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Concentrations of various Phosphorus forms along the river Warnow and its catchment

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In the environment, phosphorus (P) occurs in various forms: dissolved, particulate, organic and inorganic P. During the transport from source to sea P undergoes transformation processes from one form into the other.
In this study temporal and spatial changes of the P-forms along the river Warnow (low land river in northern Germany) were analysed to gain further information about origin, transformation, retention or export of P along the river course and to estimate the P loads and their eutrophication potential for the subsequent brackish Unterwarnow discharging into the Baltic Sea.
Surface water samples were taken monthly over a year period from August 2016 to August 2017 at nine stations along the river Warnow and at six stations of selected tributaries to cover the river catchment. Particulate and dissolved P fractions were separated by filtration through GFF-filters. In our river water analyses inorganic and organic P could not be distinguished by the molybdenum blue method. Therefore, we used the terms reactive and non-reactive P according to their behaviour in this method. Subsequently P has been classified into the following fractions: dissolved reactive (DRP), dissolved nonreactive (DNP), particulate reactive (PRP) and particulate non-reactive (PNP).
Under dry weather conditions in summer and autumn 2016 the P composition varied strongly between the different river sections, even if the concentration of total P (TP) was similar along the whole river. In contrast, in summer 2017 which was dominated by rainy weather and therefore high water discharge, the concentration of the single P fractions was more homogenous along the river course. In both years the dissolved P forms dominated during the summer months. During autumn 2016, the percentage of PNP increased and became the dominant fraction in the subsequent winter and spring 2017 when TP and DRP concentration were low. Corresponding chlorophyll showed high concentrations from October to December 2016 and from March to May 2017. In the catchment area marked differences in the P composition occurred between the single tributaries to the Warnow. Riverine lakes, like the lake Barnin which is traversed by the Warnow, may act as source for DRP and PNP during the summer months.
The results show a high variability of P concentration and composition and subsequent a variation in P export from the Warnow catchment, which would not be visible by TP and DRP monitoring alone. A detailed knowledge of the P fractions is necessary for a deeper understanding of P transport and transformation processes along the river flow path. This detailed information forms the basis for further in stream management strategies which are needed to cope with eutrophication.