THE CONTENT OF HEAVY METALS (CD, PB, AND CR) IN WATER AND SEDIMENT IN THE MESUJI RIVER, LAMPUNG, INDONESIA

Manuscript Info

Manuscript History
Received: xxxxxxxxxxxxxxx
Final Accepted: xxxxxxxxxxxx
Published: xxxxxxxxxxxxxxx

Key words:-
Pollution, heavy metals, river, sediment

Abstract

Mesuji River is a natural resource that provides water for human life. Mesuji River quality standards based on Government Regulation No. 22 of 2021 with class II water quality standards. River quality can be seen from the physical, chemical and biological parameters of the river. Pollutants that have the potential to be found in river waters are heavy metals. Based on the relatively highwater utilization of the Mesuji River, a study was conducted on the contamination of heavy metals Cd, Pb, and Cr so as to provide appropriate control measures and sustainable river management. The research was conducted in 2 time periods, namely the rainy season and the dry season and water and sediment samples were taken at 7 sample station points. Pollution of metals Cd, Pb and Cr in water and sediments in the Mesuji River as a whole still meets quality standards. The correlation between Cd content in water and Cd in sediment with a negative correlation value of -0.217 (weak correlation) while the correlation values of Pb and Cr in water and sediment each have a very strong correlation value with correlation values of 0.801 and 0.822.

Introduction:-

River pollution is currently an environmental problem that requires sustainable management. Several researchers have attempted to overcome the environmental problem such as heavy metal pollution and dyes in waters especially rivers (Suharso & Buhani, 2011), (Buhani et al., 2021), (Buhani, Suharso, & Sumadi, 2012), (Buhani et al., 2011), (Buhani et al., 2013), (Buhani, Suharso, & Aprilia, 2012), (Buhani et al., 2019), (Buhani & Suharso, 2009), (Buhani et al., 2018). Attempt to control metal pollution can be done by adsorption method. Control of Cd metal contamination has been carried out using the adsorption method. Hybrid synthesis of organo-silica from *Nannochloropsis sp* biomass and adsorption selectivity of Cd2+ ionic imprinted *Nannochloropsis sp* with silica matrix (Cd (II)-IIP) from tetraethyl orthosilicate (TEOS) precursors has been successfully applied as an adsorbent. Cd as an effort to control Cd metal pollution (Buhani et al., 2011), (Buhani, Suharso, & Aprilia, 2012). Metal pollution control can be carried out by biosorption of Pb, Cu and Cd utilizing Cassava Peel Waste Biomass (Suharso & Buhani, 2011). Rivers are natural resources that provide water for human life. Lampung Province has large rivers, one of which is the Mesuji River which is located in Mesuji Regency which is directly adjacent to South Sumatra Province which has a river length of up to 220 km with a width of 180 m – 200 m. Mesuji River quality standards based on Government Regulation No. 22 of 2021 is included in the AR class II quality standard with the allotment of water as water recreation facilities/infrastructure, fish farming, animal husbandry and irrigation. River pollution as a result of various community activities that take place around the river (Soukotta et al., 2019). (Patty et al., 2018) states that rivers often experience pollution, both from natural sources and human activities.

River quality can be seen from the physical, chemical and biological parameters of the river. One of the pollutant materials that can potentially be found in river waters is heavy metals. Heavy metal pollution will adversely affect the biological processes of aquatic organisms which can threaten their survival, including humans, through the food web. Sources of heavy metals can come from natural sources such as weathering of rocks and atmospheric deposition. Anthropogenic sources include agriculture, livestock, domestic and industry (Rohmawati & Kuntjoro, 2021). Previous researchers state that pollutant sources can be divided into domestic and non-domestic sources (Ainuddin & Widyawati, 2017). Heavy metals dissolved in columns or water bodies at certain concentrations can change their function to become a source of poison for aquatic life. The presence of heavy metals in waters directly

or indirectly endangers the life of organisms and human health (Mishra et al., 2019). The main cause of heavy metals becoming dangerous pollutant materials is because heavy metals cannot be destroyed (non-degradable) by living organisms in the environment and accumulate into the environment(Milasari et al., 2020). Heavy metals such as zinc, cadmium, mercury, lead and copper have serious harmful effects on aquatic ecosystems and the biota in them (Afzaal et al., 2022). In research based on the utilization of Mesuji River water which is quite high and important for the community, research on heavy metal pollution of Cd, Pb, and Cr is carried out in the Mesuji River so that it can provide appropriate control measures and sustainable river management.

