Geophysical Research Abstracts, Vol. 9, 00849, 2007
SRef-ID: 1607-7962/gra/EGU2007-A-00849

A spatially distributed model for hillslope contribution to suspended sediment transport in alluvial channels

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In order to provide an innovative tool for estimating surface erosion in temperate regions, a numerical model for the coupled simulation of rainfall-runoff processes and suspended sediment transport at a basin scale has been developed: the model is addressed to the analysis of fine sediments since these are of main concern for water quality, reservoir siltation and beach erosion.
The simulation model is DEM-based, operates a discretisation of the catchment in rectangular cells and calculates each quantity at the centre of the discretization lattice. The rainfall-runoff component computes the water balance in the soil matrix through the CN method, modified in order to allow for continuous simulation; surface and subsurface flows are routed through a Muskingum-Cunge scheme with variable parameters. The sediment detachment-transport component computes surface erosion from precipitation and overland flow over hillslopes. Rainfall erosion is described according to the model of Gabet & Dunne (WRR, 2003) along with a raindrop median diameter specifically calculated for the Italian climate by Zanchi & Torri (1980) and a raindrop terminal velocity estimated according to Assouline & al. (J of H, 1997). Overland flow erosion occurs whenever flow shear stress overcomes the sediment critical shear stress; once detached, the material is transported until transport capacity of overland flow is greater than specific sediment discharge, otherwise it is locally deposited. The model accounts for the local storage of deposited material and for the difference in resistance properties between the soil matrix and the deposited loose sediment during the mobilization process; the fraction of cell surface covered by loose material is calculated conceptualizing the volume of loose material as a layer of a single sediment particle (Nord & Esteves, WRR 2005). Sediment is routed through a quasi-linear partial differential equation solved with an explicit Lax-Wendroff scheme, in order to achieve

second-order accuracy and to better model the finite propagation speed involved. Both components of the model are successfully tested on a storm event in a scarcely monitored catchment in the Northern Apennines, where a single monitoring station is set for measurement of river discharge and suspended sediment at basin outlet. Model robustness is also proved through sensitivity analysis of model parameters.