Modeling the impact of Hurricane Maria on Puerto Rico with an eco-hydrological landslide model

EGU24-14949, updated on 15 Apr 2024
https://doi.org/10.5194/egusphere-egu24-14949
EGU General Assembly 2024

Modeling the impact of Hurricane Maria on Puerto Rico with an eco-hydrological landslide model

Elisa Arnone[1,2], Evren M. Soylu[2], Furuya Takahiro[2], and Rafael L. Bras[2,3]
[1]DPIA, Università degli Studi di Udine, Udine, Italy (elisa.arnone@uniud.it)
[2]School of Civil and Environmental Engineering, Georgia Institute of Technology, Atlanta, USA
[3]School of Earth and Atmospheric Sciences, Georgia Institute of Technology, Atlanta, USA

This study proposes an advanced hydrologic/landslide modeling application to assess the spatial distribution of rainfall-induced landslides for a sub-basin in central Puerto Rico. The framework implements a stability component into a spatially distributed physically-based hydrological model coupled to a model of plant physiology. Puerto Rico is an ideal study site to assess the performance of landslide modeling efforts due to the availability of thousands of catalogued landslides triggered by Hurricane Maria (HMA) during September 19-22, 2017. The main objective of the study is to simulate the observed landslide events forcing a coupled eco-hydrological-stability model, the tRIBS-VEGGIE-Landslide, with weather data of HMA. The tRIBS-VEGGIE-Landslide model has the advantage of accounting for the vegetation dynamics that affect the soil moisture patterns at an hourly scale and for the soil-water characteristic curve and the saturated shear strength parameters (cohesion and friction angle) to assess the factor of safety (FS) in space and time, using an infinite slope model.

The modeling application focuses on two small sub-basins of the Rio Saliente watershed, each smaller than 1 km^2. The small study area allows for the use of a 5m DEM resolution topography, which has been derived from a 1m resolution LiDAR measurements. Since many radar and ground stations were destroyed during the hurricane, the hourly time series of the HMA event has been reconstructed by using the NCEP (National Centers for Environmental Prediction) – Environmental Modeling Center (EMC) gridded Stage IV data, produced by NOAA National Weather Service. The precipitation data resulted in a maximum hourly intensity of 64.52 mm/hr, maximum daily intensity of 294.56 mm/day, and rainfall total of 332.15 mm, consistent with other daily reconstructions. Preliminary results demonstrate the importance of the spatial computational mesh and accurate characterization of soil parameters, which play an essential role in simulating landslides with mechanistic models.