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WATER QUALITY AND MACROZOOBENTHIC ORGANISMS OF CILIWUNG RIVER, BOGOR

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Investigation on three stations of Ciliwung River in the Bogor Regency area (upper, middle, lower) in 1998/1999 indicated that the river water quality tend to decrease toward the lower part, especially for turbidity, TSS and COD. Some heavy metals (Pb, Cd, Cu) were considered low. Based on previous data, however, Pb and Cd were found fluctuating, several times observed in quite high concentrations, i.e. more than 0.1 mg/L (Pb) and >0.01 mg/L (Cd), either in the lower or upper part. This water quality condition may relate to the composition of the macrozoobenthic organisms. The diversity indices of the benthic organisms were considered low, there were only 11–18 species found. Abundance and biomass comparison (ABC) curves indicated that in the middle and lower part of Ciliwung River might be considered as moderately polluted waters.

KEYWORDS: water quality, macrozoobenthos, Ciliwung River, ABC curve, pollution stage
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Introduction

Ciliwung River is one of big rivers in West Java which most of its part (upstream and middle) is in Bogor Regency area. The river is beginning from mountainous area called Puncak (Leuwimalang, Cisarua District, in the foot of Mount Gede, about 750 m above mean sea level) and flows through city of Bogor, Depok and Jakarta, before ending in the Gulf of Jakarta (Java Sea). The river is about 117 km long. Geographically, the river is in 6°-6°5' South and 106°40'-107° East [1]. The quality of water is strongly affected by many kinds of human activity along the catchments area such as agricultural, domestic and industrial activities. As for most rivers in Indonesia or other developing countries, Ciliwung River is used as a place for discharging any kind of wastes. Meanwhile, the river is also still used for washing and bathing for local people who live surrounding. The increase in population, therefore, will increase the activities that may cause decreasing the river water quality. A group of aquatic organisms that will directly affected by the change in water quality is macrozoobenthic organisms. These organisms have important role in food chain as food for other organisms and as decomposers. The organisms of macrozoobenthic community have different adaptation capability in response to the change in water environment. The change in water quality may cause the change in the community structure of macrozoobenthos. Therefore, as bottom organisms that are relatively stay in place, macrozoobenthos can be used as biological indicator of the change in water quality.

This study was aimed to find out the water quality of Ciliwung River, its macrozoobenthic organisms composition and its stage of pollution. This report can be used as one of basic data for improving river water quality through clean river program ("Prokasih").

Methods

Twelve water quality characteristics were observed in three stations of Ciliwung River in Bogor Regency area. Observation, water sample collection and analysis were conducted according the standard methods[2]. There were three observations in 1998 (Jan., Oct., Dec.) and one observation in 1999 (Mar.). The first station was located about 23 km downstream from the source, near the bridge of Ciawi toll highway at Katulampa and considered as upper station. The second was in Sukahati village, Cibinong, about 45 km downstream and considered as middle station, and the third was located near the bridge of Sukmajaya Village, Depok, about 60 km downstream and considered as lower station (Fig. 1). The macrozoobenthic organisms were collected from the same stations using surber sampler (30 cm x 30 cm) on the last two observations. The individual of macrozoobenthos was identified using Edmonson[3] and Pennak[4], counted and weighed (dry weight) for biomass. The diversity index (Shannon & Wiener), evenness and dominance indices[5] of macrozoobenthos were determined. The macrozoobenthos data then plotted using the abundance and biomass comparison (ABC) method of Warwick[6].

