Bayes Ahmed

The root causes of landslide vulnerability in Bangladesh

Abstract Communities living in the Chittagong Hill Districts (CHD) of Bangladesh recurrently observe landslide disasters during the monsoon season (June–September). CHD is primarily dominated by three distinct groups of hill communities, namely, urbanised hill (Bengali), indigenous tribal and stateless Rohingya refugees. Landslide vulnerability amongst them is complex and varies between physical, social, economic, environmental, institutional and cultural dimensions. This study aims to understand driving forces of landslide disasters in the region by emphasising human factors. Data from the three contrasting communities were collected through participatory workshops, in-depth interviews and fieldwork observation. The participants were local people and landslide experts who were purposefully selected from five case study communities in the CHD. They ranked different socio-economic problems, identified causes of landslides and proposed landslide mitigation action plans. Results suggest that the urbanised Bengali and Rohingya refugee communities are highly vulnerable to landslides. The urbanised hill communities largely deal with poverty, social injustice, lack of planning regulations and illegal hill cutting issues, whereas the Rohingya refugees' predominant constraints are linked to the ongoing genocide and state-sponsored violence in Myanmar hindering their sustainable repatriation, and their protracted living conditions in Bangladesh. The indigenous tribal communities are comparatively resilient to landslides due to their unique history, traditional knowledge, cultural heritage and lifestyle. Landslides in the CHD should be characterised as socio-natural hazards since the components of landslide disasters are profoundly intertwined with the culture–conflict–corruption nexus.

Keywords Landslides · Vulnerability · Culture · Rohingya · Indigenous people · Conflict · Bangladesh

Introduction

In recent years, landslide disasters have caused considerable loss to human lives and damage to critical infrastructure, ecosystems, livelihoods and local economy in the Chittagong Hill Districts (CHD) of Bangladesh (Rabby & Li, 2019). Landslide disaster has been categorised as an emerging threat at the national level driven by the impacts of increased frequency of extreme precipitation events (Khan et al., 2020), population pressure in flat lands, high rates of urbanisation, hill cutting and deforestation, and lack of cultural knowledge (Alam, 2020; Ahmed, 2017).

Historically, natural hazard-induced disasters such as flooding, tropical cyclones, tidal surge, river erosion and drought are dominant in Bangladesh. However, the recent trend of spontaneous urbanisation in the hills and the resulting impact of landslides on hilly communities indicate a sharp escalation of landslide disaster risk in Bangladesh (Ahmed, 2015; Chisty, 2014). For instance, between the years 2000 and 2018, a number of catastrophic landslide events killed over 725 people in the CHD (Sultana, 2020). Most notably in June 2017, monsoon rainfall-triggered landslides claimed at least 160 human lives and left 80 thousand inhabitants affected (UNOCHA, 2017). The landslide dynamics in the region has deteriorated with the arrival of nearly one million Rohingya refugees from Myanmar in August 2017 (UNHCR, 2020). To accommodate the refugees, nearly 6000 ha of reserved hilly woodland were cut down in Cox's Bazar District (Ahmed et al., 2020). It is estimated that over 3 million people are currently living with severe landslide risks in the CHD—it includes the urbanised Bengali communities, indigenous tribal population and the Rohingya refugees. This study aims to understand their landslide disaster vulnerability.

At present, there are broadly two schools of thought in the field of disaster risk reduction (DRR)—first, disasters are caused by natural hazards and second, disasters are not natural; rather, they are a complex blending of socio-economic and socio-cultural aspects (Kelman, 2020; Wisner et al., 2004). Conventionally, landslide research is dominated by physical scientists who mostly tend to produce/model hazard maps, quantify risk and develop probabilistic early warning systems (Guzzetti et al., 2020; van Westen et al., 2006; Glade, 2003). However, in most cases, particularly in South Asia and in Latin America, landslide disasters are associated with anthropogenic factors such as environmental degradation, unsustainable development planning, cultural barriers and lack of community risk perception and good governance. For example, Landeros-Mugica et al. (2016) found that landslide coping strategies amongst vulnerable communities in Mexico were influenced by previous experience and exposure to risk. In Nilgiri District in India, local communities found the typical landslide hazard and risk maps difficult to interpret and simplified maps were generated for their better understanding and practical implementation (Jaiswal & van Westen, 2013). In case of La Paz, Bolivia, social inequality, uneven power and resource distribution, culture of risk, inefficient top-down risk management policies and a gap between residents and their local representatives were identified as the key factors for people building their houses in landslide hazardous environments (Nathan, 2008). In Western Nepal, a combination of local economic opportunities, needed for livelihood diversification and road-side development incentives led local people to settle in landslide-prone areas (Lennartz, 2013).

Vulnerability is the human dimension of risk. In this context, vulnerability can be defined as conditions determined by physical, social, economic, environmental, political, cultural and institutional factors or processes which increases the likelihood of an individual or a community to the impacts of hazards (Birkmann et al., 2013). Resilience is expressed as the ability of a community to resist, absorb, adapt to and recover better from the impacts of landslides in a sustainable way (UNDRR, 2017). A group of people living in the same area or sharing the same culture or norms is generally defined as a community (Ahmed, 2017). A landslide is defined as the mass movement of soil/earth or debris down a hillslope triggered by both natural (rainfall and geology/lithology) and anthropogenic (hill cutting and deforestation) causes (Cruden, 1991). This work is based on the concept that hills are

not responsible for landslide disasters, but it is the decision-making process coupled with human interventions which creates vulnerability and causes landslides. In this article an attempt has been made to analyse the different dimensions of vulnerability that persist amongst different hill communities in the CHD. The vision of this study is to formulate policies to strengthen landslide DRR strategies and support resilient futures for the landslide vulnerable communities in Bangladesh.

Study area—Chittagong Hill Districts

The Chittagong Hill Districts (CHD), located in the southeast region of Bangladesh (Fig. 1a), is home to nearly 12 million people (BSS, 2014). Its total area is approximately 19,888 km². CHD is the only extensive hill area in Bangladesh bordering Myanmar in the southeast, India in the north and northeast and the Bay of Bengal in the south and southwest (Fig. 1). The CHD region (Fig. 1b) can be broadly classified into two major clusters: urbanised hill districts (includes Chittagong/Chattogram and Cox's Bazar) and indigenous hill districts (includes Bandarban, Khagrachari and Rangamati).

In the CHD, the high hills sub-region includes the hill ranges with summits rising from 300 to 1200 m that are developed mainly over consolidated Tipam and Surma siltstones and sandstones (Brammer, 2012). In the low hills sub-region, the hills are mostly less than 300 m in height and often less than 100 m. They are mainly underlain by unconsolidated Dupi Tila and Dihing sandstones and shales (Brammer, 2012). Climate change also threatens the region with the likelihood of increased precipitation in a short period of time (IPCC, 2018). CHD is characterised by a tropical monsoon climate with a mean annual rainfall of nearly 2540 mm in the northeast and 2540 to 3810 mm in the southwest. The monsoon season is from June to October (BBS, 2014). The CHD region is also highly vulnerable to earthquakes (Steckler et al., 2016); however, yet no earthquake-induced landslide disasters have been reported in Bangladesh – at present, only rainfall-induced landslides are prominent in the region.

