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Impact of Abrasion on Coastal Ecotourism Area in Medang Kampai District, Dumai City, Riau Province

Dampak Abrasi Terhadap Kawasan Ekowisata Pantai di Kecamatan Medang Kampai, Kota Dumai, Provinsi Riau

Anugrah Ramadhan Harahap[1*], Aras Mulyadi[1], Rifardi[1]
[1]*Department of Marine Science, Faculty of Fisheries and Marine, Universitas Riau, Pekanbaru 28293 Indonesia*
**email: anugerah.ramadhan2650@student.unri.ac.id*

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Abstract

One of the tourism areas in Dumai City is Medang Kampai District, which is a coastal area with an area of 373.00 km^2. Coastal areas are always used for human activities, one of which is coastal ecotourism which is a coastal tourism activity developed with a conservation approach and utilizing the characteristics of coastal resources as tourist destinations. Medang Kampai District has many coastal ecotourism areas, including Pulai Humpback Beach, Pesona Alam Mundam Beach, Aulia Dumai Beach, Marina Puak Beach, Koneng Beach, Acacia Indah Guntung Beach and Legenda Beach. The method used in this study is a survey method, which was set at 5 (five) research locations, namely Pesona Alam Mundam Beach (Station I), Aulia Dumai Beach (Station II), Koneng Beach (Station III), Acacia Indah Guntung Beach (Station IV), and Legenda Beach (Station V). Based on the results of data processing using DSAS software, the results showed that the coast in the Medang Kampai sub-district was dominated by abrasion with an average abrasion rate of -2.96 m/year. The highest abrasion occurred at Acacia Indah Guntung Beach, followed by Pesona Alam Mundam Beach, Legenda Beach, Aulia Dumai Beach, and Koneng Beach. The impact on the coastal ecotourism area due to abrasion is that several facilities and infrastructure have been damaged and there has been a reduction in the area of coastal ecotourism which is thought to cause a reduction in the capacity of visitors while at the same time directly impacting the economy of the local community whose livelihoods depend on coastal ecotourism.

Keywords: Beach Ecotourism, Abrasion, Abrasion Impact, Mapping

Abstrak

Salah satu daerah pariwisata di Kota Dumai adalah Kecamatan Medang Kampai, dimana kecamatan ini merupakan daerah pesisir yang memiliki luas wilayah sebesar 373,00 km^2. Daerah pantai selalu dimanfaatkan untuk kegiatan manusia salah satunya adalah ekowisata pantai, yang merupakan kegiatan wisata pesisir yang dikembangkan dengan pendekatan konservasi dan memanfaatkan karakteristik sumberdaya pesisir sebagai destinasi wisata. Kecamatan Medang Kampai memiliki banyak Kawasan ekowisata pantai antara lain: Pantai Pulai Bungkuk, Pantai Pesona Alam Mundam, Pantai Aulia Dumai, Pantai Marina Puak, Pantai Koneng, Pantai Akasia Indah Guntung dan Pantai Legenda. Metode yang digunakan dalam penelitian adalah metode survey, yang ditetapkan pada 5 (lima) lokasi penelitian yaitu Pantai Pesona Alam Mundam (Stasiun I), Pantai Aulia Dumai (Stasiun II), Pantai Koneng (Stasiun III), Pantai Akasia Indah Guntung (Stasiun IV), dan Pantai Legenda (Stasiun V). Berdasarkan hasil pengolahan data menggunakan software DSAS didapatkan hasil pada pesisir di kecamatan Medang Kampai didominasi oleh abrasi dengan laju abrasi rata-rata -

2,96 m/tahun. Dimana Abrasi tertinggi terjadi di Pantai Akasia Indah Guntung, kemudian diikuti oleh Pantai Pesona Alam Mundam, Pantai Legenda, Pantai Aulia Dumai dan Pantai Koneng. Dampak yang ditimbulkan pada Kawasan ekowisata pantai dengan adanya abrasi yakni beberapa sarana dan prasarana mengalami kerusakan dan terjadi pengurangan luasan ekowisata pantai yang diduga menyebabkan berkurangnya daya tampung terhadap pengunjung sekaligus secara langsung berdampak terhadap perekonomian masyarakat setempat yang mata pencahariannya bergantung pada ekowisata pantai.

