Advances in Social Science, Education and Humanities Research, volume 464
Proceedings of the 1st Progress in Social Science, Humanities and Education Research Symposium (PSSHERS 2019)

Spatial Analysis on the Utilization of Mosque in the Tsunami Disaster Mitigation in Padang

Azhari Syarief[1], Dian Adhetya Arief[1], Triyatno[1], Endah Purwaningsih[1(*)]

[1]*Department of Geography, Faculty of Social Science, Universitas Negeri Padang, Indonesia*
[*]*Corresponding author. Email: azharief@fis.unp.ac.id*

ABSTRACT
Mentawai megatrusth is a subduction zone which is currently very active in an earthquake and is expected to be a threat to the city of Padang against tsunami hazards. The mosque's institution acts as a centre of religious and social activities by Muslim communities for centuries in West Sumatera. In a disaster situation, a mosque should also be an important place in disaster mitigation activities, namely preparedness, early warning and as an evacuation site. The results of the study based on the research objectives are the number of mosques spread evenly in each district in accordance with the area built. The typology of the mosque based on the structure of the building is divided into two classes, namely multilevel and not terraced with the highest number of multilevel buildings located in the District of North Padang. Multi-storey buildings can be used as a Temporary Evacuation Site, all multi-story and non-terraced mosques can be used as information media for preparedness and for the purpose of an early warning system in the event of a tsunami disaster.

Keywords: *Hazard mitigation, mosque, community based religion, GIS*

1. INTRODUCTION

Indonesia is located at the confluence of three active earth crust plates namely the Indo-Australian plate in the south, the Eurasian plate in the north and the Pacific plate in the east. The movement of these three plates can cause these plates to move towards each other and collide. This has led to the emergence of earthquake pathways and active volcanoes along the islands of Sumatra, Java, Bali, Nusa Tenggara, Maluku and North Sulawesi. Earthquakes can be divided into two types namely volcanic earthquakes and tectonic earthquakes. Tectonic earthquakes can generate tsunamis if they occur in the ocean (BNPB. 2010). According to several studies, the area of West Sumatra, especially the city of Padang and its surroundings which is the largest city on the coast of West Sumatra is one area that is very vulnerable to earthquake and tsunami disasters in the future (Wisemann et al. (2011), Hill et al. (2012) and Sieh et al. (2008)).

Disaster risk management requires the role of local institutions and communities as the main component in managing communities in disaster-prone areas to play a role in natural disaster management. This is done in order to create disaster preparedness. The government and all relevant stakeholders should focus on disaster risk reduction efforts (Alhadi et al. 2018). Mallick & Vogt (2011) states that effective disaster management requires collaboration between the state, the private sector and civil society. Creating disaster preparedness is one of the important things in disaster management efforts. (Anam et al. 2018). Cheema et al. stated that the role of community-based religious institutions has been largely undocumented, underestimated and overshadowed in the disaster studies literature. In a special issue of the journal 'Religion' on the theme of religion, natural hazards and disasters. The existence of religious based institutions such as mosques (masjid) is still not well documented and has not been seen as part of a disaster management strategy.

Whereas religious institutions have played an important role in developing social influence, building social networks and safety in society, such as providing food, providing shelter for people in need and supporting the community are functions that have been carried out by mosque institutions for thousands years.

Cheema et al. (2014) further stated that, physically, mosque is generally located at the center of the community activities. The mosque is a connecting point for community such as through loudspeakers. In this way, the mosque provides the physical and social space needed to coordinate and organize relief efforts between affected communities and assistance during disaster conditions. Another important finding by the same researcher is the role of the mosque in the phase of disaster recovery, reconstruction and rehabilitation highly depends on the personality of an imam and the community's perception of the role of imams besides leading the prayer. The personality of an imam determines the social role of a mosque and its capacity to appear as a community institution in non-worship activities such as disaster management.

