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Nitrogen retention, removal, and nitrous oxide production in the Elbe Estuary

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The Elbe River, an important tributary to the coastal North Sea, is subject to massive anthropogenic pressures from, for example, fertilization and dredging of the river and its estuary. Despite clear improvements in nutrient loads, we find that these changes have impacted the river's capacity to cope with surplus inputs of nutrients.
Based on measurements of nitrate stable isotopes and N2O concentration profiles, we investigated the estuarine capacity of nitrogen retention and denitrification, and compared it to the situation several decades ago. A combined water-column and sediment-based approach suggests that the denitrification capacity has decreased significantly to no more than 5-10% of summer nitrate loads, while nitrate regeneration via nitrification has in turn gained in importance. Active biogeochemical nitrogen cycling, seems to be almost exclusively restricted to the deeper areas of the port of Hamburg, where deepening of the riverbed has led to immense recycling activity.
Overall, we find that the remineralization and oxidation of organic matter dominates the riverine N-budget. This is apparent in stable isotope signatures in the estuary and the limnic water sections, for which we calculated relative ratios of denitrification and nitrification. This shift from denitrification to nitrification is also mirrored in the production of nitrous oxide, which, despite improved nutrient status of the river and estuary, remained high. In combination, our data suggest that high loads of dissolved inorganic nitrogen and nitrous oxide production are a legacy of the past eutrophication period, and of enhanced upstream primary production.