EARTHQUAKE, TSUNAMI, AND SOCIETY COOPERATION: EARLY FINDINGS IN PALU POST OF INDONESIA DISASTER

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ABSTRACT

Geographically, the Sulawesi Island is located on 5.36°LU-7.48°S and 117.02°-125.74°E. It is one of the safest islands due to its location that is not directly related to two oceans, namely the Pacific Ocean and the Indian Ocean. Sulawesi is divided into six provinces and has several small islands. This makes it one of the islands with the longest coastline in Indonesia. However, this is what causes Sulawesi Island to be susceptible to marine disasters, such as high waves and tsunamis triggered by submarine earthquakes whose distribution can be seen in figure 3. In this study, we tried to examine how the society established cooperative relationships with various social elements that existed, a few days after the disaster occurred. In addition, data collection was conducted through interviews, focus group discussions (FGD) along with scientific findings or research that had previously been conducted so that the results of the research became more accurate and systematic. This article was the initial findings so that it only presented data from sources in a homogeneous manner.

Keywords: *Palu City, Earthquake, Liquefaction, Tsunami, FGD*

INTRODUCTION

An earthquake with a magnitude of 7.5, followed by a tsunami, hit the West Coast of Palu, Central Sulawesi on September 28, 2018.. As reported by the Meteorology and Geophysics Agency (BMKG) report, the quake was not only felt in Palu — as the epicenter — but also in some surrounding regencies and cities, namely Donggala, ParigiMoutong, Sigi, Poso, Tolitoli, Mamuju, Samarinda, Balikpapan, Gorontalo, and Makassar.

Although the strength of the earthquake was not as big as the earthquake in Yogyakarta in 2006 [1], however the disaster also caused severe damage to buildings and infrastructure[2]. Two thousand people were killed and many people were injured (the number tended to increase). The damages were related to ground vibration, liquefaction direction, landslides and tsunamis [3].Indonesia is known for being an archipelagic country [4] that is included in the ring of fire region [2] which often experiences earthquakes [5] and tsunamis [6]. The disaster in Palu, Sulawesi, Indonesia occurred due to faults at shallow depths inside the Molucca micro-plate, which is part of Indonesia's tectonic plate [7].

In some previous records, the earthquake that occurred at 17.02.44 WIB was located 0.18 S and 119.85 E and was 26 km far from the northern part of Donggala, Central Sulawesi, with a depth of 10 km. It was known to be not the first, but certainly this was the strongest one[8].The BNPB Command Post also confirmed to the BPBD that the tsunami had hit Talise Beach in Palu City and the coast in Donggala[9]. The tsunami also hit several settlements and buildings on the beach. The number of victims and the impact caused was still in the data collection, but around 2,000 bodies have been found [10]. In addition, according to the SAR team, the number of dead or missing victims was still unknown since there were areas swept away by the tsunami and liquefaction in which many people were alleged to be buried [14].

Figure 1. Palu City area before earthquake (left) and after earthquake(right) (based on NASA 2018 satellite imagery) [15].

Based on figure 1, liquefaction occurred in two locations (yellow circle), while abrasion happened in the coastal area of the Palu City (yellow circle). This is reinforced by previous research, namely about the geological structure of the area of Palu City and its surroundings (figure 2). The Palu City area is dominated by Alluvial Deposits which is a characteristic of soil that is not strong against water [11]. So, if there is siltation of water (liquefaction) and an earthquake occurs, then the structure of the soil will easily move [12] to reach its stable point[15].

However, as with other disasters, this disaster was received full attention from the government. The local society was also not standing still [20]. The society actively participates in taking part and cooperating in accordance with their abilities in post-disaster recovery[18]. Volunteers, who were known to be medical personnel and doctors, also came from various places[17]. In fact, this heartbreaking event for Indonesia has captured the world's attention. Until October 1, 2018; in a press conference, the Coordinating Minister for Politics, Law and Security (MenkoPolhukam), Wiranto, said that there were 18 countries offering assistance to Indonesia, namely the United States, France, Czech, Switzerland, Norway, Hungary, Turkey, European Union, Australia, South Korea, Saudi Arabia, Qatar, New Zealand, Singapore, Thailand, Japan, India, and China [16].

