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Description and analysis of major debris flows occurred during 2008 in the Eastern Pyrenees

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In the Eastern Pyrenees, debris flows are not as frequent as in other mountainous areas such as the Alps. Nevertheless, several important events have occurred in 2008 provoking damages to essential infrastructures and causing large economic loss.
A rainstorm at the beginning of June 2008 generated various surficial slides and debris flows in the area of Berga, located in the Pre-Pyrenees. A major flow obstructed the tunnel entrance of a national road during several days. Another rainstorm on August 1 caused several debris flows and debris floods in the Southern sector of Andorra, situated in the Axial Pyrenees. The most important event occurred in the Riu Runer torrent and destroyed the main building at the Andorran border. Finally, a large debris flow was triggered by a thunderstorm on September 11 near Rialp, Axial Pyrenees. Some installations of Port-Ainé's ski-resort were damaged and its access road was destroyed at several points.
Preliminary results of these three events are presented focussing on the initiation, flow behaviour and deposition processes. Moreover, the influence of human activity on the initiation was analysed. Field surveys and interpretation of aerial photographs are carried out in order to obtain geomorphologic information as well as data on the hydraulic characteristics. Additionally, rainfall as triggering is studied using records from nearby observation stations and data from weather radars. Finally, the dynamic behaviour is simulated at one site applying numerical modelling.
Volume estimates of the two events occurred in the Axial Pyrenees range from 5000 up to 10000 m3. These are rather large magnitudes compared to historic debris flows in the same area. The initiation process of both events can be defined as in-channel formation. Field observations indicated important erosion rates of up to 10 m3/m characteristic of the high flow velocities estimated along the flow trajectory. In contrast, the Berga event was caused by a surficial failure of about 600 m3 and a short runout distance with an almost neglecting erosion rate. Regarding the rainfall triggering, this event was triggered by a rainfall episode of moderate intensity over several days (152 mm in 4 days), reaching 45 mm in 4 hours and a peak intensity 23 mm/h. On the contrary, the other two events were provoked by convective summer storms of high intensity, short duration and limited spatial distribution. That's why the analysis of the rainfall records from the nearby stations only provides estimated thresholds (e.g. maximum intensity of $\tilde{3}$0 mm/h for the Riu Runer debris flow).