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Research Article

Organic pollution level and water quality in poso river with macroinvertebrate indicators

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ABSTRACT

The Poso River is one of the rivers in Poso Regency that is utilized as a water source and channeled to people's homes by the Regional Drinking Water Company. There are also people who take water directly from the river for consumption. However, there is a lot of garbage/waste found on the banks and bodies of the river due to economic and social activities of the people living along the Poso River. There are several home industries that dispose their industrial waste directly into the Poso River, causing pollution that affects the water quality of the Poso River. The objective of this study was to analyze the level of organic pollution and water quality in the Poso River with macroinvertebrate as biological indicators. The research samples were all macroinvertebrates found at the time of sampling at each station. Data collection/sampling conducted at four stations, namely station 1 in residential areas; station 2 at the central market and industrial activity; station 3 in the tofu factory; and station 4 in the estuary area. Data collected by determining the point for sampling first. The bottom substrate of the Poso River was mud, so that macroinvertebrates could only be collected by sweeping techniques. The data analysis technique used was the FBI (Family Biotic Index) formula. The results showed that there were 30 taxa of macroinvertebrate biota families obtained at 4 research stations with a Family Biotic Index (FBI) value of 6.13. This means that the water quality of the Poso River in the Poso Kota Selatan and Poso Kota Sub-districts is rather poor.

Keywords: macroinvertebrate indicators; organic pollution; poso river

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INTRODUCTION

Water is one of the necessities for the life of living things. Its nature is constantly changing both in terms of quantity and quality. It is caused by the changes in natural conditions and the activities of living things which will affect the lives of living things themselves. River water is a strategic place for living things because the river becomes an ecosystem with limitless designation (Dwitawati et al., 2015). The Poso River is one of the rivers in Poso Regency that supports people's lives in Poso City. The Poso River

is utilized as a source of water and channeled to residents' homes by the Regional Drinking Water Company. There are even people who take water directly from the river for consumption.

Based on initial observations, there were garbage and waste found in several places on the banks and bodies of the river due to the economic and domestic activities of the people living along the Poso River. In addition, there were several home industries dispose their industrial waste directly into the Poso River, one of which was the Tofu Industry with its liquid waste. This waste disposal caused pollution that affects the water quality of the Poso River. It is in line with the idea by (Dwitawati et al., 2015), stating that changes in river water quality will disrupt the survival of people who use river water and aquatic biota, especially macroinvertebrates. Aquatic biota that are sensitive to pollution, will decrease over time and even become extinct.

High levels of pollution and environmental damage have reduced the quality and quantity of the environment, so it is necessary to manage the quality of river water. The implementation of a continuous water quality monitoring program can be done for water quality management. Water quality monitoring need to be carried out to determine whether the water source is safe to be used for various community activities. Monitoring is often done by physical and chemical methods, but it is often less efficient because it requires a lot of tools and materials (reagents). In addition, this method requires special skills (trained human resources) and the availability of adequate laboratories.

Monitoring water quality with biological methods is known as Biomonitoring. This method utilizes bio responses to evaluate environmental changes that are generally caused by anthropogenic stresses (human activities), known as bioindicators. (Ali & Rosyadi, 2020) stated that bioindicators of water quality from time to time include plants, animals, and microbes that can respond specifically to changes in temperature, pH, and so on. This was in line with (Putro, 2014), which states that the use of macroinvertebrates as bioindicators in an aquatic ecosystem has advantages, namely: this group of organisms has limited mobility, is sensitive to environmental changes, and has a wide distribution with a long life span.

Macroinvertebrates are groups of animals that do not have a backbone. They play a role in maintaining ecosystems, especially aquatic ecosystems because they functioned as first-level consumers (phytoplankton eaters), second-level consumers (zooplankton eaters) in the food chain, and as nutrients balancer in the aquatic environment (Achmad Tan Tilar Wangsajati Sukmaning Kalih et al., 2018). Macroinvertebrates can be use as bioindicators because they live attached to a substrate and have low motility, making them difficult to move around (Widiyanto & Sulistyarsi, 2014).

