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Research Original Article

Evaluation of the Effectiveness of Groin Buildings Against Erosion on Ujong Blang Beach

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Abstract
Ujong Blang Beach is a dynamic area characterized by a variety of ecosystems. It serves a variety of purposes, including housing, tourism, and fishing. However, the coastline at Ujong Blang Beach, Lhokseumawe, is experiencing changes due to natural factors such as waves and sediment transport, causing erosion. This research aims to evaluate the erosivity and effectiveness of groyne structures in preventing erosion at Ujong Blang Beach. The methodology used involves 3D Delft numerical simulation using a grid size of 10 m x 10 m and a time period of 0.4 minutes. Input data for the Delft 3D simulation includes topography, bathymetry, tidal patterns, wave action, morphological factors, and sediment data. The simulation results show that Ujong Blang Beach experienced erosion, specifically, Region I Segment experienced erosion of around -40,277 meters, Segment II experienced erosion of around -29,122 meters, and Segment III experienced erosion of around -18,403 meters.

Keywords: *Delft 3D, Erosi, Sediment, Bathymetry, Topography*

1. INTRODUCTION

Lhokseumawe City is a coastal city located in Aceh Province, covering an area of 181.06 km². It is situated between 4° - 5° North Latitude and 96° - 97° East Longitude. The city borders the Malacca Strait to the north and is surrounded by North Aceh Regency. Lhokseumawe City consists of four sub-districts: Banda Sakti District, Muara Dua District, Muara Satu District, and Blang Mangat District. The city has diverse topographic conditions, with elevations ranging from 0 to 100 meters above sea level.

Recent data indicates significant changes in the city's coastline. From 2016 to 2018, the coastline decreased by 5 meters due to abrasion caused by sea waves. However, from 2018 to 2020, the coastline experienced a notable increase of 19 meters, mainly attributed to the construction of breakwaters at Ujung Blang Beach in Banda Sakti District. These breakwaters serve as wave breakers, reducing the impact of abrasion. Overall, the change in the coastline from 2016 to 2020 was 24 meters (Najah et al., 2022).

Given the issues outlined above, it is evident that the groin construction on Ujong Blang Beach has not been entirely effective, as the sedimentation process has not been adequately addressed. Therefore, research and analysis are necessary, specifically through modeling changes in the coastline. This will help identify the areas experiencing erosion and sedimentation, enabling effective measures to be implemented. Ensuring that erosion and changes in the coastline do not disrupt or damage community activities on Ujong Blang Beach is essential.

2. METHODS

2.1 Simulation Area

Lhokseumawe City is strategically located in Aceh Province, crossed by a national road and flanked by several districts. It serves as a trade center in its region. The research is situated in the coastal area of Lhokseumawe City, covering a simulation area of approximately 9 km wide.

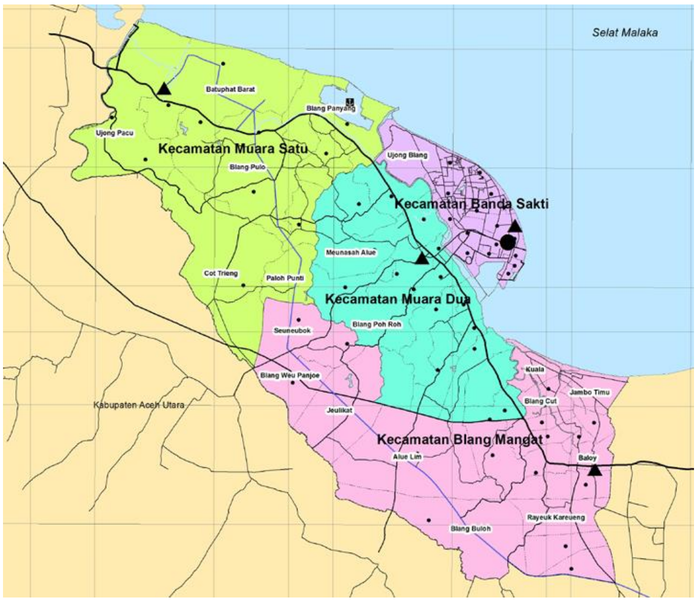

Figure 1. Simulation Area

2.2 Data

In this research, the Delft3D model will be utilized. The input data for the Delft3D model in this study includes bathymetric data, topographic data, wind data, sediment data, and tidal data.

