



Some Observations and Lessons Learned: Cyclone 'Mora' and 'Landslide of Chittagong', Bangladesh

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Abstract: In the last few years, several devastating disasters have occurred in a different part of the world. Cyclone and landslide are common disasters in Bangladesh. The cyclone is the natural disaster where a landslide is the man-made disaster. Cyclone "Mora" devastated the coast of south-western Bangladesh on May 30, 2017, and 'landslide of Chittagong' districts has occurred on June 12, 2017, and caused various socioeconomic impacts including loss of lives, damages to infrastructures and loss of coastal resources. Based on data the study sought to understand the losses due to mora and landslide of Chittagong districts consequences on the environment of the southwest part of Bangladesh. The authors rely on personal observation of activities and documentation for which they were responsible for those disaster or to which they contributed to minimizing the loss. The paper provides the causes, impacts and some technical and managerial techniques of restoration and reconstruction of the affected area. Finally, results drawn from this research will be useful for project manager, planners as well as people of Bangladesh for future disaster mitigation, restoration, reconstruction and planning in the studied area and this papers methodology can also be applied in the similar geographic area.

Keywords: Mora; Landslide; Disasters; Restoration; Reconstruction; Mitigation

Introduction: The landmass of Bangladesh is connected to the Indian Ocean through a coastline of 700 km to the north and north-eastern part of the Bay of Bengal [1]. So, Bangladesh owns a huge coastal region which consists of 19 districts with a total area of 47,203 km² and a population of 35 million, which is 28% of the country's total population [9]. Since distant past, people have been settling in the coastal belt of Bangladesh though they remain in a precarious situation of becoming hit by a natural disaster at any time. Historical statistics demonstrate that since 1970, Bangladesh has experienced 36 cyclonic storm surges bringing about more than 450,000 passing and immense financial misfortunes [10]. But still, they have been taking risks to live here in the coastal region of Bangladesh has one of the world's largest resources and opportunities as well. Severe cyclonic storm mora made landfall in Bangladesh on 30 May 2017. Mostly 200 people were dead and over half a million people were affected by the floods and landslides in Sri-lanka, and 18 000 families were moved to 366 temporary safe locations [13]. In Bangladesh, six lives lost, as well as 136 people injured and local administration in 16 coastal districts evacuated almost half a million people to about 3000 cyclone shelters [1]. These cyclones and surges resulted in the loss of lives and damages to properties thus rendering millions of people homeless. Government sources have evaluated that roughly 52,000 houses were harmed or devastated, leaving 260,000 people in possible need of shelter. Then again, landslides happen hilly area in every year [13]. The June landslides were the most exceedingly bad landslides related disaster in Bangladesh since 2007. Starting 13 June, the landslide brought about the deaths of 160 individuals, harmed 187

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individuals, and destroys 6,000 homes, in spite of being restricted in effect. It affected about 80,000 people across five districts: Bandarban, Chittagong, Cox's Bazar, Khagrachari and Rangamati [14]. Although some researches have been conducted on the cyclone and landslide risk mitigation in Bangladesh; however, there is no effective approach to mitigate the risk. That's why the amount of loss is so much higher than developed countries in the world. so the main objectives of this paper are to find out the way by which we can mitigate the losses rapidly for further disaster.

Research Methodology

Study Area: Our study area is Parbotto Chottogram (Khagrachari District, Rangamati Hill District, and Bandarban District), Chittagong and Cox's Bazar district. This area is within southeastern Bangladesh, bordering India, the Bay of Bengal, Myanmar (Burma). The area lies at 22°20'18" N latitude and 91°49'54" E longitude. It covers a total land area 33,771.18 square kilometers. Before 1984, Parbotto Chottogram was a single district, after that was divided into three districts: Khagrachari District, Rangamati Hill District, and Bandarban District. Topographically, those districts are the hilly area. This area receives a very high annual rainfall amounting to more than 100 inches (2,540 mm). The study area has been situated in humid zone 1 which soil is podzolic type including alluvial [5]. The population of the three districts (zilas) totaled 1,587,000, the population density is rough 120 per km². About 34% of the population are tribal peoples and mainly followers of Theravada Buddhism; 65% of the inhabitants are Bengali (Muslims and Hindus); and 1% Christians or animists [1].

