

FIRST DRAFT -FOR VERY SELECTED OFFICIAL CIRCULATION

Landslide Risk Management in India

Road Map

For the consideration of Expert Committee for Research on GeoHazards (Landslides and Tsunami etc.)

NRDMS

Department of Science and Technology

1. Introduction

1.1 Of the many common concerns in the area of Geohazard management, Landslide Risk Management deserves to be placed on the priority agenda for the following six main reasons: (1) Unlike earthquakes and tsunamis, it is possible to prevent and predict landslides thereby averting landslide disasters (2) A number of knowledge institutions are working at sub critical levels without cohesion , and there is a huge potential that can be tapped through a well coordinated effort (3) Sledge hammer approach in landslide management in the country which is retarding the progress of science of landslides must be made to give way to the culture of scientific investigation , analysis and management and (4)Country urgently needs inspiring examples of landslide mitigation and management and quality and trained human resource to match the felt needs , (5) Research and Development base needs to be expanded to transform mono-discipline approach to a truly multi-disciplinary approach and (6) High quality knowledge products , training manuals and education materials ought to be made available to meet the projected needs of the educational institutions , all set to launch degree and diploma courses in disaster management.

1.2 South Asia looks upto India for direction and leadership in this area because no other country is so directly exposed to such a bewildering variety of landslide problems as India is. For achieving that position we do not have to build our capacities to manage landslide risks from the scratch because we have already made some beginning. It is, however, time for us to open up and think and act together so that our country can shed reactive and quick-fix approach and leapfrog into the world of new knowledge on landslides, as also make informed choices of technologies best suited to their respective situations.

1.3 While the types of landslide problems of current concern are to be urgently addressed, it will be also essential to place on agenda the rapidly emerging new set of problems due to anthropogenic factors, climate change, environmental degradation, enhanced vulnerability to Glacial Lake Outburst Floods (GLOF) and earthquake induced landslides. All these topics are of shared concern with globally expanding body of knowledge base. For example, the threat from GLOF is faced by several of the South Asian countries because of about 15000 glaciers and 9000 glacial lakes in Bhutan, Nepal, India, Pakistan (and China). This was reported in a baseline study conducted by the International Centre for Integrated Mountain Development of Nepal, United Nations Environment Programme and Asia Pacific Network for Global Change Research. Of the 2315 glacial lakes, 26 potentially dangerous glacial lakes are in Nepal. The bursting of Glacial Lakes in the mountains of Nepal carries the potential of ravaging parts of India down stream. It is to be noted that the National Action Plan for Adaptation (NAPA) to Climate Change prepared by Bhutan and National Communication on Climate Change Mitigation and Adaptation brought out by Government of India have also placed considerable focus on GLOF vulnerability *reduction factors*¹. In May-June 2008,

glacial lake outburst floods hit three villages Passu, Ghulkin and Hussain in Gojal Tehsil of Pakistan disrupting trade and traffic on the Karakoram Highway.²

1.4 Landslide Hazard Mapping, Vulnerability and Risk analyses is another area which deserves to be placed high on our agenda with a modicum of effort. In 1980, when India hosted the third International Symposium on Landslides, the Landslide Hazard Mapping got highlighted as the first paper of that symposium. Closely on the heels of this, Nepal came out with a set of landslide hazards maps at a scale of 1:10 000 published in 1980's. The Nepalese work gave impetus to the SriLankan landslide hazard mapping programme (1990-1995). And , SriLanka came out with a set of 30 Landslide Hazard Maps covering about 7500 sq km of its Central Highlands at a scale of 1:10 000. These were the first set of ground validated landslide hazard maps in south Asia. The mapping methodology developed for SriLanka came as a trigger for India and led to production of the first small scale landslide hazard map of India in 2001. Since then a number of organizations in the country, especially the Geological Survey India, are doing landslide hazard zonation mapping. It is unfortunate that many of these programmes across our country are going ahead without general agreement on the whole range of fundamental issues such as standardization of definitions and terminology, adoption of the most appropriate landslide classification system, and broad agreement on the approach to landslide hazard mapping and vulnerability and risk analysis.

1.5 A hugely important neglected area requiring urgent attention is Earthquake Induced Landslides (EIL). We need to ensure that, earthquake and landslide hazard assessment approach, which currently do not take into account earthquake-induced landslide, is critically reviewed and suitably strengthened.

