



The Role of Public Health and Earthquake Occurrences in Myanmar: A Case Study of the 2017 Taikkyi Earthquake

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Most of the historical earthquakes and recent seismicity in Myanmar indicate that earthquake occurrences are closely associated with major fault zones of two different structural trends in N-S direction and NW-SE direction. Series of pull-apart basins along the Burma plate both in Myanmar and in the Andaman Sea are bounded by north-striking faults and controlled by ENE-WSW trending normal faults with dipping either way. The Burma plate has been rifting and drifting towards north, with relative to SE Asia by the back-arc spreading process in Central Andaman Basin since Neogene. Northward movement of the Burma plate accommodates the crustal displacement which in turn, cause continental intraplate earthquakes along the basin bounding faults in the Central Myanmar Basin. Myanmar region is tectonically and seismically active as indicated by occurrences of 15 major earthquakes with $M \geq 7.0$ in the past 100 years. Departments of Disaster management are formed all over Myanmar in every township, consisting of sub-committees: information sub-committee, search and rescue sub-committee, public health and first aid sub-committee, training and fund raising sub-committee. Disaster responses mainly involve search and rescue, helping the injured with medical aid, then providing emergency shelter, food and water.

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1. INTRODUCTION

When the rocks on which our homes are built move abruptly by an earthquake and shake the ground severely, it causes damage our homes and injured people. The first earthquake hazard is the effect of ground shaking. Ground shaking of earthquake usually causes severe damage to urban areas, resulting in the loss of life and damage to homes and other infrastructures. Earthquake sometimes trigger tsunamis, landslides and occasionally volcanic activity. Another secondary hazard of earthquakes is fire. Fires occur due to damage to gas pipe lines, fuel tanks. After a major disaster, public health workers are called upon to participate in a coordinated response to save life and prevent unfavorable outcomes to vulnerable populations. In an earthquake-prone country like Myanmar, a comprehensive disaster management system is

greatly needed for providing assistance to disaster activities such as earthquake drill exercises with act of before, during and after. Earthquakes occur either along the tectonic plate boundary or along the fault in the interior of the plate. Myanmar is located in seismotectonically active region. The Taikkyi earthquake is one of significant earthquakes which has occurred in plate-interior setting [1].

2. TECTONIC BACKGROUND

The town Taikkyi is situated in the Ayeyarwady Delta basin, one of sub-basins in N-S elongated Central Myanmar Basin in Myanmar. The faults in the basin are recently inverted and it is possible the inversion is still active as in Salin and Pyay basin [2]. The Ayeyarwady basin is one of the rift basins in N-S trending elongated Central Myanmar Basin (Fig. 1).

