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Water and Sediment Quality Status of the Enim River, South Sumatra

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Abstract

The Enim River in Muara Enim Regency, South Sumatra, remains vital for various community activities. However, as an open water source, it is vulnerable to waste inputs from surrounding human activities, which impact the river's overall condition. This research aims to assess the water and sediment quality of the Enim River by analyzing key parameters such as pH, TSS, Fe, Mn, and temperature. Additionally, it seeks to explore the correlation between Fe and Mn content in both water and sediment and evaluate the quality status of these elements. The methodology involves descriptive analysis, where the measured values are compared against established quality standards. Correlation analysis is used to examine the relationship between Fe and Mn concentrations in water and sediment. Furthermore, the Pollution Index (PI) and Geo-accumulation Index (Igeo) methods are applied to determine the quality status of water and sediment. The findings indicate that the water quality of the Enim River exceeds acceptable standards for TSS, Iron (Fe), and Manganese (Mn). Regarding sediment quality, the Iron (Fe) levels surpass the Severe Effect Level (Level 3), while Manganese (Mn) remains below the Lowest Effect Level (Level 2). The correlation analysis reveals a strong negative correlation (-1) between Fe and Mn in water and sediment, suggesting a tightly linked inverse relationship. Overall, the Enim River's water quality is classified as Mildly to Moderately Polluted. The sediment quality, however, varies. It is categorized as Extraordinarily to Extremely Severely Polluted for Iron (Fe) and Not Polluted for Manganese (Mn).

Keywords: Enim River, *Geo-accumulation Index*, Pollution Index, Sediment, Water.

1. Introduction

The Enim River is a river in Muara Enim Regency, South Sumatra Province which is still used for various community needs, including as a raw water source for drinking water, recreational facilities, industrial needs, and the community's daily needs (BPS Muara Enim Regency, 2022). As open water, the Enim River will very easily receive input in the form of waste resulting from human activities around it, both domestic waste from residential areas and non-domestic waste or industrial waste (Masykur *et al.*, 2018). Poor river water quality due to waste input will affect the surrounding environmental ecosystem hurt human health and can cause children to be susceptible to disease (Jeremia *et al.*, 2021).

Being located around a coal mining location, the Enim River not only receives waste from residential areas but also receives a lot of waste input from coal mining activities. The land stripping process carried out in coal mining activities has the potential to cause river erosion and sedimentation so that it can increase TSS parameters in river waters (Parwati *et al.*, 2011). An important impact of coal mining activities is acid mine drainage (Qomariah, 2003). Acid mine drainage is very acidic and toxic, making it dangerous for the surrounding environment

(Kiswanto *et al.*, 2020). The low pH in acid mine water can easily dissolve metals such as Iron (Fe) and Manganese (Mn) (Patel, 2010). pH, TSS, Fe, and Mn are wastewater parameters in coal activities based on Minister of Environment Decree No 113 of 2003.

Fe and Mn metals that are high in water will accumulate in river sediments due to the nature of the metals which easily settle at the bottom of the water, so the metals in the sediment will be higher than in the water (Alimah *et al.*, 2014). Fe and Mn metals that accumulate in sediment can cause biota that live and feed at the bottom of the waters to become contaminated by these metals (Bagul *et al.*, 2015). Based on these conditions, in this research, it is necessary to analyze the quality of water and sediment in the waters of the Enim River based on the parameters pH, Temperature, TSS, Fe, and Mn, examine the correlation between the metal content of Fe and Mn in the water and the metal content of Fe and Mn in the sediment in the waters of the Enim River, and analyzing the status of water and sediment quality in the waters of the Enim River.

2. Methods

2.1. Time and Location

This research was conducted in July-August 2023 in the Enim River, Muara Enim Regency, South Sumatra Province. A map of sampling locations can be seen in Figure 1.