It is a common practice to produce landslide susceptibility maps by combining advanced geospatial tools and techniques as depicted in Fig. 2. These maps are useful to classify the spatial distribution of landslides and identify physical triggering factors such as slope, land cover, drainage/stream network, lithology and geology, precipitation and distance from roads and faults. However, the susceptibility maps fail to capture the integral human dimensions of vulnerability at a community scale and other micro-level anthropogenic causes of landslides.
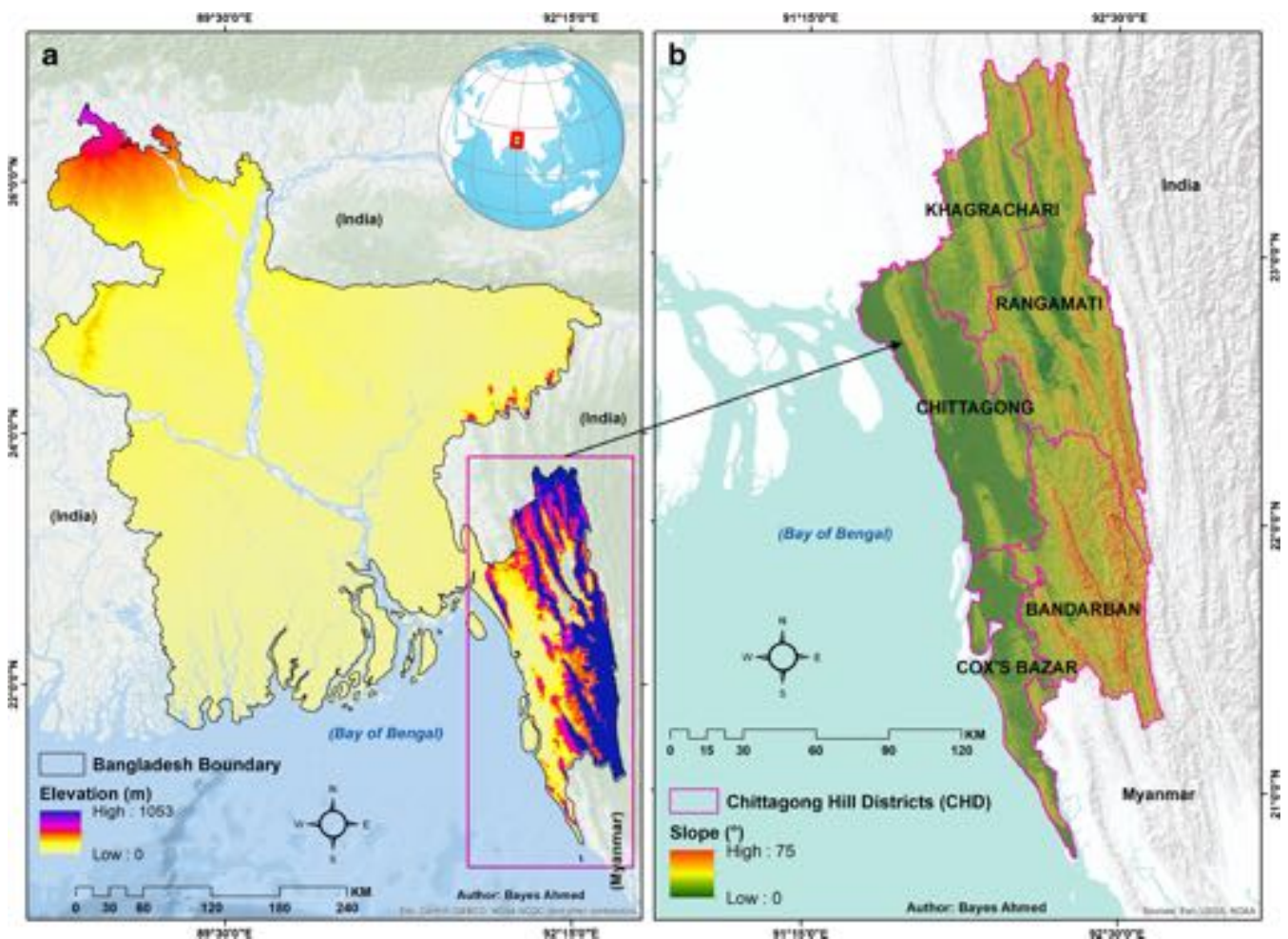

Fig. 1 Location of (a) the Chittagong Hill Districts (CHD) in Bangladesh, and (b) the five districts of CHD
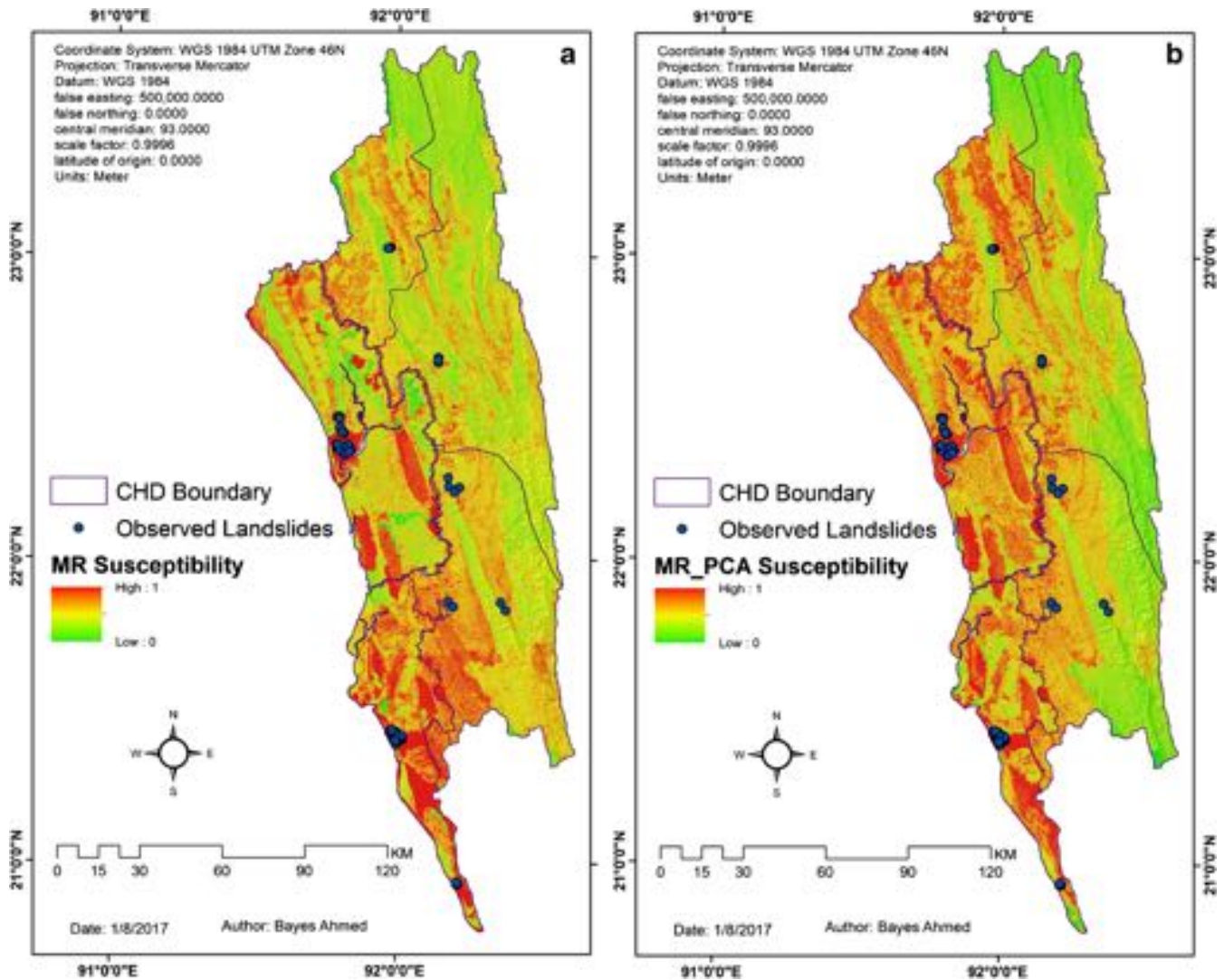
Fig. 2 Landslide susceptibility map of the Chittagong Hill Districts (CHD) by applying (a) multiple regressions (MR) and (b) combined MR and principal component analysis (PCA) methods. Source: Ahmed, 2017

CHD currently accommodates three distinct groups of hill communities. First is the Rohingya refugees presently living in Cox's Bazar District (CBD). They are an ethnic Muslim minority group from Myanmar who fled to Bangladesh to escape genocide and serious crimes against humanity that was perpetuated by the Myanmar Army/Tatmadaw (ICJ, 2020). As of 30 September 2020, the UN High Commissioner for Refugees (UNHCR) has officially registered over 861,500 Rohingya refugees in CBD. This number includes over 712,150 new arrivals from Myanmar since 25 August 2017 (UNHCR, 2020). It is estimated that another 300,000 Rohingyas are living as undocumented immigrants in Cox's Bazar (Farzana, 2017). The majority of the refugees are residing in temporary overcrowded makeshift shelters made of bamboo frames, tarpaulin and plastic sheeting (Fig. 3a, b).

