International Journal of Innovation, Creativity and Change. www.ijicc.net
Volume 5, Issue 2, Special Edition, 2019

Diversity, Resilience, and Tragedy: Three Disasters in Palu of Indonesia

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The earthquakes that occur in Indonesia are caused by several primary factors such as tectonic plate shifts which lead to the increased earthquake and volcanic activity of. Moreover, the geological condition and the rock structure of swathes of Indonesia constitute the secondary factor that contributes to the danger of these disaster in Indonesia. Various disasters having occurred in the last 2 years and are summarized in this article. This study aims to provide information concerning the history as well as attempts to cope with disasters and the consequent impacts on society following the disasters in Indonesia. A qualitative case study methodology was selected along with sources derived from various community groups and government agencies such as BNPB (The National Agency for Disaster Countermeasure) and BMKG (Meteorological, Climatological, and Geophysical Agency) that serve as a reference in this study. The study results delineate that the community's response to the natural disasters led to increased security mitigation efforts made by the community and the government. In addition, it affected social relationship between communities in a positive manner evidenced by participation in helping with the post-disaster recovery.

Key words: *Palu City, Earthquake, Disasters, Indonesia.*

Introduction

In the last decade, throughout the world, particularly in the region well-known as the ring of fire, earthquakes frequently occur. These earthquakes are triggered by the dynamic movement of the tectonic plates on the lithosphere. Earthquakes often hits such countries along the Ring of Fire (ROF) (Holloway, 1883) as New Zealand, Eastern Australia, Japan, the Philippines, the west coast of North America, the west coast of South America, and Indonesia. The magnitude of the earthquake varies, ranging from minor magnitude <4SR, moderate magnitude 4-6, to great magnitude > 6SR (Putra,Kiyono, Ono, & Parajuli, 2012).

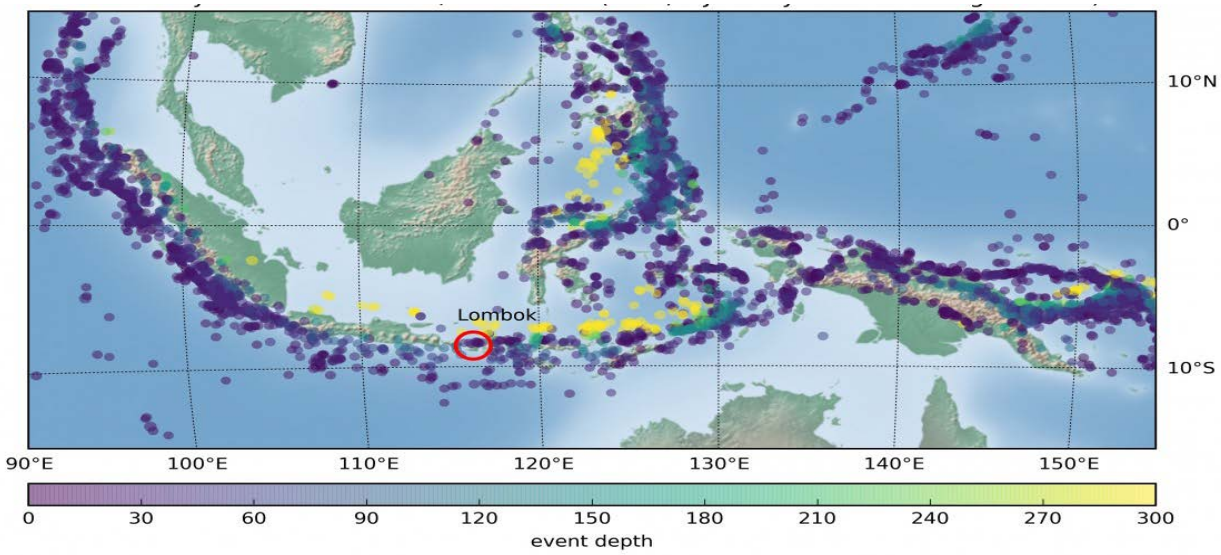
The quakes that are the subject of this study occurred in Indonesia during the two year span namely 2017 to 2018. The quakes are associated with the fact that Indonesia is an archipelago including many volcanic mountains, faults, and meeting points between the Australian plate and the Asian plate along the southern coastal region of Indonesia to the western coastal region of Indonesia (Mardiatno, Malawani, Annisa, & Wacano,2017). The earthquakes are not only caused by the tectonic plate shifts but also volcanic activity in Indonesia such as: the island of Lombok disaster that claimed 555 lives and sent 390,529 people fleeing for a refuge; one rocking the city of Palu in central Sulawesi which took death tolls of 2,113 people following a tsunami (Nugroho, 2018) and the last one for consideration here striking the south western region of Indonesia, Lampung-Banten which killed 437 people in the Sunda Strait tsunami and left 14,059 people injured. These earthquakes are caused by various factors.

