Alternative Planning for Safety Building of Namrole Beach in South Buru regency-Maluku

Muhammad Aldin, Muh.Arsyad Thaha, Mukhsan Putra Hatta

Abstract: Namrole coast faces erosion problems due to changes in the coastline because of the settlement is near to the coast where the buffer zone has not been planned. Thus, during the wave season, the settlement is within reach of wave run up. The results of the analysis of coastal building selection were carried out by alternative study methods and modeling of coastal buildings using Coastal Engineering Design and Analysis System (CEDAS)-NEMOS application. From the several models of beach building modeled, Seawall was chosen as a coastal protection building with the design characteristics of the foot depth at 0.5 m, wave height rupture at the end of the building 0.4 m, seawall elevation 2.8 MSL and minimum diameter of building foot protection stone of 22 cm.

Keywords: sea defence building, hindcasting, NEMOS, seawall, Namrole beach

I. INTRODUCTION

Namrole Beach is located in Namrole District, South Buru Regency. Besides being famous as a tourist spot, this beach is also a well-known fishing area. The potential for developing Namrole coastal land in both coastal waters and offshore waters has not been specified. Therefore, in line with the development of this area various problems began to arise, including the placement of residential land, government / private buildings, worship places, and others closer to the coastline thence eventually threatened by sea waves and coastal erosion. The occurrence of coastal erosion due to shoreline changes was led by existing settlements which are too close to the coast where the coastal border or buffer zone has not been strategized. This phenomenon can negatively impact the economy especially the tourism and endanger coastal ecosystem [1-3]. Hence there arose a need to overcome and avoid the coastal erosion issue that takes place at the surf zone.

Surf zone is the location of sediment transport activities in coastal areas. The forward retreat of the coastline depends on the rate and direction of the sediment transport in the surf zone.

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The amount and direction of sediment transport depends on the rate and direction of the current in the surf zone. Current in the surf zone generally occurs due to wave induced current. To reduce wave energy and intensity of longshore currents due to wave induction, a breakwater building is needed. With this breakwater building, it is expected that the behavior of longshore currents due to wave induction can be controlled so that the sediment transport rate in the surf zone can be reduced. The reduced rate of sediment transport in the surf zone causes the coastline to be relatively stable. There are four types of coastal protection buildings that can be used to control the position of the coastline which are seawall andrevetment, groin, jetty and detached breakwater [4-5]. In this study, comparisons were done between groin, seawall and detached backwater coastal protections building using CEDAS – NEMOS software.

II. METHODOLOGY

This study was conducted at NamroleSubdistrict which is located between 2 ° 30 'and 5 ° 50’ south latitude also between 125 ° 00 'and 127 ° 00' east longitude. Namrole sub-district in the north borders the sub-district Waeapo, bordering the Banda Sea in the south, bordering the Waesama District and the west on the east bordering with LeksulaSubdistrict. Along with the development of this area, various problems began to arise, including placement of residential land, government / private buildings, synagogues, etc. getting closer to the coastline so that it is threatened by ocean waves and coastal erosion. Figure 1 depicted a part of the Namrole beach.

Fig. 1 Ground scour behind the revetment building due to overtopping waves

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The research method used in this study is primary data retrieval with the method of field investigation, and secondary data processing analysis methods, as well as testing the model with the help of computer / software application assistance. In order to obtain good and directed results, the process flow as shown in Figure 2 was followed.

In the beach safety modelling analysis using CEDAS Software – NEMOS, there were few basic assumptions of the shoreline change model made such as the shape of the beach profile is constant, the boundary area for land and sea profiles is fixed, and sediment transport that occurs along the coast is caused by waves.

The selection of strategic types of coastal protection is strongly influenced by the location and characteristics of the area to be protected. Handling strategies can be carried out as follows:

1. No handling is done

This is chosen if damage in the coastal area does not cause negative impacts in terms of social, economic and environmental aspects, for example farming areas, forests and vacant lands or if done countermeasures will cost a lot so that in terms of economic aspects it is not profitable. At this beach, erosion is allowed to continue until balance is achieved.