Considering the importance of the mosque in the Indonesian community specifically the city of Padang, this

study aims to determine the distribution of mosque locations in tsunami disaster-prone areas, as well as typology of building conditions and calculate the affordability of mosques from residential areas in the tsunami hazard zone area of Padang City.

2. METHOD

This research was conducted in the tsunami hazard zone in Padang City (Figure 1). The research area is administratively located in 9 districts and 66 villages in the city of Padang. The research method used in this study is data collection, data analysis, and network analysis. Data collection includes: collecting the number of mosque buildings in the tsunami hazard zone, interpretation of residential buildings from the quickbird satellite and population data. Quickbird 2010 satellite imagery with 0.6 meter resolution can be identified as double-sided polygons. Population data used is the data of year 2017. Data analysis includes: population distribution analysis, road digitization and evacuation time analysis. Digitizing roads aims to find out Padang City road network system.

The initial step is to identify the distribution of mosques around the residential area of Padang City from Quickbird imagery before out to the field. Distribution of the mosque locations around the residential areas is used to determine the position of the mosque towards the tsunami vulnerability residential areas. The next step is to verify the results of the interpretation by carrying out a ground truth test. Verification results are used to update settlement data. The updating of road data is based on the Road Network Map and mapping the location of the mosque which can be used as a temporary evacuation location.

Analysis of the data used is the spatial analysis technique, namely the Buffer Zone model (distance analysis) and the analysis of the distance to the mosque on the road network in a tsunami hazard zones. Analysis of the distance between the location points of the mosque is to see how large the area of the settlement that has a mosque. Spatial analysis techniques are carried out using the help of geographic information systems.

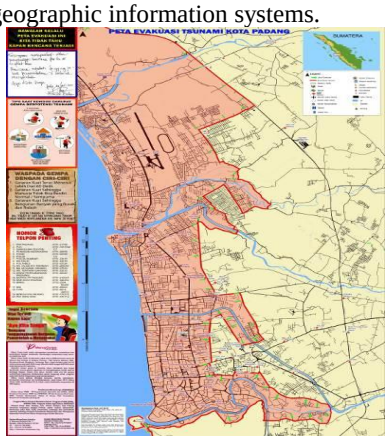


Figure. 1. Tsunami evacuation map Padang and study area
Source:http://www.gitews.org/tsunami-kit/id/id_tsunami_evacuation_map_padang.html

3. RESULTS AND DISCUSSION

Distribution of mosque locations in the tsunami hazard zones of Padang City

Based on the interpretation of satellite imagery and field surveys, data obtained is as follows, the data of the mosques in the high tsunami hazard zones is 89 mosques, in medium hazard zones is 86 mosques and 73 mosques in the low hazard zones. Hence the mosque building that can be used as a temporary evacuation site in case of a tsunami wave occurs are 104 locations, with the condition that the mosque building has 2 floors or more.

