European Environment Agency

Topic report 7/2001

Eutrophication in Europe's coastal waters

Gunni Ærtebjerg (Task Leader)
Jacob Carstensen
Karsten Dahl
Jørgen Hansen
National Environmental Research Institute, Denmark

Kari Nygaard
Brage Rygg
Kai Sørensen
Gunnar Severinsen
Norwegian Institute for Water Research

Sara Casartelli
Wolfram Schrimpf
Christian Schiller
Jean Noel Druon
EC Joint Research Centre

EEA Project Manager: Anita Künitzer

Summary

The major impacts of eutrophication due to overloading with nitrogen and phosphorus nutrients are changes in the structure and functioning of marine ecosystems, reduced biodiversity, and reduced income from fishery, mariculture and tourism.

The main objective of this report is to evaluate the causes, state and development of eutrophication in European coastal waters, and to identify areas where more monitoring data are needed to improve assessment. In addition, a first evaluation is made of the use of a trophical index for water quality assessment and the use of remote sensing as a eutrophication monitoring tool in northern seas.

Data and information from the marine conventions (AMAP, Helcom, OSPAR, UNEP/MAP, Medpol) and EEA national reference centres have been used, as well as information in grey and scientific literature. However, the data available for the project were scarce and, with the exception of some regions, inadequate for fully assessing the state and trends of eutrophication at a European level. In particular, eutrophication data were missing from the Bay of Biscay, the Iberian coast and the Mediterranean Sea.

Driving forces
The main source of nitrogen is run-off from agricultural land brought to the sea via rivers. Atmospheric deposition of nitrogen may also contribute significantly to the nitrogen load. This nitrogen originates partly from ammonia evaporation from animal husbandry and partly from combustion of fossil fuels in traffic, industry and households. Most of the phosphorus comes from households and industry discharging treated or untreated wastewater to freshwater or directly to the sea, and from soil erosion. Locally, fish farming may also cause eutrophication problems.

Pressures
The main increase in nutrient load took place before monitoring programmes and pollution load compilations were started. According to information in the literature, a conservative estimate of the increase in nitrogen loads from land and atmosphere to the Baltic and North Sea regions is a doubling from the 1950s to the 1980s, and a fourfold increase in the phosphorus load from the 1940s to the 1970s. The development in load to the Mediterranean Sea is unknown, but probably of the same magnitude.
Since the middle of the 1980s the phosphorus load has generally been reduced, in some Helcom and OSPAR areas up to 50 %, due to improved sewage treatment and phosphate-free detergents. The nitrogen load from point sources has also been reduced, but there is no discernible reduction from agriculture as the main diffuse nitrogen source to the North Sea. However, the nitrogen load to the Baltic Sea is assumed to have decreased slightly due to the reduction in the fertiliser usage in the countries in transition in this area.
Atmospheric nitrogen deposition to the Baltic Sea area decreased about 25 % from 1986 to 1995, although this was somewhat less in the transition area, mainly due to reduced production in eastern Europe. No changes have been seen in the wet deposition of nitrogen to the North Sea.

State and impact
The present state of eutrophication is assessed in terms of winter nutrient concentrations, chlorophyll-a and bottom oxygen concentrations. Nutrient concentrations gave the best spatial resolution in the assessment of eutrophication. Analysis of the relationship between nutrients and salinity showed a consistent pattern of eutrophic conditions in areas receiving freshwater input from urban and agricultural catchments. Freshwater from areas less impacted by human activity had in general no effect on the eutrophy of the seas. Chlorophyll-a concentrations showed a weak positive correlation to winter concentrations of nitrogen. Oxygen concentrations in the bottom water were not correlated with any of the other variables and the geographical pattern in hypoxia / anoxia could only be explained by the vertical stratification of the water column.
In agreement with the development in nutrient load, nitrogen and phosphorus concentrations in the Baltic Sea area and the German Bight generally doubled from the late 1960s to the middle of the 1980s. Phytoplankton production and frequency of algal blooms increased, and consequently the silicate concentrations decreased, as did also the transparency and, in stratified areas, the bottom oxygen concentrations. Since the middle of the 1980s phosphorus concentrations have decreased in many estuaries and coastal areas. However, nitrogen concentrations have remained constant or slightly decreased due to variations in run-off. General improvements in biological eutrophication variables are absent or local.
In Arctic waters with very sparsely populated drainage areas, eutrophication from

fish farming in sill fiords is the major threat. However, as location of aquacultural plants is regulated, eutrophication is not an issue of concern in European Arctic waters.
The whole coastal as well as open Baltic Sea is affected by eutrophication with enhanced nutrient concentrations and related problems. The anthropogenic nutrient load is at its lowest in the northern forested and sparsely populated Gulf of Bothnia region. The highest load can be found in estuaries and coastal areas close to rivers that drain agricultural and densely populated areas.
In the Greater North Sea eutrophication primarily affects the coastal zone. In particular, in estuaries and fiords, Wadden Sea, German Bight, Kattegat and eastern Skagerrak, nutrient related problems are widespread.
In the Celtic Seas eutrophication is restricted to the Bristol Channel, Irish Sea and many estuaries, especially the Mersey estuary, Liverpool Bay, Belfast Lough, Cork Harbour, Dublin Bay and associated estuaries.
In the Bay of Biscay and at the Iberian coast eutrophication problems are restricted to estuaries and coastal lagoons, especially Bay of Vilaine, Arcachon, Ria Formosa and Huelva.
In the Mediterranean Sea eutrophication appears to be limited mainly to specific coastal and adjacent offshore areas. Several and sometimes severe cases of eutrophication are evident, especially in enclosed coastal bays which receive elevated nutrient loads from rivers, together with direct discharges of untreated or poorly treated domestic and industrial wastewater. In the Mediterranean Sea, especially the Adriatic, Gulf of Lion and northern Aegean Sea are areas with enhanced nutrient concentrations and related problems. Discharge of untreated or poorly treated wastewater is a major eutrophication problem in the Mediterranean Sea, in addition to nutrient loads from agriculture and aquaculture.

Responses
The Baltic Sea countries have decided on a 50 % reduction in the nutrient load, while the North Sea countries have decided on a 50 % reduction in the nutrient load to areas affected by or likely to be affected by eutrophication. OSPAR countries have designated areas to which a comprehensive procedure should be applied in order to classify the maritime area in terms of problem areas, potential problem areas and non-problem areas with regard to eutrophication. In addition the EU urban wastewater treatment directive, nitrate directive and water framework directive will reduce eutrophication in European waters, and eutrophication sensitive areas are identified by the Member States.

Trophic index and remote sensing
The trophic index and remote sensing of chlorophyll-a concentrations tested in this study have the potential to be developed further into practicable methods for monitoring and assessing the trophic state and trends of European marine and coastal waters.