Modeling of Tsunami Inundation Maps Along The Pacitan Coast Using Commit 1.8.1 and Quantum Gis 2.18.28 "Las Palmas" Software

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ABSTRACT

Indonesia is a maritime country located on the equator with 3 main plates, namely the Eurasian plate, the Indo-Australian plate, and the Pacific plate which is known as the Ring of Fire (Pacific ring of fire). If these plates interact along the troughs and fractures of the earth's crust which are the source of earthquakes at sea, it will trigger a tsunami. Geographically, Pacitan Regency is located between 110 55 - 111 25 East Longitude and 7 55 - 8 17 South Latitude bordering the Indian Ocean to the south and is located on the Java Megathrust which causes Pacitan to have the potential for earthquakes that cause tsunamis. That is why it needs to be studied in relation to wave height, tsunami arrival time and tsunami inundation map as measures of tsunami hazard warnings along the coast of Pacitan. The results show that the height of the tsunami waves along Pacitan Beach with the Mw 8.7 earthquake ranged from 6 meters to 13 meters with the fastest arrival time of 23 minutes. The tsunami inundation that occurs along Pacitan Beach ranges from 0.4 km to 0.7 km from the shoreline.

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1. INTRODUCTION

Indonesia is a maritime country located on the equator with 3 main plates, namely the Eurasian Plate, the Indo-Australian Plate, and the Pacific Plate which is known as the Ring of Fire region (Pacific ring of fire) which causes earthquakes and volcanic eruptions [1] [2]. If the plates interact along the trough and the fault of the earth's crust which is the source of earthquakes in the sea, it will trigger a tsunami [3] and also liquefaction [4]. Tsunami comes from the Japanese *Tsu* meaning "harbor" and *the name* means "wave" so it can be interpreted as "harbor wave". A tsunami is a series of sea waves that can spread at speeds of up to more than 900 km per hour, mainly caused by earthquakes that occur on the seabed. In the sea tsunami waves have large with low wave heights, while when they reach shallow seas, bays, or river estuaries, the speed of tsunami waves decreases as the wave height increases and is destructive [1].

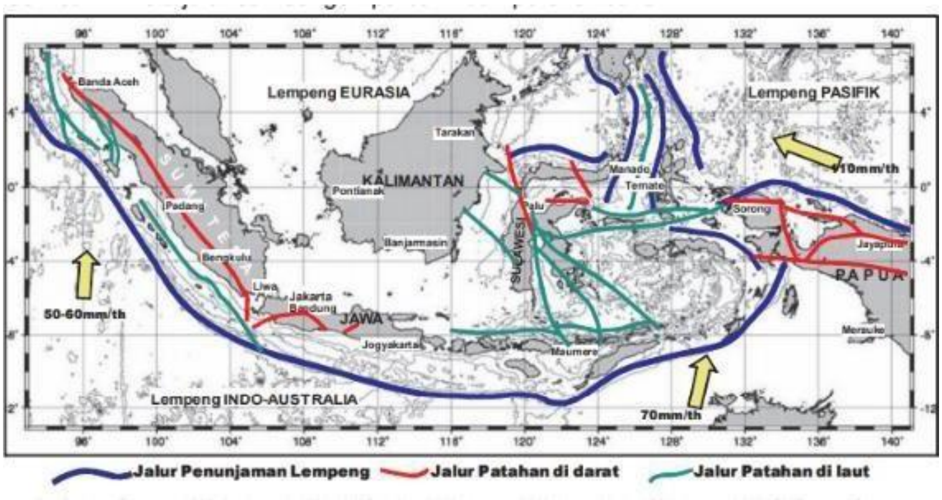


Figure 1. Image Map of earthquake source path and tsunami potential

The island of Java, especially along the southern coast of Java, has great potential to cause subduction zone earthquakes due to the presence of zones with low seismicity (seismic gap) and entering the megathrust zone which has the potential to cause a tsunami [5].

