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Technical Note

Early Warning System Implementation in Banjo West, Tanauan, Batangas, Philippines

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Abstract Early Warning systems (EWS) are a crucial component of risk management and disaster preparedness as it helps lessen disaster's impacts especially for areas specifically identified as vulnerable and at risk. Based on one of its most recent visible and impactful eruptions last 2019, an Early warning system has been implemented in the affected barangays surrounding the volcano. Barangay Banjo West of Tanauan, Batangas, Philippines is an area at risk because of its proximity to the Taal volcano. The research focused on its implementation in Banjo West specifically focusing on the process of implementation and the local implementer's knowledge of the EWS. Interviews and documentary analysis were conducted involving the barangay's implementers and residents. The results show that there is a gap between the knowledge of the potential risks, the nature and value of EWS, education regarding the environment, and participation of the community and how it should be implemented in the Barangay. Key areas were identified where there is a need to further enhance the implementation of EWS based on the results.

Keywords: early warning systems, disaster and risk management, environmental education, community implementation

1. INTRODUCTION

The Sustainable Development Goal (SDG) - Sustainable Cities and Communities emphasizes the need to make cities and human settlements inclusive, safe, resilient, and sustainable. According to SDG (Sustainable Development Goal) - Sustainable Cities and Communities the main goal is to make the cities and human settlements inclusive, safe, resilient and sustainable. Section 11.5 stated that By 2030, significantly reduce the number of

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deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations (Goal 11: Sustainable Cities and Communities - the Global Goals, 2023).

The Philippines is in the Pacific Ring of Fire where several active volcanoes are situated (Lim et al., 2022). Volcanic hazards are categorized as geological hazards together with earthquakes, tsunamis, and landslides. Thus, aside from the frequent typhoons, the Philippines also experiences volcanic eruptions that sometimes have large scale atmospheric and global effects such as the eruption of Mt. Pinatubo (Quimbo, 2020). The Philippine Institute of Volcanology and Seismology (PHIVOLCS) identified 24 active volcanoes within the country, one of which is Taal. Located in the Province of Batangas, it is a caldera volcano that last erupted in 1977 over which approximately 24 million people are living within 100-km around it. The volcano began a period of unrest on 13 January 2020 with phreatic or steam-driven activity in the main crater that evolved to a magmatic eruption (Lim et al., 2022).

To mitigate impacts of natural hazards, an emphasis is placed on disaster and risk management in affected barangays which also include the implementation of an emergency warning system. Thus, this study sought to explore how the Early Warning System (EWS) is implemented in Banjo West, Tanauan, and Batangas in the Philippines.

In this study, we sought to:

1. Describe the community and the local government's knowledge of risks and hazards in the barangay and
2. Analyzed the characteristics of the EWS of the Barangay.

1.1 Disaster and Risk Management and EWS

Disaster is a natural or human-induced hazard that causes a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its resources (UNDRR, 2017). During the last two decades, this concern has brought every nation and government to carry on its shoulders the responsibilities and obligations due to heavy losses of life, property, and resources. Disasters like typhoons, fires, floods, earthquakes, etc., pose a serious threat to people and economic development. That is why it is imperative, and an obligation of the government and everyone around to spread awareness and enlighten every citizen on the adverse effects a disaster could bring (Chakma et al., 2022; Galvizo, 2022).

Early warning systems (EWS) is a system set in the context of including the main components of an EWS, the roles of the main actors and the need for robust evaluation. Management of disaster risks requires that the nature and distribution of risk are understood,

including the hazards , and the exposure, vulnerability and capacity of communities at risk. A variety of policy options can be used to reduce and manage risks, and we emphasis the contribution of early warnings, presenting an eight-component framework of people-centered early warning systems which highlights the importance of an integrated and all-society approach. In their studies identify the need for decisions to be evidence-based, for performance monitoring and for dealing with errors and false information. They concluded that identifying gaps in current early warning systems, including in the social components of warning systems and in dealing with multi-hazards, and obstacles to progress, including issues in funding, data availability, and stakeholder engagement (Trogrlić et al., 2022).

Various disasters such as earthquakes, landslides, droughts, floods, and tsunamis occur in Asian Countries (Amarnath et al., 2021; Shah et al., 2020; Morgan et al., 2006). Nepal, Afghanistan, India, Pakistan, and Bangladesh experience major floods caused by river overflows or heavy rainflow (Dhimal et al., 2021; Shah et al., 2020; Sharma et al., 2019). Bhutan faces diverse hazards, such as landslides, floods, fires, windstorms, hailstorms, and earthquakes, which have potential impacts (Tempa & Yuden, 2023). Inadequate early warnings add to the impacts of disasters (Nhamo et al., 2019; Perera et al., 2020).

1.2 Disaster and Risk Management in the Philippine Setting

The World Risk Report categorized the Philippines as a country with a very high level of exposure and lack of adaptive capability, high level of vulnerability and susceptibility, and with a coping capability at a medium level (Behlert et al., 2020). Likewise, The Philippine Institute of Volcanology and Seismology (PHIVOLCS) have marked the Philippine geographical location and its archipelagic features as a high-risk vulnerability because of its major tectonic feature cut across the whole archipelago, from Northwest of Luzon to the Southeast part of Mindanao. Moreover, the Philippines geographical location is found in the Pacific Ring of Fire, making the country susceptible to earthquakes and volcanic eruptions. Moreover, the country faces a serious threat of typhoons and weather disturbances due to its location facing the Pacific Ocean, where almost all tropical depressions occur. All the natural hazards mentioned left a very remarkable experience in the lives of many Filipino people (Galvizo, 2022; Soriano, 2019).

