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LANDSLIDE AND ASSOCIATE ENVIRONMENTAL PROBLEMS:

A Case Study of Hlimen in Aizawl City

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Abstract

About 80% of all the landslides in different parts of the world are the result of anthropogenic factor. Even the state Mizoram also falls under the category of very high risk zone in response to landslides. This phenomenon is a major environmental issue as a result of which it is essential to study the causes, impact, the mitigation measures and precaution for further occurrence. The present study is mainly based on primary information with field observation. This paper is an attempt to study about the problems and impact of landslides in Hlimen Village Aizawl.

Keywords: Landslide, hazard, economy, slope instability.

Introduction: Landslide is a general term for a wide variety of down slope movements of earth materials that result in the perceptible downward and outward movement of soil, rock and vegetation under the influence if gravity. The materials may move by falling, toppling, sliding, spreading, or flowing. Some landslides are rapid, occurring in seconds, whereas others may take hours, weeks, or even longer to develop.

Landslide is considered as one of the major natural environmental hazards in almost all parts of the world more especially in the mountainous regions. Due to the sudden and unpredictable occurrence of this disaster causes loss of a large number of precious life and property every year in different parts of the world. Roads are blocked, communication network are disrupted, buildings collapse, developmental works are interrupted and other building constructions are left unserviceable. Hlimen is located 7 km away from Aizawl. It is the area where one of the most famous quarries in Mizoram is located. This area experienced unprecedented landslides on 9th August, 1992 involving complete collapse of a stone quarry of 300m length and 2050m thickness. Due to this disastrous incident, more than 60 people lost their lives including the villagers and laborers. 8 stones crushers and 3 air compressors are also destroyed.

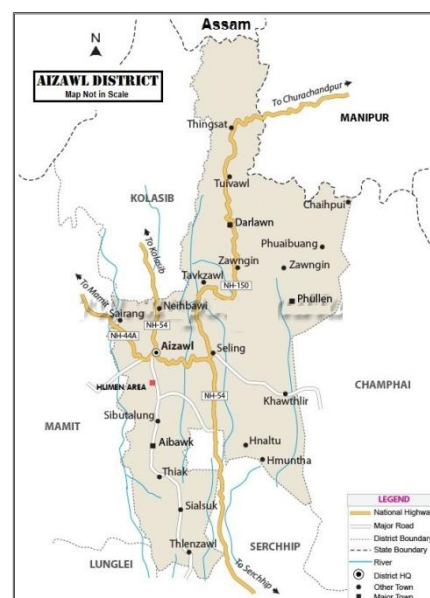
Statement of the problem: Landslide hazard and its consequences in the transportation network are well understood. A study conducted by GSI in Mizoram reveals that out of the 505 slopes 83 susceptible to very high landslides hazards; 177 to high landslides hazards, 236 to moderate hazards and 9 to low landslides hazards. It goes without saying that despite this information if the state government or the people of Mizoram decide to start development or construction activity on slopes falling in very high or high landslide zones then engineering measures will be of no help to protect mass destruction. It is impossible to imagine a landslide minus a mountain. As long as the river gradient and the mountain slopes are in a state of balance, the incidents of landslides are minimized. However, whenever due to natural or anthropogenic reasons if this precarious balance is upset a landslide starts. A river that changes course frequently is bound to erode the toe of the mountain along the new course and lead to landslide.

As the frequency of its occurrence differs, the magnitude of destruction it causes varies due to the differences in the location of its occurrence. The major problems it produces can be broadly grouped into three categories: 1). Social, 2). Economic, and 3). Political. All these three points are interrelated with each other.

The Study Area:

The study area is located about 7 km south of the Aizawl town, the capital of Mizoram, in a village named South Hlimen. The area lies between 23° 40` and 23° 40` 944`` N latitudes and 92° 42` and 92° 42` 985`` E longitudes. The length and breadth of the study area is 243.84 m and 396.34 m respectively. It covers an area of about 96643.54 sq meters. The area has a hilly landscape and the altitude ranges between 1000 to 1100m and is largely constituted by Tertiary rocks of Bhuban sub-group. Highest point of the area is 1065m from the sea level.

The location of Mizoram falls within monsoon type of climate, the study area also experience the same climate with a marked dry season from November to April during which about 10% of the annual rainfall is recorded and a wet season from May to October with an average annual rainfall of 250 cm (accounting for 90% of



annual rainfall). The temperature in the study area is range between 12°C to 27°C, hence the climate is pleasant throughout the year.

