5. Hazardous substances

5.1 Storyline for indicators

Chemicals bring about benefits on which modern society is entirely dependent, for example, in food production, medicines, textiles, cars etc. They also make a vital contribution to the economic and social wellbeing of citizens in terms of trade and employment. The global production of chemicals has increased from 1 million tonnes in 1930 to 400 million tonnes today. We have about 100 000 different substances registered in the EU market of which 10 000 are marketed in volumes of more than 10 tonnes, and a further 20 000 are marketed at 1-10 tonnes[1]. Some will end up in the aquatic environment by use or during production. Many of these substances are potentially harmful to aquatic organisms and to humans through drinking water or by exposure during recreational activities.

The **Water Framework Directive** (WFD) defines hazardous substances as:

“Hazardous substances means 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".

The definition is very similar to those used by the Commissions that administer the Conventions covering the North East Atlantic Ocean (OSPAR) and the Baltic Sea (HELCOM).

Elevated concentrations of hazardous substances have been found in many of our waters such as pesticides in groundwater, heavy metals in river and hazardous substances in coastal and more open marine water, in particular near point sources of pollution. Once there, some of these substances may be concentrated as they move up through the food chain. Ecological and health impacts of hazardous substances are complex and may include birth defects, cancers, and damage to nervous, reproductive and immune systems and may affect the different parts of the ecosystem.

Manufactured chemicals play a key role in the provision of a large range of goods and services that support our lifestyles and economies, such as pesticides in agriculture or use of chemicals in industrial processes and households. During or after use the chemicals may be released and end up in the water environment. Emissions can be from point sources such as discharges from industries, wastewater treatment plants, landfills, contaminated land and storage tanks or oil from ships and off-shore installations, or via air emissions from burning of fossils fuels or may be related to more diffuse sources such as use of pesticide or anti-fouling treatment on ships.

The main policy objectives with regards to hazardous substances are:

- *To achieve levels of water quality that does not give rise to unacceptable impacts on, and risks to, human health and the environment[2](i.e. to achieve levels of contamination that do not exceed Environmental Quality Standards (EQS))*
- *Enhanced protection and improvement of the aquatic environment, inter alia, through specific measures for the progressive reduction of discharges, emissions and losses of priority substances and ensures the progressive reduction of pollution of groundwater and prevents its further pollution, and the cessation or phasing-out of discharges, emissions and losses of the priority hazardous substances.[3]*
- *By 2020, ensure that chemicals are only produced and used in ways that do not pose significant threats to human health and the environment.[4]*
- *To eliminate pollution of the waters by the dangerous substances in the families and groups of substances in List I of the Annex and to reduce pollution by the dangerous substances in the families and groups of substances in List II.[5]*
- *Substantially reduce operational discharges from oil installation and ships and eliminate illegal discharges from these sources by 2010.[6]*

A number of initiatives are tackling these problems at global, European, national and regional levels, with some marine conventions providing binding legal frameworks and targeting zero emissions for several hazardous substances by 2020. The measures are generally focused on cessation or phasing-

[1] White Paper on the Strategy for a future Chemicals Policy COM(2001)88
[2] 6th Environment Action Programme 5.6 Ensuring the Sustainable Use and High Quality of Our Water Resources (p.45-46) 5.2. Overall Environment-Health Objective & Drinking Water Directive
[3] Water Framework Directive Article 4
[4] Sustainable Development Strategy p. 11
[5] Dangerous Substance Directive
[6] Marine Strategy (COM(2002 539 final)

out of the most dangerous substances and a reduction in emissions by wastewater treatment or cleaner technologies.

There are a number of policies relevant to these indicators:

- Dangerous Substances Directive (76/464/EEC);
- Integrated Pollution Prevention and Control Directive (96/61/EC) aims to control and prevent pollution to water by reducing or eliminating emissions from industry
- Drinking Water Directive (98/83/EC);
- Water Framework Directive (2000/60/EC) requires the achievement of good ecological status and good ecological potential of water bodies across the EU by 2015.

5.2 Indicators used

The DPSIR framework for assessing hazardous substances in water is shown below. The rectangles in green are those indicators used in this report.

Figure 5.1 DPSIR framework for assessing hazardous substances in water

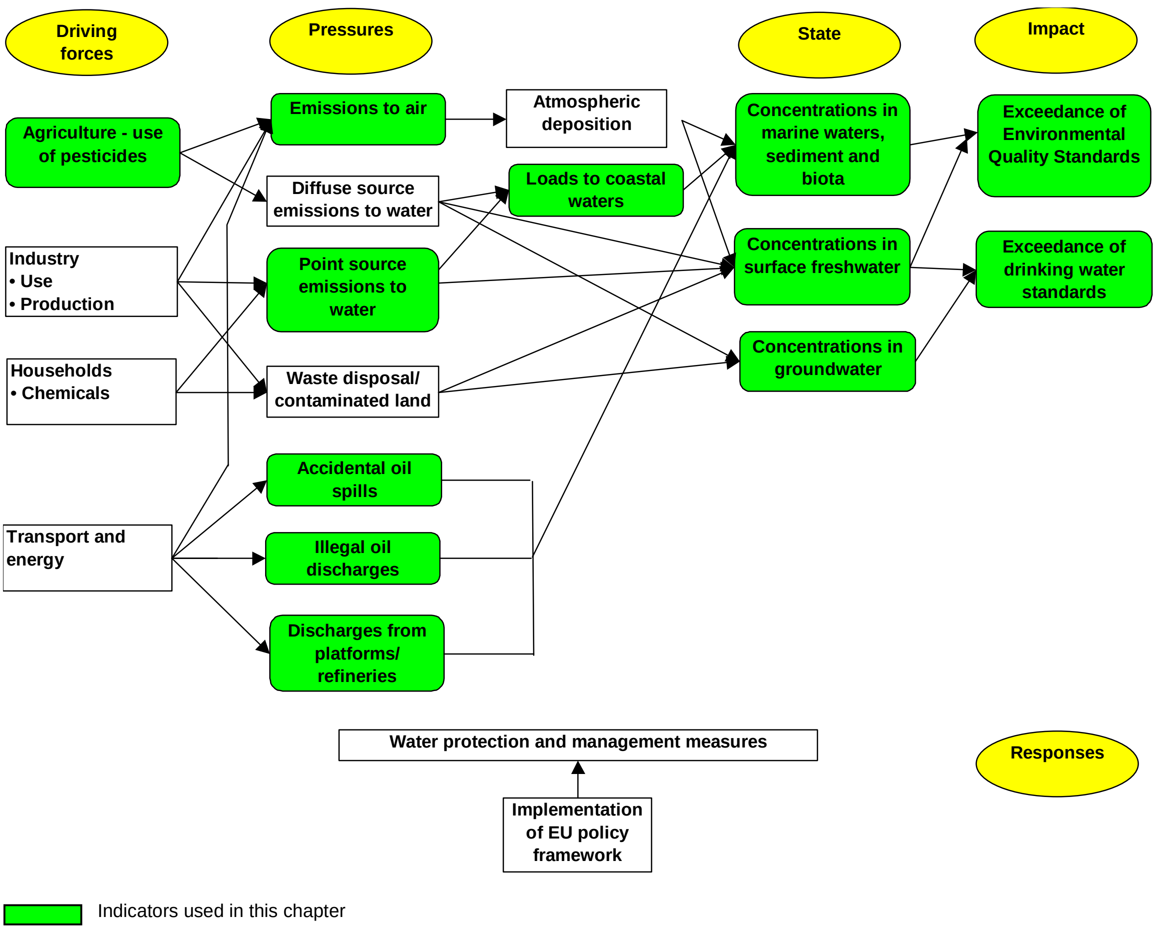


Table 5.1 summarises the assessments that are made in terms of the policy questions using relevant indicators. More detailed information and assessments then follow in the subsequent pages and indicator factsheets. An '✖' in the assessment column indicates that there is at this point no indicator developed or formulated to answer the specific policy question.

