

Coastal Abrasion Disaster Threat Analysis in North Galesong District, Takalar Regency

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ABSTRACT

Coastal damage due to abrasion can interfere with residents' livelihoods, especially those who work as fishermen. Beaches that experience abrasion will result in more severe beach damage if not addressed. Coastal dynamics caused by wave activity, tides, currents, and human activities cause shoreline changes. This study aims to determine the coastal abrasion disaster threat level in North Galesong District, Takalar Regency. The analytical method used is the analysis of coastal abrasion threat index data in coastal areas, including oceanographic data, namely wave height and current speed, ecological data, mangrove vegetation density, the physical environment, and the shape of the coastline and beach characteristics. Analysis of the data using the analysis table of disaster threat assessment issued by the Head of BNPB Regulation No. 2 of 2012 concerning General Guidelines for Disaster Risk Assessment. The study results have a high category of coastal erosion threat in the coastal area of Galesong Utara District, which is found in all coastal village areas. The high category level represents the high potential threat of coastal abrasion to the incidence of casualties and material losses on the coast of North Galesong District. It is necessary to build structural mitigation to maintain coastal stability in the form of longshore sedimentation retaining structures, abrasion absorbers, and, breakwater structures to reduce the rate of coastal abrasion.

Keywords: abrasion; coastal area; disaster; mitigation; North Galesong.

INTRODUCTION

According to Law Number 24 of 2007, a disaster is an event or series of events that threatens and disrupts people's lives and livelihoods caused, both by natural factors and/or non-natural factors as well as human factors, resulting in human casualties, environmental damage, losses property, and psychological impact.

The threat of disasters that often occur in coastal areas, apart from sudden threats such as earthquakes, tsunamis, tidal waves and others, is also a slow but sure threat, namely coastal erosion. Many coastal tourist attractions and coastal cities are threatened by abrasion. The beach is a very dynamic area with various living ecosystems that are interrelated with one another. One of the manifestations of the dynamism of the coast that occurs continuously is the change in the coastline. Shoreline changes that occur in the form of erosion of the beach body (abrasion) and addition of beach body (sedimentation).

Abrasion is an event of retreating coastline in coastal areas that are vulnerable to activities that occur on land and at sea. Activities such as logging mangrove forests, sand mining, and the phenomenon of high waves and sea tides have an impact on beach abrasion or erosion. Abrasion is a process where there is erosion of the beach caused by the destructive power of sea waves and ocean currents, and damage to the coastline due to disruption of the natural balance in the coastal area.

Coastal areas that experience abrasion are very difficult to recover or return to normal. Apart from that, coastal damage due to abrasion can disrupt the livelihoods of local residents, especially those who work as fishermen. Beaches that experience abrasion if not addressed will result in

increasingly severe beach damage. Coastal dynamics caused by wave activity, tides, currents, and human activities cause shoreline changes.

Population growth triggers the expansion of new residential areas. One of the strategic areas for this area is the coastal area, this can be seen from the development of fishing settlements that continue to jut into the sea. Knowledge of the causes, risks, impacts, vulnerability of the social environment to abrasion is very important to know as a way to be able to guide the formulation of policies and mitigation strategies. Because from year to year the spread of abrasion is a serious threat and will definitely continue to penetrate into the mainland.

North Galesong District is one of the districts located in the coastal area. Located on the west coast of Takalar Regency which has 7 villages and 1 sub-district, 4 of them are coastal villages because they are directly facing the Makassar Strait. It has an area of 15.11 km² or 2.67% of the total area of Takalar Regency. It has a coastline length of ± 10.18 km with a total population of 40,211 people and a population growth rate of 1.24 percent per year.

Every year the land on the coast along Galesong erodes due to coastal abrasion, one of the abrasion points that is quite severe every rainy season, namely along the coast of Sampulungan Village and Aeng Batu-Batu Village. abrasion and wave impact. This is a concern for local governments, provincial governments and the central government.