Figure 2.Digital Elevation Model (DEM) at Palu area (left) and Geological map of Palu depression area (right)[15].

In addition, the characteristics of the Palu earthquake were very different from those of several earthquakes occurred in other areas, including those that occurred in West Nusa Tenggara (NTB) [13]. Dwi korita Karnawati, Head of the BMKG, reported that the earthquake that occurred in Central Sulawesi was absolutely caused by a shift in the Palu-Koro fault [18], while in Lombok was triggered by an increase in the Flores fault [8]. This condition could cause a collection of aftershocks that generate an earthquake that is stronger than the previous one [19].

From information on USGS seismic data during 1927 - 2012, more than 100 earthquakes with a magnitude above 5.0 were recorded (figure 3). This reinforced the notion that the Sulawesi region experienced a change in the underground structure due to the earthquake and will continue to occur, given that the Australian continental plate also continues to move until now [15].

The Sulawesi island (Figure 3) is located at the intersection of three plates of Australia, the Philippines and Indonesia (the Indonesian plate is the eastern part of Eurasia). The Australian and Philippine plates subdue under the Sulawesi plate with speeds of 75 and 90 mm/year, respectively[6]. To the south of Sulawesi, the EW plate boundary zone that extends from eastern Indonesia to the New Guinea Trench accommodates relative movements between the Australian and Pacific plates with trans gressive faults and block rotations[7]

Figure 3.[Left]Distribution of earthquakes that occurred on the Sulawesi Island (based on USGS seismic data from 1927 - 2012)[15] and [Right] Tectonic setting and seismicity of Sulawesi island, Indonesia (modified by [7]).

Sigi, Donggala, and Palu were regions that were known to experience the most severe consequences [8]. Various vital public buildings such as residents' houses, shopping centers, hotels, hospitals, and other buildings were badly damaged, partially or completely collapsed, and swept away by the waves. Therefore, the National Disaster Management Agency (BNPB) noted that up to the time the study was conducted, there were as many as 48,025 people displaced in Palu, Central Sulawesi, after the earthquake and tsunami[9].

Emergency handling of the impact of the earthquake and tsunami in Central Sulawesi continued. The acceleration of disaster recovery continued to be intensified, particularly in meeting basic needs of the refugees, medical services, basic infrastructure improvements, and normalization of people's lives. Urgent needs include rice, sugar, baby food, children's milk, milk for pregnant women, plastic bags, tents, blankets (babies, children, adults), eucalyptus oil, bath soap, toothpaste, cooking oil, uniforms school children, school books and equipment, clean water, toilet, lighting in the shelter, and sanitation were really very important.

Apart from the Government, the local society was one of the most important elements available. They had a vital role in helping one another, while responding and rebuilding what was left[19]. This could be seen from how each community group in Palu, Sigi and Donggala

handled the problem of displacement, data collection, and trauma experienced by the society. Therefore, this article would identify society cooperation in dealing with the problem of displacement and disaster response.

METHOD

This article used a qualitative approach with a variety of phenomenology. The discussion in this article would also try to review how the society established cooperative relationships with various social elements that existed, a few days after the disaster occurred. In addition, data collection was conducted through interviews, focus group discussions (FGD) along with scientific findings, so that the results of the study became more accurate and systematic. This article was initial findings so that only data from homogeneous sources would be presented.

FINDINGS

The second day after the disaster, helps began to arrive, but not massively accepted. This happened because almost all vital sectors — one of which was transportation — were badly damaged by earthquake shocks. Airports could not be used at all for commercial flights because various communication and inter-airport connecting towers and runways were damaged. In addition, a number of ports also could not operate properly. Pantoloan Port in Palu City suffered the most damage. Quay cranes, which were usually used for container loading and unloading, collapsed. In Wani Harbor, buildings and docks were damaged. KM Sabuk Nusantara 39 was hit by a tsunami to the land as far as 70 meters from the pier[11]. Land travel became the single fastest choice.

