

Environmental Protection Council (EPC); Water and Energy Commission (WEC); Nepal Geological Society, the World Conservation Union (IUCN); and Economic and Scientific Commission for Asia and the Pacific (ESCAP) are some of the national and international organisations that also deal with various environmental issues, natural hazards, and their mitigation.

## Scope for Research and Training in Nepal

### Research Programmes

The study of natural disasters, such as landslides, should be based on an integrated approach and should include specialists such as geologists, engineers, geotechnicians, hydrologists, and geophysicists. The International Centre for Integrated Mountain Development (ICIMOD) can play a vital role in this respect. ICIMOD can conduct training courses in the study and management of landslides for this region and facilitate the exchange and dissemination of relevant information among the HKH countries. ICIMOD could be a focal point for research within the region. In collaboration with the institutions and universities of the HKH Region, it can also conduct research programmes and develop academic curricula suitable for the study and management of landslides. Government and non-government organisations, as well as academic institutions in the region, should place more emphasis on landslide study and research. The long-term output of such studies and research will undoubtedly improve the overall level and skill of landslide study and management in the region. Preparation and wider dissemination of audio-visuals to generate awareness among the people about landslide disasters are equally important.

The research programme should focus on the following aspects.

1. Working out the unified landslide classification and study methodology suitable for this region; landslide related data collection, storage, integration, and distribution within the region; and preparation of landslide study and management handbooks, manuals, and instructions for various target groups
2. Study of active and old landslides; development of programmes for landslide mapping (landslide inventory study) on a scale of 1:25,000 or more in the vulnerable parts of the country (especially where important infrastructures or settlements are located); and preparation of hazard maps and risk maps
3. Study of and research on the relationship between various factors (i.e., rock type, slope, geological structure, soil type, rainfall, and seismicity) and the occurrence of landslides in various physiographic regions of the country; classification of rocks and soil according to their landslide susceptibility and geotechnical properties
4. Programmes for the systematic study, monitoring, and control of selected active landslides; research on the appropriate measures to be taken for effective landslide mitigation and control (i.e., engineering and bioengineering methods)
5. Exchange of experiences on landslide studies in various countries, development of appropriate academic curricula, and their implementation through academic institutions

### Training Programme

At present, Nepal is facing serious problems due to landslides and related mass movements. According to the data provided by the Home Ministry, every year more than 1,000 people lose their lives as a result of landslides and related phenomena. The average annual loss of property as a result of these disasters is estimated at Rs 10,000 million, which is about 20 per cent of the GDP of the country. This clearly indicates that there is an urgent need for landslide study, mapping, management, and training in the country.

## Target Groups

The training course should be focussed on the following five target groups.

1. Engineers and geoscientists directly involved in the study, mitigation, monitoring, and control of landslides affecting important infrastructures
2. Junior technicians involved in landslide study and management
3. Planners, decision-makers, politicians, media, and other agencies involved in landslides and related disaster management
4. Villagers and volunteers at the grassroots' level directly affected by landslides and related problems

The training programmes should be conducted first by implementing pilot training programmes for qualified personnel (i.e., engineers and geoscientists), junior technicians, and villagers. There should be a sound evaluation mechanism for trainees as well as trainers to improve the training programme in the future. Planners, decision-makers, politicians, and persons from the mass media should be involved in the workshops and seminars. A short description of the programme for each target group is given below.

**Target Group 1:** Implementation of from four to six weeks' training programmes for qualified personnel (engineers and geologists), with classroom lectures, seminars, laboratory work, and field work for one week. At the end of the programme, the trainees should submit a project assignment.

**Target Group 2:** Organisation of from three to four weeks' training programmes for junior technicians, with classroom lectures, seminars, laboratory work, and field visits

**Target Group 3:** Organisation of one week-long on-the-spot workshops, seminars, and training programmes for grassroots' level persons responsible for the management of landslide disasters (e.g., school teachers, local-level NGOs, and members of district and village development committees).

**Target Group 4:** Organisation of from three- to four-day workshops for planners, decision-makers, politicians, media representatives, and other agencies involved in landslides and related disaster management.

Currently, the Central Department of Geology and Institute of Engineering, both under Tribhuvan University, teach engineering geology within the framework of the Master of Science (M.Sc) (Geology) and Bachelor of Engineering (B.E.) curricula, respectively. The engineering geology courses are given in the Annex.

## Conclusions and Recommendations

Landslides and related mass-movement phenomena are very common in Nepal and are also among the most common natural hazards. Every year, they cause heavy losses of life and property. They also damage the natural environment. Landslides often occur during the monsoon season, but some large landslides also occur at other times.

In Nepal, landslide studies are carried out by various organisations and research groups. The methods and details of landslide studies vary widely. Most of the studies are of the inventory type, a few of them deal with the hazard itself, and there are hardly any studies on risk assessment. There is no organisation responsible for landslide hazard mapping, mitigation, and control. Generally, all the efforts are concentrated after the disaster and very often the efforts are confined to easily accessible areas.

To minimise the adverse effects of landslides and related mass movements in the future, it is necessary to identify and study the hazardous areas of the country by integrating knowledge and information from various disciplines, such as geology, geomorphology, geophysics, engineering, meteorology, and hydrology, and to formulate plans and programmes for implementation.