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Natural and human causes of a flash flood in a small catchment (Rhodes Island, Greece) based on atmospheric forcing and runoff modeling techniques

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This study investigates the natural (hydro-meteorological and geomorphological) and human induced factors responsible for a flash flood event that occurred on November 22nd, 2013 in a small ungauged catchment (covering an area of about 24km^2) of Rhodes Island, Greece. The flash flooding killed four people and caused over €10 million worth of damages located mainly around the Kremasti village.

In this study the reconstruction of this extreme hydro-meteorological event is attempted by using detailed spatiotemporal rainfall information, a physically based hydrological model (LISEM) and the 1D hydraulic model HEC-RAS. Furthermore, the human impacts, which are responsible for extreme flood discharge within the drainage basin, are recorded and mapped.

The major meteorological feature of this event is associated with the passage of a cold front over SE Aegean Sea. The destructive flash flood was triggered by the extreme precipitation (almost 100 mm in 4 hours was recorded at the meteorological stations closest to the flooded area). An advanced nowcasting method is applied in order to provide high spatiotemporal distribution of the precipitation over the catchment area.

OpenLisem (Limbourg Soil Erosion Model) is used as a runoff model for exploring the response of the catchment. It is a freeware raster model (based on PCRaster) that simulates the surface water and sediment balance for every gridcell. It is event based and has fine spatial and temporal resolution. The model is designed to simulate the effects of detailed land use changes or conservation measures on runoff, flooding and erosion during heavy rainstorms. Since OpenLISEM provides a detailed simulation of runoff processes, it is very demanding on input data (it requires a minimum of 24 maps depending on the input options). The PCRaster GIS functionality was used to derive the necessary data from the basic maps (DEM, land unit map and map of impermeable areas). The sources for the basic maps include geological, hydrogeological, and land-cover maps, as well as recent detailed orthophotomaps.

After the hydrograph was derived from OpenLISEM, the HEC-RAS hydraulic model is employed in order to route it through the Kremasti stream channel. This procedure served as a model validation since it provided the ability to compare the models' results against the 'high water' marks on the bridge and discuss issues such as surface roughness coefficient.