ISOMAse
International Society of Ocean, Mechanical and Aerospace Scientists and Engineers

Journal of Ocean, Mechanical and Aerospace
-Science and Engineering-
30th July 2025. Vol.69 No.2

July 30, 2025

Identification of Seawater Quality Around PLTU Teluk Sepang Outlet Based on Oceanographic Parameters

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Paper History

Received: 27-April-2025
Received in revised form: 02-June-2025
Accepted: 30-July-2025

ABSTRACT

The heat waste produced by the PLTU is released directly into the ocean, significantly impacting the quality of sea water. This research intends to assess the quality of sea water near the PLTU Teluk Sepang outlet in Bengkulu City using oceanographic parameters. Data collection was conducted in the field at eight sites that represent the area around the PLTU outlet, focusing on parameters such as sea water temperature, salinity, density, pH, and ocean currents. The obtained measurement results were then compared against the standards set by KepMenLH No. 51, 2004. The findings reveal that parameters such as temperature, pH, and salinity did not meet the quality standards necessary for marine biota ecosystems; the average temperature ranges from 33.58 to 35.39 °C, the pH levels were between 8.59 and 8.76, indicating an alkaline condition, and salinity measures between 24.7 and 26.9 ‰, all of which fall below the standards established by KepMenLH No. 51, 2004. This research demonstrates that the discharge of heat waste substantially pollutes the sea water quality around the PLTU Teluk Sepang outlet in Bengkulu City, particularly affecting sea water temperature, which significantly influences the metabolism of marine biota.

KEYWORDS: *Heat waste; Density; Salinity; Seawater Temperature; PLTU Teluk Sepang.*

1.0 INTRODUCTION

The Steam Power Plant (PLTU) was established to enhance the availability of electricity to satisfy the demands of both communities and industries in Indonesia. The development and operation of PLTU undeniably affect on the life structure and environment of the surrounding areas. Nevertheless, it is important to acknowledge that continuous development and operation does have adverse effects on the environment [1]. Activities PLTU utilizing fossil fuels for electricity generation, are considered to be detrimental to the environment. This is due to the fact that the operations of coal power plants result in waste that poses a threat to the local ecosystem [2]. The Power Plant (PLTU) is situated in Bengkulu Province, specifically in Teluk Sepang Village, Kampung Melayu District, Bengkulu City, and has a power generation capacity of 2x100 Mega Watts (MW). It occupies an area of 35 hectares and was constructed by PT Intraco Penta (INTA) in partnership with Power Construction of China (PCCC group). The development of the Teluk Sepang PLTU in Bengkulu City employs an open cycle cooling system, where seawater is continuously supplied and circulated into the condenser to produce heat water with a temperature that is higher than that of the seawater. This wastewater is subsequently released back into the sea through an outlet channel [3]. The waste heat water emitted by the Teluk Sepang PLTU can impact the quality of the seawater surrounding and may harm the marine ecosystem [4]. Consequently, studying the seawater quality near the Teluk Sepang PLTU is crucial to ensure that the disposal of waste heat water from the PLTU sump meets both the liquid waste quality standards and the quality requirements for marine life in the Teluk Sepang waters. To assess the seawater quality around the Teluk Sepang PLTU, a variety of oceanographic parameters are utilized, such as seawater temperature, salinity, density, pH, and current velocity. Current velocity is essential for understanding how wastewater moves and spreads in the nearby waters [5].

The temperature of seawater is a key oceanographic indicator that reflects the quality of water in a particular area. The discharge of waste heat water from coal-fired power plants (PLTU) leaded to an increasing in water temperature. As outlined in KEPMEN Lingkungan Hidup No. 51 of 2004, the acceptable temperature range for marine organisms is between 28-32°C. If the temperature of the waste water exceeds this standard, it can negatively impact the local ecosystem and marine life surrounding the PLTU. The impact of the waste heat water can result in elevated seawater temperatures in the nearby waters [6]. If not handled correctly by the Waste Water Disposal Plant (WWTP), it can lead to a rise in sea water temperature. This occurs because heat water will flow into the ocean, causing it to mix with the surrounding seawater. As a result, this adversely affects the ecosystem surrounding the outlet [7]. If a sewer malfunction occurs, the discharge of heat water can lead to environmental consequences and negatively impact flora and fauna life, along with the quality of waters [8].

