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Kromong Pacet River Water Quality, Mojokerto Based on the Plankton Diversity Index

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Abstract
The Kromong river is one of rivers in Pacet Mojokerto tourist area. The Kromong river is used by residents for bathing, washing, agricultural irrigation, rafting or rafting as a tourist attraction, and sand mining. Various human activities could enable changes in the physical and chemical factors of waters which directly affect the diversity of aquatic biota, especially plankton. The quality of a body of water can be determined from the plankton diversity index. The objectives of this research were to determine the watered quality in the Kromong Pacet River, Mojokerto based on the plankton diversity index. Sampling was carried out at 3 different stations; plankton identification was carried out at the ecology laboratory. The plankton diversity index was calculated by using the Shannon-Wiener diversity index formula. The research results showed that plankton diversity in the Kromong Pacet River, Mojokerto consists of 11 divisions, 22 families, 24 genera, the plankton diversity index was 3.02479, including unpolluted conditions. Water quality shows that all criteria met quality standards with an average of 36. 44 mg/l and 3. 10 ppm.

Keywords: Kromong river; water quality; plankton diversity index.
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INTRODUCTION

All human activities ranging from food needs to daily needs require water in sufficient quantities and quality that meets the standards. Therefore, people must keep the water from degrading. Not only as drinking water, people utilize water as public facilities such as bathing, washing, cooking, and others. Water is also used for various other purposes, such as agribusiness and industry. Most of the water used to address daily human needs comes from rivers (Nugroho et al., 2020). Water is a form of provisioning service provided by aquatic ecosystems (Prasetyo and Hayati, 2020).

According to Sihombing et al. (2015), interactions that occur in rivers greatly affect the lives of aquatic organisms because river ecosystems consist of continuous biotic and abiotic elements. Human life depends on rivers. People use rivers to fulfill their daily needs. These include sources of drinking water, agriculture (irrigation), power generation, transportation, infrastructure, recreation, tourism and other economic activities. According to information from the Ministry of Environment and Forestry, 75% of river water in Indonesia is heavily polluted, mostly due to household waste disposal (Huda et al., 2020).

The Kromong River is a stream in the Pacet Mojokerto tourist area, in the Pacet Village area, Pacet District, Mojokerto Regency. Observations show that the Kromong River is a shallow river with a meandering flow and clear water. The river is approximately 1.64 km long, and much of it has a texture of rocks and sand. The Kromong River is used by residents for washing clothes, bathing, irrigation of agricultural land, sand mining, and the planned construction of a Micro Hydro Power Plant (PLTMH).

When human activities pollute a watershed, the quality of the river can change. The physical, chemical and biological factors of aquatic ecosystems are affected by the addition and discharge of organic and anargonic materials into the river. Water quality degradation is caused by uncontrolled waste disposal from development activities along the river, making it incompatible with the carrying capacity of the river (Nursaini and Harahap, 2022). Much pollution is caused by waste or outlets from tourist and household activities that are directly discharged into river bodies. Domestic activity materials are one of the causes of the decline in river water quality (Aji and Jailani, 2020). Discharge activities disrupt river ecosystems, disrupting aquatic life processes (Mardhia, 2018). This action can

result in changes in the physical, substance, and organic properties of waters. These changes can affect river water biota, especially plankton.

Plankton is one of the biotic organisms in the river ecosystem. Plankton play an important role in aquatic ecosystems. To determine the status of waters by knowing their type and abundance (Lubis, 2021). Two groups of plankton are zooplankton and phytoplankton. Phytoplankton are referred to as heterotrophs and are considered the main producers because they are able to convert inorganic materials into organic through photosynthesis (Puspita 2018). Plankton are partitioned into two, namely phytoplankton and zooplankton. Phytoplankton are one-celled organisms that live in water and play an important role as primary producers in the food chain in water because they contain chlorophyll so they can carry out photosynthesis (Setyowardani et al., 2021). In the process of photosynthesis, phytoplankton can produce organic substances formed from inorganic substances (Wahyuni and Rosanti, 2016). Environmental factors greatly affect the presence of plankton in the environment. Because of the abundance and diversity of organisms that are sensitive to changes in environmental conditions, plankton are often used as bioindicators in waters.

