3

Europe and North America

The world's wealthiest region is not immune to water-related problems. The members of the European Union are making efforts to implement the strict rules and high standards imposed by various directives, including the Water Framework Directive, which poses special challenges even for the most industrially advanced. While various climate change scenarios project reduced rainfall, especially in the Mediterranean basin, overall water quantity does not appear to be an immediate concern. The issues highest on national agendas are usually flooding, water quality and ecosystem protection.

The six European case studies presented in this companion volume to the third edition of the World Water Development Report also reveal the impact of scale issues, especially in dealing with urban areas. In the case of Istanbul, in particular, authorities face the challenge of solving water-related problems in a megalopolis of 12 million inhabitants straddling two continents.

Estonia

Increasing prosperity, water use efficiency and close adherence to European Union requirements characterize this Baltic Sea state.

Setting the scene

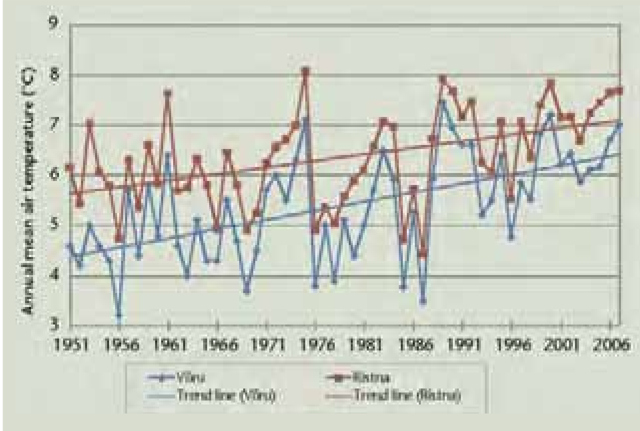
Estonia, located on the Baltic Sea and Gulf of Finland, is bordered on the south by Latvia and on the east by the Russian Federation (Map 3.1). It is a flat country, with plains along the coastline and uplands, and many lakes in the southeast. Its population of 1.3 million (2007) is dispersed across an area of 45,227 km². There are over 1,500 islands and islets, two of which, Saaremaa and Hiiumaa, are big enough to be considered counties. Although the life expectancy is over 70, the population is steadily declining due to a low birth rate.[1]

Climate change and variability: some warming expected

Several studies have been carried out to estimate the effect of climate change on water management. Statistical evidence suggests that annual mean air temperature increased during the second half of the 20th century by 1.0 to 1.7°C at various locations in Estonia. The greatest warming has been observed in the south-east (Võru) and the lowest in the north-west (Ristna) (Figure 3.1).

The warming effect has not been equally distributed throughout the seasons: the most significant changes have occurred during the first five months of the year, with that in March being the most significant. Over the last 50 years, the average monthly temperature in March has risen by between 3 and 5°C. The models for climate change suggest that winters will be milder, leading to a more rapid snow-melt, an earlier spring with reduced runoff,

Figure 3.1 Trend of annual mean air temperature at Võru and Ristna monitoring stations, 1951 2006



an extension of the dry period in summer and a likely increase in autumn precipitation. Especially in dry periods, these variations might cause significant water deficit in rivers fed by groundwater. So far, however, the results lie well within normal observed climatic variations (JRC, 2005).

Analysis of data from 1949 to 2004 shows that the number of days with sea ice has decreased significantly at all monitoring stations except those on the southern coast of the Gulf of Finland. The most substantial decrease was observed at the westernmost stations on the Baltic coast (Jaagus, 2006). Some models indicate winters could be ice-free by the end of the 21st century, even in the Gulf of Finland (HELCOM, 2007). The shortening of the period of ice cover, together with increased frequency of winter storms, will have a strong impact on coastal ecosystems. The most marked coastal changes in Estonia have resulted from a combination of big storms, high sea levels induced

Map 3.1 Estonia

[1] Except where otherwise noted, information in this case study is adapted from the draft *Estonia Case Study Report*, prepared in 2008 by the Ministry of the Environment.

Box 3.1 Setting a fair price for water

Within the last 15 years, Estonia has taken major steps towards applying the full cost recovery principle and the polluter pays principle. In 2007, the average price of water was US$0.96 per cubic metre for households and US$1.16 for businesses. The respective average wastewater charges were US$1.15 and US$1.64.

While an effort is made to reflect the economic value of water in various uses, social factors are taken into consideration to make it affordable for the general public. For example, in 2007, average net household income was US$460 per month and average per capita water consumption was 2.8 m^3; the monthly cost corresponds to 1.3% of average household income. In rural areas, where income levels tend to be lower, the percentage is higher but still in line with the acceptable EU level.

As an incentive to revive the agricultural sector, however, water used for irrigation is not charged for or taxed. Although this has not had an impact on water quantity, in areas where agricultural activities are concentrated water quality is compromised, and the dissolved nitrate concentration in water has returned to near 1992 levels.

by storm surges, ice-free seas and unfrozen sediment. An extremely strong storm like Gudrun in January 2005 could cause substantially larger changes to the depositional shores in western Estonia than all the storms over the entire preceding 10 to 15 years (Kont et al., 2003).

On the other hand, Estonia is not likely to be seriously affected by global sea level rise, which would be counteracted by uplifting caused by tectonic movement.

State of the resource and water use: substantial decrease in water consumption

Estonia's annual average surface water availability is 12 billion m^3 and the groundwater potential is 3.2 billion m^3. The rivers are characterized by short flow distances and low flow rates. Only 10 rivers are longer than 100 km. The longest is the Võhandu (162 km) and the largest is the Narva, with a catchment area of 56,200 km^2, only about one-third of which is within Estonia.

Of Estonia's approximately 1,200 lakes, half have a surface area of less than 0.03 km^2. The largest, Lake Peipsi, covering some 3,500 km^2, is the fourth largest lake in Europe. It was the subject of in-depth case studies in the first and second editions of the *World Water Development Report* (UN-WWAP, 2003; UNESCO-WWAP, 2006).

Water consumption has decreased significantly since Estonia regained its independence in 1992 (Figure 3.2). For a quick comparison, combined water use in 2006 was half that of 1992. Between 1992 and 2007, agricultural water consumption decreased by almost a factor of seven, and the average price of water increased nearly 25 times (Box 3.1). Daily per capita water consumption fell from 188 litres in 1992 to 90 litres in 2007 (Figure 3.3). The main reasons for the abrupt decrease in overall water use were the introduction of a water use charge, an increased unit price, the closure of a pulp factory in the capital, Tallin, adoption of water saving technology in industry, and reductions in numbers of livestock and in agricultural production after the system of collective farms collapsed.

Groundwater resources are used mainly for municipal water supply and to some extent in industrial processes. In line with the price increase and deployment of water saving technology, groundwater consumption decreased by one-third from 1992 and amounted to 50 million m^3 in 2006.

Reductions in agricultural area, animal husbandry and certain industrial activities have resulted in a decreased contaminant load and a general improvement in surface and groundwater quality. At the same time, Estonia's economic indices have improved. The unemployment rate has been halved since 2000 and GDP has more than doubled since 1995. Better water management through increased efficiency in water use in all sectors has enabled Estonia to achieve a strong decoupling of water use and economic output, which in turn has helped boost the economy.

Figure 3.2 Trends in sectoral water use, 1992 2007

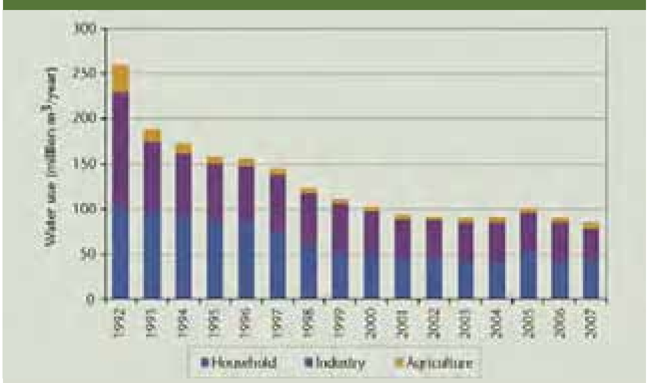


Figure 3.3 Trends in household water consumption, 1992 2007

Note 1 Estonian kroon US$0 087 (December 2008)

Thermal power plants burning oil shale account for 92% of the country's electricity production. Until recently, about 90% of overall surface water extraction was used for cooling these plants at the main power generation complex in Narva. However, thanks to reduced electricity demand, the use of water saving technology and a substantial increase in the water extraction charge, the rate of abstraction has decreased by half. The share of renewable forms of energy, including hydropower, has been minimal, accounting for about 1.7% of total electricity production in 2006. But, as required by the European Union (EU) accession agreement, Estonia has undertaken to raise the share of renewables to 5.1% by 2010. Thus, significant growth in this energy subsector is expected, especially for wind turbines.