Second is the urbanised (Bengali) hill communities who reside in landslide vulnerable areas in Chittagong, Cox's Bazar, and in other large urban centres in the CHD (Fig. 3c, d). They are predominantly poor and landless people and settle in the foothill areas or dangerous hill slopes. For them, indiscriminate hill cutting and destruction of hill forest are common for housing development.

Third is the indigenous tribal (also known as *Jumma*) people, who are living in Bandarban, Khagrachari and Rangamati districts since time immemorial. Their total population is around one million and they claim the land as their ancestral territory. There are ongoing land dispute and associated conflicts between the tribal people and Bengali population settlers (Roy, 2000). The indigenous people living in the hills have their unique cultural heritage that makes them distinctive from the Bengalis (or people from the plains). They are heavily dependent on the land and its natural resources, including the hills and forests for their economic and spiritual purposes. The tribal people live in traditional houses made of bamboo, wood and sun grass (Fig. 3e, f). Mostly the house is raised on stilts, and in some houses, a wooden ladder is used as a stairway. In early times, the concept of raising the houses was initiated to avoid the wild animals like tigers, wild
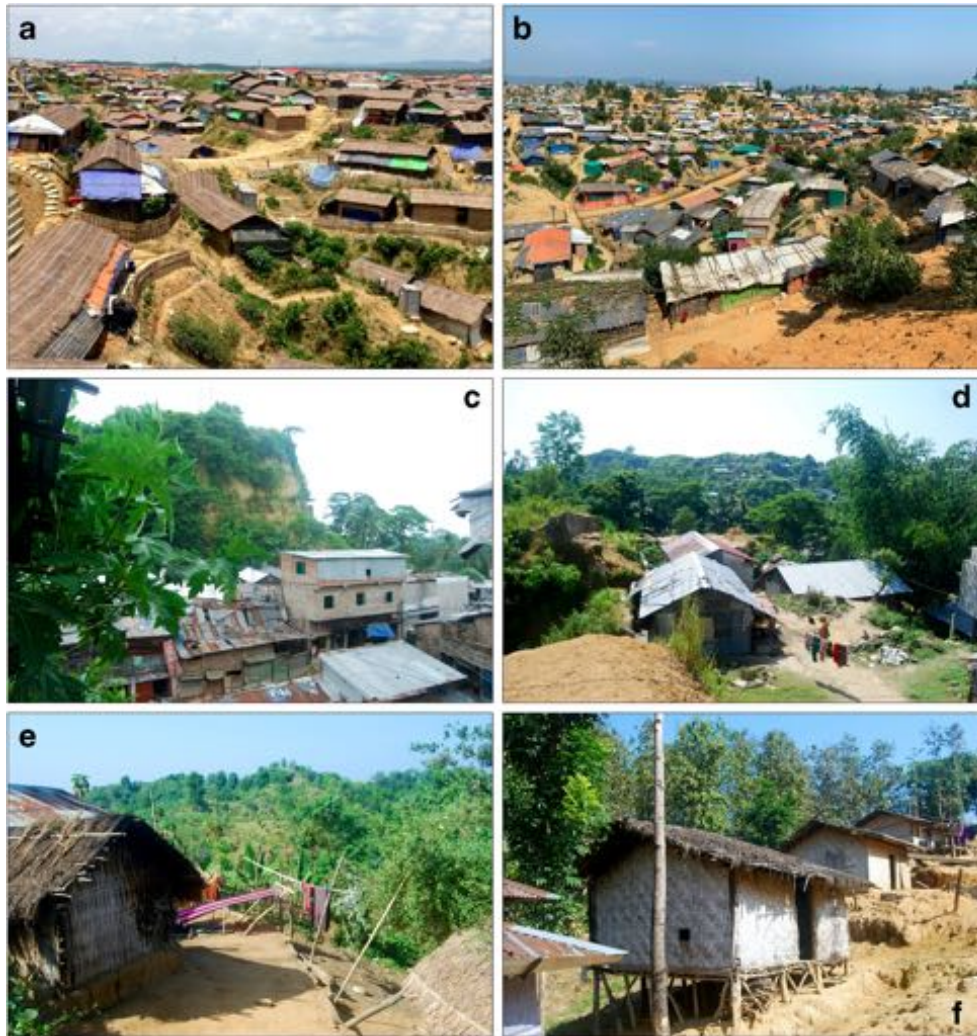
Fig. 3 Landslide vulnerable communities in the CHD. (a, b) Rohingya refugee camps in Cox's Bazar; urbanised hill community in (c) Batali Hill, Chittagong, and in (d) Light House Para, Cox's Bazar; and indigenous tribal communities in (e) Kattrol Para, Khagrachari, and in (f) Sandak Para in Bandarban District, Bangladesh. Source: Bayes Ahmed, fieldwork conducted between 2015 and 2020

boars and snakes roaming in the surrounding areas (Roy, 2000). However, still they maintain the traditional architectural design that also helps in building houses on risky hillslopes (gives foundation stability), channelizes storm water and keeps them protected from natural hazards.

Methodology

This research primarily focuses on community vulnerability and local people's perception to landslide risk; this falls within the remit of social research. Two research strategies are popular to conduct social research, namely, quantitative and qualitative research (Bryman, 2016). Quantitative research as carried out by structured and pre-determined surveying techniques often fails to accumulate the core results that represent society or people's everyday thinking or perception as a whole. In a questionnaire or top-down approach, emphasis is placed on absolute measurement (Ahmed & Kelman, 2018). To overcome such limitations, a qualitative research method, namely, community-based participatory rural appraisal (PRA), was applied. PRA tends to increase the level of interaction with the local people, focuses on rapport building and helps interpret the social world from the perspective of the people being studied (Bryman, 2016; Kumar, 2002).

In total, six participatory workshops were conducted (Table 1) to understand the grassroots reality and social vulnerabilities related to landslide disasters in the CHD between 2015 and 2020. The workshop participants were primarily local people, but in some occasions, local stakeholders from the same community also participated. They contributed through active focus group discussions and knowledge-sharing activities. As the workshops involved human participants, the study was approved by the UCL Research Ethics Committee (Project IDs: 5373/001 and 12991/002). Ethical approval is required to protect the participants, minimise risk of harm and ensure how their data is being handled. Depending on the context, the workshops were arranged after taking local-level fieldwork permissions and maintaining local norms and regulations. Before conducting a workshop, a number of field assistants/translators were recruited and trained.

Table 1 Details of participatory workshops conducted in the CHD

Community type	Community name	Date conducted	Number of participants
Rohingya refugee	Camp 13, Ukhiya, Cox's Bazar	February 2020	11 adult females
			10 adult males
Urbanised Bengali	Batali Hill, Chittagong Metropolitan Area	July 2014	7 males and 4 females
	Ramu Upazila (i.e. sub-district), Cox's Bazar	February 2020	11 males and 4 females
Indigenous tribes	Kattrol Para, Khagrachari Sadar Upazila	November 2015	4 males and 5 females
	Sandak Para, Thanchi, Bandarban	January 2016	5 males and 4 females

At the beginning of each workshop, the event coordinator (i.e. the corresponding author) described the agenda for the day and explained the activities along with the workshop objectives to the participants. Next, the coordinator clarified the institutional ethical concerns and gained consent from the participants. All necessary stationaries and presentation facilities were provided. The facilitators took detailed notes and were responsible for management of the participants.

The participants contributed in three activities, namely, problem ranking, identifying causes of landslides and proposing landslide DRR plans. At first, the participants were asked to identify some major problems as perceived by them. The problems could be any human-made or natural or hybrid threats related to their community's social, economic, environmental, cultural and institutional matters. They ranked the problems according to severity. Next, the participants were asked to identify the causes of landslides. Lastly, they were asked to list different strategies for addressing landslides in their respective communities. Overall, the workshop findings helped to understand the root causes of landslide disasters from local people's point of view.

