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Geographic Information System for Tsunami Disaster Mitigation Evacuation Routes Moving the Sunda Subduction Megathrust (Case Study: Analysis of Pangandaran Regency)

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Abstract

Pangandaran Regency has the potential for an earthquake disaster accompanied by a tsunami which occurred on July 17 2006 at 15.19 with a magnitude of 7.7, earthquake data from the USGS shows an earthquake of magnitude 5-9, there are 909 earthquake points between 1918 - 2023, 2 earthquake points above magnitude 7 (7.7 and 7.44), 18 earthquake points above magnitude 6-6.9, below magnitude 6 there were 887 earthquake points, earthquake points in the south of Pangandaran Regency were concentrated between 2 groups of locations. Raster calculation of land surface at 5 meters above sea level and 10 meters above sea level is not recommended as a location to escape for tsunami disaster mitigation, also 20 meters above sea level is not recommended unless there are no other higher areas, 30 meters above sea level is highly recommended with a note if there are higher areas it is better to shift to a higher area, because tsunami waves cannot be predicted when they hit one area, their height can be different when they hit another area, it can be calculated that the potential impact of the tsunami disaster is 90,576 buildings or houses. Several villages could be rescue locations to mitigate potential tsunami disasters in Pangandaran Regency, such as in Cimerak sub-district (Limusgede village and Cimerak village), in Cijulang sub-district (Kertayasa village and Margacinta village), in Parigi sub-district (Parakanmanggu village, Cintakarya village, Selasari village), in Sidamulih subdistrict (Kersaratu village and Kalijati village), in Pangandaran subdistrict (Pagergunung village), in Kalipucang subdistrict (Ciparakan village), in Padaherang subdistrict (Payutran village, Bojongsari village, Karangsari, Kedangwuluh, Pasirgeulis), for Mangunjaya subdistrict all areas in below 30 meters so that mitigation locations must be prepared in several border villages in Ciamis Regency.

Keywords: Megathurst, Sunda Subduction, Disaster Mitigation, Spatial, GIS, Pangandaran Regency

1. Introduction

Geographic Information System Tsunami Disaster Mitigation Evacuation Route moving Sunda Subduction Megathrust (Case Study: Analysis of Pangandaran Regency), the issue of this research is the potential for disaster due to the movement of the subduction zone between the Eurasian plate and the Indo-Australian plate, extending from the west of Sumatra to the south of Java, Bali, and Nusa Tenggara. This subduction zone is called the Sunda subduction arc and has several segments; the Java segment has a lower earthquake magnitude and frequency.

Megathrust is a shallow part of the subduction strip with a shallow dip angle, so the impact on Pangandaran Regency has the potential for an earthquake disaster.

Accompanied by a tsunami is a threat that must be mapped carefully; it is necessary to remap evacuation routes to mitigate this earthquake and tsunami disaster spatially with a precise geographic information system; it is essential to measure the height, slope, and width between the coast and the road. The central southern part of West Java, as well as evaluating existing evacuation routes so that the community has adequate and safe ones.

Pangandaran regency has a peculiarity in its topography; from the edge of the beach, you can see the ridges of big mountains, such as Gunung Godogan, Gunung Harendong, Gunung Haur, Gunung Parang, and Bukit Pilar.

So, for partial evacuation routes, you can easily find a sufficient height to save yourself. Still, if you analyze it more specifically on the southern road of West Java, which stretches in this area from west to east, if you pay close attention, several road segments are not far away. From the beach, then several villages not far from the beach.

So, community preparedness and evacuation route signs must be increased along the southern way of Pangandaran Regency so that if a disaster strikes, everyone, whether local people, migrants, or tourists, can see the signs of the evacuation route.

This research will determine the evacuation location for the threat of earthquake and tsunami disasters according to the site's specifics, height and slope of the land, large population, tourist attractions, and so on.

The Indonesian government and society had a law on disaster management in 2007 (Government of the Republic of Indonesia, 2007). However, it was a bit late in the decades since Indonesia's independence, after major disasters occurred, such as the movement of the Sunda subduction megathrust at the tip of the island of Sumatra resulting in the earthquake and tsunami in Nangroe Aceh Darusallam in 2004, even the earthquake and tsunami on the island of Sulawesi in 2018, which destroyed Palu City due to the movement of the Palu Koro fault, simply from the impact on Palu City and the large number of deaths. Significant, at first glance, according to researchers, proves the ineffectiveness of this law at lower regional levels and the importance of disaster preparedness and mitigation, especially in areas with the potential for major disasters.

