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PROJECT RESCUER: Response to Community Underlying Earthquake Risks from the Unheeded Discovery of Lubao Fault through Awareness Assessment and Modification of Existing Evacuation Plan

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ABSTRACT

Modification of evacuation system is sometimes being hindered by restrictions that include the lack of information and publicity regarding the new discovery of an environmental concern such as a fault line. The safety and well-being of residents can become significantly affected as a result of these constraints. The main purpose of this research study is to assess the sense of awareness of the local residents in Brgy. Baruya, Lubao, Pampanga towards the discovery of the Lubao Fault and to propose some modifications in their existing evacuation plan. A survey questionnaire was administered to the 357 residents of Barangay Baruya who were extracted through the use of simple random technique. The results revealed that the focused population stand to disagree that they know the Lubao Fault and its attributes in terms of the highest magnitude and the underlying risks it can produce. Moreover, a structure interview was conducted to the Lubao Disaster and Risk Reduction Management Office (LDRRMO). The summary of transcribed answers indicated that they have an available general evacuation system and does not hold separate evacuation procedures in earthquake situation. The community of Baruya was not thus far given the particular earthquake preparations that are

purposively intended for the potential strike of the Lubao Fault. The Jose Abad Santos Avenue and the Lubao Bypass Road were set to be the routes of evacuation mobility. Available rescue vehicles and the aforementioned road networks were optimized in three cases. Open safe spaces and danger zones during earthquake were identified through community evaluation and utilization of HazardHunterPH tool. The proposed safety signages were provided with specifications. Overall, the areas covered by the modification in this present study are all open for integration to the future earthquake evacuation plan of Lubao, Pampanga.

Keywords: *Lubao Fault, awareness, modification, earthquake evacuation plan*

1. THE PROBLEM AND A REVIEW OF RELATED LITERATURE AND STUDIES

1.1 Introduction

People are meant to know any discovery being supported by science whether it is beneficial or detrimental. New earthbound findings such as fault lines that can harm life and property urge technology and mathematics to produce comprehensive responses against possible casualties. However, the public is sometimes oblivious to the geological hazard surrounding them because of certain restrictions like information deprivation, absence of authoritarian support, and also plain ignorance. The aforementioned constraints, therefore, contribute to the inadequacy of disaster preparedness within a community. Evacuation plans are basic mitigations yet one of the most reliable measures to ensure the safety and welfare of all. Consequently, these should always be kept updated as a provision for the changing needs of residents to unforeseen events like earthquakes.

An earthquake is defined as the shaking of the Earth's surface brought on by a sudden release of energy in the lithosphere, which generates seismic waves. The different characteristics of earthquakes are determined through the scales of magnitude and intensity. The energy released at the epicenter of an earthquake is measured in magnitude. On the other hand, the severity of the shaking caused by an earthquake in a certain area is measured through intensity. Intensity is used to gauge effects on people, properties, and the environment.

Satellite pictures once caught the attention of geologists named Fernando Siringan and Kelvin Rodolfo in 2003 as the images revealed a lineament at Lubao, Pampanga that trended northeast from Natib Volcano. This incident opened the initial discovery of a planar fracture in the said area which is mostly covered by vegetation. The exploration of Lubao Lineament was followed by Lea Soria in her 2009 master thesis. She obtained data from paleosea-level reconstructions and scatter interferometry that arrived at her interpretation of 3.5 meters vertical component of lineament motion over the past 1500 years. Soria eventually named this earthly structure after a couple of tests and evaluations as the "Lubao Fault" extending approximately 73 kilometers and has the potential of generating up to a 7.2 magnitude earthquake.

Figure - 1: Trace Interpretation of the Lubao Fault by Lagmay et al. (2012)

Audrei Ybañez, who was a student from the National Institute of Geological Sciences at the University of the Philippines Diliman, chose to study the effect of the Lubao Fault on the soil and rock of Barangay Baruya, Lubao, Pampanga. She presented in her 2016 master thesis that profiles show small fault displacement with the more plastic response being deformed fluidly like toothpaste. The mixture of sand and water was liquified and the contacts between grains were broken during the minute or so of an earthquake test behaving as a fluid with no strength. The results are clear indications that Barangay Baruya, Lubao, Pampanga which is situated near the fault is highly vulnerable to damages from the earthquake and a supplementary response must be rendered in recognition of these serious findings.

Reverse faults are confirmed to be the causes of earthquakes within the area close to the Bataan Nuclear Power Plant (BNPP). On account of this, the Lubao Fault which is traced to be stretching up to the floor vicinity of the Natib Volcano can potentially bring hazards to the only nuclear power plant in the Philippines if it behaves in the most violent way since these are all resting at the same region. Horizontal pressures have stretched and pulled apart the rocks that a fault shifts vertically. Rocks stretch by breaking because they are stiff allowing one side to slide down the fault while being dragged by gravity. Reverse fault refers to a fissure where one side is forced up against gravity when the rocks are shattered by horizontal pressures that compressed and shortened them.

Last April 22, 2019, a magnitude 6.1 earthquake struck the Zambales-Bataan peninsula in west-central Luzon causing widespread infrastructure losses and life casualties throughout the surrounding provinces, particularly in Pampanga which received the greatest damage. The town of Lubao is one of the most affected places among the cities and municipalities of the said province. The barangay of Baruya where the forenamed fault is nearest among the communities of Lubao held the highest number of affected families with a total of 116 based on the Post-Damages Report of the Office of the Municipal Disaster and Risk Reduction Management. It was then found that stress increase is observed to affect a section of the identified active Lubao Fault. The Philippines is situated in the Pacific Ring of Fire hence our archipelago is highly susceptible to volcanic eruptions and earthquakes. Aside from that, the province of Pampanga is also lying down on soft sediment and alluvial soil making the said area more prone to impacts from a ground shake.

1.2 Review of Related Literature

These collective actualities, discoveries, and events linked to Lubao Fault are ringing a major concern that compels a sense of urgency towards the authorities and residents to become involved in formulating effective measures in an alarming situation. Community engagement and public education as stated by AghaKouchak et al. (2018) are essential to raise awareness of the potential dangers of cascading hazards and to protect lives and livelihoods. It is a major obligation that everyone especially the emergency rescuers and heads of families are in total cognizance of the natural risks around their area and the survival mechanisms to follow during phenomena at the unidentifiable time.

According to Lee et al. (2017), the effective and vital methodical evacuation planning in earthquake catastrophes is a nearby escape from danger or a safe direct evacuation route. Several aspects are need to be examined before the layout and pattern of the evacuation scheme to meet the call of people. These include the manpower, resources, population, even the emotional behavior of residents, and geography of a specific community. Roads may also become blocked when an earthquake disaster happens in densely populated areas due to the collapse and burning of structures as reported by Yamamoto and Li (2017). A route for a speedy and convenient escape from disasters must be planned as part of an evacuation strategy. Stampede because of blockages in road networks and panic is ought to be assumed beforehand and prepare a sensitive course of action to overcome the barriers such as non-compliance to the proposed plan. Rescue models are designed to not hinder individuals regardless of age, health, and house location from accessing help at any point of the day because the time matrix is crucial when it comes to evacuation.

In the last 20 years, 3 billion people lived in regions with significant seismic activity as reported by French et al. (2019). Open areas like parks, plazas, and fields are frequently occupied by displaced people in earthquake situations who often gather in these assembly areas on their own. Public open space is crucial, and conversely, a lack of vast open space in an urban setting might increase the number of earthquake-related injuries and fatalities because some objects, such as walls, trees, and even rocks, can fall to the ground during or even after an earthquake. Open spaces are crucial components of evacuation because they can initially house people to keep them safe from harm. It can have a great impact to lessen the casualties if open spaces are available and known by the residents.

Signs not only work to negotiate new norms for public conduct during a time of fear, misinformation, and inconsistent guidelines but in doing so effectively demonstrate what a grassroots community response looks like to unusual kinds of extreme events like an earthquake in consonance with Douglas (2022). Pedestrians interact with the signs and make evacuation decisions after processing the signals. Evacuation signs are the most important information and guideline indicators for indoor evacuation as affirmed by Zhu, Chen, & Ding (2020). In an emergency evacuation, a successful evacuation signage system will reduce the wayfinding time and decrease the complexity, while a poor system may lead to more congestion or wrong route choices resulting in evacuation delay.

Earthquake-induced landslides (EQL) can take a heavy toll on people's lives and properties, thus attracting extensive attention from the geo-sciences community. Carrying out earthquake-induced landslide susceptibility assessment is of great significance to the prevention and reduction of such disasters as well as recovery and reconstruction in affected areas as stated by Shao and Xu (2022). It is an earthquake hazard that can take the life, especially of someone who does not know where to go during an earthquake. It is significant to safeguard that the assembly place at the time of evacuation is not prone to any massive ground fall.

According to Jazinovic et al. (2020), rapid assessment of earthquake-generated ground motions is a fundamental task of earthquake monitoring to provide information crucial to disaster response and public information. In recent years, rapid analysis has become of primary importance since advances in communication technology and the advent of social media have enabled public dissemination of (near) real-time information on events and their associated impact. This kind of thing or event should not be taken lightly, assessing the possible outcome and giving some attention can be a factor. Being notified of the different places having a higher risk of ground shaking is key to saving a life.

During an earthquake, the ground may be pulled apart and torn as being pushed upward. These are called surface ruptures. A surface rupture may happen suddenly or more gradually; in either case, surface ruptures often happen along preexisting faults. It can result in significant damage to both land and structures if it passes along the residential areas as indicated by the California Earthquake Authority (2023). Ground rupture can be triggered by an earthquake that can cause considerable damage. This could lead to injuries and losses of life, hence, evacuation fields should not be placed near the path of fissures.

Liquefaction is a phenomenon in which the soil underneath can become unstable due to violent ground movements such as earthquakes or construction blasts. It refers to soil instability and can be caused by various factors such as the inflow of water beneath the soil or a sudden shock caused by earthquakes or human activities. If the soil of a particular region suffers from liquefaction, it may become unable to support the weight of its structures and the people above it. In that scenario, those structures could suffer severe damage, or even collapse completely into the ground. In addition to buildings, liquefaction can ruin roads, railways, airport runways, dams and anything else that sits on the ground. It can also cause damage to below-ground utilities. Liquefaction can cause landslides, unsettlement, and eruptions of mud or water from the ground as warned by Fernando (2022). Liquefaction is a major seismic hazard in areas with water-saturated sandy soils and a moderate magnitude of above 5.5 can trigger it. Sana (2021) emphasized that liquefaction results in slope, bridge, and foundation failures making urban areas more vulnerable. One thing to consider when looking for a safe space is the liquefaction of the soil because liquefaction is one of the major hazards to human life and structures during an earthquake. The damage of liquefaction can lead to the excessive death toll and economic losses.

