Seasonal Dynamics of Primary Productivity in Gobbur Reservoir, Afzalpur,Kalaburagi, Karnataka.

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Abstract— This study assessed the primary productivity of Gobbur Reservoir in Afzalpur, Kalaburagi District, Karnataka, from January 2024 to December 2024. Gross primary productivity (GPP), net primary productivity (NPP), and community respiration (CR) were measured monthly at four sampling stations using the light-and-dark bottle method. Physico-chemical parameters (temperature, pH, dissolved oxygen, alkalinity, nutrients) were analyzed to evaluate their influence on productivity. The results showed clear seasonal trends: GPP and NPP reached their highest levels in summer (0.65–0.85 gC/m³/hr and 0.40–0.55 gC/m³/hr, respectively) and northeast monsoon periods, whereas their lowest values were observed during the southwest monsoon because of turbid inflows. CR exhibited comparable patterns, showing a strong correlation with dissolved oxygen and temperature. Nutrient ratios (N:P) and morphometric variables (variations in water depth, land use of the catchment) significantly impacted productivity. The reservoir displayed mesotrophic characteristics with moderate productivity, influenced by light access, nutrient contributions from agricultural runoff, and consistent thermal stratification. These results emphasize the susceptibility of Gobbur Reservoir to eutrophication and stress the importance of sustainable land-use methods in its watershed.

***Index Terms*— Gobbur Reservoir, Primary Productivity, Gross Primary Productivity (GPP), Net Primary Productivity (NPP), Community Respiration (CR).**

I. Introduction

Primary productivity is a crucial ecological process that regulates the flow of energy in aquatic environments. It pertains to the speed at which photosynthetic organisms, mainly phytoplankton, transform solar energy into organic carbon. This stable carbon creates the foundation of the aquatic food web, facilitating the growth and reproduction of zooplankton, macroinvertebrates, and fish (Wetzel, 2001; Boyd, 1981). Consequently, primary productivity serves as both a measure of ecosystem operation and a key factor influencing fishery capacity, nutrient circulation, and water quality (Krishna Rao et al., 2011).

In freshwater reservoirs, primary productivity is affected by a complex interplay of light availability, nutrient levels, temperature, and hydrological variations. Seasonal changes, particularly in tropical and subtropical areas such as India, significantly influence productivity trends. The periods before and after the monsoon typically show elevated productivity due to better light availability and nutrient supply, while monsoon periods can lead to decreased productivity caused by higher turbidity and dilution (Lokhande & Indulkar, 2017).

Multiple regional investigations highlight the importance of these differences. Krishna Rao et al. (2011) indicated an average gross primary productivity (GPP) of 1.26 g C m^{-2} day^{-1} in Karnataka reservoirs, which has implications for evaluating potential fish production. In the Kadwai and Kumshi reservoirs of Maharashtra and North Karnataka, increases in post-monsoon GPP were linked to improved light availability and nutrient inflows from surface runoff (Lokhande & Indulkar, 2017). Expanding on this area of research, Siddaram et al. (2016) assessed the seasonal fluctuations in productivity and zooplankton dynamics in Hattikuni Reservoir (Yadgir district) and found that peak GPP and NPP occurred during the post-monsoon season. Their results highlighted that nutrient enrichment and temperature were the key factors for increased primary productivity in the area. These findings are especially pertinent to Gobbur Reservoir, which has comparable climatic, hydrological, and usage traits. Gobbur Reservoir, situated in Kalaburagi District, remains insufficiently studied from a limnological viewpoint, despite its ecological and socio-economic significance. The reservoir aids in farming irrigation and household usage. However, it lacks fundamental information on seasonal productivity patterns, essential for efficient aquatic resource management.

II. Study Area

Gobbur Reservoir is located in Kalaburagi District, Karnataka, India. It is a medium-sized, man-made freshwater reservoir primarily used for irrigation, domestic purposes, and fisheries. The reservoir is situated at 17°17'06.5"N 76°41'50.4"E. The study was conducted over a period of 12 months from January 2024 to December 2024, covering pre-monsoon, monsoon, and post-monsoon seasons to assess seasonal variation in primary productivity

III. Materials and Methods

Sampling Design

Period: Monthly sampling (January 2024–December 2024).
Stations: Four stations:

- **S1**: Near inlet (depth: 6 m).
- **S2**: Central region (depth: 7 m).

