Science in the Tropics

eISSN 3032-3223
https://doi.org/10.62090/hn4c8818

Analyzing water quality discrepancies in Manuhing River and its implications for environmental management

Ratnayanty[1]* • Sulmin Gumiri[2] • Evi Veronika[2]

[1)]Anugerah Enviropratama Consult, Palangka Raya
[2)]Faculty of Agriculture, University of Palangka Raya

*Corresponding author: yanti.reatna489@gmail.com

History

Received:
14 October 2023
Accepted:
5 December 2023
Published online:
10 January 2024

Keywords

Manuhing river •
pollution indices •
river pollution •
water quality •

Abstract

The study focuses on the issue of water pollution in the Manuhing River, which is currently a significant problem in the Gunung Mas District, West Kalimantan, Indonesia. The Manuhing River is located in the upper reaches of the river and is expected to influence the water quality downstream. The research is an observational study, involving direct sampling of water from three designated collection points. Data collection methods include direct observation, documentation, and interviews. The analysis of the data includes the comparison of water quality in the Manuhing River with the established standards, the determination of water quality status based on government regulations, and the management of water quality. The results of the analysis show that the parameters TSS, BOD, Fe, and Total Coliform do not meet the established standards. The water quality status of the Manuhing River falls into the category of heavily polluted to moderately polluted. The results of the one-way ANOVA test between the collection points with pollution indices showed a F-value greater than the F-table, so the null hypothesis (no significant difference) was rejected, indicating that the pollution indices were indeed different in a real sense from each collection point. The efforts that have been implemented so far include monitoring and involving the community, as well as the application of legal sanctions.

1. Introduction

Water as a primary necessity in the process of life, holds a crucial role as one of the natural resources essential for the existence of living beings on Earth[1]. The quantity and quality of water, aligned with human needs, are significant factors in determining the well-being of life[2,3]. Virtually all human activities require water to meet their daily needs. In addition, reliable access to water in sufficient quantity and quality for a healthy life, so-called "water security"," is crucial for agricultural food production and thus also for nutrition. Therefore, ensuring access to clean and safe water is crucial for sustaining life.

With the increasing population and economic development activities, there is a rise in human activities such as settlements, agriculture, and mining, leading to an increased discharge of waste into rivers[4]. The availability of water for the population serves as an indicator of the sustainability of water resources for both humans and the environment[5]. The sustainability of water resources encompasses aspects of meeting water needs and the capacity to withstand the burden of water pollution. Various types of pollution contribute to the contamination of rivers. Pollution arises from activities such as minings[6,7], oil palm plantations[8,9], and domestic waste from settlements[10–12].

Rivers are an integral part of the communities in Kalimantan island. They form settlements and develop into villages and districts named after the rivers that cross them. However, river water pollution is a widespread problem in this region. The Manuhing River in Central Kalimantan, for example, which flows through the districts of Manuhing Raya and Manuhing and is approximately 28.75 km long[13], has been polluted by local activities, which has led to a deterioration in water quality to the point that it no longer meets the set standards for drinking water sources[14,15]. Water pollution is becoming a critical issue for the future and emphasizes the need for awareness of environmental cleanliness and health. Pollution control measures need to be improved in order to achieve effluent quality that meets established standards.

Given that the upper part of a river, often referred to as the headwaters, significantly affects water quality downstream, it is imperative to focus on proper management of these headwaters. The unique characteristics and conditions of the headwaters, which form the starting point of a river, play a critical role in shaping the water quality of the entire river system. Recognizing these relationships, the we conduct a study to specifically assess the water quality of the Manuhing River, as it is a headwater river.

The main objective of this study is to conduct an in-depth analysis of the quality and overall condition of the water of the Manuhing River. By exploring the specific dynamics of this headwater stream, the main parameters that contribute to its water quality will be highlighted. Moreover, the study attempts to decipher the existing management measures that have been implemented in the Manuhing River. Recognizing and understanding these measures is crucial for evaluating their effectiveness in maintaining or improving water quality. By combining scientific analysis and pragmatic exploration of management practices, the researchers aim to gain valuable insights that can inform future decision-making processes related to the sustainable management of the Manuhing River and, by extension, other headwater rivers facing similar challenges.

2. Methods

2.1. Research Site

This study was conducted on the Manuhing River in the Manuhing Raya and Manuhing Districts, Gunung Mas Regency. The research was carried out in February 2019, with water sampling taking place from 06:00 to 10:00 WIB at three designated stations (Figure 1).

