Quality of Cikawung river water based on phytoplankton diversity

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Abstract. This research aims to determine the quality of Cikawung river water based on phytoplankton diversity conducted in April-May 2019. This research uses descriptive method, with quantitative approach. The sample taken was 10% of the length of the Cikawung river, which is 5 km divided into 3 stations. The quality of the waters of the Cikawung river can be seen from the diversity index, evenness index and phytoplankton dominance index. The results show that the diversity value is low to moderate. The evenness value is categorized as stable condition. While the dominance index showed as labile condition or under ecology’s pressure. Broadly speaking, the quality of the waters of Cikawung river based on the diversity index is included in the heavily polluted category.

1. Introduction
Rivers are important systems of biodiversity and are among the most productive ecosystems on the earth. River ecosystem play a vital role in the productivity as they are consisting of flora and fauna including planktons. Urbanization, expansion of irrigation and increasing trend of industrialization has contributed towards quality of river [1]. Cikawung river is located at Kampung Cadas Ngampar Desa Mekarsari Kecamatan Cibalong Garut, that close to industrial activities. Rubber processing, which dominates industrial activities around the Cikawung river, is thought to produce waste that has the potential to pollute the surrounding area.

Therefore, just as how humans will greatly be affected if the atmosphere is polluted with noxious gases, so also all aquatic life if their environment (which is water) is polluted with effluents. The quality of water affects to the survival and well-being of all aquatic life in the ecosystem. According to Rocha, [2] water quality is a complex subject which involves physical, chemical, hydrological, and biological characteristics of water and their complex delicate relations.

The plankton (phytoplankton) are the primary producers in a river ecosystem and represent the biological characteristics of water [3]. Phytoplankton are dependent on water quality parameters, especially nitrates and phosphates for optimum growth, reproduction, and survival. Any unfavorable change in physicochemical parameters could affect plankton. Therefore, the presence of plankton can be a parameter to be measured when assessing water quality.

This study was aimed to identified water quality of Cikawung river based on the phytoplankton diversity. The study is expected to be able to give evidence about water quality in Cikawung river, so that it could provide information to the community, factory owners, and the government. Furthermore, this information can be the basis for keeping the Cikawung river in the most favorable condition and as an effort of sustainable aquatic resources management.
2. Materials and methods
This study was carried out in April to Mei 2019 at Cikawung river. This study uses quantitative descriptive methods that aim to explain phenomena using numbers [4]. The purpose of this study is to describe the characteristics of things as they really are. Samples from this study are all types of phytoplankton that are in each sampling squared. The area of a square is 2 meters’ x 2 meters. Sampling is done in 10% of the Cikawung river area. The observations were done in time series at weekly basis and at three stations. Each station is divided into 3 points (left side, center side and right side). Samples were collected by plankton net. Phytoplankton species and abundance were observed using a microscope and identified following Janse Van Vuuren [5]. Water quality was measured in situ covering pH, temperature, light intensity, humidity and wind speed. Phytoplankton evaness was estimated using Simphson index [6], while diversity index and dominance index with Shanon-Wiener method [7].

3. Results and discussion
Phytoplanktons were collected from the Cikawung river water during the study period from station I, II, III. A detailed microscopic examination of phytoplanktons revealed, the presence of maximum species Chlorophyceae (11 genus), followed by Bacillariophyceae (10 genus) and Cyanophyceae (5 genus). However, the least number are Cryptophyceae (1 genus) dan Euglenoidea (1 genus). The results of phytoplanktons counts from each of the station of Cikawung River are shown in Table 1.

Table 1. Distribution of phytoplankton.

