ANALYSIS OF GEOGRAPHIC INFORMATION SYSTEM OF VULNERABILITY MAPPING TO TSUNAMI IN SOUTH GARUT COASTAL

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Abstract

A tsunami disaster can be interpreted as a disaster that can damage the area near the coast and its surroundings, and has a very highly destructive power. This study focuses on evacuation routes, planning the level of danger, and preventing the impact of the tsunami effectively and efficiently. In this study, researchers analyzed the coastal area of South Garut Beach which has a great potential for a tsunami disaster because the South Garut coast is very close to the meeting between Indonesian-Australian plates and Sunda Strait Megathrust. If there is any friction between the plates, it will cause a potential tsunami disaster not only in the coastal area, but also in the villages and seven subdistricts. The Modeling of this hazard impact can be found in three groups; low, moderate, and high. The lowest area has the highest tsunami potential because the lowest land will cause a tsunami to be *easier to obtain, which means that it is classified as being hit by a tsunami. In addition, and the last one at altitude of 30 meters and above altitude is classified as safe from the threat of a tsunami. In this study, researchers used an overlay technique on thematic maps such as distance maps from the coastline, elevation areas, slope areas, and distances from rivers. The overlay technique is carried out using the scoring and weighting method.*

Keywords: *Geographic Information Systems*, *Garut, Tsunami*

Introduction

In general, residents living around the coast are used as infrastructure to make a living for their daily needs, therefore around the coast, there must be many activities or activities such as fishermen to find fish which will later be traded for profit [1]

The type of business that is usually carried out by residents around the coast, especially residents in the South Garut Coast area is fishing, which in every activity of the surrounding population is mostly on the coast, in the activities of residents in the South Garut coastal area who work by profession. as fishermen who produce fish, shrimp, and sea salt. Which will be consumed by yourself and some are traded.[2]

Due to the large number of people who work as fishermen, or also work as traders, around the coast of South Garut, there is a threat of being affected by an earthquake or tsunami, the thing that causes a tsunami to occur is because the Indonesian ocean is located on the Indonesia-Australia ocean plate, the Eurasian plate and the Pacific plate. What causes a tsunami to occur, the plates that are on the Indonesian ocean border experience a natural shift, this can lead to natural disturbances, such as a tsunami.[3]

It is not only residents living around the coast that are affected, those affected by the tsunami may be villages and 7 (seven) sub-districts located in the southern coastal area. These sub-districts, including Cibalong, Pameungpeuk, Cikelet, Caringin, Mekarmukti, Pakenjeng, and Bungbulang have the greatest potential to be affected by natural disasters. [4, 5]

To minimize the impact of damage and casualties due to the tsunami, researchers conducted preventive research through evacuation points, which aimed to reduce the level of damage that occurred through a map of the distribution of the threat of tsunami hazard levels, which researchers hope can be used as a reference for more effective and efficient evacuation routes.

Literature Review

Tsunami is one of the disaster threats for many coastal areas in Indonesia. This disaster is generally triggered by an earthquake at sea which causes a vertical shift in the seabed. Tsunami threat analysis is to determine the character of a tsunami that may have occurred or will occur by considering the source mechanism, location, wave propagation, tsunami wave propagation and tsunami height. Records of tsunami events that have also been found were the 1907 tsunami that occurred around Simeulue Island, Aceh Province. Then the tsunami disaster on December 26, 2004 which devastated the coastal areas of the Indian Ocean has also become a very dark historical disaster record in Indonesia. The epicenter was in the waters of the Indian Ocean (255 km to Banda Aceh City), with a magnitude of 9.2 at a focal depth of 30 km. In addition to earthquakes, volcanic eruptions can also trigger tsunamis. One of the tsunamis caused by the eruption of a volcano was the tsunami that occurred on August 27, 1883, which was caused by the eruption of the Krakatoa volcano which resulted in 36,000 deaths [6]

The National Disaster Management Agency (BNPB) already has a National Disaster Management Plan especially for the 2015-2019 masterplan, the policy document of this plan should be understood and implemented at lower regional authorities, at the provincial and district/city levels, which have been widely used. Having a Regional Disaster Management Agency (BPBD), this institution is the foremost institution to prepare local governments and communities to always be prepared for and respond to disasters[6].