A pivotal part of disaster response that was published by Hu, F., Yang, Hu, X., & Wang (2017) involves emergency facilities, such as shelters. The endpoint of a post-disaster evacuation route is a shelter, whose scientific service area demarcation can have a significant positive impact on the planning of an evacuation route and schedule. Planning effective evacuation templates can help verify and support the definition of the service area for refuge. It is also important to assess the total number of evacuation centers and the accommodation they can cater to. Furthermore, the distance away of every rescue shelter from the origin of the tremor is required to be checked if it is acceptable enough in safeguarding the evacuees. Natural catastrophes seriously harm infrastructure and structures, depriving victims of decent living space. Many people are left without homes.

Communities residing in locations prone to disasters, especially natural calamities require effective mitigation plans as suggested by Raharjo, Sarjana, &Safitri (2022). The standard anatomy of an evacuation plan is composed of parts such as mitigation, preparedness, response, and recovery. Mitigation entails making efforts to prevent risks from developing into catastrophic conditions in the first place. In the occurrence of a disaster, mitigation also pertains to steps that can be taken both in advance of and during a response to alleviate the likelihood of casualties and reduce the impacts. Preparedness involves the development of comprehensive disaster management plans and detailed rescue operational plans. These plans provide a decision-making structure that contains the chain of command and specify which agencies should be represented in the decision-making structure to establish a communications system. Other important aspects of preparedness include training, emergency drills, and plan updates and revisions. Response includes mobilizing first responders such as drivers, police, medical practitioners, and other rescuers and providing emergency support services at the disaster site. Lastly, recovery implies reestablishing normal operations and can cater to the returning evacuees to the affected area. This research paper focuses mainly on the response during earthquake because it facilitates the flow of people and mobilization of rescue in a real-life scenario. It might be challenging to convert low-probability seismic forecasts into sound decisions as affirmed by Azarbakht, Rudman, & Douglas (2021). However, it is often necessary to set earthquake probability thresholds even if a science-reinforced discovery such as the Lubao Fault is still not acknowledged by the majority. Geological evaluations are already been done around the vicinity of this earth crack and claims were also been given as preliminary warnings about the possible impacts it can generate in the future. It was discussed in the study of Bernardini, Lovreglio, & Quagliarini (2019) that safety during earthquakes heavily depends on individual responses and emergency behaviors. Hence, disaster assistance tools, educational training, and evacuation plans were developed to prevent subjecting individuals to further hazards and to enable them to reach effective help from rescuers. Setting unified guidelines and safety measures for evacuation can alleviate casualties and damages within the disaster-susceptible community. Wherefore, this project intends to modify the current evacuation procedures raptly focused on saving lives in an earthquake situation. The shared ideas and efforts on this research will revolve around the optimization of the available earthquake resources for a modified evacuation plan.

1.3 Study Area

This present research entitled “PROJECT RESCUER: Response to Community Underlying Earthquake Risks from the Unheeded Discovery of Lubao Fault through Awareness Assessment and Modification of Existing Evacuation Plan” is linked under the broad discipline of Civil Engineering. It concentrates on the field of Disaster and Risk Management to help mitigate the potential impacts of earthquakes specifically to the life and safety of community residents. This dissertation will further contribute to the related existing body of knowledge with the accumulated new findings along the process of its completion. Moreover, this research initiative will also strengthen any future career that is interconnected with this nature of study, course, and specialization.

1.4 Objectives of the Study

a) Generally, this study aims:

- To assess the sense of awareness of the residents regarding the presence of the Lubao Fault and to modify some areas in the existing evacuation plan in Brgy.Baruya, Lubao, Pampanga.

b) Specifically, this study aims:

- To evaluate the current knowledge and earthquake preparedness of the people and local government in Brgy. Baruya, Lubao, Pampanga about the Lubao Fault through survey and interview.

Modification in the existing evacuation system of LDRRMO seeks:

- To identify the safe spaces and danger zones for a possible earthquake scenario in Brgy.Baruya, Lubao, Pampanga through community evaluation and utilization of the HazardHunterPH tool.
- To optimize the accessible road networks that are connected in Brgy.Baruya, Lubao, Pampanga and the available rescue vehicles for rescue mobility in an earthquake situation.
- To propose additional earthquake signages in Brgy.Baruya, Lubao, Pampanga that contain guidelines and precautions.

1.5 Statement of the Problem

The lack of awareness to new environmental concerns such as the presence of an active fault can hinder the improvement of the disaster response because it can bring complacency. Evacuation plans have to be modified and be updated to cope up with the changing needs of people especially to the unforeseeable coming of earthquakes. This study sought to answer the following questions:

1. Are the residents in Barangay Baruya, Lubao, Pampanga aware of the existence of the Lubao Fault in their community?
2. Where are the safe spaces and danger zones in Barangay Baruya during earthquake?
3. How to optimize the availability of road networks and the number of rescue vehicles in Barangay Baruya for earthquake evacuation?

1.6 Significance of the Study

This research mainly aims on helping the disaster risk reduction and management sector of the community. Therefore, this study is significant to the following:

To the Residents. The people of Barangay Baruya, Lubao, Pampanga are the major concern of this research because they are the most vulnerable group when it comes to the earthquake casualties that can bring by the Lubao Fault. This research is involved in safeguarding their well-being by raising a sense of awareness and imparting measures to subside the occurrence of serious injuries or even death due to ground tremors.

To the Rescuers. The findings of this study will open the possible improvement of their current evacuation system. The rescuers will be guided towards the modified procedures on how to save and reach the disaster victims through systematic operation.

To the Local Government. The authorities will benefit in terms of helping them to fill any insufficiency to their existing guidelines on evacuation. This will also assist local officials in enforcing earthquake policies within the community. Moreover, the evaluation will give them an overview of the requisites to meet the needs of their constituents in an earthquake situation.

To the Researchers. The process and outcome of this study will produce great satisfaction and competence to this field that can empower researchers on uplifting their careers in the future.

To the Future Researchers. This may serve as a related study to them and be able to formulate projects for strengthening research initiatives that can be put into good use for the community.

1.7 Scope and Limitation

The study only focuses on the assessment of the awareness of people towards the unheeded discovery of the Lubao Fault and on the further modification of the existing evacuation plan. The chosen community of this research project is the Barangay Baruya, Lubao, Pampanga with a total land area of 1076.42 sq.m. because it is where the said earthly fracture is nearest. This place is located at 14° 52' North, 120° 32' Easton the island of Luzon, and has a population of 4974 people. A survey about the awareness of residents regarding the said geological concern will be exclusively administered to their local population using a researcher-made questionnaire. Moreover, the structured interview will be conducted to the authorized representative of the disaster management team of the Lubao Municipality to assess the status of their current earthquake evacuation plan. The community evaluation will only be held within the vicinity of this area, incorporating the search and designation of potential danger zones and safe areas during earthquake. The routing of rescue vehicles will be instructed to the responders in Barangay Baruya when the analyses are available. Consequently, the proposed modification for the earthquake evacuation plan will be endorsed to the disaster management team for implementation. This only involves the Local Government Unit (LGU) of Barangay Baruya, Lubao, Pampanga, and the Lubao Disaster and Risk Reduction Management Office (LDRRMO) with the assistance of the Municipal Health Office (MHO), the Bureau of Fire Protection (BFP), and the Philippine National Police (PNP) of Lubao, Pampanga.

2. METHODOLOGY

2.1 Methodological Framework

This research includes a sequential procedure, in which it seeks to elaborate on or expand the findings of one method with another method. This research used the descriptive type of quantitative research. As stated by Bhandari (2021), this research incorporates the process of gathering numerical data. On the other hand, McCombes (2019) specified that descriptive research design aims to determine or describe situations, characteristics, trends, and categories as they exist at the time of the study. This study uses a quantitative research design because it involves collecting quantifiable and systematic data for the statistical analysis of the research problem. This study also utilizes the descriptive research design to describe the answers obtained from the interview and the formulation of additional instructions for the modification of earthquake response under the current evacuation system.

2.2 Research Design

The primary goals of this research study are to introduce the discovery of the Lubao Fault and to modify the existing evacuation system of Brgy. Baruya, Lubao, Pampanga. This research utilizes a mixed approach method to gather and analyze data. The assessment of the awareness of residents about the Lubao Fault and their knowledge about the earthquake evacuation were all done through the use of a researcher-made questionnaire and further proceeded to the interpretation of responses through a method of scoring. Structured interview to the official representative of the Lubao Disaster and Risk Reduction Management Office (LDRRMO) was conducted to assess their earthquake preparedness, to evaluate the current evacuation system in their area, and to check the availability of disaster resources and information in the target community. Answers were treated through a transcription process. Digital tools also aided the succeeding parts of proposed modification under this study. This research was also carried out with the guide of both local and international standards as well as the implemented road laws and evacuation policies.

2.3 Research Locale and Respondent Sampling

The respondents in this study were extracted from the population of Brgy. Baruya, Lubao, Pampanga and were selected using simple random sampling. According to Thomas (2020), simple random sampling is the most straightforward among all the probability sampling methods and it also gives exactly equal chance to all the members of the population to be selected. Any research conducted with this method should have high internal and external validity since it incorporates randomization and is less likely to be biased by factors like sampling bias and selection bias. The focused community has a total population of 4974 individuals where 2512 are male and 2462 are female based on page 59 of the Lubao 2022-2024 DRRM Plan. This research utilized the Krejcie & Morgan Formula since the population is known and finite to determine the appropriate sample size. This formula is used for determining samples when calculating population proportions at a specific probability and level of accuracy. The Krejcie and Morgan (1970) Formula is intended to calculate the sample size, n, necessary to construct a confidence interval (generally ± 5%) around the sample percentage that will, in 95% (confidence level) of all samples equal to n, contain the true population percentage.

n= (x^2 Np (1-p))/(e^2 (N-1)+ x^2 p (1-p))

Where:

n = the required sample size

x2 = 3.841 table value of chi square at desired confidence level (generally 95%)

N = the population size which is 4974

p = the population proportion (generally assumed to be .50 to maximize sample size)

e = acceptable error of sample size which is generally used as 0.05

To solve for the sample size:

n= (3.841×4974×.50 (1-.50))/(〖0.05〗^2 (4974-1)+ 3.841×.50 (1-.50))

n= 356.63 = 357 respondents

Therefore, the acceptable sample size from the given population of 4974 individuals in Brgy. Baruya, Lubao, Pampanga is 357 respondents.

