The Anthropogenic Aggravation of Landslide Disasters in Bangladesh: Key Informants' Perspectives

Bayes Ahmed, S. M. R. Arfanul Alam, Imtiaz Ahmed, and Peter Sammonds

Abstract

Landslide disasters in Bangladesh's Chittagong hill districts (CHD) put lives, livelihood, and the ecosystem at risk. Therefore, understanding the causes of landslide events in CHD is crucial to preparing and implementing disaster risk reduction (DRR) strategies. The causes of landslides are generally seen through the lenses of physical science. However, to better understand the landslide disaster mechanism, it is essential to explore the human activities that trigger and aggravate the events. This article uses qualitative social science tools and techniques to investigate CHD's anthropogenic-induced landslide disasters. Forty key informants from diverse professions, ethnicities, communities, and backgrounds were interviewed between 9 June and 3 November 2020. The recorded interviews were translated, transcribed, and thematically analysed in NVivo software. The results show that human-induced landslides in CHD evolve around three broader areas: demography, climate change, and lack of coordination and regulation. First, increased population, hill cutting, deforestation, manipulated agricultural practices, and sand and stone extraction is the leading anthropogenic activities of landslides in CHD. Second, the influx of Rohingya refugees into Bangladesh significantly increased landslide vulnerability. Third, climate change-induced erratic rainfall is leading to more rainfall-induced landslides. Finally, a lack of coordination and regulations among various institutions hinders the DRR process. The short, medium- and long-term recommendations include stopping illegal hill cutting and deforestation, regulating heavy vehicles, increasing coordination, institutionalising early warning systems, conducting massive awareness campaigns, conducting further research, addressing challenges such as lightning, climate migration and conflict, and creating a master plan exclusive for the entire region and coming up with a political consensus for better implementation of the plan.

Keywords

Landslide • Indigenous knowledge • Chittagong hill tracts • Key informant interviews • Rohingya • Bangladesh

1 Introduction

Landslide is one of the deadly disasters in Bangladesh. The disaster sometimes costs life, livelihood, ecosystem, and the local economy. Bangladesh has significantly improved in disaster risk management over the years due to the country's comprehensive disaster prevention programmes and the inclusion of local and international organisations in the process. Common disasters in Bangladesh like cyclones and floods have come under an early warning system and broader disaster risk reduction (DRR) policies and programmes. As a result, the death rate from tropical cyclones —the historical deadliest disaster in Bangladesh—decreased significantly (Alam and Ray-Bennett 2021). However, in comparison to them, landslide disaster is often less discussed. The devastating 2017 landslide events in Chittagong hill districts (CHD) in Bangladesh that killed at least 170 people (Anas 2019) was a wake-up call for researchers and policymakers.

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For effective DRR strategies, it is vital to understand the disaster risk first, which has also been prioritised in the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNDRR 2015). In the case of landslides, looking at both the natural and human-induced factors is vital for formulating and evaluating policies and existing frameworks. Including multidisciplinary research to investigate disaster risks makes it more reliable and accurate. While the physical science domain still dominates landslide studies, there is an acute need for integrating qualitative social science research.

Anthropogenic or human-induced landslides are more common in economically less developed regions (Jaboyedoff et al. 2018). Various discussions on the root causes of landslides in CHD are found in the existing literature. Alam (2020) found hill cutting, deforestation, the settlement at risky slopes, population growth, and development works as the main anthropogenic activities of landslide events. Ahammad and Stacey (2016) discussed the manipulation of agricultural practices in the region responsible for landslides. One of the reasons why it is difficult for the government to implement effective DRR measures is that the hilly locations are hard-to-reach. Similar cases are found in rural China (Peng et al. 2017). Along with these challenges, various communities in CHD, urbanised hilly, indigenous, and Rohingyas, perceive and contribute to landslide disasters differently (Ahmed 2021).

The strategies need to be diverse as the risks originate from various sources. Thus, focusing on anthropogenic activities of landslide disasters is an essential aspect of developing a comprehensive and inclusive DRR strategy. Existing literature primarily focuses on the geomorphology, lithology, rainfall pattern and slope engineering perspectives (Kamal et al. 2022). Still, there is a severe lack of exploring the anthropogenic aggravation of landslide disasters in CHD, especially from an expert's point of view.

This article aims to collect in-depth micro-narratives from local experts/key informants to explore the anthropogenic-induced landslides in Bangladesh and formulate landslide DRR policies based on their opinions. By expert, here we mean a person having extensive experience working in the context of CHD and contributing to national policy formulation. The experts were selected from the various profession, backgrounds and ethnicity covering all the five hill districts of CHD and experts based in Dhaka, the capital of Bangladesh.

The collection of experts' in-depth narratives is unique in applying the qualitative method in landslide studies in Bangladesh. Sultana and Tan (2021) interviewed forty-five officials to examine how local-level institutions mitigate regional landslides. However, no survey of key informant interview (KII) based study on understanding the anthropogenic activities involved in landslides in CHD of this aptitude was conducted in Bangladesh. Thus, this article helps to minimise the literature gap. This article is highly focused on exploring human-induced landslides by applying social science tools that put the voices of the local people and experts at the centre.

2 Study Area Profile

Chittagong hill districts (CHD) consist of five districts of the Chittagong division in Bangladesh viz: Chittagong, Rangamati, Khagrachari, Bandarban, and Cox's Bazar (Fig. 1). Three districts—Rangamati, Khagrachari, and Bandarban—are named Chittagong hill tracts (CHT). The five CHD districts are situated in Southeast Bangladesh, and the population of CHD is nearly 12 million (Ahmed 2021).

While Chittagong and Cox's Bazar have similar topography and urban demography, the other three CHT districts are unique in terms of hills, demography and culture. CHT hosts 13 tribes (Banglapedia 2021), collectively known as Jumma people (here termed indigenous hilly people). The land of CHT had been a conflict zone for more than 20 years until a peace accord was signed between the insurgents—PCJSS—and the government of Bangladesh in 1997 (Ahmmed et al. 2013). CHT has an estimated population of 1.6 million (UNICEF 2019). Despite covering one-tenth of the country's area, CHT cannot be populated as it is in plainland due to the hilly topography, the hill's structure, and complex communication system. The primary professions in CHT are agriculture, fishing, and forest resource extraction.

Chittagong (recently renamed Chattogram) is well known as the country's business hub for its port facility. It has a population of about 8 million (BBS 2015). Cox's Bazar is well known for its iconic world's longest unbroken sea beach and associated tourism activities. It has a population of about 2.5 million (BBS 2014). Cox's Bazar also currently hosts over 1 million Rohingya refugees (UNHCR 2022). The urban hill dwellers in both districts are highly vulnerable to landslide disasters, mainly low-income jobholders, daily wage earners and small business owners. A good number of them are internally displaced persons (IDPs) and climate migrants (Sammonds et al. 2021).

