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The Effect Of Mangrove Density To Estuary Water Quality Based On Physic-Chemist Parameters At Wonorejo, Surabaya

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Abstrak

Perikanan di muara membuat fungsi lahan mangrove berubah dan menurun, sehingga mempengaruhi kualitas perairan. Penelitian ini bertujuan untuk mengetahui kerapatan mangrove dan hubungannya dengan kualitas perairan muara Wonorejo. Metode yang digunakan adalah purposive random sampling dan metode line plot dengan plot 10x10 meter untuk menentukan kriteria uji kerapatan mangrove dan kualitas air berdasarkan parameter fisika-kimia kemudian dikorelasikan untuk uji pengaruh. Hasil analisis kualitas air muara Wonorejo dengan nilai optimum di stasiun 5 memiliki rata-rata nilai parameter suhu (29°C), kecerahan (22 cm), kecepatan arus (0,083 m/s), TSS (55 mg). /L), pH (7,36), salinitas (5,5), DO (1,709 mg/L), COD (42,4 mg/L), nitrat (0,18 mg/L), dan fosfat (1,045 mg/L). Kriteria kerapatan mangrove pada setiap stasiun meliputi stasiun 1-2 dengan kerapatan rendah, stasiun 3-4 dengan kerapatan sedang, dan stasiun 5 dengan kerapatan rapat. Parameter fisika-kimia yang berhubungan dengan kerapatan mangrove adalah suhu, kecerahan, salinitas, dan COD. Perairan muara berdasarkan parameter fisikokimia yaitu salinitas 40,3%, COD 33,7%, kecerahan 30,9%, suhu 30,8%, nitrat 14%, TSS 11,4%, kecepatan arus 8,1%, DO 1,3%, dan fosfat 0,1% dipengaruhi dengan kerapatan mangrove.
Kata kunci: *Muara Mangrove, Kerapatan Mangrove, Kualitas Air Muara, Wonorejo*

Abstract

Fishery in estuary make changes function of mangrove land and decreased, so that it affect water quality. This study aims to determine mangrove density and relation with the quality of wonorejo estuary waters. The method uses purposive random sampling and line plot method with a 10x10 meter plot to determine the criteria for mangrove density and water quality tests based on physic-chemical parameters and then correlated to test the effect. The results of the water quality analysis at the Wonorejo estuary with the optimum value at station 5 have an average parameter value of temperature (29°C), brightness (22 cm), current speed (0.083 m/s), TSS (55 mg/L), pH (7.36), salinity (5.5), DO (1.709 mg/L), COD (42.4 mg/L), nitrate (0.18 mg/L), and phosphate (1.045 mg/L). The criteria for mangrove density at each station include stations 1-2 of low density, stations of 3-4 of medium density, and stations of 5 of dense density. Physic-chemical parameters related to mangrove density are temperature, brightness, salinity, and COD. Estuarine waters based on physico-chemical parameters, namely 40.3% salinity, 33.7% COD, 30.9% brightness, 30.8% temperature, 14% nitrate, 11.4% TSS, 8.1% current velocity, 1 .3% DO, and 0.1% phosphate affected by mangrove density.
Keywords: *Mangrove Estuary, Mangrove Density, Estuary Water Quality, Wonorejo*

INTRODUCTION

The use of water bodies in community, industrial, tourism and fishing activities is a factor in the accumulation of pollutant loads in river watersheds from upstream to downstream. Surabaya river water in the downstream has quite poor water quality (Hendrasarie and Januar, 2019). One of the downstream areas of the Surabaya River is the watershed of the Jagir River towards the Wonorejo River. There are many human activities in empowering the Wonorejo river such as using it in mining, docks, filling ponds, and also tourist areas. This can increase the impact of waste being dumped into water bodies, causing pollution. One of the means in controlling pollution needs to be determined in quality standards. The quality standard used to determine the quality of river water is based on Government Regulation of the Republic of Indonesia number 22 in 2021 concerning the implementation of environmental protection and management. Meanwhile, the Wonorejo area is a mangrove conservation area consisting of a coastal border and a river border. In Guntur et al.'s research, (2017) identified the quality of the waters on the east coast of Surabaya in a polluted state, one of which was on the coast towards the mouth of the Wonorejo river, which was classified as moderately polluted.