Table 1. Number of mosques in tsunami disaster-prone zones in Padang City

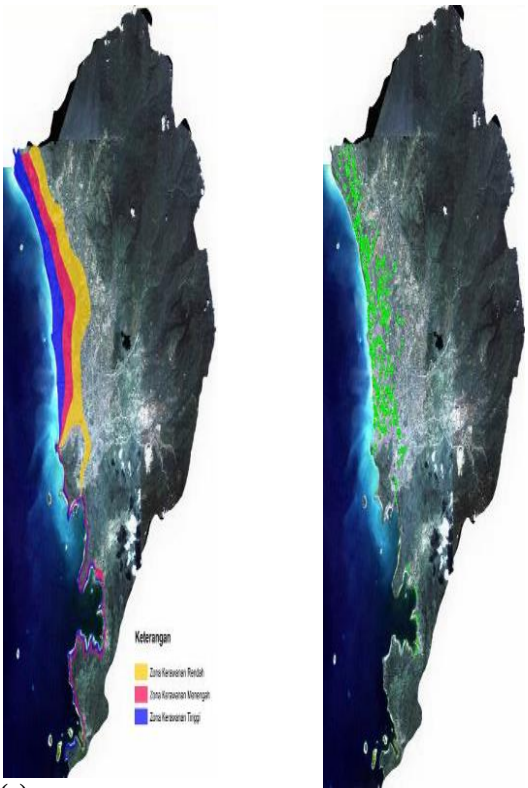
No.	District	Total of Built Area	Population	Mosque	2 floor mosques	
					Amount	%
1	Koto Tangah	1.493,73	155.235	105	19	18,1
2	Pauh	0,00	0	0	0	0,0
3	Kuranji	71,75	32.461	10	4	40,0
4	Nanggalo	473,06	61.110	20	11	55,0
5	Lubuk Begalung	45,93	17.404	8	2	25,0
6	Bungus Teluk Kabung	118,08	19.067	5	3	60,0
7	Padang Utara	659,89	70.951	38	25	65,8
8	Padang Barat	500,39	46.055	25	19	76,0
9	Padang Timur	536,94	79.469	31	15	48,4
10	Padang Selatan	159,01	59.962	6	6	100,0
11	Lubuk Kilangan	0,00	0	0	0	0,0
Total		4437,97	541.714	248	104	44,4

Source: Data Analysis, 2019

Based on the width of residential areas data and the population amount in the tsunami hazard zone, can be obtained as follow, the average population density in the

settlement area is 122 people / ha. Looking at the distribution of mosques that has the potential to become temporary evacuations in the tsunami hazard zones there are only 104 units of mosque or 44.4% of the total mosques located in that zones namely as many as 243 units of mosque. The existence of a mosque that has the potential as a temporary shelter (shelter) for the victims of the earthquake and tsunami disaster in the city of Padang consists of 14 attributes that are divided into seven criteria, namely water and sanitation, quite a large area, security, ease of access, building / construction resistant and electricity (Hadi, et, al. 2015).

All mosques can be used as a meeting point and a leading source of information in providing information about disasters. Twigg (2004) observes that religious institutions can broadly play a deeper role in disaster risk reduction.



(a) (b)

Figure. 2. Map of Potensial Tsunami (a) and Spatial Distribution of Masjid (b) in Padang City

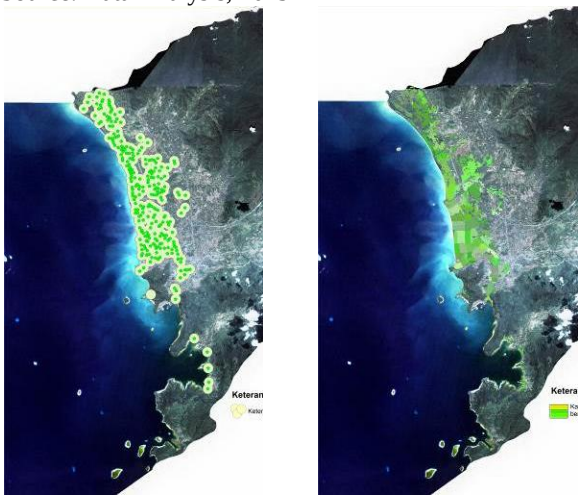
Residential areas that can be accessed by mosque institutions

Padang city is one of the largest coastal cities in Indonesia. Most people live on the coast of the Indian Ocean. Most of the residential area blocks have mosques or mushalla. Based on the assumption that the distance to the mosque as far as 500 meters can be reached by the community, considering the selection of pilgrims in the implementation of five daily prayers, Friday prayers and other religious activities. The results of the distance analysis, it can be seen that the residential area in the tsunami hazard zone with an area of 4,058.76 Ha. As many as 82.11% of that area, namely 3,696.57 hectares, has a radius of a mosque as far as 500 meters.

