Community-Based Flood Risk Management in a Flood-Prone Rural Area in Mindanao, Philippines

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Abstract
Flood-prone communities rely heavily on timely and effective communication for disaster preparedness and response. Barangay Managok, situated along the flood-prone Sawaga River in Malaybalay City, Philippines, continues to face seasonal flooding despite existing communication strategies. This study investigated how information and communication technologies (ICT) were used in the area for flood-related communication and decision-making and examined the awareness, response and preparedness of residents in the face of recurring flood risks. Using a phenomenological design, the study explored the lived experiences of seven long-term residents. Data were collected through semi-structured, face-to-face interviews, transcribed and translated from Cebuano to English.

Thematic analysis was used to analyze the data. Participants identified several ICT tools used in flood communication: hand-held radios, cellphones and social media for flood communication, with the latter two cited as most effective. Challenges included poor signal, power outages and uneven access to communication tools. Most residents were aware of flood risks and were engaged in proactive preparedness. ICT tools aided flood communication but were limited by infrastructure and access. Improved distribution and training are needed to strengthen community resilience.

Keywords: Flood preparedness, ICT tools, Disaster communication.

Introduction

Flooding remains one of the most devastating and frequent natural hazards worldwide, affecting millions of lives each year and causing significant economic, social and environmental damage[6]. Researchers highlight that floods affect 1.81 billion people, disproportionately impacting low- and middle-income countries with limited capacity for prevention and response[5,16].

Climate change, rapid urbanization and deforestation further exacerbate flood risks by increasing the frequency and severity of extreme weather events. As global efforts toward disaster risk reduction intensify, the role of technology and community-based strategies in enhancing flood resilience becomes increasingly important.

In the Philippines, flooding has become a persistent threat, particularly during the typhoon season, which spans from June to November. The country is one of four Asian nations, alongside China, India and Indonesia, identified as experiencing frequent water-related disasters[9]. With its archipelagic geography and exposure to seasonal monsoons and tropical cyclones, the country experiences multiple flood events each year, often leading to displacement, loss of livelihood and infrastructure damage[10]. In response, national and local governments have implemented a range of interventions, including early warning systems, hazard mapping and disaster preparedness campaigns[3,13].

However, in many rural areas, gaps remain in risk communication, community engagement and the adoption of information and communication technology (ICT) tools that could enhance timely awareness and coordinated response.

The province of Bukidnon is not spared from flooding, which typically takes the form of fluvial floods[18]. Barangay Managok, a flood-prone rural community in Malaybalay City, Bukidnon, presents a compelling case for examining these challenges at the local level. Nestled along the Sawaga River, the barangay experiences seasonal flooding that disrupts daily life and endangers both lives and livelihoods. Malaybalay City, although located outside the main typhoon belt, experiences heavy rainfall from May to October and 40 of its 46 barangays are considered flood-prone[11]. The city has adopted both traditional and digital media to inform residents about flood risks.

However, the recurring impacts of flooding suggest that the effectiveness and accessibility of these communication strategies warrant closer examination. While community members have developed traditional coping mechanisms over the years, the integration of ICT tools in raising flood-risk awareness and improving preparedness remains underexplored. This study investigated how ICT was used in the barangay for flood-related communication and decision-making and examining the awareness, response and preparedness of residents in the face of recurring flood risks.

Material and Methods

Study Design, Population and Setting: This study employed a phenomenological research design to explore the lived experiences of community members regarding flood-related communication and preparedness. A total of seven participants were included, which aligns with the

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recommended sample size to reach data saturation for phenomenological studies[1]. The participants were barangay and purok officials of Barangay Managok, Malaybalay City, Bukidnon. As local leaders, they possess valuable insights into the community's flood communication practices and preparedness efforts. Purposive sampling was used to select individuals who had held leadership roles for at least five years and were actively involved in disaster response and information dissemination. This criterion ensured that participants could meaningfully reflect on their experiences and responsibilities related to flood communication within their jurisdiction.

Barangay Managok was selected as the study site due to its vulnerability to seasonal flooding, being located along the Sawaga River and identified as one of the flood-prone areas in Malaybalay City. Despite the presence of traditional and digital communication efforts by the local government, the area continues to experience recurring flood impacts. This context makes Barangay Managok a relevant and critical case for understanding how flood-risk information is disseminated, received and acted upon at the grassroots level.

