

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



**Report on Training Programme on
“Landslide Risk Management”**

17-22 June 2008

Department of Roads
Babarmahal, Kathmandu
Nepal

1. 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 Nepal, Department of Roads (DoR) is the nodal participating agency.

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, Department of Roads 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.
- Organize national training programme
- Regular exchange and sharing of appropriate information on proposed activities under the project.

2. ‘Landslide Risk Management’ in Nepal

Himalayas witness each year a wave of landslides both small and large, especially in the post monsoon period. These natural disasters have occurred in all the divisions of the Himalayas. Landslide is the result of a wide variety of processes which include geological, geomorphological, meteorological and anthropogenic factors. The important terrain factors are lithology, structure, drainage, slope, land use, geomorphology, and road network. A complete landslide hazard assessment requires an analysis of all these factors leading to instability in the region. Therefore, there is a need of multi-disciplinary studies of landslide hazards, which combines geology and geomorphology, remote sensing, geodesy, fluid dynamics and social profiling.

1. Objectives of the National Training

- To discuss the policy environment for land risk management
- To discuss on Landslide risk assessment approaches in Nepal
- To facilitate the landslide mitigation (structural and non-structural) measures in Nepal
- Facilitate the onsite experience to develop the mitigation measures to reduce the impact of landslide.

2. Participants

The training was attended by participants from range of institutions including Ministry of Home Affairs, Ministry of Physical planning and Works, Department of Roads, Department of Water Induced Disaster Prevention, Department of Local Infrastructure Development and Agricultural Roads, Department of Soil Conservation and Watershed Management, Institute of Engineering , Pulchowk Campus, Department of Geology, TC, Nepal Engineering College, Department of Environmental Science, Amrit Science Campus, Executive Director, Roads Board Nepal, Consultants, Experts, Paper Presenter, DDC, NGO, INGO etc. (**Please see Annex I**).

3. Methodology

In the three days of training, following methods were adopted to facilitate the training activities:

1. Brainstorming session.
2. Presentation.
3. Focus group discussion.
4. Field visit.

4. Summary

Day 1

The first day of the training was focused on understanding the geology and characteristics of landslide risk in Nepal. In this session, main features of the presentation were; the geological setting, landslide classifications, causes and triggering factors of landslides and landslide risks. Further, role of geology and its processes in mass movement was discussed. The case of MUGLING-NARAYANGHAT slope failure was discussed in detail. This particular session was focused on highlighting the challenges to infrastructure development in Nepal, where the most of the civil structures especially road constructions are through tectonic zones, thrusts, faults, folds and jointed rock mass.

Landslide risk management was also discussed in terms of approaches and its current situation in Nepal. It was explained that; unstable steep slopes, fragile geological conditions, young mountain systems, concentrated rainfall, and inappropriate human techniques are making Nepal as one of the most landslide prone areas in the world. Following problems were highlighted during the discussion:

- Availability of local (District wise), regional (development region) and national level landslide inventory maps.
- Precise hazard maps representing different geo-morphological/geological features are also not available,
- Efforts are going on the evaluation of the likelihood of slope failure,
- Different hazard mapping techniques are emerging,
- Need to shift from hazard assessment to risk based analysis.

Following this session, emphasis was given on Landslide hazard assessment methods, where Landslide distribution analysis, landslide density analysis, subjective geomorphic analysis, bivariate or multivariate statistical Analysis, subjective rating analysis and slope stability analysis was discussed as the landslide hazard assessment methods. Day 1 was concluded with the mitigation measures where non-structural part of landslide risk mitigation was discussed.

Day 2

The second day of the training was composed of field visit and in-house discussion. Participants made a visit to Lothar River located on the East-West Highway. At present the river is carrying high sediments, which may damage the major

transportation route connecting Eastern and Western Nepal. Following were the conclusive points made during the field visit discussion:

- Catastrophic rainfall occurred during flood disaster of July 1993 (400-540 mm in 24 hours) and 2002-2003
- The collapsed materials dammed up the small streams and then turned into a debris flow after dam breaching
- This phenomenon repeated at time and the intensity of the debris flow was increased considerably and severe scouring took place in the watersheds
- With decreased in the river gradient the sediments transportation and deposition took place along the river courses.
- Steep slope 30 to 45 degrees,
- The slope angle nearly equal to or a little higher than the internal friction angle of the soil and rock mass. So, a little change in the slope and/ or soil properties sufficed to cause slides.
- Joint low spacing and low persistency
- Weathering of rock easily weatherable rocks are slate, phyllite, differential weathering of sandstone and mudstone
- The disasters (landslide and debris flow) occurred in the Lothar Khola are associated with major thrusts like Main Boundary Thrust (MBT), Mahabharat Thrust (MT) and local faults and imbricate thrusts located in the slates, limestone and schist.
- The heavy rainfall provided very high run off that overflowed the streams, consequently the stream moved considerable distance away from their previous courses and attacked and undermined cultivated land and other infrastructures. The exceptionally high flow of boulders and sands laden water as a debris flow undermined their basal parts, causing them to collapse. The unsupported materials, which was first weakened by being saturated from the heavy rainfall into the stream or river.