In addition, disaster management was not only carried out by the SAR team. Various assistances also continued to be organized by several institutions such as universities, secondary education institutions, and communities. A number of students also tried to help data collection on the number of disaster victims. Disaster survivors were handled by institutions that had been active in handling disasters [20]. Hajj dormitories and Islamic boarding school halls were used as places of early refuge. This phenomenon was of course interesting, because, in a precarious situation like this; the collective consciousness of the society was built systematically[10].

Humanitarian tasks were also pioneered by universities such as the Faculty of Industrial Technology of Muslim University of Indonesia. They initiated the construction of drinking water treatment facilities after observing the primary needs of the society. After the disaster management team from the University of Indonesia left the disaster site, the ready-to-drink water treatment equipment was handed over the journalist organization AJI (Alliance of Independent Journalists). The University of Hasanuddin with its experts was also directly located in the field to assist the operations of regional hospitals that could not operate at all.

From South Sulawesi, the State Islamic University of Alauddin of Makassar specifically formed a team that raised funds to help the needs of the refugees. Likewise, the Makassar Model State Madrasah Aliyah(MAN), its teachers and students took the initiative to raise funds and also helped in the form of goods. Far from across the North, assistance in the form of logistics came

from Gorontalo and Manado Provinces. These were confirmed by the statement of the Deputy Governor of Gorontalo, Idris Rahim, who stated that as many as 272 joint personnel were ready to depart. The details were 100 policemen, 16 social service officers, 14 Navy personnel, 15 BPBDs, 15 personnel of PMI, and 100 personnel of Korem 133/NWB. The health office deployed 2 general practitioners, 7 nurses, 1 pharmacy officer, 1 ambulance, and 1 unit of medicine car. The health team was waiting for 2 bone and orthopedic specialists from Manado, North Sulawesi [23].

In addition, various kinds of social movements as members of the society, student organizations, and small community entities in Gorontalo - and other regions - massively acted as volunteers [21]. They moved themselves voluntarily to collect donations, which would later be converted into several types of food and medical needs[21]. Measurably, assistances were also distributed by the Indonesian Lecturer Forum. The types of goods to be sent to Palu were determined through discussions and interviews with victims in the field. This was done on a rational consideration using the concept of 'classical economics' leading to minimizing the risk of "unused" items so that the probability of benefit could be obtained massively[14].

Local governments in South Sulawesi such as Enrekang and Soppeng Regencies also got involved in disaster areas including the two regents who directly come to the locations. Even the deployment of foreign aids was carried out by scholarship recipients. They took the initiative to provide lighting provided through solar panels. They spread invitations to donate internally and externally reaching across countries. Hundreds of vehicles came to the city of Palu carrying logistics and basic needs for victims [22]. Even on the fifth day, dozens of trucking fleets from several regions in Sulawesi Province also packed the land routes which at that time were successfully accessed thanks to coordination between the military apparatus namely the Indonesian National Army and several governments of regencies that directly bordered the Central Sulawesi. Not only residents of the Sulawesi Island, but also of almost all regions in Indonesia then also moved to send aids to victims of disasters, both via the airway to the sea lane. The airway at the time of the incident was almost inaccessible due to the condition of the cracked runway of the airport and the ATC watch tower which was collapsed due to the earthquake hit. The air route was only accessible by the Indonesian Air Force military flight via the Hercules aircrafts, through the Makassar-Palu route. For five days after the disaster, the Hercules aircrafts only dispatched volunteers who would assist in the evacuation process in the city of Palu and its surroundings, as well as transporting the wounded persons to be treated in several hospitals in the city of Makassar.