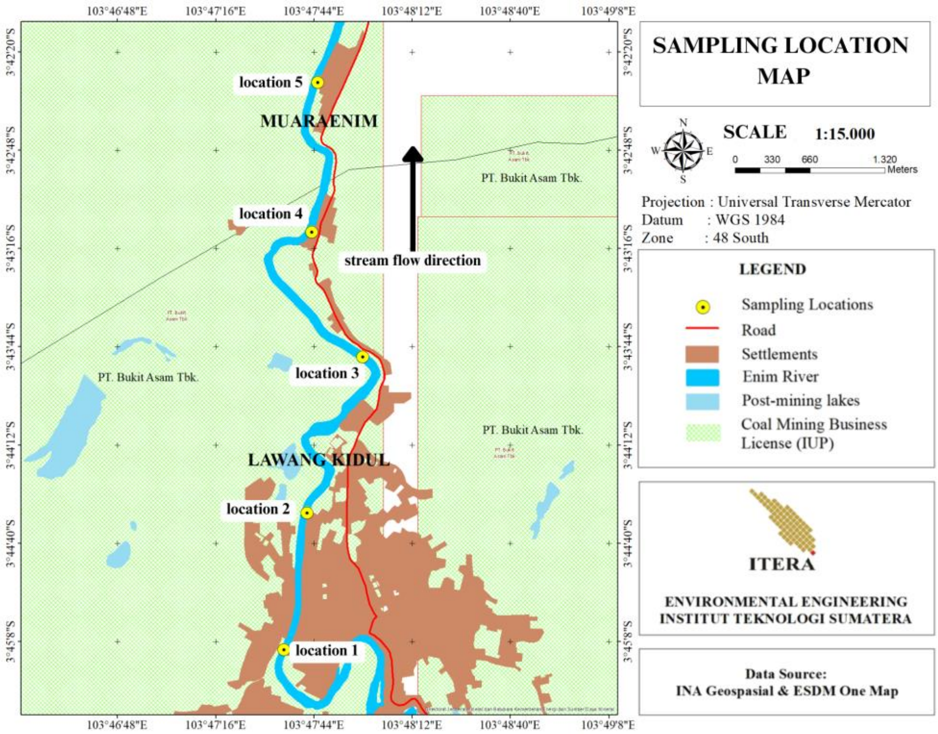

Figure 1. Sampling Location Map

2.2. Water and Sediment Quality Measurement Techniques

Determination of sampling locations (5 locations) using the purposive sampling method by considering the source of pollution that enter the Enim River. The biggest source of pollution around the Enim River, apart from residential areas, is the coal mining industry. The sampling method used in this research is grab sampling. Water sampling is carried out using a horizontal water sampler. Water quality analysis based on pH parameters refers to SNI 6989.11:2019 with a pH meter, Temperature parameters refer to SNI 06-6989.23:2005 using a Thermometer, TSS parameters refer to SNI 6989.3:2019 using Gravimetry, Fe parameters refer to SNI 6989.4.2009 using Flame Atomic Absorption Spectrophotometry (AAS) and Mn parameters refer to SNI 6989.5.2009 using Flame Atomic Absorption Spectrometry (AAS). Meanwhile, the sediment quality test for Fe and Mn parameters refer to the EPA 200.7 Rev 5 method using Inductively Coupled Plasma-Atomic Emission Spectrometry.

2.3. Data Analysis

2.3.1. Water and Sediment Quality Analysis

Water and sediment quality analysis was carried out using descriptive analysis methods. Data analysis was carried out by comparing water and sediment quality data with class 1 river water quality standard data attached to Appendix VI, Government Regulation Number 22 of 2021 concerning the Implementation of Environmental Protection and Management and sediment quality referring to the Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario.

2.3.2. Analysis of the Relationship between Fe and Mn Metals in Water and Sediment

To determine the relationship between the Fe and Mn metal content in the water and sediment of the Enim River, statistical methods were carried out, namely Bivariate Pearson correlation analysis using SPSS 23 software.

2.3.3. Pollution Index (PI)

Analysis of the water quality status of the Enim River waters refers to Minister of Environment Decree No. 115 of 2003 concerning Determining Water Quality Status, Appendix II uses the Pollution Index method.

$$PI\ j = \sqrt{\frac{\left(\frac{Ci}{Lij}\right)^2 M + \left(\frac{Ci}{Lij}\right)^2 R}{2}} \qquad \text{(Equation 1)}$$

Information:

PIj : Pollution Index Value based on classification (j)

Lij : Parameters concentration below regulation standard

Ci : Parameters concentration based on actual monitoring

(Cij/Lij)M : Maximum C*ij*/L*ij* value

(Cij/Lij)R : Average C*ij*/L*ij* value

The value obtained from the calculation is then evaluated as follows:

$0 \leq PIj \leq 1,0$: Comply to standard

$1,0 < PIj \leq 5,0$: Mildly Polluted

$5,0 < PIj \leq 10$: Moderately Polluted

$PIj > 10$: Heavily Polluted

2.3.4. Geo-accumulation Index (Igeo)

The level of Iron (Fe) and Manganese (Mn) metal pollution in sediments using the *Geo-accumulation Index* (Igeo) method was first proposed by Muller in 1969 and calculated using the following formula. Concentration of Metal in nature as background shown in Table 1.

$$Igeo = Log_2\left(\frac{Cx}{1,5\ Bn}\right) \qquad \text{(Equation 2)}$$

Information:

Igeo : *Geo-accumulation Index*

Cx : Metal concentrations in sediment samples

Bn : Metal concentration in nature (background)

1,5 : Constant

Table 1. Metal Background Value

Metal	Background (mg/kg)
Iron (Fe)	3,12
Manganese (Mn)	400

Source: (Hayton *et al.*, 1993)

The *Geo-accumulation Index* (Igeo) has 7 criteria for pollution class levels with the following value ranges.

Igeo < 0 : Not Polluted
0 < Igeo < 1 : Mildly polluted
1 < Igeo < 2 : Moderately Polluted
2 < Igeo < 3 : Quite Severely Polluted
3 < Igeo < 4 : Severely Polluted
4 < Igeo < 5 : Extraordinarily Severely Polluted
Igeo > 5 : Extremely Severely Polluted

3. Results and Discussion

3.1. Enim River Water Quality

3.1.1. Water Quality

Water quality testing on the parameters pH, Temperature, TSS, Fe, and Mn in Enim River water can be seen in Table 2.

