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Zoning of Social Vulnerability for Tidal Flood Disaster in Medan Belawan District, Medan City Based on Remote Sensing and Geographic Information Systems

Budi Rahmah Panjaitan[1*], Lili Somantri[2], Eka Wulan Safriani[3], Arifin[4]
[1,2,3] *Master Program in Geography Education, Faculty of Social Science Education, Universitas Pendidikan Indonesia, Indonesia*
[4] *Department of Geography, University College London (UCL), London, United Kingdom*
e-mail: budirahmahpanjaitan@upi.edu

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Abstract

This study aims to 1) identify the social vulnerability of tidal floods in Medan Belawan District and 2) produce a zoning map of social vulnerability to tidal floods in Medan Belawan District descriptive quantitative type research. The variable used refers to Regulation of the Head of BNPB No. 2 of 2012 with changes covering population density, sex ratio, ratio of persons with disabilities, land use, and existing tidal flooding. The social vulnerability variable is then classified using a scoring technique. Data collection techniques in this study were document studies of secondary data obtained from various agencies. The results showed that five urban villages (83%) in Medan Belawan District had high tidal flood social vulnerability, and only one urban town (17%) was classified as having moderate social vulnerability. The urban villages with high tidal flood social vulnerability are Bagan Deli urban village, Belawan Bahagia urban village, Belawan Bahari urban village, Belawan I urban village, and Belawan II urban village. Meanwhile, the urban Village with a moderate level of social vulnerability to tidal floods is the Belawan Sicanang Village. Belawan I Village occupies the highest tidal flood social vulnerability class, and the lowest tidal flood social vulnerability class is populated by Belawan Sicanang urban village.

Keywords: Social Vulnerability, Tidal Flood, Disaster

INTRODUCTION

Tidal floods are one of the disasters that often occur in coastal areas. High tides cause tidal floods, so the high tides inundate the land. Tidal floods are also known as inundation floods (Salim, 2018). Tidal flood events can occur when the sea level reaches a certain threshold (Wdowinski et al., 2016). Tidal floods inundate coastal plains or places lower than the high tide sea level (high water level) (Karana & Suprihardjo, 2013). When seawater experiences the highest tide, the tidal inundation area will increase and expand inland according to the elevation of the land surface or the morphology of the coastal plains (Asrofi & Hadmoko, 2017). Tidal flooding is a big problem with a flood depth of 10-100 cm (Dan et al., 2017). The issue of tidal flooding is also often a concern because of its bad impact. Unsurprisingly, local governments worldwide are using various strategies to deal with sea level rise and coastal flooding (Dedekorkut-Howes et al., 2020).

Big cities in Indonesia, such as Medan, face the threat of tidal flooding, especially in the northern Area, which is directly adjacent to sea waters (Panjaitan et al., 2021). Medan Belawan District, which is in the North of Medan City, is a coastal area always hit by periodic tidal floods. Medan Belawan (Rahmad et al., 2017). The district is included in the characteristics of the plains low with a height of 0-3 meters above sea level. Its location close to sea waters increases the risk of tidal flooding. The tidal flood in Medan Belawan District spread to all sub-districts: Belawan I, Belawan II, Sicanang, Bahari, Bahagia and Bagan Deli. A total of 14,929 families, or 60,102 people, became victims of this tidal flood (Fitri et al., 2023)

Several media have also highlighted the tidal floods that often-hit Medan Belawan District. This further clarifies the fact that there is a disaster that requires serious handling. One of the reports, as quoted from Beritasatu, in May 2023, tidal floods hit Medan Belawan District again with a height of 30 centimetres to 1 meter. The tidal floods even inundated and entered residents' homes. Tidal surges began to attack roads and residential areas at noon at around 11.00 and started to recede in the afternoon around 16.00 to 17.00 WIB. According to residents, the height of the tidal flood every year is also increasing.

The tidal flood that hit Belawan District harmed many aspects of people's lives. Tidal surges disrupt daily activities, reduce income, complicate social activities, and cause damage to homes and household equipment (Mardianta et al., 2022). More comprehensively, tidal floods can cause material losses, damage buildings, make the environment dirty and muddy, spread germs, disturb traffic, scarcity of clean water, and slum settlements (Tarigan et al., 2023). Communities can feel the disruption of economic activities, decreased productivity, and increased maintenance costs which have an impact on reducing the community's income as a whole (Hakim et al., 2022). Tidal floods have various effects on the socio-cultural aspects of society, including social damage (Hariani et al., 2017). Research conducted by (Rahmad et al., 2017) showed tidal floods in Medan had an impact on damage to buildings, especially residences, increased salinity of water sources, damage to pond land, and damage to work equipment or vehicles that people use daily a day. Tidal floods also disrupt the activities of fishermen and traders because when a flood occurs, fishermen are forced to stop going to sea temporarily, and their income decreases, as well as the supply of fish to the market.

The many significant impacts of tidal floods have made Medan Belawan District vulnerable to disasters. Vulnerability assessment is crucial for developing effective mitigation strategies (Sherly et al., 2016). This is inseparable from the importance of knowing the risks of major floods, as their impact increases due to socioeconomic growth (Shah et al., 2020). Disaster vulnerability itself refers to the level of weakness of an area against the threat of disaster. This is important because knowing social exposure can be useful in developing disaster mitigation policy directions (Putri, 2018). This can show the extent to which the region can survive and recover from the effects of the disaster. Disaster vulnerability is determined by various factors such as physical, social, economic, and environmental (IRBI, 2013). The biological susceptibility of the tidal flood disaster in Medan Belawan has been extensively studied. The results show that Medan Belawan District is vulnerable to tidal flooding. Meanwhile, non-physical vulnerabilities such as social vulnerabilities to tidal floods are equally important to study. However, from the results of tracing several studies, the social vulnerability of tidal floods in the Medan Belawan District has not been learned much. Including not many have done zoning or mapping of social vulnerability to tidal surges in Medan Belawan District.

