

## TSUNAMI ZONE MAP IN PADANG CITY

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### Abstract

This study aims to create the map of the earthquake and tsunami zone in Padang City, which will be developed with isometric technique. Primary data collected from field observation in the form of evacuation routes, shelter buildings, have been interpretation into visual data. Secondary data is in the form of a map of the earthquake and tsunami prone zone in Padang City. The data is the processed into Isometric Map with the graphic application using the digital imaging method. The result of the study is in the form of Isometric Zone Map by showing the digital imaging form. This map shows information in the form of the position of the Padang City to earthquake and tsunami hazard, evacuation zones and disaster services.

**Keywords:** Earthquake, tsunami zone map, Isometric

## 1. Introduction

Indonesia is known as the largest archipelagic country in the world with abundant natural wealth [1]. It is recorded that almost 80% of economic activity in Indonesia takes place in coastal areas and about 22% of the total population of Indonesia depends on natural resources in coastal areas for their livelihoods [2]. The catastrophic super wave that hit areas around the Sunda Strait, such as Lampung and Pandeglang Banten in 2018, is proof of how the tsunami tidal wave disaster has made the area completely paralyzed for quite a long time, including the people who depend on the area for their livelihood jobs [3].

In Law No. 24 of 2007 (UU RI 24/2007) said; that the earthquake and tsunami disaster has the highest level of other types of disasters that have the greatest impact in Indonesia [4]. Nearly 3.8 million Indonesians are threatened by the tsunami [5]. Geographically, Indonesia is located in a serie of rings of fire that stretches along the Pacific plate which is the most active tectonic plate in the world. As many as 90% of major earthquakes in the world originate from

this zone, one of which is the Indonesian earthquake.

Seismic conditions in Indonesia are strongly influenced by four main tectonic plates, namely the Eurasian, Indo-Australian, Pacific and Philippine plates. The impact of an earthquake that occurs in a subduction zone on the seabed can cause a tsunami disaster. Tsunami disasters that have occurred in Indonesia are tsunamis caused by earthquakes at sea, volcanic eruptions, and seabed landslides.

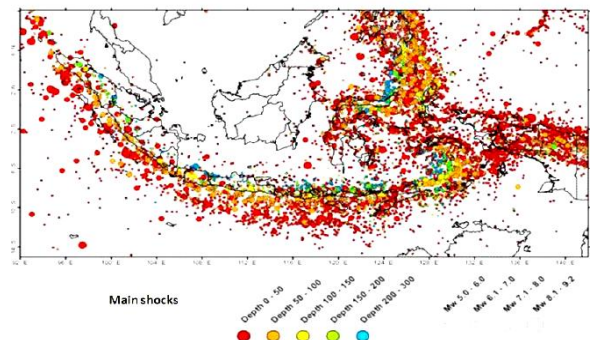


Figure 1. Map of seismicity in Indonesia [6].

Indonesia is located at the confluence of three active earth plates, namely the Indo-

Australian plate, the Eurasian plate and the Pacific plate. The activity of these plates is the most frequent cause of tsunamis in Indonesia. In the last decade, Indonesia has been hit by several tsunamis with large amounts of damage and casualties, such as the 2004 tsunami in Aceh and Nias, the 2006 Pangandaran tsunami, and the 2010 Mentawai Islands tsunami. Based on the results of the risk assessment, the total number of people exposed to tsunami risk in Indonesia is 4,102,406 people in all provinces in Indonesia with a potential loss of Rp. 879 Trillion [7].

As is well known, the existence of coastal areas in West Sumatra cannot be separated from the threat of an earthquake and tsunami that can suddenly hit the area. This condition can be seen because the position of the coastal area in West Sumatra is directly opposite the Mentawai Megathrust subduction zone and is also traversed by the ring of fire, which at any time will release earthquake energy which will affect the sustainability of life in West Sumatra, especially in the city of Padang [8].

Based on data from the Sarkorlak PB of West Sumatra, the largest material losses due to the 30 September 2009 earthquake were experienced by the city of Padang and the district of Padang Pariaman. The details of the loss include Pariaman City of Rp. 1.12 trillion, Bukittinggi City (Rp. 813 million), Agam Regency (Rp. 27.84 billion), Solok Regency (Rp. 460 billion), West Pasaman Regency (Rp. 49.16 billion). and Pesisir Selatan Regency (Rp. 265.79 billion). While the total death toll from this disaster in West Sumatra was recorded at 1,117 people, 1,214 people seriously injured and 1,688 people lightly injured [9].

