis. A very dry year was followed by an extremely cold winter and energy needs in Tajikistan and Kyrgyzstan could not be met due to low water levels in reservoirs leading to an energy and food crisis that caused terrible distress among the populations and the economies in the subregion. Degraded energy infrastructure and shortcomings of energy regulation add to the problems.

Construction of a number of new dams, mainly for hydropower but also to collect irrigation water, was initiated in the late 2000s. This includes Kambarata 2 on the Naryn; Sangtuda 1 and 2 on the Vakhsh; Koksarai on the Syr Darya; and Kara-Burinsky on the Talas River. Afghanistan was obliged to suspend a number of construction projects for multiple-use reservoirs because of war and instability. Dam infrastructure helps to mitigate impacts of flooding, but also disrupts water flow, with consequences for other uses and ecosystems. The hydraulic system of the Argun River changed with the realization of major water transfer schemes in China.

Concerns over the safety of more than 100 large dams and other water control facilities, located mostly on transboundary rivers, have grown in recent years in the subregion. Ageing dams and their inadequate maintenance, coupled with population growth in flood plains downstream from the dams, have resulted in increased risks, as demonstrated by the failure of the Kyzyl-Agash Dam in Kazakhstan in 2010. The dam is privately owned and the failure was caused by lack of safety control measures, including from the side of State authorities. The accident underlined the importance of dam safety control, regardless the form of ownership. Another consequence of the ageing of water reservoirs is the increased volume of sediments, decreasing the operational volumes.

The agricultural sector is the biggest consumptive water user in the subregion, notably in the Aral Sea Basin. Agriculture represents almost 99%[4] of water withdrawal in the Chu Basin, 94% in the Bolshoy Uzen/Karaozen, 90% in the Atrek, 89% in the Syr Darya, 85% in the Ili and 73% in the Talas Basin, just to mention a few examples in addition to the heavily affected downstream part of the Amu Darya.

The population in most of the countries is heavily dependent on agriculture, up to 80% in Afghanistan. This underlines the importance that water for agriculture currently has. There is a pressing need to improve water use efficiency. In Afghanistan, for example, where the aridity of the climate limits rain-fed agriculture, 90% of the irrigation systems are traditional, with an efficiency of the irrigation network of about 25%–30%. Lack of maintenance and damage is a common problem for the irrigation infrastructure in the subregion. Specific water use is high because of losses, evaporation and overwatering. Limited/local pressure from livestock also occurs, for example, in the Ili, Naryn and Chu Basins.

Leaking networks and irrigation canals, adding to recharge, may cause rising of the groundwater level and affect its quality negatively. As a result of water-logging, arable land is being lost or its quality degraded, limiting its uses. Irrigation return waters affect groundwater quality negatively, for example in the Tejen/Harirud Basin. Substantial stretches of irrigated area require draining, but the nutrients and agrochemicals that the waters from collectors carry degrade the environment where released. Notably in the Amu Darya, irrigation return waters affect the quality negatively with salinity and major ion concentrations increasing downstream. In areas with high evaporation, evaporation from shallow groundwater and surface water contribute to salinization of soil and groundwater. Land salinization from mineralized drainage water leads to increased water use as the salts in the fields need to be washed out before the growing season.

[4] Situation in 2006.

Water deficit downstream in the major rivers, the Amu Darya and Syr Darya, is pressing, resulting from the combined effect of extensively developed irrigation, ineffective management and changes in water regime. Among the reasons for reduction of flows is the extensive, largely outdated and inefficient irrigation infrastructure, the maintenance and replacement of which is a big financial challenge for the countries. Little flow in the Syr Darya reaches the delta because of all the withdrawals. Also, in smaller basins like the Malyi Uzen/Saryozen, scarcity is experienced. The increased mineralization with reduced flow limits the use of the water. In addition to nutrient and pesticide pollution of irrigation return waters, anthropogenic pressures on water quality include discharges of untreated or insufficiently treated wastewater.

