Volume 1263

2023

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6th International Symposium on Sustainable Urban Development 2023 02/08/2023 - 03/08/2023 Jakarta, Indonesia

Accepted papers received: 03 November 2023

Published online: 06 December 2023

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6th International Symposium on Sustainable Urban Development 2023 02/08/2023 - 03/08/2023 Jakarta, Indonesia

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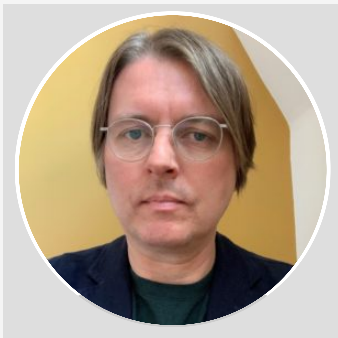

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PUBLICATION TYPE

Conferences and Proceedings

ISSN

17551307, 17551315

COVERAGE

2010-2021

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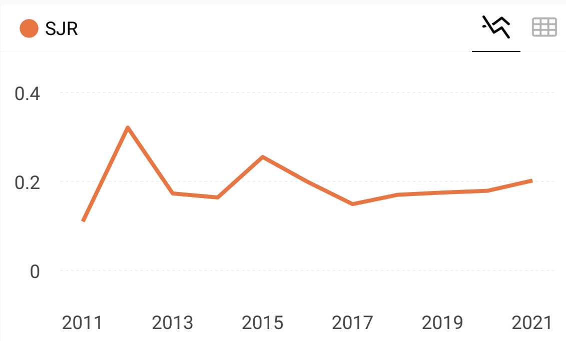

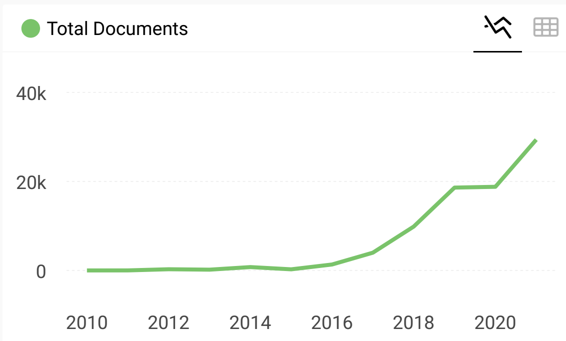

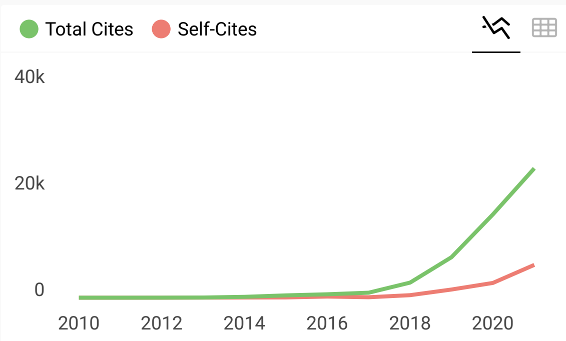

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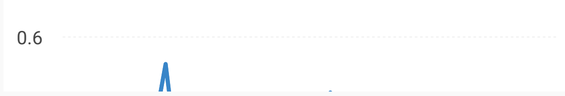

