



COASTAL ABRASION VULNERABILITY IN SUB-DISTRICT BUNGUS TELUK KABUNG KOTA PADANG

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ABSTRACT: This study aims to analyze the level of coastal abrasion vulnerability in sub-district Bungus Teluk Kabung of Padang City. This type of research is mixed method. The type of data is primary data and secondary data. The primary data obtained from research questionnaires and field observations using interview guidelines while the secondary data consists of identification of critical beaches in West Sumatra, Disaster Event Data, Reports on coastal abrasion disasters, Statistics of sub-district Bungus Teluk Kabung, The technique of analyzing the level of vulnerability of coastal abrasion disaster uses secondary data analysis from the map of coastal abrasion disaster vulnerability from BNPB which refers to the General Guidelines for Disaster Risk Assessment, PERKA BNPB No. 2 of 2012. The vulnerability index scale is divided into 3 categories: low, moderate, high. The results showed that the level of coastal abrasion vulnerability in sub-district Bungus Teluk Kabung was classified into the low category with a vulnerability score of 0.0-0.25, moderate with a vulnerability score of 0.25-0.54 and high which scores between 0.54 - 0.75. Physical vulnerability in all of villages of sub-district Bungus Teluk Kabung is come under low category. Social vulnerability is low and moderate. Environmental vulnerability in the moderate category and economic vulnerability in the high category

Keywords: Tingkat Kerentanan, Abrasi Pantai

1. INTRODUCTION

West Sumatra Province on the coast is bordered by the Indonesian Ocean. Meetings land with open sea makes beaches in West Sumatra, include on the cycle of movement of the sea water. The movement of sea water will pose a threat to the beaches directly facing the Indonesian Ocean. The development of residential areas/settlement development in coastal areas in the past poses a great risk to all threats arising from the sea.

This threat at the present time has become a major problem along the coast in Padang such as the occurrence of abrasion visible severe enough to threaten the cliff where the road located above it. This situation is exacerbated by the use of land space which is technically and environmentally in a place that is not feasible and is not in accordance with the detailed spatial plan (Padang Water Resources Management Office, 2014). Coastal abrasion events have occurred since October 2008 in Sub-District Air Manis, District Padang Selatan, here the impact of this incident has damaged residents homes, along 1 km of shoreline abraded. Based on the data, there are 4 beaches estimated to be in critical condition in Padang namely, Pasir Jambak beach, Padang Beach, Air Manis Beach, Bungus Beach (West Sumatra Province Water Resources Management Office, 2014).

One of the beaches that is estimated to be in critical condition in Padang City is the Bungus beach in sub-district Bungus Teluk Kabung. Sub-district Bungus Teluk Kabung has a coastline length of 21,050 meters and a surface area of 1,383.86 ha which has a surface shape that tends to be rounded. Located at an average height of about 0-5 m above sea level for coastal areas, and <85 m for hilly areas. Air temperature ranges between 21.6 ° C - 31.8 ° C and rainfall 302.35 mm / month (City of Padang Central Bureau of Statistic, 2016). Coastal areas are dynamic, meaning that the spatial shape and location change rapidly in reaction to natural processes and human activities. One form of natural process that causes changes in coastal areas is beach abrasion.

The problem of coastal abrasion in the sub-district Bungus Teluk Kabung has experienced severe erosion. According to information from residents around the coast, the coastline experienced a 20 meter decline. This condition can be seen from the facilities and infrastructure along the wave-hit coast. The storm that accompanied the huge waves is threatening the safety of people who live on the coast. Formerly the coastline was far from community settlements, now it is getting closer to coastal communities.



This is influenced by the pattern of currents and waves of the Indonesian Ocean which is so strong that it has eroded land gradually, also accompanied by land use activities for residential development without heeding the policy of coastal protection areas that at a distance of 100 m from the coastline is a coastline area, which should not be utilized. And the policy issued by the Department of Public Works on Guidelines for Utilizing Coastal Spaces in Urban Areas (2009), also states that housing areas specified in Spatial Planning and Territory of City of Padang (RTRW) are not allow to located in disaster prone areas (landslides, floods, erosion and abrasion).

Communities living along the coast are the first party and are important actors directly dealing with the coastal abrasion disaster. The level of public knowledge about coastal erosion disaster is still relatively moderate to low. Some efforts of the community in the prevention of coastal erosion have been observed. The community takes control by installing sand using sacks. The public expects government assistance to come quickly with the construction of the crib stone (Strategic Environmental Assessment, 2010).

