Journal of Environmental and Agricultural Studies
ISSN: 2710-1401
DOI: 10.32996/jeas
Journal Homepage: www.al-kindipublisher.com/index.php/jeas

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| RESEARCH ARTICLE

Study of Water Quality and Heavy Metals in Several Locations in Rivers and Estuaries of Lurang Village, North Wetar, Southwest Maluku, Indonesia

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| ABSTRACT
Water plays an important role in life and is a vital component that supports biodiversity and secures the existence of ecosystems. Water sampling in this study consisted of 13 stations, namely 10 stations in river waters and 3 stations in estuary areas in the waters of Lurang Village, North Wetar District, Southwest Maluku Regency, Indonesia. The water quality parameter measurement results show that the water quality conditions in several locations are below the optimum limit. Heavy metal test samples were taken from 4 locations, namely RW35, RW36, RW39 and RWBG.Ds to be tested for the metal content of Selenium (Se), Cadmium (Cd), Copper (Cu), Lead (Pb) and Mercury (Hg). The presence of heavy metals in waters is a result of pollution from industrial, agricultural and other waste products. This study aims to determine the water quality and distribution of heavy metals in the river and estuary waters in Lurang Village, North Wetar District, West Maluku Regency.

| KEYWORDS

Heavy metals, water quality, Selenium (Se), Timbal (Pb), Tembaga (Cu), Kadmium (Cd), Raksa (Hg)

| ARTICLE INFORMATION

ACCEPTED: 01 May 2023 **PUBLISHED:** 09 May 2023 **DOI:** 10.32996/jeas.2023.3.4.2

1. Introduction

The condition of sea waters cannot be separated from those of rivers, estuaries and seas. The impact of land will lead to the sea. Liu et al. (2011) suggest that human activities will affect river condition changes and decrease water quality. Increased residential, agricultural, tourism and industrial activities impact increasing the waste produced. This will affect the condition of rivers, estuaries and even the sea (Neyestani et al., 2016). Chemically, heavy metals, a contribution to electron donors and valence ions, have a role in replacing H ions in acids and form compounds with nonmetallic compounds but cannot form each other and have basic oxides. One of the pollutants that is difficult to degrade high toxicity, and certain concentrations can cause pollution (Tuhumury et al., 2022). Mercury (Hg), cadmium (Cd), arsenic (As), lead (Pb), aluminium (Al), and tin (Sn) get great attention because it is persistent and bioaccumulative, has an impact on aquatic flora and fauna and on humans who consume it (Tuhumury et al. 2022). Increasing heavy metal levels in fish is a major concern today and encourage scientists to research the impact of heavy metal accumulation and bioaccumulation on living cells steps should be taken in assessing heavy metal levels (Mensoor and Said, 2018, Azaman et al., 2015; WHO, 2011). Tuhumury et al. (2022) reported heavy metal content in reef fish caught in the waters of Lurang Village, North Wetar, Southwest Maluku, Indonesia; this is the basis for evaluating the habitat status of estuaries and rivers and analyzing heavy metal content in several types of fish and molluscs caught in estuaries and rivers at several points in Lurang village, North Wetar District, Southwest Maluku Regency, Indonesia.

2. Methodology

2.1 Sampling Procedure And Preparation

This research was located in waters neighboring PT Batutua Tembaga Raya and PT Batutua Karisma Permai, copper mining companies in Southwest Maluku Regency, and was conducted between November 2021 and February 2022 (Figure 1). Sample collection was carried out at 13 stations covering 10 river points and 3 estuary points (Table 1).

