Modeling of Total Suspended Solid based on Remote Sensing Reclamation Data of Teluk Lamong Port

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Keywords: Total Suspended Solid, Modeling, Remote Sensing.

Abstract: In relation to socio-economic development many construction projects have been carried out in Indonesia to meet the requirements of urban, agricultural and industrial use. These projects include urban construction, for example, metro construction, groundwater pumping, and reclamation in coastal areas. Activities that have a significant influence on the environment are port operational activities. Teluk Lamong Harbor is the reclaimed land product. Based on this, a physical impact study of the Teluk Lamong Bay Multipurpose Terminal Development Port is needed to find out how much influence the impact of the reclamation has on marine environmental resources. Therefore a flow pattern modeling is done, Total Suspended Solid (TSS) modeling is based on remote sensing data to see the impact after the development of the Teluk Lamong Multipurpose Terminal Port. The objectives to be achieved in this study are: Knowing the modeling of current patterns at the Port of Multipurpose Terminal in Teluk Lamong 2020, Knowing the modeling of TSS concentrations at the Port of Multipurpose Port of Lamong Bay in 2020. Stages Method: 1. modeling the flow patterns using Mike 21 software before and after reclamation, 2. TSS concentration modeling using Mike 21 software based on remote sensing data using Google Earth Engine (GEE). Model of the current pattern at low tide the maximum water level at low tide is -1.0875 meters and -1.055 meters, the speed of the current under these conditions ranges between 0.01 m / s for both points. For the current tide pattern model with the maximum water level height at tide conditions are 0.7744 meters and 0.7640 meters, the current speed under these conditions ranges from 0.008 m / s for the yellow dot and 0.008-0.016 m / s for both blacks. (D50) sediment concentration of 0.0738 mm around the Port of Teluk Lamong with an average TSS value of 4.998 per area.

1 INTRODUCTION

Indonesia has a coastal region that stretches from Sabang to Marauke which is rich and a variety of natural resources that have been utilized by the community as one source of economic income. In addition to providing a variety of resources, Indonesia's coastal area has various other functions, such as transportation in the form of a port, industrial estate, agribusiness and agro-industry, recreation and tourism, residential areas, and waste disposal sites. One of the development ideas that is being discussed by many Indonesians is the concept of reclamation. Reclamation can be defined as an effort to improve, utilize, restore capacity, and improve the quality of land through the empowerment of various technologies and community empowerment focused on land that is naturally of low quality or as a result of human influence that makes the land less productive. With changes in environmental conditions can make the coastal region undergo complex changes. The development of Teluk Lamong Multipurpose Port will have an impact on the surrounding environment due to changes in environmental conditions that adjust to environmental changes due to coastal reclamation. The construction of the Lamong Bay Multipurpose Port regarding reclamation has been explained and legalized as contained in Law Number 27 of 2007 article 34 junto Law 1 of 2014, concerning Management of Coastal Areas and Small Islands, explains that reclamation has the meaning of activities carried out by people in the context of increasing the benefits of land resources in terms of environmental and socio-economic aspects by means of confinement and drying of land. Coastal changes that occur due to abrasion and accretion, the main causes of abrasion and accretion are the action of

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waves, wind and tides. The most influencing process is waves. When moving towards the beach, the waves undergo transformation which then generates currents near the coast. Currents moving along the coast move sediments, causing shoreline changes. The change in coastline is related to sediment transport that occurred at the port of Teluk Lamong. The rate of sedimentation increases, so siltation at the Port of Teluk Lamong will have an even faster impact on other problems. Therefore, knowledge about aquatic hydrodynamics is very important to understand in order to predict the distribution of sediment after reclamation. The results of the model that have been validated and have shown correlations or similarities with actual conditions in the field can be used to predict the dynamics of various processes that occur in the waters.

