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HEAVY METAL CONTAMINATION OF CILIWUNG RIVER, INDONESIA

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Abstract

River Stream Area (DAS) of Ciliwung gives many advantages to its surrounding people, however, nowadays this river stream area of Ciliwung has been heavily polluted. One of the most harmful pollutant components for people is the existence of heavy metals. The high number of people doing activities surrounding the river area may contribute to the increase of metal contents in the river. The aim of this research is to prove that there is an increase level of heavy metal pollutant in Ciliwung River. The methodology that was used to analyze the content of heavy metal in Ciliwung River was X-Ray Flourescence (XRF) in part per million (ppm) unit. The result of this research shows that there is an increase in heavy metal pollutants of Cd, Hg, and Pb in the water of Ciliwung River that is located from Bogor to Jakarta that exceeds the standard of PP RI No.82 year 2001. The highest heavy metals pollution occurs in the river stream area of Ciliwung Jakarta. Respectively, the order of heavy metal concentration ranging from the highest to the lowest in Ciliwung River is Mn, Zn, Cu, Cd, and Hg.

Keywords: *Ciliwung River, heavy metals, pollution, XRF*

1. INTRODUCTION

Ciliwung River is one of the rivers that flows from Bogor Regency to the Jakarta gulf. The river stream area of Ciliwung (DAS) has always been used by people living surround it as an irrigation source, drinking water source, sanitation, farming, and small and medium enterprises of the people. The presence of people's activities around the river area has a great impact towards the river as it has become the pollutant source for the river.

One of harmful pollution types in the river is heavy metal. Heavy metal is an environment polluting substance that is very common and always found in the water. This heavy metal has a negative impact on people who use the water and its biota inside the water. An intense increase of urbanization and industrialization has made the river be polluted, as it has become the industry and domestic waste disposal place (Khatun & Jamal, 2014). An intense industrial and people's activity has created a heavy metal to the environment (Karbassi, et al., 2008).

Heavy metal can move from an environment to an organisms and from one organism to another through the food chain (Yalcin, et al., 2008); (Puspasari, 2006). The heavy metal found on water will sink and settle at the bottom of the water, creating a sedimentation and contaminate people who always make use of the water for their activities. Water with heavy metal will be a toxic material inside people's body and may cause death towards them (Palar, 2008).

The existence of heavy metal on Ciliwung River's water informs that there is a need to monitor and evaluate its water condition surrounding the people as a mean of supervising towards its water quality (Yudo & Said, 2018). In addition, people need to get the information about the level of pollution on the water that they use for their own virtues. Therefore, an analysis towards heavy metal contents on Ciliwung River's water needs conducting to figure out that there is a metal content on the water as well as its regular monitor towards the environmental pollution especially on the Ciliwung River's water.

This study is aimed at proving the existence of the increase of heavy metal pollution on Ciliwung River. This research is expected to be able to inform an updated condition about Ciliwung River and can be an information source for decision makers to resolve its issues.

2. MATERIALS AND METHODS

2.1. Water Sampling

The research was condacted at three sampling areas located alongside the river stream of Ciliwung River. The sampling location is located at one water area line of Ciliwung River that is divided into three locations representing the river's upstream and downstream. The first location is located at Inpeksi Ciliwung Letjen MT. Haryono Gg. Ciliwung, Cawang, Central Jakarta with the coordinate point of longitude **6°14'36.50"S** and of latitude **106°51'45.03"E**. the second location is at Poncol, Depok with the coordinate point of longitude **6°21'41.9"S** and of latitude **106°50'18.3"E.** The third location is at Otto Iskandinata, Bogor with the coordinate point of longitude **6°36'08.8"S** and of latitude **106°48'08.7"E** (Figure 1).