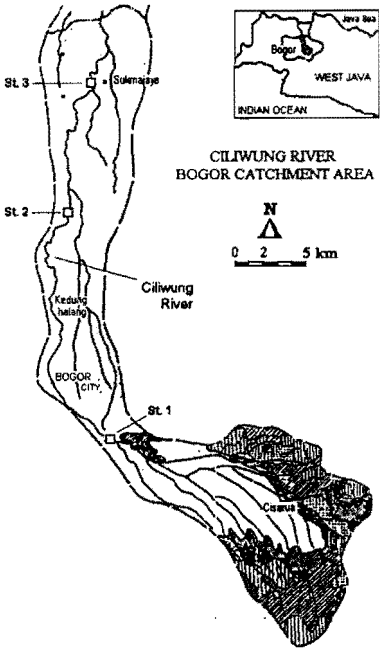

Fig. 1. Ciliwung River in Bogor Regency area and the location of observation stations (St.1, St. 2, St. 3).

Results and Discussion

The water quality of Ciliwung River was fluctuating as observed on four dates (Table 1). The water quality was tending to decrease toward downstream as the load increasing due to broader catchments area. This is true for turbidity, total suspended solids (TSS) and some heavy metals (Pb, Cd, Cu) on some dates of observation. However, it was also observed that some water quality characteristics were found in higher value at the middle station (St. 2) than those at the lower station (St. 3), as for conductivity (Jan., Oct., and Dec.), turbidity and TSS (Oct.), pH (Dec.), COD (Jan., Oct., Dec.), oil & grease (Oct.). The phenomena might be related to the position of the middle station that was located after the river water passing through various activities of Bogor City. The impact of some activities like housing, traditional market, some industries, and other business activities may increase the physic-chemical property of river water and decreasing the quality.

Among four observation dates, the river water quality of Oct. 1999 observation was more likely the worst. On that date, the turbidity, TSS content, conductivity, BOD, COD, total ammonia nitrogen (TAN), heavy metals (Pb, Cd, Cu) and detergent content were the highest. All the three heavy metals observed were exceeding the standard values for river designated as drinking water source before treatment[7]. The COD values, BOD at St. 3, TSS at St. 2, and turbidity at St. 2 and St. 3 were considered high and undesirable (Fig. 2 and Table 1). This is perhaps related to the rainfall condition. According to the rainfall data of Bogor[8], the monthly rainfall in October 1999 was quite high, i.e. 535 mm, and the highest among other observation dates. The higher rainfall cans also means the higher runoff, which in turn causing higher pollution load that enter the river.

Table 1. Water quality of Ciliwung River in upper (St.1), middle (St.2), and lower (St.3) station at four dates of observation (values in bold typed indicating high or undesirable)

Characteristic	Unit	7 Jan. 98			30 Oct. 98			3 Dec. 98			3 Mar. 99		
		St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3	St. 1	St. 2	St. 3
1. Water temperature	°C	25,0	27,3	28,2	23,5	24,5	28	23,2	29	27,7	22,3	28	26,9
2. Turbidity	NTU	15	27	36	20	65	43	7,0	5,2	9,4	17	22	40
3. TSS	mg/l	32	36	88	40	152	58	16	10	20	10	8	64
4. Conductivity	Umhos/cm	98	121	106	130	135	130	110	160	110	83	60	94
5. Color (visual obs.)	-	Clay turbid	Clay turbid	Clay turbid	Slightly turbid	Clay turbid	Clay turbid	Clay turbid	Clay turbid	Clay turbid	Clay turbid	Clay turbid	Clay turbid
6. pH	-	7,40	7,30	7,50	6,99	6,90	6,85	8,15	8,45	7,95	7,70	7,70	7,60
7. Dissolved Oxygen	mg/l	8,7	7,8	8,9	7,3	7,8	6,9	8,0	7,6	7,5	7,8	7,6	7,4
3. BOD	mg/l	2,54	3,85	2,54	7,71	8,14	11,77	3,65	4,86	2,03	3,57	2,78	2,78
4. COD	mg/l	13,13	19,20	11,11	56,75	73,63	36,87	7,63	41,40	7,63	9,28	11,79	11,79
6. Total Ammonia - N	mg/l	0,125	0,160	0,080	0,389	0,355	0,322	0,047	0,084	0,042	0,007	0,013	0,010
7. Lead (Pb)	mg/l	0,012	0,018	0,037	0,305	0,304	0,311	0,043	0,060	0,081	0,015	0,038	0,042
8. Cadmium (Cd)	mg/l	<0,001	<0,001	<0,001	0,016	0,078	0,031	0,018	0,025	0,009	0,004	0,008	0,009
9. Copper (Cu)	mg/l	<0,001	0,006	0,009	0,079	0,055	0,069	0,005	0,012	0,007	0,005	0,012	0,015
10. Detergent	mg/l	<0,001	<0,001	<0,001	0,025	0,058	0,042	<0,001	<0,001	<0,001	<0,001	0,032	0,045
11. Oil & grease	mg/l	<0,01	0,30	0,50	<0,01	3,2	2,1	<0,01	<0,01	<0,01	<0,01	0,34	0,48
12. *Fecal Coliform*	MPN/100ml	9	9	5	2	2	5	2	2	<2	130	70	40

