

Analysis of vulnerability level of beach abrasion disaster in the District of North Galesong, Takalar Regency

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Received April 24, 2022 | Accepted August 30, 2022 | Published September 21, 2022

ABSTRACT

Vulnerability is the inability of an individual or community group to minimize the impact caused by a hazard. Information about the level of vulnerability is essential to reduce the risks and effects caused by a disaster. Assessment of the level of vulnerability of threatened areas is carried out to minimize losses and the population exposed to disasters. This study aims to determine the level of vulnerability to coastal abrasion in North Galesong District, Takalar Regency. The analytical method used is the vulnerability index of coastal areas consisting of population components, namely population density and vulnerable groups, economic components, low-income families and anglers, physical components in the form of building density and ecological features in the form of mangrove vegetation. Analysis of vulnerability index data using the vulnerability assessment table issued by the Regulation of the Head of BNPB Number 2 of 2012. The overall results of the research are the vulnerability level of coastal villages in North Galesong District is in the high category. The category of high vulnerability is a condition of a community or society that leads to or causes a high inability to deal with the threat of coastal erosion in the North Galesong District. Vulnerability reduction activities can be carried out by increasing public understanding, especially vulnerable groups and poor fishers groups, through training and socialization activities regarding potential disaster threats, the driving factors for their occurrence and the risks. Socialization of the potential danger of abrasion and extreme waves for fishers is necessary to increase knowledge in dealing with disaster threats. Socialization can be done by inviting anglers to disaster management activities.

Key word: vulnerability; disaster; abrasion; North Galesong; management activities.

INTRODUCTION

Abrasion is the process of land erosion by waves causing the substrate to be washed away and the land area to be reduced (Utami & Pamungkas Adjie, 2013). Coastal erosion is an important impact due to sea level rise on sandy beaches or mud beaches in the form of a balance of beach profiles which results in a shift in the coastline (Rusdi, 2014). Coastline changes are strongly influenced by processes that occur around the coast, where the coast always adapts to the conditions that occur (GR Josiana & DR Hizbaron, 2019).

Changes in coastlines in several areas in Indonesia in recent years have experienced significant changes, coastal erosion including abrasion can submerge land between 2 to 10 meters per year (Koddeng, B, 2011). In addition to land loss and shoreline changes, another impact of coastal erosion and abrasion is the emergence of social impacts that affect people's lives and result in community social structures such as changes in livelihoods (Jatmiko, D, 2015).

Vulnerability is the inability of an individual or community group in an effort to minimize the impact caused by a hazard (Rijanta, R et al., 2014). Information about the level of vulnerability is very important in efforts to reduce the risks and impacts caused by a disaster (Choirunisa, 2016). The study of the level of vulnerability of threatened areas is carried out to reduce the level of losses and the population exposed to disasters, so that when a disaster occurs, the government can determine which areas are priority areas for disaster mitigation (Mantika & Hidayati, 2020).

Vulnerability can be divided into physical vulnerability, social vulnerability, economic vulnerability and environmental vulnerability. Vulnerability is a condition of a community or society that leads to a decrease in resilience due to external influences that threaten life, livelihoods, natural resources, infrastructure, economic productivity and welfare (BNPB, 2012). The presentation of information about disasters spatially is very much needed because by using these data residents can immediately recognize their environmental conditions (Setyaningrum, P & Giyarsih, S.R, 2012).

Vulnerability to natural disasters needs to be known for alternative sorting of areas to be developed, especially to determine areas that are limits or area boundaries with a high level of quality of natural disaster vulnerability that need to be avoided. In addition, it is also necessary to know the vulnerability of natural disasters to carry out stabilization, namely eliminating or reducing negative factors as obstacles to regional development, while maximizing or increasing positive or supporting factors for the development of the region (Arifin, Zaenal, 2010).

