Second Forum on Implementation and Enforcement of Community Environmental Law

Intensifying our efforts to clean up urban wastewater

Brussels, 19 March 2001

The effects of urban waste water treatment on the quality of rivers, lakes and seas

Presentation summary

The EEA aims to support sustainable development and to help achieve significant and measurable improvement in Europe's environment through the provision of timely, targeted, relevant and reliable information to policy making agents and the public.

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Summary

The Urban Waste Water Treatment Directive is a core element in Community efforts to improve water quality in rivers, lakes and coastal waters, and through that the protection of nature and biodiversity and human health, 2 of the priority areas of the Sixth Environmental Action Programme.

More and improved data from certain MS would help to paint a more complete picture of trends. Some Member States have provided no data.

We don't have data on river and lake quality itself. However, we have data on pollution levels in rivers and lakes with key substances found in urban waste water. These substances are:

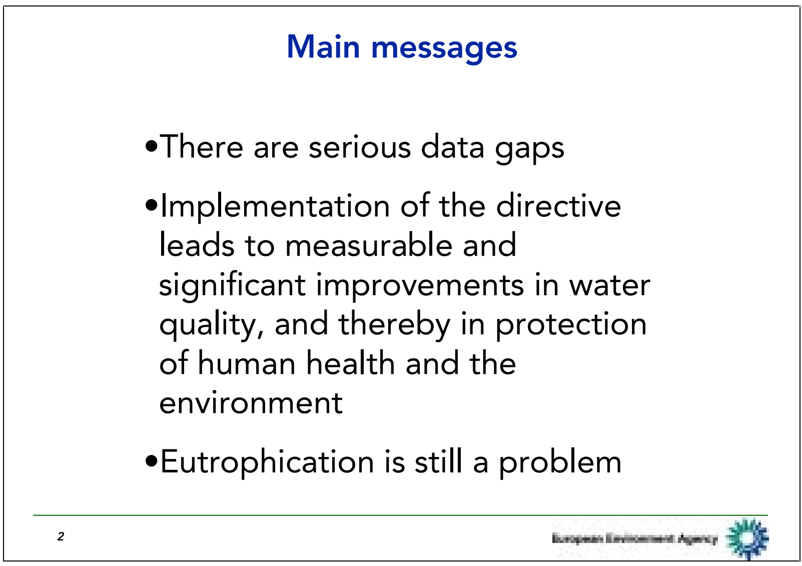
- organic material, that can give rise to problems for drinking water quality and cause oxygen depletion and thereby loss of biodiversity in the receiving waters;
- nitrate, leading to eutrophication (over-fertilisation) and giving problems for drinking water quality
- phosphorus, also contributing to eutrophication;
- ammonium, which in un-ionised form as ammonia is poisonous.

Available data from the MS that are furthest show that implementation of the directive's requirements leads to most parameters being below levels that normally give rise to poor quality, though still higher than background/natural levels. Organic material, phosphorus and ammonium all fall to lower levels. Nitrate is still a problem for two reasons: firstly, it is proving difficult to remove nitrate in waste water treatment plants, and secondly and more importantly, agriculture is the dominant source in most areas. However, Member States that are further behind and still facing major investments can rest assured that investments in urban waste water treatment in accordance with the directive will result in measurable and significant improvements in water quality.

The general positive trends that have been documented don't mean that there are no problems. Despite improved water quality eutrophication is still a major European issue. To further reduce eutrophication it may be necessary to take measures to reduce the diffuse load of phosphorus from agriculture. In many places this contribution is substantial and at the same level as the input from waste water treatment plants.

Nitrate from agriculture, addressed by other Community legislation, also plays a major role in eutrophication.