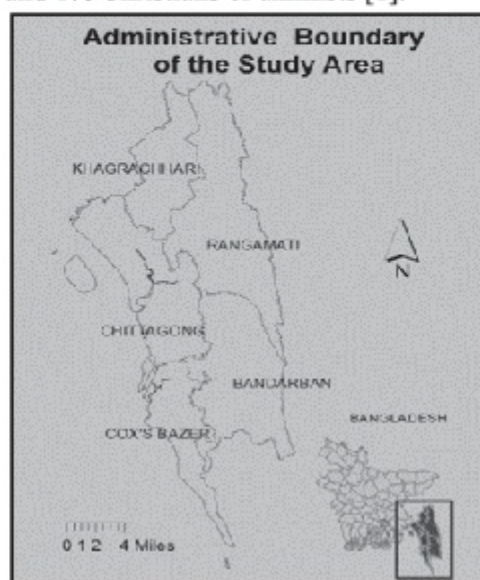


Fig. 1: Study area map

Data collection:

Primary data: Primary data were collected through interviews with people were conducted by authors. All those data are recorded and analyzed in SPSS software. About 200 household surveys were carried out for this present study to find an adverse impact of MORA and landslide as well as peoples responses in our study area.

Secondary data: Secondary data were collected through several field communications to relevant organizations with the study. Damage and compensation information was collected from Ministry Disaster Management and Relief-Government of Bangladesh, Ministry of Chittagong Hill Tracts Affairs,

Bangladesh Bureau of Statistics, UNDP, UN CR. Data on general cause of landslide were collected through interviews with local people from Chittagong hilly area.

Table 1. Secondary Data and Their Source

Landslide	Data Type	Source
	Cause of LandSlide	www.infokosh.gov.bd
	Historical Information on Landslide	The Daily Star, Date:13 June 2017
	Losses of Landslide	The Daily Star, Date:13 June 2017
Cyclone	History of natural disaster	www.livescience.com
	Impact of Different cyclone	www.livescience.com

Result and discussion

Losses: About 200 households were surveyed to see the adverse impact of landslide and mora in a study area. According to survey result, here seen that most of the community people were falling in the adverse impact of this disaster. For this, these impacts are classified into three categories [2]. Economic loss is high and loss of life is low. Below the table -2 and figure -2 which indicate the losses of mora and landslide according to field survey

Table 2. Losses of mora and landslide

Economic losses	Losses of home Losses of land Loss of income Loss of working place Loss of asset Damage to crops Damage of domestic cattle Health losses Losses of infrastructure.
Loss of lives	Loss of man, woman and child life
Social losses	Loss of social network. Damage of transportation network Loss of social inclusion