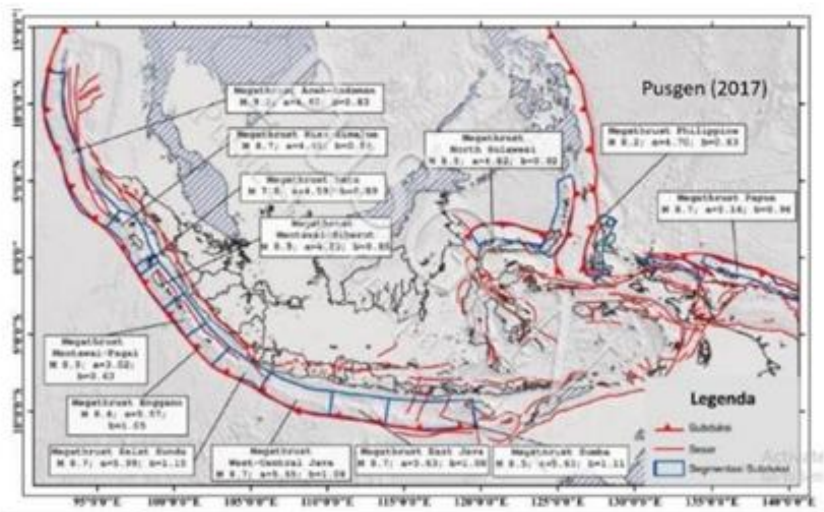


Figure 2. Distribution of active segments and faults of Indonesia

Pacitan Regency is an area which is directly adjacent to the Indonesian Ocean to the south. Geographically, Pacitan Regency is located between 110, 55 – 111, 25 East Longitude and 7 55 – 8 17 South Latitude. It borders Ponorogo Regency to the north, and Trenggalek Regency to the east. While the west is bordered by the Province of Central Java and the Indian Ocean to the south. The area of Pacitan Regency is 1,342.42 km2 which is divided into 12 sub-districts with Pacitan as the capital of Pacitan Regency [6]. The coastal area of Pacitan Regency is an object of natural destination that needs to have special considerations to be managed so that it has the opportunity to increase tourist visits [7] [8]. There are 22 beach tours that can be developed more than other natural attractions [9] [10].

The purpose of this study is to determine the height and time of arrival of tsunami waves at Pacitan Beach [11] [12]and knowing the inundation of the tsunami at Pacitan Beach.

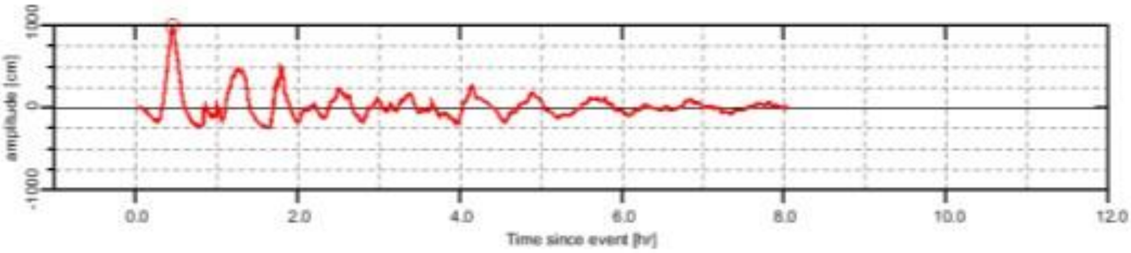
2. METHODS

This research was carried out through two stages. The first stage of tsunami modeling using ComMIT 1.8.1 software then the second stage with processing using QGIS 2.18.28 "Las Palmas" software for the creation of tsunami inundation maps in Pacitan Beach.

3. RESULTS AND DISCUSSION

The research object used in this study is along the coast of Pacitan – East Java with the source of data on the distribution of megathrust segment and active faults in the South Java Sea with the potential for an earthquake with a magnitude of 8.7.

With the difference of 3 earthquake faults used, the results of the height and time of arrival of the tsunami were obtained.



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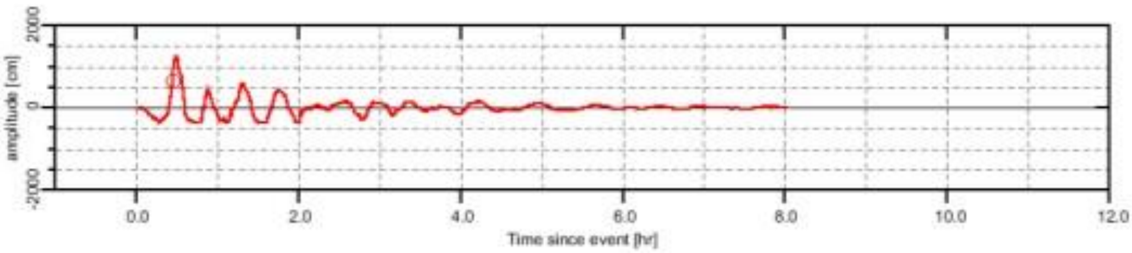