Some characteristics of macroinvertebrates as good bioindicators include: 1) Sensitive to changes in water quality that affect species composition and abundance; 2) Found in almost all waters; 3) There are quite a lot of varieties which give different responses to different disturbances; 4) Has limited movement, so that it can be used as an indicator of the state of the local environment; 5) Easy to collect and to identify its family taxa; 6) Sampling is easy to do, inexpensive and does not have a negative impact on other living things Rahayu in (Panjaitan et al., 2011). This is in line with the opinion of (Anyanwu et al., 2019) stating that macroinvertebrates are ideal bioindicators because of their wide distribution, ease and low-cost sampling. In addition, it is very sensitive to organic contaminants.

The use of biotic index to assess the water quality of the Poso river was still limited, so it was necessary to study macroinvertebrates as bioindicators of organic pollution and water quality levels in the Poso River. The purpose of this study was to analyze the level of organic pollution and water quality in the Poso River using macroinvertebrate indicators, so as to provide information for better management of river water quality in its utilization.

RESEARCH METHODS

The type of this research was quantitative descriptive research which shows a description from the data obtained at the observation location. This research was conducted in the Poso River in the Poso Kota Selatan and Poso Kota sub-districts in July - August 2021. The data/sample collection sites consisted of 4 stations including: station 1 located in a residential area (Figure 1); station 2 located in the central market (Figure 2); station 3 located in the tofu industry (Figure 3); and station 4 located in the estuary area (Figure 4).

Figure 1. Station 1 located in a residential area

Figure 2. Station 2 located in the central market

Figure 3. Station 3 located in the tofu industry

Figure 4. station 4 located in the estuary area

A descriptive quantitative approach is a type of research that describe a population or situation accurately using data obtained at the observation location The study population was all macroinvertebrates in the Poso River. The research samples were all macroinvertebrates found at the time of sampling at each station. Data was collected by determining the point for sampling first. The bottom substrate of the Poso River was mud so that macroinvertebrates could only be collected using a sweeping technique, namely by stirring the water using a stick with a net on the banks of the river in a direction against the current. All samples (catch) then were transferred into the sample container. Next was sorting. The existing biotas were observed and grouped based on the similarity of shape and characteristics in the sorting container. Biota were then counted and then identified using the Biomonitoring Guidelines for Monitoring Watershed Health (Ecoton, 2013).

Furthermore, physical and chemical conditions of the river also were taken into account by measuring the acidity level using a pH meter; water temperature using a thermometer; turbidity of the water using a turbidimeter; and dissolved oxygen levels in water using a DO meter. The data analysis technique used was the FBI (Family Biotic Index) formula, as follows:

$$FBI = \frac{\Sigma xi.\ ti}{N}$$

Notes:
FBI = Family Biotic Index
xi = Number of biota / animal per family
ti = Family tolerance value
N = Total number of samples
(Rustiasih et al., 2018)

FINDING AND DISCUSSION

Results The biomonitoring of water quality and organic pollution levels in the Poso River was carried out at four stations. Sample analysis was carried out for the physical and chemical parameters of the river water where the macroinvertebrate samples were taken, by measuring the acidity level using a pH meter, water temperature using a thermometer, and dissolved oxygen levels in water using a DO meter. Based on the observation results and analysis of macroinvertebrate samples found in the sample collection area, the data obtained will be displayed according to each sampling station.

The aquatic habitat at Station 1 had a base substrate in the form of mud. There were aquatic vegetations on the banks of the river, namely grasses, shrubs, and trees. There were piles of domestic garbage on the riverbanks since this area was residential. The measured pH level was 9.0, water temperature was 29°C, and dissolved oxygen levels was 6.0 mg/l. Macroinvertebrate data obtained during sampling at station 1 is shown in Table 1.