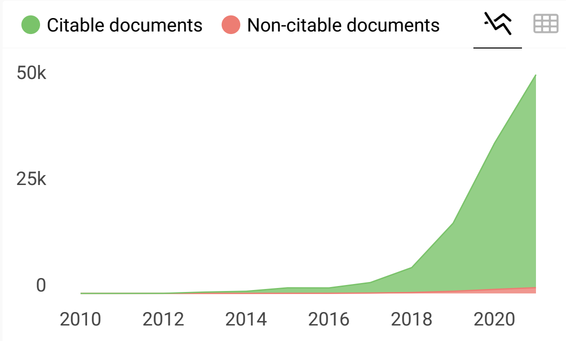

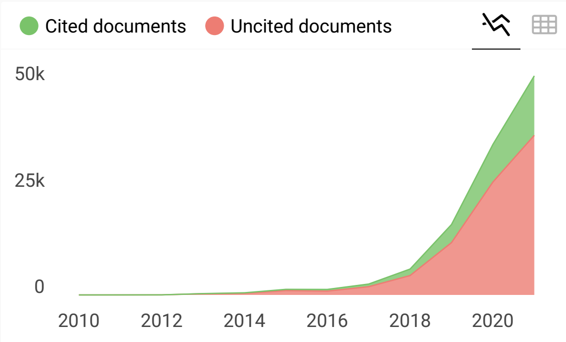

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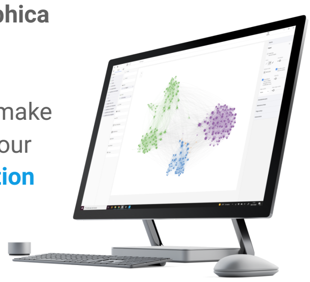

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IOP Conf. Series: Earth and Environmental Science 1263 (2023) 012033 doi:10.1088/1755-1315/1263/1/012033

Assessment of lead heavy metal pollution in Ciliwung River

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Abstract. Heavy metal contributed in bio-magnification process. So, its presence needs to be monitored and evaluated to prevent and control its hazards to human health and sustainability river ecosystem. One of that heavy metal is lead. This study aims to assessment the lead metal pollution in Ciliwung River because one of its uses is as water resources for Regional Drinking Water Company (PDAM). This study used a survey and analytical method. There were 12 samples of water column and 10 samples of sediments that distributed from upstream to the beginning of downstream. The parameters determined in site used water checker included temperature, pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), and Oxidation Reduction Potential (ORP). While the lead contained in sample used Automatic Absorption Spectrophotometric (AAS). The result showed that lead content in all samples exceeded the quality standards and the lead on sediment were more than in water column. Lead in the Ciliwung River is mostly due to anthropogenic sources because it occurred naturally in small amounts. Downstream, the EC, TDS, and ORP values increase, while the pH and DO value decreases. The ORP values at all sampling points were positive. It means that deoxygenation occurred along the Ciliwung River. The implication is needed the additional raw water processing that accompanied further economic analysis to make sure the water availability for the community sustained.

1. Introduction

Increased activities in the agricultural and industrial sectors have increased water pollution. One of the contaminants that is the main focus of water pollution is heavy metals, due to their properties which are not easily biodegradable, persistent in the environment, and spread through the food chain [1-3]. Heavy metal contamination in surface water is also a global concern because of its effects on public health even though it is consumed in small amounts [2,4].

One of the second toxic heavy metals is lead and in nature it is found in limited quantities, namely 0.002% of the earth's crust [5]. As a class B metal ion, lead has great toxicity and can cause genetic and physical disorders [6]. The presence of excess lead in waters is caused by anthropogenic causes, especially activities in the agricultural and industrial sectors that produce waste containing lead metal

[2-3]. However, it is recognized that industrial waste is the cause of more significant heavy metal pollution than any other source [4].

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Heavy metals have a specific gravity of more than 5 grams/cm3 [2] so they are easily deposited at the bottom of water body or sediment. So sediment has the potential to act as a receptor as well as a pollutant source because heavy metals can migrate and transform in the water column and sediment [7]. Water disturbances, oxidation-reduction conditions, and pH can affect the fate of heavy metals in sediments and the water column [8,10]. Therefore, in-situ examination of parameters such as pH, temperature, electrical conductivity (EC), Total Dissolved Solid (TDS), and Oxidation Reduction Potential (ORP) is needed to determine the condition of the waters that affect the characteristics of heavy metals in contaminating water bodies.