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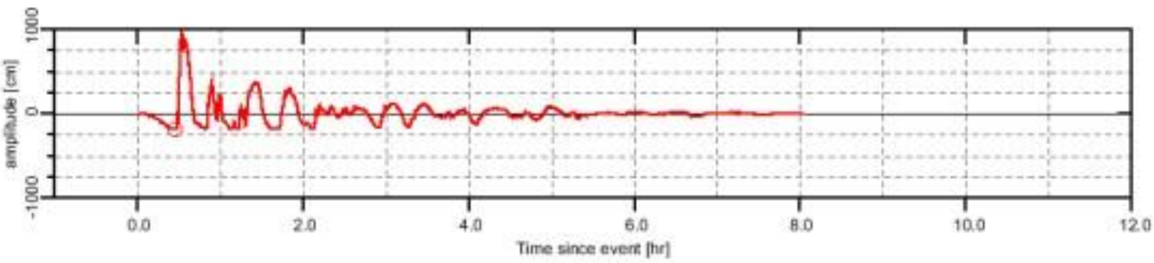

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Figure 3. Graph Relationship between height (cm) and tsunami arrival time (hours) of Karang Bolong Beach – Klayar Beach from each earthquake fault (1) (2) (3)

Vol. 6, No. 2, 2024, pp. 79-87

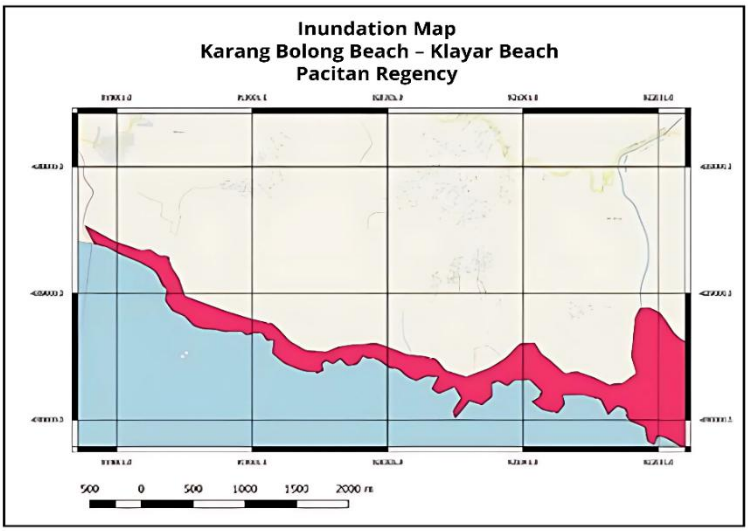
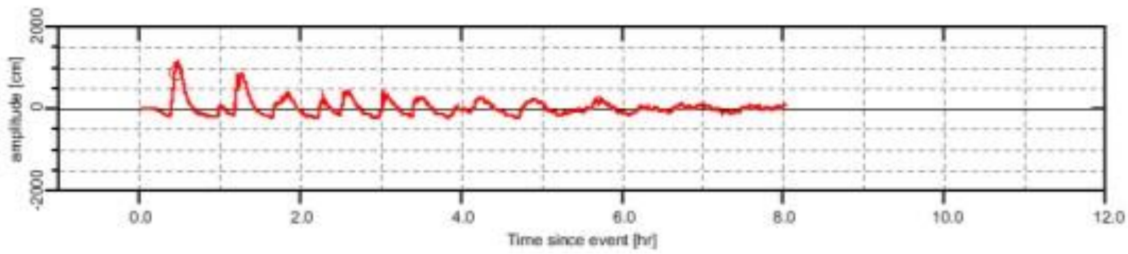


Figure 4. Map of Karang Bolong Beach Inundation Map–Klayar Beach



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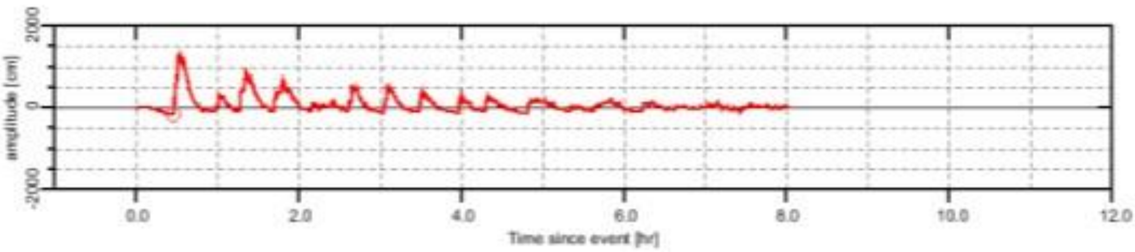

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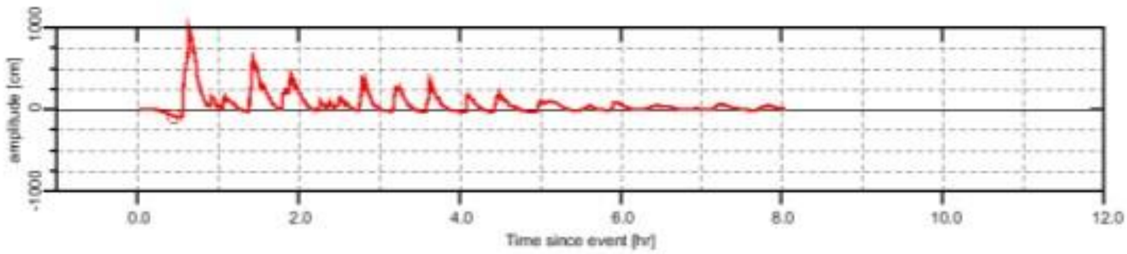

