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# Pollution level in Domas coastal waters based on some water quality parameters

*Ashifa* Rahmania, *Aliati* Iswantari, and *Sulistiono*[*]

Department of Aquatic Resources Management, Faculty of Fisheries and Marine Sciences, IPB University, Jl. Agatis Dramaga, 16680 Bogor, Indonesia

**Abstract.** The coastal area of Banten Bay has a high population and industrial growth, which can harm the aquatic environment. Domas coastal waters are one of the water areas located on the east coast of Banten Bay. This study aims to determine the water pollution level in Domas coastal waters, Banten Bay, based on water quality parameters. This study was conducted from August 2021 to January 2022 at six sites. The data were compared with the quality standards for marine biota based on Indonesian Government Regulation No. 22 of 2021, and the quality status based on the Nemerow Pollution Index according to the Decree of the Minister of Environment No. 115 of 2003. The values of each parameter during the research were temperature (29.27-29.80°C), turbidity (4.62-22.13 NTU), total suspended solid (12.72-69.07 mg $L^{-1}$), pH (7), dissolved oxygen (6.32-6.63 mg $L^{-1}$), salinity (30.67-31.67 ppt), ammonia (0.15-0.44 mg $L^{-1}$), nitrite (0.03-0.08 mg $L^{-1}$), nitrate (1.23-1.66 mg $L^{-1}$), and total phosphate (0.11-0.15 mg $L^{-1}$). The results of this study showed that Domas coastal waters have been indicated to be moderately polluted (5.7-5.9).

## 1 Introduction

Domas coastal waters are located on the east coast of Banten Bay, Serang Regency, Banten Province (Wahyudewantoro *et al.* 2023). Banten Bay has an area of approximately 150 $km^2$ and a shoreline extending 22 km. The water depth of the bay is generally shallow and its bottom mainly consists of sandy mud. The bay is known for its high potential for fisheries, including fish, seaweed, and shellfish (Sugiarti *et al.* 2016). The coastline of Banten Bay is currently undergoing rapid development, as evidenced by the high growth rates of both the population and industries surrounding the area (Wisha *et al.* 2015). This development could lead to pollution of the aquatic environment owing to increased human activity and industrialization (Surbakti *et al.* 2021). The high level of industrial activity around the waters may cause pollution and endanger aquatic biota (Kasari *et al.* 2016).

[*] Corresponding author: onosulistiono@gmail.com

Moreover, the community considers that the beach and sea are places for direct disposal of waste or garbage in a convenient and inexpensive way. The waste discharged directly into these waters can cause a decrease in water quality (Damaianto & Masduqi 2014). Apart from industrial and domestic waste, pollutants in waters, especially coastal and marine areas, can originate from river runoff (Darmawan & Masduqi 2014).

Degradation of water quality can lead to reduced natural resource productivity, usability, and carrying capacity. Aquatic ecosystems are particularly susceptible to these effects, which are primarily caused by human activities and can threaten the survival of aquatic organisms (Gholizadeh *et al.* 2016). Changes that occur in an environment or ecosystem are influenced by the amount and toxicity of waste introduced into the area (Sofiana *et al.* 2022). Therefore, managing water quality and controlling pollution in coastal waters are crucial for maintaining ecosystem balance. This is because the quality of coastal water greatly affects the ecological sustainability and biological productivity of coastal and marine ecosystems (Jahan & Strezov 2017).

Several studies on water pollution in Indonesia, especially in Banten Bay, have been conducted, such as research on pollution levels in Bojonegara coastal waters (Adnina *et al.* 2023) and sediment quality in Cengkok coastal waters (Wardani *et al.* 2020). However, the studies on pollution levels in Domas coastal waters have not been reported. Thus, this research aims to determine the water pollution level in Domas coastal waters, Banten Bay, based on some water quality parameters. This study could provide information to the public and related stakeholders regarding the condition of coastal waters, which can be used as a basis for managing the coastal area of Domas.

# 2 Methodology

## 2.1 Time and location

This research was carried out from August 2021 to January 2022, in the Domas coastal waters of Banten Bay (**Fig. 1**). Sampling and observation of water quality were carried out monthly at six sites. Water quality parameters were analyzed at the Environmental Laboratory, Department of Aquaculture, IPB University.

