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The impact of soil crusts on overland flow and soil degradation processes in Souss valley, South Morocco

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The Moroccan Souss valley between High Atlas and Anti Atlas is one of the fastest growing agricultural regions in Morocco and affected by gully-erosion for 400 years. The transition from traditional farming system into agro-industrial used areas, mostly achieved by land levelling measures, has been raised gully-erosion since the 1960s. The substrate of the re-filled gullies erodes again during the rainfall period, so that old gully systems are resumed with even higher erosion dynamic. Consequently, plantations of citrus fruits, bananas or vegetables get dissected, thus causing high restoration costs and environmental harm.
In arid and semi-arid zones, sealing and crusting are important degradation factors which can promote gully-erosion. Due to the sparse vegetation cover and the low soil organic matter content, soil surface is more vulnerable to raindrop impact during the rainfall period. Processes such as sealing and crusting as well as their consequences for environment are well documented in literature. Soil surface sealing reduces infiltration rates and consequently increases the runoff. The aim of this study was to determine the influence of existing soil crusts on runoff and soil degradation in the Souss valley in a two-month field experiment. It was hypothesized that soil crusts with different microstructure exist and may influence runoff and soil degradation in various way. In-situ rainfall simulations with a small portable rainfall simulator were conducted at different sites to determine runoff and soil loss rates on micro-plots with a size of 0.28 m^2. Levelled and un-levelled gully areas were investigated comparably. The rainfall intensity for each of the 30 minute simulations was 40 mm/h. Additionally, soil crusts were sampled before and after the rainfall simulation. Thin sections were used to analyse the micromorphological structure of each crust. The microscopic evaluation indicated a characteristic micromorphological structure for each soil crust sample. Moreover, a connection between micromorphology and runoff could be established. Platy structure and vesicles led to a high and very high runoff, while vegetation cover, biological crusts, vertical pore continuity and connectivity was linked with middle and low runoff rates. On the levelled areas, platy structure and vesicles dominated, probably due to the use of heavy land levelling machines. The crusts on the un-levelled areas showed different and more variable microstructures. Biological soil crusts lowered the runoff, however,especially pronounced in combination with vertical pore continuity and connectivity. Vegetation cover was the most effective protection against soil degradation.