Kata kunci: Ekowisata Pantai, Abrasi, Dampak Abrasi, Pemetaan

1. Introduction

Dumai City is one of the City Districts in Riau Province. This city is a strategic coastal city and has developed into a center of community activities as an industrial area, sea transportation, fisheries (fishing and pond cultivation), tourism, and other activities. One of the tourism areas in Dumai City is Medang Kampai District, a coastal area of 373.00 km^2.

Coastal areas are always used for human activities, one of which is beach ecotourism, a coastal tourism activity developed with a conservation approach and utilizing the characteristics of coastal resources as a tourist destination. Medang Kampai District has many beach ecotourism areas, including Pulai Bungkuk Beach, Pesona Alam Mundam Beach, Aulia Dumai Beach, Marina Puak Beach, Koneng Beach, Akasia Indah Guntung Beach, and Legenda Beach.

Advances in science and technology make it easier for tourists to determine their tourist destinations using natural ecotourism development models in their destination areas. In addition to enjoying the beauty of nature, it also involves elements of education and support for conservation efforts, both open and unknown. Ecotourism activities are expected to positively impact environmental sustainability and improve the economy of local communities.

The coastal area is a transition area between sea and land. This condition causes coastal areas to experience pressure from various activities and phenomena that occur on land and at sea. Phenomena that occur on land, such as flood erosion and movements carried out, such as residential development, clearing forests for rice fields, building ponds, and so on, ultimately impact coastal ecosystems. Likewise, phenomena in the ocean include tides, storm waves, and so on (Damaywanti, 2013).

Abrasion is a problem in coastal areas, which is the reduction or erosion of beaches. It can be dangerous for buildings at the boundaries of marine areas, such as those in coastal ecotourism areas. The erosion process threatens tourist attractions, the surrounding community's economy will be affected, and the country's foreign exchange from the tourism sector will also decrease.

GIS can provide the desired convenience. GIS makes it easier for us to see terrestrial phenomena from a better perspective. GIS can accommodate the storage, processing, and display of digital spatial data and even integrate various data, including satellite images, aerial photos, maps, and statistical data. GIS also accommodates data dynamics, so updating data will become easier

Based on the explanation above, this is the reason why it is necessary to research the impact of abrasion on coastal ecotourism areas in the Coastal Area of Medang Kampai District, Dumai City, which aims to identify areas experiencing abrasion and analyze the effect of abrasion on coastal ecotourism areas in Medang Kampai District, Dumai City.

2. Material and Method

2.1. Time and Place

This research was carried out in February – April 2022 at the Beach Ecotourism Area, Medang Kampai District, Dumai City (Figure 1). Data was analyzed at the Physical Oceanography Laboratory, Faculty of Fisheries and Marine, Universitas Riau.

2.2. Methods

The method used in the research is the ground check (field survey) method, aimed at validating the results obtained from secondary data processing. Ground checks were carried out in several coastal ecotourism areas in the Medang Kampai District. Primary data was obtained from interviews with respondents who were relevant stakeholders and local communities, as well as conducting literature studies through news, articles, or journals related to the impact of abrasion on the Coastal Ecotourism Area in Medang Kampai District. Secondary data processed using DSAS (Digital Shoreline Analysis System) includes spatial data from Landsat

satellite image analysis, which will be carried out to identify areas where abrasion or accretion occurs. The DSAS method used to analyze coastline changes is the End Point Rate (EPR). The analysis is based on the rate of coastline change and the distance of coastline changes that occur within a previously determined year range.

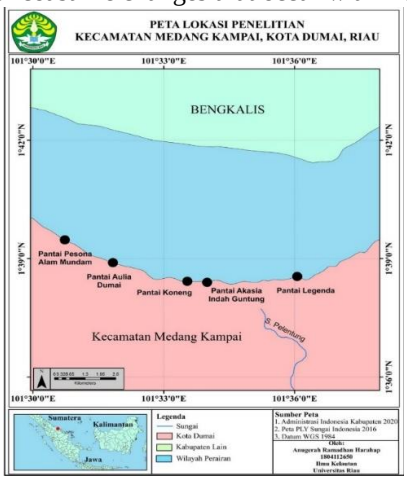

Figure 1. Research location

2.3. Procedure

Research procedures are the steps used to collect data to answer the research questions asked in this research. This research procedure begins with conducting a preliminary study on the research topic, gathering the data required for the research, analyzing the data, and preparing a research report.

