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Research Paper

Identification of Coastal Damage Along the Coast of Riau

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ABSTRAK

Riau Province has a broad coastline along its territory and it directly meeet the Malacca Strait. Costal, marine and island areas in Riau Province are currently of serious concern due to problems such as the reduction and addition of coastline (abrasion, erosion and sedimentation). This research aims to examine the extent of coastal damage that has occurred so far in reducing abrasion and priorit determination to the beach to be handled based on the level of coastal damage associated with the level of coastal importance. The areas that have the highest level of weighting (priority level A and B) are coastal areas in Bengkalis Regency (Api-api Beach, Tanjung Leban Beach, Muntai Beach and Senekip Beach), Dumai City (Purnama Beach and Bahtera Alam Beach) adn Indragiri Hilir Regency (Kuala Enok Beach). Meanwhile in Meranti Regency all the beaches reviewed have a high weighting value.

1. Introduction

Riau's coastal area is very large and strategic, with a coastline that reaches 2,468 kilometers in 6 districts from 12 districts / cities in Riau. Coastal, marine and island areas in Riau Province are currently a serious concern of the Riau Provincial Government. The problem of abrasion that occurs on the islands that enter the area of Bengkalis Regency and Meranti Islands has been very concerning. If there is no immediate effort to accelerate recovery, the coastline will continue to erode and have an impact on the lives of coastal communities in Riau Province.

Shoreline changes are natural events that occur continuously. Changes in the coastline can be the reduction of the coastline (abrasion) and the addition of coastal area (sedimentation). The size of the beach abrasion is in line with the size of the waves crashing onto the beach. Large waves can be waves that have a large height and speed. As a result, the water rotates again and has less time to soak into the sand, when the next wave comes, a lot of water will collect and then carry the sand material out to sea.

The coastline on Bengkalis Island, Rupat and Rangsang experienced more than 1 kilometer of abrasion. The cause of this abrasion, in addition to the impact of sea waves and minimal defense of mangrove forests, the rate of abrasion is also due to land conversion into oil

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palm plantations. The condition of Bengkalis Island, originally covered in mangroves, peat swamp forests and marine plants that turned into palm oil field. Various efforts have been made by riau coastal communities, for example the people in Bantan Bengkalis sub-district do mangrove planting and making simple breakwater from self-help communities themselves. The breakwater built north of Bengkalis before 2016 has not been fully effective in holding back the rate of abrasion along the coast. Abrasion rate at Bengkalis beach is 6 to 10 meters per year (Suryadi, 2019).

The construction of safety buildings and coastal protection against abrasion can basically be divided into two groups. The first group is a natural protection group, such as a coral group that will break down and reduce the energy of waves coming to the beach, the appearance of mangroves and dunes (sand dunes). The second group is an artificial beach safety and protection building by erecting beach protective buildings such as groin buildings, beach revetment/embankment, and breakwater.

Based on the problems that exist along the riau coastal area and the lack of research on building construction and coastal protection in riau coastal area, it is necessary to conduct in-depth research on the analysis of building construction and coastal protection as a step in disaster mitigation to reduce the risk through both physical and awareness and increased ability to deal with disaster threats.

2. Objectives and Benefits

The purpose of this study is to analyze the level of damage that occurs in coastal areas that will be associated with the level of coastal importance and determining the building of safety and protection of the beach in restraining abrasion in coastal areas in Riau Province.

3. Theoretical Basis

3.1 Beaches and Coastal Areas

According to Triatmodjo (1999), the coast is the boundary line between land and sea measured at the highest and lowest tide, influenced by marine physics and maritime socio-economy, while landward is limited by natural processes and human activities in the terrestrial environment.

Generally, the coast can be divided into 2, namely coasts and shore. The beach is a geographical form consisting of sand and is found in coastal areas. The coastal area becomes the boundary between land and sea waters. The length of this coastline is measured around the entire coast which is the territorial area of a country. The coastal area is a region that is very dynamic towards change, as is Peru's coastline material. The change of coastline is a relentless process through various natural processes on the coast which include sediment movement, longshore current, wave action and land use (Arief, Winarso, & Prayogo, 2011).

