



Macrozoobenthos Spatial Distribution as the Indicator of Cikeruh River Pollution in Sumedang Regency, West Java

Muhamad Lutfi^{1*}, Isni Nurruhwati¹, Zahidah Hasan¹ and Heti Herawati¹

¹Faculty of Fisheries and Marine Sciences, Padjadjaran University, Jatinangor, Indonesia.

Authors' contributions

This work was carried out in collaboration among all authors. Author ML designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors IN and ZH managed the analyses of the study. Author DHH managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJFAR/2020/v6i230093

Editor(s):

(1) Dr. Pinar Oguzhan Yildiz, Ataturk University, Turkey.

Reviewers:

(1) Tashlykova Natalya Aleksandrovna, The Siberian Branch of Russian Academy of Sciences, Russia.

(2) R. Uma Maheswari, Arulmigu Palaniandavar Arts College for Women, India.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/56189>

Received 13 February 2020

Accepted 21 April 2020

Published 27 April 2020

Original Research Article

ABSTRACT

Cikeruh River is one of the tributaries of the Citarum River which has received a variety of inputs, which can affect the river water quality and cause pollution. Macrozoobenthos is an organism that can determine the pollution of waters. This research aims to determine the spatial distribution of macrozoobenthos communities in the Cikeruh River as the indicator of pollution. This research was conducted in July 2019 - August 2019 using the field survey method. The data collection technique used is purposive sampling, setting 5 stations based on environmental factors and land use around the river flow. The parameters observed were the physical-chemical parameters of the waters, physical-chemical parameters of the substrate and macrozoobenthos as biological parameters as indicators of pollution, as well as calculating the abundance of macrozoobenthos, diversity index, uniformity index, species deficit and morisita index. The results of the macrozoobenthos spatial distribution along the Cikeruh River flow differed at each location of observation. At station 1 found several intolerant species *Heptagenia* sp., *Tipula* sp., *Leptophelbia* sp., *Polycentrophus* sp. and *Enallagma* sp., station 2 found several facultative species *Melanoides tuberculata*, *Lymnaea* sp., *Tarebia granifera*, *Sulcospira testudinaria*, and *Corbicula fluminea*, station 3 found several

*Corresponding author: Email: muhamadlutfi2923@gmail.com;

facultative species *Melanoides tuberculata*, *Lymnaea* sp., *Tarebia granifera*, *Sulcospira testudinaria*, *Pomacea canalicuta* and *Corbicula fluminea*, station 4 found several facultative species *Melanoides tuberculata*, *Tarebia granifera*, *Sulcospira testudinaria* and *Corbicula fluminea*, and station 5 found intolerant species *Chironomus* sp., *Tubifex* sp., and *Lumbriculus* sp. The abundance of macrozoobenthos is around 590 ind/m² - 7420 ind/m². Diversity index ranges from 0.46-1.85. The uniformity index ranges from 0.16 to 0.64. Species deficits at each station are different. Cikeruh River morisita index ranging from 0.14 to 0.80 which is in the uniform category.

Keywords: Cikeruh; distribution; macrozoobenthos.

1. INTRODUCTION

River is one of the lotic ecosystems (flowing waters) having a function as a place for organisms to live [1]. River is one of the environments that is often affected by pollution. Pollution can be caused by various types of human activities along watersheds.

Cikeruh River is one of 36 Citarum River tributaries whose upstream area is located in Baru Beureum, Sindang Sari Village, Jatinangor District and its downstream is located in Rancaekek District, Bandung Regency. This watershed is administratively located in two districts namely Bandung Regency and Sumedang Regency with a river length of 23.08 km. The large amount of agricultural waste, domestic waste, and industrial waste that is discharged directly into the river without treatment first makes the river water full of garbage and polluted [2]. The current condition of the Cikeruh River has received input from several types of waste such as domestic, agricultural and tofu industries, which will certainly have an influence on the water quality of the Cikeruh River.

The waste in the river such as the result of domestic activities, agriculture and industry, is thought to cause pollution into the waters. One indicator that can be used to look at water pollution is macrozoobenthos. Macrozoobenthos plays a very important role in the ecosystem of a waters, the existence and diversity of macrozoobenthos can be used as bioindicators of water pollution, because macrozoobenthos has relatively permanent living habitats (sesile). Changes in water quality and life substrate greatly affect the abundance and diversity of macrozoobenthos. This abundance and diversity is very dependent on their tolerance and sensitivity to environmental changes. The use of macrozoobenthos as a bioindicator of water quality can be used to determine pollution from both domestic and industrial waste as well as

waste from agricultural, fishery, and livestock waste [3].