Vulnerability is a condition of a community or society that leads or causes an inability to deal with threats. The level of vulnerability is an important thing to know as one of the factors that influence disaster risk, because a new disaster will occur if the hazard occurs in a vulnerable condition (Putri, 2019). A disaster will occur when the danger faced by the community is more than the community's capacity to deal with the hazard. In the sense that the community's ability to deal with disaster hazards is still lacking. This condition means that the effects caused by disasters are influenced by the level of community vulnerability to a disaster (Adhietya, D et al., 2017). One of the disaster management efforts according to Law number 24 of 2007 is by mitigating or reducing disaster risk. One of the steps taken in disaster risk reduction is by identifying the level of vulnerability, especially social vulnerability (Puspitotanti & Karmilah, 2022).

Social vulnerability describes the social fragility of an area due to the influence of hazards, threats and disasters that have the potential to damage, disrupt and harm (Rahmaningtyas, N. & Setyono, J. S, 2015). The community becomes the main object when a disaster occurs, the community should have the ability to know the existing vulnerabilities, so that they can become the main actors in disaster risk reduction efforts, so that losses can be minimized (Desfandi, M, 2016). Vulnerable social conditions, so if a disaster occurs it can be ascertained that it will cause huge losses (Ratu Nabillah et al., 2020).

In the District of North Galesong, abrasion is the main problem that occurs along the coast with strong waves that threaten the plant ecosystem on the coast of North Galesong. This is further exacerbated by the loss of breakwaters or coastal protective buildings which continue to erode or erode, thus threatening the surrounding settlement ecosystem (Hidayat, 2021). Seeing the high potential threat of coastal abrasion, as well as the rapid development and population growth in the coastal area of North Galesong District, efforts to overcome coastal abrasion are needed based on the characteristics of the disaster (Chaerul, 2022). This study aims to determine the level of vulnerability to coastal abrasion in North Galesong District, Takalar Regency.

RESEARCH METHODS

Research Object Location

The location of the object of this research was carried out in the District of North Galesong, Takalar Regency which is on the equator between 5019'30" south latitude and 1190 21'30" east longitude. Administratively, Galesong District consists of 12 villages/kelurahan with a land area of 25.93 km² or about 4.5% of the total area of Takalar Regency. The administrative area is bordered on the north by Makassar City, on the east by Gowa Regency, on the south by Galesong District and on the west by the Makassar Strait.

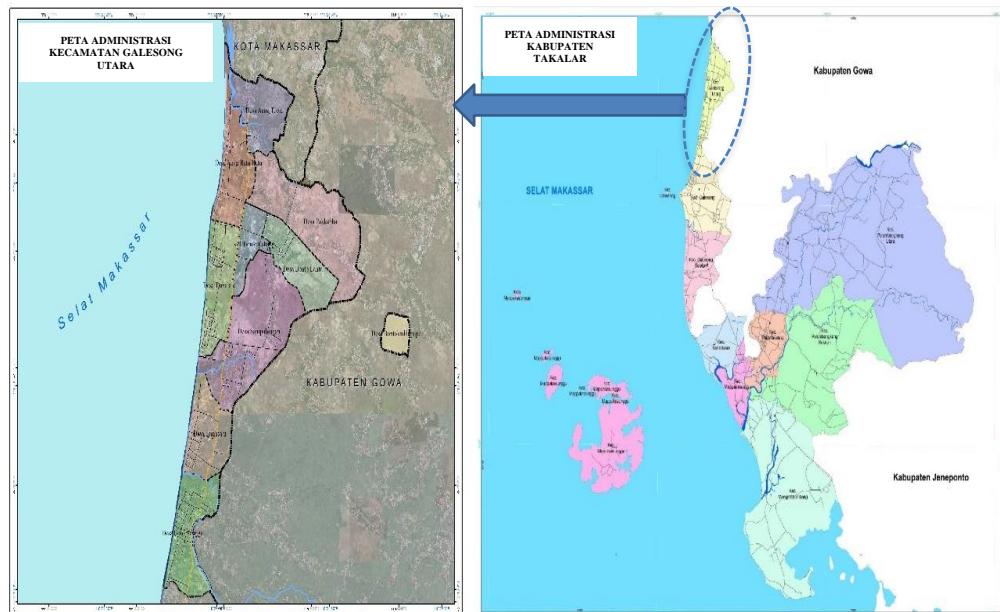


Figure 1. Orientation Map of North Galesong District, Takalar Regency

Research time

This research was conducted for 6 (six) months from August 2021 to January 2022.