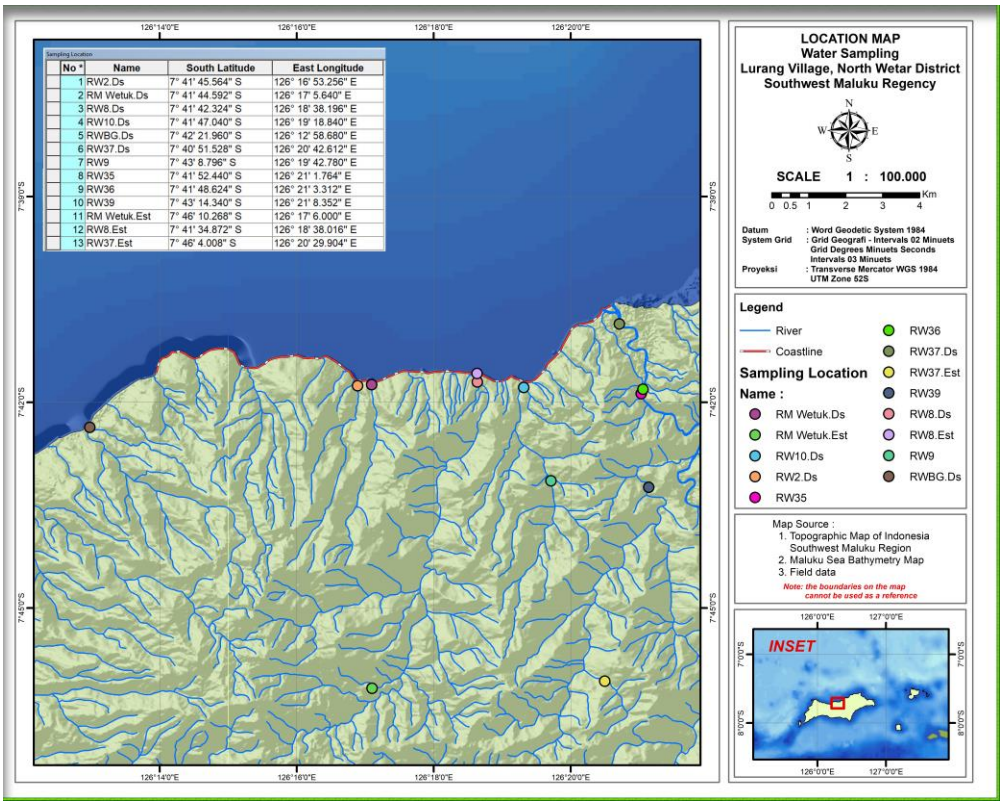

Figure I. Sampling Location

Table 1. River and Estuary Sampling Location

No	Sampling Location	Coordinates	
		South	East
1	RW2.Ds	07.69599	126.281460
2	RMWetuk.Ds	07.69572	126.28490
3	RW8.Ds	07.69509	126.31061
4	RW10.Ds	07.69640	126.32190
5	RWBG.Ds	07.70610	126.21630
6	RW37.Ds	07.68098	126.34517
7	RW9	07.71911	126.32855
8	RW35	07.69790	126.35049
9	RW36	07.69684	126.35092
10	RW39	07.72065	126.35232
11	RMWetuk.Est	07.69519	126.28500
12	RW8.Est	07.69302	126.31056
13	RW37.Est	07.67780	126.34164

Note: Rw: River Water, Ds: Down Stream, BG: Background, Est: Estuary

Water sampling is carried out at each location, and then in situ, measurements and laboratory analysis are carried out to determine the physical-chemical condition of the waters. Fish and mollusc samples collected from each location are cleaned and filed for heavy metal content analysis. The meat is filed and frozen for later analysis at the Productivity and Environment Laboratory of Bogor Agricultural University. Small fish are immediately frozen, while large fish are separated. Then 200 g of tissue per individual is sterilised with dissection sets for heavy metal content analysis (Tuhumury Et., al 2023).

2.2 Data Analysis

2.2.1 Water Quality And Heavy Metals

Water plays an important role in ecosystems and is nature's most valuable resource; water quality criteria (WQC) refer to the highest acceptable concentration or level of pollutants or harmful factors in the aquatic environment, where those pollutants will have adverse effects on human health, aquatic ecosystems, and their useful functions (Wu, F et, al 2013). Water samples measured include Temperature, Dissolved oxygen, pH, Conductivity and salinity. In general, salinity (salt content), acidity (pH), and dissolved oxygen content (Dissolved Oxygen / DO) are part of chemical oceanographic parameters that play an important role in waters. These three parameters greatly affect the survival of biota in water. Fish samples caught were taken with a minimum meat weight of 50g and analyzed for heavy metal content, each location with 3 repeats. After being labelled, the fish were taken to the Productivity and Environment laboratory of IPB Bogor to analyse their heavy metal content.