The existence of mangroves plays a role in maintaining the stability of protective coastal waters from abrasion, as a fauna habitat, tourist attraction, and waste neutralizer (Syamsu et al., 2018). In addition, mangrove plants are also influential in inhibiting seawater intrusion by desalination (Hendriati and Novirina, 2013).

Therefore it is necessary to control pollution by assessing it in terms of water quality using quality standards for river water allocation and then how the relationship between the estuary quality waters and mangrove density in the area on the east coast of Surabaya especially wonorejo estuary. Through this research it is expected to be able to monitor the quality of estuary waters according to policy and obtain further information about the development of mangrove ecosystem reserves on wonorejo estuary.

METHODS

Determination of research time in the dry season September-October. Data sampling was carried out at the mouth of the Wonorejo river. Sampling locations were determined based on the direction of the water flow of the Wonorejo River and its tributaries which lead to the estuary of the Surabaya coast where there are mangrove forests along the river. Determination of research locations by monitoring mangrove density at five sampling locations.

Sample location 1 is the Wonorejo River which receives water from a tributary of the Jagir River. Sample location 2 is the Wonorejo River which receives water from settlements in the Keputih District. Sample location 3 is the Wonorejo River which receives water from ponds in the Keputih area. Sample location 4 is the Wonorejo River which receives water from ponds and the Wonorejo mangrove ecotourism. Sample location 5 is the estuary of the Wonorejo River which empties into the east coast of Surabaya.

Mangrove data collection techniques are as follows:

1. Distance measurement by making a sample line measuring 10 x 10 meters.
2. Calculation of tree density by recording mangrove data which includes tree criteria, namely plant height >1 meter and diameter ≥10 cm.
3. Do it at different locations to get the criteria for sparse, medium, and dense mangroves then mark with the coordinates of the sampling points using GPS.

The variables of this study are:

1. Sampling variable: there are 5 sampling points at the station, sampling is carried out from morning to noon during low tide and with three repetitions in different weeks.

2. Variable parameters: brightness, current strength, TSS, temperature, pH, DO, COD, salinity, nitrate and phosphate.

Observational Data Analysis

Mangrove data analysis at different densities can be seen from the amount of vegetation or mangrove trees, namely the number of individual trees counted per sample area and classified using mangrove density criteria based on Regulation no. 201 of the Ministry of Environment in 2004, ie. ≥1500 trees/ha in dense mangrove forest, ≥1000-<1500 trees/ha in medium mangrove forest and <1000 trees/ha in sparse mangrove forest. Then it is simplified by reforming the sample curve for a 10 x 10 meter plot to:

$$\text{Kerapatan} = \frac{Jumlah\ vegetasi}{Luas\ Petak\ Contoh} = \frac{n}{10x10\ meter}$$

$$\frac{\geq 1500 \text{ pohon}}{ha} = \frac{n}{100\ m2} \quad \sim \frac{\geq 1500 \text{ pohon}}{10000\ m2} = \frac{n}{100\ m2} \quad \sim \text{n} = \geq 15 \text{ pohon}$$

$$\frac{\geq 1000 - < 1500 \text{ pohon}}{ha} = \frac{n}{100\ m2} \quad \sim \frac{\geq 1000 - < 1500 \text{ pohon}}{10000\ m2} = \frac{n}{100\ m2} \quad \sim \text{n} = \geq 10\text{-}<15 \text{ pohon}$$

$$\frac{\geq 1500 \text{ pohon}}{ha} = \frac{n}{100\ m2} \quad \sim \frac{< 1000 \text{ pohon}}{10000\ m2} = \frac{n}{100\ m2} \quad \sim \text{n} = <10 \text{ pohon}$$

Statistical analysis of the data needed to determine the relationship between the physical-chemical parameter variables of water and mangrove density is a simple linear regression statistical test using Pearson correlation with minitab.

In this case, the range of correlation coefficient values is $-1 < r < 1$. And the resulting P-value used is an important parameter of the information obtained. The P-value is a random or probable value that is observed in a statistical test. If the P-value is less than 0.05, the data can be considered to be significantly related. The interpretation of the correlation value with the p-value when it approaches -1 or 1 can be said to be more related, and the positive and negative correlation values indicate the direction of a unidirectional relationship (+) or (-) that mean inverse.