Data Types and Sources

a. Data type

To support the analysis process, several types of data that will be used in this study include:

- 1) Primary data is carried out by taking the coordinates of the earth and observing and documenting coastal conditions in North Galesong District.
- 2) Secondary data obtained from various agencies and literature studies, consisting of: image data, population, population density, number of elderly people, number of people with disabilities, number of poor people, number of fishermen, density of residential buildings and area of mangrove vegetation.

b. Data source

Sources of data that will be used in this research include:

- 1) Primary data obtained by identifying in the field, and documentation in the form of photographs of coastal conditions, environmental conditions of settlements and building density, conditions of vegetation distribution and damage due to abrasion using a field survey approach at the study site.
- 2) Secondary data obtained from literature, image data and interviews with local government officials, related and relevant agencies, interviews were also conducted with people who inhabit locations along the coast in North Galesong District.

Vulnerability Index Analysis

Analysis of the vulnerability index data using the vulnerability assessment table issued by the Regulation of the Head of BNPB Number 2 of 2012 which was modified by the author. The analysis of the vulnerability index assessment of coastal areas in facing abrasion disasters is presented in the following table:

Table 1. Vulnerability Index Assessment Parameters

No.	Component	Indicator	Index Class			Weight (%)
			Low(1)	Medium (2)	High (3)	
1	Population	Population Density (people/km ²)	< 10.000	10.000-20.000	> 20.000	30
		Vulnerable group (%)	< 20	20 -30	> 30	20
2	Economy	KK of Poor (%)	< 15	15-30	> 30	15
		KK of Fisherman's (%)	< 5	5 -15	> 15	10
3	Physique	Building Density (Unit/km ²)	< 1.500	< 1.500-3.000	> 3.000	10
4	Ecology/	Area of Mangrove Vegetation (Ha)	> 30	30-10	> 10	15

Source: Head of BNPB Regulation No. 2 of 2012 modified

To calculate the vulnerability level of each study area, the vulnerability index parameters are calculated using the following equation (Regulation of the Head of BNPB Number 2 2012):

$$V_{Tot} = \sum_{i=1}^6 V_i = V_1 + V_2 + V_3 + V_4 + V_5 + V_6$$

Dimana : $V_i = S_i \times B_i$

Information:

V1 = Population density parameter

V2 = Vulnerable group parameter

V3 = Poor KK parameter

V4 = Fisherman's KK Parameter

V5 = Building density parameter

V6 = Parameter of mangrove area

B_i = Indicator Weight i

S_i = Parameter Class Value i

Classification of the level of vulnerability of each study location to the threat of coastal abrasion is presented in the following table:

Table 2. Vulnerability Classification

No.	Total V Value Range	Class
	1,0 - 1,66	Low
	1,67 - 2,35	Medium
	2,36 - 3,0	High

Source: Head of BNPB Regulation Number 2 of 2012

RESULTS AND DISCUSSION

Vulnerability Index Data Collection

a. Population density

The population is the object of the impact of the disaster. The greater the number of people exposed to or affected by a disaster, the disaster in question is considered to be large and threatening. Population density data collection in this study used secondary data sourced from the Central Bureau of Statistics of Takalar Regency in the book of North Galesong District in Figures in 2020. The population density in the coastal area of North Galesong District is presented in the following table:

Table 3. Population density in the coastal area of North Galesong District

No	Village	Area (Km ²)	Number of Population (people)	Density (people/Km ²)
1	Bontosunggu	0,77	5.146	6.683
2	Tamasaju	1,13	5.228	4.626
3	Tamalate	0,70	4.035	5.764
4	Aeng Batu-Batu	2,17	5.621	2.590
5	Sampulungan	0,72	2.631	3.654
Total Number		5,49	22.661	23.317