Table 2. Water Quality and Heavy Metal Observation Methods

No	Parameters	Tool	Method
1	Temperature	Thermometer	insitu
2	DO	DO meter	insitu
3	Ph	pH meter	insitu
4	Conductivity	Conductivity meter	insitu
5	Salinity	Refractometer	insitu
6	Mercury (Hg)	Spectrophoto- meter	Exitu
7	Cadmium (Cd)	Spectrophoto- meter	Exitu
8	Lead (Pb)	Spectrophoto- meter	Exitu
9	Copper (Cu)	Spectrophoto- meter	Exitu

Table 3. Preparation and measurement of heavy metals and reference methods

No	Metals	Preparation Method	Measurement	Reference Methods
1	Hg (Mercury)	Acid digestion + $NaBH_4$ reduction	Hydride Cold Vapor	APHA, 23rd Edition, 2540G, 3030-E, 3112-B, 2017
2	Cu (Copper)	Acid digestion	FAAS (Air-A cetylene)	APHA, 23rd Edition, 2540G, 3030-E, 3112-B, 2017
3	Cd (Cadmium)	Acid digestion	FAAS (Air-A cetylene)	APHA, 23rd Edition, 2540G, 3030-E, 3112-B, 2017
4	Pb (Lead)	Acid digestion	FAAS (Air-A cetylene)	APHA, 23rd Edition, 2540G, 3030-E, 3112-B, 2017
5	Se (Selenium)	Acid digestion	FAAS (Air-A cetylene)	APHA, 23rd Edition, 2540G, 3030-E, 3112-B, 2017

Explanation
FAAS: Furnace Atomic Absorption Spectroscopy
APHA: American Public Health Association

3. Results and Discussion

Table 4. River and Estuary Water Quality

No	Sampling Location	Parameters				
		Temperatures (°C)	Dissolved oxygen (mg/L)	Ph	Salinity (PPT)	Conductivity (µS/cm)
1	RW2.Ds	30.4	2.1	8.35	0.0	6.40
2	RM Wetuk.Ds	29.4	3.7	4.14	0.0	1.397
3	RW8.Ds	30.8	4.1	8.73	0.0	0.304
4	RW10.Ds	35.3	1.6	2.97	0.0	4.49
5	RWBG.Ds	25.2	5.68	8.97	0.0	0.13
6	RW37.Ds	31.3	2.1	8.67	0.0	0.787
7	RW9	24.5	3.7	7.28	0.0	0.448
8	RW35	33.9	2.9	8.81	0.0	0.737
9	RW36	33.0	2.5	8.75	0.0	0.724

10	RW39	34.8	4.6	7.7	0.0	0.993
11	RMWetuk.Est	30.3	2.5	6.45	27.0	10.23
12	RW8. Est	31.7	2.9	7.99	23.0	0.138
13	RW37. Est	32.5	2.9	8.03	9.0	12.54

Table 4. Shows a picture of water quality from 13 locations observed, namely 10 river locations and 3 estuary locations. From the ditas data, it can be seen that the condition of the waters is very fluctuating, both rivers as a whole and estuaries. The results of measuring temperature conditions in as many as 13 sampling locations in the study area ranged from 25.5 ° C to 35.3 ° C with an average of 31.01 ° C. At 13 sampling locations, the lowest water surface temperature at the RW9 sampling location was 24.5°C due to its high location from sea level and dense vegetation, while the highest sea surface temperature was at the RW10.Ds sampling location was 35.3°C due to small and low water discharge due to thick mud deposits. Salinity was measured only at 3 estuary locations, namely RMWetuk.Est, RW8. Est, and RW37Est with a salinity range between 9-27 ppt.

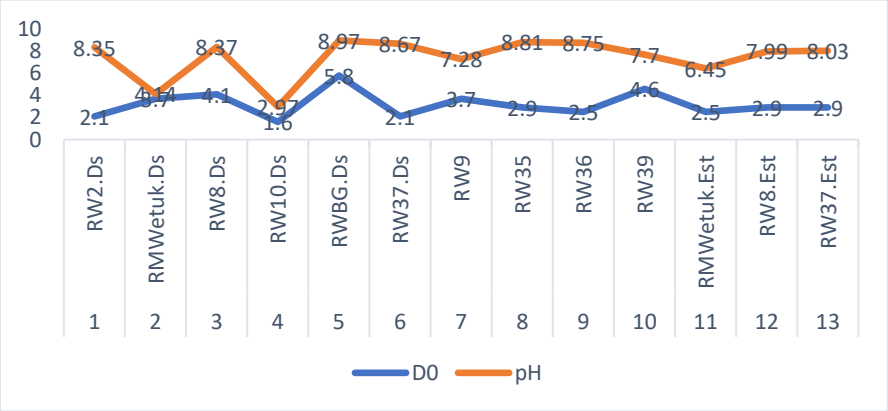

Figure 2. The relationship between DO and Ph

The relationship between DO and pH can be seen in Figure 3. This shows the ratio between pH and Do, where the higher the pH of the DO content will also increase. A case in point can be seen at RM Wetuk's sampling location. Ds and RW10.Ds where the pH value is 4.14 while the DO value is 3.7 for RM Wetuk. Ds while RW10.Ds pH value is 2.97 while DO value is 1.6 mg / L. However, in some locations, high pH does not participate in affecting dissolved oxygen levels; this is influenced by water contour factors and aquatic substrates at the RW2.Ds location, it can be seen that the pH condition is classified above 8.35, but the dissolved oxygen level is low at 2.1 mg / L.

