Water quality study and pollution index based on Physics-chemical parameters in the Youtefa Bay tourism area, Jayapura

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Abstract. Good water quality is extremely important to support the life of the organism. The determination of water quality status was needed as a reference to monitor water pollution. This study aimed to assess the status of water quality and determine the pollution index based on physical-chemical parameters in the Youtefa bay tourism area. Sampling was carried out in august 2019 across six research stations; then, the result was compared with water quality standard based on KEPMEN-LH No. 51 the Year 2004 For marine biotas. The results showed that the parameter according to the quality standard is physics parameters; pH, Salinity, DO, and BOD_5, while those that have exceeded the quality standards are total ammonia, nitrate, surfactant (detergent), phosphate and dissolved metal. The pollution index indicates the Youtefa Bay waters were in light to medium categories.

1. Introduction

The city of Jayapura has a fairly rapid growth dynamics, characterized by the development of residential centers, offices, trade centers, and population growth. In 2018 the population of Jayapura City was 297,775 people with a growth rate of 4.10% per year with an average population density of 374 / km2 [1].

Youtefa Bay and its surroundings have several functions and use, namely as a catching and aquaculture area, fishermen and tourist transportation routes, fishing boat docks, and waste disposal sites for anthropogenic activities that can affect the carrying capacity of river ecosystems and the Youtefa Bay ecosystem. Community, Fishermen, and Government as actors in the management of Youtefa Bay itself. The problems in Youtefa Bay that have occurred so far have been due to increasing population, low levels of income and education, poverty, and social behavior with various activities that are increasingly increasing, such as fishing, bay transportation and settlements. These activities have an impact on increasing sediment, the turbidity of river and seawater, increase in waste production, increase in nutrients, so that fish catches are low, vegetation is disturbed, the decline in aesthetic value and tourism, as well as disease transmission and reduced business premises.

Problems with the preservation of coastal and marine ecosystems in the case of Youtefa Bay include the destruction of ecosystems such as sedimentation, increased pollutants, increased domestic waste entering the bay due to poor land management. According to [2], various types of waste and

pollutants at sea will be found. This can result in the entry of organic and inorganic substances into the waters which results in a decrease in the quality of seawater physically and chemically. Therefore, if the quality of the environment in the bay is poor, it is suspected that the biological components in it will experience changes. Sea pollution not only kills biota and marine ecosystems but also endangers human health, damages aesthetic value and threatens the functioning of the bay ecosystem.

Based on these problems, to maintain the sustainability of the Youtefa bay, a study of water quality is needed. This study aims to assess the status of water quality and determine the pollution index based on physical-chemical parameters in the Youtefa bay tourism area. This research is expected to provide information that can be useful in managing the Youtefa bay area as a tourist park area. This research was conducted in August 2019-February 2020 in the Youtefa bay, Jayapura. Sampling was conducted in 5 stations, namely:

- ST 1. Kampung Tobati: Mangrove ecosystem near the residential area and part of the mangrove land was converted into a ring road bridge construction area but now development has not continued
- ST 2. Enggros Village: The condition of mangroves is relatively natural, located along the Enggros village area
- ST 3. Nafri Village 1: Mangrove condition is relatively natural and is located in the Youtefa bay basin far from the settlement
- ST 3. Nafri Village 2: Mangrove Ecosystem is close to the settlement and part of the land is used as a residential area and road widening
- ST 4. Abe Pantai: Mangrove Ecosystem is close to a settlement and part of the land is used as a burial area
- ST 5 Youtefa Bay Jetty: is a Mangrove Rehabilitation Area development area