Materials and Methods:-

Area Study

The research was conducted on the Mesuji River, Mesuji District, Lampung Province. The Mesuji River has a length of 220 km with a width of 180 m – 200 m. The map of the research locations can be seen in Figure 1 and the sampling points in the study were 7 points which can be seen in Table 1.

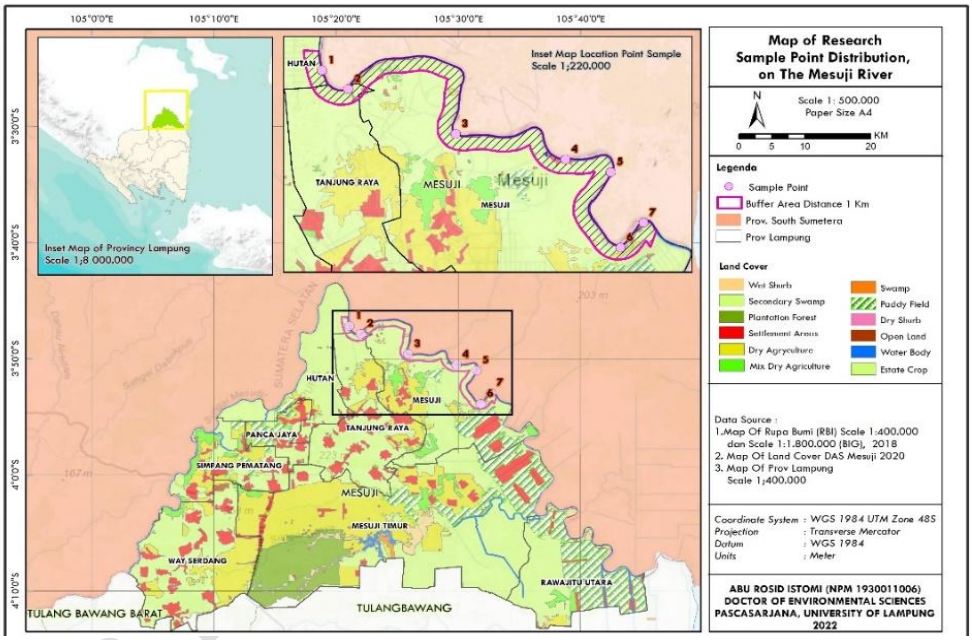

Figure 1. Research Location Map.

Table 1. Research Locations and Sample Stations

Station	Location	Coordinate	
		E (Longitude)	S (Latitude)
1	Keagungan Dalam Village River	E: 105° 21' 31,6"	S: 03 ° 4 7' 44, I"
2	Sri Tanjung Village River	E: 105° 22' 00,5"	S: 03° 47' 53,4"
3	Sungai Badak Village River	E: 105° 26' 03,2"	S: 03° 49' 38,4"
4	Wiralaga II Village River	E: 105° 29' 38,9"	S: 03° 56' 31, I"
5	Gajah Mati Village River	E: 105° 31' 36,2"	S: 03° 50' 58,0"
6	Gebang Village River	E: l 05° 31' 35, I"	S: 03° 53' 58,4"
7	Gebang and Mesuji river estuaries	E: 105° 31' 57,3"	S: 03° 53' 46, l"

Sample Collection

Water and sediment samples were taken from 7 sampling points taken in September 2022 and February 2023. September represents a dry season month with <100 mm rainfall, while February represents a rainy season month with > 100 mm rainfall. Water samples taken at each station were put in 2 L sample bottles, then nitric acid (HNO3) was added as a preservative. Furthermore, the sample is stored in a cool box filled with ice cubes and then taken to the laboratory (Permata et al., 2018). Sediment sampling at a depth of 5-10 cm on the banks of the river using a steel spatula of 2 kg (Vidmar et al., 2017) deep rivers using sediment grabbers and ropes. Furthermore, reducing the water content in the sediment by filtering it and putting it in a plastic ziplock and labeling it so that it is not mixed up, the sediment sample is brought to the laboratory for sample preparation.