2 THEORETICAL

The ecological coastal area is a transitional area between terrestrial and marine ecosystems, which is towards the coastal area including land areas, both dry and submerged in water affected by marine processes, such as tides, sea winds, and sea water intrusion, while towards the sea area coastal areas include ocean waters that are influenced by natural processes such as sedimentation and freshwater flow, as well as those caused by human activities on land (Dahuri et al, 1996). According to Law No.27 / 2007 article 1 paragraph 2, coastal areas are transitional areas between terrestrial and marine ecosystems which are influenced by regulations on land and sea. Coastal waters are seas bordering the plains covering waters as far as 12 nautical miles measured from the coastline, waters connecting the coast and islands, estuaries, bays, shallow waters, swamps, brackish, and lagoons (Law No.27 / 2007 article 1). In coastal areas there are interrelated ecosystems. Coastal ecosystem is a unit that interacts between organisms and the environment and together carry out their respective functions in habitat (Odum, 1971). Coastal ecosystems are a set of biological (biotic) and non-biological (abiotic) components that are absolutely necessary for life and improve the quality of life (Bengen, 2004). Furthermore, biological and non-biological components are functionally related to each other and interact with each other to form a system. If there is a change in one of the existing systems, it will affect both the functional structure unity and balance (Bengen, 2002). One form of linkages between ecosystems in coastal areas is the movement of river water, runoff, runoff with various materials contained (nutrients, sedimentation, and pollutants) which will all lead to to coastal waters. In addition, this pattern of movement of water mass will also play a role in the movement of aquatic biota (plankton, fish, and shrimp) and pollutants from one location to another (Bengen, 2004). Ecosystems in the coastal and marine areas are natural and artificial. Natural ecosystems located in coastal areas, namely mangrove forests, coral reefs, seagrass, sand beaches, rocky beaches, and estuary waters.

2.1 Reclamation

Coastal reclamation is carried out taking into account the socio-economic conditions of the population, given the increasingly rapid growth rate, which causes the land for development increasingly narrow. Reclamation makes watery areas that are damaged or of less value become better and more useful. The new area is usually used for residential, industrial, business, and urban areas, ports, and tourist attractions. In the theory of urban planning, coastal reclamation is one step in city expansion. Usually the reclamation is carried out by the state or big city with the rate of growth and land needs increasing rapidly, but experiencing constraints of land limitations. This condition is no longer possible to expand to the mainland, so new land is needed. Another alternative is to form a vertical division by building a port as part of the distribution of goods and anchoring ships. Coastal reclamation is a subsystem of the coastal system.

2.2 Impact of Coastal Reclamation

Based on the Minister of Home Affairs Regulation (PERMENDAGRI) No. 1 of 2008 concerning coastal reclamation, the implementation of coastal reclamation must pay attention to environmental interests, ports, mangrove forest areas, fishermen, and other functions in the coastal area and the sustainability of the surrounding coastal ecosystem. Planning in reclamation activities should be aligned with the city spatial plan. The new city spatial planning must pay attention to the social and ecological carrying capacity of the city. Reclamation project activities around the coastal area require a scientific feasibility study through a technical study of how much environmental damage will be caused and then conveyed openly to the public. It is important to remember that reclamation is a form of human intervention in the balance of the natural environment of the coast. In a coastal ecosystem that has long been formed and arranged as it should, it will lose its balance due to reclamation activities. The effect of these impacts is one of which affects the lives of surrounding communities. Many fishermen and workers in the fisheries sector will lose their livelihoods due to the decrease in the number of fish due to damage to the ecosystem due to runoff from sediments (Francisca, 2017).

2.3 Limitations of Environmental Carrying Capacity Due to Coastal Reclamation

According to Dahuri (2000) the main problems in the management of coastal areas are activities of pollution, overfising, erosion, coastal sedimentation, extinction of biota types, and conflicts in the use of the region: due to the high environmental pressure caused by the population along with all the gait of life and development of the environment of the coastal area which has a limited ability to support the concept of the environment based on the idea that the environment has the maximum capacity to support the growth of organisms (Bengen, 2002). The environmental carrying capacity classification includes:

1. Ecological: The maximum level (both quantity and volume) of the use of a resource or ecosystem that can be accommodated by an area before ecological decline;
2. Physical: The maximum amount of utilization of a resource or ecosystem that can be absorbed by an area without causing physical quality degradation.
3. Social: The level of comfort and appreciation of users of a resource or ecosystem to an area due to the presence of other users at the same time.
4. Economy: The level of scale of effort in the utilization of a resource that provides maximum economic benefit on a sustainable basis.

According to Scones (1993) the carrying capacity of the environment is divided into two namely ecological carrying capacity and economic carrying capacity. Ecological carrying capacity is the maximum number of organisms on a land that can be supported without causing death due to density factors, as well as the occurrence of permanent environmental damage. While economic carrying capacity is the level of production of businesses that provide maximum profit and is determined by the business objectives economically.

2.4 Tidal

Knowledge about tides will be very important when we plan to build a port by coastal reclamation. The ups and downs that occur in each region are not the same. In general, tides in various regions can be divided into 4 types:

1. A single daily tidal (diurnal tide)

In one day there is one tide and one tide with a tidal period is 24 hours 50 minutes.

