Landscape processes controlling nitrogen loss from mountainous systems.

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Project Abstract:
Nitrogen is often a limiting element within mountainous ecosystems. Coarse soils, sparse vegetation, and strong hydrological events, such as snowmelt and monsoonal precipitation, can lead to significant losses of inorganic and organic nitrogen prior to assimilation and retention in plant and microbial biomass. Here we examine how rock weathering, atmospheric deposition, and biogeochemical cycling contribute to the aggregate signal of multiple years of nitrogen (nitrate, and DON) concentration-discharge data within contrasting pristine (East River) and metal- impacted (Coal Creek) catchments within the Upper Colorado River Basin. These paired catchments differ in terms of their bedrock properties and land cover. Coal Creek lithology is dominated by crystalline rock and sandstones, with conifers the predominant land cover type particularly on north-facing slopes. By contrast, a majority of the East River drainage is underlain by nitrogen-rich, marine black shale of the Mancos formation, with a mix of montane, subalpine, and alpine vegetation, with meadow species dominating. Both catchments are characterized by significant interannual variability in the CQ relationships for nitrate and DON, whereby chemostatic, and chemodynamic (both negative and positive) relationships are noted for both elements during different years. Despite higher export of nitrate from the predominantly shale- hosted East River, DIN: DON ratios suggest severe nitrogen limitation within both watersheds.

Intensive work within the East River has focused on two distinct spatial scales: (1) a hillslope-to- floodplain transect; (2) the entire 85km^2 drainage. By coupling long-term monitoring, field experiments, and mechanistic modeling we constrained a number of terrestrial fluxes for nitrogen including atmospheric deposition, nitrification, denitrification, and hydrological export. We note that shale weathering and atmospheric deposition are the dominant sources of nitrogen into the catchment. Furthermore, hydrological export represents only a small fraction of nitrate lost from the system, with denitrification likely responsible for the bulk of nitrogen loss. Furthermore, genomic data strongly suggests a high abundance of dissimilatory nitrate reduction to ammonium, representing a microbial ecosystem adapted towards minimizing loss by recycling nitrogen. We further note that within river nitrate export generally peaks during the peak discharge accompanying snowmelt, with minimum nitrate export occurring in the summertime. While this pattern likely represents the seasonal biological activity driving nitrogen retention during the growing season, more complex relationships are noted whereby nitrate exports do not scale linearly with discharge maxima. Overall, this work intends to improve understanding of the feedback between hydrological perturbation associated with snowpack dynamics and biogeochemical processes to improve predictions of nitrogen export at the watershed scale.