Utilization of QGIS 3.22 with a Spatial Approach in Assessing Tsunami Risk on Small Islands in Ternate City

Sabaruddin Sabaruddin[1], Rusman Rasyid[2*]

[1] Faculty of Agriculture, Universitas Khairun, Indonesia, adhisabar@gmail.com
[2] Faculty of Teacher Training and Education, Universitas Khairun, Indonesia, rusman_rasyid68@unkhair.ac.id

ABSTRACT

The city of Ternate is an archipelago city consisting of 5 small islands and 3 large islands. This city is prone to earthquake activity because it is right above the active volcano, namely Mount Gamalama. in 2012 there was an earthquake that caused severe damage to residential areas. This incident was caused by local tectonic earthquakes occurring 39 times, distant tectonic earthquakes occurring 432 times, and tectonic earthquakes being felt 5 times. It is not surprising that in the future this city will experience a tsunami as a result of the activity of mount gamalama because geographically this city is an archipelago city where activities between cities and districts depend on sea transportation. The purpose of this study is to model a tsunami with a height of 30 meters in the city of Ternate. Based on the results of spatial data, the impact of the tsunami occurred that almost all districts on the island of Ternate would sink. The most severe sub-districts are the sub-districts of Central Ternate city, North Ternate city and South Ternate city. Meanwhile, for the Ternate island sub-district, the impact was not too significant.

Keywords: Ternate city, Tsunami, Spatial analysis

ABSTRAK

Kota Ternate merupakan kota kepulauan yang terdiri dari 5 pulau kecil dan 3 pulau besar. Kota ini rentan dengan aktivitas gempa karena berada tepat diatas gunung api aktif yakni gunung gamalama. pada tahun 2012 terjadi gempa yang menyebabkan kerusakan yang parah bagi pemukiman warga. Kejadian tersebut disebabkan oleh gempa tektonik lokal sebanyak 39 kali kejadian, gempa tektonik jauh 432 kali kejadian, dan gempa tektonik terasa 5 kali kejadian. Tak mengherankan jika di kemudian hari kota ini akan mengalami bencana tsunami akibat dari aktivitas gunung gamalam tersebut karena secara geografis kota ini merupkan kota kepulauan dimana aktivitas antar kota dan kabupaten bergantung pada trasnportasi lautnya. Tujuan dari penelitian ini yakni melakukan pemodelan tsunami dengan ketinggian 30 meter di kota Ternate. Berdasarkan hasil data spasial, dampak dari tsunami terjadi hampir seluruh kacamatan yang berada di pulau Ternate akan tenggelam. Adapun kecamatan yang paling parah yakni kecamatan kota Ternate Tengah, kota Ternate Utara, dan kota Ternate Selatan. Sedangkan untuk kecamatan pulau Ternate dampaknya tidak terlalu signifikan.

Kata kunci: Kota ternate, Tsunami, Analisis spasial

INTRODUCTION

Ternate City is one of the cities in North Maluku province. This city is very unique because it is located right above the active volcano area (Husni et al., 2018). The majority of its people depend on fisheries, agriculture, and trade (Robo & Haerullah, 2017). The problem with islands is that

their dependence on aquatic resources is very high and their activities are dominated by sea transportation (Ginting, 2016).

As one of the cities that supports several regions and cities in North Maluku Province, the economy in this city is very advanced when compared to cities or regencies in North Maluku Province. Based on data from BPS Ternate city shows that this city has 348 shop units, 25 kiosk units, 1115 kiosk units, 28 markets with an area of 162.17 km². Ternate city is also an archipelago city consisting of 5 small islands and 3 large islands (BPS Ternate City, 2022). So that the interaction between islands and regencies and cities depends on sea transportation. This causes the interaction of economic activities mostly in the coastal areas of the city (Idham et al., 2021).

In certain months the city will experience high tides, causing sea transportation to experience delays due to these waves (Anshar et al., 2021). Information collected on online media shows that on January 7, 2023 there was a ship delay by the North Maluku Syahbandar (Marzuki, 2023). This has an impact on hampering economic activities and community activities in this city (Kosuma, 2016).