2.3.1. Preliminary Studies

Collect several literature studies related to the conditions or general description of the research location. How to process satellite image data for coastline changes using the Digital Shoreline Analysis System (DSAS) version 5 tools on ArcGis 10.4.1 software and literature related to abrasion and accretion.

2.3.2. Data Collection

Data collection was carried out with primary and secondary preliminary data obtained from field surveys (Ground Check) and interviews at the study location. Secondary data is received by downloading it on a site that provides data requirements. This research's secondary data includes coastline parameters and land use.

2.4. Data Processing

Data processing in this research is processing coastline change data. Processing data with satellite imagery to produce maps of coastline changes and carrying out EPR calculations to analyze changes in coastlines and land use in ecotourism areas.

2.4.1. Coastline Changes

2.4.1.1. Image Cropping

Cropping the satellite image area aims to simplify the image data processing process. Sites not included in the AOI (Area of Interest) will be colored black, so they need to be removed. Image cropping was carried out using ENVI software.

2.4.1.2. Radiometric Correction

Radiometric is digital image processing to increase brightness values. The main goal of applying radiometric correction is to reduce the influence of errors or inconsistencies in image brightness values that can limit one's ability to interpret or quantitatively process and analyze images. The condition of the satellite imagery, which is still raw (raw data), is processed using Er-mapper software.

2.4.1.3. Geometric Correction

Geometry contains data information that refers to the earth (geo-referenced data), both position (latitude and longitude coordinate system), and the information contained therein (Lukiawan et al., 2019). Geometric correction occurs because geometric distortion occurs between the sensed image and the object.

2.4.1.4. Delineation

The delineation process separates land and water in the form of a coastline that will be analyzed using a composite band technique to display the boundaries of the observed object. The land and water delineation method in this research uses the Modified Normalized Difference Water Index (MNDWI) method.

$$MNDWI = \frac{Green - MIR}{Green + MIR}$$

2.4.1.5. Coastline Digitization

This digitization is the stage of converting from raster to vector. This is done to simplify the classification of coastlines. The steps that will be taken are as follows: 1) Change the Satellite Image Year according to research, namely 1991, 2001, 2011, and 2021, 2) Digitize the coastline in ArcGIS software

2.4.1.6. Input RBI Map of Research Area

This research uses the 2017 RBI map which was published in 2020. The RBI map is used as a benchmark for the boundaries of the research area to be conducted.

2.4.1.7. Calculation of Rate, Distance, and Prediction of Coastline Change

This research calculates the rate, distance, and prediction of shoreline changes using the Digital Shoreline Analysis System (DSAS) version 5, integrated with ArcGIS 10.4 software. Next is the transect; in making a transect, apart from requiring a baseline, it is also necessary to have a shoreline.

$$EPR = \frac{\text{The distance between two coastlines (m)}}{\text{The second-year span of the coastline (year)}}$$

This analysis will later be strengthened by supporting data such as online and offline interviews with residents in the coastal area of Medang Kampai District, Dumai City, as well as conducting literature studies through news, articles, or journals related to the Coastal Area of Medang Kampai District, Dumai City.

2.5. Data analysis

The secondary data obtained is then collected in the form (layout) of maps and tables, which are then analyzed descriptively. Secondary data obtained from Landsat imagery was processed using ArcGIS 10.4.1 software. The data is collected and grouped, and then shoreline changes are analyzed by calculating the average rate and average distance of shoreline changes in Ms. Excel. From the results of the data processing that has been carried out, an analysis of changes in the coastline is then carried out. After data analysis is carried out, and data on land classification points during ground checks or field surveys and interview results are collected, the level of accuracy is calculated.

3. Result and Discussion

3.1. General Conditions of the Research Area

Medang Kampai District is one of the sub-districts of Bukit Kapur District in Dumai City with a land area of 373 km². The Medang Kampai District is right on the edge of Dumai City, with the capital of Medang Kampai District being Teluk Makmur. The characteristics of the Medang Kampai District area according to elevation (height above sea level/asl) are between 0 – 15 m. The entire area is land, and the topography is relatively flat.