The earthquakes hammering the island of Lombok were brought on by the Australian tectonic plates moving northwest - north (Lewerissa, Sismanto, Setiawan, & Pramumijoyo, 2017). The movement of the Australian tectonic plates reaches approximately 60 mm/year (Valkaniotis, Ganas, Tsironi, & Barberopoulou, 2018). Meanwhile, the quakes that rattled the city of Palu in Central Sulawesi is caused by the built-up grinding pressure between the Australian plates and Phillipine plate in addition to the vulnerability of the city of Palu to tremors triggered by the slip in the fault and finally, liquefaction in the area (Gaffar et al., 2018). The predominant cause of the earthquake hitting the south western part of Indonesia or Lampung-Banten, was volcanic activity (Putra et al., 2012; Adusei,2018). Volcanic Mountain, which is Anak Krakatoa was formed by the large eruption of Mount Krakatau in 1883. The ceaseless activity of Gunung Anak Krakatau continues to increase because the Australian plate moves under the earth through subduction along the southern coast of Java and Indonesian Sumatra. (Holloway, 1883).

Literature Review

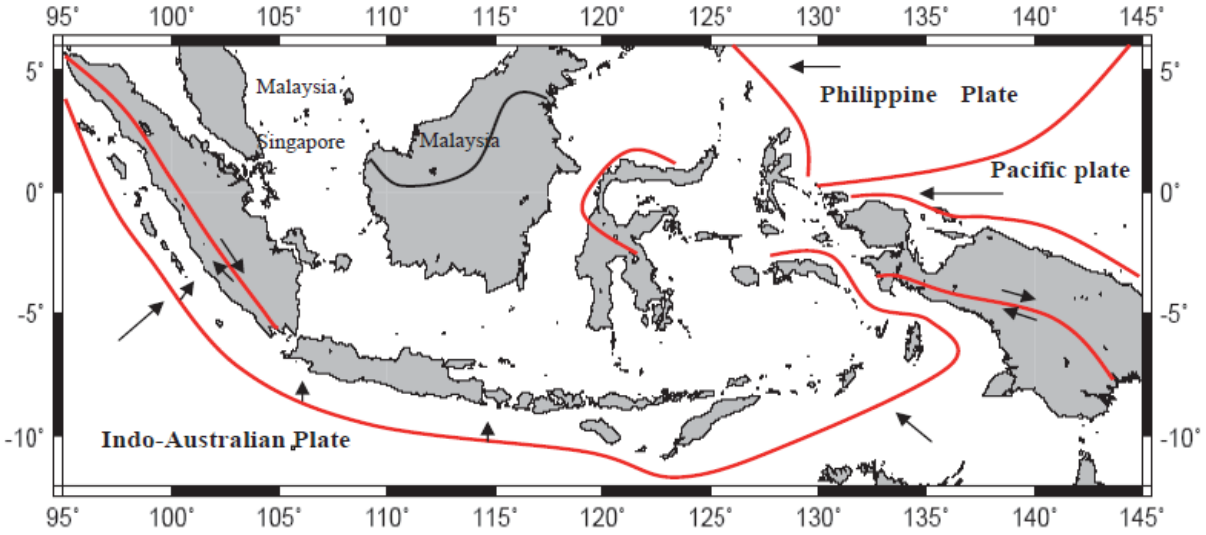
A series of earthquakes occurred in Indonesia starting with Lombok, Palu, and Banten - Lampung. Natural events ensuing in the earthquake-prone areas, especially Indonesia (Figure 1) (Løvholt, Kühn, Bungum, Harbitz, & Glimsdal, 2012) result in people's need to learn how to survive in the Indonesian region. With disasters increasingly a part of the life of the Indonesian, a further need arises to commit to recording the series of historical events worth remembering. Thus creating the potential use of an evaluating instrument in the event that a future earthquake strikes in order to keep losses down in the aftermath (Folger, 2013).

