YANGON UNIVERSITY OF ECONOMICS

MASTER OF PUBLIC ADMINISTRATION PROGRAMME

A STUDY ON COMMUNITY KNOWLEDGE, ATTITUDE AND PRACTICE ON EARTHQUAKE PREPAREDNESS IN NYAUNG U TOWNSHIP

AYE ZAR MYO HAN

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ABSTRACT

This study assessed the community knowledge, attitude and practices on earthquake preparedness in selected areas of Nyaung U township. The survey found that earthquake is the major disaster for township, however, most of community do not have knowledge and awareness on earthquake preparedness. 94% of respondents said there is no public awareness session for earthquake in their ward/ village and 81% of respondents do not have family level earthquake preparedness plan. Some people still need to change their attitude and practice on what to do in the time of earthquake shaking to save their lives. Community need to be informed to do "crouch, cover and hold" during the earthquake and village people needs more knowledge than the ward people. There is no regular plan for public awareness sessions at Nyaung U township and township do not have enough capacity to respond to major earthquakes. There is no regular meeting of township disaster management committee and less coordination between regional and district level government. In order for earthquake knowledge and awareness to reach more villages, it needs to open more township level DDM offices, however, there is budget limitation for staff and office construction cost. This study provides recommendations that not only public awareness sessions but also drill exercises need to be organized at the community level and also require to be distributed earthquake awareness IEC materials to community. Law enforcement and policies strengthening should be undertaken by the government.

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LIST OF ABBREVIATIONS

AADMER	ASEAN Agreement on Disaster Management and Emergency Response
ADPC	Asian Disaster Preparedness Center
ASEAN	Association of Southeast Asian Nations
CBO	Community Based Organization
CCH	Crouch, Cover and Hold
DDM	Department of Disaster Management
DMH	Department of Meteorology and Hydrology
DSHA	Deterministic Seismic Hazard Assessment
GAD	General Administrative Department
IEC	Information, Education and Communication
MAPDRR	Myanmar Action Plan on Disaster Risk Reduction
MCCDDM	Myanmar Consortium for Capacity Development on Disaster Management
MEC	Myanmar Earthquake Committee
MES	Myanmar Engineering Society
MGS	Myanmar Geoscience Society
MMI	Modified Mercalli Intensity
MSWRR	Ministry of Social Welfare, Relief and Resettlement
NDMC	National Disaster Management Committee
NGO	Non-Governmental Organization
PSHA	Probabilistic Seismic Hazard Assessment
PWD	People with Disabilities
RRD	Relief and Resettlement Department
UNDP	United Nations Development Program
UN-Habitat	United Nations Human Settlement Programme
UNISDR	United Nations International Strategy for Disaster Reduction
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs

CHAPTER 1
INTRODUCTION

1.1 Rationale of the Study

The seismic hazard of Myanmar is quite high since it is located along one of the earthquake belts of the world, the Alpide Belt and the entire country is prone to earthquakes of varying intensity. With regards to the active faults that can generate large earthquake in the future, Sagaing Fault is the most active. The active Sagaing fault is also one of the great strike- slip faults of Southeast Asia and, trending north – south across the entire length of central Myanmar and there have been many major earthquakes in the past (Hla Hla Aung, 2017).

Nyaung U is one of the townships of Mandalay region which is located along the Sagaing fault area. Bagan located in Nyaung U township, the land of pagodas was destroyed by an earthquake with magnitude 6.8, in 1975 and many pagodas and temples were damaged within seconds. Due to the recent Chauk earthquake in 2016 August 24th, which caused 3 deaths and approximate number of pagodas ie. 400 out of 4000 and those from surrounding area were damaged in Bagan area (Hla Hla Aung, 2017). According to the seismic zone map of Myanmar developed by Myanmar Earthquake Committee, Nyaung U township fall in the zone IV, Severe zone and peak ground acceleration PGA value is 0.31 to 4 g and possible damages includes minor damages of strong built buildings, collapse of proper built buildings, falling of stone walls and furniture, liquefaction and changes of water level in wells (Seismic Hazard Profile of Myanmar, 2015). Nyaung U township is vulnerable to earthquake due to its geographical location and also weak in the preparedness measures. Due to these reasons, Nyaung U township was selected for this study.

Despite the history of great and destructive earthquakes occurrences and enacted preparedness measures statements in disaster management law; the knowledge, understanding and preparedness of earthquake risk have been minimal at township and community level. If people do not have awareness of potential earthquakes and have no preparation for earthquakes, there will be huge losses caused

by earthquakes. Moreover, it is not possible yet to predict exactly when an earthquake will occur, with what magnitude in a particular place at a particular time which have been challenging numerous lives of people. Furthermore, since early warning of an earthquake is not yet available, any earthquake in near future will have significant impacts (UN-Habitat, 2010).

At the institutional level, there are less coordination and participation of different government departments and stakeholders in the disaster management work. Township level disaster management committee formed by inter government departments and also its action plan on disaster preparedness, mitigation, response and recovery are not functioning due to the limited budget allocation. Institutional strengthening and capacity building efforts are also needed to undertake to minimize the risk and impact of earthquakes at national level and also sub national level as well. All these above mentioned factors and consequences act as alarms to conduct the study in Nyaung U township area.

1.2 Objective of the Study

The overall objective of the study is to assess the community knowledge on earthquake disaster and to enhance their knowledge and awareness by providing correct message and information in order to contribute to community resilience on earthquake disaster. The specific objectives of the study are:

i) To examine the community knowledge, attitude and practices on earthquake preparedness of selected area.

ii) To assess the earthquake preparedness measures at the institutional level for the community awareness.

1.3 Method of Study

Both primary and secondary data were used for this study. For the secondary data, the sources of data are collected from the information of Township General Administrative Department, Department of Disaster Management, Myanmar Earthquake Committee MEC, Myanmar Geoscience Society MGS, Myanmar Engineering Society MES and United Nations Human Settlement Program and literatures from various research papers and publications as well as websites and sources from the internet. The research was applied with a quantitative approach to

assess community knowledge, awareness and practice on earthquake preparedness in Nyaung U Township.

The interview was used structured questionnaire for the primary data collection and purposive sampling method was used in targeted ward and village selection. Simple random sampling method was used in the collection of primary data and descriptive method was applied in the survey reporting. This survey has been conducted in 3 wards and 4 villages of Nyaung U Township in November 2018. Key Informant Interview KII with government authorities was used in order to find out institutional level preparedness and for their recommendations. The questionnaire included four parts for demographics, general earthquake hazard awareness, attitude and practices on what to do in before, during and after earthquake. Questionnaires are provided in Appendix A and B.

1.4 Scope and Limitations of the Study

This study mainly focuses on earthquake preparedness and do not consider all the sectors of disaster management cycle such as disaster prevention, mitigation, response, recovery and risk reduction. The survey collected information only on general knowledge on earthquake awareness, community attitude on what they do or will do in time of earthquake and community practices on what they do before, during and after earthquakes. The survey was collected only in 3 wards (Ward No.3, No.4 and No.5) out of 7 and only one Kone Tann Gyi village tract (4 villages of Kone Tann Gyi village tract which are Thant Sin Kyale, PyaukSait Pin, Kone Tann Gyi and Taung Ba villages) out of 85 village tracts. The survey, it interviewed only people at ward and village level and does not include teachers, students and people from the construction sector. Key informant interviews were conducted with two focal departments from Department of Disaster Management and General Administrative Department and interviewed only 6 key government staffs.

1.5 Organization of the Study

The study is organized into five chapters. Chapter 1 introduces rationale, objective, methods, scope and limitations, and organization of the study. Chapter 2 discusses about literature review on concepts and theories of earthquake and conceptual framework. Chapter 3 studied the overview of earthquake risk in Myanmar. Chapter 4 presents the analysis of survey on community knowledge,

attitude and practices on earth quake preparedness in Nyaung U Township and also recommendations of government authorities. Chapter 5 presents conclusion, highlighting survey key findings and suggestions.

CHAPTER 2
LITERATURE REVIEW

2.1 Definition and Terminology Relating with Disasters

Terminology and basic definitions on disaster risk reduction to promote a common understanding on the subject for use by public, authorities and practitioners. Definition and terminology of disasters were taken from Disaster Management Course of Relief and Resettlement Department, MSWRR and United Nations International Strategy for Disaster Reduction UNISDR Terminology on Disaster Risk Reduction, 2009. Key definitions and terminologies as follows:

(A) Disaster and Hazard

Disaster is a serious disruption of the functioning of a community causing widespread human, material or environmental losses which exceed the ability of the affected community to cope using its own resources. Hazard is an event or occurrence that has the potential for causing injuries to life and damaging property and the environment.

(B) Vulnerability and Capacity

Vulnerability is a condition or sets of conditions that reduces people's ability to prepare for, withstand or respond to a hazard. Capacity is the combination of all the strengths, attributes and resources available within an organization, community or society to manage and reduce disaster risks and strengthen resilience.

(C) Risk and Disaster Risk Assessment

Risk: the probability that a community's structure or geographic area is to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction, and proximity to a hazardous area. Disaster Risk Assessment is a qualitative or quantitative approach to determine the nature and extent of disaster risk by analyzing potential hazards and evaluating existing conditions of exposure and

vulnerability that together could harm people, property, services, livelihoods and the environment on which they depend.

(D) Emergency and Response

Emergency is sometimes used interchangeably with the term disaster, as, for example, in the context of biological and technological hazards or health emergencies, which, however, can also relate to hazardous events that do not result in the serious disruption of the functioning of a community or society. Response is actions taken immediately following the impact of a disaster when exceptional measures are required to meet the basic needs of the survivors.

(E) Disaster Risk Reduction and Disaster Management

Disaster Risk Reduction is the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events. Disaster Management is the collective term for all activities that contribute to increasing capacities and will lead to reducing immediate and long-term vulnerabilities. It covers activities before, during and after a disaster. There is gradual shift and currently, Disaster Risk Management is more in usage

(F) Relief, Rehabilitation and Reconstruction

Relief: measures that are required in search and rescue of survivors, as well to meet the basic needs for shelter, water, food and health care. Rehabilitation is actions taken in the aftermath of a disaster to assist victims to repair their dwelling, to re-establish essential services and to revive key economic and social activities. Reconstruction is permanent measures to repair or replace damaged dwellings and infrastructure and to set the economy back on course.

(G) Mitigation, Preparedness and Prevention

Mitigation is the measures taken prior to the impact of a disaster to minimize its effects (sometimes referred to as structural and non-structural measures). Preparedness is measures taken in anticipation of a disaster to ensure that appropriate

and effective actions are taken in the aftermath. Prevention is measures taken to avert a disaster from occurring, if possible (to impede a hazard so that it does not have any harmful effects).

(H) Earthquake, Fault and Contingency Planning

Earthquake is shaking and vibration at the surface of the earth resulting from underground movement along a fault plane or from volcanic activity. The Event is the result of a sudden release of energy in the Earth's crust that creates seismic waves. A fault is a fracture along which the blocks of crust on either side have moved relative to one another parallel to the fracture. Contingency planning is a management process that analyses disaster risks and establishes arrangements in advance to enable timely, effective and appropriate responses.

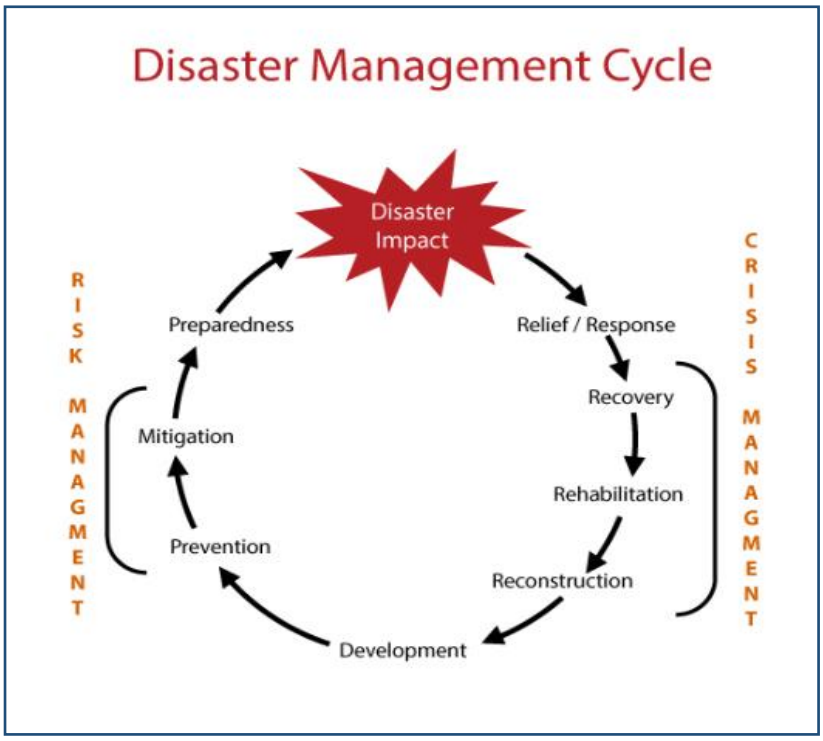
2.2 Disaster Management Cycle

The cycle of disaster management represents for before and after disaster. In the time of before disaster, it is important to undertake the interventions on prevention, mitigation and preparedness measures to prepare for disaster in order to reduce damage and impacts from disasters which include mainstreaming disaster risk reduction DRR concept into development planning, program for public awareness and education, and capacity building, early warning and risk communication development and practice on contingency planning, strengthening of policy and regulation, structural and non-structural mitigation activities and also formation of disaster management committees at all levels, planning for mitigation and preparedness and so on.

When disaster happens, the response tasks are to be undertaken within 24 hours, 72 hours and within short period after disaster. Firstly, search and rescue tasks are to be carried out to save people's lives then to conduct the damage and needs assessment to provide emergency assistance according to victims' needs. Distribution of food and non-food items and also provide services and assistance on health, water and sanitation, shelter etc. After the response, followed by recovery phase with short and long term which includes rehabilitation, resettlement, reconstruction, support for livelihood and economic and so on to get back to the original and/ or better condition of affected people and area to achieve short term and long term development. In all processes of the cycle, coordination is the crucial factor to have between government

and key actors and also reviewing, monitoring and evaluation should be undertaken. should Figure 2.1 shows the disaster management cycle phases by identifying before disaster (risk management) and after disaster (crisis/ emergency management).

Figure (2.1) Disaster Management Cycle



Source: Disaster Management Department, Municipal Corporation of Greater Mumbai, 2017

2.3 Concept of Earthquake Hazard

"An earthquake is a sudden shaking of the ground due to rupture and extremely rapid shifting of rocks along ruptures called faults below the earth's surface. Based on their respective causes, there are 3 different types of earthquakes: (1) Tectonic Earthquakes: Solid earth is composed of concentric shells or layers, which are stacked one above the other, depending on their density. The lightest outermost rigid layer is called the earth's crust. All the plates are moving against one another: two plates slide over, under or collide against each other. Tectonic earthquakes are caused by stresses set up by movements of a dozen or so huge plates that form the earth's crust. Most earthquakes occur along the boundaries of these plates, mostly within the crust and some in the upper part of the underlying mantle

layer. Only a very minor proportion is scattered isolated elsewhere. Tectonic earthquakes are the most common and devastating. (2) Volcanic earthquakes: Earthquakes related to volcanic activity may produce hazards which include ground cracks, ground deformation, and damage to man-made structures. They often precede or accompany volcanic eruptions. (3) Man-made earthquakes: Earthquakes could also be formed by man-made activities. Dam induced earthquakes and those formed by nuclear bomb explosions are good examples. These types of earthquakes are noticeable but are rarely destructive.

Magnitude of an earthquake is a measure of its size based on energy released. The Richter scale measures the magnitude of an earthquake instrumentally at the epicentral area of the earthquake. It is a quantified measurement of an earthquake. An earthquake of magnitude 5 or more on the Richter scale can cause damages but there are other factors which contribute to the scale of the damages. A classification of earthquakes based on magnitude can be seen in Table (2.1) below.

Table (2.1) Classification of an Earthquake based on Magnitude

Sr.	Descriptive Class	Magnitude Range	Annual Average Occurrence
1	Giant	>9.0	
2	Great	8.0-8.9	1
3	Major	7.0-7.9	17
4	Strong	6.0-6.9	134
5	Moderate	5.0-5.9	1319
6	Light	4.0-4.9	13,000
7	Minor	3.0-3.9	130,000
8	Very Minor	2.0-2.9	1,300,000

Source: National Earthquake Information Center, USGS, 1900-1990

Intensity is an indicator of the severity of ground shaking generated at a given location. The most common indicator to measure the intensity of an earthquake is the Modified Mercalli Intensity (MMI) Scale, ranging from I-XII levels. It is not based on measurement by instruments but on an elementary description of levels of damage to physical structures such as buildings, towers, bridges, water reservoirs etc.," (UN-Habitat, 2010, p.1 to 4). The Modified Mercalli Intensity (MMI) Scale describes the effects of the earthquake as given in Table (2.2).

Table (2.2) Classification of Earthquakes Based on Intensity

Class of Earthquakes (MMI)	Effects of Earthquake
I	Not felt except by very few under especially favorable circumstances.
II	Felt only by few persons at rest, especially on upper floors of buildings. Delicately suspended objects may swing.
III	Felt quite noticeably indoors, especially on upper floors of buildings but many people do not recognize it as an earthquake; standing motorcars may rock slightly. Vibration may be felt like that of a passing a truck.
IV	During the day felt indoors by many and outdoors by a few; at night some are awakened; dishes, windows, doors disturbed; walls make cracking sound; sensation like heavy truck striking the building; and standing motor cars rocked visibly.
V	Felt by nearly everyone; many awakened; some dishes, windows etc. broken; a few instances of cracked plaster; unstable objects overturned; disturbance to trees, poles, and other tall objects noticed and pendulum clocks may stop.
VI	Felt by all; many frightened and run outdoors; some heavy furniture moved; a few instances of fallen plaster or damaged chimneys and damage slight.
VII	Everybody runs outdoors; damage negligible in buildings of good design and construction; slight to moderate in well built ordinary construction; considerable in poorly built or badly designed structures; some chimneys broken; noticed by persons driving motor cars.

Class of Earthquakes (MMI)	Effects of Earthquake
VIII	Damage slight in specially designed structures; considerable in ordinary but substantial buildings with partial collapse; very heavy in poorly built structures with panel walls thrown out of framed structures; heavy furniture overturned; sand and mud ejected in small amounts; changes in well water and person driving motor cars disturbed.
IX	Damage considerable in specially designed; well designed framed structures thrown out of plinth; very heavy in substantial buildings with partial collapse; buildings shifted off foundations; ground cracked conspicuously and underground pipes broken.
X	Some well built wooden structures destroyed; most masonry and framed structures with foundations destroyed; ground badly cracked. Rails bent. Landslides. Shifted sand and mud; water splashed over banks.
XI	Few, if any masonry structures remain standing; bridges destroyed; broad fissures in ground; underground pipelines completely out of service, Earth slump; land slips in soft ground and rails bent greatly.
XII	Total damage; waves seen on ground surface; objects thrown upward into the air.

Source: UN-Habitat, 2010

The Modified Mercalli Intensity (MMI) Scale Intensity has approximately the following relation to the magnitude. Table (2.3) displays the relationship between magnitude and intensity of earthquake.

Table (2.3) Relationship between Magnitude and Intensity of an Earthquake

Magnitude (Richter Scale)	**5**	**6**	**6.5**	**7**	**7.5**	**8**
Intensity (Mercalli Scale)	VI-VII	VII-VIII	VIII-IX	IX-X	X-XI	XI-XII

Source: UN-Habitat, 2010

"Ground shaking and ground rupture by earthquake cause the damage or collapse of buildings and bridges resulting in death, injuries and extensive property damages and also destruction of lifelines such as communication, transportation, power, water supply & waste disposal, industries in urban areas, etc. Destruction depends on interrelated factors such as magnitude, distance from causative fault, dept of focus, duration of shaking, geologic condition, age, life and design of building or structure etc", (UN-Habitat, 2010, p.6). After a big earthquake, the secondary disasters such as fault rupturing, landslide, Tsunami, liquefaction, fires and dam failures may accompany it (UN-Habitat, 2010).

Earthquakes typically occur in clusters. In any cluster of earthquakes, the one with the largest magnitude is called the Mainshock. Earthquakes that occur before the main shock are called foreshocks, while those that occur after the main shock are called Aftershocks. Generally, the stress on the earthquake fault drops drastically during the mainshock event and the small redistribution of stress and frictional strength cause that fault to produce most of the aftershocks. Although study of the aftershock sequence can give the pattern, it is not possible to predict the specific location, time and size of the aftershocks. The drop in stress in the mainshock fault causes a redistribution of stresses in all nearby faults. Sometimes, an increased stress is great enough to trigger aftershocks on the nearby faults (ADPC and UN-Habitat, 2017). Table (2.4) shows the relationship between peak ground acceleration and potential damage.

Table (2.4) Relationship between Peak Ground Acceleration & Potential Damage

Intensity	Peak Ground Acceleration	Potential Damage
I	<0.0017	None
II-III	0.0017 - 0.014	None
IV	0.014 - 0.039	None
V	0.039 - 0.092	Very Light
VI	0.092 - 0.18	Light
VII	0.18 - 0.34	Moderate
VIII	0.34 - 0.65	Moderate to Heavy
IX	0.65 - 1.24	Heavy
X+	>1.24	Very Heavy

Source: UN-Habitat, 2015

2.4 Mitigation Measures for Earthquake

"Earthquake mitigation is the measures taken prior to the impact of an earthquake to minimize its effects. It needs the government's intervention and enforcement as well as community participation for implementation. These measures can be undertaken in two ways: Structural and Non-structural mitigation measures. Structural Mitigation includes retrofitting of buildings, construction of earthquake resilient infrastructures, and other hard ware interventions" (UN-Habitat, 2010, p.22). Non-Structural measures include public education and awareness generations, enactment of building codes, land-use and settlement planning, micro-zonation map for earthquake resistant structures, policy regulations and legislation, insurance, training, sensitization and capacity building of various stakeholders, and other preparedness measures such as earthquake preparedness and response plans at all levels (UN-Habitat, 2010).

2.5 Preparedness Measures for Earthquake

Disaster Preparedness includes all activities that will ensure prompt and effective action at all levels to save lives, reduce suffering, and minimize damage to property. Preparedness is to be undertaken at all levels: community level, household level, and township level, district level, state/ regional level and up to national level.