QGIS is one of the most popular open source GIS with a growing user base and increasing importance in the education sector (see, for example, the courses offered by. It is a multi-purpose open source GIS, which can be used for spatial data creation, editing, analysis and mapping. Besides the desktop GIS application, the QGIS project also provides server and related web mapping applications, as well as versions adapted to the requirements of mobile devices. Processing is an object-oriented Python framework for QGIS. Although QGIS did include geoprocessing tools before Processing was introduced, it lacked a comprehensive framework for spatial analysis. The main goal of Processing is to provide a platform for the development of analysis algorithms that makes it easy to implement and use these algorithms.[7]

Methodology

The research area is the southern region of Garut Regency, precisely around the coast which is located at coordinates 6º56'49 – 7 45'00 South Latitude and 07º25'8 – 108º7'30 East Longitude. According to the Garut Regency BPS, in 2019 it has a population of around 253,520 people in the southern region of Garut Regency. The coast of Garut Regency is divided into 7 sub-districts, namely, Cisewu, Bungbulang, Pakenjeng, Cikelet, Pameungpeuk, and Cibalong districts.

To find out and estimate the level of tsunami hazard, overlay techniques are applied to thematic maps such as distance maps from coastlines, elevation areas, slope areas, and distances from rivers. The overlay technique is carried out using the scoring and weighting method.[8]

According to [9], After determining the level of tsunami hazard, the next step is to determine the residential areas exposed to the tsunami by overlaying the hazard map with the settlement map using the scoring and weighting method.[9, 10]

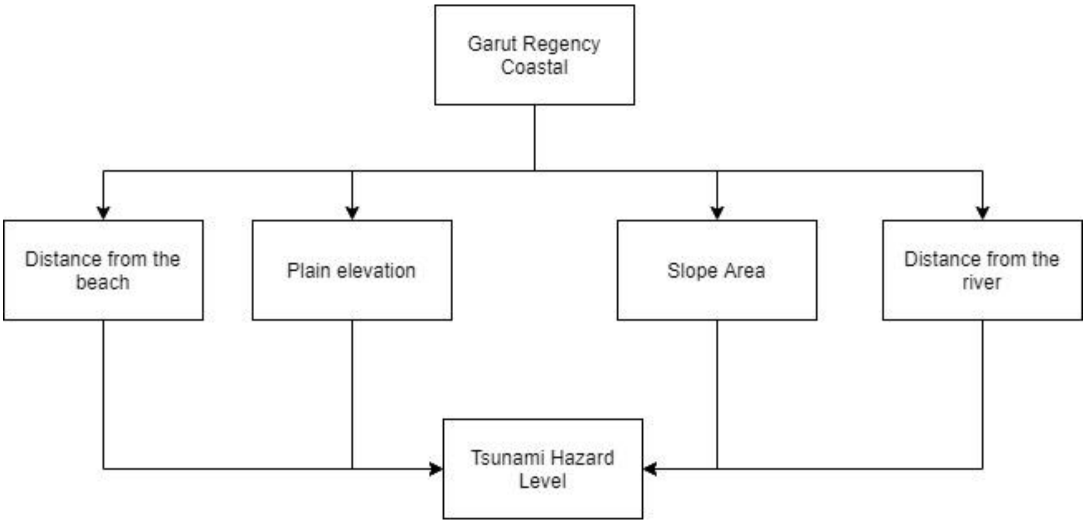

Figure 1: Flowchart of Settlement Exposure Factors to Tsunami.