The National Disaster Management Agency (BNPB) has a National Disaster Management Plan, especially for the 2020-2024 master plan (National Disaster Management Agency, 2015); this plan's policy document should be able to be understood and implemented at lower regional authorities, at the provincial and district levels/ Many cities have Regional Disaster Management Agencies (BPBD), this institution is the leading institution for preparing local governments and the community always to be ready and responsive to disasters.

The National Earthquake Study Center (Pusgen) has the latest Indonesian Earthquake Source and Hazard Map released in 2017 (National Earthquake Study Center (Pusgen), 2017); this document is very, very important for the entire Indonesian government and society always to be aware of the local environment. residence, and becomes a reference document for development and regional spatial planning.

In developed countries such as Australia, New Zealand, and the United States, studies on preparedness and response to earthquake and tsunami disasters, in particular, have in-depth and comprehensive studies such as the Tsunami Evacuation Signs document.

(Tsunami Evacuation Signs, 2019) (Ruth Garside, etc., 2009) (Oregon Office of Emergency Management, 2012) (National Tsunami Signage, 2019) (Signs & Symbols - International Tsunami Information Center, 2019) in these documents In fact, it is similar to several papers that have been released by BNPB or Regional Governments which have the potential for earthquakes and tsunamis. Still, in this research, we will compare documents that our government and the governments of other countries have released.

Some critical studies when an evacuation occurs are traffic arrangements and transportation routes; people can die because of car and motorbike collisions, not because of the earthquake and tsunami. In some countries, there are several standards for transportation arrangements if a disaster occurs, such as

Emergency Management Signing and Sign Policy and Guidelines (Manual on Uniform Traffic Control Devices, 2019) (Oregon Sign Policy and Guidelines, 2019).

Researchers will create thematic maps (F. Ormeling, 2018) to describe evacuation routes, height and slope of land, village locations, population density, tourist locations, distance from the coastline to residents, and the main road south of Pangandaran Regency.

The spatial and geographic information system software that researchers will use is Quantum GIS (Quantum GIS, "QGIS - The Leading Open Source Desktop GIS", 2019) (Quantum GIS, "QGIS User Guide", 2018) (Retno Astrini, Patrick Oswald, 2012).

In this research, researchers used a research methodology framework by C. R. Kothari (C. . R. Kothari, 1990) for analysis of addressing and measuring land resources using geographic information systems by Burrough P., Stephanie Rogers, and Patricia Vivas (Burrough P, 1986) (Stephanie Rogers, Patricia Vivas,2014)

2. Research Methods

According to C. R. Kothari, the detailed process steps to provide useful procedural guidance in the research process are as follows:

1. *Formulating The Research Problem*, At this stage, the researcher will re-examine the importance of the research problem of Mapping Evacuation Routes for Tsunami Disaster Mitigation moving the Sunda Subduction Megathrust (Case Study: Analysis of Pangandaran Regency), several mitigation activities along the southern coastal route of Pangadaran Regency have been carried out such as evacuation direction signs. Still, Some early warning tools for earthquakes and tsunamis must be clarified for disaster preparedness and mitigation.
2. *Extensive Literature Survey*, Researchers conducted an initial literature survey that researchers carried out; it found that in developed countries, signs such as evacuation routes, tsunami signs, and early warning systems appear to be more advanced with in-depth research studies, so with the addition of studies that the Government has carried out, National Agency Disaster Management, Earthquake, and Tsunami Study Agency, in analyzing this research, researchers used spatial methods such as geoprocessing using geographic information system tools. Researchers will review spatial literature that is suitable for this disaster study; researchers will reconstruct its suitability in the field with existing disaster indicators.
3. *Development Of Working Hypotheses*, According to the title of the research, it is essential to review the Geographic Information System Mapping of

Tsunami Disaster Mitigation Evacuation Routes for the Sunda Subduction Megathrust (Case Study: Analysis of Pangandaran Regency) because of the potential for earthquake and tsunami disasters which will impact the community along the southern route of Pangandaran Regency.

