Community Vulnerability to Landslides in Bangladesh

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Declaration

I, **Bayes Ahmed** confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Landslides are a common hazard in the Chittagong Hill Districts (CHD) of Bangladesh. The communities that live on dangerous hill slopes in CHD repeatedly experience landslide hazards during the monsoon season, with casualties, economic losses and property damage. Although landslides are hazard events triggered by a variety of environmental phenomena, vulnerability emerging from a social system is predominantly responsible for disasters. With this background, this study develops an understanding of the root-causes of community vulnerability to landslides in the CHD.

To begin, two distinct groups of communities were identified, namely the urbanized hill communities and the indigenous hill communities. Seven urbanized and four indigenous communities were selected and compared by developing and applying mixed methods. Quantitative information from household-level questionnaires was associated with qualitative maps and diagrams from participatory rural appraisal surveys. A convergent parallel design and index based weighted average decision support model was applied, covering community-level vulnerability indicators for physical, social, economic, ecological, institutional and cultural aspects.

The urbanized hill communities were found to be highly vulnerable to landslides, as they are attracted by city pull factors, deprived of social justice and involved in indiscriminate hill cutting for developing settlements. They fail to incorporate indigenous knowledge and are culturally less aware of how to deal with hazard extremes in the hilly environment. In contrast, the indigenous communities have a distinctive history and culture, inherited lifestyle, customs, beliefs and values, traditional housing pattern, land tenure and ownership, administrative system, and agricultural practice as a major livelihood. These unique characteristics are facilitating the indigenous communities to address the different dimensions of community vulnerability to landslides.

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List of Acronyms

ASTER	Advanced Space-borne Thermal Emission and Reflection Radiometer
BARC	Bangladesh Agricultural Research Council
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BUET-JIDPUS	Bangladesh University of Engineering and Technology-Japan Institute of Disaster Prevention and Urban Safety
CBDRR	Community-based Disaster Risk Reduction
CBM	Cox's Bazar Municipality
CCA	Climate Change Adaptation
CCC	Chittagong City Corporation
CDA	Chittagong Development Authority
CDMP	Comprehensive Disaster Management Programme
CHD	Chittagong Hill Districts
CHT	Chittagong Hill Tracts
DAP	Detailed Area Plan
DEM	Digital Elevation Model
DoE	Department of Environment
DRR	Disaster Risk Reduction
FAO	Food and Agriculture Organization
GIS	Geographic Information System
GoB	Government of Bangladesh
GPS	Global Positioning System
GSB	Geological Survey of Bangladesh
HKH	Hindu Kush Himalayan
ICIMOD	International Centre for Integrated Mountain Development
IFRC	International Federation of Red Cross and Red Crescent Societies
IHC	Indigenous Hill Community
ILO	International Labour Organization

IPCC	Intergovernmental Panel on Climate Change
LSM	Landslide Susceptibility Modelling
MSL	Mean Sea Level
NDVI	Normalized Difference Vegetation Index
NGO	Non-Governmental Organizations
PRA	Participatory Rural Appraisal
RS	Remote Sensing
SDSM	Statistical Downscaling Model
SPSS	Statistical Package for the Social Science
SWOT	Strengths, Weaknesses, Opportunities, and Threats
UHC	Urbanized Hill Community
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNICEF	United Nations Children's Fund
UNISDR	United Nations Office for Disaster Risk Reduction
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
WGS	World Geodetic System

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Chapter 1

Introduction

1.1. Background

Disasters resulting from environmental hazards are prominent worldwide and are responsible for casualties, human displacement and property damage on a catastrophic scale. Around 1,388 disasters were reported worldwide from 2013–2016 and around 45% of all those disasters only occurred in Asia (Figure 1.1). In 2015, the United Nations (UN) registered 346 disasters worldwide that caused more than 22,000 deaths (approximately 72% occurred in Asia), affected almost 100 million people and the economic damage totalled approximately 66.5 billion US dollars (UNISDR/CRED 2016). The World Economic Forum has acknowledged extreme weather events, failure of climate-change mitigation and adaptation, and natural hazards triggering catastrophes as the top global risks for the next 10 years (World Economic Forum 2016).