Figure 1. Seismicity (BMKG and USGS) map of Indonesia region period 2000-2018 (Cahyadi & Heki, 2015).



The National Disaster Management Agency (BNPB) has set a high risk tsunami plan in to be included in the Indonesian Tsunami Master Plan in the 2012. Based on this document, Indonesia is divided into four high risk tsunami areas, namely megawrust Mentawai, Sunda Strait and south (Sismanto, 2015; Sinh, 2018). a part of Java, Bali and Nusa Tenggara, as well as the Papuan region as referenced below (Figure 2).

Figure 2. Potential Hazard of Tsunami Disaster in Indonesia (Pramono & Harapan, 2018).



As found in the observation conducted by BNPB over the region, many people are exposed to the danger of tsunami. More than 2.5 millions of people are vulnerable to tsunami occurences (Scientometrics & Hospital, 2007). The number of people exposed to tsunami can be seen in Table 1 below. According to (Nohara, 2011), people generally prefer to inhabit areas which potentially support their daily living (Nugroho,2018). However, they occasionally disregard potential hazard since their location choices are then limited (Lewerissa et al., 2017). Under such circumstance, challenges and opportunities present themselves in terms of tsunami risk management in Indonesia (Diambama, Anggraini, Nukman, & Lühr, 2018). The first challenge is "how to minimize the tsunami risk in all areas? There are some obstacles to the tsunami risk management application in every area (Lin & Henschke, 2018). This possible issue emerges from the lack of preparation or the mismanagement carried out in all area (Ahmed, Umrani, Qureshi & Sarmad, 2018; Ali & Haseeb, 2019; Haseeb, Abidin, Hye, & Hartani, 2018; Haseeb., 2019; Suryanto, Haseeb, & Hartani, 2018).

Table 1: Number of People Exposed in Priority Area of Tsunami Mitigation [Source:(BMKG,2018;Pramono & Harapan, 2018)].

No	Priority Area	Province	Nr. of people exposed
1	Megathrust Mentawai	North Sumatera	106,601
		West Sumatera	298,203

		Bengkulu	98,246
2	Sunda Strait and Southern part of Java	Lampung	43,004
		Banten	346,381
		West Java	123,095
		Central Java	943,497
		Yogyakarta (DIY)	92,342
		East Java	194,649
3	Bali and Nusa Tenggara	Bali	358,905
		West Nusa Tenggara	119.138
		East Nusa Tenggara	31.823
4	Papua region	West Papua	14.092
		Papua	20.998
Total			2.790.974

Aside from earthquakes, the possible danger of a tsunami in eastern Indonesia such as in Maluku, the northern part of Papua and Sulawesi should be given due consideration (Rasyid, Bhandary, & Yatabe, 2018). Based on the facts issued by BNPB, to conceive tsunami mitigation plans, the hazard information gleaned must include the consideration of the worst case scenario which is done so by estimating the maximum level of inundation generated by the tsunami modeling (Djafri, Chongsuvivatwong, & Geater, 2015). Concerning the evacuation route, a route with a high index of tsunami victims must be kept free from the evacuation before the tsunami reaches which is possibly carried out by using tall buildings that are located within the tsunami inundation area. Alternately, coastal areas containing sandy and muddy materials tend to run a higher risk of tsunami. Different mitigation treatments must be administered to the two different regions, such as by planting mangroves to take the brunt of a tsunami that is crashing in (Syafriani, 2018). It is also imperative to plan rural land use to minimize coastal hazards (eg tsunami impacts). This is a part of a mitigation strategy intended for the protection of coastal areas instrumental in the conservation of coastal resources and rescuing people living in that location (Bambang Sunardi, Melinda Utami Istikomah, 2017). Additionally, the development of coastal forests and thecoastline belt is also crucial for tsunami mitigation. Such mitigating strategies are most effective and more economical compared to the construction of solid structures, however, mangrove planting is a long-term project (Pramono & Harapan, 2018).

