8. Water

Only a few European citizens suffer from the devastating shortages of water and poor water quality experienced by people in many other parts of the world. However, water resources in many areas of Europe are under threat from a range of human activities. About 31 % of Europe's population lives in countries that use more than 20 % of their annual water resource, this being indicative of high water stress. Drinking water quality is still of concern throughout Europe, with significant microbiological contamination of drinking water supplies in eastern Europe, the Caucasus and central Asia (EECCA), contamination by salts in central Europe and more than 10 % of European Union citizens potentially exposed to microbiological and other contaminants that exceed the maximum allowable concentrations.

Problems are generally highest near pollution 'hot spots' resulting from a range of industrial and other activities. The situation is generally of greatest concern in some EECCA countries, especially as regards the quality of drinking water in terms of microbiology and toxic substances. This reflects the relatively poor economic conditions in this region, and in several countries the deterioration or lack of infrastructure for providing clean drinking water.

The health of humans and ecosystems is also threatened in other parts of Europe. One example is water contaminated by organic and inorganic pollutants such as pesticides and heavy metals at concentrations greater than those laid down in standards by the EU and other international organisations.

Total fresh water abstractions fell during the last decade in most regions. However, 31 % of Europe's population lives in countries that experience high water stress, particularly during droughts or periods of low river flow. Water shortages also continue to occur in parts of southern Europe where there is a combination of low water availability and high demand, particularly from agriculture.

Although there has been significant progress in management of water resources and quality across Europe, problems still persist. This is especially so where there is a lack of capacity and financial resources for monitoring and for implementing essential measures and technical improvements.

In western Europe and the accession countries, river, lake and coastal water quality, in terms of phosphorus and organic matter, is generally improving, reflecting decreases in discharges, resulting mainly from improved wastewater treatment. Nitrate levels have remained relatively constant — but significantly lower in accession countries reflecting less intensive agricultural production than in the EU. Concentrations of nutrients are much higher than natural or background levels. Eutrophication, as indicated by high phytoplankton levels in coastal areas, is highest near river mouths or big cities.

Heavy metal concentrations in western European rivers, and their direct discharges and atmospheric deposition into the North East Atlantic Ocean and the Baltic Sea, have all fallen as a result of emission reduction policies. Existing information on the state of waters in EECCA shows that many rivers, lakes, groundwater and coastal waters are polluted, often with hazardous substances including heavy metals and oil. The pollution tends be concentrated in localised hot spots downstream of cities, industrialised and agricultural areas and mining regions. Away from these hot spots, river and lake water quality appears to be relatively good.

Oil pollution caused by discharges from coastal refineries and offshore installations is decreasing in western Europe. However, illegal discharges, mainly from ships, are still a problem, especially in the North Sea and Baltic Sea. Oil pollution in general, from several sources, is of major concern in the Black Sea, the Caspian Sea and the Mediterranean. The recent disaster involving the oil tanker Prestige, off the coast of northern Spain, highlighted the need to reduce risks from similar accidents in the future.

8.1. Introduction

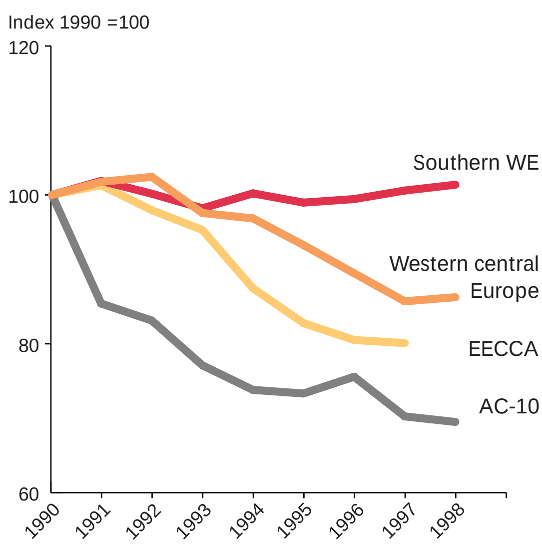
Few European citizens suffer from the devastating water shortages and poor water quality experienced by people in so many areas of the world. However, water resources in Europe are, in many locations, under threat from a range of human activities leading in some areas to significant problems of overexploitation and of quality of inland and marine waters.

Pressures result from economic growth and economic recovery in some countries of central and eastern Europe, the Caucasus and central Asia (EECCA). In these countries, demands for agriculture, particularly for irrigation, growing urbanisation, continuing inadequacies in wastewater treatment and increasing leisure activities create high stresses on water. This arises both from natural changes and from disasters such as floods and droughts.

The environmental consequences of over-stressed water resources, improper irrigation practices, pollution discharges and poor water quality include salinisation, eutrophication, erosion and, in extreme cases desertification (see Chapter 9, Box 9.1). Problems are often greatest near 'hot spots' that result from a range of industrial and other activities. The situation is generally of greatest concern in some of the EECCA countries, with the disastrous changes in the Aral Sea being an extreme example, but the environment and the health of humans and ecosystems are also threatened in other parts of Europe. Of particular significance is water contamination by organic and inorganic pollutants such as pesticides and heavy metals at concentrations greater than those laid down in directives, recommendations and target levels from the European Union (EU) and other international organisations.

Although problems remain, there has been significant progress in the management of water resources and quality as a result of a number of policies and measures implemented in recent years following international and regional agreements and conventions. But some indicators of water quality show a slowing or even levelling out of the rate of improvement and, particularly in some eastern European countries, there is a lack of capacity and financial resources for monitoring and for implementing essential measures and technical improvements.

Figure 8.1. **Changes in water abstraction in European regions (index 1990 = 100)**



Notes: Western central: Austria, Belgium, Denmark, Germany, France, Luxembourg, Netherlands, England and Wales; western southern: Spain, France, Greece, Italy, Portugal; AC-10 (central accession countries): Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia; EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Republic of Moldova, Russian Federation, Turkmenistan, Tajikistan, Ukraine, Uzbekistan.

Sources: Eurostat New Cronos; EEA questionnaire (2002)

8.2. Water abstraction and use

8.2.1. Rates of water abstraction and their impacts

Overall, Europe abstracts a relatively small portion of its total renewable water resources each year. Total water abstraction in the region is about 595 km^3/year, only 7 % of the total freshwater resource. Resources are unevenly distributed across the region, and even if a country has sufficient resources at the national level there may be problems at regional or local levels. Kazakhstan, Turkmenistan, Cyprus, Tajikistan, Malta and Kyrgyzstan have the least available water, with an annual runoff of less than 160 mm, and as little as 37 mm for Kazakhstan. The countries with the highest runoff, more than 1 700 mm, are the ones most dependent on external resources, such as Bulgaria, Serbia and Montenegro, Croatia and the Netherlands.

For this assessment the following threshold values/ranges for the ratio of abstraction against renewable resources have been used to indicate levels of water stress:

- non-stressed countries — less than10 %;
- low stress — 10 % to less than 20 %;
- stressed — 20 % to less than 40 %;
- severe water stress — 40 % or more.

The thresholds above are averages and it would be expected that areas for which the ratio is above 20 % would also experience severe water stress during drought or low river flow periods. In 33 countries this ratio is less than 10 % while in 14 countries it is more than 20 %.

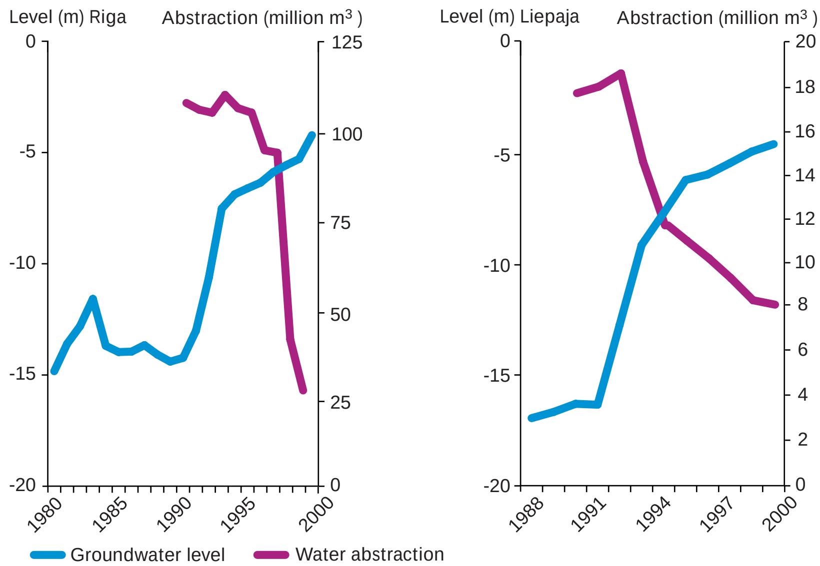
The region abstracts only 7 % of its freshwater resources. A total of 33 countries can be considered as non-stressed or low-stressed. However, there are 14 countries that abstract more than 20 % of their freshwater resources.

As a consequence, the most highly stressed countries have problems with overexploitation of groundwater resources and consequent water table depletion and salt-water intrusion into coastal aquifers. Basins with higher exploitation indices suffer the impacts of over-abstraction in many of their rivers or aquifers. The Mediterranean area is particularly affected by saline intrusion due to groundwater overexploitation. The drying-up of the Aral Sea and Lake Sevan (see Box 8.1) are examples of the consequences of very intensive abstraction.

High rates of direct river abstraction and the rapid expansion of groundwater abstraction over the past 30–40 years have supported new agricultural and socio-economic development in regions where alternative surface water resources are insufficient, uncertain or too costly (EU, 2000). Many originally perennial streams (particularly in arid regions) have become intermittent due to various abstractions (Smakhtin, 2001).

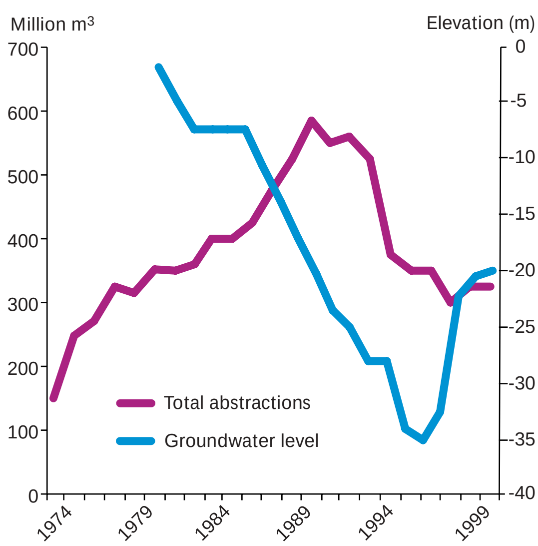
However there are examples of how water resources can recover once overexploitation has ceased. In Hungary (OECD, 2000a) the intensity of groundwater use has fallen by one third since the mid-1980s. In Transdanubia, after overexploitation of karstic groundwater by mining operations was stopped in the early 1990s, the water table, which had fallen by 30 m, recovered. In Latvia, intensive and non-balanced use of groundwater had caused large underground depression fields in Liepaja (1 000 km²) and Riga (7 000 km²) catchments but a decrease in water consumption during the 1990s, due to the implementation of water consumption accounting and economic instruments, has led to a gradual rise in the water level (Latvian Environment Agency, 2002) (Figure 8.2). In the Amsterdam dunes, a large-scale artificial recharge scheme made possible a substantial restoration of the freshwater store (EUCC, 2000). In the late 1980s the Spanish La Mancha Occidental in the upper Guadiana basin was declared overexploited with abstractions of 600 million m³/year. Since then abstractions have been reduced to 300 million m³/year and there has been a marked recovery of the water stored in the aquifer, which also means a recovery of the valuable associated ecosystems (Figure 8.3). This decrease in agricultural water use in the area was to a large degree the result of implementing an EU-funded agri-environment scheme.

Changes in the underground water level and water abstraction in Riga and Liepaja, 1980–2000 Figure 8.2.



Source: Latvian Environment Agency, 2002.

Annual abstractions from the aquifer and water-level recovery at representative borehole in La Mancha Occidental Figure 8.3.



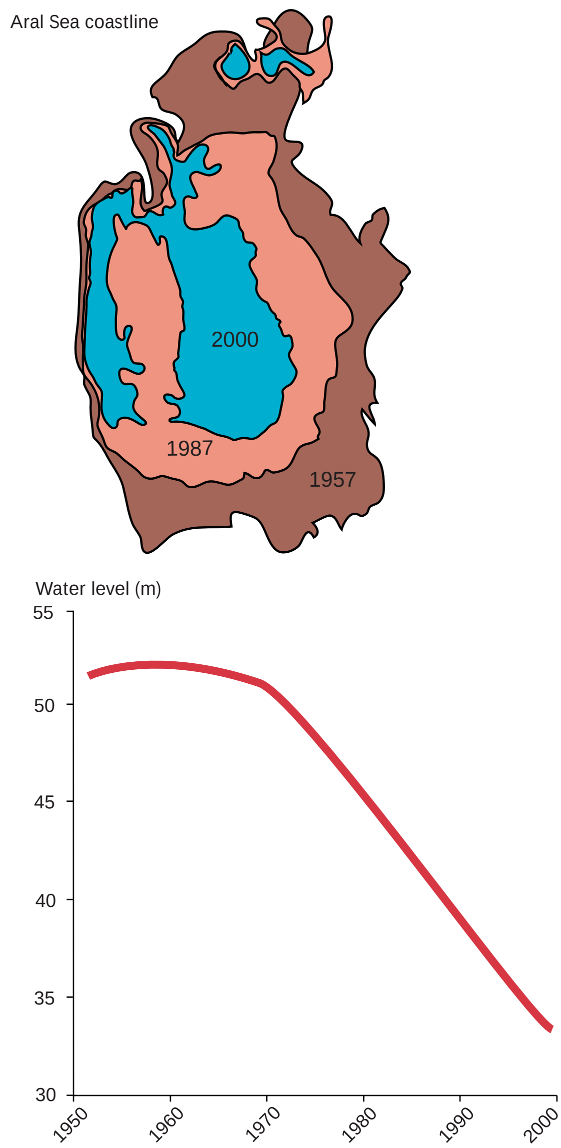
Source: MMA, 2000

Total fresh water abstractions have decreased over the past decade in most regions.

However, in southwestern European countries, some of which have high water stress, water abstraction has remained constant.

Box 8.1. Impact of water exploitation on major water bodies: examples of the Aral Sea and Lake Sevan

Figure 8.4. **Water consumption in Aral Sea basin**



The Aral Sea was the fourth largest inland water body in the world before 1960 but the sea has been drying up since then. Central Asia uses almost 67 % of its freshwater resources and almost 100 % in the Aral Sea basin, largely for irrigation of cotton and rice. This has caused the sea level to fall by 17 m and the surface area to diminish by 75 %. As a consequence water salinity increased from 10 g/l in 1965 to 40–50 g/l in 2000 and the sea lost its fishery importance. In the late 1970s, several species of fish failed to reproduce. Marshes and wetlands which covered around 550 000 ha in 1960 have almost disappeared (only 20 000 ha were left in 1990). More than 50 lakes have dried up.

Most of the catchment is salinised because of irrigation, the salt content of soils and pastures being 0.5–1.5 %. It has been estimated that at least 73 km^3/year of water would have to be discharged to the Aral Sea for a period of at least 20 years to recover the 1960 level (53 m above the sea level).

Lake Sevan in Armenia (1 256 km^2) is another lake affected by the overexploitation of water resources. It is one of the oldest lakes in the world and has an important endemic flora and fauna. The surface of the lake has shrunk by 11 % over the past 60 years because of water overexploitation. Since 1981, there has been a tunnel transferring water from the Arpa River, which is in another catchment, to compensate for the loss of water.

The lake's water has traditionally been used for irrigating crops on the Ararat plain. The reduction in water levels and surface area has had detrimental consequences on the ecology of the lake: fish populations have decreased and the aquatic habitat has deteriorated. Fishing, tourism, irrigation, hydropower production and drinking-water supply have all been badly hit. In response, the Armenian Government initiated the Lake Sevan Environmental Action Programme in 1995 to solve or mitigate the problems.

Sources: UNEP/GRID-Arendal; Saving Aral Sea Fund (Aral Sea web page); Armenia, 1998

8.2.2. Water use by sectors

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 (Figures 8.5 and 8.6).

> Agriculture accounts for 50–70 % of total water abstraction in southwestern European countries and EECCA. Cooling for electricity production is the dominant use in the central European countries.

In western central Europe, during the past decade, water abstraction for public water supply has fallen by about 9 %, for agriculture by 10 %, for energy production by 14 %, and for industry by a dramatic 28 %.

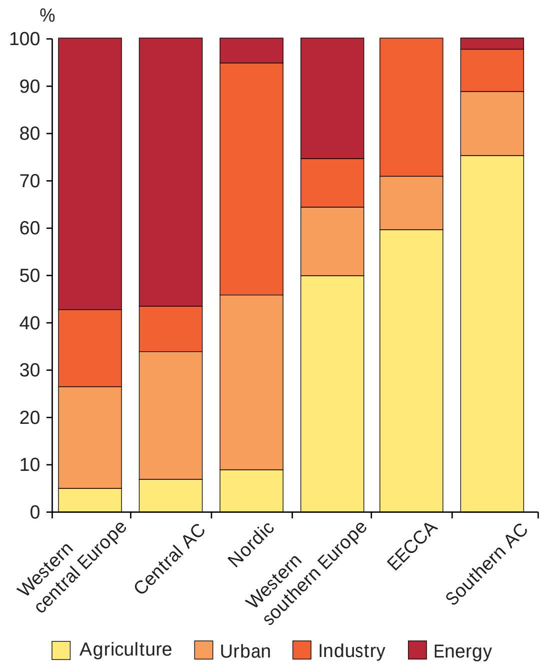
In southwestern countries, where water abstraction for agriculture is the dominant (70 %) water use, abstraction for irrigation increased by 5 % in the past decade. Abstraction for urban use and industry was relatively constant, and abstraction for cooling for energy production fell by 15 %.

