International Journal of GEOMATE, July 2019, Vol.17, Issue 59, pp.189-196
Geotec., Const. Mat. & Env., DOI: https://doi.org/10.21660/2019.59.66719
ISSN: 2186-2982 (Print), 2186-2990 (Online), Japan

EVALUATION OF PHYSICAL DEVELOPMENT OF THE COASTAL TOURISM REGIONS ON TSUNAMI POTENTIALLY ZONES IN PARIAMAN CITY- INDONESIA

*Dedi Hermon

Department of Geography – Padang State University, Indonesia

*Corresponding Author, Received: 01 Jan. 2019, Revised: 21 Jan. 2019, Accepted: 10 Feb. 2019

ABSTRACT: The purpose of this research is to determine the location of evacuation lines, TES or assembly points and shelters, and knowing the extent of the distribution of coastal tourism regions, as well as the distance of evacuation routes to TES or assembly points and shelters when tsunami occurs through the creation of a zoning model of coastal tourism-based disaster mitigation regions in Pariaman City. Methods in this research, i.e determining the location of TES or assembly points and shelters, and determine the capacity of TES or assembly points and shelters. Data processing and analysis for determining location, the capacity of TES or assembly points and shelters through the GIS approach. The results showed the tourism region of Gandoriah beach (7.8 Ha) an average tourist visit in 1 month in 2017 as many as 89.188 people/month with the number of TES or assembly points 2 and shelters 2, the tourism regions of Anas Malik and Cermin beach (16.11 Ha) an average tourist visit in 1 month in 2017 as many as 55.743 people/month with the number of shelter 1, the tourism region of Kata beach (19.68 Ha) an average tourist visit in 1 month in 2017 as many as 44.594 people/month the number of TES or assembly points 3 and does not have a shelter; and the tourism region of Naras beach (7.54 Ha) an average tourist visit in 1 month in 2017 as many as 33.445 people/month with the number of TES or assembly point 1 and shelter 1.

Keywords: Coastal tourism, Tsunami, Evacuation, Pariaman City

1. INTRODUCTION

The environmental arrangement of coastal regions is an important part now in supporting sustainable development and for the welfare of the Indonesian people and coastal society in particular [1] [2]. So far the development orientation has mainly only made use of all available resources on land but has not touched marine resources. Though the potential that exists in the coastal and marine regions of Indonesia and all of its biological natural resources can be an important factor in improving the nation's economy.

Coastal regions often experience natural disasters caused by various natural processes that occur in the ocean [3]. The vulnerability of coastal regions to natural disasters is increasing in line with the increasing concentration of the population making the coastal regions a centre of economic activity and a densely populated city [4] [5]. [6-10] added that throughout the area with active geology, one of the disasters that often occurred was earthquakes followed by a tsunami that often occurs around the Pacific Ocean and the Indian Ocean. Noting the history of events, the areas around the Pacific Ocean and the Indian Ocean, also known as the *Pacific Ring of Fire*, often experience tsunami events [11] [12]. In fact, this area is indeed in a location where geologically has the most active faults. [13] explains that a strong earthquake that occurs under the sea with a scale of more than 7 (*Richter Scale*) have occurred several times in this area each year. The latest earthquake and tsunami event and one of the biggest in Indonesia are that which occurred on September 28, 2018, which hit the West coast of Sulawesi Island, with the epicentre being ± 26 Km North of Donggala and ± 80 Km Northwest of Palu City with a depth of 10 Km [14].

[14] [15] added that the Donggala tsunami was one of the events that had not been previously suspected by many because the area had relatively few earthquakes followed by tsunamis. In addition, a tsunami is not always produced by an earthquake. [16] [4] further explains that underwater volcanic eruptions (for example the Krakatau eruption in 1883), hilly coastal landslides (for example Landslides in Lituya Bay in 1958), and the impact of meteors from outer space are other potential factors causing a tsunami on the coast. Therefore, given the tsunami that can spread rapidly in the high seas without losing much of its energy, coastal regions in the vast oceans such as the Indian Ocean, the Pacific Ocean and the Atlantic Ocean are very vulnerable to the impact of the tsunami.

