International Journal of Multidisciplinary Research and Growth Evaluation.

Tidal Analysis and Depth of the Seato Know the Base Contour of Kambunong Island Waters

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Article Info

Abstract
Kambunong Island waters are an area located in Central Mamuju Regency, West Sulawesi Province, based on the geographical location of Kambunong Island waters in the Makassar Strait which has unique bottom characteristics, to obtain more specific information about the topography of the water bottom, further research is carried out. This study aims to determine the value of water level elevation, water depth and bottom topography of Kambunong Island waters. This research was conducted from December to January 2023. Data processing was carried out using the Admiralty method and map interpolation using Arcmap software. Based on the results of the research conducted, it can be concluded that the water level elevation of Kambunong Island waters is the highest astronomical tide HAT = 2,52 m, mean higher high wate springs MHHWS = 2,17 m, mean higher high water neaps MHHWN = 1,34 m, mean sea level MSL = 1,26 m, mean lower low water neaps MLLWN = 1,18 m, mean lower low water springs MLLWS = 0,35 m, lighest astronomical tide LAT = 0 m. And the water depth of Kambunong Island at The research area has a depth of -28.5 m at the lowest tide, and can reach a depth of -31.5 m at the highest tide with an average tide height of 2.5 m to 3 m. In the research area with an area of 295 m2, the bottom topography of Kambunong Island waters has 4 gusung areas with heights of 23 m, 18 m, 6.5 m and 10 m and from the bottom of the waters. It is hoped that the data from the research conducted can be utilized by the local community as a reference in the construction of beach facilities.

Keywords: water level elavation, bathymetry, arcmap, kambunong Island

Introduction
Kambunong Island is an island located in the waters of the Makassar Strait which is one of the national and international shipping lanes so it has a very strategic potential economically. The topography of the seabed is very important to know in understanding marine ecosystems, shipping navigation and understanding the geology and geography of an area. In the context of Kambunong Island, knowledge of seabed topography is very important because of its impact on human activities, such as fishing, tourism, navigation routes and natural resource exploration.

In this study, analysis of tides and sea depth will be used as material to obtain information about the topography of the seabed in the waters of Kambunong Island. Tide data is recorded at sea level and at certain intervals. Measuring the tides for 15 piantans is a relatively short period for carrying out a harmonic approach to tidal phenomena (Febriarta et al., 2022) [2]. Meanwhile, sea depth data will show variations in depth at various points around the island. By combining these two types of data, this research can produce a topographic map of the seabed, according to (Novriza & Agusmaniza, 2020) [7] a topographic map is a visual representation that presents information about the topography or shape of the earth's surface as a whole, including relief and elevation using a scale and system, which is determined (Rauf et al, 2020) [9].

Research on tides and topography of the seabed has been widely carried out using external data such as tides and national bathymetry data, but in Indonesia, especially research on tides and seabed topography using internal data is still rarely carried out because it requires a lot of money and takes a long time. So the authors decided to conduct this research using internal data with analysis of tides and sea depth to determine the topography of the seabed in the waters of Kambunong Island, Central Mamuju Regency, West Sulawei Province.

This study aims to determine the water level elevation, depth and bottom topography of the waters of Kambunong Island, Central Mamuju Regency, West Sulawesi Province. This research is expected to be a reference for the construction of coastal buildings in the waters of Kambunong Island and it is hoped that the community will be able to know which areas are safe to traverse, especially shipping navigation.