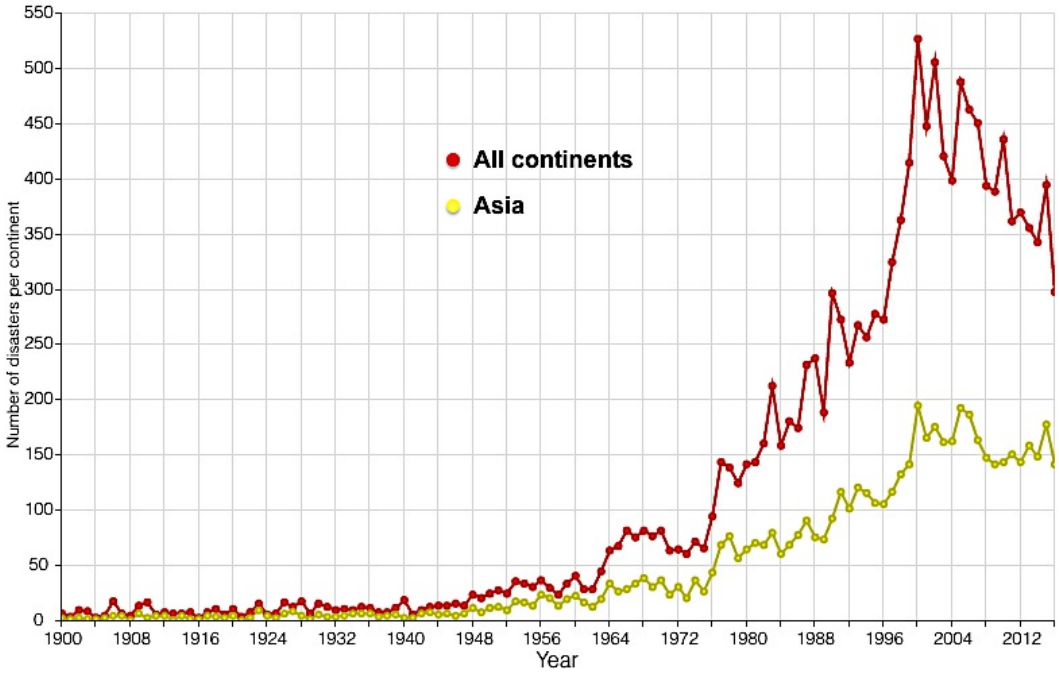

Figure 1.1. Total number of natural hazard induced disasters between 1900 and 2016. Source: EM-DAT 2017, the OFDA/CRED International Disaster Database – www.emdat.be - Université Catholique de Louvain, Brussels, Belgium.

In Bangladesh, at least 22,500 people were reportedly killed and 130 million people were affected by disasters from 1995–2014 (World Disasters Report 2015). At present, Bangladesh is ranked as the world's fifth most disaster-prone country (World Risk Report 2016; UNISDR/CRED 2016). Historically, disasters such as flooding, tropical cyclones, storm surges, and drought (Table 1.1) are dominant in Bangladesh. The recent trend of spontaneous urbanization in the hills (i.e. covering approximately 10% of the total land area of Bangladesh) and the resulting impact of landslides on hilly communities indicate a sharp escalation of landslide disaster risks in Bangladesh (Ahmed and Rubel 2013; BUET-JIDPUS 2015; Ahmed and Dewan 2017). Yet most hazard-related research for Bangladesh focuses on tropical cyclones (Ahmed et al. 2016; Mallick et al. 2017), flooding (Brouwer et al. 2007), and diseases (Ali et al. 2005; Hashizume et al. 2008), with some work on droughts (Brammer 1987) and earthquakes (Steckler et al. 2016), but with little research on landslides (Chisty 2014; Mia et al. 2016).

Table 1.1. Major disasters in Bangladesh (1900–2016).

Disaster Type	Disaster Subtype	Events Count	Total Deaths	Total Affected
Drought	Drought	7	1,900,018	25,002,000
Earthquake	Ground movement	8	43	19,395
Earthquake	Tsunami	1	2	0
Epidemic	Parasitic disease	3	1,396	69,904
Epidemic	Viral disease	5	393,085	48,928
Epidemic	Bacterial disease	5	3,639	420,479
Extreme temperature	Heat wave	2	62	0
Extreme temperature	Cold wave	18	2,148	313,200
Extreme temperature	Severe winter	2	230	101,000
Flood	Riverine flood	45	7,278	138,558,760
Flood	Coastal flood	2	51	473,335
Flood	Flash flood	11	261	7,634,577
Landslide	Landslide	8	200	56,283
Storm	Tropical cyclone	88	626,935	78,965,167
Storm	Convective storm	37	2,108	1,470,091
Storm	Others	98	5,5621	182,336,367

Source: EM-DAT, the OFDA/CRED International Disaster Database – www.emdat.be - Université Catholique de Louvain, Brussels, Belgium.

Landslides are recognized as the third type of natural hazard induced disaster in terms of worldwide importance (van Westen et al., 2011). Landslides and associated slope failure phenomena (e.g. debris flows and mudslides) are a major hazard around the world and occur frequently due to rainfall in South Asia (Chapagai 2011). From 2004–2010, around 2,620 non-seismic and fatal landslides were recorded worldwide causing at least 32,322 deaths, with the majority of human losses occurring in Asia, especially along the Himalayan Arc (Petley 2012), although Asia is the most populous continent, so vulnerability plays a significant role in the landslide disasters experienced. On 22 July 2016, at least 154 people were killed and some 8.6 million people were affected by destructive floods and landslides caused by heavy rain in China (ReliefWeb 2016). The earthquakes that struck Nepal on 25 April 2015 caused at least 3,000 landslides and other mass movements (ICIMOD 2015). The Abe Barek landslide that hit Ago district, Afghanistan on 2 May 2014 was rainfall-induced and killed almost 2,700 people (Zhang et al. 2015). Similar to China, Nepal and Afghanistan, the south-eastern hilly region of Bangladesh (i.e. the study area) is a part of the Hindu Kush Himalayan (HKH) region and is highly vulnerable to landslides due to torrential rainfall and earthquakes.

Disasters are socially constructed. The steep-slopes or the hills are solely not responsible for landslides, but the people residing on the hills and their associated vulnerability cause landslide disasters (O'Keefe et al., 1976). Alexander (2016) has mentioned – "vulnerability is the main component of risk and may be more important than hazard or threat, as small hazards can cause big disasters if vulnerability is high (p. 254)". Henceforth, it requires a holistic understanding of the various components of community vulnerability to reduce the landslide disaster risks and this is the primary motivation for this research.