Data Collection and Analysis: Data were collected through in-depth, face-to-face interviews with the selected participants. The primary data-gathering tool was a semi-structured interview guide, consisting of four parts: (1) an introduction to the study; (2) questions on socio-demographic characteristics; (3) items related to participants' access to flood-related information and (4) questions assessing the perceived effectiveness of current communication strategies in reaching and informing residents in flood-prone areas. The interview guide was originally written in English and later translated into Cebuano, the local language spoken by the participants to ensure clarity and ease of understanding. The data were analyzed using thematic analysis following the six-phase approach of Braun and Clarke[2]. This method allowed for the identification, analysis and reporting of recurring patterns or themes within the data. The process involved familiarization with the data, generating initial codes, searching for themes, reviewing themes, defining and naming themes and producing the final report.

Ethical Considerations: This study adhered to established ethical standards for conducting research involving human participants. Prior to data collection, the research protocol was reviewed and approved by the Bukidnon State University Research Ethics Committee, ensuring compliance with ethical guidelines related to informed consent, confidentiality and participant welfare. All participants were fully informed about the nature, purpose and scope of the study. Written informed consent was obtained from each participant before the interviews were conducted. Participants were assured that their participation was voluntary and that they could withdraw at any time without any consequences. They were also informed that there were no risks or direct benefits associated with their participation.

To ensure confidentiality and anonymity, participants' names and other identifying details were omitted from transcripts and replaced with codes. All interview data were securely stored in password-protected digital files accessible only to the researchers. Additionally, the interviews were conducted in a respectful and culturally sensitive manner, taking into account the local language and customs of the area. The researchers also ensured that findings were reported honestly and without fabrication, falsification, or misrepresentation of data.

Results and Discussion

As mentioned earlier, a total of seven participants participated in the study. Their sociodemographic characteristics are shown in table 1.

ICT Tools for Information Dissemination: According to the participants, the ICT tools they used to disseminate information about floods included handheld radios, cellphones, social media and early warning devices.

Hand-held Radios: Participants underscored that they utilized handheld radios at the onset of flooding in their community. "*Hand-held radios gyud amo gamit kay naa man mi napulo ka hand-held radios karon sa amo barangay.*" (We used the hand-held radios as we have 10 units available in the barangay) (Participant 1). "*Lage, hand-held radios gyud kay naa man sa barangay hall ang base niini.*" (Yes, we used the hand-held radios as the base of these are in the barangay hall) (Participant 2). During the interview, most of the participants revealed that they used cellphones during the flood.

Table 1
The sociodemographic characteristics of the participants

Participant No.	Sex	Occupation
1	Male	Barangay Councilor
2	Male	Barangay Councilor
3	Female	Barangay Secretary
4	Female	Purok Chairwoman
5	Female	Purok Chairwoman
6	Male	Purok Chairman
7	Male	Barangay Councilor

"*Ang mga tawo naa naman poy mga cellphone. Ug naa na silay number namo tanan diri sa barangay*" (Everyone has cellphones already and they have all our barangay officials' numbers) (Participant 3). "*Cellphone ra gyud.*" (We only used cellphone) (Participant 4). Participants saved the contact number of their barangay officials to contact in case of emergency.

Social Media: Participants mentioned that they utilized their social media in the onset of flood. "*Tungod kay katag-katag ang mga tawo sa amo barangay, maong social media gyud ang ila ginagamit.*" (Because the people in our barangay are scattered, they primarily use social media to reach everyone) (Participant 3).

Early Warning Device: A participant revealed that they were aware of an early warning device installed in their dike to monitor water levels. "*Naa mi early warning device nga mabaw-an nimo kung yellow, orange so kuan na gyud siya locate na gyud kung unsa na ka taas ang tubig.*" (We have an early warning device that you can use to determine if it is yellow, orange, or something else and it will also indicate the water level) (Participant 2).

A siren was also used as a warning if the level of water was high. "*Naa mi siren na mutingog pag taas na ang level sa baha*." (We have a siren that will activate when the level of water rises) (Participant 5). However, participant 5 also highlighted that it was somewhat not entirely effective if the residents lived far from the siren. "*pero dili moabot sa layo ang tingog taga duol ra gyud ang makadungog*." (but the sound won't reach far; only those nearby will hear it).

Radio: The participant who lived far from the población revealed that radio was the primary source of information in their area. Participant 6 said that. "*Radyo ra gyud amo gisaligan sa lagyo kay mao raman ang moabot sa amoa*" (We rely solely on radio because it's the only thing that reaches us from afar). Participant 7 supported the answer of participant 6 that radio was accessible in their area. "*Juander Radio ra gyud ang among mapaminawan*." (We can only listen to Juander Radio). It should be noted that radio information about weather updates did not originate from Barangay Managok. When such information was aired, it was no longer a real-time update.

Flood-related Information: When asked about the information they obtained from these ICT tools, the participants reported receiving weather forecasts as well as updates from the City Disaster Risk Reduction and Management Office (CDRRMO) regarding dam conditions and rainfall.

