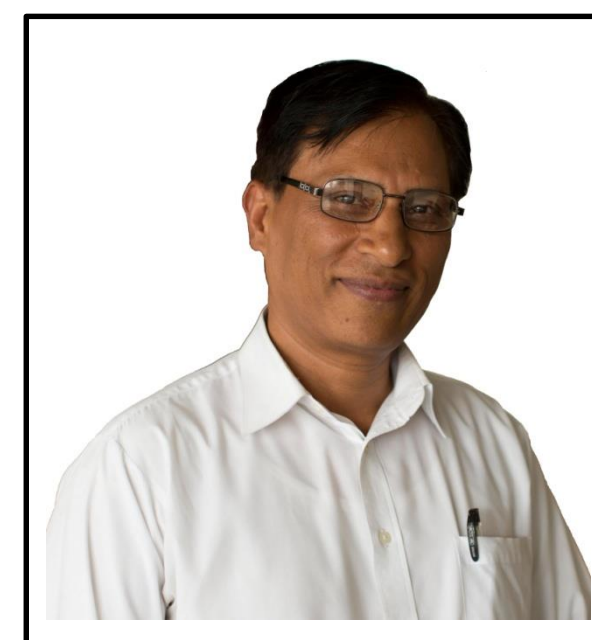




1 Introduction

There are more than 12 types of Disasters in Nepal. The Flood, Landslide, Fire and Thunderbolt are the major disasters having higher losses of lives and properties. Out of them the casualty due to Landslide Disaster in Nepal is highest to date. The highest casualty due to landslide in the year 2077 was 302 (53% of the total annual casualty), Figure 1.

The landslide in Nepal is affecting directly to the settlements threatening to life and property of people, agricultural land, infrastructures and is affecting the national goal as poverty alleviation and the Gross Domestic Product (GDP) by 4%. (Amatya, S.C. 2020). The twelve years data analysis from 2009/10 to 2020/21 of Ministry of Home Affairs (MoHA), exhibit the average toll death due to landslide disaster covers 120/year (about 25% of total average annual casualty) and average property loss due to landslide becomes more than 157million rupees per year. This situation of landslide disaster is challenging for the development of Nepal. The landslide disaster can be reduced by the application of appropriate technologies and their management which need the preparation of the basic data map like an inventory map with a degree of hazard, selected hot spot and hazard map with the zoning of landslide.

This time the disaster focal institute National Disaster Risk Reduction and Management Authority (NDRRMA), Ministry of Home Affairs (MoHA) is focusing mainly on immediate response sector as rescue and relief works. The NDRRMA, MoHA is supported by Ministry of Health in Health disaster sector, Department of Hydrology and Meteorology (DHM) in weather disaster area including Flood and GLOF Early Warning Systems and the Municipalities in Fire Disaster sector but there is no such institution which will support to NDRRMA in implementation of Landslide disaster mitigation and management sector. Thus, it is felt that an institute is in need which will support to the National Disaster Risk Reduction and Management Authority (NDRRMA) to address the issues and mitigation of landslide disaster in Nepal. The present Institutional setup of DRM in Nepal is presented in Figure 2 below.