1.2. Landslides in the Chittagong Hill Districts

Landslides are a common problem in the Chittagong hill districts (CHD) of Bangladesh (Figure 1.2a). CHD is broadly classified into two major groups (Figure 1.2b): urbanized hill districts (includes Chittagong and Cox's Bazar) and indigenous hill districts (includes Bandarban, Khagrachari and Rangamati). Although landslide disasters were infrequent in densely populated Bangladesh

in the past, increasing human activities such as hill cutting for residential development has resulted in many landslides. This is particularly evident in the CHD, putting people and properties at risk. In recent years, devastating landslides have repeatedly hit CHD and caused casualties, damages and loss (Appendix–I). People particularly living on the steep slopes in the urbanized hill districts are highly vulnerable to landslide disasters (Ahmed 2015a,b). Most recently on 13 June 2017, rainfall triggered landslides caused at least 160 deaths in Rangamati, Chittagong and Bandarban districts. Thousands of families took refugee in different shelters. Till now, this is considered as the biggest landslide disaster in Bangladesh. Another notable landslide event occurred on 11 June 2007 that killed about 128 people in the vicinity of various hills because of landslides triggered by heavy rainfall (610 mm) for eight consecutive days (Ahmed and Dewan 2017).

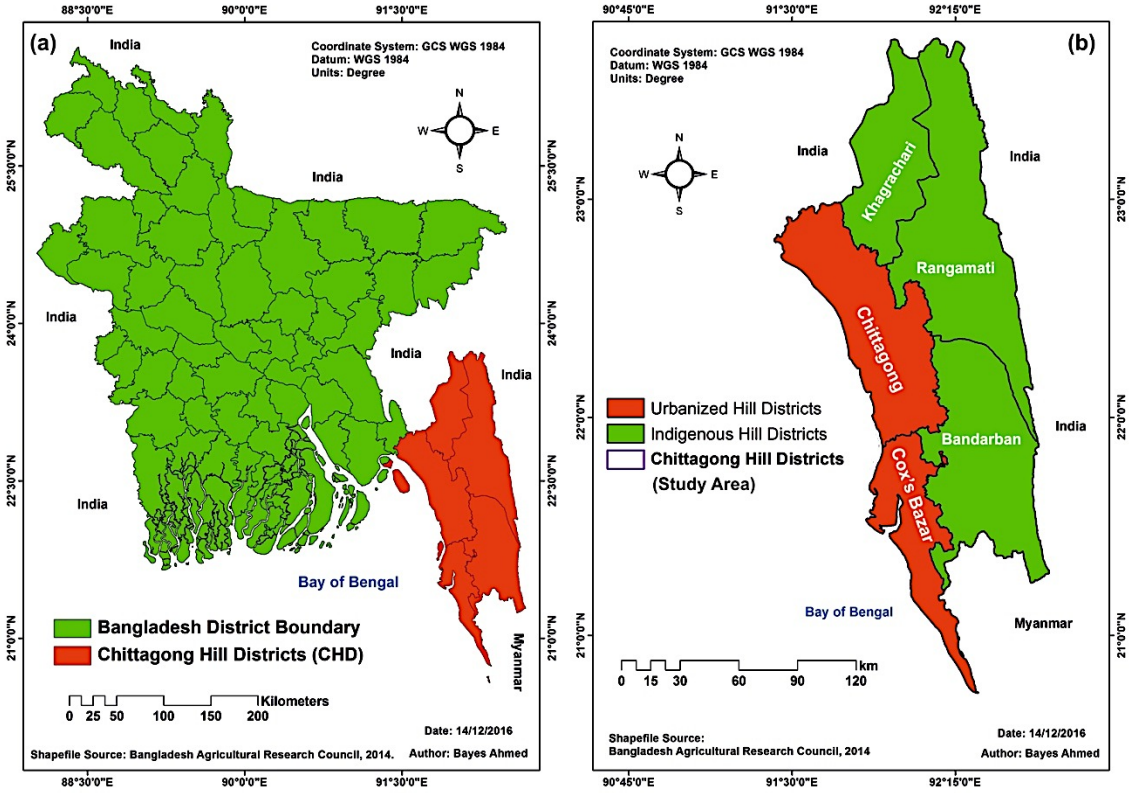

Figure 1.2. Location of **(a)** Chittagong hill districts in Bangladesh, and **(b)** the urbanized and indigenous hill districts in CHD. Source: Bayes Ahmed.

The major landslides in the CHD were related to extreme rainfall intensities in a short period of time and much higher rainfall amount compared to the monthly average (CDMP-II 2010: 107; Khan et al. 2012). The Chittagong hill tracts consist of sequences of valleys and hills, coinciding, respectively, with synclines

and anticlines of late Tertiary age, generally elongated in a NNW–SSE trend. The main outcropping formations in Chittagong area are, from the older to the younger, Bubhan formation (Miocene), Boka Bil formation (Miocene- Pliocene), Tipam sandstone (Miocene- Pliocene), Girujan Clay (Neogene- Pleistocene), Dihing and Dupi Tila formation (Pliocene- Pleistocene). The hills in the CHD are mainly composed of unconsolidated or little-consolidated beds of sandstones, siltstones and shales, with minor beds of limestone and conglomerates (Chowdhury 2015; Brammer 1986: 10). The weakness of such formations, coupled with steep slopes and heavy rainfall (especially in the monsoon season, May–September), makes this area highly vulnerable to landslides (Ahmed 2015c). Increased population pressure, rapid urban growth, improper land use, weak governance, hill cutting, indiscriminate deforestation and agricultural practices are further aggravating the situation (Sarker and Rashid 2013; Ahmed and Dewan 2017). The changing global climate is also posing a serious threat in the region, and the likelihood of increased precipitation could worsen landslide hazards in CHD (IPCC 2014). CHD is also located in a high-risk earthquake area (Cummins 2007; Steckler et al. 2016) susceptible to cyclones or storms (Islam and Peterson 2009) zone, which could trigger more landslide events.