In the EECCA and central accession countries, the decrease in industrial and agricultural activities (see Chapters 2.2 and 2.3) during economic transition led to a marked decrease in water abstraction for these uses. In the central accession countries water use by industry and agriculture both fell by 70 %, in EECCA; industrial use fell by 50 % and agricultural use by 74 %.

There was a 30 % decrease in abstraction for public water supply in the past decade in central accession countries. In EECCA there was also a 10 % reduction in urban water use. In most countries, the new economic conditions made companies increase the price of water and install water meters in houses. This contributed to a reduction in the amount of water used. Industries connected to the public supply system also had decreasing production. Nevertheless in most countries the supply network is still obsolete and losses in distribution still lead to high abstractions to meet demand.

Among the southern accession countries, there has been a recent 35 % increase in irrigation water demand in Turkey because of new irrigation projects (Table 8.1). In Malta, water abstraction for urban use has fallen and in Croatia there has been a 10 % reduction in water demand mainly because of the decline in industrial production (MZOPU, 2002).

Sectoral abstraction of water per region Figure 8.5.



Notes: Western central: Denmark, Germany, Belgium, United Kingdom, Ireland, Austria, Luxembourg, Switzerland, the Netherlands, Liechtenstein; central accession countries: Poland, Czech Republic, Estonia, Lithuania, Latvia, Romania, Slovakia, Hungary, Slovenia, Bulgaria; Nordic: Finland, Sweden, Norway, Iceland; western southern: Spain, France, Greece, Italy, Andorra, Portugal, San Marino, Monaco; EECCA: Kazakhstan, Turkmenistan, Tajikistan, Kyrgyzstan, Ukraine, Russian Federation, Belarus, Uzbekistan, Republic of Moldova, Armenia, Azerbaijan, Georgia; southern accession countries: Cyprus, Malta, Turkey. Industry in EECCA may include water use for cooling.

Sources: Eurostat New Cronos; EEA questionnaire (2002); Aquastat (FAO), 2002 for EECCA countries

Agricultural water use

The major part (85 %) of irrigated land in western Europe (WE) is in the Mediterranean area (France, Spain, Italy, Portugal, Greece). In the accession countries the major part (93 %) is in Romania and Turkey. In EECCA, the Aral Sea basin accounts for 51 % of the total.

Traditionally, much of the irrigation in Europe has consisted of gravity-fed systems, where water is transported from surface sources through small channels and used to flood or furrow-feed agricultural land. However, in an increasing number of regions in the north and south, irrigation by sprinklers using pressure, often drawing water from subterranean aquifers, is the most common practice. It is often in these areas that the quantities of water used, and thus the impact on the environment, are the largest.

Irrigation is the main cause of groundwater overexploitation in agricultural areas. Examples include the Greek Argolid plain of eastern Peloponnesus, where it is common to find boreholes 400 m deep contaminated by sea-water intrusion. Irrigation in the area between the Danube and Tisza in Hungary,

Table 8.1. Planned water supply projects in Europe

Greece	The Acheloos river diversion project aims to irrigate 380 000 ha in the plain of Thessalia, on the eastern side of the Mount Pindos watershed.
Portugal	The Alqueva water development project in the Guadiana basin (to be completed in 2024) is expected to have a strong irrigation component, expanding Portugal's current total 632 000 ha of irrigated land by some 110 000-200 000 ha, largely by converting traditional extensive agroforestry systems (*mentador*) to intensive irrigated cropping.
Spain	The old infrastructure of most irrigation projects and their poor maintenance was the basis for the Spanish national plan for irrigation, approved in 1996, which affects 1.1 million ha. The measures are intended to improve the efficiency of water use, adapt crops to production and avoid aquifer overexploitation and pollution. The Spanish national hydrological plan (SNHP) from 2001 proposes to meet the country's water demands by transferring water from areas where it is in excess to other areas with a water deficit. Water transfer was envisaged as the most feasible solution for satisfying water demands across the country, after a cost-benefit analysis which took account of the environmental, socio-economic and technical variables. The National SNHP Act does not allow the use of the transferred resources either for new irrigation projects or for broadening existing ones. The main water transfer is planned from the Ebro basin to the southeast, where water resources shortage has been identified as 'structural'.
Turkey	The southeastern Anatolia project (GAP) aims to develop an area of more than 7 million ha within the basins of the Dicle (Tigris) and Firat (Euphrates). It includes 13 sub-projects, to be completed over a period of 10 years and an extra 1.7 million ha will be irrigated.

Source: OECD, 1999–2001; national state of the environment reports

Box 8.2. Examples of the impacts of tourism on water resources

Greece
The most serious shortages occur in the Aegean islands. Tourism's heavy water demand sometimes leads to over-pumping of groundwater and salt intrusion into aquifers. Water use for tourism activities, which averages 450 l/day per tourist in deluxe hotels, is several times higher than average water use by Greek residents, placing a strain on water resources. The popularity of golf courses and swimming pools is a major factor in the high water intensity of the tourism sector. During the peak tourist season, tankers are used to transport drinking water to 14 islands in the Aegean, at an annual cost of EUR 1.5 million (OECD, 2000b).

Turkey
In many tourist areas (and nearby residential areas) adequate drinking water, sewerage and water treatment services are still sorely lacking. Tourism's heavy seasonal and geographical concentration results in over-pumping of groundwater and the discharge of large volumes of untreated wastewater to lakes, rivers and coastal waters. The development of golfing (land acquisition, high water use for sprinkling, fertiliser and pesticide use) also increases environmental pressures (OECD, 1999).

Croatia
Due to the concentration of tourists in space and time, there is often a shortage of freshwater, particularly on the islands and in the driest coastal regions. Existing sources of water are sufficient for most of the year but problems arise in the summer months, when water consumption is four to five times higher than in winter. The resulting shortage is resolved by bringing in water from the mainland (UNECE, 1999a).

Balearic Islands, Spain
Water demand per inhabitant is estimated to be around 279 l/day. Most of the water (89.5 %) is taken from groundwater, 2.5 % from surface water (reservoirs), 6.8 % is reused water and 1.2 % comes from desalination plants. Most of the available water is used for agriculture and urban purposes, but irrigation of golf courses is becoming more important. Different measures have been implemented to reduce the increasing demand for water created by tourism. These include the diversification of supply (e.g. desalination plants and wastewater reuse), water-saving campaigns and economic instruments such as an eco-tourist tax. (BIRHP, 1999).

and the aquifers of the upper Guadiana River basin in Spain, have both led to a lowering of the shallow groundwater table, threatening some natural wetlands.

In the 1990s there was a slight increase (1 %) in irrigated area in southwestern countries, mainly due to increased cropping and irrigation of maize. In the central accession countries and EECCA, the area under irrigation only decreased slightly during the 1990s, however, water use for irrigation dropped markedly (Figure 8.6). In many accession countries only a minor part of the area equipped with irrigation structures is actually irrigated, for example only 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. In Armenia, for example, the cost of electricity for irrigation represents 65 % of the total operating cost of the irrigation system and is barely affordable.

Several new water supply projects are planned in Europe (see Table 8.1) and rehabilitation of the badly maintained irrigation structures in eastern Europe and EECCA may increase the demand for irrigation water.

Urban water use
Increased urbanisation, population growth and higher living standards have been major drivers of the increase of urban water use in the past century. In WE and the accession countries, urban use (households and industries connected to public water supply) of water per capita is around 100 m^3/year. In some western countries, water use fell during the 1990s as a result of a focus on water saving, increased metering and the use of economic instruments (water charges and tariffs). In others, urban water use has continued to increase as a result of more people being connected to water supply systems, more households and changes to more water-consuming lifestyles (more washing machines, baths, swimming pools, etc.)

In the accession countries and EECCA, urban water use around 1990 was in general very high. However, in some countries there was a large rural population not connected to the public water supply. In the central accession countries and EECCA there was a 30 % and 10 % decrease, respectively, in urban water use during the 1990s (Figure 8.6).

Tourism water use
Tourism places severe, often seasonal, pressures on water resources at the regional and/or local level across parts of Europe, and is one of the fastest increasing socio-economic activities in Europe. The increase in water demand is often associated with recreational uses such as swimming pools, golf courses and aquatic parks as well as consumption by a much-increased population during holiday seasons (see Box 8.2.).

8.2.3. Measures to reduce water use

While there has been a general trend towards higher water prices throughout Europe, water prices still vary considerably. Milan and major cities in Turkey have the lowest prices, about 75 % below the average of approximately EUR 1/m³ in the late 1990s. Many of the capitals and major cities in Mediterranean countries also have below-average prices, as do those in countries with abundant water supplies. In contrast, water prices are highest in northern and western European cities (about 75–100 % more than the average). Charging consumers for water is an economic instrument used by some countries to help to reduce water use. Other factors that influence water-use patterns include climate variations, information campaigns, use of water-saving technologies and improved performance of distribution networks (reduction of leakages and mains pressures).

In many eastern European countries, water prices were heavily subsidised before 1990 but there was a marked increase in prices during transition, resulting in lower water use. In Hungary, for example, water prices increased 15-fold after subsidies were removed which led to a reduction in water use during the 1990s of about 50 % (Figure 8.7).

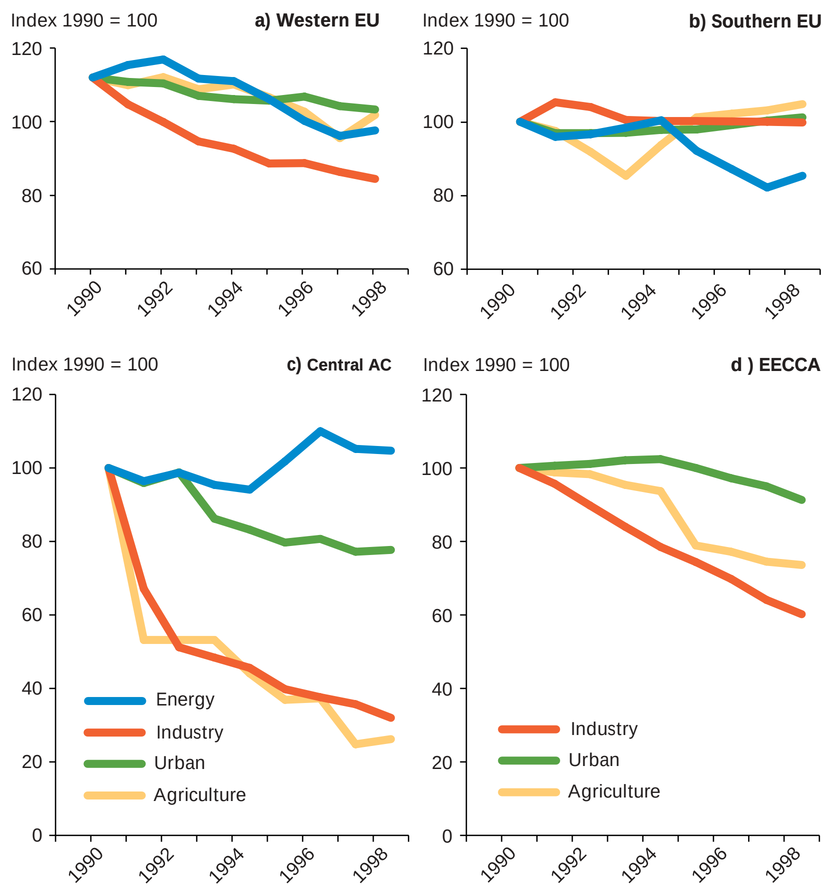
In many of the eastern European countries and EECCA the water supply networks are in a poor condition due to faulty design and construction, as well as lack of maintenance and ineffective operation as a consequence of the decline of the economic situation in the past decade. Leakages are generally high and in many cases 30–50 % of the water is lost. Some cities only have water for part of the day (UNECE, 1998–2000).

8.3. Drinking water quality

8.3.1. Overall trends

Drinking water quality in still of concern throughout Europe (Figure 8.8). All of the

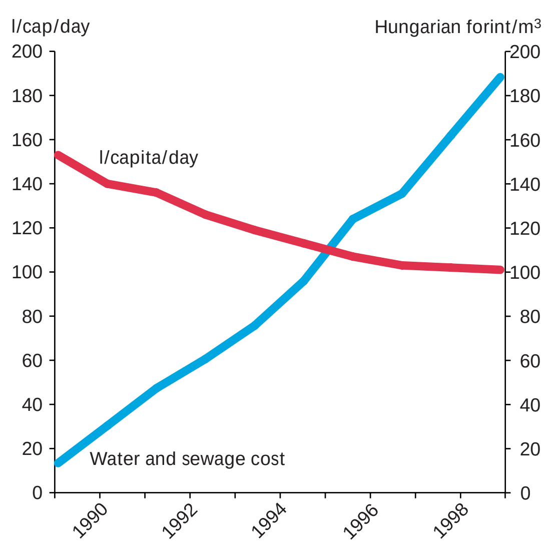
Changes in sectoral water use in western EU countries (a), southern EU countries (b), central accession countries (c), EECCA (d) Figure 8.6.



Notes: Western EU: Austria, Belgium, Denmark, Germany, France, Luxembourg, Netherlands, England and Wales; southern EU: Spain, France, Greece, Italy, Portugal; central accession countries: Bulgaria, Czech Republic, Estonia, Hungary, Lithuania, Latvia, Poland, Romania, Slovakia, Slovenia; EECCA: Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Romania, Turkmenistan, Tajikistan, Ukraine, Uzbekistan.

Sources: Eurostat New Cronos; EEA questionnaire (2002)

Changes in household water use and price of water in Hungary Figure 8.7.



Source: Hungarian Central Statistical Office, 2001

EECCA countries for which information was available (eight out of twelve countries) have major problems with microbiological contamination of drinking water supplies (Figure 8.9). The percentage of samples exceeding microbiological standards in EECCA is between about 5 % and 30 %. Exceedances are higher in non-centralised drinking water sources, primarily in rural areas. At least half the population of the Russian Federation is thought to be at risk from unclean water (OECD, 2000c) as a result of ageing infrastructures and the prohibitive cost of disinfectants. These countries also have problems with contamination from toxic chemicals and metals and there are also some reports of nitrate pollution.

EU countries also have problems with their drinking water. The most common problem identified from national reports is nitrate contamination (Figure 8.8). In addition, at least 12 % of citizens in nine EU countries were potentially exposed to microbiological and some other undesirable contaminants that exceeded the maximum allowable concentrations laid down in the drinking water directive, in the years reported.

In the accession countries and southeastern European countries, the physico-chemical criteria for drinking water quality are the ones most commonly failed, often because of contamination by salts. The percentage of samples failed on the basis of other criteria implies that populations are also significantly exposed to other contaminants but the data are not available to calculate the proportion of the population affected.

8.3.2. The main source of drinking water: groundwater

Groundwater is a major source of drinking water all over Europe, and thus the state of groundwater in terms of quality and quantity is of vital importance (see Box 8.3). Groundwater is affected by human activities such as the use of nitrogen fertilisers and pesticides, water abstraction, and interventions in the hydrological cycle such as land sealing.

Nitrate in groundwater

Agriculture is the main source of nitrogen input to water bodies. The current usage of nitrogenous fertiliser per unit of arable land is highest in WE and lowest in EECCA (except for Uzbekistan). The agricultural use of commercial nitrogen fertilisers fell in nearly all of Europe in the 1990s (see Chapter 2.3). This decrease has been most marked in central and southeastern Europe (accession countries and others). However, average consumption per hectare remains lowest in EECCA.

Assessment of comparable time series for nitrate in groundwater shows relatively high mean values without any significant changes (Figure 8.10). Exceedances of the nitrate limit value (50 mg/l, defined in the EU drinking water directive) were found in around a third of the groundwater bodies for which information is currently available.

> 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.

