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Rockfall Activity in Nepal Himalaya: A Case Study of Kangchenjunga Area

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Rockfall is a major geomorphic process in mountain slope denudation in cold, wet and arid periglacial environment such as the Himalayas. It occurs in cold mountains due to several weathering processes, including freeze thaw cycles, frost wedging, and expansion and contraction of joints. These processes are to some extent moderated by structure of bedrock and its exposure to thermal regime. Processes such as frost shattering, crack movements and cliff retreat have been addressed in many previous studies (Ballantyne and Eckford, 1984; Fahey and Lefebure, 1988; Hall, 1999; Ishikawa et al. 2004). In Himalaya, rockfall activity has been studied in terms of ambient air temperature and precipitation at altitude below 4500 m (Matsuoka, 1984; Shiraiwa 1992).

In this study Rockfall activity and related environmental factors (e.g., bedrock thermal regime, freeze-thaw cycles, frost wedging, precipitation) were monitored and evaluated at altitudes above 4600 to 6800 m in the Kangchenjunga Valley of Nepal Himalaya for the purpose of (a) establishing an in depth statistical profile of the rockfall dynamics at altitudes above 4500 m; (b) assessing rockfall frequency and rockwall retreat rate in different aspects; (c) assessing temporal and spatial variations in rockfall activity.

For this purpose, rockfall were monitored in pre-monsoon, monsoon and post-monsoon season. The percentage of the exposed bedrock (snow free area) in different seasons was calculated using photographs taken during intermittent stay in the field. The contribution of frost wedging in the expansion and contraction of the joints were evaluated using the crack extensometer following Matsuoka (2001). The rock surface temperatures were monitored at nine different sites representing different aspects at an

altitude ranging from 4947 m to 6000 m. The volume of rockfall was calculated from a total of 100 rocks randomly sampled below rockwall at four different sites representing different aspects. Finally, the rockwall retreat rate was computed using the average volume of 100 sampled rock accumulated on talus slope from rockfall activity.

Result of the study indicates that (1) the interaction of bedrock thermal regime and moisture plays a dominant role in rockfall activity; (2) seasonal freeze-thaw action produces bigger boulders, less frequent rockfall, and greater cliff retreat than diurnal freeze-thaw cycle; (3) frost shattering, crack movement, and other cliff retreat processes are moderate to some extent by the structure of the bedrock and by the level and duration of its exposure to sunlight and other elements. For example, north- and south-facing slopes exhibit seasonal and diurnal retreat characteristics relative to their distinct solar exposures; i.e., rockfall activity is greater on the more solar-exposed east-west and south-facing slope; and the north-facing slope experiences its peak rockfall activity during the relatively warm and wet monsoon season.

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