

Exploring the Causes of Landslide: A Study on Chittagong Metropolitan City

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Abstract

Landslide is a very destructive natural disaster in hilly areas. This paper shows the main causes of landslides in Chittagong metropolitan city from 2001- 2019. The data used in this study are secondary in nature. Most of the data are collected from government and non-government organization, news papers and research papers on relevant study. In this study I used Google Earth Pro software to compare historical images with the images from the year when landslide occurred to indentify deforestation of hill forest before landslide event. I have collected landslide data from news papers as well as media and then recorded the causes of every landslide and analyzed them. Then I arranged them by cause and 98% of them found to be directly related with hill cutting and deforestation. I found that most of the landslide occurred between the months May to August, which is known as rainy season in Bangladesh. Heavy rain is the main trigger for landslide in Chittagong city. As the climate is changing the rain pattern of Chittagong city also changing, it is increasing every year; the highest rainfall was recorded in Chittagong city in 2019. To reduce landslide and damage from landslide in Chittagong city, government needs to take strong action against illegal hill cutting. Cheap housing should be provided for the low income people and the urbanization should be done with proper planning.

Keywords: Chittagong hill tract, Deforestation, Hill cutting, Landslides, CDA.

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I. Introduction

A landslide is the movement of rock, earth, or debris down a sloped section of land. Landslides are caused by rain, earthquakes, volcanoes, or other factors that make the slope unstable. Near populated areas, landslides present major hazards to people and property. Hilly regions all over the world are prone to landslide. The dreadful rainfall-induced landslides in the Hiroshima area of Japan in July 2018 induced extensive damage. At least 104 people were killed in landslide events, and there were over 120 fatalities when the impacts of the associated flooding are included. That a country that is so prepared for landslides can suffer this level of loss was a surprise to many. It is a clear demonstration that physical management of landslides has limits, and the increasing intensity of rainfall associated with climate change will mean that these limits are tested repeatedly. This places huge emphasis on the importance of building resilience.

Bangladesh is vulnerable to many natural disasters like flood, drought, cyclone, flash flood and landslide that often happen in hill tract area of Chittagong. Before 2000 the number of landslides was low, after that the number is increasing day by day. There are many causes for this increase but the main cause is hill cutting; to provide accommodation, people cutting hills indiscriminately. The most devastating landslides in Bangladesh occurred in 2007 and 2017. The 2007 mudslides occurred in the port city of Chittagong in south-eastern Bangladesh. On 11 June 2007, heavy monsoon rainfall caused mudslides that engulfed slums around the hilly areas of the city. Experts had previously warned the increasing likelihood of landslides due to the Bangladesh government's failure in curbing the illegal hill cutting taking place in Chittagong. One third of Chittagong, a city of five million residents, came under water due to heavy rainfall and tidal water. The flash floods in the hills caused mud slides and rubble to bury shanties at the foot of the hills near Chittagong Cantonment. The death toll was reported to be at least 128, including at least 59 children, with more than 150 injured. The country-wide death toll from the floods and landslides neared 130 on 12 June, according to Reuters. Most of the deaths were a result of the landslides or from buildings collapsing in the rain. On June 13th the districts of Bandarban, Chittagong, Rangamati, Khagrachari and Cox's Bazaar suffered from possibly the deadliest landslides in their history. The disaster killed an estimated 160 persons, including 115 persons in

Rangamati alone. According to the Chittagong Divisional Health Office Control Room Report, a total of 187 injured persons were admitted in local level hospitals. While landslide related disaster occurs nearly every year, the second highest death toll of 127 deceased persons was recorded in 2007 [Disaster Forum, June 2017]. Monsoon rains caused severe flooding in low-lying areas to significantly damage road and communication infrastructure. Flood water rendered remote communities in Bandarban, Chittagong, and Rangamati districts were inaccessible by road. On June 14th, mudslides in southeast Bangladesh claimed additional lives in Cox's Bazaar and Khagrachari districts to further damage homes and infrastructure. The June landslides resulted in heavy loss of life (160 persons), injury (187 persons), and destruction of houses (6000 structures) and other key infrastructures despite being localized in impact. It is the worst landslide-related disaster since 2007. It affected about 80,000 persons across five districts: Bandarban, Chittagong, Cox's Bazar, Khagrachari and, Rangamati. Landslides can be caused in two ways; manmade and natural. Here we tried to find out the causes that are responsible for the landslides that occurred in Chittagong metropolitan area.