Relief & Geology: The relief condition is one of the important physical factors affecting landslides. As the physical set up of Mizoram is composed predominantly of mountainous terrain of tertiary rocks. The mountainous ranges are inclined north to south direction in parallel series. The ranges are separated from one another by narrow gorges and valleys. Hlumen is located on the side slope of the mountainous range that runs from the outskirts of Melthum. The study area is considered as mountainous region and it characterized with Young and immature terrain that shows the relief features with moderately steep slopes.

Geologically, the area belongs to the Upper Bhuban unit, Bhuban Subgroup of Tertiary age. The rock types exposed in the area are thickly bedded sandstones with thinly alternate thinly bedded shale. The sandstones of the quarry are gray to brown in colour, fine to medium grained, compact, micaceous, and relatively hard with cementing material of varying composition, namely calcareous, arenaceous, ferruginous etc. The shale is also gray to brown in colour, micaceous, thinly laminated and occasionally clayey.

At the quarry site, the rock formations trend roughly N-S with 45° dip due west and are traversed by E-W trending vertical joint planes. The bedding and joint planes are lacking asperities on their surface, thereby resulting into relatively smooth planes of structural discontinuities. Due to the smooth plane structure of the rock, the vegetations in this area do not have a deep root and when the vegetation covers are cleared the soil composition are able to loosen easily by the direct rainfall, thereby resulting into rapid slide down. The overburdens at the quarry site are also practically negligible. A road passes through the middle of the hill slope.

Objectives of the study: The objectives of the present study are as follows:

- 1. To get an insight into the Slope instability Problems:* In fact, landslides are caused mainly by the instability of the slopes. This instability is caused by both natural and anthropogenic factors. To determine which one is more relevant in the study area is our proper aim and objectives.
- 3. To assess and suggest measures of consequences or effects:* To find out the consequences or effects of landslides and to suggest remedial measures is also the basic aim of the study. The study focuses exclusively the effects of landslides on social, political, economic and environment.

Database and Methodology:

The study is completely based on primary data analysis. The landslide area is first surveyed and field observations are made in area of landslide to obtain information on the mechanism and instability factors involved in terrain failures. In the present study the areas affected by terrain failures i.e. the areas where landslide start, is taken into account. With the aid of photo-interpretation and field observation, it is possible to obtain significant information on terrain characteristics such as slope, soil characteristics, land use etc. Actual measurement is taken directly by the time of survey work. Besides, GPS has been used in the study to collect basic information about the area. The GPS is used here to determine the exact location of the study area, and its elevation from the mean sea level (MSL).

As there is no sufficient secondary information about the study area, the information is obtained mainly from the primary source of data. But the geological structure of the study area is derived from a research paper entitled 'South Hlimesh landslides in Mizoram (a pointer)', the physical setting, climate, vegetation, soil and landslides analysis is also collected from relevant books and journals.

Since the present study is to get insight the geological structure, causes of instability of the slope causing frequent landslide, consequences or effects and to suggest mitigation measures, it is done mainly on the basis of field observations. Interview of the locals were carried out to understand the historical background as there is no detailed secondary source of information about the area. Human activities including the use of explosive are by far the most potent single cause which is accompanied by tropical and heavy rainfall in reducing the cohesive strength of the joint planes.

Impacts of Landslide:

1. Social problem: Landslide is one of the major problems faced by the people living in the hilly region. Landslide can cause large scale destruction of residential buildings, bridge and other building constructions, resulting loss of a large number of human life and properties. Moreover, hundreds of people are wounded and many more people are rendered homeless. Children lost their parents and even the parents lost their children thereby increasing the number of widows and orphans. Landslide damage roads constructed on the hill slope or block

even built on the plain which disturb the movement of people, goods and commodities thereby interrupting the everyday life of the effected region.

2. Economic Problem: Landslide also creates a serious setback in the economic life of the effected regions. As the economy of the hilly or mountainous regions is mainly dependent on agriculture, the method of cultivation is primitive since most of them practice shifting cultivation, terraced cultivations, plantation farming or orchid farming etc, on the hill slope. A severe landslide occurs in the agriculture fields and crops are vehemently damaged which ultimately leads to deterioration in agriculture production. Moreover, landslides sometimes disrupt the transportation network which creates obstacles to the movement of goods, commodities and other products produced even from agricultural sectors. The scarcity of food grains and other allied productions, sometimes lead many people to starvation. Besides this, it also gives rise in price of goods and commodities; this is very awful to the victims.