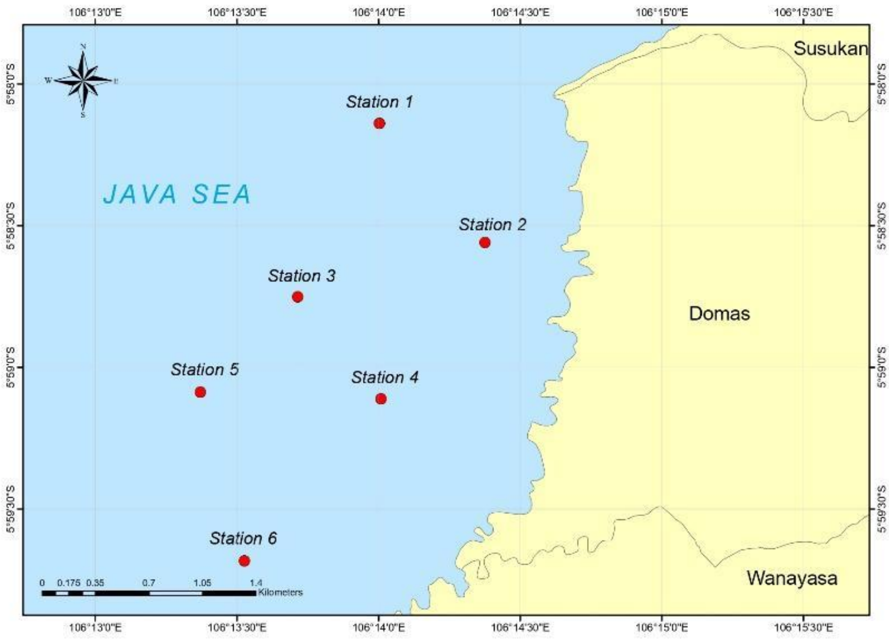


**Fig. 1.** Research location at Domas coastal waters (Station 1 to Station 6) of Banten Bay.

### 2.2 Data collection

Primary data were collected from the measurement and analysis of water quality parameters, and secondary data were rainfall information from the Meteorology, Climatology, and Geophysics Agency (BMKG) (http://dataonline.bmkg.go.id). The water quality parameters used in this study were physical and chemical. Physical parameters included temperature, turbidity, and total suspended solid (TSS). Furthermore, the chemical parameters included pH, dissolved oxygen (DO), salinity, ammonia, nitrite, nitrate, and total phosphate. Water sampling in this research refers to SNI 6964.8:2015 concerning Sampling Methods for Seawater Tests and laboratory analysis refers to APHA.

### 2.3 Data analysis

The Pollution Index (PI) can be used to assess the water quality. The principle of the PI method is to compare the water quality parameter concentrations with established quality standards for a specific purpose. The PI formula and category (**Table 1**) regulated by the Decree of the Minister of Environment No. 115 of 2003 are as follows:

$$PI = \sqrt{\frac{\left(\frac{C_i}{L_{ij}}\right)_M^2 + \left(\frac{C_i}{L_{ij}}\right)_R^2}{2}} \quad (1)$$

Note:

| | | |
|---|---|---|
| PI | : | Pollution Index |
| $C_i$ | : | Concentrations of water quality parameters (i) |
| $L_{ij}$ | : | Standard of water quality parameters for marine biota (i) designation of water (j) |
| $(C_i/L_{ij})_M$ | : | Maximum value of $C_i/L_{ij}$ |

$(C_i/L_{ij})_R$ : Average value of $C_i/L_{ij}$

**Table 1.** The category of water quality based on PI values.

| Value | Water Pollution Status |
|---|---|
| $0 \leq PI \leq 1.0$ | Good condition |
| $1.0 < PI \leq 5.0$ | Lightly polluted |
| $5.0 < PI \leq 10$ | Moderately polluted |
| $PI > 10$ | Heavily polluted |

# 3 Results and discussion

## 3.1 Water quality

The water quality analysis in this study revealed varying values (**Table 2**). In accordance with Indonesian Government Regulation No. 22 of 2021, which outlines the quality standards for marine biota, some parameters, such as turbidity, TSS, ammonia, and nitrate do not meet the required standard values.

