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A Baseline Assessment of the Multi-Hazard Early Warning Systems in the Province of Batangas, Philippines

Marlon Era [a,*], Edgar Vallar [b], Abdul Jhariel Osman [c], Ruben Paul Borg [d], Glorianne Borg Axisa [e], Ignacio Aguirre Ayerbe [f], Maria Merino Gonzalez-Pardo [f], Boyko Ranguelov [g]

[a] *Behavioral Sciences Department, De La Salle University, Manila, 1004, Philippines*
[b] *Physics Department, De La Salle University, Manila, 1004, Philippines*
[c] *Educational Leadership and Management Department, De La Salle University, Manila, 1004, Philippines*
[d] *Department of Construction and Property Management, Faculty for the Built Environment, University of Malta, Msida, Malta*
[e] *Area Coordinator Social Sciences, Faculty for Junior College, University of Malta, Msida, Malta*
[f] *IHCantabria – Instituto de Hidráulica Ambiental de la Universidad de Cantabria, Santander, Spain*
[g] *Department of Geophysics, Geological Faculty, Mining and Geology University, Sofia, Bulgaria*
Corresponding author: [*]marlon.era@dlsu.edu.ph

***Abstract*— Batangas is a first-class province of the Philippines located on the southwestern part of Luzon in the CALABARZON region. Its capital is Batangas City and the provinces of Cavite and Laguna border it to the north and Quezon to the east. Across the Verde Island Passages to the south is the island of Mindoro and to the west lies the South China Sea. Geographically, Batangas is a combination of plains and mountains, including the world's smallest volcano, Mt. Taal, with an elevation of 600 meters, located in the middle of the Taal Lake. Other important peaks in Batangas include Mt. Makulot with an elevation of 830 m, Mt. Talamitan with 700 m, Mt. Pico de Loro with 664 m, Mt. Batulao with 811 m, Mt. Manabo with 830 m, and Mt. Daguldol with 672 m. The province has many beaches and is famous for its excellent diving spots. It has the second largest international seaport in the Philippines after Metro Manila. The city's identification as an industrial growth center in the region and the focal point of the CALABARZON program resulted in the increasing number of business establishments in the city's Central Business District (CBD) and numerous industries operating at the province's industrial parks. Given the geographical nature of the province and its current development, the present study was envisioned to assess its preparation for any forms of an imminent natural disaster. In particular, the study assessed the usage of multi-hazard early warning systems in the province using survey interviews with various stakeholders. The results of the 30 survey interviews showed that there is a limited multi-hazard early warning system in the province although the majority of the participants have experienced natural disasters in their respective areas.**

***Keywords*— Early warning system; multi-hazard; Assessment of early warning systems.**

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I. INTRODUCTION

Batangas is a first-class province of the Philippines located in the southwestern part of Luzon in the CALABARZON region. Its capital, Batangas City, is a major urban center of the province accommodating regional industrial growth and international seaport activities. And due to the numerous commercial and industrial activities in the city, the City Planning and Development Office (CPDO) identified it as a Regional Agro-Industrial Center and Special Economic Zone. The identification of the city as an industrial growth center in the region and being the focal point of the CALABARZON program resulted in the increasing number of business establishments in the city's Central Business District (CBD) as well as numerous industries operating at the province's industrial parks. In the region, it is the home of many business establishments and regional development programs. In its business district, development is observable everywhere [1]. Meanwhile, the said development has not only brought rewards to the people, but also it has opened new challenges that the local government units need to address [2].

Given the geographical nature of the province and its current development, the present study assessed the preparation of the Province of Batangas for any form of an imminent natural disaster. In particular, it assessed the status

of multi-hazard early warning systems in the province using survey interviews with various stakeholders.