Pesticides in groundwater

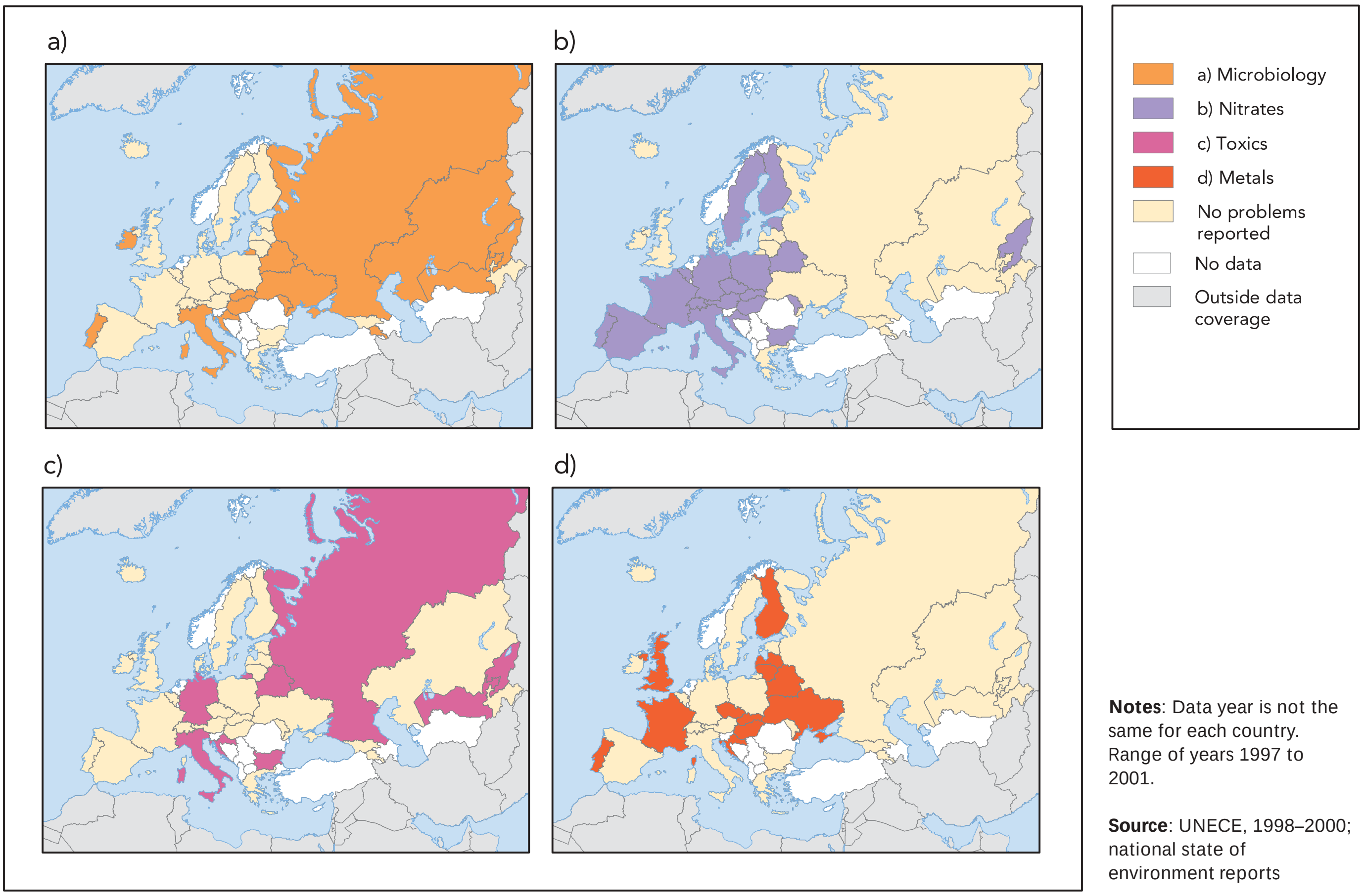
Pesticides in groundwater (and surface waters) arise from diffuse and point sources. They are used in agriculture, horticulture,

Box 8.3. General groundwater quality in eastern Europe, the Caucasus and central Asia

For several countries, there is a substantial lack of comparable groundwater quality data. However, an assessment of national state of environment reports and other sources has provided some information.

In Armenia and Azerbaijan the groundwater resources are reported to be of high quality. However, Armenia has some local problems with high natural mineral content and also the threat of heavy-metal pollution from mine tailings. Belarus reports that its groundwater is generally of good quality with an improvement in overall quality over recent years. However, shallow wells in rural areas of Belarus are seriously affected by nitrates. In Georgia there are around 500 sites where groundwater pollution is found and in Kazakhstan there is extensive contamination with a number of toxic substances, and most areas do not comply with drinking water standards. In Kyrgyzstan increased nitrate concentrations have been observed at depths of 150 m in aquifers and serious groundwater contamination was reported in a region which provides 60 % of the drinking water for the capital. Approximately 75 % of deep aquifers in the Republic of Moldova have high natural mineralisation and so the water requires pre-treatment, and about 61 % of shallow rural wells have severe nitrate pollution. In the Russian Federation one of the main pollutants of groundwater is nitrate and in Ukraine there is major pollution from industry, mining and agriculture. Uzbekistan has a number of contaminated aquifers, particularly where the use of agricultural chemicals is high and close to large industrial enterprises.

Main drinking water problems identified by national reports — Figure 8.8.



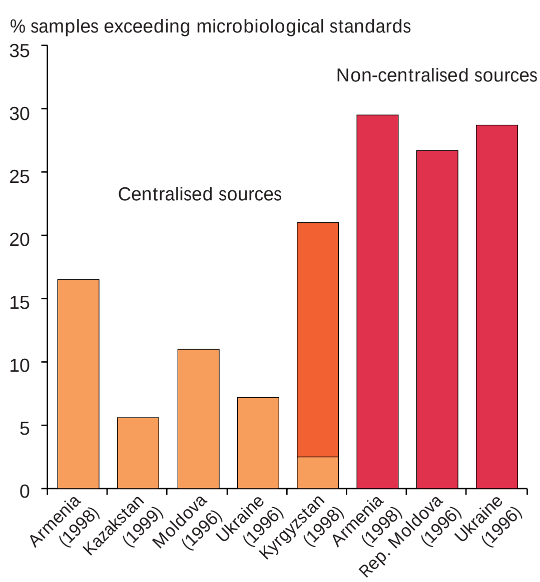
Notes: Data year is not the same for each country. Range of years 1997 to 2001.

Source: UNECE, 1998–2000; national state of environment reports

fruit growing, viticulture and forestry, for public and private pest-control purposes, manufacturing and industrial activities. As groundwater is a major source of drinking water and also forms the base flow of many rivers, the presence of pesticides in groundwater is of concern from the point of view of human health and the protection of aquatic ecosystems. The monitoring of pesticides is a challenging task due to the high number of registered pesticide substances, but the data suggest that pesticide pollution of groundwater is a problem in parts of Europe.

Pesticides are causing groundwater quality problems in many European countries. Six EU countries, six accession countries and eight of the twelve EECCA countries have indicated that there is a danger of pesticide pollution in their groundwater.

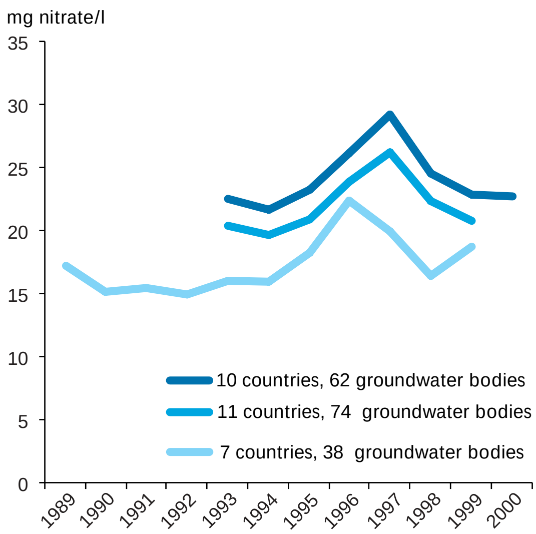
Samples exceeding microbiological parameters in the countries of eastern Europe, the Caucasus and central Asia — Figure 8.9.



Note: Data for Kyrgyzstan show the range of percentage exceedances since the only regional data that were available could be not aggregated.

Source: UNECE, 1998-2000

Figure 8.10. **Temporal development of nitrate mean values in groundwater bodies**



Notes: For each time series the annual mean values of sampling sites were aggregated on the level of groundwater bodies and, furthermore, the groundwater body means were aggregated at the European level (arithmetic mean). Elevated NO_3 mean concentrations in 1996, 1997 are mostly caused by single, very high nitrate concentrations. Data from Austria, Belgium, Bulgaria, Denmark, Estonia, Spain, Hungary, Lithuania, Latvia, Netherlands, Slovenia, Slovakia.

Source: Eurowaternet-Groundwater (2002)

8.4. Nutrient and organic pollution of inland and coastal waters

High organic matter concentration (measured as biological oxygen demand or BOD) has several effects on the aquatic environment including reducing the chemical and biological quality of river water, the biodiversity of aquatic communities and the microbiological quality of waters. High biological oxygen demand is usually a result of organic pollution, caused by discharges of untreated or poorly treated sewage, industrial effluents and agricultural runoff. A decrease in biological oxygen demand in rivers illustrates general improvements in river water quality in terms of the chemical and microbiological properties of the river.

Large inputs of nitrogen and phosphorus to water bodies (including rivers) can lead to eutrophication causing ecological changes. These result in a loss of plant and animal species, and have negative impacts on the use of water for human consumption and other purposes. Eutrophication contributes to a number of water quality problems such as phytoplankton blooms, reduced recreational aesthetics, oxygen depletion, and reduced transparency and fish kills. Some algal blooms produce toxins and also tastes and odours that make the water unsuitable for water supply.

In many catchments the main source of nitrogen pollution is runoff from agricultural land, though discharges from wastewater treatment works can also be significant. For phosphorus, industry and households are often the most important sources though in some countries and agricultural catchments, and particularly where point sources have been reduced, agriculture can be the most important source.

8.4.1. In rivers

Organic matter concentrations (measured as biological oxygen demand at five days or BOD5) have fallen in rivers in accession countries and WE countries during the 1990s, with concentrations in accession country rivers being generally higher than those in WE rivers (Figure 8.11). The average orthophosphate concentrations are similar in rivers in WE countries and accession countries and have fallen during the 1990s. Concentrations are much lower in northern rivers and are around background levels.

Nitrate concentrations are considerably higher in WE rivers than in those in the accession countries, reflecting the more intensive agricultural practices in the WE countries. Concentrations in northern countries are much lower and are around background levels. Nitrate concentrations have remained fairly constant during the 1990s in northern accession countries and WE rivers.

In the central accession countries and Balkan countries, industrial production and pollution discharges decreased in the 1990s and there was a drastic reduction in pesticide and fertiliser use in agriculture. Consequently, pollution pressures on waters have eased considerably and in many places

Levels of phosphorus and organic matter have generally been decreasing in rivers in WE countries and accession countries over the past decade. This reflects the general improvement of sewage treatment and, in the EU, the success of policies such as the urban wastewater treatment directive in reducing pollution of rivers.

In contrast, levels of nitrate have remained relatively unchanged and above background levels in WE countries and accession countries. Levels of orthophosphate are also above background levels.

river quality has improved. However, there are still many polluted river stretches, in particular downstream of cities and industrial regions and in mining areas.

There are limited comparable data available from the EECCA countries. They indicate that phosphorus and nitrate levels in rivers are low compared to WE countries, and orthophosphate levels lower than those in the accession countries. Biological oxygen demand at five days is also generally low. Eight of the twelve EECCA countries identified nitrate levels as being of major concern in their rivers. Five countries reported ammonium and four countries reported microbiological quality as being a major concern. The latter is consistent with the reported high levels of microbiological contamination in drinking water in these countries.

8.4.2. Water quality in lakes and reservoirs

It has been recognised since the 1970s that anthropogenic discharges of nutrients were causing eutrophication in many European lakes. Since then, the proportion of lakes and reservoirs with low phosphorus concentrations (less than 25 (µ/l) has increased and the proportion with high concentrations (more than 50 (µ/l) has decreased. This indicates that eutrophication in European lakes is decreasing.

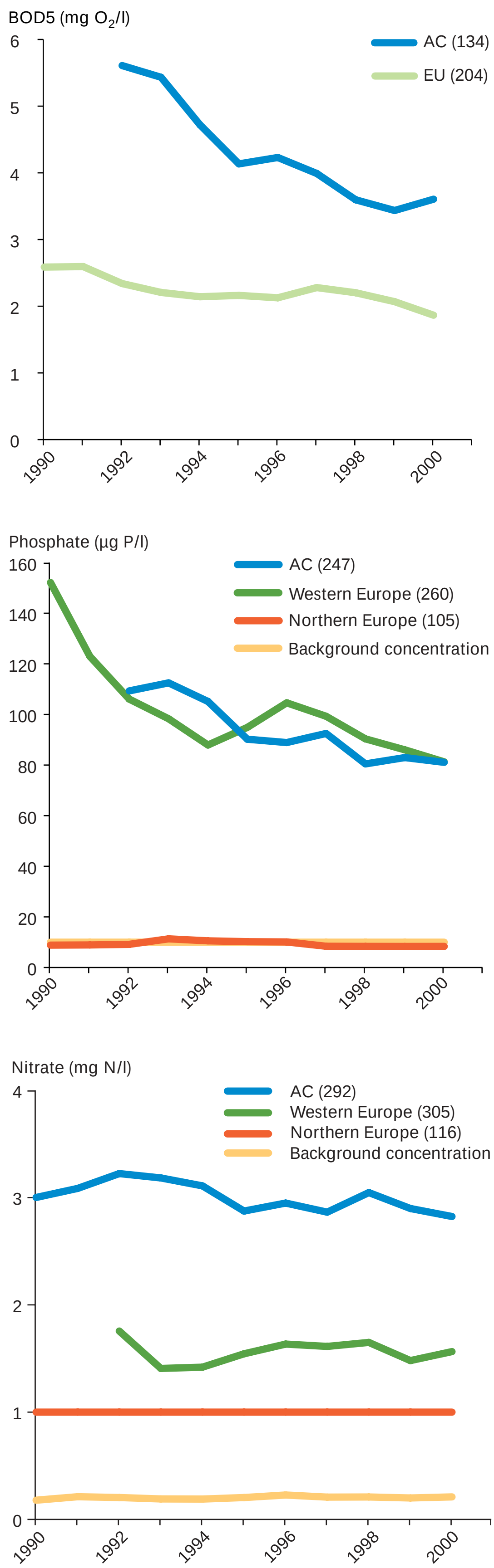
In the past, urban wastewater has been a major source of nutrient pollution but recently treatment has improved and outlets have been diverted away from many lakes. Diffuse pollution, particularly from agriculture, continues to be a problem.

Phosphorus enrichment of lakes is a bigger problem in the accession countries and WE than in the Nordic countries (Figure 8.12). This is because the Nordic countries (Iceland, Norway, Sweden and Finland) have lower population densities and lower agricultural intensities.

Eutrophication of European lakes, reflected as phosphorus concentration, is generally decreasing.

However, there are still many lakes and reservoirs with high concentrations of phosphorus due to human influence. Phosphorus concentrations are highest in the eastern European countries and lowest in the Nordic countries.

Biological oxygen demand at five days (a), orthophosphate (b), and nitrate (c) concentrations in rivers of western and northern part of western Europe and accession countries, 1990–2000 — Figure 8.11.

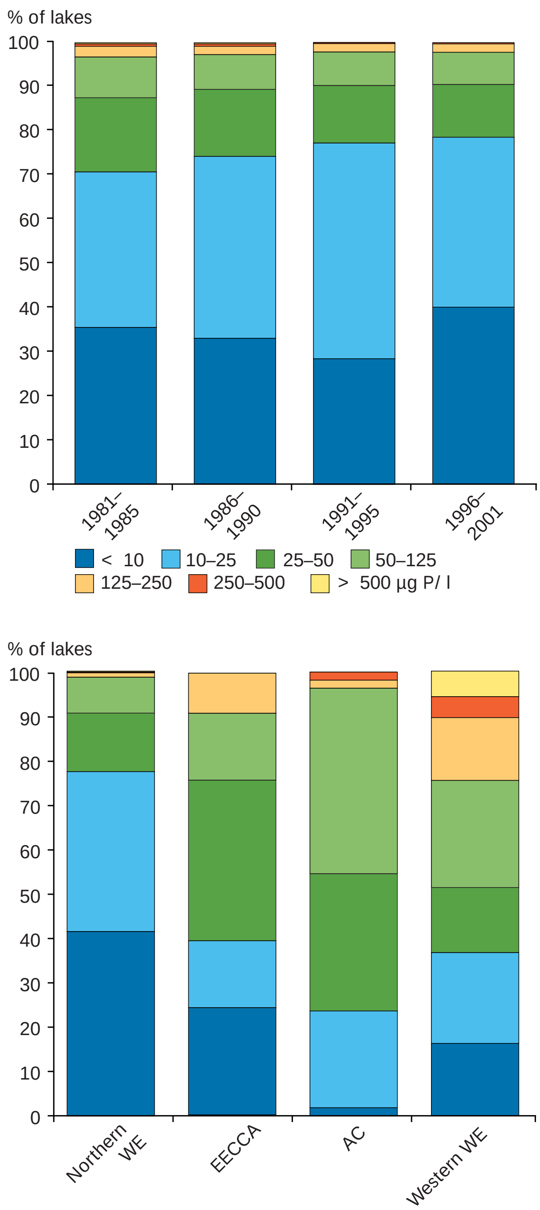


Notes: Number of stations in brackets and dotted line upper limit of the range of background concentrations.

Source: EEA European Topic Centre on Water (ETC/WTR), based on Waterbase

Figure 8.12. **Average summer total phosphorus concentrations in lakes: changes 1981–2001 (a) and in parts of Europe (b)**

Source: EEA European Topic Centre on Water based on Waterbase



In many lakes, which were previously highly polluted by phosphorus, the phosphorus concentration has steadily decreased in recent decades in response to control of point sources such as urban wastewater treatment with phosphorus removal (e.g. Lake Constance and Ijsselmeer) (Figure 8.13).

In other lakes e.g. Loughs Neagh and Erne, concentrations have steadily increased. This is the result of a steady build-up of a surplus of phosphorus (arising from fertilisers) in the soils in the catchments draining into these lakes.

On many large European rivers, cascades of reservoirs have been constructed during the past century. The rivers Volga and Dnepr, for example, have six major reservoirs, each located on their main course, mostly downstream of large cities such as Moscow and Kiev. The reservoirs are heavily affected by nutrients and other pollutants discharged in the catchment.

8.4.3. Wastewater treatment

Wastewater from households and industry represents a significant pressure on the water environment. As well as containing organic matter and nutrients, it can also contain hazardous substances. The level of treatment of the wastewater before discharge and the sensitivity of the receiving waters will affect the impact it has on the aquatic ecosystem. EU countries have to implement directives such as the urban wastewater treatment directive, which prescribes the level of treatment required before discharge.

There has been marked improvement in the level of treatment (see Box 8.4 for definitions) and proportion of the population connected to treatment plants in WE countries since the 1970s. In the northern and central WE countries most of the population is now connected to wastewater treatment plants, many to tertiary plants which efficiently remove nutrients and organic matter.

