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ABSTRACT

Anthropogenic activities have increased the flux of nitrogen and phosphorus from the terrestrial into the mangrove water system causing an increase in water fertility. The aim of this study was to analyze the water quality and fertility status of mangrove aquatic ecosystems at low tide in Pagatan Besar Village, Tanah Laut District, South Kalimantan, Indonesia. The four research stations were repeated three times with a distance of 100 meters during high and low tide. Fertility of Mangrove Waters as an Indicator of the Quality of Pagatan Besar Mangrove Waters in terms of the value of water quality parameters. The phosphate and TSS parameters for all stations were above the quality standard, total ammonia and DO at station one were not in accordance with the quality standard stipulated in Permen LH No. 51 of 2004, the correlation parameter of phosphate has a positive and strong relationship, the increase in phosphate values in mangrove waters is always high during high and low tide. Calculation of the TSI (Trophy State Index) these waters have experienced euthanasia.

KEY WORDS

Mangroves, fertility, water quality, Pagatan Besar, land of the sea.

Mangrove ecosystems are formed between a combination of coastal communities that grow on tropical coastlines and are influenced by tides. The ecological function of the mangrove ecosystem is useful for supporting the survival of aquatic biota, spawning ground, nursery ground and feeding ground are all included in the ecological function of mangrove forests. Mangroves prevent coastal abrasion and protect community settlements from waves, wind and storms (Marois and Mitsch, 2015). A biological natural resource, mangrove ecosystems have a lot of potential that must be preserved in line with the sustainable management of mangrove ecosystems in accordance with Presidential Regulation of the Republic of Indonesia Number 73 of 2012.

Mangrove ecosystems in South Kalimantan are scattered in river estuaries and coastal coastlines, the area that is the focus of this research is in the mangrove ecosystem area of Pagatan Besar village. Anthropogenic activities have increased the flux of nitrogen and phosphorus from terrestrial into aquatic systems, this will cause nutrient enrichment caused by population growth and agricultural land (Wong et. al., 2015) water nutrient enrichment causes waters to experience eutrophication, eutrophication can cause problems such as blooms of harmful algae or plankton are harmful for algae blooms (Brand and Compton, 2007). The decomposition of water nutrients during Hurricane Wilma that occurred in Florida affected sediment and nutrient decomposition where the storm crosses through the Florida Coastal Everglades mangrove area. Measurements of sediment deposits and their chemical properties are affected where nutrients near water bodies have nutrient thickness (0.5 to 4.5 cm) and decrease with distance inland at each location (Castaneda et al, 2010). Research on tidal mangroves in Kenya has a sediment capture efficiency of 64% (Kitheka et.al., 2002).

Photosynthesis of plankton, the abundance of phytoplankton in water bodies can absorb nutrients from water bodies, the abundance of plankton in water bodies due to nutritional factors, temperature. and mangroves in the aquatic environment, which greatly affect the life of aquatic organisms (Soeprobowati et.al, 2010). Cases of decreased catch values in several areas around the Pagatan Besar mangroves (Takisung Village, Tabanio and Kuala Tambangan) occurred. The value of catches from 2006 to 2017 data, the difference in fishermen's profits decreased, Takisung village experienced a shrinkage of 50% from 2006 to 2017 catches (Mustika, 2017). The aim of this study was to analyze the water quality and fertility status of mangrove aquatic ecosystems during high tides in Pagatan Besar Village, Tanah Laut Regency.

MATERIALS AND METHODS OF RESEARCH

This research was carried out by taking water samples at each sampling point of the mangrove forest waters in Pagatan Besar Village, Tanah Laut Regency, South Kalimantan Province, Indonesia, ULM Water Quality Laboratory, Laboratory of the Center for Standardization and Industrial Services of Banjarbaru & Laboratory of the National Research and Innovation Agency. The division of stations in the study, namely four research stations, was repeated three times with a distance of 100 meters during high and low tide, broken down as follows:

- Station I, water sampling in the mangrove forest Ecotourism area of Pagatan Besar village;
- Station II, water sampling was carried out on the outermost mangroves of the confluence of two watersheds (Pagatan Besar & Tabanio);
- Station III, water sampling was carried out in the mangroves of the Tabanio watershed area;
- Station IV, water sampling was carried out in the mangroves of the Pagatan Besar watershed area.