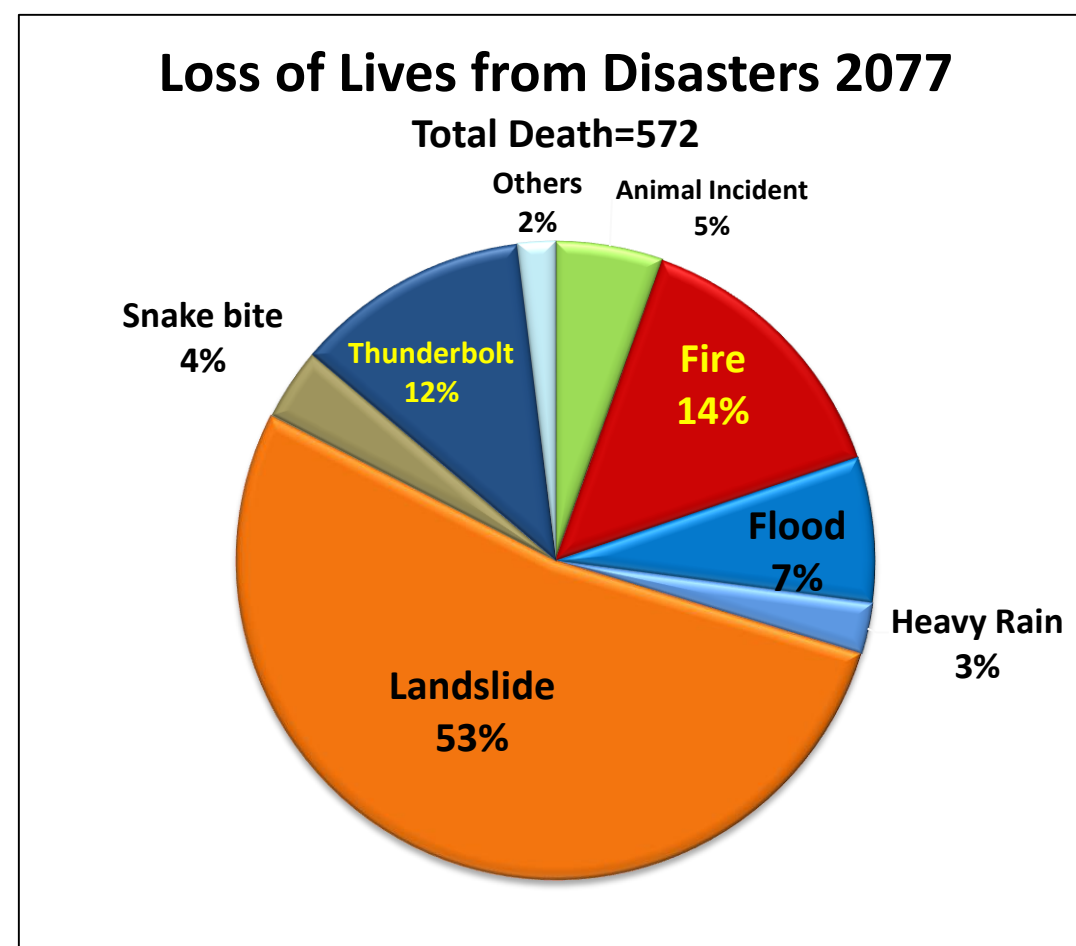


Figure 1: Loss of Lives from Disasters 2077

Present Institutional Setup for DRM in Nepal

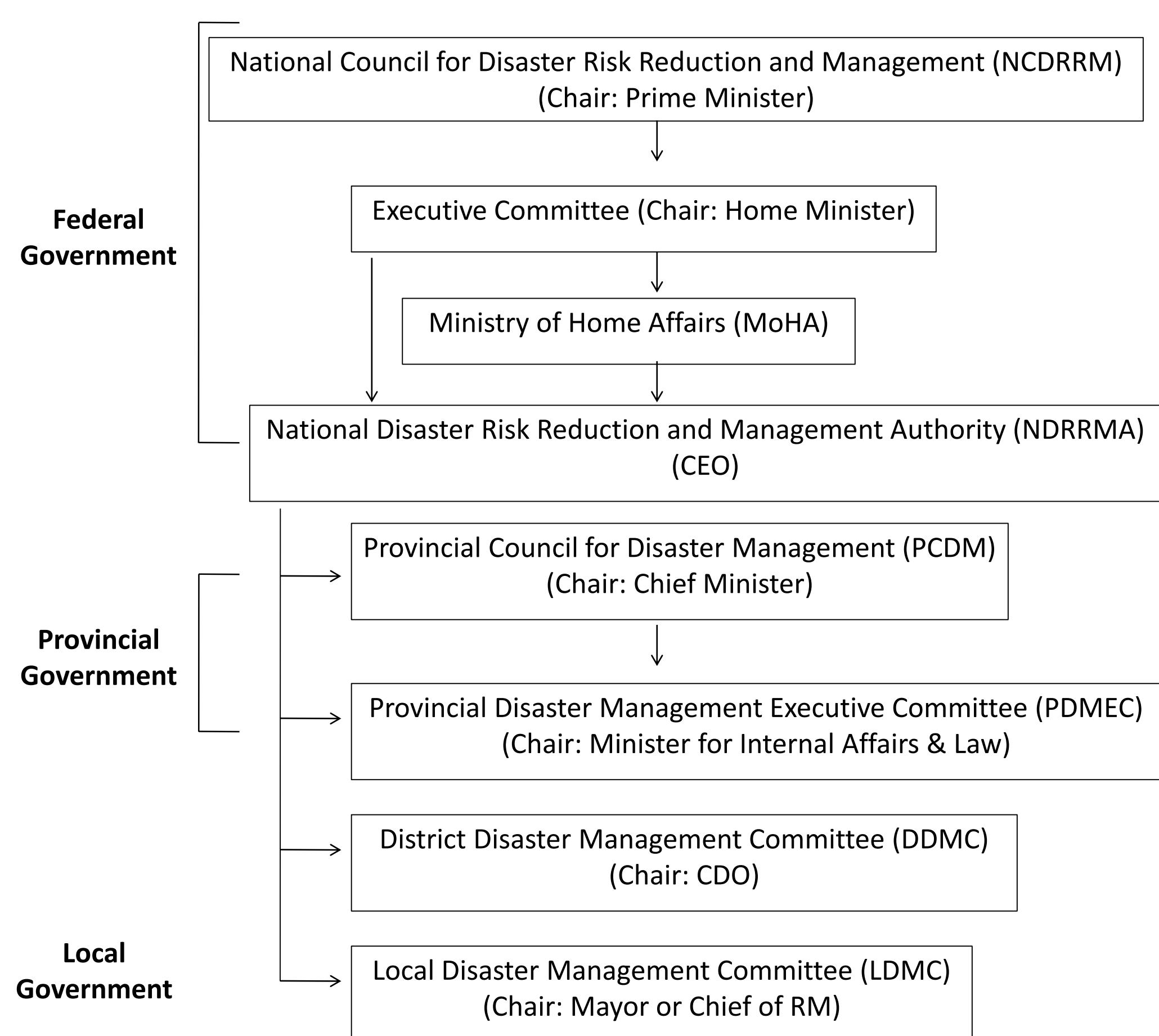


Figure 2: Flow chart on Present Institutional Setup for DRM in Nepal

But it is not clear which government is responsible to control or mitigate the landslides and there are no Geologists/landslide experts in those institutions for landslide disaster management. (Bhattarai, T.N. et.al. 2020)

2 Aim of NDRI

Develop NDRI as supportive Institute and think-tank for Government and NGOs in Landslide Disaster Management in Nepal.

3 Activities

Based on the NDRI's aim and the issues mentioned above, the following activities took place in actions.

3.1 Detailed Study of Budhanilkantha-5, Tushal Landslide, Kathmandu District

Background: The Budhanilkantha Landslide occurred on August 18, 2018 (2075 Bhadra 12 BS), Tuesday at the residential area, Ward No 5, Tushal, Budhanilkantha Municipality, Kathmandu. The landslide badly damaged two houses and affected more than 15 houses, and roads to the residential area but no casualties, Figure 3. The detailed study of landslide was done by NDRI as referred by District Disaster Management Committee.

