

Analysis of Hydrodynamics and Water Quality in Padongko Beach Barru Regency South Sulawesi

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ABSTRACT

This research aims to analyse the hydrodynamic and water quality in Padongko Beach, Barru regency, South Sulawesi Province. The hydrodynamics and water quality of Padongko Beach effect of community livelihood. The hydrodynamic characteristics of the beach are influenced by the presence of tides, flow, waves and the type of beach. This study used the tidal method, the conjecture ball method, the wave data measurement method, the water quality checker method and the Secchi Disc method to analyses the hydrodynamic and water quality in Padongko beach. Based on the observation and data collecting of tides was taken in the field, the highest tide of 174 cm and the lowest tides of 61 cm. The tide level of Padongko beach was 113 cm, obtaining from reduction of the lowest tide. The tide level of Padongko beach has 113 cm of high, which was qualified as development area of boat harbour of fisherman, auction fish and life resource by benthic organism animal and plants can continue their life well. Implication of sanitation, temperature, turbidity, pH and Dissolve Oxygen (DO) generally in beach has positive low correlation. Therefore, it can conclude that seawater in the beach did not change water quality significantly and recommended for community to do activity in Padongko beach.

KEYWORDS: *Hydrodynamic, Tides, Waves, Currents, Water Quality, Padongko Beach.*

NOMENCLATURE

CCD	Secchi Disc
DO	Dissolve Oxygen
NTUs	Nephelometric Turbidity Units
pH	Potential of Hydrogen
WQC	Water Quality Checker

1. INTRODUCTION

The beach is the boundary between the land and the sea, where the land area is located at the top, at the bottom of the land surface starting from the boundary of the highest tide. Indonesia is the second country with the longest coastline in the world. The length of the Indonesian coastline reaches 99,093 Km. Padongko Beach is one of the beach located on the island of Sulawesi with a coastline length of up to 3 Km. Padongko Beach is located in the west of Barru City, which extends from north to south. Padongko Beach is used by the local community as fish auction and as a beach garage for fishermen to store their boats when they are out at sea [1].

Padongko Beach is a beautiful beach and has its own attraction as a beach tourist attraction, there is an interesting physical appearance of the texture of beach sand, the insistence of tidal waves that alternately lean on the beach, the melting of pillow lava with a unique texture and various sedimentary structures that are deposited through the sedimentation process from the mainland through the river that flows from the Barru river and the return of sand-clay-sized material back to the coastline is both carried by the wind and sea currents [2].

The hydrodynamic characteristics of the beach are influenced by the presence of tides, flow, waves and the type of beach [3]. Tides are the periodic movement of sea tides surface and fall resulting from the combination of gravitational forces and pulling forces of astronomical objects, especially the sun and moon. The types of tides consist of 3, namely single daily tides, double daily tides and mixed tides. The difference between tides and ebbs is the rise of sea level, high and low recede is the decrease in sea level. Flow is the movement of seawater generally influenced by wind speed, water pressure, seafloor topography and coriolis forces. Waves are the oscillating movement of water with a surface rising and falling in length, height, period, speed and energy [4].

This study aims to identify and analyze the influencing factors of hydrodynamics and water quality on Padongko beach. The data observed and sampled related to coastal hydrodynamics are tides, currents, waves and types of beaches. Meanwhile, the data taken related to water quality on the beach are temperature, pH, salinity, conductivity, turbidity and water clarity [5]. The benefits of research on the hydrodynamics and water quality of Padongko Beach for community livelihoods are to provide a scientific basis for sustainable coastal

management, identify environmental risks, and ensure the sustainability of local community livelihoods such as fisheries and tourism.

2. METHOD

2.1 Research Location

This research was conducted on the Padongko beach, Barru District, Barru Regency, South Sulawesi Province. The Padongko Beach is a beach that has interesting and beautiful hydrodynamics. The movement of seawater greatly affects the lives of the people who live along the coast of Padongko, especially when it comes to setting the time for fishermen to search for fish in the sea as the main source of livelihood for most fishermen in this area. Research on hydrodynamics and water quality on Padongko beach expected be primary data that can be useful for fishermen as a reference in planning easier and more profitable fish hunting activities to improve the welfare of their families [6].

