Sediment load estimation of the Arroyo Cabrera, Spanish Central System, hyperconcentrated flow of 1997

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The Arroyo Cabrera watershed, in the Gredos Mountain Range of the Spanish Central System, is prone to catastrophic floods, as demonstrated by geomorphic evidences. On 17 December 1997, in response to a torrential storm, a debris slide that subsequently evolved to hyperconcentrated flow took place in the headwaters of the watershed. Field measurements, hydrogeomorphic and rainfall-runoff models, and hydraulic calculations made possible the estimation of sediment load for this event. To this end, the peak discharge was estimated using palaeoflood reconstructions combined with the critical-depth method and empirical equations. The value obtained is the result of the solid and water volume conveyed through the channel during the event. In order to separate both fractions, the critical rainfall, which is the minimum constant rainfall needed to cause instability was determined by implementing a physically based model of hillslope stability. This model combines steady-state hydrologic concepts with the infinite slope stability model and depends on soil properties and topography. Since critical rainfall is defined for 24-hour periods, this precipitation value was distributed over time based on rain gauges located within the catchment, and by applying a deterministic rainfall dissagregation method whose output reproduces some important statistical characteristics of the precipitation time series observed. The design-storm hyetograph was used as input to a semi-distributed hydrologic model to study the watershed response to the 1997 storm event. This precipitation-runoff model was previously calibrated using automated procedures based on both streamflow and rainfall data collected at 5-min intervals at the Arroyo Cabrera watershed. Finally, sediment load was defined by deducting peak discharges obtained from the application of hydraulic methods and the calibrated precipitation-runoff model.

Keywords: Sediment load; critical flow; rainfall disaggregation; semi-distributed hydrologic model; model calibration