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Geomorphological study with special reference to landslide in the adjoining areas of National Highway No. 52-A (Banderdewa to Itanagar), Arunachal Pradesh

Tage Rupa
** Assistant Professor, Department of Geography, Rajiv Gandhi University*

Abstract: *Arunachal Himalayan region experience landslide problems from time to time due to its rugged topography. This paper evaluates the landslide as a geomorphic hazards caused by both natural and anthropogenic activities. The episodic upliftment has caused many structural deformations forming unique depositional and constructional landforms. As the study area falls within the highly fragile mountain region, the environmental condition and the ecological risks of resource utilization are intimately linked together. The landslide along the NH 52A from Banderdewa to Itanagar has cause problem to roads, leading to disruption of communication, impacts on economic activities as well as tourism apart from being a threat to lines and properties at specific locations. The rapid growth of population in the basin due to location of twin capital, Itanagar – Naharlagun, is corresponding increase in pressure on the natural resources and the consequent danger on environmental degradation. Specifically, an increase in population pressure puts a greater number of people at risk from a natural event. Due to unavailability of plain area, the increasing population pressure is leading to settlement expansion along with agricultural activities on the steep sided slopes mostly along the road highways through earth cutting on the hill top. This has lead to abundant and abnormal supply of loose sediment which during rainy season frequently mud slide, debris flow, etc occurs. High intensity of rains for long duration causes soil and rock debris to move down slope that cause frequent road blockage and disturb traffic movement. The land transformation in the hills due to more new road cutting, construction of buildings has reduced the strength of the regolith cover and has rendered the slopes more susceptible to slope failure. In this study, an attempt has been made to identify the landslide types and its cause through field work carried out during the monsoon seasons from 2008 to 2011. Besides that, the climatic data of ten years are also collected from secondary sources of the study area to see the impact of climate on the occurrence of landslide.*
Keyword: *Slope failure, land transformation, earth cutting, regolith cover*

I. Introduction

Natural hazards are the events that occur suddenly and swiftly causing great harm to the people. Most of these hazards occur naturally or triggered off by anthropogenic activities. Landslide as a natural hazard poses serious threat to human habitation and structures. It imparts significant damages to property, highways, and other infrastructure development. The term landslide is defined as the collective term for the slope monuments of the mass movement category excluding creep and subsidence. However, the generic term, landslide, is the sum of all down slope movements of materials due to shear failure at the boundaries of moving mass (Skempton and Hutchison, 1969). Basu and Ghatowar (1986) have opined that the landslide and floods are the most serious natural problems that undermine the economic and cultural development of the area. Landslide is responsible for considerably greater socio-economic losses than is generally recognized. Loss of life and property from landslides in the hilly terrain are substantial. Many landslide damages are not documented separately because it is considered to be a result of the triggering process such as earthquake, down pour, floods etc, even though the cost of damages from landslides sometimes may exceed all other costs from the overall multiple hazard disaster (Khire, 2004). Geomorphic hazards like the landslide and its related phenomena such as mudflows, earth flows, rock falls, debris avalanches and subsidence are natural as well as anthropogenic events. However, a human land use practice has led increases in events of landslide, etc. Earth material along slopes may fail and moves or deform in several ways, including sliding, falling and subsidence (Sharpe, 1938).

II. Study Area

The National Highway No. 52A connecting the twin capital Naharlagun and Itanagar with the rest of the world has been selected for this study. In terms of terrestrial coordinates, the area lies between 27°03’ to 27°07’ N latitude and 93°35’ to 93°45’ E longitude covering an area of 225 Km² (Fig.1).

The realm and whole study area is covered with the Siwalik rocks. Though the geological survey was carried out by Geological Survey of India and many other agencies, like Wadia Institute of Himalayan Geology, ONGC and Rajiv Gandhi University, still many parts of the area is unexplored.