- Station I, located at LS 01°12’42.19” S, 113°19’00.80” E, represents the upper part of the Manuhing River in Luwuk Tukau Village, Manuhing Raya District, an area characterized by residential, mining, and forestry activities.
- Station II, at LS 01°21’03.90” S, 113°22’44.41” E, represents the middle part of the river in Tumbang Talaken Village, Manuhing District, an area with residential and agricultural activities.
- Station III, at LS 01°34’57.81” S, 113°37’16.59” E, represents the lower part of the river in Takaras Village, Manuhing District, an area with residential, agricultural, and mining activities. The Manuhing River is located at the confluence before joining another river.

The determination of stations in this study is conducted through the sample survey method. Research sites are systematically divided into three stations, each serving as a representative sample of the broader research population. The criteria for selecting these sampling stations along the Manuhing River hinge on considerations such as cost and ease of access.

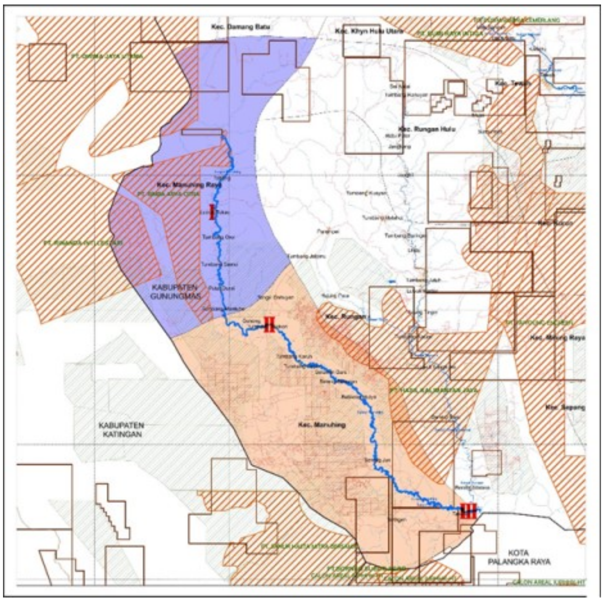

Figure 1. Map of research locations

2.2. Materials and Tools

The equipment used in this research is as in Table 1. Supporting tools include water sample containers (2-liter plastic containers for physically and chemically analyzed water samples; 0.25-liter glass bottles for microbiological analysis), location maps, Global Positioning System (GPS), camera, labels, markers, writing tools, and data analysis equipment.

Table 1. Equipment used in this research

No.	Parameter	Tool/Method Used	Specification	Remarks
1	Brightness	*Sechi Disk*	Diameter 20 cm	*In-situ*
2	pH	SNI 06-6989.11-2004	-	Laboratory
3	Temperature	SNI 06-6989.23-2005	-	Laboratory
4	TSS	SNI 06-6989.3-2004	-	Laboratory
5	TDS	SNI 06-6989.27-2005		Laboratory
6	BOD	SNI 6989.72:2009	-	Laboratory
7	DO	SNI 06-2425-1991	-	Laboratory
8	NO_3-N	SNI 06-2480-1991		Laboratory
9	NO_2-N	SNI 06-6989.9-2004	-	Laboratory
10	NH_3-N	SNI 06-6989.30-2005		Laboratory
11	Fe	SNI 6989.4 : 2009	-	Laboratory
12	Total *Coliform*	MPN Coliform IKM/5.4.30/ BLK-PKY (Double Tube)	-	Laboratory

2.3. Research Design

This study adopts an observational research design, involving the collection of river water samples at predetermined stations (research locations). Subsequently, in-situ measurements are conducted for water brightness. For parameters such as Temperature, Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Biochemical Oxygen Demand (BOD), Dissolved Oxygen (DO), Iron (Fe), Nitrate-N (NO_3-N), Nitrite-N (NO_2-N), Ammonia-N (NH_3-N), and Total Coliform, quality testing is carried out at the Central Kalimantan Provincial Health and Calibration Laboratory.

The status of Manuhing River water quality is assessed using the Pollution Index. The ex-situ test results are compared with the Republic of Indonesia Government Regulation Number 82 of 2001 on Water Quality Management and Pollution Control, yielding a Pollution Index as an indicator of the water body's quality status, following the guidelines outlined in Minister of State for the Environment Decision Number 115 of 2003 on Guidelines for Determining Water Quality Status.