1.6 After reviewing the national capacities and closely studying the ongoing initiatives in the country , and after analyzing Strengths, Weaknesses Opportunities and Threats (SWOT Analysis), it should be possible to strengthen institutional mechanisms and launch highly targeted mega national projects

2. Landslide Risk Assessment

2.1 Guidelines on Terminology and Classification of Landslides and Other mass movements

Establish Common Scientific Language, Terminology and Landslide Classification System for reliable and effective communication. The following four step action programme is suggested to deliver the proposed knowledge product for adoption for landslide studies in South Asia:

- a) Preparation of draft Guidelines (a base paper) on Landslide Terminology and Classification system based on a critical review of the current variations within and among the SAARC member states, in the light of the global state-of-the-art.
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- b) Circulation of the draft Guidelines to the peers Asia for comments and value addition.
- c) Revision and Finalization of the Guidelines through interactive dialogue at a thematic DST workshop
- d) Adoption and Promotion of the Guidelines and its enforcement within member States.

2.2 Landslide Hazard Zonation Mapping

Practical Guidelines on Landslide Hazard Mapping should be developed with particular reference to situation specific choice of mapping scale and a transparent methodology for landslide hazard mapping fashioned to deliver user friendly and validated large scale landslide hazard maps. The task may involve following steps:

- a) Preparation of a compendium of reports on Landslide Hazard Zonation Mapping Practices in India (prepared in a specified format) and a critique on the mapping scales and methodologies currently being followed.
- b) Preparation of draft Guidelines on Landslide Hazard Mapping Methodology based on the critical review of the compendium of country reports in the light of the current global state of the art.
- c) Circulation of the draft Guidelines to selected Peers for comments and value addition.
- d) Revision and Finalization of Guidelines on Landslide Hazard Mapping Methodology through interactive dialogue at a DST workshop
- e) Adoption and Promotion of Guidelines and its enforcement within India

2.3 Landslide Risk Assessment

Comprehensive Guidelines on Landslide Risk Assessment should be developed for typical landslide situations, including aspects such as (a) earthquake -induced landslides (b) landslide runout effects and (c) occurrence of first time landslides. . Guidelines should squarely address complex issues and clearly answer (a) how reliable are currently used earthquake risk assessment methods without recognizing hazards due earthquake induced landslides (b) how serious are the implications of such a neglect and (c) what needs to be done to introduce landslide concerns in earthquake risk assessment and seismic retrofitting programmes?

2.4 National Capacity Building in the area of Landslide Hazard and Risk Assessment

For national landslide hazard and risk assessment programmes to be successful it is imperative that highly trained professionals man the mapping teams and institutional

infrastructure for mapping is improved. The following steps are recommended in this regard:

- a) DST Expert Group should design highly focused thematic training programmes and recommend these for implementation with DST patronage to the well established institutions in the country. Some of the topics which need to be covered on priority are (a) Field oriented engineering geological, geomorphological, hydro-geological and seismo-tectonic mapping at large scale (b) Integration of State-of-the- Nature or Factor Maps on a GIS Platform (c) Geotechnical Investigation and Characterization of Slopes and Stability Analysis in terms of total and effective stress.
- b) Preparation of high quality training manuals in each area selected for training. The experts hired to deliver training programmes should be charged with the responsibility to develop training manuals

3. Landslide Risk Mitigation

3.1 Learning from Landslides and Landslide Disasters

Every landslide disaster leaves behind signatures of knowledge and a great deal can be learned by alert minds by co-relating experiences of the experts and knowledge institutions in investigating and managing similar problems. Since some of our institutions and organizations like BRO have gone through the pain of managing landslide disasters, it will be only appropriate to learn from these and advance the frontier of knowledge by undertaking the following tasks:

- a) Prepare Monographs on Case Histories of major Landslides in India. Many of multiple documentation of the same case history needs critical review and rewriting after validation of observations and unsubstantiated statements.
- b) Field visits by experts should be arranged to the sites where major case histories were made. DST should facilitate such visits.

3. 2 Prediction of Landslides

Recognizing the fact that unlike earthquakes, most landslides could be predicted through a timely systematic programme of detailed engineering geological, geotechnical and hydro geological investigation, instrumentation, modeling and real time monitoring, India can take a big leap forward by initiating a well coordinated, multi-institutional research programme on Landslide Prediction. The following steps are suggested towards creating inspiring example(s) of landslide prevention:

- a) Preparation of a state-of-the-art report on Landslide Prediction under the aegis of DST and its critical study by peers. One of the knowledge institution may be assigned by DST the role of coordinating the R & D programme with the commitment to provide institutional parking place and project facilities.

