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Our decision is: Revisions Required

Dr Dedy Suhendra
Department of Chemistry, Faculty of Mathematics and Natural Science, University of Mataram.
dedysuhendra@unram.ac.id

Reviewer A:

This article falls within the scope of the ACA. Needs minor revisions before publication. My comments can be seen in the attached attachement.

Reviewer B:

The author presents an effort to determine and analyze the levels of lead contained in the water and sediments of the Rumbia River. In my opinion, this article can be published after the majors revision:

1. When was the sample taken, in what year? It's important to know the time span. 2. The author claims that the Pb level in the water is not yet dangerous. What is the basis for this statement. 3. Is it necessary to discuss the socio-economic community in the abstract while this article is about the Pb content in water. 4. Authors must follow the ACA journal writing format. Otherwise this article cannot be accepted.

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Notifications ×

[ACA] Editor Decision

2020-12-07 11:56 AM

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RESEARCH PAPER

Lead Metal in Water and Sediment: A Case Study of Rumbia River

Deasy Natalia Botutihe, [a] Sri Wanti Sappe,[b] Ahmad Kadir Kilo,[c] Jafar La Kilo,[d] and Akram La Kilo,*[e]

[a] MSc, DNB, Deasy
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[b] B.Sc. SWP, Sri
Department of Chemistry Education
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[c] M.Sc., AKK, Ahmad
Department of Chemistry Education
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[d] M.Sc., JLK
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[e] Dr, ALK, Akram
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
*E-mail: akram@ung.ac.id

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Keywords: Rumbia river; lead in river; water

INTRODUCTION

The increase in global pollution and the occurrence of industrialization have a real impact on the environment. One of the impacts is pollution and degradation of surface water quality. Sources of water pollution include domestic household activities, industrial waste disposal, agricultural activities, inadequate wastewater treatment and climate change (Eliku and Leta, 2018; Chatanga *et al*, 2019). The river is one of the aquatic environments that is most vulnerable to pollution by pollutants because river waters get runoff from urban and industrial domestic waste. In addition, there are still community habits that make the river as a garbage dump is also a factor that increases the level of water pollution.

One of the pollutants that are commonly found in waters is heavy metal. The abundant, persistent and toxic characteristics of heavy metals have caused

heavy water pollution by global metals. Increased heavy metals in the waters will have health impacts on humans and marine life (Ali *et al*, 2016). The impact of heavy metals on marine biota and humans can occur because of heavy metal contamination that enters the river water environment will dissolve in water and accumulate in sediments whose concentration can increase over time, depending on environmental conditions of the waters. Furthermore, heavy metals can move from the environment to organisms and from one organism to another through a food chain (Wulan *et al*., 2013; Yalcin *et al*., 2008).

Studies on heavy metal content in water and sediments can be used to assess the impact of anthropogenic, industrial activities and the risks posed by waste disposal in river ecosystems. So it is very important to analyze the levels of heavy metals in water and sediments in polluted river ecosystems (Ali *et al*, 2016).

Rumbia River is a river located in Rumbia Village, Botumoito District, Boalemo Regency. This river is often used for household purposes such as washing clothes, washing vehicles and other domestic activities. This condition allows river pollution, especially pollution by heavy metals. Research on heavy metals in Rumbia river water is Pb heavy metals. Until now, there has been no scientific research on the pollution of heavy metals of Pb in water and sediments in the Rumbia river. Therefore, the purpose of this study is to analyze the levels of heavy metals Pb in water and sediment and to generally evaluate the water quality of the Rumbia River.

MATERIALS AND METHODS

Tools and Materials

The tools used in this research are dropper, funnel, sample container, 100 mL erlenmeyer flask, mortar and pestle, bath, analytical balance, 50 mL and 100 mL measuring flask, 50 mL and 1000 mL beaker, thermometer, filter paper, glass measure, pH paper, oven, perselin dish, and petri dish. The material used in this study were river water, sediments, distilled water, and chemicals of $Pb(NO_3)_2$ and concentrated HNO_3. Lead metal content in samples was measured using Atomic Absorption Spectrophotometry of .

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Preparation of water samples is carried out in a chemical laboratory using the wet destruction method, namely the breakdown of samples with strong acids both single and mixed (Kristianingrum, 2012). Preparation is done by mixing a 200 ml water sample with concentrated HNO_3 until the pH of the mixture becomes 2. The sample is then put into a separating funnel and the complex is added in the form of ammonium pyrrolidine ditiocarbonate (APDC) in an organic methyl isobutyl ketone (MIBK) solvent. The heavy metal-APDC complex decomposes with concentrated HNO_3, thus forming ions and dissolving in the water phase. The water phase is collected then measured Pb metal content using AAS (atomic absorption spectrophotometer) of Simatzu AA 500.

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Sediment samples were aerated for several weeks to remove the water content. Sediment samples were each put in a cup and carried out the graying process at a temperature of 400-450^{o}C for ± 1 hour. After the graying process is finished the sample is mashed and weighed as much as 5 grams then dissolved by adding 10 mL of concentrated HNO_3 and diluted with 40 mL of distilled water. The solution is heated to boiling until the volume becomes 10 mL. If the fog is not visible again, add 10 mL of concentrated HNO_3 to the solution and reheat until mist occurs. Then the solution is diluted with distilled water until the sample volume becomes 50 mL, then filtered. The filtrate obtained was measured in lead using AAS.

Data Analysis Technique

Water quality data analysis is carried out descriptively, comparing measurement results obtained with sea water quality standards based on the Decree of the Minister of Environment of No. 51 of 2004 concerning Sea Water Quality Standards, specifically the quality standards for marine biota. Pb levels in water and

sediment samples are calculated using the linear regression equation obtained from a standard solution calibration curve which is a plot of the relationship between absorption at maximum wavelength and concentration of standard solution. Lead levels in water and sediment are obtained by entering data from the measurement of sample solutions into the regression equation.

RESULTS AND DISCUSSION

General Conditions of Sampling Location

Rumbia River is located in Rumbia Village, Botumoito District. The source of the Rumbia river comes from the forested Datahu Da'a spring which has abundant water. This water was taken over by the Regional Drinking Water Company by establishing a drinking water supply system and flowing water to the subdistrict center and several neighboring villages, as well as supplying water needs in tourism areas such as water park games and the Bolihutuo tourist beach (Paino, 2015). Sampling in the Rumbia River was carried out at 3 points. The condition of the sampling location can be presented in Table 1.

