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Landslides along Asian highway-1 from Dimapur to Moreh, India

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Abstract
National Highway-39 is a part of AH-1 that connects Asian countries through Moreh, i.e. hope line for Look East Policy. NH-39 is lifeline of both Nagaland and Manipur states. This highway experienced number of landslides every year in rainy season. It starts around Patkai Bridge, Chumukedima and at many places both small and large scale landslides occurred. Some major landslides occurred in this decade are Patkai-Kukidulong slide (July 2011, 2013), Phesama-Kigwema (12July, 2013) Zubza slide (2007, 2012), Phikomei slide (2004), Maram Slide (2010), Gopibung Mudslide (2004) and Moreh slide (2010). After 4-lane expansion from Dimapur-Kohima, whole rainy days people suffer while traveling along this highway. It took five to ten hours, even overnight to pass this section because of the landslides. By the combined effect of factors like large scale human activities; fragile lithology; rugged terrain; complex geological structures; seismicity and heavy rainfall, mud flow, debris flow cum slide, and rock fall have been taken place after every heavy rainfall in this area. To mitigate landslide incidences successfully in future it is suggested that the geological and geotechnical properties should be taken due importance by the planners in the initial stage and public awareness programme should be given.

Keywords: national highway-39, Asian highway-1, landslides, mitigation, public awareness

1. Introduction
Natural disasters have claimed several thousand lives all over the world every year. This is quite costly to the world economy both in human affairs and in economical aspects as natural disasters have major direct and indirect economic and socio-economic effects as well as physical destruction. Literally, nowhere on earth is safe from the impact of the natural hazards. Due to an increasing population density and non-existing or inadequate development plan, especially in mountainous region, more and more people are prone to such disasters. Unfortunately, the impact of these disasters is more severe in many developing countries as the developed countries have already created disaster mitigation and disaster preparedness programs while the developing countries normally only give in to such vulnerability.

Mass movements in mountainous terrain are natural degradational processes. Under the influence of a variety of causal factors, and triggered by events such as earthquakes or extreme rainfall, most of the terrain in mountainous areas has been subjected to slope failure at least once (Naranjo and van Westen, 1994) [5]. In recent years, growing population and expansion of settlement and life-lines have largely increased the impact of natural hazards both in industrialized and developing countries. In many countries, the economic losses and causalities due to landslide are greater than commonly recognized and generate a loss of property larger than from any other natural hazards. Landslides are considered the second most significant natural hazard among those identified by the United Nations Development Program (UNEP, 1997). The full awareness of the effects produced by natural hazards led the United Nations, in 1989, to sponsor a resolution that declared the years 1990-2000 the "International Decade for Natural Disaster Reduction". Damage caused by catastrophic events is too costly even for industrialized societies. In other words, natural catastrophes occur with higher frequency than our resilience or ability to recover from previous events. The recent trend is towards the development of warning systems and land utilization regulations aimed at minimizing the loss of lives and property damage. Keeping this view in mind, the present paper aims at the study of landslides along NH-39, from Dimapur to Moreh.

NH-39 starts from Numaligarh, Assam and ends at Moreh, Manipur (Fig. 1). It covers a distance of 436km (271mi), of which 115km (71mi) is in Assam, 100km (62mi) is in Nagaland and 211km (131mi) is in Manipur. It is a part of Asian Highway (AH)-1 that connects Asian countries through Moreh, i.e. hope line for Look East Policy. This highway is lifeline of both Nagaland and Manipur, The present study area covers from Dimapur (Nagaland) to Moreh (Manipur) for a distance of about 311km. Dimapur town is the commercial hub of the state and is the magnet around which the economic and developmental activities of the district are centered; it is one of the fastest developing townships of the North East. The town is also a gateway to Nagaland and Manipur state as it has the rail head leading to other Indian States. In Manipur roads are the only means for surface transport and the essential commodities of Manipur are mainly transported along NH-39 which connect Nagaland in the north and Myanmar in the southeast. Moreh is an important Indo-Myanmar Border town where border trade takes place. It is located in Chandel district of Manipur.