JOMAse | Received: 27-April-2025 | Accepted: 30-July-2025 | [(69) 2: 106-112]
Published by International Society of Ocean, Mechanical and Aerospace Scientists and Engineers, www.isomase.org., ISSN: 2354-7065 & e-ISSN: 2527-6085

2.0 METHODS

The site of this study was located near the sewage discharge of the Teluk Sepang PLTU in Bengkulu City. Data collection comprised 8 locations with 10 repetitions at each site, and the parameters depicted in Figure 1. The measurement sites were indicated with a yellow mark. The gathered data includes seawater temperature, density, salinity, pH, and current speed. The instruments utilized were a refracto-meter, global positioning system (GPS), current meter, sample bottles, a water quality tester, Microsoft Excel, and ArcGIS software.

The results of measurements for seawater temperature, density, salinity, pH, and current velocity were processed in Microsoft Excel to create graphs for each of the parameters recorded. An entirety analysis of the data employs both quantitative and descriptive methods to evaluate the values of each measured parameter. This analysis aimed to assess the impact of heat water discharge on the quality of the seawater in the vicinity of the Teluk Sepang PLTU outlet.

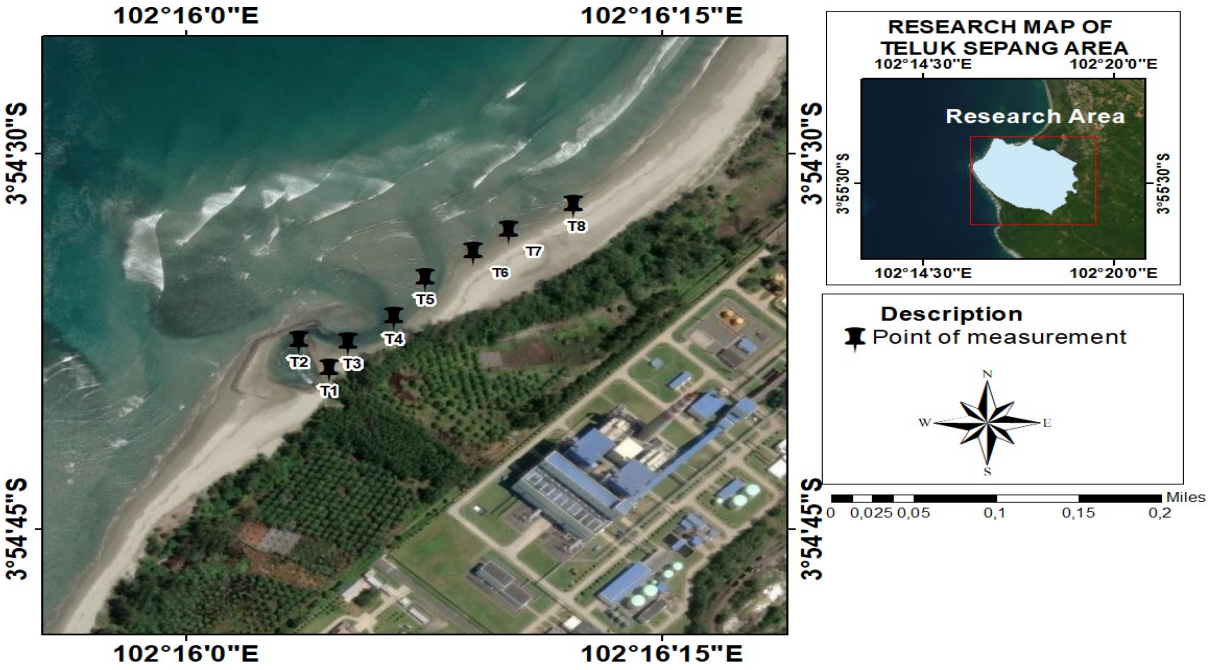

Figure 1: Research map in the PLTU Teluk Sepang region of Bengkulu City

3.0 RESULTS AND DISCUSSION

3.1. Seawater Temperature