4. *Preparing The Research Design*, The researcher's research design will start by formulating the research problem, then conduct a study on disaster preparedness and mitigation with a case study area along the southern route of Pangandaran Regency, then carry out an initial hypothesis on this problem, trying to find examples of secondary data related to this research, then conducted a data survey along the southern route of Pangandaran Regency, then analyzed the data using geo-processing and visualized output using a geographic information system, the results were analyzed and interpreted as to whether the tsunami disaster mitigation evacuation route along the southern way of Pangandaran Regency was appropriate and adequate, then prepare the final report of this research activity.
5. *Determining Sample Design*, Will make an example of an initial research design plan with existing data, such as the required spatial topography along the southern route of Pangandaran Regency, which can be obtained from the Geospatial Information Agency (BIG), data needed on population density, dense residential locations, tourist locations, height, slope of the land, distance between the shoreline and the main road in the southern route of Pangandaran Regency.
6. *Collecting The Data*, Will carry out field observations and surveys along the southern route of Pangandaran Regency, observing and assessing signs of evacuation routes on all main road routes along the Southway of Pangandaran Regency; observations will also be carried out at densely populated locations and tourist locations, starting from the District Pangandaran in the east to Parigi District in the east. Pangandaran Regency has a coastline of approximately 65 km; there is the Pangandaran Protected Forest area to the east, and the rest are residential areas, tourist sites, gardens, and so on.
7. *Execution Of The Project, will carry out geo-processing of secondary data and existing primers, and create visualizations with geographic information systems.*
8. *Analysis Of Data*, The output of the processing and geographic information system will be analyzed and synthesized to determine whether the disaster evacuation routes along the southern way of Pangandaran Regency are safe and adequate.
9. *Hypothesis-Testing*, It will be concluded whether the signs of the tsunami evacuation routes, especially along the southern way of Pangandaran Regency, are safe and adequate.
10. *Generalisations And Interpretation*, We will generalize and interpret this research and provide evaluations and recommendations that can be given to this research, especially regarding signs of tsunami evacuation routes along the southern way of Pangandaran Regency.
11. *Preparation Of The Report*, I will prepare the final report of this research. It can add to the study of the importance of tsunami evacuation route signs, especially in the southern route of Pangandaran Regency, for better disaster preparedness and mitigation.

3. Discussion

The potential for a Tsunami disaster is moving Megathrust. The Sunda subduction in the south of the island of Java is a potential disaster issue; the potential for the subduction zone to move between the Eurasian plate and the Indo-Australian plate, extending from the west of Sumatra to the south of Java, Bali and Nusa Tenggara, this subduction zone is called the Sunda subduction arc, has several segments, the Java segment has a lower magnitude and frequency of earthquakes, as shown in Figure 1 below:

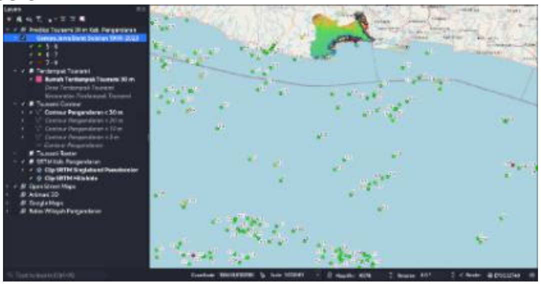


Figure 1. Earthquake distribution in the south of Pangandaran Regency 1918 – 2023 (Source USGS)

In Figure 2, you can see two red dots with magnitudes 7.7 and 7.44; magnitude 7.7 is located southwest of Pangandaran Beach, approximately 219 km away. The possible cause of the Pangandaran tsunami occurred on July 17, 2006, at 15.19; several areas in Pangandaran Regency experienced high water levels. 5–7 meters high, 21 meters on Nusa Kambangan.