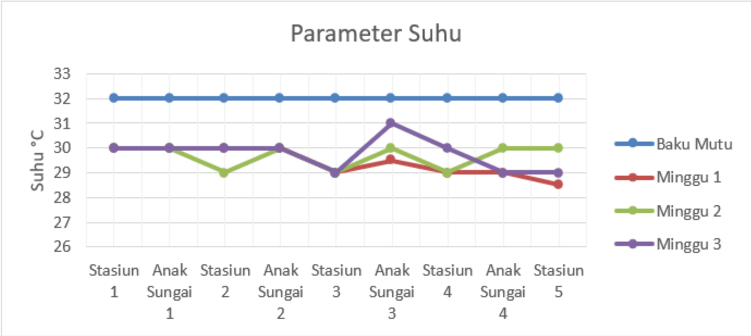
Analysis of Physic-Chemical Parameters

In testing water quality based on physical and chemical parameters using SNI 06-6989.11-2019 for pH, SNI 06-6989.23-2005 for temperature, SNI 06-6989.14-2004 for DO, SNI 06-6989.15-2019 for COD, SNI 06-6989.79-2011 for nitrate, SNI 06-6989.31-2021 for phosphate, SNI 06-6989.3-2019 for TSS, salinity using a refractometer, and current velocity parameters using *flow meter*

RESULTS AND DISCUSSION

Quality water physic-chemist parameters

Quality Water quality was assessed at various points according to settlement, pond and tourism aspects. The places studied in the research for stations 1, 2, 3, 4 and 5 are the main river, namely the Wonorejo river from the Jagir river, while stations A, B, C and D are tributaries that flow into the main river, namely the Wonorejo River

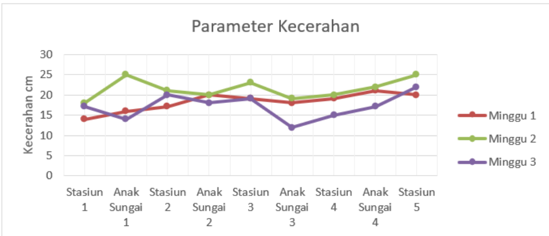


(Source: Research Results, 2022)

Figure 1. Temperature parameter relationship to station every week

Temperature

Changes in temperature from station 1 to 2 tend to be stable and experience slight changes when heading to stations 3, 4 and 5 even though they are repeated the following week, some temperature values are fixed and some are fluctuating. Weather conditions at the time of sampling affect temperature values (Pratiwi et al., 2022). Temperature also affects the metabolic activities of organisms, both in sea and in fresh waters. Temperature plays a role in controlling water conditions, affecting the life and growth of aquatic biota (Warman et al., 2015). In addition, the temperature is also influenced by the intensity of the sun that reaches the water. The more the intensity of the sun hitting the water body, the higher the temperature of the river water (Agustina, 2022). While mangroves with their shade are able to block light from entering the water so that the temperature parameters can be affected by mangroves.

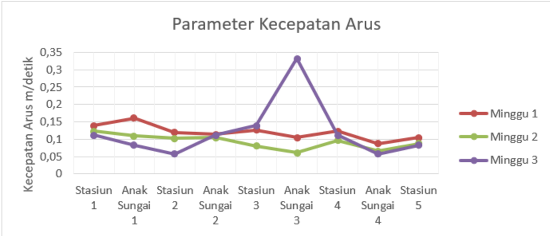


(Source: Research Results, 2022)

Figure 2. Brightness parameter relationship to station every week

Brightness

The lowest brightness value is found at station 1 where the area is an area adjacent to housing or settlement effluents where pollutant loads in the form of wastewater or domestic waste can increase turbidity and suspended solids so that the brightness value becomes low. the entry of effluent and water flow from tributaries causes the current speed to increase and spreads the substrate or sediment making the water body turbid and the brightness value low. Brightness is an indicator of pollutant physical parameters related to the process of photosynthesis in an aquatic ecosystem. Brightness is affected by the intensity of light that falls on the surface of the water, dissolved and suspended organic matter (Pratiwi et al, 2022). Light entering the water can increase the brightness value, in mangroves it can potentially block light penetration so that the brightness value can also be affected by mangroves.