Communities who live around the coast have a big role to overcome the problem of coastal abrasion. The community participates in the process of development planning, planning of policy formation, monitoring of the development. And enforceability of a policy is one thing that drives the success of an effective and efficient development, resulting in good cooperation between the government and the community in addressing the impacts of coastal erosion. Judging from the physical vulnerability and social vulnerability of the people affected by coastal abrasion, it is very important to consider delivering the policy that fully understands by these communities.

2. RESEARCH METHODS

This research is combining qualitative and quantitative models. The type of data is primary data and secondary data. Primary data were obtained from research questionnaires and field observations using interview guidelines. Interview guidelines are prepared using a questionnaire (list of questions) that has been prepared in advance.

Whereas secondary data consists of identification of critical beaches in West Sumatra, Data on Disaster Events, Reports on coastal abrasion disasters, Statistics of Teluk Kabung, Level of Coastal Abrasion Disaster vulnerability, Administrative maps, land use and disaster prone of Teluk Kabung. Technique of analyzing the level of vulnerability of coastal abrasion disasters by using secondary data analysis from the map of coastal abrasion disaster vulnerability from National Disaster Management Agency (BNPB) which refers to the General Guidelines for Disaster Risk Assessment, PERKA BNPB No. 2 of 2012.

The vulnerability index scale is divided into 3 categories: low, moderate, high, with each index value as follows:

Table 1. Scale of Coastal Abrasion Vulnerability

Num	Score	Level of Vulnerability
1	0,0-0,3	Low
2	>0,3- 0,6	Moderate
3	> 0,6-1,0	High

Sumber: Perka BNPB No 2, 2012

3. RESULT AND DISCUSSION

3.1 Level of Coastal Abrasion Vulnerability in Sub-District Bungus Teluk Kabung

Sub-district Bungus Teluk Kabung is a coastal area that has 1 *Kelurahan* (urban village) in the hills and 5 *Kelurahan* located along the coast that is vulnerable to natural disasters from the sea. Vulnerability is a condition that is determined by physical, social, economic and environmental factors or processes that cause a decline in ability to deal with hazards (IRBI, 2013).

The level of vulnerability of coastal abrasion disaster can be obtained from secondary data from the map of coastal abrasion disaster vulnerability from BNPB which refers to the General Guidelines for Disaster Risk Assessment, PERKA BNPB No. 2 of 2012. The level of vulnerability of coastal abrasion disasters in



Sub-district Bungus Teluk Kabung is measured by 4 variables namely physical vulnerability with indicators namely home scores, public facility scores and critical facilities. Social vulnerability with a score indicator of

population density, sex ratio, poverty ratio, the ratio of people with disabilities and the ratio of age groups. Economic vulnerability includes indicators of productive land scores and GRDP scores. Environmental vulnerability includes three indicators of protected forest, mangrove forest and bush.

All calculations and data processing results obtained using secondary data analysis conducted by National Disaster Management Agency (BNPB) using variable guidelines and indicators that refer to Perka BNPB No. 2 of 2012. Results from secondary data analysis of the level of vulnerability are explained further in the paragraph below.

Based on the results of the analysis of the level of coastal abrasion vulnerability in the Sub-district Bungus Teluk Kabung belong to the categories of low, moderate and high. Regions classified as low vulnerability with vulnerability index score of 0.0-0.25, namely 5.97% territory of *Kelurahan* Bungus Barat, 7% territory of Teluk Kabung Tengah and 11.53% territory of Teluk Kabung Selatan. For regions classified as moderate vulnerability with a vulnerability index score of 0.25-0.54 are 1.9% territory of Bungus Barat, 9.09% territory of Bungus Selatan, 4.30% territory of Teluk Kabung Utara, and 3.79% territory of Teluk Kabung Tengah then 2.93% territory of *Kelurahan* Teluk Kabung Selatan. For areas categorized as high vulnerability with a vulnerability index score of 0.54 - 0.75 are 1.58% area of Bungus Barat, 3.02% area of Bungus Selatan, 0.4% area of Teluk Kabung Utara, 1.51% area of Teluk Kabung Tengah and 0.57% area of Teluk Kabung Selatan. For more details, the level of disaster vulnerability can be seen in **Figure 1** below.