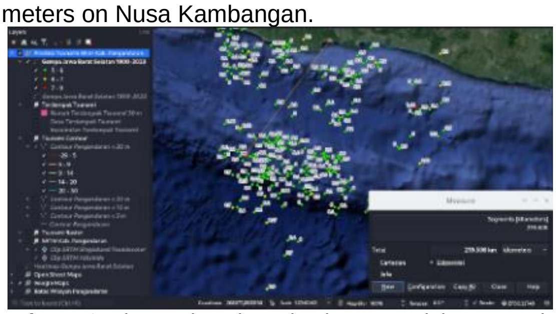


Figure 2. The earthquake point that caused the tsunami Pangandaran 2006, with a magnitude of 7.7

The following Figure 3 is the distribution of earthquake points that have occurred in the south of Pangandaran Regency, data taken from the USGS website (United States Geological Survey), which records earthquakes throughout the world manually and in real-time, data taken between the years 1900-2023, location of earthquake data taken around the south of Pangandaran Regency, data obtained from USGS, for earthquakes of magnitude 5 – 9 there were 909 earthquake points between 1918 – 2023, 2 earthquake points above magnitude 7 (7.7 and 7.44), 18 earthquake points above magnitude 6-6.9, below magnitude six as many as 887 earthquake points.

The concentration of a collection of earthquake points in the south of Pangandaran Regency, shown in Figure 3, is a heatmap analysis; the earthquakes are concentrated between 2 groups of locations.

Figure 3. Heatmap of earthquake concentration in the south of Pangandaran Regency

In this research, a DEM (digital elevation model) map is needed in the form of a raster map, which is an altitude data map that represents the height of the area being spread out. This DEM map was obtained from the NASA EarthData website, shown in Figure 4. The size of Pangandaran Regency, the orange color indicates the mountainous area, green at the foot of the mountains, and turquoise blue indicates the lowlands. The DEM map concludes that most of Pangandaran district is a high area, except for the coast and the Segara Anakan River, which can potentially be affected by the tsunami disaster.

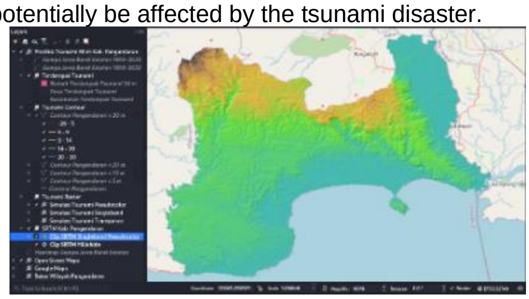


Figure 4. DEM (digital elevation model) map of Pangandaran Regency

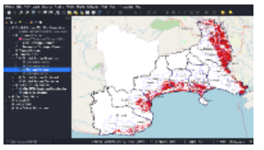
After the Pangandaran Regency DEM map was obtained, calculations were carried out to analyze the height of a region; in this study, the focus is on lowland areas, as shown in Table 1. There are four map images, which are the result of extraction-raster calculation, description of lowland areas with heights of 5 meters, 10 meters, 20 meters, and 30 meters, especially in the southern (coastline) and eastern (Segara Anakan river flow) areas of Pangandaran Regency.

Table 1. Lowland Altitude Raster Calculation in Pangandaran Regency

Altitude area of more than 5 meters	Altitude area of more than 10 meters
	
Altitude area of more than 20 meters	Altitude area of more than 30 meters
	

To get a clearer picture of the regional heights in Pangandaran Regency, the raster-type DEM map above was converted into a vector map to be used as a terrain map or height map to get the decimal value for the height of an area, shown in table 2. Picture of the first row on the left (red indicates a terrain height of 5 meters), the first row on the right (red terrain height 10 meters), the second row on the left (blue terrain height 20 meters), and finally the second row to be precise (blue terrain height 30 meters).

Table 2. Terrain map or altitude map of lowlands in Pangandaran Regency

In red, the terrain altitude is more than 5 meters	In red, the terrain altitude is more than 10 meters
	
In blue, the terrain altitude is more than 20 meters	In blue, the terrain altitude is more than 30 meters
	

To be clearer, below in Figure 5. The red color is a map of lowland terrain, with a maximum height of the ground surface of 5 meters above sea level (asl) in Pangandaran Regency (red). This plain is 5m above sea level and is very vulnerable if there is a tsunami. , because the last tsunami in Pangandaran Regency was recorded in several areas as high as 7m, so it is not recommended as a location to escape for tsunami disaster mitigation. If you pay attention, the distribution is in the districts of Cijulang, Parigi, Sidamulih, Pangandaran, Kalipucang, Padaherang, a small part of Mangunjaya.