3. Political Problem: When a severe landslide occur causing large scale destruction of properties and loss of many human life, the government is sought for welfare of the victims in the effected regions. Again for the welfare and wellbeing of the victims there is immediate needs to sanction huge amount from the state/national budget, which is sometimes either diverted or reconsidered from their budget that already fixed earlier with different heads of expenditure. Sometimes it create trouble for the local govt. authorities and sometimes it also create chaos to the administration.

4. Environmental Problem: Apart from the above landslides also creates natural environmental problems. A vast forest tracts and natural vegetation cover can be devastated by landslides which bewilder the wild animals and also contribute to the factor influencing ecological imbalances. Lakes and reservoirs or dams are sometimes silted by landslide thereby causing the overflow of a large volume of stored water which can reduce the potential capacity of power generation.

Causes of landslide:

Many factors contribute to slides, including geology, gravity, weather, groundwater, wave action, and human actions. Although landslides usually occur on steep slopes, they also can occur in areas of low relief. Landslides can occur as ground failure of river bluffs, cut and fill failures that may accompany highway and building excavations, collapse of mine-waste

piles, and slope failures associated with quarries and open-pit mines. Underwater landslides usually involve areas of low relief and small slope gradients in lakes and reservoirs or in offshore marine settings. Typically, a landslide occurs when several of these factors converge.

1. Natural Factors:

Gravity, Geological instability Factors, Heavy and prolonged rainfall, Earthquakes, Waves, etc.

2. Anthropogenic Factor:

Human impact on drainage system, Cutting & deep excavations on slopes for building, roads, canals & mining, Change in land use pattern, deforestation, agricultural practices on steep slopes, etc.

In the hilly terrain of Mizoram state, landslides have been one of the major disasters that strike life and property almost perennially. These landslides, year after year, bring about untold misery to human settlements apart from causing devastating damages of transportation and communication network. Landslide in Mizoram is associated with the following common problems in every year.

i). *Landslides cause property damage:* Injury and death, impact on water supplies, fisheries, forests, dams and roadways. ii). *The negative economic effects of landslides:* Includes the cost to repair structures, loss of property value, disruption of transportation routes, medical posts in the event of injury, and indirect costs such as lost of timber and local fish stocks.

Water availability, Quantity and quality can be affected by landslides. Geotechnical studies and engineering projects to assess and stabilize potentially dangerous sites etc are still very costly for a state like Mizoram. Large, infrequent landslides contribute less to personal and property losses than do the smaller, more frequent slides and debris torrents in populated areas. Every year in India, especially in mountainous regions landslides became hazards and many houses, buildings, roads, railways, pipelines, agricultural land and crops cause loss of millions of rupees.

Analysis of Landslide in Hlimen Village:

Hlimen is one of the largest and the best site for stone-quarry in Mizoram. The stones are hard and compact enough which are suitable for different types of constructions. Before the quarry operation is started, the area was covered with thick natural vegetation and some parts of the area are dominated by gardens owned by the local people. These natural vegetations provide the local people useful materials for constructing residential houses and other purposes.

The road passes through the middle of the hill slope along which residential houses were constructed.

The idea of converting the area into quarry started in 1974 and it was converted into stone quarry from 1975 onwards. This quarry is owned by the locals. In the initial period, the stones excavated in this quarry were not used for commercial purposes but only to meet the local requirement. After a few years, this operation was enlarged even for commercial purpose. This quarry is used as one of the main area where the building materials for Aizawl city are obtained in a huge quantity.

Due to the excavation of stones, the foundation of this quarry is loosening which ultimately results into the occurrence of unprecedented disaster on 9th August, 1992. Many workers lost their precious life and a large number of residential houses and properties were destroyed. A total numbers of 22 houses were damaged along with 8 stone crushers and air compressors. The recorded life loss in this incident was 70 persons and the estimated value of the lost properties accounted for about Rs. 100 lakh. Complaints raised by the local people about the safety of the village, the state administration closed down the quarry for three years. It has started functioning again in recent years. Small scale mining and collection of rock boulders from the failed slope have started once again.