Apart from the wave factor, the city is also vulnerable to earthquake activity because it is located directly above the active volcano, mount gamalama. The activity of mount gamalama that occurred in 2012 caused severe damage to residential areas (Masinu et al., 2018). The incident was caused by 39 local tectonic earthquakes, 432 distant tectonic earthquakes, and 5 felt tectonic earthquakes.

It is not surprising that the city experienced a tsunami disaster as a result of the activity of mount gamalama because geographically it is an archipelago city where activities between cities and districts depend on sea transportation (Djalil et al., 2015). There is a correlation between earthquakes and the impact of tsunamis (Nur, 2010; Muhammad & Syaifuddin, 2017). The study shows that mountain activity can cause plate movements which in turn allow tsunamis to occur.

Therefore, based on this information, there is a need for research related to modeling the tsunami potential of small islands. So that in the future the impact of wave activity and volcanoes that cause tsunamis can be minimized. In addition, this research also has an impact on the design of policy makers, especially the Ternate city government and the North Maluku government in making decisions related to disaster mitigation and adaptation focused on tsunami potential in Ternate city.

METHODOLOGY

This research was conducted in Ternate city with spatial approach method. The data needed are:
1. Indonesian Landform data of Ternate city and SRTM (Shuttle Radar Topoghraphic Mission) Elevation data, that is digital elevation modeling (Rahayu et al., 2023).
2. Then the data is analyzed using QGIS 3.22 software.
3. The output of the data analysis is the creation of a map of tsunami potential in the city of ternate with a wave height of 30 meters.

Spatial approach is one way to conduct analysis with a spatial model. The output of this method is in the form of a digitized map that can be used for certain purposes, such as analyzing tsunami potential (Septiana, 2020). The systematic analysis can be shown in the figure 1.
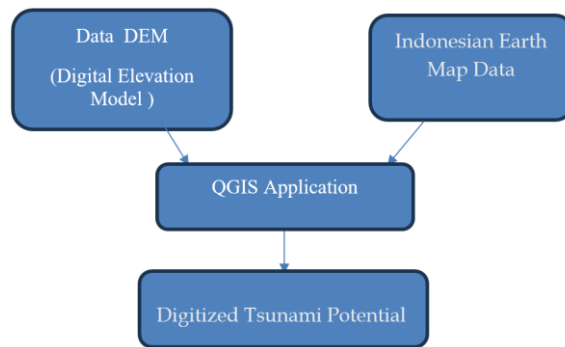
Figure 1. Research flow chart

RESULTS AND DISCUSSION

A topographic map is a map that provides information related to the height of a land surface (Rostianingsih et al., 2004). Topography plays a very important role in order to identify the height of an area (Bahri & Madlazim, 2012). In accordance with this research to determine the impact of the tsunami, the topographic map is needed. In addition, topographic maps can also be used to identify the distribution of landslides and their impacts (Sehah et al., 2016). This previous research shows that topographic maps can be the basis for modeling the N3 tsunami (Muchlian et al., 2021). In other research, mapping the level of risk of floods and landslides in North Sumatra, they used topographic maps to identify the impact of landslides that occurred in North Sumatra (Damanik & Restu, 2012). The topographic map of Ternate city can be seen in Figure 2.