Areas directly bordering the sea or coastal areas are all sub-districts. Based on its geographical position, the Medang Kampai District has the following regional boundaries: To the north, it borders the Rupat Strait. To the south, it connects with Bukit Kapur District. To the west it borders Dumai Utara, to the east it borders Bandar Laksamana Bengkalis Regency. Government administration, Medang Kampai District consists of 4 sub-districts extending from north to south, namely Pelintung, Guntung, Teluk Makmur, and Mundam, respectively, with land areas of 113 km², 100 km², 65 km², and 95 km².

3.2. Coastline Changes

In field observations, the waters of Dumai City have significant wave heights ranging from 0.10 – 0.30 m. According to Nedi et al. (2010), without considering the tidal phase conditions, the wave height in Dumai City is around 0.07– 0.21 m under normal conditions. The current speed in the waters of the Rupat Strait ranged from 0.03 – 0.57 m/s. According to Nedi et al. (2010), the current rate in Dumai City varies from 0.22 – 0.82 m/s. The currents in Dumai City's waters are produced by wavy movements caused by tides that propagate from the Malacca Strait.

The images used in this research are Landsat images from 1991, 2001, 2011, and 2021 (Figure 2). This image was processed using DSAS (Digital Shoreline Analysis System) and analyzed using EPR to determine coastline changes in coastal ecotourism areas. Changes in the coastline in Medang Kampai District, seen over the 30 years 1991-2021.

Changes in the coastline at the research location are dominated by abrasion, namely 95.56% (with 1097 transects out of 1148 transects). Based on image data processing using the EPR method, it is known that changes in the coastline in the Medang Kampai sub-district over 30 years consist of 1) Abrasion: Land reduced by ±2.96 to ±57.87 m. The highest abrasion occurred at Akasia Indah Guntung Beach, Pesona Alam Mundam, Legenda Beach, Aulia Dumai Beach, and Koneng Beach. 2) Accretion: Land increased by ±2.02 to ±12.10 m. The highest accumulation occurred on Koneng Beach.

Coastline changes in the study area are divided into several maps with a larger scale. The function of dividing the map is to clarify areas experiencing changes in coastlines. Map division is based on research stations. (Figure 3) shows changes in the shoreline at Pesona Alam Mundam Beach. Based on image data processing using DSAS, it is known that land reduction has occurred ranging from -2.65 m to -40.15 m, resulting in an abrasion rate of ±4.56 m/year.

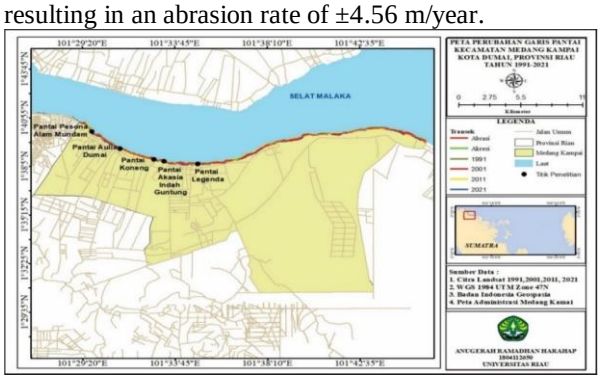

Figure 2. Abrasion in Medang Kampai District 1991-2021

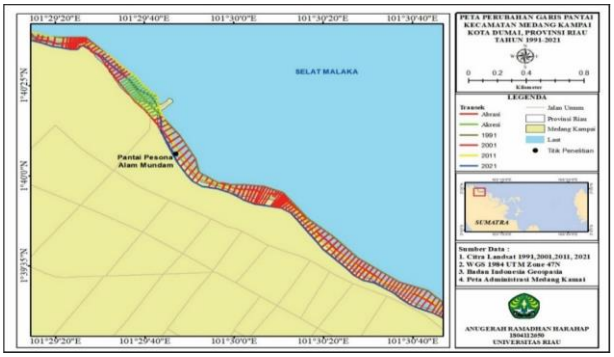

Figure 3. Abrasion at Pesona Alam Mundam Beach 1991-2021

Pesona Alam Mundam Beach with coordinates 1°40'5.98"N and 101°29'46.83"E. This beach is close to Pulai Bungkuk Indah Beach. This beach borders directly on water areas without any natural or artificial barriers so that facilities and infrastructure will immediately suffer damage if abrasion occurs. The beach protection in the Pesona Alam Mundam Beach area is in the form of groins, most of which have been damaged so that there are no current and wave dampeners in the coastal region. The abrasion caused several facilities and infrastructure to be relocated (moved to land), resulting in higher management costs. Based on the EPR analysis, land reduction occurred ranging from -2.43 m to -35.36 m, resulting in an abrasion rate of ±3.26 m/year. Based on Setyandito in Rahmawati (2018), 2 – 5 m/year can be classified as heavy damage. So, it can be interpreted that abrasion in the Aulia Dumai Beach Area is classified as severe damage (Figure 4).

