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Effects of connectivity within a river corridor on storm-pulse fluvial particulate organic carbon

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Agricultural conversion of natural watersheds often increases the landscapes' water drainage, soil erosion and lateral transport of particulate organic carbon (POC) via rivers, all exacerbated during storm events. Across various catchment scales, the compositional dynamics of fluvial POC during storms are not yet well-understood due to few studies having adequately high resolution sampling to capture intra-event dynamics. For small, low-gradient agricultural streams, a conceptual model describing the sequential introduction of in-channel and landscape-derived POC source signals has been developed in recent studies based on high resolution storm event data, but the question remains as to whether the model is applicable when catchment size is scaled up.

This study investigates storm response dynamics of fluvial POC in a 5th order stream network using high spatiotemporal-resolution sampling and makes comparisons to a conceptual model developed for a 3rd-4th order stream network. Samples were collected over three storm events from five sampling stations that encompassed tributary, main river stem, and tile drainage water networks within the agriculturally-dominated Upper Sangamon River Basin (USRB), Illinois. POC was chemically characterized using elemental and stable isotope analyses.

Results indicate POC dynamics within the USRB act outside the conceptual framework, likely due to landscape processes. Based on the model, we hypothesized the main stem of the USRB would display high levels of POC source signal integration, attenuated early flush peaks and discharge-dependent POC concentrations. However, distinct time-resolved POC source inputs were determined throughout the watershed, along with high organic content, presence of early flush peaks, and little to no correlation between discharge and POC concentrations. Through a combination of natural and anthropogenic landscape features, the USRB experiences low connectivity between hillslopes and channels. Thus, our results suggest most of the storm-mobilized POC within the river is derived from near-channel sources and that the system is filtering eroded particles such that lower density, organic-rich materials are preferentially transported to the channel. The near-channel dominance and source filtering is not consistent with the model-predicted dominance of integrated upstream sources. The results demonstrate the importance of landscape-river connectivity when interpreting POC storm response and evaluating the applicability of generalized model behavior.