The tsunami event triggered by the strong earthquake that occurred in Aceh on December 26, 2004, which killed up to 126,741 people and lost more than 750,000 people for their livelihoods, is proof of how the impact of this disaster has caused enormous losses as a result of this disaster [10]. Prior to that, Indonesia had also been hit by several tsunamis, with damage and a large number of victims, such as the 1992 tsunami in Flores and 1994 in Banyuwangi.

Table 1. The Indonesian tsunami event was triggered by an earthquake [11].

No	Lokasi	Th	Mw	Akibat Tsunami		
				Death	Poor	Destroy building
1	Aceh	2004	9.2	22898	25000	NA
2	Nias	2005	8.7	10	NA	NA
3	Bali	1818	8.5	NA	NA	NA
4	Bengkulu	2007	8.4	0	-	-

5	Celebes Sea	1918	8.3	6	-	-
6	Papua	1996	8.2	110	100	-
7	Sunda	1997	8.0	189	75	283
8	Banda Sea	1996	7.9	9	63	-
9	Andaman Sea	1881	7.9	-	-	31765
10	Flores sea	1992	7.8	2500	500	-
11	Jawa sea	1994	7.8	250	233	1500
12	Mentawai	2010	7.7	485	-	-

Most of the coastal areas in Indonesia are located in areas that are at risk of the threat of earthquakes and tsunamis. Meanwhile, many residents who live in the area around the coast also depend on this location for their livelihood, for example selling at coastal tourist sites, especially those who work as fishermen at sea. If this condition is left unchecked and integrated and systematic mitigation efforts are not carried out, it can create anxiety and lose residents' livelihoods and reduce the number of tourist visitors to the coastal area [12].

After the 2004 earthquake and tsunami in Aceh and the 2006 earthquake in Yogyakarta, the government continued to pursue disaster management efforts in Indonesia in a regulatory manner through cooperation LIPI-UNESCO in 2006 and the establishment of the RI Law 24/2007 on disaster management [13]. The experience of the tsunami disaster in Pandeglang Banten and the coast of Lampung two years ago due to underwater landslides proves that many of the victims who died came from local residents as well as visitors or tourists [14]. Based on this, to reduce the impact and concerns of the community around the coastal area, it is necessary to carry out and improve earthquake and tsunami disaster mitigation efforts by increasing community capacity and preparedness through understanding the availability of more informative and communicative earthquake-tsunami-prone zone maps, namely with 3D visualization. isometric art.

According to the RI Law 24/2007, disaster mitigation is a series of efforts to reduce disaster risk, both through physical development as well as awareness and capacity building in dealing with disaster threats. Prior to the issuance of the RI Law 24/2007, the implementation of disaster management in Indonesia was not systematic and still sporadic. The paradigm of conventional society in some areas which still considers that disaster is a disaster and destiny that must occur, makes

mitigation efforts (mitigation) not run optimally. With this law, it is hoped that disaster management (especially earthquake and tsunami) can run in a systematic, planned, coordinated and integrated manner [15].

The implementation of disaster mitigation after the issuance of the RI Law 24/2007 is not only done technically, but also must be done non-technically as well, namely by involving all existing elements, both the government, vulnerable local communities, heeding local culture (local wisdom). local areas, drafting regulations and policies as well as making maps of earthquake-prone zones. So far, the existing map of tsunami-prone zones has not been able to be understood properly as an informative means of earthquake and tsunami disaster mitigation by most people. Meanwhile, the availability of informative and communicative maps is needed so that the information provided is able to reach all levels of society to deal with the earthquake and tsunami disasters that will occur in the future.

The influence of information and digital technology continues to show developments every year, including in the field of disaster management, such as the use of the internet during the tsunami disaster management in Aceh in 2004 to share information developments with the families of victims. Other examples are the use of websites, early warning systems and many more [16]. At the end of 2004 or to be precise on December 26, 2004, a large part of Aceh, then known as Nanggroe Aceh Darussalam (NAD), was hit by an earthquake followed by a devastating tsunami. The impact of the tsunami at that time had caused casualties and lost up to 200 thousand people. Then successively in other parts of the archipelago an earthquake followed by a tsunami also occurred in Bengkulu in 2007 and the North Pagai tsunami in the Mentawai Islands in 2010 [17].