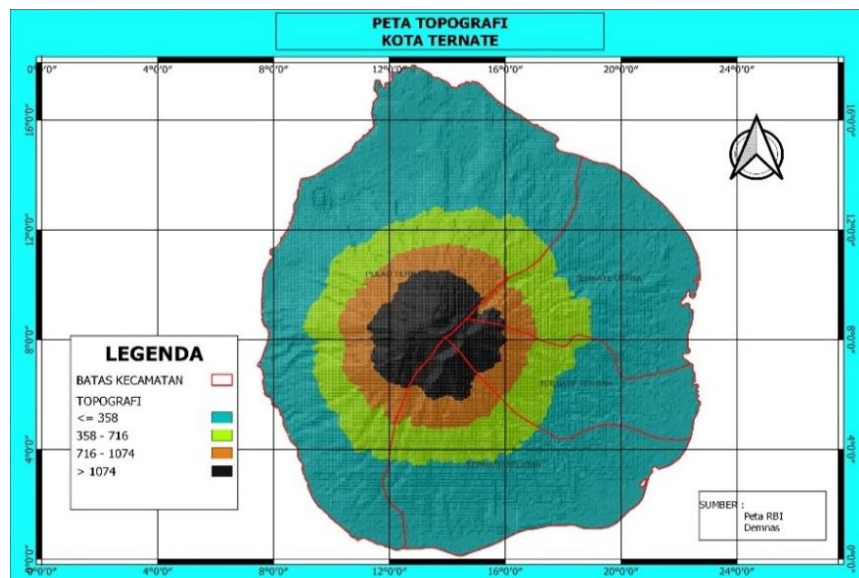Figure 2 Topographic map of Ternate city

Based on the map image 2 shows that the lowest topography of Ternate city is at <358 meters from sea level. While the topographic height of Ternate city is at >1074 meters from sea level. with sub-district boundaries consisting of North Ternate, Central Ternate, South Ternate, and Ternate Island. The city is also located directly above the active volcano and part of the "ring of fire", so volcanological activity often occurs which may cause tsunami activity at sea level. The disaster-prone map of mount gamalama activity can be seen in figure 3.
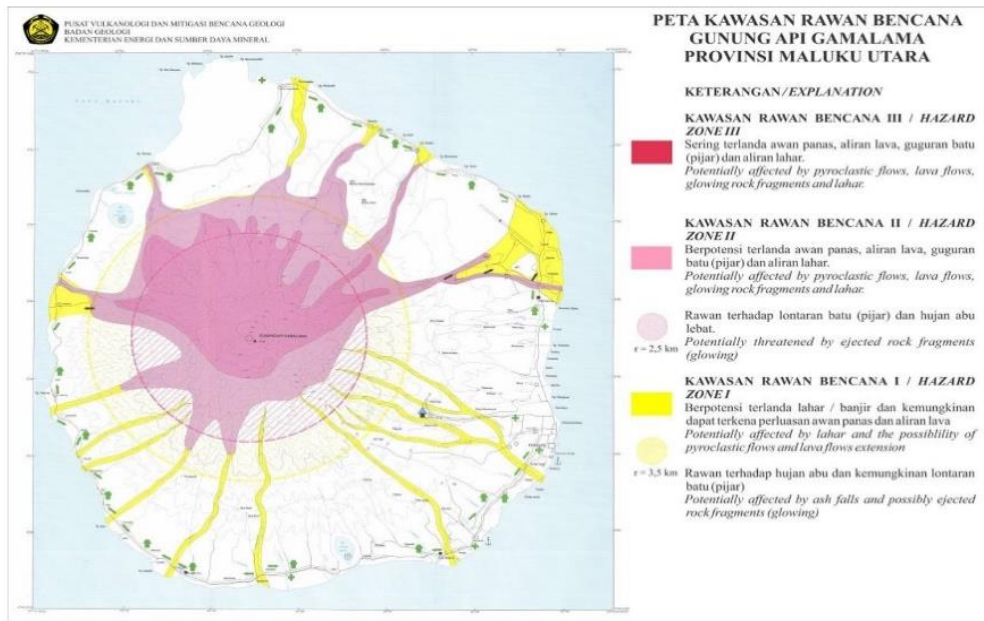
Figure 3 Disaster prone map of mount gamalama activity