- b) Formulation of a draft proposal by the coordinating organization in consultation with other participating institutions and its finalization through a DST roundtable meeting between the participating institutions during which roles and responsibilities of every individual organization should be defined and budgetary requirements to be worked out.
- c) DST should consider supporting projects in this important area.

3.3 Early Warning against Landslides

- a) Early warning against landslides through instrumentation and trained and alert communities can save lives. The following approach is suggested to achieve the objective.
- b) Development of a state-of-the-art paper on simple and effective slope instrumentation approaches and methodologies for early warning. This should include community based early warning using simple indicators such as visual observations on the slope, and surroundings, rainfall data and so on. The architecture of the report should be such that it encourages knowledge institutions to take-up projects on early warning in their respective countries.

3.4 Retrofitting of problematic slopes as an integral component of retrofitting of seismically unsafe buildings.

The current building retrofitting programmes for seismic safety stops at retrofitting of the superstructure of buildings. This practice is grossly unsafe inasmuch as even the retrofitted buildings will fail, if the slopes on which they are supported fail by sliding. Two things ought to be done in this regard:

- a) Prepare Guidelines on retrofitting of slopes
- b) Engineer appropriate field oriented training programmes to promote the culture of retrofitting of problematic slopes

3.5 Establish DST Regional Centre of Excellence on Landslide Studies, Education and Training.

If established the DST can, inter alia, undertake following tasks:

- a) DST may provide technical support for establishing the knowledge network provided all other project costs including those on equipment and manpower will be borne by the institution in the coordinating role.
- b) Coordinating institute may eventually make the centre of excellence self sustaining by (a) carrying out regular education and training programmes (b) promoting Landslide Knowledge Dissemination Service (c) publishing a Landslide eNewsletter and (d) introducing a Landslide Journal for global circulation.

4.1 Landslide Education and Training

The shortfall or absence of knowledge products, manuals, monographs and video graphs on diverse aspects of landslide stifles the quality of education and training, especially of trainers. A few of the knowledge products suggested below will raise the quality of education and training, besides serving as useful training material.

- a) A Monograph on Glacial Lake Outburst Floods
- b) A Monograph on Technology for Search and Rescue for improved response to Landslide Disasters.
- c) A Monograph on Landslide Damage Assessment.
- d) A Monograph on retrofitting of slopes and houses in landslide and earthquake prone areas.
- e) Guidelines on Geological and Geotechnical Investigation of Landslides. This is identified as very poorly developed area in the entire developing world.

5.1 Landslide Response, Rescue and Reconstruction

Lives can be saved via prompt response to a landslide disaster. The following can be done to build national and regional capacities in this direction:

- a) Guidelines should be developed for exhumation of people buried alive under a rapid motion landslide. It should deal exhaustively with technological options to scan through debris and equipment and tools for efficient rescue.
- b) Simulated Training Programmes should be organized to create skilled professionals who would be on regional call.

5.2 Thrust of Research and Development

- Revisiting of past major landslide disasters for scientific post-mortem and documentation of lessons learned.
- Refinement of approaches to GIS based landslide hazard mapping, vulnerability, risk, impact and damage assessments.
- Integration of Landslide hazards into user-friendly multi-hazard mapping. Projection of multi-hazard risk scenarios.
- Fundamental Mechanisms of earthquake- induced and earthquake-triggered landslides.
- Establishing best practice examples of Deterministic and Probabilistic stability analyses of complex natural and manmade slopes and landslides
- Scientific Design of surface and subsurface drainage systems, technology for their speedy installation and field evaluation of their efficacy
- Development of Innovative technologies for landslide control, especially mechanized construction of complex subsurface drainage networks and their critical evaluation.

- Quantification of environmental degradation, cost of loss of land and agriculture produce and of traffic delays
- Retrofitting and Protection of heritage buildings in landslide prone areas
- Development of simple and easy to install instrumentation and slope monitoring for real time early warning including early warning thresholds and criteria
- Study of landslide dams and management of consequent threats
- Reservoir induced seismicity
- Fashioning landslide rescue operations to their typology
- Snow Avalanches
- Coastal landslides
- Submarine Slumping and Tsunami induced landslides

NOTE:

**EXPERTS COMMENT MAY BE SENT BY 31ST AUGUST, 2010
DIRECTLY TO THE CONCERNED PERSON: -**

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