2. Install double daily shrinkage (semi diurnal tide)
   In one day there are two tides and two tides with almost the same height and tides occur regularly. The average tidal type is 12 hours 24 minutes.
3. Tidal mixture tends to a single daily (mixed tide prevalling diurnal)
   In one day there is one tide and one tide, but sometimes temporarily there are two tides and two tides with a very different height and period.
4. Tidal mixture tends to double daily (mixed tide prevalling diurnal)
   In one day there were two tides and two times low tide, but the height and period were different.

According to Haryono (2004), tides are the result of gravitational forces and centrifugal effects. Centrifugal effect is the movement or push towards the outside center of rotation of the earth. The influence of the moon's gravitational force is two times greater than the force of the sun in generating the tides, because the distance of the moon is closer than the distance of the sun to the earth. Within a month, the daily variation of the tidal range changes systematically to the lunar cycle. The tidal range also joins to the shape of the volume of the water and the shape of the ocean floor undergoing movement. Vertical water movements associated with the ups and downs of the tides, accompanied by horizontal water movements called tidal currents.

2.5 Wave

The main energy that forms the coastal system is waves. Ocean waves are a natural phenomenon in the form of raising and decreasing water slowly and can be found throughout the world. Waves in the sea often appear irregular and change frequently. This can be observed from the surface of the water which is caused by the direction of wave propagation that is very varied and irregular waveforms, especially if the waves are under the influence of the wind. According Pratikto (2000) said that the shape and propagation of waves that vary and irregularly greatly affect the characteristics of the waves that occur in these waters. In addition to changes in height, length and speed of waves also occur other phenomena such as silting, refraction, diffraction and reflection before the wave breaks. The process resulted in changes in wave speed. Sea waves that move into coastal waters experience a high increase which makes the waves to increase. Furthermore, the speed of water particles at the peak of the wave approaches the speed of the wave, so that when the water particles are greater than the speed of the wave, the wave becomes unstable and breaks (Duxbury, et. Al., 1994).

2.6 Current

The current is a very broad movement of water, often occurring throughout the ocean. Waves that come towards the coast can cause nearshore current. Currents are also formed due to the wind blowing in a very long time interval, can also be caused by waves that form the beach obliquely. It can also be caused by waves coming towards the coastline. Currents can also carry suspended sediments or those found at the bottom of the sea. Circulation of ocean currents is divided into two categories, namely surface circulation and circulation in the sea (intermediate or deep circulation). Sea surface currents are generally driven by wind stress acting at sea level. Wind tends to push the layer of water on the surface of the sea in the direction of the movement of the wind. But because of the influence of the earth's rotation or the influence of the Coriolis force. The variation of currents generated by the wind against depth is explained theoretically by Ekman (1905).

2.7 Total Suspended Solid

TSS are suspended materials (> 1μm diameter) that are held in a filter with a pore diameter of 0.45 μm. TSS consists of mud and fine sand and microorganisms. The main causes of TSS in waters are soil erosion or soil erosion carried into water bodies. TSS concentration if too high will inhibit the penetration of light into water and cause disruption of photosynthesis. The spread of TSS in coastal and estuary waters is influenced by several physical factors including wind, rainfall, waves, currents and tides (Effendi, 2000). Sastrawijaya (2000) states that TSS concentrations in waters generally consist of phytoplankton, zooplankton, human waste, animal waste, mud, crop and animal residues, and industrial waste. Materials that are suspended in natural waters are not toxic, will occur if excessive amounts can increase the value of turbidity which further inhibits the penetration of sunlight into pools of water (Effendi, 2000). Remote sensing technology has been widely applied to study water quality, one of which is TSS. The quality of waters has different light penetration in certain areas, can be determined by multispectral techniques (Barret and Curtis, 1982). The higher TSS concentration will have a higher reflectance value.

3 METHOD

This research was conducted at the Lamip Bay Multipurpose Terminal Port, located in the border area between Surabaya City and Gresik Regency, which is adjacent to two ports owned by PT Pelabuhan Indonesia III, namely Gresik Port to the west and Tanjung Perak Main Port to the east. The selection of research sites is done purposively. Based on the results of reading the literature and information related to the existence of port development by means of coastal reclamation that can affect coastal resources, this location was chosen to be used as a research location. Based on the Port Development will affect the condition of coastal ecosystems and the livelihoods of coastal communities, it is necessary to study the impact of coastal resources on the development of Teluk Lamong Multipurpose Terminal Port from the aspect of physical impact. The research was carried out starting in the third semester, with the research location in Figure 1 and the survey point in Figure 2.