The notes from the workshops were analysed, and the results were combined to produce SWOT (Strengths–Weaknesses–Opportunities–Threats) diagrams for each distinct community. Strength and weakness represent internal factors, whereas opportunity and threat are external factors. A SWOT analysis is useful to identify factors that need to be addressed to mitigate landslide disaster risks (Ahmed & Kelman, 2018). The ultimate achievement would be to minimise internal weaknesses and external threats by enriching internal strengths and external opportunities.

The results were validated by analysing landslide inventory, susceptibility and hazard maps, and by conducting extensive social science fieldwork (Ahmed, 2017) in all the five hill districts (e.g. collecting in-depth micro-narratives from the local people, face-to-face key informant interviews, transect walk and field observation) between 2012 and 2020.

Results

Identification of problems

The purpose of this activity was to understand where do 'the threats of landslides' fall in comparison to other problems within the community as a whole. The participants discussed amongst themselves the identification of the common problems in their locality and ranked them according to their priority. The general problems listed by the three distinct hill communities in the CHD are depicted in Fig. 4.

The Rohingya refugees were mainly concerned about their protracted and extremely poor living conditions in the camps in Cox's Bazar. They frequently deal with harsh climatic disasters like landslides, flooding and cyclones. Participants who are living on high slopes have no fear of floods, but they are worried about landslides after any heavy rainfall (Zaman et al., 2020). Almost all of the participants referred to their religious belief for not facing any major landslides or cyclones at the camps for the last 3 years. Fire hazard is also common. They have no source of income, the children lack proper educational facilities, the adolescents are staying idle, women are facing violence, and overall, they feel hopeless about their return in their homeland in Rakhine (Fig. 4). The local and international humanitarian organisations have undertaken some DRR initiatives within the camps, such as distribution of rope, tool kits, tarpaulins, steel pegs, sandbags and bamboo as part of early preparedness during the monsoon season (ISCG, 2020); however, the refugees are not fully aware of them and do not feel safe to rely on them.

In contrast, fewer job opportunities, social and political violence, poor economic conditions of the tenants, illegal business activities in the hills, lack of education and utility services, and social injustice were found to be the major problems within the urbanised Bengali hill communities (Fig. 4). Interestingly, they mentioned landslides as their least prioritised problem. The most likely reason behind this is probably they treat landslides as a seasonal threat; however, they face other socio-economic problems throughout the year on a daily basis. They are also reluctant to discuss matters interconnected to hill cutting and illegal tenancy disputes because they are always afraid of being evicted from the informal settlements located in the hills.

In reference to the indigenous tribal community (Fig. 4), the major problems were identified as poverty, availability of water during the dry season, no electricity supply, crop damage, no formal jobs, and conflict and land ownership complications. Although they face landslides during the monsoon season, it was not mentioned as a major problem. Their cultural values and inherited lifestyle (i.e. traditional housing, agricultural practice, nature-based solutions and indigenous knowledge system) have created a solid platform to adapt to the harsh mountain environment and helped achieve resilience to landslides compared with the Bengalis living in the urbanised hilly areas. Landslides mainly damage connecting roads and consequently cut communication links with other sub-districts and hinder supply-chain management with nearby town centres.

Causes of landslides and mitigation measures

The workshop participants defined some causes of landslide disasters based on their experience and personal observation. Results show

Rohingya	Urbanised	Tribal
• Congested and poor living condition • No source of income • **Landslides**, cyclones, and hilly flash-flooding • Fire hazard • No repatriation and citizenship rights • Lack of children's educational and public awareness • Gender based violence • Aid-dependent living • Uncertain future	• Economic condition • Lack of daily needs • No water supply • No gas supply • Social violence • No formal job • Illegal business • Lack of education • Poor health facilities • **Landslides** and flash-flooding • Hill cutting, and illegal top-soil and sand extraction	• Water shortage • Political unrest/ land dispute • Lack of electricity supply • Poor income • Lack of development and economic prosperity • Crop damage • Extreme weather events – flash flooding and **landslides**

Fig. 4 Problem ranking diagram of the different hill communities in the CHD

that the hill forests are being converted to vegetation type in the high hills because of increased agricultural practice, and furthermore, vegetation type is being converted to urban built-up areas in low hills (Ahmed, 2017). In the urbanised hill communities, landslides occur almost every year during the monsoon season. Sometimes flash-flooding, triggered by heavy rainfall, causes landslides that are mostly linked to hill cutting and development of housing blocks on dangerous hill slopes in violation of the existing master plans. Particularly, in Chittagong and Cox's Bazar (Ahmed, 2017), the hill cutting soil is transported to the nearby brick kilns for the mass production of bricks and other construction materials (Fig. 5).

With the overwhelming population pressure and acute land scarcity, land prices in these areas have greatly increased and are out of reach to middle- to lower-income people (Alam, 2020). As a

Fig. 5 Hill cutting soil is being transported as raw materials in the brickfields. Source: Department of Environment, Chittagong, 2014 and Ahmed, 2017

result, powerful land developers/grabbers are systematically destroying the hills by promoting profit-making businesses in selling plots and flats. The land developers are making full use of the extremely poor people who are migrating to the large urban agglomerations in search of better livelihood opportunities and who have lost their lands to river erosion or who are victims of other natural hazard-induced disasters (Siddiqui, 2019) in different parts of Bangladesh (e.g. drought, sea-level rise, flooding and cyclones). By law, only the government owns the hills in Bangladesh, thus it is not possible to build houses on them. To avoid this barrier, the land grabbers strategically guide the incoming urban poor people to those hills by providing temporary housing and other utility facilities for living. Consequently, the government authorities fail to evacuate them on humanitarian grounds. In this way, informal settlements start in hills and later they cut the hills gradually. After years, when the hills disappear, there is no other way than permitting multi-storied buildings on the flat-lands that have been converted from hills (Ahmed, 2017). This is the overall scenario in the urbanised hilly areas for the past few decades (Fig. 6).

All of the aforementioned reasons have a common connection with a lack of political goodwill. Some local politicians are unaware of the adverse effects of hill cutting and they often do not consider it illegal. Several organisations are working on the issue of landslides in the area, including government and non-government bodies, but a lack of coordination amongst them has made the entire effort slow and scattered.

Landslide disaster scenario is multi-dimensional in terms of its origin, and thus, it requires solutions from various directions. The participants proposed a number of mitigation measures to manage landslide disasters in the highly urbanised areas in the CHD (Table 2). Primarily, they emphasised on to stop hill cutting and developing informal settlements on the hills, creating public awareness and promoting risk-sensitive land use planning. They recommended implementing environmental conservation laws strictly, relocating people living on risky hills and harnessing the natural resources in a sustainable way (Table 2).

Discussion

Landslide vulnerability of the Rohingya refugees

The case of Rohingya refugees, who are officially known as the Forcibly Displaced Myanmar Nationals (FDMN), is unique and complex (Table 3). They were forced to leave their place of birth in Rakhine due to communal violence (Buddhists vs Muslims), and systematic torture and genocide imposed by the Myanmar Army (ICJ, 2020). To avoid one form of disaster (conflict), they are now facing another type of disaster (landslides). A SWOT diagram was produced to better understand the inter-linkages between the internal and external factors related to landslide disasters (Table 3). Results show that the Rohingyas are not allowed to move outside the camps or build permanent shelters that are somewhat physically resilient to natural hazards like landslides,

Fig. 6 Illegal hill cutting for development of residential housing in Chittagong City corporation area. Source: Bayes Ahmed, 2014 and Ahmed, 2017

Table 2 Causes of landslides and mitigation measures proposed by the urbanised hill communities