3.2 Beach Damage

Problems that occur in coastal areas in their utilization often experience damage or changes in the quality of the physical environment. Nature also provides muddy beaches with coastal plants such as mangrove trees, api-api trees or nyppa palm as beach protectors. These coastal plants will break the wave energy and spur coastal growth. The slow movement of water among the roots of the tree can support the deposition process and is a good place for the proliferation of marine life, such as fish and other marine life.

The beach is said to be damaged in the event of changes both physical and environmental that could harm lives and economic activities. Some of the damage to the beach includes coastal erosion, sedimentation of the river estuary, loss of natural protectors of the beach (such as sand dunes, mangroves and coral reefs and the death of marine parks). In general, the causes of coastal damage are a combination of the above factors. In order for the treatment of coastal abrasion problems to be done properly, the cause must be identified in advance in general, the force that causes the damage to the beach is waves and current waves.

The damage to beaches in coastal areas in some places is very concerning. These damages are indicated to be the impact of buildings jutting out to sea, loss of coastal protection, and the effects of global warming. These factors affect changes in sediment transport and abrasion in one place and accretion on the other (Hartati, 2016).

3.3 Assessment of Beach Damage Rate

The level of damage is divided into 5 levels which are light, medium heavy, very heavy and very very heavy which is assessed from the conditions in the field. The extent of damage is described to be as follows:

1. Erosi/gerusan

Coastline changes

a. Lightweight : <0,5 m/year
b. Medium : 0,5 – 2,0 m/year

c. Heavy : 2,0 - 5,0 m/year
d. Very heavy : 5,0 – 10,0 m/year
e. Very very heavy : > 10 m/year

Scour at the foot of the building
a. Lightweight : does not harm construction
b. Medium : not so andgerous against the construction
c. Heavy : somewhat harmful the stability of construction
d. Very heavy : compromising stability of the buildings
e. Very very heavy : compromising stability of the buildings and Other buildings nearby

Areas that affected by erosion and itsinfluence on other regions.
a. Lightweight : local (5 – 10 m)
b. Medium : local and surroundings (10 – 100 m)
c. Heavy : a rather large area (100 – 500 m)
d. Very heavy : a fairly large area (500 – 2000 m)
e. Very very heavy : very large area (> 2000 m)

2. Abrassion

Abrasion in rocks
a. Lightweight : does not harm the environment
b. Medium : not so andgerous to the environment
c. Heavy : somewhat jeopardizes the stability of the environment
d. Very heavy : enandger environmental stability
e. Very very heavy : enandger the stability of the environment and other buildings near the coast

abrasion on the sea wall/beach protector
a. Lightweight : does not harm the construction
b. Medium : not so andgerous to construction
c. Heavy : somewhat jeopardize the stability of the construction
d. Very heavy : jeopardize construction stability
e. Very very heavy : enandger the stability of the building and other buildings around it

Areas that affected by abrasion and the effect on the surroundings
a. Lightweight : local
b. Medium : local and surrounding
c. Heavy : a rather large area
d. Very heavy : quite large area
e. Very very heavy : very large area

3. Silting of estuaries and sedimentation

The length of time the estuary is closed
a. Lightweight : 0 – 1 month
b. Medium : 1 – 2 month
c. Heavy : 2 – 3 month
d. Very heavy : 3 – 6 month
e. Very very heavy : > 6 month

Percentage of estuary opening to estuary width
a. Lightweight : > 90%
b. Medium : 70 – 90 %
c. Heavy : 50 – 70 %
d. Very heavy : 40 – 50 %
e. Very very heavy : < 30 %

Areas affected by sedimentation and its effects
a. Lightweight : local
b. Medium : local and surrounding (1 –2 km^2)
c. Heavy : a rather large area (2 – 3 km^2)
d. Very heavy : quite large area (3 – 5 km^2)
e. Very very heavy : very large area (>5 km^2)

4. Environmental damage

Settlements
a. Lightweight : several houses (1 to 5 houses) are on the coastline and are not reached by the waves
b. Medium : 5 to 10 houses are on the coastline and are not reached by the waves
c. Heavy : 5 to 10 houses are on the border of the beach and reached by the waves
d. Very heavy : 10 - 15 houses are on the coast and reached by the waves
e. Very very heavy : densely populated settlements (> 15 houses) are on the coast and are reached by the waves