2.4 Research Instrument

A tool that was used in this study is a researcher-made questionnaire checklist. It composed of different questions that aim to assess the sense of awareness of the residents on the unheeded discovery of the Lubao Fault, their current earthquake preparedness, and their agreement on some of the modifications that can improve their earthquake evacuation plan. Options that include of Strongly Disagree, Disagree, Agree, and Strongly Agree were provided in the 4-Point Likert Scale to cater specific responses about the primary concern. This research also used structured interview to the authorized representative of the Lubao Disaster and Risk Reduction Management Office (LDRRMO) to check the current evacuation system and to gather available data that would be beneficial in formulating a modified rescue plan. According to George and Merkus (2022), a structured interview differs from other types of interviews because the set of questions was organized beforehand to attain relevance to the topic. Structured interviews are considered to be more credible and reliable because these are carefully predetermined and systematized in nature.

Both drafts of the survey questionnaire and interview questionnaire underwent on the content validation of three (3) professional experts in the field of this research study to assure impartiality and reliability before the distribution and retrieval of instruments. They are licensed civil engineers who hold the relevant experiences, skills, and competencies in lieu with the present study.

Furthermore, essential components in identifying the available road networks and their distances to the target community were determined by utilizing the freely available computer programs and websites like Google Map and Google Earth. These digital tools helped this research to recognize the visual characteristics of roads in specified locations and to conveniently measure land areas for the possible open spaces that can be utilized during earthquake. Moreover, this study was also aided by GeoRiskPH and HazardHunterPH that stand as freely available websites supported by the PHIVOLCS-DOST. These modern sources of data also help to acquire the hazard maps needed for the present study and to determine the important factors in the designation of safe spaces and danger zones such as the ground rupture, ground shaking, earthquake-induced landslide, and liquefaction. Lastly, the proposed earthquake signages were designed using Canva which is a free-to-use graphic editing app.

2.5 Municipal Visitation

This research administered a structured interview and gathering of information to the Municipal Hall of Lubao, Pampanga. The Lubao Disaster and Risk Reduction Management Office (LDRRMO) was consulted to check the current procedures of their evacuation system and the available resources for rescue since this study is align with their community functions.

2.6 Rescue Vehicles

The following data were gathered based from Annex page 19 of Lubao 2022-2024 DRRM Plan:

Table - 1: Inventory of functional evacuation vehicles of LDRRMO

ITEM	UNIT	CAPACITY
Army Truck (10 wheeler)	1	40
Dump Truck (10 wheeler)	2	40
Mini-Dump Truck (6 wheeler)	2	20
Forward Truck (6 wheeler)	2	30
Service Vehicle	9	16
Rescue Hilux	1	5
Ambulance	3	5
Total:	**20**	**384**

2.7 Evacuation Centers

The following data were gathered based from Annex pages 53-55 of Lubao 2022-2024 DRRM Plan:

a) The Municipality of Lubao has a total number of 31 functioning evacuation centers within their locality.

b) Barangay Halls and the Baruya Church have single comfort room. Meanwhile, MRF Sta. Catalina, Sto. Niño Covered Chapel, and San Roque Dau Church have double comfort rooms for both men and women.

c) Covered Courts have no comfort room and source of water but they have nearby restrooms and source of water that can accommodate the evacuees if ever.

d) The rest of specified evacuation centers have source of potable water either from water district, artesian well, or jetmatic.

e) Schools within Lubao, Pampanga that are not listed can also receive evacuees based from the suggestion of LDRRMO. The DHVSU Lubao Campus with an estimated area of around 4200 sq.m. was seen by this study to be the initial settlement of rescued residents before distributing them to the enumerated evacuation centers. This is to maximize first the time for a uniform and direct route of transferring all the people away from their earthquake-susceptible community which is the Barangay Baruya where the Lubao Fault is nearest.

2.8 Population

Adults with ages 18-59 years old shared 2899 in the given population of 4974, where 1443 are men and 1456 are women. This group will take the lead on guiding their relatives from the priority groups during earthquake evacuation.

The priority groups during rescue operations in the aforementioned target community are divided into three: (1) the children with ages 0-17 years old (2) the senior citizens with ages 60 and above, and (3) the persons with disabilities. They have a totality of 2118; children were 1569, senior citizens were 506, and PWDs were 43 respectively. The proposed evacuation plan will highly consider these groups for a safer rescue execution.

2.9 Community Evaluation

Upon the approval of the research adviser, research coordinator, and other related bodies to the permission letter in conducting a survey and doing a community evaluation, free time were allocated in the next course of actions to avoid distractions towards the normal schedule of classes. The survey was administered through a face-to-face interaction to the residents of Brgy. Baruya, Lubao, Pampanga during the visitation. The search and designation of potential danger zones and safe assembly spaces during earthquake also took place through in person evaluation within the vicinity of the aforementioned area. These were done with the consent of their local officials especially the barangay captain.

2.10 Routing

This research used Google Maps which is a freely available computer web service to check the connected road networks to the focus community of this study. The evacuation trip will take around from the Municipal Hall of Lubao, Pampanga to Brgy. Baruya, Lubao, Pampanga and vice versa. Distances were set as kilometers to follow the standard road measurement in the Philippines. From this, the following data were obtained:

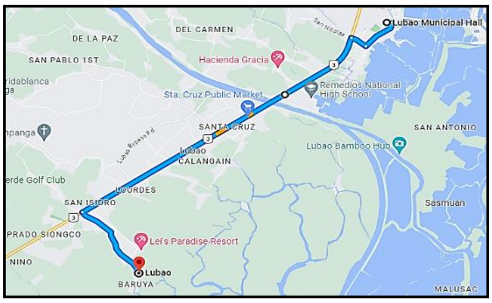


Figure - 2: The First Evacuation Route via Jose Abad Santos Avenue

The above shown road network has a total distance of 13.3 kilometers from Lubao Municipal Hall to Barangay Baruya, Lubao, Pampanga. The Jose Abad Santos Avenue is classified as major highway and the driving speed of rescue vehicles during evacuation will still be on prior change depending on the road guidelines and other deciding factors.

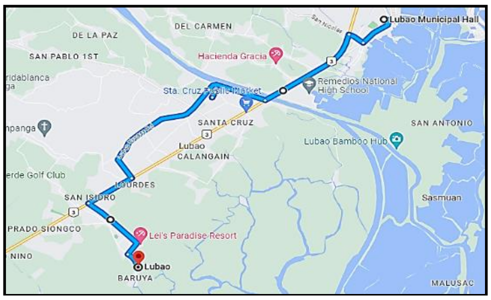


Figure - 3: The Second Evacuation Route via Lubao Bypass Road

The above shown road network has a total distance of 15.6 kilometers from Lubao Municipal Hall to Barangay Baruya, Lubao, Pampanga. The Lubao Bypass Road is considered as an alternative highway and also the driving speed of rescue vehicles during evacuation will still be on prior change depending on the road guidelines and other deciding factors.

2.11 Speed Limit for Rescue Vehicles

This research only set a 30 kmph speed limit for all of the involved rescue vehicles in the evacuation response plan. Emergency responders should not themselves contribute for "additional accidents" due to over-speeding amidst the life-threatening situations as emphasized by former President Rodrigo Duterte in 2013 upon mandating a 30-40-60kph speed limit to Davao City that applies even to the rescue vehicles, hence, this road concept was adopted to this present study to ensure that drivers will arrive safely to their target destination such as in Brgy.Baruya, Lubao, Pampanga during the earthquake evacuation. Furthermore, both Jose Abad Santos Avenue and Lubao Bypass Road are critical facilities when it comes to earthquake based on the assessment of the HazardHunterPH tool. The Jose Abad Santos Avenue manifested a moderate susceptibility to liquefaction while the Lubao Bypass Road has high susceptibility to liquefaction, therefore, a speed limit of 30 kmph is enough to be more aware of the possible sinking of road floors in earthquake situation. Nevertheless, these two road networks were both safe from ground rupture so these can still cater the passage of rescue vehicles during evacuation.

This is also to consider the possible blockages and other barriers along the routes that can be generated by the Lubao Fault in a post-earthquake situation that may slow down the mobilization of rescue. In addition, the National Safety Council in America recommends an international standard of at least three seconds or 60 centimeters distance of vehicle-to-vehicle at any speed. This rule was also being used in the Philippines, hence, this research also incorporated it on the flow of rescue to maintain a safe trail between the vehicles.

2.12 Ethical Considerations

The following things were put into place throughout the research period:

1. The respect for dignity and well-being of respondents was being prioritized.

Thus, no participant is subjected to any kind of harm.

2. Adequate level of privacy and confidentiality for the research data were ensured.

3. Any deception and exaggeration about the aims and objectives of the study was avoided.

2.13 Statistical Treatment of Data

The responses gathered from the survey questionnaire were organized, tallied, and processed through the appropriate statistical tool. This research used frequency and percentage distribution and weighted mean. The formulas were as follows:

Frequency and Percentage Distribution Method:

$P = f/(N) \times 100\%$

Where:

P = percentage of category

f = frequency or number of response in a category

N = total number of respondents or the sample size

Weighted Mean:

The formula was used as a measure of central tendency.