The Aral Sea catastrophe is the clearest example of the negative impacts on human health and ecosystems of overabstraction, land degradation and desertification. Since 1960, the Aral Sea Basin lost 80% of its volume, the surface area was reduced by more than two thirds, the water level dropped by 22 m, and water salinity increased 6 to 12 times. The rivers that feed it have been intensively used for irrigation. This has created tremendous ecological problems both for the lake and for the surrounding area. The lake is badly polluted, largely as a result of fertilizer run-off and industrial pollution. The ecosystem of the Aral Sea has been nearly destroyed: fish disappeared from the lake, and a significant number of waterfowl and water-related birds moved to other regions. Moreover, the receding lake has left huge plains covered with salt and toxic chemicals, which are picked up and carried away by the wind as toxic dust and thereby spread to the surrounding area. As a result, the land around the Aral Sea has become heavily polluted, and people living in the area are suffering from a lack of freshwater, as well as from a number of health problems, such as certain forms of cancer and lung disease. These processes result in the deteriorating drinking water quality and health of the population, in decreasing land productivity and crop yields, and in the growth of poverty, unemployment and migration. However in recent years there have been some positive developments. To increase the volume of water in the northern part of the sea, the Kok-Aral Dam has been built by Kazakhstan to capture the flow from the Syr Darya. As a consequence, the surface of the North Aral Sea has increased and the water level raised from 30 to 42 meters. An important effect is the revival of fisheries. Efforts have also been made in the Amu Darya delta in Uzbekistan to establish waterbodies and artificially regulated lakes. Considerable social efforts are also made by the respective countries to alleviate the situation for the population suffering from the drying out of the Aral Sea.

In the Ili Delta, water-dependent ecosystems are also negatively affected by flow regulation and diversion. This site is under pressure from pollution and desertification too. It is crucial to establish adequate protection of this area so as to maintain its ecological balance and biodiversity, and avoid another catastrophe like the Aral Sea.

The region is highly vulnerable to extreme hydrological events such as floods and droughts. Afghanistan is particularly vulnerable to flooding because it lacks flood protection infrastructure; elsewhere, such infrastructure is in need of rehabilitation. In the mountainous part of the subregion, for example in Kyrgyzstan, sudden flooding is occasionally caused by overflow of glacier lakes. Release of water from reservoirs in winter for hydropower generation may cause winter flooding in downstream countries. On the Syr Darya this is less of an issue now that Kazakhstan has developed reservoir capacity downstream. The Ussuri and the Sujfun, for instance, are heavily affected by flooding. In some basins, an additional concern related to flooding is the surface pollution it mobilizes.

In the mountainous upstream part of the major rivers, soil stability problems such as landslides and mudflows are reported in several basins, among them the Naryn and Kara Darya. Problems related to erosion are not limited to the arid and semi-arid parts of the subregion, but are an issue even in basins such as the Irtysh, Malyi Uzen/Saryozen and the Tumen/Tumannaya. High sediment loads due to erosion add to the silting of reservoirs. In the Chirchik, as well as Atrek and the tributary Sombar, sediment loads are a problem. Diverse factors related to land management can aggravate erosion problems, including, for example, expansion of settlements (Surkhan Darya), deforestation (Naryn, Amu Darya) and overgrazing (Selenga).

Groundwater level decrease has been observed, for example, in the Pre-Irtysh (transboundary between Kazakhstan and the Russian Federation) and Pre-Tashkent aquifers (transboundary between Kazakhstan and Uzbekistan) as a result of heavy abstraction. Rising groundwater tables pose problems locally, e.g., in the Chu Basin.

Towards the north, the importance of industry as a water user increases, and so do pressures related to it. In the basins of the Ural and of the Irtysh/Ertis, withdrawals for industry are significant. Discharges of industrial wastewater are seen as a pressure factor in the Syr Darya, Naryn, Ural, Selenga, Atrek/Atrak, Irtysh/Ertis, Tobol, Ishim/Esil and Tumen, among others. The upper Argun is highly polluted from industry. The Amur has been seriously affected by industrial accidents on the Sungari tributary.

Discharges of untreated or insufficiently treated municipal wastewaters are a pressure factor in a number of basins: the Atrek, Bolshoy Uzen/Karaozen and Malyi Uzen/Saryozen, Chatkal, Chu, Ili, Ishim, Kafirnigan, Naryn, Surkhan Darya, Talas, Tumen and Ural. Wastewater collection is often lacking, or where facilities exist the treatment is often limited to mechanical treatment or hampered by technical problems or their degraded state, or by the insufficient capacity of the network.