2.4. Data Collection

The research conducted utilized both primary and secondary data. Primary data involved direct measurements of the river's physical, chemical, and biological parameters at the research location, as well as additional analyses conducted in the laboratory. On the other hand, secondary data were derived from various sources such as reports, literature studies, and documents from relevant institutions related to the research topic. The data collection procedures included field observation, documentation, laboratory analysis, and interviews. During field observation, measurements were taken, water brightness was recorded, and samples were collected for measuring the river water quality, encompassing physical, chemical, and biological parameters. Documentation was used to illustrate the conditions at the research location. Laboratory analysis was conducted to further analyze the collected samples, and interviews were carried out with the Gunung Mas District Environmental Agency to gather relevant information. The survey includes the collection of information from literature studies, reports and documents from the Gunung Mas District Environmental Agency, such as the Environmental Quality Monitoring Activity Reports for the years 2017 and 2018

2.4. Data Collection

Data analysis involved the use of statistical methods, in particular analysis of variance (ANOVA), as the study included more than two treatment groups. The decision-making process involved comparing the calculated F value with the tabulated F value. The hypotheses for the analysis were defined as the null hypothesis (H0), which states that the mean pollution index value of the river water at the observation sites is the same, and the alternative hypothesis (H1), which states that the mean pollution index value of the river water at the observation sites is different. The test criteria were set so that the null hypothesis is rejected if the significance value is less than 0.05 and the null hypothesis is accepted if the significance value is greater than 0.05.

Data analysis for the Manuhing River water quality management efforts conducted descriptively using a qualitative approach. The data analysis is used to formulate management strategies for the Manuhing River based on the water quality analysis, water quality identification and interview results.

3. Results and Discussion

The results of the parameter measurements conducted by Gunung Mas Regency Environmental Service in 2017 are shown in Annex 1[13]. The results of the measurements conducted by Gunung Mas Regency Environmental Service in 2018 and 2019 are shown in Annex 2[16].

3.1. Water Quality Parameters

Water Brightness. Brightness measurements for the years 2017 and 2018 were not conducted based on monitoring data from the Gunung Mas District Environmental Agency. The brightness values obtained during the 2019 measurements (primary data) ranged from 8 to 14 cm. The brightness values at Station I were 8 cm, Station II measured 9 cm, and Station III recorded 14 cm. The measurement results indicate significantly lower brightness in the upstream compared to the downstream of the

Manuhing River. The reduced brightness in the upper part of the river (Station I) is attributed to rainfall that occurred before the sampling, leading to rainwater runoff entering the water body and carrying solid materials. Previous research on water brightness levels in the Kahayan River yielded results of approximately ±10 cm[17].

Water Temperature. The finding that the water temperature measurements in 2019 did not exhibit significant differences from Station I to Station III along the Manuhing River, with the highest temperature recorded at Station III, is significant in the context of water quality and environmental impact. Water temperature patterns are influenced by various factors such as sunlight intensity, heat exchange between water and surrounding air, geographical factors based on elevation, and the presence of vegetation along the water's edge[18]. This finding indicates that human activities such as settlements, plantations, and mining at Station III may be contributing to the higher water temperature, which can have implications for the river's ecosystem and water quality.

The impact of water temperature on aquatic ecosystems is well-documented. For instance, higher water temperatures can affect the dissolved oxygen levels in water, promote the growth of algae and bacteria, and influence the migration, spawning, and hatching of local fish species[19,20]. Additionally, temperature variations can impact the circulation and mixing patterns within a water body, which in turn affects nutrient levels and the overall health of the aquatic environment. Therefore, the recorded higher temperature at Station III, attributed to human activities, may have implications for the Manuhing River's ecosystem and water quality, particularly in the downstream areas where the effects of temperature changes and pollution accumulation from upstream activities are more pronounced.

Total Suspended Solids (TSS). The measurement results for the Total Suspended Solids (TSS) parameter in the Manuhing River, from Station I at the upstream to Station III, range between 123 – 464 mg/L. The concentration of suspended solids (TSS) indicates that it has exceeded the threshold for water quality standards of Class I and II as per Government Regulation Number 82 of 2001. The 2019 measurement results reveal TSS concentration values at Station I of 464 mg/L, Station II at 194 mg/L, and Station III at 123 mg/L. The TSS parameter shows a decrease from the upstream to the downstream. The elevated TSS values in the upstream (Station I) are attributed to rainfall during the preceding sampling, leading to runoff water entering the river with suspended solid materials. Additionally, the upstream region includes areas subjected to mining activities. Subsequently, a decrease in concentration levels occurs downstream due to dilution processes, resulting in reduced suspended solid content and turbidity levels

This finding indicates the potential impact of human activities, such as mining and land use, on the river's TSS levels. Elevated TSS levels can have various adverse effects on aquatic ecosystems, including reduced light penetration, increased water turbidity, and potential harm to aquatic organisms[21]. The study's results underscore the importance of monitoring and managing TSS levels in the Manuhing River to preserve its water quality and ecological balance.

pH Value. The pH values at Station I range between 6.63 – 6.75; at Station II, they vary from 6.46 – 6.84, and at Station III, the range is 6.18 – 6.85. The pH measurement results show a consistent trend at each station. The pH values in the Manuhing River water still adhere to the water quality standards for Class I and II as per Government Regulation Number 82 of 2001. The measured pH values in the Manuhing River water are considered normal, indicating that the supply of organic waste containing mineral acids has a relatively minimal impact on the river's acidity. The pH values for river water typically range from 6.0 to 8.5[22].