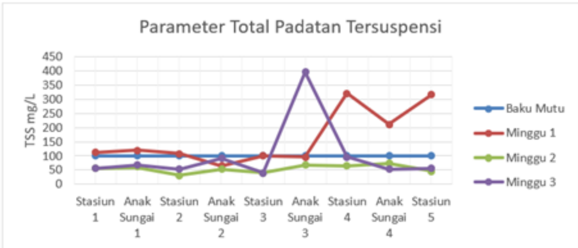


(Source: Results Research, 2022)

Figure 3. Current velocity parameter relationship to station every week

Flow Velocity

The current speed of each station per week tends to fluctuate, namely experiencing a decrease from the first week to the second week and an increase in time from the second week to the third week. This is due to the tides that change every week. Low current speed can be caused by the large number of water hyacinths that block the river so that it can reduce the frequency of currents, including floating and floating garbage in the water. This was confirmed by Putra (2015) that current speed is influenced by many things including friction with land, wind, river contours, river location and also disturbances such as weeds, garbage or algae plants that grow in rivers. In addition, mangrove roots and trees can also withstand current velocity which is influenced by tides (Suharjo, 2017).

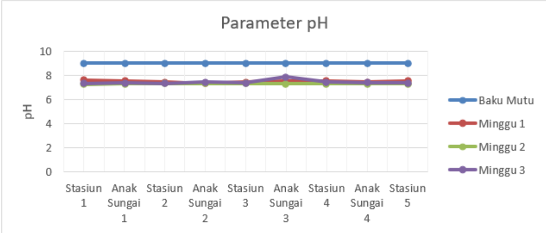


(Source: Research Results, 2022)

Figure 4. Relationship of total suspended solids parameters to stations every week

TSS

Total Suspended Solid (TSS) every week tends to fluctuate, the first week to the second week it decreases and the second week to the third week it increases. Station 4 is a tourist area that is close to the pier so that ship or boat transportation activities can make the water flow and also sediment stirred up by engine propellers, this is supported by Fachrul (2016) in Kurnianti et al., (2020) that ship movement can This causes sediment agitation and increases turbidity. So that the suspended solids become high. Sediments can come from the mainland in the form of soil erosion or the results of mangrove decomposition. Meanwhile, the difference in the following week was due to high rainfall increasing the flow of river water to the estuary and becoming a factor that acts as sediment transport (Misra, 2014 in Komang Iwan, 2019). In addition, an increase in the amount of suspended solids causes turbidity in the water because it will block sunlight from entering the waters so that the productivity of the waters decreases and can be said to be polluted if it does not meet quality standards.

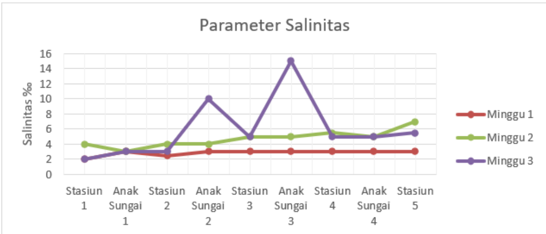


(Source: Research Results, 2022)

Figure 5. Relationship of pH parameters to stations every week

pH

pH in estuarine waters is still within the quality standard limits, namely between 6-9, while the values obtained are an average of pH 7. The temperature of industrial wastewater and household waste is another factor that can cause the pH of a water to fluctuate (Wibowo, 2020). So that the pH becomes a determining parameter to determine the productivity of the waters. The high and low pH of a water is strongly influenced by the level of CO2 dissolved in these waters. Photosynthetic activity is a process that greatly determines CO2 levelsin water. besides that a decrease in pH can occur due to increased microbial activity in decomposing organic matter so that O2 can decrease then CO2 increases. Increasing CO2 will make the waters more acidic, in other words, the pH will decrease. However, the pH can rise again due to the self-purification process in the waters, due to the reduced concentration of organic matter, so that the work of microorganisms can also be reduced in degrading organic matter (Wulandari, 2020).

