Landslides in India: Issues and Perspective by Dr. V.K. Sharma, Expert/Adviser: Engineering Geologist, Water Resources, Govt. of Bihar, Patna and Former Deputy Director General, Geological Survey of India

Landslides in India are one of the major hydro-geological hazards affecting large parts of landmass of the country. The landslide hazards in mountainous environment are the threat to our infrastructure, communication, water resources, transmission line projects, open cast mines, tunnels, heritage buildings and urban development etc. About 0.42 million sq. km or 12.6% of land mass, in India is prone to landslide hazard. As per the estimates of the Geological Survey of India (GSI) 0.18 million sq. km falls in Northeast Himalaya, including Darjeeling and Sikkim Himalaya; 0.14 million sq. km falls in Northwest Himalaya; 0.09 million sq. km in Western Ghats and Konkan hills (Tamil Nadu, Kerala, Karnataka, Goa and Maharashtra) and 0.01 million sq. km in Eastern Ghats of Aruku area in Andhra Pradesh. The national perspective towards landslide mitigation is gradually growing in view of the burgeoning settlements over hilly slopes across the country. Landslides are significant amongst those hazards that can be impulsively disastrous to human life and property in a sudden hydro-meteorological situation largely driven by the climate change scenario in Indian subcontinent. The sub-continent is characterised by a great and diversified group of physical features such as Himalayas and other ranges, Indo-Gangetic plain, Thar deserts and coastal belts and Islands region.

The Himalayan mountains is most unstable ecosystem, characterized by immature and rugged topography, fragile rock conditions, high seismicity resulting from proximity to the plate margins, and high rainfall which persistently modify the slope profiles. The region has inestimable landslides of almost all varieties. The extensive anthropogenic interference, as part of developmental activities, is another significant factor that increases the landslide hazard manifold. In addition, the reactivated landslides are also common in the region. The landslide-prone Himalayan terrain is also the region of high earthquake possibilities (Zone-IV and V; BIS 2002) thus, are also prone to earthquake-triggered landslides.

The Himalayan and northeastern regions are potential sites where landslide dams have formed at many places in the past and the potentiality of such occurrences in the future is also high. As a result, the landscape in the Himalayan and northeastern regions is most susceptible to landslides.

Peninsular region, considered to be tectonically stable as compared to other regions, faces low to moderate level of landslide activities. The region consists of hard and massive crystalline Precambrian rocks, mature topography and is characterized by undulating and moderate slopes supporting thick vegetation. The landslide phenomenon in eastern coastline is comparatively less. This region is considered to be moderate from the point of landslide occurrence. The landslides in Peninsular region revived public attention after an unprecedented rain triggered hundreds of landslides within an area of 250 sq. km in Nilgiri region during 1978, killing 78 people and again in 1979, resulting in the death of 3 people and immense damage to the properties and hill environment. Then, in 2001 Amboori landslide in Kerala killed 23 people. The terrain is part of the larger Western Ghats mountain chain making up the western edge of the Deccan plateau. The western coastline of Kerala, considered a critical zone for mass movements,

experiences several types of landslides especially during the monsoon. This includes rock falls, slumps, creeps, debris/mud flows mainly caused by the increase in pore water pressure due to percolating rain water in rocks, soil and their interface. The debris flow movement is the dominant type of landslide in Western Ghats and even in other part of Peninsular India. Coastal areas have also witnessed some incidences of landslides. The phenomenon of slope instability is limited to minor slips along bank of rivers and subsidence in Indo-Gangetic plain and deserts.

National perspective on assessment of landslide hazard has become a topic of major interest due to an increased socioeconomic significance of landslide hazards in different parts of the country. Vulnerability to landslides can be assessed only if we know the exposure to landslide hazard and our preparedness to face that hazard. In order to assess the vulnerability, a national, regional and site-specific perspective is imperative for the landslide susceptibility zoning. For this Macro-scale (1:50,000/25000), Meso scale (1:10,000/1:5000) and site specific (1:1000) mapping of areas encompassing the landslide hazards are important to specify the causative factors. Such mapping is a prerequisite that guide the mitigation strategies and stabilization methods. The studies on mega-regional scale are useful for understanding the pattern of distribution of hazards, they cannot be effectively useful for planning purposes. The macro scale studies and output maps can be used for effective planning on general location of major satellite townships and other such developmental activities. For detailed scale map analytical methods are employed which are useful to identify the required control measures on the realistic estimates. The landslide susceptibility mapping on an appropriate scale, thus, helps to identify the important controlling processes affecting the stability. It also determines the appropriate techniques to be sufficiently applied to reduce the influence of that process. Landslide hazards are a function of a site's location (topography, geology, drainage etc.), type of activity, and frequency of past landslides. The effects of landslides on people and structures can be lessened by total avoidance of landslide hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity.

Assessment of landslide risk and vulnerability is a major issue for planning landslide hazard management practices. Vulnerability will be close to nil in the case of well managed and protected slopes. It will be the maximum for unprepared populations living on slopes with a proven history of landslides. This vulnerability to landslides can be reduced by creating remediation through careful land use planning, timely and suitable engineering solutions, meticulous maintenance of slopes and connected utilities, early warning, public awareness, and preparedness. In addition, biotechnical landslide mitigations are nature-based solutions used to reduce the adverse environmental consequences of landslide-mitigation measures, may also be preferred as landslide management tool over the conventional earth-retaining structures made of steel or concrete usually not visually pleasing or environmentally friendly. The main issue of landslide management is to develop a comprehensive mitigation strategy to reduce the impact of the disasters.

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