The hills can be broadly categorised into low hills in Cox's Bazar and Chittagong districts and high hills in CHT (in some places, elevation can go above 1000 m from the mean sea level). The CHD region gets around 4000 mm of rainfall during the monsoon season (June–September), with the highest incidents reported in June and July (Ahmed 2017). Other essential factors triggering landslides in the region are rock types or lithology, age of the rocks, degree of weathering, and presence of weak zones and fissile shales. The rock types of the hills in CHD are primarily composed of sandstone, siltstone, and shale (Kamal et al. 2022). Among them,
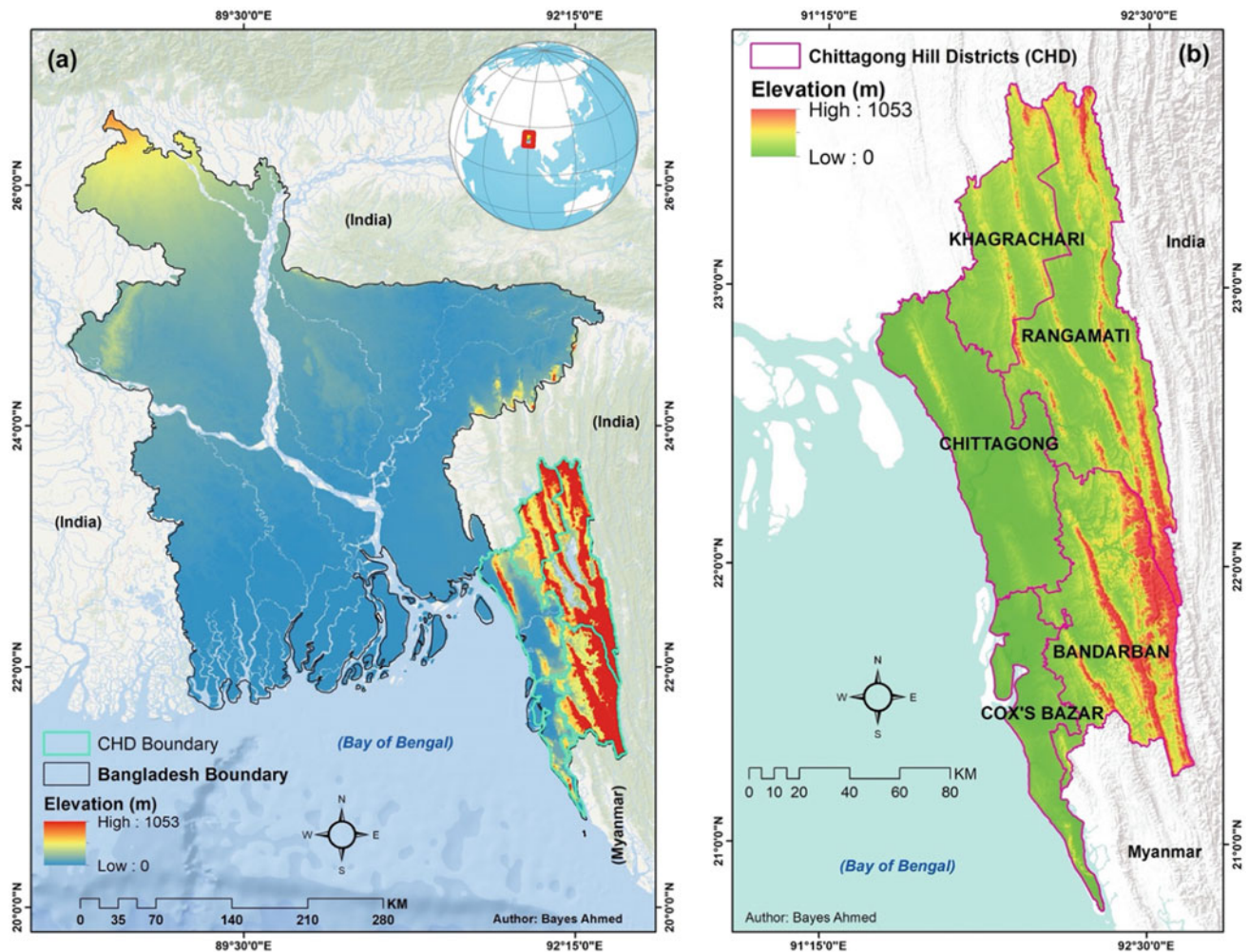
Fig. 1 The location of the Chittagong Hill Districts (CHD) in Bangladesh

sandstone grains are explicitly susceptible to coarse landslides and have more porosity and permeability. Such physical characteristics allow rainwater easily to penetrate the rocks, increasing pore water pressure, exceeding the rock strain, and initiating landslides. Due to its unique geological formations, intense precipitation, and socio-economic context, CHD is considered a hot spot for landslides.

3 Methodology

The study was conducted using multiple qualitative tools to collect and validate the data. The key informants were the experts/academics, local political representatives, journalists, local development/non-governmental organisation (NGO) workers, leaders of the ethnic communities, various government stakeholders including scientific officers, DRR specialists, forest officers, researchers and notable members of the civil society.

Later, to validate (where necessary) the data accumulated from the KIIs and understand the ground-level reality, a total of 82 micronarratives were collected from five tribes and the Bengali communities living in both urban and rural areas in Rangamati and Cox's Bazar districts from 8 to 15 December 2020 and 4 to 16 January 2021, respectively. Most of the participants of micronarratives had either been directly affected by the landslide disasters or were vulnerable to them. The field observation technique was also used, along with analysing the micronarratives.

3.1 Sampling

The study used purposive and snowball sampling methods (Bryman 2016). Since landslide is a less-discussed issue than other disasters in Bangladesh, several experts were selected through the purposive sampling method. An extensive review of journal articles, news and intellectual discussion

Table 1 KII distribution

Districts	KII distribution	Remarks
Chittagong	03	
Rangamati	11	
Bandarban	06	
Khagrachari	04	
Cox's Bazar	05	
Dhaka	11	Experts based in Dhaka
Total	40	

on landslides was done before choosing the key informants. After the purposive sample of the experts, the snowball technique was applied to select people from various fields who have in-depth knowledge of landslides either for their professional exposure or experiencing the impact of the disaster. In total, 40 key informant interviews were conducted in five hill districts and Dhaka from 9 June to 3 November 2020 (Table 1 and Appendix 1).
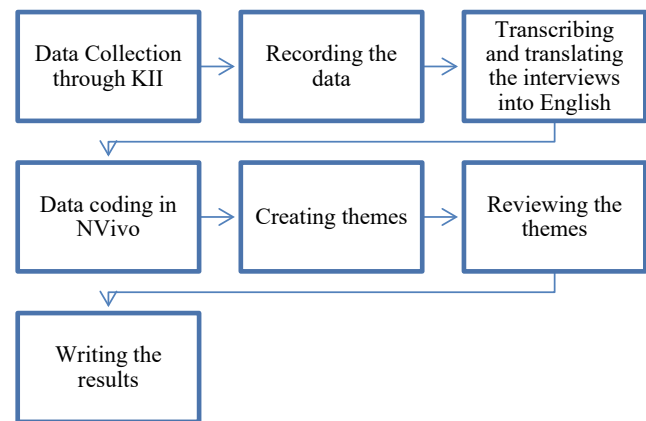
3.2 Data Collection

Since the data collection commenced during the early stage of the global pandemic of COVID-19, all the interviews were conducted virtually via Skype, Zoom, and phone calls to ensure the safety of the participants and the researchers. The interviews were recorded (audio) with the participants' permission and later transcribed and translated from the Bengali language into English by the researchers.

