SLAC Groundwater Quality SFA: Preferential Mobilization of Nutrients Driven by Distinct Forms of Inundation on a Semi-Arid Floodplain

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Project: SLAC Groundwater Quality SFA (John Bargar)

Project Website: https://www-ssrl.slac.stanford.edu/sfa/groundwater-quality-science-focus-area

Project Abstract: Floodplains are a central link in the transfer of nutrients between landscapes; they can retain, transform, or release nutrients as solutes move between the terrestrial and riverine ecosystems. In arid and semi-arid environments, seasonal floods are short-duration events that have an outsized impact on the annual flux of nutrients between these two systems. Though flood frequency and duration are often considered the most important factors in determining floodplain nutrient fluxes, other elements of inundation – especially the source of inundated water – play a role as well.

To examine the relative impact of each of these factors, we monitored porewater solute concentrations during multiple types of inundation events on a semi-arid floodplain in Riverton, WY. Observations from the site over the 2017, 2018, and 2019 field seasons show that the Riverton floodplain experiences two main drivers of inundation: water table rise and surface ponding. In an inundation event driven by water table rise, rising river stage increases hydraulic head such that the water table within the floodplain rises to the surface. By contrast, in an inundation event driven by surface ponding, water pools up on the surface during intense precipitation, then percolates downward through the vadose zone to the water table.

Surface ponding events result in limited downward flushing of vadose zone nutrients, as water percolating through the unsaturated zone flows primarily along preferential flow paths. Water table rise events, on the other hand, result in complete saturation of the soil profile, but may or may not flush nutrients from the vadose zone, depending on the composition of the inundated water. Our results suggest that monitoring flood frequency and duration is not adequate for understanding subsurface response to inundation events; other factors – including antecedent soil moisture, the driver of inundation, and the composition of inundated water – need to be taken into account for a complete understanding of floodplain nutrient fluxes.