Materials and Methods
Time and Location of Research
This research was carried out for two months from December 2022 to January 2023, taking place on Kambunong Island, Kambunong Village, Central Mamuju Regency, West Sulawesi Province. Making a topographic map of the bottom waters of Kambunong Island was carried out at the GIS Laboratory at the Indonesian Muslim University, Faculty of Fisheries and Marine Sciences. The map of the research location can be seen in Figure 1.
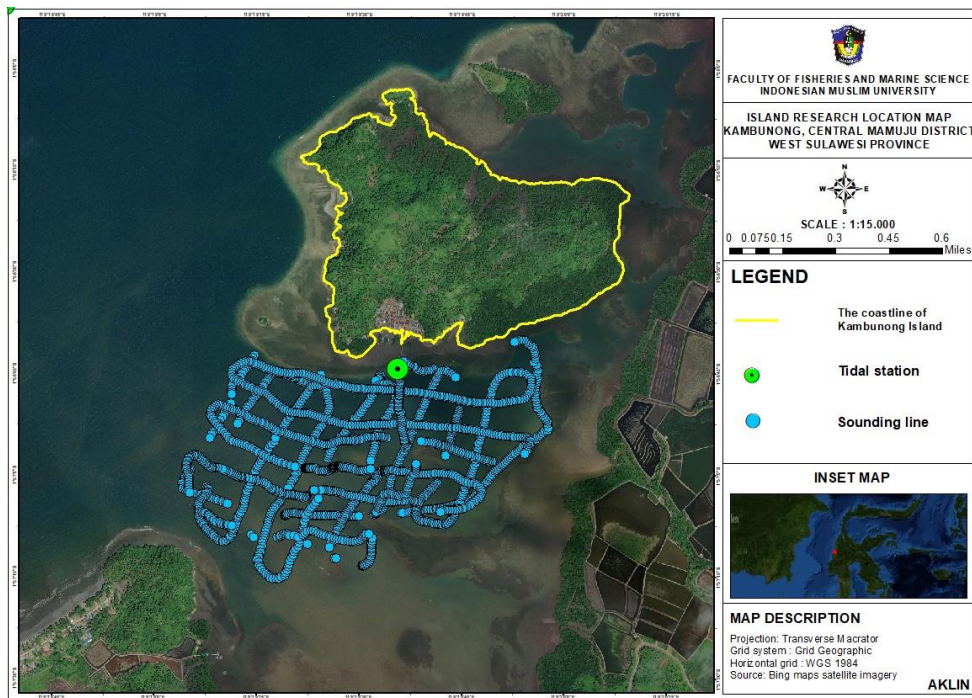

Fig 1: Map of Research Locations

Tools and materials
The tools and materials used in this study are GPS to make coordinate points, measuring signs are used to monitor tides, echosounder GPS maps 585 are used to measure depth (bathymetry), motorized boats are used to mobilize measurements, stelit imagery, ArcMap software, ArcScene, laptops/computers are used to make bathymetry maps and topographic maps, cameras are used to take pictures or documentation.

Data Sources and Data Collection Techniques
Based on the research objectives to be achieved, this research is a quantitative descriptive study, because the data generated is in the form of a map of bathymetry, topography and in the form of water level elevation values 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.

Method of collecting data
The data collection method was carried out using the observation method by conducting field surveys. The observation method is a data collection method that is carried out by observing and recording systematically either directly or indirectly at the observed place (Joesyiana, 2018) [3]. Data collection began by collecting tide data for fifteen days with one hour recording time interval. Tides are the attractive force between the earth and the moon which causes the periodic movement of sea water up and down (Korto et al., 2015) [4]. This data collection is done by using measuring signs. The next data collection is the collection of depth data (bathymetry). This data collection uses an instrument in the form of an echosounder. The Garmin Echosounder map 585 is a tool used to measure the depth of the sea using the principle of reflected sound waves, this tool transmits a sound signal to the seabed and then receives the reflection back, based on the sound reflection travel time, the depth of the sea at that location can be calculated and then corrected with tidal values at the place of measurement (Supriadi et al., 2014) [10]. In addition to collecting tide and depth data, image data collection at the research location was also carried out using the sasplanet software, these images will be used in making bathymetric and topographic maps of the seabed of Kambunong Island waters.