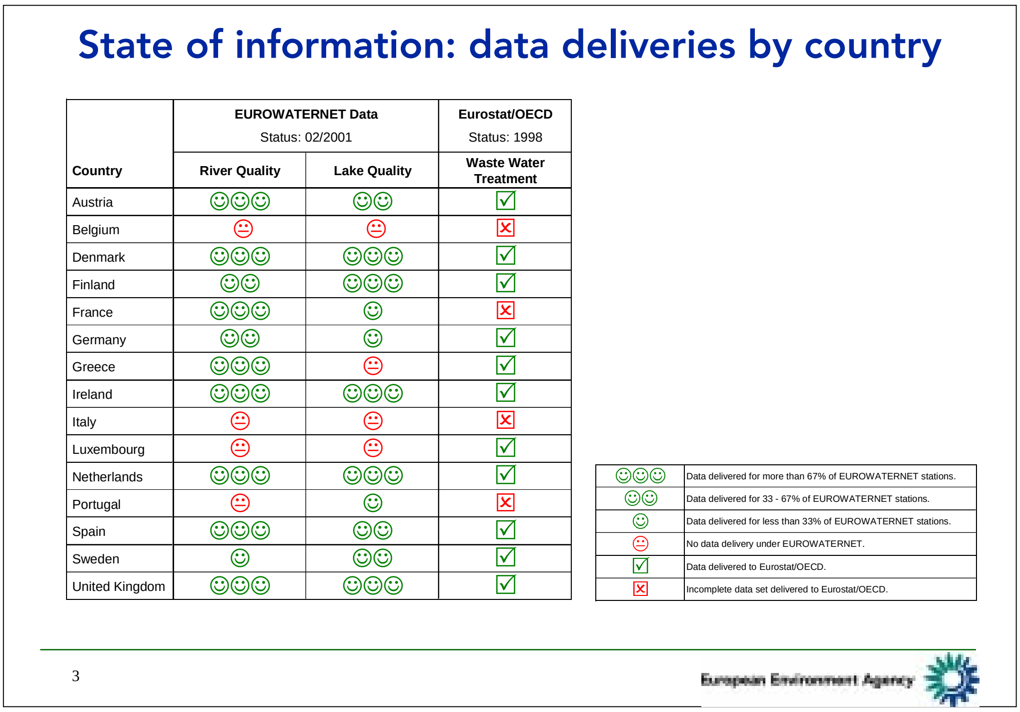
In the future, implementation of the water framework directive will bring these different elements together to a coherent whole.



Basis of the assessment

This assessment is mostly based on data and information gathered by the EEA since the Urban Waste Water Treatment Directive does not oblige Member States to report information on the state of their water bodies to the Commission. The data gathering has mainly been done using EUROWATERNET, a network of monitoring sites established with Member States. Delivery of data under the EUROWATERNET process is voluntary. As of February 2001 Belgium, Italy and Luxembourg had delivered no data whereas Denmark, Ireland, the Netherlands and UK had delivered all river and lake data requested.

The parameters most relevant for assessing the impact of UWWT are nitrogen compounds, phosphorus – expressed as total phosphorus and orthophosphate - and Biochemical Oxygen Demand.



State of information: data deliveries by country

	EUROWATERNET Data Status: 02/2001		Eurostat/OECD Status: 1998
Country	River Quality	Lake Quality	Waste Water Treatment
Austria	☺☺☺	☺☺	☑
Belgium	☹	☹	☒
Denmark	☺☺☺	☺☺☺	☑
Finland	☺☺	☺☺☺	☑
France	☺☺☺	☺	☒
Germany	☺☺	☺	☑
Greece	☺☺☺	☹	☑
Ireland	☺☺☺	☺☺☺	☑
Italy	☹	☹	☒
Luxembourg	☹	☹	☑
Netherlands	☺☺☺	☺☺☺	☑
Portugal	☹	☺	☒
Spain	☺☺☺	☺☺	☑
Sweden	☺	☺☺	☑
United Kingdom	☺☺☺	☺☺☺	☑

☺☺☺	Data delivered for more than 67% of EUROWATERNET stations.
☺☺	Data delivered for 33 - 67% of EUROWATERNET stations.
☺	Data delivered for less than 33% of EUROWATERNET stations.
☹	No data delivery under EUROWATERNET.
☑	Data delivered to Eurostat/OECD.
☒	Incomplete data set delivered to Eurostat/OECD.

