J E E S
Journal of Ecology and Environmental Sciences
ISSN: 0976–9900 & E-ISSN: 0976–9919, Volume 2, Issue 1, 2011, pp-11-14
Available online at http://www.bioinfo.in/contents.php?id=41

PRIMARY PRODUCTIVITY IN INLAND RESERVOIRS, GULBARGA DISTRICT, KARNATAKA, SOUTH INDIA

KANEEZ FATIMA, RAJASHEKHAR M.[2], GAYATHRI[3], VIJAYKUMAR K.[2], RATANDEEP[2] AND MAHESH BABURRAO[2]
[1]Bi Bi Raza Degree College, Gulbarga, Karnataka,
[2]Department of Zoology, Gulbarga University, Gulbarga Karnataka, India
[3]Singania University Research Scholar, Department of Zoology Vijaynagara Degree College, Hospet
*Corresponding author. E-mail: m_rajshekhar@rediffmail.com

Received: March 03, 2011; Accepted: April 30, 2011

Abstract- Nutrient concentrations and their ratios are important factors influencing the primary productivity of a reservoir. Based on the study results of Bosga and Khaji Kotnoor reservoirs it was noticed that, in addition to their nutrient status and ratios and other chemical variables, physiographical factors such as geography, catchment land use, water basin morphology, bathymetry and changing water levels or flushing rates also influenced the productivity of these two reservoirs.
Keywords: Reservoir, Nutrient status, N: P ratio, GPP.

Introduction

Photosynthetic primary production by phytoplankton in aquatic ecosystems gives an indication of the utilization of the Photosynthetically Active Radiation (PAR). Although extensive studies of primary production have been conducted in Africa and temperate regions of the world, relatively few studies have been conducted in south and south-east Asia [16]. The shallow reservoir s are subject to rapid fluctuations in water level and surface area, such morphometric and hydrographical changes lead to a question as to whether photoautotrophic or detrital energy flux is more important in these reservoir ecosystems with respect to carrying capacity for fish production [13]. To answer this question, more estimates of primary production of tropical Asian reservoir s are needed.

The primary productivity of a water body is the manifestation of its biological production. It is an ultimate outcome of photosynthesis that forms the basis of ecosystem functioning since it makes the chemical energy and organic matter available to the entire biological community. The chlorophyll bearing organisms utilize solar energy and convert it into chemical energy in the form of carbohydrate molecules by taking carbon dioxide and water from the environment [8]. In comparison to work done on the productivity of stagnant waters very little information is available [3, 6, 7, 9, 10, 11, 12, 14]. Factors such as water level, meteorological factors like light intensity, photoperiod, rainfall, wind velocity, etc., and hydrological cycle (inflow and outflow) have great influence on the rate of primary production in lacustrine and flowing waters [5, 17].

Water from both reservoir s is used for domestic water supply, irrigation and industry. It is noteworthy that, although adequate concentrations of phosphorus (P) and nitrogen (N) are present in both reservoirs, Bosga exhibits significantly less primary productivity than observed for Khaji Kotnoor. Possible reasons for this difference in productivity were examined in this study, including nutrients (P, N) and non-chemical factors.

Materials and methods

The locations of the sampling sites for the two reservoir s are illustrated in Figures 2 and 3. During the January 2009 to December 2010 water samples were collected from 08 sites in Khaji Kotnoor reservoir and 08 sites in Bosga reservoir. Physicochemical analyses included nitrate and phosphate based on Standard Methods APHA [1]. Gross primary productivity (GPP) was measured with light-and-dark bottle method [4].

RESULTS AND DISCUSSION

The physico-chemical variables, transparency, pH, electrical conductivity, concentration of soluble nutrients and other anions and cations influence the productivity of waterbodies [8]. Algal production also is correlated with in-lake levels and ratios of nitrogen (N) and phosphorus (P) in the water column. A low ratio of nitrogen to phosphorus concentration often indicates

eutrophic lakes, while a higher ratio often indicates possible mesotrophic or oligotrophic conditions [15]

The annual average nitrogen content in Bosga reservoir decreased slightly in second year compare to the first year. The low concentration was recorded in the Northeast Monsoon Season of the both the years. The average phosphate concentration was also decreased in second year. During the study period the low concentration of phosphate was recorded in the Summer season of both the years (0.13 and 0.11 mg L^{-1}) and peak values was noticed in the South West Monsoon season seasons of both the years (0.26 and 0.21 mg C L^{-1} day^{-1}). Although the N:P ratio in the SWM was high in both the years (1.36 and 1.06 mg L^{-1}) and the primary production was low in SWM (0.12 mg C L^{-1} and 0.11 mg C L^{-1} day^{-1}) respectively. During the southwest monsoon season the N:P was increased. This may be due to the inflow of nutrients from surroundings along with runoff water. Some correlation was observed between the phosphorus concentration and GPP in Bosga reservoir . The mean values of GPP was 0.21 mg C L^{-1} day^{-1} (Summer), 0.12 mg C L^{-1} day^{-1} (SEM) and 0.28 mg C L^{-1} day^{-1} (NWM), while second year the GPP values were 0.21 mg L^{-1} (summer), 0.11 mg C L^{-1} day^{-1} (SWM) and 0.18 mg C L^{-1} day^{-1} (NEM) respectively. (Table 2). This observations indicate that N:P ratio is limited in this reservoir and productivity also low.