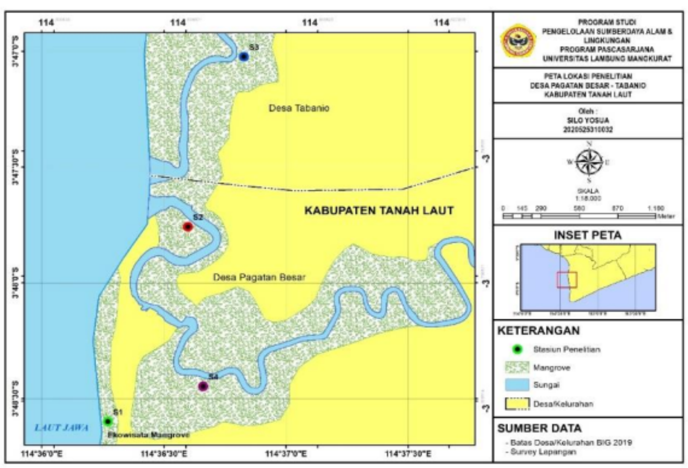

Figure 1– Sketch of Sampling Station

Analysis of water quality obtained from data analysis in the field and laboratory was compared with the stipulation of KEPMEN LH No. 51 of 2004 based on the Quality Standard of Mangrove Marine Biota.

The data findings that have been tested for both aquatic environmental parameters and aquatic nutritional parameters are tested for correlation to determine the relationship that occurs when there are changes in the tides and ebb of the water.

Table 1 – Water Quality Quality Standards

No	Parameter	Unit	Quality standards
PHYSIQUE			
1	Brightness	M	Mangroves: -
2	Total Suspended Solids (TSS)	mg/l	Mangroves: 80
3	Temperature	° c	Mangroves: 28-32
CHEMISTRY			
4	pH	-	Mangroves: 7-8.5
5	Salinity	%0	Mangroves: up to 34
6	Dissolved Oxygen	mg/l	>5
7	Total ammonia (NH_3-N)	mg/l	0.3
8	Phosphate (PO_4-P)	mg/l	0.015
9	Nitrates (NO_3-N)	mg/l	0.008
BIOLOGY			
10	Plankton	cells/100 ml	No *blooms*

The fertility level of mangrove forest waters can be analyzed using the TSI Trophic State Index calculation approach (Carlson, 1977), provided that the data for total phosphate, chlorophyll a, and water brightness are fulfilled at the time of sampling. Fulfillment of the required data will be taken at 4 predetermined stations. The data that has been obtained is calculated using the TSI formula as follows:

$$TSI\ average = \frac{TSI\ (SD) + TSI\ (TP) + TSI\ (Chl)}{3}$$

$$TSI\ (SD) = 60 - 14.41\ \ln\ (SD)$$

$$TSI\ (CHL) = 30.6 + 9.81\ \ln\ (CHL)$$

$$TSI\ (TP) = 4.15 + 14.42\ \ln\ (TP)$$

Where: SD = Secchi disk (m); TP = Total phosphate (mg/m^3); Chl = Chlorophyll-a (mg/ m^3).

The calculation results obtained are compared with the TSI table (Carlson 1977).

Table 2 – Criteria for Fertility Status of Trophic State Index (TSI) waters

TSI	SD (m)	TP (mg/m ^{3})	Chl (mg/m ^{3})	Status
< 30 – 40	>8 - 4	6 – 12	0.94 – 2.6	Oligotroph
40 – 50	4 – 2	12 – 24	2.6 – 6.4	Mesotroph
50 – 70	2 – 0.5	24–96	6.4 – 56	Eutroph
70 - 100	0.5 – 0.062	96-768	56 – 1.183	Hyper-eutrophic

Responding to the formulation of the first research problem, namely the fertility status of mangrove waters using the TSI Trophic State Index data (Carlson, 1977) will be described with the results obtained at all research stations and matched with the latest research revisions related to water fertility both in the form of benefits and what to do with it.

RESULTS AND DISCUSSION

Based on the results, it can be seen that the results of the water quality of the mangrove forest in the village of Pagatan Besar can be seen in the table 3.

