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Hydro-Oceanography Modelling Characteristic (Tides, Waves, and Currents) in Kelabat Bay, Bangka Belitung

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***Abstract*— Kelabat Bay is one of the most important waters in northern Bangka Island since it is a semi-enclosed bay and directly face Karimata Strait and Natuna Sea. Furthermore, in the last ten years, the provincial government of Bangka Belitung plans to make Teluk Kelabat become an intergrated marine-fisheries development. Thus, the purpose of this study is to obtain a good database of hydro-oceanography characteristics (Currents, Waves, and Tides) in Kelabat Bay to support the development plans in these region.**

Interest area of this study is at the outer and inner part of Kelabat Bay. In this study, hydro-oceanography characteristics of Kelabat Bay will be focused on 3 parameters : currents, waves, and tides. Numerical modelling method is used in this research using Regional Ocean Modeling System (ROMS) for current model and Simulating Waves Nearshore (SWAN) for wave model. This research also use tidal data from Babel Ocean Observation Science and Technologies (BOOST) Center under the Marine and Fisheries Agency of Indonesia to verify the model's results.

From this research, tides type of Kelabat Bay is diurnal with Formzahl 3.1687, mean sea level 61 cm, and tidal range around 0-2.1 m. Significant wave height (Hs) in Kelabat Bay around 0.07-0.8 meters. At west monsoon, the wave direction dominant to southeast and goes to north at east monsoon. Furthermore, the currents start from 0.02 m/s to 1.3 m/s and dominantly influenced by tidal. The highest current amplitude are located at the gap between Teluk Kelabat Luar dan Teluk Kelabat Dalam caused by very narrow and shallow condition.

Keywords*— *Hidro-Oceanography Modelling, Currents, Waves, Tides, Kelabat Bay

I. INTRODUCTION

Kelabat Bay is located at the Belinyu, Bangka Regency, Bangka Belitung Islands Province. Kelabat Bay is located on north Bangka island and facing directly onto Natuna sea. Uniquely, the geographical shape of the Kelabat Bay consist of two regions : Teluk Kelabat Luar (TKL) and Teluk Kelabat Dalam (TKD). Those parts are separated with narrow and shallow 'crack'. Furthermore, Kelabat Bay water can be categorized into the semi-closed estuaries with depth ranged from 1.5 to 13 meters and high tide 2.0 meters [1]. With these conditions, the waters in this area has unique characteristics of hydro–oceanography.

In the last ten years, the government of Bangka Belitung Province planned to make Kelabat Bay as an integrated region for fisheries development [2]. So, information about condition of the waters of Kelabat Bay is very important to know in order to support that government plan. Some of the research that has been done previously in the Kelabat Bay, such as condition of aquatic oceanography [3], condition of heavy metals [2], and also water quality of Kelabat Bay [4]. Furthermore, this research was conducted in order to complete the information about the condition of Kelabat Bay waters that will be focused on examining the characteristics of hydro–oceanography which includes tidal, waves, and currents of Kelabat Bay.

II. RESEARCH METHOD

The focus region located at Kelabat Bay, Bangka Regency, Bangka Belitung Province (Fig. 1). Teluk Kelabat Dalam (TKD) and Teluk Kelabat Luar (TKL). The survey was held 1-3 February 2017 that collect parameters oceanographic such as currents, tides, and waves. The survey also take bathymetry data for numerical model's input. MIKE21 and Simulating Waves Nearshore (SWAN) software are used in this research as modelling methods.

The verification process are necessary in numerical modelling to prove the confidence level of model's results. Therefore, in this research used secondary data from Babel Ocean Observation Science and Technologies (BOOST) Center. In this research, the tidal data from BOOST Center will be compared with the numerical model.

