

Asian Program for Regional Capacity Enhancement for Landslide
Impact Mitigation (RECLAIM-II)

**Report on Workshop and Training Programme
on
“Landslide Inventory, Hazard & Risk Management”**

03-19 January, 2008

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Background

The Norwegian Ministry of Foreign Affairs (MFA) and the Asian Disaster Preparedness Center (ADPC) have entered into an agreement regarding cooperation for implementation of Asian Program for Regional Capacity Enhancement for Landslide Impact Mitigation (RECLAIM) in seven countries namely Bhutan, India, Indonesia, Nepal, Philippines, Sri Lanka and Thailand. The Asian Disaster Preparedness Center is executing the program activities under phase II of the program RECLAIM in collaboration with the Technical Partner: Norwegian Geotechnical Institute (NGI), Oslo, Norway.

The goal of the RECLAIM project is to reduce the landslide disaster vulnerability of human settlements, infrastructure, and critical facilities in the targeted countries of Bhutan, India, Indonesia, Nepal, Sri Lanka, and Thailand. From India, IIRS is the nodal participating agency along with Central Building Research Institute (CBRI) and Central Road Research Institute (CRRI).

More specifically, the project's objectives are:

- To provide target countries with a cadre of specialists and decision makers with up-to-date knowledge of landslide disaster mitigation practices and to integrate this knowledge in routine development work initiated by national and local governments. The project will achieve this by:
 - Providing the scientists and geotechnical engineers involved in landslide studies and services a forum for academic discussion on landslide disaster mitigation,
 - Promoting better practices and models among the target countries,
 - Facilitating the introduction of new concepts into the land use planning process,
 - Promoting a participatory approach of all stakeholders including decision makers in the search for solutions for current problems in landslide disaster mitigation,
 - Promoting sustainable development and environmental protection through landside disaster impact reduction and integration of concepts of risk-based mitigation planning at all levels.
- To increase collaboration between Norwegian and Asian institutions in jointly developing cost effective methodologies for landslide risk mitigation and training at national level for enhancement of capacity of national partners, which will result in more joint programs and opportunities for sharing of experience and learning applications in the subject area.

The Ministry of Foreign Affairs of the Royal Norwegian Government has made available funds for implementation of the project. The selected countries are Bhutan, India, Indonesia, Nepal, Sri Lanka, and Thailand.

As a part of the project, IIRS is committed to contribute in the following activities:

- Participation in training and capacity building activities in disaster management under RECLAIM project,
- Participation in development of training course by ADPC and adapt the course for the national training program. The course materials will be developed and made available by ADPC to the partner institutions under the project.
- Organise national and international training programme and workshop
- Regular exchange and sharing of appropriate information on proposed activities under the project.

Regional workshops and Training Programmes

As a part of the project, Asian Workshop on Regional Capacity Enhancement for Landslide Mitigation (RECLAIM) was organised by Asian Disaster Preparedness Centre (ADPC), Bangkok and Norwegian Geotechnical Institute, Oslo at Bangkok during 13-15 Sept 2004 in which IIRS contributed a paper on “Landslide Hazards in India- a status report”.

Additionally, two more seminars/training programmes were organised: International Seminar on Landslides Risk Management, Colombo, 6 June 2005 and Regional Training for Landslide Risk Mitigation, Bandarawela, 8-12 June 2005. IIRS has contributed papers on “Landslide Hazard and Risk Assessment in India- IIRS experience” highlighting the methodology and parameters that can be extracted from satellite data products and different modeling techniques for hazard and risk assessment using Indian case examples from Garhwal Himalaya.

In the regional training programme, a presentation was made on “Assessment of Precipitation Control on Triggering of Debris Slide/ Flow in Garhwal Himalaya, India”. The paper emphasizes on establishing precipitation threshold for debris slide initiation based on ground as well as satellite based precipitation estimation. During discussion a paper on “Spatial models for landslide hazard assessment using Geographic Information System and remote sensing techniques” was also presented. As a part of the training programme, field visits were conducted to important landslides of SriLanka and examples were shown how remedial measures could be successfully applied in reducing landslide related hazards.