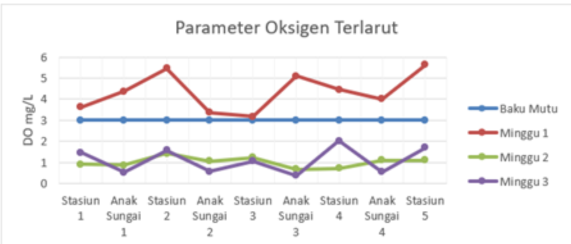


(Source: Research Results, 2022)

Figure 6. Relationship of salinity parameters to stations every week

Salinity

The higher the salinity value indicates the area that is further away from the river, in other words, the highest salinity is in the area near the ocean , namely the estuary. The value of the salinity parameter in the waters of the estuary of the Wonorejo river shows that it is within the brackish water limit of 0.5–30. Meanwhile, the value of 0-0.5 per mil is the limit for fresh water flow (Afrina, 2020). the presence of fresh mixing with seawater or brackish water can affect the salinity value (Djamaluddin, 2018).

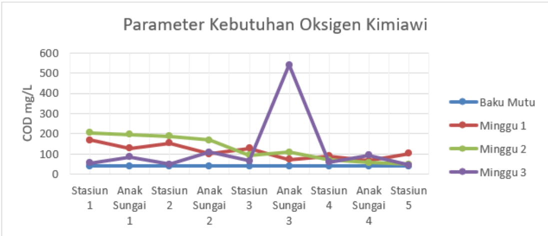


(Source: Research Results, 2022)

Figure 7. Relationship of dissolved oxygen parameters to stations every week

DO

The Wonorejo estuary waters with dissolved oxygen (DO) values tend to fluctuate every week, namely decreasing from the first week to the second week and increasing from the second week to the third week. This is due to changes in weather anomalies with high rain intensity every day so that the increase in water volume also affects the flow of river currents. Nurhayati and Suyarso, (2000) in Rais, (2015) explained that rainfall certainly affects the distribution of aquatic biota, and influences water conditions by increasing the volume of the waters themselves. The low value of dissolved oxygen in waters that does not meet the minimum limits in the quality standards does not support the life of aquatic biota, one of which is for fisheries. Most of the fish that die in polluted waters are not due to the toxicity of the waste materials, but due to a lack of oxygen in the waters as a result of being used for the degradation of organic matter by microorganisms. the DO parameter is based on the PP RI quality standard number 22 of 2021 class III, namely 3 < mg/L, the waters of the Wonorejo estuary are classified as not meeting quality standards or can be said to be polluted.

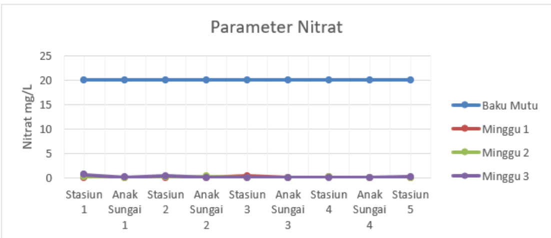


(Source: Research Results, 2022)

Figure 8. Relationship of parameters of chemical oxygen demand to stations every week

COD

The value of chemical oxygen demand (COD) in the waters of the estuary of the Wonorejo river tends to fluctuate, namely it increases from the first week to the second week and in the third week the COD value decreases. The COD parameter with the highest value in the first and second weeks was at station 1. This was due to the high organic matter originating from residential effluents adjacent to station 1 and aquaculture effluents in tributaries 3. Effluent in the form of domestic and fish waste discharges contained -organic material so that it can increase the COD content in water (Kurnianti et al., 2020). The high COD value at each station with designation for class III water bodies, namely 40 mg/L based on PP RI number 22 of 2021 at each station has exceeded the quality standard, so that the waters of the Wonorejo estuary can be said to be polluted.

