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Analysis of tidal influence on current pattern in Kambunong Island

Yusriadi Rusdi ^{1*}, Rustam ², Dan Danial ³

¹ Faculty of Fisheries and Marine Sciences, Indonesian Muslim University Makassar, Indonesia

^{2,3} Lecturer at the Faculty of Fisheries and Marine Sciences, Indonesian Muslim University, Indonesia

* Corresponding Author: **Yusriadi Rusdi**

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Abstract

Indonesia is a country that has a large water area compared to its land area. In a waters there are physical parameters that occur at any time, one of which is tides and currents. Tides in Kambunong Island waters occur twice highs and two lows within 24 hours. At high tide, the water will rise to the yard of the residents' houses, and at low tide, the water will recede to the end of the pier, the length of the pier is about 160 m. The occurrence of tides will result in a current pattern. The purpose of this study was to determine the types of tides, the effect of tides on current patterns, and to model current patterns in the waters of Kambunong Island. The research was carried out in November-December 2022 at Kambunong Island, Kambunong Village, Karossa District, Central Mamuju Regency, West Sulawesi Province. The method used in processing tidal data is the Least Square Method, processing current data using the help of software belonging to Marinegeophysics, namely MarroteHsconfig. Modeling the current pattern using software, namely Mike 21. The results of the study explain the type of tides in the waters of Kambunong Island. The main factor for the occurrence of the pattern of currents is the tides, and the modeling shows that the pattern of currents in the waters of Kambunong Island occurs in 4 conditions, namely high tide, high tide, low tide and low tide. Based on the results of the study it can be concluded that Kambunong Island waters have a Double Daily Leaning Tidal Type, tides have a very large influence on the current pattern in Kambunong Island waters, and the modeling results show 4 conditions for the occurrence of current patterns, namely high tide, highest tide, low tide, and lowest ebb.

Keywords: Tidal, Current, Kambunong Island

Introduction

Indonesia is a country that has a wider water area, where this water area has the widest area compared to the land area. According to (Haryo Daruwedho, Bandi Sasmito, 2016) ^[13] Dalam (Janhidros, 2006). Says the area of Indonesian waters is $\pm 5,877,879$ km², while Indonesia's land area is $\pm 2,012,402$ km². In a body of water, of course, it has parameters that occur at any time one of the parameters that actively occurs in a body of water is a physical parameter, where one example of a physical parameter is currents and tides.

In a body of water, of course, it has parameters that occur at any time one of the parameters that actively occurs in a body of water is a physical parameter, where one example of a physical parameter is currents and tides. (Dilla Dwi Kartika, Dian Candra Rini Novitasari, 2020) ^[1]. Meanwhile according to (Hutabarat dan Evans, 1985) In (Modalo *et al.*, 2018) ^[8]. The process of collecting current data can produce flow data which can include current generating factors, current patterns, current directions, and current speeds.

Tides are the movement of rhythmic fluctuations in sea level which are caused by space objects, especially the moon and the sun, to the mass of sea water on the earth's surface. (Triatmodjo, 1999) in (Korto *et al.*, 2015) ^[4].

Meanwhile according (Dronkers., 1964) Dalam (Korto *et al.*, 2015) ^[4] said that the notion of tides is a phenomenon of the periodic rise and fall of sea level caused by a combination of gravitational forces, and the attraction of astronomical objects in outer space. Mainly on the sun, moon, and earth. Indonesia has 4 types of tides namely (*Semi Diurnal Tide*), (*Diurnal Tide*), (*Mixed Tide Prevailing Semidiurnal*), and (*Mixed Tide Prevailing Diurnal*), according to (Triatmodjo, 1999) dalam (Fitriana *et al.*, 2019) ^[2].

