Geophysical Research Abstracts,
Vol. 11, EGU2009-12452, 2009
EGU General Assembly 2009

Mimicking soil crust development of abandoned fields using artificial rain

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Land abandonment is associated with the interruption of soil tillage operations. This has large impacts on soil surface properties, such soil crust development, prior to vegetation development, inducing increased runoff. This study discusses the changes in soil surface properties by simulating the development of soil crusts after abandonment in comparison to soil crust properties of semi-natural fields.
Soil samples were taken from ploughed fields that were under cereal cultivation, and were prone to abandonment in the Canada Hermosa valley in the Guadalentin basin in SE Spain, with a semi-arid climate and an annual rainfall of 270 mm yr-1. Also undisturbed crust samples were taken from nearby abandoned and semi-natural fields on similar parent material. In the laboratory the sampled soils from the cultivated fields were deposited in shallow boxes of 0.5 m2, and underwent four different artificial rainfall treatments with constant but moderate rainfall intensities, totaling one, two, three or four years of annual rainfall with successive drying periods in between. After these rainfall applications, the surface soil of each of these treatments was sampled for thin section preparation. The undisturbed samples taken from the field were also prepared as thin sections.
Macroscopic and microscopic analyses were used to study the development of the crusts in relation to the amount of applied rainfall. A clear progressive development of structural crusts at the upper part and in the middle part of the boxes as well as depositional crusts at the lower end of the boxes could be monitored with increasing rainfall amounts. Even after the application of rainfall, equaling one year of natural rainfall, already a clear crust developed by slaking processes and showing clear blockage of fine pores at the soil crust surface. After the artificial application of four years of rainfall even similarities started to appear with the typical characteristics of crusts on semi-natural fields. The artificial crusts showed a structural crust with two micro-horizons, a mm-sized loose non-embedded silt and sand horizon on top of a dense plasmic micro-horizon, in contrast to the semi-natural ones having a sieving crust, consisting of a structural crust with three micro-horizons showing a loose sand and gravel micro-horizon on top of a loose silty micro-horizon on top of a dense plasmic micro-horizon.
Despite the limited kinetic impact of the raindrops generated by the dripping plate simulator, the limited drying periods in between the simulations, as well as the absence of wind, it was surprising that these crusts developed so quickly. This is certainly related to the high sensitivity to slaking and welding processes of the soils involved. The enrichment of coarser material on the top of the crust might also indicate the importance of overland flow processes in this type of crust formation, and which crust are very common on the siltloam soils with semi-natural and abandoned fields in the upper Guadalentin basin.