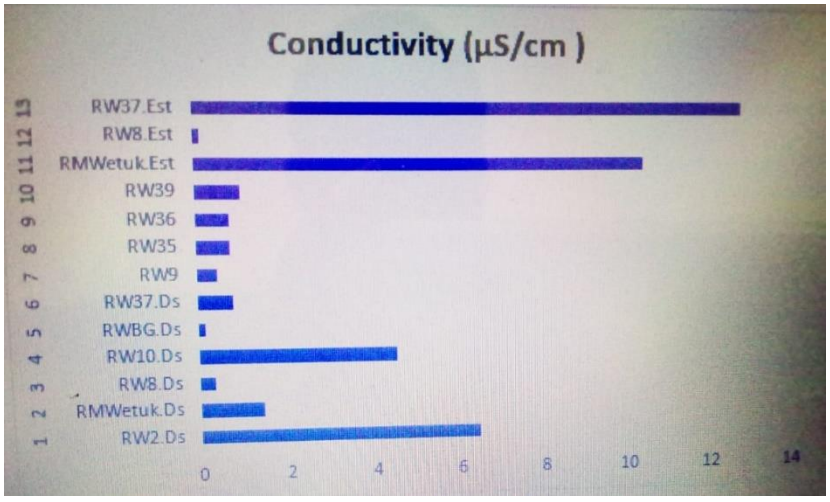

Figure 3. Conductivity Value

The highest conductivity is in RW37. Est is 12.54 Us/cm, followed by RMWetuk.Est 10.23 µS/cm, RW2.Ds 6.40 µS/cm, RW10.Ds 4.49 µS/cm and the lowest value at RWBG.Ds location is 0.13 µS/cm. The conductivity of pure water ranges from 0-200 µS/cm (low conductivity), the conductivity of major rivers ranges from 200-1000 µS/cm (middle range conductivity), and saline water is 1000-10000 µS/cm (high conductivity).

Table 5. Heavy Metal Content in Fish Meat

Heavy Metal	DL	Standards	Safe Standard for Consumption	Sampling Location			
				RW35	RW39	RW36	RWBG.Ds
One	0.002 mg $^{kg-1}$	NA	TDI 0.005 mg/kg-day [e]	0.050	0.066	0.123	0.071
Pb	0.23 mg $^{kg-1}$	0.3 A / 0.4 $^{A(I)}$ / 0.5 ^{C} / 0.3^{D}	NA	0.785	< 0.23	1.49	1.54
Cu	1.20 mg $^{kg-1}$	20.0[b]	PMTDI 0.05-0.5 mg/kg bw [d]	2.85	2.795	7.63	5.30
Cd	0.05 mg $^{kg-1}$	1.0^{A} / 0.5$^{C(I)}$	PTMI 0.025 mg/kg bw [d]	0.31	0.096	0.57	0.50
Hg	0.004 mg $^{kg-1}$	0.5 A / 1.0^{A}(I) / 0.5-1(^{III}) / 0.5 D / 1 $^{D(I)}$	PTWI 0.0016 mg/kg bw [d]	0.030	0.016	0.051	0.052

Note: NA: unavailable, TDI: Tolerable Daily Intake, PTMI: Provisional Tolarable Monthly Intake, PMTDI: Provisional Maximum Tolarable Daily Intake, PTWI: Provisional Tolarable weekly Intake, BW: Body Weight, DL: Detection Limit, a: Head of BPOM Regulation No. HK.00.06.1.52.4011 Year 2009, b: POM DG Decree No. 03725/B/SK/VII/89 Year 1989, c: FRANZ-Standard 1.4.1-Contaminant your Natural Toxicant, d: Join FAO/WHO. Codex Committee on Contaminants in Foods 2012. HG Standard uses methyl mercury, e: USEPA. IRIS (Integrated Risk Information System) Toxicity Values, (i): Predator Fish, (ii): Fish, (iii): Excluding oysters and scallops, (iiii): Mean level.

