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Pan-European modelling of riverine nutrient concentrations – spatial patterns, source detection, trend analyses, scenario modelling

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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 support tool for environmental assessment and management. Results from model applications over large areas, i.e. from major river basin to continental scales can fill a gap where monitoring data is not available. Here, we present results from the pan-European rainfall-runoff and nutrient transfer model E-HYPE, which is based on open data sources. We investigate the ability of the E-HYPE model to replicate the spatial and temporal variations found in observed time-series of riverine N and P concentrations, and illustrate the model usefulness for nutrient source detection, trend analyses, and scenario modelling.

The results show spatial patterns in N concentration in rivers across Europe which can be used to further our understanding of nutrient issues across the European continent. E-HYPE results show hot spots with highest concentrations of total nitrogen in Western Europe along the North Sea coast. Source apportionment was performed to rank sources of nutrient inflow from land to sea along the European coast. An integrated dynamic model as E-HYPE also allows us to investigate impacts of climate change and measure programs, which was illustrated in a couple of scenarios for the Baltic Sea.

Comparing model results with observations shows large uncertainty in many of the data sets and the assumptions used in the model set-up, e.g. point source release estimates. However, evaluation of model performance at a number of measurement sites in Europe shows that mean N concentration levels are generally well simulated. P levels are less well predicted which is expected as the variability of P concentrations in both time and space is higher. Comparing model performance with model set-ups using local data for the Weaver River (UK) did not result in systematically better model performance which highlights the complexity of model structure and input data interaction but also the potential of open data for large scale nutrient modelling.

Monitoring data from several national data bases were examined along with the model to detect temporal trends across Europe. Residuals between model results and observations indicate both positive and negative trends in nutrient concentrations in European rivers. These results were compared with previous reports from local and regional studies.