Based on the Regulation of the Head of the National Disaster Management Agency (BNPB) No. 2 of 2012, social vulnerability can be assessed from population density, sex ratio, the ratio of poor people, the ratio of age groups and the percentage of people with disabilities. The denser the population of an area, the higher the level of vulnerability (Santius, 2015). Meanwhile, through the poverty parameter, it can be indicated that groups of people have more potential to experience the negative impacts of disasters (Desmonda & Pamungkas, 2018). Infants, toddlers, children and persons with disabilities are vulnerable in disaster situations (Bali, 2021). Particularly in Indonesia, persons with disabilities are increasingly vulnerable because of the mismatch between disaster risk reduction efforts and their diverse needs (Rahmat et al., 2020). Older people often live alone, increasing the risk of older people being

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affected by disasters (Siregar & Wibowo, 2019). Children are part of the community members vulnerable to disasters because of their experience, knowledge and physical limitations (Rahma, 2020). The female population who are more susceptible to disasters than the male population (Arif et al., 2017). Preliminary studies conducted on various secondary data indicate the existence of social vulnerability that deserves further study to determine the level of social vulnerability in Medan Belawan District. Therefore, this study aims to 1) identify the social vulnerability of tidal floods in Medan Belawan District and 2) produce a zoning map of social vulnerability to tidal floods in Medan Belawan District. It is hoped that the research will be useful as a useful tool for the government and related institutions in making decisions related to the mitigation and management of tidal floods in Medan Belawan District. The information obtained from the zoning map can be used to direct mitigation efforts and allocate resources more effectively, focusing on areas with higher social vulnerability.

RESEARCH METHODS

This research was conducted in Medan Belawan District, Medan City, North Sumatra Province, Indonesia. This sub-district comprises six urban villages: Bagan Deli, Belawan Bahagia, Belawan Bahari, Belawan I, Belawan II and Belawan Sicanang Villages. The administrative map of Medan Belawan District, the research area, can be seen in Figure. 2. Descriptive quantitative type research. The variable used refers to the Regulation of the Head of BNPB No. 2 of 2012 concerning General Guidelines for Disaster Risk Assessment, which are modified into population density, sex ratio, ratio of persons with disabilities, land use, and existing tidal floods. The research framework can be seen in Figure 1.

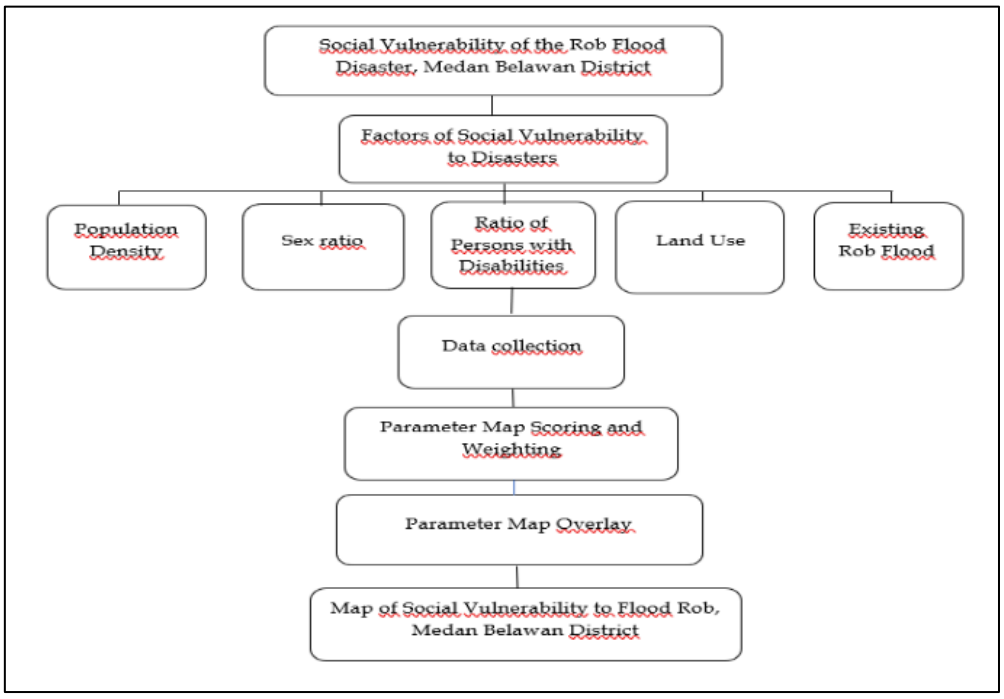

Figure 1. Research Framework

The social vulnerability variable is then classified using a scoring technique. This study discusses the unit of vulnerability analysis down to the Kelurahan level. Data collection techniques in this study were document studies of secondary data obtained from various agencies. The details of the data used can be seen in Table 1.