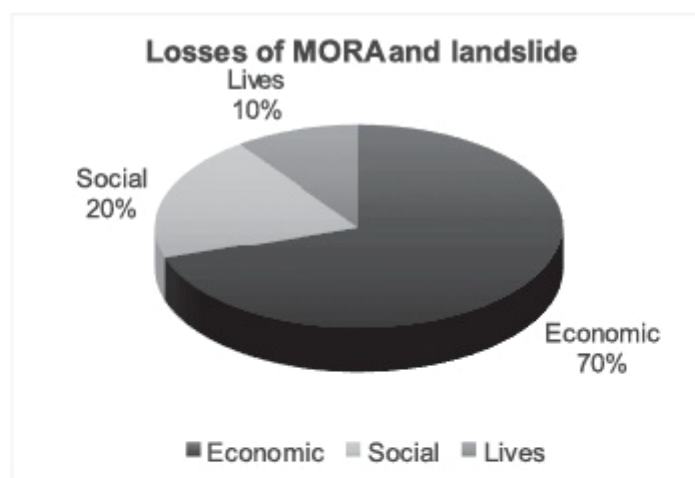


Fig. 2: Losses of mora and landslide

Loss of ecosystem services: It is known that a large number of trees were uprooted, and logs of trees were swept away by the storm surge [3]. A significant decrease in regeneration and growth of mangrove forests was seen in the Sundarbans after mora. Infrastructures like forest camps were severely damaged. Floral and faunal decent variety alongside numerous seaside individuals' livelihood was additionally seriously harmed. Local people informed that many dead frogs, snakes, etc., were seen floating in the water after mora. Due to long-term waterlogging, many trees died due to anoxic conditions [13]. Below the table 3 which indicates the historical information of landslide in study area.

Table 3. Historical information of landslide in study area at a glance [7]

Date	Reason	Losses
1968	Tree cutting	Transportation and infrastructure losses
1970	Tree cutting	Losses of lives and asset
1990	Heavy precipitation	Losses of lives and asset
1997	Heavy precipitation	About 90,000 sq. Km area was affected
1999	Earthquake	Losses of 19 lives and economic losses
2003	Tree cutting	Losses of 6 lives
2007	Heavy precipitation	Kusumbag, ladies club of senanibash and losses of around 127 lives
2008	Heavy precipitation	Losses of 6 lives
2010	Earthquake	Losses of 53 lives and economic losses
2011	Tree cutting	Losses of 17 lives in a single family and economic losses
2012	Heavy precipitation	Losses of 94 lives and economic, social losses
2015	Heavy precipitation	Losses of 19 lives and economic losses

Aforesaid information of landslides is alarming issues for Bangladesh as well as in study area [4]. A number of the devastating landslides is occurred frequently and resulting a lot of damage of social and economic, even loss of lives also. If we are not conscious of this disaster and there is no mitigation approach against the landslide and different types of a disaster than our lives will remain at stake. Below the table 4 which indicates the major cyclones losses in Bangladesh. Here we can see that the rate of losses is decreasing day by day in our country.

Table 4. Major cyclone occurrence in Bangladesh [7]

Date	Name	Losses
1991 (29 April)	-	The loss of property was estimated at about the 60 billion. The death toll was estimated at 150,000; cattle head killed 70,000.
1994 (29 April 3 may)	-	People killed about 400, cattle lost about 8,000.
1995 (21-25 November)	-	About 650 people killed, 17,000 cattle head perished.
1997 (16-19 may)	Hurricane	Only 126 people killed because of better disaster management
2007 (15-17 November)	Sidr	About 3000 persons killed
2009 (27-29 may)	Alia	About 150 persons killed, 2 lac houses and 3 lac acres of cultivated land and crops losses.
May 30, 2017	Mora	Fatalities 40 total, 81 missing Damage \$297.8 million (2017 USD)

The above table concerns us that a number of cyclones hit our study area in different time and bring a miserable condition for the community people. We can't remove the impact of these natural calamities, but we have to take an effective initiative to reduce the fine negative impact of cyclone and landslide [5].

Personal opinion of respondent: While surveying some respondent objection that they don't get any logistics or training facilities like information about the disaster, precaution, alarm, fast aid and recovery to face any natural disasters like mora and landslide. Those preparation offices specified above ought to be given by nearby government experts like union board part or administrator, school teacher, NGOs.

The main reasons of those landslides are (According to field survey)

A) Tree cutting: Trees of the hilly areas are improved with different species and exceptionally demandable for the medicines, furniture, log pit, been and from different essential viewpoints [6]. In this way, different illicit gatherings are constantly engaged with the accumulation of those trees by cutting indiscriminately considering they're high economic and market values [3]. So, the soil of the hilly areas become uncovered and loses their bonding strength quickly. That causes serious landslides every now and again mainly during rainy seasons. The tree is cut down by a vast amount in our study area (as a table:2) and is the striking reason for the landslide.