2. MATERIALS AND METHODS

2.1 Research Location

The study was conducted in the Cikeruh River. The study area falls within coordinates 06°53'22" and 06°57'22.9" SL 107°45'51.9" and 107°46'00.2" EL. The method used in this research is survey method. The research station is divided into 5 stations (Fig. 1). The determination of stations is based on environmental factors and land use as well as input of waste into the river.

- Station 1, the upstream of the Cikeruh River is located in Baru Beureum village and is in the Kiarapayung forest area.
- Station 2, the part of the river that has received input from agricultural waste.
- Station 3, part of the river that has received input from tofu industry waste.
- Station 4, the part of the river that has received domestic waste input because the location is around housing.
- Station 5, the downstream of the Cikeruh River with various kinds of waste inputs from activities along the river flow.

2.2 Sampling and Measurement

Water and macrozoobenthos samples were taken once every 7 days for 6 weeks, and for substrate samples taken once in the 6th week. The water samples analyzed consisted of 8 parameters, namely, temperature, transparency of light, turbidity, depth, current velocity, pH, DO, and BOD₅ carried out in-situ and ex-situ. Ex-situ analysis of water parameters and macrozoobenthos observations were carried out at the Laboratory of Aquatic Resources, Faculty of Fisheries and Marine Sciences, Padjadjaran University. Whereas substrate analysis consisted

of 5 parameters, namely, substrate texture, C-Organic, N-Organic, C/N ratio and pH of the substrate conducted ex-situ at the Soil Chemistry and Plant Nutrition Laboratory, Faculty of Agriculture, Padjadjaran University.

2.3 Macrozoobenthos Sampling

Macrozoobenthos at each station were taken using a 25x40 cm surber mesh with 3 repetitions, macrozoobenthos and substrate were separated using a 1 mm mesh filter, and inserted into labeled plastic. Macrozoobenthos samples were cleaned and identified at the Aquatic Resources Laboratory, Faculty of Fisheries and Marine Sciences, Padjadjaran University.

2.4 Data Analysis

Data analysis was performed in a comparative descriptive manner at each station to provide an overview of the state of the research object. And

present data in the form of diagrams from each research station to determine the level of pollution of the Cikeruh River with macrozoobenthos, water quality and substrate texture.

2.4.1 The abundance of macrozoobenthos

Abundance is the number of individuals and the number of species found in the area of observation. Abundance is calculated by the formula:

$$Di = \frac{Ni}{A}$$

Information:

Di: Abundance of macrozoobenthos (ind / m).

Ni: Number of individuals (ind).

A: Area.

