Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN : 2550-0023

Vol 18, No 1, 2021, 81-87
Article available at homepage presipitasi

Research Article

Analysis of Chemical Properties and Heavy Metals from Cisadane River, Tangerang, Indonesia

Desy Rosarina[1*], Ellysa Kusuma Laksanawati[1], Dewi Rosanti[2]

[1] Department of Chemical Engineering, Universitas Muhammadiyah Tangerang, Tangerang, Indonesia
[2] Faculty of Mathematic and Natural Science, Universitas PGRI Palembang, Palembang, Indonesia
* Corresponding Author, email: derosa.heryansyah@gmail.com

Abstract

This paper explained heavy metals and chemical properties from the Cisadane River in Tangerang City. A survey method was used to determine the place for sampling the test material. Water measurement is carried out in situ and laboratory tests. Data retrieval was done by purposive sampling determining three observation stations, namely in the Taman Gajah Tunggal park area (station1), Babakan Cikokol residential area (station 2), and Karawaci paper mill area (station 3). The analysis was carried out exactly using analysis. Namely, analysis carried out in the laboratory. The parameters observed were COD, phosphate, DO, BOD, pH. Results of this study informed the water quality in the Cisadane City river did not meet Class II Water Quality Standards based on Government Regulation Number 82, the year 2001. The COD content only meets class II water quality standards at stations 1 and 3. BOD and phosphate content is high and exceeds class II water quality standards. Heavy metal content still meets the water quality standard threshold with a value of Cd less than 0.01 mg/L, Cu less than 0.02 mg/L, Pb less than 0.03mg/L, and Cr less than 0.05mg/L. Zn content exceeds the water quality standard threshold at station three and meets water quality standards at stations 1 and 2 with a value of less than 0.05mg/L.

Keywords: water quality standard, cisadane river, chemical properties, heavy metals

1. Introduction

Water Resources have been an international issue for some problems caused by climate and human activities (Jacangelo and Trussell, 2002). All of those can have an impact on biological diversity and human wellbeing. Water has been classification by surface water and underground water. Indonesia has some water problems, especially surface water; good water quality is essential to human health, social, economic development, and the ecosystem. Grow of the population could have an impact to degradation environments, especially water resources. Surface water pollution has been caused by industry, agriculture, domestic waste, mining, and else (Maryani and Wibowo, 2020; Naswir *et al.*, 2020; Wibowo *et al.*, 2020).

Indonesia has more ocean than land, especially surface water; Indonesia has 70% ocean and only 30% land. Indonesia's surface water availability by island is 4% in Java, 27% in Papua, 5% in Maluku, 22% in Sumatera, 8% in Sulawesi, 34% in Kalimantan, and 1% in Bali and Nusa Tenggara (Table 1).

Table 1. Surface water availability in indonesia

Island	Water Availability (million m^3/year)		
	$Q_{average}$	Q80%	Q90%
Java	164	88.909	69.791
Nusa Tenggara and Bali	49.620	35.632	32.165
Sulawesi	299.218	184.487	154.561
Kalimantan	1.314.021	900.381	727.301
Papua	1.062.154	794.496	716.443
Maluku	176.726	132.103	117.296
Sumatera	840.737	571.703	485.732
Total	**5.906.476**	**2.707.702**	**2.303.289**

Source: (Asian Development Bank, 2016)

Surface waters are classified into flowing and inundated water bodies, and one example of which is flowing water bodies are rivers (Oluyege *et al.*, 2009). The river has changed function along with the increasing activity around the river; Cisadane River is one of the major rivers in Tatar Pasundan, Java Island, which empties into the Java Sea; this river has a very high function and value for human life and wildlife.

Based on several previous studies, the Cisadane River quality has decreased and has been polluted caused by many factors like industrial, residential, office, restaurant, and cafe wastes and sedimentation caused by microplastic (Gumelar *et al.*, 2017a; Lubada *et al.*, 2018). The quality of surface water is an international issue and challenge to solve the harmful properties such as BOD, COD, DO, pH, phosphate, and heavy metal content in the Cisadane River. Polluted water is hazardous for the environment. Polluted water will harm aquatic biota, human health, and the environment (Ali *et al.*, 2019; Jiwan and Ajay, 2011). The research has described just for COD, BOD, river flow and DO except others chemical properties and heavy metals contents. This research would describe chemical properties and heavy metals content on Cisadane River Tangerang, Indonesia.

