Geophysical Research Abstracts,
Vol. 11, EGU2009-3806-1, 2009
EGU General Assembly 2009

A numerical tracing experiment of water erosion at the plot scale

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A numerical experiment of water erosion was set up on a plot of 100m^2 (20m long by 5m wide) using PSEM_2D (Plot Soil Erosion Model). Various environmental factors were tested: six topographies combining different slopes and microtopography, four extreme rainfall events representative of the Temperate and the Mediterranean climates, four different textured soils, and two conditions of upstream injected discharge. 192 simulations were run. The results enabled to study the processes that control erosion and sediment yield at the plot scale. A notable contribution of this study was the possibility to trace numerically eroded sediment. Sediment originated from five successive zones of 20m^2 (4m long by 5m wide) was labelled in a different way and traced to assess re-deposition within the plot and exportation at the outlet of the plot.

Over the 100m^2 plot, the contribution of rainfall erosion processes was dominant for most of the simulations without upstream injected discharge. However, in certain conditions of runoff discharge, slope, and critical shear stress, flow erosion was activated in the downer part of the plot, becoming the major source of sediment and producing substantial sediment yield. For the simulations with upstream injected discharge, flow erosion processes were generally the primary source of sediment over the whole plot and sediment yield was very high.

Sediment that left the 100m^2 plot originated mostly from the downer part of the slope. In the case of low slope and break in slope, sediment came exclusively from the toeslope pointing out the efficiency of the break in slope to reduce significantly sediment yield. In the case of topographies with microrelief, an increase in slope caused an increase in both sediment yield and maximum travel distance of sediment. In the case of fine sediment, plane surfaces, and upstream injected discharge, the contribution of sediment from upper parts of the plot and the maximum travel distance of sediment were enhanced. The microtopography tested in this study emphasized the concentration of runoff in depressed zones and accentuated rill erosion, especially at the toeslope where flow depth and velocity were the more important.