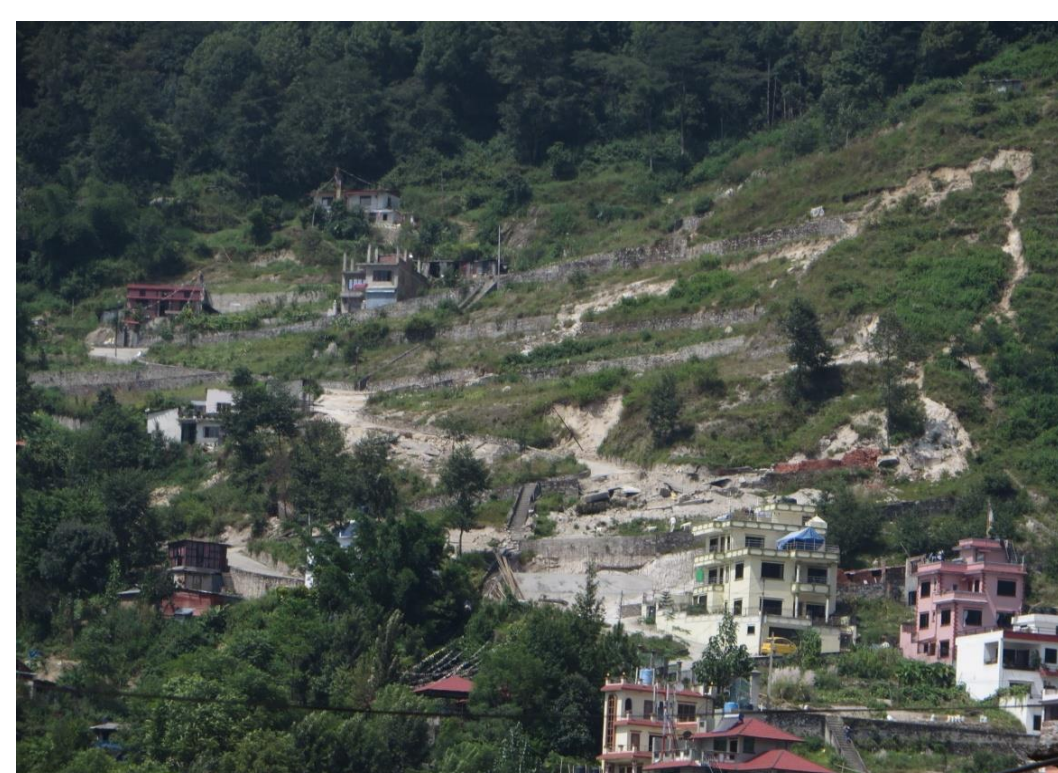


Figure 3: Budhanilkantha-5, Tushal Landslide

- Objectives:**
- To prepare landslide hazard map of the area with ERT and topographical survey.
 - To suggest appropriate mitigating measures (structural and non structural).

Methodology: Engineering teams were deputed to carry out detailed topographical survey and ERT survey and geological survey. The topographic survey was carried out by using "Total Station". The ERT survey team used Resistivity Meter for Two-Dimensional Electrical Resistivity Tomography (2DERT). The Landslide hazard map was prepared on the base of those survey data. Based on the landslide hazard map the landslide mitigation structures were recommended.

Findings:

- The rock type in the landslide study area is Sheopuri Gneiss with medium to coarse grained. The rocks are intensively weathered. The average thickness of the weathered over burden in the landslide area varies from 2-3m to 7-8m according to the ERT survey, Figure 4.
- The landslide profile showed the clear features of the slow moving landslide as crown, head, head scarp, body, and toe part of the landslide.

Recommendations for Landslide Mitigation Measures:

- Check dams in the local streams
- Horizontal drilling drainage in the main landslide to release pore water pressure
- Surface drainage management in the main landslide with drainage pits
- Hillside works as terracing
- Bio-engineering works in the head and body part of the landslide with wickers
- Sand bag packing at the scarps created by the landslide
- Trimming the head part at 45° and
- Counter weight at toe of the main landslide for toe protection

3.2 Lidi Landslide Disaster Study and Management

Background: It was found that 11 different landslide events were occurred in Sindhupalchowk district with loss of enormous life and property in the period of six months (March –August 2020). Hence, the district comprises of maximum human casualties in the monsoon 2020. Out of them, the devastating landslide occurred in the Lidi Village of Jugal Rural Municipality-2 on 14th August, 2020 which had caused maximum human death of 37 people. Thus, to address the issues, NDRI initiated to study the area around Jugal Rural municipality covering with a small catchment area of Balephi river of Sindhupalchowk district, Central Nepal as a pilot study area. The catchment area of the selected watershed area is of around 100 km². The location map of the study area is shown in Figure 5.

Objectives:

- Preparation of Landslide Inventory Maps.
- Preparation of Landslide Susceptibility Maps

Methodology: The Landslide Inventory map and landslide susceptibility maps of the study area were prepared from the available secondary data from reports, MoHA data and geological maps using Google Earth engine and GIS as tool.

Results:

Preparation of Landslide Inventory Maps: The landslide inventory map of the study area prepared on the base of Report J-RAPID after Gorkha Earthquake 2015. (J-RAPID 2016). The map is presented in the Figure 6. In the same way, the landslide inventory map of the study area was prepared on the base of Google Earth Engine data of before and after the Earthquake 2015. The map is presented in the Figure 7, (Khatiwada, D. 2020).

Preparation of Landslide Susceptibility Maps: The landslide susceptibility map of the selected watershed area was prepared using the eight different landslide causative factors as Slope, Aspect, Elevation, Curvature, Distance to road, Distance to river, Geology and Land-use. These data were derived from DEM with a spatial resolution of 10m using arc toolbox raster surface in ArcGIS. The Landslide Susceptibility map is presented in the Figure 8, (Khatiwada, D. 2020).

Recommendations:

- The study of landslide on the study area can be further done with the field verification and detail geomorphologic mapping.
- The validation of the landslide inventory prepared from the Google earth images can be done with the field survey.
- The types of landslide can be differentiated as a rainfall induced landslide and earthquake induced landslide too.

