Integrated Coastal Ecosystem Monitoring of Cirebon Waters as a Scientific Basis for Food Security Resilience and Climate Change Adaptation in the Era of Sea Level Rise and Giant Sea Wall Development

Riset Peningkatan Kapasitas

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Abstract

Coastal port ecosystems are shaped by interacting physical, chemical, and biological processes that influence water quality and plankton communities. This study assessed physicochemical conditions and plankton community structure at a fixed station in Cirebon Port, northern Java, Indonesia, based on 12 observations from January to June 2026 under spring and neap tidal conditions. Water quality was measured, while plankton samples were collected using a 250-µm net and examined microscopically with a Sedgwick–Rafter counting cell. Total plankton abundance ranged from 75.45 to 1,688.22 ind. L^{-1}, comprising 2,277 individuals across 16 taxonomic entries. Bacillariophyceae dominated (89.9%), particularly *Chaetoceros* sp. (40.7%), *Skeletonema* sp. (23.1%), and *Asterionellopsis* sp. (14.2%). Mean abundance was slightly higher during spring tide, but the difference was not significant (ρ = 0.818). Exploratory correlations showed positive associations with salinity (ρ = 0.614) and ammonia (ρ = 0.632), and a negative association with TDS (ρ = −0.648). These findings provide preliminary insights into plankton variability and water quality in a tropical port ecosystem.

Keyword: seawater quality; plankton; port ecosystem; spring–neap tidal cycle; Cirebon

Introduction

Coastal ecosystems provide important ecological and socioeconomic benefits but are increasingly affected by human activities and environmental variability. Port environments are particularly dynamic due to maritime activities, land-based inputs, and tidal processes that influence water quality and biological communities.

Physicochemical conditions, such as temperature, salinity, dissolved oxygen, and nutrient availability, play important roles in regulating plankton growth, distribution, and community structure. Tidal fluctuations can further influence water exchange, mixing, and particle transport, potentially affecting plankton abundance and composition.

Cirebon Port, located along the northern coast of Java, experiences interactions between maritime activities and coastal environmental processes. Understanding these dynamics is important for establishing a baseline for coastal ecosystem monitoring.

This study aimed to:

- Characterize temporal variations in water quality and plankton community structure.
- Compare plankton abundance between spring and neap tidal conditions.
- Explore relationships between physicochemical parameters and plankton abundance.

Research Method

Study area and sampling design

Sampling was conducted at a fixed station at the MTCRC pier, Cirebon Port, West Java, Indonesia (6.716196° S, 108.572581° E; Fig. 1). Twelve observations were collected between January and June 2026, comprising six spring and six neap tide events. Tidal classification was based on combined locally generated tidal model outputs and predictions from the Indonesian Agency for Meteorology, Climatology, and Geophysics (BMKG).

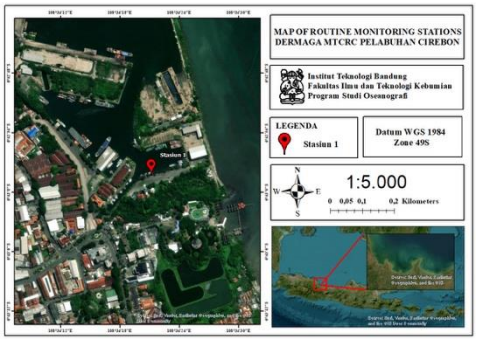

Figure 1. Location of the fixed sampling station at the MTCRC pier, Cirebon Port, West Java, Indonesia (6.716196° S, 108.572581° E).

Physicochemical measurements

Temperature, pH, salinity, dissolved oxygen (DO), and total dissolved solids (TDS) were measured in situ using a Horiba multiparameter instrument. Water samples were collected for laboratory analysis of total suspended solids (TSS), turbidity, nitrate, nitrite, ammonia (NH_3-N), phosphate, and chlorophyll-a. Chlorophyll-a was determined spectrophotometrically. Parameters were recorded in their respective units, including °C, ppt, mg L^{-1}, g L^{-1}, and NTU.

Plankton sampling and enumeration

Plankton samples were collected using 30-µm and 250-µm mesh nets for phytoplankton and zooplankton, respectively. The 250-µm net was horizontally towed at the water surface along a 50-m transect. Samples were concentrated from 7.9 L to 250 mL, preserved with 10% Lugol's solution, and stored at 4 °C. Taxonomic identification and enumeration were performed microscopically at 10× magnification using a Sedgwick–Rafter counting cell. Ten squares (1 µL each) were examined in duplicate for each sample. DNA metabarcoding of two representative samples (spring and neap tides) targeted the COI gene to detect morphologically unidentifiable taxa through eDNA extraction, PCR, and NGS.

Data processing and statistical analysis

Physicochemical parameters and plankton abundance were summarized descriptively. Tidal differences were tested using the Mann–Whitney U test, while relationships with physicochemical variables were explored using Spearman correlation (α = 0.05; no multiple-comparison adjustment). ND nutrient values were treated as missing. Analyses were performed using Python.

Discussion & Result

1. Physicochemical conditions

Water quality varied throughout January–June 2026. Temperature ranged from 26.32–32.50 °C, salinity from 14.49–31.20 ppt, and DO from 5.18–8.81 mg/L. Nutrient concentrations and other parameters also showed temporal variability.

2. Spring–neap comparison

Total plankton abundance ranged from 75.45–1,688.22 ind. L^{-1}. Mean abundance was slightly higher during spring tides (613.57 ind. L^{-1}) than neap tides (579.51 ind. L^{-1}), but the difference was not significant (Mann–Whitney, p = 0.818).

3. Plankton composition

The assemblage was dominated by Bacillariophyceae (89.9%). The most abundant taxa were Chaetoceros sp. (40.7%), Skeletonema sp. (23.1%), and Asterionellopsis sp. (14.2%), indicating strong diatom dominance.

4. Environmental relationships

Plankton abundance was positively correlated with salinity (ρ = 0.614) and ammonia (ρ = 0.632), and negatively correlated with TDS (ρ = −0.648). These relationships were exploratory and require cautious interpretation due to the limited sample size and unadjusted multiple comparisons.

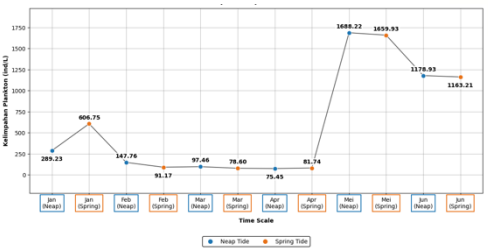

Figure 2. Pooled taxonomic composition of the plankton assemblage, showing the relative contributions of major taxonomic groups and dominant taxa

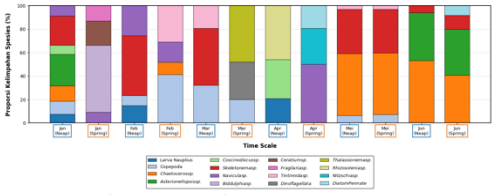

Figure 3. Comparison of total plankton abundance between spring and neap tidal observations. Individual observations, medians, and interquartile ranges are shown

Conclusion

- Water quality and plankton abundance varied during January–June 2026.
- Plankton assemblages were dominated by diatoms, particularly Chaetoceros, Skeletonema, and Asterionellopsis.
- No significant difference in plankton abundance was observed between spring and neap tides.
- Plankton abundance was positively associated with salinity and ammonia, but negatively with TDS.
- Longer-term and spatially replicated monitoring is needed to better understand plankton dynamics in Cirebon Port.