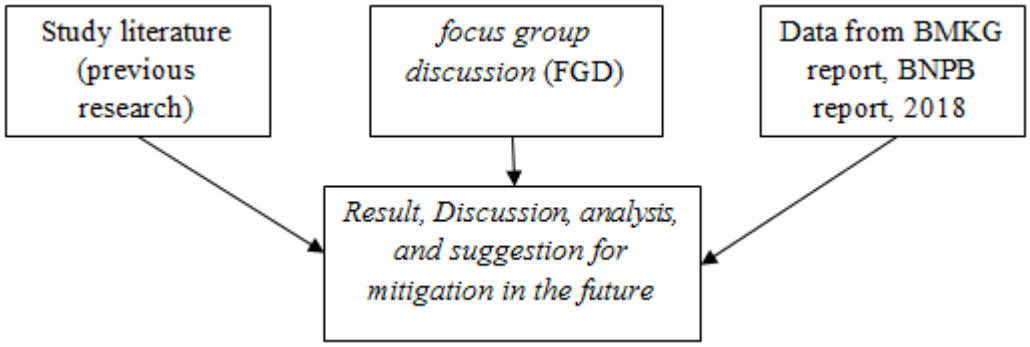
In this study, ahistorical record of natural disasters has been made to learn how to come up with disaster mitigation measures for the future. It is also of note to record community activities and government responses (Rashid, M; Vetha, Roy D; Chandrasekhar, 2010), so

that in the future, this research can serve as a reference in terms of disaster mitigation and history not only in the region of Indonesia, but also as an example for other parts of the world. The study of tsunami mitigation plans in Indonesia is a topic of interest as referenced through all the challenges discussed above.

Method

This qualitative research employed a type of case study, literature studies, and the latest data derived from various social elements. This article illustrates the conditions of the affected areas and information has been obtained from the government and social assistance organisations from various elements of the community, in an attempt to interview the community in the wake of the disaster. In addition, data was collected by conducting interviews and focus group discussions (FGD) alongside scientific findings considered to buttress the accuracy and systemic nature of the research results. (Figure 3 below).

Figure 3. Methodology from various data collection techniques.



In addition, this article was written to provide an overview of how to draw up a good disaster mitigation policy. This article conveys initial findings that present data from homogeneous sources. Alternative approaches selected are consistent with the characteristics of each region. The tsunami mitigation action plan is one of management arrangement (Moss & Howells, 1996). This article is aimed to serve as a publication from which b a National Action Plan for Disaster Risk Mitigation (RAN-PRB) for a period of 10 years can be made. The framework used to conceive action plans in general is by taking coastal typology and settlement approach in the Indonesian region (Figure 2 below).

Results

The earthquake which occurred on September 28, 2018 in Palis was a phenomenon with a far-reaching impact as it was followed by a surge of tsunami hitting with three waves. The people in Palu call this a high-wave. Ensuing afterwards was liquefaction in the Balaroa Housing area, Jono Oge Village and Petobo Subdistrict. The community managed to get back to normal life four months after the disaster (Putra et al., 2012).

Data released by BMKG revealed that this type of earthquake would continue to strike as long as the geological conditions in the disaster-prone area were unstable. The BNPBalso states that the number of victims would continue, and victims were reported missing due to the liquefaction that followed (Rusydi, Efendi, Sandra, & Rahmawati, 2018). Secondly, this report rendered the community anxious and restless. Network communication was literally cutoff raising a concern for the people outside of Palu, particularly those who had relatives remaining in Palu.

Meanwhile, the disaster was compounded even more by the hoaxes circulating through the community concerning the failure of the mayor and deputy mayor to spring into action to deal with the disaster. In fact, at eight o'clock the two of them had stepped in to address the problem by dealing with the corpses at the scene. “The community suspected that which is not confirmed that the three disasters are deemed as God’s dealing or the so -called adzab as he found fault with human behaviors” (Nohara, 2011).