Theoretical background

Chittagong city is known as the port city of Bangladesh and financial center situated in southeastern of Bangladesh. Chittagong lies at 22°22'0"N 91°48'0"E. It straddles the coastal foothills of the Chittagong Hill Tracts in southeastern Bangladesh. Mount Sitakunda is the highest peak in Chittagong District, with an elevation of 351 meters (1,152 ft). Within the city itself, the highest peak is Batali Hill at 85.3 metres (280 ft). Under the koppen climate classification, Chittagong is a tropical monsoon climate. The Chittagong Division is known for its rich biodiversity. Over 2000 of Bangladesh's 6000 flowering plants grow in the region. Its hills and jungles are laden with waterfalls, fast flowing river streams and elephant reserves. St. Martin's Island, within the Chittagong Division, is the only coral island in the country. The fishing port of Cox's Bazar is home to one of the world's longest natural beaches. In the east, there are the three hill districts of Bandarban, Rangamati, and Khagrachari, home to the highest mountains in Bangladesh. The region has numerous protected areas, including the Teknaf Game Reserve and the Sitakunda Botanical Garden and Eco Park. The hill soils (dystric cambisols) are mainly yellowish brown to reddish brown loams which grade into broken shale or SANDSTONE as well as mottled sand at a variable depth. The SOILS are very strongly acidic. The hills are unsuitable for cultivation but natural vegetation remains widely. As the hilliest region of Bangladesh Chittagong city is populated with more than 4,009,423 people. This region is most vulnerable to landslide disaster. The highest landslide 208 was recorded from 2001- 2017 in Chittagong hill tract area. The biggest landslide occurred in 2017; 152 people were killed Chittagong hill tract. In Chittagong city alone 75 people were killed. It also results in power cut, telecommunication disruption and huge property damage. In this paper we tried to discover the reasons of landslide by analyzing the landslides from 2001-2019, the vegetation of the landslide area and the precipitation of Chittagong area.

II. Materials and Methods

The study is conducted with secondary data collected based on Chittagong hilly area. The main sources of data's are Bangladesh disaster preparedness center, Bangladesh disaster management ministry, CHRS, CDMP-II, World weather online, news papers. The comparison has been made between two Google earth images before deforestation and after deforestation to observe the landslide areas. In this study I considered the change in vegetation as the first indicator of landslides in historical images of Google Earth. Landslides remove vegetation, and this can be detected in pre-event and post-event Google Earth images. I had previously mapped the landslide area and recorded the location, date, type, of the landslide. Then I compared them to find out the cause and relationship. We used "Google Earth Pro" computer software to find the historical and present satellite image of the landslide prone area and compare them. We also collected many real-time pictures and data of landslide in Chittagong metropolitan area from online newspapers and different organizations like CDA (Chittagong development association), Asian disaster preparedness center etc.

III. Result And Discussion

Bangladesh is a country with subtropical monsoon climate with varieties of seasons and is prone to many natural disasters like flood, drought, cyclone, landslide etc. Recently landslides are happening frequently and become a disastrous natural phenomenon as the number of casualties high. A landslide also destroys infrastructure, household utilities and materials required for daily life.

Landslides data analysis of Chittagong metropolitan city: Chittagong metropolitan city has the highest record of landslide in Bangladesh as it is the hilliest area. The landslide data are given in the table below:

Table 1: Landslides in Chittagong hill tract area.