Policy framework and decision-making: following the EU example

The Water Act is the main law establishing the regulatory framework of water resource management in Estonia. It takes an integrated water resources management approach, and states that while the main responsibility for the use and protection of water resources lies with the central government, local governments have the authority to take temporary measures within their jurisdictions, if necessary, regarding the use of water resources.

Water management issues in Estonia are dealt with under several plans of differing time scales. Long term goals and objectives, up to 2030, are set forth in the Estonian National Environmental Strategy. The Estonian National Environmental Action Plan for 2007 2013 contains detailed actions to achieve the short and medium term goals.

As a member of the European Union, Estonia bases its water management planning on the guidelines of the Water Framework Directive (WFD) and other EU directives regulating the use and protection of water resources and the environment. As the WFD requires, water management is based on management plans compiled for eight river basin subdistricts forming three main river basin districts. Compiling the plans is a complex process. It includes general characterization of the districts, identification of pressures, the setting of monitoring standards for assessment of the status of surface and groundwater resources, establishment of environmental objectives, identification of the measures necessary to bring water bodies to 'good' status and to supply the population with drinking water of good quality, and procedures for reporting back to the European Commission.

The Minister of the Environment established a Commission on Water Resource Management to coordinate and supervise water management planning. The commission includes representatives of relevant ministries, along with scientists and other experts. Sub-basin water management plans are overseen by working groups that include representatives of the Ministry of the Environment and of county environment services, along with relevant experts. Working groups, established by a decree of the Minister of the Environment, coordinate the implementation and updating of the management plans. Representatives of other relevant stakeholders can participate in the meetings on cases in which they have an interest.

In achieving the WFD objectives, water supply and sanitation development plans have a very important role. Upon accession to the EU, Estonia undertook to ensure by the end of 2010 that the appropriate wastewater collection and treatment was in place for all wastewater collection areas whose waste load was more than 2,000 population equivalents, and, by the end of 2013, that all communities of more than 50 people were supplied with safe drinking water.

The main challenges

Chemical contents of groundwater: Drinking water often fails to meet quality requirements due to the presence of substances such as manganese and ammonium. Although these minerals affect the sensory properties of water (taste, colour, odour), they pose no direct threat to human health. In some parts of Estonia, the groundwater also contains excessive amounts of fluorine and boron. There is an effort to regulate mineral content: drinking water purification plants are being improved, with the installation of technology to remove such minerals, and the infrastructure is being renovated where necessary.

Eutrophication of lakes: The main problem facing Estonia's multiple lakes, including many impounded lakes, is eutrophication. Many lake ecosystems are endangered due to overgrown vegetation that significantly reduces the oxygen content in water during summer and winter, with a devastating impact on fish populations. The status of Lake Peipsi has been assessed as moderate, and that of the country's second largest lake, Lake Võrtsjärv, as good. Studies regarding the environmental status of small lakes have revealed that out of 68 lakes, 3 were in a poor state, 17 were in moderate condition and the rest were ranked as good or very good.

Hydromorphological alteration of rivers: Due to the decrease in agricultural pollution and more efficient wastewater treatment, the water quality of Estonian rivers has improved significantly in the last 15 years. At present only a few rivers and their biota are limited by poor quality. However, additional effort is needed to improve fish migration in rivers where numerous small dams without fish passes now impede their passage.

Conclusions

As an EU member country endowed with sufficient water resources, Estonia does not have many water management problems. The initial economic difficulties that followed independence have been diminishing since the late 1990s and industrial production has increased in almost all branches since 2000. Although climate change scenarios point to potential alteration in the flow regimes of rivers and in recharging of groundwater reservoirs, this does not seem to pose a serious problem for socio-economic development in Estonia. Drinking water quality, sanitation and environmental protection are being handled in line with strict EU legislation.

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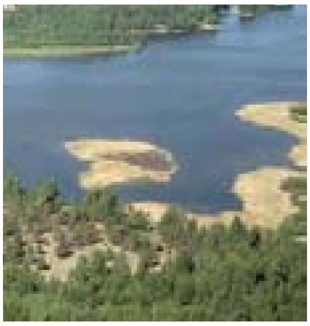
Finland and the Russian Federation: the Vuoksi River basin



Through concerted efforts, water quality has been significantly improved in the basin since the 1970s, when large amounts of untreated industrial waste were being dumped into waterways. Today, both the water quality and the environmental status are much better. However, increasing industrial activities in the Russian Federation may pose a renewed risk of some degradation.

Setting the scene

The Vuoksi is a transboundary river that flows 150 km from Lake Saimaa in south-eastern Finland to Lake Ladoga in north-western Russia. The Vuoksi River basin extends between these two lakes and covers an area of 4,100 km^2 (Map 3.2). It is part of the much larger basin through which the Neva River flows to the Baltic Sea. Human activities have divided the Vuoksi basin into two independent parts. The northern part, the Lake Vuoksi sub-basin, is not connected to Lake Saimaa. This case study examines only the southern part, through which the Vuoksi River passes.[1]

Average precipitation in the region is 775 mm per year and the mean annual temperature is around 3.2°C. The period without frost lasts from April to October. Up to 70% of annual precipitation falls during this period, mostly in August. The total population is about 80,000 people, of whom at least 52,000 live in towns in the Russian part of the basin.

Climate change and variability: sparse population, reduced risks

At national level, certain climatic trends are observed in both Finland and the Russian Federation. For example, over the last 150 years, the yearly average temperature in Finland has risen by 1°C (Finnish Ministry of Agriculture and Forestry, 2005); during the 20th century, the increase was 0.7°C (Carter, 2007). March to May was the period that saw the greatest increase in monthly mean temperatures, ca. 1.5ºC (Pöyry & Toivonen, 2005). Moreover, there was a statistically significant increase of 1°C in winter temperatures between 1961 1990 and 1971 2000 (Finnish Meteorological Institute, 2006). In the Russian Federation, the mean annual ambient temperature increased by about 0.4°C between 1990 and 2000 (Roshydromet, 2005).

In Finland, the rising mean temperature has led to a decrease in the duration of the snow cover and in the amount of snow in southern Finland. Fluctuations in precipitation remain within the range of climatic variability, however (Finnish Ministry of Agriculture and Forestry, 2005). To address the inevitable socio-economic impact of climate change and variation, Finland prepared a National Strategy for Adaptation to Climate Change (2005). The strategy describes the likely effects of climate change for a range of sectors and outlines actions and measures to improve the capacity to deal with them. It also aims at reducing negative effects and taking advantage of the opportunities climate change may offer.

In the Russian Federation, out of 11 anomalous winters in the last 109 years (i.e. with more than a 2°C deviation from the annual average), eight were observed in the last 30 years. In addition to warmer winters, climatic changes observed in the Russian Federation include increased evaporation in warmer periods combined with unchanged or decreased precipitation, a higher number of droughts, alteration of the amounts and periods of water discharges, and changes in ice conditions (Roshydromet, 2005). In 2005, under the UN Framework Convention on Climate Change, the Russian Federation adopted an action plan on implementation of the Kyoto Protocol to mitigate the effects of climate change (Ministry of Economic Development and Trade of the Russian Federation, 2006).

Not many water-related disasters on a big scale have been observed in or around the Vuoksi River basin. Nor has a link between climate change and water-related disasters been clearly identified. Nevertheless, scenarios for the basin and its surroundings project a rise of 3 to

[1] Except where otherwise noted, information in this case study is adapted from the draft *Vuoksi River Basin Case Study Report*, prepared in 2008 by the Finnish Environment Institute and the Center for Transboundary Cooperation, St. Petersburg.

Map 3.2 The Vuoksi basin

4°C in temperature and a 10% to 25% increase in annual precipitation between 1971 2000 and 2071 2100. Extreme runoff is expected to be more frequent and winter floods are likely to become more severe (Silander et al., 2006). The discharge volume of the highest flood recurring about once in a 250 year period could rise from 1,100 m^3 per second to as much as 1,400 m^3/s by 2100, and the water level in Lake Saimaa could increase by almost a meter during such floods (Veijalainen, 2006). Over the same period, the duration of snow cover could decrease from 150 days to 30. Overall, climate change in the Vuoksi River basin is likely to make water-related disasters both floods and droughts more frequent and costly for society. However, as the basin is sparsely populated and has abundant water resources, the impact at basin level is not expected to be critical.

State of the resource and water use

The Vuoksi River has an annual water potential of some 20.4 billion m^3. The part of the basin that lies in Finland, although very limited in extent (10% of the overall basin area), contributes almost 94% of the average flow.
The Vuoksi River basin also contains several freshwater lakes. On both the Russian and Finnish sides of the basin, groundwater resources exist but are of limited capacity (0.03 billion m^3 and 0.001 billion m^3 per year, respectively) (VIVATVUOKSIA, 2003).

The abundance of surface water resources means that meeting water demand is usually not an issue in the Vuoksi River basin. However, during severe droughts, low water levels can affect fish farms, water transport, industrial and household water supply (with intake pipes not reaching the water level), and recreational activities (Box 3.2).