Table 2. Percentage and area of slope of the Upper Opak Watershed

No	Parameter	Class 1 River Water Quality Standards	Unit	Test Results				
				L.1	L.2	L.3	L.4	L.5
1.	pH*	6-9	-	6.7	6.8	6.7	6.8	6.4
2.	Temperature*	Dev 3	°C	28.5	27	28.6	28.8	27.8
3.	TSS**	40	mg/L	240	380	220	60	80
4.	Fe**	0.3	mg/L	0.35	1.21	0.96	0.49	0.44
5.	Mn**	0.1	mg/L	0.57	2.37	1.27	1.17	0.97

Source : *Research Primary Data, 2023*
Information:
* : in-situ testing
** : ex-situ testing

Based on the results of testing pH parameters in Enim River water, a pH concentration of 6.4-6.8 was obtained which comply the class I river water quality standards listed in PP No. 22 of 2021. The pH value of water is influenced by water temperature. This is because the water temperature triggers an increase in the rate of acid-base reactions so that if the water temperature rises, the pH of the water will also rise. The water temperature of the Enim River is in the range of 27-28.8°C. When the water temperature is the highest, namely 28.8°C, the pH value is also at the highest, namely 6.8.

The TSS concentration test results at all river water sampling locations exceeded water quality standards. It can be seen from Figure 2 that the distance between the 2 water sampling locations and the coal mining location is a factor that can influence the increase in TSS content at that location. Rainwater that falls in mining and PLTU areas will flow over the ground surface and carry soil particles into river flows, thereby increasing the TSS content in river water (Loah, 2002).

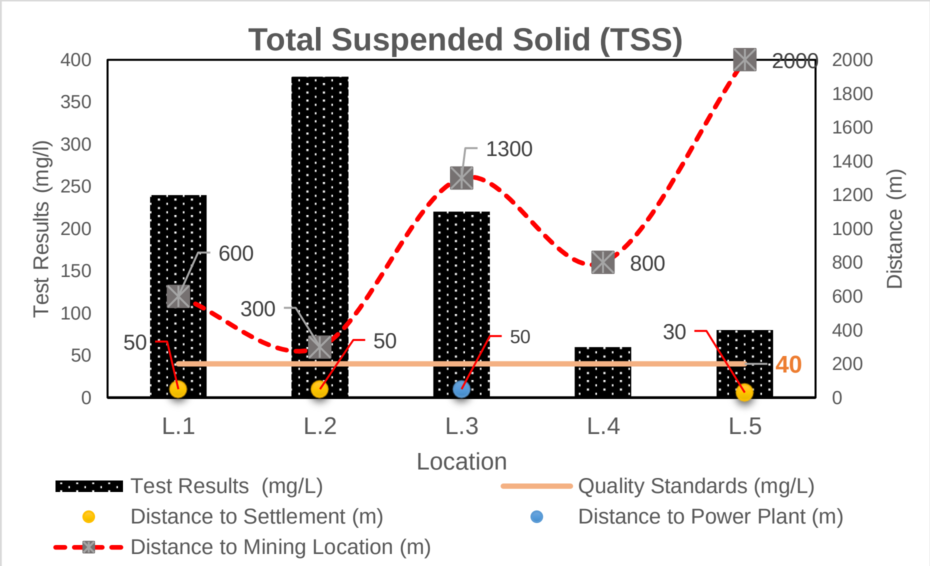

Figure 2. Graph of TSS Test Results on Enim River Water

Location 1 and location 2 for water sampling contain higher TSS than other locations because these locations are closer to residential areas. The increase in TSS content from location 4 to location 5 for water sampling was also caused by location 5 being close to residential areas. The increase in TSS content in the waters of the Enim River is influenced by land use and activities of surrounding communities which are sources of pollutant input that have an impact on river water quality.

Apart from that, the high and low levels of TSS in the Enim River water are not only caused by the influence of land use but also by water circulation patterns, one of which is the speed of the river flow (Purba *et al.*, 2018). If the river flow speed increases, TSS will also increase (Lutfi, 2014). The turbulence process caused by increasing river flows causes resuspension of sediment in river water so that the fluctuating flow speed will increase the TSS content in river water (Rahmat *et al.*, 2023). The speed of water flow can influence the deposition process of suspended particles on the riverbed. This is proven by the rise and fall of the TSS content at the sampling location which is also accompanied by the rise and fall of the flow speed of the Enim River. This research is in line with research conducted by Chairuddin *et al.*, (2023) in the waters of the Malutu River in South Kalimantan in rivers around coal mining. The highest TSS content in the Malutu River reached a value of 790 mg/L. The high TSS content in Malutu River water is caused by soil erosion due to mining activities around the river.

The Fe concentration in Enim River water has also exceeded quality standards. The highest Fe content was at location 2, namely 1.21 mg/L and the lowest was at location 1, namely 0.35 mg/L (Figure 3). Location 2 is close to the location of the coal mining industry and residential areas which are thought to be the cause of the increase in Fe content in the river water around that location.

Land stripping activities and the coal excavation process in mining will cause the surrounding rocks containing sulfide minerals in the form of pyrite and marcasite to become oxidized and come into contact with water, thus forming acid mine drainage which is acidic and contains Fe metal (Kiswanto *et al.*, 2020). The acid mine water will flow and enter the river waters, increasing the Fe metal content in the Enim River water. The high Fe content in Enim River water can also come from the domestic activities of people who use well water for daily needs. The high Fe content in residents' well water can be seen from the sediment and yellow crust in residents' bathrooms. This is confirmed by research conducted by Maryani *et al.* (2019) on groundwater in Muara Enim Regency showing that groundwater in Muara Enim Regency contains high levels of Iron (Fe) ranging from 0.3-1.62 mg/L.