3.3 Questionnaire

An open-ended questionnaire was developed by the research team (Appendix 2) after several rounds of iteration. The objectives of the questionnaire were to explore the causes of landslides from the key informants' perspective, their impact, the historical change in landslide pattern, policy aspects and the recommendations to reduce the vulnerability to the disaster.

3.4 Data Analysis

The collected data were thematically analysed using qualitative data analysis software, NVivo. First, the data were coded in a deductive approach. Since this article is focused on the anthropogenic exacerbation of landslide disasters in five hill districts in Bangladesh, the data were coded deductively to exclude the other more prominent themes resulting from the KIIs. Second, the codes were systematically turned into

Fig. 2 The cycle of data collection and writing the results

broader themes according to the research objective, and finally, the results were written following the themes (Fig. 2).

3.5 Ethical Consideration

Data collection ethics were strictly maintained during the fieldwork and interviews. No security, safety and ethical issues were reported during or after the data collection. We obtained institutional ethical approval from UCL (ID: 12991/002). Before conducting the KII interviews, all other local and individual level permissions and consent were taken.

4 Results

In this section, the data gathered from the KII have been critically analysed. Since the contexts for all five CHD districts are different, CHT is mentioned where the situations are exclusive for CHT districts—Bandarban, Khagrachari, and Rangamati only. At the same time, CHD covers all five districts—Bandarban, Chittagong, Cox's Bazar, Khagrachari, and Rangamati. The landslides in the region mainly occur during the monsoon (June–September). However, the results section intentionally excludes physical factors of landslides such as precipitation, soil type, lithology, and earthquakes. A total of eight anthropogenic activities causing landslides in CHD were found through the thematic analysis.

4.1 Demography

The key informants put demography at the heart of the anthropogenic-induced landslide disasters. The data show that demography is the top-level influencer for landslide-inducing activities. While the context in CHT is different from that of Chittagong and Cox's Bazar, all five

districts experienced more people living on risky hill slopes and conducting landslide-triggering activities.

The CHT region observed a significant population growth compared to the other areas of Bangladesh. There are a few reasons for this sharp population increment besides Bangladesh's steady rapid population growth. The urban underprivileged non-indigenous communities are mostly internally displaced persons from various parts of the country. Most key informants blamed the policy of Bengali settlement in the CHT in the 1970s for the demographic impacts.

4.1.1 Increased Population in Urban Areas

Observing the previous events, it is seen that in CHT, deadly landslides mainly occur in township areas. One of the reasons for population growth in the townships is that people from rural hill villages are moving to the townships in CHT for better civic facilities. The hill districts have uneven topography, which makes communication very difficult. Consequently, people from different rural areas accumulate in the towns for a better life, education, jobs, and other community facilities. This can be described as the 'pull factor' of internal migration. The flow of people from the plains is also adding to it.

In the case of Cox's Bazar and Chittagong, the people living on risky hill slopes are predominantly daily wage earners, small business owners and very low to low income-generating jobholders. Many of these people are IDPs and climate migrants from extreme climatic-hotspot rural areas. They come to the city for a better livelihood and to live; they choose the cheapest places/houses, and the hills in the urban areas are the ideal places for that. Thus, it can be said that this kind of floating poverty contributes to landslide disasters.

4.1.2 Overpopulation Leading to More Agricultural Activities

Overall population growth necessitates more agricultural activities. The topography in CHT is unsuitable for all kinds of farming activities. However, due to the increased need, non-native agrarian practices such as horticulture, mono-culture and planting/growing non-native species are taking place. In addition, the frequency of crop cultivation has amplified, which is unsuitable for the hills. The pressure from overpopulation also forced the traditional agricultural practice to mutilate its century-old form. As a result, the topsoil gets washed during the monsoon leading to various stages of erosion to landslides. This issue has been further discussed in the 'agricultural practices' section.

4.1.3 Increased Housing Needs

The population and land ratio are not compatible in CHT. Due to the high density of the population, more housing facilities are required. Most often, this kind of housing remains non-administered. The people build houses at random places- sometimes on risky slopes. Unplanned housing facilitates deforestation and hill cutting. In some cases, people living on risky slopes do not want to leave their houses during the evacuation process mainly because they are not sure whether they will be able to return to the same place again since the land is either illegally acquired or rented (Fig. 3).

In all five hill districts, the existing non-indigenous hill dwellers (i.e., predominantly Bengali ethnic population) help their relatives or close ones to settle in the hills, increasing the number of houses in that area. The non-indigenous hill communities do not know the traditional house-making practices in the hills. They treat the hills like plainland which increases their vulnerability to landslide disasters.

4.1.4 Rohingya Influx from Myanmar

The military crackdown, continual human rights violations and genocide in the Rakhine state of Myanmar in 2017 forced nearly a million Rohingya minority people to flee their homes (Martuscelli et al. 2022). The influx of forcibly displaced Myanmar nationals (FDMN), commonly known as Rohingyas, into Bangladesh has contributed significantly to the landslide vulnerability. Although more than a million FDMNs have been residing in Cox's Bazar district, their presence and the demographic impact have altered the hills. Since they did not have land, the Rohingyas settled at various places and made houses cutting the hills.

4.1.5 Alteration in the Habitat Style

Three CHT districts are unique in terms of landscape, demography and culture. The indigenous hilly communities have their unique style of constructing houses. Being in the hills for centuries, they created a strong cultural bond with the hill's environment. Consequently, their house construction method does not require hill cutting, cementation or large-scale forest destruction. Usually, they build houses on stilts at comparatively stable places in the hills. This way, the houses do not create any barrier to the natural water drainage, the topsoil does not erode since only some poles are earthed, and the residents remain safe from various wild animals.

Nowadays, many people from both the indigenous and non-indigenous hill communities are building houses following the methods used in the plains. It requires making the land plain by cutting the topsoil of the hills. Big, cemented pillars are also used, weakening the hill's load-bearing capacity. This type of housing hampers the proper rainwater drainage during the monsoon.

Besides the data gathered from the key informant interviews, it was also observed at the field level that most landslide-hit areas were generally densely populated with modern infrastructures. Some key informants mentioned that this transition from traditional house construction to the

Fig. 3 a–d Urban population inhabiting unstable hill slopes and the congested housing put more lives at risk. e Some residents are trying to protect their homes from mudflow using plastic sheets, corrugated-iron/ tin sheets, and tarpaulin. f A family belonging to the non-indigenous hill community—originally migrated from the plains—made their house at a highly vulnerable location and denied leaving it even after falling victim to a landslide. *Source* Fieldwork, the authors

plainland building method is because of the influence of the non-indigenous/Bengali communities—they introduced the technique used in the plainland, and the indigenous communities started to follow them. But a counternarrative of this statement was found during the community-level fieldwork, which will be discussed in the 'discussion' section.