On the other hand, one week after the disaster, the condition of basic infrastructure was still not recovered, where the electricity, clean water and telecommunications networks were still not fulfilled and operating optimally, so that at night, the condition of the Palu City was very tense, coupled with aftershocks that still continued to happen almost all the time. Technicians of the PLN, the PDAM, and Telecommunications Providers also arrived from outside the city of Palu, to immediately repair the damage. Good cooperation was also seen from several humanitarian organizations that had served on the second day after the disaster. The arrival of

volunteers throughout Indonesia, even overseas, was one form of support and concern in the name of humanity. One of the first foreign volunteer teams to come to Palu was a volunteer team from Turkey.

The volunteers seemed endlessly trying to find and evacuate victims who could still be saved. Victims with minor injuries at the initial stage would be treated at a local hospital, although with minimal conditions because the Palu Regional Hospital also suffered considerable damage but some rooms could still be used for the light treatment process. As for victims with quite severe injuries, they would immediately be flown to other hospitals in the city of Makassar. Volunteers from abroad also arrived shortly after the flight path to Palu was fixed, with all the experience and skills they had. These outside volunteers then worked according to their respective fields. Some of them were able to change turbid water both of seawater and river water to be clean and ready for consumption for the refugees by using the equipment they brought from their respective countries.

Muhammadiyah Disaster Management Center (MDMC) was one of those who move quickly to respond to this disaster. Its deputy chairman, Arif Jamali, stated "the first response carried out by Muhammadiyah was to establish a Coordination Post (poskor) in the Building of Muhammadiyah Leadership for Central Sulawesi Region. This post will later become the MDMC's main post which will coordinate service posts in the affected areas".

DISCUSSION

This article shows that disasters can be overcome by cooperation. Theoretically, besides being "structural consciousness" —that is as part of the government's structural awareness to act responsively to disasters, this phenomenon is also the nature of "volunteerism". Shaskolsky defined this voluntary movement as something that is directly or indirectly oriented to help the interests of others without questioning the status [23], class, and place of the beneficiaries [24]. The fact seen in the case of the earthquake that hit Palu, Sigi and Donggalawas that assistance continued to be optimized through institutions that had not initially focused on disaster management activities. Wahdah Islamiyah and the Islamic Defenders Front (FPI) were of institutions that arrived on the second day after the disaster. They later became pioneers in helping to deal with victims [17].

In Shaskolsky's [25] deeper study, the post-disaster cooperative activities in Palu could then be seen through four basic characteristics: (1) the parties that arrive and help to recover are a way to assist the government in facilitating coordination; (b) formally, the society then forms an *ad hoc* organization to deal with situations in specific disasters; (c) in precarious circumstances, the society together with communities and youth organizations directly act as disaster responsive organizations or; (d) these cooperative efforts utilize the network to organize post-disaster supporting data and information.

In addition, positive responses also appeared directly from social media booths. The integration of data and information has made our society massively connected. Through Facebook, Twitter, and Google Maps, people could participate in disaster management in a more

conventional way without having to be directly involved. Freely and measurably, the use of social media could be a place to produce information related to data on disaster victims and damage in various sectors[21]. So, this made it easy for the Central Sulawesi government and the Central Government to distribute aids through the coordinate points provided by the society.

The most important thing to look at in the case of the Central Sulawesi disaster, based on the above studies, is that the humanity of the people - not only Central Sulawesi, but the whole world - was organized collectively. They moved on moral consciousness to help others without consideration of social and class status. This also proved that global society is in fact bound to one another in terms of humanity, so that it is possible for doing recovery faster and more systematic and constructive.

The emergency response period that was implemented at that time was until 26/10/2018. Some public facilities such as electricity and communication had largely been restored in the affected areas. The economic condition was gradually returning to normal. Regional markets, traditional markets, supermarkets, and exchanges had returned to operation. Emergency schools had been run even though there were still shortages of emergency tents and educational infrastructure and not all students attended school. Cleaning of building debris continued to be carried out by joint officers and volunteers.

