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Bathymetry Mapping in The Batu Ampar Waters, Batam: Using Teledyne Odom MB1 Multibeam Echo Sounder (MBES)

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***Abstract*—Batu Ampar waters, Batam are waters that are in the Riau archipelago, Indonesia. These waters are waters that are very often crossed by cargo ships in shipping goods between provinces. Bathymetry mapping in Batu Ampar waters is the initial activity to obtain accurate depth value information, as a preliminary study for the determination of bottom waters sedimentation. The purpose of this study is to determine the value of bathymetry and determine the type of Batu Ampar waters, Batam, Riau Islands. The method used in this study is the underwater acoustic method, using research instruments namely Teledyne Odom MB1 Multibeam Echo Sounder (MBES). The results of bathymetric mapping in Batu Ampar waters that have been corrected show bathymetry values classified as shallow waters with a depth range that is (-1 to -10.5 meters), with the measured waters area being 775,094 m2, and having a type of bottom water sediment which is dominated by sand-based sediments.**

***Keywords*— Batu Ampar waters, Bathymetry Mapping, Teledyne Odom MB1 Multibeam Echo Sounder (MBES), Sediment**

I. INTRODUCTION (*HEADING 1*)

Utilization of bathymetry or ocean depth mapping has now begun to develop in the marine sector in Indonesia. This bathymetric mapping serves to provide information to users in understanding and utilizing information from depth values and objects that have been mapped. Utilization of bathymetry mapping uses the hydroacoustic method which is an underwater detection technology using acoustic waves [1-2]. The information provided is in the form of information quickly and directly in the detection area and does not endanger the objects that are in the research location using certain frequencies.

Bathymetry survey is an activity in measuring depth in waters to obtain information about the image model and surface form topography of the bottom of the waters or known as the method of casting [3]. The casting device used in conducting bathymetry surveys is using multibeam echosounder (MBES) [4]. This tool is very suitable for measuring the depth of the sea because the area of the seafloor area is wide, has a high resolution (0.1 meters on vertical accuracy and less than 1 meter on horizontal accuracy) and consumes very little time with a sufficient degree of depth detection [5-6].

Information obtained by using multibeam echosounder is the position data (x, y) and depth data (h) of waters which are then able to produce extraction of information data about the image of the seabed surface [7]. This is certainly supported by correction of tidal waters data using the datum chart of Mean Sea Level (MSL) [8].

Batu Ampar waters are waters that are on the island of Batam, Riau island province. This is the importance of conducting a bathymetry survey with the number of ships passing around the Batu Ampar waters, especially cargo ships which will be loaded at the Batu Ampar cargo port, Batam. To obtain the value of the depth of the sea and analyze the morphology of the base of Batu Ampar waters, information or knowing the bathymetry is needed so that a bathymetry survey is carried out.

II. RESEARCH METHOD

A. Time and Location of The Research

The location of data collection is in the Batu Ampar port pond. Data collection was carried out in 2 parts of the pond at Batu Ampar port. The location of the data collection is 775,094 m^2. The location of the data collection can be seen in Figure 1. The time of the study was carried out on September 19-20, 2019.

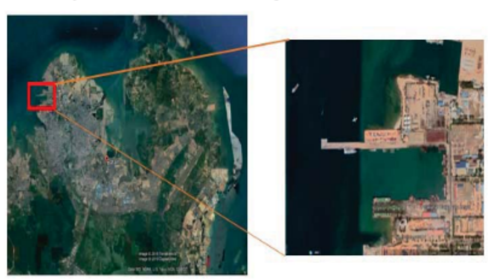

Fig. 1. Research location in Batu Ampar waters, Indonesia

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B. Tools and materials

The measurement of ocean depth in this study uses Multibeam Echosounder (MBES) Teledyne Odhom Multi-Beam (MB1), using a 120-degree swath coverage and a frequency of 182 kHz Figure 2. MBES is an instrument that uses a hydroacoustic method by applying the same principle as a single beam but the difference lies in the number of beams emitted more than one beam. Software used in the acquisition and processing of PDS 2000 bathymetry data.