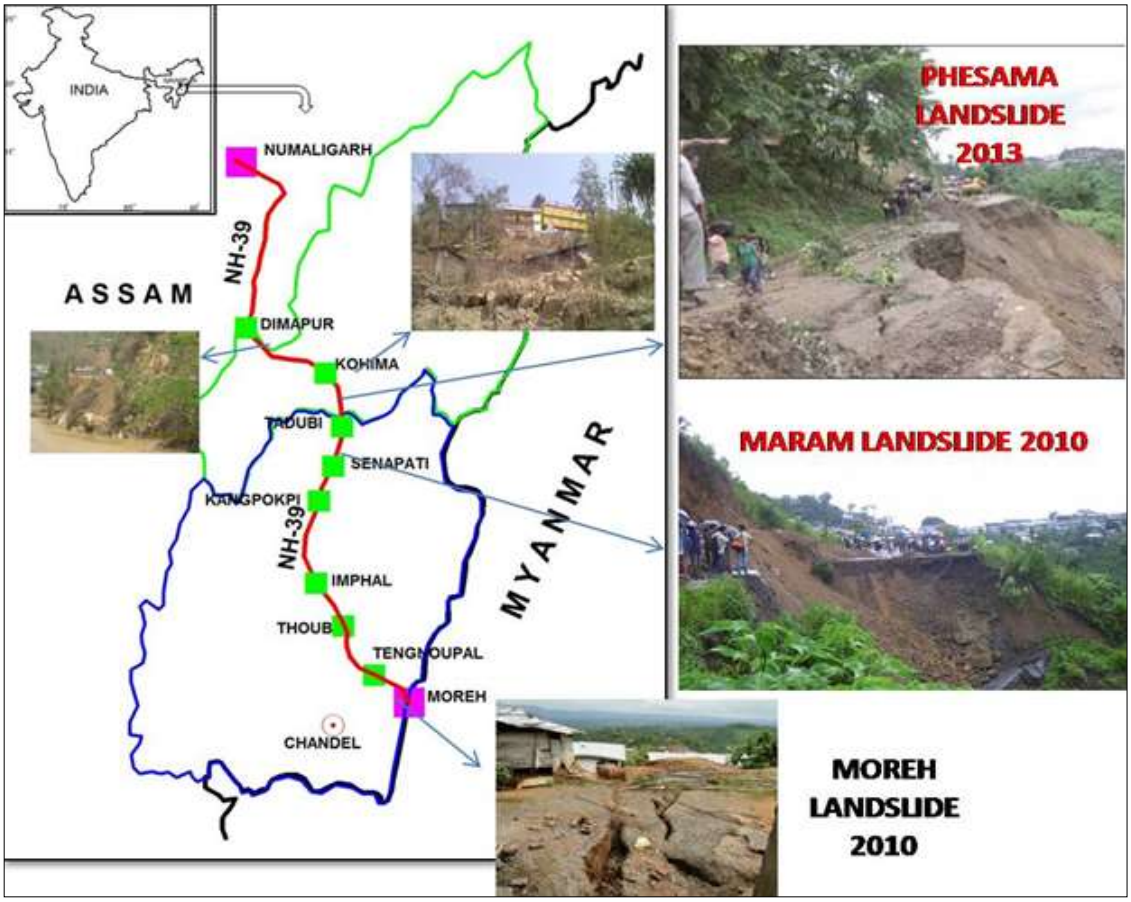

Fig 1: Study Area

2. Landslide Hazard

A wide variety of terms have been used for the denudational process whereby soil or rock is displaced along the slope by mainly gravitational forces. The frequently used terms are slope movement, mass movement, mass wasting, and landslide. Mass movement is defined as "the outward and downward gravitational movement of earth material without the aid of running water as a transporting agent" (Crozier, 1986) [1], or "the movement of a mass of rock, debris or earth down a slope". These are the most widely used definitions of the phenomenon. Although they are slightly different from each other when considering beyond the scope of inclusion of water, both definitions point to a mass transportation down slope in which a hazardous activity for humans may occur. In the last few decades, landslide is a term being the most used, though in the narrow sense of the word (sensu strictu), it only indicates a specific type of slope movement with the specific composition, form and speed. Mass movement, or slope instability or land sliding is the same natural denudational and degradational processes, unless they threaten human life. Their interference with ongoing human activities in the terrain marks a landslide hazard. The general accepted terminology explained below is that's of Vernes's (1984) and is illustrated in a form of formula:

Rs=H*V, where

- Natural hazard (H): The probability of occurrence of a potentially damaging phenomenon within a specified period of time and within a given area (Figure 2-1).
- Vulnerability (V): The degree of loss of a given element or set of elements at risk resulting from the occurrence of a natural phenomenon of a given magnitude. Scale is 0 (no change) to 1 (total loss).
- Specific risk (Rs): The expected degree of loss due to a particular natural phenomenon. It may be expressed by the product of H and V.

