Linking River Corridor Processes and Watershed Zonation through Concentration- Discharge (C-Q) Analysis

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Project Abstract:
River corridor systems in snow-dominated, mountainous regions often express complex biogeochemistry and river water nutrient indicators as a function of watershed characteristics. River corridors host important subsystems for solute and nutrient processing at fine scales yet can have major impacts on large scale watershed exports as revealed by concentration-discharge (C-
Q) and export-discharge (E-Q) time series where export is defined as the mass flux of solutes. C- Q and E-Q statistical relationships can be built from surface, subsurface, and snowmelt compartments of the watershed. C-Q and E-Q statistical relationships offer critical insights into how watersheds respond to a range of snow scenarios and often display diagnostic patterns within a watershed network, such as clockwise or counter-clockwise hysteresis patterns. In this work we utilize daily C-Q and E-Q time series datasets, both measured and modeled, from our WFSFA 5- year time series of water quality and discharge data to capture interannual variability in climate conditions. Longer term historical USGS data is also used to analyze single-station and multi- station relationships across a range of watershed scales characterized by different watershed zones (i.e., patterns of watershed characteristics based on geology, vegetation). Efforts are underway to develop novel differential C-Q approaches that can characterize spatial variability in solute behavior, including methods to link watershed zonation patterns to C-Q and E-Q relationships. Additionally, we are utilizing a data-rich modeling approach with both subsurface, hyporheic, floodplain (i.e. MIN3P, PFLOTRAN) and large scale integrated hydrologic models (ParFlow- CLM) to investigate how river corridor subsystems, and large-scale hydrologic flow paths contribute to C-Q and E-Q relationships.

Results demonstrate significant differences in solute behavior within upstream versus downstream reaches. In particular, the heavily sinuous downstream section is marked by significant gains in both groundwater and solute concentrations, as opposed to the dilution and the declining trends observed in the higher-relief, fluvially energetic upstream reaches. Using numerical modeling, we demonstrate that during spring snowmelt, riverbed hyporheic zones support specific flow, biogeochemical, and microbial conditions that are more passive, leading to chemodynamic C-Q curves for nitrogen on the rising limb of the hydrograph. During the growing season, temperature, plants, microbes, and hydrologic gradients shift dramatically and lead to chemostatic C-Q behavior for nitrogen. Watershed zonation data revels strong controls of geology and vegetation on nitrogen exports. Our preliminary work indicates the importance of watershed features and development of zonation as a novel technique to understand C-Q.