Table 1. Macroinvertebrate Biota at Station 1

No	Name (Family/Order)	Number of Individuals (xi)	Tolerance value (ti)	xi.ti	FBI = $\frac{\Sigma xi.\ ti}{N}$
1.	Vellidae	4	5	20	5.55
2.	*Gerridae*	2	6	12	
3.	*Nepidae*	3	6	18	
Total (N)		9		50	

Based on Table 1 above, three macroinvertebrate biota family taxa were obtained, with a Family Biotic Index (FBI) value of 5.55, which means that the water quality at station 1 was moderate. Judging from the level of organic pollution, the river water at this station was categorized as moderately polluted. The water quality at station 1 (residential area) was categorized as moderate and the level of pollution was moderately polluted. In the area the pollution was from domestic activities which can be seen from the accumulation of household garbage from residents who live near river banks. The river banks were used by residents as garbage dumps. There were only 3 macroinvertebrate biotas found at this station, namely Vellidae, Gerridae, and Nepidae. These types of macroinvertebrates are predatory animals that eat other animals as prey. Their existence is generally jumping on the surface of the water to catch their prey near the surface of the water.

The condition of the aquatic habitat at Station 2 was not much different from Station 1, which had a base substrate in the form of mud. There were aquatic vegetations on the river banks, namely grass, shrubs, and bamboo trees. The types of solid waste found on the river banks were in the form of livestock manure and discarded leftover fish waste. Station 2 was a central market area located on the banks of the river. The measured pH level was 8.5, the water temperature was 30°C, and the dissolved oxygen level was 5.80 mg/l. Macroinvertebrate data obtained during sampling at station 2 is shown in Table 2.

Table 2. Macroinvertebrate Biota at Station 2

No	Name (Family/Order)	Number of individuals (xi)	Tolerance value (ti)	xi.ti	$FBI = \frac{\Sigma xi.\ ti}{N}$
1.	*Parathelphusidae*	1	6	6	5,80
2.	*Nepidae*	30	6	180	
3	*Vellidae*	3	5	15	
4.	*Baetidae*	1	5	5	
5.	*Lymnaeidae*	1	6	6	
Total (N)		36		212	

There were 5 family taxa of macroinvertebrate biota found in Station 2, with a Family Biotic Index (FBI) value of 5.80, which means that the water quality at station 2 was rather poor. Judging from the level of organic pollution, the river water at this station categorized as quite heavily polluted. More macroinvertebrates were found at station 2. Apart from predatory species, namely Nepidae and Vellidae, macroinvertebrates living as collectors were also found, namely Parathelphusidae, Baetidae, and Lymnaedae. Rini in (Susanti, 2017), stated that the collector group eats the fine particles carried with the flow of water. Station 2 was located in the central market area and directly adjacent to the river where all the waste produced, both solid and liquid, was directly discharged into the river body. This resulted in the level of pollution at station 2 being categorized as moderately polluted, while the water quality at this station was rather poor.

The aquatic habitat at Station 3 had a base substrate in the form of mud. There were aquatic vegetations on the river banks, namely grasses, shrubs, and various trees. The measured pH level was 8.4; the water temperature was 30°C, and the dissolved oxygen content was 5.75 mg/l. Macroinvertebrate data obtained during sampling at station 3 shown in Table 3.