For this reason, it is necessary to study the analysis of the causes of abrasion so that the extent of abrasion can be identified, and then the countermeasures can be identified and determined by the construction of the most effective coastal buildings in reducing coastal abrasion. This study aims to determine the level of threat of beach abrasion in North Galesong District, Takalar Regency.

RESEARCH METHODS

Location of Research Object

The location of the object of this research was carried out in North Galesong District, 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 around 4.5% of the total area of Takalar Regency. The administrative boundaries are to the north by Makassar City, to the east by Gowa Regency, to the south by Galesong District and to the west by the Makassar Strait.

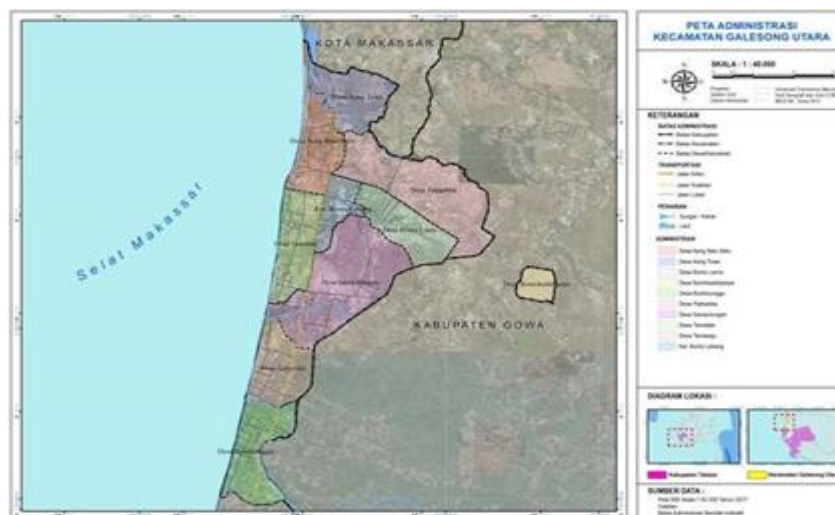


Figure 1. North Galesong District Administrative Map

Data Types and Sources

Data type

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

- a. Primary data was carried out by taking the coordinates of the research location in North Galesong District and observing and documenting the condition of the beach in North Galesong District.
- b. Secondary data were obtained from various agencies and literature studies, consisting of: image data, wave height data, current velocity data, data on the presence of mangrove vegetation, data on the shape of the coastline and data on beach characteristics.

Data source

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

- a. Primary data obtained by conducting field surveys through photographs of beach conditions and damage caused by abrasion.
- b. Secondary data obtained from the literature in the form of image data and related and relevant agency data.

Data analysis technique

Threat index analysis

Analysis of coastal abrasion threat index data in coastal areas includes oceanographic data, namely wave height and current speed; ecological data, namely the density of mangrove vegetation and the physical environment, namely the shape of the coastline and beach characteristics. Data analysis used the disaster threat assessment analysis table issued by BNPB Head Regulation Number 2 of 2012. The threat index analysis table is described as follows:

Table 1. Parameters for assessing the Disaster Threat Index

No.	Component	Indicator	Index Class			Weight (%)
			Low (1)	Medium (2)	1 - 2	
1	Hydro-Oceanography	Wave height (m)	< 1	1 - 2	0.06 - 0.09	30
		< 1 1 - 2 > 2 30	0 - 0.05	0.06 - 0.09	1 - 10	30
2	Ecology		> 10	1 - 10	Bend straight	15
3	Physical Environment	Current speed	Bay	Bend straight	Sandy rock/	15
		(m/s) mangrove vegetation (%)	Permanent building	Sandy rock/	muddy	10

Source: Regulation of the Head of BNPB Number 2 of 2012

To calculate the threat level of coastal abrasion in the coastal area of North Galesong District, each parameter is calculated using the following equation (Regulation of the Head of BNPB No.2/2012):

$$H_{Tot} = \sum_{i=1}^5 H_i = H_1 + H_2 + H_3 + H_4 + H_5$$

Where: $H_i = S_i \times B_i$

- HTot = Total threat value
- H1 = Wave height parameter
- H2 = Current speed parameter
- H3 = Mangrove density parameter
- H4 = Coastline shape parameters
- H5 = Beach characteristic parameters
- Si = Parameter class value i
- Bi = Weight of indicator i