Analysis

Research data were analyzed descriptively in the form of tables and pictures. To see the relationship between the concentration of heavy metal pollution in water and river sediments using correlation analysis using Microsoft Excel software.

The Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario stipulates 3 levels of quality standard values, namely No Effect Level, Lowest Effect Level, and Severe Effect Level.

1. No Effect Level: this is the level at which the chemicals in the sediment do not affect the fish or organisms living in the sediment. At this level there is no transfer of chemicals through the food chain and no effect on the expected water quality.
2. Lowest Effect Level: this indicates the level of contamination that has no effect on the majority of organisms living in the sediment. Sediments are the main storehouse for marginal contamination. Contamination in sediments exceeding the Lowest Effect Level may require further testing and a management plan.
3. Severe Effect Level: At this level, the sediment is considered highly polluted and is likely to affect the health of organisms living in the sediment. If the level of contamination exceeds the Severe Effect Level then testing is required to determine whether the sediment is toxic or not.

Results and Discussion:-

Heavy Metal Concentration in Water River

Based on the measurements of heavy metals Cd, Pb and Cr carried out in Mesuji River water samples taken from 7 sampling stations, the measurement results were different for each type of metal. Measurement results can be seen in the following figure.

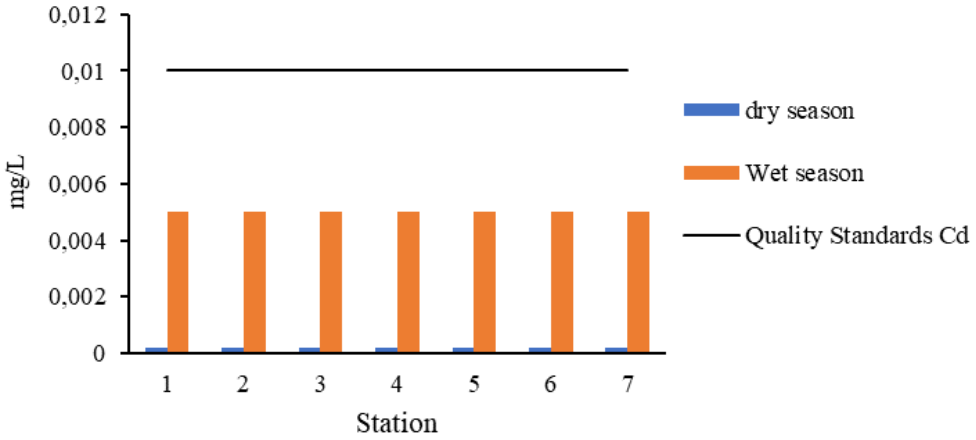

Figure 2. Cd Heavy Metal Concentration in Mesuji River Waters.

Based on Figure 2. The results of measurements of Cd metal in river water during the rainy season have a higher Cd concentration than during the dry season. The Pb value in the dry season at stations 1-7 had the same Cd content of

0.0002 mg/L and the Pb value in the rainy season at stations 1 to 7 had the same value of 0.005 mg/L. Based on several previous studies, it was revealed that high concentrations of Cd metal were caused by several human activities such as excessive fertilization, fishing activities, such as diesel fuel spills and domestic waste (Asati et al., 2016), (Afzaal et al., 2022).

