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Studying the combined effect of wind and rain using rainfall simulators

João de Lima

(1) Department of Civil Engineering, Faculty of Science and Technology, Campus II - University of Coimbra, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal, plima@dec.uc.pt (2) Institute of Marine Research (IMAR), Marine and Environmental Research Centre, Portugal

Although rainfall is assumed spatially uniform in conventional soil erosion and soil hydrology studies, moving storms have been shown to have substantial influence on runoff since the spatial and temporal characteristics of rainfall are altered by wind. The importance of storm movement, due to the combined effect of wind and rain, on surface flows has long been acknowledged, at scales ranging from headwater scales (e.g. plots) to large drainage basins. All the processes involved (e.g. rainfall, wind, runoff, soil erosion), typically exhibit extreme variability. In regions where intense rainfall events are frequent these issues assume an increasing importance in a context of possible climate change scenarios.

The main objective of this work is to quantify the hydrologic response in terms of surface flows and soil loss caused by both non-moving and moving rainstorms. Results of a physically-based erosion model and laboratory rainfall simulations on soil flumes are presented. Controlled flume laboratory experiments were carried out using several soil flumes and a movable sprinkling-type rainfall simulator. To simulate moving rainstorms, the rainfall simulator was moved over the soil surface at different speeds. During runoff events overland flow and sediment transport were measured in order to determine hydrographs and sediment production over time. Granulometric curves, obtained through conventional hand sieving and optical spectrophotometer method (material below 0.250 mm), were constructed.

Both laboratory soil flumes and numerical model simulations showed that the direction of storm movement, especially in case of extreme rainfall events, significantly affected runoff and water erosion process. Downstream-moving storms caused significantly higher peak runoff and erosion than did upstream-moving storms. The hydrograph shapes were also different: for downstream-moving storms, runoff started later and the rising limb was steeper, whereas for upstream moving storms, runoff started earlier and the rising limb was less steep. The evolution of grain-size distributions of sediments generated during experimental simulations on a soil flume shows a clear dependence on the direction of storm movement.