2. Methods

This study uses quantitative methods by taking measurements directly at the research and laboratory analysis location. The analysis was done in an integrated service unit laboratory on Tangerang city, Indonesia. The flow chart of this research can be seen in fig 1.

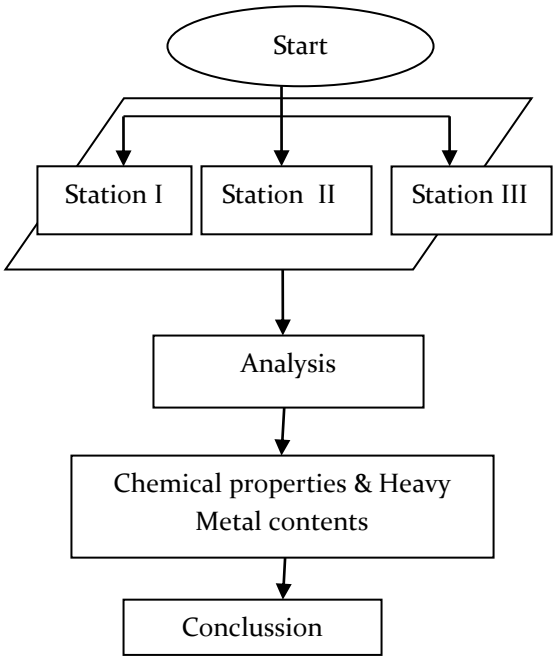

Figure 1. Research method

The research was conducted at three different stations using the National Indonesian Standard survey method (SNI 6989.57:2008); purposive sampling was done. The sampling location is in the park area in Taman Gajah Tunggal Cikokol (Station 1), a residential area in the Babakan Cikokol area (station 2), and a paper mill area in the Karawaci area (station 3). Water quality analyzes were carried out, including COD, DO, BOD, pH, phosphate, and heavy metals (Cu, Cd, Zn, Cr, and Pb). Cisadane Watershed is situated between 6^{o} 02' S to 6^{o} 54' S and 106^{o} 17' E.

Three different locations have been chosen to represent water quality on the Cisadane River; every station is different from other stations. City Park (Gajah Tunggal) Cikokol explains water quality in the city park, the second station can explain the residence area, and the last can describe the industrial area. Data were analyzed in the integrated regional service unit Environmental Laboratory of the Environment and Hygiene Office of Tangerang Regency, specifically by comparing the results of laboratory tests with quality standards following Government Regulation No. 82/2001 for class II designation.

3. Result and Discussion

3.1 Chemical Properties from Cisadane River

Water is one of the international issues; clean surface water will be supporting a healthy lifestyle and become a living place for several animals (Bouwer, 2000). Pollution and damage to surface water will hamper various developments and be harmful to human and animal life. Surface water that supports life and development has started to become polluted due to industrial activities, dumping garbage and waste into river bodies and dumping waste into receiving lands (Misra *et al.*, 2007). The activity of disposing of waste in wild rivers will increase pollutant parameters which can be dangerous and cause unpleasant odors. The uncontrolled disposal of waste into river basins will also threaten the life of microorganisms and other living things. Disposing of waste in surface water can increase levels of phosphate, chemical oxygen demand (COD), and Biological Oxygen Demand (BOD) cause water to be acidic or alkaline (Dayanandan *et al.*, 2003).

Increased BOD levels will reduce the oxygen in the water that fish, microorganisms need to survive (Zhou *et al.*, 2009). Microorganisms, such as bacteria, are living things that are responsible for decomposing organic material that enters river water. If this continues to happen, these microorganisms will consume the oxygen needed by other living things (fish). High levels of BOD cause the water quality of the Cisadane River to decline. The high BOD content is caused by the deficient dissolved oxygen (DO) concentration and the unsuitable living conditions of fauna and flora in the Cisadane River.