What waste water treatment can achieve

Typically, primary treatment removes 50 % of BOD load and tertiary treatment 95 %. Little phosphorus is removed by primary treatment whereas tertiary treatment would reduce loads by 90 %.
Thus any changes in water quality resulting from increased waste water treatment should be indicated by changes in measured determinands, such as total phosphorus, orthophosphate and BOD. There should also be secondary changes resulting from decreases in the loads and concentrations of these determinands, such as improvement in the quality of the aquatic ecosystems.

What waste water treatment can achieve

Percentage removal

Type of treatment	Nitrogen	Phosphorus	BOD
Primary	20	25	50
Secondary	35	40	90
Tertiary	75	90	95

Changes in waste water treatment by region 1980-1997

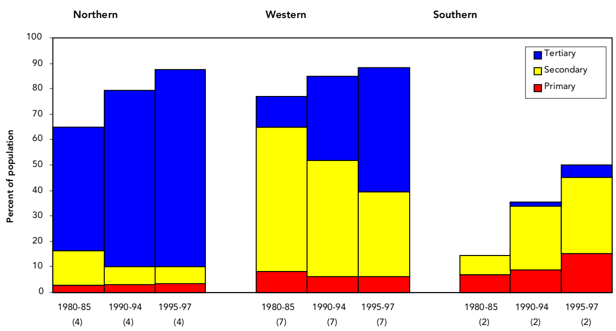
The period 1980-1997 saw a marked increase in the proportion of the population connected to waste water treatment facilities and considerable changes in treatment levels.

In northern countries the majority of the population was connected to sewers with waste water treatment in the early 1980s. In many other countries a large increase in the population served occurred over the 1980-1997 period. Austria and Spain saw the proportion of population connected to sewers and waste water treatment more than double over the period while Greece has experienced a marked increase since 1990.

The percentage of population connected to tertiary treatment (the most rigorous level) has also increased since 1980 in all European regions. Many western countries have constructed tertiary treatment plants since the late 1980s.

State of action

Changes in waste water treatment in regions of Europe between 1980/85, 1990/94 and 1995/97



Notes: Only countries with data from all periods included, the number of countries in parentheses.
Northern: Iceland, Norway, Sweden, Finland.
Western: Austria, Ireland, United Kingdom, Luxembourg, Netherlands, Germany, Denmark.
Southern: Greece, Spain.
Incomplete datasets from: Liechtenstein, Belgium, Italy, France, Portugal.

Source: OECD/Eurostat

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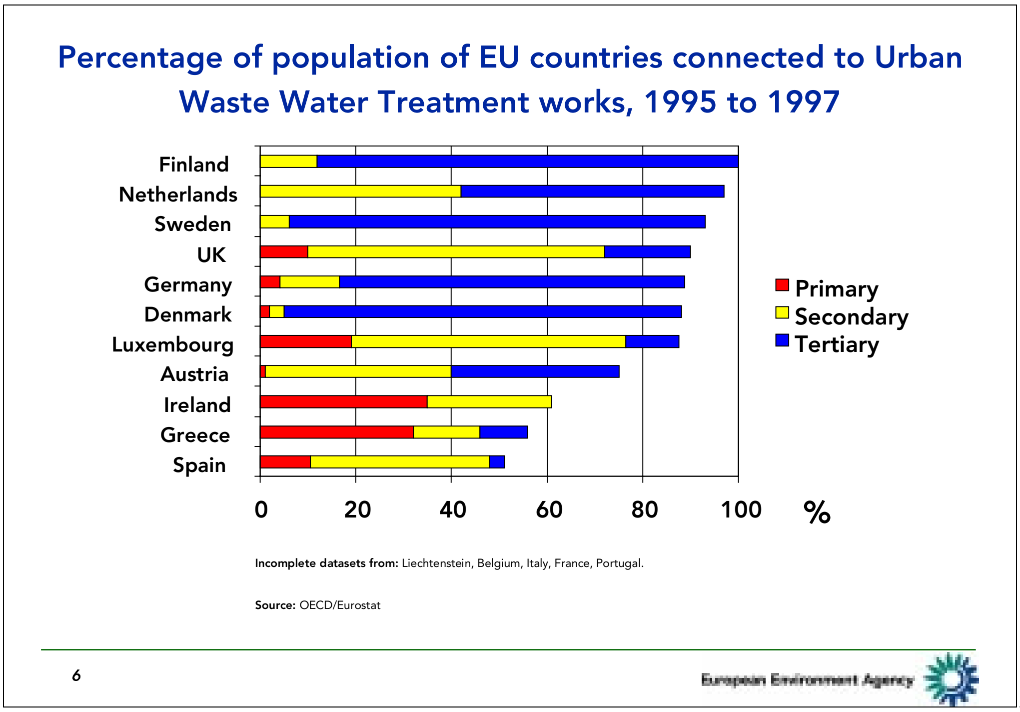
Percentage of population of EU countries connected

