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The quality status of mangrove waters in Pagatan Besar Village

Dini Sofarini[1]*, Suhaili Asmawi[1], Anisa Firli Nabila[1]
[1] *Department of Aquatic Resource Management, Faculty of Fisheries and Marine Science, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan 70714, Indonesia.*
*Correspondence: dini.sofarini@ulm.ac.id

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ABSTRACT
Background: Mangrove waters are one of the areas that produce fish resources and other aquatic biota in Tanah Laut Regency, especially in Pagatan Besar Village. However, several previous studies stated that the average heavy metal content in other mangrove waters in Tanah Laut Regency has exceeded the quality standards set based on Republic of Indonesia Government Regulation No. 22 of 2021. Heavy metal content that is too high can be the cause of high levels of pollution in waters. This research aims to determine the quality status of mangrove waters in Pagatan Besar Village. **Methods**: The method used is calculation using the Pollution Index Method, based on Minister of Environment Decree No. 115 of 2003.. **Findings:** The results of the pollution index calculation show that at the three observation stations in the Mangrove Waters of Pagatan Besar Village, all of them are classified as heavily polluted. The mangrove waters in Pagatan Besar Village is often used for water transportation, nature conservation, capture fisheries, tourism and fishermen's settlements, for example Pagatan Besar Beach, Takisung Beach, Nyiur Ampat Beach and Pier Senja Beach, so that the coastal area of Takisung District has the potential for significant environmental damage. **Conclusion** The further impact of this condition can disrupt the survival of important biota in mangrove waters, such as crabs, shrimp and shellfish which have local economic value. **Novelty/Originality of this article:** All locations that were observation stations in this research found that the status of mangrove water quality in Pagatan Besar Village which is heavily polluted.

KEYWORDS: mangrove; pagatan besar; pollution index.

1. Introduction

Pagatan Besar Village is one of the villages in Tanah Laut Regency, South Kalimantan Province, which is known as a fishing resource producing area and also a tourist area. However, these conditions provide quite a large opportunity for cases of water pollution to occur, especially in coastal and mangrove areas.

Several previous studies conducted in several coastal and mangrove areas in Tanah Laut Regency, such as Takisung Beach, showed that the concentration of heavy metals Pb and Cd (Rahman, 2016) had exceeded the quality standards required in Government Regulation No. 82 of 2001. This is of course This alone is an early warning for the government and local communities about the need to know the level of pollution in the mangrove area of Pagatan Besar Village, which is also in Tanah Laut Regency. The normal

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concentration of heavy metals required is 0.05 ppm for Pb and 0.01 ppm for Cd (Peraturan Pemerintah No 22, 2021).

The accumulated metal properties will undergo a dissolving process in water bodies, and have an impact on the water itself. This condition can be indicated as waters that have been contaminated with dangerous heavy metals. Apart from metals, contamination of several microbiological elements such as E. coli bacteria can also occur. Further impacts will also occur on demersal biota in waters, through food chain and food web processes.

The concept of food safety can be made wise if several indicators that influence it can be obtained properly. Data collection and processing activities that are relevant to water pollution conditions, which in fact are important elements in making decisions about water management and food safety, need to be carried out. So in the end this research needs to be carried out so that a decision can be made on the quality status of mangrove waters in Pagatan Besar Village.

2. Methods

The research was conducted in the mangrove waters of Pagatan Besar, Takisung District, Tanah Laut Regency, South Kalimantan. Sampling was carried out twice in June – July 2023. Sampling was carried out at three stations.

The tools and materials used in this research were sample bottles and distilled water. Apart from that, they also use ponar grabs, plastic bags, demersal biota tagging tools, water transportation tools, identification books, cameras and permanent markers.

The method used was purposive sampling, namely at locations close to river mouths, in the middle of mangrove waters, and locations far from river mouths. All water quality parameters taken were analyzed in situ at the sampling location, and ex situ in the laboratory for tapah shellfish and sediment samples. The sediment and biota samples are first added to the formalin solution before being placed in a cold box. All samples will be analyzed for heavy metal content using the Atomic Absorption Spectrophotometer (AAS) method for identification in the laboratory.

