Evaluation of Coliform Bacteria and Copper (Cu) in Upstream of Blanakan River, Subang, West Java

G Nabila and N D Takarina
Department of Biology, Faculty of Science and Mathematics, Universitas Indonesia
E-mail: noverita.dian@sci.ui.ac.id

Abstract. This study aims to determine the quality of water by evaluating the presence or absence of coliform bacteria and heavy metal Cu as well. The water quality evaluation was conducted in the upstream of Blanakan river, considering that the upstream is vulnerable since it receives more pollutants due to human activity. The water samples were collected from three stations in upstream. The Cu in water was analyzed using Atomic Absorption Spectroscopy (AAS). Likewise, the coliform bacteria were counted by using Most probably Number (MPN) method. The results showed that the range of coliform bacteria was 0.43 – 110 MPN/ml and the average was 36.9 MPN/ml, which is exceeding the range of water quality standard class I according to Government Regulation No.82 of 2001. Meanwhile, the average value of heavy metals Cu is 0.04 mg/L, which is also exceeding the range of water quality standard class I according to Government Regulation No.82 of 2001. Hence, the upstream of Blanakan river has been contaminated by coliform and Cu.

1. Introduction
Water is one of the essential natural resources that are very useful for the survival of living things. The availability of water resources for an allotment depends on the quality of the water resources. One of the primary sources of water in the surface water is the river [1]. The upstream area of Blanakan river, Subang, West Java is an area that has many community activities. One of the impacts is the pollution on the environment in water due to wastes. Waste originating from land to upstream and estuary generally comes from human activities such as animal husbandry, fishponds, settlements and shipping [2]. In the upstream of Blanakan river, there are several settlements around the riverbanks (Figure 1). That causes the river to becomes vulnerable to pollution. One of the pollutants that have the potential to contaminate the Blanakan river is heavy metal Copper (Cu) and coliform bacteria.

Copper is one of the essential metals that can be found in air, soil and water. However, the presence of heavy metals Cu at high concentrations will be toxic for the aquatic organisms in the river and can reduce the quality of the waters. Cu can be distributed to the organism and will be accumulated through various intermediaries, such as air, food, or water that has been contaminated by heavy metals [3]. Cu that enters the river can come from a variety of sources. Usually, the source that causes high concentrations of Cu in water is household waste, urban waste and hull preservative paint [4].

The decrease in water quality can be detected, for example, by using an indicator of microorganisms pollution. There is a group of microorganisms commonly used as bioindicators, namely coliform bacteria. Coliform bacteria are a group of microorganisms commonly used as biological indicators, and these bacteria can be used as a detector to determine whether pathogens have contaminated a water
source or not and its density is directly proportional to the level of water pollution. In addition, coliforms have more prolonged survival and age compared to pathogens and are easily detected and identified [5].

Risk of heavy metal and coliform contamination in the upstream of Blanakan river has led to the need for heavy metal pollution and coliform studies which can be used as an indicator of water quality in this area. This study aims to determine the quality of water by evaluating the presence or absence of coliform bacteria and heavy metal Cu in the upstream of Blanakan river. This study is expected to increase knowledge that can improve water quality in the upstream of Blanakan river.

![Figure 1. Conditions of upstream riverbank in Blanakan river](image1)

2. Methods

2.1 Study Site

The Blanakan river located in Subang district, West Java province. The station geo-coordinates were from upstream at -6.277444, 107.6599 to downstream (river mouth) -6.240083, 107.667472 (Figure 2). The width of Blanakan river is varied from 11 m in the upstream to 60 m in the downstream. In upstream, the river was surrounded by settlements and paddy field, in midstream was transition area from paddy field to fish pond and downstream was dominated by the fish pond and vegetated by mangrove. The coliform samples were collected upstream in station 1, 2 and 3.

![Figure 2. The locations of 3 stations in upstream of Blanakan river](image2)
2.2 Coliform Bacteria Sampling and Measurement

Samples were taken at three stations in the upstream of Blanakan river in April 2019. The collection of water samples to detect microorganisms was using a sterile bottle. The bottle was dipped in the same direction as the water, and the bottle was closed tightly. Then the sample was placed in a cool box [6].

The water samples were analyzed in the BPPT laboratory using the Most Probable Number (MPN) method. MPN test was performed in three steps, namely presumptive test, confirmed test, and complete test. The density of coliform bacteria was calculated according to the below formula [7]:

\[
\text{Density (MPN/ml)} = \frac{\text{MPN table values}}{100} \times \text{the middle dilution factor}
\]

2.3 Cu Sampling and Measurement

Cu sample was taken from the water at three stations in the upstream of the Blanakan river in April 2019 using a bottle sample. Content of Cu was analyzed in the laboratory by using the Atomic Absorption Spectrophotometry method (AAS) [8].

