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STUDIES ON PRIMARY PRODUCTIVITY OF HATTIKUNI RESERVOIR, YADGIR DISTRICT, KARNATAKA, INDIA

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AUTHORS' CONTRIBUTIONS

This work was carried out in collaboration between both authors. Author LS designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript and managed the literature searches. Author BRR managed the analyses of the study. Both authors read and approved the final manuscript.

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ABSTRACT

Productivity study is needed for the evaluation of the productivity of any aquatic ecosystems. The purpose of this study is to provide a baseline information regarding Hattikini Reservoir, Yadgir District, Karnataka, India for effective reservoir management. The study was carried out for a period of one year (February 2015 to January 2016) in each first week of the month using 'light and dark bottle' method. Results indicate that High productivity of Hattikuni reservoir favors better growth of zooplanktons and higher organisms in the reservoir.

Keywords: PP; GPP; NPP; CR; Hattikuni reservoir.

1. INTRODUCTION

The flow of energy through any ecosystem starts with the fixation of sunlight by plants and other autotrophic organisms. In this way the plants accumulate which is called primary production. The rate at which this energy accumulates is called primary productivity. The total energy accumulated is gross primary production [1]. Phytoplankton, macrophytes and periphyton are the essential forms of primary producers in the aquatic ecosystem. Measuring primary production helps to understand the trophic status and to assess the capacity for fish production, plants, macro and microorganisms in the aquatic environment [2]. Therefore, measurements of primary productivity are crucial to evaluate the biological activity of a reservoir [2].

Primary production estimation is concerned with evaluation of the potentiality of an ecosystem to build up, at the expense of radiant and chemical energy, primary organic compounds for transformation and

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flow to a higher level trophic system. Several factor such as nutrient status, water transparency, high seasonal rate of variations in water level, solar radiation etc., are known to influence the rate of primary production in fresh water reservoir [3,4].

Many Scientists have carried out investigations of reservoirs productivity globally [5,6,7,8,9,10,11,12], unfortunately, such study has not been reported on Hattikuni Reservoir; Hence this study has been undertaken.

2. MATERIALS AND METHODS

2.1 Study Area

Hattikuni is one of the villages in Yadgir District of Karnataka, India. It is situated 10 km away from the district of Yadgir. Hattikuni reservoir is a fresh water body located one km away from Hattikuni village. It falls between Latitudes of 16°52'50" North and Longitude of 77°10'21" (Figs. 1 and 2) and the catchment area of 137.89 sq.km. This reservoir is exclusively used for irrigation, fishing and drinking purpose.

The primary productivity is determined by using standard "light and dark bottle" method of at an interval of 30 days in every month for a period of one year from February 2015 to January 2016. Primary productivity was measured at all the stations following light and dark bottles method [13]. For this purpose, glass stoppered black and white BOD bottles of 250 ml were used. In case of surface water samples, the bottles were suspended about 15 cm below the water line and in case of bottom, the bottles were suspended near the bottom, using thread and float, at the same depth from where the bottom water sample was collected. The incubation period was kept three hours. Oxygen (O_2) estimation in the BOD bottles was made following usual Winkler's method [14]. The calculation was done as under:

1. Gross Oxygen Production (GOP) mg l-1 = LB-DB
2. Net Oxygen Production (NOP) mg l-1 = LB – IB
3. Community Respiration (CR) mg l-1 = IB – DB

Fig. 1. Map of India showing Hattikuni reservoir in Yadgir District in Karnataka, State, India