2. Maintain the existing coastline

This choice is made if the beach that is damaged is a relatively favourable beach in terms of social (residential areas), cultural (places of worship and historic relics), economic (aquaculture or rice fields) and environmental (mangroves) aspects.

3. Return the coastline to the position before erosion occurs

This option is carried out if beach damage occurs in areas where the coastal setback causes extensive beach benefits for the public interest.

Strategies 2 and 3 are security strategies for problems that occur. Each strategy choice must be considered the possible impact. All of this must be based on the stated goals and the assessment of the benefits and costs of these strategic choices must be carried out to determine economic feasibility. The strategic choices that are set must be carried out continuously and the negative impacts as small as possible.

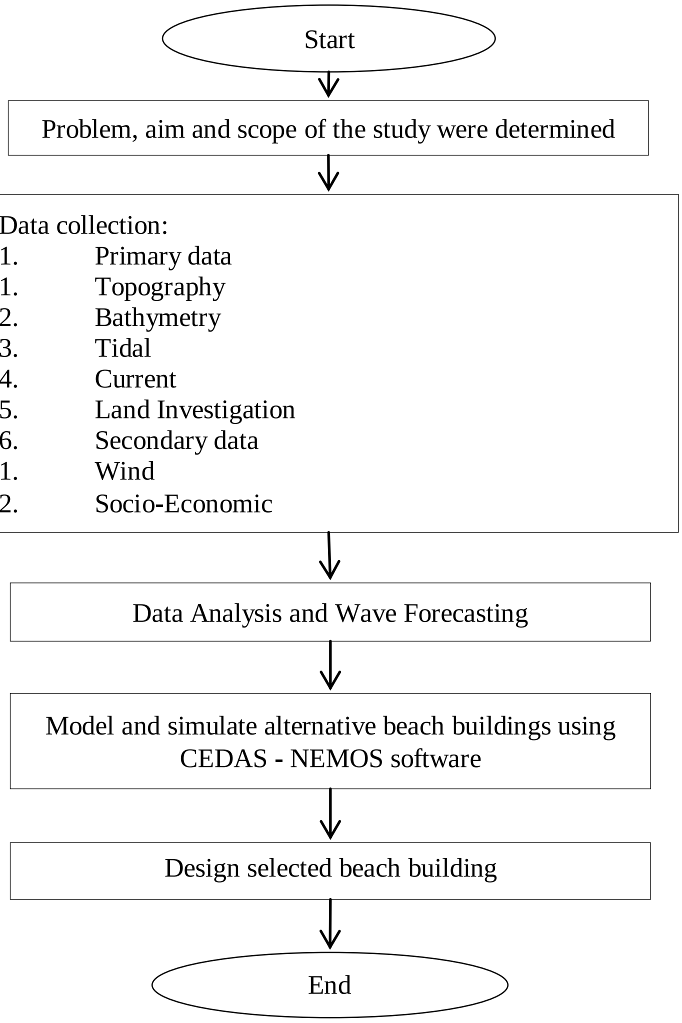

Fig. 2 Overall Process Flow

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III. RESULTS and DISCUSSION

From the modelling of 10 years as shown in Figure 3, the maximum sedimentation is 68.11 m. The direction of sediment transport movement is dominated towards the East. The direction of the sediment is strongly influenced by the direction of the incoming wave. Sediment transport that occurs is dominated by coastal direction sediment transport caused by longshore current. This condition can be seen from the form of river estuary which experiences sedimentation in the river mouth leading to the East.

Alternative I: Groin Installation

Based on these conditions, several models of groins can be used as an alternative in solving coastal abrasion problems in the Namrole City Beach area. The selection of groins as an alternative solution to the problem because the groin is very effective in reducing sediment transport due to longshore currents. The addition of a 50-meter-long groin and 100 meter inter-building with settlements in the village that has the worst impacts from the abrasion of Namrole beach, the village of Lektama and Fatmite village. Figure 4 shown the modelling of the coastline with groin after 10 years, the maximum sedimentation was 69.48 meters.