Talking about parameter phenomena that occur in the waters of Kambunong Island, the main physical parameters are tides and currents. During the highest tide, the water will rise to the yard of the residents' houses. When the highest tide arrives, the rising water can pass over the pier and even reach the road area. The occurrence of the tidal phenomenon will certainly be related to the occurrence of currents, if currents occur they

will form the direction in which the current pattern is. This research was conducted with the aim of knowing about the effect of tides on current patterns in the waters of Kambunong Island, Central Mamuju Regency. By first collecting data on tidal and current parameters, then data analysis will be carried out and in the final stage modeling will be carried out using the help of a MIKE 21 software.

Materials and Methods

Time and location of research

This research was conducted for 1 month, namely in November 2022 which took place on Kambunong Island, Kambunong Village, Karossa District, Central Mamuju Regency, South Sulawesi Province. To analyze the influence of tides on current patterns in the waters of Kambunong Island. The research location can be seen in Figure 1 below.

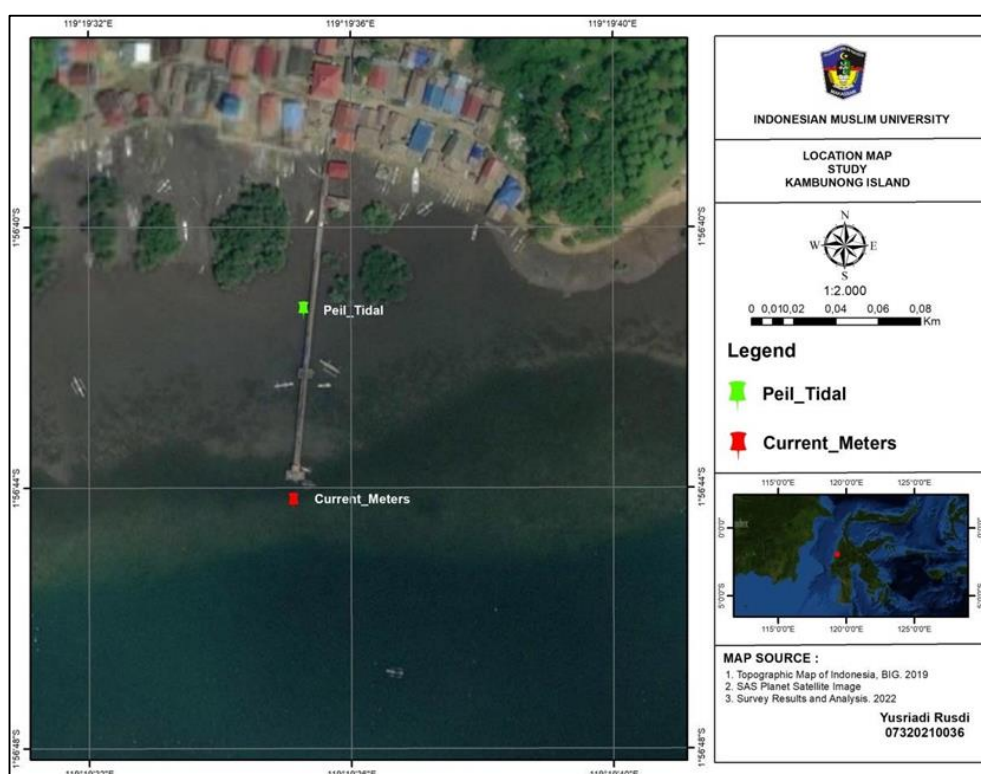


Fig 1: Map of research locations on Kambunong Island, Central Mamuju Regency

Tools and materials

The tools and materials used in this study are the Marotte HS Type B2128 Current meter, MIKE 21, Arcmap 10.8, Measuring/Peil Signs, Microsoft Excel, Camera for documentation retrieval, and Laptop/Computer for processing and making maps.

Data Sources and Data Collection Techniques

Based on the research objectives to be achieved, this research is a descriptive and quantitative research, because the data produced in this study is a description of current patterns by modeling and in the form of tidal types in the waters of Kambunong Island. And supported by literature studies from trusted sources so as to support and strengthen the results of research analysis in compiling a report.

Data Retrieval Method

Retrieval of tide data is by taking direct measurements using

a tide gauge (Peil).