Classification of the threat level of beach abrasion in the coastal area of North Galesong District uses the following classification table:

Table 2. Classification of disaster threat levels

No.	Total H Value Range	Class
	1,0 - 1,66	Low
	1,67 - 2,34	Currently
	2,35 - 3,0	Tall

Source: Regulation of the Head of BNPB Number 2 of 2012 modified by researchers

RESULTS AND DISCUSSION

Threat Index Data Collection

Data on the threat index of coastal abrasion disaster in North Galesong District is explained as follows:

Wave Height

The wave height used in this study is the maximum wave height and real time data. Based on the results of wave height data at the research location based on the BMKG Maritime Meteorology Center data source. The wave heights for each coastal area of North Galesong District are presented in the following table:

Table 3. Wave height in the coastal area of North Galesong District

No.	Village/Subdistrict	Wave Height (m)
1	Aeng Batu-Batu	1.25 - 2.50
2	Sampulungan	1.25 - 2.50
3	Tamalate	1.25 - 2.50
4	Tamasaju	1.25 - 2.50
5	Bontosunggu	1.25 - 2.50

Source: <https://maritim.bmkg.go.id/> accessed on 9 August 2021

Wave height is generally influenced by wind speed. Based on the results of real time data from the BMKG Maritime Meteorology Center, the waves that occurred in the coastal area of North Galesong District came from southwest Makassar's Spermonde waters. The wave height is generally the same in all coastal Villages/Kelurahans because they have almost the same characteristics of the sea and the coast.

Flow Speed

Current speed is influenced by the displacement of water masses caused by the influence of tides and wind speed. The current speed measured in this study is the current speed which is influenced by the tides along the coast. The speed of this current is very influential in moving coastal sediments to other places. Current speed data for each study location is presented in the following table:

Table 4. Current speed data for the coastal area of North Galesong District

No.	Village/Subdistrict	Current speed (m/s)
1	Aeng Batu-Batu	1.30
2	Sampulungan	1.50
3	Tamalate	1.50
4	Tamasaju	1.50
5	Bontosunggu	1.06

Source: Maritime Research Center Marine and Fisheries Research and Human Resources Agency, Ministry of Maritime Affairs and Fisheries, 2018

The current velocity of the coastal waters of North Galesong District generally ranges from 1 m/s to 1.50 m/s. this is in accordance with data from the Maritime Research Center, Marine and Fisheries Research and Human Resources Agency, Ministry of Maritime Affairs and Fisheries in 2018 according to the latest data that researchers obtained. In coastal areas with open waters, the current velocity is found to be higher than in waters protected by islands. Current speed in the coastal waters of North Galesong District is influenced by the topography of the seabed. The North Galesong waters in the north and south, namely Bontosunggu Village and Aeng Batu-batu Village, tend to have a sloping and shallow seabed topography so that the current speed is lower than the waters of the coastal areas in the middle. In the central part of the Village/Kelurahan, namely Sampulungan Village, Tamalate Village and Tamasaju Village, the topography of the seabed tends to be steep and deep so that the pattern of current velocity is higher.

Existence of Mangrove Vegetation

The appearance of the mangrove ecosystem in North Galesong District is not found in mangrove areas that face directly to the sea. The characteristics of the beach in North Galesong District are mostly sandy beaches and most of the community settlements as well as ponds and plantations. In this study, mangrove vegetation is one of the parameters determining the threat of beach abrasion waves so that with the characteristics of the beach in North Galesong District where mangroves are not found, it has a high threat of beach abrasion disasters against residents' settlements which occur every year in the research area.