$W.M. = \Sigma WV/N$

Where:

WM = weighted mean

ΣWV = summation of the weighted values

N = total number of respondents or the sample size

2.14 Method of Scoring

The responses from the questions in the researcher-made questionnaire were interpreted through the use of a 4-point Likert Scale to avoid neutral answers. According to Bhandari and Nikolopoulou (2020), the Likert Scale is a rating system used to quantify attitudes, behaviors, and opinions. Respondents are free to select the choice that most accurately represents their views toward the statement or question that is relevant to the matter of interest. The Likert Scale is great for capturing respondents' level of agreement or their thoughts toward the topic in a more nuanced manner since it gives respondents a variety of viable options. The items in the survey form were treated using the following scoring:

Table - 2: The Likert Scale Used in the Survey Questionnaire

WEIGHT	VERBAL DESCRIPTION
4	Strongly Agree
3	Agree
2	Disagree
1	Strongly Disagree

After organizing the weight of the given levels of agreement in the 4-Point Likert Scale, the range was computed based on the following formula:

$R = (H-L)/N$

Where:

R = range

H = highest weight in the Likert Scale

L = lowest weight in the Likert Scale

N = total number of points in the Likert Scale

To solve for the range:
R = (4-1)/4
R = 3/4
R = 0.75

Therefore, a range of 0.75 has governed the limit of each mean value in determining their equivalent interpretation for the tabulation and analysis of every item in the survey questionnaire. The following table shows the application of the computed range:

Table - 3: Range of Mean Value and its Corresponding Interpretation

WEIGHT	RANGE OF MEAN VALUE	INTERPRETATION
4	3.26 - 4.0	Strongly Agree
3	2.51 - 3.25	Agree
2	1.76 - 2.50	Disagree
1	1.0 - 1.75	Strongly Disagree

2.15 Interview Transcription

The audio from the structured interview was processed to interpret the responses of the official representative of the Lubao Disaster and Risk Reduction Management Office (LDRRMO) about their current earthquake knowledge and preparedness. It was saved using a phone recorder and important points were also written down on paper. The following procedures were made to transcribe the audio inputs for the whole duration of the interview:
1. Prepare the right tools such as headphones, speakers, smartphones, and computers.
2. Choose the transcription method to use. In this research, Intelligent Verbatim Transcription was utilized to remove irrelevant fillers, improve readability, and fix grammar lapses. It was then followed by the Edited Transcription which contains the cleaner version of the first transcript. Answers in vernacular language and unnecessary sentences were omitted as long as these do not change the exact meaning of the responses.
3. Since the audio recording is not very high in quality, transcribing the interview for this research was done manually to improve the clarity of conversation.
4. Review the first draft for possible errors such as missing parts that need to be rectified. Replay the recording and check for its accuracy.
5. Format the document and finalize the transcription.
6. Proceed to the extraction of important points from the responses to the structured interview.

2.16 Rescue Mobility

To perform the trip computation by utilizing the available data, the following procedures were done to this present study:
1. Consider the total number of rescue vehicles and their total capacity. Based from the data gathered, there are currently 20 items of LDRRMO vehicles with a total capacity of 384 individuals.
2. List down the total population and the total number of priority individuals. The Barangay Baruya has a general population of 4974. The children, senior citizens, and persons with disabilities are comprised of 2118 residents. A ratio of 1:1 was set, which means there is one adult (ages 18-59) who will accompany one priority resident during earthquake evacuation. They should be relatives as much as possible. From this, the remaining 738 adults will be rescued at latter part of evacuation.
3. Specify the available road networks attached to the target community and their end-to-end points. The trip will take between the Lubao Municipal Hall and Brgy.Baruya, Lubao, Pampanga and vice versa. Based from the mapping, the Jose Abad Santos Avenue with a travel distance of 13.3 km and the Lubao Bypass Road with a travel distance of 15.6 km are the identified routes.
4. Determine what case to follow considering the actual rescue situation. In this study, three cases were overseen during the earthquake evacuation to optimize the availability and accessibility of routes.
Case 1: When the Jose Abad Santos Avenue and the Lubao Bypass Road are both passable during earthquake evacuation, use the two road networks.
Case 2: When the Jose Abad Santos Avenue is not passable during earthquake evacuation, all rescue vehicles will transfer the whole population via Lubao Bypass Road.
Case 3: When the Lubao Bypass Road is not passable during earthquake evacuation, all rescue vehicles will transfer the whole population via Jose Abad Santos Avenue.
Note: Any of the herein above cases presented will be considered depending upon the situation during earthquake evacuation. A person in-charged from the rescue team will check the availability, accessibility, and condition of predetermined road networks before the mobility flow of rescue vehicles.
5. Use the settled speed limit of 30 kmph to all the involved rescue vehicles to reach the destination.

The succeeding formula will be used for the computation on this section:
Required No. of Trip = (Total Population)/(Total Capacity of Vehicles)
Trip Duration (in minutes) = (Distance (km))/(Speed (kmph))×60 mins.
Estimated Span of Evacuation (in hours) = (Trip Duration (mins) × No.of Trip)/(60 mins.)
Note: The answer in trip duration was doubled to show a round trip. Moreover, an additional 30 minutes was appended to get the final trip duration. This additional time is allotted for potential discrepancy during the actual evacuation rescue.

2.17 Nature of the Lubao Fault

A 6.1 magnitude earthquake on April 22, 2019 rocked the provinces of Zambales and Pampanga. It was the last recorded strong earthquake that affected Pampanga, specifically the focused community of this research which is the Brgy. Baruya in Lubao. Considering the potential 7.2 magnitude earthquake that can be generated by the Lubao Fault, how strong it can be in a real-life scenario in comparison to the 6.1 magnitude Luzon Earthquake last 2019? The following formula was used:

$M = \log_{10} (I/I_O)$

Where:

M = magnitude

I = intensity in question

I_o = intensity of an arbitrary chosen earthquake

To solve:

Consider Event 1:

$M_1 = 7.2$

$M_1 = \log_{10} (I/I_O)$

$I_1 = ?$

$7.2 = \log_{10} I_1 - \log_{10} I_o$

$\log_{10} I_o = \log_{10} I_1 - 7.2$ -> equation 1

Consider Event 2:

$M_2 = 6.1$

$M_2 = \log_{10} (I_2/I_O)$

$I_2 = ?$

$6.1 = \log_{10} I_2 - \log_{10} I_o$

$\log_{10} I_o = \log_{10} I_2 - 6.1$ -> equation 2

Equate 1 & 2:

$\log_{10} I_o = \log_{10} I_1 - 7.2$

_

$- (\log_{10} I_o = \log_{10} I_2 - 6.1)$

$0 = \log_{10} I_1 - \log_{10} I_2 - 1.1$

Transform into logarithm:

$1.1 = \log_{10} (I_1/I_2)$

$10^{1.1} = 10^{(\log_{10})} (I_1/I_2)$

$10^{1.1} = (I_1/I_2)$

$I_1/I_2 = 12.59$

- say, 13 times

Therefore, the 7.2 magnitude earthquake that can cause by the Lubao Fault will be 13 times stronger than the past 6.1 magnitude Luzon Earthquake.

To further visualize its strength and the damage it can produce, the equation devised by Gutenberg-Richter that is known to be the most accurate and is widely used was utilized to this study:

$\log_{10} E = 11.80 + 1.50 M_L$

Where:

M_L= magnitude measured on the Richter scale

E = the energy released in ergs

According to Richter, the World War II type of an atomic bomb released is about 8×10^{20} ergs of energy (20000 tons of TNT). How many atomic bomb is equal to the energy that can be made by a 7.2 magnitude earthquake from the Lubao Fault?

To solve:

$\log_{10} E = 11.80 + 1.50 (7.2)$

$\log_{10} E = 22.60$

$10^{(\log_{10})E} = 10^{22.60}$

$E = 10^{22.60}$

$E = 3.981\times 10^{22}$ ergs

No. of atomic bombs = $(3.981\times 10^{22}$ ergs$)/(8\times 10^{20}$ ergs$)$

No. of atomic bombs = 49.76

- say, 50 atomic bombs

Therefore, a 7.2 magnitude earthquake from the Lubao Fault can devastate like the strength of 50 atomic bombs which is tremendous enough to negatively impact the community.

In computing for the possible surface rupture length that can be created by a 7.2 magnitude earthquake from the worst-case movement of the Lubao Fault, the following formula was used based on the requirement of NSCP 2015 since the given magnitude is greater than 6.5, hence:

$M_L = 5.65 + 0.98 \log_{10} t$

Where:

M_L = magnitude of the earthquake

t = surface rupture length

To solve:

$7.2 = 5.65 + 0.98 \log_{10} t$

$t = 38.16$ km

- say, 39 kilometers

Therefore, a 7.2 magnitude earthquake from the Lubao Fault can leave a surface rupture with a length of 39 kilometers.

2.18 Designation of Safe Spaces and Danger Zones

The search of areas that can serve as safe spaces and danger zones during earthquake in Brgy.Baruya, Lubao, Pampanga were examined through on-site community evaluation. This is to check the general surroundings and to assess the accessibility of each location. Aside from the community evaluation, this study utilized the GeoRiskPH and HazardHunterPH from the PHIVOLCS-DOST to further examine the pre-determined areas through the generated data and reports of both aforementioned tools.

The requirements for a "safe space" in Brgy.Baruya, Lubao, Pampanga during earthquake are the following:

1. An open area that is away from trees, poles, cable posts, and outside walls of a building or house. Unreinforced bricks or concrete are the most susceptible to earthquake failure because of their inflexibility and the relatively low strength of the materials used. Structures and buildings that are irregular in plan had the higher tendency to collapse due to the differences in the center of mass and the center of stiffness that can lead to torsional effects. Irregularities in vertical structures are enumerated and defined in Section 208-9 of NSCP 2015, including stiffness irregularity, weight (mass) irregularity, vertical geometric irregularity, in-plane discontinuity, and discontinuity in capacity.
2. An open area that is accessible near the dwelling places of the residents. The area should have clear pathways to reach it.
3. An open area where the ground rupture will not pass through it. Ground rupture is the visible breakage or tearing of land surface due to the release of force from the movement of a fault line. The recommended buffer zone or Zone of Avoidance to ground rupture hazard in an earthquake scenario is 5 meters on both sides from its

zone of deformation as per the seismic guidelines of the PHIVOLCS.

4. An open area where the ground shaking will not impose a higher intensity than the other parts of the community. During earthquake, all sites are affected by ground shaking but it is important to select an area wherein it has a lower chance of catching damages in consideration with the other factors.

5. An open area that is not prone to earthquake-induced landslide. Earthquake-induced landslides are the downward slope movement of rocks, soil solids, and other debris commonly triggered by strong shaking. This usually happens in places with elevation such as near the mountains and hills.