In Belgium, Ireland and southwestern Europe only about half of the population is connected to wastewater treatment plants, with 30–40 % of the population connected to secondary or tertiary treatment plants.

In CEE countries on average 25 % of the population is connected to wastewater treatment plants, with most of the wastewater receiving secondary treatment. In some countries like Estonia around 70 % are

Box 8.4. Wastewater treatment — definitions

Primary treatment: removal of floating and suspended solids, both fine and coarse, from raw sewage.

Secondary treatment: following primary treatment by sedimentation, the second step in most wastewater systems in which biological organisms decompose most of the organic matter into an innocuous, stable form.

Tertiary treatment: the process which removes pollutants not adequately removed by secondary treatment, particularly nitrogen and phosphorus.

connected, while in countries like Hungary and Turkey only 32 % and 23 % are connected. There are still many large cities that discharge their wastewater nearly untreated (e.g. Bucharest).

There is no comparable or recent information for EECCA but the available information indicates that generally the level of wastewater treatment is low. At present only a small part of the population is connected to operating wastewater treatment plants and the existing plants are generally in a bad condition. There are high leakage levels in the networks, which leads to direct releases of raw wastewater to the environment (see Chapter 12). Many plants often operate only primary treatment, for technical reasons or because of economic conditions and the high price of electricity. However, in Belarus more than 70 % of the population is connected to operational urban wastewater treatment plants, the majority of which are in good operational condition. In addition, all cities have plants with biological treatment.

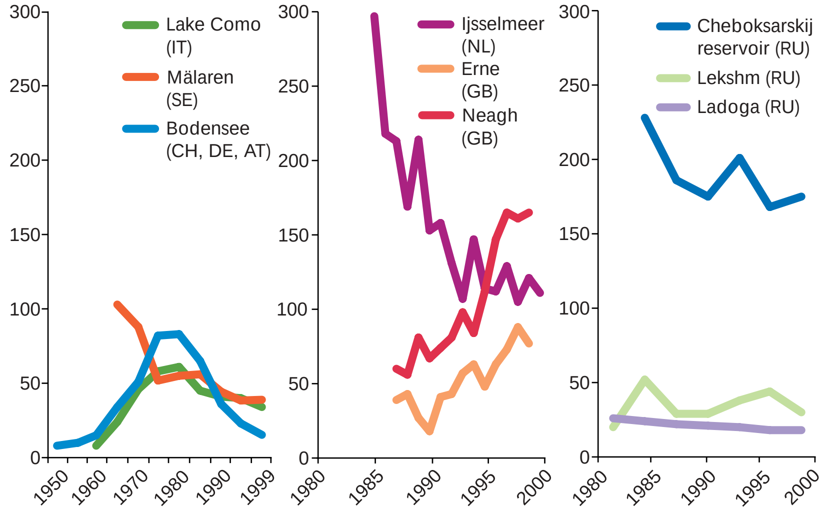
Though the percentage of the western European population that is connected to wastewater treatment plants increased between 1970 and 1990 and then remained fairly constant to 1999 (Figure 8.14), levels of biological oxygen demand have declined due to improvements in wastewater treatment. Organic matter discharged from urban wastewater treatment plants has decreased in Denmark, Finland, the Netherlands and the United Kingdom (Figure 8.15).

The levels of wastewater treatment in western Europe and in central and eastern Europe have improved significantly since the 1970s.

However the percentage of the population connected to wastewater treatment is still relatively low in central and eastern Europe, although increasing.

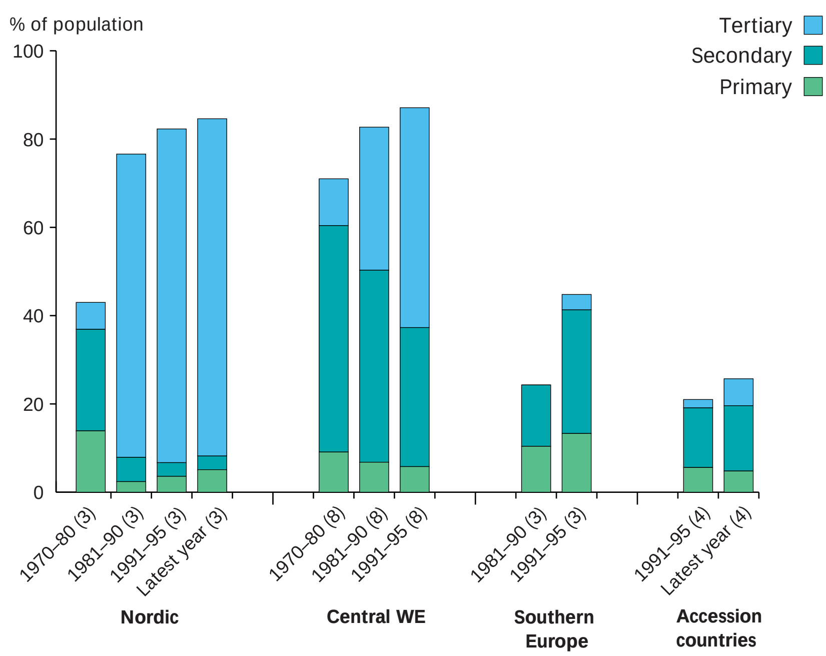
In eastern Europe, the Caucasus and central Asia there is a very low level of treatment of wastewater in terms of population connected to treatment works, treatment levels applied and the operational efficiency of those treatment plants that do exist.

Trends in total phosphorus concentrations in some large European lakes Figure 8.13.



Source: Information from national state of the environment reports

Changes in wastewater treatment in regions of Europe between 1980 and late 1990s Figure 8.14.



Notes: Only countries with data from all periods included, the number of countries in parentheses; Nordic: Norway, Sweden, Finland; western central: Austria, Denmark, Germany, Ireland, the Netherlands, Luxembourg, Switzerland, United Kingdom; southern: Greece, Spain and Portugal; accession: Estonia , Hungary, Poland ,Turkey.

Source: Eurostat /OECD joint questionnaire (2000)

Figure 8.15. **Discharge of organic matter (BOD) from urban wastewater treatment plants in Denmark, Finland, the Netherlands, and England and Wales**

Source: Information from national state of the environment reports and Eurostat /OECD joint questionnaire (2000)

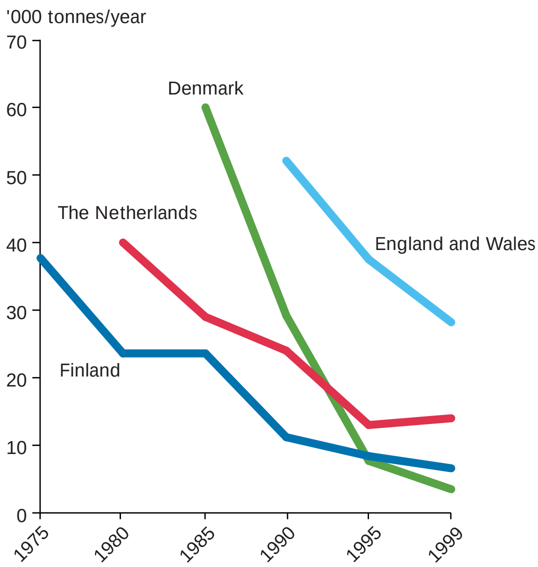
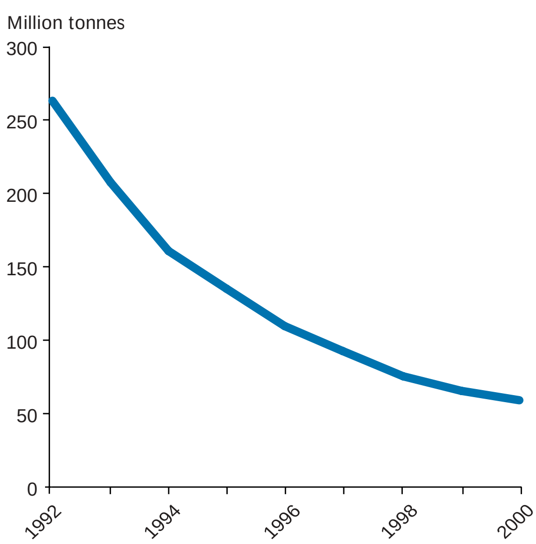


Figure 8.16. **Discharge of organic matter (BOD) from point sources in five EU accession countries**

Note: Czech Republic, Estonia, Latvia, Lithuania and Slovakia.

Source: Information from national state of the environment reports



Organic matter discharged from point sources in the accession countries decreased dramatically during the 1990s (Figure 8.16). This may be due partly to the deep economic recession in the first half of the decade and the consequent decline in highly polluting heavy industry. Although economies have since improved and industrial output has increased, there has been a shift towards less-polluting industries.

Several industrial sectors, which in the 1970s and 1980s had large emissions of organic matter, have now markedly reduced their discharges by the introduction of cleaner technology and improved wastewater treatment (Figure 8.17).

The move towards cleaner technologies is driven partly by EU directives such as the integrated pollution prevention and control directive, which requires large facilities to use the best available technology to make radical environmental improvements.

In several countries in the northwestern part of Europe there was a marked increase in the percentage of the population connected to tertiary wastewater treatment (removal of nutrients) during the 1990s. In the countries included in Figure 8.18 the percentage of the population connected to tertiary treatment increased from 40 % to 80 %. In the same period the discharge of phosphorus and nitrogen from wastewater treatment decreased by 30 % and 60 % respectively, reflecting that nearly all the tertiary treatment plants have phosphorus removal while only some of the plants, in particular the large plants, have nitrogen removal.

8.4.4. Discharge of nutrients to the seas

There is a direct relationship between riverine and direct discharges of nitrogen and phosphorus and the concentration of nutrients in coastal waters, estuaries, fjords and lagoons, which in turn affects their biological state. Measures to reduce the input of anthropogenic nutrients and protect the marine environment are being taken as a result of various initiatives at all levels (global, regional conventions and ministerial conferences, European and national). The EU nitrate directive and urban waste water treatment directive aim at reduction of nitrate discharges mainly from washout from agricultural soils and nutrient discharges from point sources, respectively. Also, the recent EU water framework directive aims, among other things, at achieving good ecological quality of coastal waters.

There were significant reductions in phosphorus discharges to the North Sea from urban wastewater treatment works, industry and other sources between 1985 and 2000 (Figure 8.19.). The reduction from agriculture has been less and this source was the largest in 2000. Nitrogen discharges to the North Sea decreased significantly from all four sources between 1985 and 2000 with agriculture being the major source in 2000. However some countries such as Norway, Sweden and the United Kingdom reported higher riverine discharges (and direct discharges for the United Kingdom) of nitrogen to the North Sea in 2002 than in

Discharges of both phosphorus and nitrogen from all quantified sources to the North Sea and Baltic Sea have decreased since the 1980s.

Agriculture is now the major source of nitrogen and phosphorus discharges into the North Sea. For the Baltic Sea agriculture is the main source of nitrogen pollution and urban wastewater treatment the main source of phosphorus pollution.

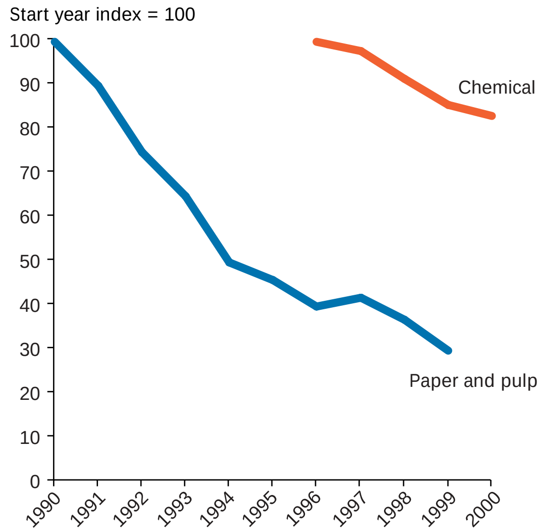
Data for the Black Sea and Caspian Sea is less comprehensive than for the Baltic and North Seas, but indicates that riverine discharges are the largest sources of nitrogen and phosphorus for both seas.

Comprehensive data are also not available for the Mediterranean, but all coastal cities discharge their (treated or untreated) sewage to the sea and only 4 % have tertiary treatment, indicating that the nutrient input from this source may be high.

1985, whereas the other states reported reductions (North Sea progress report, 2002). The high values in 2000 for Norway and Sweden could to a large extent be explained by unusually high precipitation levels during the autumn of that year causing high levels of non-anthropogenic runoff to rivers.

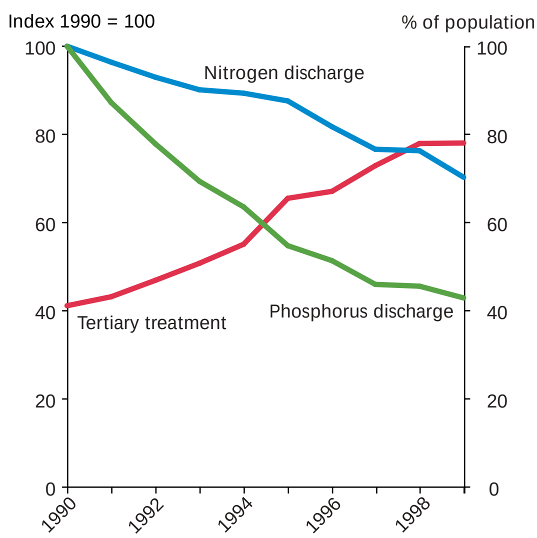
Even though the data for the Baltic Sea are less recent (late 1980s to 1995) they give a similar picture to the North Sea, with significant reductions in discharges of nitrogen and phosphorus from agriculture (partly due to the reduction in agriculture in some southern Baltic states), urban wastewater treatment works, industry and aquaculture (Figure 8.19). In 1995 the major sources of phosphorus and nitrogen to the Baltic Sea were urban wastewater treatment works and agriculture, respectively. Regarding point sources, the 50 % HELCOM (the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area) reduction target was achieved for phosphorus by almost all the Baltic Sea countries, while most countries did not reach the target for nitrogen (HELCOM, 2000).

Discharge of organic matter (BOD) from selected industries Figure 8.17.



Sources: CEPI Environment Report, 2000; CEFIC, 2001

Changes in discharge of phosphorus and nitrogen from urban wastewater treatment plants and percentage of population connected to tertiary treatment Figure 8.18.

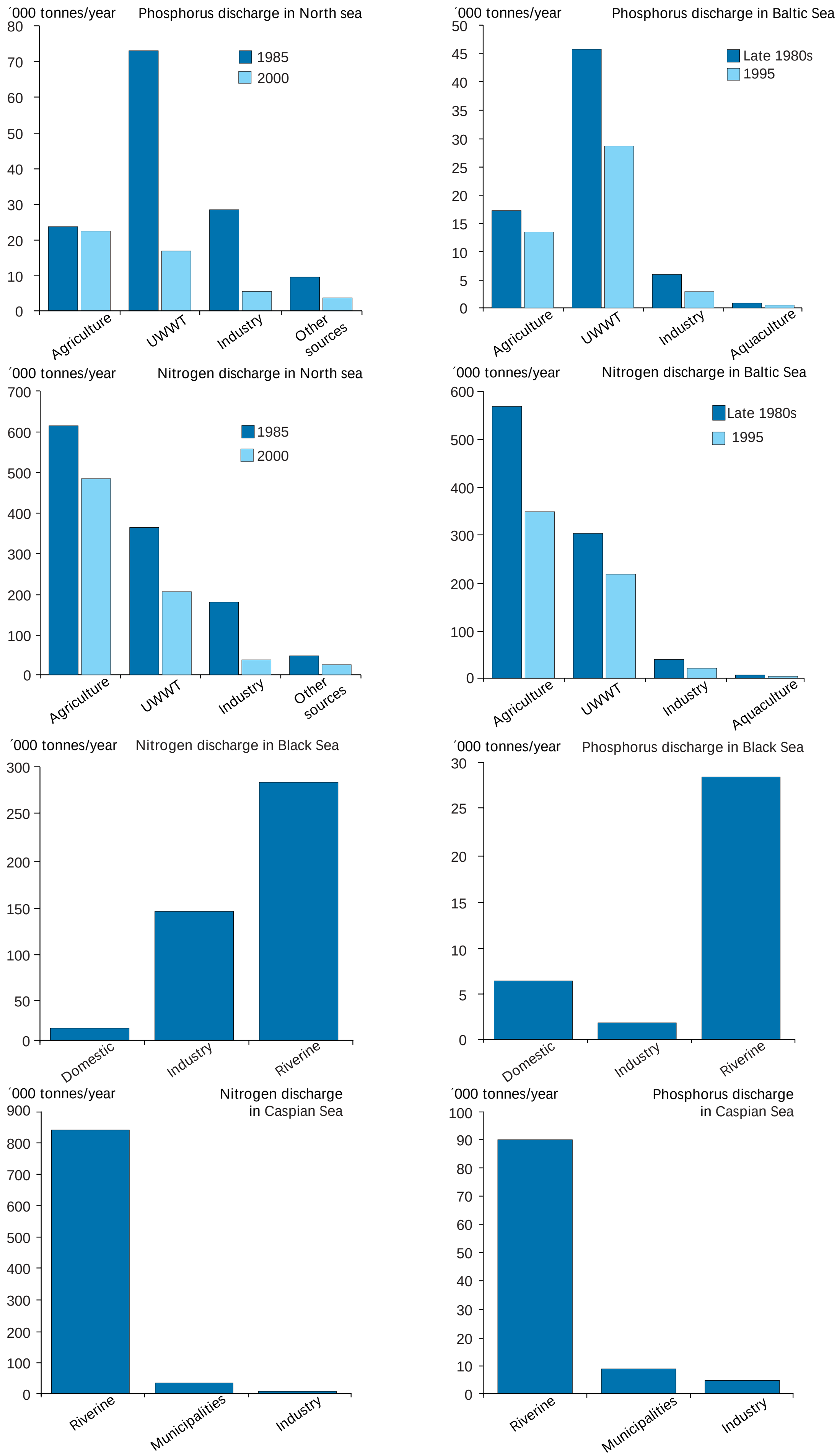


Source: Information from national state of the environment reports and Eurostat/OECD joint questionnaire (2000)

The information from the Black and Caspian Seas is less comprehensive in terms of source apportionment and how discharges have changed with time (Figure 8.19.). In 1996 the most significant sources of phosphorus and nitrogen to the Black Sea were riverine inputs. The major rivers in the Black Sea catchment are the Danube, Dnepr, Don, southern Bug and Kuban, draining an area of around 2 million km² and receiving wastewater from more than 100 million people, heavy industries and agricultural areas. The Danube contributes about 65 % of the total nitrogen and phosphorus

Figure 8.19. **Source apportionment of nitrogen and phosphorus discharges to Europe's Seas and percentage reductions**

Sources: North Sea progress report, 2002; Finnish Environment Institute, 2002; Black Sea Commission, 2002; Caspian Environment Programme, no date.