Alternative II: Installation of Offshore Breakwater

Offshore breakwaters are buildings that are parallel to the coast and are at a certain distance from the coastline. Protection by offshore breakwaters occurs because of the reduced wave energy that reaches the waters behind the building. Under these conditions, it will reduce sediment transport in the area. Sediment transport along the coast coming from the surrounding area will be deposited behind the building. The sedimentation will cause the formation of cuspate. If the offshore wave building is long enough to distance from the coastline, it will form a button. The building is planned to protect the Namrole City Coast from wave attacks. The addition of this breakwater with a 100 meter long side of the building, and the distance from the coastline of 100 meters, and the distance between buildings is 100 meters. The planned peak elevation is the same as the mean sea level (MSL) elevation. Thus in terms of aesthetics, it will look beautiful and will not interfere with the shipping lane for fishermen who live in Namrole City. Figure 5 showed the results of the modelling of the offshore breakwater. From the modelling result there is a maximum condition where tombolo has been formed on the side of the breakwater, this event occurred in the 6th year of modelling where the maximum sedimentation occurred was 89.83 meters.

Alternative III: Seawall Installation

In planning the sea wall (seawall) for Namrole City Beach, it is necessary to review the function and shape of the building, location, length, height, stability of the building and foundation soil, elevation of the water level in front and behind seawall. Seawall is made with a sloping side facing the sea and is made of stone pile material. (rubble mound). At the bottom of the front of the building is a protective layer (toe protection) and the foundation uses piling or dolken timber to withstand the decline.

Drainage is made on the back of the construction so that the water does not enter the seawall. Figure 6 presented the image of the modelling of the coastline after 10 years. It was found that the maximum sedimentation was 46.58 meters.

The comparisons of the three suggested alternatives with the current beach condition are tabulated as in Table 1. With reference to the results of coastline change simulation using the CEDAS-NEMOS program by comparing existing conditions, seawall is selected as solutions for coastal building.

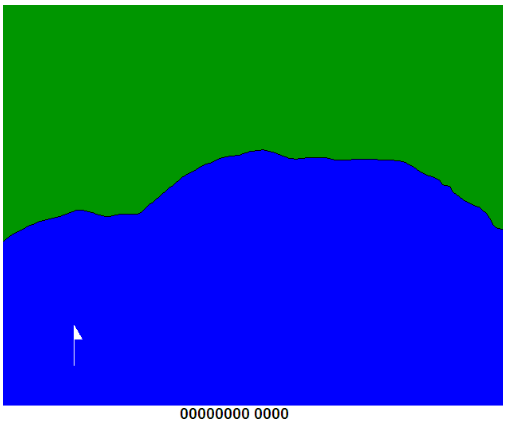

Fig. 3 Existing condition of Namrole beach

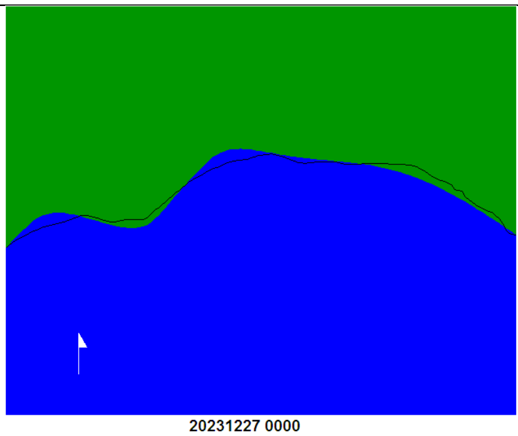

Fig. 4 Coastline changes in the 10th year.