After the earthquake, tsunami and liquefaction occurred, groups of people assemble for prayers including at the beach which was the worst-hit location unfolding as witnessed by viewing the damaged buildings not fifteen meters from the shoreline. Prayer assembly was held regularly in several mosques also. A few hours after the tsunami reports of people thieving goods circulated. Perpetrators were at large in the night time and continued to loot for another two days. Word of the increased lootings spread as well as an assumption that the government would pay all the victims of the disaster. In fact, the news was the ministry’s statement distorted (Nugroho, 2018).

This happened due to a shortage of law enforcement officers. The police force lost seven officers among the disaster victims and the condition worsened as there was no one watching over and acting immediately in response to the theft and looting. The people were longing for a return to trade and this initiated by peddlers. The peddlers even offered beverages on the beach where the tsunami hit a week later. Initially, they were afraid but in the context of the need to make livelihood, they had to do what they did.

Jusuf Kalla's visit was an encouragement. He came to present himself as the national disaster management coordinator and was able to find a solution to address the distribution of fuel oil. Each gas station could serve the community directly without queuing. Jusuf Kalla in his authority as the vice president and as Chairperson of the Indonesian Red Cross mobilized the community and local government to take immediate action.

To address the lecture attendance issues, through the Indonesian Rector's Forum, Tadulako University provided students who had been temporarily evacuated with opportunities to sit in at the university in whichever province they found themselves in. By simplifying the procedure and with sufficient coordination, each student can attend classes with no concern for the usal payment obligations.

Discussion

Articles show that disaster survivors demonstrated resilience. Family is a major support system which helps survivors to recover immediately and resume their normal activities. A mother goes back to her selling activities on the beach after taking refuge with her children for a week in South Sulawesi. Similarly, a woman went on the quest for her mother in the affected area after receiving approval from her husband. She waited for 48 hours at the airport to get evacuated to Makassar. This shows that family support sustains disaster victims through post-disaster recovery.

The same is true with the family tie that binds the community in the four provinces in Sulawesi. They rendered financial help and sprang into a swift action to identify victims, this involved people working for the regional government who inspired elementary school students to take the same action. The religious organization of Muhammadiyahworked together with the Muhammadiyah Disaster Management Center team did likewise. Furthermore, the University of Muhammadiyah Malang, the University of Muhammadiyah Purwokerto and the University of Muhammadiyah Palu altogether delivered thematic lectures on disasters.

A disaster survivor who works as a lecturer took shelter in his uncle's house. His parents' house was destroyed. He stayed there in the wake of the disaster. A week after the disaster occurred, some Palu residents fled to their safety by taking refuge in other areas. The disaster destroyed the infrastructure utilities in the city such as electricity, clean water (PDAM) and cellular networks and resulted in the scarcity of fuel at gas stations. Compared to the 2004 earthquake and tsunami in Aceh, public facilities were totally paralyzed. The government needs to heed that as a disaster strikes, the aid to be provided includes public utilities such as

electricity. Electrical energy can be temporarily obtained from diesel (Devi, 2007) if necessary.

Furthermore, the urban community was consumed with severe trauma, because they were exposed to relentless aftershocks intensified by roaring sounds from the underground of the earth and many residents dreaded that the city of Palu would cave into the bottom of the sea. This chaos was intensified by several stories told by residents who said that the city used to be a land rising from the seabed through the earthquake and tsunami hundreds of years ago and that they predicted the land would slip back down to the sea. If we take into account the 2018 earthquake on the island of Lombok, the 2009 earthquake in West Sumatra, and 2004 Aceh earthquake – tsunami, we can assume that earthquakes will continue (aftershocks) until the geological conditions are relatively stable (Commission, 2018). In this regard, the psychology or traumatic scale of the community will increase. Therefore, to overcome this, the government and the community need a strategy to maintain calm e.g. through reciting prayers and entertaining children and also need to provide updated information pertaining to seismic activity to the affected community (National Agency for Disaster Management (BNPB), 2015).