III. RESULT AND DISCUSSIONS

A. Tides

The comparison between BOOST Center's tidal data with model results are presented at Figure 2. The Root Mean Squared Error (RMSE) of this comparison is 0.1425 while the correlation measurement is 0.9418. The correlation value shows that the model's result and field data has samilarity of its tidal phase. The RMSE and correlation value prove that the model's results are pretty good to be used in this research. Thus, the tidal, current, and vave value from model can be used as hydro-oceanography data at Kelabat Bay waters.

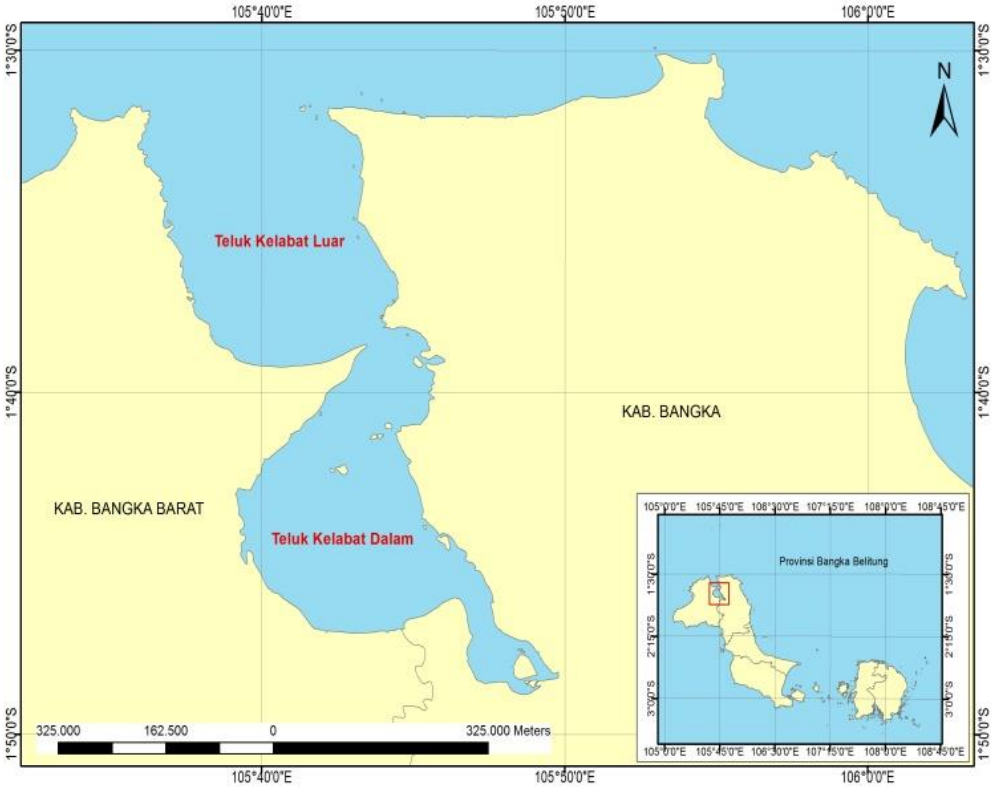


Fig. 1. Research location at Kelabat Bay, Bangka Belitung

The characteristic of Kelabat Bay tidal obtain from measurement and model results. The tidal type at Kelabat Bay is diurnal which there are single high tide and single low tide in one day. This statement is strengthened with value of Formzahl 7.223. The Formzahl number above 3, It indicate the diurnal type of tides at Kelabat Bay [5]. This Formzahl number caused by its dominant amplitude of K1 and O1, each 69 and 52 cm. It's also known that K1 constituent on Karimata Strait has the largest amplitude, exceeding 50 cm [6]. Kelabat Bay will have a similar tides characteristic to Karimata Strait, which are diurnal type [7]. Furthermore, the value of mean sea level at Kelabat Bay is 61 cm with the value of the Zo is 167 cm.

