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Nutrient concentrations and transport at Pan-European scale – from 1900s to 2050s

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Nutrient transport models are important tools for large scale assessments of macro-nutrient fluxes (nitrogen, phosphorus) and thus can serve as a support tool for environmental assessment and management. Here, we present results from the pan-European rainfall-runoff and nutrient transfer model E-HYPE, which is based on open data sources. We illustrate the model usefulness for trend analyses and demonstrate its value in evaluating watershed changes both in the past and in the future.

An integrated dynamic model like E-HYPE allows us to investigate impacts of not only climate change but also impacts of other societal and economic changes that occurred in Europe such as land use and its management, population and its waste water handling, and atmospheric deposition. E-HYPE was used to quantify these impacts for three time periods: 1900s, current time period, and 2050s. This was accomplished by changing the model input data to match relevant conditions for each time period.

The future conditions were evaluated within the framework of Shared Socio-economic Pathways (SSPs) that define alternate futures along distinct narratives. We have selected three of the five SSPs: sustainability, middle of the road, or fossil-fuel development. The impact of selected nutrient abatement measures was also illustrated for current and future conditions in a number of scenarios for the Baltic Sea. An ensemble of 4 climate models that preserves the range of projected changes in precipitation and temperature from a larger ensemble was selected for this analysis. A complete evaluation of the impact of this selection was conducted on selected rivers.
The results show spatial patterns in nutrient concentrations in rivers across Europe as well as total nutrient transport carried from these rivers to adjacent seas and their changes. These can be used to further our understanding of nutrient issues across the European continent and their changes in time. We show that societal changes can have a far more significant impact on nutrient loads than individual mitigation measures.

Another way we used E-HYPE to detect temporal trends across Europe was to examine monitoring data from several national data bases along with the model results. Analyzing residuals between model results and observations together with the observed data provided additional insights into the causes of the trends detected in observed data and their relation to trends in climate data. These results were compared with previous reports from local and regional studies.