Analysis of the triggering conditions of the Arroyo Cabrera hyperconcentrated flow in December 1997

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Processes such as debris and hyperconcentrated flows are normally triggered by heavy rainfall events. These flows deposit and redistribute large quantities of sediment, which is controlled by the episodic supply of hillslope material, and they may be a potential local hazard On December 17th of 1997, a hyperconcentrated flow took place in Arroyo Cabrera (Spanish Central System), which generated local infrastructure damages. The aim of this study is to calculate the critical rainfall that caused the instability. To carry out this investigation, a physically based model of hillslope stability has been used. It combines steady-state hydrological concepts with an infinite slope stability model. This model works with the following parameters: (a) morphometric parameters of the catchment, (b) thickness and transmissivity of the soil mantle and, (c) key geotechnical parameters such as moisture, porosity, specific weight, granulometry, cohesion, and angle of internal friction (obtained by geotechnical testing). The soil mantle thickness has been calculated applying Seismic Refraction Tomography in two cross sections, which add up to 108 meters long, obtaining the P-wave velocity models. With these models it is possible to analyze the geological stratigraphy. In order to calculate the transmissivity value of the soil mantle, a value of saturated hydraulic conductivity was estimated based on soil moisture data. There are three Time Domain Reflectometers (TDR) installed, and with the data collected from them, temporal and spatial soil moisture variability has been obtained. Subsequently, this variability was compared with the rainfall data registered by a gauge installed, and a good correspondence has been observed. As a result of the above investigations, the minimum value of rainfall, which caused the instability in the Cabrera Stream Catchment, was 182 mm/day, similar to other values proposed by other researchers in similar conditions.

Keywords: hyperconcentrated flow, critical rainfall, TDR, Seismic Refraction Tomography, Spanish Central System.