Table 1. Condition of Sampling Location

Location	Activities	Water	Sediment
Point 1 (estuary)	Residential areas	clear	Gray; Sandy
Point 2	Residential areas; Vehicle washing	clear	Gray; Sandy
Point 3	Residential areas	muddy	Black; Clay

Rumbia River Waters Quality

The quality of a waters can be measured using physicochemical parameters such as temperature and pH. Physicochemical parameters are considered as one of the important factors in influencing the aquatic environment. Temperature is a controlling factor of aquatic ecosystems because temperature affects the solubility of oxygen in water and the rate of metabolic activity of organisms so that it impacts on the survival of flora and fauna. The pH affects the acidic or basic nature of a waters. This property is vital for the chemical and biological processes of the aquatic system (Chatnga, *et al.*, 2019., Rameshkumar *et al*, 2019). The results obtained generally indicate that the quality of the Rumbia River waters is still relatively normal.

The measurement results of Rumbia river water temperature at points 1, 2 and 3 are 29, 30, and 28 ^{o}C, with an average temperature of 29 ^{o}C. This means that the temperature of the Rumbia River waters is still within the normal limits of water quality standards for the needs of marine biota based on Ministerial and Environmental Decree of No.51 of 2004 (Table 2).

Table 2. The temperature and pH of the Rumbia River water

Parameter	Quality standards	Average Rating
Suhu (^{o}C)	Coral: 28-30 Mangrove: 28-32 Seagrass: 28-30	28
pH	7 – 8,5	7

An increase in temperature can cause the rate of biological and chemical processes, in the water to increase, an increase in dissolved oxygen levels, an increase in the solubility of carbonates and hydroxides (Li *et al.*, 2013). The toxicity of heavy metals to biota is also affected by temperature. An increase in temperature can increase the process of entering heavy metals in the body and accelerate the reaction between heavy metals and protein (Budiastuti *et al*., 2016).

The measurement results for the pH of the Rumbia River waters are 7. Based on water quality standards by the Ministry of Environment No. 51 of 2004, the pH value obtained is within the permissible limits for marine biota (Table 2). The optimum pH for most aquatic organisms ranges from 6.5 to 8.5. A low pH value of around 4 and a high pH of around 11 can endanger the survival of aquatic organisms. In general, pH that is too low or too high can cause respiratory problems in fish and disturbance of acid-base balance in the blood (Boyd, 2015).

Besides pH affects the solubility of metals. At low pH, the metal solubility increases while at high pH, the metal will settle to the sediment. Increasing the pH of water will result in a change in the stability of the form of carbonate into hydroxide which can bind to particles in a body of water so that it will settle to form mud (Palar, 2004). Factors that influence the pH value include acid rainfall, water hardness, mineral water, waste from industrial processes, detergent waste (Utami, 2019).

Lead Heavy Metal (Pb) Concentration in Water and Sediments

Determination of Pb heavy metal content in the water and sediments of the Rumbia River was carried out in a quantitative manner using Atomic Absorption Spectrophotometry (AAS). The results show that Rumbia River water does not contain heavy metals Pb at point 1 and 0.001 mg/kg at point 2 and 3, whereas sediments contain Pb of 1.80 mg/kg dry weight at point 1 and 0.90 mg/kg dry weight at points 2 and 3 (Table

3). Pb metal content obtained in sediment is below the threshold standard of sediment quality based on sediment quality guidelines for metals and associated levels of concern to be used in doing assessments of sediment quality.

Table 3. Lead levels in the river Rumbia

Parameter	Point 1	Point 2	Point 3	Quality Standars
Water (mg/kg)	0	0,001	0,001	0,008[a]
Sediment (mg/kg)	1.80	0.90	0.90	36[b]

[a]Seawater quality standard according to Minister of the Environment Decree No.51 of 2004;
[b]Sediment quality standard with standard sediment quality guidelines for metals and associated levels of concern to be used in doing assessments of sediment quality in 2003

Based on the results of measurement of Pb content in sediments is higher than in waters that indicate there is accumulation of Pb in the bottom waters of the Rumbia River. Factors causing the presence of heavy metals Pb in sediments but not in waters, including due to the dilution of river waters because of their tendency to move freely due to the influence of currents, tides and waves so that Pb is not found in waters (Amriani et al, 2011). Current velocity affects the rate of distribution of heavy metals in waters. Strong currents cause heavy metals to be evenly distributed so that heavy metal content tends to be low (Mukhtasor, 2007). Heavy metals that enter the waters, both in rivers or the sea will be removed from the body of water through several processes such as precipitation, adsorption, absorption by aquatic organisms (Defew *et al*., 2005). Another factor is the ability of heavy metals to interact with free organic matter or particles suspended in water which are then sedimented to the bottom of the water. The process of heavy metal sedimentation can take place continuously so it will accumulate in the sediment. This causes the heavy metal content of sediment to be higher than in waters (Harlyan, 2015).

Pb heavy metals obtained in the Rumbia River sediment may be sourced from community activities, for example from domestic disposal such as cans, batteries, or cables. Other sources can also come from public vehicles that use lead-containing fuel which is then deposited on the riverbed. Low lead levels at the location between the middle and the estuary are caused by some metals being deposited on the riverbed and some of them being absorbed by organisms such as the Totok River (Buyang, 2013).

CONCLUSION

Based on the results of this study concluded that Rumbia River water does not contain heavy metals Pb. The Pb content in sediment at point 1 is 3.02 mg / kg dry weight while at points 2 and 3 that is 1.34 mg / kg respectively. Rumbia river water quality is based on temperature and pH parameters in accordance with water quality standards for marine biota determined by the Ministry of Environment No. 51 of 2004. In general it can be said that the waters of the Rumbia River are still at harmless levels. However, socio-economic conditions that continue to change over time can cause changes in the level of water pollution. So that there needs to be an effort and community awareness in maintaining the occurrence of increased levels of pollutants in the Rumbia River.

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Suhu (^{o}C)	Coral: 28-30 Mangrove: 28-32 Seagrass: 28-30	28
pH	7 – 8,5	7

An increase in temperature can cause the rate of biological and chemical processes, in the water to increase, an increase in dissolved oxygen levels, an increase in the solubility of carbonates and hydroxides (Li *et al.*, 2013). The toxicity of heavy metals to biota is also affected by temperature. An increase in temperature can increase the process of entering heavy metals in the body and accelerate the reaction between heavy metals and protein (Budiastuti *et al*., 2016).