Tide data retrieval is carried out hourly records within 24 hours for 15 days. Meanwhile, current data collection is carried out using a current measuring device, namely the Marotte HS Type B2128 Current Meter. This measuring instrument records every second for 15 days.

Data Analysis

In analyzing tidal data, the Least Square method is used, to facilitate this analysis, a visual basic application is used that analyzes tides as a whole, this application is called Least Square.Exe. The data generated are tidal constants, tidal types, tidal forecasting, and tidal elevation. Flow data processing is carried out using the default software from Marinegeophysics' measuring tool, MarroteHsconfig, and to do the modeling of flow patterns also used software, namely MIKE 21. The following is a research flowchart presented in Figure 2 below.

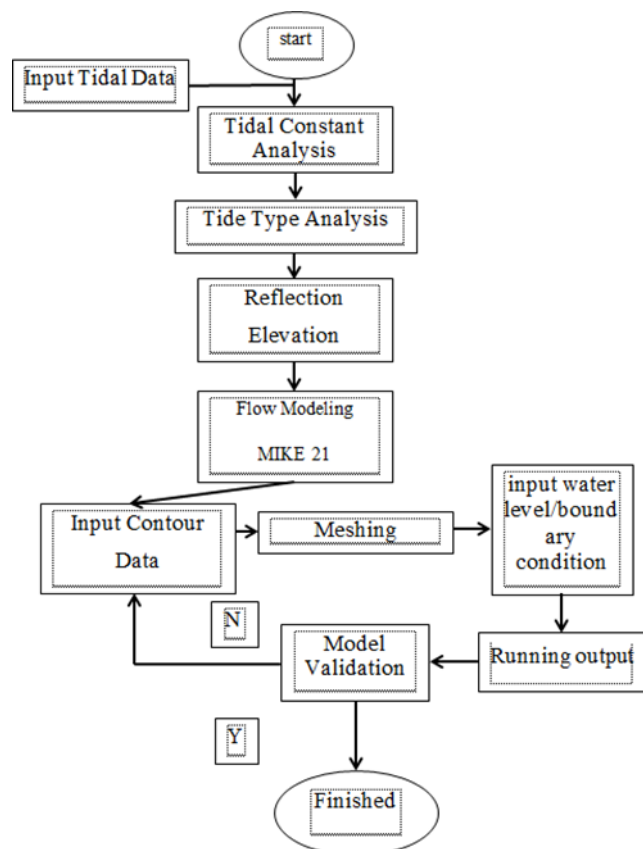


Fig 2: Research Flowchart

Results and Discussion

Overview of research locations

Kambunong Island is an island located in West Sulawesi Province, Central Mamuju Regency. Kambunong Island has an area of about 4883 km², with a population of approximately 125 families. Furthermore, geographically, Kambunong Island is located at 1°56'27.00"S Latitude and 119°19'45.00"E Longitude. Kambunong Island is surrounded by a stretch of water so that it has a parameter phenomenon that occurs every time one of the parameters that occur include tides and currents.

Tidal Analysis Results

The process of analyzing tidal data uses the Least Square method. To make it easier to analyze tidal data, an application is used that can produce tidal constants, types of tides, forecasting tides, and water level elevation. The following are the results of tidal analysis using the help of a tidal analysis application.

Tidal Harmonic Constants

Tidal harmonic constants at the study site can be seen in Table 1 below.

Table 1: Tidal Constants

	S ₀	M ₂	S ₂	N ₂	K ₁	M ₄	O ₁	P ₁	K ₂	MS ₄
A	1,10	0,43	0,84	0,01	0,11	0,00	0,17	0,29	0,45	0,01
0	0	6,92	-1,14	1,72	8,71	4,57	8,29	7,81	6,23	7,90

The table above shows the values of the tidal harmonic constant components, with the amplitude components (A) namely M₂ (0.43 m), S₂ (0.84 m). According to (Pinet., 1992) Dalam (Rampengan Royke, 2013) M₂ is the main component of the tides from the moon while -S₂ is the main component of the tides from the sun.

