Risk Analysis of Cr and Cu Heavy Metals in the Ciwaringin Watershed

Analisis Risiko Logam Berat Cr dan Cu Pada DAS Ciwaringin

Kesia Aprillia Br Sitepu[1], Adelia Marliana[2], Mega Indah Handayani[3], Nurmalia[4], Stefani Yulita Leftungun[5,] Desy Sulistyorini[6]
[12345] Public Health Section,University Indonesia Maju, Jakarta
e-mail: [1]keziaapprilia@gmail.com , [2]megaindahh13@gmail.com, [3]adreliatenker@gmail.com , [4]stfhyleft@gmail.com, [5]nurmaliayaya675@gmail.com, [6]desy.sulistiyorini@gmail.com.

ABSTRACT

There are many human activities around the Ciwaringin River Basin which can cause polluted water, one of the pollutant substances is heavy metals. The purpose of this study was to measure the concentration and analyze the risk of exposure to the heavy metals Cr and Cu contained in river water. This research was conducted in the Ciwaringin River, Bogor Regency. Sampling was carried out 3 times in April, June and October 2020 at 4 different sampling points. Method: The data used is secondary data from the Department of Environment and Forestry. Based on the results of the study, it can be concluded that the average concentrations of the heavy metals Cr and heavy metals Cu when compared with the quality standards of class 1 PP No. 82 of 2001 the results of the concentration of heavy metals Cr and heavy metals Cu are lower than the quality standard. The risk of heavy metal Cr and Cu metal contamination has a risk value of ≤ 1, which means that the Raja Galuh River, Palimanan River, Cendrawasih River, and Kapetakan River are not at risk.

Keyword: analys risk, heavy metal, river

CORRESPONDENCE
Main author's name : Kesia Aprillia Br Sitepu
Address of house/residence, zip code : jl sub-district head of gabun 2 no 6, lenteng agung
Phone number : 081387446063

INTRODUCTION

Today environmental pollution, especially waters by heavy metals, is not only a national but also an international problem. Heavy metal pollution can come from industrial and natural activities (Novianto, Rachmadiarti, & Raharjo, 2012). Water pollution can be in the form of heavy metal salts and heavy metals which form toxic compounds. Heavy metals that are often found in water pollution are Hg, Pb, Cd, Cr, Cu, Ni, and Zn in the form of toxic compounds (Priyanto, Dwiyitno, & Ariyani, 2008).

In carrying out the inventory and identification, many variables affect its success, including the technical calculations that must be carried out. For this reason, a guideline is needed that provides guidance for the government, provincial governments and district/city governments in conducting an inventory and identification of water pollutant sources (Regulation of the Minister of State for the Environment, 2010). These metals are known to accumulate in the body of an organism and remain in the body for a long time as poisons (Kristanto, 2002). If the metal content in the waters increases little by little, the metal can be absorbed in the body tissues of organisms from the smallest which act as producers to the largest organisms which act as end consumers of the food chain such as fish, shrimp, shellfish and finally buried in the animal's tissues. Murtiani, 2003)

The river is one part of the possible sources of water for living things. The existence of human activities in the watershed can cause environmental pollution such as dirty rivers, scattered garbage, bad odors, disruption of the balance of aquatic ecosystems. As a result of activities in the upstream of the river that causes metals to accumulate downstream and in the Musi River. Exposure to heavy metals in the environment, even in low concentrations, can be harmful to human health. Industrial waste is a very dangerous toxic substance, especially those containing heavy metals in the production process. Heavy metals are widely used in industries such as the chemical industry, cement, metal smelting, mining, batteries, paint industry and other fields. Pollution caused by heavy metals is a serious problem because they can contaminate soil and groundwater and spread to the surrounding environment through water and wind and accumulate in plants. Hazards of heavy metal Cr Toxic effects include carcinogenicity, immune system disorders, nervous system disorders, kidney disorders and damage, respiratory effects, while hazards of heavy metal Cu include kidney disorders, liver damage, vomiting, dizziness, anemia, seizures, and death.