Earthquake disasters that have the potential for a tsunami originate from earthquakes that occur in subduction zones located at sea, so the risk of this disaster is higher for areas that are close to the coast. As an archipelagic country, of course, Indonesia's territory is surrounded by the high seas, even 3.25 million km<sup>2</sup> of the total territory of Indonesia consists of oceans [18]. In addition, from the northern tip of the island of Sumatra, to the south of the island of Java and Bali, to the northern part of Sulawesi, the circum-pacific zone is known as the ring of fire, as shown in Figure 1, where this area is the area with the greatest potential for disaster.

compared to other regions in Indonesia [19]. Among these disasters, earthquakes with the potential for a tsunami are the ones with the greatest frequency and impact to hit the archipelago. Even 9% of the world's total tsunami disasters occurred in the territory of Indonesia, which reached 71 events [20].



Figure 2. Circum pacific: red line shows the path of the ring of fire

The earthquake and tsunami disaster in NAD in 2004, as explained above, became the beginning of the importance of disaster mitigation in Indonesia, especially earthquake disasters that have the potential for a tsunami, and then after the Mentawai tsunami on October 25, 2010 experts have focused their attention on coastal areas in West Sumatra, especially the Padang City area, through the contribution of research on the disaster. Earthquake and tsunami disaster mitigation efforts that have been carried out include planting mangrove forests, building shelters, compiling regulations and policies, installing early warning system properties, socializing and making maps of tsunami-prone zones and evacuation routes [21].

The Padang City tsunami-prone zone map that has been released by the Padang City Regional Disaster Management Agency (BPBD), as shown in Figure 3 below, is still an important reference for the community in efforts to mitigate earthquake disasters that have the potential for a tsunami in Padang City to date. However, in several cases encountered in the field, not a few residents stated that they had difficulties in understanding the tsunami-prone map, especially the case for residents with low education levels [22]. Problems like this case are certainly an important task and urgency that is no less important than the availability of the tsunami-prone zone map itself. So that the map can be understood by all levels of society, it is necessary to update and modify it, to provide information that is accessible to all citizens.

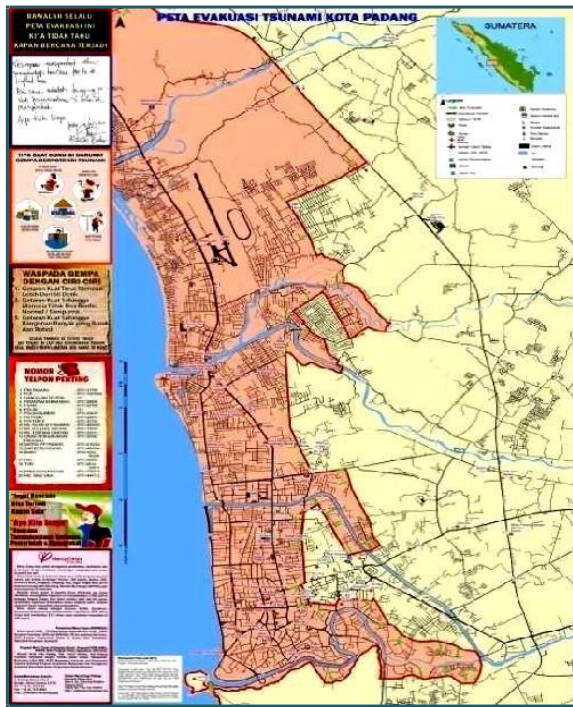


Figure 3. Map of evacuation routes and tsunami prone zones in Padang City [23].

To answer the above problems, it is necessary to design a map of earthquake and tsunami prone zones using isometric techniques, so that the information provided to the public is easier to understand, then this information is used for disaster preparedness in the future and is able to minimize the impact caused by disasters earthquake-tsunami in Padang City.

One of the important activities in an effort to increase community capacity and awareness to the threat of earthquake and tsunami disaster is through maps of earthquake and tsunami prone zone. Earthquake and tsunami prone zone maps can be developed using isometric techniques. This design has been widely used by designers in developing column data which is converted to a more communicative and aesthetically pleasing visual form.

## 2. METHOD

This research will be conducted in Padang City, West Sumatra Province. Important considerations and reasons for choosing this research location are:

1. The location of Padang City which is directly opposite the subduction zone which is the source of a large tectonic earthquake with the potential for a tsunami,
2. Padang City is an area with the highest potential threat of earthquake and tsunami in Indonesia, and

3. including areas that have informative data on disasters, especially earthquakes and tsunamis.

