SPAMAST Research Journal Volume 7 • January 2024
DOI: https://doi.org/10.64656/spamastrj.v7i1.37

Primary Productivity of Coastal Waters in Malita, Davao Occidental

MICHAE JERIEL I. BERSALDO[1], PEDRO M. AVENIDO[2], MICHELLE M. ELEMINO[1]
[1] Department of Marine Biology, Institute of Fisheries and Marine Sciences,
[2] Institute of Fisheries and Marine Biology,
Southern Philippines Agri-business and Marine and Aquatic School of Technology, 8012 Poblacion, Malita, Davao Occidental

Corresponding author: mjbersaldo@spamast.edu.ph

ABSTRACT

Article History

Received: 27 June 2023
Revised: 5 October 2023
Accepted: 15 December 2023
Published: 30 January 2024

Keywords— Chlorophyll a, Coal-fired Power Plant, Malita, Nutrients, Temperature

This study evaluates the primary productivity of coastal waters in Barangay Culaman, Malita, Davao Occidental, by analyzing physicochemical parameters and chlorophyll a concentration. The choice of these parameters was based on their significance in understanding the health and productivity of marine ecosystems. Surface and sub-surface water samples were collected from ten sampling points, and parameters such as temperature, dissolved oxygen, salinity, total dissolved solids, and pH were measured on-site. Chlorophyll concentrations were determined using spectrophotometric analysis. Results indicate stable and favorable conditions for marine life, with minimal stratification and uniform nutrient distribution. However, the potential impacts of human activities highlight the need for sustainable management practices to mitigate eutrophication and harmful algal blooms. The findings provide a scientific basis for policy recommendations and community actions aimed at preserving the ecological integrity of Malita's coastal waters.

INTRODUCTION

The primary productivity of coastal waters is a critical indicator of the health and sustainability of marine ecosystems, particularly in regions like Malita, Davao Occidental, where coastal resources are vital for local livelihoods and economic activities. Primary productivity, driven by photosynthetic organisms such as phytoplankton, forms the base of the marine food web, supporting fisheries and aquaculture that are essential for food security and income generation in the area (Nixon, 1995). However, coastal ecosystems in Malita face increasing threats from human activities, including overfishing, pollution, and habitat destruction, as well as natural factors like climate change, which can alter nutrient dynamics and water quality (Cloern et al., 2016). These pressures can reduce primary productivity, leading to declines in fish stocks and other marine resources, ultimately impacting the well-being of coastal communities.

The coastal waters of Malita, part of the ecologically significant Davao Gulf, are under severe stress from sedimentation, agricultural runoff, and untreated wastewater. These factors contribute to eutrophication and harmful algal blooms, which can deplete oxygen levels in the water, creating dead zones that disrupt marine ecosystems and reduce primary productivity. Additionally, climate change-induced factors such as rising sea temperatures and ocean acidification may further impact phytoplankton growth and the overall productivity of coastal waters. These changes pose significant risks to the marine resources that local communities depend on, underscoring the urgent need for a comprehensive assessment of primary productivity in Malita's coastal waters.

The background of this project is grounded in the growing recognition of the link between healthy marine ecosystems and the socio-economic well-being of coastal communities. Studies in the Davao Gulf have highlighted the need for localized research to address specific environmental challenges and support sustainable development. By focusing on Malita's coastal waters, this project not only contributes to broader efforts in marine conservation and climate resilience but also empowers the local community to take action. It ensures that these ecosystems remain productive and sustainable for future generations, with the community playing a crucial role in preserving the ecological integrity of their coastal waters.

This project aims to evaluate the primary productivity of Malita's coastal waters by measuring key parameters such as chlorophyll a concentration and other physicochemical parameters in the area. These metrics provide insights into the rate of photosynthesis and the overall health of the marine ecosystem. By identifying areas of high productivity and those at risk from environmental stressors, the project seeks to provide a robust scientific basis for policy recommendations and community actions aimed at preserving the ecological integrity of Malita's coastal waters while supporting the livelihoods of its

residents. The potential of these findings to guide policy recommendations cannot be overstated, underlining the importance of this study.

Objective of the Study

This project aims to evaluate the primary productivity of Malita's coastal waters by measuring key parameters such as chlorophyll a concentration and other physicochemical parameters in the area.

CONCEPTUAL FRAMEWORK

The study evaluated how the dependent variables, such as chlorophyll a and other physicochemical parameters, were affected by the independent variables, surface and bottom waters, in the coastal water of Malita, Davao Occidental.

MATERIALS AND METHODS

The study was conducted at Barangay Culaman, Malita, Davao Occidental, a region of significant ecological and economic importance. This area, with a land area of 3,418 hectares, is one of the barangays of the Municipality of Malita. The barangay was created on November 17, 1936. The distance from Barangay Poblacion to this area is 3.55 km. Its geographical coordinates are latitude 6° 23' 32.98" N and longitude 125° 37' 12.13" E, and it is where the Coal-Fired Power Plant is located, the biggest coal-fired power plant in Mindanao.