4.2 Hill Cutting

The most responded cause of landslide disasters is cutting the hills in all five districts. Hill cutting has the most tangible, direct and immediate impact on landslides. Cutting hills at inappropriate angles and not maintaining proper slope stability weakens the hills leading to landslides during monsoon. This non-scientific method of hill cutting is used by people at a small scale for personal needs like constructing a house and by larger groups at a medium to a larger scale for business and land grabbing purposes. This often happens under the auspices of influential local people. Many large-scale hill-cutting events occurred for numerous government-funded projects (Fig. 4).

It is important to understand why the hills are cut and how the causes of hill cutting differ in different areas of CHD. Although the consequences of hill cutting are similar, the reasons for hill cutting are multidimensional.
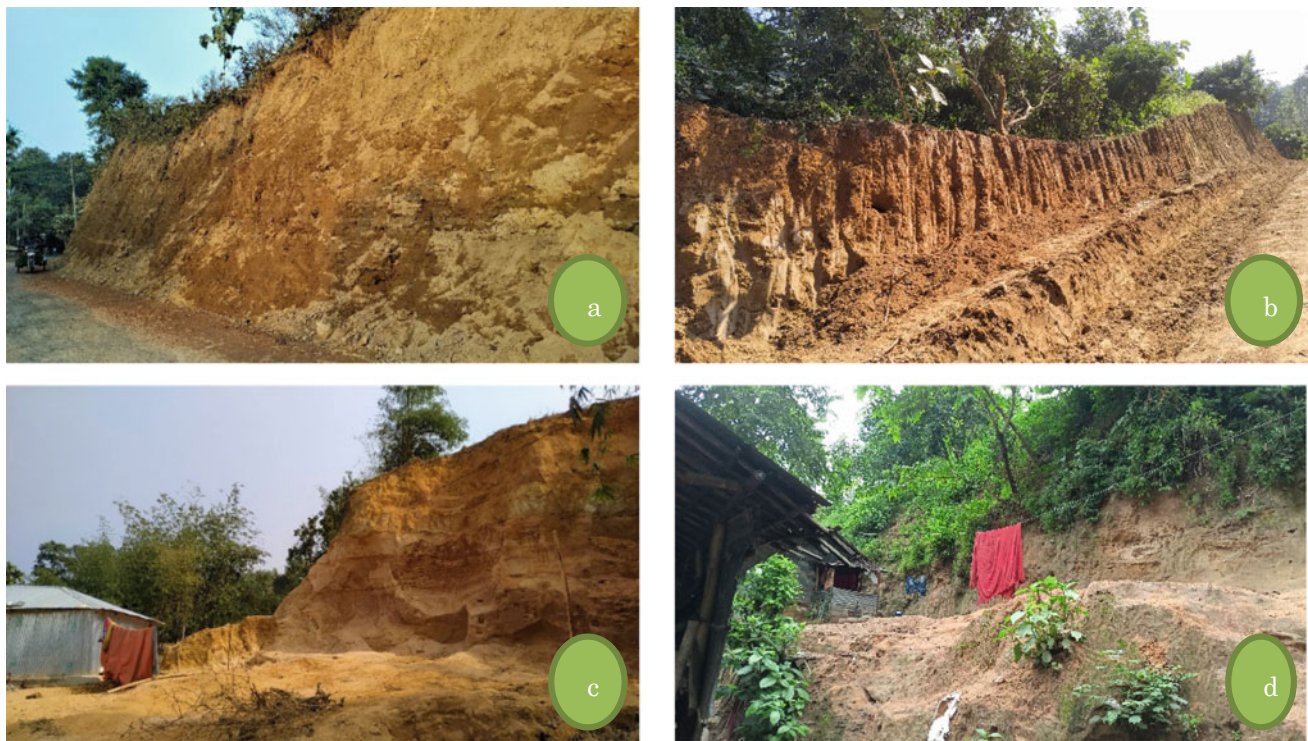
Fig. 4 Roads are being constructed, cutting the hills in **a** rural and **b** hilly urban areas. **c** A low hill is cut to sell the soil as construction material in a rural area in CHD. **d** Houses are made at risky slopes cutting the hill in the urban area of Chittagong. *Source* Fieldwork, the authors

First, hills are cut to extract the soil in brickyards and construction sites in rural and reasonably distant places from the townships. This hill cutting is done mainly by a larger group of people. Hill cutting without permission from the relevant authorities is illegal. This large-scale hill cutting is often done at night and during the monsoon when the soil is found to be relatively weaker in bonding strength. Hill cutting is done in daylight in remote areas where forest and administrative officers cannot reach faster.

Second, some hills are cut for government-funded projects like constructing roads and infrastructures for tourism and communication purposes. Generally, this hill cutting takes place at a large scale in CHT but is not rare in the other two districts. For example, in Chittagong, 18 hills were cut to construct a link road from Dhaka Trunk Road to Bayezid Bostami road, where the hills were cut at a 90° angle. The Chittagong development authority (CDA) was fined considerably by the Department of Environment in 2020 for destroying the hills (TBS 2020).

Third, the objective of hill cutting is not limited to extracting sand and soil or turning the high land into plains; it is a means of grabbing the land as well. Notably, in Chittagong and Cox's Bazar urban areas, some hills are cut so that the upper portion will slide during the monsoon. After the hill gets slid and the mud is cleared, the landowner uses the land for housing and other purposes. Besides this, the alleged local powerful groups facilitate the underprivileged people to live in the government-owned hills so that they can grab the land without any hassle. They make tiny temporary houses (stronger than makeshift houses) and rent them out.

Lastly, the causes of hill cutting by the Rohingyas in Cox's Bazar district are linked to constructing houses, making walking paths and selling the topsoil. During the early months of the influx in late 2017, some hilltops were cut to make it plain to construct roads and drainage systems and spread the water networking (supply) facilities.

It is essential to mention that the Rohingyas are involved in hill cutting in camp-adjacent areas. Often, they are being used as labourers for this job. Government officials book the on-spot workers when they raid the hill cutting sites. But the workers cannot be fined because, according to their living status in Bangladesh as the FDMNs, they should not have the Bangladeshi currency, and for the same reason, they cannot be brought under the local law. Their commands-influential local host community members- do not show up during the hill cutting or raid. This way, the main perpetrators remain out of the clutch.

4.3 Destruction of the Natural Setting

The KIIs described several components of destructing the natural setting in the hills as landslide triggering factors.

When the natural environment of the hills is destroyed, the entire ecosystem in that area gets disturbed. This contributes to waterlogging, soil erosion and ultimately landslides.

4.3.1 Deforestation

Deforestation has been going on for decades in CHD. Rapid urbanisation, tourism industry expansion, and legal and illegal timber businesses are responsible for deforestation. Illegal logging usually occurs in natural and reserved forests (Fig. 5). Although tree cutting from private property is legal, it largely contributes to deforestation because of the untimely logging of immature trees.

Large-scale sawmills and brickyards are seen in CHT, and the number of adjacent areas has risen at an alarming scale. The collected forest timbers are processed at those sawmills and sent to various parts of the country. The wood collected from CHD is coveted even in Dhaka and Chittagong. This increases the demand for more logging, both in legal and illegal ways. In addition, many trees are cut to fuel the brick kilns.

