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Recent sediment dynamics in the landslide-debris flow complex of the Sattelkar, Obersulzbachtal, Hohe Tauern

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High mountain landscapes are dynamic and heterogeneous environments shaped by diverse geomorphological processes, serving as primary sources of sediment and water with significant implications for downstream areas. Climate change can reduce slope stability and thus increase sediment availability. Yet, given the mixed influences of temperature and precipitation, the impact of climate change on mass movements remains unclear. The Sattelkar cirque in the Hohe Tauern mountain range, Austria, has experienced significant landslide activity since 2003. In 2014 a catastrophic debris flow delivered 70,000 m³ of sediment from the cirque and mobilised a total of 170,000 m³, resulting in severe damage to the Obersulzbach Valley.

This study quantifies sediment dynamics based on a multi-temporal surface change analysis. Using high resolution digital elevation models (DEMs) of 2012-2023 surface processes are quantified and interannual dynamics are reconstructed for the cirque area and the adjacent debris cone. Additionally, sediment availability and exhaustion within the active landslide area are reconstructed based on an assessment of sediment volumes in the cirque area.

In 2012-2023, 920,000 m³ (83,000 m³/a) of sediment was discharged from the cirque, of which 540,000 m³ (39,000 m³/a) accumulated at the debris cone. Over the study period, the average sediment discharge from the cirque increased slightly by 1,440 m³/a, whereas the debris cone grew by 2,980 m³/a. While the sediment dynamics in the area of the cirque show significant spatial and quantitative variations between years, the sediment balance of the debris cone fluctuates only slightly. Yet, in years of high sediment discharge from the cirque, strong height differences in the channels and extensive accumulation areas in the lower debris cone occur. Based on the sediment dynamics of recent years and a remaining sediment volume of 1,000,000-1,800,000 m³, depletion is expected between 2033 and 2042.

This study provides estimates of expected sediment dynamics of the Sattelkar landslide-debris flow complex. Together with ongoing monitoring, the investigations enable a hazard assessment based on sediment availability near the cirque threshold.

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