The consistent trend in pH values at each station indicates that the Manuhing River's water acidity remains within acceptable limits. This is an important indicator of the river's overall water quality, as pH values are indicative of a healthy and well-buffered aquatic environment, which is essential for supporting diverse aquatic life[23]. The finding also sheds light on the spatial variations in pH along the river, which can be influenced by various factors such as natural processes, human activities, and the characteristics of the surrounding landscape.

Dissolved Oxygen (DO). The research finding on the dissolved oxygen (DO) values in the Manuhing River provides important insights into the river's water quality and the potential impact of organic waste and pollution on its oxygenation process. The study found that the DO values in the Manuhing River still met the water quality standards according to Government Regulation Number 82 of 2001, with monitoring data from 2017 and 2018 showing relatively high values ranging from 6.6 to 9.9 mg/L. However, the DO concentration values in 2019 at Station I, Station II, and Station III were lower, with values of 5.48 mg/L, 5.76 mg/L, and 5.72 mg/L, respectively. This indicates a decrease in the oxygenation process in the water, which can be attributed to pollution by organic materials, especially domestic wastewater in residential areas.

The decrease in DO levels can have significant implications for the river's ecosystem and aquatic life. Low DO levels can lead to reduced oxygen availability for aquatic organisms, which can affect their growth, reproduction, and survival[24]. Additionally, low DO levels can promote the growth of anaerobic bacteria, which can produce harmful compounds and further degrade water quality.

Biologycal Oxygen Demand (BOD). The biological oxygen demand (BOD) parameters were monitored in the Manuhing River in 2017 and 2018, with values ranging from 2.1 to 27.6 mg/L. The BOD values in 2019 at the three stations (I, II, and III) did not show a significant difference, with values of 4.72 to 4.78 mg/L. The research results indicate that the water quality parameter BOD in the Manuhing River does not meet the Class I and II water quality standards specified in Government Regulation Number 82 of 2001. The increase in BOD levels suggests an increase in organic wastewater discharge into the river, which is common along the Manuhing River. According to Salmin[25], based on BOD levels, the water quality is considered highly polluted and does not fall into the category of good water quality (BOD levels of 1-10 mg/L). Organic wastewater discharged into the river, especially in residential areas, usually increases the BOD concentration[26].

Iron (Fe). The research finding on the iron (Fe) content in the Manuhing River provides insights into the river's water quality and the potential impact of mining activities on its iron levels. The monitoring data for the iron parameter in 2017 and 2018 ranged from <0.048 to 9.99 mg/L, while the Fe concentration values in 2019 at the three stations (I, II, and III) were 1.56 mg/L, 1.10 mg/L, and 1.38 mg/L, respectively. The measurement results of the Fe content exceeded the water quality standards for Class I rivers at all sampling points. The iron content in natural waters typically ranges from 0.05 to 0.2 mg/L. The increase in iron levels in the Manuhing River can be attributed to mining activities such as coal mining, excavation, or stone mining.

This finding is worrying as elevated iron levels can have various negative effects on aquatic ecosystems and human health. High iron concentrations can lead to reduced light penetration, increased water turbidity and potential harm to aquatic organisms[27]. In addition, high iron levels can promote the growth of anaerobic bacteria[28], which can produce harmful compounds and further degrade water quality. The finding also highlights the potential impacts of mining activities on the water quality of the Manuhing River and the need for effective management strategies to mitigate these impacts.

Ammonia (NH_3-N). The ammonia (NH_3-N) concentrations in the Manuhing River in 2019 were found to range from 0.425 to 0.315 mg/L. The concentrations decreased from station I to station III. The ammonia levels in the Sungai Manuhing still complied with the water quality standards for Class I rivers, as specified in Government Regulation Number 82 of 2001. The sources of ammonia in the river include the decomposition of organic matter such as aquatic biota and decaying vegetation or fungi, which are the results of nitrogenous organic and inorganic compounds (proteins and urea) present in the soil and water. These organic compounds can come from various activities, including wastewater discharge, agricultural waste, and fish farming waste that directly enters the river[22].

