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Floodplain Processes Impacting Water Quality and Nutrient and Metal Export

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The advances derive from a combined effort of field observation, laboratory experimentation, and integrative modeling focused on assessing how biogeochemical processes in floodplain soils and sediments impact the release of carbon, nutrients, and metals to the river. In order to measure the effect of spring snowmelt (a major annual hydrologic forcing event in the system) on nutrient and metal release from sediments we installed a transect of depth-resolved piezometers across Meander C, parallel to an existing transect of piezometers. Water was collected from both transects from peak river discharge (June 2017) through the falling limb (October 2017) at high temporal resolution (every 3-7 days). Strong temporal trends correlated to river stage were observed for DOC and dissolved Fe as well as other nutrient and metal species. In some locations, strong correlations between Fe and trace contaminants (e.g., As) were also observed, emphasizing the link between redox processes and contaminant release. In addition, we tracked elemental concentrations and isotopic compositions of surface and subsurface water and gas through punch probe sampling at key stages of the hydrograph. These data were more spatially extensive than the piezometer data, being collected at multiple locations across the floodplain and stream bed hyporheic zone. In addition, we instrumented a 2nd floodplain site (Meander Z) to allow for future comparisons with the Meander C location. To complement the field efforts, laboratory batch incubation experiments were conducted with sediment from selected depths from Meander C transects under site-specific redox conditions. Results revealed that DOC plays a key role in metal mobility significantly enhancing Fe(II) solubility through the formation of DOC-Fe(II) complexes which dominate Fe(II) aqueous speciation. Field and laboratory data were used to constrain two distinct but complementary modeling efforts, a vertical streambed hyporheic zone model that included microbial and flow feedback dynamics as well as a lateral cross-meander 2D reactive transport model. The stream bed hyporheic zone model suggested that the hyporheic zone can serve many roles throughout the year, as a net source and sink for nutrients, and that the dynamics are strongly forced by the size of the snowpack. The cross meander simulations indicate that low water conditions following high water conditions caused subsurface exports of inorganic and organic carbon, nitrogen, and iron to increase up to 91%, 63%, 75%, and 61%, respectively, further emphasizing the important role of transient hydrologic conditions on floodplain and hyporheic zone biogeochemical processes.