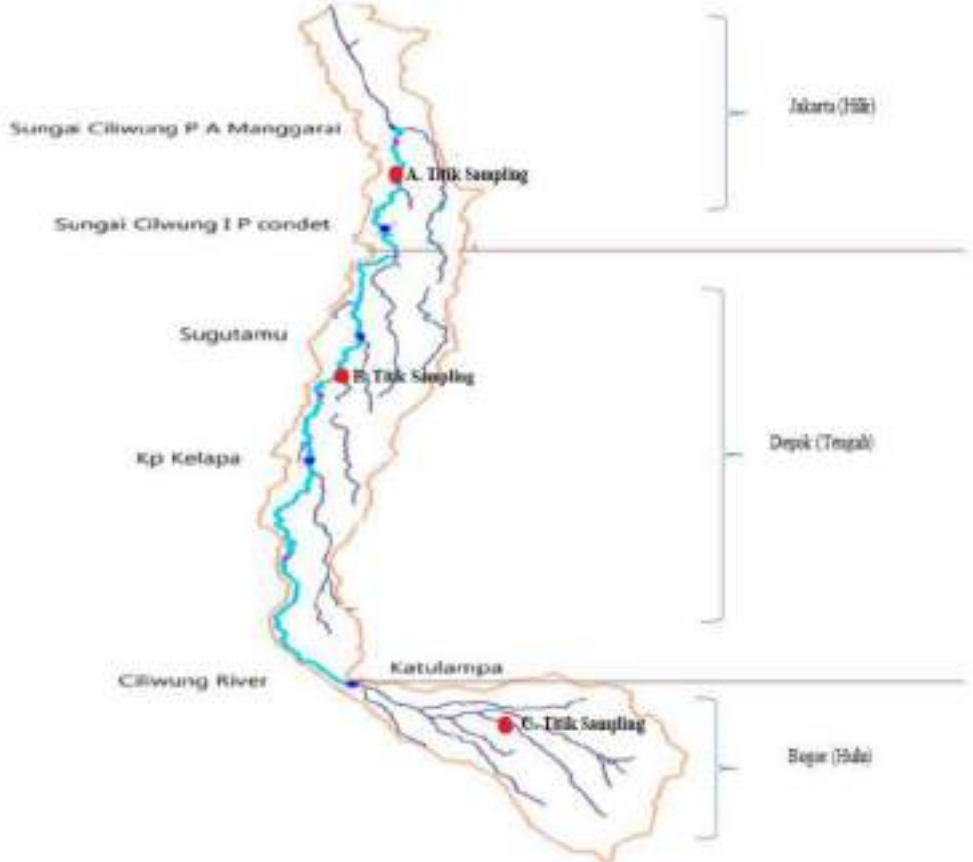

Figure 1. Map of Sampling Location of Plecostomus at the Ciliwung River Stream Area.

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2.2. Heavy metal analysis of water sampling

The analysis of water sample was conducted using *X-Ray Fluorescence* (XRF) spectrometer. XRF (X-ray fluorescence) is a non-destructive analytical technique used to determine the elemental composition of materials. XRF analyzers determine the chemistry of a sample by measuring the fluorescent (or secondary) X-ray emitted from a sample when it is excited by a primary X-ray source. Each of the elements present in a sample produces a set of characteristic fluorescent X-rays ("a fingerprint") that is unique for that specific element, which is why XRF spectroscopy is an excellent technology for qualitative and quantitative analysis of material composition.

This research using the XRF Method based on Ene et al., (2010). In this method, fish samples were made into cup samples. The making of cup samples began by scaling sample powder as many as 5 grams, later the samples were placed into cups. Then, samples inside the cups were coated with three layers of tissue and sealed with plastic. Fish samples inside the cup will be analyzed using XRF. Sediment samples were later changed into pellet samples. The making of pellet samples began by scaling sample powder as many as 5 grams, later added with 1 gram of fluxana before getting homogenized. Then, the samples were put into hydraulic press machine.

Water sample were analyzed by making the samples into cup samples. The process began by scaling the water before placed into cups. The samples were later coated with three layers of tissue and sealed with plastic. Then, the samples are ready to be analyzed using XRF.

Devices used to analyze metal contamination were calibrated and measured for its sensitivity to every elements with metal sheet fluxana HD Electronic MCACAL RA 1012. Measured data, such as intensity and elements energy later converted to numbers, so the result will come into absorbent percentage and part per million (ppm) metal element on samples. (AMPTEK, 2009) explain that XRF utilize X-ray emitted from materials that later forwarded to detector and transmitted into signal which intensity is appropriate with the amount of elements inside the samples (figure 4). The result of the metal measurement process can be seen in the program so that the output received in the form of chart, spectrum, and table.

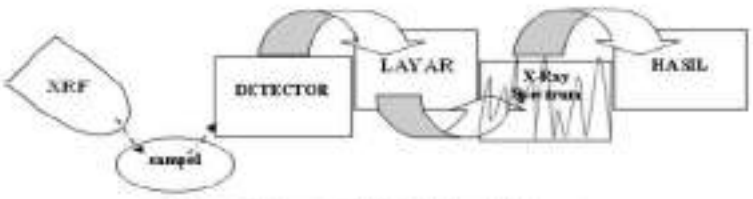

Figure 2. Analysis XRF Methods Scheme

3. RESULTS

The research result shows that on the Ciliwung River's water, contains the heavy metals of Pb, Hg, Cd, Cu, Mn, and Zn with a very high concentration, far beyond the standard of PP RI No.82 year 2001 (Table 1). The polluting source of heavy metal is suspected to have come from industrial activities of waste disposal on to the river so that it pollutes the water and its biota within the river (Widowati, et al., 2008). The industrial waste coming into the river stream area of Ciliwung Bogor and Depok is brought by the streams to the river stream area of Ciliwung Jakarta, resulting in high pollution at the river stream area of Ciliwung Jakarta.

