MACROZOOBENTHOS DIVERSITY IN THE LEGONKULON IRRIGATION, SUBANG AS A BIOINDICATOR OF POLLUTION STATUS

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ABSTRACT

The Legonkulon Subang Irrigation is widely used as a water source for milkfish and shrimp aquaculture activities. The input of waste originating from human activities can reduce water quality. Macrozoobenthos is one of the organisms that can be used as an indicator of the occurrence of pollution because of its permanent nature and is strongly influenced by water conditions so that its diversity can be used to determine the status of pollution. This research was conducted to determine the pollution status of the Legonkulon Irrigation based on the diversity of macrozoobenthos. Sampling was carried out from July to September 2020 at 4 stations determined based on land use. The results of this study indicate that the macrozoobenthos diversity index value ranges from 1.49 to 3.01 which indicates that the pollution status conditions at stations 1 and 3 have not been polluted, stations 2 and 4 are moderately polluted.

Keyword: *Pollution status, Macrozoobenthos, Subang*

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1. INTRODUCTION

The use of pond land in the coastal area of Subang is very intensive and spread evenly in almost every coastal district. Ponds scattered in the coastal area of Subang are used to cultivate various types of fish and shrimp. The main commodity of fish cultivated in this area is milkfish (Chanos chanos), while the most superior shrimp commodity in this area is white shrimp (Litopenaeus vannamei).

Based on BPS data from West Java Province (2016), Subang is one of the districts that produces the largest aquaculture aquaculture in West Java. Subang Regency in 2016 was able to produce aquaculture fish of 34,062 tons/year. The next three years, namely in 2019, aquaculture production decreased to 32,392 tons/year (BPS West Java Province 2021). The significant decline in production was caused by many factors. Declining water quality is one of the factors for decreasing aquaculture production in Subang Regency.

Decreased water quality will affect the physical, chemical and biological conditions of a waters. One of the biological parameters that can be used to determine water quality is macrozoobenthos. According to Odum (1993) in Nanngin et al. (2015), macrozoobenthos is a biotic component that can provide an overview of water conditions. Macrozoobenthos are organisms that live on the bottom of the waters, have relatively slow movements, and can live relatively long so that they have the ability to respond to water quality conditions (Zulkifli and Setiawan 2011). Macrozoobenthos can be found in all bodies of water so that these organisms are easy to identify. Good quality waters usually have high species diversity and conversely, poor or polluted waters usually have low species diversity (Fachrul 2007).

2. MATERIALS AND METHOD

Sampling was carried out at 4 stations determined based on land use around the pond irrigation canal with an interval of 14 days. Station 1 is an agricultural land with coordinates 6º12'46.4"LS and 107º49'25.3"E. Station 2 is a residential area with coordinates 6º12'56.9"LS and 107º49'37.4"E. Station 3 is a fishing pier with coordinates 6º12'19.8"LS and 107º50'43.7"E. Station 4 is a mangrove area with coordinates 6º11'33,3"LS and 107º50'54.3"E (Figure 1).

