Flow Pattern in the Port of Kalbut Situbondo

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Abstract: One of the important reviews in port development is a current. The pattern and velocity of the current greatly affect the movement of the ship, so this research is needed to know the pattern and speed of the current at port of Kalbut Situbondo. The data used in this research are bathymetry, tidal, wind, and current. Bathymetry, tidal, and wind data are processed using hydrodynamic modules. Based on the simulation results the current pattern can be predicted that at high tide, the current flows from the Northeast to the Southwest with a starting speed of 0.05 m/s up to 0.45 m/s. The current velocity at low tide is 0.05 m/s to 0.15 m/s which is flows from Southwest to Northeast.

1 INTRODUCTION

The Port of Kalbut Situbondo is a regional feeder port whose main function is to serve the domestic sea transport activities, the restructuring of domestic sea transport in limited quantities, feeder for the main port and gathering port, and as the place of origin of passenger and goods destinations, and the ferry transportation with service range within the province. Site selection to build ports should take into account the factors of the ocean and land (Syaefudin, 2008). The flow review in the port development plan is very important, as the current determines how much sedimentation can occur at the port.

The current is the movement of a mass of water from one place to another caused by wind blowing or caused by tidal movement of sea water (Nontji, 1993). The movement of water masses is caused by three factors: wind, tidal currents, and turbulence (Pond and Pickard, 1983). The currents can also be formed by winds blowing in very long periods of time, can also be caused by the waves that hit the beach at an angle (Loupatty, 2013). It can also be caused by waves formed from waves coming into the shoreline, thus there will be two current systems that dominate seawater movement i.e. rip current and longshore current. The purpose of this research is to know and analyze the direction and speed of current in The Port of Kalbut Situbondo.

2 METHODS

This research was started from January to July 2017 and took place in Kalbut Harbor Waters located in Semiring Village, Mangaran Subdistrict, Situbondo District, East Java Province. Situbondo district is adjacent to Madura Strait in the north, Border with Bali Strait in the east, District of Bondowoso and Banyuwangi in the south, District of Probolinggo in the west (http://situbondokab.go.id). Geographically, Kalbut Port is located at coordinates 07 ° 37'30 ° S and 114 ° 01'00 ° E. The location of the study is shown in Figure 1:

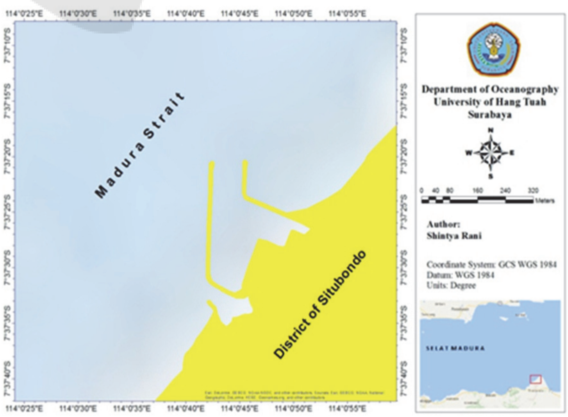

Figure 1: Research location at Port of Kalbut Situbondo.

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The materials required in this study are bathymetry data obtained from the Pusat Hidro Oseanografi TNI-AL (Pushidrosal), tidal data obtained from field observations using tidal palms, five years of wind data obtained from Badan Meteorologi Klimatologi dan Geofisika (BMKG). Current data obtained from field observations using current meters at depth of 0.2d, 0.6d, 0.8d. Equipment needed to assist data processing in order to obtain the results of current patterns in the waters of Kalbut Port Situbondo using hydrodynamic module program.

The implementation of this research is divided into two stages, the first stage is the data collection bathimetri, tides, winds, waves, currents and sediments and then proceed with data processing and data analysis. The first step is to digitize the bathymetry map to get the depth contour. Tidal data is processed using Admiralty method to obtain tidal harmonic constants (Fikri, et.al, 2013). Wind data as a wave generator is used to determine the direction, height, and significant period, while the current data is processed to determine the current velocity as the validation of the model results. The results of tidal, bathymetric, and wind data processing as inputs to create a simulation in hydrodynamic module (Oktiarini, 2015) which will produce simulation in the form of pattern and current velocity.

3 RESULTS

3.1 Bathymetry

The depth of Kalbut Waters Situbondo ranged from 2-5.2 meters indicated by the gradation of dark orange to purple. The depth of the water in the pond is about 2-2.4, while slightly in front of the pond water depth ranging from 2.8-4 meters. The average slope of the topography of this area is 0.02 ° or 1:42. Based on Verstappen which refers to the United State Soil System Management (USSSM) and Universal Soil Loss Equation (USLE), a slope of less than 1 ° is included in the almost flat category (Verstappen, 1953). The bathymetry profile of The Port of Kalbut waters region as shown in Figure 2.