Year	Description
1999	Landslide occurred in Chittagong Metropolitan area on 13 th August 1999 claiming the life of 10 people.
2000	At least 13 people were killed and 20 injured in landslide incidents on the Chittagong University campus and other parts of Chittagong City on 24 th June, 2000.
2005	Three children were killed and another was injured in a landslide at Shantinagar area adjacent to the Bangladesh Cooperative Housing Society in Bayezid Bostami thana in the port city on 31 st October 2005.
2007	At least 128 people were killed and hundreds more injured and missing and a lot of property damaged as torrential rains sparked a series of devastating landslides at Baizid Bostami, Kushumbag, Motijharna, Sikandarpara, Lebubagan, Kochuarghona, Workshopghona, Chittagong University campus, Hathazari in Chittagong Metropolitan city on 11 th June, 2007.
2008	A rain induced mudslide at Matijharna in Chittagong Metropolitan city on 18 th August, 2008 left 11 people injured. This event destroyed 14 houses of a slum built on a hillside from which the government was relocating families apprehending the danger.
2012	At least 13 people were killed at Khulshi, north Pahartoli, Banshkhali, Ambagan and Hathazari in and Banshkhali area in land-slide on 26 th June, 2012 due to heavy torrential rains while wall collapse and electrocution. Landslide at Yasin Colony in Khulshi area had buried 20 houses.
2013	12 people died in separate landslides in different parts of Chittagong City area on 27 th July, 2013 and the areas that suffered more includes Halishahar, Pahartali, Khulshi and Bakalia.
2014	Medical hill Goachi bagan, Pachlish Land slide in this site occurred on May 2014. no houses got damaged due to this event. none was found to be dead or injured. There are many settlements located on slope of this hill.
2015	According to the NDRCC report dated June 28, 2015, Last night (July 18, 2015) 07 (seven) peoples had been reported died, 03 (three) peoples are seriously injured due to landslide at Bayezid bostami and lalkhan bazar in Chittagong district.
2017	On 12 June 2017, heavy monsoon rain triggered a series of landslides and floods in Rangamati, Chittagong and Bandarban - three hilly districts of Bangladesh - and killed at least 152 people.
2018	A landslide occurred in august in feroze shah colony, Chittagong.
2019	Three days of continuous rain in Bangladesh have destroyed 273 shelters and injured 11 people in the Cox's Bazar settlements where more than 900,000 Rohingya refugees live. An estimated 350mm of rain fell in 72 hours from Monday and more heavy downpours are expected throughout next week, with four months of the monsoon season to go. According to preliminary reports, there have been 26 landslides.

Source: NDRCC, UNHCR.

This table shows the landslide occurred from 1999-2019 in Chittagong hill tract area. The data shows that maximum damage done by landslide in Chittagong metropolitan city is in 2007; almost 128 people were killed and 100 were injured in different place in Chittagong in different landslide. We now discuss the causes related to these landslides.

The first suspect is **deforestation and hill cutting**. Deforestation and hill cutting both are closely related. Deforestation is the first step of hill cutting or to settle establishment on hill. People clear forests to settle down there or to establish buildings or infrastructure. The poor people settle down on hill foot because it is free of rent, to settle down they cut down the supporting forest which holds the hill slope from being fall or slide with their roots and covers the soil from being hit by direct rainfall. As a result when the rain fall starts it triggers the landslide.

Deforestation

To show the deforestation we used historical image and the image of the year in which the landslide took place in the area of study. A comparison is made in the images given below that are the images of one of the study area named 'Akbar shah mazar hill'. A series of disastrous landslide occurred in 2007 in Chittagong; Akbar shah mazar hill was one of them. Two Google earth images are taken from this area, one from 2001 and another from 2007 before the landslide occurred. The image of 2001 shows green vegetation which are covering the hill. On the other hand the image from March, 2007 shows the green vegetations are almost gone and there are many new settlements that can be spotted with naked eyes. As a result in June, 2007 a massive landslide was caused by heavy rainfall in this area.