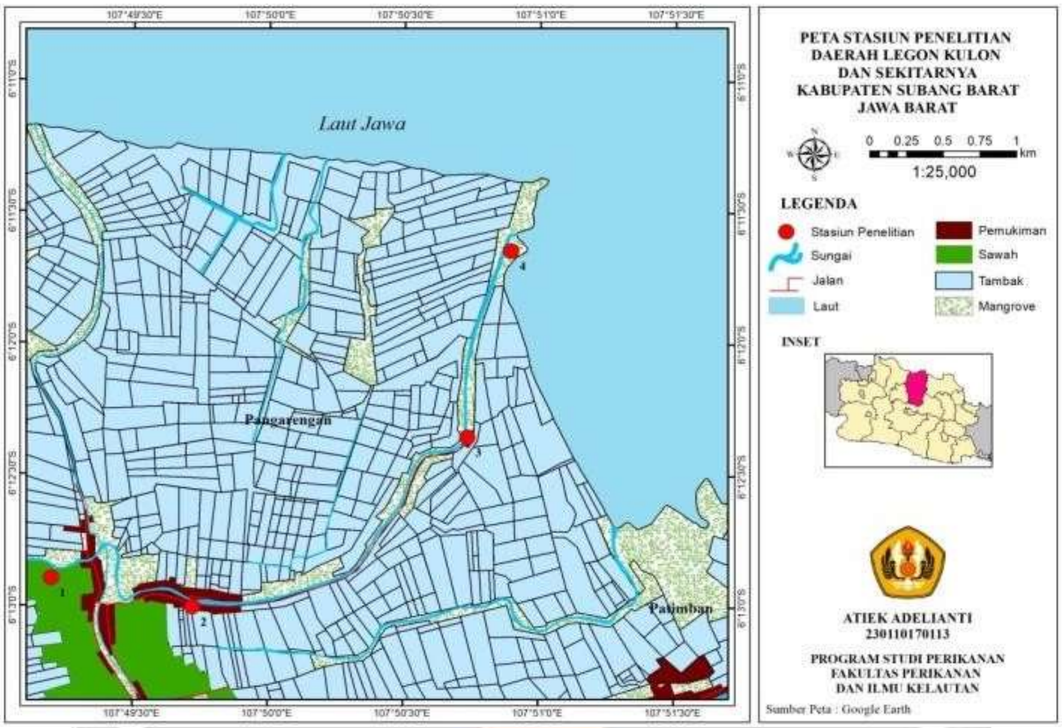

Fig. 1. Map of the Macrozoobenthos observation station

Sample Analysis

Analysis of samples was conducted on the diversity index, density, and Equability macrozoobenthos as well as physical and chemical water quality

1. Shannon-Wiener Diversity Index (H ')

$$H' = -\Sigma (pi \log2 pi), \text{ where } pi = \frac{ni}{N}$$

Information :
H '= diversity index,
ni = Number of individuals of species
N = Number of individuals in the community

2. Evenness Index (E)

$$E = \frac{H'}{H\ max}$$

Information :
E = Equability Index
H '= Diversity Index
H max = Ln S
S = Number of Species

3. The density of macrozoobenthos

$$K = \frac{ni}{A}$$

Information :
K = density of macrozoobenthos (individual / m2)
ni = Number of individuals of macrozoobenthos (Individual)
A = Area of sample transect (m^2)

Pollution Status Determination

Determination of the water pollution status in this research is determined based on the index of Macrozoobenthos diversity found. The diversity index used is the Shannon-Wienner index. The classification of the annexation index according to Lee et al. (1978) can be seen in the following table 1:

Table 1. Pollution Level Classification Based on Diversity

No.	Pollution degree	Diversity Index
1	H> 2	Contaminated yet
2	1.6 <H ≤ 2	Lightly polluted
3	1 <H ≤ 1.5	contaminated Medium
4	H <1	tainted weight

Physical and chemical parameters of the waters contributing factor to the determination of the water pollution status and the life support of Macrozoobenthos. According to Ratih (2015) The physical and chemical factors of the water are factors of the element that determines a population of the organism in maintaining its life.

3. RESULTS

The results of the identification of macrozoobenthos taken at 4 stations found 28 species of macrozoobenthos. The abundance of macrozoobenthos at station 1 found two classes, namely Gastropods and Bivalvia, with a total abundance of 295 individuals/m^2. At station 2, only one class was found, namely the Gastropod class with a total abundance of 235 individuals/m^2. Station 3 found four classes including Bivalvia, Hexanaplia, Malanostraca, and Gastropods, with a total abundance of 40 individuals/m^2. Station 4 found four classes, namely Gastropods, Hexanauplia, Clitellata, and Bivalves with a total abundance of 175 individuals/m^2 (Table 1).