Winter surface nitrate concentrations in the greater North Sea are not changing. Concentrations are generally not changing in the Baltic Sea area, except for a fall at a few Danish, Finnish and Swedish stations. In the Black Sea, there is a slight decrease of nitrogen concentrations in Romanian coastal waters and a steady decline in Turkish waters at the entrance of the Bosphorus.

Decreases are observed in winter surface phosphate concentrations at a number of stations in the Belgian, Dutch, Norwegian and Swedish coastal waters of the North Sea and Skagerrak, and in the Danish, German, Lithuanian and Swedish waters of the Baltic Sea.

No general changes of total nutrient concentrations are observed at the majority of the coastal and marine stations in the Black Sea. A slow decrease in Turkish waters at the entrance of the Bosphorus is reported.

discharges from all sources. The information for the Caspian also shows riverine inputs contributing to the greatest proportion of nutrient loads. The Volga, Ural, Kura and Araks are the main rivers discharging into the Caspian Sea. The Volga's contribution to pollution discharges is more than 80 %.

Comprehensive data are also not available for the Mediterranean Sea, but all coastal cities discharge their (treated or untreated) sewage to the sea and only 4 % have tertiary treatment, indicating that the nutrient input from this source may be high. Agriculture is also intensive in the region and 80 rivers have been identified as contributing significantly to the pollution of the Mediterranean (EEA, 1999).

Quality of coastal waters

Maps 8.1 and 8.2 illustrate the mean winter surface concentrations (January to February/March, 0–10 m) of nitrate and phosphate, based on data from the Baltic Sea area, greater North Sea, Celtic, Mediterranean and Black Seas. In winter biological uptake and turnover of nutrients is lowest and the concentration of nutrients highest. There is a relationship between riverine discharges of nitrogen and phosphorus and the winter concentration of nutrients in lagoons, fjords, estuaries and coastal waters. Generally the nutrient concentrations decrease from fjords and estuaries through coastal waters to the open sea. Background nitrate concentrations in river water are between 0.1 and 1 mg N/l (7–70 µmol/l) and background phosphate concentrations are around 10 µg P/l (0.3 µmol/l).

The nutrient concentrations illustrated should be assessed against what is considered to be background levels of nutrients, which are quite different for the European seas (Table 8.2). The Mediterranean Sea is naturally oligotrophic and background nutrient levels would be expected to be lower than in the North or Baltic Seas. Due to the differences in nutrient regimes, no Europe-wide classification of nutrient concentrations is possible.

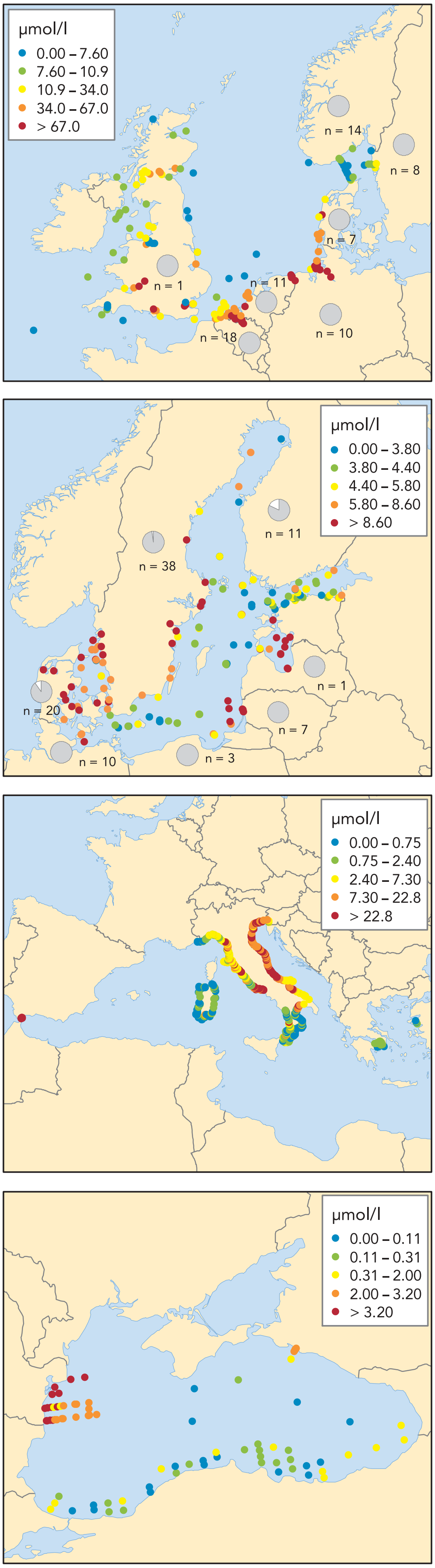
Nutrient concentrations at most stations have not significantly increased or decreased and levels at most stations in the Baltic, Mediterranean and Black seas are generally low. Some high nitrate and phosphate concentrations occur in the greater North and Celtic seas, particularly in estuaries, and there are some high phosphate concentrations on Italy's west coast.

At most of the stations for which there are enough data, no changes in nutrient concentrations are apparent. However, nitrate and phosphate concentrations are decreasing at a number of Danish and Swedish stations and decreases have also been reported in Turkish waters at the entrance of the Bosphorus (Black Sea Commission, 2002). Decreases in phosphate concentrations were also seen at some Belgian, Dutch, German and Lithuanian stations. However some Belgian and German North Sea stations showed increases. In two Finnish stations, increasing concentrations were also observed due to hypoxia and upwelling of phosphate-rich bottom water in the late 1990s.

Mean winter surface concentrations of nitrates (NO_3-N+NO_2-N) in sea water (1995 – 2000)

Trend analysis
1985 - 2000
(stations with at least three years data 1995 - 2000 and at least five years in total)

Increase
No trend
Decrease



Map 8.1.

Notes: Classification not related to background values. In addition, the results of trend analyses of time series 1985–2000 (with at least three years data in the period 1995–2000) are shown for each country by a pie diagram. Pie diagrams are based on statistical trend assessments of nutrient concentrations at individual stations and show the percentage of stations with increasing, decreasing or no trend respectively.

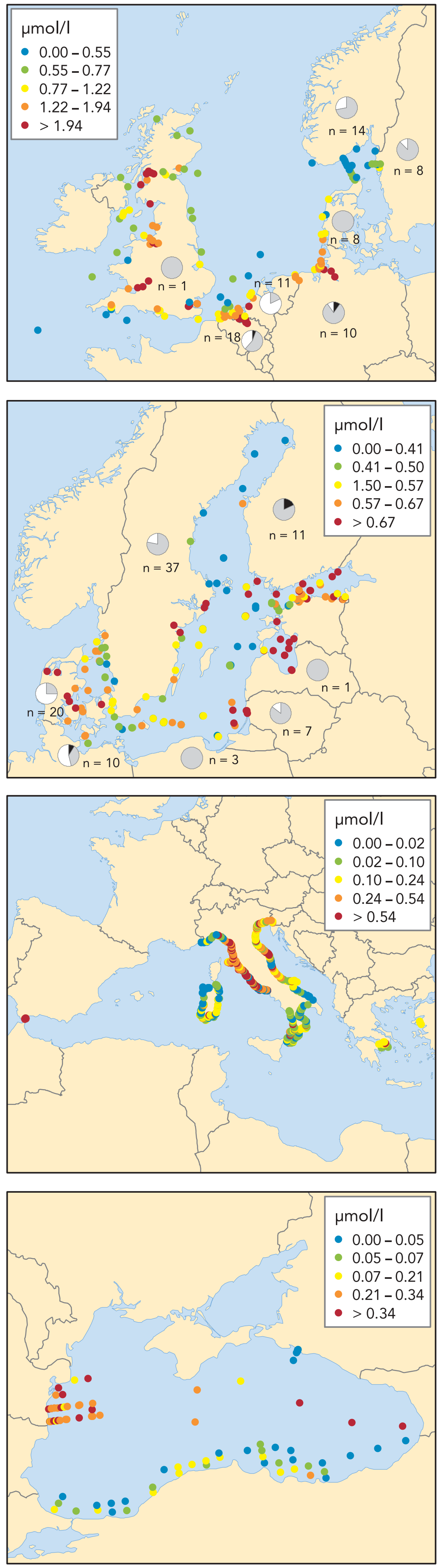
Source: OSPAR, HELCOM, ICES, BSC and EEA member countries compiled by EEA European Topic Centre on Water

Map 8.2.

Mean winter surface concentrations of phosphate (PO_4 –P) in sea water (1995–2000)

Trend analysis
1985–2000
(stations with at least three years data 1995–2000 and at least five years in total)

Increase
No trend
Decrease



Eutrophication effects

In summer, phytoplankton primary production and chlorophyll-a concentration is nutrient-limited in most areas, and dependent on the general availability of nutrients (eutrophic level) in the specific area. The phytoplankton biomass expressed as chlorophyll-a determines the light conditions in the water column and the depth distribution of bottom vegetation, as chlorophyll-a might shadow the light necessary for growth of bottom vegetation. Secondary production of bottom fauna is most often food limited and related to the input of phytoplankton settling at the bottom, which in turn is related to the chlorophyll-a concentration (Borum, 1996). Adverse effects of eutrophication include low oxygen and hypoxic/anoxic conditions caused by the bacterial degradation of dead phytoplankton. Oxygen consumption is therefore high when the biomass of dead phytoplankton is high due to excessive growth of phytoplankton caused by enhanced nutrient availability. Bottom-dwelling animals and fish die if oxygen concentrations fall below 2 mg O_2/l. Eutrophication often leads to the disappearance of bottom vegetation in deeper coastal waters and the occurrence of harmful algal blooms.

Comparing seas on the basis of measurements from ships, mean summer surface chlorophyll-a concentrations are lowest (less than 0.4 µg/l) in Mediterranean open waters, low in the open North Sea (less than 3 µg/l) and high in the open waters of the Baltic Sea (more than 3 µg/l), probably due to summer blooms of cyano-bacteria. Some European coastal areas show higher chlorophyll concentrations, which reflect the land-based nutrient discharges to seas. These measurements are supported by satellite images.

Map 8.3 shows clear differences in the geographical distribution of concentration levels of chlorophyll-like pigments, especially in the eastern and southern North Sea and in the Baltic Sea. There are also relatively high concentrations seen in the Black Sea, particularly in the northwestern parts where hypoxia and hydrogen sulphide formation have gradually developed over the past 30 years leading to severe adverse effects on the ecological system. Thus, the area with hypoxic water in 2000 reached approximately 14 000 km^2, or 38 % of that part of the Black Sea. Table 8.3 summarises the areas where enhanced chlorophyll levels were observed from the satellite imagery.

Background concentrations of nutrients in µmol/l — Table 8.2.

	Rivers	North Sea	Baltic Sea	Mediterranean Sea	Black Sea
Nitrate + nitrite	7–70	9.2	4.6	0.5	0.1
Phosphate	0.3	1.3	0.68	0.03	0.29

Sources: EEA, 2001 (North and Baltic Sea); GESAMP (1990) (Mediterranean Sea)

Eutrophication is also a problem in the Caspian Sea, which is currently facing increasing anthropogenic pressures. However, chlorophyll-a is not routinely measured and so the extent of the problem is difficult to assess. It appears to be greatest in the shallow waters off the Volga delta (Caspian Environment Programme, no date).

In the Arctic Ocean, eutrophication is not a great problem since human population densities in the area are low and the duration of seasonal phytoplankton production is short due to the physical conditions (low temperatures and limited light during the winter).

Generally no changes have been observed in summer surface chlorophyll-a concentrations in the Baltic Sea, greater North Sea or Greek coastal waters during the past decade. Reductions have been observed at a few stations in Danish estuaries, and increases at a few stations in Belgian, Finnish, Lithuanian and Swedish coastal waters. The chlorophyll-a concentration is generally highest in estuaries and close to river mouths or big cities, and lowest in open marine waters.

Map 8.3. **Mean spring-summer concentrations of chlorophyll-like pigments in European seas determined from satellite observations**

Source: Joint Research Centre, compiled by EEA

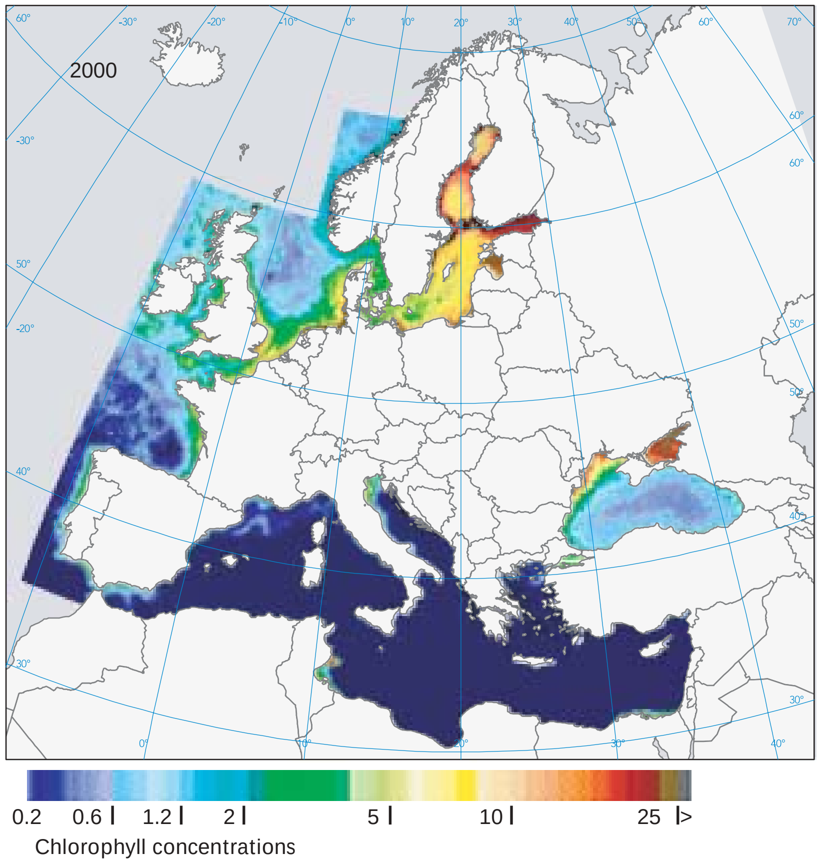


Table 8.3. **Coastal areas with apparently enhanced chlorophyll levels compared to neighbouring seas from the satellite spring-summer mean chlorophyll images**

Source: EEA, 2001

Baltic Sea	Northeastern part and eastern coast of Bothnian Bay; the Quark area; coastal areas of Bothnian Sea; Gulf of Finland; Gulf of Riga; coastal areas off Kaliningrad and Lithuania; Gulf of Gdansk; Pomeranian Bight; Swedish Baltic coast proper
Belt Sea and Kattegat	Especially coastal and shallow areas of the Belt Sea and Kattegat
Skagerrak	Northeastern and southwestern parts and coastal areas of Skagerrak
North Sea	Eastern North Sea; German Bight; Wadden Sea; Southern Bight; UK coast and estuaries
English Channel	Coastal areas, especially Baie de Somme, Baie de Seine and Baie du Mont St Michel
Celtic Seas	Bristol Channel; Liverpool Bay with associated estuaries; Solway Firth; Firth of Clyde; Ireland's coast to the Irish Sea
Bay of Biscay and Iberian Coast	French coastal areas and estuaries in Bay of Biscay, especially in the vicinity of the Loire and Gironde estuaries; Spanish and Portuguese Atlantic coasts
Mediterranean Sea	Costa del Sol; vicinity of the Ebro delta; Gulf of Lyon; Italian west coast, especially Gulf of Gaeta, Napoli Bay and in the vicinity of the rivers Tiber and Arno; northern Adriatic Sea, especially Gulf of Venice and the areas influenced by the River Po; northern Aegean Sea, especially Bights of Thessaloniki and Thermaikos and in the Limnos area with inflow from the Black Sea through the Marmara Sea. Outside EU countries enhanced chlorophyll concentrations are found along the southeast coast of Tunisia and the Egyptian coast from Alexandria to Gaza
Black Sea, Marmara Sea and Sea of Azov	Marmara Sea, especially close to Istanbul and southern coastal areas; the northwestern Black Sea, especially along the Ukrainian and Romanian coasts influenced by the large rivers Danube, Dnieper, Dniester and Southern Bug, and less along the Bulgarian and Turkish coasts; the Sea of Azov

8.4.5. Bathing water quality

EU Directive 76/160 on bathing water quality was designed to protect the public from accidental and chronic pollution discharged in or near European bathing areas. The directive requires Member States to designate coastal and inland bathing waters and monitor the quality of these waters throughout the bathing season (May-September in most European countries). The directive sets both minimum standards (mandatory) and optimum standards (guideline). The designated beaches, for which data are reported by countries, are not the same each year, and compliance with the directive standards might be better than shown in Figure 8.20 if data from the same beaches were reported each year. However, studies have shown that meeting guide values does not necessarily protect public health. The European Commission proposed a new bathing water directive in October 2002.

