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Biocrust spatial distribution at landscape scale is strongly controlled by terrain attributes: Topographic thresholds for colonization

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Biological soil crusts (biocrusts) are spatially variable components of soil. Whereas biogeographic, climatic or soil properties drive biocrust distribution from regional to global scales, biocrust spatial distribution within the landscape is controlled by topographic forces that create specific microhabitats that promote or difficult biocrust growth. By knowing which are the variables that control biocrust distribution and their individual effect we can establish the abiotic thresholds that limit natural biocrust colonization on different environments, which may be very useful for designing soil restoration programmes.

The objective of this study was to analyse the influence of topographic-related variables in the distribution of different types of biocrust within a semiarid catchment where cyanobacteria and lichen dominated biocrust represent the most important surface components, El Cautivo experimental area (SE Spain). To do this, natural coverage of i) bare soil, ii) vegetation, iii) cyanobacteria-dominated soil crust and iv) lichen-dominated soil crust were measured on 70 experimental plots distributed across 23 transect (three 4.5 x 4.5 m plots per transect). Following that, we used a 1m x 1m DEM (Digital Elevation Model) of the study site obtained from a LiDAR point cloud to calculate different topographic variables such as slope gradient, length slope (LS) factor (potential sediment transport index), potential incoming solar radiation, topographic wetness index (WI) and maximum flow accumulation. Canonical Correspondence Analysis was performed to infer the influence of each variable in the coverage of each class and thresholds of biocrust colonization were identified mathematically by means of linear regression analysis describing the relationship between each factor and biocrust cover.

Our results show that the spatial distribution of cyanobacteria-dominated biocrust, which showed physiological and morphological adaptation to cope with drought and UVA radiation, was mostly controlled by incoming solar radiation, being mostly located on areas with high incoming solar radiation and low slope, showing a threshold at 48 degrees from which they are not found. Lichen-dominated biocrust, on the other hand, colonize the uppermost and steepest part of north aspect hillslopes where incoming solar radiation and ETP are low, as consequence of their lower capacity to survive under extreme temperatures and drought conditions. With higher capacity of the soil to retain run-on (WI), surface is mostly cover by plants instead of lichens. Bare soil distribution is controlled by the combination of two factors, slope and solar radiation, covering the south aspect hillslopes, where slope gradient is high and there is high incoming solar radiation and ETP for lichen colonization.