

Designing Standard Operating Procedures for a Landslide Early Warning System for Cox's Bazar, Bangladesh

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Abstract

The southeastern hilly region of Bangladesh is frequently affected by flash floods and landslides during the monsoon season. Over the years, landslides have claimed lives and severely impacted communities, ecosystems, livelihoods, and critical infrastructures. In response, a web-based landslide forecasting system was introduced for Cox's Bazar District (CBD), which hosts over a million Rohingya refugees from Myanmar and remains highly vulnerable due to both natural and anthropogenic factors. Despite these efforts, Bangladesh still lacks an effective and operational landslide early warning system (LEWS), highlighting the urgent need for a standard operating procedure (SOP). A high-level key stakeholder workshop was held in the CBD in January 2021 to address this. The objectives were to assess existing preparedness and response mechanisms related to LEWS, identify gaps,

define organisational responsibilities and coordination pathways, and develop an action plan grounded in practical insights.

A total of 57 participants attended, including government officials, disaster management experts, fire service and civil defence personnel, journalists, NGO representatives, and community members. Working in five groups, they discussed current LEWS-related mechanisms in CBD, inter-agency collaboration, and strategies to ensure the sustainability of the forecasting system. Findings revealed that landslide forecasting in CBD primarily relies on rainfall thresholds, without incorporating spatial hazard zoning.

Warnings are typically disseminated using hand-held megaphones during heavy rainfall events. While several challenges persist, participants agreed that an operational and sustainable LEWS is achievable through improved coordination, greater community awareness, enhanced communication systems, regular training, mock drills, planning for evacuation centres, and securing dedicated funding for ongoing initiatives. A functional LEWS will significantly benefit local communities by reducing panic and safeguarding lives and property. The proposed SOP framework should be refined and formalised into a national policy guideline to ensure systematic implementation and maximise its impact on at-risk populations.

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1 Introduction

Landslides are one of Bangladesh's most destructive and recurrent natural hazard-induced disasters, particularly in the southwestern hilly region (Fig. 1) known as the Chittagong Hill Districts (Ahmed 2017; Sultana and Tan 2021). Landslides are a seasonal disaster that occur during the monsoon period (June–September), sometimes combined with hilly flash floods, and cause widespread loss and damage (Sultana 2020; Ahmed 2021). However, the communities and local governments still lack reliable ways to mitigate landslide risks. To develop an effective landslide disaster risk reduction (DRR) strategy, early warning systems should be introduced in line with the United Nations (UN) Early Warnings for All (EW4All) initiative (WMO 2025).

There is still no operational and people-centric landslide early warning system (LEWS) available in Bangladesh. Earlier initiatives include community-based LEWS developed for Cox's Bazar district (CBD) in 2012 (CDMP-II 2012). Later on, some non-governmental organisations (NGOs) funded by various donors worked sporadically for

implementing LEWS and other types of warning systems in different parts of CHD. Still, they failed due to a lack of long-term funding commitments, skilled human resources, maintenance and effective continuity of the projects. For example, a 3-day rainfall, temperature, humidity, daylight duration, and wind speed-based agricultural forecasting system was introduced in the Alikadam Upazila in Bandarban. Regrettably, the whole system, which was implemented by the Department of Agricultural Extension and funded by the World Bank, is now non-operational and inactive (Fig. 2). This manual information board/alert system requires extensive funds for regular maintenance, local-level training and dissemination. The system could also be extended for rainfall-induced landslides and flash floods warning, however, at present, the whole project initiative seems like failed with no long-term impact.

To overcome such limitations, Ahmed et al. (2018, 2020) developed a protocol for a landslide forecasting system for Chittagong and Cox's Bazar districts (Fig. 1b), respectively. After several years of multi-partner collaboration, calibration and validation, in October 2022, a web-based dynamic land-

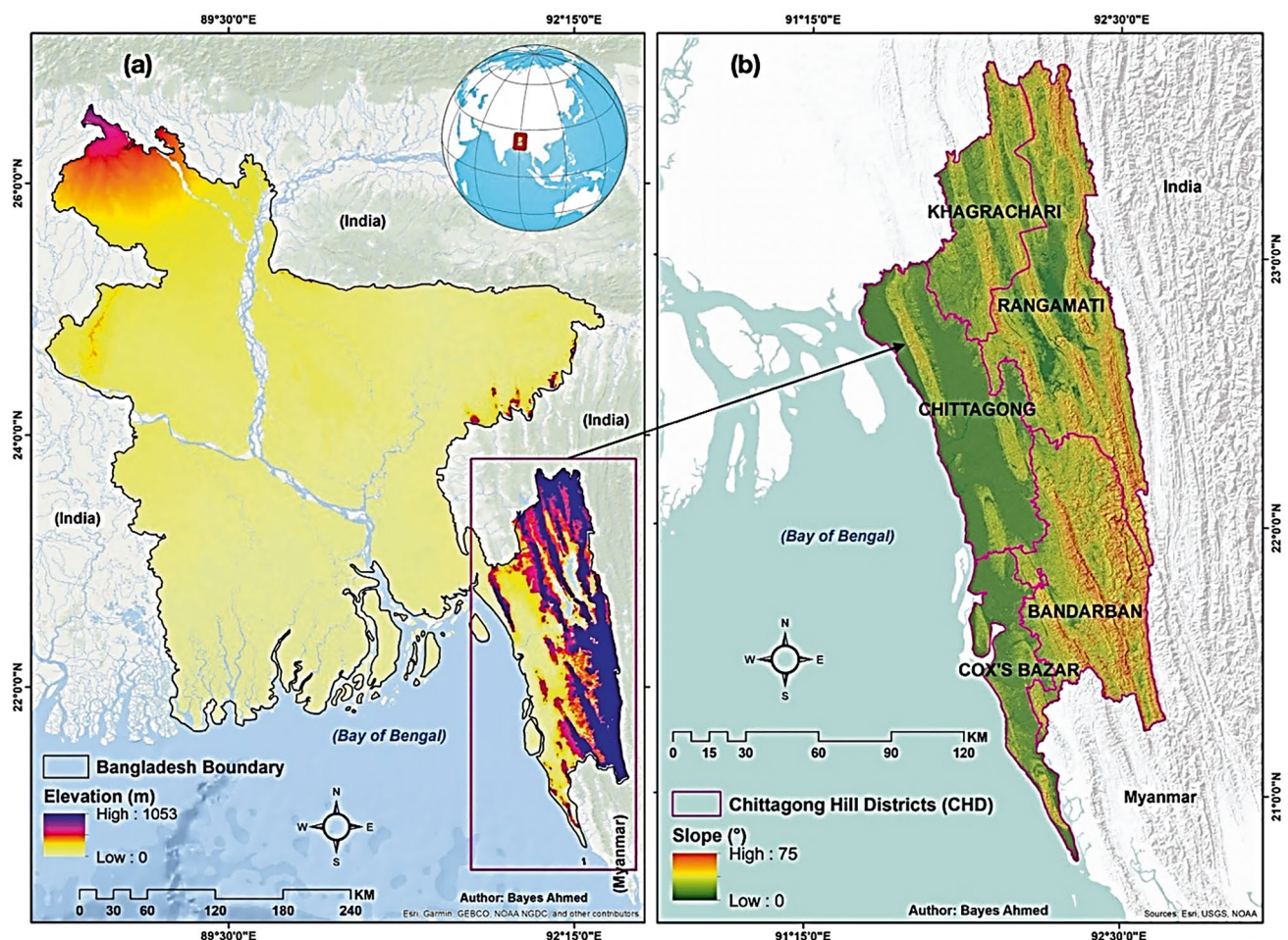


Fig. 1 Map showing the geographical location of the Chittagong Hill Districts (CHD) in Bangladesh. (Source: Ahmed 2021)



Fig. 2 A weather-based agricultural alert system (now non-operational) visible in the Alikadam Upazila in Bandarban district, Bangladesh. (Source: Bayes Ahmed, fieldwork, May 2023)

slides forecasting system was formally introduced for Cox's Bazar, the first of its kind in Bangladesh. The system is now being piloted on the Bangladesh Meteorological Department's (BMD) official website and is going through further recalibration and validation processes (BMD 2022).