A. Disaster Preparedness and Multi-Hazard Early Warning Systems

Natural disasters refer to "the natural processes that occur in the ecosystem, which can lead to the loss of stability of the social-economic system, and serious imbalance between supply and demand of social resources" [3]. Natural disasters have six categories, namely: geological disasters, meteorological disasters, environmental pollution disasters, fire, marine disasters, and biological disasters [3]. World records show that the frequent occurrences of natural disasters have a negative impact on all aspects of life [4]. Natural disasters have significant devastating consequences worldwide. They are the cause of the loss of many lives and economic resources [5]. From 1960 until 2017, 34% of natural disasters (e.g., floods) led to 1254 deaths and loss of more than 2.5-billion-dollars' worth of socio-economic resources [6]. Moreover, given the effects of climate change and globalization, the impacts of natural disasters have considerably increased [7].

Considering the staggering occurrences of natural disasters, disaster preparedness cannot be ignored. Disaster preparedness entails knowledge development and capacity building of individuals and communities to respond and quickly recover from disasters effectively [8]. Better and effective disaster response activities depend on disaster preparedness [9]. With disaster preparedness, the impacts of disasters can be considerably dropped [10]. Disaster preparedness played a key role in reducing the impact of disasters [11], yet people's level of disaster preparedness, in general, was still low and problematic. In disaster-prone countries, the pre-positioning of relief inventories, a preparedness method, is a big logistical problem because of the unpredictability of disasters [12]. This scenario put many children and families vulnerable to disasters [13].

For an individual, adequate disaster preparedness can help understand disasters and more rationally respond to the danger disasters can bring [14]. Furthermore, the study shows a positive and significant correlation between disaster-preparedness behavior and quality of life. This means that individuals with disaster preparedness tend to have higher happiness, satisfaction, and better health [15].

In many countries, natural disasters or natural hazards have caused serious loss of life and socio-economic resources annually. The Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) revealed scientific evidence that shows that potential risks are associated with weather-related hazards such as "increasing frequency and severity of droughts, extreme temperature, severe precipitation, and severe storms." Hydro-meteorological hazards have been correlated to the increasing economic losses this past five years. In the Philippines, only a third of Filipinos undertake measures to prepare for disasters [16]. Also, half a million Filipinos would experience transient poverty due to natural disasters [17].

However, it is still feasible to reduce the negative impacts of disasters and ensure the safety of lives and economic resources with innovative technologies. While it is true that humans cannot control disasters, they can anticipate, prepare, and reduce the impact of disasters by using technologies in an integrated way [18]. For instance, multi-hazard early warning systems have helped people assess the range of risks they will face before, during, and after disasters. Consequently, they are better prepared and can effectively respond to disasters. Data showed a decrease in loss of life due to the development of early warning systems that monitored weather-related hazards. Some countries, like the United States, Cuba, France, and Bangladesh, have reduced the impact of weather-related hazards because of developing early warning systems at the national and local levels. Coupled with effective communication and disaster preparedness, the development of the early warning systems in those countries had saved lives and decreased their citizens' loss of life [19].

However, building early warning systems at different levels requires major investment, participation, involvement, and time of local authorities, government, civic groups, and at-risk communities [20]. The World Bank (2010) identified early warning systems as one of the desirable investments to have to prevent the threats of natural disasters. Early warning systems can improve the detection of approaching natural disasters, inform the communities about the imminent threat, and advise people what actions they should take [21]. Also, they help in building resilient communities [22] And to better anticipate specific natural disasters, many humanitarian organizations (e.g., International Federation of the Red Cross [23]; START Network's Disaster Risk Financing Mechanisms [24]; the Famine Early Warning Network [25]) developed early warning systems [26]. Early warning systems can save lives and protect properties. In Hong Kong, for instance, the tropical cyclone warning system of the country, together with the active response of their relief agencies, had been proven very effective. It reduced the loss of life and helped the Hong Kong economy to recover faster from the hazard [27].

In the light of this literature, the present study conducted a forum on "Strengthening Multi-Hazard Early Warning Systems in Batangas Province." Local and international experts attending the 5th Steering Committee meeting of the Erasmus+ Capacity Building in Asia for Resilient Education (CABARET) in the Philippines last March 25 to 30, 2019 were invited to share their expertise, scientific findings, and experiences related to hazard warning systems. The forum served as an impetus to conduct the baseline assessment.