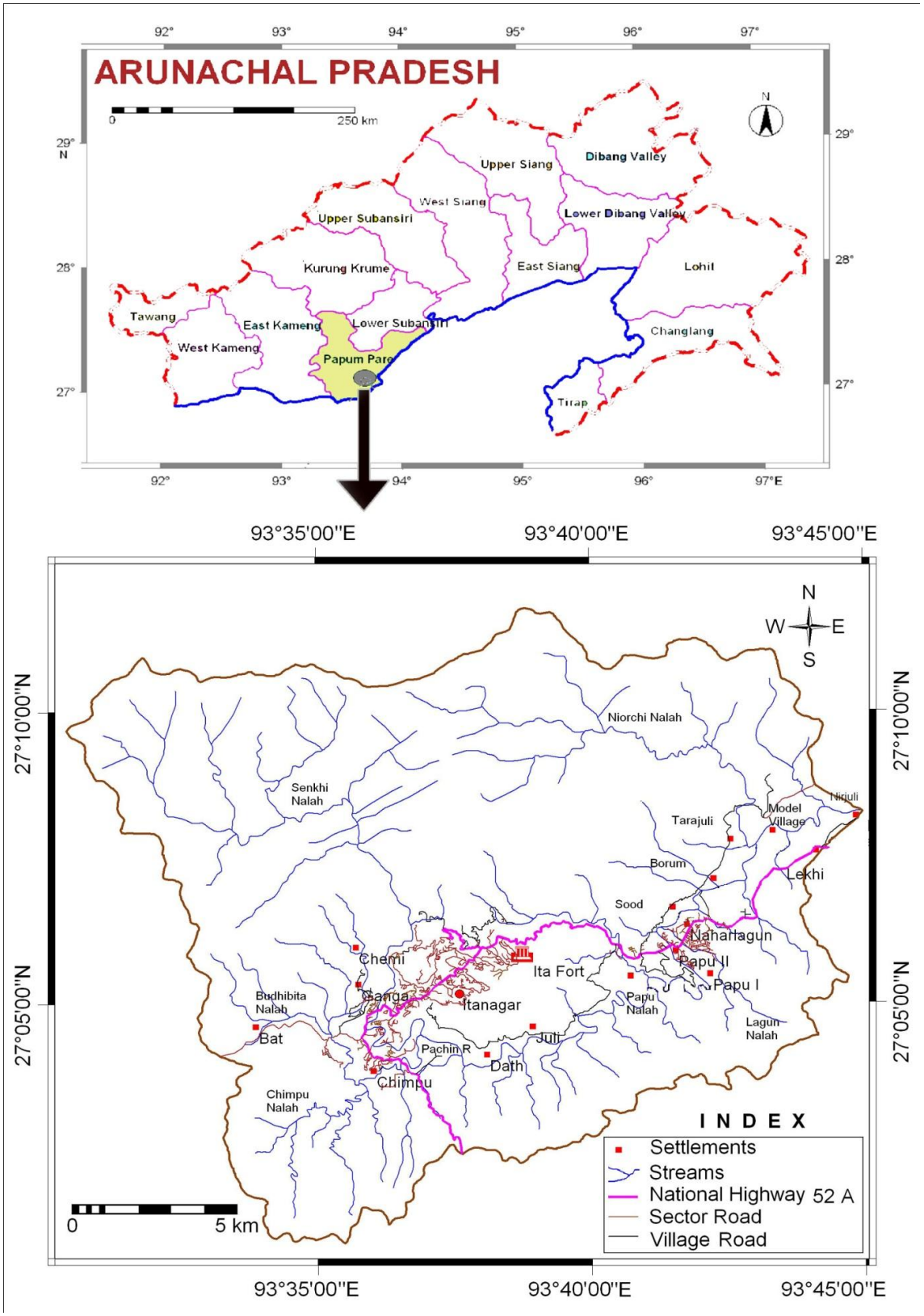

Figure 1: Locational Map

Geologically study area is divided into 4 (four) major geological units, i.e. Recent alluvium, Kimin formation, Subansiri formation and Dafla formation. Subansiri formation covers the maximum area of 96.21 Km² (31.92%) of the total basin area. Whole study area NH 52A is mostly concentrated within the Kimin formation (Fig.2).