2.2 Research Method

This study used the tidal method, the conjecture ball method, the wave data measurement method, the water quality checker method and the Secchi Disc method. The tidal method was to determine the average sea level. The way to measure it was, the palm meter was installed in a safer place, the position of the palm meter must not sink or the water level if there is a tide, observations had been made in 24 hours with different intervals at each time, there were intervals of 10 minutes, 30

minutes, 45 minutes to intervals of 1 hour. This interval division was carried out to adjust to the research location conditions and the level of safety during data collection [7].

The sea level levels were recorded at each interval. The Ball Method was the tool used to determine the direction of the current. It was used by lowering the zinc plate that has been formed with a predetermined model to the seabed. Then it was also throwing the ball into the sea, still holding the rope, so that it can still take the tool back, when the rope was stretched, shoot the direction where the ball was going to use a compass. Hence, the record of direction obtained, that was the direction of the flow. The method of measuring wave data was prepared by two beams, each with a length of 1.5 meters. In each block was in a 1.5 meters band on the beam to measure the peaks and valleys of the waves, as well as using a compass to measure the direction of the waves. The Water Quality Checker (WQC) method focuses more on determining temperature, acidity levels, conductivity, and oxygen content.

The Secchi Disc (CCD) method was used to measure water turbidity in both shallow and deep water locations. Using a CCD, the disc was slowly lowered from a boat to a depth where the white part of the disc was no longer visible to the naked eye. This turbidity limit (visibility depth) was recorded when the disc was pulled back up and placed back on the surface to determine the depth of visibility [8]. This method thus provides a direct indication of the transparency of the water column, which was important for assessing water quality and light penetration.

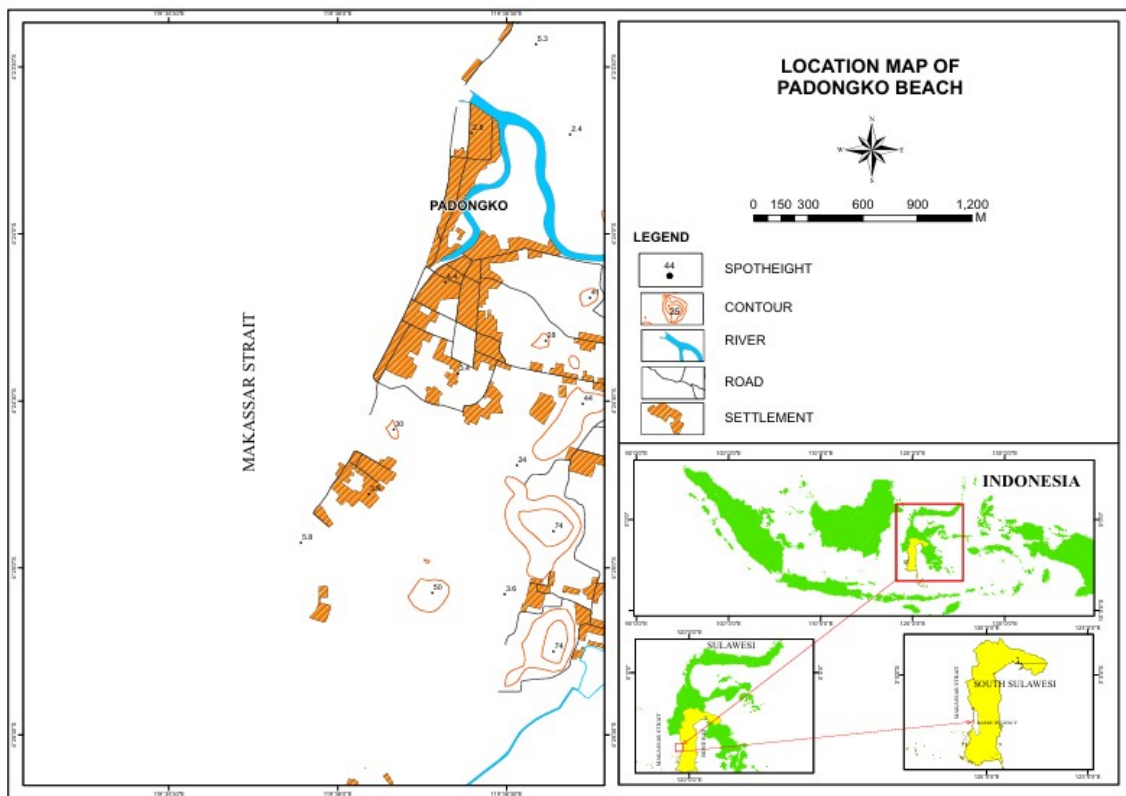


Figure 1: Research Location

3. RESULT AND DISCUSSION

3.1 Hydrodynamics

Hydrodynamics is the motion of liquids or the motion of liquid fluids, especially the movement of water, hydrodynamic conditions. It is one of the aspects that greatly affect the processes that occur on the coast, especially waves and flow depending on the shape and characteristics of the beach (Hatta et al., 2018). The hydrodynamics research of Padongko beach consists of tides, flow, waves and types of beaches [9].

