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Effect, Causes, and Possible Measure of Landslide in Bangladesh (Chittagong)

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Abstract: Bangladesh is a densely populated developing country. Landslide is a regular geologic hazard in Bangladesh, specially urbanized hilly areas in Chittagong. Generally, the hills consist of unconsolidated sedimentary rocks such as sandstone, siltstone, shale and conglomerate. it is observed that soil characteristic of Chittagong Hill Tracts is alluvial, silty clay which is vulnerable to landslides. At least 141 people, were killed in separate series of landslides triggered by heavy rains in Rangamati, Bandar ban, and Chittagong on June 13, 2017. The losses have been monumental, and officials fear that the death toll may rise even further in the worst landslide since 2007, when a landslide resulted in the death of around 130 people and affected 1.5 million people in the region. It is disheartening that despite the occurrence of such disasters in the past, we have learnt little from our experiences. This paper mainly discusses the causes and impact of landslides and possible measures that can be taken to prevent future landslides. Southwest monsoon flows over the Bay of Bengal, heading towards northeast India and Bangladesh picking up more moisture from the Bay from June through September. The winds arrive at the Eastern Himalayas with large amounts of rain. Bangladesh and certain regions of India frequently experience heavy rains during this season, and most landslides occur after heavy rainfall. The main reasons identified for landslide were hill cutting ,weak soil structure and devegetation The major impacts of landslide on the local communities, as reported by the respondents were loss of natural scenic beauty economic loss destruction of lives and environmental problems . It is suggested to implement some new and modified structural measures such as vegetation with jute geo-textile can significantly improve the stability of hill slopes.

Keywords: Chittagong, Landslide, Hill-Cutting, Soil Structure, Heavy Rainfall, Slope Stability

1. Introduction

Landslide has always been a geological hazard in Bangladesh, especially in the southeastern part of the country. Landslide occurs every year in the hilly areas of Chittagong, a south-eastern part of Bangladesh .Landslide is a generic term used to describe the detachment and downward movement of soil, rock, or other earth material under the influence of gravity. Landslide is a very common hazard in Bangladesh, especially in Chittagong. It is the second largest city and the busiest sea port of Bangladesh. Landslide has become a terror here for its increasing trend of frequency and damage. This division is full of hill tracts. These hills are the main attractions of Chittagong. But now-a-day, these hills have become curse for Chittagong because of Landslide. Rapid urbanization and human development activities such as, building and road construction through deforestation and excavation of hill slopes have increased landslide in densely populated cities located in mountainous areas [13]. Different studies show that more than 500,000 impoverished people are living in informal settlements on the risky foothills of Chittagong city [8].Chittagong hills are degrading by different anthropogenic stresses such as, hill cutting for construction, sand and clay mining, establishment of settlement in foothills, deforestation etc. [9].Considering above facts, the present study is carried out to assess socio-economic condition of the people living in the landslide prone area, causes of landslide, impacts of landslide on local communities and preventive measures of landslide to reduce vulnerability of landslide in the study area of Bangladesh.

2. Location and Selection of Area

Chittagong is a major coastal city and financial center in southeastern Bangladesh. Chittagong city is situated within 22°14′ and 22°24′N Latitude and between 91°46′ and 91°53′ E Longitude and on the right bank of the river Karnaphuli.

Figure 1. *Map of Bangladesh showing Chittagong district, (red portion).*

The hills generally consist of unconsolidated sedimentary rocks such as sandstone, siltstone, shale and conglomerate. The soils are very strongly acidic. The soil of the hill slope is usually silty clay (liquid limit: 32-40; plasticity index: 15-21). Percent finer # 200 sieve (0.074 mm) and clay content varied between 92%-94% and 18%-19%, respectively [8].

2.1. Types of Landslides

2.1.1. Slide

Movement parallel to planes of weakness and occasionally parallel to slope.