Any warning system should have the following four pillars in place (WMO 2025):

1. Disaster risk knowledge: community risk perception, vulnerability components, hazard pattern and trends, data availability and risk maps.
2. Detection, observation, monitoring, analysis and forecasting: hazard monitoring, early warning services based on sound scientific methodology, accuracy and validation.
3. Warning dissemination and communication: reaching the at-risk communities, interpretation and appropriateness, clear and usable risk information.
4. Preparedness and response capabilities: detailed response plan, capacity building, and willingness to act.

In most cases, general people, non-governmental organisations (NGOs) and stakeholders confuse landslide forecasting systems with LEWS. An effective LEWS should include all four pillars mentioned above, and there should be an integrated and interconnected network of links. The Ministry of Disaster Management and Relief (MoDMR) published a guideline for landslides DRR (MoDMR 2018), but this document does not provide any details about community involvement and organisational operation plans. Before inaugurating the newly developed landslide forecasting system for CBD (BMD 2022), it was necessary to understand the existing mechanism available for warning

dissemination and communication, identify gaps, and produce an effective and operational response and preparedness plan. Consequently, this study aimed at developing a standard operating procedure (SOP)¹ farmwork for landslides in Bangladesh. The objectives of this study were threefold:

- (a) To identify gaps and understand existing LEWS-related preparedness and response mechanisms in Cox's Bazar.
- (b) To produce a framework for organisational responsibilities and intra-organisational connectivity.
- (c) To develop a three-tier (low, medium, and high) action plan for landslides DRR by analysing practical challenges.

2 Methodology

2.1 Case Study Area: Cox's Bazar District

The Cox's Bazar District (CBD) was taken as a case study area for this study, as the landslide forecasting system was officially developed and ready to be deployed at that stage. Myanmar bounds CBD on the south-east and the Bay of Bengal on the south and west sides (Figure 3a). Currently, CBD hosts over one million Rohingya refugees (Fig. 3b),

¹In DRR studies, SOP is defined as a set of clearly defined guidelines that outline the specific roles and responsibilities for stakeholders, agencies, and communities. SOP also defines coordinated actions to be taken before, during, and after a disaster event. These protocols enhance preparedness, ensure timely response, and minimise confusion and delays in decision-making during emergencies (Fathani et al. 2016; IFRC 2018).

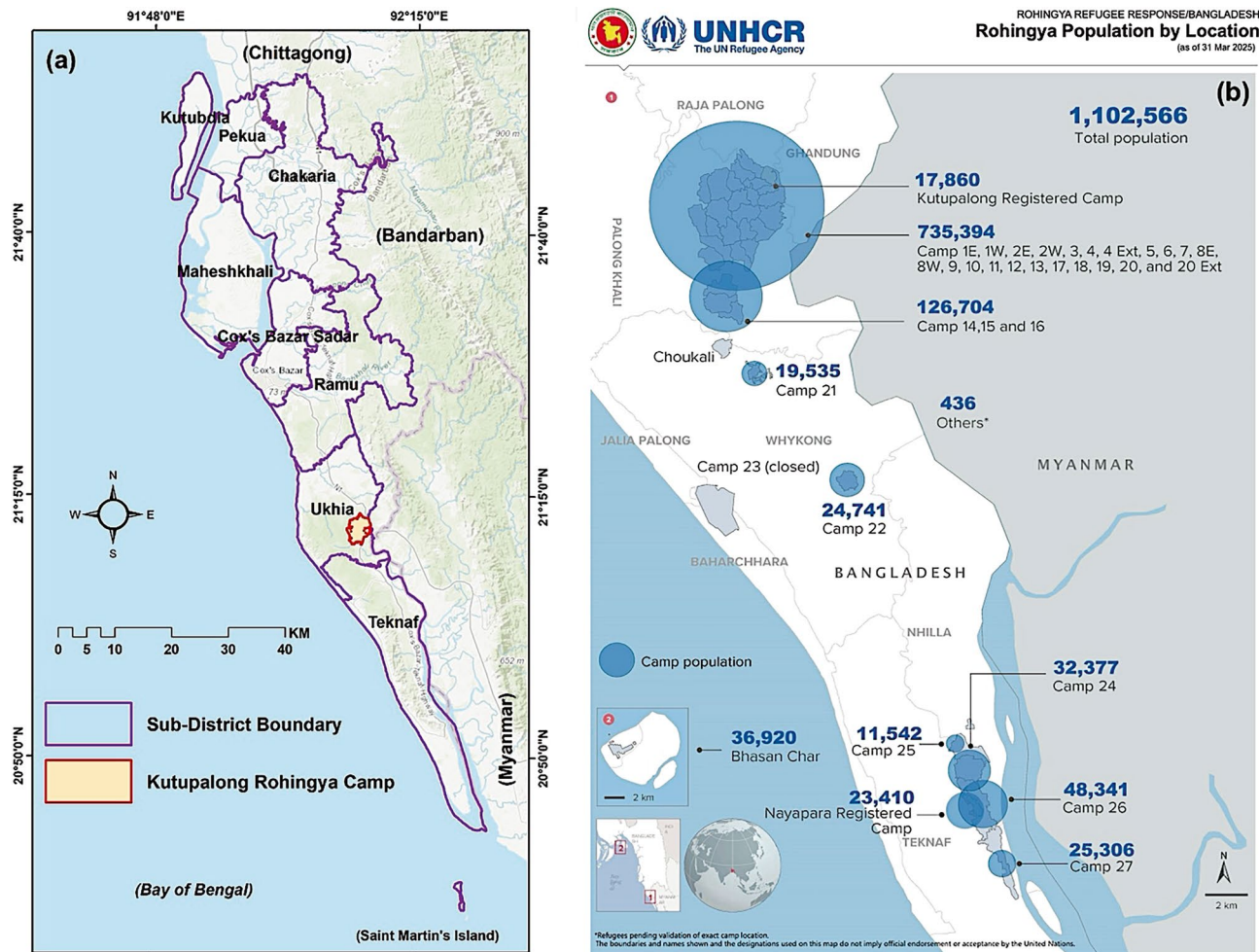


Fig. 3 Location maps showing (a) the Cox's Bazar district, and (b) the Rohingya refugee camps. (Source: (a) Bayes Ahmed, and (b) UNHCR 2025)

who primarily fled from Myanmar in 2017 to avoid genocide and serious crimes against humanity (UNHCR 2025). In addition, CBD has a total population of about 2.8 million with a density of 1133 people per square kilometre (BBS 2023). The elevation of hills ranges from 30–100 m, and the surface geology is dominated by Dupi Tila, Tipam, and Boka Bil formations. Such rock types are suitable for triggering landslides during the monsoon (June–September) as the bed-rocks are primarily made of clay, sand and siltstones (Persits et al. 2001).

Overall, Cox's Bazar is highly vulnerable to landslides (Ahmed 2015) due to a combination of high population density, fragile rock types, torrential rainfall, hill cutting, unplanned urbanisation, deforestation, and other human-caused factors (Ahmed 2021). For example, in 2024, a total of 634 landslides were recorded inside the Rohingya camps, affecting over 1500 shelters and 8000 refugees. The team identified 891 landslide locations after conducting fieldwork between 20 August and 19 October 2020 (Fig. 4). The landslide movement type was dominated by fall (36.50%) fol-

lowed by topple (19.40%); the landslide type was predominantly active (65%); the distribution was advancing (36%); the style was single (62%); and around 60% of the landslide locations were marked as highly vulnerable (BMD 2022). Based on the fieldwork experience, it was found that Ukhia, Cox's Bazar Sadar, Teknaf, Ramu, and Maheshkhali Upazilas (e.g., sub-districts) were affected mainly by landslides (Fig. 3a).

2.2 High-Level Key Stakeholders' Workshop

A high-level key stakeholder workshop was organised to develop an SOP for an effective landslide early warning system (LEWS) in Cox's Bazar district. The workshop focused on three main areas: (a) the organisational response mechanism after the early warning/alert message is received, (b) the probable collaboration among different organisations, and (c) formulating recommendations to make the LEWS sustainable in the context of Bangladesh.



Fig. 4 Landslide vulnerable houses located on the (a, b) urbanised and (c, d) rural hilly communities, and (e, f) the Rohingya refugee camps in Cox's Bazar district. (Source: The authors, fieldwork, 2021 and 2023)

2.2.1 Workshop Participants

The workshop participants were high-level government officials, local political representatives, national and international NGO staff, disaster management and landslide experts, fire service and civil defence officials, journalists, and community representatives.

Before conducting the workshop, all the necessary institutional approvals, local-level permissions, and consent were in place. During the workshop, all the recommended COVID-19 safety measures were ensured.