3.2 Tidal

Tidal data collection was carried out by going down to the sea to look at movement of the tides with pipes and wood provided with buoys and tape meters to read the ups and downs of the tides [10]. Based on observations and tidal data taken in the field, the tides found from 15.08-23.45 WITA. The highest tide obtained was 174 cm at 19.00 WITA. Meanwhile, the retreat was found at 08.28-14.38 WITA, the lowest retreat was 61 cm at 11.40 WITA. In Figure 2 can be seen the Tidal data logging of collection. The Tide chart of Padongko Beach is shown in Figure 3. The variation of tidal water level over time at Padongko Beach (Table 1) was analyzed to characterize its temporal dynamics and to identify the dominant tidal patterns influencing the coastal environment. The location, time and current direction of Padongko Beach is shown in Table 2.



Figure 2: Tidal data logging

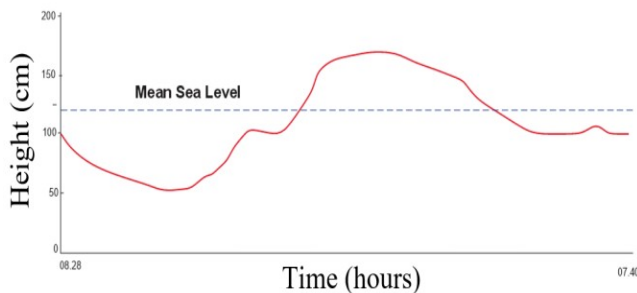


Figure 3: Tide chart of Padongko Beach

Table 1: Tidal water level measurement versus time of Padongko Beach

No.	Water Level (cm)	Time	No.	Water Level (cm)	Time
1	100	08.10	33	107	15.05
2	95	08.40	34	110	15.25
3	92	09.05	35	110	15.45
4	86	09.15	36	113	15.58
5	84	09.25	37	128	16.28
6	82	09.35	38	140	16.58
7	81	09.45	39	155	17.28
8	78	09.55	40	164	17.58
9	76	10.05	41	171	18.20
10	74	10.15	42	171	18.45
11	73	10.25	43	171	18.53
12	72	10.35	44	173	19.23
13	71	10.45	45	175	19.53
14	68	10.55	46	172	20.23
15	66	11.05	47	169	20.53
16	65	11.15	48	152	21.23
17	66	11.25	49	157	21.53
18	66	11.35	50	145	22.38
19	64	11.45	51	131	23.23
20	63	11.55	52	129	23.30
21	63	12.05	53	129	23.45
22	65	12.15	54	121	00.08
23	65	12.25	55	105	01.08
24	64	12.35	56	91	02.08
25	64	12.45	57	88	03.08
26	64	12.55	58	85	04.08
27	68	13.05	59	84	05.08
28	73	13.15	60	94	06.09
29	76	13.25	61	93	06.27
30	88	13.35	62	93	06.38
31	88	14.05	63	93	07.08
32	95	14.35	64	90	07.38

Table 2: Location, time and current direction of Padongko Beach

No.	Coordinates	Time	Current Direction
ST-1	4°23'50"LS-119°36'68"E	08.27	N 240° E
ST-2	4°23'56"LS-119°36'05"E	08.35	N 285° E
ST-3	4°24'00"LS-119°36'14"E	08.45	N 300° E
ST-4	4°23'50"LS-119°36'13"E	08.59	N 315° E
ST-5	4°23'47"LS-119°36'10"E	09.25	N 333° E
ST-6	4°23'41"LS-119°36'09"E	09.40	N 60° E
ST-7	4°23'37"LS-119°36'62"E	10.02	N 343° E
ST-8	4°23'52"LS-119°36'06"E	10.14	N 316° E
ST-9	4°23'50"LS-119°36'03"E	10.52	N 80° E
ST-10	4°23'34"LS-119°36'05"E	11.08	N 50° E
ST-11	4°23'26"LS-119°36'18"E	11.26	N 142° E
ST-12	4°23'40"LS-119°36'10"E	11.37	N 119° E