Source: North Galesong District, 2020

b. Vulnerable Group

Vulnerability to disasters is a factor that causes a person to be helpless or have difficulty saving themselves when a disaster occurs. In another sense, vulnerable groups are understood as groups that still need other parties to be able to save themselves when a disaster occurs. A group can be said to be vulnerable due to their physical condition, which can be in the form of a weak physical condition or the condition of their senses and body movements that are limited, making it difficult for them to carry out activities. As a result of this difficulty in activities, when a disaster occurs, vulnerable groups have difficulty saving themselves compared to human groups in general. In this study, the authors took two categories of vulnerable groups, namely:

- 1) Elderly population, often experience acute malnutrition, difficulty communicating, easily experience physical and psychological stress.
- 2) The disabled group, both blind, speech impaired, and disabled, which makes it difficult to communicate and move like normal humans in general.

Data collection on vulnerable groups in this study used secondary data sourced from the Central Statistics Agency and the Takalar District Health Office. The data on the vulnerable groups of each village/kelurahan where the research is located are summed to facilitate further analysis. The data on vulnerable groups in the coastal area of North Galesong District are presented in the following table:

Table 4. Vulnerable groups in the coastal area of North Galesong District

No	Village	Vulnerable Group (people)	Amount (%)
1	Bontosunggu	206	18.39
2	Tamasaju	314	28.04
3	Tamalate	161	14.38
4	Aeng Batu-Batu	281	25.09
5	Sampulungan	158	14.11
Total number		1.120	100,00

Data Source BPS Takalar Regency and Health Office, 2021

c. Poor Family (Pre-Prosperous)

Data collection for poor families comes from data from the Central Statistics Agency for Takalar Regency. Poor families are indicators of vulnerability because difficult economic conditions will be even more difficult if affected by disasters. Poor families will find it difficult to recover to earn income when a disaster occurs. Economically, poor families need help from other parties to support their daily lives. The higher the number of poor families in an area, the more vulnerable the area is to the threat of disaster. When compared with villages/kelurahan with few poor people, villages/kelurahan with more poor families will need more assistance and require greater handling of disaster victims.

The number of heads of poor families in the coastal area of North Galesong District is presented in the following table:

Table 5. Number of poor family heads in the coastal area of North Galesong District

No	Village	KK of poor	Amount (%)
1	Bontosunggu	138	24.00
2	Tamasaju	145	25.22
3	Tamalate	97	16.87
4	Aeng Batu-Batu	135	23.48
5	Sampulungan	60	10.43
Total number		575	100,00

Source: Takalar Regency BPS data and PMD Office, 2021

d. Fisherman Family

Fishermen are a group of people who spend most of their livelihood activities looking for and cultivating fish in the sea. Because many economic activities are carried out in sea waters, fishermen become a community that is easily affected when a coastal abrasion disaster occurs.

Data collection on the heads of fishermen's families uses secondary data sourced from the Marine and Fisheries Service of Takalar Regency in 2021. The number of fishermen in each coastal village/kelurahan in North Galesong District is presented in the following table:

Table 6. Heads of fishing families in the coastal area of North Galesong District

No	Village	KK of fisherman's	Amount (%)
1	Bontosunggu	232	23.01
2	Tamasaju	240	23.75
3	Tamalate	191	18.92
4	Aeng Batu-Batu	215	21.34
5	Sampulungan	131	12.99
Total number		1.010	100,00

Source: Takalar Regency BPS data and Marine and Fisheries Service, 2021

e. Residential Building Density

Buildings around the coast will be easily affected by disasters. The more densely populated an area is, the more buildings will be affected and the higher the losses will be. The density of buildings also makes it difficult for an area to handle disasters, due to the difficulty of finding a suitable evacuation route for evacuation vehicles to pass.