The measurement results for the pH of the Rumbia River waters are 7. Based on water quality standards by the Ministry of Environment No. 51 of 2004, the pH value obtained is within the permissible limits for marine biota (Table 2). The optimum pH for most aquatic organisms ranges from 6.5 to 8.5. A low pH value of around 4 and a high pH of around 11 can endanger the survival of aquatic organisms. In general, pH that is too low or too high can cause respiratory problems in fish and disturbance of acid-base balance in the blood (Boyd, 2015).

Besides pH affects the solubility of metals. At low pH, the metal solubility increases while at high pH, the metal will settle to the sediment. Increasing the pH of water will result in a change in the stability of the form of carbonate into hydroxide which can bind to particles in a body of water so that it will settle to form mud (Palar, 2004). Factors that influence the pH value include acid rainfall, water hardness, mineral water, waste from industrial processes, detergent waste (Utami, 2019).

Lead Heavy Metal (Pb) Concentration in Water and Sediments

Determination of Pb heavy metal content in the water and sediments of the Rumbia River was carried out in a quantitative manner using Atomic Absorption Spectrophotometry (AAS). The results show that Rumbia River water does not contain heavy metals Pb at point 1 and 0.001 mg/kg at point 2 and 3, whereas sediments contain Pb of 1.80 mg/kg dry weight at point 1 and 0.90 mg/kg dry weight at points 2 and 3 (Table 3). Pb metal content obtained in sediment is below the threshold standard of sediment quality based on sediment quality guidelines for metals and associated levels of concern to be used in doing assessments of sediment quality.

Table 3. Lead levels in the river Rumbia

Parameter	Point 1	Point 2	Point 3	Quality Standars
Water (mg/kg)	0	0,001	0,001	0,008[a]
Sediment (mg/kg)	1.80	0.90	0.90	36[b]

[a]Seawater quality standard according to Minister of the Environment Decree No.51 of 2004;
[b]Sediment quality standard with standard sediment quality guidelines for metals and associated levels of concern to be used in doing assessments of sediment quality in 2003

Based on the results of measurement of Pb content in sediments is higher than in waters that indicate there is accumulation of Pb in the bottom waters of the Rumbia River. Factors causing the presence of heavy metals Pb in sediments but not in waters, including due to the dilution of river waters because of their tendency to move freely due to the influence of currents, tides and waves so that Pb is not found in waters (Amriani et al, 2011). Current velocity affects the rate of distribution of heavy metals in waters. Strong currents cause heavy metals to be evenly distributed so that heavy metal content tends to be low (Mukhtasor, 2007). Heavy metals that enter the waters, both in rivers or the sea will be removed from the body of water through several processes such as precipitation, adsorption, absorption by aquatic organisms (Defew *et al*., 2005). Another factor is the ability of heavy metals to interact with free organic matter or particles suspended in water which are then sedimented to the bottom of the water. The process of heavy metal sedimentation can take place continuously so it will accumulate in the sediment. This causes the heavy metal content of sediment to be higher than in waters (Harlyan, 2015).

Pb heavy metals obtained in the Rumbia River sediment may be sourced from community activities, for example from domestic disposal such as cans, batteries, or cables. Other sources can also come from public vehicles that use lead-containing fuel which is then deposited on the riverbed. Low lead levels at the location between the middle and the estuary are caused by some metals being deposited on the riverbed and some of them being absorbed by organisms such as the Totok River (Buyang, 2013).

CONCLUSION

Based on the results of this study concluded that Rumbia River water does not contain heavy metals Pb. The Pb content in sediment at point 1 is 3.02 mg / kg dry weight while at points 2 and 3 that is 1.34 mg / kg respectively. Rumbia river water quality is based on temperature and pH parameters in accordance with water quality standards for marine biota determined by the Ministry of Environment No. 51 of 2004. In general it can be said that the waters of the Rumbia River are still at harmless levels. However, socio-economic conditions that continue to change over time can cause changes in the level of water pollution. So that there needs to be an effort and community awareness in maintaining the occurrence of increased levels of pollutants in the Rumbia River.

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RESEARCH PAPER

Lead Metal in Water and Sediment: A Case Study of Rumbia River

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Abstract: The purpose of this study was to determine and analyze the levels of lead (Pb) content in the water and sediments of the Rumbia River. This research was conducted in a quantitative manner. Lead levels were measured using Atomic Absorption Spectrophotometer (SSA) of Simatzu AA 500. The results showed that the leadcontent in Rumbia River water for point A1 was undetectable whereas point 2 and 3 were 0.001 $mg.kg^{-1}$. In sediments, at point A1 is 1.8 $mg.kg^{-1}$ and at points 2 and 3 were 0.9 $mg.kg^{-1}$. The level of Pb in Rumbia River water is still below the water quality standard limit for marine biota determined by the Ministry of Environment No. 51 of 2004. Similarly, lead levels in sediments are below the threshold standard for sediment quality based on marine sediment quality standard for chemical criteria WAC 173-204-320. In general, it can be said that the concentration of lead in the Rumbia River is still at a harmless level. However, the changing socio-economic conditions from time to time can cause an increase in water pollution. Therefore, efforts and public awareness are needed to prevent heavy metal pollution, especially lead in the Rumbia River.

Keywords: Rumbia river; lead in river; water

INTRODUCTION

The increase in global pollution and the occurrence of industrialization have a real impact on the environment. One of the impacts is pollution and degradation of surface water quality. Sources of water pollution include domestic household activities, industrial waste disposal, agricultural activities, inadequate wastewater treatment and climate change [1], [2]. The river is one of the aquatic environments that is most vulnerable to pollution by pollutants because river waters get runoff from urban and industrial domestic waste. In addition, there are still community habits that make the river as a garbage dump is also a factor that increases the level of water pollution.

One of the pollutants that are commonly found in waters is heavy metal. The abundant, persistent and toxic characteristics of heavy metals have caused heavy water pollution by global metals. Increased heavy metals in the waters will have health impacts on humans and marine life [3]. The impact of heavy metals on marine biota and humans can occur because of heavy metal contamination that enters the river water environment will dissolve in water and accumulate in sediments whose concentration can increase over time, depending on environmental conditions of the waters. Furthermore, heavy metals can move from the environment to organisms and from one organism to another through a food chain [4], [5].