Table 1

Score and Weight of Each Parameter

Parameter	description	class	score	weight	Total Score
Slope	0 – 8	Flat	4	25	100
	8 – 15	Sloping	3		75
	15 – 35	Wavy	2		50
	>35	Steep	1		25
Distance From Shoreline (Meter)	<500	Close	3	30	90
	500 – 1000	Currently	2		60
	>1000	Far	1		30
Land elevation (Meter)	0 – 20	Low	3	25	75
	20 – 30	Currently	2		50
	>30	Tall	1		25
Distance From River (Meter)	0 – 200	So Close	4	15	60
	200 – 500	Close	3		45
	500 – 1000	Far	2		30
	>1000	So Far	1		15

The methodology used in this study is how data is collected, both spatial data such as village territorial maps and DEM (Digital Elevation Model) raster data as well as non-spatial data (coastal and river lines).

Then the data will be processed and the process of selecting / merging data, then data will be overviewed or visualized in GIS tools.

Figure 2**:** General Process Methodology for Tsunami Hazard Analysis.

Input data in the form of village territorial maps, coastlines, rivers, raster maps, and satellite maps. This process is to collect, analyze and generate spatial data, as well as convert it to a format that can be used by GIS tools.[11, 12]

Then the data processing in this process is to organize or combine spatial data with non-spatial data to get the expected output.

After that, it will manipulate and analyze the processed data to determine the information that can be generated by GIS, and perform modeling manipulation to produce the expected information s.

Finally, the output of the analysis is in the form of a map display, including exporting it to the desired format, such as changing the color display and changing the CRS. These steps are as shown in Figure 2 below:

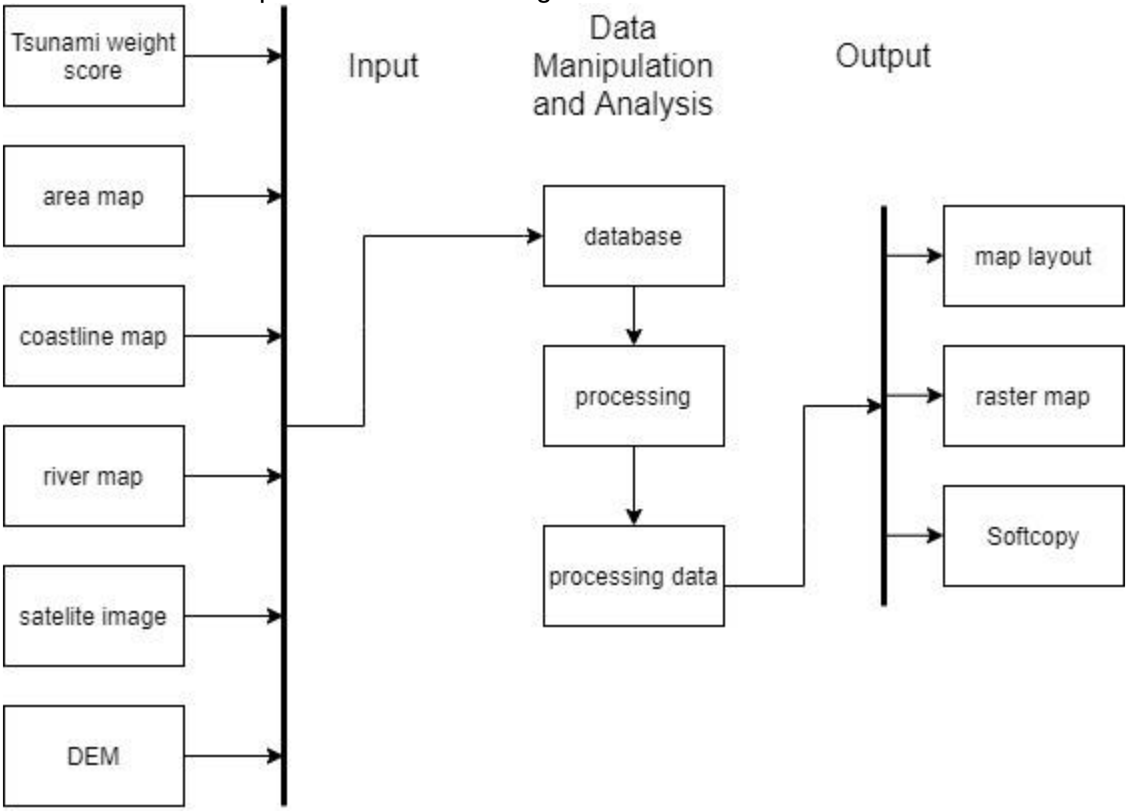

Figure 3: Special Process Methodology for Tsunami Vulnerability Analysis.

The software tools used by researchers are using Quantum GIS for processing and Arcgis for processing map layouts, both applications have complete geoprocessing tools.

The data used in this study consisted of village territorial data, coastlines, rivers, and Garut Regency DEM data which were downloaded from the Tanahair.indonesia.go.id. website.

Result and Discussiossns

Tsunami Hazard Level Parameters

The level of tsunami hazard can be based on several parameters including altitude, distance from the shoreline, slope area, and distance from rivers, quoted from Aditya's 2010 disaster risk visualization, while the thematic maps are shown below.

Figure 4: South Garut coastline map

The distance from the shoreline has an inverse relationship with the tsunami hazard area. The closer it is to the coastline, the higher the tsunami hazard. And the farther the distance from the coastline, the lower the tsunami hazard level. Based on BNPB data in 2012 and can also be seen on the map, it is known that the southern Garut Regency is dominated by an area that is more than 30000 meters from the coastline. Reporting from data from the BNPB in 2012 South Garut Regency has an average height consisting of three classes. [13]That is, the first class has a height of below 20 m, then the second is 30 m, the third is an area that has a height of more than 30 m. Figure 5 shows the lowest class meaning that the area is the lowest area in South Garut Regency. The lowest area has the highest tsunami potential because the very low land will cause a tsunami to be easier to obtain. means that it is classified as being hit by a tsunami, while for heights above 30 meters and above it is classified as prone to tsunamis and the last one at an altitude of 30 meters and above is classified as safe from the threat of a tsunami.