2.2.2 Workshop Details

The workshop was divided into four parts. Inauguration and discussion were carried out in the first part, technical and operational aspects of the newly-introduced landslides forecasting system (BMD 2022) was presented in the second part, the activities and presentations by the workshop participants took place in the third part, and finally, the closing remarks were made in the fourth part. Five groups were formed randomly for the workshop activities. All groups were assigned three similar activities. All necessary materials, such as the guiding questions, pen, paper, and posters, were provided. The co-authors of this paper facilitated the workshop, and three additional assistants were recruited to run the group activities. The workshop was conducted in Bengali language; however, everything was later translated into English.

First, the groups discussed an activity following the guiding questions one by one and then made a draft of their ideas. Second, after finalising the concepts to be presented, they wrote them down on posters. Lastly, two/three group representatives from each group presented the activity to the entire workshop participants. This way, all five groups shared their ideas through a total of 15 short presentations. The presentations were recorded, and the hardcopy posters were collected by the workshop team members. The workshop team members collected the hardcopy posters for analysis later on.

2.2.3 Workshop Activities

We conducted the following three group activities during the workshop.

Organisational Response Mechanism

In Activity 1, the participants in all five groups identified the existing and initial response mechanisms of the organisations that work in the disaster management domain in Cox's Bazar. Then, the group members discussed the challenges and the way forward for the working procedures during the initial response to the early warning at the organisational level. The guiding questions for this activity were:

- (a) What are the existing LEWS-related mechanisms available in Cox's Bazar?
- (b) What should be the organisations' first steps immediately after receiving an early warning/alert for the landslide?
- (c) What are the available tools and techniques to disseminate the warning to the masses?
- (d) What are the challenges and ways forward for the organisations in disseminating the warning to people living in landslide risk zones and evacuating/relocating them to a shelter or safer place?

Collaboration Among Organisations

In Activity 2, the participants were asked to discuss various ways to enhance collaboration among organisations to effectively make the landslide early warning system (LEWS) operational. They were also instructed to produce a flowchart for organisational resilience for implementing the LEWS. The guiding questions were:

- (a) Can you please list organisations that can collaborate to work on the landslide disaster risk reduction?
- (b) What are the areas of collaboration among them?
- (c) What are the challenges and ways forward?
- (d) Can you produce a flow diagram for a multiple organisational collaboration strategy?

Recommendation to Make the LEWS Sustainable

In Activity 3, the participants in each group discussed the recommendations to make the LEWS sustainable. Their experience of the existing early warning system for other disasters, such as tropical cyclones, is integrated during the discussion. The following were the guiding questions for the activity:

- (a) What are the different mitigation steps for low, medium, and high-risk scenarios?
- (b) What are the real-world challenges to implementing the newly developed landslide forecasting system?
- (c) How could the local people benefit from the LEWS implementation?

3 Results

The workshop occurred at Sabarang Banquet Hall, Best Western Heritage, Kolatoli, Cox's Bazar, Bangladesh on Monday, 11 January 2021 from 09:30 to 15:00 h. 57 people, and 37 directly participated in the workshop activities (Appendix 1). Six guests discussed various aspects of landslide disasters and the LEWS in Cox's Bazar. The guests were the high-level government officials from the Department of Environment, the Ministry of Agriculture, the Cox's Bazar

District Administration, senior officials from International NGOs, and landslide experts.

3.1 Welcome Session and Presentation on LEWS

The Programme Coordinator of the International Union for Conservation of Nature (IUCN) in Bangladesh inaugurated the workshop by welcoming the distinguished guests, participants, and audience.

The Senior Emergency and Rehabilitation Officer, Food and Agriculture Organisation (FAO) in Cox's Bazar, Bangladesh, started his speech by thanking all the guests. He described that landslides cannot be tackled until different stakeholders come together and communities are put at the centre of the discussion. He adds- if the LEWS is put in place and implemented correctly, eventually, for the first time in Bangladesh, we will have the capacity to inform the authority 5 days in advance. He emphasized that the work needs an effort from different authorities, stakeholders and groups. He expressed the need to put the communities at the centre.

The Country Representative of IUCN Bangladesh said that, from a climate change perspective, when the amount of rainfall gets abruptly higher, the risk of landslides also gets higher. Early warnings and capacity building are the two main pillars of adaptation and mitigation, as highlighted in Bangladesh's climate change strategy and action plan. He further insisted that any such LEWS will only be functional when the local community backs it. So, capacity development is an important aspect.

The Director (Planning) at the Department of Environment said that a landslide is a sorrowful incident for us. The hills are naturally made. Although people cannot create the hills, they are harming them. So, as a result, landslide events are occurring. He insisted that the landslide disaster is human-made. People are cutting down the hills and using them for different purposes- all these have negative impacts. Hill cutting is costing life and also destroying the whole ecosystem. He emphasised stopping hill cutting, saying that the people who are directly cutting the hills might be illiterate and unaware, but their bosses are not. The bosses are cutting the mountains on purpose- for their benefit. He explained how the LEWS will work in a real-world scenario and requested the participants to contribute to the activities, as this kind of LEWS system is the first in Bangladesh.

Next, the first author presented on the newly developed landslide forecasting system (BMD 2022) and the roadmap for initiating a sustainable, community-centred and effective LEWS. He mentioned that there is already a cyclone early warning system available here. They are trying to implement a LEWS and for that to happen, they are collaborating with the District Administration and other rele-

vant organisations. His presentation brought the past scenarios of hill cutting and the adverse impact on the hills due to the Rohingya influx. Both Bangladeshi and the Rohingya communities are living in risky areas that are highly prone to landslides in Cox's Bazar, Chittagong Hill Tracts and the wider region. There was always the risk of landslides in this region, and the influx of over one million Rohingyas made it even riskier. The massive deforestation for constructing houses for the Rohingyas took place in Cox's Bazar. He further discussed the historical events of the landslides, the methodology for the scientific data collection for the research, and the current scenario of landslides in the region. He described to the participants how the EWS will work. Finally, he explained the objectives of the workshop.

Afterwards, the Upazila Nirbahi Officer (UNO)/ the chief executive officer of an Upazila of Cox's Bazar Sadar said that landslide events are one of the challenges in conducting administrative work in the region during the monsoon. She described how the hills are cut to grab the land and the implementation of the law that she does to stop it. She welcomed the LEWS and requested to make it easy to operate and easily accessible to the marginal areas. She also emphasized building awareness among the people by bringing some giving examples of her experience of dealing with landslide disasters. Finally, she requested the participants to contribute to the workshop capacity and thanked the organisers and the audience.

Finally, the Deputy Director of Agricultural Extension at the Ministry of Agriculture described the scenario of landslides in the Cox's Bazar district and his experience of observing hill cutting that leads to landslides in other hill districts. He then depicted the scenario of the unaware people who live in the foothills. He also brought some mismanagement issues in the area and opined that the administration needs to be strict.

3.2 Activities Undertaken

During Activity 1, the groups discussed and shared the organisational response mechanism after receiving the early warning. In doing so, they described the existing mechanisms for LEWS, different organisations' responses, available tools and techniques to disseminate alerts or warnings to the people and finally, the challenges to implementing the LEWS. During Activity 2, the groups made lists of organisations that can collaborate on landslide disasters and the challenges and ways forward. In Activity 3, the participants discussed the different mitigation steps for low, medium, and high-risk scenarios, the challenges, and how the LEWS will benefit the local people. All five groups presented the activities one by one to the audience (Fig. 5).



Fig. 5 Photographs from the Cox's Bazar LEWS SOP development workshop. (Source: The authors, 11 January 2021)

3.3 Organisational Response Mechanism After Receiving Alerts

In this activity, the participants in all five groups identified the existing and initial response mechanisms of the organisations working in disaster management in Cox's Bazar District. The group members discussed the challenges and the way forward for the working procedures during the initial response to early warning at the organisational level.

3.3.1 Existing Landslide EWS-Related Mechanisms Available in Cox's Bazar

Based on the group discussion and poster presentations, the groups identified the following LEWS-related mechanisms in Cox's Bazar (Table 1).

