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FRESHWATER IN EUROPE An Environmental Atlas

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FRESHWATER IN EUROPE

Facts, Figures and Maps

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Freshwater in Europe - Facts, Figures and Maps

UNEP | DEWA Europe

Aknowledgments

This is a publication of the Division of Early Warning and Assessment, Office for Europe (DEWA~Europe), of the United Nations Environment Programme (UNEP).

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Contents

Executive Summary

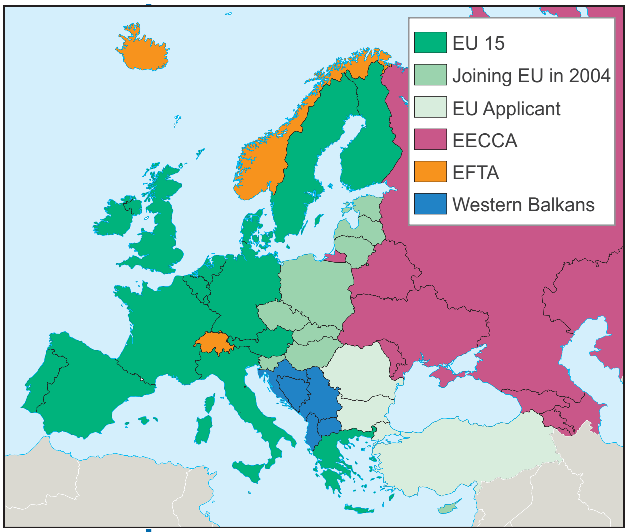
The goal of this publication is to produce a clear overview, through a set of graphics, maps and other illustrations, on the state of freshwater in Europe. The review has been compiled by UNEP/DEWA~Europe in support of UNEP's reporting work and the International Year for Freshwater in 2003, and provides an easily-accessible resource on this vital subject.

Few Europeans suffer from important shortages of water and poor water quality experienced by people in many other parts of the world. However, while many parts of Europe are currently well-provided with freshwater, the water resources are unevenly distributed between and within countries. Pressures resulting from human activities affect the quality of water resources in many areas of Europe, and thus drinking water quality is still of concern.

Water stress exists in many places in Europe, resulting in serious water shortages, flooding, pollution and ecosystem damage. Climate change may also play a role, especially in coastal areas where flooding may disrupt sanitation infrastructure and thereby contaminate watercourses. Although there has been much improvement in water quality since the first European law on bathing water twenty years ago, there has been little progress in the integrated management of water resources.

Data in this report are presented by geographical areas

EUROPEAN REGION



EU 15 - the fifteen countries of the European Union - Austria, Belgium, Denmark, Germany, Greece, Finland, France, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

Joining EU in 2004 - Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic, and Slovenia.

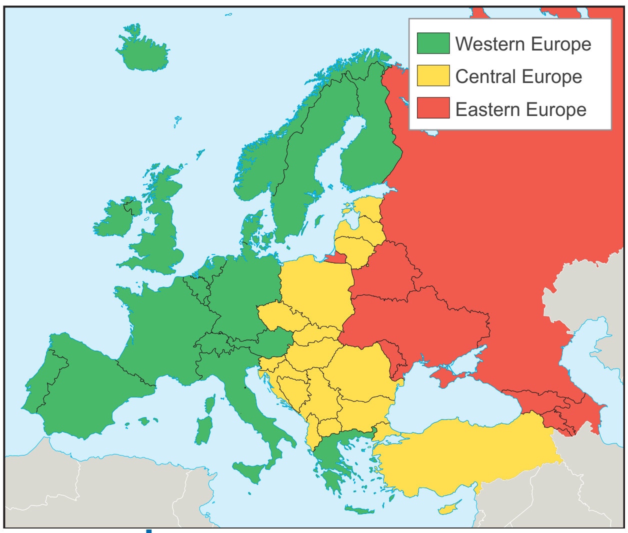
EU Applicant - Bulgaria, Romania and Turkey.

EECCA - Eastern Europe, Caucasus and Central Asia - Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russian Federation, Tajikistan, Turkmenistan, Ukraine, Uzbekistan.

EFTA - European Free Trade Area - Iceland, Liechtenstein, Norway and Switzerland.

Western Balkans - Albania, Bosnia and Herzegovina, FYR Macedonia, Croatia, Serbia and Montenegro (formerly known as the Federal Republic of Yugoslavia).

UNEP GEO SUB-REGIONS



Global Environment Outlook (GEO) European Sub-Regions

Western Europe - Andorra, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Holy See, Iceland, Ireland, Israel*, Italy, Liechtenstein, Luxembourg, Malta, Monaco, Netherlands, Norway, Portugal, San Marino, Spain, Sweden, Switzerland, United Kingdom

Central Europe - Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Serbia and Montenegro, Slovakia, Slovenia, The Former Yugoslav Republic of Macedonia, Turkey.

Eastern Europe - Armenia, Azerbaijan, Belarus, Russian Federation, Georgia, Republic of Moldova, Ukraine.

* Although Israel is part of the GEO European Region, it has not been included in the data presented in this report.

Freshwater Ecosystems

Freshwater Systems

Freshwater systems are created by water that enters the terrestrial environment as precipitation, and flows both above and below ground towards the sea. These systems encompass a wide range of habitats, including rivers, lakes, and wetlands, and the riparian zones associated with them. Their boundaries are constantly changing with the seasonality of the hydrological cycle. Their environmental benefits and costs are distributed widely across time and space, through the complex interactions between climate, surface and groundwater, and coastal marine areas. Freshwater ecosystems in rivers, lakes and wetlands contain only a small fraction (0.01%) of the Earth's water and occupy less than 1 percent of the Earth's surface.

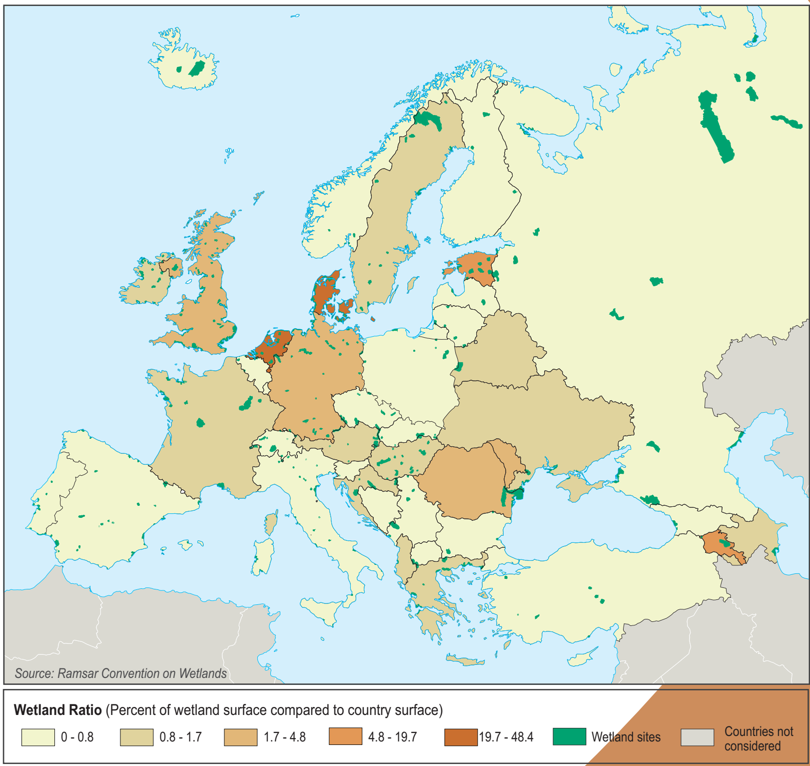
Wetlands

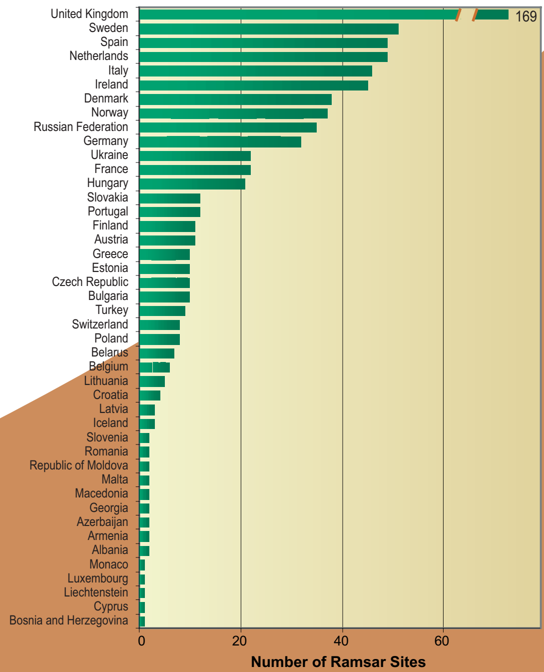
In 1995, the EEA estimated that around 25 percent of the most important wetlands in Europe were threatened by groundwater overexploitation.

In the Mediterranean basin, wetland loss is severe. Spain, for example, has lost more than 60% of all inland freshwater wetlands since 1970; Lithuania has lost 70% of its wetlands in the last 30 years; and the open plains of the southwestern part of Sweden have lost 67% of their wetlands and ponds to drainage in the last 50 years. Overall, draining and conversion to agriculture alone have reduced wetland area in Europe by some 60%.

Despite global and national recognition of their importance, Europe's wetlands remain under severe pressure from changing land use and pollution. Many wetland areas border agricultural land and most are near transport infrastructure. All EEA member countries have now ratified the Ramsar Convention on Wetlands of International Importance, but the process of designation to protect important wetlands takes many years to complete.

RAMSAR CONVENTION WETLANDS IN EUROPE





More than half of Europe's wetlands have disappeared in recent years. About 25% of Europe's remaining wetlands are potentially endangered today.

Groundwater

Groundwater is a major source of drinking water all over Europe

In Switzerland half of groundwater consumed does not need any treatment.

The Importance of Groundwater

Groundwater represents the largest single source of freshwater in the hydrological cycle (about 95% globally), greater in volume than all the water in rivers, lakes and wetlands combined.

In general, groundwater is of good quality because of natural purification processes, and very little treatment is needed to make it suitable for human consumption.

Natural underground reservoirs can have an enormous storage capacity, much greater than the largest man-made reservoirs; they can supply "buffer storage" during periods of drought.

In addition, groundwater provides base flow to surface water systems, feeding them all through the year. Thus, groundwater quality has a direct impact on the quality of surface waters as well as on associated aquatic and terrestrial ecosystems.

Estimated Percentage of Drinking Water Supply Obtained from Groundwater

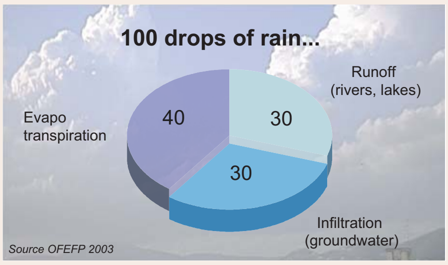
Region	percent	Population served (millions)
Asia–Pacific	32	1 000 – 2 000
Europe	75	200 – 500
Central and South America	29	150
USA	51	135
Australia	15	3
Africa	NA	NA
World	-	1 500 –2 750

Source: UNEP 2003

What is Groundwater ?

Groundwater represents the portion of precipitation that infiltrates into the land surface, entering the empty spaces between soil particles or fractured rocks. The larger the soil particles, the larger the empty spaces, and the greater the potential for water infiltration.

Precipitation and Groundwater



When it rains at the latitude of Switzerland, only 30 drops out of 100 infiltrate towards the groundwater reservoir, 40 evaporate into the atmosphere and 30 run off in the rivers.

Groundwater systems are dynamic. Water is continuously in motion; its velocity is highly variable, ranging from a few meters per year to several meters per day.

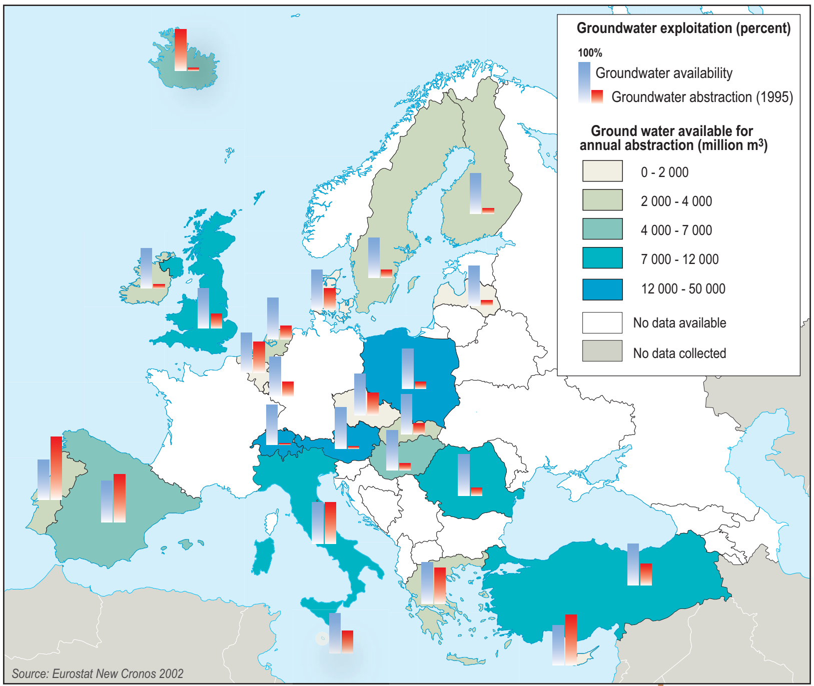
Many aquifer systems possess a natural capacity to attenuate and thereby mitigate the effects of pollution. The ground purifies the infiltrating water in three different ways. It serves as a physical filter retaining dirt like a sieve. Pollutants undergo chemical conversion through contact with soil minerals. Surface soil supports intense microbial life; bacteria break down certain undesirable substances, neutralising them.

Although groundwater is not easily contaminated, once this occurs it is difficult to remediate. Therefore, it is important to identify which aquifer systems are most vulnerable to degradation. The replacement cost of a failing local aquifer will be high and its loss may stress other water resources turned to as substitutes.

Driving Forces

Groundwater quality and quantity are threatened by human activities that cause pressures on the environment, including urbanization, tourism, industry and agriculture.

Driving Forces	Consequences for Groundwater
Urbanization	Increasing urban population causes substantial pressures on groundwater. More than two-thirds of Europe's population lives in urban areas and the rate of urbanization is, in particular, increasing in Central and Eastern Europe, while in Western Europe it has stabilized.
Industry	Industrial pressures involve: high water demand for cooling and cleaning purposes; pollution with potentially toxic inorganic and organic substances (e.g. organic matter, metals, chlorinated hydrocarbons, nutrients…); disposal or dumping of sludge and waste, and inadequate containment of old industrial sites; accidents during production and transport. Further pollution arises from emissions to air, mainly from the combustion of fossil fuels, which initiate a process of acidification.
Tourism	Tourism causes very high pressures on groundwater, especially because of the additional water demand during seasons when the groundwater situation may already be rather critical. Waste and sewage from this sector represent another potential source of groundwater pollution.
Agriculture	The legacy of the agricultural intensification of the post-war years is still present, and it is widely predicted that groundwater will continue to be contaminated with nitrate for several decades.



Groundwater availability

In some regions the extent of groundwater abstraction exceeds the recharge rate (over-exploitation). In Europe, the share of groundwater needed at the country level to meet the total demand for freshwater ranges from 9% up to 100%. In the majority of countries, however, total annual groundwater abstraction has been decreasing since 1990.

The vulnerability of an aquifer to over-exploitation depends on its type, the climate, hydrological conditions and the uses of the water.

The rapid expansion in groundwater abstraction over the past 30–40 years has supported new agricultural and socio-economic development in regions where alternative surface water resources are insufficient, uncertain or too costly. The main reported cause of groundwater over-exploitation is water abstraction for public and industrial supply. Mining activities, irrigation and dry periods can also lower groundwater tables.

Over-abstraction leads to groundwater depletion, with consequences like deterioration of water quality (e.g. saltwater intrusion), loss of habitats (e.g. wetlands), modification of river-aquifer interactions and ground subsidence.

Over-exploitation Effects

~ Groundwater Quality

Continuous groundwater over-exploitation can cause isolated or widespread groundwater quality problems. Over-abstraction causes a draw-down in groundwater level which can influence the movement of water within an aquifer. Significant draw-downs can cause serious quality problems. One of these changes is displacement of the freshwater/saltwater interface, causing active saltwater intrusion.

~ Saltwater Intrusion

Large areas of the Mediterranean coastline in Italy, Spain and Turkey have been affected by saltwater intrusion. The main cause is groundwater over-abstraction for public water supply, followed by agricultural water demand and tourism-related abstractions.

Irrigation is the main cause of groundwater over-exploitation in agricultural areas. An example is the Greek Argolid plain of eastern Peloponnesos, where it is common to find boreholes 400 m deep contaminated by salt water intrusion.

~ River-Aquifer Interactions

Aquifers can exert a strong influence on river flows. In summer, many rivers are dependent on the groundwater base flow contribution for their minimum flow. Lower groundwater levels due to over-exploitation may, therefore, endanger river-dependent ecological and economic functions, including surface water abstractions, dilution of effluents, navigation and hydropower generation.

~ Wetlands

Water abstraction in areas near wetlands can be a very severe problem: groundwater pumping usually lowers the groundwater table and then produces a new, deeper unsaturated zone. This can severely damage wetland ecosystems which are very sensitive to minor changes in water level.

~ Ground Subsidence

Heavy draw-down has been identified as the cause of ground subsidence or soil compaction phenomena in some parts of Europe, notably along the Veneto and Emilia-Romagna coasts, the Po delta and particularly in Venice, Bologne and Ravenna in Italy.

Groundwater Quality

As groundwater moves slowly through the ground, the impact of human activities can last for a relatively long time. This makes pollution prevention very important for addressing groundwater issues.

Note: data for groundwater resources are long term annual average; data for groundwater abstractions refer to year 1995 except for Cyprus 1998, Ireland 1994, Netherlands 1996, Portugal 1998, Italy 1985, and Turkey 2000.

Pollution of a water body occurs when an impurity (micro-organism or chemical) is introduced by or as a result of human activities, creating an actual or potential danger to human health or the environment when present at high concentrations.

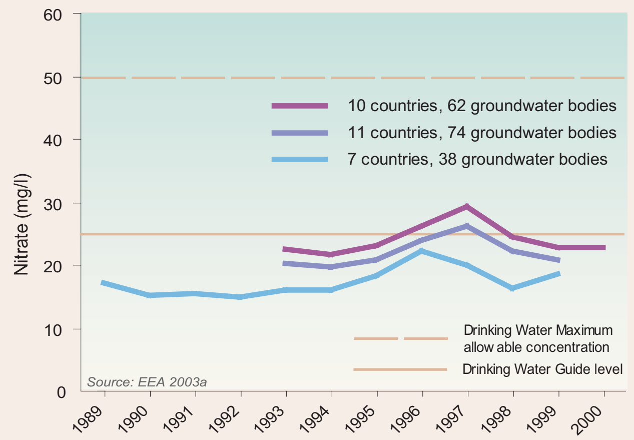
Europe's groundwater is polluted in several ways: nitrates, pesticides, hydrocarbons, chlorinated hydrocarbons, sulphate, phosphate and bacteria. Some of the most serious problems are pollution by nitrates and pesticides.

~ Nitrate

Nitrate is a significant problem in parts of Europe, in particular, in regions with intensive livestock production.

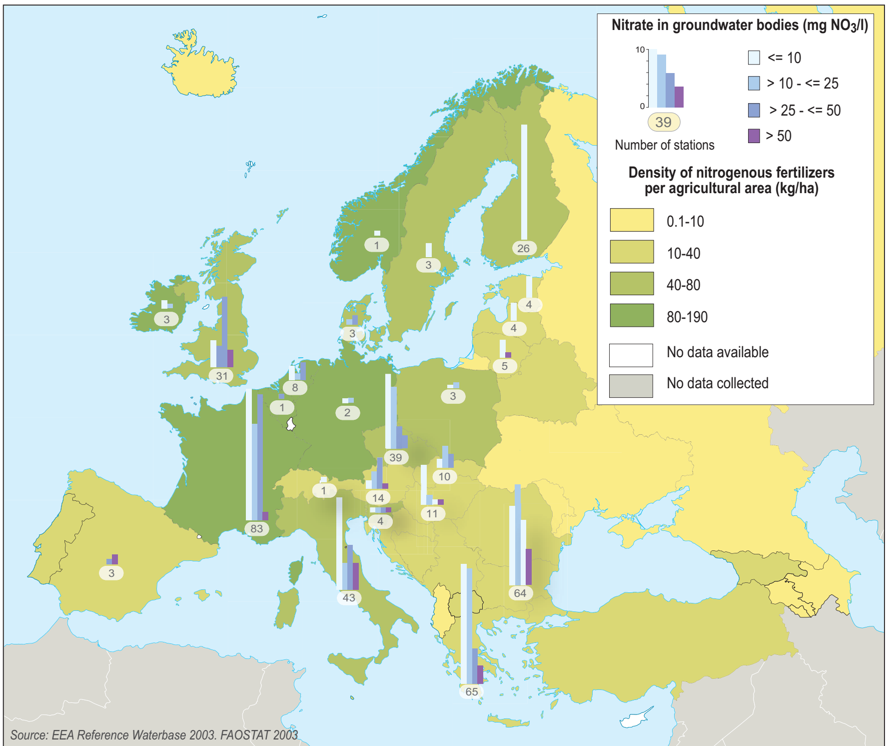
Natural nitrate levels in groundwater are generally very low (typically less than 10 mg/l NO_3). Concentrations higher than natural levels are caused by human activities, such as agriculture, industry, domestic effluents and emissions from combustion engines.

Mean Nitrate Values in Groundwater Bodies



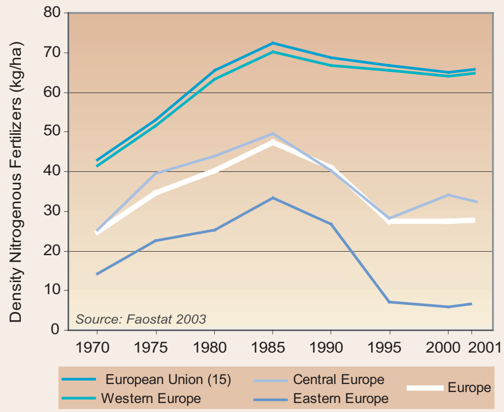
The figure compares three time series containing different numbers of groundwater bodies, time spans and countries. Elevated mean NO_3 concentrations in 1996 and 1997 are mostly caused by single, very high nitrate concentrations (data from Austria, Belgium, Bulgaria, Denmark, Estonia, Spain, Hungary, Lithuania, Latvia, Netherlands, Slovenia, Slovakia).

NITRATE IN GROUNDWATER BODIES



Agriculture is the largest contributor of nitrogen pollution to groundwater. Nitrate surpluses in agricultural soils are high in EU countries (around 50–100 kg N/ha of agricultural area), and remained nearly constant in the 1990s.

Nitrogenous Fertiliser Trend



Nitrogen from excess fertiliser percolates through the soil and is detectable as elevated nitrate concentrations under aerobic conditions and as elevated ammonium concentrations under anaerobic conditions. The rate of percolation is often slow, and excess nitrogen concentrations today may reflect surface pollution up to 40 years ago, depending on the hydrogeological conditions.

The Nitrates Directive (91/676/EEC) aims to control nitrogen pollution and requires Member States to identify groundwater that contains more than 50 mg/l nitrate or could contain more than 50 mg/l nitrate if preventative measures are not taken. In addition, the Drinking Water Directive (98/83/EC) sets a maximum allowable concentration for nitrate of 50 mg/l. Groundwater is a very important source of drinking water in many countries and it is often used untreated, particularly from private wells.

Mean nitrate concentrations in groundwater in Europe are above background concentrations (>10 mg/l), but do not exceed the limit value of 50 mg/l. However, concentrations higher than 50 mg/l were observed frequently in 39 groundwater bodies (14%).

Around 20% of EU measure stations had concentrations in excess of the limit concentration, and 40% were in excess of the guide value of the drinking water directive (25 mg/l) in 1996–98. Countries showing an overall increase in nitrate concentrations in groundwater are France and Sweden.

~ Pesticides

Pesticides by their nature are designed to kill unwanted organisms. Most act by interfering with biochemical and physiological processes that are common to a wide range of organisms. They are potentially harmful to non-target organisms and can be serious pollutants even in low concentrations.

The Drinking Water Directive (98/83/EC) establishes maximum allowable concentrations (in any single result/sample) for pesticides in water for human consumption of 0.1 µg/l for individual substances, and of 0.5 µg/l total pesticides.

Approximately 800 pesticide substances are approved for use in Europe, and many could potentially reach groundwater. The application of pesticides in terms of the amount of active ingredients has decreased within the last decade. This does not necessarily indicate a decrease in environmental impact, as new pesticide substances are more efficient than older products.

In some accession countries pesticide consumption decreased radically during the past decade, mainly due to a general decline in national economies. In Estonia the consumption dropped by 78%, in Latvia by 86%, and in Macedonia by 75%. In the Czech Republic the consumption in 1999 corresponded to 47% of the consumption in 1990. However, the situation is currently reversing itself. It is the toxicity of the particular pesticide, not necessarily the amount used, that determines its potential for environmental damage.

Across all European countries, atrazine, desethylatrazine and simazine are probably the most polluting pesticide substances. There is some evidence that levels of certain pesticides, in particular atrazine, have recently declined as a result of the control or banning of their use.

In Austria, between mid-1997 and mid-1999, about 15% of sampling sites exceeded 0.1 µg/l for desethylatrazine and 10% for atrazine.

In Finland, pesticide pollution of groundwater has been reported around tree nurseries. In France, pesticide contamination was recorded at 56% of the sampling points concerned.

In Hungary, groundwater close to the surface is not regarded as suitable for drinking and irrigation, as a result of inappropriate use of pesticides.

The awareness of pesticide problems in groundwater continues to grow in many countries.

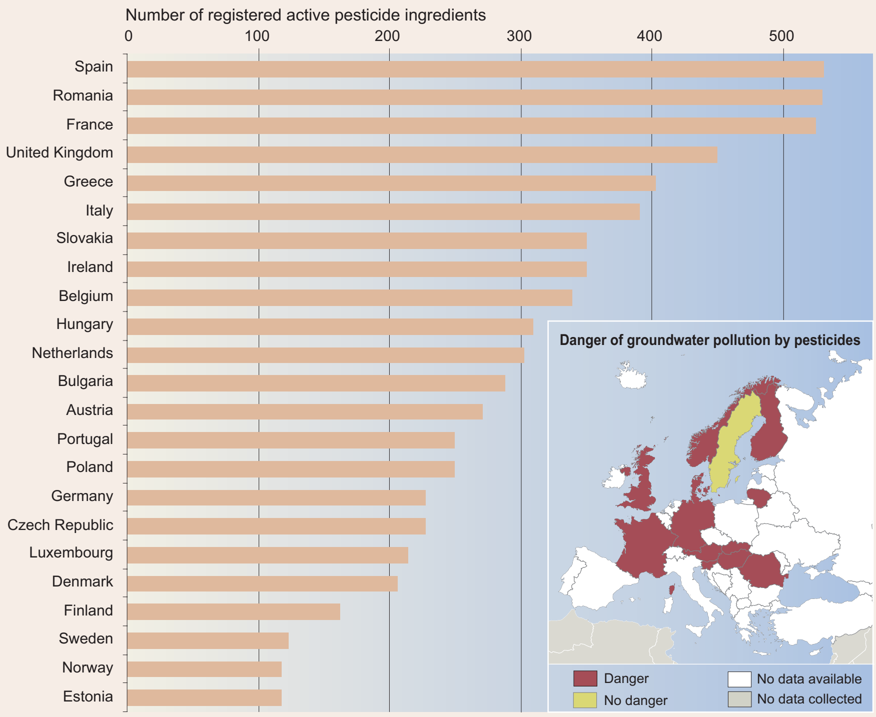
In general, there has been no substantial improvement in the nitrate situation in European groundwater and hence nitrate pollution of groundwater remains a significant problem.

Nitrate drinking water limits are exceeded in around one-third of the groundwater bodies for which information is currently available.

Groundwater protection against pollution under the Water Framework Directive (WFD)

The European Commission adopted a proposal for a new Directive to protect groundwater from pollution on 19 September 2003 (COM(2003)550). Based on an EU-wide approach, the proposed Directive introduces quality objectives for the first time, obliging Member States to monitor and assess groundwater quality and to identify and reverse trends in groundwater pollution. The proposed Directive will ensure that groundwater quality is monitored and evaluated across Europe in a harmonised way. The proposed approach to establishing quality criteria takes account of local characteristics and allows for further improvements. It represents a proportionate and scientifically sound response to the requirements of the WFD related to the assessment of the chemical status of groundwater, and the identification and reversal of significant and sustained upward trends in pollutant concentrations.

Number of Registered Active Pesticide Ingredients



Source EEA 2003b

The limnicity, i.e. the total freshwater lake surface area in relation to a country's size, is a good indicator of the "density" of lakes. In Europe, limnicity ranges from over 9% in Nordic countries such as Sweden to 1% in the UK and less than 0.5% in Greece.

Origin of Lakes and Reservoirs

Lakes are formed when water fills natural depressions left by geological processes such as glaciers, volcanic and tectonic activity.

Lakes can disappear through long-term natural processes such as sedimentation or evaporation. In recent times, lakes have been threatened by drainage and over-exploitation. Most lakes are not much older than 10 000 years (the end of the last Ice Age).

Lakes can be subdivided into seven major types:

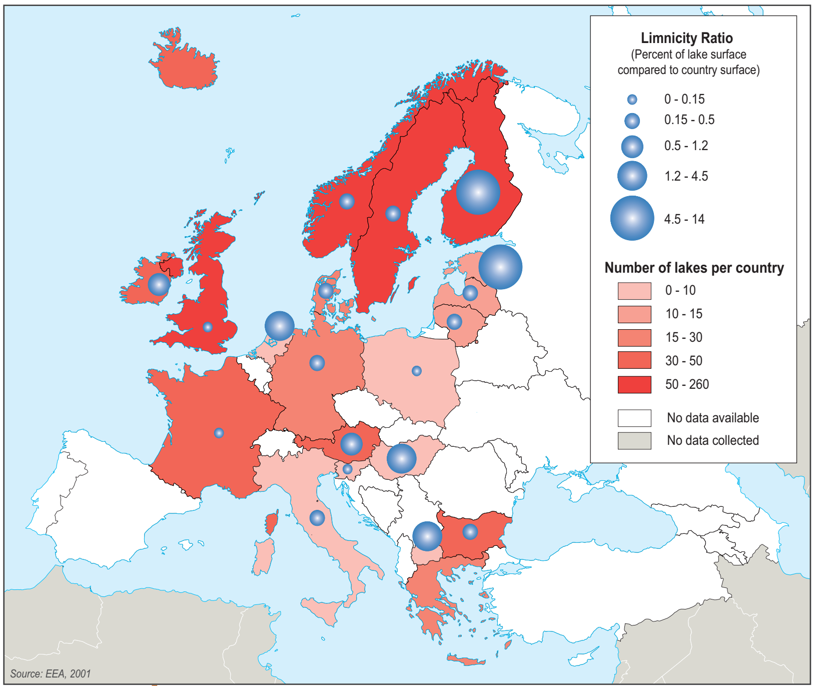
- *glacial* (depressions left by glaciers);
- *tectonic* (continental crust movements);
- *fluvial* (created by rivers);
- *shoreline* (water bodies cut off from the sea due to sedimentation);
- *naturally dammed* (formed by landslides);
- *volcanic*;
- *karstic* (due to dissolution of rocks such as limestone).

In contrast to the natural process of lake formation, reservoirs are water-bodies formed by the construction of a dam across a flowing river or other depression. A dam may also be constructed to control the water level of a natural lake.

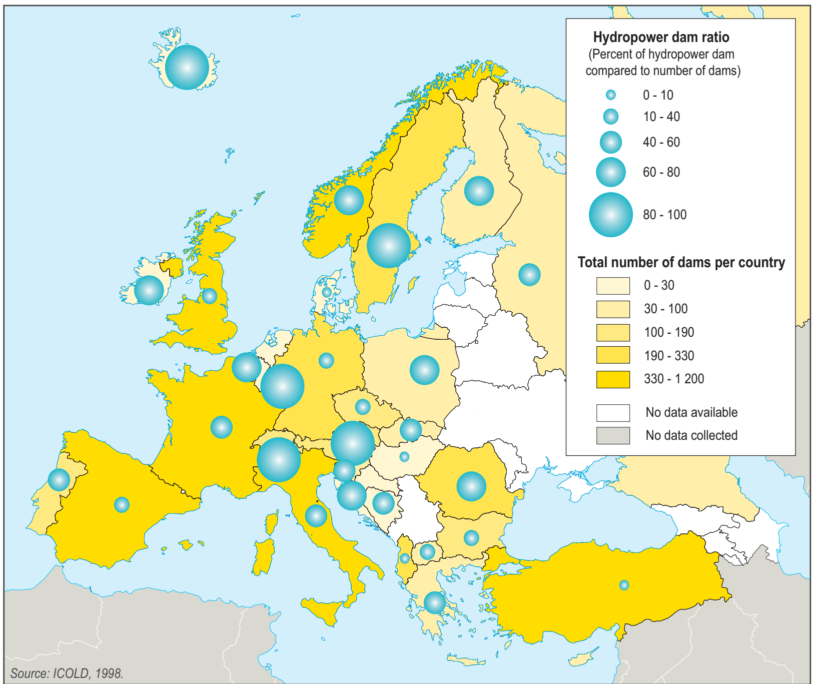
Reservoirs are found in regions where there are relatively few natural lakes, or where the lake water is not suitable for human consumption.

The earliest dams constructed in Europe are located in Spain and were probably built in the 2nd century AD, primarily to supply drinking water and for irrigation. This suggests that water supply problems were identified long ago in this region.

LAKES IN EUROPE



DAMS IN EUROPE



Processes

Processes in water-bodies are strongly determined by different factors such as:

- climate: solar radiation, wind, precipitation/evaporation ratio;
- physical properties of water: maximum density at 4°C, etc.;
- edaphy: structure, bed-rock texture;
- topography: depth, exposition, etc.;
- chemical properties: oxygen, carbon, phosphorus, nitrate, etc.

Solar radiation plays a major role, as it determines the temperature profile. Lakes are often stratified: the water in the bottom layer usually has the highest density (temp. 4°C) and is overlain by a layer of colder or warmer water. When the surface layer cools or warms towards 4°C, the lake has a near constant temperature and mixing of the water layers occurs.

Facts on dam construction in Europe

- 2nd century AD: Cornalbo and Prosperpina dams built in Spain (24 and 19 m).
- ~ 20 dams constructed in the 17th and 18th centuries in Germany, Spain, France and UK.
- During 19th century, the rate of dam construction increased rapidly in UK, reflecting the water requirements of the expanding industrial centres. By 1900, over 200 large dams had been built, more than the total number of dams in Europe at that time.
- In early 20th century, the UK construction rate slowed while other countries began dam-building programmes.
- Italy built many dams from 1920 to 1950.
- Spain showed a similar pattern of construction until the late 1950s. The rate of Spanish dam completion has been regular throughout the second half of the 20th century and continues to the present day.
- France also built dams predominantly in the second half of the 20th century af a rate of eight per year.
- During the period 1980-1988, France and Spain show the highest rate of dam completion. At the same time the UK, Germany and Sweden had no construction. Portugal, Austria and Norway continued to construct dams but at a slower rate.
- In Belgium, Finland, Iceland, Ireland, Luxembourg and the Netherlands, no large dams have been constructed since 1980.
- The highest overall rate of dam construction in Europe was reached during 1955-1985. A quarter of the total number was built just in Spain, with an average rate of 15 reservoirs per year.
- During the same period, Greece, Finland, the Netherlands, Sweden and Iceland commissioned, on average, larger capacity reservoirs but in smaller numbers than Spain.

Geographical Distribution

There are approximately 500,000 water bodies of over 1 ha in Europe. The largest number of natural lakes occurs in the Northern region of Europe (Norway, Sweden, Finland) with around 55% of European lakes. It has been estimated that 9% of the surface of Finland and Sweden are covered by freshwater lakes. Significant numbers of lakes occur in Iceland, Ireland and Scotland. The largest lakes are located in the Nordic countries and in the Alpine area. The distribution of natural lakes and reservoirs shows that:

- reservoirs are located in regions with water supply problems or where flood control was necessary;
- natural lakes are found in the Nordic and Alpine Regions.

With the exception of Denmark, there is at least one major (>15m depth) reservoir in each European country. The number of major reservoirs in Europe is about 3 350.

The number of reservoirs in each country reflects several factors:
- geographic and climatic situation;
- national policies concerning the relative importance of large reservoirs in water management;
- national policies on the importance of hydropower for energy needs;
- availability of suitable dam sites;
- size, population and industries of the country.

Spain, France and Italy have the largest number of major reservoirs (>400 each). Nordic countries have reservoirs of larger capacity.

In Europe, most lakes are dimictic, typical for cool temperate climates. This means that the water layers overturn twice a year in spring and in autumn. There are also monomotic lakes (both cold and warm) with only one overturn per year. The frequency of overturn in lakes and reservoirs is very important because it determines the chemical exchange (O_2, PO_4, NO_4, nutrients) between the lake layers and often influences the oxygenation of the deepest layers.

Use and Functions

Lakes:

Natural lakes are an important resource for the human population living near the water body and are used for a variety of purposes: water supply, drinking water, irrigation, industry, commercial fisheries, transport, recreation (sports, fishing, tourism), protection of natural areas, disposal of wastewater effluents.

Lake ecosystems contain a large variety of habitats that control the extent of primary producton and biological activity: shelf area (calm and agitated), pelagic zone, euphotic zone, aphotic zone and benthic zone.

Reservoirs:

In general, dams are constructed when there is a need to compensate for spatial or temporal deficiencies in the natural water resource in relation to water demand, or a need to control excess water.

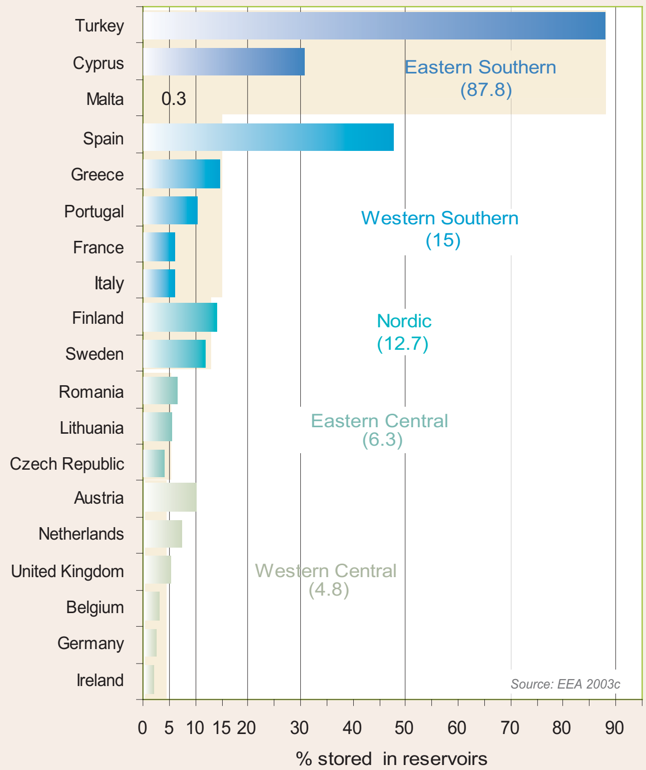
Dams are constructed for: hydropower generation, public water supply, industrial water supply, fisheries, irrigation, transport, recreation, flood control, low flow enhancement, and mining spoil storage.