Table 1. Macrozoobenthos Abundance Value at Each Station

Species	**Station**			
	1	**2**	**3**	**4**
Gastropoda class				
Filopaludina javanica	158	69		
Pomacea canaliculata	8	19		
Melanoides tuberculata	16			
Melanoides maculata	24	1		

Terebia granifera	28	134		
Bythinia truncatum	49	10		
Melanoides riquerti	7	2		
Nassarius stolatus			2	2
Thais tissoti			1	
Cerithidea cingulata			10	120
Telescopium telescopium			1	6
Nassaria pusilla			1	2
Murex trapa			1	
Cymatium cingulatum			1	
Hemifusus sp			1	
Cerithidea weyersi				1
Cerithidea quadrata				4
Dostia violacea				1
Bivalvia class				
Pilsbryoconcha exilis	4			
Mytilus pictus	1	1		
Placuna placenta			1	
Perna viridis			5	
Saccostrea cucullata			7	
Crystospira ventri				1
Pholas orientalis				1
Hexanauplia class				
Balanus balanoides			10	36
Malanostraca class				
Pagurus acadianus			1	
Clitellata class				
Hirudinaria sp				1
Total Abundance	295	235	40	175

The results showed that the highest abundance of macrozoobenthos was found at station 1 and the lowest abundance was at station 3. Station 1 is agricultural land as a place for agricultural waste to enter which contains a lot of organic matter. Most of the macrozoobenthos organisms found at station 1 came from the gastropod class, this happened because the gastropod class was included in the facultative group of organisms that can live in waters that contain lots of organic matter. Environmental conditions at station 1 still support the survival of macrozoobenthos such as the temperature does not exceed the maximum limit of macrozoobenthos, which is 35-40 ^{o}C, pH at station 1 is neutral, it also supports the survival of macrozoobenthos. The optimal pH value for macrozoobenthos ranges from 7 to 8.5 (Effendi 2003). In addition, station 1 has dissolved oxygen levels that exceed the minimum oxygen level tolerated by macrozoobenthos, which is 3-4 mg/L (Clark 1974 in Akhrianti et al. 2014).

Station 3 has an average salinity that is at the highest limit of the optimum salinity range for the survival of macrozoobenthos, which is 36, so the organisms found at station 3 are organisms that are able to adapt to high salinity. The life support factors of macrozoobenthos at station 3 are very low, including dissolved oxygen (DO) levels are at the minimum oxygen level that can be tolerated by macrozoobenthos. In addition, the temperature at station 3 is quite high, this will be dangerous for the survival of the macrozoobenthos because it can suppress the growth of the macrozoobenthos population.

Luoma and Carter (1991) stated that the decrease in macrozoobenthos density was due to disturbances entering the macrozoobenthos habitat (stressor), this disturbance could be in the form of pollution or other biota disturbances. Macrozoobenthos density can describe whether or not a water is polluted by looking at its low or high density, but it cannot be used to determine the status of pollution because other supporting data are still needed to determine it. In addition, there is no density index that shows the level of pollution of a waters.

The evenness index in Legonkulon ranges from 0.43 to 0.81, according to Odum (1993) the evenness index (E) ranges from 0-1. If the value is close to 0 it means low evenness because of the dominating species, and if it is close to 1 high evenness indicates that no species dominates. The lowest evenness is at station 4 and the highest is at station 3. From all indices, none is close to the value 1, meaning that there is one macrozoobenthos species that dominates the area. The evenness of macrozoobenthos in the pond irrigation canals in Legonkulon at each station was not evenly distributed. Station 1 and station 2 have moderate evenness values. This means that the macrozoobenthos community at the station is not evenly distributed, and is not balanced. Species that dominate station 1 are *Filopaludina javanica* and *Bythinia truncatum*, while species that dominate station 2 are *Filopaludina javanica* and *Tarebia granifera*. These three species belong to the class gastropods. Hutagalung (1991) in Sidik et al. (2016) stated that gastropods can accumulate pollutants without being killed, found in large numbers, and live for a long time. Station 1 is agricultural land, the land use used as agricultural land is the source of the entry of waste into the pond irrigation canal.

According to Jailani and Nur (2012), it is stated that macrozoobenthos of the Gastropod class can survive in various places more than other classes and have a good level of adaptation and require sufficient organic content in the substrate to live. This shows that station 4 which is dominated by the gastropod class has been polluted. The dominance of some of these species is caused by only certain species that have a tolerance level according to the conditions of the area. This evenness shows the balance of species of each species, and can also indicate whether or not a water is good (Masson 1981).