It is the best practice for a community to form a Community based Organization (CBO) on Disaster Risk Reduction to cater on different disaster management activities such as early warning dissemination, evacuation, search and rescue, first aid, and relief operation, etc. Disaster Management Plan should also to be developed at all levels by forming with disaster management committee and working committee/task forces which includes different stakeholders: respective government departments, NGOs, civil society associations and community representatives and identifying roles and responsibilities to carry out the preparedness, mitigation, response and recovery plan activities of Disaster Management Plan. Through community participation, vulnerability and risk assessment needs to be carried out where the area is located in the seismic zone and in which seismic zones, who are the vulnerable people, what are the vulnerable buildings and other infrastructures and so on. The result and findings of the assessment should be well informed to the community so that all community members are well aware of the vulnerability of their community (UN-Habitat, 2010).

Regarding for “Public Awareness, if the community has no past experience on any kind of disaster during their lifetime, they are usually less aware on it. They may think that such disasters may not occur in the area they reside. Earthquakes have a distinct characteristic that the time interval between the big ones in an area is much longer, perhaps than of a man’s lifetime. For example, the last big earthquake in the area was the 1956 Sagaing Earthquake preceded by the 1839 Innwa Earthquake. The time interval between the two was 117 years. The worst case scenario is for people to be caught by surprise by disasters such as earthquakes and tsunamis. Therefore, public awareness on earthquake in Myanmar communities, especially in earthquake prone urban areas should be strongly and regularly emphasized.

A lot of information is available indicating what to do before, during and after an earthquake in order to reduce vulnerability against it. This knowledge should be widely disseminated at the community level. Workshops, seminars and talks on earthquakes should be organized in earthquake prone areas. Public awareness programs should undertake with comprehensive approaches through essays, posters, cartoons, debate competitions, quiz contests, street plays, dramas or songs on Do’s and Don’ts of disasters, photo exhibitions or display of newspaper clippings on earthquake events. Moreover, radio and television programs on earthquake hazard would be a strong media tool for generation of public awareness.

Drills or simulation exercises are an important part of the community preparedness on earthquake. Drills can be organized by the community-based organizations and government on Disaster Risk Reduction with participation of the larger community. The community should be well informed about the drills, such as why it is organized, who should be involved, what they have to perform during the drills. Moreover, the evacuation routes, the open areas (safe location) which are identified in advance should also be informed to the community, through the drills. In this way, the community will also get a practical opportunity of learning do’s and don’ts during an earthquake. A mock drill for earthquake should be organized one or two times a year: one drill can be well informed in advance and the other can be a surprise one. After each mock drill, evaluation should be done to get feedback” (UN-Habitat, 2010, p.27, 28).

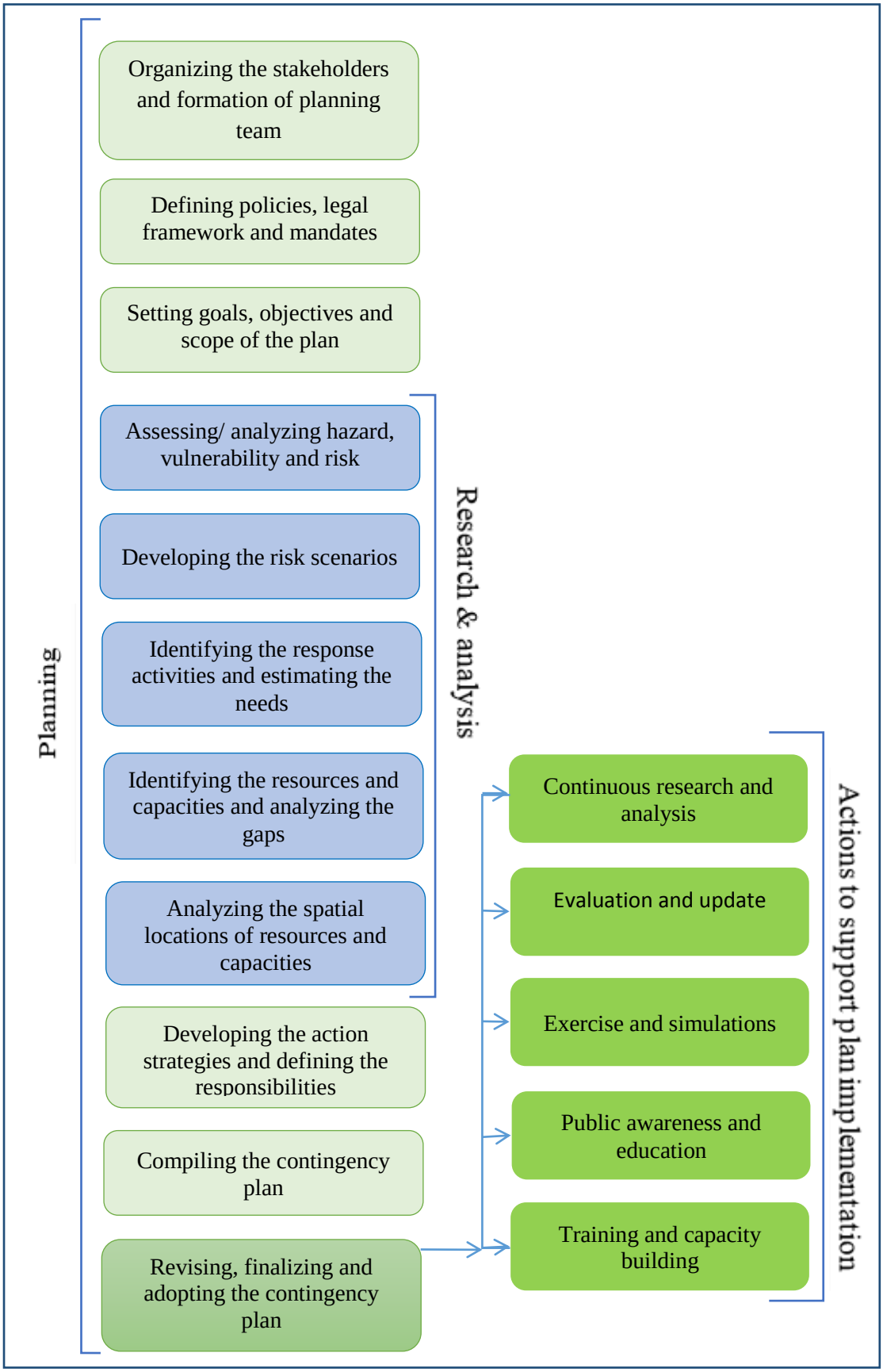
Training is important to enhance capability of community-based organizations and community members to reduce disaster risks. Training to be delivered inclusively to children, women, differently-abled and the elderly so that they could know how to

behave and what to do during and after earthquake. The smallest unit of a community is the family. Each member of the family should share the knowledge and information on earthquakes and other disasters. If they live in an earthquake prone area, the family members should prepare a plan for earthquake hazards should be developed. And do's and don'ts during an earthquake should be well understood by the family members. Moreover, safe places inside the house during an earthquake should be identified and open field and the evacuation route to that place should be identified. Furthermore, the earthquake resistance of the building/house should be checked and retrofitting should be done if required. In addition, the furniture and other heavy things inside the house should be secured to prevent from falling down during an earthquake (UN-Habitat, 2010).

2.6 Contingency Planning for Earthquake Disaster

The United Nations Human Settlement Program UN-Habitat developed the earthquake contingency plans for two townships of Yangon in 2017 in collaboration with DDM and GAD and one more township of Yangon will emerge in 2019. Contingency planning is the preparatory process of identification of and planning for an emergency situation. It aims to prepare a community or an organization to respond well to an emergency and its potential impact. Developing a contingency plan involve making decisions in advance about the management of human and financial resources, coordination and communication procedures, and being aware of a range of technical and logistical responses. Such planning is a management tool, involving all sectors, which can help ensure timely and effective provision of humanitarian aid to those most in need when a disaster occurs. Today, contingency planning is a common term in emergency management. However, it confers different ideas to different disaster managers and emergency personnel, depending on their circumstance and area of concern. While there are many definitions in use (Plan-B, Emergency Plan, Specific Hazard Plan, etc.), they all include the idea of planning for some specific accident, failure, or emergency scenario. A contingency plan may never need to be activated. However, if the anticipated situation does arise, the plan will provide a basis for rapid and appropriate action.

Figure (2.2) Flow Diagram of Contingency Planning Process



Source: Asian Disaster Preparedness Center ADPC and UN-Habitat, 2017

Figure 2.2. shows the flow for the development of earthquake contingency plan which includes three major components: planning, research & analysis and implementation of plan. In the contingency plan development process, it needs to involve respective government departments and stakeholders and goal, objectives and scope of the plan to be in line with legal and policy frameworks. After that it is mandatory to assess the earthquake hazard, vulnerability, capacity and risk then to develop risk scenarios. Next step is to identify the response activities according to scenarios and also to identify resources and capacity including its spatial location and then to find and analyze the gaps. Then another important step is to identify standard operation procedures and roles and responsibilities of respective departments and agencies considering for within 12 hours, 24 hours, 48 hours, 72 hours after earthquake. Table top simulation and drill exercise are to be conducted regularly with key actors in order to practice among them. According to lesson learned from drills and government coordination meetings, the reviewing, updating and evaluation process of contingency plan is required to be undertaken. Moreover, the community should be informed about contingency plan through public awareness sessions, training and capacity building program.

2.7 Safety Tips for Earthquake

This session mentioned safety tips for earthquake on what to be prepared in advance before earthquake in order to reduce the damages from earthquake, next, it is explaining about what to do and what should be avoided during earthquake shaking then and also mentioning on safety tips after earthquake.

2.7.1 Safety Tips Before Earthquake

Myanmar is prone to earthquakes and according to earthquake zoning map, the entire country is prone to earthquakes of varying intensity. Check the earthquake zoning map to locate your town and its associated intensity. Share your information to your society. Earthquakes are recurrent in nature and cannot be predicted. In Myanmar, major earthquakes along Sagaing fault has a reoccurence approximately every 100 years. Earthquakes can trigger collateral hazards such as fire, flooding, landslides, accidents (industrial, road etc.) and Tsunami (if the earthquake has occurred off the coast). Hazard maps can help people to identify which zone they live

or work in, or go to school. They need to take specific preparedness and mitigation actions to prepare for an earthquake depending on which zone they are in.

If the house is under these conditions: located in earthquake zone, having unstable slopes, located in industrial zone, downstream of dams, manmade lakes or embankment, irrigation channels or river, liquefaction coastal, the house need to undertake preparation. If there is no engineer, to use the check list to identify safe places and it is important to engage family members while identifying safe places. It is also important to engage a qualified engineer to identify safe places. Minimizing and mitigating earthquake risk is possible in a new building by designing and constructing it with earthquake resistant features. Better planning and being prepared can certainly minimize loss of lives, injuries, financial losses and damages to buildings.

As the safety tips in houses, to move or secure objects that may fall and block door's and exits. To identify safe places outside the building in an open space which you can reach as quickly as possible. It should be clear of falling hazards, overhead water-tanks, and away from compound wall. To remember a safe place depends on the type of buildings. In general, it should be located away from exterior walls, attic, unsecured partition walls, windows, glass and shelves that can fall, slide or collide, or objects such as heaters, water tanks, and open fireplaces that can cause fire. Safe places in the building and in each room, should be easily accessible and clear from falling hazards.

Around 30 to 50 % of earthquake related injuries in recent years have been caused by falling objects or furniture and other heavy items toppling over or sliding into people. The best approach is to arrange furniture in your home so that you will not be damaged by it. To fix items to sturdy walls or to the ground. To secure furniture such as cupboards to nearby sturdy walls, prevent furniture such as tables and chairs' legs from sliding. To use stabilizing devices such as chains for fixing hanging lightings or other hanging materials to the ceiling to reduce falling hazards. Anti-shatter glass film should be put and to ensure that escape routes are clear (UN-Habitat, 2016).

In each family, it should be prepared in advance for family preparedness plan for safety and faster family reunion. Evacuation areas and evacuation routes should be known by all family members, to discuss and decide who will do what activities and practice the activities regularly or participate in disaster drills by all family members.

To ensure that every family member know the meeting point where to meet up after the earthquake and how family members will contact each other. To prepare a family emergency kit which includes dried food, medicine, torch light, battery, fire lighter, important and valuable documents such as NRC card, property owned certificate, bank book, medication record, pension record etc., and radio, plastic bag etc., (https://transition.fcc.gov/pshs/emergency-information/tips.html*).*

2.7.2 Safety Tips During Earthquake

Earthquake can strike during anytime of the day (and at any season). Remember earthquake cannot be predicted. If you feel or sense it is a shaking due to earthquake, don't get panic, try to stay calm by having deep breath. Look around to assess the situation before moving. As soon as you feel shaking, if you can get outside to a clear space and reach within 5 seconds, then exit quickly and carefully. During earthquake shaking, don't enter into a building. Stay away from windows, door, glass panels, shelves, hanging objects, exterior walls and unstable and heavy objects (air cons, fans, cupboard, television, refrigerator etc.). If you are in along the coast or close to river mouth, move to high ground as it may cause tsunami. After the ground shaking, listen to advisories issued by Department of Meteorology and Hydrology and the local authorities.

Crouch, cover and hold on (CCH) is an important action during an earthquake to protect from injuries, particularly those with falling hazards. By making yourself small, it can protect the head, neck and throat and other important parts of the body and can crawl to a safer location instead. At home, identify safe places in which you can Crouch, Cover and Hold. However, CCH may not be an appropriate action, if the building is weak and might collapse. In such case, it is important to upgrade or retrofit the building for earthquake safety.

Avoid running to stairs during the shaking, after the shaking check for its safety, before using it. Do not use elevators or escalators during and after the earthquake shaking. If you are in the kitchen, quickly turn off the stove and take cover at the first sign of shaking. Ensure that the all the gas /stove is closed. Do not touch any exposed power line without switching off the main If you have stove (wood or charcoal), doze the flames once the shaking is over and move outside. If you are in a public hall, auditorium, local market, shopping mall; these places may not be familiar, often crowded and the risks of falling hazards and whether these may damage or

collapse may be unknown or cannot comprehend immediately. When CCH is appropriate do so and crawl to nearest safe place by covering your headstay away from signage's, billboards, doors, glass panels, merchandise displays and hanging objects and protect your head. Remember in public place where many people assemble there are likelihood of panic leading to stampede.

If you are in a moving vehicle, stop as quickly and safely as possible. Move your car to the shoulder or curb, away from electric lines, signage's, boards, overhead wires, and under- or overpasses. Stay in the car and set the parking brake. Turn on the radio for emergency broadcast information. A car may jiggle violently on its springs, but it is a good place to stay until the shaking stops. If a power line falls on the car, stay inside until a trained person removes the wire. When you drive on, watch for hazards created by the earthquake, such as breaks in the pavement, downed utility poles and wires, rising water levels, fallen overpasses and collapsed bridges.

Persons with special needs - limited mobility, elderly and disability get as low as possible and move away from windows or other items that can fall on you. As the ground shaking increase it may be difficult to move for those with mobility and disability. Quickly get to the floor in a seated position and against an inside wall and away from falling hazards. Protect your head and neck with your arms. Do not try to transfer from your wheelchair, recliner, or bed during the shaking. Wait for the shaking to stop before transferring. If you use a wheelchair; lock your wheels and remain seated until the shaking stops. Always protect your head and neck with your arms, a pillow, a book, or whatever is available (UN-Habitat, 2016).

2.7.3 Safety Tips After Earthquake

After a major earthquake, expect for aftershocks over the following days, weeks and months, listen to the radio, information from government and experts' opinion then share to other people. Earthquake creates panic situation, do not believe or spread rumors. In an existing building, assess the safety and structural integrity of the building and retrofit if required. Contact to certified engineers / carpenters / masons. To check all damages of electrical lines and devices in your house and its surrounding. Do not enter to the building without checking the damage condition of building. Do not go to near river bank and mountain area and be aware of soil erosion and landslide. Do not go near to dam and reservoir because these can be damage and break out due to earthquake. If you are in coastline area, be aware of Tsunami and

leave the seashore and go to higher place quickly. Be careful for the fire as the aftermath of earthquake and check for electric lines, gas pipe and be ensure for all hazardous chemical and materials which can occur explosions if you are in industrial zone. Do to go to towers and high rise buildings and be aware of collapse of buildings (Department of Disaster Management, 2017).

2.8 Conceptual Framework for Earthquake Preparedness

The theoretical framework to achieve community resilient through earthquake preparedness which includes public awareness activities and interventions on institutional strengthening by comprehensive approaches. Figure 2.3 presents the conceptual framework to achieve effective earthquake preparedness for better community resilience.

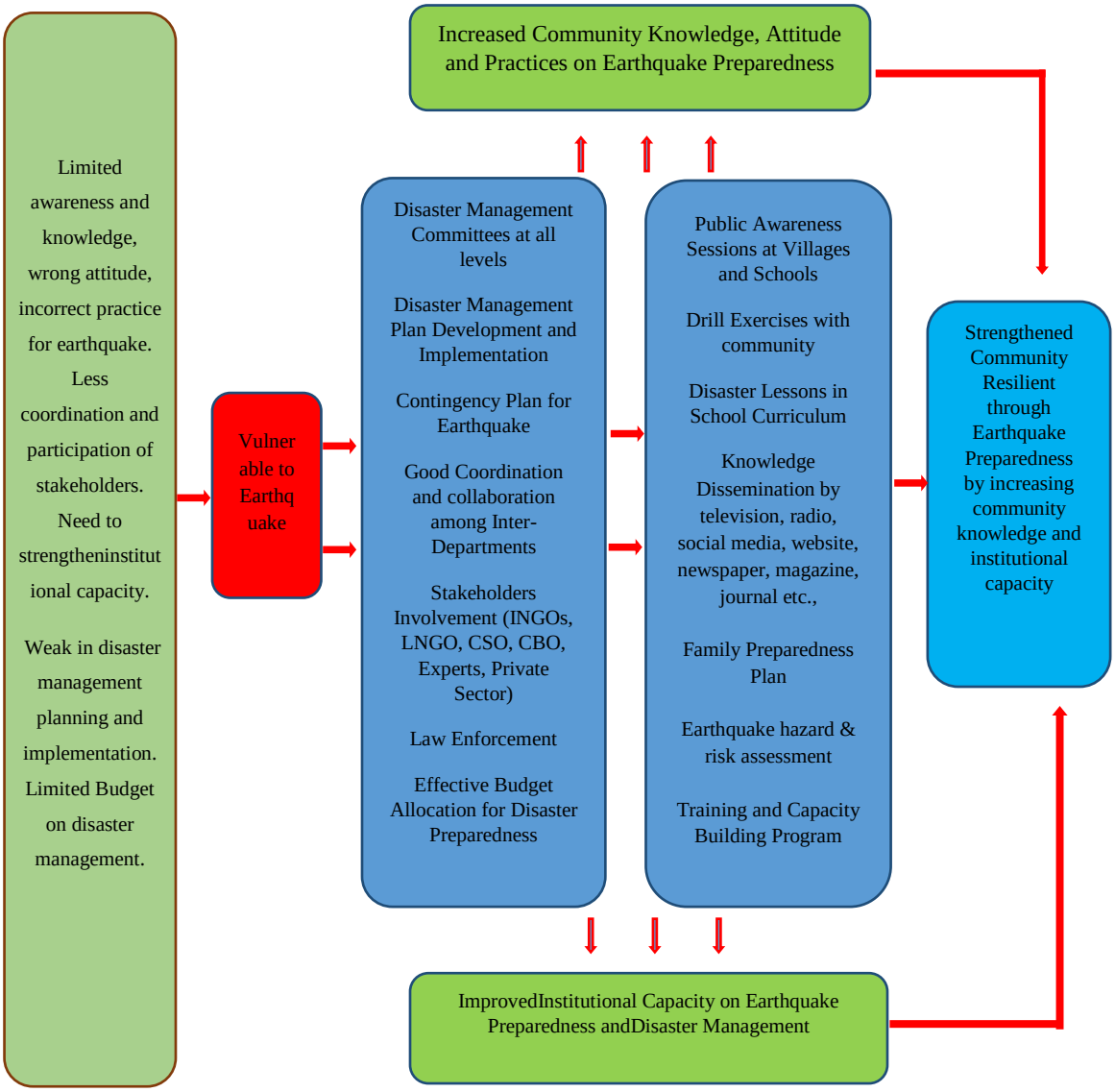
Knowledge gaps for earthquake preparedness are limited knowledge and awareness of community, wrong attitude and incorrect practices of community in time of earthquake shaking. Problems include less coordination between government department for disaster management works, lack of active participation of stakeholders, not functioning of disaster management plans and implementation on preparedness measures and also budget limitation. These problems and knowledge gaps are driving force to vulnerability to earthquake. In order to reduce these problems and vulnerability and also to strengthen community resilience through earthquake preparedness; the resilient measures should be undertaken.

Interventions on preparedness is one of the resilient measures and this conceptual framework shows preparedness measures for public awareness and also for institutional level strengthening. Intend to improve institutional capacity on earthquake preparedness; to form disaster management committee at all levels with respective government departments and stakeholders, to develop disaster management plans and to implement activities according to its plan, to develop earthquake contingency plan as well and to practice on it, to make sure the effective coordination and involvement of respective government departments and key stakeholders. Law enforcement is the vital one and also budget allocation on disaster management activities is the priority for decision makers.

In order to increase community knowledge, attitude and practice on earthquake preparedness; to conduct public awareness sessions at community and school level. Trainings and capacity building programs to be implemented and

earthquake simulation drill exercise with the participation of community is the mandatory activity. Lessons about disaster knowledge in the school curriculum to be active and earthquake knowledge and information to be disseminated to community via multi channels such as edutainment in television, radio, website, social media, and also through newspapers, magazines, journals and son on. Family preparedness plan to be prepared by each household and government should develop the strategy on it. Earthquake hazard and risk assessment should be undertaken by technical experts in all townships in order to emerge earthquake risk reduction action plan.

Figure (2.3) Conceptual Framework for Effective Earthquake Preparedness for Community Resilience



Source: Own Compilation

2.9 Review of Previous Studies

Chong Su Feng Elaine (2015) studied school level activities on earthquake awareness, readiness and resilience and mainly emphasize on school earthquake awareness according to three pillars of safe schools which are safe learning facilities, school disaster management and resilience education.

Pe Aung (2011) studied about the lessons on earthquake management based on the experiences of two major earthquakes in Haiti and Chile and some good lessons and experiences can be replicable in other countries.

Yadanar Kyaw (2014) also conducted seismic risk assessment for Bago city of Myanmar. In this study, a seismic risk assessment method using fragility functions reflecting damage levels of buildings focused on the completely collapsed damage, was developed. Influence of structural parameters on vulnerability of commercial building class is studied and band of fragility curves representing low rise commercial building class is developed. This study presents the study of earthquake effect on reinforced concrete R.C buildings located in Bago City (seismic zone 5) by using Perform 3D structural software and develop earthquake hazard maps by using HAZUS Software.