Causes of landslides	Mitigation measures
Natural factors	
(1) Torrential rainfall	(1) To address the adverse impacts of climate change
(2) Earthquakes	(2) Hill classification should not be changed
(3) River or canal filling	(3) River dredging
	(4) Reduce constructing embankments and inflatable rubber dams
Human-made factors	
(1) Hill cutting	(1) Stop hill cutting
	(2) Create public awareness
(2) Uncontrolled deforestation	(3) Sustainable forest resource management
	(4) Stop uncontrolled deforestation
	(5) Afforestation and reforestation activities should be prioritised
	(6) Community forestry should be encouraged for meeting family needs
	(7) To arrange alternative livelihood activities for the people dependent on forests and hills
(3) Unplanned construction	(8) Roads and structures should not be built by cutting hills
(4) Agricultural activities	(9) Agricultural activities such as slash-and-burn farming, tobacco, betel leaves and fruit cultivation should be avoided
(5) Constructing dams	(10) Avoid constructing dams on hilly rivers or steams
	(11) Unplanned inflatable rubber dams should not be constructed on river channels
(6) Urbanisation	(12) Unplanned urbanisation should be avoided
(7) Sand extraction or sand mining	(13) Sand extraction should be stopped from hilly streams
(8) Political willingness	(14) Greater political cooperation is required

Table 3 SWOT analysis of the Rohingya refugees

Internal factors	
Strength	**Weakness**
•Community bonding	•Hill cutting and deforestation
•Enthusiasm to learn new things	•Purdah or conservative society
•Strong culture and heritage	•Muslim identify
•Awareness building	•Domestic violence
•Adapting with the new environment	•Safety for women and girls
•Co-existence with host community members	•Mental wellbeing
	•Crime
	•Drugs

External factors	
Opportunity	**Threat**
•Ongoing basic support from the United Nations, Government of Bangladesh and NGOs	•Overcrowded camps
•Multi-hazard early warning system	•No disaster-resilient permanent shelters
•Basic life-learning training	•No evacuation centres
•Elementary specialised education for the Rohingya children	•No freedom of movement
•Limited mobile network	•Ongoing conflict in Rakhine
•Refugee identify card	•Lack of DRR trainings
•Third-country repatriation	•Statelessness
•Shelter strengthening kits and site management plans	•No progress on sustainable repatriation
	•Multi-hazard threats
	•No work permit
	•No formal education
	•No justice
	•Frustrating global and regional cooperation for resolving the refugee crisis

flooding and cyclones. Furthermore, no formal education is also allowed; however, non-government organisations (NGOs) are trying to provide basic, non-formal education to the Rohingya children and DRR trainings for the adults. The humanitarian partners are also trying to strengthen the shelters by providing some kits and they have produced multi-hazard maps for better site management (ISCG, 2020). The Rohingyas have strong community bonding and are trying their best to adapt in this dreadful situation (Table 3); however, all these efforts are not enough to make the camps resilient to natural hazards.

The Kutupalong Rohingya site is the world's largest, most densely populated (40,000 refugees/km²) and most (natural) hazard-prone refugee camp. It was a government-designated reserved forest area, but, an enormous area of hill forests have been removed to accommodate the refugees in shelters and to arrange fuel for their cooking (Adnan et al., 2020). In the months of June, July and September in 2019, at least 226, 731 and 243 landslide incidents were reported in the camps in Cox's Bazar (IOM, 2019). Henceforth, the Rohingya population, mostly women and children, are forced to live in landslide-prone campsites. In a similar context, Pollock et al. (2019) found that the influx of over 1.5 million Syrian refugees increased the landslide risk profile of Lebanon, a mountainous country on the eastern Mediterranean, by 75%. The Syrian refugees, fleeing armed conflict in their home country, were forced to settle in informal camps in Lebanon where they were experiencing 9–11 times greater landslide risk compared with the local urban populations due to sub-standard shelter quality (Pollock et al., 2019).

Given the international and national conventions, the only sustainable solution for the Rohingya refugees would be to repatriate them to Myanmar with safety and dignity (Table 3).

Landslide vulnerability of the urbanised hill community

In case of the urbanised (Bengali) hill communities, it is primarily their economic and social vulnerability that are responsible for landslide disasters. The residents are mostly poor, landless and marginalised people coming from either different parts of the district or the country (some of them are climate migrants) and are forced to live on dangerous hill slopes or foothills as they cannot afford housing in expensive safer places (Siddiqui, 2019). Some influential local people use this opportunity to exploit the poor and helpless by providing them with shelter in risky hills with landslide risks and by charging some monthly rents. There is another group, the land grabbers, who are even more powerful and they illegally cut hills to build new housing blocks. They maintain solid acquaintances with local authorities to continue their illegal businesses and ecological destruction. This trend is common in Chittagong and Cox's Bazar districts, especially in highly urbanised hill areas.

The urbanised hill people are highly dependent on nearby city-level activities (pulling rickshaw, garment worker, taxi driver, retail shop-keepers and daily labourer) for their livelihoods. They obtain almost all urban facilities within 1-km radius and they can easily travel to desired destinations on foot. Most of the community-related influential institutions are also located in close proximity and are easily accessible. They do not have enough internal strengths and external opportunities to overcome their social,

economic and physical vulnerability-related problems. The urbanised hill people are quite knowledgeable and aware of landslide threats, but they keep silent due to external pressures created by the powerful elite people. They lack knowledge on how to deal with the hilly environment and they are always under the threat of eviction (Table 4).

Overall, within the urbanised communities—hill cutting, migration due to climate-push and city-pull factors, improper implementing of master plans, institutional ignorance and corruption, and power politics were found to be the common problems associated with landslides. The incorporation of indigenous cultural knowledge can significantly reduce landslide disaster risk, especially when it can be combined with ensuring social justice for the urban poor, implementing risk-sensitive land use plans, developing community-based landslide early warning systems and preventing indiscriminate hill cutting. This concept is depicted in Fig. 7.

Likewise, residents in the informal settlements in the Guatemala Metropolitan Region lack access to income (reduces capacity to withstand landslide risk), central government support and necessary community services (Miles et al., 2012). In the case of the southern part of Rio de Janeiro State, Brazil, the people living on highly landslide-prone areas were more concerned about other socio-economic threats (violence, drugs and access to healthcare) than landslides (de Mendonca & Gullo, 2020). In Teziutlán municipality in Puebla, Mexico, the survey respondents could categorise the natural and human causes of landslides, which indicates a better risk perception and highlighted on reducing vulnerability, improving living standards and enhancing landslide awareness and knowledge at the community level (Hernández-Moreno & Alcántara-Ayala, 2017). In a developed country perspective, for example in Italy, it was found that the landslide-exposed communities were less aware of the disaster risk (Calvello et al., 2016), did not consider landslides as a threat and were less unwilling to participate in prevention activities (Gravina et al., 2017). In all these case studies in an urban hill context, the common recommendations to address landslide disasters were focused on developing landslide early warning systems, initiating community-based DRR activities (Raška, 2019), integrating land use planning, understanding social vulnerability and increasing communications between communities at risk and government agencies (Klimeš et al., 2019; Antronico et al., 2020). This proves that the findings from the urbanised hill communities in Bangladesh are comparable with other developing and developed nations globally.

Table 4 SWOT diagram of the urbanised hill communities

Internal factors	
Strength	**Weakness**
•Local knowledge •Afforestation and reforestation activities •Guide-walls on risky hills •Drainage facilities •Alternative livelihoods •Political willingness •Local monitoring system •Community forestry •Social bonding •Local government initiatives •Utilising the existing cyclone shelters as temporary landslide evacuation centres •Take advantages of modern technological facilities	•Hill cutting •Deforestation •Less agricultural land •Population growth •River encroachment •Powerful land grabbers •Lack of (hilly) indigenous knowledge •*Jhum* and tobacco cultivation •Excess grazing/animal husbandry •Law and order deterioration •Rubber dams in hilly streams •Educational institutions
External factors	
Opportunity	**Threat**
•Landslide hazard mapping •Landslide early warning systems •Proper environmental planning •Community awareness trainings •Rehabilitating the vulnerable or marginalised people •Landslide task force •River dredging •Forest resource management •Landslide disaster risk reduction strategies •Enforcing existing planning and environmental conservation acts/by-laws	•Rohingya influx •*Khas* land/government-owned fallow land •Reserved forests •Political interference •Unplanned development/urbanisation •Heavy rainfall •Climate change •Road construction •Lack of social justice •Natural disasters—flash flooding, cyclones, river and coastal erosion, and earthquakes