The coastline of Barangay Culaman is covered by Aquacor and Sitio Inaburan, as shown in Figure 1. Preliminary observations were done to map out the sampling points in the study area. Ten sampling points were in the vicinity of the study area, 50 meters perpendicular to the shoreline, and water samples were collected from the sea surface with 5 to 10 cm depth and sub-surface at exactly 1 meter below the surface water. Sampling points were spread throughout the area from the river mouth of the Culaman River to Aquacor, where a banana plantation is located, and to the jetty port of Malita Coal Fired Power Plant. The sampling process was conducted systematically and rigorously to ensure the reliability of the data collected.

Figure 1
Map of Brgy. Culaman coastline, Malita, Davao Occidental

Collection of Water Samples

The water samples were collected randomly in three different sampling stations in the study area, 50 meters perpendicular to the shoreline. Wherein, each sampling point was tagged through GPS waypoints. Samples were obtained vertically, in the sea surface and bottom water at exactly 5 meters below the surface. The water samples were collected using D.O. bottles. The water samples were placed in a sterilized empty water bottle that was rinsed three times with water to be collected in the sampling area and labelled accordingly. The collected water samples were placed in an ice bucket with ice tubes to maintain their freshness prior to the laboratory analysis of the nutrients and chlorophyll a.

Physicochemical Parameters and Sea Water Analysis

The temperature, dissolved oxygen, salinity, total dissolved solids, and pH were measured on site using a YSI Pro multi water parameter tester. Moreover, for chlorophyll extraction, water samples were brought to the SPAMAST General laboratory for extraction and analysis of chlorophyll a using the spectrophotometric method. A Shimadzu AA-7000 spectrophotometer was used, and the wavelength was set at 645 nm and 663 nm. The chlorophyll content was determined by using the equation formulated by Arnon (1949):

$$\text{Total chlorophyll (mg/L)} = 20.2(A645) + 8.02(A663)$$

Where A = absorbance at respective wavelengths

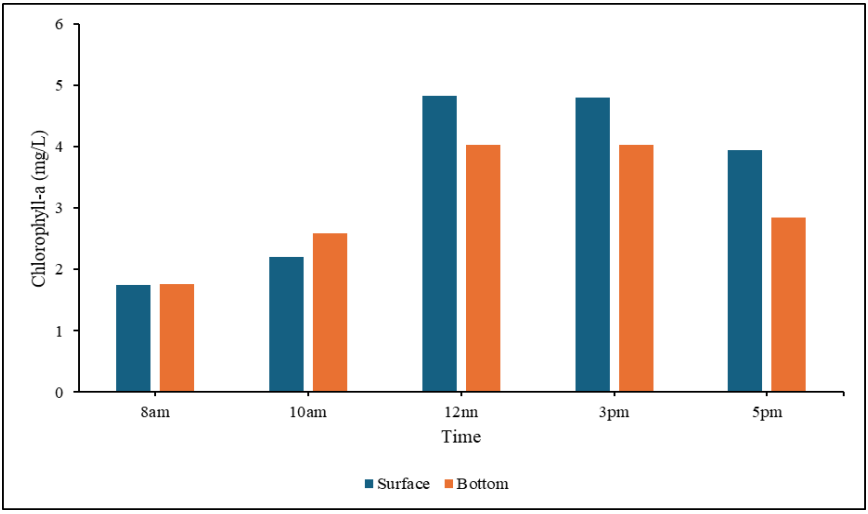
Statistical Analysis

Paired t-test analysis was used to compare the significant difference in Chlorophyll a content of the water sample between the surface and bottom water. Analysis was done using SPSS version 17.0.

RESULTS AND DISCUSSION

Chlorophyll a is a critical biomarker for phytoplankton biomass and serves as a proxy for primary productivity in marine ecosystems. In this study, spectrophotometric analysis revealed higher chlorophyll a concentration in surface waters compared to subsurface waters. This is consistent with the findings of Falkowski and Raven (2007), who emphasized that light availability is a primary driver of photosynthesis in surface waters. The higher chlorophyll a level in surface waters suggests that phytoplankton are more active in these regions due to optimal light conditions, which are essential for photosynthetic processes. Conversely, the lower chlorophyll a concentration in sub-surface waters can be attributed to reduced light penetration, which limits photosynthetic activity (Behrenfeld et al., 2006). This vertical distribution of chlorophyll a is typical in tropical coastal waters, where light attenuation with depth plays a significant role in regulating primary productivity. The paired t-test analysis revealed no significant difference ($p=0.0815$) in chlorophyll a content between surface and bottom waters, indicating a well-mixed water column with uniform nutrient distribution. This finding aligns with studies in tropical coastal ecosystems, where tidal currents and wind action often promote vertical mixing, ensuring that nutrients are evenly distributed throughout the water column (Campos et al., 2011). The absence of significant stratification suggests that the study area benefits from natural processes that enhance nutrient availability for phytoplankton, supporting higher primary productivity. This is particularly important in coastal ecosystems, where nutrient availability is a key limiting factor for phytoplankton growth (Cloern et al., 2016).

Figure 2
Chlorophyll a measurement in the study area between the surface and bottom water.



