**Poster #21-35**

**Watershed Function SFA: Hydrological and Biogeochemical Dynamics from Genomes to Watershed Scales**

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Climate change, extreme weather, fires, land-use change, and other disturbances are significantly reshaping interactions within watersheds throughout the world. While mountainous watersheds are recognized as the "water towers" for the world, hydrological processes in watersheds also mediate biogeochemical processes that support all terrestrial life. Developing a predictive understanding of how watersheds respond to disturbances is challenging, as complex, multi-scale interactions can lead to a cascade of effects on downstream water availability and quality. Although these interactions can have significant implications for energy production, water availability, water quality, agriculture and other benefits valued by society, uncertainty associated with predicting watershed hydrobiogeochemical behavior remains high.

The Watershed Function Scientific Focus Area (SFA) is reducing this uncertainty through development of a predictive understanding of how mountainous watersheds retain and release water, nutrients, carbon, and metals. In particular, the project is investigating the impacts of early snowmelt, drought, and other disturbances on watershed hydrobiogeochemial dynamics over seasonal to decadal timescales. While the development of novel watershed conceptualizations and approaches are expected to be broadly transferable, our current research is undertaken within a headwater catchment of the Upper Colorado River Basin – the East River watershed. This watershed has evolved into a so-called "Community Watershed" – a platform for advancing indivisible watershed problems through nucleating and connecting National Lab and University- based research. Characterized by sharp gradients in elevation, climate, vegetation, biogeochemistry and hydrogeology, a system-of-systems approach is being used to predict the integrated watershed response to disturbance. This approach involves intensive investigations in a limited number of archetypal subsystems and scale-adaptive approaches to simulate the aggregated response of the subsystems. Given extreme weather contrasts in recent years, the watershed has served as an ideal 'natural laboratory' for investigating the impact of annual variations in snow pack thickness and melt timing on subsystem and aggregated watershed hydrobiogeochemistry, including nitrogen exports.

Recent Watershed Function SFA research has led to numerous insights and capabilities including: acquisition and use of extraordinary watershed data layers to characterize the organization of the watershed; quantification that early snowmelt significantly influences bedrock-through-canopy interactions, including rapid infiltration, groundwater recharge and baseflow – and that the subsurface hydrobiogeochemical activation region varies with snow accumulation; discovery of how the below-snow microbial community influences nitrogen exports; use of snowmelt experiments to discover that earlier snowmelt leads to great synchrony in greening and flowering across elevation gradients; a predictive understanding of how river stage, microbial community and meander permeability influences riparian zone nitrogen exports; and the development of new scale-adaptive modeling and data management capabilities. This poster will describe the Watershed Function SFA scientific goals, approaches, key study sites, and collaborators, and will also summarize select recent achievements.