B. Waves

The modelling of waves in Kelabat Bay is focused on west monsoon and east monsoon. East monsoon comes around June-August and December-February will be West monsoon. The wave characteristic such as significant wave height (Hs) will be important parameters to analyze the influenced of its two different monsoon to Kelabat Bay's waves [8]. If we see the direction of the propagation waves, the waves on West monsoon will move in into the Kelabat Bay from the northern direction (Fig. 3 a). The wave entered to Kelabat Bay from the North which come from Natuna Sea. The wave in Kelabat Bay will follow the wind that move from North to South when West monsoon. Significant wave height at Kelabat Bay in this monsoon are around 0-0.8 m.

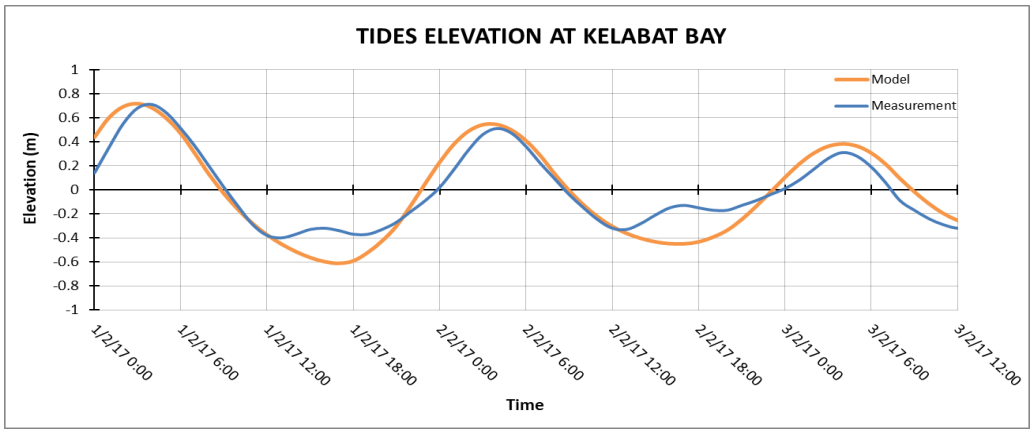


Fig. 2. Tides value comparison between model's result and measurement.