The index of macrozoobenthos diversity in the Legonkulon irrigation canal has a range that ranges from 1.49 to 3.01. Macrozoobenthos diversity with the highest average is at station 3 and the lowest is at station 4. This diversity value is related to environmental conditions that affect the tolerance level of macrozoobenthos. Because the level of tolerance for macrozoobenthos is different for each species. The low diversity value indicates that the area is polluted because only a few types of macrozoobenthos can survive and vice versa if the diversity is high, it shows that the area is still good because many macrozoobenthos can adapt to environmental conditions (Odum 1993).

The diversity index at station 3 with a value of 3.01 is included in the medium diversity category, meaning that station 3 has moderate ecological pressure so that there is an indication of pollutants entering the waters. Station 3 is a fishing pier area that is used as a berth for fishing boats. So that the source of pollution that causes ecological pressure comes from the waste discharged from the activities of ships anchored at the pier. Generally, waste is in the form of plastic bottles, plastic bags, fishing gear (fishing lines, nets, and buoys), and liquid waste in the form of spilled fish blood, diesel fuel, and remaining ice (Wahyudi et al. 2017).

Station 4 has the lowest diversity index value with a value of 1.49 which is also included in the category of moderate diversity so that it has moderate ecological pressure. Station 4 is a mangrove area that is used as ecotourism. The source of pollution comes from the high activity of tourists in the mangrove area so that this area is accumulated by various types of waste. Based on the diversity value, the pollution status for stations 1 and 3 is not polluted because it has a diversity value >2, stations 2 and 4 are moderately polluted.

Physical and chemical parameters

Physical parameters of waters analyzed in this study include the temperature, current speed, brightness, and TSS. The results of measurements of physical parameters can be seen in Table 2.

Table 2. Physical and Chemical Parameters of Legonkulon Irrigation Channel

		Station			
Parameters		**1**	**2**	**3**	**4**
Temperature(˚C)	Range	30-30,5	30,6-32	31,2-33,2	31,8-33,3
	Average	30,27 ±0,25	31,30 ±0,70	32,33 ±1,03	32,63 ±0,76
Current (m/s)	Range	0,1-0,71	0,03-0,1	0,05-0,1	0,03-0,25

	Average	0,31 ±0,35	0,07 ±0,04	0,08 ±0,03	0,12 ±0,12
Depth(meter)	Range	0,42-0,73	0,52-0,62	0,3-0,67	0,25-0,57
	Average	0,57 ±0,16	0,59 ±0,06	0,46 ±0,27	0,44 ±0,17
Transparency (meter)	Range	0,32-0,37	0,16-0,41	0,3-0,38	0,19-0,38
	Average	0,35 ±0,03	0,31 ±0,13	0,33 ±0,05	0,28 ±0,09
Salinity (‰)	Range	17-20	20-23	33-38	32-34
	Average	18,67 ±1,53	21,33 ±1,53	36,00 ±2,65	33,33 ±1,15
pH	Range	6,92-7,11	6,84-6,9	6,7-6,97	6,93-7,34
	Average	6,99 ±0,11	7,03 ±0,28	6,81 ±0,14	7,16 ±0,21
DO (mg/L)	Range	6,4-8,0	6,5-7,0	3,6-5,3	6,2-6,8
	Average	7,33 ±0,83	6,67 ±0,29	4,37 ±0,86	6,5 ±0,30

The water temperature in the pond irrigation canal in Legonkulon ranges from 30 –33.30 C. Overall the water temperature in the pond irrigation canal is still within the optimal temperature value for macrozoobenthos growth, which ranges from 25 – 35 C (Zahidin 2008). The tolerance limit of macrozoobenthos to temperature is not past 35-40 o C, because if it is above this limit it will cause the death of macrozoobenthos (Rijjaluddin 2017). However, the water temperature in the pond irrigation canals exceeds the maximum limit of class III water quality standards set out in PP no. 82 of 2001, so that the water in pond irrigation channels which is a source of water for cultivation activities is considered to be not good.