| No | Phytalplankton Class | Phytalplankton Species     | Station I | Station II | Station III | Number of Species |
|----|----------------------|---------------------------|----------|------------|-------------|------------------|
| 1  | Bacillariophyceae     | Gyrosigma sp              | 9        | 13         | 0           | 22               |
| 2  | Bacillariophyceae     | Pinnularia sp             | 14       | 17         | 0           | 31               |
| 3  | Bacillariophyceae     | Achnanthidium minutissimum| 9        | 13         | 11          | 33               |
| 4  | Bacillariophyceae     | Cymatopleura solea        | 14       | 14         | 9           | 37               |
| 5  | Bacillariophyceae     | Eunotia formica           | 14       | 9          | 0           | 23               |
| 6  | Bacillariophyceae     | Nitschia capitalia        | 15       | 10         | 0           | 25               |
| 7  | Bacillariophyceae     | Aulacoseira granulate     | 12       | 11         | 0           | 23               |
| 8  | Bacillariophyceae     | Cocconeis placentula      | 13       | 8          | 0           | 21               |
| 9  | Bacillariophyceae     | Surirella sp              | 15       | 11         | 9           | 35               |
| 10 | Bacillariophyceae     | Cymbell sp                | 13       | 16         | 10          | 39               |
| 11 | Chlorophyceae         | Actinastrum hantzschii     | 10       | 11         | 0           | 21               |
| 12 | Chlorophyceae         | Coelastrum nageli         | 10       | 18         | 0           | 28               |
| 13 | Chlorophyceae         | Dictyosphaerium sp        | 13       | 11         | 9           | 33               |
| 14 | Chlorophyceae         | Stigeoclonium sp          | 14       | 12         | 0           | 26               |
| 15 | Chlorophyceae         | Tetraedron minimum        | 11       | 12         | 8           | 31               |
| 16 | Chlorophyceae         | Pandorina sp              | 10       | 6          | 0           | 16               |
| 17 | Chlorophyceae         | Treubaria sp              | 11       | 11         | 0           | 22               |
| 18 | Chlorophyceae         | Chlamydomonas sp          | 13       | 13         | 0           | 26               |
| 19 | Chlorophyceae         | Microactinium pusillum     | 13       | 0          | 10          | 23               |
| 20 | Chlorophyceae         | Chlorogonium sp           | 11       | 0          | 0           | 11               |
| 21 | Chlorophyceae         | Oedogonium sp             | 0        | 0          | 10          | 10               |
| 22 | Cyanophyceae          | Microcystis wesenbergi    | 0        | 0          | 15          | 15               |
| 23 | Cyanophyceae          | Cylindrospermopsis raciborskii | 0     | 11         | 10          | 21               |
| 24 | Cyanophyceae          | Spirulina sp              | 7        | 14         | 16          | 37               |
| 25 | Cyanophyceae          | Microcystis aeruginosa    | 0        | 0          | 17          | 17               |
| 26 | Cyanophyceae          | Oscillatoria limosa       | 0        | 0          | 14          | 14               |
| 27 | Cryptophyceae         | Cryptomonas sp            | 9        | 0          | 0           | 9                |
| 28 | Euglenoidea           | Euglena sanguinea         | 0        | 0          | 12          | 12               |
| 29 | Euglenoidea           | Trachelomonas sp          | 0        | 0          | 13          | 13               |
| **Total Number of Species** |                      |                           | 260      | 241        | 173          | 674               |
Station I, phytoplankton from the Bacillariophyceae class included 10 species with a total of 128 individuals, Chlorophyceae class included 10 species with a total of 116 individuals, Cyanophyceae class included 1 species with a total of 7 individuals, and the Cryptophyceae class included 1 species with a total of 9 individuals. Station II was covered by Phytoplankton class of Bacillariophyceae as many as 122 individuals from 10 species, Chlorophyceae as many as 94 individuals from 8 species and Cyanophyceae as many as 25 individuals from 2 species. Station III was covered by Bacillariophyceae phytoplankton class as many as 39 individuals from 4 species, Chlorophyceae as many as 37 individuals from 4 species, Cyanophyceae as many as 72 individuals from 5 species and Euglenoidea as many as 25 individuals from 2 species. There were 29 types of phytoplankton that were sampled, while the total number of individual from 3 sampling stations studied was 674. The number of samples sampled at Station I was 260, Station II was 241, and Station III was 173.

*Nitschia capitalia* dan *Surirella sp* showed highest number of individuals and *Spirulina sp* showed less number of individuals in station I. However, *Coelastrum nageli* showed highest number of individuals and *Pandorina sp* showed less number of individuals in station II. *Microcystis aeruginosa* showed highest number of individuals and *Tetraedron minimum* showed less number of individuals in station III. The most sampled species at 3 stations are *Cymbella sp*, while the least is *Cryptomonas sp*.

### 3.1. Diversity

Based on the calculation, the phytoplankton diversity index in the station I was 1.333 with an average value of 0.333 indicating a low diversity value. While at station II, it was 1.277 with an average value of 0.425 indicating that the diversity was low. At station III is 0.893 with an average value of 0.223 which shows low diversity.

As can be seen in diagram 1. The phytoplankton diversity index at Station I was dominated by the Bacillariophyceae and Chlorophyceae classes. Whereas the lowest diversity index values are the Cryptophyceae and Cyanophyceae classes. At station II, the greatest diversity index was the Bacillariophyceae and Chlorophyceae classes. While the least is the Cyanophyceae class. At station III, the greatest diversity index is the Cyanophyta and Bacillariophyceae classes. While the least is the class of Chlorophyceae and Euglenoidea.

![Figure 1. Diversity index of phytoplankton at Cikawung river.](image)

The presence of Bacillariophyceae and Chlorophyceae classes or better known as diatoms in large quantities indicates the stage of clean water quality [8]. If an area is dominated by Cyanophyceae class population or better known as blue-green algae which indicates that the waters are polluted. According to Boyd, blue-green algae cause many river pollution problems such as disturbance to aquatic habitat. Increased toxic content, and cause taste and odor in drinking water, as well as dirty scenes [9].

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As is known, species diversity is all the differences found in living things between species or between species that are measured from the total number of species both animals, plants, microorganisms on earth. Odum states that species diversity has two components that can react differently to geographical, developmental, or physical factors. The two components are the richness of the types or components of the variety in the unity of the area and equality or aguitability in the equal distribution of individuals between the two types [10].

A community is said to have high diversity if the community is composed by many species with the same abundance of species and about the same. Sugihara stated that on the contrary if a community is composed of few species and if only a few species are dominant the species diversity is low [11].