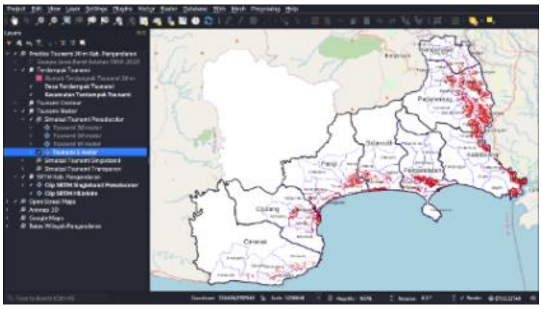


Figure 5. Map of lowland terrain, maximum height 5 meters (above the sea level) in Pangandaran Regency (red)

In Figure 6, the red color is a map of the terrain with a ground height of 10 meters above sea level (asl); the distribution of the red color is extensive in several sub-districts because there are records stating that the size of the Pangandaran tsunami wave in several locations was up to 11 meters, even hitting the island. Nusa Kambangan can be up to 21 meters, so a land height of 10 meters above sea level is not recommended for tsunami disaster mitigation in Pangandaran Regency.

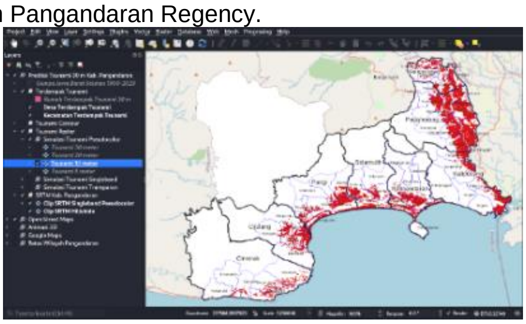


Figure 6. Map of lowland terrain, maximum height 10 meters in Pangandaran Regency (red).

In Figure 7, the blue color is the height of the land 20 meters above sea level (asl). In several locations in several sub-districts, such as Cimerak, many areas are above 20 meters above sea level. Still, in Padaherang sub-district, the area 20 meters above sea level is tiny compared to the area below 20 meters above sea level. (red), there are even several areas, such as the Parigi sub-district, which are not far from the coastline, and the ground level is above 20 meters above sea level (blue). Still, behind this area, there are many locations below 20 meters above sea level (red); in this area, it could be that there is a river flowing towards the estuary, just like in Kalipucang and Padaherang sub-districts, there is a river flowing at the Sagara Anakan estuary, in several incidents in the Aceh tsunami, the river estuary became the entrance to the tsunami waves, so basically this location 20 meters above sea level is not recommended as a tsunami disaster mitigation rescue location unless there are no other higher areas.

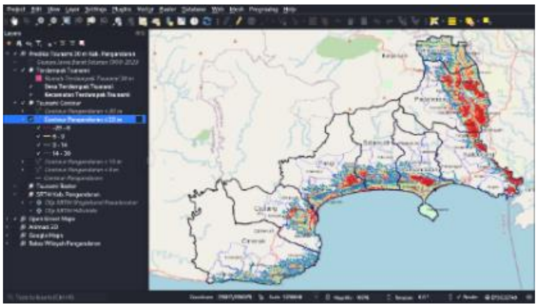


Figure 7. Map of lowland terrain, maximum height 20 meters in Pangandaran Regency (blue)

In Figure 8, the blue color is predicted to be an area with a height of 30 meters above sea level; these locations are highly recommended for tsunami disaster mitigation rescue in Pangandaran Regency, with a note that if there is a higher area, it is better to shift to a higher place because Tsunami waves cannot be predicted when they hit one spot, their height can be different when they hit another area.

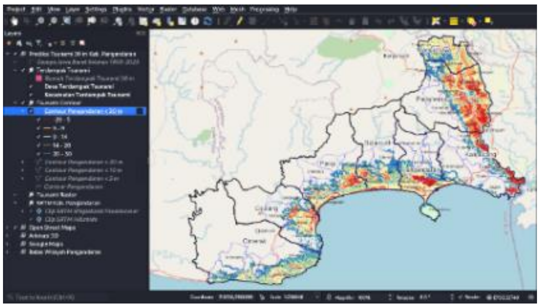


Figure 8. Map of lowland terrain, maximum height 30 meters in Pangandaran Regency (blue).

