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Peculiar debris-flow event of June 2013 in Livingstone mountain range (Alberta, Canada)

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Heavy precipitations occurred in western Alberta in mid-June 2013, which lead to several floods. In particular, this event produced a lot of debris-flow in the area of Mount Livingstone Alberta, Canada (N50° 8' 24.20", W114° 24' 19.69"). The area is mainly composed of folded Devonian to Jurassic carbonates. The peculiarity of the event is that the initiations of the debris-flows were located high in scree slopes, with reduced contributing area. No debris-flow deposits anterior to that event are visible, which contrasts with the number of simultaneous events ($\sim$30) triggered by this specific precipitation period (up to 220 mm in 36 hours).

Fieldwork was carried out in July, less than one month after this event. Extensive photographic and Terrestrial Laser Scanner (TLS) data was acquired. In-line grain-size distribution, fine matrix sampling and cross-sections of the debris flow channel were performed at the initiation zone, the propagation zone and deposition area.

Samples are analyzed by sieving as well as using laser diffraction methods for fine materials. Morphologic characterization is performed through pre-event HR-DEM (1m cell size) and TLS point-cloud comparison, along with cross-sections. Volumes can thus be calculated. The pristine debris-flow lobes, levees and source areas allowed the dynamic of the different debris-flow pulses to be reconstructed. Comparison between 2012 and 2013 field photographs emphasize the radical morphologic change caused by this single event on an apparently dormant erosion context.

The conditions of initiation of the debris flows are compared with literature values, in term of slope, contributing area and saturation of the scree material. Preliminary analysis indicates that these debris-flows started at unusually low slopes in regard to the contributing area. This reinforces the extreme character of this event, attributed to two identified causes: the accumulation and weathering of rock debris in the scree slopes over time and the variability of permeability between the layers of the scree or at the interface with the bedrock, including the possibility of karst.

This study, thanks to its extensive dataset and combination of methods, sheds a new light on a poorly known debris-flow initiation context. It points out the role of single high-magnitude pulse events as a dominant factor in term of mass wasting, after an extended period of scree accumulation.