In northern and western Europe more than 60% of the population is connected to waste water treatment facilities. In southern Europe the figure is less than 60% and treatment is less efficient.

Efficient tertiary treatment is most widespread in Finland, Sweden and Denmark



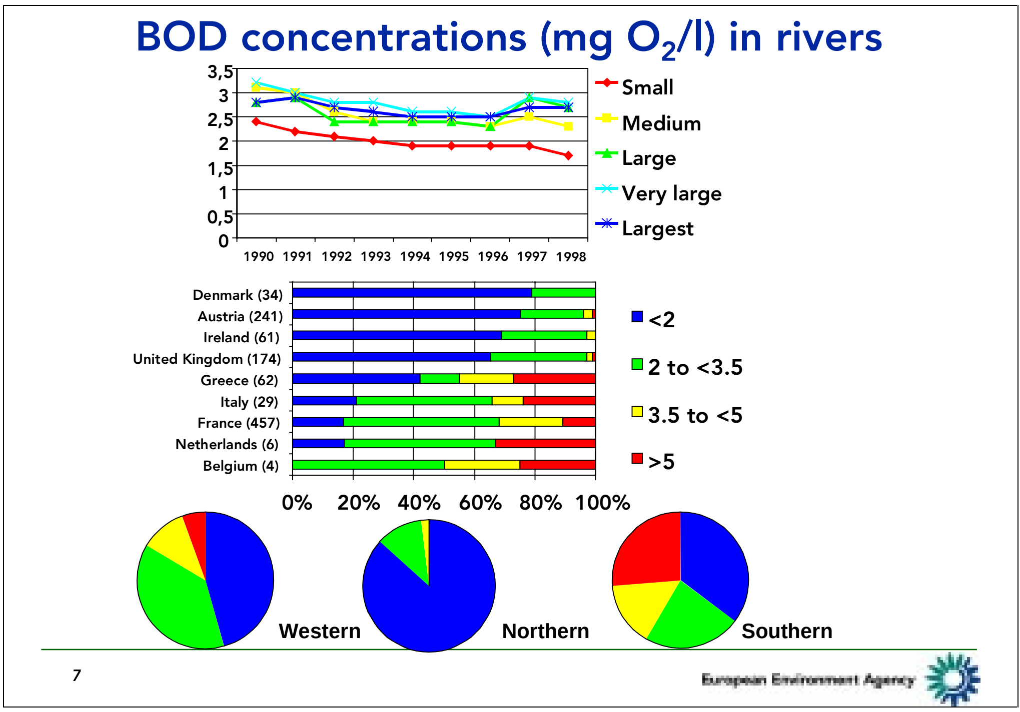
Organic pollution – a success story

Biochemical oxygen demand (BOD) is a measure of the oxygen demand arising from the microbiological breakdown of organic matter in water. High biochemical oxygen demand (BOD) may indicate a potential for reduced oxygen levels in water, thereby affecting the biodiversity of aquatic communities. It is one of the main parameters used in the UWWTD for controlling discharges. A BOD level of less than 2 mg O_2/l is indicative of a relatively clean river, while more than 5 mg O_2/l points to a river that is relatively polluted.

The slide indicates that BOD levels have decreased during the 1990s in all sizes of river in the EU. The drop is due at least in part to improved levels of sewage treatment, which in turn is partly a result of implementation of the Urban Waste Water Treatment Directive.

