Ministry of Mines
Geological Survey of India

NATIONAL DISASTER MANAGEMEMT PLAN IN RESPECT OF LANDSLIDES

STANDARD OPERATING PROCEDURE OF GSI

I. BACKGROUND

In the wake of the recent **cloudburst, flood and landslide disaster in Uttarakhand (15-17th June 2013)**, instruction came from the National Executive Committee of the Union Government that the proposed National Disaster Mitigation Plan should be prepared in the form of a Standard Operating Procedure (SOP) and should reflect the lessons learnt from the recent extreme disastrous event in Uttarakhand. This SOP should act as future guidelines to attend to such calamities with urgency and cover the primary requirement of *human resource deployment, mitigation measures* and *response to calamity.*

II. ROLE OF GEOLOGICAL SURVEY OF INDIA (GSI)

GSI provides necessary inputs on geological/geotechnical aspects to meet the requirement of disaster resilient structures. GSI engages in studying and ascertaining causes, nature of various natural hazards and subsequently associated disasters with an aim to provide input parameters to work out suitable corrective and remedial measures. Technical design and execution of actual corrective measures is the responsibility of the concerned stakeholders.

As the designated nodal agency, the responsibilities of the GSI include coordinating all activities related to landslide hazard mitigation, assisting National Disaster Management Authority (NDMA) and national Technical Advisory Committee (TAC) in all matters of landslide and related disasters, studying and monitoring the occurrence of landslides anywhere in India with the assistance of various departments of the central and state governments, coordinating and carrying out preliminary investigations of these incidences, reporting the same to various designated functionaries in the governments, and carrying out Landslide Susceptibility Mapping (LSM) and other relevant studies.

III. HUMAN RESOURCE DEPLOYMENT

GSI has specialized Landslide Divisions, with geoscientists trained in landslide studies, in the all the Regions affected by landslide hazard. The workforce takes up pre and post-disaster studies apart from regular field season items of GSI on landslides. In cases of disastrous events, geoscientists from different Regions are mobilized for emergency response and studies as is being currently done in Uttarakhand.

IV. STANDARD OPERATING PROCEDURE
Specific responsibilities and Action Plan of GSI for landslide related hazards

GSI, being a part of the National Disaster Management Plan, takes up the following works, **duly adhering to the Guidelines given by the NDMA** and **recent lessons learnt from the Uttarakhand disaster of 15-17 June 2013:**

A. PRE- DISASTER ACTIVITIES

1. **Landslide Susceptibility Zonation on Macro Scale** (1:25,000/50,000) is followed based on BIS guidelines. It is a multi-thematic exercise taking into account the relevant causal geofactors such as i) *slope morphometry* (Slope gradient, aspect, slope shape), ii) *lithology, iii) structure, iv) geomorphology, v) land use/cover, vi) geohydrology etc.* Objective is to facilitate the planners and settlers to understand the dynamics of slope stability and plan accordingly. Based on Uttarakhand experience **additional thematic layers such as "*proximity of low-level alluvial terrace (T0 & T1 etc.) to the higher order and/ or Trunk River/ stream", "potency of toe and headward erosion by different order streams or drainage networks"* and "*possible run out length of slides and flows"* will be considered.**

2. **Landslide Susceptibility Zonation on Meso Scale** (1:5000/10,000): Aimed to assess the stability status of the existing thickly populated townships/ important civil engineering structures, proposed expansion schemes for urban development, new construction sites of townships in the landslide prone hilly terrain etc. It is multi-thematic, more detailed and uses mainly the expert-driven weighting, map integration techniques and safety values and matrix.

   Prioritization of the areas for Susceptibility Zonation for 1 and 2 will be done by a committee of experts in GSI with inputs from various stakeholders.

3. **Monitoring of a few conspicuous landslides:** Multidimensional instrument-aided 3-D approach will be adopted as far as possible in locations of large human settlement, critical installations such as dam, power house, etc. However, cost is a prohibiting factor and has rarely been applied barring a few like Varunavat landslide.

4. **Development of Early Warning System**: The next higher-level step; involves sophisticated instruments and specialized knowledge on this particular subject. GSI is looking for collaboration with some knowledge-based institute (national/ international) having past experience in this particular field of specialization on R&D basis. For regional or local scale, empirical modeling using rainfall threshold is ideal. Weather monitoring equipments need to be installed close to the landslide prone areas for a more realistic site specific data generation activities.