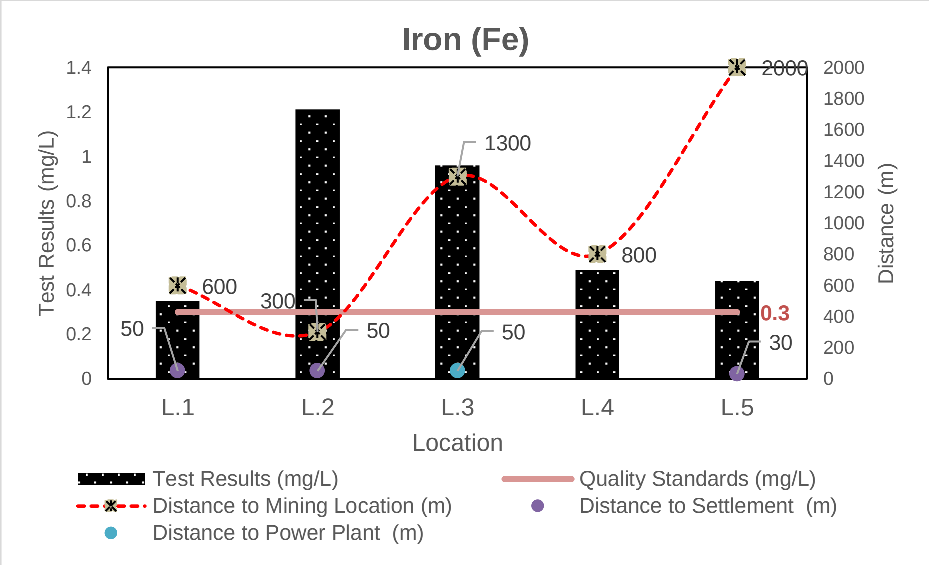

Figure 3. Graph of Fe Test Results on Enim River Water

Corrosion of metal objects due to electrochemical processes that occur in water also causes iron (Fe) content in industrial waste (Ginting, 2007). Dissolved iron comes from workshops located in residential areas around the Enim River and comes from the corrosion of cars parked along the road around the sampling location. The fluctuating concentration of Fe at sampling location is caused by the dilution process in the river. The results of research conducted by Chairuddin, *et al.* (2023) on river water around the coal mining area on the Malutu River also showed a high Fe content, namely 1,202 mg/L. Likewise with the Enim River which is also located around the coal mining area.

The high concentration of Manganese (Mn) in Enim River water can also come from coal mining activities which produce acid mine drainage (Castello, 2003). Based on Figure 3, it can be seen that the Mn concentration in river water has exceeded the quality standard. The highest Mn value was found at location 2 of sampling, namely 2.37 mg/L and the lowest value was at location 1 of water sampling, 0.57 mg/L.

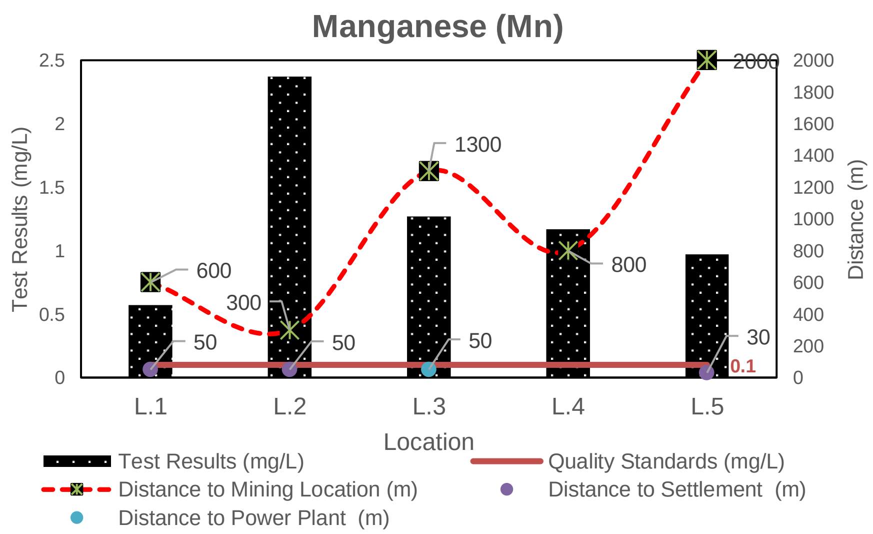

Figure 4. Graph of Mn Test Results on Enim River Water

The high concentration of Mn at location 2 for water sampling was due to the distance between location 2 and the adjacent coal mining location. Apart from that, the high concentration of Mn at location 3 could also be caused by the proximity to the Bukit Asam PLTU. Rainwater runoff originating from the Bukit Asam PLTU coal stockpile runoff will increase the Mn content in river water. Apart from mining activities, the high Mn content in Enim River water can come from natural sources such as groundwater which contains manganese and comes from household waste (Indra *et al.*, 2020).