The recent most considerable deforestation occurred in Cox's Bazar district due to the influx of about a million FDMNs from the Rakhine state of Myanmar. The 6500 acres of reserved forest under the Social Forestry Programme—local communities took care of the trees under a mutually beneficial agreement with the government—were turned into the campsite. The Rohingyas cut the trees and cleared the forests for two reasons: they needed to make tents immediately after arriving in Bangladesh and cut many trees for fuelwood. The administration aided this deforestation to create living space for the Rohingyas while increasing the camp size. Tree cutting for fuelwood decreased after they had been provided with the Liquefied Petroleum Gas (LPG) cylinder for cooking at the end of 2018.

Uncontrolled tree cutting leaves the topsoil exposed to rain and overheat. The sandy topsoil absorbs water more than usual during monsoon due to its exposure. This helps open cracks and leads to various types of erosion. The cracks and erosion lead to landslides. The key informants observed that hills covered with naturally grown trees and shrubs are less susceptible to landslides.

Besides harming the environment and topsoil, deforestation generates another threat of landslides. Transporting the logs is usually tricky in hilly topography, and therefore powerful vehicles are used there. The overweight trucks carrying some extra tonnes of logs are unsuitable for hilly roads. The weight and vibration from the bizarrely heavy trucks form cracks and destroy the roads in CHT (Fig. 6a).

Fig. 5 Illegal logging activities inside the reserved forests in Ruma Upazila, Bandarban. *Source* The authors, fieldwork, January 2022

Fig. 6 **a** Heavy trucks carrying logs left a deep trail in the forest in a CHT district. **b** A brickyard close to the hills is in operation in a CHT district. **c** The monoculture of the teak tree is seen in a CHT district. The previous mature trees are already cut; the new ones are growing now. **d** Traditional houses made with lightweight materials (right) are now being replaced with built-construction materials (left) in an indigenous community in CHT. *Source* Fieldwork, the authors

4.3.2 Sand and Stone Extraction

Overexploitation of sand and stone occurs in all four districts —Rangamati, Khagrachari, Bandarban, and Cox's Bazar. The urban areas in Chittagong are not mentioned in this case. The intensity of sand and stone extraction is incredibly high in CHT.

The extraction of sand and stone from the streams and foothills is directly linked to landslides. This illegal exploitation is carried out for various construction works in the hilly region. The construction is supposed to take place using materials from legal sources. Still, the available materials from the surrounding areas illegally make it easy for the contractors to profit more. The people involved often dodge the administration and the conservation/climate activists.

4.3.3 Brickyards

Although the policies require brickyards to maintain some strict rules to safeguard the environment, they are not followed by the brickyard owners most of the time. The brickyards nearby the CHT outnumber the actual need. These brickyards adjacent to various hills require fuelwood; the primary sources are the forests. The soil from the foothills is used as the brick's raw material evading the administration's eyes (Fig. 6b).

4.4 Agricultural Practices

Various types of agricultural practices exist in CHT. Among them, the traditional swidden is the oldest one. It is named '*Jhum*' (slash and burn), and the people involved in Jhum cultivation for time immemorial are known as '*Jumma*'. The customary agricultural practices have been through many changes and manipulations. Some of the farming practices are contributing to landslides in CHT.

4.4.1 Root Crop Cultivation

The hill's soil and topography require zero-tillage system cultivation. This means the less the soil will be dug, the better it is for the topsoil. But due to the introduction of the modern cultivation system in the hills, various root crops are planted. Root crops like ginger, turmeric and taro are cultivated at a large scale in CHT. This needs to plough the soil twice—once during the plantation of the seed/rhizomes and again at the time of harvest. Due to this practice of root crop cultivation, a significant amount of soil is eroded yearly.

Besides increasing the landslide risks, the eroded soil deposits as sediment in the stream lead to water overflow during monsoon. According to the agricultural scientists

working in CHT, if the zero-tillage method is used for cultivation, there will be only 10–15 tonnes of soil erosion. In contrast, tillage erodes 70–80 tonnes of soil per year.

4.4.2 Monoculture

Large scale commercial plantation is taking place in the hills of CHT. This sort of plantation introduced monoculture in CHT, replacing the natural forests with native species of trees. For example, it is seen that the non-native teak tree is planted across the CHT. Non-native species like teak and rubber trees are responsible for topsoil deterioration and purging shrubberies that would otherwise safeguard the topsoil from rain and heat (Fig. 6c).

Rubber and tobacco cultivation are also turning the jungle into gardens' Due to the increasing practice of monoculture, native species like bamboo are being replaced with foreign species. Traditionally, bamboo is considered a natural land stabiliser. The existing teak and rubber gardens were once naturally grown forests. For example, the union (smallest administrative unit in Bangladesh) of Baishari in Bandarban district was covered with naturally grown forest but now is replaced by nearly 200 rubber gardens. Although these gardens are creating more jobs for the local people, they significantly contribute to destroying the hills' natural setting.

4.4.3 Jhum Cultivation

Jhum cultivation—slash and burn—is a century-old traditional agricultural method used by the indigenous hill communities in CHT. Jhum's contribution to the landslide disaster is a debated issue. The data show that the key informants from indigenous hill communities resist the idea that Jhum has a link with landslide disasters. In contrast, others hold it responsible for large-scale vegetation destruction and landslides.

The indigenous hill key informants argue that Jhum has been cultivated for centuries, and there were no landslides in CHT. Secondly, the Jhum cultivators leave the land for nearly three years once the Jhum is harvested, so they do not repeat the process every year. Thirdly, they do not cut the giant trees, and the fire to burn the soil and vegetation is controlled. Finally, they do not plough the ground as people do on plains. Subsequently, Jhum erodes some amount of topsoil but does not cause landslides.

The ground-level reality is that the frequency of Jhum cultivation has increased due to population growth. Most non-indigenous hill communities do not follow the century-old timeline for cultivation. The loss of vegetation and small trees is detrimental to the topsoil, leading to land degradation and landslides. Besides, the cultivation method, if not done correctly, can block the natural water drainage systems or stream networks in the hills.

4.5 Development Work

The globalisation of the economies has made the term development a catchphrase. It is generally perceived that more development equals more progress. While it is true in most cases, a few other matters must be considered. While undertaking infrastructural development works, keeping the local environment and geological factors in mind is necessary. This principle applies in the case of CHT. The following development activities are contributing to landslides in CHT.

4.5.1 Road Construction

Previous records of landslide events show that the deadliest ones occurred near a road. To ease communication for the growing population, road connection is vital. But unplanned road construction by hill cutting with no slope stabilisation measures increases the vulnerability to landslide disasters. Not maintaining proper slope, not constructing suitable retention walls, and hill cutting for the construction are the main reasons for the vulnerability. One of the geologists interviewed said that the roads on the back slope are stable, but the ones on the dip slope are unstable. These kinds of geological features are often ignored while constructing a road. Building roads in CHT is costlier than in any other region of Bangladesh because of its remote location and hilly communication system. Yet, the heavy log carrying trucks are destroying the roads—which require repair and maintenance within a short time.

