Water quality assessment of Saluran Tarum Barat, West Java, based on biological monitoring working party-average score per taxon (BMWP-ASPT)

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Abstract. A water quality assessment in the Saluran Tarum Barat was conducted at three stations, representing the beginning, middle, and end of the canal between February and May 2017. This research aimed to determine the quality of Saluran Tarum Barat water using benthic macroinvertebrates as a bioindicator through the Biological Monitoring Working Party-Average Score Per Taxon (BMWP - ASPT) method. Environmental parameters were also measured. The sampling found six families of macroinvertebrates: Naucoridae; Viviparidae; Parathelphusidae; Pisauridae; Palaemonidae; and Thiaridae. However, Parathelphusidae and Pisauridae families are not covered in the BMWP scoring list. Saluran Tarum Barat has an ASPT range from 4.25–4.5, which indicates that the water is moderately polluted.

Keywords: Water quality assessment, biological monitoring working party-average score per taxon, macroinvertebrates

1. Introduction
Saluran Tarum Barat is a canal that was created by the government of DKI Jakarta to be a source of raw water for Bekasi and Jakarta residents. The beginning of Saluran Tarum Barat is located in Karawang area, West Java, and it ends in Cawang, East Jakarta [1]. The canal has a length of 68.8 km, a width of 20 m, and an average depth of 2.7 m [2]. A side from being a source of raw water, the Saluran Tarum Barat is also used for agricultural irrigation and mini hydropower. The water from Saluran Tarum Barat is also used by eight municipal water companies (PDAM) from the Karawang area to Jakarta [3]. Various community activities occur along the channel, including agriculture, industry, and bathing, washing and toileting activities (MCK: Mandi Cuci Kakus). These activities are thought to affect the Saluran Tarum Barat water quality and have a negative impact on aquatic biota, particularly on benthic macroinvertebrates [3]. The water quality can be determined chemically, physically, and biologically [4]. One organism that can be used as a water bioindicator is benthic macroinvertebrates. The persistence or attachment to the benthic macroinvertebrates to the bottom substrate of water are affected by those activities [5]. The Biological Monitoring Working Party Index-Average Score Per Taxon (BMWP-ASPT) is one of the best methods used to assess water quality based on benthic macroinvertebrate tolerance to organic contamination in waters. This method is common in many countries and is appropriate for use in flowing waters [6].
2. Experimental
This study was conducted at the beginning, middle, and end of Tarum Barat, West Java (figure 1). The first area of focus was in the Curuk Dam, Karawang (station 1), the middle study area was between Jababeka and Cikarang (station 2), and the end study area was in Cawang area, East Jakarta (station 3). The process of identification and analysis of benthic macroinvertebrates was conducted at the Laboratory of Animal Taxonomy, Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Indonesia, Depok and Laboratory of Perum Jasa Tirta II, Karawang. The study was conducted between February and May 2017.

A bottom sampling dredge suspected of containing macroinvertebrate samples was taken from the substrate. The substrate was then filtered using a sieve net to obtain the desired sample. The samples were put into a plastic bag that contained 10 % formalin solution. All samples were taken to the Laboratory of Animal Taxonomy Department of Biology, FMIPA UI, to be identified. Samples in the 10 % formalin solution were transferred into a sample bottle containing 70 % alcohol solution, for preservation. Identification was completed by referring to the Ward & Wipple manual and by matching the morphological characteristics to the family level.

The water quality assessment of the Saluran Tarum Barat was conducted at each station by dividing the total scores of BMWP from every organism found per station with the number of families in the scores of BMWP found at each station. The ASPT values for each station were then compared with the ASPT criteria table to determine the water quality level based on organic pollution (table 1). In addition to ASPT values, environmental conditions per station were also analyzed to understand the relationship between environmental conditions and ASPT criteria in order to obtain representative results. Environmental parameters were measured on the left and right side of each station from February to May 2017. The results of the environmental parameters were then averaged per station to obtain one value per parameter from each station. The substrate type is the only environmental parameter measurement that was not averaged. ASPT score is calculated by the formula [7]:

\[ \text{ASPT score} = \frac{\sum A_i}{B} \]  

with A: Index score of the i-family BMWP; B: Total number of families found.

Figure 1. Sampling location
3. Results and discussion

Environmental parameters were measured at the beginning, middle, and end of the Saluran Tarum Barat canal through samples taken between March and May 2017. The three sampling results from each station were used to determine the average value for environmental parameter data for each station. Only substrate type was not averaged. In addition to the seven environmental parameters measured, water flow data obtained from the Perum Jasa Tirta II report was also collected to present data complementary to the environmental parameters. The average value of each station is presented in table form (table 2).