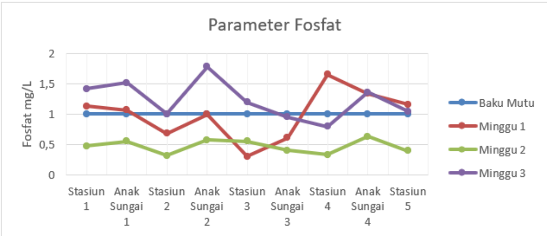


(Source: Research Results, 2022)

Figure 9. Relationship of nitrate parameters to stations every week

Nitrate

The nitrate parameter increases relatively every week from the first week to the third week such as stations 1, 2 and 5 along with all the tributaries every week it always increases, but there is also a decrease at stations 3 and 4 during the second week to the third week. This is due to substances Nitrate pollutant sources originating from settlements and ponds are distributed by river flow. As is the case with Citra et al., (2022) the varying nitrate content is caused by activities that occur close to ponds and human settlements many activities occur causing sources of nitrate to enter the mangrove area which is carried away by the river flow. This was also confirmed in Pratiwi et al., (2022) the nitrate content in the waters of the mangrove ecosystem is influenced by the condition of the surrounding environment, as well as the presence of other sources originating from household and agricultural waste including animal and human waste. The parameter of nitrate is the main nutrient for plant and algae growth. According to Warman, (2015) it is easier for aquatic plants and phytoplankton to use nitrogen in the form of nitrate. The formation of nitrate is highly dependent on the presence of oxygen in the aerobic oxidation process by nitrobacter which converts nitrite to nitrate. It can be concluded that the value of the nitrate parameter based on quality standards is still below the provisions of PP RI number 22 of 2021, which is 20 mg/L for class 3, so that the waters of the Wonorejo estuary are quite safe with nitrate content as a nutrient.



Source: Research Results, 2022

Figure 10. Relationship Of Phosphate Parameters To Stations Every Week

Phosphate

The phosphate parameter every week has a value that tends to fluctuate, namely the first week to the second week it decreases except for station 3 which rises and the second week to the third week it increases a lot at all stations. This is due to the inflow of water in the form of organic matter originating from residential areas, pond areas and tourist areas. the main source of organic matter is from river water flow (Maslukah et al., 2014). Organic material that is decomposed with the help of microbes will later become a source of phosphate so that the decomposition process affects the enrichment of nutrients or nutrients (Citra et al., 2020). According to Pesulima et al., (2018) natural sources of phosphate come from rainfall, weathering of plants, soil erosion, waste from animals and the sea. The existence of phosphate parameters is very important, especially in the formation of proteins and metabolism for organisms. The waters along the estuary area are filled with water hyacinth and algae which is an indication of the phosphate content in the waters. This is in line with Warman (2015) that high phosphate is feared to cause eutrophication in the form of an explosion in the number of algae which is bad for aquatic biota, but the phosphate parameter is not toxic to humans or animals. It can be concluded that the waters of the Wonorejo river with phosphate parameters within the range of quality standards of PP RI number 22 of 2021, namely 1 mg/L, are classified as safe for water fertility.

Density of Mangrove

Table 3. Identification of Mangrove at Each Station

Spesies Mangrove	Jumlah Individu Mangrove				
	Stasiun 1	Stasiun 2	Stasiun 3	Stasiun 4	Stasiun 5
Rhizophora mucronata	1	1	3	4	6
Sonneratia alba	2	2	2	3	2
Bruguiera gymnorrhiza	-	2	3	2	3
Avicennia alba	-	1	2	3	4
Total	3	6	10	12	15

Source: Research Results, 2022

The results of the observations found true mangrove species in the riverbanks namely Rhizophora mucronata, sonneratia alba, bruguiera gymnorrhiza, and avicennia alba. A study that supports mangrove species in reducing pollutants, according to Mentari et al. (2022) that Rhizophora mucronata acts as a phytoremediator in reducing Cu heavy metal. Mahmudi et al (2021) explained that the mangrove trees Avicennia Alba and Rhizophora mucronata are bioaccumulators for the parameter of the heavy metal Pb. Titah and Herman (2020) claim that Avicennia alba can reduce the heavy metal Cr in phytoremediation. In their paper, Elfrieda et al (2020) explained that the mangrove species Bruguiera gymnorrhiza and Rhizophora apiculata absorb heavy metals Pb, Cu and Zn through a phytoremediation process. In Phytoremediation, Saiyood et al (2013) described the mangrove species Bruguiera gymnorrhiza which is capable of reducing bisphenol (BPA), TDS and COD from industrial wastewater. Putro et al., (2013) Sonneratia Alba are also able to reduce levels of nitrate, phosphate, turbidity, and organic matter through wetland processes.