2.3 Wave Analysis

Waves commonly found in the ocean are created by the wind. The energy generated by these waves can influence coastal formations, create currents, transport sediment in various directions, and exert pressure on coastal structures (Triatmodjo, 2009).

When analyzing significant wave height and significant wave period, it is necessary to calculate the wind speed at sea to determine the wind speed and effective fetch. Fetch is the formation of waves that are assumed to have relatively constant wind speed and direction (Triatmodjo, 1999).

UW = RL x UL (2.1)

UA = 0,71 x UW1,23 (2.2)

RL = 2,7605 x UL-0,305 (2.3)

$$F_{eff} = \frac{\sum Xi \cos\propto}{\sum \cos\propto} \quad (2.4)$$

Once you have the appropriate values for wind drag and fetch, you can proceed to calculate the significant wave height and period.

$$\frac{g.H_S}{{U_A}^2} = 0{,}30\left[1 - \frac{1}{\left\{1+0{,}004\left(\frac{g.F}{{U_A}^2}\right)^{1/2}\right\}^2}\right] \quad (2.5)$$

$$\frac{g.T_S}{2\pi U_A} = 1{,}37\left[1 - \frac{1}{\left\{1+0{,}008\left(\frac{g.F}{{U_A}^2}\right)^{1/3}\right\}^5}\right] \quad (2.6)$$

2.2 Simulation Preparation

When preparing the model, it's essential to set up the simulation domain, including the grid, land boundary, and depth values. You'll also need to gather various types of data for input into the modeling. This data includes bathymetry, topography, wind, sediment, and tidal data. The prepared data will be used as input in Delft3D.

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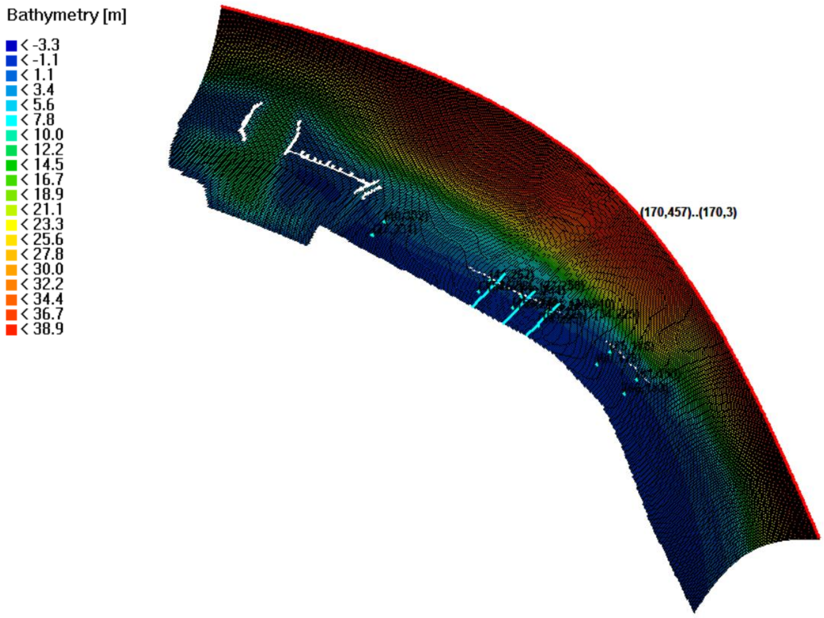