Studies on heavy metal content in water and sediments can be used to assess the impact of anthropogenic, industrial activities and the risks posed by waste disposal in river ecosystems. So it is very important to analyze the levels of heavy metals in water and sediments in polluted river ecosystems [3].

Rumbia River is a river located in Rumbia Village, Botumoito District, Boalemo Regency. This river is often used for household purposes such as washing clothes, washing vehicles and other domestic activities. This condition allows river pollution, especially pollution by heavy metals. Research on heavy metals in Rumbia river water is Pb heavy metals. Until now, there has been no scientific research on the pollution of heavy metals of Pb in water and sediments in the Rumbia river. Therefore, the purpose of this study is to analyze the levels of heavy metals Pb in water and sediment and to generally evaluate the water quality of the Rumbia River.

MATERIALS AND METHODS

This research was carried out for four months from November until February 2016. Sample was obtained from Rumbia river in Rumbia Village, Botumoito District, Boalemo Regency.

Tools and Materials

The tools used in this research are dropper, funnel, sample container, 100 mL erlenmeyer flask, mortar and pestle, bath, analytical balance, 50 mL and 100 mL measuring flask, 50 mL and 1000 mL beaker, thermometer, filter paper, glass measure, pH paper, oven, perselin dish, and petri dish. The material used in this study were river water, sediments, distilled water, and chemicals of $Pb(NO_3)_2$ and concentrated HNO_3. Lead metal content in samples was measured using Atomic Absorption Spectrophotometry.

Sampling

Sampling was carried out at 3 different points. The first point is at the mouth of the Rumbia river with taking on the west bank, middle and east bank of the river mouth. The second point is 50 meters away from the river mouth and the third point 50 meters from the second point. The sample is then put into a container and then taken to a chemical laboratory for lead heavy metal testing.

Water Quality Measurement

Water quality measurements are carried out in situ at each point with the measured parameters are the temperature and pH of each using a thermometer and a pH meter. Temperature and pH measurements were carried out to obtain a picture of the physical and chemical conditions of the waters during the study. The results of temperature and pH measurements are compared with water quality standards according to the Minister of Environment Decree No. 51 of 2004, specifically for marine biota.

Preparation

Water
Preparation of water samples is carried out in a chemical laboratory using the wet destruction method, namely the breakdown of samples with strong acids both single and mixed [6]. Preparation is done by mixing a 200 ml water sample with concentrated HNO_3 until the pH of the mixture becomes 2. The sample is then put into a separating funnel and the complex is added in the form of ammonium pyrrolidine ditiocarbonate (APDC) in an organic methyl isobutyl ketone (MIBK) solvent. The heavy metal-APDC complex decomposes with concentrated HNO_3, thus forming ions and dissolving in the water phase. The water phase is collected then measured Pb metal content using AAS (atomic absorption spectrophotometer) of Simatzu AA 500.

Sediment
Sediment samples were aerated for several weeks to remove the water content. Sediment samples were each put in a cup and carried out the graying process at a temperature of 400-450^{o}C for ± 1 hour. After the graying process is finished the sample is mashed and weighed as much as 5 grams then dissolved by adding 10 mL of concentrated HNO_3 and diluted with 40 mL of distilled water. The solution is heated to boiling until the volume becomes 10 mL. If the fog is not visible again, add 10 mL of concentrated HNO_3 to the solution and reheat until mist occurs. Then the solution is diluted with distilled water until the sample volume becomes 50 mL, then filtered. The filtrate obtained was measured in lead using AAS.

Data Analysis Technique

Water quality data analysis is carried out descriptively, comparing measurement results obtained with sea water quality standards based on the Decree of the Minister of Environment of No. 51 of 2004 concerning Sea Water Quality Standards, specifically the quality standards for marine biota. Sediment quality was obtained by comparing Pb content from AAS measurement in this study with marine sediment quality standard for chemical criteria WAC 173-204-320. Pb levels in water and sediment samples are calculated using the linear regression equation obtained from a standard solution calibration curve which is a plot of the relationship between absorption at maximum wavelength and concentration of standard solution. Lead levels in water and sediment are obtained by entering data from the measurement of sample solutions into the regression equation .

RESULTS AND DISCUSSION

General Conditions of Sampling Location

Rumbia River is located in Rumbia Village, Botumoito District. The source of the Rumbia river comes from the forested Datahu Da'a spring which has abundant water. This water was taken over by the Regional Drinking Water Company by establishing a drinking water supply system and flowing water to the subdistrict center and several neighboring villages, as well as supplying water needs in tourism areas such as water park games and the Bolihutuo tourist beach [7]. Sampling in the Rumbia River was carried out at 3 points. The condition of the sampling location can be presented in Table 1.

Table 1. Condition of Sampling Location

Location	Activities	Water	Sediment
Point 1 (estuary)	Residential areas	clear	Gray; Sandy
Point 2	Residential areas; Vehicle washing	clear	Gray; Sandy
Point 3	Residential areas	muddy	Black; Clay

Rumbia River Waters Quality

The quality of a waters can be measured using physicochemical parameters such as temperature and pH. Physicochemical parameters are considered as one of the important factors in influencing the aquatic environment. Temperature is a controlling factor of aquatic ecosystems because temperature affects the solubility of oxygen in water and the rate of metabolic activity of organisms so that it impacts on the survival of flora and fauna. The pH affects the acidic or basic nature of a waters. This property is vital for the chemical and biological processes of the aquatic system [1], [8]. The results obtained generally indicate that the quality of the Rumbia River waters is still relatively normal.

The measurement results of Rumbia river water temperature at points 1, 2 and 3 are 29, 30, and 28 ^{o}C, with an average temperature of 29 ^{o}C. This means that the temperature of the Rumbia River waters is still within the normal limits of water quality standards for the needs of marine biota based on Ministerial and Environmental Decree of No.51 of 2004 (Table 2).