The result of sea water temperatures at 8 points near the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024, is depicted in Figure 2. The map showing the sea water temperatures at 8 points near the outlet of the PLTU Teluk Sepang in Bengkulu City, with data measured on June 1, 2024, is depicted in Figure 3. As shown in Figures 2 and 3, the seawater temperature measured with a current meter exhibits variations across the eight sampled locations. The sea surface temperature near the Bengkulu PLTU discharge varied between 33.58°C and 35.57°C. The highest temperature recorded in this study occurred at point 3, where the sea surface temperature reached 35.7°C. In contrast, the lowest sea surface temperature was noted at point eight, which measured 33.58°C.

In points 1, 2, and 3, temperatures have increased due to thermal pollution, which happens when a large amount of water is released at high temperatures from one or more industries using the same water source, resulting in temperatures that exceed normal ranges [9]. The decline in seawater temperature from points 4 to 8 is attributed to the reduced impact of thermal pollution as the distance from the source has increased. This is also illustrated in Figure 3, which shows a color spectrum representing the variation throughout the research area. Elevated ocean temperatures significantly influence the metabolic processes of marine life. For instance, coral reefs are unable to endure increased sea temperatures, which can lead to coral bleaching [10].

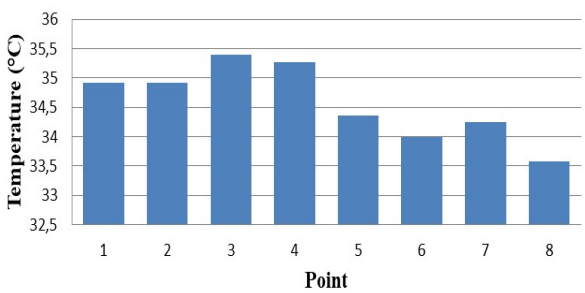

Figure 2: A graph displaying sea water temperatures at 8 points near the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024.

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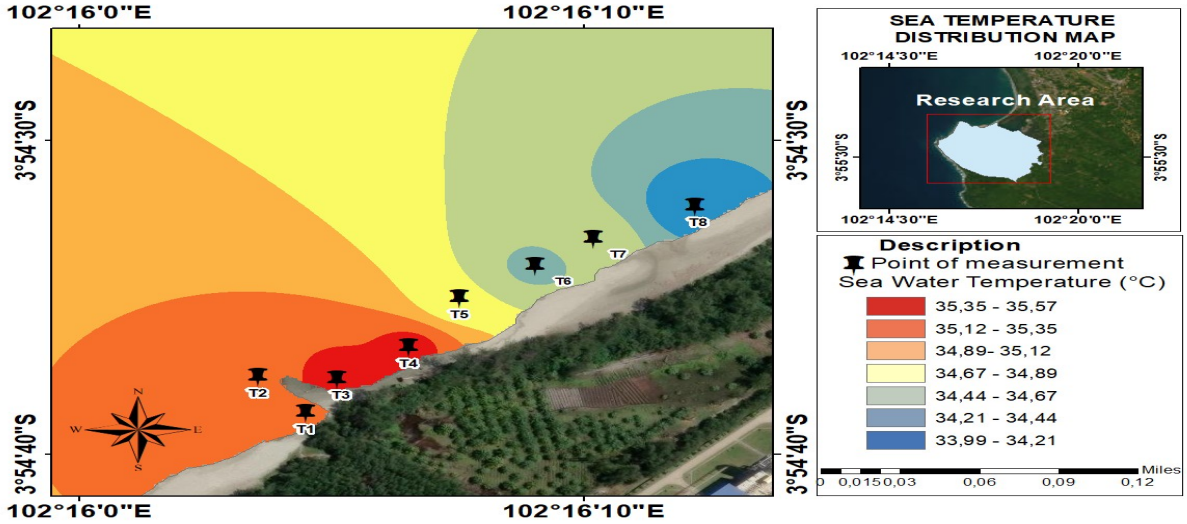

