

## **Institutions Involved in Landslide Research, Training, Warning, Monitoring, and Management**

In the past, the Geological Survey of India (GSI) was the only organisation that was called upon to undertake hazard investigation studies in the country. The GSI has geotechnical divisions in its regional headquarters, and the divisions manage the engineering geology aspects of all the engineering projects, including power projects funded by the Government of India. The GSI's services are also sought from time to time by state governments and border road organisations for landslide-related problems.

Since the pace of development in the mountain regions has increased considerably in the last few decades, the impacts of landslide problems have also multiplied as a result of increased human activity. As a result, more organisations are now studying landslide hazards. Although the GSI still provides its consultancy services to government departments, several other institutions provide services for individual cases. Institutions most actively involved in landslide consultancies are the Central Road Research Institute, the Wadia Institute of Himalayan Geology, the Central Building Research Institute, the Central Soil and Material Research Station, the Indian Institute of Remote Sensing, the National Remote Sensing Agency, the Defence Terrain Research Laboratory, Roorkee University, Kumaon University, and the Indian Institutes of Technology in Bombay, Delhi, and Kanpur. These institutions provide specialised expertise to solve difficult slide problems and also carry out their own research and development (R&D) work. Routine landslides are tackled by the respective engineering departments such as the Public Works' Department (PWD), the State Directorate of Geology and Mining from different states, and the Border Road Organisation of the Central Government.

### **Research and Development Efforts**

Landslides are one of the principal natural hazards in the Indian subcontinent, and particularly in the Himalayan region. Considering the increased frequency of landslides, the heavy expenditure involved in controlling slides, and the lack of scientific landslide studies, the Department of Science and Technology (DST) of the Government of India has launched a coordinated programme for the study of landslides. The programme calls for a multidisciplinary and holistic approach using new techniques, such as remote sensing, GIS, and instrumentation, to understand the physical causes of and mitigation measures for landslides.

The objectives of the DST coordinated programme are: a) setting up a database for landslides, b) zonation of landslide-prone areas for risk assessment, c) monitoring of selected high-risk zones, d) development of suitable control measures, e) development of models and a prognostic system, f) documentation and dissemination of data, and g) training of personnel.

The institutions involved in the R&D programme of DST are the Central Building Research Institute, the Central Road Research Institute, the Wadia Institute of Himalayan Geology, the Geological Survey of India, the Indian Institute of Remote Sensing, Roorkee University, the Indian Institute of Technology at Bombay and Kanpur, and the Defence Terrain Research Laboratory.

Under the coordinated programme of the DST, landslide hazard zonation mapping is being carried out in parts of the Sutlej-Beas Valley in Himachal Pradesh, the Garhwal Himalayas, the Kumaon Himalayas, the Western Ghats, Sikkim, Mizoram, and the Nilgiri hills. Other activities of the programme include monitoring of the Powai landslide in Kinnaur district, Himachal Pradesh, through instrumentation, creation of databases, and development of models and a prognostic system. The Powai slide mass movement is being monitored by instruments such as rain gauges, piezometers, inclinometers, and borehole extensometers.

Though considerable R&D efforts are being made and expertise has been developed at various institutions and universities, transfer of expertise to user agencies is still lacking. The Public Works' Department (PWD) and the Border Roads' Organisation are the two main agencies who look after the maintenance of roads. The institutions are called upon from time to time by these agencies to tackle specific landslide problems. However, there is no mechanism for the transfer of expertise from R&D institutions to implementing agencies or for updating knowledge.