The primary purpose reflects the country's water resources, demand and supply. For example, in Scandinavia, major reservoirs are mainly used for energy, while in the UK they are mainly used for water supply.

According to the EEA, the rate of growth in European hydropower and irrigation capacity increased significantly in the 1960s, whereas the total European capacity for public water supply increased at a steady rate.

The gross capacity of major reservoirs is defined as the total volume of water present in the reservoir at its normal maximum water level. The largest total gross capacity in Europe is held by the three Suova dams in Sweden containing 5 900 million m^3. Spain has the largest total major reservoir capacity: 849 major reservoirs representing over 50 000 million m^3.

Proportion of Total Freshwater Resources Stored in Reservoirs



Note: Figures in parenthesies refer to regional averages.

Eutrophic lakes and reservoirs are characterized by high concentrations of nutrients and high primary productivity. On the other hand, oligotrophic lakes and reservoirs have low nutrient concentrations.

Anthropic eutrophication is more rapid than natural eutrophication but can be slowed or reversed by controlling the causes.

Lake Leman in Switzerland had serious problems of eutrophication in the early 1980s, leading the Swiss and French governments to take measures to reduce phosphorus in effluents. In less than 20 years, the lake is now mesotrophic and the water quality is improving.

Many European countries have adopted different preventive measures to reduce the emissions of nutrients: increased wastewater treatment (reducing nutrients in effluents), reduction of phosphorus in detergents, and controls on fertiliser application. In general, these measures serve to improve water quality and decrease eutrophication.

The transparency of the water (expressed as Secchi depth) has improved in European lakes since 1980.

Morphology: relating to physical structure (depth, shoreline length, shape) of a lake.

Mesotrophic Lake: Lake characterized by moderate nutrient concentrations such as nitrogen and phosphorous and resulting significant productivity.

Environmental Problems

In general, lakes and reservoirs are more vulnerable and sensitive to pollution than rivers, seas and oceans. This is due to the fact that water is not frequently renewed and the morphology tends to lead to accumulation of pollution.

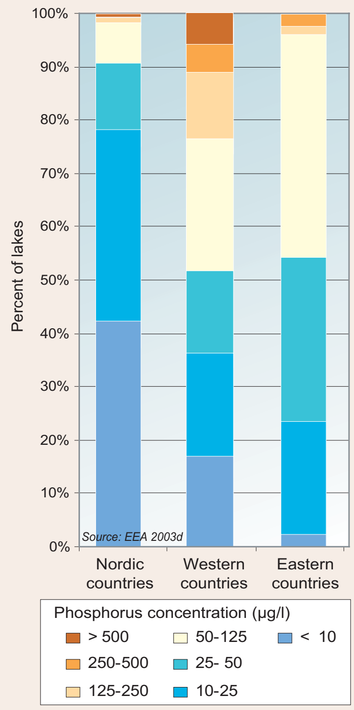
If a lake's water quality deteriorates, the flora and fauna may be affected and the water becomes unsuitable for certain uses.

Sedimentation can have repercutions on reservoir usage because it reduces storage capacity and may affect the water quality.

The construction of a reservoir may cause a number of impacts on the surrounding environment, including the dammed river. Construction and urbanisation near lakes may affect the lake ecosystem.

Eutrophication causes an accelerated growth of algae and plants, resulting in high turbidity. This is a nuisance to the recreational use of lakes for bathing, fishing and to the immediate visual impression. Large amounts of algae also affect the entire ecosystem. This disturbs the balance of organisms present in the water and water quality. These effects can render the lake or reservoir unsuitable for uses such as water supply and recreation.

Phosphorous Concentrations in Lakes by Region



Phosphorus concentrations are high in the western European countries and low in the Nordic countries (Iceland, Norway, Sweden, Finland). In the Nordic countries there are large areas with low population density and little human activity, and many lakes in these areas are under virtually no influence from human impact causing eutrophication. In western Europe the population density is higher and agriculture is more intensive.

Acidification is mainly due to "acid rain" that can affect pH levels of lakes and cause major ecological changes. The effects of acidification can be direct (effect of lowered pH on phytoplankton) and indirect (toxicological effects of leaching, etc.). The sensitivity of lakes reflects the subsurface geology, which determines the buffering capacity of lakes. Carbonate areas have a better buffering capacity than cristalline rocks and sandstone.

Nordic lakes have been especially affected by acidification. In Sweden, for example, this problem was so serious that the authorities took curative measures.

International reduction measures in Europe have resulted in a decrease in atmospheric sulphur emissions of up to 50%, reducing the concentration of sulphate in lakes. At some sites, invertebrate fauna have partly recovered.

Metal pollution can be an important source of local pollution, especially in regions that have mining and related industrial activities. Pollution sources include effluent discharges to water bodies in the catchment or directly into the lake, and also atmospheric deposition from air pollution resulting from urban, industrial or mining activities.

In Nordic lakes, high concentrations of metals have been observed as an effect of acidification. In Spain and Italy, a number of reservoirs show high concentration of heavy metals related to mining activites.

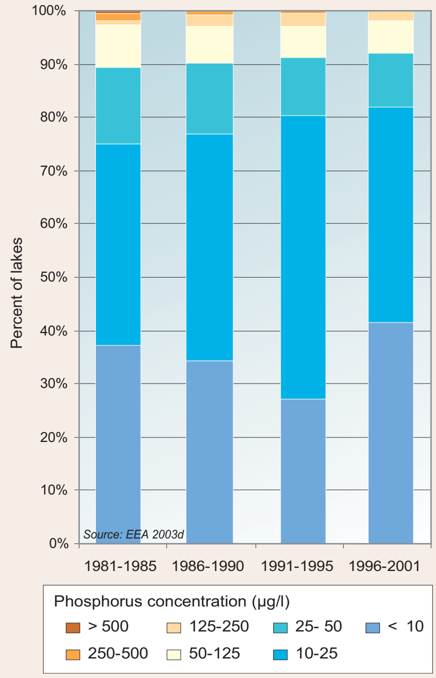
Bioaccumulation is the increase in the concentration of a chemical substance over time in a biological organism, compared to the chemical's concentration in the environment. Compounds which are chemically and biologically stable and persistent in the environment tend to accumulate in sediment, which can later function as a dispersion source. Many benthic organisms feed on sediment. The compounds reach higher concentrations as they accumulate in the food chain.

Generally, high concentrations of persistent organic pollutants (POPs) bioaccumulation are observed near large cities and industrialized areas. Aluminium, manganese, zinc, lead, mercury, and cadmium have also been found in high concentrations in benthic organisms, plants and fish.

Radioactivity in the European environment is mainly due to the impact of the Chernobyl accident. The level of radioactivity is directly related to the level of deposition, depending on the distance from Chernobyl, wind direction and rainfall. The peak in radioactivity in rivers occurred very soon after the accident, but declined rapidly due to dilution. However, in lakes this process was much slower. Sediments store radionuclides which tend to bioaccumulate. Fish were differently affected depending on the lake location and their position in the food chain.

Some lakes, such as in the Massif Central in France, may be affected by uranium mining activities, and/or can be situated in regions of naturally high radioactivity.

Change in Average Summer Concentration of Phosphorus



Eutrophication of European lakes is decreasing. The proportion of lakes and reservoirs with high phosphorus concentrations has decreased since 1980. However, there are still many lakes and reservoirs with high phosphorus levels. Many European lakes have been impacted by discharges of nutrients over several years. In most lakes, phosphorus is the limiting nutrient and the state of water quality is determined by the input of phosphorus. Urban wastewater has been a major source of pollution by phosphorus, but as purification has improved and many outlets have been diverted away from lakes, this source of pollution is gradually becoming less important. Agricultural sources, both from animal manure and from diffuse pollution by erosion and leaching, are also significant.

Environmental changes due to dams

The creation of a reservoir can affect the river basin's ecosystem. A dam can create a migration barrier for fish and mammals. Artifical flow regimes and variations in water quality are often observed to have important effects in the downstream ecosystem. Dams can also affect the people living around the new water-body: displacement of population, loss of valuable land (forestry, agriculture), replacement of a riverine habitat by a permanent water habitat, creation of a micro-climate and changes in land use and tourism.

The construction of dams creates a new water resource, and involves substantial modifications to the environment (during construction and exploitation). They can be perceived as beneficial or detrimental to the environment. In many European countries, an environmental impact assessment is now required before the construction of a dam in order to anticipate environmental problems.

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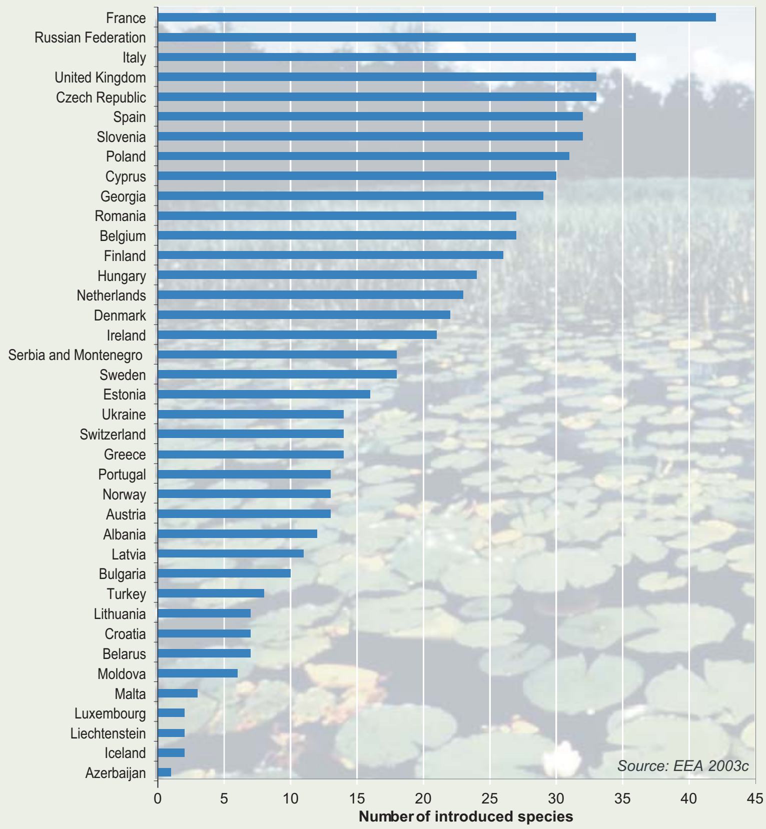
Freshwater Quality

Ecological Quality

Ecological quality reflects the effects of all chemical and physical pressures on the biological system.

The introduction of non-indigenous species has affected the ecological quality of Europe's water ecosystems. These invasions represent a growing problem due to the unexpected and harmful impacts they cause to the environment, the economy and human health. The introduction of non-indigenous species is ranked as the second most important threat to biodiversity by the World Conservation Union.

Number of Introduced Freshwater Fish Species



Introductions of non-indigenous species into rivers and lakes are due mainly to accidents or result from aquaculture. For example, Chinese mitten crabs (*Eriocheir sinensis*), originally from East Asia, can now be found from Finland to southern France. This is predominantly a freshwater species, but one that migrates to the sea to breed. They cause riverbank erosion and destabilise unprotected engineering earthworks, since they can burrow deeply into them. The crabs can also cross dry land to invade other river systems, where they may cause damage to the freshwater communities. In the UK, for example, they prey on the native crayfish, *Austropotambius pallipes*, which is already under threat from other non-native crayfish.

The majority of non-indigenous freshwater species listed for EEA countries have adverse ecological effects, including introduction of parasites, habitat alterations, genetic deterioration and trophic alterations.

The Water Framework directive (WFD), is fundamentally changing how water is monitored, assessed and managed in many European countries, as one of the key concepts it introduces to legislation is the ecological status.

Common fertilizers contain varying proportions of nitrogen, phosphorus and potassium

Nitrogen from excess fertiliser percolates through the soil and is detectable as elevated nitrate concentrations under aerobic conditions and as elevated ammonium concentrations under anaerobic conditions.

Point and non-point sources

The impact of water pollutants on the environment depends on the quantity of pollutants discharged and on their physico-chemical characteristics. A distinction can be made between point sources and non-point sources of pollution. While the former are fixed sources usually emitting high levels of pollutants, non-point sources are characterised by the emission of substances from mobile sources, by sources covering wide areas or by a large number of sources with low levels of pollution. For example, discharges of wastewater from industrial plants are point sources of nitrogen, whereas agriculture is a non-point source of nitrogen and pesticide pollution. Pollution from point sources is often easier to treat, while polluting emissions from non-point sources are difficult to estimate or to measure, and therefore to control.

Industrial processes produce contaminated wastewater that may be released into marine and fresh surface waters, either directly or following treatment. Contamination may persist for several decades.

Nutrients

~ Eutrophication

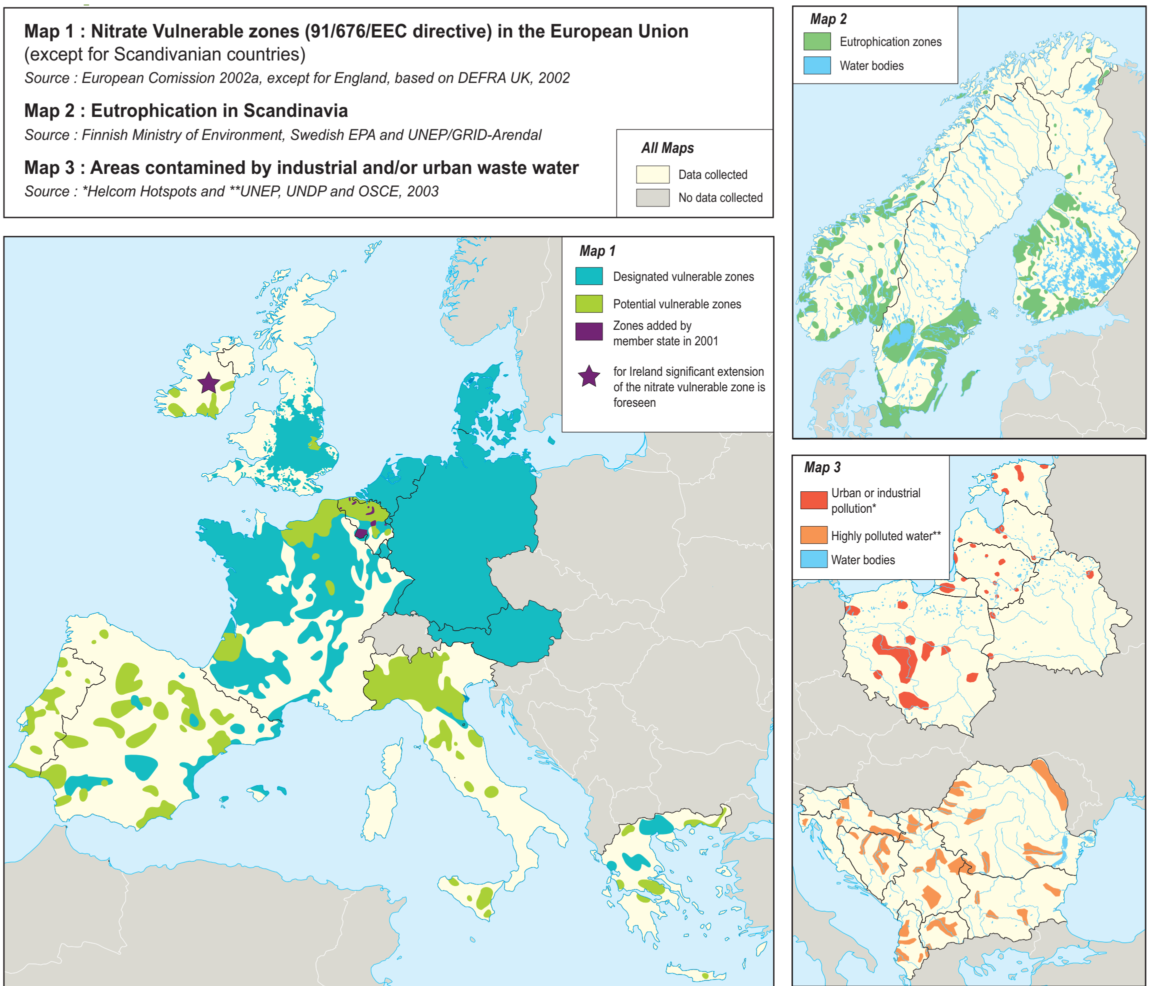
Eutrophication is a major threat to European surface waters. Although point sources such as sewage discharges may contribute significantly to nutrient enrichment in some regions, diffuse sources – particularly agriculture – are the major contributors. The use of fertilizers varies between countries, depending on the economic situation and predominant agricultural practices. In some countries, the proportion of water pollution caused by diffuse sources is steadily increasing.

The consequences of eutrophication are biodiversity loss, reduction in fish diversity, appearance of abnormal colours, smells and increased cost from drinking water treatment.

~ Nitrates

Nitrates stimulate eutrophication and can affect human health. Maximum admissible nitrate concentration limits have been set for drinking water. Directive 98/83/EC on the quality of drinking water specifies a limit of 50 mg/l, matching the

NITRATE VULNERABLE ZONES AND WATER POLLUTION HOT SPOTS



WHO guideline value. The directive also sets a guide level of 25 mg/l.

Water contamination by nitrates is one of the main problems associated with agricultural activities. This is mainly due to the fact that nitrates are highly soluble and migrate easily into groundwater. Overuse of fertilisers always increases the nitrate level in water.

There is a large nitrogen surplus in the agricultural soils of EU countries that can potentially pollute both surface and groundwaters. It is nonetheless difficult to establish a link between nitrogen supply and water pollution. The leaching of nitrates also depends on geological, climatic and biological factors, particularly in porous rock aquifers and in wet climates. Nitrates can be denitrified by microbes, however.

Nitrates and ammonium are the most common forms of nitrogen in rivers, with nitrates alone accounting for over 80% of total nitrogen. For the period 1992-1996, over 65% of the rivers in the European Union had average annual nitrate concentrations exceeding 1 mg N/litre. During the same period, concentrations of over 7.5 mg N/l were also found in approximately 15% of cases. The highest concentrations are in Northwest Europe, where agriculture is intensive.

Agriculture remains the largest source of nitrogen in water, but industrial wastewater also contains nitrogen, particularly water discharged by manufacturers of fertiliser or explosives, metal-processing industries and food-processing industries.

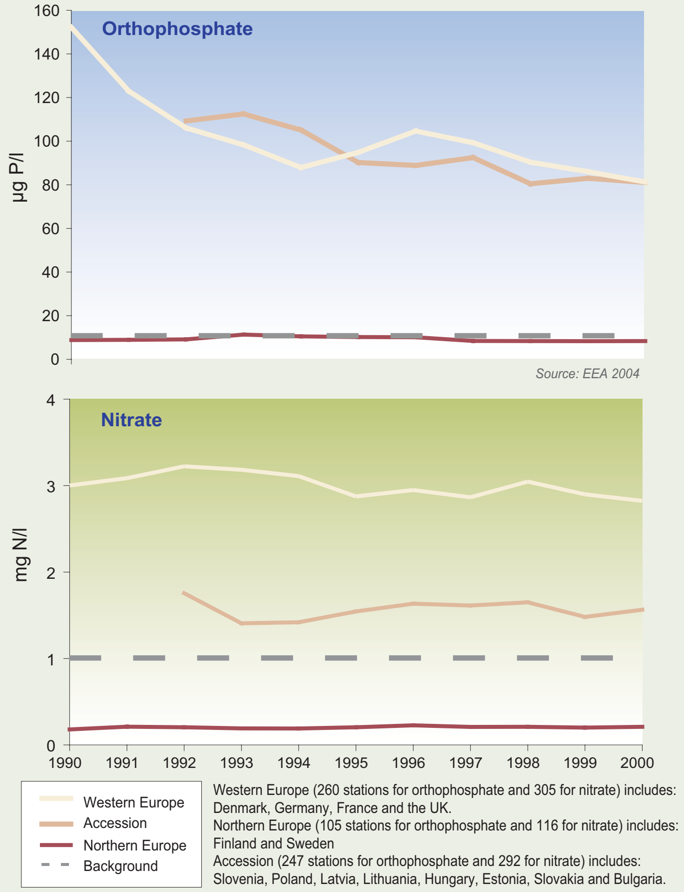
~ Phosphorus

Phosphorus is the main cause of eutrophication and of water quality deterioration. Even a minimal phosphorus content (some tens of μg/l) can constitute a dangerous pollutant. Thus, according to the UN ECE classification of surface water, water is considered fairly eutrophic at 25 μg/l. Much of the phosphorus is adsorbed into particles and suspended matter. As a result, soils act as phosphorus reservoirs restricting the impact of excess supplies.

Agriculture produces phosphorus pollution in the form of livestock effluents and mineral fertilisers (calcium or ammonium phosphates). The use of phosphorus, associated with the use of fertilisers, contributes to surface water pollution. However, the main source of phosphorus in Europe is not agriculture, but domestic and industrial wastewater. In France, for example, the phosphorus produced by agriculture accounts for only 23% of the total.

The reduction in phosphorus discharges in recent years is in large part the result of the major actions undertaken to process domestic wastewater and reduce industrial discharges.

Orthophosphate and Nitrate Concentrations in Selected European Rivers



Phosphorus concentrations in EU15 and accession country rivers generally declined during the 1990s, as a result of the reduction in loads of organic matter and phosphorus arising largely from wastewater treatment and industry.

Nitrate concentrations in rivers remained relatively stable throughout the 1990s and are highest in those Western European countries where agriculture is most intensive.

Current concentrations of orthophosphate and nitrate are still above what might be considered to be 'background' or natural levels except in Northern European countries.

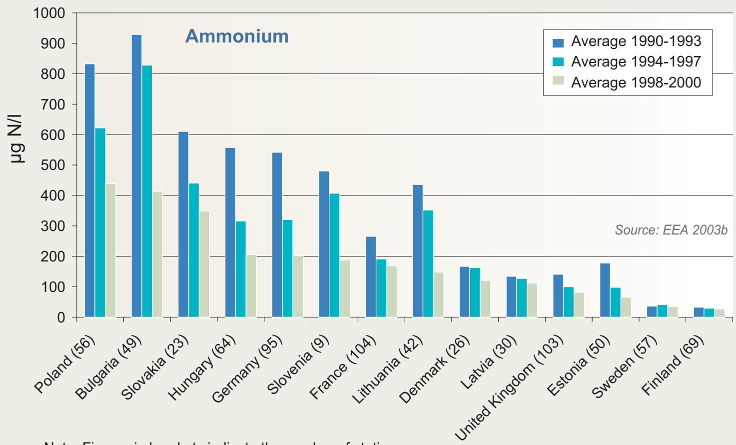
The agricultural sector is the starting point for a stringent phosphorus waste control policy, including, for example, measures designed to improve the storage of animal effluents and the implementation of environmentally friendlier cultivation practices.

~ Ammonium

Ammonium can be toxic to some aquatic fauna species under certain conditions. In clean and oxygenated water it is transformed into nitrates.

Ammonium levels have fallen in European rivers since 1990. The largest rivers show the highest concentrations, reflecting the fact that the main sources of ammonium – sewage treatment plants – are not usually located on small rivers. The decrease is directly attributable to improvements in these plants, although levels are still above the 'natural', or background level.

Average Ammonium Concentration by Country



Note: Figures in brackets indicate the number of stations

Ammonium concentrations are normally raised as a result of organic pollution, caused by discharges from wastewater treatment plants, industrial effluents and agricultural runoff.

Total ammonium concentrations decreased in the 1990s in both EU and EU Accession countries. However, levels are still above background concentrations which are around 15 µg/l (as N) and are much higher in the Accession Countries than in EU countries.

The reduction in organic pollution in EU countries during the 1990s was largely due to the Urban Waste Water Treatment Directive, which increased the level of treatment of waste water.

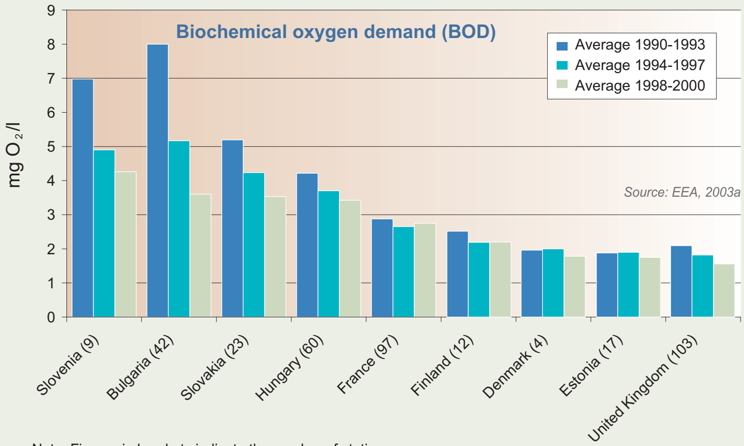
~ Organic Material

The levels of organic matter, measured as biochemical oxygen demand (BOD), and of ammonium are key indicators of the oxygen content in water bodies. Concentrations of these substances are raised as a result of organic pollution, caused by discharges from wastewater treatment plants, industrial effluents and agricultural run-off. High BOD indicates poor chemical and biological quality of river water and may reduce the aquatic biodiversity and microbiological quality.

Organic matter discharged from urban wastewater treatment plants has decreased in Denmark, Finland, the Netherlands and the UK. Organic matter discharged from point sources in the EU accession countries decreased dramatically in the 1990s. This may be partly due to the deep economic recession that occurred early in that decade.

Several types of industry that discharged large amounts of organic matter in the 1970s and 1980s, have since markedly reduced their discharges. This is because these industries have become cleaner. Production has often increased whilst pollution has declined. For example, discharges of organic matter from the European pulp and paper industry have declined as more mills now have secondary treatment of their effluents.

Average BOD Concentrations by Country



Note: Figures in brackets indicate the number of stations.
Data are for BOD5 for all stations except for Finland and Estonia which are for BOD7

BOD is a measure of how much dissolved oxygen is being consumed as microbes break down organic matter. A high demand can indicate that levels of dissolved oxygen are falling, with potentially dangerous implications for the river's biodiversity. High BOD is usually the result of organic pollution, caused by discharges from wastewater treatment plants, industrial effluents and agricultural run-off (high nitrate levels). A decrease in BOD in rivers illustrates general improvements in river water quality in terms of the chemical and microbiological properties of the river.

Improvements in wastewater management led to the fall in biochemical oxygen demand in rivers during the early 1990s. However, levels started increasing recently in the smallest rivers.

■ Hazardous Substances

~Pesticides

Pesticides products can have undesirable side effects on man and the environment. Pesticide residues (insecticides, weedkillers, fungicides, etc.) are found in water, soil, air and food. Owing to their high solubility, pesticides are readily transported by run-off and drainage water, or infiltrate into groundwater.

Monitoring of pesticide residues in water is complex and costly. It is impossible at present to assess the presence and scope of the residues of numerous pesticides likely to have adverse effects on health. The pesticides most frequently detected in water analyses are atrazine, simazine and bentazone - all three substances being broad-spectrum weedkillers used not only in agriculture, but also in industry and households. A considerable proportion of residues from plant-care products comes from the industrial production of these products, as well as from pesticide use by railway companies, road-maintenance/conservation services, private individuals and local communities.

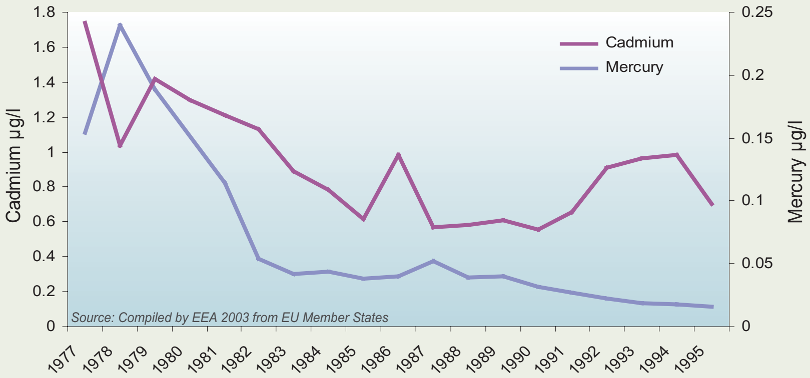
The EU Directive on the quality of drinking water has set the maximum admissible concentrations of each substance at 0.1 µg/l, and the total concentration of all pesticides at 0.5 µg/l. This Directive sets threshold values at 0.03 µg/l for the most toxic substances. The WHO threshold values for concentrations of pesticides in drinking water, based on toxicological considerations, are less strict than the maximum concentrations allowed by EU.

~Heavy Metals

Humans have been releasing metals into the environment in damaging quantities for the last two centuries. Aquatic ecosystems are particularly sensitive to such pollution since their food chains generally contain more trophic levels than terrestrial ecosystems and so bioaccumulation is enhanced.

In the EU, the concentrations of heavy metals regulated by the Discharges of Dangerous Substances Directive are decreasing in some rivers - where data series are available.

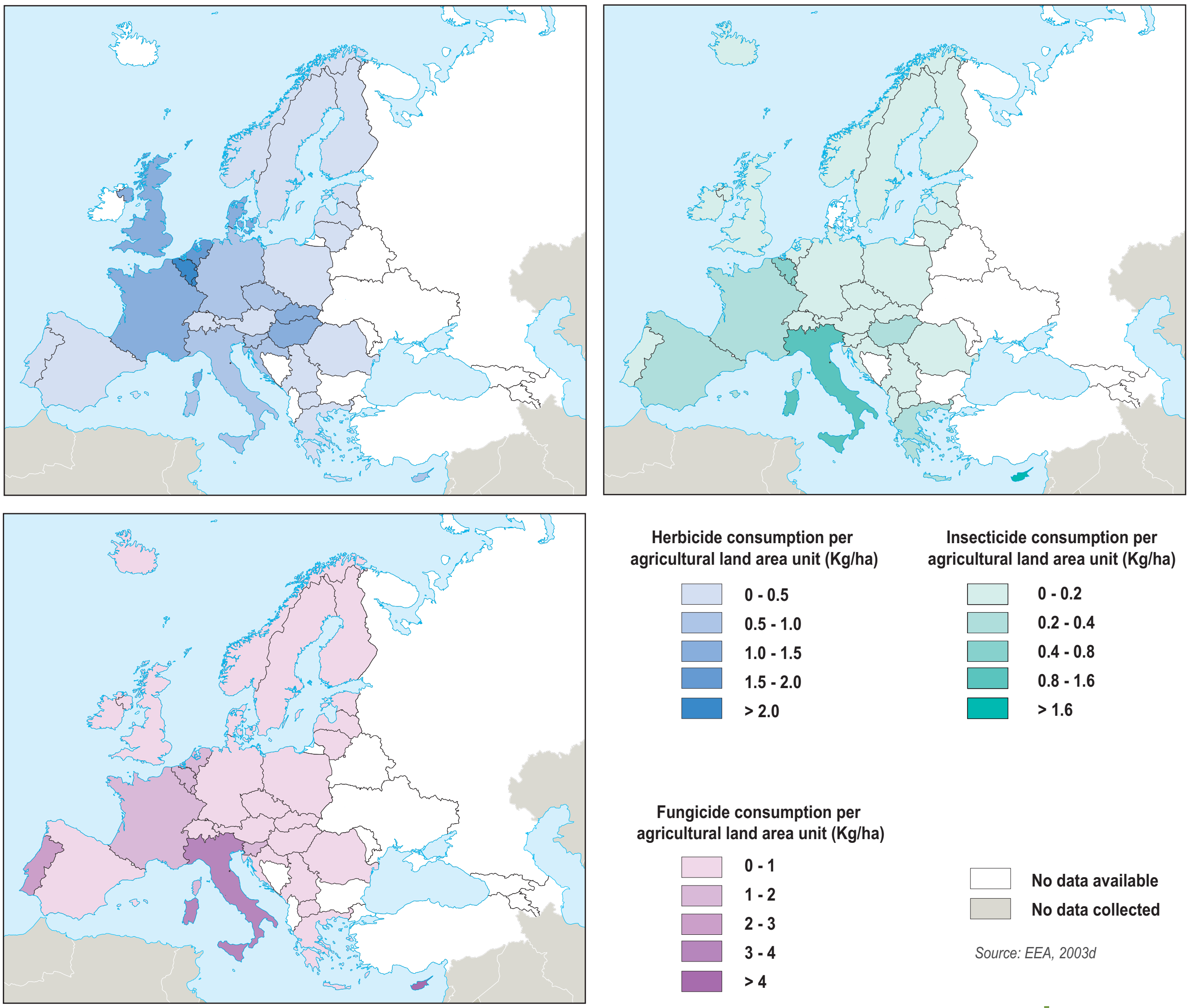
Cadmium and Mercury Concentrations for Selected Rivers



The EU environmental quality standards for cadmium and mercury are 5 µg/l and 1 µg/l as annual averages, respectively.
Cadmium data from Belgium, Germany, Ireland, Luxembourg, Netherlands, UK.
Mercury data from Belgium, France, Germany, Ireland, Netherlands, UK.
In less polluted areas in e.g. Nordic countries concentrations of cadmium and mercury are only 10 and 1% of these values.

Concentrations of cadmium and mercury have decreased in EU rivers since the late 1970s, reflecting the success of measures to eliminate pollution by these two substances.

PESTICIDES IN EUROPE



Wastewater Treatment

Wastewater in Europe

Wastewater from households and industry represents a significant pressure on the water environment, as it contains organic matter and nutrients, and occasionally hazardous substances.

The past decades have seen significant progress in treating the sewage and industrial wastes being pumped into Europe's river systems, resulting in lower levels of most pollutants and a significant improvement in water quality.

Wastewater Treatment Levels

The level of treatment of wastewater before discharge will affect the impact it has on the aquatic ecosystem. EU countries must implement directives such as the Urban Waste Water Treatment Directive, which prescribes the level of treatment required before discharge.

The levels of wastewater treatment in Europe have improved significantly since the 1970s. Markedly lower discharge of organic matter and nutrients are now discharged to water.

In Northern and Western Europe, most of the population is now connected to wastewater treatment plants. Many have tertiary treatments, which efficiently remove nutrients and organic matter.

The percentage of the population connected to wastewater treatment is still relatively low in Central and Eastern Europe, although it is increasing. In the EECCA region there is a very low level of treatment of wastewater in terms of population connected to sewage plants, treatment levels applied, and the operational efficiency of the existing treatment plants.

Southern countries and the EU accession countries only have half of their population connected to wastewater treatment plants. Some 30 to 40% of the population is connected to secondary or tertiary treatment.

Primary, Secondary and Tertiary Wastewater Treatments

Wastewater treatment can be made up of roughly three (consecutive) steps and a preliminary process called pre-treatment.

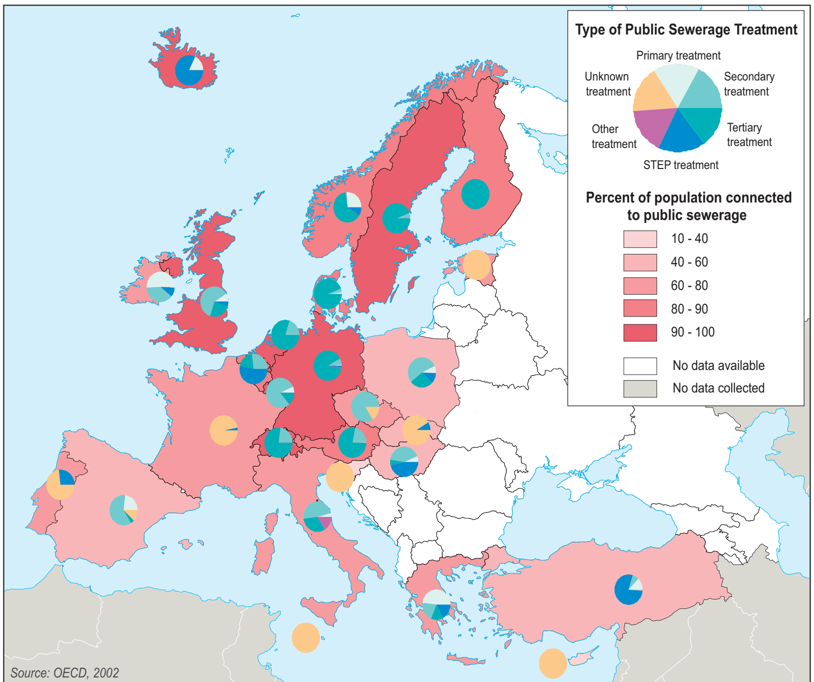
Pre-treatment is the removal of stones, sand and fat/grease using mechanical processes such as screening, settlement or flotation.

Primary treatment is the removal of suspended solids by passing waste water through settlement or flotation tanks.

Secondary treatment is a biological treatment: waste water passes through tanks where bacteria eat pollutants and transform them into sludge.

Tertiary, more advanced, treatment involves nutrient removal or disinfection by means of chlorination, ultraviolet (UV) radiation or ozone treatment.

PUBLIC SEWERAGE TREATMENT IN EUROPE



Urban Wastewater Directive

Europe's Urban Wastewater Treatment Directive)detailed page 85) has resulted in significant improvements in urban plant processing capacity, with advanced wastewater treatment becoming more common.

The Directive is resulting in increased treatment capacity in all EU countries except Sweden, Finland and the Netherlands, where it was already sufficient. The largest increase is expected to occur in Southern Europe and Ireland.

The Directive has important deadlines. By 30 June 1993, the Directive had to be transposed into national law. Many EU Member States were late in transposing the directive, the last being Italy in 1999. Member States were also required to identify sensitive areas at the latest by 31 December 1993.

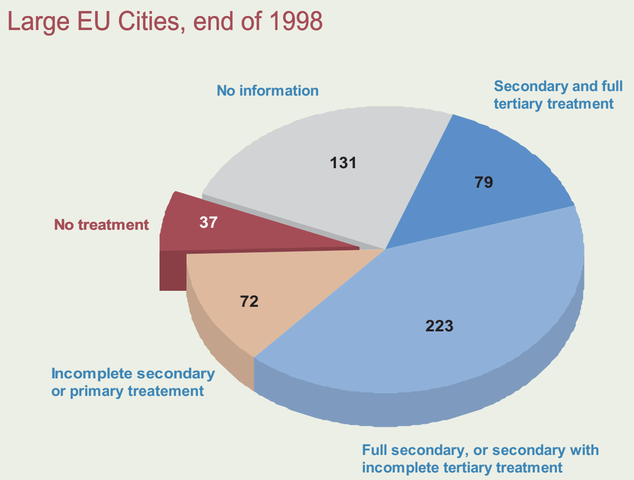
By 31 December 1998, Member States were required to ensure that wastewater treatment facilities with stringent (tertiary) treatment were available for all agglomerations with a population greater than 10 000 and where the effluent was being discharged into a sensitive area. Only two EU countries were close to conforming to this requirement for their large agglomerations, and eight countries were far from conformity. Many large cities did not have a sufficient standard of treatment to meet the objectives of the Directive.