6. An open area that is not prone to rapid liquefaction. The ground can sink like a quicksand during earthquake and can swallow up anything above it, therefore, it is substantial to stay distant from wetlands. The southern part of Barangay Baruya is surrounded by this topographical feature. Wetlands are areas in which surfaces are covered with water for varying periods of time. It is also bounded by some ponds.

On the other hand, an area in Brgy. Baruya, Lubao, Pampanga is considered as "danger zone" if under the following descriptions:

1. An area within the circumferential height reach of trees, poles, cable posts, and outside walls of a building or house.
2. An area that can be the passage of ground rupture and near to the trace of it.
3. An area where the ground shaking could bring a higher earthquake intensity compared to the other parts of the community. A red warning from the HazardHunterPH denotes that an area is prone to Intensity 8 and above earthquake based from the PHIVOLCS Earthquake Intensity Scale (PEIS). The shaking within this bracket can go from very destructive to completely devastating in terms of its effects.
4. An area that is prone to earthquake-induced landslide.
5. An area near the wetlands or ponds with a high susceptibility to liquefaction during an earthquake scenario.

3. RESULTS AND DISCUSSIONS

3.1 The Profile of the Respondents

It exhibits that, most of the respondents have ages 18-59 years old with 305 or 85.43% share in the sample size. It was followed by respondents with ages 60 and above that corresponds to 36 or 10.08%. The age bracket of 0-17 years old is last in rank with 16 individuals or 25.24%. Moreover, it exhibits that in terms of sex, 195 or 54.62% of the respondents are female followed by male with 162 or 45.38%.

3.2 Presentation and Interpretation of the Survey Responses

The computation shows a weighted mean of 2.43 to Statement 1 with a verbal description of "Disagree" towards the statement, "I know what a 'fault line' is". This implies that the residents of Brgy.Baruya, Lubao, Pampanga are not fully familiar with the term 'fault line' that is being used to emphasize a geological concern capable of producing earthquakes and how it looks like.

Statement 2 has achieved a weighted mean of 1.96 with a verbal description of "Disagree" towards the statement, "I am aware of the existing Lubao Fault near our community". This indicates that the residents of Brgy.Baruya, Lubao, Pampanga do not recognize yet the presence of the Lubao Fault throughout the years it was discovered and named after their town.

A weighted mean of 1.99 manifested in Statement 3 with a verbal description of "Disagree" towards the statement, "I have the knowledge about the highest magnitude earthquake that this fault can generate in a worst-case scenario". This signifies that the residents of Brgy.Baruya, Lubao, Pampanga do not have the information about the possible 7.2 magnitude earthquake that the Lubao Fault can generate when it behaves in the most violent manner.

Moreover, a computed weighted mean of 2.08 encapsulated Statement 4 with a verbal description of "Disagree" towards the statement, "I am informed about the risks it can bring to Brgy.Baruya, Lubao, Pampanga". This denotes that the residents of Brgy.Baruya, Lubao, Pampanga are not being told yet by the authorities about the hazards that can be manifested when a strong earthquake from the Lubao Fault suddenly came. Some of these include ground rupture, landslide, and specifically liquefaction since their community is surrounded by wetlands and ponds.

Answers from Statement 5 produced a weighted mean of 2.29 with a verbal description of "Disagree" towards the statement, "I still feel safe upon recognizing the fault in our area because I am familiar with the earthquake evacuation procedures". This exhibits that the residents of Brgy.Baruya, Lubao, Pampanga are worried about their safety after knowing the Lubao Fault because they are not well-equipped with the knowledge regarding the proper earthquake evacuation procedures.

Statement 6 displays a weighted mean of 2.55 with a verbal description of "Agree" towards the statement, "I am confident that our local government is well-prepared for strong earthquakes". This means that the residents of Brgy.Baruya, Lubao, Pampanga are trusting the capability and readiness of their leaders to the possible occurrence of powerful earthquakes.

Moreover, a computed weighted mean of 2.43 governs in Statement 7 with a verbal description of "Disagree" towards the statement, "I know where the danger zones to avoid and the safe spaces to go to during earthquake". This reveals that the residents of Brgy.Baruya, Lubao, Pampanga do not know yet the location of the areas within their community that can be the catch basin of higher earthquake risks and those that can be the assembly spaces for them while waiting for rescue.

Responses from Statement 8 yield a weighted mean of 3.53 with a verbal description of "Strongly Agree" towards the statement, "I believe that relevant signages about the Lubao Fault can strengthen the awareness and readiness of the residents". This illustrates that the residents of Brgy.Baruya, Lubao, Pampanga greatly think that providing earthquake signages can reinforce their consciousness towards the presence of the Lubao

Fault and their safety measures for survival in a ground shaking event.

Statement 9 arrives into a computed weighted mean of 3.60 with a verbal description of "Strongly Agree" towards the statement, "I believe that optimization of road networks that are linked to Brgy.Baruya can provide an efficient earthquake rescue". This infers that the residents of Brgy.Baruya, Lubao, Pampanga greatly consider the systematic utilization of available routes in reaching their community during earthquake evacuation to achieve a speedy rescue.

Lastly, a weighted mean of 3.56 evinces in Statement 10 with a verbal description of "Strongly Agree" towards the statement, "I am willing to join any modified earthquake drill in our community that is intended for the potential destruction of the Lubao Fault". This expresses that the residents of Brgy.Baruya, Lubao, Pampanga greatly support the conduct of earthquake drill that is purposively formulated to lessen the potential casualties of earthquake that is connected to the Lubao Fault.

3.3 Transcribed Answers from the Interview

The following are the transcribed answers of the Lubao Disaster and Risk Reduction Management Office (LDRRMO) to the questions from the structured interview. The thoughts were organized to further understand their current evacuation system. The copy of the set of questions were initially presented herein:

1. Are you also aware of the Lubao Fault? If yes, have you already introduced it to the residents of Brgy. Baruya, Lubao, Pampanga?
2. How do you coordinate with the local officials of Barangay Baruya in terms of earthquake preparedness?
3. What is your lastly recorded strongest earthquake that jolted Barangay Baruya and what are the devastations it left to the said community?
4. Do you have an existing evacuation plan? If yes, do you have a separate earthquake evacuation or just general evacuation procedures for all types of natural disasters?
5. How do you administer earthquake evacuation and how is the flow of command about this matter? What are the steps to follow?
6. Where is the starting point of your rescue vehicles for evacuation mobility and are the rescue vehicles in good condition?
7. Do you have enough rescuers for evacuation and who leads the rescue team? How often do the rescuers train for evacuation procedures?
8. How often do you conduct earthquake drills? Where do you conduct it and who are the participants?
9. Have you already established safety guidelines and precautions in Brgy.Baruya through signages or posters for potential earthquake relating to the Lubao Fault?
10. Have you already identified the danger zones and safe spaces in Brgy.Baruya? If yes, how did you determine those areas? Have you already informed the residents about those places to avoid and to go to incase of an earthquake?
11. How do you make the most efficient use of available road networks in an earthquake rescue operation? Do the rescuers know the evacuation map and how long does it takes for a usual evacuation rescue?
12. How prepared is the Lubao Disaster and Risk Reduction Management Office (LDRRMO) for a potential 7.2 magnitude earthquake that can be generated by the Lubao Fault? Does the disaster management team of Lubao, Pampanga still open for the improvement of their current evacuation system?

"We are not sure about the exact way of the Lubao Fault and we have not talk yet about it with the people of Barangay Baruya. However, the LDRRMO has an available ground shaking map that shows all the affected barangay in case of an earthquake. We are still conducting earthquake drills and distribution of Information, Education and Communication (IEC) materials even though we are not fully aware about the fault line in Pampanga. In that way, the residents still have the idea of what to do if ever an earthquake occurs." *(English translation)*

"Yes, we have an evacuation plan. Our current evacuation plan is general for all types of natural disaster and it came from the Municipal Social Welfare and Development Office (MSWD). It is the Intensity 5.7 Luzon Earthquake last April 22, 2019 that hit Barangay Baruya and the data based from the Post Damages Report of the LDRRMO are 116 families were partially affected and no individual was killed by the earthquake. The fence in Baruya National High School amounting to 50,000 pesos collapsed. An 80-meter portion of the barangay road amounting to 600,000 pesos and the bridge amounting to 500,000 pesos were also left damaged by the said event." *(English translation)*

"Contingency plan is like we give a scenario, a worst-case scenario, then you can see the clustering of what are the things to do. The goals and objectives can be seen there. The sequence of steps that the office will do in the occurrence of an earthquake were divided on every member. The recue vehicles of LDRRMO are all located at the operation center and evacuation usually starts here in Lubao Municipal Hall. However, the Barangay Baruya has also identified vehicles like boats in the docking area. All of the rescue vehicles are functional and we check them every time." *(English translation)*

"Yes of course the office had enough numbers of rescuers and vehicles, the LDRRMO officer will take the lead. We participate in the quarterly earthquake drills. Then during resilience month, we also join in trainings for the observance of the event. We are conducting earthquake drills here in the municipality, in school, and it depends on the request. The barangays of Lubao are also conducting their drills quarterly. It is often being administered in school and here in the municipality. At school, the students and teachers are the participants. In the barangay that you are talking about, I know all their councils including the appointed residents but not the majority of their population.” *(English translation)*

“We have posters and signages for ground shaking but these are generally intended for all types of earthquakes. We have not provided yet the guidelines for the possible earthquake that can be made by the Lubao Fault in particular. As of now, we have not determined and assigned yet those safe spaces and danger zones in Barangay Baruya since we do not have the enough idea about the fault. The LDRRMO has a copy of evacuation map but it is for the flood and not for the earthquake. We have not tested yet all the routes going to Barangay Baruya but our rescue vehicles usually take the path via the Lubao Bypass Road during evacuation. The evacuation lasts depending the severity of a disaster but it can take up to one week long in transferring the whole population of a certain barangay during forced flood evacuation.” *(English translation)*

“Every year we are doing some modifications in the contingency plan when a new strong earthquake was recorded and it left unexpected casualties. Yes, we are always open for improvement and please give me a copy of your study once it is completed so we can integrate your research to the evacuation plan of LDRRMO.” *(English translation)*

Table - 4: The Summary of the Structured Interview

THEME CLUSTER	FORMULATED MEANING
Awareness	• Uncertainty to the exact way of Lubao Fault • Not enough idea about the presence of the said geological concern
Preparation	• Conduct of quarterly earthquake drills in municipal hall and barangays (mostly at schools) • Testing of contingency plan • Distribution of informative materials
Evacuation Procedures	• Generation of text message • Conduct of disaster risk assessment before help assistance • Call for evacuation order
Availability of Evacuation Resources	• General evacuation plan for all types of natural disasters • Rescuers are trained and enough in numbers • Rescue vehicles are seen to be sufficient and are all in good functioning terms
Gaps in the Current Evacuation System	• Absence of separate earthquake evacuation system • Non-identification of open spaces and danger zones • Insufficient earthquake signages • Non-optimization of evacuation routes • Lack of attention in the most vulnerable community to the Lubao Fault

The LDRRMO itself is not also aware of the existing Lubao Fault near the community of Brgy.Baruya, Lubao, Pampanga. However, safety measures such as drills, distribution of informative materials, availability of ground shaking map, and establishment of contingency plan are part of their preparedness to earthquake.

