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Developing Predictive Understanding of Metal Export from Coal Creek, CO

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The project is to understand and model biogeochemistry at the Coal Creek Watershed, which is located in the Gunnison Country and drains an area of approximately 52.8 km2 in the west central Colorado. Biogeochemical reactions at the watershed release base cations (e.g. Na, K, Ca, and Mg) and nutrients (e.g. dissolved organic carbon (DOC), N, and P). The transport and export of these cations and nutrients could affect ecosystem functionality and downstream water quality. Specifically, we aim to understand 1) hydrological cycle and its response to climate at this snow-dominated mountainous watershed; 2) concentration – discharge (CQ) relationship of these solutes; 3) important ecohydrological drivers that govern solute transport and CQ behaviors; 4) soil organic carbon (SOC) and DOC processes and their roles in determining carbon cycling and solute transport.

This project includes: 1) compiling and analyzing the existing USGS field measured data and writing a manuscript focusing on hydrological controls on the transport of DOC and metals; 2) developing a model framework for a bio module bioRT, which features the microbially-driven redox reactions to model roots-microbe-soil-water interactions (e.g. DOC) at the watershed scale. Current results include: 1) spring snowmelts are major hydrological events at the Coal Creek Watershed and stream DOC concentration is highly responsive to discharge conditions, indicating a hydrological control on the DOC concentration; 2) large discharge events that occurred much less frequently contribute disproportionately higher fractions to the total annual water and DOC export. For example, the highest discharge bin (avg. 6.0 m3/s) occurred 4.5% of total time yet accounted for 37% of total annual water export and 49% of total annual DOC export; 3) contrasting CQ behaviors of dilution and enrichment are observed at the Coal Creek Watershed and groundwater is likely to exhibit both influences on the dilution and enrichment behaviors. Specifically, groundwater is an important source for stream Cl, Na, Ca, and Mg and the diluted groundwater in the wet period leads to the synchronized dilution pattern in stream concentration. Trace metals (i.e. Al, Zn, Mn, Fe, Cu, and Cd in ug/L) that originate from mine tailings and naturally-occurring deposits tend to be enriched in the organic-rich soils via soil adsorption and DOC complexation. A rising groundwater table under high flow conditions (during spring snowmelts) could intersect more shallow riparian soils and then flush out the accumulated trace metals that are previously disconnected to the stream, maintaining higher concentration of trace metals at high flow conditions and thus prompting enrichment behavior of trace metals.