CHAPTER-1

1.1 INTRODUCTION:

A land with bounteous vistas of untrammelled beauties enamelled with rich and unique ancient traditions, the Shangri-La of north east, a galaxy of natural wonders, also renowned as the Jewel of India, is the small state of Manipur. It is the home of colourful people. The serenity of these pristine environ has promulgated the life-style of these people with a lavish land, allowing them to live for centuries together in harmony.

This small hilly state is situated in the far north-eastern corner of the Indian sub-continent and is bound by Nagaland in the north, Assam in the west, Mizoram in the south and Myanmar in the east. It is situated at the periphery of the Indo-Myanmar Range (henceforth abbreviated as IMR) between 23° 80' N to 25° 68' N Latitudes and 93° 03' E to 94° 47'E Longitudes and occupies about 23,327 sq km area. Of the total geographical area about 90% is occupied by rugged hilly terrain and thick deciduous forest. The average elevation of the valley is 790 m. above mean sea level and that of the hills is 1600m. Out of nine districts of the state, five are situated in the hills and remaining four in the valley. Physiographically, the state has been divided into the following four zones:
1. The Eastern Hills,
2. The Northeastern Hills,
3. The Central Valley, and
4. The Western Hills.

Various forms of natural disasters/hazards have threatened the mother earth, which exceed the tolerable limit of magnitude, thereby resulting in catastrophic loss of life, property and impeding developmental activities. Certain initiative measures have been adopted by the Government to monitor such hazards/disasters in order to mitigate their impediment. The Indian sub-continent has been affected by different kinds of hazards like floods, droughts, cyclones, tsunamis, earthquakes and landslides. It has also been estimated that on an average, the damage caused by landslides alone in the Himalayan region costs more than one billion US dollar, besides causing more than 200 deaths every year, which overall is considered 30% of such types of losses occurring world-wide (Naithani, 1999). The direct and indirect losses owing to landslides can be reduced by implementing effective planning and management as suggested by Slosson and Krohn, (1982); Schuster and Leighton, (1988) and Schuster, (1996) which include:

1. Restriction of developmental activities in landslide prone areas,
2. use of excavation, landscaping and construction codes,
3. use of physical measures (structures, drainage, slope-geometry & its modification) to prevent or control landslides and
4. development of warning systems

By adopting such planning and management schemes, landslide related losses could be reduced by more than 90% in California (Schuster and Leighton, 1988). However, in most of the countries due
to lack of awareness of such schemes the economic and societal loss of life continue to rise.

Landslides are the downward and outward movement of slope-forming materials, composed of rocks, soils or artificial fills (Varnes, 1958). These range from rapidly moving catastrophic rock-falls or topples and debris-flows to slowly moving earth slides and other ground failures. Landslides occur when disturbing forces exceed than the resisting forces. The stability of a slope is termed as factor of safety and can be denoted as follows:

\[ F = \frac{M_R}{M_D} \]

where, \( M_R = \) resisting forces, \( M_D = \) disturbing forces, \( F = \) factor of safety.

The term mass wasting was used by Thornbury (1954) for the gravitational and down slope movements of weathered rock debris. There is no sharp distinction between weathering and erosion, but mass wasting narrows down the gap between weathering and erosion. Both weathering and erosion require transporting medium, whereas mass wasting is the only force which does not require transporting medium. Although, water plays an important role, it is not included in the definition of mass wasting.

Factors which are responsible for the down-slope movements include internal friction and cohesion of the sliding plane material. Apart from this, the presence or absence of discontinuity planes plays a very important role on the stability of the rock-slopes. While considering the stability of a slope, the most important factor is the geometry of the rock-mass behind the slope face. The geometrical relationship between the discontinuities in the rock-mass and the slope, and orientation of the excavated face determines whether, parts or whole of the rock-mass is free to slide/fall or not. The next important
factor is the shear strength of the failure surface, which may consist of a single discontinuity plane or a complex structure.

When deformed geological structures and high seismicity combine with tropical climate and adverse hydrological conditions, it may trigger various kinds of mass wasting. The lithological and structural conditions etc are also influenced, when exposed to various conditions. Moreover, the state is located in a very High Risk Seismic Zone (V), mobile belt of Indo-Myanmar Ranges (IMR), i.e., tectonically very active zone, and have aggravated the instability of hill-slopes in the region.

To start any journey into unfamiliar territory is often spurred on by dreaming, a kind of dreaming that spawns not light-headedness by intense curiosity and setting of goals. The present journey has been planned to explore the various causes of landslide incidences along the NH-53.