One victim of the disaster interviewed by the researcher, H. Bada, a man who is turning 70 this year, left South Sulawesi for Palu in 1980s and started his culinary business. He did not want to leave the city of Palu although many relatives from South Sulawesi came to Palu to fetch him. He holds fast to his principle that the resulting accident and death had been destined by God, and that God has predetermined whatever befalls him and his family long before he was born to earth. Hence, he resolved to stay with his extended family (7 children, 4 sons-in-law, 8 grandson) by pitching a tent in front of his store and choosing not to join other refugees, even though he, his children and in-laws have access to cars to evacuate to South Sulawesi.

The same is true with Hj Noni, a fruit monger at the Inpres Manonda market in Palu. When interviewed by the author, the mother of 5 children said that her family ran short of food three days after the disaster. Her husband and children had to travel several kilometers to look for help from relatives in the city. Things were dreadful, but this 50-year-old woman stayed put with her family and chose not to go back to her hometown in South Sulawesi to relocate with her extended family. She pitched a tent in front of a kiosk where her place of business was, like H. Bada, Hj Noni also did not want to leave home for a refuge and chose to stay put with family and fellow traders.

Both H.Bada and Hj Noni said that, some of traders from Bugis & Makassar at the market in Palu's Inpres Manonda, chose to remain in front of their shop a few weeks later. Those who finally chose to take refuge in their native village in South Sulawesi were prompted by situations involving seriously injured family members, seniors, pregnant women and some toddlers while the rest remained to stick it out and help each other. One of Bada's son-in-laws noted that after the disaster, fellow Bugis & Makassar traders who chose to stay coordinated mutual help. For example, those selling rice donated some rice to the family of fruitmongers.Those selling vegetables set up public kitchens and cooked whatever was left over from their stock and bakers etc shared food items in their possesion.

What happened to Amrullah, a young man in his 30s was different. He had a motor workshop in one corner of the city of Palu, a week after the disaster he chose to keep his business going in the city of Makassar, along with his family. However, two weeks later he chose to return to Palu City as he was worried about his workshop in the midst of the rampant looting of shops and supermarkets because he had much costly equipment which are easily sold. So he chose to go home and re-open his workshop a month later. The city was quiet as it was deserted by residents and only volunteers on guard were seen during the intermittent aftershocks.

The results of the FGD above reveal that when a disaster occurs, not everyone will flee the affected area as some choose to remain. There are different attitudes apparent in victims in the event of disaster. Some people want to remain in the affected areas because they want to help other victims (Imamura et al., 2012). One victim said that on the first day he opened his workshop, dozens of people came flocking into his workshop to get their vehicles repaired. Some residents even came to change their motorcycle tires with new tires. He remarked that on the first day he earned more than a million rupiahs which is fantastic amount as far as the size of his workshop was concerned.

The looting however spread to several locations especially places considered to have valuable merchandise. One of the warehouses located north of the city of Palu was ransacked. The author saw with his own eyes people who tore down warehouse doors and snatched whatever they could lay their hands on. Even worse, in the center of the warehouse were dozens of pickup trucks parked to deliberately transport the goods they looted, said one resident to the researcher.

The victims who witnessed incidents firsthand stated that the looters came in from outside the city and had not experienced the direct impact of the disaster. He said that the residents of Palu were still traumatized by what happened and that they were afraid to come into the

building, until at least a week after. Meanwhile, others were still busy looking for lost family members and could no longer think about searching for nor looting goods elsewhere. When compared to the disasters that occurred in Lombok in 2018, in West Sumatra in 2009, and in Aceh in 2004, each community took different action in the wake of the disaster. The level of panic is heavily influential as the medical research states that a level of panic will occur when human beings cannot think well due to high distress experienced and intensified by external factors such as hoax that the government is allowing public looting in shops or stalls as a survival response for victims (Mardiatno et al., 2017).

The public wa sapprehensive about the circulating news or information in the community about the occurrence of larger aftershocks than those that had happened on September 28, 2018. According to information obtained from Mr. Rapiuddin that some people were prepared to leave the city to areas considered safer or distant from the disaster, some people left for the southern Sulawesi region, some for Java and a few of t chose to go to Central Sulawesi.

