Characterization and Quantification of Plant Traits and Species at Watershed Scale: Analysis and Results from the NEON AOP Campaign at the East River watershed, Colorado

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Project Abstract:
The Watershed Function Scientific Focus Area (WFSFA) aims to improve the predictive understanding of mountainous watershed hydrological and biogeochemical functioning, including the response to environmental perturbations. In such environments, plant communities play a critical role in hydrological and biogeochemical dynamics, given their principal role in the evapotranspiration and nutrient cycling. To capture such dynamics, it is necessary to accurately characterize the ecology governing such mountainous ecosystems.

To advance ecological characterization at the watershed scale, the WFSFA has acquired high- resolution visible-to-shortwave infrared hyperspectral and LiDAR data from airborne surveys over four headwater watersheds in the Upper Colorado Basin. The data were acquired by the NEON Airborne Observation Platform (AOP) during the summer 2018 via a collaborative proposal spanning multiple research institutions, including Lawrence Berkeley National Laboratory (LBNL), Rocky Mountain Biological Laboratory (RMBL), Stanford University, and UC Berkeley. The data acquisition was supported by a 3-week ground sampling campaign to collect foliage, litter, and soil samples along 14 hillslopes at various elevations and orientations. Data collection resulted in the characterization of 437 sites that encompass land cover dominated by trees, shrubs, and meadows. Other measurements included high-resolution RTK-GPS, near-surface geophysical measurements, soil moisture, and temperature.

Here we present cumulative results obtained from the analysis of the NEON data along with that derived from ground sampling. A first result is the estimation of plant species distribution across the entire study domain. We used machine-learning-based approach that integrated hyperspectral and LiDAR data to map plant species at 1-meter resolution. This spatial characterization allowed for further investigation of the coupling of plant distribution with topography and soil properties, revealing the strong impact of elevation on plant structure variability in tree species. Partial least squares regression was used to estimate plant traits, including foliar nitrogen concentration and leaf mass per area. Different models were built to estimate trait values for needle and non-needle leaf vegetation.