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Nutrient and carbon dynamics along the river-estuary-ocean continuum on Central European scale

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Nutrient and carbon dynamics within the river-estuary-coastal water systems are key processes to understand the matter fluxes from the terrestrial environment to the ocean. In a large-scale study we analysed those dynamics with the focus of the prevailing low water conditions by following a sampling approach based on the travel time of water.

We started with a nearly Lagrangian sampling along the River Elbe (German part; 580 km within 8 days travel time). After a subsequent investigation of the estuary, the plume of the river was followed by raster sampling the German Bight (North Sea) using three ships simultaneously. In the river, intensive growth of phytoplankton was determined connected with high oxygen saturation and pH values as well as under-saturation of CO_2, whereas concentrations of dissolved nutrients declined. In the estuary, the Elbe shifted from an autotrophic to a heterotrophic system: Phytoplankton died off upstream of the salinity gradient causing minima in oxygen saturation and pH, supersaturation of CO_2, and a release of nutrients. In the coastal region, phytoplankton and nutrient concentrations were low, oxygen close to saturation, and pH in a typical marine range. We detected a positive relationship between pH values and oxygen saturation and a negative one between pCO_2 and oxygen saturation. Corresponding to the significant particulate nutrient flux via phytoplankton, flux rates of dissolved nutrients from the river into the estuary were low and determined by depleted concentrations. In contrast, fluxes from the estuary to the coastal waters were higher and the pattern was determined by tidal currents.

Overall, the presented observation approach is appropriate to better understand land-ocean fluxes, particularly if it is performed under different hydrological conditions including extremes and seems to be suitable to investigate the impact of such events in freshwater on coastal systems in future.

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