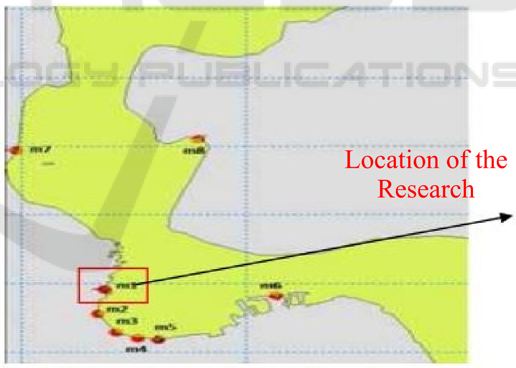

Figure 1: Research Sites.

Figure 2: Location of the Research River.

3.1 Systematics and Research Limits

This thesis research is carried out for one semester, while the research activities include:

1. Problem Formulation.
   This stage as the identification of problems, determinants or focus of a study. The main problem of this research is the factors or impacts caused by coastal resources namely, the pattern of water currents, TSS in the construction of the Port of the Lamip Multipurpose terminal.
2. Literature Study.
   This activity is carried out to gather information related to research in the form of theoretical concepts and relevant matters. Literature sources obtained from the internet, reports related institutions, scientific articles, journals, media, books, and other documents.
3. Data Processing.
   Namely knowing the analysis of shoreline changes, modeling the pattern of water currents, and modeling TSS concentrations based on sensing data long before and after the construction of the Teluk Lamong Multipurpose Port terminal
4. Data Validation.
   Data validation is an activity carried out to measure the extent of differences and errors.
5. Results and Discussion.
   It is a modeling of waters flow patterns in 2012 and 2020 based on Navy Hydrographic and Oceanographic Center data (DISHIDROS) and the National Meteorology, Climatology and Geophysics Agency (BMKG), and TSS concentration modeling based on remote sensing data of the 2A Sentinel Image 2020 National Institute of Aviation and Space (BMKG), and modeling of TSS concentrations based on remote sensing data of the 2A Sentinel Image in 2020. LAPAN). The input from this data processing explains the correlation of the coastal condition of the Teluk Lamong Multipurpose Port terminal with the physical environmental conditions based on 2020.
6. Conclusion.
   It is the answer of the research objective, which is to know the current pattern and sediment distribution.

3.2 Data Processing Stages

In the stages of managing the impact study data before and after the construction of the Teluk Lamong Multipurpose Port:

1. Analyze shoreline changes using DSAS software based on Landsat 7 in 2012 and Landsat 8 in 2020 satellite image data.
2. Determine the focal point of TSS research using remote sensing aids, namely Sentinel 2A satellite imagery recording on January of 2020 then processed using Google Earth Engine at the LAPAN Agency.
3. Modeling the condition of water flow patterns in the Port of Multipurpose Bay in Lamong Bay based on wind, tidal and bathymetry data processed using Mike 21 software.
4. TSS modeling using Mike 21 software based on remote sensing data.

4 RESULTS

4.1 Total Suspended Solid Remote Sensing

TSS is suspended material that causes water turbidity consisting of mud, fine sand and microorganisms mainly caused by soil erosion or water-borne erosion (Effendi, 2003). TSS is one of the important factors to measure water quality based on physical aspects including the addition of solids both organic and inorganic material into the waters so as to increase turbidity which will further inhibit the penetration of sunlight into water bodies. The amount of TSS that is in the waters can reduce the availability of dissolved oxygen. So the high TSS can also directly disrupt aquatic biota. To identify the TSS of Teluk Lamong Port, TSS remote sensing was carried out using Sentinel 2A imagery in 2020 and Landsat 8 satellite imagery in 2017 and 2019. Remote sensing of the distribution of TSS at Teluk Lamong Port using Sentinel 2A satellite imagery in 2020 using Google Earth Engine Software software. In the work of remote sensing the first step taken is to make a mosaic.Data analisi *Total Suspended Solid* (TSS) Data processing from Sentinel 2A satellite imagery in 2020 uses Google earth engine software that can produce TSS remote sensing output. The channels in the Sentinel satellite image data processing are used to obtain reflectance values which are used to estimate TSS concentrations. The first stage, radiometric correction is done to eliminate errors in the sun's elevation angle and the sun-earth distance. The second conversion from the DN value to the radiant value. Third is the conversion of the radiant value to the reflectance value. Fourth conduct TSS analysis.

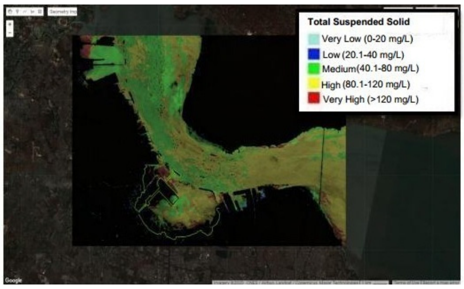

Figure 3: Distribution Total Suspended Solid.