II. Material and Method

In education, a baseline assessment is highly regarded. It is used to identify the specific needs of students [28]. Teachers used baseline data to provide developmentally appropriate support to students. In disaster risk reduction, having robust baseline data is the foundation of an effective coping process from future disasters. The Sendai Framework for Disaster Risk Reduction acknowledges the key role of baseline assessment in risk reduction. It recognizes that understanding the frequency, magnitude, and impact of recent and past natural disasters can help everyone to prepare and cope from injuries, destruction of property, and loss of economic resources caused by disasters (e.g., flooding) [29]. In the U.S., the capital structure of firms is associated to the baseline data on natural disaster risks in their area. Firms in disaster-prone areas receive less favorable lending terms, and prefer short-

term borrowing [30]. In South Korea, tunnel-construction projects used assessment data to address effectively the risks caused by natural disasters (e.g., heavy rainfall and earthquakes) to prevent huge losses [31]. In this regard, it is important to recognize that as societies continue to confront natural disasters, early warning systems can provide rapid disaster assessment and post-disaster recovery [32]. Thus, it is imperative to also assess the status of early warning systems in communities. For this study, the researchers focused on assessing the status of multi-hazard early warning systems in the Province of Batangas so their local government units can better prepare and respond to natural disasters periodically affecting their area.

This baseline assessment of the Multi-Hazard Early Warning Systems was conducted immediately after the forum on "Strengthening Multi-Hazard Early Warning Systems in Batangas Province" last March 28, 2019, at the Matabungkay Beach Club Hotel, Lian Batangas. Thirty selected participating barangay officials and members, and representatives of the local government units, of the academe, and of the disaster risk reduction and management office (DRRMO) of the Province of Batangas had been invited to participate in the survey interviews. Figure 1 shows the actual distribution of the type of participants.

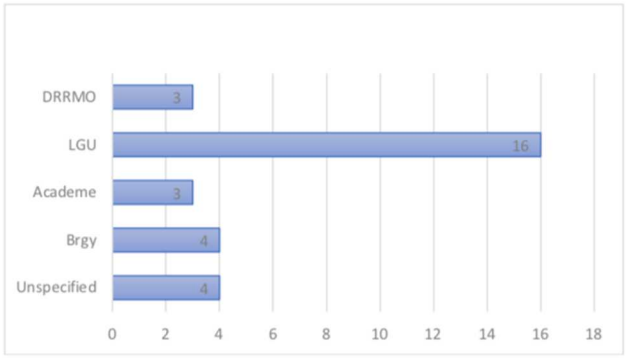

Fig. 1 Frequency distribution of types of participants

The thirty participants who were selected to participate to the baseline assessment answered the following questions:

- Which disasters have you experienced and which disasters do you expect in your area?
- Do you have MHEWS in place and do you think it is adequate?
- Is the presentations on MHEWS best practices and standards relevant in the context of Batangas province? Why?
- Are there any initiatives or additional support, knowledge transfer and training you feel required to assist you in improving your DRM activities?
- Which challenges and opportunities do you currently experience in your disaster management activities as officers?

The answers of the participants were collected, encoded in Microsoft Excel, organized, analyzed, and interpreted by the researchers. For questions 1 and 2, frequency counts were recorded. Using the Microsoft Excel sheet, the researchers generated graphs to facilitate the analysis of the statistics. More so, the researchers used word cloud, a text mining and visualization technique [33] to facilitate the qualitative data analysis.

III. Results and Discussion

The survey interview with the selected participants had provided baseline data. It revealed some insights on the status of the multi-hazard early warning systems of the Province of Batangas, which its stakeholders might consider in planning their disaster risk reduction and management program.

A. Question Number 1

As shown in Figure 2, 86.67 percent of the participants experienced flooding brought by typhoons, 63.33 percent of them experienced earthquake, and 23.33 percent of them experienced tsunami in the coastal area of the Province Batangas.