The current evacuation procedures of LDRRMO are generally applicable to all natural disasters. Earthquake has no separate evacuation system. Last April 2019, a 6.1 magnitude Luzon Earthquake caused harm to the residents of Barangay Baruya and destroyed some community properties, hence, contingency plan to earthquake was actively being tested and reviewed by the LDRRMO.

The flow of command will start from the message generation of LDRRMO, then followed by the evaluation of barangay chairman to their affected area and will arrive to the evacuation command of the mayor or MDAO for rescue order. The starting point of evacuation takes place in the Lubao Municipal Hall since the rescue vehicles reside in the operation center of LDRRMO located at the aforementioned ground.

The Lubao Municipal Hall quarterly holds earthquake drills and the officers from LDRRMO are the major involved bodies. Communities within Lubao such as in Barangay Baruya also quarterly conduct earthquake drills that are being participated by teachers, students, barangay council, and some selected residents.

The guidelines were not specifically intended for the possible earthquake that can be made by the Lubao Fault and to the nearest community to it which is the Brgy.Baruya, Lubao, Pampanga. The lack of consciousness about the presence of the Lubao Fault caused the non-identification of the safe spaces and danger zones in Barangay Baruya. The Lubao Bypass Road was the only road network that is being used by the rescuers when reaching a community in Lubao that needs help. Moreso, the evacuation map was usually dedicated to flood evacuation and not in earthquake-related operation. Forced evacuation in a community can last to one week.

The LDRRMO is evaluating for the aspects in their contingency plan that need to be ameliorated to become more ready and is always welcome for any improvement towards their current evacuation system specially in earthquake response.

3.4 Trip Computation

Three possible cases were drafted in evacuation routing during an actual earthquake situation to maintain an optimization of available road networks. These are the following:

Case 1: When the Jose Abad Santos Avenue and the Lubao Bypass Road are both passable during evacuation:

• Divide the rescue vehicles and the population into two groups.

Case 2: When the Jose Abad Santos Avenue is not passable during evacuation:

• All rescue vehicles will transfer the whole population via Lubao Bypass Road.

Case 3: When the Lubao Bypass Road is not passable during evacuation:

• All rescue vehicles will transfer the whole population via Jose Abad Santos Avenue.

For Case 1:

*Group 1

Required No. of Trip = 2490/194

Required No. of Trip = 12.84, say 13 trips

Trip Duration (in minutes) = (13.3 km)/(30 km/hr).(60 mins)

Trip Duration = (26.6 mins. × 2) + 30 mins.

Trip Duration = 83.2 mins, say 84 minutes

*Group 2

Required No. of Trip = 2484/190

Required No. of Trip = 13.07, say 14 trips

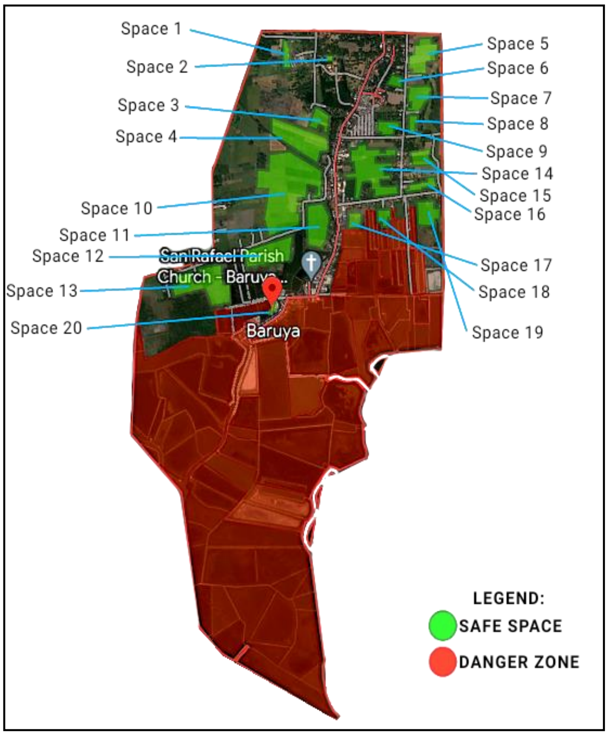
Trip Duration (in minutes) = (15.6 km)/(30 km/hr).(60 mins)

Trip Duration = (31.2 mins. × 2) + 30 mins.

Trip Duration = 92.4 mins, say 93 minutes

Average Trip Duration for Case 1 = (84 mins+93 mins)/2

Average Trip Duration for Case 1 = 88.5 minutes



Estimated Span of Evacuation (in hours) = ((84 mins.× 13) + (93 mins.× 14))/(60 mins.)

Estimated Span of Evacuation = 19.98 hours, say 20 hours

For Case 2:

Required No. of Trip = 4974/384

Required No. of Trip = 12.95, say 13 trips

Trip Duration (in minutes) = (15.6 km)/(30 km/hr).(60 mins)

Trip Duration = (31.2 mins. × 2) + 30 mins

Trip Duration = 92.4 mins, say 93 minutes

Estimated Span of Evacuation (in hours) = (93 mins. × 13)/(60 mins.)

Estimated Span of Evacuation = 20.15 hours, say 21 hours

For Case 3:

Required No. of Trip = 4974/384

Required No. of Trip = 12.95, say 13 trips

Trip Duration (in minutes) = (13.3 km)/(30 km/hr).(60 mins)

Trip Duration = (26.6 mins. × 2) + 30 mins.

Trip Duration = 83.2 mins, say 84 minutes

Estimated Span of Evacuation (in hours) = (84 mins. × 13)/(60 mins.)

Estimated Span of Evacuation = 18.2 hours, say 19 hours

Any of the three cases presented will be considered depending upon the situation during earthquake evacuation. A person in-charged will check the availability, accessibility, and condition of predetermined road networks before the mobility flow of rescue vehicles. Based from the calculations, Case 3 when the Jose Abad Santos Avenue is the only passable route has the shortest span of evacuation time with 19 hours. It was followed by Case 1 when both routes are passable with 20 hours and Case 2 when the Lubao Bypass Road is the only passable route attained the longest span of evacuation time with 21 hours. All of the cases were calculated with forced evacuation as the basis.

3.5 Safe Spaces and Danger Zones

The following are the identified safe spaces that can serve as assembly areas during earthquake in Brgy.Baruya, Lubao, Pampanga. The danger zones that need to avoid during earthquake are also incorporated in the map. The susceptibility of each area in terms of ground shaking, ground rupture, earthquake-induced landslide, and liquefaction were determined through the utilization of HazardHunterPH tool that is being supported by the PHIVOLCS-DOST.

Figure - 4: Earthquake Safe Spaces and Danger Zones in Barangay Baruya

Table - 5: The Specifications of Every Identified Open Space in Barangay Baruya

OPEN SPACES	SPECIFICATIONS
	**SPACE 1** **Area:** 4700 sq m **Coordinates:** 120.52618, 14.87543 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Moderately Susceptible **Capacity:** 4700 individuals
	**SPACE 2** **Area:** 900 sq m **Coordinates:** 120.52821, 14.87707 **Ground Rupture:** Safe **Ground Shaking**: Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction**: Moderately Susceptible **Capacity:** 900 individuals
	**SPACE 3** **Area:** 11280 sq m **Coordinates:** 120.53048, 14.87452 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 11280 individuals
	**SPACE 4** **Area:** 27600 sq m **Coordinates:** 120.53028, 14.87339 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 27600 individuals
	**SPACE 5** **Area:** 27600 sq m **Coordinates:** 120.53154, 14.88198 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide**: Safe **Liquefaction:** Moderately Susceptible **Capacity:** 27600 individuals

	**SPACE 6** **Area:** 27600 sq m **Coordinates:** 120.53193, 14.87917 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 27600 individuals
	**SPACE 7** **Area:** 16400 sq m **Coordinates:** 120.53355, 14.87945 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 16400 individuals
	**SPACE 8** **Area:** 8300 sq m **Coordinates:** 120.53441, 14.87834 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 8300 individuals
	**SPACE 9** **Area:** 9500 sq m **Coordinates:** 120.53356, 14.87706 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 9500 individuals

	**SPACE 10** **Area:** 136700 sq m **Coordinates:** 120.53163, 14.86969 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 136700 individuals
	**SPACE 11** **Area:** 37500 sq m **Coordinates:** 120.53443, 14.87062 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 37500 individuals
	**SPACE 12** **Area:** 38670 sq m **Coordinates:** 120.53414, 14.86785 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 38670 individuals
	**SPACE 13** **Area:** 48700 sq m **Coordinates:** 120.53249, 14.86348 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 48700 individuals

	**SPACE 14** **Area:** 62000 sq m **Coordinates:** 120.53463, 14.87509 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 62000 individuals
	**SPACE 15** **Area:** 10400 sq m **Coordinates:** 120.53610, 14.87760 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 10400 individuals
	**SPACE 16** **Area:** 12200 sq m **Coordinates:** 120.53748, 14.87656 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 12200 individuals
	**SPACE 17** **Area:** 7500 sq m **Coordinates:** 120.53612, 14.87225 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 7500 individuals