A number of ecological problems are inherited from the past and are legacies from industrial and radioactive pollution. Unmonitored storage or dumping of pesticides and other hazard-

ous chemicals is a problem in specific locations, for example, in the Vakhsh sub-basin. Remnants of mining activities include extensive uranium tailings areas in the Naryn and Kara Darya sub-basins of the Syr Darya. Their gradual degradation releases hazardous substances to the environment and accidental failures of tailings or flooding could have severe impacts. Mining also affects water quality in the basins of the Chu, Irtysh/Ertis, Selenga, Tobol, Tumen/Tumannaya and Vakhsh. Mining adds to erosion of slopes and triggering of landslides locally, which through sediment transport affect water quality downstream. In the Ural and Ob basins, oil or gas exploration are potential pressure factors.

Sectoral and economic interests dominate over environmental concerns. In a subregion where poverty is widespread, countries give priority to economic development with serious threats for sustainability.

CLIMATE CHANGE AND ITS IMPACTS ON WATER RESOURCES

In Central Asia, the contribution of snow and ice melt to the formation of renewable water resources is decisive. The glaciers have a stabilizing effect on the stream-flow and add to the water flow during the important irrigation season after the melting of snow. The mean snow-water equivalent in the Northern and Western Tien Shan has remained relatively stable over the past few decades, but several studies have concluded that the glacial systems of the Central Asian mountains are decreasing in size and volume. A compensating mechanism such as meltwater contribution from thawing underground ice in areas of perennial permafrost area may delay the impact on the observed run-off. The reliability of assessments of climate variability and related changes in water flow is affected by degradation of monitoring in the past 20 years and complicated by the human-induced changes in land use and in the river systems.[5]

Observations of climate change over many decades in Uzbekistan include a statistically significant increase in air temperature. The number of days of high air temperature (>40 °C) has increased from the 1950s to 2000s. The number of days with low temperatures (below either -15 °C or -20 °C) has decreased, for example, in Tashkent since the late 1870s. In Tashkent, variability of precipitation has increased from the 1880s to the early 2000s, as has the number of days with heavy precipitation (>15 mm/day). A tendency towards decreasing snow cover has been observed, and glaciers continue to shrink at rates ranging from 0.2%–1% by area. According to scenario A2,[6] no significant changes in water resources of the Amu Darya or Syr Darya by 2030 are predicted. By 2050, the reduction of water resources by 10%–15% in the basin of the Amu Darya and by 2%–5% in the basin of the Syr Darya is considered possible. In general, the zone where the total precipitation is less than 100 mm (arid) is predicted to decrease and zones with precipitation ranging from 100 to 200 mm/year (arid, 200 mm/year is low precipitation limit of semi-arid) will increase. According to scenario B2,[7] an increase of 5%–15% in precipitation in Uzbekistan compared with the 1961–1990 reference period is assessed as a possibility by 2030 and 2050. Due to the high level of zoning in the processes of formation of precipitation, this can result in a decrease or even an increase in flow compared with the current situation in the shared rivers. Beyond 2030, the predicted increase in air temperature is expected to lead to reduced river flows.

[5] *Source:* Severskiy, I. Current and projected changes of glaciation in Central Asia and their probable impact on water resources. In: Braun, L. N., Hagg, W., Severskiy, I., Young, G. (eds) Assessment of Snow, Glacier and Water Resources in Asia: Selected papers from the Workshop in Almaty, Kazakhstan, UNESCO-IHP and the German IHP/HWRP National Committee. 2006.

[6] This refers to the scenarios described in the Intergovernmental Panel on Climate Change (IPCC) Special Report on Emissions Scenarios (SRES) (IPCC, Nakicenovic, N. and Swart, R., (eds.), Cambridge University Press, United Kingdom, 2000). The SRES scenarios are grouped into four scenario families (A1, A2, B1 and B2) that explore alternative development pathways, covering a wide range of demographic, economic and technological driving forces and resulting greenhouse gas emissions. Scenario A2 describes a very heterogeneous world with high population growth, slow economic development and slow technological change.

[7] For explanation, please see the previous footnote. Scenario B2 describes a world with intermediate population and economic growth, emphasizing local solutions to economic, social, and environmental sustainability.

