# Intense rainfalls, sediment availability and frequency of torrential flows at the Rebaixader catchment (Pyrenees)

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## ABSTRACT

Erosion and sediment transport in steep mountain catchments are mainly carried out by torrential flows; including both debris flows and debris floods. These flows are hazardous phenomena, typically triggered by intense rainfalls.

This study extends the analysis of rainfall events causing torrential flows in a test site in the Pyrenees (the Rebaixader catchment) made by [1] and [2]. The basin is a small (0.5 $km^2$) and steep one which has been continuously monitored since 2009 [2]. The sediment source is a glacial bouldery sand deposit 15 m thick; thus, sediment availability is apparently unlimited at the site. A rainfall threshold for the site is available in [2] and updated in [3] using data from July 2009 till September 2018. 11 debris flows and 22 debris floods occurred in this period. The threshold was calculated using rainfall events with a minimum daily rainfall of 10 mm, a time interval with no rainfall (IEP) of 1 h to differentiate rainfall events, and a lower intensity-duration threshold envelope including 90% of the flow events (herein called threshold A).

Herein, we have calculated A new threshold to consider all the rainfall events recorded in the site, does not restricted by a minimum daily amount. A set of threshold curves was obtained using nine different IEP values ranging from 30 min to 24 h and the lowest threshold envelope, including 100% of the flow events. The threshold corresponding to an 1 h IEP showed the maximum area under a ROC curve and was regarded as the optimum one (named threshold B). We have checked the predictive capability of both thresholds. The threshold A classifies correctly 79% of the rainfalls events as true positives and true negatives (success rate); however, rainfall events exceeding the threshold and that did not trigger flows (false positives) are common (76% of the positives were false). The success rate of threshold B is 89%, though the false positive ratio raised to 90%, though this threshold includes all the rainfalls recorded in the site (2670 events for 1h IEP instead of 479 events in threshold A) and does not miss any flow event. False positives in rainfall thresholds are common in the literature and usually represent >50% of positives [3], suggesting that other factors, as antecedent soil humidity or sediment availability, play a significant role in the formation of torrential flows.

A major change in the response of the catchment to rainfall was noted in summer of 2015. The frequency of the rainfall events exceeding the threshold (B) was doubled whereas the frequency of flow events reduced more than half. Consequently, the frequency of false positives increased significantly (it was multiplied by a factor of 2.5). 68% of the false positives occurred since summer 2015. The change of behaviour followed the occurrence of a large debris flows (14000 $m^3$) in august 2014, the second biggest registered in the site. This debris flow initiated at the bottom of the source area, and eroded it markedly. Furthermore, a wall of large boulders formed some meters upslope the debris flow scar. This wall might be operating as a check dam, trapping the sediments. The former findings suggest that sediments are stored temporally at the bottom of the source area, which has a typical funnel shape; and that sediment availability here exerts a major control in the formation of torrential flows.

## REFERENCES

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