The table above shows that the content of some heavy metals found in fish meat has exceeded the optimum limit. All observation stations' selenium (Se) metal content exceeded the optimum limit. The highest Se content was in fish samples at the RW36 location of 0.123 mg $^{kg-1}$. Excessive selenium levels can be toxic to the fish themselves. This is according to (Pattipeilohy et al., 2020). Lead Metal (Pb) was highest found in fish meat at the RWBG location, which was 1.54 mg kg-1, but at the RW39 location, the Pb content was far below the standard of < 0.23. Copper metal (Cu) in fish meat found in all locations has exceeded the optimum limit of 1.20 mg kg-1, the range of copper content at RW35, 36, 39 and RWBG.Ds locations are 2-7.63 mg kg-1. Dawood (2022) states that Cu is a microelement that both terrestrial and aquatic organisms need in small quantities. The same is found in Cadmium (Cd) and Mercury (Hg) metals, where the content of these two logs has also exceeded the maximum allowable limit of 0.05 mg kg-1 for Cd and Hg 0.004 mg $^{kg-1}$.

One of the most toxic compounds for fish is methyl mercury produced through inorganic mercury methylation by anaerobic microorganisms such as SRB sulphate-reducing bacteria, MPA methanogen and FeRP iron-reducing (Pack et al., 2014). In this case, the Hg content for pseudo fish meat found has exceeded the optimum limit of 0.004 mg kg-1, and the range of Hg content found in fish meat ranges from 0.016-0.052 mg $^{kg-1}$. Toxicity caused by mercury is characterized by seizures and ataxia, gill release, the fusion of secondary gill filaments, and acute inflammation in the liver (Selvanathan et al., 2013 Raihan et al., 2020).

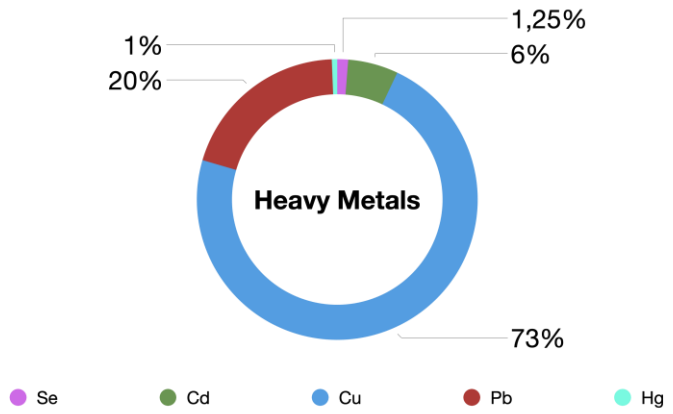

Figure 4. Distribution of heavy metals in fish meat

The highest metal concentration in fish meat found is Copper (Cu) metal, where the concentration of this metal is ranked first at 73%, followed by Lead (Pb) at 20%, Cadmium (Cd) at 6%, Selenium (Se) at 1.25% and Mercury (Hg) at the bottom of the bottom position at 1%. The copper (Cu) concentration is related to mining activities at the sampling site. (Balasim et al., 2013). Copper pollution comes from the continuous use of pesticides, fungicides, insecticides, nematicides, molluscicides, and algicides and the disposal of copper-containing waste. However, something different was stated by (Tuhumury Et., al 2023), where heavy metals found in fish meat at seawater locations in Lurang Village, North Wetar District, West Maluku Regency, were in substandard conditions. This shows that heavy metal pollution in Lurang Village is still concentrated in river waters.

4. Conclusion

From the results of this study, the condition of water quality and heavy metal content at 13 sampling locations showed saline data. Several locations found that water quality conditions, especially pH and dissolved oxygen, were at the lowest level, namely the location of RMWetuk.Ds and RW10.Ds were the conditions of DO 3.7 mg / L and pH 4.14 for RMWetuk.Ds and DO 1.6 mg / L and pH 2.97 for RW10.Ds. Another water quality parameter is the highest conductivity is RW37. Est is 12.54 Us/cm and the lowest value at RWBG.Ds is 0.13 µS/cm. The content of 5 types of heavy metals found in fish meat is above the optimum limit, with the presentation of Copper (Cu) metal as the metal with the largest distribution and content found, which is 73%.

Acknowledgements: We are grateful to PT Batutua Tembaga Raya and PT Batutua Karisma Permai, Pulau Wetar, Indonesia, that supported this research.

Conflicts of Interest: The authors declare no conflict of interest.

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