Weather Forecast: Among the information obtained from these sources, weather forecasts were cited most frequently. Participant 6 stated that, "*Makahatag sila ug weather update kaso dili siya connected sa amoa*." (They can provide a weather update, but it's not connected to us).

Monitoring by the CDRRMO on Dam and Rainfall Conditions: Participant 1 explained that the CDRRMO of Malaybalay City received notifications when water levels rose and, consequently, automatically issued warnings to barangay officials. "*Ang CDRRMO naay early warning alert na mo-notify sa ilaha kung taas na ang baha aron mainform sad nato ang mga apektado na purok ug barangay*." (The CDRRMO has an early warning alert system that will notify them if the river water level rises, so we can inform the affected neighborhoods and barangays).

Participants shared that the CDRRMO of Malaybalay not only notified them about rising water levels but also informed them when rainfall intensified. "*Ang CDRRMO ga broadcast ug warning sa mga laing purok bisa'g kusog pa lang ang ulan*." (The CDRRMO broadcasts warnings to different neighborhoods even if it is just raining heavily) (Participant 4). "*Every now and then na sila gamonitor, sir. Inig mag kusog ang ulan, gina alert na mi diri.*" (They monitor every now and then, sir. When the rain gets heavy, they alert us here) (Participant 2).

Perceived Effectiveness of the ICT Tools: The participants were asked about the effectiveness of these ICT tools. The majority considered cellphones and social media to be effective, as most of them had access to these tools. For the participants, cellphones were accessible and information could be disseminated quickly. Since most participants perceived cellphones as a reliable source of flood-related information, this tool played an important role in facilitating timely communication. "*Tanan tawo nay access ani ug dali ra moabot ang information*." (Everyone has access to this and the information reaches them quickly) (Participant 3). "*Cellphone ra gyud kay mao may makakontak ug dali.*" (Cellphones are really the only way since they can contact us quickly) (Participant 4). "*Maong cellphone kay mas dali man sila ma communicate, mas dali sila ma-kontak.*" (That is why we use cellphones, because it is easier to communicate and contact people quickly) (Participant 5).

Some participants revealed that social media could also be effective in disseminating flood-related information because it allowed them to reach a larger audience with a single post. Several participants reported using this platform specifically to extend the reach of such information. "*Ang uban kay gina live na nila ang baha para makita na dayon sa tanan ang sitwasyon*." (Others live stream the flood so everyone can immediately see the situation) (Participant 3). "*Tanan man nato naay access sa Facebook mao dali ra sa ilaha ma abot ang balita sa baha*." (Everyone has access to Facebook, so news about the flood reaches them quickly) (Participant 4). Cellphones were generally accessible during floods. Participants noted that if a handheld radio were available, it would be more useful and the dissemination of information could be faster.

Challenges in the Access and Use of ICT Tools: During the interviews, several participants considered some ICT

tools as less important, particularly during crises or disasters. In certain areas of Managok, cellphone reception was unavailable, even though it was accessible in other locations. Additionally, at the onset of flooding, electricity was often cut off, rendering vendo Wi-Fi services inoperable. "*Kaning cellphone man gud pod, dili magamit kung walay signal, walay wi-fi, walay internet ug walay load.*" (The cellphone is indeed unusable without a signal, Wi-Fi, internet, or load) (Participant 4). "*Usahay maulahi mi sa information sa balita kay mawala na ang signal tungod sa ka kusog na sa ulan.*" (Sometimes we receive news information late because the signal is lost due to heavy rain) (Participant 6).

Participants also reported that handheld radios were provided only to barangay officials. "*Ang hand-held radios kay sa Barangay Public Safety Officer ra, ma'am, mao pud unta ang amoang gusto e-sulti kay kapitan nga unta mahatagan mi diri sa purok na dili kaabot ang signal.*" (The handheld radios are only allocated for use by the Barangay Public Safety Officer, ma'am. This is also what we wish to tell the Barangay Captain, the necessity of providing us with radios here in the areas where the signal is not available).

Community Awareness on Flood Risk: All participants reported being aware of the flood risks in their community. When asked to rate their level of awareness, all participants assigned a score of four, noting that there was always room for improvement. They emphasized that evaluation and monitoring of rescue response actions vary with each calamity, making every situation unique. "*Naanad na mi na baha-onon among lugar ug naa na mi mga preparations gi-andam daan. Abtik na mi, sir."* (We are accustomed to the frequent flooding in our area and have made preparations in advance. We are proactive in our approach, sir) (Participant 2).