Aye Aye Khine (2011) found the community knowledge, awareness and perception on natural disasters in terms of flood and also attitudes towards disasters and risks in Ayeyarwaddy Region. The study emphasized three key components, which are community based disaster preparedness activities, community based prevention and mitigation activities and school based disaster risk reduction activities.

Pone Nyet Khaing (2014) assessed community capacity for response and preparedness against flood hazard in Hpa-an Town, Lower Myanmar. The study finds out hazard, vulnerability and risk Assessment of selected areas in Hpa-An township of Myanmar and also household and community Level preparedness by identifying risk awareness and perception on flood resilience.

Thinn Hlaing Oo (2017) also studied on sustainability of disaster education in Yangon, Myanmar with a case study of high schools in Kungyangon, Botataung, and Pazundaung Townships. Her study finds out the school based disaster education program in the areas of human resources, planning and management, financial, collaboration, technical material and also students' knowledge and preparedness action on disaster risk reduction.

This study is different from above mentioned studies and this study assesses the community knowledge, attitude and practice on earthquake preparedness for earthquake general knowledge, what to do in the time of earthquake shaking and preparedness and safety tips for before, during and after earthquake. The study targeted community people who are living in urban and rural areas of Nyaung U township.

CHAPTER 3
OVERVIEW OF EARTHQUAKE RISK IN MYANMAR

3.1 Hazard Profile of Myanmar

Myanmar is prone to almost all types of hazards, which include fire, forest fire, earthquake, strong wind/cyclone, storm surge, tsunami, landslide, floods, drought and industrial/technological hazards. In recent years, the country is also witnessing a spate of localized disasters such as lightning and riverbank erosion. In 2014-2017, lightning led to the loss of 175 lives. During the same period, Myanmar also experienced loss of 261 and 782 lives due to riverbank erosion and strong wind respectively. The 2015 floods caused damages and losses amounting to USD 1.5 billion, while the 2008 Cyclone Nargis led to USD 4.1 billion. Since comprehensive multi-hazard risk assessment of Myanmar needs to be done at the national level. Table (3.1) presents basic information of major hazards in Myanmar.

Table (3.1) Hazard Profile of Myanmar

Hazard	Profile
Earthquake and Tsunami	Two main sources: Sagaing fault and the Sunda subduction mega thrust zone. Four areas are designated as the Destructive Zone: 1), Bago-Phyu, 2) Mandalay-Sagaing-Tagaung, 3) Putao-Tanaing, and Kale-Homalin. Although the latter two have major earthquake hazards, their risk-level is low because they are sparsely populated. In coastal areas of Myanmar: Rakhine Coast falls in the Strong Zone with MMI 8, the Ayeyawady Delta and Taninthayi coasts fall in the Moderate Zone with MMI 7.
Fire/Forest fire	Most frequent hazards occurring in Myanmar. In the last ten years (2007-2016), 12,000 cases were recorded and Yangon, Mandalay, Ayarwaddy, Sagaing and Bago are the most affected States and Regions.

Hazard	Profile
Drought	Approximately 51 townships spread across Magway, Mandalay and Sagaing (lower) regions are prone to drought.
Landslide	The mountainous regions, especially in the western ranges and some localities in the eastern highland are prone to landslides. The western ranges have experienced different types of landslides and earth movements such as rock falls, rockslides, soil avalanches and mud flows.
Floods	Flood is one of the most frequent hazards in Myanmar. The threat of flooding usually occurs three times per year, in June, July-August late, September and October with the biggest threat in August, as monsoon rains peak around that time. Most of the areas of Myanmar are prone to floods and the central part of Ayarwaddy Region is the most affected one.
Cyclone/ Storm Surge	Myanmar is highly vulnerable to these hazards, particularly, during the months of April and May, and also during October to November. Cyclones often occur in the middle of the monsoon season, but they usually don't reach their maximum strength. However, in 2015 Cyclone Komen had disruptive effects, causing heavy rain, landslides and flood. In coastal areas, cyclone can cause storm surges. Climate change is likely to worsen the risk of existing cyclone/storm surge.

Source: Myanmar Action Plan for Disaster Risk Reduction MAPDRR, 2017

3.2 Earthquake Risk in Myanmar

Myanmar is an earthquake-prone country since it is located along one of the earthquake belt of the world, Alpide Belt. With regard to the active faults that can generate large earthquake in the future, Sagaing Fault is the most active right-lateral, strike-slip fault and the others are Kyaukkyan Fault, Nampon Fault, Moemeik Fault, Shweli Fault, Kyaukme Fault, Papun Fault, and Three Pagodas Fault in Eastern Highland, West BagoYoma Fault, and Gwegyo Fault in the Central Lowland and Kabaw Fault and Myauk U Fault in the Western Ranges. Subduction Zone of India Plate under Eurasia Plate (Burma micro-plate) to the West and the Collision Zone of

India Plate with Eurasia Plate to the North West of the country are the other seismic sources that can generate the large and great earthquake in and around Myanmar.

The moderate to large magnitude seismic events experienced in Myanmar and the country has also experienced many large earthquakes such as the Magnitude 8.0, May 23, 1912 Maymyo earthquake (caused by Kyaukkyan Fault), the March 23, 1839 Ava (M 7.5) Earthquake, the Swa earthquake of 1929 (M 7.0), May 5, 1930 (M 7.3) Bago Earthquake, the Phyu earthquake of 1930 (M 7.0), the Kamaing earthquake of 1931 (M 7.6), the Tagaung earthquake of 1946(M 7.3), July 16, 1956 (M 7.0) Sagaing Earthquake (originated from the well-known Sagaing Fault), the Tarlay earthquake of 2011 (M 6.8), the Thabeikyn earthquake of 2012 (M 6.8) and the Chauk earthquake of 2016 (M 6.8) (Hla Hla Aung, 2017). Among them the Maymyo earthquake is the largest event and Bago earthquake is the deadliest event causing 500 deaths in Bago. The second-most deadliest event is the 1839 Ava (Innwa) earthquake and it caused 400 casualties and several buildings damaged in the epicentral areas such as Amarapura, Innwa and Sagaing, etc. Moreover, during the recent years, three magnitude 6.8 earthquakes; 2011 Tarlay Earthquake, 2012 Thabeikkyin Earthquake and 2016 Chauk Earthquake happened in Myanmar. These three earthquakes struck from three different faults; Namma Fault, Sagaing Fault and Subduction of India Plate beneath Eurasia Plate (Burma micro-plate). More than 70 peoples died and several buildings collapsed due to Tarlay Earthquake and about 26 peoples died and more than 500 different types of buildings got damaged by Thabeikkyin Earthquake. The most recent Chauk Earthquake caused 3 deaths and several pagodas damaged in Bagan area.

In 2005, Deterministic Seismic Hazard Assessment Map of Myanmar (DSHA) was developed classifying into five seismic zones, Zone I (Low Zone), Zone II (Moderate Zone), Zone III (Strong Zone), Zone IV (Severe Zone) and Zone V (Destructive Zone). The seismic zone map of Myanmar (2005) was prepared by a team led by Maung Thein during 2003 to 2005 and modified by Maung Thein and Tint Lwin Swe, 2006. It should be mentioned that in some countries, there are zones higher than Zone V as used here (ADPC, 2009, p.32, 33). For each zone, a probable maximum range of ground acceleration in g values and equivalent Modified Mercalli (MM) Scale classes are given in Table 3.2.

Table (3. 2) Seismic Zone with Ground Acceleration and Modified Mercalli Scale

Seismic Zone	General Description	Probable Range of Ground Acceleration	Equivalent Modified Mercalli Scale Classes
V	Destructive Zone	0.4-0.5 g	IX
IV	Severe Zone	0.3-0.4 g	VIII-IX
III	Strong Zone	0.2-0.3 g	VIII
II	Moderate Zone	0.1-0.15 g	VII
I	Low Zone	0.05-0.07 g	VI

Source: Myanmar Earthquake Committee, 2005

In 2012, Probabilistic Seismic Hazard Assessment Map (PSHA) was developed for Myanmar for various Peak Ground Acceleration (PGA) and Peak Ground Velocity, various time period and 475 years return period and 2475 years. Both DSHA and PSHA maps are important source of information to earthquake risk management.

According to the seismic hazard map of Myanmar for 475 years recurrence interval and seismic hazard map of Myanmar for 2% probability of exceedance in 50 years, 2475 years recurrence interval, most of the major cities such as Yangon, Mandalay, Nay Pyi Taw, Bago, Taungoo, Pyinmana, Meiktila, Sagaing, and Myitkyina are located along and near the most active Sagaing Fault and the seismic hazard for those cities are very high.

Table (3.3) shows the major historical earthquakes and recent seismicity in Myanmar which recorded from 1858 Thayet earthquake to 2016 Chauk earthquake. The list shows the major earthquake which is from minimum 6.8 magnitude to maximum 8 magnitude and also including the shallow and deep depth of epicenter from 5 km lowest to 84 km highest.

Table (3.3) Major Historical Earthquakes and Recent Seismicity in Myanmar

Date	Name	Magnitude	Depth
24 Aug 1858	Thayet Earthquake	7.0, 5.5	5 km
23-May-1912	May Myo Earthquake	8	
8-Aug-1929	Swa Earthquake	7	
5-May-1930	Bago Earthquake	7	
3-Dec-1930	Phyu Earthquake	7.3	
27-Jan-1931	Kamaing Earthquake	7.3	
10-Aug-1931	Pyinmana Earthquake	-	
12-Aug-1946	Tagaung Earthquake	7.5, 7.75	
16-Jul-1956	Sagaing Earthquake	7	
8-Jul-1975	Bagan Earthquake	6.8	10 km
22-Sep-2003	Taungdwingyi Earthquake	6.7	40 km
11-Mar-2011	Tarlay Earthquake	6.8	10 Km
11-Nov-2012	Thabeikyin	6.8	9.9 km
13-Apr-2016	Maw Lite Earthquake	6.9	134 km
24-Aug-2016	Chauk Earthquake	6.8	84 km

Source: Hla Hla Aung, 2017

3.3 Areas Prone to Earthquake in Myanmar

"Majority of the earthquakes in Myanmar are mainly confined to three zones: (1) The zone along the western fold belt of Myanmar with mostly intermediate-focus earthquakes; where the earthquake frequency is much higher in the northern part. (2) The zone along the Sagaing Fault, including the offshore part in the Andaman Sea with shallow-focus earthquakes; the earthquake frequency is higher in three segments, namely (from south to north), Bago-Taungoo, Sagaing-Tagaung, and Myitkyina-Putao Segments. (3) The zone in the north-eastern part of Myanmar, which is continuous with the earthquakes in southern Yunnan.

According to the seismic intensity zone map of Myanmar (2005), the five seismic zones are demarcated and named (from low to high). The highest intensity zone designated for Myanmar is the Destructive Zone (with probable maximum range of groundacceleration 0.4 – 0.5 g), which is equivalent to Modified Mercalli Intensity (MMI) class IX. There are four areas in that most vulnerable zone; namely, Bago-

Phyu, Mandalay-Sagaing-Tagaung, Putao-Tanaing, and Kale-Homalin areas. Although the latter two have major earthquake hazards potential, they may be less vulnerable as they are sparsely populated. Important cities and towns that lie in Zone IV (Severe Zone, with probable maximum range of ground acceleration 0.3 – 0.4 g) are Taungoo, Taungdwingyi, Bagan-Nyaung-U, Kyaukse, PyinOo Lwin, Shwebo, Wuntho, Hkamti, Hakha, Myitkyina, Taunggyi, and Kunglong" (UN-Habitat, 2010, p.11,12). Table 3.4 illustrates the seismic zonation of states and divisions of Myanmar by percentage.

Table (3.4) Seismic Zonation in Percentage: States and Divisions of Myanmar

State/ Region/ Zone	I	II	III	IV	V
Bago Region		35	30	20	15
Chin State			55	22	23
Ayarwaddy Region		95	5		
Kachin State		18	27	32	23
Kayah State		98	1		
Kayin State	30	50	20		
Magway Region		15	50	35	
Mandalay Region			45	40	15
Mon State	20	70	10		
Rakhine State		15	85		
Sagaing Region			10	65	25
Shan State		40	40	20	
Tanintharyi Region	85	15			
Yangon Region		40	23	20	17

Source: ADPC, 2009

3.4 Earthquake Risk Along the Sagaing Fault

The Sagaing fault is one of the great strike- slip faults of Southeast Asia. The active Sagaing fault, trending north – south across the entire length of central Myanmar, and the Sunda subduction megathrust zone running through off-shore southwest and west of the Myanmar coast and on-land to the west and northwest of Myanmar. The Sagaing Fault passes through the most populated areas of Myanmar

where large cities have been built, active fault studies with characterization of earthquake response spectrum on engineering structures and design code for buildings are necessary (ADPC, 2009).

The Sagaing fault runs through Myanmar from north to south for more than 1000 km and has created a series of sag ponds and scarps along the fault. The Sagaing fault is clearly visible on the satellite image from the northern terminus in Kachin State to Mandalay in the south for about 450 km. From Bago to the south, the Sagaing fault enters terrain of alluvial deposits that becomes difficult to follow the fault trace on the satellite image until the coast line at latitude 16° 30'N. The Sagaing fault is composed of numerous fault segments creating a series of tectonic geomorphic features such as fault scarps, pressure ridges, sag ponds and pull-apart basins, where the fault segments can give rise to either zones of compression or extension. Right-stepping segments arranged in an echelon pattern are designated as Yega, Singu, Thebeikkyin, Hti-chaing, Indaw and Indawgyi segments along the northern part of thefault from Mandalay to the north. From Mandalay to the coast in the south for about 550 km long stretch, the fault has many right-stepping fault segments Yamethin, Pyinmana, Swa, Phyu, Shwedan, Zwedeik, Kabauk, and coastal segments.

Where the fault segment overlap, extensional forces have created the linear depression between them such as Lake Indawgyi, Indaw lake, a sag pond near Hti-chaing, another sag pond near Singu, Yega In, Shwedan In, Zwegaik In and Kabauk In, Bagan In, and more sag ponds are tectonic lakes that were created by transtensional forces. The folded structures or pressure ridges such as Tagaung ridge near Tagaung, Sagaing ridge and Minwon ridge near Sagaing, Magyigyin ridge near Pyinmana, Khindangyi ridge near Phyu, Desunpa ridge and Pale ridge near Bago area where the fault steps to the left. These tectonic features do not represent the fault itself but rather continued motion on the Sagaing fault and squeezing across the fault zone by transpressional forces. These tectonicgeomorphic features are critical area for seismic hazard in Myanmar (https://www.researchgate.net/publication/274701088).

3.5 Recent Large Magnitude Earthquake (2016 Chauk Earthquake)

"The 6.8 magnitude earthquake occurred on 24thAugust 2016 at intermediate depth of 84 km with epicenter 20° 919' N 94° 579'E, 25 km west of Chauk. The ground shaking lasts approximately1 minute. It spread to locations across the western part of the Sagaing fault including Rakhine region in the west, Central Myanmar in

the east. The M 6.8 Chauk earthquake was one of the three subduction earthquake events that occurred within a year of 2016. Based on interpretation of post-earthquake damages in Bagan area and field survey in surrounding areas, the geometry, geomorphology and kinematics of co-seismic rupture as well as geologic hazards along the subduction zone indicate neotectonic deformation due to the reorganization of interplate motion between India and Burma. Detailed investigation indicates that the August, 2016 Chauk earthquake, the April, 2016 Mawlaik earthquake and October, 2016 Ta-ma-thi earthquake occurred along the N-S trending megathrust. The main surface rupture zone of Mawlaik earthquake on the segment of megathrust is approximately 250 km in length and the Chauk earthquake on another segment is approximately 180 km, respectively. These sub-parallel ruptures may merge at depth. The Chauk earthquake provides new insight into the nature of subduction zone earthquake in Myanmar. The seismological studies obtained from USGS earthquake report indicates that the main shock was initiated at 25km W of the town Chauk, with the rupture propagating N-S for about 200 km. Such deformation style may be characteristics of the environments under compressional stresses that occurred in the downgoing slab. The earthquake was felt in much of central Myanmar and extended to northeastern India and Bangladesh" (Hla Hla Aung, 2017, p.110,111).

"Many Buddhist temples and pagodas were built on the stretches of sandy wind-swept plains and Bagan became a stronghold of Buddhism and was well known as the seat of Buddhist learning and culture among its contemporaries in Southeast Asia. Bagan, the land of pagodas was destroyed by an earthquake with magnitude 6.8, in 1975 and many pagodas and temples were damaged within seconds. Some of pagodas are being left intact and withstand to maintain the role of its past glory as historical monuments in Southeast Asia. Due to this Chauk earthquake, approximate numbers of pagodas 477 out of 4000 and those from surrounding area were damaged the same as the previous 1975 Bagan earthquake" (Hla Hla Aung, 2017, p.112) and caused 3 deaths. The 1975 Bagan earthquake was also an intraplate subduction zone earthquake in Myanmar. It occurred at 112 km depth with Magnitude 6.8 (USGS) (Hla Hla Aung, 2017). In the same day of Chauk earthquake 24th August 2016, an earthquake struck in Italy with 6.2 magnitude and shallow depth 10 km which caused huge destruction in Italy and left at least 247 people dead. When comparing the casualties and damages of Chauk earthquake and Italy earthquake; causes of damages

will include the difference of depth because Chauk earthquake happened in deep depth with 84 km and Italy was hit in shallow depth 10 km.

3.6 Earthquake Vulnerability in Myanmar

"Myanmar is located in the earthquake prone region of the Alpide Belt, one of the two main earthquake belts of the world. Earthquake belts are areas of interaction between tectonic plates of the earth. There are a number of faults in Myanmar territory, some of which are active and some, possibly active. Among them, Sagaing Fault is the most active one and the past earthquakes recorded in Myanmar occurred along this fault. In addition, the faults appear to be locked and stress is accumulating in those segments because some large segments of the active faults have not exhibited any significant seismic activity in the past 50 to 75 years. These factors indicate that there is possibility of a big earthquake occurring in Myanmar at any time.

Vulnerability to Earthquake is also increasing in Myanmar compared to the past earthquakes in history. The population of Myanmar has considerably increased, from 15 million in 1930, at the time of the Bago earthquake, to 54 million in 2018 (Based on United Nations estimates). Rapid urban growths has occurred as lifestyles are changing from that of rural agricultural life to that of crowded urban areas with industries. These include congested high-rise buildings supported by sophisticated and potentially hazardous infrastructure like electricity and water supply, waste and sewage disposal, communication and transportation systems; and dams, bridges, air-fields, oil storage tanks, all required for modern living.

More importantly, the big cities, Yangon, Mandalay and Bago are located along the active Sagaing Fault. In the rural areas, the non-engineered structures and dwellings are vulnerable to moderate to high intensity earthquakes. Unlike other natural disasters, earthquakes do not occur frequently in a region and people may not experience such big earthquakes in their life time. Usually, people have little awareness on the disasters they never encounter before. If people do not have awareness of potential earthquakes in their own area and have no preparation of counter-measures for prevention and mitigation of earthquakes, there will be huge losses caused by earthquake.

It is not possible yet to predict exactly when an earthquake will occur in a particular place at a particular time. Instead, based on the information on well-understood fault lines, patterns of earthquakes, seismic hazard assessment maps, the

probability of an earthquake of a given size in a given location over a certain number of years can be estimated. Since early warning of an earthquake is not yet available, the best way forward is to have preparedness and mitigation measures adopted and applied in earthquake prone countries like Myanmar" (UN-Habitat, 2010, p.20, 21).

3.7 Loss and Damages from Disasters in Myanmar

The deadest disaster of Myanmar "Nargis Cyclone" took the casualties of over 84,537 people (Hazard Profile of Myanmar, 2009) impacted to about 1.5 million and made enormous destruction. After that huge event, the intensity and occurrence of disasters in Myanmar is also increasing. Table (3.5) shows the loss and damages database for disasters in Myanmar from 2011 to 2018 prepared by the Department of Disaster Management DDM, Ministry of Social Welfare Relief and Resettlement MSWRR.

Table (3.5) Loss and Damages of Disasters in Myanmar

Year	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Victims
2011	0	0	0	0	700	0
2012	6	36	0	33	866	8,357
2013	0	0	0	0	0	0
2014	0	0	0	0	0	0
2016	9	4	0	6	26	81
2017	0	6	0	0	6	29
2018	0	0	0	0	0	0
Total	**15**	**46**	**0**	**39**	**1,598**	**8,467**

Source: DDM, MSWRR, 2018

3.8 Getting Myanmar Prepared for Earthquake

The Department of Meteorology and Hydrology (DMH) has been the nodal agency for earthquake monitoring in Myanmar. The Department for Disaster Management (DDM) former Relief and Resettlement Department (RRD) under the Ministry of Social Welfare, Relief and Resettlement (MSWRR) is the focal department for disaster management and has started its function since 1945. DDM has

been instrumental in increasing the public awareness sessions on earthquake risk and drills exercise with community and strengthening the response and recovery in the country.

National Level Earthquake Preparedness and Response Plan is under ongoing process to develop by DDM and UNDP and will be launched in 2019. Regional level Earthquake Preparedness and Response Plan is also starting to develop for Yangon Region in 2018 and will be disseminated in 2019 by DDM and UNDP. At the regional level earthquake forum, DDM organized 2 earthquake forums at Yangon in 2016 and 2018 and one at Mandalay in 2016. The United Nations Human Settlement Program UN-Habitat developed Township Level Earthquake Contingency Plan for Lanmadaw and Shwe Pyi Thar Townships of Yangon Region in 2017 and Mingalar Taung Nyunt Township of Yangon Region is now an ongoing process and will be launched in 2019. The National Disaster Management Committee NDMC and it's working committee conducted the earthquake response simulation exercise in 2018 February with the support of UNOCHA in order to reinforce the coordination and cooperation within the NDMC and its working committees and familiarize participants with the roles and responsibilities of Myanmar disaster management mechanisms and structure.

In the aftermath of Cyclone Nargis, 2008, Myanmar has taken several measures to strengthen the institutional landscape of disaster management to manage disaster risk. After Cyclone Nargis, Myanmar took a more proactive approach from initially response driven to mitigate and preparedness. Myanmar became a signatory of various global and regional commitments which include signing of ASEAN Agreement on Disaster Management and Emergency Response (AADMER) in 2009 and now AADMER (2016-2020), Myanmar Action Plan for Disaster Risk Reduction (MAPDRR, 2012) and updated in 2017, enactment of Disaster Management Law in 2013, Disaster Management Rules in 2015. Myanmar has adopted SENDAI framework for Disaster Risk Reduction 2015-2030 in 2015 to take proactive steps to minimize disaster risk and enhance resilience of communities in line with four priority pillars identified in the framework.