Table 5.1 Overall assessment of progress in meeting policy objectives in terms of hazardous substances

Policy question	Indicators	Assessment
Question 1: Are we reducing pollution of waters with hazardous substances?		
• Are pollution levels with hazardous substances such as priority substances including pesticides decreasing?	*Hazardous substances in groundwater*	✖
	Heavy metals in rivers	☺ The concentration of the heavy metals regulated by the Dangerous Substances Directive is decreasing in some European rivers.
	Hazardous substances in lakes	☹ Based on data from the Nordic countries there are elevated levels of heavy metals and organic micropollutants in several lakes.. In a few cases, fish are so contaminated, that it is recommended they are not eaten. ☺ The concentrations of banned substances such as PCB and DDT appear to be decreasing.
	Concentrations of hazardous substances in coastal and marine waters	✖
	Concentration of hazardous substances in marine sediment	✖
• Are some areas of Europe facing negative trends regarding hazardous substances?		✖
Question 2: Are discharges of hazardous substances from socio-economic sectors decreasing?		
	Loads of hazardous substances to seas	☺ Direct and riverine inputs of cadmium, mercury, lead, zinc, lindane and PCBs into the North-East Atlantic have decreased between 1990-1999 ☺ Atmospheric inputs of cadmium, lead and mercury into the North Sea have decreased between 1987 and 1995 ☺ The loads 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 the loads entering the Mediterranean and Black Seas, and how these have changed over recent years.
	Atmospheric deposition waters of heavy metals and persistent organic pollutants (POPs) to marine and coastal waters	✖
• In which sector are discharges of hazardous substances increasing/decreasing?	*Sources of metals discharged to the North Sea*	☺ There have been significant reductions in the discharges/releases to water of some heavy metals from most socio-economic sectors in some North Sea countries, in particular from industrial activities and waste disposal. The reductions achieved for the agricultural and transport and infrastructure sectors were generally smaller. ☺ There have also been significant reductions in the releases to air of some heavy metals from the most important (in terms of relative loads) socio-economic sectors in some North Sea countries, in particular from industrial activities and waste disposal. There have also been very significant reductions in lead releases to air from the transport sector.

• In which sector are discharges of hazardous substances increasing/decreasing?	*Sources of organic substances discharged to water*	☺ There have been significant decreases in the emissions to air and water of dioxins and PAHs from most socio-economic sectors in some North Sea countries between 1985 and 1999. This is particularly so for the industrial sector (water – dioxins and PAHs, air - PAHs), waste disposal (air - dioxins), small and medium enterprises (air - PAHs) and transport (air - PAHs). ☹ The loads of some other organic substances however have remained relatively stable over the last decade in some countries e.g. the Netherlands.
	Source apportionment (emissions) of hazardous substance loads to groundwater	✖
• Are sectors stopping or phasing out the use of priority hazardous substances?		✖
• Is the agricultural sector reducing water pollution caused by pesticides?	*Consumption of pesticides*	☹ Pesticide consumption per hectare of arable land in the EU decreased in the early 1990's but then rose again in the mid 1990's so that 1996 values were still similar to 1990. ☺ Consumption in the Accession countries steadily declined between 1993 and 1998.
• Are the discharges of hazardous substances from industry being reduced?	*Emissions to water of heavy metals and POPs from industry*	✖
• Are discharges of hazardous substances from urban waste water treatment plants being reduced?	*Source apportionment (emissions) of hazardous substance loads to surface waters*	✖
• Are we reducing discharges from oil installations and ships and eliminating illegal discharges from these sources?	*Illegal discharges of oil to sea*	😐 The number of illegal oil spills has slowly decreased in the North Sea, but remains steady in the Baltic Sea. No aerial surveillance is conducted over the Mediterranean and the Black Seas.
	Discharge of oil from refineries and offshore installations	☺ Despite increased oil production, oil discharges from offshore installations and coastal refineries in the EU are decreasing.
	Accidental oil spills from marine shipping	☹ Despite the fact that pollution from oil spills on a world-wide scale has been reduced by 60 % since the 70's, major accidental oil tanker spills still occur at irregular intervals in European seas.
Question 3: Are the levels of hazardous substances such that they do not give rise to unacceptable impacts on, and risks to, human health and the environment?		
• Is water intended for human consumption (drinking water) wholesome and clean (free of hazardous substances such as pesticides and lead)?	*Hazardous substances in drinking water*	☹ Pesticide and metal contamination of drinking water supplies has been identified as a problem in many European countries.
	Groundwater: Drinking water supply sources endangered or closed	✖
• Do the levels of man-made chemicals give rise to significant risks to, and impacts on, human health and the environment?	*Non-compliance with EU Environmental Quality Standards*	☺ Levels of List I substances in rivers are generally below EU Environmental Quality Standards. ☹ The monitoring of hazardous substances in surface waters is very variable between countries and it is as a result very difficult to make conclusions about current concentrations and trends.
• Are we reducing the impact of pesticides on surface and groundwater	*Pesticides in surface and groundwater*	☹ Pesticides occur in surface waters and groundwaters at levels that are of potential concern in terms of supplies for drinking water and in terms of adverse effects on aquatic organisms.
• Is the number of locations with less than good (ecological/chemical) status due to pollution by hazardous substances decreasing?		✖

	Hazardous substances in marine organisms	☺ Levels of some hazardous substances are decreasing in marine organisms at some monitoring stations in the Mediterranean and Baltic Seas, and the NE 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.
• Are there indications of negative trends in the aquatic ecosystem due to contamination by hazardous substances (e.g. endocrine disruptors, TBT and intersex in snails, oiled sea birds)?	*Biological effects of hazardous substances on aquatic organisms*	☹ The presence of endocrine disrupting chemicals in the aquatic environment has been linked with sexual disruption of aquatic animals, and is an emerging issue of concern.
Question 4: How effective are existing policies in reducing pollution with hazardous substances?		
• Are the emissions, discharges and losses of priority hazardous substances being ceased or phased out?		✖
• Are we integrating the Water Framework Directive and other water quality policies into further developments of the Community's Common Agricultural Policy and Regional Development Policy?		✖
• Are we changing to less polluting society (lower use of priority substances per economic activity)?		✖

✖ Indicator to be developed

Policy Question 1: *Are we reducing pollution of waters with hazardous substances?*

Heavy metals in rivers

Since the Industrial Revolution humans have been releasing metals into the environment in damaging quantities. Aquatic ecosystems are particularly sensitive to such pollution since their food chains generally contain more trophic levels than on land and so bioaccumulation is enhanced.

The concentrations of cadmium and mercury have decreased in some rivers in the EU since the late 1970's reflecting the success of measures to eliminate pollution of these two List I substances under the Dangerous Substances Directive (Figure 5.2). However, this information should be treated with some caution as the data are from relatively few stations and may not be representative. The Dangerous Substances Directive also requires the pollution of List II substances to be reduced. List II metals include zinc, copper, nickel, chromium and lead. Data from the Rhine and Elbe indicate that the levels of some of these metals have also been reduced since the 1970s (Figure 5.3).

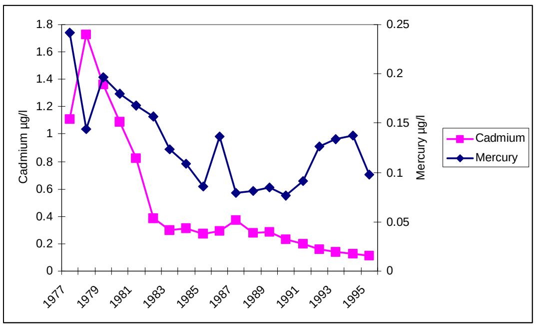
In the Rhine levels of certain heavy metals were reduced by between 50 and 90 % by the end of the eighties compared with the early seventies though the Rhine is still subject to sizeable inputs of pollutant substances. This reduction was achieved by the control and reduction of point sources of these metals, and had a positive impact on aquatic communities in the Rhine.

In the Elbe there have been considerable reductions in inputs of almost all substances, mainly as a result of the drastic drop in production and of factory closures but also due to the construction and modernisation of sewage treatment plants. However heavy metal pollution is still high. The reduction in mercury was due primarily to the discontinuation of the amalgam process for chloride production in two factories in the New German Länder and the Czech Republic, and to remediation of existing contaminated sites.

