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Spatial and temporal dynamics of nitrogen in a mountainous watershed

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Mountainous watersheds are characterized by substantial heterogeneity in geomorphology, soil texture, and vegetation that determine hydrological flow paths and residence times through distinct 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 distinct spatial scales: a small hillslope to floodplain transect within the catchment, and the whole watershed. At the hillslope scale, we employ a combination of geochemical approaches, isotope geochemistry and molecular microbiology to identify and quantify specific mechanisms regulating the input (e.g., nitrogen fixation, Mancos shale weathering, or 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 scale of the watershed we use a semi-distributed mechanistic model to address how broad features of the landscape (e.g., topography, river sinuosity, soil properties) and biology determine the export of nitrogen (as nitrate or organic nitrogen) during distinct periods of the hydrograph. Our model output is benchmarked against high-resolution nitrate and organic nitrogen riverine flux data collected along the East River and it's major tributaries over 3+ years. Overall, this work intends to improve understanding of the feedback between hydrological perturbation (in the timing and extent of snowpack formation and loss) and biogeochemical processes to improve predictions of nitrogen export at the watershed scale.