Table 3. Macroinvertebrate Biota at Station 3

No	Name (Family/Order)	Number of individuals (xi)	Tolerance value (ti)	xi.ti	$FBI = \frac{\Sigma xi.\ ti}{N}$
1.	*Gerridae*	30	6	180	6.13
2.	*Vellidae*	2	5	10	
3	*Thiaridae*	2	7	14	
4.	*Atydae*	1	6	6	
5.	*Bucinidae*	5	7	35	
Total (N)		40		245	

At Station 3, more types of macroinvertebrate biota were found than in the previous two stations, which were 5 family taxa of macroinvertebrate biota, with a Family Biotic Index (FBI) value of 6.13, which means that the water quality at station 3 was rather poor. Judging from the level of organic pollution, the river water at this station was categorized as quite heavily polluted. At station 3, the biggest contribut to water pollution was liquid waste from the tofu factory which was directly discharged into the river. It was

found that the water quality at station 3 was rather poor with the level of organic pollution included in the category of moderately polluted. Thiaridae and Buccinidae, macroinvertebrate species that live as scrapers, were found in this station. Scrapers are algae eaters attached to the surface of rocks and objects in the water. Although the numbers are small at this station, Thiaridae, and Buccinidae are pollution-resistant animals with a tolerance value of 7. This was in accordance with Stevi in (Hellen et al., 2020) who found that the macroinvertebrates in the Thiaridae family are resistant to pollutants.

The finding of animals resistant to pollution and also some animals that live as predators and collectors have provided a clear fact that industrial waste that was directly discharged into the river has polluted the river water and affected its quality to a worse level. In line with this, (Rustiasih et al., 2018) stated that disposing of waste from community activities directly into the river resulted in decreased river water quality and affected the survival of organisms in the river.

The condition of the aquatic habitat at Station 4 was that it had a basic substrate in the form of mud. Vegetations on the banks of the river were lacking, only grass. There was various household waste found which was disposed of directly in the river body since there were houses right in the river area. The measured pH level was 8.8, the water temperature was 30°C, and the dissolved oxygen content was 4.82 mg/l. Macroinvertebrate data obtained during sampling at station 4 is shown in Table 4.

Table 4. Macroinvertebrate Biota at Station 4

No	Name (Family/Order))	Number of individuals (xi)	Tolerance value (ti)	xi.ti	$FBI = \frac{\Sigma xi.ti}{N}$
1.	*Buccinidae*	20	7	140	6,20
2.	*Atydae*	1	6	6	
3	*Viviparidae*	30	6	180	
Total (N)		53		326	

There were 3 family taxa of macroinvertebrate biota found at station 4, with a Family Biotic Index (FBI) value of 6.2 which means that the water quality at station 4 was rather poor. Judging from the level of organic pollution, the river water at this station was considered to be quite heavily polluted. At station 4 which was located in the estuary area, 3 types of macroinvertebrates were found, namely Buccinidae, Atydae, and Viviparidae. The highest FBI value obtained at this station was 6.2, meaning that the water quality was rather poor and the level of organic pollution was moderately polluted level. This station was the most downstream of all research stations and was located close to the river mouth where all organic pollutants were collected. This was supported by (Hamuna et al., 2018) that the concentration of nitrate is influenced by the input of organic matter originating from human activities around the waters, be it land erosion, household waste, or agricultural waste that is carried directly into water bodies.

Comprehensive data on river quality and organic pollution levels in the Poso River in the South Poso City and Poso City Sub-district was made to recap the data of macroinvertebrates found at all sampling stations, from station 1 to station 4 which is shown in Table 5.

Table 5. Macroinvertebrate Biota at All Research Stations

No	Name (Family/Order))	Number of individuals (xi)	Tolerance value (ti)	xi.ti	$FBI = \frac{\Sigma xi.ti}{N}$
1.	*Veliidae*	9	5	45	6,13
2.	*Gerridae*	32	6	192	
3	*Nepidae*	33	6	198	
4.	*Parathelphusidae*	1	6	6	
5.	*Baetidae*	1	5	5	

6.	*Lymnaeidae*	1	6	6
7.	*Thiaridae*	2	7	14
8.	*Atydae*	2	6	12
9.	*Buccinidae*	25	7	175
10.	*Viviparidae*	30	6	180
Total (N)		136		633

