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# Spectral detection of different types of soil crusts under intact and disturbance conditions in semiarid environments from SE Spain.

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Biological Soil Crusts (BSCs) consist of an association of soil particles with cyanobacteria, algae, microfungi, liverworts, bryophytes and lichens creating a cohesive thin horizontal layer on the soil surface. They have a widespread distribution in arid and semiarid regions, which comprise over 40% of the world´s land surface. BSCs play an important role on hydrological and ecological functioning of arid and semiarid ecosystems since they influence all components of hydrological balance (runoff, rainfall capture, infiltration, evaporation, water retention capacity) and erosion. It is well known that BSCs at local scale reduce water erosion by protecting soil against raindrop impact. However, their effects have to be evaluated at different spatial scales, because in many cases BSCs lead to an increase of runoff and downslope erosion or water harvesting from crusted areas to nourish adjacent vegetated areas. Moreover, BSCs are easily damaged by livestock or human activities and the disturbance usually has great significance for the coverage and the composition of the community of the BSCs, the developmental stage of the BSC and their effects on hydrology and erosion. So, to accurately predict runoff and erosion processes, the spatial distribution of soil crust types and their disturbance conditions should be included in models. To map soil crusting at large scales, the use of their spectral characteristics can be a useful method. The objectives of this work are i) to analyze the spectral characteristics of different crust types (physical and biological soil crusts), also corresponding to different crust development stages, in two semiarid areas in SE Spain, El Cautivo (in the Tabernas Desert) and Amoladeras (in the Natural Park Cabo de Gata-Níjar), ii) to demonstrate the efficiency of diffuse reflectance spectroscopy, especially in the visible part of the spectrum, for classifying different crust types and different crust disturbance conditions. Spectral measurements were carried out with a GER 2600 portable spectroradiometer on plots covered by the main crust types and under three disturbance conditions for each crust type (undisturbed/trampling/scraping) at both sites. The main spectral differences found among crust types and treatments were: 1) a lower average reflectance and a decrease of the minimum reflectance value as the development and darkening of crust increased; 2) the presence of an absorption peak due to chlorophyll at 680 nm in the BSCs, which was absent in the physical crust; 3) a higher total reflectance and a lower deepness of the absorption peak at 680 nm in the trampled and in the scraped crust, compared to the undisturbed crust. Spectroscopy quantitative analyses were used to check their capacity for the discrimination of the different crust types, crust development stages and disturbance conditions. Principal component analysis (PCA) and partial least squares regression (PLSR) were applied to the spectral data to reduce them to a smaller number of non collinear variables and later, a Linear Discriminant Analysis (LDA) was applied to the extracted principal components. A good classification of the different crust types (or development stage) and crust disturbance conditions was obtained after applying LDA on the principal components extracted by PLSR. This analysis demonstrates the power of spectroscopic techniques to distinguish between plots with different crusting development. The differences observed on the spectral features were used to develop a spectral index to classify different crust types (or crust stage of development) that constitutes a promising tool for mapping BSCs with hyperspectral remote sensing.