It can be interpreted that the abrasion in the Aulia Dumai Beach area is classified as heavy damage. Results of interviews with the management of the tourist area where this beach used to have a pier collapsed because of the abrasion.

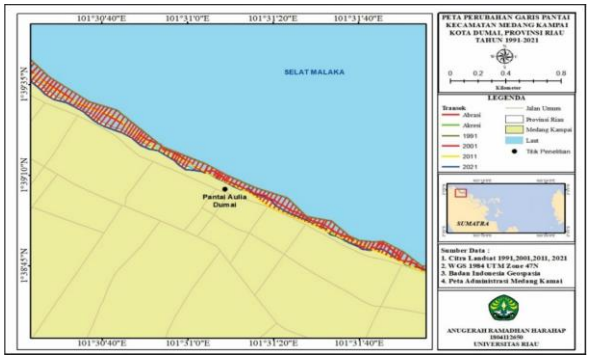

Figure 4. Abrasion at Aulia Dumai Beach 1991-2021

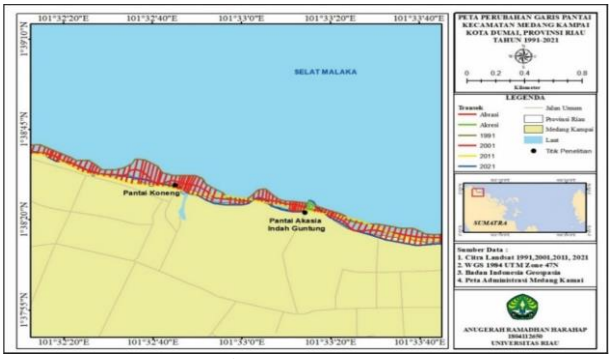

Figure 5. Abrasion of Koneng Beach and Akasia Indah Guntung Beach

The beach has a sloping topography that tends to be flat so that tourist areas around the coast are vulnerable to abrasion disasters. The abrasion, which caused severe damage to the beach, was why the government collaborated with the local community to install artificial beach protection in sheet piles to minimize the impact of abrasion. Koneng Beach shows land reduction ranging from -2.26 m to -30.15 m, resulting in an abrasion rate of ±2.96 m/year (Figure 5). This data is processed using DSAS. Furthermore, abrasion at Akasia Indah Guntung Beach ranged from -2.89 m to -56.76 m, resulting in an abrasion rate of ±5.87 m/year. Koneng Beach is classified as abrasion with heavy damage, while Akasia Indah Guntung Beach is categorized as very heavily damaged.

According to interviews with beach managers, Koneng Beach has experienced many changes, including beach reclamation. Beach reclamation aims to expand the land area so that the reclamation area can be used as a coastal ecotourism area. The main factor that causes abrasion in the Akasia Indah Guntung Beach area is no beach protection. This beach experienced heavy damage, reducing its aesthetic value to be used as an ecotourism area. This is proven by the change in function of Akasia Indah Guntung Beach to become an oil palm plantation. The existence of oil palm plantations causes the land to be drier than other land. Land reduction at Legenda Beach ranges from -2.52 m to -38.44 m, resulting in an abrasion rate of ±3.34 m/year (Figure 6). This is based on image data processing using DSAS.

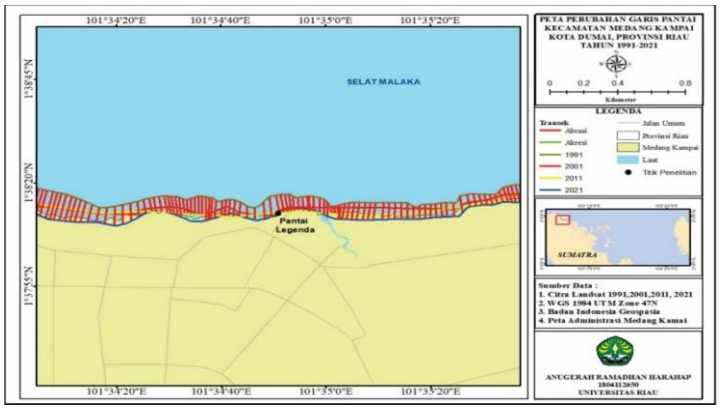

Figure 6. Legenda Beach abrasion 1991-2021

3.3. Impact of Abrasion

The impact of abrasion can be in the form of ecological or economic losses. Table 1 presents the effects in Medang Kampai District based on the results of ground checks carried out by researchers.