Myanmar is also committed to achieve the Sustainable Development Goal and to implement the New Urban Agenda which also advocate for a disaster and climate resilient society. Myanmar is the chair of ASEAN Working Group on "Preparedness for Recovery" which shows the leadership and coordination among ASEAN countries. In order to develop knowledge in the area of earthquake sciences and

earthquake engineering, the Myanmar Earthquake Committee MEC was established in 1999 under the aegis of the Myanmar Engineering Society MES as a non-profit organization.

3.9 Disaster Preparedness Measures of Mandalay Region

Mandalay region is located in the dry zone of Myanmar and it is also one of the disaster prone areas affected by fire, flood, strong wind, drought and also facing the impact of climate change and extreme weather event. The intensity and times of occurring disasters are also increasing in the region. Mandalay region has high risk of earthquake as it is located along and near the Sagaing fault. According to table 3.2, Mandalay region located in Zone III (Strong Zone), Zone IV (Severe Zone) and Zone V (Destructive Zone).

Due to high disaster risk of the region and also historical records of disasters, Mandalay Regional Department of Disaster Management DDM has been undertaking relief and resettlement measures and also preparedness interventions as well. Preparedness actions of Mandalay region DDM includes public awareness session on disaster in many townships of the region and also providing capacity building trainings on disaster management to government officials, civil society organizations and youth volunteers on trainings of trainers, refresher and multiplier courses. Moreover, Mandalay region DDM also delivers regional level and township level disaster management courses in order to strengthen the capacity on disaster management of government departments and organizations and also to achieve better coordination and linkage among them in the time of emergency. Earthquake drill exercises are also organized by DDM with community at village and ward level, at schools, colleges, hospitals and government offices in order to enhance community capacity on disaster response and to reduce the impact of disasters. Table (3.6) demonstrates the list of disaster management training, public awareness sessions and earthquake drill exercises conducted by Mandalay region DDM.

Table (3.6) Training, Public Awareness Sessions and Earthquake Drill Exercise Organized by the Department of Disaster Management, Mandalay Region

Budget Year	Training (times)	Beneficiary	Public Awareness (times)	Beneficiary	Drill Exercise (times)	Beneficiary
2016-2017	6	6405			6	1405
2017-2018	3	120	20	4100	5	1600
2018 (Apr - Dec)	4	140	50	14080	5	1800

Source: Department of Disaster Management, Mandalay Region, 2019

Standard Operation Procedures for earthquake response was drafted for Mandalay region which includes the components of search and rescue, damage and needs assessment, emergency health care, food and non-food items distribution. transportation and logistics, information and communication, restoring family link and recovery by identifying the roles and responsibilities of respective government departments, institutions, organizations, associations, technical experts, NGOs and UN agencies.

CHAPTER 4
ANALYSIS OF SURVEY

4.1 Survey Profile

Regarding the geographical factors, Nyaung U Township is situated between North Latitude 20° 51′ 38″ and 25° 18′ 33″, and East Longitude between 94° 39′ 32″ and 95° 13′ 50″ in the Mandalay Division at the central part of Myanmar, at 206 feet above the sea level. It is surrounded by Pakkoku Township, Magway Division in the North; Taung Tha and Kyauk Pandaung Township, Mandalay Division in the East, Chauk Township, Magway Division in the South and Ayeyarwady River in the West. The township has a coverage area of 572.75 square mile.

Concerning its topography, Tu Yuun Mountain, which is 1171 feet high and 10 miles long, exists in the East. Pyke Hlan mountain range and ThaGyar mountain range lie in the south of the township. In contrast, there is a flat region, blessed for agriculture within the township.

With regard to climate, April or May is the hottest month in the hot season, with highest temperature being approximately 45°C. The lowest temperature is 10°C in the cold season. Regarding rainfall, it rains less in July, but more than normal in September and October. The average annual rainfall is 24.6 inches, and it usually rains more than average rainfall only for 36 days per year. Hence, it is regarded as a type of dry-hot climate.

According to the data from Nyaung U Township General Administrative Department in 2018 November, total population is 250,376 persons comprising male 115,230 male and 135,146 female. There was a total of 51,038 households: comprising of 6,420 households in the urban area; and 44,618 households in the rural area in Nyaung U Township. Regarding races, although the majority are Bamar (250,091 persons, 99.88%) there are other races such as Shan and Kayin in the township. Concerning their religions, the majority of the people are Buddhists (approximately 99%), whereas the minority are Muslims (133 persons) in Nyaung U

Township. The number of Christians (18 persons) was the smallest proportion in the township.

In terms of hazards of the township, earthquake, drought, flood and fire are the most significant within 2017-2018, there was happened 4 times for fire, 2 times for flood and 2 times for storm effect (Nyaung U Township General Administrative Department, 2018). According to the rapid damage assessment report for Chauk earthquake of Myanmar Engineering Society in September 2016, most of the buildings in in the urban area of Nyaung U township are one story buildings and vey little number of three stories buildings. Moreover, most of the buildings are built by mixed use and wood and not too much number for reinforced concrete RC and timber framed masonry. For those reasons, generally, the physical vulnerability on earthquake of Nyaung U townships will not be too high. Table (4.1) shows the building structural type and story of Nyaung U township urban area.

Table (4.1) Building Structural Type and Story of Nyaung U Township Urban Area

Structural Types		No of Story		
Building Type	**Building Unit**	**Three Story**	**Two Story**	**One Story**
Reinforced Concrete RC	645	3	147	495
Timber Framed Masonry	978		479	499
Brick Noggin	0			
Wood	2172		1256	916
Mixed Use Building	3266		725	2541
Masonry	100		33	67
Total	**7161**	**3**	**2640**	**4518**

Source: Myanmar Engineering Society, September 2016

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4.2 Survey Design

The survey questionnaire included four parts. The first part is to study about the demographic characteristics of the respondents, which consists of questions regarding the profiles of the samples and relevant with disaster. The second part contains questions to assess the knowledge of the community in the study area on earthquake hazard awareness. The next part is to know about community's attitudes

towards what to do in the time of earthquake shakes. The last part is to assess community practices on how to do before, during and after earthquake, then followed by community suggestions. In the development of questionnaire, it took references from internet and also consulted with experts of disaster risk reduction and earthquake. A pilot test was conducted at Yangon in November 2018 with five colleagues, who have been to Nyaung U township many times and some of who are familiar with earthquake knowledge. Based on the feedbacks received from the pilot test, it was modified by editing some questions.

The data were collected in three wards and four villages of Nyaung U township which are Ward No.3, No.4, No.5 and Thant Sin Kyale, Pyauck Sait Pin, Kone Tann Gyi and Taung Ba villages. Wards and villages were selected with purposive sampling method and criteria includes high population density and building density which have more risk for earthquake. The target population were people living in urban and rural community in Nyaung U Township. The survey respondents were chosen from those who are at least 18 years old and can answer well about survey questions. Simple random sampling method was used in the selection of respondents. Table (4.2) shows the number of respondents in each ward and village.

Table (4.2) Number of Respondents in each Ward and Village

Respondent Age Group	**No. of Respondent**	**Percentage**
Ward Name		
Ward No.3	55	26
Ward No.4	30	14
Ward No.5	30	14
Ward Total	**115**	**53**
Village Name	**No. of Respondent**	**Percentage**
Thant Sin Kyale Village	25	12
Pyauck Sait Pin Village	25	12
Kone Tann Gyi Village	30	14
Taung Ba Village	20	9
Village Total	**100**	**47**
Total	**215**	**100**

Source: Survey data, 2018

The data collection was carried out from 19th to 22nd November 2018. Quantitative data were collected through interviews and sample size is 215 (5.4 % of the total households) out of 4,012 households in the selected area. The unit of analysis is household as one respondent per household and confidence level is 95% and margin of error is 6.5. The following formula is used to calculate the minimum required sample size.

$$\text{sample size}_{\,r} = \frac{Z^2 * p * q}{e^2}$$

The sample size was adjusted, using the following formula and finally, the minimum sample size for the population 4,012 is 215 households.

$$\text{New sample size} = \frac{\text{sample size}_{\,r}}{1 + \frac{(\text{sample size}_{\,r} - 1)}{N}}$$

This sample size represents a pragmatic compromise between level of accuracy and costs of data collection. The demographic profile of the samples can be considered representative to the population of the township.

Not only the survey method is used in the study; but also, the key informant interviews was applied for getting insights into perspectives and attitudes towards this problem. Thus, the key informant interview was done with officials from the Department of Disaster Management DDM at regional and district level, and the Township General Administrative Department GAD. There were a number of 6 interviews in the study.

4.3 Survey Result

Survey results involved the components on profiles of respondents, community knowledge and awareness on earthquake, community attitude on during earthquake, community practices on earthquake preparedness, community suggestion on earthquake preparedness, incorrect community suggestion due to limited knowledge and government authorities' recommendation on earthquake preparedness and response.

4.3.1 Profiles of Respondents

In the total of 215 respondents, the survey was conducted 53% in wards and 47% in villages of Nyaung U township in order to know the knowledge and preparedness status of both urban and rural areas. In the survey, the interview

comprised slightly more female 55% than male 45% because women are more vulnerable to disaster rather than men, among them, 80% are male household heads and only 19% are females according to the traditional practice of Myanmar. Table (4.3) shows the number of respondent and percentage on the survey area, respondents' gender and household head.

Table (4.3) Survey Area, Respondents' Gender and Household Head

Survey Area	**No. of Respondent**	**Percentage**
Ward	115	53.5
Village	100	46.5
Total	**215**	**100**
Respondents' Gender	**No. of Respondent**	**Percentage**
Male	97	45.1
Female	118	54.9
Total	**215**	**100**
Household Head	**No. of Respondent**	**Percentage**
Male	173	80.5
Female	41	19.1
Do Not Know	1	0.5
Total	**215**	**100**

Source: Survey data, 2018

The interview covered age groups from 18 to 74 years aim to know the knowledge of respondents according to their age in which the most respondent age group is from 18-36 years with 37.2% and second group is 37-55 years, 32.6% then followed by 56-74 years with 28.4 percent but only 1.9% for above 75 years. 69% of respondent live in less than or equal five family members and 31% have big family above 5 members, hence, survey found that in Nyaung U township, most of the households are small and normal size, at this point, big families need to prepare and discuss more for disaster in terms of family level preparedness and restoring family link, including the identification of the points/ places where to meet family members after earthquake. Respondents' age group and their household size could be seen in table (4.4) by number of respondents and percentage.

Table (4.4) Respondents' Age Group, Household Size, Education, Occupation, Income Level and People with Disabilities

Respondents' Age Group	No. of Respondent	Percentage
18-36	80	37.2
37-55	70	32.6
56-74	61	28.4
75-93	4	1.9
Total	**215**	**100**
Respondents' Household Size	**No. of Respondent**	**Percentage**
Less than equal 5	148	68.8
Above 5	67	31.2
Total	**215**	**100**
Respondents' Education Level	**No. of Respondent**	**Percentage**
Do Not attend	2	0.9
Primary	41	19.1
Middle	62	28.8
High	59	27.4
University or College	36	16.7
Monastic Education	15	7.0
Total	**215**	**100**
Respondents' Occupation	**No. of Respondent**	**Percentage**
Unemployed	8	3.7
Student	12	5.6
Farmer	34	15.8
Fishery	1	0.5
Own Business	67	31.2
Wageworker	27	12.6
Private Employee	27	12.6
Government Employee	5	2.3
Dependent	16	7.4
Housewife	12	5.6
Retired	6	2.8
Total	**215**	**100**

Respondents' Income Level (MMK)	No. of Respondent	Percentage
Under 50000	11	5.1
50000-100000	25	11.6
100000-300000	120	55.8
300000-500000	43	20.0
Above 500000	15	7.0
No Response	1	0.5
Total	**215**	**100**
People with Disabilities (PWD)	**No. of Respondent**	**Percentage**
Have	12	5.6
Do Not Have	202	94
Do Not Know	1	0.5
Total	**215**	**100**

Source: Survey data, 2018

In terms of education level of respondents, most are middle and high school level with 28.8% and 27.4% respectively, while primary level is 19.1% and university or college education level involves only 16.7% and monastic education level includes about 7%, the survey shows that high level educated persons are not a big percentage and it can be assumed that educated persons will have more knowledge and awareness of earthquake and will know how to prepare for earthquake than those with low education level. Table (4.4) shows also the education level of respondents.

Regarding the occupation of respondent, 62.4% can earn money in which about 31.2% work their small-scale business, 15.8% are farmers, 12.6% work for private employee, government staffs involves only 2.3% and 0.5% works for fishery. Among respondents, 25.1 percent cannot earn income such as the unemployed, students, dependents, housewives and retired people, and 12.6% are wageworkers who depend on their daily wages. Generally, people who cannot earn money and daily workers are more vulnerable to disasters than people with regular income. Table (4.4) represents the also respondent's occupation by number of respondent and percentage.

Concerning the income level of respondents, about half of respondents can earn income from 100,000-300,000 MMK per month and 20% have 300,000-500,000 MMK then only 7% earns above five lakh MMK per month, on the other hand, 11.6%

can earn only 50,000-100,000 MMK and 5.1 percent have only under 50,000 MMK per month who are getting the wage under the minimum standard. From the social economic point of view, people with income are more vulnerable to disaster than others. Table (4.4) describes the respondents' income level.

In regard to religion, all 100% of respondents are Buddhists and about 88 percent of respondents said Nyaung U township is their native town, and other people/ families moved to the township from another place since last 20-50 years ago and over 50 years ago. Out of 215 respondents, 94.4% live in own houses and only 5.6% live in rented houses. For people with disabilities PWD, 94% of respondent said that their family has no PWD but 6 percent of respondents' family have PWD. The figures for people with disabilities PWD in the table (4.4). It needs to highlighted that people with disabilities are significantly more vulnerable to disaster than others, therefore, they should be informed about what to do for before, during and after disaster to save their lives, moreover, search and rescue team members need to know the houses of PWDs in order to evacuate them to safe places in emergency in a timely manner.

4.3.2 Community Knowledge and Awareness on Earthquake

This session discusses the community knowledge and awareness on earthquake and other natural disaster experience of Nyaung U township, occurrence of multi hazard disaster in the township and their causes, impacts after earthquake, experience, remembrance on earthquake and township earthquake risk, community perception on earthquake safety, prediction on earthquake, indigenous knowledge on earthquake predication and measurement on earthquake, earthquake zoning of Nyaung U township, community receiving on earthquake knowledge and information, community discussion about earthquake and student knowledge and sharing about the earthquake.

4.3.2.1 Natural Disaster Experience of Nyaung U Township

Regards of disasters experienced in Nyaung U township, it is the most affected with earthquake disaster of township 52.3%, therefore, this is the reason why this township was selected for this survey. Second disaster is the drought with 20.4% as the township located in dry zone, central Myanmar then followed by flood with 14.9% and fire only 5.5%, the occurrence of other disasters such as strong wind, water

shortage, storm, landslide, erosion and salination is very few. Table (4.5) describes the natural disaster experience of Nyaung U township.

Table (4.5) Natural Disaster Experience of Nyaung U Township

Natural Disaster	No. of Respondent	Experienced Percentage
Earthquake	112	52.3
Flood	32	14.9
Tornado & Strong Wind	5	2.2
Fire	12	5.5
Drought	44	20.4
Landslide	1	0.6
Storm	2	1.1
Erosion	1	0.6
Salination	1	0.3
Water Shortage	5	2.2
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.2 Occurrence of Disaster in Nyaung U Township

In the occurrence of disasters, most of the respondents said that earthquake occurs about every 20-50 years, 10-20 years and 5-10 years, some respondents said it occurs every 1 to 5 years, see in table (4.6). Drought occurs annually and 1 to 5 years per time and other disasters happen only very occasionally. Disaster occurrence of Nyaung U Township can be shown in table (4.6).

Table (4.6) Occurrence of Disaster in Nyaung U Township

Occurrence	Drought %	Earthquake %	Flood %	Storm %	Water Shortage %
Annually	37.3	1.5	46.3	4.5	7.5
1 Year- 5 Years	29.8	43.9	15.8	7.0	0.0
5 Years- 10 Years	10.3	86.2	0.0	0.0	0.0
10 Years- 20 Years	0.0	91.3	0.0	1.3	0.0
20 Years- 50 Years	0.0	96.3	3.7	0.0	0.0

Source: Survey data, 2018

4.3.2.3 Causes of Disasters

Concerning community knowledge on the causes of disasters, among 215 respondents; 52 persons said that earthquake happens due to natural causes, however, 48 respondents answered that it was due to climate change and 5 people answered that it was due to human causes, on the other hand, 33 persons responded that earthquake occurs due to fate and 77 respondents do not know the causes of earthquake. This result highlighted that only 52 persons out of 215 can provide the correct answer for cause of earthquake. For drought, many respondents said it was due to human causes and some people answered that it was because of fate and some do not know the causes. Even for flood, some respondents said that it was due to fate. Table (4.7) represents the causes of different disasters answered by respondents. According to the survey results, most of community do not have knowledge and awareness on disasters, hence, they need to know about disasters including earthquake which is the most common disaster of the township.

Table (4.7) Causes of Disasters

Causes of Disasters					
Cause	**Drought**	**Earthquake**	**Flood**	**Storm**	**Water Shortage**
Natural Causes	15	52.5	27.5	1.7	0.8
Human Causes	57.9	5.3	5.3	5.3	5.3
Fate	33.3	33.3	33.3	0	0
Climate Change	25	47.9	12.5	8.3	6.3
Do Not Know	17.6	76.5	0	5.9	0

Source: Survey data, 2018

4.3.2.4 Impacts After Earthquake

In terms of the impacts of earthquake, 47.1% said earthquake damages the buildings, 20.9% told that damage to infrastructure, each of 9 percent replied that loss of life and loss of property, 7.4% said that pagodas were damaged due to earthquake and 4.1% answered that landslide occurs after earthquake and table (4.8) illustrates the impacts after earthquake.

Table (4.8) Impacts After Earthquake

Impacts After Earthquake	No. of Respondent	Percentage
Damage Building	101	47.1
Loss of Life	20	9.4
Loss of Property	19	8.9
Damage to Infrastructure	45	20.9
Tsunami	1	0.5
Landslide	9	4.1
Collapsed dam	3	1.5
Fire	1	0.3
Damaged Pagodas	16	7.4
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.5 Experience, Remembrance on Earthquake and Township's Earthquake Risk

In all respondents, 98% had the experience on earthquake shaking as Nyaung U is the earthquake affected township and the recent earthquake happened in 2016. For the remembrance on strong earthquake in Myanmar, about 73% of respondents remembered and the rest percentages are do not remember and do not know. Concerning the knowledge of other countries' strong earthquake, 44% of respondents know and remember 66% are do not remember and do not know.

Regarding for the perception of community on earthquake risk of the township, only 19% of respondents said that township has high risk and 75% assumed the township has only low risk for earthquake and 6% do not know. Table (4.9) displays the remembrance of strong earthquake in Myanmar and also demonstrates the community perception on earthquake risk of Nyaung U township.

Table (4.9) Remembrance on Earthquake and Community Perception on Township Earthquake Risk

Strong Earthquake	No. of Respondent	Percentage
Remember	156	72.6
Do Not Remember	37	17.2
Do Not Know	22	10.2
Total	**215**	**100**
Earthquake Risk	**No. of Respondent**	**Percentage**
High Risk	40	18.6
Low Risk	161	74.9
Do Not Know	14	6.5
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.6 Community Perception on Safety from Earthquake and Prediction on Earthquake

Regarding the perception of community for safety from earthquake, 83% of respondents had the confidence and they said they will be safe from earthquake, in contrast, 14.4% told that they will not be safe from earthquake and about 3 percent do not know. In the township, there are less high and middle rise buildings and not high population density, hence, they feel that they will be safe from earthquake.

58% said that earthquake can be predicted and 31% told that it cannot predict, 11 % do not know on that. This result also points out that over half of respondent gave wrong answer, therefore, community needs to have awareness and knowledge on earthquake disaster as only 31% can give correct answer. Table (4.10) indicates community perception on safety from earthquake and also for community knowledge on earthquake prediction.

Table (4.10) Community Perception on Safety from Earthquake and Prediction on Earthquake

Safety from Earthquake	No. of Respondent	Percentage
Safe	178	82.8
Not Safe	31	14.4
Do Not Know	6	2.8
Total	**215**	**100**
Earthquake Prediction	**No. of Respondent**	**Percentage**
Can Predict	124	57.7
Cannot Predict	67	31.2
Do Not Know	24	11.2
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.7 Indigenous Knowledge for Earthquake Prediction

In the regards of indigenous knowledge of community for earthquake prediction, 37.2% said that earthquake can be predicted by studying the movement of birds, 21% of respondents answered that by hearing strange noises, 14% replied that they can know the earthquake in advance by crawlers' movement, 14% said by the movements of ants, 12% responded that high temperature can cause earthquake and 2.3% told that it can be known in advance by seeing dogs' movement. Table (4.11) displays that community indigenous knowledge on earthquake prediction.

Table (4.11) Indigenous Knowledge for Earthquake Prediction

Indigenous Knowledge	No. of Respondent	Percentage
Ants' Movement	30	14
Birds' Movement	80	37.2
Dogs' Movement	5	2.3
Strange Noise	45	20.9
High Temperature	25	11.6
Crawlers' Movement	30	14
Total	215	100

Source: Survey data, 2018

4.3.2.8 Measurement of Earthquake

On the community knowledge on how to measure for earthquake, it is significantly showed in the figure that 81.4% percent of respondents do not know and 13.5% said that can measure by magnitude or richter scale, 4.7% told by intensity and only 0.5% answered for both. This finding is also indicated that community need more knowledge and awareness on earthquake. Table (4.12) describes community answers on measurement of earthquake includes richter scale, magnitude and intensity.

Table (4.12) Measurement of Earthquake

Earthquake Measurement	No. of Respondent	Percentage
Richter Scale or Magnitude	29	13.5
Intensity	10	4.7
Both	1	0.5
Do Not Know	175	81.4
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.9 Earthquake Zone of Township and Receipt of Knowledge and Information

Regarding the community knowledge about which earthquake zone their township is located; do not know respondent is very high with 87.4% and only 1.9 percent can provide correct answer which is zone 4 namely severe zone, other percentage of respondent answered zone 1, 2 and 3. When asking the question to community for "Have you ever seen/heard/received any information for earthquakes in Myanmar", 88% of respondents said they received, heard, seen the information for earthquakes, 7% do not receive, hear, see and 5% do not know. Table (4.13) demonstrates the community knowledge on earthquake zone of their township and receipt of earthquake knowledge and information by community.