The high number of phytoplankton causes the decrease in BOD content in Cisadane River water; high phytoplankton growth is due to ammonia, which impacts nutrients and light that can enter the water (Xu *et al.*, 2010). Several studies have also reported that the BOD levels in the Cisadane River are below standard and are categorized as polluted (Akbari and Pangesti, 2020; Gumelar *et al.*, 2017b; Namara *et al.*, 2020; Siahaan *et al.*, 2011). Apart from BOD content, COD levels in the Cisadane River also indicate pollution. COD is an indicator of water pollution; COD is defined as the equivalent amount consumed in the oxidation of organic compounds by potent oxidizing agents such as dichromate or permanganate.

High COD level on Cisadane River is a sensitive issue because surface water impacts human activities. Anthropogenic influences and natural processes degrade surface waters and impair their use for drinking, industry, agriculture, recreation, and other purposes. Based on laboratory analysis. While COD is the amount of oxygen needed to oxidize good chemicals that can be degraded biologically (biodegradable) or that are difficult to degrade biologically (non-biodegradable) into CO_2 and H_2O, the highest that is found at station 2, namely 168mg/L, it is remarkable that the air quality standard is 25mg/L. The high COD level at station two is thought to be caused by the large amount of domestic waste entering the waters, organic and inorganic waste due to household activities discharged into water bodies.

National Indonesian Standard has been compared with water quality index about surface water qualification based on the use of standard parameters for water characterization. National Indonesian standard used three classifications for water quality class (class 1, class 2, and class 3). Water quality index by Indonesian standard index with water quality class 2 has used as a standard index about water pollution.

Table 2. Results of chemical analysis

Chemical Parameters	Station			Unit	Water Quality (Class II)
	1	2	3		
COD	9	168	18	mg/L	25
DO	3	4	3	mg/L	4
BOD	6	96	7	mg/L	3
pH	7,57	7,44	7,55	-	6-9
Phosphate	0,37	0,73	0,41	mg/L	0,2

In this study, the concentration of COD is bigger than BOD; it is caused by the number of chemical compounds that can be oxidized chemically is greater than biologically. The high value of COD and BOD indicates the number of organisms in the waters with high bacterial growth. This phenomenon causes unpleasant odors in the aquatic environment. The highest COD at station 2 indicates a high level of pollution in the area, as evidenced by the water's unpleasant odor and cloudy color with higher domestic activities besides the other two stations. Station 2 area is not suitable for aquatic biota life due to their characteristic. This area has a high concentration of COD, BOD, and Phosphate. These elements are harmful to the environment and human health.

BOD is one of the chemical parameters that indicates the amount of decomposed organic compounds in water, which shows the rate of use of dissolved oxygen (DO) used by microbes to decompose decomposed organic compounds. It has exceeded the class II water quality standard in all three stations, even though stations 1 and 3 are only slightly higher than the standard quality of 3mg/L, almost not so significant. The highest BOD is at station 2 of 96 mg/L. based on field observations, station II is a station with high activity. Thus, the high BOD at the station is thought to be due to high human activity in the region. Changes in land use characterized by increased domestic, agricultural and industrial activities will affect and impact river water quality, which provides the most considerable BOD input to river bodies. BOD is directly related to the oxygen content in water. BOD is the amount of oxygen used by microorganisms (bacteria) to decompose organic materials in water. The amount depends on the pH, temperature, type of microorganism, and organic and inorganic materials in the water, source of BOD leaves and pieces of wood in stagnant water, dead plants or animals, animal feces, so on. The higher the BOD content, the faster the oxygen in the water runs out, so it will harm the development of living things in the water, so that this area is not suitable for drinking water and aquatic biota life.

The value of pH in Cisadane River is neutral; this parameter is a figure expressing the acidity or alkalinity of a solution on a logarithmic scale on which 7 is neutral, lower values are more acid, and higher values more alkaline. The pH is equal to -log10 c, where c is the hydrogen ion concentration in moles per liter. National Indonesian Standard has made pH standard around 7-9 for surface water, pH of Cisadane River is around 7 in all station, It has been explaining water characterization by pH has not polluted, Cisadane River have normal pH in city park Cikokol, Regency of Babakan Cikokol and industrial area of Karawaci

Phosphate content in the water dramatically influences the balance of aquatic ecosystems; when phosphate levels in low waters, aquatic organisms' growth will be inhibited. Whereas if phosphate levels in high waters, aquatic organisms' growth becomes unlimited, it will damage the water ecosystem. Phosphate content in three stations exceeds the class II water quality standard threshold at three stations, which is 0.2 mg / L. High phosphate values are caused by phosphate accumulation originating

from waste at each station, especially in stations 2. Phosphates found in river waters are sourced from anthropogenic activities such as waste from urban, domestic, and industrial activities (Ni *et al.*, 2020). Waters contaminated with organic waste, especially phosphate, will increase the surface tension of the water in the form of a thin layer to block the diffusion of O2 from the air into the body of water. Bacteria can immediately absorb the presence of phosphate in the waters. Nearly half of the phosphorus in household waste comes from detergents (Koohsaryan *et al.*, 2020).