Data analysis uses the pollution index method according to Minister of Environment Decree No. 115/2003 Appendix II concerning determining water quality status, to determine the level of river pollution, using the following formula:

$$IP_j = \sqrt{\frac{(\frac{C_i}{L_{ij}})_M^2 + (\frac{C_i}{L_{ij}})_R^2}{2}} \qquad \text{Eq. 1}$$

The pollution index for designation j (IPj) is determined based on the concentration of water quality parameter i (Ci) in relation to the concentration of the same parameter listed in the water designation standard j (Lij). Additionally, the calculation involves the maximum value (M) and the average value (R) of the concentration ratio per parameter to the quality standard value.

The IP water quality value is determined based on the maximum value and the average value of the concentration ratio per parameter relative to the quality standard value. The pollution index is classified into four categories: a score between 0 and 1.0 indicates good water quality, a score greater than 1.0 and up to 5.0 signifies lightly polluted water, a score between 5.0 and 10.0 represents fairly polluted water, and a score exceeding 10 indicates heavily polluted water.

3. Results and Discussion

3.1 Pollution Index

Table 1. Pollution Index at Station 1

No	Parameters	Unit	Li (class 1 water quality standards)	Ci	Ci/Li	New Ci/Li
1	Hg (water)	ppm	0.002	0.46900	234.500	234.500
2	Cu (water)	ppm	0.05	0.05700	-4.962	-4.962
3	Zn (water)	ppm	0.095	0.04300	0.453	0.453
4	Cd (water)	ppm	0.002	0.00032	0.160	0.160
5	Fe (water)	ppm		0.24900	1.853	2.339
6	Pb (water)	ppm	0.005	0.00095	0.190	-2.606
7	Hg (sediment)	ppm	0.66	0.0580	0.088	-4.281
8	Cu (sediment)	ppm	65	9.4780	0.146	-3.181
9	Zn (sediment)	ppm	200	84.1940	0.421	-0.879
10	Cd (sediment)	ppm	1.5	0.0010	0.001	-14.880
11	Fe (sediment)	ppm	20000	5,0416.5840	2.521	3.008
12	Pb (sediment)	ppm	220	6.8970	0.031	-6.519
13	Hg (clam meat)	ppm	0.5	0.00004	0.000	-19.485
14	Cu (clam meat)	ppm	1	3.32600	3.326	3.610
15	Zn (clam meat)	ppm	100	12.68400	0.127	-3.484
16	Cd (clam meat)	ppm	0.1	0.00100	0.010	-9.000
17	Fe (clam meat)	ppm	1	113.36300	113.363	11.272
18	Pb (clam meat)	ppm	0.3	0.00100	0.003	-11.386
(Ci/Li)R			9.704			
(Ci/Li)M			234.500			
PI			165.958			
Category			Heavily Polluted			

(Processed Primary Data, 2023)

Based on the Pollution Index Table at Station 1, it can be concluded that this location is experiencing severe pollution due to the high concentration of heavy metals in water, sediment, and clam meat. The parameter with the highest level of pollution is mercury (Hg) in water, with a Ci/Li ratio of 234.5, indicating that the mercury concentration at this site far exceeds the Class 1 water quality standard. Additionally, the iron (Fe) content in sediment is alarmingly high, reaching 50,416.5840 ppm, which significantly contributes to the pollution index. Other heavy metals, such as zinc (Zn), lead (Pb), and cadmium (Cd), are also present at concerning levels across different environmental media, including water, sediment, and aquatic biota (clam meat).

The pollution index analysis indicates that the (Ci/Li)M value reaches 234.5, while the (Ci/Li)R value is 9.704, resulting in a Pollution Index (PI) of 165.958, categorizing this area as heavily polluted. These findings suggest a serious threat to the aquatic ecosystem and the organisms within it, including edible species such as clams. Therefore, appropriate mitigation measures are urgently needed, such as regular water quality monitoring, identification of pollution sources, and the implementation of advanced wastewater treatment technologies to minimize environmental and public health risks.

