Enlarged reconstruction of 1874 Santa Tecla flash floods in NE Iberian Peninsula

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In September 23 1874, a sudden and severe rainstorm caused multiple flash floods in many small catchments through an area of around 10,000 km² in NE Iberian Peninsula (Figure 1) .

Due to its magnitude, this event has been used as a case study in our multidisciplinary reconstruction methodology (historical, hydraulic, hydrological and meteorological).

So far, six peak flows and five hyetographs of six sites have been calculated (Figure 1 and Table 1; Balasch et al. 2010), and the synoptic atmospheric situation has been analysed (Ruiz-Bellet et al. 2013).

Our two next objectives are:

1) **to enlarge the list of reconstructed peak flows to better understand the storm's effects variability in space, and**
2) **to numerically quantify the atmospheric instability with convection to classify the meteorological process that caused the storm.**

Figure 1. Location of the area affected by the flood within Europe (a) and within the Iberian Peninsula (b), and location of the ten reconstructed sites (Table 1) and of the town of Valls (Table 2) within the affected area (c). Source: Own elaboration from a map Copyright © 2009 National Geographic Society, Washington, D.C.

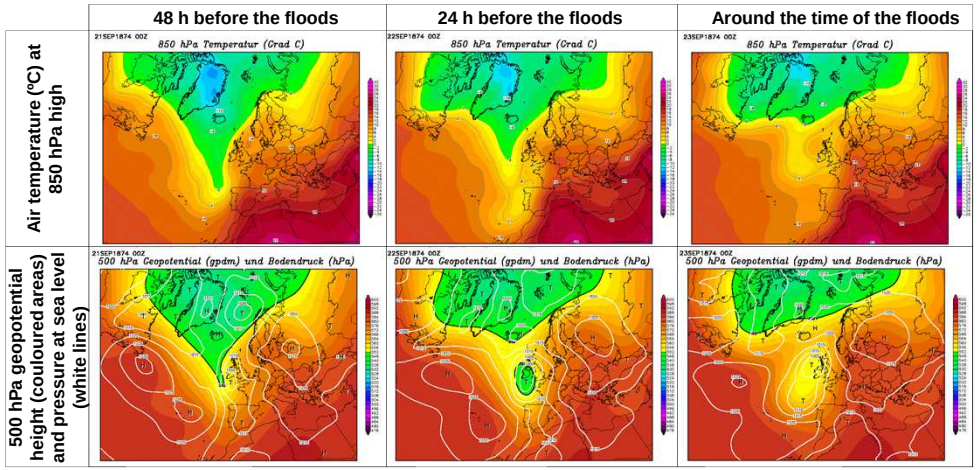

Figure 2. Air temperature (in ºC) at a height of 850 hPa (approx. 1500 m) (upper row), and (bottom row) 500 hPa geopotential height (couloured areas, in dam) and pressure at sea level (white lines, in hPa) the days around 1874 floods. **Notice the hot air mass (in dark red) at 850 hPa high crossing the Iberian Peninsula from west to east, the withdrawal of an air lid at 5500 m high, and the air depression at sea level that sent humid air from the Mediterranean onto the flooded area.** Source: Wetterzentrale.de from data by NOAA's 20th Century Reanalysis

The exceptionality of the event is confirmed by (Table 1) the extremely high specific peak flows in sites 3, 5, 8 and 9; the high rainfall depth and intensity; and the high return periods of the total rainfall (250-500 years) (Casas, 2005) and of site 4 peak flow (250 years).

Indeed, the rainstorm was caused by a severe convection situation (Table 2). This convection was due to the withdrawal of a mass of hot air at 850 hPa (approx. 1500 m a.s.l.) (Figure 2). It is the same process that caused the equally destructive 1962 floods in a nearby area.

These kind of events are difficult to foreseen by meteorological forecasts; our study's long-term aim is to detect potentially flood-causing meteorological situations.

Table 1. Results of the peak flow and the hyetograph reconstructions at the ten sites. Source: Own elaboration with the HEC-RAS and HEC-HMS models

				Peak flow reconstruction			Hyetograph reconstruction		
Site number in Fig. 1	River	Site	Basin area (km^2)	Peak flow ($m^3 s^{-1}$)	Peak flow return period (years)	Specific peak flow ($m^3 s^{-1} km^{-2}$)	Total rainfall (mm)	Total rainfall return period (years)	Maximum rainfall intensity (mm h^{-1})
1	Sió	Mont-roig	219	1120	---	5.1	112	250	56
2		Agramunt	214	1005	---	3.2	---	---	---
3	Ondara	Cervera	86	852	---	9.9	155	> 500	70
4		Tàrrega	150	1190	250	7.9	147	> 500	67
5	Corb	Vallfogona de Riucorb	46	452	---	9.8	---	---	---
6		Guimerà	91	410	---	4.5	114	250	61
7		Ciutadilla	123	580	---	4.7	114	250	61
8	Vall Major	Granyena de les Garrigues	50	580	---	11.7	---	---	---
9	Francolí	Espluga de Francolí	101	1183	---	11.7	---	---	---
10		Montblanc	344	1550	---	4.5	---	---	---

Table 2. Results of the convection indexes reconstruction at the town of Valls (see Fig. 1c) the days around the rainstorm, which occurred the night between 22 and 23 September 1874. Source: Own elaboration

Convection indexes	September 22 1874, 12 UTC	September 23 1874, 00 UTC	September 23 1874, 12 UTC	September 24 1874, 00 UTC	Explanation of the indexes' values
Convective Available Potential Energy, CAPE (km ºC)	62	67	65	61	66 ≤ CAPE ≤ 92 → severe thunderstorms likely
Lifted Index, LI (K)	-4	-11	-8	-6	LI ≤ -6 K→ severe thunderstorms likely
K-index, KI (K)	30.4	33	31.5	31.4	31 ≤ KI ≤ 35 → 60-80% thunderstorm probability
Vertical Total index, VT (K)	28.5	28	27	29	VT ≥ 26 K → thunderstorm prone weather
Cross Total index, CT (K)	21.9	23.1	22.4	23.4	CT ≥ 20 K → thunderstorm prone weather
Total Total index, TT (K)	50.4	51.9	50.9	52.5	TT ≥ 50 K → severe thunderstorms possible
Humidity index, HI (K)	16.9	16.5	16.1	20.3	HI ≤ 30 → thunderstorm prone weather

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