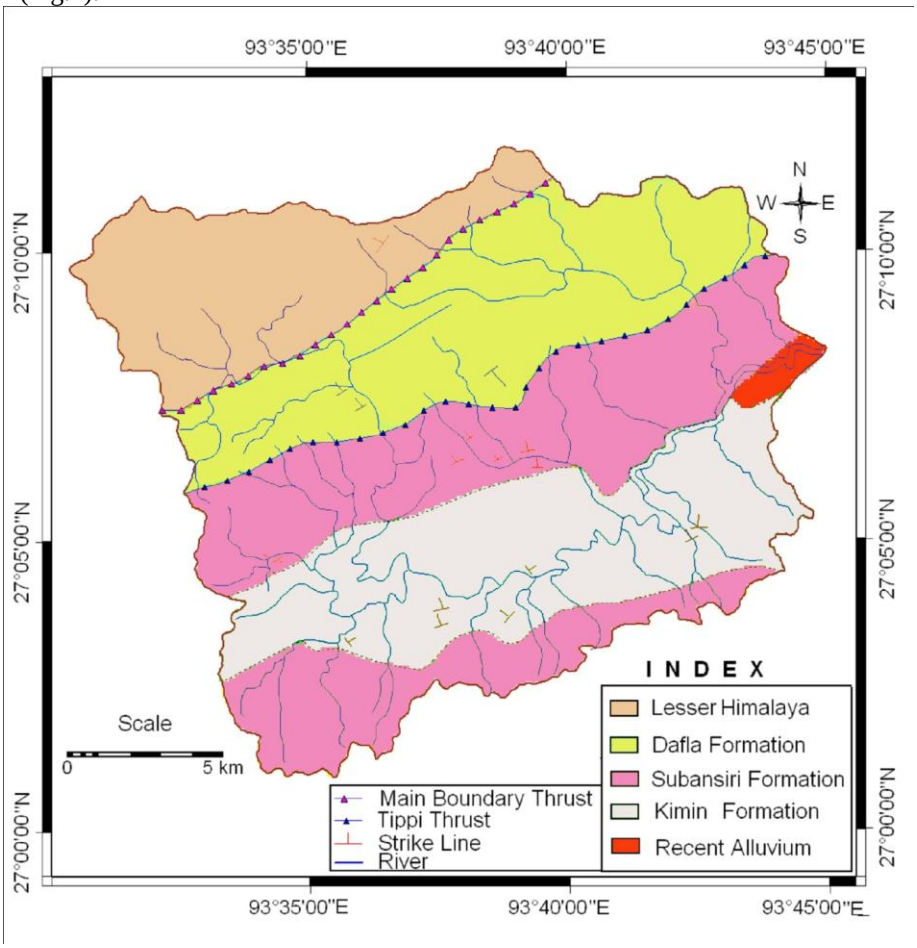

Figure 2: Geological map

The lithology of the region is consisting of the debris which are worn out from the granitic core of the Central Himalaya. The composition of Siwalik deposits shows that they are nothing else than the alluvial detritus derived from the sub - aerial waste of the mountains, swept down by the numerous river and deposited at their foot and these detrital rocks are coarsely – bedded sandstones, sand rock, clay and conglomerated, measuring between 4500 and 5200m in thickness (Wadia, 1981). The sandstones show poor stratification and are generally ungraded as regards the grain size. A number of lineaments and active faults have made the area more vulnerable to the landslides, which are occurring not only along the roads but also in the urban agglomeration area. The landslides, which include both old and presently active slides, are located within the unconsolidated Quaternary deposits and poorly cemented Siwalik sediments. Landslides, and other geologic and geomorphic features suggest that the area is tectonically unstable and geodynamically active (Singh and Mrinalinee, 2006).