Data Analyst
Tide data analysis was carried out using the admiralty method of harmonic analysis, the admiralty method is a method of

calculating sea tides that allows calculations using only a short data range, namely 15 piantan and 29 piantan (Prayogo, 2021) [8]. To simplify the analysis process, this is done using the help of schematic formulas and tables in Microsoft Excel developed by Pranoto Yudho. The data generated are the nine main tidal constants, the type of tide and the water level elevation value. Processing of the depth data (bathymetry) used is by correcting the depth value of the measurement results terhadap nilai *mean sea level* (MSL) and the sensor depth value (transducer) used the formula used (Febriarta et al., 2022) [2]:

$H = (H\_x + H\_d) - (H\_t - X)$
Information:
H: Depth corrected
Hx: The depth value of the measurement result (sounding) (at time t)
Hd: Transducer depth value (echosounder sensor)
Ht: Tidal depth value (at time t)
X: mean sea level (MSL)

Results and Discussion
Overview of Research Locations
Kambunong Island is an island located in Kambunong Village, Karossa District, Central Mamuju Regency, West Sulawesi Province, this island is in the waters of the Makassar Strait, this island is inhabited by ± 125 heads of households (KK), the island's position is at latitude S 1056' longitude 24.5898" E 119 019'40.2649" the structure of this island is soil and rocks. The beach has a muddy sand texture and is dominated by sea grass. Kambunong Island is ± 172 km from the city of Mamuju which is the capital city of West Sulawesi and can be reached within ± 4 hours by land transportation.

Tidal Analysis Results
The process of analyzing tides is carried out with the help of schematic formulas and tables using Microsoft Excel software, which produces tidal constants, types of tides and water level values. Following are the results of tidal analysis using the Admiralty method.

Tidal Constants
According to (Dina 'Amalina et al., 2019) [1] the results of determining the tidal constant are the amplitude and phase of the tidal components, which are used to predict tidal elevations. Tidal constants at the study site can be seen in Table 1.

Table 1: Tidal constants of the admiralty method

	So	M2	S2	N2	K1	O1	M4	MS4	K2	P1
A (cm)	126	49.7	66.8	4.2	19.4	17.0	0.7	1.5	18.0	6.4
g (º)	-	103.3	433.5	468.4	119.4	353.2	-54.1	151.2	433.5	119.4

Results of Tidal Type Analysis
According to (Lisnawati et al., 2015) [5] a comparison between the main daily tide constant and the main double tide constant can be used to determine the type of tide in a waters. The formzahl equation is used to calculate the type of tide (Supriyadi et al., 2019) [11]:

$$F = \frac{A(K_1) + A(O_1)}{A(M_2) + A(S_2)}$$
$$= \frac{19.4 + 17}{49.7 + 66.8} = 0.312$$

According to (Mardika & Pratama, 2021) [6] in determining the tides at the study location, the formzahl number is used which is divided into a predetermined range of values based on the value of the formzal number.

0 < F 0.25: semidiurnal
0.25 < F 1.50: mixed tide prevailing semi-diurnal
1.50 < F 3.00: mixed tide prevailing diurnal
F > 3.0: diurnal

Based on the results of the formzahl number, the tides at the study site are classified as semi-diurnal mixed tide prevailing because they are in the range of 0.25 <F 1.50, that is, in 1 day there are two high tides and two recede.

Results of Analysis of Water Level Elevation
According to (Korto et al., 2015) [4] the design water level can be determined using the tidal components obtained from the tidal analysis calculations. Based on the values of the nine main constants of tides at the Penelin location, the water level elevation values in the waters of Kambunong Island can be generated, HAT = 2.52 m MSL = 1.26 m, LAT = 0. Details can be explained through the tide chart which can be seen in Figure 2.
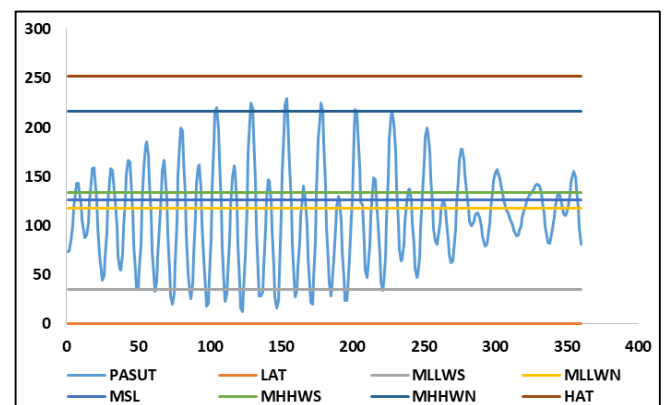