The quality of water at designated bathing beaches in the EU (coastal and inland) improved throughout the 1990s. In 2001, 97 % of coastal bathing waters and 93 % of inland bathing waters complied with the mandatory standards.

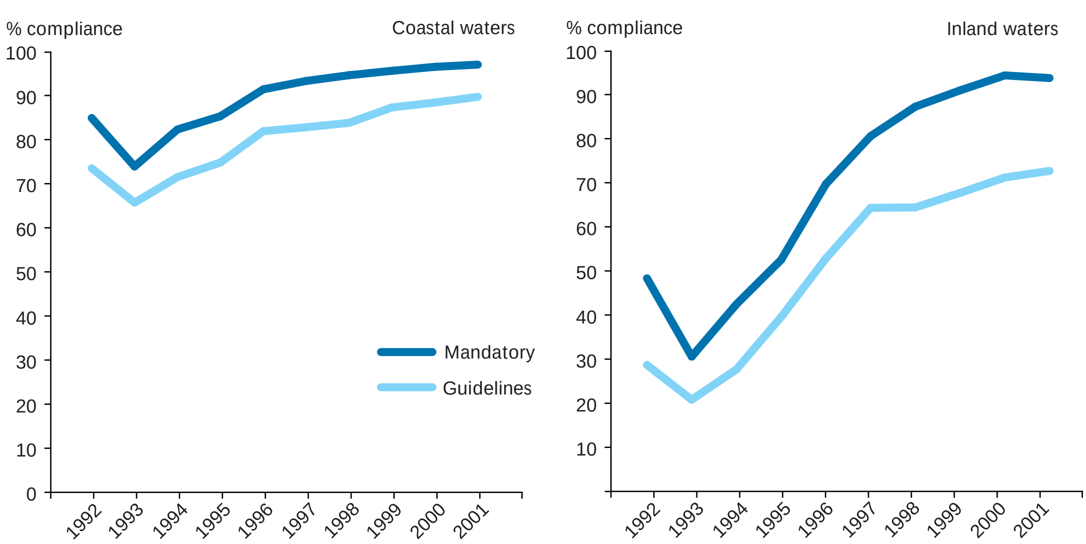
Despite this improvement, 10 % of the EU's coastal bathing waters and 28 % of inland bathing beaches still do not meet (non-mandatory) guide values even though the bathing water directive was adopted almost 25 years ago.

There are frequent problems with the quality of bathing waters reported for eastern Europe, the Caucasus and central Asia.

Other European countries do not yet have to comply with the EU directive, although the accession countries have started its transposition into national law. In Romania there was an improvement of bathing water quality between 1996 and 2000. In Turkey in 1993, three of the 28 beaches along the Black Sea coast were unsuitable for bathing because the World Health Organization (WHO) standard for faecal streptococci was exceeded (OECD, 1999).

Within EECCA there are frequent closures of beaches on the Black Sea coast of the Ukraine, mainly because of the poor bacterial state of the water (UNECE, 1999b). One of the major causes of increased microbiological pollution in Ukrainian bathing waters is the lack of adequate systems for treatment of storm waters. River beaches in the Ukraine suffer from considerably higher bacterial pollution than sea beaches. In Georgia some beaches were closed in 1997 because of bacteriological pollution but since then there have been no closures despite the inadequate sanitary and epidemiological conditions of the beaches in summer seasons. In Azerbaijan, 95 % of the 140 km of Caspian Sea beaches and of the 10 km of lake and reservoir beaches meet national standards (Azerbaijan NCP, 2002).

Compliance of EU coastal (a) and inland (b) bathing waters with the bathing water directive Figure 8.20.



Notes: The directive sets both minimum standards (mandatory) and optimum standards (guide). For compliance with the directive, 95 % of the samples must comply with the mandatory standards. To be classified as achieving guide values, 80 % of the samples must comply with the total and faecal coliform standards and 90 % with the standards for the other parameters. The data set does not include France for 1999, 2000 and 2001.

Source: European Commission from annual reports by EU Member States

8.5. Pollution of water bodies by hazardous substances

The new EU water framework directive defines hazardous substances as 'substances or groups of substances that are toxic, persistent and liable to bio-accumulate; and other substances or groups of substances which give rise to an equivalent level of concern'. Hazardous substances include heavy metals, pesticides and other organic micro-pollutants (see Chapter 6) (see also EU, 2001a).

There is generally little comparable information at the European level on the presence and concentrations of hazardous substances in surface waters and groundwaters.

The quality of rivers in EECCA is hard to quantify because of the lack of comparable information. However, it is clear that many water bodies are heavily contaminated by hazardous substances. These hot spots are often downstream of major cities and/or major installations (e.g. industry or military) and/or mines.

Table 8.4 summarises information on the general status, main pressures and hot spots in rivers in EECCA, obtained from examination of national state of the environment reports and other sources. Some of the EECCA countries, such as Kyrgyzstan, Republic of Moldova and Tajikistan, reported that their surface waters are generally of good quality away from identified hot spots whilst others, such as Azerbaijan, Belarus, the Russian Federation and Ukraine, indicated higher levels of pollution. Two countries (Ukraine and Republic of Moldova) indicated that smaller rivers were more polluted than larger ones. Limited monitoring is also reported to be a problem in Armenia and Kyrgyzstan though it is likely that this is a problem in all EECCA. A common theme is the decline in economies leading to some industries closing but also to poor levels of treatment of effluents for those that remain. Also some countries have low levels of sewage treatment and connection to sewerage systems. The main sectors that affect water quality are reported to be industry, urban populations, mining, agriculture (particularly livestock), oil refining and military bases (including nuclear weapons testing sites).

8.5.1. Hazardous substances in rivers

Environmental quality standards are set for some hazardous substances for application at the EU level (List I substances — Figure 8.21) under the dangerous substances directive, and others are set nationally (e.g. List II substances). There are also standards for the levels of these substances in drinking water. These are to be complied with at the point of supply to the consumer (e.g. less than 0.1 µg/l for individual pesticides) but they are also useful for assessing concentrations in untreated water. For example Figure 8.22a shows the trends in occurrence of some commonly found pesticides in surface waters in England and Wales — the data show no definite trends but indicate that some pesticides occur at concentrations that would be of concern if the water were drunk untreated. Figure 8.22b shows the number of monitoring sites failing standards for the dangerous substances directive in England and Wales between 1994 and 2000. In terms of List I substances, compliance has improved over this period whilst there is no clear trend in terms of List II substances.

The concentrations of cadmium and mercury in selected EU rivers have decreased since the late 1970s, reflecting the success of measures to eliminate pollution by these two substances under the dangerous substances directive.

Though there is evidence that the concentrations of some hazardous substances have been decreasing in some EU rivers, pesticides and other hazardous substances still occur at levels that are of potential concern in terms of supplies for drinking water and adverse effects on aquatic organisms.

Though there is very limited information on the presence and levels of hazardous substances in their rivers, most of the EECCA countries identify the presence of hazardous substances as a major concern.

Summary of main hot spots and pressures in rivers in EECCA Table 8.4.

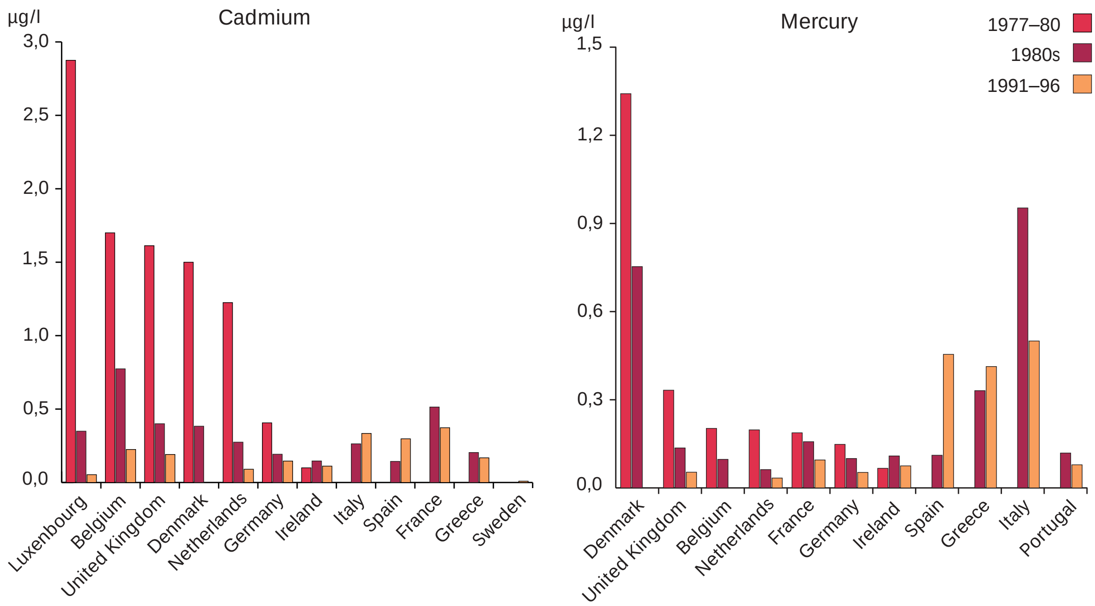
Armenia	The main pollution problems in rivers originate from agriculture and municipal waste generation. Monitoring of water pollution is not well developed and will have to be extended as water management is improved. Water quality has improved in recent years as a result of the economic crisis and the reduction in industrial and agricultural activity. Regions with mines have high concentrations of heavy metals.
Azerbaijan	The estimates show that the total transit and flow of Azerbaijan's rivers on average (50% of provision) with only 30% of river flow resources formed within the country. Subsequently a large part of the pollution is of transboundary character. More than half of the larger rivers are considered contaminated. Many lakes are in a critical state.
Belarus	Most rivers in Belarus are moderately polluted. The most polluted tributary of the Dnieper is the Svisloch, which carries discharges from the Minsk sewerage system. With the decline in industrial production, the pollution load of water bodies has dropped significantly in recent years. In southern Belarus groundwater is considered to be relatively polluted.
Georgia	There are several polluted rivers in Georgia, where concentrations of phenols, hydrocarbons, copper, manganese, zinc and nitrogen are considerably higher than the national and international standards. Most water treatment plants are not operating or work at a very low level of efficiency; pollution by fertilisers and pesticides is also important.
Kazakhstan	Most water bodies suffer from serious environmental problems. Some of the most seriously polluted rivers are the Ural (phenols, petroleum by-products, boron), the Irtysch (copper, zinc, and petroleum by-products), Syr-Darya (sulphates and copper), Ilek (boron and chromium) and the Nura (mercury). The main polluters are industrial, mining, metal and refinery enterprises, and farms.
Kyrgyzstan	It is difficult to have a clear picture of the quality of surface waters, as monitoring is scarce and increasingly unreliable. In general it is said that the water bodies suffer only low levels of pollution. However, the quality of river water deteriorates near urban, agricultural and industrial centres. Pollution from mine tailing dumps also occurs in several places, for example contamination with radioactive materials, cadmium and other heavy metals (copper, zinc and lead).
Republic of Moldova	The water quality of the Dniester and Prut rivers, as well as of the lakes and reservoirs, is generally satisfactory. In comparison with the 1950s, the mineralisation of Dniester water has increased by 50 %. During the past two decades, concentrations of nitrogen and phosphorus have increased to 10 mg/l and 0.2 mg/l, respectively. The water of most small rivers falls between 'polluted' and 'strongly polluted'.
Russian	Some of the major rivers in the Russian Federation (e.g. the Volga, Obj, Yenisej, Northern Dvina and Federation the Don) and their tributaries are highly polluted. The main reservoirs are also highly polluted, especially the Volga cascade. The main sources of pollution are wastewaters discharged by industrial and agricultural enterprises, communal services, and also surface runoff. The most common surface water contaminants include oil, phenol, easily oxidised organic substances, metal compounds, nitrates and nitrites.
Tajikistan	The quality of surface water and groundwater in Tajikistan is high and only in separate regions does it tend to deteriorate. Huge pollution comes from housing and municipal sectors. Mining enterprises greatly influence the state of surface water and groundwater reservoirs. Sometimes, unexpected industrial water discharges result in fivefold to tenfold increases in the concentrations of toxic substances such as mercury, zinc or phosphorus in watercourses.
Turkmenistan	The Amu-Darya River is one of the most polluted water bodies of the central Asian region. The salt content of the river has increased markedly as a result of drainage from irrigated areas, which are for a significant part of transboundary character.
Ukraine	The main water-quality problems are related to municipal waste, diffuse sources of pollution and eutrophication. Almost all river basins in the Ukraine are classified as polluted or very polluted. The large rivers (Dnieper, Dniester, Southern Bug) are all polluted with oxygen-consuming substances, nutrients, heavy metals, oil and phenols. The smaller tributaries are more heavily polluted than the main rivers. However, there are also many unspoiled water bodies, particularly in the mountainous areas.
Uzbekistan	The majority of waterways are moderately polluted. The principal sources of water pollution are industry, agriculture and human settlements.

Sources: UNECE, 1998-2000; OECD, 1999-2001; national state of the environment reports

Figure 8.21. **Annual average concentration of cadmium and mercury in EU rivers between late 1970s and 1996**

Note: The EU environmental quality standards for cadmium and mercury in inland waters are 5 µg/l and 1 µg/l as annual averages, respectively.

Source: EU Member State returns under the exchange of information decision (European Council, 1977)



Ten of the twelve countries in EECCA identified heavy metals as a major problem in their rivers in their most recent state of the environment reports, with zinc, copper and cadmium being the metals most often reported as being of concern. In terms of organic micro-pollutants, oil and oil products were identified as a major concern by eight of the twelve countries, followed by phenol (seven) and pesticides (three) (see Box 8.5). Radioactivity was also reported to be a major concern in three countries. Ukraine and Kazakhstan reported the most 'major concerns'. More detailed information can be found in Table 8.4.

8.5.2. Input of hazardous substances to the seas

Inputs of hazardous substances to the seas result from direct discharges into marine waters, riverine inputs and atmospheric deposition, which follow emission of these substances into rivers and to air. There is specific legislation tackling these issues (see Box 8.6).

Box 8.5. Pressures caused by cotton production in Europe

Cotton is an economically important crop for a few southern European and several central Asian countries. Cotton growers use large and increasing amounts of fertilisers, dangerous pesticides and large quantities of irrigation water, all of which give rise to a range of health and environmental problems. Cotton production has become increasingly associated with severe negative environmental impacts which include reduced soil fertility, salinisation, loss of biodiversity, water pollution, adverse changes in water balance, and pesticide-related problems including pollution and resistance.

Cotton production has played a big role in the degradation and drying-up of the Aral Sea (see Box 8.1). Cotton receives more pesticide (insecticides, herbicides, fungicides, defoliants) applications per season than any other crop, and accounts for at least one quarter of all agricultural insecticides used in the world. Banned pesticides (DDT, forms of HCH, aldrin and dieldrin) are associated with cotton-growing areas in several countries. For example, in Uzbekistan (the largest producer in central Asia), there are reported to be 1 500 tonnes of banned pesticides, including DDT and the HCH group, in various places (see also Chapter 2.3, Box 2.3.1).

Direct and riverine inputs of cadmium, mercury, lead and zinc into the North East Atlantic fell between 1990 and 1999, which shows the effects of emission reduction target setting in OSPAR.

Atmospheric inputs of cadmium, lead and mercury into the North Sea fell between 1987 and 1995, showing the effect of air pollution abatement policies in the countries surrounding the North Sea.

Discharges of many hazardous substances to the Baltic Sea have been reduced by at least 50 % since the late 1980s.

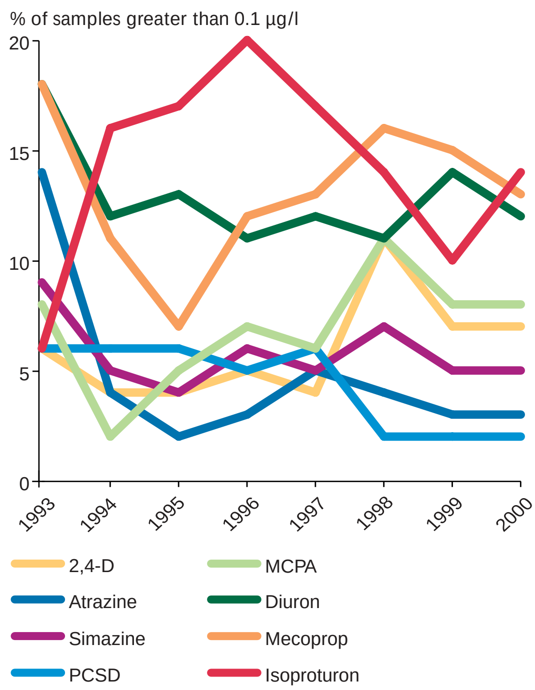
There is very limited information on discharges to the Mediterranean, Black and Caspian Seas, and how these have changed over recent years.