4.5.2 Unplanned Tourism

The scenic beauty of CHT attracts many tourists every year. The tourism industry in Bangladesh has been growing faster in recent years. To meet the demand, unplanned infrastructures for tourism have been developed. The tourism industry is one of the reasons for land-related conflict between the indigenous hill communities and the non-hilly Bengali communities. Since CHT has different geological features than other parts of the country, so it needs specialised policies for construction. But no detailed plan for the tourism industry and specific construction policies for the brutal landscape have been found in action. The rapidly growing tourism infrastructures might threaten the environment and put the people involved at the risk of landslide hazards if they are not compatible with the area's natural setting.

4.6 Lack of Coordination

In CHD, various government and non-government agencies are working on DRR, climate change adaptation and safeguarding the environment. The government institutions are

responsible for planning and implementing multiple projects. The institutions run their activities without proper coordination with the others. For example, the Department of Agricultural Extension promoted the zero-tillage method for agricultural practices in the hills. However, a government bank was encouraging the farmers to plant turmeric and ginger by providing them loans with a minimum interest rate. Although landslide DRR is a task of the Ministry of Disaster Management and Relief, the local administration does the core activities- evacuation, relocation, and rehabilitation-. A severe lack of coordination is seen among the ministries in CHT. Some field-level irregularities were also found.

The previously discussed event of fining the Chittagong Development Authority (CDA) by the Department of Environment (DoE) for inappropriately cutting 18 hills to construct a road is another example of the lack of proper coordination among the institutions. Both the CDA and DoE are public institutions. This lack of coordination is generated by the absence of a holistic policy for the hill districts in Bangladesh.

4.7 Lack of Awareness

The lack of awareness among the low-income families living on the risky hill slopes was high. Lack of awareness increases the vulnerability to landslides at three stages: (a) during settlement—they do not avoid risky slopes; (b) they cut hills, making it even riskier to live; and (c) they do not leave their houses even during extreme rainfall events. The evacuation process during an emergency by the administration and the Bangladesh Fire Service and Civil Defence is greatly hampered by this.

4.8 Human-Induced Climate Change

The most visible cause of CHD's landslides is extreme rainfall events. The hill communities opined that the rainfall has become erratic. In recent years, the amount of rain in a short amount of time increased at an alarming rate. The 2017 landslide events in CHD were rainfall-induced; there was a rainfall event for several days at a stretch. Human-caused climate change is erratic: sometimes there is no rain, and sometimes there is excessive rainfall. The extreme precipitation in a short amount of time triggers landslides.

Figure 7 summarises findings linked to the anthropogenic causes of landslides as obtained from the KII interviews in eight major categories (orange rectangles) and their interlinkages with other sub-categories (blue rectangles).

5 Discussion

Landslide events in Bangladesh and other parts of South Asia and Latin America are closely associated with human factors (Ahmed 2021). The anthropogenic activities found in this study can be classified into three broader categories: demography, human-induced climate change, and lack of regulation and coordination.

5.1 Social Factors

The demographic impact is mainly responsible for landslides in CHD (Ahmed 2021). The demographic effects on landslide risk in CHD are intricate because it is difficult to classify whether all the results are equally generated from actual human need-based activities or a less regulated and less aware population. The spill-over effect of the demographic implications is actively influencing hill cutting, tree cutting, destruction of nature, and the manipulation of traditional agricultural and housing practices.

The population in CHT increased manifold. Although the three CHT districts cover about one-tenth of the total area of Bangladesh (Banglapedia 2021), they cannot be populated like the flatland due to the hilly geological and geomorphological conditions. The non-indigenous communities from flatland (Bengali) share tremendous responsibility for population growth in the hills; the Bengali population in CHT increased five times between 1961 and 1981 (Ahammad and Stacey 2016). In contrast, the cultural differences between the indigenous hill communities and the migrated Bengali hill communities often implement the agricultural and house-building methods used in the plains (Ahmed 2017).

The key informants from the indigenous hill communities blamed the Bengali hill community for introducing a non-traditional housing method that is replacing the stilts-made traditional lifted houses. It is to be mentioned that the traditional stilt houses are made with lightweight materials, contrary to the non-traditional ones that require comparatively heavier materials and flat space. However, some of the indigenous community members during the fieldwork explained why they prefer non-traditional housing methods used in flatlands. First, the stilts-made traditional housing needs regular maintenance, and the price of the material used is rising along with the labour cost. Second, the houses with clay/brick walls give better protection in winter and monsoon. Although the traditional stilts house is more comfortable in summer, it is impracticable for them to build both types of houses.
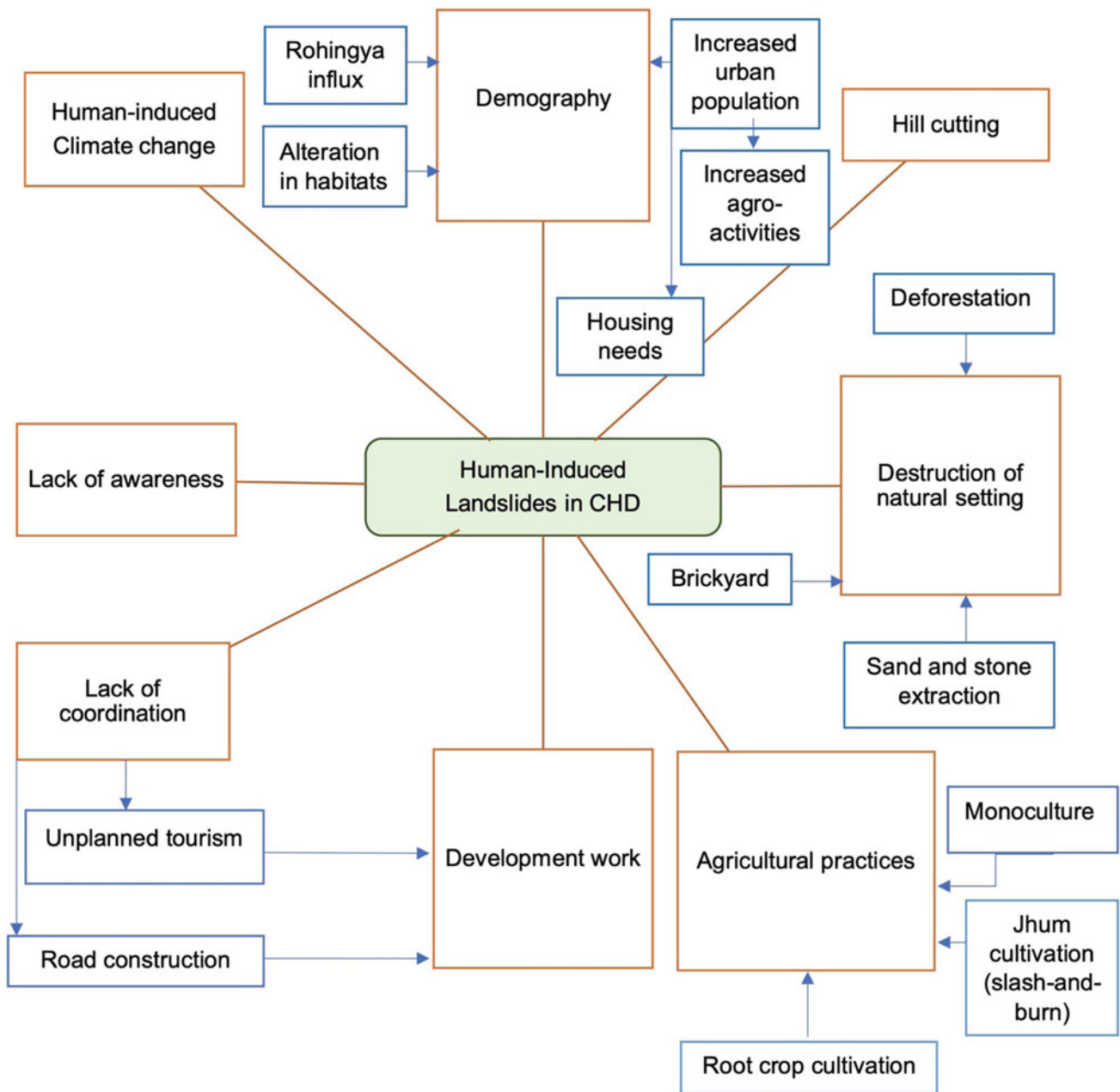
Fig. 7 The anthropogenic activities causing landslide disasters in CHD. *Source* The authors

