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Evaluating the Accessibility and Actionability of Early Warning Messages of Cyclone among Last Mile Communities in Bangladesh

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Abstract

Bangladesh is highly vulnerable to natural disasters. Early warning systems are an essential tool for risk management and disaster preparedness that help save lives and minimize the potential impact of disasters. To be effective, early warning systems need to rely on the direct participation of at-risk communities, facilitate public education and awareness among at-risk communities, and disseminate warning messages in a timely manner. The aim of the study is to identify the factors influencing the accessibility and actionability of early warning messages and provide some recommendations to increase the resilience of poor and vulnerable people on the coast. The study was conducted in the Gulishakhali union under Amtali Upazila in Barguna District. The study results show that the highest number of people receive early warning messages through social media, at 34%, receive word-of-mouth messages from people by 30%, through mobile phone by 19%, receive messages through TV by 14%, and the lowest number of people receive early warning messages through community meetings by 3%. The result also shows the factors that influence the early warning systems and locally managed warning systems to increase resilience. Among the factors, communication barriers are in the first position, and lack of access to communication channels is not sufficient for the study area. Understanding the level of the messages, language barriers, and transportation barriers also influences the early warning systems. Increased awareness-raising, regular community meetings, and training programs are the recommendations for locally managed early warning systems to increase the resilience of poor and vulnerable people on the coast.

Keywords: *accessibility, actionability, early warning messages, last mile communities*

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Introduction

Climate change has introduced extreme weather patterns, altering the amount, intensity, and frequency of disasters like cyclones, storm surges, floods, rainfall, landslides, etc., making people highly vulnerable (Daramola et al., 2025; Faisal et al., 2021, 2024; Saha et al., 2024; Satyanaga et al., 2025; Shen et al., 2026). Early Warning Systems (EWS) are a primary source of information that enhance the capacity of vulnerable communities to prepare for and respond to disasters, thereby helping to protect lives and livelihoods from natural hazards (Ahsan et al., 2020). An effective warning system empowers individuals, communities, and businesses to respond in a timely and appropriate manner to hazards in order to reduce the risk of death, injury, and loss of property. Warning messages must be clearly communicated and should motivate people at risk to take appropriate action (Rogers & Tsirkunov, 2011; Shen et al., 2026). The effectiveness of cyclone early warning systems largely depends on accurate hazard detection, efficient information dissemination, and appropriate responses by affected populations (Shahjahan, 2018). However, EWS should not be viewed as disaster prevention mechanisms alone; rather, they are vital components of capacity-building processes for disaster risk reduction and management (Alcantara-Ayala & Oliver-Smith, 2017).

Early warning systems generally involve three interlinked stages: knowledge gained from past hazard events, forecasting of future hazards, and the dissemination of early warnings (Sahana et al., 2023). The integration of these multiple components creates a comprehensive system for rapid notification to last-mile households, which can significantly reduce loss of lives, livelihoods, and assets at both community and household levels (Syed et al., 2021). An effective EWS requires a reliable communication system consisting of two main components. The first is a robust and dependable communication infrastructure that can function during natural disasters. Multiple communication channels are currently used to disseminate warnings, including mobile text messaging, email, radio, television, and web-based services. Ensuring redundancy in communication systems is essential, and emergency power supplies and backup systems play a critical role in preventing communication failures during disasters (Grasso & Singh, 2012). The second component is the warning message itself. The content and structure of warning information significantly influence public perceptions of risk and subsequent behavior. Warning messages typically reflect official assessments of the presence and severity of threats, along with guidance on protective actions for the public (Lindell & Perry, 2004).

Bangladesh is one of the most cyclone-prone and vulnerable countries in the world due to its disaster-prone geographical location and natural setting (Akhand, 2003). The Government of Bangladesh has prioritized the development of weather forecasting systems using satellite imagery and advanced computational methods, enabling cyclone warnings to be issued and disseminated to vulnerable populations through radio, television, and other information media at frequent intervals during cyclone events (Akhand, 2003). Vital warning information from the Bangladesh Meteorological Department (BMD) can be disseminated to responding agencies and at-risk communities within 15 minutes of issuance, facilitating the initiation of evacuation orders (Habib et al., 2012). Despite notable progress in cyclone forecasting, challenges remain in the clear communication of warning information at the local level, as well as in the accuracy of landfall timing and intensity predictions (Paul & Routray, 2013). The country's geographical location, unique natural setting, and tropical monsoon climate further exacerbate its exposure to cyclones and storm surges (As-Salek, 1998; Madsen & Jakobsen, 2004; Paul, 2009; Paul & Rahman, 2006). Bangladesh has 19 coastal districts, where approximately 37 million people reside. Among these, 14 districts are classified as high or moderate cyclone-risk areas, placing a large population at significant risk (Ferdous, 2017). To ensure the safety of coastal populations, the Government of Bangladesh has invested considerable effort in improving cyclone emergency management, including forecasting, warning dissemination, and shelter infrastructure. As a result, public response to evacuation orders has improved compared to the past. However, current evacuation rates remain unsatisfactory, indicating the need for further improvements in the cyclone early warning system and associated response mechanisms (Ferdous, 2017).

Amtali Upazila of Barguna District is one of the most vulnerable areas to cyclones, experiencing devastating events almost every year. Many residents are reluctant to evacuate to cyclone shelters due to various limitations and inadequate facilities. Previous studies have not sufficiently documented these facility-related challenges. The effectiveness of early warning dissemination and the level of public understanding of warning messages are critical factors influencing evacuation behavior. Many people fail to receive warnings in a timely manner, and mistrust of warning messages often leads to non-compliance with evacuation orders (Roy et al., 2015). In Amtali, both the early warning dissemination system and the number of cyclone shelters are insufficient relative to the population size. Moreover, the local population's understanding of official warning signals remains limited, and shelter management systems are

often inadequate (Nur et al., 2021). Several key problems have been identified in the existing early warning system. The language used in warning messages is often official and technical, making it difficult for many people to understand. As a result, community members may ignore warnings due to poor comprehension. Access to warnings is also constrained by frequent communication failures during extreme events. Additionally, previous experiences with false alarms and delayed warnings have reduced public trust in the system. There is limited systematic analysis of how well the general public comprehends warning signals and messages. Therefore, it is essential to collect, synthesize, and analyze information on the effectiveness of the current warning system and identify existing gaps.

This research provides an analysis of the current early warning dissemination system and offers recommendations for improving its effectiveness. The findings are expected to have practical implications for enhancing existing forecasting and communication mechanisms, with the broader goal of strengthening disaster resilience among vulnerable coastal communities. Although this study is geographically limited to Gulishakhali Union, its broader contribution lies in identifying the last-mile gap in early warning systems-where accurate scientific forecasts exist, but effective community response is lacking. Understanding this gap is essential for improving disaster risk reduction strategies in vulnerable coastal regions. The specific objectives of this study are: (1) to assess the factors influencing the accessibility and actionability of early warning messages among last-mile communities, and (2) to propose recommendations that can be incorporated into locally managed early warning systems to enhance the resilience of vulnerable coastal populations.