The topography of the study area is highly undulating. Hills of 120m to 1980m height surround the study area. Pachin river serve as the main drainage of this area (Figure 1). The total distance covered by Pachin river from the source to mouth 51.32 Km. It flows from the western side of the basin and is joined by number of tributaries like Senki Nalah, Budhibita Nalah, Chimpu, Papu Nalah, Lagun and Niorchi Nalah. The study area is dominated by low to very steep side slopes. Within landslide zones shrub and degraded forest are observed. Other areas in the hill slope along the road has shifting cultivation land, settlements, dense forest and open forest (Fig.3). The average slope of the basin shows that the maximum area (110.05 Km²) is under the very gentle slope category (Fig.4) with minimum (26.15 Km²) under gentle to moderate slope.

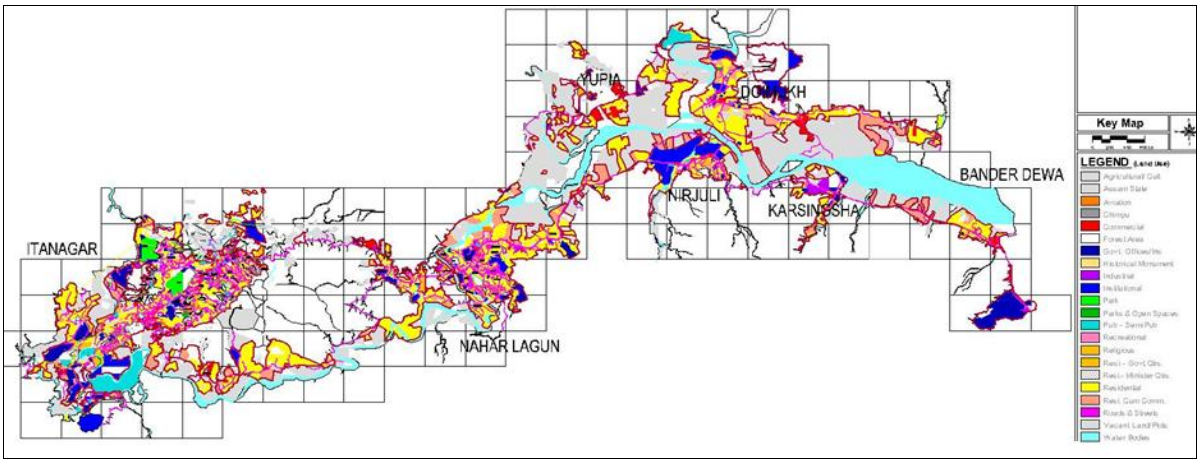

Figure 3: Existing landuse/landcover of capital complex (Source: City Development Plan 2006)