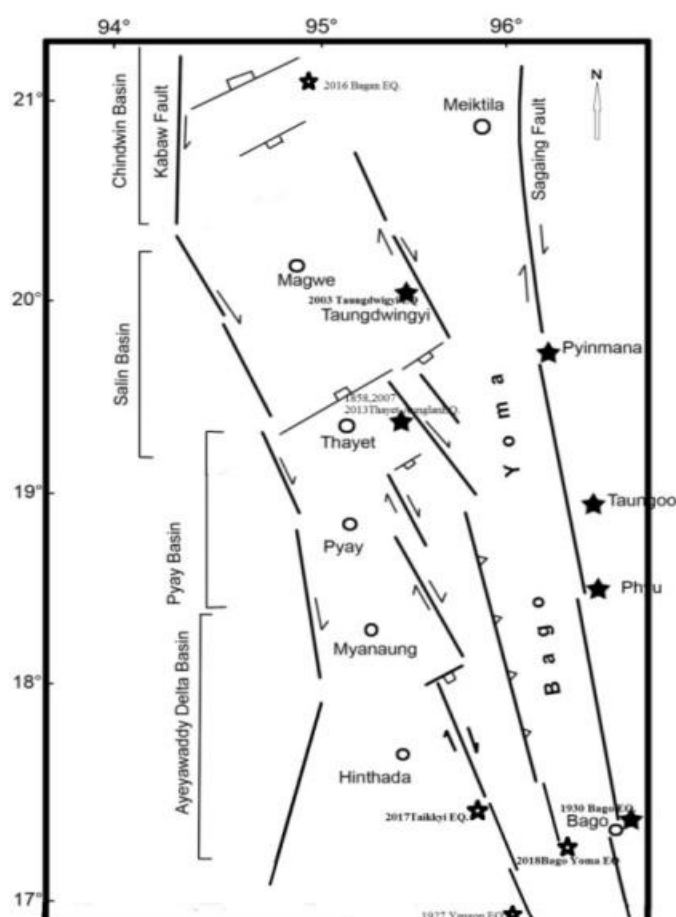


Fig. 1. Seismicity in the Ayeyarwady Delta Basin, Pyay Basin, Salin Basin and Chindwin Basin along the NW-trending transfer zone of Central Myanmar Basin. Seismicity along the Sagaing fault is shown in the map

It is bounded with NNW-SSE trending fault to the east and a fault that separates the basin from Rakhine Yoma in the west. These basin bounding faults are capable of triggering earthquakes in the region. Intraplate stresses cause earthquakes on particular faults. Most area of the Ayeyarwady basin is covered with alluvium so that surface geology can only be found in very few areas. Structure and geology are deciphered mainly on the basis of seismic profile [3]. NNW-SSE trending folds and NNE-SSW striking transverse faults occur in Taikkyi area.

The intraplate seismicity in the Central Myanmar Basin are: the Taungdwingyi earthquake (2003 M 6.8 D 10km), the Thayet-Aunglan earthquake (2013 M 5.4 D 11km), the Yangon earthquake (2013 M3.4 D10km), the Gwegyo earthquake

(2016 M 4.7, estimated depth 15km), the Taikkyi earthquake (2017 M 5.1 D 10km), the Bago Yoma earthquake (2018 M 6.0 D 10 km) [4] (Fig. 1). The present-day deformation field of the Basin-Uplift province is revealed by the pattern of seismicity of horizontal velocity estimates data derived from GPS, which show 8 mm/yr between basin and uplift [5,6].

3. METHODOLOGY

3.1 Setting

The town Taikkyi was hit by an earthquake with magnitude 5.1 on 13th March 2017 at 14:19:06 (UTC). The epicenter is situated at latitude 17.415°N, longitude 95.999°E, at focal depth 10 km (USGS) (Fig. 2). The shock was felt by nearby cities of Thayawady, Okkan, Mhawbi and