In all research stations, 10 family taxa of macroinvertebrate biota were found with a Family Biotic Index (FBI) value of 6.13, which means that the water quality of the Poso River in the South Poso City and Poso City sub-districts was rather poor. Judging from the level of organic pollution, river water in this area was considered to be quite heavily polluted. The research results on the water quality of the Poso River using biomonitoring techniques with macroinvertebrates showed there were ten family taxa of the macroinvertebrate biota with a Family Biotic Index (FBI) value of 6.13. Of the ten taxa, there were eight taxa with a tolerance number above 5, which indicates resistance to river pollution. Some biotas with a tolerance number of 5 were found in small quantities because these types of biotas were generally sensitive to pollution. If there was high enough organic pollution in the river water, the macroinvertebrate biotas that are sensitive to pollution would leave to find a more suitable area. The pollutants source were several industries that dispose of their waste directly into river bodies. Likewise, residents' activities, both settlements, and markets use the river as a dumping ground for garbage.

Some of the physical and chemical parameters of water measured as supporting data were described as follows: temperature and degree of acidity (pH) at the four stations did not differ much from each other, namely between 290 -300 and 8-9 respectively, and still acceptable according to the water quality standards of class II and class III for the use of clean water. This was possible because in the river body there was no industrial wastewater which has a higher temperature and acidity level beyond the threshold. In addition, the swift currents of the river also affect the dilution of acidity levels. This is supported by the opinion of (Nufutomo & Muntalif, 2017) stating that aquatic biota can live in waters with a pH range of 7-8.5.

The average dissolved oxygen level at all four stations was 5.59 mg/l. This value indicated an acceptable result according to water quality standards because it was above the threshold and was still suitable for macroinvertebrates. In line with the opinion of (Ratih, Iin, Prihanta Wahyu, 2018), which stated that oxygen is needed by an organism so high oxygen levels indicate that more organisms are living. High levels of dissolved oxygen in the water indicate that the water had not been heavily polluted and the water can be used for various purposes, even for consumption. This was supported by (Pasisingi et al., 2014), that oxygen levels in stagnant waters are lower than in flowing waters, because they provide opportunities for oxygen diffusion from air to water due to water movement.

Another physical parameter that also affects the life of macroinvertebrates is temperature. Temperatures that are too high will cause macroinvertebrates to decrease and even die. Measurement of temperature parameters shows that the average temperature at the four observation stations was 29.75°C. It was still an appropriate temperature for the growth of macroinvertebrates. In accordance with (Pamuji et al., 2015), the survival of macrozoobenthos will be threatened if it lives in a temperature range of 35-40°C and it will affect migration, metabolic rate, and mortality of macrozoobenthos. Furthermore, (Sutanto & Purwasih, 2015) argues that aquatic organisms such as macroinvertebrates can live in a temperature range of 20°C – 30°C. Furthermore, (Abdul Halim et al., 2018) stated that temperature is a water quality parameter that directly affects the physiological activities of aquatic organisms. The oxygen requirements of aquatic animals tend to increase abnormally with every 10°C increase in the temperature range the organism can tolerate.

(Hamakonda et al., 2019) stated that the condition of poor river quality should not be left alone. The stipulation of waste management regulations for industries is necessary so that the waste discharged into the river is in a suitable condition for disposal so that it does not pollute the environment and would not have a negative impact on the community. Water quality needs to be analyzed to determine the suitability of water in a particular designation by comparing it to the water quality standards according to water class. (Kahirun et al., 2019) also stated that the high organic matter in the waters can damage the quality of the waters. This can be overcome by minimizing activities that can damage water quality, for example by not disposing of domestic and industrial waste into the river. Proper use of rivers can maintain water quality.

CONCLUSION

Based on the results of the study, the value of the Family Biotic Index (FBI) was 6.13. By using macroinvertebrate indicators, it can be concluded that the level of organic pollution of the Poso River was rather heavy and the river water quality was in rather poor condition.

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