PHYSIOCHEMICAL WATER QUALITY AND PLANKTON ABUNDANCE IN THE WESTERN COAST OF BENGKULU PROVINCE

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ABSTRACT

The western coast of Bengkulu Province has been directly influenced by the Indian Ocean and anthropogenic activities, so the characteristic of water quality parameters is essential to be monitored. This study is aimed to observe the physiochemical water parameters and plankton abundance of coastal areas. We observed two sites of tourist destinations in May 2022, which are carried out at Zakat Beach and Berkas Beach. Water surface temperature, current velocity, and tidal range have been simultaneously measured as physical water parameters. Dissolved oxygen, water salinity, and water pH were also measured as chemical water properties. Plankton density, diversity, and dominance were studied as water condition indicators. Two research sites have relatively good

quality conditions in physiochemical water properties with low-high plankton dominance and low-moderate plankton diversity. This is followed by the Cyclotella kuatzingiana and Schroederia segitera with 50% and 41.5% in abundance, which are dominant in Zakat Beach. A total of 47.8% Rhizosolenia robusta is dominant plankton both in occurrence and abundance in Berkas Beach waters. PCA analysis showed that plankton abundance has the highest correlation with dissolved oxygen, salinity, and water temperature, while plankton diversity has the highest correlation with pH value.

Keywords: Bengkulu, Chemical Water Parameters, Coastal, Physical Water Parameters, Plankton

1. Introduction

Bengkulu Province, which is located on the western side of Sumatera Island, is directly adjacent to the Indian Ocean and has approximately 525 km of coastline (BPS-Statistic of Bengkulu Province, 2023). The coastal habitats which have important areas for tourism activities and recreation provide various ecosystem services, such as water quality, nutrient recycling, and ecological sustainability (De Giglio et al., 2022). As a coastal area, it has dynamic interaction and influences the variation of physico-chemical water parameters (Sinu & Ajimila, 2023). Human activities and anthropogenic impacts in coastal areas will provide significant threats to this ecosystem. Monitoring of water quality based on physicochemical properties will be useful for understanding the water quality parameters and indicate the health of water (Gharib et al., 2011).

Physiochemical parameters such as temperature, pH, salinity, and dissolved oxygen play important roles in marine species distribution (Suganthi et al., 2018). Water biological monitoring is used to determine the presence, amounts, and effects of the water environment in physical, chemical, and biotic factors (Baker, 1976). The plankton community structure is essential to determine the water richness of the marine environment according to the abundance, diversity, uniformity, and plankton dominance (Takarina et al., 2019). The distribution and abundance of plankton are limited by physical water properties such as light penetration, water temperature, salinity, and water surface currents (Djumanto et al., 2009).

Regarding the importance of coastal water quality, this study aims to observe the physiochemical water parameters and plankton abundance of coastal areas of Bengkulu Province. Water temperature, current velocity, and tidal range were observed as physical water properties, whereas dissolved oxygen, pH, and salinity were carried out as chemical water parameters. Principle Component Analysis (PCA) was applied to determine the correlation between physiochemical parameters and biological properties.

2. Research Methodology

The present study was carried out along Zakat Beach and Berkas Beach which can be seen in Figure 1. These locations are well-known as tourist destinations, fishing activities, and settlement areas. The research study area shown in Fig 1 was divided into four stations regarding their location that are influenced by human interventions.

Figure 1. Map of the study area.

Sample collections for this recent study were carried out from selected stations on the western coast of Bengkulu Province, which consisted of Station I (Berkas Beach), Station II (Berkas Beach, Station III (Zakat Beach), and Station IV (Zakat Beach) during the day. Berkas Beach was determined as a sample location due to high tourism activities and coastal anthropogenic impact. Zakat Beach is the coast curved that is a popular tourism destination in Bengkulu Province.

Tabel 1. Location of the four stations along the Berkas Beach and Zakat Beach.