From the analysis above, on the south side, the potential for tsunami waves to become critical could hit all sub-districts facing the sea in Pangandaran Regency. However, there are several sub-districts, such as Cimerak, which meet the sea and have higher contours and even cliffs in some locations; on the east side, the Kalipucang Sub-district has The potential is more significant because it has a Sagara Anakan estuary river. In several tsunami disasters, the river estuary becomes a path for tsunami waves to penetrate further inland. In eastern areas such as Padaherang and Mangunjaya sub-districts, you still have to be alert to the potential for tsunami disasters coming from the river. Sagara Anakan River.

To be able to get a situational picture of areas affected by a potential tsunami disaster, a map of the distribution of buildings/houses is needed; this vector map is obtained from the APIOpenStreet map, shown in Figure 9., figure 10., and Table 3. is a map of the distribution of buildings/houses in Pangandaran Regency (black) with a building height of fewer than 30 meters above sea level (asl), because this map of the distribution of buildings/houses in the form of a vector type map polygon accurate in the form of roofs of buildings or houses, then if there is the potential for tsunami waves of 20 meters or even 30 meters, forcing people to leave their homes, it can be calculated that the potential impact of the tsunami disaster is 90,576 buildings or houses.

Figure 9. Buildings/houses with a height of less than 30 meters above sea level

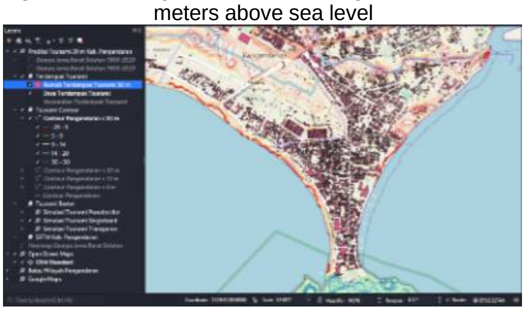


Figure 10. Detailed example of the distribution of buildings/houses with a height of less than 30 meters above sea level, around the west and east coasts of Pangandaran beach

Table 3. Tabulation of map data for 90,576 distribution of buildings or houses

Rumah Terdampak Tsunami 30 m — Features Total: 90576, ...

	full_id	osm_id	osm_type	building	government	tower_
1	r8766258	8766258	relation	yes	NULL	NULL
2	r8766358	8766358	relation	yes	NULL	NULL
3	r8766359	8766359	relation	yes	NULL	NULL
4	r8766360	8766360	relation	yes	NULL	NULL
5	r8766361	8766361	relation	yes	NULL	NULL
6	r8766362	8766362	relation	yes	NULL	NULL
7	r8766363	8766363	relation	yes	NULL	NULL
8	r8768643	8768643	relation	yes	NULL	NULL
9	r9570126	9570126	relation	yes	NULL	NULL
10	r11340172	11340172	relation	yes	NULL	NULL
11	w419709814	419709814	way	yes	NULL	NULL
12	w547163644	547163644	way	yes	NULL	NULL
13	w547163645	547163645	way	yes	NULL	NULL
14	w547163646	547163646	way	yes	NULL	NULL
15	w547163647	547163647	way	yes	NULL	NULL
16	w547163648	547163648	way	yes	NULL	NULL
17	w547163649	547163649	way	yes	NULL	NULL
18	w547163650	547163650	way	yes	NULL	NULL
19	w547163651	547163651	way	yes	NULL	NULL

Show All Features

In Figure 11, the terrain or altitude map (orange, green) of Pangandaran Regency is overlaid with a terrain or altitude map of 30 meters above sea level (asl) in blue, the maximum is above 20-30 meters above sea level, and the lowest in red is 0-5 meters above sea level, overlay map 95.576 buildings/houses in black, and on picture 12. in overlay with a map of sub-district and village administrative areas in Pangandaran Regency.