If the environment, especially water is polluted by heavy metals, it is very difficult to carry out the purification process. Risk analysis is the characterization of potential hazards affecting human health and the environment. Various activities on the Raja Galuh, Palimanani, Cendrawasih and Kapeakan rivers can cause water pollution, possibly releasing heavy metals which can cause disease for people who use the river water as raw water for their daily needs. One of the heavy metal pollutants such as Cr and Cu which are harmful to human health and the environment. To determine the threat of river pollution load to the health of river users, a study was carried out on the concentration of river pollution, then a risk analysis was carried out on the pollution load. The purpose of this study was to measure the heavy metal elements Cr and Cu and to analyze the health risks of the people in the Raja Galuh, Palimanan, Cendrawasih and Kamapakan rivers.

RESEARCH METHODS

This research was conducted in the Rajagaluh, Palimanan, Cendrawasih, and Kapetaka rivers. The data used in this research is secondary data from the

Department of the Environment. The time of this research was conducted in December 2022-January 2023.

Data analysis techniques in this study were divided into river water quality analysis with reference to PP No. 82 of 2001 which aims to compare measured heavy metal concentrations with quality standards, and perform risk analysis calculations. To find out the amount of risk that is accepted, the amount of intake of heavy metals Cr and Cu that is exposed to the human body is calculated first. Contaminant intake can be calculated by the following equation:

$$I_{nk} = \frac{C \ x \ R \ x \ tE \ x \ fE \ x \ Dt}{Wb \ x \ tavg}$$

Information :

Ink = Intake, the amount of risk agent that enters [(mg/kg-day)]

C = Concentration of risk agent (metal in water) (mg/l)

R = Intake rate; 1 liter/day (for children) and 2 liters/day for adults

FE = Annual exposure frequency (day/year)

tE = daily exposure time (hours/day)

Dt = duration of exposure, real time or 30 years projected (years)

Wb = body weight (kg)

TAVG = Average time period, 30 years x 365 days/year (carcinogenic)

Meanwhile, to calculate health risk characteristics, it is expressed as a Risk Quotient (RQ or Risk Level) for non-carcinogenic effects, calculated using the formula:

$$RQ = \frac{I_{nk}}{RfD}$$

Information :

RQ = Risk Quotient

Ink = Intake (intake) non-carcinogenic

RfD = Reference Dose (for oral exposure).

Health risks are declared to exist and need to be controlled if RQ > 1. If RQ < 1, the risk does not need to be controlled but needs to be maintained so that the RQ numerical value does not exceed 1.

RESEARCH RESULT

Analysis of Results of Heavy Metal Cr and Cu Heavy Metal Concentration

Table 1. Average Concentrations of Heavy Metals Cr and Heavy Metals Cu

Sampling Point	Concentration (Mg/l)	Average
	Cr	Cu

Raja Galuh	0;005	0;016
Palimanan	0;005	0;016
Cendrawasih	0;005	0;016
Kapetakan	0;005	0;016

The average concentration of Cr heavy metal is 0.005 mg/L. when compared with the quality standards of class 1 PP No. 82 of 2001 results in the concentration of the heavy metal Cr being lower than the quality standard. The average concentration of the heavy metal Cu is 0.016 mg/L. When compared with the quality standards of class 1 PP No. 82 of 2001, the concentration of Cu heavy metal was lower than the quality standard.

Estimated intake dose can be calculated according to the equation below

:

$$Ink = \frac{C \ x \ R \ x \ tE \ x \ fE \ x \ Dt}{Wb \ x \ tavg}$$

$$= \frac{C \ x \ R \ x \ tE \ x \ fE \ x \ Dt}{Wb \ x \ tavg}$$

Information :

Ink = Intake, the amount of risk agent that enters [(mg/kg-day)]

C = Concentration of risk agent (metal in water) (mg/l)

R = Intake rate; 1 liter/day (for children) and 2 liters/day for adults

FE = Annual exposure frequency (day/year)

tE = daily exposure time (hours/day)

Dt = duration of exposure, real time or 30 years projected (years)

Wb = body weight (kg)

TAVG = Average time period, 30 years x 365 days/year (carcinogenic)

The intake dose of the heavy metal Cr is at points 1 – 8 in segments 4 and 5 with an intake value of 0.00014 mg/kg/day which is obtained from the calculation results above.

