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Soil surface roughness decay in contrasting climates, tillage types and management systems

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Soil surface roughness describes the variations in the elevation of the soil surface. Such variations define the soil surface microrelief, which is characterized by a high spatial variability. Soil surface roughness is a property affecting many processes such as depression storage, infiltration, sediment generation, storage and transport and runoff routing. Therefore the soil surface microrelief is a key element in hydrology and soil erosion processes at different spatial scales as for example at the plot, field or catchment scale. In agricultural land soil surface roughness is mainly created by tillage operations, which promote to different extent the formation of microdepressions and microelevations and increase infiltration and temporal retention of water. The decay of soil surface roughness has been demonstrated to be mainly driven by rain height and rain intensity, and to depend also on runoff, aggregate stability, soil reface porosity and soil surface density. Soil roughness formation and decay may be also influenced by antecedent soil moisture (either before tillage or rain), quantity and type of plant residues over the soil surface and soil composition. Characterization of the rate and intensity of soil surface roughness decay provides valuable information about the degradation of the upper most soil surface layer before soil erosion has been initiated or at the very beginning of soil runoff and erosion processes. We analyzed the rate of decay of soil surface roughness from several experiments conducted in two regions under temperate and subtropical climate and with contrasting land use systems. The data sets studied were obtained both under natural and simulated rainfall for various soil tillage and management types. Soil surface roughness decay was characterized bay several parameters, including classic and single parameters such as the random roughness or the tortuosity and parameters based on advanced geostatistical methods or on the fractal theory. Our results indicate that two or more parameters may be needed to characterize the spatial variability of the soil surface microrelief and to best describe the roughness decay in agricultural soils under the various climatic and anthropogenic conditions studied. Then, rates of soil surface roughness decay were used to evaluate the susceptibility to degradation of the soil surface under the main tillage ands management types studied. Finally the effects of soil surface roughness on soil losses and water losses under typical tillage and management systems of the two contrasting regions studied were outlined.