Station 1 has a surface width of 63 m and a water flow of 80 m$^3$/s. The water discharge in this region is highest due to the large number of flow pumps located at the beginning of the canal [3]. All measurements of environmental parameters at station 1 fall into the good category in supporting life of benthic macroinvertebrates, except the BOD5 value, which registered at 12.7 mg/L. This value exceeds 8 mg/L, which is the safe limit for supporting aquatic biota life [8].

The benthic macroinvertebrate families found in station 1 were Naucoridae, Viviparidae, Palaemonidae and Thiaridae. Based on the BMWP scoring table, the Naucoridae and Palaemonidae families are intolerant to organic pollution with BMWP values of 5 and 6. Viviparidae and Thiaridae share the same BMWP score of 3, which indicates that both families are tolerant to pollution [9]. Naucoridae and the Viviparidae were found only in station 1. This was due to the vegetation present at this station, which is also the most common site of these two families [10]. Station 1 had an ASPT value of 4.25, which indicates that this station is moderately polluted [11].

Station 2 has surface width and water discharge that is less than station 1, with values of 44 m and 49 m$^3$/s, respectively. The decrease in water discharge is caused by the existence of some secondary streams coming out from the canal bodies that are aimed at industrial interests [3]. In addition to a BOD5 value that exceeds the safe limit, the turbidity value also exceeds the threshold of a good turbidity for aquatic biota. A good turbidity value for growth and development of aquatic biota is less than 25 NTU. The high value of the average turbidity of the Saluran Tarum Barat can lead to disruption of life of benthic macroinvertebrates [12].

| Table 1. Average Score Per Taxon (ASPT) classification |
|-----------------------------------------------|
| **ASPT score** | **Water quality** |
| <4              | Heavy polluted   |
| 4–5             | Moderately polluted |
| 5–6             | Slightly polluted |
| >6              | Not polluted (clean) |

| Table 2. Environment parameters measurement results |
|-----------------------------------------------|
| **Parameter** | **Unit** | **Beginning** (station 1) | **Middle** (station 2) | **End** (station 3) |
| Dissolved Oxygen (DO) | mg/L | 5.3 | 4.95 | 5.5 |
| Biochemical Oxygen Demand (BOD5) | mg/L | 12.7 | 21 | 10 |
| pH | pH unit | 8.07 | 7.97 | 7.9 |
| Temperature | °C | 27.3 | 29 | 28.7 |
| Turbidity | NTU | 17.3 | 61.1 | 56.3 |
| Depth | m | 0.33 | 0.27 | 0.18 |
| Substrate type | - | Clay |
The families of Palaemonidae, Thiaridae, Parathelphusidae, and Pisauridae were found in station 2. Pisauridae is not present in the BMWP scoring table. This may be due to the Pisauridae not being a group of water insects, but rather insects with terrestrial and aboreal habitats [13]. In addition to the Pisauridae, the Parathelphusidae is also not included in the BMWP scoring table. However, Parathelphusidae is included in the scoring table based on the SIGNAL index, with a grade indicating that this family belongs to the category of organisms that are resistant to severe pollution [14]. The ASPT value at station 2 was 4.5, which is moderately polluted based on ASPT category [11].

Station 3 has the smallest surface area and water discharge when compared with the other two stations. The surface area of station 3 is 19 m² with a water flow of 17 m³/s [3]. Almost all environmental parameters have a good value for life of benthic macroinvertebrates, unless the turbidity value is too high (> 25 NTU) from the safe limit [12].

Macroinvertebrate families found in station 3 were Palaemonidae, Thiaridae and Parathelphusidae. Only the Parathelphusidae was missing from the scoring of the BMWP [14]. The Palaemonidae had a BMWP score of 6, while the Thiaridae had a BMWP score of 3 [9]. Station 3 had an ASPT value of 4.5, so it is moderately polluted.

4. Conclusion
The range of ASPT values for the Saluran Tarum Barat canal was found to be 4.25–4.5, which indicates that this canal is moderately polluted. Some benthic macroinvertebrates found in the canal are tolerant to organic pollution, while Naucoridae and Palaemonidae are intolerant (organisms with a range of BMWP 3–6 scores). Measurement of water quality using another biotic index needs to be done.

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