Table 2. Pollution Index at Station 2

No	Parameters	Unit	Li (class 1 water quality standards)	Ci	Ci/Li	New Ci/Li
1	Hg (water)	ppm	0.002	0.24300	121.500	121.500
2	Cu (water)	ppm	0.05	0.05800	-4.961	-4,961
3	Zn (water)	ppm	0.095	0.02300	0.242	0.242
4	Cd (water)	ppm	0.002	0.00023	0.115	0.115
5	Fe (water)	ppm		0.15500	1.874	2.364
6	Pb (water)	ppm	0.005	0.00095	0.190	-2.606

7	Hg (sediment)	ppm	0.66		0.0320	0.048	-5.572
8	Cu (sediment)	ppm	65		6.5240	0.100	-3.392
9	Zn (sediment)	ppm	200		53.9460	0.270	-1.845
10	Cd (sediment)	ppm	1.5		0.0010	0.001	-14.880
11	Fe (sediment)	ppm	20000		42004.5780	2.100	2.611
12	Pb (sediment)	ppm	220		5.5390	0.025	-6.995
13	Hg (clam meat)	ppm	0.5		0.50000	1.000	1.000
14	Cu (clam meat)	ppm	1		1.00000	1.000	1.000
15	Zn (clam meat)	ppm	100		100.00000	1.000	1.000
16	Cd (clam meat)	ppm	0.1		0.10000	1.000	1.000
17	Fe (clam meat)	ppm	1		1.00000	1.000	1.000
18	Pb (clam meat)	ppm	0.3		0.30000	1.000	1.000
(Ci/Li)R				5.110			
(Ci/Li)M				121.500			
PI				85.989			
Category				Heavily Polluted			

(Processed Primary Data, 2023)

Based on the Pollution Index at Station 2, the analysis indicates that this location is heavily polluted due to elevated concentrations of heavy metals in water, sediment, and clam meat. The most concerning parameter is mercury (Hg) in water, with a Ci/Li ratio of 121.5, significantly exceeding the Class 1 water quality standard. Additionally, iron (Fe) in sediment is present at an extremely high level of 42,004.5780 ppm, contributing significantly to the pollution index. Other heavy metals, such as zinc (Zn), lead (Pb), and cadmium (Cd), are also found in concerning concentrations across different environmental compartments.

The pollution index calculation shows that (Ci/Li)M reaches 121.5, while (Ci/Li)R is 5.110, resulting in a Pollution Index (PI) of 85.989, categorizing this site as heavily polluted. These findings highlight serious environmental and health risks, particularly due to the bioaccumulation of toxic metals in aquatic organisms, including clams. Immediate mitigation actions are necessary, such as enhanced water quality monitoring, identification of pollution sources, and the implementation of effective wastewater treatment measures to prevent further ecological damage and protect human health.

Table 3. Pollution Index at Station 3

No	Parameters	Unit	Li (class 1 water quality standards)	Ci	Ci/Li	New Ci/Li
1	Hg (water)	ppm	0.002	0.21600	108.000	108.000
2	Cu (water)	ppm	0.05	0.05100	-4.966	-4.966
3	Zn (water)	ppm	0.095	0.02400	0.253	0.253
4	Cd (water)	ppm	0.002	0.00269	1.345	1.345
5	Fe (water)	ppm		0.14900	1.875	2.365
6	Pb (water)	ppm	0.005	0.00095	0.190	-2.606
7	Hg (sediment)	ppm	0.66	0.0070	0.011	-8.872
8	Cu (sediment)	ppm	65	5.2880	0.081	-4.448
9	Zn (sediment)	ppm	200	14.2970	0.071	-4.729
10	Cd (sediment)	ppm	1.5	0.0010	0.001	-14.880
11	Fe (sediment)	ppm	20000	32840.4670	1.642	2.077
12	Pb (sediment)	ppm	220	1.4970	0.007	-9.836
13	Hg (clam meat)	ppm	0.5	0.00004	0.000	-19.485
14	Cu (clam meat)	ppm	1	3.31400	3.314	3.602
15	Zn (clam meat)	ppm	100	10.87100	0.109	-3.419
16	Cd (clam meat)	ppm	0.1	0.00100	0.010	-9.000
17	Fe (clam meat)	ppm	1	174.08400	174.084	12.204
18	Pb (clam meat)	ppm	0.3	0.00100	0.003	-11.386
(Ci/Li)R			1.990			
(Ci/Li)M			108.000			