The diversity index calculation results are known that the water conditions at station I have been polluted or included in the heavily polluted category. As for Station II, it shows that the water conditions at Station II are polluted or included in the heavily polluted category. Furthermore, at station III shows that the water conditions at station III are polluted or included in the heavily polluted category.

One industry that is closely related to environmental problems at cikawung river is the rubber industry. Rubber processing produces waste that contains lots of organic compounds. Pollution caused by rubber waste needs serious attention to be studied and examined so that the level of pollution of waste discharged into the environment is below the established environmental quality standards. The stench and liquid waste is a big problem and must continue to be overcome with the commitment of all parties, entrepreneurs, governments, and researchers. The stench produced by the freezing process of natural rubber is very disturbing to breathing. While liquid waste that is not managed properly is often discharged directly into rivers, thus damaging the environment [12].

3.2. Evenness
Species are said to be evenly distributed if the evenness or equability index \( j = 1 \) [10]. The results of the phytoplankton evenness index calculation at station I is 1.282, which means in a stable condition. Whereas at station II the participation value is 1.187, which means in a stable condition. And the value of evenness at station III is 1,000, which means in stable conditions. Evenness illustrates the size of the number of individuals between species in a community. The more even distribution of individuals between species, the balance of the ecosystem will increase [13]. The results of the study obtained stable evenness.

3.3. Dominance
The calculation result of the Domination index can be seen in diagram 2, which indicates that all stations are included in the medium criteria. The results of this study indicate that the dominance index is moderate or can be said that no phytoplankton species were found to dominate or dominate at the location of the study site. In addition, the dominance index is being caused among the phytoplankton species there is no intense competition in controlling the environment or food sources. This shows that the condition of the community structure is stable, the environmental conditions are prime and there is no ecological pressure on the biota in the habitat concerned. Whereas when dominance approaches 1, it means that within the observed community structure, species that dominate other species are found. This reflects the community structure in an unstable state or ecological pressure [14].
4. Conclusion
The phytoplankton at Cikawung river had low to moderate diversity, stable evenness and medium dominance. Based upon average diversity index value, which is 0.333, Cikawung river categorized as polluted category. The study identified 674 species of phytoplankton from 4 classes, Chlorophyceae (11 genus), followed by Bacillariophyceae (10 genus) and Cyanophyceae (5 genus). However, the least is Cryptophyceae (1 genus) dan Euglenoidea (1 Genus).

The present study provides details on plankton diversity, evenness and abundance of Cikawung river which unravel the quality of the river ecosystem. It will serve as a useful tool for further ecological assessment and monitoring of the river ecosystem. The results have shown the need of planktons as index of water quality.

References
[1] Nguyen T H, Helm B, Hettiarachchi H, Caucci S and Krebs P 2019 The selection of design methods for river water quality monitoring networks: a review Environmental Earth Sciences 78(3)
[2] Rocha F C, Andrade E M and Lopes F B 2014 Water quality index calculated from biological, physical and chemical attributes Environmental Monitoring and Assessment 187(1)
[3] Nassar M Z, El-Din N G S and Gharib S M 2015 Phytoplankton variability in relation to some environmental factors in the eastern coast of Suez Gulf, Egypt Environmental Monitoring and Assessment, 187(10)
[4] Sugiyono 2012 Metode Penelitian Kuantitatif Kualitatif dan R&D (Bandung: Alfabeta)
[5] Janse van Vuuren S and Taylor J C 2015 Changes in the algal composition and water quality of the Sundays River, Karoo, South Africa, from source to estuary African Journal of Aquatic Science 40 339–357
[6] Simpson E H 1949 Measurement of diversity Nature 163 688-688
[7] Shannon C E 1948 A mathematical theory of communication The Bell System Technical Journal 27 379-423
[8] Dalu T, Magoro M L, Tonkin J D, Human L R D, Perissinotto R, Deyzel S H P and Whitfield A K 2018 Assessing phytoplankton composition and structure within micro-estuaries and micro-outlets: a community analysis approach Hydrobiologia 818(1) 177–191
[9] Rai U N, Dubey S, Shukla O P, Dwivedi S and Tripathi R D 2007 Screening and identification of early warning algal species for metal contamination in fresh water bodies polluted from point and non-point sources Environmental Monitoring and Assessment 144(1-3) 469–481
[10] Odum E P 1996 Dasar-dasar Ekologi (Yogyakarta: Gadjah Mada University Press)
[11] Sugihara G 1980 Minimal community structure: an explanation of species abundance patterns The American Naturalist 116 770-87
[12] Huang H and Lu J 2014 Identification of river water pollution characteristics based on projection pursuit and factor analysis Environmental Earth Sciences 72(9), 3409–3417
[13] Wilhm J L 1975 Biological Indicator of Pollution in River Ecological (London: Blackwell Scientific Publication)
[14] Webber M, Edwards-Myers E, Campbell C and Webber D 2005 Phytoplankton and zooplankton as indicators of water quality in Discovery Bay, Jamaica Hydrobiologia 545(1) 177–193.