The increased population needs more space for housing and agricultural activities, so they need to cut trees and hills. It is very challenging for the government to relocate the landslide-vulnerable communities living on dangerous hills to somewhere in a safer place/shelter, given that Bangladesh is already a densely populated country. Most people living on the risky hill slopes are economically insolvent, so they cannot choose an alternative, safer habitat either (Fig. 8). On top of all these complexities, the lack of awareness among the non-indigenous hill dwellers is high. It is a vicious cycle; if not broken, it will keep increasing the risk.

The manipulation of century-old agricultural practice works as an aggravating factor, while hill and tree cutting are triggering factors. The type of landscape and soil must be considered in agriculture. The agricultural activities needed to be done with a zero-tillage method to avoid soil erosion. But the increased practice of deep-rooted crop cultivation is seen. Ginger, turmeric, pineapple, and taro cultivation were encouraged, but this agricultural practice erodes the topsoil and leaves the pores open for the rainwater to infiltrate during the monsoon. Besides this, mono and horticulture are increasing due to the commercialisation of the hills

Fig. 8 Landslide disasters occurred on 18 June 2022, killing two people in an urbanised hilly area in Chittagong metropolitan area. *Source* Fieldwork, the authors

agro-industry. This practice threatens the existence of native species like jungle bamboo that would resist landslide triggers.

Hill cutting is a unique way of harming the environment compared to other mechanisms. Hill cutting does destroy not only biodiversity but also creates a non-replenishable loss for the future generation. The use of heavy machines to cut hills augments the process and helps the illegal soil smugglers to quickly cut and transport the hill soil, sand and stone. Road construction is a well-discussed anthropogenic-induced landslide. Road constructions without enough slope stabilisation mitigations measures and hill cutting are triggering factors. Besides this, road blockage after the landslide halts the communication that impacts the entire economy and community activities of the vicinity. For example, the vegetables, fruits and fish produced in the CHT get spoiled if they are not transported to the market on time. The overweight trucks carrying logs create vibration, which can intensify the process of the slide. This kind of vibration-instigated landslide event is also reported in Argentina (Jaboyedoff et al. 2018).

5.2 Weather and Climatic Factors

Climate change has connections in several ways with the landslide disaster. One of the causes of rainfall-induced landslide events is the unpredictable rainfall pattern. Extreme rainfall events within a short time are observed to be the main reason for landslides in CHD. Climate change influences this uneven precipitation pattern (IPCC 2021). The International Centre for Integrated Mountain Development (ICIMOD) reported that the wider eastern Himalayan region is experiencing fewer rainy days. However, the total amount of precipitation has not changed in the past five decades. It is causing a higher amount of rainfall in a short period and thus, triggering flash floods and landslides in the hilly regions (Wester et al. 2019, p. 73).

Poverty is connected to landslide disasters in hilly urban areas (Ahmed 2017). It is crucial to identify and acknowledge how the climate migrants- in this case, the people from southern coastal or northern flood-affected zones who lost their livelihood, homes, and land due to cyclones, salinity, land degradation, sea level rise and river erosion and the

disadvantaged section of the society rush to the city/township for a better living (Sammonds et al. 2021). While struggling with their daily basic needs, affording to live in a safer place becomes next to impossible for them. They look for cheap housing when the illegal landgrabbers/ hilly landowners step in. They rent out small makeshift houses/the hilly land to these people cheaply, or the displaced people settle in the hills alone. The newly settled people came from plains and were unaware of the hill's nature and importance. They start cutting the trees and hills and building houses on risky slopes.

Consequently, climate-induced extreme disasters are forcing vulnerable people to their tipping points and creating a new migration flow of IDPs and climate migrants. Thus, they contribute to the vulnerability to landslide disasters directly and indirectly. In contrast, the CHT region is already facing severe land-tenure and indigenous rights-related conflicts with the Bengali ethnic population (Mohsin 2022). The influx of non-indigenous settlers would cause more armed insurgencies and destabilise the existing peace deals in the region.

Lightning has emerged as another significant disaster for Bangladesh in recent years. Since 1990 over 6000 casualties have been reported, with an annual average of about 115 fatalities in Bangladesh (Dewan et al. 2017). The southeastern region is experiencing high lighting activity, especially during the pre-monsoon and monsoon seasons (Dewan et al. 2018). Correspondingly, the local people and KIIs frequently mentioned that lighting is another causative factor for landslides which needs to be addressed in future research.

5.3 Governance Factors

Lack of regulation and coordination among various actors and agencies contributes to regional landslides. Although hill cutting is associated with population density and poverty, large-scale hill cutting occurs due to the corrupt system, lack of proper monitoring, lack of enough government intervention, availability of technology and lack of awareness of the people in the specific areas. The people behind large-scale hill cutting are not insolvent; most often, they are the affluent and influential people in society. For example, in Chittagong and Cox's Bazar districts, the hill dwellers are mainly daily wage earners, and they cut hills mostly with the support and guidance of a powerful group of people.

People who experience the disaster are more aware of it (Damm et al. 2013). In this case, poverty and the high population density are contributing as push factors for the people to live in the hilly zones even after many experienced landslides. The construction works in the hills actively contribute to the overexploitation of forest resources. The

extraction and use of sand and stone from the surrounding area of the construction sites are more accessible and cheaper than transporting the materials from outside. The lack of a robust monitoring system over the sources of construction materials in the hills is one of the reasons the illegal exploitation of these forest resources continues.

6 Conclusion

The article unveils the less explored sides of landslide disasters in Bangladesh's Chittagong Hill Districts (CHD). The anthropogenic-induced landslide disasters have been identified through the interviews of key informants from various sectors. This article reflects the ideas and critical thinking of participants from multidisciplinary professions and experiences. The results were validated with the field-level data and observation. This article contributes to the study of disaster management from a more people-centric approach.