PI	76.380
Category	Heavily Polluted

(Processed Primary Data, 2023)

Based on the Pollution Index at Station 3 in Table 3., the analysis reveals that this location is heavily polluted due to significant concentrations of heavy metals in water, sediment, and clam meat. The most concerning parameter is mercury (Hg) in water, with a Ci/Li ratio of 108.0, indicating a severe exceedance of the Class 1 water quality standard. Additionally, iron (Fe) in sediment is present at an extremely high level of 32,840.4670 ppm, contributing notably to the pollution index. Other heavy metals, such as zinc (Zn), lead (Pb), and cadmium (Cd), are also detected at considerable levels in different environmental components.

The pollution index calculation shows that (Ci/Li)M reaches 108.0, while (Ci/Li)R is 1.990, resulting in a Pollution Index (PI) of 76.380, which classifies this site as heavily polluted. These findings indicate substantial environmental risks, particularly for aquatic organisms and human health through bioaccumulation in seafood such as clams. Given these alarming pollution levels, urgent mitigation strategies are needed, including continuous water quality monitoring, identification of pollution sources, and the implementation of effective wastewater treatment technologies to minimize ecological damage and safeguard public health.

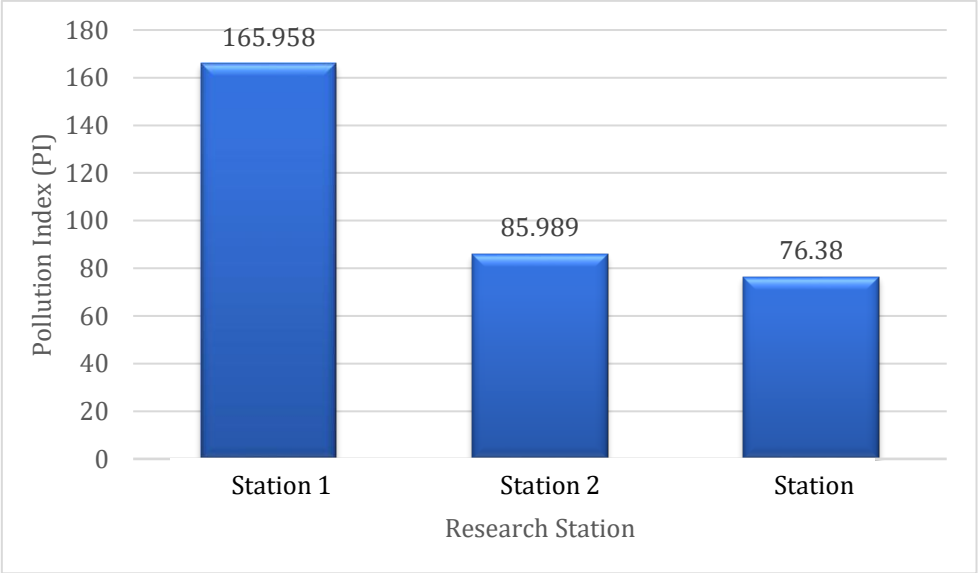

Fig. 1. Pollution index (PI) at different research stations

Based on Minister of the Environment Decree Number 115 of 2003, the pollution index is used to determine the level of pollution relative to the permitted water quality parameters. The results of this pollution index serve as a reference for decision-makers to assess the quality of water bodies for specific uses and take necessary actions to improve water quality if degradation occurs due to pollutant compounds. The evaluation of pollution index values is categorized as follows: an index value between 0 and 1.0 indicates that the water meets quality standards, a value greater than 1.0 and up to 5.0 signifies lightly polluted water, an index between 5.0 and 10.0 represents moderately polluted water, and a value exceeding 10 indicates heavily polluted water.