4.2 Modeling of Teluk Lamong Harbor

4.2.1 Wind

One that influences the speed and direction of the current is the wind factor. In Mike 21 modeling, the use of wind data as input wind data forcing contained in the hydrodynamics module. In addition to influencing the pattern of current movement, wind can influence wave generation, so that in relation to sediment transport these three factors are intermittent. The wind data input used in March 2020 was adjusted for the timestep modeling simulation conducted. The following diagram of the rose wind shows the dominant direction coming from west to southeast.

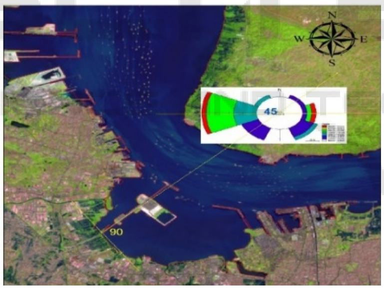

Figure 4: March winds.

4.2.2 Depth

Data on seabed depth is a supporting data used in this study so it is necessary to know the seabed condition of the Gulf waters, using topex satellite imagery with file format in the form of SRTM in 2011 to create a year boundary depth of Teluk Lamong Port. The data is managed using Global Mapper 14 software which is done by generating countours with a contour interval of 0.1 meters. Furthermore, the data plot has been processed in Surfer 11 software to get a bathymetry contour map in the form of 2D maps.
Then the data is meshed on a map plot in Arcgis 10.61 software used in the bathymetry plot in Mike 21 software. The input file is boundary of land and water.

Next is the display of the xyz input file modeling results in Mike 21 software.

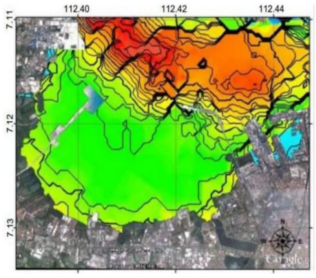

Figure 5: Depth.

4.2.3 Tides

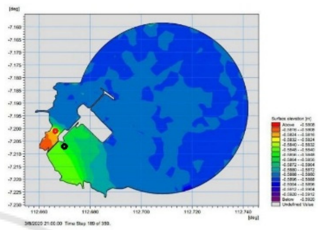

Figure 6: Low Tide Conditions.

For the model of current patterns at low tide in Figure 6 occurred on timestep 191 dated March 8, 2020 at 23:00 with the maximum water level at low tide conditions is -1.0875 meters at the red point and -1.055 meters at the black point, the speed of the current at this condition range between 0.01 m / s for both points.

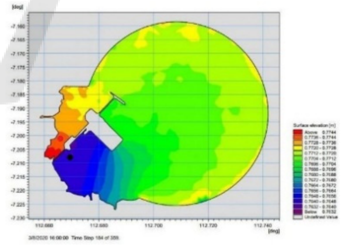

Figure 7: High Tide Conditions.

For the current tide pattern model in Figure 7 occurs on timestep 184 dated March 8, 2020 with the maximum water level at tide conditions is 0.7744 meters for the yellow point and 0.7640 meters for the black point, the current speed in this condition ranges from 0.008 m / s for the yellow dot and 0,008-0,016 m / s for the second black.

Tidal Validation. Tidal conditions are analyzed using the harmonic analysis method, this method has a tidal pair hypothesis is the sum of several wave components that have a certain amplitude and frequency. This analysis is to obtain the amplitude and phase of the tidal components. Tidal recording and forecasting is carried out for 15 days in a row with observation points 7 ° 12 '17 "LS and 112 ° 40 '46" East. The high observations that were started were analyzed using the Admiralty method and verified with the Root Mean Square Error (RMSE) and Cost Function (CF) methods. The following is the tidal data presented in Table 2 and Table 3. While graphs representing tidal data for 2012 and 2020 are presented in Figure 12.

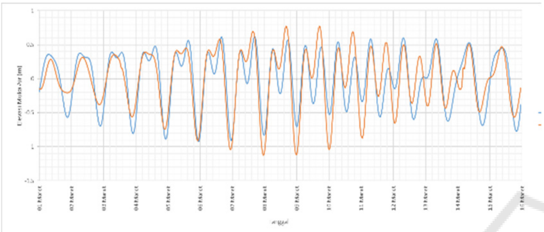

Figure 8: Tide Comparison Charts for 2012 and 2020.