The current speed of each observation station is different. The current velocity obtained in the pond irrigation canal in Legonkulon ranges from 0.03 to 0.71 m/s. According to Mason (1993) in Fisesa et al. (2014) waters are categorized in waters with very fast currents if the current speed is >1 m/s, fast currents are 0.5 – 1 m/s, moderate currents are 0.25 – 0.5 m/s, slow currents if 0 .1 – 0.5 m/s, and very slow currents are 0.1 – 0.25 m/s. Based on this category, station 1 is classified as waters with moderate currents, stations 2, 3, and 4 are classified as waters with very slow currents.

The results of depth measurements in pond irrigation canals in Legonkulon found that the depth varies between 0.25 – 0.73 meters. The depth of a waters affects the number of species, individuals and distribution patterns or distribution of macrozoobenthos (Simanjuntak et al. 2018). According to Minggawati (2013) in Simanjuntak et al. (2018) Macrozoobenthos that live in shallow waters tend to have higher species diversity compared to deep waters. This is in accordance with the results of the research which showed that at station 4 with shallow depths it had a higher species diversity, compared to station 2 with the deepest waters having lower species diversity.

The brightness of the water obtained in this research ranged from 0.16 to 0.39 meters. According to Pradana et al. (2019) in Sulaeman et al. (2020), waters with low brightness cause inhibition of the penetration of sunlight into the waters so that the photosynthesis process of algae and microphytes does not take place properly. Indirectly, brightness can affect the life of macrozoobenthos because algae and macrophytes are a food source for macrozoobenthos (Ratih et al. 2016).

The salinity value in pond irrigation canals in Legonkulon ranges from 17‰ – 38‰, the lowest average salinity value is obtained at station 1 because the location of the station has a greater influence of fresh water than other stations. The highest average salinity value was obtained at observation station 3 of 36.00 ± 2.65 (Table 6), this is because station 3 has a high temperature. According to Nontji (2000) in Irmawan et al. (2010) salinity increases due to high evaporation of water which causes the salt content to settle. The results showed that the average salinity value for each observation station was still suitable for the survival of macrozoobenthos because Nybakken (1992) believed that the salinity range for the survival of macrozoobenthos was between 20 – 36 .

In general, the average pH value in pond irrigation canals in Legonkulon at each station is at a neutral pH with a range of 6.7 – 7.34. Based on PP No. 82 of 2001, the average at all observation stations meets the water quality standard for class III which requires the pH to range from 6 to 9. In addition, according to Effendi (2003), aquatic biota such as macrozoobenthos prefer a pH in the range of 7 to 8.5. pH value 6 – 6.5 can cause a decrease in the diversity of macrozoobenthos. The optimum pH will support the survival of aquatic organisms, but if the pH of the waters is too high or too low it will affect the survival of aquatic organisms (Odum 1993). The pH obtained from the observations included the optimum value for the sustainability of macrozoobenthos.

The value of dissolved oxygen in pond irrigation canals in Legonkulon ranges from 3.6 – 8 mg/L. Based on research results, the value of dissolved oxygen in pond irrigation canals is still suitable for the survival of macrozoobenthos because the optimum DO for growth and activity of benthos is 4.1 – 6.6 mg/L (Clark 1974 in Akhrianti et al. 2014). Low or critical DO can make it difficult for macrozoobenthos to grow and even cause death. The pond irrigation channel in Legonkulon has the appropriate oxygen concentration because it has met the minimum requirement for dissolved oxygen for class III water quality standards in PP. 82 of 2001 which is 3 mg/L, so that pond irrigation water is suitable for use as a water source in aquaculture activities. So it can be seen that the relationship between diversity and water quality parameters is directly proportional. It is shown by the more supportive water quality parameters, the higher the diversity value and vice versa.

4. CONCLUSIONS

The macrozoobenthos diversity index in the Legonkulon Irrigation Channel shows the pollution status at station 1 is not polluted, station 2 is moderately polluted, station 3 is not polluted and station 4 is moderately polluted.

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