Table 2. The temperature and pH of the Rumbia River water

Parameter	Quality standards	Average Rating
Suhu (^{o}C)	Coral: 28-30 Mangrove: 28-32 Seagrass: 28-30	28
pH	7 – 8,5	7

An increase in temperature can cause the rate of biological and chemical processes, in the water to increase, an increase in dissolved oxygen levels, an increase in the solubility of carbonates and hydroxides [9]. The toxicity of heavy metals to biota is also affected by temperature. An increase in temperature can increase the process of entering heavy metals in the body and accelerate the reaction between heavy metals and protein [10].

The measurement results for the pH of the Rumbia River waters are 7. Based on water quality standards by the Ministry of Environment No. 51 of 2004, the pH value obtained is within the permissible limits for marine biota (Table 2). The optimum pH for most aquatic organisms ranges from 6.5 to 8.5. A low pH value of around 4 and a high pH of around 11 can endanger the survival of aquatic organisms. In general, pH that is too low or too high can cause respiratory problems in fish and disturbance of acid-base balance in the blood [11].

Besides pH affects the solubility of metals. At low pH, the metal solubility increases while at high pH, the metal will settle to the sediment. Increasing the pH of water will result in a change in the stability of the form of carbonate into hydroxide which can bind to particles in a body of water so that it will settle to form mud [12]. Factors that influence the pH value include acid rainfall, water hardness, mineral water, waste from industrial processes, detergent waste [13]. Natural waters have a pH of around 7 which is characterized by sufficient dissolved oxygen level [14].

Lead Heavy Metal (Pb) Concentration in Water and Sediments

Determination of Pb heavy metal content in the water and sediments of the Rumbia River was carried out in a quantitative manner using Atomic Absorption Spectrophotometry (AAS). The results show that Rumbia River water does not contain heavy metals Pb at point 1 and 0.001 mg.kg^{-1} at point 2 and 3, whereas sediments contain Pb of 1.80 mg.kg^{-1} dry weight at point 1 and 0.90 mg.kg^{-1} dry weight at points 2 and 3 (Table 3). Pb metal content obtained in sediment is below the threshold standard of sediment quality based on sediment quality guidelines for metals and associated levels of concern to be used in doing assessments of sediment quality.

Table 3. Lead levels in the river Rumbia

Parameter	Point 1	Point 2	Point 3	Quality Standars
Water (mg.kg^{-1})	0	0,001	0,001	0,008[a]
Sediment (mg.kg^{-1})	1.80	0.90	0.90	450[b]

[a]Seawater quality standard according to Minister of the Environment Decree No.51 of 2004;
[b] marine sediment quality standard for chemical criteria WAC 173-204-320

Based on the results of measurement of Pb content in sediments is higher than in waters that indicate there is accumulation of Pb in the bottom waters of the Rumbia River. Factors causing the presence of heavy metals Pb in sediments but not in waters, including due to the dilution of river waters because of their tendency to move freely due to the influence of currents, tides and waves so that Pb is not found in waters [15]. Current velocity affects the rate of distribution of heavy metals

in waters. Strong currents cause heavy metals to be evenly distributed so that heavy metal content tends to be low [16]. Heavy metals that enter the waters, both in rivers or the sea will be removed from the body of water through several processes such as precipitation, adsorption, absorption by aquatic organisms [17]. Another factor is the ability of heavy metals to interact with free organic matter or particles suspended in water which are then sedimented to the bottom of the water. The process of heavy metal sedimentation can take place continuously so it will accumulate in the sediment. This causes the heavy metal content of sediment to be higher than in waters [18].

Pb heavy metals obtained in the Rumbia River sediment may be sourced from community activities, for example from domestic disposal such as cans, batteries, or cables. Other sources can also come from public vehicles that use lead-containing fuel which is then deposited on the riverbed. Low lead levels at the location between the middle and the estuary are caused by some metals being deposited on the riverbed and some of them being absorbed by organisms such as the Totok River [19].

Elemental lead often binds to sulfur in the form of sulfides (S2-) or phosphates (PO43-). In this case, lead is very insoluble, and exists as an immovable compound in the environment [20]. However, lead can dissolve in water as $PbCO_3$. From the point of view of the biological donor site, the lead ion (Pb^{2+}) is a borderline ion in Hard Soft-Acid Base (HSAB) theory which forms a complex with suflur and oxygen rather than nitrogen [21]. As a borderline ion, lead prefers to react with NO_2^- and SO_3^- ions [22].

CONCLUSION

Based on the results of this study concluded that Rumbia River water does not contain heavy metals Pb. The Pb content in sediment at point 1 is 3.02 $mg.kg^{-1}$ dry weight while at points 2 and 3 that is 1.34 $mg.kg^{-1}$ respectively. Rumbia river water quality is based on temperature and pH parameters in accordance with water quality standards for marine biota determined by the Ministry of Environment No. 51 of 2004. In general it can be said that the waters of the Rumbia River are still at harmless levels. However, socio-economic conditions that continue to change over time can cause changes in the level of water pollution. So that there needs to be an effort and community awareness in maintaining the occurrence of increased levels of pollutants in the Rumbia River.

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RESEARCH PAPER

Lead Metal in Water and Sediment: A Case Study of Rumbia River

Deasy Natalia Botutihe, [a] Sri Wanti Sappe,[b] Ahmad Kadir Kilo,[c] Jafar La Kilo,[d] and Akram La Kilo,*[e]

[a] MSc, DNB, Deasy
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[b] B.Sc. SWP, Sri
Department of Chemistry Education
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[c] M.Sc., AKK, Ahmad
Department of Chemistry Education
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[d] M.Sc., JLK
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
[e] Dr, ALK, Akram
Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119
*E-mail: akram@ung.ac.id

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Abstract: This study aimed to determine and analyze the levels of lead (Pb) content in the water and sediments of the Rumbia River. This research was conducted quantitatively. Lead levels were measured using an Atomic Absorption Spectrophotometer of Simatzu AA 500. The results showed that the lead content in Rumbia River water for point A1 was undetectable, whereas points 2 and 3 were 0.001 $mg.kg^{-1}$. In sediments, at point A1 is 1.8 $mg.kg^{-1}$ and at points 2 and 3 were 0.9 $mg.kg^{-1}$. The level of Pb in Rumbia River water is still below the water quality standard limit for marine biota determined by the Ministry of Environment No. 51 of 2004.
Similarly, lead levels in sediments are below the threshold standard for sediment quality based on marine sediment quality standard for chemical criteria WAC 173-204-320. In general, it can be said that the concentration of lead in the Rumbia River is still at a harmless level. However, the changing socio-economic conditions from time to time can cause an increase in water pollution. Therefore, efforts and public awareness are needed to prevent heavy metal pollution, especially lead in the Rumbia River.