3.3 Flows

Flows are the movement of seawater that is generally influenced by wind speed, water pressure (density), seafloor topography, coriolated forces, and elemental currents. The average flows in the northern part of the study area are from the northwest to the northeast and in the southern part of the research area, the dominant current moves from the east to the northwest. The type of current that occurs in the study area is coastal currents [11]. Coastal currents arise due to the movement of water masses along coastal waters such as the movement of waves, tides, river currents and the influence of ocean currents or seasonal currents whose conditions have been fragmented. The currents that arrive in coastal waters will move and separate, some of them move in the direction of the coastline called long-shore currents and some will be reflected back towards the sea called rip-current. Based on the collection of current direction data, it was concluded that there was a tendency in the direction of the current to the northwest and southwest [12].



Figure 4: Determination of the current direction using the approximate ball method



Figure 5: Wave data taken to the Douth (N175°E)

3.4 Wave

Waves are the oscillating movement of water with the surface rising and falling. It has length, height, period, speed, frequency, and energy [13]. The highest wave peak was 141 cm, while the lowest valley of 62 cm. The height of the waves was 35 cm. It was an average wave height of 15.06 cm and a minimum wave height of 6 cm. The average wave energy was 0.033 J/m², average the wave speed of 2.526 m/s. And the average frequency was 0.830 Hz, the direction of the wave from West to East. Padongko Beach Wave data is depicted in Table 3.

3.5 Types of Beaches of This Study

The type of beach in the study area is a type the beach that rises or Emergency Coast (Johnson, 1919), which is characterized by a decrease in the sea level of coral reefs with a depth of 2 m, relatively straight coastline and flattening with a slope of 4° - 7° [14]. The beach in the study area has an age of approximately 3,000 years, which was characterized by a coral reef depth of 2 meters [14].

3.6 Correlation

The correlation is connection all data obtained on Padongko beach using water quality checker, namely the correlation of sanitation, temperature, turbidity, pH and Dissolve Oxygen (DO). Temperature is a measure of the level of heat or cold of an object or environment. In general, sea surface temperatures in the tropics can reach around 27-30°C, whilst in the polar region it can be close to 0°C. Ocean temperatures affect a variety of phenomena, including weather patterns, global climate, and ocean biological cycles, and play a role in heat transport systems in the atmosphere and oceans. Ocean temperatures can be measured using a marine thermometer or other temperature measuring device [15]. The temperature obtained in the study area had an average temperature of 29.5°C with a high temperature of 30.2°C and a low of 28.2°C. The temperature spread of 30.2°C was found at station 12, temperature of 30°C was found at station 5, temperature of 29.6°C was found at station 1 and 4. The temperature of 29.5°C was found at station 3, temperature of 29.3°C was found at station 6, temperature of 29.2°C was found at station 10, and temperature of 28.2°C was found at station 11 [16].

3.7 Temperature Correlation

The temperature correlation was obtained as in depicted in Figure 6. The x axis value of the temperature was obtained from the temperature values of 29.6, 29.7, 29.5, 29.6, 30, 29.3, 29.7, 29.8, 29.2, 29.7, 28.2, and 30.2. And the y axis value of the depth data of 6, 6, 1, 2, 3.7, 2, 2.7, 9.3, 4.2, 3, 5, 0.5 and 2 m. It can be seen in Figure 6, the temperature correlation was included in the positive low correlation, which the same trend with [17].

The correlation analysis between turbidity and depth was presented as shown in Figure 7. The turbidity values obtained from the measurements were 2, 4, 4, 4, 1, 1, 1, 2, 2, 1, 2, and 5 the Nephelometric Turbidity Units (NTUs). Meanwhile, the depth data represented by the Y axis in Figure 7 is also presented in this analysis. Based on the data visualization, the apparent correlation between the two variables was classified as a low positive correlation. This indicates that although there was a tendency for depth to increase with increasing turbidity, the linear relationship between the two is not very strong.