Table (4.13) Earthquake Zone of Township and Receipt of Knowledge and Information

Earthquake Zone	No. of Respondent	Percentage
Zone 1	2	0.9
Zone 2	9	4.2
Zone 3	12	5.6
Zone 4	4	1.9
Don't Know	188	87.4
Total	**215**	**100**
Earthquake Knowledge & Information	**No. of Respondent**	**Percentage**
Hear/ See / Obtain	190	88.4
Don't Hear/ See / Obtain	15	7.0
Don't Know	10	4.7
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.10 Sources of Earthquake Information and Link with Education Level

While accessing their sources of information on earthquake knowledge, 33.3% and 29% received by television and radio, 13.1% through newspaper and magazine, 11.8% from words of mouth of family members and friends, 4.9% from village/ tract head, 3.6% from internet and 2.8% from government. In this question result, only very small percentage of respondents said that 0.4% from training and awareness session, 0.2% received from poster, public events and simulation/ drill exercise respectively which also indicate that key activities at community level required to be undertaken such as organizing training and awareness sessions, dissemination of IEC materials including posters and pamphlets and conducting earthquake drill exercise to have better accessibility of knowledge, awareness and practice of community for earthquake preparedness. Community sources of earthquake information can be seen in table (4.14). When linking with the education level of respondents and their sources of information, people who did not attend school, they get information only from television and radio, on the other hand, people who have high level education and university or college level, they can access information through multiple channels

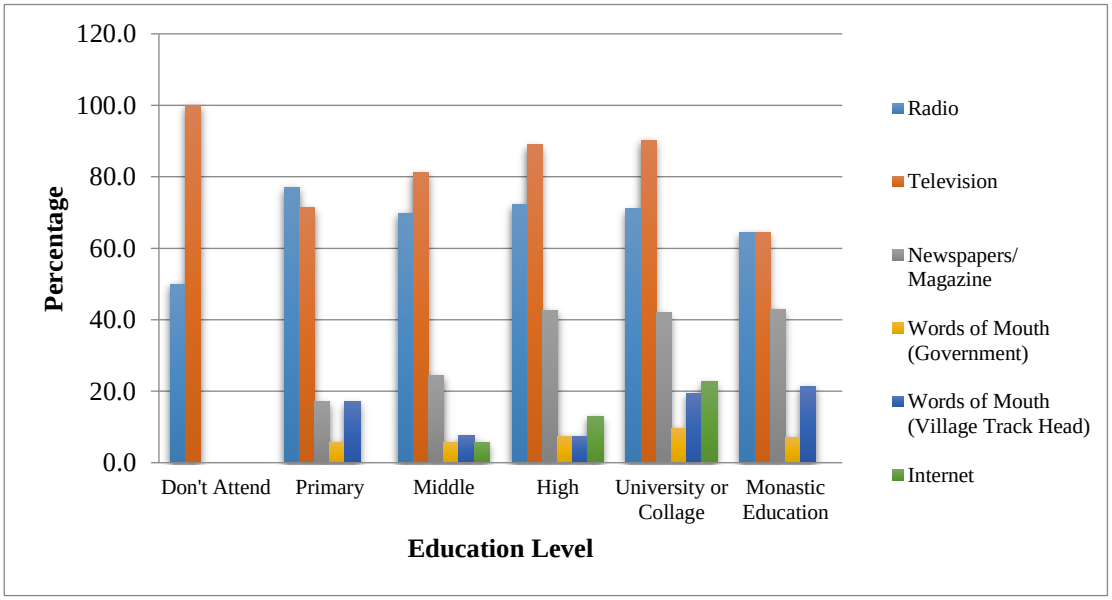
including newspaper, magazine and internet. Figure (4.1) shows the community earthquake information sources based on their education level.

Table (4.14) Sources of Earthquake Information

Sources of Earthquake Information	No. of Respondent	Percentage
Radio	62	29.0
Television	72	33.3
Newspaper / Magazine	28	13.1
Poster	0	0.2
Public Events	0	0.2
Training & Awareness Session	1	0.4
Drill Exercises	0	0.2
Words of Mouth(Government)	6	2.8
Words of Mouth (Military/ Police)	0	0.2
Words of Mouth (Village Track Head)	11	4.9
Words of Mouth (Family & Friend)	25	11.8
Words of Mouth (NGO & Religious Group)	0	0.2
Internet	8	3.6
Total	**215**	**100**

Source: Survey data, 2018

Figure (4.1) Earthquake Information Sources Based on Education Level

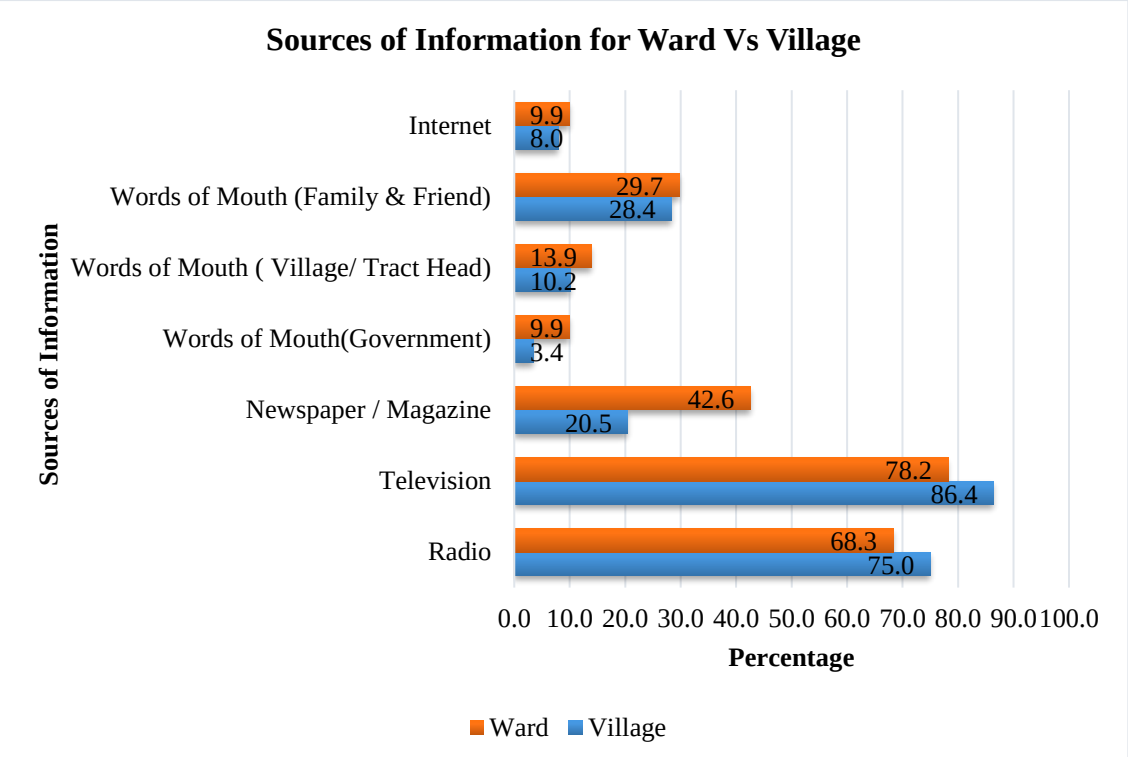


Source: Survey data, 2018

4.3.2.11 Difference between Wards and Villages on Sources of Earthquake Information

When comparing ward and village for their sources of information; village community give more time to watch the television and listen to the radio than ward community, hence, the acceptance percentage of community for earthquake information is higher than ward 86.4%and 78.2% through television and 75% and 68.3% by radio. In contrast, the accessibility on newspaper and magazine of village community is highly low doubly than ward 20.5% and 42.6%. The survey result shows that government can cover more for ward than village for the delivery of awareness message, the graph indicates that 3.4% and 9.9% which triple times difference between village and ward community for their sources of information on earthquake awareness through government which finding points out that government need to spread their activities more in villages. For surfing the internet, it was a bit higher accessibility of ward than village community 9.9% and 8.0%. Figure (4.2) represents the difference between wards and villages for their sources of earthquake information.

Figure (4.2) Wards and Villages on Sources of Earthquake Information



Source: Survey data, 2018

4.3.2.12 Discussion about Earthquake and Public Awareness Session on Earthquake

In the question of "Do you hear in your environment for the discussion about earthquake", the result is noticeable that 75% of respondents do not hear about the discussion on earthquake in their environment and only 25% heard it. Another visible result is that 94% of respondents said there is no public awareness session for earthquake in their ward/ village and only 5 percent said yes and 1% replied do not know. Table (4.15) demonstrates on community discussion about earthquake in their environment and also for public awareness session on earthquake at community level. This result also indicates that government and concerned stakeholders need to conduct more public awareness sessions for disasters at villages and wards level in order to enhance the community knowledge and resilience.

Table (4.15) Discussion about Earthquake and Public Awareness Session on Earthquake

Discussion for Earthquake	**No. of Respondent**	**Percentage**
Heard	54	25.1
Do Not Hear	161	74.9
Total	**215**	**100**
Public Awareness for Earthquake	**No. of Respondent**	**Percentage**
Have	11	5.1
Do Not Have	203	94.4
Do Not Know	1	0.5
Total	**215**	**100**

Source: Survey data, 2018

4.3.2.13 Students Sharing their Earthquake Knowledge to Elders

One more obvious result is that 92% of respondents said students of their families do not share to them about the earthquake knowledge what they have learned in school and only 8% said yes. At this point, children should be agents of change to sensitize adults about disaster preparedness through school lessons, therefore, children should be taught and trained at school for disaster awareness, knowledge and also what to do for before, during and after disaster because children are more vulnerable

to disaster than adults. Students should be part of school disaster management committee members and they also need to be informed where is the location of the assembly point, evacuation route in the emergency time and need to practice through drill exercise. For that reason, awareness sessions should be conducted in all schools at ward and village level and to encourage to children to share back their knowledge to adults in their homes which is a kind of knowledge dissemination channel. Disaster awareness lessons in the school curriculum to be more actively taught and should be part of exams.

4.3.3 Community Attitude on Activity During Earthquake

This session mentioned about the community attitude on what to do during earthquake shaking in the manner of running outside of building and running inside into the building and also their concept on crouch, cover and hold and community perception on reducing damages from earthquake.

4.3.3.1 Community Attitude on Running Outside of Building and Running Inside into the Building

When assessing the community attitude on earthquake, 77% of respondent said that if they can reach to outside of building within 5 seconds in the time of earthquake shaking, they will run to the outside of building and 23% said that they will not leave the building.

Moreover, 88% of respondent said that if they are in outside of building in time of earthquake shaking, they will not be running into the building, however, 12% of respondents said they will run into the building which is a very dangerous attitude.

Table (4.16) shows the result on percentage of people who will leave the building during earthquake shaking and those who will not leave the building. Moreover, it also represents the percentage of respondents' answers on running inside into the building in case of earthquake. Survey found that some people still need to change their attitude on what to do in the time of earthquake shaking and in order to change their attitude, it is crucial that public awareness sessions to be conducted at community level.

Table (4.16) Running Outside of Building and Running Inside into the Building

Running Outside of Building	No. of Respondent	Percentage
Will Leave	165	76.7
Will Not Leave	50	23.3
Total	**215**	**100**
Running Inside to Building	**No. of Respondent**	**Percentage**
Enter	26	12.1
Will Not Enter	189	87.9
Total	**215**	**100**

Source: Survey data, 2018

4.3.3.2 Crouch, Cover and Hold CCH on During Earthquake, Reasons for not doing "CCH" and Community Perception on Reducing Damages from Earthquake

87% of respondents said that during the earthquake, they will do "crouch, cover and hold" which crouch in safe place, try to cover for them and hold tightly something to be safe from earthquake, on the other hand, 12% of respondent said they will not do "crouch, cover and hold" and 1% do not know, please see in table (4.17).

When asking to 12% why they will not do for "crouch, cover and hold", most of respondent said that they not be able to decide suddenly in such a short time and some people said that because they do not have practice on that, table (4.17) shows this result. Through public awareness sessions, community need to be informed to do "crouch, cover and hold" during the earthquake. Furthermore, not only awareness sessions but also drill exercises need to be organized at the community level to offer chance to them for practice, otherwise, people may forget what to do during earthquake due to the fear and panic.

Assessing the perception of community with the question that "Do you think that you can do something to reduce damages from earthquake", only 32.6% answered "Yes", they can reduce damages from earthquake, conversely, about a half of respondents 55.8% said that "No" it cannot be reduced, it is according to fate and 11.6% do not know. Table (4.17) illustrates the result for community perception on reducing damages from earthquake. This result shows that there is need to change the perception of the community on reducing damages from earthquake through training

and awareness sessions. These sessions will be able to reduced damages from earthquakes by training the community on preparedness and mitigation measures at household and village/ ward levels.

Table (4.17) Crouch, Cover and Hold (CCH) on During Earthquake, Reasons for not doing "CCH" and Community Perception on Reducing Damages from Earthquake

Crouch, Cover and Hold	No. of Respondent	Percentage
Yes	188	87.4
No	26	12.1
Do Not Know	1	0.5
Total	**215**	**100**
Reasons for Not to do Crouch, Cover & Hold	**No. of Respondent**	**Percentage**
Do Not Know Suddenly	179	83.3
Do Not Have Practice	36	16.7
Total	**215**	**100**
Community Perception on Reducing Damages	**No. of Respondent**	**Percentage**
Reduce	70	32.6
Fortune	120	55.8
Don't Know	25	11.6
Total	**215**	**100**

Source: Survey data, 2018

4.3.4 Community Practices on Earthquake Preparedness

This section describes the community practices on what to do in advance before earthquake to minimize the impacts of earthquake, discussion on family meeting point for their reunion and family preparedness plan on earthquake. Moreover, it is mentioning about what to do during earthquake shaking when inside the building and outside the building. Furthermore, the difference between urban and rural community practices are also mentioned and then describes the community practices in after earthquake situations.

4.3.4.1 Before Earthquake

When asking the question on "Before earthquake what should be prepared in order to reduce damages", 35.5% of respondents said that they will strengthen/ retrofit their houses, 16.7% told that they will assess the safety of their buildings, 11.6% replied that they will try to know about earthquake, 10.1% responded that they will takes measures to prevent heavy objects from falling inside their houses, 5.8% answered that they will build new house, 5.1% will identify the safe places, 3.6% said that they will protect important documents, 2.9% told that they will teach children and elders what to do during earthquake, 2.2% answered that they will save money, 14% respondents replied that they will make family plan for emergency and will help people respectively, 0.7% of respondent answered that they will store food and water, will keep fire extinguishers, will join the disaster response team, will do public awareness, will identify emergency exits in their homes and will clear route of exits respectively. Table (4.18) shows the respondents' answer on preparedness activities before earthquake.

Table (4.18) Preparation for Reducing Damages Before Earthquake

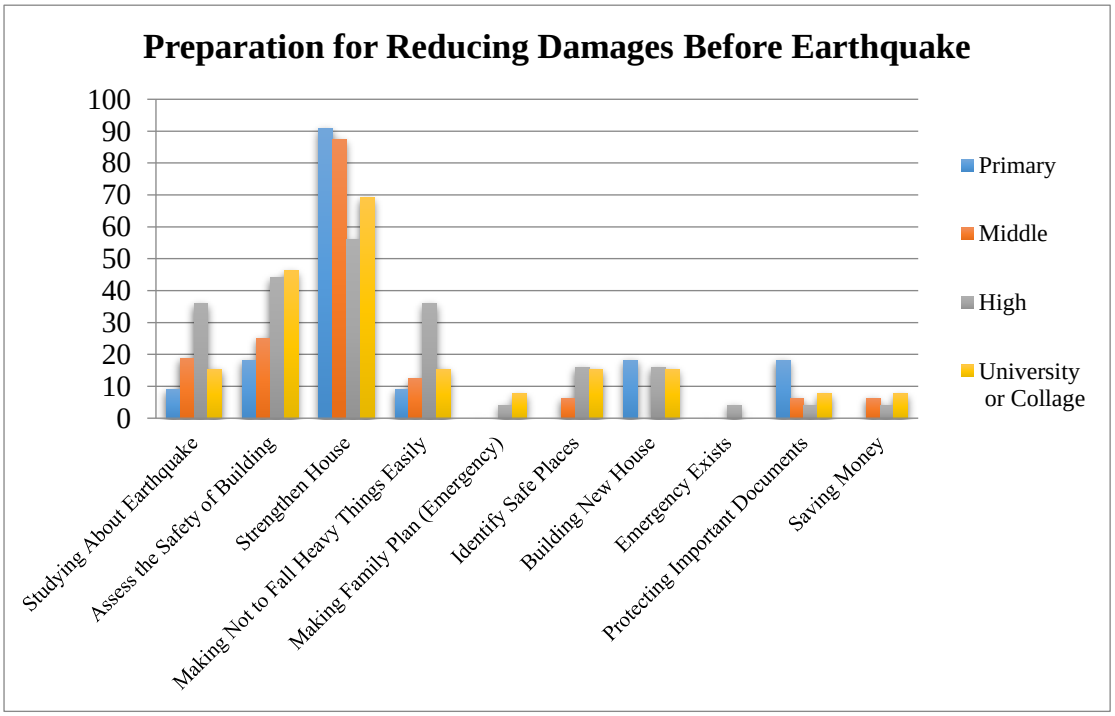
Preparation for Reducing Damages	No. of Respondent	Percentage
Studying About Earthquake	25	11.6
Assess the Safety of Building	36	16.7
Strengthen House	76	35.5
Making Not to Fall Heavy Things Easily	22	10.1
Making Family Plan (Emergency)	3	1.4
Identify Safe Places	11	5.1
Building New House	12	5.8
Emergency Exists	2	0.7
Public Awareness	2	0.7
Teaching Children & Elders	6	2.9
Membership in Disaster Response Team	2	0.7
Fire Extinguishers	2	0.7
Protecting Important Documents	8	3.6
Saving Money	5	2.2
Storing Foods & Waters	2	0.7
Helping People	3	1.4
Total	**215**	**100**

Source: Survey data, 2018

(A) Link between Education Level and Community Knowledge on Preparedness

While linking with education level and their preparedness knowledge on earthquake to reduce damages, most people with primary and middle school level said that they will strengthen their houses, on the other hand, high school and university or college level people said that in addition to strengthening house, they will also study about earthquake, they will assess the safety of building, making heavy things not to fall easily, will make family emergency plan, will identify safe places and will save money. Figure (4.3) displays the linkage with education level and their preparedness knowledge for before earthquake.

Figure (4.3) Linkage with Education Level and Preparedness Before Earthquake



Source: Survey data, 2018

(B) Discussion for Family Meeting Point and Family Preparedness Plan for Earthquake

For the family level preparedness activity before earthquake, 78% of respondents said that they do not discuss with their family members on what to do, how to stay for earthquake disaster and do not identify the family meeting point where family members to meet after earthquake, however, 22% told that they had discussion

about that. It should be mandatory that families to discuss in advance what to do for earthquake and to specify the points/ places where family members can meet after the earthquake in order to avoid separation of family members and community should be encouraged to learn from IEC materials, awareness sessions and trainings.

Another visible result is that 81% of respondents said they do not have family level earthquake preparedness plan and 19% told that they have. Family level preparedness plan also should be developed at all households which should include what to do before, during and after earthquake and also to specify family meeting point for after earthquake. Government should develop strategy on this, community to be implemented practically. Table (4.19) describes the result on community discussion for their family meeting point for quick family reunion and also demonstrates the result of community family preparedness plan for earthquake.

Table (4.19) Discussion for Family Meeting Point and Family Preparedness Plan for Earthquake

Discussion for Family Meeting Point	**No. of Respondent**	**Percentage**
Have	47	21.9
Do Not Have	168	78.1
Total	**215**	**100**
Family Earthquake Preparedness Plan	**No. of Respondent**	**Percentage**
Have	42	19.5
Do Not Have	173	80.5
Total	**215**	**100**

Source: Survey data, 2018

4.3.4.2 During Earthquake

(A) When Inside the Building

For the result of what to do during earthquake when staying inside the building, 30.2% of respondents said that they will run to open space from home, 22.7% replied that they will do “crouch, cover and hold”, 21.9% answered that they will stay under desk, 16.1% responded that they will run to safe places, 4.9% told that they will avoid places where objects can fall, 3.1% said that they will help their families and children and 1% of respondents answered that they will wait until

earthquake stop. Table (4.20) illustrates on community practice on what to do during earthquake when staying inside the building.

Table (4.20) When Inside the Building During Earthquake

When Inside the Building	No. of Respondent	Percentage
Running to Open Space from House	65	30.2
Crouch, Cover and Hold	49	22.7
Running to Safe Places	35	16.1
Staying Under Desk	47	21.9
Avoiding the Places can be fallen things	11	4.9
Helping my Family & Children	7	3.1
Waiting Until Earthquake Stops	2	1.0
Total	**215**	**100**

Source: Survey data, 2018

(B) When Outside the Building

Regarding for what to do during earthquake when staying outside the building, 38.2% answered that they will do "crouch, cover and hold", 27.7% said that they will run to open space, 23.2% replied that they will stay away from buildings, trees, electric poles and electrical lines, 3.9% told that they will sit outside during earthquake and 4.9% gave wrong answer that they will run into the nearest building and also 2.1% as well they will run back to the home. Table (4.21) shows community practice on what to do during earthquake while staying outside the building. This result also highlights that some people need to know and avoid wrong behavior and practice in time of earthquake shaking in order to save their lives.