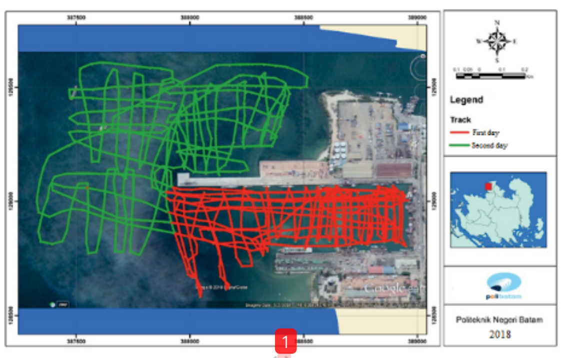
Fig. 2. Teledyne Odhom Multi Beam (MB1)

C. Collecting data and processing

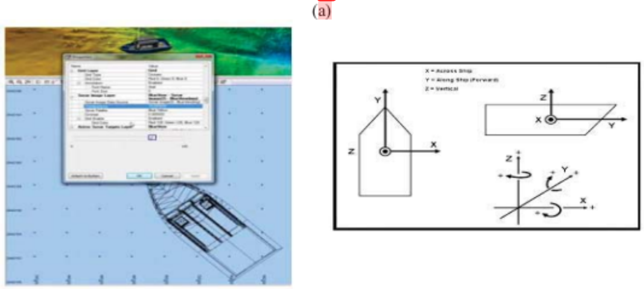
Collecting data of ocean depth data (extraction) is carried out with an area of about 10x1 km with a distance between survey lanes of around 25 meters. According to [9], the main survey lane must be perpendicular to the coastline with a maximum interval of one cm on the survey scale. Map of the distribution lane is shown in Fig. 3.

The depth value of the multibeam echosounder sounding that has been done, is then corrected by the value of tides (MSL). According to [10], the magnitude of the tidal correction is the value of the depth (which has been corrected by the transducer) corrected by the value of reduction corresponding to the position of the sea level at the time of measurement. Tidal correction performed is obtained directly by using tidal palm for 4 days with a continuous 15-minute recording time interval (01-30 September December 2018). The Admiralty method is used to analyze tidal data to obtain MSL, LLWL, HHWL, and water types. The Admiralty method will produce tidal components so that the value obtained can be calculated. The formula used according to [11] is as follows:

1. MSL (Mean Sea Level) MSL = A(So)
2. LLWL (Lowest Low Water Level) LLWL = A(So) – [A(M2) + A(S2) + A(N2) + A(K1) + A(O1) + A(P1) + A(K2) + A(M4) + A(MS4)]
3. HHWL (Highest High Water Level) HHWL = A(So) + [A(M2) + A(S2) + A(N2) + A(K1) + A(O1) + A(P1) +A(K2) + A(M4) + A(MS4)]



(a)



(b)

Fig. 3. (a). Lane of Batu Ampar Waters (b). The design of the flagship ship uses PDS 2000 software (Data Processing, 2018)

After this has been done, the tidal type is determined at the location of the study using (1):

$$F = \frac{K_1 + O_1}{M_2 + S_2} \quad (1)$$

where: F is the value of Formzhal K1 and O1 is the main daily tidal constant M2 and S2 are the main double tide constants.

Extraction of extracting data was taken using a multibeam echosounder with the Multibeam Echosounder (MBES) type Teledyne Odhom Multi-Beam (MB1) with a frequency of 182 kHz. Correction of the results of the casting data to erase error data from the results of the casting or the error values. The casting data is processed using PDS software for correction of tides, namely the value of datum or Z0 chart results of tidal predictions and correction of sound velocity profile data. The corrected data is then converted so that it will get a value of xy (coordinate point) and z (depth) [12].

Corrections made include:

a. Correction of depth (correction of acoustic creepage);
b. Transducer position;
c. Correction of transducer draft (ship diagram);
d. Correction of ship movements (HPR);
e. Tidal correction; and others.
f. Deep sea reduction which is visually displayed in Fig.4.

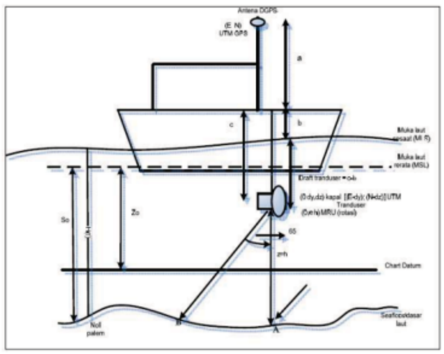


Fig. 4. Sea depth reduction [8]