The table of results for the analysis of water quality parameters for the mangrove forest in Pagatan Besar Village provides information that there are values that exceed the quality standards, parameters of Ammonia, Phosphate, DO, TSS & Temperature. The results of this analysis are continued by testing the correlation of each parameter to see the relationship of each parameter to the tidal conditions of mangrove forest waters. Tidal waters obtained the results of the correlation value of the relationship between each parameter. The correlation coefficient of environmental parameters to tides can be seen in the table 4.

The relationship of the test parameters to the tides and ebbs in the mangrove forest waters of Pagatan Besar Village obtained results with a positive value relationship and a strong relationship, namely the total phosphate relationship in the high and low tide waters with a correlation value of 0.677, the water temperature in this study obtained results with a positive value and a very strong relationship, namely 0.923, that there is a relationship between temperature changes in the waters during high and low tide. A negative value with a very strong relationship with a value of -0.886 in the current velocity parameter in this case that there is a relationship between changes in current velocity during high and low tide in the mangrove forest waters of Pagatan Besar Village.

Table 3 – Quality of Mangrove Forest Waters

STATION	Repetition	TA (mg/l)	TP (mg/l)	TN (mg/l)	Chl-a (mg/l)	DO (mg/l)	pH	sal (0/00)	TSS (mg/l)	temp °c	Brightness (Meters)	Kec A (m/s)
	Quality standards Ministry of Environment Decree No. 51 of 2004	0.3mg/l	0.015mg/l	0.008mg/l	-	> 5mg/l	7-8.5	up to 34	80 mg/l	28-32 °c	-	-
1	S1.P1 Low tide	0.14	0.044 *	0.06 *	0.0004	6.85	7,36	4,6	215 *	29,8	0.175	0.1
	S1.P2 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S1.P3 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S1.P1 Plug	0.344 *	0.023 *	0.001	Nd	6,54	7,54	4,4	172 *	29,6	0.185	0.4
	S1.P2 Plug in	0.532 *	0.048 *	0.25 *	0.0275	3.02 *	7,4	2,6	121 *	26.7 *	0.13	0.1
	S1.P3 Plug in	0.345 *	0.153 *	0.002	0.0337	1.36 *	7,47	2.39	58	27.7 *	0.13	0.1
2	S2.P1 Low tide	0.115	0.03 *	1.47 *	Td	6.75	7,12	1,3	68	30,7	0.13	0.1
	S2.P2 Recede	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S2.P3 Recede	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S2.P1 Plug in	0.089	0.064 *	0.001	Td	6.03	7,29	5,1	120 *	30.5	0.2	0.1
	S2.P2 Plug in	0.149	0.03 *	0.001	Td	7,26	7,29	5,2	89 *	30,4	0.24	0.1
	S2.P3 Install	0.211	0.031 *	0.002	Td	6,13	7,27	3,2	43	29,7	0.28	0.1
3	S3.P1 Low tide	0.125	0.019 *	[illegible]	Td	7,28	7.03	3,4	98 *	29,9	[illegible]	0.2
	S3.P2 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S3.P3 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S3.P1 Install	0.193	0.035 *	0.001	Td	6.95	7,43	5,6	119 *	29,7	0.24	0.2
	S3.P2 Install	0.172	0.047 *	0.001	Td	7.58	7.45	5,5	272 *	30,4	0.135	0.2
	S3.P3 Install	0.107	0.031 *	0.001	Td	6.75	7.57	5,8	190 *	28,1	0.125	0.3
4	S4.P1 Low tide	0.304 *	0.036 *	0.12 *	0.0977	6,34	7,1	0.2	151 *	27,4	[illegible]	0.4
	S4.P2 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S4.P3 Low tide	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td	Td
	S4.P1 Plug in	0.11	0.03 *	0.001	Td	6,84	7,12	3,7	78	26.5 *	0.16	0.1
	S4.P2 Plug in	0.096	0.031 *	0.001	0.0522	5.92	7,31	1,2	85 *	26.5 *	0.145	0.1
	S4.P3 Install	0.18	0.037 *	0.001	0.0594	6.75	7,33	5,5	109 *	26.7 *	0.15	0.1
Standard Deviation		0.122	0.031	0.367	0.033	1,638	0.161	1,780	61,881	1.615	0.050	0.108
Means		0.201	0.043	0.121	0.045	6,147	7,318	3,731	124,250	28,769	0.167	0.169
Mean ± SD		0.201 ± 0.122	0.043 ± 0.031	0.121 ± 0.367	0.033 ± 0.045	6.147 ± 1.638	7.318 ± 0.161	3.731 ± 1.780	124,250 ± 61,881	28.769 ± 1.615	0.167 ± 0.05	0.073 ± 0.144