The level of dominance of plankton species is very closely influenced by water productivity factors and the dynamics of existing water quality, because biologically plankton are cosmopolite microorganisms (Ariadi et al., 2019; Wafi et al., 2021). High or low plankton diversity in a body of water can be seen from the diversity index value. Based on the number and diversity of types of organisms in a body of water used to see water quality is called the plankton diversity index (Odum, 1994). The plankton diversity index in a body of water can be used to determine the water quality of the river. According to Patty et al. (2019). there are several indicators that indicate clean water quality, including water temperature, brightness, pH, DO, BOD, etc. In addition, there are various fauna inhabiting the waters, if the river indicates that it is polluted, the fauna that inhabits the place has residues of the pollution. Due to the lack of information on water quality in the river, researchers chose to conduct research on this issue.

The lack of data on the water quality of the Kromong River in Pacet, Mojokerto makes information on the waters still unknown whether it is polluted or not. Therefore, it is necessary to conduct research that aims to determine the water quality of the Kromong River based on the plankton diversity index.

MATERIALS AND METHODS

This study was conducted at 3 stations in the Kromong River in Pacet village, Pacet sub-district, Mojokerto district. Each station has 3 data collection points, namely edge I, center, and edge II. There were 3 repetitions at each point so that 27 replicates were obtained. Station 1 was located at coordinates 7°40'24.4 "S 112°32'12.2 'E, station 2 was located at coordinates 7°40'17.9 'S 112°32'05.1 'E, station 3 was located at 7°40'07.4 'S 112°31'50.8" E (Figure 1). This research was conducted in October - December 2023.

There were five research procedures carried out, namely field observation, station determination, plankton sampling, water quality measurement, plankton identification. Direct field measurements including physical parameters (temperature, current speed, depth, brightness) and chemical parameters (pH, BOD, DO, CO_2) were carried out at each station. The material used was Phenolphthalein (PP) solution; while the tools used were DO meter, light winkler bottle, dark winkler bottle, erlenmeyer, pH meter, syringe, dropper pipette, thermometer, sacchi disk, label paper, stationery, and camera for documentation.

Plankton identification was carried out in the Biology Ecology Laboratory, with the help of a microscope and a plankton identification manual. To see the plankton diversity index, the Shannon-Wiener diversity index was used as follows:

$$H' = -\sum_{i=1}^{s} \quad (PiPi)$$

Where:

H' : Diversity index
Pi : ni/N
ni : Number of individuals of the i-th species
N : Total number of individuals
S : Number of species

The level of diversity and distribution is seen based on the Shannon-Weaner plankton diversity index criteria, namely a diversity index value <2.3026 has low diversity, a diversity index value of 2.3026-6.9076 has a medium diversity value, a diversity index value >6.9078 has a high diversity value (Odum, 1994)