Table (4.21) When Outside the Building During Earthquake

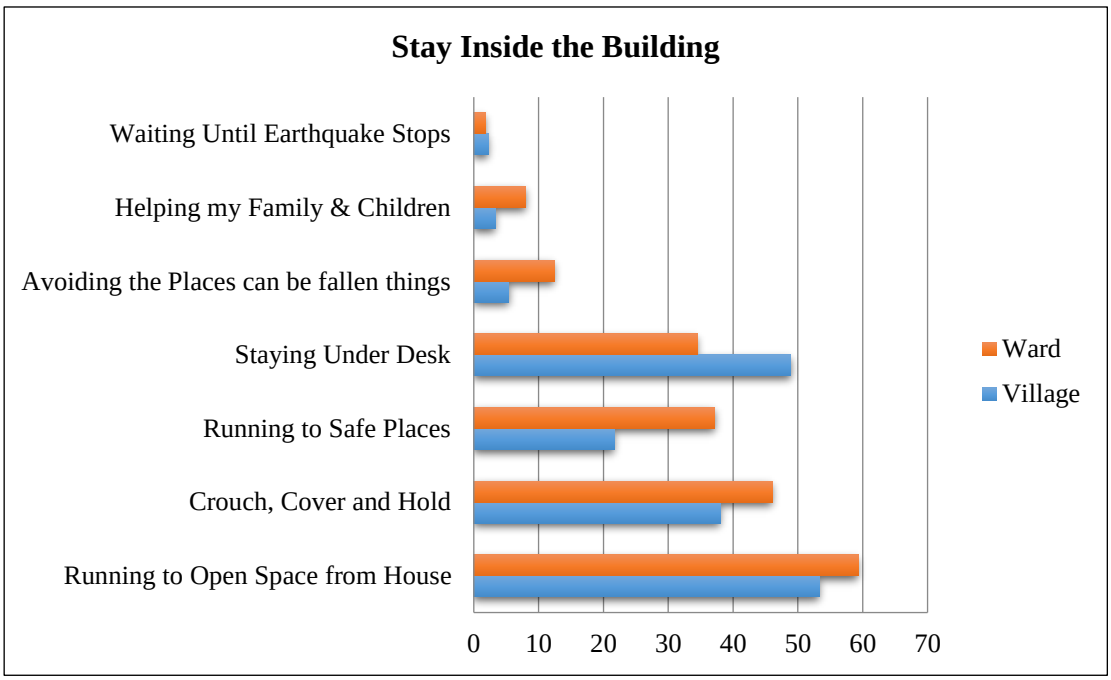
When Outside the Building	No. of Respondent	Percentage
Crouch, Cover and Hold	82	38.2
Running to Open Space	60	27.7
Running into the Nearest Building	11	4.9
Staying away from Building, Trees, Electric Poles & Electrical Line	50	23.2
Running Back to Home	5	2.1
Sitting Outside	8	3.9
Total	**215**	**100**

Source: Survey data, 2018

(C) Ward and Village Practices on Earthquake While Staying Inside the Building

While comparing the results of wards and villages, for what to do during the earthquake when staying inside the building, ward people answered more than village people; they will run to safe places, run to open space from house and will do crouch, cover and hold. Village people said more for staying under desk. Figure (4.4) shows this result by comparing ward and village. This result means that ward people know more about what to do during earthquake than village people.

Figure (4.4) Ward and Village Practices on Earthquake While Staying Inside the Building



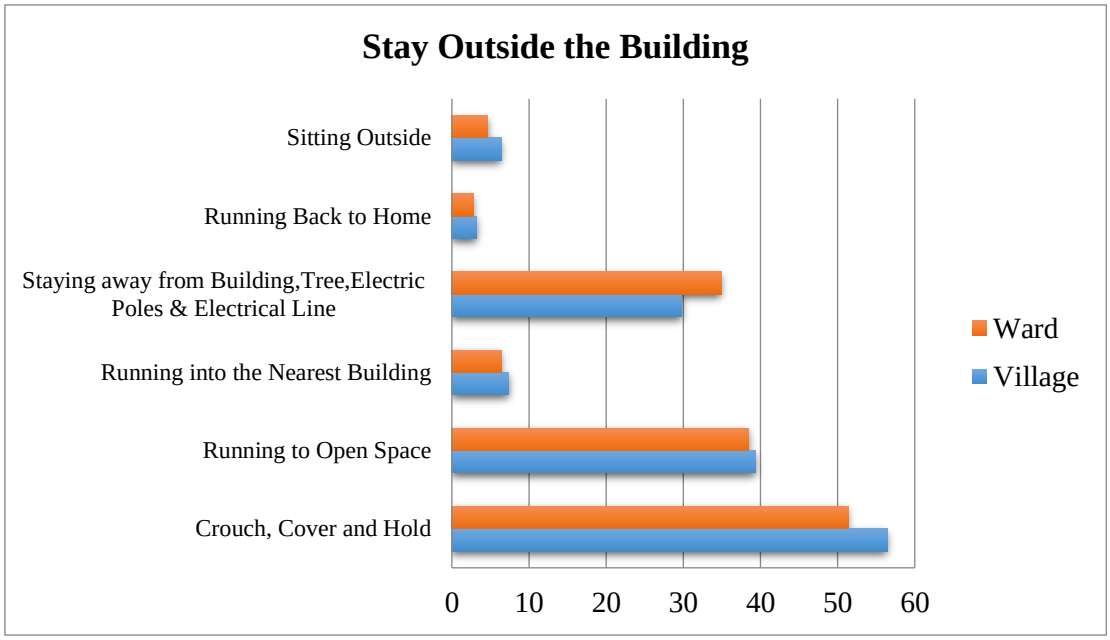
Source: Survey data, 2018

(D) Ward and Village Practices on Earthquake While Staying Outside the Building

When comparing the wards and villages on what to do during earthquake when staying outside the building, ward people more answered that they will stay away from buildings, trees, electric poles and power line, in contrast, more wrong answers given by village people than ward people, that they will run into nearest building. Figure (4.5) compares the result on differences between wards and villages

concerning their practices on earthquake while staying outside the building. This result also points out that village people needs more knowledge than ward people, hence, villages should be the priority for awareness sessions on earthquake.

Figure (4.5) Ward and Village Practices on Earthquake While Staying Outside the Building



Source: Survey data, 2018

4.3.4.3 After Earthquake

As the result on what to do after earthquake, 34.2% of respondent said that they will check the damages of building, 30.7% told that they will send people who got injuries to hospitals and clinics, 11.1% answered that they will listen updated earthquake news from television and radio, 9.8% responded that they will stay away from electric power lines and buildings, 8.7% replied that they will help to people and elders, 1.6 % said they will repair damages, 1.4% told that they be will alert for aftershocks and landslide, 0.5 % answered that they will be alert for fire and dam burst correspondingly. Table (4.22) describes the community actions on what to do after earthquake.

Table (4.22) Actions to do After Earthquake

Actions to do After Earthquake	No. of Respondent	Percentage
Listen to Updated Earthquake News from TV & Radio	24	11.1
Send the wounded people to Hospital or Clinic	66	30.7
Check the Buildings	74	34.2
Alert for After Shock	3	1.4
Stay away from Electrical Power Lines & Buildings	21	9.8
Alert for Fire	1	0.5
Alert for Breaking Dam	1	0.5
Alert for Landslide	3	1.4
Helping Other People & Elders	19	8.7
Repairing Damages	3	1.6
Total	**215**	**100**

Source: Survey data, 2018

4.3.5 Community Suggestions on Earthquake Preparedness

When collecting suggestions from community for earthquake preparedness, most of the respondents suggested to government to conduct more awareness sessions till to village level which is the most effective ways and also better to conduct awareness sessions at all schools. Moreover, to be distributed earthquake awareness IEC materials and pamphlets to all households and to disseminate those in crowded places. Furthermore, they also would like to request government to deliver training on first aid to community in order to treat and provide first aid to people who get injuries in the disaster. Most of them suggested construction of strong buildings and also to check the resistance and quality of buildings and to ensure safety. Many people suggested to access the earthquake related information by reading newspaper, journal, and listening to the radio and to prepare in advance and to keep important documents at the family level.

4.3.6 Incorrect Community Suggestions due to Limited Knowledge

From the community suggestions, it was found that some community gave incorrect suggestions due to their limited knowledge in which they think that earthquake occurs due to climate change, hence they suggested to plant more trees, to conserve forest and to do green activities. Some people said to cut trees in advance for the safety. Some of the people think that earthquake can be forecasted, therefore, they suggested that to forecast the earthquake with machines and then to inform earthquake shaking information to community in advance before earthquake in order to have evacuation time like in flood cases. This result also shows that community needs knowledge on earthquake and awareness sessions to be undertaken at the community level.

4.3.7 Government Authorities' Recommendation on Earthquake Preparedness and Response

According to township level GAD, there is no regular plan for awareness sessions at Nayung U township and also no regular meeting of township disaster management committee. Township do not have enough capacity to respond to major earthquakes and also for search and rescue activities. As the recommendation of GAD, earthquake simulation exercises should be conducted with people regularly and township should have alarm system for earthquake. At the township, it should construct the disaster resilient buildings for all disasters and also to conduct earthquake awareness sessions and trainings.

At the district level, DDM conduct awareness session one to three times per month which covers for all major hazards. At the community level, DDM conduct the drill for cyclone only and not yet for earthquake even though Nyaung U district located in earthquake prone area, on the other hand, DDM conducted earthquake drill exercises in some schools. In regard to the recommendation of district DDM, to strengthen the law, policies, rules and regulations and building codes for the quality and safety of buildings. To conduct awareness raising program strategically, including to find alternative ways and approaches in order to get more participation of community in awareness sessions. More earthquake drill exercises should be organized with the participation of the community. It is also important to sensitize and advocate to government authorities about the importance of earthquake

preparedness in order to reduce the damages of earthquake. In disaster management, government needs to collaborate with respective departments, development committees, Fire Brigade, Police forces, Red Cross, community- based organizations, civic society organizations, NGOs, community leaders, private sectors, institutions, media and also community including children, teachers, women, and people with disability.

According to the discussion and recommendation of regional level DDM, there is less coordination between regional and district level government, hence, it needs to have vertical linkage among disaster management committee members at all levels; national, regional, district, township and villages level and also horizontal linkage among different departments. At all levels, it is needed to form disaster management committee and also to develop disaster management plan through consultation workshop with government departments and multi stakeholders. Then it is required to do the functioning of its disaster management plan in order to respond effectively in emergency situations in terms of search and rescue, medical care, camp management, water and sanitation, food and family kit distribution, transportation, communication, information management, logistics and so on. Apart from DDM, participation level of other departments still need to be improved and also community as well since, at present community participation is only at the level of listening. There is as yet, no detail discussions by community and also has still to reach the decision-making level. DDM is the focal department to deliver the community awareness and now DDM have only regional and district level office and starting to open township level office only in very few townships. In order that earthquake knowledge and awareness reach more to village and community level, it also requires opening of more township level DDM offices. However, there is budget limitation for staff recruitment and also land to construct office as well.

CHAPTER 5
CONCLUSION

5.1 Findings

Regarding for the disasters experienced in Nyaung U township, earthquake is the most major disaster for the township. 98% of respondents had the experience on earthquake shaking as Nyaung U is an earthquake prone township and the recent earthquake happened in 2016. On the perception of community for safety from earthquake, 83% of respondents had the confidence that they will be safe from earthquake, probably because there is very less high and middle rise buildings in Nyaung U Township.

According to the survey results, most of community do not have knowledge and awareness on earthquake, hence, many wrong answers were given by respondents in which only 24% of interviewees knew the cause of earthquake and other people think that earthquake happens due to climate change, due to fate and some do not know the cause. In terms of earthquake forecasting, 58% respondents said that earthquake can be forecasted and only 31% can give correct answer. Moreover, some survey results showed obviously, the need for community knowledge on earthquake in which 81.4 percent of respondents do not know on how to measure earthquake and similarly 87.4% of interviewees do not know in which earthquake zone their township is located.

One of the positive results is that 88% of respondents received information for earthquakes in Myanmar. On the other hand, while accessing their sources of information on earthquake knowledge, only very small percentage of respondents 0.4% received training and awareness session and only a very tiny percent 0.2% received from poster, public events and simulation/ drill exercises. When linking with the education level of respondents and their sources of information, people who did not attend school, they obtain information only from television and radio, on the other hand, people who have high level education and university or college level, they can

access information through multiple channels including newspaper, magazine and internet.

Regarding visible results for public awareness sessions on earthquake in the community, 94% of respondent said there is no public awareness session for earthquake in their ward/ village and also 75% of respondent have not heard about any discussions on earthquake in their environment. Government delivers more earthquake awareness message and information in wards than in villages, therefore, government needs to spread their activities more in villages. For the family level preparedness,78% of respondents do not discuss with their family members on what to do, how to stay for earthquake disaster and do not identify the family meeting point where family members can meet after earthquake. Another visible result is that 81% of respondents do not have family level earthquake preparedness plan.

92% of respondents said students of their families do not share to them about the earthquake knowledge what they have learned in school. Children should be agents of change to sensitize to adults about disaster preparedness and they should be learned and trained at school for disaster awareness, knowledge and also what to do for before, during and after disaster because children are more vulnerable to disaster than adults. Students should be part of school disaster management committee members and they also need to be informed the location of the assembly point, evacuation route in the emergency time and need to practice through drill exercise.

The survey found that some people still need to change their attitudes on what to do in the time of earthquake through public awareness sessions. 23% of respondents said that if they are in inside of building, when earthquake shaking, they will not leave the building even though they can reach outside in time. Likewise, 12% of respondents gave very dangerous answer that they will run into the building when earthquake shaking if they are in outside the building. This result highlights that some people need to know and avoid wrong behavior in the time of earthquake shaking to save their lives. Only 32.6% of respondents answered damages from earthquake can be reduced and this result shows that community perception should be changed through training and awareness sessions on how damages from earthquake can be reduced by preparedness and mitigation measures at their household level and village/ ward level.

Through public awareness sessions, community need to be informed to do “crouch, cover and hold” during the earthquake. Furthermore, not only awareness

sessions but also drill exercises need to be organized at the community level to offer opportunity to practice drills, otherwise, people may forget what to do during earthquake due to the fear and panic. Village people needs more knowledge than ward people because while comparing the results of ward and village, ward people know more about what to do during earthquake than village people. Similarly, more wrong answers given by village people than ward people, for instance, they will run into nearest building in the time of earthquake.

Regarding the institutional level, there is no regular plan for awareness sessions at Nyaung U township and also no regular meeting of township disaster management committee. The township do not have enough capacity to respond to major earthquakes and also for search and rescue. DDM conducts the drill at the community level only for cyclone and not yet for earthquake even though Nyaung U district is located in earthquake prone area, on the other hand, DDM conducted earthquake drill exercise in some schools. At the regional level, there is less coordination between regional and district level government, hence, it needs to have vertical linkage among disaster management committee members at all levels; national, regional, district, township and villages level and also horizontal linkage among different departments. In order for earthquake knowledge and awareness to reach more villages, it needs to open more township level DDM offices, however, there is budget limitation for staff recruitment and also land to construct office as well.

5.2 Suggestions

Government and concerned stakeholders should conduct more public awareness sessions and trainings up to village and ward level which is the most effective way to enhance the community knowledge and resilience. It is required to disseminate earthquake awareness IEC materials such as posters and pamphlets should be disseminated to all households and to disseminate those in crowded places as well. Media has a vital role in conveying message to grassroot level, hence, to broadcast many awareness programs in more television and radio channels with multi approaches for earthquake awareness message to reach to community level. Moreover, it is also crucial to conduct earthquake drill exercises with community regularly to have practices for community what to do in earthquake. It should deliver trainings on first aid to community in order to treat people in the emergency situation.

Government should allocate budget to open more township level DDM offices in order that earthquake knowledge and awareness reach to more villages at the community level.

To develop public awareness strategy considering the comprehensive ways and approaches to get more active participation of community in awareness sessions and community participation to be improved to discussion and decision-making level. Government should develop strategy for family level preparedness in order to encourage all families to develop family level preparedness plan at all households which includes discussions in advance what to do for earthquake and also to specify the points/ places where family members can meet after the earthquake in order to avoid separation of family members. It is also better to conduct awareness sessions at all schools and encourage to children to share back their knowledge to adults in their home which is also a kind of knowledge dissemination channel. Disaster awareness lessons in the school curriculum should be more actively taught and should be part of exams. Government to strengthen the law, policies, rules and regulations and building codes for the quality and safety of buildings. At the township, it should construct the disaster resilient buildings for all disasters.

It is also important to sensitize and advocate to government authorities about the importance of earthquake preparedness in order to reduce the damages from earthquake. At all levels, it needs to form disaster management committee and also to develop disaster management plan through consultation workshops with government departments and multi stakeholders. Functioning of its disaster management plans is also critical issue in order to prepare, mitigate the disaster risk and also to respond effectively in emergency situation within 12, 24, 48 and 72 hours. Effective mechanism for disaster response need to be developed and practiced and apart from DDM, the participation level of other departments still needs to be improved in disaster management work, therefore, it also requires to organize regular coordination meeting with all respective departments. In disaster management, government needs to collaborate and coordinate with respective departments, development committees, Fire Brigade, Police forces, Red Cross, community- based organization, civic society organization, NGOs, community leaders, private sectors, institutions, media and also community including children, teachers, women, people with disability and so on.

REFERENCES

1. Asian Disaster Preparedness Center ADPC and UN-Habitat (2017). *Training Manual on Earthquake Risk Management*, Yangon, Myanmar.

2. Aye Aye Khine (2011). *A Study on Community Based Disaster Risk Reduction in Ayeyarwaddy Region*, Unpublished MPA thesis, Yangon University of Economics.

3. Chong Su Feng Elaine (2015). *Earthquake Awareness, Readiness and Resilience of Schools in Bago Township, Myanmar*, Unpublished Master thesis, Asian Institute of Technology AIT, Thailand.

4. Department of Disaster Management, Disaster Risk Reduction Working Group and MCCDDM (2017). *Earthquake Education Pamphlet*, Myanmar.

5. Geohazards International (2018). *Guidance on Protective Actions during Earthquake Shaking*, GHI, California, United States.

6. Government of India (2007). *National Disaster Management Guidelines: Management of Earthquakes*, NDMA, India.

7. Hla Hla Aung (2017). *Myanmar Earthquake History*, Myanmar.

8. Imelda Abarquez and Zubair Murshed (2004). *Community-based Disaster Risk Management: Field practitioners' Handbook*, ADPC, Thailand.

9. Maung Thein and Tint Lwin Swe (2006). *The Seismic Zone Map of Myanmar (Revised version, 2005),* MEC and MES, Myanmar.

10. MES, MEC, MGS, & UN-Habitat (2016). *Family Preparedness Plan for Earthquake*, Yangon, Myanmar.

11. MES, MEC, MGS, & UN-Habitat (2016). *Key Messages for Earthquake Safety and Action* (2016)., Yangon, Myanmar.

12. MES, MEC, MGS, & UN-Habitat (2016). *Seismic Hazard Profile of Myanmar*, Yangon, Myanmar.

13. Murty C.V.R. (March 2005). *Earthquake Tips: Learning Earthquake Design and Construction*, National Information Center of Earthquake Engineering, Indian Institute of Technology Kanpur, India.

14. Myanmar Earthquake Committee MEC (2009). *Living with Earthquake*, Myanmar.

15. Myanmar Engineering Society MES, Myanmar Earthquake Committee MEC, Myanmar Geosciences Society MGS, & United Nations Human Settlement Program UN-Habitat (2015). *Earthquake Tips Learning Earthquake Design and Construction,* Myanmar.

16. Myo Thant, Nwe Le′ Nge, Soe Thura Tun, MaungThein, WinSwe, & ThanMyint (2012). *Seismic Hazard Assessment Myanmar*, MES and MGS, Myanmar.

17. National Earthquake Information Center (1900-1990). USGS, Colorado, United States.

18. Pe Aung (2011). *Earthquake Management Lessons from Haiti and Chile*, Unpublished MPA thesis, Yangon University of Economics.

19. Pone Nyet Khaing (2014). *Assessing Community Capacity for Response and Preparedness against Flood Hazard in Hpa-an Town, Lower Myanmar*, Unpublished Master thesis, Asian Institute of Technology AIT, Thailand.

20. Relief and Resettlement Department and UNDP (2017). *Myanmar Action Plan on Disaster Risk Reduction MAPDRR*, Myanmar.39

21. Relief and Resettlement Department and UN-Habitat (2010). *Manual on Earthquakes*, Yangon, Myanmar.

22. Relief and Resettlement Department, Department of Meteorology and Hydrology, Forest Department, Irrigation Department, Fire Services Department, Myanmar Engineering Society, Myanmar Geosciences Society, Myanmar Information Management Unit, & Asian Disaster Preparedness Center ADPC (2009). *Hazard Profile of Myanmar*, Myanmar.

23. Relief and Resettlement Department, MSWRR (2015). *Disaster Management Course*, Myanmar.

24. Soe Thura Tun *(2005). The Sagaing Fault*, MEC, Myanmar.

25. Thinn Hlaing Oo (2017). *A Study of Sustainability of Disaster Education in Yangon, Myanmar: A Case Study of High Schools in Kungyangon, Botataung, and Pazundaung Townships*, Unpublished Master thesis, Kyoto University, Japan.

26. Tint Lwin Swe (2011). *Earthquake and Disaster Reduction*, Sarpay Beikman, Myanmar.

27. UN-Habitat, MES, MEC & MGS (2015). *Endline Survey Comparative Analysis of Knowledge, Attitude and Practice on Earthquake Risk in Bago City*, Myanmar.

28. United Nations International Strategy for Disaster Reduction (2009). *Terminology on Disaster Risk Reduction*, UNISDR, Geneva, Switzerland.

29. Win Swe and Win Naing (2008). *Seismicity and Major Active Faults of Myanmar*, Myanmar Geoscience Society, Myanmar.

30. Win Swe (2009). "*An overview of earthquake and earthquake hazards in Myanmar*", Power Point Presentation at DRR workshop, Mandalay, Myanmar.

31. Yadanar Kyaw (2014). *Seismic Risk Assessment for Bago City of Myanmar*, Unpublished Master thesis, Yangon Technological University.

Website:

1. http://earthquake.usgs.gov/
2. https://transition.fcc.gov/pshs/emergency-information/tips.html
3. http://www.fema.gov/library/prepandprev.s
4. https://www.researchgate.net/publication/274701088

APPENDIX

Appendix A Survey Questionnaire (Community)

Data Entered By: _____ Date: _____ / _____ / 2018	**ID No. _____**

KAP SURVEY – EARTHQUAKES
QUESTIONNAIRE

a. Date conducted:	**b. Enumerator ID:**	**c. Checked by supervisor**
__ / __ / 2018	**_____**	**(signature):_____**

GEOGRAPHIC INFORMATION		
A.	**Ward/ Village Name**	

INTRODUCTION AND CONSENT

Hello, my name is "_____" and I am enumerator for a thesis survey of Ma Aye Zar Myo Han for the Executive Master degree on Public Administration of Yangon University of Economics.

I would like to ask you some questions about natural disasters in -your township. We are asking many people these questions in order to know peoples' perceptions and opinions. Your answers will be counted along with all the others. The questions will take about 20 minutes.

The interview is confidential. Your name is not on this paper and your answers will be private.

You don't have to answer if you don't want to. You may decline to answer any questions or stop the interview at any time.

