

Present and past nitrogen turnover in the Danube estuarine transition zone

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The Danube Delta – Black Sea shelf region has overall received dynamic nutrient loads from the River Danube that rose to critical levels in the 1970s and 1980s but decreased sharply in the 1990s due to the collapse of eastern European economies. However, nutrient release from organic rich sediments retarded the recovery of the ecosystem for another decade. During two cruises in 2012/2013 in the Danube estuarine transition zone, we analyzed nutrients, dual isotope signatures of nitrate, and $\delta^{15}\text{N}$ of suspended particulate matter across the salinity gradient. Water column data were complemented by a series of short sediment cores. Nutrient concentrations in surface waters indicate intense drawdown and complete uptake of river-borne nitrate, phosphate, and dissolved silica in the river plume. Isotopic patterns of nitrate and suspended N illustrate clearly the dominance of nitrate assimilation over the entire salinity gradient until turnover is completed, highlighting the River Danube as a point source to a now nutrient starving system. However, spatial and temporal patterns in sedimentary $\delta^{15}\text{N}$ witness the shift from past severe eutrophic conditions to the currently recovered ecosystem. A temporary significant role of nitrogen fixation, as a consequence of excess phosphate, is evidenced by a depth decrease of sedimentary $\delta^{15}\text{N}$ values in the outer plume. Isochronous time-slices imply a two endmember mixing of this isotopically depleted nitrate with isotopically enriched riverine nitrate. Overall, data quality is remarkably good and all N species exceptionally clearly illustrate the isotopic coherences that characterize the present and the past nitrogen turnover.