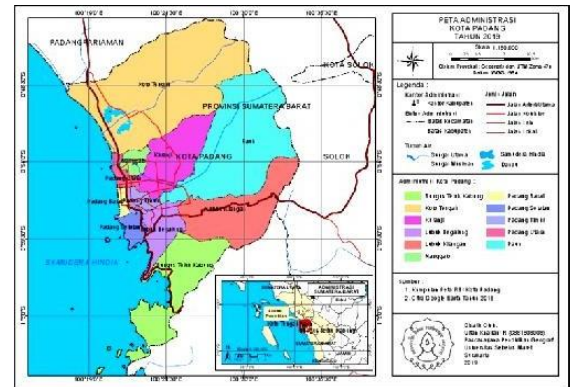


Figure 4. Padang city administration map [24]

The design of isometric art on the earthquake-tsunami-prone zone map consists of several stages adapted based on isometric techniques. The following stages in the design of isometric art are:

1. Make a projection angle, which is  $30^\circ$  from the horizontal position.
2. Sets the x, y, z axis lines to display the left, right and top sides.
3. Determine the size of the image by creating a grid unit.
4. Coloring and lighting to clarify images.

### A. Isometric Art

Isometric art design is a 3D design in a 2D scope. As seen in the image below, the z axis produces the depth angle, while the x axis is the width and the y axis is the height.

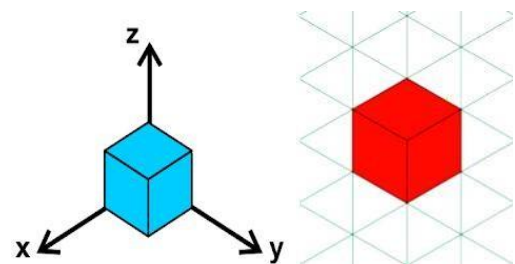


Figure 5. Axis x, y, z and axis position in isometric

### B. Digital Imaging

Digital imaging is the digital processing of images using design software to display new forms. In this design, digital imaging will be adapted into isometric art techniques for good design results. This design certainly applies design principles such as balance, proportion, unity and so on.

### 3. RESULT

#### A. Design analysis

The The design of isometric art in the disaster-prone zone is divided into several stages in the process of its creation, the following stages bellows:

- Creating an isometric space. At At this stage the designer creates a 3-dimensional space in 2D and the x, y and z axes are connected into an isometric shape.
- Determine the location of the map of the city of Padang using Google Earth. The position of the shooting angle of the Padang city is chosen from the perspective of the designer. This is done for adjustments in isometric art. The part of the image taken covers the coastal area. This is because the coastal area is the most vulnerable area to be affected by the threat of the tsunami disaster.
- Choose a font. The font that is selected and adjusted is Coolvetica Regular. This font is a sans serif font that is not angular and looks firm so that it is also clearly legible.
- Map position. Map is adjusted and cut to the desired shape. The image cutting process is done using Adobe Photoshop software. The cutting of the map image is carried out according to the isometric shape that has been made. Make sure the most important parts are entered into the isometric space so that no errors are found in the mapping results.
- Digital imaging. The next process in this design is to add several assets such as adding the sea, the land in the shape, to the map texture. It must also be understood that this process is included in the design of digital imaging because it has merged into several images and made a new image. This also means that the need for digital imaging adapted to isometric art forms is very important in producing good works.
- Icon-point. Making pointers according to the designed isometric art model. pointers are made in different heights and colors. This will facilitate the readability of the information provided to the public.

#### B. Result

The map in Figure 10 above describes the final shape or result of the previous stage. This final map contains information on earthquake and tsunami-prone zones in Padang City in the form of information using icons, signs and text as information enhancement.



Figure 6. The final results will be published

### 4. CONCLUSION

From the results of the design above, it can be concluded that:

- Isometric art maps are aesthetically pleasing to the eye, attractive colors and have a shape according to media developments.
- Judging from the legibility of the information, it can be concluded that this earthquake-tsunami-prone zone map is easier to understand, because it is emphasized by icons, symbols and text, so that the layout becomes better.