Station No.	Sampling Stasion	Longitude	Latitude
I	Berkas Beach	102.25250571300	-3.79928480910
II	Berkas Beach	102.25056407300	-3.79760966855
III	Zakat Beach	102.25753395200	-3.78374862824
IV	Zakat Beach	102.25877577500	-3.78284357085

Water quality samples were collected for physical parameters, chemical parameters, and plankton assemblages from the four selected stations. Water surface temperature, seawater velocity, and tidal range were simultaneously measured at the site itself as physical water quality. The dissolved oxygen content, salinity, and pH of the samples were fixed at the station itself. Plankton samples were collected at the site itself and then brought to the laboratory for analysis. Water surface temperature was analyzed using a thermometer with an accuracy of 0.5 °C. Water velocity was analyzed using the floating method (FAO, 2023), and the tidal range was measured using a tidal gauge with an accuracy

of 0.5 m. pH was determined by a digital pH pen, salinity was measured by the refractometer and dissolved oxygen was analyzed by a digital DO analyzer. Plankton samples were collected by plankton net and then preserved in 4% formaldehyde for laboratory identification (Sinu & Ajimila, 2023) using a binocular microscope (Olympus) at the magnification of 1000x (Kadwe et al., 2022). Biological indices were analyzed using Shannon Weiner Index (H'), and Simpson's dominance index. Principle Component Analysis (PCA) was used to analyze the correlation between physiochemical parameters and water biological properties.

3. Result

3.1. Marine Plankton Composition and Abundance

Species composition and abundance of plankton population consisted of Cyclotella kuatzingiana, Schroederia segitera, Oscilatoria sp., Selenastrum gracile, Rhizosolenia robusta, Cyclotella kuatzingiana, Coscinisdiscus radiatus, Coscinisdiscus asteromhalus, and Thalassiosira fluviatilis. Among these, Selenastrum sp. (71,4%) contributed the greater abundance at station II. Schroederia sp. can be found in each station along the coast. Rhitoselenium sp. and Coscinisdiscus sp. were only found in station III and station IV, respectively.
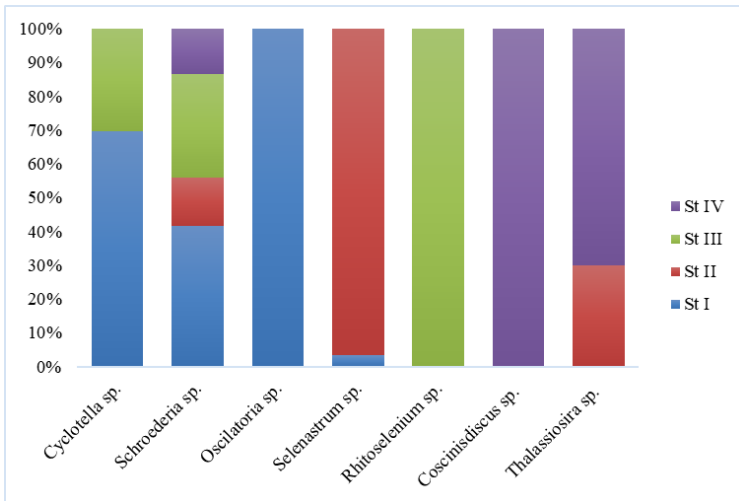
Figure 2. Variation in the percentage occurrence of plankton abundance.

Table 2 shows that Cyclotella sp. was the highest abundance on the coast, while Oscilatoria sp. was the lowest abundance species on the coast. Schroederia sp. can be found along the coast at each station. Oscilatoria sp., Rhizosolenia sp., and Coscinisdiscus sp. were the plankton species found in certain sites, which consisted of Station I, Station III, and Station IV. The highest assemblages of plankton in each station were Cyclotella sp. (50%) in Station I, Selenastrum sp. (71,4%) in Station II, Rhizosolenia sp. (47,8%) in Station III, and Coscinisdiscus sp. (53,3%) in Station IV. Plankton abundance showed that station I has the highest value

(128.1 x 103 ind/l), while station IV has the lowest value
(46.9 x 103 ind/l). Plankton abundance in Station II is 50
x 103 ind/l and Station III is 71,9 x 103 ind/l.

Table 2. Variation in the composition of plankton abundance
along the western coast of Bengkulu Province.

Species	Station I	Station II	Station III	Station IV
Cyclotella sp.	+++	-	++	-
Schroederia sp.	+++	+	++	+
Oscillatoria sp.	+	-	-	-
Selenastrum sp.	+	++++	-	-
Rhizosolenia sp.	-	-	+++	-
Coscinisdiscus sp.	-	-	-	+++
Thalassiosira sp.	-	+	-	++

Symbol: + indicates less than 20%, ++ indicates 21-40%, +++ indicates 41-60%, ++++ indicates 61-80%, +++++ indicates 81-100% and (-) indicates absence.