All discharges of industrial wastewater into collecting systems and treatment plants are subject to regulation or specific authorization.

UNEP/WHO/WSSCC/UN-HABITAT Guidelines on Municipal Wastewater Management outlining global consensus on innovative approaches in municipal wastewater management

1. Secure political commitment and domestic financial resources as absolute prerequisites for appropriate wastewater management.
2. Create an enabling environment for sustainable solutions at both national and local levels.
3. Develop integrated and demand-driven management systems combining the collection and treatment of wastewater with drinking water supply and the provision of sanitation services.
4. Prevent pollution at the source; use and re-use water efficiently; and apply appropriate low cost technologies for wastewater treatment.
5. Make water users and polluters pay for services based on social equity and solidarity to reach cost-recovery.
6. Use time-bound targets and indicators for environmental integrity as well as for public health or economic welfare to make actions successful.
7. Implement measures step-by-step while exploring alternatives to reach long-term management goals.
8. Involve all stakeholders through partnership from the very beginning to secure their commitment.
9. Link the municipal wastewater sector to other economic sectors to ensure financial stability and sustainability.
10. Introduce innovative financial mechanisms, including private sector involvement.

Urban Wastewater Treatment in Large EU Cities in 1998



Source: European Commission, 2002b

Today

Milan, with a population of 2.7 million, discharges its untreated wastewater into the Lambro-Olona river, a tributary of the River Po. The Po empties into the Adriatic sea, which suffers from eutrophication along its coastline.
Three wastewater treatment plants are currently under construction to serve Milan, but are not due for completion until 2005.

Brussels (1.1 million inhab.) utilizes a station with capacity of 350 000 inhabitant equivalents inaugurated in 2000.
A new station with capacity of 1 100 000 inhabitant equivalents will be operational in 2006.

Porto (260 000 inhabitants) currently has 36% of its population connected to wastewater treatment plants.

Sources: INE; ISTAT, 2004

By the end of 1998 many of the 527 cities with population equivalents of greater than 150 000 did not have a sufficient standard of treatment meet the objectives of the UWWT Directive. 37 Agglomerations had no treatment at all, including Brussels, Milan and Porto, while a total of 72 agglomerations were discharging a large part of their effluents untreated or had a clearly insufficient level of treatment in place, including Aberdeen, Athens, Barcelona, Dublin, Liege, Marseille and Florence.
Since 1998 plans have been put into place to improve the situation in those cities with no treatment and incomplete treatment.

Water-related Diseases

Waterborne Diseases

In the pan-European region, 120 million people do not have access to safe drinking water, and even more have no access to sanitation. The resulting waterborne diseases are diarrhoeal diseases, hepatitis A and typhoid fever. The chemical composition of water may also have significant impacts on human health.

New and emerging pathogens, such as *Giardia*, *Cryptosporidium* and chemicals, pose additional challenges in the short-term, while extreme weather events, such as floods and increased water scarcity, pose challenges for the mid-term future.

Although high water sanitation standards have been reached in some countries, outbreaks of waterborne diseases continue to occur across Europe, and minor supply problems are encountered in all countries. The immediate area of public health concern is microbial contamination, which can affect large numbers of people. The standard of treatment and disinfection of drinking-water is inconsistent across Europe, and is often insufficient in countries where economic and political changes have led to infrastructural deterioration. Increased outbreaks of waterborne diseases have occurred in areas that have experienced recent breakdowns of infrastructure, resulting in discontinuous supply.

Individual wells are vulnerable to contamination from adjacent sewage drains. This is considered to have caused between two and 10 outbreaks of disease in small communities each year in Sweden.

Numerous chemicals are found throughout the aquatic environment, but evidence of effects on human health, except for effects arising from accidental releases, are often difficult to obtain. Problems of significant chemical contamination are often localized and may be influenced by geology or anthropogenic contamination. Concern about the effect of agriculture on the quality of water resources is often related to diffuse sources – contamination by agricultural chemicals, nutrients and microbial pathogens in particular.

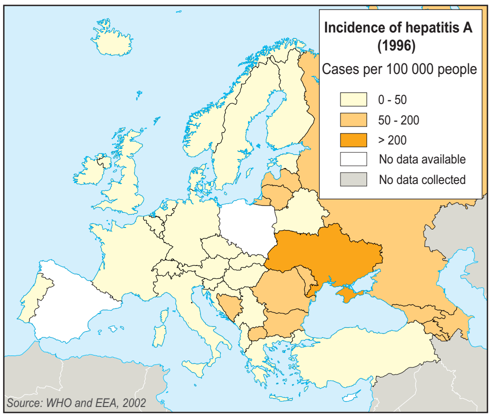
Bathing Waters

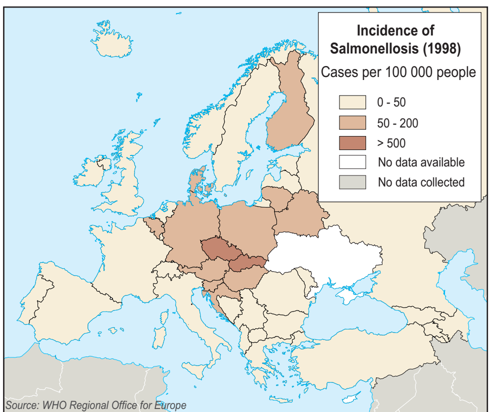
Considerable evidence has linked the quality of bathing water with minor illnesses. The use of water for recreational activities is economically linked to the tourism industry, and therefore the quality of such water is of considerable importance to tourism-dependent communities.

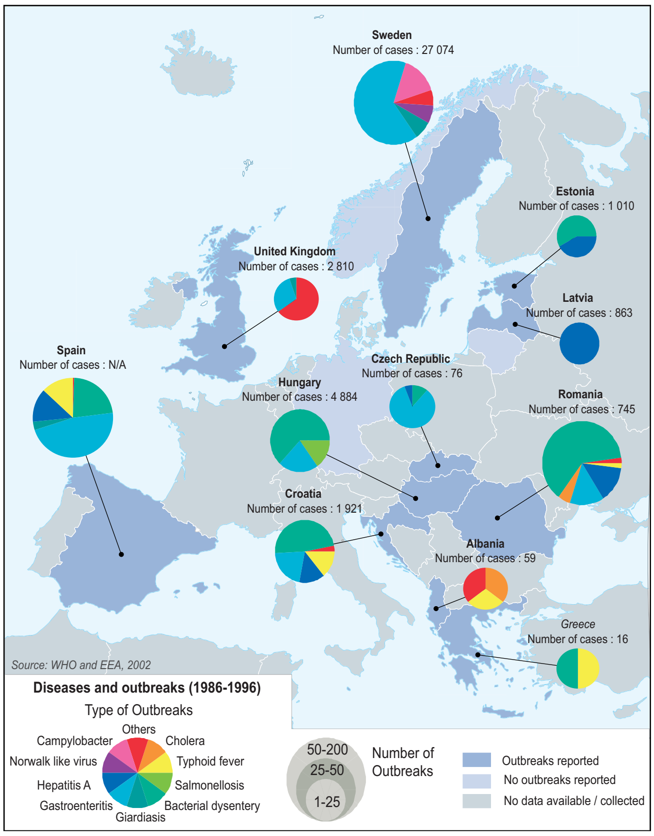
Drinking Water

An adequate quantity of water is of primary importance to public health, since diseases are more easily transferred directly from person-to-person or via contaminated food when poor hygienic practices occur.

WATER-RELATED DISEASES IN EUROPE



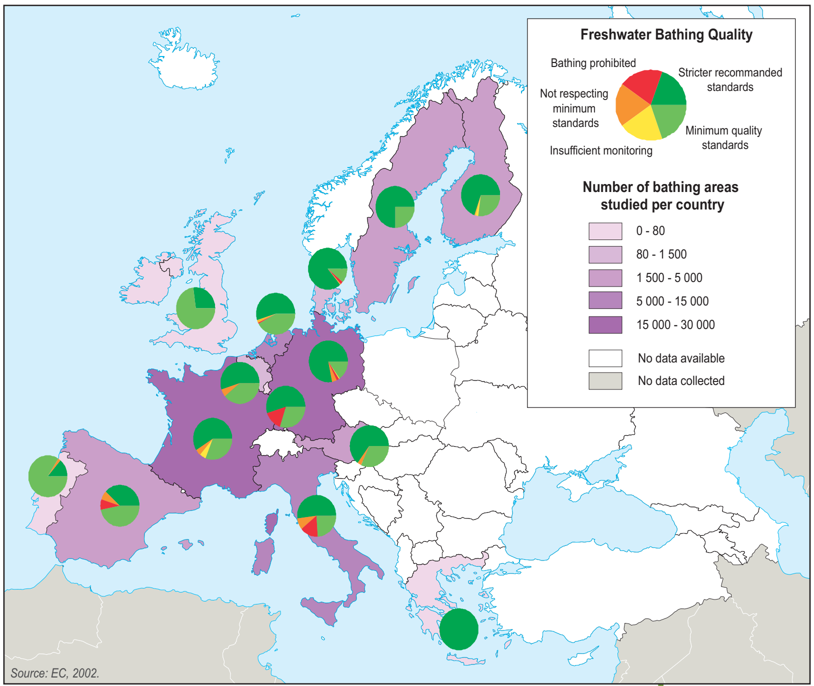




A number of serious diseases can be spread via contaminated drinking water, such as cholera and typhoid fever, as well as common enteric diseases such as gastroenteritis. A supply containing high levels of chemical contaminants may also significantly affect the health of a whole community.

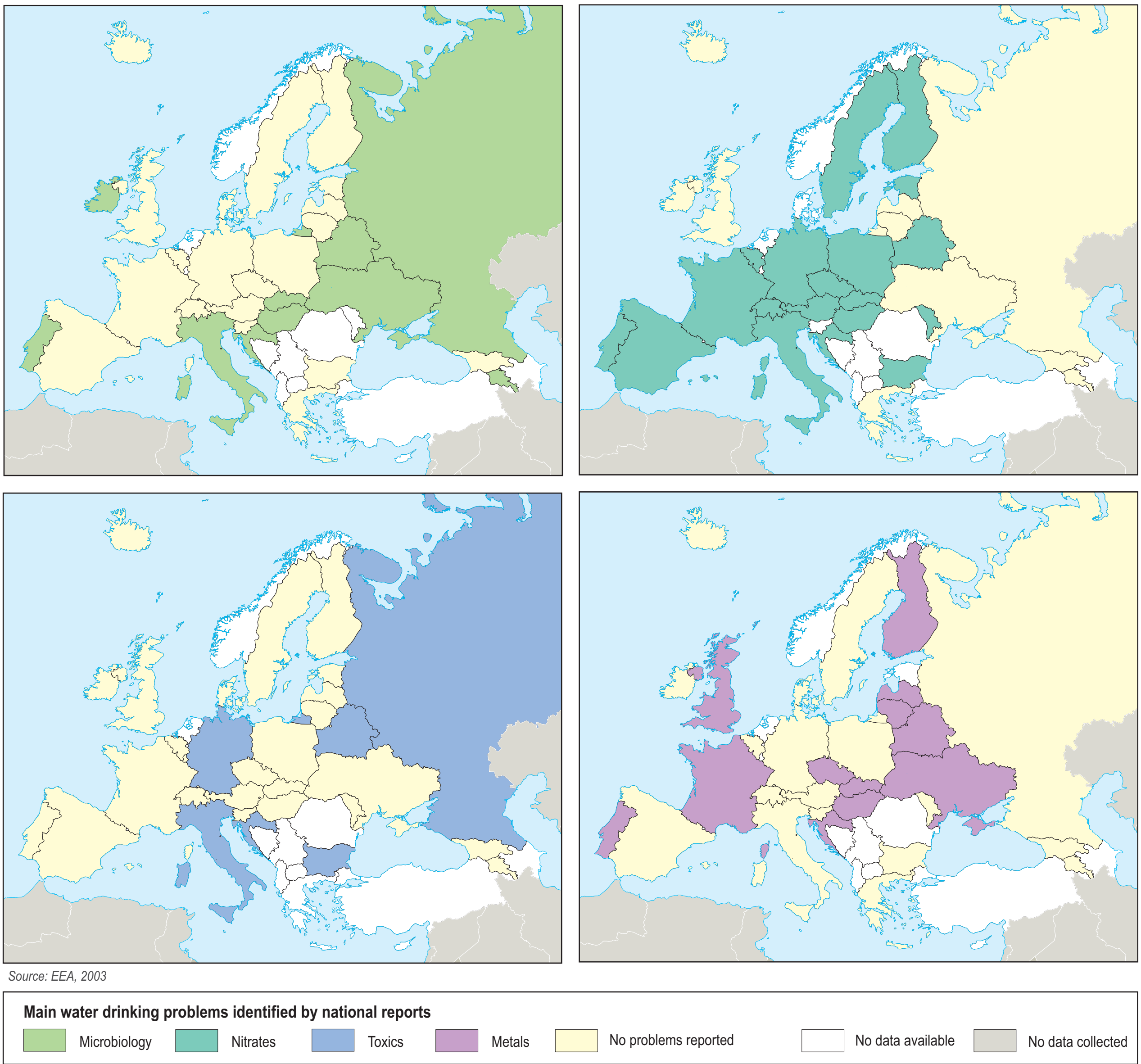
Water quality has been evaluated for the following five relevant parameters : total coliforms, faecal coliforms, mineral oils, surface-active substances and phenols. The charts on the map show the proportion from the highest bathing quality (dark green), that complies with stricter recommended values for the first two parameters, to the poorest bathing quality (red), where bathing is prohibited for the duration of the bathing season.

FRESHWATER BATHING QUALITY IN EU COUNTRIES



Enteric: of or relating to the small intestine.

DRINKING WATER QUALITY



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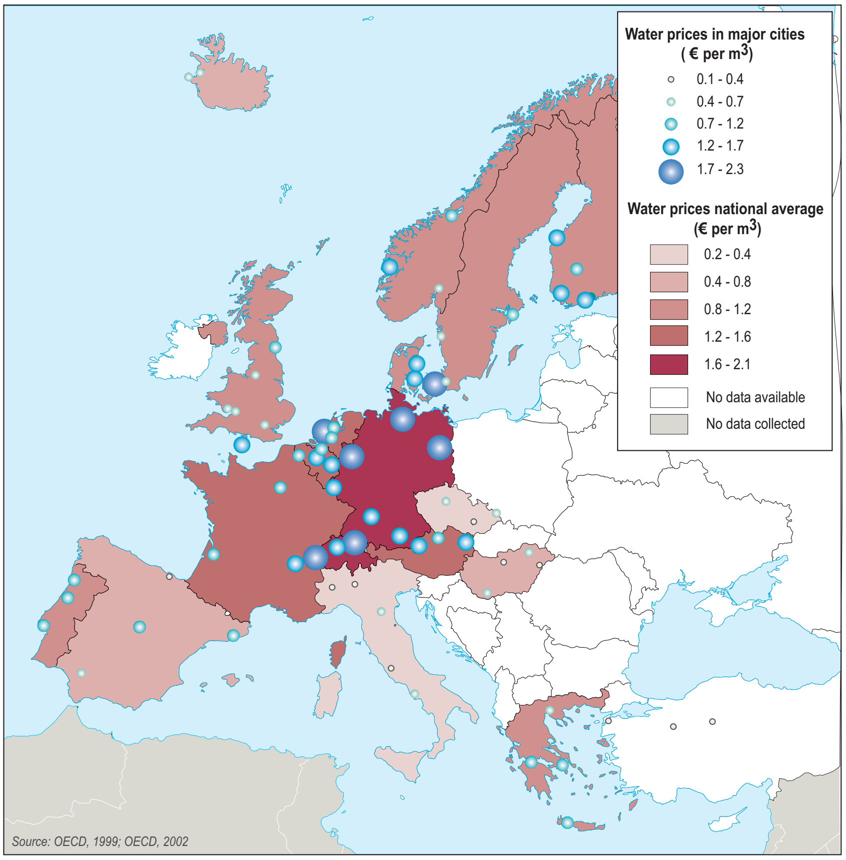
Freshwater Consumption

Water a Public Good?

The roles of government and especially the private sector in water management are being radically reappraised. The EU water framework directive requires EU Member States to ensure, by 2010, that water-pricing policies provide adequate incentives to use water resources efficiently and to recover the true costs of water services in an equitable manner. Most countries are progressing towards water pricing systems. Investing in water supply and sanitation has produced benefits far greater than those directly related to the cost of treating water-related diseases.

WATER PRICES IN EUROPE



Data from 1998 for city water prices, and from 1996 for national average water prices

The privatisation of water supplies in some countries has resulted in an increase in the number of households disconnected from water supplies.

In the United Kingdom, for example, the number of domestic disconnections rose from 8 000 to over 21 000 between 1989 and 1992 following privatization of the water industry. Water has become an increasingly expensive commodity and where water meters have been introduced, those with lower incomes use less water.

While there has been a general trend towards higher water prices throughout Europe, water prices still vary considerably. Many of the capitals and major cities in Mediterranean countries have below average prices, as do cities in countries with abundant water supplies. In contrast, water prices are highest in northern and western European cities.

Water Supply

Public water supply

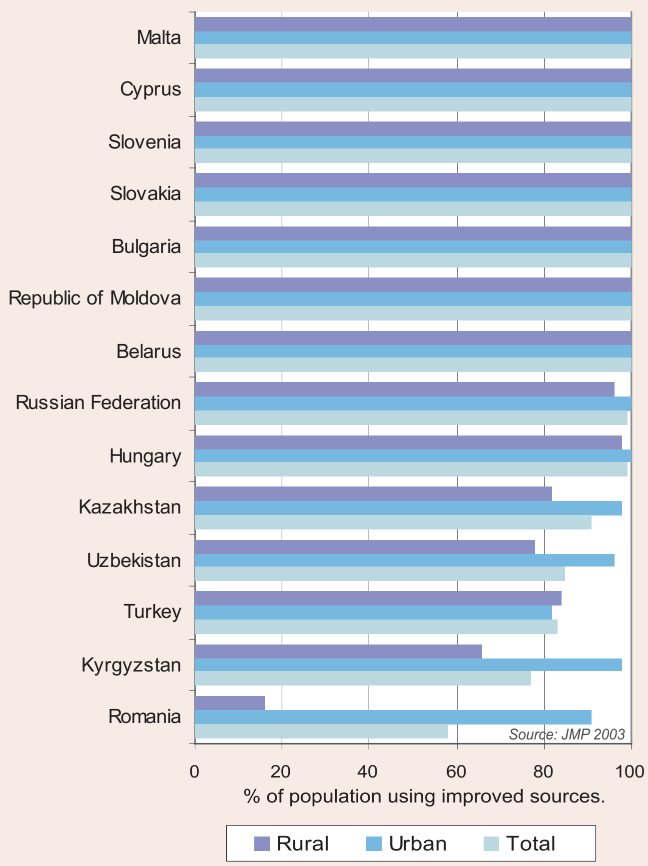
Public water supplies are used by households and industry. In Europe, they rely heavily on groundwater. In Southern European urban areas, water supply can be severe.

EECCA: Eastern Europe, Caucasus and Central Asia.

In many EECCA countries, the water supply networks are in poor condition due to faulty design and construction, as well as lack of maintenance and ineffective operation as a consequence of the economic decline in the past decade. Leakage is generally high and in many cases 30–50% of the water is lost.

Water supply is often interrupted in localities across the EECCA region. In many cities water is provided according to a schedule. The number of infrastructure accidents is growing. The water pressure in the system is not always sufficient due to old pipes; households living on higher floors often do not receive any water.

Percentage of Population Served with Improved Water Supply

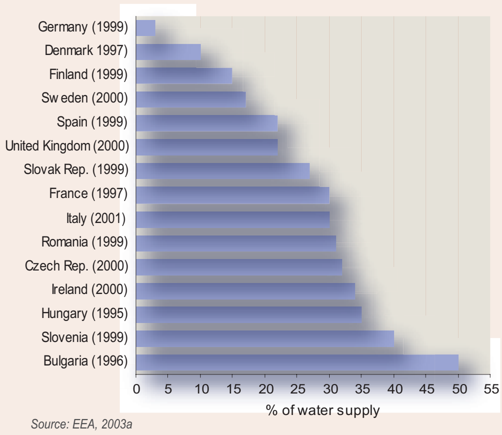


EECCA and EU Accession Countries (2000)

IMPROVED: Household connection, public standpipe, borehole, protected well, protected spring, rainfall collection.

NOT IMPROVED: Unprotected well, unprotected spring, river, pond, vendor-provided water, tanker truck.

Water Losses from Urban Water Networks



The extent of provision of piped drinking water supplies to households varies between urban and rural areas, with rural populations in Eastern Europe least well provided. Continuity of supply is also a problem in some areas. Inefficient use of water resulting from factors such as network leakage and inappropriate irrigation is a significant problem.

Irrigation

In many EU accession and applicant countries, only a minor part of the area equipped with irrigation structures is actually irrigated (e.g. 10-15% in Romania). In many eastern countries and in EECCA, the water distribution networks, pumps and sprinklers are badly maintained, leaks have increased and the pumping systems are highly energy-intensive.

Irrigation Techniques

Traditional flood irrigation is the most popular method. Water is pumped or brought to the fields and allowed to flow along the ground among the crops. This method is simple and cheap, and is widely used. The problem is that about one-half of the water used ends up not getting to the crops.

Spray irrigation requires machinery. Large scale spray irrigation systems are in use on large farms. These systems have a long pipe fixed at one end to the water source, such as a well. Water flows through the pipe and is shot out by a system of spray-guns.

For irrigating fruits and vegetables, drip irrigation is more efficient. Water is sent through plastic pipes with holes that are either laid along the rows of crops or even buried along their rootlines. Evaporation is low, and water is saved when compared to flood irrigation.

Water Privatisation in Europe

Water is recognised as being a public good, but in the last two decades water services have been under huge pressure for privatisation and market liberalisation.

In 1977, the first major United Nations conference on water resources, held in Argentina, stated in its final declaration that everyone has the right of access to drinking water in quantities and quality equal to their basic needs. This right is also mentioned in chapter 18 of Agenda 21. However, among the Dublin principles, derived at an International Conference on Water and the Environment in 1992, is the notion that, "water has an economic value in all its competing uses, and should be recognised as an economic good". A similar concept was adopted at the World Water Forum in The Hague in March 2000. This economic approach contrasts with other statements, like the Declaration of the Fourth P7 Summit, the summit of the world's seven poorest countries, in 2000, which called for a right to water, since water is the basis of sustenance and life.

The EU-Water Framework Directive of December 2000 considers water not to be "a commercial product like any other but, rather, a heritage, which must be protected, defended and treated as such." But the new EU water law also encourages the use of economic instruments to achieve environmental objectives. Article 9 of the Water Framework Directive obliges Member States to ensure, by 2010, that water-pricing policies recover the costs of water services and provide adequate incentives for the sustainable use of water resources to thereby contribute to the environmental objectives of this Directive.

For historical reasons, three private nationwide companies grew up in France over the last century, operating water concessions for a number of local authorities. This happened nowhere else in the world, and these three French companies – Suez-Lyonnaise, Vivendi, and SAUR – were the only water companies in the world which were private, used to operating across a number of different public authorities, and with the size and capital resources to take advantage of the fashion for privatization which started in the 1990s. Today, about 5 percent of the world's water is in private hands. The water sector thus has enormous potential for the few multinational corporations that dominate this market.

A report, Water Justice for All, released in March 2003 shows that water privatization has had negative impacts on communities in many countries and threatens to affect an increasing number of people. It reports global and local resistance to the control and commodification of water.

Civil society demands that access to drinking water be recognized as a universal human right, in order to ensure that everyone can benefit from water resources. At the same time, it raises its voice against leaving water exploitation in the hands of private corporations whose only concern is making a profit from such services. Signed in Lisbon, Valencia (Spain) in 1998, the Water Manifesto is intended to demonstrate symbolically, politically and technically the urgent need for a 'water revolution'.

New water supply projects are planned in Greece, Portugal, Spain, and Turkey and rehabilitation of the badly maintained irrigation structures in Eastern Europe and Central Asia may increase the demand for irrigation water.

Most crops only require water for a limited number of months that do not necessarily coincide with the seasonal distribution of precipitation and runoff. The natural water supply decreases in summer and autumn, having a negative effect on crops. As a result reservoirs have been constructed along watercourses.

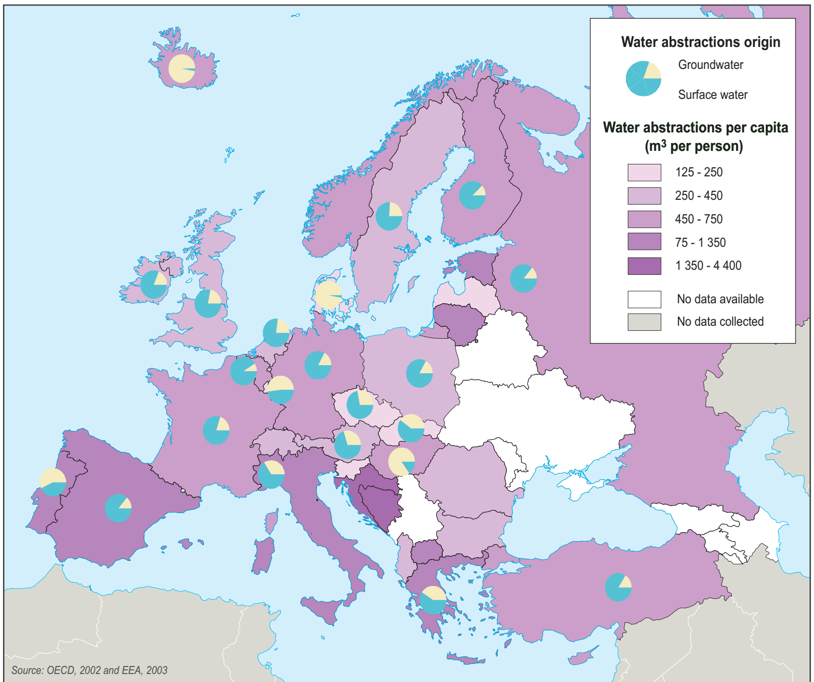
Storage Reservoirs

In Europe, approximately 13% of mean annual runoff is stored behind dams. The primary functions of the reservoirs are hydroelectric power production, public water supply and irrigation storage.

The countries with the highest percentage volume of stored water in relation to their annual renewable freshwater resources (over 20%) are Turkey, Spain and Cyprus. These countries use the highest proportion of their water resources for irrigation.

Spain and the United Kingdom have the largest number of reservoirs used for public water supply with consequent problems of evaporation.

WATER ABSTRACTIONS IN EUROPE



During the 1990s, there were decreases in water abstracted for agriculture, industry and urban use in central and western countries, and in water used for energy production in southern, western and central western countries.

Water Use in Europe

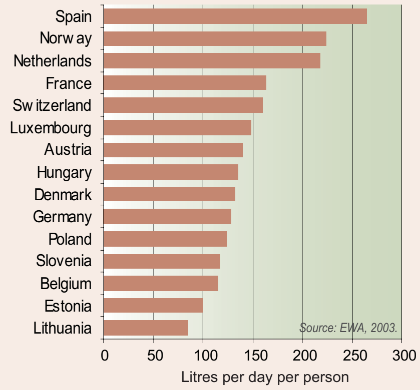
On average, 42% of total water abstraction in Europe is used for agriculture, 23% for industry, 18 % for urban use and 18% for energy production. Agriculture accounts for 50–70% of total water abstraction in southwestern European countries and EECCA. Cooling for electricity production is the dominant use in Central European countries.

The breakdown of water consumption between the various economic sectors varies considerably from one region to another, depending on natural conditions and economic and demographic structures. In France (64%), Germany (64%) and the Netherlands (55%), for example, most of the water abstracted is used to produce electricity. In Greece (88%), Spain (72%) and Portugal (59%), water is mostly used for irrigation. In Northern European countries such as Finland and Sweden, little water is used in agriculture. In contrast, cellulose and paper production, both highly intensive water-consuming industries, are significant activities and water is abstracted mainly for industrial purposes (66% and 28% respectively of total abstractions).

Domestic Use

The water required for drinking and other domestic purposes is a significant proportion of the total water demand. The proportion of water for abstracted urban use ranges from about 6.5% in Germany to more than 50% in the United Kingdom.

Household Consumption in Europe

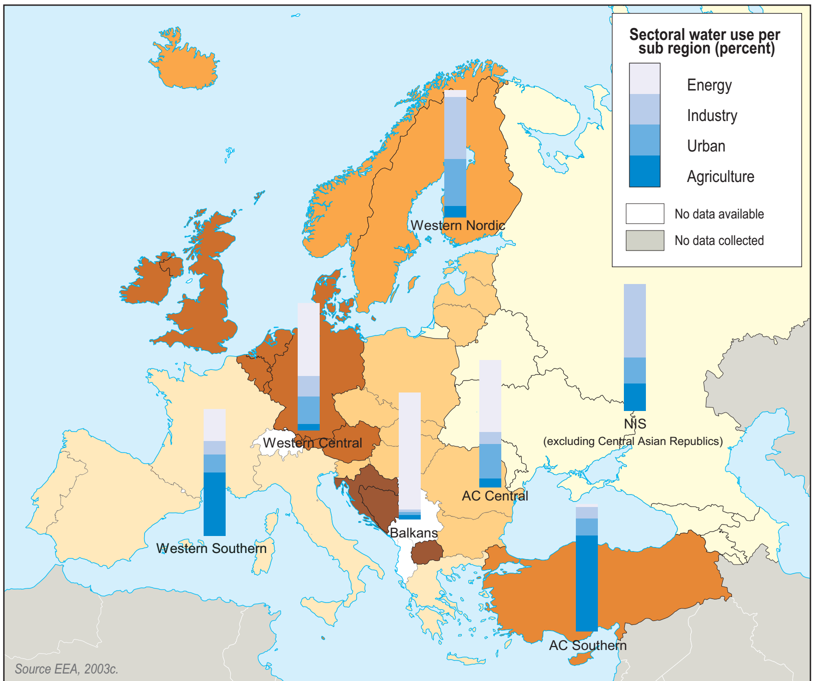


Population distribution and density are key factors influencing the availibility of water resources. Increased urbanization concentrates water demand and can lead to the over-exploitation of local water resources.

Higher standards of living are changing water demand patterns. This is reflected mainly in increased domestic water use, especially for personal hygiene. Most of the European population has indoor toilets, showers and/or baths for daily use. The result is that most of urban water consumption is for domestic use. Most of the water use in households is for toilet flushing (33%), bathing and showering (20-32%), and for washing machines and dishwashers (15%). The proportion of water used for cooking and drinking (3%) is minimal compared to the other uses.

Despite unreliable water supply, the level of domestic water consumption in EECCA is high. The leakage in pipes is very high and is often counted as consumption.

WATER USE BY SECTOR



Agriculture

One of the biggest pressures on water resources is agriculture and irrigation practices. Agriculture accounts for approximately 30% of total water abstraction and about 55% of water use in Europe.

The role of irrigation differs between countries and regions because of climatic conditions. In Southern Europe, it is an essential element of agricultural production, whereas in Central and Northern Europe, irrigation is generally used to improve production in dry summers.

The amount of water used for irrigation in Italy and Spain is about 10 times higher than in the central EU countries combined. France, Greece and Portugal each use about the same amount of water for irrigation as central EU countries.

Given high temperatures and high evapotranspiration, average water consumption per hectare is higher in Southern European countries such as Italy, Portugal, Spain and Greece.

Southern European countries account for 74 % of the total irrigated area in Europe. This is expected to increase further following new irrigation development in some countries. In the central EU Accession Countries, changes in the economic structure and land ownership, and the consequent collapse of large-scale irrigation and drainage systems and agriculture production have been the main drivers for agriculture changes over the past 10 years.

There has been a clear upward trend in irrigable land in the EU Member States. Across the 15 Member States, irrigable surfaces rose by 152 000 ha/year between 1961 and 1980, 146 000 ha/year between 1980 and 1990 and 123 000 ha/year between 1990 and 1996.

In Europe, the most intensively cultivated land area forms an arc extending from northern France to the Ukraine. Crop intensity is higher in basins in northern France, the Netherlands, and southern England, and in the sub-basins of the Oder, Vistula, Dnieper, and Don rivers in Eastern Europe. There are also intensively cropped areas in parts of the Danube basin and sub-basins close to the Black Sea, particularly around the Sea of Azov.

Industry

Industrial water demand is especially pertinent to urban areas with high populations, as industries are usually located in these areas. The amount of water used by industry and the proportion of total abstraction accounted for by industry vary greatly between countries. Abstraction for industrial purposes in Europe has been decreasing since 1980.

How much water do you use?

(data refers to swiss householder)

Activity	water use (l/day)
Toilet	47.7
Bath/shower	31.7
Washing machine	30.2
To cook, drink, to wash dishes (by hand)	24.3
Wash yourself and wash dresses (by hand)	20.7
Dishwashers	3.6
Other	3.8
TOTAL	**162**
Drinking and wash yourself and above all to produce your food (if you are a good farmer and you not waste your water)	2 000

The hidden water use

Commodity	water consumed (l)
1 litre of beer	7
1 litre of gasoline	10
1 cola	70
A single bath	200
1 kg of paper	320
1kg of bread	1 000
1 kg of potatoes	1 000
Television set	1 000
1 kg of meat	4 000 to 10 000
One pair of jeans	8 000

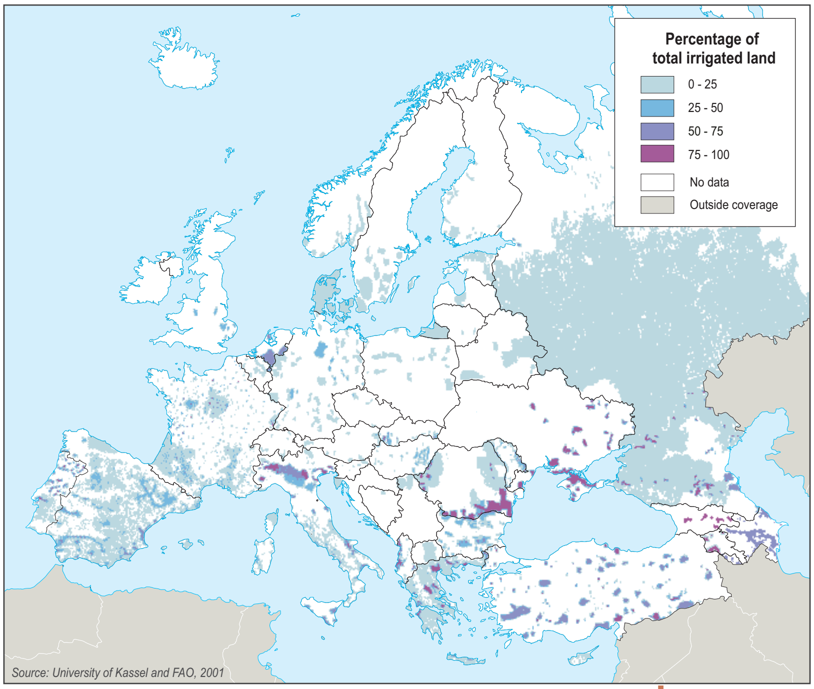
Source: OFEFP, 2003; FAO; Environment Canada

Water Use Efficiency

Water demand management measures are being introduced to promote water use efficiency in the major water sectors.

The reform of the EU Common Agricultural Policy should lead to planting of crops with lower water requirements. Introduction of more efficient irrigation systems should also reduce water use. However, improvements in water use efficiency in the agricultural sector generally lag behind those in the urban and industrial sectors.

PERCENTAGE OF TOTAL IRRIGATED LAND



Southern European countries have the largest area of irrigated land in Europe, and use around three times more water per unit of irrigated land than other parts of Europe.

Irrigated areas have increased during the past 15-20 years, especially in Southern Europe. An increase of about 7 % in the irrigated area in Southern Europe between 1990 and 1996 has been observed. There was particularly rapid growth in Greece during this period, although Italy and Spain have experienced the largest absolute growth.

Water Stress

Water Availability in Europe

Water resources are unevenly distributed in Europe. Average annual rainfall ranges from 3 000 mm in western Norway to 100-400 mm over much of Central Europe and less than 25 mm in central and southern Spain.

Many European countries have relatively little water available. Southern countries are particularly affected, with Malta having only 100 m^3 per capita per year (less than 5 000 m^3 is regarded as low; less than 1 000 m^3 is extremely low and is commonly used as a benchmark of water scarcity; and above 20 000 m^3 is considered high).

Heavily populated countries with moderate rainfall in Western Europe (Belgium, Denmark, United Kingdom) are also affected, as are those in Central Europe (Czech Republic, Poland). Water resources are unevenly distributed and declining in regions of the Russian Federation. Insufficient water resources are reported in southern Ukraine, the Republic of Moldova, the middle and lower reaches of the Volga River, the Caspian lowland, the southern parts of western Siberia, Kazakhstan and the Turkmenistan lowland. Only the Nordic countries, sparsely populated with high rainfall, have high water availability.

Excess of water abstraction over water use is especially prominent in the Central Asian republics, the Russian Federation and Ukraine.

Abstractions for different uses exert the most significant pressure on the quantity of freshwater resources.

The total water abstraction in Europe is about 353 km^3/year.

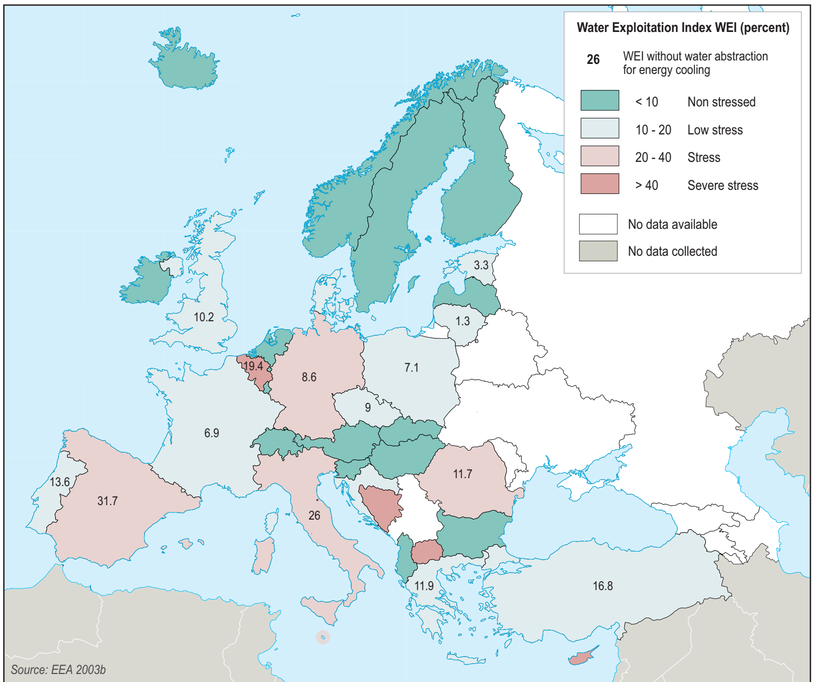
10 % of Europe's total freshwater resource is abstracted.

