

# A Policy Model of Preparedness the General Hospital in Reducing Victims of Earthquake and Tsunami Disasters in Siberut Mentawai Island, Indonesia



Lucyanel Arlym, Dedi Hermon, Dasman Lanin, Olivia Oktorie, Aprizon Putra

**Abstract:** *The purpose of this research was to know the general hospital locations which are in the zone the earthquake hazard potentially tsunami to optimize the response of disaster victims and formulate a general hospital preparedness policy model in dealing with victims of the earthquake hazard potentially tsunami. The research focusing on accessibility aspects was analyzed using GIS Arc-GIS 10.5 analysis technique, while the general hospital preparedness policy model in the response to victims of the earthquake hazard potentially tsunami in Mentawai Islands Regency was using the Analytic Hierarchy Process (AHP) technique. The research results show that the development of settlements in regions not designated for settlements, especially in the hazard zone high has the highest weight value (0,750). Then followed by composing zones of hazard level to develop an early warning system (0,600), empowering people who carry out activities in the hazard zone high (0,525), compile of land allotment zones for settlements (0,500), and conduct coaching, training, and technical guidance to the people, government apparatus, private sector and hospital staff in stages and continuously (0,488).*

**Index Terms:** *Tsunami, Earthquake, Policy, General Hospital, Reducing Victims, Mentawai Island*

## I. INTRODUCTION

Indonesia is located at the confluence of the four very active tectonic plates of the world, i.e the Eurasian plate, the Pacific plate, and the Indo-Australian plate and one microplate i.e the microplate in the Philippines [1-8]. Where these conditions make Indonesia vulnerable to disasters, especially earthquakes and tsunamis, which have the potentially to suffer enormous human casualties [9-13].

Mentawai Islands Regency is an archipelagic regency located in the westernmost part of the island of Sumatra and surrounded by the Indian Ocean [14]. [13] [15] add that geologically, the Mentawai Islands Regency is a series of non-volcanic islands and the archipelago is the peaks of an undersea mountain ridge.

In addition, the Mentawai Islands Regency is located on a relatively weak Asian plate. The western part of the Mentawai Islands is composed of steep topography, due to the process of lifting due to the collision between the Asian plate and the Australian plate [16]. Based on this, the Mentawai Islands Regency has the potentially for large earthquakes, and can cause significant casualties. The large earthquake that occurred due to the collision of the Asian and Australian plates in the Mentawai Islands occurred in 1833, with an earthquake strength of 8.7 SR. The massive earthquake was followed by a tsunami which also devastated the Mentawai islands and the west coast of Sumatra [17-19]. The results of research from the Indonesian Institute of Sciences (LIPI) and Earth Observational Singapore (EOS) stated that the megathrust found around the Mentawai Islands (Mentawai Megathrust) is expected to cause a large earthquake with magnitude 8.8 SR, where the earthquake occurred through a series of other large earthquakes. The massive earthquake that occurred on September 30, 2009 with more than 700 fatalities [19].

The hospital preparedness policy model in the response to earthquake and tsunami disaster victims must be developed in Indonesia, especially in areas prone to earthquake and tsunami disasters with the Hospital Preparedness for Emergency (HOPE) [20] approach in including Siberut Island - Mentawai. HOPE constitute the concept of disaster preparedness in hospitals. Hospitals have a central role in tackling disaster victims so that in addition to disaster responsive management, the location and accessibility of hospitals also greatly determine the optimization of earthquake and tsunami disaster relief [21-24]. In addition, hospital buildings are safe from earthquake disasters, so that the role of hospitals in managing victims of earthquakes and tsunamis can be carried out optimally.

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## II. RESEARCH METHODS

The method used to conduct location analysis and hospital accessibility is to use GIS analysis techniques using Software Arc-GIS 10.5 with analysis *query* and *proximity* tools, i.e by doing map *overlay* analysis, buffer analysis and *multi-ring buffer*, *polygon to raster* analysis, and *weighted overlay* analysis.