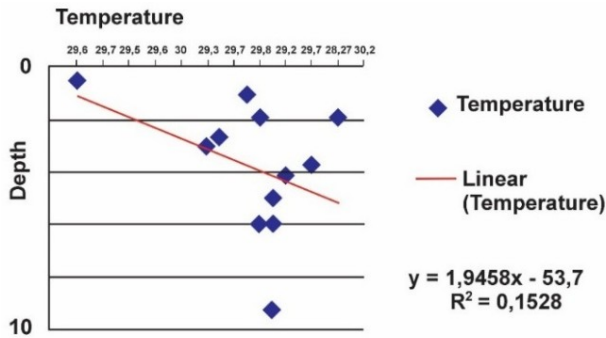


Figure 6: Temperature correlation

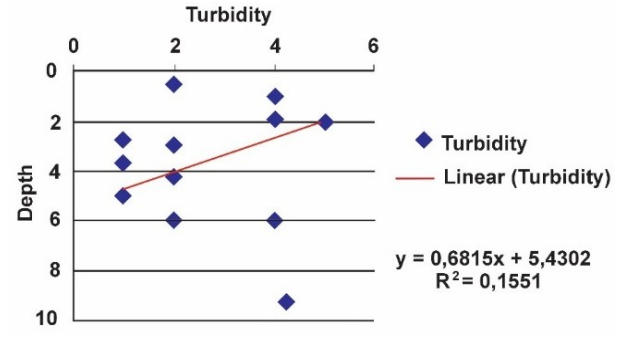


Figure 7: Correlation of turbidity

Table 3: Padongko Beach Wave data

No.	Wave Peak (M)	Wave Valley (Cm)	Wave Height (Cm)	Length (M)	Old	Time	Energy J/m ²	Frequency (Hz)	V (M/S)
1	106	91	15	2.40	05.71	17.12	0.28	0.17	0.004
2	110	90	20	2.60	06.64	17.13	0.05	0.15	0.39
3	113	90	23	1.80	09.48	17.15	0.06	0.10	0.18
4	109	91	18	2.74	03.65	17.16	0.04	0.27	0.74
5	114	92	22	2.90	02.80	17.16	0.06	0.35	0.017
6	112	98	14	3.20	02.40	17.24	0.02	0.41	0.31
7	116	96	20	2.50	02.53	17.24	0.05	0.39	0.97
8	114	97	17	2.30	03.22	17.25	0.03	0.31	0.71
9	117	99	18	4.20	03.62	17.26	0.04	0.27	1.13
10	123	90	33	4.30	02.77	17.13	0.13	0.36	1.55
11	119	98	21	3.30	03.33	17.12	0.05	0.30	0.99
12	118	96	22	4.60	02.67	17.13	0.06	0.37	1.70
13	114	97	17	6.00	03.85	17.12	0.03	0.25	1.50
14	115	101	14	4.50	04.04	17.13	0.02	0.24	1.08
15	118	98	20	4.00	03.37	17.12	0.05	0.29	1.16
16	116	97	19	3.20	04.02	17.13	0.04	0.24	0.76
17	112	89	23	4.10	04.75	17.12	0.06	0.21	0.86
18	116	93	23	3.10	03.40	17.13	0.06	0.29	0.90
19	111	94	17	1.90	02.90	17.12	0.03	0.34	0.64
20	115	97	18	2.45	03.62	17.13	0.04	0.27	0.66
21	119	94	25	5.00	03.95	17.12	0.07	0.25	1.25
22	116	98	18	3.80	03.77	17.13	0.04	0.26	0.98
23	116	104	12	2.60	03.75	17.12	0.18	0.26	0.67
24	113	94	19	3.20	03.17	17.13	0.04	0.31	0.99
25	114	100	14	2.65	03.53	17.12	0.02	0.28	0.74
26	128	102	16	2.25	03.88	17.13	0.032	0.25	0.56
27	127	99	28	3.80	03.80	17.12	0.09	0.26	0.98
28	129	110	19	2.90	03.28	17.13	0.04	0.30	0.87
29	118	103	15	2.90	02.93	17.12	0.028	0.34	0.90
30	130	102	20	3.50	02.90	17.13	0.09	0.34	1.19
31	126	105	21	4.95	03.77	17.12	0.05	0.26	1.28
32	123	104	19	3.50	04.81	17.13	0.04	0.20	0.70
33	127	112	15	3.00	03.29	17.12	0.28	0.30	0.90
34	129	113	16	2.60	03.20	17.13	0.032	0.31	0.80
35	131	107	24	4.35	03.62	17.12	0.072	0.27	1.17
36	128	109	19	5.15	03.69	17.13	0.04	0.27	1.39
37	133	107	26	5.15	02.57	17.12	0.08	0.38	1.95
38	126	110	16	3.65	03.52	17.13	0.032	0.28	1.02
39	134	114	20	2.95	03.45	17.12	0.05	0.28	0.82
40	130	108	22	2.55	03.48	17.13	0.06	0.28	1.02
41	126	112	14	3.70	03.17	17.12	0.02	0.31	1.14
42	132	109	23	4.40	02.45	17.13	0.06	0.40	1.76
43	134	112	22	3.65	03.57	17.12	0.06	0.28	1.02
44	128	109	19	2.80	03.27	17.13	0.40	0.30	0.84
45	128	114	14	2.50	03.17	17.12	0.02	0.31	0.77
46	129	113	16	2.60	03.14	17.13	0.032	0.31	0.80
47	130	112	18	1.80	03.35	17.12	0.04	0.42	0.75
48	130	113	17	3.20	03.29	17.13	0.03	0.30	0.96
49	132	118	14	4.55	03.30	17.12	0.02	0.30	1.36
50	135	113	22	3.70	02.37	17.13	0.06	0.42	1.55

