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Hydrological behaviour of microbiotic crusts on sand dunes of NW China: Experimental evidences and numerical simulations

Xin Ping Wang (1), Anna Tedeschi (2), Nadia Orefice (2), Roberto De Mascellis (2), and Massimo Menenti (3)

(1) Cold & Arid Regions Environmental & Engineering Research Institute, Chinese Academy of Sciences, 260 West Donggang Road,Lanzhou 730000, China, (2) CNR-ISAFOM.Institute for Mediterranean Agro Forestry Systems- Via Patacca 85, 80056 Ercolano Naples-Italy;, (3) Optical and Laser Remote Sensing, Delft University of Technology, The Netherlands

Large ecological engineering projects were established to reduce and combat the hazards of sandstorms and desertification in northern China. An experiment to evaluate the effects of dunes stabilization by vegetation was carried out at Shapotou in Ningxia Hui Autonomous Region at the southeast edge of the Tengger Desert using xerophyte shrubs (Caragana korshinskii, Hedysarum scoparium and Artemisia ordosica) planted in straw checkerboard plots in 1956, 1964, 1981, 1987, 1998, and 2002. The fixed sand surface led to the formation of biotic soil crusts. Biotic crusts formed at the soil surface in the interspaces between shrubs and contribute to stabilization of soil surfaces. Previous results on the area have showed that: i) straw checkerboards enhance the capacity of the dune system to trap dust, leading to the accumulation of soil organic matter and nutrients; ii) the longer the period of dune stabilization, the greater the soil clay content in the shallow soil profile (0-5 cm), and greater the fractal dimension of soil particle size distribution.
Benefit apart, one should be aware that the formation of a crusted layer at the soil surface is generally characterized by an altered pore-size distribution, with a frequent decrease of hydraulic conductivity which can induce changes of the water regime of the whole soil profile. Accordingly, the main objective of the paper is to evaluate the equivalent (from a hydraulic point of view) geometry of the crusted layer and to verify if the specific characteristics of the crusted soil layer, although local by nature, affect the hydrological behaviour of the whole soil profile. In fact, it is expected that, due to the formation of an upper, impeding soil layer, the lower soil layers do not reach saturation. Such behaviour has important consequences on both water flow and storages in soils. The final aim will be to understand how the crust at the surface of the artificially stabilized sand dune affects the infiltration capacity at the soil surface and how, in turn, this affects the soil water content profiles.