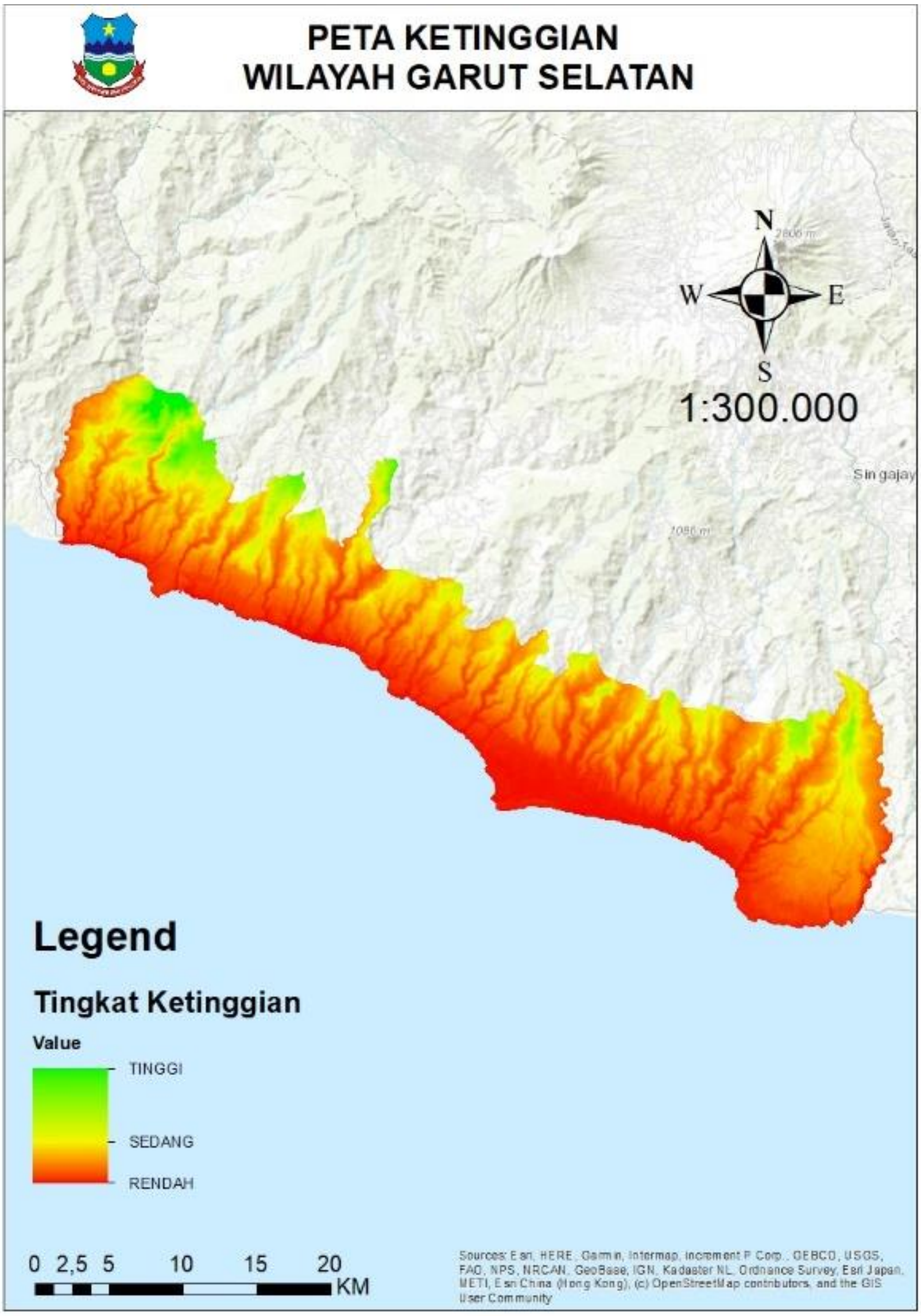

Figure 5: South Garut area map

Based on the map in Figure 6, information about the slope of the south Garut Regency is obtained which is divided into four classes, namely, the slope of 0%-8%, 8%-15%, 15%-35%, and >5%. Here it can be found that the existing slopes in the South Garut Regency area are dominated by slopes with a slope of between 8% to 15% which have a gentle or flat slope. Therefore, the slope of the southern Garut Regency has a high level of tsunami hazard because it is dominated by moderately gentle slopes and some wavy slopes, which means that the flat area is sloping to ward off incoming sea waves because there is no soil as a medium for the seawater barrier. because the slope of the southern Garut Regency is dominantly flat and sloping.

Figure 6: South Garut slope map

Based on the map Figure 7. South Garut Regency is dominated by 0-200 meters, for the distance from the river in the city of South Garut Regency is divided into four classes, namely 0-200 m, 200-500 m, 500-1000 m, and >1000 m which for class 0-200 meters from this river is in the highest danger zone against tsunamis. Because the river area closest to the sea will make it easier for tsunami waves to hit the land. And for a class distance of >1000 meters from the river, it is in a low hazard zone because of its far distance from the river. This means that based on the distance parameter from the river, South Garut Regency has a high tsunami hazard.