3.2 Metals Content from Cisadane River

Heavy metals are an indicator of water pollution and dangerous for human health (Chan *et al.*, 2003; Ha *et al.*, 2017; Martin and Griswold, 2009; Sun *et al.*, 2018). Based on laboratory analysis results, the water content of the Cisadane River contains heavy metals above the grade 2 water quality. Some studies do explain the benefits of heavy metals such as trace elements in biology, but on the other hand, heavy metals have an adverse impact above the threshold. What makes heavy metals dangerous is their precipitation and oxidation state. A recent study informs that some heavy metals that are very dangerous to humans (Wibowo *et al.*, 2020). Recent studies have informed that the adverse effects of exposure to or contamination with Cd damage bones and fractures (Liao *et al.*, 2016). Pb contamination has occurred and been reported throughout the world (Wibowo and Ramadan, 2021). At present, lead contamination through the water that occurs frequently occurs frequently; the worst and the most incidence is lead contamination through the consumed water (Ngoc *et al.*, 2020). This is because the water used for drinking has a high lead content.

The heavy metal content as in the Cisadane River, as listed in Table 2, is still within the class II water quality standard threshold. Only zinc (Zn) is very high in station 3. The high Zn content is thought to be caused by the waters in this region being waste from factory waste. Zn content is very high in rivers, especially in Central Java, around the factory area. Heavy metal is one of the biggest problems in water pollution that must be observed, often used as a raw material in industrial activities around river bodies. The results of the analysis of heavy metal content are shown in **Table 3**.

Table 1. Analysis of heavy metal

Parameter	Station			Unit	Water Quality (Class II)
	1	2	3		
Cadmium	<0,0029	<0,0029	<0,0029	mg/L	0,01
Copper	0,02	0,02	0,02	mg/L	0,02
Lead	<0,047	<0,047	<0,047	mg/L	0,03
Chrom	<0,008	<0,008	<0,008	mg/L	0,005
Zinc	<0,02	<0,02	9,6	mg/L	0,05

Increasing the content of heavy metals, especially lead and cadmium, in water bodies will continue to occur along with the increase in industrial activities, domestic activities due to the increasing number of settlements with outlets to river bodies (Fytianos *et al.*, 2001; Khademi *et al.*, 2019). Fishing activities also contribute heavy metals to the rotor from fuel spills. The industrial environment is the most significant contributor of heavy metals, especially copper (Cu), to water bodies; in addition to changing the quality of water, heavy metals can cause the transfer of toxic materials to organisms, from zooplankton is usually fish and crustacean larvae. The content of heavy metals and other chemicals also affects the abundance of plankton in the waters.

Several publications indicate that cadmium exposure's adverse health effects may occur at lower exposure levels than previously anticipated, primarily in the form of kidney damage but possibly also bone effects and fractures (Järup, 2003; Johri *et al.*, 2010; Kazantzis, 2004). Many individuals in Europe already exceed these exposure levels, and the margin is very narrow for large groups (Tóth *et al.*, 2016). Therefore, measures should be taken to reduce cadmium exposure in the general population to

minimize the risk of adverse health effects. Chemical concentration and fractionation of six globally alarming heavy metals (Cr, Ni, Cu, As, Cd, and Pb) and four are on the Cisadane River. Overall, the metals ion contaminated in the Cisadane River is less than water quality (level II). Thus, this surface water is safe from metal ion contamination. The regulation and preventive measures should be sustained and, if necessary, developed.

