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Are coastal North Sea sediments an efficient filter for anthropogenic nitrogen?

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Coastal oceans like the North Sea and German Bight nowadays receive very high amounts of surplus nitrogen from anthropogenic sources such as rivers or atmospheric deposition. The subsequent removal of these excess nutrient loads hence is a critical feature of coastal and marine sediments, with the strong potential to alleviate negative eutrophication phenomena.

However, massive dredging of riverine and estuarine sediments and a long history of diverse anthropogenic pressures can potentially alter this natural filter function of marine/coastal sediments, and we accordingly aimed to quantify denitrification along a gradient from the Elbe River estuary to the German Bight and North Sea.

In a joint approach, we measured natural and potential denitrification rates along a gradient from the Elbe estuary to the Wadden Sea and further off-shore sediments. We used both in situ and incubation techniques, aiming to quantify natural and potential rates of denitrification. Based on our data, we also tried to unravel the influence of different factors that limit denitrification. A statistical data analysis suggests that TOC and water column nitrate are main controlling factors, with surprisingly little influence of oxygen penetration depth.

We find that bulk N_2 production is largely fuelled by coupled nitrification-denitrification, with an equivalent of 19-43% of the Elbe River nitrate load being removed via this process in spring and summer. In contrast, the direct removal of nitrate from the water column is of subordinate role. Overall, our results show that the sedimentary filter function is only able to remove small portions of anthropogenic nitrogen entrained to the coastal North Sea along the coastal strip. An extrapolation of rates to different natural sediment types and their respective areas suggests that $\sim$ 2-3 kt, representing 5% of the spring/summer nitrate load of the Elbe River, are removed in the near-shore region. This accordingly leaves a vast amount of surplus nitrogen in the water column available for processes that further fuel eutrophication of the coastal zone.