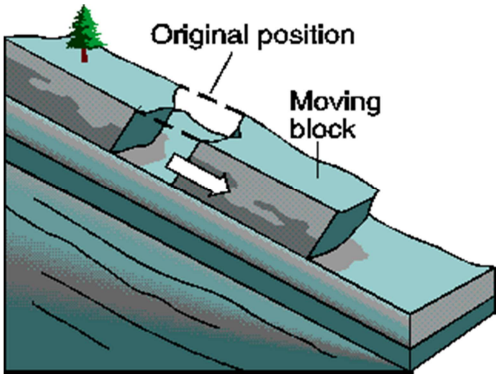


Figure 2. *Slide.*

2.1.2. Slump

Complex movement of materials on a slope, includes rotational slump.

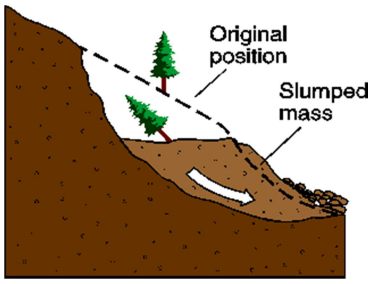


Figure 3. *Slump.*

2.1.3. Topple

The end-over-end motion of rock down a slope.

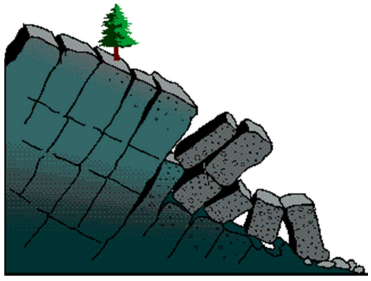


Figure 4. *Topple.*

2.1.4. Fall

Material free fall.

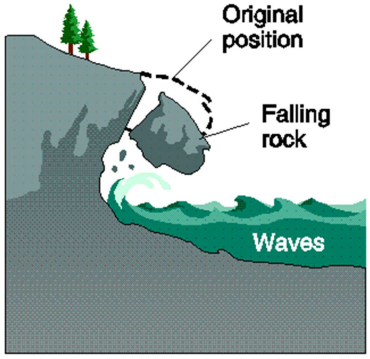


Figure 5. *Fall.*

2.1.5. Flow

Viscous to fluid-like motion of derbies.

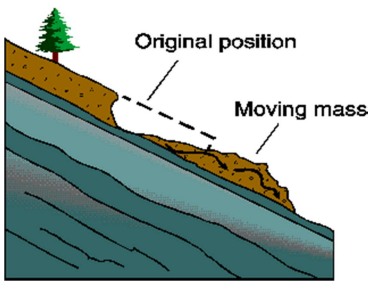


Figure 6. *Flow.*

2.2. Some Landslides in Bangladesh

The landslide on 11 June 2007 which occurred in several areas of Chittagong city was the severest of such occurrences

in the country's history. Major city areas affected were the foothill settlements consisting of the slums of Lebubagan Baizid Bostami, Kusumbag, Motizharna, and Lalkhan bazaar hilly area. 127 people died and a total of 2072 families were affected.

Figure 7. *Damaged houses due to heavy rainfall.*

In 2015, heavy floods and landslides during the last week of June inundated the districts of Chittagong, Bandarban and Cox's Bazar. A second series of heavy rain from July 22–27 caused new floods, landslides and further displacements. The side-effects, so to speak, of Cyclone Komen, were again heavy rainfall, causing additional landslides and flooding which extended to all the coastal regions.

Figure 8. *People have built temporary solution while local road have been damaged.*

On 12 June 2017, heavy monsoon rain over 343 millimeters triggered a series of landslides and floods in Rangamati, Chittagong and Bandarban - three hilly districts of Bangladesh, At least 141 people (at the time of writing), including children and four army personnel, were killed in separate series of landslides triggered by heavy rains.