The pH obtained in the object study has an average of 7.8 with the highest pH of 8.0 and the lowest pH of 7.8 and the pH distribution point of 8.0 was found at stations 4, 6, and 11. The pH 7.8 was found at stations 1, 2, 3, 5, 8, 9, 10, and 12. The pH correlation was obtained based on the Table 4. It can be seen in Table 4, the x value of the pH values was obtained, namely 8, 7.9, 7.8, and 7.6. The Y value of the depth data was 6, 6, 1, 2, 3.7, 2, 2.7, 9.3, 4.2, 3, 5, 0.5 and 2. Based the graph in Figure 8, it can be said that the pH correlation was included in the positive low correlation [18].

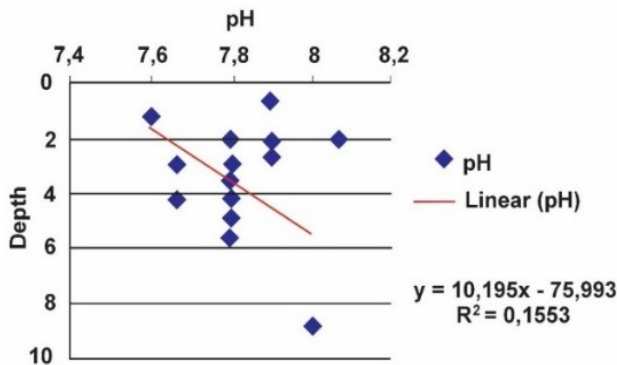


Figure 8: Correlation of pH (Potential of Hydrogen)

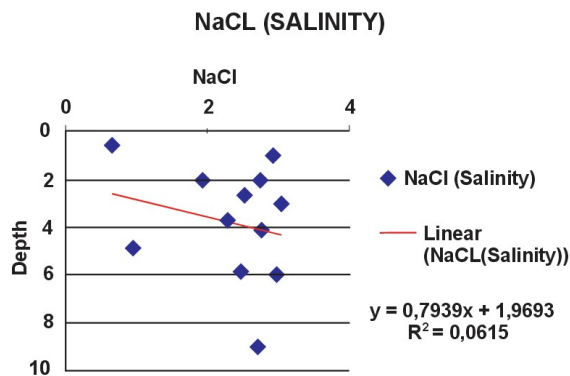


Figure 9: Salinity correlation

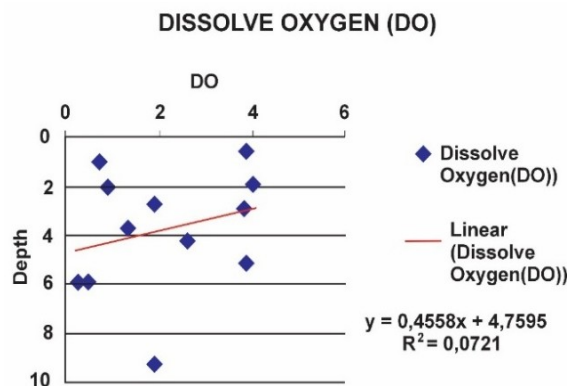


Figure 10: The Oxygen Dissolve (DO) correlation

The salinity level is the salt content measured using a water quality checker [19]. Among the salinity found in several stations in the object study, the average value was 2.2 with the highest salinity level of 3.0 and the lowest 0.6. The distribution of salinity was 3.0 at station 9, salinity of 2.9 at stations 2 and 3, salinity of 2.7 at stations 7.8 and 12, salinity of 2.5 at station 6, salinity of 2.4 at station 1, salinity of 2.2 at station 5, salinity of 1.9 at station 4, salinity of 0.9 at station 10 and salinity of 0.6 at station 11.