Small rivers have the lowest concentrations of BOD and very large rivers the highest concentrations. This probably reflects the discharges from sewage treatment works and industry, the largest of which tend to be located on the bigger rivers.

Austria and Denmark had lowest levels of BOD at the stations measured, and Belgium and the Netherlands the highest.

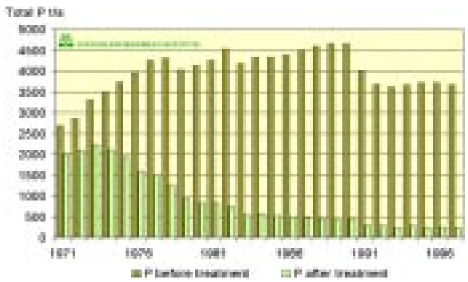


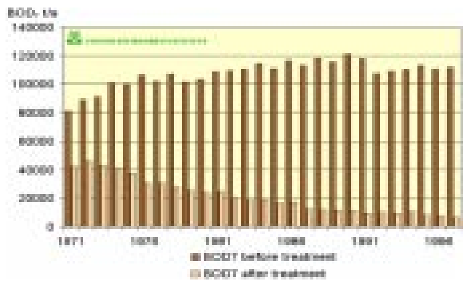
BOD7 and phosphorus loads in Finland before and after WW treatment

Finland provides a best-practice example of the beneficial impact of steadily expanding sewage treatment. By 1996 the average level of organic matter (BOD_7) removal and phosphorus removal had risen to 93 %. As a result the total load of organic matter from public wastewater plants into lakes, rivers and sea areas had fallen by 82 % since the early 1970s, and the load of total phosphorus by 88 %.

BOD_7 and phosphorus loads in Finland before and after treatment in municipal sewage works, 1971-1997

Pressure is decreasing





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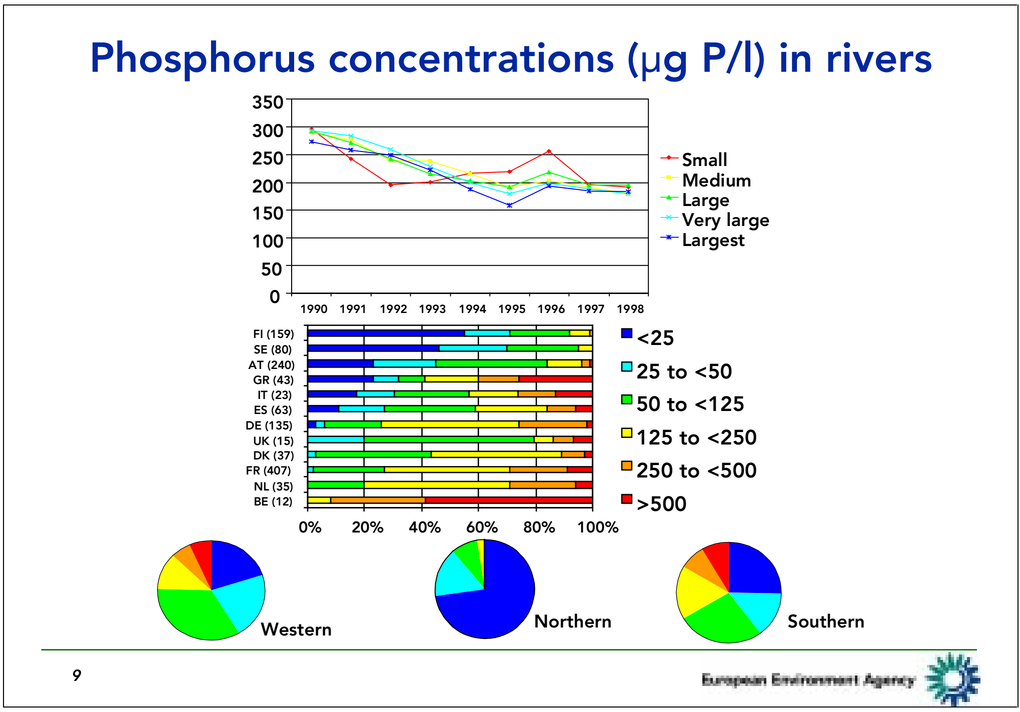
Phosphorus concentrations in rivers

Natural concentrations of total phosphorus and orthophosphate will vary by catchment depending upon factors such as geology and soil type. Natural ranges are considered to be approximately 0 to 10 µg P/l for orthophosphate and 5 to 50 µg P/l for total phosphorus in surface freshwaters. Waters containing concentrations above 100 µg P/l would be considered to be of poor quality as significant eutrophication effects would be expected.