Tidal Type

Based on the analysis of tidal constants using software assistance, the type of tides obtained are (Mixed Tide Prevailing Semi Diurnal) with elevation (0,127 m).

The results of this analysis can be seen the type of tides at the research location, namely (Mixed Tide Prevailing Semidiurnal). (Mardika & Pratama, 2021) suggested that the type of tide in the category (Mixed Tide Prevailing Semidiurnal) when it is $0,25 < F \leq 1,50$.

Sea level amplitude and phase corrections

Using the observed data and the prediction results of sea level elevation using the methods or equations that have been presented previously, a comparison of sea level graphs as a function of time between the observed data and the predicted results can be obtained and presented graphically. The graphic images can be seen in Fig. following 3.

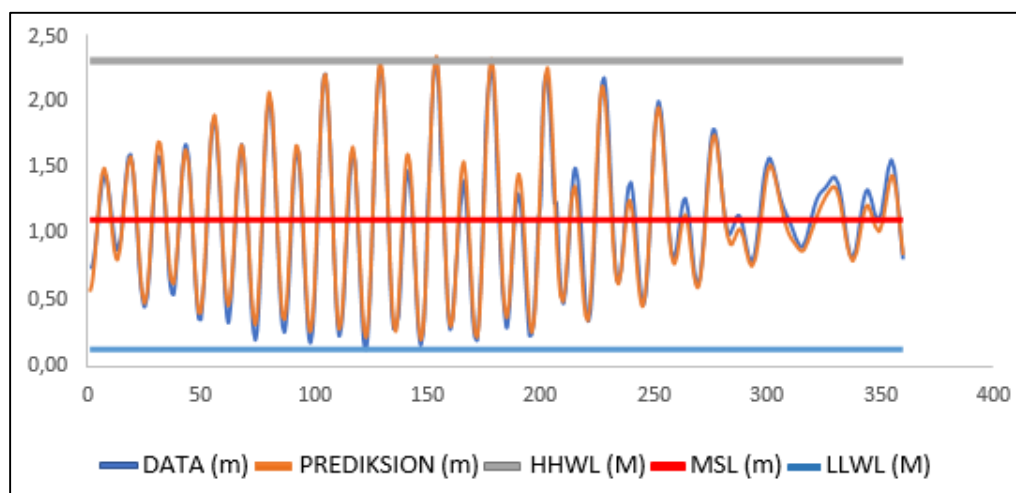


Fig 3: Tidal Charts

Based on the results of the tide forecasting above, it can be seen that the average water level at the study site. The results

of the LWL reference water level elevation can be seen in Table. 2 following.

Table 2: LLWL Water Level Reference

Sea Level Elevation		Elevation	
HHWL	=	2,929	m
MHWS	=	2,672	m
MHWL	=	1,92	m
MSL	=	1,449	m
MLWL	=	0,978	m
MLWS	=	0,576	m
LLWL	=	0	m

The table above describes the LLWL reference water level at the study site, where LLWL itself has no value, MSL has its water level (1,449 m) while HHWL has elevation (2,929 m). The LLWL water level reference data can be used in planning the construction of marine structures. According to (Mardika & Pratama, 2021).