Ciliwung River is an important river because it is often associated with flooding in Jakarta [11-12] as well as being a source of raw drinking water [13]. While the results of previous studies indicate that Ciliwung River has been polluted by heavy metals. And lead metal is one of the heavy metals that is found in abundance in the Ciliwung River, both in the water column and sediment [14]. Therefore, a temporal spatial study of the pollution of Ciliwung River is crucial in order to know changes in its quality status. Understanding the quality of water body status becomes the basis for making decisions related to determining stream standards and effluent standards. Rivers with heavy to very heavy pollution loads require a longer time to carry out natural purification of incoming contaminants.

2. Methods

This study was conducted on Ciliwung River. The Ciliwung is a watershed in the West Java region which is located between 06°06'00” - 6°46'12” S and 106°48'36”-107°00'00” E. The Ciliwung watershed covers an area of 347 Km2 with the length of main river is 117 Km [11], which crosses the administrative areas of Bogor District, Bogor City, Depok City, and Jakarta Province [15]. For the purposes of this study, 12 water samples and 10 sediment samples were taken along the Ciliwung River, from upstream in Bogor Regency to downstream in Jakarta Province. Figure 1 shows the study area and sampling locations.

The method used in this study is a survey, sampling, quantify the water quality parameters, and interpret the data using descriptive and correlation statistics. Water sampling was carried out using a Horiba water checker, DO Meter YSI Pro20 and a digital pH meter water quality tester. The three tools are used to determine in-situ parameters which include temperature, pH, EC, TDS, DO, and ORP. Meanwhile, metal parameters were analyzed in the National Research and Innovation Agency (BRIN) laboratory using an Automatic Absorption Spectrophotometric (AAS)-Shimadzu AA 7000. Before being measured using AAS, water samples were filtered using Whatman filter paper number 41. As for solid samples (sediments), sample preparation was carried out using SNI 8910-2021 procedures with the acid digestion method.

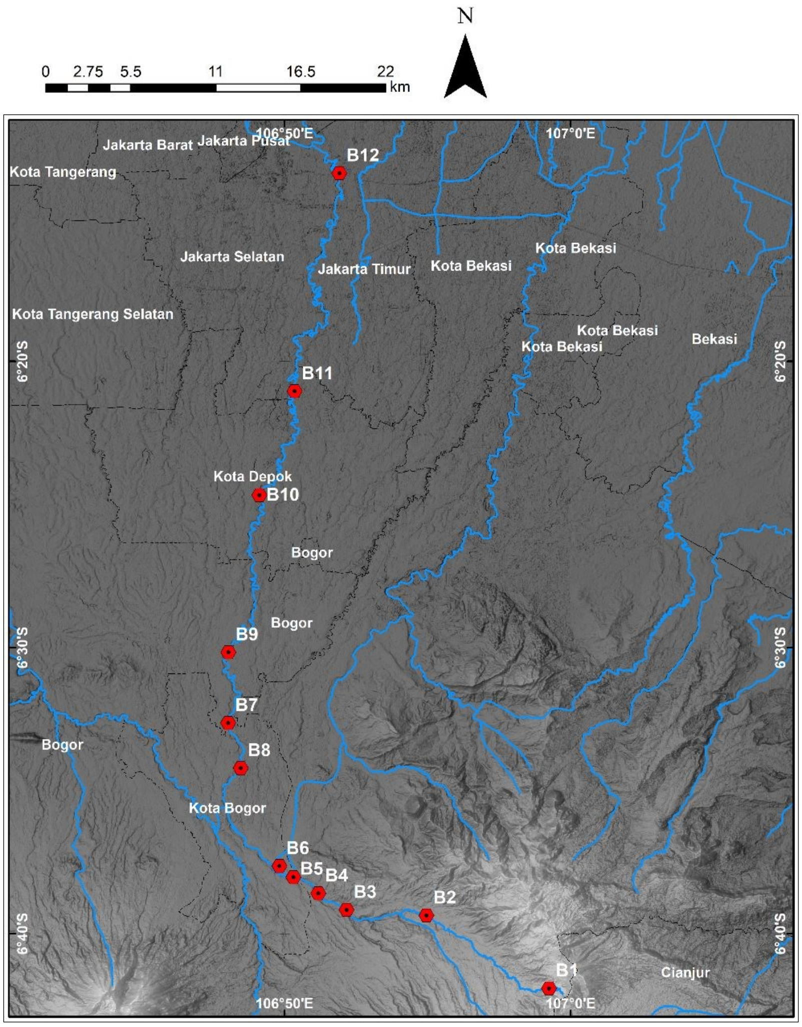


Figure 1. Study area and sampling location.