Manipur is a land-locked state and does not have any water way or railway transport system to link with other states of the country. Imphal, a small metropolitan town is the capital of the state and linked with Guwahati, Silchar, Kolkata and New Delhi by air. The National Highways 53, 39 and 150 running across the state connect Manipur with the rest of India and neighbouring countries like Myanmar and Bangladesh. These three National Highways are the only surface routes for the transportation of all-essential commodities. In absence of rail or water transport and high cost of the Air Travel/transportation for common people, these National Highways become very important and are considered as "Lifelines" of the state. Due to the frequent landslides, particularly during monsoon-season, traffic along these highways is often disrupted for long period and causes huge loss of life and property.
1.2 STUDY AREA:

The present study area along parts of NH-53 between Imphal and Nungba is running across part of Imphal Valley and the western hill ranges of Manipur. The western hills of Manipur are among the highest rainfall areas in the state. In the present study, main emphasis is being laid on landslides, accordingly the area between Keithelmanbi and Nungba is selected for the detailed investigation, where number of landslides occurs almost every year (Fig.1.1). A brief description of the study area is given below.

1.2.1 Location:

The study area stretches between Keithelmanbi and Nungba, covering an area of about 786.25 sq km. It is a part of Imphal West, Senapati and Tamenglong districts situated between 24° 45' N to 24° 55'N Latitudes & 93° 25' E to 93°60'E Longitudes and falls in Survey of India Topographic Sheets numbers 83H/5, 83H/9 and 83H/13 (Fig. 1.2).

1.2.2 Physiography:

The entire study area is in the hilly terrain. These hill ranges are parallel to sub-parallel, trending NNE-SSW and N-S directions. General height of these hill ranges varies between 320m to 2133m from the mean sea level. The entire area is drained by rivers the Ijai (Iyai), the Tupul, the Leimatak and the Irang and their tributaries. The area under investigation can be divided into following physiographic units:

a) Hills:

Structural and denudational hills cover major part of the study area. They are arranged in parallel to sub-parallel and sometimes rectilinear in nature. This is either due to folding and/or faulting.
Fig. 1.1 Photograph showing a panoramic view of Landslide Incidences along a part of NH-53
b) Valleys:

In the study area valleys are occupied by the major rivers like the Ijai, the Tupul, the Leimatak, the Irang, the Aleng, the Sajirok rivers and their tributaries. General trends of the major valleys are NNW-SSE and NE-SW. These rivers are flowing either along the faulted zones or axes of folds.

c) Piedmont zones:

Piedmont zones are of lesser extent and occur along the foothills between Keithelmanbi and Kangchup.

d) Alluvium:

These Quaternary deposits are irregularly distributed along the river valley and hill slopes. It is more conspicuous at the meander loops and the areas where valley becomes wider. These mainly consist of boulders, cobbles and pebbles of sandstones and shales, sand, silt and clay. Weathered residual soil is confined to the hill slopes.

1.2.3 Climate:

The climatic condition of the state, in general and the study area in particular, is broadly divided into two main seasons, viz., summer/monsoon season from April to September and winter season, which spreads from November to February. Autumn and spring are short duration seasons, and experienced the transition months of October and March respectively. Since the study area is a hilly terrain, it enjoys tropical to temperate climatic conditions. Temperature usually ranges from 0° C to 36°C. January is the coldest month of the year. The temperature starts rising from the month of March and reaches its highest in the months of May and June.
The western hills receive the highest rainfall, with an average of about 2300mm, with monsoon season stretching from April to September. The period from June to August accounts for the maximum rainfall. However, due to the altitudinal variations, there is considerable variation in the temperature and rainfall from place to place. During the months of December and January in hilly regions of Tamenglong, temperature falls below the freezing point.

1.2.4 Flora and Fauna:

State has a wondrous balance of flora and fauna that abound in its environs. 70% or more of its land is under forest cover. The study area is covered with thick vegetation. Economy of the people living in the area mainly depends upon the forest and horticultural products like timber, bamboo, banana, orange, lemon, pineapple, mushroom etc. However, other important trees in the area include Cymbidium tigrinum, Pinus khasiya, Quercus serrata, Q. griffithii, Castanopsis sp., Acer oblongum, Magnolia campbellii, Prunus acuminata, Saurauja napalensis, S. panduana, S. roxburghiana, Phoebe lanceolata, P. paniculata, Beilschmiedia assamica, Artocarpus chaplasha, Cynometra polyantra, etc. Some of the endangered species of orchids found in the area include Renanthera (Kwakle angangba), Dendrobium Chrysotoxum (Melei leisna), and Schoenorchis etc. In addition, the area is blessed with a variety of medicinal plants and about 500 species of orchids. Some of these medicinal plants and orchids are rare and not found in other parts of the country.