Key message

☺ The concentration of the heavy metals regulated by the Dangerous Substances Directive are decreasing in some European rivers

Figure 5.2 Trends in concentration of cadmium and mercury at river stations included in the EU Exchange of Information Decision

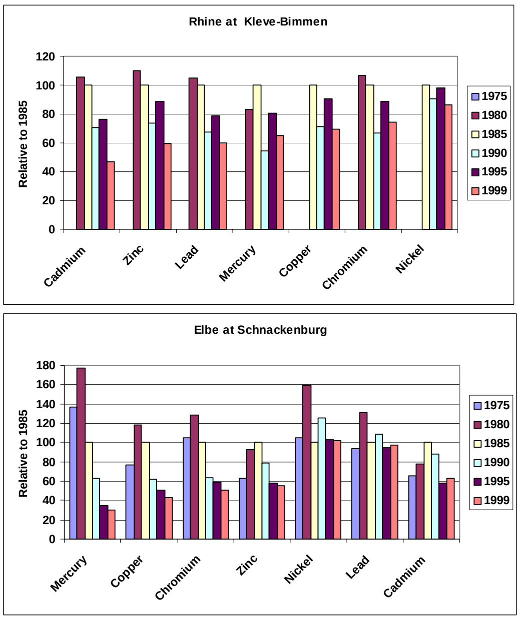


Average of country annual average concentrations. Cadmium data from Belgium, Germany, Ireland, Luxembourg, Netherlands, UK

Mercury data from Belgium, France, Germany, Ireland, Netherlands, UK

Source: EU Member State returns under the Exchange of Information Decision

Figure 5.3 Concentration of heavy metals in the rivers Rhine and Elbe



Source: UBA 2001

Policy Question 1: *Are we reducing pollution of waters with hazardous substances?*

Note: Demonstration indicator

Hazardous substances in lakes

There is limited information on heavy metals (and other hazardous substances) in European lakes. The most comprehensive information is from the Nordic countries.
The Nordic lake survey, 1995 measured the heavy metal concentrations in the water of 3 000 lakes. The survey revealed that the concentrations of lead are low (< 0.1 µg/l) in the northern parts of the countries and in areas of high altitude, corresponding to areas with low population density and low consumption of gasoline. In the southern parts of the countries there are often elevated concentrations of up to 1-10 µg/l. High concentrations are particularly evident in south-western Norway due to high deposition from long-range air pollution. Cadmium and zinc follow a similar general geographical distribution whereas the occurrence of other heavy metals are to a higher extent determined by bedrock geology in combination with indirect effects from acidification (e.g. acid dissolution of bedrock).

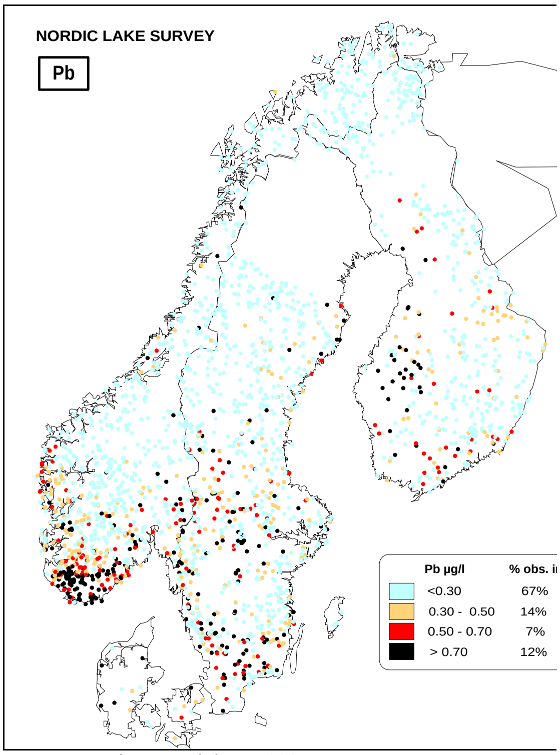
The concentrations of some hazardous organic substances have been monitored in a number of Swedish lakes since the 1960s. For example, the concentration of PCB's and DDT in pike tissue has fallen since the late 1960s. In addition to this, concentrations of a-HCH and HCB have also fallen. Contrary to this, the concentrations of brominated flame retardants have been stable in lake Bolmen after an increase during the 1970s. While PCB and DDT are found in the highest concentrations in southern Sweden where they have been used most intensely, the more volatile HCH and HCB are found in similar concentrations throughout the country due to long-range air transport. The fish of Norwegian lakes showed that the levels are generally low with a few exceptions. In fish from the large lakes Mjøsa and Randsfjorden there were elevated levels of PCBs and DDTs, particularly in predatory fish such as trout and burbot. The livers of burbot in Mjøsa also had very high concentrations of brominated flame retardants and the trout in lake Mårvatn contained high concentrations of dioxins.

Key message:

☹ Based on data from the Nordic countries there are elevated levels of heavy metals and organic micropollutants in several lakes.. In a few cases, fish are so contaminated, that it is recommended they are not eaten.

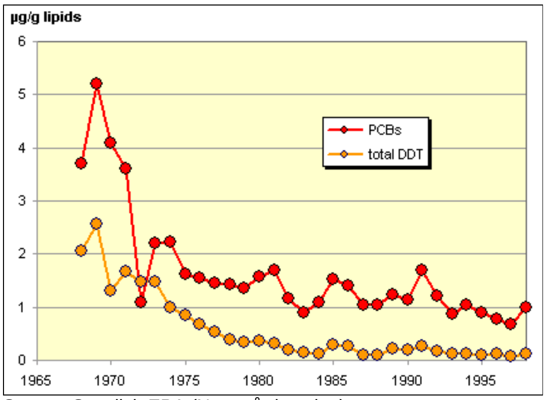
☺ The concentrations of hazardous substances such as PCB and DDT appear to be decreasing.

Figure 5.4 Lead concentration in lakes in the Nordic countries autumn 1995



Note: Denmark autumn/winter 1996
Source: Skjelvåle *et al*. Heavy metal surveys in Nordic lakes; harmonised data for regional assessment of critical limits

Figure 5.5 PCB and DDT in pike from Lake Storvindeln, Sweden



Source: Swedish EPA (Naturvårdsverket).

Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Loads of hazardous substances to seas

The North Sea Conferences had set a target of a 50 – 70 % reduction in releases (discharges, emissions and losses) to water and air of several hazardous substances between 1985 and 1995. They further agreed on the one-generation cessation target (2020), which also has been adopted by the OSPAR-Commission for the protection of the North East Atlantic.

HELCOM has adopted a Recommendation in May 2001 for the cessation of hazardous substance discharges/emissions by 2020, with the ultimate aim of achieving concentrations in the environment near to background values for naturally occurring substances and close to zero for manmade synthetic substances.

The Mediterranean Action Plan has three protocols, which control pollution to the sea including the input of hazardous substances. 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 matter .

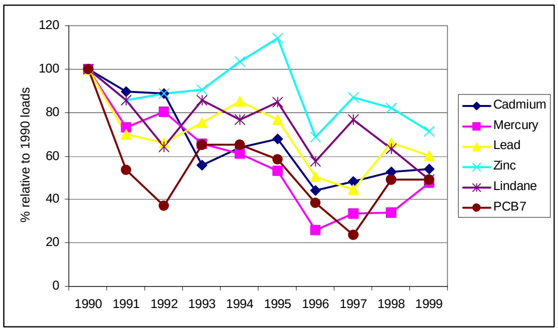
The reduction in direct and riverine loads, and atmospheric inputs of some metals to the North-East Atlantic and North Sea (fig. 5.7), respectively, reflect the emission reduction targets set by OSPAR, the implementation of the Dangerous Substances Directive and the air pollution abatement policies in the countries surrounding the North Sea. The loads of many hazardous substances discharged to the Baltic Sea have been reduced mainly due to the effective implementation of environmental legislation, the substitution of hazardous substances with harmless or less hazardous substances, and technological improvements. In Estonia, Latvia, Lithuania, Poland and Russia reductions have been mainly due to fundamental socio-economic changes (Source HELCOM web page) as well as implementation of environmental legislation.

Key messages

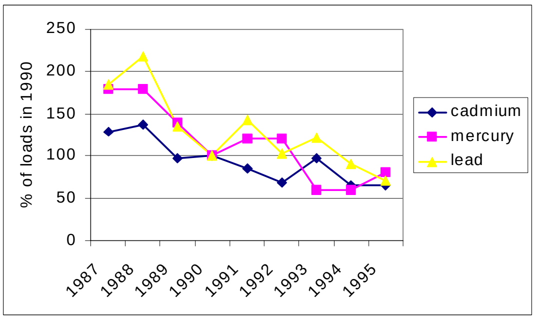
- ☺ Direct and riverine inputs of cadmium, mercury, lead, zinc, lindane and PCBs into the North-East Atlantic have decreased between 1990-1999.
- ☺ Atmospheric inputs of cadmium, lead and mercury into the North Sea have decreased between 1987 and 1995.
- ☺ The loads of many hazardous substances to the Baltic Sea have been reduced by at least 50 % since the late 1980s.
- ☹ There is very limited information on the loads entering the Mediterranean and Black Seas, and how these have changed over recent years.

