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Runoff variability of an extreme flash flood event on the Catalan Coastal System-Ebro Basin water divide (NE Iberian Peninsula)

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On the 22nd and 23rd of October 2019 a severe rainfall produced floods in the basins of the Catalan Coastal Range-Ebro Depression border (Francolí, Set, Femosa rivers) that affected various towns such as L'Espluga de Francolí, Montblanc, l'Albi, Vinaixa, among others, causing 6 deaths and material damages that exceeded 100 million euros. According to historical records, this rainfall episode would exceed the maximum rainfall estimates expected for 500 years in this region and the maximum heights reached by the water are comparable to, or exceed, those of the remembered Santa Tecla flash flood on September 1874, which would have a recurrence of more than 250 years.

This rain was caused by a S-SE warm and wet Mediterranean air mass over the Catalan Coastal System (Prades and Llena Ranges). The area of maximum rainfall was located at the headwaters of the rivers Set, Francolí and Montsant rivers, with rain depths above 200 mm. The hourly distribution at El Vilosell and Prades rain gauges shows 50 mm from 6 to 14 UTC and maximum intensity of 10 to 15 mm h⁻¹, followed by a second pulse of 180-220 mm from 16 to 01 UTC and maximum intensity of 65 mm h⁻¹ (maximum 3.1 mm min⁻¹).

Soil moisture content was low at the time of the rain after a dry summer. Early precipitation saturated the topsoil, therefore the soil surface was very wet at the beginning of the second rainfall event and it generated a hortonian overland flow. The highest rainfall intensity occurred around 19 UTC and the peak flow response was immediate, around an hour later, depending on the location.

Despite the similarity of rainfall and initial soil moisture conditions, the hydrological response in the two analyzed basins was markedly different. The flows generated in the Set River basin at l'Albagès reservoir produced a peak flow of 245 m³ s⁻¹ (1.5·m³·s⁻¹·km⁻²) and a very low flood runoff ratio of only 8%. In the basin of the Francolí River, at L'Espluga de Francolí, the peak flow was 1,300 m³ s⁻¹ (13 m³·s⁻¹·km⁻²) and the runoff ratio was of the order of 70%. The Set river basin is basically agricultural with terraced slopes that retained much of the precipitation, only released after the

flood as baseflow. The Francolí river basin has steeper slopes and channels and is dominated by an extensive tree cover but very poorer soils that caused little water retention, giving rise to a major hydrological response, an order of magnitude larger than that of the Set River.