Causes of instability: It is clearly depicted that the causes of slope failure was mainly due to the unscientific practice of quarrying. However, the local geology and the topography of the area also favoured the slope instability. Before quarrying operation is started the area is covered with thick natural vegetation but these vegetations are cleared by the local people. It has ultimately lead to rapid movement of the materials under the influence of direct heavy rainfall and gravity.

Another causes for this instability is contributed by the blocky nature of the sandstones. The intersecting planes of structural discontinuities formed the huge blocks of these sandstones which run north to south direction and East to West direction. With the continuous removal of the toe material, the natural support for the uphill blocks was losing strength and thus the stability got disturbed and ultimately these were subjected to freefall along the bedding plane.

Explosives were used to speed up the excavation operation. As a result of excessive blasting numbers of minor and major cracks were developed. Some joints were filled with clay and thereby formed very weak joint planes when saturated with water during rainy season.

They have also facilitated the rapid fall of huge and sandstone boulders. Moreover the tropical climate and heavy rainfall had further reduced the cohesive strength of the joint planes.

Present scenario: The quarry is a big sliding plane. The slope degree is around 45° which are devoid of rocks debris. The bedding planes are under the condition of easy accessible to sliding down due to the removal of the toe materials. At present, the quarry is large enough to supply building materials to the local people as well as to the adjoining areas including Aizawl City. This quarry is not owned by the Government and it is owned by several individuals. It is mainly used for commercial purposes.

A large numbers of people are working everyday to sustain their livelihood. 13 to 15 truckloads of stones are taken out from this quarry everyday to meet the growing demand of building materials resulting from the rapid rate of urbanization and developmental works. Quarrying activity is undertaken in a haphazard manner without properly surveying the area. As already mentioned a huge landslide occurred in 1992 in this quarry which caused the death of numbers of workers and huge loss of properties. And again in 1995 major landslide occurred which was not considered as much destructive as the one occurred in 1992. Besides these, there have been numbers of landslides at the same area till today.

If the present method of quarrying operation is still carried on then the possibility of occurring landslide in the future is inevitable. Fortunately there is no major landslide so far and quarry operation is still going on. At the same time the use of explosive is prohibited except within the safety areas.

SUMMARY OF CONCLUSION:

The main cause of landslides in Hlumen, Mizoram is human activity. This quarry is now operating in a large scale supply of stones as building materials for commercial purpose. Many families are now getting employments from this quarry to sustain their livelihood. Considerable numbers of trucks loads are taken out every day. Nowadays, there is no major landslide in this area. From the overall study in can be summed up with the following findings:

Findings: Present study enables us to get an insight into the study area about the causes and effect of landslide. It is an area where one of the best quarries known so far in our state existed. In addition to human activities, the geological structure, topography and anthropogenic factors are the main for the occurrence of landslides. The most single potent cause for the occurrence of landslide in this area is quarry operation as it is undertaken in a most haphazard manner

without proper survey of the area. Moreover, it is located along the road sides and excavation of stones starts from the base of the hill upward. This is not the right way for quarrying operation. The removal of the toe materials weakens the natural support of the uphill block resulting into free fall along the bedding planes.

Earlier it was covered with nearly thick natural vegetation and the roots of the trees bind the soils together which are not easily removed by erosion and is not vulnerable to sliding. The cutting down of trees allows the pouring of rain water directly into the soil and after being saturated with water the soil becomes loose and soft which are susceptible to sliding. In the addition, use of explosive are also used caused to developed major and minor cracks through which water pour in and the cohesive strength are reduced. This is ultimately leads to the rapid fall of the stones and the outcome is the fear of the villagers to construct residential houses along the road sides. If this type of quarry operation is still carried on the occurrence of mishaps in the future is inevitable.

Suggestions:

The undergoing Quarry operation the excavation process is not very scientific in the state. In order to have safe quarrying and to minimize landslide and its consequences, the following points may be recommended:

- 1). The best and the most effective measure to prevent further occurrence of landslide is to close down the Quarry immediately as the Quarry operation is considered to be the main cause.
- 2). Afforestation should be done in a large scale to prevent land degradation through landslide and soil erosion.
- 3). To conduct awareness campaign extensively on causes, the adverse impacts of landslide on socio-economic, political and environment and the mitigating measures not only among the localities but also among the Government officials and Department concern.
- 4). If the quarry continues then the excavation of stones should be started from top to bottom making benches. This is the right way of quarrying operation.
- 5). Explosives should be used only within permissible limits.
- 6). The area needs to study properly and also necessary to survey before continuing the ongoing quarrying operation.

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