In addition, an analysis of the hospital preparedness policy model for the response to victims of the earthquake

and tsunami disaster was carried out with the *Analytic Hierarchy Process (AHP)* consisting of formulating policy criteria, formulating stakeholders as respondents, formulating policy alternatives, and analyzing policy priorities [18] [25].

The location of the distribution of hospitals on the Siberut island in the Mentawai Islands Regency can be seen in Fig. 1 below.

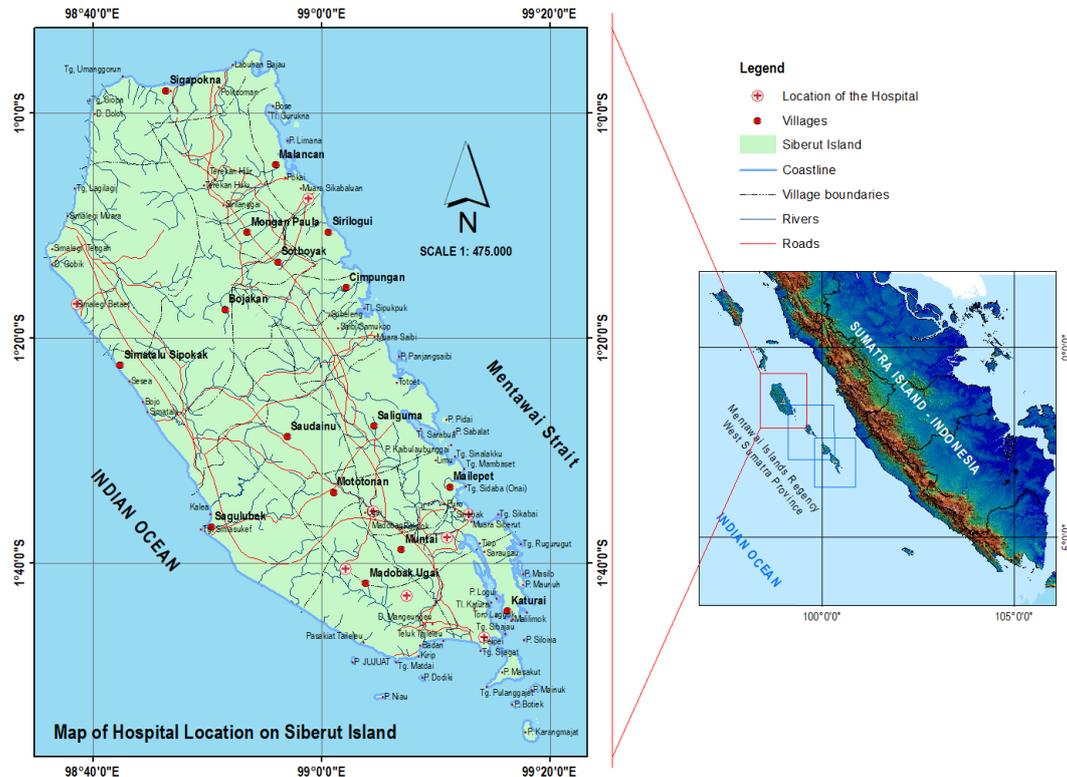


Figure 1. Map of hospital service distribution in Siberut island.