**Table 2.** The average and standard deviation value of water quality in Domas coastal waters (Aug 2021 - Jan 2022).

| Parameters | Unit | Station | | | | | | Strandard value* |
|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | |
| Temperature | °C | 29.70±2.24 | 29.80±2.02 | 29.63±2.58 | 29.62±2.80 | 29.50±2.53 | 29.27±0.99 | Natural |
| Turbidity | NTU | 5.56±3.54 | 22.13±35.76 | 19.60±32.12 | 6.10±4.63 | 4.62±4.42 | 6.52±5.97 | 5 |
| TSS | mg $L^{-1}$ | 12.72±3.92 | 69.07±91.02 | 51.40±81.55 | 23.30±13.85 | 21.45±19.50 | 31.33±38.91 | 20 |
| pH | - | 7±0 | 7±0 | 7±0 | 7±0 | 7±0 | 7±0 | 7-8.5 |
| DO | mg $L^{-1}$ | 6.32±0.85 | 6.45±0.80 | 6.63±0.91 | 6.57±0.91 | 6.50±1.18 | 6.53±0.65 | >5 |
| Salinity | ppt | 31.00±2.45 | 30.67±1.51 | 31.50±1.64 | 30.83±0.98 | 31.67±1.86 | 30.67±0.82 | Natural |
| Ammonia | mg $L^{-1}$ | 0.26±0.45 | 0.17±0.28 | 0.44±0.70 | 0.15±0.27 | 0.27±0.36 | 0.42±0.75 | 0.3 |
| Nitrite | mg $L^{-1}$ | 0.04±0.03 | 0.04±0.03 | 0.08±0.08 | 0.03±0.02 | 0.03±0.02 | 0.06±0.07 | - |
| Nitrate | mg $L^{-1}$ | 1.66±1.61 | 1.45±1.37 | 1.23±1.14 | 1.49±1.41 | 1.37±1.30 | 1.52±1.43 | 0.06 |
| Total phosphate | mg $L^{-1}$ | 0.15±0.18 | 0.14±0.14 | 0.11±0.12 | 0.15±0.21 | 0.15±0.20 | 0.14±0.17 | - |

*Indonesian Government Regulation No. 22 of 2021 (in Attachment VIII for Marine Biota)

The Domas coastal waters are known to be influenced by anthropogenic activities. The data indicate that the temperature in these waters ranges from 29.27 to 29.80°C (**Table 2**), which falls within the suitable temperature range for marine biota, particularly fish. The optimal temperature range for tropical fish growth is typically 25–32°C (Koniyo & Lamadi

2017). Various factors such as season, cloud cover, time of day, air circulation, water flow, latitude, sea level, and water depth can affect seawater temperature (Salim *et al.* 2017).

The results indicated that turbidity and TSS generally exceeded the quality standards, with the highest concentrations of these two parameters found at Station 2 (**Table 2**). This can be influenced by the observation location, which was close to the mainland. Previous research conducted at Cengkok Nearshore yielded similar results, showing that turbidity tends to be higher near rivers and coastal areas, which tend to receive input from the mainland (Pramadhana *et al.* 2023). High turbidity in water can be affected by the presence of inorganic compounds, organic compounds, and dissolved and suspended microorganisms (Rahman *et al.* 2021). Furthermore, human activities in coastal areas, such as settlements and industries, can contribute to an increase in TSS due to pollutant waste entering water (Winnarsih *et al.* 2016). High levels of turbidity and TSS can negatively impact the aquatic environment by hindering photosynthesis in marine life, resulting in reduced oxygen production. As a result, marine life may suffer and fish mortality may occur (Yonar *et al.* 2021).

Dissolved oxygen can be affected by photosynthesis and respiration by the aquatic biota. The high concentration of dissolved oxygen can be caused by photosynthesis, which occurs optimally owing to an adequate supply of sunlight (Sidabutar *et al.* 2019). Dissolved oxygen concentrations are generally higher on the surface of water owing to the diffusion process between water and air, and the process of photosynthesis. The concentration of dissolved oxygen decreases with increasing depth, owing to reduced photosynthetic processes. The dissolved oxygen concentrations in this study can be concluded to be good for marine biota because they comply with quality standards (>5 mg $L^{-1}$) (**Table 2**). An organism has a dissolved oxygen (DO) requirement that varies depending on its type, stage, and activity. Fish in a relatively quiet state require less dissolved oxygen than fish when moving or spawning (Muslim *et al.* 2020).