Data on the number of buildings is obtained from secondary data in the form of village potential data collection documents (Podes) in 2019. The total number of buildings on the coast of North Galesong District is presented in the following table:

Table 7. Building Density in the Coastal area of North Galesong District

No	Village	Building (unit)	Amount (%)
1	Bontosunggu	1.504	24.22
2	Tamasaju	1.432	23.06

3	Tamalate	1.025	16.50
4	Aeng Batu-Batu	1.585	25.52
5	Sampulungan	665	10.71
Total number		6.211	100,00

Source: Village potential data collection document (Podes), 2019

f. Area of mangrove vegetation

Mangrove ecosystems have an important role in maintaining coastal stability in coastal areas. The existence of mangroves can support coastal areas to avoid damaging ocean waves. Dense and massive mangrove roots can reduce the energy of ocean waves that reach the coast. The wider the mangrove area that lies in the coastal area, the less influence of ocean waves that reach the coast. Based on the interpretation of satellite imagery at the research location, no mangrove vegetation was found, only a sandy beach which tends to be open with various means of socio-economic activities and residential developments in the coastal area.

Table 8. Mangrove area in the Coastal area of North Galesong District

No	Village	Area of mangrove (Km ²)	Amount (%)
1	Bontosunggu	0,00	0,00
2	Tamasaju	0,00	0,00
3	Tamalate	0,00	0,00
4	Aeng Batu-Batu	0,00	0,00
5	Sampulungan	0,00	0,00
Total number		0,00	0,00

Source: Field Survey and Interpretation of Satellite Imagery, 2021

Vulnerability Index Analysis

a. Population density

Scoring and weighting of population density using the following table of vulnerability parameter assessment:

Table 9. Analysis of Wave Height Parameters

No.	Village	Population density	Index Score	Score	Category
1	Bontosunggu	6.683	3	0,9	Tinggi
2	Tamasaju	4.626	3	0,9	Tinggi
3	Tamalate	5.764	3	0,9	Tinggi
4	Aeng Batu-Batu	2.590	3	0,9	Tinggi
5	Sampulungan	3.654	3	0,9	Tinggi

Source: Data Analysis Results, 2022

From the population density scoring, it was found that all villages/kelurahan in the coastal area of North Galesong District have a high population density category. The population density of an area is influenced by several factors, namely the area of the village/kelurahan is largely dominated by residential land, trade facilities, services and public facilities.

b. Vulnerable Group

The scoring and weighting of parameters for vulnerable groups uses the following vulnerability assessment table:

Table 10. Scoring parameters Indicators of vulnerable groups

No.	Village	Percentage of Vulnerable Group	Index score	Score	Category
1	Bontosunggu	4.00	1	0,2	Rendah
2	Tamasaju	6.01	1	0,2	Rendah
3	Tamalate	3.99	1	0,2	Rendah
4	Aeng Batu-Batu	5.00	1	0,2	Rendah
5	Sampulungan	6.01	1	0,2	Rendah

Source: Data Analysis Results, 2022

From the scoring of the vulnerable group, it was found that all villages/kelurahan in the coastal area of North Galesong District have a low category vulnerable group. Physically vulnerable groups find it difficult to save themselves. When a disaster occurs, the potential for casualties is due to difficulties in saving themselves.

1. Head of a Poor Family

Scoring and weighting of heads of poor households using the vulnerability assessment table as follows:

Table 11. Scoring parameters of poor family heads

No.	Village	Percentage KK of Poor	Index score	Score	Category
1	Bontosunggu	11.97	2	0,3	Sedang
2	Tamasaju	11.99	2	0,3	Sedang
3	Tamalate	10.96	2	0,3	Sedang
4	Aeng Batu-Batu	11.54	2	0,3	Sedang
5	Sampulungan	10.95	2	0,3	Sedang

Source: Data Analysis Results, 2022

From the scoring of the parameters of the heads of poor families, it was found that, all villages/kelurahan in the coastal area of North Galesong District had poor families in the medium category. The existence of poor family heads greatly affects the level of vulnerability of the population of an area. Economically poor people, will be very hard to feel the impact of the disaster. economic difficulties due to minimal income and precarious work, making it difficult for the poor to recover when a disaster occurs.