The intake dose of heavy metal Cu at points 1-4 in segments 4 and 5 with an intake value of 0.000438356 mg/kg/day obtained from the above calculation results.

No	Parameter	RfD RAIS (mg/kg/day)	PP No. 28 Years 2001 (mg/L)	PERMEN KES No. 429 Years2010 (mg/L)

1	Cr	0;003	0,05	0,05
2	Cu	0;04	0,02	2

No	**Concentration (C)**	**R**	**Dt**	**fE**	**Wb**	**Hasil Calculation (Ink)**	**RfD**	Result **Calculation** Risk Quotient (RQ)	**Category**
1	0,016	2	30	350	70	0,00043	0,04	0,010	No Risk
2	0,016	2	30	350	70	0,00043	0,04	0,010	No Risk
3	0,016	2	30	350	70	0,00043	0,04	0,010	No Risk
4	0,016	2	30	350	70	0,00043	0,04	0,010	No Risk

Nitrate Concentration

Based on data from the analysis of nitrate levels conducted by the Health Service at 4 sample points, the results were quite varied. Table 1 shows the concentration of nitrate in river water in the study area around 0.016 mg/L, with an average concentration of nitrate at 4 sample points of 0.005 mg/L.

Dose Response and Exposure Analysis

In conducting a dose response analysis, the variable value of adult body weight in the risk estimate used was 70 kg, with the value of the intake rate variable in the estimated risk each day, namely 2 liters/day. So that the value used as the reference dose (RfD) is that which has been set by IRIS from the US-EPA of 1.6 mg/kg/day.

Exposure Analysis

Nitrate exposure analysis was carried out to determine the value of INK and is used to determine the level of health risk due to exposure. Based on table 1, the average intake (Ink) was obtained at sample point 1 (0.016 mg/day). After doing the calculations, the average intake value (Ink) at the 4 sample points of the study was 0.005 mg/day.

DISCUSSION

Hazard Identification

The first stage in risk analysis is hazard identification, which discusses the identification of sources of danger in the research location. The hazard identification stage is the identification of the types and characteristics as well as inherent capabilities of a risk agent that can cause adverse impacts on organisms, systems, or sub/populations 11. This research was conducted in the Rajagaluh, Palimanan, Cendrawasih, and Kamapakan River Basins. Sampling points were determined in the Rajagaluh, Palimanan, Cendrawasih, and Kamapakan segments

based on the types of activities that have the potential to produce heavy metal contamination. There are 4 segments obtained from the case study: point 1 is on the Rajagaluh River, point 2 is in Palimanan, point 3 is in Cendrawasih, and point 4 is in Kapetaka.

Exposure Assessment

Exposure assessment is a step to find out the exposure route of a risk agent into the body, whether through inhalation, ingestion, or absorption so that the amount of intake received by the at-risk population can be calculated. 12. At this stage, intake dose calculations will be carried out. Estimated intake dose can be calculated according to the equation below:

Estimated intake dose can be calculated according to the equation below:

$$Ink = \frac{C \ x \ R \ x \ tE \ x \ fE \ x \ Dt}{Wb \ x \ tavg}$$

$$= \frac{C \ x \ R \ x \ tE \ x \ fE \ x \ Dt}{Wb \ x \ tavg}$$

Keterangan :

Ink = Intake, the amount of risk agent that enters [(mg/kg-day)]
C = Concentration of risk agent (metal in water) (mg/l)
R = Intake rate; 1 liter/day (for children) and 2 liters/day for adults
FE = Annual exposure frequency (day/year)
tE = daily exposure time (hours/day)
Dt = duration of exposure, real time or 30 years projected (years)
Wb = body weight (kg)
TAVG = Average time period, 30 years x 365 days/year (carcinogenic)

The intake dose of the heavy metal Cr is at points 1 – 4 in segments 4 and 5 with an intake value of 0.00014 mg/kg/day which is obtained from the calculation results above.