The Philippine Disaster Risk Management and Reduction Act of 2010 (RA1021) was created based on the nation's realizations after experiencing the devastating effects of Typhoons Ondoy (Ketsana) and Pepeng (Parma) in 2009 (Viana, 2014). This law focuses on disaster risk reduction through prevention and mitigation, preparation, response, and recovery and rehabilitation. To ensure that a body supervises the implementation of this law, the National Disaster Risk Reduction and Management Council was created (NDRRMC, 2014).

Past typhoons and other natural disasters brought about an increase in damages and losses. It was thus found that there is a need to build the capacity of the local government in coordination efforts and risk knowledge (NDRRMC, 2020; Cruz & Ormilla, 2022). The

policy was then reformed which included the four pillars. These were then revised to disaster prevention and mitigation, disaster preparedness, disaster response and early recovery, and disaster rehabilitation and recovery (NDRRMC, 2020). DRRM were then streamlined in all plans and levels of government, vulnerability risk assessments, multi hazard mapping with community members were conducted, coordination with various stakeholders and improved reporting before, during, and post-disaster were also initiated (NDRRMC, 2014; Mohammed, 2018).

Thus, the DRRM strategies have shifted more towards initiatives focusing on prevention and mitigation instead of just response and recovery since the implementation of the RA 101021 (Granstrom, 2022).

1.3 Early Warning System in the Philippine Context

The early warning system (EWS) is one of the identified chief instruments in becoming more prepared for disasters. This highlighted a focus on prevention and preparedness over response and recovery (Tozier de la Poterie & Baudoin, 2015). The Hyogo Framework emphasized people centered EWS. Hyogo's successor, Sendai Framework for Disaster Risk Reduction 2015–2030, identified EWS as one of the seven global targets, stressing the need to significantly increase the access and availability to EWS and multi-hazard early warning systems and disaster risk management (Trogrlić et al., 2022).

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 of risks, disseminate messages and warnings efficiently, and help maintain a constant state of preparedness to enable early action. Early warning system (EWS) represents the set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss (Kovalevski, 2023) specially when populated areas are prone to natural hazards (Allen, 2020; Kron et al., 2003)

The UN International Strategy for Disaster Reduction (UNISDR) updated the description of EWS to include multi-hazard early warning system wherein "an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication, and preparedness activities systems and processes that enables individuals, communities, governments, business, and others to take timely action to reduce disaster risks in advance of hazardous event" (UNDSIR, 2017).

A study by Aguirre-Ayerbe et al. (2020) found that the Philippine's multi-hazards EWS (MHEWS) are fully operational and well-developed specifically in the areas of disaster risk

knowledge, detection, monitoring, analysis, and forecasting of the hazards and possible consequences. For single hazard EWS, another study by Gumiran et al. (2019) found that in Leyte's case, an established landslide EWS was integrated with community-based monitoring of surficial measurements. A similar case was also identified in Baguio, where The Smart Flood Early Warning, Information and Mitigation System project under the ASEAN Australia Smart Cities Trust Fund was established to improve the flood early warning system (Fonseca et al., 2021). On the other hand, a study found that Mindano del Norte as highly capable of disaster preparedness, response, and recovery (Maido, 2023).

Aside from this, early warning technologies were also developed by independent groups such as the one developed as an earthquake warning systems for Colegio de San Juan de Letran Calamba in the Philippines. Its location is widely known as prone to volcanic eruptions and seismic activities. The system aimed to accurately detect earthquakes, locate safe routes during emergencies, and provide warnings through an Android app called Juan Alert. By using sensors and data from PHIVOLCS, the system can notify people quickly, even those with older phones, and guide them to safe exits using LED displays. This project enhances preparedness and aims to reduce damage and casualties during earthquakes at the school. The design project aimed to create a system that will provide an accurate detection of the accelerometer to distinguish real earthquakes from man-made vibrations; locate passable routes during and/or after an earthquake phenomenon by improvising a sensor that will detect falling debris; and develop an Android Application that will provide warning notification in the Letran Calamba community (Santiago et al., 2022).

2. METHOD AND INSTRUMENT

2.1 Locale and Participants

The study was conducted in Barangay Banjo West in Tanauan, Batangas. The barangay has 272 hectares of land used for agriculture and 150 hectares are occupied by houses. A part of Banjo West is declared as part of the zone that needs to be evacuated in the event of the eruption of Taal volcano.

Participants of this research are selected members of the BDRRMC, Barangay Disaster and Risk Reduction Management Council, the Barangay secretary, and the Barangay Captain, and selected residents of Barangay Banjo West.

2.2 Data Gathering Procedure

Data was gathered through interviews, documents, observation, and focused group. Aside from this, researchers' journals and memos were also used as sources of data.

After reaching out to the Banjo West Barangay office, an initial visit was scheduled. A key informant (KI) Interview with the barangay secretary was then conducted on February 21, 2023 to form a background of the Barangay's Early Warning System, their implementation process, and programs that were set up to support the EWS. It was also through this that documents were also presented to us regarding the EWS.

As part of the observation, a short walk around Banjo West was also conducted to check the tools that were used for the system as well as other infrastructures. The walk also gave us a brief overview of the landscape of the Barangay and the structural nature of how the houses were built around the area.

Two focus group interviews were conducted on May 3, 2023. The first group consisted of five. Our main selection criteria for the first group was that they are members of the departments and organizations of Barangay. The second focused group included five participants from families residing in Banjo West. The interview guide consisted of questions pertaining to their knowledge and understanding of the EWS, and their experiences with the implementation of the EWS in the Barangay.