Table 1 Availability of existing landslide EWS-related mechanisms in Cox's Bazar

Group 01	The warning is disseminated through: • Megaphones • Local radio • CT (control and communication) cable network • Local Media • Religious institutions • CPP (Cyclone Preparedness Program) volunteers
Group 02	The local administration, disaster management committee, and district, Upazila (sub-district), and Union (the lowest administrative unit) committees manage landslide warnings
Group 03	Massive campaign at the district, Upazila (sub-district), and Union level through CPP volunteers, announcement through megaphones in Mosques, government and non-government volunteers and the Bangladesh Fire Service and Civil Defence (FSCD)
Group 04	Warning through megaphones, sending the warning to homes (in person), taking people to safer places, warning people through megaphones in Mosques, Temples, and Pagodas, and sending messages through radio and cable networks
Group 05	• People are warned through megaphones by the volunteers of the Upazila Disaster Management Committee (CPP and Scouts) after an hour of downpour • A message (warning) is sent through radio and television

Source: The workshop participants, January 2021

3.3.2 Steps for the Organisations Immediately After Receiving an Alert

Following the activity's guiding question, the participants came up with the ideas presented in Table 2 regarding the initial steps undertaken by the organisations immediately after receiving early warnings for landslides.

3.3.3 Available Tools and Techniques to Disseminate the Warnings

The participants presented the existing tools and techniques for disseminating the warning to the mass population in posters. Responses from all groups are given in Table 3.

3.3.4 The Challenges for the Organisations

The participants in all five groups came up with the ideas below (Table 4) regarding the challenges for the organisations in disseminating the warning to people living in risk zones and evacuating/relocating them to a shelter or safer place.

3.4 Collaboration Among the Organisations

In this activity, the participants were asked to discuss various ways to strengthen collaboration among organisations to make the landslide early warning system (LEWS) effectively operational. They were also instructed to produce a flowchart for organisational resilience for implementing the LEWS and present their findings at the end of the session.

Table 2 Organisations' immediate response to landslide warnings

Group 01	• Coordination meeting • Dissemination of decisions
Group 02	• Arranging a meeting with government assistance • Evacuating the victims to a safe place
Group 03	• Holding a coordination meeting • Massive campaign • Evacuating people from risky places
Group 04	• Arrangement of vehicles for faster evacuation • Engaging the volunteers • Helping people in shifting furniture or household stuff • Taking special care of children, elderly people and pregnant women
Group 05	• Making sure that the temporary shelter centres are usable • Making sure that people from risk zones are evacuated to the shelters

Source: The workshop participants, January 2021

Table 3 Available tools and techniques to disseminate the warning to the masses

Group 01	Available tools	Available techniques
	• Hand mic • Mobile van loudspeakers • Warning flag	• Direct communication • Official order letter • Emails/telephones • Scroll message on local television
Group 02	• Information services through mobile phones • Dissemination system by a microphone • Awareness by forming community teams	
Group 03	• Radio, Television, megaphone, microphone, social media, and rescue equipment	
Group 04		
Group 05	• Community radio, microphone, Bangladesh Betar (national radio service), television, and door-to-door campaign by various groups	

Source: The workshop participants, January 2021

Table 4 The challenges for the organisations

Groups	Challenges
Group 01	• Lack of awareness • Remote area • Risk-taking attitude (ignoring the risks) • Inadequate human resources
Group 02	• Lack of skilled workforce • Lack of landslide awareness • Not identifying vulnerable communities in remote areas • Lack of physical and telecommunication (system) • Lack of enough safe shelter centres • Lack of warning and preparedness resources for the volunteers
Group 03	• Not giving importance • The fear among the illegal settlers of not being able to resettle in the same place • Lack of enough shelter centres • Lack of security of the property • Illegal housing by cutting down the hills
Group 04	• Not having good (road) communication • Not having a mobile (cellular) network (in remote places) • Lack of interest in going to a safer place • Not getting administrative assistance on time

(continued)

Table 4 (continued)

Groups	Challenges
Group 05	• Precautions are taken based on assumptions • Lack of interest in leaving the house/place • Lack of public awareness about the risks • (Lack of) a modern landslide warning and response system

Source: The workshop participants, January 2021

3.4.1 Collaborate on Strategies for Landslide EWS Dissemination

The participants in all five groups came up with the following ideas (Table 5).

The following ideas emerged from the group discussions (Fig. 6):

- (a) Warning dissemination
 - District/Upazila administration
 - Local Police
 - CPP, Red Cross
 - BMD
- (b) Emergency response
 - Fire service
 - Volunteers (CPP, UDMC, UZDMC)
 - Department of Health

3.4.2 The Challenges in Organisational Collaboration

The common challenge in organisational collaboration is the lack of coordination. In addition, the participants mentioned the lack of advanced technology, remote areas, and skilled professionals (Table 6).

3.4.3 Multi-Organisation Collaboration Strategy

Multiple organisations that work in disaster management can collaborate according to their specialisation. Figures 7, 8, 9, 10 and 11 show the flow diagrams produced by the workshop participants to show the collaboration strategy among various organisations:

- (a) Organisational collaboration strategy by Group 01
- (b) Organisational collaboration strategy by Group 02
- (c) Organisational collaboration strategy by Group 03
- (d) Organisational collaboration strategy by Group 04
- (e) Organisational collaboration strategy by Group 05

3.5 Recommendations to Make the LEWS Sustainable

In this part, the group participants discussed the recommendations to make the LEWS sustainable. Their experi-

Table 5 List of organisations that can collaborate to work on landslide disasters

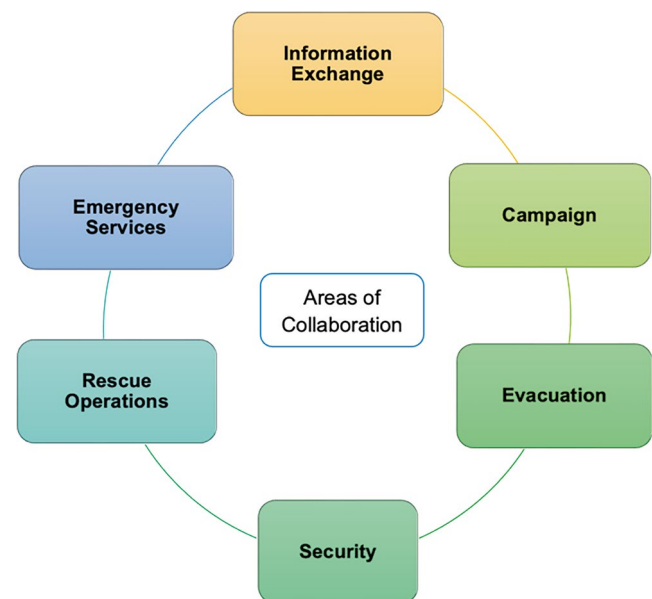
Group 01	• NDMC (National Disaster Management Council) • DDMC (District Disaster Management Committee) • UZDMC (Upazila Disaster Management Committee) • UDMC (Union Disaster Management Committee) (Upazila is sub-district, and Union is the lowest administrative unit in Bangladesh)
Group 02	• DDM (Department of Disaster Management) • BMD (Bangladesh Meteorological Department) • UNO (Upazila Nirbahi Officer) or Chief Executive Officer • PDB (Power Development Board) • RHD (Roads and Highways Department) • LGED (Local Government Engineering Department) • BWDB (Bangladesh Water Development Board) • FD (Forest Department) • CPP (Cyclone Preparedness Programme) • BDRCS (Bangladesh Red Crescent Society) • Media • NGOs (Non-Government Organisations)
Group 03	• Fire Service • CPP • Red Crescent • Scouts • Social Welfare Department • Social Media • NGOs • Engineering Core of Army • Police • Ansar/Village Defence Party (VDP) • ISCG (Inter-Sector Coordination Group) for the Rohingya camps
Group 04	The organisations that can collaborate in disseminating the warning • District Disaster Management Committee • Fire Service • Voluntary Organisations • Mass Media • Local Representatives The organisations that can collaborate for rescue operations • Administration • Vehicle Owners • Fire Service • Law Enforcing Agencies • Voluntary Groups/Bangladesh Ansar and VDP The organisations that can collaborate for food supplies • NGOs • Local administration • Volunteers The organisations that can collaborate for rehabilitation • District Relief and Rehabilitation Office • Non-Government Voluntary Organisations/ NGOs

(continued)

Table 5 (continued)