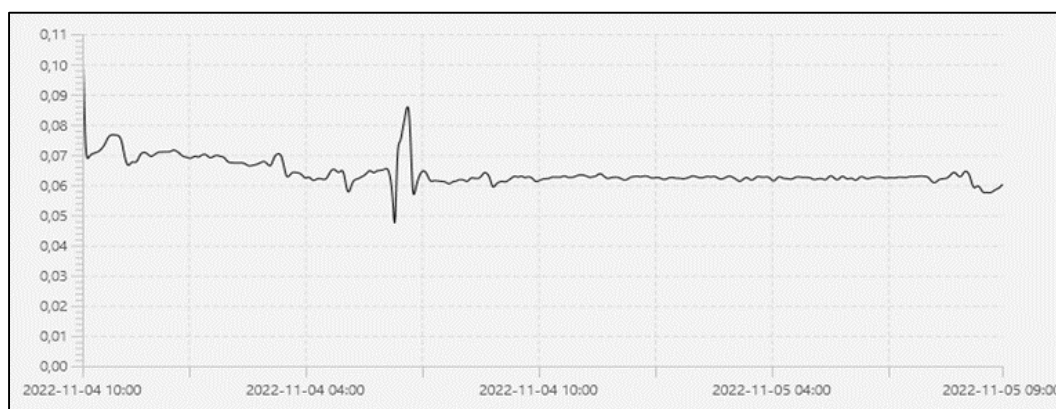
Flow Data Analysis Results

After analyzing the data from the measurement results, it will then be analyzed with the help of software, so the results obtained from this software analysis can be seen in Table following 3.

Table 3: Software Analysis Results

Speed Upper (m/s)	0,24 m/s
Speed Lower (m/s)	0,21 m/s
Temp (Celsius)	32°

After the flow data is analyzed, graphs are then made. This graph shows the speed for 24 hours at the study site. The following graph of the speed and direction of the current for 24 hours can be seen in picture 4.

**Fig 4:** Current Speed For 24 Hours

Based on the graphic above, the current speed in Kambunong Island waters is (0.999 m/s) and the current speed in Kambunong Island waters is 0.1 m/s. The average value of the current velocity in the waters of Kambunong Island (0.616 m/s). According to (Bernawis., 2000). In (Setianto *et al.*, 2020). The current speed will decrease as the depth increases so that the wind does not affect the current speed at a depth of 200 meters.

The effect of tides on current patterns

From the results of this modeling, it can be explained that the influence of tides is one of the factors causing currents to occur. In the process of the occurrence of ups and downs, of course, it will go hand in hand with the occurrence of currents. One of the factors for the occurrence of currents is the result of the process of the occurrence of tides, the currents generated by the tides are called tidal currents, wind is one of the factors for the occurrence of currents. Besides that the earth's gravity, topography, and bottom conditions of the waters are one of the factors for the occurrence of currents.

This is what causes the current pattern in the waters of Kambunong Island to occur in four conditions, among others. In high tide conditions, the highest tide conditions, ebb conditions, and the lowest ebb conditions. According to (Simatupang *et al.*, 2016) Currents can be influenced by

several factors apart from tides, other factors are the force of gravity, water conditions, and topography. The factor for the occurrence of currents was also stated by (Hadi., 2000). In (Simatupang *et al.*, 2016) said that in most waters the main factors for currents are wind and tides.

Flow Pattern Modeling

Modeling currents with the MIKE 21 model using tidal data, bathymetry of the surrounding waters. Current speed at the study site is influenced by tides and seasonal winds with speeds between 0.01 and 0.25 m/s. The pattern of current movement follows the pattern of the tides that occur, at the time of tide, ocean currents move from south to north. The results of modeling current patterns at research sites in Kambunong Island waters in several conditions, namely:

1. The pattern of current velocity towards tides in the existing conditions
2. Pattern of Current Velocity Towards Highest Tide in Existing Conditions
3. Pattern of current velocity towards ebb in existing conditions
4. Pattern of Current Velocity Towards Lowest Ebb in Existing Conditions
5. The pattern of current velocity at the research location is presented in more detail in pictures 5, 6, 7, and 8 below.