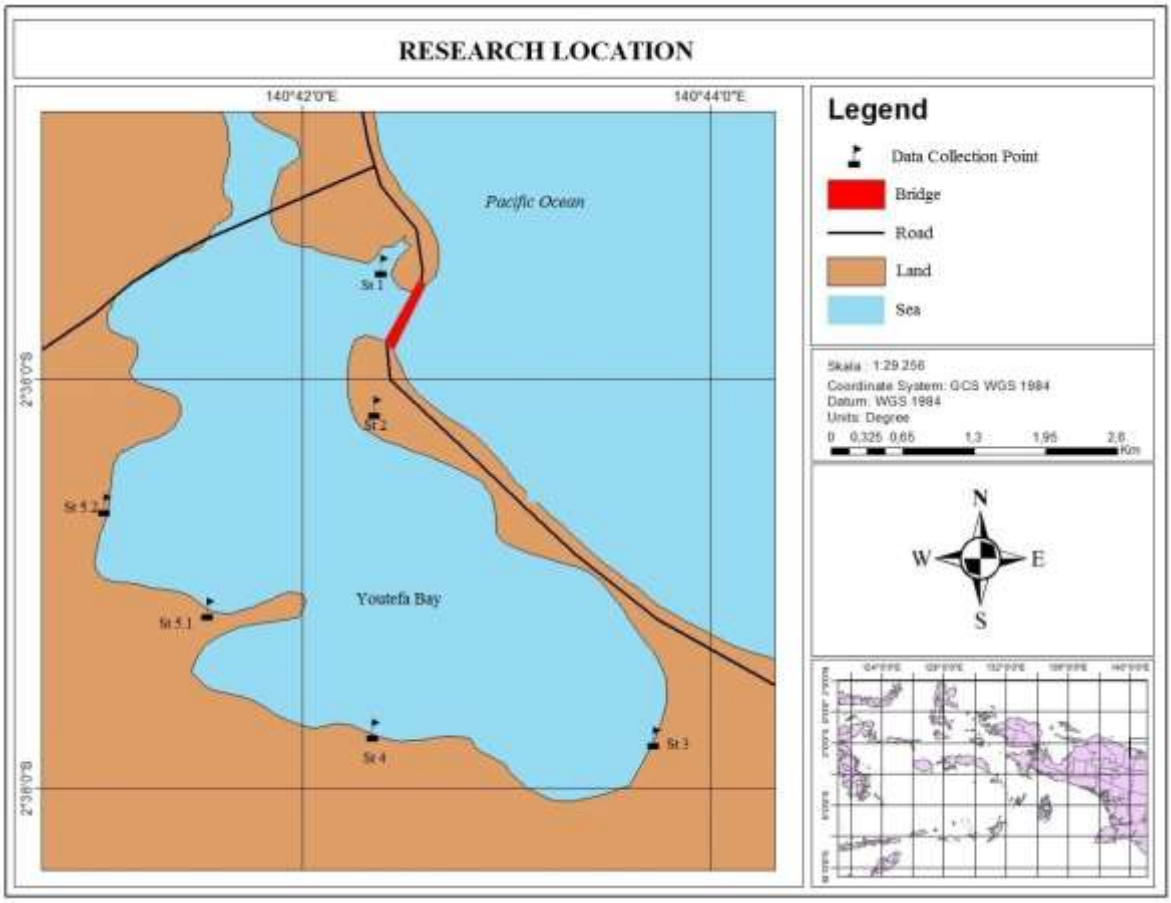

Figure 1. Research location

2. Material and Methods

2.1. Methods Of Data Collecting

Water Quality Measurements are carried out in situ and seawater sampling is carried out by inserting samples into poor bottles and stored in coolboxes for analysis at the Environmental Quality Management Laboratory of the Department of Environmental Engineering, Faculty of Civil, Environmental and Earth Sciences Sepuluh November Institute of Technology and Jayapura City Labkesda.

2.2. Analysis of Data

Data analysis was performed descriptively, namely by comparing the results obtained with the quality standards of seawater for marine biota based on the Decree of the Minister of Environment No. 51 of 2004 concerning Sea Water Quality Standards. Determination of pollution status using the pollution index in accordance with Minister of the Environment Decree Number 51 of 2004, as follows:

$$PI_j = \sqrt{\frac{(C_i/L_{ij})_M^2 + (C_i/L_{ij})_R^2}{2}} \quad (1)$$

Where :

L_i : Concentration of water quality parameters in water quality designation standards
C_i : Concentration of water quality parameters from survey results
PI_j : Pollution index for designation (j)
$(C_i/L_{ij})M$: Maximum Ci / Lij Value
$(C_I/L_{ij})R$: Average CI / Lij Value

The results of the Pollution Index calculation are then evaluated based on the Pollution Index criteria as follows:

$0 \leq PIj \leq 1,0$: Good condition
$1,0 \leq Plj \leq 5,0$: lightly polluted
$5,0 \leq Plj \leq 10$: moderately polluted
$Plj \geq 10$: heavily polluted

3. Results and Discussion

In general, the quality of seawater that can be utilized by organisms and the community must meet physical and chemical quality standards, if the value of water quality exceeds the value of quality standards will be classified in polluted waters. The results of physical and chemical waters quality analysis of waters in Youtefa Bay can be seen in table 1.