Figure 9. *Detrimental effect of landslide due to rains.*

3. Causes of Landslides

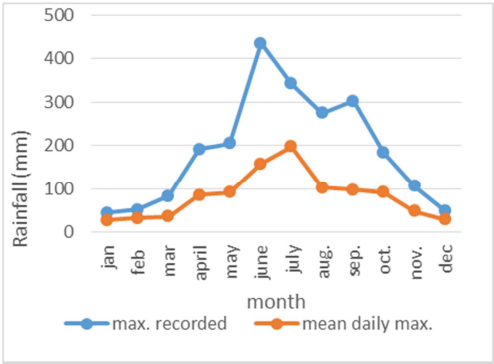
Landslide are considered as the most destructive hazards in developing countries, particularly where urbanization and population growth is high, and intensive land use and deforestation or mining practices are going on .There were many causes of landslide in Chittagong city, some major factors are discussed below.

3.1. Hill Cutting

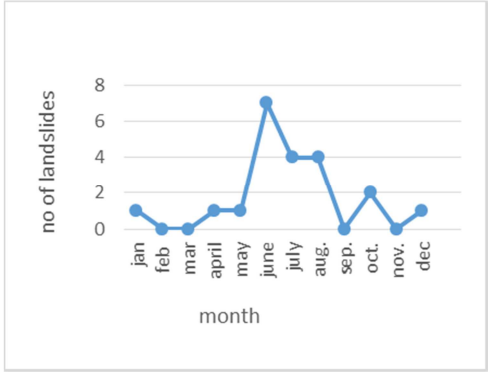
Most of the landslide occurred in Chittagong region due to indiscriminate hill cutting Soils are extracted haphazardly from the hills of Chittagong region for the activities of housing, urbanization, industrialization, road construction.

3.2. Heavy Rainfall / Climate

In the hill cutting areas, soil erosion occurs easily dug the rainfall. In Chittagong city, maximum hills consist of sandy and muddy soil which is easily eroded when heavy rainfall occurs in hill cutting slope areas. Long-term climatic changes can significantly impact soil stability. A general reduction in precipitation leads to lowering of water table and reduction in overall weight of soil mass, a significant upsurge in precipitation or ground saturation would dramatically increase the level of ground water. When sloped areas are completely saturated with water, landslides can occur. If there is absence of mechanical root support, the soils start to run off.



(a)



(b)

Figure 10 *(a). Rainfall pattern of Chittagong, (b) Average landslide frequency in Chittagong.*

3.3. Earthquake

Seismic activities have, for a long time, contributed to landslides across the globe. Any moment tectonic plates move, the soil covering them also moves along. When earthquakes strike areas with steep slopes, on numerous occasion, the soil slips leading to landslides.

3.4. Weathering

Weathering is the natural procedure of rock deterioration that leads to weak, landslide-susceptive materials. Weathering is brought about by the chemical action of water, air, plants and bacteria. When the rocks are weak enough, they slip away causing landslides.

3.5. Erosion

Erosion caused by sporadic running water such as streams, rivers, wind, currents, ice and waves wipes out latent and lateral slope support enabling landslides to occur easily.

3.6. Volcanoes

Volcanic eruptions can trigger landslides. If an eruption occurs in a wet condition, the soil will start to move downhill instigating a landslide. Stratovolcano is a typical example of volcano responsible for most landslides across the globe.

3.7. Devegetation

Devegetation in the hill was an important cause of landslide.

3.8. Gravity

Steeper slopes coupled with gravitational force can trigger a massive landslide.

3.9. Mining

Mining activities that utilize blasting techniques contribute mightily to landslides. Vibrations emanating from the blasts can weaken soils in other areas susceptible to landslides. The weakening of soil means a landslide can occur anytime.

4. Effect of Landslides

Landslide, a natural phenomenon,that is occurring frequently in the hilly regions of the country, especially in hilly areas like Chittagong. Landslide has huge impacts on the human being and their environment, including effects on people, their homes and possessions, farms and livestock, industrial establishments and other structures.