Fig 2: Graph of Tides and Water Level Elevation of Kambunong Island Waters

Kambunong Island Waters Depth
Calculation and processing of bathymetry measurement results using computer programs MapSource and MS-Excel. Depiction of the depth contour map of Kambunong Island waters using ArcMap 10.8 software. Before making the contour, first make corrections to data kedalaman yang diperoleh pada saat field measurements using the analysis results of water level elevation and transducer elevation.
Based on the results of measurement and data correction as well as the interpolation carried out, it can be explained that, the waters of Kambunomg Island have a peak tide height of 3 m which is measured from line 0 (lowest ebb), the deepest point in the study area reaches a depth of -28.5 at the lowest ebb.
The scale of the map is made using a scale of 1:6000, the minus sign (-) at the elevation point is a sign that the elevation area is an area that, at low tide or high tide, is still submerged by sea water. The yellow line is the coastline of Kambunong Island, while the green dot is the place for installing tide gauges. The color gradation shown on the map is the color that shows the depth level in the waters of Kambunong Island. The depth of the color gradation is as follows:

a) Blue color (1) is an area that sinks at high tide and is dry at low tide, this area has a depth of 0 m – 3 m at the highest tide

b) Blue color (2) is an area that has a depth level of -3 m to -5 m at the lowest tide and can reach a depth of -6 m – -8 m at the highest tide.

c) Blue color (3) is an area that has a depth of -5 m to -9 m at the lowest tide and can reach a depth of -8 m to -12 m at the highest tide

d) Blue color (4) is an area that has a depth of -9 m to -14 m at the lowest tide and can reach a depth of -12 m to -17 m at the highest tide

e) Blue color (5) is an area that has a depth level of -14 m to -17 m at the lowest tide and reaches a depth of -17 m to -20 m at the highest tide

f) Blue color (6) is an area that has a depth level of -17 m to -24 m at the lowest tide and can reach a depth of -20 m to -27 m at the highest tide

g) He blue color (7) is the area that has the deepest depth in the study area, namely -24 m to -28.5 m at the lowest tide and reaches a depth of -27 m to -31.5 m at the highest tide. Details can be seen in Figure 3.
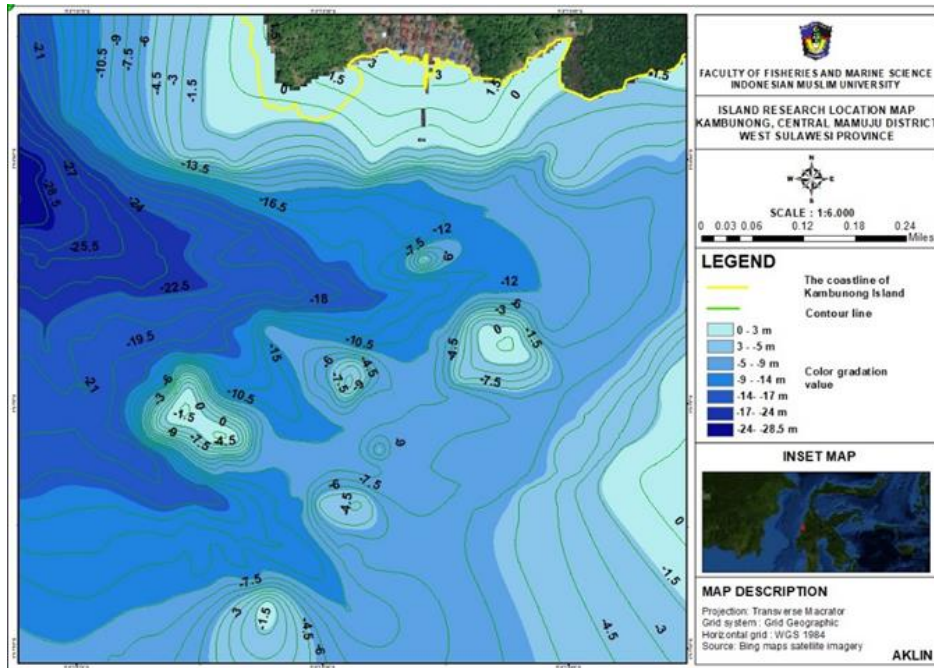

Fig 3: Bathymetry Map of Kambunong Island Waters

Topography of Kambunong Island Waters

A topographic map is a base map that displays the elements that exist above the earth's surface, both natural and man-made elements that significantly affect the natural form depicted (Novriza & Agusmaniza, 2020) [7]. The bottom topographic map of Kambunong Island waters is presented in the form of a bottom profile and a three-dimensional (3D) topographic map.