Methods

Description of the Study Area

This study was conducted in Gulishakhali Union of Amtali Upazila in Barguna District (Figure 1), located in the southwestern part of Bangladesh. Amtali Upazila covers an area of 720.75 sq. km. The upazila is bordered by Patuakhali Sadar Upazila of Patuakhali District to the north, Galachipa and Kalapara upazilas of Patuakhali District to the east, the Bay of Bengal to the south, and Barguna Sadar Upazila to the west. Amtali Upazila consists of six unions, among which Gulishakhali Union is one of the most vulnerable to various natural disasters. Gulishakhali Union was selected for this study due to time constraints and logistical limitations.

It is located between 22°13′22.001″ north latitude and 90°15′34.999″ east longitude (BBS, 2012). The quality of life, economic condition, literacy level, occupational status, and housing conditions are generally poor. Most residents depend on agriculture, fishing, and daily labor for their livelihoods. The union is very close to the Payra River and frequently experiences natural hazards such as cyclones, storm surges, heavy rainfall, salinity intrusion, riverbank erosion, and groundwater-related problems. The total population is approximately 28,183, including 14,065 males and 14,118 females, with about 6,457 households. The literacy rate is around 75%, and the population density is about 1,409 persons per sq. km. (BBS, 2012).

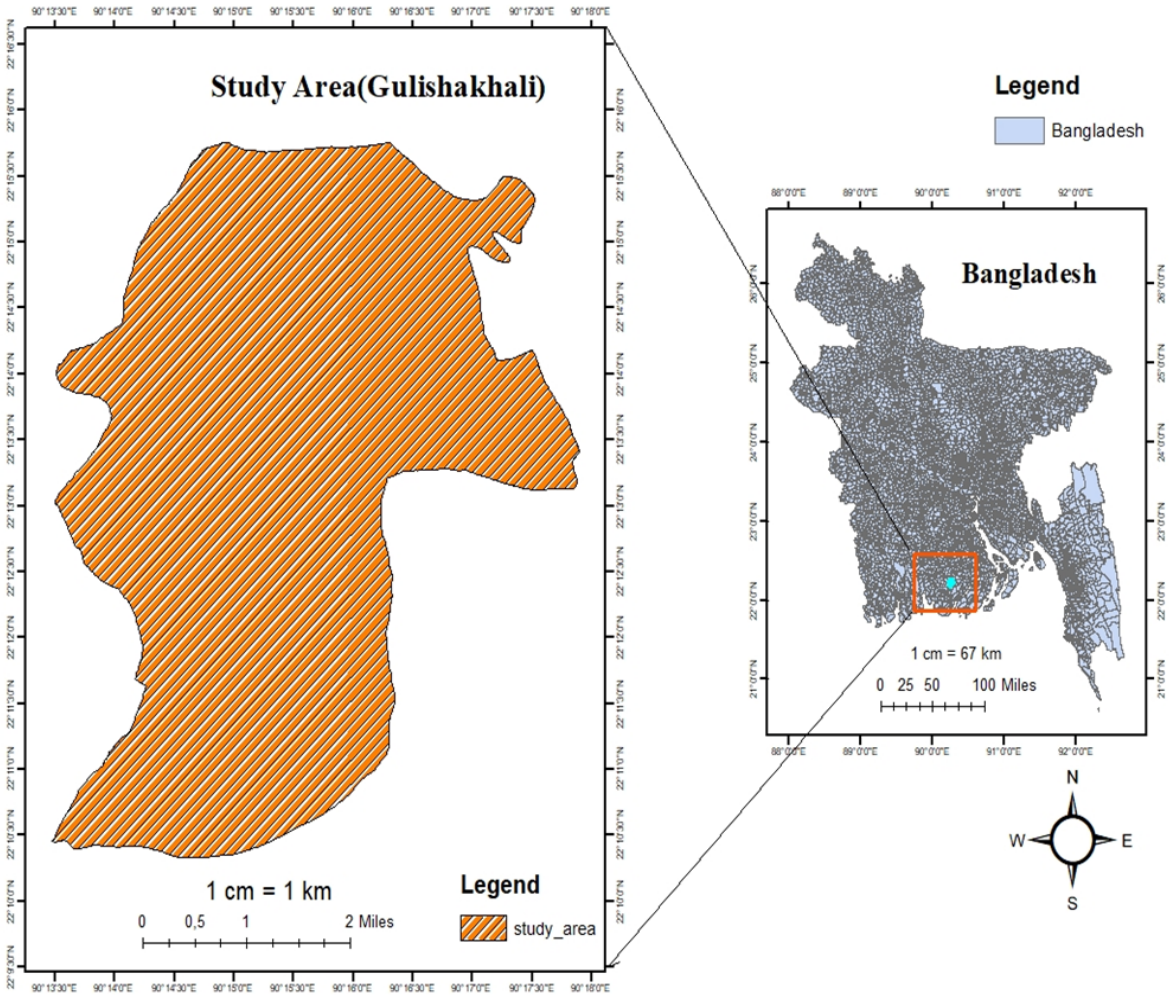

Fig. 1. Location map of the study area (Gulishakhali Union of Amtali Upazila in Barguna District)

Methods

All data and information required for this research were collected carefully and systematically. The step-by-step research methodology followed in this study is shown in Figure 2. The study

was conducted using two types of data sources: primary and secondary. Primary data were collected through questionnaire surveys, interviews, focus group discussions (FGDs), and key informant interviews (KIIs). Secondary data were obtained from existing literature, including official documents, books, newspaper reports, research articles, reports, and seminar papers. This study was conducted independently and did not involve formal partnerships with any specific organization for implementation or funding. However, it examines the roles and performance of existing stakeholders, including government agencies, non-governmental organizations (NGOs), and local community leaders, in the dissemination and effectiveness of early warning systems in the study area.