The west Sunda arc region of the Indian Ocean covers the entire Sumatra Island from the Sunda

Strait in the South to the Andaman Islands in the North [17] [18]. According to [19] the area of West Sumatra, especially Pariaman City and its surroundings which is one of the densely populated cities on the coast of Western Sumatra and is one of the areas that are very vulnerable to disasters in the potential tsunami zone in the future. As a newly developing city, Pariaman City needs to plan coastal regions spatial planning based on disaster mitigation that takes into account the comfort of local communities and visiting Tourism. Therefore mitigation efforts need to be carried out to reduce the impact that can be caused due to the earthquake that has the potential for a tsunami.

Natural disasters can occur anytime and anywhere, including in the tourism destinations. When natural disasters hit a tourist attraction, at that time a tourism organization experienced a crisis including the tourist attraction itself, hotels, restaurants, and all other relevant organizations [20] [4]. In the context of disaster risk reduction and mitigation which can occur at any time, it is necessary to evaluate the physical development of zoning in tourism regions prone to disasters. [21] [22] explains zoning is a grouping system of elements that have the same function. This system will provide direction in determining the location of building masses physically, where zoning is always activity oriented. Therefore, it is necessary to evaluate the development of coastal tourism areas that are in the right tsunami prone zone. This study aims to analyze coastal regions that are vulnerable and potentially affected by the tsunami disaster and to model zoning for the physical development of responsive coastal tourism regions to the tsunami disaster in Pariaman City.

2. RESEARCH METHODS

2.1 Data Analysis

In this research, data processing was carried out to evaluate the physical development of coastal tourism regions that existed in tsunami potentially zone, i.e: 1) Determining the location of the TES or assembly points and shelters at the potential tsunami zone; and 2) Determination the capacity of TES or assembly points and shelters at the potential tsunami zone. Data processing and analysis for determining location, the capacity of TES or assembly points and shelters. The following is a description of the data processing stages for evaluating the physical development of coastal tourism regions in the tsunami potentially zone in Pariaman City:

1. The zone of the potential tsunami in coastal tourism areas that have the most densely populated tourisms and densely populated areas, so that the proposed TES or assembly points and shelters in a potential tsunami zone with a large population can be proposed.
2. Need to pay attention to the speed of humans to walk in this case using the assumption of the average human ability (travel time) in evacuating themselves. This assumption was taken from *the Institute of Fire Safety and Disaster Preparedness Japan*. [Evacuation speed = 0.751 m/sec (running speed MANULA) Evacuation process time = 12 minutes = 12 x 60 seconds = 720 seconds, Distance from TES $\leq$ 720 seconds x 0.751 m/sec = 540.72 m = 541 m] [23-25].
3. The next stage is the determination of the TES or assembly points and shelters using the *Geography Information System* (GIS) approach. The location of the TES or assembly points and shelters is determined by taking into account the parameters, i.e settlement regions and number of tourism, road network and safe distance that can be reached (541 m), the *network analysis* tool approach that is processed from Arc GIS 10.4 aims to analyze the proposed location for TES or assembly points and shelters in coastal tourism regions, as well as meeting main roads in settlements area in the potentially tsunami zone.
4. The results of the *network analysis* process produce point or locations for TES or assembly points and shelters, polygon or area with a 541 m radius zones and lines categorized as proposed roads or safe routes [25].
5. Furthermore, information on coastal tourism regions found in the tsunami potentially zone and tsunami safe zone. The boundary between the tsunami potentially zone and the tsunami safe zone intersecting with the main road is proposed as a horizontal path to the TES or assembly points and shelters.

3. RESULTS AND DISCUSSION

3.1 Results of Analysis of Number the Tourism Visits And The Area of Coastal Tourism Regions

The model of equality of the average number of visits of tourism both local and foreign is taken based on every day in monthly and yearly in 2017, Data obtained from the *Central Statistics Agency* (BPS) of Pariaman City shows the highest number of tourism in the coastal tourism regions of Pariaman City, i.e Gandoriah beach tourism region with an average tourism visit of 2932 people/day, Cermin beach tourism region with an average tourism visit of 1832 people/day, Kata beach tourism region with an average tourism visit of

1466 people/day, and Naras beach tourism region (turtle beach) with an average tourism visit of 1099 people/day. For more details, see Table 1 below.

