Hillslope factors that influence the mobilization and retention of nutrients and other elements

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Project Abstract:
Hillslope processes critically regulate the rates at which nutrients become biologically available and the pathways and timescales over which water and elements solutes are transported to streams and rivers. Nutrient retention is enhanced through ecological soil-plant-microbe interactions and their synchronization with climate variables. In contrast, solute mobilization, including rock, mineral, and fluid biogeochemical reactions, generate flow paths and mobilize elements into the aqueous phase through the critical zone.

Our objectives are to (1) Determine how hydrological, soil-plant-microbe, mineral-fluid processes and their interactions influence water and element cycling at representative hillslope locations and their export to inland waters. By establishing mechanistic linkages between hillslope processes, our goal is to develop and evaluate predictive models that will be tested across a diversity of hillslope locations having unique characteristics. (2) Evaluate the sensitivity of export of elements to climate/disturbance from these locations as a function of dominant watershed factors that include geology, geomorphology, elevation, plant and microbial traits, and phenology characteristic of distinct watershed functional zones. (3) Develop sensor infrastructure to evaluate geomorphology and vegetation functional traits as windows into numerous subsurface properties. To date we: (1) have established a comprehensive integrated suite of weather, energy and soil sensors and deployed these at four locations at the East River lower montane site covering meadow, aspen and conifer areas; (2) are benchmarking these sensor suites using the prototype SMART Soils testbed; (3) have quantified inventories of bedrock elements, including nutrients and elements of water quality concern, and started to establish their pathways of release and impacts; (4) have identified slope and microtopographic controls on vegetation type and functional trait distribution that covary with subsurface physical properties at the hillslope scale, as well as covariance between vegetation functional types, soil chemistry and microbial metabolic potential; (5) have surveyed above- and below-ground plant traits at key moments in the water year that enable links between precipitation, ET, nutrient cycling to be understood mechanistically and linked to remote sensing methods; (6) have identified microbial metabolic potential for nutrient cycling across hillslope areas with different vegetation types; and (7) have started to connect hillslope-to-floodplain-to-river biogeochemical dynamics by developing zone-based transect models to quantify water and solute exports as a function of hydroclimate variance.

This information is used to challenge our understanding of how Watershed Functional Traits co- evolve at the hillslope scale such that remotely-sensed watershed-scale observables can be used to predict subsurface features relevant to elemental mobilization and retention.