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Knowledge guided selection of geofactors in quantitative landslide hazard assessment in the Darjeeling Himalayas, India

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For the generation of a medium scale landslide hazard assessment using statistical methods, it is very important to have a good separation of the landslide inventory into different landslide types and failure mechanisms, and to have a good understanding of the causal factors involved. The above task was achieved through understanding the failure mechanisms of each landslide type during detailed field investigations and correlating the associational spatial behaviour of probable causal factors with the respective landslide types. This paper presents the structure of a knowledge-based system of terrain evaluation for the optimal selection of geofactors and determination of their weights using a number of quantitative data integration methods. The Darjeeling Himalayas experience a variety of landslides and failure mechanisms owing to the interplay of various related geofactors, which are associated with the prevalent geological, geomorphological and tectonic processes of Himalayas. To investigate the relationship between relevant geofactors and various landslide failure mechanisms, a case study in the Lower Himalayas of Darjeeling has been taken up, where ENE-WSW to NE-SW trending thrusted formations ranging from Tertiary clastic sediments to Precambrian crystalline gneisses are exposed. Two main groups of failure mechanisms are predominant in the study area: the first group consists of small ($<$ $\sim$10,000 sq. m. in area), shallow translational debris and debris/rock slides and the second group consists of

large (∼10,000 sq.m. up to 60,000 sq.m. in area), deep-seated rock failures (both planar and wedge). The relevant preparatory geofactors consist of a number of obvious ones, such as lithology, geological structure, slope steepness, land use types, road cuts. Apart from these, also specific factors have been identified, such as the accumulation of thin scree and colluvium over weathered and jointed rock mantle, toe erosion due to road cutting or by streams, barren or sparse vegetation etc. for group 1 slides., Concentrated antecedent rainfall of 1 to 3 days is found instrumental in triggering of landslides of this type, whereas for large, deep-seated rock slides, the antecedent rainfall of a longer period is more relevant. Continued mass wasting and reactivation of old landslides, presence of incompetent and deformed rock masses close to regional thrusts, unfavourable orientation of slope/ aspect in relation to the attitudes of prominent discontinuity planes in bedrock and erosional activity along drainage systems could be the relevant causal factors of such large deep-seated rock slides. Landslide susceptibility prediction in the study area with moderate to high prediction rate was achieved by taking into account the major failure mechanism types and their relevant geofactors following a knowledge-guided quantitative method.