The solubility of manganese in water is influenced by pH, oxidation-reduction reactions, and electron activity. Under acidic pH conditions, namely pH 2 - 7.5, Mn will dissolve in the form of dissolved Manganese (Mn2+). At pH 7.5 – 11, Mn will precipitate in the form of MnCO3, at pH 11 it will begin to form $Mn(OH)_2$ and at pH 13.5 it will form Mn(OH)3. In the pH condition of the Enim River water which is in the range of 6.4 – 6.8, Mn is still in dissolved form in the water and has not yet settled in the sediment (Bruins, 2016).

The Mn concentration in Petangkep River water, Central Kalimantan Regency from research by Susanto *et al.* (2021) also does not meet the quality standards for Mn parameters at all sampling locations. The Mn concentration at the research location was 1.372 mg/L in the upstream section of the river, 5.935 mg/L in the middle section and 0.9 mg/L in the downstream section. The high Mn content in river water is caused by coal mining activities, oil palm plantations, residential areas and mining company employee mess offices.

3.1.2. Sediment Quality

The results of testing the quality of Enim River sediment on Fe and Mn parameters in Enim River water can be seen as follows.

Table 3. Results of Enim River Sediment Quality Testing (mg/kg)

No	Parameter	*Lowest Effect Level*	*Severe Effect Level*	Test Results				
				L.1	**L.2**	**L.3**	**L.4**	**L.5**
1.	Fe (%)	2	4	145,15	179,31	163,72	210,6	185,06
2.	Mn	460	1100	217,13	216,07	283,24	249,7	220,08

Source: *Primary Research Data, 2023*

The Enim River sediment quality testing on the Iron (Fe) parameter was in the range of 14,515.83 - 21,060.44 mg/kg. This value shows that the metal content in the sediment exceeds the quality standards listed in the Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. The Fe content in the sediment exceeds level 2, namely the Lowest Effect Level, and level 3, namely the Severe Effect Level.

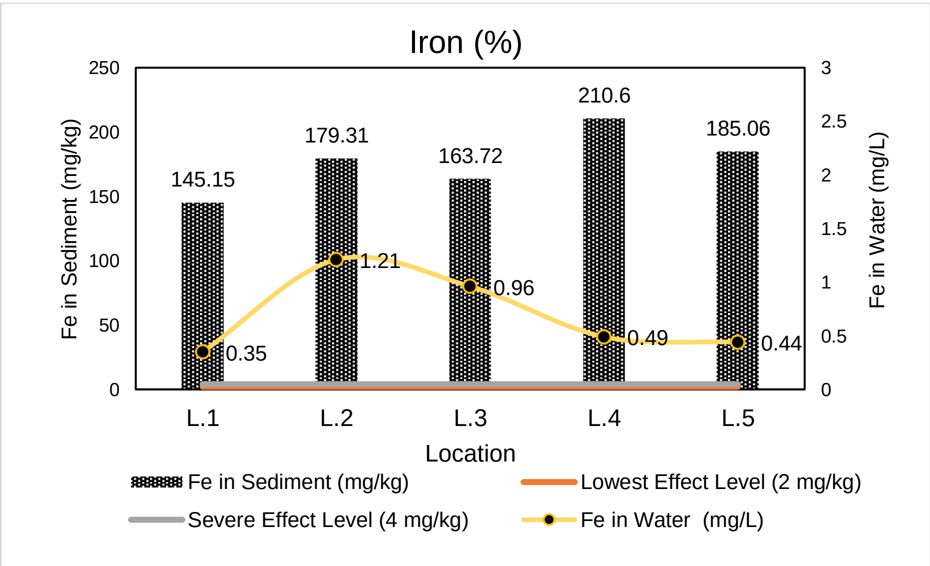

Figure 5. Graph of Fe Test Results on Enim River Sediment

Based on the results, it is known that the Iron (Fe) in the sediment at all sampling locations is much greater than the heavy metal Iron (Fe) in the water. This is caused by heavy metals in nature which easily settle at the bottom of water which occur because the specific gravity of the metal is higher than the specific gravity of water (Hutagalung, 1991). Continuous accumulation of metals in sediments over a long period caused by river flows results in high Fe metal content in sediments.

In Figure 5, the rise and fall of the value of Fe metal content in sediment is accompanied by the rise and fall of the value of Fe metal content in water. However, at location 4, the Fe metal in the sediment increased, unlike the Fe metal in the water which decreased. The increase in Fe content at sampling location 4 could be caused by physical factors including the deposition/sedimentation and stirring processes which are influenced by river flow speed (Maslukah, 2013). At location 4 of the sampling, the river flow speed relatively decreased, which could affect the rate of sedimentation or deposition of the heavy metal Fe. At location 5, the Fe content in the sediment decreased which was also accompanied by an increase in the speed of the river water flow at location 5. River flow speed influences the deposition of Fe metal in the waters of the Enim River. The effect between current speed and the rate of metal deposition in sediment is inversely proportional, so that if the current speed increases, the metal deposition rate will decrease. The results of testing the quality of the Enim River sediment on the Iron (Fe) parameter are in line with research conducted by Amrullah *et al.* (2013). This research was carried out on sediments in the Morosari River and Gonjol River, Demak Regency. The Fe content in the Morosari River and Gonjol River sediments ranges from 14,017.14 mg/kg – 68,065.87 mg/kg. The high Fe metal content in this study is thought to come from industrial activities and household activities.

