

Slope Instability and its Related Problems: A Case Study of South Hlimen Landslide

Bobby Beingachhi*
F. Vanlalmangaihsangi**

Abstract

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 of gravity. Landslides in the hilly terrains occur in varying magnitude and frequency causing heavy damage to human property and life. Moreover, frequent road blocks leads to disruption of communication network. Besides, geo-environment of the region is also adversely affected and is at constant danger as its different facets are regularly degrading. About 80% of all the landslides in different parts of the world are the result of anthropogenic factor. The present study with reference to slope instability of South Hlimen landslide is a case study which includes the geological structures that enhance the vulnerability of the soil to slide down and the consequences or its effect, the preventive and mitigation measures.

Keywords: landslide, terrain, quarry, toe material.

Introduction:

The term 'landslide' includes all varieties of mass movements of hill slopes and can be defined as the downward and outward

* Ph.D., Assistant Professor, Department of Geography, Pachhunga University College, Aizawl

**Assistant Professor, Department of Geography, Govt. Hrangbana College, Aizawl. Corresponding address: beingachhibobby@gmail.com

movement of slope forming materials composed of rocks, soils, artificial fills or combination of all these materials along surfaces of separation by falling, sliding and flowing, either slowly or quickly from one place to another. Although the landslides are primarily associated with mountainous terrains, these can also occur in areas where an activity such as surface excavations for highways, buildings and open pit mines takes place.

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 of 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.

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 study area is located 7 km away from Aizawl. It is the area where one of the most famous quarries in Mizoram. This area experienced unprecedented landslides on 9th August, 1992

involving complete collapse of a stone quarry of 300meters length and 2050meters 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.

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 1000m and 1100m. The area is largely constituted by Tertiary rocks of Bhuban sub group. The highest point of the area is 1065m from sea level. The rocks are covered by an uneven layer of soil which is composed mainly of alternate thinly bedding shale. Hlimen, where the study area is located is very famous in the state for quarrying. This is mainly because of the compact and hardness of the stones. A road passes through the middle of the study area which connects the nearby village named Lungleng.

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 sometimes fluctuates between 17°C in winter and 27°C in summer. As a result, the climate is pleasant throughout the year.

Geology and Relief:

Landslides in the hilly terrains of north-eastern regions are common like elsewhere in the mountains. These occur in varying

magnitude and frequency in the region causing heavy damage to human property and life. Moreover, frequent road block leads to disruption of communication network. Besides, geo-environment of the region is also adversely affected and is at constant danger as its different facets are regularly degrading.

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 shales are 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 aspirates 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.

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 deep river valleys. The study area is located on the side slope of the mountainous range that runs from the outskirts of Melthum. The terrain of this area is young and

immature. It shows relief features with moderately steep slopes. The study area falls under the category of physiographic division of Mountainous Terrain Province. The slopes are moderately steep and the elevation ranges between 1000 to 1100 m from the mean sea level. The slope degree of the study area is about 45° which is sufficient for the development of slope failures.

Objective of the Study:

The objectives of the present study are as follows:

1. To get an insight into the causes of slope instability;
2. To study the effect of landslide and to suggest its mitigation measures.

Methodology:

Since the present study is to get insight into the geological structure, causes of instability of the slope causing frequent landslides, consequences or effects and to suggest mitigation measures, it is done mainly on the basis of field observations. Interview of the local people was carried out which is also an important means of collecting information about the historical background as there is no detailed secondary source of information about our study area.

According to the analysis of terrain conditions in areas affected by landslides in the past or the present it is possible to determine the zones with similar characteristics such as areas prone to landslides. A given area is declared to be susceptible to terrain failures when the terrain conditions at the given site are comparable to those in an area where the terrain failure has occurred. The different instability factors allow us to study the landslides area.

The causes of the instability of the slope in the study area are easily understood with present trends of quarry operation.

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.

Application of GPS is very useful for determining the actual length and breadth as well as the exact location of the study area. The elevation from the mean sea level is measured by applying this type of technique. Photo-interpretation is an effective method used to obtain significant information on terrain characteristics such as slope, soil characteristics and land use pattern etc.

Sources of Data:

The information of the study area is obtained both from primary and secondary sources of data. The primary data includes:

i) Field work: 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. The actual measurement of the area is taken with the help of measuring tape.

ii) Use of Global Positioning System (GPS): With the help of GPS the exact location of the study area and the acceleration in landslide movement is clearly identified. In this observation the GPS is generally used to determine the exact location of the study area, and its elevation from the mean sea level. The equipment is highly automated and consequently their use is not labor intensive.

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 Hlimen landslides in Mizoram (a pointer)’, the physical setting, climate, vegetation, soil and landslides analysis is also collected from relevant books and journals.

Causes of Instability:

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.

Hlimen is one of the largest and the best site for quarry in our state. The stones are hard and compact enough which are suitable for different types of building 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.

Since a long time back till today small landslides occur frequently. At the beginning this area was not used as quarry but after a few years the idea of converting the area into quarry started in 1974, it was converted into stone quarry from 1975 onwards. This quarry is owned by the local people. 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 lost in this incident was around 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.

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, which 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.

Findings:

South Hlimen where the present study is conducted is located within Aibawk R.D Block and situated about 7 km away from the south of Aizawl city. On 9th August, 1992 there happened a disastrous landslide that was not likely to occur before in this area due to the blocky nature of the rocks. But the continuous removal of the toe material and in association with rain water the natural support for uphill block was losing strength and the cohesive strength of the joint planes was further reduced and ultimately these were subject to free fall along the bedding planes. The main cause of landslides in Mizoram is human activity.

There existed one of the best quarries in Mizoram in the present study area which is known as South Hlimen Quarry. This quarry is now operating in a large scale supplying huge quantities of stones for building materials not only for the local consumption but also 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.

This 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, topographic features and human interference are the main factors 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 properly surveying 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.

The area was once 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. Moreover, there is no proper drainage system in this area. In addition, in this area explosive were also used to speed up stone excavations which developed major and minor cracks through which water pour in and the cohesive strength are reduced which ultimately leads to the rapid fall of the stones. As a result the villager fears 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.

In this area, a large number of people are working everyday to sustain their livelihood. 13 to 15 truck load 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.

Suggestion for Mitigation Measures:

Quarry operation in the state is undertaken in a most unscientific manner and the excavation starts from the base of the hill upward. This is not the right way of quarrying. 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) 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 should be properly surveyed before quarrying operation is undertaken.

References:

Dayal. P. (1996). *A Text Book of Geomorphology*, Shukla Book Depot, Patna.

E. Ahmad, (1985). *Geomorphology*; Kalyani Publishers, New Delhi.

Ray, Animesh, (1993). *Mizoram*, New Delhi, National Book Trust, India.

Stratler, A.N. Stratler, A.H. (1992). *Modern Physical Geography*, John Wiley & Sons (Revised).

Thornbury, W.D. (1969). *Principles of Geomorphology*, Wiley Eastern.

Wooldridge S.W and R.S. Morgan,(1988). *An Outline of Geomorphology; The Physical Basis of Geography*, Orient Longman,Swapna Printing Works; Kolkata.