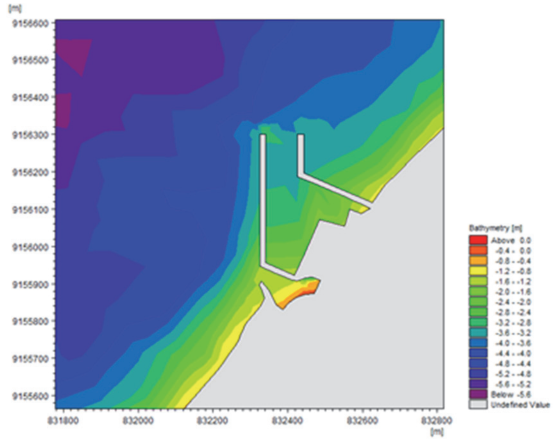


Figure 2: Bathimetry of The Port of Kalbut Situbondo.

3.2 Tidal

The observed data obtained were calculated using the admiralty method to find the tidal harmonic constant. The harmonic constant will be used to process time series data that will be input into the hydrodynamic module. The harmonic constants are as shown in Table 1:

Table 1: Constant tidal harmonics.

S_o	M_2	S_2	N_2	K_1
128	38	2	55	22
	347	20	112	112
O_1	M_4	MS_4	K_2	P_1
16	1	2	0.4	7
296	91	282	20	112

The values of the constants M2, S2, O1 and K1 have relatively larger values than the other constant values because they are the major constants in the tides used as determinants of the type of tides. M2 is a constant influenced by the moon, O1 is a constant influenced by the declaration of the moon, K1 is a constant influenced by moon and sun declination, whereas S1 is a constant influenced by the sun. Among the four constants M2 and O1 values are relatively larger than K1 and S2, this indicates that the moon has a greater influence than the influence of the sun in the up and down movement of water in Kalbut Situbondo waters. Rthe tides are influenced by the gravitational pull of celestial bodies, especially the moon and the sun, because the position of the moon closer to the earth, the gravity of the earth is stronger so that its influence on tidal fluctuations is also more Great than the sun (Pariwono, 1989). The value of Fromzahl in these waters is 0.97 which indicates that this type of tidal in these waters is a mixture of double daily skew that occurs twice and twice a day at low tide but occasionally occurs once and once the high tide has high and time different.

The mean sea level (MSL) value of the waters is 128 cm from the zero point of the known tidal signs of the constant value in Table 4.1 above in column S0. After knowing harmonic constants, then can be calculated face of low or low water and high water that happened in those waters. The high water (HW) that occurs in the area is 206 cm above the middle seat or MSL, while the low water value (LW) in the region is 49 cm below the middle seat or MSL. At the time of tidal measurement there should be a benchmark that serves as a bounding point of measurement. The height of the benchmark for this tidal measurement is 380 cm from the point of zero tide sign. Tidal profile can be seen in Figure 3 and Figure 4.

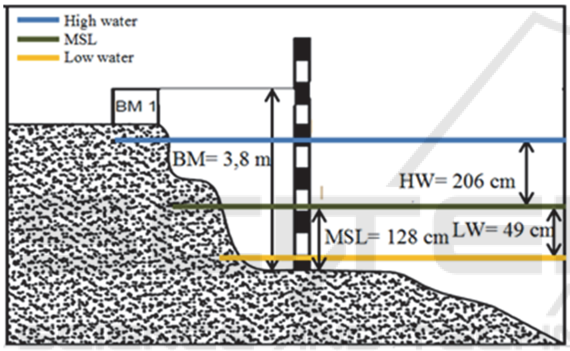


Figure 3: Benchmark profile of tidal signs.

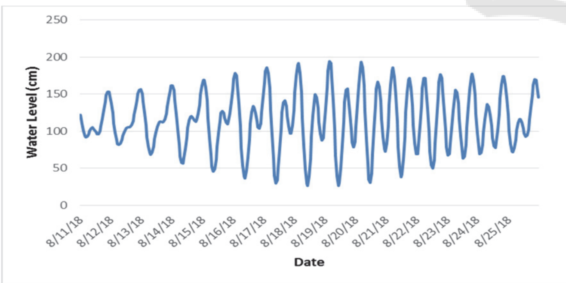


Figure 4: Tidal fluctuation.