Sea water quality
a. Lightweight : contamination is below the

threshold

b. Medium : pollution is around the threshold, the polluted area is 1 to 2 km^2

c. Heavy : pollution is at a level of 50 to 100% above the threshold in an area of 1 to 2 km^2, or pollution at a level around the threshold in a fairly large area (> 2 km^2)

d. Very heavy : pollution is at a level of 100 to 200% above the threshold in an area of 1 to 2 km^2, or pollution is low but reaches a very large area

e. Very very heavy : pollution is at a level of more than 200% above the threshold in a fairly large area (> 2 km^2)

Coral reefs

a. Lightweight : minor and local damage

b. Medium : minor damage to an area of 1 to 2 km^2

c. Heavy : moderate damage to an area of 1 to 2 km^2

d. Very heavy : moderate damage to an area of 2 to 3 km2 or serious damage to an area of 1 to 2 km^2

e. Very very heavy : moderate to severe damage over a large area (> 2 km^2)

Mangrove forest

a. Lightweight : minor and local damage

b. Medium : minor damage to an area of 1 to 2 km2

c. Heavy : moderate damage to an area of 1 to 2 km^2 and combined with erosion

d. Very heavy : moderate damage to an area of 2 to 3 km2 or serious damage to an area of 1 to 2 km^2 and combined with erosion

e. Very very heavy : moderate to severe damage over a large area (> 2 km^2) and combined with erosion

Problematic buildings

a. Lightweight : the building is on the coastline (an area used for beach protection and preservation, which is approximately 100 m wide from the coastline at full moon tide), but does not cause damage.

b. Medium : the building is on the beach border and disturb the openness of the beach to the public

c. Heavy : the building is on the beach border causing the beach to be closed to the public

d. Very heavy : the building is on the beach border or coastal waters and causing environmental damage (erosion, landslides and so on)

e. Very very heavy : the building is on the beach border or coastal waters and causing serious environmental damage

3.4 Weight of Damage Level and Importance Level

Determining the priority order for the protection of damage to coastal areas, it is necessary to weigh the types of damage that occur. So that we need a weighting for the assessment of damage and interests carried out by the Research by Puslitbang Pengairan (1992) (Table 3.1 and 3.2).

Table 3. 1 Damage Rate Weight

No	Damage Level	Types of Damage		
		Erosion /Abrasion	Sedimen-tation	Environ-ment
1	R (Lightweight)	50	25	50
2	S (Medium)	100	50	100
3	B (Heavy)	150	75	150
4	AB (Very heavy)	200	100	200
5	ASB (Very very heavy)	250	125	250

Source : Nur Yuwono, 1998

Table 3. 2 Weight of Importance

No	Level of Importance	Weights
1	Fishing settlements, businesses, places of worship, large industries, cultural reserves, tourist areas that bring in state foreign exchange, country roads, urban areas, etc.	175-250
2	Villages, Provincial roads, sea/river ports, airports, medium/small	125-175

	industries.	
3	Traditional farmland and/or ponds	100-125
4	Domestic tourist attractions, ponds and intensive farmland	75-100
5	Protected forests, mangroves,avicennia	50-75
6	Material sources, dunes and vacant land	00-50

Source : Nur Yuwono, 1998

Based on Nur Yuwono (1998), the results of field data analysis and proposed priority weights, then proposed priorities as follows:

1. Above 500 : Very highly prioritized (A)
2. Between 400 sd 499 : highly prioritized (B)
3. Between 300 sd 399 : preferably (C)
4. Between 200 sd 299 : less prioritized (D)
5. Less than 200 : not prioritized (E)

4. Research Methodology

The preparation of this study through literature review and field observations. A literature review was carried out on the design of the construction of coastal protection and safety structures that are possible to build in the coastal areas of Riau and to obtain information about materials or materials that can be used to construct coastal protection and safety structures. Field observations were made to determine the characteristics of the location to be built for the safety and protection of the coast and the availability of materials according to the recommended design.