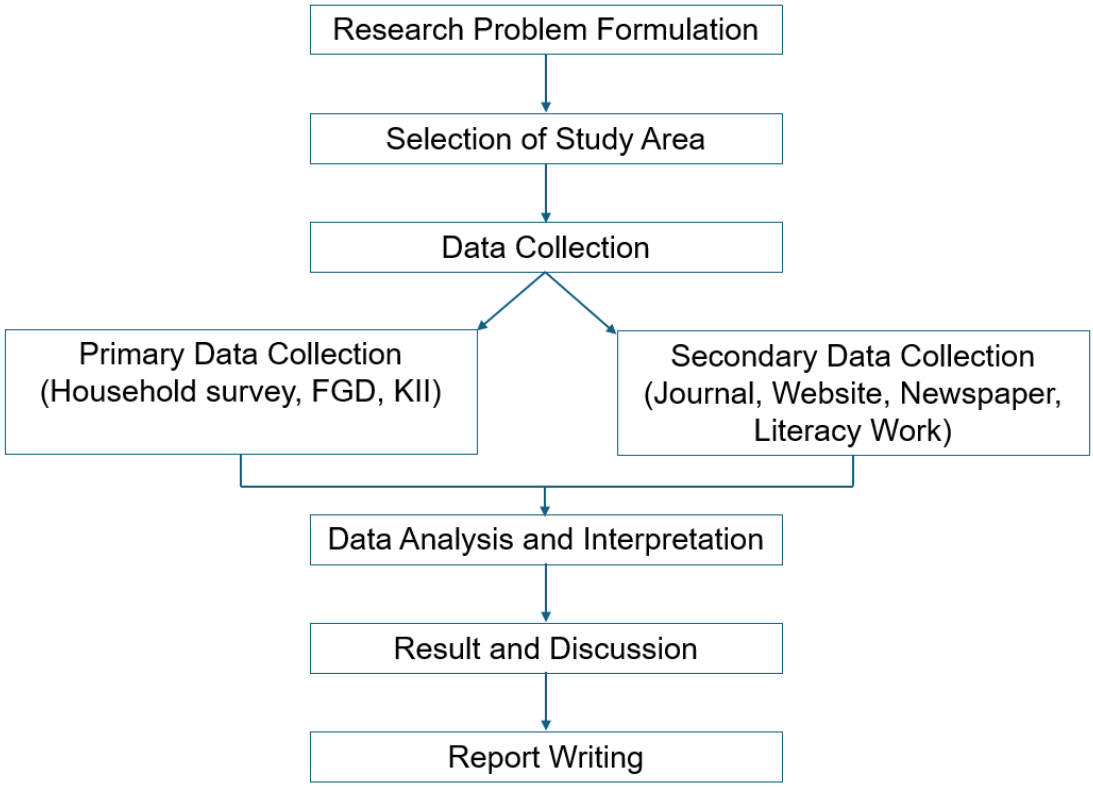

Fig. 2. Flowchart of research methods

Sample Size Calculation

The sample size is calculated through the following equation (Suissa & Shuster, 1985): Total household, N = 6457; Confidence level = 95%; Margin of error, e = 10%; 95% level of significance, Z= 1.96; Estimated Proportion of success, Standard Deviation, P =0.5; Estimated proportion of failures, q = (1-p) = 0.5

$$\text{Sample Size, } n_0 = \frac{(z^2 * p * q)}{e^2}$$

$$= \frac{1.96^2 * o.5 * 0.5}{0.1^2}$$

$$= 96.04 = 96$$

$$\text{Adjusted, } n = \frac{n_0}{1+\left[\frac{n_0-1}{N}\right]}$$

$$= \frac{96}{1+\left[\frac{96-1}{28183}\right]}$$

$$= 95.68 = 96$$

From the above formula, the study found the sample size would be 96, but for more justification of the research, the study conducted 100 household surveys.

Primary Data Collection

Primary data were collected through a standardized household questionnaire survey, focus group discussions (FGDs), and semi-structured key informant interviews (KIIs). To understand the general conditions and practical situation of the study area, field observations were conducted prior to the questionnaire survey using an analytical and scientific approach. A structured questionnaire was developed for the household survey. Respondents were randomly selected from different occupational groups, including farmers, fishers, small traders, and government employees. It is generally recognized that older members of the community possess more knowledge about the history and development of local knowledge systems, including past successes and failures. Therefore, most responses were obtained from older participants; however, people of different ages and genders were also included for comparative analysis. In total, 100 household questionnaire surveys were conducted.

FGDs were conducted to gather community-level information. Three FGDs were organized: one with women, one with men, and one mixed group of both men and women. A checklist and open-ended questions were used to collect both qualitative and quantitative information. To obtain in-depth qualitative insights from experienced individuals involved in disaster risk reduction and relevant decision-making processes, nine key informant interviews were conducted. The key informants included the Upazila Nirbahi Officer (UNO), Project Implementation Officer (PIO), Surveyor of the LGED Office, Upazila Statistics Officer, Chairman of Gulishakhali Union Parishad, a village member, a school teacher, an Imam, and

an area manager of a local NGO. Government agencies and local administration were mainly responsible for disseminating official warning messages, coordinating evacuation activities, and providing disaster-related information. Local authorities and community leaders facilitated communication with residents, organized community meetings, and supported field-level coordination. NGOs contributed by conducting awareness campaigns, providing disaster preparedness training, and assisting vulnerable households with emergency support. These actors were also interviewed as key informants to validate the study findings and to identify practical recommendations for improving the effectiveness of early warning systems in last-mile communities.

Prior to data collection, informed verbal consent was obtained from all respondents. Participants were informed about the purpose of the study and were assured that their participation was voluntary. They were also informed that they could withdraw from the interview at any stage. To maintain confidentiality and privacy, no personal identifiers such as names or contact details were recorded, and all collected information was used solely for academic purposes.

Secondary Data Collection

Secondary data refers to information previously collected for other studies. Information on early warning messages was obtained through cross-checking multiple sources. Secondary data were collected from relevant research articles, reports, maps, journals, research papers, websites, libraries, and reports from local NGO offices, as well as from the websites of the Bangladesh Bureau of Statistics (BBS) and the Ministry of Disaster Management and Relief (MoDMR). After data collection, the secondary information was edited, scrutinized, verified, and reviewed by the researcher to minimize inconsistencies and errors.

Data Processing and Analysis

The study was conducted in close accordance with the research objectives. Data were collected from various sources, including field surveys, FGDs, KIIs, reports, relevant research papers, books, newspapers, internet sources, and national and international journals. After collecting the primary data, the information was compiled in Microsoft Excel 2010 and analyzed using appropriate statistical functions to achieve the study objectives and interpret the results. Finally,

the report was prepared using Microsoft Word, presenting findings in tabular, textual, and graphical forms.

Results and Discussions

Demographic Characteristics

Demographics refer to the classifiable characteristics of a population. Commonly used demographic variables in public statistics include age, gender, ethnicity, geographic location, occupation, and educational attainment. Table 1 presents the demographic characteristics of the respondents in the study area. The selected sample comprised 100 respondents, including both men and women. Among them, 61% were female, and 39% were male.

Table 1. Socio-demographic information of the respondents (frequency, N = 100)

Variable	Values	Percentage (%)
Gender	Male	61
	Female	39
Age profile	Under 18	5
	18-25 years	12
	26-35 years	18
	36-45 years	24
	46-55 years	21
	56 and above	20
Educational Status	No formal education	39
	Primary Education	12
	Secondary Education	16
	Higher Secondary Education	19
	Tertiary Education	14
Occupational Status	Farmer	17
	Homemaker	41
	NGO worker	4
	Fisherman	5
	Student	11
	Business	10
	Garment Worker	5
	Government Job	7

Respondents belonged to different age groups: 5% were under 18 years, 12% were aged 18-25 years, 18% were aged 26-35 years, 24% were aged 36-45 years, 21% were aged 46-55 years, and 20% were aged 56 years and above. The largest proportion of respondents (24%) fell within the 36-45 age group, while the smallest proportion (5%) was under 18 years of age. Education plays an important role in raising environmental awareness and developing rational

understanding of various life issues. The respondents represented different levels of educational attainment. Among them, 39% had no formal education, 12% had primary education (completed grades 1-5), 16% had secondary education (grades 6-10), 19% had higher secondary education, and 14% had completed tertiary education. These findings indicate that the overall educational status in Gulishakhali Union remains relatively low. Educational level also influences people's ability to understand and respond to disaster early warning systems. In terms of occupation, most respondents were female, and 41% were homemakers. Other occupations included farmers (17%), students (11%), businesspersons (10%), government officials (7%), fishermen (5%), garment workers (5%), and NGO employees (4%), which represented the smallest proportion of respondents.