Exactly a month after the Earthquake and Tsunami in the Central Sulawesi, the condition of the city of Palu had been recovered even though not yet fully. This is inseparable from the collaboration of all parties involved in disaster response. The same thing was found in a study conducted by Nohara M (2001) who said that recovery after natural disasters requires cooperation by all parties including government, volunteers, and the society to solve problems, especially in handling the most basic public health problems. [14]. This article has identified that society cooperation is needed in dealing with refugee issues and disaster response.

CONCLUSION

From the results of the FGD survey and literature study, the natural disaster that occurred in Palu City and its surroundings provided information that generally the attitude of caring for the affected communities was very high. These results were obtained from field data that logistical assistance and heavy equipment assistance for the recovery of disaster areas began to be carried out less than 24 hours after the disaster occurred. In addition, the caring activities in the community did not only come from one region (Sulawesi), but also from various regions of Indonesia such as Java, Sumatra, Kalimantan, Maluku, Bali, and even from other countries such as Turkey, Saudi Arabia, Europe, Japan, and others.

On the other hand, communities in areas that are not affected by the disaster can also learn to understand how to respond and survive in areas that often experience earthquakes and have volcanic lines. This attitude needs to be improved and socialized by the government in order to minimize losses, especially related to human mortality rates.

REFERENCES

- [1] A. D. Diambama, A. Anggraini, M. Nukman, and B. Lühr, "Velocity Structure of the Earthquake Zone of the M6 . 3 Yogyakarta Earthquake 2006 from a Seismic Tomography Study," *Geophysical Journal International*, vol. 20, p. 2156, 2018.
- [2] M. Farid, Sunarto, and W. Suryanto, "Mapping of potential areas tsunami prone in Bengkulu city," *ARPN Journal of Engineering and Applied Sciences*, vol. 11, no. 7, pp. 4828–4832, 2016.
- [3] R. R. PUTRA, J. KIYONO, Y. ONO, and H. R. PARAJULI, "Seismic Hazard Analysis for Indonesia," *Journal of Natural Disaster Science*, vol. 33, no. 2, pp. 59–70, 2012.
- [4] E. Gaffar, H. Permana, Y. Sudrajat, S. Indarto, H. Bakti, and H. Nurohman, "Geology , Geochemistry and Geophysics of Guci Geothermal Prospect Area, Central Java.," no. May, 2018.
- [5] R. Holloway, "Indonesia , Geology," pp. 454–460, 1883.
- [6] M. Rusydi, R. Efendi, Sandra, and Rahmawati, "Earthquake Hazard Analysis Use Vs30 Data in Palu," *Journal of Physics: Conference Series*, vol. 979, no. 1, 2018.
- [7] S. Valkaniotis, A. Ganas, V. Tsironi, and A. Barberopoulou, "A preliminary report on the M7.5 Palu earthquake co-seismic ruptures and landslides using image correlation techniques on optical satellite data," pp. 1–15, 2018.
- [8] BMKG, "Gempabumi Tektonik M=7.7 Kabupaten Donggala, Sulawesi Tengah pada hari Jumat, 28 September 2018, Berpotensi Tsunami," 2018. .
- [9] S. P. Nugroho, "Percepatan Pemulihan Dampak Bencana Terus Diintensifkan di Sulteng - Badan Nasional Penanggulangan Bencana," 2018. .
- [10] M. M. Lin and R. Henschke, "Gempa, tsunami dan likuifaksi: Rangkaian bencana di Palu yang perlu Anda ketahui - BBC News Indonesia," 2018. .
- [11] D. Mardiatno, M. N. Malawani, D. N. Annisa, and D. Wacano, "Review on tsunami risk reduction in Indonesia based on coastal and settlement typology," *Indonesian Journal of Geography*, vol. 49, no. 2, pp. 186–194, 2017.
- [12] S. J. Moss and C. G. Howells, "An anomalously large liquefaction structure, Oligocene, Ombilin Basin, West Sumatra, Indonesia," *Journal of Southeast Asian Earth Sciences*, vol. 14, no. 1–2, pp. 71–78, 1996.
- [13] R. Lewerissa, S. Sismanto, A. Setiawan, and S. Pramumijoyo, "The Study of Geological Structures in Suli and Tulehu Geothermal Regions (Ambon, Indonesia) Based on Gravity Gradient Tensor Data Simulation and Analytic Signal," *Geosciences*, vol. 8, no. 1, p. 4, 2017.
- [14] M. Nohara, "Impact of the Great East Japan Earthquake and tsunami on health, medical care and public health systems in Iwate Prefecture, Japan, 2011.," *Western Pacific surveillance and response journal : WPSAR*, vol. 2, no. 4, pp. 24–30, Oct. 2011.
- [15] P. S. Thein., et al, "Estimation of Seismic Ground Motion and Shaking Palu City, Central Sulawesi Province, Indonesia", *International Journal of Geological and Environmental Engineering* Vol:8, No:5, 2014.
- [16] Yoga Sukmana, "Daftar 18 Negara Yang Tawarkan Bantuan Untuk Palu dan Donggala," 2018 [Online]. Available: <https://nasional.kompas.com/read/2018/10/01/19384081/ini-daftar-18-negara-yang-tawarkan-bantuan-untuk-palu-dan-donggala>. [Accessed: 06-Nov-2018].
- [17] Deutsche Welle, "Panggilan Nurani Kumpulkan Para Relawan di Palu," 2018. [Online]. Available: <https://www.dw.com/id/panggilan-nurani-kumpulkan-para-relawan-di-palu/av-45749973>. [Accessed: 6-Nov-2018]
- [18] Eiser, J. Richard., Bostorm, Ann., Ian, Burton. Risk interpretation and action: A conceptual framework for responses to natural hazards. *International Journal of Disaster Risk Reduction*, vol. 1, no. 2, pp. 5-16, May, 2012.
- [19] Michael Hangga Wismabrata. "Fakta Gempa Donggala dan Tsunami Palu dari Jenazah di Pantai Hingga Bantuan. 2018. [Online]. Available: <https://regional.kompas.com/read/2018/09/29/09445151/fakta-gempa-donggala-dan-tsunami-palu->