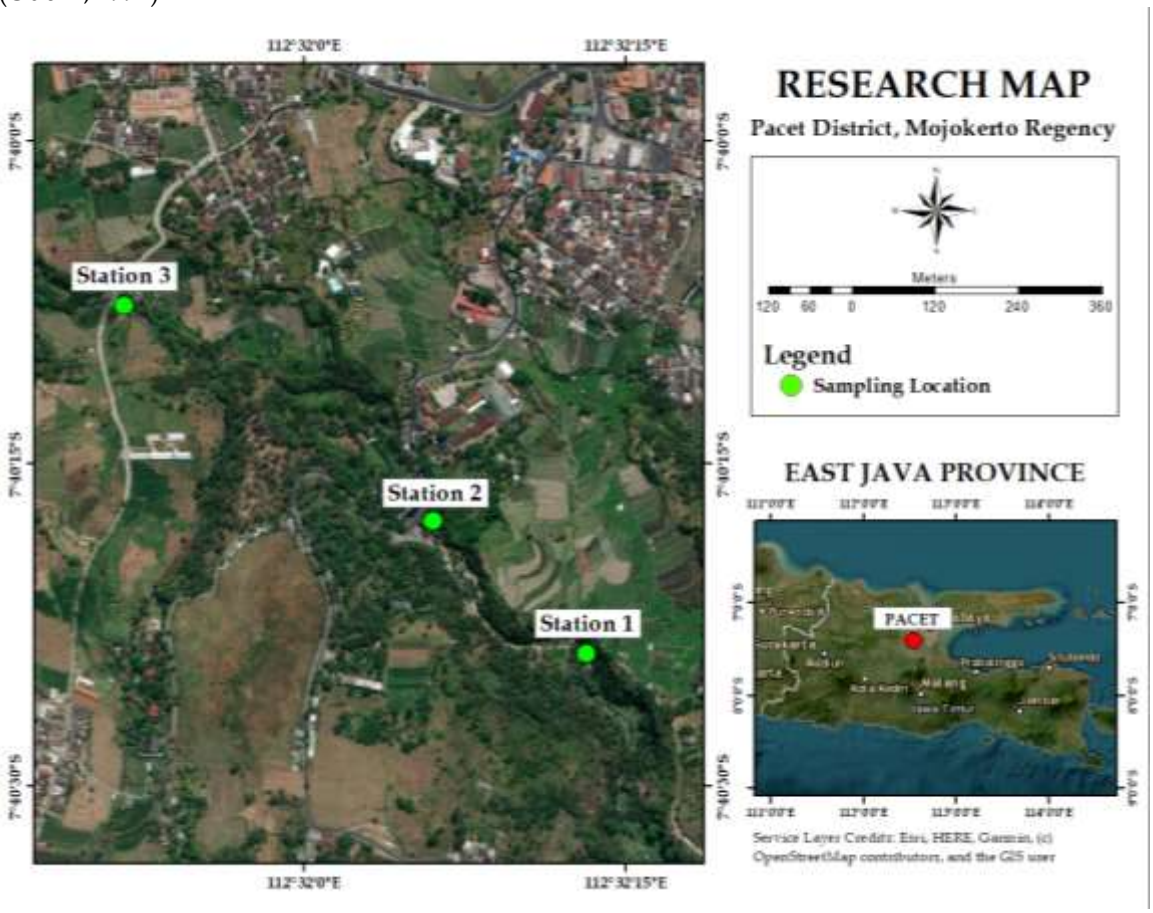

Figure 1. Research location map (Documentation: Google Maps 2023).

RESULTS

Based on research conducted in Kromong River Pacet, Mojokerto, the results of phytoplankton identification consisting of 9 divisions, 18 families, and 20 species, and zooplankton consisting of 2 divisions, 4 families, and 4 species (Table 1). Based on the identification results, it is known that in the Kromong Pacet river, Mojokerto, 9 phytoplankton divisions and 2 zooplankton divisions were found. Nine phytoplankton divisions consist of Chlorophyta (8 species), Cyanophyta (1 species), Gyrista (1 species), Bacillariophyta (2 species), Euglenozoa (3 species), Myzozoa (1 species), Cyanobacteria (1 species), Chrysophyta (2 species), and Heterokontophyta (1 species), while 2 zooplankton divisions consist of Rotifera (2 species), Arthropoda (2 species). The identification results revealed that the dominating plankton is the Chlorophyta division.

The value of the plankton diversity index in the Kromong Pacet River, Mojokerto were as follows: station 2 which was 2.6543, station 1 was 2.5772, and station 3 was 2.4972 (Figure 2). Based on the Shannon Wiener plankton diversity index criteria, the plankton diversity index at stations 1 to 3 has moderate diversity because it is in the range of 2.3026-6.9076 (Odum, 1994). Based on the water pollution criteria, the waters at stations 1 to 3 were not polluted because the plankton diversity index was > 2.00.

Table 1. Plankton diversity in Kromong River Pacet, Mojokerto

Plankton species	Division	Family	Species
Phytoplankton	Chlorophyta	Zygnemataceae	*Spirogyra* sp.
			Zygnema sp.
		Desmidiaceae	*Closterium* sp.
		Hydrodictyaceae	*Pediastrum* sp.
		Chlorellaceae	*Dictyosphaerium* sp.
		Volvocaceae	*Pandorina* sp.

