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What controls dryland soil stability? The surprising importance of biocrusts and their possible sensitivity to climate change

M.A Bowker (1), J. Belnap (2), F.T. Maestre (3), and V.B. Chaudhary (4)

(1) US Geological Survey, Southwest Biological Science Center, Flagstaff, Arizona, United States (matthew.bowker@nau.edu), (2) US Geological Survey, Southest Biological Science Center, Moab, Utah, United States (jayne_belnap@usgs.gov), (3) Área de Biodiversidad y Conservación, Escuela Superior de Ciencias Experimentales, Universidad Rey Juan Carlos, Móstoles, Spain (fernando.maestre@urjc.es), (4) Department of Biological Sciences, Northern Arizona University, Flagstaff, Arizona, United States (vbc2@nau.edu)

In drylands of the world, wind and water erosion is controlled by the interplay of erosivity—-the propensity of wind and water to move sediment—-and erodibility—-the mobility of soil particles. Land use can have several impacts on this interplay, particularly by increasing erodibility. Here we examine the system underlying dryland erodibility, which is determined by the interrelationships of inherent soil properties and dynamic biotic features, including plants and their root symbionts and soil biocrusts. We applied structural equation models to 7 datasets from drylands, mostly drawn from the Colorado Plateau of the United States but also from parts of Spain. The datasets spanned spatial resolutions of 25 cm2 up to 2 ha. Our models were able to explain 20–79% of the variation in soil aggregate stability (SAS), an attribute of erodibility. We found: 1. Dynamic biotic attributes tend to be more influential in determining SAS than inherent soil properties; 2. The magnitude of the effect of inherent soil properties on SAS? is remarkably stable among different datasets and scales; 3. Of the dynamic biotic attributes, biocrust abundance was the strongest predictor of SAS in 5 of the 6 datasets in which they were measured; 4. Plants may exert a strong positive effect on SAS, but this effect is highly variable among datasets. Because these dynamic biota are expected to respond to climate change, we can also expect climate change to affect soil erodibility. In a recent spatial modeling effort at the scale of the entire Colorado Plateau, we found that the most informative predictor of biocrust abundance was a negative effect of the ratio of summer to winter precipitation. Because climate projections suggest a decrease in cool season precipitation, and some suggest an increase in summer monsoonal precipitation (with much uncertainty) across the studied areas, the ratio of summer to winter precipitation is likely to increase, and soil erodibility may increase with it.