North Sea states have met the 50 % reduction target for a large number of the 37 priority substances of the North Sea Conference, and most also achieved the 70 % reduction target for mercury, cadmium, lead and dioxins (Figure 8.23). However, targets were not consistently met for some other substances such as copper, tributyltin and some pesticides. For mercury and cadmium the largest sources in 1985 were industrial activities. In 1999 the importance of these sources had been reduced with waste disposal now the most important source for both metals (Figure 8.24).

Discharges of many hazardous substances to the Baltic Sea have been reduced by at least 50 % since the late 1980s — mainly as a result of the effective implementation of environmental legislation, the substitution of hazardous substances with harmless or less hazardous substances, and technological improvements. In Estonia, Lithuania, Poland and the Russian Federation, reductions have been due mainly to fundamental socio-economic changes (HELCOM web page). The reductions in Latvia have been due to construction of wastewater treatment facilities, and the implementation of new technologies and environmental legislation.

Occurrences of some commonly found pesticides in surface freshwaters in England and Wales, 1993–2000

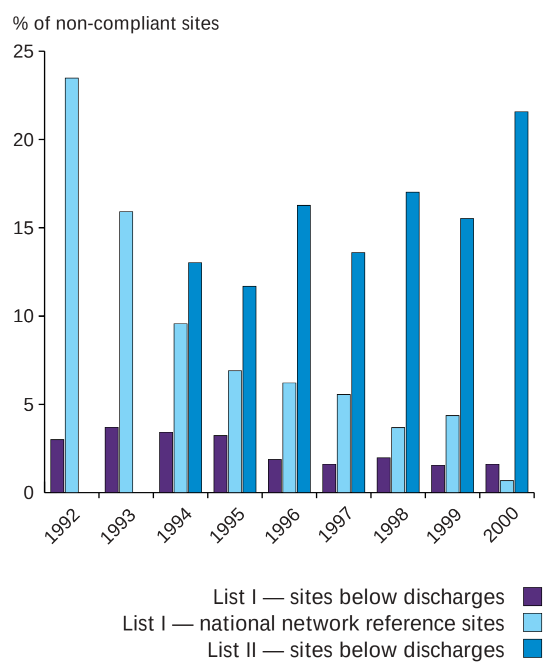
Figure 8.22a



Source: Environment Agency of England and Wales web page

Non-compliance with List I and List II dangerous substances directive on environmental quality standards in England and Wales, 1994–2000

Figure 8.22b



Source: Environment Agency of England and Wales web page

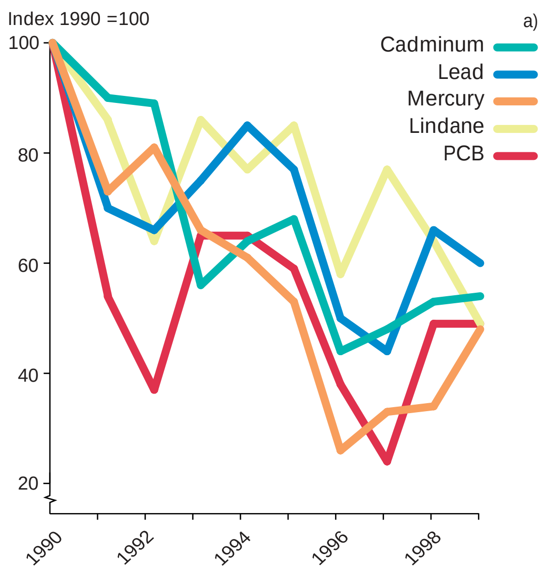
Box 8.6. Marine conventions legislation on reduction of emissions of hazardous substances and their inputs to seas

- The North Sea Conferences had set a target of a 50–70 % reduction in releases (discharges, emissions and losses) of several hazardous substances to water and air between 1985 and 1995. An action arising out of the Fourth North Sea Conference in 1995 was to continue to aim to achieve by 2000 the reduction targets set by the previous conference. It further agreed on the one-generation target for total cessation of discharges by 2020, which has also been adopted by the OSPAR Commission for the Protection of the North-East Atlantic. The ministers at the Fifth North Sea Conference in March 2002 recognised that increased efforts were necessary in order to meet the one-generation target.
- The Helsinki Commission for the Protection of the Baltic Sea adopted Recommendation 19/5 in May 2001 for cessation of hazardous substance discharge/emissions by 2020, with the ultimate aim of achieving concentrations in the environment near to background levels for naturally occurring substances and close to zero for man-made synthetic substances.
- The Mediterranean action plan (MAP) has three protocols which control pollution to the sea, including the input of hazardous substances. The dumping protocol lists a number of hazardous substances for which dumping is prohibited and sets out what must be considered before a dumping permit is issued for other substances. The emergency protocol details what national states must do when a harmful substance accidentally gets discharged, and the land-based sources protocol requires parties to eliminate pollution from certain hazardous substances and strictly limit pollution from others.
- Article VI of the Bucharest convention aims to prevent pollution of the Black Sea by hazardous substances and organic matters. The convention contains three protocols: the control of land-based sources of pollution, dumping of waste and joint action in the case of accidents.
- The Caspian Environment Programme is developing a strategic action plan to control pollution of the Caspian Sea, which should be adopted by the five states bordering the Caspian Sea.

Some marine conventions have monitoring programmes to measure the annual riverine inputs and direct discharges of hazardous substances as well as atmospheric deposition to seas.

Figure 8.23. **Direct and riverine inputs into the North East Atlantic (a) and atmospheric inputs of some heavy metals into the North East Atlantic (b)**

Source: OSPAR data, compiled by ETC/WTR



In the Mediterranean there is no available information on how discharges of hazardous substances have changed over time. MAP (UNEP/MAP, 1996) has estimated that riverine discharges are the largest source of mercury (92 %), lead (66 %), chromium (57 %) and zinc (72 %) although direct industrial discharges from the coastal zone are also significant (around 30 % of the total) for chromium and lead.

The Caspian Regional Thematic Centre for Pollution Control has estimated that 17 tonnes of mercury and 149 tonnes of cadmium are discharged into the Caspian Sea each year (Caspian Environment Programme, no date). The largest source of both metals is rivers although there are also contributions from industry and municipalities.

The Arctic Ocean also receives considerable quantities of hazardous substances from rivers. For example, Eurasian rivers transport 10 tonnes of mercury each year to the Arctic Ocean although the main source of mercury is atmospheric deposition (AMAP, 2002). Atmospheric deposition and riverine inputs contribute equally to cadmium pollution. Persistent organic pollutants (POPs) also reach the Arctic Ocean via the atmospheric and riverine pathways with the Russian rivers, the Ob, Yenisej and Pyasina, having the largest inputs (AMAP, 2000a).

Effects of hazardous substances in seas

Hazardous substances may affect human health through consumption of marine organisms and have deleterious effects on marine ecosystem function. Lethal and sub-lethal effects on aquatic biota are known to occur. The long-term effects of these persistent substances in the European marine environment are not adequately known.

Contaminant concentrations above the limits for human consumption set by the EU for fish and shellfish (EU, 2001b; EU, 2002) are found mainly in mussels and fish from estuaries of major rivers. Examples are cadmium and PCB (polychlorinated biphenyls and their degradation products) in the Seine, northern France; lead in the Elbe; PCB in the Scheldt and the Rhine on the Belgium-Dutch border area and the Ems in northern Germany; cadmium (possibly from the River Rhone) near some industrial point discharges (e.g. cadmium and DDT in the Sørfjord, western Norway); and, lead in some harbours (e.g. lead and PCB in the inner Oslo Fjord) — see Map 8.4. Some areas remote from point sources may, however, have elevated concentrations of some hazardous substances (e.g. cadmium in northern Iceland, mercury in northern Norway).

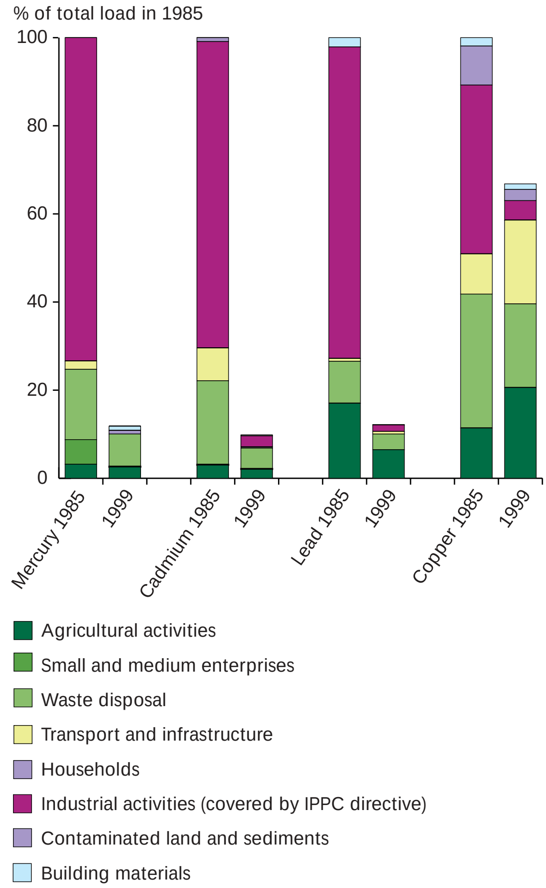
The aggregated results on time trends in concentrations per sea area during the past 15 years (Figure 8.25) indicate falling concentrations of cadmium, mercury, lead, DDT, lindane and PCB in mussels and fish from both the North East Atlantic and the Mediterranean Sea. For each sampling site, the time trend was statistically analysed as well: of the 178 (DDT) to 286 (cadmium) time series analysed for mussels, 8–15 % showed significant trends, mostly of concentrations decreasing. Only 25 time series for lindane were available. All of these concerned mussels from the Mediterranean and seven showed significant decreases.

Analysis of time trends per sampling point indicates few significant trends in the coastal regions of the North East Atlantic but most of these show decreasing concentrations of cadmium, mercury, lead, DDT and PCB. In the Baltic the levels of cadmium, mercury and lead in herring muscle appear to be low and generally no trends were detected. The one area where mercury increased in this species was at the estuary of the river Oder (near Stettin). Concentrations of DDT and PCB in fish generally decreased although PCB concentrations in North East Atlantic cod increased. In the Mediterranean (only French and Greek data) concentrations of cadmium, mercury and lead are generally above background levels but below levels of potential concern. The results also suggest that concentrations are generally decreasing. The results for lindane (only French data) indicate low and decreasing concentrations.

Analysis of the concentrations of hazardous substances in water, sediment and biota in the Caspian Sea is so far inadequate to provide a comprehensive overview. It is, however, known that the greatest concentrations are found close to major coastal industries (e.g. the Absheron peninsular in Azerbaijan) and the mouths of rivers with industrialised catchments (Caspian Environment Programme, no date).

Hazardous substances also affect wildlife in the Arctic. Much of the pollution is from the long-range transport of persistent chemicals and is a legacy from previous emissions, although significant pollution is still occurring. Biomagnification of persistent organic pollutants up the food chain is particularly evident in the Arctic food web as the top predators, e.g. seals and polar bears, have large fat reserves where lipid-soluble compounds accumulate. There is also some evidence that mercury concentrations in marine mammals are increasing (AMAP, 2000b). Local metal pollution is very severe in some areas, for example in the Russian Federation on the Kola Peninsula and near Norilsk due to copper-nickel smelting (AMAP, 2002).

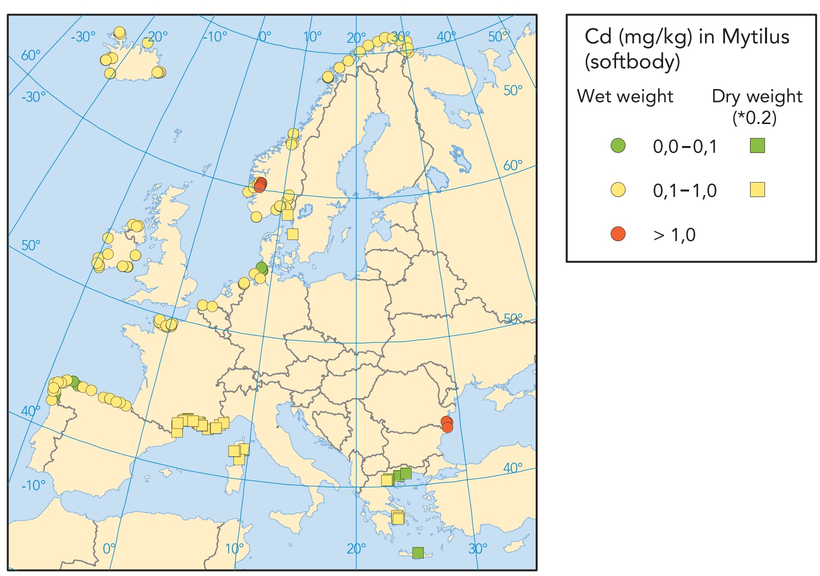
Main sources of some metal discharges to water in North Sea countries in 1999 — Figure 8.24.



Note: Waste disposal includes municipal wastewater. Discharges to water based on: mercury (Denmark, Germany, Norway, Netherlands, Sweden); cadmium (Denmark, Germany, Norway, Netherlands, Sweden)

Source: North Sea progress report, 2002

Median cadmium (Cd) concentrations in mussels, 1995–99 — Map 8.4.

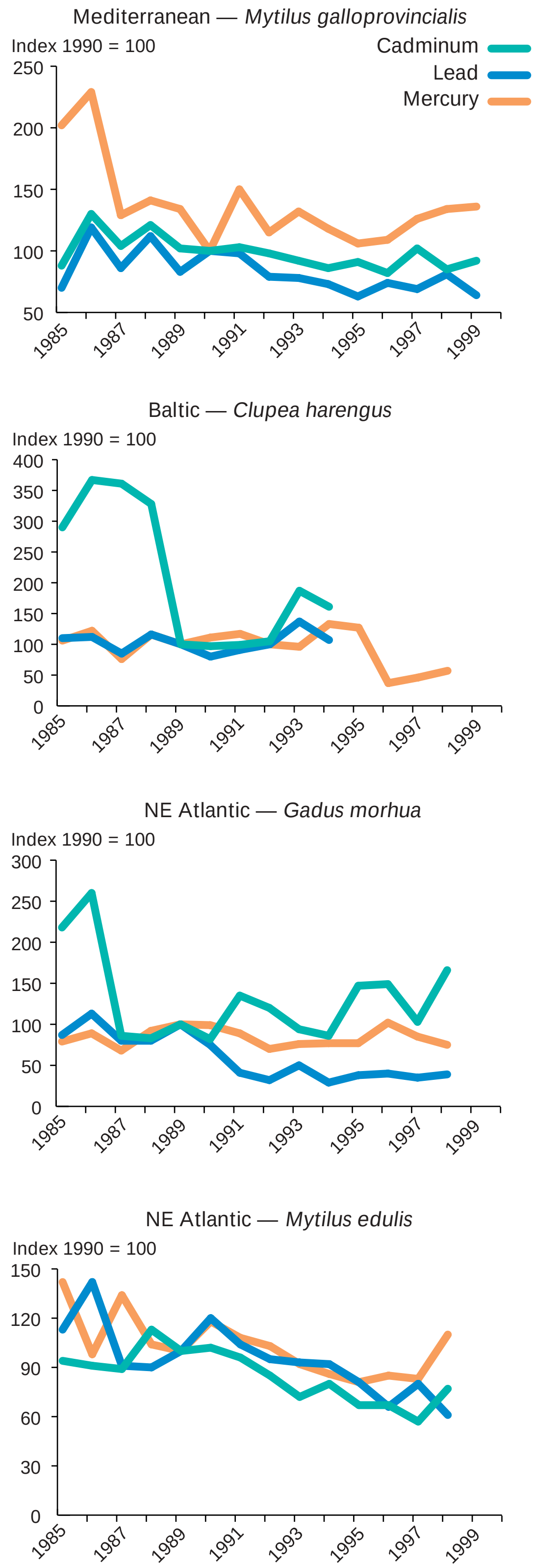


Notes: Mussels: Mytilus edulis - North East Atlantic; M. galloprovincialis — Mediterranean and Black Sea. Classification uses background level for lower class and EU limit value for foodstuff for higher class. EU-legislation limit for cadmium in foodstuffs 'bivalve molluscs' is 1 mg/kg wet weight (EU, 2001b). Larger symbols may obscure other symbols. 2001 for Black Sea.

Sources: Compiled by ETC/ WTR based on data from OSPAR and EEA member countries (Mediterranean), and data reported by Romania

Figure 8.25. **Concentrations of selected metals and synthetic organic substances in marine organisms in the Mediterranean and Baltic Seas, and in the North East Atlantic Ocean**

Sources: Complied by ETC/WTR from OSPAR, HELCOM and EEA Mediterranean member countries data



The levels of some hazardous substances in marine organisms are decreasing at some monitoring stations in the Mediterranean and Baltic Seas and the North East Atlantic Ocean in response to measures to reduce the inputs of these substances to these seas.

However, contaminant concentrations above limits for human consumption are still found in mussels and fish, mainly from estuaries of major rivers, near some industrial point discharges and in some harbours.

Oil pollution

The main sources of oil pollution in the marine environment include maritime transport, coastal refineries and offshore oil and gas installations, land-based activities (either discharging directly or through riverine inputs) and atmospheric deposition. No reliable data sources exist at present for marine oil pollution from land-based activities and atmospheric deposition. Within the EU, the dangerous substances directive (Directive 76/464/EEC) includes targets for oil pollution discharges with reference to persistent and non-persistent mineral oils and hydrocarbons of petroleum origin. The OSPAR and HELCOM conventions set targets for oil pollution from land-based sources and offshore oil and gas installations. In accordance with the MARPOL 73/78 convention established by the International Maritime Organization (IMO) for the prevention of pollution from ships, aerial surveillance continues, allowing a control of observed slicks, in 'special areas' (e.g. Baltic, North Sea, Mediterranean Sea and Black Sea) where discharges are prohibited.