Akbar Shah Mazar-2001

Akbar Shah Mazar-2007

Figure-1: Comparison of Akbar Shah Mazar Hill images between 2001 and 2007.

Hill Cutting

The next step of deforestation is hill cutting. Most of the deforestation is the result of the demand for wood but in Chittagong metropolitan city the demand is housing. As the population increases the need for housing is also increasing but the land is fixed in Chittagong city which is known as the port city of Bangladesh. To support huge population the housing companies building houses under the hill foot without fulfilling the requirements of CDA. Moreover the poor people are building illegal settlements under the foothill and even on the hill. For that they cut the slope of the hill and who builds their houses on the hill cut the hill slope and flattens the hill surface. As they have no idea on how to properly cut a hill they cut the hill making the slope steeper and steeper hill slopes are responsible for devastating landslides. Furthermore, many hills are being cut down for development purposes and the developers developer's careless behavior makes it life threatening. The 'Tiger pass' is a hilly road in Chittagong metropolitan area. The road was built in around 2012 before that it was mud road. The road was built by cutting hill and the worst scenario is that people build houses under the vertical hilly road slope. A landslide occurred here due to the collapse of the retaining wall of tiger pass road in 1 July 2011 and 7 people were found dead. Many housing societies are built under vertical hill foot like tiger pass and are in danger. Any time landslide can hit those buildings incurring huge damage and even cost life. Generally steeper hill slopes are more susceptible to landslide. In a natural formation, the slope of a hill is not vertical and lies between 15-45 degree angles which also help to slow down the landslide or mudflow and reduces the damage. But the vertical hill slope is the most dangerous and destructive. Figure-2 is a picture of a hill that is subjected to illegal hill cutting in Chittagong. All the trees on the hill is cut down too, only rain is needed to trigger the landslide, which further worsen the situation is the houses right underneath the hill foot. The houses will be wiped out if landslide occurs.



Figure-2: Hill being cut down illegally in Chittagong.

According to CDA there are 28 hills in Chittagong district which are vulnerable to landslides and district administration has so far listed 684 families who are living on these foothills. They are all in great danger, in these year monsoon season can trigger landslides in this areas and can cause casualty and property damage.

Precipitation Data of Chittagong

Generally landslide does not occur without something to trigger it like earthquake, volcano eruption or rain. In Bangladesh we have no active volcano but sometime we have weak earthquake, so the main trigger for landslide in Bangladesh is rain. Here we presented the rainfall data of Chittagong metropolitan city in the figure from 2009-2019. The data in the figure shows that all the high rainfalls are recorded between the month June-August and the highest rainfall was recorded in July, 2019. And it is no coincidence that the landslide