Most parts of the Vuoksi River basin are in a natural state and unpopulated. On the Russian side, 76% of the basin is forested, 17% is used for agriculture and 7% for other purposes. The main towns in the Russian part of the basin are Priozersk (pop. 21,000), Svetogorsk (pop. 15,600), Kamennogorsk (pop.12,000) and Lesogorsk (pop.4,000). The small part of the basin area that is located in Finland is centred on the town of Imatra (pop. 29,000) (VIVATVUOKSIA, 2003).

Industry is a leading water user in the Vuoksi River basin. Industrial production in the region grew steadily during the 20th century before declining in the recession of the early 1990s, then started to recover after 1997 (VIVATVUOKSIA, 2003). In the Russian part of the basin, industrial water consumption is 66 million m^3 per year (2004), close to 80% of which is used by the pulp and

Box 3.2 Recreational activities in the Vuoksi River basin

With its abundant water resources, numerous lakes and islands, good water quality and extensive shorelines offering vast and peaceful natural areas, the Vuoksi River basin is one of the most popular areas for recreation in the north-western part of the Russian Federation. The Vuoksi River itself is not used for large-scale goods or public transport as dams block the upper part of the river. However, residents and tourists in Finland and the Russian Federation use the river for boating. The water quality of the river has greatly improved since the 1970s, and fish of the salmon family have been introduced on the Finnish side, which has become very popular for recreational fishing. As the local standard of living has risen, other leisure activities, such as swimming, hiking and boating, have become more popular and are likely to contribute increasingly to the economy of the region.

paper industry. In the Finnish part, annual industrial water use is around 210 million m^3 (2007): 17 million m^3 directly withdrawn from the Vuoksi River and the rest from Lake Saimaa. As on the Russian side, most of the water on the Finnish side is used by the pulp and paper industry (99%), with the metal industry accounting for most of the rest. Despite increased production, industrial water use has been declining in Finland thanks to higher productivity and water recycling. In fact, water consumption in 2007 was 50% lower than in 1974.

Access to drinking water is widespread. In towns, more than 80% of residents are connected to centralized cold and hot water infrastructure and sewer networks (VIVATVUOKSIA, 2003). In rural areas, wells are quite common for providing drinking water. In some places in the Russian part of the basin, however, private wells are in poor condition and their water quality is not always adequate or has not even been analysed. Overall, municipal water consumption in the basin amounts to about 2.7 million m^3 per year, of which around 60% is withdrawn from surface waters (VIVATVUOKSIA, 2003). By 2015, municipal water use in the basin is expected to have decreased by up to 4.5% because of a reduction in water loss and decline in population. As adequate wastewater treatment is lacking in some settlements, however, ground and surface water pollution is likely to be a problem.

Farming and animal husbandry are mainly practised in the Russian part of the Vuoksi River basin to assure local self-sufficiency. The extent of the cultivated area, including pasture land, is 77 km^2. The sector seems to be recovering from the effects of the recession that ended in 1997 (VIVATVUOKSIA, 2003). Due to the climate of the basin, agricultural land is excessively damp and requires drainage. This in turn has led to phosphorous contamination of water resources because of fertilizer use (Kondratyev et al., 2007). Although the potential impact of climate change on agriculture in the Vuoksi River basin has not yet been fully studied, there are indications that rising temperatures may lead to increased production. Such a change could translate into higher water demand and fertilizer consumption, potentially aggravating surface and groundwater pollution. Finland's response to such pressures is guided by the European Union (EU) Water Framework Directive, to which it adheres as an EU member. Similarly, policy in the Russian Federation calls for adoption of modern agricultural methods that help reduce nutrient loads to the environment.

The four hydropower plants in the basin (two in each country) harness about 93% (2.5 TW) of its hydropower potential. As construction of new dams is not considered profitable, the preferred option for increasing energy production is to renovate existing facilities. Energy demand in the basin is expected to grow as economic development of the region intensifies and industrial production increases. However, thanks to the adoption of more energy efficient methods and processes, the growth in energy demand is not likely to be substantial. The hydropower plants on the Vuoksi River lack fish passages. To reduce their environmental impact, Finnish hydropower companies are obligated to release 1,125 kg of lake trout every year, mainly in the section of the river that lies between the two dams, but also in Lake Saimaa.

Water management and transboundary cooperation

As a member of the European Union, Finland bases its water resource policies on the Water Framework Directive. In the Russian Federation, the 2006 Water Code sets the framework for all water-related legislation.

The integrated water resources management approach has been adopted in both countries. Thus they consider the river basin as the basic unit in planning and management, while ensuring that different water uses are taken into consideration. Sustainability of water resources and stakeholder participation in decision-making are also viewed as important principles in water policy. While public participation in decision-making is well organized in Finland, there are implementation problems in the Russian Federation. In addition, overlap in the responsibilities of various Russian Federation administrative bodies has complicated the process by hindering inter-agency cooperation on environmental protection and natural resources management.

Regarding management of shared waters, since its establishment in 1964 the Finnish-Russian Commission on the use of transboundary watercourses has played a significant role in the Vuoksi River basin. The commission's co-chairs are representatives of the Finnish Ministry of Agriculture and Forestry and the Russian Federation Ministry of Natural Resources and Environment. With three working groups   on the use of water resources, on fisheries and on water quality and monitoring   the commission monitors activities that could affect transboundary waters and assesses the compensation required in the event of damage caused by either party.

The main challenges

Reducing water pollution: The pulp and paper industry is responsible for most of the organic and nutrient pollution in the Vuoksi River basin, whereas the mining, chemical and metal industries generally release considerable amounts of heavy metals into the river. Initial measures to treat industrial wastewater were taken in the 1960s and such action continued into the 1970s. As a result, industrial effluents have significantly decreased and water quality in the river has improved. For example, the loading of suspended solids and biochemical oxygen demand (BOD) in the Finnish part of the river has declined by 90% since the early 1970s (Figure 3.4). A major metal processing plant situated on the banks of the Vuoksi River on the Finnish side has adopted the ISO 14001 environmental management system (Ovako, 2008). Overall, while some minor industries and enterprises still do not treat their wastewater, most others have quite efficient wastewater treatment systems. As a result, not only has water quality improved, but valuable fish species have been observed returning to the river.

In the Russian Federation, the total point-source load into the Vuoksi River in 2006 was estimated at 1.4 tonnes/day (t/d) of suspended solids, 1.4 t/d of BOD,

Figure 3.4 Annual means of daily industrial and municipal point-source loading in the Vuoksi-Saimaa area in Finland

Notes The industrial loading is from pulp and paper mills Results are from an area 8 km from the border with the Russian Federation BOD7 BOD demand of a wastewater sample, measured over seven days' exposure CODCr chemical oxygen demand
Source Mitikka et al , 2004

0.47 t/d of nitrogen and 0.12 t/d of phosphorus (Finnish-Russian Commission, 2007). In general, for Russia, the sharpest decrease in Vuoksi River pollution came during the 1990s recession. In recent years the pollution load has started to increase again.

In the Russian part of the basin, about 73 million m^3 of wastewater is produced per year. Of this, 13 million m^3 is cooling water. The rest is treated in the wastewater treatment plants of large industrial enterprises (VUOKSIAGAIN, 2006). The Russian Federation requires permits and environmental impact assessments for actions that could negatively affect water resources or ecosystems. In addition, one objective in the Long Term Development Strategy for Water Economics is to rationalize industrial water use over a 20 year period.

Mitigating floods and droughts through joint action:
The natural discharge in the Vuoksi River is usually large enough to provide water for all users. If exceptionally high floods or intense droughts are forecast, however, the flow is regulated, under the Discharge Rule for Lake Saimaa and the Vuoksi River, to alleviate socio-economic damage.

Administered by the Finnish-Russian Commission, the Discharge Rule is an effective allocation mechanism that takes the interest of both countries into account. Decisions about changes in the discharge are jointly taken, and the damage one country may suffer as a result is compensated by the other. The Discharge Rule has been successfully applied since it came into force in 1991. Flood peaks have been lowered six times since then and low water levels in Lake Saimaa normalized three times. The key reason for these adjustments is to prevent flood damage to industrial facilities situated on the shores of Lake Saimaa. During two of the floods, discharge control caused a deficit in hydropower production on the Russian side. In accordance with the Discharge Rule, Finland paid the Russian Federation the agreed compensation for this damage.

Conclusions

Even in years when rainfall is below average, the water potential of the Vuoksi River basin is large enough to meet all water demand without significant problems. The main concerns have been the increasing human impact on water quality and the need to regulate the flow regime. Water quality has improved remarkably since the 1970s, creating better conditions for the use and protection of the water resources. In cases of severe floods and droughts, the flow regime can be (and has been) adjusted through cooperation based on the needs of all communities involved. Since the end of the 1990s recession, the region's economy has been improving. It will be critical for sustainable practices to be adopted, especially in the part of the basin that lies in the Russian Federation: such action can crucially affect overall water quality in the basin in the years to come.