As a basic ecosystem that supports useful life in seaside and oceanside areas, the existence of flora and fauna found in mangrove forests is an ability that can be developed in meeting social, economic and environmental needs. Mangroves are an important link that is useful in maintaining the biological balance in coastal areas. Mangrove forests have very beneficial socio-economic and environmental functions. The role of mangrove forests is very large, namely carbon sequestration, sorting and capturing pollutant materials, protecting and balancing the seafront, forming new land, protecting the natural habitat, becoming a nesting place and rearing various kinds of birds, shellfish, shrimp, fish and other types of fauna.

As an ecosystem on the waterfront, mangrove forests are a unique and vulnerable ecosystem with its ecological and economic functions. the existence of mangrove forests is important enough that the government requires that every area has a sea coast as stipulated in the Law of the Republic of Indonesia Number 27 of 2007 regarding the management of coastal areas and small islands. The coastal border is land along the shore whose width is commensurate with the shape and physical condition of the sea coast, a minimum of 100 (one hundred) meters from the highest tide point towards the land.

Efforts to increase the area of mangrove forests in coastal border areas often experience obstacles. Many mangrove seedlings eventually died after being planted where the failure kept repeating itself when replanting was carried out to replace dead mangroves. Various environmental factors that affect the development of mangroves in a location include: seaside physiography (topography), tides (range, duration, duration), waves and currents, climate (wind, temperature, rainfall, light), dissolved oxygen, salinity, soil and nutrients.

Shape of the Shoreline

The shape of the coastline of the coastal area of North Galesong District is strongly influenced by several factors including the movement of currents, the crashing of sea waves, and coastal area development activities in the form of tourist areas and dock and fishery facilities. The coastline data collection for the coastal area of North Galesong District uses a Google image map downloaded with the SAS 21.0.12 2021 tool. The downloaded image is then georeferenced to get exact coordinates and can be processed on a GIS device. Furthermore, the digitization of the coastline is carried out based on actual conditions. In addition, the coastline data for North

Galesong District was obtained from the 2020 Geospatial Information Agency map. The shape of the coastline for the coastal area of North Galesong District can be seen in the following figure:



Figure 2. The shape of the coastline of the coastal area of North Galesong District

The assessment of the shape of the coastline is done visually, by looking at the dominant shape of the coastline. The dominant coastline is straight. The coastline data for North Galesong District is presented in the following table:

Table 5. Form of the North Galesong District Coastline

No.	Village/Subdistrict	Coastline shape
1	Aeng Batu-Batu	Straight
2	Sampulungan	Straight
3	Tamalate	Straight
4	Tamasaju	Straight
5	Bontosunggu	Straight

Source: Results by SAS Satellite Imagery data with GIS, Year 2021

Beach Characteristics

The beach is the area between the lowest tide level and the highest tide level (Perpres 51 of 2016). The beach has a dominant function in supporting and protecting dwellings on land from being hit by sea waves. The characteristics of the beach are generally dynamic and vary according to the constituent structures, both those that are still natural and those that have been changed by human activities (beach building and sand mining).

In this study, data collection on the characteristics of the coast of North Galesong District was carried out by looking at the soil types of the coastal area on the 2020 North Galesong District soil type map. In addition, a survey was carried out directly to the field to see the changing characteristics of the coast due to development developments. The characteristics of the coast of the coastal area of North Galesong District are presented in the following table:

Table 6. Coastal Characteristics of the Coastal Area of North Galesong District

No.	Village/Subdistrict	Beach characteristics
1	Aeng Batu-Batu	sandy and tends to be open
2	Sampulungan	sandy and tends to be open

3	Tamalate	sandy and tends to be open
4	Tamasaju	sandy and tends to be open
5	Bontosunggu	sandy and tends to be open

Source: Field survey and secondary data processing, 2021

Based on the data above, the characteristics of the beach in North Galesong District are dominated by sand which has been partially covered by beach buildings and natural stone structures. In this area, beaches are widely used as docks, settlements, fishing facilities and coastal tourism areas.