Keywords: Rumbia river; lead in river; water

INTRODUCTION

The increase in global pollution and the occurrence of industrialization have a real impact on the environment. One of the impacts is pollution and degradation of surface water quality. Sources of water pollution include domestic household activities, industrial waste disposal, agricultural activities, inadequate wastewater treatment, and climate change [1-2]. The river is one of the aquatic environments that are most vulnerable to pollution by pollutants because river waters get runoff from urban and industrial domestic waste. In addition, there are still community habits that make the river a garbage dump and increase the level of water pollution.

One of the pollutants that are commonly found in waters is heavy metal. The abundant, persistent, and toxic characteristics of heavy metals have caused heavy water pollution by global metals. Increased heavy metals in the waters will have health impacts on humans and marine life [3]. The effect of heavy metals on marine biota and humans can occur because heavy metal contamination that enters the river water environment will dissolve in water and accumulate in sediments whose concentration can increase over time, depending on the waters' environmental conditions. Furthermore, heavy metals can move from the environment to organisms and from one organism to another through a food chain [4], [5].

Studies on heavy metal content in water and sediments can be used to assess the impact of anthropogenic, industrial activities and the risks posed by waste disposal in river ecosystems. So it is crucial to analyze the levels of heavy metals in water and sediments in polluted river ecosystems [3].

Rumbia River is a river located in Rumbia Village, Botumoito District, Boalemo Regency. This river is often used for household purposes such as washing clothes, washing vehicles, and other domestic activities. This condition allows river pollution, especially pollution by heavy metals. Research on heavy metals in Rumbia river water is Pb heavy metals. There has been no scientific research on the pollution of heavy metals of Pb in water and sediments in the Rumbia river. Therefore, this study aims to analyze the levels of heavy metals Pb in water and sediment and generally evaluate the water quality of the Rumbia River.

MATERIALS AND METHODS

This research was carried out for four months, from November until February 2016. The sample was obtained from Rumbia river in Rumbia Village, Botumoito District, Boalemo Regency.

Tools and Materials

The tools used in this research are dropper, funnel, sample container, 100 ml Erlenmeyer flask, mortar and pestle, bath, analytical balance, 50 mL and 100 mL measuring flask, 50 mL and 1000 mL beaker, thermometer, filter paper, glass measure, pH paper, oven, porcelin dish, and petri dish. The material used in this study were river water, sediments, distilled water, and chemicals of $Pb(NO_3)_2$ and concentrated HNO_3. Lead metal content in samples was measured using Atomic Absorption Spectrophotometry.

Sampling

Sampling was carried out at three different points. The first point is at the Rumbia river's mouth with taking on the west bank, middle and east bank of the river mouth. The second point is 50 meters away from the river mouth, and the third point 50 meters from the second point. The sample is then put into a container and then taken to a chemical laboratory for lead heavy metal testing.

Water Quality Measurement

Water quality measurements are carried out in situ at each point, with the measured parameters are the temperature and pH of each using a thermometer and a pH meter. Temperature and pH measurements were carried out to obtain a picture of the waters' physical and chemical conditions during the study. The results of temperature and pH measurements are compared with water quality standards according to the Minister of Environment Decree No. 51 of 2004, specifically for marine biota.

Preparation

Water

Preparation of water samples is carried out in a chemical laboratory using the wet destruction method, namely the breakdown of samples with strong acids, both single and mixed [6]. Preparation is done by mixing a 200 ml water sample with concentrated HNO_3 until the mixture's pH becomes 2. The sample is then put into a separating funnel, and the complex is added in the form of ammonium pyrrolidine ditiocarbonate (APDC) in an organic methyl isobutyl ketone (MIBK) solvent. The heavy metal-APDC complex decomposes with concentrated HNO_3, thus forming ions and dissolving in the water phase. The water phase is collected then measured Pb metal content using AAS (atomic absorption spectrophotometer) of Simatzu AA 500.

Sediment

Sediment samples were aerated for several weeks to remove the water content. Sediment samples were each put in a cup and carried out the graying process at a temperature of 400-450^oC for ± 1 hour. After the graying process is finished, the sample is mashed and weighed as much as 5 grams, then dissolved by adding 10 mL of concentrated HNO_3 and diluted with 40 mL of distilled water. The solution is heated to boiling until the volume becomes 10 mL. If the fog is not visible again, add 10 mL of concentrated HNO_3 to the solution and reheat until mist occurs. Then the solution is diluted with distilled water until the sample volume becomes 50 mL, then filtered. The filtrate obtained was measured in lead using AAS.

Data Analysis Technique

Water quality data analysis is carried out descriptively, comparing measurement results obtained with

seawater quality standards based on the Decree of the Minister of Environment of No. 51 of 2004 concerning Sea Water Quality Standards, specifically the quality standards for marine biota. Sediment quality was obtained by comparing Pb content from AAS measurement in this study with marine sediment quality standard for chemical criteria WAC 173-204-320. Pb levels in water and sediment samples are calculated using the linear regression equation obtained from a standard solution calibration curve which is a plot of the relationship between absorption at a maximum wavelength and standard solution concentration. Lead levels in water and sediment are obtained by entering data from sample solutions' measurement into the regression equation.

RESULTS AND DISCUSSION

General Conditions of Sampling Location

Rumbia River is located in Rumbia Village, Botumoito District. The source of the Rumbia river comes from the forested Datahu Da'a spring, which has abundant water. The Regional Drinking Water Company took over this water by establishing a drinking water supply system and flowing water to the subdistrict center and several neighboring villages and supplying water needs in tourism areas such as water park games and the Bolihutuo tourist beach [7]. Sampling in the Rumbia River was carried out at 3 points. The condition of the sampling location can be presented in Table 1.

Table 1. Condition of Sampling Location

Location	Activities	Water	Sediment
Point 1 (estuary)	Residential areas	clear	Gray; Sandy
Point 2	Residential areas; Vehicle washing	clear	Gray; Sandy
Point 3	Residential areas	muddy	Black; Clay

Rumbia River Waters Quality

The quality of waters can be measured using physicochemical parameters such as temperature and pH. Physicochemical parameters are considered as one of the important factors in influencing the aquatic environment. Temperature is a controlling factor of aquatic ecosystems because temperature affects the solubility of oxygen in the water and the rate of organisms' metabolic activity, so that it impacts the survival of flora and fauna. The pH affects the acidic or basic nature of waters. This property is vital for the aquatic system's chemical and biological processes [1], [8]. The results obtained generally indicate that the quality of the Rumbia River waters is still relatively normal.