Uzbekistan assesses the Amu Darya and small rivers of the region to be most vulnerable to climate change. The predicted increased aridity and evapotranspiration in the region are expected to be reflected in increased irrigation requirements in the region. Among the implications of predicted changes is aggravated desertification. Frequency of drought events in the Pre-Aral area (around the former Aral Sea) is predicted to increase with warming of the climate.

Options for adaptation to climate change identified in Uzbekistan include reconstruction of irrigation systems and introduction of drought-resistant crops. Socio-economic scenarios, plans for long-term development of the agriculture sector and the development of a methodological basis for assessment of water losses, as well as the study of possible approaches to their reduction, are needed.

Tajikistan is a pilot country in a World Bank project to study the impact of climate change on glaciers and the development of adaptation measures. During the past 60 years the air temperature on average increased by 1 °C. By 2030, a further increase of 1.5 °C is predicted. Glaciers in Tajikistan are decreasing both in surface area and volume. The volume of glaciers is predicted to decrease by 30% in the coming 50 years. At the same time, the flow in large snow- or glacier-fed rivers is predicted to increase for 5 to 7 years and then to gradually decrease by 5%–15% over the next 30 years. The frequency of years with extremely low or high flows is expected to increase. By 2030, Tajikistan predicts the flow of the Amu Darya to decrease by 21%–40% and of the Syr Darya by 15%–28%.

Adaptation measures envisaged in Tajikistan include renovation and modernization of water infrastructure to reduce water losses, improvement of productivity in water use through, e.g., better irrigation technology; construction of reservoirs in the mountains to compensate for the diminishing glaciers; increase in the level of regulation of national and transboundary rivers; use of brackish groundwaters and desalinization; a switch to less water-demanding crops in agriculture; application of economic tools in water management; and improvement of water management effectiveness through introduction of an IWRM approach.

In Kyrgyzstan, a slight increase in run-off due to an increase in the proportion of glacial run-off is predicted by 2025–2030. In the subsequent years, run-off is expected to decrease. At the same time, the number of glacial lakes is predicted to increase, which may increase the risk of flooding events.

Vulnerability assessments for the glaciers and the amount of surface run-off in major hydrological basins have been carried out in Kyrgyzstan using digital elevation models and moisture conditions of Kyrgyzstan's land area developed at the Institute of Water Problems and Hydropower of the National Academy of Sciences of Kyrgyzstan. The more systematically collected data on the glaciers in Kyrgyzstan is from the 1960s. With preparation of a national climate change adaptation strategy and its adoption by the Government, Kyrgyzstan expects to gradually take related measures in the coming years.

In Kazakhstan, the following are considered as priorities with regard to climate change adaptation: development of low-water technologies adapted to more arid conditions; increase in the proportion of groundwater use; inter-basin transfer; and integration of water management issues in the instruments related to other sectors, such as agriculture, energy and industry.

Adaptation measures in the Russian Federation include flood protection; regulation of run-off and redistribution of water resources; improvement of water management, including water-saving technologies; and introduction of insurance against natural disasters.

Strategies of the Islamic Republic of Iran to adapt to climate change include the following: development of agriculture and aquaculture activities based on brackish water use and increasing water use efficiency; development and implementation of national response strategies using innovative technology and engineering solutions for installation of flood warning and drought monitoring systems; construction of water resources facilities such as dams, aqueducts, well fields, levees, banks and drainage channels; non-structural measures including water conservation, integrated ground and surface water management and improved water supply; improved operation of reservoirs, water saving policy and water recycling and reuse.

The problems associated with climate change are generally recognized in the subregion, but the scientific basis is still weak and, due to this, the basis for adaptation measures in the water sector is poor. For example, future irrigation requirements remain to be assessed. In some countries, efforts have been made to assess the likely impact climate change will have on water resources in the major river basins. However, the limited results show a significant spread in predictions.

RESPONSES

Plans for development, use and protection of water resources have been developed in Kyrgyzstan for some basins, including the Talas, and are expected to be adopted by the National Council on Water. In the implementation of the national water resources development plan, which has started in Afghanistan, priority is given to projects that reduce the likelihood of damage by drought and floods, create job opportunities, increase irrigation and power supply and provide access to safe drinking water.