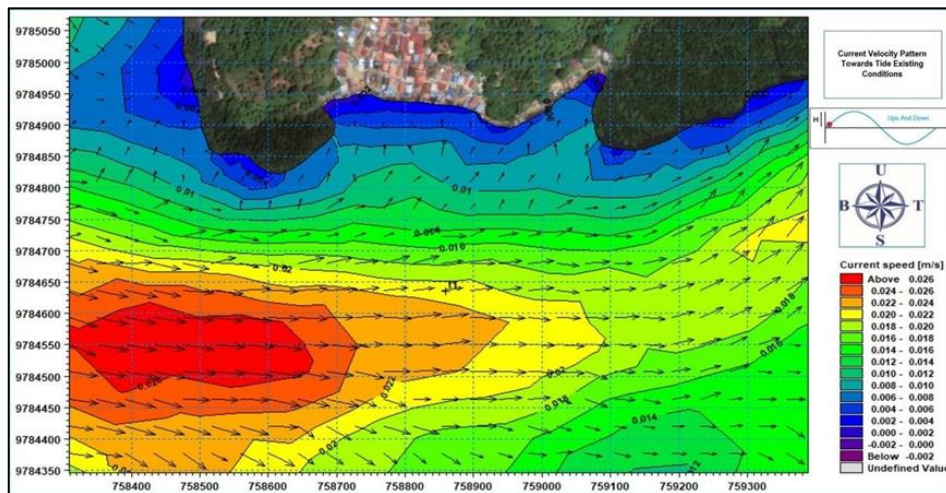


Fig 5: Pattern of Current Velocity Towards Tides of Existing Conditions

The current velocity pattern at high tide conditions has a current pattern from the West to the North, namely land with the highest speed (0.026 m/s). The difference in color

gradations is the difference in the speed of the current pattern in the waters of Kambunong Island.

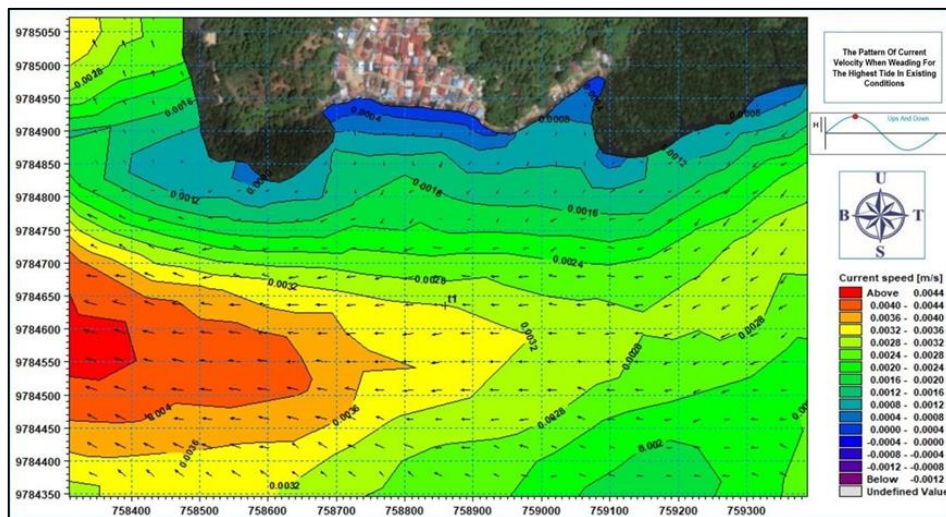


Fig 6: Pattern of Current Velocity towards Highest Tide in Existing Conditions

The current velocity pattern at the highest tide conditions has a current pattern from east to west with the highest speed (0.044 m/s). The arrows on the map indicate the direction of

the current pattern. The arrows show the current pattern moving from East to West.