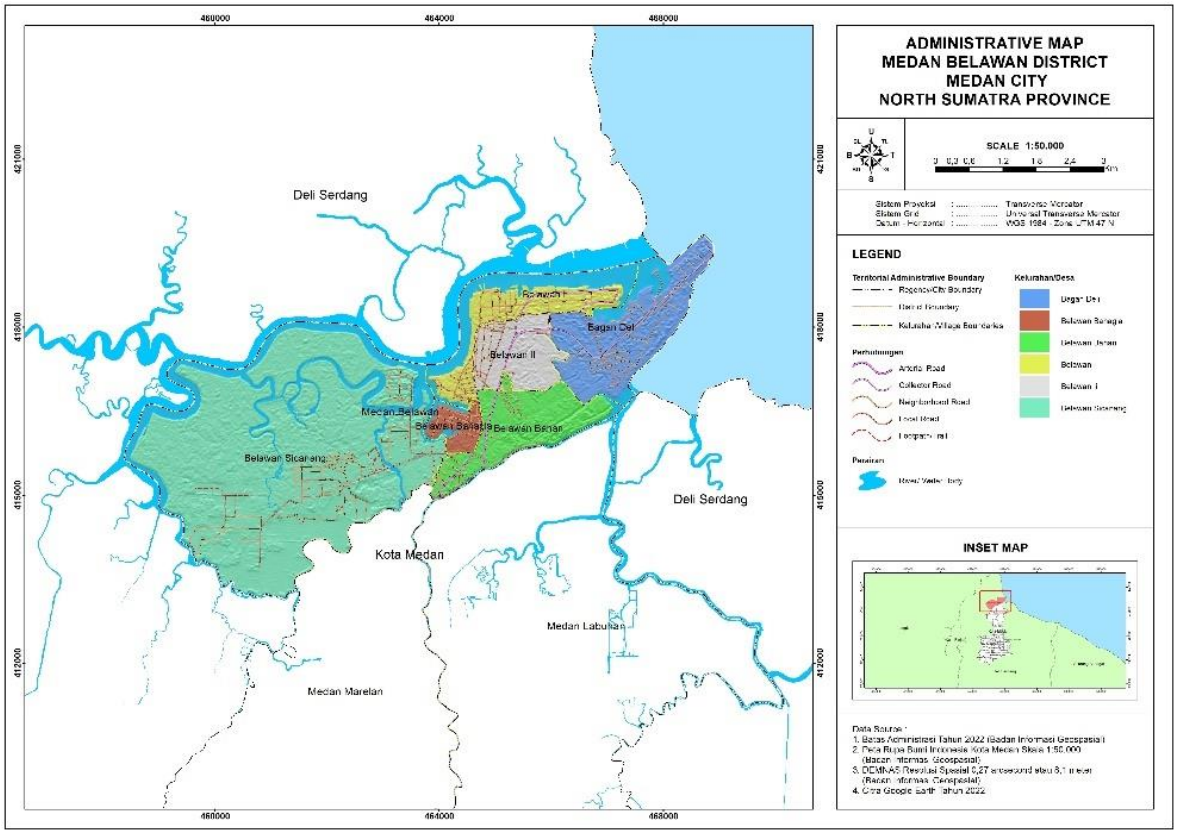

Figure 2. Administrative Map of Medan Belawan District

Table.1 Secondary Research Data

No.	Parameters Map	Data source
1	Population Density Map	BPS, BIG
2	Sex Ratio Map	BPS
3	Map of the Ratio of Persons with Disabilities	Pemko Medan
4	Land Use Map	Google Earth, BIG
5	Existing Tidal Flood Zoning Map	BIG

Source: Perka BNPB No. 2 of 2012 with changes, 2023.

Table.2 Classification of Population Density

No.	Classification	Mark	Score
1	High	>1000 inhabitants/km ^{2}	3
2	Medium	500-1000 people/km ^{2}	2
3	Low	<500 people/ km2	1

Source: Perka BNPB No. 2 of 2012 with changes, 2023

Table.3 Classification of Sex Ratios

No.	Classification	Mark	Score
1	High	>40%	3
2	Medium	20-40%	2
3	Low	<20%	1

Source: Perka BNPB No. 2 of 2012 with changes, 2023

Table.4 Classification of the Ratio of Persons with Disabilities

No.	Classification	Mark	Score
1	High	>40%	3
2	Medium	20-40%	2
3	Low	<20%	1

Source: Perka BNPB No. 2 of 2012 with changes, 2023.

Table.5 Classification of Land Use

	Built-up Land Types		
No.	Classification	Mark	Score
1	High	2.17-2.96	3
2	Medium	1.37-2.16	2
3	Low	0.56-1.36	1
	Water Body Type		
No.	Classification	Mark	Score
1	High	0.16-4.06	3
2	Medium	4.07-7.96	2
3	Low	7.97-11.86	1
	Undeveloped Land Types		
No.	Classification	Mark	Score
1	High	0.01-1.21	3
2	Medium	1.22-2.41	2
3	Low	2.42-3.61	1

Source: Data Processing, 2023.

Table.6 Classification of Combined Land Use

No.	Classification	Mark	Score
1	High	7,68-9	3
2	Medium	6.34-7.67	2
3	Low	5-6,33	1

Source: Data Processing, 2023.

Table.7 Classification of Existing Tidal Floods

No.	Classification	Mark	Score
1	High	Affected Area > Unaffected Area	3
2	Low	Affected Area < Unaffected Area	1

Source: Data Processing, 2023.

Furthermore, the way this research works uses the five social vulnerability variables, which are classified by scoring, and are then overlaid using. To calculate total social vulnerability, refer to BNPB Head Regulation No. 2 of 2012 with the formula:

Total social vulnerability: (0.6 x population density score) + (0.1 x sex score) + (0.1 x disability score) + (0.1 x land use score) + (0.1 x score existing tidal flood)

Data analysis in this study used a spatial-based quantitative approach, producing a map of social vulnerability to tidal floods in Medan Belawan District. All forms of spatial data processing are carried out using ArcGIS 10.8 software and tabular data processing using Microsoft Excel software.

RESULTS AND DISCUSSION

Population Density Parameters

The population density of each Village is calculated by dividing the total population of each Village by the Area of each Village. The population density of Medan Belawan District can be seen in Table.8. There are five sub-districts (83%) that are at a high-density level, and there is only one sub-district (17%) that is at a medium density level, namely Belawan Sicanang. The highest density is in the Belawan Bahari Village, 18659 people/km 2; the lowest is in the Sicanang Village, 982 people/km 2. The social vulnerability map of the research area based on population density is presented in Figure 2.

Table.8 Calculation of Population Density of Medan Belawan District

No	Sub-Districts	Total population	Sub-district Area (Km ^{2})	Density (Person/Km^2)	Classification	Score
1	Bagan Deli	17871	3,979	4491.18	High	3
2	Belawan Bahagia	13564	0.727	18659,21	High	3
3	Belawan Bahari	12749	2,785	4578.30	High	3
4	Belawan I	23226	3,148	7377,39	High	3
5	Belawan II	24181	1,800	13434.51	High	3
6	Belawan Sicanang	17396	17,699	982.85	Medium	2

Source: Research Results, 2023.

