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High frequency turbidity as a proxy for total phosphorus: application in a mixed land use catchment in Sweden

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Surface water eutrophication resulting from excessive phosphorus (P) input is one of the most challenging water issues of today. Total phosphorus (TP) concentrations have high temporal variability, which makes the parameter hard to monitor adequately. We explored the possibility of using high frequency turbidity as a proxy for TP in Sävjaån, a stream in a mixed land use catchment in Sweden. An in situ sensor (YSI 600OMS VS) monitoring turbidity every 10^{th} minute, was situated close to the outlet of Sävjaån during 2014 and 2015. In situ and grab sample turbidity measurements were highly correlated (linear regression, r^2=0.90). The maximum turbidity concentration measured by the sensor was at most 13 times higher than the highest concentration from the grab samples. The average turbidity concentration from the two methods was close to similar, as well as the Ecological Quality Ratios (EQR) calculated from the two data sets. The correlation between TP and high frequency turbidity was very high (r^2=0.79) and between TSS and turbidity high (r^2=0.67). When comparing load estimations from the high frequency data with monthly grab sampling and linear interpolation, the high frequency load was 7 % smaller in 2014 and 17 % larger in 2015. In 2014 the monthly grab sampling caught peaks in TP concentration, which with linear interpolation affected the nearby months and furthermore the yearly load. However, in 2015 peaks in concentration were overlooked when using grab sampling, which gave a larger yearly load when using the high frequency data. Season and flow intensity may affect the relationship between turbidity and TP, however this could not be statistically proven in this study. The proxy relationship could also result in uncertainties tied to unexplained diurnal variations of turbidity, proportion particulate bound P or hysteresis. Uncertainties arising from the use of sensors (e.g. sensor calibration and spatial representation) must as well be recognized. To successfully understand the site specific relationships between turbidity and TP we need to investigate these uncertainties. The results from the study will be used for further exploring potential of sensor technology in environmental monitoring. Specifically, we are exploring the use of sensors to support long term water quality monitoring and better estimate phosphorus load for regulatory water quality assessment.

Keywords: High frequency monitoring, in situ sensor, surrogate measurements, total phosphorus, turbidity, load estimations