3.3 Landslide Data Bank Management

Based on the aim of NDRI, all data related to the landslide disaster management were initiated to collect, compile and store for establishment of Landslide Data Bank. In this regard, the following listed data were established.

- National Policies of Nepal
- National and International DRR initiatives
- History of landslide evidences in Nepal
- Situation of landslide in Monsoon
- Available technical guidelines of Landslide disaster management
- Act, Policies and strategies related to Landslide disaster management

4 Further Targets of NDRI to meet the Aim

- Study and Management of Landslide Disasters in Nepal
- Create Landslide Disaster Data Bank
- Prepare Landslide policy, Guidelines and Manuals for Landslide Disaster Management to support Government and NGOs
- Study and Management of Landslide Early Warning System in Nepal
- Capacity building/HR related to Landslide Disaster Management to Line Agencies.

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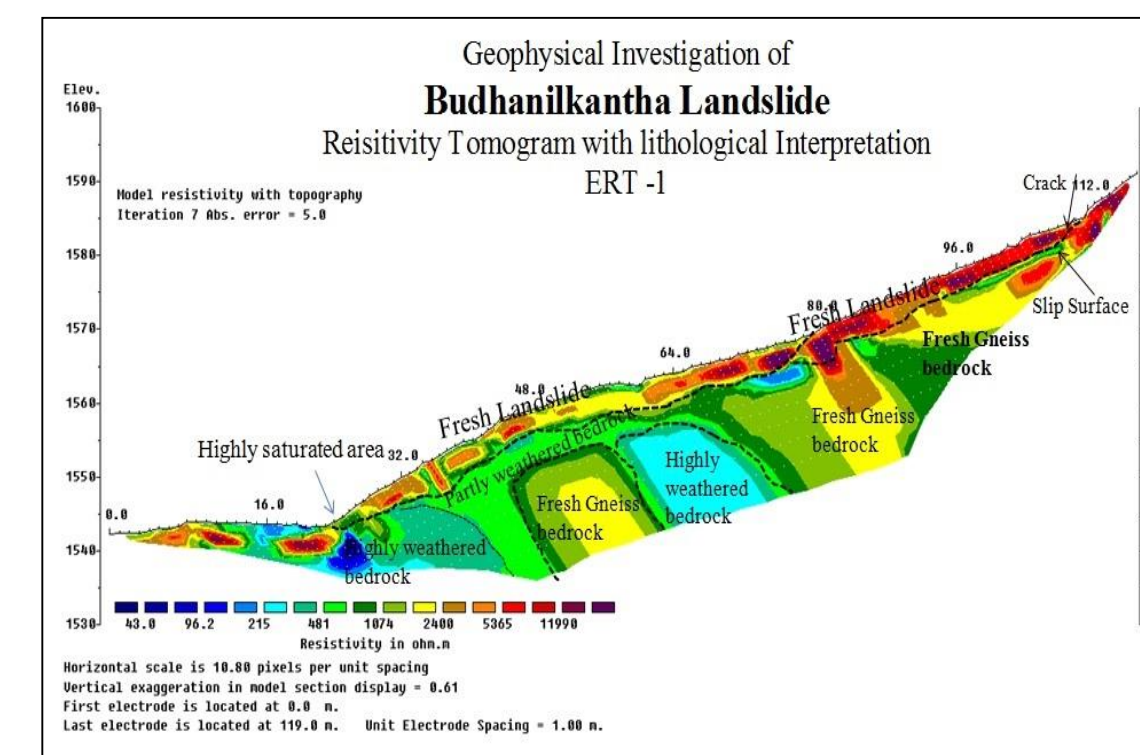


Figure 4: Electrical Resistivity Tomogram with Lithological Interpretation of ERT-1