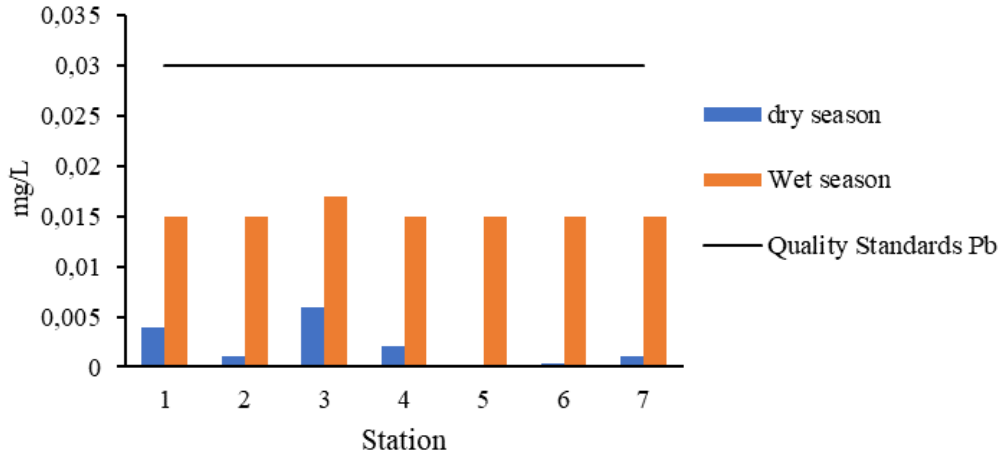

Figure 3. Pb Heavy Metal Concentration in Mesuji River Waters.

The results of measurements of heavy metal Pb in Mesuji River water at 7 sampling stations were in conditions that met quality standards with dry season Pb values ranging from 0.00003 to 0.006. The value of Pb during the rainy season has a range of 0.015 - .0017. According to (Azhar et al., 2012) that the largest source of Pb metal contaminants is lead-additive gasoline for motor vehicle fuel and agricultural activities. Heavy metals will mix in waters through adsorption, emulsion and dilution processes before settling in the basic substrate (Firmansyaf et al., 2013). The decrease in heavy metal content in water at a location can change due to the influence of water hydrodynamics (Hanifah et al., 2019).

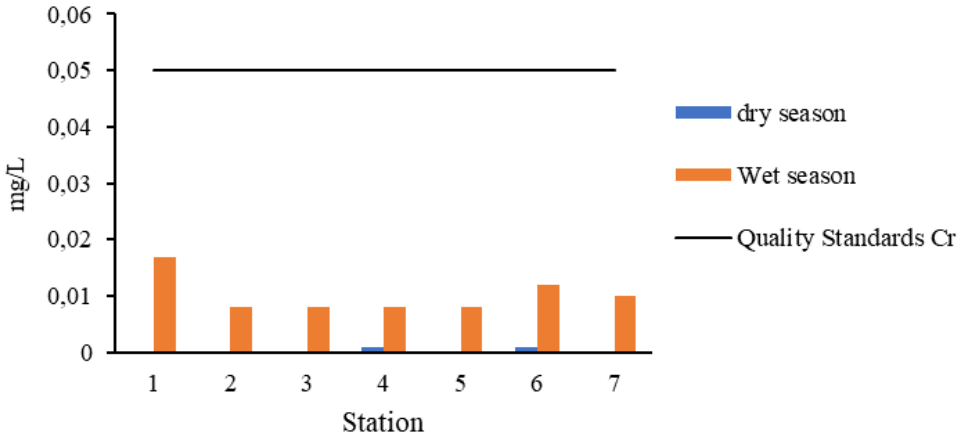

Figure 4. Cr Heavy Metal Concentration in Mesuji River Waters.

Based on Figure 4 it can be seen that the concentration of Cr metal in river water during the dry season is between 0.0002-0.001 and Cr metal in the rainy season is between 0.008 - 0.017.

Heavy Metal Concentration in Sediment River

The concentration of heavy metals in sediments is generally higher than in surface water because of their ability to precipitate, precipitate, accumulate and bind strongly to sediments (Schertzinger et al., 2018).