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Figure 5. Graph Relationship between altitude (cm) and tsunami arrival time (hours) of Watu Karung Beach – Srau Beach from each earthquake fault (1) (2) (3)

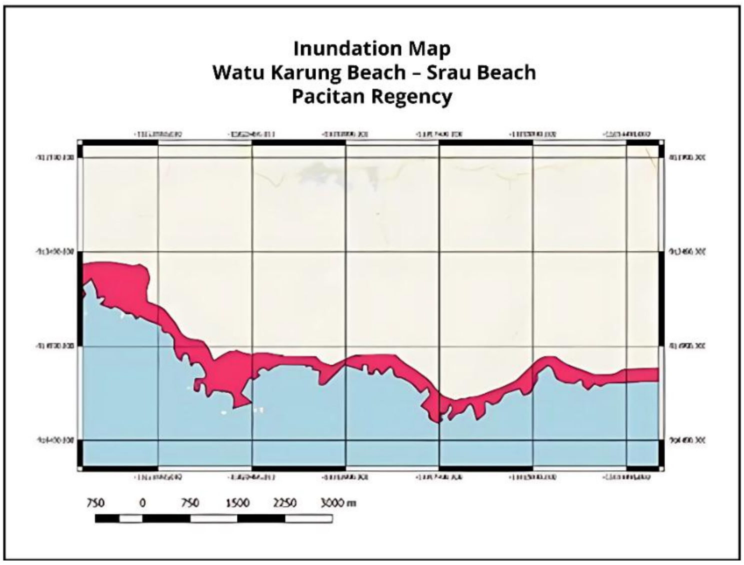
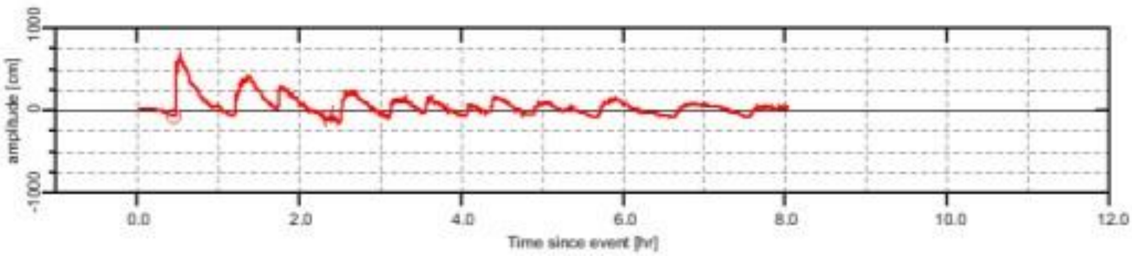


Figure 6. Map of Inundation of Watu Karung Beach – Srau Beach



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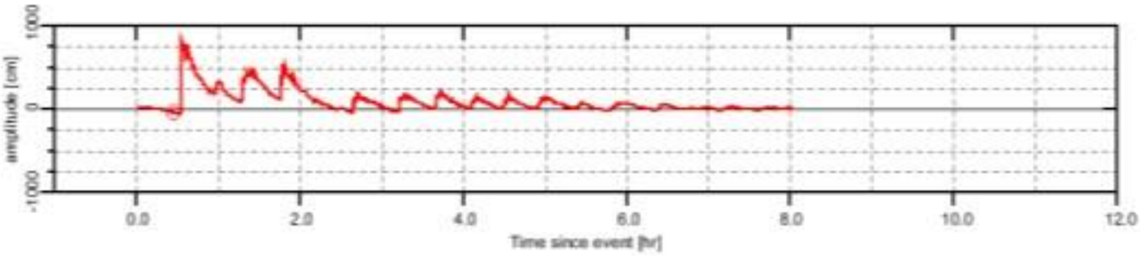