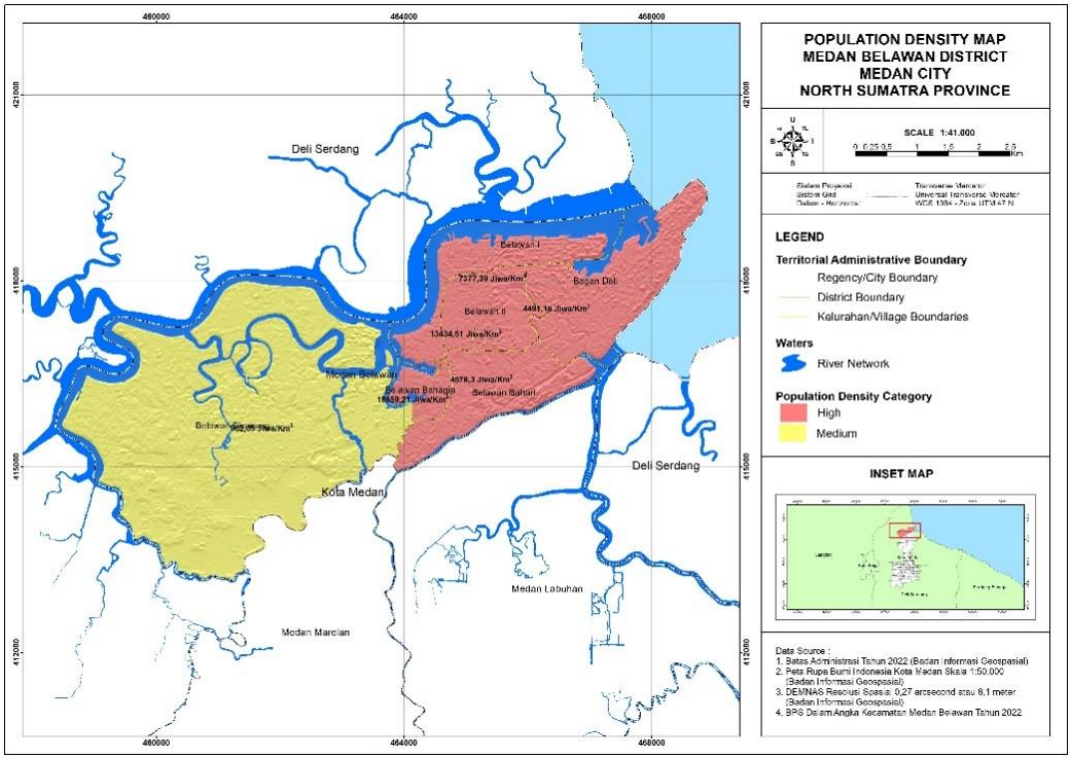

Figure.2 Social Vulnerability Map Based on Population Density

Sex Ratio Parameters

The sex ratio per Village is calculated by dividing the number of female residents in each Village by the total population in each Village. The sex ratio of Medan Belawan District can be seen in Table 9. The sex ratio in all villages is high because it has a percentage of >40%. The Belawan Bahagia Village occupies the highest rate of the female population, with 49.58%, and the Bagan Deli Village occupies the lowest with 48.12%. A spatial distribution map of the level of social

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vulnerability in the research area based on the sex ratio is presented in Figure 3.

Table 9. Calculation of the Sex Ratio in Medan Belawan District

No.	Sub-Districts	Total Female Population	Total Population	Percentage (%)	Category	Score
1	Bagan Deli	8600	17871	48,12	High	3
2	Belawan Bahagia	6725	13564	49,58	High	3
3	Belawan Bahari	6252	12749	49.04	High	3
4	Belawan I	11306	23226	48,68	High	3
5	Belawan II	11905	24181	49,23	High	3
6	Belawan Sicanang	8435	17396	48,49	High	3

Source: Research Results, 2023

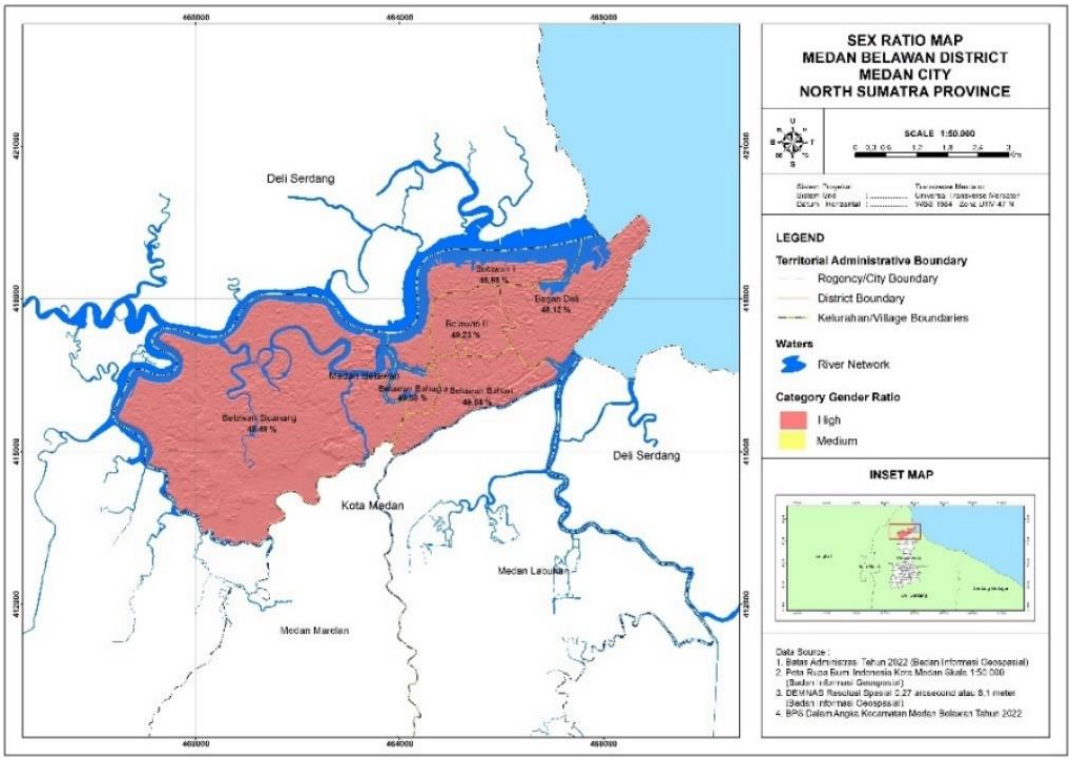

Figure 3. Map of Social Vulnerability Based on Sex Ratio

Parameter of the Ratio of Persons with Disabilities

The ratio of persons with disabilities per Village is calculated by dividing the number of persons with disabilities in each Village by the total population. The percentage of persons with disabilities in the Medan Belawan District can be seen in Table 10.