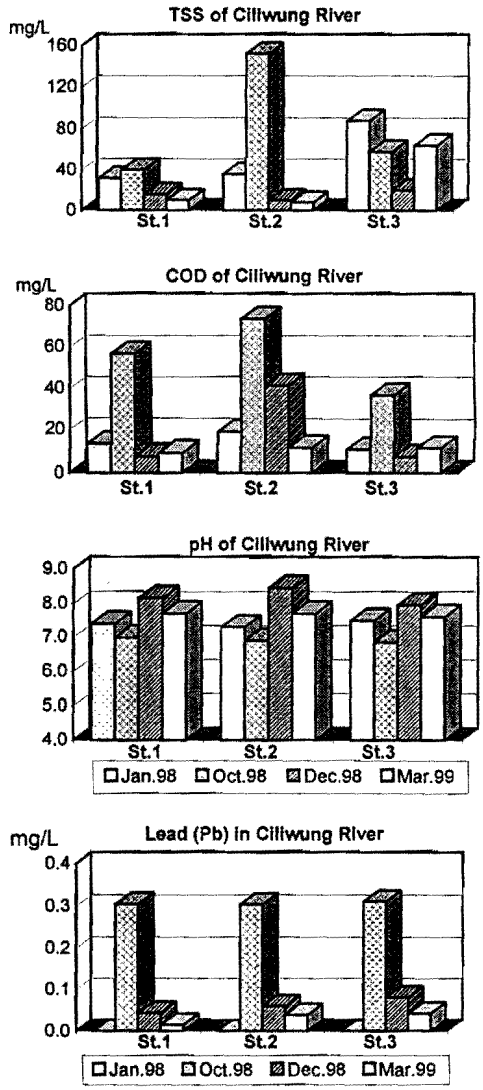

Fig. 2. Observed suspended solids (TSS), pH, COD and lead (Pb) in three stations of Ciliwung River (Jan. 1998–Mar. 1999)

In general, by also considering the previous data[9], the concentration of lead (Pb) and cadmium (Cd) were found fluctuating. Several times the two heavy metals were observed in quite high concentrations, i.e. more than 0.1 mg/L (for Pb) and more than 0.01 mg/L (for Cd), either in the lower or upper part.

Macrozoobenthic organisms or macrozoobenthos is a group of aquatic animals that lived in the bottom which size is more than 1 mm[10]. The observation result of two dates (December 1998 and March 1999) indicated that there were only 11–18 species (genus) found, mostly were of Pterygota class (Table 2). There were found 11 species of 4 classes at the upper station (St. 1), 18 species of 6 classes at the middle (St. 2), and 11 species of only two classes at the lower (St. 3). Due to the high water discharge, there was no macrozoobenthos found from Mar. 99 sample of St. 3.

Table 2. The availability of macrozoobenthic organism in the three stations of Ciliwung River (Dec. 1998 and March 1999 observation).