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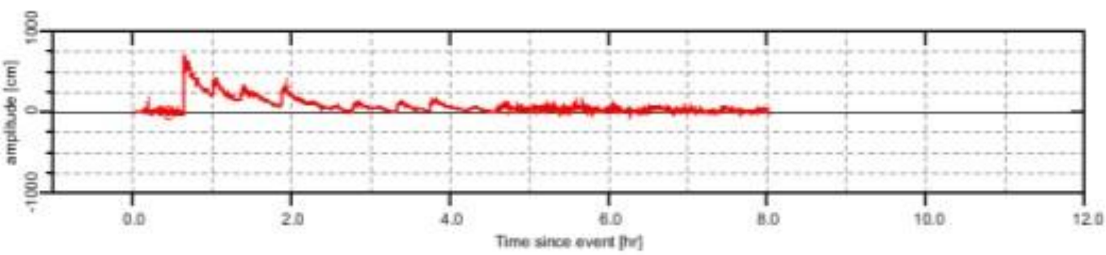

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Figure 7. Graph Relationship between altitude (cm) and arrival time (hours) of the Taman Pancer Door tsunami from each earthquake fault (1) (2) (3)

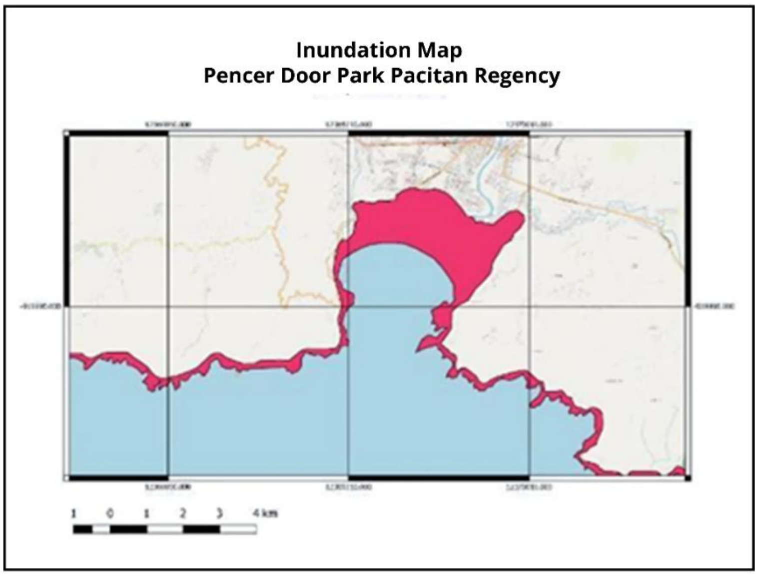
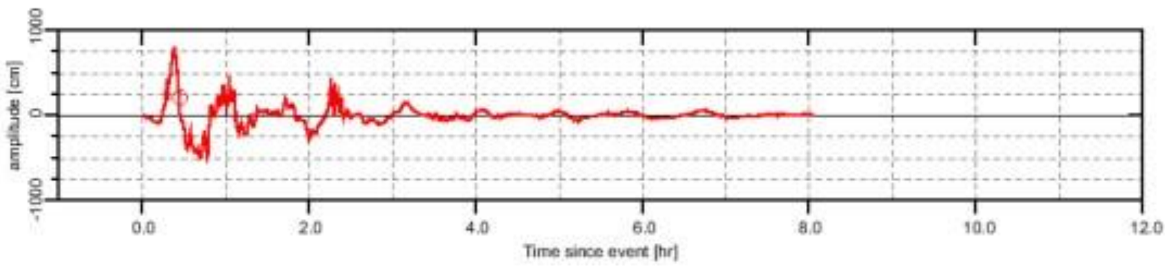


Figure 8. Map of Pancer Door Park Inundation Map



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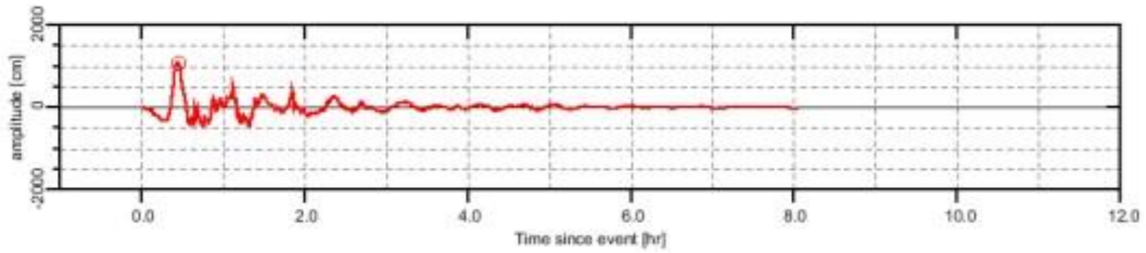