The Mn content in Enim River sediment does not exceed level 2, namely the Lowest Effect Level, and level 3, namely the Severe Effect Level, as stated in the Guidelines for the Protection and Management of Aquatic Sediment Quality in Ontario. This means that the sediment in the waters of the Enim River shows contamination that has no effect on the majority of organisms living in the sediment and is considered not polluted based on the Manganese (Mn) parameter. Based on Figure 6, the highest Mn concentration was at location 3 sampling, namely 283.24 mg/kg and the lowest was at location 2 sampling, 216.07 mg/kg.

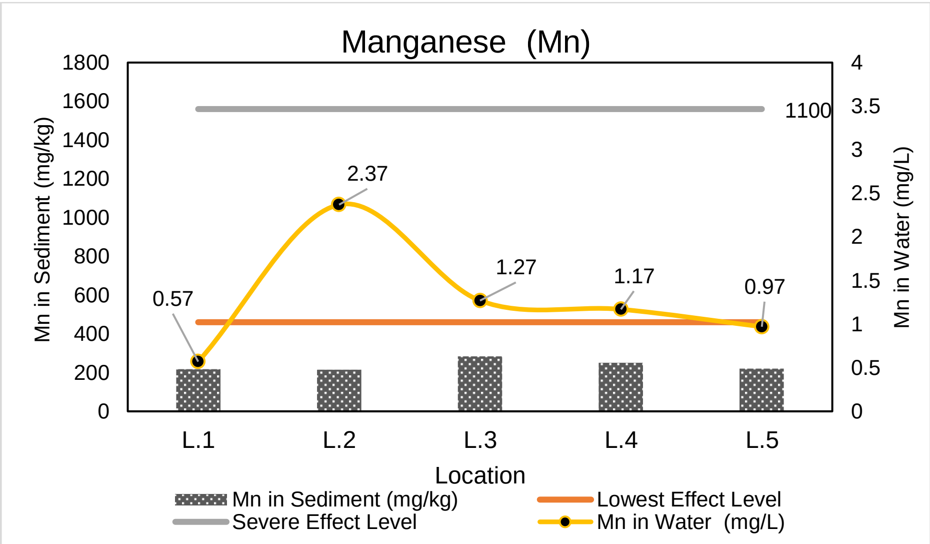

Figure 6. Graph of Mn Test Results on Enim River Sediment

The fluctuating Mn metal content in sediment goes hand in hand with the rise and fall of the Mn metal content in water due to the metal's nature which easily settles at the bottom of the water. At location 2 of sampling, the Mn content in the sediment tended to decrease from location 1 to location 2 and did not increase like the increase in Mn content in the water from location 1 to location 2. This is caused by the speed of the river flow which influences the metal deposition process in sediment (Maslukah, 2013). At location 2 the river flow speed tends to increase which can influence the deposition or sedimentation process of Mn metal in the Enim River sediment.

pH of river water influenced the concentration of Mn metal in Enim River sediments. Apart from pH, the solubility of manganese in water is influenced by oxidation-reduction reactions and electron activity. Under acidic pH conditions, namely pH 2 - 7.5, Mn will dissolve in the form of dissolved Manganese (Mn^{2+}). At a pH of 7.5, it will start to form a solid. In the pH condition of the Enim River water which is in the range of 6.4 – 6.8, Mn is still in dissolved form in the water and has not yet settled in the sediment (Bruins, 2016). Therefore, the Enim River sediments are not polluted by Mn metal.

3.2. Correlation between Fe and Mn Metal Contents in Water and Sediment

The results of the correlation analysis of Fe metal content in air and Fe in sediment can be seen in Table 4 and the results of the correlation analysis of Mn metal content in air and Mn in sediment can be found in Table 5.

Table 4. Correlation Values Between Fe in Water and Fe in Sediment

		Fe in Sediment	**Fe in Water**
Fe Sedimen	Pearson *Correlation*	1	-1.000**
	Sig. (2-tailed)		.000
	N	5	5
Fe Air	Pearson *Correlation*	-1.000**	1
	Sig. (2-tailed)	.000	
	N	5	5

**. *Correlation is significant at the 0.01 level (2-tailed).*
Source: *Primary Research Data, 2023*

Table 5. Correlation Values Between Mn in Water and Fe in Sediment

		Mn in Sediment	**Mn in Water**
Mn on Sediment	Pearson *Correlation*	1	-1.000**
	Sig. (2-tailed)		.000
	N	5	5
Mn on Water	Pearson *Correlation*	-1.000**	1
	Sig. (2-tailed)	.000	
	N	5	5

**. *Correlation is significant at the 0.01 level (2-tailed).*
Source: *Primary Research Data, 2023*

Based on Table 4 and Table 5, the Sig value. (2-tailed) < 0.05, then there is a correlation between Mn metal in water and Mn metal in sediment. The calculated r value is 1 and the table r value is 0.878 (SPSSIndonesia.com). The calculated r value > table r value means there is a correlation between metals in water and sediment. It is known that the correlation value for Fe and Mn metals in water and sediment is -1, which means the strong relationship between the metals in water and sediment is very strong. The direction of the relationship is negative, which means that if the Fe and Mn metals in the water increase, the Fe and Mn metals in the sediment will decrease, and vice versa.