Looking at the unprecedented problem aroused due to high sedimentation on the river bed, the participants discussed about the mitigation measures for Lothar Bridge. Following were the highlights of the mitigation measures:

Sediment Production:

- Total sediment production about- 6.00- million m³
- Sediment discharges from basin- 2.45 -million m³.
- Deposited in river basin- 2.78-millon m³
- Sediments retained on hill slope 0.80-million m³.

Three options were floated to overcome from the existing problem:

Option # I: Construction of new RCC T-Beam Bridge of total length 120 m with maximum vertical clearance at upstream and this will cost around NRs 100 million)

Option # II: Upliftment of the existing bridge superstructure and it will cost NRs 70 million.

Option # III:

- Debris Clearance
 - Check Dam Construction
 - River Training and Protection Works
 - Bioengineering Works
- (Total Cost about NRs 61.59 mil)

All participants were agreed with the available option III and highlighted benefits attached with this option:

- Environmental Consideration
- Bio-Engineering Plantation Area can be developed as Recreation Park.
- Lothar-Sunachuri Road Sector of East-West Highway will be Protected

Day 2 was concluded with the discussions to propose Option III to Department of Roads to formulate project based on the field experience.

Day 3

The last day of the training was focused on highlighting integrated use of Bio-engineering and civil engineering techniques in stabilizing the slope movements. Policy environment on Landslide risk management was also discussed. Department of Roads (DoR), Nepal is responsible for maintenance of about 5,000 kms of strategic road networks. About 70% of these road networks are locate within the fragile mountain and hill slopes where slope stability problem is one of the major concern. Krishnabhir Landslide of Prithvi Highway is one such example that DoR has faced in recent years. The slope failure at Krishnabhir, 83 kilometers west of Kathmandu in August 2000 triggered a huge national crisis in the history of Nepal's modern development. The road obstruction along the busiest supply highway detached capital Kathmandu with the rest of the country for eleven consecutive days which resulted in acute shortage of daily commodities in the capital. This was the one of the worst slope disasters.

Department of Roads carried out the mitigating measures in stages with the aim to minimize the traffic obstruction and maximize the scarce financial resources by combining civil and bio-engineering techniques in the design. This technique proved successful as the entire problem was tackled with total expenditure of 55 million Nepalese Rupees (equivalent to US\$ 0.85 million) cost which is less than 2 per cent cost compared to a proposal from an international company to solve the same problem. The experience gained from this slope stabilization endeavor has brought out some

lesson learning which DoR Nepal could incorporate in the policy documents of sustainable slope management.

5. Way Forward

- The training programme on ‘Landslide Risk Management’ was appreciated and earnest need was felt to organize same kind of training where heterogeneous group can participate and share experience and information to each other.
- Participants from the academic institutions, Home Ministry and non-governmental organizations have recognized the efforts by the Department of Roads and expressed willingness to support actively through different platform.
- In concluding remarks by the participants, emphasis was given on coordination aspects where policy makers, government agencies, non-government organizations, academic and research institutions have a bigger role to play in minimizing the impact of Landslide Risk in Nepal.

Annex I: List of Participants

S. N	Institution	No of Participants
1	Ministry of Home Affairs	2
2	Ministry of Physical Planning and Works	2
3	Department of Roads	22
4	Department of Water Induced Disaster Prevention	2
5	Department of Local Infrastructure Development and Agricultural Roads	1
6	Department of Soil Conservation and Watershed Management	3
7	Institute of Engineering , Pulchowk Campus	1
8	Department of Geology, TC	1
9	Nepal Engineering College	1
10	Department of Environmental Science, Amrit Science Campus	1
11	Executive Director, Roads Board Nepal	1
12	Participants from ADPC	1
13	Other Stakeholders(Consultants, Experts, Paper Presenter, DDC, NGO, INGO etc.	7