Drought

A drought is an extreme hydrological event, whereas aridity is restricted to regions with low rainfall and is a permanent feature of climate. Recent European droughts have emphasized that the hazard is not limited to semi-arid countries and may become a normal part of climate in many countries. Drought has a number of effects: loss of human lives (directly through thirst or indirectly through starvation or disease); loss of crops and animal stock; water supply problems, including shortages and deterioration of quality; increased pollution of freshwater ecosystems by concentration of pollutants; regional extinction of animal species by the loss of biotopes; forest fires; wetland degradation; desertification; effects on aquifers; and other environmental consequences.

In Europe, drought is causing significant ecological and economic impacts. Drying out of rivers threatens the ecological balance; grasslands are less productive; crops dry in the fields; and dry conditions favour higher occurrence and magnitude of forest fires. In other parts of the world, repetitive drought events are causing soil desiccation leading to desertification.

WATER EXPLOITATION INDEX



The Water Exploitation Index (WEI) in a country is the mean annual total demand for freshwater divided by the long-term average freshwater resources. It gives an indication of how the total water demand puts pressure on the water resource.

A total of 20 countries (50% of Europe's population) can be considered as non-stressed, lying mainly in Central and Northern Europe.

When not considering water abstraction (numbers in bold) for energy cooling, nine countries can considered as having low water stress (32% of Europe's population). These include, Belgium, Denmark and Romania and southern countries (Greece, Portugal and Turkey). Four countries (Cyprus, Italy, Malta and Spain) are considered to be water stressed (18% of Europe's population).

Desertification in Europe

Desertification is land degradation occurring in the arid, semiarid and dry sub-humid areas of the world. It has affected large areas in the Mediterranean basin and Russian Federation and is threatening even larger surfaces.

The vulnerability of land to severe degradation that leads to desertification is attributed to several factors, including: large moisture deficits, climatic variability with frequent extreme events, steep terrain, unfavourable geologic formations, disrupted climatic and vegetative periods, shallow soils and long periods of intensive human interference.

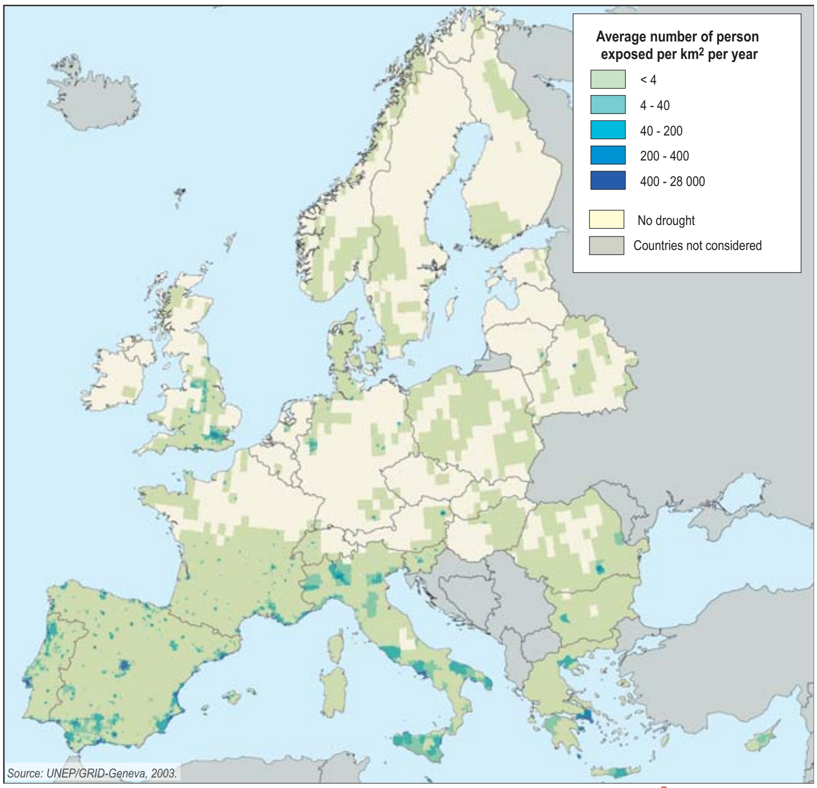
The heatwave that scorched Europe during the summer of 2003 and the ensuing forest fires made the affected regions more vulnerable to desertification

In Portugal, a total of 215 000 ha of land were devastated by fires in 2003, or 7% of Portugal's woodland. Already more than one-third of its land is at risk of desertification. In Spain, 31% of the land is under serious threat of desertification.

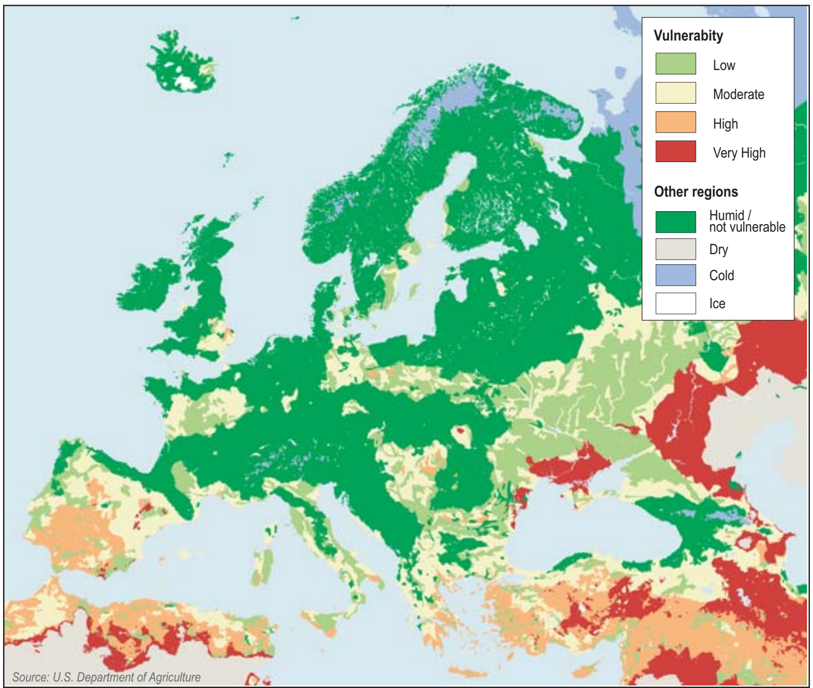
The Kalmyk Republic (comprising most of the Northern Caspian Depression) is the most arid region of the European part of the Russian Federation. Over 80% of its territory is now in the grip of desertification, and almost half is either severely or very severely affected. This is surpassed only by the deserts of Central Asia.

Among European countries, 44 countries are Parties to the United Nations Convention to Combat Desertification (UNCCD) and 22 countries are affected by desertification, land degradation and drought.

POPULATION EXPOSED TO DROUGHT EVENTS IN EUROPE



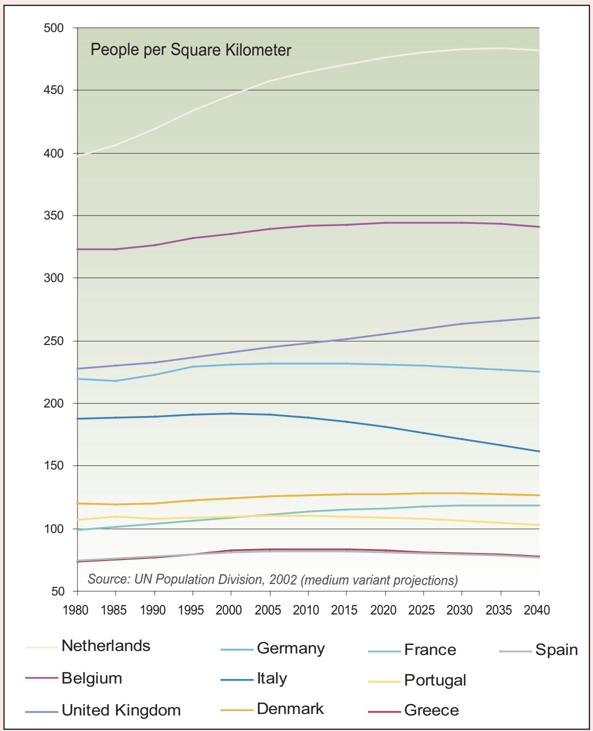
DESERTIFICATION VULNERABILITY



The Desertification Vulnerability map is based on a reclassification of the global soil climate map and global soil map.

Source: U.S. Department of Agriculture, Natural Resources Conservation Service, Soil Survey. Division, World Soil Resources, Washington, D.C. 2001.

Population Density in Nine EU Countries



The population of the EU15 currently exceeds 375 million, with positive growth rates in nearly all countries. The current trends, however, are not entirely clear. One long-range forecast based on Bulgaria, France, Greece, Hungary, Italy, the Netherlands and the United Kingdom predicts a decrease in population for the next three decades. Other projections show that the population is expected to increase for the next 15 years, with the total population in the current EU countries reaching about 390 million by 2010.

Tourism

In the Mediterranean Sea region, it was estimated in 1990 that 135 million tourists (international and domestic) stayed along the coasts, which represented more than half of the total tourism in all Mediterranean countries and doubled the coastal population. This figure rose to 187.5 million in 1997.

Tourism places a wide range of pressures on local environments. The impact on water quantity (total and peak) depends on water availability in relation to the timing and location of the water demand from tourism and on the capability of the water supply system to meet peak demands.

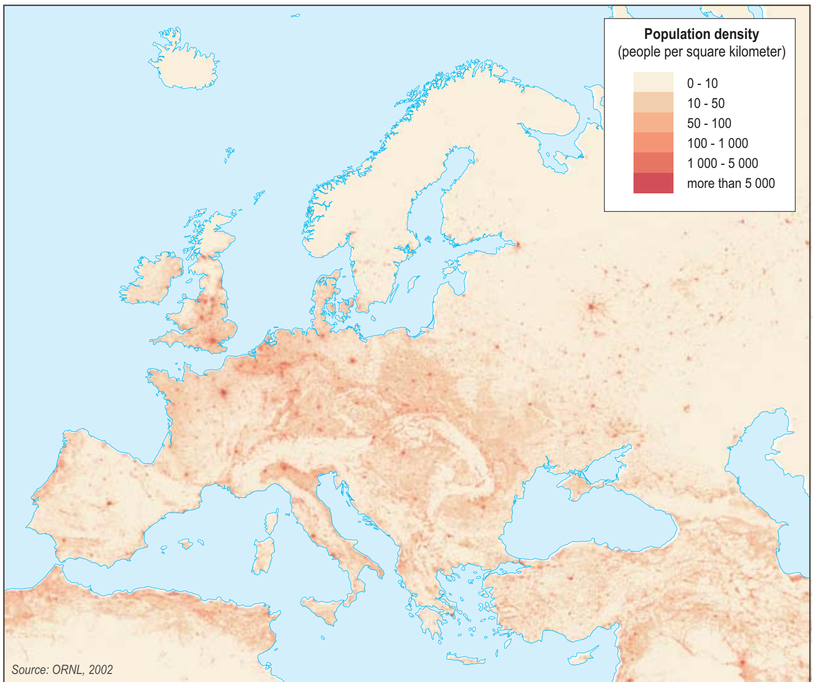
The intensity of the natural resources use by tourism can conflict with other needs, especially in regions where water resources are scarce in summer, and with other sectors of economic development such as agriculture and forestry. Uncontrolled tourism development, typical in the past, has led to a degradation of the quality of the environment, particularly in coastal and mountain zones.

Tourist water use is generally higher than water use by residents. A tourist consumes around 300 litres per day; European household consumption is around 150-200 litres. In addition, recreational activities such as swimming pools, golf, and aquatic sports contribute to put pressure on water resources.

Example: Majorca (consumption per day per capita):

Resident consumption rural areas	140 l
Resident consumption urban areas	250 l
Average tourist consumption	440 l
Luxury tourist consumption	880 l

POPULATION DENSITY IN EUROPE



Population Density

Population density determines the availability of water per person. Population density varies widely across Europe, from fewer than 10 inhabitants per km^2 in Iceland, the Russian Federation and some of the central Asian republics (Kazakhstan and Turkmenistan) to over 300 per km^2 in the Benelux countries and San Marino and over 1 000 per km^2 in Malta.

Water and Sanitation

Meeting Goals

In Europe and Central Asia, 120 million people do not have access to safe drinking water, and even more have no access to sanitation. The biggest challenge to meeting the environmental targets of the internationally agreed development goals, including those contained in the Millennium Declaration for the region is in water supply and sanitation. Despite official data showing that a large percentage of people have access to improved water supplies, there is a serious problem of water quality, which constitutes a major health hazard.

Drinking Water

The quality and the quantity of drinking water supply are important to public health, since direct transfer of diseases from person to person, or by contaminated food, is higher when poor hygiene practices result from insufficient water.

Many European countries have high quality drinking water supplies. However, treatment and disinfection are insufficient in some countries, particularly in those where economic/political changes have led to infrastructure deterioration. Installation of advanced treatment works is increasing in many countries, particularly in Western Europe.

Drinking water quality is particularly of concern in the EECCA countries. These countries have major problems with microbiological contamination of drinking water supplies. The percentage of samples exceeding microbiological standards in EECCA is between about 5 and 30%. This percentage is higher for non-centralized drinking water supplies, primarily in rural areas. At least half the population of the Russian Federation is estimated to be at risk from unclean water as a result of ageing infrastructure and the high cost of disinfectants.

EU countries also have problems with their drinking water and more than 10% of European Union citizens are potentially exposed to microbiological and other contaminants that exceed the maximum allowable concentrations. In Western Europe, as well as in other parts of the region, the overuse of groundwater resources for drinking water raises grave concerns. About 60% of the European cities with more than 100 000 inhabitants (or a total of 140 million people) are supplied with water from overexploited groundwater resources.

Recreation Water

Faecal pollution of recreational waters is one of the major hazards facing users, although microbial contamination from other sources as well as chemical and physical aspects also affect the suitability of water for recreation.

Millenium Development Goals Target 10:

Halve by 2015 the proportion of people without sustainable access to safe drinking water.

WSSD plan of implementation states: Halve, by the year 2015, the proportion of people who do not have access to basic sanitation.

Efforts are still needed to ensure that Europe's population is supplied with wholesome and clean drinking-water and has access to safe recreational water. These include measures to control demand and to prevent, contain and reduce contamination by improving water and sanitation management at the international, national and local levels.

Drinking Bottled Water

Bad tap water taste or quality, temporary tap water contamination, fitness objectives or safety purposes, are some of the reasons leading consumers to buy bottled water. The trend toward increasing consumption of bottled water is thus likely to continue in the coming years.

Bottled water quality is generally good, although it can suffer from the same contamination hazards as tap water. Negative environmental impacts of bottled water could be reduced by implementing simple solutions, e.g. re-using water bottles in adequate sanitary conditions on a local basis, rather than just recycling or re-manufacturing them into new products. Certification of local supplies under international brand names could reduce environmental impacts due to worldwide transportation of some bottled water brands.

It has even been proposed that, since tap water for drinking or cooking represents only a minor part of household consumption, it does not need to be of full drinking water quality. Tap water could be of lower quality, and replaced for drinking purposes by delivered purified water.

Bottled water should not be considered a sustainable alternative to tap water, as it is not exempt from ocasional contamination. Tap water is more energy-efficient as it is provided through underground pipes, compared to the fuel and energy needed for filling bottles and transport.

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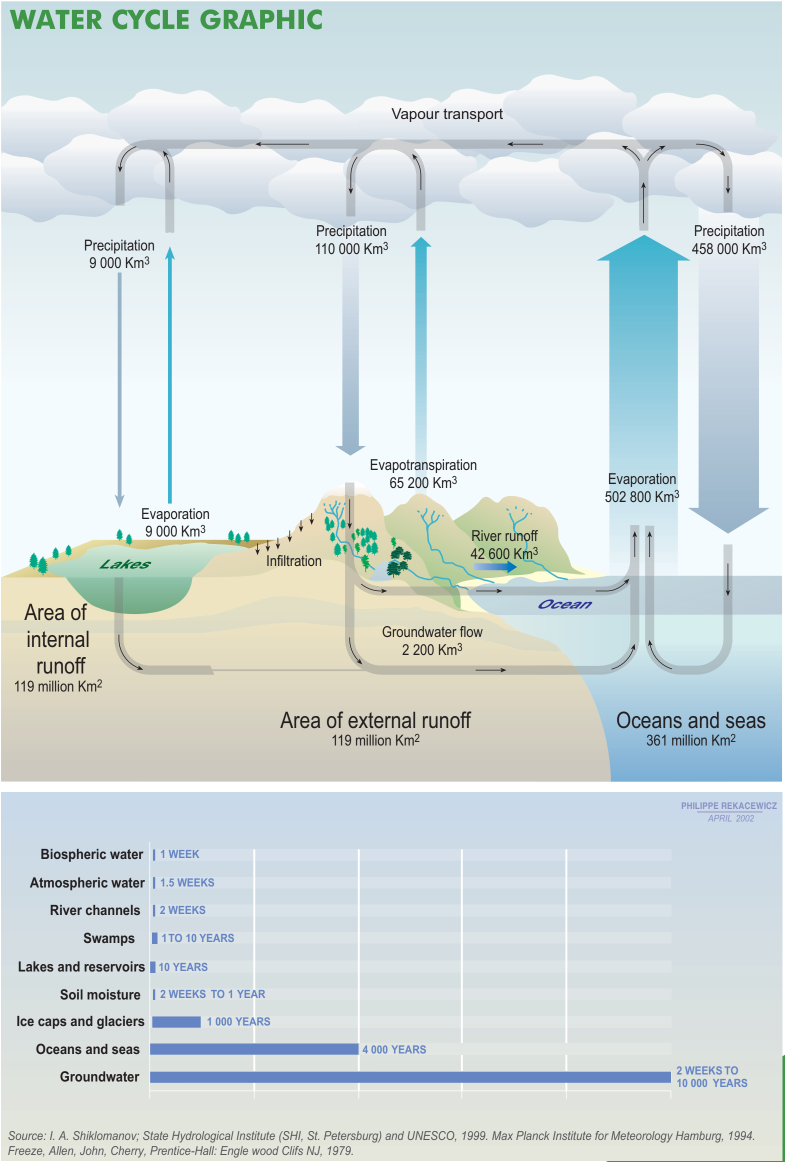
Freshwater Resources

The Water Cycle

Water is a vital component of the Earth ecosystems, redistributing itself through natural cycles, contributing to climate control and the hydrologic cycle. It ignores political boundaries, fluctuates in both space and time, and has multiple uses.



Graphic Source: UNEP, 2002. Vital Water Graphics - An Overview of the State of the World's Fresh and Marine Waters.

Freshwater resources are continuously renewed by the natural processes of the hydrological cycle. Water evaporates from the Earth's surface. Land, lakes, rivers and oceans send up a steady stream of water vapour; this spreads through the atmosphere before descending as precipitation. Approximately 65% of the precipitation falling on land returns to the atmosphere through evaporation and transpiration; the remainder, or runoff, recharges glaciers, aquifers, streams and lakes as it flows to the sea. This process repeats itself without ceasing.

Water distribution in Europe

On the continental scale, Europe appears to have abundant water resources. However, these resources are unevenly distributed, both between and within countries. Once population density is taken into account, the disequity in the distribution of water resources per inhabitant is striking.

Glossary

A

Agenda 21 - Global action plan adopted by the 1992 United Nations Conference on Environment and Development. Agenda 21 contains principles and recommendations aiming at sustainable development for the 21st century.

Aquifer - The underground layer of water-soaked sand and rock that acts as a water source for a well; described as artesian (confined) or water table (unconfined).

B

Base flow - The portion of stream flow that is not runoff and results from seepage of water from the ground into a channel slowly over time. The primary source of running water in a stream during dry weather.

Biochemical Oxygen Demand (BOD) - Amount of dissolved oxygen required by organisms for the aerobic decomposition of organic matter present in water.

Biosphere reserves - Established under UNESCO's Man and the Biosphere (MAB) programme, biosphere reserves are a series of protected areas linked through a global network, intended to demonstrate the relationship between conservation and development.

C

Chemical Oxygen Demand (COD) - The amount of oxygen consumed by the chemical breakdown of organic and inorganic matter.

Climatic Change - Significant change observed in the climate of a region between two reference periods.

D

Dam - A structure of earth, rock, concrete, or other materials designed to retain water, creating a pond, lake, or reservoir.

Desertification - Land degradation occurring in the arid, semiarid and dry subhumid areas of the world.

Dimictic Lake (or Reservoir) - A stratified lake or reservoir that experiences two periods of full mixing or (Fall and Spring) overturns annually.

Discharge - Outflow of water from a stream, pipe, groundwater aquifer or watershed; opposite of recharge.

Drought - Phenomenon that exists when precipitation has been significantly below normal recorded levels, causing serious hydrological imbalances that adversely affect land resource production systems.

E

Ecosystem - A system formed by the interaction of a group of organisms and their environment.

Effluent - The sewage or industrial liquid waste that is released into natural waters by sewage treatment plants, industry, or septic tanks.

Enteric Diseases - Diseases of or relating to the small intestine.

Estuary - Regions of interaction between rivers and nearshore ocean waters, where tidal action and river flow create a mixing of freshwater and saltwater. These areas may include bays, mouths of rivers, salt marshes, and lagoons.

European Envionment Agency (EEA) - The European Environment Agency, with currently 31 member countries, aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

European Union (EU) - The European Union--previously known as the European Community, created after World War II to unite the nations of Europe economically to avoid another war --is an institutional framework of 15 countries (25 from May 2004), sharing the common institutions and policies, for the construction of a united Europe.

Eutrophic lake - Shallow, murky bodies of water that have high concentrations of plant nutrients causing excessive algal production.

Eutrophication - The process by which lakes and ponds become enriched with dissolved nutrients, resulting in increased growth of algae and other microscopic plants.

Evapotranspiration - The loss water from the soil through both evaporation and transpiration from plants.

F

Flood - The temporary inundation of normally dry land areas resulting from the overflowing of the natural or artificial confines of a river or other body of water.

Food and Agriculture Organization of the United Nations (FAO) - UN specialized agency and lead agency for agriculture, forestry, fisheries and rural development.

G

Glacier - Accumulation of ice of atmospheric origin generally moving slowly on land over a long period.

Global Environment Outlook (GEO) - Global state of the environment reporting project initiated by UNEP in response to the environmental reporting requirements of Agenda 21 and to a UNEP Governing Council decision of May 1995.

Global Environment Facility (GEF) - established in 1991, helps developing countries fund projects and programmes that protect the global environment.

GEMS/Water - UN Programme providing scientifically-sound data and information on the state and trends of global inland water quality.

Global International Waters Assessment (GIWA) - Water programme led by UNEP, aiming at producing a comprehensive and integrated global assessment of international waters.

Groundwater - The supply of fresh water found beneath the earth's surface (usually in aquifers) that is often used for supplying wells and springs.

I

International Atomic Energy Agency (IAEA) - Independent intergovernmental, science and technology-based organization, in the United Nations family, that serves as the global focal point for nuclear cooperation and promotes safe, secure and peaceful nuclear technologies.

International Strategy for Disaster Reduction (ISDR) - Established by the UN as a global framework to foster the resiliency of communities to the effects of natural hazards through the implementation of risk management, hazard mitigation, and ultimately sustainable development.

Irrigation - The controlled application of water to cropland, hayland, and/or pasture to supplement that supplied through nature.

L

Lake - Any inland body of standing water, usually fresh water, larger than a pool or pond; a body of water filling a depression in the earth's surface.

Lake morphology - Relating to physical structure (depth, shoreline length, shape) of a lake.

Land degradation -A human induced or natural process which negatively affects the land to function effectively within an ecosystem, by accepting, storing and recycling water, energy, and nutrients.

M

Marsh - A type of wetland that does not accumulate appreciable peat deposits and is dominated by herbaceous vegetation. Marshes may be either fresh water or saltwater and tidal or non-tidal.

Mesotrophic Lake - Lake characterized by moderate nutrient concentrations such as nitrogen and phosphorous and resulting significant productivity.

Millennium Development Goals (MDGs) - Eight targets that would help meet these basic needs, to ne acheived by 2015, proposed at the United Nations Millennium Summit in September 2000.

N

Natural hazards - Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.

Nutrient - As a pollutant, any element or compound, such as phosphorus or nitrogen, that fuels abnormally high organic growth in aquatic ecosystems (e.g., eutrophication of a lake).

O

Overturn - The sinking of surface water and rise of bottom water in a lake or sea that results from changes in temperature that commonly occur in spring and fall.

P

Pesticide - A substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest, or intended to regulate plant or leaf growth. Pesticides can accumulate in the food chain and/or contaminate the environment.

Physical exposure - Elements at risk, an inventory of those people or artefacts that are exposed to a hazard.

Persistent Organic Pollutants (POPs) - POPs are chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of living organisms and are toxic to humans and wildlife.

R

Remediation - Cleanup or other methods used to remove or contain a toxic spill or hazardous materials from a site.

Reservoir - A pond, lake, or basin (natural or artificial) that stores, regulates, or controls water.

River - A natural stream of water of substantial volume.

River basin - The area drained by a river and its tributaries.

Runoff - The amount of precipitation appearing in surface streams, rivers, and lakes; defined as the depth to which a drainage area would be covered if all of the runoff for a given period of time were uniformly distributed over it.

S

Sewage (Water) - Liquid waste matter, usually containing human excrement.

Sustainable development - Development that ensures that the use of resources and the environment today does not restrict their use by future generations.

Swamp - A type of wetland that is dominated by woody vegetation and does not accumulate appreciable peat deposits. Swamps may be fresh water or saltwater and tidal or nontidal.

U

United Nations Children's Fund (UNICEF) - The lead UN organization working for the long-term survival, protection and development of children. Its programmes focus on immunization, primary health care, nutrition and basic education.

United Nations Department of Economic and Social Affairs (UN/DESA) - UN Department aiming at promoting broad-based and sustainable development through a multidimensional and integrated approach to economic, social, environmental, population and gender related aspects of development.

United Nations Development Programme (UNDP) - The central funding, planning, and coordinating organization for technical assistance and development in the UN system.

United Nations Economic Commission for Europe (UNECE) - Regional commission of the United Nations. Its primary goal is to encourage greater economic cooperation among its member States.

United Nations Educational, Scientific and Cultural Organization (UNESCO) - Specialized UN agency, promoting education for all, cultural development, protection of the world's natural and cultural heritage, international cooperation in science, press freedom and communication.

United Nations Environment Programme (UNEP) - UN agency providing leadership and encouraging partnership in caring for the environment.

United Nations Human Settlements Programme (UN-HABITAT) - UN agency for human settlements promotes socially and environmentally sustainable towns and cities with the goal of providing adequate shelter for all.

United Nations Industrial Development Organization (UNIDO) - UN specialized agency helping developing countries and countries with economies in transition in their fight against marginalization.

United Nations University (UNU) - International community of scholars, contributing, through research and capacity building, to efforts to resolve the pressing global problems that are the concern of the United Nations, its Peoples and Member States.

W

Wastewater - Water that carries wastes from homes, businesses, and industries; a mixture of water and dissolved or suspended solids.

Wastewater treatment plant - A facility containing a series of tanks, screens, filters, and other processes by which pollutants are removed from water.

Watershed - The land area that drains into a stream; the watershed for a major river may encompass a number of smaller watersheds that ultimately combine at a common point.

Water consumption - Consumptive water use. Water abstracted which is no longer available for use because it has evaporated, transpired, been incorporated into products and crops, consumed by man or livestock, ejected directly to the sea or into evaporation areas or otherwise removed from freshwater resources.

Water stress - Water stress occurs when the demand for water exceeds the available amount during a certain period or when poor quality restricts its use. Water stress causes deterioration of fresh water resources in terms of quantity (aquifer over-exploitation, dry rivers, etc.) and quality (eutrophication, organic matter pollution, saline intrusion, etc.).

Water supply - Refers to the share of water abstraction which is supplied to users (excluding losses in storage, conveyance and distribution).

Water use - Use of water by agriculture, industry, energy production and households, including in-stream uses such as fishing, recreation, transportation and waste disposal.

Wetlands - Lands where water saturation is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the surrounding environment. Other common names for wetlands are bogs, ponds, estuaries, and marshes.

World Bank Group - UN specialized agency providing loans and technical assistance to developing countries to reduce poverty and advance sustainable economic growth.

World Health Organization (WHO) - UN specialized agency, coordinating programmes aimed at solving health problems and the attainment by all people of the highest possible level of health.

World Meteorological Organization (WMO) - UN specialized agendy promoting scientific research on the Earth's atmosphere and on climate change, and facilitating the global exchange of meteorological data.

World Summit on Sustainable Development (WSSD) - held in Johannesburg in August-September 2002.

Sources: EEA multilingual environmental glossary; Environment Canada Water Glossary, United Nations, UNDP.

List of Illustrations

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Water Policy and Institutions

Numerous United Nations agencies address water issues and have developed programmes for improving water management worldwide. Several projects were implemented in Europe and contributed to the success of commissions for cooperative management of water resources.

Numerous institutions at global and regional scale work on the promotion of policies and general instruments for water management in the region.

In recent decades, several legal instruments have been prepared and adopted at different levels. The European Union regularly revises its policies, taking into account international directives. Important changes in water management are expected in the coming years, following implementation of recent directives. However, civil society has been criticizing the privatisation of water resources and resistance to privatisation is growing in some quarters.

The commemoration of the International Year for Freshwater in 2003 stimulated numerous water-related activities at all levels world-wide.

United Nations Conference Outcomes

Agenda 21

Agenda 21
www.un.org/esa/sustdev/documents/agenda21

The rationale for sustainable development and management of freshwater resources is clearly articulated in chapter 18 of Agenda 21.

Agenda 21's freshwater management guidelines focus on the following areas: Integrated water resources development and management; Water resources assessment; Protection of water resources, Water quality and aquatic ecosystems; Drinking-water supply and sanitation; Water and sustainable urban development; Water for sustainable food production and rural development; and The impact of climate change on water resources.

Current global water challenges and future targets are clearly stated in the Millennium Development Declaration, and are strengthened and expanded in the Plan of Implementation of the World Summit on Sustainable Development.

Millennium Development Goals

Millennium Development Goals Website:
www.un.org/millenniumgoals/

The Millennium Development Declaration includes the access to safe drinking water as one of the internationally-agreed Millennium Development Goals. The water targets are:

Target 10 - Halve by 2015 the proportion of people without sustainable access to safe drinking water and basic sanitation.

Target 11 - Have achieved by 2020 a significant improvement in the lives of at least 100 million slum dwellers.

WSSD

WSSD Website:
www.johannesburgsummit.org

The role of sustainable water management for poverty eradication has been one of the key outcomes of the World Summit on Sustainable Development. The plan of implementation outlines several central statements related to freshwater and sanitation issues, including:

- Halve, by the year 2015, the proportion of people without access to safe drinking water;

- Halve, by the year 2015, the proportion of people who do not have access to basic sanitation;

- Combat desertification and mitigate the effects of drought and floods;

- Develop integrated water resources management and water efficiency plans by 2005, with support to developing countries;

- Support developing countries and countries with economies in transition in their efforts to monitor and assess the quantity and quality of water resources;

- Promote effective coordination among the various international and intergovernmental bodies and processes working on water-related issues, both within the United Nations system and between the United Nations and international financial institutions.

UN system-wide World Water Assessment Programme

WWAP
www.unesco.org/water/wwap/

The initiation of a UN system-wide World Water Assessment Programme (WWAP) was first announced during the 2nd World Water Forum, held in The Hague, in March 2000. This UN-wide programme seeks to develop the tools and skills needed to achieve a better understanding of the basic processes, management practices and policies that will help improve the supply and quality of global freshwater resources.

The primary output of the WWAP is the biennial World Water Development Report (WWDR). The Programme will evolve with the WWDR at its core.

The Programme, including the new WWDR, is undertaken by the UN agencies concerned aided by a Trust Fund, donors providing support in cash and in kind either through specific agencies or through the Trust Fund. UNESCO currently hosts the WWAP Secretariat.

International Year for Freshwater

International Year for Freshwater:
www.wateryear2003.org

In recognition of the importance of water resources as a key to sustainable development, the United Nations General Assembly proclaimed the year 2003 as the *International Year for Freshwater*.

UN and Specialized Agencies

FAO

FAO AGLW:
www.fao.org/landandwater/aglw

AQUASTAT
www.fao.org/ag/agl/aglw/aquastat/main/

FAO's water-related activities include: water resources inventories and evaluation; development of a global water information system; a programme for water policy formulation and river basin planning; improved water use technologies and management tools; a programme on water development and irrigation expansion; and water quality control, conservation and environmental effects projects.

FAO's Water Resources, Development and Management Service (AGLW) is concerned with sustainable use and conservation of water in agriculture. The service assesses water resources and monitors agricultural use; assists in water policy formulation and promotes irrigated agriculture and efficient water use through management innovations, modernization and institutional reforms.

AQUASTAT is FAO's global information system on water and agriculture. The objective of AQUASTAT is to provide users with comprehensive information on the state of agricultural water management across the world, with emphasis on developing countries and countries in transition.

IAEA

IAEA is mandated to assist its Member States in using nuclear science and technology for various peaceful purposes, including food and agriculture, human health, marine and terrestrial environments, and water resources. The water resource programme of IAEA aims to increase the global hydrological knowledge base, including a better understanding of the water cycle, and scientific capacity of developing countries to assess water resources.

ISDR

ISDR's 2003 World Disaster Reduction Campaign looks at water-related hazards.

UNDP

UNDP's water strategy focuses on assisting countries to meet the Millennium Development Goals, with an emphasis on poverty reduction and reduced child mortality. Its water strategy is implemented at global, regional and national levels. UNDP is focused on achieving effective governance of freshwater resources and the aquatic environment and targets actions to address four principal challenges - human health, food security, the decline of the environment, and social, economic and political stability.

UNDP is also one of the implementing agencies of the Global Environment Facility (GEF). UNDP-GEF administers and implements an important programme on International Waters. In addition, several UNDP-GEF Biodiversity projects involve freshwater ecosystems.

UN/DESA

Through its Water Management Branch, DESA provides project execution and policy advisory services at national and regional levels in integrated water resource management. While providing policy advice to Member States, DESA stresses the importance of water as a key resource to achieve the goals of sustainable development.

UN/ECE

UN/ECE participates in the two major international cooperative processes: the Environment for Europe process and the regional promotion of Agenda 21.

Among the conventions developed by the commission, the Convention on the Protection and Use of Transboundary Watercourses and International Lakes is intended to strengthen national measures for the protection and ecologically sound management of transboundary surface waters and groundwaters. Under the Convention, the Protocol on Water and Health was adopted in London on 17 June 1999, and the Protocol on Civil Liability was adopted on 21 May 2003.

UNEP

UNEP has been at the forefront of assessing and monitoring global water resources and presenting information on their use and management for 30 years. Through its different assessment activities, UNEP focuses on highlighting key areas to promote policy recommendations.

UNEP, in collaboration with partners and collaborating centres, collates and analyses water resources data on a global basis. Despite a concerted effort to create a comprehensive database on global water use, there remain many gaps in the information available. Several projects and programmes are working to fill these gaps. Among them are the Global International Waters Assessment (GIWA), the Global Programme of Action for the Protection of the Marine Environment from Land Based Activities (GPA/LBA), and the Global Environment Monitoring System Freshwater Quality Programme (UNEP-GEMS/Water), as well as many other programmes dealing with fresh and coastal/marine waters within other United Nations agencies and partners.

UNESCO

The International Hydrological Programme (IHP), UNESCO's intergovernmental scientific co-operative programme in water resources, is a vehicle through which Member States can upgrade their knowledge of the water cycle and thereby increase their capacity to better manage and develop their water resources. The current phase of IHP, IHP-VI, covering the period 2002-2007, is devoted to "Water Interactions : Systems at Risk and Social Challenges".

The UNESCO Water Portal is intended to enhance access to information related to freshwater available on the World Wide Web. The site provides links to the current UNESCO and UNESCO-led programmes on freshwater and serves as an interactive point for sharing, browsing and searching websites of water-related organizations, government bodies and NGOs, including a range of categories such as water links, water events, learning modules and other on-line resources.

GEMS/Water is jointly implemented by WHO, WMO, UNEP and UNESCO.

UNDP Water activites:

www.undp.org/water/

Further information on UNESCO freshwater-related activities available from:

www.unesco.org/water/

GIWA:

www.giwa.net/

GEWS Water:

www.gemswater.org

Further information on UNE/ECEctivities available from:

www.unece.org

Further information on UNICEF activities available from:

www.unicef.org

Further information on UNEP freshwater-related activities available from:

www.unep.org/themes/freshwater/

Further information on WMO activities available from:

www.wmo.ch

ECOLEX:

www.ecolex.org

Further information on WHO activities available from:

www.who.int/water_sanitation_health/

FAOLEX:

www.faolex.org

UN-HABITAT

A central focus of UN-HABITAT's work is sanitation and access to adequate water, especially for suburban agriculture and for municipal drinking water. Most of its programmes and projects are located in the least developed countries.

UNICEF

UNICEF works to improve water supplies and sanitation for communities, including schools. The organization promotes good hygiene practices, and provides water and sanitation when supplies are threatened by crisis situations, such as natural disasters and conflict.

UNIDO

UNIDO's water strategy focuses on promoting sound management of water resources and environmental conservation, maintaining environmental quality and preserving the productivity of river basins, coastal areas and large marine ecosystems, as well as the health and well-being of those populations dependent on and living in them.

UNU

The UN University includes several water-related research programmes. Among these, the UNU's International Network on Water, Environment and Health (INWEH) is a research and capacity-development centre contributing to the resolution of global water problems, particularly in the developing world.

WHO

WHO aims at reducing water- related diseases and optimizing the health benefits of sustainable water and waste management.

Its main objectives are to support the health sector in effectively addressing the water-related disease burden and in engaging others in its reduction. The organization assists non-health sectors in understanding and acting on the health impacts of their actions.

One of the core functions of WHO is to "propose regulations and to make recommendations with respect to international health matters". In relation to water, sanitation and hygiene, this is achieved through development of normative Guidelines:

- *Guidelines for Drinking-Water Quality*

- *Guidelines for Safe recreational Water Environments*

- *Guidelines for the Safe Use of Wastewater*

These guidelines have had a major impact on the rational reuse of wastewater and excreta in countries world-wide. The WHO guidelines for the safe use of wastewater and excreta in agriculture and aquaculture are currently under revision, with expected publication in 2004.

WMO

The WMO Hydrology and Water Resources Programme (HWRP) concentrates on promoting world-wide cooperation in the evaluation of water resources and the development of hydrological networks and services, including data collection and processing, hydrological forecasting and warnings and the supply of meteorological and hydrological data for design purposes.