The activity of mount merapi can cause a tsunami at sea level. The volcanic activity on the krakatau child in 2018 caused a tsunami this was caused by volcanic activity on the mountain (Chasanah et al., 2020; Ginting, 2020). The impact of the eruption of mount merapi will have a significant effect on the process of tsunami occurrence (Yulaelawati, 2008). So it does not rule out the possibility that in the future the potential for tsunamis in Ternate city can occur as a result of the activity of mount gamalama.meanwhile, the modeling of the tsunami potential of the city of Ternate can be seen in Figure 4.
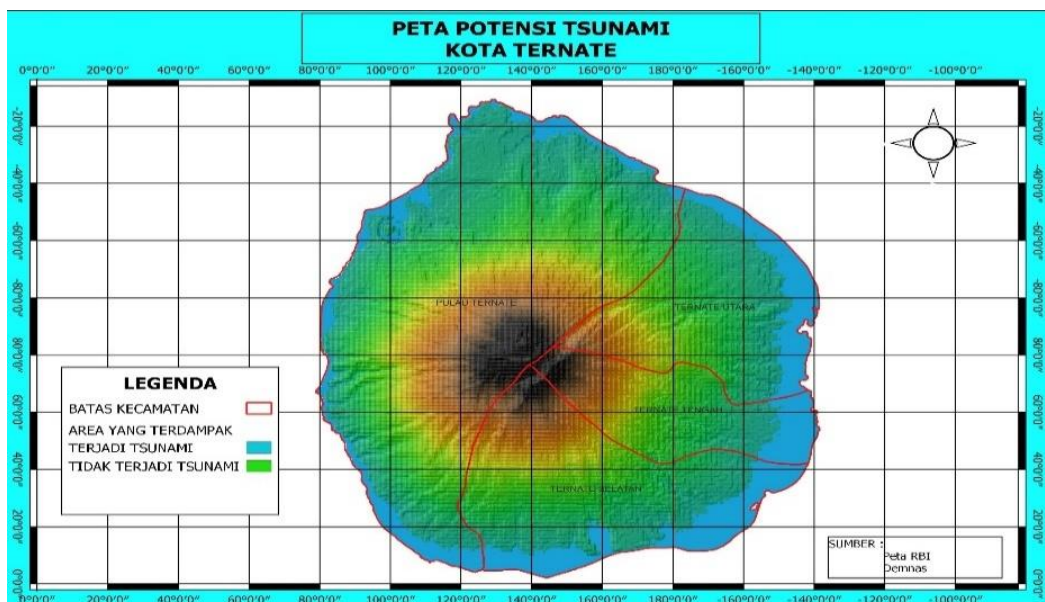

Figure 4 Map of tsunami potential of Ternate City

Based on figure 4, it can be seen that when tsunami activity occurs, it almost affects the sinking of all sub-districts on Ternate Island. The most severe sub-districts are Central Ternate city, North Ternate city, and South Ternate city. As for Ternate Island sub-district, the impact was

not too significant. If it is related to the population in Ternate city, the densely populated areas on the island can be seen in the table 1.

Table 1 Population, population density, area of sub-districts in Ternate city

No	Kecamatan	Jumlah Penduduk	Kepadatan/Km	Luas Areal Kecamatan
1	Ternate Selatan	74.810	3699,80	20,22
2	Ternate Utara	49.060	3524,14	13,92
3	Ternate Tengah	53.800	4057,24	13,26
4	Pulau Ternate	8.810	506,67	17,39

Source: BPS Kota Ternate (2022)

The table 1 shows that the largest population in Ternate city is South Ternate district 74,810 people with a density of 3699.8 and a sub-district area of 20.22 km². Meanwhile, the lowest population is Ternate Island sub-district with a population of 8,810 with a density of 506.67 km with a sub-district area of 17.39 Km², so that of the 4 sub-districts in Ternate city, the South Ternate sub-district is the sub-district most prone to causing many casualties if a tsunami occurs in Ternate city. This is supported by research results which state that the presence of volcanoes on small islands in both Maluku and North Maluku can cause potential tsunamis so that natural disaster mitigation activities are needed in these areas (Latue et al., 2023).

CONCLUSION

Based on the results of tsunami modeling spatial data when tsunami activity occurs, almost all sub-districts located on the island of ternate will sink. The most severe sub-districts are the sub-districts of central ternate city, north ternate city, and south ternate city. As for the ternate island sub-district, the impact is not too significant. So the recommendations from the results of this study require basic disaster mitigation activities for people living in Ternate city. Provide a special area as a place for protection if in the future volcanoes and tsunamis occur in this city.

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