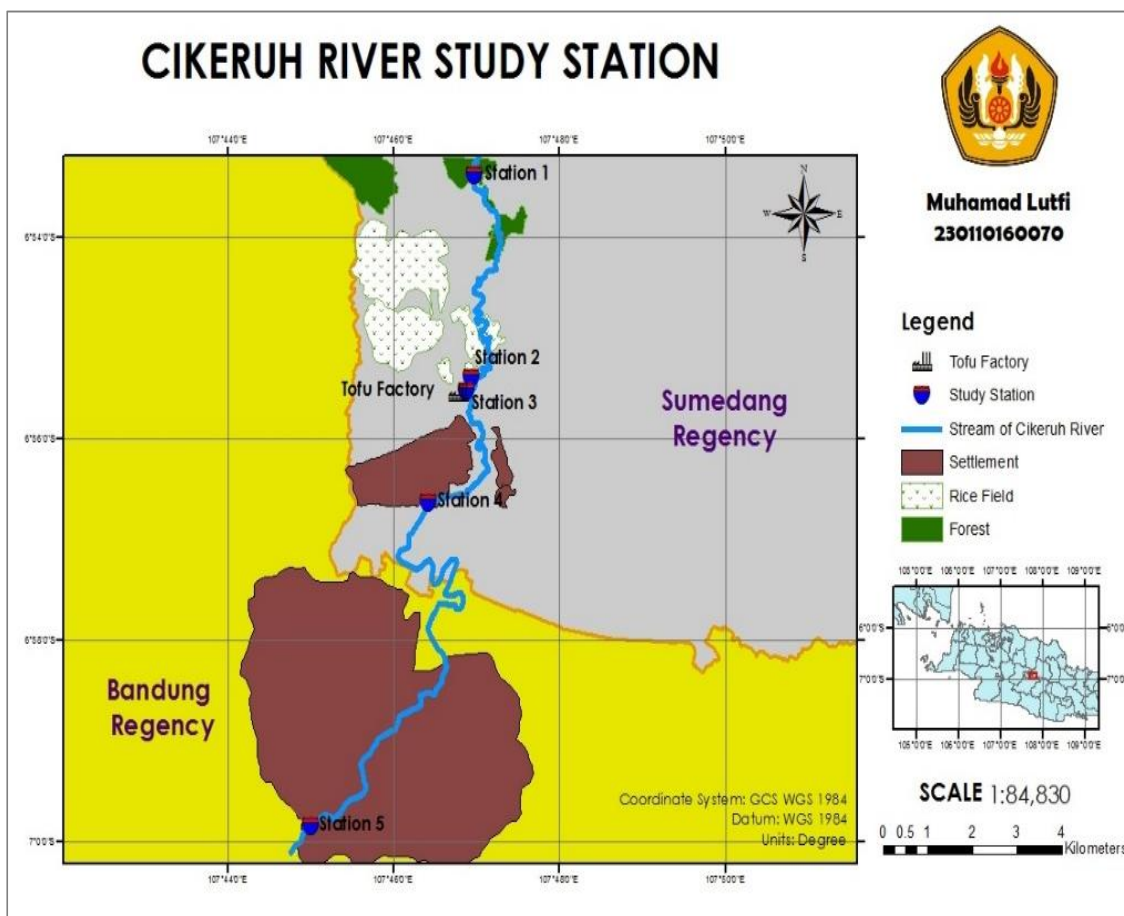


Fig. 1. Research location map

2.4.2 The diversity of macrozoobenthos

The diversity index shows the richness of species in a community and also shows the balance in the distribution of numbers per individual per species. The diversity index is calculated by the Shannon-Wiener index:

$$H' = - \sum_{i=1}^S (Pi \ln Pi) \text{ dengan } Pi = \frac{ni}{N}$$

Information:

H': Shannon-Wiener Diversity Index.

ni: Number of individual species i.

Pi: ni / N or the number of individuals of each type (i = 1,2,3, ...).

N: The total number of individuals.

S: Number of species.

The Shannon-Wiener Diversity Value has a certain range of values, namely:

H' < 1: Low diversity.

1 < H' < 3: Medium diversity.

H' > 3: High diversity.

2.4.3 The uniformity of macrozoobenthos

Uniformity is calculated using the Shannon-Wiener diversity index formula.

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

Information:

E: Uniformity Index.

H': Diversity Index.

Hmax: Ln-S.

S: Number of species.

2.4.4 Deficit species

Species deficit is a comparison of abundance of macrozoobenthos by looking at the comparison of abundance at stations downstream with stations upstream. Species deficits are calculated by the formula:

$$I = \frac{Su - Sd}{Su} \times 100$$

Information:

I: Species deficit.

Su: Number of genus upstream.

Sd: The number of genera is downstream.

2.4.5 Morisita index

To find out the distribution pattern of macrozoobenthos, Morisita dispersion index is used. This index is calculated by using the formula:

$$Id = n \left[\frac{\sum X^2 - N}{N(N-1)} \right]$$

Information:

Id = Morisita Distribution Index

n = Number of units taken (plot)

X = Number of individuals in each plot

N = Total number of individual biota

N = Total number of individual biota

The distribution pattern criteria are as follows:

Id = 1, then the population distribution is a random category

Id > 1, then the population distribution is a clustered / grouped category

Id < 1, then the population distribution is uniform.

3. RESULTS AND DISCUSSION

3.1 Waters Physical and Chemical Parameters

Physical and chemical parameters of the waters can be seen in (Table 1), the lowest temperature is at station 1, due to the upstream of the river in the Manglayang Mountain area and the number of trees around and measurements made in the morning. The highest temperature at station 5 is due to the station 5 is downstream with various inputs such as industry, settlement and agriculture.

Temperature measurements at station 5 are conducted during the day so that the intensity of the sun entering the waters is higher which will certainly increase the temperature of the waters. High light intensity will produce heat which will further increase the temperature and vice versa [4]. Factors that cause differences in the results of temperature measurements at each station include the intensity of sunlight, the temperature exchange between water and air, geographical altitude, the presence of trees that grow on the banks of the river [5].