## III. RESULTS AND DISCUSSION

### 3.1 Zone of level the earthquake hazard potentially tsunami

The analysis model result for distribution level the earthquake hazard potentially tsunami provides a clear visual picture of distribution level the hazard tsunami in the research location [21] [22] (Fig. 2). From the tsunami hazard model that has been generated, there are 3 zones of level the earthquake hazard potentially tsunami, i.e: 1) *safe* hazard zone for tsunami. In this zone there is very little or no tsunami, both old and new tsunami, with the exception of riverbanks or no hazard of a potentially tsunami earthquake that threatens community settlements; 2) *moderate* hazard

zone for tsunami. In this zone there is rarely a tsunami if there is no disturbance on the slope and if there is a long earthquake, the slope has been steady again. Small-scale tsunami may occur, especially on river (grooves) and slopes 8 - 14 % or have the chance of a long earthquake 1 time in 5 years on sea; and 3) *high* hazard zone for tsunami. In this zone the earthquake hazard potentially tsunami is very potentially (high), while the old tsunami footprint and prediction of tsunami potentially is at still actively moving due to the Indo-Australian subduction zone and strong earthquake or having a chance of tsunami >2 times in 10 years. Distribution of level the earthquake hazard potentially tsunami in the study locations can be seen in Table 1 and Fig. 2 below.

Table 1. Zone of level earthquake hazard and tsunami and the existence of hospitals

Zona	Criteria	Villages	Hospital	Area (Ha)	%
Flat	High (0-8 %)	Simatalu, Sigapokna, Malancan, Sirilogui, Cimpungah, Sigulubek	Mampu Poned Betaet, Sikabualan, Muara Siberut, Siberut, Peipei Pasakiat Taileleu UPT I	134.455	35%

Zona	Criteria	Villages	Hospital	Area (Ha)	%
Sloping	Moderate (8-14%)	Madobak, Katurai, Mailepet, Saliguma, Sotboyak, Mingan Paula	Madobag, Peipei Pasakiat Taileleu UPT II	106.223	28%
Steep	Safe (> 15%)	Natural (Topography > 15%)	Peipei	145.565	38%
Total				386.243	100%

Source: Data analysis, 2019.

