Nutrient Inputs to the Greater North Sea and the Bay of Biscay and Iberian Coast

MSFD Descriptor: 5 - Eutrophication
MSFD Criterion: 5.1 - Nutrient levels

OSPAR COMMISSION

Key Message Inputs of nitrogen to the Greater North Sea via water and air show a weak downward trend. Waterborne phosphorus inputs have reduced significantly. The decline slowed in the early 2000s but continues. Waterborne phosphorus inputs to the Bay of Biscay and Iberian Coast have decreased but nitrogen inputs have not

Background

OSPAR's strategic objective with regard to eutrophication is to combat eutrophication in the OSPAR Maritime Area, with the ultimate aim to achieve and maintain a healthy marine environment where anthropogenic eutrophication does not occur. The procedure to assess progress towards this objective takes into account the causes, and direct and indirect effects of eutrophication. Enriching the sea with nutrients can lead to eutrophication problems if this results in undesirable disturbances such as excessive growth of phytoplankton (algae), causing oxygen depletion in bottom waters leading to behavioural changes or even death of fish and other species. Elevated nutrient concentrations are thus an important indicator of where eutrophication might occur.

Nutrients, such as nitrogen and phosphorous, enter the marine environment from the atmosphere, rivers, land runoff, or by direct discharges into the sea. Human activities can result in large quantities of nutrients entering the sea (**Figures 1 and 2**). Data from long-term monitoring help scientists to quantify the effects of human activities and evaluate the success of measures taken to reduce nutrient inputs. One of main directions in the OSPAR Eutrophication Strategy is to cooperate to set appropriate nutrient reduction targets for problem areas with regard to eutrophication.

Nutrient emissions are regulated through OSPAR Recommendations and several EU Directives. Atmospheric emissions are also regulated through the UNECE Convention on Long range Transport of Atmospheric Pollution.

This assessment describes nutrient inputs of nitrogen and phosphorus to the Greater North Sea (waterborne and airborne) and the Bay of Biscay and Iberian Coast (waterborne).

Figure 1 (above): Exhaust emissions, including from shipping, are a significant source of atmospheric nitrogen deposition at sea ©Alfvan Beem

Figure 2 (left): Fish farming in Torskefjorden Norway. Open cage fish farms are a source of nutrients to the surrounding waters ©Ximonic/Simo Räsänen

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The full assessment can be found at www.ospar.org/assessments

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Results

There has been a reduction in nitrogen inputs to the Greater North Sea since 1990, but the trend is weak. Nitrogen inputs to the Greater North Sea vary from about 1 400 to 2 000 kilotonnes per year (kt/y). Of this, approximately 500 kt/y is from atmospheric deposition (24–38% of the total). Particularly high nitrogen inputs occurred in 1994, 1995 and 2002, associated with central European flood events. Since 2003, total nitrogen inputs to the Greater North Sea have remained fairly constant at around 1 500 kt/y. Total nitrogen inputs to the Greater North Sea have decreased by about 500 kt/y over 24 years. Of this, approximately 150 kt/y is due to measures taken to reduce atmospheric nitrogen pollution.

Phosphorus inputs to the Greater North Sea have significantly decreased since 1990. Annual phosphorus inputs to this area have halved since 1990 to about 40 kt/y. Prior to 2003, phosphorus inputs varied from 70 to 90 kt/y. Highest inputs occurred in 1995 and lowest in 1996 and 2001. After 2002 phosphorus inputs of around 40 kt/y became typical. Since 2006, waterborne phosphorus inputs have decreased by about 1.5 kt/y. This compares to a rate of decrease of about 2 kt/y for the entire period 1990–2015.

Overall, waterborne nutrient inputs to the Bay of Biscay and Iberian Coast are considerably lower than those to the Greater North Sea, approximately half, and are more variable. Total nitrogen inputs are around 300 kt/y after 2000, although during 2000 they exceeded 500 kt. This is probably due to the extreme floods that occurred in autumn 2000. The minimum observed nitrogen input in 2005 (a year when Portugal did not report data) was approximately 137 kt. Nitrogen inputs are too variable to discern a temporal trend. Atmospheric nitrogen deposition to the Bay of Biscay and Iberian Coast was not assessed.

Phosphorus inputs to the Bay of Biscay and Iberian Coast have declined over the period since 1997. Highest phosphorus inputs occurred, as for total nitrogen, in 2000, and reached nearly 30 kt/y. Since 2004, inputs have been around 10 kt/y, although in the years when Portuguese data are available, this increases to about 12 kt.

Data reporting in the Bay of Biscay and Iberian Coast has been intermittent. The extreme variability in nutrient inputs in this OSPAR region makes a complete dataset important if trends and the impacts of measures are to be determined.

There is moderate confidence in the data used and moderate confidence in the methodology.

Image: Nutrients, such as nitrogen and phosphorous, enter the marine environment from the atmosphere, rivers, land runoff, or by direct discharges into the sea © Lucy Ritchie

Conclusion

Nutrient inputs to the Greater North Sea have decreased significantly since 1990. Total nitrogen inputs to the area are variable, but have decreased significantly. Reduced emissions of nitrogen to air have led to a reduction of about 150 kt/y in atmospheric nitrogen inputs. Changes in the proportion of nitrogen to phosphorus entering the Greater North Sea may affect algal community diversity.

Phosphorus inputs to the Greater North Sea are less variable than nitrogen and the significant reduction in input is particularly obvious. Since 2000, phosphorus inputs have roughly halved to about 40 kt/y. The greatest changes occurred between about 2000 and 2005, although further significant input reductions have occurred since 2006.

Riverine inputs to the Bay of Biscay and Iberian Coast are strongly affected by regional flood events. Furthermore, the time series of available data is shorter than for the Greater North Sea and recent reporting is less complete, making it difficult to draw conclusions on trends. However, phosphorus inputs between 1997 and 1999 were typically about 20 kt/y, while phosphorous inputs of about 13 kt/y are now found. Analyses show a statistically significant downward trend in phosphorus inputs to the Bay of Biscay and Iberian Coast, but not for nitrogen.

Knowledge Gaps

Nutrient input assessment is based on a combination of observations, statistical analyses and dynamic numerical models. Observations of river flow and chemical concentration could be improved by increasing measurement frequency, particularly under high flow conditions. Assessing nutrient inputs from unmonitored areas is dependent on high quality reporting from industry and agriculture and modelling tools adapted to local conditions. Atmospheric input estimates and pathways are sensitive to model resolution and could be improved, for example by data assimilation and more detailed emissions data. Atmospheric phosphorus deposition is effectively unknown, with no observations over the sea, few observations over land and no operational modelling.

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