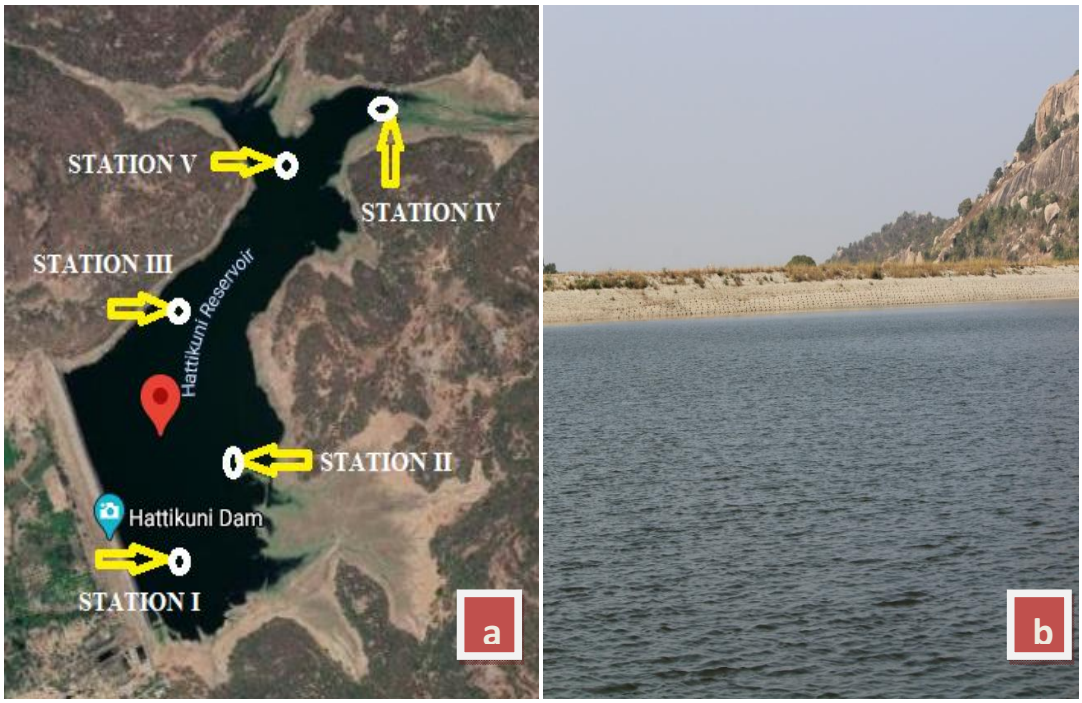

Fig. 2. (a) Showing Sampling Points (b) A View of Hattikuni reservoir

The values of gross and net primary productivity were calculated as follows:

Gross Primary Productivity ($gCm^{-3}h^{-1}$) = $\frac{GOP}{1.2 \text{ X } h}$ X 0.375

Net Primary Productive ($gCm^{-3}h^{-1}$) = $\frac{NOP}{1.2 \text{ X } h}$ X 0.375

Where,

LB = Dissolved oxygen in light bottle
DB = Dissolved oxygen in dark bottle
IB = Dissolved oxygen in initial bottle
H = Duration of incubation or exposure
1.2 = A constant
0.375 = A factor value (1 g of oxygen is equal to 0.375 g carbon)

The observed Gross Primary Productivity (GPP), Net Primary Productivity (NPP) and Community Respiration (CR) in mg/l/hr were converted into $gCm^{-3}h^{-1}$ by multiplying these values by a factor of 0.375 as suggested by Benton and Werner [15].

3. RESULTS

Primary Productivity of Hattikuni Reservoir, Yadgir District, Karnataka, India was analyzed for one year, from February 2015 to January 2016. Monthly variation of primary productivity recorded and all the values were presented in the Tables 1, 2, 3 and 4 and Figs. 3, 4, 5 and 6 respectively.

3.1 Gross Primary Production ($gC/m^3/hr$)

In the present investigation seasonal variations of GPP in Hattikuni reservoir recorded maximum during pre monsoon season i.e.1.09 $gC/m^3/hr$ in the month of May and minimum value was recorded during monsoon season i.e.0.47 $gC/m^3/hr$ in the month of July. Seasonal mean of GPP was found maximum in pre monsoon season i.e. 0.95 $gC/m^3/hr$ followed by post monsoon season i.e. 0.71$gC/m^3/hr$ and was minimum in monsoon season i.e. 0.55 $gC/m^3/hr$ respectively.