4. Conclusions

Based on the results of the study, it can be concluded that the chemical content of water and heavy metals in the Cisadane River in Tangerang City still meet the class II water quality standards based on Government Regulation No. 82 of 2001 on the three stations where DO, pH, Cd, Cu, Pb, and Cr. The COD content only meets class II water quality standards at stations 1 and 3, Zn content meets water standards at stations 1 and 2 and is very high at station 3, BOD and phosphate are high and exceed class II water quality standards.

References

Akbari, T., Pangesti, F.S.P., 2020. Water Quality Index of Cisadane River and Ciujung River 410, 131–134.

Ali, H., Khan, E., Ilahi, I., 2019. Environmental chemistry and ecotoxicology of hazardous heavy metals: Environmental persistence, toxicity, and bioaccumulation. Journal *of* Chemical. 2019.

Asian Development Bank, 2016. Indonesia Country Water Assessment.

Bouwer, H., 2000. Integrated water management: Emerging issues and challenges. Agric. Water Manag. 45, 217–228.

Chan, H.M., Scheuhammer, A.M., Ferran, A., Loupelle, C., Holloway, J., Weech, S., 2003. Impacts of mercury on freshwater fish-eating wildlife and humans. *Human and* Ecological Risk Assessment. 9, 867–883.

Dayanandan, A., Kanagaraj, J., Sounderraj, L., Govindaraju, R., Suseela Rajkumar, G., 2003. Application of an alkaline protease in leather processing: An ecofriendly approach. *Journal of* Cleaner Production. 11, 533–536.

Fytianos, K., Katsianis, G., Triantafyllou, P., Zachariadis, G., 2001. Accumulation of Heavy Metals in Vegetables Grown in an Industrial Area in Relation to Soil. Bull. *E*nvironmental Contamination *and* Toxicology. 67, 0423–0430.

Gumelar, A.R., Alamsyah, A.T., Gupta, I.B.H., Syahdanul, D., Tampi, D.M., 2017a. Sustainable Watersheds: Assessing the Source and Load of Cisadane River Pollution. International Journal of Environmental Science *and* Development. *8*, 484–488.

Gumelar, A.R., Alamsyah, A.T., Gupta, I.B.H., Syahdanul, D., Tampi, D.M., 2017b. Sustainable Watersheds: Assessing the Source and Load of Cisadane River Pollution. International Journal of Environmental Science *and* Development. 8, 484–488.

Ha, E., Basu, N., Bose-O'Reilly, S., Dórea, J.G., McSorley, E., Sakamoto, M., Chan, H.M., 2017. Current progress on understanding the impact of mercury on *Human and* Ecological Risk Assessment. 152, 419–433.

Jacangelo, J.G., Trussell, R.R., 2002. International report: Water and wastewater disinfection - Trends, issues and practices. Water Science *and* Technology*:* Water Supply. 2, 147–157.

Järup, L., 2003. Hazards of heavy metal contamination. Br. Med. Bull.

Jiwan, S., Ajay, K., 2011. Effects of Heavy Metals on Soil, Plants, Human Health and Aquatic Life. International Journal of Environmental Science *and* Development. 1, 15–21.

Johri, N., Jacquillet, G., Unwin, R., 2010. Heavy metal poisoning: The effects of cadmium on the kidney. BioMetals 23, 783–792.

Kazantzis, G., 2004. Cadmium, osteoporosis and calcium metabolism. BioMetals 17, 493–498.

Khademi, H., Gabarrón, M., Abbaspour, A., Martínez-Martínez, S., Faz, A., Acosta, J.A., 2019. Environmental impact assessment of industrial activities on heavy metals distribution in street dust and soil, Chemosphere. Elsevier Ltd.

Koohsaryan, E., Anbia, M., Maghsoodlu, M., 2020. Application of zeolites as non-phosphate detergent builders: A review. International Journal of Environmental Science *and* Development. 8, 104287.