Admiralty Analysis. Calculation using the admiralty method, which is a calculation to find the value of the amplitude (A) and phase difference (g0) of the observation data for 15 or 29 pigs (observation days) and the mean sea level (S0) which has been corrected (Smoothing). The following are tidal components of the 2012 admiralty method analysis results and 2020.

Table 1: Tidal Component 2012.

Tidal Component Result											
		S0	M2	S2	N2	K1	O1	M4	MS4	K2	P1
A Cm		0.000	0.259	0.181	0.086	0.331	0.256	0.002	0.002	0.049	0.109
g°			282.07	179.70	30.07	104.52	67.42	147.06	282.48	179.70	104.52

The types of tides in the Madura Strait waters in 2012 according to Formzahl (F) numbers based on the tidal components in the table above are as follows.

$$F = (K1+O1) / (M2+S2) = (0.331+0.256) / (0.259+0.181) = 1.336$$

Table 2: Tidal Component 2020.

Tidal Component Result											
		S0	M2	S2	N2	K1	O1	M4	MS4	K2	P1
A Cm		0.000	0.253	0.180	0.105	0.381	0.239	0.002	0.003	0.049	0.126
g°			249.03	189.46	4.63	125.04	4.21	157.48	256.17	189.46	125.04

Tidal types in the waters of the Madura Strait in 2020 according to the Formzahl (F) number based on the tidal components in the table above are as follows.

$$F = (K1+O1) / (M2+S2) = (0.381+0.239) / (0.253+0.180) = 1.433$$

The explanation of the tidal components above is as follows:

- S0 is MSL
- M2 is a tidal component that is influenced by the moon's gravitational phenomenon with circular orbits and parallel to the earth's equator.
- S2 is a tidal component that is influenced by the phenomenon of solar gravity with circular orbits and the earth's equatorial alignment.
- N2 is a tidal component that is influenced by the phenomenon of changes in the distance of the moon to the earth due to elliptical paths.
- K1 is a tidal component that is influenced by the phenomenon of the declination of the moon and sun systems.
- O1 is a tidal component that is influenced by the phenomenon of moon declination.
- M4 is a tidal component that is affected by the phenomenon of twice the angular velocity of M2.
- MS4 is a tidal component that is influenced by the phenomenon of interaction between M2 and S2.
- K2 is a tidal component that is influenced by the phenomenon of changes in the distance of the moon to the earth due to elliptical paths.
- P1 is a tidal component that is influenced by the phenomenon of solar declination.

Table 3: Classification of Tidal Type.

Value	Tidal Type	Phenomenon
0 < F <0.25	Coupled Daily	2x pairs a day with the same relative height
0.25 < F <1.5	The mixture tends to double daily	2x a day with different height and different intervals
1.5 < F <3	The mixture tends to single daily	1x or 2x pairs a day with different interval
F > 3	Single Daily	1x pair, when spring occurs 2x pairs a day

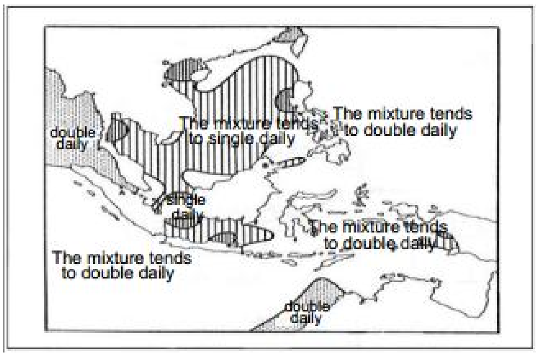

Figure 9: Distribution of Tidal Types in Indonesian Waters (Triatmodjo, 1999).

Formzahl's numbers are 1,336 and 1,433, according to Table 4.9, the numbers are classified as 0.25 <F <1.5 or a mixture of double daily skew. In Figure 2, the tidal type in the Madura Strait Waters indicated by a red circle is the Mixed Daily Condong Mix.

Data Verification. 2012 Tidal Analysis is used as a reference for verification of 2020 data. Quantitatively by calculating the amount of errors that occur from each data can be calculated by:

$$\text{RMSE} = \left(\frac{\Sigma(y_i - \hat{y}_i)}{\text{n}}\right)^{1/2}$$

dimana:
RMSE : Root Mean Square Error
y : data of 2012
ŷ : data of 2020
n: amount of data

Based on the results of analysis and verification of tides obtained RMSE value of 0.253 or a level of confidence of 74.7%.

