Muddying the Waters: Using Sediment Fingerprints to Constrain POM Sources Under Diverse Hydrologic Conditions

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Sediment fingerprinting techniques are increasingly employed to characterize sediment sources and transport processes across a range of environmental and hydrologic conditions. However, consensus on how best to apply these physical and biogeochemical fingerprints— particularly with respect to particulate organic matter (POM) sources and transport— remains elusive. We used multiple sediment fingerprinting approaches to understand how individual sediment source contributions influence the patterns of suspended sediment particle characterisitics and organic matter contents observed across a wide range of hydrologic conditions. Suspended sediments collected during 16 storms ranging in size from small events to large hurricanes in the White Clay Creek sub-catchment of the Christina River Basin Critical Zone Observatory (Pennsylvania, USA) showed significant declines in mineral (BET) surface area, POC, and PON content with increasing discharge ($p < 0.0001$ in all cases). The greatest declines in BET surface area and organic matter content occurred during Hurricanes Sandy, Irene, and Tropical Storm Lee. $\delta^{15}N$ values of PON also decreased significantly with increasing discharge ($R^2=0.22$, $p=0.0068$), suggesting additional contributions of PON from terrestrial plants, forest soils, and/or in-stream sources during higher flows.

Results of suspended sediment fingerprint analyses indicated varying sediment source contributions along the hydrograph during individual storms. However, identification of individual sources was highly influenced by the particular suite of physical and biogeochemical predictors that were included in the analysis, pointing to a potentially important limitation of the sediment fingerprinting approach. We will address the selection of sediment fingerprint predictors for POM source characterization and discuss some of the challenges facing the application of sediment fingerprinting techniques for understanding POM source and transport dynanmics at the catchment scale.