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Abstract:

Over the past two decades, wildfire activity in the western US, especially in California, has increased, partly caused by a warming climate. Wildfires modify physical and chemical soil properties and generally cause Fire-Induced Soil Hydrophobicity (FISH), which reduces water infiltration into the soil and accelerates runoff after precipitation events. This may induce cascading disasters including flooding, landslides, and deterioration of water quality. To predict and mitigate such disasters, FISH is generally quantified at a few fire-affected locations using a manual infiltration test. Unfortunately, this limited spatial coverage poorly represents FISH on a watershed scale as needed for prediction and mitigation purposes.

Watershed-wide monitoring of FISH is only practical using airborne or satellite-based remote sensing, for example utilizing solar reflectance spectra to characterize and monitor physical and chemical properties of fire-affected soils. Such spectra depend on light scattering and absorption at the soil surface. Here, we sampled surface soils from four recent California (US) megafires: the Dixie (2021, 3,890 km^2), Caldor (2021, 897 km^2), Beckwourth Complex (2021, 428 km^2), and Mosquito (2022, 311 km^2) fires. We studied the optical, chemical, and hydrological properties of fire-affected and unaffected (i.e., control) soil samples. Optical hyperspectral reflectance spectra (350–2,500 nm) were obtained using natural solar (blue sky) illumination and a spectroradiometer (ASD FieldSpec3), operated in reflectance mode. FTIR technique was used for characterizing soil chemical functional groups and organic and inorganic species based on their infrared absorption throughout the FTIR spectral range (4,000 to 400 cm^{-1} corresponding to wavelengths of 2.5 to 25 μm). To assess soil water repellency, hydrological soil properties were characterized using water drop penetration time and apparent contact angle tests.

Currently, we are investigating the temporal variations of hyperspectral soil reflectance spectra pre- and post-fire and the correlations between these spectra and soil chemistry.