Research conducted by Situmorang *et al.* (2018) in the waters of Kundur Island Beach, Riau states that the correlation results between Cu and Zn metals in water and Cu and Zn metals in sediments show a negative relationship direction, which means that if the metal content in the water increases then the metal content in sediment decreases, and vice versa. Based on this research, it can be seen that the increase in metals in water is not always accompanied by an increase in metals in sediment because the increase in metals in waters is also influenced by other factors such as temperature, pH and current speed.

3.3. Quality Status of the Enim River

3.3.1. Pollution Index (PI)

Based on Minister of Environment Decree Number 115 of 2003 concerning guidelines for water quality status, seen from Figure 6, the pollution index at location 1 is 3.95, location 4 is 4.87, and sampling location 5 is 4.62 in the range $1.0 \leq PIj \leq 5.0$, namely polluted Light while location 2 is 6.43 and location 3 sampling is 5.34 in the range of values $5.0 \leq PIj \leq 10$, namely Moderately Polluted. The high value of the Enim River Pollution Index indicates that these waters are not following their designation as raw drinking water as stipulated in South Sumatra Governor Regulation Number 16 of 2005. The water quality parameters that cause the Enim River water quality status to be in the moderately polluted category (Class I) are relatively high TSS, Fe, and Mn parameters in Enim River water.

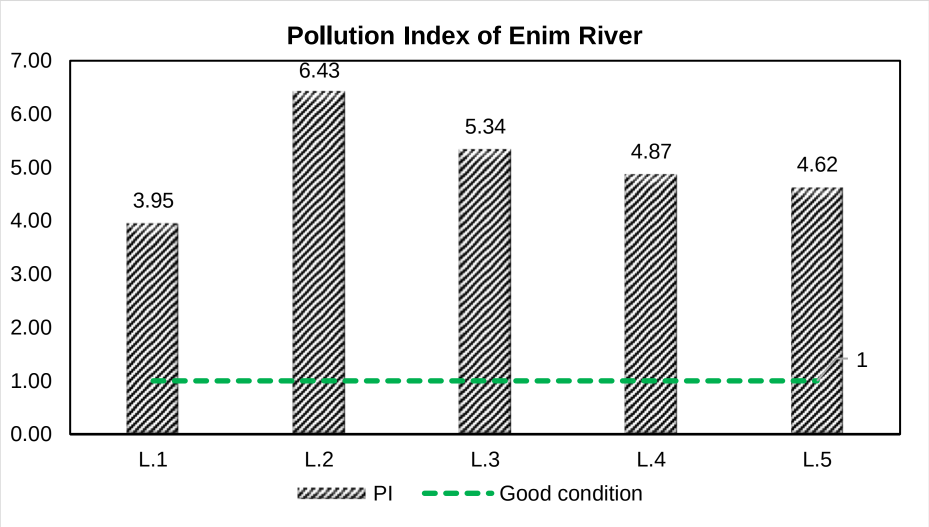

Figure 7. Enim River Water Pollution Index Graph

The shift in the water quality status of the Enim River is caused by land use along the Enim River. Coal mining activities and the activities of residents around the river influence the high value of the Enim River Pollution Index. This is because each activity produces waste which ends up in water bodies. The large load of incoming pollutants is estimated to exceed the river's ability to assimilate these pollutants. Research conducted by Susanto *et al.* (2021) on the waters of the Petangkep River, Central Kalimantan also shows that the quality status of the river is in a Lightly Polluted condition at all sampling locations. This is thought to be influenced by coal mining activities and palm oil plantations around river waters. Apart from that, research conducted by Triarjunet *et al.* (2020) on the water of the Ombilin River, West Sumatra, namely the quality status of the Ombilin River, which is Heavily Polluted, is also thought to be due to coal mining activities and the Ombilin PLTU around the river.

3.3.2. Geo-accumulation Index (Igeo)

The results of geo-accumulation index for Iron (Fe) metal in the Enim River sediments in Figure 7 shows that the highest value is at location 4, namely 5.49, and the lowest value is at location 1, namely 4.96. The *geo-accumulation* index value for Fe metal in the Enim River sediment at location 1 of sampling is in the range 4 < Igeo < 5, which means that the sediment in the Enim River is Extraordinarily Severely Polluted, and at location 2 to location 5 sampling is in the range Igeo > 5 which is This means that the sediment in the Enim River is extremely badly polluted by Fe metal. Iron (Fe) metal pollution in Enim River sediments originates from coal mining activities and residential activities around the Enim River. This mining activity produces acid mine waste containing Fe.