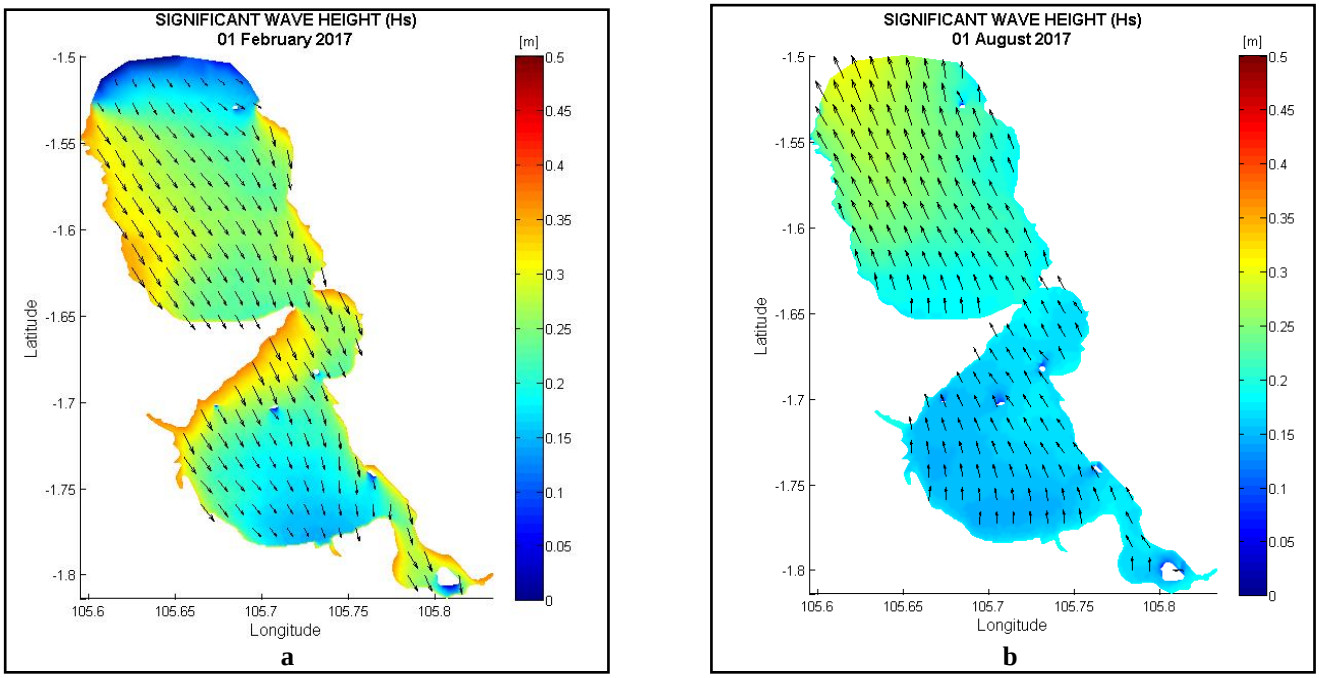


Fig. 3. The value of significant wave height at Kelabat Bay on a) West monsoon, and b) East monsoon

When East monsoon, The direction of the dominant waves moving north with significant wave height tend to be smaller than West monsoon (Fig.3 b). Significant wave height when East monsoon range between 0-0.35 meters. When west monsoon, the direction of the waves on the East monsoon are also follow the wind direction even though the value of significant wave height are smaller due to the geographical shape of the Kelabat Bay that blocks the fetch area of waves formation in East monsoon.

C. Currents

The current's profiles in the Kelabat Bay are quite interestin influenced by its geographical shape. Geographically, the Kelabat Bay is separated by the narrow and shallow gap in the midst of its waters. So, Kelabat Bay can be divided into two parts i.e. Teluk Kelabat Luar (TKL) at northern part and the Teluk Kelabat Dalam (TKD) at southern part (Fig. 1). Teluk Kelabat Dalam waters relatively more shallow than Teluk Kelabat Luar and has an estuary to the South. While in the Teluk Kelabat Luar is directly connected to the open waters that face Natuna Sea and its southern part is linked to Teluk Kelabat Dalam through the narrow and shallow gap. This gap will makes the unique hydro-oceanographic conditions in Kelabat Bay.