2. Head of Fisherman Family

Scoring and weighting of fishermen's household heads uses the following vulnerability assessment table:

Table 12. Scoring parameters of fishermen's family heads

No.	Village	Percentage KK of fisherman's	Index score	Score	Category
1	Bontosunggu	20,12	3	0,3	Tinggi
2	Tamasaju	19,85	2	0,2	Sedang
3	Tamalate	21,58	3	0,3	Tinggi
4	Aeng Batu-Batu	18,38	2	0,2	Sedang
5	Sampulungan	23,91	3	0,3	Tinggi

Source: Data Analysis Results, 2022

From the results of the parameter scoring of the head of the fishermen's family (KK) it was found that the village of Bontosunggu, Tamalate village and Sampulungan village had a high category of fisherman's family head. The medium category is in Tamasaju village and Aeng Batu-Batu village.

3. Building Density

Classification of building density using a vulnerability assessment table as follows:

Table 13. Scoring Parameters of Building Density

No.	Village	Density of building	Index score	Score	Category
1	Bontosunggu	1.504	3	0,3	Tinggi
2	Tamasaju	1.432	3	0,3	Tinggi
3	Tamalate	1.025	2	0,2	Sedang
4	Aeng Batu-Batu	1.585	3	0,3	Tinggi
5	Sampulungan	665	2	0,2	Sedang

Source: Data Analysis Results, 2022

From the results of scoring the building density parameter, it was found that Bontosunggu Village, Tamasaju Village and Aeng Batu-Batu Village had a high category of building density. The medium category is in Tamalate village and Sampulungan village. The density of buildings has a major influence on the potential for physical damage to settlements and the high loss of an area when affected by a disaster. Areas with high building density will experience higher levels of damage and losses than areas with low building density categories.

4. Mangrove Vegetation Area

The mangrove vegetation area of each village/kelurahan is classified using the following vulnerability assessment parameter table:

Table 14. Scoring parameters of mangrove vegetation area

No.	Village	Mangrove area (Km ²)	Index score	Score	Category
1	Bontosunggu	0,00	3	0,45	Tinggi
2	Tamasaju	0,00	3	0,45	Tinggi
3	Tamalate	0,00	3	0,45	Tinggi
4	Aeng Batu-Batu	0,00	3	0,45	Tinggi
5	Sampulungan	0,00	3	0,45	Tinggi

Source: Data Analysis Results, 2022

From the scoring of the mangrove vegetation area parameter, it was found that all villages/kelurahan in the coastal area of North Galesong District did not have mangrove vegetation so that overall it was included in the high category. The high mangrove area will reduce the vulnerability of coastal areas in facing the threat of coastal erosion. The existence of the mangrove ecosystem can reduce threats and reduce vulnerability.

Vulnerability Rating

The assessment of the level of vulnerability is carried out by adding up all indicator scores that affect the vulnerability index. The total value from the sum of the vulnerability indicators is the value of the vulnerability of the study area to the threat of coastal abrasion. The results of the sum and the total value of the vulnerability of coastal areas in facing the threat of coastal erosion are presented in the following table:

Table 15. Value of coastal area vulnerability

No.	Village	V ₁	V ₂	V ₃	V ₄	V ₅	V ₆	V _{Total}
1	Bontosunggu	0,9	0,2	0,3	0,3	0,3	0,45	2,45
2	Tamasaju	0,9	0,2	0,3	0,2	0,3	0,45	2,35
3	Tamalate	0,9	0,2	0,3	0,3	0,2	0,45	2,35
4	Aeng Batu-Batu	0,9	0,2	0,3	0,2	0,3	0,45	2,35

5	Sampulungan	0,9	0,2	0,3	0,3	0,2	0,45	2,35
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Source: Data Analysis Results, 2022

Based on the results, the total vulnerability value will be analyzed and classified into three classes, namely high, medium and low. Classification is carried out to obtain differences in the vulnerability of each village/kelurahan in facing the threat of coastal erosion. The results of the analysis and classification of the vulnerability value of the coastal area of North Galesong District are presented in the table as follows:

Table 16. The level of vulnerability of the coastal area of North Galesong District

No.	Village	Vulnerability value (V_{Total})	Category
1	Bontosunggu	2.45	Tinggi
2	Tamasaju	2.35	Tinggi
3	Tamalate	2.35	Tinggi
4	Aeng Batu-Batu	2.35	Tinggi
5	Sampulungan	2.35	Tinggi

