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Rainfall triggered hyperconcentrated flow in the Cabrera Stream catchment (Spanish Central System) in December 1997

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Debris flows and hyperconcentrated flows deposit and redistribute large quantities of sediment and they may be a potential local hazard. These flows are normally triggered by heavy rainfall during storm events.
The aim of this study is to calculate the critical rainfall, which triggered the hyperconcentrated flow that took place on December 17th of 1997 in the Cabrera Stream catchment (Spanish Central System) and generated numerous infrastructure damages. To carry out this investigation, a physically based model of hillslope stability has been used, which combines steady-state hydrological concepts with an infinite slope stability model.
This model works with the following factors, the morphometric parameters of the watershed, the thickness of the soil mantle, the transmissivity of the soil mantle and key geotechnical parameters such as moisture, porosity, specific weight, granulometry, cohesion, and Coulomb friction index. Beside all these, a detailed geomorphological analysis has been included.
A digital elevation model using a geographic information system (GIS) has been used to obtain the morphometric parameters of the catchment. Furthermore, a geomorphologic mapping has been done using the GIS.
The spatial variability of 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 P-wave velocity 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. Three Time Domain Reflectometers (TDR) have been installed since 2007. With the data collected from the TDR temporal and spatial soil moisture variability has been obtained. Subsequently, this variability was compared with the rainfall data registered by 6 raingauges installed along the catchment since 2004.
Original and altered samples of soil were taken to obtain the geotechnical parameters of the model.
As a result of the above investigations, the minimun value of rainfall, which caused the instability in the Cabrera Stream Catchment on December 17th of 1997, was 265 mm/day, similar to other values proposed by other researchers in similar conditions.