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Italy: the Po River basin

Although national regulations for water use and protection of the environment and water resources are in place, their local implementation and enforcement are generally insufficient. This poses many risks for the Po River basin, which generates nearly 40% of national GDP through intensive industry and other economic activities.

Setting the scene

The Po River basin extends from the Alps in the west to the Adriatic Sea in the east (Map 3.3) and covers an area of 74,000 km². While 5% of the basin lies in Switzerland and France, most of it is situated in northern Italy. This is where the basin is the largest, its main channel the longest (650 km), and its discharge the biggest.[1] The Po basin is home to some 16 million people (2001), and extends over 24% of Italy's territory. The regions of Piedmont, Aosta Valley, Liguria, Lombardy, Veneto, Emilia Romagna and Tuscany lie partially or completely within it, as does the Autonomous Province of Trento. The climate is variable, ranging from Alpine in the mountainous north to cool temperate in the Apennines in the south. The flat central region is characterized by a continental climate. Average precipitation varies from a maximum of 2,000 mm in the Alpine range to slightly less than 700 mm in the eastern plains, with an annual average of 1,100 mm.

Climate change and variability: raining less and getting warmer

Meteorological records indicate that the total number of rainy days in Italy decreased by 14% from 1951 to 1996. The decrease was most pronounced in winter. The amount of rainfall also declined, especially in central and southern Italy. In addition, during the same period, persistent droughts grew more frequent.

Similar trends have been observed in the Po River basin. Average annual rainfall has diminished there by 20% since 1975 (Figure 3.5), and the average yearly discharge at Pontelagoscuro, near the lower end of the river, has fallen by between 20% and 25%.

Analysis of data covering 130 years (1865 1996) reveals that declining rainfall was accompanied by increases in both minimum winter and maximum summer temperatures. In northern Italy, where the

Map 3.3 The Po River basin

[1] The maximum discharge measured to date at Pontelagoscuro, at the lower end of the Po River basin, was 10,300 m³ per second, during the flood of 1951.

[2] Except where otherwise noted, information in this case study is adapted from the draft *Po River Basin Case Study*, prepared in 2008 by the Po River Basin Authority.

Figure 3.5 Yearly cumulated rainfall in the Po River basin, 1975 2006

Note Excludes the area lying beyond Pontelagoscuro
Source Tibaldi et al , unpublished

Po River basin lies, maximum temperatures increased by nearly 0.6°C and minimum temperatures by 0.4°C. The warming effect was 0.2 to 0.3°C higher in central and southern Italy.

The change in average temperatures has accelerated the melting of glaciers in the Alps. In 2005, at 2,500 metres of altitude, the spring snow-melt period started 15 days earlier than in 1990 (Caracciolo, 2007). The overall extent of glaciers in the range as a whole shrank by 49% between 1850 and 2000, from 4,474 km^2 to 2,272 km^2 (CGI, 2006), and glaciers in the northern Italian Alps decreased from 525 km^2 in 1961 to 482 km^2 in 1989, a decline of 8% (Biancotti and Motta, 2000). The increase in temperatures has also accelerated desertification, especially in central and southern Italy.

State of the resource

The amount of available freshwater resources in the Po River basin is estimated at 77.7 billion m^3. Table 3.1 provides the breakdown of water use by sector. The basin is economically important for Italy, as 38% of the country's GDP is generated there, thanks to extensive industrial activity complemented by farming, animal husbandry and tourism (Figure 3.6).

Agriculture in the Po River basin is highly developed, accounting for more than half of the land use in the basin. In fact, at 30,000 km^2 it is the largest cultivated area in Italy, and accounts for 36% of the country's agricultural production. Accordingly, agriculture has the highest water demand of any sector in the basin, withdrawing nearly 17 billion m^3 per year. About 11,000 km^2 of the cultivated area is irrigated, almost exclusively (87%) from surface watercourses. Irrigation networks are mainly composed of open channels, though pressurized systems are also used, chiefly for high value crops. Overland flow is commonly practised in almost half the irrigated areas. Rice, which has high water demand, is grown on over 20% of the irrigated land. Nationwide, about 40% of agricultural production and more than 60% of agricultural exports depend on irrigation (Bazzani et al., 2002, citing ANBI, 1992).

The Po River basin is also urbanized, and home to 28% of Italy's population. Lombardy, Piedmont and Emilia Romagna are the most populated regions and have a concentration of economic activities (Table 3.2).

Milan and Turin are the main urban and industrial agglomerations. The basin's residents enjoy universal water supply and sanitation coverage. However, some

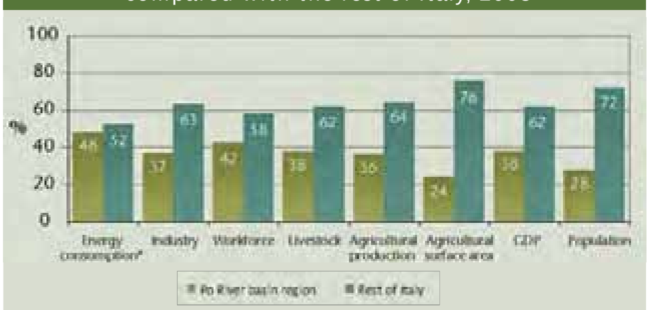
30% of the water in the drinking water network goes unaccounted for, and steps are being taken to minimize leakage from the water supply and sanitation infrastructure.

Meeting growing energy needs is one of the most important requirements for assuring sustainable socio-economic development in the Po River basin. To harness the hydroelectric potential of the basin, 890 dams have been built. The Po basin accounted for 46% of national hydroelectric production in 2004, and 48% of total national electricity consumption as of 1994.

Policy framework and decision-making: delayed implementation of the EU Water Framework Directive

At national level, the Royal Decree of 1933 recognized water resources as a public good. In 1989, Law 183 established the river basin as the basic unit within which all regulatory actions concerning water resource management, water pollution control and soil protection are to be coordinated for economic and social development and for environmental protection. The law also established major basin authorities and entrusted them with planning responsibilities (Box 3.2). In 1994, Law 36 introduced a reform under which municipal

Figure 3.6 Socio-economic indicators of the Po River basin compared with the rest of Italy, 2003



* 1994 value

Table 3.1 Annual water consumption by sector, 2006

Type of use	Volume withdrawn (billion m^3/year)	% from surface water	% from groundwater
Municipal	2.5	20	80
Industry*	1.5	20	80
Farming and livestock	16.5	83	17
Overall	20.5	71	29

* Excludes electricity generation

Table 3.2 Regional population distribution by number of inhabitants and share within the Po River basin

Region	Resident population	% of basin population
Emilia Romagna	2,193,177	13.78
Liguria	107,459	0.68
Lombardy (capital: Milan)	9,014,287	56.63
Piedmont (capital: Turin)	4,211,128	26.46
Autonomous Province of Trento	97,861	0.61
Tuscany	1,504	0.01
Aosta Valley	119,548	0.75
Veneto	15,916,707	1.08
Total		100.00

Source Adapted from Istat, 2001

utilities were aggregated into Optimal Territorial Areas (OTAs), which are responsible for the management and supply of water services such as wastewater treatment, sanitation and drinking water provision. OTAs also have to draft Optimal Territory Plans (OTPs), which analyse the availability of water resources and plan for their current and future use. Basin authorities have the responsibility of verifying that the OTP is coherent with basin plans and objectives.

Legislative Decree 152 was introduced in 1999 to protect water resources by preventing and reducing pollution and improving water quality. It also required regions to classify water bodies (i.e. surface, ground and coastal waters) and establish limits for the pollution loads that can be discharged into the environment. The Water Protection Plan, which directly complements the basin plan required by Law 183, is the main instrument for implementing the laws enacted by Legislative Decree 152. This decree is considered a forerunner of the EU Water Framework Directive of 2000, as it also aims for a comprehensive action framework for water resources protection by introducing measures for specific uses (e.g. drinking water, bathing water) and for specific sources of pollution, such as agricultural and industrial effluents.

In 2006, a consolidated text on environmental protection, Decree 152, was approved. It includes rules for waste management, strategic environmental assessment and environmental impact assessment procedures, and water resources protection and management, as well as for dealing with environmental damage. The part concerning water resources protection and management formally adopts the contents of the EU Water Framework Directive, for example by creating river district authorities and assigning them the task of producing river basin management plans. As of October 2008, however, Legislative Decree 152 of 1999 was still in effect because the 2006 decree had not yet been implemented.

The main challenges

Quality and quantity issues: The Po River is subject to extensive regulation. In some stretches, its flow is reduced to a trickle during the months of high consumption. The deficit in water availability creates tension among users and aggravates quality-related problems. However, in spite of these water quantity and quality issues, there are no national or regional plans for reducing high water consumption in agriculture. Although technological improvements have been introduced, low efficiency

Box 3.3 Role and structure of the Po River Basin Authority

National river basin authorities, whose members include representatives of the central and regional administrations, have as their main role the preparation of basin plans, which aim to protect water resources, mitigate hydrogeological risks (such as floods, landslides and erosion, including that of river banks) and promote sustainable use of water resources in an environmentally conscious way. The Po River Basin Authority and five other national river basin authorities (along with a pilot basin authority) were created by Law 183 in 1989.