Source: Data Analysis Results, 2022



Figure 1. Abrasion Disaster Vulnerability Level

Classification of the level of vulnerability of coastal areas to the threat of coastal abrasion, illustrates that the coastal area of North Galesong District has the same level of vulnerability. Based on the results of the overall analysis, the village/kelurahan vulnerability in North Galesong District is in the high category. The area vulnerability map is shown in the following figure

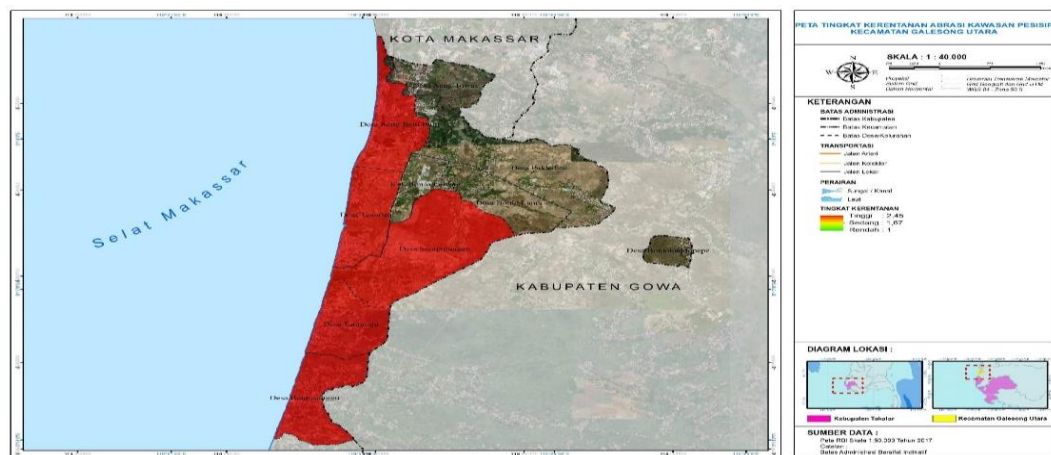


Figure 2. Abrasion Disaster Vulnerability Level

CONCLUSION

Classification of the level of vulnerability of coastal areas to the threat of coastal abrasion, illustrates that the coastal area of North Galesong District has the same level of vulnerability. Based on the results of the overall analysis, the village/kelurahan vulnerability in North Galesong District is in the high category. The category of high vulnerability is a condition of a community or society that leads or causes a high inability to deal with the threat of coastal erosion in North Galesong District.

Vulnerability reduction activities can be carried out by increasing public understanding, especially vulnerable groups and poor fishermen groups through training and socialization activities regarding potential disaster threats, the driving factors for their occurrence and the risks that may occur. socialization of the potential threat of abrasion and extreme waves for fishermen is very necessary to increase knowledge in dealing with disaster threats. Socialization can be done by inviting fishermen to disaster management activities.

ACKNOWLEDGEMENT

My deepest gratitude for the knowledge and experience to my thesis supervisor in pursuing a master's degree in infrastructure and environmental engineering at Fajar Makassar University, namely Dr. Muhammad Chaerul and Mrs. Dr. Sri Gusty, I wish you good health and success always.