World Bank

The World Bank water activities reflect the Bank's long-term water resources management policy, focusing on freshwater, coastal and marine resource management, integrating the ecological dimension into water resources management. Water resources management projects include investments for: urban, rural, industrial and agricultural water supplies; sewerage treatment; flood control; irrigation and drainage; hydropower; and navigation projects.

■ UN Environment-related Law Databases

ECOLEX

ECOLEX is an information service on environmental law, operated jointly by FAO, IUCN and UNEP. Its purpose is to build capacity worldwide by providing a comprehensive global source of information on environmental law.

The ECOLEX database includes information on treaties, international soft-law and other non-binding policy and technical guidance documents, national legislation, judicial decisions, and law and policy literature. Users have direct access to the abstracts and indexing information about each document, as well as to the full text of most of the information provided.

FAOLEX

FAOLEX is a legislative database, one of the world's largest electronic collections of national laws and regulations on food, agriculture and renewable natural resources.

FAOLEX contains treaties, laws and regulations on food, agriculture and renewable natural resources from all over the world. Most of the material comes from the official gazettes sent by FAO's Member Nations. Upon receiving such material, the FAO Legal Office selects, indexes and summarizes in English, French or Spanish significant texts pertaining to FAO's mandate, i.e. legislation on agriculture, livestock, environment, fisheries, food, forestry, land, plants, water and wild fauna & flora. The language of the records is the official language or the language of communication of the originating country.

Transboundary Basins

There are 150 major transboundary rivers in Europe that form or cross borders between two or more countries, some 25 major transboundary lakes, and some 100 transboundary aquifers.

The numbers of international basins and the nations which they traverse change over time in response to alterations in the political situation. For example, the break-up of the Soviet Union in 1991 led to the internationalization of several basins (e.g. Dnieper, Don and Volga) and to a change in the political composition of existing international basins.

Agreements and Cooperation

Several international agreements cover the management of shared water resources in Europe.

The river basins in western and central European region with treaties are: Bidasoa, Danube, Daugava, Dnieper, Dniester, Don, Douro, Ebro, Elbe, Garonne, Glama, Guadiana, Isonzo, Kemi, Klaralven, Kogilnik, Lake Prespa, Lava/Pregel, Lima, Maritsa, Minho, Näätämo, Narva, Neman, Nestos, Oder, Olanga, Oulu, Pasvik, Po, Rhine, Rhone, Roia, Sarata, Schelde, Seine, Struma, Tagus, Tana, Tigris-Euphrates, Torne, Tuloma, Vardar, Vistula, Volga, and Vuoksa.

The river basins in Eastern Europe and Central Asian region are: Amur, Aral Sea, Asi/Orontes, Har Us Nur, Jenisej, Kura-Araks, Lake Ubsa-Nur, Ob, Ural.

The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes, supported by soft-law recommendations, guidelines and specific action plans, has been an important tool for institutional cooperation on transboundary waters. The convention has been signed and/or ratified by 32 countries of Europe, including the Russian Federation and Azerbaijan, Kazakhstan, the Republic of Moldova and Ukraine from EECCA.

Examples of international cooperation in international river basins were listed in the Major European Watersheds chapter of this report.

Examples of important international monitoring programmes for large lakes where international commissions have been set up to coordinate action programmes are:

Lake Leman – France and Switzerland - protection, navigation, monitoring and abstraction;

Lake Constance – Austria, Switzerland and Germany - protection and abstraction;

Inari – Finland and Norway - regulation of hydroelectric power;

Lugano – Italy and Switzerland - regulated by the Convention.

GEF Freshwater Projects

GEF has been funding projects to reverse the degradation of international waters that are related to - and help to realize the objectives of - a mosaic of regional and international water agreements. These projects enable countries to recognize and learn more about the water-related challenges they share, find ways to work together, and undertake important domestic changes needed to solve problems. The three categories of water projects are: 1) water bodies; 2) integrated land and water projects; and 3) contaminants.

In Central and Eastern Europe GEF projects include:

- Addressing Transboundary Environmental Issues for the Caspian Environment Programme;
- Danube River Basin Environmental Management;
- Developing the Danube River Basin Pollution Reduction Programme;
- Lake Ohrid Management;
- Preparation of a Strategic Action Programme (SAP) for the Dnieper River Basin and Development of SAP Implementation Mechanisms;
- Water and Environmental Management in the Aral Sea Basin.

An Agricultural Development Project in Georgia and a Rural Environmental Project in Poland are under preparation.

Disputes

Although most of the shared water resources in Europe are covered by numerous transboundary agreements, some tensions and disputes still exist. These include water shortage problems during the summer, dam construction, pollution and boundary problems, as water bodies are often used as international boundaries.

Transboundary Dispute Database available from:

www.transboundarywaters.orst.edu/

European Union

European Water Initiative

Further information on water legislation (and related policies) in the European Community available from:

europa.eu.int/comm/environment/water/

The European Union launched the Water Initiative during WSSD, with the aim of creating strategic partnerships to achieve the WSSD goals on clean water and sanitation, and to contribute to meeting the Millennium Development Goals on water.

The EU Water Initiative seeks to make significant progress in poverty eradication and health, in the enhancement of livelihoods, and in sustainable economic development. The initiative also seeks to serve as a catalyst for peace and security.

The actions of the EU Water Initiative are developed in a multi-stakeholder process together with the partner regions, NGOs and the private sector. Close working relations with the partner regions were established in order to ensure that the initiative is shaped in response to demand rather than being pre-determined. Together with its partners, the EU is exploring options to improve the efficiency of existing financing mechanisms and to develop new approaches involving public/private partnerships.

The Environment for Europe Conference in Kiev, in May 2003, adopted the EU Water Initiative for EECCA Countries.

EU Directives

Water Framework Directive (2000/60/EC)

On 23 October 2000, the Directive establishing a framework for Community action in the field of water policy - EU Water Framework Directive (WFD) - was adopted.

WFD is a legislative framework to protect and improve the quality of all water resources such as rivers, lakes, groundwater, transitional and coastal waters within the EU. Member States must incorporate the WFD into national law by the end of 2003.

The new approach to managing Europe's water resources in the WFD has ambitious objectives and clear deadlines; the introduction of River Basin Management on a Europe-wide scale; the requirement for cross border co-operation in water management between countries and other parties involved; pollution prevention and control on the basis of a "combined approach"; greater public participation in water management, and economic analysis of water use.

The WFD promotes the integrated management of water resources to support environmentally sound development and reduce problems associated with excessive water abstraction, pollution, floods and droughts. The WFD provides the framework for water policy decision-making within the river basin context. It will require the integration of industrial, agricultural, rural development, nature conservation and forestry programmes, etc., at the river basin scale and, in many cases, transboundary collaboration between European countries.

The total of seven directives will be repealed by WFD.

Drinking Water Directive (80/778/EEC) and its revision (98/83/EC)

The Drinking Water Directive specifies quality standards for water intended for drinking and use in food or drink production. Standards are set for six different categories of parameters: organoleptic quality and physicochemical parameters; parameters concerning substances undesirable in excessive amounts; toxic substances; microbial contaminants; and the minimum required concentrations for softened water intended for human consumption.

The Directive sets maximum admissible concentrations and minimum required levels for most parameters, which must be incorporated into the legislation of EU members, and includes guidelines for other parameters. The standards are backed up by monitoring and legal enforcement, and regulations also govern the quality of surface water abstracted for potable supply and the extent of treatment required.

The Directive has been reviewed and updated in 1998. The number of parameters to be regulated were reduced, with only those considered to indicate a significant risk to human health being specified.

Nitrates Directive (91/676/EEC)

EU members are required, under the Nitrates Directive, to identify bodies of water that may be affected by pollution from nitrate (vulnerable zones) and establish action programmes to prevent pollution in these areas. The Directive is intended both to safeguard drinking-water supplies and to prevent ecological damage, by reducing or preventing the pollution of water caused by the application and storage of inorganic fertilizers and manure on farmland. Waters covered by the Directive include surface bodies of freshwater (particularly those used for the abstraction of drinking-water), groundwater actually or potentially containing more than 50 mg/l nitrate, and water bodies (lakes, other freshwater bodies, estuaries, coastal waters and marine waters) that are, or may become, eutrophic. Action programmes include periods when applying certain types of fertilizer is prohibited, limits on the quantities of fertilizer applied, a limit on the application of livestock manure, conditions relating to the available storage capacity on farms for livestock manure, and a code of good agricultural practice.

Urban Waste Water Treatment Directive (91/271/EEC) - (amendment by 98/15/EC)

The Urban Waste Water Treatment Directive sets minimum standards for the collection, treatment and discharge of urban wastewater, with the aim of reducing the pollution of raw water by domestic sewage, industrial wastewater and rainwater run-off. It introduces controls over the disposal of sewage sludge and prohibits the practice of dumping sewage sludge at sea. Under the Directive, all towns and villages with a population of 2 000 or more are required to have sewage collection systems. The wastewater is subject to treatment requirements; a minimum of secondary treatment is normally required. Tertiary treatment is required for discharge to particularly sensitive areas (as designated by Member States), including waters subject to eutrophication and surface waters intended for abstraction for drinking-water that have high nitrate levels. Exceptions and derogation are made for specific circumstances; for example, septic tanks giving the same degree of protection as sewage collection may be used if the installation of sewerage systems involves "excessive cost".

The Directive requires that all discharges of industrial wastewater into collecting systems and treatment plants be subject to regulation or specific authorization, and is being implemented progressively until 2005.

Groundwater Directive (80/68/EEC)

The Groundwater Directive aims to protect exploitable groundwater sources by prohibiting or regulating direct and indirect discharges of dangerous substances. The dangerous substances covered by the directive are those controlled by the Dangerous Substances Directive. Member States are required to prevent the introduction of List I substances into groundwater and to limit the introduction of List II substances.

The European Commission adopted a proposal for a new Directive to protect groundwater from pollution on 19 September 2003 (COM(2003)550).

Discharges of Dangerous Substances Directive (76/464/EEC)

The Dangerous Substances Directive sets a framework for eliminating or reducing pollution of inland, coastal and territorial waters by particularly dangerous substances. The regulation of specific substances is promulgated in sub-directives.

The Directive requires EU members to eliminate or reduce pollution of water bodies by certain substances contained in an annex to the directive, and to set standards for their occurrence in water. The dangerous substances to be controlled are contained in two lists, List I - black list - of priority chemicals and List II - grey list. Discharges to water of substances on either list must be authorized prior to release. Procedures for determining acceptable levels of release differ between the two lists. List I chemicals are controlled by community-wide emission standards specified in sub-directives, whereas individual EU members are responsible for setting standards for the List II substances that require control.

Bathing Water Directive (Council Directive 76/160/EEC)

The Bathing Water Directive sets out the quality requirements for identified bathing waters in each EU member country to "reduce the pollution of bathing water and to protect such water against further deterioration". The standards were set in order "to protect the environment and public health". The Directive specifies minimum sampling frequencies – every two weeks for most parameters. The water quality standards of the 1976 Bathing Water Directive are being revised after a considerable period of consultation. On 24 October 2002, the Commission adopted the proposal for a revised Directive of the European Parliament and of the Council concerning the Quality of Bathing Water COM(2002)581.

Other EU water-related directives are:

Surface water for drinking water abstraction (75/440/EEC), amended by 79/869/EEC and art. 9a amended by art. 3 of 91/692/EEC.

Shell Fish Directive (79/923/EEC), amended by 1985 Act of accession and art. 16 amended by art. 2(1) of 91/692/EEC.

Methods of measurement/sampling/analysis of surface drinking water (79/869/EEC)

Freshwater Fish Directive (78/659/EEC)

National legislation and institutional frameworks vary considerably across Europe.

A recent WWF report on critical issues in water policy across Europe, assessed the water policies of 23 countries. Of these, Finland, Switzerland, and Belgium (Flanders) came out best, while Italy, Greece, and Spain were ranked the lowest across a range of water issues. In the majority of cases, countries were taking ineffective measures to tackle the region's water problems such as pollution and over-consumption. Six countries (Croatia, Hungary, Italy, Portugal, Spain, and Turkey) failed to reduce the amount of water used by their agricultural sectors, and in three of these countries (Italy, Portugal, and Spain) farmers were not under the constraint of having to pay for the amount of water they use to irrigate their fields.

National Water Authorities

In most EU countries, national ministries are ultimately responsible for enforcing the legislation on water resources and supply. Responsibility may be shared by two ministries, each covering different aspects. In practice, supervision of compliance is often fragmented, with much of the responsibility delegated to the regional level and more frequently to the local level.

Eastern European Countries

Countries in the eastern part of Europe have experienced many changes in the past decade. Previous legislation in the USSR and other countries contained numerous strict standards for drinking-water quality, but these were often poorly or not enforced at all because institutional mechanisms and resources were lacking. For most parameters, methods of analysis were inadequate and there was no clear distinction between those responsible for providing services and those responsible for supervising standards and enforcing the law. Moreover, drinking-water quality was often severely compromised by intensive industrial activity without any concern for the environment and, consequently, inadequate protection of water resources. A lack of investment in treatment and distribution facilities also contributed to significant problems.

Many of the countries in this region are preparing or have recently introduced new legislation closely linked to the WHO guidelines and/or the EU Drinking Water Directive, especially candidate countries for membership of the EU.

As with the other countries, ministries are responsible for overall water supply. Although suitable legislation is being prepared and, to some extent, responsibilities are being allocated in most countries, resources and experience are often lacking to enforce the standards effectively. Many countries require considerable investment to improve the infrastructure.

Public Participation

Public participation in water management is rather poor in Europe, especially in Southern and Eastern Europe. The most critical aspects of public participation are the lack of pro-active information provisions to non-governmental stakeholders and the quality of the means to enable the active involvement of interested parties in decision-making processes. Stakeholders often lack specialist knowledge and human capacity to get involved in decision-making for water management measures. It is difficult for non-governmental water stakeholders to contribute and influence the decision-making process because the issuing of consultation documents and the participation of interested parties often take place only towards the end of the process. There is often low transparency for specific projects.

Integrated Management of Water Resources

In most European countries, there are too many actors responsible for and involved in water management. The jurisdiction over water is often very fragmented and there is not always a single institution ensuring coordination between the different managing agencies. Some examples were given in the Major European Watersheds part of this document.

Wetlands Management

Wetlands management is considered a nature conservation issue. This leads to uncoordinated actions in managing wetlands and missed opportunities for fully exploiting their positive role in water management. National wetland restoration policies are almost non-existent, although the international framework should lead to a national wetland protection policy.

Iberian Peninsula

In Portugal and Spain, water policy is based on the principle of satisfying water demand for the different water-consuming sectors (agriculture, hydropower, human supply, industry), which led to the construction of many dams and related water infrastructure. There is no integrated planning of water infrastructure that considers the balance between the conservation of water ecosystems and water needs of the different economic and human activities. The evaluation of impacts is limited to the length of river directly affected by the works and, although measures to minimise the negative impact of dams are frequently requested as a result of the Environment Impact Assessment process, there is no legal obligation to maintain a minimum ecological river flow or to build fish ladders.

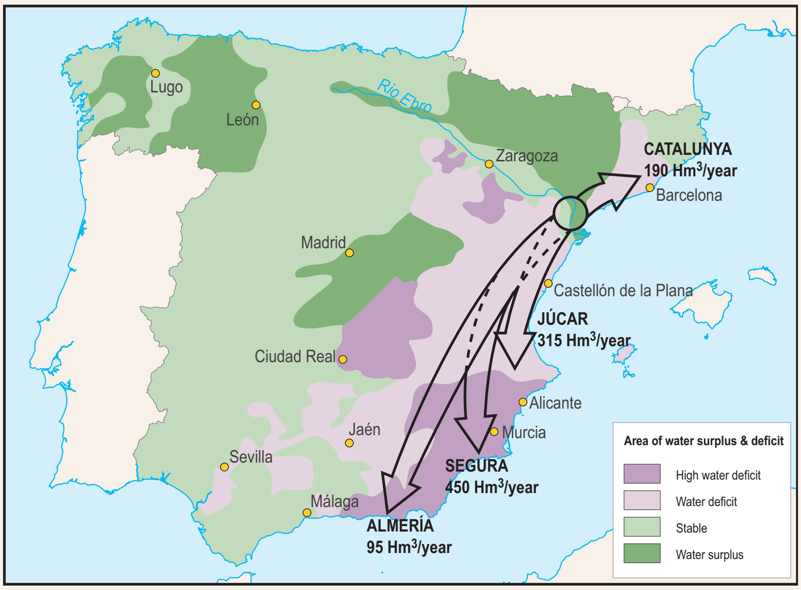
Spanish National Hydrological Plan

Adopted by the Spanish government in June 2001, the Spanish National Hydrological Plan (SNHP) foresees the building of 118 new dams (Spain already has 1,200 large dams) as well as huge transfers from the Ebro river to southeast Spain and from the Rhône river to Barcelona. The Plan calls for the re-routing of 35 rivers and tributaries and the building of 14 canals (one over 700 km long), a 900 km pipeline and all the supporting infrastructure. The Plan embraces a total of 889 projects. Environmental and other NGOs, as well as numerous academics, scientists, unions and political parties are involved in trying to halt this project, as they estimate it is contrary to sustainable development objectives. The European Commission and Parliament are critically reviewing the Plan, since a third of the project funding will come from the EU.

Environmental NGOs urged the Spanish government to apply a different, modern, and worldwide successfully applied alternative to large-scale water transfers. They massively reject the current plan, which was conceived more than 40 years ago. They estimate that it does not sufficiently consider economic alternatives to the large water infrastructure it promotes. It does not prioritise the option of reducing, for example, current water losses in urban water distribution systems, or introducing water banks, nor does it take into consideration recent techniques that reduce desalinisation costs by nearly half.

In April 2004, the new elected Spanish Prime Minister, Jose Luis Rodriguez Zapatero, has ordered a review of the entire workings of the Spanish National Hydrological Plan and cancelled its most controversial project, the Ebro Transfer.

NGOs are still concerned about some of the other infrastructure projects, notably the La Brena Dam in Andalucia, which would create an enormous reservoir in the middle of a Natura 2000 area, threatening local ecology and the endangered Iberian lynx.



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Major European Watersheds

Selection of Major Watersheds

Heighteen watersheds were selected as case studies for this report. For each basin, a map was prepared including the river, its principal tributaries and topographic features. Major canals were also included.

A complete legend of the features used in these maps is included on page 78.

False-colour satellite images are presented for each basin (Landsat 5 - 1990s).

False-Colour Satellite Images

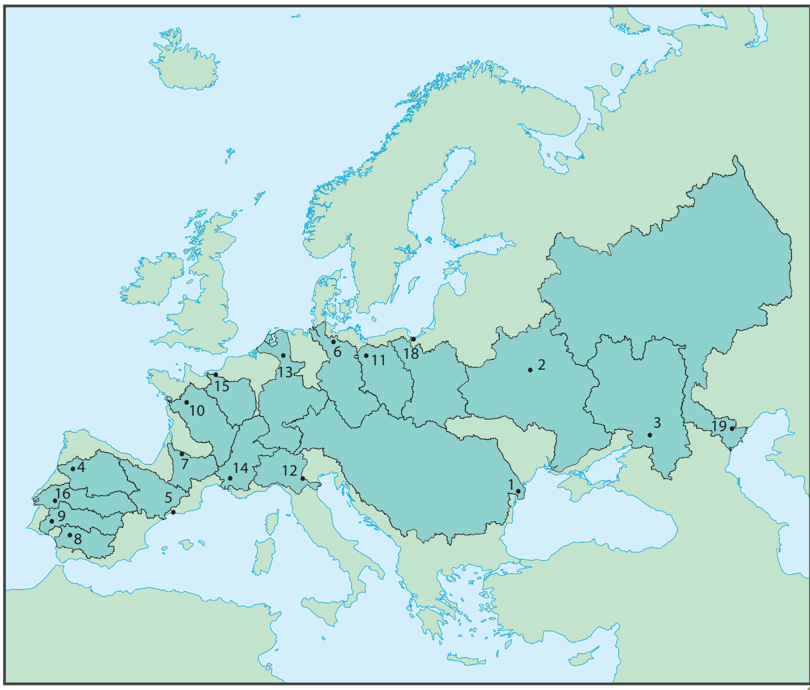
A false-colour image is an artificial representation of a multi-spectral image. Many environmental features are more readily discernible when satellite images are processed as false-colour composites.

The infrared ranges of the spectrum are some of the most useful for identifying what a surface is made of, because they consist of both reflected energy and emitted energy. Plants reflect much more energy in the infrared than in the visible bands, and one can determine the relative health of a plant from its reflectance.

The specific bands used in three-band composites are often identified by giving the band numbers used for red, green and blue in this specific order. Thus, an image using band seven for red, band four for green, and band two for blue would be designated (7,4,2).

Cultivated areas are shown in different shades of red and pink. Roads are visible as straight light-coloured lines. Rivers have a dark blue colour.

WATERSHEDS SELECTED AS CASE STUDIES



Nº	Hydrometric station ●	Water basins	Country (at station)
1	Ceatal Izmail	Danube	Romania
2	Rechitca	Dnepr	Belarus
3	Razdorskaya	Don	Russia
4	Regua	Douro	Portugal
5	Tortosa	Ebro	Spain
6	Darchau	Elbe	Germany
7	Mas D'Agenais	Garonne	France
8	Alcala Del Rio	Guadalquivir	Spain
9	Pulo Do Lobo	Guadiana	Portugal
10	Montjean	Loire	France
11	Gozdowice	Oder	Poland
12	Boretto	Po	Italy
13	Rees	Rhine	Germany
14	Beaucaire	Rhone	France
15	Poses	Seine	France
16	Almourol	Tagus	Portugal
17	Tczew	Vistula	Poland
18	Verkhnee Lebyazhe	Volga	Russia

Danube

German: Donau, Slovak: Dunaj, Serbo-Croatian and Bulgarian: Dunav, Romanian: Dunarea, Russian: Dunay.

Second longest river in Europe

The Danube is the second longest river in Europe; it is approximately 2 900 km long and drains an area of about 817 000 km^2. It rises in the Black Forest Mountains of Germany and empties into the Black Sea. About one-third of the Danube river basin is mountainous, while the remainder consists of hills and plains.

The climate in its basin is very diverse: an Atlantic climate in the western part of the upper basin; Mediterranean climate through the Drava and Sava river basins, and Continental climate elsewhere. Annual precipitation ranges from about 2 000 mm per year in the high regions, to only about 500 mm per year on the plains.

International Commission for the Protection of the Danube River (ICPDR): www.icpdr.org

The mean altitude of the river basin is only 475 metres, but the maximum differences in height between the lowland and Alpine peaks is over 3 000 metres. The natural flow regime is strongly influenced by hydraulic structures and intensive water use in the basin.

The Danube Delta covers an area of about 600 000 hectares. It was formed by the division of the river at its mouth into three main branches, forming a triangle with sides about 70 km long. Almost two-thirds of the delta area is seasonally submerged. The Romanian part of the delta was declared a Biosphere Reserve in September 1990 and registered under the Ramsar Convention. Over half of its area is listed under the World Heritage Convention.

There are many countries, international, national and local governmental and non-governmental organisations and projects that are working for the protection of the Danube Basin's natural environment.

UNDP, with support from GEF, has been addressing priority environmental problems in the Danube since 1992. This initial assistance helped build the basis for cooperation leading to the signing and ratification of the Danube River Protection Convention (DRPC), which came into force in 1998. The International Commission for the Protection of the Danube River (ICPDR) was created to coordinate the implementation of the convention. Since its creation, the ICPDR has been effective in reaching agreed policy among countries on priorities and strategies for improving the Danube and implementing the DRPC.

Scale 1 : 9 500 000

Kilometres 0 100 200 300 400 500

In June 2000, the Declaration for the Establishment of the Lower Danube Green Corridor (LDGC) was signed by the environment ministers of Romania, Bulgaria, Moldova and Ukraine in Bucharest. Romania. The agreement creates a "Green Corridor" of natural wetlands, lakes, flooded areas, floodplain forests and meadows along the Lower Danube in the four countries (including the Danube Delta) - resulting in the largest international, cross-border wetland restoration and protection initiative in Europe. Three of the four countries have developed Action Plans for implementation activities, while all have identified sites for the Green Corridor. The commitment of the countries has prompted international donors to fund projects for the Corridor. The countries also pledged to develop a monitoring system and a regular exchange of information and experiences in wetland conservation, restoration and pollution reduction.

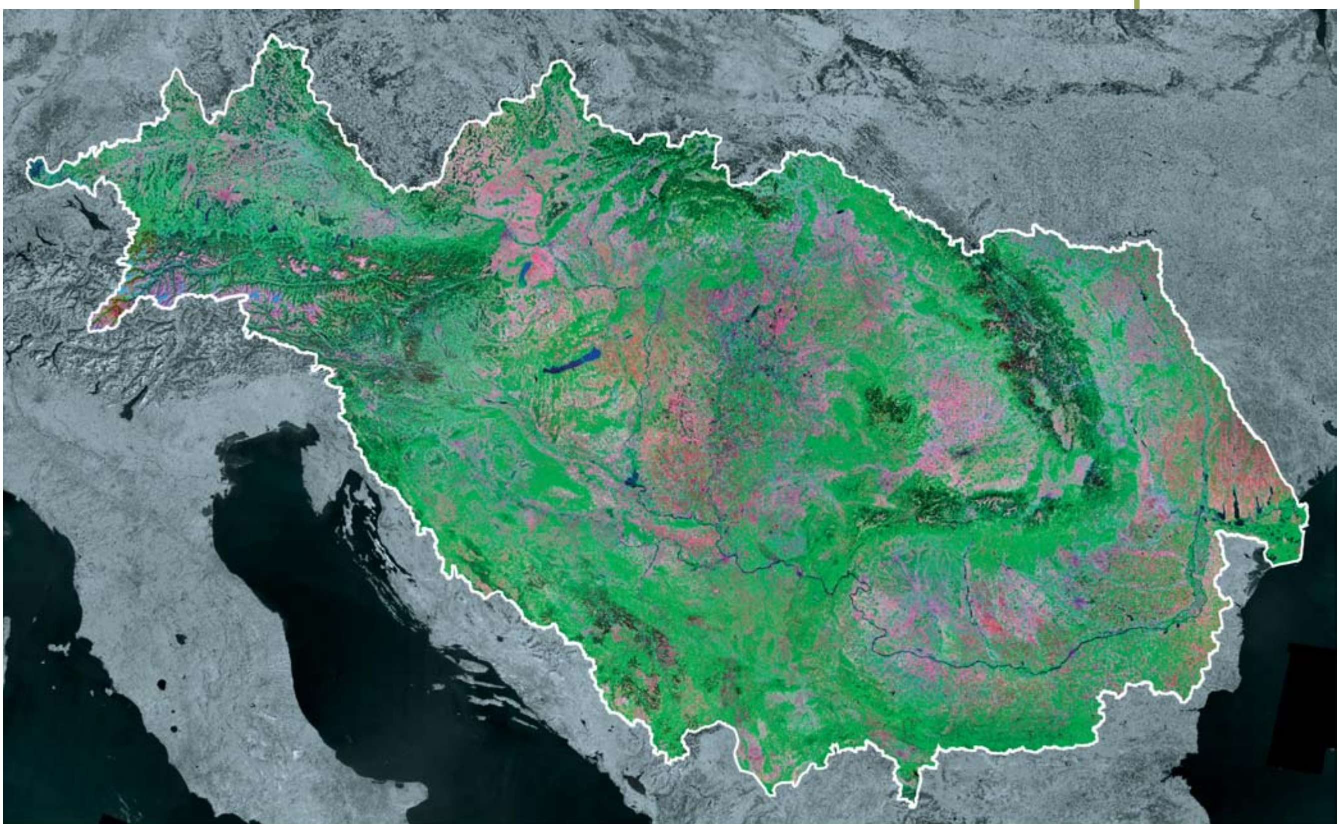
Length (km)	*2 960*
Drainage Area (km²)	*817 000*
Discharge (m³/s)	*6 500*
Countries	*17*
Population	*80 000 000*
Sea at Mouth	*Black*
Ramsar Sites	*65*

Mean Discharge at mouth.

Baia Mare Cyanide Spill

On 30 January 2000 a dam broke at the Aurul Mine Tailings Recovery Plant near Baie Mare in northwestern Romania. Around 100 000 m^3 of wastewater with a high concentration of cyanide and heavy metals were released into the environment. The original discharge took place in the Szamos River, a tributary of the Tisza river. The Tisza covers 48% of the territory of Hungary and is the most important tributary of the Danube.

In view of the magnitude of the ecological disaster and its potential impact on human health, the Governments of Romania, Hungary and Yugoslavia, as well as the International Commission for the Protection of the Danube River Basin, asked for assistance from the UN system to assess the effects of the spill. A UNEP/OCHA Report presented the conclusions of a joint investigative mission to the affected areas by a team of 20 scientists.



Dnieper

Ukrainian: Dnipro, Russian: Dnepr, Belorussian: Dnepro.

UNDP-GEF Dnipro Basin Environment Programme: www.dnipro-gef.net

Rising in the southwestern part of the Russian Federation, at an altitude of about 220 metres on the southern slope of the Valdai Hills, west of Moscow, not far from the sources of the Volga, the Dnieper River flows generally south through Belarus, then southeast through Ukraine, ending in the Black Sea. The Dnieper is the third longest river in Europe, and the second longest river flowing into the Black Sea. Its watershed is 58% in Ukraine, 24% in Belarus and only 18% in Russia.

Some 33 million people inhabit the Dnieper Basin, of which 22 million live in Ukraine. The River flows through Smolensk (350 000) in Russia, Mogilev (350 000) in Belarus, through the Ukrainian capital Kiev with its 3 million inhabitants, Cherkasy (290 000), Kremenchuk (237 000) and Dnepropetrovsk (1.2 million).

The Dnieper Basin contains approximately 300 hydroelectric plants and several major dams. The River is navigable for about 1 677 km during the 10 months of the year when it is not frozen. It represents an important shipping artery for Eastern Europe; the navigable tributaries of the Dnieper are the Berezina, the Pripet, the Sozh and the Desna.

The Dnieper has undergone considerable changes due to construction of a series of reservoirs. Hydropower stations, nuclear power stations located in the basin, and heavy industries have caused ecological, social and economic damage at a regional scale. The environmental and human health problems both in the Dnieper Basin and the Black Sea region as a whole are worsened by large-scale development of timberland, and draining of waterlogged lands for agriculture, and the intensive growth of cities where sewage purification is insufficient. After the Chernobyl catastrophe, a large amount of radioactive cesium was deposited in reservoir sediment (especially in the Kiev Sea) and risks potentially increasing the radioactivity both in this region and along the entire length of the River to the Black Sea.

Many swamps and wetlands have formed in the northwestern part of the river basin (Pripet swamps) and drain their water into the Pripet, the main tributary of the Dnieper. Humic substances combined with manganese and iron give the water a red-brown colour, especially during Spring.

Scale 1 : 9 000 000

Kilometres 0 100 200 300 400 500

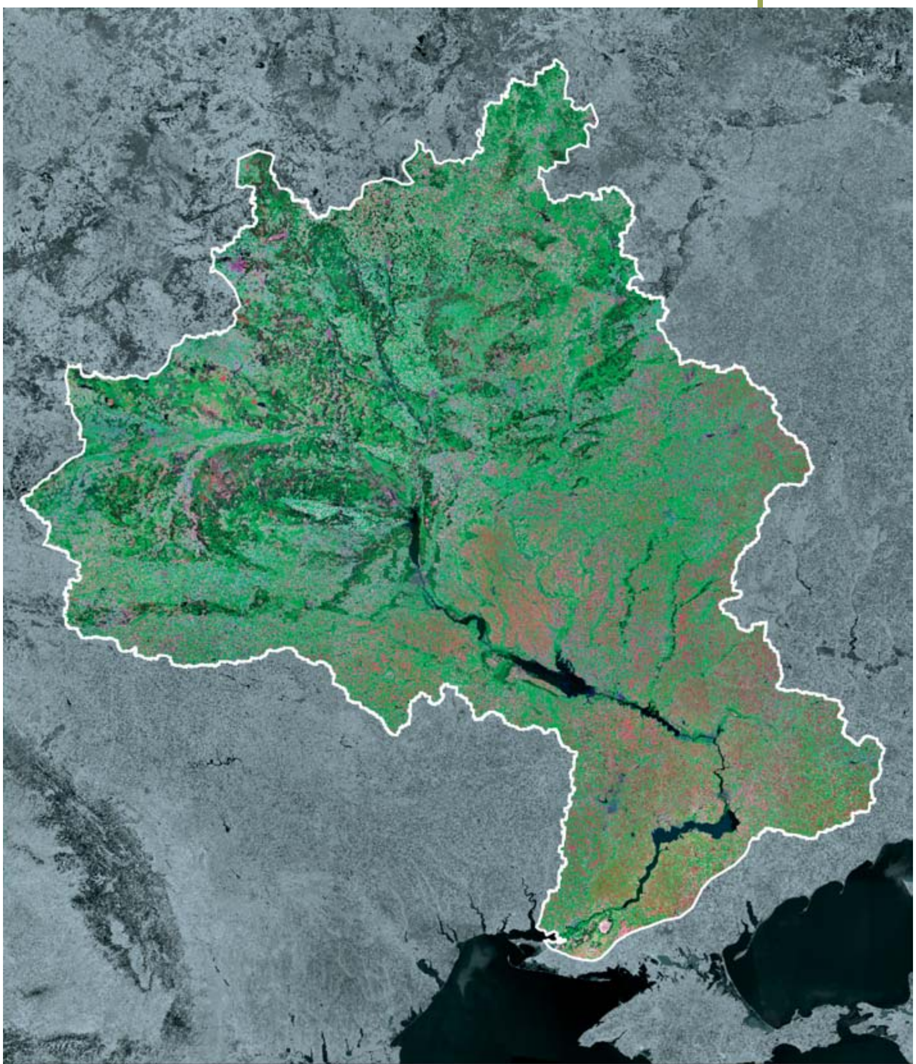
International Dnieper Basin Council

In 2003, Ministers of Belarus, Russian Federation and Ukraine signed a statement on ecological rehabilitation of the Dnieper River, leading to the creation of the International Dnieper Basin Council. The creation of this Council was facilitated within the framework of the UNDP-GEF Dnieper Basin Environment Programme.

The Council is consultative in nature and will function as a coordinating body to ensure effective international cooperation focused on the environmental rehabilitation of the Dnieper basin. It will play an active role in the development and implementation of both the regional Strategic Action Plan as well as the three countries' National Action Plans. It will also aim to ensure the development of stable transboundary monitoring systems, encourage sustainable exchange of environmental information and facilitate wide participation of interested stakeholders in river basin management.

Length (km)	*2 285*
Drainage Area (km^2)	*503 000*
Discharge (m^3/s)	*1 605*
Countries	*3*
Population	*33 000 000*
Sea at Mouth	*Black*
Ramsar Sites	*5*

Mean Discharge at mouth.



Don

Tatar: Duna, Ancient: Tanais.

GIWA - Black Sea:
www.giwa.net/sr22/

The Don River is the fourth-longest river in Europe. Its basin covers an area of 425 600 km^2 (87% in Russia and 13% in Ukraine). The Don's largest tributary is the Donets. Other important tributaries are the Voronezh, Khoper, and Medveditsa, and it is linked to the Volga by the Volga-Don Canal.

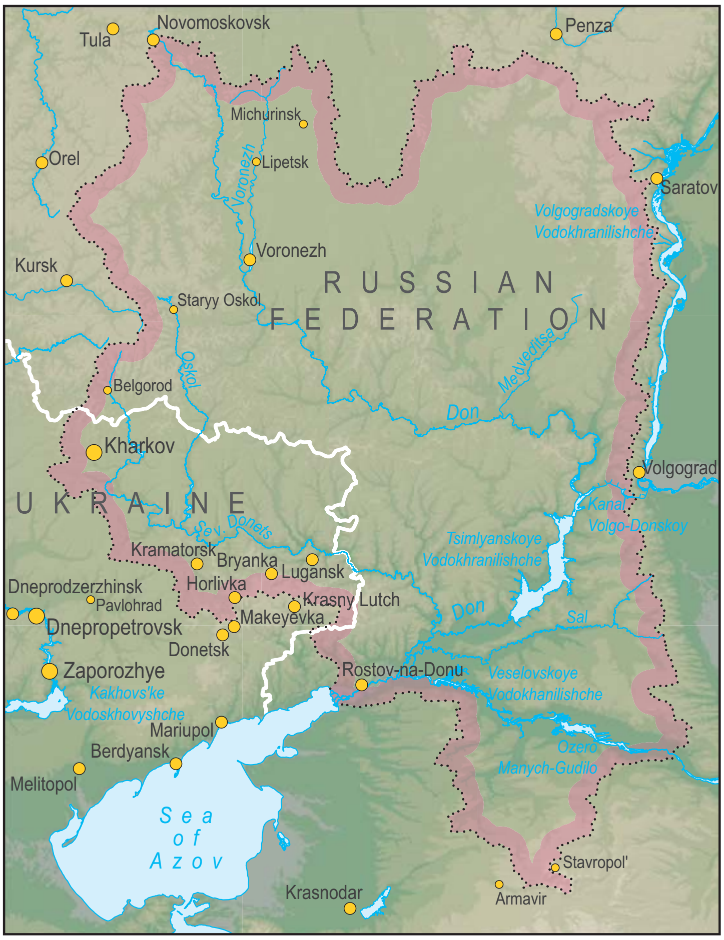
The source of the river is in Russia, southeast of Moscow near Tula. It then flows for a distance of about 1 950 km, through Voronej, crossing Rostov and entering the Gulf of Taganrog in the Sea of Azov. The Don River is linked to the Volga River by a canal (102 km) near Volgograd.

The Don is an important artery for grain, coal and lumber shipments. Rostov-na-Donu is the chief city and port on the Don. Known to the ancients as the Tanaïs, the Don has been a trading route since Scythian times.

The lower section of the Don is subject to annual floods. The most important took place in the XIX century. Although most of the River is navigable, the water level is very low in August, and the River is usually closed by ice from November or December to March or April.

Fishing activity is very important, particularly in the delta, with salmon and herring taken in large numbers, and salt fish and caviar widely traded.