Organism	St. 1 (upper)	St. 2 (middle)	St. 3 (lower)
OLIGOCHAETA			
Lumbriculus	-	+	-
HIRUDINEA			
Helobdella	-	+	-
Glossiphonia	+	+	-
GASTROPODA			
Melanoides	+	+	-
PELECYODA			
Corbicula	+	-	+
PTERYGOTA			
Pupae heleidae	-	+	+
Chironomus	+	+	+
Parophlus	-	+	-
Polypedilum	+	+	+
Baetis	+	+	+
Neoephemera	-	+	-
Paralepthlopedia	+	+	-
Ameletus	+	-	-
Traverella	+	+	-
Agabus	-	-	+
Narpus	+	-	+
Ectopria	-	+	-
Nymphula	-	+	+
Cheumatopsyche	-	+	+
Parapsyche	+	+	+
Potamya	-	-	+
Neothrichia	-	+	-
MALACOSTRACA			
Macrobrachium	-	+	-
Number of species	11	18	11

Note: + = available - = not available

The values of diversity index indicated that there was no difference between upper and middle station, but at the middle the macrozoobenthos tend to have lower evenness index with higher dominance index (Table 3). However, the indices of macrozoobenthos at the lower station were quite different with the other two stations. The diversity index was lower, with lower evenness and higher dominance. This is means that the diversity of macrozoobenthos was lower in the lower station with a tendency there would be dominated by certain species. The difference in this macrozoobenthic community structure was probably related to the difference in water quality as mention earlier. On the other hand, it seemed that the highest number of species and abundance of macrozoobenthos at St. 2 and the fact that class of Oligochaete (*Lumbriculus*) and Malacostraca (*Macrobrachium*) were only found at this station (St. 2) was not configured in the difference of the diversity index, especially compared to that of St. 1.

Table 3. The diversity, evenness, and dominance indices of macrozoobenthic community in Ciliwung River at two dates of observation.

Component	St. 1		St. 2		St. 3*
	Dec.98	Mar.99	Dec.98	Mar.99	Dec.98
Diversity index	3,10	2,54	3,10	2,70	2,30
Evenness index	0,89	0,9	0,74	0,9	0,66
Dominance index	0,15	0,19	0,25	0,18	0,28
Abundance (ind/m^2)	123	48	1895	51	1651

*Note: no data for Mar. 99 of St. 3)

Using the data of the rank in order of importance of each species processed based on its individual number per unit area and its biomass per unit area as x-axis (logarithmic scale) and the percentage dominance as y-axis (cumulative scale), it can be plot an ABC curve[6]. The ABC curve of macrozoobenthic community at each station in Ciliwung River on two dates of observation was presented in Fig. 3. biomass curve and the numbers curve at both stations. It means that principally the biomass curve and the numbers curve at the two stations was close together, and therefore, the quality of macrozoobenthic community at St. 2 and St. 3 were considered as moderately polluted. The ABC curve of St. 2 at second date with the biomass curve and the numbers curve was cross each other, also indicated that the macrozoobenthic community was in moderately polluted stage.

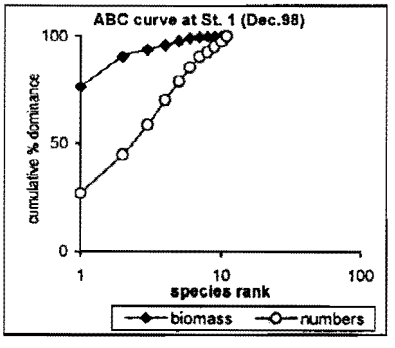

Fig. 3. Biomass curve and the numbers curve at both stations.