In the third Regional Training Course in Phuket, Thailand during 29 January – 2 February 2007, IIRS presented paper on “Spatial Modelling of Seismicity Induced Landslides”. It was attended by 30 participants from Sri Lanka, Norway, Indonesia, Thailand, Bhutan, Nepal and India. The most important aspect of the training was field visit to important landslide sites in the mountain areas of Phuket Island. In Patong municipality area of Phuket Island, after the Tsunami of 2004, people have started moving to higher up hilly areas for settlement and for setting up Hotels, which also provide better sea view due to high relief. This has resulted in settlements in unfavorable hill slopes and isolated landslides have already been experienced. Unless suitable preventive and slope strengthening measures are taken, it may lead to another disaster in future. At five different landslide locations preliminary investigation was carried out and information was collected on past history of the landslide and location specific details. Present status and future risk was also analyzed. The most suitable preparedness and mitigation measures were also discussed for short term as well as long term solution.

Landslide Hazard Mitigation Workshop in India

In order to generate awareness on preventive measures, it was proposed to organize awareness workshop in all member countries for which brief guideline was presented by Dr. N.M.S.I. Arembepola, Director, Urban Risk Management (UDRM), ADPC and it was also agreed to partially fund such programmes from RECLAIM budget. In consultation with Dr. P. K. Nanda, Director, Central Road Research Institute (CRRI), it was decided to organize the workshop in India during 2007-2008.

In a similar development in the field of landslide studies in India, the Geological Survey of India (GSI), the National Remote Sensing Agency (parent organization of IIRS) and ITC signed an MOU for collaboration on landslide studies some two years ago. The MOU included activities on joint work on courses and research on landslide. In the last two years training courses have been organized on new developments in landslide hazard and risk assessment in Hyderabad and in Trivandrum. Additionally, GSI and Geological Survey of Canada (GSC) are also perusing research in landslide related topics. Realizing the common interest of RECLAIM-II and GSI-NRSA-ITC collaboration as well as interest of GSI-GSC collaboration, it was envisaged to organized a combined training course and workshop on landslide inventory, susceptibility mapping and hazard mitigation.

Landslide inventory mapping is the most important step in landslide mitigation. In order to evaluate the susceptibility, hazard, and risk for landslides it is crucial to know where landslide have occurred in the past, when they occurred and what were their failure mechanisms and causal factors. Traditionally landslide inventory is done through aerial photo interpretation, combined with field investigations and archive studies. However, in India aerial photographs are either not available or very old. Therefore, there has been a lot of efforts in detecting landslides from satellite images, but until recently the spatial resolution of these images were not good enough for the detailed mapping of landslides. Due to the recent developments in EO in India, particularly with the availability of Cartosat-1 data, there is now a renewed interest for detailed stereo-image interpretation of landslides, and the correct mapping and classification of landslides.

The training course and workshop

Based on the interest of above collaborative programmes, a joint training course and workshop programme was organized as per the following details.

Programme	Objective	Target
Training Course 3-9 January 2008	<ul style="list-style-type: none">• The use of GIS (with emphasis on the open source GIS system: ILWIS) for landslide susceptibility, hazard and risk assessment.• Landslide inventory mapping from images.• The characteristics of Cartosat images, and generation of DEMs.• The use of landslide inventories in hazard and risk assessment.	15 and 20 participants, which would be a mix of young professionals with limited experience and also expert with a large experience in landslide work.
Workshop: RECLAIM-II	To share knowledge and experience on landslide hazard mitigation strategies	70-80 participants involving experts and stake