The Don's tributary, Severskiy Donetz, is one of the most polluted rivers in Europe



Azov Sea

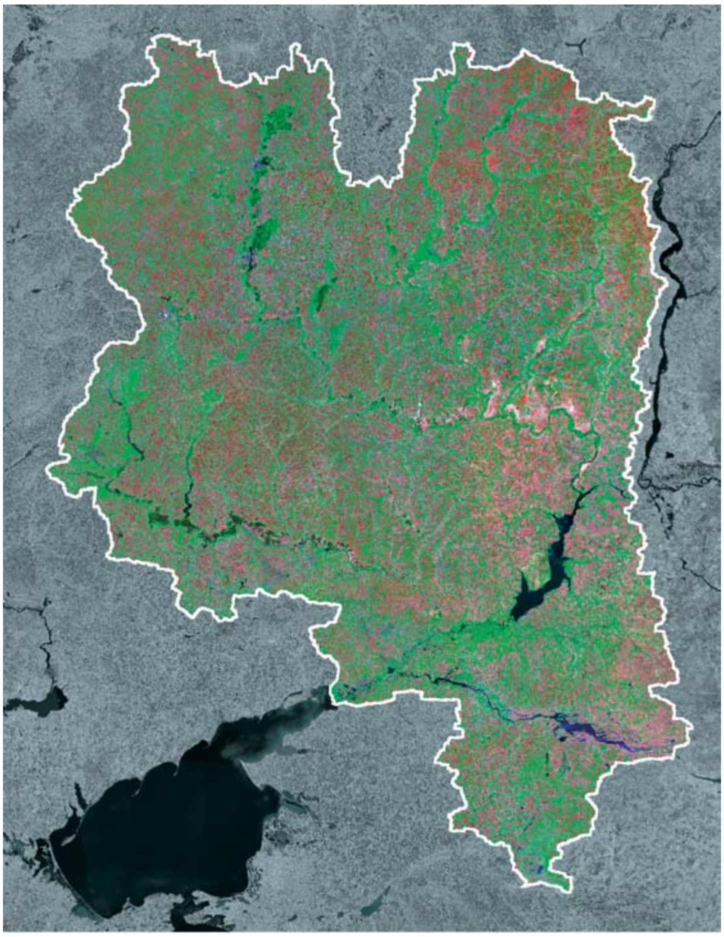
The quality of the Azov Sea water system is very much dependent upon the quantity and quality of the freshwater runoff from its drainage basin. The main influencing river is the Don, with an average natural flow of 28 km^3 (65% of total flow) per year. The Azov Sea is a shallow (a maximum depth of 9 m) inland sea on the northern Black Sea. From the hydrological point of view, the Azov Sea is a bay (lagoon) of the Black Sea, and therefore it could be considered as a part of the Black Sea.

During the Soviet era, the Azov Sea was polluted from multiple sources. Heavy volumes of waste-water from industry, households and agriculture were regularly discharged into the Sea and the rivers of its basin. Wastewaters contained heavy metals, chlororganic chemicals, phosphates and pesticides. In the late 1980s, the sea encountered the problem of intrusion of alien species: the jellyfish Mnemiopsis, which inhabits Atlantic Ocean coastal waters in the USA. The jellyfish eats almost entire zooplankton, causing changes in biota. Building of large-scale hydroprojects on the Don also resulted in the loss of natural breeding grounds for many valuable fish.

Overall, a 10-fold decline in fish productivity has been reported for major fish breeding grounds. Annual commercial catch in the Azov Sea, which in the past was one of the most productive Seas, amounts to about 5 000 tons annually, while the figure was 120-160 000 tons annually in 1935-36. Seal catch has been almost near to zero since 1992.

Length (km)	*1 970*
Drainage Area (km^2)	*422 000*
Discharge (m^3/s)	*870*
Countries	*2*
Population	*22 000 000*
Sea at Mouth	*Azov*
Ramsar Sites	*1*

Mean Discharge at mouth.



Douro

Latin: Durius, Spanish: Duero, Portuguese: Douro.

CONFEDERACIÓN HIDROGRÁFICA DEL DUERO - Spain:
www.chduero.es

Instituto da Água - Portugal (INAG):
www.inag.pt

The Douro River is the third longest in the Iberian Peninsula and its basin is the largest there. It rises in the Sierra de Urbión in central Spain, and crosses the Numantian Plateau. The river flows generally westward across Spain and northern Portugal to the Atlantic Ocean at Foz do Douro. It has extensive barge traffic in its Portuguese section, and has been harnessed for hydroelectric power.

Silting rapids, and deep gorges combine to make most of the Douro un-navigable. The middle Douro is extensively used for irrigation. There are everal hydroelectric power plants along the river, and through an international agreement the power is used for irrigation and development.

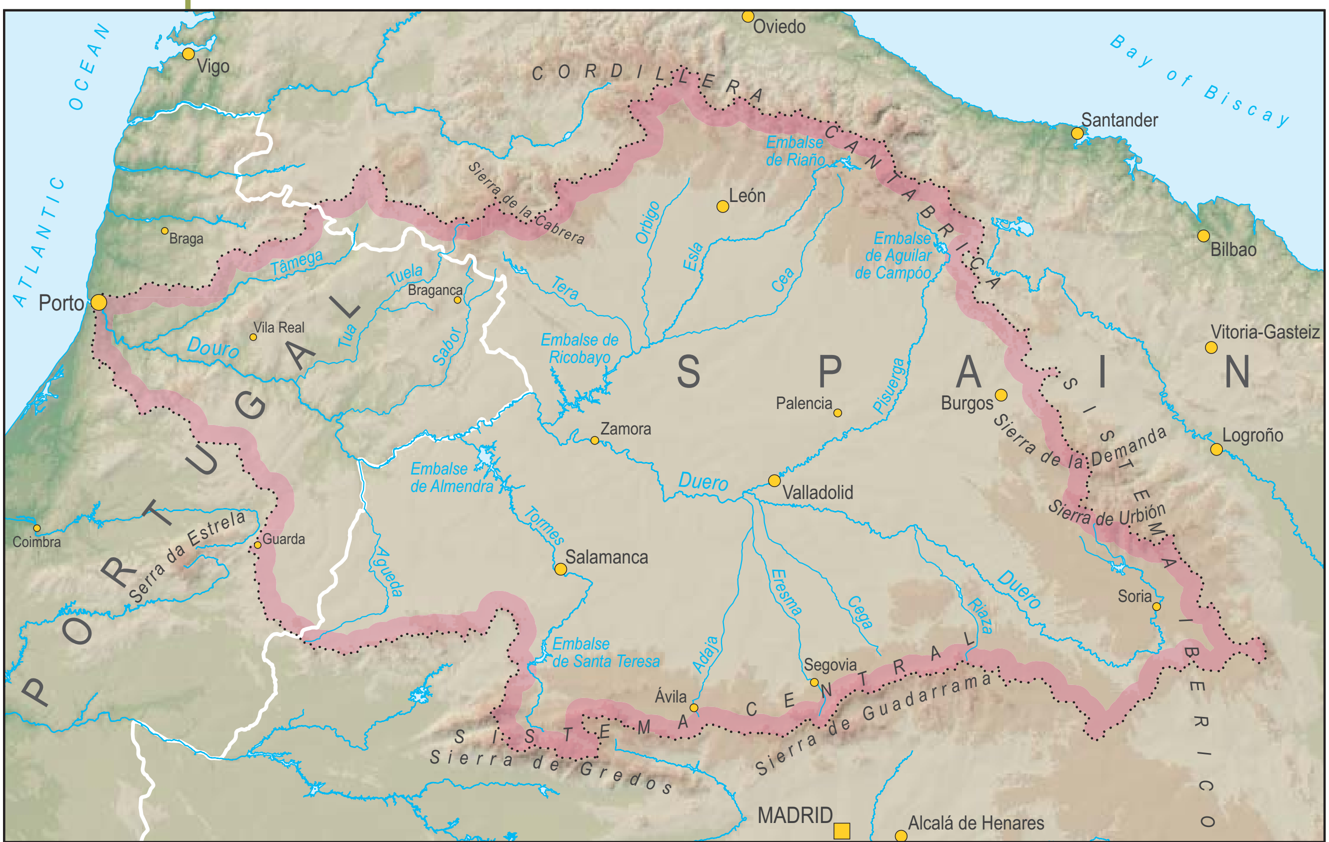
Grapes are the chief crop of the Douro valley, and the Douro estuary is the centre of the Portuguese wine trade.

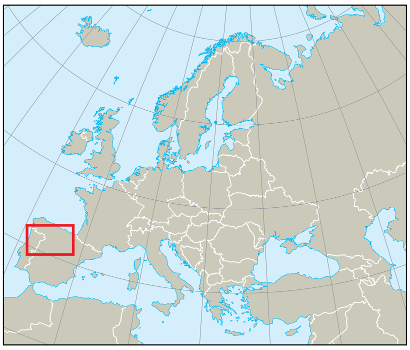
The Douro River watershed drains 17% of the Iberian Peninsula. The Douro River estuary receives largely untreated sewage from about 1 million inhabitants of Greater Porto.

In its Spanish section the Douro's most important tributaries are the Pisuerga, passing through Valladolid, and the Esla. After the Douro enters Portugal, there are few population centres. Tributaries are small and flow into canyons to enter the larger River. The most important are the Coa, Tua, Tâmega, Balsemão and Sousa. None of these small, fast-flowing rivers are navigable.

There are nine dams on the Portuguese Douro, regulating the flow of water and generating hydroelectric power.

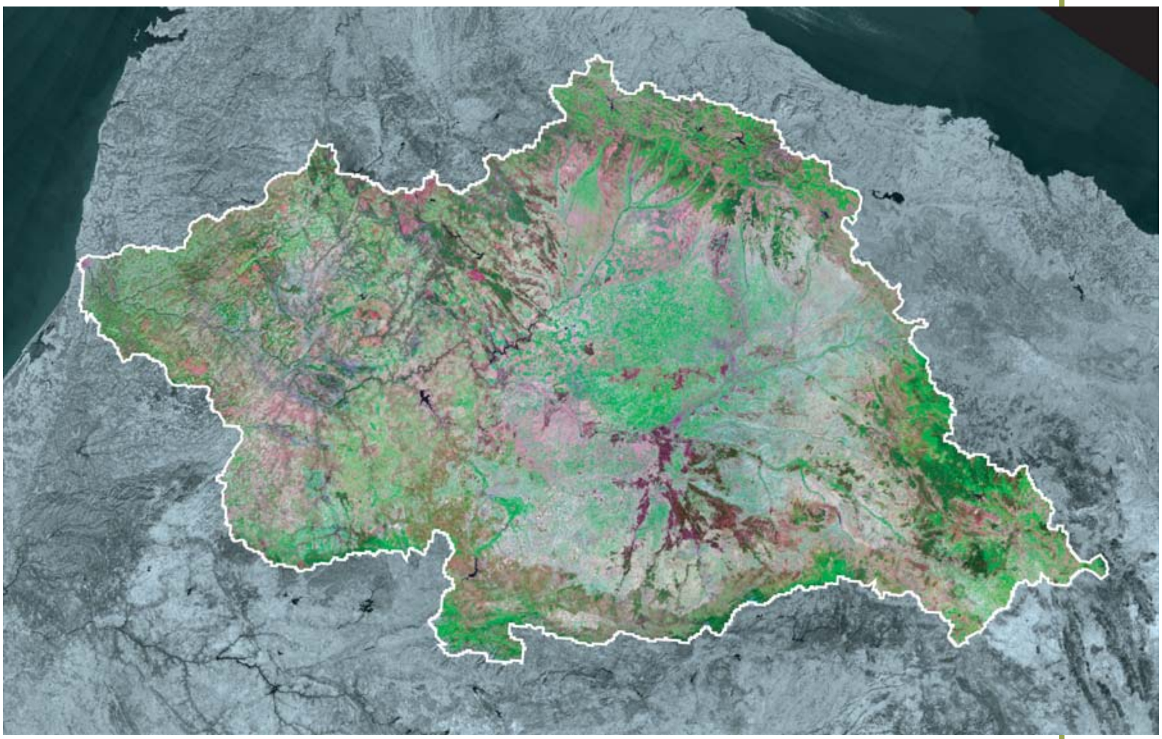
Some Spanish tributaries of the Douro River have a high phosphate concentration due to urban and industrial effluents, which make their waters unsuitable for human use. The local presence of nitrates affects different areas of the water basin: the central Duero region, Esla-Valderaduey and Arenales.





Length (km)	*897*
Drainage Area (km²)	*97 290*
Discharge (m^3/s)	*488*
Countries	*2*
Population	*4 100 000*
Sea at Mouth	*Atlantic*
Ramsar Sites	*1*

Mean Discharge at mouth.



Ebro

Spanish: Ebro, Latin: Iberus or Hiberus.

CONFEDERACIÓN HIDROGRÁFICA DEL EBRO - Spain:
oph.chebro.es

Instituto da Água - Poerugal (INAG):
www.inag.pt

The Ebro, rising near the Atlantic coast in the Cantabrian Mountains of northern Spain, drains a triangular basin between the Pyrenees and the Iberian Mountains, before emptying through a wide delta into the Mediterranean. This delta, covering 320 km², is one of the most important wetlands in Europe. An intensive rice-growing area covers 60 % of the delta.

The Ebro has the greatest discharge of Spanish rivers. In the Tortosa gauging station, the mean flow in March is 695 m^3/s while the mean flow in August is only 178 m^3/s. However, in some very dry years (1929, 1949) the mean flow was only around 30 m^3/s. Today, the minimum ecological flow is 100 m^3/s, in addition to 50 m^3/s for the delta irrigation canals.

The Spanish government plans to shift water from the Ebro basin to the southern province of Almeria (Spanish National Hydrological Plan) – but environmentalists disagree. Almeria is the site of intensive greenhouse culture, with hundreds of trucks taking produce directly to supermarkets in northern Europe on a daily basis.

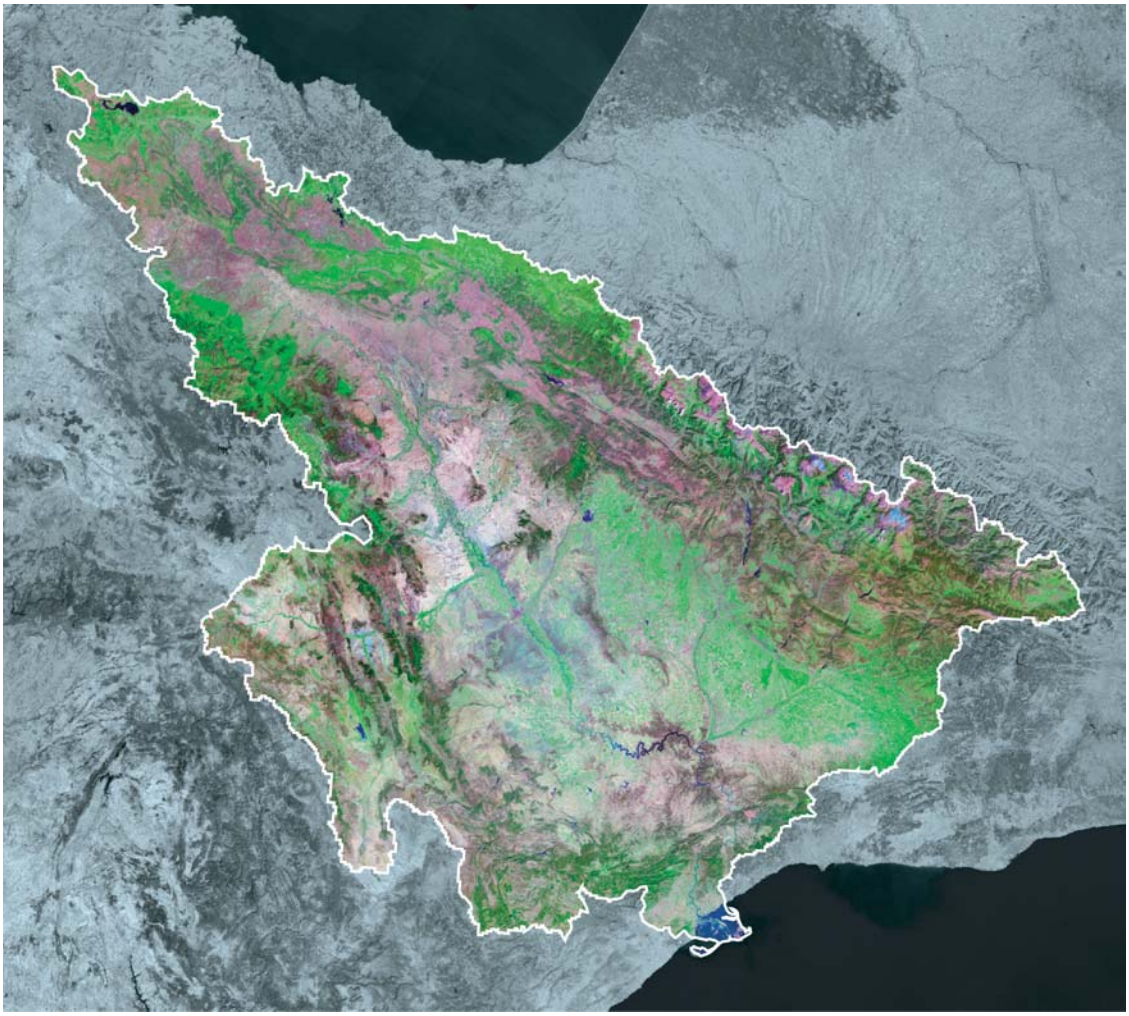
The greenhouses, golf courses, hotels and housing developments along the coast are using far more water than the underground sources can provide. Sea-water intrusion is turning the aquifers saline, while the rivers have completely dried up, with greenhouses now covering their parched beds.

Scale 1 : 3 500 000

Kilometres 0 25 50 75 100 125

Length (km)	*928*
Drainage Area (km^2)	*86 000*
Discharge (m^3/s)	*425*
Countries	*3*
Population	*2 800 000*
Sea at Mouth	*Mediterranean*
Ramsar Sites	*6*

Mean Discharge at mouth.



Elbe

Czech: Labe, Ancient: Albis.

ELBE Links:
elise.bafg.de
www.glowa-elbe.de
www.ikse.de
www.arge-elbe.de

The Elbe River forms one of the largest river systems of central Europe. It originates in the Northwest part of the Czech Republic before traversing Germany and emptying into the North Sea. Its basin covers different geographical regions from middle mountain ranges in the west and south to large flatlands and lowlands in the central, northern and eastern part of the basin. The Elbe has been navigable by commercial vessels since 1842, and provides important trade links as far inland as Prague. The river is linked by canals to the industrial areas of Germany and to Berlin. The Elbe-Lübeck Canal also links the Elbe to the Baltic Sea.

About two thirds of the river basin area belongs to Germany and one third to the Czech Republic. Austria and Poland have nearly the same small shares in the catchment. The Elbe catchment covers 27.2% of Germany and 64% of the Czech Republic. About 25 million inhabitants live in the catchment, 76% of which are in Germany and the remaining 24% in the Czech Republic. This amounts to about 58% of the Czech population and 23% of the German population. The most significant cities are Berlin (3.47 million inhabitants), Hamburg (1.71 million), Prague (1.21 million), Leipzig (480 000), Dresden (477 000), Halle (290 000), Chemniz (278 000) and Magdeburg (256 000).

The Elbe and its tributaries are mostly used for obtaining drinking water and water for industrial or irrigation purposes. Due to the poor quality of the river water, the use as drinking water and industrial water is only possible after adequate treatment or with corresponding restrictions. Compared with other areas of Europe, water availability per inhabitant (680 m^3) can be considered extremely low. Along the Elbe numerous filtration plants provide water to about 1.8 million people.

The devastating flooding in August 2002 and the winter flooding 2002/2003 suddenly brought the Elbe region to public attention. These floods brought destruction and damage to large parts of the Elbe catchment in which, until that time, the dominant problem had been low water availability.

Agriculture is an important land use in the upper reaches of the Elbe. The upper Elbe River in the Czech Republic is characterized by many regulation measures taken from 1904 to 1976. For a distance of 170 km (from Pardubice to Usti and Labem) the Elbe is a canalized river with 24 weirs and sluices. Damming on this part the Elbe has reduced the flow velocity from a slow flowing river to nearly standing water.

Known point sources of pollutants are wastewater treatment plants and industrial discharges. High potential pollution is also associated with abandoned industrial sites as well as with waste disposal sites. Between 1990 and 1999 a total of 181 water treatment plants were constructed or improved in the catchment, improving water quality significantly.

Among diffuse sources of pollutants are those connected with agriculture and farming. About 55.7% of the catchment (148 268 km^2) is used for agriculture, 55 160 km^2 (56.9% of the German basin) in Germany and 26 810 km^2 (53.4% of the Czech basin) in the Czech Republic.

In 1998 the IKSE identified the most significant industrial emissions in the Elbe basin as originating from chemical, pharmacological, cellulose and paper, metallurgic, electrical, leather, fur, glass, ceramic and textile industries, as well as from mining. In 1999 in the Elbe basin, 33 industrial sites and 15 waste disposal sites were identified as potentially dangerous.

While before and soon after the reunification of Germany the Elbe water quality was described as LAWA class III (excessively polluted) to IV (ecologically spoiled), the present state of the Elbe can be described as class II-III (critically polluted) to II (moderately polluted). The main pollutants are heavy metals, chlorinated hydrocarbons, and nitrogen compounds. A high concentration of heavy metals and chlorinated hydrocarbons (especially HCB) can still be found in sediments; this accumulates in mussels and fish, particularly in the Czech Republic. Pollution of the Moldau downstream of Prague is due to insufficient waste water treatment in this city.

Length (km)	*1 091*
Drainage Area (km²)	*148 000*
Discharge (m³/s)	*877*
Countries	*4*
Population	*25 000 000*
Sea at Mouth	*North*
Ramsar Sites	*11*

Mean Discharge at mouth.

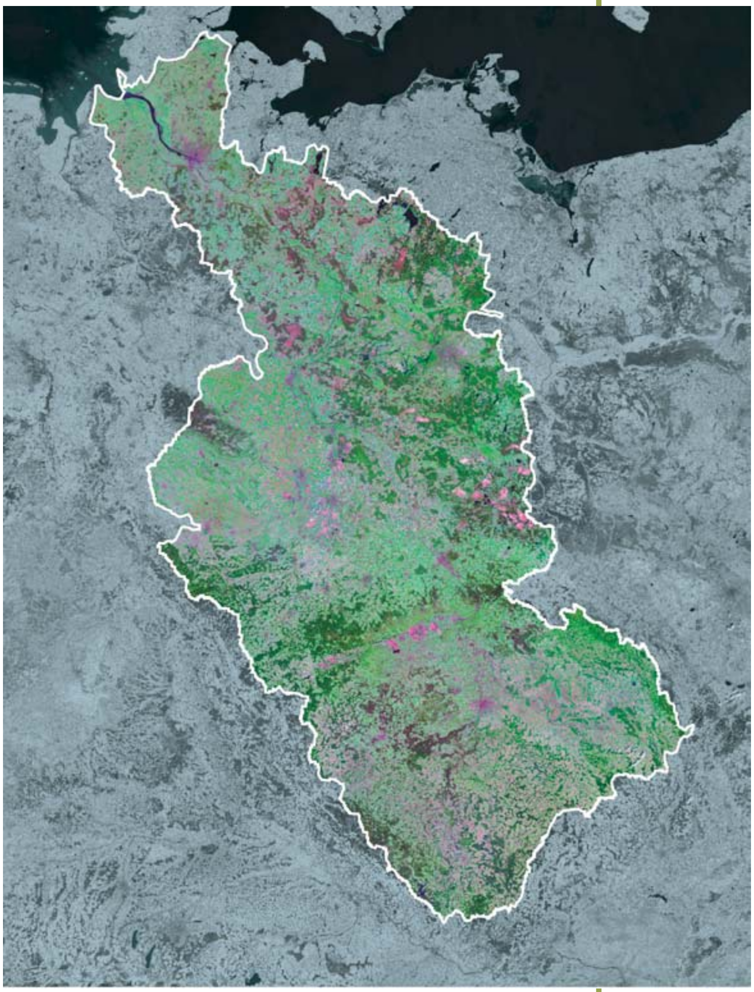
LAWA water quality classification, used in Germany, was developed by the Working Group of the Federal States on water problems in cooperation with the Federal Environmental Agency.

IKSE-MKOL

The International Commission for the Protection of the Elbe river (IKSE-MKOL) was founded in 1990 through an agreement between Germany, the Czech Republic and the European Commission. The Commission maintains a network of international monitoring stations.

GLOWA-ELBE

The GLOWA-ELBE project focuses on the impacts of Global Change on water availability problems and water use conflicts in the Elbe catchment. In the primary problem area, the Spree/Havel Basin, the project not only aims to identify problems and conflicts, but also to develop integrated strategies to tackle these in a sustainable way.



Garonne

French: Garonne, Spanish: Garona.

Agence de l'Eau Adour-Garonne:
www.eau-adour-garonne.fr

Garonne Portal:
www.lagaronne.com

Flowing for a distance of 525 km, the Garonne is the most important river of Southwestern France. Its watershed covers 57 000 km². It originates in Spain at 1 900 m altitude in the Val d'Aran in the Pyrénées. Its main tributaries are the Lot, the Tarn and the Aveyron. After the city of Toulouse, the Garonne becomes navigable. It goes through Bordeaux and joins the Dordogne to form the Gironde estuary. The Gironde estuary is the largest estuary in Europe: 75 km long, up to 12 km wide, covering an area of 635 km².

The Garonne traverses 217 French municipalities including five main cities: Saint-Gaudens, Toulouse, Agen, Marmande, and Bordeaux. The Bordeaux industrial region extends along the Gironde's southern coast. The estuary region is well known for the quality of its vineyards.

A accompanying canal was built in the XIX century connecting Bordeaux and the canal du Midi at Toulouse. The Garonne frequently leaves its bed; the most catastrophic floods were recorded in 1770, 1856 and 1930.

The Garonne is an important breeding area for sturgeon and also for the migration of Atlantic salmon. The Gironde estuary in particular is a very important site for fish and bird migrations. The water quality varies with the tide, with wastewater from Bordeaux causing important nitrogen and phosphorous concentrations downstream of Bordeaux. One tributary of the Garonne, the Dropt, is particularly sensitive to eutrophication, but globally the water quality of the Garonne is between good to very good.

2003 Heat-wave

The Garonne was the French river which most suffered from the 2003 summer heatwave. During the month of August, its runoff fell to 41 m^3/s at Lamagistère, and 14 m^3/s at Valentine, reaching the critical runoff limit at this station. The 27 million m^3 of water released by EDF (Electricite de France) and the restrictive measures for consumers only limited the impacts.

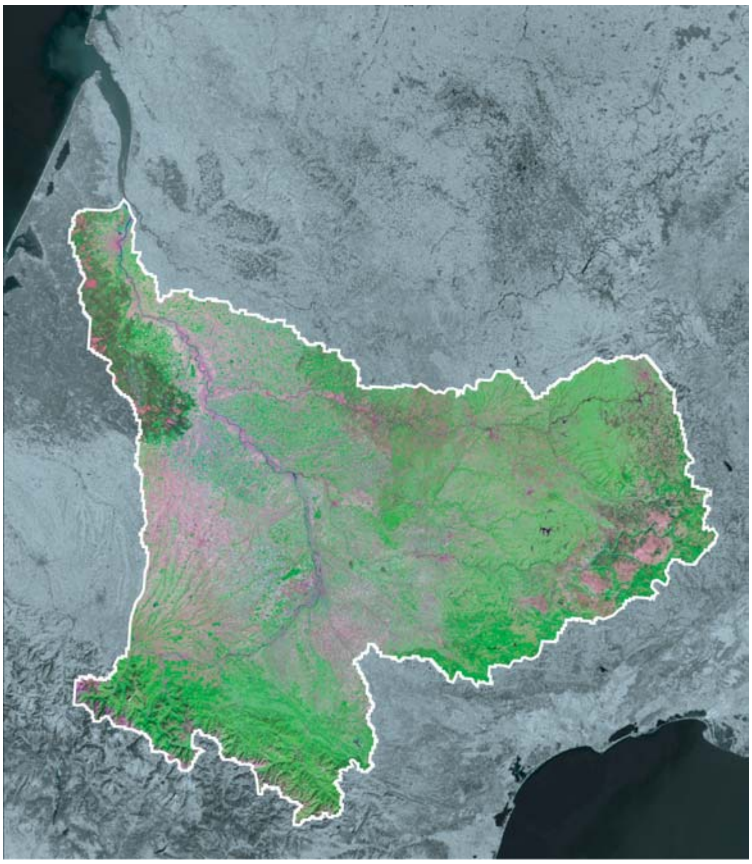
AZF Factory Explosion

The explosion which destroyed the "AZF" factory in Toulouse on 21 September 2001 is one of the most severe industrial accidents of the last decades in terms of magnitude and consequences.

Among its environmental impacts, the explosion released a cloud of atmospheric pollution essentially made up of nitrogenous compounds which then spread over the South-Western part of the urban centre. The accident also caused the release of nitrogenous compounds into the branch of the Garonne river bordering the plant. Finally, the blast sprayed fragments of soil and particles from this old industrial site over the neighbouring districts.

Length (km)	525
Drainage Area (km^2)	57 000
Discharge (m^3/s)	200
Countries	2
Population	2 500 000
Sea at Mouth	Atlantic
Ramsar Sites	0

Mean Discharge at mouth.



Guadalquivir

Arabic: Wadi Al-Kabir, Spanish: Guadalquivir.

CONFEDERACIÓN HIDROGRÁFICA DEL GUADALQUIVIR - Spain:
www.chguadalquivir.es

Instituto da Água - Portugal (INAG):
www.inag.pt

The Guadalquivir River rises in the Sierra de Cazorla, Southeastern Spain, and flows generally south-west past Córdoba and Seville into the Gulf of Cádiz near Sanlúcar de Barrameda.

The Guadalquivir is Spain's second longest river. Its natural environment is one of the most varied in Europe, containing representatives of half of the continent's plant species and nearly all those of the North African region. The fauna also includes a great variety of European and North African species.

There are several hydroelectric plants along the course of the river. Its middle reaches flow through a populous fertile region at the foot of the Sierra Morena, where its water is used extensively for irrigation. The lower course of the Guadalquivir traverses extensive marshlands (Las Marismas) that are used for rice cultivation. The river is tidal to Seville (80 km upstream), a major inland port and head of navigation for ocean-going vessels. The Guadalquivir is canalized between Seville and the sea.

In 1969, the World Wilde Fund for Nature (WWF) together with the Spanish government purchased a section of the Guadalquivir Delta marshes and established the Coto Doñana National Park. This important wetland area, one of the last refuges of the Spanish imperial eagle and the Iberian lynx, is threatened by agricultural development and tourism.

Navigation in the Guadalquivir River up to the Port of Seville also leads to a serious environmental problem due to the erosion this causes to the riverbanks within the National Park and to the dredging carried out in order to deepen the navigation canal.

In 1997, the Jaen area within the Guadalquivir river basin had a water deficit of 480 million m^3, of which some 300 million m^3 were used for irrigating olive groves.

Scale 1 : 2 500 000

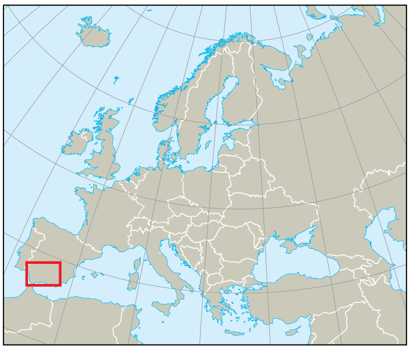
Kilometres 0 30 60 90 120 150

Pollution from Mining Activities Threatens Doñana National Park

A supporting wall of the reservoir containing toxic wastes of the Aznalcollar mine burst on 25 April 1998, releasing 5 million cubic metres of toxic mud and acidic water onto the surrounding landscape. The toxic waste entered the Agrio River, a tributary of the Guadiamar River, which feeds the swamps of the Guadalquivir situated within the Doñana National Park.

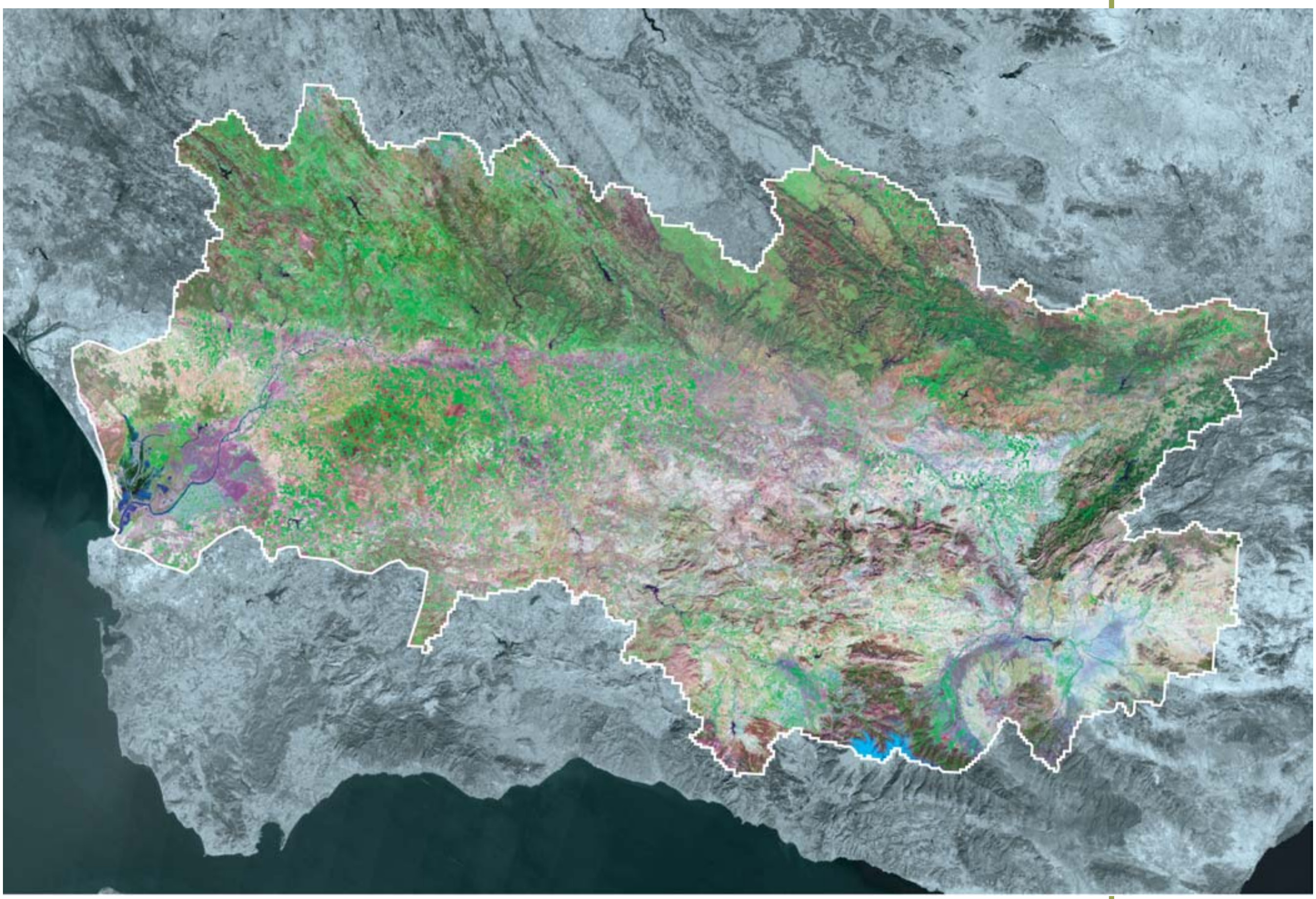
The toxic mud contained high levels of iron, manganese, lead, nickel, zinc, cadmium and arsenic, as well as traces of mercury, and flowed downstream, systematically overflowing the banks and covering the adjacent fertile land, reaching widths of 1 000 m in certain places. Twenty-four hours later, the mud stopped advancing very close to the limits of the National Park after affecting the swamps and rice fields to the north of the Lucio del Cangrejo. However, the polluted waters, with less concentrations of heavy metal, entered the Lucio del Cangrejo and flowed through the Brazo de la Torre into the Guadalquivir River. The toxic mud did not enter the National Park. However, it polluted between 5 000 and 7 000 hectares of surrounding land, directly affecting the Natural Park, Ramsar Site and Biosphere Reserve. The Spanish Ministry of Environment has formulated the “Doñana 2005” project, which encompasses a series of strategic actions to restore the traditional hydraulic dynamics of the site.

In recent years, concern has also been expressed over the impact of mass tourism and intensive irrigated agriculture in the region outside the National Park. There have been fears that these activities are causing over-exploitation of regional aquifers, leading to a fall in groundwater levels and a gradual reduction in the extent and duration of seasonal flooding in the marshes.



Length (km)	*666*
Drainage Area (km²)	*57 527*
Discharge (m³/s)	*230*
Countries	*1*
Population	*4 000 000*
Sea at Mouth	*Atlantic*
Ramsar Sites	*3*

Mean Discharge at mouth.



Guadiana

Arabic: Wadi Ana, Portuguese: Guadiana, Spanish: Guadiana.

CONFEDERACIÓN HIDROGRÁFICA DEL GUADIANA-Spain:
www.chguadiana.es

Instituto da Água - Portugal (INAG):
www.inag.pt

The Guadiana River basin has a total drainage area of 66 800 km^2 of which 11 580 km^2 are located in southeastern Portugal. It constitutes one of the three main drainage units of the Iberian Peninsula shared between Portugal and Spain. The River flows westward through south-central Spain and southeastern Portugal to the Gulf of Cádiz and the Atlantic Ocean.

The land use is predominantly rural. Of the total needs for irrigation and domestic water supply in the Guadiana basin, 19% are in Portugal and 81% in Spain, while 25% of the average annual discharge is generated in Portugal and 75% in Spain.

The Portuguese section of the River has a slight water deficit, aggravated in extremely dry years. The river discharge is very irregular.

A major part of the water quality problem comes from agricultural practices, where nitrates, phosphates and phytopharmaceutical products such as pesticides abound. The loads stemming from agricultural activity combined with the summer high temperatures periodically stimulate algae blooms. Eutrophication is affecting several man-made lakes.

The main problems within the river basin are the overexploitation of the aquifers in the upper river basin for agricultural use, the agricultural contamination, and fragmentation by dams. The severe drying-out of the upper river and associated wetlands, such as the Tablas de Daimiel National Park, has aggravated water management problems in the river basin. The current solution is water transfer from the Tagus river basin, which has resulted in the introduction of a number of alien species that endanger the local endemic fish species in the Guadiana.

Point source pollution from industries, mining, sewage treatment plants, landfills, and others, also cause major pollution problems.

Another type of pressure on the ecological status and water quantity is the large number of dams built for irrigation both upstream in Spanish territory and on the Portuguese downstream side. There are 1,824 dams in the Guadiana river basin, of which 86 are major dams that retain about 150% of the average annual rainfall. The Alqueva is the largest and one of the newest dams in the Iberian peninsula.

In Spain, the River Basin Authority is drafting with the farmers - while excluding other stakeholders - an "Upper Guadiana Plan".

The CADC (Commission for the Application and Development of the Albufeira Convention between Portugal and Spain) is particularly active in the Guadiana river basin. There are a number of Working Groups and Sub-commissions working in the Guadiana and several joint studies have been executed on the transboundary river basin.

Scale 1 : 3 500 000

Kilometres 0 25 50 75 100 125

Alqueva Dam

The Alqueva dam, located on the Portuguese section of the Guadiana River, is one of the biggest dams in the Iberian Peninsula. It has given its name to the Alqueva Dams Scheme.

The first plans to create a water reservoir in the Alentejo region of the Guadiana River were made nearly 100 years ago. The project was prepared in 1957, as part of the the Alentejo Irrigation Plan.

The preliminary work in the 1970s lasted only two years, during which the downstream and upstream cofferdams, the provisional deflection tunnel, and access and support infrastructure were built.

After interruptions, construction began in 1998. The Alqueva reservoir began filling in February 2002.