The ratio of persons with disabilities in all villages is in the low category because it has a percentage of <20%. The Belawan Bahagia Village occupies the highest rate of the population with disabilities, with 0.22%, and the Belawan Bahari Village occupies the lowest with 0.03%. A map of the spatial distribution of social vulnerability levels in the research area based on the ratio of persons with disabilities is presented in Figure 4.

Table.10 Ratio of Persons with Disabilities in Medan Belawan District

No.	Sub-Districts	Total Population with Disabilities	Total Population	Percentage (%)	Category	Score
1	Bagan Deli	11	17871	0.06	Low	1
2	Belawan Bahagia	30	13564	0.22	Low	1
3	Belawan Bahari	4	12749	0.03	Low	1
4	Belawan I	22	23226	0.09	Low	1
5	Belawan II	22	24181	0.09	Low	1
6	Belawan Sicanang	16	17396	0.09	Low	1

Source: Research Results, 2023.

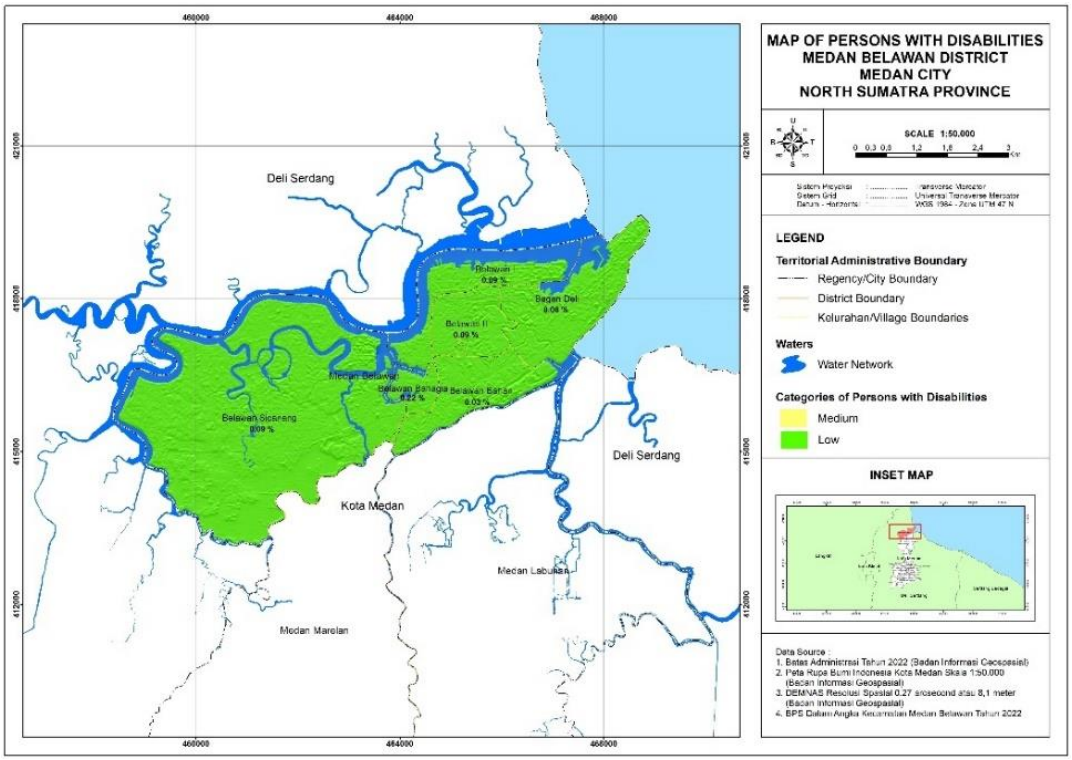

Figure.4 Map of Social Vulnerability Based on the Ratio of Persons with Disabilities

Land Use Parameters

Land use per Village is classified into 3: built-up land, bodies of water, and undeveloped land. The classification of land use takes into account its effect on tidal flooding. The type and extent of land use are the benchmarks for scoring. Each type of land use is given an interval class which is obtained by finding the difference in the Area of the highest and lowest land use types and then dividing it by 3. Note that in this study, the interval classes assigned were three. The accumulated land use score for each sub-district is obtained by adding the scores for each land use type. To determine the interval class of land use, it is done by finding the difference between the accumulated score of the highest and lowest land use and then dividing by 3. Thus, based on land use, high, medium, and low classifications for tidal flood social vulnerability will be obtained. Bagan Deli Sub-district ranks first as the Village with the most heightened social exposure regarding land use parameters. Meanwhile, based on

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land use parameters, Sicanang Village has the lowest social vulnerability. Medan Belawan District land use can be seen in Table 11. The spatial distribution map of land use types in Medan Belawan District is presented in Figure 5.

Table. 11 Land Use in Medan Belawan District

No.	Sub-Districts	Accumulated Land Use Score	Classification	Score
1	Bagan Deli	9	High	3
2	Belawan Bahagia	7	Medium	2
3	Belawan Bahari	7	Medium	2
4	Belawan I	8	High	3
5	Belawan II	7	Medium	2
6	Belawan Sicanang	5	Low	1

Source: Research Results, 2023.