1.2.1. The Urbanized Hill Communities

Landslides are mostly associated with human activity and community vulnerability in the urban areas. For instance, a retention wall in Batali Hill area in Chittagong City Corporation (CCC) collapsed and fell down next to the nearby informal settlements on 1 July 2011 at 7 in the morning (Figure 1.3). The event was responsible for 19 human fatalities and several houses were destroyed. The CCC authority was in charge of constructing the retention wall (which was approximately 10 m high and 50 m long) to protect the surrounding houses and the road above it from potential landslides. Unfortunately, even though it was supposed to save lives and protect property, a part of the retention wall (10.5 metres wide) collapsed and caused a devastating landslide. The triggering factors of this landslide were several days of heavy rainfall, overexploited soil-strength and low quality of construction works. As a consequence, four concerned CCC engineers were temporarily suspended. It

represents the interaction of both the physical and social aspects (human activity) of vulnerability in creating a disaster. Accordingly, landslides in the CHD can be considered as socio-natural hazards (UNISDR 2017).

Figure 1.3. A fatal landslide event in Batali Hill, CCC on 1 July 2011. (a, b) – top view and (c, d) – bottom view. Source: Department of Environment, Chittagong, Bangladesh; July 2014.

After this incident, the nearby informal houses were evacuated, but the residents came back after several months and started to live in the same disaster-hit area (Figure 1.4). The construction of the retention wall was suspended until 2013. Thereafter, in 2014, the authorities started erecting it again with design modifications. The new design integrated a drainage network along the roadside and additional reinforcing pillars at the back of the walls to prevent future landslides (Figure 1.5). Considering the degraded soil condition, steep slopes, high amounts of rainfall in the monsoon season and the

surrounding exposed households, this place still poses a serious threat of landslides. This is a typical scenario of community-level landslide vulnerability in the urbanized hill districts of Bangladesh.

Figure 1.4. Houses rebuilt in the same hazardous area after the 1 July 2011 landslide in Chittagong. Source: Bayes Ahmed, September 2013.

Figure 1.5. Reconstruction of the retention wall in Batali Hill, Chittagong. (b, c, d) top view and (a, e) bottom view. Source: Bayes Ahmed, field visit, September 2013 and July 2014.

Figure 1.6 depicts how the people of Motijharna, a residential area surrounding a hill in CCC, are living with the risks of landslides.

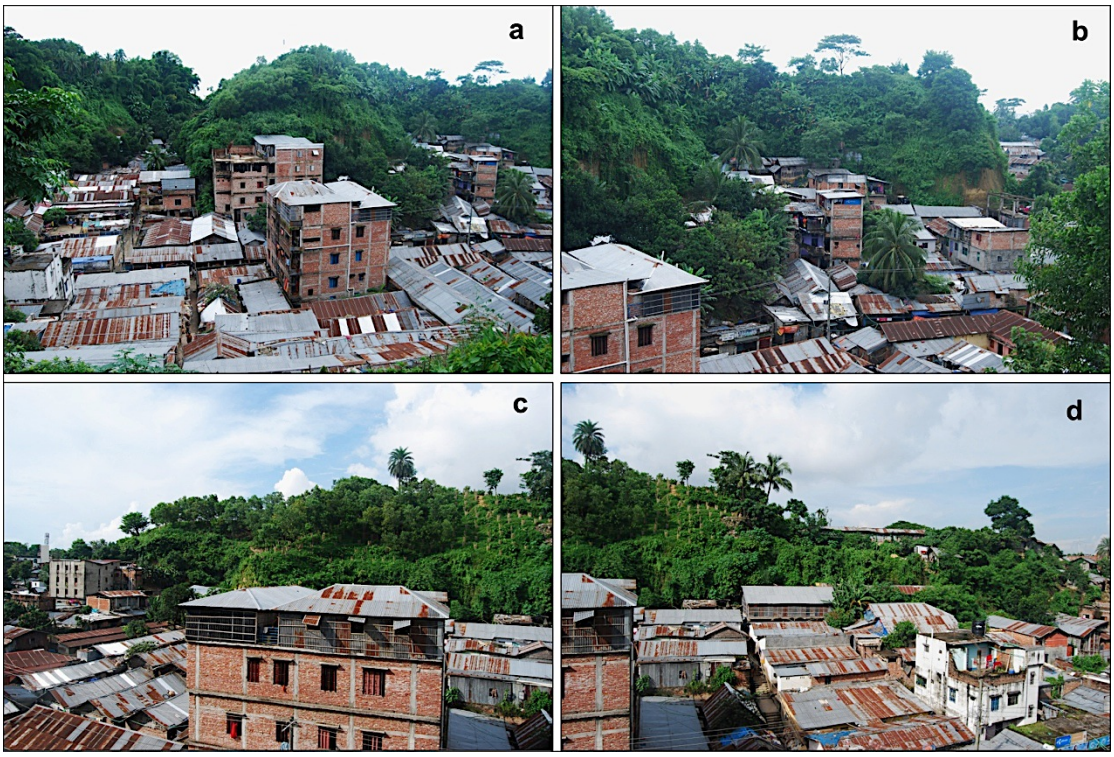

Figure 1.6. Landslide vulnerable areas in Motijharna, CCC. (a, b) N-S view, and (c, d) S-N view. Source: Bayes Ahmed, field visit, September 2013.

