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Spatially-distributed information on soil surface roughness at the millimetre to centimetre scale is required for inclusion in a range of physical and functional algorithms including heat budgets, runoff and sediment transfer models, and can also be used to understand soil degradation processes. Such information is necessary to describe the variability of a highly heterogeneous variable, to parameterise hydrology and erosion models and to understand the temporal evolution of the soil surface in response to rainfall. Previous work has shown that soil surface roughness can be obtained from both geostatistically analysed close-range laser data and multiple view angle measurements of hyperspectral reflectance factors. However, whether these techniques work on soils of different biochemical composition and structural characteristics has not yet been demonstrated.

The objective of this experiment was to determine the capability of these approaches for discriminating soil surface roughness conditions when different soil types are considered. Five soil types with varying biochemical properties were subjected to artificial rainfall, producing a sequence of soil states of progressively declining soil surface roughness. Point laser data (2 mm sample spacing) were geostatistically analysed to give a spatially-distributed measure of surface roughness. Hyperspectral, directional reflectance factors from the same soil states were measured using a ground-based hyperspectral spectroradiometer for a range of viewing zenith angles. Measurements angles ranged from the extreme forwardscatter (-60°) to the extreme backscatter (+60°) at a 10° sampling resolution in the solar principal plane. A directional index (Anisotropy Measure; AM) was determined, using a ratio between extreme forward-scattered and backscattered reflectance factors. Regression analysis of AM against the geostatistically-derived value of soil surface roughness (sill variance) was used to test the ability of AM for description of surface roughness for all soil types.

Results show that processes such as aggregate breakdown and soil crusting are represented by a quantifiable decrease in sill variance, from 8.01 (control) to 0.74 (after 60 minutes of rainfall). Soil surface features such as soil cracks, tillage lines and erosional areas were also quantified by local maxima in semi-variance at a given length-scale. Strong results were also found for the ability of directional reflectance to represent soil roughness; where the use of a directional AM index dramatically improved the relationship with sill variance compared to the use of a single viewing angle ($R2 = 0.67$ at $\theta r = 40°$; $R2 = 0.89$ (AM)). This demonstrates the ability of this approach for compensating for spectral differences between different soil types.

The results illustrate the potential for both geostatistically-analysed laser data and directional reflectance factors for retrieving soil microtopographical data; providing an empirical and theoretical basis for the future retrieval of spatially-distributed assessments of soil surface structure across larger spatial extents.