



## **The role of alpine rockfall aquifer systems in baseflow maintenance and flood attenuation**

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Rockfall masses are frequent in alpine valleys. Huge rockfalls (millions to billions  $\text{m}^3$ ) precipitated after the end of the last glaciation, but many large events (thousand to millions  $\text{m}^3$ ) have occurred in historical time, and increasingly during the past decades, as a result of glacier retreat and thawing of permafrost. Most hydrological research focuses on water as a cause or trigger of rockfalls, while much less research has been done on the hydrogeological properties and functions of rockfall masses in alpine valleys. We have studied a series of rockfall and alluvial aquifer systems in the Reintal valley, German Alps, where all surface water infiltrates underground and reemerges downgradient from the rockfall masses. The goal of the study was to characterize the role of this rockfall aquifer in baseflow maintenance and flood attenuation. Employed methods include geomorphological and hydrogeological mapping, tracer tests, and continuous flow measurements. Field observations have revealed that both the infiltration and exfiltration locations vary as a function of the hydrologic conditions. Underground flow path length range from 500 m during high flows to 2 km during low flows; measured groundwater flow velocities range between 13 and 30 m/h; lag times between upstream and downstream flood peaks are 5 to 101 hours. Flood peaks were dampened by a factor of 1.5 and the maximum discharge ratio (22) and peak recession coefficient (0.2/d) downstream are very low compared with other alpine catchments. These results indicate that rockfall aquifers can play an important role in the flow regime and flood attenuation in alpine regions.