The loss and damage due to landslides are also evident in Cox's Bazar Municipality (CBM), Bangladesh. The first fatal landslide event (with 6 casualties) in CBM was recorded on 16 June 2003. A series of other rainfall-triggered landslides killed at least 47 people in CBM on 15 June 2010 (CDMP-II 2012). The arrival of a large number of marginalized people from other parts of Bangladesh is evident in CBM. The concerned authorities are failing to offer them cheap and safer accommodation on flat lands with necessary community facilities. To support their livelihoods, the marginalized people illegally cut the hills for the development of residential houses (Figure 1.7) and are consequently making themselves vulnerable to landslides (Ahmed 2015b).

1.2.2. Landslides and Institutional Aspects

There is no strict hill management system in the urbanized hill districts. This has encouraged many informal settlements to grow on the landslide-prone hill slopes in CCC. These settlements are considered as illegal by the formal

authorities, while the settlers claim themselves to be legal occupants or owners of the hills. An acute land tenure conflict has been on going among the public agencies, settlers, powerful elites and the local community representatives over the past few decades. This kind of contradiction has undermined the institutional arrangement for reducing landslide risk in the urbanized hilly areas. (Ahmed and Rubel 2013).

Figure 1.7. Systematic hill cutting to build residential houses in Cox's Bazar Municipality (CBM). Source: Bayes Ahmed, fieldwork, August to October 2014.

The Chittagong Department of Environment (DoE) is primarily responsible for protecting and managing the hills. On 13 March 2008, after the 11 June 2007 catastrophic landslide event in CCC, the DoE submitted an investigation report to the Government of Bangladesh (GoB). The report depicted a sequential flowchart of the causative factors of landslides (Figure 1.8). Not surprisingly, the components of landslides as identified by the DoE were largely focused on physical or hazard related aspects (i.e. geology, soil, and rainfall etc.). The human-induced factors were only limited to hill cutting and deforestation. The other essential components of community vulnerability such as social, economic, cultural and institutional dimensions were clearly missing (Figure 1.8).

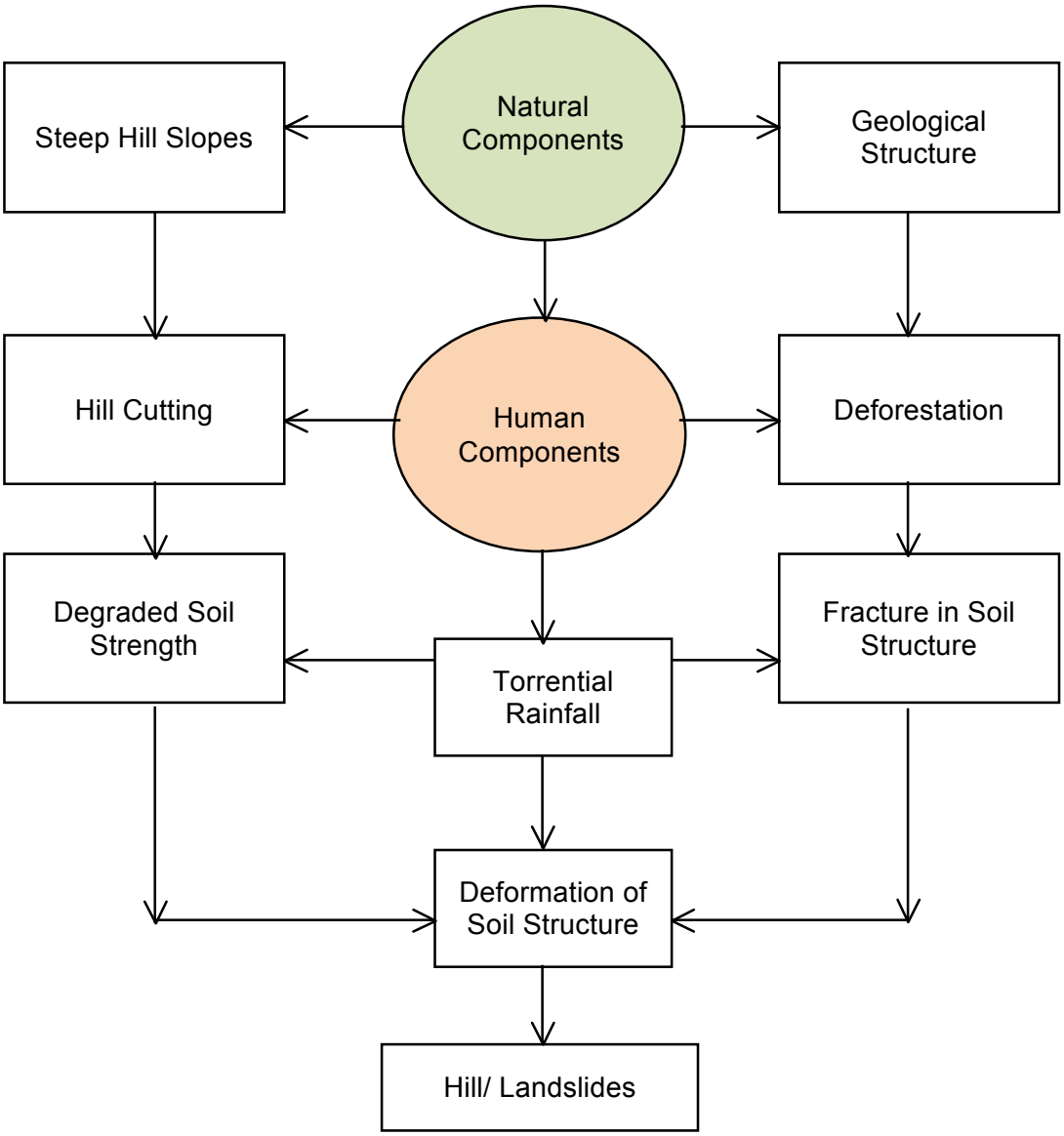

Figure 1.8. Flowchart showing causes of landslides in Chittagong as prepared by the Department of Environment, Chittagong Division, March 2008.