Informed consent was obtained before the interviews were conducted. We briefed the participants of purpose of the research, the data will be included and used, and that the interviews will be recorded. We also assured the participants that the transcripts and recordings will be kept confidential and only used and accessed by the researchers.

2.3 Data Analysis

The focus group discussion and Interviews were transcribed. The documents that were shown to us were also analyzed. Themes were derived from the transcribed data and analyzed data and were juxtaposed with data from the researcher memos and research journals and observation.

3. RESULTS AND DISCUSSION

The themes derived from the data are emergency response system of Banjo West and knowledge of the risk and EWS. The themes are discussed after the brief discussion of the risk management protocols of Barangay Banjo West. Transcript citations were also included to highlight the results wherein they are assigned the codes KI (Key Informant) and PA (Participant).

3.1 Risk Management Protocols of Barangay Banjo West

The Banjo West risk management protocols consists of conduct of the Community Risk Assessment (CRA); establishing and implementing risk and disaster prevention, mitigation, and rehabilitation and recovery programs, projects and activities; and monitoring and evaluation of these programs. The CRA of Banjo West focused on identifying and assessing risks that could lead to possible disasters. It also highlights the strengths and opportunities in the community that could help minimize the impact of disasters and risks. The EWS is part of the risk and disaster mitigation program.

3.2 The Emergency Response System of Barangay Banjo West

Community- based early warning system is characterized as democratic and executed with the people in the community (including the leaders and LGU) but with technical support provided. The community is viewed as partners whose ability to respond to emergencies caused by disasters, natural hazards, and risks should be developed. It also identifies community workers and leaders as key players in its implementation. It is consultative and there is an assumption that the community where it will be implemented is already organized (IFRC, 2012).

The early warning System of Barangay Banjo West consists of giving warnings based on the alert level of the natural disaster or hazard and the actions to be taken based on the warning (Table 1).

Table 1. Community-based early warning system of Barangay Banjo West

Alert	Warning	Description	Actions to be taken
Level I	Announcement of incoming hazard	Incoming typhoon/Heavy rains	Preparation
Level II	Issuing of warning	Strong winds are being experienced	Preparation for evacuation
Level III	Issuing of warning	High signal	Evacuation

They also have an evacuation plan that complements the warning system. This plan consists of an evacuation map (Figure 1) that shows the flow of the evacuation process highlighting where they should proceed based on their location. Evacuation centers are also highlighted in this map. There are two centers: Banjo Laurel Elementary School and Banjo Laurel National High School. The former can accommodate 65 families or 297 individuals while the latter can accommodate 46 families or 281 individuals.