Figure 5.7 Direct and riverine inputs (a) into the North-East Atlantic and (b) atmospheric inputs into the North Sea of some heavy metals and organic substances.

a)



b)



Loads relative to 1990
Source: OSPAR

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

Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Sources of metals discharged to the North Sea

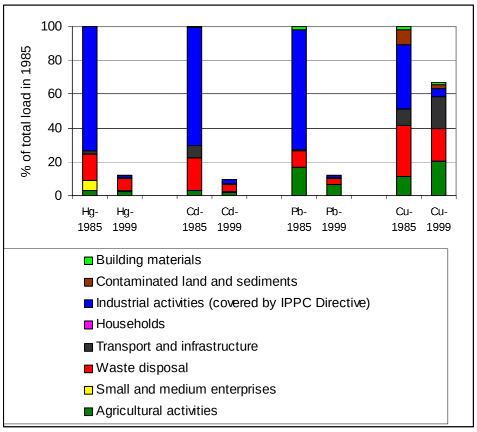
Key messages:
☺ There have been significant reductions in the discharges/releases to water of some heavy metals from most socio-economic sectors in some North Sea countries, in particular from industrial activities and waste disposal. The reductions achieved for the agricultural and transport and infrastructure sectors were generally smaller.
☺ There have also been significant reductions in the releases to air of some heavy metals from the most important (in terms of relative loads) socio-economic sectors in some North Sea countries, in particular from industrial activities and waste disposal. There have also been very significant reductions in lead releases to air from the transport sector.

North Sea States have met the 50 % reduction target for discharges/releases to water for a large number of the 37 North Sea Conference priority substances, and most also achieved the 70 % reduction target for mercury, cadmium and lead. However for some other substances such as copper, they were not consistently met. Industrial activities were the largest source of mercury, cadmium, lead and copper in 1985, and there had been significant reductions in all these metals by 1999 (99 %, 96 %, 98 % and 88 %, respectively). Waste disposal was the second most important source of mercury, cadmium and copper in 1985, and again there had been significant decreases in their loads to water by 1999 (54 %, 75 %, and 38 %, respectively). Waste disposal was the largest source of mercury, cadmium and lead, and a significant source of copper in 1999. Agricultural activities were also significant sources of these metals in 1985 and there had been reductions in the discharges of mercury (20 %), cadmium (32 %) and lead by 1999 (62 %), though in the case of copper there was an increase of 80 %. There had also been increases (108%) in the releases of copper from transport and infrastructure over this period.

Atmospheric deposition is a source of heavy metals in marine waters, and thus the control and reduction of releases to air is of relevance to the status of Europe's Seas. Industrial activities are major sources of mercury, cadmium, lead and nickel releases to air though there were significant reductions (71 %, 82 %, 75 % and 56 %, respectively) between 1985 and 1999 in releases from some North Sea countries. There have also been significant reductions of releases of mercury (90 %), cadmium (95 %) and lead (97 %) from waste disposal. Transport and infrastructure was the largest source of lead and a major source of nickel in 1985, but whereas there had been a very significant reduction (99.8 %) in lead releases by 1999, there had only been a 16 % reduction in nickel releases. Lead emissions reduced from the transport sector as a result of the decrease in the use of leaded petrol.

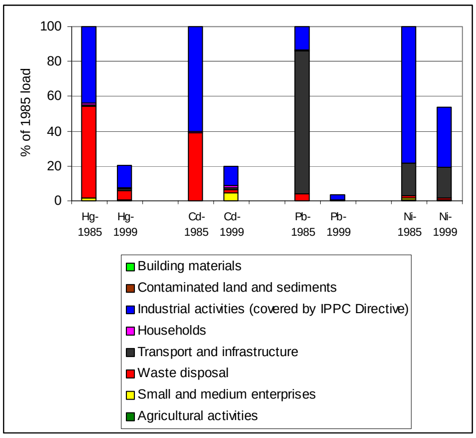
Reductions have been achieved through the implementation of measures such as: the substitution of hazardous substances with less or non hazardous substances; the banning of the use of substances; the development and application of Best Available Techniques/Best Environment Practice; development and use of clean technology; environmental taxes; and, voluntary agreements to reduce use.

Figure 5.8 Changes in the main sources of some metal discharges to water in North Sea countries



Note: Waste disposal includes municipal wastewater
Discharges to water based on:
Mercury: Denmark, Germany, Norway, Netherlands, Sweden
Cadmium: Denmark, Germany, Norway, Netherlands, Sweden
Lead: Denmark, Norway, Netherlands, Sweden
Copper: Germany, Norway, Netherlands, Sweden
Source: Progress report to 5th North Sea Conference 2002

Figure 5.9 Changes in the main sources of some air emissions of metals in North Sea countries



Notes Waste disposal includes municipal wastewater
Discharges to air based on:
Mercury: Belgium, Norway, Netherlands, Sweden
Cadmium: Norway, Netherlands, Sweden
Lead: Norway, Netherlands, Sweden
Nickel: Denmark, Norway, Netherlands, Sweden
Source: Progress report to 5th North Sea Conference 2002

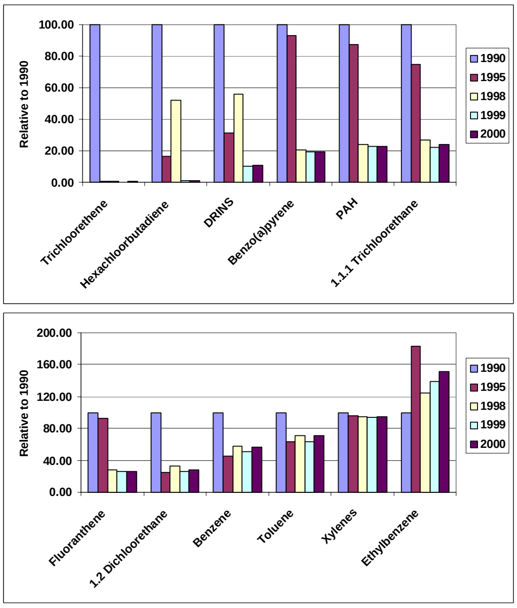
Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Sources of organic substances discharged to water

North Sea Conferences had agreed a 50% reduction for 36 substances, most of which were organic substances. The largest reductions in discharges of dioxins and PAHs to water have been achieved in industry though this remains the most important source for PAHs (Figure 5.10). In terms of emissions to air for dioxins, waste disposal was the most significant source in 1985 followed by households and industry. In 1999 there had been significant decreases in all sectors with industry as the most important source. For PAHs, industry was the most important source in 1995 and 1999 with small and medium enterprises, transport and household also being significant sources of emissions to air.

In the Netherlands there have been significant reductions in the emissions of most of the substances monitored including hexachlorobutadiene, drins and PAHs but others such as xylene and ethylbenzene have remained relatively stable (Figure 5.11).

Figure 5.11 Emissions of organic substances into water in the Netherlands,



Notes:. The data includes emissions into sewers (indirect) plus those into surface waters (direct). Loads relative to 1990 = 100.
Source: Dutch Environmental Data Compendium 2001
http://www.rivm.nl/environmentaldata/

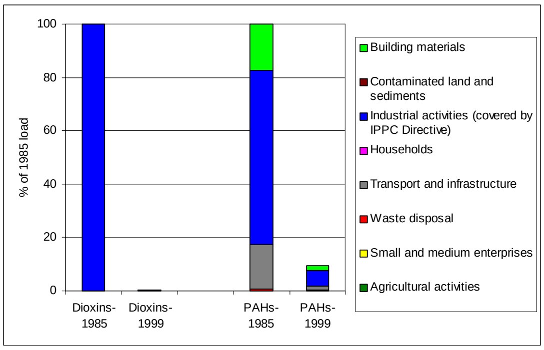
Key messages

☺ There have been significant decreases in the emissions to air and water of dioxins and PAHs from most socio-economic sectors in some North Sea countries between 1985 and 1999. This is particularly so for the industrial sector (water – dioxins and PAHs, air - PAHs), waste disposal (air - dioxins), small and medium enterprises (air - PAHs) and transport (air - PAHs).

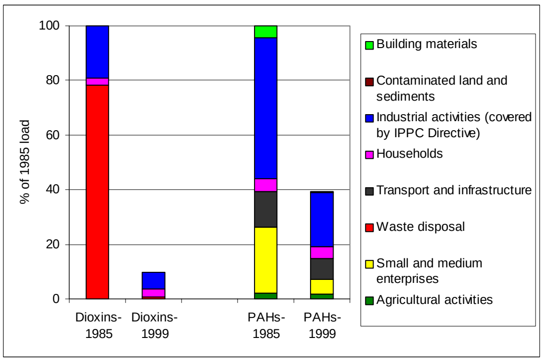
☹ The loads of some other organic substances however have remained relatively stable over the last decade in some countries e.g. the Netherlands.