The intake dose of heavy metal Cu at points 1-4 in segments 4 and 5 with an intake value of 0.000438356 mg/kg/day obtained from the calculation results above.

Characteristics of Risk (Risk Characterization)

Health risk characteristics are expressed as RQ (Risk Quotient) or risk level for non-carcinogenic effects. The RQ value indicates the level of health risk due to pollutant parameters (chemical agents). The RQ value is calculated by comparing the intake or the amount of chemical agent concentration that enters the human body with a certain body weight every day with the RfD (Reference Dose) value that has been obtained based on the literature in The Risk Assessment Information System (RAIS) database.

The results of this study indicate that the risk of Cr heavy metal contamination at points 1 – 4 is 0.00014. Meanwhile, the risk of Cu heavy metal contamination at point 1-4 is 0.000438356.
The risk level is said to be safe if the risk value is ≤ 1 and the risk level is said to be unsafe if the risk value is > 1. From the risk value of the two metals Cu and Cr the risk value is ≤ 1 which means that the Raja Galuh River, Palimanan River, Cenderawasih River, and Kapetakan River are not at risk . In line with research in the Tabalong watershed, the concentrations of Cu and Cr metals in In contrast to the study in the Sail River, Cu exceeded the quality standard of 0.06 mg/L while Cr was 0.14 mg/L. The limitations of this study were the examination of Cu and Cr content, while other heavy metal parameters were not examined.

CONCLUSION

Based on the results of the study, it can be concluded that the average concentrations of the heavy metals Cr and heavy metals Cu when compared with the quality standards of class 1 PP No. 82 of 2001 the results of the concentration of heavy metals Cr and heavy metals Cu are lower than the quality standard. The risk of heavy metal Cr and Cu metal contamination has a risk value of ≤ 1, which means that the Raja Galuh River, Palimanan River, Cendrawasih River, and Kapetakan River are not at risk.

SUGGESTION

Suggestions for the Raja Galuh River, Palimanan River, Cendrawasih River, and Kapetakan River to always maintain good water quality. Then it is important to apply warnings against the dangers of heavy metal pollution and others that can affect the quality of rivers so that people can avoid health problems around the Raja Galuh River, Palimanan River, Cendrawasih River, and Kapetaka River. In addition, the importance of waste management so that people do not throw garbage around the river. The community is also expected to be careful in using river water which contains heavy metals Cr and Cu. It is necessary to carry out further research and monitor water quality on a regular basis as a goal to obtain the latest information about water conditions.

THANK-YOU NOTE

Acknowledgments are optional, given to research funders/heads of research institutions/parties who have contributed a lot to help research. Acknowledgments are not addressed to any of the journal authors.

BIBLIOGRAPHY

-

Adam, M.A. et al. (2018) 'Analysis of the Environmental Quality of the Wangi-Beji River, Pasuruan Allegedly Contaminated by Factory, Settlement and Agriculture Waste', Samakia: Journal of Fisheries Science, 9(1), pp. 01–05.

Handayani, M. et al. (2022) 'Analysis of Environmental Health Risks for Nitrate Content in Well Water for Residents of Depok City', Journal of Environmental Sanitation, 2(1), pp. 14–20. doi:10.36086/jsl.v2i1.1143.

Lepa, O. et al. (2020) 'WATER QUALITY AND ENVIRONMENTAL QUALITY ANALYSIS FOR FISH FARMING IN LAIMADAT LAKE, EAST NUSA TENGGARA ANALYSIS OF WATER QUALITY AND ENVIRONMENTAL QUALITY FOR INTRODUCTION

Environment, J.S., Berat, L. and Cu, C. (2022) 'RISK ANALYSIS OF HEAVY METALS Cr AND Cu IN THE WATERSHED CILEFUNCTION WATERSHED', 2(1), pp. 1–6.

พวงผกา มะเสนา และประณต นันทิยะกุล (2557) 'No Titleการบริหารจัดการการบริการที่มีคุณภาพใน โรงพยาบาลสังกัดกระทรวงสาธารณสุข', วารสารวิชาการมหาวิทยาลัยอีสเทิร์นเอเชีย, 4(1), pp. 88–100.