10-11 January 2008	involving advance hazard zonation techniques, landslide inventory, monitoring and early warning methods, stabilization and mitigation measures	holders who are directly or indirectly affected by landslides in India in general and in Uttarakhand in particular
Field Investigation for remedial measures 12-13 January 2008	To investigate and analyse causative factors, monitoring methods, risk assessment and suggest remedial measures for a specific landslide around Joshimath	All the participants of training course with experts / stake holders invited under RECLAIM programme: Total 50 persons
Field meeting with stake holders on landslide remedial measures 14 January 2008	To generate awareness and share knowledge on causative factors, monitoring methods, risk assessment and remedial measures for a specific landslide around Joshimath	50-60 participants involving experts and local stake holders who are directly or indirectly affected by a large landslide in Joshimath town
Field investigation for landslide inventory 15-19 January 2008	Validation of landslide inventory and visit to learn from remedial measures at Uttarkashi landslide	Same as the training programme with additional experts from GSI

RECLAIM workshop

The workshop on Landslide was inaugurated by Dr. B. R. Arora, Director, Wadia Institute of Himalayan Geology. He praised the initiatives under RECLAIM programme and emphasized on quantitative modeling aspects for landslide. Prof. R.C. Lakhera welcomed delegates for the workshop and Dr. V. K. Dadhwal, Dean, IIRS addressed the audience and mentioned about IIRS contribution in landslide studies and initiatives under RECLAIM programme.

In total 61 persons from various organizations attended the two-day workshop and 21 presentations were made on various aspects of landslide mapping, monitoring, and hazard mitigation (Annexe-1). All leading agencies such as Geological Survey of India, Wadia Institute of Himalayan Geology, Disaster Management and Mitigation Centre and Directorate of Geology and Mines (Govt. of Uttarakhand), Defence Terrain Research Lab., Indo Tibetan Border Police, Border Road Organisation, Universities, National Thermal Power Corporation, Tehri Hydro Power Corporation, Water and Power Consultancy Services, Jharkhand Space Applications Centre, Central Road Research Institute (CRRI), Central Building Research Institute (CBRI), National Disaster Management Institute (NDMI) and NGOs participated in the workshop. International agencies such as International Institute for Geoinformation Science and Earth Observation (ITC), The Netherlands, Norwegian Geotechnical Institute (NGI), Road Development Agency (SriLanka), and Geological Survey of Canada participated in the programme.

Field site selection

During RECLAIM workshops in Sri Lanka and Thailand very useful field visits were organized to demonstrate the practical examples of the landslide problem and remedial measures. Therefore, in the present workshop, it was envisaged to visit a landslide in Joshimath town (Lat: 30 33 N, Long: 79 33E) in Garhwal Himalaya that requires urgent remedial measures as it has attained dangerous proportion and is very adversely affecting life line road to Tibet border as well 3 power projects (at a cost of nearly USD 1.5 billion) coming up at places connected by the affected road. Apart from this it has affected Indian Army establishment and large tracts of high value land (under public and private holding) in Joshimath township, which is also experiencing subsidence at several places, reported by IIRS using IRS-Cartosat-1 data (study was carried out under CSSTE-AP programme and results were presented to Secretary, Disaster Management, Uttarakhand) and confirmed by an independent investigation team of Uttarakhand state govt. Recently during an interaction meet (attended by Prof. R.C. Lakhera, Head, Geosciences Division, IIRS) on disaster management organized by RIMC (Army institute), this concern was raised and expert opinion was sought. Therefore, in order to address a real world problem, AT Nala landslide was selected for field visit. The aim is to generate awareness among stake holders on landslide hazards and possible remedial measures and to educate local people on how to detect the problem at the early stage and take preventive measures.