Do you agree to let me ask you these questions? **YES** **NO**

I. DEMOGRAPHICS			
1.	Sex	Male	1
		Female	2
2.	How old are you?		____ years
3.	How many people are there in your household?		___ persons
4.	Who is the head of your household?	Man	1
		Woman	2
		Do Not Know	99
5.	What is the highest level of schooling you have <u>completed</u>? *<u>Only one</u> answer possible*	None	1
		Primary school	2
		Middle school	3
		High school	4
		College / University	5
		Master Degree	6
		Monastic Education	7
		Other_____	88
		No Response	99
6.	What is your <u>primary</u> occupation? *<u>Only one</u> answer possible*	Not working / earning	1
		Student	2
		Farmer (crops, livestock)	3
		Fisher	4
		Self-employed / own	5
		business	6
		Daily wage laborer	7
		Employed in private sector	8
		Employed in government	9
		Retired	10
		Other _____	88
7.	What is your income level (Economic Status)?	<50000	1
		50000-100000	2

		100000-300000	3
		300000-500000	4
		>500000	5
		Other _____	88
		No Response	99
8.	What is your religion?	Buddhist	1
		Muslim	2
		Christian	3
		Hindu	4
		Other _____	88
		No Response	99
9.	Are you native citizen of this	Yes	1
	township?	No	2
		No Response	99
10.	If you are from another place how	< than 5 years	1
	long you have been residing in the	5 – 10 years	2
	township?	10-20 years	3
		20-50 years	4
		> than 50 years	5
		Other _____	88
		No Response	99
11.	Do you live in which house?	Own house	1
		Rental house	2
		Government housing	3
		Other _____	88
		No Response	99
12.	Is there anyone in your household	Yes	1
	with a disability?	No	2
		Do Not Know	99
	II. Knowledge and Preparedness on Earthquake		
13.	What kinds of natural hazards	Earthquake	1
	do your township face?	Flood	2
		Cyclone / strong storm or wind	3

	<u>Do not</u> read answer options *<u>Multiple</u> answers possible* *Prompt once – any others?*		Tornado / wind funnel Fire Drought Landslide Erosion / loss of land Soil salinization Epidemic infections (crops, animals) Epidemic infections (humans) Other _____ None / Do Not Know	4 5 6 7 8 9 10 11 88 99	
14.	(a) What are the most occurrence of 3 disasters in your township?	(b) How often does these occur?		(c) How do you think why these disasters happen?	
		Every Year 1- 5years 5 -10 years 10-20 years 20-50 years Once only Never happened but it may happen Do Not Know	1 2 3 4 5 6 7 99	Natural causes Human causes God's will / Karma Climate Change Do Not Know	1 2 3 4 99
		Every Year 1- 5years 5 -10 years 10-20 years 20-50 years Once only Never happened but it may happen Do Not Know	1 2 3 4 5 6 7 99	Natural causes Human causes God's will / Karma Climate Change Do Not Know	1 2 3 4 99

		Every Year	1	Natural causes	1
		1- 5years	2	Human causes	2
		5 -10 years	3	God's will / Karma	3
		10-20 years	4		
		20-50 years	5	Climate Change	4
		Once only	6	Do Not Know	99
		Never happened but it may happen	7		
		Do Not Know	99		

15.	In particular, do you know why earthquakes happen? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – any others?*	Natural causes Human causes God's will / Divine Punishment Climate Change Do Not Know	1 2 3 4 99
16.	Do you know the impacts after the earthquake? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – any others?*	Damage to buildings Loss of life Loss of livelihood and property Damage to infrastructure Tsunami Landslides Industrial Accidents Dam break Fire Others_____ Do Not Know	1 2 3 4 5 6 7 8 9 88 99
17.	Have you felt any earthquakes in the past?	Yes No No Response	1 2 99
18.	Do you know/remember any major earthquake that has occurred in Myanmar?	Yes No Do Not Know	1 2 99
19.	Is your township prone to	Yes	1

	earthquake?	No	2
		No Response	99
20.	Do you know/remember any major earthquake that has occurred in other countries?	Yes	1
		No	2
		Do Not Know	99
21.	Are you / your family safe from earthquakes?	Yes	1
		No	2
		Do Not Know	99
22.	Do you think earthquakes can be predicted?	Yes	1
		No	2
		Do Not Know	99
23.	How can they be predicted by indigenous knowledge? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible*	Movement of Ants	1
		Birds movement	2
		Dogs movement	3
		Early (strange) noises	4
		Others----------	88
		No Response/ Do Not Know	99
24.	How earthquake can be measured? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible* Prompt *once- anything else?*	Magnitude/Richter scale	1
		Intensity	2
		Combination of both	3
		Do Not Know	99
25.	Do you know your township located in which seismic zone?	Zone1	1
		Zone2	2
		Zone3	3
		Zone4	4
		Zone5	5
		Do Not Know	99
26.	Have you ever seen/heard/received any information for earthquakes in Myanmar?	Yes	1 -> A
		No	2
		Do Not Know / Cannot Remember	99
A	How did you see/hear/receive	Radio	1

	that information? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – any other sources?*	Television Newspaper / Magazine Other written (leaflet, poster, etc.) Public events (theatre, songs, marches, celebrations, etc.) Meeting / Workshop Training/ Public Awareness Sessions Simulation exercise Word of mouth: Government Word of mouth: Police Word of mouth: Village Head Word of mouth: Friend/Family Word of mouth: NGO/CBO/religious org Other_____ Do Not Remember	2 3 4 5 6 7 8 9 10 11 12 13 14 88 99
27.	Did you hear about the discussion on earthquake in your environment?	Yes No No Response/ Do Not Know	1 2 99
28.	Is there any public awareness session about earthquake in your ward/ village?	Yes No Do Not Know	1 2 99
29.	In your family, do students share their school lessons about earthquake knowledge to adults at home?	Yes No No Response/ Do Not Know	1 2 99
30.	Do your family members discuss each other about what to do, how to stay and where will meet and so on when earthquake happen?	Yes No No Response/ Do Not Know	1 2 99
31.	Do your family have	Yes	1

	earthquake preparedness plan?	No	2
		No Response/ Do Not Know	99
III. Community Attitude on Earthquake			
32.	When earthquake shaking, will you run outside of building if you can reach there within 5 seconds?	Yes	1
		No	2
		No Response/ Do Not Know	99
33.	When earthquake shaking, if you are in outside of building will you run inside into the building?	Yes	1
		No	2
		No Response/ Do Not Know	99
34.	During earthquake, will you do "Crouch, Cover and Hold on"?	Yes	1-35
		No	2 – A
		No Response/ Do Not Know	99-35
A.	Why you will not do "Crouch, Cover and Hold on"?	Do Not Know Suddenly What to Do	1
		Do Not Have Practice	2
		Do Not Have Table, Chair and Bedstead	3
		Other_____	88
		No Response/ Do Not Know	99
IV: Community Practice on Earthquake			
35.	Do you think there is anything that can be done to prepare for earthquakes? *<u>Only one</u> answer possible*	Yes	1 - A
		No / It is God's will	2 -36
		Do Not Know	99-36
A	What can be done to prepare in advance to minimize loss and damage from earthquake? *<u>Do not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – anything else?*	Know about earthquake	1
		Assess the building safety	2
		Strengthen / retrofit the house	3
		Make not to falling of heavy things easily	4
		Make family/household plans	5
		Identify safe places within	6

		&outside house	
		Remind to family members to turn off gas and electric stove	7
		Build /move to a new house	8
		Clear the routes of exit and reserve exit	9
		Educate/ public awareness	10
		Teach children and elders	11
		Join disaster teams/volunteers	12
		Keep Fire extinguisher	13
		Protect important documents	14
		Save money	15
		Stockpile food/water/materials	16
		Help vulnerable people	17
		Learn first aid	18
		Other_____	88
		Do Not know	99
B	What you will do in case of during earthquake?		
(i)	While within building (ground shakes) <u>*Multiple*</u> *answers possible* *Prompt once – anything else?*	Run out of the building	1
		Crouch, Cover and Hold	2
		Will go to safe place	3
		Duck into a sturdy table or desk	4
		Stay away from falling objects	5
		Help my family / children	6
		Just wait till shaking stops	7
		Others_____	88
		Do Not know	99
(ii)	While outside the building (eg. road / market) <u>*Multiple*</u> *answers possible* *Prompt once – anything else?*	Crouch, Cover and Hold	1
		Run to open space	2
		Will run into nearby building	3
		Stay away from buildings, trees, electric poles	4

		Run to my home	5
		Others_____	88
		Do Not know	99
C	What will you do after earthquake? <u>*Multiple*</u> *answers possible* *Prompt once – anything else?*	Get update earthquake news from radio and Television	1
		Send people who get injuries to hospital	2
		Check the damages of building	3
		Be ready for aftershock	4
		Stay away from building and electric lines	5
		Not using match, switch off electricity and use torch light and battery	6
		Run away quickly if get the smell of gas, petrol and fuel	7
		Be aware of fire as the aftermath of earthquake	8
		Be aware of breaking dam and reservoir	9
		Be aware of landslide	10
		Be aware of Tsunami as the aftermath of earthquake	11
		Others_____	88
		Do Not know	99
36	Please give your suggestions on earthquake preparedness?		

Questions are finished and thank you very much for your time and answers. Anything else would like to talk and ask something?

Appendix B Survey Questionnaire (Government)

Data Entered By: _____ Date: _____ / _____ / 2018	**ID No.** _____

KAP SURVEY – EARTHQUAKES

QUESTIONNAIRE –Government

a. Date conducted: __ / __ / 2018	b. Enumerator ID: _____	c. Checked by supervisor (signature): _____

Department INFORMATION

	Department	

GOVERNMENT STAFF

1.	What is your <u>current position</u>? *<u>Only one</u> answer possible*	Junior staff Senior Officer Ward Administrator Township Administrator Engineer Other _____ No response	1 2 3 4 5 88 99
2.	Does your Township has a disaster management committee	Yes No Do Not know	1-> A 2-> 3 9->3
A	Do you represent your organization in the committee?	Yes No Do Not know	1 2 99
B	How often does the Township Disaster Management Committee meets	Once a month 1-3 months Not regularly No response	1 2 3 99
C	Does your Township / Ward have a disaster management plan	Yes No No response	1 2 99
D	What hazards does it cover? *<u>Do</u> <u>not</u> read answer options*	Floods Cyclone	1 2

	<u>Multiple</u> answers possible *Prompt once – anything else?*	Earthquake Drought Fire Epidemics Others_____ Do Not know	3 4 5 6 88 99
3.	Does the plan (Ward / Township / Department) focus on reducing risk?	Yes No Do Not know	1 2 99
4.	Do you have an implementation plan for the plan?	Yes No Do Not know	1 2 99
5.	Does the plan has monitoring and implementation mechanism?	Yes No Do Not know	1 2 99
6.	Does your department or township organize awareness programme?	Yes No No response / Do Not know	1-> A 2–>7 99-> 7
A.	How often do they organize the awareness programme?	6 Months One year Not regular No response / Do Not know	1 2 3 99
B.	What hazards are being covered in your awareness programme? *<u>Do</u> <u>not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – anything else?*	Floods Cyclone Earthquake Drought Fire Epidemics Others_____ Do Not know	1 2 3 4 5 6 88 99
7.	In your opinion is township or community is adequately prepared / mechanism in place to deal with	Yes No Do Not know	1 2 99

	earthquakes?		
8.	Do you know what are the likely impacts if there is an earthquake effecting your township?	Yes No Do Not know	1 -> A 2 99
A	Do you know the impacts (After the earthquake)? *<u>Do</u> <u>not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – anything else?*	Damage to buildings Loss of life Loss of property Damage to infrastructure Damage to Schools Damage to Hospitals Tsunami Landslides Industrial Accidents Dam break Fire Combination of above Others_____ Do Not know	1 2 3 4 5 6 7 8 9 10 11 12 88 99
9.	In your opinion who are most vulnerable group affected by earthquake?	Women Children's Elderly Disabled Poor People Rich People Farmers Everyone in the community Others_____ Do Not know	1 2 3 4 5 6 7 8 88 99
10.	In your opinion does your city or community has adequate resources to respond to earthquake (search and rescue)?	Yes No No response / Do Not know	1 2 99
11.	Does your department	Yes	1-> A

	organize or participate in mock drill or evacuation drill	No No response / Do Not know	2 –> 12 99 -> 12
A.	What kind of drill and hazards do you practice? *<u>Do</u> <u>not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – anything else?*	Floods Cyclone Earthquake Drought Fire Epidemics Others_____ Do Not know	1 2 3 4 5 6 88 99
B.	Do you participate in the drill?	Yes No No response / Do Not know	1 2 99
C.	How often do they organize the drill?	6 Months One year Not regular No response / Don't know	1 2 3 99
12.	Do you think there is a need for organizing drill (multi-hazards) regularly?	Yes No No response / Do Not know	1 2 99
13.	What can be done by local government to minimize damages? *<u>Do</u> <u>not</u> read answer options* *<u>Multiple</u> answers possible* *Prompt once – anything else?*	Know /assess the risk Identify high risk areas Establish Disaster Management Committee Assess the building safety Strengthen / retrofit buildings Enforce building code for new buildings Assess the safety of school, hospital Develop / implement Disaster Management Plan Educate / public awareness School awareness programme	1 2 3 4 5 6 7 8 9 10

		Form /strengthen disaster teams/volunteers	11
		Strengthen partnerships	12
		Other _____	88
		Do Not know	99
14.	Whom should we engage in making the township prepared (partnership)?	Government Departments	1
		Township /Ward Development Committee	2
		Township / Ward Development Support Committee	3
		Community members	4
		Red Cross	5
		Children's	6
		Women	7
		Disabled	8
		Religious leaders	9
		Community leaders	10
		Private sector / business	11
		Universities	12
		Media	13
		Civil Society Organizations (INGO/NGO)	14
		Other _____	88
		Don't know	99
15.	In your opinion, what are the challenges and gaps for township earthquake resilient?		
16.	Please provide your recommendations in order to address these challenges and to be better preparedness for earthquake in your township.		

We are finished. Thank you very much for your time. Is there anything else you would like to tell me or do you have any questions for me?

Appendix C **Sample Size Calculation**

The following formula is used to calculate the minimum required sample size.

$$\text{sample size}_{\,r} = \frac{Z^2 * p * q}{e^2}$$

A confidence level is considered at 95%. Thus, Z value is 1.96. As for the percentage of the population (p), since there are no data available on the proportion currently who have experienced in earthquake shakes, the research takes the worst case scenario and set p = 0.5. Consequently, q = 0.5. Regarding e, a margin of error of ± 6.5% will be accepted because it is a new study in this township.

Confidence level = 95%

Sample size $_r$ = the required sample size

Z = Z value

= 1.96 (for 95% confidence level)

p = percentage of the population having the characteristic

= 0.5

q = 1 – p

= 1- 0.5 = 0.5

e = margin of error

= 0.065

$$\text{sample size}_{\,r} = \frac{1.96^2 * (0.5) * (0.5)}{0.065^{\,2}}$$

$$= \frac{0.9604}{0.004225}$$

$$= 227.3136$$

The minimum sample size (required) would be 227.

For finite population correction factor, the second step is to estimate the new sample size with a finite population correction factor. With the exact number of the population, the sample size can be adjusted, using the following formula.

$$\text{New sample size} = \frac{\text{sample size}_{\,r}}{1 + \frac{(\text{sample size}_{\,r} - 1)}{N}}$$

N = Population size

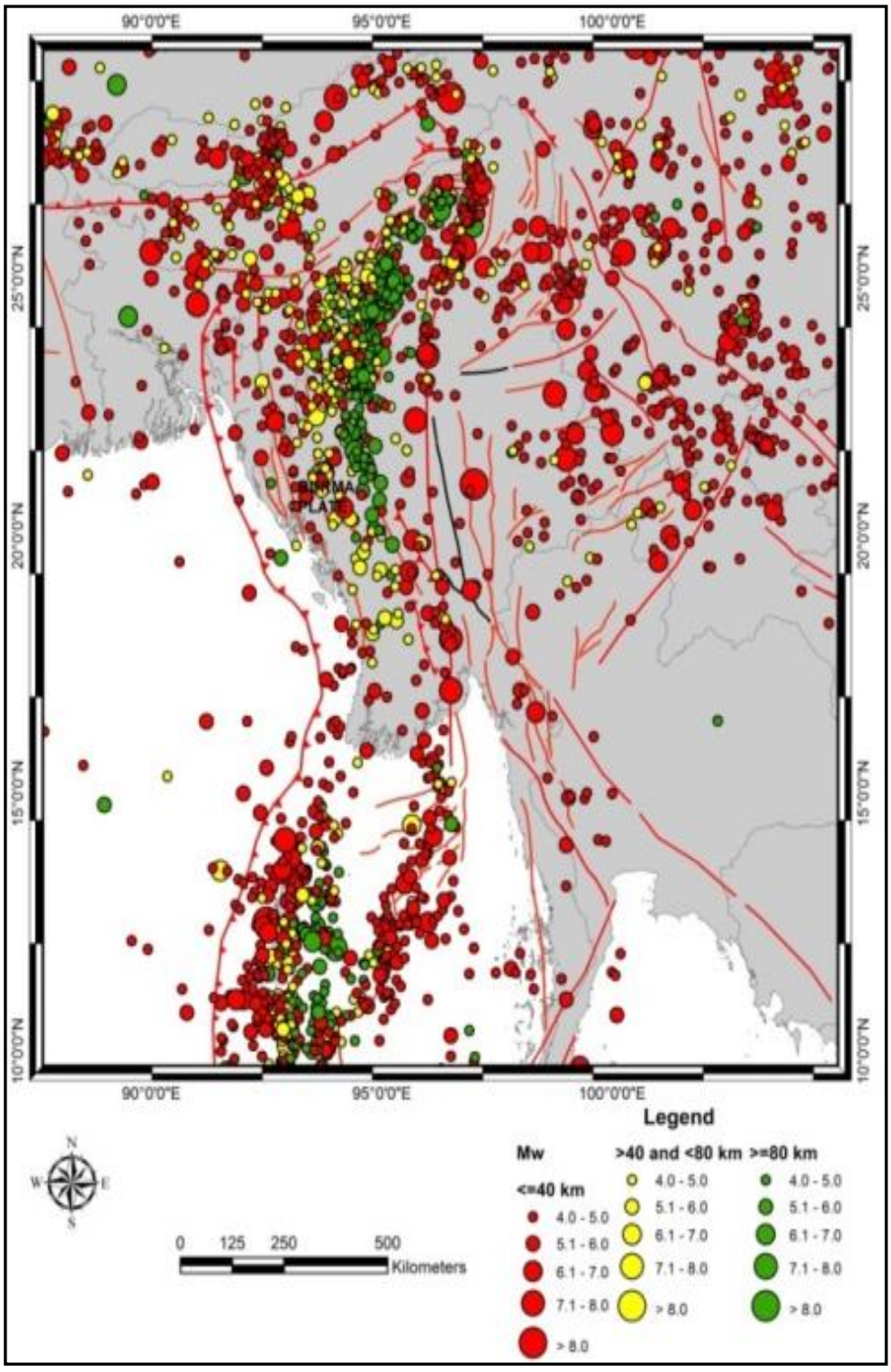
New sample size = adjusted sample size

The population size is 4,012 households; so N= 4.012.

$$\text{New sample size} = \frac{227}{1 + \frac{(227-1)}{4012}}$$
$$= \frac{227}{1 + 0.05633}$$
$$= \frac{227}{1.05633}$$
$$= 214.8949$$
$$= 215$$

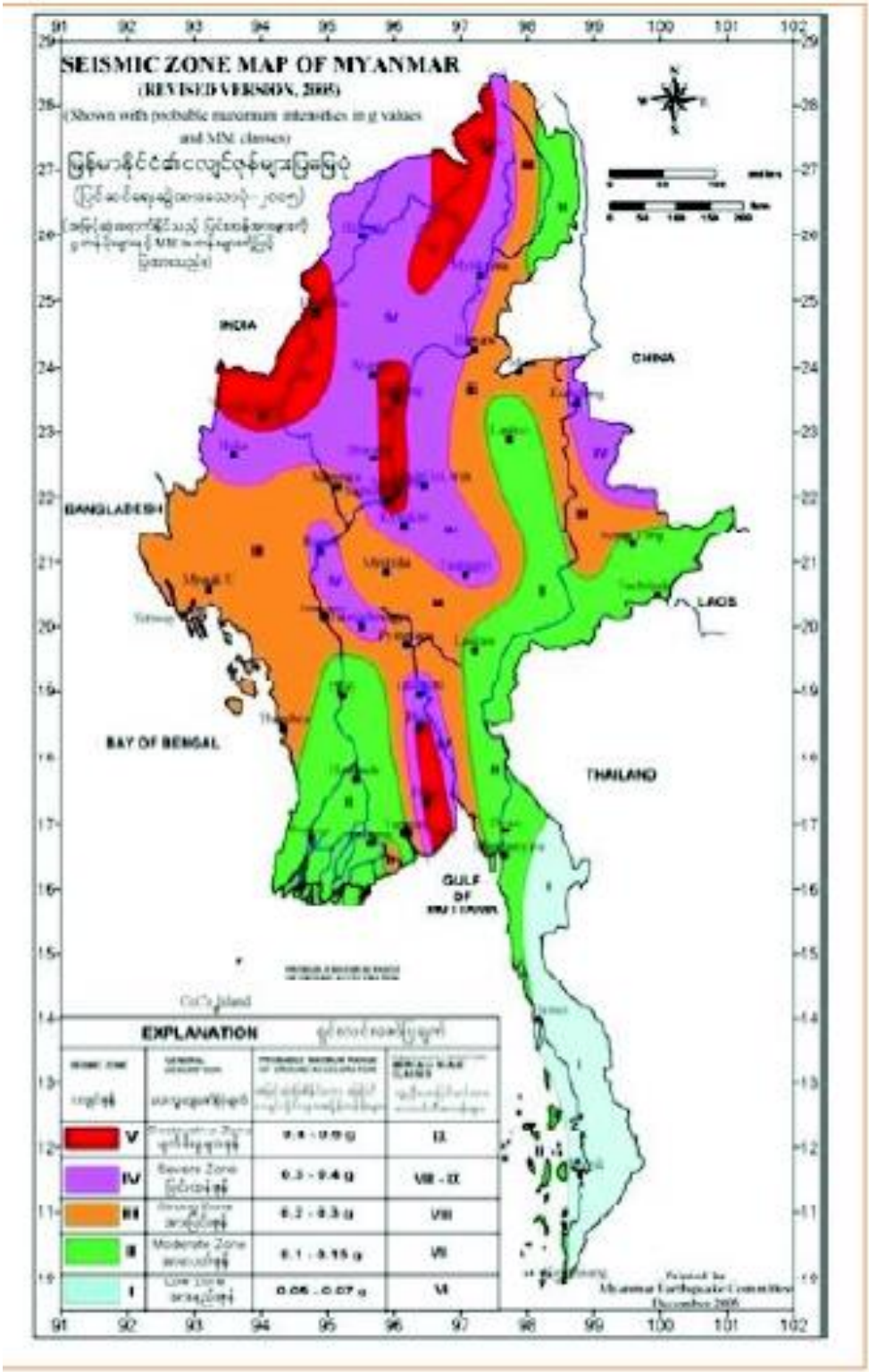
Finally, the minimum sample size for the population 4,012 is 215 households.