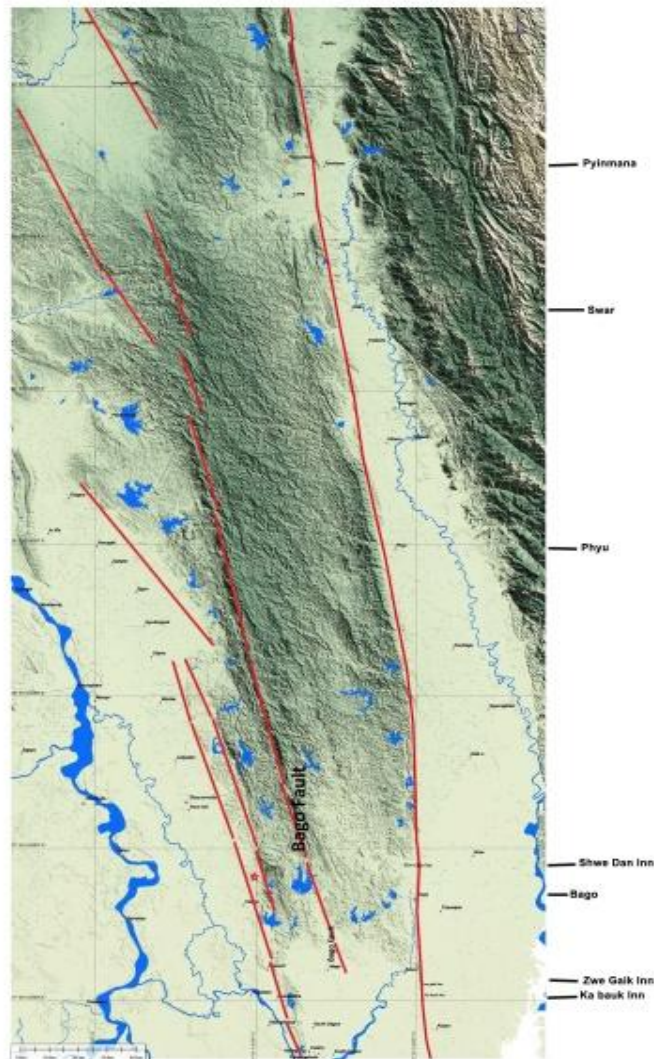


Fig. 2. Shaded relief map showing the location of epicenter of the Taikkyi earthquake on the western side of the NNW-oriented Bago Yoma mountain range

Yangon region. The main shock was initiated at approximately 33 km southeast of Thayawady and 10 km northeast of Taikkyi, (USGS) with rupture propagating southward for about (75) km towards Yangon. The shock was most severe near Taikkyi. After that, an earthquake with average magnitude of 4.8 took place on the same evening. Several aftershocks with average magnitude of less than 4.5 occurred on following days.

3.2 Method of Analysis

The important observation from satellite imagery, topographic map, aerial photograph and field investigation are introduced to better understand the relation between seismicity and tectonics. To better understand the seismic hazard posed by the fault, the surface trace of the fault has been mapped by interpretation of Landsat TM images and shaded relief map. The field survey was conducted in the town Taikkyi and the epicentral area. A number of interviews were done to the local people to get a felt report. The causative fault of this earthquake is Taikkyi fault trending in NNW-SSE direction for (80) km length, with a mix of thrusting and right-lateral motion. The Taikkyi fault is an active reserve fault with right lateral strike-slip component, as a result of basin inversion. It is a basin bounding fault of the Ayeyarwady Delta Basin. Thrust fault exist where compressional forces are squeezing the crust to shorten and thicken due to vertical motion. If a region is under compression, crustal blocks try to escape with lateral motion [7,8].

4. RESULTS

The Taikkyi earthquake spread a wide area including Thayarwaddi, Okkan in the north, TawLaTi, Aphauk in the west, Yangon in the south and surrounding area west of Bago Yoma. The region surveyed was found to have three grades of the Modified Mercalli Intensity scale: VI, VII, VIII based on people's perception, indoor effects, damaged buildings, and ground survey of affected area. A small number of simply constructed houses and aged buildings were collapsed. Upper portion of some pagodas are fallen down. Position of objects in monastery was shifted and brick fences are fallen down. Some portion of water pipe-line from Gyophyu Reservoir to Yangon has been uplifted and shifted. It is due to that the ground motion was strong enough to fling up the ground as the fault rupture beneath it. The overall width of the pavement was reduced and shortened (Fig. 3a-i).

People of Taikkyi strongly and distinctly felt the quake. Local people are interviewed for a felt report of ground deformation during Taikkyi earthquake. Villagers explained that the main shock was very powerful and they felt like their houses were hit by an elephant with great fury. Intensity (MMI VII) was reached in the town Taikkyi where the shaking was severe. Isoseimals followed the trace of the Taikkyi fault in elongated pattern of NNW-SSE direction. Aftershock activity of the Taikkyi earthquake was distributed over much of Taikkyi area. The seismic activity migrated to the south towards Yangon [1].