Figure 3: Map showing the sea water temperatures at 8 points near the outlet of the PLTU Teluk Sepang in Bengkulu City, with data measured on June 1, 2024.

3.2. pH

Result of the pH levels of seawater at eight different locations surrounding the outlet of Teluk Sepang PLTU, located in Bengkulu City, measured on June 1, 2024, depicted in Figure 4. The existing variation in seawater pH concentration changes was observed at all measurement locations. Figures 4 and 5 illustrate that the pH level of seawater ranges from 8.59 to 8.76. This seawater pH was outside the acceptable normal limits since the typical pH range for seawater that was between 6.8 and 8.5 [11]. The pH levels of seawater across all sampling sites exhibited considerable fluctuation. These results, as depicted in Figures 4 and 5, suggest that the analyzed seawater possessed a higher alkalinity than what is typically observed in thriving marine ecosystems.

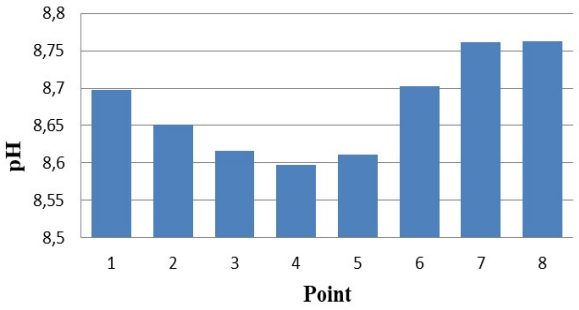

Figure 4: The pH levels of seawater at eight different locations surrounding the outlet of Teluk Sepang PLTU, located in Bengkulu City, measured on June 1, 2024.