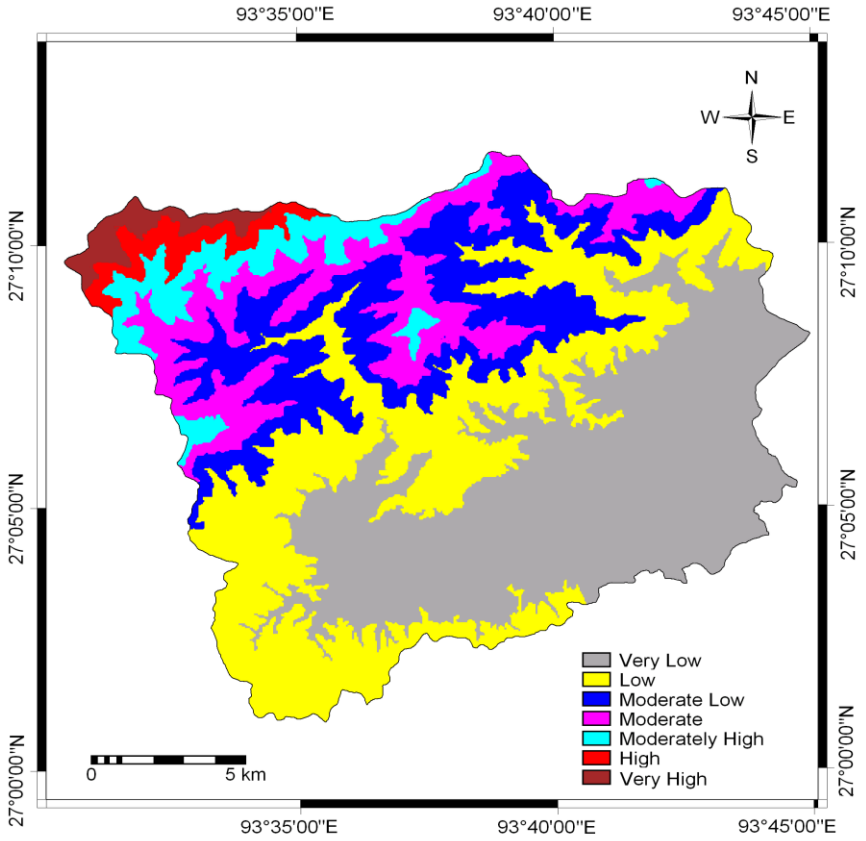

Figure 4: Average Slope

The south- west monsoon has influenced a lot in the study area. The annual mean precipitation (Table 1) in the area is 3350.8 cm and typically 65% of it falls during the monsoon season from June to September.

Table 1: Showing the Monthly rainfall (in cm)

Month/Year	2006	2007	2008	2009	2010
January	7.6	18.8	68.9	41.6	0
February	246	113	21.8	23.8	10
March	42	62.3	162.5	47.2	326.4
April	184.2	469.7	186.6	248.6	649.4
May	147.2	505.8	405.8	389.3	478.2
June	429.9	923.1	1035	520.4	648.3
July	381.4	643.9	791.9	571.4	505.5
August	191	272.9	1017.1	564.4	385.9
September	315.3	541.9	382.8	101	790

October	108	127.8	180	204.7	41.5
November	72.3	11.6	0	25.8	63.5
December	22.3	8.8	8.4	7	1.5

Source: Indian Meterological Department

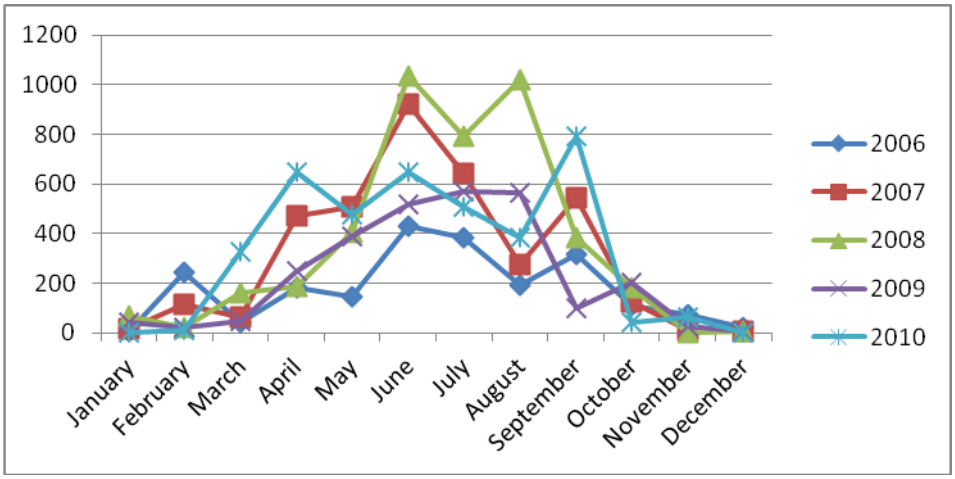

Figure 5: Rainfall variation

III. Study Objectives And Methodology

This study, therefore, sought to investigate the landslides in the area under study based on field observation and morphological measurements. In their investigation the following data are collected from different sources:

1. Surveys of India topographic map no 83 E/12 in 1:50,000 scale.
2. Indian Remote Sensing (IRS 1B, LISS-III - 1:50,000,)
3. Climatic data collected from Indian Metrological centre, Itanagar
4. Field work during Monsoon season (2009, 2010 & 2011).