Phosphorus concentrations generally decreased in European rivers in the 1980s and 1990s (top figure). There are not very marked differences between the different sizes of rivers though medium-sized rivers generally have higher concentrations of phosphorus than others.

There are, however, clear differences between the regions of Europe in terms of phosphorus concentrations, with Finland having far lower and more stable phosphorus concentrations over the nine-year period compared with other countries (middle figure). Western European countries appear to have similar median phosphorus concentrations over this period.

The bottom figure indicates that northern countries such as Finland have more river stations with low concentrations of phosphorus, and western and southern countries fewer.



Phosphorus in lakes

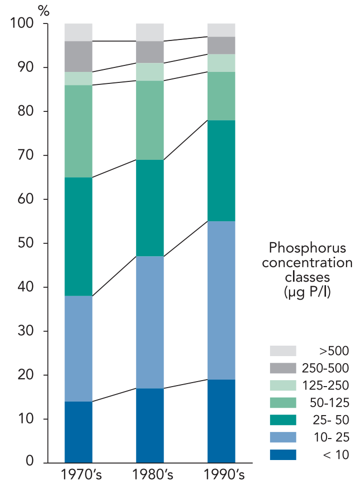
Good geographical and historical data for phosphorus concentrations in lakes are lacking, making regional comparisons difficult. Available data are probably unrepresentative because they are generally more available for lakes with problems than those without.

What is clear is that over the past decades the environmental quality of some lakes has improved. For lakes for which data exist, the proportion of those rich in phosphorus has decreased and the proportion of lakes of near-natural quality (assumed to be below 25 µg P l^{-1}) has increased. The cleanest lakes (<10 µg P l^{-1}) have generally remained unchanged while the most polluted lakes have improved since the 1980s.

Much of the change can be ascribed to banning of phosphorus in detergents and improved treatment of urban waste water, most noticeably in the Nordic and western European countries. Industrial pollution has similarly been substantially reduced. In addition, the discharge of waste water has in some instances been moved to a point downstream of the lake. In certain lakes and reservoirs, special action programmes in the catchment have been put in place and some are beginning to have positive effects.

Phosphorus in lakes is decreasing

Temporal change in distribution to total phosphorus classes (in µg P l^{-1}) amongst selected European lakes.



Note: 126 lakes across Europe
Source: compiled by ETC/IW from questionnaire returns

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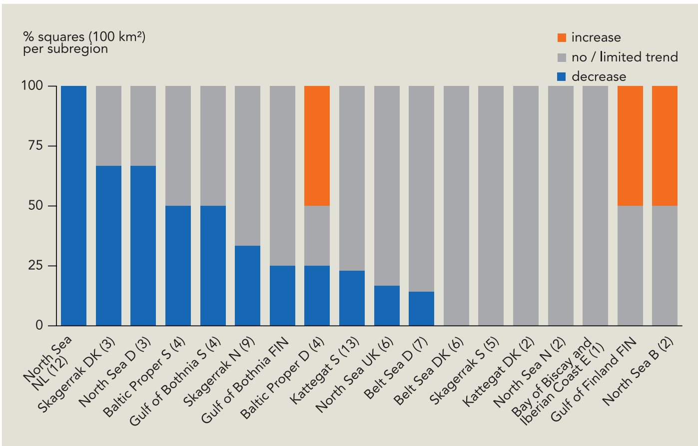
Phosphorus in coastal waters

Concentrations of nutrients in coastal waters in winter time are an indicator for the state of the marine environment and the potential for eutrophication.
The trend of phosphorus concentration in the coastal waters of each country in the North-east Atlantic and Baltic are shown in the graphic. For several regions the trend in phosphorus is decreasing (blue bars) while in the majority of the regions no trend could be observed (grey bars). The decrease in phosphorus correlates with the observed decreasing trend in major EU rivers.

