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Rock avalanches and topography - a temporally and spatially dynamic natural hazard

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In the past two years rock avalanches have killed in excess of 2000 people and can be considered at the extreme tail of landslide distribution statistics. This paper focuses on three discreet events with different final triggering mechanisms that allowed the rock masses to cross a critical strain threshold resulting in catastrophic, and to be discussed, arguably predictable failures. All three rock masses exhibited precursory phenomena as surface deformation and minor landsliding over a period of weeks or years before final failure as derived from landslide inventories and eyewitness reports. Although the final trigger varies, the primary forcing factor has been tectonic production of relief and rock mass structure sufficient to allow the rock avalanche process, and indeed require it as minor mass movement and stream flow has been insufficient to relieve the rapid tectonically derived topography.

The three events, Leyte (Phillipines), Tsatichhu (Bhutan), and Hattian Bala (Pakistan) all have significantly reduced the average topography or their contributing drainage basin but are in differing stages of dispersing the eroded mass downstream and out of the mountains. The mechanisms of rock-avalanche dam formation, failure and subsequent long-term downstream debris dispersal exemplified by the Tsatichhu event, are poorly constrained and require a greater degree of interdisciplinary monitoring and modelling at case study level and as regional contributors to mountain topographic destruction, and valley fill production and transport.

The direct hazard associated with rock avalanches varies spatially though surrounding topography, and temporally as a function of both tectonic processes such as uplift and earthquakes and with climatic conditions, the change in the latter is expected to trigger new events at a higher rate. After failure the ‘cascading’ hazards increase spatially through lake formation, dam bursts and aggradation over a number of timescales

that require quantification for both risk assessment and the temporal contribution to sediment flux.