There has been some cooperation in the development of hydraulic infrastructure on transboundary rivers of the subregion. For example, in 2004 the Islamic Republic of Iran and Turkmenistan completed the construction of the Dosti Dam on the Tejen/Harirud. On the Chu and Talas Rivers, Kazakhstan and Kyrgyzstan cooperate on the operation and maintenance of flow regulation infrastructure. Turkmenistan and Uzbekistan cooperate in jointly operating the Tyuyamuyunsk Dam.

Several countries have been increasing their investments to enhance irrigation systems, improve and rehabilitate the aged infrastructure. Moreover water saving technologies have been introduced, such as drip irrigation. However, a shortage of financial resources for renovation and maintenance persists and more effort is needed to improve efficiency by reducing water losses.

Some change of crops has occurred in the past decades, with crop diversification, including replacing water consumptive crops such as cotton and rice with cereals, and thereby reducing water requirements.

Work has also been done to reduce risks of dam failures. Kyrgyz authorities have agreed to develop cooperation to jointly review and assess the safety of the Kirov Dam on the Talas in response to Kazakhstan's concerns. Kyrgyzstan has gradually increased Government funding, been involved in borrowing funds for rehabilitation work on structures such as the Kirov, Orto-Tokoi and Papan Dams and on the Big Chu Canals. However, in general legislation and procedures for assessing, monitoring and communicating about dam safety need improvement.

The Aral Sea Basin Programme-3 has been prepared. It seeks to improve the socio-economic and environmental situation by applying the principles of IWRM to develop a mutually acceptable mechanism for a multipurpose use of water resources and to protect the environment in Central Asia, taking into account the interests of all the States in the region. Donor funding is sought for the projects identified for this Programme, prepared under the leadership of the Executive Committee of IFAS at the request of the Heads of the Central Asian States.

Countries report reduced pressure from wastewater discharges in a few basins, the Irtysh among them, where both the total sewage discharge and the untreated part have decreased. In the area of the basins of the Malyi Uzen/Saryozen and the Bolshoy Uzen/Karaozen in Saratov oblast in the Russian Federation a number of wastewater treatment plants have been constructed. Measures have also been taken elsewhere. In the Islamic Republic of Iran, wastewater treatment plants have been constructed in Mashhad (Tejen/Harirud Basin), but use of treated wastewater in agriculture is also foreseen.

Mongolia is limiting mining companies' activities in the proximity of water bodies through the enforcement of a law adopted in 2009.

THE WAY AHEAD

Noting the number of problems that Central Asia faces, the region has to work out its priorities within the limits of its resources, taking into account the limitations fixed by the history of environmental degradation and infrastructural set-up, and to orient water management accordingly.

A sustainable solution for cooperation on transboundary waters requires a careful balance between water use for irrigation, human consumption, the generation of electricity and the protection of fragile natural environments. It is important to note that water gains for one sector do not necessarily take away water from another. For instance, it can be a question of using the reservoir infrastructure to optimally time the releases so that different sectors benefit simultaneously, or for different reservoirs in a cascade to have complementary operating modes. Regional cooperation on water should be complemented by cooperation in other economic sectors, and sustainable benefit-sharing arrangements may be developed that are not limited to water.

The willingness of all the riparian countries to cooperate, establish an open dialogue and compromise to find a consensus between their positions is necessary for agreement. There is concern that without the will to cooperate, knowledge of technical issues will not help. Cooperation on water can pave the way to cooperation in other fields like transport, trade, transit and energy.

Basin management institutions need to be enhanced and transboundary cooperation based on international legal instruments strengthened. The region needs a common overarching legal framework to serve as "rules of the game" for developing agreements and effective institutional arrangements for the management and protection of shared waters. The Water Convention can play such a role and provide a fair, sound and sustainable framework for cooperation on shared water resources. It is positive that Kazakhstan and Uzbekistan are Parties to the Convention, that Turkmenistan is committed to acceding to it and that understanding of the Convention is growing also in the countries which are not Parties to it. It is important that the amendments to articles 25 and 26 of the Water Convention enter into force, opening it to countries outside the UNECE region, so that the region can have a common legal basis for cooperation including also non-UNECE countries such as Afghanistan, China, the Islamic Republic of Iran and Mongolia.