(a) (b) (c) (d)

Figure 2. The tools were used in this study included: (a) Horiba water checker; (b) DO meter YSI Pro 20; (c) pH meter digital water quality tester; and (d) Automatic Absorption Spectrophotometry (AAS).

3. Results and Discussions

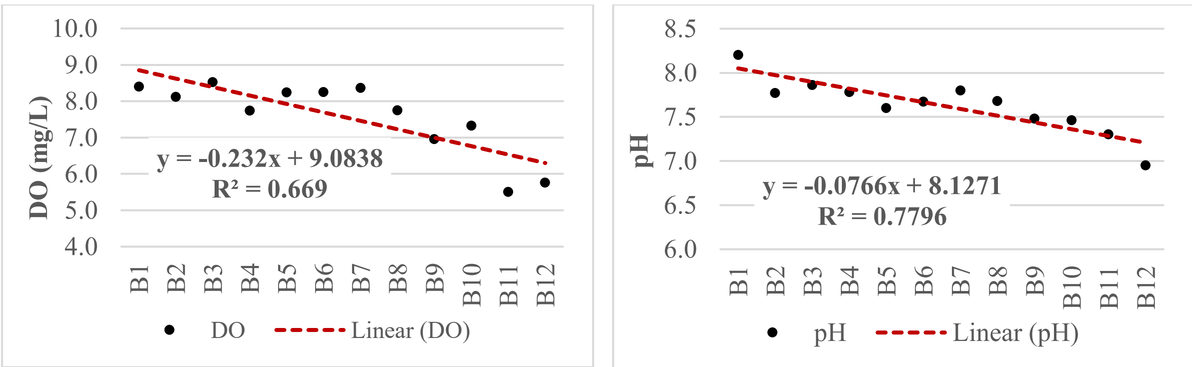
Table 1 is the result of parameter examination for water samples in situ. The pH value ranges from 7 to 8.2; temperature ranges from 19.9°C to 27°C, DO ranges from 5.5 mg/L to 9.2 mg/L, EC ranges from 102 µS/cm to 201 µS/cm, TDS ranges from 47 mg/L to 104 mg/L, and the ORP ranges from 253 mV to 333 mV.

Table 1. The parameters by in-situ checked for water sample.

Sample Codes	Temperature (°C)	DO (mg/L)	pH	EC (µS/cm)	TDS (mg/L)	ORP (mV)
B1	19.7	8.4	8.2	107	47	264
B2	24.3	8.1	7.8	103	51	304
B3	26.0	8.3	7.9	116	58	282
B4	26.0	7.7	7.8	103	50	271
B5	23.0	8.2	7.6	102	51	253
B6	24.0	8.3	7.7	108	54	264
B7	24.0	8.4	7.8	110	58	270
B8	24.0	7.8	7.7	120	60	277
B9	24.0	7.0	7.5	135	67	284
B10	24.0	7.3	7.5	154	76	313
B11	27.0	5.5	7.3	158	79	310
B12	27.0	5.8	7.0	201	104	333
Water Standard*	Deviation of 3	6	6 - 9	-	1000	-

*Water quality standard for drinking water in Indonesia [23]

The difference in temperature of the 12 samples taken was more due to differences in the time and location of sampling. It can be seen that B1 has the smallest temperature value compared to other sample points because it is at an altitude of more than 1000 m above sea level. While other sampling points are below 700 m asl. Temperature can control the life of aquatic organisms and affect the solubility of compounds in water, including oxygen [16]. Dissolved oxygen (DO) is the most important indicator of other water parameters for assessing water quality [17]. Apart from temperature, other factors also affect the solubility of oxygen in water. When sampling is carried out, turbulent river water can also increase the dissolved oxygen value naturally. The process of production and consumption of DO in rivers that cross urban areas is quite complex and nonlinear [18].