Changes in phosphate concentrations in OSPAR and HELCOM coastal waters, 1985-1998

Phosphorus is decreasing



Source: ICES, Finnish National Focal Point

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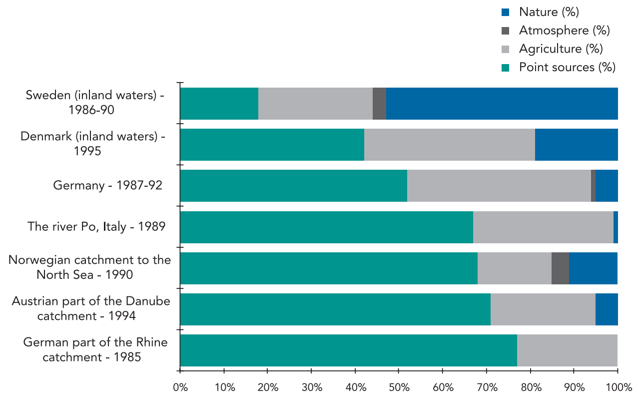
Sources of phosphorus

Emissions of phosphorus are decreasing in many parts of Europe. Results from large river catchments or national emission inventories show that a reduction of, typically, 30-60% has occurred since the mid-1980s. Emissions from the industrial sectors in Denmark and the Netherlands have decreased by as much as 70-90%.

Phosphorus loading generally increases with increasing human activity in the catchment. In more densely populated areas, 50-96% of the dissolved phosphorus load to inland waters is derived from point sources, while agricultural activity generally accounts for 20-40%. If there were no human activity, phosphorus levels would only be 5-10% of current levels. In these densely populated catchments, municipal sewage discharges generally account for the major part of the total point source discharges.

Where does phosphorus come from



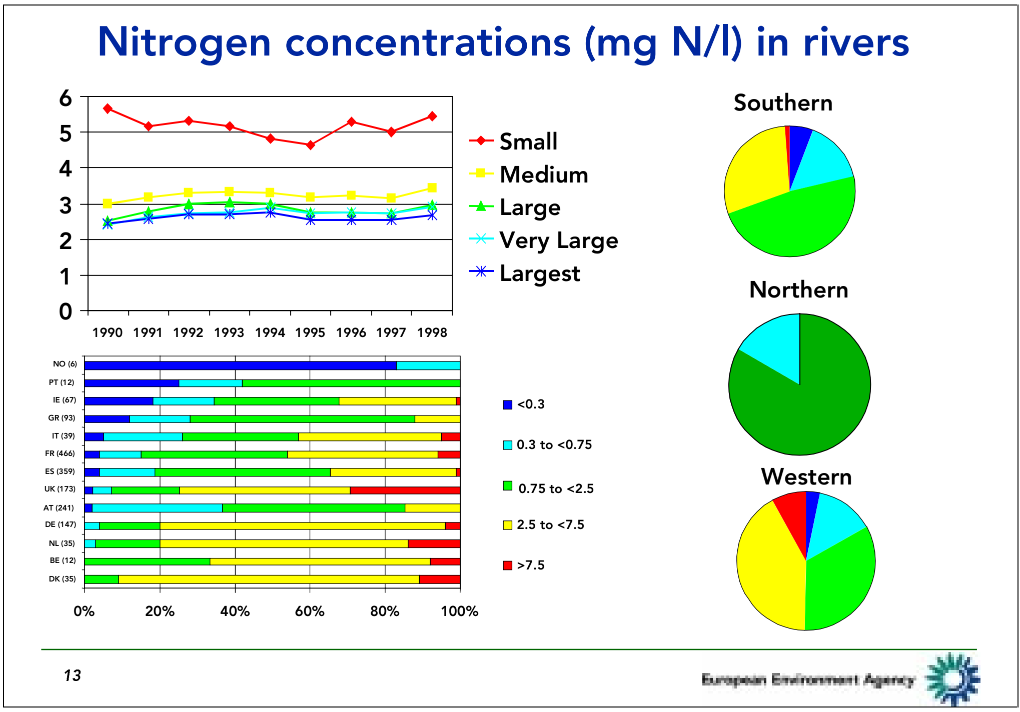
Notes: Atmospheric precipitation only considered for some catchments. Natural load included in agriculture for the Dutch rivers. The lower bars have the highest proportion of agricultural pollution
Source: compiled by ETC/IW from state of the environment reports: Windolf, 1996; Swedish EPA, 1994; Umweltbundesamt, 1994; BMLF, 1996; Ibrekk et al., 1991; Italian Ministry of the Environment, 1992; RIVM, 1992; Löfgren and Olsson, 1990