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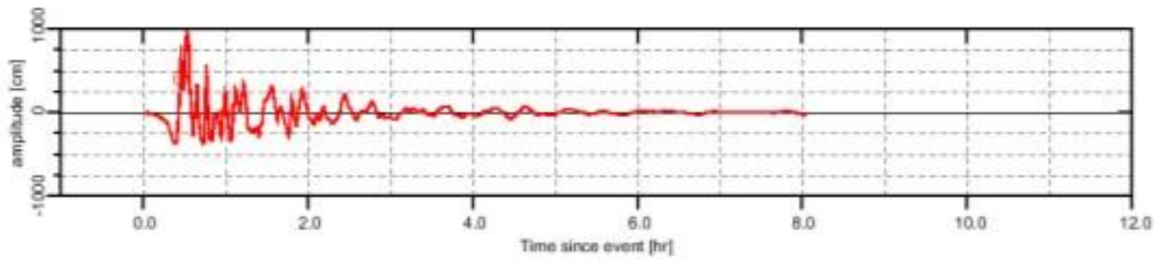

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Figure 9. Graph Relationship between height (cm) and arrival time (hours) of the Wawaran Beach tsunami from each earthquake fault (1) (2) (3)

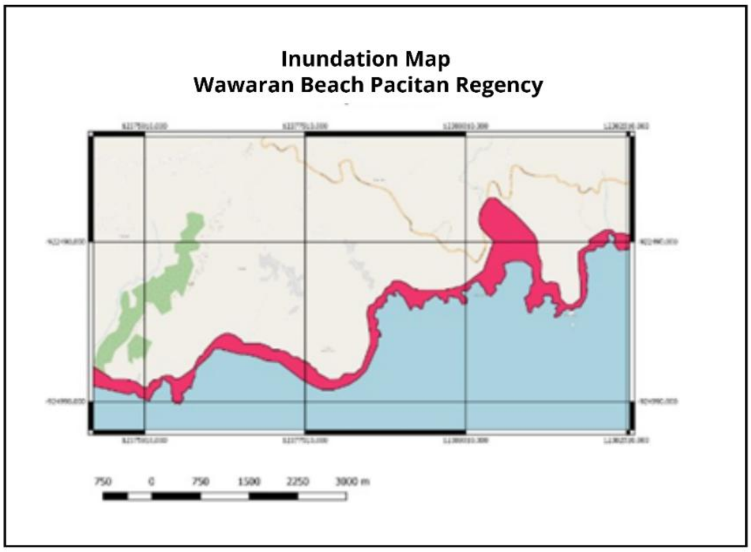
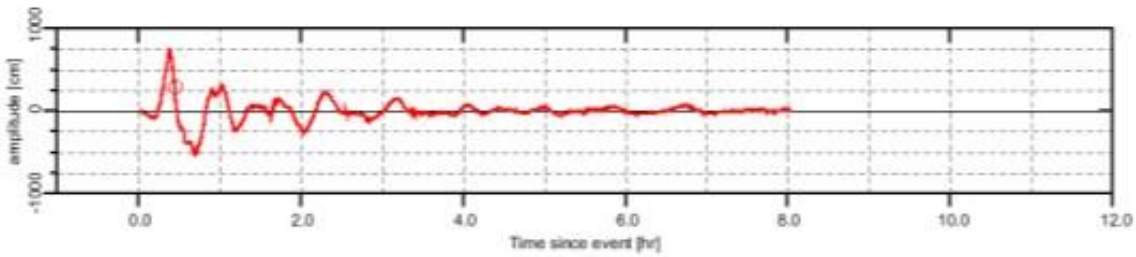


Figure 10. Map of Wawaran Beach Puddle



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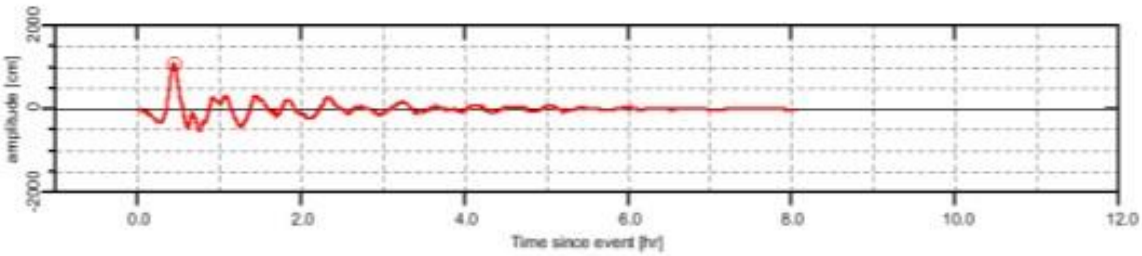