Accessibility of Early Warning Systems to People

Receiving Methods of Early Warning Messages

During the questionnaire survey, 100 respondents were asked how they receive early warning messages. The findings show that people receive early warning information through various sources. The highest proportion of respondents (34%) reported receiving early warning messages through social media. This was followed by word-of-mouth communication (30%), mobile phones (19%), and television (14%). The lowest proportion of respondents (3%) reported receiving early warning messages through community meetings (Figure 3).

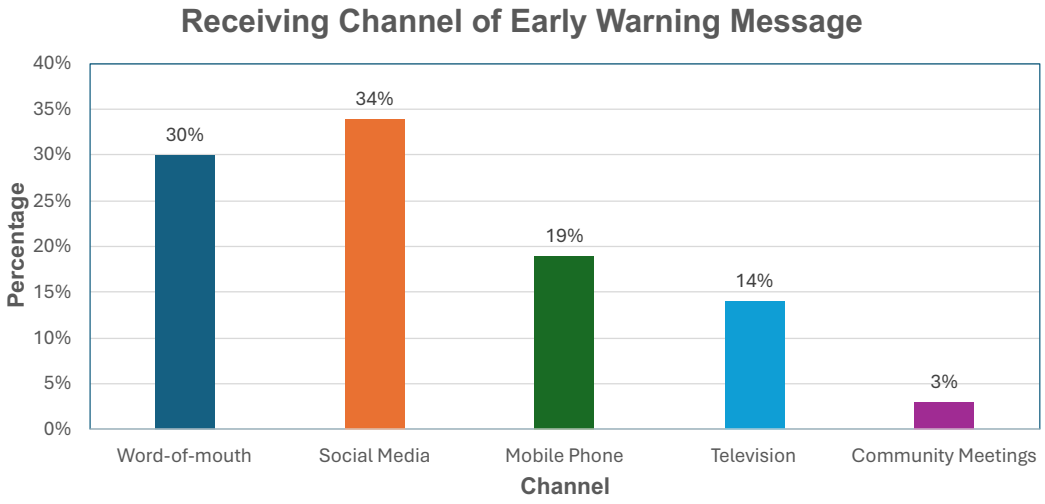

Fig. 3. Ratio of receiving early warning messages of the respondents

The study also indicates that the government has increased investment in early warning systems, enabling people to access more information through electronic media such as radio

and television (Akhand, 2003). Similarly, another study found that the main sources of early warnings were local village assemblies (18%), relatives (14%), radio (20%), television (13%), and newspapers (3.2%) (Sahana et al., 2023).

Communication Barriers in Accessing Early Warning Messages

Many community members do not receive early warning messages due to various communication barriers. As a result, they are unable to take timely preparatory measures to reduce property damage and livelihood vulnerability. The findings show that the highest proportion of respondents (33%) reported a lack of access to communication channels, meaning they do not receive early warning messages from reliable sources. Additionally, 28% of respondents face language barriers, indicating that the language used in warning messages is not easily understood by them. About 23% have a limited understanding of the message content, meaning they cannot fully comprehend the information provided. Furthermore, 16% of respondents stated that they receive warning messages too late, leaving them with insufficient time to undertake preparedness activities (Figure 4).

Ferdous (2017) found that one of the major problems with the existing early warning system is the use of official and technical language, which is not easily comprehensible to most people. As a result, many individuals do not pay attention to the warnings because they do not understand the technical information. In many cases, access to early warning messages is also disrupted due to malfunctioning wireless communication systems. Moreover, repeated false warnings have reduced people's trust in the system. Roy et al. (2015) also revealed that delayed warning messages may lead to a loss of confidence among residents.

Another study showed that most households (41.2%) received early warnings only 12 hours before a possible disaster. This was followed by 35.6% who received warnings at least one day before, 10.4% two days before, 6.8% five days before, and only 1.8% received warnings a week in advance. Households were also asked to disclose the actions they took after receiving early warnings about a potential hazard event (Sahana et al., 2023).

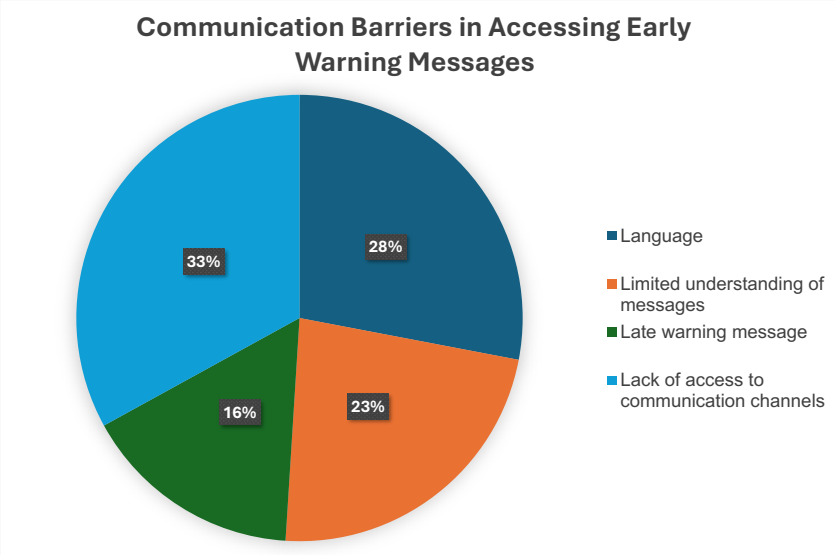

Fig. 4. Communication barriers faces by the respondents

Understanding Level of Early Warning Messages

According to the questionnaire survey, early warning messages are disseminated through various sources, and several communication barriers exist during their dissemination. As a result, the level of understanding of these messages varies among community members. The findings show that 32% of respondents understand the content of early warning messages very well, 43% understand them somewhat well due to limited comprehension of the message content, and 25% do not understand them well because of language barriers and lack of access to communication channels (Figure 5).