IV. Results And Discussion

Large scale of landslide which is occurring frequently during monsoon season in the study area has been observed. Existence of large drainage system i.e Pachin and Dikrong and very high rainfall (65%) during rainy season are responsible for the weakening of rock mass and large scale erosional activities and toe cutting of the valley slope has influenced the occurrence of landslide in the area. Besides this, the unplanned growth of settlements on hill faces, cutting and levelling of hill slopes, degradation of natural drainage system, cutting and felling of trees, especially along hill faces and increased run off due to increase in impervious areas are the main issues and challenges that has triggered more landslide in the study area. The human activities and necessities accentuate slope failures, accelerated soil erosion and landslides in the fragile Himalayan ecosystem (Valdiya, 1992).

The Highway which runs only 34.5Km connecting Banderdewa – Nirjuli – Naharlagun – Itanagar – Chimpu – Gohpur plays lifeline for the people residing in these localities. During the last decades Capital Complex area has grown very fast with linearly growth along the NH 52A with poles / nodes of commercial and related activities. Pressures of urban expansion and resultant land necessities have caused in spilling over the urban activities on ecologically fragile hill slopes have accelerated the effect of hazard.

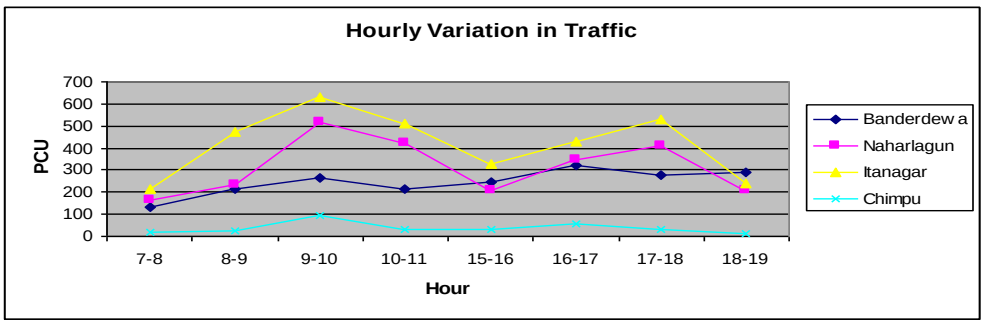

Figure 6: Hourly variation in traffic in NH52 –A (Source: City Development Plan)

The graph shows that the traffic at Itanagar remains maximum throughout the day flowed closely by traffic at Naharlagun. Traffic at Chimpu is marginal and would increase when Itanagar – Gohpur section becomes fully operational. There are distinct peaks observed at Itanagar and Naharlagun at the same time, which proves that NH 52 A operates as an urban road. But many road stretches in the Capital region are under mud and water and are damaged by reoccurrence of landslide in different locations during every monsoon season. Several sector roads are also snapped during monsoon season. Because of which it's a challenging task for the government to maintain this highly fragile road. There is no dearth of funds for road received under various heads including Central Road Fund (CRF), DoNER, NEC, NLCPR, SPA, State plan etc., but due to non-pragmatic planning, no proper utilization of funds and untimely maintenance of road had created nightmarish problem to the government and people. The Urban Development and PWD departments' half hearted attempt at beautification of the Capital region was another contributing factor in the landslide. The protection walls built as part of the beautification process led to landslides on many areas in Itanagar. The drainage system is blocked at many areas by constructing buildings due to which in many points the road cave has developed.

The road (NH 52-A) like those in other parts of hilly terrain, run parallel to the river channels and hence are extremely sinuous. The undercutting of the river on the concave ridges often causes the road to overhang which ultimately leads to collapse. The distribution of landslide though controlled by the geology of the area but the rate has been accelerated by the human influence.