Table 1 A number of tourism visits in the coastal tourism region of Pariaman City.

Regions	Village	2017 (people)	Day (7 days)	Week (52 weeks)	Month (12 months)	Area (Ha)	Information
Sunur	Sunur	-	-		-	7,01	Recommended Zone
Karan	Karan	-	-		-	13,86	Utilization Zone
Taluak	Karan	-	-		-	8,44	Utilization Zone
Kata	Taluak	535,133	1,466	10,262	44,594	19,68	Tourism Zone
Cermin	Karan Aur	668,917	1,832	12,824	55,743	9,99	Tourism Zone
Gondoriah	Pasir	1.070,267	2,932	20,524	89,188	7,4	Tourism Zone
Ombak Pauh	Pauh	-	-		-	19,66	Utilization Zone
Naras (Turtle Beach)	Manggung	401,350	1,099	7,693	33,445	7,54	Tourism Zone
Belibis	Padang Birik-Birik	-	-	-	-	29,87	Utilization Zone

Source: Data Processing, 2018 (BPS, 2017).

In the preparation of this model, the factors that influence the demand for recreation in the coastal tourism regions of Pariaman City are divided into two, i.e the factors that influence the demand for recreation to the coastal tourism regions of Pariaman City for respondents who do not stay and for respondents who stay overnight. The coastal tourism regions of Pariaman City does not provide a complete place of accommodation/hotel, where based on data from the *Department of Tourism and Culture* (DISPARBUD) in Pariaman City in 2017 shows the number of Non-Star Hotels totaling 8 units and Lodging/Homestay totaling 21 units, one of the famous lodging in the coastal region tourisms of Pariaman City i.e Nan Tongga Hotel located in Gandoriah beach recreation regions. In Pariaman City which includes coastal protected areas are river border areas, pristine mangroves and green belt. The utilization region is a region designated as a built-up, development and planning [22] [26]. According to [9] [22] [27] in this region, coastal tourism regions can be developed, but seeing the existing conditions, not all land in the coastal border can be developed for coastal tourism regions. This is because many activities have been developed in the utilization area, such as sea turtle breeding at Naras in coastal of Pariaman City. Therefore in the future, the development of coastal tourism regions can only be carried out on vacant land suitable for tourism use land.

Furthermore, after the analysis and evaluation of the development of coastal tourism areas in the potentially tsunami zone were carried out, the results to be obtained were revised to make the map of the location of the coastal tourism zone and the utilization of the existing space in Pariaman City, directive greenhouses for evacuation routes and shelters, and the TES or assembly points and shelters as an effort to reduce the level of non-structural disaster vulnerability and risk level (Tabel 2).

Table 2 Existing conditions for proposed locations for evacuation routes, TES or assembly points and shelters.

Regions	Area (Km^2)	Number of evacuation lines	Number of shelters	Number of *TES/assembly point*	Area *TES/assembly point* (Km^2)	Capacity	Recommended	*Number of Proposal *TES/ A-P/Shelter*	Existing Proposal
Sunur	69239	2	0	0	0	0	*TES/A-P/Shelter*	3	1
Karan	138600	29	0	1	852	1704	*TES/A-P/Shelter*	-	-
Taluak	84394	4	0	0	0	0	*TES/A-P/Shelter*	-	-
Kata	196754	16	0	3	9491	9782	*TES/A-P/Shelter*	3	2
Cermin	99864	13	1	0	0	0	*TES/A-P/Shelter*	3	1
Gandoriah	73991	7	2	2	7587	15174	*TES/A-P/Shelter*	3	3
Pauh	139146	14	0	4	15095	30190	*TES/A-P/Shelter*	-	-
Nareh	75433	7	1	1	3410	6820	*TES/A-P/Shelter*	2	1
Belibis	327137	43	3	5	40190	51632	*TES/A-P/Shelter*	-	-

Source: *BPBD Pariaman, 2012 and Field Survey, 2018.