The measurement results of Rumbia river water temperature at points 1, 2, and 3 are 29, 30, and 28 ^{o}C, with an average of 29 ^{o}C. It means that the Rumbia River waters' temperature is still within the normal limits of water quality standards for marine biota needs based on Ministerial and Environmental Decree of No.51 of 2004 (Table 2).

Table 2. The temperature and pH of the Rumbia River water

Parameter	Quality standards	Average Rating
Suhu (^{o}C)	Coral: 28-30 Mangrove: 28-32 Seagrass: 28-30	28
pH	7 – 8,5	7

An increase in temperature can cause the rate of biological and chemical processes in the water to increase, an increase in dissolved oxygen levels, an increase in the solubility of carbonates and hydroxides [9]. The toxicity of heavy metals to biota is also affected by temperature. An increase in temperature can increase the process of entering heavy metals into the body and accelerate the reaction between heavy metals and protein [10].

The measurement results for the pH of the Rumbia River waters are 7. Based on water quality standards by the Ministry of Environment No. 51 of 2004, the pH value obtained is within the permissible limits for marine biota (Table 2). The optimum pH for most aquatic organisms ranges from 6.5 to 8.5. A low pH value of around 4 and a high pH of around 11 can endanger aquatic organisms' survival. In general, pH that is too low or too high can cause respiratory problems in fish and disturbance of acid-base balance in the blood [11].

Besides, pH affects the solubility of metals. At low pH, the metal solubility increases, while at high pH, the metal will settle to the sediment. Increasing the pH of the water will result in a change in the form of carbonate's stability into hydroxide, which can bind to particles in a body of water so that it will settle to form mud [12]. Factors that influence the pH value include acid rainfall, water hardness, mineral water, waste from industrial processes, detergent waste [13]. Natural waters have a pH of around 7, characterized by sufficient dissolved oxygen levels [14].

Lead Heavy Metal (Pb) Concentration in Water and Sediments

Determination of Pb heavy metal content in the water and sediments of the Rumbia River was carried out in a quantitative manner using Atomic Absorption

Spectrophotometry (AAS). The results show that Rumbia River water does not contain heavy metals Pb at point 1 and 0.001 mg.kg^{-1} at point 2 and 3, whereas sediments contain Pb of 1.80 mg.kg^{-1} dry weight at point 1 and 0.90 mg.kg^{-1} dry weight at points 2 and 3 (Table 3). Pb metal content obtained in sediment is below the threshold standard of sediment quality based on sediment quality guidelines for metals and associated levels of concern for sediment quality assessments.

Table 3. Lead levels in the river Rumbia

Parameter	Point 1	Point 2	Point 3	Quality Standards
Water (mg.kg^{-1})	0	0,001	0,001	0,008[a]
Sediment (mg.kg^{-1})	1.80	0.90	0.90	450[b]

seawater quality standard according to Minister of the Environment Decree No.51 of 2004;
[b] marine sediment quality standard for chemical criteria WAC 173-204-320

Based on the results of measurement of Pb content in sediments is higher than in waters that indicate there is an accumulation of Pb in the bottom waters of the Rumbia River. Factors causing the presence of heavy metals Pb in sediments but not in waters, including due to the dilution of river waters because they tended to move freely due to the influence of currents, tides and waves so that Pb is not found in waters [15]. Current velocity affects the rate of distribution of heavy metals in waters. Strong currents cause heavy metals to be evenly distributed so that heavy metal content tends to be low [16]. Heavy metals that enter the waters, both in rivers or the sea, will be removed from the body of water through several processes such as precipitation, adsorption, absorption by aquatic organisms [17]. Another factor is heavy metals' ability to interact with free organic matter or particles suspended in water, which are then sedimented to the bottom of the water. The process of heavy metal sedimentation can take place continuously, so it will accumulate in the sediment. It causes the heavy metal content of sediment to be higher than in waters [18].

Pb heavy metals obtained in the Rumbia River sediment may be sourced from community activities, for example, from domestic disposals such as cans, batteries, or cables. Other sources can also come from public vehicles that use lead-containing fuel, which is then deposited on the riverbed. Low lead levels at the location between the middle and the estuary are caused by some metals being deposited on the riverbed and some of them being absorbed by organisms such as the Totok River [19].

Elemental lead often binds to sulfur in sulfides (S2-) or phosphates (PO43-). In this case, lead is very insoluble and exists as an immovable compound in the environment [20]. However, lead can dissolve in water as $PbCO_3$. From the point of view of the biological donor site, the lead ion (Pb^{2+}) is a borderline ion in Hard Soft-Acid Base (HSAB) theory which forms a complex with sulfur and oxygen rather than nitrogen [21]. As a borderline ion, lead prefers to react with NO_2^- and SO_3^- ions [22].

CONCLUSION

Based on the results of this study concluded that Rumbia River water does not contain heavy metals Pb. The Pb content in sediment at point 1 is 3.02 mg.kg^{-1} dry weight while at points 2 and 3 that is 1.34 mg.kg$^{-1,}$ respectively. Rumbia river water quality is based on temperature and pH parameters in accordance with water quality standards for marine biota determined by the Ministry of Environment No. 51 of 2004. In general, it can be said that the waters of the Rumbia River are still at harmless levels. However, socio-economic conditions that continue to change over time can cause water pollution changes. There needs to be an effort and community awareness in maintaining the occurrence of increased levels of pollutants in the Rumbia River.