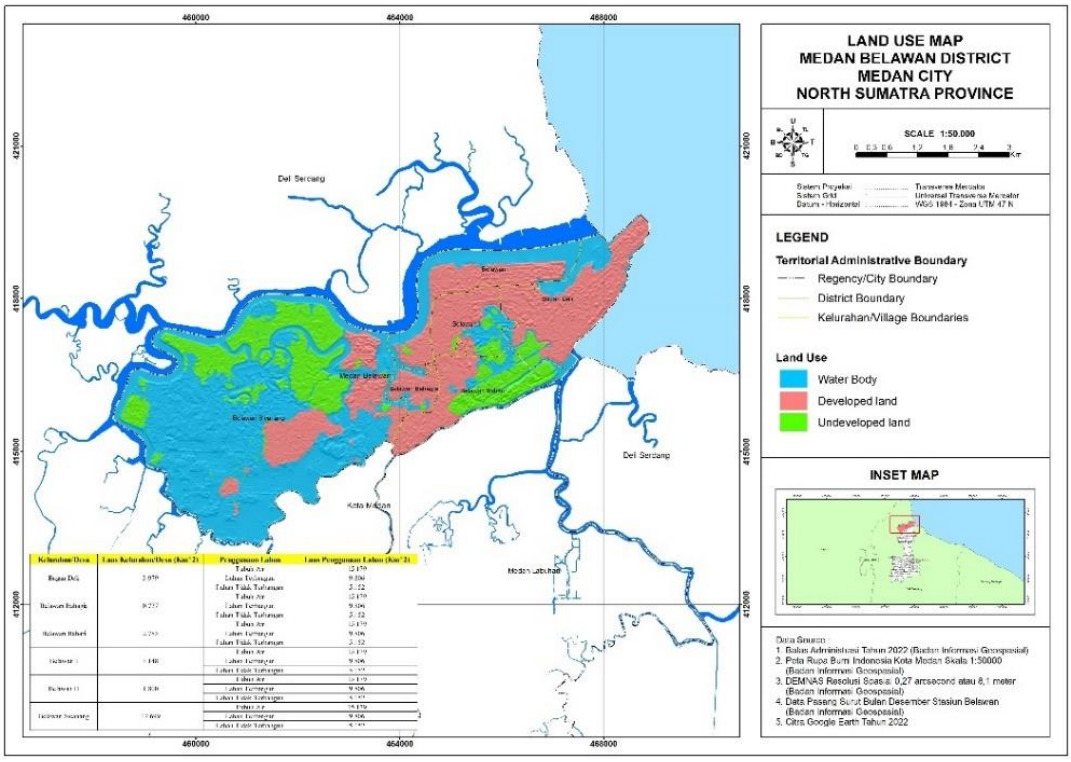


Figure.5 Map of Social Vulnerability Based on Land Use

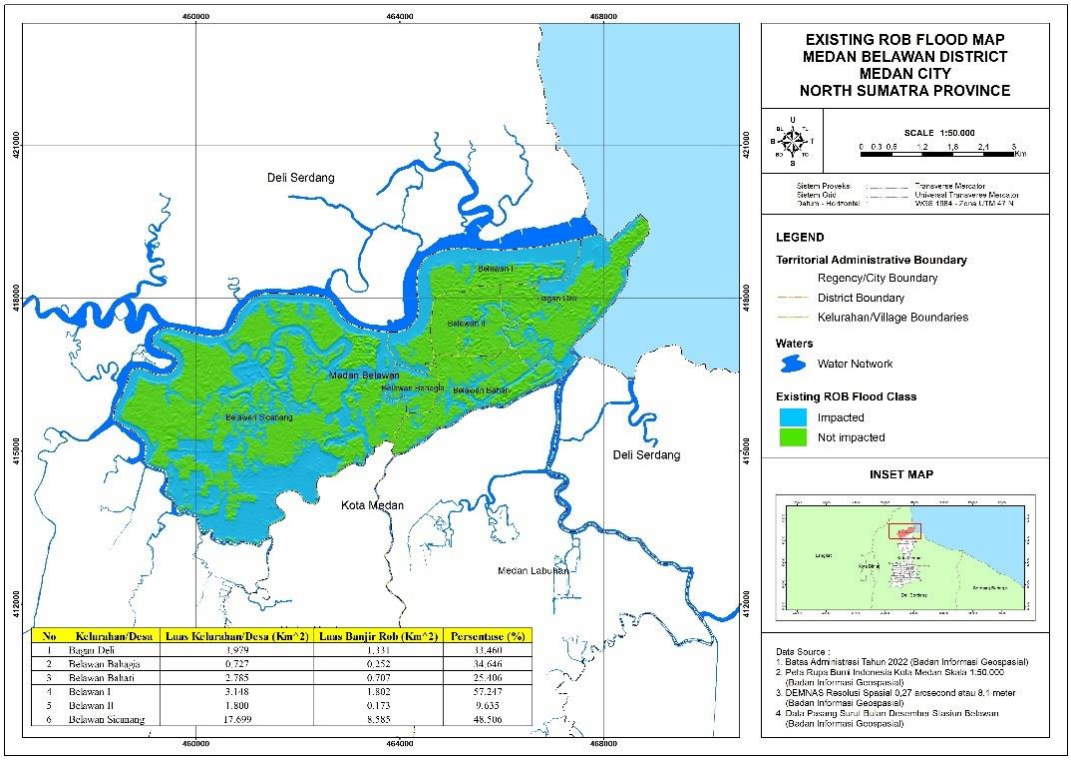
Existing Tidal Flood Zoning Parameters

The existing tidal flood zoning uses December 2022 data and is calculated using the Admiralty method for 15 days. This calculation produces the highest value, which is then used as the threshold for the areas affected by tidal floods. Belawan I Sub-District has the highest tidal flood-affected Area of 1.8 km 2, and Belawan II Sub-District has the lowest tidal flood-affected Area of 0.17 km 2. The areas affected and not affected by tidal floods, along with the classification of social vulnerability for each Village, are presented in Table 11. The spatial distribution map of the existing tidal surges in Medan Belawan District is shown in Figure 6.

Table.12 Existing Tidal Flood Zoning in Medan Belawan District

No.	Sub-Districts	Affected Area (Km^2)	Unaffected Area (Km^2)	Classification	Score
1	Bagan Deli	1.331435991	2.635964772	Low	1
2	Belawan Bahagia	0.251855715	0.475077548	Low	1
3	Belawan Bahari	0.707466188	2.069972908	Low	1
4	Belawan I	1.802295889	1.337071159	High	3
5	Belawan II	0.173427125	1.626489529	Low	1
6	Belawan Sicanang	8.585237766	9.081885413	Low	1

Source: Research Results, 2023.



