Modeling nitrogen sources, sinks and transformations in a mountain watershed under changing climate

TAYLOR MAAVARA[1]*, NICHOLAS BOUSKILL[1], BHAVNA ARORA[1], ERICA SIIRILA-WOODBURN[1], JAMES SAMPLE[2], RAOUL-MARIE COUTURE[3], MICHELLE NEWCOMER[1], LAUREN FOSTER[4], REED MAXWELL[4], KEN WILLIAMS[1], CARL STEEFEL[1]

[1]Lawrence Berkeley National Laboratory, Berkeley, CA
[2]Norwegian Institute for Aquatic Research, Oslo, Norway
[3]Université Laval, Québec City, QC
[4]Colorado School of Mines, Boulder, CO
*tmaavara@lbl.gov

Climate-driven changes to winter snowpack, the timing of spring melt, and air temperature can have profound impacts on nitrogen (N) cycling in high-altitude watersheds. In this study, we develop a chain of models to quantify long-term changes to N cycling in the East River Watershed (ERW) in the Colorado Rocky Mountains. The ERW has experienced a decrease in N fluxes exiting the watershed over the last three decades, but obvious drivers such as decreasing atmospheric loads account for only a minor proportion of the change. Our model chain consists of a watershed-scale semi-distributed mechanistic N model that quantifies major sources, sinks, and transformations of NO_3^-, NH_4^+, and dissolved organic N in the stream, soil and groundwater. Sub-basin residence times characterizing surface and subsurface hydrologic dynamics were computed using the three-dimensional integrated hydrologic model ParFlow-CLM and a Lagrangian particle tracking approach. We use the *ecosys* model to constrain plant and microbial N uptake and release rates. The model chain was calibrated against a riverine N time series using a Markov Chain Monte Carlo algorithm. We use historical climate and land cover data to quantify the role of changing temperature, precipitation, and vegetation distribution on N export. In particular, we investigate whether climate-driven shrubification is responsible for the long-term N decline.