Threat Index Parameter Analysis

Wave Height

To receive the threat level of coastal abrasion according to wave height indicators, scoring and weighting of wave height data for each location are carried out based on the analysis table. The resulting scoring as well as the weighting of the hazard height data and the grouping of the wave height parameters of the beach abrasion threat in the coastal area of North Galesong District in the following table below:

Table 7. Analysis of Wave Height Parameters

No.	Village/Subdistrict	Wave Height (m)	Index Score (SI)	Weight (B)	Value (SIxB)	Category
1	Aeng Batu-Batu	1.25 - 2.50	2	0,3	0,6	Currently
2	Sampulungan	1.25 - 2.50	2	0,3	0,6	Currently
3	Tamalate	1.25 - 2.50	2	0,3	0,6	Currently
4	Tamasaju	1.25 - 2.50	2	0,3	0,6	Currently
5	Bontosunggu	1.25 - 2.50	2	0,3	0,6	Currently

Source: Data Analysis Results, 2022

Based on the classification of the wave height assessment, it was found that all villages/kelurahans in North Galesong District are in the moderate category. Wave height is very influential on the threat of coastal abrasion. High waves can cause damage and cause disasters. Based on this, the North Galesong sub-district has the potential to be hit by a coastal abrasion disaster.

Flow Speed

The results of the scoring and weighting of the current speed data are shown in the table below:

Table 8. Analysis of Current Speed Parameters

No.	Village/Subdistrict	Current speed (m/s)	Index Score	Weight	Value	Category
1	Aeng Batu-Batu	1.30	3	0,3	0,9	Tall
2	Sampulungan	1.50	3	0,3	0,9	Tall
3	Tamalate	1.50	3	0,3	0,9	Tall
4	Tamasaju	1.50	3	0,3	0,9	Tall
5	Bontosunggu	1.06	3	0,3	0,9	Tall

Source: Data Analysis Results, 2022

Based on the assessment of the current velocity parameters, the results show that the high category current velocity is found in villages/sub-districts in North Galesong District. The speed of the current can affect the movement of materials along the coast to other places. The speed of a current that is owned in an area, the ability of the seaside material to be carried will also be faster. Based on the scoring results, North Galesong District has a very large potential for abrasion events.

Mangrove Vegetation Density

Scoring and weighting of mangrove vegetation density is presented in the table below.

Table 9. Analysis of mangrove vegetation density parameters

No.	Village/Subdistrict	Mangrove Density	Index Score	Weight	Value	Category
1	Aeng Batu-Batu	0.00	3	0,15	0,45	Tall
2	Sampulungan	0.00	3	0,15	0,45	Tall
3	Tamalate	0.00	3	0,15	0,45	Tall
4	Tamasaju	0.00	3	0,15	0,45	Tall
5	Bontosunggu	0.00	3	0,15	0,45	Tall

Source: Data Analysis Results, 2022

The results of grouping the density parameter values of mangrove vegetation on the coast of North Galesong District, namely that all villages/kelurahan do not have mangroves so that the wave threat category due to the absence of mangrove ecosystems is high.

Shape of the Shoreline

The shape of the coastline based on the results of scoring and weighting in North Galesong District with a threat parameter assessment approach is shown in the following table.

Table 10. Analysis of shoreline shape parameters

No.	Village/Subdistrict	Coastline shape	Index Score	Weight	Value	Category
1	Aeng Batu-Batu	Straight	3	0,15	0,45	Tall
2	Sampulungan	Straight	3	0,15	0,45	Tall
3	Tamalate	Straight	3	0,15	0,45	Tall
4	Tamasaju	Straight	3	0,15	0,45	Tall
5	Bontosunggu	Straight	3	0,15	0,45	Tall

Source: Data Analysis Results, 2022

Based on the results of grouping the parameter values of the shape of the coastline, the result is that all villages/kelurahans in North Galesong District have coastline values in the high category. So that the tendency of the beach to be straight and open has a great potential threat of coastal abrasion.