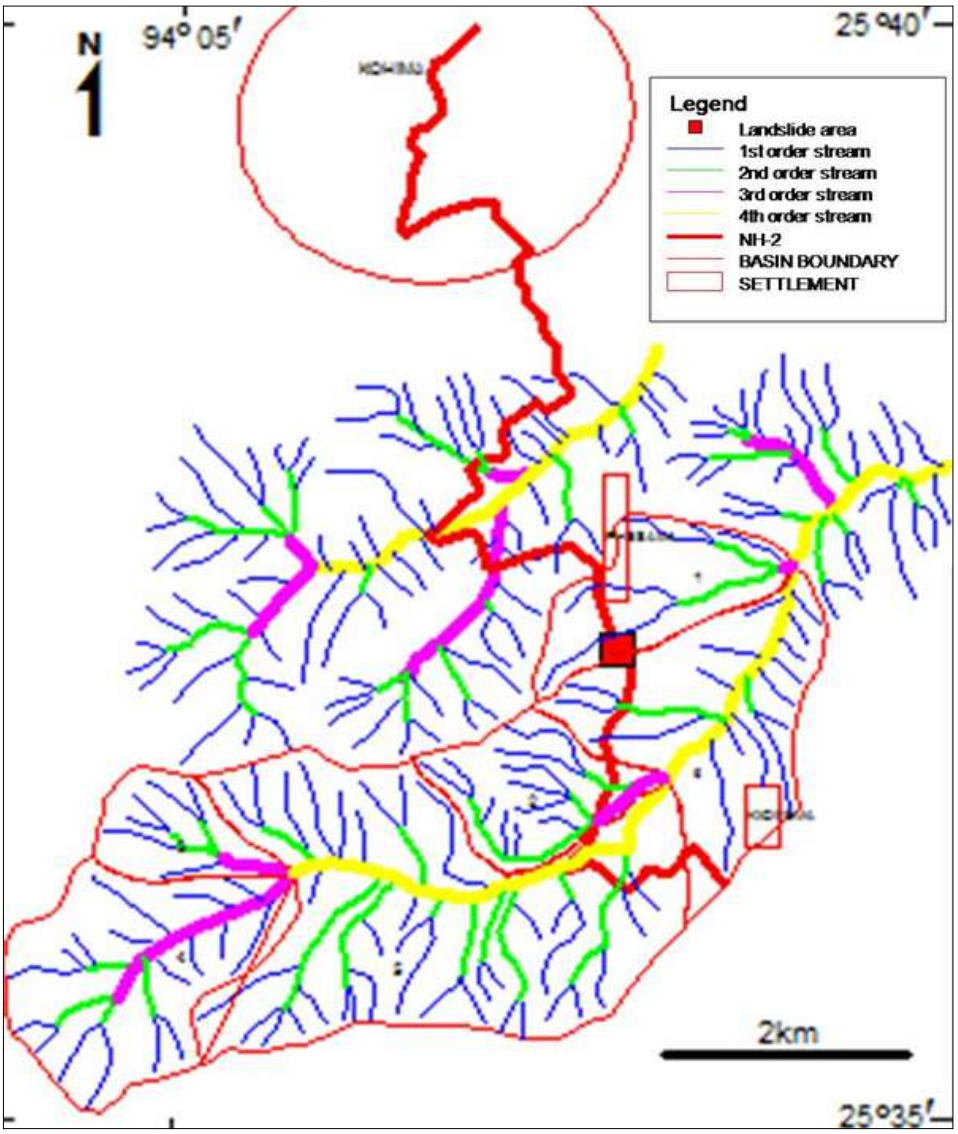

Fig 2: Mezi River Ba

The total risk could also be expressed in another formula:
RT=E*Rs, where

- Elements at Risk (E): The population, properties, economic activities, including public services, etc., at risk in a given area.
- Total Risk (RT): The expected number of lives lost, persons injured, damage to property or disruption of economic activity due to a particular natural phenomenon.