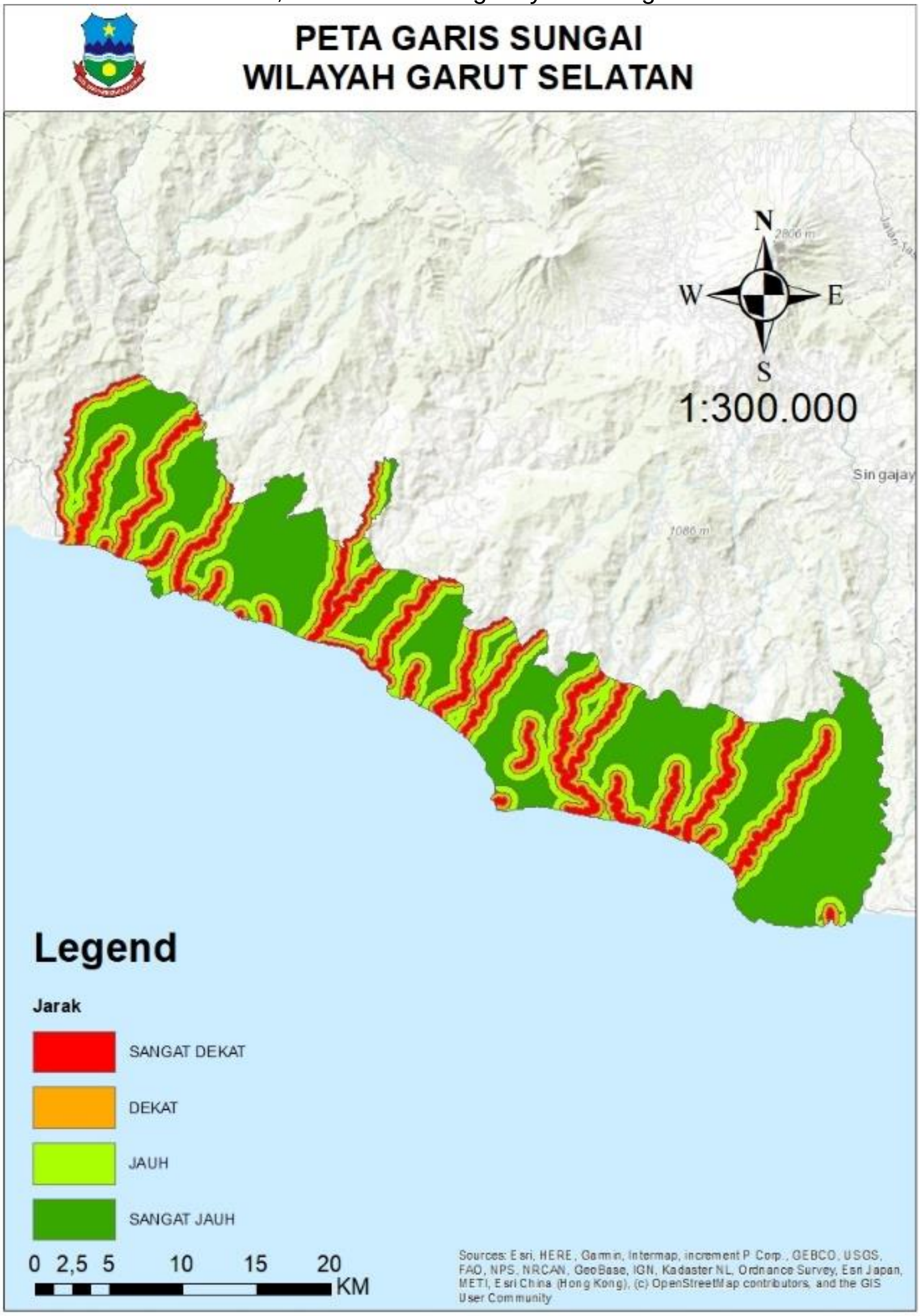

Figure 7: South Garut river line map.