Salinity values in this study ranged from 30.67 to 31.67 ppt (**Table 2**). This salinity value is within the range of salinity common in Indonesian waters (30–35 ppt) (Mustari *et al*. 2018). The optimum salinity range to support the growth and reproduction of each organism depends on the species, the stadia, and other environmental factors. For example, the salinity range required for marine bivalves to survive is 30–35 ppt (Siahaan *et al*. 2014). Water salinity can lead to a difference in osmotic pressure between the environment and the biota, in which the organism must maintain the osmotic pressure in the body with the osmotic pressure of the environment through osmoregulation (Asmiani *et al*. 2020). Various factors, such as precipitation, evaporation, water circulation, and runoff, can affect water salinity (Meidji *et al*. 2020).

Ammonia concentrations in this study still met the standard value for marine organisms (0.3 mg $L^{-1}$) (**Table 2**). However, there were several stations with ammonia concentrations that exceeded the quality standard at Stations 3 and 6. This is thought to be due to the influence of the river runoff. Domas coastal waters are flanked by two rivers, namely the Ciujung Lama River and the Ci Anyer River; it is possible that they can still be influenced by the existence of these two rivers. River runoff that enters the sea contains domestic waste, and ammonia is a chemical compound commonly contained in waste. Natural sources of ammonia in water can be produced through bacterial decomposition and aquatic biota metabolism (Hamuna *et al*. 2018). High ammonia concentrations can have a negative impact, such as decreasing dissolved oxygen levels in water, because available oxygen is used for the $NH_3$ nitrification process. Therefore, ammonia in water can be toxic to biota if present at high concentrations or exceeds the maximum threshold (Aris & Tamrin 2020).

Nitrite concentrations in this study were generally still relatively low, below 0.05 mg $L^{-1}$ (**Table 2**). This can be caused by the high amount of dissolved oxygen because under these conditions, nitrite is immediately oxidized to nitrate (Sermatang *et al*. 2021). This can also be caused by the unstable nature of nitrites. Nitrite is a transitional form of nitrification (ammonia with nitrate) and denitrification (nitrate with nitrogen gas) and is commonly found at low concentrations (Widyasari *et al*. 2016). However, the results also showed that several stations had high nitrite concentrations. Aquatic life can be negatively impacted if the concentration of nitrite exceeds 0.05 mg $L^{-1}$ (Paputungan *et al*. 2022).

Nitrate concentrations in this study indicated that they did not meet the standards for marine biota (0.006 mg $L^{-1}$) (**Table 2**). Waters with high nitrate concentrations can have both positive and negative impacts on the environment. A positive impact is an increase in phytoplankton production. The negative impact is a reduction in dissolved oxygen, which can trigger the growth of harmful types of phytoplankton (Rumanti *et al*. 2014). Nitrates in seawater can be sourced from waste disposal on land through rivers, which contain many organic compounds. The nitrate concentration is naturally affected by the condition of the water itself, which is formed from the results of decay, weathering, or decomposition of dead organisms, both animals and plants (Maradhy *et al*. 2022).

Total phosphate values in this research ranged from 0.11 to 0.15 mg $L^{-1}$ (**Table 2**). This result is within the range of the total phosphate commonly found in natural waters. In natural waters, the total phosphate concentration does not exceed 1 mg $L^{-1}$ (Asaad *et al*. 2015). Phosphate in water can be sourced from the excrement of living things, paper, soap, and detergent industries. Phosphate can also be produced from the decomposition of organic matter and agricultural fertilizer runoff. Phosphate plays a significant role in supporting phytoplankton growth. However, high or excessive phosphate concentrations can endanger aquatic biota survival by inducing eutrophication, which results in a lower dissolved oxygen content in the water (Patty *et al*. 2015).

### 3.2 Pollution level in Domas coastal waters

Determining the quality or status of water requires monitoring of water pollution (Hamuna *et al*. 2018). The Pollution Index was used in this study to assess the extent of pollution in Domas coastal waters. The PI results for each station are presented in **Fig. 2**, and those for each month are presented in **Fig. 3.**

The Pollution Index results showed that all observation sites were categorized as moderately polluted (**Fig. 2**). The high level of pollution was caused by some parameters, such as turbidity, TSS, nitrate, and ammonia, which exceeded the standard. The source of pollution in the Domas coastal waters is thought to originate from domestic waste that flows into the river and then enters the waters. Domas coastal waters are flanked by two rivers: the Ciujung Lama River and the Ci Anyer River (Wahyudewantoro *et al*. 2023). Most of the pollution sources in the sea come from land, which drains through rivers (Darmawan & Masduqi 2014). Pollutants originating from domestic activities are known to contain complex waste, because they consist of almost all forms of waste, such as liquid and solid waste, plastics, metals, and chemical waste (Elenwo & Akankali 2015).