There are eight major landslide zones such as Karsingsa landslide (some 8 Km away from the plains of Assam), Nirjuli landslide, Lekhi landslide, Naharlagun landslide, Barapani landslide, Pahalwan Mod landslide and Gohpur road landslide. Besides these landslides, there are numbers of minor slides in the form of road cave in different locations which becomes menace for the people during rainy days. These all landslides, resulting subsidence and sinking of road, blockage of road through accumulation of huge amount of debris, has affected and damaged the adjacent settlement during monsoons.

During the 2008 landslide, all the entry points from northern Assam to the NH 52A to the hill state was blocked. The main block point was at Karsingsa where there was hardly any kilometre of road left without landslide. On 10th September, 2010 landslide triggered after the heavy rainfall in the capital (790 cm that month) region causing damages to road and communication, life and properties and affected water and electric supply line. During that monsoon the road connection between Itanagar and Naharlagun was under threat with the washing away of a major culvert of near Shiv Mandir. Due to severe damage of road at Karsingsa NH 52 –A, the connectivity between Assam and State capital was at halt for 2 months. Consequently, the people were compelled to choose the alternative road. i.e from Harmuty to Gumto in the south and Gohpur to Chimpu in the north for transport of goods and services in the region.

V. Distribution Of Landslide

1. **Karsingsa Landslide:** This slide is mainly caused by translational process. This type of landside occurs along geologic planes of weakness within slopes. This slide is mostly manifested in the form of rock slides, block slides, debris slides and mudflows. The rocks here have a dip slope of about 15° towards the road (NH 52 A) and Dikrong river. Though the dipping of the bedding plane is not so high and the driving force is less, the landslide occurs frequently in a massive way. In addition to all these causative factors, construction of road in this area equally plays a dominant role in such slide. Since the construction of road process disturb the structural formation and weaken the structure and ultimately leads to downward movement of soil.
2. **Nirjuli Landslide**: Lithologically, the area is covered with a thick layer of riverine deposits made of loose sediments consisting of sandy layer in the top most followed by small and big size pebbles which are agglomerated together with sandy matrix which reflects very poor sorting. In between this layer, the clayey lenses are also seen. Therefore, the lithology of this area is very loose and is susceptible to any hazard. In 2010, no any landslide took place in this part of area, but in 2011 the anthropogenic activities i.e. hill slope cutting has triggered the landslide contributing large amount of debris deposited on the road due to heavy rainfall.
3. **Lekhi Landslide:** The lithology of this area is the continuation of lithology in Nirjuli landslide. In 2011, within a distance of 50m, two major landslides took place in Lekhi village creating traffic problem for more than a month. This landslide was also triggered by human influence. Due to earth cutting and new construction, the natural course of the river was disturbed and the heavy rainfall has resulted lateral spread of huge amount of loose debris on the road.
4. **Naharlagun landslide:** This slide is caused by the subsidence or sinking of the ground surface. The lithology of the area is very weak. It is consisting of pebbles with sand layer in the topmost part, followed by thick deposits of pure sand and clayey layer in the bottom. This is a shallow landslide that has slopes with high permeable soils on top of low permeable bottom soils. The clayey layer, bottom soil has trapped the water in the shallower, while high permeable soils has created high water pressure in the top soils.

During intense rainstorm, due to trapping of rain water in the top soil, the area becomes unstable and subsidence or sinking has taken place with the collapse of ground surface.