The Po authority is composed of the secretary general, an institutional committee, a technical committee and a technical-operational secretariat. As the main decision-making body, the institutional committee comprises representatives of several ministries (Public Works/Environment, Territory/Agriculture, Forestry/ Cultural Assets), the presidents of the regional councils in the basin, and the secretary general. The institutional committee supervises the implementation of the basin plan. The technical committee, chaired by the secretary general and formed of experts and regional representatives, is the consultative body of the institutional committee.

The secretary general, who is elected by the institutional committee, plays a central role in the basin authority by overseeing and coordinating its activities and directing the secretariat. The secretariat drafts the basin plan in cooperation with the technical committee. The institutional committee then adopts it as a project proposal. The proposal is published in the official gazette and regional newspapers so all stakeholders may comment.
The regions analyze all comments collected within their jurisdiction and send a revised basin plan to the institutional committee for adoption. Some experts have criticized the public consultation stage as a weak link, since the regions do not have to make an analytical evaluation of the comments, the period for comments is limited, and the entity doing the review is usually the one that helped design the project plan (CABRI-Volga, n.d.). After a second approval by the institutional committee, the basin plan is passed to the national level for final validation by the National Council of Ministers. Although the basin plan has an implementation period of three years, there is no fixed schedule for reviewing progress or outcomes.

irrigation methods are still widely used, particularly in rice farming (Zucaro and Pontrandolfi, 2005).

Pollution: Surface and groundwater quality is affected by industrial, agricultural and household pollutants. Excessive organic content in surface water causes eutrophication in rivers with low flow rates and in lakes. Although a network of wastewater treatment facilities has stopped further degradation of water quality, it has not been sufficient to reverse the process. Groundwater resources continue to contain high concentrations of nitrates due to fertilizer use in agriculture, while excessive exploitation has caused salt intrusion into coastal aquifers and, in some places, ground subsidence.

Disconnect between planning and implementation: For the most part, these problems stem from the current management approach in the Po River basin. Although only the Po River Basin Authority is responsible for basin-wide planning (Box 3.3), other institutions (regions, provinces, city councils, etc.) are in charge of implementing the authority's plans. Their actions, however, have been fragmented and mainly focused on local interests (WWF, 2003). At national level, water issues are still regulated mostly by Legislative Decree 152 (1999), which delegates government responsibilities to regions. Each region has the right to make its own laws, and shares the responsibility for local implementation with the provinces (subunits of the regions). The 2006 decree incorporating the EU Water Framework Directive has yet to be implemented.

Overall, regulations for water use and for protection of the environment and water resources are in place, but implementation is weak and enforcement is generally lacking.

Conclusions

The Po River basin is a strategic region for the Italian economy, with significant agriculture, industry and tourism sectors, employing 42% of the national workforce and generating 38% of the national GDP. However, the high level of regional development has put heavy pressure on water resources and led to degradation of surface and groundwater quality. Increasing efficiency in agriculture is an issue that still needs to be addressed. Although policy tools for managing and safeguarding water resources are in place at national level, there are problems with the implementation and enforcement of rules and regulations at regional level. Installing a legal framework for application of the EU Water Framework Directive, and making greater efforts to develop a basin-wide vision agreed by all stakeholders, are among available options for safeguarding the resources of the Po River basin for future generations.

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The Netherlands

Adapting to the reality of climate change and increased risk from floods has meant overturning centuries of reliance on big engineering solutions, returning land to nature and integrating risk management into policies based on stakeholder participation.

The Netherlands is located in western Europe, bordered by Belgium to the south, Germany to the east and the North Sea to the north and west (Map 3.4). Geographically, the Netherlands is a flat, low lying country formed by the estuary of four important European rivers: the Rhine, the Meuse, the Ems and the Scheldt. Two-thirds of the country is threatened by flooding. Through history, the country has defended itself against threats posed by water, building dikes and dams, canalizing rivers and reclaiming land from the sea. Today, about 9.6 million of its inhabitants (60% of the population) live below sea level, and about 70% of the country's GDP is generated below sea level (Netherlands Water Partnership, 2006), thanks to a 3,500 km primary flood defence system composed of dikes and sand dunes.[1]

Climate change: the danger of floods and a rising sea

In 2006, the Royal Netherlands Meteorological Institute (KNMI) announced the results of a new study based on four climate change scenarios from the Intergovernmental Panel on Climate Change (Figure 3.7). The projections for 2050 include temperature increases of up to 2.9°C, the possibility of as much as 14% more precipitation in winter, and hotter summers with fewer rainy days but up to 27% more extreme rainfall events. These changes are likely to increase the flow of rivers in winter and the probability of longer dry periods in summer.

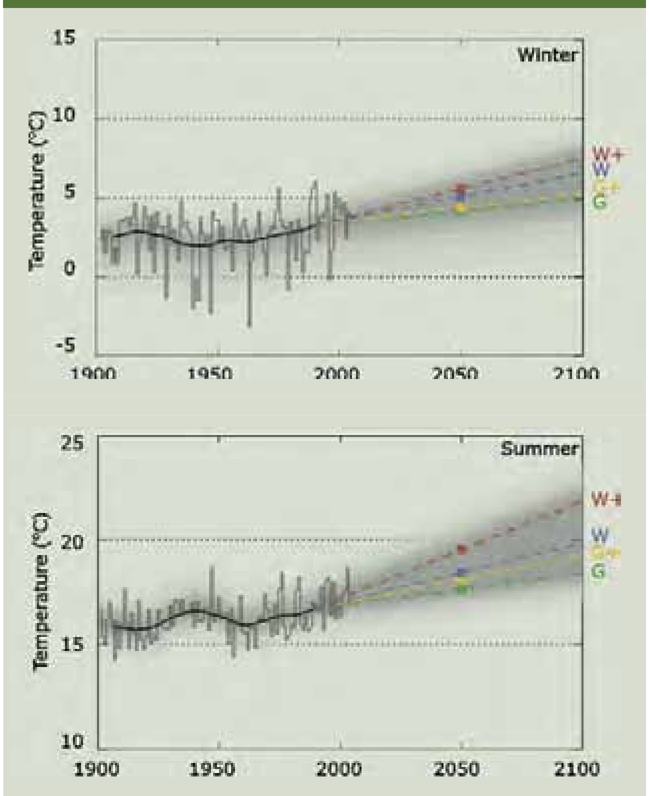
Besides a currently projected absolute rise in sea level of 35 to 85 cm by 2100, allowance needs to be made for land subsidence in the west, which will make the relative sea level rise even greater. Accordingly, the Governmental Delta Committee advised in 2008 that the Netherlands should prepare for an overall sea level rise of 0.65 to 1.30 metres by 2100.

These changes will have a definite impact on flood protection measures, water resource availability, the

[1] Except where otherwise noted, information in this case study is adapted from the draft *Netherlands Case Study Report*, prepared in 2008 by the Unie van Waterschappen.

Map 3.4 The Netherlands

Figure 3.7 Temperature variation in De Bilt, 1900 2005, and the four climate scenarios for 2050



Notes The thick black line represents the 30-year moving average of observed temperatures Coloured dashed lines connect each climate change scenario with the baseline year, 1990 The grey band represents year-to-year variation derived from the observations G denotes a scenario with moderate temperature change and W a scenario with higher temperatures De Bilt, a municipality in Utrecht province, is where KNMI is based

Source van den Hurk et al , 2006

Table 3.3 Water use by sector, 2005

	Water abstraction (million m³)			Water use (million m³)			
	Total	Groundwater	Surface water	Total	Groundwater	Surface water	Tap water
Tap water companies	1,256	766	490	0	0	0	0
Agriculture	52	37	15	99	37	15	47
Industry and refineries	3,375	220	3,155*	3,616	220	3,155	241
Power plants	9,771	1	9,770*	9,773	1	9,770	2
Other companies and households	481	1	480	1,279	1	480	799

* Cooling water

Source Statistics Netherlands

environment and the economy. The Delta Committee has drawn up an integrated vision, including risk management and investment components, to help the country cope better with climate change.

State of the resource and water use

Although there are some local water shortages, the presence of large rivers such as the Rhine and its tributaries, as well as the Meuse, ensures that water quantity and water allocation to various sectors are not generally an issue in the Netherlands (Table 3.3). Only 9% of the total annual renewable water resources is used. In recent years, however, periods of low river flow have become more frequent and tended to last longer. Recent studies indicate that water level and water quality and control may be most severely affected during the summer, when longer dry spells are expected. Water shortages and decreasing quality would affect agriculture, navigation, the energy sector (cooling water), nature and tourism. Consequently, the Dutch water management system could face a new challenge of having to allocate freshwater to priority areas. Current national priorities for freshwater allocation are based on minimizing irreversible damage and economic losses.