The transparency of light is lowest at station 1 and highest at station 3. This is because the

surrounding conditions at station 1 are covered by trees which will block the entry of sunlight into the waters, whereas at conditions around station 3 there are not too many trees and more incoming light and the depth at station 1 is lower than station 3. Low transparency causes the inhibition of sunlight penetration into the waters so that the photosynthesis process cannot run properly [6].

The lowest turbidity measurement result is at station 1 and the highest at station 4. The low turbidity at Station 1 is due to the absence of waste input from anthropogenic activities and is a spring from Mount Manglayang. It is different from station 4; the conditions of the river flow have received input from waste from the settlement, and the tofu industry has been carried by the current. The higher the value of suspended solids, the turbidity value will be higher, and general turbidity of water caused by organic and inorganic materials both suspended and dissolved such as fine sand, organic and inorganic materials [7].

The depth at each research station is relatively shallow. Because the research was carried out in the dry season so that the river water flow was small. Station 1 has the lowest depth and the highest depth at station 3. The depth of water is one of the factors that limits the waters' brightness. Shallow water conditions, the intensity of sunlight can penetrate the entire body of water so that it reaches the bottom of the water, shallow regions usually have a greater variety of habitats than deeper areas so that they tend to have diverse macrozoobenthos [8].

The results of the measurement of current speed at all research stations ranged from 0.17 to 0.35 m/s. Rivers are grouped into very fast-flowing rivers (> 1 m/sec), fast flowing (0.5-1 m/sec), medium flowing rivers (0.25-0.5 m/sec), slow flowing rivers (0.1- 0.25 m/s) and very slow flowing rivers (0.1 m/s) [9]. Thus, the results of measurements of Cikeruh River flow velocity is included in the medium category.

The results of pH measurements range from 7.5 to 8.65. The pH value is classified as ideal for aquatic biota life, one of them is macrozoobenthos. Most aquatic biota will be sensitive if there is a change in pH, while the preferred pH range is around 7 - 8.5 if the pH value of 6.0 - 6.5 can cause macrozoobenthos diversity to decrease [7].

The results of DO concentration measurements ranged from 3.35 - 8.05. The lowest concentration is at station 5. It is because the river flow at station 5 has received various inputs of organic and inorganic materials, and the highest concentration is at station 2. It because the current velocity at station 2 is swifter than other stations. The density of dissolved oxygen depends on: temperature, the presence of photosynthetic plants, the degree of light penetration which depends on the depth and turbidity of the water, the degree of hardness of the flow of water, the amount of organic matter described in water, such as garbage, dead algae, or industrial waste [10].

The average BOD₅ concentration is 10.83 - 25.42 mg/L. The lowest concentration is Station 1 which has not received input of waste from human activities, and station 5 has the highest BOD₅ concentration due to human activities such as agricultural activities, household activities, and industrial activities that dispose of the waste from these activities into the river. The amount of BOD₅ is determined by the activity of decomposing organisms such as bacteria in decomposing organic matter [5]. In addition, domestic and industrial waste that enters water bodies can also affect the value of BOD₅ [7].

3.2 Substrate

The results of substrate measurements can be seen in (Table 2). Substrate pH ranges from 5.55 - 7.5. The lowest pH is at station 5 and the highest is at station 1. The chemical concentration of C-Organic and N-Total substrates at each station is low, C-Organic <2% and N-Total <0.19%. The lowest C-Organic concentration was found at station 4 with household waste input of 0.32, while the highest C-Organic concentration was at station 3 with tofu industry waste input of 2. This is because the abundance of macrozoobenthos at station 3 is lower than station 4, where the macrozoobenthos at station 4 utilizes C-Organic as a food ingredient contained in the aquatic substrate. This sand and clay substrate is preferred by the gastropod macrozoobenthos in accordance with the abundance at stations 3 and 4 more than the gastropod class. The quality of sediments determines the presence of benthic organisms that reside, mainly chemical compounds present in sediments that are formed by oxidation-oxidation processes [11]. The lowest C/N ratio is 7 at stations 4 and 5 and tends to contain decomposed organic matter