Landslide resilience of the indigenous tribal community

In contrast, the indigenous tribal communities primarily living in the Chittagong Hill Tracts (CHT), the former conflict zone of Bangladesh, were found to be more resilient to landslides in comparison to the Bengali and Rohingya refugee communities. The indigenous people generally view the hills as part of their cultural identity. They have known for generations how to live in the mountains and hills, building raised homes by using lightweight material like bamboo and constructing in stages against gentler slopes rather than cutting into the hill. However, landslides are becoming more deadly and increasingly common even within the tribal communities in recent years. Mostly, the Bengali settlers are becoming the victims of landslides or tribal people living in the sub-district towns. There is ongoing land dispute between the settlers (people coming from other parts of Bangladesh) and the tribal communities.
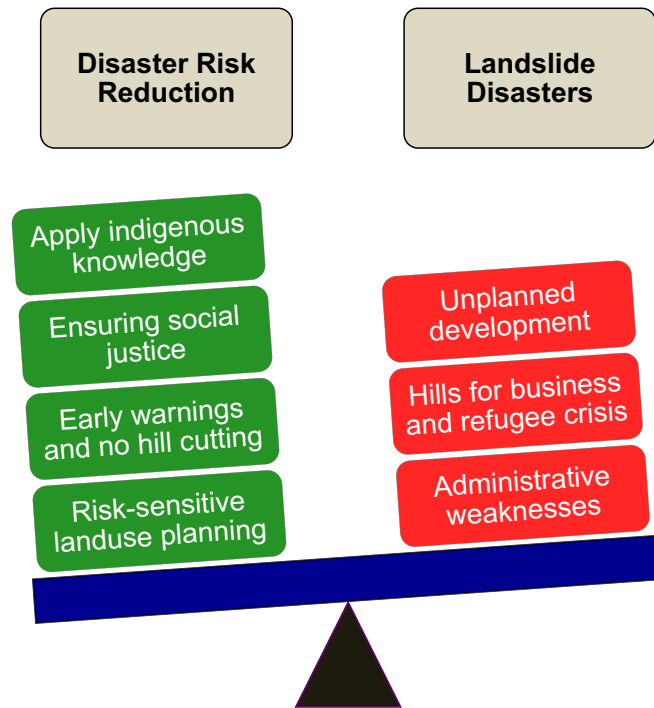
Fig. 7 Components of landslide disaster risk reduction strategy in the CHD

The indigenous people do not want the Bengalis to settle in their ancestral land in the CHT as they consider it a threat to their existence, indigenous rights and unique culture. However, the Bengali people perceive it as their rights to settle in any part of the country, despite both groups belonging to the same country. It resulted in armed conflict between them for two decades until a peace deal was agreed in 1997, known as the Chittagong Hill Tracts Peace Accord (Roy, 2000). As a consequence, some of the remaining Bengalis or settlers (as called by the tribal people) in the CHT region were forced to live on dangerous hills (Anas, 2019). Up until now, the indigenous people are adjusting perfectly to minimise landslide risks by utilising traditional cultural knowledge. But, ongoing challenges such as increasing cost of construction materials, changes in lifestyle in urban centres, impacts of globalisation and persistent disputes with Bengalis are posing additional threats in achieving disaster resilience and sustainable development in the region (Table 5).

The indigenous people, primarily living in rural areas, are highly dependent on their ancestral land/hills for economic and livelihood activities like being *Jhum* (slash-and-burn agriculture) cultivators, hunters, fishermen or small agriculturalists. The land, hills and surrounding natural resources in the CHT are considered the source of their cultural, spiritual and social identity. For most of the tribal people, a piece of land is recognised as their home—it is their physical, historical and mythical space, it is their identity and without the land their fundamental cultural ideology will be at stake (Roy, 2000).

The indigenous people who live in the hills have adequate economic opportunities and livelihood activities based on hill agriculture. They are able to manage their surrounding natural resources in a sustainable way that ensure food security. They can meet their basic needs by utilising the available resources; they have access to necessary infrastructure and services, they maintain a unique and rich cultural heritage developed through the

generations and they are connected to internal and external institutions. They are able to manage the natural hazards and adapt to the hill environment through both tangible (such as using traditional housing, preserving the hill slope and availing themselves of unique designs) and intangible (shared community values, heritage, norms and indigenous knowledge) cultural heritage. These

Table 5 SWOT analysis of the indigenous tribal people

Internal factors	
Strength	**Weakness**
•Indigenous and traditional knowledge •Strong community leadership (Headman and *Karbari*) •Good road communication •Easy access to markets •Same tribe and social bonding •Alternative livelihood (weaving cloths, and retail business) •Unique culture and lifestyle	•Less availability of water •High illiteracy rate •Less income •Rising construction costs of bamboo and grass (special type) •*Jhum* (slash-and-burn)/shifting cultivation •Internal conflicts or rebels
External factors	
Opportunity	**Threat**
•Help from NGOs •Growing tourism •Solar energy •Hill forest resources •Education •Help from the local council •Micro-credits •The 1997 Chittagong Hill Tracts Peace Accord •Co-existence with the Bengali settlers	•Excessive rainfall •Crop damage •Violation of peace deal •Bengali settlements and land disputes •Conflicting policies •Globalisation and attraction towards city-life •Lack of utility supply or development

Physical
- Traditional thatched housing with unique design
- Local, non-manufactured materials, and development of settlements in an organized manner

Social
- An enduring historical background, a strong sense of belonging to ancestral land and hills
- Less attraction or exposure to urbanization, less conflict about cultural identity preservation, and greater social cohesion

Economic
- Food security through sustainable livelihood options, sustainable agricultural practice
- Selling agricultural and traditional hand woven clothes, and not using the hills for commercial activities

Environmental
- Protecting the hills, sustainable natural resource management
- Not destroying the hill forests or indiscriminately cutting the hills for settlement development or other purposes
- Maintaining a human ecology of landslides

Institutional
- Traditional social hierarchy, no external pressure, no power politics
- Strong local and regional networks, strong ethnic and social groups
- Collaboration with institutions and autonomous administration

Cultural
- Treating hills as sacred places, individual perception of risk management
- A rich inherited indigenous and cultural knowledge of how to deal with an extremely hilly environment.

Fig. 8 Multi-dimensional resilience characteristics of the indigenous tribal communities in the Chittagong Hill Districts (CHD)

unique characteristics help the tribal communities address the different dimensions of landslide vulnerability as illustrated in Fig. 8.

These findings are consistent with other comparable works. For example, the residents of rural mountain settlements in the Three Gorges Reservoir Area in China were found to be having stronger social bonding, place dependence and unique culture and lifestyle compared to other urban residents (Peng et al., 2017). Taking two indigenous group (Maori and Pohnpei) case studies from New Zealand, Harmsworth and Raynor (2005) investigated how cultural differences impact landslide risk perception. In both cases, the groups were found to be facing socio-economic and constitutional disparities, conflict (Maori vs non-Maori population), marginalisation, rapid transformation of the natural environment and increasing tension between the modern and the traditional lifestyle. However, the indigenous communities developed a strong sense of landslide disaster awareness and risk perception that was evidently linked to their traditional cultural values, spiritual links, close relationship with the nature and cumulative heritage passed on through several generations through stories,

folklore, songs, dances and knowledgeable people (Harmsworth & Raynor, 2005).

Addressing landslide disasters

The CHD hill communities confront natural hazard-induced disasters such as landslides, flash flooding, cyclones and earthquakes on a regular basis. Landslides occur mainly during the monsoon and cyclone season (between May and September). In this perspective, the rainfall-induced landslide hazards and associated impacts of climate change should be considered external threats. It is not possible to modify the core hazard characteristics or eradicate landslide threats entirely from the region. However, undertaking appropriate disaster risk mitigation strategies can certainly reduce the negative consequences on human lives and society that leads to understanding the broader community vulnerability aspects.

The hilly communities in the CHD try to balance between a number of distinctive but deeply interlinked aspects of disaster vulnerability. The Bengali communities largely deal with social, economic, environmental and institutional factors, whereas the Rohingya refugees' main constrains are linked to physical, social

and political/institutional dimensions. The indigenous tribal communities are resilient because of their strength in cultural (history, heritage and uniqueness) and social norms (Fig. 9).