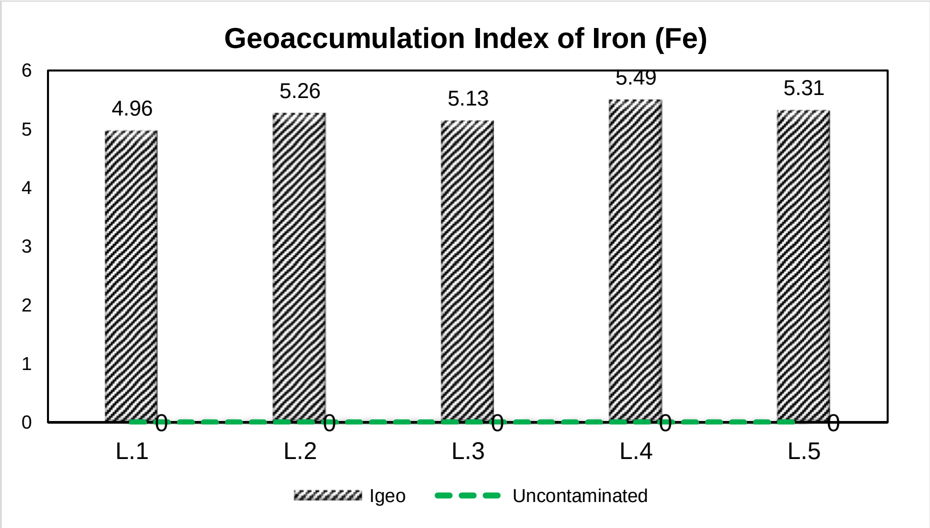

Figure 8. Graph of Fe *Geo-accumulation* Index in Enim River Sediment

Inversely proportional to Fe, the *geo-accumulation* index value of Mn metal in Enim River sediments is in the Igeo < 0 range. Figure 8 shows that the highest value is at location 3, namely -1.08, and the lowest value is at location 2, namely -1.47. This value shows that the sediment in the Enim River is not contaminated with manganese (Mn).

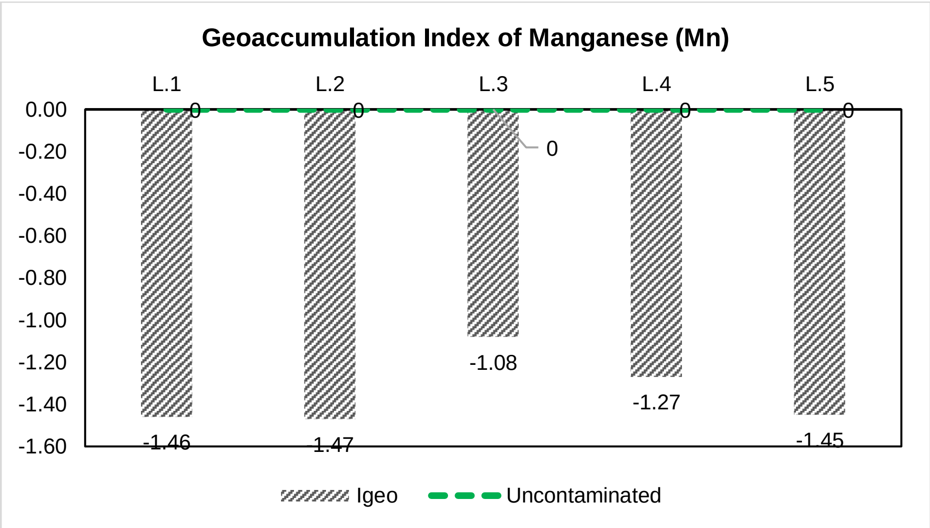

Figure 9. Graph of Fe *Geo-accumulation* Index in Enim River Sediment

The results of *Geo-accumulation Index* (Igeo) of Mn metal in Enim River sediments are in line with the concentration of Mn metal at each sampling location. When the Manganese (Mn) concentration is below the lowest effect level quality standard, the *Geo-accumulation Index* value is below 0, namely the sediment is not polluted. Metals with concentrations between the lowest effect level and saver effect level, namely the sediment quality status, are lightly polluted to severely polluted. Meanwhile, metals with concentrations above the save effect level indicate the quality status of the sediment, namely extraordinarily severely polluted to extremely severely polluted. Research conducted by *Aprillia (2020)* on Winongo River sediments also showed that the Mn *Geo-accumulation Index* value was below 0, namely in the range of -3.41 to -7.90. This index value indicates that the Winongo River sediment is not contaminated with Mn metal, the same as the Enim River.

4. Conclusion

The water quality of the Enim River does not fulfil Class 1 river water quality standards for TSS, Iron (Fe), and Manganese (Mn) parameters. The quality of the Enim River sediment in the Iron (Fe) parameter exceeds level 3, namely the Severe Effect Level, and in the Manganese (Mn) parameter, it does not exceed level 2, namely the Lowest Effect Level. The correlation value of Fe and Mn metals in water and sediment shows a value of -1,000, namely the relationship is very tight. The direction of the relationship is negative, which means that if the metal content in the water increases, the metal content in the sediment will decrease, and vice versa. From the Pollution Index values, it was found that the water quality status of the Enim River at locations 1, 4, and 5 was slightly polluted, while for locations 2 and 3 it was moderately polluted. In the Enim River sediments, the *Geo-accumulation Index* index value shows that Fe metal at location 1 is extremely heavily polluted and at locations 2 to 5 are extremely polluted. Meanwhile, the Mn metal in the Enim River sediment is not polluted.

5. Acknowledgement

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