4.1 The Role of Public Health and Earthquake Occurrences

Earthquakes are probably the scariest among the natural disasters that teach us about the forces of nature and their unpredictability knowing that there is nothing we can do to prevent the occurrences of earthquakes we are forced to learn from our own experience [9]. Earthquake usually causes severe damage to urban areas, resulting in the loss of life and damage to homes and other infrastructures. Sometimes severe crushing injuries to the head or chest, external or internal hemorrhage, or drowning from earthquake-induced tidal waves like tsunamis needs medical care [10].

Departments of disaster management are formed all over Myanmar in every township, consisting of sub-committees: information sub-committee, search and rescue sub-committee, public health and first aid sub-committee, training and fund raising sub-committee. Disaster responses mainly involve search and rescue, helping the injured with medical aid, then providing emergency shelter, food and water. Various professional disaster relief workers are organized and send to the area where the seismic hazard is the most serious and all kinds of disaster relief materials are delivered to affected area. Urgent action is taken to restore water supply. It is also necessary to show concern for the well-being of the affected people and to reconstruct their homeland.

Public health professionals focus on preventing diseases and injury by promoting healthy lifestyles. They implement educational program, developed policies, administrative services, conduct research, and regular health systems to achieve the goals. To prevent deaths, injuries, and illness, public health field staffs provide

emergency medical care. To provide emergency assistants to disaster affected people and to do cash donation for earthquake disaster affected victims.

Most earthquakes are followed by many aftershocks, some of which may be as strong as

the main shock itself. In some cases landslides may be triggered by an aftershock, after having been primed by the main shock. Again, it is important to recognize that earthquakes will recur and that lesson learned during the surveillance effort following a particular earthquake can help save lives during subsequent earthquakes [11].