- dari-jenazah-di-pantai-hingga-bantuan. [Accessed: 7-Nov-2018]
- [20] Mileti D, editor. Disasters by design: a reassessment of natural hazards in the United States. Washington, DC: Joseph Henry Press; 1999.
 - [21] Joshua, Whittacker., Blythe McLennan., John Handmer., A review of informal volunteerism in emergencies and disasters: Definition, opportunities and challenges. *International Journal of Disaster Risk Reduction*, Volume 13, pp. 358-368.2015.
 - [22] Caroline Damanik. “Berita Foto Hari Pertama Sekolah di Palu Mendata Korban yang Selamatkan dan Meninggal,” 2018.[Online]. Available: <https://regional.kompas.com/read/2018/10/08/11301621/berita-foto-hari-pertama-sekolah-di-palu-mendata-yang-selamat-dan-meninggal>. [Accessed: 7-Nov-2018].
 - [23] Humas Provinsi Gorontalo. “Bantuan Pemerintah Provinsi Gorontalo Bergerak ke Palu,” 2018.[Online]. Available: <https://humas.gorontaloprov.go.id/bantuan-pemprov-gorontalo-bergerak-ke-palu>. [Accessed: 7-Nov-2018]
 - [24] L. Shaskolsky, Volunteerism in disaster situations. Preliminary paper no. 1. Disaster Research Center, University of Delaware. Delaware, 1967.
 - [25] R.P. Wolensky, Toward a broader conceptualization of volunteerism in disaster, Nonprofit Volunt. Sect. Q. 8 (1979) 33–42.