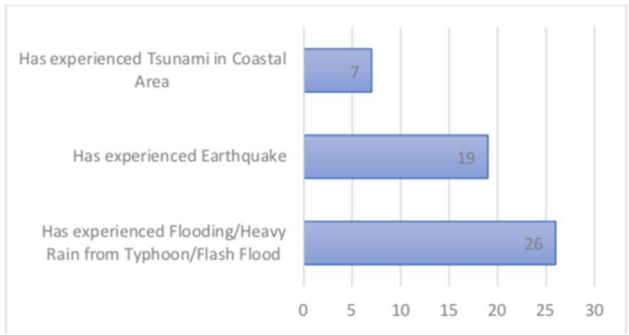

Fig. 2 Frequency distribution of types of natural hazards experienced by the participants

This finding revealed the type of hazards commonly experienced in the province. In 2012, the World Risk Index identified the Philippines in number 3 among 173 countries that were most vulnerable to disaster risks and natural hazards. The Philippines periodically encounters floods, volcanic eruptions, earthquakes, landslides, typhoons, and tsunamis [34]. In Batangas Province, the said natural disasters have damaged infrastructures, and caused loss of lives.

The data in Figure 3 also revealed that some of the participants were expecting some forms of hazards, such as volcanic activity, landslides, and storm surge.

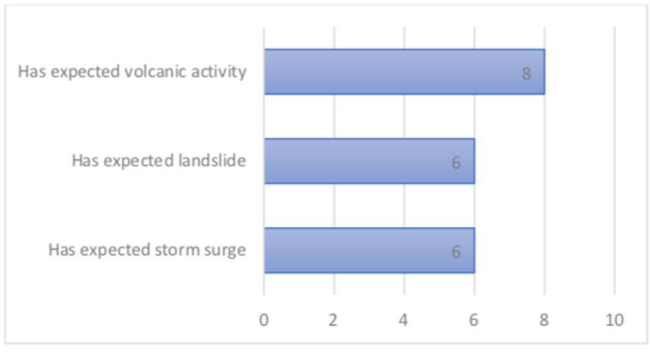

Fig. 3 Frequency distribution of types of natural hazards expected by the participants to occur in the province

More than a quarter percent or 26.67 percent of the participants expected to feel the impact of volcanic activity in the province, 20 percent of the participants expected

landslides to occur, and another 20 percent expected storm surge.

B. Question Number 2

Even though the responses of the participants to Question Number 1 in the survey interview validated historical reports of occurrences of natural hazards in the province, the data still displayed a serious limitation of the province in terms access to and adequateness of early warning systems. Only 26.67 percent of the participants mentioned that they have MHEWS in their area, while 33.33 percent of them confessed that they have no MHEWS. In the meantime, 40 percent of the participants chose not to answer. Correspondingly, only 6.67 percent of the participants feel that they have an adequate MHEWS in their area.

C. Question Number 3

Correspondingly, the participants felt that the forum on "Strengthening Multi-Hazard Early Warning Systems in Batangas Province" was relevant to their context. The representative from the LGU of Lian (Health Unit) said that the forum is "very relevant due to the conditions of the people in the area." The LGU of Catagan also mentioned that the forum is relevant since they "are prone to disaster." By the same token, the DRRMO representative confirmed the relevance of the forum given that they "have same experiences" with natural hazards in the province.

Fig. 4 Word clouds on the relevance of the presentations on MHEWS in the Province of Batangas

In addition, many of the representatives from the barangay and from the academe felt that the forum was mainly helpful to them as they hold drills for evacuation, seek to improve their evacuation plan, and assess or construct evacuation buildings. Figure 4 shows the results of the word clouds, which the researchers used to facilitate the analysis of the study's qualitative data.

D. Question Number 4

The representatives of the selected barangays of the province felt the need to improve their disaster risk management programs. In particular, they had expressed their need for training to improve their knowledge. They said, "the people in the barangay and rescue teams need the training to improve knowledge of disaster and MHEWS, and community preparedness and alerts for any kind of disasters." Figure 5 exhibited the result of the word clouds.