3. Results

Table 1. The comparable data of coliform bacteria (MPN/ml) in Blanakan river with Government Regulation No. 82 of 2001

| Stations | Result (this study) | Government Regulation Standard |
|----------|---------------------|-------------------------------|
|          | Coliform (MPN/ml)   | I    | II   | III  | IV   |
| 1        | 110                 | 10   | 50   | 100  | 100  |
| 2        | 0.43                | 10   | 50   | 100  | 100  |
| 3        | 0.43                | 10   | 50   | 100  | 100  |

In Table 1 and Figure 3, we can see that the coliform in station 2 and 3 still below the range of water quality standard Class I issued by Government Regulation No. 82 of 2001. While, the result of coliform in station 1 exceeding the range of all water quality standard, including Class I, Class II, Class III and Class IV issued by Government Regulation No. 82 of 2001.
Table 2. The comparable data of Cu (mg/l) in Blanakan river with Government Regulation No. 82 of 2001

| Stations | Result (this study) | Government Regulation Standard |
|----------|---------------------|-------------------------------|
|          | Cu (mg/L) | I  | II  | III | IV  |
| 1        | 0.04      | 0.02| 0.02| 0.02| 0.2 |
| 2        | 0.04      | 0.02| 0.02| 0.02| 0.2 |
| 3        | 0.04      | 0.02| 0.02| 0.02| 0.2 |

Figure 4. The comparable data of Cu (mg/l) in Blanakan river with Government Regulation No. 82 of 2001

From Table 2 and Figure 4 we can see that the Cu in the water at three stations were equal to 0.04 mg/l and it has exceeded Class I, Class II, Class III of water quality standard issued by Government Regulation No. 82 of 2001.

Table 3. The comparable data of coliform bacteria (MPN/ml) with other locations

| Value/Range | Locations                  |
|-------------|----------------------------|
| 0.43–110    | Blanakan river (this study) |
| 0.3         | Pakerisan river [9]        |
| 280         | Banjir Kanal Timur river [10] |

Table 4. The comparable data of Cu (mg/l) with other locations

| Value/Range | Locations                   |
|-------------|-----------------------------|
| 0.04        | Blanakan river (this study) |
| 0.006-0.02  | Pangkajene river [11]       |
| <0.005      | Lowatog river [12]          |

4. Discussion

The result of coliform and Cu at three stations in the upper stream of Blanakan river was comparable to water quality criteria based on Government Regulation No.82 of 2001. In this regulation, water quality is divided into four classes: (1) Class I, water can be used for drinking water service, and or other designation that requires the same water quality as the purpose. (2) Class II, water can be used for infrastructure/facilities for water recreation, cultivation of freshwater fish, livestock, water to irrigate crops, and or other purposes that require the same water quality as these uses. (3) Class III, water can
be used for the cultivation of freshwater fish, animal husbandry, water for irrigating crops, and other designation that requires the same water as the use. (4) Class IV, water can be used to irrigate, plant and or other uses that require the same water quality as these uses [13].

The result of coliform in station 1 has exceeded the range of all water quality standard, including Class I, Class II, Class III and Class IV issued by Government Regulation No.82 of 2001. Meanwhile, at station 2 and 3, the coliform results were still within the range of water quality standard of Class I. Furthermore, the average of total coliform which is $3.69 \times 10^{5}$ MPN/ml has exceeded the Class I but still below Class II. That happens because, in station 1, the settlement in the riverbank is denser than in station 2 and station 3. That will cause a high risk of contamination of domestic waste into rivers. Besides that, there were also several latrines observed on the riverbank (Figure 1). When coliform in Blanakan river compared to the other locations in Table 3, the range of coliform in the Blanakan river and Banjir Kanal Timur river are quite high than in the Pakerisan river. At Banjir Kanal Timur river, domestic wastewater treatment plants are not yet available, so domestic waste is generally disposed of directly into the river. Based on the literature, coliform contamination in water bodies is caused by human activities and domestic wastes [14] and by poor sanitation, such as the absence of adequate sewage treatment.

The result of Cu in three station at Blanakan river has exceeded the range of water quality standard of Class I, Class II and Class III issued by Government Regulation No. 82 of 2001. The Cu in Blanakan river is higher compared to Cu in Pangkajene river and Lowatog river (Table 4). High Cu can be caused by population density, which leads to domestic waste disposal. The majority of Blanakan residents are fishermen who have boats. Hence, many boats park along the river banks (Figure 5) and many boat activities. The Cu contamination in water bodies is related to domestic waste and ship washing activities. That also related to the fact that Cu is generally contained in the boat paint [4,15].

Cu and coliform are indicators that can be used for assessing environmental quality, according to Government Regulation No. 82 of 2001. Therefore, Cu and coliform data reinforce each other [13]. This fact indicates that based on Cu and coliform data in this study, the upstream of Blanakan river in station 1 has been polluted. The coliforms were high, even though the Cu contents were high related to various factors. For example, the resistance factor. Some waterborne bacteria were reported having resistance against antibiotics and heavy metals as well [16].