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RESEARCH PAPER

Lead Metal in Water and Sediment: A Case Study of Rumbia River

Deasy Natalia Botutihe [a], Sri Wanti Sappe[b], Ahmad Kadir Kilo[b], Jafar La Kilo[a], and Akram La Kilo*[a]

[a] Department of Chemistry
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119, Indonesia
[b] Department of Chemistry Education
State University of Gorontalo
Jl. Prof. Dr. Ing. B. J. Habibie, Moutong, Tilongkabila, Kabupaten Bone Bolango, Gorontalo 96119, Indonesia
Email: akram@ung.ac.id

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Abbreviations: AAS: Atomic Absorption Spectrophotometer

Abstract: This study aimed to determine and analyze the levels of lead (Pb) content in the water and sediments of the Rumbia River. This research was conducted quantitatively. Lead levels were measured using an Atomic Absorption Spectrophotometer of Simatzu AA 500. The results showed that the lead content in Rumbia River water for point A1 was undetectable, whereas points 2 and 3 were 0.001 $mg.kg^{-1}$. In sediments, at point A1 is 1.8 $mg.kg^{-1}$ and at points 2 and 3 were 0.9 $mg.kg^{-1}$. The level of Pb in Rumbia River water is still below the water quality standard limit for marine biota determined by the Ministry of Environment No. 51 of 2004. Similarly, lead levels in sediments are below the threshold standard for sediment quality based on marine sediment quality standard for chemical criteria WAC 173-204-320. In general, it can be said that the concentration of lead in the Rumbia River is still at a harmless level. However, the changing socio-economic conditions from time to time can cause an increase in water pollution. Therefore, efforts and public awareness are needed to prevent heavy metal pollution, especially lead in the Rumbia River.

Keywords: Rumbia river, lead in river, water

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INTRODUCTION

The increase in global pollution and the occurrence of industrialization have a real impact on the environment. One of the impacts is pollution and degradation of surface water quality. Sources of water pollution include domestic household activities, industrial waste disposal, agricultural activities, inadequate wastewater treatment, and climate change [1-2]. The river is one of the aquatic environments that are most vulnerable to pollution by pollutants because river waters get runoff from urban and industrial domestic waste. In addition, there are still community habits that make the river a garbage dump and increase the level of water pollution.

One of the pollutants that are commonly found in waters is heavy metal. The abundant, persistent, and toxic characteristics of heavy metals have caused heavy water pollution by global metals. Increased heavy metals in the waters will have health impacts on humans and marine life [3]. The effect of heavy metals on marine biota and humans can occur because heavy metal contamination that enters the river water environment will dissolve in water and accumulate in sediments whose concentration can increase over time, depending on the waters' environmental conditions. Furthermore, heavy metals can move from the environment to organisms and from one organism to another through a food chain [4], [5].

Studies on heavy metal content in water and sediments can be used to assess the impact of anthropogenic, industrial activities and the risks posed by waste disposal in river ecosystems. So it is crucial to analyze the levels of heavy metals in water and sediments in polluted river ecosystems [3].

Rumbia River is a river located in Rumbia Village, Botumoito District, Boalemo Regency. This river is often used for household purposes such as washing clothes, washing vehicles, and other domestic activities. This condition allows river pollution, especially pollution by heavy metals. Research on heavy metals in the Rumbia

river water is Pb heavy metals. There has been no scientific research on the pollution of heavy metals of Pb in water and sediments in the Rumbia river. Therefore, this study aims to analyze the levels of heavy metals Pb in water and sediment and generally evaluate the water quality of the Rumbia River.

MATERIALS AND METHODS

This research was carried out for four months, from November until February 2016. The sample was obtained from Rumbia river in Rumbia Village, Botumoito District, Boalemo Regency.

Tools and Materials

The tools used in this research are dropper, funnel, sample container, 100 ml Erlenmeyer flask, mortar and pestle, bath, analytical balance, 50 mL and 100 mL measuring flask, 50 mL and 1000 mL beaker, thermometer, filter paper, glass measure, pH paper, oven, porcelin dish, and petri dish. The material used in this study were river water, sediments, distilled water, and chemicals of $Pb(NO_3)_2$ and concentrated HNO_3. Lead metal content in samples was measured using Atomic Absorption Spectrophotometry.

Sampling

Sampling was carried out at three different points. The first point is at the Rumbia river's mouth with taking on the west bank, middle and east bank of the river mouth. The second point is 50 meters away from the river mouth, and the third point 50 meters from the second point. The sample is then put into a container and then taken to a chemical laboratory for lead heavy metal testing.

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Water quality data analysis is carried out descriptively, comparing measurement results obtained with seawater quality standards based on the Decree of the Minister of Environment of No. 51 of 2004 concerning Sea Water Quality Standards, specifically the quality standards for marine biota. Sediment quality was obtained by comparing Pb content from AAS measurement in this study with marine sediment quality standard for chemical criteria WAC 173-204-320. Pb levels in water and sediment samples are calculated using the linear regression equation obtained from a standard solution calibration curve which is a plot of the relationship between absorption at a maximum wavelength and standard solution concentration. Lead levels in water and sediment are obtained by entering data from sample solutions' measurement into the regression equation.

RESULTS AND DISCUSSION

General Conditions of Sampling Location

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The measurement results of Rumbia river water temperature at points 1, 2, and 3 are 29, 30, and 28^{o}C, with an average of 29^{o}C. It means that the Rumbia River waters' temperature is still within the normal limits of water quality standards for marine biota needs based on Ministerial and Environmental Decree of No.51 of 2004 (Table 2).

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Lead Heavy Metal (Pb) Concentration in Water and Sediments

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Elemental lead often binds to sulfur in sulfides (S^{2-}) or phosphates (PO_4^{3-}). In this case, lead is very insoluble and exists as an immovable compound in the environment [20]. However, lead can dissolve in water as $PbCO_3$. From the point of view of the biological donor site, the lead ion (Pb^{2+}) is a borderline ion in Hard Soft-Acid Base (HSAB) theory which forms a complex with sulfur and oxygen rather than nitrogen [21]. As a borderline ion, lead prefers to react with NO_2^- and SO_3^- ions [22].

CONCLUSION

Based on the results of this study concluded that Rumbia River water does not contain heavy metals Pb. The Pb content in sediment at point 1 is 3.02 $mg.kg^{-1}$ dry weight while at points 2 and 3 that is 1.34 $mg.kg^{-1,}$ respectively. Rumbia river water quality is based on temperature and pH parameters in accordance with water quality standards for marine biota determined by the Ministry of Environment No. 51 of 2004. In general, it can be said that the waters of the Rumbia River are still at harmless levels. However, socio-economic conditions that continue to change over time can cause water pollution changes. There needs to be an effort and community awareness in maintaining the occurrence of increased levels of pollutants in the Rumbia River.

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