The Building Construction (Amendment) Ordinance, 1990 (section 3C.1) states that hill cutting is allowed only for the construction of dwelling houses without causing any major damage to the hill, especially if there is any issue of major public interest (GoB 1990: 86). According to the Bangladesh Environment Conservation (Amended) Act 2010 (section 6B under Act No. 1 of 1995), it is prohibited to cut or raze hills by a person or government institution or semi-government or autonomous organization or occupied by personal acquisition unless in the case of necessity of national interest (GoB 2010: 9126). It clearly puts restriction on hill cutting. These two coexisting hill protection related (by-) laws are contradictory and have some grey-areas in defining what is national or public interest or what it means by damage to hills. The Chittagong

Development Authority (CDA) prepared the Chittagong Metropolitan Master Plan (1995-2015), which was officially approved by the GoB in 1999. The master plan consists of a structure plan, urban area plan, and a detailed area plan (DAP). The plans have detailed and strict land use guidelines for both the public and private sector development. The following guidelines are clearly mentioned in the DAP to protect the hills in CCC (DAP 2009: 3-27 and 3-29):

- All types of hill cutting should be stopped. In the case of an absolutely necessary government project for public interest, it can be allowed after proper environmental impact assessment, public hearing, expert opinion and law clearance etc.
- The areas already affected by hill cutting should not be allowed for development, rather it should be turned to green belts and the levelled land should be covered with forest at the cost of the land grabbers.
- All the slums and squatters should be gradually removed and the inhabitants should be rehabilitated from the hilltops, slopes and valleys.
- The existing hills have been mapped in the DAP, but the respective authorities should survey and update the information of the hills regularly.

Despite having all the gazetted rules and regulations to protect the hills and ensure safety of lives and property, a group of people are taking advantage of the inconsistencies in the by-laws and violating the existing laws, and are building housing complexes by cutting the hills. For example, in 2008, there was not a single high-rise building in the Motijharna area. Then, within the next six years (in 2014), two five-storey buildings were constructed by cutting the hills (Figure 1.9). It clearly depicts how institutional weaknesses are making people and communities more vulnerable to landslides. The people living with landslide risks in the urbanized hills mostly belong to marginalized communities, who are quite new in dealing with the hilly environment. Their monthly income is much less than the national average and many of them are environmental refugees or displaced due to minority attack or political violence or are victims of other disasters. Yet the government has no plan to provide reasonable accommodation for the disadvantaged people who live on the dangerous hillslopes (Sarker and Rashid 2013; Ahmed and Rubel 2013).

Figure 1.9. Landuse change in Motijharna, Chittagong. Source: **(a)** DoE, Chittagong; and **(b)** Bayes Ahmed, September 2014.

The urbanized hill people neither are capable of making their houses landslide-resistant, nor are they aware of using indigenous knowledge for building safer houses on the hills. They are also culturally less aware of how to utilize the surrounding hills and forests in a sustainable way. It makes them both socio-economically and culturally vulnerable to landslides. The concerned authorities have failed to bring social justice to address community level vulnerability and they are more decisive about the geological and engineering solutions to landslides. The key informants were found to be well aware of the landslide disaster situation in the CHD and they were in full support of implementing the master plans and hill cutting related regulations (BUET–JIDPUS 2015). The assistant commissioner (AC) of Land in Chittagong circle took initiatives to evacuate the people living on the dangerous hills in the monsoon of 2014 (Figure 1.10). After a few weeks, the inhabitants came back (in some cases new occupants were rented) and started living on the same place.

Figure 1.10. A cluster of highly vulnerable informal settlements at the top of Motijharna community was destroyed by the AC land office, Chittagong. Source: Bayes Ahmed, fieldwork, July 2014.

A Web-GIS based and a community based landslide early warning system was also introduced in CCC (BUET-JIDPUS 2015) and CBM (CDMP-II 2012) respectively, but the attempts failed, as there was no interest among the urbanized hill communities and respective authorities. It proves institutional interventions such as preparing land use plans, restricting settlement on the hills and enforcing hill cutting law are not enough to address the landslide problems in urban areas.

In a nutshell, the influx of urban migrants, lack of cultural knowledge in dealing with hill environments, socio-economic vulnerability and in some cases institutional detachment are making the landslide disaster scenario worse in the urbanized hilly areas in CHD. To address these issues, this study will focus on the community vulnerability aspect to identify the root causes and attraction forces for residing on the hill slopes, and to analyse peoples' risk perception.

1.2.3. The Indigenous Hill Communities

In contrast to the situation described in the previous section, the impacts of landslides are much smaller among the indigenous hill communities (IHC). The IHC have lived on the hills (Figure 1.11) since time immemorial and they consider the hills as their ancestors' land (Roy 2000). The IHC do not enjoy formal electricity and water supply or other basic utility and community facilities, yet still they are resilient to landslides. The urbanized hill communities (UHC) mostly use the hills for temporary accommodation purposes and they are more concerned about residing close to a city centre. In contrast, the IHC treat the hills as a sacred place and the hills are part of their cultural identity (Roy 2000). They also have the necessary indigenous knowledge, inherited through generations, to deal with the hills, the natural hazards and the surrounds in a sustainable way. For example, they build houses in a traditional way by preserving the hillslopes, which ensures adequate defence against slope failures. This research studies the IHC in order to understand the relationships between culture and landslide disaster risk reduction (DRR) in Bangladesh.

