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Consequences of storm movement direction for surface runoff and erosion at two scales: plot and watershed

J.P. Nunes (1), J.L.M.P. de Lima (2), V.P. Singh (3) and M.I.P. de Lima (4)

(1) New University of Lisbon, Portugal, (2) University of Coimbra, Portugal, (3) Texas A and M University, U.S.A., (4) Polytechnic Institute of Coimbra, Portugal (jpcn@fct.unl.pt / Phone/fax: +351 – 212 948 374)

This work deals with the impact of storm movement characteristics on the hydrological response at two distinct scales: plot and watershed.

The plot-scale study was conducted in a laboratory. A rainfall simulator was mounted on a wheeled structure so it could be used to simulate upward and downward movements of storms along soil flumes of different sizes and shapes. The results showed that rainfall moving downstream produced greater peak runoff rates and sediment transport than rainfall moving upstream; the flow hydrographs at the end of the flumes had steeper rising limbs. The increase in soil erosion was a direct consequence of runoff dynamics.

The watershed-scale study used computer simulations: the MEFIDIS storm erosion model was applied to the Alenquer watershed. This watershed is located near Lisbon (Portugal) and has an area of 120 km2. The model was used to compare runoff and soil erosion caused by synthetic circular storms moving downstream along the watershed's axis with similar upstream moving storms. The results were similar to those observed for the laboratory experiments: an increase of surface runoff, peak runoff rates and soil loss for storms moving downstream.

However, the processes leading to the results obtained at the two scales are somewhat different. The physiographic nature of the watershed is much more complex than the laboratory plot; this introduces other processes in the dynamics of surface water flow and consequently the soil erosion by water at the watershed scale. In the watershed there are slopes facing several directions, leading to a complex combination of the effects caused by the movement of storms in a given direction. Nevertheless,

downstream-moving storms cause runoff from tributaries to reach the main channel sequentially, which results in a rapid increase of discharge along the main channel. The inflows from tributaries reach the main channel in a limited time, leading to a significant increase in the flow rate and preventing sediments eroded upstream from depositing on the channel bed. Conversely, upstream-moving storms delay the inflow from tributaries in time and therefore lead to lower peak flow rates and higher sediment deposition.