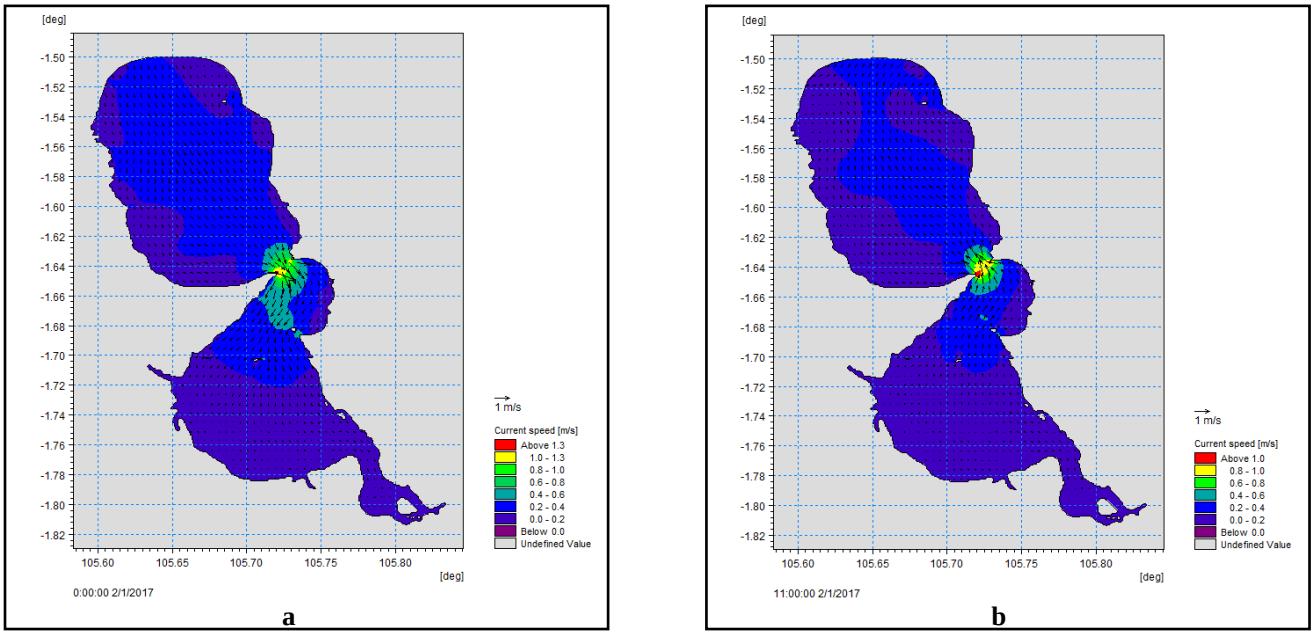
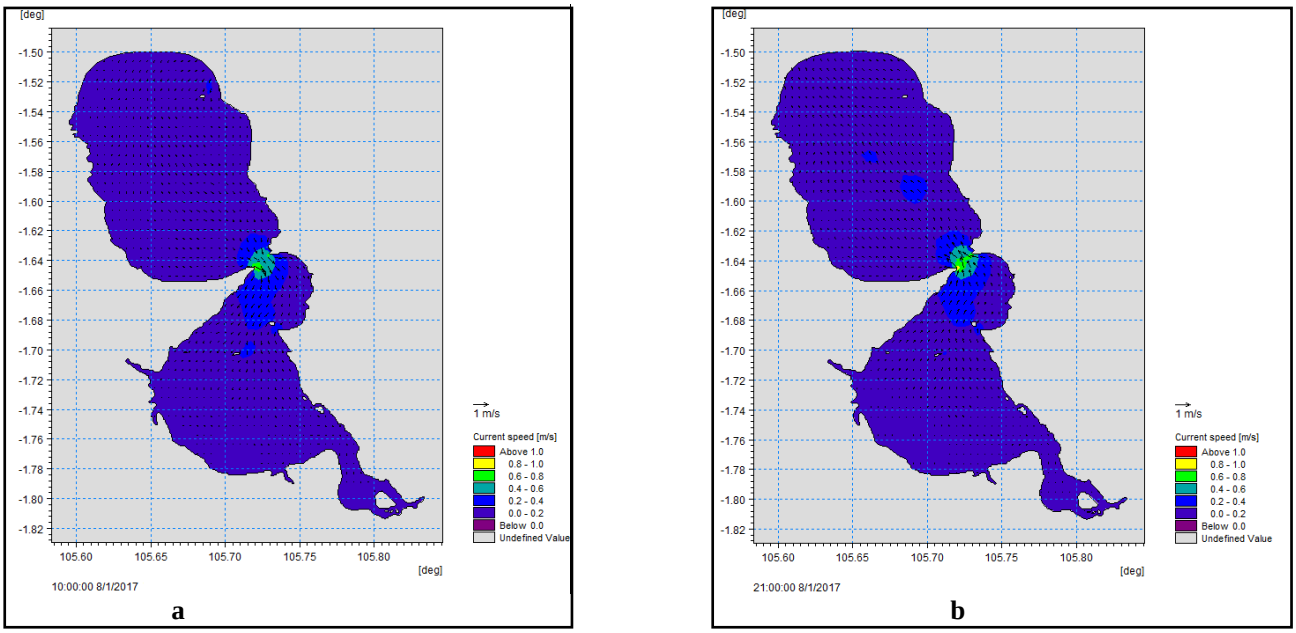