No	Kelurahan/Desa	Luas Kelurahan/Desa (Km^2)	Luas Banjir Rob (Km^2)	Persentase (%)
1	Bagan Deli	3.979	1.331	33.460
2	Belawan Bahagia	0.727	0.252	34.646
3	Belawan Bahari	2.785	0.707	25.406
4	Belawan I	3.148	1.802	57.247
5	Belawan II	1.800	0.173	9.635
6	Belawan Sicuaang	17.699	8.585	48.506

Figure.6 Map of Social Vulnerability Based on Existing Tidal Flood Zoning

Total Social Vulnerability

Total social vulnerability is obtained after overlaying all parameter maps. Five urban villages (83%) in Medan Belawan District are included in the high tidal flood social vulnerability classification, and only one urban Village (17%) is included in the medium social vulnerability classification. Belawan I Village occupies the highest social vulnerability class value for tidal floods, and the lowest social vulnerability class for tidal floods is occupied by Sicanang Village. The parameters of population density, gender, and zoning of the existing tidal surge significantly affect the social vulnerability of the tidal flood disaster in Belawan I Village. This is increasingly influenced by the position of Belawan I Village, which is directly adjacent to sea waters. The total social vulnerability to the tidal flood disaster in the Medan Belawan District can be seen in Table 13. A map of the Social Vulnerability of Tidal Flood Medan Belawan District is presented in Figure 7.

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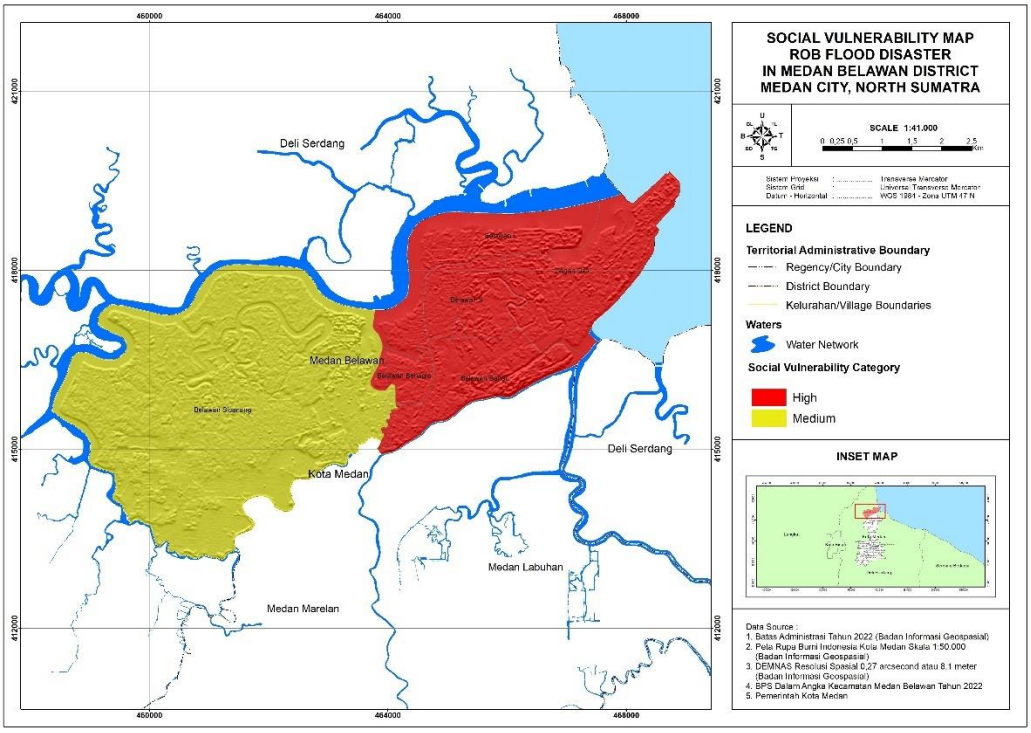
Table. 13 Total Social Vulnerability in Medan Belawan District

No.	Sub-Districts	Vulnerability Class Value	Classification
1	Bagan Deli	2,6	High
2	Belawan Bahagia	2,5	High
3	Belawan Bahari	2,5	High
4	Belawan I	2,8	High
5	Belawan II	2,5	High
6	Belawan Sicanang	1,8	Medium

Source: Research Results, 2023



Picture. 7 Map of Social Vulnerability to Flood Disaster, Medan Belawan District

CONCLUSION

The level of social vulnerability to tidal floods in Medan Belawan District is mostly in the high category. Belawan I sub-district is the sub-district with the highest level of social vulnerability, and the Sicanang sub-district is the sub-district with the lowest level of social exposure. Belawan I Village is directly adjacent to sea waters, thus increasing the impact of the tidal flood. High population density is a significant factor in increasing social vulnerability to tidal surges in Medan Belawan District. The zoning map of social vulnerability to the tidal flood disaster in Medan Belawan District shows the need for decisions related to mitigation and efforts to deal with massive tidal flood disasters. Almost all Villagess were prioritized, especially those in the zone of high social vulnerability, namely Belawan I Sub-District, Bagan Deli Sub-District, Belawan Bahagia Sub-District, Belawan Bahari Sub-District, Belawan II Sub-District, and Sicanang Sub-District.

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REFERENCE

Arif, D. A., Mardiatno, D., & Giyarsih, S. R. (2017). Kerentanan Masyarakat Perkotaan Terhadap Bahaya Banjir Di Kelurahan Legok Kecamatan Telanipura Kota Jambi. Majalah Geografi Indonesa, 31(1), 1-11.

Asrofi, A., & Hadmoko, DS (2017). Adaptation strategies for coastal communities in handling tidal floods and their implications for regional resilience (Study in Bedono Village, Sayung District, Demak Regency, Central Java). Journal of National Resilience, 23 (2), 125–144.