Figure 1.11. Indigenous hill communities in Bandarban district, Bangladesh. Source: Bayes Ahmed, field visit, 2013–14.

1.3. Research Hypothesis

It is apparent that landslide disasters in the urbanized hilly areas in the CHD are triggered by a combination of physical, social, economic, ecological, institutional and cultural components. In order to identify, address and understand the root causes of landslides in Bangladesh, this research will focus on these multi-dimensional facets of vulnerability at the community level.

In this research, two different groups of communities have been identified in the CHD namely, the urbanized hill communities (UHC) and the indigenous hill communities (UHC). It is assumed that the IHC have a strong perception of landslide risk (e.g. indigenous knowledge), cultural beliefs (e.g. a sense of belonging to nature) and coping strategies (e.g. cultivation methods, building materials, architecture and the land tenure system). The unique characteristics that exist within the IHC point towards landslide disaster risk reduction. In general, the UHC indiscriminately destroy the hills. They lack local knowledge and fail to adapt to the hilly environment. Even though they enjoy higher economic status, utility facilities, community services, landslide shelters and early warnings, the UHC tend to be more vulnerable to landslides. Now, on the basis of the considerations reported above (to be elaborated and expanded more throughout the thesis), the following hypothesis will be tested in this research:

Hypothesis: The indigenous tribal communities are resilient to landslides in comparison to the urbanized hill communities in the Chittagong Hill Districts.

Context is important in DRR studies. Vulnerability can respond to particular contexts and cultural environments (Ayala 2002; Füssel 2007). The context of this research is set to analyse the communities living on the hills of CHD in Bangladesh and the physical, social, economic, ecological, institutional and cultural aspects of vulnerability at community level will be analysed.

1.4. Research Aim and Objective

The aim of this research is to understand the root causes of the vulnerability of the communities living with landslide risks in the Chittagong Hill Districts of Bangladesh. Within this context, the specific objective is to answer the following research questions:

(a) Who are vulnerable to landslides in the Chittagong hill districts?
(b) What makes the communities vulnerable or resilient to landslides?
(c) Why are people living on the risky hill slopes?
(d) Can the cultural dimension of community vulnerability override the economic dimension?
(e) Is it possible to incorporate cultural knowledge into landslide DRR?

In recent years, the paradigm of DRR studies has moved from focusing only on natural hazard-related engineering and technical solutions to giving importance to societal issues (Pelling 2003; Wisner et al. 2004). It is argued that vulnerability is related to poverty (Schneiderbauer and Ehrlich 2006), but meticulous emphasis should be given to cross-cultural vulnerability assessment and incorporating indigenous knowledge in DRR (Alexander 2000; UNISDR 2008; Hewitt 2009; Mercer et al. 2010). This thesis concentrates on the cultural make up of a community and its risk perception concerning landslides.

Community vulnerability to environmental hazards can have multiple dimensions such as economic, social, institutional, cultural, and ecological etc. This thesis argues that a community with inherited indigenous knowledge (i.e. cultural community) can tackle the adverse impacts of landslides than the urbanized hill communities who enjoy more economic and social benefits.

1.5. Originality and New Knowledge

Bangladesh is one of the most disaster-prone countries of the world. Landslide disaster is an emerging threat at the national scale fuelled by the impacts of increased frequency of extreme precipitation, population pressure and higher density in flat lands, high rates of urbanization and deforestation, and lack of cultural knowledge (Kelman 2015; Ahmed and Dewan 2017). Yet there has been limited research activity on landslides in Bangladesh. Considering the local context and limitations, conducting research on landslide DRR issues in Bangladesh is imperative and timely.

This research is based on primary data collection at community level, and all the analytical figures or diagrams and tables are original. The research activity included reconnaissance surveying, the construction of landslide inventories (Appendix-II), landslide susceptibility mapping, detailed community-based questionnaires (Appendix-III), stakeholder and expert opinion surveys (Appendix-IV), and participatory surveying. To achieve the aims and objectives of the research and answer the research questions, the work incorporates both qualitative (participatory) and quantitative (questionnaire) methods. The hypothesis testing and answers to the research questions will allow one to

compare the socio-economic and socio-cultural vulnerability of the two different groups (UHC vs. IHC) that live on the landslide-prone hilly areas in the Chittagong Hill Districts. This kind of research has never been conducted in Bangladesh, and a comparison of the urbanized and indigenous communities living in the same regional or environmental setup is unique.

At the local scale, the outcome of this research allows one to understand how a particular community deals with extreme hazards in the hilly environment. At the national scale, this research promotes awareness of landslide studies by incorporating landslide hazard maps into the gazetted urban master plans and traditional cultural knowledge in landslide DRR initiatives. In order to control hill cutting and deforestation, it encourages the adoption of stricter land-use regulations. At the global and regional scales, this research helps one to understand the root causes of disasters and the characteristics that make a particular community vulnerable or resilient. It is intended that the attempts undertaken in this research to scrutinize the various components of landslide disasters will contribute to the generation of new knowledge by advancing the current trends of DRR studies on community vulnerability and resilience, and cultures and disasters.

1.6. Structure of the Thesis

Figure 1.12 illustrates the structure and inter-connectivity of different chapters of this thesis. Chapter 1 of this thesis presents the background of landslide disasters from global to local scale and the prerequisite of conducting a landslide DRR study in Bangladesh. The geographic focus is identified as the Chittagong hill districts (CHD). Chapter 1 also outlines the research aim, objective and research questions. Chapter 2 is a literature review that explains the DRR terminologies used, examines the various frameworks, social levels and dimensions of vulnerability, and the significance of culture and indigenous knowledge, a mixed methods research and community participatory approach in DRR studies. Chapter 3 sets the fundamental methodology of this thesis. Chapter 4 describes the various aspects related to landslides in Chittagong hill districts.

