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Surrogate water quality monitoring in four distinct sub-catchments in central Germany

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It is well known that a good evaluation of surface water quality is depending on the number of assessed parameters and their sampling frequencies as well as their spatial distribution. High frequency field measurements of wide range of environmental parameters are still costly and time consuming. Consequently, techniques that use surrogate data for estimating some grab sampled parameters from continuously monitored descriptors are more practical and are increasingly adopted to inform water resources management. The aim of this study was to develop a surrogate monitoring method to continuously estimate instream sediment, carbon, nitrogen and phosphorus concentrations as well as ions contributions based on commonly available high resolution measurement of turbidity (Turb), discharge (Q), electrical conductivity (EC), nitrate-N concentration (NO_3-N) and specific adsorption coefficient (SAC). To this end, high frequency data (15 min interval) were collected during three years period at the UFZ-TERENO platform in Bode catchment (Terrestrial Environmental Observatories). Surrogate models were analysed for suspended sediment concentration (SSC), particulate organic carbon (POC), total organic carbon (TOC), dissolved organic carbon (DOC), particulate nitrogen (PN), total nitrogen (TN), particulate phosphorus (PP) and different ions contributions ( ) using simple and multiple linear regression models. They were developed in four distinct (in terms of size, dominant land use, and topography) sub-catchments. The available data sets were divided into two years (2010-2012) calibration and one year (2012-2013) validation periods.
Results revealed that the Turb, Q and EC were the most predictive variables. For all gauging stations, the SSC could be explained using simple linear regression model by the Turb with a lowest correlation coefficient of 0.93. The non-uniqueness of the obtained simple linear models between the different sub-catchments reflected the sensitivity of the Turb signal to the size of particles and catchment geographical characteristics and roughness. Best predictions of POC, TOC, PP, TP and PN were achieved when multiple linear regression models were used including Turb, Q, EC and NO_3-N as predictor variables (lowest correlation coefficient is 0.60). The ion contributions were reconstructed reasonably well when the Turb and EC were considered (lowest regression coefficient is 0.74). Results showed that the SAC together with the Turb and Q are good surrogates for the DOC concentration (lowest correlation coefficient is 0.60).
The developed methodology provides a cost-effective technique to obtain continuous, reliable and long-term estimates of water quality status. Also, the results are beneficial to water managers who are charged with the determination of attainment or exceedance of water quality standards.