3. Landslides in the Study Area

NH-39 experienced number landslides every year in rainy season. It starts around Patkai Bridge, Chumukedima and at many places both small and large scale landslides occurred. Some major landslides occurred in this decade are Patkai-Kukidulong slide (July 2011, 2013), Phesama-Kigwema (12 July, 2013) Zubza slide (2007, 2012), Phikomei slide (2004), Maram Slide (2010), Gopibung Mudslide (2004) and Moreh slide (2010). After 4-lane expansion from Dimapur-Kohima, whole rainy days people suffer while traveling along this highway. It took five to ten hours, even overnight to pass this section because of the landslides. The important affected areas along Dimapur-Moreh section are presented below.

1. Along Dimapur to Kohima in Nagaland:
   - Patkai to Kukidulong
   - Pherima to Pephima
   - Around Lalmati and Zubza
   - Around Kohima town
   - Phesama to Kigwema
   - Around Khuzama
2. Along Mao to Moreh in Manipur
   - Around Phikomei
   - Around Mauzu
   - Tadubi to Maram
   - Around Maram
   - Karong to Senapati Bazar
   - Around kangpokpi
   - Around Gopibung
   - Around Lokchau
   - Around ADC complex Moreh

Based on field study it is observed that the landslides along Patkai to Kukidulong is mainly due to erosion by parallel to sub parallel gullies along steep slopes added by toe erosion by Chathe river. At many places the terminal water forces of chathe river act upon the toe part of the slope over which NH-39 lies. Fragile nature sandstones intercalated with

shale and siltstone in this section are highly prone to weathering and erosion. The study area is an integral part of Indo-Myanmar Range which was evolved as a result of collision between Indian Plate and Myanmar plate and remains seismo-tectonically active, often experience earthquakes in variable magnitudes. By the combined effect of these factors, debris flow cum slide, and rock fall have been taken place for every heavy rainfall in this area.

After Kukidulong, due to large scale human activities like road cutting and widening, constructing houses, quarrying, deforestation, paddy cultivation along steep slope; fragile lithology; complex geological structures; seismicity and heavy rainfall lead to landslides. Detailed geotechnical analysis of some samples indicates that these soils are semi-solid state and moderate to high plastic in nature. Evaluation of factor of safety reveals that most of the sites are under unstable category (Devala, 2011b). Based on the hazardousness to landslide from Kangpokpi to Mao, more than 50% falls under the high risk zone (Devala 2011a). Morphometric analysis of landslide area at Phesama-Kigwema (12 July, 2013) reveals that Mezi River basin (Fig. 2) belong to high drainage frequency and moderate to high drainage density (Table 1). The slope angle ranges from gentle to steep categories (Table 2). The relative relief has categorized to moderate and high, only 1.87% of the area belongs to low relief (Table 3). Besides, the litho-boundary between Disangs and Barails run parallel to the highway.

Table 1: Mezi River Morphometry

Sub basin	Drainage Density	Drainage frequency
1	3.41	5.32
2	3.79	6.96
3	4.50	9.82
4	5.55	10.17
5	3.93	6.74
6	3.02	5.80

Table 2: Slope Morphometry

Slope angle	Categories	Area (%)
<15°	Very gentle slope	00.00
16°-25°	Gentle slope	47.73
26°-35°	Moderately steep slope	43.34
36°-45°	Steep slope	07.88
>45°	Escarpment/cliff slope	01.05

Table 3: Relative Relief.

Relative Relief	Categories	Area %
<100	Low relief	01.87
101-300	Moderate relief	58.37
>300	High relief	39.76

4. Conclusion

A way of dealing with natural hazards is to ignore them. In many parts of the world, neither the population nor the authorities choose to take the danger of natural hazards seriously, for various reasons namely socio-economic, political, cultural, religious, etc. To effectively mitigate disasters, a complete strategy for disaster management is required, which is also referred to as the disaster management cycle. Disaster management consists of two phases that take place before a disaster occurs, disaster prevention and disaster preparedness (both phases together are also referred to as disaster mitigation), and three phases after the occurrence of a disaster: disaster relief, rehabilitation and reconstruction. Unfortunately, the emphasis in most countries has always been on the phase of disaster relief, and most disaster management organizations in developing countries have been established only for this purpose. Recently, the emphasis is being changed to disaster mitigation, and especially to vulnerability reduction. To mitigate landslide incidences successfully in future it is suggested that the geological and geotechnical properties should be taken due importance by the planners in the initial stage and public awareness programme should be given.

5. References

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