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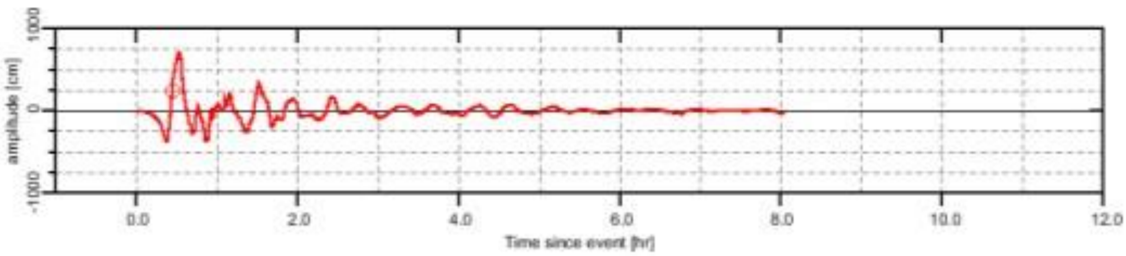

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Figure 11. Graph Relationship between altitude (cm) and arrival time (hours) of the Pidakan Beach tsunami – Watu Soge Beach from each earthquake fault (1) (2) (3)

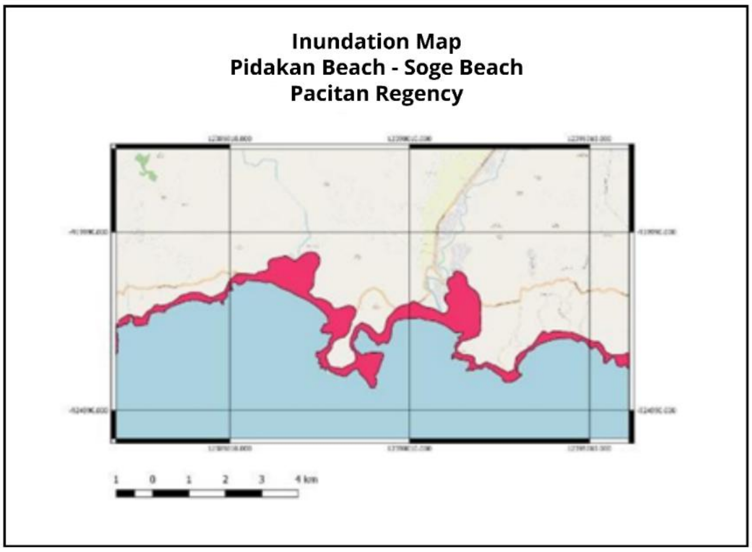

Figure 12. Inundation Map of Pidakan Beach – Soge Beach

Based on the results of the modeling above, it is known that the highest potential tsunami height is on Watu Karung Beach to Srau Beach with a wave density of 13.0288 with an arrival time of 31.78 minutes. For the range of inundation resulting from the combination of three faults, the longest is Wawaran Beach with 0.7 km from the shoreline. The second fault data has the highest tsunami height potential than the first data fault and the third data fault. In studies that have been carried out, the potential danger of Tsunami on the coast with an earthquake magnitude (Mw) of 8.0 is very high near beaches and rivers [13]

Because the area has a deeper inundation. Meanwhile, the potential hazards that are currently present in low-lying areas and very low potential are in higher areas. This means that the inundation resulting from the tsunami inundation simulation made is influenced by the topographic factors of the coastal area of Pacitan. So that a relatively different inundation was obtained from the beach with the same earthquake magnitude simulation used.

Table 1. of Altitude, arrival time and tsunami inundation along Karang Bolong Beach – Soge Beach, Pacitan Regency

No.	Place	Tsunami Wave Height (m)			Tsunami Wave Arrival Time (Minute)			Inundation (Km from shoreline)
		Data 1	Data 2	Data 3	Data 1	Data 2	Data 3	
1.	Karang Bolong Beach – Klayar Beach	9.9447	12.5934	9.0723	26.38	29.29	33.03	0.6
2.	Watu Karung Beach – Srau Beach	11.4922	13.0288	9.6126	28.46	31.78	38.86	0.45
3.	Pancer Dorr Park	6.792	8.1599	7.0311	31.78	33.03	39.27	0.65
4.	Wawaran Beach	7.8276	10.844	10.0146	23.05	26.38	31.78	0.7
5.	Pidakan Beach – Soge Beach	7.3925	11.0933	7.0923	23.05	26.79	32.2	0.4

4. CONCLUSION

1. The height of the tsunami wave along Pacitan Beach with an earthquake of Mw 8.7 ranged from 6 meters to 13 meters with the fastest arrival time of 23 minutes.
2. The tsunami inundation that occurred along Pacitan Beach ranged from 0.4 km to 0.7 km from the coast.
3. The highest height of the tsunami occurred from Watu Karung Beach to Srau Beach in the second earthquake fault data, which was 13,0288 meters.

DECLARATION

Author Contribution

This research focused on analyzing from modeling of tsunami inundation maps along the pacitan coast using commit 1.8.1 and quantum gis 2.18.28 "las palmas" software.