Table 1. Results of analysis of Physical and Chemical Quality of Youtefa Bay

No	Parameter	Unit	Quality Standart[1]	Average measurement results[2]					
				St 1	St 2	St 3	St 4	St 5	St 6
	PHYSICS :								
1	Smell	-	-	odorless	odorless	the odor is not pungent	the odor is not pungent	odorless	strong scent
2	suspended solids	mg/L	Coral 20; Mangrove 80; Seagrass 20	12	14	18	16	14	24
3	rubbish	-	Nihil	√	√	√	√	√	√
4	Temperature	°C	Coral 28-30; Mangrove 28-32; Seagrass 28-30	24	24	24	24	24	26
5	Turbidity	NTU	< 5	0,53	0,75	5,37	2,64	1,62	13,5

6	Brightness	m	Coral > 5; Mangrove - seagrass> 3	2,5	2,8	0,7	0,75	1	0,6
7	Flow Speed	m/s		2,2	1,2	1,5	1	7,3	1
	CHEMISTRY :								
1	pH	-	7-8,5	8,5	8,2	7,8	7,7	7,7	7,3
2	Salinity	‰	coral 33-34; mangrove s/d 34 Seagrass 33-34	32	28	18,6	20,6	20,9	19,2
3	Total Ammonia(NH_3-N)	mg/L	0,3	0,53	1,1	0,82	1,45	0,8	2,14
4	Sulfide (H_2S)	mg/L	0,01	0	0	0	0	0	0
5	Dissolved Oxygen(DO)	mg/L	> 5	5,4	5,3	5,2	5,4	5,3	5,2
6	BOD_5	mg/L	20	7	6	12	8	10	14
7	Nitrate (NO_3 N)	mg/L	0,008	1,1	0,08	0,2	0,07	0	0
8	Surfactant (Detergent)	mg/L	1	6,41	4,08	3,7	4,37	4,17	3,66
9	phosphate (PO_4 P)	mg/L	0,015	0,54	0,7	0,45	0,53	0,88	1,28

Source : [1]*Decree of the Minister of Environment No*. 51/2004; [2]*Data analysis* 2020

3.1. Brightness and Turbidity

The brightness level of Youtefa Bay waters is still relatively good, ranging from 0.6-2.8 m, the brightness value is said to be good because it is still within the range of seawater quality standards for marine biota in accordance with the Minister of Environment Decree Decree No. 51 of 2004. The low brightness in Nafri village and Youtefa bay wharf because the area is dominated by mangroves and muddy substrates. According to [3] High and low brightness is influenced by the amount of sediment and particle supply. The turbidity level is caused by organic and inorganic materials entering the waters, the level of brightness is influenced by the intensity of sunlight that can penetrate to the bottom of the waters. The level of brightness and turbidity is very influential on the survival of aquatic biota, such as growth and photosynthesis [4].

3.2. Suspended Solids (TSS)

The total value of suspended solids ranged from 12-24 mg / l, the highest TSS value was found at Youtefa Bay Pier (St 5.2) and the lowest in Tobati Village. The high value of TSS on the Youtefa bridge shows that TSS has exceeded the seawater quality standard for marine biota, indicating that there has been a decrease in the rate of photosynthesis and the number of suspended particles consisting of mud, fine sand, and erosion carried into the waters. According to [5][6] that the high suspended solids will reduce the level of dissolved oxygen in the waters and TSS consists of industrial discharges, fine sand and mud carried by the flow of water from several rivers that flow into the bay.

3.3. Water Temperature

Water temperature is one of the factors that greatly influence the life of an aquatic organism. Temperature measurements carried out in situ range from 24-26oC. The temperature of the waters found is relatively the same between the observation stations and these values indicate that the temperature of the waters is still within the range of seawater quality standards.

