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Large Rock-Slope Failures in the Southern Alps of New Zealand

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This contribution reviews current knowledge on large rock-slope failures in the tectonically active Southern Alps of New Zealand. The mountain belt is subject to high uplift ($<$10 mm/yr), episodic high-magnitude earthquakes, and extreme orographically-enhanced precipitation. The main predisposing factors for rock-slope failure include reduced rock-mass strength due to earthquake shaking, slope debuttressing by deglaciation and river incision, gravitational stress, and slope dilatation following precursory landsliding. Several reports on rockslides in the region suggest that high-intensity rainstorms, fluvial undercutting, and seismic ground shaking are among the most probable trigger mechanisms.

Over 120 locations of large rock-slope failures (arbitrarily defined here as extending over an area >1 km^2) are presently compiled in a regional inventory. These large failures dominate the total area affected by landsliding ($>$500 km^2), although they are by far less numerous than smaller landslides. In the western Southern Alps, a negative power-law relationship between spatial density of landslides [km^{-2}] and landslide area [km^2] is applicable to large rock-slope failures also. This is surprising, given the lack of absolute ages, and thus uncertainty about the temporal observation window encompassed by the data.

Rock avalanches and sackungen are characteristic failure types in the greywacke terrain in the eastern and central Southern Alps. In the schist terrain of the western Southern Alps many failures are complex deep-seated rotational rockslides and sackungen, involving between 10^6 and 10^{10} m^3 of material. Most of the rock-slope failures are inferred to be of postglacial and pre-historic (i.e., pre-1840) age, while several low-displacement features appear to be dormant. Locally, ridge rents may be interpreted

as precursory phenomena of accelerated or even catastrophic failure.

From a landslide hazard perspective, the currently high probability for a $M \sim 8$ earthquake in the region raises concerns about a regional coseismic landsliding episode potentially affecting $\sim$10,000 km^2 of mountainous terrain. Numerous locations of mainly breached rockslide and rock-avalanche dams in the Southern Alps attest to the possibility of synchronous and short-lived blockage of major alpine rivers following such an event. Historic case studies on aseismic landslides causing outburst floods and massive sediment slugs serve as templates for assessing adverse impacts on housing, infrastructure, and World Heritage tourism facilities in the Southern Alps and their adjacent surrounds.