Nitrate (NO_3-N). The monitoring data for the nitrate (NO_3-N) parameter in the Manuhing River in 2018 ranged from 0.44 to 1.09 mg/L. The NO_3-N concentration values in 2019 at the three stations (I, II, and III) were 0.400 mg/L, 0.560 mg/L, and 0.720 mg/L, respectively. The measurement results of NO_3-N showed that the values still complied with the water quality standards for Class I and II rivers at all sampling points. Nitrogen compounds play an important role in water quality, especially the forms of nitrogen that can be utilized by phytoplankton and the forms that are harmful to aquatic life. The high levels of NO_3-N indicate anthropogenic pollution originating from residential and agricultural activities around the water.

Nitrite (NO_2-N). Monitoring data for the years 2017 and 2018 regarding the NO_2-N parameter ranged between 0.0012 – 0.0137 mg/L. The concentration values of NO_2-N in 2019 at Station I were 0.053 mg/L, at Station II they were 0.0405 mg/L, and at Station III, they were 0.042 mg/L. Nitrite (NO_2-N) concentrations indicate values that still comply with the water quality standards for Class I and II rivers at all sampling station points. Nitrite serves as an intermediate compound between ammonia and nitrate, as well as between nitrate and nitrogen gas. The source of nitrite can include organic waste. Nitrite compounds are reactive and toxic to aquatic organisms[29].

Total Coliform. The monitoring data for the total coliform parameter in 2018 at station I was 28,000 MPN/100ml, at station II was 2,100 MPN/100ml, and at station III was 1,300 MPN/100ml. In 2019, the total coliform concentrations increased, with values of 170,000 MPN/100ml at station I, 350,000 MPN/100ml at station II, and 33,000 MPN/100ml at station III. These concentrations exceeded the water quality standards. The 2018 measurements showed a decrease in coliform concentrations downstream. However, in 2019, there was an increase at station II and a subsequent decrease at station III. The high coliform content is attributed to the large population along the banks of the Manuhing River, which disposes of feces and waste directly into the river. Additionally, the coliform content is suspected to increase as the water travels from the upper reaches to the lower reaches, receiving fecal waste along the way[30]. The coliform content subsequently decreases at station III, likely due to the dilution of the waste, influenced by the presence of many tributaries along the river.

3.2. Water Pollution Index (WPI) of the Manuhing River

The calculation of the pollution index is based on the sampling stations and predetermined parameters, namely Total Suspended Solids (TSS), Total Dissolved Solids (TDS), pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Nitrate-N (NO_3-N), and Nitrite-N (NO_2-N), with results depicted in Figure 2.

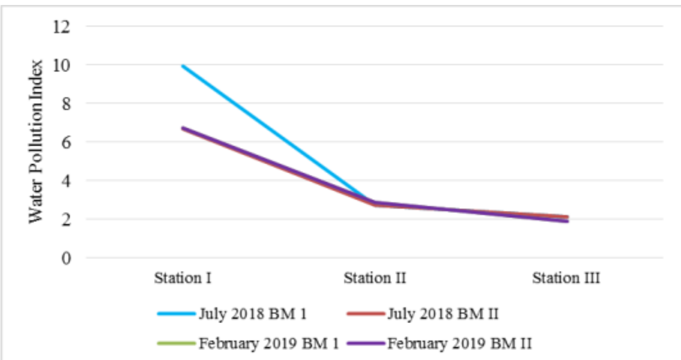

Figure 2. Manuhing River Pollution Index

Remarks
BM1: Class 1 Quality Standard
BM2: Class II Quality Standard

The pollution index calculations at each sampling station indicate that the water quality of the Manuhing River, from upstream to downstream, is already polluted (ranging from moderate to light pollution). Water pollution occurs due to concentrations of Total Suspended Solids (TSS) and Biochemical Oxygen Demand (BOD) exceeding the prescribed water quality standards at all observation stations.

3.3. Relationship Between Sampling Stations and Pollution Index

The spatial relationship between sampling stations and the pollution index of the Manuhing River will be analyzed using One-Way Analysis of Variance (ANOVA). The measurement years will be defined as groups, and the water quality variables will be the response variable, specifically the Pollution Index (PI), as shown in Table 3.