Figure 5.10 Main sources of (a) discharges to water and (b) emissions to air of dioxins and PAHs in North Sea countries in 1985 and 1999

(a) Water



(b) Air



Based on data from:
Water
Dioxins: Netherlands, Norway
PAH: Belgium, Netherlands, Norway
Air
Dioxins: Netherlands, Norway, Sweden
PAH: Belgium, Netherlands, Norway, Sweden
Source: Progress report to 5th North Sea Conference 2002

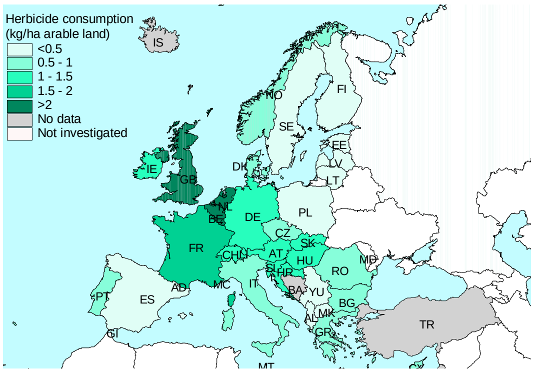
Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

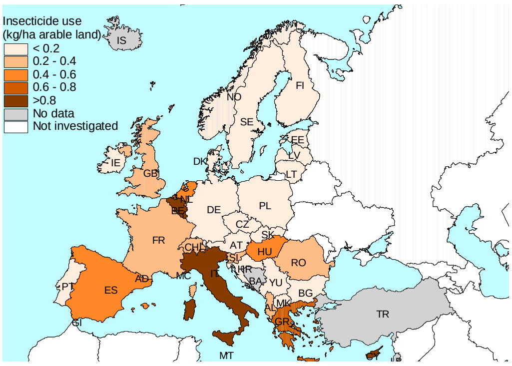
Consumption of pesticides

Pesticides contribute to agricultural productivity but can also be harmful to humans and the environment depending greatly on the toxicity of individual pesticides. The main source of pesticide pollution of water is from agriculture but pollution also occurs from industrial discharges, pollution incidents, sewage treatment works, urban run-off and anti-fouling paints (particularly in coastal areas).

There has also been a trend towards using active ingredients that are effective at lower concentrations. The reduction in pesticide consumption in Accession countries was due to the economic transition in these countries that, in many cases, ended state support for farmers and saw an end of subsidies. However, some Accession countries have recently seen a slight rise in the use of pesticides but levels are still much lower than pre-economic transition e.g. in the Czech Republic 4 302 t of pesticide active ingredients were used in 2000 compared to 8 920 t of active ingredient in 1990 (Czech Ministry of the Environment, 2001).

Map 5.1 Use of herbicides, insecticides and fungicides across Europe





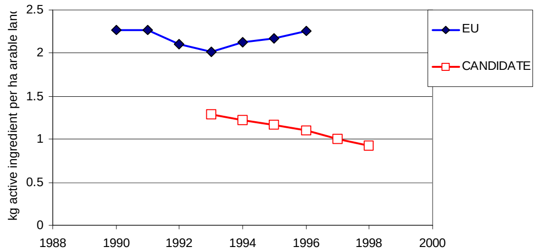
Years: 1996 EU and 1998 Accession countries

Key messages:

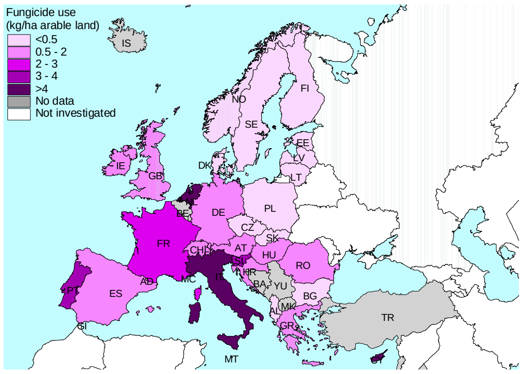
☹ Pesticide consumption per hectare of arable land in the EU decreased in the early 1990's but then rose again in the mid 1990's so that 1996 values were still similar to 1990.

☺ Consumption in the Accession countries steadily declined between 1993 and 1998.

Figure 5.12 Pesticide consumption in EU and Accession countries



Notes:
It is important to note that these figures are mostly based on sales and for many countries actual pesticide consumption correlates closely with fluctuations in crop production. In agriculture, different types of pesticides are used for different crops. For example, greater volumes of fungicides tend to be applied for viticulture and greater volumes of herbicides for cereal crops.
EU countries: Austria, Denmark, Finland, Germany, Netherlands, Portugal, Spain, Sweden, United Kingdom.
Accession countries: Czech Republic, Estonia, Latvia, Poland, Romania, Slovenia, Slovak Republic
Source: FAO



These maps show the pesticide use per unit area of arable land for the latest year for which data is available. Generally consumption is higher in Western Europe than in Nordic or Eastern Europe. However, it is important to note that the total consumption figures are dominated by sulphur and copper products that are used in vineyards, orchards and on organic farms (European Commission 2000).

Policy Question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Illegal discharges of oil to sea

The main sources of oil pollution in the marine environment are maritime transport, coastal refineries and offshore 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. Illegal oil discharges from ships and offshore platforms are regularly observed at sea. Oil pollution may cause significant local damage to beaches, fish and shellfish and bird populations because of its physical and chemical properties (e.g. PAHs). Oil pollution from illegal discharges tends to be a greater problem than from accidents since it occurs widespread and continuously in offshore waters. Accidents involve a larger amount of oil but cause local impact, which on the other hand receives high public attention when it reaches coastal waters. Specific aerial surveillance is conducted over “special areas” defined by international conventions. The annual frequency of observed oil slicks from aerial surveillance in maritime areas in the EU is a useful indicator of the trends in illegal oil discharges.

All discharges of oil are prohibited in the North Sea, Baltic Sea and Mediterranean, which are designated as International Maritime Organisation "special areas". Aerial surveillance is conducted in order to prevent and detect any violation of these regulations from ships and platforms. In the North Sea the number of oil slicks declined between 1990-2000. The high frequencies in 1997 and 1998 are due to methodological discrepancies where one country reported very small oil spills (less than 1 m^3). The North Sea is designated an IMO/MARPOL special area only since 1 August 1999. In the Baltic Sea, the number of oil spills is rather constant, showing poor change in shipping habits of oil discharge.

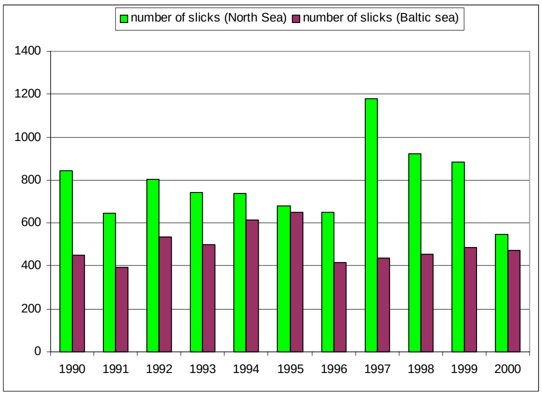
No data on hydrocarbon pollution is available for the North-East Atlantic Ocean. Hydrocarbon pollution in the French and Italian Mediterranean areas of responsibility exceed 200 slick occurrences per year. But the data are available only at national level and not commonly reported under the Barcelona convention. There is no other report for the Mediterranean sea, where there are about 40 oil-related sites (pipeline terminals, refineries, offshore platforms, etc.).

Much of the Black Sea is severely polluted with oil, especially near ports and river mouths, probably as a result of heavy boat traffic in the Black Sea; oil pollution along shipping lanes is especially heavy and is suggested to be caused by deballasting and bilge discharges.

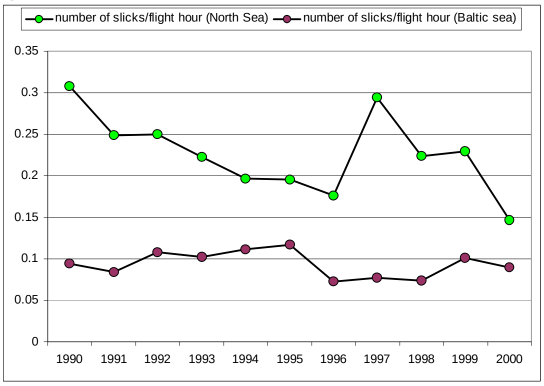
Key message
☹ The number of illegal oil spills has slowly decreased in the North Sea, but remains steady in the Baltic Sea. No aerial surveillance is conducted over the Mediterranean and the Black Seas.

Figure 5.13 Annual number of observed slicks (a) and number of slicks per flight hour (b) in the North and Baltic Seas from aerial surveillance

a)



b)



Source: Bonn Agreement and HELCOM

Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Discharge of oil from refineries and offshore installations

Coastal refineries and offshore installations[7] represent significant sources of oil discharged to the marine environment. The EU Dangerous Substances Directive includes targets on oil pollution discharges with reference to persistent and non-persistent mineral oils and hydrocarbons of petroleum origin. The OSPAR and HELCOM Conventions set targets on oil pollution land-based sources and offshore installations. For example, there is a target for reducing inputs of oil in produced water by 15 % by 2006 and a standard of 30 mg/l oil for individual installations by the end of 2006 in the OSPAR area.