*Notes: TA (Total Ammonia), TP (Total Phosphate), TN (Total Nitrate), Chl-a (Chlorophyll-a), DO (Dissolved Oxygen), pH (Acidity), Sal (Salinity), TSS (Total Suspended Solid), Temp (Temperature), Kec A (Current Velocity), Td (No data). S1P1 (Station 1 & Repetition 1), * Does not comply with the Ministry of Environment Quality Standard No 51 of 2004.*

Table 4 – Parameter Correlation Values for Water Tide

Parameter	Station 1	Station 2	Station 3	Station 4	Correlation (r)	Relationship Level
TP Low TP Install	0.044 0.075	0.03 0.042	0.019 0.038	0.036 0.033	0.6770496	Strong
TN Low TN Install	0.06 0.086	1,473 0.001	0.001 0.001	0.128 0.001	-0.331797	Low
TA Low tide TA Install	0.14 0.407	0.115 0.15	0.125 0.157	0.304 0.129	-0.316001	Low
DO Recede DO Install	6.85 3.64	6.75 6,473	7,28 7,093	6,34 6,503	0.085196	Very low
Low pH pH Plug	7,36 7,47	7,12 7,283	7.03 7,483	7,1 7,253	0.3031728	Low
Low tide Sal Install	4,6 3,13	1,3 4,5	3,4 5,633	0.2 3,467	0.0535174	Very low
Low Temp Temp Install	29,8 28	30,7 30,2	29,9 29,4	27,4 26,6	0.923825	Very strong
TSS Low TSS Install	215 117	68 84	98 193.67	151 90.67	-0.103973	Very low
Brightness Recede Pair Brightness	0.175 0.148	0.13 0.24	0.15 0.167	0.1 0.152	-0.177302	Very low
Kec A Low tide Sub-district A Install	0.1 0.2	0.2 0.1	0.1 0.23	0.3 0.1	-0.886621	Very strong

Notes: TA (Total Ammonia), TP (Total Phosphate), TN (Total Nitrate), DO (Dissolved Oxygen), pH (Acidity), Sal (Salinity), TSS (Total Suspended Solid), Temp (Temperature), Kec A (Current Velocity).

Trophic State Index (TSI) calculation approach to determine the level of water fertility, this calculation was put forward by Carlson in 1977 data fulfillment with phosphate, brightness and chlorophyll-a values. The data fulfilled for this study can describe the condition of water fertility at various stations; this data explains that changes in fertility conditions during high and low tide and the process of nutrient enrichment in the waters.

Table 5 – Trophic State Mangrove Forest Index in Pagatan Besar

STATION	Repetition	TSI (Brightness)	TSI (TP)	TSI(Chl-a)	Carlson TSI	Status
		Meters	mg/L	mg/L	mg/L	
1	S1.P1 Low tide	85.1162	-40,892	-46.153891	28.8397406	Oligotrophic
	S1.P1 Plug	84.3154	-50,246	nd	Nd	-
	S1.P2Install	89.3996	-39,637	-4.6529146	48.2114981	mesotrophic
	S1.P3 Plug in	89.3996	-22,921	-2.6584255	65.592524	eutrophic
2	S2.P1 Low tide	89.3996	-46,415	Nd	Nd	-
	S2.P1 Plug in	83,192	-35,489	Nd	Nd	-
	S2.P2Install	80.5647	-46,415	Nd	Nd	-
	S2.P3 Install	78.3434	-45,942	Nd	Nd	-
3	S3.P1 Low tide	87.3375	-53,001	Nd	Nd	-
	S3.P1 Install	80.5647	-44,192	Nd	Nd	-
	S3.P2Install	88.8557	-39,941	Nd	Nd	-
	S3.P3 Install	89.9648	-45,942	Nd	Nd	-
4	S4.P1 Low tide	93.1803	-43,785	7.783375	51,9892215	eutrophic
	S4.P1 Plug in	86.4075	-46,415	Nd	Nd	-
	S4.P2Install	87,826	-45,942	1.63428	42.4290447	mesotrophic
	S4.P3 Install	87.3375	-43.39	2.9018471	44.9143865	mesotrophic

Notes: Nd (Not Detected), TSI (Trophic State Index), SDT (Secchi Disc Transparency), TP (Total Phosphate), Chl-a (Chlorophyll-a).