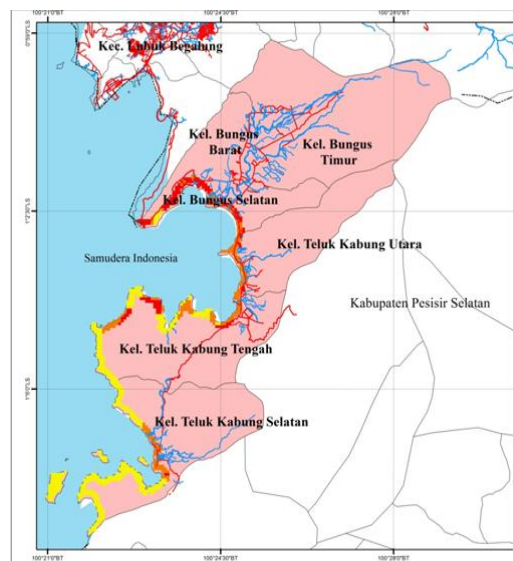


Figure 1. Area of Coastal Abrasion Vulnerability
Source: Secondary Data Analysis, 2018

The map above shows that the vulnerability of coastal abrasion varies in a low, moderate and high vulnerability index. Furthermore, the percentage of vulnerability from each *kelurahan* (urban village) can be seen in **Table 1** below:

Table 1. Percentage of Vulnerability in Kelurahan Bungus Barat

Num	Category	Vulnerability area (km ²)	Total area (km ²)	Percentage
1	Low	0,49	8,2	5,97 %
2	Moderate	0,16		1,95%
3	High	0,13		1,58%

Source: Secondary Data Analysis, 2018



Based on secondary data analysis above, the Bungus Barat Village with a total area of 8.2 km², has 3 level categories of vulnerability of coastal abrasion. The low level of vulnerability includes an area of 0.49 km² or

5.97%. Then the level of vulnerability is moderate with an area of 0.16 km² or 1.95%. The level of vulnerability of high category includes area of 0.13 km² or 1.58%. For *Kelurahan* Bungus Barat the vulnerability level that has the highest score index is the low category of 5.97%.

Furthermore the percentage of vulnerability level in *Kelurahan* Bungus Selatan can be seen in **Table 2** below:

Table 2. Percentage of Vulnerability in Kelurahan Bungus Selatan

Num	Category	Vulnerability area (km ²)	Total area (km ²)	Percentage
1	Low	0	4,4	0 %
2	Moderate	0,40		9,09 %
3	High	0,13		3,02 %

Source: Secondary Data Analysis, 2018

Based on the analysis of secondary data above the level of vulnerability of coastal abrasion in *Kelurahan* Bungus Selatan has 2 categories of vulnerability namely moderate and high. Of the total area of 4.4 km², the category of moderate vulnerability is 0.40 km² or 9.09%. High vulnerability category located on area of 0.13 km² or 3.02% of the total area of this village.

The percentage of vulnerability level in *Kelurahan* Teluk Kabung Utara can be seen in **Table 3** below:

Table 3. Percentage of Vulnerability in Kelurahan Teluk Kabung Utara

Num	Category	Vulnerability area (km ²)	Total area (km ²)	Percentage
1	Low	0	11,14	0 %
2	Moderate	0,48		4,30 %
3	High	0,04		0,40%

Source: Secondary Data Analysis, 2018

Based on secondary data analysis above the level of vulnerability of coastal abrasion in the *Kelurahan* Teluk Kabung Utara is the same as *Kelurahan* Bungus Selatan which has 2 categories of vulnerability, moderate and high with a total area of 11.14 km². Moderate vulnerability category includes in an area of 0.48 km² with a percentage of 4.30% of all area. Then the high vulnerability category has an area of 0.04 km² with a percentage of 0.4%.

The percentage of vulnerability level in *Kelurahan* Teluk Kabung Tengah can be seen in **Table 4** below:

Table 4. Percentage of Vulnerability in Kelurahan Teluk Kabung Tengah

Num	Category	Vulnerability area (km ²)	Total area (km ²)	Percentage
1	Low	1,17	16,8	7 %
2	Moderate	0,64		3,79 %
3	High	0,25		1,51 %

Source: Secondary Data Analysis, 2018

Table above shows that the level of vulnerability of coastal abrasion in *Kelurahan* Teluk Kabung Tengah has 3 categories of vulnerability, i.e. low, moderate and high. This village has total area of 16.8 km². Low vulnerability category found on an area 1.17 km² equivalent to 7% of the total area of this village. While the category of moderate vulnerability found in area of 0.64 km² equivalent to 3.79% of the total area. For the category of high vulnerability includes in an area of 0.25 km or 1.51% of the total area.