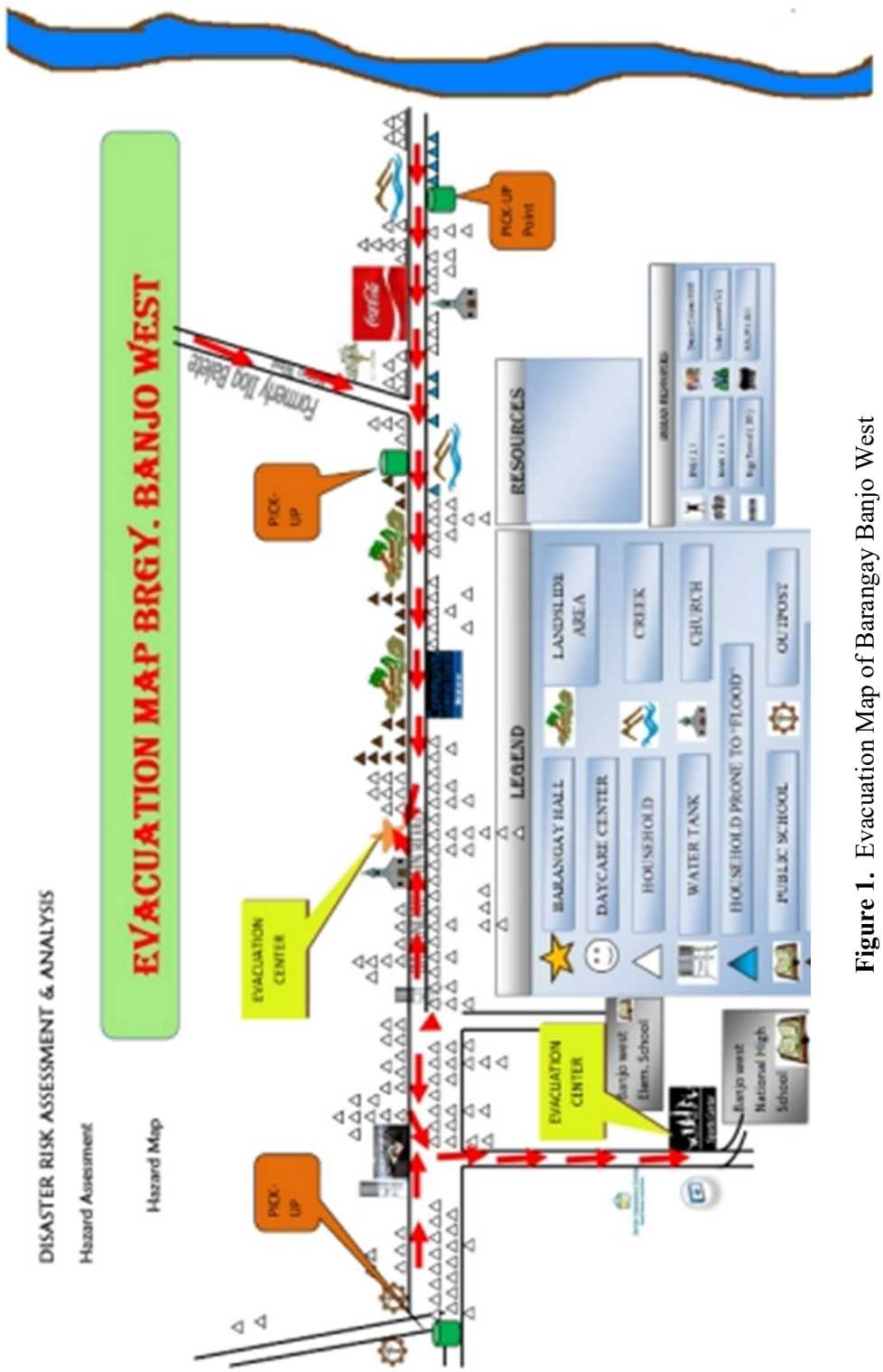

Figure 1. Evacuation Map of Barangay Banjo West (source: Banjo West Barangay Office)

3.3 Knowledge of Risks and EWS

Risk knowledge is one of the four core components of the early warning system (Gumiran & Daag, 2021; UNDP, 2020). This is the reference point of the implementers and community members. Risk knowledge pertains to the community's familiarity with disaster risk. Risk knowledge paves the way towards community resilience and encourages community participation in Disaster and Risk Reduction programs (Choi et al., 2022; Raza & Cruz, 2021; Vasileiou et al., 2022; Adgar, 2006; Allen, 2006; McEntire & Myers, 2004). In this study, we also explored the actual understanding of the implementers and the community of risks in their area.

Based on the Barangay's Disaster Risk Profile, it is prone to typhoons, flood, and volcanic eruptions wherein typhoons and volcanic eruptions are ranked as those with high impact (Table 2). Risk or hazards classified as 4 in the probability scale means that it is most likely to occur while those assigned 4 in the Impact/Effect column indicate that it has a high impact,

Historical records also show that the most devastating typhoon was Glenda in 2014 which left many properties and livelihood in a dire state. Taal's volcanic eruption in 2020 is the most recent one that the Barangay experienced in a long period.

Table 2. Possible risks and hazards in Barangay Banjo West

Risk/hazards	Probability	Impact/Effect	Rank
Volcanic eruption (Taal)	4	4	1
Typhoons	4	4	1
Floods	1	1	2
Landslide	2	2	3

Source: Barangay Banjo West Disaster Risk Profile 2022-2024

3.3.1 Extent of the Knowledge

The barangay is also vulnerable to this hazard and risks because of its proximity to the Taal volcano. These are all declared in detail in the documents kept by the Barangay office. However, it was observed that the community itself, even those who belong to the committees identified in both the document and shared by the KI, have little knowledge about the risks, hazards, and vulnerability of their barangay. They even shared that during the volcanic eruption, they were surprised to be declared as part of the *identified danger zone* since there was no existing disaster plan then:

> *During volcanic eruption noong taal wala talaga kasi walang disaster plan even ang city during that time wala din* (During the volcanic eruption, we (Barangay) did not have a disaster plan, even the city (municipal office) did not have one then) - PA1

> *…kasi po noong pumutok ang bulkan talagang wala naman pong alam na pumutok, talagang noon po surprise ngayon dumating po ang mga military, tapos nandito lahat may bigas na dala so total lockdown evacuate talaga, wala pa naman talaga kaming plano noon na kung saan dadalhin* (we were unaware when the volcano erupted. We were really surprised. The military came and evacuated us. It was a total lockdown. We all brought with use rice here and went where they asked us to go) -PA3

There is this perception that they will not be affected by the eruption and its effects. Post eruption, they are still unaware of the risks that they are vulnerable to and recognize that the eruption is simply a singular event that could be evaded through evacuation and the securing of their properties and belongings.

3.3.2 Emphasis on Practice

On the other hand, the community's knowledge of the EWS emphasizes the practices that they have in the event of a volcanic eruption including the means to inform the community of the barangay. This includes the use of churchbell as a warning, the knowledge of each resident of what evacuation center they can go, as reflected in what they shared:

> *yung simbahan, announce kasi may, pinapatunog po nila, hindi tsaka may sound system din po sa simbahan* (the church has a sound system and a bell that is used for announcements) – PA1

> *kaya po ngayon lagi ng nakaalerto ang evacuation center may kanya-kanya na po kaming pupuntahan* (the evacuation center is always on alert. We already know the specific evacuation areas to go to in case of volcanic eruption) – PA2

> *sa amin po kasi nakapokus po kami di sa barangay namin kami-kami lang po nag-ano yun pong katabi namig barangay nagtatanongan din kami kung ano since kung baga ang ang naging ano po doon ang situation po doon …nagtatanungan po kami para po may division of labor* (we focus on our barangay, we ask those in the other barangay of their current situation…we ask each other so we can divide the tasks among us) – PA3

> *Announcement galing sa barangay. Nag-iikot iyong patrol may megaphone po.* (The announcement comes from the. They go around using a megaphone.) – PA1

> *abay meron po maghanda kayo ng damit, gamit, go bag just in case magkabiglaan bubuhatin na lang laging nakahanda* (we already have an emergency bag composed of clothes and other things ready in case the volcano suddenly erupts) - PA1, PA2, PA3

Similarly, the community members were also familiar with the warning announcements coming from the barangay and the kit that they needed to have ready for the evacuation. However, the extent of their understanding and their knowledge is only limited to these.