5. **Barapani landslide:** This landslide is located on the steep scarp of about 60m above the river bed lying on the left immediate bank of Pachin river in the Barapani area. The lithology consisting of clay – blackish in color (siltstone), conglomerate rounded boulders with sand, loose sandstone – reddish brown in color and at the bottom is clay stone bluish grey in color. It is clears that the lithology which is having loose soil is frequently affected by landslide during rainy season. The dip of the slope is 30° which is also responsible for landslide. Toe cutting made by Pachin river has also enhanced the chances of downward crumbling of soil.
6. **Pahalwan Mod landslide:** This landslide zone is devoid of mature vegetation. Only scrubs and long grasses are present on the slope. The area is having very loose soil with boulders and pebbles in the bottom layer and weathered yellowish sandy layer on the top. In earlier days though landslide occurred here but the effect was very less but the hill slope cutting has contributed huge amount of loose materials to form as debris which finally leads to debris flow.
7. **Gohpur road landslide:** This road is very important for the capital dwellers, as it provides services during blockage in Karsingsa road. The road is constructed in very loose lithology i.e. salt pepper sandstone with few pebbles and weathered yellowish sand. Due to its lithology, many landslides both small and large occur in many sites of the road. Many temporary steel bridges are built over a deep gorge which is vulnerable during monsoon season.

VI. Conclusion:

The basin area is a very eco – sensitive area, as it presents a fragile environment due to its geological setting, soil characteristics, geomorphology and landuse. Therefore, it is very important to consider all these aspects while defining the spatial form of expansion of town. At the same time appropriate planning norms and standards along with planning principles related to sustainable urban development practices have to be adopted which results in a city form appropriate to the physical setting and socio – cultural attributes of the population.

The encroachments along the hill sides of the capital region for settlement and Jhum field by cutting the trees, levelling of hill tops and blockage of natural drainage system has lead to environmental degradation such as soil erosion and human occupation of catchment area. The mountain slopes which once covered with lush green forest are now converted into ugly patches of Jhum field. The Wildlife Protection Act and Environmental Protection Act are not followed properly in the region. Therefore, there should be strict inspection by the high level body on this kind of agricultural practices and unplanned way of settlement expansion within the twin capital. Restriction of developments along hill faces which includes identification and declaration of ecologically sensitive areas as green zones and earmarking them as no - development zone

Prevention of large, natural landslides is difficult, but proper planning and good engineering practice can do much to minimize the hazard. Common engineering techniques for landslide prevention include provisions for surface and subsurface – drainage, removal of unstable slope materials (grading) and construction of retaining walls wherever possible. The felling of trees and earth cutting should be completely forbidden on the hill slopes and awareness should be given to promote the plantation on the slopes through social forestry schemes and conservation of soils.

Building constructions are carried out haphazardly without any kind of expert consultation and soil testing. Henceforth, seriously public awareness is needed regarding the soil type, geomorphic process and its all associated hazards.

Key Issues and Challenges

- Strengthening and development of system of roads in the Capital Complex
- Development of alternate road links and corridors for meeting emergency situation and maintenance works of NH 52 A

Reference

[1]. Basu, S.R. et.al. (1986). Landslide in the Lish Basin of the Eastern Himalayas and their contrao, North Bengal University, Siliguri
[2]. Final Report (2006), City Development Plan, Capital region, Itanagar, Department of Urban Development and Housing.
[3]. Howard, Arthur D. et. al. (1978). Geology in Environmental Planning. McGraw- Hill, Inc. United States of America. 4p.
[4]. Joshi, R.C. (1989). Landslide along Main Boundary Fault in Kotadun: Nature, cause and prevention, Kumaun Himalaya.
[5]. Khire, M.V (2004). Terrain Evaluation and mitigation for landslides. In: Dr. R. Nagarajan editor, Landslide disaster (assessment and monitoring). Anmol Publication pvt. Ltd, New Delhi. 37p.
[6]. Sharpe, C.F.S. (1938). Landslide and related phenomena. Columbia University press, New York.
[7]. Trilochan Singh and Mrinalinee Devi. (2006) Landslide Occurrences and Risk Assessment in Itanagar Capital Complex, Arunachal Himalaya. Himalayan Geology, Vol. 27 (2), pp.145-162, Printed in India.
[8]. Wadia, D.N. (1981). Geology of India. Tata Mc.Graw Hill co. Ltd. New Delhi.