

Poster #21-76

Spatial and Temporal Dynamics of Nitrogen in a Mountainous Watershed

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BER Program: SBR

Project: Berkeley Lab Watershed Function SFA

Project Website: watershed.lbl.gov

Mountainous watersheds are characterized by substantial heterogeneity in geomorphology, soil texture, and vegetation that determine hydrological flow paths and residence times through catchment subsystems. Despite advances in understanding the spatial and temporal drivers of biogeochemical cycling within snowmelt-dominated ecosystems, knowledge gaps remain. Here we describe ongoing work employing a combination of field and laboratory approaches alongside multi-scale modeling to characterize and quantify the sources, transformations, and sinks of nitrogen, a major limiting nutrient, within the East River (CO) watershed. This work focuses on two spatial scales, a hillslope to floodplain transect, and across the whole watershed. At the hillslope scale, we employ a combination of geochemistry, isotope geochemistry and molecular microbiology to identify and quantify specific mechanisms regulating the input (e.g., nitrogen fixation, Mancos shale weathering, atmospheric deposition), retention (plant and microbial accumulation), transformation (mineralization, nitrification) and loss (denitrification or hydrological export) of nitrogen across temporal aridity gradients (capturing baseflow, snowmelt, drought, and monsoonal precipitation). At the watershed-scale we use an auto-calibrated, semi-distributed mechanistic model to ask the question of how broad features of the landscape (e.g., topography, land cover type, soil properties) and biology determine the export of nitrogen (as NO_3^- or organic nitrogen) throughout the water year. Our model output is benchmarked against high-resolution nitrate and organic nitrogen flux data collected along the East River and major tributaries over 3+ years. Overall, this work intends to improve understanding of the feedback between climate change-driven hydrological perturbations (in the formation and loss of snowpack) and biogeochemical processes to improve predictions of nitrogen export at the watershed scale.