The results show that anthropogenic activities like hill cutting, deforestation, sand and stone extraction, various construction works, and manipulation of agricultural practices generate by the demographic impact like dense population, internal migration, lack of awareness and cultural differences among the communities. The lack of regulation and coordination among the institutions works as an aggravating factor. The population–poverty–destruction of hills' natural setting nexus is fuelling the process.

Human-induced climate change plays direct and indirect roles in triggering landslides in CHD. Climate change is causing extreme precipitation within a short time, leading to rainfall-induced CHD landslides. In addition, climate migrants are moving to large cities for a better livelihood. They are forced to reside in the hilly areas without the orientation to adaptation strategies and local knowledge. In contrast, the indigenous hill communities were well adapted to the hills. This means they, by culture, do not cut the hills or mature trees and do not engage in excessive forest resource exploitation. But with the population growth, there has been a paradigm shift in their lifestyle, agricultural practices, and housing methods. This pattern of modernisation is more evident in urban indigenous communities.

It is highly recommended to stop illegal hill and tree cutting immediately and conduct massive awareness-building campaigns among the hilly communities. It would be beneficial to introduce anticipatory action-based activities such as regional landslide early warning systems, promoting nature-based solutions for tackling disasters, and establishing a forecast-based financing mechanism for protecting the hilly ecosystem, indigenous culture, and people. Finally, it is critical to producing a holistic master plan to manage CHD's population density and overall development and tourism activities. These need to come up with a political decision to

work on resolving conflict, bringing hill-friendly agricultural practices, and regulating the activities relating to natural resource extraction.

Appendix 1: List of the Key Informant Interviewees

ID	Designation of the participants	District	Interview date
01	NGO Worker, Project Name: Community Empowerment and Action Against Illegal Stone Extraction to Preserve the Natural Environment in Bangladesh	Bandarban	09/06/2020
02	Chairman, Parbatta Chattagram Bon o Poribash Andolon-Bandarban Chapter [Chittagong Hill Tracks Forest and Environment (protection) Movement]	Bandarban	13/06/2020
03	Chief Scientific Officer, Soil Development Institute, Bandarban	Bandarban	17/06/2020
04	Ex-Chairman, Babuchara Union, Dighinala Upazila (i.e., sub-district)	Khagrachari	23/06/2020
05	NGO Worker; Organisation: Green Hill	Rangamati	25/06/2020
06	General Secretary, CHT Headman Network	Rangamati	25/06/2020
07	General Secretary, Parbatta Chattagram Bon o Poribash Andolon-Rangamati Chapter [Chittagong Hill Tracks Forest and Environment (protection) Movement]	Rangamati	27/06/2020
08	Range Officer, Forest Department, Bandarban	Bandarban	27/06/2020
09	Journalist, Ekushey Television, Khagrachari	Khagrachari	15/07/2020
10	Executive Director, Shining Hill, Rangamati	Rangamati	15/07/2020
11	Associate Professor, Geography and Environmental Studies, University of Chittagong	Chittagong	16/07/2020
12	Assistant Commissioner and Executive Magistrate, (In-Charge, Rohingya Refugee Camp), Office of the Refugee Relief and Repatriation Commissioner (RRRC)	Cox's Bazar	18/07/2020

(continued)

ID	Designation of the participants	District	Interview date
13	President, Parbattya Chattagram Nagarik Committee; First Chairman of the Local Government in CHT	Rangamati	11/08/2020
14	Senior Journalist, *Prothom Alo* (national daily newspaper)	Dhaka	13/08/2020
15	Former Chairman, Thanchi Upazila	Bandarban	13/08/2020
16	Executive Director, Society for Environment and Human Development	Dhaka	17/08/2020
17	Former President, Rangamati Press Club	Rangamati	25/08/2020
18	Senior Journalist, Prothom Alo (national daily newspaper)	Bandarban	25/08/2020
19	Former Member, Bangladesh Human Rights Commission and Activist	Rangamati	26/08/2020
20	Range Officer, Bagkhali, Ramu, Cox's Bazar	Cox's Bazar	30/08/2020
21	Professor of Geology, University of Dhaka	Dhaka	01/09/2020
22	Professor of International Relations, University of Dhaka	Dhaka	08/09/2020
23	Senior Researcher, Bangladesh Centre for Advanced Studies (BCAS)	Dhaka	12/09/2020
24	Economics editor and journalist covering international development, migration, poverty, and the environment	Dhaka	13/09/2020
25	Associate Professor, Department of Peace and Conflict Studies, University of Dhaka	Dhaka	16/09/2020
26	Executive Director, Research Initiatives Bangladesh	Dhaka	17/09/2020
27	Range Officer, Department of Forestry (Positioned in Bashkhali, Chittagong)	Chittagong	20/09/2020
28	Member- SONAK, Transparency International Bangladesh (TIB)	Rangamati	22/09/2020
29	Activist, Committee on Hill Protection Movement	Chittagong	22/09/2020
30	President, Bangalee Odhikar Songrokkhon Andolon (Bengali Rights Movement)	Rangamati	22/09/2020
31	Social Worker/Local Businessman	Khagrachari	23/09/2020
32	Associate Professor, Environmental Economics, Dhaka School of Economics	Dhaka	25/09/2020
33	Former Chairman, Rangamati Pourashava (City Corporation)	Rangamati	25/09/2020

(continued)

ID	Designation of the participants	District	Interview date
34	Chief of Policy and Deputy Director, Chittagong Hill Tracts Development Facility (CHTDF), United Nations Development Programme (UNDP)	Rangamati	27/09/2020
35	Chairman, Upazila Parishad, Khagrachari	Khagrachari	30/09/2020
36	Professor, Urban and Regional Planning, Jahangirnagar University	Dhaka	16/10/2020
37	Disaster risk reduction (DRR) specialist, American Red Cross	Cox's Bazar	20/10/2020
38	Professor, Department of Geography and Environment, University of Dhaka	Dhaka	28/10/2020
39	Project Manager, DRR Project, Nobolok (NGO)	Cox's Bazar	02/11/2020
40	Camp Manager, ACTED (NGO)	Cox's Bazar	03/11/2020

Appendix 2: Guiding Questions for the Key Informant Interviewers

[1] What causes landslide disasters in Chittagong Hill Districts (CHD)?

[2] Do you find any historical changes in landslide patterns in CHD?

[3] What are the social vulnerabilities linked to landslide disasters in CHD?

[4] What are the impacts of landslides on livelihood and vice-versa in CHD?

[5] What are the external forces that contribute to the vulnerabilities of the disaster?

[6] What are the internal forces that contribute to the vulnerabilities of the disaster?

[7] Could you please share your idea on different CHD communities' perceptions of the landslide disaster?

[8] What are the various psychological and gender aspects of landslide disasters in CHD?

[9] How would you evaluate the existing policies to address the landslide disasters in CHD?

[10] What are your recommendations at the local and national levels to prevent landslide disasters in CHD?

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