Table 1. The quality of water in research stations

Parameter	Station					
		1	2	3	4	5
Temperature (°C)	Average	18,58±0,73	24,23±0,75	25,70±2,07	26,57±1,22	27,77±1,3
	Range	17,5-19,6	23,4-25,2	23,7-29,5	25,1-28,40	25,8-29,4
Light transparency (cm)	Average	16,68±1,4	31,92±8,0	33,67±9,7	18,57±4,06	17,95±2,4
	Range	14,4-18	25-46	24-47	15-26	15-20
Turbidity (NTU)	Average	8,8±0,46	16,21±0,68	14,87±1,32	16,56±0,72	16,21±0,52
	Range	8,05-9,1	15,4-16,8	12,6-16,1	15,4-17,5	15,4-16,8
Depth (cm)	Average	17,8±1,6	32,8±3,86	47,5±3,61	20,2±2,92	19,5±2,42
	Range	16-20	29-39	43-52	17-25	16-22
Current Velocity (m/s)	Average	0,25±0,16	0,32±0,10	0,35±0,07	0,23±0,03	0,17±0,03
	Range	0,14-0,57	0,24-0,53	0,25-0,44	0,17-0,26	0,12-0,21
pH	Average	7,81±0,24	8,65±1,35	7,67±1,14	7,86±0,65	7,52±0,35
	Range	7,47-8,10	7,89-11,4	5,43-8,47	7,31-9,12	7,21-8,20
DO (mg/L)	Average	7,91±0,53	8,05±0,60	7,38±0,39	6,15±0,61	3,35±1,38
	Range	7,2-8,6	7,3-9,1	6,9-7,8	5,5-6,8	2-5,2
BOD ₅ (mg/L)	Average	10,83±2,21	18,71±3,26	18,22±3,23	16,77±1,68	25,42±3,80
	Range	8,15-14,6	15-24	16,25-24,3	14,6-19,5	21,1-30,85

which causes more organic material or nutrients for macrozoobenthos, so that the abundance of macrozoobenthos at stations 4 and 5 is high. Stations 2 and 3 with a low C/N ratio of 10 have lower abundances than stations 4 and 5 and station 1 with a moderate C/N ratio of 12 has the lowest macrozoobenthos abundance.

Soils with a low C/N ratio tend to contain easily decomposed organic matter, whereas at high C/N the ratio of organic matter decomposes very slowly [12].

3.3 Macrozoobenthos Community Structure

The abundance of macrozoobenthos can be seen in (Table 3), with the lowest abundance at station 1 with the number 590 ind/m² with the species found are from the insect class which is the intolerant macrozoobenthos group, showing that the condition of the waters of station 1 is still good and has not received waste input organic and inorganic ingredients.

The highest abundance is at station 5 with 7420 ind/m². But the species with the highest abundance are Tubifex sp. of 6250 ind/m². This is because at station 5, the water conditions are heavily polluted so that tolerant species such as Tubifex sp. can live and thrive in polluted waters.

Macrozoobenthos diversity ranges from 0.46 to 1.85 (Fig. 2), the lowest diversity index is at

station 5, allegedly because station 5 is downstream of the Cikeruh River with water quality contaminated by various kinds of waste so that the species found at station 5 are only 4 species and classified as intolerant groups, which can grow and develop in a wide range of environmental conditions, can be found in polluted waters or poor quality and the abundance continues to grow in waters polluted by organic matter such as at station 5. But at station 3 with the highest diversity value due to the input of tofu industrial waste which is suspected to be input of tofu industrial waste can become food for several macrozoobenthos species so that there are several macrozoobenthos species that live at this station, and the C-Organic content in the substrate at station 3 is higher which can be food for macrozoobenthos that lives at station 3.

The uniformity of macrozoobenthos in the Cikeruh River ranges from 0.16 to 0.64 (Fig. 2), the uniformity index (E') ranges from 0-1, if values close to 0, it means low uniformity due to species dominating, and when approaching 1, it means high uniformity which shows no species dominating [13]. Station 5 has the lowest value of 0.16 due to the dominating species, Tubifex sp. and the highest index value at station 3 is 0.64, which shows that station 3 has no dominant species. The dominance of an organism indicates that not all macrozoobenthos have the same adaptability and survival ability [14].

The average value of comparison of the genus percentage in station 1 to station 4 shows that the downstream genus is more than the genus upstream (Table 4), the largest percentage is in the comparison of station 1 with station 3, input of organic material from the tofu industry makes several types macrozoobenthos can use it as food. The percentage of genus at station 5 is lower than the genus of the upstream because the water quality is decreasing and has been polluted resulting in only tolerant macrozoobenthos groups that can survive.