Oil discharges from refineries steadily decreased during the 1990's and discharges from offshore installations were lower in the late 1990's than in the early 1990's. These decreases are due to increased application of cleaning technologies and improved wastewater treatment. Additional improvements are expected due to new OSPAR regulations, which entered into force in 2000.

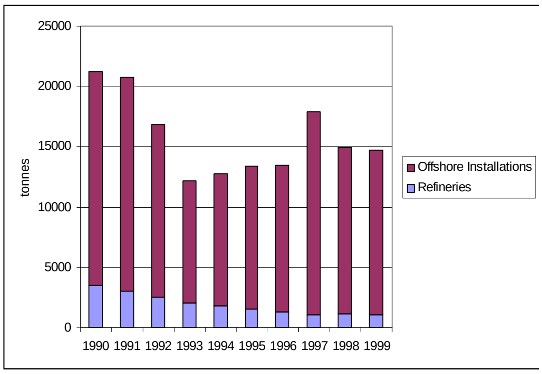
There are a large number of installations over marine oil fields (Map 5.2). For instance, OSPAR has published a database of offshore installations which includes more than 900 different installations some of which produce up to 800 000 tonnes of oil per year.

Oil discharges from refineries and offshore installations have been decreasing since the 80s, despite an increase in the corresponding industrial activity. In 1990 offshore installations of Denmark, United Kingdom and The Netherlands discharged 15 500 tonnes of oil while they produced 102 MT. In 1999 those installations discharged less than 10 400 tonnes of oil while they produced 154 MT. Between 1990 and 1998 the total refinery output across EU increased by 15%, while discharges decreased by 70% (EC/EUROSTAT 2001).

The assessment of discharges from offshore installations in the Mediterranean and Black Seas is lacking. There is an extensive oil refining and petrochemical industries operating in the entire 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 1996).

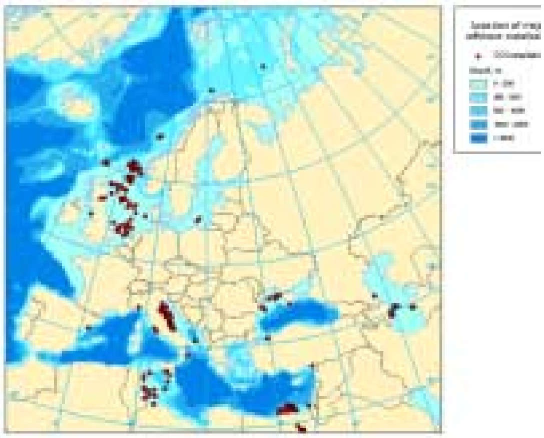
Key message
☺ Despite increased oil production, oil discharges from offshore installations and coastal refineries in the EU are decreasing.

Figure 5.14 Total discharges of oil from refineries and offshore installations in EU-15 and Norway



Note: Offshore installations include data only from Denmark, Spain, Norway, The Netherlands and United Kingdom.
Sources: OSPAR 1999, OSPAR 2001, EUROSTAT 2001, DHI based on data from EUROSTAT 1999 (Discharges from refineries (1991-1992, and 1994-1999) are based on emission coefficients developed by DHI), OSPAR 1997 and CONCAVE 1999

Map 5.2 Location of offshore oil installations



Sources: UKHO, SHOM, EEA 2002

[7] "Offshore installation" is defined by OSPAR as "any man-made structure, plant or vessel or parts thereof, whether floating or fixed to the seabed, placed within the maritime area for the purpose of offshore activities". It includes for example exploration and production platforms or ships.

Policy question 2: *Are discharges of hazardous substances from socio-economic sectors decreasing?*

Accidental oil spills from marine shipping

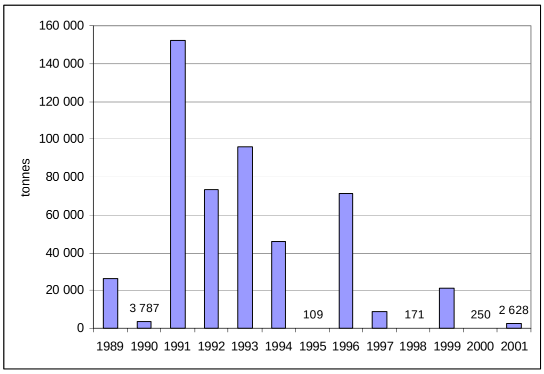
Key message:
☹ Despite the fact that pollution from oil spills on a world-wide scale has been reduced by 60 % since the 70's, major accidental oil tanker spills still occur at irregular intervals in European seas.

Oil spills to marine areas have a significant impact on environmental quality affecting all aspects of marine ecosystems. The consistency of oil can cause surface contamination and smothering of marine biota. In addition, its chemical components can cause acute toxic effects and long-term accumulative impacts. Marine life may also be affected in clean-up operations, either directly or through physical damage to marine and coastal habitats. Natural recovery is possible, but the time required depends on the size of spill. In the case of large accidental spills, expensive clean up operations and programmes to save marine sea birds and sea life are required. The impacts of accidental spills can be catastrophic on coastal zones that are often sites designated for their high ecological quality. Spills can also have severe repercussions for tourism, mariculture and fisheries in affected areas.

The indicator shows reported oil spills (greater than seven tonnes per spill) in the North East Atlantic, Baltic and Mediterranean Seas (Figure 5.15). It provides a partial indication of the total amount of oil released to the marine environment from the transport of oil. The International Tanker Owners Pollution Federation (ITOPF) estimates that 83 % of the nearly 10 000 ship-related oil spill incidents are of a size less than 7 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 over 7 tonnes, totalling
830 000 tonnes, just over 1% of the accidents produced 75 % of the spilt oil volume. Thus the figures for a particular year may be distorted by a single accident.

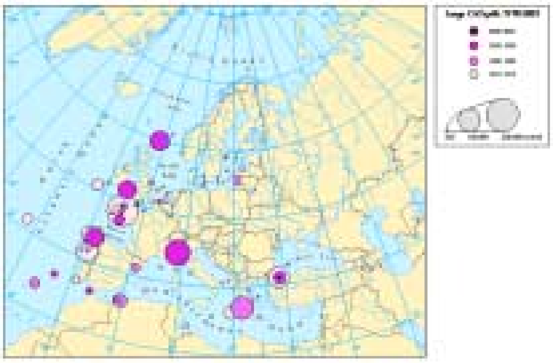
Oil production and consumption is increasing, as are net imports of oil to the EU, which increases the risk of oil spills. More rapid introduction of double hulls for tankers will help to reduce this risk. This is demonstrated

Figure 5.15 Accidental oil spills from tankers, combined carriers and barges in European seas



Note: Data are for spills above 7 tonnes per spill. The mass of oil spilt is approximate, as some records do not contain the exact amount of oil spilt but shows that there were less major spills from 1994 onwards than in the early 1990's.
Source: 1990-1998, Eurostat, based on data from ITOPF; 1999-2001, ITOPF

Map 5.3 Large accidental oil spills from tankers in European seas



Source: EEA 2002 based on ITOPF data

by the break up of the single hulled "Prestige", carrying 77 000 tonnes of oil, off the north west coast of Spain on 19 November 2002

There is a high sea-borne trade of oil in the Mediterranean Sea. Between 1987 and the end of 1996 an estimated 22 000 tonnes of oil were spilt as the result of shipping incidents (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.

Policy question 3: *Are the levels of hazardous substances such that they do not give rise to unacceptable impacts on, and risks to, human health and the environment?*

Note: Demonstration indicator

Non-compliance with EU Environmental Quality Standards

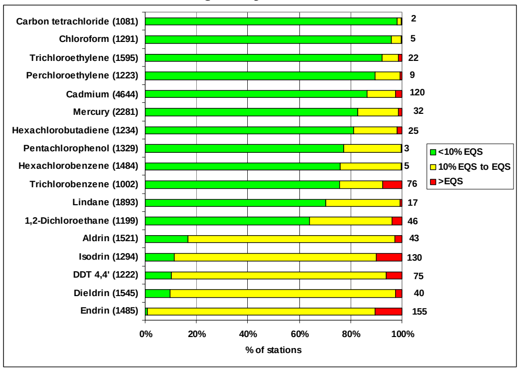
Environmental Quality Standards are set for some hazardous substances for application at an EU level (List I substances) under the Dangerous Substances Directive, whilst others are set nationally (e.g. List II substances). These standards are set to protect aquatic organisms. European standards will also be established for Priority List Substances and national standards for other pollutants under the Water Framework Directive.