3.2 Results of Analysis for Evaluation of Physical Development of Coastal Tourism

3.2.1. Tourism region of Gandoriah

Tourism region of Gandoriah which is located administratively in Pasir Village, and adjacent to the train station for access to Padang - Pariaman. Gandoriah beach is the icon of Pariaman City as the City of "Tabuik". In terms of coastal disaster, Gandoriah is a vital location of the city and also the location is in the potential tsunami zone. Based on the range radius for the distribution of existing TES or assembly point, shelter and evacuation lines or processed by GIS with *network analysis*. The results of this process show that the tourism region of Gandoriah is affordable TES or assembly

points and shelters through evacuation routes and those that are not affordable. As shown in Table 2, generally the Gandoriah tourism region is in the potential tsunami zone with the number of TES or assembly points 2 and shelters 2 facilities, so it is necessary to propose an additional evacuation route to the TES or assembly points and shelters. In the region only found a number of shelter locations such as the Nan Tongga Hotel, buildings over 2 levels (markets) and several government buildings. Gandoriah tourism region is along the coastline which is included in the tsunami potentially zone so it needs attention in disaster mitigation efforts. To find out the location of the proposed TES or assembly points and shelters, it is necessary to know the existing distribution as shown in Table 4. Based on the analysis with the GIS approach, it is known that the region of Gandoriah beach tourism is 7.8 Ha with an average tourism visit in one month for 2017 as many as 89,188 people/month. The distribution of evacuation lines, TES or assembly points and shelters is processed using the GIS approach with *network analysis*. The results of the process show that the Gandoriah tourism region is affordable through unaffordable evacuation routes and unisex as shown in Fig 1 shows that the Gandoriah tourism region is in a tsunami potentially zone which still has minimal TES or assembly points and shelters, so additional network system needs to be proposed crossroads can be seen in Table 3 and Table 4 below.

Table 3 Evaluation of physical development the tourism region of Gandoriah.

Location	Village	Sub-district	Capacity (people)	Evacuation Village	Distance from Number	Distance from Coastline
Simpang Piluang	Kampung Jawa	Central Pariaman	2200	Pasir Kampung Jawa Alai Gelombang	500 750 200	1,2 KM

Source: BPBD Pariaman, 2012 and Field Survey, 2018.

Table 4 Requirements for evacuation routes, TES or assembly points and shelters needed (Gandoriah).

Region	evacuation routes	TES/assembly point	Shelter	Proposed Evacuation	Proposed Shelter	Proposed TES/assembly point
Gandoriah	7	2	2	-	3	0

Source: Data Analysis, 2018.

3.2.2. Tourism Regions of Anas Malik Park and Cermin Beach

Tourism regions of Anas Malik are part of the Cermin beach region located administratively in the Pasia Lohong, and Cermin Beach in Karan Aur village, sub-district Central Pariaman. Anas Malik Park is named to remember the legendary leader, recognized and respected by the Pariaman community (Regent of Padang Pariaman 1980 - 1990). In terms of disaster, the tourism regions of Anas Malik Park and Cermin beach is at the location the tsunami potentially zones.

Based on range radius for existing shelters and evacuation routes or processed by GIS with *network analysis*. The results of the process show that the tourism regions ofAnas Malik and Cermin beach are affordable for shelter through evacuation routes. As shown in Table 2, generally the tourism regions of Anas Malik and Cermin beach are in the potential tsunami zone with the number of shelter 1 facilities, i.e the Padang Pariaman Regent Hall Building, so it is necessary to propose the addition of shelter construction. The Tourism regions of Anas Malik and Cermin beach is along the coastline which is included in the tsunami potentially zone so that it needs attention in disaster mitigation efforts. To find out the location of the proposed TES or assembly points and shelters, it is necessary to know the existing distribution as shown in Table 6. Here it appears that 13 evacuation lines existing to a higher location. Based on the analysis with the GIS approach, it is known that the regions of Anas Malik and Cermin beach are an area of 16.11 Ha with an average tourism visit in one month for 2017 as many as 55,743 people/month. The distribution of evacuation lines, TES or assembly points and shelters is processed using the GIS approach with network analysis. The results of this process show that Anas Malik and Cermin beach are affordable through evacuation and unreachable beaches as shown in Fig 1 showing the Tourism region of Anas Malik and Cermin beach in a tsunami potentially zone that still has minimal TES or assembly points and shelters, so it is necessary to propose additions based on the network system at the crossroads can be seen in Table 5 and Table 6 below.