Plankton species	Division	Family	Species
		Chlamydomonaceae	*Chlamydomonas* sp.
		Scenedesmaceae	*Scenedesmus* sp.
	Cyanophyta	Oscillatoriaceae	*Oscillatoria* sp.
	Gyrista	Aulacoseiraceae	*Aulacoseira* sp.
	Bacillariophyta	Diatomaceae	*Synedra* sp.
		Tabellariaceae	*Tabellaria* sp.
	Euglenozoa	Euglenaceae	*Euglena* sp.
		Phacaceae	*Phacus* sp.
		Euglenaceae	*Trachelomonas* sp.
	Myzozoa	Dinophysaceae	*Dinophysis* sp.
	Cyanobacteria	Pseudanabaenaceae	*Limnothrix* sp.
	Chrysophyta	Naviculoideae	*Frustulia* sp.
		Melosirales	*Melosira* sp.
	Heterokontophyta	Naviculaceae	*Caloneis* sp.
Zooplankton	Rotifera	Collothecidae	*Collotheca* sp.
		Brachionidae	*Brachionus* sp.
	Arthropoda	Chydoridae	*Alonella* sp.
		Colpodidae	*Calanoid* sp.

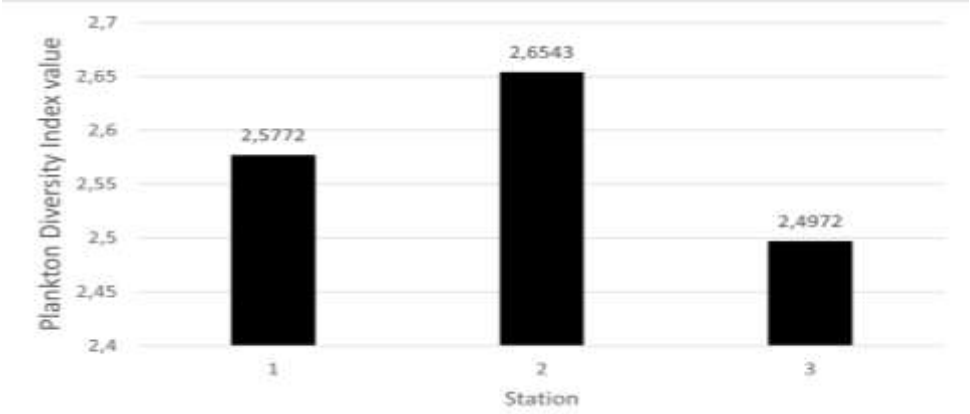

Figure 2. Plankton diversity index value in Kromong River Pacet. Mojokerto

Measurements of physical and chemical parameters of the Kromong River were carried out three times at each station (Table 2). The data results were compared with the class 2 river water quality standards referring to PP No. 22 of 2021 concerning the implementation of environmental protection and management. The results of water quality measurements were still in accordance with the established quality standards, but there were two parameters that do not meet the quality standard criteria, namely CO_2 and BOD.

Tabel 2. Measurement Results of Physical and Chemical Parameters in Kromong River Pacet, Mojokerto

Parameters	Station 1	Station 2	Station 3	SDV	SBM
Temperature (°C)	19.07	20.18	21.64	±1.16	22-28
Brightness (m)	0.44	0.48	0.32	±0.09	-
Current Speed (m/s)	0.08	0.02	0.13	±0.05	-
Depth (m)	0.44	0.48	0.32	±0.09	-
pH	8.23	8.24	8.28	±0.03	6 - 9
DO (ppm)	9.93	9.85	10.49	±0.39	3
CO_2 (mg/L)	36.00	38.67	34.67	±3.94	< 15
BOD (ppm)	2.75	2.57	3.96	±0.85	3

Notes: SBM = Quality Standard according to PP No. 22 of 2021. SDV= Standard Deviation.

DISCUSSION

Plankton is one of the organisms that can be used as an indicator of the fertility and pollution level of a water body. Based on the results of the study, it can be seen that in the Kromong River there

were 9 divisions, 18 families, 20 species of phytoplankton, and 2 divisions, 4 families, 4 species of zooplankton. The number of phytoplankton found in the Kromong River Pacet, Mojokerto, was more than the number of zooplankton. This was in accordance with the research of Rusdiyani and Purnomo (2020), that phytoplankton was more dominant than zooplankton in the morning. Phytoplankton are found in the morning because these organisms have positive phototaxis to the sun, while zooplankton are negative phototaxis. Therefore, zooplankton can survive in waters that do not get enough sunlight.

