Geophysical Research Abstracts,
Vol. 10, EGU2008-A-02576, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-02576
EGU General Assembly 2008

Changes of soil surface roughness under simulated rainfall evaluated by photogrammetry

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Erosion and runoff processes are influenced mainly by the soil surface characteristics. Among them, soil surface roughness is a key parameter. As this parameter is usually anisotropic, it can not be calculated from elevation measurements along one direction (1D). The close-range photogrammetric method is a rapid and flexible tool to obtain digital elevation models (DEM) at the 1m^2 scale but it still needs to be evaluated against a reference method such as the laser relief-meter. The objective of this study was first to validate photogrammetry by comparing roughness indices extracted from a DEM obtained using this method with indices calculated from 1D laser relief-meter measurements, and then to monitor rainfall induced changes of the soil surface roughness with photogrammetry. Two experimental plots were subjected to successive simulated rainfall events. Plot 1 is a seedbed plot with a random roughness, whereas plot 2 is a harrowed plot with an oriented roughness. Comparison was made between the two soil roughness measurement techniques with regard to data acquisition, computation efforts, resolution, precision and capability to represent soil surface features and especially to monitor the evolution of soil surface roughness. Horizontal resolution for the laser scanner was approximately 1mm along a 1m long transect while it was about 0.5 mm for the photogrammetric method for a 1m^2 plot. Elevation data were extracted from the DEMs on the same profile as the one measured with the laser method. We compared roughness indices calculated on these profiles, namely Random Roughness (RR) and Tortuosity (T). Results obtained using the two methods were closely related:

after a 160 mm cumulative rainfall, RR was found to be reduced from about 7.0 to 4.8 using the laser technique and from 7.6 to 5.5 with the photogrammetric method for the seedbed plot. The T index was reduced from 2.41 to 1.99 (laser method) and from 1.64 to 1.34 (photogrammetry). Both measurements methods detect the evolution of soil surface roughness and yield very close RR indexes. However T index is lower when it is measured using photogrammetry then when the reference method is used. Overall, results show that the photogrammetric data were useful for soil surface characterization and can detect the soil surface evolution: they can therefore be helpful for soil erosion and runoff processes study. Moreover, photogrammetry can be used under rainfall, it is very flexible, data acquisition is quick, and DEM calculated from this method provide more information on the spatial structure of the soil roughness than a 1D method.