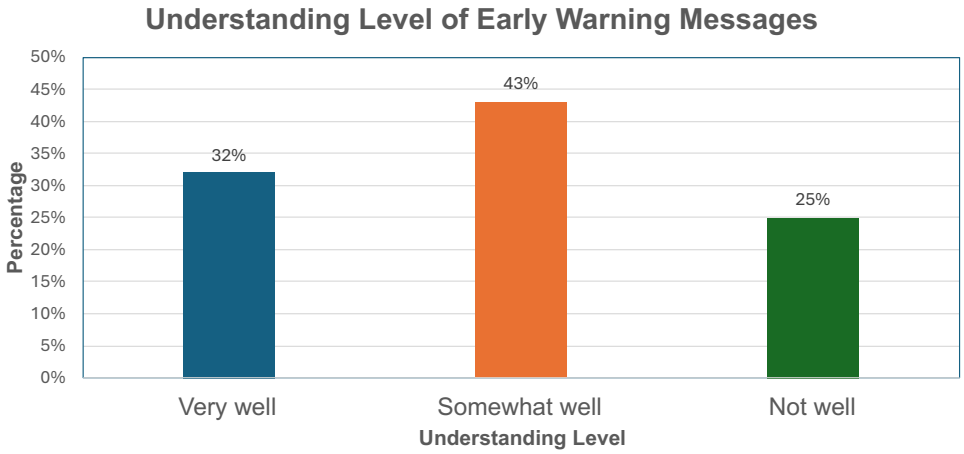

Fig. 5. Understanding level of early warning messages of the respondents

A study by Akhand (2003) found that the major causes of high casualties in cyclone-prone areas included weak cyclone warning and weather forecasting systems, false alarms without

actual cyclone or storm events, and the absence of prior disaster awareness programs despite the issuance of high warning signals. Furthermore, Baudoin et al. (2014) emphasized that the development of effective early warning systems can enhance livelihood resilience by strengthening coping mechanisms and improving adaptive capacity.

Actionability of Early Warning Messages

Ratio of Taking Timely Actions in Early Warning Systems

According to the field survey, most community members in the study area receive early warning messages before a disaster occurs through community meetings, miking (public announcements), social media, mobile phones, neighbors, and natural signs. However, the timing of their response varies. The highest proportion of respondents (37%) reported taking action later because they believed that the disaster might not occur. About 19% never took any action due to their attachment to property and assets. Meanwhile, 17% took action within a few hours, 18% took action within a day, and only 9% took immediate action after receiving the warning (Figure 6).

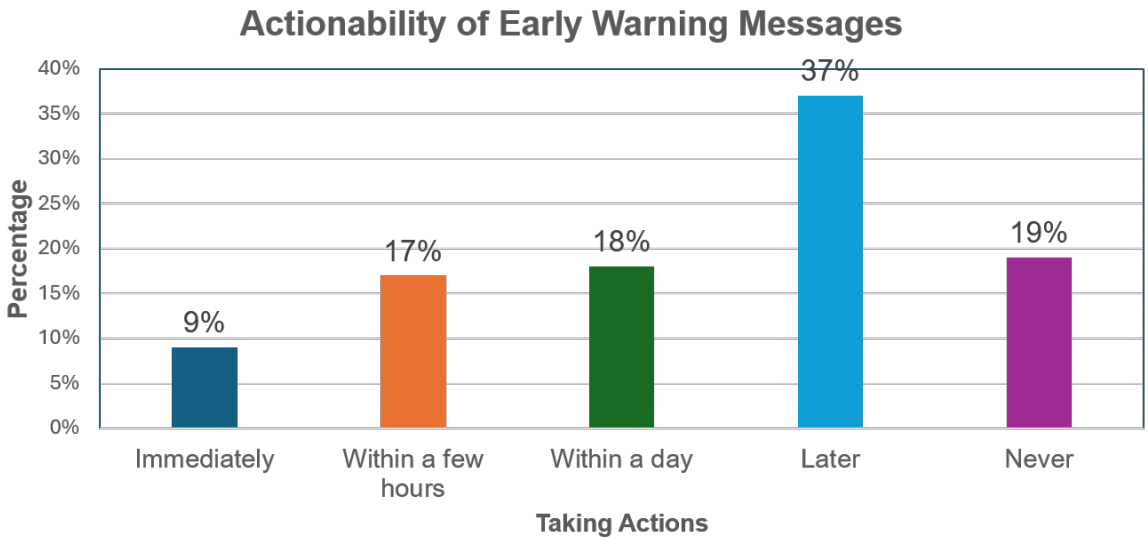

Fig. 6. Ratio of taking timely actions of the respondents

Roy et al. (2015) revealed that early warning messages often do not come more than 12 hours in advance. As a result, long-term warnings may create doubts and reduce reliability among residents. Another finding indicates that some residents do not follow evacuation orders due to mistrust in the early warning system. They have expressed the need for a more reliable and effective early warning system that would reduce false alarms. Similarly, Sahana et al. (2023)

found that most respondents (52.1%) preferred to stay at home after receiving an early warning, while about 27.2% moved to other safer shelters. Only 20.7% relocated to cyclone shelters after receiving warning messages.

Challenges in Taking Timely Action

Every year, different types of disasters strike this coastal area and cause significant damage to property and livelihoods. Discussions with the respondents revealed that they are often unable to take timely action due to several challenges. The largest proportion of respondents (33%) identified a lack of resources as the main challenge. About 27% reported a lack of clear guidance on what actions to take in advance and insufficient direction at temporary shelters. Additionally, 23% faced transportation problems that prevented them from moving to safer locations in time, while 17% experienced difficulties in communication with responsible authorities and other community members (Figure 7).

Similarly, Sahana et al. (2023) found that household responses after receiving cyclone warnings were relatively limited, with most preferring to remain at home, mainly due to the distant location of the nearest cyclone shelter.

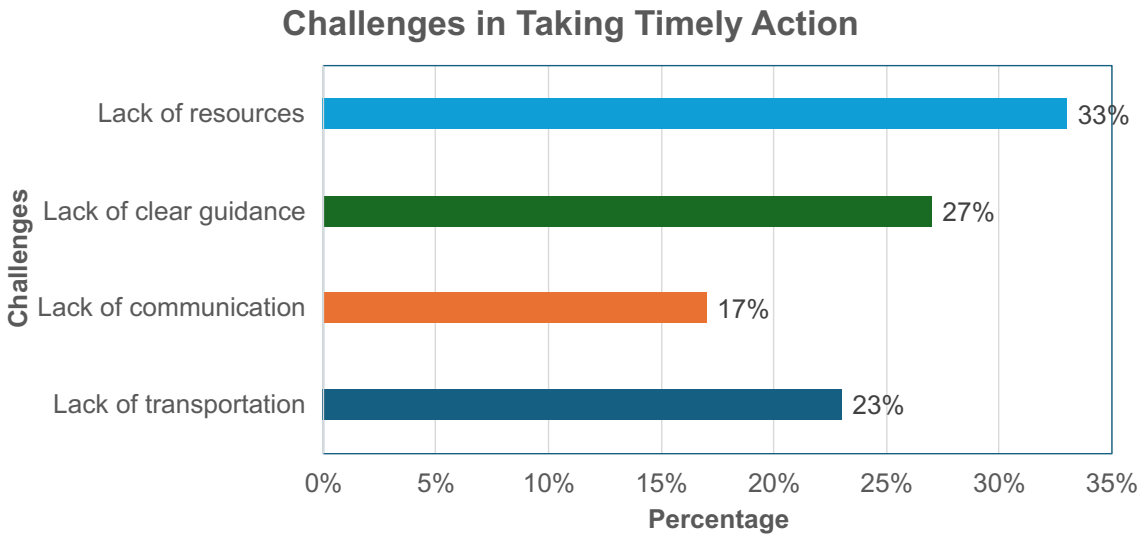

Fig. 7. Challenges in taking timely action of the respondents

Required Financial Resources to Take Early Action

Financial resources are essential for taking early action to reduce loss of life, property damage, and economic loss. The survey findings show that 34% of respondents require emergency

supplies, including food, drinking water, medication, and other necessary items to sustain themselves during a disaster or evacuation. About 23% need transportation costs to use public transport or hire vehicles to move to safer locations. Additionally, 16% require communication expenses to stay connected, 15% need funds for medical expenses such as treatment and healthcare services during disasters, and 12% require financial support for pet care (Figure 8).