The best available information shows that levels of hazardous substances are generally quite low in water and exceedences of the Dangerous Substances Environmental Quality Standards for List I substances are relatively rare (Figure 5.16). This is supported by information from England and Wales where the numbers of sites where Environmental Quality Standards are exceeded have decreased during the 1990s. However there are still a relatively high proportion of sites that are failing national Environmental Quality Standards for List II substances (Figure 5.17).

The combined monitoring-based and modelling-based priority setting scheme database (COMMPS) was developed by the European Commission to establish a list of priority substances for the Water Framework Directive and as such is the best data source available at present. It contains over 750 000 data points from EU Member States but is biased towards a few countries that provided most information. Even though it is not certain whether or not the absence of data in the COMMPS database from a particular country indicates that no monitoring is undertaken, it is clear that there are very large differences in the number of substances and stations at which hazardous substances are monitored. This implies that many EU countries are not undertaking adequate monitoring for these substances. The number of hazardous substances monitored is highest in Germany, the UK and Austria and lowest in Finland, Ireland and Portugal. In addition, seven of the EU countries do not appear to monitor any of the substances that are on the Water Framework Directive Priority List.

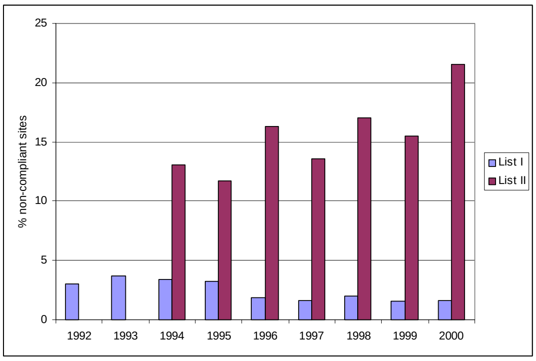
Key messages:
☺ Levels of List I substances in rivers are generally below EU Environmental Quality Standards.
☹ The monitoring of hazardous substances in surface waters is very variable between countries and it is as a result very difficult to make conclusions about current concentrations and trends.

Figure 5.16 Numbers of monitoring stations exceeding List I Environmental Quality Standards



Notes:
European Environmental Quality Standards are established for List I substances under the Dangerous Substances Directive. Numbers in brackets equate to the number of stations at which substances are monitored. The concentrations recorded at the stations have been divided into ranges equivalent to less than 10 % of the substance's EQS value, between 10 % and less than the EQS, and greater than the EQS value. The number on the right axis equates to the number of stations at which the EQS value is exceeded.
Source: COMMPS database, Data analysis by ETC/WTR

Figure 5.17 Non-compliance with List I and List II Environmental Quality Standards in rivers in England and Wales



Notes: Monitoring sites downstream of discharges. The causes of failures include run-off from historically contaminated land, discharges from old mines and re-suspension of contaminated sediments from historic discharges. Consented discharges were not responsible for any of the failures.
Source: Environment Agency of England and Wales, web page.

Policy question 3: *Are the levels of hazardous substances such that they do not give rise to unacceptable impacts on, and risks to, human health and the environment?*

Hazardous substances in marine organisms

Hazardous substances may affect human health through consumption of marine organisms and have deleterious effects on marine ecosystem function. Lethal and sublethal effects are known to occur. The long-term effects of these persistent substances in the European marine environment are not adequately known. Measures to reduce input of hazardous substances and to protect the marine environment are being taken as a result of various initiatives on different levels. These are described in other indicators. More recently, the Water Framework Directive will require Member States to achieve good ecological and chemical status in transitional and coastal waters. Chemical status will be defined in terms of standards for a Priority List of the most hazardous substances.

Table 5.2 summarises the main trends found in the data from the Baltic Sea (herring muscle), Mediterranean Sea (mussels) and the NE Atlantic (mussels, and cod liver and muscle). Decreasing trends have been found for cadmium, mercury and lead in mussels in the NE Atlantic and Mediterranean Sea (Figure 5.18), and for lindane in Mediterranean mussels, and DDT and PCBs in mussels from the NE Atlantic. In terms of fish, there was less evidence of generally decreasing trends and in the case of PCB in cod liver in the NE Atlantic there was evidence of an increase in concentrations since 1990. Even though some stations have decreasing trends other areas remote from point sources may have elevated concentrations of some hazardous substances (e.g. cadmium in northern Iceland, mercury in northern Norway).

Table 5.2 Summary of trends in concentrations in biota in Baltic and Mediterranean Seas and the North East Atlantic Ocean

	Baltic Herring	NE Atlantic Cod	NE Atlantic Mussels	Mediterranean Mussels
Cadmium	😐	😐	☺	☺
Mercury	😐	😐	☺	☺
Lead	😐	☺	☺	☺
DDT	☺	😐	☺	ni
PCBs	☺	☹	☺	ni
Lindane	ni	ni	ni	☺

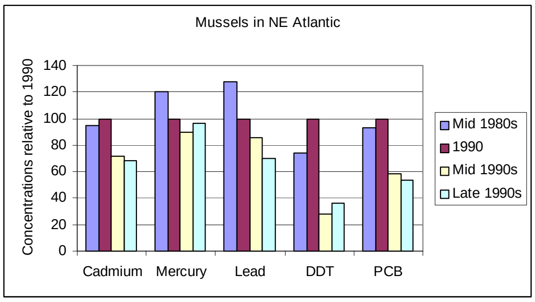
☺ inconsistent but decreasing trend; 😐 no trend; ☹ upward trend; ni = no information
Muscle analysed in herring; liver analysed in cod except for mercury where muscle was used.

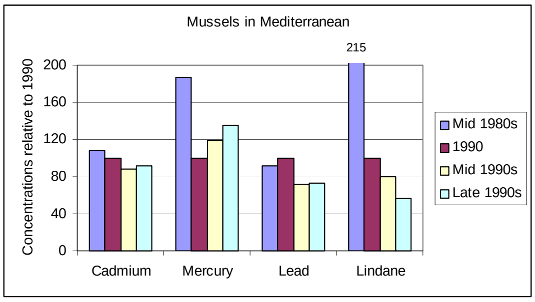
Key messages

☺ Levels of some hazardous substances are decreasing in marine organisms at some monitoring stations in the Mediterranean and Baltic Seas, and the NE 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.

Figure 5.18 Concentration of selected metals and organic substances in mussels in the Mediterranean Sea and the North East Atlantic Ocean





Notes:
It should be noted that the lack of consistent or reliable data from the marine conventions or EEA countries inhibits adequate assessment of levels and trends of hazardous substances in European marine waters. Aggregated data do not necessarily convey the uncertainty these problems cause.
Source: complied by ETC/WTR from OSPAR, HELCOM and EEA Mediterranean member country data.

Policy question 3: ***Are the levels of hazardous substances such that they do not give rise to unacceptable impacts on, and risks to, human health and the environment?***

Note: Demonstration indicator

Pesticides in surface and groundwater

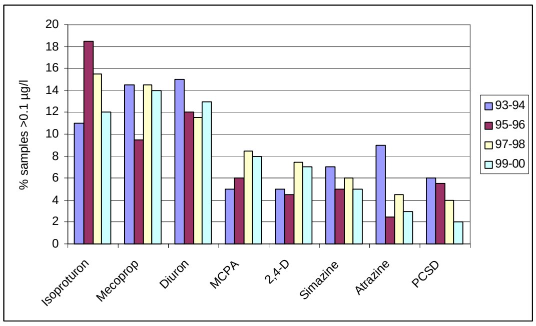
Key message:
☹ Pesticides occur in surface waters and groundwaters at levels that are of potential concern in terms of supplies for drinking water and in terms of adverse effects on aquatic organisms.

There are standards for the levels of pesticides in drinking water. These have to be complied with 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. Unfortunately, data are limited at a European level on the levels of pesticides in water.

Groundwater is often used as a drinking water source, yet there is limited information available on pesticides contamination and a lack of reliable and comparable data on European levels. In addition, the monitoring of pesticides is not yet undertaken nationally in many countries.