In terms of landslides in Bangladesh, there is a clear gap in local people's and government authority's understanding in landslide disaster preparedness and acquaintances with modern technology. Addressing a wide range of internal (hill cutting, deforestation, illegal land grabbing, grazing or cultivation style) and external (torrential rainfall, climate change, natural hazard-induced disasters, refugee influx, rapid urbanisation or geopolitical interference) factors is sometimes difficult to achieve within a short period of time. But, it is possible to utilise the available technologies, incorporate modern physical science, undertake community-based landslide DRR strategies and prepare for landslide disasters well in advance to reduce potential loss and damage. For example, in Cox's Bazar District, most people have access to mobile phones and text message services available in their hand-held devices. It is possible to develop a dynamic web-based landslide early alert system and send text messages at least 5 days in advance to them. It would disseminate information on the possibilities of landslides in certain high-risk areas. This type of technological intervention would be indisputably helpful for the local authorities to warn the vulnerable populations in advance and evacuate them to a safer place efficiently. Other structural (slope stabilisation, drainage network, reforestation, retaining walls, nature-based solutions, installing landslide deformation monitoring instruments) and non-structural hazard mitigation initiatives (community awareness, strict implementation of environmental protection laws, political willingness) should be in place. Some key recommendations to tackle landslide disasters in the CHD are highlighted below.

Recommendations: short term (1–3 years)

1) To produce landslide susceptibility and risk maps at local and regional levels by applying advanced scientific methods.
2) To produce a detailed fieldwork-based landslide inventory for the entire CHD region with the help of local experts and community people.
3) To develop effective end-to-end and people-centred landslide early warning systems (EWS) at the local and regional levels.
4) Extensive community awareness and landslide resilience building training is required to empower the local communities for early actions.
5) To integrate landslide DRR plans into national and local policies, address public authorities, incorporate indigenous knowledge, train volunteers and develop effective communication strategies.
6) Producing risk-sensitive land use plans for each sub-district (Upazila) and implementing them properly.
7) Utilising the existing cyclone shelters or other critical infrastructure (e.g. primary schools) for temporary landslide evacuation during the monsoon season and to plan for new multi-purpose landslide shelters.

Recommendations: long term (4–10 years)

8) To produce an integrated manual for landslide disaster risk mitigation.
9) Conducting detailed social vulnerability assessment.
10) Forming national- and local-level landslide task forces to prevent hill cutting, monitoring surface deformation and maintaining landslide EWSs.
11) Ensuring social justice and strengthening legal frameworks.
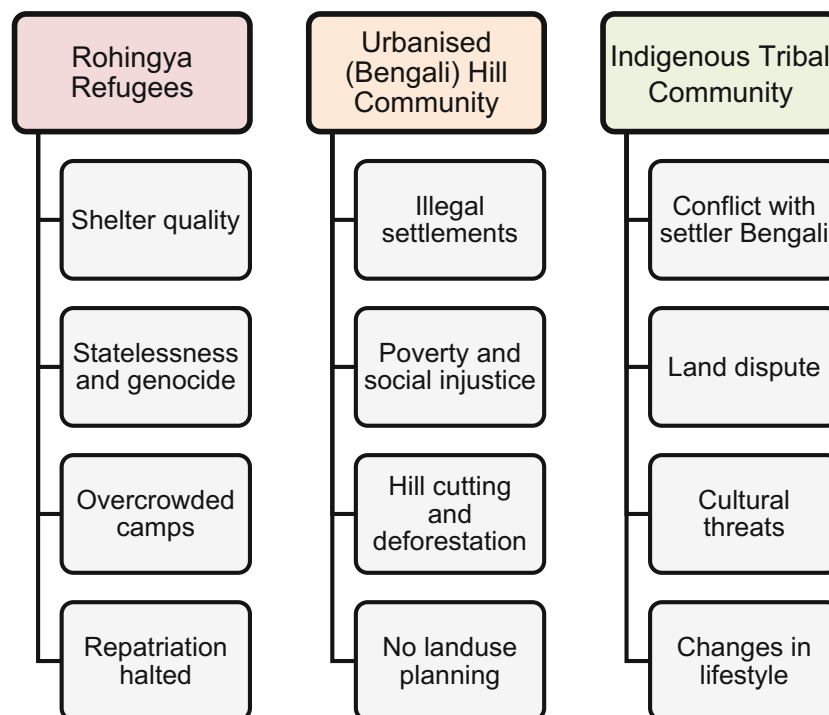12) Finding sustainable solutions for Rohingya repatriation in Myanmar.

Fig. 9 A schematic diagram showing landslide vulnerability amongst the three major hill communities in the Chittagong Hill Districts (CHD) of Bangladesh

13) Identifying pathways for long-term and permanent resolutions for peacebuilding between the Bengali and tribal populations in the hill tracts.
14) Undertaking measures for tackling the impacts of human-induced climate change.
15) Increased international and regional cooperation and promoting peace deals and reconciliation activities.

Conclusion

Landslides in the Chittagong Hill Districts (CHD) can be characterised as socio-natural hazards and the root causes of landslide disasters are profoundly intertwined with the culture–conflict–corruption nexus (in this context, corruption is similar to flawed institutional management). It requires longstanding and continuing efforts to address multifaceted landslide vulnerabilities such as poverty, social and humanitarian justice, communal violence, cultural differences, hatred towards ethnic and minority communities, armed conflicts, refugee crisis and forced migration, upholding human rights, implementing master/development plans and environmental laws, safeguarding institutional transparency and promoting global peace and security. Mostly, local authorities, politicians and top-level decision-makers fail to understand the deep-seated causes of disasters. They tend to focus on structural hazard mitigation strategies rather than investing time and resources to tackle the critical vulnerability dimensions.

Nevertheless, to achieve the overall success in landslide disaster risk reduction in Bangladesh, it is essential to form a research, policy and planning, and networking-oriented landslide taskforce by involving multidisciplinary (physical and social science academes) and multisectoral (governments, local communities, NGOs, donors and the United Nations) stakeholders.

This paper provides an original and substantive contribution to the advancement of disaster risk reduction research, policy and practice through improving our understanding of community vulnerability to natural hazards.

References

Adnan MSG, Rahman MS, Ahmed N, Ahmed B, Rabbi M, Rahman RM (2020) Improving spatial agreement in machine learning-based landslide susceptibility mapping. Remote Sens 12(20):3347

Ahmed B (2015) Landslide susceptibility modelling applying user-defined weighting and data-driven statistical techniques in Cox's Bazar Municipality, Bangladesh. Nat Hazards 79(3):1707–1737

Ahmed, B. (2017). Community vulnerability to landslides in Bangladesh. *PhD Thesis*. University College London (UCL), UK

Ahmed B, Rahman MS, Sammonds P, Islam R, Uddin K (2020) Application of geospatial technologies in developing a dynamic landslide early warning system in a humanitarian context: the Rohingya refugee crisis in Cox's Bazar, Bangladesh. Geomatics, Natural Hazards and Risk 11(1):446–468

Ahmed B, Kelman I (2018) Measuring community vulnerability to environmental hazards: a method for combining quantitative and qualitative data. Nat Hazards Rev 19(3):04018008

Alam E (2020) Landslide hazard knowledge, risk perception and preparedness in Southeast Bangladesh. Sustainability 12:6305

Anas, A. (2019). Why landslides in Bangladesh's former conflict zone are becoming deadlier? The New Humanitarian. https://www.thenewhumanitarian.org/analysis/2019/06/25/Bangladesh-landslides-climate-change-Indigenous. Accessed 24 Aug 2020

Antronico L, De Pascale F, Coscarelli R, Gullà G (2020) Landslide risk perception, social vulnerability and community resilience: the case study of Maierato (Calabria, southern Italy). International Journal of Disaster Risk Reduction 46:101529

BBS. (2014). Community Report, Zila: Cox's Bazar. Bangladesh Population and Housing Census 2011. Bangladesh Bureau of Statistics (BBS), Statistics and Informatics Division (SID), Ministry of Planning, Dhaka, Bangladesh

Birkmann J, Cardona OD, Carreño ML, Barbat AH, Pelling M, Schneiderbauer S, Kienberger S, Keiler M, Alexander D, Zeil P, Welle T (2013) Framing vulnerability, risk and societal responses: the MOVE framework. Nat Hazards 67(2):193–211