The decisions taken after receiving an early warning were significantly related to the level of losses experienced and the decision to move to a cyclone shelter. During the field survey, it was observed that people from lower-income groups and those living in mud houses were more likely to relocate, as these dwellings are structurally vulnerable (Sahana et al., 2023).

According to the questionnaire survey, respondents require specific resources to take early action or evacuate during disasters. Community members meet these needs from various sources. About 47% manage the required resources from their personal savings specifically set aside for emergencies, including natural disasters and evacuation. Government agencies provide 18% of the required resources to support timely action and safe evacuation. Local organizations contribute 12% by offering temporary shelter, transportation, or food assistance. The remaining 23% of resources are obtained through loans when immediate funds are needed, but personal savings are insufficient.

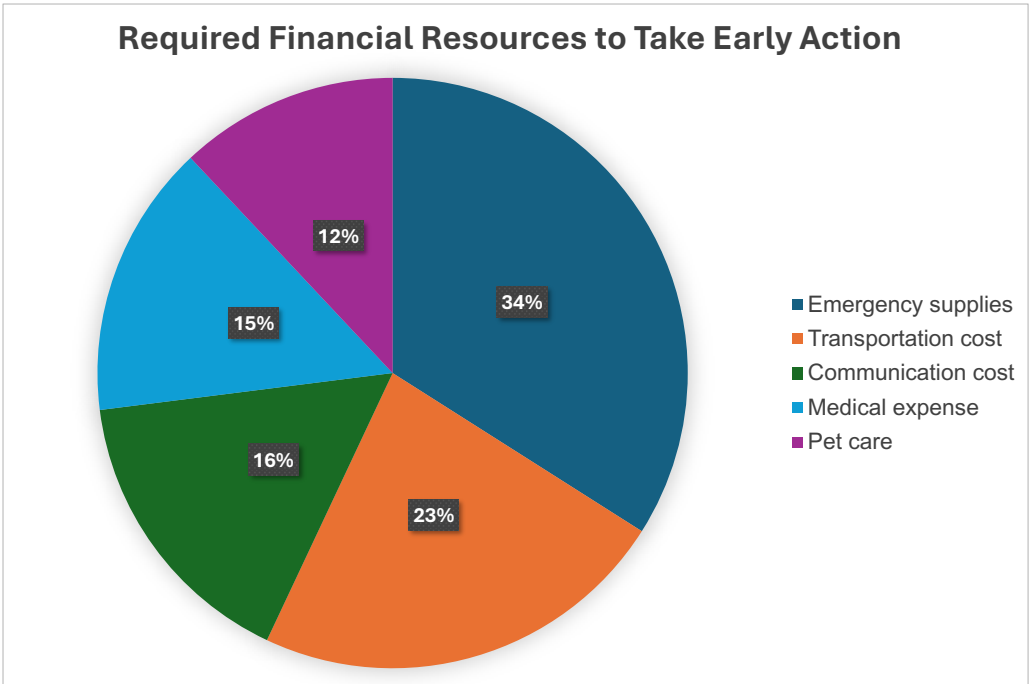

Fig. 8. Required financial resources of the respondent

Locally Managed Warning Systems to Increase Resilience

Local Solution to Support Early Warning Systems

Local solutions and community-led initiatives play a crucial role in ensuring an effective early warning and action system. During the questionnaire survey, respondents were asked about local solutions used to reduce the loss of life, property damage, and economic losses. The findings show that local people disseminate early warning messages about impending disasters by implementing technologies and methods such as sirens, miking (public announcements), awareness-raising activities, and community meetings (Figure 9).

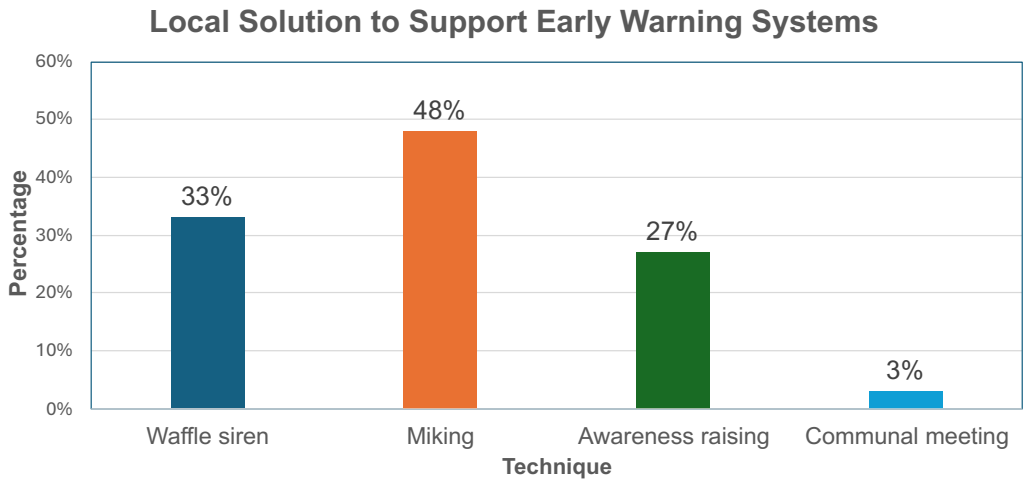

Fig. 9. Local solution to support early warning systems

To enhance last-mile communication and address the digital divide identified in this study, a Digital-to-Analog Bridge mechanism can be introduced as a community-based strategy within the early warning system. In this approach, digitally connected youth and mobile phone users in the community can be formally trained as local volunteers to receive early warning messages through social media, SMS, or other digital platforms and immediately relay them to vulnerable and digitally excluded groups-such as the elderly, persons with disabilities, and marginalized households-through direct, face-to-face communication. These volunteers can also simplify technical messages into locally understandable language and ensure that recipients clearly understand the required actions. By combining digital access with traditional interpersonal communication, this mechanism can improve the timeliness, accessibility, and effectiveness of early warning dissemination, strengthen community trust, and promote more proactive disaster preparedness and response among last-mile populations.

Effectiveness of Local Solutions

Local solutions for early disaster action are often highly effective because they utilize community knowledge, local resources, and existing social networks. These approaches rely on communication channels and methods that are familiar and accessible to residents. During the questionnaire survey, 34% of respondents stated that local solutions are very effective, 16% mentioned that they are somewhat effective, and 14% believed that local solutions are not effective for last-mile communities.