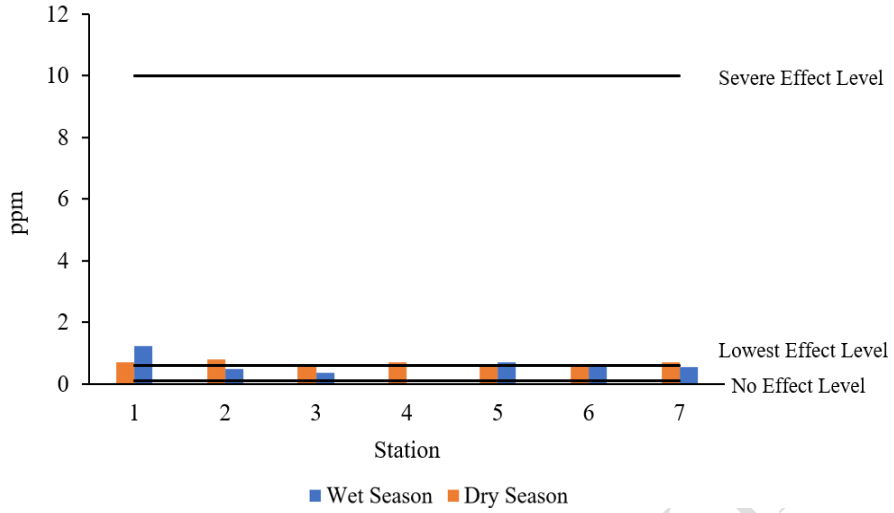

Figure 5. Cd Heavy Metal Concentration in Mesuji River Sediments.

The concentration of heavy metal Cd in river sediments compared to quality standards is included in the lowest effect level category. The Cd concentration is in the Lowest effect category where the maximum concentration of cadmium is considered safe for humans and the environment, where negative effects on human health or ecosystems are not detected or do not exceed the established threshold (Mayaserli & Rahayu, 2018).

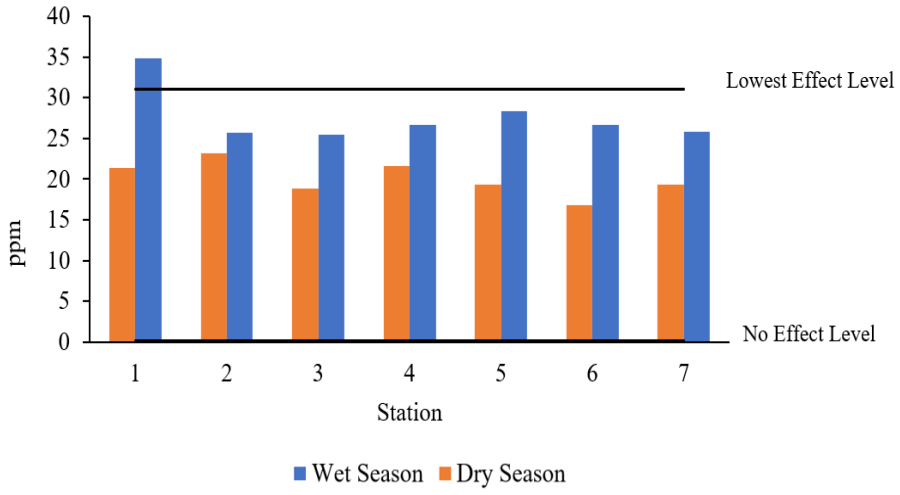

Figure 6. Pb Heavy Metal Concentration in Mesuji River Sediments.

The concentration of Pb in river sediments at station 1 exceeds the quality standard of the lowest effect during the rainy season. At station 1 during the dry season it is in the lowest effect level quality standard, and at stations 2, 3, 4, 5, 6, and 7 it is still at the lowest effect level limit.

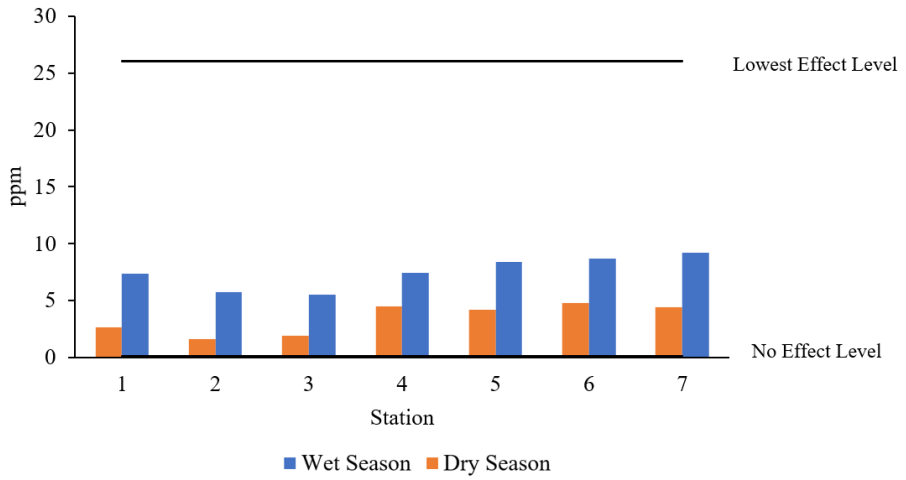

Figure 7. Cr Heavy Metal Concentration in Mesuji River Sediments.