Based on Table 1, it is known that the most common division found is Chlorophyta, which is 8 species. Chlorophyta is one division that includes the largest group of algal vegetation whose habitat is in fresh water. Chlorophyta is a division of phytoplankton that is cosmopolite, can adapt to its environment compared to other divisions, and has a relatively fast reproductive ability. Chlorophyta is one of the main producers in aquatic ecosystems and has chlorophyll pigments that are effective for photosynthesis (Fauziah and Laily, 2015). This causes the Chlorophyta division to be found more than other phytoplankton divisions.

The most common type of plankton from the Chlorophyta division is *Closterium* sp. with a total of 26 individuals. *Closterium* sp. has chloroplasts so that it can photosynthesize. *Closterium* sp. habitat is very important and necessary in aquatic ecosystems, because of its existence as a primary producer, namely as a producer of organic substances or oxygen (Syaifuddin and Melisa, 2020). Closterium sp. ecosystem is very easy to find in various waters, can be found in ponds, lakes, or rivers, so this species is found in many waters.

Based on Table 1, it is known that the Rotifera and Arthropoda divisions are zooplankton found in the Kromong Pacet river, Mojokerto, with a total of 2 species each. Rotifera is the most zooplankton found in fresh waters. The large number of Rotifera divisions is due to the abundance of organic matter in the river. Rotifera is easy to find because of its rapid reproduction by parthenogenesis, which means that eggs can produce new individuals without being fertilized (Humaira and Izmiarti, 2016). *Brachionus* sp. is the most species found in the Rotifera division, namely 9 individuals from all stations.

The diversity of plankton species in a body of water can indicate the level of pollution of these waters (Wibowo et al., 2014). Plankton diversity index is a value that can be seen from the results of the number and diversity of a type of organism in a body of water that is used to see water quality (Odum, 1994). Based on the results of the study, Station 2 has the highest diversity index, while the plankton diversity index value at station 3 is the lowest.

Water quality measurements of Kromong Pacet River, Mojokerto were conducted at 3 stations. Water quality indicates that there are natural resources still available to support the sustainability of aquatic ecosystems (Manikannan et al., 2011). The number of human activities in water areas can pollute water areas (Hamuna et al., 2018).

The results of temperature measurements in the Kromong River averaged 20.29^{o}C, these results prove that the temperature in the Kromong river is still included in the quality standards (PP Number 22 of 2021). The highest temperature at station 3 is 21.64^{o}C, while the lowest temperature at station 1 is 19.07^{o}C. The high temperature at station 3 is influenced by the altitude of the area, vegetation cover on the riverbank, while the low temperature at station 1 is influenced by the sampling time and altitude of an area. The altitude of an area, time, sunlight intensity, and rainfall as well as the presence of vegetation cover from trees growing on the banks of the river can affect water temperature (Leidonald, et al., 2022). The Kromong River is located in a highland area with an altitude of 700 meters above sea level and is at the foot of Mount Welirang, so the area has a low temperature.

Kromong River waters have an average brightness of 0.41. The highest value of brightness at station 2 is 0.48 m and the lowest value of brightness at station 3 is 0.32 m. The brightness value of Kromong river water Pacet, Mojokerto is not suitable for plankton life. According to Suardiani, et al. (2018) the optimal water brightness for the life of aquatic organisms ranges from >0.45 m. Clarity, which is determined by the presence of particles dissolved in mud, is one of the factors that affect the brightness of natural waters, because it is very important for photosynthesis and primary production. (Muhtadi, et al., 2017).

The current speed of the Kromong Pacet river, Mojokerto averaged 0.08 m/s. The measurement results at station 3, the highest current speed is 0.13 m/s, and at station 2 the lowest current speed is 0.02 m/s. According to Yusuf, et al. (2012), low and medium current velocities range from less than 0.5 m/s. Current velocity can also affect the life of aquatic organisms, one of which is plankton. The current speed is large, the abundance of plankton will be less, because there are several plankton populations that are followed by water currents (Gunawan, et al., 2019).