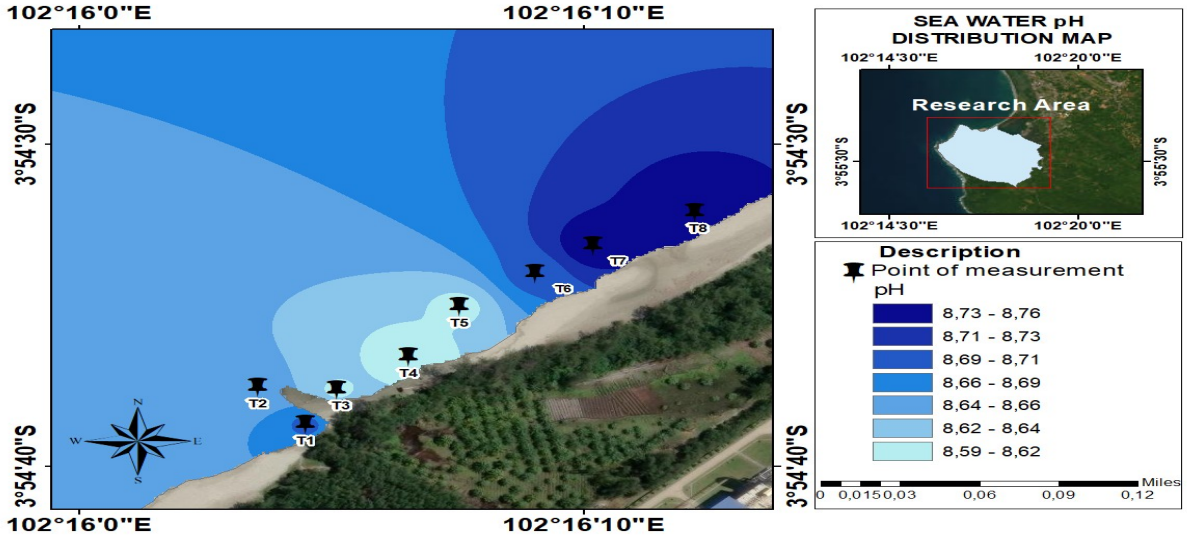

Figure 5: A distribution map displaying seawater pH at eight locations near the outlet of PLTU Teluk Sepang in Bengkulu City, measured on June 1, 2024.

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3.3. Salinity of Seawater

Result of salinity of ocean water at eight locations near the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024 depicted in Figure 6. Changes in salinity that began to become noticeable at point eight suggested that this area was significantly affected by the hot water from the PLTU. The salinity levels in these waters no longer correspond with the typical salinity measurements found in seawaters generally, where Indonesian waters usually range between 30.0-35.0 ppt. In coastal zones, salinity commonly falls between 32.0-34.0 ppt. In the open ocean, it usually spans from 33.0-37.0 ppt, with an average around 35.0 ppt. Consequently, the salinity levels in these waters are not conducive to supporting marine organisms, such as corals, sea grasses, and mangroves [12]. This is also evident from the distribution map in Figure 7, which is highlighted by the color spectrum within the study area.

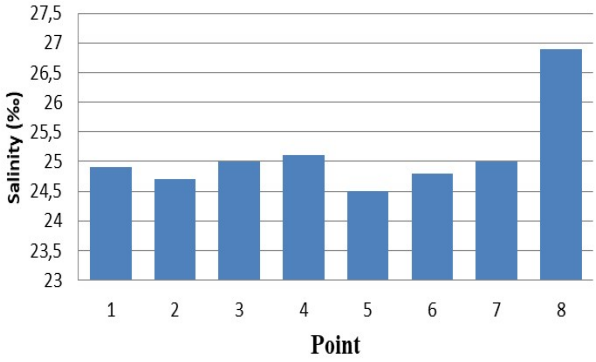

Figure 6: Salinity chart of ocean water at eight locations near the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024