Policy framework and decision-making

Responsibility for the management of natural water systems in the Netherlands and for protecting residents from flooding is largely allocated to the *Waterschappen* (regional water authorities or water boards) (Box 3.4). The 26 current *Waterschappen* constitute a fourth form of government body in the Netherlands, alongside the central, provincial and municipal governments.

These decentralized public authorities focus on water quality and quantity, water management and flood protection, and wastewater treatment. They are also active in environmental development. (Issues concerning spatial planning and the environment are first vetted by provinces and municipalities.) Sanitation is the joint responsibility of municipalities, which deal with the sewage systems, and the *Waterschappen*, which focus on wastewater treatment. In addition, water supply companies are responsible for delivering safe drinking water. Groundwater is the responsibility of the provinces.

The main challenges

Floods: Floods have always been a major threat in the Netherlands. They can come from storm surges from the sea, high river discharges after heavy rain or snow-melt upstream, or intense local rainfall.

One of the worst floods in Dutch history took place in 1953. A combination of a high tide and a severe windstorm overwhelmed the sea defence structures on the North Sea coast. The extensive flooding caused major

Box 3.4 History and functions of the *Waterschappen* (water boards)

The history of the *Waterschappen* goes back to the 13th century. People, mostly farmers, living in the low lying areas of the Netherlands felt the need to organize to improve their living conditions. Over time the *Waterschappen* merged, usually because of extreme circumstances and disasters such as floods. For example, in 1950 there were around 2,500 *Waterschappen*. After a major flood in 1953 and high river levels in 1993 and 1995, the number went down, and is currently 26. The mergers are a response to the increased efficiency and professionalism needed to deal with the growing complexity of water management.

The *Waterschappen* are based on stakeholder participation. They allow local communities to play a direct role in development. The *Waterschappen* function around the three principles 'interest, pay, say': that is, the more benefit an interest group gets from work the *Waterschap* is doing, the larger its contribution to the budget and the more seats it has on the *Waterschap*.

In 2007, the 26 *Waterschappen* together had some 11,000 employees and a combined budget of €2.4 billion to manage about 3,450 km of primary dikes, 55,000 km of watercourses, 7,000 km of roads and 390 treatment plants.

socio-economic losses. More recently, flooding on the Rhine and Meuse rivers in 1993 and 1995 caused hundreds of thousands of people to evacuate homes in low lying areas. Similarly, excessive rainfall in 1998, 2001 and 2002 caused problems in certain areas. These events served as a warning that future floods could have even more disastrous results due to their increasing frequency, magnitude and intensity combined with the very dense land use and population behind the embankments.

Such considerations led the government to take a new approach and make spatial planning an integral part of water management. One significant result was a programme to make more 'room for the river'. In this context, a set of measures was adopted, including deepening the flood plains, moving dikes further from the river, lowering groynes and enlarging river beds. The aim is to create a 'comfort zone' for the river. Unfortunately, ever-increasing urbanization and likely climatic changes mean these measures by themselves will not fully address the problem.

Consequently, the Netherlands has also made substantial investments in real-time monitoring, scenario development, flood forecasting and data collection to increase preparedness and provide early warning. In addition, innovative and comprehensive risk management policies and strategies are being based on the key principles of resistance, resilience and adaptation. This approach, unlike previous practices, considers reinforcing dikes to be a viable option only when other measures are judged too expensive or inadequate.

To limit economic losses associated with floods, a risk-based cost-benefit analysis method is being developed to identify the most cost-effective measures. These include accepting a higher frequency of inundation or controlled inundation in certain areas, or even change in land use. The risk-based approach supports local decision-making while allowing for future spatial planning on a larger scale.

In addition to its national plans and legislation, as a European Union member the Netherlands is meeting its obligations under the Flood Directive and the overall Water Framework Directive.

Expanding and maintaining the water infrastructure

For centuries the Dutch have invested in building structures to mitigate extreme events and regulate water levels and supply in accordance with each sector's needs. Such structures are as expensive to maintain as to construct. Table 3.4 shows the annual costs covered by the Ministry of Transport, Public Works and Water Management, the *Waterschappen* and provincial and local government for flood defence and water management.

Although the country has these complex structures in place and keeps up with the cost of maintaining and expanding them, it is increasingly clear that complete safety and security can never be guaranteed. Faced with this reality, the government is implementing measures and strategies based on the principles of resistance, resilience and adaptation.

Table 3.4 Total cost of water management, 2007

	Cost (million euros)	% of total
Ministry of Transport, Public Works and Water Management	1,405	27
Provinces	165	3
Municipalities	1,100	21
Waterschappen	2,453	48
Total	5,123	100

Conclusions

Throughout the centuries, the Netherlands has defended itself against water-related threats through structural solutions that made it possible to live and work below sea level. However, the impact of climate change on national security, the economy, livelihoods and the environment is weakening the country's resilience against the increasing intensity of extreme events and calls for new responses. Rising sea level, land subsidence, more pronounced variation between wet and dry seasons, an increase in river levels due to intense rainfall, and increasing water demand during warmer summers are just some of the challenges requiring appropriate adaptation strategies. Acting on the advice of the Delta Committee, authorities are already taking measures relying on a mix of spatial planning, risk analysis and technical innovation. Stakeholder consultation and public participation remain the core of any solution.

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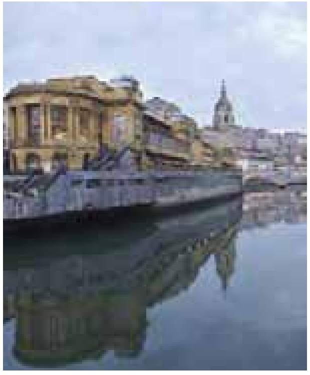
Spain: the Autonomous Community of the Basque Country



With a long history of floods and a risk of drought, Basques know how important it is to plan ahead while protecting ecosystems and water quality. Building on a new regulatory framework in line with European Union directives, they are implementing strategies to anticipate, mitigate and manage these risks, along with new ones linked to climate change and variability.

Setting the scene

The Autonomous Community of the Basque Country is located in the northern part of the Iberian Peninsula along an Atlantic coastline of 209 km (Map 3.5). Its population of 2.1 million (2005) is dispersed over 7,234 km^2 of very mountainous territory. On the slopes facing the sea, an Atlantic climate brings moderate temperatures and abundant rainfall. In the interior, the climate is more Mediterranean, characterized by hot, dry summers and scant precipitation. The region has been enjoying steady economic growth and a per capita income that is higher than the European Union (EU) average.[1]

Climate change and variability: looking ahead

Although no statistically significant changes have been observed in the hydrological cycle so far, the Basque Sustainable Development Environmental Strategy 2002 2020 plans for and reflects the current understanding that the uncertainties introduced by climatic variation and climate change translate into a potential risk to the environment and socio-economic development. The Basque Climate Change Office was established to address this potential risk, and the Basque Plan to Combat Climate Change was drafted in 2006 (Box 3.5). As part of this effort, the Basque Water Agency has initiated an in-depth study to determine what measures related to water resources need to be taken in the event of variation from current climatic conditions over 2011 2040. The study will allow the agency to further improve its database on impacts and to align itself with the best international practices for adapting to climate change.

State of the resource and water use

Of the 24 major river basins in the Basque Country, 14 empty into the Atlantic Ocean and the rest flow towards the Mediterranean Sea, with the Cantabrian Mountains forming the Atlantic-Mediterranean divide. For the rivers that empty into the Atlantic, major industrial and urban development on the river banks and pollution caused by these activities are the main and most extensive pressures. The high topographical relief of the region, for example, makes it possible for effluents to spread easily.

Another major source of pollution is agriculture, including forestry. It is largely practised in the Mediterranean basins, which account for some 4,500 km^2 or 62.4% of the Basque Country territory. Of this area, about 850 km^2 is cultivated; meadows and pasture cover around 1,500 km^2 and the

The second edition of the *World Water Development Report* included a case study on the Basque Country (UNESCO-WWAP, 2006). The present case study builds upon the findings of the previous one. It emphasizes current policy development efforts, which include strategies to mitigate the effects of climatic variation and climate change and a legal and political framework for the full implementation of integrated water resources management with stakeholder involvement.

Map 3.5 The Basque Country

[1] Except where otherwise noted, information in this case study is adapted from the draft *Autonomous Community of the Basque Country Case Study Report*, prepared in 2008 by the Basque Water Agency and UNESCO-Etxea.

Box 3.5 Methodology for assessing the cost of climate change in the Basque Country

The Department of Environment and Territorial Management of the Basque Country Government has developed a methodology for analyzing the impact of climate change on the Bilbao metropolitan area. The methodology makes it possible to calculate the economic costs associated with climate change and to select cost-efficient adaptation measures.

