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To end the eutrophication of the Baltic Sea: Do the measures show effects?

Between 1995 and 2014, river discharges of the two main drivers of eutrophication, nitrogen and phosphorus, were significantly reduced in the western Baltic Sea. But are these measures also having an effect in the open Baltic Sea? The marine chemists of the Leibniz Institute for Baltic Sea Research Warnemünde (IOW) have not yet found any clearly discernible changes there. In a recently published study, they report on a method they used to track the fate of nutrients from river mouths into the Baltic Sea. They show: Yes, the reductions in river discharges are also detectable in the Baltic Sea, but they are compensated by discharges from other sources.

Let us imagine the Baltic Sea as one big pot of soup, to which many cooks have contributed. The soup is spoiled, but which cook is responsible? Once the spice is in the pot, it mixes with all the ingredients, so that it is no longer possible to tell, who the culprit was who put it there. This is also the problem the marine chemists at the Leibniz Institute for Baltic Sea Research Warnemünde are facing, when they want to find out, whether measures to reduce nutrient discharges via the rivers into the open Baltic Sea are effective. Between 1995 and 2014, the nitrogen load into the western Baltic Sea was reduced by a total of 40,000 tonnes and the phosphorus load was reduced by 1,000 tonnes in this period. The nutrient concentrations measured in the open Baltic Sea, however, still show no improvement.

Recently, a team led by Joachim Kuss, a marine chemist from Warnemünde, Germany, evaluated for the first time a dataset of more than half a million data in order to trace the effects of the nutrient reduction measures. They took advantage of the fact that the rivers ultimately leave their mark in the sea by reducing the salinity of the Baltic Sea water. As expected, the nutrient concentrations generally decreased with growing distance from the river mouth and increasing salinity. Moreover, the large amount of data available to the scientists for the period 1995 – 2016 also enabled them to work out that the way, the ratio of nutrient concentration to salinity changes on the route between the coast and the open sea, did not remain the same but changed during the period under investigation: This made the reduction in nutrients visible!

And this data analysis approach revealed even more information: While the scientists could detect a particularly good correlation between salinity and nitrogen components, the phosphorus levels showed only a week dependency on salinity. This underlines the fact that nitrogen levels are significantly linked to river water input, whereas phosphorus is clearly also derived from internal sources in the Baltic Sea.

To obtain significant information on the temporal decrease of phosphorus components, which are undoubtedly also discharged via rivers in significant amounts, and to improve the data basis for nitrogen, the IOW data set was extended by the measurement results of the state authorities from the coastal area, the State Agency for Environment, Nature Conservation and Geology, Mecklenburg-Western Pomerania, and the State Agency for Agriculture, Environment and Rural Areas, Schleswig-Holstein.

On the basis of this augmented data pool, the effects of the diverse processes that affect nutrients in the transition region between fresh and salt water could be well identified: Organisms take advantage of the favourable nutrient situation and form blooms. As a result, nutrients are removed from the water and converted into organic matter. The dying bloom sinks to the sea floor, where it is decomposed by microorganisms. These make an ambivalent contribution to nutrient reduction, as they convert reactive nitrogen components into inactive elemental nitrogen. This is an important positive effect regarding the nitrogen balance, but can be harmful for the phosphorus balance: During the decomposition of organic matter, oxygen is consumed. If the shallow water of the transition area is well mixed by wind and waves, this is not critical. In calm weather conditions, however, “dead zones” with little or no oxygen can form on the sea floor. Phosphorus compounds, which are stored in the sediment under good oxygen conditions, are then released and increase the phosphorus content in the water.

“At present, oxygen deficiency situations are becoming more frequent in coastal waters,” explains the leading author Joachim Kuss. “Therefore, phosphate pollution of the western Baltic Sea currently appears to be the primary problem. However, this should not mask the fact that it is also the introduced nitrogen compounds that ultimately lead to oxygen deficiency and the reactivation of old phosphorus deposits in the sea floor. There is still a need for action to reduce both nutrients”, Kuss concludes.

Original scientific publication with detailed results:

Kuss J., Nausch G., Engelke C., Weber M., Lutterbeck H., Naumann M., Waniek J. J. and Schulz-Bull D. E. (2020): *Changes of Nutrient Concentrations in the Western Baltic Sea in the Transition Between Inner Coastal Waters and the Central Basins: Time Series From 1995 to 2016 With Source Analysis.* (Frontiers in Earth Science 8:106. doi: 10.3389/feart.2020.00106)

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The data sets provided by the IOW were collected within the framework of the HELCOM monitoring on behalf of the Federal Maritime and Hydrographic Agency.

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