Physicochemical Parameters

The physicochemical parameters measured in the study area, including temperature, dissolved oxygen (DO), salinity, total dissolved solids (TDS), and pH, are critical indicators of water quality and ecosystem health. The results are summarized in Table 1. The temperature values are consistent with tropical coastal waters, where temperatures typically range between 28–30°C (Reynolds, 2006). The slight increase in sub-surface temperature could be attributed to thermal stratification, a common phenomenon in coastal waters where surface waters are influenced by solar radiation. In contrast, deeper waters retain heat (Lalli & Parsons, 1997). However, the minimal difference suggests a well-mixed water column, which is beneficial for nutrient distribution and primary productivity.

The higher DO levels in surface water are consistent with the presence of photosynthetic activity, where phytoplankton produce oxygen during daylight hours (Falkowski & Raven, 2007). The lower DO in sub-surface waters may result from reduced light penetration and higher respiration rates by marine organisms (Diaz & Rosenberg, 2008). These values are within the acceptable range for marine life, as DO levels below two ppm can lead to hypoxia, adversely affecting marine ecosystems (Rabalais et al., 2010).

The consistent salinity levels indicate a stable marine environment with minimal freshwater input from rivers or rainfall. Salinity is a critical factor influencing the distribution and growth of marine organisms, particularly phytoplankton, which thrive in stable saline conditions (Cloern et al., 2016).

The high TDS values reflect the presence of dissolved salts and minerals, typical of coastal waters. These values are consistent with the

salinity measurements and suggest a well-mixed water column with minimal stratification (Lalli & Parsons, 1997).

Table 1. *Physicochemical parameters observed in the study area between the surface and bottom water.*

	Surface	Sub-Surface
Temperature	29.2 ± 0.6	29.4 ± 0.5
Dissolved Oxygen	5.9 ± 0.8	5.4 ± 0.7
Salinity	34.4 ± 0.3	34.4 ± 0.3
Total Dissolved Solids	34090 ± 320	34080 ± 310
pH	7.6 ± 0.1	7.6 ± 0.1

The study highlights the potential impacts of human activities, such as agricultural runoff and untreated wastewater, on the primary productivity of coastal waters. These activities can introduce excess nutrients into the water, leading to eutrophication and harmful algal blooms (Azanza et al., 2005). Eutrophication can deplete oxygen levels in the water, creating dead zones that disrupt marine ecosystems and reduce primary productivity (Diaz & Rosenberg, 2008). The presence of a coal-fired power plant in the study area further underscores the need for sustainable management practices to mitigate the impacts of industrial activities on coastal ecosystems (Campos et al., 2011).

The findings of this study have important implications for marine conservation and climate resilience in Malita, Davao Occidental. The stable physicochemical parameters and chlorophyll concentrations indicate a relatively healthy marine environment, but the potential impacts of human activities highlight the need for effective management strategies. Reducing nutrient inputs, promoting sustainable fishing practices, and implementing measures to mitigate the impacts of climate change are essential to preserve the ecological integrity of Malita's coastal waters (Cloern et al., 2016). These efforts will ensure that the area remains productive and sustainable for future generations, supporting the livelihoods of local communities.

SUMMARY AND CONCLUSIONS

The study provides a comprehensive assessment of the primary productivity of coastal waters in Barangay Culaman, Malita, Davao Occidental. The physicochemical parameters and chlorophyll concentrations indicate a stable and productive marine ecosystem, with minimal stratification and uniform nutrient distribution. However, the potential impacts of human activities, such as agricultural runoff and untreated wastewater, underscore the need for sustainable management practices to preserve the ecological health of the area. The findings contribute to broader efforts in marine conservation and climate resilience, ensuring that Malita's coastal waters remain productive and sustainable for future generations.

IMPLICATIONS AND RECOMMENDATIONS

The findings of this study have important implications for marine conservation and climate resilience in Malita, Davao Occidental. The stable physicochemical parameters and chlorophyll concentrations indicate a relatively healthy marine environment, but the potential impacts of human activities highlight the need for effective management strategies. Reducing nutrient inputs, promoting sustainable fishing practices, and implementing measures to mitigate the impacts of climate change are essential to preserve the ecological integrity of Malita's coastal waters (Cloern et al., 2016). These efforts will ensure that the area remains productive and sustainable for future generations, supporting the livelihoods of local communities.

LITERATURE CITED

Azanza, R. V., Fukuyo, Y., Yap, L. G., & Takayama, H. (2005). Prorocentrum minimum bloom and its possible link to a massive fish kill in Bolinao, Pangasinan, Northern Philippines. Harmful Algae, 4(3), 519-524.

Behrenfeld, M. J., O'Malley, R. T., Siegel, D. A., McClain, C. R., Sarmiento, J. L., Feldman, G. C., ... & Boss, E. S. (2006). Climate-driven trends in contemporary ocean productivity. Nature, 444(7120), 752-755.

Berkes, F., Colding, J., & Folke, C. (2000). Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications, 10(5), 1251–1262.

Campos, W. L., Del Norte-Campos, A. G. C., & McManus, L. T. (2011). Coastal fisheries of the Davao Gulf, Philippines: An update. Science Diliman, 23(2), 1-12.