Reconstructing the Santa Tecla flash flood in the Ondara River (Ebro Basin, NE Spain)

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The Santa Tecla flood may be considered the most catastrophic rainfall event in the modern history of Catalonia (NE Iberian Peninsula), and one of the most important in the Western Mediterranean Basin. This event took place during the night between 22nd and 23rd September 1874, in which torrential convective rainfalls generated significant flash floods in most of the small streams in the southern half of Catalonia (i.e. Ondara, Corb, Francolí and Siurana catchments). More than 570 people died, 150 of which in the town of Tàrrega, by the Ondara River.

Despite being one of the last huge floods of the pre-instrumental era and, consequently, without any precipitation or flow data, the event was reconstructed both hydraulically and hydrologically for the Ondara River at Tàrrega (150 km2). Thus, the maximum water level and the temporal evolution of the flood were obtained, respectively, from several epigraphic limnimarks found in Tàrrega and from the event description recorded in historical documents. Additionally, the information from local archaeological sites allowed the reconstruction of the fluvial section at Tàrrega at the end of the 19th century. Finally, some old cellars flooded during the event provided information about sediment concentration at the peak flow.

The methodology put into practice for the event reconstruction had two stages. The first stage was the hydraulic modelling, which estimated the peak flow. The input data used were the maximum water level given by the limnimetric marks, a digital terrain model of the river bed shape, and the stream and floodplain roughness and channel slope (which were considered similar to the present ones, according to archaeological data). The hydraulic model used was the unidimensional HEC-RAS (USACE), applied in several cross sections of the Ondara River at Tàrrega.

The second stage was the hydrological modelling. The objective of this stage was to derive the event hyetograph from the above calculated peak flow and the hydrologic response of the basin. This hydrologic behaviour, that is the relation between the hyetograph and the hydrograph, was estimated taking into account rainfall duration (6-8 hours according to historical documents), basin characteristics, soil type, soil land use and cover and the antecedent soil moisture, using SCS Curve Number method. After that, a transfer Synthetic Unitary Hydrograph function and a wave propagation method (Muskingum) were applied to describe the discharge evolution and the water routing into the stream channel. The software used in this stage was the HEC-HMS (USACE).

The results of the hydraulic simulation at the Sant Agustí street cross section were the following: a) a maximum water depth of 6.16 m above the original river bed, b) a mean water velocity of about 2 m•s-1, c) a peak flow of 996 m3•s-1 (increased by 480 m3•s-1 from the Cercavins River downstream Tàrrega), and d) a specific peak discharge of the event of 6.6 m3•s-1•km-2, which exceeds the values of the 500-year return period floods compiled from the Ebro drainage basin systematic database.

From the information obtained in the flooded cellars, the sediment concentration during the peak flow was estimated in 11.2% (in volume), characteristic of a hyperconcentrated flow. The water level reached in the abovepresented cross section is partly explained by the recently discovered Sant Agustí Bridge, buried until now in the river bed.

The results of the hydrologic modelling were: a) a surface runoff total volume of 12 hm3, b) a runoff coefficient of about 35.5%, c) a lagtime of 2.5-3 hours, and d) if the previous soil humidity for the Curve Number method was low (situation I), a total rainfall of 225 mm with a peak intensity higher than 100 mm•h-1 is needed; if the previous soil humidity for the Curve Number method was medium (situation II), a total rainfall of 156 mm with a peak intensity of about 70 mm•h-1 occurs. Rainfall values for medium previous moisture condition (II) represent a 1000-year return period according to the regional systematic data.