Table 5 Evaluation of physical development the tourism region of Anas Malik and Cermin beach.

Location	Village	Sub-district	Capacity (people)	Evacuation Village	Distance from Number	Coastline
Simpang Taratak	Taratak	Central Pariaman	1650	Lohong Kampung Baru Taratak	400 750 500	800 M

Source: BPBD Pariaman, 2012 and Field Survey, 2018.

Table 6 Requirements for evacuation routes, TES or assembly points and shelters needed (Cermin beach).

Region	evacuation routes	TES/assembly point	Shelter	Proposed Evacuation	Proposed Shelter	Proposed TES/assembly point
Anas Malik and Cermin Beach	13	0	1	-	3	0

Source: Data Analysis, 2018.

3.2.3 Tourism Regions of Kata Beach

Tourism region of Kata beach is administratively in the Karan Aur and Taluak, sub-district Central Pariaman. This Tourism region is still happening, the number of sea pine trees that grow makes this area look shady. In terms of coastal disaster, Kata beach is at the location the tsunami potentially zone.

Based on range radius for existing shelter and evacuation routes or processed by GIS with network analysis. The results of the process indicate the beach Tourism area said affordable shelter through evacuation routes. As shown in Table 2, generally the Kata beach tourism region is in the tsunami potentially zone with the number of TES or assembly point 3 facilities and does not have a shelter, so it is necessary to propose the addition of TES or assembly points and shelters. In this region, there are only a few locations for TES or assembly points such as green open spaces in front of the Kata beach area and some community vacant land. Tourism region of Kata beach is along the coastline which is included in the tsunami potentially zone so that it needs attention in disaster mitigation efforts. To find out the location of the proposed TES or assembly points and shelters, it is necessary to know the existing distribution as shown in Table 8. Here it appears that there are 16 existing evacuation routes to a higher location. Based on the analysis with the GIS approach, it is known that the region of Kata Beach Tourism region is 19.68 Ha with an average Tourism visit in one month for 2017 as many as 44,594 people/month. The distribution of evacuation lines, TES or assembly points and shelters is processed using the GIS approach with network analysis. The results of the process show that the Kata beach Tourism region is affordable through evacuation routes and unreachable unisex as seen in Fig 1 shows that the Kata beach tourism region is in a tsunami potentially zone which still has minimal TES or assembly points and shelter, so additions based on the system need to be proposed the network at a crossroads can be seen in Table 7 and Table 8 below.

Table 7 Evaluation of physical development the tourism region of Kata beach.

Location	Village	Sub-district	Capacity (people)	Evacuation Village	Distance from Number	Coastline
Simpang Jalan Baru	Jalan Baru	Pariaman Tengah	17000	Karan Aur Kampung Baru Jalan Baru	300 700 700	800 M

Source: BPBD Pariaman, 2012 and Field Survey, 2018.

Table 8 Requirements for evacuation routes, TES or assembly points and shelters needed (Kata beach).

Region	evacuation routes	TES/assembly point	Shelter	Proposed Evacuation	Proposed Shelter	Proposed TES/assembly point
Pantai Kata	16	3	0	-	3	0

Source: Data Analysis, 2018.

3.2.4 Tourism Region of Naras Beach

Tourism region of Naras beach is administratively in Ampalu and Simpang Apar, sub-district North Pariaman. This tourist area is the Turtle Breeding UPTD region of Pariaman City as a conservation centre wherein the area is also a

mangrove and lagoon protected area which is still maintained, the abundance of sea pine and mangrove trees that grow make this area look shady and natural. In terms of disaster, Naras beach is at the tsunami potentially zone.

Based on range radius for existing shelter and evacuation routes or processed by GIS with network analysis. The results of the process show that the tourism region of Naras beach is affordable for shelter through evacuation routes and unreachable shelters because it is hampered by a line of mangrove vegetation along the coastal regions. As shown in Table 2, generally the tourist area of Naras beach is in the tsunami potentially zone with the number of TES or assembly point 1 facilities and shelter 1, so it is necessary to propose the addition of TES or assembly points and shelters. In this area, only a few locations of TES or assembly point were found such as Pariaman Tourism Office shelters in the south of tourist area of Naras beach and several community vacant lands. Based on the analysis with the GIS approach, it is known that the area of Naras beach tourist area is 7.54 Ha with an average tourist visit in one month for 2017 as many as 33,445 people/month. The distribution of evacuation lines, TES or assembly points and shelters is processed using the GIS approach with network analysis. The results of the process show that the Naras beach tourism region is affordable through unaffordable evacuation routes and unisex as shown in Fig 1 showing the Naras beach tourism region is in a tsunami potentially zone which still has minimal TES or assembly points and shelters, so additions based on the system need to be proposed the network at a crossroads can be seen in Table 9 and Table 10 below.