The percentage of vulnerability level in *Kelurahan* Teluk Kabung Selatan can be seen in **Table 5** below:

Table 5. Percentage of Vulnerability in Kelurahan Teluk Kabung Selatan

Num	Category	Vulnerability	Total area	Percentage
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		area (km ²)	(km ²)	
1	Low	1,99	17,4	11,43 %
2	Moderate	0,51		2,93%
3	High	0,1		0,57%

Source: Secondary Data Analysis, 2018

Table 5 shows that the level of vulnerability of coastal abrasion in the Teluk Kabung Selatan Village has 3 categories of vulnerability, namely low, moderate and high with a total area of 17.4 km². Low vulnerability category includes in area of 1.99 km² equivalent to 7% of the total area of the village 11.43%. Moderate vulnerability category includes in area of 0.51 km² with a percentage of 2.93%. While the high vulnerability category is 0.1 km² or 0.57% of the total area of this village.

3.2 Discussion

The results of secondary data analysis from BNPB show that physical vulnerability in all *kelurahan* in Sub-district Bungus Teluk Kabung is included in the low category. Physical vulnerability is also shown by the isolation of the region affecting the livelihoods of the people. Potential areas of natural disasters - not only the threat of earthquakes with potential tsunamis, but also tidal floods, extreme waves, and coastal abrasion - are exacerbated by housing structures that are not fully abrasion resistant. The number of houses in Sub-district Bungus Teluk Kabung included in the coastal abrasion susceptibility zone varies from 0 – 366 unit,

Kelurahan Bungus Barat with a low category of coastal abrasion vulnerability has 4 houses, moderate category has 14 houses and high category has 120 houses included in the zone disaster vulnerability for coastal abrasion. In *Kelurahan* Bungus Selatan with a low level of beach abrasion vulnerability there is no house standing there. However, in the moderate category of coastal abrasion vulnerability there are 352 numbers of houses and the high category of beach abrasion vulnerability there are 78 houses standing. Teluk Kabung Utara does not have houses that are in area the category of low abrasion vulnerability. The number of houses that stand in the moderate category of coastal abrasion vulnerability is 366 houses. The number of houses that stand in high abrasion vulnerability is 85 houses (Secondary Data Analysis, Beach Abrasion Vulnerability Level from BNPB, 2017).

Social vulnerability is shown by the low level of education of the population and the level of community satisfaction of basic infrastructure (educational facilities and clean water are still lacking). The indicator of social vulnerability is the ratio of productive age groups where the more productive age population in an area, the lower the level of social vulnerability to disasters. This is caused by the productive age having the ability to save themselves better than the non productive age. Likewise with the sex ratio, the more male sex the lower the level of social vulnerability and vice versa. Population density also influences the level of an area's social vulnerability to disaster, a densely populated population the higher the level of social vulnerability. Similarly, the ratio of people with disabilities. (Antomi, 2016). Secondary data analysis results show that the level of social vulnerability Sub-district Bungus Teluk Kabung has 2 categories of social vulnerability, low and moderate.

Economic vulnerability is shown by the magnitude of the impact of the lack of development facilities and infrastructure on people's lives. To determine economic vulnerability by looking at productive land scores and GRDP scores in areas affected by coastal abrasion. Based on secondary data analysis, it can be concluded that The Bungus Barat Village has productive land, namely food crops, with a low vulnerability category of 0%, moderate 0.6% and high 5.5%. *Kelurahan* Bungus Selatan has productive land, i.e. food crops and horticultural crops, with a low vulnerability category of 0%, moderate 17.2% for food crops and high 100% for horticultural crops. Teluk Kabung Utara has productive land, i.e. horticulture, with a low vulnerability category of 0%, moderate of 0.4% and high of 3.5%. Teluk Kabung Tengah has productive land, i.e. horticultural crops with a low vulnerability category of 1.5%, moderate at 3.2% and high at 2%. *Kelurahan* Teluk Kabung Selatan has productive land, namely horticultural crops with low vulnerability category of 0%, moderate of 14.3% and high of 1.7% (Secondary Data Analysis, Level of Coastal Abrasion susceptibility from BNPB, 2017).