4.1 Preparation Stages

It is a series of activities before starting data collection and processing in the form of preparation of field survey tools, determining data needs, listing data on agencies that will be resource persons, and surveying locations to get an overview of conditions in the field.

4.2 Data Collection

To support the study of the construction of Riau's coastal protection structures, direct observations of the coastline using drones were carried out and also secondary data such as aerial or satellite photo maps, wind data, tidal data, waves, bathimetry and soil survey data.

4.3 Alternative Studies of Beach Protection Buildings

In the determination of the chosen alternative is done by using the points and rank system. The number of scoring points is on average based on the number of studies assessed so that it will later get the highest point rating. From alternative safety buildings and beach protection mentioned will be assessed based on several assessment criteria, namely:

1. Reduction of coastal areas
   a. Reduction of sandy or soft coastal areas is called erosion
   b. Reduction of rocky areas/building is called abrasion
2. Sedimentation and estuary suoerficiality
3. Damage to the coastal environment

4.4 Data Analysis

Analysis of primary data obtained using a drone is displayed in the form of an image of the coastline of the Riau coastal area to see the current condition of the coastline and compare it with secondary data from aerial photographs from satellites several years earlier. Secondary data analysis in the form of wind, wave, tidal and bathimetric data is analyzed using a hydro-oceanographic approach and for soil testing data analyzed using a geotechnical approach. Geotechnical analysis is carried out to see the stability of safety buildings and coastal protection against the effects of rolling, shear, bearing capacity and the decline that occurs using software. The flow chart in this study can be seen in Figure 4.1:

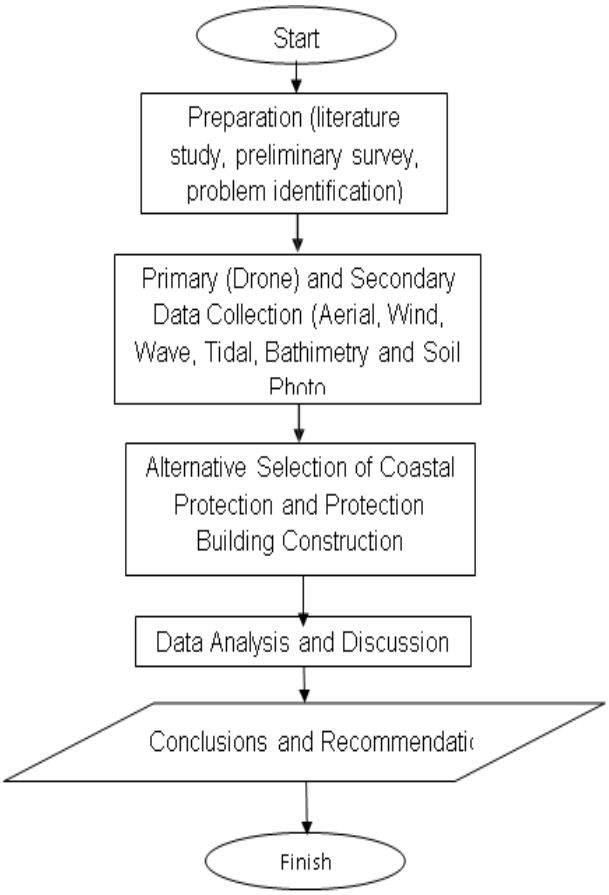

Figure 4. 1 Flowchart of Study on Coastal Protection and Protection Building Construction

5. Results and Analysis

5.1 Survey of Riau Coast Conditions

This initial survey was conducted to look at coastal conditions in Riau ranging from Rokan Hilir, Dumai, Rupat Island, Bengkalis, Meranti and Indragiri Hilir so that weighting can be done to determine the level of perioritas of beach security in Riau. Here is shown one example survey at Senekip Beach and Pambang Parit III Beach Kec. Bantan Kab. Bengkalis.

