Geophysical Research Abstracts,
Vol. 10, EGU2008-A-06213, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-06213
EGU General Assembly 2008

Multiplie occurrence regional landslide events: a complex and simple response to land use change

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Landsliding can be shown to be the dominant geomorphic process in many parts of New Zealand, and is particularly prevalent in those hill country regions that experienced rapid and extensive deforestation with 19^{th} and 20^{th} Century land use change. Of particular importance are episodes of extensive slope failure associated with intense rainfall and seismic triggers. Mass movement response to triggers such as these can be localised, but is more often regional in its extent, reflecting the spatial distribution of the triggering energy. Multiple Occurrence Regional Landslide Events (MORLEs) have a number of defining characteristics: they involve multiple mass movement failures, with effects on a regional scale; they are 'events' in the sense that they are a response to a temporally discrete trigger, typically storm rainfall or seismic shaking.

Geomorphic response is complex, and MORLEs have generally been characterised in a frequency/magnitude framework. The most widely documented of these events in recent times, Cyclone Bola (1988), has become the de facto benchmark against which other events are compared. This may have validity in an economic sense. Yet in many ways, this means of characterisation has no geomorphological basis. Rainfall magnitude is often used as a surrogate index for the magnitude of geomorphic events. Yet there is clear evidence that rainfall events of given magnitude can have very different impacts in terms of, for example, landslide density or total volume of sediment mobilised. Characterising the geomorphic event itself is problematic. It is difficult to quantitatively define the extent of landsliding, and typically an envelope will be used to delimit the affected region. Nevertheless, within an envelope defining a rainfall-triggered event impacts can vary substantially. Density of landsliding varies considerably, influenced by local precipitation, topography, vegetation, slope hydrology and

contemporary landsurface condition. For example, the density of landsliding produced by Cyclone Bola at Tutira varies considerably when measured over a range of spatial scales, although data suggest asymptotic behaviour of the relation between spatial scale and density at approximately 25 km^2. Objectively quantifying the geomorphic significance of MORLEs is difficult. Although the geomorphic work they perform over a discrete period can be measured, this does not necessarily fully reflect their geomorphic significance in terms of, for example, their contribution to regional sediment fluxes and landscape development. While MORLEs exhibit frequency/magnitude behaviour that is asynchronous with that of fluvial sediment transport, and it can be argued that mass movement directly produces only a small proportion of the terrestrial/marine fluvial sediment flux, it is nevertheless clear that there is a complex interaction between these two broad divisions of the terrestrial sediment budget; if episodic hillslope sediment supply were shut off, overall sediment flux would ultimately be dramatically reduced – because fluvially entrained sediment is frequently derived from storage sources generated by mass movement processes. Hillslope mass movement is thus an integral component of the medium- to long-term regional sediment flux.

At broader spatiotemporal scales, the response can be described more simply. Clearly, mass movement produces morphological change at local scales. Cumulatively MORLEs also make a contribution to medium- to long-term landform development. At the scale of the low order drainage basin, mass movement source slopes develop an enhanced micro-topography of swales and sharply defined spurs. Beyond the primary source area, however, topography can become subdued as colluvial material overprints the existing fluvial signature. In terrains dominated by MORLEs, colluvial footslopes and fans act as buffers between hillslope and channel, controlling sediment delivery and landform development. The significance of MORLEs, and the land use change which is an underlying causal factor, can thus be assessed from the extent to which the landscape shows the imprint of these phenomena, Variation in the extent of this imprint over time and space may be an important indicator of changing environmental and geomorphic boundary conditions.