Based on the interpolation results, the bottom topography of Kambunong Island waters has a relatively steep bottom shape, and has several hilly areas with varying heights, including the following:

a) Profile A with a distance of 1,200 m, there is a gusung with a height of 20 m from the seabed at a distance of 700 m from the beach.

b) Profile B with a distance of 1,200 m has steep bottom conditions and there are two gusung, the first gusung has a height of 23 m from the seabed which is located at a distance of 600 m from the beach, while the second gusung has a height of 6.5 m from the seabed at a distance of 850 m from the beach.

c) Profile C has a distance of 1,200 m and there are gusung with a height of 14 m from the seabed at a distance of 500 m from the beach.

d) In the D profile with a distance of 1,200 m has a steep water bottom with a distance of 650 m from the beach. Details can be seen in Figure 4.
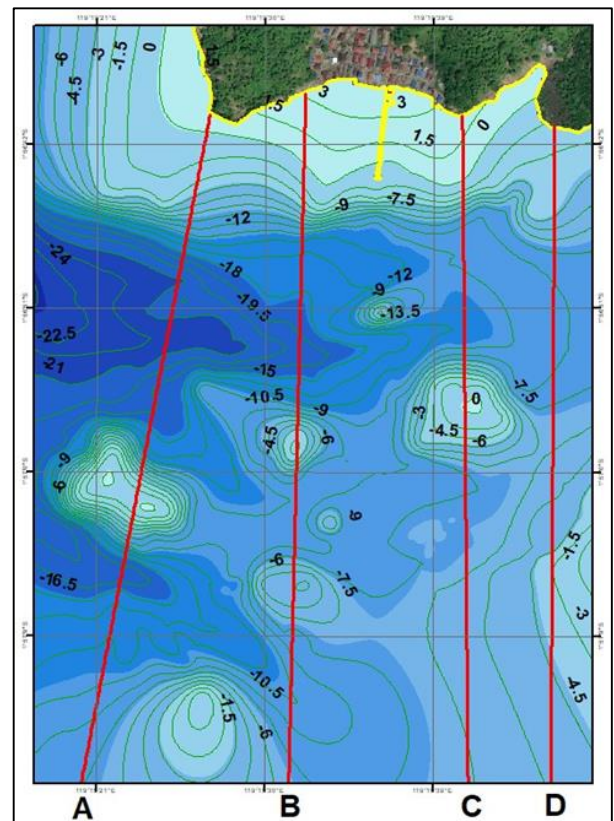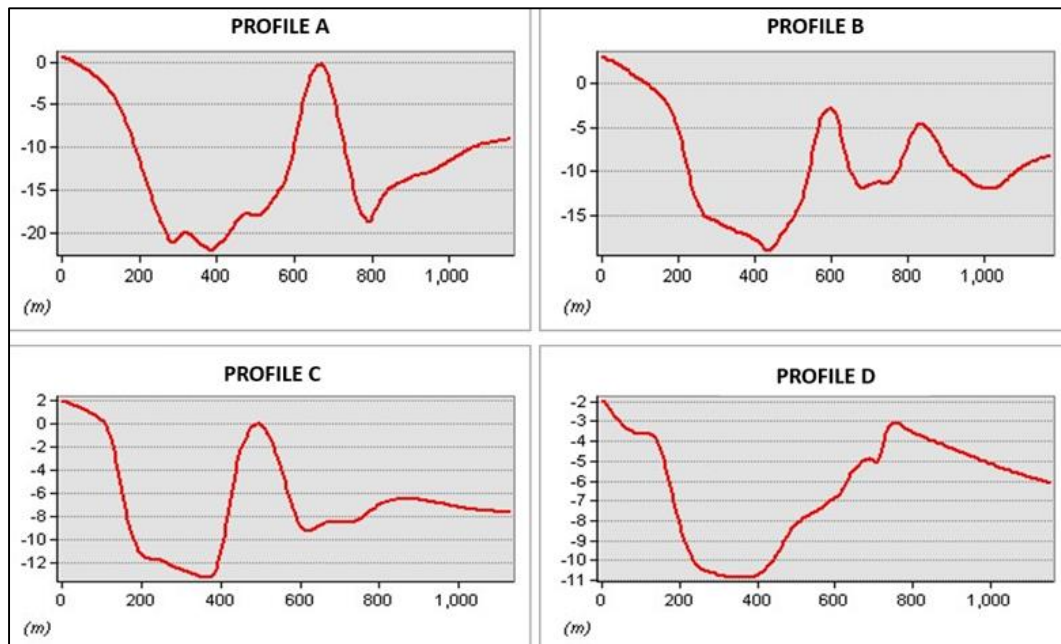
Fig 4: Profile of the Seabed of Kambunong Island Waters