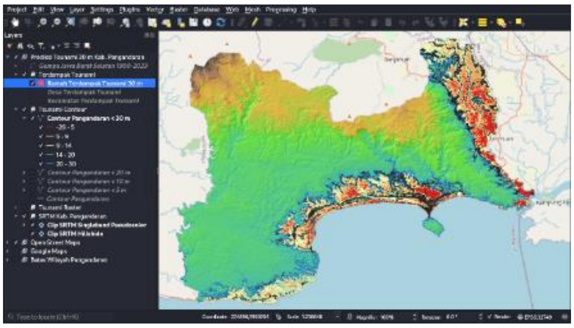


Figure 11.Overlay terrain or elevation map (orange, green) Pangandaran Regency,overlay with terrain maps of areas 20-30 m above sea level (blue), 0-5 m above sea level (red),overlay building (black)

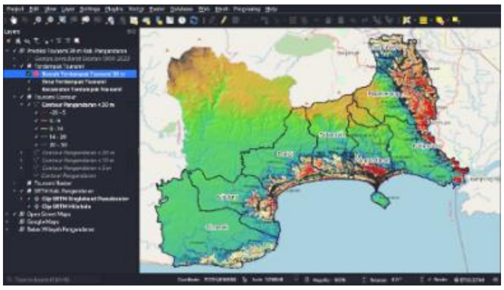


Figure 12. Overlay terrain or altitude map (orange, green) of Pangandaran Regency, overlaid with area terrain map 20-30 m above sea level (blue), 0-5 m above sea level (red),overlay 90,576 buildings or houses (black), overlay sub-district and village administrative areas in Pangandaran Regency

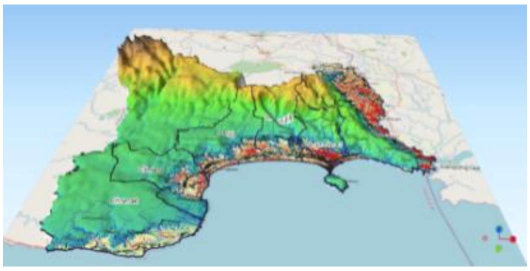


Figure 13. 3D map of Pangandaran Regency seen from the south, blue is the plain 20-30 meters above sea level and red is the plain 5 meters above sea level

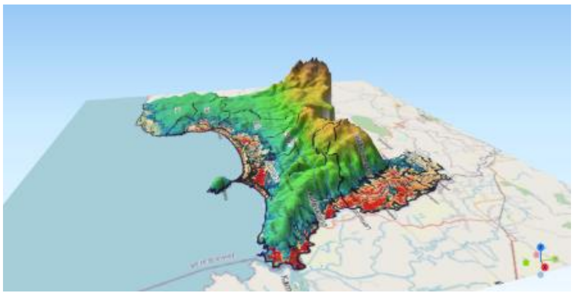


Figure 14. 3D map of Pangandaran Regency seen from the east, blue is the plain 20-30 meters above sea level and red is the plain 5 meters above sea level

Based on the analysis above, the massive areas affected by potential tsunami disasters in several sub-districts and villages in Pangandaran Regency means that several villages could become rescue locations for mitigating potential tsunami disasters in Pangandaran Regency, such as in Cimerak sub-district (Limusgede village and Cimerak village), in Cijulang sub-district (Kertayasa village and Margacinta village), in Parigi sub-district (Parakanmanggu village, Cintakarya village, Selasari village), in Sidamulih sub-district (Kersaratu village and Kalijati village), in Pangandaran sub-district (Pagergunung village), in Kalipucang sub-district (Ciparakan village), in Padaherang District (Payutran village, Bojongsari village, Karangsari, Kedangwuluh, Pasirgeulis), for Mangunjaya district all areas are below 30 meters so that mitigation locations must be prepared in several border villages in Ciamis Regency.

4. Conclusions and Suggestions

The Pangandaran tsunami occurred on July 17, 2006, at 15.19 with magnitudes 7.7 and 7.44; for magnitude 7.7, it was located to the southwest of Pangandaran beach, approximately 219 km away, several areas in Pangandaran Regency experienced water levels as high as 5–7 meters, 21 meters in Nusa Kambangan.

Earthquake points that have occurred in the south of Pangandaran Regency, data taken from the USGS (United States Geological Survey) website, data taken between the years 1900-2023, location of earthquake data taken around the south of Pangandaran Regency, data obtained from USGS, for There were 909 earthquakes of magnitude 5 – 9 between 1918 – 2023, 2 earthquake points above magnitude 7 (7.7 and 7.44), 18 earthquake points above magnitude 6-6.9, below magnitude six as many as 887 earthquake points. The concentration of earthquake points in the south of Pangandaran

Regency appears to be concentrated between 2 groups of locations.

In conclusion, the DEM (digital elevation model) map is a raster-type map; most of the Pangandaran district is a high area, except for the coastline and the Segara Anakan River, which could be affected by the tsunami disaster.