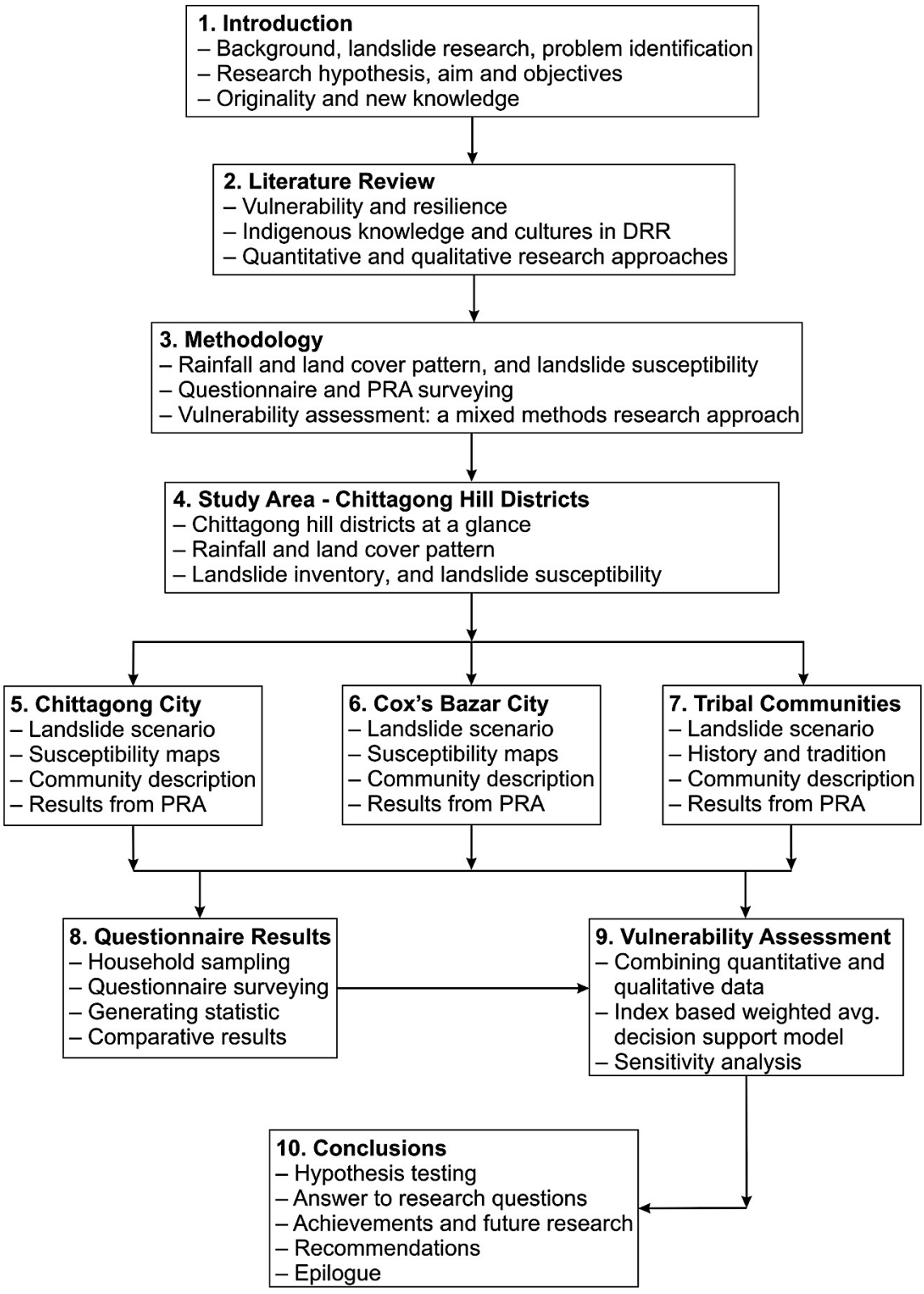

Figure 1.12. Thesis map.

Chapter 5, 6 and 7 describe the Chittagong city corporation, Cox's Bazar municipality, and the indigenous hill communities respectively. They cover the community selection procedure and the detailed results from the community participatory surveying. Chapter 8 presents the results obtained from household

questionnaire surveys of all the communities. In order to understand the similarities and differences, it compares the results. Chapter 9 applies a method for combining quantitative and qualitative data to assess and compare the overall community vulnerability. Chapter 10 is the conclusion. It presents the answers to the research questions, justifies the results and explains the root-causes of community vulnerability to landslides in Bangladesh. It ends by explaining the achievements and contribution of this study, overall landslide vulnerability scenario in the CHD, and future research and policy guidelines or recommendations to accelerate landslide DRR at local level in Bangladesh.

In summary, landslides are a serious threat for the millions of people living in the hilly region of CHD considering the rate of population growth and urbanization, availability of flat lands and resources for the marginalized people, extensive level of hill cutting and deforestation, absence of land use plan integration in DRR; politics, policy and governance, and absence of cultural knowledge in dealing with the extreme climate and natural hazards in the hills. With this background, conducting research on landslides in CHD by focusing on community vulnerability sets the agenda for the first time in Bangladesh.

In the next chapter (Chapter 2), the theoretical framework of this thesis is discussed.

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