Group 05	• District Administration • District/Upazila Parishad • DRRO (District Relief and Rehabilitation Office) • Project Implementation Officer (PIO) • Department of Forestry • Land Office • Fire Service and Civil Defence • Bangladesh Meteorological Department • Water Development Board • LGED • Civil Surgeon • Upazila Health Complex • CPP • Red Cross • Ansar VDP • Police • International Humanitarian Assistance (FAO, IOM, UNDP, WFP, UNHCR)/ INGOs
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Source: The workshop participants, January 2021

**Fig. 6** Areas of collaboration among the organisations as presented by Group 2**Table 6** The challenges in organisational collaboration

Group 03	• Lack of advanced technology/materials • Hard-to-reach areas • Lack of coordination and a lack of a signalling system
Group 04	• Not disseminating the proper warning at the right time/ not giving enough importance • Not getting materials/ assistance
Group 05	• Lack of coordination • Lack of enough rescue professionals and rescue materials

Source: The workshop participants, January 2021

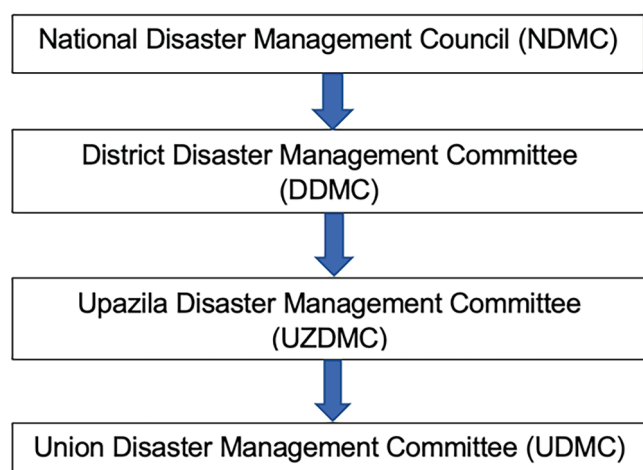


Fig. 7 Strategic collaboration among various organisations proposed by group 01

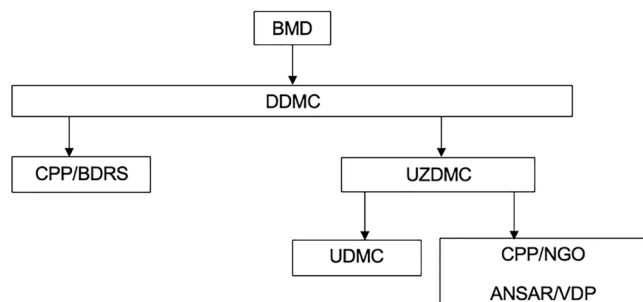


Fig. 8 Strategic collaboration among various organisations proposed by group 02

ence of the existing early warning system for other disasters (e.g. tropical cyclones) is integrated during the discussion.

3.5.1 Different Mitigation Steps at Low, Medium, and High-Risk Scenarios

Table 7 shows different mitigation steps in various risk scenarios shared by the workshop participants.

3.5.2 The Real-World Challenges to Implementing the Newly Developed LEWS

According to the participants, the real-world challenges to implementing the LEWS are mainly a lack of infrastructure, advanced technological features and institutional capacity. Table 8 below depicts the ideas of the participants:

3.5.3 Local People's Benefits from the LEWS

Table 9 below shows the benefits shared by the participants from the LEWS for the local people in the CBD.

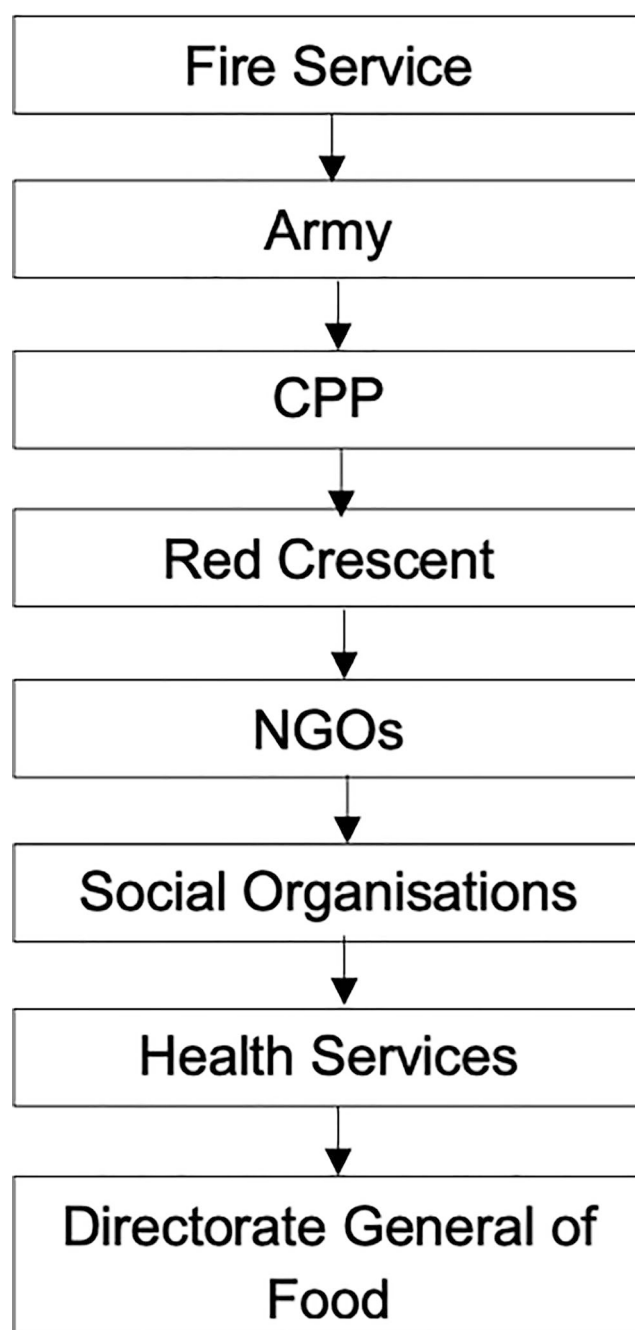


Fig. 9 Strategic collaboration among various organisations on landslide disasters from top to bottom. (Source: Group 03)

4 Discussion

This report is prepared based on the data gathered from participants' group work and presentations at the workshop. It discusses all three activities undertaken by the participants focusing on the existing response mechanisms, the steps to be undertaken after an early warning is received, organisational collaboration, the challenges in implementing the

Fig. 10 Strategic collaboration among various organisations on landslide disaster from top to bottom. (Source: Group 04)

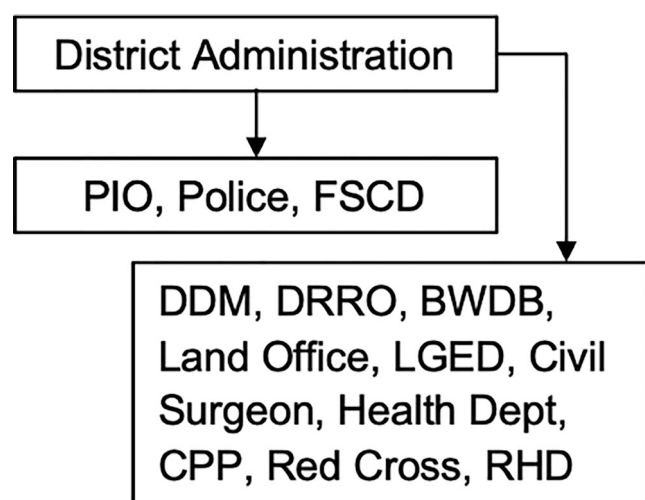
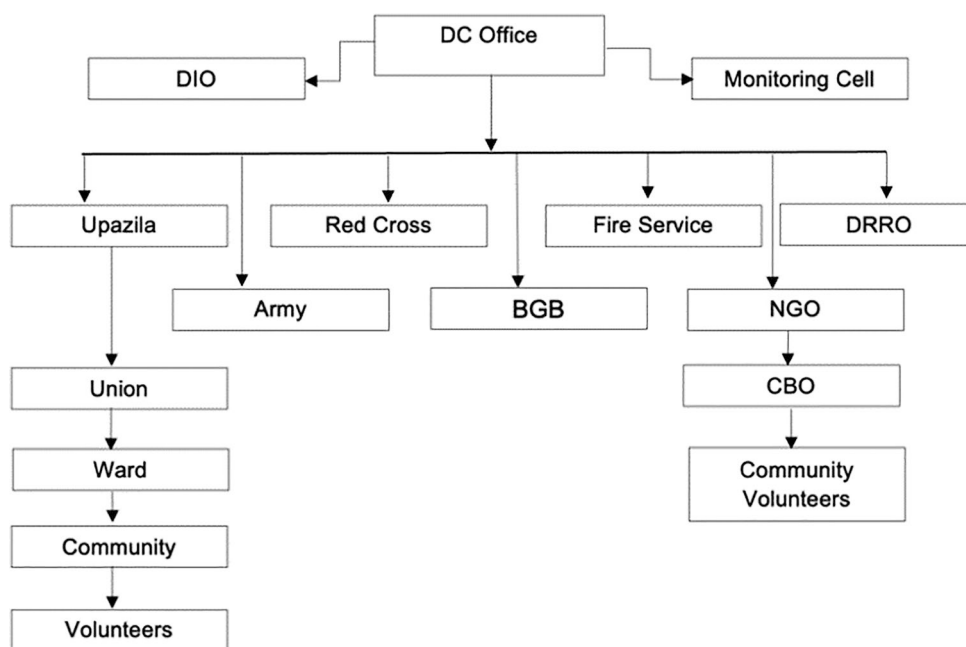