The tide is closely related to bathymetry, low water or so-called Z0 is the zero point of the map in the bathymetry map. Z0 serves as a zero in the bathymetry, meaning that the entire depth of the waters is measured from Z0 not from the bottom of the waters. This is done for the sake of safety of shipping. In the bathymetry field measurement results are also required correction of the tides to be able to know the actual depth before it is affected by the tidal and low tide conditions. In the next stage, this tidal data will be used as input in the program to be able to know the current pattern and the sedimentation that occurred. Tidal data will be processed in the form of time series which is then stored with a separate file form to later be used as input material on the hydrodynamic module.

3.3 Wind and Wave

Wind data obtained made a form of wind rose to determine the direction of wind movement, speed, and frequency of wind movement. Wind that has been processed into a form of wind rose indicates that the first dominant wind direction comes from the East with a frequency of 62%, the second dominant wind comes from the North with a frequency of 15%, the third dominant wind from the North West with a frequency of 11%, and the fourth dominant wind comes from the Northeast with a frequency of 11%. The frequency distribution and the result of wind roses can be seen in Figure 5.

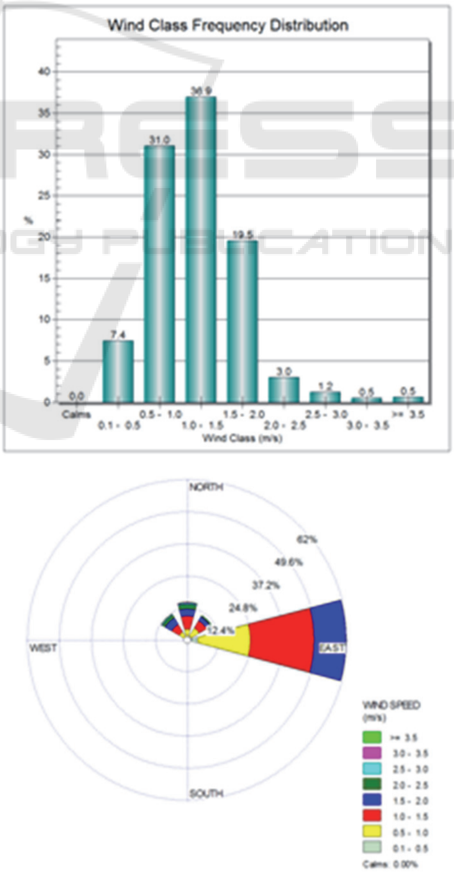


Figure 5: Frequency of wind.

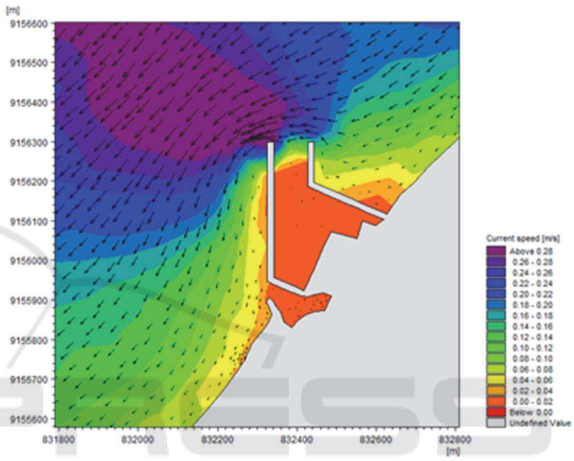
The dominant velocity of all dominant directions is 1-1.5 m / s indicated by the red color then the second dominant velocity is 0.5-1 m / s indicated by the yellow color. These two dominant velocities are highly visible in the first dominant wind direction originating from the East. In the area of the water visible speed 1-1.5 m / s is indicated by the red frequency greater. The third dominant velocity of 1.5 - 2 m / s is indicated by the blue color. The dominant speed is applicable in all dominant wind directions. Based on the wind data can be forecasting the wave to determine the significant height (Hs) and significant period (Ts) of the wave. The winds are sorted into significant winds corrected to determine the wind above sea level (Uw) which has a value of 5.25. Then from the value of Uw is known value of wind voltage factor (UA) is 5.45. To find out Hs and Ts have to know the fetch value as presented in Table 4.2 and Figure 4.7 which yields a fetch value of 98.2. Based on the value of UA and fetch it can be known the value of Hs and Ts using nomogram graph in Figure 2.6. Kalbut Waters Port Situbondo has a Hs value of 0.7 m with a value of Ts 4.5 seconds.