Conceptualization, Asa Latifah.; methodology, Asa Latifa and A. F. Masykuri.; software, A. F. Masykuri.; validation, Asa Latifah and Khumaedi.; formal analysis, A. F. Masykuri.; investigation, Khumaedi; resources, Sri Herwiningsih.; data curation, Wiyono and Aditya Prawira Nugraha.; writing—original draft preparation, Asa Latifah.; writing—review and editing, A. F. Masykuri and Khumaedi.; supervision, Khumaedi.; project administration, Asa Latifah. All authors have reviewed and approved the final version of the manuscript.

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Conflict Of Interest

The author declare no conflict of interest

REFERENCES

[1] N. Sugito, Tsunami, Bandung: Jurusan Pendidikan Geografi Fakultas Pendidikan Ilmu Pengetahuan Sosial Universitas Pendidikan Indonesia, 2008.

[2] D. H. Natawidjaja, Riset Sesar Aktif Indonesia Dan Peranannya Dalam Mitigasi Bencana Gempa dan Tsunami, Jakarta: LIPI Press, 2021.

[3] P. Triyono, Bertahan dari Gempa Bumi dan Tsunami, Jakarta: UNESCO office LIPI, 2010.

[4] M. C. Annas, T. F. Niyartama and N. B. Wibowo, "Analisis Potensi Likuefaksi Berdasarkan Metode Global Geospatial Di Kecamatan Sanden Kabupaten Bantul Yogyakarta," *S. K. J. Phys,* Vols. 3, No. 1, pp. 1-8, 2021.

[5] Pusat Studi Gempa Nasional, Peta Sumber dan Bahaya Gempa Indonesia Tahun 2017, Bandung: Pusat Peneliti dan Pengembangan Perumahan dan Pemukiman Kementrian Pekerjaan Umum dan Perumahan Rakyat, 2017.

[6] G. Priyowidodo and J. Luik, "Literasi Mitigasi Bencana Tsunami Untuk Masyarakat Pesisir Kabupaten Pacitan Jawa Timur," *Jurnal EKOTRANS* , 2013.

[7] S. Yuliani, "Strategi Penataan Kawasan Pantai Klayar Pacitan Sebagai Destinasi Pariwisata Berkelanjutan Dengan Prinsip Arsitektur Ekologi," *Jurnal RUAS,* 2018.

[8] R. Probosiwi, "Manajemen Risiko Tsunami Untuk Penataan Ruang di Pesisir Perkotaan Jawa Timur," *JUrnal TeknoSains,* 2013.

[9] B. P. J. Timur, Buku Bappeda, 2013.

[10] D. Furohmah and A. Setyadharma, "Analisis Permintaan Wisatawan Nusantara pada Objek Wisata Pantai Klayar Kabupaten Pacitan," *Economic Development Analysis Journal,* vol. 7 No. 4, 2018.

[11] B. Mambu, G. H. Tamuntuan and G. Pasau, "Simulasi Ketinggian dan Waktu Tiba Gelombang Tsunami di Tahuna Sebagai Upaya Mitigasi Bencana," *Jurnal Unsrat,* vol. 8 No. 1, 2019.

[12] K. M. Noviantoro, H. R. Widjaja and M. Ridwan, "Penataan Ruang Wilayah Pesisir Sebagai Upaya Mitigasi Bencana Tsunami di Pantai Pecak Kabupaten Lumajang," *Jurnal Wilayah dan Lingkungan,* vol. 10 No. 3, pp. 236-245, 2022.

[13] P. M. I, "Kajian Resiko Tsunami Terhadap Bangunan Gedung Non-Hunian Dengan Aplikasi PJ dan SIG Di kota Pacitan," *Jurnal Bumi Indonesia,* 2012.

[14] S. Mokodenseho, Hasrullah, M. Mokodompit, J. Salinsehe and N. Paputungan, "Analisis Geologis Gempa di Cianjur : Karakteristik Seismik, Zona Patahan, dan Peran Geologi dalam Penilaian Risiko Gempa," *Jurnal Geosains West Scince,* pp. Vol. 1, No. 02, pp. 96-104, 2023.

[15] N. Haerudin, F. Alami and Rustadi, "Mikroseismik, Mikrotremor, dan Microaerthquake, Dalam Ilmu Kebumian," Pusaka Media, Bandarlampung, 2019.

[16] M. S, Hasrullah, M. M, S. J and P. N, "Analisis Geologis Gempa Cianjur: Karakteristik Seismik, Zona Patahan, dan Peran Geologi dalam Penilaian Resiko Gempa," *Jurnal Geosains West Science,* pp. Vol. 1, No. 02, pp. 96-104, 2023.