Geophysical Research Abstracts
Vol. 20, EGU2018-13649, 2018
EGU General Assembly 2018

Non-stationarity in relationships between flow, turbidity and suspended sediment transport: examples from a Swedish mixed-land use catchment

Emma Lannergård, Jens Fölster, and Martyn Futter
Swedish University of Agricultural Sciences, Aquatic Sciences and Assessment, Uppsala, Sweden (emma.lannergard@slu.se)

The relationship between turbidity and sediment transport is complex and interactions between different drivers over different spatial and temporal scales are poorly understood. Since high frequency turbidity measurements from in-situ sensors are increasingly used as a proxy for water quality parameters including suspended sediments and total phosphorus, a better understanding regarding the nature of and controls on these relationships is needed. Here, we use a combination of flow, sensor and laboratory measurements to evaluate non-stationarity in the relationship between turbidity and suspended sediments and to explore hysteresis in the flow:turbidity relationship.

While it is well established that site specific relationships are needed to link turbidity and water quality parameters, the within-site variation in these relationships is less well understood. Here we present results from a 5 year sampling campaign (2012-2017) including all seasons conducted at a mixed land use catchment in central Sweden. The data set represented 85 % of observed discharge rates between 1979 and 2017, and included a 50-year flow event in spring 2013.

There was a non-linear relationship between laboratory measurements of suspended sediment and turbidity. Correlations between these parameters varied with season, with the highest values in the summer and autumn and lower values in winter and spring. There was much better relationship between sensor-measured turbidity and suspended sediment when observations were made on the rising limb of the hydrograph (r2=0.85) versus the falling limb (r2=0.08).

While catchment properties like soil type and topography constrain soil erosion and the manner in which the sediment is mobilized within a catchment, rainfall and snowmelt are examples of first order drivers. We used a multivariate approach to explore the drivers of hysteresis in flow:turbidity relationships. Twenty-four storm events were included in the analysis. Principal Component Analysis (PCA) was used to relate parameters connected to the storm events (hysteresis characteristics, season, duration of storm, amplitude of discharge and turbidity, mean discharge, mean turbidity) to potential direct and indirect drivers e.g. rainfall, snowfall, snowmelt, average snow depth, soil moisture and temperature.

We found that the winter season was connected to anti-clockwise hysteresis patterns, indicating a slow response of the system. This could be related the fact that frozen/thawing soil needs more energy to mobilize particles than ice free soil. While most of the events had a clockwise pattern the 50-year flow event showed an anti-clockwise pattern. This could indicate a larger connectivity in the catchment during this time and that other flow paths were activated. Despite the decline in flow (50 m3/s to 1.6 m3/s) the turbidity remained high.

Our results illustrate the importance of ongoing laboratory analyses and data exploration for validation of proxy relationships and for understanding catchment processes on the basis of high frequency in-situ measurements.