Fig. 11 Collaboration among various organisations on the landslide disaster. Source: Group work at the workshop by Group 5

Table 7 Different mitigation strategies at low, medium, and high-risk scenarios

Group 01	• Strengthening institutional capacity • Increasing inter-organisational connectivity • Proper data management • Awareness programmes and updated contingency planning • Integration of the vulnerable community in planning and implementation
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(continued)

Table 7 (continued)

Group 02	Low-risk scenario • Regular observation and community awareness building Medium-risk scenario • Population identification • Building community awareness (knowledge and signals) • Increasing community-level preparedness • Alert phases dissemination at the community level • Evacuation (if needed) and prepositioning services (water, sanitation, food, health, security, and shelter) • Search and rescue team preparation High-risk scenario • Select and identify high-risk areas • Building community awareness (knowledge and signals) • Increase community-level preparedness • Alert phases dissemination at the community level • Evacuate to safe locations (women, aged people, and children need to be prioritised) • Primary response services in place
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(continued)

Table 7 (continued)

Group 03	Low-risk scenario • Sending alerts for awareness Medium-risk scenario • Warning through megaphones • Evacuating people to a safer place • Stocking enough food and keeping the shelter centres prepared High-risk scenario • Evacuating people to a safe shelter immediately after a warning is received • Keeping the rescue personnel prepared and increasing the security
Group 04	Low-risk scenario • Sending minor warnings • Preparing the necessary household goods beforehand • Stocking food/dry food • Keeping necessary medicines and saline ready • Keeping vehicles on standby • Demolishing illegal housing in the risk zones Medium-risk scenario • Sending a medium warning • Increasing the campaign of the warning • Zone-wise dissemination of warning through microphones from mosques, temples and in other ways • Dissemination of the warning online-through Facebook, online news and sending text messages • Keeping arrangements for enough vehicles High-risk scenario • Following the instructions from the administration • Ensuring safe shelter • Keeping necessary medicines and dry food with oneself • Keeping the goods in a secure place • Ensuring that medical teams are ready • Ensuring volunteer teams are ready • Keeping coordination among the law-enforcing agencies • Keeping the rescue team ready

(continued)

Table 7 (continued)

Group 05	Low-risk scenario • Constructing guide walls to protect homes in low-risk zones • Building awareness about all kinds of risks Medium-risk scenario • Ensuring proper land management and landslide warning system by geographic information system (GIS) mapping • Developing a proper water drainage system • Constructing a protection wall High-risk scenario • Evacuating people from high-risk areas • Halting housing in high-risk areas • Doing forestation with long-lasting and fruit trees in risky hill slopes • Strict implementation of land management law
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Source: The workshop participants, January 2021

Table 8 The real-world challenges to implementing the newly developed LEWS

Group 01	• Lack of institutional capacity • Lack of coordination of institutions • Inadequate data management • Inadequate awareness programmes and planning • Absence of involvement of stakeholders (beneficiaries)
Group 02	• Lack of authority for an authoritative protocol for information production and dissemination • Lack of availability of mobile network connection • Common people do not understand the message properly • Lack of institutional capacity
Group 03	• Not having a sufficient mobile (cellular) network • Not having the skill to use digital devices • Lack of awareness • Lack of skilled human resources
Group 04	• Lack of sufficient mobile (cellular) network • Not finding enough skilled volunteers • Lack of trained workers • Poor road communication system
Group 05	• Lack of reliable real-time information on rainfall • Recurrent land-use change and lack of vegetation coverage and settlement data • Lack of enough devices to get the message at the root level

Source: The workshop participants, January 2021

Table 9 Benefits to the local people from the LEWS

Group 01	- Receiving appropriate information in real-time - Saving lives and belongings
Group 02	- At least the community will get the message (warning) of risks - Evacuation to a safer location immediately (will be possible) - Save life and livelihood - It may reduce fear among the masses
Group 03	- Opportunity to get an early warning - Opportunity to save people and property - Opportunity for evacuating pregnant women, aged people and children to a safer place beforehand - The casualties in landslides will decrease - The risk of panicking will decrease
Group 04	- People can take early preparedness measures if they get an early warning - Can save life and property - Can arrange a safe shelter beforehand
Group 05	- Receiving information about the risky situation immediately - Getting a real-time, modern GIS-based warning system through the coordination of all related organisations - The risk of panicking suddenly will decrease

Source: The workshop participants, January 2021

early warning system, the benefit that the EWS will bring to the local people and finally, the recommendations to make the LEWS sustainable.

4.1 Organisations' Response Mechanism

4.1.1 The Challenges to Implementing the LEWS

Previously, a classic method of landslide prediction based solely on the amount of rainfall was in place, which did not give any spatial information. The warning is mainly disseminated to the masses through hand-held megaphones during or after a downpour. The leading actors involved in this process are CPP (Cyclone Preparedness Programme) volunteers, the local administration, the fire service, the local police stations and in some areas, the Bangladesh Army and the Border Guard Bangladesh (BGB). The use of mega-

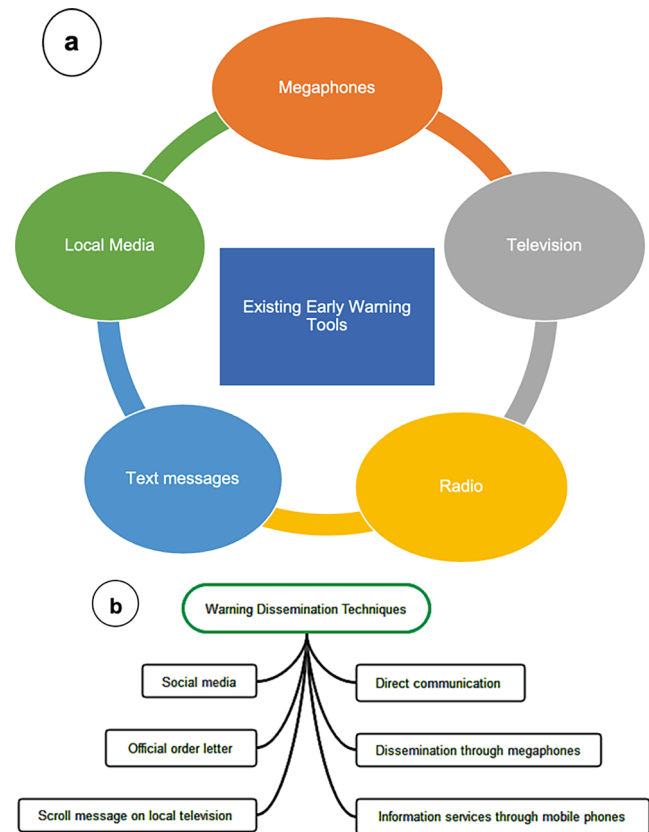


Fig. 12 Existing early warning dissemination system for landslides in Cox's Bazar District; (a) existing tools, and (b) techniques to disseminate the early warning. (Source: the workshop participants, January 2021)

phones in local religious institutions-like Mosques, Pagodas, and Temples-the local cable network, radio network, text messages through mobile phone and news on national television complement disseminating the warning (Fig. 12).

