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Landslides predating and triggered by the 2005 Kashmir Earthquake: rockfall to rock avalanches

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The 8^{th} October 2005 magnitude 7.6 Asian Earthquake killed an estimated 88,650 people in Pakistani and Indian-administered Kashmir, of whom 25,500 can be attributed directly to seismically triggered landslides. The landslides are distributed unevenly and strongly clustered on the hanging wall of the fault reflecting the crustal deformation during the event. Within these statistics, 3.9% of the landslide fatalities, some 1000 people, were killed by the 68 x 10^6 m^3 Hattian Bala Rock Avalanche, the largest mass movement associated with the earthquake.

This paper reports on the catchment upstream of the rock avalanche deposit that currently forms a landslide dam with considerable future risk implications. The catchment of 78 km^2 contains the trace of the earthquake causative Tanda Fault and divides steep hanging wall topography from that of the footwall to the west. Imagery from 1992, 2001, 2005 and an image acquired using the new 2.8 m resolution TopSat microsatellite revealing the situation one year on from the earthquake have been examined for evidence of landsliding. A total of 183 landslides have been mapped in the catchment, with a considerable number predating the earthquake, a feature neglected in recent papers describing the slope response of the region. Of the pre-existing landslide population, the largest mapped event rivals Hattian Bala in extent though differs in process being a creeping rotational failure. The landslide population both pre- and post-earthquake in this sub-sample of the total number of landslides mapped in the earthquake affected region (2,424 as mapped by other authors) is best described by a lognormal distribution based on slide areal extent up to 100,000 m^2 above which the relationship breaks down. The study allows for discussion of the relevance of pre-existing landslides, few of which were truly reactivated but were clustered in the same region of the future co-seismic landslides, and the ongoing landslide hazard. In particular, field mapping suggest the presence of a far larger population of seismically

triggered incipient landslides, currently only defined by tension cracks that will not be evident to remote sensing for several years to come.