Fig. 5 Word clouds on the felt need of the representatives to improve their DRRM activities

In line with the expressed needs of the barangays' representatives, they have identified the mayor and LGU's support as key factors to improve their DRRM activities. They said that the "support of mayor and other LGU officers is needed to manage the barangay DRRM activities, community announcements, and evacuations."

E. Question Number 5

Correspondingly, when the participants were asked about the challenges, they have currently experienced, the representatives from the barangays identified the giving of support to evacuees. In particular, one of the barangay representatives said they were challenged by the need to "give support (e.g., food, medicine, personal needs) to evacuees in evacuation area. Since we do not have big funds." In light of this, the same person identified that the LGU would play a vital role to the said challenge. The person said that "the support of the LGU and the province is needed." The other barangay representatives shared similar thoughts. Some of their statements are as follows:

- "Support of mayor and other LGU officers is needed to manage the barangay DRRM activities, community announcements, evacuation."
- "Need support of officers to attain goal of municipality."

Moreover, the LGU of Bauan and Lian, and the Mayor shared a social challenge related to evacuation. The LGU of Bauan said that there were "designated evacuation area. But some people do not evacuate maybe because they feel they can manage the situation or they do not want to leave their property, etc." Together with the LGU of Lian, the mayor recognized that there is still a huge need for "social preparation of the various barangays." This social challenge encountered by the LGUs can be traced to the limited funding and/or funding mechanism for the DRRM programs in the province.

The Mayor and the LGU representative of Lian said that they "Need additional budget allocation for training...Need for drills and exercises related to natural disasters (e.g., tsunami, earthquake). Need more MHEWS to be set up especially in disaster-prone barangays." Other LGU representatives also validated such concern. The LGU of San Nicolas mentioned that there was a "lack of cooperation from officers. Lack of equipment (MHEWS) in their area." according to the LGU of Calaca, due to this "lack of MHEWS especially in the evacuation area, people cannot evacuate properly."

On the positive side, some of the participants still look forward to better opportunities not despite the identified challenges. The LGU representative of Taal and the DRRMO of the province identify the challenges as an impetus that will help the province have improved funding and a better mechanism for their DRRM programs.

The LGU representatives of Calatagan and Balayan, for instance, said that the acknowledgment of the challenges surrounding their DRRM programs would lead to programs such as "continuous community awareness of the need for disaster preparedness, and dissemination of information for the expected disasters."

In addition, according to the LGU representatives of Balayan, Rosario, and Taysan, the said the discussion on their challenges in the province could propel support coming from the CABARET partner institutions who could share their expertise and knowledge on MHEWS and/or equipment and motivate the installation of MHEWS in their respective areas.

The discussion on the challenges could lead to better utilization and regulation of funds for DRRM. The LGU representative of San Juan, Alitagtag, and Sta. Teresita said it can enhance the "political will" of LGUs and improve the "utilization of DRRM funds by observing COA's rules and regulations." Furthermore, the discussion would pave more opportunities for "information and education campaign" on disaster risk reduction and management with MHEWS. Figure 6 exhibited the result of the word clouds of the participants' responses that the researchers noted.

Fig. 6 Word clouds on the challenges and opportunities in the current disaster management activities in the province

IV. Conclusion

Based on the findings, it becomes noticeably clear that the province of Batangas regularly experiences natural disasters caused by typhoons, earthquakes, and to some extent Tsunami in their coastal areas. More so, natural hazards such as volcanic activities, landslides, and storm surges are expected to occur in the province's municipalities, cities, and barangays. Given the data and the geographic profile of the province, it can be concluded that the province needs to improve its disaster preparedness using multi-hazard early warning systems. However, the findings of this study revealed that as of the time this study was conducted, the status of the MHEWS in the province was still inadequate. The province of Batangas needs significant support from the national government to install and maintain the MHEWS in their area. Likewise, there is a need to build the local government personnel's capacity to understand the different types of hazards in using MHEWS and improve community preparedness.

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