Hazard and vulnerability assessment are crucial in risk knowledge and community resilience (Bogardi & Birkman, 2004) because it allows the community to craft adaptive response to a potential disaster (Cutter et al., 2008). Apart from this, risk knowledge

improves their adaptive response through their participation in the mitigation programs, activities, and plans (Bhuia & Shao, 2022; Gaillard & Pangilinan, 2010). With risk knowledge, and awareness of local hazards, the community can have an opportunity to collaborate on how to address community vulnerability (Arinabo, 2023, Mercer et al, 2009). Risk knowledge also involves information on potential consequences of disaster (Tierney et al, 2001). This, in turn, influences how community members interpret their vulnerability (Lejana et al., 2021; Oliver-Smith & Hoffman, 1999; Mitchel, 1999; Wachinger et al., 2023).

Thus, the risk knowledge and perception of the community members are reflected in their more passive participation in the EWS-related activities and how relevant they see it. Similarly, the community, and the assigned committees, are also unaware of the EWS and the actions expected at each level.

3.4 EWS Implementation and Continuity

The EWS cases presented in this study feature a common characteristic of EWS implementation. One is that their EWS is centrally operated by a national government institution (in the case of Leyte) or by an external group (in the case of Baguio) which will be accessed by the local government. Banjo West is more of the former wherein the local government receives training, and instructions (including modules and manuals), and they are expected to cascade this to the existing appointed community officers. However, these appointments are tied to the term of the current local government officials. Thus, if the current line-up changes, there will be a new set of officers to assume the Baranggay Disaster and Risk Management Committees.

Although there are available copies of the EWS plan and the process at the Baranggay office, this is utilized and accessed only by the appointed officials and elected local officials. Also, there was no community training or seminars implemented that included household heads.

This is the opposite of what was advocated by UNISDR wherein community participation should be in all key EWS elements. Takeuchi (2020), Gumiran et al. (2019) and Machera and Chimbari (2016) argued that community-owned systems are more sustainable as opposed to those initiated by external bodies or institutions. There is a difference between community-based early warning system (CBEWS) and national -based EWS. The former embodies equal participation of local communities in all four elements of EWS wherein their preferences and needs lead the development and implementation of EWS (Gumiran et al., 2019; Antwi et al., 2014; Gautam & Phaiju, 2013; International Federation of Red Cross and Red Crescent Societies, 2012).

4. CONCLUSION

4.1 Conclusion of the Study

Based on the results of this study, we were able to establish that the EWS implementation is rooted in the local implementers' understanding of what the EWS is. Although there is a more standard approach reflected in the documents, the way that these were cascaded to them shaped how they implemented it in the community. This is also reflected in the observed disconnect between the documents and the actual implementation and the lack of participation of the community members.

It could also be surmised, from what we have discussed, that their approach is reactive rather than proactive. The importance of the early warning system lies in its ability to provide early warnings, allowing communities to reduce the potential impact of incoming hazards, thereby potentially saving lives. Although the EWS implementation still depends on the situation and state of the Barangay and its community, there should be a semblance of a proactive approach in the implementation.

4.2 Contribution of the Study

This study will inform the crafting of proactive policies and practices. This will also help shape the direction of the current EWS implementation, specifically in the area of building local knowledge and creating a more resilient community. Disaster risk knowledge needs up to date information of the characteristics of the people and their location and the shifts that occur because of their changing environment and conditions. It is also crucial to have information that would shed light on the fundamental vulnerabilities that the members of the at-risk community faces (Global Facility for Disasater Reduction and Recovery, 2023). This will further allow the local government officials and implementers to address the community's different needs and create warnings that is fit to the target audience. The Global Facility for Disaster Reduction and Recovery (2023) further argues that the core of an inclusive and effective EWS implementation also involves a co-production of disaster management knowledge. Furthermore, engaging the community in the different levels of the EWS creation and implementation will encourage high participation among community members since they have also contributed in the warning process (Yasmin et al., 2023; Aranda & Humean, 2022).

5. RECOMMENDATION

5.1 Practice

Three key areas were identified where there is a need to further enhance the implementation of EWS based on the results.

5.1.1 Monitoring and Warning Service

Based on the four core components of the Early Warning System, greater attention should be given to Monitoring and Warning Service. Continuous monitoring of hazard parameters and precursors is essential to generate accurate warnings promptly for the awareness of the residents within the barangay, not just the officials. If possible, it is advisable to coordinate warning services for various hazards to take advantage of the benefits provided by shared institutional, procedural, and communication networks. Specifically for the residents in the barangay, it is crucial to provide clear and comprehensive explanations of the procedures to be followed both during and after the calamity occurs. Secondly, Dissemination and Communication are crucial, wherein the use of various communication channels is necessary to ensure that many people are warned, not only those near warning devices but also those in different corners of each barangay, to effectively convey the message of the Early Warning System. Lastly, Response Capability should include practice, testing, and seminars to ensure that everyone understands what to do when Early Warning System methods and protocols/rules are activated.

5.1.2 Risk Knowledge

The community's, as well as the Barangay officials', knowledge of risks and possible hazards should be enhanced by including them in the conduct of hazard and risk assessments. Their own experiences and knowledge would contribute to the actual activity and its content. This would in turn shape the EWS implementation and Barangay Risk reduction plans.