The ABC curves results were somewhat in agreement with water quality status. Except the quite different water quality condition on Oct. 98 observation, in general the water quality condition at St. 1 were better than the other two stations. It can be seen from its relatively lower turbidity, suspended solids, and total ammonia nitrogen, its lower BOD and COD values and its low or undetected heavy metals, detergent and oil and grease content. As the upper station, the water in St.1 was not influenced by as many and intense of human activities as other stations at

It is shown that at the upper station (St. 1), the biomass curve of macrozoobenthos was above the numbers curve either in the first or second date of observation. The curves illustrated that the "numbers diversity" was higher than the "biomass diversity" and it is mean that at the St. 1 can be considered as unpolluted community. At the middle (St. 2) and lower station (St. 3) the biomass curves were seemed under the numbers curves. Using single factor analysis of variance, it can be concluded that there were not significantly difference ($P \leq 0.05$) between the lower parts. At the two lower stations, the human activities that may influence water quality become larger both in numbers and intensity as the catchments area become broader. From the ABC results it also can be inferred that the relatively high concentrations or values of most water quality characteristics at lower station (St. 3) obviously were still in moderately polluted stage. This means that by proper management practices and participation of all surrounding people the river water quality is still possible to be recovered.

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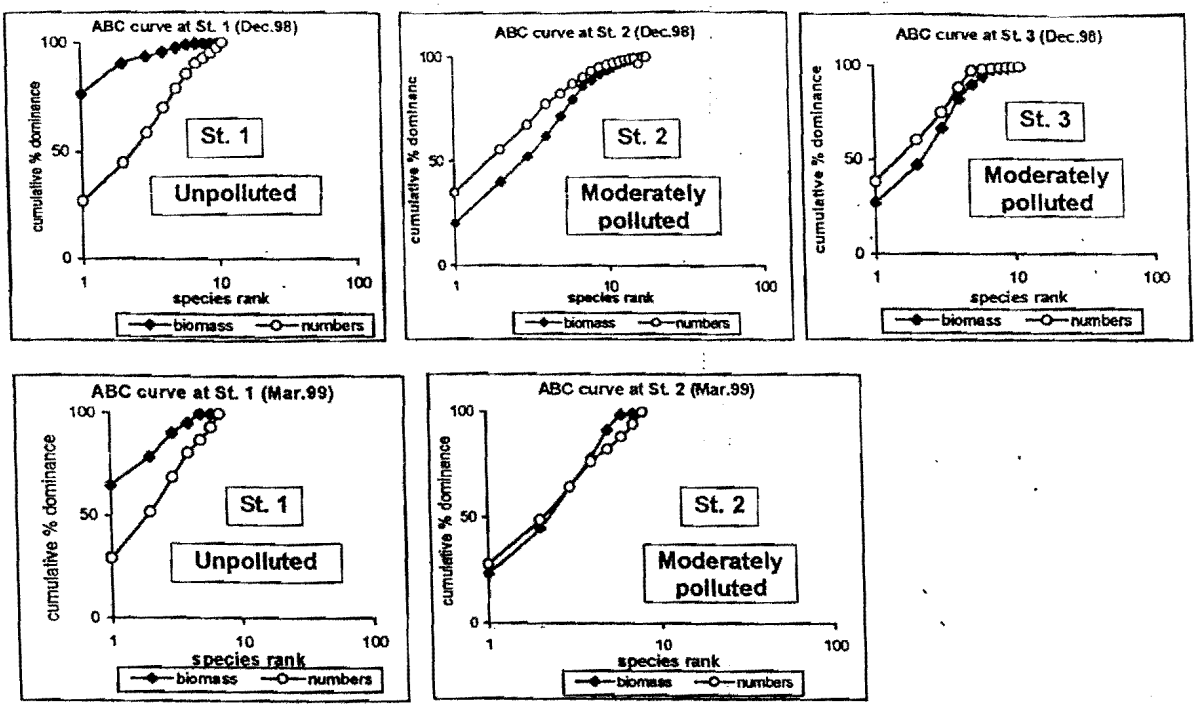

Fig. 3. ABC curves of macrozoobenthic community at upper (St.1), middle (St. 2), and lower (St. 3) station of Ciliwung River on Dec. 98 (above) and Mar. 99 (below) observation showing stage of pollution