There is a large number of oil and gas installations over marine oil fields (Map 8.5). For instance, OSPAR has published a database of offshore installations including more than 900 different installations producing from a few tonnes to 800 000 tonnes per year (Figure 8.26). However, an assessment of discharges from refineries and offshore installations in the Mediterranean and Black Seas is lacking. There are extensive oil refining and petrochemical industries operating in the Mediterranean region (EEA, 1999) with 40 major refineries in 1997. The amount of oil discharged into the sea from 13 of these refineries was estimated in 1995 to be 782 tonnes (UNEP/MAP, 1996).

There is also a large seaborne trade of oil in the Mediterranean Sea. The risk of shipping accidents in the Mediterranean is very high and some of these cause oil pollution. Between 1987 and 1996 an estimated 22 000 tonnes of oil were spilled as the result of shipping incidents. The figures for individual years vary from some 12 tonnes in 1995 to 13 000 tonnes in 1991 (EEA, 1999).

Oil spills from accidents at sea in the Black Sea are relatively small compared with the inputs of oil from domestic and industrial land-based sources and from the River Danube.

Commercial oil and gas exploration took place in Azerbaijan's Caspian Sea shelf in 1950, and intensive exploration and production has been taking place in the Caspian coastal waters of Kazakhstan, the Russian Federation and Turkmenistan since the mid-1990s. In 1978–92, as the result of a critical rise in the water level, many oil wells and production enterprises on the Caspian coast and its shallow waters were flooded. The result was pollution of the coastal waters

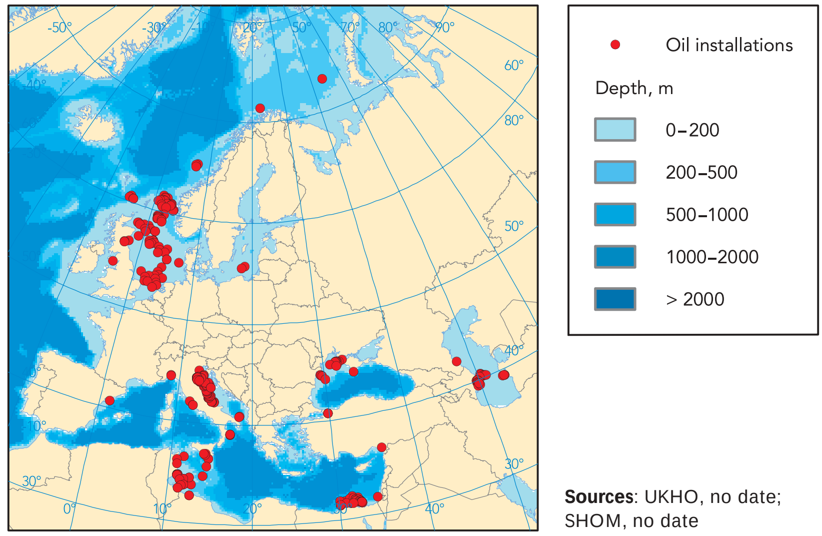
Despite increased oil production, oil discharges from offshore installations and coastal refineries in the EU are decreasing as a result of the OSPAR ban on discharges of oil-contaminated cuttings and an increased application of cleaning technologies and improved wastewater treatment before discharge. Additional improvements are expected in North Sea/Atlantic as a result of new (OSPAR) regulations, which entered in force in 2000.

However, the level of discharges associated with the release of 'production water' on offshore installations is steadily increasing in the North Sea.

Illegal oil discharges from ships and offshore platforms are regularly observed at sea. The number of illegal oil spills is slowly decreasing in the North Sea, but remains constant in the Baltic Sea.

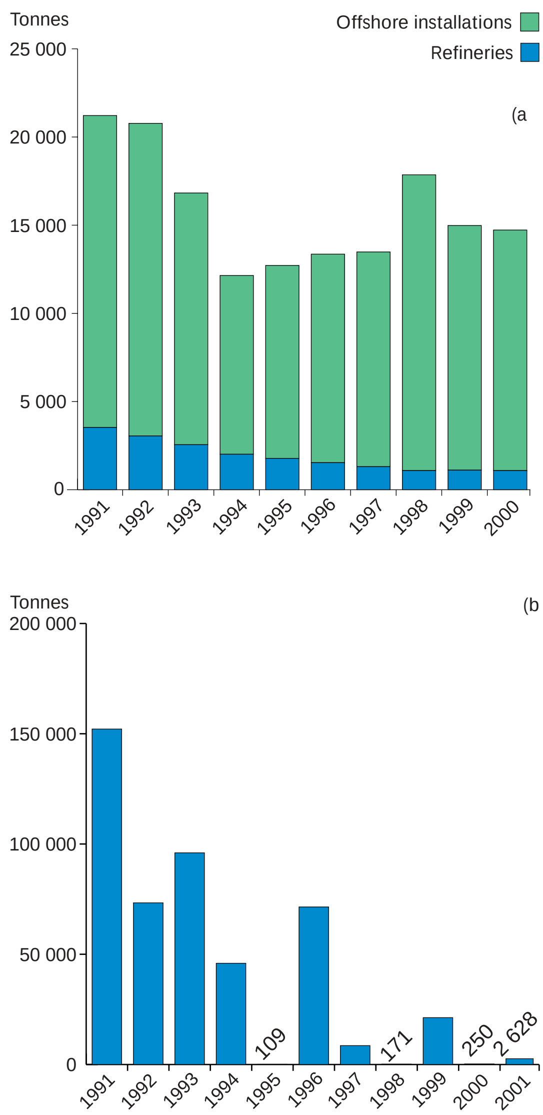
Despite pollution from oil spills on a worldwide scale being reduced by 60 % since the 1970s, major accidental oil tanker spills (i.e. greater than 20 000 tonnes) still occur at irregular intervals in European seas.

Location of offshore oil installations Map 8.5.



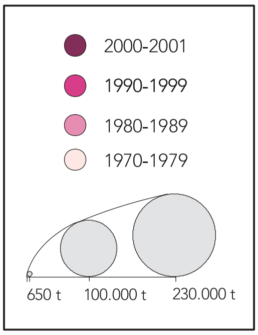
Sources: UKHO, no date; SHOM, no date

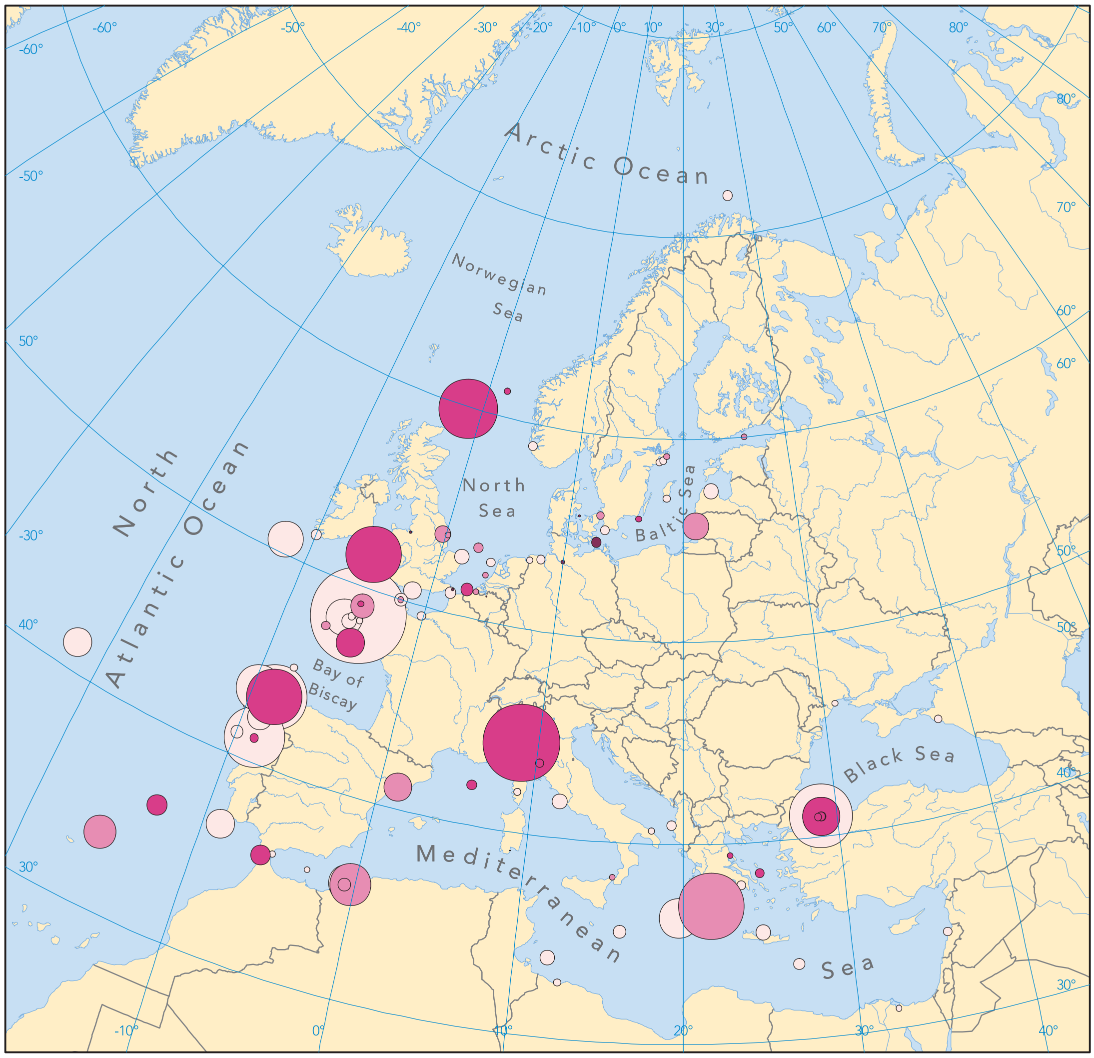
Total discharges of oil from refineries and offshore installations in EU (a) and annual number of observed oil slicks discharged mainly from ships in the North and Baltic Seas from aerial surveillance (b) Figure 8.26.



Source: OSPAR (1999; 2001); Eurostat (2001); DHI based on data from Eurostat (1999), OSPAR (1997) and CONCAVE (1999); Bonn agreement and HELCOM, 2001

Map 8.6. **Large accidental oil spills from tankers, 1970–2001**





Source: EEA based on data from ITOPF

of all Caspian states by oil and oil products. The Caspian Regional Thematic Centre for Pollution Control estimated in 2001 that 160 000 tonnes were discharged each year into the Caspian Sea, with rivers being the most important source (47 %). Oil industry activities contributed only 5 % of the total with natural seepage contributing 13 % and erosion and other industry 21 %.

Oil exploration and production is also significant in the Arctic and is a major source of oil pollution. For example, produced water from drilling operations accounted for 76 % of oil pollution of the sea on the Norwegian shelf between 1990 and 1995 (AMAP, 2002). Oil pollution is also evident in a number of Russian rivers. For example, the lower part of the Ob is severely contaminated. Oil pollution from accidents in the region has also occurred, for example in the Komi Republic in 1994 when a dike containing oil from a leaking pipeline collapsed. The spill reached the Kolva River, a tributary of the Pechora River and tar balls from the spill were found at the mouth of the Pechora.

Despite an increase in the marine transport of oil, the worldwide average number of accidental oil spills of more than 7 tonnes has been estimated at 24.1 per year for 1970–79, 8.8 per year for 1980–89 and 7.3 per year for 1990–99 (see Chapter 10, Section 10.2.3). In 2000 there was one spill of 250 tonnes (Germany) and in 2001 three spills totalling 2 628 tonnes including one spill (Denmark) of 2 400 tonnes. The Prestige accident in 2002 (Spain) spilled more than 20 000 tonnes. A few very large accidents are responsible for a high percentage of the oil spilt from maritime transport. For example, during the period 1990–99, from all the 346 accidental spills of more than 7 tonnes from tankers, combined carriers and barges, totalling 830 000 tonnes, just over 1 % of the accidents produced 75 % of the spilt oil volume.

Oil production and consumption are increasing, as are net imports of oil to the EU, which increases the risk of oil spills. More rapid introduction of double hulls for tankers will help to reduce this risk.

8.6. International cooperation on water management

8.6.1. Transboundary inland water courses

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.

Cooperation in managing transboundary waters requires an effective institutional structure such as a river commission based on an international agreement or other arrangement (Table 8.5). It is important that joint bodies interact closely with each other and with joint bodies established to protect the marine environment. The UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (http://www.unece.org/env/water/), which was adopted in Helsinki in 1992, supported by soft-law recommendations, guidelines and specific action plans, has proved to be a useful 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. The remaining EECCA countries have not signed the convention.

8.6.2. Marine conventions

Table 8.6 summarises the marine conventions covering Europe's seas. The future role of the marine conventions is currently under review as part of the process of developing and implementing the European Commission's strategy to protect and conserve the marine environment (European Commission, 2002). All regional marine conventions have established monitoring and assessment programmes. However, when seen in a European context, the programmes are not coherent in terms of scope, content, approach and detail. In addition there are problems, including inadequate spatial coverage and/or sampling frequency, which lead to lack of harmonisation between datasets, making their scientific analysis and comparability nearly impossible. The view of the European Commission is that activities carried out for the implementation of the water framework directive could act as a stimulus for integration of the activities of the regional marine conventions. The inter regional forum set up by the EEA could possibly be the framework under which integration takes place.

Selected examples of international cooperation on inland surface waters — Table 8.5.

River, lake, basin	Commission
Danube	International Commission for the Protection of the Danube River (ICPDR) http://www.icpdr.org/pls/danubis/DANUBIS.navigator
Rhine	Internationale Kommission zum Schutz des Rheins (IKSR) http://www.iksr.org/
Elbe	Internationale Kommission zum Schutz der Elbe http://www.ikse-mkol.de/html/ikse/ikse/deutsch/index_d.htm
Oder	International Commission for the Protection of the River Oder (signed by Germany, Czech Republic and Poland on 11 April 1996)
Dnieper	International DNIPRO Fund (IDF) — National Program of Environmental Sanitation of River Dnipro Basin and Drinking Water Quality Improvement http://greenfield.fortunecity.com/hunters/228/toppage1.htm
Bodensee/ Lake Constance	Internationale Gewässerschutzkommission für den Bodensee http://www.igkb.de
Lake Geneva/ Lac Leman	Commission Internationale pour la Protection des Eaux du Léman contre la pollution (CIPEL) http://www.cipel.org
Lake Peipsi	A bilateral agreement between Estonia and the Russian Federation has been established regarding Lake Peipsi and its outlet, the Narva River. Regular exchanges of monitoring data, scientific information and information of public interest now take place through the subgroups that were established under the joint commission
Ohrid	On the basis of the UNECE convention on transboundary watercourses, Albania and the former Yugoslav Republic of Macedonia have an agreement on the common management of Lake Ohrid. There are several projects which aim at establishing sound environmental management of the lake and monitoring its quality
Kura-Araks rivers	There are no common management systems or environmental agreements on these rivers. Negotiations have started between Armenia, Azerbaijan and Georgia on a joint river management project
Aral Sea basin	Inter-State Commission for Water Coordination (ICWC) Water ministers of the five states in the basin, Kazakhstan, Kyrgyzstan, Turkmenistan, Tajikistan and Uzbekistan, signed the Agreement on Water Resources Management in the Aral Sea basin on 18 February 1992 and the ICWC was established with joint responsibility for water management with the two river basin agencies (Amu-Darya and Syr-Darya). The main functions of the ICWC include allocation of annual abstraction for each country, definition of regional water management policy and coordination of large projects

Note: See IWAC (www.iwac-riza.org) for complete list of transboundary cooperations.
Source: Compiled from various sources by ETC/WTR

Table 8.6. Summary of marine conventions in Europe

OSPAR — The Convention for the Protection of the Marine Environment of the North-East Atlantic — Paris 1992, entered into force 1998 http://www.ospar.org/	The convention has been signed and ratified by all the contracting Parties to the former Oslo or Paris conventions (Belgium, Denmark, the Commission of the European Communities, Finland, France, Germany, Iceland, Ireland, the Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom) and by Luxembourg and Switzerland
HELCOM is the governing body of the Convention on the Protection of the Marine Environment of the Baltic Sea Area, more usually known as the Helsinki Convention http://www.helcom.fi/	Signatory or contracting Parties are: Denmark, Estonia, the European Community, Finland, Germany, Latvia, Lithuania, Poland, Russian Federation and Sweden
Convention for the Protection of the Mediterranean Sea against Pollution — Barcelona 1976 and protocols (1980, 1982) entered into force 1978	Signatory or contracting Parties are: Albania, Algeria, Bosnia-Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libyan Arab Jamahiriya, Malta, Monaco, Morocco, Slovenia, Spain, Syrian Arab Republic, Tunisia, Turkey
Convention on the Protection of the Black Sea against Pollution (Bucharest Convention); adopted 1992, in force 1994 and protocols (1992) http://www.blacksea-commission.net or http://www.blacksea-environment.org/	Signatory Parties are the Black Sea states: Bulgaria, Georgia, Romania, Russian Federation, Turkey and Ukraine.
AMAP — Arctic Monitoring and Assessment Programme — is an international programme established in 1991 to implement components of the Arctic environmental protection strategy (AEPS) of the Arctic Council for the Protection of the Arctic Marine Environment http://amap.no/	Member countries (the eight Arctic rim countries): Canada, Denmark/ Greenland, Finland, Iceland, Norway, Russian Federation, Sweden, United States

Source: Compiled from various sources by ETC/WTR

8.7. References

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