Table 2. Area of Settlement

No.	District	Area of Settlement		The average of accessibility (%)
		Settlement in Tsunami Hazard Zones	Settlement 500 meters from the mosque area	
1	Bungus Teluk Kabung	118,08	67,44	57,11
2	Koto Tangah	1.493,73	1.368,60	91,62
3	Kuranji	71,75	70,25	97,92
4	Lubuk Begalung	45,93	20,23	44,05
5	Nanggalo	473,06	374,69	79,21
6	Padang Barat	500,39	486,12	97,15
7	Padang Selatan	159,01	115,04	72,35
8	Padang Timur	536,94	536,93	100,00
9	Padang Utara	659,89	657,28	99,60
Jumlah		4.058,76	3.696,57	82,11

Source: Data Analysis, 2019



(a) (b)

Figure. 3. Coverage area of the mosque in the tsunami Hazard Zone (a) and Residential area that is a range of mosques (b) in Padang City

4. CONCLUSIONS

The mosque is a very important religious institution that affects the society in Indonesia, because the majority of the community are devoted Muslim. Distance analysis calculates the distribution pattern of the location of mosques in the city of Padang scattered in groups following blocks of residential areas. All locations of the mosque can be used as a means of early warning and prepare the community capacity in disaster preparedness.

Most of the mosques are located in residential areas with a radius of reach as far as 0-500 meters and have reached 82.11% of the residential areas in the tsunami hazard zone of Padang City.

5. ACKNOWLEDGMENTS

Thank you to the Institute of Research and Community Service (LP2M) of Padang State University, which has funded this research using the PNBP fund allocation in the 2019 fiscal year.

REFERENCES

[1] Alhadi, Z., Maani, K. D., Nurhabibi, P., & Syarief, A. (2018). An analysis of problem in composing of tsunami contingency plan in Padang City. In MATEC Web of Conferences (Vol. 229, p. 03007). EDP Sciences.

[2] Anam, K., Mutholib, A., Setiyawan, F., Andini, B. A., & Sefniwati, S. (2018). Kesiapan Institusi Lokal dalam Menghadapi Bencana Tsunami: Studi Kasus Kelurahan Air Manis dan Kelurahan Purus, Kota Padang. Jurnal Wilayah dan Lingkungan, 6(1), 15-29.

[3] Bencana, B. N. P. (2010). Peraturan Kepala Badan Nasional Penanggulangan Bencana Nomor 17 Tahun 2010 Tentang Pedoman Umum Penyelenggaraan Rehabilitasi dan Rekonstruksi Pasca Bencana. Jakarta: BNPB.

[4] Cheema, A. R., Scheyvens, R., Glavovic, B., & Imran, M. (2014). Unnoticed but important: revealing the hidden contribution of community-based religious institution of the mosque in disasters. Natural hazards, 71(3), 2207-2229.

[5] Hadi, W. Z., & Hadiguna, R. A. (2015). Model Kebijakan Penetapan Institusi Masjid sebagai Shelter dalam Sistem Logistik Bencana di Kota Padang. Jurnal Optimasi Sistem Industri, 14(1), 16-30

[6] Hill, E. M., Borrero, J. C., Huang, Z., Qiu, Q., Banerjee, P., Natawidjaja, D. H., ... & Li, L. (2012). The 2010 Mw 7.8 Mentawai earthquake: Very shallow source of a rare tsunami earthquake determined from tsunami field survey and near-field GPS data. Journal of Geophysical Research: Solid Earth, 117(B6).

[7] Sieh, K., Natawidjaja, D. H., Meltzner, A. J., Shen, C. C., Cheng, H., Li, K. S., ... & Edwards, R. L. (2008). Earthquake supercycles inferred from sea-level changes recorded in the corals of west Sumatra. Science, 322(5908), 1674-1678.

[8] Twigg, J. (2004). Disaster risk reduction: mitigation and preparedness in development and emergency programming. Overseas Development Institute (ODI)

[9] Wiseman, K., Banerjee, P., Sieh, K., Bürgmann, R., & Natawidjaja, D. H. (2011). Another potential source of destructive earthquakes and tsunami offshore of Sumatra. Geophysical Research Letters, 38 (10)