The methodology contemplated three possible scenarios: a basic scenario (current situation), a reference scenario (a future projection not taking climate change into account) and a climate change scenario (basically, the reference scenario incorporating climate change criteria). Mean annual damage in the basic scenario was put at between €224.65 million and €275.09 million, with the bulk of the cost involving residential properties. It should be noted that the economic damage caused by floods in August 1983 was equivalent to around €930 million (in 2005 prices). Mean annual damage in the reference scenario ranged from €229.25 million to €281.27 million, and that in the climate change scenario from €358.46 million to €439.77 million (in 2005 prices).

Thus, the variation in costs attributable to climate change that is, the difference between the cost estimated in the climate change scenario and that in the reference scenario was between €129.21 million and €158.50 million. By anticipating the problem and taking appropriate adaptation measures, the city of Bilbao could reduce the cost of damage incurred by a hypothetical flood by more than 50%. This conclusion led to establishment of the interdepartmental Basque Climate Change Office in January 2006. The office was responsible for drafting and launching the Basque Plan to Combat Climate Change.

Source Ministry for Environment and Territorial Planning

remaining land is used for timber production. Current water demand for agriculture amounts to 34.94 million m^3 per year, which corresponds to 9.14% of total water consumption in the Basque Country. The agricultural sector is not a significant contributor to GDP, but its environmental impact is getting more pronounced through increasing pollution in both surface and groundwater, due especially to the nitrates in fertilizers. Furthermore, pesticide concentrations in water resources occasionally exceed standards.

Industry plays a dominant role in the Basque Country economy, accounting for some 28% of overall water withdrawals (91 million m^3) and, in 2007, 29.8% of GDP (Eustat, 2008). Initiatives under the 2002 2020 environmental strategy aim to reduce the high contaminant load in industrial effluents.

Overall, freshwater demand is much lower than the available supply. Nevertheless, interbasin water transfers are made to alleviate local water stress. For example, the Zadorra, Ullibarri and Urrunaga reservoirs in the Ebro region link to the Undurraga reservoir in the north and provide water to the Bilbao-Bizkaia Water Consortium, which supplies water to several municipalities, most notably Bilbao, the largest city in the Basque Country.

The hydroelectric sector comprises a little over 100 plants, most of them mini-hydropower stations with no significant regulation. There may be potential to develop hydropower further. In its 2010 Energy Outlook, issued in 2001, the Basque Country Government states its intent to improve energy efficiency to save energy, diversify sources of energy production, increase the level of self-sufficiency in energy production and substantially reduce the environmental impact of energy production.

With its climatic, geographical and topographical features, the Basque Country is very rich in flora and fauna: over 3,000 plant species and 400 vertebrate species. The 2006 Water Act of the Basque Country specifies that the minimum flow reserved for environmental purposes is not classified as water use and needs to be taken into account in basin planning. Some 20.3% of the territory (1,470 km^2) lies within the Network of Protected Natural Spaces, including natural parks and the Urdaibai Biosphere Reserve. The network includes many areas linked to aquatic environments that have been declared Sites of Community Importance under the European Council Habitats Directive.

Policy framework and decision-making: coming into line with EU directives

Spain’s 1985 Water Act defines water as a state owned asset. Under the Act, river basins crossing territories of multiple autonomous communities are managed by 15 river basin agencies known as hydrographic confederations. The Basque Country Government is mainly responsible for the basins that are confined to its territory. However, under a 1994 decision it also plays a functional role as regards the intercommunity basins on its territory, although the river basin confederations remain the principal decision-making bodies.

The Basque Country is obliged to comply with the EU Water Framework Directive, which sets priorities for the protection and improvement of all water resources and aquatic habitats. The 2006 Water Act aims to establish the mechanisms necessary to put relevant EU policies into practice, including the creation of a regulatory framework. The Act also led to the establishment of the Basque Water Agency, which began operating in January 2008 and is the central instrument for implementing water policy in the Basque Country.

The Basque Country Water Act also allows for a participatory approach in decision-making. The Basque Water Agency has initiated comprehensive consultation with sector representatives and the public to lay the foundation for an all-inclusive water management policy. Two advisory bodies, the Users’ Assembly and the Basque Country Water Council, work with the Basque Water Agency in this participatory process. The Users’ Assembly includes representatives of the Basque Parliament, the Basque Government, the Basque water operators and other local governments and institutions. The Water Council broadens the participation to other stakeholders, such as municipalities and representatives of environmental conservation groups.

The 2006 Water Act also deals with valuing water. Cost recovery is assured through the setting of tariffs differentiated by use. Because the management system in place is efficient, water services can recover a high percentage of their costs. In addition, an ecological tax is imposed to deter polluters, reduce water consumption and support the conservation, protection and restoration of the environment, including aquatic ecosystems. The tax is also aimed at funding measures to maintain environmental services and achieve good ecological conditions for water bodies, in compliance with the EU Water Framework Directive.

In July 2008, the Basque Country Government Council established a solidarity initiative supporting sub-Saharan countries' efforts to meet the water and sanitation targets of the Millennium Development Goals (MDGs). In so doing it agreed to allocate 5% of the ecological tax revenue for this purpose (see section 15.5 on sustainable financing in the third edition of the *World Water Development Report*).

The main challenges

Floods: Due to its topographic features and abundant rainfall, the Basque Country experiences frequent flood alerts. Bilbao alone has recorded 39 events classed as natural disasters. Early records of floods in the region date back to the 15th century. More recently, large-scale floods occurred in October 1953, June 1975, June 1977, August 1983, July 1988 and February 2003. The 1983 flood, in particular, claimed 34 lives and caused damage amounting to about €930 million.

To minimize socio-economic risks associated with floods, the Basque Water Agency has produced flood risk maps illustrating the extent of floods over the last 10, 100 and 500 years. They are used to establish land use criteria based on flood vulnerability. In 2007, the European Union passed a directive concerning the evaluation and management of flood risks. In support of this directive, a Spanish Royal Decree in 2008 incorporated risk management into public water management. Such policy measures are backed up by structural measures, including construction of drainage channels in highly urbanized areas, demolition of structures that cover rivers and obstruct flow (e.g. obsolete bridges and abandoned hydraulic structures such as water wheels and dams), rehabilitation of river beds and improvement of drainage capacity.

Drought: Although drought is unexpected and exceptional in the Basque Country, it is within the natural range of climatic variation. Two prominent drought periods took place from 1940 to 1950 and from 1989 to 1990. To minimize the environmental, economic and social effects of drought, a hydrological plan and the Special Action Plan in Situations of Urgency and Possible Drought, known as PES (Plan Especial de actuación en situaciones de alerta y eventual Sequía), were approved for the Ebro and Norte basins in 2007.

Basque Country administrative bodies are adopting various mechanisms to improve water supply and demand management under normal conditions and to deal with extreme episodes of drought with as little disruption to water supply as possible. These measures will be used to counterbalance the possible effects of climate change, especially in areas with the drier Mediterranean climate. To this end, the Basque Country Government has carried out research projects on increasing efficiency in the current use of water and harnessing additional resources, under both normal and extreme conditions. Examples include connecting intra- and intercommunity basins and modifying the use of reservoirs and groundwater abstraction in line with prevailing climatic conditions. Of particular note is a series of studies on improving water supply to the metropolitan areas of Bilbao and the Basque Country capital, Vitoria-Gasteiz.

Conclusions

As the second edition of the *World Water Development Report* concluded, the central challenge for the Basque Country is to define and successfully implement a series of case-specific and efficient programmes to protect and improve the status of valuable water resources and associated ecosystems. This is being done through the 2006 Water Act, which enforces relevant EU legislation while creating the legal framework for active involvement of all stakeholders. Basque Country authorities are also working on institutional development to plan for and mitigate potential risks associated with climate change and variability. The establishment of the ecological tax not only helps protect the environment but also, through the solidarity initiative, allows Basque officials to set a precedent for an innovative funding mechanism to support developing country achievement of the water and sanitation targets of the MDGs.

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Turkey: Istanbul

In coping with the challenges and demands of a megalopolis suffering the effects of an unplanned urban boom, officials are relying on significant infrastructure investment, public information campaigns and better enforcement of city planning regulations.

Background

Istanbul, located in north-western Turkey, has a population of over 12 million (Turkish Statistical Institute, 2007). Home to 17.6% of the country's population, it is the largest city in Turkey and one of the 25 largest in the world. Uniquely, by virtue of its situation straddling the Bosphorus strait, it has a presence on both the European and Asian continents (Map 3.6).[1]

Climate change and variability: anticipating problems

Although the data do not indicate a clear declining trend in rainfall in Istanbul and its surroundings (Figure 3.8), extreme events especially droughts seem more pronounced than in the past. In 2006, the measured rainfall of 66.7 mm was the record low for the previous 50 years, a period during which the average was 257.2 mm per year. Furthermore, the water level in reservoirs serving the city was just 45% in 2004, and plummeted to around 25% in 2007 and 2008 (ISKI, 2008). Officials at Istanbul Water and Sewerage Administration (ISKI), using the Inter-governmental Panel on Climate Control scenario of a 2°C temperature increase by 2030, have estimated the likely decrease in total reservoir capacity due to higher evaporation rates. Their calculations revealed that the water potential of the city might drop by as much as 14% over the next two decades. This projection, coupled with water demand scenarios, indicates that the onset of a water crisis is likely by 2030. In response, remedial actions are being taken, ranging from water saving campaigns (Box 3.6) to projects transferring water to Istanbul from as much as 150 km away.