Table 2

The extent of the distance from the coastline, river distance, elevation and slope area in South Garut Regency**.**

Parameter	Description	Large
Slope	0 – 8 %	220.0399 km²
	8 – 15 %	194.6266 km²
	15 – 35 %	124.8951 km²
	>35 %	47.29123 km²
Distance From Shorline (Meter)	<500 m	34.53592 km²
	500 – 1000 m	33.32944 km²
	>1000 m	526.4702 km²
Land Elevation (Meter)	0 – 20 m	278.1406 km²
	20 – 30 m	242.6592 km²
	>30 m	74.31909 km²
Distance From Beach (Meter)	0 – 200 m	78.00594 km²
	200 – 500 m	97.06705 km²
	500 – 1000 m	139.7878 km²
	>1000 m	279.6268 km²

Tsunami Hazard Level

The tsunami hazard level in South Garut Regency, which has a high level of danger, is mostly located in the coastal area, which is an area with low altitude and close to the coast. In addition, the low level of tsunami hazard in southern Garut Regency is mostly in the northern part, which is an area that is quite high in altitude and far from the coastline. The sub-districts that have a high level of danger against tsunamis are Cisewu, Bungbulang, Pakenjeng, Cikelet, Pameungpeuk, and Cibalong sub-districts.

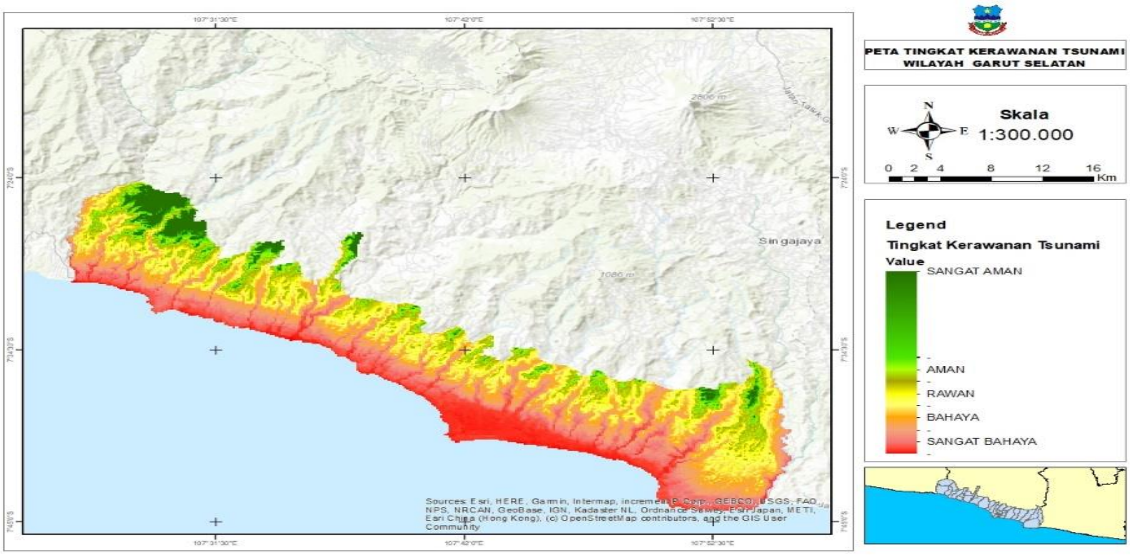

Figure 8: Tsunami vulnerability level in South Garut region.

Conclusion

A tsunami disaster can be interpreted as a disaster that can damage the area near the coast and its surroundings, the disaster has a very high destructive power, this research focuses on planning the hazard and preventing the impact of a tsunami effectively and efficiently, in this case, the Analysis Study of the South Garut Coastal Area which Great Potential for Tsunami Disasters South Garut Beach is very close to the confluence of the Indonesia-Australia Plate and the Sunda Megathrust Strait which if friction occurs between the plates can cause a potential Tsunami Disaster, Not Only Coastal Areas Affected by the Tsunami With this, villages and seven sub-districts will hit by the Tsunami.

Based on the Tsunami Hazard Level Map in the southern Garut Regency, it can be seen that the tsunami hazard level is moderate to high. This can be seen from several parameters such as the distance from the antal line, the height of the area, the slope, and the distance from the river. The main parameters that are seen from the tsunami hazard in South Garut Regency are the height of the area and the distance from the coastline. The level of exposure in the South Garut Regency is dominated by high levels of tsunamis.

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