

A Decadal Analysis of Phytoplankton Response to Nutrient Variability and Dynamics in the Arabian Sea**Gunarathna, M.G.M.P.* , Rajapaksha, J.K.***Department of Oceanography, Faculty of Fisheries and Ocean Sciences, Ocean University of Sri Lanka, Colombo, Sri Lanka***maheeshal15@gmail.com***Abstract**

Phytoplankton growth in the global ocean is often limited by nutrient availability. Understanding these nutrient-phytoplankton relationships are essential, especially in the Arabian Sea (AS), where nutrient-driven variations in time and space significantly influence its primary productivity. The present study aimed to investigate the relationship between phytoplankton biomass and dissolved nutrients (phosphate, nitrate, silicate, and iron) in the AS for a 30-year period from 1993 to 2023. Spatial diversity in nutrient dynamics was investigated, splitting the study area into four sub-regions: western, eastern, northern, and central AS. Monthly mean data were obtained from Copernicus Marine Environment Monitoring Service (CMEMS), with spatial resolution of 0.25° at the ocean surface layer of 50 m depth. Data analysis was performed using the R programming language. Descriptive statistics revealed that the monthly mean nutrient concentrations over the three-decade period, ranked from highest to lowest, were 0.110 mg L^{-1} for silicate, 0.018 mg L^{-1} for phosphate, 0.014 mg L^{-1} for nitrate, and $0.00005 \text{ mg L}^{-1}$ for ferrous. Phytoplankton biomass showed significant positive correlations with nitrate ($r=0.67$, $p<0.001$) and phosphate ($r=0.59$, $p<0.001$), indicating nitrate is the primary limiting nutrient. Correlations with silicate ($r=0.13$, $p<0.05$) and ferrous ($r=-0.04$) were weak suggesting minimal influence on phytoplankton growth. Nitrate concentration peaked from July to September, due to seasonal upwelling (Southwest monsoon) in western AS. In contrast, nitrate levels remain consistently low during April and November (inter-monsoon periods), characterized by less upwelling. The monthly variation of nitrate concentrations corresponds closely with the phytoplankton biomass, highlighting the influence of monsoon cycles on nutrient availability and primary productivity in the AS. One-way ANOVA showed significant spatial variations in monthly mean nutrient concentrations ($p<0.001$) across the four sub-regions. Being a strong upwelling region, nitrate was abundant, but Fe was highly limiting in the western AS. Elevated surface silicate concentrations in the eastern AS was primarily attributed to significant riverine inputs from India. Multiple linear regression showed nitrate, phosphate, and ferrous significantly influence phytoplankton biomass, explaining 54% of its variability, while silicate shows no significant effect. In conclusion, this study underscored the critical role of nutrients in driving phytoplankton biomass in the AS, particularly in response to monsoon-driven upwelling. Utilizing CMEMS data on phytoplankton-nutrient relationships can enhance biodiversity conservation and ecosystem management by monitoring and predicting nutrient-driven productivity trends, supporting sustainable resource use on a large scale.

Keywords: *Arabian sea, Phytoplankton, Dissolved nutrients, Nitrate, Phosphate*