The depth of the Kromong Pacet river, Mojokerto averaged 0.41m. The highest depth measurement results at station 2, which is 0.48 m, while at station 3 has the lowest value, which is 0.32 m. The results of depth measurements at station 3 have the highest value. The results of depth measurements at station 3 are lower than the other stations, this is because there are many human activities in the area, such as waste disposal which results in changes in water conditions at the research site. Kromong River is included in the water with shallow conditions having a texture of rocks and sand that is difficult to absorb water. From this depth, plankton can grow well because of the sunlight that enters and plankton utilize it as a photosynthesis process (Fitria and Harahap, 2023).

The measurement results of the degree of acidity (pH) show that Kromong River water has an average pH value of 8.25 (Table 1) (PP. No. 22 of 2021), this value is in accordance with the class 2 quality standard, which is in the range of 6-9. Based on the measurement results at station 3, the highest pH is 8.28. Meanwhile, station 1 shows the lowest pH, which is 8.23. In general, the optimal pH for phytoplankton life is in the range of 6-9 while for zooplankton life in the range of 5-9 (Soliha, et al., 2016). Based on this, Kromong River water is still favorable for plankton growth. Several factors, including biological factors such as organism respiration, photosynthesis and the presence of ions in these waters, can affect water pH. (Prasiwi and Wardhani, 2018).

The waters of the Kromong River had an average DO of 10.09 ppm. These results were in accordance with the DO quality standard >3. This indicated that the Kromong Pacet River water, Mojokerto was suitable for the life of plankton organisms. The results of DO measurements at station 3 have the highest value, which was 10.49 ppm. While the lowest at station 2, which was 9.85 ppm. The DO content that exceeds 5 then the waters were included in a low polluted condition, while the DO value was less than 5 then the waters experience moderate pollution (Aryawati et al., 2021). Therefore, this Kromong River shows that the condition of the waters is not polluted. Dissolved oxygen is directly proportional to temperature, the higher the dissolved oxygen value, the higher the temperature (Darmawan et al., 2018).

Kromong River waters has an average CO_2 value of 36.44 mg/l. This result does not meet the quality standard, which was less than 15 mg / L, (PP. No. 22 of 2021). The highest CO_2 measurement results at station 2, which was 38.67 mg/L. While the lowest was at station 3, which was 34.67 mg/L. It can be seen that the CO_2 value in the Kromong river was high. An organism can reproduce well if CO2 levels are in the range of <15 (Octasari, et al., 2018). If the carbon dioxide (CO_2) content is high enough, it can cause poison or affect the aquatic biota in it (Al Idrus, 2018).

The BOD level of Kromong Pacet River water, Mojokerto averages 3.10 ppm. BOD levels at station 3 have the highest value, which is 3.96 ppm. While at station 2 shows the lowest value, which is 2.57 ppm. This shows that stations 1 and 2 in the Kromong River waters meet the class 2 quality standards with a range of 3 ppm because the condition of the area is still natural there are many trees, but at station 3 does not meet the quality standards because the condition of the area is already near the settlement. Polluted waters are indicated by the value of BOD levels> 10 mg/L so that the results of BOD measurements in the Kromong River are still in good water conditions. High BOD levels prove that more organic matter is dissolved or decomposed with the amount of oxygen in the waters (Sudinno et al., 2015). While the low BOD value is caused by the small amount of organic matter that is not decomposed in the water (Soliha et al., 2016). BOD is an indicator of the concentration level of organic matter in waters. A greater value of BOD is proportional to the concentration of organic matter in the water. Because the level of organic matter is high, microorganisms need more oxygen to decompose it. Organic waste materials such as waste that can be decomposed or broken down by microorganisms, as well as domestic waste that enters the river, contribute to an increase in BOD (Ghozali et al., 2024).

CONCLUSION

The results showed that the plankton diversity index at station 1 to station 3 has moderate diversity because it is in the range of 2.3026-6.9076 and it was categorized as unpolluted. Based on the physical and chemical parameters of the Kromong Pacet River, Mojokerto, all of them do not exceed the threshold value of quality standards.

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CONFLICT OF INTEREST

There is no conflict of interest.

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