### References

- [1] M. B. Habibie., S. Sjafei., Khairuddin. Mitigasi Bencana Tsunami Melalui Pariwisata (Studi Kasus di Situs Tsunami Kapal PLTD Apung Banda Aceh), *Jurnal Ilmu Kebencanaan (JIKA)*, Pascasarjana Universitas Syiah Kuala, Volume 4, No. 2, pp. 36-41. ISSN 2355-3324, 2017.
- [2] R. R. Ramdhany, Perencanaan Lanskap Pantai Pangandaran Berbasis Mitigasi Bencana Tsunami. Thesis, Departemen Arsitektur Lanskap, Institut Pertanian Bogor, Bogor, Jawa Barat, 2016.
- [3] Online article, available at: <https://www.cnbcindonesia.com/news>. Accessed 10 August 2020.
- [4] Law No. 24 of 2007 concerning Disaster Management
- [5] National Disaster Management Agency of the Republic of Indonesia (BNPB-RI), 2019.
- [6] Academic Paper on Earthquake

- Disaster Risk Reduction, 2013.
- [7] National Disaster Management Plan (RENAS-PB), 2015.
- [8] Sudibyakto, 28 Earthquake and Tsunami Prone Areas, Online, Available at: [www.ugm.ac.id](http://www.ugm.ac.id), 2014.
- [9] Kompas Newspaper, Online. Available at: <http://www.kompas.com>
- [10] Agency for the Rehabilitation and Reconstruction of Aceh - Nias (BRR NAD-Nias), Final Report of the Steering Committee of the Regional Rehabilitation and Reconstruction Agency and Community Life of the Province of Nanggaroe Aceh and Nias Islands, North Sumatra Province, 2005-2009. Aceh & Nias: BRR NAD-Nias Steering Committee, 2009.
- [11] Tsunami Disaster Risk Reduction Academic Paper, 2013.
- [12] F. W. Rizqiyah., W. Setyawan. Application of Monumentalism in the Design of the Yogyakarta Earthquake Museum as an Effort to Raise Public Awareness of Responding to Earthquakes in Yogyakarta. ITS Journal of Science and Arts, Vol. 1, No. 1, pp. 6-10, 2012.
- [13] Cooperation between LIPI and UNESCO, 2006.
- [14] Article online, Available at: <https://www.ayobandung.com> .
- [15] Sarwidi, "Basic Knowledge of Disasters and Earthquakes." Edition 02, Kati-Kata Publisher, Malang, East Java, 2015.
- [16] Online article:  
<https://bogorkab.go.id/post/detail/perke-mbangan-teknologi-informasi-dalam-penanggulangan-bencana-alam-di-indonesia>. 23 November 2020.
- [17] L.C. Sinaga, "Problems of Rehabilitation and Reconstruction Case Study Post Mentawai Tsunami Disaster 2010." *Jurnal Penanggulangan Bencana BNPB*, Vol. 4 (1), 23-34, 2013.
- [18] Central Bureau of Statistics of West Sumatra province (BPS West Sumatra), Available online: <https://sumbar.bps.go.id/>. Accessed August 23, 2019.
- [19] A. Wibowo, H. C. Pratama, "Penyuluhan Perencanaan Bangunan Tahan Gempa," *Jurnal Inovasi dan Kewirausahaan: Seri Pengabdian Masyarakat*, Vol 2, No 2, hal 109-114, ISSN: 2089-3086, 2013.
- [20] R.A. Pratomo., I. Rudiarto, "Tsunami Modeling and Its Implications for Disaster Mitigation in Palu City," *Jurnal Pembangunan Wilayah & Kota (JPWK)*, Biro Penerbit Planologi Undip, Vol. 9 (2), 174-182, 2013.
- [21] Ruswandi, A. Saefuddin, S. Mangkuprawira, E. Riani, P. Kardono, "Identifikasi Potensi Bencana Alam dan Upaya Mitigasi yang Paling Sesuai Diterapkan di Pesisir Indramayu dan Ciamis," *Jurnal Riset Teknologi dan Pertambangan*, Jilid 18, No. 2, 1-19, 2008.
- [22] Interview : society of Padang City, 2020.
- [23] S. Alhanda, "An Overview of the Readiness of Elementary Schools in the Red Zone in Facing the Earthquake and Tsunami Disaster in Koto Tangah District, Padang City 2011," *Thesis*, Department of Occupational Safety and Health Faculty of Public Health, University of Indonesia, 2012.
- [24] Peta administrasi Kota Padang 2021, Pemerintahan Kota Padang Sumatera Barat, 2021.