Respectively, the types of metal that have the highest concentration at the three sampling points are Mn, Zn, Cu, Pb, Cd and Hg (Table 1). The river stream area of Ciliwung Jakarta shows a very high metal concentration at other sampling points. The metal content in a water area can make the downstream have a higher metal concentration compared to the upstream area (Mishra, et al., 2008).

The finding is in line with the research result that the heavy metal contents at the three sampling points show the highest value at the river's downstream.

Table 1. Heavy Metal Concentration at the Ciliwung River Stream Area

		Concentration (ppm)			
Heavy Metals	Year 2013*	Bogor (Upstream)	Depok (Middle stream)	Jakarta (Downstream)	Standard (ppm)**
Mn (Manganese)	-	1468 ± 3	472.1 ± 2.3	3101 ± 5	0.1
Zn (Zinc)	85.30-1270	689.7 ± 3.9	39.9 ± 0.8	912.7 ± 4.7	0.05-2
Cu (Copper)	16.90-157	120.2 ± 2.4	6.4 ± 6.4	152.5 ± 2.7	0.02-0.2
Pb (Lead)	7.800-89.4	59.9 ± 1.4	4.2 ± 0.4	73.8 ± 1.3	0.03-1
Cd(Cadmium)	0.29-1.74	<0.3 ± 0.0	1.3 ± 0.1	6.3 ± 0.3	0.01-0.01
Hg (Mercury)	-	2 ± 0.9	<0.7 ± 0.0	<0.7 ± 0.0	0.001-0.005

* Budianto and Lestari 2017; **Indonesia's Government Regulation No.82 year 2001;

(-): metals research was not conducted

4. DISCUSSION

There are three factors that cause the increase of heavy metal contents at Ciliwung's downstream (Jakarta area), first is the erosion of mineral stones at Ciliwung's upstream area. This condition happens because the upstream area is eroded which deepens the valley alongside the river stream, the erosion rate is faster than the sedimentation, and the density of the drainage is higher with steep slopes. Therefore, mineral erosion at the upstream area will settle at the middle stream and upstream of the river area (Harjadi, 2009). The second factor is the typology of the middle stream and downstream with their characteristics of sedimentation process and less erosion. Consequently, there is an accumulation value of heavy metal on the water and river sedimentation (Cahyani, et al., 2016). The third factor is an additional number of polluting substance that comes from people's activities. As what has been informed, people's activities by disposing wastes and activities related to river are more at the downstream area. It results in the higher potential increase of pollutant substance at the river stream area (Susanti, et al., 2014); (Supenah, et al., 2015)

The research results from 2013 to 2018 show the increase value of heavy metals of Zn, Cu, Pb and Cd. The Zn metal content is higher that is caused by industrial wastes that keeps getting higher each year in the water (Silambarasan, et al., 2012). This will lead to zinc ore smelting that has become the main source of zinc pollutant. Besides, the increase number of garbage, transportation, pesticide, and farming fungicide which contains ZnSo4 is an additional polluting source of the environment as the zinc has become one of the polluting sources (Silambarasan, et al., 2012).

The metal content of Cu keeps increasing along with the increase number of transportation (Silambarasan, et al., 2012). Cu metal has a tendency to be complex with organic species in the water. Through the process of water stagnation, the Cu ion can interact with organic species (which is from industrial waste) that has the capability of being settled as a solution in a complex and stored at the bottom surface of the river and is absorbed on to the water surface (Silambarasan, et al., 2012).

The source of pollution of Lead metal content in a water comes from the use of Lead as a medium to connect pipes used in industrial and domestic wastes disposal drainage. The presence of waste or solution cases the contact with the pipes containing Lead, that leads to the absorption of Lead to the river surface (Widowati, et al., 2008).

The natural source of cadmium (Cd) is found in the form of mineral in the water that is rare in the environment. Cadmium is the biggest and most toxic that is used in industries to metal coating, steel coating protection, and certain pigments of nickel-cadmium batteries and on plastic stabilizer during its manufacture and disposal thrown at the water. The concentration value of cadmium ranges from <0.3 ± 0.0 - 6.3 ± 0.3 ppm. The cadmium polluting source is suspected to have existed due to the waste disposal by paper, food, and pulp industries located alongside the river area. The previous studies also supported the fact that the water in Ciliwung River has been contaminated by Cd metal (Budiyanto & Lestari, 2017).

5. CONCLUSION

There has been an increase in terms of heavy metals on the river area of Ciliwung River. The highest heavy metals pollution occurs in the river stream area of Ciliwung Jakarta. The level of heavy metal pollution on Ciliwung River's water is beyond the basic water standard PP no. 82 Year 2001.

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