The administration evacuates people living in risky hill-slopes and foothills during a downpour. The challenges in disseminating the warning and evacuating people to a safe shelter are a lack of enough skilled human resources, insufficient technological equipment, a lack of a proper communication system -both road and mobile network- in remote areas and sometimes, a lack of evacuation shelters. Even after willing to receive an early warning, and some people are unwilling to go to a shelter. There are a few reasons for this unwillingness: (a) people who have been living in unsafe foothills or slopes grabbed the land illegally, so they get afraid that once they are evacuated, they will not have a second chance to come back to their houses, (b) they are afraid of losing their property or household items/materials once they go to a shelter, and (c) they underestimate the risks because of lack of awareness.

The main actors in disseminating the warning, evacuating people from risk zones and conducting rescue operations are



Fig. 13 Megaphones kept at a CPP Office in Ukha, Cox's Bazar for disseminating warnings at the community level. (Source: Fieldwork in CBD, January 2021)

the Administration, Fire Service, Civil Defence, Police, BGB, Army, CPP volunteers, and NGO workers. All groups discussed the CPP volunteers with special importance (Fig. 13).

4.1.2 Initial Preparation After Getting Early Warnings

While discussing the initial steps after an early warning (EW) is received, three of the five groups opined that there should be a coordination meeting in the first place. After the meeting, the warning should be disseminated using the existing channels. The participants also emphasised on a massive campaign. The third step is to ensure the shelter centres are ready and evacuating people from medium-and high-risk zones to the centres (Fig. 14).

4.1.3 The Challenges for the Organisations in Disseminating the Warning

The participants discussed the common challenges of a lack of coordination and signalling systems, a lack of communication systems in hard-to-reach areas, and a lack of necessary equipment and trained personnel.

4.1.4 The Way Forward

- Increase the coordination among the organisations that work in disaster management.
- Massive awareness campaign at the community level and training volunteers.
- A planned protocol/SOP for disseminating the alert, evacuation and rehabilitation of the people living in risk zones.

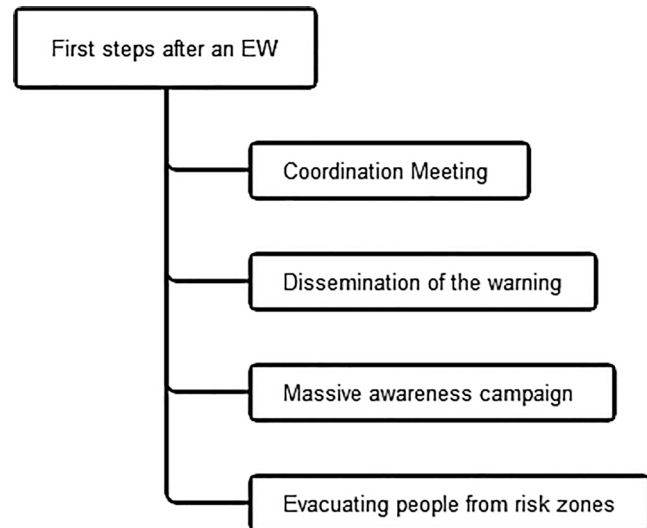


Fig. 14 The initial steps after receiving early warnings. (Source: The workshop participants, January 2021)

4.2 Collaboration Among the Organisations

The administration plays the main role in disseminating the warning at the appropriate levels at various stages. The participants kept the District Administration at the centre of district-level warning dissemination and overall response mechanisms, while the National Disaster Management Council (NDMC) and the Bangladesh Meteorological Department (BMD) can coordinate the process at the national level.

For Cox's Bazar district, the participants described the District Disaster Management Committee and the District Administration as the authorities to disseminate the warning. After the coordination meeting of all the important stakeholders, dissemination can take place through the Upazila Disaster Management Committee, local police, CPP volunteers, NGOs, and the media (Fig. 15). While all other organisations can directly work in dissemination, some are specially mentioned for emergency response: Fire Service and Civil Defence, Bangladesh Army, Border Guard Bangladesh, CPP, Upazila Disaster Management Committee, Union Disaster Management Committee, and the Department of Public Health. While TV and radio broadcast the news on the warning, social media can become a very effective tool for reaching the community faster (Fig. 15).

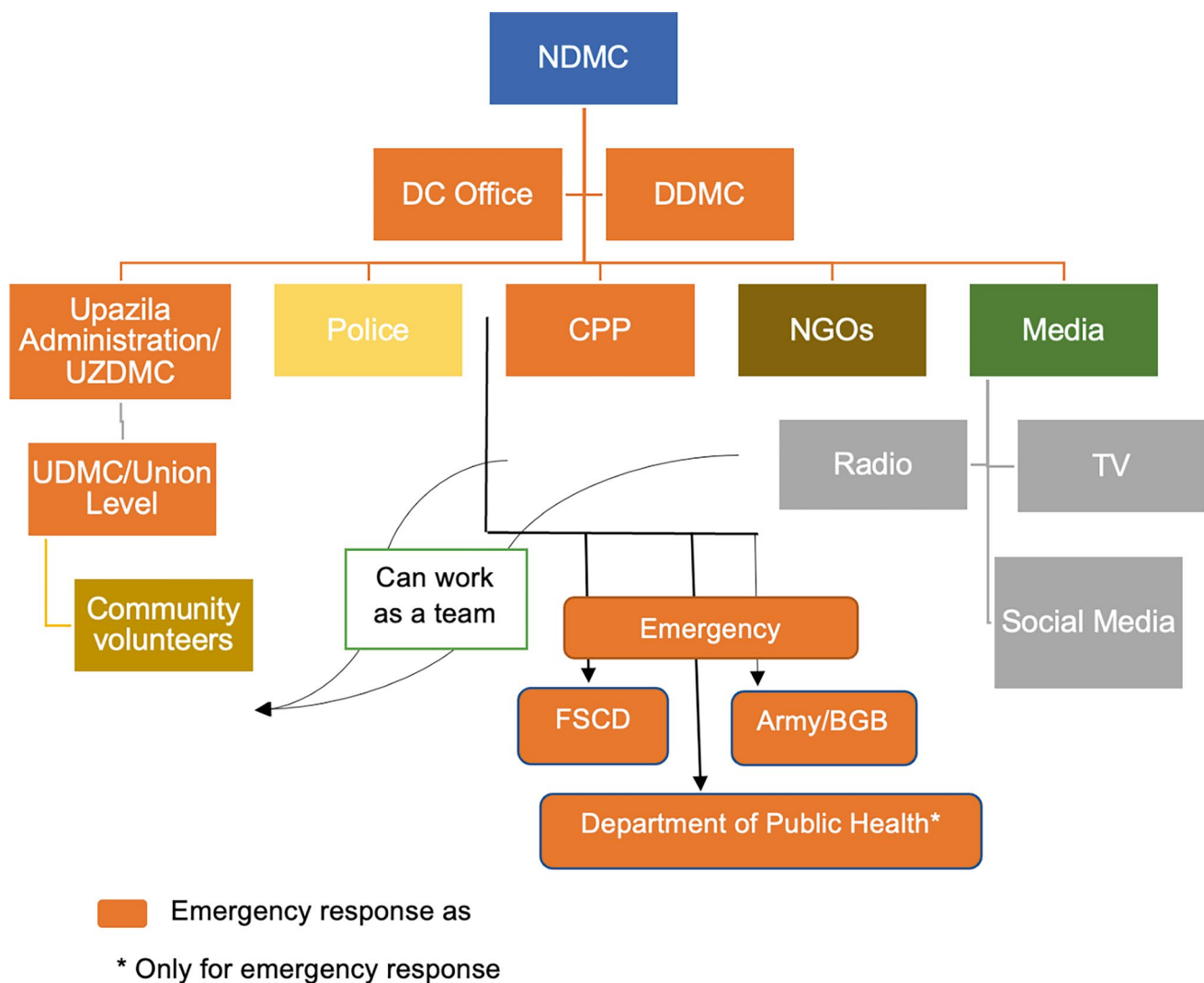


Fig. 15 Organisations that can collaborate in disseminating the LEW and emergency response as well. (Source: The workshop participants, January 2021)

4.3 Recommendations to Make the LEWS Sustainable Different Mitigation Steps at Low, Medium, and High-Risk Scenarios

In a low-risk scenario, the participants suggested these mitigation steps: awareness campaigns, constructing guide walls on risky slopes, and sending alerts so that people become aware beforehand (Fig. 16). In a medium-risk scenario, the participants suggested massive dissemination of

the warning through various means such as megaphones, social media, and evacuating people to a safer place if necessary. The long-term mitigation steps in this scenario would be ensuring proper land management and integrating LEWS, creating an adequate water drainage system, and constructing retention walls (Fig. 16). In a high-risk scenario, the mitigation steps would be evacuating people from high-risk areas, halting housing in high-risk areas, doing forestation with long-lasting and fruit trees in risky hill slopes, and the strict implementation of land management law (Fig. 16).