The first station was at low tide during the research of oligotrophic water conditions, but at high tide at station one there was a change and an increase in status occurred to mesotrophic and eutrophic. The fourth station in the first iteration at low tide the water status is eutrophic and at high tide the water status changes to mesotrophic.

DISCUSSION OF RESULTS

The Mangrove Village of Pagatan Besar has an important role in improving the quality of runoff water from various sources of atropogenic pollutants from various human activities in the upstream waters. Parameters of water quality and fertility were measured at 4 stations by measuring three repetitions of sampling within 100 meters entering the mangrove forest area during high and low tide. The value of water quality during tidal conditions in this study was measured by testing the correlation analysis whether there was a relationship between changes in water quality parameters and comparisons with the Decree of the Minister of Environment No. 51 of 2004.

This study analyzed 11 water quality parameters in mangrove waters, through this it will describe the environmental conditions of the waters in the Pagatan Besar Mangrove forest waters, namely:

- *Total Ammonia*. At the first observation station from the first to the third repetition, when sampling the tides, there was a finding of a total ammonia value that was above the quality standard in the Decree of the Minister of Environment No. 51 of 2004, namely 0.344 mg/l, when the tide rose at each repetition of the observations, the results were 0.532 & 0.345 mg/l of ammonia, but repeated observations at low tide the value of ammonia was found to be not above the quality standard. The first station at the research location is located in an ecotourism area, cattle breeding pens and residential areas allow the entry of waste (urea) into the water system causing an increase in the toxicity reaction that occurs at station one at every repetition of observations during high tide.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the ammonia parameter and the presence of tides. The value of ammonia at ebb and tide was analyzed to get a value of r = -0.316001, a low and negative correlation value meaning that the relationship between low ammonia and tides was low.

Ammonia in the aquatic environment can be found due to anthropogenic interactions that enter water bodies. The first station is a description of the location adjacent to settlements and mangrove forest tourism objects in Pagatan Besar Village. The fourth station in the first iteration is on the main river of Pagatan Besar Village and data collection at low tide accompanied by rain increases ammonia leaching from various areas entering the river waters of Pagatan Besar Village. Research on observing the state of ammonia in mangrove forest conditions that are rare and close to human activities (agriculture, settlements and industry) increases the amount of ammonia runoff in waters (Ahmed, 2021).

- *Total Nitrate.* Analysis of total nitrate at each observation station found four repetitions of observations both at high and low tide, with nitrate values above the quality standard from the Decree of the Minister of Environment No. 51 of 2004, namely 0.008 mg/l. The four repetitions in this study were located at station one, station two and station four. The first repetition at the first repetition at low tide and the second at high tide the value of nitrate was 0.256 mg/l and 0.06 mg/l at low tide in the first repetition. The second station on the first iteration during low tide the nitrate value was 1.473 mg/l, and the fourth station on the first repetition during low tide the nitrate value was 0.128 mg/l.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the nitrate parameter and the presence of tides. The value of nitrate at ebb and tide was analyzed to get a value of r = -0.331797, a low and negative correlation value meaning that the relationship between nitrate and low tide is low. The nitrate value in the tidal correlation is related to Mac Donnell's research statement in 2017 by analyzing 180 samples in different areas showing that nitrate in the study during the tides and wet and dry seasons did not show significant data so that during the highs and lows in the study could not describe the existence clear relationship between changes in nitrate values in mangrove areas.

