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The comparison between two airborne LiDAR datasets to analyse debris flow initiation in north-western Iceland

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A debris flow is a very rapid to extremely rapid flow (e.g., 0.8-28 ms^{-1}) [1], that occurs when coarse and poorly-sorted debris, mixed with water and/or air, move down hill slopes in response to gravity [2]. Both the fluid and the solid have a strong influence on the movement of debris flows. They can be extremely destructive, due to their capability of transporting metre-size boulders [e.g., 3, 4].

There are two main ways in which a debris flow can be initiated: by slope failure or by the “fire hose” effect. The slope failure type is particularly common in alpine regions, where landslides can evolve into debris flows [5], triggered by the coalescence of different slope failures. Steep slope gradients, high pore-water pressures, heavy rainfall and/or snowmelt favour this process. The “fire hose” effect occurs when there is a high concentration of debris accumulated within a pre-existing channel; a surge of water through the channel can then develop into a debris flow by incorporating this debris [e.g. 5-7].

In this study, we examine the triggering style of debris flows above the town of Ísafjörður in the Westfjords of Iceland. The slope above the town is characterised by a large topographic bench upon which 20-35 m of glacial till is perched. The sediments are unstable at the bench margin and thus generate frequent, large, hillslope debris flows [8, 9]. In our new analysis, we report on the comparison between the two airborne LiDAR elevation models (collected in 2007 and 2013 by the UK Natural Environment Research Council Airborne Research and Survey Facility), which display several new debris flows and also related mass movements. From these analyses, we find that debris flows in the region are triggered by simple failure of the glacial till, as recognised before [8, 9]. However, debris flows may also be regenerated by the “fire hose” effect, when debris that has collapsed into chutes is remobilised by a later snowmelt or precipitation event. Comparing different airborne LiDAR datasets has proven to be a powerful tool, not just in the topographic analysis of landscape, but also in the discrimination of the causes of potentially disastrous phenomena. This suggests new possibilities for using remote sensing analysis to mitigate the effects of natural hazards.

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