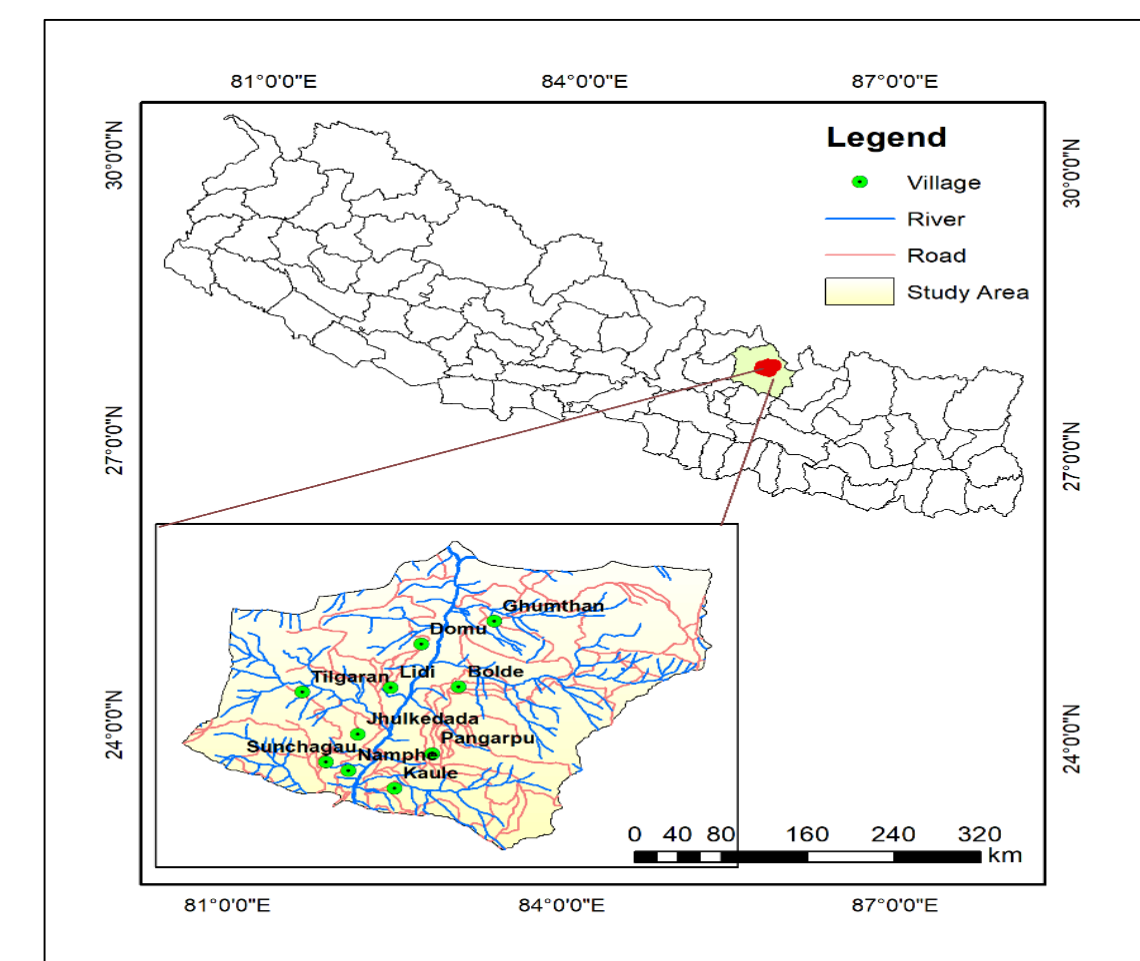


Figure 5: Location of the study area