![Figure 5. Boat parking at the riverbank in upstream of Blanakan river](image)

5. Conclusion
The results of this study indicate that the range of coliform in the upstream of Blanakan river was 0.43-110 MPN/ml, and the Cu content was 0.04 mg/l. The upstream of Blanakan river in station 1 was extremely polluted since the coliform has reached 110 MPN/ml and has exceeded the Government Regulation No. 82 of 2001. Moreover, Cu content in upstream of Blanakan river has exceeded the range of water quality standard of Class I, Class II and Class III issued by Government Regulation No. 82 of 2001.
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References

[1] Samekto C and Winata E S 2016 Potensi Sumber Daya Air di Indonesia Seminar Nasional: Aplikasi Teknologi Penyediaan Air Bersih untuk Kabupaten/Kota di Indonesia Pusat Teknologi Lingkungan BPPT

[2] Nyairo W N, Owuor P O and Kengara F O 2015 Effect of Anthropogenic Activities on the Water Quality of Amala and Nyangores tributaries of River Mara in Kenya Environ Monit Assess 187 691

[3] Bui T L, Chi L, Dao T and Hoang T C 2016 Copper Toxicity and the Influence of Water Quality of Dongnai River and Mekong River Waters on Copper Bioavailability and Toxicity to Three Tropical Species Chemosphere 144 872-878

[4] Suwondo, Fauziah Y, Syafrianti and Wariyanti S 2005 Akumulasi Logam Cuprum (Cu) dan Zinicum (Zn) di Perairan Sungai Siak dengan Menggunakan Bioakumulator Eceng Gondok Biogenesis 1 51-56

[5] Pelczar J R and Chan E C S 2008 Dasar-dasar Mikrobiologi (Jakarta: UI Press)

[6] Safitri L F, Widyorini N and Jati O E 2018 Analisis Kelimpahan Total Bakteri Coliform di Perairan Muara Sungai Sayung, Morosari, Demak Indonesian Journal of Fisheries Science and Technology 14 30-35

[7] Sutapa I D A and Widiyanto T 2014 Kualitas Mikrobiologis Air Sungai dan Pipa Distribusi di Kabupaten Aceh Besar dan Kota Banda Aceh Limnoteh 21 135-144

[8] Supriyantini E and Soenardi N 2015 Kandungan Logam Berat Timbal (Pb) dan Tembaga (Cu) pada Akar dan Buah Mangrove Avicennia marina di Perairan Tanjung Emas Semarang Jurnal Kelautan Tropis 18 98-106

[9] Asrini N K, Adnyana I W S and Rai I N 2017 Studi Analisis Kualitas Air di Daerah Airan Sungai Pakerisan Provinsi Bali Journal Ecotrophic 11 101-107

[10] Atmojo T Y, Bachtiar T, Radjasa O K and Sabdono A 2004 Kandungan Koprostanol dan Bakteri Coliform pada Lingkungan Perairan Sungai, Muara, dan Pantai di Banjir Kanal Timur, Semarang pada Monsun Timur Indonesian Journal of Marine Fisheries 9 54-60

[11] Daud A, Sartika D and Manyullei S Studi Kadar Tembaga (Cu) pada Air dan Ikan Gabus di Sungai Pangkajene Kecamatan Bungoro Kabupaten Pangkep 2013 (Universitas Hasanuddin)

[12] Patty O S, Siahaan R and Maabuat P V 2018 Kehadiran Logam-logam Berat (Pb, Cd, Cu, Zn) pada Air dan Sedimen Sungai Lowatag, Minahasa Tenggara - Sulawesi Utara Jurnal Bioslogos 8 16-20

[13] Peraturan Pemerintah Republik Indonesia No. 82 Tahun 2001 tentang Pengelolaan Kualitas Air dan Pengendalian Pencemaran Air (Jakarta: Pemerintah Pusat)

[14] Traoré A N, Mulaudzi K, Chari G J E, Foord S H, Mudau L S, Barnard T G and Potgieter N 2016 The Impact of Human Activities on Microbial Quality of Rivers in the Vhembe District, South Africa International Journal of Environmental Research and Public Health 13 817

[15] Putri A D D, Yona D and Handayani M 2016 Kandungan Logam Berat (Cd, Cu dan Zn) pada Air dan Sedimen Perairan Pelabuhan Kamal, Kabupaten Bangkalan–Madura Seminar Nasional Perikanan dan Kelautan VI Universitas Brawijaya

[16] Oves M and Hussain F M 2016 Antibiotics and Heavy Metal Resistance Emergence in Waterborne Bacteria Journal Investigative Genomics 3 23-25