The procedure for using the pollution index can be expressed by the Ci value from the concentration resulting from the analysis of water quality parameters and the Li value from the concentration of water quality parameters included in the water quality standards.

The results of the pollution index calculation show that the three (3) observation stations (Fig. 1) in the Mangrove Waters of Pagatan Besar Village are all classified as heavily polluted. The Mangrove Water Area of Pagatan Besar Village is often used for water

transportation, nature conservation, capture fisheries, tourism and fishermen's settlements, for example Pagatan Besar Beach, Takisung Beach, Nyiur Ampat Beach and Pier Senja Beach, so that the coastal area of Takisung District has the potential for significant environmental damage tall.

Rapid industrial development and extractive mining activities as well as increasing urbanization, especially in coastal and mangrove areas without the use of waste handling facilities, increase the negative impact on the environment, especially coasts, mangroves and oceans, so that the pollution that occurs causes a decline in the quality of the aquatic environment. Mangroves are also a direct disposal site for rubbish or waste from various human activities in a cheap and easy way. Thus, in the sea you will find various types of rubbish and polluting materials, especially metals (Damaianto & Masduqi, 2014; Warlina, 2004).

Increased industrial activities have the potential to use heavy metals above the carrying capacity and carrying capacity of the environment and increased metal accumulation in coastal and marine areas as well as on land. Emissions of Cd, Zn and Pb result from processes such as fuel combustion and mining activities. As a result of the increasing accumulation of metals in the environment, organisms living in water and soil environments will be exposed to metals (Maddusa et al., 2017). Metals are declared very toxic pollutants or contaminants because metals cannot be decomposed, many metal pollutants are used by industry such as mercury (Hg), hexavalent chromium (Cr(VI)), arsenic (As), cadmium (Cd), copper (Cu), Lead (Pb), Zinc (Zn) and Nickel (Ni). According to Government Regulation Number 22 of 2001 concerning Water Quality Management and Water Pollution Control, every person responsible for a business and/or activity that discharges waste water into water or water sources is obliged to prevent and overcome water pollution.

This condition will disrupt the survival of surrounding biota, such as fisheries resources and coastal and marine ecosystems (mangroves, seagrass beds and coral reefs) and will ultimately have a broad impact on reducing the income of coastal communities who depend on biological productivity in coastal areas for their livelihoods. and sea. Pollution caused by metals can change the structure of aquatic communities, food webs, behavior, physiological effects, genetics and resistance (Sasongko et al., 2023). According to (Yudo, 2006), metals can accumulate in the body, threatening human life and can also result in death or death if the metal enters the food chain.Landrigan et al., (2006) also said that this pollution can be carried by the body's organs and accumulate, and if it enters the body in excess, it is certain that you will immediately suffer from poisoning. This is one of the subsequent effects on the food chain process and is an early warning regarding the safety of food products sourced from the Mangrove Waters of Pagatan Besar Village.

4. Conclusions

The water quality status at the three mangrove water sampling stations in Pagatan Besar Village is included in the heavily polluted category so it cannot be used for aquaculture activities. The level of pollution in the Mangrove Waters of Pagatan Besar Village is heavily polluted. The concept of food safety can be made wise if several indicators that influence it can be obtained properly. Data collection and processing activities relevant to water pollution conditions, which in fact are important elements in making decisions about water management and food safety, need to be carried out

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Author Contribution

Conceptualization, Dini Sofarini. and Suhaili Asmawi.; Methodology, Anisa Firli Nabila.; Software, Dini Sofarini.; Validation, Dini Sofarini. and Suhaili Asmawi.; Formal Analysis, Anisa Firli Nabila.; Investigation, Dini Sofarini.; Resources, Suhaili Asmawi.; Data Curation, Anisa Firli Nabila.; Writing – Original Draft Preparation, Dini Sofarini.; Writing – Review & Editing, Dini Sofarini.; Visualization, Suhaili Asmawi.; Supervision, Suhaili Asmawi.; Project Administration, Anisa Firli Nabila.; and Funding Acquisition, Dini Sofarini..