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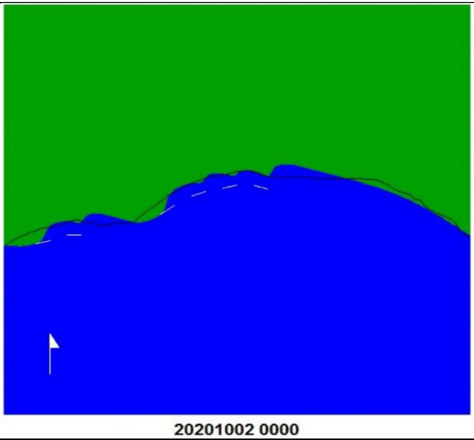

Fig. 5 Modelling of offshore breakwater of the coastline change in 6 years

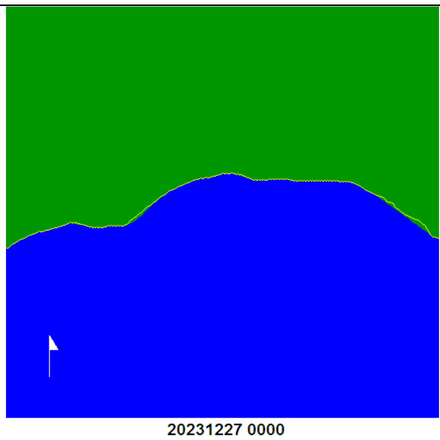

Fig. 6 Change of the coastline after 10 years of seawall installation

Table. 1 Comparison of three suggested alternatives with current beach condition

Coastal Building model	Abrasion(m)	Sedimentation (m)	Coastal Sediment Movement per-Grid (m^3)		Simulation years
			West	East	
Existing	-73.53	68.11	262.48	28626.40	10
Seawall	0	46.58	380.78	12788.96	10
Groin	-136.74	69.48	974.02	13329.60	10
Detached backwater	-88.74	89.83	459.17	15854.90	6

The proposed seawall design for the Namrole beach is as follow:

Planning data for seawalls are as follows:

a) Wave Period in Deep Sea (T) = 10.2 sec
b) Beach Tilt (m) = 1: 35.4 (obtained from a bathymetric map)
c) Depth at the foot of the building (ds) = 0.5 m
d) The sea wall is planned without overtopping
e) Tilt wall of sea = 1: 1.5 (Cot ϴ = 1.5)
f) Land data ᵞ = 1.88 ton / m^3
Φ = 23°
C = 0 ton / m

To calculate the height of wave, the following high breaking wave plan is used:

$$\frac{ds}{gT^2} = \frac{0.5}{9.81 \times 10.2^2} = 0.0005 \quad (1)$$

By using the High-Grade Wave Scale plan at the foot of the building with the value of ds / g(T^2) = 0.0005 and the value of m = 0.03, the height of the breaking wave at the end of the building is 0.4 m.

By using the Run Up Wave, the value of Ir = 13.421, for rip-rap the obtained elevation of the seawall height:
HWL + Ru + Fb = 0.85 + 0.55 + 1.35 ≈ 2.8m

To prevent erosion at the foot of the wall, in front of the foot of the wall need to be installed foot aphrodisiac at 1.0 m above the base of the building. The formula used is:

$$W = \frac{W_r H^3}{Kd^3 (Sr-1)^3 \cot\theta} \quad (2)$$

Where;
W = Weight of one unit of coating / armor (ton)
Wr = Weight of stone unit (2.65 ton / m3)
Ww = Weight of sea water unit (1,025 tons / m3)
H = High wave plan at building location (0.4 m)
Kd = Stability coefficient (from the stability coefficient table for various types of stones) = 1.9

$$Sr = \frac{Wr}{Ww} = \frac{2.65}{1.025} = 2.59 \quad (3)$$

θ = The slope angle of the building

Therefore, the minimum stone diameter used is 22 cm.

IV. CONCLUSION

Based on the alternative selection of coastal safety construction on the above, the treatment selected is protection using groin and seawall. From the willingness of the community, people agree more if the groin is built because of the existing groin conditions that have already been beneficial. Besides, the groin building does not block the fishing boats. So as an early suggestion for the settlement area was protected with groin and non-settlement areas such as roads being seawalled.

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