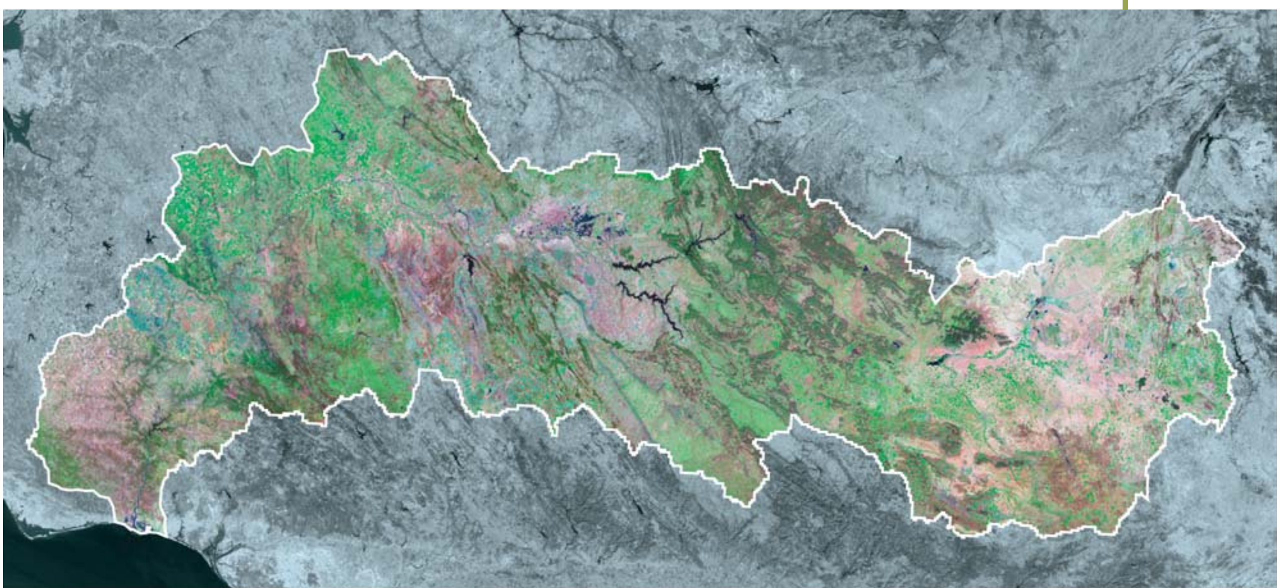
The Multipurpose Alqueva Project is a regional development project. It is a hydroelectic facility located in the heart of Alentejo, the main target region to benefit from the objectives of the Project.

The Alqueva reservoir is 83 kilometres long and covers an area of 250 km2 (63 km2 in Spain). Its shoreline extends for approximately 1 100 km. The total capacity of the reservoir is 4 150 billion m3 with a useful capacity of 3 150 billion m3.

National and regional environmental NGOs are represented on the CAIA (Commission for the Environmental Monitoring of Alqueva Dam).

Length (km)	778
Drainage Area (km^2)	66 800
Discharge (m^3/s)	80
Countries	2
Population	4 000 000
Sea at Mouth	Atlantic
Ramsar Sites	2

Mean Discharge at mouth.



Loire

French: Loire.

Loire Basin Agency:
www.eau-loire-bretagne.fr

The Loire River, with 1 010 km, is the longest river in France. From its source in the Ardèche, it flows through the Massif Central to the Atlantic Ocean beyond the city of Nantes. Its watershed covers one-fifth of France (120 000 km^2). The Loire is subject to heavy flooding and important seasonal fluctuations in volume. Spring floods alternate with dry summers causing very low water levels. Extreme high and low levels were recorded in December 1910 (6 300 m^3/s) and August 1949 (49 m^3/s). With such variability the use of the Loire for navigation is very limited. The river is called "the last wild river in Europe". Floods over 3 200 m^3/s cover the valley flood-plain. At low water levels, "a sand river" replaces the usual river. Because of the potential heavy flooding, dikes line the river banks. Attempts to control the river must have begun at a very early date. The Loire is channelized for a long distance and is linked to the Seine and the Saône by canals.

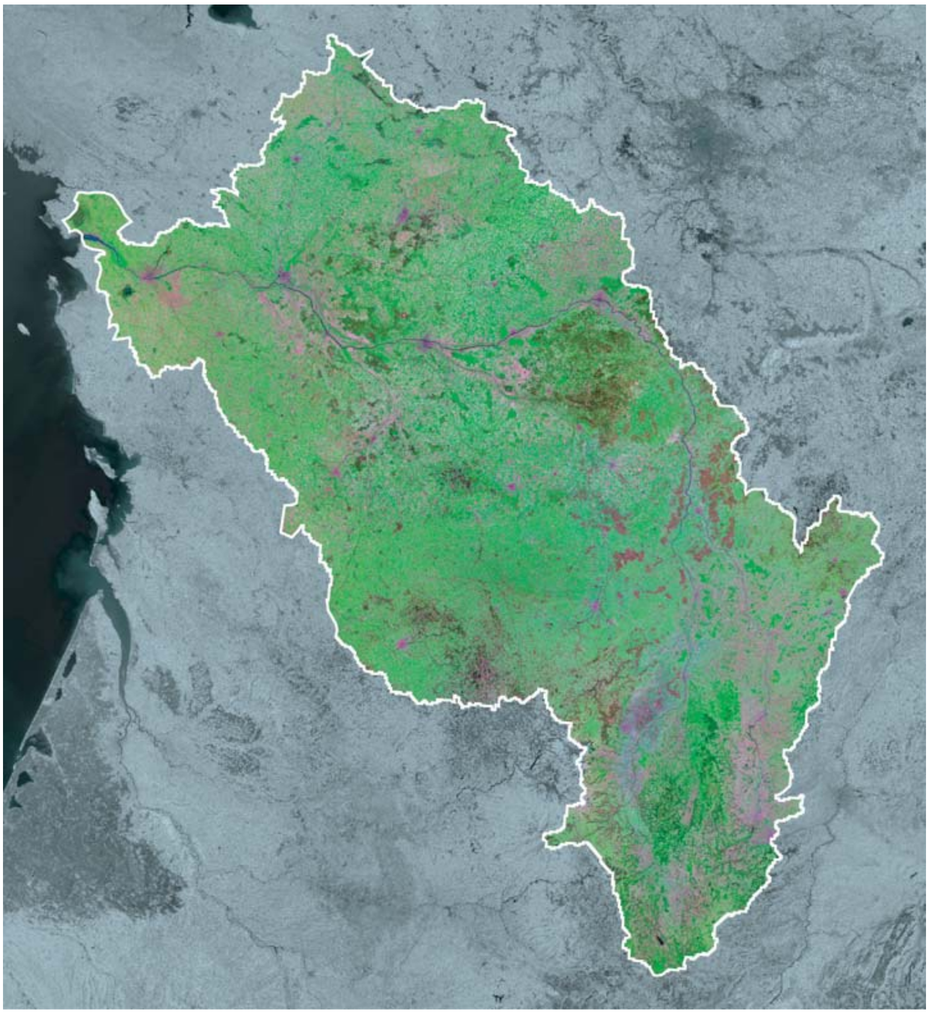
The Loire basin is an important farming area, producing two thirds of the livestock and half of the cereal production of France. The valley is famous for its vineyard and castles. Kings of France at the end of Middle-Ages and during the Renaissance chose to live on the banks of the Loire. Several castles were listed in 2000 by UNESCO as World Heritage sites. Its watershed also includes four RAMSAR natural wetland sites and several natural parks such as the Parc Naturel Loire/Anjou/Touraine created in 1996. A number of areas along the Loire are also classified as Natura2000 sites. Although 50% percent of its banks are diked, natural zones remain and host an important biodiversity. The Loire is a refuge for european beavers, otters, and crested newts, and a migration route for fish such as atlantic salmon.

Scale 1 : 4 500 000

Kilometres 0 25 50 75 100 125

Length (km)	*1 100*
Drainage Area (km²)	*120 000*
Discharge (m³/s)	*850*
Countries	*1*
Population	*11 500 000*
Sea at Mouth	*Atlantic*
Ramsar Sites	*3*

Mean Discharge at mouth.



Oder

German Oder, Czech and Polish Odra.

ICPOAP: www.mkoo.pl

The second longest river emptying into the Baltic Sea, the Oder River flows northward from the Oder Mountains of the Czech Republic to form, with the Neisse River, the border between Poland and Germany. It is an economically important transport route, navigable for more than 700 km of its 903 km length, and connected by canal with the Vistula River and with western European waterways. Most of the river basin is densely populated lowland less than 200 m above sea level.

The Oder valley, with its old riverbeds, floodplain forests and wet meadows, constitutes one of the most vital ecological corridors in Central Europe.

Known for catastrophic floods in 1997, the Oder River and its tributaries have valuable natural floodplains that are of great importance for effective flood prevention. However, lack of traditional ecological methods of flood prevention is one of the most important problems hindering the realisation of effective and permanent flood control in Poland. An effective, cheap and long-lasting flood prevention method along the Oder is the restoration of the natural floodplain areas, including the forested areas.

The Oder estuary at the German/Polish border is charcterized by various water quality problems. Due to the heavy nutrient load, the Oder river is one of the most important sources of eutrophication and pollution in the southwestern part of the Baltic Sea.

ICPOAP

The International Commission on the Protection of the Oder against Pollution (ICPOAP) is one of thirteen international commissions for the protection of rivers, lakes and seas whose catchment areas fall within the territories of more than one country. The ICPOAP was established on the basis of a Convention signed by the Governments of the Republic of Poland, the Czech Republic and the Federal Republic of Germany and by the European Community.

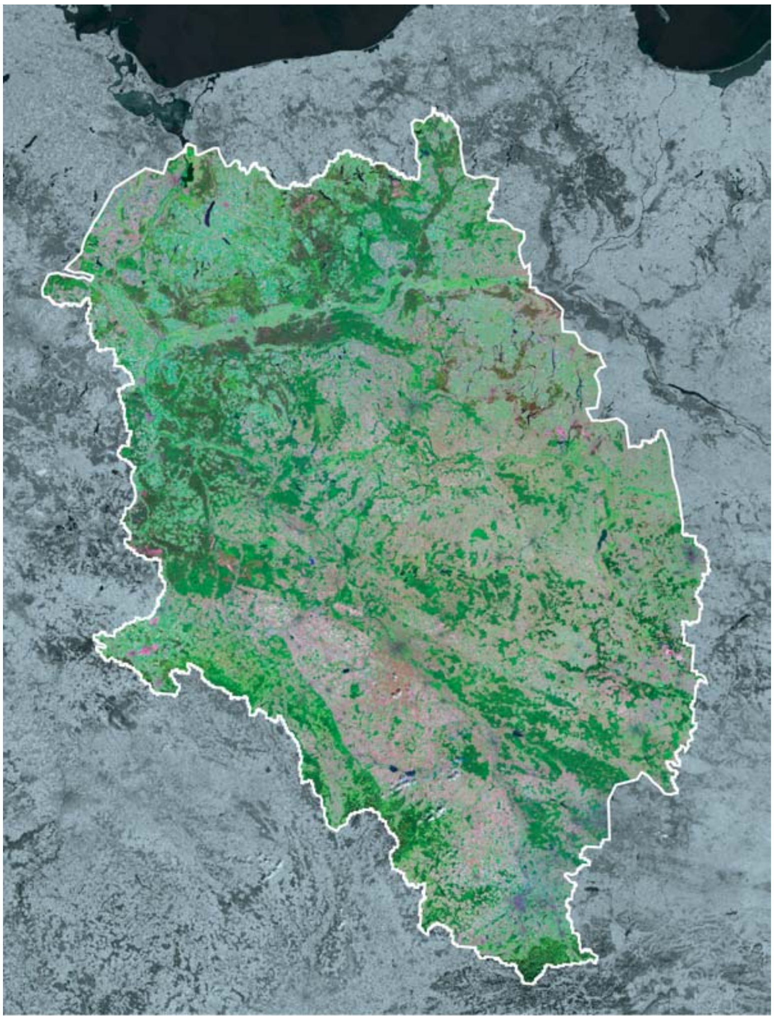
In May 2002 ICPO received the mandate to coordinate the implementation of the EU Water Framework Directive within the international Oder River basin.

1997 Flood

As a result of extreme rain during July 1997, Poland was affected by a devastating flood, the worst in the past 200 years. Areas in seven voivodships in the upper and middle Oder river basin and upper Vistula river basin were flooded over more than 25% of their territory, causing flood damage of approximately 3 billion US dollars.

Length (km)	*906*
Drainage Area (km²)	*125 000*
Discharge (m^3/s)	*540*
Countries	*3*
Population	*10 000 000*
Sea at Mouth	*Baltic*
Ramsar Sites	*4*

Mean Discharge at mouth.



Po

Ancient: Padus, Italian: Po.

Po Basin Authority: www.adbpo.it

The Po River basin is the largest Italian basin, covering an area of 74 000 km^2 (70 000 km^2 in Italy, 4 000 km^2 in Switzerland and France). The Po crosses the northern part of Italy for over 650 km and discharges its water into the Northern Adriatic Sea at an average 1 470 m^3/s. Its delta, covering about 380 km^2, is regarded as one of the most complex estuarine systems in Europe.

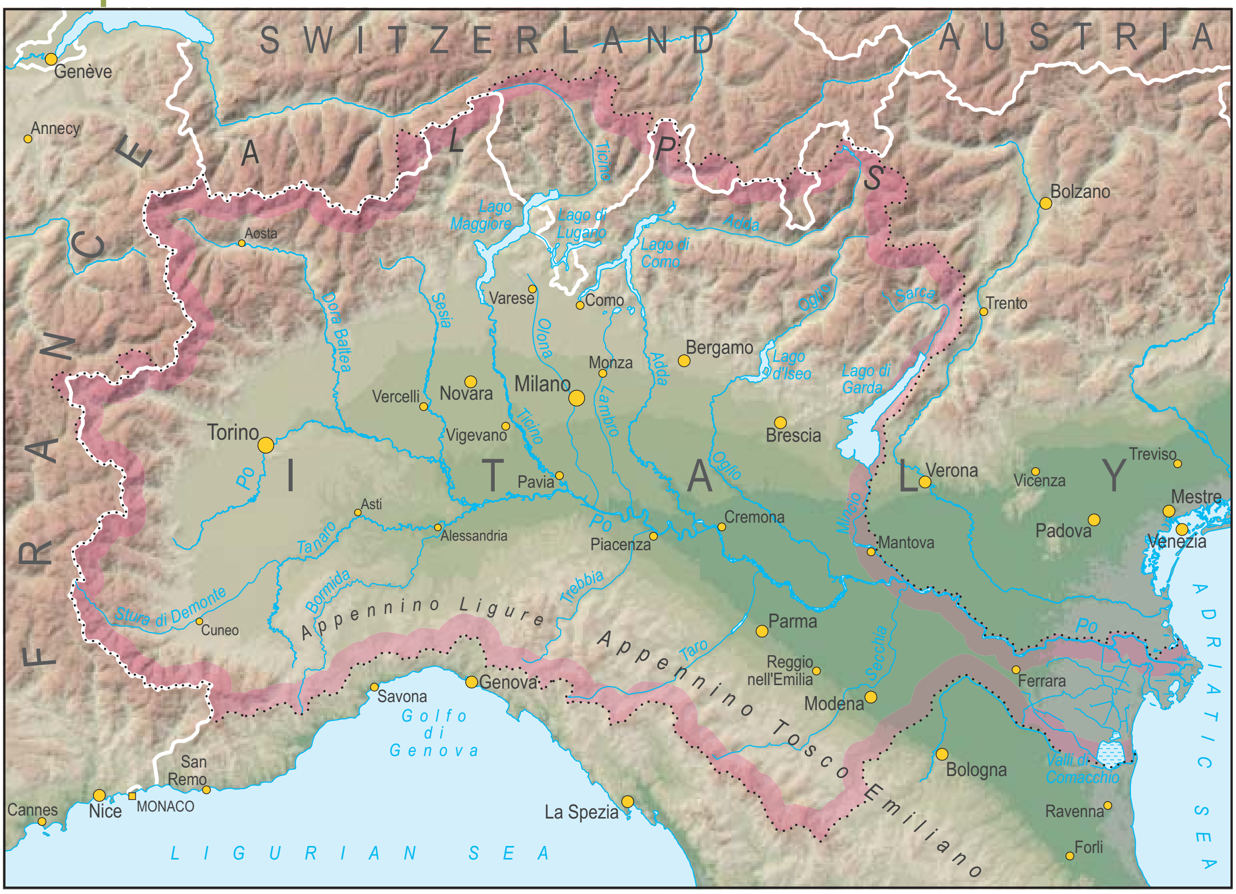
The Po river basin area can be divided into two parts: the North side and the South side . On the North side, the water flow from 16 000 km^2 is regulated by five large lakes. These lakes are directly connected to the main tributaries of the Po River, maintaining a continuous interchange of ground water and surface water between the lakes and rivers. The lakes have an important role in the tourism industry, but are affected by eutrophication.

The Po area is a strategic region for the Italian economy, with significant agriculture, livestock, industry and tourism. Covering some 24% of the national territory, with a resident population of about 17 million inhabitants, the basin accounts for 40 percent of the country's GDP. Among the industrial activities in the area, the most important are chemicals, engineering, textiles, paper and food production.

Each year about 27.9 billion m^3 of water are withdrawn, 5.1 billion of which are for industry, 0.6 billion for agriculture and 2.2 billion from wells for domestic and commercial use.

The two main urban and industrial agglomerations are the municipalities of Milan and Turin. The population density is about 232 inhabitants/km^2 for the whole basin. The highest density of settlements is found in the Lambro-Olona-Seveso catchment basin, south of Milan, with 1 478 inhabitants/km^2, while the lowest densities are in the upper part of the Trebbia and Parma sub-basins, with 24 to 26 inhabitants/km^2. Some 37% of Italy's industry is located in the basin, employing 47% of the workforce and accounting for 48% of the total national electricity consumption. There are some 280 power plants (269 hydroelectric, 11 thermal power).

The principal farming areas in the Po catchment are localised in the Po valley, covering 45% of



Scale 1 : 3 000 000 Kilometres 0 25 50 75 100 125 the basin's total area, 50% of which is irrigated. Most of the agricultural land in the Po valley is arable land, drained by artificial ditches, and irrigated during summer. The major crops that are grown are wheat, maize, fodder, barley, sugar beets and rice. The agricultural sector is an important consumer of water, resulting in a high level of water wastage due to infiltration and discharge. The main environmental problems are related to chemical and organic fertilizer input, and to the use of pesticides.

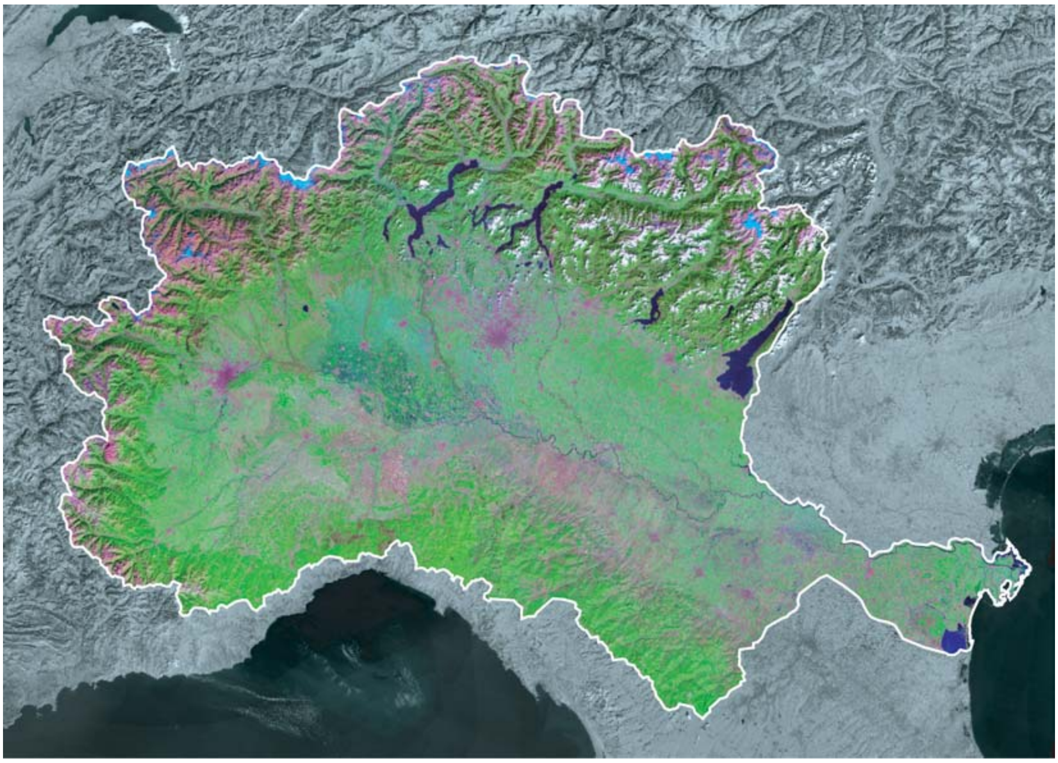
Nutrient concentrations have decreased in the last decade, as new sewage networks and wastewater treatment plants were constructed.

Length (km)	*650*
Drainage Area (km^2)	*74 000*
Discharge (m^3/s)	*1 470*
Countries	*3*
Population	*17 000 000*
Sea at Mouth	*Mediterranean*
Ramsar Sites	*9*

Mean Discharge at mouth.

Institutions

There are many public institutions in the area that are responsible for water quality. The principal ones are the Basin Authority of the Po River (ABP), the Regional Councils (RC) and the Regional Agencies for Environmental Protection of the involved regions: Veneto (ARPAV), Friuli Venezia Giulia (ARPA FVG), Emilia Romagna (ARPA EMR), Lombardia, Piemonte, Liguria, Trentino Alto Adige, Valle d'Aosta; the Italian Ministry of Environment (ME) and the National Agency for Environmental Protection (ANPA). The Councils of Provinces have some local responsibilities. The Po Basin Authority has promoted the creation of a Consultation Committee including a number of stakeholders. However, this committee has not yet been officially established.



Rhine

German: Rhein, Dutch: Rijn, French: Rhin.

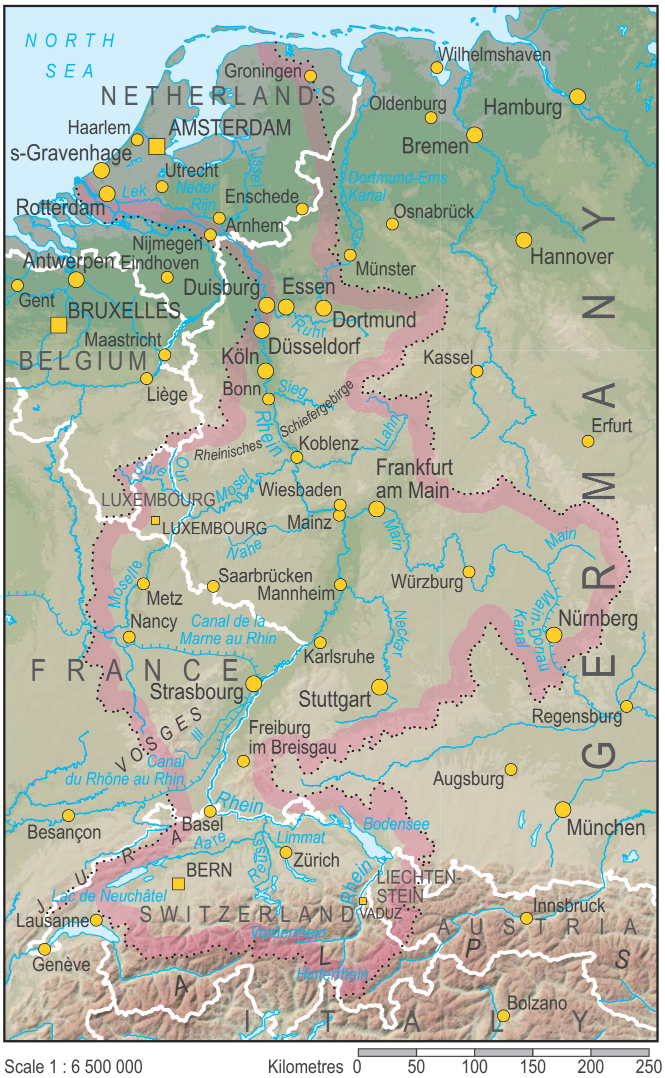
CHR:
www.chr-khr.org

IKCR-ICPR:
www.iksr.org

The Rhine River is Western Europe's largest river basin, with an area of 185 000 km² and mean annual discharge of 2 200 m³/s. Rising in the Alps, it flows from the Swiss mountains through Austria, Germany, France and Luxembourg to the Netherlands. Navigable from Rotterdam to Basel, the Rhine is one of the most important transboundary waterways in the world.

Many cities and major industrial areas have occupied its banks for centuries. The major cities are situated on the Rhine or on its larger tributaries. One of the world's densest road and railway networks follows its course. The Rhine also irrigates areas of intensive agriculture and vineyards producing highly-prized wines. Run-off from dairy and pig farms also cause degradation.

For decades, industrial and domestic waste flowed untreated into the river, and the Rhine was one of Europe's most repelling waste dumps. Fish disappeared and it was dangerous to swim. The International Commission for the Protection of the Rhine (ICPR) was finally established in 1950 as a permanent intergovernmental body to handle general pollution issues. The catalyst for improving the Rhine water quality came in 1987, when an accident at a Basel chemical plant let tonnes of toxic pesticides leak into the river. Thousands of fish died and some species disappeared. Since 1987, point discharges of hazardous substances have decreased by 70 to 100 per cent. Effluents containing dioxins and DDT are no longer found. Discharges of heavy metals such as lead, cadmium, copper and zinc and of pesticides have been substantially reduced. Nitrogen running off from non-point sources into tributaries, i.e. from agricultural soils, is still a problem.



The idea of an integrated ecosystem that will enable a rich variety of animal and plant life to thrive in the Rhine basin has come a long way. In 1998, the ministers of the European Commission set targets to restore natural areas as part of a single ecosystem stretching from the mouth of the Rhine to the Jura, the Alps, the Rhine mountain range, the old softwood forests of the floodplains and streams of the Rhineland-Palatinate, the Black Forest and the Vosges.

Concerted efforts by all the basin countries have contributed to restore the river's health. The return of fish is a clear sign that the water quality has improved. But, although the water quality itself is now good, the natural habitats of the river can be improved. A clear passage for migrating fish is needed so the salmon can return. A new project to restore salmon in the river has been delayed, since hydro-electric power stations have limited access to spawning grounds.

Several environmental problems remain. A major issue is the Rhine delta's huge basin in the Netherlands, where toxin-filled mud dredged from the port of Rotterdam has been dumped since the 1970s.

Contamination levels are falling now, but several old toxins in the river's sediment are only very slowly being removed.

Length (km)	*1 320*
Drainage Area (km²)	*185 000*
Discharge (m³/s)	*2 200*
Countries	*9*
Population	*50 000 000*
Sea at Mouth	*North*
Ramsar Sites	*18*

Mean Discharge at mouth.

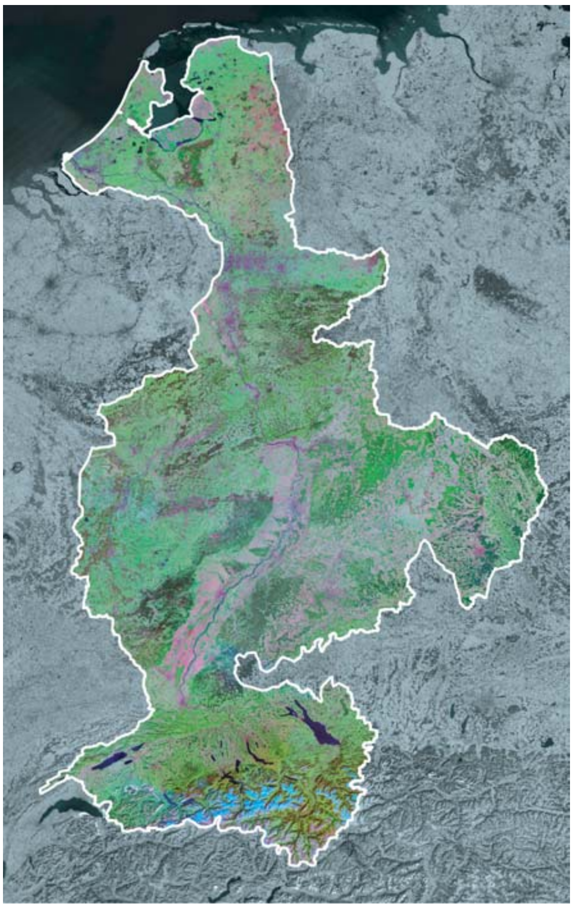
International Commission for the Protection of the Rhine against Pollution

The "International Commission for the Protection of the Rhine against Pollution" (ICPR) was founded in Basel on 11 July 1950. ICPR co-operates with states, other intergovernmental organisations and non governmental organisations.

When signing the new Convention on the Protection of the Rhine in Bern on 12 April 1999, the Governments of the five countries bordering the Rhine (France, Germany, Luxemburg, the Netherlands, Switzerland), and the representative of the European Community formally confirmed their determination to reinforce their co-operation for continued protection of the valuable character of the Rhine basin, its banks and its flood plains. This Convention replaces the Bern Convention signed in 1963, and entered into force on 1st January 2003.

International Commission for the Hydrology of the Rhine Basin

The International Commission for the Hydrology of the Rhine basin (CHR) is an organisation where the scientific institutes of the Rhine riparian states formulate joint hydrological measures for sustainable development of the Rhine basin.



Rhône

Latin: Rhodanus, French: Rhône.

Rhône Basin Authority:
www.eaurmc.fr
rdb.eaurmc.fr

The Rhône River, one of the major rivers in Western Europe, rises from the Rhone glacier at an altitude of 1 765 m. After flowing through Switzerland for 260 km, it enters France through Lake Leman. The river flows through France for 550 km before entering the Mediterranean Sea.

The total area of the river basin is 98 000 km², of which 8 000 km² is in Switzerland. The main tributaries are the Ain (200 km), the Saône (450 km), and its tributary the Doubs (430 km), the Ardèche (112 km), the Gard (140 km), the Arve (100 km), the Isère (290 km), the Drôme (100 km) and the Durance (350 km).

The Rhône is an important resource for agriculture, industry, tourism, transportation and the generation of energy.

The Rhône delta is known as the Camargue and begins 3 kilometres above Arles. The Camargue has a surface area of 800 km² and is surrounded by the Petit and Grand Rhône. This region is one of the major wildlife areas of Europe. At the end of the nineteenth century, the area between the delta and the sea was closed with dykes. This has had major consequences for what was once a dynamic area.

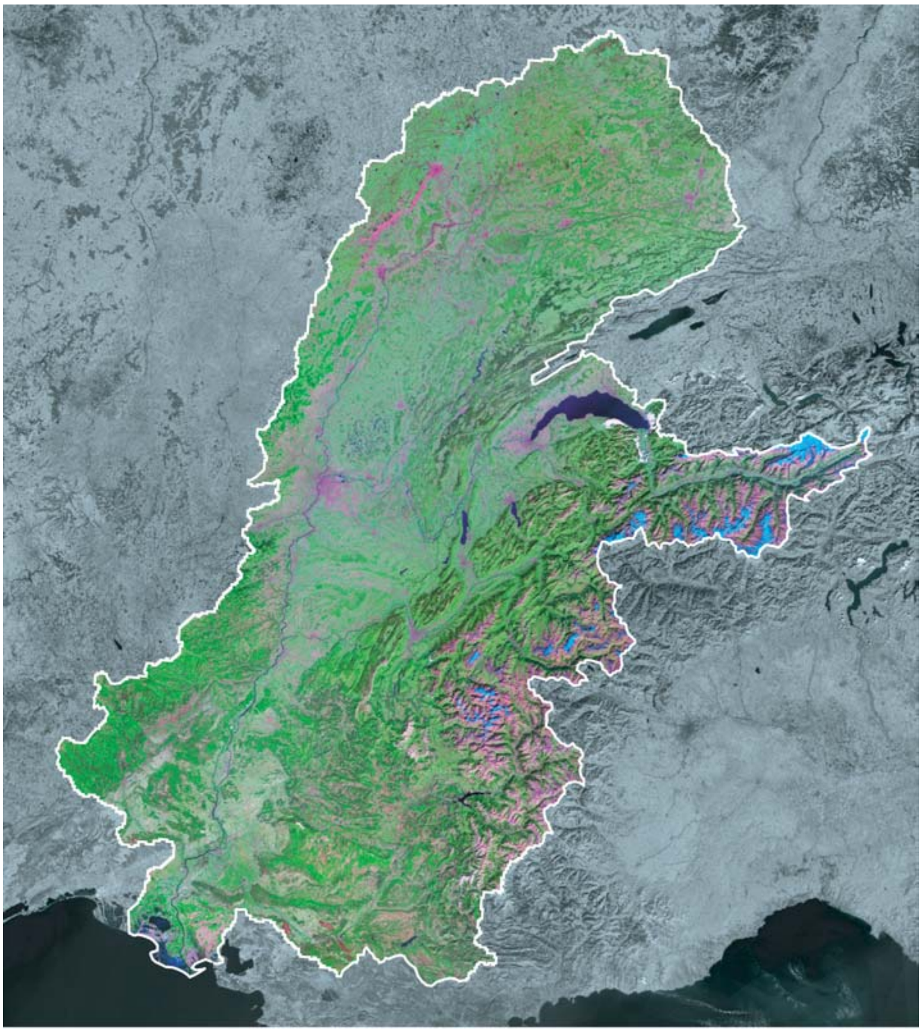
The Camargue is used for extraction of salt, agriculture, recreation and industry. In particular, the cultivation of rice and the extraction of salt have opposite requirements. The rice producers pump millions of m³ of freshwater into the Camargue, while the salt industry pumps millions of m³ of seawater into the delta.

Extent of the flooding in the lower part of the Rhône valley and the Camargue. Image acquired by SPOT 4 on 7 December, 2003

Source: : http://www.spotimage.fr/

Length (km)	*810*
Drainage Area (km²)	*98 000*
Discharge (m³/s)	*1 700*
Countries	*3*
Population	*15 000 000*
Sea at Mouth	*Mediterranean*
Ramsar Sites	*3*

Mean Discharge at mouth.



Seine

Ancient: Sequana, French: Seine.

Seine Basin Authority:
www.eau-seine-normandie.fr

The Seine has its source on the Langres Plateau, at 471 meters altitude, in Burgundy about 30 km northwest of Dijon. Known as the river going through the French capital Paris, the Seine also flows through the city of Rouen and joins the English Channel not far from the city of Le Havre. Its name comes from a Roman goddess called Sequana who was worshipped 2000 years ago at the source of the river. This Roman name came from a Celtic word which meant "similar to a snake", as the Seine has the most sinuous course of all French rivers, especially between Paris and the Channel. Its main tributaries are the Aube (240 km), the Yonne (293 km), the Loing (160 km), the Essonne (90 km), the Eure (225 km), the Marne (525km), the Aisne (280 km), and the Oise (330 km) which has its source in Belgium.

The Seine's run-off is relatively regular, in part due to dams and flood protection infrastructure. These have reduced flooding which historically was very important (1910, 1924, 1955, 1982, 1999-2000:). A monitoring system for floods is essential because exceptional flooding could be catastrophic for the region, not only for houses and infrastructure, but also for economic activity, streets, subways and railways.

The course and banks of the Seine are highly modified; the majority of its course is used for navigation (the Seine accounts for 50% of national river traffic). Numerous dams have been built on the Seine and its main tributaries. It is connected by canals to the Scheldt (also called the Escaut), Meuse, Rhine, Saône and Loire rivers.

Scale 1 : 3 000 000

Kilometres 0 25 50 75 100 125

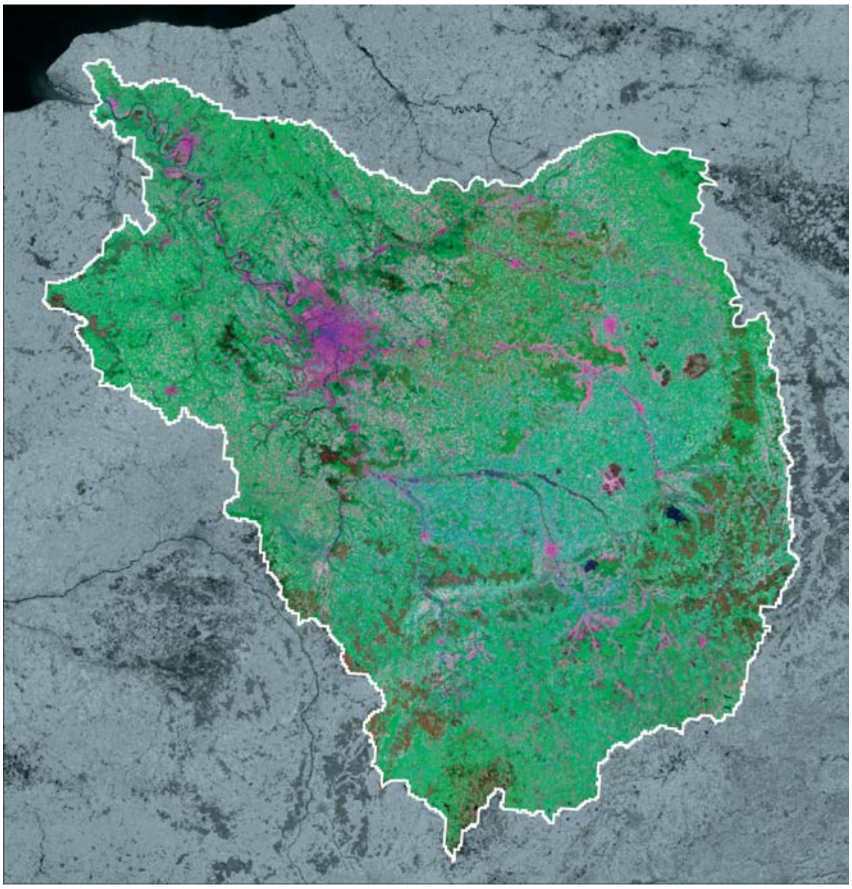
The high level of industrialization and urbanization has a major impact on water quality in the watershed, especially in its centre where analysed results range between 'bad' and 'adequate' ratings. Water quality is directly altered by intensive agriculture, water treatment plant effluents and the presence of one of the biggest megacities of Europe (25% of the French population lives here on 12% of the national territory). The main problems are nitrate levels, contamination by pesticides, and sediment contamination by heavy metals like mercury, copper, cadmium, and lead, especially in the estuary. In spite of this degraded state, there has been real improvement since 1990 for phosphates, organic matter, and heavy metal concentrations. Moreover, the quality of the water is an important issue as the Seine supplies 80% of the potable water for Paris after treatment.

The Seine is an important habitat for eels, although their population is diminishing. In fact, trend is not specific to the Seine but is true of Europe as a whole.

The Banks of the Seine in Paris were added to UNESCO's list of World Heritage Sites in 1991.