Environmental vulnerability in *Kelurahan* Bungus Barat is included in the moderate category. Bungus Selatan and Teluk Kabung Utara have a low vulnerability index, *Kelurahan* Teluk Kabung Tengah and Teluk Kabung Selatan have a high vulnerability index. Environmental vulnerability is demonstrated by the geomorphology of the built up area which is characterized by sandy soil, causing very few people to have latrine facilities in their homes. In terms of community sanitation system, the location of the beach is still often used as a place to defecate residents and littering. The decline in natural resources shown by the limited water resources to irrigate rice fields and decreasing of fish catches. The environments vulnerability also can be evaluated from the scores of protected forests, natural forests of mangroves and shrubs (Secondary Data Analysis, Level of Coastal Abrasion vulnerability from BNPB, 2017).

Based on research findings and field surveys, areas that have a high level of vulnerability to abrasion are caused by several factors such as:

1. *Coastal distance to settlement*. The effect of this variable for abrasion vulnerability is that if the settlement of the population is getting closer to the coast, the level of vulnerability of the settlement to abrasion will be higher. The coastal border area serves to prevent the occurrence of coastal abrasion and protect the coast from activities that can disrupt or damage the function and preservation of the coastal area. Coastal border areas are only allowed for plants that function as coastal protectors and protectors, also public facilities in this area can be built and used as long as do not change the function of land as a safeguard and preservation of the beach.
2. *Slope factor*. The slope factor of an area is closely related to the rate of abrasion because the lower the slope the higher the abrasion, because it is easily hit by the waves of the sea. Further the effect of the slope on the abrasion is that if the settlement is on the sloping land, it will increase the vulnerability of the population to abrasion. The slope of the high-vulnerability is declivous (5-8%).
3. *Rock types*. When the rock type is getting smoother then the level of vulnerability of settlements to abrasion is higher. Because the sand is not able to hold the foundation of the house strongly. According to Delgazzo (2015) minerals and rocks are elements that have very different definitions. Rocks can be divided into three i.e. a). *Igneous rocks* are characterized by a smooth, flat texture and there are fossils in rocks, b). *Sedimentary rocks* are characterized by fine to coarse, layered textures and there are fossils of rocks, c) *Metamorphic rocks* are deposited by volcanoes. Metamorph and sedimentary rocks sizing sand which is mixture of gravel, sand and clay are generally less strong. Those rocks will easily become soil if it experiences weathering and is generally vulnerable to coastal abrasion.
4. *Type of beach areas*. Sub-district Bungus Teluk Kabung is dominated by sandy beaches. Therefore it will be more susceptible to coastal abrasion due to sand particles that will erode toward the sea so that it is separated from the land. In the long run this will makes the land affected by sea waves eroded. This type of beach is less vulnerable compare to rocky steep beaches, because on the rocky coast there is a higher erosion process. On the other hand mud beaches have the lowest level abrasion rates because usually on the mud coast there are mangrove plants as a barrier to sea waves (Triadmodjo, 1999).
5. *Type of residential building*. The condition of residential buildings in this study area is semi permanent and permanent. The condition of semi-permanent residential buildings is more susceptible to coastal abrasion because semi-permanent buildings cannot withstand the waves and sea winds

4. CONCLUSION

The level of vulnerability of coastal abrasion in the Sub-district Bungus Teluk Kabung falls into the low, moderate and high categories. Regions classified as low vulnerability with a vulnerability index score of 0.0-0.25 are 5.97% area of *Kelurahan* Bungus Barat, 7% area of Teluk Kabung Tengah and 11.53% area of Teluk Kabung Selatan. For regions classified as moderate with a vulnerability index score of 0.25-0.54 which is 1.9% area of *Kelurahan* Bungus Barat, 9.09% of Bungus Selatan territory, 4.30% area of Teluk Kabung Utara, and 3.79% area of *Kelurahan* Teluk Kabung Tengah also part *Kelurahan* of Teluk Kabung Selatan as much as 2.93%. For areas categorized as high vulnerability with a vulnerability index score of 0.54 - 0.75, 1.58% area of *Kelurahan* Bungus Barat, 3.02% area of *Kelurahan* Bungus Selatan, 0.4% area of *Kelurahan* Teluk Kabung Utara, 1.51% area of Teluk Kabung Tengah and some part of Teluk Kabung Selatan as much as 0.57%..

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