Liao, J., Wen, Z., Ru, X., Chen, J., Wu, H., Wei, C., 2016. Distribution and migration of heavy metals in soil and crops affected by acid mine drainage: Public health implications in Guangdong Province,

China. Ecotoxicology *and* Environmental *Safety* 124, 460–469.
Lubada, L.A., Yokota, K., Hartono, A., Miyaura, R., 2018. Effects of Agriculture on the Water Quality of the Cisadane River System in West Java, Indonesia. Trop. Agric. Development. 62, 94–103.
Martin, S., Griswold, W., 2009. Human Health Effects of Heavy Metals. nd Technol. Briefs Citizens Page 1 Environ. Sci. Technol. Briefs Citizens 15, 1–6.
Maryani, A.T., Wibowo, Y.G., 2020. The physical and Chemical Impact of Microplastic in The Marine Environment : A Systematic Review. Sriwijaya Journal *of* Environment. 5, 60–68.
Misra, A.K., Saxena, A., Yaduvanshi, M., Mishra, A., Bhadauriya, Y., Thakur, A., 2007. Proposed river-linking project of India: A boon or bane to nature. Environation Geologi. 51, 1361–1376.
Namara, I., Hartono, D.M., Latief, Y., Moersidik, S.S., 2020. The Effect of Land Use Change on the Water Quality of Cisadane River Of the Tangerang City The Effect of Land Use Change on the Water Quality of Cisadane River Ofthe Tangerang City. Journal *of* Applied Science *and* Engineering. 2128–2134.
Naswir, M., Natalia, D., Arita, S., Wibowo, Y.G., 2020. Adsorption of Mercury Using Different Types of Activated Bentonite : A Study of Sorption , Kinetics , and Isotherm Models. J. Rekayasa Kim. dan Lingkung. Journal *of* Environmental Chemical Engineering. 15, 123–131.
Ngoc, N.T.M., Chuyen, N. Van, Thao, N.T.T., Duc, N.Q., Trang, N.T.T., Binh, N.T.T., Sa, H.C., Tran, N.B., Ba, N. Van, Khai, N. Van, Son, H.A., Han, P. Van, Wattenberg, E. V., Nakamura, H., Thuc, P. Van, 2020. Chromium, Cadmium, Lead, and Arsenic Concentrations in Water, Vegetables, and Seafood Consumed in a Coastal Area in Northern Vietnam. Environmental Health Insights. 14, 1–9.
Ni, Z., Wang, S., Wu, Y., Pu, J., 2020. Response of phosphorus fractionation in lake sediments to anthropogenic activities in China. Sci. Total Enviroment. 699, 134242.
Oluyege, J.O., Dada, A.C., Odeyemi, A.T., 2009. Incidence of multiple antibiotic resistant Gram-negative bacteria isolated from surface and underground water sources in south western region of Nigeria. Water Science *and* Technology. 59, 1929–1936.
Siahaan, R., Indrawan, A., Soedharma, D., Prasetyo, L.B., 2011. Kualitas Air Sungai Cisadane , Jawa Barat - Banten (Water Quality of Cisadane River , West Java - Banten) Water Quality Of Cisadane River, West Java-Banten. Journal Ilmiah Sains 11, 2.
Sun, D., Zhang, D.-X., Wu, W., Wu, P., Zhou, Y.-K., Yang, F., 2018. Assessment of heavy metal pollution and human health risks in urban soils around an electronics manufacturing facility. Science *of the* Total Environment. 630, 53–61.
Tóth, G., Hermann, T., Da Silva, M.R., Montanarella, L., 2016. Heavy metals in agricultural soils of the European Union with implications for food safety. Environment International. 88, 299–309.
Wibowo, Y.G., Ramadan, B.S., 2021. Enhanced Remediation and Recovery of Metal-Contaminated Soil Using Electrokinetic Soil Flushing. In: Electrokinetic Remediation for Environmental Security and Sustainability. pp. 603–628.
Wibowo, Y.G., Sudibyo, Muhammad, D., Naswir, M., Muljadi, B.P., 2020. Low-cost modified reactor to produce biochar and clamshell as alternative materials from acid mine drainage problem solving. In: The 4th International Symposium on Green Tecnology for Value Chains 2019. IOP Conferense Series: Earth and Environmental Science, pp. 1–7.
Xu, H., Paerl, H.W., Qin, B., Zhu, G., Gao, G., 2010. Nitrogen and phosphorus inputs control phytoplankton growth in eutrophic Lake Taihu, China. Limnol. Oceanogr., 55(1), 2010, 420–432. Limnol. Oceanography. 55, 420–432.
Zhou, Q., Li, K., Jun, X., Bo, L., 2009. Role and functions of beneficial microorganisms in sustainable aquaculture. Bioresour. Technology. 100, 3780–3786.