Table 1. Impact of abrasion in Medang Kampai District

No	Location	Documentation	Information
1	Charm Beach Natural Mundam		This area has been installed with *a groin*, but due to heavy abrasion, the *groin* has been damaged, and repairs are needed to optimize its function.
2	Aulia Beach, Dumai		This area is experiencing severe erosion, creating a very steep beach. Coastal vegetation cannot grow again in this area.
3	Koneng Beach		This area experienced relocation of facilities and infrastructure due to abrasion. The abrasion is also due to the change in function of the green belt as a coastal buffer into a residential and tourist area so that nothing is left to stop the abrasion rate.
4	Beautiful Acacia Beach Guntung		This area has beaches that tend to be flat so that beach erosion occurs more easily. The result of easy erosion is the reduction in beach area, especially the area of tourist attractions, so managers must respond quickly to deal with abrasion.
5	Legenda Beach		This area has infrastructure located directly facing the sea. As a result of this placement, the infrastructure is directly affected by sea waves, which can cause damage to the infrastructure, which will cause losses.

Abrasion began in this village in 1995, causing a shift in livelihoods from agriculture to fish farming and fishing. This is because agricultural land has been exposed to abrasion and inundated with seawater. The impact of subsequent abrasion meant that the pond could not be maintained. So many residents then changed their livelihood to become factory workers. However, quite a few are unemployed and depend on other family members for their economic livelihood.

Abrasion causes residents to lose their residential land agr, agricultural land, and fish farms, which results in a loss of livelihood and a reduction in their income. If this is related to land ownership status, many residents still have ownership documents for land that has become the sea due to abrasion scouring. This is coupled with increasing expenses related to the suitability of housing. From in-depth interviews, the average population has an income ranging from 500,000 to 1,000,000 rupiah with 3-5 dependents. However, this number could increase because, according to some residents whose livelihood is fishing, the number of catches tends to increase around mangrove forests.

The aquaculture sector that can still be cultivated is shrimp ponds. This shrimp pond, which was established in 2019, has produced tons of shrimp located in the Mundam sub-district, Medang Kampai District, Dumai City. From the center of Dumai City, this pond is only a few kilometers to the east or near Pulai Bungkuk Beach and Koneng Beach. The economic impact is the emergence of new livelihoods in mangrove forest products' trading and processing sectors. Trade, in this case, is supporting beach tourism in this district. Beach tourism is also being developed a lot.

3.4. Abrasion Area in Medang Kampai District

The coast of Medang Kampai District is dominated by abrasion. This area has high levels of human activity, making the buffer area an ecotourism area. The impact of abrasion in the research area is in the form of ecological losses where the government and community have attempted to plant mangroves. Still, mangroves can no longer grow in the abrasion area. When viewed economically, there is a reduction in area, which causes losses such as damage to ecotourism facilities and infrastructure that directly encounter the sea.

The ecotourism areas observed in this research consisted of Pesona Alam Mundam Beach, Aulia Dumai Beach, Koneng Beach, Akasia Indah Guntung Beach, and Legenda Beach. In general, the entire tourist area experienced abrasion with heavy damage. At Pesona Alam Mundam Beach, there was abrasion, which was classified as heavy damage. The factor that causes abrasion on this beach is the lack of coastal protection, such as no mangrove plants. However, at Pesona Alam Mundam Beach, there are groins. The groin condition from the ground check results is minor in size, so it does not significantly reduce abrasion. The situation of the groins is also worrying, namely due to abrasion, which can cause severe damage. The groins as artificial protection are also affected by injury, so several treatments and updates to the coastal security in this area are needed.