Fig. 4. Profile of the current at Kelabat Bay on West monsoon when a) high tide, and b) low tide



Profile of the current at Kelabat Bay on East monsoon when a) high tide, and b) low tide

If we focus on geographical shape of Kelabat Bay that can be categorized a semi-enclosed waters, then tidal will affected the current profiles dominantly than monsoon wind. For example, Pelabuhan Ratu Bay's currents dominantly influenced by its geographical condition and similar between each monsoon [9]. Otherwise, some regions in Indonesia seas, such as Java Seas, its current pattern will be very influenced by wind monsoon [10]. The current profiles presented in Fig. 4 for West monsoon and Fig. 5 for East monsoon.

On the West monsoon around February 1st 2017 at 00.00 WIB, Kelabat Bay being towards to high tide conditions. At this conditions, the current pattern will move from the Teluk Kelabat Luar to the narrow and shallow gap and entering Teluk Kelabat Dalam (Fig. 4 a). When towards to high tide condition on West monsoon, the current speed can reach 1.3 m/s near the gap between Teluk Kelabat Luar dan Teluk Kelabat Dalam. This pattern similar to current profile at Ambon Bay. When low to high tide, the current will flow from Teluk Ambon Luar toward Teluk Ambon Dalam and vice versa at high to low tide [11] with the magnitude around 0-1.463 m/s [12].

Meanwhile, on February 1st 2017 at 11.00 WIB, Kelabat Bay being towards to low tide conditions. At this condition, the current pattern will move from the Teluk Kelabat Dalam tow the narrow and shallow gap then entering Teluk Kelabat Luar (Fig 4 b). When the low tide condition on West monsoon, the current speed can reach 1.1 m/s near the gap between Teluk Kelabat Luar dan Teluk Kelabat Dalam.

On the East monsoon precisely on August 1st 2017 at 10.00 WIB, Kelabat Bay being towards high tide conditions. At this conditions, the current pattern will move from the Teluk Kelabat Luar towards the narrow and shallow gap and entering Teluk Kelabat Dalam (Fig. 5 a). When the low to high tide condition on West monsoon, at the gap between Teluk Kelabat Luar dan Teluk Kelabat Dalam, the current speed can reach 0.6 m/s.

Meanwhile, on August 1st 2017 at 21.00 WIB, Kelabat Bay being towards to low tide conditions. At this conditions, the current pattern will move from the Teluk Kelabat Dalam towards the narrow and shallow gap then entering Teluk Kelabat Luar (Fig. 5 b). When the high to low tide condition on West monsoon, the current speed can reach 0.8 m/s near the gap between Teluk Kelabat Luar dan Teluk Kelabat Dalam

IV. Conclusion

From this research, there are known that tides in Kelabat Bay is diurnal, which is in a day there are one high tide and one low tide. With its dominating amplitude of component K1 and O1 each 69 and 52 cm, retrieved number Formzahl 3.1687 with the mean sea level 61 cm. The waves direction in Kelabat Bay tend to follow the wind direction where leading into Teluk Kelabat Dalam on West monsoon and vice versa when East monsoon. The significant wave height when West monsoon tend to be higher then East monsoon season i.e. 0-0.35 meters on West monsoon and 0-0.25 metres when East monsoon.. For current profile, the current direction patterns are more influenced by tides than wind monsoon, where the current is moving from the Teluk Kelabat Luar to Teluk Kelabat Dalam at high tide, and vice versa when low tide. The highest current speed value is around are around the gap that separate Teluk Kelabat Luar dan Teluk Kelabat Dalam which reached around 1.3 m/s when high tides and 1.2 m/s when low tide. This massive magnitude of the current is due to the geographical condition of Kelabat Bay itself which has a very narrow and shallow gap that causes current speed are amplified on that area.

Acknowledgment

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