- *Total Phosphate.* The observation stations in this study found that all stations had total phosphate values above the quality standard, Kepmen LH No. 51 of 2004, namely 0.015 mg/l. In this study, at each station, the lowest value was found, namely 0.023 mg/l at station 1 repetition 1 at high tide and the highest value was obtained at station 1 repetition, the third with a phosphate value of 0.153 mg/l, but this value was still above the quality standard. The total value of phosphate in natural waters in small amounts can act as mineral compounds and organic compounds, but if large phosphates in the environment are dangerous for the survival of aquatic biota. An increase in phosphate will cause eutrophication in an aquatic ecosystem causing anaerobic conditions which result in a decrease in DO (Barus, 2004). The high phosphate value at one third repetition station was in line with Barus' 2004 statement, the dissolved DO value at the time of observation was very low at 1.36 mg/l. This emphasized that anaerobic processes occurred at the observation site.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the phosphate parameters and the presence of tides. Phosphate values at ebb and tide were analyzed to get a value of r = 0.6770496, a strong and positive correlation value meaning a strong relationship between phosphate and ebb and flow. The increase in phosphate during high tide gives a positive and strong relationship where when the tide of phosphate found in the mangrove forest environment dissolving into the waters. Ahmed's research in 2021 where the concentration of phosphate is dominated by mangrove plants and the fall of leaf litter is a high input for phosphate in the mangrove aquatic environment.

- *DO (Dissolved Oxygen).* Dissolved Oxygen at station one in the second and third repetitions found that the DO value was outside the quality standard, the quality standard of Kepmen LH No. 51 of 2004 was > 5 mg/l. The first station on the second and third repetitions found values of 3.02 and 1.36 mg/l at very low dissolved oxygen tides, from the Kepmen LH quality standards. This station is located in the mangrove ecotourism location of Pagatan Besar village.

The location of the second and third iteration stations is an ecotourism area of mangrove forests in this area which will be inundated during high tides, the condition of the entry of waste and the small exchange of water from this location so that tidal inundation in this area has a distinctive impact and thick smell of mud.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the Dissolved Oxygen parameter and the presence of tides. The value of dissolved oxygen at ebb and tide was analyzed to get a value of r = 0.085196, a very low and positive correlation value, meaning that the relationship between dissolved oxygen and tide is very low. Changes in DO values in this study in mangrove waters do not reflect changes in values at high and low tide.

- *Degree of Acidity (pH).* The degree of acidity in this study is classified as very good and according to the quality standard of Minister of Environment Decree No. 51 of 2004, which is 7 to 8.5. The lowest condition for each station was 7.03 at the third station in repetition one, the highest degree of acidity was 7.57 at the third station in the third repetition. In line with this, from the statement of Syarani and Suryanto in 2006 the value of acidity affects the bottom substrate of the waters, the estuary area has a basic substrate in the form of sand and silt, the nature of the sand is alkaline so that the content of biogenic salts, especially calcium (Ca 2+) affects the alkalinity of the estuary waters.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the Degree of Acidity parameter and the presence of tides. The dissolved pH value at ebb and tide was analyzed to obtain a value of r = 0.3031728, a low and positive correlation value, meaning the relationship between low pH and ebb and flow. Changes in the pH value of this study in the mangrove waters did not reflect changes in values during high and low tide.

- *Salinity.* The quality standards of Minister of Environment Decree No.51 of 2004 where the maximum salinity in the waters is 34 $^{00/00,}$ in estuary waters tidal conditions occur in this study, where fresh water input is mixed in this $_{study}$ where the value is 0.2 $^{00}/_{00,}$ there is a mixture of fresh and salt water with the dominance of fresh water at the fourth station. The fourth station is the farthest area from the edge of the mouth of the Pagatan Besar river. During low tide, the salt water pressure is reduced at this station, not only at the fourth station, the second and third stations, when low tide, has a low salinity value. Changes in the salinity value in this study occurred when the tide entered the saltwater pressure at the farthest location at the fourth station showing an increased salinity of 5.5 $^{00}/_{00}$ indicating mixing of water in the mouth of the Pagatan Besar river.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the salinity parameter and the presence of tides. Dissolved salinity values at ebb and tide were analyzed to obtain a value of r = 0.0535174, a very low and positive correlation value, meaning that the relationship between very low salinity and ebb and flow of water. Changes in salinity values in this study in mangrove waters do not reflect changes in values at high and low tide.