B) Heavy Precipitation: Due to the geographical position of the area, the area is enriched with various types of hills-large or tinny [7]. Besides, due to enrich of high vegetation and trees transpiration, evaporation occurs here highly. This vapor goes high and floating, and then creates heavy rainfall. From the figure of annual precipitation, it has been seen that every year a huge amount of precipitation may occur in study area and it leads to landslide [8].

C) Earthquake: Here the study is being fall in earthquake zone 2 and zone 3 the earthquake is one of the major causes of the landslide. Vibration power is forced the soli structure to collapse their natural bonding and leads to slide [10].

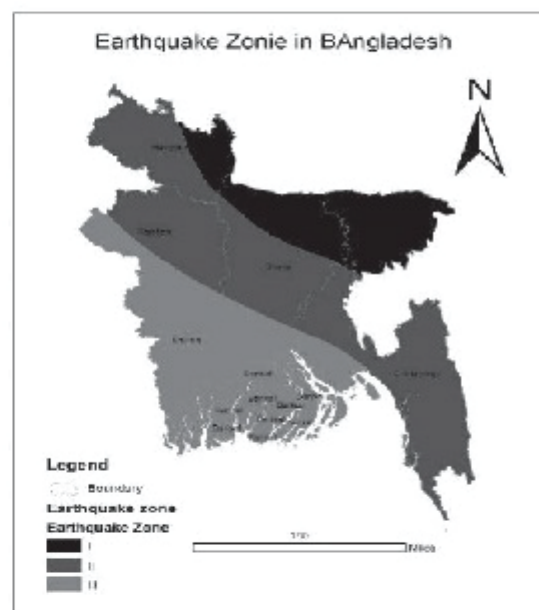


Fig. 3: Earthquake zone in study area

- D) Human modifications of slopes such as cuts pits, and canals.
- E) Removal of vegetation

Mitigation: From the above information, it was seen that heavy precipitation is one of the prime reason for the landslide in the study area[8]. Due to heavy rainfalls, the soil structure of the hilly area is collapse and resulting destruction of a various asset as well as human lives. if there was a system in the hilly area to instant drain out the participation than the rainwater cannot percolate into the soil structure at a large quantity. Consequently, the falling of soil structure is minimized and its lead to minimize landslide [14].

Indiscriminate tree cutting is another reason for a landslide. but we need tree cutting for our essential. For doing this a specific rule is prepared to cut down a tree for hilly reason [8].

Hill land cutting major issues resulting from unplanned urbanization. Due to this land cutting in the hilly area, a number of devastation landslide occurred in the study area. To regulate the land cutting process and achieved a balanced landscape planning there must need some plan and policy as well as the relevant authority (cda) must be a concern to implement and monitoring this policy [8].

Marginal people can be found in the venerable hilly region.in this case, to reduce the number of losses, we need to restate them to another place[8].

In case of emergency situation, we need cyclone shelter, nearby information center, and other logistics need to reduce the adverse impact of the disaster. By providing various training facilities like information about disaster, precautions, alarm, fast aid and recovery on the disaster to the community people we can strengthen them to face natural calamities. Finally, mutual coordination of authority and community people can help to reduce the losses of mora and landslide [8].common engineering techniques for landslide prevention include provision for surface and subsurface drainage, removal of unstable slope materials, construction of retaining walls, or some combination of these. Many of them are currently used in Bangladesh [7]. To mitigate the damage of a disaster, some adapting effectively need to change through strong communication via electronic mail, radio, television. That decision will be sudden and totally unexpected. Good communication and accurate exchange of information of the affected area are the main key point for restoration of any disasters like cyclone, landslides [9]. Accurate building and facility triage must be required. To recover a disaster or mitigate loss the role of logistics is very high.to control the project after disaster some policy should be required for human resources to schedule the activities to mitigate stress. Follow this procedure especially those who have little experience in major disaster recovery efforts [15] prevention is the better option than protection to mitigate the damages of cyclone or landslide in Bangladesh. For that reason, the united states has conducted experiments in the Atlantic by spraying silver iodide in the region of the maximum wind speed to minimize the wind speed. These experiments, though very promising, have remained inconclusive. Moreover, there is a chance that these cyclones could change their track and move towards another direction. The cyclone is a natural phenomenon like an earthquake or a volcanic ejection [11]. Nations like Bangladesh need to figure out how to live with it. Nowadays the disaster management system has improved. In the event of a cyclone, the whole of the army, navy, air force and related ministries and agencies perform their duties properly. Below a chart which is shown a disaster restoration professional body and disaster restoration manager should go through it to mitigate damages of a disaster[12]. Authority should know and follow this chart.