Table 3. Anova results for pollutant index values

Variance source	Sum of Squares	**df**	Mean Square	F-value	**P-value**
Class I water quality standards					
Between Groups	47,658	2	23,829	13,553	0,031
Within Group	5,275	3	1,758		
Total	52,933	5			
Class II water quality standards					
Variance source	Sum of Squares	**df**	Mean Square	F-value	**P-value**
Between Groups	25,374	2	12,687	905,471	0,000
Within Group	0,042	3	0,014		
Total	25,416	5			

The results of the ANOVA test on the relationship between sampling stations and the pollution index indicate that the null hypothesis (Ho) is rejected (significant). This implies that the pollution index values differ significantly among each sampling station. These differences are influenced by the increase in Total Suspended Solids (TSS), Total Dissolved Solids (TDS), and Biochemical Oxygen Demand (BOD), as well as a decrease in Dissolved Oxygen (DO) levels.

3.4. Efforts in Managing the Water Quality of the Manuhing River

The results of interviews conducted with the Gunung Mas District Environmental Agency regarding efforts to manage the water quality of the Manuhing River are following.

Monitoring and control of the water quality of the Manuhing River. Monitoring is conducted to ensure that the requirements set out in the environmental permit for the discharge of wastewater into water bodies and the technical requirements for water pollution control set out in the environmental documents are met. The purpose of river water quality monitoring is to determine the water quality status of the river. It forms the basis for assessing the environmental impact around the river, provides information for decision-makers and serves as a warning in the event of incidents of water pollution of the river. Monitoring of the Manuhing River also serves to provide factual information on the river's water quality status, past trends, current situations and anticipated future changes.

Community involvement. Community involvement in the management of the river's water quality is crucial. Community knowledge of river water quality management will be improved through socialization and training. The residents of Gunung Mas District who have attended trainings on the role of river water quality management contribute to the protection of the river by not dumping waste into the river.

Enforcing the law. Environmental issues such as pollution of river water must be reported to the Gunung Mas District Environmental Agency. The community is encouraged to actively report environmental problems, either through written notices or personal visits to the office. In addition to individuals, businesses are also encouraged to inform the authorities if there are incidents indicating pollution or environmental damage to ensure effective and prompt remedial action.

4. Conclusion

The water quality of the Manuhing River shows that parameters such as total suspended solids (TSS), biochemical oxygen demand (BOD) and total coliform bacteria have exceeded the quality standards for classes 1 and 2 and the parameter Iron (Fe) does not comply with the standards of class 1 as stipulated in Government Regulation No. 82 of 2001. The quality status of the Manuhing River is slightly to moderately polluted according to the Pollution Index under the Decision of the State Minister of Environment No. 115 of 2003. Efforts to control the water quality of the Manuhing River include water quality monitoring and control, community involvement and law enforcement. These measures aim to address and mitigate the observed pollution of the river.

Building on these positive efforts, it is recommended to further strengthen community engagement through continuous education and awareness programs. Encouraging wider participation and empowering community members with the tools to identify and report environmental issues will foster a more vigilant and responsive community. Additionally, exploring opportunities for collaborative initiatives between the Environmental Agency, local businesses, and residents can amplify the impact of remedial actions. This synergy can be pivotal in creating a sustainable and resilient approach to managing and preserving the water quality of the Manuhing River for the benefit of both the environment and the community.

References

1. Sultana, F. Water justice: why it matters and how to achieve it. *Water Int.* **43**, 483–493 (2018).
2. Nesmith, A. A. *et al.* Water, Air, and Land: The Foundation of Life, Food, and Society. in *The Intersection of Environmental Justice, Climate Change, Community, and the Ecology of Life* 13–25 (2021). doi:10.1007/978-3-030-55951-9_2.
3. Ptak-Wojciechowska, A., Januchta-Szostak, A., Gawlak, A. & Matuszewska, M. The Importance of Water and Climate-Related Aspects in the Quality of Urban Life Assessment. *Sustainability* **13**, 6573 (2021).
4. Liu, Y. *et al.* A review of water pollution arising from agriculture and mining activities in Central Asia: Facts, causes and effects. *Environ. Pollut.* **291**, 118209 (2021).
5. Hoekstra, A. Y., Buurman, J. & van Ginkel, K. C. H. Urban water security: A review. *Environ. Res. Lett.* **13**, 053002 (2018).
6. Murdifin, I. *et al.* Environmental disclosure as corporate social responsibility: Evidence from the biggest nickel mining in Indonesia. *Int. J. Energy Econ. Policy* **9**, 115–122 (2019).
7. Gafur, N., Sakakibara, M., Sano, S. & Sera, K. A Case Study of Heavy Metal Pollution in Water of Bone River by Artisanal Small-Scale Gold Mine Activities in Eastern Part of Gorontalo, Indonesia. *Water* **10**, 1507 (2018).
8. Dislich, C. *et al.* A review of the ecosystem functions in oil palm plantations, using forests as a reference system. *Biol. Rev.* **92**, 1539–1569 (2017).
9. Sarido, L. Study of Water Quality in Bengalon River on Oil Palm Estate. *E3S Web Conf.* **68**, 04007 (2018).
10. Sabarinah, Z. The Importance of Waste Management Knowledge to Encourage Household Waste-Sorting Behaviour in Indonesia. *Int. J. Waste Resour.* **07**, (2017).
11. Wijaya, I. M. W. & Soedjono, E. S. Domestic wastewater in Indonesia: Challenge in the future related to nitrogen content. *Int. J. GEOMATE* **15**, 32–41 (2018).
12. Subagiyo, L., Nuryadin, A., Sulaeman, N. F. & Widyastuti, R. Water quality status of kalimantan water