3.2. *Diversity Indices*

The diversity indices (Figure 3) revealed that
Shannon diversity (H') showed maximum values at
station III (H'=1.51) and minimum values at station IV
(0.29). Simpson dominance recorded a minimum value at
station IV (0.03) and a maximum value at station I (0.7).
It can be noted that there were low-high plankton
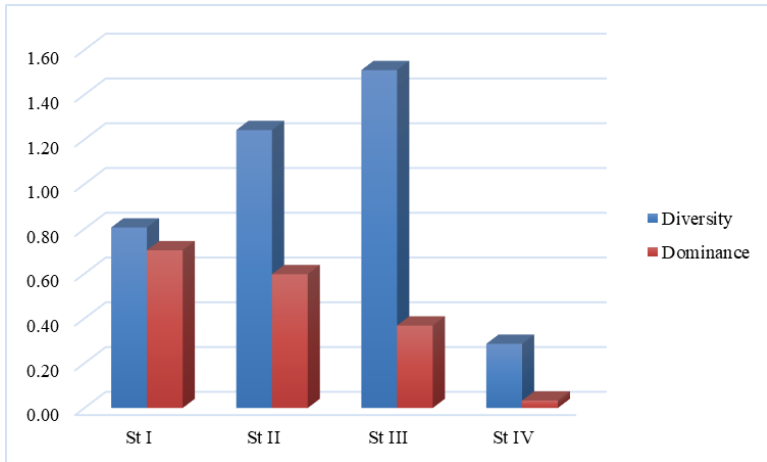dominance and low-moderate plankton diversity along
the coast.

Figure 3. Variation in the diversity indicates plankton abundance.

3.3   Physiochemical Parameters

Figure 4 shows the physiochemical characteristics of coastal waters. Water temperature was recorded at 28 to 32 oC with 0.54 to 29.4 m/s of current velocity and 0.8 to 1.5 m of tidal range. Station I has the highest dissolved oxygen (7.1 mg/l) while station IV has the lowest value of dissolved oxygen (6 mg/l). All stations have similar values of pH which consisted of 7.9 to 8.1. Station II has the highest value of salinity (34.7 m/s) while station IV has the lowest value (27.7 m/s).
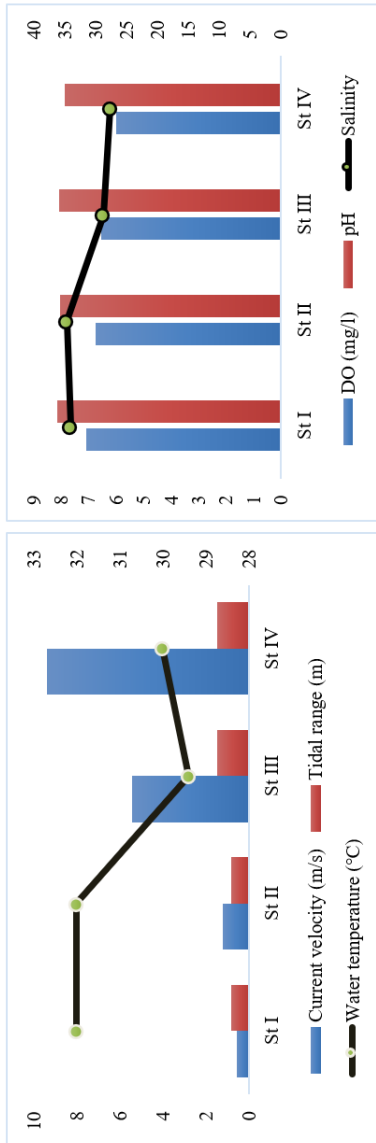
Figure 4. Physiochemical parameters along the coast.

3.4 PCA Plot for Analyzing The Relationship Between Plankton Assemblages and Physiochemical Parameters

PCA analysis for physiochemical parameters and plankton abundance provided a total cumulative variance of 90.12%. The first pc result is 6.561 eigenvalue with 72.9% cumulative variance, while the second pc result is 1.550 eigenvalue with 90,12% cumulative variance, and the third pc result is 0.889 eigenvalue and 100% cumulative variance. Physiochemical parameters like water temperature, salinity, dissolved oxygen, and pH ordinated to the right side had greater relationships to plankton dominance and diversity. Plankton dominance and density had the highest relationship to dissolved oxygen, salinity, water temperature, and pH. Current velocity and tidal range have the lowest relationship with plankton diversity and abundance.