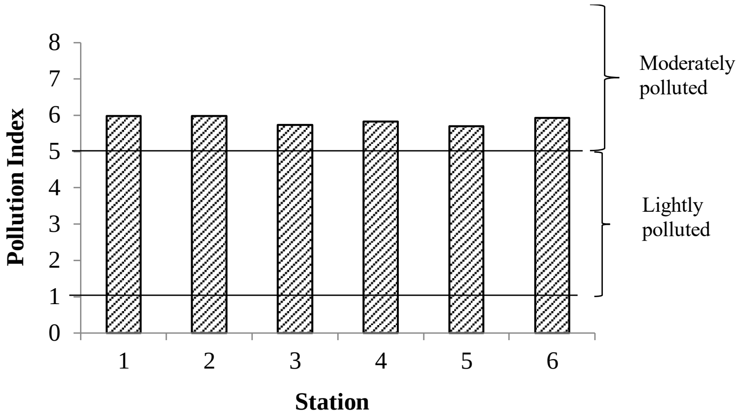


**Fig. 2.** Pollution Index for each station in Domas coastal waters.

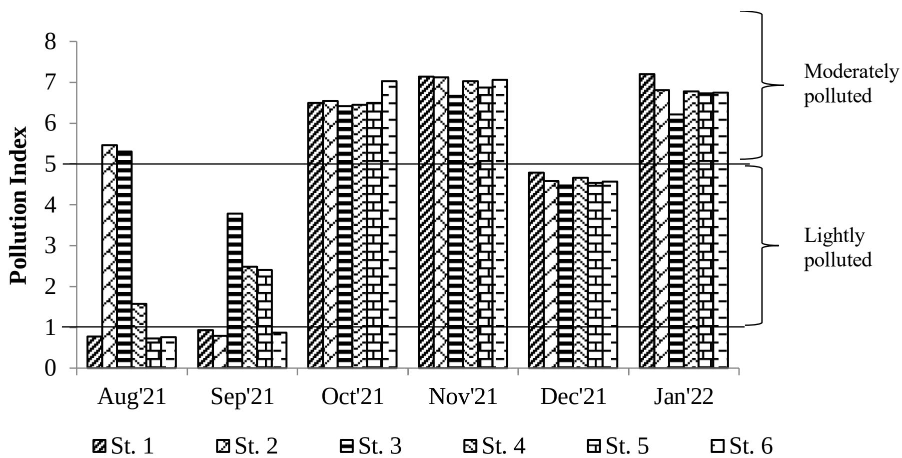


**Fig. 3.** Pollution Index for each month in Domas coastal waters.

The PI analysis results for each month of observation (**Fig. 3**) show that the pollution levels were relatively low in August and September 2021. However, several stations were lightly polluted in September 2021 and moderately polluted in August 2021 (stations 2 and 3). This was influenced by the high turbidity and TSS values at these stations. The high levels of turbidity and TSS could be caused by the observation location being close to land and the influence of river runoff. Furthermore, the pollution levels in this study tended to increase from October 2021 to January 2022. This was thought to be due to the influence of rainfall. Based on data from the Meteorology, Climatology, and Geophysics Agency (BMKG), this research is generally carried out during the rainy season, except in August 2021 (dry season) and September 2021 (transition season). The high level of pollution is thought to be because high rainfall can increase the volume of water runoff from land into water. In the rainy season, organic and inorganic matter such as nitrate, ammonia, and phosphate originating from the mainland are generally present in higher concentrations than during the dry season (Santika *et al.* 2021). A high concentration of these water quality parameters can have an impact on increasing the pollution index value and water pollution levels.

## 4 Conclusion

The results of this study showed that all observation stations had similar levels of pollution and were moderately polluted. Stations 2, 4, and 6 are near the coastal area, and stations 1, 3, and 5 are known to still be influenced by river runoff. Thus, the source of pollution in this study is thought to originate from land and river runoff that enters the water. Therefore, public awareness is needed to manage waste before it is discharged directly into water, and the local government needs to provide adequate waste disposal and handling facilities. Furthermore, it is important to monitor water quality to maintain the condition of Domas coastal waters.

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