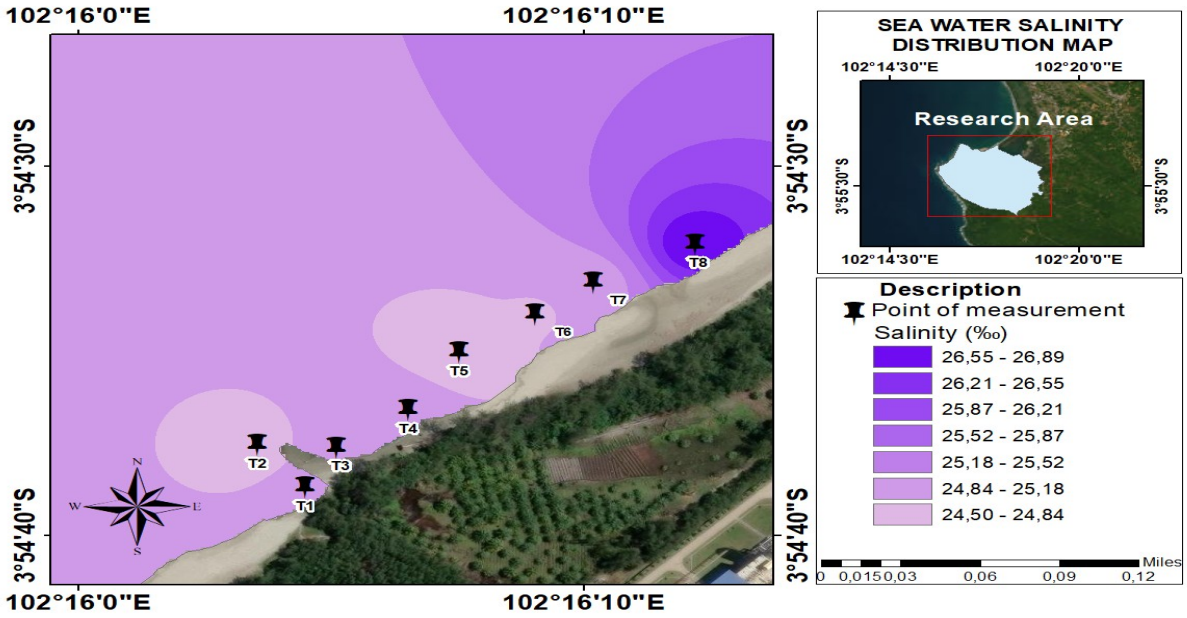

Figure 7: Salinity distribution map of seawater at eight locations surrounding the outlet of Teluk Sepang PLTU, Bengkulu City, measured on June 1, 2024

3.4. Seawater Density

The density of seawater at eight locations surrounding the Teluk Sepang PLTU outlet in the Bengkulu City District, measured on June 1, 2024, is depicted in Figure 8. It can be seen in Figure 9, the density of seawater at eight locations surrounding the Teluk Sepang PLTU outlet in the Bengkulu City District, measured on June 1, 2024.

There were differences in the variations of seawater density at every measurement point. The density of seawater falls between 1019.5 and 1021.8. The seawater density was no longer within the ideal range because it is classified as perfect for water areas in Indonesia (which typically ranges from 1022 to 1024 kg/m³) [13].

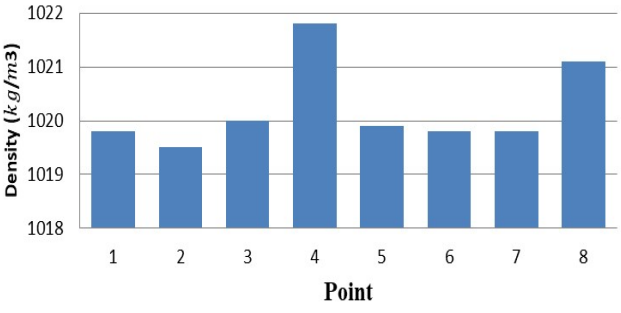

Figure 8: A graph depicting the density of seawater at eight locations surrounding the Teluk Sepang PLTU outlet in the Bengkulu City District, measured on June 1, 2024.

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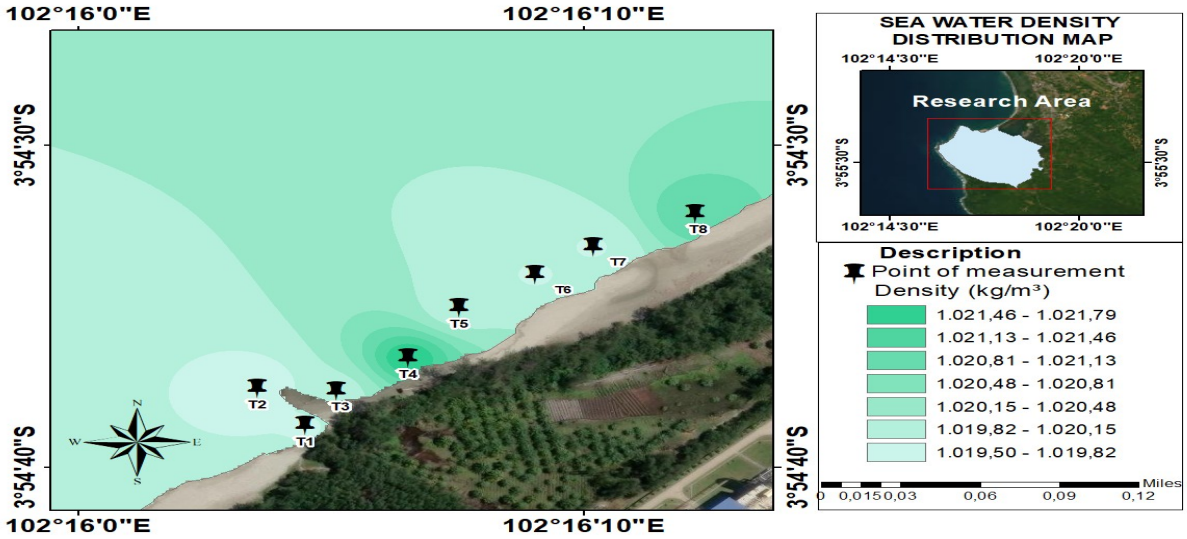