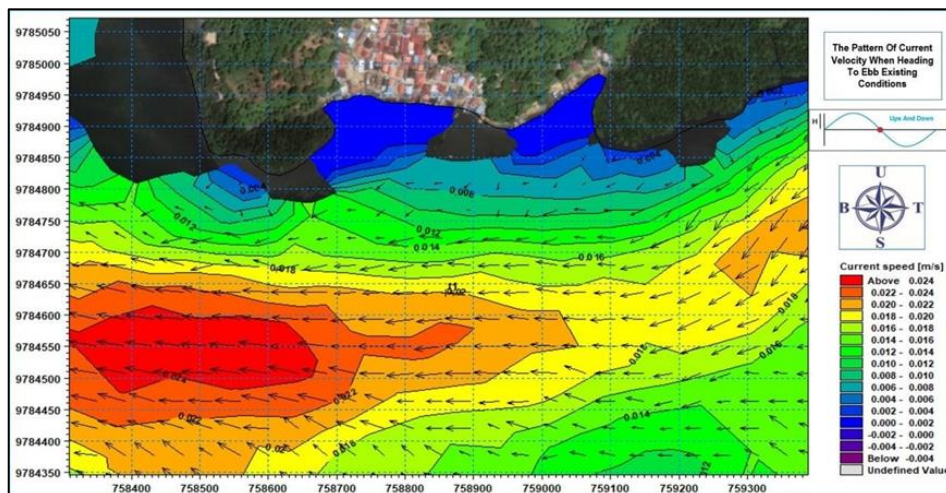


Fig 7: Pattern of current velocity towards ebb in existing conditions.

Current velocity pattern at low tide that leads from east to west. This west direction is the direction towards the open sea, and the arrows indicate the direction of the moving

current pattern for the highest speed is (0.024 m/s) while the lowest speed is (-0.004 m/s).

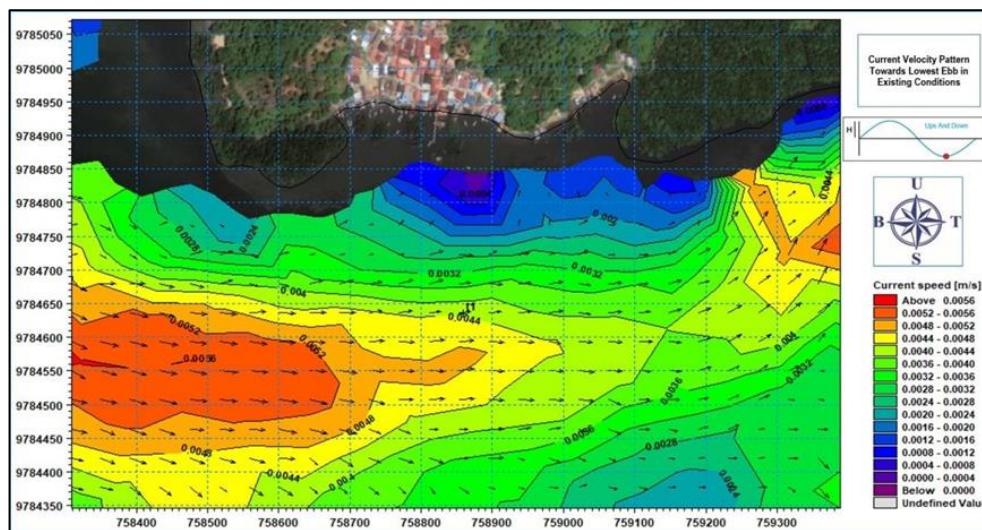


Fig 8: Current Velocity Pattern towards Lowest Ebb in Existing Conditions The pattern of current velocity at the lowest ebb conditions that leads from the

West to the East with the highest speed (0.056 m/s). The map image above shows the direction of the current pattern which is marked with an arrow, the color difference is the difference in current speed.

Conclusion

The results of the research that has been done can be concluded that the type of tide that occurs at the research location is the type of Tide Prevailing Double Daily (Mixed Tide Prevailing Semidiurnal). The effect of tides on current patterns at the study site, tides are one of the main factors in their occurrence. So that the current pattern occurs in four conditions during high tide, highest tide, lowest ebb, and lowest tide. The modeling results show that there are 4 conditions for the current pattern to occur, namely the current velocity pattern at high tide (0.026 m/s), at the highest tide (0.044 m/s), at low tide (0.024 m/s), and at the lowest ebb (0.024 m/s)..56 m/s).

Suggestion

The results of the research can be used as study material in the field of Marine Science as well as support in the development of coastal buildings on Kambunong Island. Other researchers are advised to conduct further research with the same theme in other areas.

Thank-You Note

The author believes that this research would not have been possible without the help and support of all parties, therefore the author would like to thank all those who have supported and provided input and suggestions during the research and fellow students involved in completing this research.

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