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A new operational method for soil degradation monitoring: directional reflectance using an Ocean Optics spectroradiometer

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Soils can experience rapid structural degradation in response to land use and land cover changes, resulting a reduction in soil productivity and water retention and an increased release of greenhouse gases into the atmosphere. However, due to the time and resources involved in using traditional field sampling techniques there is a lack of spatially-distributed information on soil condition. This prevents the assessment of both current rates of soil degradation and the effectiveness of mitigation strategies. The physical consequences of soil degradation are the rapid breakdown of macro-aggregates and an increase in compaction and crusting. This results in a decline in surface roughness, which has been correlated with directional reflectance factors (Anderson and Kuhn, in press). Remotely sensed data can provide a cost-effective means of monitoring soil properties over broad spatial extents, with the growing recognition of the importance of the directional domain leading to an increasing number of satellites with multiple view angle capabilities, e.g. MISR, CHRIS on Proba. Consequently, field and laboratory directional data are central for model development and understanding fine-scale processes.

This study follows work conducted by Anderson and Kuhn (in press), using directional measurements for characterising soil structural effects on reflectance factors. Previous experiments have utilized spectrometer instruments such as the Analytical Spectral Devices FieldSpec Pro (ASD), which produces high quality data but is costly, and its weight and size constrain effective operational use in field situations.

In this study, the ASD (dimensions: 3,300mm x 1,140mm x 4,060mm and 7,200g) is substituted with an Ocean Optics USB2000 spectroradiometer (dimensions: 89.1 mm

x 63.3 mm x 34.4 mm and 190g), which is significantly cheaper, lighter and consumes less power – hence it potentially provides a more operational means of characterising soil directional reflectance *in situ*. The experiment described here, aimed to test the validity of using a smaller and more portable spectroradiometer for soil degradation monitoring. In addition, the methodology is applied to a range of soil types and conditions at a range of view azimuth and zenith angles.

Directional reflectance measurements in the solar principal plane (SPP) were achieved by attaching the USB2000 to an A-frame device, which clips into a horizontal base circle. The pre-assigned holes in the base represent azimuth angles of 10º, which span the full 360º, allowing for more rapid data acquisition in the field. The methodology provides an opportunity to capture reflectance data at a large number of discrete angles in the SPP and in orthogonal axes.

Initial results from this study show promise for monitoring changes in aggregate stability for several soil types. This suggests that Ocean Optics spectrometer may provide a more versatile and accessible alternative to more expensive and perhaps less portable instruments.