The impact of abrasion on Aulia Dumai Beach is the same as other tourist areas, namely damage to facilities and infrastructure, which requires managers to be more alert in repairing facilities for visitor comfort. The high damage due to abrasion caused Aulia Dumai Beach to be built with sheet piles. According to Fachriyan (2018), sheet piles are a form of beach protection. Stones are arranged in such a way as to form a sturdy wall to hold the soil. Aulia Dumai Beach used to have a pier, but it was damaged before the construction of a shore protector in the form of a sheet pile. This can also cause problems for local people who depend on these tourist attractions for their livelihoods.

Koneng Beach is a reclaimed beach that was initially mud. Reclamation of this beach only focuses on tourism, such as building huts and other infrastructure. Abrasion on this beach is classified as heavy, with an abrasion rate of ±2.96 m/year. The impact of this abrasion is that income from tourist visits does not match expenditure for efforts to procure facilities and infrastructure. This opinion is supported by the results of interviews conducted by researchers that in managing tourist facilities and infrastructure, quite large expenditures are required to minimize damage. One of the efforts usually made is piling up sandbags to block the speed of destructive waves.

Akasia Indah Guntung Beach has the most excellent abrasion, causing damage to facilities and infrastructure such as huts for tourists, some of which collapsed and some were moved. This follows research by Sofyan (2014) that one of the impacts of physical damage caused by abrasion is damage to tourist facilities. Akasia Indah Guntung, the beach manager, said that he had relocated the huts seven times, and some had collapsed.

Legenda Beach is an ecotourism beach at the end of Medang Kampai District. The abrasion rate on this beach is ±3.34 m/year, considered heavy. This is caused by the conversion of coastal ecosystems into coastal ecotourism areas. The transition of land function into a tourist area causes direct exposure of waves to facilities and infrastructure. No coastal ecosystem can reduce the speed of locks, which causes damage and economic losses. According to Suryawan (2015), the transition of the function of coastal areas, which should be a buffer, into the form of ecotourism reduces the ecological and physical processes of coastal ecosystems, increasing vulnerability to abrasion in these ecosystems.

The coast of Medang Kampai District experiences abrasion with a general abrasion rate of ±2.96 m/year, referring to Setyandito in Rahmawati (2018) regarding the level of abrasion damage, so the research area is

classified as heavily damaged. High levels of abrasion cause damage to tourist facilities and infrastructure. Damage to tourism facilities and infrastructure certainly brings economic losses to managers because managers have to reconstruct facilities and infrastructure. This is supported by the opinion of Fauziah (2018) that the direct impact of abrasion on the community is a decrease in the income of coastal communities whose livelihoods depend on coastal ecotourism. According to Ambarau et al (2021), the impact of abrasion cannot be seen from the perspective of physical damage alone but is also related to the impact of the social environment and changes in social life that accompany it.

The results of interviews conducted by researchers with some communities who have lived for ±17 years show that many huts have been relocated towards land due to the high level of abrasion in the Coastal Ecotourism Area of Medang Kampai District in general. Damage to coastal ecosystems is considered a natural thing as an impact that will arise as a result of management activities. Many stakeholders tend to be reluctant to repair and rehabilitate exploited coastal ecosystems to meet their needs (Handayani et al., 2018). Coastal protection efforts need to be carried out to minimize the impact of coastal erosion. According to Hartati et al. (2016), Efforts to protect coastal areas are generally carried out to protect various forms of land use such as settlements, industrial areas, agricultural and fisheries cultivation areas, trade areas, and so on in coastal areas from the threat of abrasion. Several beach ecotourism managers in Medang Kampai District, in general, have made several efforts, including fortifying coastal areas with rocks, this was done because the mangrove planting that was carried out did not produce positive results, this is by the explanation of several sources where the mangroves planted did not grow

4. Conclusions

The Beach Ecotourism Area in Medang Kampai subdistrict, Dumai City, Riau Province is dominated by coastal erosion or abrasion with an abrasion rate of ± 2.96 m/year. The impact caused to coastal ecotourism areas by abrasion is that several facilities and infrastructure are damaged and there is a reduction in the area of coastal ecotourism which is thought to cause a reduction in capacity for visitors and will also directly impact the economy of the local community.

5. Suggestion

This research only describes the impact of abrasion in the coastal ecotourism area of Medang Kampai District, so it is recommended that for further research, parameters can be added which are factors that cause abrasion in coastal areas in terms of physical oceanographic parameters such as wind data, sediment transport, tides and etc. so that the research results obtained are more accurate and appropriate abrasion management plans need to be implemented to reduce the impact of abrasion.

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