Respondents' Suggestions for Improving Early Warning Systems

During the questionnaire survey, respondents provided several suggestions to improve the effectiveness of the early warning system. The highest proportion (27%) emphasized the need for timely dissemination of early warning messages, noting that delays in data transmission can significantly reduce the effectiveness of warnings. About 21% highlighted the importance of developing communication systems that are timely and easily understandable, particularly for remote and marginalized communities. Furthermore, 14% of respondents suggested organizing disaster preparedness training programs to build local capacity, as such programs empower communities with the knowledge and skills needed to respond effectively to warnings and mitigate risks. Around 16% recommended conducting regular community meetings to foster awareness, preparedness, and trust among residents. These meetings can educate people about potential risks, provide updates, and encourage active participation in disaster preparedness and response efforts. In addition, 22% stressed the importance of providing accurate and complete data, as inaccurate or incomplete information may result in false alarms or missed warnings (Figure 10).

Since the early warning system in this area is not well developed, respondents also suggested further improvements. About 33% emphasized the need to strengthen regular community meetings to enhance awareness and trust. Meanwhile, 37% expressed interest in participating in training programs to improve their knowledge and skills for effective disaster response. Additionally, 30% recommended conducting awareness campaigns to encourage individuals to take appropriate actions during emergencies. Such campaigns should inform and educate community members about potential hazards and the purpose and operation of the early warning system.

During the survey of 100 respondents, only 28% reported having participated in disaster preparedness training programs, while 72% had not received any such training. Community meetings were also found to be essential for strengthening early warning systems and improving disaster prevention and preparedness measures. However, 51% of respondents stated that they did not participate in community meetings because they were not conducted regularly in their area. About 32% participated occasionally, and only 17% attended meetings on a monthly basis.

Regarding the use of social media, 46% of respondents reported using social media daily and preferred to receive early warning messages through these platforms. About 8% used social media monthly, 14% used it occasionally, and 32% never used social media-particularly older individuals-who therefore do not rely on these platforms for warning messages. Sahana et al. (2023) suggested that increasing social media awareness and developing a digital early warning system (EWS) platform could be an effective step toward reducing disaster-related damages.

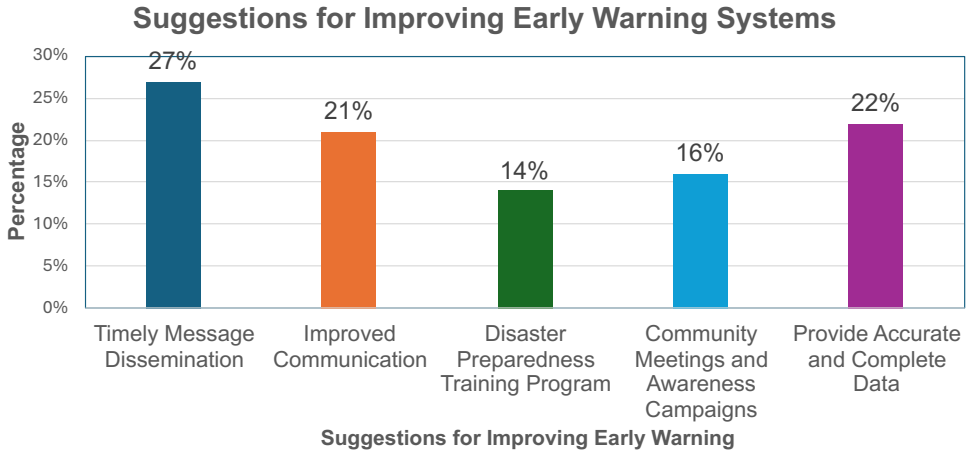

Fig. 10. Respondents suggestions for improving early warning systems

Effectiveness of the Early Warning System in the Community

Early warning systems are generally effective when they are well designed, properly implemented, and when communities are adequately informed about how to respond to warning messages. During the field survey, 22% of respondents stated that the early warning system in the area is very effective. The majority (49%) considered it somewhat effective, while 29% reported that the early warning system is not effective, particularly for last-mile communities (Figure 11).

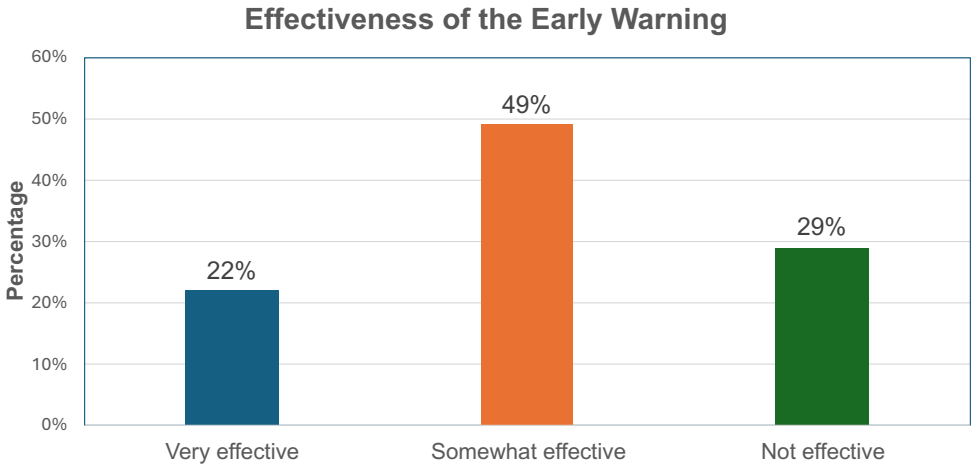

Fig. 11. Effectiveness of the early warning systems

Conceptual Framework of Barrier-Action Matrix in Early Warning Response

Based on the findings of this study, communication barriers (Figure 4) such as lack of access to communication channels, language barriers, limited understanding of warning messages, and delayed warnings are closely linked with practical challenges (Figure 7) including lack of resources, lack of clear guidance, transportation difficulties, and weak communication with responsible authorities. A Barrier-Action Matrix shows the relationship between warning barriers and response challenges and clearly linking barriers with likely outcomes and by highlighting areas where targeted interventions can improve the effectiveness of early warning systems and disaster preparedness. For example, Lack of access to communication channels + delayed warning = limited preparedness time and lead to evacuation failure; Language barriers + limited understanding of messages = reduce trust in warnings and poor response to warnings; Lack of transport + distant cyclone shelters = evacuation failure; Lack of resources + lack of clear guidance = delayed or no action; Weak communication with authorities + mistrust of warnings = low evacuation participation.

Figure 13 presents the conceptual relationship between communication barriers, response challenges, and their impacts on early action in coastal communities. The framework demonstrates that barriers such as language difficulties, delayed warning dissemination, and lack of access to communication channels interact with resource constraints, transportation problems, and mistrust in authorities, ultimately reducing the effectiveness of early warning systems. The figure also highlights potential policy and community-level interventions to improve preparedness and response. Presenting these issues together would help government

agencies, NGOs, and donors quickly identify how specific barriers directly influence preparedness and evacuation behaviour in last-mile communities.