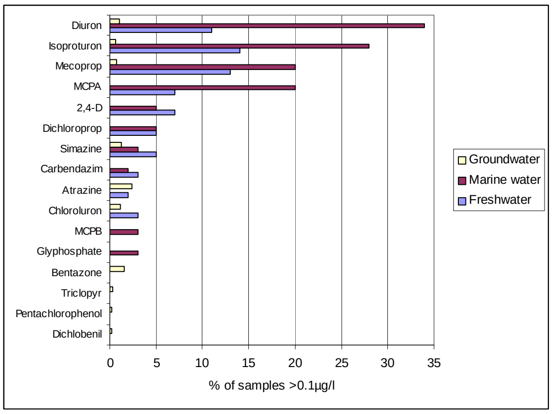
Figures 5.19 and 5.20 show the trends and occurrence of some commonly found pesticides in groundwater and surface waters in England and Wales – the data show no definite trends but indicate that some pesticides occur at concentrations that would be of concern if the water was drunk untreated. Many other countries report pesticide pollution of their groundwater. In Austria between mid 1997 and mid 1999 about 15 % of sampling sites exceed 0.1 µg/l for desethylatrazine and 10 % for atrazine. Trend analyses for atrazine of 247 sampling sites showed significant downward trends for 72 % of the sites. Atrazine was banned in 1995 and the ban seems to be effective (UBA Vienna, 2001). In Finland pesticide pollution of groundwater is reported around tree nurseries (FEI, 2001). In France over half of all monitoring points (52%) are considered to be unaffected. Excessive contamination is suspected at 35 % of points and definitely present at 13 % of points. However the available data covers only 75 % of France (RNDE, 2002). In Denmark in 2001 pesticides were found to be present in 27 % of the well screens and levels of pesticides in 8.5 % of the screens exceeded the limit value for drinking water (Geus 2002). In the UK in 2000 about 9 % of the freshwater sites failed to meet the Environmental Quality Standards at least once (EA of England and Wales, 2002). Even Sweden, which confirmed that pesticides do not cause

Figure 5.19 Trends in occurrence of some commonly found pesticides in England and Wales



Notes: Percentage of samples greater than 0.1 µg/l. Samples from surface waters and groundwater
Source EA of England and Wales Web page.

Figure 5.20 Frequently occurring pesticides in freshwater, marine water and groundwater in England and Wales in 2000



Notes: Percentage of samples greater than 0.1 µg/l. A total of 180 different pesticides are analysed at over 3 000 locations (2 159 freshwater, 1 219 groundwater and 439 marine), at a frequency of four to 12 times a year giving over 200 000 determinations a year. The herbicides diuron, isoproturon and mecoprop are the pesticides found in all 3 water types and are the ones that most frequently exceed 0.1 µg/l in marine and freshwaters.
Source: Environment Agency of England and Wales (2002)

problems in groundwater, reports sometimes on low but not insignificant concentrations of pesticides in groundwater (Swedish EPA, 2002).

Policy question 3: *Are the levels of hazardous substances such that they do not give rise to unacceptable impacts on, and risks to, human health and the environment?*

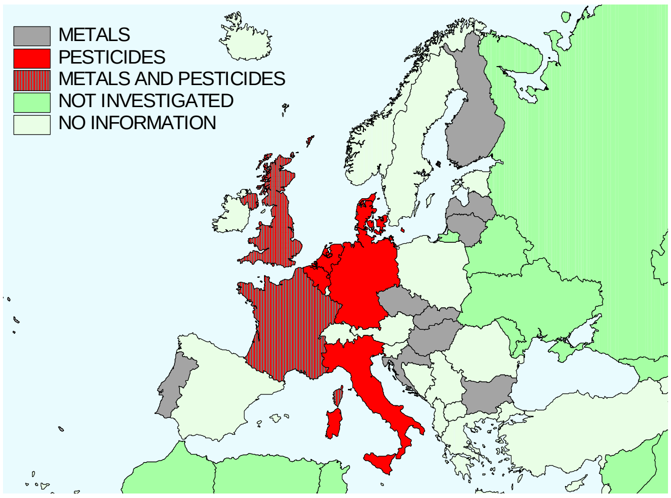
Hazardous substances in drinking water

The Drinking Water Directive (80/778/EEC), and its successor (98/83/EC which comes in force in 2003), aims to ensure that water intended for human consumption is safe. In addition to monitoring for microbiological and physicochemical parameters a number of toxic substances are also monitored for such as pesticides, polyaromatic hydrocarbons, cyanide compounds, and heavy metals. This is because the raw supply may be contaminated e.g. with pesticides from agricultural land which have leached into ground water or from contamination within the distribution system e.g. lead from piping. Some problems with pesticides and/or heavy metals in drinking water have been identified in national reports and by the European Union of National Associations of Water Suppliers and Waste Water Services (EUREAU) (Map 5.4).

Pesticide pollution of drinking water has been identified as a problem in Belgium, Denmark, France, Germany, Netherlands and UK (EUREAU, 2001) where it is estimated that between 5 % and 10 % of resources are regularly contaminated with pesticides in excess of 0.1 µg/l. For example, in Germany in 1995 10 % groundwater monitoring stations exceeded 0.1 µg/l particularly for atrazine despite its ban in 1991. One of the main causes of metal contamination of drinking water is from lead plumbing. For example, in France, extensive replacement of lead pipes is still required and in the UK the use of lead solder is still common even though it has been illegal since 1987. In some of the Accession countries there are also problems with lead and other metals e.g. in the Czech Republic, barium and nickel are at levels that are of concern in some supplies and the Slovak Republic has recorded some high cadmium concentrations.

Key message
☹ Pesticide and metal contamination of drinking water supplies has been identified as a problem in many European countries.

Map 5.4 The threat of metal and pesticide contamination in drinking water



Sources: Countries national reports, EUREAU (2001)

Policy Question 3: *Are we reducing pollution of waters with hazardous substances?*

Biological effects of hazardous substances on aquatic organisms

Key message:
☹ The presence of endocrine disrupting chemicals in the aquatic environment has been linked with sexual disruption of aquatic animals, and is an emerging issue of concern.

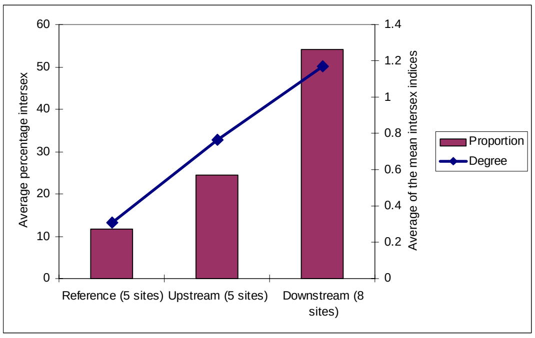
An Endocrine Disrupting Chemical as defined by the Weybridge Conference (1996) is 'an exogenous substance or mixture that alters the function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) populations'.

Several classes of chemicals such as pesticides, phthalate plasticisers, dioxins and anti-fouling paints are known to have endocrine disrupting properties (Royal Society, 2000). Pharmaceuticals with hormonal effects (e.g. synthetic oestrogen used in contraceptives) are also emitted into the environment and the effects that these substances might have are also an increasing concern (e.g. UBA, Berlin 2001). There are currently 553 substances on a candidate list of substances for further evaluation of their roles in endocrine disruption drawn up by a study for the European Commission (2001).

A number of studies have now been carried out on freshwater and estuarine systems in Europe and endocrine disruption has been noticed in fish exposed to effluent from sewage treatment works. The main observation is the feminisation of males including the induction of vitellogenin (an egg yolk protein) and abnormal gonadal development. The effects on populations are, at present, unclear but it is generally considered to be mainly due to natural and synthetic oestrogens from domestic sewage.

The most undisputed evidence for Endocrine Disrupting Chemicals effecting wildlife populations is that for organo-tin compounds. Organo-tin compounds were first used in anti-fouling paints in the 1960's and have now been shown to cause imposex (penis formation induced in females) in over 100 species of marine molluscs.

Figure 5.6 Sexual disruption in wild fish in England



Notes: Downstream: sites downstream of sewage treatment works
Upstream: sites upstream of sewage treatment works
Reference waters that do not receive sewage effluents
Source: Environment Agency of England and Wales 1998 (www.environment-agency.gov.uk/your/env/eff/wildlife/fish

Results from a study of wild roach in several English rivers in 1996 and 1997 showed that the prevalence and degree of feminisation of male fish was generally higher at river sites downstream of sewage treatment works than at sites upstream or in waters that do not receive sewage effluents (Figure 5.6). In one case the sewage effluent contained alkylphenol detergents which are known to have endocrine-disrupting properties. Similar feminisation of male roach has also been observed in 2 rivers polluted with wastewater in Denmark (NERI 2002).

Feminisation of flounder in estuarine and coastal waters in the UK has also been reported, even though abnormal sex ratios were not seen in any estuary (CEFAS 1998). Here it was concluded that oestrogenic hormones were not the major causative agent but were likely to be contributing to the observed effects. The presence of industrial effluents and chemicals in these waters also suggested that non-hormonal substances were major contributors to the effect.

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