Beach Characteristics

Coastal characteristics are quite important markers to take into account a coastal area potentially threatened by abrasion. beaches that are rocky or have a hard structure and the presence of coastal vegetation will be difficult to experience abrasion. The coastal characteristics of North Galesong District based on the results of scoring and weighting can be seen in the following table:

Table 11. Analysis of Coastal Characteristics Parameters

No.	Village/Subdistrict	Beach Characteristics	Index Score	Weight	Value	Category
1	Aeng Batu-Batu	sandy and tends to be open	3	0,1	0,3	Tall
2	Sampulungan	sandy and tends to be open	3	0,1	0,3	Tall
3	Tamalate	sandy and tends to be open	3	0,1	0,3	Tall
4	Tamasaju	sandy and tends to be open	3	0,1	0,3	Tall
5	Bontosunggu	sandy and tends to be open	3	0,1	0,3	Tall

Source: Data Analysis Results, 2022

The coast which is dominated by sand and is generally open and also directly affected by wave height without a barrier will have the potential for beach abrasion. according to the results of the assessment, all villages/kelurahan in North Galesong District have great potential for coastal abrasion.

Threat Level Assessment

The calculation of the level of threat of abrasion is done by adding the scoring results and the weighting of each parameter. Additions are made to obtain the total threat index value. The total value of the threat index will be used to decide the level of threat for each village/kelurahan location. The beach abrasion threat parameters based on the sum of the scoring and weighting analyzes are shown in the table below:

Table 12. Total Value of Disaster Threats

No.	Village/Subdistrict	H ₁	H ₂	H ₃	H ₄	H ₅	H _{Total}
1	Aeng Batu-Batu	0,6	0,9	0,45	0,45	0,3	2.7
2	Sampulungan	0,6	0,9	0,45	0,45	0,3	2.7
3	Tamalate	0,6	0,9	0,45	0,45	0,3	2.7
4	Tamasaju	0,6	0,9	0,45	0,45	0,3	2.7
5	Bontosunggu	0,6	0,9	0,45	0,45	0,3	2.7

Source: Data Analysis Results, 2022

The threat level of coastal abrasion at each research location is obtained by classifying the total value of the disaster threat. The total disaster threat value obtained from the results of the analysis can be concluded and generalized as the coastal abrasion disaster threat value owned by each village/kelurahan. The classification of the total value of the threat of coastal abrasion in the coastal area of North Galesong District is presented in the following table:

Table 13. Level of threat of abrasion disaster

No.	Village/Subdistrict	Threat Value (H _{Total})	Category
1	Aeng Batu-Batu	2.7	Tall
2	Sampulungan	2.7	Tall
3	Tamalate	2.7	Tall
4	Tamasaju	2.7	Tall
5	Bontosunggu	2.7	Tall