3.4. Acidity (pH)

The pH parameter values for each station range from 7.3 to 8.5. The occurrence of differences in pH values due to the influence of temperature and salinity indirectly. Variations in the pH value of waters greatly affect the biota in the waters. In addition, the high pH value greatly determines the dominance of phytoplankton that affects the primary level of productivity of water, where the presence of phytoplankton is supported by the availability of nutrients in sea waters [7]. Based on research results

[8] shows the range of pH values of the nine stations in Youtefa Bay, ranging from 7.16 to 7.65, shows that the waters of the Youtefa bay are still within the range that can be tolerated by aquatic organisms.

3.5. Salinity

Measurement of salinity parameters by using a Refaktometer salinity value range at each station is 18.6-32. The difference in salinity at these two stations is due to the influence of freshwater from the estuary and human activities on the estuary coast. Salinity is determined based on the number of salts that dissolve in water. Salinity is influenced by rainfall and evaporation (evaporation) that occurs in an area. Generally, the salinity of seawater is more stable except at the mouths of rivers where the meeting place of freshwater and seawater [9]. The low salinity at station 3 is caused by the presence of freshwater supply originating from a river flowing into Youtefa bay. According to [3] the low salinity found in Depapre waters is due to the presence of freshwater entering the sea and tidal waters.

3.6. Dissolved Oxygen (DO)

Dissolved oxygen (DO) is the total amount of oxygen dissolved in water. DO is needed by all aquatic organisms for breathing, metabolism which then produces energy for growth. The range of DO values obtained is 5.2-5.4. DO values obtained are quite varied and meet seawater quality standards which indicate that the waters are in very good condition to support marine life. According to [3] DO content in waters is 3-7 mg/l; the high DO value in waters originates from the photosynthesis of organisms that live in waters, besides the DO content also explains the relationship with the level of pollution and the amount of organic matter in the waters.

3.7. Biochemical Oxygen Demand (BOD_5)

BOD5 is the amount of dissolved oxygen content needed by microorganisms for the process of decomposition of organic material under aerobic conditions. BOD is used as a way to indicate organic pollution in waters. The more organic material contained in the waters, the greater the amount of oxygen needed so that the greater the BOD levels. BOD5 values range from 6-14 mg / l; BOD values are still below the recommended quality standard for marine biota. In general, the BOD content of the measurement results varies, because at each station, organic waste material can enter the Youtefa Bay waters with BOD levels and discharge certain rivers through which can cause a decrease or increase in the BOD level of Youtefa Bay [8]. BOD parameter is one of the parameters to determine the level of water pollution if the BOD value is higher than the quality standard indicating that the waters are polluted whereas if the BOD value ranges from 0-10 mg / l the level of pollution is low while 10-20 mg / l the level of pollution is high [10].

3.8. Ammonia Total (NH3N)

Ammonia content in seawater varies greatly; ammonia can be toxic if the levels exceed the specified quality standards. The observations showed that the range of total Ammonia values was 0.53-2.14 mg/l. The total ammonia content in Youtefa bay waters has passed the quality standard which indicates that the waters have experienced organic pollution. The high ammonia at the Youtefa bay pier is caused by residential and industrial wastes as well as the results of animal metabolism and the process of decomposition of organic matter by bacteria.

3.9. Nitrate (NO3 N)

Nitrate is an important nutrient in the synthesis of plant and animal proteins. Nitrate concentrations in water can stimulate the growth and development of organisms. The results of the analysis show that the range of nitrate in Youtefa bay waters is 0-1.1 mg / l; this value indicates that the Youtefa bay waters are included in the oligotrophic category. The relative nitrate concentration values are almost the same as the results of the study [11]; that is, Depapre waters are included in the oligotrophic category with nitrates ranging from 0.009 to 0.54. If based on the quality standard of Minister of the

Environment Decree No. 51 of 2004, the nitrate content in Tobati Village is quite high at 1.1 mg / l, this can lead to eutrophication and accelerate the growth of algae and aquatic plants.

3.10. Phosphate (PO4-P)

Phosphate is an essential element for metabolism and protein formation and is needed for the growth process. In the waters of seawater, phosphate is inorganic and dissolved organic and particulate matter [10]. Based on observations of Phosphate concentrations ranging from 0.45 to 1.28 mg / l, the value has exceeded the quality standard. These conditions can be dangerous for aquatic biota and can cause eutrophication. High phosphate water can cause phytoplankton blooms. The varying phosphate content in the waters of the Youtefa bay comes from human activities, for example, domestic waste, industrial waste and agricultural waste.