Nitrogen concentrations in rivers

The data for nitrate or total oxidised nitrogen (TON) show no trend between 1990 and 1998. Small rivers, however, have higher concentrations than the other size categories. The lowest concentrations of nitrate or TON are generally found in Norway, Portugal and Ireland, and the highest in Denmark, Belgium and Germany. However, it should be noted that the number of monitoring stations provided by Norway, Portugal and Belgium is small and has not been provided through the EUROWATERNET process. The information for those countries may therefore not be representative of all of their rivers.

In addition, the concentration of nitrate in rivers is significantly influenced by year-to-year variability in water run-off and river flow. Concentration data 'adjusted' for this variability would improve the information on trends of nitrate in rivers.

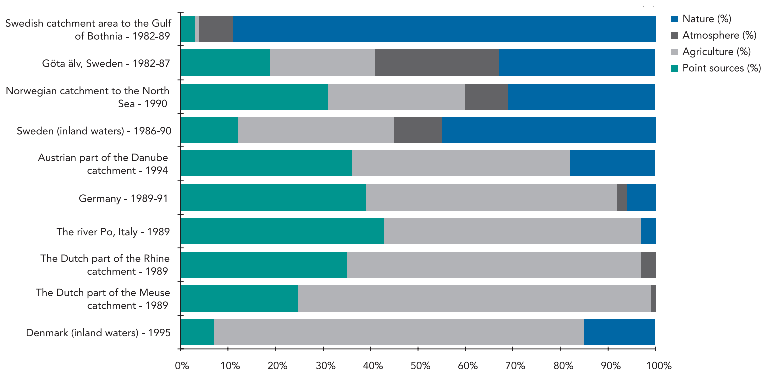
Concentrations of nitrate below 0.3 mg N/l would be considered as natural or background levels for most European rivers, although for some rivers levels of up to 1 mg N/l are reported. Concentrations of nitrate above 7.5 mg N/l would be taken as relatively poor quality and would exceed the guideline concentration for nitrate of 5.6 mg N/l as given in the directive on Surface Water for Drinking (75/440/EEC).



Sources of nitrogen

Nitrogen pollution is usually dominated by diffuse sources, in particular agriculture. There is a significant relationship between nitrogen concentrations and the percentage of farmland in river catchments. In those river systems draining catchments in the central and western part of Europe, 46-87% of the nitrogen load to inland waters is related to agriculture.
In Denmark, for example, where 65 % of the total land area is farmland, approximately 80% of the nitrogen discharge to inland waters is a consequence of agricultural activities.

Where does nitrogen come from



Notes: Atmospheric precipitation only considered for some catchments. Natural load included in agriculture for the Dutch rivers. The lower bars have the highest proportion of agricultural pollution

Enlargement

A study carried out by the EEA showed that implementation of the UWWT Directive in 10 accession countries would improve water quality. The most costly scenario, tertiary treatment as required for sensitive areas, would cost a total of approximately nine billion eur for those countries and yield quite substantial emission reductions. For BOD the cut would be 70 %, for phosphorus 50 % and for nitrogen 35 %. However, if simultaneous measures were not taken to reduce emissions from diffuse sources – agriculture – the improvement in water quality would not be enough to prevent the eutrophication of receiving waters.