After being observed, the results were classified according to the criteria for the number of trees to determine the mangrove density level based on the reconfiguration of the sampling area in the Minister of Environment Decree No. 201 of 2004, where Stations 1 and 2 contain mangrove areas with low density, stations 3 and 4 contain areas with medium density levels, then station 5 has mangrove areas with one density level. In the figure the density level of the east coast estuary of Surabaya is shown in Figure 12.

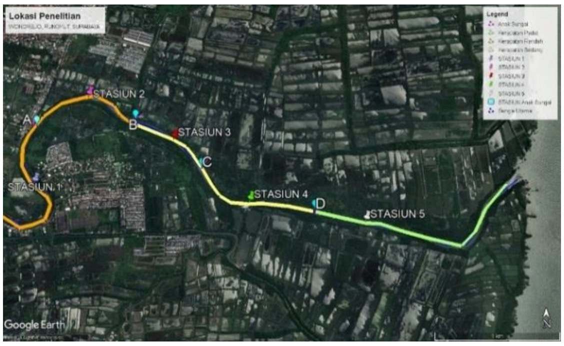


Figure Map of the distribution of mangrove density levels on the estuary of the East Coast of Surabaya.

The Relationship between Water Quality and Mangrove Density

Positive correlation values associated with mangrove density variables are brightness (0.556) and salinity (0.635). This shows that the higher the mangrove density, the lower the temperature, brightness, and salinity parameters. The negative correlation with mangrove density, namely temperature parameters (-0.555) and COD (-0.580), indicates that the higher the mangrove density, the lower the temperature and COD parameters, or conversely, the lower the mangrove density, the higher the temperature. tall. and COD parameters. Variables related to physico-chemical parameters in the same direction or direct comparison are brightness with salinity (0.653), TSS with pH (0.722), TSS with DO (0.803), TSS with phosphate (0.530) and pH with DO (0.837) . While the variables related to the physico-chemical parameters in the opposite direction or vice versa are the clarity of the flow rate (-0.639), the clarity of pH (-0.544), and the DO salinity (-0.583). A positive value in the correlation between physico-chemical parameters shows a directly proportional relationship, that is, the higher one parameter is to another, the greater. Negative values between physico-chemical parameters indicate an inverse relationship, i.e. the higher one parameter is to the other, the lower it is.

This shows that during the mangrove density regression, the parameters that most influenced the physico-chemical parameters were the salinity parameter with the effect of mangrove density of 40.3%, COD of mangrove density of 33.7%, and brightness of mangrove density of 30.9%. Mangrove density affects temperature 30.8%, mangrove density affects nitrate 14%, mangrove density affects TSS 11.4%, current velocity 8.1% affects mangrove density, DO, 1.3% and mangrove phosphate density affects 0.1% mangrove density.

CONCLUSION

The optimum estuarine water quality at station 5 with parameter values is temperature (29 °C), brightness (22 cm), flow velocity (0.083 m/s), TSS (55 mg/L), pH (7.36), salinity (5 .5), DO (1.709 mg/L), COD (42.4 mg/L), nitrate (0.18 mg/L) and phosphate (1.045 mg/L). The COD is over standart and even though the phosphate parameter exceeds the PP RI quality standard number 22 of 2021, it is still possible for aquatic communities related to fisheries and mangrove ecosystems. while the density of mangroves in the Wonorejo river is indicated by low density stations 1-2, medium density stations 3-4 and high density stations 5.

Mangrove density affects physico-chemical parameters including brightness (0.556), salinity (0.635), with positive values or a unidirectional relationship, namely the higher the mangrove density, the higher the brightness and salinity parameters. At the same time, the density of mangroves can also affect the water quality parameters temperature (-0.555) and COD (-0.580) with a negative value, which means the relationship is inversely proportional, namely the higher the density of mangroves, the lower the parameters of temperature and COD. The most influential physico-chemical parameters in estuarine waters were salinity 40.3%, COD 33.7%, brightness 30.9%, temperature 30.8%, nitrate 14%, TSS 11.4%, flow velocity 8.1 %. DO of 1.3% and phosphate of 0.1% is influenced by mangrove density.

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