Manipur being one of richest states in faunal bio-diversity with many rare species like Hoolock Gibbons, Serow, Slow-Loris, Golden Cat, Clouded Leopards, Bear etc. The brow antler deer locally called “Sangai,” which is facing extinction from the globe, is found only in Manipur. Black kite, Spotted Dove, Lagger Falcon, Indian Myna,
**Pheasants, Blythes, Burmese Pea Fowl** are the main species of birds found in the area. In addition, thousands of migratory birds visit the area every year. Important reptiles found in the area include Cobra, different varieties of Kraits, Pythons, Vipers, and Lizards etc.

### 1.3 REVIEW OF THE PREVIOUS WORK:

The geological account of Manipur dates back to the last two centuries. Most of the earlier geological traverses were on the regional scale and largely of the expedition types. Theobald (1873) gave the geological picture of Pegu, Godwin-Austin (1874) gave the some geological information about the Manipur state; Mallet (1876) gave an account on the coal-fields of Naga Hills, Oldham (1883) was the first who gave geological picture of Manipur, Hayden (1910) described the coal fields of Assam, Pascoe (1912) presented first geological report on Manipur, Evans (1932) established a stratigraphic sequence of the Tertiary rocks of Assam. He designated the rocks of the eastern part of the Imphal Valley as Disangs and that of the western part as Barails. Evans (1964) gave an account of the tectonics of NE India. Evans (1964) and Brunnschweiler (1966) described the Tertiary succession of the region. Dayal and Duara (1963, 1966) and Debadhikari *et al.* (1968) carried out systematic geological mapping in some parts of Manipur state. Workers like Brunnschweiler (1974) and Mitchell and Mckerrow (1975), Dutta and Saikia (1975) studied the major structural features of Arakan-Naga-Patkai Schuppan Belt. Ranga Rao (1983), Acharyya and Ghose (1986), Mitra *et al.* (1986), Acharyya, *et al.* (1986a, 1989), Chakraborty *et al.* (1987), Saxena (1987), Das Gupta and Nandy (1990), Joshi (1990), Khan (1990), Mishra (1990), Mohanty and Purusothanan (1990), Setty and Raju (1990), Acharyya (1991), Bhattacharjee (1991), Bora and Raju (1991), Das Gupta and Nandy (1995) have attempted to solve the intricate geology and structures of North East India in general and Manipur in particular.
1.4 **SCOPE OF THE WORK:**

From the foregoing review of literature, it is evident that though considerable work has been done on various aspects of geology in Manipur, however, no systematic and detailed studies covering the geomorphology, land-use/land-cover, and in relation to incidences of landslides/landslide, hazard/risk zonation mapping and mitigative measures have been attempted by the earlier workers, especially from the present study area.

Keeping in view of the above facts, the present study aims to:

i) study the geomorphic set up and its bearing on mass wasting process/landslides,

ii) map and decipher landslide prone areas and highlight its probable impact,

iii) point out the probable mode of failure from effective site specific studies,

iv) generate awareness among the decision makers, planners, stake holders and general public, about the losses caused by landslides,

v) fill up a gap in the data already available, and

vi) suggest requisite mitigative measures so that NH-53 become safe and secure passage way or route for the people of the state.

1.5 **METHODOLOGY:**

The following methodology has been followed in order to give a glimpse of various criteria employed for detailed investigations of landslide in the area.
Flow Chart for the Present Investigation

LAB WORK

TOPOGRAPHIC MAPS & LANDSAT IMAGERIES ACQUISITION 1:50000

REGIONAL GEOLOGICAL MAP ACQUISITION

VISUAL INTERPRETATION OF IMAGERIES & MAPS

PRE-FIELD GEOLOGICAL MAP

IDENTIFICATION OF HAZARD EVALUATION

Drainage Network

Slope Morphometry

Relative Relief

Land use/cover

REMEDIAL MEASURES

FIELD WORK

COLLECTION OF ROCK SAMPLES

SAMPLES TESTING

GEOTECHNICAL INVESTIGATION

LITHOTECTONIC MAP 1:50000

COLLECTION OF LANDSLIDE INCIDENCES

ASSIGNMENT OF LHEF

CALCULATION OF TEHD

PREPARATION OF LHZ MAP

LANDSLIDE STUDY ALONG NH-53