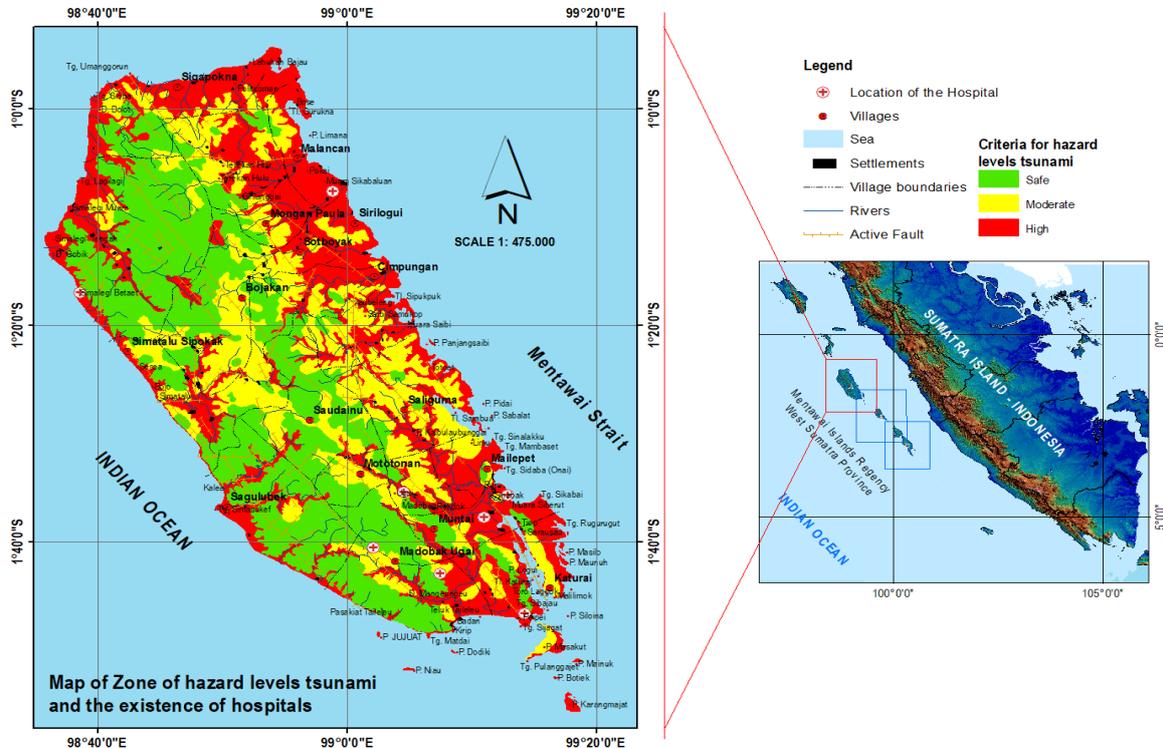


Figure 2. Map of Zone of hazard levels tsunami and the existence of hospitals

[21] [23] explained that the hazard zone of very high earthquake has a very high tendency for a tsunami to occur. This is due to the regions slope of 0-8%, especially in flat coastal flats - sloping or in furrow river valleys. Then [24-25] explains that the process of tsunami occurrence with a very high level of danger is caused by a shallow earthquake due to the subduction activity of the Indo Australia Plate under the Eurasian Plate. Precisely, in the Megathrust zone the Pagai Segment which is a plate subduction zone located in the Indian Ocean west of Sumatra.

### 3.2 Direction of hospital preparedness policy in earthquake hazard potentially tsunami

The analysis results of level the earthquake hazard potentially tsunami in the presence of hospitals in the research location based on the results in Table 1 and Fig. 2, obtained 3 zones of the regions for hospital preparedness in response of the earthquake hazard potentially tsunami disaster, i.e:

1. Zone A (*safe*), i.e the settlement development region and the existence of hospitals that are in accordance with the low tsunami hazard level.
2. Zone B (*moderate*), i.e the settlement development region and the existence of hospitals that are with the moderate tsunami hazard level. This region needs special attention from the local government, especially the development of settlement land and adequate road access as a location for tsunami evacuation.
3. Zone C (*high*), i.e region that is not permitted to the

settlement development with the high tsunami hazard level.

Zone A is used for (permanent occupancy) and final evacuation site. While the arrangement directives for structuring in zone B is more focused in terms of supervision and controlling the use of the region used for the settlements, in addition, it is necessary to do geological analysis and slope stability, engineering to reduce slope, apply vegetative techniques, terracing, and drainage systems that are appropriate for making evacuation routes and temporary evacuation sites [26] [27].

Arrangement directives in zone C are for protected forests (mangroves), shelter/evacuation buildings, artificial coastal protection, and lands that have been used for settlements must be relocated because are not in accordance with the designation of space for settlements in the Mentawai Islands Regency, except for the Port .

### 3.3 The model of general hospital preparedness policy in response to victims in the earthquake hazard potentially tsunami

Based on the results of the research that has been carried out, various alternative preparedness policies for general hospitals have been obtained in the response to victims of the earthquake hazard potentially tsunami on Siberut island,

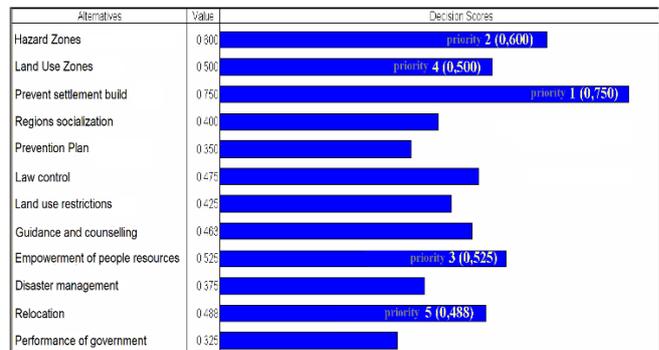
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Mentawai Islands Regency which is viewed from 3 aspects, i.e: 1) region zones with the earthquake hazard potentially tsunami (sustainability of physical resources with **5 policies**); 2) the dynamics of settlements around general hospitals in the earthquake hazard potentially tsunami (sustainability of settlements development and hospital preparedness in disaster management with **5 policies**); and 3) factors that affect general hospital preparedness in the response to victims of the earthquake hazard potentially tsunami (**2 policies**).