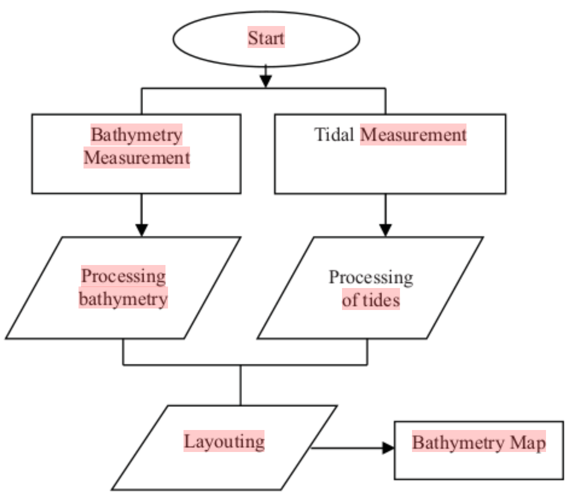


Fig. 5. Data processing flow chart

Fig. 4 shows the position of the ship globally obtained from GPS, namely (E, N) UTM then measured the static offset between the transducer or MRU, in this case, the vessel and GPS antenna and instantaneous sea level (a, b, c) so that the draft transducer can be obtained namely cd The position of the transducer when retrieving data is (0, dy, dz) and the position of MRU (0, e, h) after the rotation effect in this case is z = h (has been corrected rotation) Then the depth reduction obtained is: So that the depth point on the seabed determined on the multibeam depending on the draft transducer (cd), tide reduction (Z0), phase difference (Δt) which affects depth with a certain beam angle resolution. The general data processing flow chart carried out in this study can be seen in Fig. 5.to the south of Batam with varying wind power.

III. Result and Discussion

Seawater Tides 30-day tidal data obtained from field measurement data were analyzed using the Admiralty method. Calculations using the tidal component values will get the Mean Sea Level, Low Water Level, High Water Level, Surge Face (Zo). The results of the calculations are presented in Table 1.

TABLE I. The results of the analysis of tidal harmonic constants with the Admiralty method

	So	M2	S2	N2	K2	K1	O1	P1	M4	MS4
A cm	195.6	70.6	41.0	15.9	9.4	21.6	22.8	7.1	16.7	5.6
g		325.1	15.4	245.6	15.4	282.7	211.0	282.7	77.0	195.6

TABLE II. Important elevation values resulting from tidal data processing using the Admiralty method

Information	Elevation(cm)
MSL	1245.3
HWL	368.1
LWL	23.0
Z0	1.58

The Formzahl numbers obtained from the analysis of tidal harmonic components are 0.3972 which indicates that the tidal type in the waters of Batu Ampar, Batam is a mixed type with a mixed type leaning to double daily. The tidal graph is presented in Fig. 6.

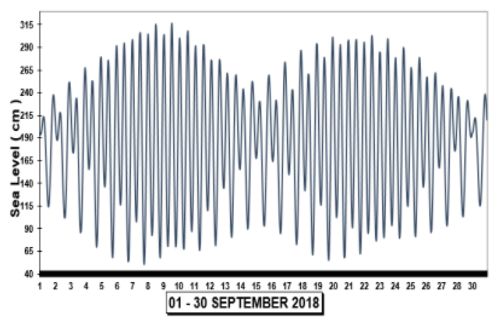


Fig. 6. Batu Ampar Tidal Height Chart, Batam (Data Processing, 2018)

The results of measuring the bathymetry of Batu Ampar waters using corrected data, then producing accurate depth data. Accurate depth data is then extracted in PDS 2000 software into a grid model using the azimuth 290° angle and elevation of 30° can be seen in Figure 7. The beam pattern, 2D and 3D bathymetric maps are shown in Figure 8.