Model verification is used to determine the accuracy of both wind data sources quantitatively by calculating the amount of error that occurs from each data. Wind speed verification uses a Cost Function (CF) statistical analysis. According to George et al. (2010), the calculation of the CF method can be done with the formula:

$$\text{CF} = \frac{1}{N}\sum_{n=1}^{N}\frac{|Dn - Mn|}{\sigma D}$$

dengan

$$\sigma D = \sqrt{\frac{1}{N}\sum_{n=1}^{N}(Dn - \bar{D})^2}$$

Where N is the amount of data; n is nth data; D is the 2012 data value; σD is the standard deviation; M is the 2020 data value; D is the 2020 average data and CF is the Cost Function. According to George et al. (2010), the criteria used are:

CF < 1 = Sangat Baik 1 < CF < 2= Baik
2 <CF <3 = Less CF> 3 = Very Less

Based on the analysis, it is known that CF is obtained by 0.485 This means that verification of data for 2012 and 2020 is in the range of CF <1 or very good.

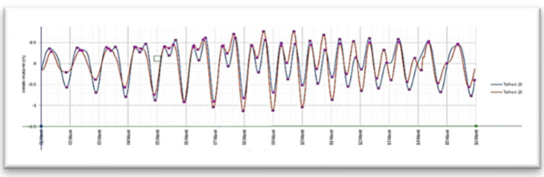

Figure 10: Tidal 2012 and 2020.

4.3 Total Suspended Solid

Sediments on the coast cannot be separated due to oceanographic factors that occur in the waters around the coast. Oceanographic factors that influence sediment type and sediment distribution are tides, wind, waves and currents. Sediment distribution modeling uses the parameters of currents generated by tides and wave effects. Sediment sample data based on the journal Sediment Distribution Pattern Analysis to Support Maintenance of Port Waters Depth Using 3D Hydrodynamic Modeling by Pratomo et al., 2017 with a density value of 1188 kg/m³, dry density 884 kg/m³ and sediment concentration of (D50) 0, 0738 mm. Sediment transportation is important to know the speed of sediment, especially supine sediment. For non cohesive sediments, such as sand, sedimentation velocity depends on the density of sediment and water mass, water viscosity, dimensions and shape of sediment particles (Triatmodjo, 2016). Also in calculating the rate of sedimentation hydrometer analysis is needed which aims to determine the grain size of the suspended sediment which intends to determine the speed of deposition of soil grains in water using Stoke's Law, with the formula;

$$V = \frac{1}{8} + \mu\frac{Dxg}{\eta}(\gamma S - \gamma w)$$

D : grain diameter (mm)
V : speed of settling soil grains (cm / s)
γS : grain weight (g / cm³)
γw : weight of water content (g / cm³)
μ : water thickness

Sediment transportation is the transfer of material from one place to another. This transfer is in the form of an increase (inflow) or reduction (outflow). (Achmad, 2011).

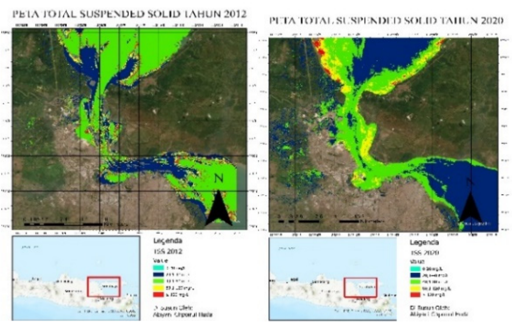

Figure 11: Remote Sensing of Total Suspended Solid.

Sources of sediment data based on the journal Study of the Impact of the Reclamation Plan in Lamong Bay, East Java Province on Tidal Flow

Patterns and Sediment Transports and data on the tide and tide flow velocity results of Mike 21 modeling based on BIG 2012 data Tidal current velocity of 0.2 m / s, tidal current velocity of 0.1 m/s and (D50) sediment concentration of 0.0738 mm.

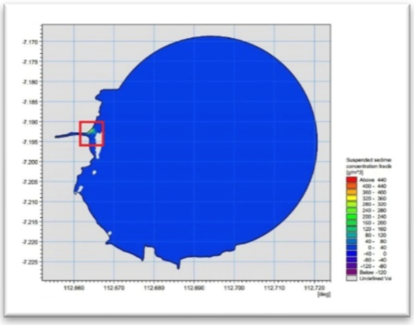

Figure 12: TSS of Law Tide 2012.

Based on observations of suspended sediment at low tide in Figure 12 on March 5, 2012 at 22:00 timestep 115. It can be seen that the value is quite high in the area around the Lamong River with values ranging from 320-360 g / m³.

