

# Overall Conclusions and Recommendations for a Practical Training Programme

## Overall Conclusions

It can be concluded that geology and rain water are the two principal factors that influence the initiation of landslides. Landslides cause serious damage to road networks and other infrastructures every year, mainly during the monsoon rains. Landslide control is essential for keeping communication networks open and running in mountainous regions. This involves heavy and recurring expenditure by the national exchequer. It has also been observed that construction of roads and large projects in the mountains has caused hillslope instability and initiated landslides which, in turn, have accelerated the degradation of the environment.

There are two aspects of landslide control and mitigation that merit serious consideration. Existing landslides need to be arrested using various control measures. A landslide hazard zonation study can delineate areas of poor stability, as well as normal stable slopes, so that mitigation measures can be adopted to prevent landslides. The following recommendations have been made for tackling landslide problems.

- a. Preparation of a landslide inventory and creation of a database of the existing landslides, preferably on the basis of the watershed area, using satellite imagery, aerial photographs, and GIS
- b. Preparation of landslide hazard zonation maps
- c. Monitoring of some problematic and important landslides, using instrumentation
- d. Research and development work in control measures, instrumentation, and modelling for risk assessment
- e. Training programmes on capacity building for landslide studies and transfer of knowledge to user agencies

## Training Programme for Landslides

The study of landslides requires an integrated and interdisciplinary approach to subjects such as geology, hydrology, and engineering. The main aim of the programme should be to impart training on the mapping of geological and hydrological characteristics of the landslide area and to suggest appropriate corrective measures

for controlling landslides. In addition, the training should include preparation of an inventory and a database of landslides, using PCs and GIS, and monitoring landslides through instrumentation.

**Course Contents**

- a. Introduction to landslides: nomenclature, reporting etc.
- b. Geological mapping of landslide area on a scale of 1:10,000 or even on a smaller scale, including lithological mapping, structural characteristics, and mapping of landslides using aerial photographs and satellite imagery
- c. Kinematics of faults, joints and fractures, folds, and foliation
- d. Geomorphology should include slope classification and slope analysis
- e. Hydrology should include surface runoff and movement of groundwater at a shallow level
- f. Stress and strain, mechanical properties of rocks, soil, and rock mechanics
- g. Construction of engineering structures, such as retaining walls, gabions, and so on, as landslide control measures
- h. Monitoring of landslides and knowledge and use of instruments
- i. Use of PCs for database creation and GIS applications
- j. Field training on some landslides

Duration of the Course	:	Theory	:	Two weeks
		Field work		One week
		Total		Three weeks

Number of Trainees	:	20
Minimum Qualification	:	M.Sc Geology or B.E. Civil (Assistant Engineer/Executive Engineer level)
Specialists Invited for Lectures:		Geologist, Geomorphologist, Hydrogeologist, Civil Engineer, Landslide Monitoring Specialist, GIS Specialist