Low-Risk Scenario	Medium-Risk Scenario	High-Risk Scenario
• Awareness campaigns • Constructing guide walls in risky slopes • Sending alerts so that the people become aware beforehand	• Dissemination of the warning • Evacuating people to a safer place • Ensuring proper land management • Landslide early warning systems • Developing proper water drainage system • Constructing retention walls	• Evacuating people from high-risk areas • Halting housing in high-risk areas • Doing forestation with long-lasting and fruit trees in risky hill slopes • Strict implementation of land management law

Fig. 16 Different mitigation steps at low, medium, and high-risk scenarios. (Source: The workshop participants, January 2021)

5 Conclusion

Rainfall-induced landslides cause extensive loss and damage to communities living in Bangladesh's Chittagong Hill Districts (CHD). Although landslides are not a new phenomenon in the region, the Bangladesh Meteorological Department (BMD) only recently introduced a forecasting system for Cox's Bazar district (CBD) in October 2022. This system (BMD 2022) has significantly improved the capacity for detecting, monitoring, and forecasting landslides. However, a significant gap remains in developing a formal standard operating procedure (SOP) to ensure the system's robustness, regular updating, validation, and overall functionality.

To address this gap, a national workshop was held in Cox's Bazar in January 2021, with participation from 57 national and international experts, policymakers, community leaders, and other stakeholders. Based on the workshop's outcomes, this study presents key findings and recommendations to support the development of an effective, community-centred, and sustainable LEWS for Bangladesh.

5.1 Key Findings

1. There is no formalised early warning system for landslides in Cox's Bazar District (CBD), also in Bangladesh. Some NGOs and institutions are working to develop community-based LEWS with little to no success.
2. The district administration and volunteers use megaphones as the main technique for disseminating early warnings.

3. Sending an early warning to hard-to-reach areas is difficult because of fragile road communication systems, and poor cellular signal makes it even more difficult.
4. The major obstacles in operationalising the LEWS are a lack of awareness, coordination among the organisations, trained workers/ volunteers, and critical infrastructure.
5. The LEWS will benefit the local people by lessening panic and helping the administration decide on evacuation, relocation, and rehabilitation.
6. A new coordination plan for the organisations and persistent communication among them will enhance the sustainability of the LEWS.

5.2 Recommendations

To make the LEWS effective, operational and sustainable, the following steps should be taken:

5.2.1 Short Term (1–3 Years)

1. Establish a coordination committee under the auspices of the district administration with direct connections at the community level.
2. Specifying the roles for each organisation may eliminate the coordination gap.
3. Run massive awareness campaigns with the help of all stakeholders (Government, non-government, Multinational, and community volunteers).
4. Creating a specialised and trained group of volunteers and administrative officials related to landslide disaster risk reduction in CBD.
5. Regularly updating and validating the landslide forecasting system based on rainfall patterns, landslide inventory,

land use changes, and other relevant factors contributing to landslide disasters.

6. Community-based participatory methods should be implemented to understand the persistent social vulnerability dimensions within the vulnerable hilly communities in CHD.
7. To successfully operationalise the LEWS, the concerned local authorities should take appropriate measures like training local volunteers, creating awareness among the landslide vulnerable communities, arranging landslide shelters for the people in need, commencing temporary relocation or permanent resettlement plans for the extremely marginalised people, and developing inter-organisational cooperation and data sharing mechanism.

5.2.2 Medium to Long Terms (4–10 Years)

1. Building an infrastructure network for proper warning dissemination.
2. Developing a landslide monitoring and early warning system operationalisation division for Bangladesh by involving relevant organisations such as the Bangladesh Meteorological Department (BMD), Geological Survey of Bangladesh (GSB), Ministry of Disaster Management and Relief (MoDMR), Bangladesh Space Research and Remote Sensing Organization (SPARRSO), and the Ministry of Environment, Forest and Climate Change.
3. The Government of Bangladesh (GoB) must prioritise landslides along with flash floods in the hilly regions and ensure an appropriate funding mechanism working closely with national partners, NGOs, international donors, and UN bodies for long-term project continuity and implementation.
4. The GoB should create specialised landslide expert positions in various research organisations, semi-autonomous and govt. Institutions, and local government agencies, particularly in the landslide-vulnerable Upazilas and Unions.
5. Effective policy guidelines should be in place to protect the natural environment, cultural heritage, ecology, and ecosystem in the CHD, particularly the areas dominated by Indigenous communities.
6. An integrated multi-hazards early warning system should be implemented by considering cascading hazards impacts, such as extensive rainfall triggering flash floods and floods triggering landslides.
7. Finally, the four pillars of the UN EW4All initiative should be considered along with any additional local context for ensuring a people-centric functional LEWS.

The SOP development methodology presented in this study, being the first of its kind, can be applied across Bangladesh and replicated in other contexts facing landslide and multi-hazard risks globally. The MoDMR, BMD, and other relevant organisations will benefit from this proposed framework, which we hope will pave the way for the formal institution-alisation of a comprehensive, step-by-step national LEWS policy guideline.

Appendix 1: List of the Cox's Bazar LEWS SOP Development Workshop Participants

Sl	Participant's Designation and Organisation
01	UNO, Sadar, Cox's Bazar
02	Country Representative, IUCN Bangladesh
03	Programme Coordinator, IUCN Bangladesh
04	National Forestry Specialist, FAO
05	Secretary, Bangladesh Scout, Cox's Bazar
06	Chairman, Jilongza, Sadar, Cox's Bazar
07	Chairman, Upazila Parishad, Cox's Bazar Sadar
08	Chairman, Ramu Upazila Parishad
09	Forestry Programme Associate, FAO
10	Research Fellow, CGS, University of Dhaka
11	Research Fellow, CGS, University of Dhaka
12	Senior Forestry Specialist, FAO
13	Programme Coordinator, PHALS
14	Staff Reporter, Doinik Cox's Bazar
15	Senior Emergency and Rehabilitation Officer, FAO
16	District Food Controller
17	GIS Specialist, FAO
18	DD, DAE, Cox's Bazar
19	SAE, Distribution Division, PDB, Cox's Bazar
20	ENE Assistant, UNHCR
21	M.U.P., Fatekharkul Union Parishad
22	Assistant Inspector, DEO, Cox's Bazar
23	PIO, Ukhia
24	Director (Planning), Department of Environment
25	DFO, Cox's Bazar North Forest Division
26	Station Officer, Fire Service and Civil Defence
27	M.U.P., Fatekharkul
28	President, Cox's Bazar Press Club
29	Journalist, The Daily Star
30	Journalist, The New Age
31	News Editor, The Cox's Bazar News
32	Communication Officer, FAO
33	Reporter, The Dhaka Post
34	SAE, DPHE
35	M.U.P., Jilongza, Cox's Bazar
36	ULO, Sadar, Cox's Bazar
37	Deputy Director, CPP, Cox's Bazar

(continued)

(continued)

Sl	Participant's Designation and Organisation
38	Deputy Director, Department of Youth Development
39	Lead, DRM and Resilience, BRAC
40	Journalist, NTV, Cox's Bazar
41	DRR Coordination Specialist, UNDP Crisis Response
42	DD, DSS, Cox's Bazar
43	DFO, Forest Department
44	S.A.E., BWDB, Cox's Bazar
45	M.U.P., Jilongza, Cox's Bazar Sadar
46	A.E. (SupRB) LGED
47	CES-DRR, TRD, IOM
48	FAO- Landslide Expert
49	Senior Program Assistant, IUCN Bangladesh
50	Program Assistant, IUCN, Bangladesh
51	Senior Program Assistant, IUCN, Bangladesh
52	Senior Program Assistant, IUCN, Bangladesh
53	Program Assistant IUCN, Bangladesh
54	Program Assistant IUCN, Bangladesh
55	DRRO, Cox's Bazar
56	Program Assistant, IUCN, Bangladesh
57	Senior Program Assistant, IUCN, Bangladesh

Source: Participants' attendance sheet, 2021

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