Based on three-dimensional (3D) images, it can be seen the shape of the topography of the bottom of the waters, this condition is formed naturally without human intervention such as mining or recalation activities. This figure also explains the conditions and depth based on seven color gradations, each of which has a depth level in the waters of Kambunong Island, which are as follows:

a) The dark orange color is the shallowest area, this area is the lowest ebb area. This area has a depth of 0 m to -3 m.
b) Orange color is an area that has a depth level of -3 m to -5 m depth.
c) The light orange color is an area that has a depth level of -5 m to -9 m.
d) Yellow is an area that has a depth level of -9 m to -14 m.
e) The green color is an area that has a depth level of -14 m to -17 m.
f) The dark green color is an area that has a depth level of -17m to -24 m.
g) The blue color is the deepest area which has a depth level of -24 m to -28.5 m.
h) Black color is the color of the shadow effect that has no depth. Details can be seen in Figure 21.
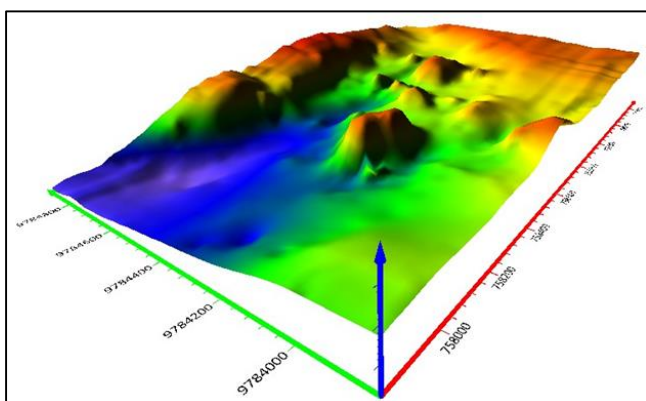

Fig 5: Three-dimensional (3D) topographic map of the bottom of Kambunong Island waters

Conclusion
Based on the description of the results of the discussion, the following conclusions can be drawn:
1. The value of the water level elevation in Kambunong Island waters is highest astronomical tide HAT = 2,52 m, mean higher high wate springs MHHWS = 2,17 m, mean higher high water neaps MHHWN = 1,34 m, mean sea level MSL = 1,26 m, mean lower low water neaps MLLWN = 1,18 m, mean lower low water springs MLLWS = 0,35 m, lighest astronomical tide LAT = 0 m.
2. The deepest waters of Kambunong Island reach a depth of -28.5 during the lowest tide conditions and the depth can reach -31.5 during the highest tide conditions
3. The bottom topography of Kambunong Island waters is relatively steep and there are 4 hilly areas with heights of 23 m, 18 m, 6.5 m and 10 m and from the bottom of the water.

Suggestion
It is hoped that the data from the research conducted can be utilized by the local community as a reference in the construction of coastal facilities and to be aware of areas that have the potential to run aground on passing ships so as to avoid losses.

Thank-you note
The author fully believes that this research would not have been possible without the help and support of all parties, therefore the author would like to thank the Head of Kambunong Village who has given permission to conduct the research and fellow students who were involved in completing this research.

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