- **S3**: Agricultural runoff zone (depth: 5 m).
- **S4**: Littoral zone with macrophytes (depth: 4 m).

Primary Productivity

Estimated using the **light-and-dark bottle method** (Gaarder & Gran, 1927):

- **Gross Primary Productivity (GPP)** = DO in light bottle – DO in dark bottle
- **Net Primary Productivity (NPP)** = DO in light bottle – DO in initial bottle
- **Community Respiration (CR)** = DO in initial bottle – DO in dark bottle

All productivity values were expressed in **mg O_2 L^{-1} hr^{-1}**, and later converted to **g C m^{-3} day^{-1}** using standard conversion factors.

IV. Results and Discussion

The seasonal primary productivity of Gobbur Reservoir was evaluated through the light and dark bottle method and expressed in grams of carbon per cubic meter per hour (g C/m³/hr). The derived values for Gross Primary Productivity (GPP), Net Primary Productivity (NPP), and Community Respiration (CR) reflect distinct seasonal patterns corresponding to climatic and limnological changes across the year.

Table 1. Seasonal variation in primary productivity (g C/m³/hr) in Gobbur Reservoir

Season	GPP (Range)	NPP (Range)	CR (Range)
Summer	0.243 – 0.319	0.150 – 0.206	0.094 – 0.113
SW Monsoon	0.094 – 0.150	0.056 – 0.094	0.038 – 0.075
NE Monsoon	0.218 – 0.270	0.131 – 0.180	0.075 – 0.094
Winter	0.169 – 0.225	0.105 – 0.150	0.056 – 0.083

Seasonal Trends in Productivity

The highest GPP was observed during the summer season (0.243–0.319 g C/m³/hr), which can be attributed to increased solar radiation, higher water temperatures, and greater light penetration resulting from reduced turbidity. These elements together boost phytoplankton growth and photosynthetic activity. Comparable seasonal productivity highs have been observed in other Indian reservoirs like Kadwai and Kumshi (Lokhande & Indulkar, 2017), where warm and consistent summer conditions encouraged elevated autotrophic rates.

In the southwest monsoon, productivity decreased significantly to a GPP range of 0.094–0.150 g C/m³/hr. This decrease is probably due to increased turbidity, significant inflows, and cloudiness, which diminish light access and photosynthesis effectiveness. The increase in water volume causes nutrient dilution, which also leads to lower productivity. This monsoon suppression corresponds with observations from Krishna Rao et al. (2011) and Nagbhushan Reddy et al. (2016), who noted comparable trends in the reservoirs of North Karnataka.

After the monsoon, the northeast monsoon season showed a rebound in productivity, with GPP values between 0.218 and 0.270 g C/m³/hr. This increase after the monsoon results from sediment deposition, nutrient replenishment, and enhanced light conditions, which collectively support the resurgence of phytoplankton. Nagbhushan Reddy et al. (2016) state that these recovery times frequently align with nutrient remineralization and mixing, boosting biological productivity. Winter productivity was average (GPP: 0.169–0.225 g C/m³/hr), supported by consistent water conditions and remaining nutrient availability, although reduced temperatures might hinder metabolic rates. The NPP and CR values remained consistent, indicating a fairly balanced autotrophic and heterotrophic system.

Environmental Consequences

The proportion of NPP to GPP throughout all seasons stayed within a moderate efficiency range (about 60–65%), indicating that a considerable amount of the carbon captured through photosynthesis is maintained as net productivity. The CR values indicate active microbial and zooplankton respiration, contributing to organic matter cycling.

Overall, the productivity profile suggests that Gobbur Reservoir is a mesotrophic to moderately productive freshwater system, with seasonally responsive autotrophic activity influenced by climatic and hydrological variables. These findings are consistent with regional observations made by Krishna Rao et al. (2011), and they underscore the ecological potential of Gobbur Reservoir for sustainable fisheries and water resource management.

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