Trekking through Parasar and AT Nala landslide

On 12th morning, the field party of 38 persons left for Joshimath at approximately 250 km from Dehradun. On the way, several stops were made to observe major geological discontinuities, landslides and terrain features and Dr. M.P.S. Bist, Garhwal University, explained about local geology. As per the plan, the field work was carried out at AT Nala landslide. The entire group was divided into 4 sub-groups to specifically look into landslide causative factors, monitoring methods, risk assessment and mitigation measures. All the 4 sub-groups trekked from the crown portion of the landslide, partly snow covered near Auli at 3100m down to 1700 m elevation in the Joshimath township area. While trekking down, at several places, observations were made, local persons were interviewed, locations were marked with GPS and features were observed on Cartosat-1 (2.5m) satellite images as well as on the ground. Recently developed numerous cracks, sign of head-ward erosion, subsidence of several meters on road as well as on agriculture field, human interference as well as remedial measures, damage to buildings, roads and overall loss of precious urban land, risk to roads and buildings in civilian as well as army domain were observed and analysed by all group members.

RECLAIM Field meeting

The field meeting was organized in the IBEX Auditorium, 9 Independent Mountain Brigade with the full cooperation of Brigadiar R. Ravindran, Commander of the Mountain Brigade. The chief administrator, Ms. Yadav, Sub-Divisional Magistrate, Joshimath instructed all local officials to attend the meeting. Local officials presented their views on the AT Nala and other landslides of the region highlighting the devastating effect of such landslides on local population as well as developmental activities of the region mainly hydropower projects. After a strenuous field visit from 10.00 hrs to 17.00 hrs on 13th (we even skipped lunch to spend more time on landslide), all sub-groups worked intensively and after listening to local

officials, presented their views on causative factors by Saibal Ghosh, GSI, monitoring methods by Mr. Tapas Martha, NRSA, risk assessment by Dr. Cees vanWesten and on remedial measures by Dr. P.K.Champati ray. The meeting was organized in the form of a panel discussion with panel members: Dr. Cees van Westen, Prof. R. C. Lakhera, Dr. J. Jayamanne, and Mr. S.K. Ghildyal, GSI. All the presentations were highly interactive and stake holders took note of the impending danger due to AT Nala landslide and challenges ahead. All presentations were followed by general discussion and sharing of knowledge and information on landslide causative factors, risk assessment, monitoring methods and hazard mitigation specific to Joshimath landslide to generate awareness and initiate appropriate action for remedial measures.

It was also informed to local stake holders about IIRS initiative under DMS programme of DOS, wherein Automated Weather Station (AWS) has been installed in Joshimath and procured 3 extensometers and 4 piezometers to install close to the landslide and monitor rainfall, movement and water level regularly. The entire road stretch from Nandprayag to Badrinath (100 km) has been set up as a field laboratory under the guidance of Dr. V. K. Dadhwal, Dean, IIRS for landslide studies and 12 AWS have been installed and some more are planned and the programme is being executed in cooperation with BRO/ ITBP/ JP Hydro/Administration/ GSI / NGOs.

The field meeting was concluded by distribution of certificates to all participants of RECLAIM-II workshop and field work by Dr. Cees van Westen, ITC, The Netherlands. On the following day (15.01.2008), at the request of Border Roads Organisation, the team visited prominent landslides on Joshimath-Pipalkoti road sector and discussed remedial measures with the Major Naresh Kumar, Officer Commander, 75 RCC, BRO. Based on the previous study and recent field visit and input from all participants a separate technical report is envisaged on remedial measures for mitigation landslide hazard in areas similar to visited road sector and AT Nala landslide, Joshimath, Garhwal Himalaya.

Field visit to Okhimath and Uttarkashi

The next leg of field visit was carried out in Okhimath and Uttarkashi sector to validate image interpretation for landslide detection using Cartosat-1 data. Field visits were made to important landslides in the region coordinated by Mr. Tapas Martha and Mr. I.C. Das, and Dr. P.C. Nawani, Director, GSI explained about the mitigation measures at Varunavat landslide. On the return journey to Dehradun, the team visited the Tehri dam site. The programme was concluded by distribution of certificates by Mr. Ravi Kumar, GSI at Uttarkashi and it was felt that more such programmes should be undertaken in future in other parts of India.