Table 9 Evaluation of physical development the tourism region of Naras beach.

Location	Village	Sub-district	Capacity (people)	Evacuation Village	Distance from Number	Distance from Coastline
Ampalu Village Office	Ampalu	North Pariaman	1000	Ampalu Pauh Barat	750 250	500 M

Source: BPBD Pariaman, 2012 and Field Survey, 2018.

Table 8 Requirements for evacuation routes, TES or assembly points and shelters needed (Naras beach).

Region	evacuation routes	TES/assembly point	Shelter	Proposed Evacuation	Proposed Shelter	Proposed TES/assembly point
Naras	7	1	1	-	3	3

Source: Data Analysis, 2018.

3.3 Results of Mileage Analysis of Disaster Evacuation in Coastal Regions

At this stage, the preparation reaches an inventory of resources found in the coastal regions of Pariaman City. For the next stage, the preparation of this research will be continued at the stage of determining the distance from the results of GIS analysis using a network analysis approach to connect the locations of evacuation routes to TES or assembly points and shelters (proposed). Determining the location of buildings that are used as shelter and TES or assembly point are also assessed based on the capability of the capacity of each shelter. Then after the existing and proposed locations of shelter and TES or assembly points have been determined, the fastest evacuation routes will be made to the TES or assembly points and shelters (Table 9).

Table 9 Estimated mileage of the evacuation path towards the TES or assembly points and shelters proposed by the government and the field survey.

No	Location (Village)	Evacuation Line (m)	Road Type	Condition	Travel Time (minutes)
1	Padang Birik-birik	694	city	well	± 12
2	Padang Birik-birik	762	village	well	± 13
3	Padang Birik-birik	904	city	well	± 15
4	Ampalu	716	village	well	± 12
5	Ampalu	394	village	well	± 7
6	Ampalu	544	village	well	± 9
7	Ampalu	621	village	well	± 10
8	Ampalu	381	village	well	± 6
9	Kampung Jawa	679	city	well	± 11
10	Kampung Jawa	520	city	well	± 8
11	Jalan Baru	1180	city	well	± 19
12	Karan Aur	842	village	well	± 14

Table 9 continued

No	Location (Village)	Evacuation Line (m)	Road Type	Condition	Travel Time (minutes)
13	Karan Aur	1090	village	well	± 18
14	Karan Aur	1147	village	well	± 19
15	Taluak	1144	village	well	± 19
16	Taluak	2155	village	well	± 35
17	Taluak	2135	village	well	± 35
18	Taluak	1849	village	well	± 30
19	Marunggi	937	village	well	± 15
20	Marunggi	414	village	well	± 6
21	Marunggi	233	village	well	± 3
22	Marunggi	507	village	well	± 8

Source: BPBD Pariaman City 2012; Modification with the 2018 Field Survey using the GIS 2018 *network analysis* approach.