As for the description of alternative general hospital preparedness policy in overcoming the victims of the earthquake hazard potentially tsunami on Siberut Island, Mentawai Islands Regency as follows:

1. Compose the division zones to develop an early warning system.
2. Compose the division of land allotment for settlements based on the earthquake hazard potentially tsunami levels.
3. Compose a plan for preventing the earthquake hazard potentially tsunami *high* based on region zones.
4. Preventing settlement construction in regions that are not the priority for settlements, especially in the zone of the earthquake hazard potentially tsunami *high*.
5. Socialization of the division region zones to people so as not to build settlements in the earthquake hazard potentially tsunami *high*.
6. Undertake strict and law-controlled controls on the build settlements in regions of *high* hazard.
7. Restrictions on construction of public facilities except for ports in the hazard zone *high*.
8. Conduct guidance and counselling to the people, government apparatus, hospital staff in handling disaster victims.
9. Empower local communities as well as government apparatus and hospital staff who carry out activities in the hazard zone *high*.
10. Forming and develop disaster management for earthquake and tsunami hazard-prone regions on Siberut Island, Mentawai Islands Regency.
11. Carry out gradual and continuous simulation training for people living in high-risk regions.
12. Increasing the role of hospitals and government apparatus in managing and managing hospital preparedness in disaster management.

The selection of policy priorities is based on the amount of weight (eigenvalue) in each alternative policy. Preventing the development of settlements in regions not designated for settlements, especially in the hazard zone *high* has the highest weight value (0,750). Then followed by composing zones of hazard level to develop an early warning system (0,600), empowering people who carry out activities in the hazard zone *high* (0,525), compile of land allotment zones for settlements (0,500), and conduct coaching, training, and technical guidance to the people, government apparatus, private sector and hospital staff in stages and continuously (0,488). As for the results of the policy priority analysis using AHP are shown in Figure 3 following.



**Figure 3. Priority policy of hospital preparedness in the earthquake hazard potentially tsunami.**

The research results of having set the priority of the direction of the general hospital preparedness policy in overcoming the victims of the earthquake hazard potentially tsunami on Siberut Island, Mentawai Islands Regency. The results of policies using AHP analysis with various implementation strategies will be able to answer the hopes and objectives of general hospital preparedness in the response to victims of the earthquake hazard potentially tsunami. The research results are compiled based on research that has been carried out in zoning potential tsunami hazard regions, settlement dynamics, and factors that influence general hospital preparedness in managing victims of the earthquake hazard potentially tsunami on Siberut Island, Mentawai Islands Regency.

## II. CONCLUSIONS

Policy implications really need to strengthen the commitment of hospital service actors, both regency governments, the private sector and the community. The regency government must be consistent and continuous to make efforts to foster general hospital preparedness in disaster relief efforts at sub-district, village, private and people governments on the earthquake hazard potentially tsunami to maintain consistency in the safety of the people by making efforts: 1) Compile technical standards, technical guidelines, zone regulations and manuals for reference in developing settlements, evacuation routes, and evacuation site in disaster-prone regions; 2) Organize guidance, training, and technical guidance to people, government apparatus, private sector and hospital staff; 3) compile a mechanism for giving sanctions and rewards for violations of land use in regions with *high* tsunami hazard potential; 4) Conduct guidance and counselling to the people, government apparatus, hospital staff in handling disaster victims; and 5) Undertake strict and law-controlled controls on the build settlements in regions of high hazard. In addition, the community, government apparatus, private sector, and hospital staff were encouraged by their commitment to implement the direction of public hospital preparedness policies in the response to victims of the earthquake hazard potentially tsunami on Siberut Island, Mentawai Islands Regency.

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