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The nitrogen cycle of the Baltic Sea from an isotopic perspective

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Stable nitrogen isotope ratios (^{15}N/^{14}N; δ^{15}N) were determined in sediments, suspended matter and water at selected sites in the Baltic Sea area in order to set up a source budget and trace the fate of anthropogenic N-sources. Sediments of the shallow near-coastal area of the southern and eastern Baltic Sea have an average δ^{15}N of 7.3$\pm$2.1$\permil$, interpreted as a characteristic trace of residual anthropogenic nitrogen delivered by rivers and diffuse runoff. In contrast, δ^{15}N values in sediments deposited in the basins of the central Baltic Sea are depleted (average δ^{15}N of 3.5$\pm$0.6$\permil$), indicating a significant contribution by diazotrophic cyanobacteria. Statistical analysis of long-term nutrient data (1969-2001) indicates no increase in nitrate concentrations in the central Baltic Proper, where only phosphate concentrations have increased. The physical circulation pattern and the enthalpy, as derived from a circulation model, show a closed circulation cell in the Baltic Proper with limited transport of riverine material into the basins and elevated temperatures in the Baltic Proper. Together, the isotope and nutrient data suggest that eutrophication by riverine nitrogen is pronounced in the coastal rim of the Baltic Sea, and that coastal sediments appear to be very efficient in removing riverborne nitrogen by denitrification. A nitrogen isotope mass-balance model suggests that N-loss by sediment denitrification and N-input by N-fixation can be as high as 855 ktonsN a^{-1}.