Bali, E. N., Khotijah, I., Wollo, S., Kale, S., & Mundiarti, V. (2021). Pendampingan Psikososial Anak Korban Bencana di Sekolah Alam Manusak. Kelimutu Journal of Community Service, 1(1), 1-7.

Dang, A. T. N., & Kumar, L. (2017). Application of remote sensing and GIS-based hydrological modelling for flood risk analysis: a case study of District 8, Ho Chi Minh City, Vietnam. Geomatics, Natural Hazards, and Risk, 8(2), 1792-1811.

Dedekorkut-Howes, A., Torabi, E., & Howes, M. (2020). Ketika air pasang semakin tinggi: Tinjauan respons adaptif terhadap kenaikan permukaan laut dan banjir pesisir. Jurnal Perencanaan dan Manajemen Lingkungan, 63(12), 2102-2143.

Desmonda, N. I., & Pamungkas, A. (2014). Penentuan zona kerentanan bencana gempa bumi tektonik di Kabupaten Malang wilayah selatan. Jurnal Teknik ITS, 3(2), C107-C112.

Fitri, R., Iskandar, B., & Nurfadillah, EU (2023). Floating House as Rob Flood Mitigation In Bagan Deli, Belawan District. Media Throne Publishers.

Hakim, B. A., Kustiyanto, E., Cholisoh, E., Airawati, M. N., Wibawa, B., Susilo, Y. S., & Asharo, R. K. (2022, November). Menilai Fisika Lingkungan: Dampak Banjir Pasang dengan Pendekatan Multidisiplin (Studi Kasus Kota Pesisir Semarang Indonesia). Dalam Jurnal Fisika: Seri Konferensi (Vol. 2377, No. 1, hlm. 012059). Penerbitan IOP.

Harini, R., Susilo, B., Sarastika, T., Supriyati, S., Satriagasa, M. C., & Ariani, R. D. (2017, July). The survival strategy of households affected by tidal floods: the cases of two villages in the Pekalongan coastal area. In Forum Geografi (Vol. 31, No. 1, pp. 163-175).

IRBI. 2013. Indonesia Disaster Risk Index 2013

Karana, RC, & Suprihardjo, R. (2013). Tidal flood disaster mitigation in North Jakarta. ITS Engineering Journal, 2 (1), C31–C36.

Mardianta, AV, Nasution, ZP, & Purba, RM (2022). Community Perception and Adaptation Towards the Tidal Flood Disaster (Case Study: Belawan City – Medan). Social, Humanities, and Educational Studies (SHES): Conference Series, 5 (4), 1. https://doi.org/10.20961/shes.v5i4.68935

Panjaitan, M., Mulia, AP, & Nasution, ZP (2021). North Medan Rob Flood Mapping Using Artificial Neural Network and Gis for Mitigation Measures. Journal of Syntax Admiration, 2 (8), 1512–1526.

Panji Satrio, & FER. (2023, May 18). Rob Floods Hit Medan Belawan, Thousands of Residents' Houses Submerged. https://www.beritasatu.com/nusantara/1045348/banjir-rob-terjang-medan-belawan-ribuan-rumah-warga-terendam

Putri, Y. P. (2018). Arahan Kebijakan Mitigasi Bencana Banjir Bandang di Daerah Aliran Sungai (DAS) Kuranji, Kota Padang. Majalah Ilmiah Globe, 20(2), 87-98.

Rahma, A. (2020). Pembelajaran Sains Untuk Mengenalkan Kebencanaan Pada Anak Usia Dini. Jurnal Golden Age, 4(02), 250-260.

Rahmad, R., Panjaitan, BR, Silaban, D., & Muladi, MR (2017). The Impact of Rob Flood and Community Adaptation in the Coastal Area of Medan Belawan,

Medan City, North Sumatra, Indonesia. Journal Of Geography, 9 (2), 117. https://doi.org/10.24114/jg.v9i2.6902

Rahmat, H. K., Sari, F. P., Hasanah, M., Pratiwi, S., Ikhsan, A. M., Rahmanisa, R., ... & Fadil, A. M. (2020). Upaya pengurangan risiko bencana melalui pelibatan penyandang disabilitas di Indonesia: Sebuah tinjauan kepustakaan. Jurnal Manajemen Bencana (JMB), 6(2).

Regulation of the Head of the National Disaster Management Agency No 2 of 2012 concerning General Guidelines for Disaster Risk Assessment

Salim, MA (2018). Management of floods and rob in the Pekalongan area. Journal of Civil Engineering, 11, 15–23.

Santius, S. H. (2015). Pemodelan tingkat risiko bencana tsunami pada permukiman di Kota Bengkulu menggunakan sistem informasi geografis. Jurnal Permukiman, 10(2), 92-105.

Shah, A. A., Gong, Z., Pal, I., Sun, R., Ullah, W., & Wani, G. F. (2020). Wawasan manajemen risiko bencana tentang kesiapsiagaan darurat sekolah – studi kasus Khyber Pakhtunkhwa, Pakistan. Jurnal Internasional Pengurangan Risiko Bencana, 51, 101805.

Sherly, M. A., Karmakar, S., Parthasarathy, D., Chan, T., & Rau, C. (2015). Disaster vulnerability mapping for a densely populated coastal urban area: an application to Mumbai, India. Annals of the Association of American Geographers, 105(6), 1198-1220.

Siregar, J. S., & Wibowo, A. (2019). Upaya pengurangan risiko bencana pada kelompok rentan. Jurnal Dialog dan Penanggulangan Bencana, 10(1), 30-38.

Tarigan, CP, Fitri, R., & Sigit, FF (2023). Construction of Floating Houses as Mitigation of Rob Floods in Bagan Deli Belawan Medan. Jaur (Journal of Architecture And Urbanism Research), 6 (2), 198–206.

Wdowinski, S., Bray, R., Kirtman, B. P., & Wu, Z. (2016). Increasing flooding hazard in coastal communities due to rising sea level: Case study of Miami Beach, Florida. Ocean & Coastal Management, 126, 1-8.