Figure 9: A graph depicting the density of seawater at eight locations surrounding the Teluk Sepang PLTU outlet in the Bengkulu City District, measured on June 1, 2024

3.5. Ocean Current Speed

Result of the flow velocity on 8 measurement points surrounding the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024, is depicted in Figure 10. In Figure 11 shows a map displaying the distribution of sea current speeds at eight locations surrounding the outlet of Teluk Sepang PLTU, located in Bengkulu City, measured on June 1, 2024. The speed of ocean currents near the outlet of the Teluk Sepang PLTU in Bengkulu City shows a change that was not too significant, except for point one. At point one, the current speed was quite low due to the lack of influence from ocean currents. This is illustrated in the distribution map in Figure 11, which is marked by the color spectrum in the research area

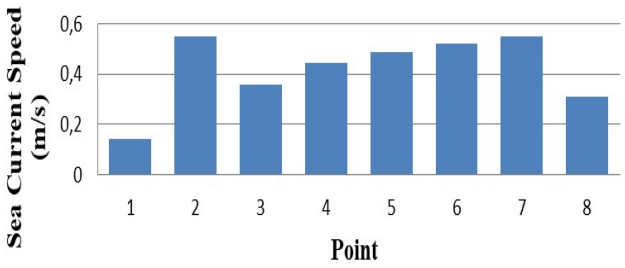

Figure 10: Flow velocity chart depicting 8 measurement points surrounding the outlet of Teluk Sepang PLTU in Bengkulu City, measured on June 1, 2024.