5.1.3 Capacity Building

Training on Early Warning System implementation, its extent, components, and how it is implemented, and modified based on the needs of the community, should be done. This would drive engagement of the community and aid in the community's mobilization. Furthermore the Authorities like Local Government Unit (LGU) should initiate and facilitate a series of training focused on Early warning signals and create a plan or framework assuring that the community gained readiness to disaster. After the training, monitoring and evaluation is a must to all areas of the community, it is the way to keep track and see the results if it is successful or achieved. Impose community participation as a vital requirement during disaster. Working together, spreading knowledge, raising issues to be defined correctly and finding solutions right away. Door-to door outreach must be required to check community awareness, set meetings regularly and strengthen work together towards common goals. Coordination is through one another is one strategy to save lives and saving each in community.

5.2 Policy

5.2a EWS protocols should also include regular information dissemination through annual seminars and training in Disaster response and the Early Warning system. This will ensure that the community and the LGU know the existing Disaster Response and EWS protocols.

5.2b The Community Risk Assessments should be regularly updated and should include data from the experiences of the community.

5.2c Household heads should be included as part of community representatives should be included as part of the committees of Barangay Disaster and Risk Management.

5.2d Members of the BDRRM committees should develop knowledge management infrastractures and processes. This will address possible loss of knowledge whenever local government officials line-up changes.

5.3 Future Research

To address the limitations of this study, research about the following areas should be conducted:

5.3a Social and behavioral considerations for EWS implementation. Researchers need to pay attention to the social and behavioral aspects of Disaster and Risk management and EWS implementation.

5.3b Effectiveness of EWS and Disaster and Risk Management trainings. Researchers should examine the efficacy of the trainings conducted, including the extent of their understanding of the objectives and protocols of BDRRM.

5.3c Role of community dynamics in implementing EWS. Research is needed to further understand the current relationships and transactions of the community. This will help determine the areas that could be enhanced to match the dynamics existing in the community and facilitate a better EWS implementation.

REFERENCES

Adgar, W.N. (2006). Vulnerability, Global Environmental Change, 16 (3), 268-281.10.1016/j.gloenvcha.2006.02.006

Aguirre-Ayerbe, I., Merino, M., Aye, S.L., Dissanayake, R., Shadiya, F., Lopez, C.M. (2020). An evaluation of availability and adequacy of Multi-Hazard Early Warning Systems in Asian countries: A baseline study, *International Journal of Disaster Risk Reduction*, *49*, 101749. https://doi.org/10.1016/j.ijdrr.2020.101749.

Allen, A. (2020). Memory, Risk, and Regional Identity: Assessing the Socio-Cultural Impacts of Tornadoes in Oklahoma, USA. *IDRiM Journal, 10* (2): 1–14. https://doi.org/10.5595/001c.18136.

Allen, K.M. (2006). Community based disaster preparedness and climate adaptation: Local capacity-building in the Philippines, *Disasters. 30* (1), 81–101. 10.1111/j.1467-9523.2006.00308.x

Amarnath, G., Amarasinghe, U. A., & Alahacoon, N. (2021). Disaster risk mapping: A desk review of global best practices and evidence for south asia. *Sustainability* (Switzerland), *13*(22). https://doi.org/10.3390/su132212779

Antwi, E. F., Otsuki, K., Obeng, F. K., Gyekye, K.A, Boakye-Danquah, J., Boafo, Y. A., Kusakari, Y., Yiran, G. A. B., Owusu, A. B., Asubonteng, K. O., Dzivenu, T., Kodjo, V., Abagale, F. K., Jasaw, G. S., Lolig, V., Ganiyu, S., Donkoh, S. A., Yeboah, R., Kranjac-Berisavljevic,G., ... Takeuchi, K. (2014). Developing a Community-Based Resilience Assessment Model with Reference to Northern Ghana. *IDRiM Journal, 4* (1): 73–92.

Aranda, C., & Humeau, E. (2022). *Early Warning Systems in the Philippines: Building resilience through mobile and digital technologies*. GSMA. https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2022/06/PhilippinesEWS_R_Web.pdf

Behlert, B., Diekjobst, R., Felgentreff, D., Manandhar, T., Mucke, P., Pries, P., Radtke, D. and Weller, D. (2020). *World Risk Report 2020, Focus: Forced Displacement and Migration. WorldRiskReport*. Ruhr: Bündnis Entwicklung Hilft and Ruhr University Bochum – Institute for International Law of Peace and Armed Conflict (IFHV), pp.1-73.

Bhuia, MMR, & Shao, W (2022). Perceptions of earthquake risks and knowledge about earthquake response among movement challenged persons in Dhaka city of Bangladesh, *International Journal of Disaster Risk Reduction*, *70*, 10.1016/j.iijdrr.2021.102743.

Bogardi, J., & Birkmann, J. (2004) Vulnerability assessment: The first step towards sustainable risk reduction, *Disaster and society – From hazard assessment to risk reduction*, pp. 75–82, Logos Verlag, Berlin.

Chakma, S., Hokugo, A., & Rahman, M.A. (2022). Factors affecting the cyclone preparedness programme volunteers' performance in early warning dissemination in emergency response in Bangladesh, *IDRiM Journal, 12* (1): 56–79. https://doi.org/10.5595/001c.38750.