3.11. Water Pollution Index

The determination of the quality status of Youtefa bay waters is based on the Pollution index method. The results of the analysis of the pollution index value at each station can be seen in Figure 2. Based on the calculation of the pollution index (PI), it can be seen that all stations have been polluted with the category of light pollution. In figure 2 the Nafri 1 and 2 village stations show a relatively low pollution index (PI) value; this is presumably due to the still low activity in this region. The highest IP value is in the coastal area and the Youtefa bay jetty, this is due to the high activity in this area and upstream activity that has the potential to change the condition of these waters.

Pollution index values are also seen in several water parameters that have passed seawater quality standards for marine biota, including pH, total ammonia, nitrate and phosphate. During the study, there was no eutrophication, but it must be watched out because environmental parameters that have passed the quality standard are environmental parameters that contain nutrients and nutrients so that if the levels are high water, it will cause eutrophication (blooming) which is very dangerous for another marine biota.

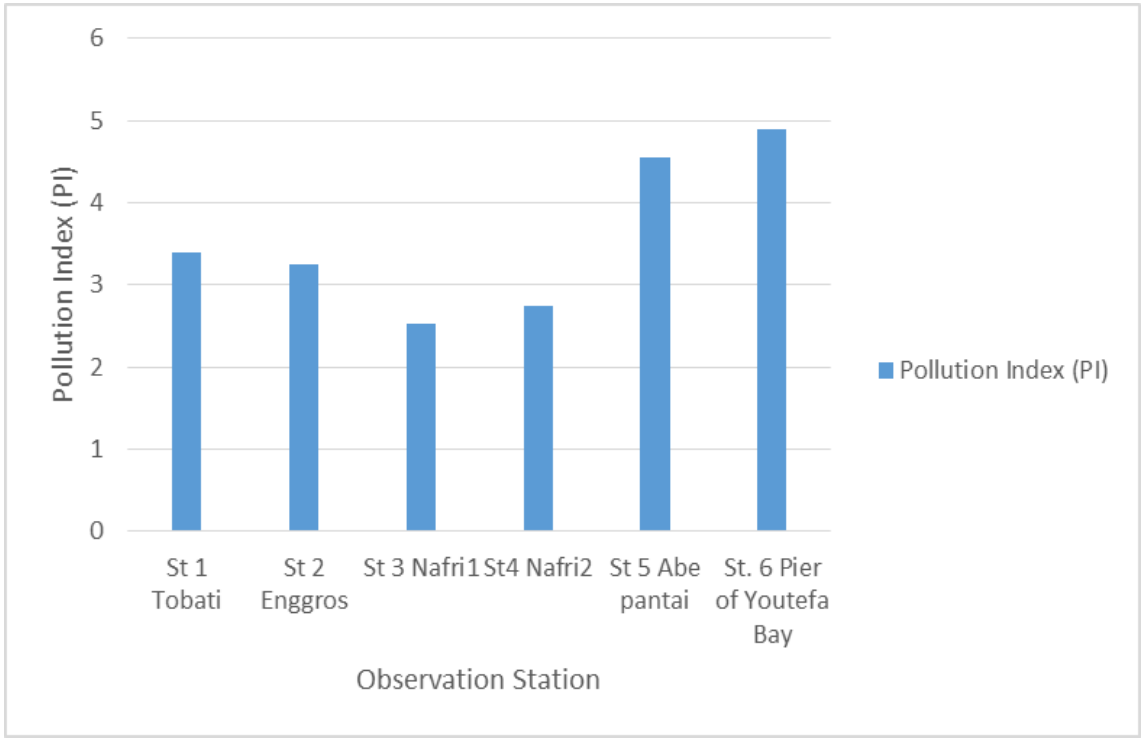

Figure 2. Pollution Index Graph

4. Conclusion

The condition of the waters in the Youtefa Bay Tourism Park area is included in the light-polluted category. Environmental parameters that are still in accordance with the quality standards for marine biota include pH, temperature, salinity, DO, BOD and brightness except for the Youtefa bay pier, while environmental parameters that have passed the quality standard limits include Total Ammonia, Phosphate and Nitrate. Sources of pollutants that enter the waters of the Youtefa bay come from domestic waste and industrial waste from activities that are quite high in the region.

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