This forms a good basis for what disaster restoration managers should know. It consists of the managerial and technical knowledge that helps to restore a disaster-prone area[10]. The managerial part describes project control, project administration, and marketing. The technical part indicates material science and contents restoration, structural restoration process and peripheral restoration concerns[14]. It will be helpful for making a sustainable built environment to restore the area after a disaster. Below the figure 4 of a disaster restoration professional body [9].

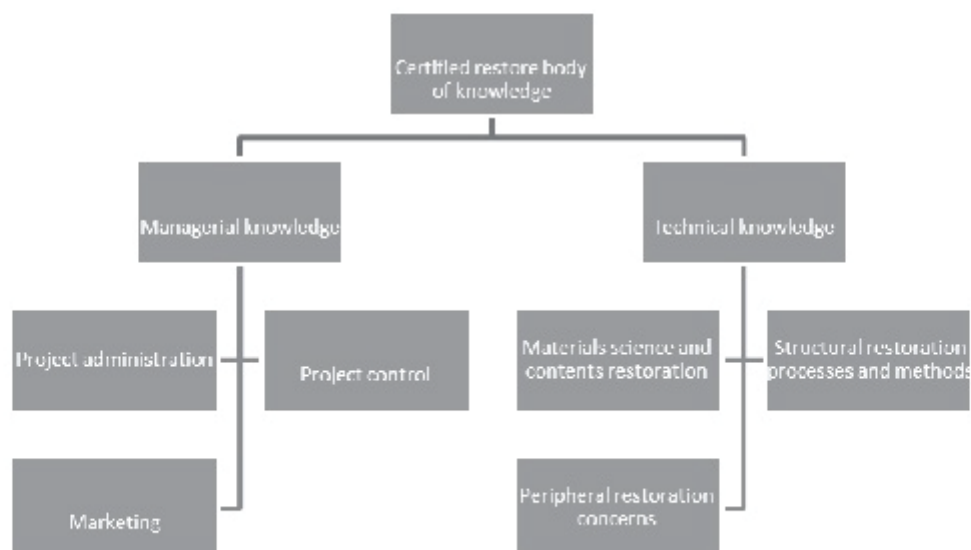


Fig. 4: Chart of a body of knowledge for the certified restorer1[®] credential [9].

Conclusions: The above lessons in disaster recovery management are among those that had a substantial impact on projects in which the lead author observed recently. Findings of this research are 70% of economic losses, 20% social losses and 10% losses of lives according to data analysis. While surveying some respondent complaint that they do not get any logistic or training facilities like information about disaster, precaution, alarm, fast aid and recovery to face any natural disasters like mora and landslide. There is no effective system for providing an early precaution as well as no system for emergency response. Those training facilities mentioned above should be provided by local government authorities like union council member or chairman, primary school teacher, NGOs through oral or sometimes workshop. The distinguished difficulties, including; insufficient financial and human resources, political interference, abuse of assets, constrained participation by the nearby group and lack of supporting laws and directions are an indication of high institutional vulnerability and ought to be addressed. Instructive and examine associations ought to be bolstered consistently. In the region of disaster management, Bangladesh is not bad in front of numerous nations. This is the reason the nation will be viewed as a good example of overseeing catastrophic events. To fulfill this expectation, future research should concentrate on evaluating the effectiveness of early warning frameworks for landslide and cyclone disaster risk reduction in Bangladesh.

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