- *TSS (Total Suspended Solids).* Total Suspended Solid at all twelve repetition stations above the quality standard, Kepmen LH No. 51 of 2004 The maximum TSS in water is 80 mg/l. The average TSS value in this study was 124 mg/l. The number of TSS values affects the brightness value of the waters. The content of suspended solids in water will reduce the light/light depth of the water so that oxygen regeneration in the process of photosynthesis is reduced (Wardana, 2001). The condition of the mangrove waters in this study was cloudy due to the high TSS value in the waters. The formation of deposits is influenced by seawater and estuaries where the physical processes of wind, rainfall, currents and tides cause the waters to experience agitation.
- *Temperature.* The temperature in this observation found a change in temperature values at several stations. The first station and the fourth station are below the water quality standard, Minister of Environment Decree No. 51 of 2004, the maximum

temperature in the waters is 28 to 32 ^{0}C. The first station in the second and third repetitions has values of 26.7 and 27.7 ^{0} C, on the fourth station for all repetitions of temperature values in waters below the quality standard with values of 27.4, 26.5, and 26.7 ^{0} C this was caused by the time of sampling in cloudy conditions. The temperature of water generally has a different value in this study it is estuary water which is influenced by the tides which cause an increase and decrease in temperature. The inflow of fresh water causes the temperature to be lower than seawater due to the large heat capacity of seawater and the slow response of seawater to heating and cooling processes (Aziz, 2007).

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the temperature parameter and the presence of tides. The temperature values at ebb and tide were analyzed to get a value of r = 0.923825, a very strong and positive correlation value, meaning a very strong relationship between temperature and tide. Changes in the temperature value of this research in the mangrove waters area illustrate that changes in temperature values during high and low tides greatly impact the process of utilizing organic matter and the metabolic processes of aquatic biota in the aquatic environment (Alhaq, 2021).

- *SDT (Secchi Disc Transparency).* The brightness of the waters in Kepmen LH No. 51 of 2004 is not determined, data acquisition in this study uses measurements with a secchi disc plate, the average brightness at this research location is 0.167 meters where at this research location the color of the water is cloudy and muddy, this is in line with the findings High TSS above the quality standard stipulated in Minister of Environment Decree No. 51 of 2004. Research conducted by alhaq in 2021 studied the relationship of chlorophyll-a to phytoplankton on Sintok Karimunjawa Island where increasingly transparent water results in a lack of phytoplankton by increasing temperatures. excessive,

Testing the results of the parameters is continued with correlation analysis to see the relationship between the Secchi Disc Transparency parameter and the presence of tides. The dissolved SDT value at ebb and tide was analyzed to get a value of r = -0.177302, a very low and negative correlation value, meaning that the relationship between SDT and tide was very low. Changes in SDT values in this study in mangrove waters do not reflect changes in values at high and low tide.

- *Flow Speed.* The speed of the current in Kepmen LH No. 51 of 2004 is not determined, data acquisition in this study uses a current meter to determine the flow of water in units of m/s. The current speed at low tide at the first station is very sloping, there is no strong current in pushing the water current towards the land, the current speed at low tide at the first station with a value of 0.1 m/s, but changes occur at high tide, the current pressure towards the land strong mangrove forest with a value of 0.4 m/s, the second and third repetitions during high tide the speed of the water current drops to 0.1 m/s. The role of mangrove forests as a barrier to waves and abrasion at the first station is very real (Marois and Mitsch, 2015).

The second station for all repetitions has a current speed of 0.1 m/s for all repetitions, this is due to the position at this station in front of the Pagatan Besar river mouth and the influence of mangrove forest vegetation in this area makes the current speed slower. this also happened at the fourth station at the first to third repetitions at high tide the current speed slowed down when the tide entered the river area of Pagatan Besar Village, but at the fourth station and in low tide conditions the river water pressed very hard towards the river mouth with a value of 0.4 m /s. The condition of the third station is that the current velocity at this station is 0.2 m/s to 0.3 m/s, this is because the third station is a small tributary of the mangrove river area, causing inflows from large rivers to continue to exert strong pressure.

Testing the results of the parameters is followed by a correlation analysis to see the relationship between the current velocity parameter and the presence of tides. The value of the dissolved current velocity at ebb and tide was analyzed to get a value of r = -0.886621 the value of a very strong and negative correlation, meaning that the relationship between the current velocity is very strong with the tide and water ebb. Changes in current velocity values in this study in mangrove waters reflect changes in values at high and low tide. Physically, a healthy mangrove community can increase the ability to protect coastal areas against the threat of abrasion, storms and tsunamis (Marois & Mitsch, 2015; Del Valle et al., 2020; Xiao et al., 2020).