However, participant 4 emphasized that, although they were already accustomed to frequent flooding, they still required additional training in flood preparedness and access to supplementary equipment. "*Additional training para sa mga katawhan. Additional na mga equipment para sa pag-communicate.*" (Additional training and equipment for easy communication among residents). Participants indicated that experience and historical knowledge served as the primary basis for their understanding, as Purok leaders lacked formal training and equipment for disaster risk reduction and management.

Community Preparedness: The participants revealed several actions taken in response to flooding. Residents demonstrated initiative by following evacuation plans and taking personal measures to ensure the safety of themselves and their families.

These actions included: (1) evacuating to higher ground; (2) conducting house-to-house visits to inform neighbors about evacuation; (3) elevating their homes and (4) preparing emergency kits or go-bags. "*Kung kusog na ang baha, mag-evacuate ug adto sa taas nga lugar*." (In the event of heavy flooding, we will evacuate to higher ground for safety) (Participant 2).

"*Kung taas na ang baha, mag-adto mi tagsa-tagsa sa mga balay ug i-inform ang mga pamilya na mag evacuate na*." (In the event of rising floodwaters, we conduct house-to-house visits to instruct residents to evacuate) (Participant 6). **"***Gipang-elevate na namo among balay. Mga 1 meter siguro para dili na gyud mosaka ang tubig*." (We have elevated our homes, perhaps by about 1 meter, to prevent water from rising further) (Participant 1). "*Andam na daan ang mga emergency kit naa poy tindahan nga makakuha mi mga barangay officials kung kailangan na gyud*." (We have already prepared emergency kits and there is a store where barangay officials can obtain supplies when needed) (Participant 3).

Flood preparedness in Barangay Managok was shaped by a complex interplay of ICTs, community practices and structural constraints. The residents' reliance on hand-held radios, mobile phones and social media reflects the convergence of traditional and modern communication strategies, a trend observed in disaster-prone areas globally[20]. Mobile phones and Facebook were particularly valued for their speed and accessibility in reaching residents scattered across geographically dispersed sitios. As participants emphasized, having direct access to Barangay officials' numbers enhanced rapid communication, which is consistent with previous findings highlighting the role of interpersonal ties and mobile connectivity in community-based disaster response[21].

Social media platforms were also repurposed as real-time broadcasting tools; residents even live streamed flood conditions to warn others, showing how networked publics in rural communities can transform into active informants during crises[8,12,14]. The popularity and perceived effectiveness of Facebook, especially in contexts with fragmented settlements, underlined the growing importance of digital platforms in grassroots resilience-building.

However, digital communication tools were not equally accessible to all residents in Barangay Managok. Signal disruptions, especially during heavy rains and the reliance on vendo Wi-Fi, disabled during power outages, highlight persistent infrastructural vulnerabilities. These concerns echoed broader issues of digital inequality discussed by United Nations[19], particularly in rural and geographically marginalized settings. While early warning systems such as sirens and automated alerts from the CDRRMO existed, their effectiveness was spatially limited; sirens often failed to reach remote areas and real-time information was not always localized to Barangay Managok. Hence, LGU should make sure that these warning tools also reach the said areas because as found by a previous study, residents in Tanzania actively respond to warnings through these tools, resulting in damage reduction[17].

Residents living farther from the población reported greater reliance on AM/FM radio, such as Juander Radio. While radio was accessible and affordable, it provided less localized and less timely information – a limitation also identified in studies on urban and peri-urban disaster risk communication in the Philippines[15]. The community's high flood risk awareness stemmed from lived experience, reinforcing the role of local knowledge in disaster preparedness[3]. Proactive behaviors like house-to-house alerts, home elevation and pre-packed emergency kits illustrated the community's resilience. Yet, residents, especially Purok leaders, identified the need for continued training and improved access to equipment. This echoed the findings that emphasize that capacity development for disaster risk reduction should be structured as a social learning system that integrates local knowledge and fosters long-term community engagement, rather than being treated as a one-time task[7].

Overall, the study revealed that while ICT tools were crucial to flood preparedness, their effectiveness hinged on contextual relevance, infrastructural reliability and inclusive distribution. Efforts to improve disaster communication in Barangay Managok must therefore address both technological and social dimensions, ensuring that strategies are localized, equitable and community-led.

Conclusion

Context-sensitive communication strategies played a vital role in enhancing flood preparedness in flood-prone communities like Barangay Managok, Malaybalay City, Bukidnon. While residents actively used both traditional and digital tools, especially mobile phones and social media, to receive flood-related updates, challenges persisted due to limited access and infrastructure gaps. The findings highlighted the need to integrate localized knowledge, strengthen community engagement and invest in capacity-building efforts. To build a more resilient and informed community, disaster communication systems must be inclusive, culturally responsive and technologically adaptive.

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