Figure 3.8 Combined rainfall in Istanbul for December, January and February, 50 year average

State of the resource: monitoring, water transfer and expanded treatment facilities

Water to meet the needs of metropolitan Istanbul comes from the Marmara and Melen basins, whose combined water potential (including artificial storage) amounts to about 3.34 billion m^3. Groundwater resources are limited; their annual potential is around 0.175 billion m^3. To protect this precious resource, regulations prohibit the drilling and operation of wells without obtaining a permit. Depending on quality, some groundwater resources are mainly used for drinking water supply while others meet water needs in industry. However, uncontrolled settlement and over-abstraction have

Map 3.6 Istanbul

[1] Except where otherwise noted, information in this case study is adapted from the draft *Istanbul Case Study Report*, prepared in 2008 by ISKI and DSI.

Box 3.6 Water saving campaigns

Given climatic variation and the lower than average rainfall of recent years, water saving campaigns are now considered an important measure for raising awareness among Istanbul residents about climate change and its impact, and for promoting sustainable use of the limited freshwater resources.

For example, the 'Don't Waste Your Water' campaign, a joint effort of the Turkish Foundation for Combating Soil Erosion, for Reforestation and the Protection of Natural Habitats (TEMA) and the Istanbul Metropolitan Municipality, proved quite effective. It resulted in a decline in daily water consumption from 2.35 million m^3 to 1.9 million m^3 by promoting basic water saving methods that households can apply. ISKI estimated that 18 million m^3 of water was conserved during the course of the campaign.

Such campaigns also pave the way towards implementation of the EU Water Framework Directive, which focuses heavily on the need to keep the public well informed about water management issues and to devise participatory approaches for solving problems.

Source Istanbul Water and Sewerage Administration

diminished groundwater levels and led to saltwater intrusion in coastal areas. The decline in the water table due to unsustainable abstraction ranges from 30 metres to as much as 150 metres in some areas. Both surface and groundwater quality is monitored through 51 observation stations scattered throughout the two basins.

In 2007, the amount of water resources in use was 1.42 billion m^3. This means 40% of the water potential is being exploited, on average. However, geographic and seasonal disparities in the distribution of water resources, coupled in recent years with severe drought, have necessitated interbasin water transfer projects to provide more water where needed in Istanbul. For example, the Melen Project Phase I, which became operational in December 2007, supplies an additional 0.27 billion m^3 of water per year. With the full realization of similar projects, some 66% of the potential water resources would be made available for use.

As of 2007, ISKI operated six large water treatment plants and a number of smaller units. ISKI's master plan for water, which included construction of treatment plants, was based on projections of population growth and an accompanying increase in water demand. However, the projections proved to be overestimates, and the treatment plants currently operate at 61% of capacity. Although the existing plants can keep up with population growth in the near future, new facilities are being planned and constructed to assure the long term needs of the Istanbul metropolitan area.

Some 0.2 billion m^3 of treated wastewater is discharged from Istanbul into the sea every day. To make more efficient use of water resources and cope with periods of drought, water recycling plants are being planned, with the first one expected to be operational in 2009.

Institutional mechanisms for water and sanitation service provision

In its long history, Istanbul has served as the capital of many great civilizations. During the time of the Ottoman Empire (ca 1299 1922), water structures dating from Roman times were improved and extended, and aqueducts, reservoirs, wells and cisterns were added to improve freshwater supply to a growing population. After 1923, when the Republic of Turkey was founded, the Istanbul Water Administration (ISI) took over responsibility for managing the city's water resources.

Intensive internal migration to Istanbul resulted in a population boom and unplanned urbanization in the shape of shanty towns on the outskirts of the city. These conditions, which made it all but impossible for the ISI to meet everyone's water and sanitation needs in a city astride two continents, necessitated the establishment of institutions with the financial and human resources needed to cope with the challenges. Today, ISKI and the General Directorate of State Hydraulic Works (DSI) are the main institutions responsible for developing water resources for Istanbul. DSI was founded in 1954 and is responsible for planning, managing and developing all water resources in Turkey. ISKI, founded in 1982, is charged with setting up and maintaining water and sanitation infrastructure, managing surface and groundwater resources for domestic and industrial use, collecting, treating and disposing of wastewater, and protecting water resources from pollution. It is also responsible for river rehabilitation within greater Istanbul.

Although investment by both institutions has helped address water-related problems in Istanbul, a lack of coordination among various agencies dealing with water management in the city, combined with a complex and fragmented division of authority that makes it difficult to enforce regulations, is a critical issue that stands in the way of effective water governance.

The main challenges

Service coverage and expansion of the metropolitan area: In 1900, Istanbul was one of the few cities in the world with a population of 1 million, and it took almost 70 years for this number to double. However, with the onset of east to west migration in the mid-1970s, the population more than quadrupled in just 20 years' time, reaching some 6.6 million in 1990. Since then the population has again almost doubled, making Istanbul one of the world's 25 most populous cities. Most of its estimated 12 million people live on the European side. In 2004, the borders of the city were extended significantly, increasing ISKI's service area from 1,972 km^2 to 5,342 km^2 (or 6,500 km^2 if one includes the basin areas outside the provincial borders). These figures make clear the sheer magnitude of the challenge involved in providing basic water and sanitation services to the city.

However, thanks to significant investment, which especially gained momentum from the mid-1990s to total US$3.6 billion between 1994 and 2004, the water supply and sanitation infrastructure has improved considerably. Water storage capacity, for example, increased from 0.59 billion m^3 in 1994 to 1.17 billion m^3 in 2005. In addition, ISKI formulated the Water Master Plan in 2004 to address long term needs to 2040 by taking into account population estimates, water demand, water resources availability, water purification and sewerage work, etc. The plan includes new large water supply projects, such as pipelines to bring water from the Asian side to the European side (e.g. the Melen Project), to meet projected demand (Altınbilek, 2006).

River improvement and environmental protection: River improvement projects are necessary to ameliorate the quality of urban life and protect residents from socio-economic hazards associated with flooding. They become even more critical in densely populated settlements like Istanbul, where the rate of infrastructure expansion cannot keep up with the increase in demand stemming from continued internal migration. Such unplanned growth also creates serious problems with enforcement of urban planning rules and building codes.

Many projects have aimed to restore the quality of rivers that had turned into open sewers, especially during the 1990s. Unfortunately, due to a lack of financial resources, only 313 km of the 1,825 km of streams within the boundaries of the Istanbul Metropolitan Municipality have so far been improved.

The best example of environmental restoration in Istanbul concerns the Golden Horn. Once the pearl of Istanbul, the Golden Horn became an environmental disaster after its surroundings turned into an unplanned industrial zone housing docks, factories and warehouses. By 1985 around 700 industrial plants and 2,000 workshops had been opened along the Golden Horn. Hundreds of thousands of tonnes of waste were dumped directly into the waterway every year, gradually destroying all aquatic life. Finally, in the late 1980s, the Istanbul Metropolitan Municipality Government and ISKI joined forces to save the Golden Horn by constructing wastewater collectors, tunnels, pumping stations, wastewater treatment plants and related utilities, thus revitalizing the environment of the area. The Golden Horn Environmental Protection Project, with a total cost of some US$650 million, received first prize in 2002 from the World Association of the Major Metropolises (Altınbilek, 2006).

Unplanned urbanization: Unplanned urbanization through illegal construction is a serious problem in Istanbul. It entails risks of socio-economic losses, especially if structures are built in flood prone areas like those near river embankments. Such settlements are either not connected or illegally connected to water supply and sanitation infrastructure. Illegal connections can lead to water pollution, environmental degradation, and discontinuity in service provision due to resultant malfunctioning of local infrastructure. The combination of these factors often leads, in turn, to health problems. As part of an effort to prevent illegal urban development in protected water basins, ISKI uses remote sensing technology to run a basin information system for periodic monitoring of structural changes in its service area. The system has allowed municipal authorities to detect illegal construction in a relatively short time and to intervene accordingly.

Conclusions

Istanbul is one of the great metropolitan areas of the world, but it is suffering from unplanned and accelerating urbanization. Seasonal and geographic variations in water availability, coupled with pollution and wasteful water use, put the resource under ever-increasing pressure. The authorities are working seriously to address quality issues and improve the coverage of water supply and sanitation services. Nevertheless, there is still some progress to be made in terms of service provision, public awareness raising, implementation of laws and regulations, and the much needed political will to move forward.

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