Figure 1. Simulation Domain

2.4 Simulation Procces

2.4.1 Delft3D-FLOW

Delft3D-FLOW is a system used to calculate Shallow Water Equations (SWE) for variable speed and height in two or three-dimensional form on a grid or guidelines in the Delft3D section (Fahmi, et al 2019). Simulations running in Delft3D-FLOW require a simulation area (domain) showing the calculated area and its limits. The simulation area is created by using Delft3D-RGFGRID to create a grid and enter depth data using Delft3D-QUICKIN. The parameters used in Delft3D-FLOW include tidal data, sediment data, and morphological values to facilitate the simulation process. The simulation was conducted based on 15-day tidal data covering 4 tidal components (M2, K1, O1, N2). Parameters for sea level rise are based on values from the Intergovernmental Panel On Climate Change (IPCC) for 25 years. Morpac was used to predict changes in coastal morphology over 50 years based on tidal data, significant waves, and IPCC values.

2.4.2 Delft3D-WAVE

The simulation of changes in beach morphology is linked to Delft3D-WAVE. Delft3D-WAVE is a component of the Delft3D system used to model waves in coastal waters. It can be applied to deep, medium, and shallow waters. The input parameters for Delft3D-WAVE are significant wave height and significant wave period (Fahmi, et al 2019).

3. RESULTS AND DISCUSSION

3.1 Wind Data

Offshore wave conditions are obtained by forecasting from wind data (Kasury, et al 2016). Wind analysis using wind data from the Malikussaleh Meteorology, Climatology, and Geophysics Agency (BMKG) from 2014 to 2023 resulted in the percentage of wind direction based on maximum wind speed, as shown in Figure 2 below.

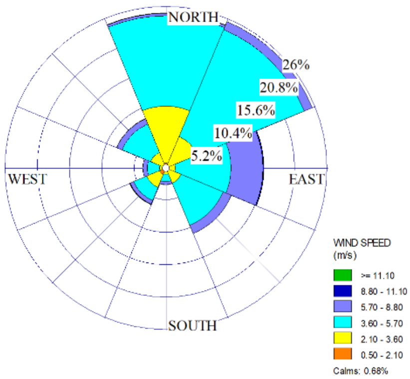

Figure 2. percentage of wind speed

3.2 Wave Analysis

According to the wind rose, the dominant wind directions that have the potential to generate waves are from the North East, North, East, North West, and West. The analysis of fetch length was conducted in these 5 directions using the distance from the wave observation point to the end of the fetch, which was determined to be up to 250 km. Wave forecasting is the process of predicting significant wave height (Hs) and wave period (Ts). These values serve as input in Delft3D-Wave.

Table 1 Hs (Wave Significant) and Ts (Period Significant)

Direction	**Hs (m)**	**Ts (s)**
east	0.669	1.062
Northeast	0.859	3.291
north	0.816	1.062
Northwest	0.269	1.062

3.3 Tidal Tide

Tides are the result of gravitational attraction and centrifugal effects. Gravity varies directly with mass but inversely with distance (Hafli, et al 2022). Tidal data observations were conducted over a period of 15 days, 24 hours each day. The tidal data is analyzed using the Least Square Method, which utilizes previous tidal data to predict future tides. This method enables us to obtain the amplitudes (H) and phases (g) for the tidal harmonic components M2, S2, K1, and O1.

Table 2 Tidal Tide

No.	Kompenen Harmonik	Keterangan	*Periode* (*jam*)	*Phase* (°)	*Amplitude* (*m*)
1.	M_2	*Semi Diurnal*	12.42	288.17	0,53
2.	S_2		12.00	356.92	0,25
3.	K_1	*Diurnal*	23.93	238,83	0,22
4.	O_1		25.82	134.91	0,06

3.4 Erosion and sedimentation modeling

The results that will be discussed in this sub-chapter are erosion modeling on Ujong Blang beach, with a return period of 25 years.

The modeling results show that Ujong Blang beach is experiencing erosion along the coastline. To make it easier for researchers to explain the simulation results, researchers divided the area into three segment areas, as in Figure 3. In Segment I, erosion extends to approximately -40,277 m; in Segment II which covers the area of the groyne structure, the erosion size is around -29,122 m; and in Segment III erosion was -18,403 m.

