A 4-D reconstruction of post debris-flow sediment dynamic inferred from multi-temporal terrestrial laser scanning and photogrammetry (Roßbichelgraben, Germany)

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Debris flows are destructive mass movements in steep alpine torrents. Due to their high magnitudes and impact pressures economic goods and human lives are threatened in inhabited areas. The amount of entrained material depends largely on the mobilisable loose debris available for transport, which in turn controls debris-flow mobility and runout. However, still very limited data exists regarding rates and controls of sediment recharge in debris-flow channels.

In June 2015 an extraordinary rainfall event triggered a debris flow in the Roßbichelgraben torrent in southern Germany. Twelve terrestrial laser scan campaigns (> 450 scans positions) and nine temporally synchronised UAV surveys were carried out between June 2015 and September 2019. Both TLS and SfM-based photogrammetry reveal the temporal, spatial and seasonal sediment dynamic in the channel. A nearby meteorological station recorded the rainfall intensity in 10 min intervals. The results show that both terrestrial laser scanning and SfM-based photogrammetry provide equivalent erosion and deposition volumes (difference < 5%). Between June 2015 and September 2019 the channel was refilled with material of adjacent slopes and the above lying catchment (= 1.2 m³/d), whereby a higher activity was observed in summer than in winter. In addition, the activity decreased with elapsed time since the debris-flow event, as most over-steepened river banks failed shortly after the event and stabilised over time. Short, intense rainstorm events best explain the sediment dynamic in the channel (R² up to 0.9).

The results contribute to better understand the sediment dynamic in highly active debris-flow channels and allow for a more reliable estimation of potential debris-flow volumes.