4. Discussion

The water quality of the western part of the coast was still in water quality standard based on Kepmen LH Number 51, 2004. The water temperature, pH, dissolved oxygen, and salinity measurement have the range of water quality standards which consisted of water temperature standard (28 to 32 oC), pH (7 to 8.5), salinity (less than 34 o∕oo), and dissolved oxygen more than 5
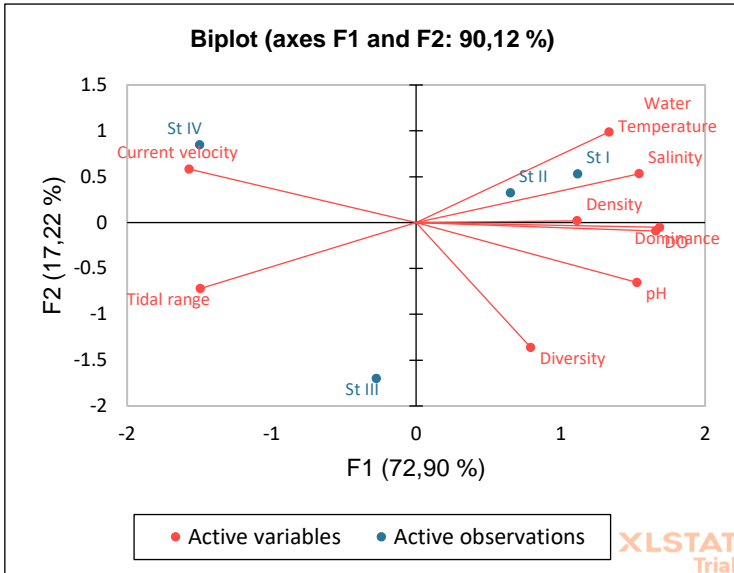
mg/l.

Figure 5. PCA plot for physiochemical parameters and plankton abundance.

Schroederia sp. from Chlorococcal algae has more density in the season of low rainfall when nutrients are concentrated and light is affected (Ramirez-Restrepo et al., 2015). Oscillatoria sp. from the Cyanophyceae division has the lowest abundance in this research, however, it was the most abundant phytoplankton species found in Segara Anakan Cilacap (Asiddiqi et al., 2019). Oscillatoria genus is commonly found in freshwater, brackish, and marine environments

(Hoffmann, 1996). Cyclotella sp. and Thalassiosira sp. from marine diatoms can thrive in upwelling conditions, periodically nutrient-rich conditions, and the most energy-efficient food webs (Allen et al., 2006). Rhizosolenia sp. is widely distributed in warm waters both in tropical and subtropical regions (Hernandez-Becerrjl et al., 1996).

PCA analysis showed that plankton density and dominance high correlation with dissolved oxygen in Stations I and II. Density in this station reached 50×10^3 to 128.1×10^3 ind/l, while dominance indicates high-moderate from 0.6 to 0.7. However, dissolved oxygen in this station reached the highest value (6.7 to 7.1 mg/l). Plankton assemblages were dominated by Cyclotella sp., Schroederia sp., Selenastrum sp., and Oscilatoria sp that were found in Berkas Beach. Temperature, oxygen, and solar radiation influenced the plankton abundance and dissolved oxygen concentration (Yang et al., 2020).

Plankton diversity has a correlation with pH value. Diversity indicates low-moderate from 0.8 to 1.2 in stations I and II, while 0.3 to 1.5 in stations II and IV. pH value was recorded as 8.05 to 8.1 in stations I and II, while 7.9 to 8.07 in stations III and IV. The distribution and diversity of life biota in an aquatic ecosystem are mostly controlled by the physical, chemical, and

biological properties of water (Khushbu & Sushma, 2022).

5. Conclusion

Plankton dominance recorded *Cyclotella kuatzingiana* and *Schroederia segitera* with 50% and 41.5% in abundance in Zakat Beach. A total of 47.8% *Rhizosolenia robusta* is dominant plankton both in occurrence and abundance in Berkas Beach waters. PCA analysis showed that plankton abundance has the highest correlation with dissolved oxygen, salinity, and water temperature, while plankton diversity has the highest correlation with pH value.

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