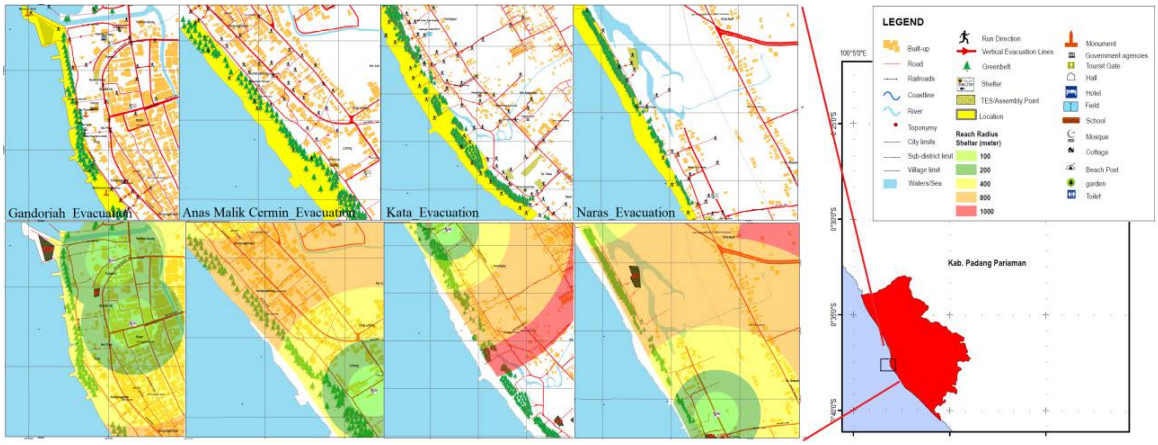

Fig. 1 Map of an evaluation model for the physical development of coastal tourism regions in Pariaman City based on tsunami disaster mitigation.

4. CONCLUSIONS

Coastal regions have TES or assembly points and shelters that are minimal both in number and capacity in coastal tourism regions, the least number of TES or assembly points and shelters is found in the coastal tourism regions of Naras beach, and Anas Malik - Cermin beach. The evacuation route determined to go to the TES or assembly points and shelters proposed by the Government and based on the 2018 field survey shows the highest number in the Ampalu Village of 5 TES or assembly points and shelters, the proposal must be built with earthquake resistance and tsunami resistance standards. TES or earthquake-resistant assembly points and shelters with the proposed location have a specific earthquake spectrum response standard taking into account the acceleration of bedrock and soft soil below. This research achieves the objectives of location design and capacity of TES or the optimal assembly points and shelters at the research location.

5. ACKNOWLEDGMENTS

This research can be carried out smoothly, because of the help and cooperation of various parties. Therefore, the author would like to thank the Government of Pariaman City - Indonesia who have provided the opportunity and time to sharpen the academic ability us, especially in the field of Mitigation of the tsunami disaster

6. REFERENCES

[1] Moghal A. A. B., Dafalla M. A., Elkady T. Y., and Al-Shamrani M.A., Lime Leachability Studies on Stabilized Expansive Semi-Arid Soil. International Journal of GEOMATE, Vol. 9, Issue 18, 2015, pp.1467-1471.

[2] Hermon, D. Geografi Lingkungan: Perubahan Lingkungan Global. 2010. pp. 1-230.

[3] Brotosusilo, A., Apriana, I. W. A., Satria, A. A and Jokopitoyo, T. Littoral and Coastal Management in Supporting Maritime Security for Realizing Indonesia as World Maritime Axis. In IOP Conference Series: Earth and Environmental Science, Vol. 30, No. 1, 2016, pp. 012016.

[4] Martinez, G., Armaroli, C., Costas, S., Harley, M. D and Paolisso, M. Experiences and results from interdisciplinary collaboration: Utilizing qualitative information to formulate disaster risk reduction measures for coastal regions. Coastal Engineering, Vol. 134, 2018, pp. 62-72.

[5] Husrin, S., Kongko, W and Putera, A. Tsunami Vulnerability of Critical Infrastructures in the City of Padang, West