REFERNCES

- Adhietya, D, Mardiatna, D, & Giyarsih, S. R. (2017). Kerentanan Masyarakat Perkotaan Terhadap Bahaya Banjir di Kelurahan Legok, Kecamatan Telanipura, Kota Jambi. *Jurnal Majalah Geografi Indonesia*, 31, 79–87.
- Arifin, Zaenal. (2010). Pola Spasial Kerentanan Bencana Alam (Studi Kasus Kabupaten Cianjur) [Tesis]. Fakultas Matematika dan Ilmu Pengetahuan Alam. Universitas Indonesia.
- BNPB. (2012). *Pedoman Umum Pengkajian Risiko Bencana*. Badan Nasional Penanggulangan Bencana (BNPB).
- Chaerul, M. (2022). Analisis Pengurangan Risiko Bencana Abrasi Pantai Di Kecamatan Galesong Utara Kabupaten Takalar. *Syntax Literate: Jurnal Ilmiah Indonesia*, 7(4), 13. <http://dx.doi.org/10.36418/syntax-literate.v7i4.6726>
- Choirunisa, A. K. (2016). Kajian Kerentanan Fisik, Sosial, Dan Ekonomi Pesisir Samas Kabupaten Bantul Terhadap Erosi Pantai. 10.
- Desfandi, M. (2016). Urgensi Kurikulum Pendidikan Kebencanaan Berbasis Kearifan Lokal Di Indonesia. *SOSIO DIDAKTIKA: Social Science Education Journal*, 1(2).
- GR Josiana, & DR Hizbaron. (2019). Kajian Kerentanan Sosial dan Ekonomi Masyarakat Pesisir Terhadap Erosi Pantai di Pantai Trisik, Kulonprogo, DIY [Skripsi]. Universitas Gadjah Mada.
- Hidayat, M. I. (2021). Arahana Pengurangan Risiko Bencana Abrasi Di Kawasan Permukiman Pesisir Desa Sampulungan, Kabupaten Takalar [Skripsi]. Universitas Hasanuddin.
- Jatmiko, D. (2015). Pola Adaptasi Masyarakat Terhadap Abrasi Pantai: Studi di Kawasan Pesisir Samas, Bantul, Yogyakarta [Tesis]. Universitas Gadjah Mada.
- Koddeng, B. (2011). Zonasi Kawasan Pesisir Pantai Makassar Berbasis Mitigasi Bencana (Studi Kasus Pantai Barombong-Celebes Convention Centre). *Prosiding Hasil Penelitian Fakultas Teknik. Grup Teknik Arsitektur, Makassar*.
- Mantika, N. J., & Hidayati, S. R. (2020). Identifikasi Tingkat Kerentanan Bencana Di Kabupaten Gunungkidul. 1(1), 12.
- Puspitotanti, E., & Karmilah, M. (2022). Kajian Kerentanan Sosial Terhadap Bencana Banjir. *Jurnal Kajian Ruang*, 1(2), 177. <https://doi.org/10.30659/jkr.v1i2.20023>

Putri, T. D. (2019). Analisis Kerentanan Sosial Masyarakat dan Adaptasi Perubahan Iklim Oktober 2019 Kampung Gemblakan Atas, Kota Yogyakarta. *Proceeding Biology Education Conference*, 16, 256–264.

Rahmaningtyas, N., & Setyono, J. S. (2015). Tingkat Kerentanan Sosial Wilayah Kabupaten Wonogiri. *Jurnal Teknik PWK*, 4(4).

Ratu Nabillah, Iwan Setiawan, & Bagja Waluya. (2020). Kerentanan Sosial pada Wilayah Potensi Bencana Tsunami di Pesisir Kecamatan Rajabasa Kabupaten Lampung Selatan. *Jurnal Geografi, Edukasi dan Lingkungan (JGEL)*, 4(2), 96–112. <https://doi.org/10.29405/jgel.v4i2.4318>

Rijanta, R, Hizbaron, D.R, & Baiquni, M. (2014). *Modal Sosial dalam Manajemen Bencana*.

Rusdi. (2014). *Persepsi dan Adaptasi Masyarakat dalam Pengurangan Risiko Dampak Erosi Pantai di Kabupaten Pinrang Sulawesi Selatan [Tesis]*. Fakultas Geografi, Universitas Gadjah Mada.

Setyaningrum, P, & Giyarsih, S.R. (2012). *Identifikasi Tingkat Kerentanan Sosial Ekonomi Penduduk Bantaran Sungai Code Kota Yogyakarta Terhadap Bencana Lahar Merapi [Skripsi]*. Fakultas Geografi, Universitas Gadjah Mada.

Utami, H., Veranita, & Pamungkas Adjie. (2013). Identifikasi Kawasan Rentan Terhadap Abrasi di Pesisir Kabupaten Tuban. *Jurnal Teknik POMITS*, 2(2), C14–C17. <https://doi.org/10.12962/j23373539.v2i2.4340>