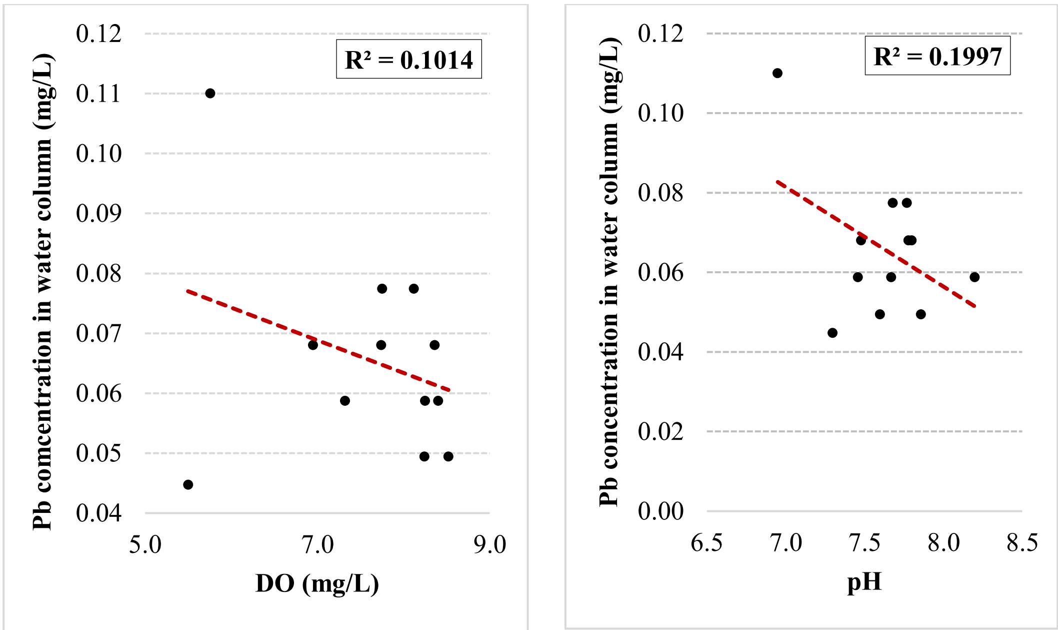


(a) (b)

Figure 3. Trend of water quality parameter of Ciliwung River from upstream to downstream: (a) Dissolved Oxygen (DO) and (b) pH.

Based on the data obtained, DO values decreased further downstream (Figure 3a). This shows that the more downstream the use of oxygen for the decomposition of organic matter and the oxidation of chemical compounds is getting bigger. Reduced oxygen at the water and sediment column boundaries will also encourage the release of reducing materials such as metals [19]. Thus, the reduced levels of dissolved oxygen in the water column, will potentially increase the concentration of lead. However, based on the analysis of the resulting data, the correlation between DO and Pb concentrations was very weak ($R^2 \approx 0.1014$), (Figure 4a).

The pH value also tends to decrease downstream (Figure 3b). This pH value will affect the solubility of heavy metal compounds, especially in the form of oxides, hydroxides, carbonates, or mineral forms. The lead metal leaching process will increase with a pH value below 7 [20]. However, the data from the analysis showed that the correlation value between the concentration of Pb metal and pH was also very weak ($R^2 \approx 0.2$) (Figure 4b). Therefore, there are parameters other than pH that influence each other on the solubility of heavy metals in the water column.



(a) (b)

Figure 4. The correlation between in water column: (a) Pb concentration vs pH; (b) Pb concentration vs DO.