Figure 5. 1 Condition of Senekip Beach

Table 5. 1 Coastal Damage Inventory

No	sical Condition of the Beach
1	Erosion
	- Conditions of Coastline Change
	- Scour conditions at the foot of the building
	- Areas affected by erosion
2	Abrasion
	- Abrasion in rocks
	- Sea wall abrasion/marine protection
	- Abrasion affected areas
3	Estuary prevention and sedimentation
	- The length of the estuary is tight
	- Percentage of estuary opening
	- Sedimentation affected areas
4	Linguistic damage
	- Settlement
	- Sea water quality
	- Coral reefs
	- Mangrove forest
5	Problematic Buildings
	- Erosion-threatened facilities
	- Distance of facilities with coastline

Referring to the criteria for the level of beach damage, the inventory of coastal damage conditions is done by filling out a questionnaire. In addition to the immediate review of the field, it is also assisted with ArcGIS applications to see the changes in the coastline. The results of the inventory of coastal damage in each area, provided in Table 5.1. The table is summarized from questionnaire data. The study included beaches in Riau, but in Table 5.1 only showed inventory of damage to Senekip Beach and Pambang Parit III Beach, Bantan District, Bengkalis Regency.

Figure 5. 2 Condition of Pambang Parit III Beach

5.3 Damage Level Weighting Results

Table 5. 2 Damage Level Assessment Weight

No	Beach Name	Types of damage		
		Erosion /Abrasi	Sedi men-tation	Environ-ment
	Rokan Hilir			
1	Subang Beach	50	25	100
2	sei. Panji – panji Beach	100	100	100
	Dumai			
1	Purnama Beach	200	50	100
2	Pulai Bungkuk Indah Beach	100	50	100
3	Pasir Putih Beach (Koneng)	50	25	50
4	Bahtera Alam Beach	200	75	100
	Rupat Island (Bengkalis)			
1	Tanjung Medang Beach	50	25	100
2	Lapin Beach	50	25	50
3	Pasrir Putih Beach	50	25	50
4	Teluk Rhu Beach	50	25	50
	Kab. Bengkalis			
1	Api-Api A Beach	250	75	250
2	Api-Api B Beach	250	75	200
3	Tenggayun A Beach	250	100	150
4	Tenggayun B Beach	50	25	150
5	Tenggayun C Beach	50	25	150
6	Tenggayun D Beach	50	25	150
7	Tenggayun E Beach	50	25	150
8	Sepahat Beach	50	25	100
9	Tanjung Leban Beach	250	100	200
10	Selat Baru Beach	50	25	100
11	Perapat Tunggal Beach	50	50	100
12	Muntai Beach	150	50	150
13	Senekip Beach	200	75	100
14	Pambang Beach	100	25	150
	Kep. Meranti			
1	Centai Beach	200	50	100
2	Selancap Beach	200	75	100
3	Tebing Pinang Beach	150	75	50
4	Dara Sembilan Beach	200	50	50
5	Beting Beras Beach	200	50	50
6	Pacol Beach	200	75	50
7	Pisang Beach	200	75	50
8	Motong Beach	200	75	50

5.4 Importance Rate Weighting Results

Table 5. 3 Damage Level Assessment Weight

No	Beach Name	Weight
	Rokan Hilir	
1	Subang Beach	100
2	sei. Panji – panji Beach	6 0
	Dumai	
1	Purnama Beach	100
2	Pulai Bungkuk Indah Beach	145
3	Pasir Putih (Koneng) Beach	175
4	Bahtera Alam Beach	80
	Pulau Rupat (Bengkalis)	
1	Tanjung Medang Beach	175
2	Lapin Beach	175
3	Pasrir Putih Beach	175
4	Teluk Rhu Beach	75
	Kab. Bengkalis	
1	Api-Api A Beach	75
2	Api-Api B Beach	115
3	Tenggayun A Beach	75
4	Tenggayun B Beach	100
5	Tenggayun C Beach	100
6	Tenggayun D Beach	80
7	Tenggayun E Beach	75
8	Sepahat Beach	100
9	Tanjung Leban Beach	75
10	Selat Baru Beach	90
11	Perapat Tunggal Beach	75
12	Muntai Beach	75
13	Senekip Beach	80
14	Pambang Beach	70
	Kep. Meranti	
1	Centai Beach	135
2	Selancap Beach	150
3	Tebing Pinang Beach	145
4	Dara Sembilan Beach	135
5	Beting Beras Beach	145
6	Pacol Beach	160
7	Pisang Beach	160
8	Motong Beach	150
9	Pane Beach	125
10	Impian Beach	130
11	Batu Gronjo Beach	160
12	Paus Beach	145
13	Party Beach	145
14	Bani Beach	145
	Indragiri Hilir	
15	Kuala Enok Beach	150