Raster calculation of the height of an area, in this research, focuses on lowland areas, with peaks of 5 meters, 10 meters, 20 meters, and 30 meters, especially in the southern (coastline) and eastern (Segara Anakan river flow) areas of Pangandaran Regency.

Plains with a maximum height of 5 meters above sea level (asl) in Pangandaran Regency are 5m above sea level. It is very vulnerable if there is a tsunami because the last tsunami in Pangandaran Regency was recorded in several areas as high as 7m, so it is not recommended as a rescue location. To mitigate the tsunami disaster, if you pay attention, the distribution is in the sub-districts of Cijulang, Parigi, Sidamulih, Pangandaran, Kalipucang, Padaherang, a small part of Mangunjaya.

Plains with a ground height of 10 meters above sea level (asl) spread very widely in several sub-districts because there are records stating that the size of the Pangandaran tsunami wave in some locations was up to 11 meters, even the one that hit Nusa Kambangan island could be up to 21 meters, so because of this The ground height of 10 meters above sea level is not recommended for tsunami disaster mitigation in Pangandaran Regency.

Plains with a land height of 20 meters above sea level (asl), in several locations in several sub-districts, such as Cimerak, there are many areas above 20 meters above sea level, but in Padaherang sub-district, areas 20 meters above sea level are very few compared to areas below 20 meters above sea level, in fact there are several In regions such as Parigi sub-district, which is not far from the coastline, the ground level appears to be above 20 meters above sea level, but behind this area there are many locations below 20 meters above sea level, in this area there could be a river flowing towards the estuary, just like in Kalipucang and Padaherang sub-districts there are the flow of the Sagara Anakan estuary river, several incidents in the Aceh tsunami, the river mouth became the entrance to the tsunami wave, so basically the location was 20 meters above.

Above sea level is only recommended as a rescue location for tsunami disaster mitigation if there are no other higher areas.

Plains with a height of 30 meters above sea level (asl) are highly recommended for tsunami disaster mitigation rescue in Pangandaran Regency, with the note that if there are higher areas, it is better to shift to more elevated areas because tsunami waves cannot be predicted when they hit a site can be different in height when it falls on another site.

On the south side, the potential for tsunami waves to become critical could hit all sub-districts facing the sea in the Pangandaran Regency. However, there are several sub-districts such as Cimerak, which meet the sea and have higher contours and even cliffs in some locations; on the east side, Kalipucang Sub-district has more significant potential because it has Sagara Anakan estuary rivers in several tsunami disasters, the river estuary became a pathway for tsunami waves to penetrate further inland, so that in eastern areas such as Padaherang and Mangunjaya sub-districts you still have to be alert to the potential for tsunami disasters entering from the Sagara Anakan river.

Situational description of areas affected by a potential tsunami disaster, the height of buildings is less than 30 meters above sea level (asl), if there is the potential for tsunami waves of 20 meters or even 30 meters, forcing people to leave their homes, it can be calculated that the potential tsunami disaster will be 90,576 buildings affected. Or home.

Based on the analysis above, the massive areas affected by potential tsunami disasters in several sub-districts and villages in Pangandaran Regency means that several villages could become rescue locations for mitigating potential tsunami disasters in Pangandaran Regency, such as in Cimerak sub-district (Limusgede village and Cimerak village), in Cijulang sub-district (Kertayasa village and Margacinta village), in Parigi sub-district (Parakanmanggu village, Cintakarya village, Selasari village), in Sidamulih sub-district (Kersaratu village and Kalijati village), in Pangandaran sub-district (Pagergunung village), in Kalipucang sub-district (Ciparakan village), in Padaherang District (Payutran village, Bojongsari village, Karangsari, Kedangwuluh, Pasirgeulis), for Mangunjaya district all areas are below 30 meters so that mitigation locations must be prepared in several border villages in Ciamis Regency.

The suggestion is that it is necessary to remap evacuation routes to mitigate the earthquake and tsunami disaster spatially using a precise geographic information system, measuring the height, slope, and width between the coast and the main road south of West Java, as well as evaluating existing evacuation routes. So that the community has adequate and safe evacuation routes, locations for shelters must be prepared in high areas, where clean water wells can be used must be drilled now.

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