4.1. Loss of Life

Communities living at the foot of hills and mountains are at a greater risk of death by landslides. A substantial landslide carries along huge rocks, heavy debris and heavy soil with it. This kind of landslide has the capacity to kills lots of people on impact. At least 141 people, including children and four army personnel, were killed in separate series of landslides triggered by heavy rains in Rangamati, Bandar ban, and Chittagong on June 13, 2017.

Figure 11. *Loss of lives due to landslides.*

4.2. Decimation of Infrastructure

The force flow of mud, debris, and rocks as a result of a landslide can cause serious damage to property. Infrastructure such as roads, railways, leisure destinations, buildings and communication systems can be decimated by a single landslide.

4.3. Lead to Economic Decline

Landslides have been varied to result in destruction of property. If the landslide is significant, it could drain the economy of the region or country. After a landslide, the area affected normally undergoes rehabilitation. This rehabilitation involves massive capital outlay.

Figure 12. *Economically damages due to landslides.*

4.4. Impacts River Ecosystems

The soil, debris, and rock sliding downhill can find way into rivers and block their natural flow. Many river habitats like fish can die due to interference of natural flow of water. Communities depending on the river water for household activities and irrigation will suffer if flow of water is blocked.

4.5. Landslide Victims Reeling Under Water, Sanitation Crises

Landslide victims, who took sanctuary at different shelters in affected towns, suffered from acute drinking water crisis and lack of sufficient lavatories, while children and infants are getting infected with diseases

Figure 13. *sanitation and under water crisis due to landslides.*

5. Preventive Measures of Landslides

We cannot prevent disasters but we can try to take some precautions to decrease the losses. Such as.

5.1. Stop Hill Cutting

Hill land cutting is the main issues resulting from unplanned urbanization. Due to this land cutting, a number of landslides occurred. To protect landslide, it is necessary to stop all types of hill cutting, sand collection and other activities which all cause landslide in Chittagong city.

5.2. Schools in Disaster Preparedness

It is school where we can be taught to be prepared for the environmental hazards. It is the place where we first come to know in a deeper sense about the natural hazards and the reasons behind its origin. The educational organizations can add more texts so that the students can learn about the natural disasters like landslide and be prepared for it.

5.3. Tree Plantation

Tree plantation is a great way to mitigate landslide problem in Chittagong since trees holds soil from being washed away by rain water. In every year tree plantation programs can be arranged in the schools and educational organizations all over the country.

5.4. Public Awareness

Seminars should be organized more frequently to create awareness among the young generations of our country. Moral education should be imparted to the students in the fullest sense so that they can restrain themselves from business like soil grabbing in future. Schools can also be used as shelters during such hazards. These are the ways which can help a lot to mitigate landslide problem in Chittagong.

Besides these, Structural measures considering the safety measures, building codes and better drainage facilities are inevitable for mitigation of landslide disaster risk.

Detailed Area planning (DAP) of the city and a better management of government owned land are needed to minimize landslides and its hazards in Chittagong. Politically and socially empowered people of the society in conjunction with corrupt

Government officials are involved with hill graving and cutting in Bangladesh, violating the existing rules and regulations. Legal instruments should be in place and the enforcement of existing rules should be executed to manage risk-free hills.

6. Conclusion

Heavy rainfall and soil grabbing from hills are the main factors for landslide in Chittagong. This dreadful disaster causes unbearable loss of lives and properties every year. If the local people are made aware of this devastating natural Hazard in their early lives and if the faith based organizations come forward and increase moral awareness among the common people then it will definitely be possible to mitigate the effects of landslip in future. Detailed land use planning of the city, a landslide database, landslide mapping and geo-physical analysis of the city is essential to minimize landslides and its impacts in the region.1 It should be remembered that hills are important to maintain ecological balance. If we fail to protect them, larger disaster is waiting for us.

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