Source: Data Analysis Results, 2022

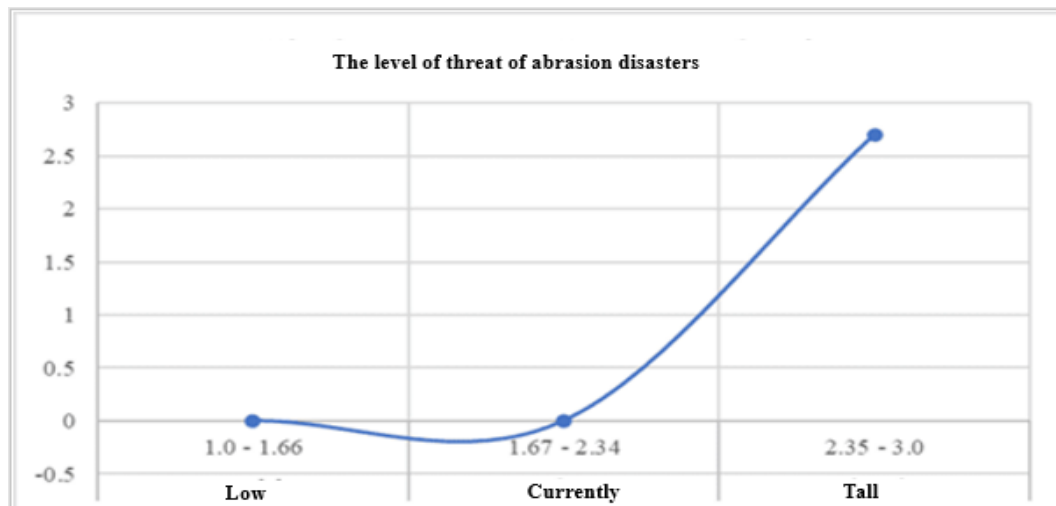


Figure 3. Abrasion Disaster Threat Level

From the results of the parameter classification of the threat level of beach abrasion in the coastal areas of North Galesong District, it was found that the level of disaster threat that has a high category is found in all villages/kelurahans in North Galesong District. The category of disaster threat level is given a color symbol which is displayed in the form of a map. The threat of coastal abrasion can be seen on the map as follows:

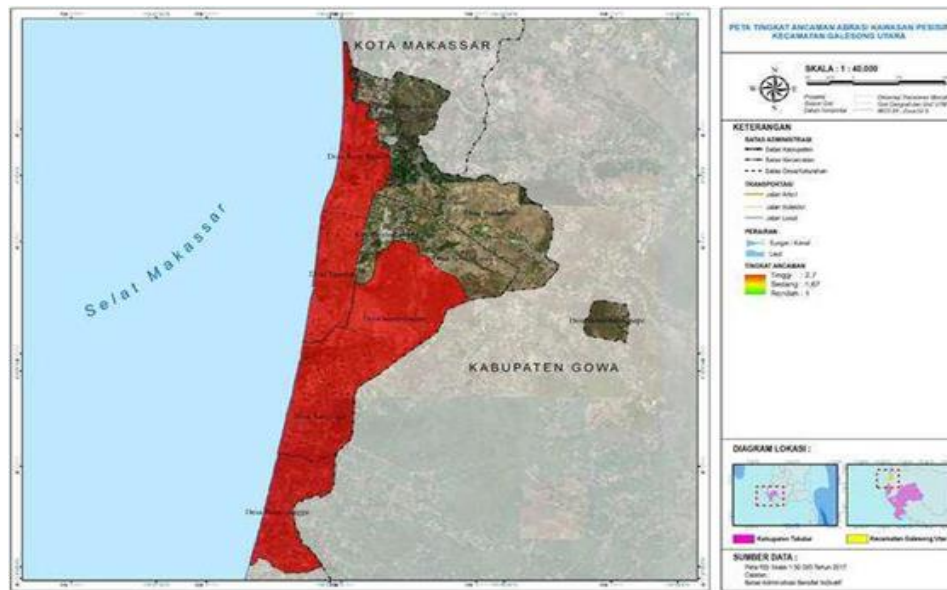


Figure 4. Map of the threat level of the coastal area of North Galesong District

CONCLUSION

From the results of the parameter classification, the threat level of beach abrasion in the coastal area of North Galesong District has a high category in all coastal village areas. The high category level is a high potential threat of coastal abrasion to the occurrence of casualties and material losses on the coast of North Galesong District. Activities to reduce the threat of disasters can be carried out through the development of structural and non-structural mitigation to reduce the impact of disasters, namely by strengthening coastal protection structures at strategic locations. Structural mitigation activities can be carried out in areas that have not been touched by mitigation efforts but have experienced disaster impacts. Aeng Batu-Batu Village, Sampulungan Village and Tamasaju Village are among the areas that have been affected by the most severe abrasion, need to build structural mitigation to maintain coastal stability in the form of longshore sedimentation retaining buildings (groins), abrasion dampers (bank revetment) and wave breakwaters to reduce the rate of beach abrasion that occurs. In addition to structural buildings, abrasion impact mitigation can also be carried out by planting vegetation that is suitable for the characteristics of sandy beaches.

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