bodies based on the pollution index. *Pollut. Res.* **38**, 536–543 (2019).

13. Dinas Lingkungan Hidup Kabupaten Gunung Mas. Laporan Kegiatan Pemantauan Kualitas Lingkungan 2017 Kabupaten Gunung Mas Provinsi Kalimantan Tengah. (2017).
14. Diduga Tercemar Limbah PKS PT BMB, Ribuan Ikan Mati di Sungai Masien Manuhing – Canal Berita. https://www.canalberita.com/2023/05/diduga-tercemar-limbah-pks-pt-bmb-ribuan-ikan-mati-di-sungai-masien-manuhing/.
15. Perusahaan Sawit Milik Malaysia di Gunung Mas Jadi Tersangka Pencemaran - elaeis.co. https://www.elaeis.co/berita/baca/perusahaan-sawit-milik-malaysia-di-gunung-mas-jadi-tersangka-pencemaran.
16. Dinas Lingkungan Hidup Kabupaten Gunung Mas. Laporan Kegiatan Pemantauan Kualitas Lingkungan 2018 dan 2019 Kabupaten Gunung Mas Provinsi Kalimantan Tengah. (2019).
17. Arivanae, M. Profil darah ikan Nila (*Oreochromis niloticus*) dan Mas (*Cyprinus carpio*) yang terpapar bakteri Aeromonas Hydrophila di keramba Pahandut Seberang Sungai Kahayan. (Universitas Palangka Raya, 2017).
18. Triyuly, W., Triyadi, S. & Wonorahardjo, S. Synergising the thermal behaviour of water bodies within thermal environment of wetland settlements. *Int. J. Energy Environ. Eng.* **12**, 55–68 (2021).
19. Nasution, A. K., Dian Takarina, N. & Thoha, H. The presence and abundance of harmful dinoflagellate algae related to water quality in Jakarta Bay, Indonesia. *Biodiversitas J. Biol. Divers.* **22**, 2909–2917 (2021).
20. Henny, C. & Nomosatryo, S. Changes in water quality and trophic status associated with cage aquaculture in Lake Maninjau, Indonesia. *IOP Conf. Ser. Earth Environ. Sci.* **31**, 012027 (2016).
21. Alfiah, T. & Caroline, J. Total Suspended Solids (TSS) Spatial Distribution of Manganese in Resident Well Impacted by Residential Activity: A Case Study of Medokan Ayu District-Surabaya. *Paragraphs Environ. Des.* 1–10 (2023) doi:10.59260/penvid.2023.01101317.
22. Effendi, H., Adimas Kristianiarso, A. & M Adiwilaga, E. Karakteristik kualitas air sungai Cihideung, Kabupaten Bogor, Jawa Barat. *J. Ecolab* **7**, 81–92 (2013).
23. Purwono, P., Ristiawan, A., Ulya, A. U., Matin, H. A. A. & Ramadhan, B. S. Physical-chemical quality analysis of Serayu River water, Banjarnegara, Indonesia in different seasons. *Sustinere J. Environ. Sustain.* **3**, 39–47 (2019).
24. Fakhrudin, M., Subehi, L., Jasalesmana, T. & Dianto, A. Dissolved oxygen and temperature stratification analysis for early warning system development in preventing mass mortality of fish in lake Maninjau, West Sumatera - Indonesia. *IOP Conf. Ser. Earth Environ. Sci.* **380**, 012002 (2019).
25. Salmin. Oksigen Terlarut (DO) dan kebutuhan Oksigen Biologi (BOD) Sebagai Salah Satu Indikator Untuk Menentukan Kualitas Perairan. *Oseana* **30**, 21–26 (2005).
26. Widyarani *et al.* Domestic wastewater in Indonesia: generation, characteristics and treatment. *Environ. Sci. Pollut. Res.* **29**, 32397–32414 (2022).
27. Boyd, C. E. Particulate Matter, Color, Turbidity, and Light. in *Water Quality* 101–112 (2015). doi:10.1007/978-3-319-17446-4_5.
28. Baek, G., Kim, J. & Lee, C. A review of the effects of iron compounds on methanogenesis in anaerobic environments. *Renew. Sustain. Energy Rev.* **113**, 109282 (2019).
29. Yanti, E. V. Dinamika musiman kualitas air di Daerah Sungai Kahayan Kalimantan Tengah. *ZiRAA'AH* **42**, 107–118 (2019).
30. Amru, K. & Makkau, B. A. Analisis Kualitas Air Sungai Palopo Akibat Pencemaran Limbah Domestik Dengan Metode Index Pollution. *J. Teknol. Lingkung.* **24**, 137–142 (2023).