The salinity correlation is obtained as in the Figure 9, the x value of the salinity value was obtained, namely 2.4, 2.9, 2.9, 1.9, 2.2, 2.5, 2.7, 2.7, 3, 0.9, and the value of y, namely 6, 6.1, 2, 3.7, 2.7, 9.3, 4.2, 3.5, 0.5, and 2. In the graph in Figure 9, it can be said that the salinity correlation was included in the positive low correlation. A pH value between 7.8 and 8.0 classified as neutral. Therefore, it would not disrupt the biological balance of the coastal water ecosystem. The lives of fish, plankton, and aquatic plants can continue to thrive [20].

The conductivity level was measured by the water quality checker. The conductivity level of the object research has an average value of 3.0 with the highest conductivity of 4.4 and the lower of 1.1. Conductivity spread 4.4 at station 8 connectivity 4.3 at stations 7 and 9, conductivity 4.1 at station 10, conductivity 3.9 at station 6, conductivity 3.3 at station 1, conductivity 2.7 at station 3, conductivity 2.3 at stations 2 and 12, conductivity 1.9 at stations 4 and 5, conductivity 1.1 at station 11.

3.8 Dissolve Oxygen (DO) Correlation

The correlation of Dissolve Oxygen (DO) obtained can be seen in Figure 10. In Figure 10 shows the x value from the DO namely 4, 3.9, 2.6, 1.9, 1.3, 0.9, 0.7, 0.4 and 0.3. The Y values of the depth data were 6.6, 1.2, 3.7, 2.7, 9.3, 4.2, 3, 5, 0.5 and 2. In the Figure 10, it can be seen the Dissolve Oxygen (DO) correlation includes a positive low correlation depth.

Turbidity is the level of turbidity in seawater. The higher the turbidity value, the turbidity of the water the turbidity point obtained in the object study area has an average of 57.02, with the highest turbidity of 83.26 and the lowest of 27.04. Based on the average turbidity and turbidity classification, the study area included turbidity (25 to 100 NTUs (Nephelometric Turbidity Units)) [21].



Figure 11: Temperature measurement using a Salinometer

The level of water clarity was measured using the Sechi Disc (CCD) device. The water clarity level of the study area [22] has an average depth value of 2.4 m. The maximum depth was 3 m and a minimum depth of 0.2 m. Water quality checker measurement results are shown in Table 4.

Table 4: Water quality checker measurement results

No.	Depth	Salinity	pH	Dissolve Oxygen (Do)	Temperature	Turbidity
1	6.0	2.4	7.8	0.3	29.6	2
2	6.0	2.9	7.8	0.4	29.7	4
3	1.0	2.9	7.6	0.7	29.5	4
4	2.0	1.9	7.9	0.9	29.6	4
5	3.7	2.2	7.8	1.3	30.0	1
6	2.7	2.5	7.9	1.9	29.3	1
7	9.3	2.7	8.0	1.9	29.7	1
8	4.2	2.7	7.8	2.6	29.8	2
9	3.0	3.0	7.8	3.9	29.2	2
10	5.0	0.9	7.8	3.9	29.7	1
11	0.5	0.62	7.9	3.9	28.2	2
12	2.0	2.7	7.8	4.0	30.2	5

4. CONCLUSION

In research of hydrodynamics and water quality in Padongko beach used wave measurement method, water quality checker and Secchi Disc method. Result of study revealed the tides of type semidiurnal. The wave direction from west to east by wave energy average was 0.033 J/m^2 and the frequency of 0.830 Hz, which had average speed of 2,526m/s. At northern wave lead stream from western to eastern, and in south stream moved from east to western. The water sea quality had pH average of 8.0, temperature average of 29.5°C , and salinity average of 2.2 gram/litres. The conductivity average was 3.0 and turbidity average of 57.02, and water clarity level was into depth 2.4 m. Tides level had 113 cm of high that was very qualified as boat harbour, fish auction place, life resource by benthic organisms.

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