B. POST- DISASTER ACTIVITIES (RESPONSE TO DISASTER):

1. Immediate response - Reconnoitory (Level-1)

Maximum stress needs to be given for preliminary assessment using high-resolution satellite imageries and/or air surveillance as evacuation, relief and rehabilitation are the immediate focus.

The field-based first-level ground appraisal will be taken up within 15 days of the event. This reconnoitory study is expected to be completed within 1 month and submission of preliminary report within 7 days after completion of fieldwork. Study includes rapid assessment of damages, preliminary identification of landslides, its broad typology, identification of stretches of affected roads/ accessibility corridors and if possible, tentative identification of probable safer slopes for temporary rehabilitation. Another objective of this study is to delineate vulnerable tracts and the assess quantum of work to be taken up for the 2nd level appraisal.

2. Response study – Preliminary/ feasibility & multi-thematic (Level-2)

To be initiated within 1-2 months of the disaster. As per the suggestions of the 1st level response studies, GSI will take up a rapid macro-scale (1:50000/25000) slope stability assessment (preferably GIS-enabled) by taking additional item of investigation in that particular Field Season itself and by prioristising the areas (districts, NH/ SH corridors, villages etc.) after consulting with the State Governments. The total time period of this study is 6 months to 1 year including submission of reports to the stakeholders. Arrangements for provision of interim reports will also be kept.

The main objectives of the first level of response are:

- To update the existing macro-scale landslide inventory database of the area, and preparation of a event-based landslide inventory (Landslide inventory mapping- the most fundamental tool to convert susceptibility maps into hazard and risk maps which are essential for any landslide management and mitigation planning).
- To evaluate tentatively the geogenic causes of this geomorphic hazard.
- To identify the susceptible locations for fresh mass wasting and failures,
- Preliminary assessment on effective mitigation measures for restoration of roads/ accessibility tracks along NH and SH.
- Preliminary evaluation of the proposal of re-alignment of NH and/or SH wherever essential for suggesting futher more detailed site specific studies geological/ geotechnical studies.
- To preliminarily identify safer and stable locations for rehabilitation/ relocation of settlement and for taking up detailed and site-specific geological/ geotechnical investigation in future.

3. Response study – Detailed site-specific (Level-3) Action plan

Based on the preliminary appraisal of the landslide hazards at two levels (Level 1 & 2), detailed site specific studies are initiated with micro scale (1:5000 or larger) geological mapping, followed by sub-surface exploration (if required), sampling of slope forming mass and testing for physical and shear parameters and deterministic slope stability modeling. Main aim is to identify activity, extent, causes and failure mechanisms of such landslides for effectively suggesting the slope protection measures; to suggest suitable and stable sites for housing buildings, suggesting realignment of roads and for preparing the foundation for constructing some critical infrastructures (e.g., bridges, rope ways, transmission tower etc.). For detailed site-specific studies, requests can also come from National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA) and State Governments.

V. LANDSLIDE HAZARD INFORMATION MANAGEMENT AND DISSEMINATION

As part of National Disaster Management Programme, GSI is functioning as one of the Primary Nodes of DMS (Disaster Management Support) Network. It is connected to Disaster Management Support Network of Ministry of Home Affairs (MHA), other primary nodes, viz., PMO, MHA-HUB, IMD, CWC, INCOIS, NRSA and other user nodes located in capital cities of landslide prone States. The aim of this entire network is to disseminate information and required data to MHA-HUB as well as to the user nodes on emergency basis so that action to mitigate the impact of hazard is initiated and wherever possible early warning about impending hazard is communicated to affected populace.

As part of the SOP, the first information reports of the major landslide incidences are planned to be uploaded on the GSI Portal. Database on landslide incidences and landslide reports (*Landslide inventory database)* is being maintained and updated. Information on 1350 landslide incidences and metadata of 225 landslide reports has already been incorporated in the database.

Periodic workshops involving State Government and Central Government agencies and other stakeholders are planned for better coordination, cooperation and collaboration in the field of landslide management and mitigation. Recently, in June 2013, one such workshop was conducted with the participation of the States of J&K, Uttarakhand and HP and other related Central Government agencies etc.