How to Cite:
Ratnayanty, Gumiri, S., & Veronika, E. (2023). Analyzing water quality discrepancies in Manuhing River and itsimplications for environmental management. *Science in the Tropics*, *1*(1), 42-53. https://doi.org/10.62090/hn4c8818

Annex 1. Values of the water quality parameters of the Manuhing River in 2017

No.	Parameter	Unit	Quality Standards		Year 2017					
					Station I		Station II		Station III	
			Class I	Class II	May	Sep	May	Sep	May	Sep
			A. Physical Properties							
1	Temperature	°C	Deviation 3		-	-	-	-	-	-
2	Total Suspended Solids (TSS)	mg/L	50		-	-	-	-	-	-
3.	Total Dissolved solids (TDS)	mg/L	1.000		-	-	-	-	-	-
			B. Chemical Properties							
1	pH	-	6-9		-	-	-	-	-	-
2	Biologycal Oxygen Demand (BOD)	mg/l	2	3	7,3	23,4	9,2	14,0	12,1	20,5
3	Dissolved Oxygen (DO)	mg/L	6	4	7,5	7,6	6,8	8,8	6,6	8,4
4	Ammonia (NH_3-N)	mg/L	0,5	-	<0,008	<0,008	<0,008	<0,008	<0,008	<0,008
5	Iron (Fe)	mg/L	0,3	-	0,25	2,87	0,13	1,81	0,22	1,65
6	Nitrate (NO_3-N)	mg/L	10		-	-	-	-	-	-
7	Nitrite (NO_2-N)	mg/L	0,06		0,0084	0,0012	0,0094	0,0017	0,0137	0,0039
			C. Microbiology Properties							
1	Total Coliform	MPN/100ml	1.000	5.000	-	-	-	-	-	-

Source: Dinas Lingkungan Hidup Kabupaten Gunung Mas[13]

Annex 2. Values of the water quality parameters of the Manuhing River in 2018 and 2019

No.	Parameter	Unit	Quality Standards		Year 2018						Year 2019		
					Station I		Station II		Station III		Station I	Station II	Station III
			Class I	Class II	July	Sep	July	Sep	July	Sep	Feb	Feb	Feb
	A. Physical Properties												
1	Temperature	°C	Deviation 3		25,2	-	25,4	-	23,6	-	21,8	28,1	29,0
2	Total Suspended Solids (TSS)	mg/L	50		152	-	181	-	141	-	464	194	123
3.	Total Dissolved solids (TDS)	mg/L	1.000		132	-	82	-	80	-	9,22	6,36	7,25
	B. Chemical Properties												
1	pH	-	6-9		6,75	-	6,84	-	6,85	-	6,63	6,46	6,18
2	Biologycal Oxygen Demand (BOD)	mg/L	2	3	27,6	-	6,0	-	2,1	-	4,72	4,78	4,74
3	Dissolved Oxygen (DO)	mg/L	6	4	9,3	-	8,1	-	9,9	-	5,48	5,76	5,72
4	Ammonia (NH_3-N)	mg/L	0,5	-	0,03	-	<0,01	-	<0,01	-	0,425	0,205	0,315
5	Iron (Fe)	mg/L	0,3	-	9,99	2,88	7,83	1,49	<0,048	1,96	1,56	1,10	1,38
6	Nitrate (NO_3-N)	mg/L	10			-	1,09	-	0,58	-	0,400	0,560	0,720
7	Nitrite (NO_2-N)	mg/L	0,06			-	0,0082	-	0,0061	-	0,0530	0,0405	0,0420
	C. Microbiology Properties												
1	Total Coliform	MPN/100ml	1.000	5.000	-	28.000	-	2.100	-	1.300	170.000	350.000	33.000

Source: Dinas Lingkungan Hidup Kabupaten Gunung Mas[16]