Choi, J., Lee, S. & Choi, H. (2022). The Influence of Knowledge, Trust, and Perceived Risk on Firefighters' Preparedness and Willingness to Respond to Nuclear Emergencies: The Case of South Korea. *Int J Disaster Risk Sci 13*, 536–548. https://doi.org/10.1007/s13753-022-00426-1

Cutter, S.L., Barnes, L., Berry, M., Burton, C., Evans, E., Tate, E., & Webb, J. (2008). A place-based model for understanding community resilience to natural disasters, *Global Environmental Change, 18*(4), 598–606. 10.1016/j.gloenvcha.2008.07.013

Dhimal, M., Bhandari, D., Dhimal, M. L., Kafle, N., Pyakurel, P., Mahotra, N., Akhtar, S., Ismail, T., Dhiman, R. C., Groneberg, D. A., Shrestha, U. B., & Müller, R. (2021). Impact of Climate Change on health and well-being of people in Hindu Kush Himalayan Region: A Narrative Review. *Frontiers in Physiology*, *12*(August). https://doi.org/10.3389/fphys.2021.651189

Cruz, R. D. D., & Ormilla, R. C. G. (2022). Disaster Risk Reduction Management implementation in the public elementary schools of the Department of Education, Philippines. *International Journal of Disaster Risk Management*, *4*(2), 1-15. https://doi.org/10.18485/ijdrm.2022.4.2.1

Kovalevski, V. (2023). Early warning systems. PrepareCenter. https://preparecenter.org/topic/early-warning-systems/

Fonseca, A., Solomon, M. ,Prajnya , P., Ryne, M., Gregersen, IB, Alvarez, L.,Terkelsen, M., Munk, T. , Funa, F. ,Guioguio, M., Rivera, P., Lucero, E., Asmussen, M., Sulejmani, M., Holm, B., Baum, I. (2021). PHI: Baguio city Smart flood warning infrastructure and mitigation system, baseline assessment report, Asian Development Bank.

Gaillard, J.C., & Pangilinan, M. L. C. J. D. (2010). Participatory mapping for raising disaster risk awareness among the youth, *Journal of Contingencies and Crisis Management, 18*(3), 175–179. 10.1111/j.1468-5973.2010.00614.x

Galvizo, R. E. (2022). *The Integration of Disaster Risk Reduction Education in the ASEAN Region: The Case of Butuan City*, Philippines. https://ejournals.ph/article.php?id=16994

Gautam, D. K., & Phaiju, A.G. (2013). Community based approach to Flood Early Warning in West Rapti River Basin of Nepal." *IDRiM Journal, 3* (1): 155–69

Global Facility for Disaster Reduction and Recovery. (2023). *Designing Inclusive Accessible Early warning system : good practices and entry points*.

Goal 11: Sustainable cities and communities - The Global Goals. (2023, April 18). The Global Goals. https://www.globalgoals.org/goals/11-sustainable-cities-and-communities/

Granstrom, S. E. (2022). Disaster risk reduction and management in Metro Manila, Philippines, Case study of the 202 typhoons: Quinta, Rolly, and Ulysses. Degree Project in Strategies for Sustainable Development. KTH Royal Institute of Technology.

Gumiran, B. A., & Daag, A. (2021). Negotiated participatory action research for multi-stakeholder implementation of early warning system for landslides. *International Journal of Disaster Risk Reduction, 58*. 10.1016/j.jdrr.2021.102184

Gumiran, B. A. L., Moncada, F. M., Gasmen, H. J., Boyles-Panting, N. R., & Solidum, R. U. (2019). Participatory capacities and vulnerabilities assessment: Towards the realisation of community-based early warning system for deep-seated landslides. *Jamba (Potchefstroom, South Africa)*, *11*(1), 555. https://doi.org/10.4102/jamba.v11i1.555

International Federation of Red Cross and Red Crescent Societies (2012). *Community early warning systems: Guiding principles*, Technical Report, International Federation of Red Cross and Red Crescent Societies, Geneva

Kron, W., Smolka, A., & Berz, G. (2003). *Benefits of Early Warning from the viewpoint of the insurance industry*. In Springer eBooks (pp. 95–102). https://doi.org/10.1007/978-3-642-55903-7_16

Lejana, R.P., Haque, C.M., Berkes, F. (2021). Co-production of risk knowledge and improvement of risk communication: a three- legged stool, *International Journal of Disaster Risk Reductio*n, *64*,102508

Lim, H. R., Lim, M. B. B., & Camposano, R. L. E. (2022). Modeling evacuation behavior of households affected by the eruption of Taal volcano. *Transportation Research Part D-transport and Environment*, *109*, 103393. https://doi.org/10.1016/j.trd.2022.103393

McEntire, D.A., & Myers, A. (2004) Preparing communities for disasters: Issues and processes for government readiness, *Disaster Prevention and Management An International Journal, 13*(2), 140–152. 10.1108/09653560410534289

Mercer, J., Kelman, I., Suchet-Pearson, S. & Lloyd, K. (2009). Integrating indigenous and scientific knowledge bases for disaster risk reduction in Papua New Guinea, *Geografiska Annaler: Series B, Human Geography, 91*(2), 157–183. 10.1111/j.1468-0467.2009.00312.x

Mitchel, J.K. (1999). *Natural disasters in the context of mega cities*, United Nations University, New York

Mohammed, M.P. (2018). Disaster risk reduction and management of Tarlac City, *Procedia Engineering, 122*, 77-84. Elsevier.

Morgan, O. W., Sribanditmongkol, P., Perera, C., Sulasmi, Y., Van Alphen, D., & Sondorp, E. (2006). Mass fatality management following the south Asian tsunami disaster: Case studies in Thailand, Indonesia, and Sri Lanka. *PLoS Medicine*, *3*(6), 0809–0815. https://doi.org/10.1371/journal.pmed.0030195

NDRRMC. (2014). *Why It Happened: Learning from Typhoon Yolanda*. Metro Manila: NDRRMC, pp.1–128.