3.2 Net Primary Productivity ($gC/m^3/hr$)

In the present investigation, seasonal variation of NPP in Hattikuni reservoir recorded maximum during post monsoon season i.e.0.64 $gC/m^3/hr$ in the month of December and minimum value was recorded during monsoon season i.e.0.26 $gC/m^3/hr$ in the month of August. Seasonal mean of NPP was found maximum in post monsoon season i.e. 0.48 $gC/m^3/hr$ followed by post monsoon season i.e. 0.36 $gC/m^3/hr$ and was minimum in monsoon 0.27 $gC/m^3/hr$ respectively.

3.3 Community Respiration ((gC/m^3/hr))

In the present investigation, seasonal variation of CR in Hattikuni reservoir recorded maximum during pre-monsoon season i.e.0.68 gC/m^3/hr in the month of April and minimum value was recorded during monsoon season i.e.0.16 gC/m^3/hr in the month of September. Seasonal mean of CR was found maximum in pre monsoon season i.e 0.59 gC/m^3/hr followed by post monsoon season i.e 0.39 gC/m^3/hr and was minimum in monsoon season i.e 0.23 gC/m^3/hr respectively.

4. DISCUSSION

The present study has been undertaken to analyze the GPP, NPP and CR of Hattikuni reservoir, Yadgir District, Karnataka, India from February 2015 to January 2016.

Table 1. Monthly variation of Gross Primary Productivity (gC/m^3/hr) in Hattikuni reservoir

Seasons	Months	Stations					Average
		S-1	S-2	S-3	S-4	S-5	
Pre Monsoon	Feb-15	0.71	0.71	0.75	0.81	0.84	0.76
	March	0.84	0.95	1.04	1.1	1.08	1.00
	April	0.87	0.89	0.92	0.95	0.97	0.93
	May	1.01	1.03	1.11	1.12	1.18	1.09
Seasonal Mean							**0.95**
Monsoon	June	0.59	0.6	0.62	0.6	0.61	0.60
	July	0.49	0.46	0.45	0.43	0.51	0.47
	August	0.54	0.53	0.58	0.6	0.62	0.57
	September	0.56	0.56	0.58	0.61	0.61	0.58
Seasonal Mean							**0.55**
Post Monsoon	October	0.64	0.63	0.67	0.65	0.72	0.66
	November	0.7	0.72	0.71	0.81	0.83	0.75
	December	0.58	0.65	0.66	0.66	0.67	0.64
	Jan-16	0.81	0.8	0.76	0.79	0.8	0.79
Seasonal Mean							**0.71**
Maximum	**May**	**1.09**					
Minimum	**July**	**0.47**					

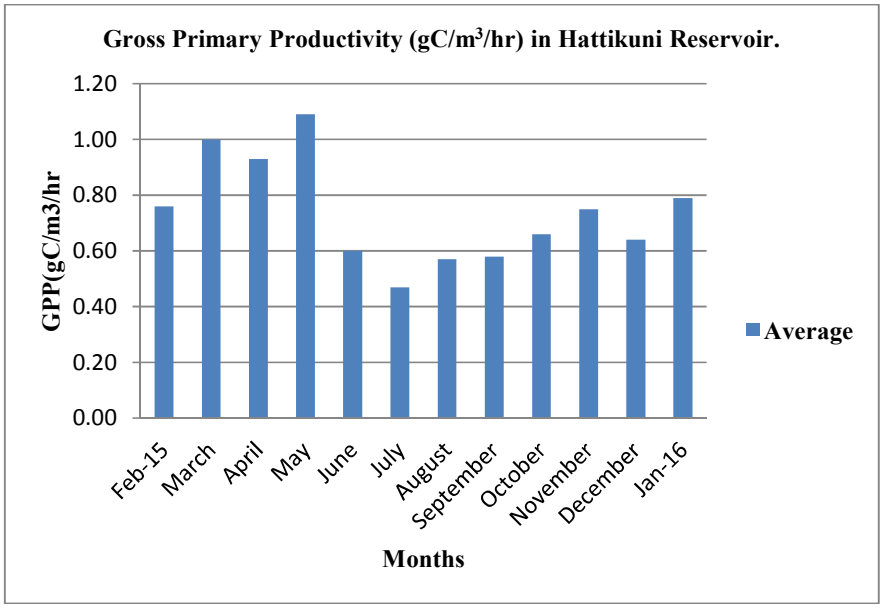

Fig. 3. Monthly variation of average Gross Primary Productivity (gC/m^3/hr) in Hattikuni Reservoir