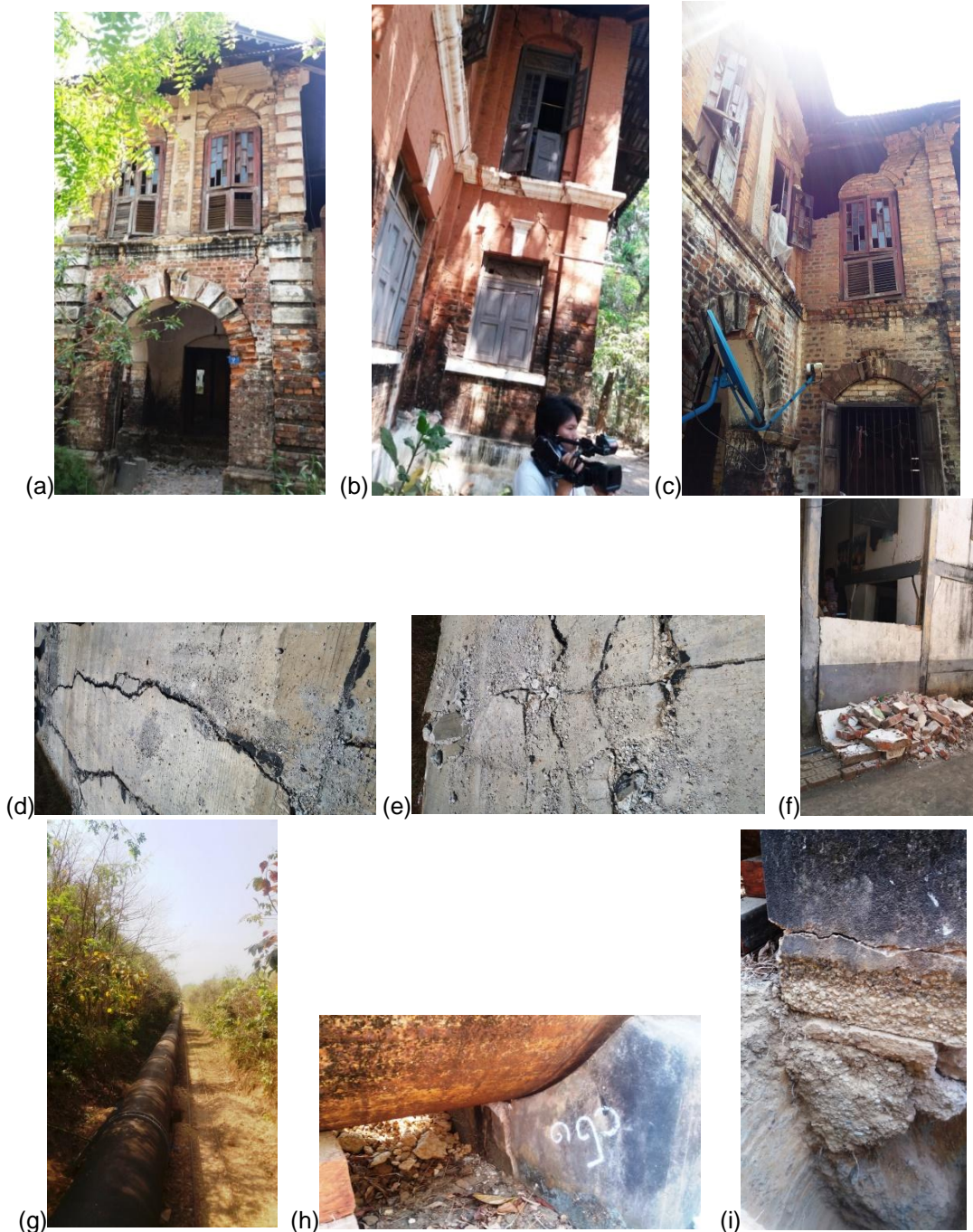


Fig. 3. (a,b,c) Photos of damage to a building in which upper floor was fallen to the ground due to Taikkyi earthquake. (d,e) damage to the pavement of the road in Taikkyi. (f) Damage to the wall of a building. (g,h,i) Damages at the base of Gyophyu pipeline

Public health problems common to all natural disasters are:

1. Social reaction
2. Communicable diseases
3. Population displacement
4. Climate exposures
5. Food and nutrition
6. Water supply and sanitation
7. Mental health
8. Damage to the health infrastructures

Public health systems play an integral role in preparing communities to respond to and recover from threats and emergencies. The public health consequences of disasters and emergencies initially affect local jurisdictions. During the initial response, the people and communities that are impacted must rely on local community resources. As a result, all state, local, tribal, and territorial emergency response stakeholders must be prepared to coordinate, cooperate, and collaborate with cross-sector partners and organizations at all government levels when emergencies occur, regardless of the type, scale, or severity [12]. Public health has many types of jobs to do, among which community health, epidemiology, and environmental health are related to earthquake disaster. Public health professionals are responsible for initiating the public health response during the first 24 hours of a disaster and then coordinating with the existing public health preparedness for disaster management such as air quality, water pollution problems, food safety, and waste sanitation [13].

5. DISCUSSION AND CONCLUSION

Public health professionals play a major role in the disaster management program in a country. They work together with search and rescue sub-committee members for injured and vulnerable victims to put them in safe shelters giving medical aids as soon as possible. Some affected people are afraid of staying in the building because their home was happened to get collapsed due to earthquake. They are placed in the make-shift tents. This is fear and panic caused by earthquake shaking. Cash donations are provided by the township administrative personnel to the earthquake-affected victims. People who live in the earthquake-prone region needs a good preparedness program with the act of: before, during and after training for future event. Before an earthquake disaster, one must practice how to protect himself when ground shaking starts. You have to keep household

things to be secured from falling down. During the disaster, check people in your surrounding whether injured or need help. Use emergency first-aid kit and give necessary treatment to the victims before public health professionals come. After disaster, take a look around your neighborhood to know the degree of damage and to take action for repair. People can draw a lesson from previous earthquake event and take reasonable measures to prevent from earthquake occurring and mitigate damage. This is an effective means of raising awareness for future earthquake. This is public health impact of earthquakes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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