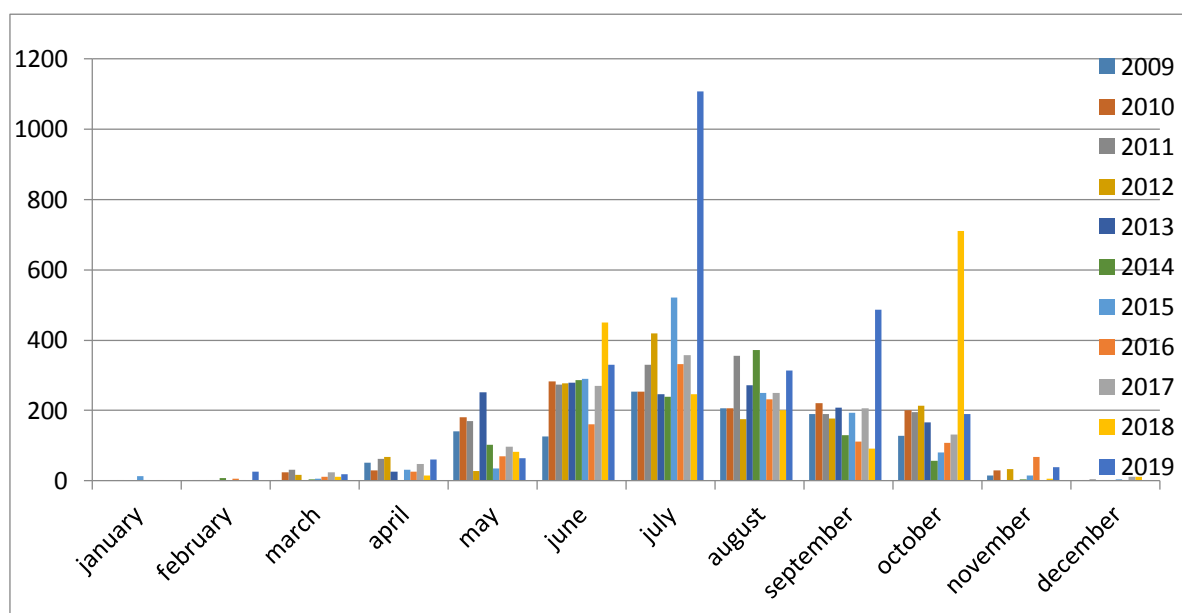


Figure-3: Precipitation data of Chittagong.

Data we have given above all of them occurred in between June – August. These data's are the concrete evidence that deforestation, hill-cutting and rainfall are inseparable causes of landslide in Chittagong city.

IV. CONCLUSION

Chittagong is the hilliest area of Bangladesh and Chittagong city is built on hills. Most of the infrastructure are built on hills or built by flattening hills. In British era there were more than 200 hills in Chittagong city, now only forty hills are standing in the city area. Recently 18 hills were cut down to prepare link road in bayejid bostami area Chittagong by CDA. Though CDA were fined 10cr tk, the hills cannot be restored. Moreover, they didn't follow the safety rules set by international organization that is maintaining hill slope between 30-45 degree angle, well water drainage system, and strong retaining wall to support the hill. These can result in devastating landslide like the landslide occurred in 'Tiger pass' area in Chittagong city. As heavy rainfall in the monsoon season is the nature of Bangladesh's climate, here landslide in hilly area like Chittagong is natural and deforestation as well as hill cutting just aggravates the landslide situation. With all the evidence we gathered we can conclude saying that the main cause of landslide in Chittagong city area is deforestation and hill cutting and the trigger is heavy rainfall.

V. RECOMMENDATION

We cannot completely stop the landslide from happening neither we can leave the hilly area and settle somewhere else with a huge population nor we can live without roads, culverts. We have to live in accordance with the nature, we have to develop roads and built infrastructure keeping in mind that if we don't make a sustainable development plan or consider the safety of the infrastructure, it will result in environmental degradation and loss of property and life. Here is some recommendation for development in hilly area like Chittagong which can mitigate the effect of landslide-

1. Building retaining wall around all the hills situated in residential areas in Chittagong city. It will help to support the hill from falling down easily.

2. Building well organized drainage system on the hills that can cause casualty in the city. The drainage system helps to direct the rain water safely from the top of the hill to the ground without creating a mudflow which in terms create landslide.
 3. When conducting development work in hilly area the slope of a hill is the most important thing. The steeper or vertical the hill slope the more chances of landslide occurrence. It is suggested by the experts to keep hill slope between 30-45 degree angles, steeper than 45⁰ can cause landslide.
 4. preparing a list of landslide susceptible area and resettle the people living in those areas to a safe place.
 5. Strong law on illegal hill cutting and deforestation will reduce the amount of landslide in Chittagong dramatically.
 6. Tree plantation and protection of the hills that are susceptible to hill cutting.
- Finally, a strong law and strict guideline on hill cutting and development in hilly region should be maintained. Following these rules can at least reduce the damage and casualty from landslide in Chittagong city.

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