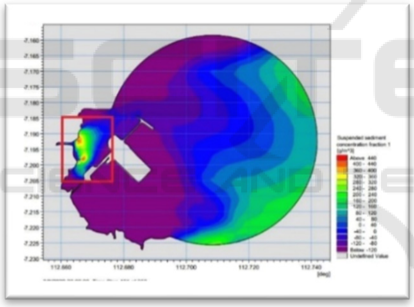

Figure 13: TSS of Law Tide 2020.

Based on observations of suspended sediment at low tide in Figure 13 on March 8, 2020, 23:00 timestep 191. There are high values in the area around the Lamong River with values ranging from 360-400 g / m³.

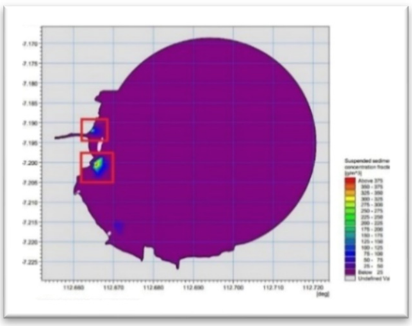

Figure 14: TSS of High Tide 2012.

Based on observations of suspended sediment at low tide in Figure 14 on March 7, 2012 at 17:00 timestep 161. It can be seen that the value is quite high in the area around the Lamong River at two observation points with values ranging from 325-350 g/m³.

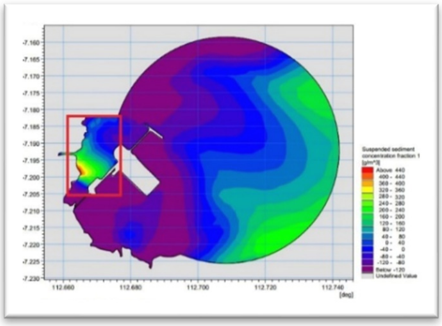

Figure 15: TSS of High Tide 2020.

Based on observations of suspended sediment at low tide in Figure 15 on March 8, 2020 at 16:00 timestep 184. There are high values in the area around the Lamong River at two observation points with values ranging from 440 g/m³. Changes in the bottom profile of the water can occur due to the sedimentation process or due to silting. Factors affecting the sedimentation or siltation process include the movement of currents, waves, and tides as well as new buildings created on the coast of Lamong Bay. In this study, sediment changes were observed based on changes in the bed base change (bed level change) located in the area within the Port of Teluk Lamong. Modeling observations were carried out by comparing changes in the bottom profile of the water after modeling simulations for 15 days with the object of the port research conditions before reclamation and after beach reclamation. Based on the results of the pomedelan, TSS conditions are greater in the Lamong River. Lamong River is part of the Bengawan Solo River Basin Unit which is managed by the Solo Bengawan River Basin. The Lamong River estuary is a tidal area, where at high tide the area is submerged in seawater, but at low tide this area becomes landlocked. As a result of this land tends to increase sedimentation processes so that the land area becomes wider. The Lamong River downstream flows on the alluvial land with a gentle slope, so sediment transport is dominated by fine fractions with relatively large amounts that can settle at the estuary (Sulistyaningsih, 2000). The following is data on river flow and river sediment concentrations which empties into Lamong Bay based on research by Alwafi Pujiraharjo (2013) with the title Study of the

Impact of the Reclamation Plan in Lamong Bay, East Java Province on Tidal Flow Patterns and Sediment Transportation. With the reclamation of the waters of the lamong bay, the narrowing of the flow of water around the lamong river and the silting of galang island, the velocity of the flow between the lamong river becomes large. This will result in greater sediment transport from rivers. Likewise, at low tide, outflows from lamong bay pass through the lamong river area. The currents are quite large at high tide but at low tide, the flow velocity in the lamong river and galang island areas becomes so small that the sediment transported will be easily deposited and gradually cause siltation.

5 CONCLUSION

The model of the current pattern at low tide in Figure 6. The maximum water level at low tide is -1.0875 meters at the red point and -1.055 meters at the black point, the current velocity at this condition ranges between 0.01 m / s for both points. For the current tide pattern model in Figure 7 occurs with the maximum water surface height at tide conditions is 0.7744 meters for the yellow point and 0.7640 meters for the black point, the current speed in this condition ranges from 0.008 m / s for the yellow point and 0.008-0.016 m / s for the second black. Tidal current velocity of 0.2 m / s, tidal current velocity of 0.1 m / s and (D50) sediment concentration of 0.0738 mm around the Port of Teluk Lamong with an average TSS value of 4.998 per area.

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