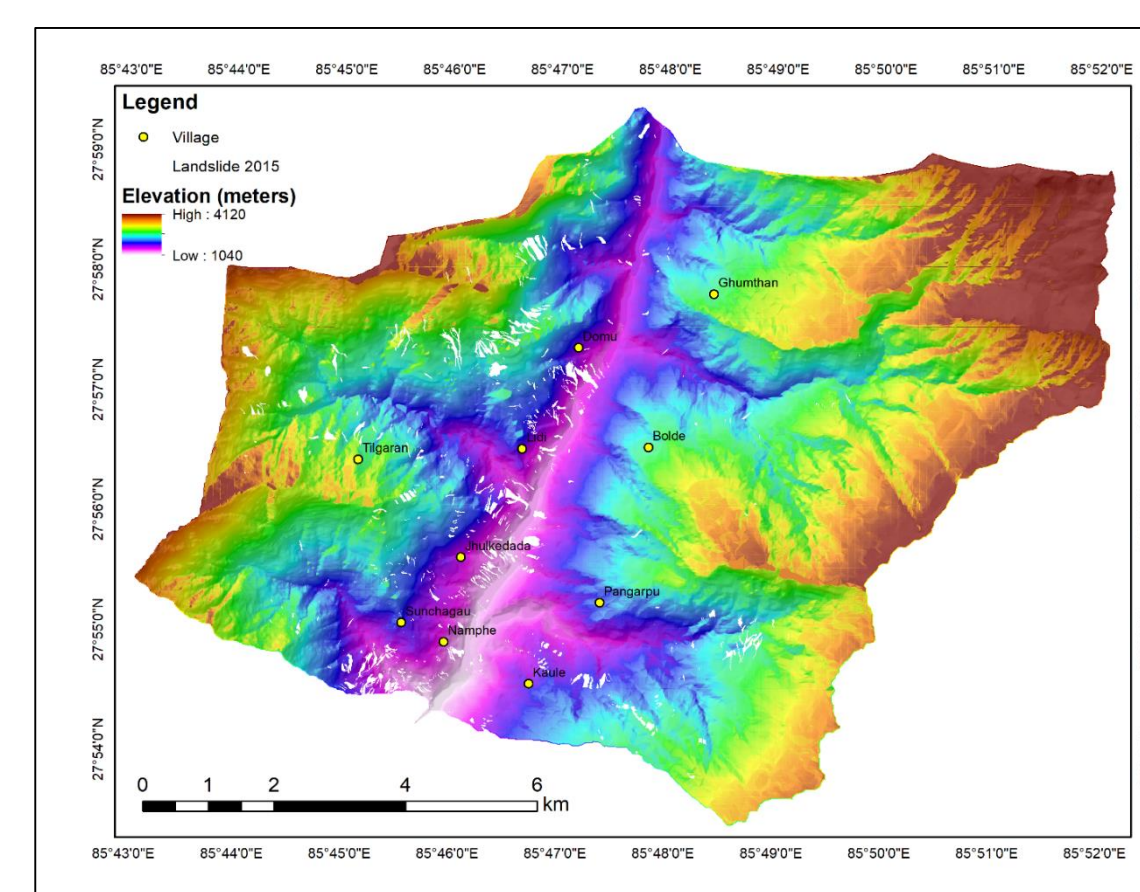


Figure 6: Landslide inventory map after Earthquake 2015 (J-RAPID, 2016).