5.5 Damage Management Priority Results

The priority level is calculated based on the tabulation of the weight of damage and the weight of importance. Then, the value will be classified into 5 levels. Based on Nur Yuwono (1998), the results of field data analysis and the proposed priority weights, the following priorities are proposed:

1. Above 500 : Very highly prioritized (A)
2. Between 400 sd 499 : highly prioritized (B)
3. Between 300 sd 399 : preferably (C)
4. Between 200 sd 299 : less prioritized (D)
5. Less than 200 : not prioritized (E)

The results of the priority level can be seen in Table 5.4:

Table 5. 4 Damage Management Priorities in Riau

No	Location and Beach Name	Weight					Total	Priority
		Damage Rate			Score	Level of importance		
		Erosion/ Abrasion	sedimen-tatition	Environ-ment				
	Rokan Hilir							
1	Subang Beach	50	25	100	175	100	275	D
2	Panji – panji Beach	100	100	100	300	60	360	C
	Dumai							
1	Purnama Beach	200	50	100	350	100	450	B
2	Pulai Bungkuk Indah Beach	100	50	100	250	145	395	C
3	Pasir Putih (Koneng) Beach	50	25	50	125	175	300	D
4	Bahtera Alam Beach	200	75	100	375	80	455	B
	Pulau Rupat (Bengkalis)							
1	Tanjung Medang Beach	50	25	100	175	175	350	C
2	Lapin Beach	50	25	50	125	175	300	D
3	Pasrir Putih Beach	50	25	50	125	175	300	D
4	Teluk Rhu Beach	50	25	50	125	75	200	E
	Bengkalis							
1	Api-Api A Beach	250	75	250	575	75	650	A
2	Api-Api B Beach	250	75	200	525	115	640	A
3	Tenggayun A Beach	250	100	150	500	75	575	A
4	Tenggayun B Beach	50	25	150	225	100	325	C
5	Tenggayun C Beach	50	25	150	225	100	325	C
6	Tenggayun D Beach	50	25	150	225	80	305	C
7	Tenggayun E Beach	50	25	150	225	75	300	D
8	Sepahat Beach	50	25	100	175	100	275	D
9	Tanjung Leban Beach	250	100	200	550	75	625	A
10	Selat Baru Beach	50	25	100	175	90	265	D
11	Perapat Tunggal Beach	50	50	100	200	75	275	D
12	Muntai Beach	150	50	150	350	75	425	B
13	Senekip Beach	200	75	100	375	80	455	B
14	Pambang Beach	100	25	150	275	70	345	C
	Meranti							
1	Motong Beach	200	75	50	325	150	475	B
2	Pane Beach	200	75	100	375	125	500	B
3	Impian Beach	200	75	50	325	130	455	B
4	Batu Gronjo Beach	200	50	50	300	160	460	B
5	Paus Beach	200	75	50	325	145	470	B
6	Party Beach	200	75	50	325	145	470	B
7	Bani Beach	200	75	50	325	145	470	B
8	Indragiri Hilir							
9	Kuala Enok Beach	150	50	150	350	150	500	B

6. Closing

Based on the results of the research and analysis in this study, the following conclusions can be drawn as coastal areas that have the highest level of weighting of the level of coastal damage (priority A and B) are the coastal areas in Bengkalis Regency (Api-Api beach, Tanjung Leban, Muntai and Senekip), Dumai City (Purnama Beach and Bahtera Alam) and Indragiri Hilir Regency (Kuala Enok Beach). Meanwhile, in Meranti Regency, all the beaches under review have a high weighting value. The coastal area that has the highest level of weighting is a priority in coastal management and a review is carried out and the appropriate handler is determined. There are several coastal protection structures in the coastal area in the form of break water, revetment and groynes, but in some places they are not effective to withstand the rate of coastal abrasion / erosion. Soil types for beaches that have high weight are soft soils in the form of clay, silt and peat.

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