Appendix D Seismicity Map of Myanmar



Source: International Seismological Center, ISC earthquake catalog, 1906 – 2014

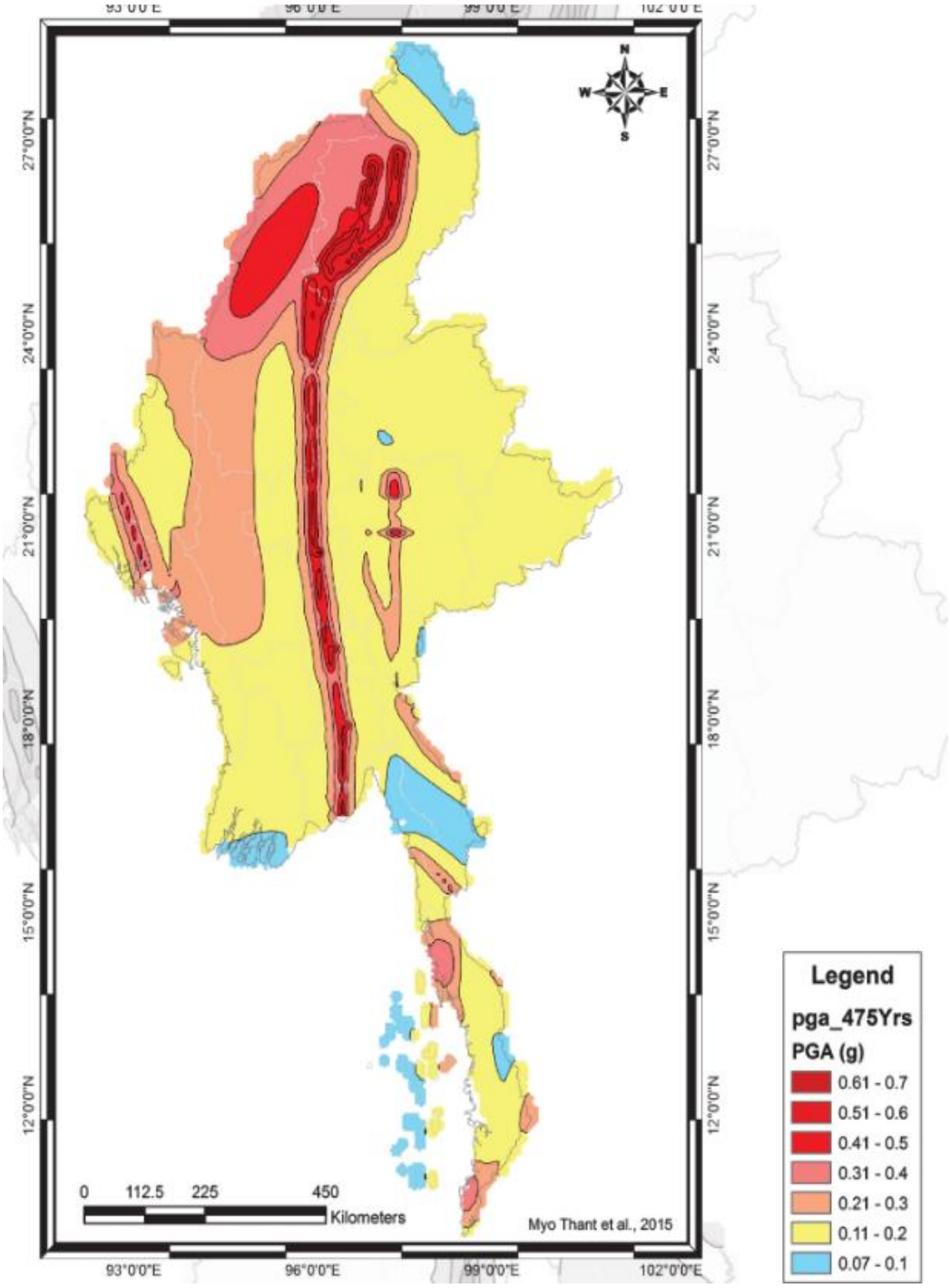
Appendix E Seismic Zone Map of Myanmar



Source: MEC

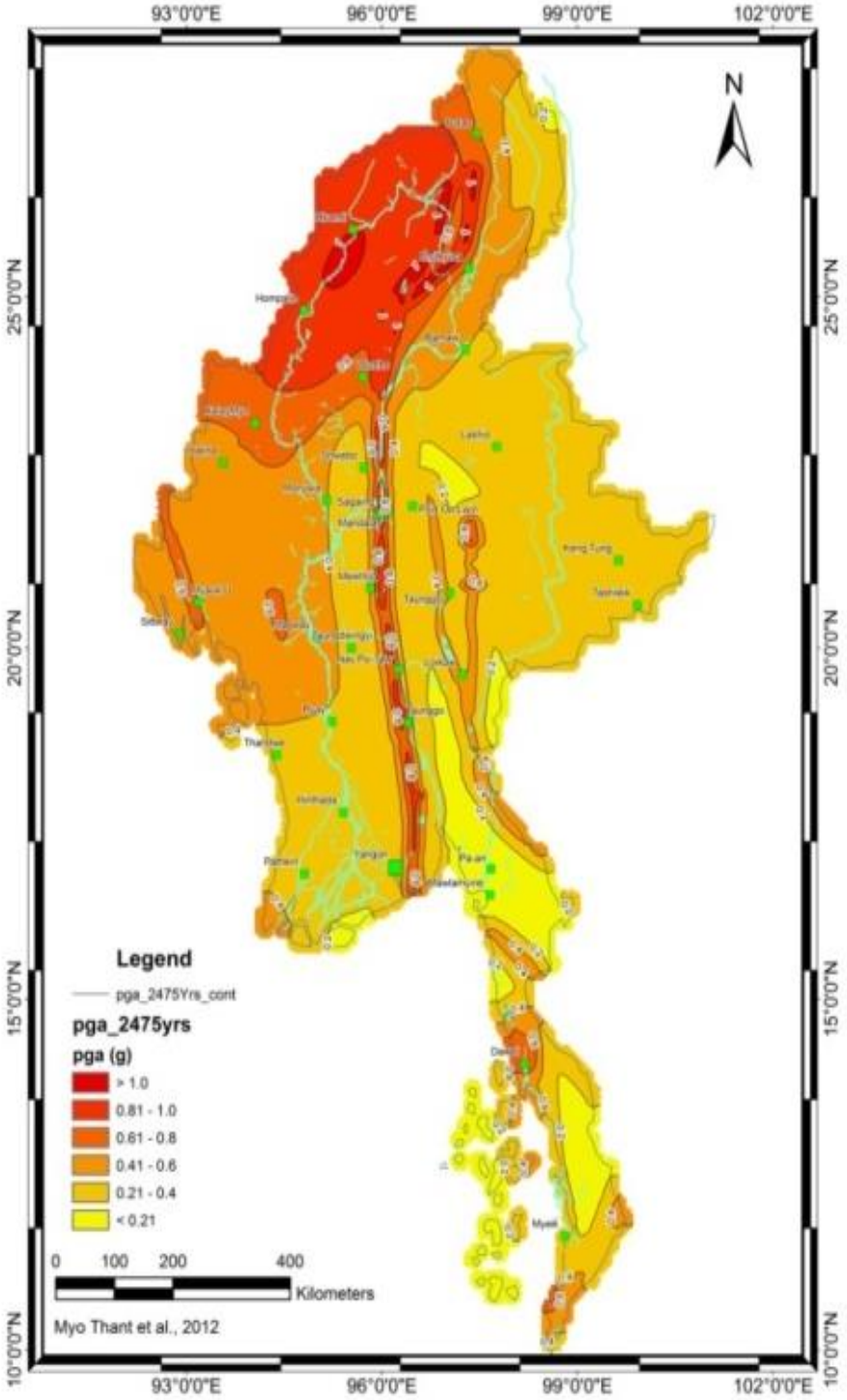
Source: Myanmar Earthquake Committee, 2005

Appendix F Seismic Hazard Map of Myanmar for 475 Years Recurrence Interval



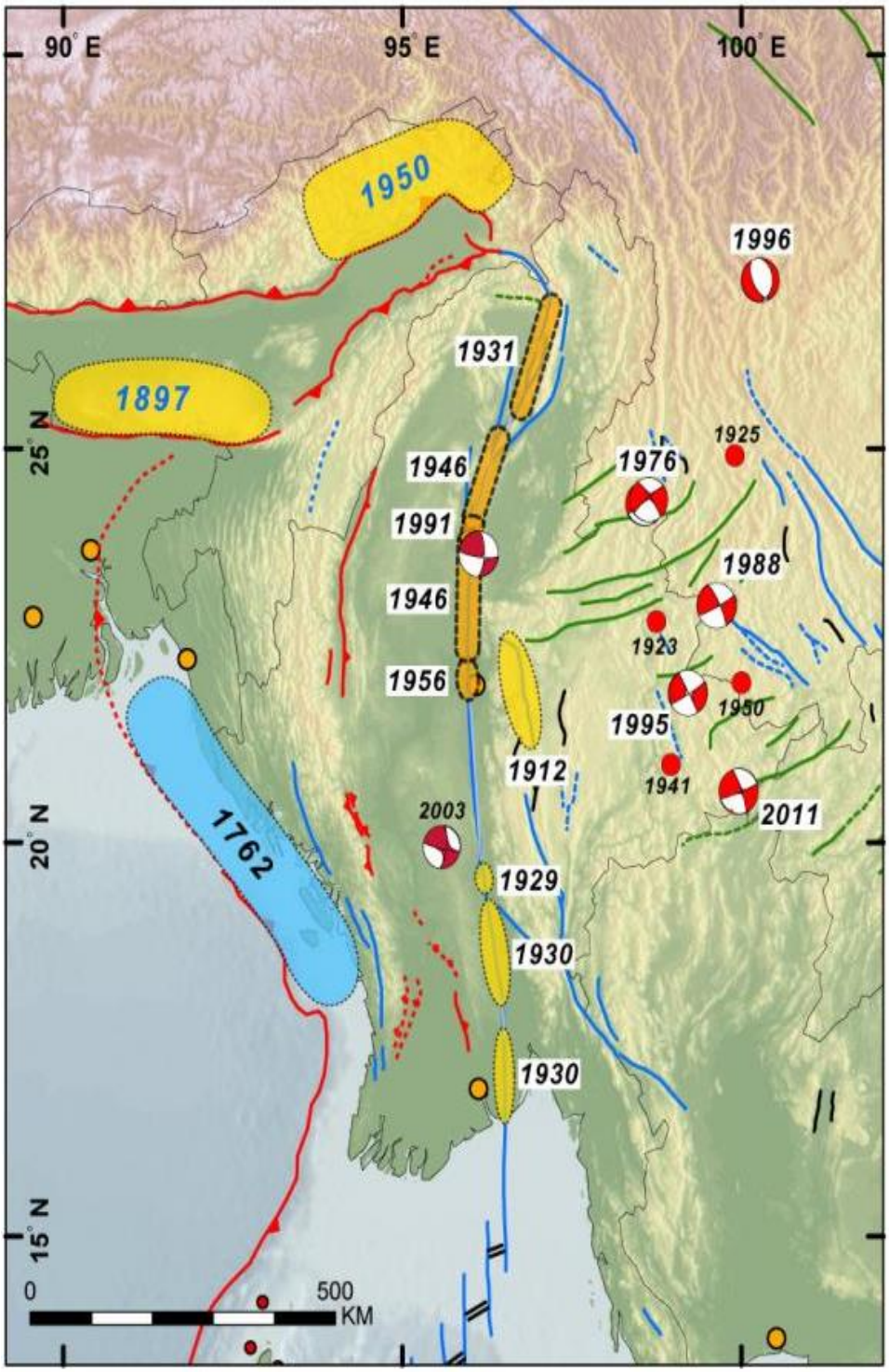
Source: Myo Thant et al., 2015

Appendix G Seismic Hazard Map of Myanmar for 2475 Years Recurrence Interval



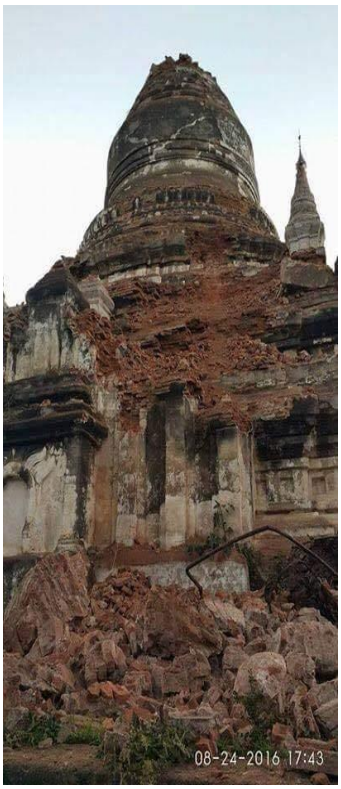
Source: Myo Thant et al., 2015

Appendix H Past Major Earthquakes Along the Sagaing Fault and Others in Myanmar

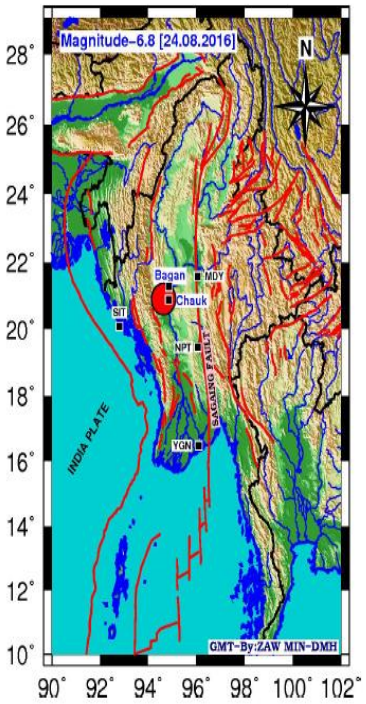


Source: Wang Yu et al, 2012

Appendix I Information and Damages of Chauk Earthquake



CHAUK EARTHQUAKE (2016)



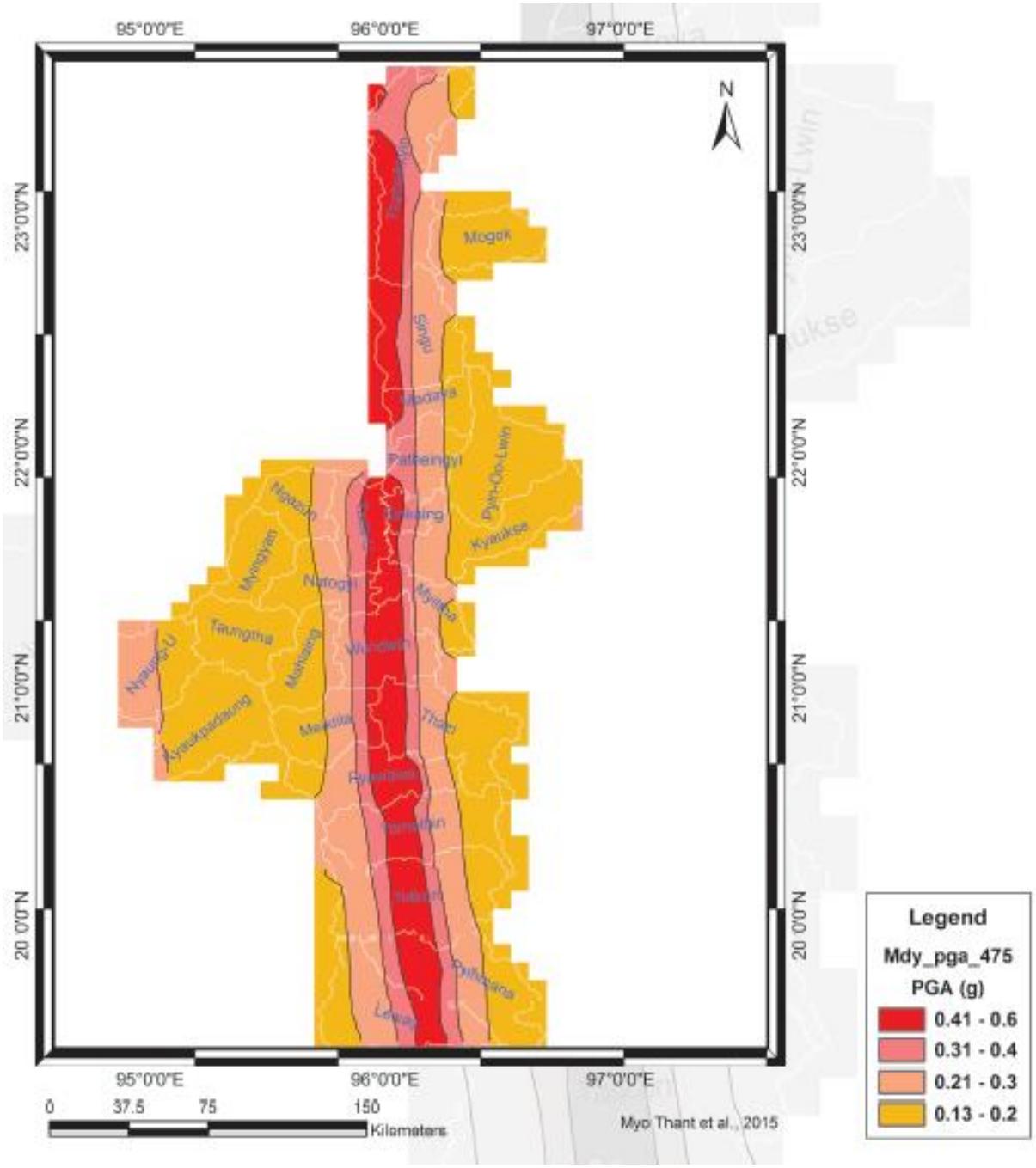
- 24 August 2016
- 17:04:55 (M.S.T)
- Lat:20.90 N°, Lon:94.63 E°
- Depth: 88km
- M = 6.8

No.	Damage/ Dead	Total
1	Ancient Pagodas	477
2	Peoples died	3
3	Monasteries	9
4	Parliament, Schools and Houses	5

Source from Ministry of Culture-MOC

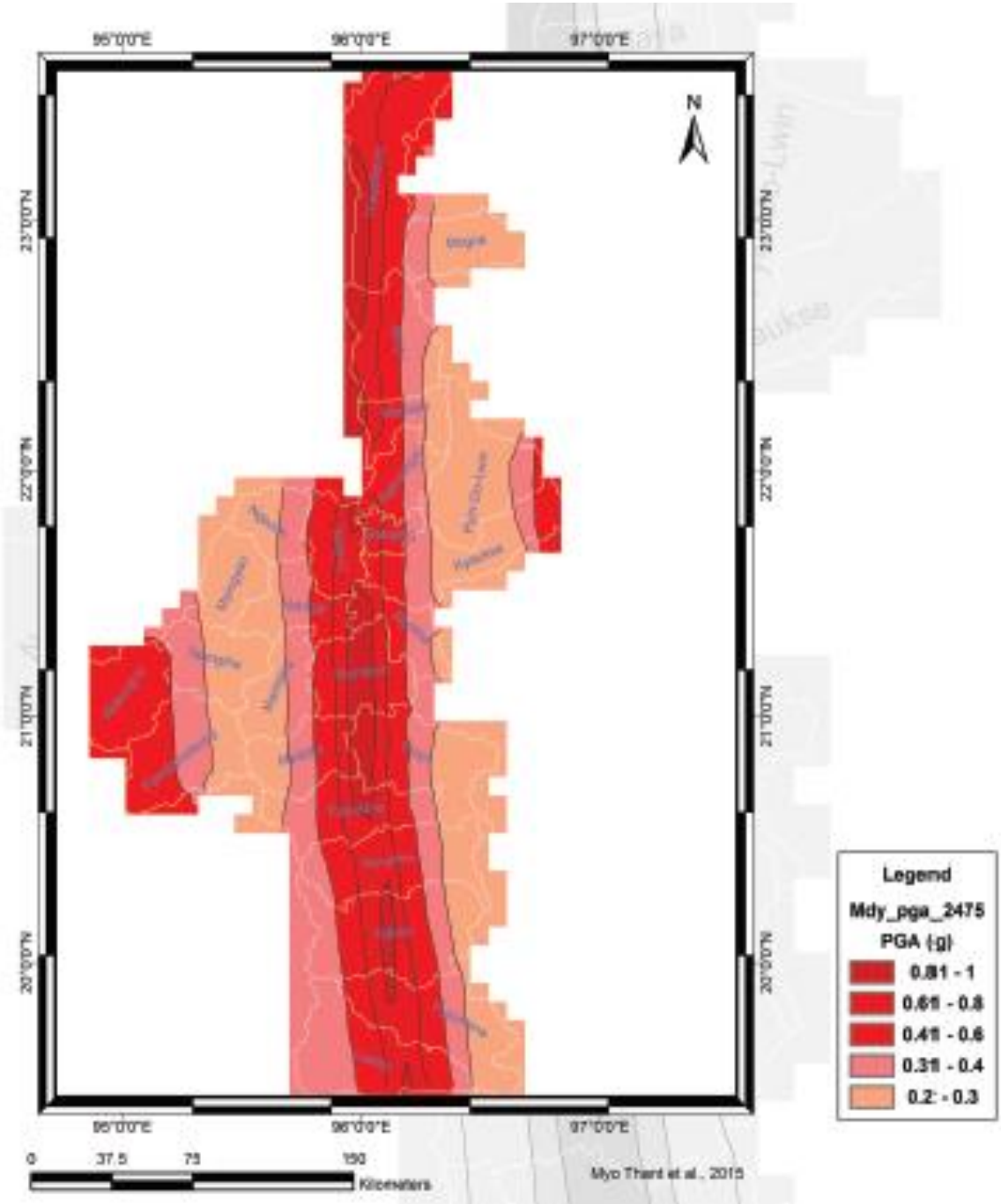
Source: Hla Hla Aung, 2017

Appendix J Seismic Hazard Map of Mandalay Region for 475 Years Recurrence Interval



Source: Myo Thant et al., 2015

Appendix K Seismic Hazard Map of Mandalay Region for 2475 Years Recurrence Interval



Source: Myo Thant et al., 2015