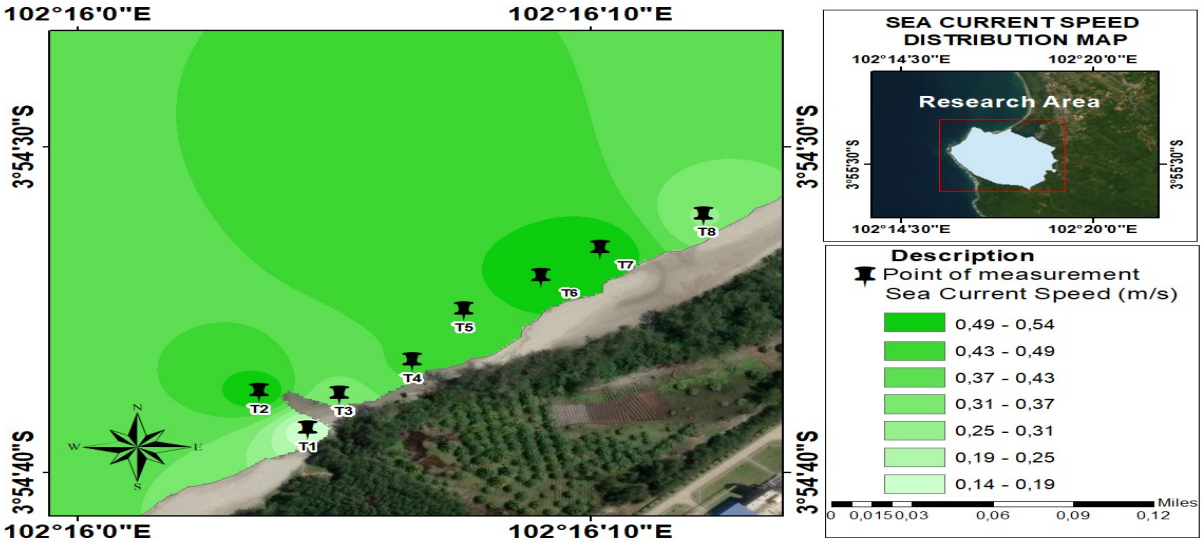

Figure 11: A map displaying the distribution of sea current speeds at eight locations surrounding the outlet of Teluk Sepang PLTU, located in Bengkulu City, measured on June 1, 2024.

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Table 1: The average measurements of temperature, salinity, pH, density, and current velocity recorded around the outlet of Teluk Sepang PLTU Bengkulu City on June 1, 2024, along with the seawater quality standards for marine organisms as outlined in KepMenLH No. 51, 2004

Parameter	Seawater quality standards for marine biodata (KepMenLH No. 51, 2004)	Point 1	Point 2	Point 3	Point 4	Point 5	Point 6	Point 7	Point 8
Temperature (°C)	28-30	34.91	34.91	35.39	35.27	34.36	33.99	34.24	33.58
Salinity (‰)	33-34	24.9	24.7	25	25.1	24.5	24.8	25	26.9
pH	7-8,5	8.69	8.65	8.61	8.59	8.61	8.7	8.76	8.76
Density (kg/m^3)		1019.8	1019.5	1020	1021.8	1019.9	1019.8	1019.8	1021.1
Ocean current speed(m/s)		0.14	0.55	0.36	0.44	0.49	0.52	0.53	0.31

The quantification of temperature, salinity, pH, density, and ocean current velocity was systematically documented in proximity to the discharge point of Teluk Sepang PLTU in Bengkulu City. These quantifications were imperative for evaluating the immediate ecological ramifications of the power plant's operations on the adjacent marine ecosystem. To ascertain the viability of the aquatic environment and its appropriateness for marine organisms, these documented values necessitate comparison with established seawater quality benchmarks. The pertinent reference for these evaluations was encapsulated in *Keputusan Menteri Negara Lingkungan Hidup* No. 51, 2004 (KepMenLH No. 51, 2004), which delineates the seawater quality standards applicable to marine organisms within the jurisdiction of Indonesia. This regulatory framework stipulates explicit permissible thresholds for an array of physical and chemical parameters, including temperature, pH, and salinity, to ensure the sustainability and welfare of marine biota. In Table 1 presents the average measurements of temperature, salinity, pH, density, and current velocity recorded around the outlet of Teluk Sepang PLTU Bengkulu City on June 1, 2024, along with the seawater quality standards for marine organisms as outlined in KepMenLH No. 51, 2004.

4.0 CONCLUSION

According to the findings of the study, it is evident that the conditions of parameters such as temperature, pH, and salinity do not satisfy the quality standards for marine biota ecosystems as outlined in KepMenLH No. 51, 2004. The average temperature ranges from 33.58 to 35.39 °C, with a pH level between 8.59 and 8.76, indicating an alkaline condition, and salinity fluctuates between 24.7 and 26.9 ‰. This research indicates that the seawater surrounding the outlet of the Teluk Sepang PLTU in Bengkulu City has become polluted due to wastewater discharge, leading to a decline in seawater quality, particularly concerning seawater temperature. This situation has significant repercussions for marine biota ecosystems like coral reefs, mangroves, and seagrasses; for instance, an increase in seawater temperature exceeding 2°C above natural levels can trigger coral bleaching. Furthermore, a reduction in seawater density results in heightened ocean current speeds, which could lead to coastal erosion near the PLTU outlet.

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