Table 2. Monthly variation of Net Primary Productivity (gC/m^3/hr) in Hattikuni reservoir

Seasons	Months	Stations					Average
		S-1	S-2	S-3	S-4	S-5	
Pre Monsoon	Feb-15	0.28	0.28	0.31	0.31	0.33	0.30
	March	0.31	0.34	0.36	0.36	0.38	0.35
	April	0.34	0.32	0.41	0.42	0.41	0.38
	May	0.36	0.37	0.39	0.41	0.42	0.39
Seasonal Mean							**0.36**
Monsoon	June	0.28	0.3	0.29	0.29	0.3	0.29
	July	0.26	0.27	0.27	0.29	0.29	0.28
	August	0.22	0.23	0.25	0.27	0.31	0.26
	September	0.27	0.27	0.26	0.26	0.29	0.27
Seasonal Mean							**0.27**
Post Monsoon	October	0.32	0.36	0.39	0.39	0.4	0.37
	November	0.41	0.43	0.48	0.52	0.59	0.49
	December	0.61	0.62	0.63	0.65	0.68	0.64
	Jan-16	0.42	0.41	0.43	0.43	0.45	0.43
Seasonal Mean							**0.48**
Maximum	**December**	**0.64**					
Minimum	**August**	**0.26**					

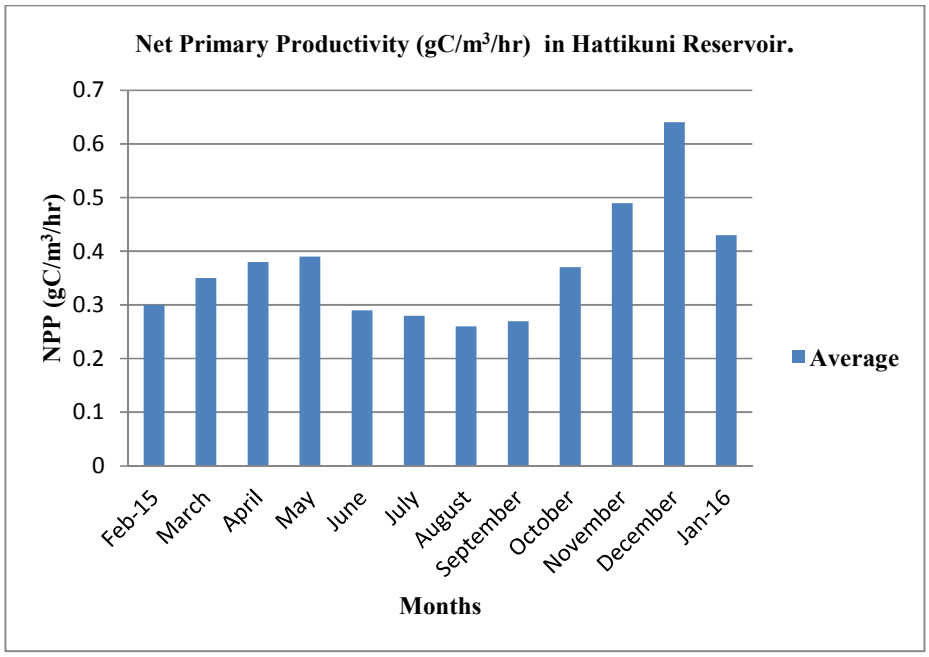

Fig. 4. Monthly variation of Net Primary Productivity (gC/m^3/hr) in Hattikuni Reservoir

4.1 Gross Primary Productivity

Gross primary productivity is the total rate of photosynthesis including the organic matter utilizes in respiration during the period of measurement. This is also known as total photosynthesis or total assimilation [9].