Brammer, H. (2012). The physical geography of Bangladesh. The University Press Limited (UPL), Dhaka, Bangladesh

Bryman, A. (2016). Social research methods. Oxford: Oxford University Press

Calvello M, Papa MN, Pratschke J, Crescenzo MN (2016) Landslide risk perception: a case study in Southern Italy. Landslides 13(2):349–360

Chisty KU (2014) Landslide in Chittagong City: a perspective on hill cutting. J Bangladesh Inst Plan 7:1–17

Cruden, D. M. (1991). A simple definition of a landslide. Bulletin of the International Association of Engineering Geology-Bulletin de l'Association Internationale de Géologie de l'Ingénieur, 43(1), 27–29

de Mendonca MB, Gullo FT (2020) Landslide risk perception survey in Angra dos Reis (Rio de Janeiro, southeastern Brazil): a contribution to support planning of non structural measures. Land Use Policy 91:104415

Farzana, K.F. (2017). Memories of Burmese Rohingya refugees: contested identity and belonging. Palgrave Macmillan US

Glade T (2003) Landslide occurrence as a response to land use change: a review of evidence from New Zealand. Catena 51(3–4):297–314

Gravina T, Figliozzi E, Mari N, Schinosa FDLT (2017) Landslide risk perception in Frosinone (Lazio, Central Italy). Landslides 14(4):1419–1429

Guzzetti F, Gariano SL, Peruccacci S, Brunetti MT, Marchesini I, Rossi M, Melillo M (2020) Geographical landslide early warning systems. Earth Sci Rev 200:102973

Harmsworth G, Raynor B (2005) Cultural consideration in landslide risk perception. In: Glade T, Anderson M, Crozier MJ (eds) Landslide hazard and risk. England, John Wiley & Sons Ltd, pp 219–249

Hernández-Moreno G, Alcántara-Ayala I (2017) Landslide risk perception in Mexico: a research gate into public awareness and knowledge. Landslides 14(1):351–371

ICJ. (2020). Application of the convention on the prevention and punishment of the crime of genocide (The Gambia v. Myanmar). International Court of Justice (ICJ), the Hague, Netherlands. https://www.icj-cij.org/en/case/178. Accessed 21 Aug 2020

IOM. (2019). Site management and site development daily incident report: survey analysis (April-November 2019). Bangladesh Mission – The International Organization

for Migration (IOM). https://www.humanitarianresponse.info/en/operations/bangladesh/document/site-management-site-development-daily-incident-reportsurvey-analysis. Accessed 5 Nov 2020

IPCC. (2018). Global warming of 1.5°C. The Intergovernmental Panel on Climate Change (IPCC). http://www.ipcc.ch/report/sr15/. Accessed 7 Mar 2020

ISCG. (2020). The 2020 Joint Response Plan for Rohingya Humanitarian Crisis. Inter Sector Coordination Group (ISCG). United Nations Office for the Coordination of Humanitarian Affairs (OCHA). https://www.humanitarianresponse.info/ru/operations/bangladesh/document/2020-joint-response-plan-rohingya-humanitarian-crisis-january. Accessed 16 Aug 2020

Jaiswal P, van Westen CJ (2013) Use of quantitative landslide hazard and risk information for local disaster risk reduction along a transportation corridor: a case study from Nilgiri district, India. Nat Hazards 65(1):887–913

Kelman I (2020) Disaster by choice: how our actions turn natural hazards into catastrophes. Oxford University Press, UK

Khan MJU, Islam AS, Bala SK, Islam GT (2020) Changes in climate extremes over Bangladesh at 1.5° C, 2° C, and 4° C of global warming with high-resolution regional climate modeling. Theor Appl Climatol 140:1451–1466

Klimeš J, Rosario AM, Vargas R, Raška P, Vicuña L, Jurt C (2019) Community participation in landslide risk reduction: a case history from Central Andes, Peru. Landslides 16(9):1763–1777

Kumar S (2002) Methods for community participation: a complete guide for practitioners. Vistaar Publications, New Delhi

Landeros-Mugica K, Urbina-Soria J, Alcántara-Ayala I (2016) The good, the bad and the ugly: on the interactions among experience, exposure and commitment with reference to landslide risk perception in México. Nat Hazards 80(3):1515–1537

Lennartz T (2013) Constructing roads—constructing risks? Settlement decisions in view of landslide risk and economic opportunities in Western Nepal. Mt Res Dev 33(4):364–371

Miles SB, Green RA, Svekla W (2012) Disaster risk reduction capacity assessment for precarious settlements in Guatemala City. Disasters 36(3):365–381

Nathan F (2008) Risk perception, risk management and vulnerability to landslides in the hill slopes in the city of La Paz, Bolivia. A preliminary statement. Disasters 32(3):337–357

Peng L, Lin L, Liu S, Xu D (2017) Interaction between risk perception and sense of place in disaster-prone mountain areas: a case study in China's Three Gorges Reservoir area. Nat Hazards 85(2):777–792

Pollock W, Wartman J, Abou-Jaoude G, Grant A (2019) Risk at the margins: a natural hazards perspective on the Syrian refugee crisis in Lebanon. International Journal of Disaster Risk Reduction 36:101037

Rabby YW, Li Y (2019) An integrated approach to map landslides in Chittagong Hilly Areas, Bangladesh, using Google Earth and field mapping. Landslides 16:633–645

Raška P (2019) Contextualizing community-based landslide risk reduction: an evolutionary perspective. Landslides 16(9):1747–1762

Roy, R.C.K. (2000). Land Rights of the Indigenous Peoples of the Chittagong Hill Tracts, Bangladesh. IWGIA Document No. 99. The International Work Group for Indigenous Affairs (IWGIA), Copenhagen, Denmark

Siddiqui, T. (2019). Climate change and displacement: locating the most vulnerable groups. Working paper series no: 49. Refugee and Migratory Movements Research Unit (RMMRU), Dhaka, Bangladesh

Steckler MS, Mondal DR, Akhter SH, Seeber L, Feng L, Gale J, Hill EM, Howe M (2016) Locked and loading megathrust linked to active subduction beneath the Indo-Burman Ranges. Nat Geosci 9(8):615–618

Sultana N (2020) Analysis of landslide-induced fatalities and injuries in Bangladesh: 2000-2018. Cogent Social Sciences 6(1):1737402

UNDRR. (2017). UNISDR Terminology on Disaster Risk Reduction – 2009. The United Nations Office for Disaster Risk Reduction (UNDRR). https://www.undrr.org/terminology. Accessed 22 Aug 2020

UNHCR. (2020). Refuge response in Bangladesh. United Nations High Commissioner for Refugees (UNHCR). https://data2.unhcr.org/en/situations/myanmar_refugees. Accessed 5 Nov 2020

UNOCHA. (2017). Bangladesh: report on landslides (20 June 2017). United Nations Resident Coordinators Office, Bangladesh. United Nations Office for the Coordination of Humanitarian Affairs (UNOCHA). https://www.humanitarianresponse.info/en/operations/bangladesh/document/bangladesh-report-landslides-20-june-2017. Accessed 21 Aug 2020

van Westen CJ, Van Asch TW, Soeters R (2006) Landslide hazard and risk zonation—why is it still so difficult? Bull Eng Geol Environ 65(2):167–184

Wisner B, Blaikie P, Cannon T, Davis I (2004) At risk: natural hazards, people's vulnerability and disasters. Routledge, Oxon

Zaman S, Sammonds P, Ahmed B, Rahman T (2020) Disaster risk reduction in conflict contexts: lessons learned from the lived experiences of Rohingya refugees in Cox's Bazar, Bangladesh. Int J Disaster Risk Reduction 50:101694

B. Ahmed (✉)
Institute for Risk and Disaster Reduction,
University College London (UCL),
Gower Street, London, WC1E 6BT, UK
Email: bayes.ahmed@ucl.ac.uk

B. Ahmed
Department of Disaster Science and Management, Faculty of Earth and Environmental Sciences,
University of Dhaka,
Dhaka, 1000, Bangladesh