	**SPACE 18** **Area:** 6700 sq m **Coordinates:** 120.53723, 14.87358 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 6700 individuals
	**SPACE 19** **Area:** 16600 sq m **Coordinates:** 120.53862, 14.87571 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 7 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 16600 individuals
	**SPACE 20** **Area:** 600 sq m **Coordinates:** 120.53640, 14.86536 **Ground Rupture:** Safe **Ground Shaking:** Prone, Intensity 8 **Earthquake-Induced Landslide:** Safe **Liquefaction:** Highly Susceptible **Capacity:** 600 individuals

Based from the specifications, all the identified open spaces within Brgy.Baruya, Lubao, Pampanga are not prone to ground rupture and earthquake-induced landslide which are good indicators of an assembly area. Space 1, Space 2, and Space 5 are the safest areas during earthquake in the said community because these exhibit a moderate susceptibility to liquefaction among others. However, the remaining open spaces can still be the initial settlement of residents during earthquake since these are accessible and near to their dwelling places but need to be vacated immediately when the ground shaking stops because these areas have high susceptibility to liquefaction. Residents who are on these regions should be transferred out to the northern part of Barangay

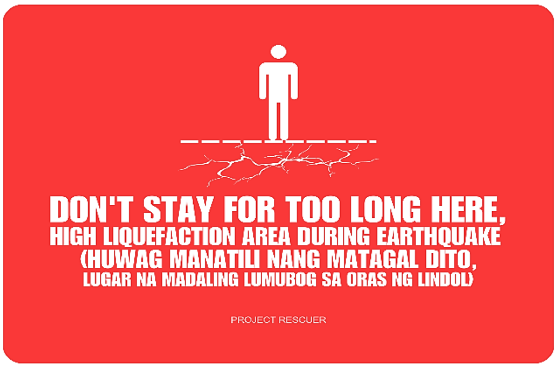
Baruya where the soil is denser when the earthquake calmed down. All of the above specified spaces are at least 5 meters away from the cable posts, trees, and exterior walls of structures to avoid harm from collapse while waiting for rescue.

On the other hand, areas from the map that are shaded with red are considered as danger zones during earthquake in Brgy.Baruya, Lubao, Pampanga. The southern part of the aforementioned community is being surrounded by wetlands and ponds, hence, land areas near these topographical features are very prone to rapid liquefaction during earthquake. The main road of Barangay Baruya was also included under the danger zone because of the cable posts that were built on its sides that can fall during ground shaking. Moreover, some streets from Purok 1A and Purok 1B that are narrow and being encompassed by trees and houses were also marked to be avoided in an earthquake situation.

According to Breen (2017) from the Mathematics of Crowd Safety, math is used to determine how many people can fit in a space at its most fundamental level. It is two (2) persons per square meter, which is widely used as a first-pass approximation to determine how many people can fit somewhere and is frequently regarded as the safe starting point for crowds. However, an adjustment of one (1) resident per square meter was set to this study as the standard rule to ensure that the evacuees can still comfortably move and breathe during earthquake evacuation and also to avoid panic attack in the assembly spaces.

3.6 Proposed Earthquake Signages

The following signages were designed using Canva to purposively guide the residents of Brgy.Baruya, Lubao, Pampanga during evacuation for a possible earthquake that can be generated by the Lubao Fault.



Figures - 5 to 17: The Proposed Earthquake Signages in Barangay Baruya

The shown proposed earthquake signages in this study should all meet the following descriptions once approved by the LDRRMO:

1. All signages should not be less than 2.5 × 1.5 meters and should be made in galvanized metal sheets.
2. All figures and letters should be printed out from 62 mm to 100 mm in size. This is to effectuate favorable reading conditions even from 18 m to 30 m viewing distance as established by the Irish and European Union Standards.

Figure - 18: Two-Dimensional Perspective View of Proposed Signages

3. All signages should be supported by two metal poles that are both 2.8 meters in size, with 1 meter being subjected underground.

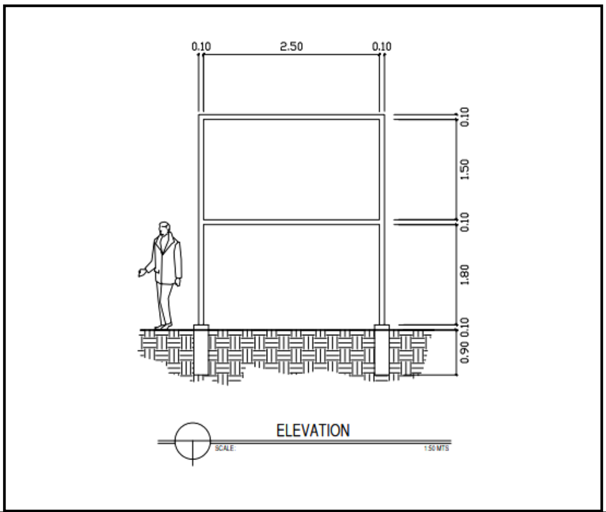
Figure - 19: Three-Dimensional Perspective View of Proposed Signages

4. Letters and images should be photoluminescent to still become readable when there is power failure at night during earthquake.
5. The indicated background colors should not be changed. Green signages are coordinated with the safe spaces while the red signages are linked to the danger zones and earthquake precautions.
6. The Filipino translation of all signages should not be altered or removed so more residents can understand what are being instructed to them.

3.7 Modifications in the Evacuation System

The following table presents the summary of proposed modifications that are supplied in this present study primarily considered for the Brgy.Baruya, Lubao, Pampanga:

Table - 6: The Proposed Modifications in the Current Evacuation System



AREAS	EXISTING EVACUATION PLAN	MODIFICATIONS
Earthquake Usage	No separate evacuation procedures for earthquake because the plan is generally intended for all natural disasters	Specified earthquake preparations and evacuation procedures particularly incase of ground shaking events that can be made by the Lubao Fault
Evacuation Route	The Lubao Bypass Road was the only road network that is being used for rescue mobility	Provided three cases of rescue mobility incorporating the optimization of two road networks: the Jose Abad Santos Avenue and the Lubao Bypass Road
Safe Spaces and Danger Zones during Earthquake	Not yet identified in Brgy.Baruya, Lubao, Pampanga	Determined and listed the specifications of spaces in terms of area, susceptibility to ground shaking, ground rupture, earthquake-induced landslide, and liquefaction
Earthquake Signages	Not sufficiently provided in Brgy.Baruya, Lubao, Pampanga	Proposed additional signages specifically designed to give guidelines and precautions to the residents in Barangay Baruya
Time Span of Mandatory Evacuation	No estimated time for earthquake rescue operation but mandatory flood evacuation can last for one week	Performed trip computation to calculate the possible duration of mandatory earthquake evacuation in Barangay Baruya and it only arrived between 19-21 hours depending upon the case being used

3.8 Proposed Earthquake Response in Evacuation

a) The LDRRMO will generate text message as preliminary earthquake signal. This will be sent to the barangay chairman.
b) The barangay chairman will activate their operation center.
c) The residents will be instructed to go to the identified open safe spaces during earthquake. People who were initially settled from open areas with high susceptibility to liquefaction will be immediately transferred by the rescue vehicles of the barangay to Space 1, Space 2, and Space 5 when the ground shaking stops.
d) The residents will wait for municipal rescue in the northern part of Barangay Baruya where the soil is denser compared to the southern part of the said community where the ground is mostly surrounded by wetlands and ponds, thus, it is prone to submerge.
e) The barangay chairman will act as overseer and will call for help assistance to the LDRRMO.
f) The municipal mayor or the MDAO will declare a forced evacuation order.
g) A person-in-charge from the LDRRMO will check first the accessibility of the two pre-determined road networks to know what is the case to be used before proceeding to the mobility flow.
h) The starting point of the rescue operation will commence at the Lubao Municipal Hall going to Brgy.Baruya, Lubao, Pampanga.
i) The priority group including the children, senior citizens, and person with disabilities will be evacuated first as planned from Barangay Baruya while being guided by their adult relative. Injured individuals should be treated in urgency.
j) The initial settlement of the evacuees will be at the DHVSU Lubao Campus near the Lubao Municipal Hall to create a uniform rescue mobility.
k) The LDRRMO will examine if the residents were all evacuated and no one was trapped within the community. When everybody was confirmed to be transferred safely, the rescuers will move the evacuees to the proper evacuation centers.

4. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

4.1 Summary of Findings

In accordance with the objectives of this study, the following were the summarized findings based on the results gathered through the research instruments and the key points leading to the conclusion:

1. The Profile of the Respondents

In terms of age, most of the respondents have ages 18-59 years old with 305 or 39.81%. It was followed by 60 and above age bracket with 36 or 10.08%. The ages of 0-17 years old had the least share in the sample population with 16 or 4.48%.

In terms of sex, 195 or 54.62% of the respondents are females followed by the males with 162 or 45.38%. Overall, the entire sample size of this study is 357.

2. Survey Responses

Statements 1-5 that include, “I know what a ‘fault line’ is.”, “I am aware of the existing Lubao Fault near our community.”, “I have the knowledge about the highest magnitude earthquake that this fault can generate in a worst-case scenario.”, “I am informed about the risks it can bring to Brgy.Baruya, Lubao, Pampanga.”, and “I still feel safe upon recognizing the fault in our area because I am familiar with the earthquake evacuation procedures.” all got a computed weighted mean from the range of 1.76-2.50 with a verbal description of Disagree. Meanwhile, responses from Statement 6, “I am confident that our local government is well-prepared for strong earthquakes.”, and Statement 7, “I know where the danger zones to avoid and the safe spaces to go to during earthquake.”, obtained an interpretation of Agree and Disagree respectively. Lastly, Statement 8, Statement 9, and Statement 10 all arrived into a weighted mean from the range of 3.26-4.0 with a verbal description of Strongly Agree. These include of “I believe that relevant signages about the Lubao Fault can strengthen the awareness and readiness of the residents.”, “I believe that optimization of road networks that are linked to Brgy.Baruya can provide an efficient earthquake rescue.”, and “I am willing to join any modified earthquake drill in our community that is intended for the potential destruction of the Lubao Fault.”.

3. Interview Transcription

The LDRRMO itself is not also aware of the existing Lubao Fault near the community of Brgy.Baruya, Lubao, Pampanga. However, safety measures such as drills, distribution of informative materials, availability of ground shaking map, and establishment of contingency plan are part of their preparedness to earthquake.

