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Agricultural crop choices offsetting positive effects of long-term P emission control measures in Austria

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Despite decades of awareness of the crucial role played by phosphorus (P) emissions in triggering eutrophication, and despite the implementation of diverse remedial measures, P impairment of surface waters still represents a worldwide concern. European countries, for example, have made substantial progresses, but a considerable number of water bodies still fail to achieve the good ecological status defined by the Water Framework Directive owing to high P concentrations. This is primarily attributable to legacy P inputs, inadequate agricultural practices, and climate fluctuations. It is thus of crucial importance to provide decision makers with reliable modelling tools, which allow identifying the contribution of distinct sources and pathways to total P emissions, thus assisting the interpretation of monitoring data and the assessment of alternative management strategies. The semi-empirical model MONERIS (Modelling of Nutrient Emissions in River Systems) was conceived to offer such a tool for river basin management. It shows a relatively high accuracy in estimating yearly nutrient river loads, with mean deviations from observed loads ranging between 15% and 35%, which approximately equal the intrinsic error expected in observed loads. Nevertheless, in view of its role as policy-support tool, its robustness and reliability in delivering predictions also need to be investigated.

In such context, this contribution addresses the following research questions: i) how does MONERIS perform in depicting temporal changes of in-stream P concentrations? and ii) can specific causes of temporal changes of in-stream P concentrations be identified? Since future scenarios cannot be employed for such assessment, this work utilizes the analysis of past trends. Concretely, it compares the results of statistical trend analysis of measured in-stream total phosphorus (TP) concentration in three river catchments and in their sub-catchments located in Upper Austria for the period 2001-2014 with concentrations and trends modelled with MONERIS. The results show that the model correctly depicts both the existence of significant increasing trends (4–5 μg TP L-1y-1) and the lack thereof (<0.1 μg TP L-1y-1) in different sub-catchments, although it systematically underestimates the trends magnitude. Further, in combination with an optimized data management system, the model has allowed identifying the probable cause of such increasing trends. Upper Austria has undertaken considerable efforts to reduce P point discharges through wastewater treatment and it has successfully implemented a long-lasting agri-environmental programme aimed to decrease diffuse emissions (-7% TP emissions through cover crops and minimum tillage). However, changes in land use (contraction of grassland) and in cultivated crops, i.e. more maize, maize silage and soybeans, have led to an offsetting increase of erosion-driven emissions (+15% TP emissions). This conclusion consistently holds also when considering uncertainty in key model parameters. Further, an alternative hypothesis that would explain such increase through changes in the discharge regime was rejected based on trend statistical analysis.

In conclusion, this work presents MONERIS as a powerful tool to depict trends and to predict the effect of changes in the catchment on in-stream water quality. Further, it puts forward the adequateness and the necessity of combining trend analysis, emissions modelling and input data assessment to correctly identify causal relationships.