Excessive burden of decomposed organic matter usually causes damage to the aquatic environment, as shown by the incomplete genus found [15].

The morisita dispersion index ranges from 0.14 to 0.80 (Fig. 3). Overall, all research stations have a uniformity distribution pattern category. The pattern of uniformity distribution is rarely found in natural populations approaching such a situation is when thinning occurs due to competition between individuals that encourage the distribution of the same living space [16].

Table 2. The content and characteristics of the research station substrate

Parameter	Station				
	1	2	3	4	5
pH	7,35	6,39	6,02	6,46	5,55
C-Organic	0,37	1,48	2	0,32	0,47
N-Total	0,03	0,14	0,19	0,05	0,07
C/N	12	10	10	7	7
Texture	Sandy Clay	Loamy Clay	Sandy Loam	Loamy Sand	Loamy Sand

Table 3. The abundance of makrozoobentos

Class	Species	The abundance of macrozoobenthos(ind/m ²)				
		Station 1	Station 2	Station 3	Station 4	Station 5
Insect	<i>Heptagenia</i> sp.*	130	0	0	0	0
	<i>Tipula</i> sp.*	120	0	0	0	0
	<i>Leptophelbia</i> sp.	100	0	0	0	0
	<i>Polycentrophus</i> sp.	60	0	0	0	0
	<i>Enallagma</i> sp.*	170	0	0	0	0
	<i>Chironomus</i> sp.***	0	0	0	0	1120
Malacostraca	<i>Paratropidius convexa</i>	10	10	0	20	10
Gastropod	<i>Melanooides tuberculata</i> **	0	80	140	200	0
	<i>Lymnaea</i> sp.**	0	340	290	0	0
	<i>Thiara scabra</i>	0	90	90	420	0
	<i>Phisastra</i> sp.	0	280	320	30	0
	<i>Tarebia granifera</i> **	0	1190	170	1320	0
	<i>Sulcosifira testudinaria</i> **	0	140	20	530	0
	<i>Filopaludina javanica</i> **	0	0	80	0	0
	<i>Pomacea canalicuta</i> **	0	0	260	0	0
Bivalvia	<i>Corbicula fluminea</i> **	0	450	100	920	0
Clitellata	<i>Lumbriculus</i> sp.***	0	0	80	0	40
	<i>Tubifex</i> sp.***	0	0	0	0	6250
Total		590	2580	1550	3440	7420

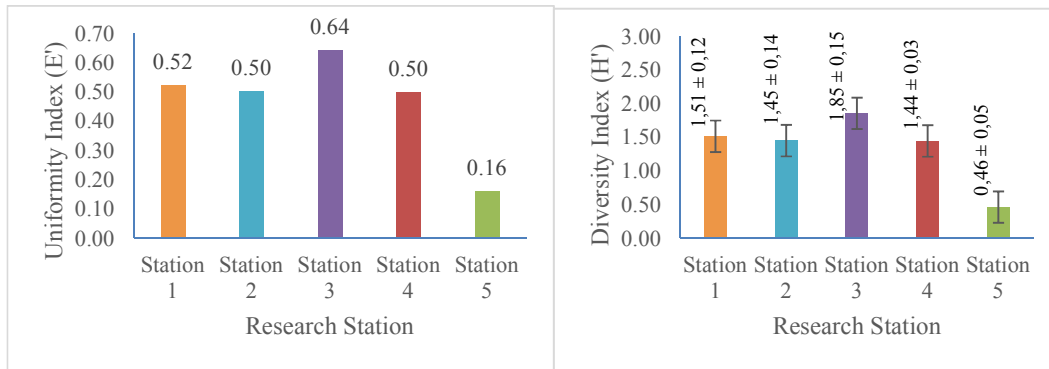


Fig. 2. Diversity and uniformity index

Table 4. Species of macrozoobenthos deficits

Station	Sampling number						Average
	1	2	3	4	5	6	
1 and 2	0%	-50%	-40%	-20%	-20%	-20%	-25%
1 and 3	-33%	-100%	-20%	-20%	-40%	-80%	-49%
1 and 4	0%	-25%	0%	0%	-20%	-20%	-11%
1 and 5	67%	25%	60%	40%	20%	60%	45%

