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Transferability of multi- and hyperspectral biocrust mapping indices

Emilio Rodriguez-Caballero (1,4), Paula Escribano (2), Claas Olehowski (3), Sonia Chamizo (4), Yolanda Cantón (4), and Bettina Weber (1)

(1) Multiphase Chemistry Department, Max Planck Institute for Chemistry, Mainz, Germany (e.rodriguez-caballer@mpic.de), (2) Experimental Station of Arid Zones (EEZA-CSIC), Almería, Spain, (3) Geography Department, University of Education Heidelberg, Heidelberg, Germany, (4) Department of Agronomy, University of Almería, Spain

Biological soil crusts (biocrusts) are complex communities formed by a close association of cyanobacteria, algae, microfungi, lichens and bryophytes in varying proportions. These communities live within or immediately on top of the uppermost millimeters of the soil surface in arid and semiarid regions, where they may cover up to 80 % of the soil surface. Biocrusts exert a strong impact on numerous soil surface properties, as C and N content of the soil, soil texture and porosity, infiltration and water retention capacity, soil evaporation, and soil erodibility. Given these highly relevant effects of biocrusts on ecosystem processes, a correct characterization of their spatial distribution is required. Following this objective, considerable effort has been devoted to the identification and mapping of biocrusts using remote sensing data, and several mapping indices have been developed. Utilization of biocrust indices and remote sensing images has been presented as a promising tool to map biocrusts in different ecosystems. Transferability of indices on areas different to those where they have been developed has only rarely been checked and needs to be assessed. In this study we tested this transferability of indices published in the literature for mapping biocrusts (i.e. i) the Crust Index (CI), ii) the Biological Soil Crust Index (BSCI), iii) the Continuum Removal Crust Identification Algorithm (CRCIA), and iv) the Crust Development Index (CDI)) in two different areas dominated by biocrusts.

As a consequence of the differences in crust composition and phenology at the date of image acquisition the threshold for crust identification needs to be adapted for all indices and study areas. After calibration, contrasting results have been observed for multispectral and hyperspectral indices. Multispectral indices (CI and BSCI) showed very bad results in both study areas with Kappa values lower than 0.6. Hyperspectral indices (CRCIA and CDI), on the other hand, showed a good classification accuracy (Kappa values about 0.8) in both the study area where they have been developed and in the newly tested region. These results highlight the capability of hyperspectral sensors to identify the specific absorption features related to photosynthetic pigments as chlorophyll and carotenoids, but also the limitation of multispectral information to discriminate between areas dominated by biocrusts and vegetation or bare soil. Based on these results, we conclude that remote sensing offers an important and valid tool to map biocrusts. However, the spectral similarities between the main surface components of drylands and biocrusts demand for mapping indices based on hyperspectral information to correctly map areas dominated by biocrusts at ecosystem scale.