chapter 6

landslide hazard zonation

introduction

Landslide Hazard Zonation mapping has been attempted in different parts of the world for nearly three decades. It implies the identification of zones in a mountainous terrain having varying degree of proneness to landslides. Sharan (1995) states that LHZ maps are prepared to evaluate landslide susceptible zones. However, the prediction of mass wasting events in an area remains enigmatic, both in time and space. The present attempt at zonation mapping of Kohima Town takes into account the topography, lithology, structural details, geohydrology, and land use and land cover. The maps thus prepared are superimposed to provide essential data for the Landslide Hazard Zonation (LHZ) maps. Such maps are useful in that they provide data regarding stability of areas. Hence, high instability risks can be minimized or avoided. The Landslide Hazard Zonation map can play a significant role in minimizing loss to life and property and to give a boost to development.

Several workers, spanning nearly four decades, attempted Landslide Hazard Zonation by Cartographic methods. Today Remote Sensing and GIS with the help of computers have changed the scenario. Slope surfaces may be divided into different categories related to stability if the required information on terrain characteristics is available. Geological formations of different lithologic groups that are combined with slope categories, below and above the critical, have been used to prepare Landslide Hazard Zonation maps by Blanc and Cleveland (1968) for Southern California. The San Francisco Bay region was studied by Nilsen and Brabb (1972) using maps showing geological formations, slope ranges, and landslide debris to prepare a Landslide Zonation map. On the basis of percentage of outcrop area of a formation occupied by landslide debris in combination with
slope categories Brabb et al (1972) have rated the slope stability of geological units in San Mateo County. Radbruch and Crowther (1973), in California, classified the area on the basis of lithology and the number of landslides present. In the United States, Radbruch et al (1976) considered the frequency of slope failure in different groups of geologic units. A similar grouping of lithology and mass movements was used by Rodriguez et al (1978) in southern Spain.

The ZERMOS method of hazard mapping adopted in France includes factors like lithology, structure, slope morphology, and hydrology where the mapped area is divided into four zones of different levels of hazards with types of movement and direction, activity, and sites of erosion that are noted using different symbols. Varnes (1980) prepared a Landslide Zonation map using slope, soil thickness, land use practice, and drainage as the basic factors. The type of rock fracturing, weathering characteristics, springs, vegetation, valley slopes, etc. were taken into account to describe methods for making Debris Flow Hazard maps (Takie, 1982). Hansen (1984) discussed two principal categories of Landslide Hazard mapping, namely direct and indirect mapping. Kawakami and Saito (1984) used valley density, elevation, slope angle, and formations for preparing a quantified landslide risk map. Brabb (1984) provided a useful review of development of Landslide Hazard mapping. Risk maps for road alignment using geologic, structural, slope, and geomorphologic factors was also prepared for rock and debris slide (Wagner et al, 1987). Koirala and Watkins (1988) described a slope ranking system mainly for adopting preventive measures during excavations. Fugita (1994) worked out the relationship of landslides with the geomorphologic and geological features of SW Japan.

In India too several workers have attempted LHZ mapping considering various factors of the terrain. Using numerical ratings of slope, land use, soil cover, and drainage, and depending on the frequency of landslides, Seshagiri and Badrinarayan (1982) carried out the zonation of the Nilgiri hills. Hazard Zonation studies were taken up during 1984 at four locations in North and East Sikkim (CRRI, 1989). On the basis of the nature and characteristics of the rock and soil materials the overall stability of the slope constituting the slope formation, the slope angle, condition of the slope surface, hydrological features, and toe erosion
was assessed quantitatively. In this study the overall rating of slope stability was divided into three categories, viz., very good, good, and fair. Similarly Gupta and Joshi (1990), using a GIS approach, worked in the Himalayas where an index value was given to factors like land use, lithology, major tectonic features, and azimuth of landslides. Considering slope, lithology, structure, and earthquake epicentres a LHZ mapping was constructed in the Garhwal Himalayas (Choubey and Litoria, 1990). Mehrotra et al (1992) attempted an empirical approach for LHZ mapping based on a Landslide Susceptibility Index (LSI) using factors like lithology, slope angle, distance from major thrusts and faults, land use pattern, and drainage density in relation to frequency of existing landslides. Anbalagan (1992) carried out Landslide Hazard Zonation mapping of the Kathgodam-Nainital area in the Kumaon Himalayas. This was prepared based on slope, lithology, structure, relative relief, land use and land cover, and groundwater conditions. For preparation of the LHZ maps he proposed the Landslide Hazard Evaluation Factor (LHEF) rating scheme. This method is suitable for zonation mapping of mountainous terrain. The method involves demarcation of facets, preparation of thematic maps, estimation of LHEF ratings, calculation of Total Estimated Hazard (TEHD) values, and construction of Hazard Zonation maps of the area. Kohima Town is studied following Anbalagan (1992) and the recommendations of the DST (1994). However, difficulties exist in preparing Hazard Zonation maps. This is mainly due to the paucity of data on topography, climate, geology, hydrogeology, seismicity, and anthropogenic activity, and their components or variables (Thigale et al, 1998).

LANDSLIDE HAZARD ZONATION MAPPING

The Landslide Hazard Zonation maps of this area indicate that the area of investigation is made up of categories of land comprising low, moderate, high hazard, and very high hazard zones. The low hazard zones together cover an area of about 0.18 sq kms. This represents 1.63 percent of the total area of investigation. Medium hazard zones occupy an area of 5.28 sq km which represents 47.74 percent of the area while high hazard zones are noted in an area of 4.39 sq km, i.e.,
39.69 percent of the total area. Very high hazard is noted in 1.21 sq kms that represents 10.94 percent of the area of investigation. Detailed Landslide Hazard Zonation mapping on closer domain may be carried out for the High Hazard and Very High Hazard zones to accurately assess the causative factors and evolve precautionary and mitigation measures.

Segment 1

Segment 1 is made up of categories including low hazard, moderate hazard, high hazard, and very high hazard zones (Fig. 6.1). Low hazard is noted in 0.1 sq kms which represents 1.94 percent of segment 1. Medium hazard zones are noted in 2.43 sq km that represents 47.1 percent of the segment while high hazard zones cover are noted in 2.17 sq km, i.e., 42.05 percent of the area. Very high hazard is noted in 0.46 sq kms, i.e., 8.91 percent of the area of segment 1. The different categories of hazard in relation to TEHD values for this segment are given in table 5.2a.

Segment 2

In segment 2 also the same four categories of hazard zones are identified (Fig. 6.2). Very high hazard is noted in 1.21 sq kms that represents 10.94 percent of the area of investigation. Detailed Landslide Hazard Zonation mapping on closer domain may be carried out for the High Hazard and Very High Hazard zones to accurately assess the causative factors and evolve precautionary and mitigation measures.
Fig. 6.1
LANDSLIDE HAZARD ZONATION
I. INTRODUCTION

Schoonder (1997) opines that landslides affect the natural habitats. Paleotempos are essential in a observation in that whenever such slides occur, the surface is exposed to natural forces. The exposure is due to the incident of landslides. The section of the soil is then exposed to various elements of the environment.

7.1 CHAP.

7.1.1 Introduction

The Chempahundy valley is located at 25°39'36" N latitude. It is a part of the length of the valley in which a landslide has occurred, that is, a major depositional event. This landslide is categorized into four hazard levels: low, medium, high, and very high.