3.4 Current

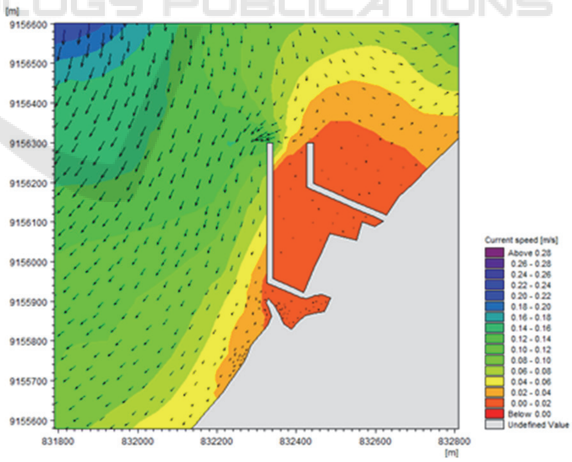
The pattern of current distribution in The Port of Kalbut Situbondo when the tide flows from the North to Northeast and Southwest with a speed of 0.02 - 0.28 m / s. The current velocity outside the port gradually increases until the highest maximum speed of 0.28 m / s reaches the front of the left jetty mouth marked in red. There are two patterns of distribution, some of the currents flowing from the Northeast flow directly to the Southwest. The second pattern is the current from the North, the current flows towards the coast then the current turns to two different directions ie to the Northeast and Southwest. This is due to the current flowing toward the coast obstructed by the rising coastal topography so that the current is turned in two different directions.

The current in the pond is relatively quiet with a range of 0.02-0.04 m / s as it is protected by the jetty. Current velocity at high tide is shown in Figure 6. At low tide (Figure 7) the current velocity in The Port of Kalbut Situbondo ranges from 0.02-0.2 m / s marked by blue to light green. The current pattern at low tide flows from the Southwest to the Northeast, increasingly to the Northeast increasing relative speed which is characterized by the green color in the Northeast. In the mouth of the jetty to the left also occurs the addition of current velocity caused by the jetty turns.

The difference in current velocity at both high and low tides can be caused by different depths. The current will be faster when the depth is increased, it is also clearly indicated by the current at the next tide on the right and left of the jetty. The current velocity inside a very small port can be caused by two things, the first being a jetty that deflects the current coming from the North East so as not to enter the harbor area, the second being the depth towards the shallower shore, hampering the movement of the current.

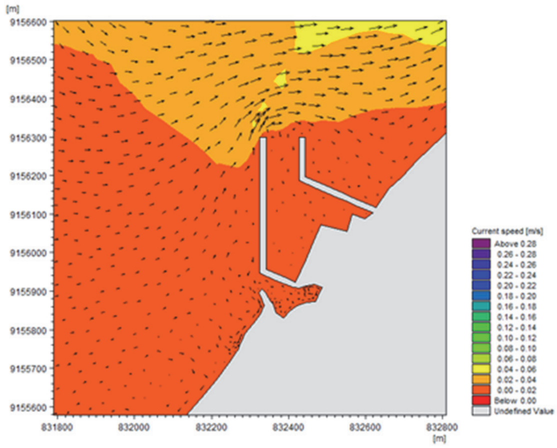


(a)



(b)

Figure 6: (a) Current pattern at high tide; (B) the current pattern towards the pairs.



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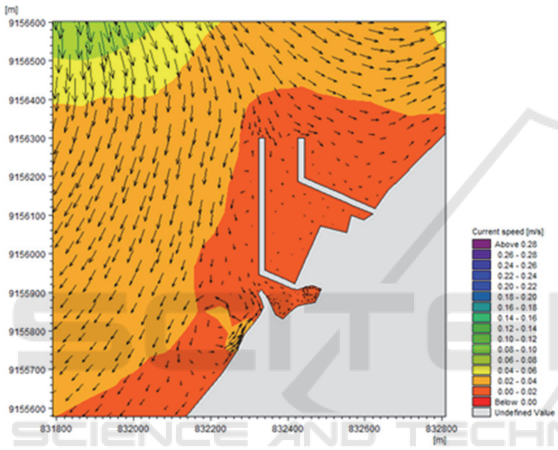

(b)

Figure 7: (a) Current pattern at low tide; (b) the pattern of the current toward receding.

The existence of two different patterns in tidal or low tide conditions in a day due to the type of tidal that occurs in this area of water is a mixture of double daily skew. At a time when the currents originating from the North usually occur at the turn of the transit. At when the maximum tide, the current flows from the Northeast with a long time span, then becomes receded and the direction of change in flow from the southwest, the decrease in speed occurs briefly. At the time of re-currents flowing from the North to the mainland and in the two-way northeast of Northeast and Southwest, after that become receded with the same direction of flow until completely in real receding condition with the current pattern flowing from the Southwest toward Northeast with a long time.

4 CONCLUSIONS

There are two patterns of current in the waters of the Port of Kalbut Situbondo that is the current flowing from the Northeast to the Southwest at high tide and at low tide flowing from the Southwest to the Northeast. At the time of the transition when heading to high tide or to the low tide, current flows from the north to the beach and diverted to the Northeast and Southwest. The mean current velocity within the port area is 0.02-0.04 m / s.

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