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Conflicts of Interest

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

References

Damaianto, B. B., & Masduqi, A. A. (2014). Indeks pencemaran air laut pantai utara Kabupaten Tuban dengan parameter logam. *Jurnal Teknik ITS*, *3*(1), D1-D4. http://dx.doi.org/10.12962/j23373539.v3i1.5378

Landrigan, P. J., De Garbino, J. P., & Newman, B. (2006). Framing the future in light of the past: living in a chemical world. *Annals of the New York Academy of Sciences*, *1076*(1), 657-659. https://doi.org/10.1196/annals.1371.030

Maddusa, S. S., Paputungan, M. G., Syarifuddin, A. R., Maambuat, J., & Alla, G. (2017). Kandungan logam berat timbal (Pb), merkuri (Hg), zink (Zn) dan arsen (As) pada ikan dan air Sungai Tondano, Sulawesi Utara. *Al-Sihah: The Public Health Science Journal*. https://doi.org/10.24252/as.v9i2.3766

Peraturan Pemerintah No 22. (2021). *Penyelenggaraan Perlindungan Dan Pengelolaan Lingkungan Hidup*. Kementerian Sekretariat Negara Republik Indonesia. SK No 097107 A. Retrieved from https://jdih.setkab.go.id/PUUdoc/176367/Lampiran_VI_Salinan_PP_Nomor_22_Tahun_2021.pdf

Rahman, M. (2016). Produktivitas primer perairan pantai kawasan hutan mangrove Desa Pagatan Besar Kecamatan Takisung Kabupaten Tanah Laut Propinsi Kalimantan Selatan. *Fish Scientiae*, *6*(1), 11-24. https://dx.doi.org/10.20527/fs.v6i1.1906

Sasongko, A. S., Rahayu, B. D., & Satibi, A. (2023). Kandungan Logam Berat di Perairan Teluk Lada Kabupaten Pandeglang, Provinsi Banten. *Samakia: Jurnal Ilmu Perikanan*, *14*(2), 100-105. http://dx.doi.org/10.35316/jsapi.v14i2.2745

Yudo, S. (2006). Kondisi pencemaran logam berat di perairan sungai DKI Jakarta. *Jurnal Air Indonesia*, *2*(1), 246263. https://dx.doi.org/10.29122/jai.v2i1.2275

Warlina, L. (2004). Pencemaran air: sumber, dampak dan penanggulangannya. *Unpublised). Institut Pertanian Bogor*. https://www.rudyct.com/PPS702-ipb/08234/lina_warlina.pdf

Biographies of Authors

Dini Sofarini, Department of Aquatic Resource Management, Faculty of Fisheries and Marine Science, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan 70714, Indonesia.

- Email: dini.sofarini@ulm.ac.id
- ORCID: 0000-0003-1311-2661
- Web of Science ResearcherID: N/A
- Scopus Author ID: 57208800263
- Homepage: https://sinta.kemdikbud.go.id/authors/profile/52991/?view=wos#!

Suhaili Asmawi, Department of Aquatic Resource Management, Faculty of Fisheries and Marine Science, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan 70714, Indonesia.

- Email: suhailiasmawi@gmail.com
- ORCID: 0000-0002-2826-4126
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: https://sinta.kemdikbud.go.id/authors/profile/6040175

Anisa Firli Nabila, Department of Aquatic Resource Management, Faculty of Fisheries and Marine Science, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan 70714, Indonesia.

- Email: 211071412002@mhs.ulm.ac.id
- ORCID: N/A
- Web of Science ResearcherID: N/A
- Scopus Author ID: N/A
- Homepage: N/A