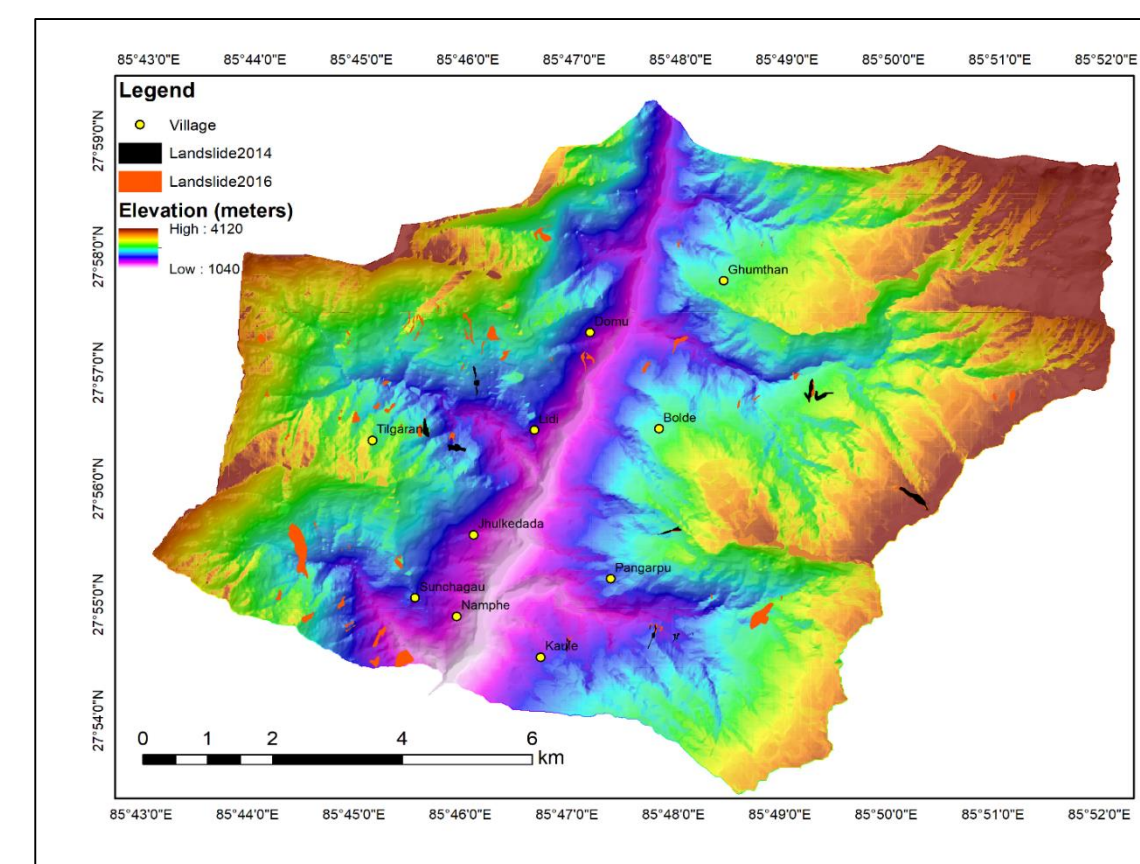


Figure 7: Landslide inventory map before and after Earthquake 2015 based on Google Earth.

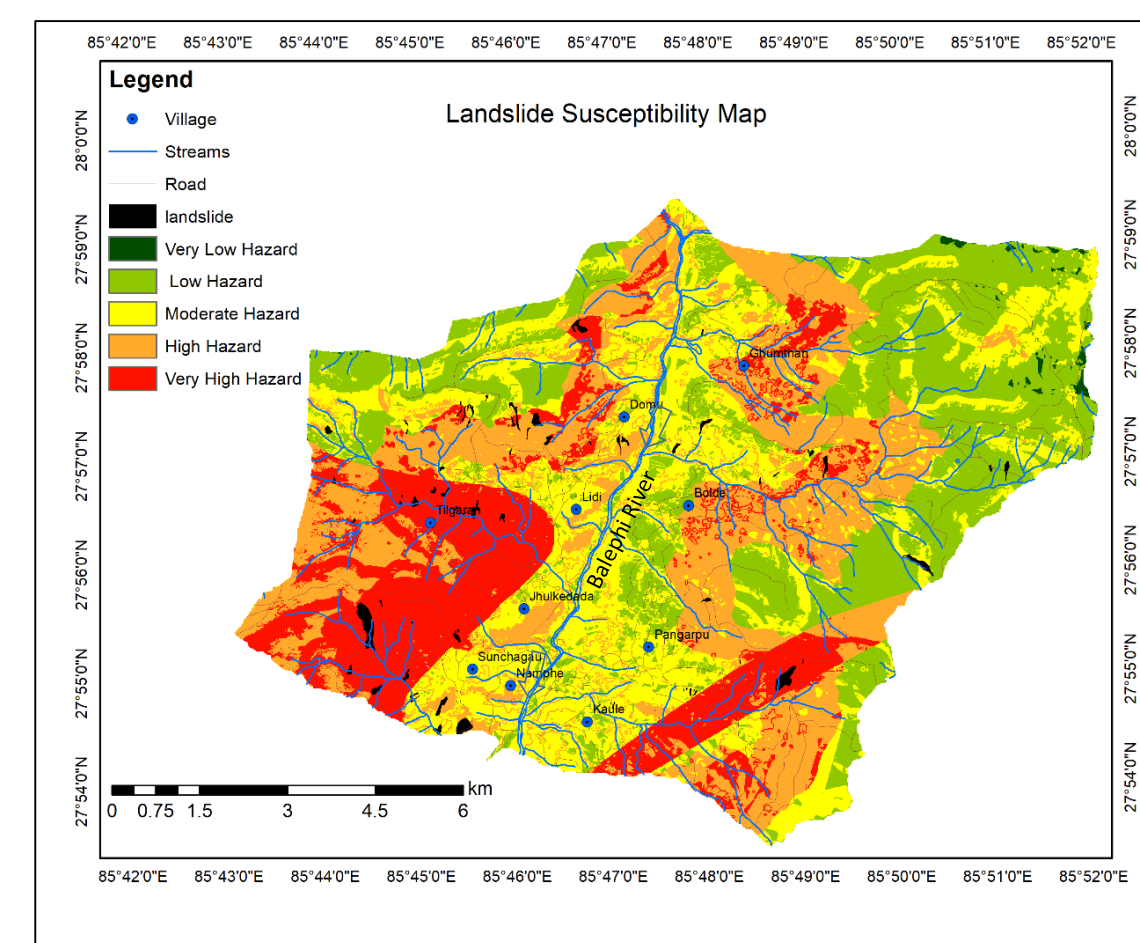


Figure 8: Landslide Susceptibility Map of study area.