The current evacuation procedures of LDRRMO are generally applicable to all natural disasters. Earthquake has no separate evacuation system. Last April 2019, a 6.1 magnitude Luzon Earthquake caused harm to the residents of Barangay Baruya and destroyed some community properties, hence, contingency plan to earthquake was actively being tested and reviewed by the LDRRMO.

The flow of command will start from the message generation of LDRRMO, then followed by the evaluation of barangay chairman to their affected area and will arrive to the evacuation command of the mayor or MDAO for rescue order. The starting point of evacuation takes place in the Lubao Municipal Hall since the rescue vehicles reside in the operation center of LDRRMO located at the aforementioned ground.

The Lubao Municipal Hall quarterly holds earthquake drills and the officers from LDRRMO are the major involved bodies. Communities within Lubao such as in Barangay Baruya also quarterly conduct earthquake drills that are being participated by teachers, students, barangay council, and some selected residents.

The guidelines were not specifically intended for the possible earthquake that can be made by the Lubao Fault and to the nearest community to it which is the Brgy.Baruya, Lubao, Pampanga. The lack of consciousness about the presence of the Lubao Fault caused the non-identification of the safe spaces and danger zones in Barangay Baruya. The Lubao Bypass Road was the only road network that is being used by the rescuers when reaching a community in Lubao that needs help. Moreso, the evacuation map was usually dedicated to flood evacuation and not in earthquake-related operation. Forced evacuation in a community can last to one week.

The LDRRMO is evaluating for the aspects in their contingency plan that need to be ameliorated to become more ready and is always welcome for any improvement towards their current evacuation system specially in earthquake response.

4. Evacuation Routing

Two connected road networks from Brgy.Baruya, Lubao, Pampanga were determined namely: the Jose Abad Santos Avenue with a travel distance of 13.3 kilometers and the Lubao Bypass Road with 15.6 kilometers. The starting point of rescue mobility was set to be at the Lubao Municipal Hall. Priority groups such as the children, senior citizens, and persons with disabilities were distributed accordingly in a ratio of 1:1 with their adult relatives who will serve as their companions in an actual earthquake evacuation. Based from the calculations, Case 3 when the Jose Abad Santos Avenue is the only passable route has the shortest span of evacuation time with 19 hours. It was followed by Case 1 when both routes are passable with 20 hours and Case 2 when the Lubao Bypass Road is the only passable route attained the longest span of evacuation time with 21 hours. All of the cases were calculated with forced evacuation as the basis.

5. Safe Spaces and Danger Zones

A total of 20 safe spaces during earthquake evacuation were identified in Brgy.Baruya, Lubao, Pampanga using HazardHunterPH tool. The susceptibility of each area in terms of ground shaking, ground rupture, earthquake-induced landslide, and liquefaction were considered. The capacity of all spaces were also computed using a basis of 1 person per square meter and it shows that these can accommodate the total population of the aforementioned community in case of a mandatory earthquake evacuation.

On the other hand, the southern part of Barangay Baruya is being surrounded by wetlands and ponds, hence, land areas near these topographical features are very prone to rapid liquefaction during earthquake. Its main road was also included under the danger zone because of the cable posts that were built on its sides that can fall during ground shaking. Moreover, some streets from Purok 1A and Purok 1B that are narrow and being encompassed by trees and houses were also marked to be avoided in an earthquake situation.

6. Proposed Earthquake Signages

A total of 13 signages were designed purposively for the residents of Brgy.Baruya, Lubao Pampanga who are the most vulnerable people to the possible earthquake generated by the Lubao Fault. Right specifications were provided to be followed by the LDRRMO once approved. Lastly, the locations of the signages were also plotted to the map illustrations of the focused community.

7. Modifications in the Evacuation System

Some areas in the existing evacuation plan of the LDRRMO were modified to cater the changing needs of the residents specifically to the underlying earthquake risks of the Lubao Fault. These include of earthquake usage, evacuation route, earthquake safe spaces and danger zones, earthquake signages, and time span of evacuation. The interconnectivity of this research, the local government of Lubao, and the residents of Barangay Baruya is the primary compass to the improvement of earthquake awareness and preparedness. The present study tackled the factors that are lacking in the current evacuation system and proceed to the modifications. The authorized officials of Lubao, Pampanga has now the power to approve the proposals enlisted throughout this dissertation, and will lead the implementation of all contents. The residents will take a piece of their share by giving the utmost support, openness, and participation once the changes and supplementary actions were integrated to the new earthquake evacuation plan. It is indeed a collective responsibility for the abovesaid bodies involved to elevate the status of disaster education and readiness in the community.

4.2 Conclusions

The Barangay Baruya is the nearest community to the Lubao Fault among all the other residential areas in the municipality of Lubao, Pampanga. Disaster report from the April 22, 2019 Luzon Earthquake shows that the aforementioned community was highly hit by the 6.1 magnitude ground shaking with 116 affected families and an estimated of over 1.1 million pesos damages to public properties. Some speculations from the local officials were also brought to the table because of the strength it manifested to Barangay Baruya beside of the actuality that the epicenter was located in Catillejos, Zambales.

A survey questionnaire was administered to the residents of Barangay Baruya to assess their awareness towards the existence of the Lubao Fault. It was shown that the focused population of this study does not have the prior knowledge about the discovered geological concern. Residents disagreed to prove the following: that they know what a fault line is, that they are aware about the presence of Lubao Fault, that they are conscious about the highest magnitude it can produce, and the underlying earthquake risks attached to it.

The residents still trust the earthquake readiness of their local government, however, they felt worried after perceiving the existence of Lubao Fault near their community because they are currently unfamiliar with the evacuation procedures as well as the location of safe spaces and danger zones. Proposed modifications were greatly supported by the people of Barangay Baruya by expressing a strong agreement to the establishment of signages and optimization of road networks in preparation for earthquakes. The residents also exhibited their strong willingness to participate in earthquake drills that are intended for the Lubao Fault.

The status of the evacuation system and the earthquake preparedness of the Lubao Disaster and Risk Reduction Management Office (LDRRMO) was evaluated through structured interview. It was found that the office is also unaware of the Lubao Fault just like the residents of Barangay Baruya. Safety measures were still being put into practice despite of that but were seen to be insufficient. The Barangay Baruya was not given a certain treatment and wider scope of earthquake preparation because the LDRRMO is oblivious beforehand that this is the nearest community to the Lubao Fault among their subordinating barangays. The LDRRMO is always open to improvements and it is a good indicator that proposed modifications to their existing evacuation system are going to be considered.

The determined road networks for rescue mobility are the Jose Abad Santos Avenue and the Lubao Bypass Road. These two routes are connected to the Brgy.Baruya, Lubao, Pampanga and were set to be the passage of rescue vehicles during evacuation. The trip computation indicated that the Case 3 when the Jose Abad Santos Avenue is only passable during earthquake situation can provide the fastest time span of mandatory earthquake evacuation with an estimated total of 19 hours which is better than the recorded one-week duration of mandatory flood evacuation in the said barangay. The route will start from the Lubao Municipal Hall going to the Barangay Baruya and vice versa.

The community evaluation and utilization of the HazardHunterPH tool made possible to identify the safe spaces and danger zones in Brgy.Baruya, Lubao, Pampanga while considering their vulnerability to ground shaking, ground rupture, earthquake-induced landslide, and liquefaction. It was found that the said barangay was surrounded by wetlands and ponds in the southern part of it making the areas near to these topographical features as highly susceptible to rapid liquefaction. Among the 20 open spaces that were examined, Space 1, Space 2, and Space 5 from the northern part of Barangay Baruya are the safest because they hold moderate susceptibility to liquefaction. The combined areas of the mentioned spaces can accommodate the 4974 expected evacuees in time of mandatory earthquake evacuation. All of the listed open areas are free from ground rupture and earthquake-induced landslide but all prone to ground shaking up to Intensity 7. These spaces will serve as the initial assembly places of residents in an earthquake situation.

The proposed earthquake signages were designed to cater the need of Barangay Baruya amidst the unforeseen earthquake events that can be produced by the Lubao Fault. The right specifications in terms of size, color, translation, and materials were provided to ensure the proper delivery of guidelines and precautions to the residents. Modifications that are being supplied in areas such as the earthquake usage of evacuation plan, evacuation route, safe spaces and danger zones during earthquake, earthquake signages, and time span of mandatory evacuation all denoted good and positive differences to the existing evacuation system.

Overall, the proposal of some modifications to the current evacuation system were seen to be attainable with the sufficient allocation of resources and are open for integration towards the future plan of LDRRMO.

4.3 Recommendations

The present study was part of the first initiatives to highlight the Lubao Fault, therefore, resulting in primary findings which necessitate more practical perfections. These obtained inferences however enlightened several prospective matters for future research. The following recommendations and the areas for further research that were not possible to undertake within this study are herein presented by the authors:

- Educational symposiums and seminars should be conducted to address the concern about the Lubao Fault and its possible impact on the residents. Earthquake drills should be done with the majority of the population and not only with the selected residents.
- Rescue vehicles should be fueled and stocked with sufficient gasoline at all times. Spare tires should also be available on every rescue vehicle. Moreover, providing additional rescue vehicles can shorten the time span of mandatory earthquake evacuation.
- The exact locations of safe open spaces and danger zones should be introduced to the residents of Brgy. Baruya, Lubao, Pampanga through the joint force of the LDRRMO and the local government. The map in Figure 11 can be printed out for supplementary assistance to the people. A copy of the proposed response to earthquake evacuation should be immediately disseminated to the barangay upon approval to familiarize its flow.
- Food and water supply, light, and first aid kit should be provided in all designated assembly spaces to cover the need of residents while waiting for rescue.
- Enough monetary funds should be allocated to the formation of proposed earthquake signages to ensure the quality based on the listed specifications.
- Future-related studies can widen the range of earthquake preparedness in Lubao, Pampanga by incorporating the other subordinating communities within the municipality. Earthquake impacts in terms of physical damage, casualties, and economic loss can be considered by future researchers through the use of REDAS (Rapid Earthquake Damage Assessment System) software that was developed by the PHIVOLCS. This requires certain training before operation.
- The study also suggests the soil profiling and investigation for land usage safety to construction activities in Barangay Baruya amid the underlying geological threats of the Lubao Fault. This can also include the seismic vulnerability assessment of vertical structures.
- Lastly, this research recommends the study of possible hazards that can be imposed by the Lubao Fault to the Bataan Nuclear Power Plant which were found close to each other.

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