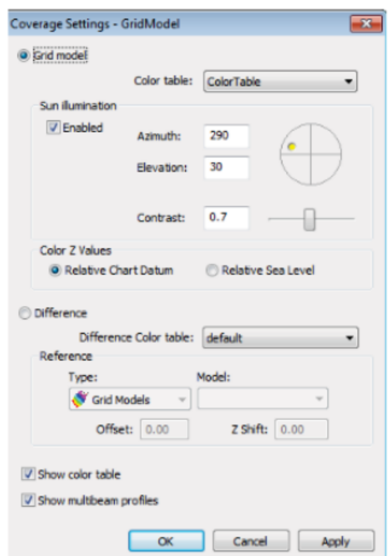


Fig. 7. Coverage settings - PDS 2000 Grid Model of bathymetry

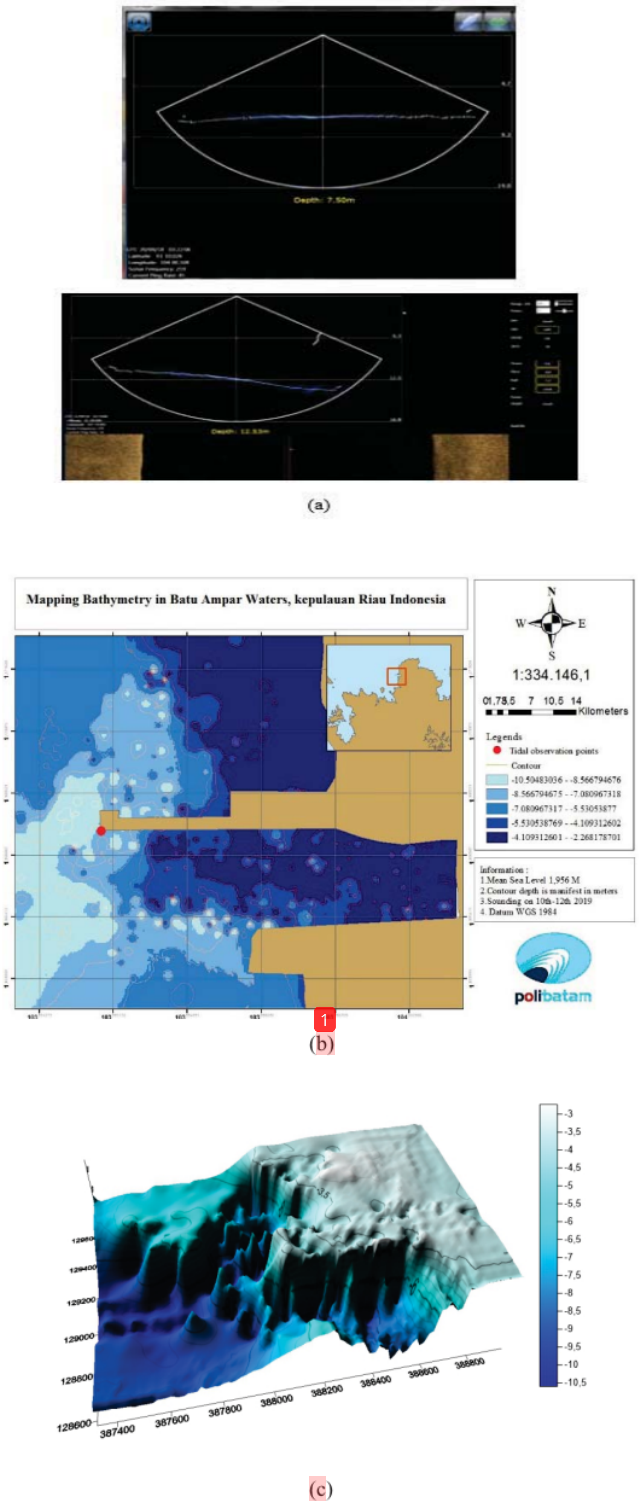


Fig. 8. (a). Beam bathymetry pattern, (b). 2D bathymetry maps in Batu Ampar, Batam (Data Processing, 2018), and (c). 3D bathymetry map in Batu Ampar waters, Batam (Data Processing, 2018)

The speed of transport of the ship performs the shoot from point to point with an average of 8.94 kph or 4.8 Knots. This value is included in the standard classification where the speed of the ship when the cast must be less than 7 knots. In addition, the interval between the data point distance from the point to the dominant point is between 5-15 meters. The results of processing bathymetry data in amber waters clearly show that the deepest bathymetry data is worth -10.5 meters and the shallowest is worth -3 meters. The 3D model is the result of processing bathymetry data made using Surfer 12 software. The purpose of making 3D models is to analyze and find out the surface morphology of the seabed surface.

The results of the 3D model are addressed in Figure 8c. The results of depth (Figure 8) are corrected results with observations of the tide and sound velocity profile. Tidal water types in Batu Ampar waters are mixed to double daily. The bathymetry in water can change at any time following sea level changes. Measuring the results of bathymetry at the location of this study did not show significant changes in depth or slope. According to [13], it is explained that the sloping area has a spacing between contours that is rare, while the distance between contours that are close to other contour lines shows that the area has a steep depth, this can be seen in the results of bathymetry in the Batu Ampar waters shallow sea. The north coast of Java tends to be a gentle slope, which is between 0-2%. Sloping depth can be caused by several factors, namely calm waters, small wave height and the type of sediment formed [14] states that Batam waters tend to be sloping slope types which are between 0-2%, and sloping depth can be caused by several factors, namely calm waters, small wave height and the type of sediment formed.

IV. Conclusion

Based on survey data and research results, it can be concluded that bathymetry mapping in Batu Ampar waters, Batam including shallow waters with a depth of between -3 meters - 10.5 meters, with the measured water area being 775,094 m^2. The results of measuring bathymetry in Batu Ampar waters are classified as gentle slopes which are indicated by the insignificant value of bathymetry. The tidal pattern which is used as a correction in determining the bathymetry value has a daily to double skew pattern. The type of sediment in the base of Batu Ampar waters is dominated by sand-based sediments.

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