The earthquake, tsunami and liquefaction in Palu, Donggala and Sigi traumatised Burhanuddin, Farid and Ikhsan took a flight to Makassar and experienced panic attacks until they managed to sleep through the flight before the plane landed where they feared there was another earthquake. Jamli's brother in the sub-district of Tondo experienced a panic attack when he felt a gust blow in and jumped on his motorbike to charge up the hill. He came to his senses when his wife shouted that it was not an earthquake (Gaffar et al., 2018).

In the same manner, people who walked along the shore were ill at ease when the tide was rising concerned there would be another tsunami striking because they did not know that in the afternoon the sea rises up to a few meters over the road. Salmiati's mother was apprehensive every time she passed the road on the edge of the beach thinking about earthquakes, tsunamis and liquefaction (Boen, 2008) which could occur at any time because she had heard that about 25% of the fault had not returned to its place and that consequently a disaster three times larger than the one that occurred on September 28, 2018, was imminent. She thought it was better to stay away than to get close to places that could be hit by an earthquake or tsunami. Just as post the tsunami that occurred in Aceh in 2004, a series of earthquakes continued to occur until the soil or geological conditions became stable, however these aftershocks were not greater than the main earthquake that triggered a tsunami wave (Nguyen, Griffin, Cipta, & Cummins, 2015).

Mr. Daeng believed in all the information he heard and he made the decision to move to South Sulawesi, selling all of his possessions including his kiosk at unreasonable prices just

to sell them, he was severely traumatized by the earthquake as a cabin toppled and fell on him. Hearing about the possibility of aftershocks, he resolved to go to a safer place because he thought to himself that possessions could be earned but his soul could not be replaced. This indicates that the community needs to be educated about how to mitigate disaster by being mindful of surroundings and access to support in the local area of residence in such cases where objects such as cabinets or even trees can fall on them (Holloway, 1883).

The Nusi family, Saharuddin and the Hasman family through the head of the neighbourhood unit, Mr. Irwan explained to the researcher that they chose to sleep outside of their house rather than inside the house because they were constantly concerned with the possibility of a greater earthquake striking than the previous earthquakes that had already occured. They also assumed that while sleeping outside they would receive some help from the government such as food and drinks. Even though they had been informed that the aid was temporary and makeshift shelter had been provided, they chose to sleep outside together as a family even though it was worse off to sleep outside. In an effort to prevent more casualties, when earthquakes struck Padang, Jogja, Aceh, and Lombok, the community were advised to get outside to the open area in case aftershocks followed. However, a further need is to consider that liquefaction- prone areas shake causing the ground to crack apart and engulf things and that evacuation efforts must also be informed by knowledge about areas that are safe from liquefaction (Diambama et al., 2018).

Conclusion

It was necessary to conduct qualitative research in a country frequently hit by earthquakes. Analysis of seismic records of disaster occurence is important to predict possibility of future impacts and can also be used as a reference to conceive disaster mitigation measures. Natural disasters that occur in Indonesia exert a negative impact apart from the immediate damaged area and buildings, they interfere in a country's economy and can also be traumatic for the Indonesian people. Economic shift can drastically lead to increased societal stress levels. In this respect, the government is expected to provide assistance not only in the form of material objects and food but also psychological support and scientific information disclosure for the victims of the disaster. Societal life in disaster-prone areas is subject to change. Disaster affected communities reflect increased curiosity in learning about "how disasters occur and what needs to be prepared before a disaster takes place". Even those who live in areas that are not affected by natural disasters indicate a need to learn about disaster mitigation and preparation.

Suggestion

From a geographical and geological standpoint, Indonesia is an archipelago with the longest coastline in the world and is a tropical area with many volcanic mountains. The positive is that fertility is a major advantage in Indonesia and while some vital vegetation decreases during the disasters which are the focus of this study, Indonesian mangroves can survive. In Indonesia mangroves are a more effective barrier to take the brunt of tsunami impact compared to solid structures such as the breakwaters previously erected. Providing education and government pograms in mangrove conservation could prove to be effective in dissipating the tsunami impact and is of necessity to carry out mitigation measures in the future.

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