Length (km)	**776**
Drainage Area (km²)	**78 650**
Discharge (m³/s)	**500**
Countries	**2**
Population	**15 000 000**
Sea at Mouth	**Atlantic**
Ramsar Sites	**1**

Mean Discharge at mouth.



Tagus

Latin: Tagus, Portuguese: Tejo, Spanish: Tajo.

Tagus Basin Authority:
www.chtajo.es

Instituto da Água - Portugal (INAG):
www.inag.pt

The Tagus River rises in east-central Spain, in the Sierra de Albarracin at an altitude of 1 590 meters, and flows through Portugal where it empties in the Atlantic Ocean near Lisbon. It is the longest river on the Iberian Peninsula. The river's main tributaries are the: Jarama, Alberche, Tietar, Alagon, Guadelia, Almonte and Salor Rivers in Spain and the Erges, Ponsul, Zezere, and Sorraia Rivers in Portugal.

Two European capitals with a total of 11 million people depend on the river for their water supply. It is navigable for about 160 km from its mouth, while dams harness its waters for irrigation and hydroelectric power, creating large artificial lakes.

The lower and upper courses pass through deep gorges and are broken by waterfalls. There have been efforts to reforest the land surrounding the river.

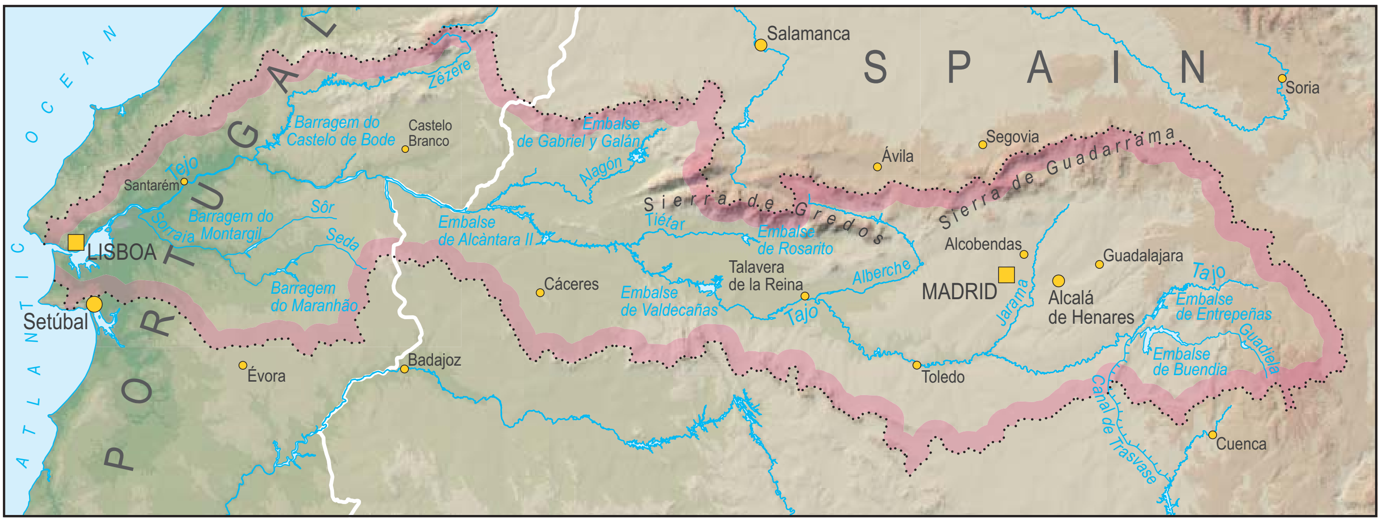
Of the total water demand, 80% is for agriculture and the 20% remaining for drinking-water supplying both Madrid and Lisbon. Further uses include the disposal of waste water, recreation, and basic ecological functions.

Part of the flow in Spain is diverted to the Segura basin, supplying 1.5 million people in southern Spain with drinking water, providing irrigation and supporting the ecosystem in the La Mancha Nature Reserve.

The Tagus basin is managed by a basin organization in Spain, the "Confederacion Hidrografica de Tajo" (CHT), and by the National Institute for Water, INAG; in Portugal three Regional Water Departments oversee its management.

The total storage capacity of the numerous reservoirs in the Tagus basin corresponds to 74% of the average annual runoff. In most of the basin natural flow conditions have now been replaced by regulated flow.

The main environmental pressures on the River are pollution from industrial and municipal point sources and diffuse sources.



Scale 1 : 4 000 000

Kilometres 0 50 100 150 200 250

Tagus-Segura Transfer

The Tagus-Segura Transfer from the Iberian System in Central Spain to the Mediterranean Levante Zone has been operating since 1979, and has caused severe impacts in both river basins:

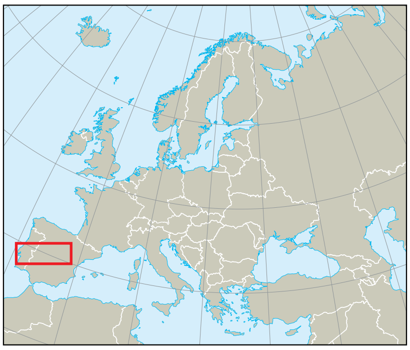
Increasing water deficit: The water demand in the receiving basin has doubled in 24 years to 500 million m^3 due to the increasing requirements for irrigation and tourism.

Habitat destruction and promotion of unsustainable agriculture: The increase in irrigated land and tourist activities has led to the destruction of thousands of hectares of protected natural areas.

Black market for water and illegal water uses: Water uses are partially uncontrolled. More than 100 million m^3 of transferred water "disappear" illegaly to supply tourist resorts and golf courses.

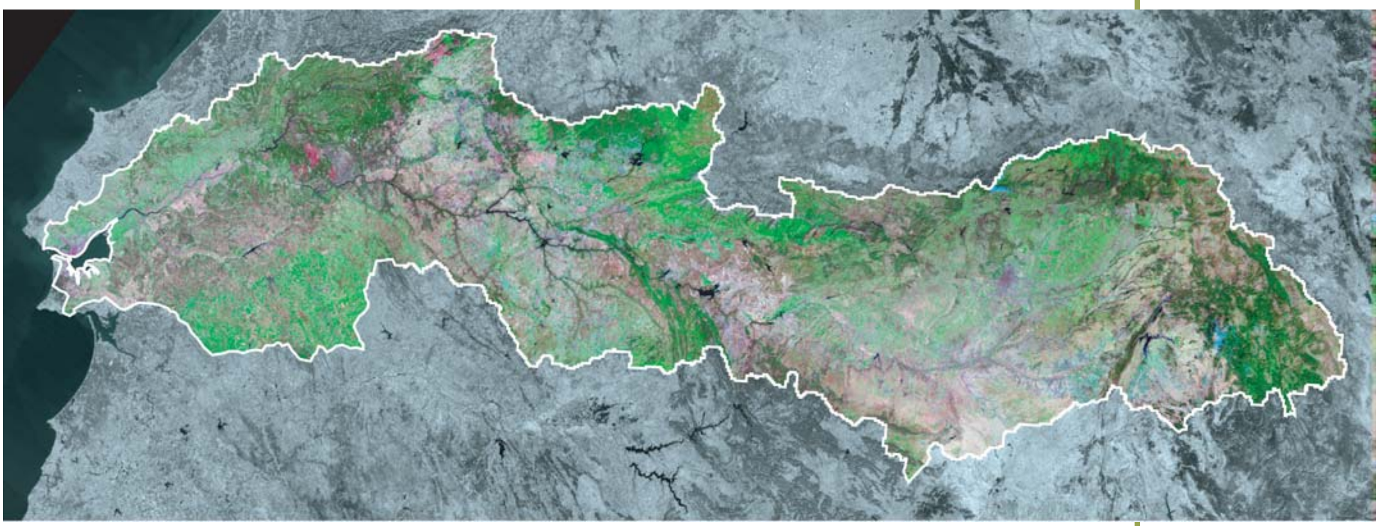
Water over-exploitation in the Tagus donor basin and, as a consequence, chemical contamination and the deterioration of the River 's ecosystem: Even in normal summers, the River no longer flows in some places, let alone during critical periods of drought. The legal minimum flow of $6m^3/s$ is not respected.

Social imbalances have increased as the transfers mainly benefit big agro-businesses and construction companies, marginalizing traditional farmers. Illegal immigration and exploitation of immigrants are increasing with about 30% undeclared labour.



Length (km)	*1 100*
Drainage Area (km²)	*88 700*
Discharge (m³/s)	*600*
Countries	*2*
Population	*9 000 000*
Sea at Mouth	*Atlantic*
Ramsar Sites	*2*

Mean Discharge at mouth.



Vistula

Polish: Wisla, German: Weichsel.

Flowing eastward and then northward from the Carpathian Mountains of southern Poland to its delta near Gdansk on the Baltic Sea, the Vistula River forms a giant letter S. With its branches, including the Bug, Wieprz, San, Narew, Nida, Pilica, Brda, and Wierzyca rivers, the Vistula drains a basin of about 194 000 km^2.

The middle and lower sections of this river are considered to be one of Europe's most exceptional areas of natural and landscape value, with meanders, ox-bows, steep banks and sand islands. These habitats and features help to explain why 76% of the breeding bird species of Poland occur here, including many species that are threatened in Europe. The Vistula also has a particular cultural prominence. It is the "spiritual monument" of Poland, known by many as the "Queen".

The existing deterioration of this Polish river's natural functioning would be accelerated by a plan to build new dams on the river's lower reaches. In addition to altering natural physical and hydrological characteristics, the creation of more reservoirs would generate greater problems of sediment, nutrient, and toxic accumulation and have serious negative impacts on fisheries.

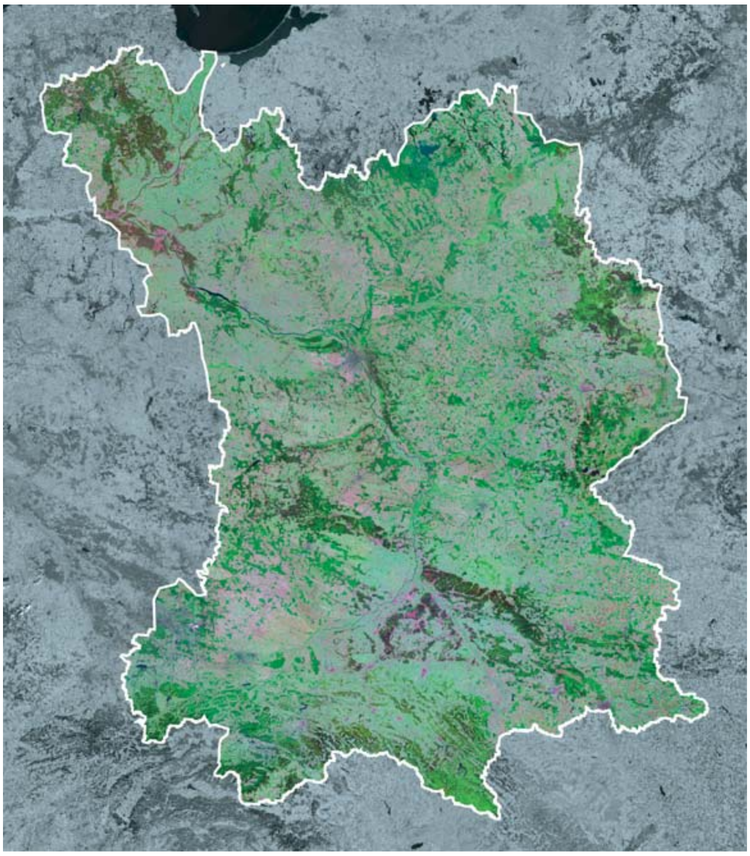
Municipal wastewater is a major problem in the Vistula River basin. The main cities are Warsaw (ca. I 500 000 inhabitants), Bydgoszcz, Torun, Wloclawek, Lublin, Krakow and the Katowice region. In the early 1990s, municipal systems in Poland discharged about 900 000 million m^3 of untreated sewage, while about I 400 000 m^3 were treated mechanically and/or biologically with an average treatment efficiency of 64, 64, 23 and I7% for BOD.5, COD, N, and P respectively. The share of industrial wastewater in total discharges to municipal sewage systems is on the order of 27%. In Ukraine, the city of Lvov is a major industrial center and sewage disposal for its 800 000 inhabitants is unsatisfactory. Similar concerns may be raised for the city of Brest (280 000 pop.), one of the principal industrial centers of Belarus. In both cities, lack of pretreatment of industrial wastes discharged to municipal sewage systems is a serious problem. Disposal of municipal sludge is one of the major environmental problems in the Vistula catchment area.

The most critical pollutants entering the Vistula River are: nutrients, phenols, heavy metals (Cd, Pb, Zn, Hg, Cu, As, Cr, Ni), plankton, organic compounds (Trihalomethanes, hydrocarbons and their derivatives, POP's, phenol compounds, pesticides etc.) and sediments. The Vistula river, together with the Oder river, is also the main deliverer of pollutants to the Baltic Sea (90%).

Scale 1 : 5 000 000 Kilometres 0 50 100 150 200 250

Length (km)	*1 064*
Drainage Area (km²)	*194 000*
Discharge (m³/s)	*1 100*
Countries	*5*
Population	
Sea at Mouth	*Baltic*
Ramsar Sites	*4*

Mean Discharge at mouth.



Volga

Russian: Volga, ancient Greek: Ra, Tatar: Itil or Etil.

The Volga River is the longest river of Europe. It lies entirely within the Russian Federation, comprising about one-third of European Russia. The source of the river is in the Valdaj hills north of Moscow at a height of 228 m above sea level.

The Volga Basin comprises four geographical zones: the dense, marshy forests; the forest steppes; the steppes; and the semi-desert lowlands. The course of the Volga is divided into three parts: the upper; the middle; and the lower Volga. Starting as a small stream, it becomes a bigger river when it is joined by some of its tributaries. It also passes through a chain of small lakes.

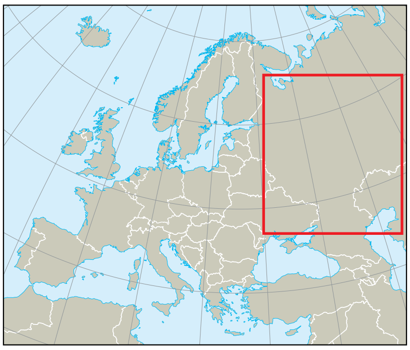
After being joined by other tributaries, the Volga flows through the Rybinsk reservoir. It is then joined by the Oka River, after which it almost doubles in size. After it is joined by its major tributary, the Kama, the river flows southward along the foot of the Volga Hills. The Volga's major distributary, the Akhtuba, runs parallel to the main river on its way towards the Caspian Sea. Above Astrakhan, the Buzon River, another main distributary of the Volga, marks the start of the Volga Delta. The mouth of the river is situated on the Caspian Sea at 28m below sea level.

The major tributaries are the Oka, the Belaya, the Vyatka, and the Kama, each of which is longer than 1 000 km and has a catchment area exceeding 100 000 km^2. As the Volga approaches the Caspian Sea it divides into a delta comprised of about 275 channels covering about 12 000 km^2.

The Volga Basin covers 10% of the total territory of the Russian Federation, and has a population of over 60 million. The biggest environmental problems stem from major industrial complexes, big dams, large cities and maintaining navigability. The problem being faced now is that this system and all of the associated infrastructure exists, and, although it is extremely expensive and inefficient, it must somehow be maintained.

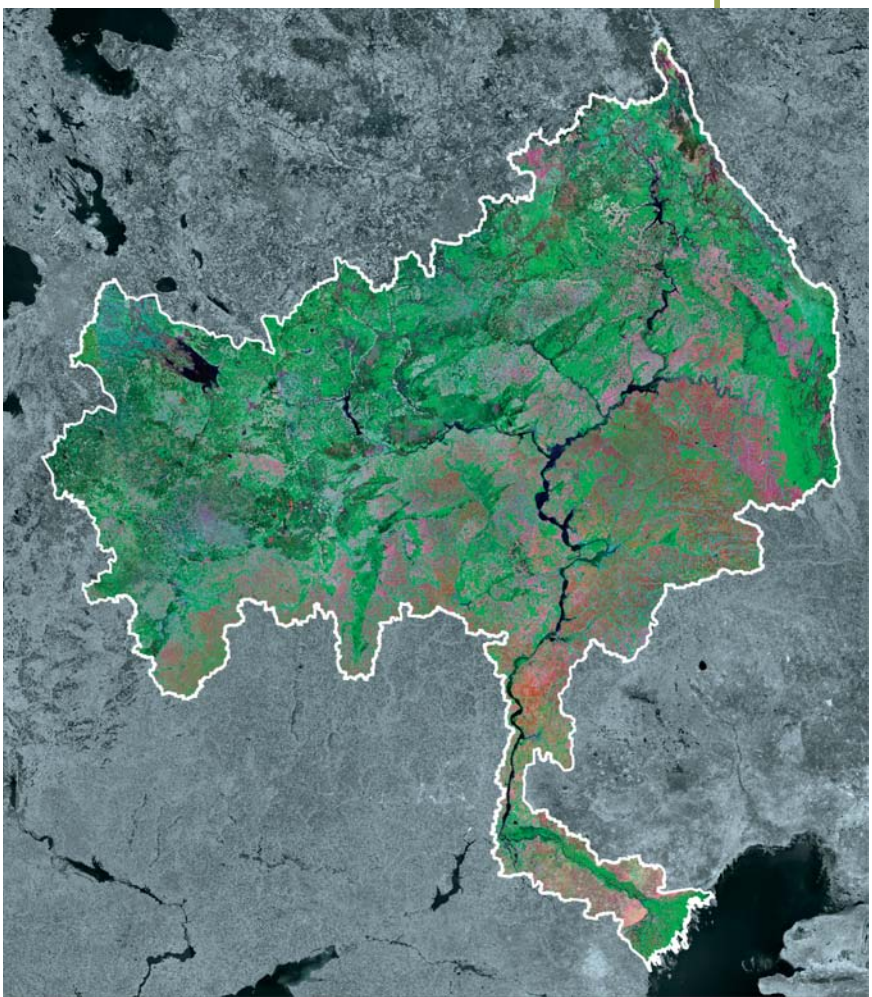
The most urgent need is to establish a new system of communication between the different levels of governance – local, state and national – and to begin to develop a modern management structure. The problem is finding the funds needed to maintain, de-centralize and diversify the old Soviet system.

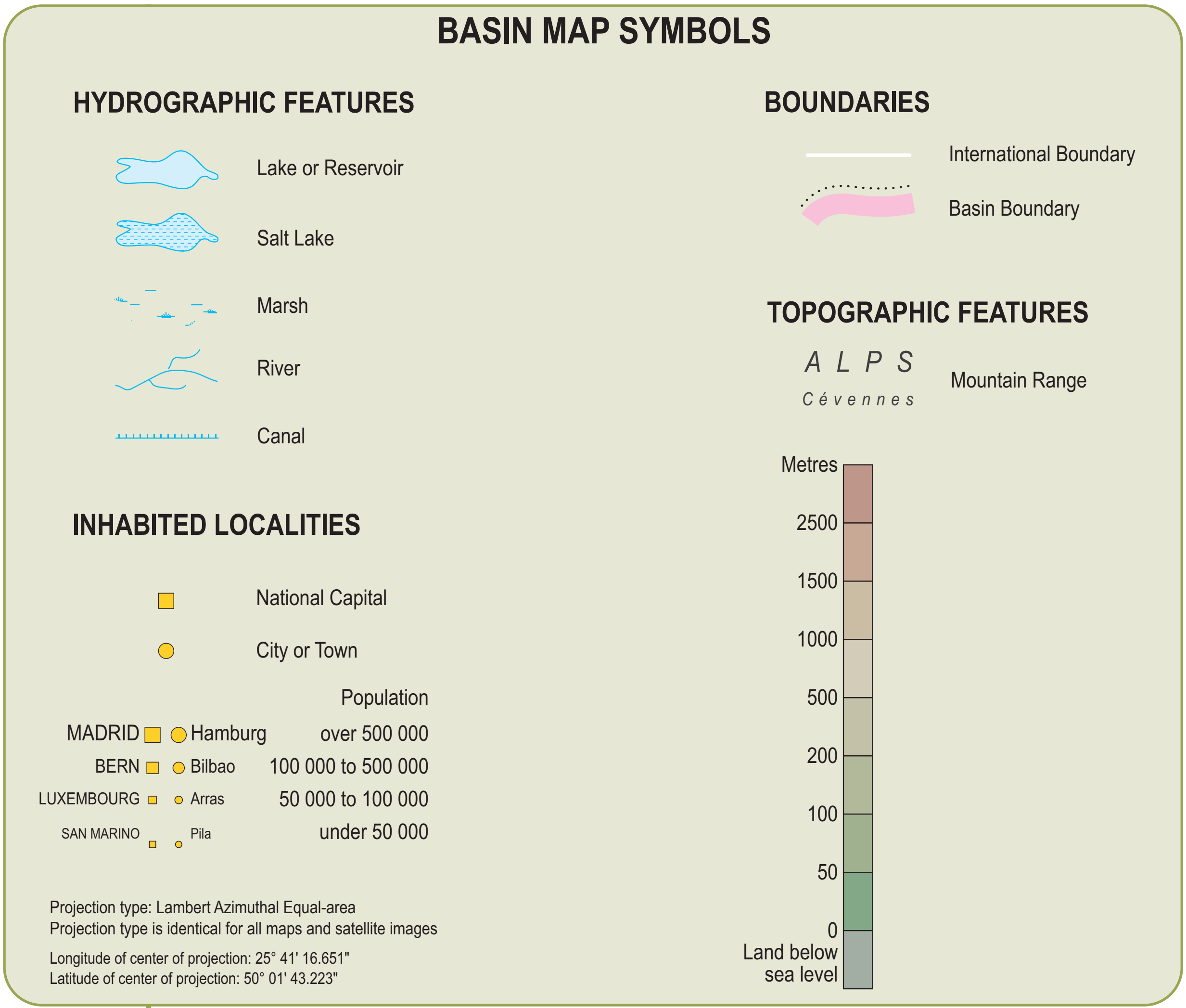
Just three percent of surface water in the Volga River Basin is considered an environmentally safe source of drinking water. Some 42 million tons of toxic waste pile up each year in the Basin, causing immense health problems.



Length (km)	3 660
Drainage Area (km²)	1 380 000
Discharge (m³/s)	8 500
Countries	3
Population	61 000 000
Sea at Mouth	Caspian
Ramsar Sites	2

Mean Discharge at mouth.





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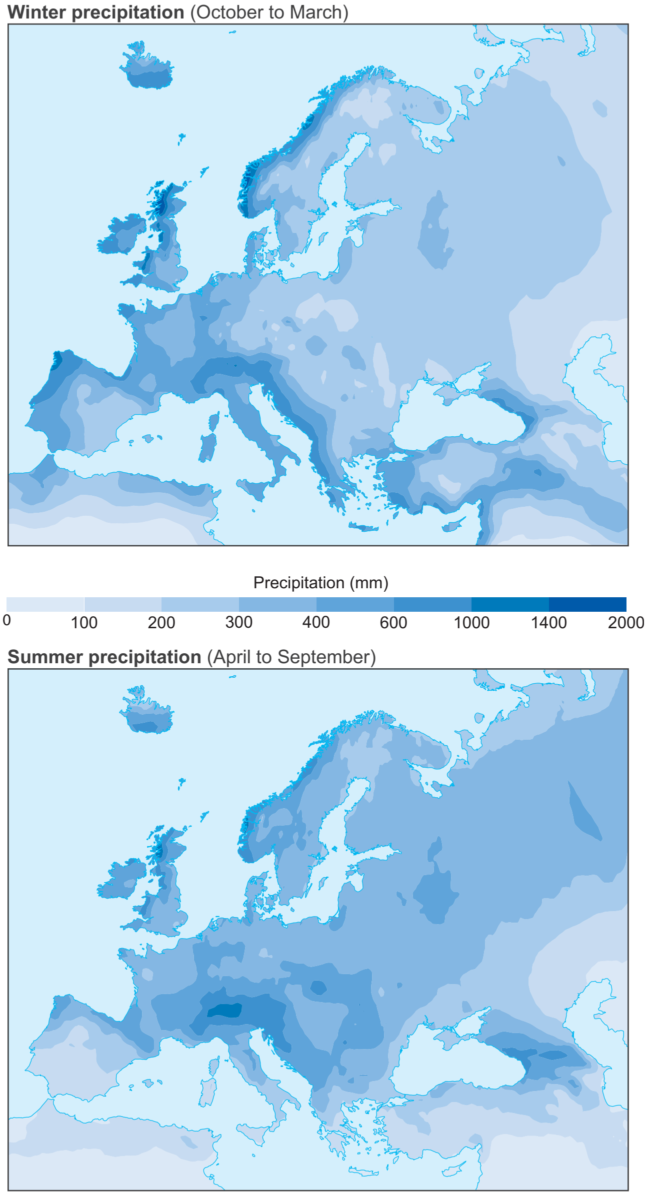
It is expected that water resource problems associated with desertification, flooding, erosion and sediment transport, water contamination, over-exploitation of aquifers, etc., will become more acute in the future.

Source: IPCC, 2001. Climate Change 2001: Impacts, Adaptation, and Vulnerability

PRECIPITATION IN EUROPE



Source: Climatic Research Unit

Mean monthly precipitation sum from 1960 to 1998

Climate Change

The water cycle plays an important role in the climatic system, both conditioning the climate and being affected by it. Changes in precipitation can bring changes not only to the amount and timing of runoff, but also to the frequency and intensity of storms and droughts.

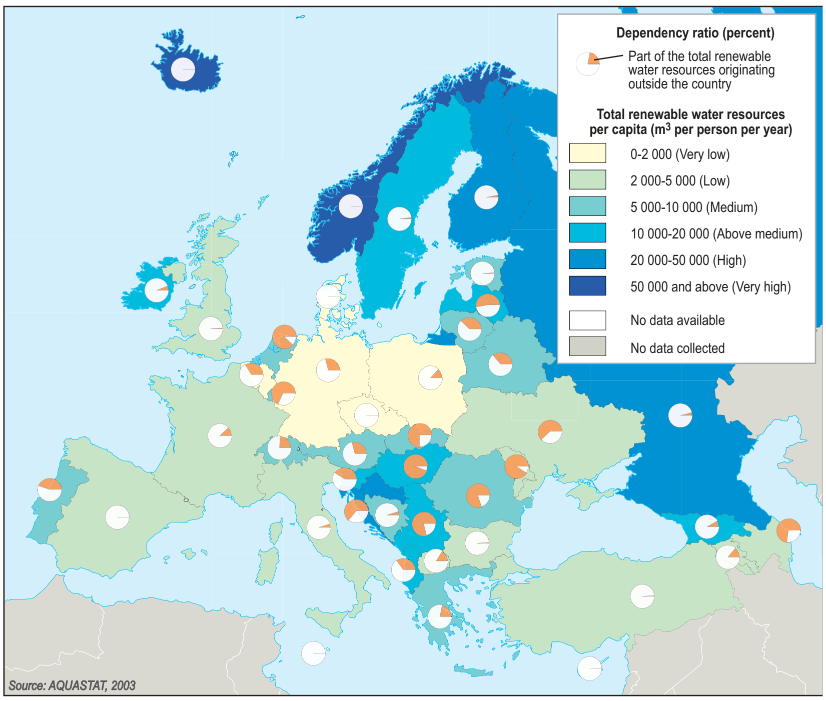
Precipitation is unevenly distributed in Europe, being highest in the western part and in regions with mountains. It varies between seasons and years. Countries or areas that usually have access to adequate water resources may suffer shortages at certain times of the year or in certain years.

Climate change is likely to increase flood hazard across much of Europe. The risk of water shortage is projected to increase, particularly in southern Europe, and water resource differences between northern and southern Europe will widen. As average temperatures rise, sea levels are also rising, glaciers melting, and the frequency of extreme weather events and precipitation are changing.

Transboundary Issues

Some countries are highly dependent on transboundary flows, and thus water originating outside the country is essential to meet the needs of the population. These countries are therefore especially vulnerable to the effects of extraction, impoundment and pollution by countries upstream.

RENEWABLE WATER RESOURCES AND DEPENDENCY RATIO



Most water used for all purposes in Europe is abstracted from surface water sources. Groundwater comprises most of the remainder, with only a minor contribution from desalination of seawater, mainly in Italy, Malta and Spain.

The pressures exerted by increasing demand for water are leading to over-exploitation of local reserves in many regions. Moreover, 20 European countries are dependent for more than 10% of their supply on river water from neighbouring states; this figure rises to 75% in the case of The Netherlands and Luxembourg.

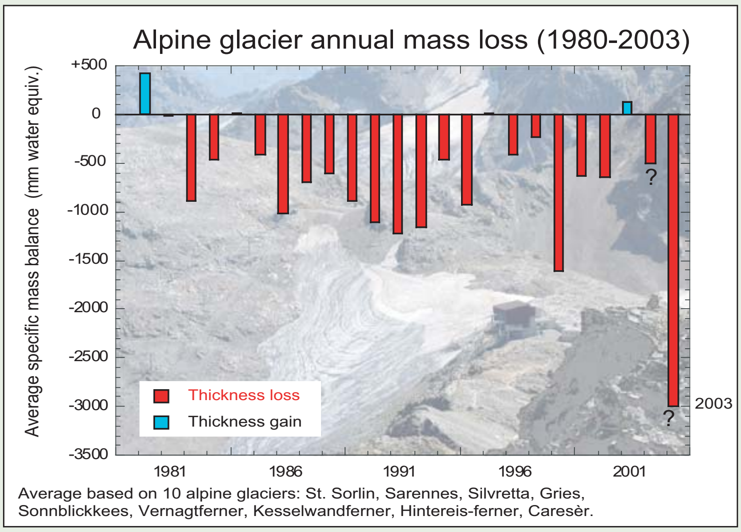
Glacier Melting

As part of the natural water cycle, most rivers originate in mountainous areas. Upstream regions and their fragile ecosystems are important for water storage, groundwater replenishment and flood control. Glaciers store large quantities of water during wet and cold periods and release water during hot and dry seasons.

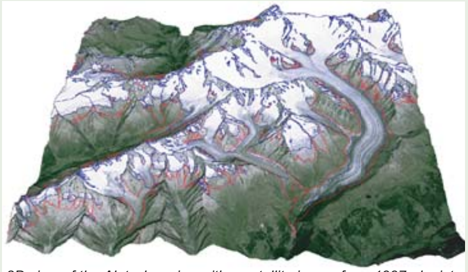
The rise in temperature over the last decades has set in motion a significant shrinkage of mountain glaciers. Many small glaciers in the Alps are melting because of global warming.

Half of Europe's alpine glaciers could disappear by 2025. In 2003, the extreme warm and dry weather conditions caused an average thickness loss of glaciers in the Alps of about 3 metres water equivalent, nearly twice as much as during the previous record year, 1998, and roughly five times more than the average loss recorded during the exceptionnally warm period 1980 - 2000.

Alpine glaciers had already lost more than 25% of their volume between 1975 and 2000, and roughly two-thirds of their original volume since 1850. At such rates, less than 50% of the glacier volume still present in 1970/80 would remain in 2025 and only about 5% in 2100.



Courtesy: Regula Frauenfelder (World Glacier Monitoring Service, Zürich)



3D view of the Aletsch region with a satellite image from 1997, depicts glacier extent in 1850 (in red), 1973 (in blue). The Aletsch glacier is now formally part of the UNESCO world Heritage. DEM25©2004 swisstopo (BA045897)

Source: WGMS

The World Glacier Monitoring Service (WGMS) follows the evolution of annual glacier mass balance through the monitoring of more than 60 reference glaciers worldwide.

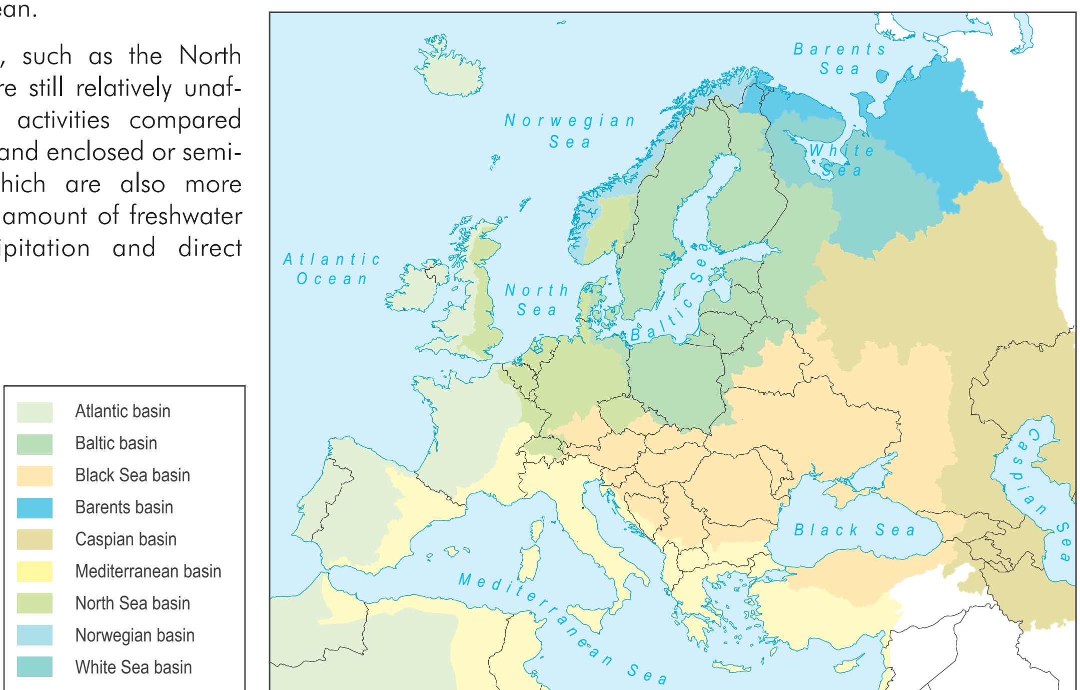
www.geo.unizh.ch/wgms/

European Sea Basins

Europe is surrounded by nine sea basins: the Mediterranean Sea, Black Sea and Sea of Azov, the Caspian Sea, White Sea, Barents Sea, Norwegian Sea, Baltic Sea, North Sea and the North Atlantic Ocean.

The open oceans, such as the North Atlantic Ocean, are still relatively unaffected by human activities compared with coastal areas and enclosed or semi-enclosed seas, which are also more dependent on the amount of freshwater input from precipitation and direct runoff.

EUROPEAN SEA BASINS



Floods

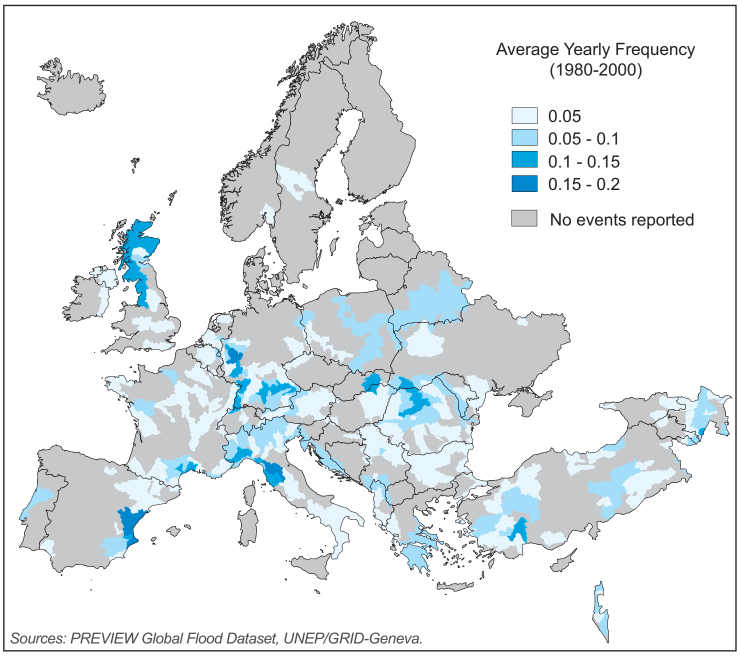
Flooding is the most common natural hazard in Europe. The Centre of Research on Epidemiology of Disasters (CRED) recorded 188 flood events for the period 1980 to 2000. The map of disaster frequency shows that floods are widespread and affect nearly all the countries of Europe, causing more than 1500 casualties. With 439 casualties, and over 1.8 million people exposed, Turkey is the most vulnerable country. At the other extreme in Germany, despite very high yearly physical exposure (3.9 million) the number of casualties was only 21. Apart from the high resilience of a well-off country such as Germany, this might also reflect the difference between the low-lying German floodplains as compared to mountainous slopes where water forces are stronger and cause higher impacts.

CRED
www.cred.be/

UNEP/DEWA~Europe
www.grid.unep.ch/data/grid/climate.php

Physical exposure: Elements at risk, an inventory of those people or artefacts that are exposed to a hazard.

REGIONS AFFECTED BY FLOOD



Sources: PREVIEW Global Flood Dataset, UNEP/GRID-Geneva.

Increasing pressure on land for human settlements often leads to a drastic loss of natural riverbed areas and fails to take into account exceptional events. Flood disasters usually result from a lack of appropriate planning of human infrastructure. For example, in the case of the flood and landslide that killed 13 persons in Gondo (Switzerland, 2000), the disaster was caused by a structure for rockfall/avalanche protection which retained 10 000 m^3 of material before collapsing, unleashing mudflows and rockslides. However, other structures such as dams have proven efficient in absorbing surplus rainfall, thus reducing the probability of a large flood.

Natural riverbed areas incorporating flood plains should be restored wherever possible to decrease the risk of casualties and reduce economic impact, as well as to preserve river ecosystems.

Radar sensors constitute efficient tools for flood detection and monitoring due to their ability to monitor through clouds and without depending on visible light. This ERS-2_SAR_PRI image acquired on 2 December 2003 at Matera Station shows the flooded area in the southeastern Rhône delta northeast of the city of Nimes. Flooded areas can be seen in black.

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FLOOD OCCURENCE AND IMPACTS (1980-2000)

Country	Events	Physical Exposure	Killed
Albania	4	131 704	15
Austria	6	336 735	19
Belarus	2	620 500	2
Belgium	6	386 689	7
Croatia	1	108 929	0
Czech Republic	1	62 435	29
France	23	1 821 024	111
Germany	8	3 976 284	21
Greece	4	482 663	25
Hungary	5	237 148	9
Iceland	1	-	0
Ireland	2	77 876	3
Israel	2	542 419	11
Italy	12	2 994 349	294
Luxembourg	1	1 524	0
Moldova, Republic of	3	193 262	56
Netherlands	3	558 068	0
Norway	2	50 683	1
Poland	5	1 287 600	62
Portugal	4	348 453	70
Romania	9	1 174 894	194
Russian Federation	28	2 393 629	194
Slovakia	2	129 203	56
Spain	11	888 261	176
Sweden	1	5 008	0
Switzerland	4	157 413	18
Macedonia	1	17 784	0
Turkey	14	1 883 782	439
Ukraine	6	589 853	63
UK	9	2 082 205	10
Yugoslavia	8	321 934	82
Total	**188**	**23 862 312**	**1 967**