In the present study, the maximum values of GPP observed in pre-monsoon season may be availability and utilization of solar radiation leads to the high biomass of phytoplankton and algal blooms. The lower values of GPP in monsoon season may be due to the minimum photoperiod of the seasons with low solar radiation, temperature coupled with less abundance of number phytoplankton [10].

Mitsch and Gosselink [16] were studied on different aquatic ecosystems and reported that, high values of GPPP during summer season may be due to high

assimilation of solar energy, while minimum production of GPP during monsoon season because of the inflow of more rainwater with high amount of turbidity in to the reservoir. Mitsch and Gosselink [16] reported high primary productivity during summer season due to high light penetration while low productivity during monsoon season because of the influx of the turbid water to the reservoir.

Table 3. Monthly variation of Community Respiration (gC/m^3/hr) in Hattikuni reservoir

Seasons	Months	Stations					Average
		S-1	S-2	S-3	S-4	S-5	
Pre Monsoon	Feb-15	0.51	0.51	0.52	0.52	0.54	0.52
	March	0.58	0.59	0.58	0.61	0.63	0.60
	April	0.64	0.67	0.69	0.69	0.71	0.68
	May	0.49	0.52	0.53	0.59	0.59	0.54
Seasonal Mean							**0.59**
Monsoon	June	0.24	0.26	0.26	0.29	0.31	0.27
	July	0.22	0.25	0.26	0.29	0.29	0.26
	August	0.19	0.19	0.21	0.23	0.24	0.21
	September	0.15	0.07	0.17	0.19	0.21	0.16
Seasonal Mean							**0.23**
Post Monsoon	October	0.29	0.31	0.35	0.37	0.38	0.34
	November	0.33	0.34	0.38	0.39	0.41	0.37
	December	0.36	0.36	0.39	0.41	0.43	0.39
	Jan-16	0.41	0.42	0.48	0.49	0.51	0.46
Seasonal Mean							**0.39**
Maximum	**April**	**0.68**					
Minimum	**September**	**0.16**					

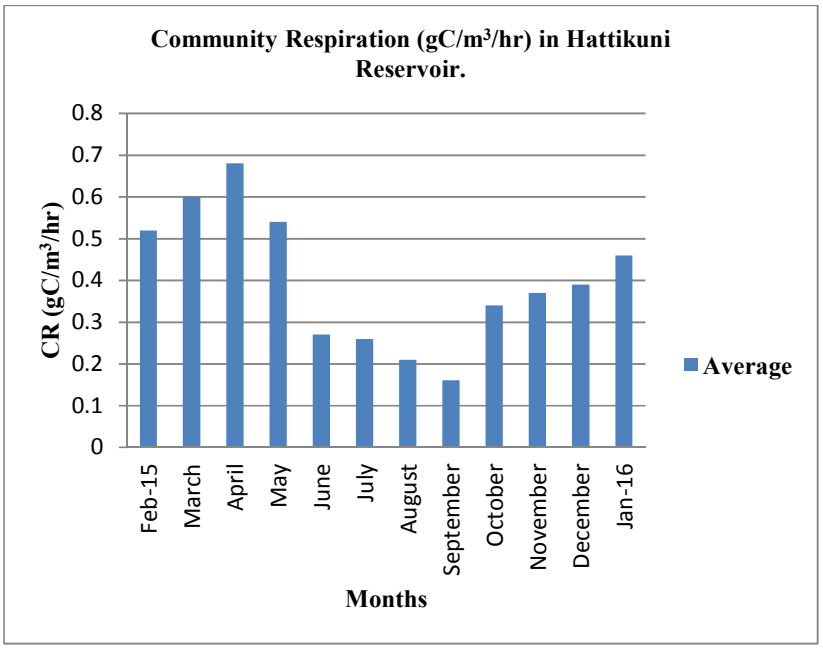

Fig. 5. Monthly variation of Community Respiration (gC/m^3/hr) in Hattikuni Reservoir