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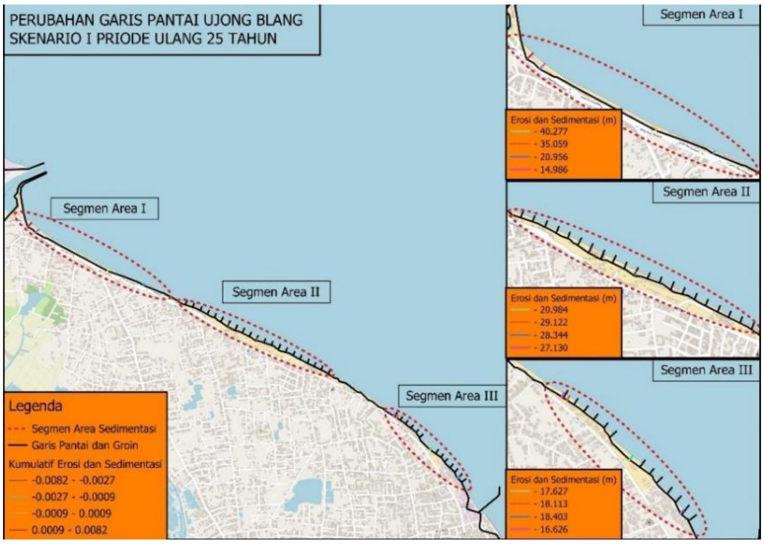

Figure 3. Scenario modeling I

4. CONCLUSIONS

Based on research results, it shows that Ujong Blang beach is experiencing erosion along the coast. In segment I, erosion occurred approximately 40.28 meters long. In segment II, there was erosion/setback of the coastline along 29.12 meters and in segment III, erosion occurred along 18.40 meters. Modeling results show that the current groyne structure is ineffective because it cannot hold sediment optimally, causing continuous erosion.

5. REFERENCES

[1] Fahmi, Mirza, dan T Mudi Hafli, 2019, Simulasi Numerik Perubahan Morfologi Pantai Akibat Konstruksi Jetty Pada Muara Lambada Lhok Aceh Besar Menggunakan Sofware Delft3D, Jurnal Teknik Sipil Universitas Syiah Kuala. 8(2), 50-59.

[3] Hafli, T. M., Fasdarsyah, F., Nidya, N., Sarana, D., & Syibral, S. (2022, December). Analysis The Impact of The Coastal Protection Construction Development Plan On Shoreline and Estuary Changes. In Proceedings of Malikussaleh International Conference on Multidisciplinary Studies (MICoMS) (Vol. 3, pp. 00009-00009).

[4] Ibrahim, dan Abdullah Irwansyah, 2014, Pengaruh Pembangunan Jetty Muara Kr. Meuredu Terhadap Perubahan Garis Pantai Disekitarnya, Jurnal Portal, 6(1), 1-11.

[5] Kasury, Ahmad Reza, 2016, Simulasi Perubahan Garis Pantai Terhadap Rencana Jetty Muara Labuhan Haji, Jurnal Teknik Sipil Universitas Syiah Kuala. 5(3), 231-240.

[6] Najah, S, Mirza, D, Ahmad, N.G. 2022, Analisis Perubahan Garis Pantai Ujung Blang Kecamatan Banda Sakti Kota Lhokseumawe Pada Tahun 2016 - 2020, Jurnal Samudra Geografi, 5(2), 167-173

[7] Ninda Nidya Mumtaz., 2022. Pengaruh Rencana Jetty Terhadap Perubahan Morfologi Pantai Dengan Menggunakan Pemodelan Numerik. Skripsi. Universitas Malikussaleh

[8] Triatmodjo, B, 1999, Teknik Pantai, Edisi Pertama, Penerbit Beta Offset, Yogjakarta.

[9] Triatmodjo, Bambang, 2009, Perencanaan Pelabuhan, Beta Offset, Yogjakarta.