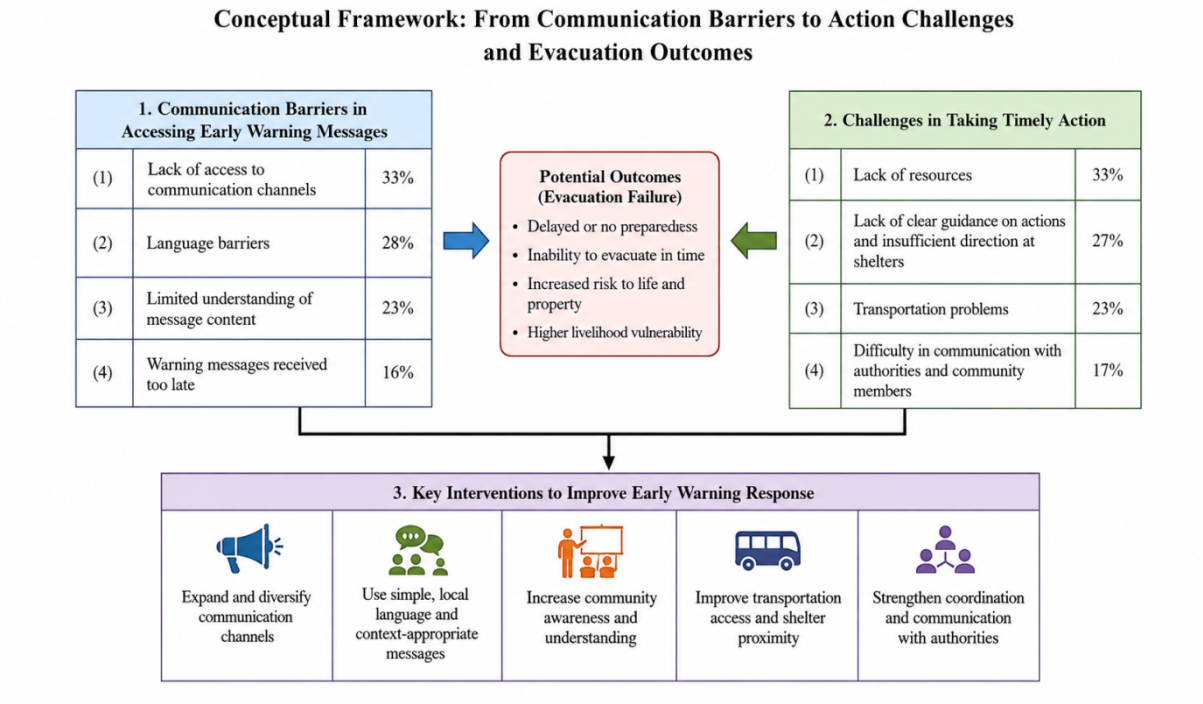

Fig. 12. Barrier-action matrix for early warning response

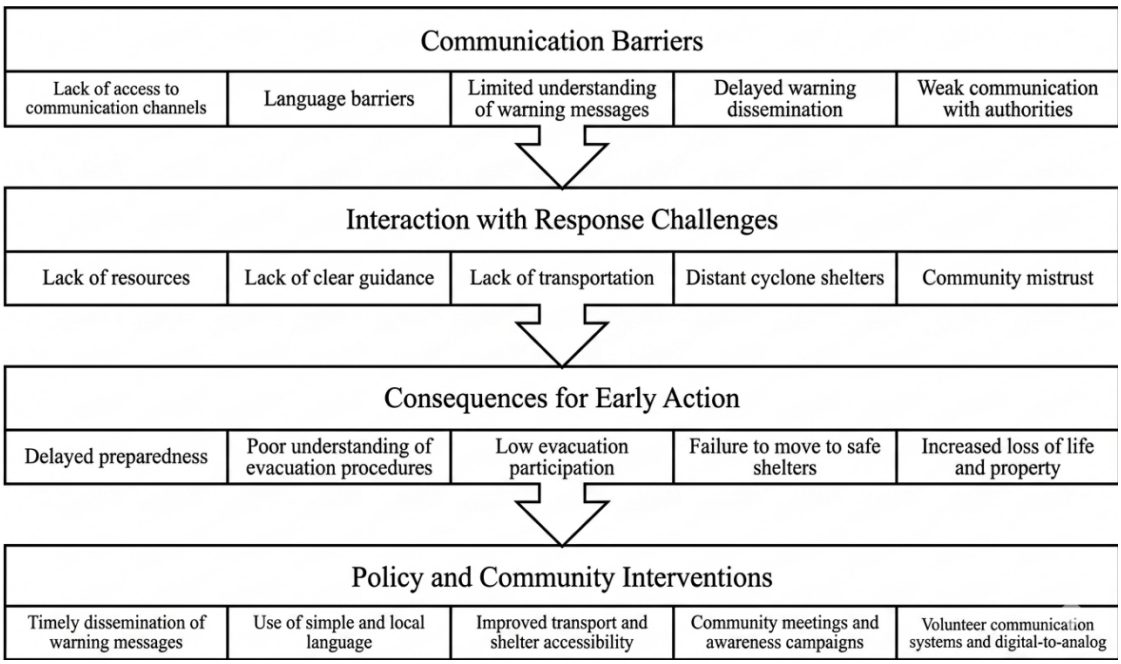

Figure 13: Conceptual framework of barrier-action linkages in early warning response

Conclusion

In conclusion, the evaluation of early warning messages among last-mile communities reveals both progress and persistent challenges in ensuring accessibility and actionability within disaster preparedness and response efforts. Through this study, we have uncovered the complexities inherent in disseminating timely and effective warnings to populations at the forefront of vulnerability. Our analysis underscores the importance of adopting a multifaceted approach that addresses the diverse needs and circumstances of last-mile communities. In the study area, 28% of people participate in and get training for disaster preparedness. Analysis found that 22% found the early warning system very effective, 49% found it somewhat effective, and 29% found it not effective. Results show that 33% wanted to enhance regular community meetings, 37% were interested in a training program, and 30% wanted to raise awareness among the community people.

Accessibility demands the utilization of multiple communication channels, including traditional media, mobile technology, and community networks, to reach individuals with varying access to resources and infrastructure. Inclusivity necessitates the integration of linguistic, cultural, and disability considerations into warning systems, ensuring that messages are comprehensible and relevant to all recipients, regardless of background or ability. Actionability requires the clear articulation of actionable steps and the provision of resources necessary for individuals to prepare, respond, and recover from disasters effectively. Achieving truly actionable early warning systems requires sustained investment in community-based approaches, participatory decision-making, and capacity-building initiatives that empower last-mile communities to actively participate in disaster risk reduction efforts.

Moving forward, it is imperative for stakeholders at all levels, including governments, NGOs, and local communities, to prioritize the enhancement of early warning messaging strategies through collaborative partnerships, innovative technologies, and targeted interventions. By centering the needs and voices of last-mile communities in the design and implementation of warning systems, we can strengthen resilience, reduce vulnerabilities, and ultimately save lives in the face of future disasters. In closing, the journey towards accessible and actionable early warning messages is ongoing, but with concerted effort and collective commitment, we can build a more resilient and equitable future for all.

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