Table 2 is the result of examining heavy metal parameters for water and sediment samples. For lead concentration data at points B8 and B10 it was empty because no sediment was obtained around the sampling location and operational barriers. The lead inspection results as shown in Figure 5 show that the lead metal content at all sampling location points exceeds the applicable quality standards (> 0.03 mg/L) according to [23] Appendix VI, for the designation of rivers as raw drinking water (class I).

The concentration of Pb in the sediment is much higher than the concentration of Pb in the water column because sediment is a reservoir for heavy metals [21]. Changes in environmental conditions in sediments can cause the release of the heavy metal lead into the aquatic environment above [22]. This phenomenon will increase the concentration of lead metal contained in the water column. The dynamics of the water conditions in the Ciliwung River cause differences in concentration values at each sampling point. The high concentration of lead above the required quality standard indicates that the Ciliwung River has been heavily polluted and will endanger human health as well as increase financing for water treatment that uses the Ciliwung River as a raw water source.

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Table 2. Lead content in column water and sediment samples.

Sample codes	Lead Content in Column Water (mg/L)	Lead Content in Sediment (mg/L)
B1	0.059	0.39
B2	0.077	0.44
B3	0.049	0.62
B4	0.068	0.50
B5	0.049	0.41
B6	0.059	0.49
B7	0.068	0.51
B8	0.077	-
B9	0.068	0.55
B10	0.059	-
B11	0.045	0.50
B12	0.110	0.66

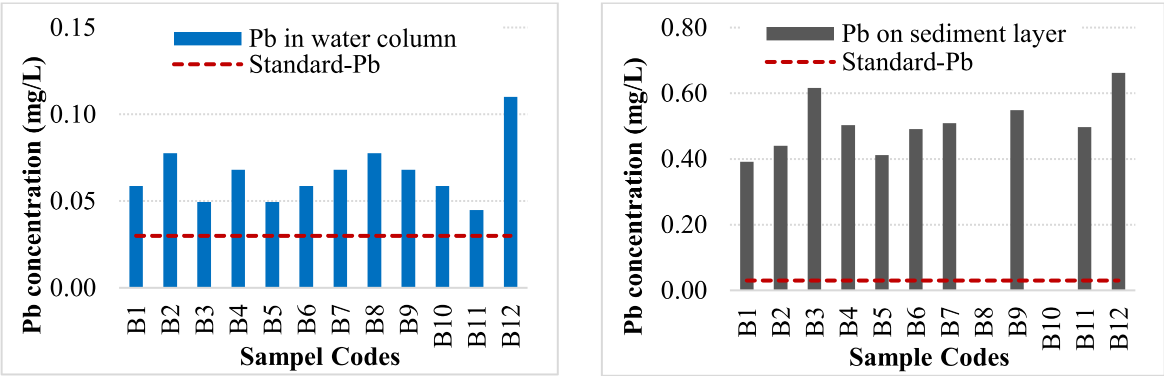

Figure 5. Pb concentration in water column and on sediment.

4. Conclusion

The results of the analysis show that the Ciliwung River has concentration levels of lead above the water quality standard for drinking water. Excess lead concentrations have been identified starting from point B1 (upstream of the river) to B12 (downstream), each of which has a relationship with the cultivation activities carried out in the vicinity of the sampling location. Lead concentrations in the sediments were on average 8 times higher than those measured in the water column. Changes in environmental conditions that occur in sediments will affect the release of lead metal into the water column above it. Therefore, it is necessary to study the dynamics of the waters in the Ciliwung River in order to be able to take control measures.

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CERTIFICATE

No.23168/FALTL/6.ISOSUD/VIII/2023

This is to certify that

Iwan Juwana

Has actively participated in the 6th International Symposium on Sustainable Urban Development 2023 with the theme
"From Recovery to Resilience: Building a Sustainable Future for a Better Life"
held by Faculty of Landscape Architecture and Environmental Engineering, Universitas Trisakti

as

PRESENTER

Jakarta, August 2nd - 3rd, 2023

Dean of Faculty of Architecture Landscape and Environmental Engineering, Universitas Trisakti

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