Sumatera. In The Proceeding of SIBE. 2013.
[6] Husrin, S., Kelvin, J., Putra, A., Prihantono, J., Cara, Y and Hani, A. Assessment on the characteristics and the damping performance of coastal forests in Pangandaran after the 2006 Java Tsunami. Procedia Earth and Planetary Science, Vol. 12, 2013, pp. 20-30.
[7] Titov, V., Rabinovich, A. B., Mofjeld, H. O., Thomson, R. E and González, F. I. The global reach of the 26 December 2004 Sumatra tsunami. Science, Vol. 309, No. 5743, 2015, pp. 2045-2048.
[8] Levy, J. K and Gopalakrishnan, C. Promoting disaster-resilient communities: the Great Sumatra–Andaman earthquake of 26 December 2004 and the resulting Indian Ocean tsunami. Water Resources Development, Vol. 21, No. 4, 2005, pp. 543-559.
[9] McCloskey, J., Nalbant, S. S., Bell, A. F., Natawidjaja, D. H and Rietbrock, A. The September 2009 Padang earthquake. Nature Geoscience, Vol. 3, No. 2, 2010. pp. 70.
[10] Hermon, D. The Strategic Model of Tsunami Based in Coastal Ecotourism Development at Mandeh Regions, West Sumatera, Indonesia. Journal of Environment and Earth Science, Vol. 6, No. 4, 2016, pp. 40-45.
[11] Hermon, D. Mitigasi Perubahan Iklim. Rajawali Pers (Radjagrafindo), 2016, 116-121.
[12] Griffin, J and Cipta, A. Historical Earthquakes of the Eastern Sunda Arc: Source Mechanisms and Intensity-Based Testing of Indonesia's National Seismic Hazard Assessment. 2018. the Seismological Society of America.
[13] Ashar, F., Amaratunga, D., and Haigh, R. Practices of Tsunami Evacuation Planning in Padang, Indonesia. Coastal Management (2019, pp. 399-433). Academic Press.
[14] Fritz, H. M., Kongko, W., Moore, A., McAdoo, B., Goff, J., Harbitz, C and Titov, V. Extreme runup from the 17 July 2006 Java tsunami. Geophysical Research Letters, Vol. 34, No. 12, 2008.
[15] Hui, G., Li, S., Wang, P., Suo, Y., Wang, Q and Somerville, I. D. Linkage between reactivation of the sinistral strike-slip faults and 28 September 2018 Mw7. 5 Palu Earthquake, Indonesia. Science Bulletin, 2018.
[16] Rahmadaningsi, W. S. N and Setyonegoro, W. Study of characteristic of tsunami base on the coastal morphology in north Donggala, Central Sulawesi. In Journal of Physics: Conference Series, Vol. 979, No. 1, 2018, pp. 012020.
[17] Watts, P., Grilli, S. T., Kirby, J. T., Fryer, G. J., & Tappin, D. R. (2003). Landslide tsunami case studies using a Boussinesq model and a fully nonlinear tsunami generation model. Natural Hazards And Earth System Science, Vol. 3, No. 5, pp. 391-402.
[18] McCloskey, J., Steacy, S., Nalbant, S and Dunlop, P. Tsunami threat in the Indian Ocean from a future megathrust earthquake west of Sumatra. Earth and Planetary Science Letters, Vol. 265, No. 1-2, 2008, pp. 61-81.
[19] Hermon, D. Geografi Bencana Alam. Jakarta: PT RajaGrafindo Persada. 2015.
[20] Muhari, A., Imamura, F., Diposaptono, S., and Latief, H. Tsunami mitigation efforts with PTA in West Sumatra province, Indonesia. Journal of Earthquake and Tsunami, Vol. 4, No. 04, 2010, pp. 341-368.
[21] Maditinos, Z and Vassiliadis, C. Crises and disasters in the tourism industry. MIBES 2008, pp. 67-76.
[22] Odum, E. P. The strategy of ecosystem development. science, Vol. 164, 1966, pp. 262.270.
[23] Hermon, D., Putra, A and Oktorie, O. Suitability Evaluation of Space Utilization Based on Environmental Sustainability at The Coastal Area of Bungus Bay in Padang City. International Journal, Vol. 14, No. 41, 2018, pp. 193-202.
[24] Budiarjo A 2006 Evacuation Shelter Building Planning For Tsunami-Prone Area; A Case Study of Meulaboh City, Indonesia. Master Thesis unpublished. International Institute for Geo-Information Science and Earth Observation, Enschede.
[25] Federal Emergency Management Agency. Guidelines for the design of structures for vertical evacuation from tsunamis. 2008.
[26] Putra, A and Mutmainah, H. The Mapping of Temporary Evacuation Site (TES) and Tsunami Evacuation Route in North Pagai Island, Mentawai Islands Regency-Indonesia. In IOP Conference Series: Earth and Environmental Science, Vol. 47, No. 1, 2016, pp. 012020.
[27] Raymond-Yakoubian, J and Daniel, R. An Indigenous approach to ocean planning and policy in the Bering Strait region of Alaska. Marine Policy, Vol. 97, 2018, pp. 101-108.