The present regional institutional mechanism, based on the international Fund for Saving the Aral Sea (IFAS), is in need of stronger efficiency, coordination and collaboration between its organizations. The recognition by the Heads of Central Asian Governments in April 2009 of the need to improve institutional and legal frameworks for regional cooperation under the umbrella of IFAS initiated an important process to strengthen the legal frameworks and build the institutional capacity of regional organizations.

Afghanistan is presently not represented in regional institutions related to water management. As Afghanistan's need for water is increasing — with development of agriculture and irrigation among its national priorities — its participation in regional cooperation efforts would be beneficial.

Sustainability of structures of cooperation is a challenge, and reduction of their dependency on external funding should be aimed at. There is need for assistance but, in the long term, sustaining the water management institutions and the necessary information collection for decision-making will require the countries of the region to take responsibility. International organizations can facilitate transboundary cooperation, and coordination among them to avoid duplication is important.

There is a need for transparency and consultations among co-riparian countries concerning future development plans with implications for transboundary water resources, so that costs and benefits of various development plans can be analysed. Joint environmental impact assessments of planned transboundary projects should be carried out. This is particularly relevant considering further flow regulation. In addition, developing small-scale hydropower, which many of the countries have the potential for, could be in some cases an option for energy provision which is less disruptive to the environment by not impounding the water flow.

Water allocation and water sharing are transboundary problems, but efforts also need to be made nationally in, for example, reducing water use and increasing water efficiency. The water deficit experienced, especially downstream, is to a large degree a result of shortcomings in management of water and inefficient water use rather than physical scarcity. There have been increases in water use due to different reasons which include demographic increase, expanded irrigation, losses and low water efficiency. Improving water use efficiency and introducing water saving technology is necessary to ease the pressure and relieve scarcity. Moreover, the focus on national food sufficiency results in unnecessary production of certain crops using irrigation; food imports could help to decrease the pressure on water resources.

Efforts to address water quality issues are also needed together with a coherent regional strategy for water quality. Countries need to identify and apply best practices in the management of water resources and ecosystems. Moreover, with the reduction of flows seriously affecting water quality, it is important to take measures to prevent anthropogenic water pollution.

With the current prioritization of economic development, it is a serious concern that water-dependent ecosystems get little attention. On the positive side, the Concept of the Development of the Water Sector and Water Management Policy until 2010 and the sectoral Programme on Drinking Water that were approved in Kazakhstan in 2002 encourage an ecosystem approach to water management. Furthermore, Mongolia would like to have special protected areas expanded in a transboundary direction. The operational rules for the joint management of some reservoirs — the Segrejevsk and Petropavlovsk reservoirs on the Ishim shared by the Russian Federation and Kazakhstan — specify a minimum flow at the border section. Signing an agreement on environmental flow and enhancement of the network of protected areas has been suggested for the Argun/Hailaer, which is subject to various development pressures.

Groundwater plays a potentially important role in sustaining ecosystems and limiting land degradation, at the same time wetlands can have an important groundwater recharge function. Studies of groundwater resources need to be continued to address the current low level of knowledge.

Means of sound land management, like limiting deforestation and moving away from unsustainable agricultural and grazing practices, have potential for limiting erosion problems.

Only assessing reliably the quality and quantity status of water provides the necessary basis for management interventions to limit human impact, including economizing water use, and for decisions about water allocation. This requires taking monitoring of water resources seriously — investing in it and improving dissemination of the data where it is needed to support management. More regular and systematic data exchange and harmonization of approaches is needed. Restoration and development of a monitoring network for water resources is called for, as well as monitoring of the status of glaciers, which will give indications about how water availability will develop. A complete inventory of glaciers of the Pamir-Alaya and Tien Shan with the help of high-resolution remotely sensed data and the development of regional mathematic models of snow cover formation in the mountains and of the glacial flow are all proposed to be carried out.

Not all the countries in the region give priority to climate change-related concerns, despite their awareness that it needs to be taken into account when making plans for water use and management. There is a need for training in this area and for a methodological basis for addressing the issue. In particular, there is a need for studying probable impacts and for applying results to adapt river basin management. The predictions about the gravity of impacts of climate change — albeit known to be uncertain — vary substantially. Thus, regional cooperation on climate change and variability studies would be beneficial for all countries. Regional strategies for adapting to climate change, and to promote rational and economical use of water and conservation of water bodies are needed.