Table 4. Seasonal variation in GPP, NPP and CR (gC/m^3/hr) in Hattikuni Reservoir

Seasons	GPP	NPP	CR
Pre Monsoon	0.95	0.36	0.59
Monsoon	0.55	0.27	0.23
Post Monsoon	0.71	0.48	0.39

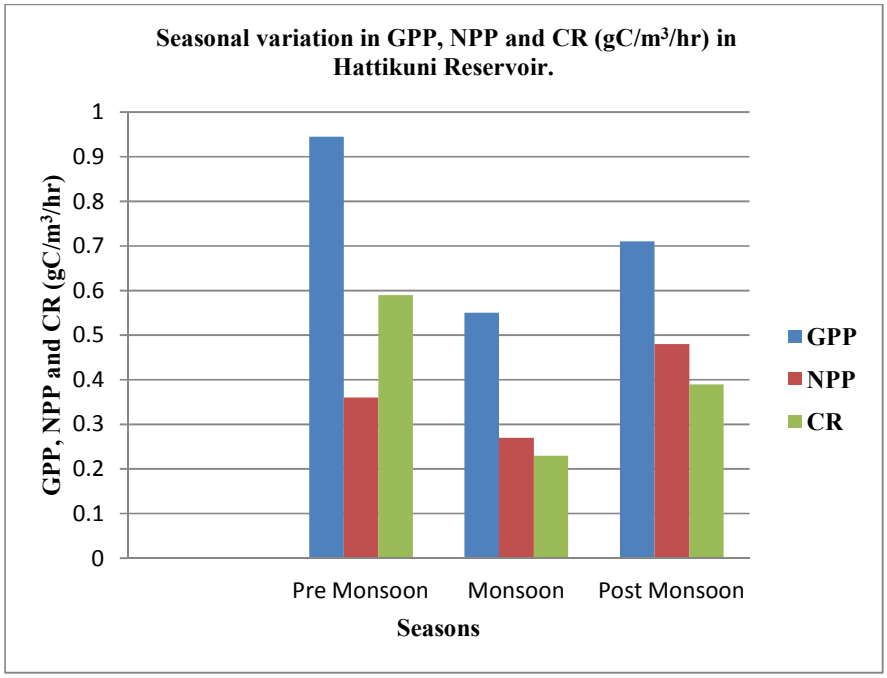

Fig. 6. Seasonal variation in GPP, NPP and CR (gC/m^3/hr) in Hattikuni Reservoir

4.2 Net Primary Productivity

Net production efficiency is the determination of ratio of the efficiency with which an organism converts assimilated energy into GPP or NPP production [10].

In the present investigation, maximum values of NPP observed maximum during post monsoon season may be the addition of nutrients with runoff water during monsoon rain and later clarity of water during this season are responsible for high primary productivity during winter. and minimum value was recorded during monsoon season might be due to increased turbidity and suspended silt content of water resulting from soil erosion from surrounding hills [17]. Similar results are also observed by Sontakke and Mokashe [9] and Radwan [18].

4.3 Community Respiration

Community respiration is characterized as a reduction in NPP from GPP and subsequently converted into release of carbon dioxide.

The results of this study indicate that the Community respiration of the reservoir is minimal during the monsoon, while the maximum values were reported during the pre-monsoon because this reservoir receives domestic sewage from surrounding village and other human activities responsible for higher community respiration. The high community respiration of all biotic and abiotic components organic matter reduces the content of dissolved oxygen [10]. The rate of respiration attains highest values in summer due to the effect of drainage water discharged from the different drains around the station. These effluents enhance the biological activities of bacteria, especially in summer due to the decomposition of organic matter [9]. Similar results were reported by Prabhakar et al. [17], Radwan [18] and Sheriff and Ezz [19].

5. CONCLUSION

From the result of the above investigation, it is concluded that, the Hattikuni reservoir is relatively productive in nature during the study period. High

productivity of reservoir indicates their food chain and food web is in good condition and rich productivity of reservoir also favors better growth of zooplanktons and higher organisms in the reservoir.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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