- *Chlorophyll-a*. The measurement of chlorophyll-a is a study of the advanced characteristics of the phytoplankton present in the mangrove forest waters in this study, the further characteristics of the chlorophyll-a in this study are a follow-up study to determine the continued analysis of water fertility (trophic status) at the time the research was carried out. Chlorophyll-a is the result of the photosynthesis process of phytoplankton in the waters, the presence of phytoplankton can absorb the presence of nutritional compounds (phosphate and nitrate) in the waters, the presence of phytoplankton and this photosynthesis process affects the primary productivity of the waters (Alhaq, 2021).

Phosphate values in this study at all stations and repetition of observations obtained values above the water quality standard stipulated by Minister of Environment Decree No. 51 of 2004, this is the very point where the water quality has decreased in the observation of the mangrove waters area of Pagatan Besar Village. The SDT (Secchi Disc Transparency) value in this study area also experienced a very small value, where the waters in the area were turbid, this was in line with the TSS (Total Suspended Solid) value which was also high at each research station and above the quality standards set by Minister of Environment Decree No. 51 of 2004. These results illustrate that the water quality of the mangrove waters in Pagatan Besar Village has experienced changes that are not up to standard.

Changes in the tides from these observations show a strong correlation to the state of phosphate in the mangrove forest waters of Pagatan Besar Village with a value of r = 0.6770496 this indicates that there is a process of enrichment of phosphate elements during high and low tides. Research conducted by Ahmed in 2021 on the Pakistani coast found that the presence of mangroves with high phosphate values in high waters and further findings that the quality of the waters with the condition of mangrove plants that have slightly low phosphate values but ammonia contamination has increased. This study observed the same thing that the presence of mangroves was also found in the presence of phosphates in the waters in amounts outside the water quality standards.

Observations that have a strong correlation value to the tides other than phosphate in this observation are temperature. The temperature in this observation also has a big impact where changes in temperature during high and low tide illustrate the condition of the plankton in this study is very good where the temperature range is 24-32 ° C plankton can grow optimally, where the quality of light entering the waters can be responded to by the chloroplasts in it. phytoplankton for the photosynthesis process to take place (Alhaq, 2021). The value of chlorophyll-a from the interaction of phytoplankton photosynthesis makes the temperature closely related to the tides and ebbs of the water. Observations that have a strong correlation value with respect to tides other than phosphate and temperature in this observation are current velocity. Phosphate values that have a strong correlation indicate that the speed of water currents enriches phosphorous nutrients in the mangroves of Pagatan Besar Village, both from outside the mangrove waters or in the waters.

The correlation relationship on several environmental factors illustrates that the formation of water fertility at one time is influenced by the tides in the waters of Pagatan Besar Village. The fertility of the waters requires a value from the analysis of the continued characterization of chlorophyll-a from phytoplankton, but in this study only a few stations and repetitions were detected, namely the first and fourth stations containing chlorophyll-a in the water samples obtained. Undetectable sample values are caused by damage to the sample or at that time it can occur or the phytoplankton in the sample bottle is not obtained.

Castaneda's research in 2010 looked at how the impact of nutrient inputs related to Hurricane Wilma in Florida mangroves found that the phosphate value in the mangrove forest area had increased from the storm and the fall of decomposed mangrove litter. This research also illustrates that flooded mangrove forest waters caused by sea tides will cause accumulation of nutrients in the waters so that eutrophication of the waters occurs.

The fourth station in this study is the deepest area of the Pagatan Besar river area, where in this area there is still mangrove vegetation, it was found that nutrient enrichment occurred during low tide in the first iteration with a TSI value of 51.9892215 with Eutrophic status and changes occurred at high tide with the condition of the second and third repetitions, TSI values were found of 42.4290447 mg/l and 44.9143865 mg/l with the condition of Mesotrophic status.

CONCLUSION

Mangrove Waters Fertility as an Indicator of Pagatan Besar Mangrove Waters Quality, namely the value of mangrove water quality parameters, several indicators do not comply with quality standards based on the results of analysis of overall phosphoric parameters for all stations at high tide above the quality standards set by Permen LH No. 51 of 2004, the correlation parameter of phosphate has a positive and strong relationship, the increase in phosphate values in mangrove waters is always high during high and low tide. This phosphate value is a reference for fertility in the mangrove waters of Pagatan Besar. The results of the TSI (Trofik State Index) analysis found that several areas of the mangrove waters of Pagatan Besar experienced eutrophication.

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