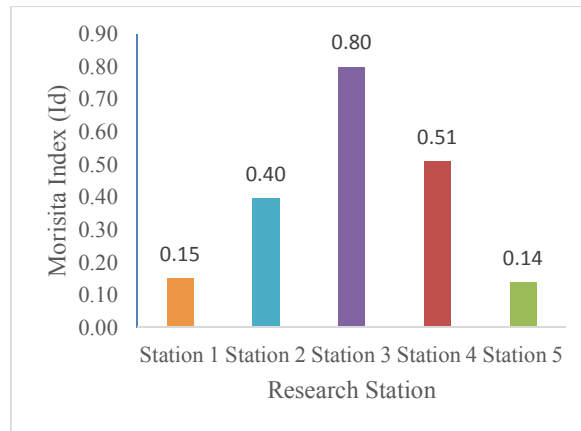


Fig. 3. Morisita index

4. CONCLUSION

Spatial distribution of Cikeruh River macrozoobenthos is different at each station, Station 1 consists of 6 species and 2 classes, species found at station 1 are intolerant macrozoobenthos, station 2 consists of 8 species 3 classes, species found include facultative groups, station 2 consists of 10 species and 3 classes, species found include facultative macrozoobenthos, and station 5 consists of 4 species 3 classes, species found among those are tolerant macrozoobenthos. The part of the river that has not been polluted is in Station 1 because it has not yet received waste into the water body, while station 5 is the part of the river

that has been heavily polluted due to various kinds of waste entering the water body. Shown with the type of macrozoobenthos that can live in different station conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Maryono A. Eco-Hydraulic river development. Yogyakarta: Masters in Engineering Systems UGM Postgraduate Program; 2005.

2. Unualual CB. Study of River Water Quality as a Source of Raw Water for PDAMs (Citarum River and Cikapundung River). Geological Bulletin of Environmental Management. 2010;20(1):1-12.
3. Handayani ST, Suharto B, Marsoedi. Determination of the quality status of Upstream River River Waters with Macrozoobentos Biomonitoring: Overview of Organic Material Pollution. Biosciences. 2001;1(1):30-38.
4. Zahidah. Aquatic Productivity. Unpad Press. Bandung; 2017.
5. Barus TA. Introduction to Limnology Studies on Mainland Water Ecosystems. USU Press. Field; 2004.
6. Pradana MSF, Hasan Z, Nurruhwati I, Herawati H. Strankton community structure in Cekdam Padjadjaran University Campus. Journal of Fisheries and Marine Science. 2019;10(2):1-8.
7. Effendi, H. Study of water quality for water resources and environmental management. Kanisius. Yogyakarta; 2003.
8. Simanjuntak SL, Muskananfola MR, Taufani WT. Analysis of sediment textures and organic materials on the abundance of Macrozoobenthos in Muara Sungai Jajar, Demak. Jorunal of Maquares. 2018;7(4): 423-430.
9. Ningsih WD, Kusri MD, Kartono AP. Anura Tadpole Community Structure in the Cibeureum River Gunung Gede Pangrango National Park, West Java. Journal of Conservation Media. 2013;18 (1):10-17.
10. Sastrawijaya AT. Environmental pollution. RinekaCipta. Jakarta; 1991.
11. Sanusi HS. Marine chemistry physical process chemistry and its interaction with the environment. Bogor: Department of Marine Science and Technology Faculty of Fisheries and Marine Sciences Bogor Agricultural University. Bogor; 2006.
12. Boyd CE. Water quality in warm water fish ponds. Alabama: Auburn University Press; 1979.
13. Odum EP. Fundamentals of Ecology. Tjahjono Samingan, Translator; Yogyakarta: 3rd ed. GadjahMada University. Translation from: Fundamental of Ecology. 1993;697.
14. Fitriana RY. Diversity and abundance of macrozoobenthos in mangrove forest rehabilitation results of Bali Ngurah Rai Grand Forest Park. Journal of Biodiversity. 2005;7(1):67-72.
15. Putra AW, Zahidah W. Lili. Plankton community structure in the upper Citarum River in West Java. Journal of Fisheries and Marine Science. 2012;3(4):313-325.
16. Nurhikmayani R. Distribution patterns of individuals in population. Laboratory of Environmental and Marine Sciences, Department of Biology. Faculty of Math and Science. Makassar: Hasanuddin University; 2013.

© 2020 Lutfi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

*The peer review history for this paper can be accessed here:
<http://www.sdiarticle4.com/review-history/56189>*