The concentration of heavy metal Cr in river sediments compared to quality standards is included in the lowest effect level category. The Cd concentration is in the Lowest effect category where the maximum concentration of cadmium is considered safe for humans and the environment.

Heavy Metals in Water and Sediments

Measurement of heavy metal levels carried out in this study consisted of heavy metals Cd, Pb and Cr at 7 sampling points in water and sediment. The results of metal measurements in water and sediment can be seen in Table 2.

Table 2. Results of measurements of Cd, Cr and Pb metals in the water and sediments of the Mesuji River.

Time	Cd		Cr		Pb	
	Water	Sediment	Water	Sediment	Water	Sediment
Dry Season	0.0002	0.7	0.0002	2.67	0.004	21.4
	0.0002	0.79	0.0002	1.62	0.001	23.2
	0.0002	0.64	0.0002	1.92	0.006	18.9
	0.0002	0.7	0.001	4.48	0.002	21.6
	0.0002	0.65	0.0002	4.23	0.00003	19.3
	0.0002	0.61	0.001	4.77	0.0004	16.8
	0.0002	0.71	0.0002	4.45	0.001	19.3
Wet Season	0.005	1.25	0.017	7.41	0.015	34.8
	0.005	0.5	0.008	5.78	0.015	25.7
	0.005	0.38	0.008	5.55	0.017	25.5
	0.005	0.03	0.008	7.46	0.015	26.6
	0.005	0.71	0.008	8.37	0.015	28.3
	0.005	0.62	0.012	8.7	0.015	26.6
	0.005	0.55	0.01	9.19	0.015	25.8

The results of measurements of Cd, Cr and Pb in water and sediment carried out at 7 sampling points during the rainy season and dry season in Table 2 show that the metal concentrations in the water and sediment have different values where the metal content in the sediment is much higher than in water. This is also in line with several previous studies where the metal content was higher in sediments than in surface water because metals easily accumulate and settle in sediments (Roza & Muhelni, 2019). The levels of heavy metals in sediments will be higher than in water due to the nature of heavy metals which easily bind organic matter and settle to the bottom of the

waters which then unite with the sediments (Suprihatin et al., 2022). In this study, the correlation value was calculated between metal pollution in water and sediment for each type of metal which can be seen in Table 3.

Tabel 3. Correlation Value of Metal Content in Water and Sediments

Correlation		Correlation Value
Cd Water	Cd Sediments	-0.217
Pb Water	Pb Sediments	0.801
CrWater	Cr Sediments	0.822

Based on the correlation value in Table 3, the correlation value between metal content in water and sediment shows that the relationship between Cd content in water and Cd in sediment has a negative correlation value of -0.217, which means there is a negative relationship between the two variables where an increase in the value of one variable is associated with a decrease the value of other variables so that when one variable increases, the other variable tends to decrease, and vice versa. But with a small correlation value, the relationship is very weak. The correlation of Pb metal in water and sediment has a correlation value of 0.801 which is included in the very strong correlation category. The correlation of Cr metal in water and sediment has a correlation value of 0.822 which is included in the very strong correlation category. In this study the concentrations of Pb and Cr metals in water and sediments have a very strong correlation. The correlation is very strong between the levels of Pb in water and in sediments and the correlation between the levels of Cr in water and Cr in sediments means that when one variable increases, it is likely that other variables will also increase, and when one variable decreases, other variables also tend to decrease. This relationship has a high degree of certainty, and a change in one variable tends to cause a large change in the other variable.

Conclusion:-

Pollution of Cd, Pb and Cr metals in water and sediments in the Mesuji River which was carried out at 7 sampling stations as a whole still met the quality standards. The correlation between Cd content in water and Cd in sediment with a negative correlation value of -0.217 (weak correlation) while the correlation values of Pb and Cr in water and sediment each have a very strong correlation value with correlation values of 0.801 and 0.822.

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