NDRRMC. (2020). *NDRRMC Resolution No.08, s.2020: Resolution approving the national disaster risk reduction and management framework and plan 2020- 2030 and recommending the issuance of a directive by the office of the president on its adoption*. Quezon City: NDRRMC.

Nhamo, L., Mabhaudhi, T., & Modi, A. T. (2019). Preparedness or repeated short-term relief aid? Building drought resilience through early warning in southern africa. *Water SA*, *45*(1), 75– 85. https://doi.org/10.4314/wsa.v45i1.09

Maido, L. (2023). *The Philippine Disaster Risk Reduction and Management Act (RA 10121) of 2010 program: the case of the province of Maguindanao del Norte*. https://ejournals.ph/article.php?id=22185

Oliver-Smith, A., & Hoffman, S.M. (1999). *The angry earth: Disaster in anthropological perspective*, Routledge, London

Sharma, T. P. P., Zhang, J., Koju, U. A., Zhang, S., Bai, Y., & Suwal, M. K. (2019). Review of flood disaster studies in Nepal: A remote sensing perspective. *International Journal of Disaster Risk Reduction, 34*(9), 18–27. https://doi.org/10.1016/j.ijdrr.2018.11.022

Perera, D., Agnihotri, J., Seidou, O., & Djalante, R. (2020). Identifying societal challenges in flood early warning systems. *International Journal of Disaster Risk Reduction, 51*(July 2020), 101794. https://doi.org/10.1016/j.ijdrr.2020.101794

Quimbo, M. (2020). *The impact of the 1991 Plinian eruption of Mt. Pinatubo, Philippines on soil development, phytolith accumulation, phosphorus status, and crop productivity* . Prom. : Delmelle, Pierre ; Sanchez, Pearl. http://hdl.handle.net/2078.1/237679

Raza, W. A., & Cruz, A. M. (2021). Understanding Households' Perceptions Regarding the Effect of a Natech Accident on Residential Property Values: The Case of Ichihara City. *IDRiM Journal*. https://doi.org/10.5595/001c.30768

Trogrlić, R. Š., van den Homberg, M., Budimir, M., McQuistan, C., Sneddon, A., Golding, B. (2022). Early Warning Systems and Their Role in Disaster Risk Reduction. In: Golding, B. (eds) Towards the "Perfect" Weather Warning. Springer, Cham. https://doi.org/10.1007/978-3-030-98989-7_2

Santiago, J. D., Carreon, B. M., & Gecha, J. R. C. (2022). *Juan Alert: Real-Time Earthquake Warming Device with Passable Emergency Exit Locator using Android Application for Colegio de San Juan de Letran Calamba*. https://ejournals.ph/article.php?id=19024

Shah, S. M. H., Mustaffa, Z., Teo, F. Y., Imam, M. A. H., Yusof, K. W., & Al-Qadami, E. H. H. (2020). A review of the flood hazard and risk management in the South Asian Region, particularly Pakistan. Scientific African, 10, e00651. https://doi.org/10.1016/j.sciaf.2020.e00651

Soriano, G. (2019) Disaster risk reduction knowledge among local people in selected community in the Philippines, *Journal of Health and Caring Sciences*, *1*(2). San Beda Univesity Philippines

Tempa, K., Yuden, K. (2023) Multi-hazard zoning for national scale population risk mapping: a pilot study in Bhutan Himalaya. *Geoenviron Disasters* **10**, 7 . https://doi.org/10.1186/s40677-023-00239-4

Takeuchi, K. (2020). Incorporating Public Participation into Landslide Risk Information and Response: Disaster Response Switch in the Taisho District of Shimanto-Cho, Kochi, Japan. *IDRiM Journal, 10* (1): 43–68. https://doi.org/10.5595/001c.17362

Tozier de la Poterie, A., & Baudoin, M.A. (2015). From Yokohama to Sendai: Approaches to participation in International Disaster Risk Reduction Frameworks. *Int. J. Disaster Risk Science, 6* (2), 128–139. https://doi.org/10.1007/s13753-015-0053-6

Tierney, K.J., Lindell, M.K. & Perry, R.W. (2001). *Facing the unexpected: Disaster preparedness and response in the United States*, Joseph Henry Press, Washington, DC.

UNDRR. (2017) UNISDR Annual Report. https://www.undrr.org/publication/unisdr-annual-report-2017

Viana, A.V. (2014). The Philippines' typhoon alley: The historic bagyos of the Philippines and their impact. *Journal KajianWilayah*, *5*(2), 184-216

Wachinger, G., Renn O., Begg, C., & Kuhlicke, C. (2013). The risk perception paradox – Implications for governance and communication of natural hazards, *Risk Analysis, 33*(6), 1049–1065. 10.1111/j.1539-6924.2012.01942.x

Vasileiou, K., Barnett, J., & Fraser, D.S. (2022). Integrating local and scientific knowledge in disaster risk reduction: a systematic review of motivation processes, and outcomes, I*nternational Journal of Disaster Risk Reduction*, *81*,103255

Yasmin, T., Khamis, K., Ross, A., Sen, S., Sharma, A, Sen, S., Sharma, A., Sen, D., Sen, S., Buytaert, N., & Hannah, D.M.(2023). Brief communication : Inclusiveness in designing and early warning system for flood warning system for flood resilience, *Natural Hazards and Earth System Sciences*, *23*, 667-674