The seasonal average nitrogen concentration in Khaji Kotnoor reservoir ranged between 0.1 mg L^{-1} to 2.1 mg L^{-1} during year of 2009 and 0.1 mg L^{-1} to 1.9 mg L^{-1} during the year of 2010, while high concentration was recorded in southwest monsoon seasons (SWM) both the years. (Table 1). The seasonal average phosphate concentration in the reservoir ranged between 0.01mg L^{-1} to 0.41 mg L^{-1} in 2009 and 0.01 to 0.62 mg L^{-1} of both the years, while high concentration was noticed in SWM of 2009 and 2010 respectively. These data suggest that higher phosphate concentration in this reservoir influenced its productivity. During the monsoon season (SWM) organic substances are generally washed into this reservoir. Because of its greater abundance in waste and its greater transport of the nitrogen load to the reservoir s is generally larger than the phosphorus load.

During the SWM, the N: P ratio increased and this may be due to enrichment with nitrogen, and the average GPP was almost halved. Thus, despite the low nitrogen concentrations, the GPP was higher in Khaji Kotnoor reservoir; the limiting function of phosphorus was somewhat evident.

According to may investigators, an in lake phosphate concentration of about 0.01 mg L^{-1} generally will support phytoplankton growths, while concentrations between 0.03 and 0.1 mg L^{-1} or higher are likely to trigger blooms. The direct relationship between nutrient concentrations, ratios and GPP, however, is not observed in this reservoir.

Bosga reservoir , falls under Krishna basin, Bheema will be sub-basin and the main feeder to the Khaji Kotnoor reservoir is Muchukulla Nala (Kagina tribute), experiences good precipitation patterns. Water inflows to the reservoir during the monsoon season are high. The water level in Bosga reservoir varies from +2 to +3 m during the monsoon season; a change of +2 m in the water level was observed almost every month. Furthermore, the full reservoir level is achieved and maintained by releasing any further water inflows via monsoon freshets from the catchment area. Because of downstream water demands during other seasons, the water releases from Bosga reservoir can cause level fluctuations of up to –4 m over a month. Such frequent and intense fluctuations are not supporting the growths of phytoplankton, hydrophytes and periphyton, such conditions being more characteristic of lentic ecosystems. As a result, the reservoir GPP is low. In contrast to Khaji Kotnoor reservoir is located on a plateau in the downstream side of Bheema basin, with the average annual precipitation usually being <600 mm. The monthly change in the water level of Khaji Kotnoor reservoir rarely exceeds 2 m, and only during the monsoon season. During the rest of the year, the monthly water level change does not usually exceed 1 m. Because of this behaviour, the reservoir is a lacustrine ecosystem for most of the year. Khaji Kotnoor reservoir supports a high level primary productivity, as well as substantial growths of hydrophytes, periphyton, mollusks and fish.

The nitrogen and phosphorus loads to Bosga reservoir originate mostly from soil erosion and animal wastes. Surrounding areas follow traditional agricultural activities in the catchment, which is devoid of major fertilizer use. Thus, the irrigation return flows from this catchment do not typically carry high amount of nutrients or potassium loads. The few sparsely populated small villages in the surrounding areas also do not have a significant influence on the water quality of Bosga reservoir. Soil erosion is known to add potentially large quantities of suspended phosphate to streams [5]. Moreover, leaching of phosphate phosphorus occurs more readily in the neutral to slightly acidic soils in the Bosga reservoir basin . The pH of Bosga reservoir water seldom exceeded the range of 7.0–7.7 throughout the year. The Bosga reservoir catchment is comprised of lateritic and humic soils deficient in nitrogen, phosphorus and calcium [2, 13]. Thus, the reservoir showed a low electrical conductivity (60–110 µS) and total alkalinity (16–52 mg L^{-1}), and low GPP. In contrast, Khaji Kotnoor reservoir is subjected to human activity and organic matter from farm and agricultural run-off, drainage systems in surrounding locations, industral wastewater, etc. The immediate land use around the reservoir includes extensive paddy and sugarcane cultivation involving fertilizer application. There are small-scale industries located close to the reservoir, with the discharges from such areas promote the luxuriant growths of hydrophytes in some parts of

Khaji Kotnoor reservoir. Biologically available phosphorus is added to the reservoir in surface drainage from land used for agricultural and domestic purposes. Khaji Kotnoor reservoir water has carbonate alkalinity, and comparatively more calcium concentration (35–46 mg L^{-1}). Such conditions can lead to formation of calcium carbonate and co-precipitation of phosphates. The land around Khaji Kotnoor reservoir is used mainly for agriculture, with an extensive use of commercial fertilizers, thereby increasing the possibility of nitrogen enrichment in terrestrial water run-off into the reservoir. Ammonium ions are strongly retained on clays, while nitrate is more mobile in soil water. Despite nitrate enrichment, however, the nitrogen concentration was also high in Khaji Kotnoor reservoir than in Bosga Reservoir during the monsoon season,

Nitrogen is an essential nutrient for all types of phytoplankton and hydrophytes. The photosynthetic process constantly utilizes nitrate, converting it to organic nitrogen in plant cells. By stimulating phytoplankton growth, nitrate indirectly facilitates increased fish production; all these manifestations of favorable conditions were observed for the Khaji Kotnoor reservoir ecosystem. Thus, the topography, precipitation and surrounding land use collectively influence phytoplankton and hydrophyte growth in this reservoir.

Based on the water capacity and area, the mean depth for Khaji Kotnoor and Bosga Reservoir s is 7.25 m and 10.25 m, respectively. Khaji Kotnoor reservoir is situated on the plains, wide and flat bathymetry. Thus, more than 50% of its gross water storage appears as dead storage, being available to dilute any nitrogen and phosphorus influxes. Furthermore, the good precipitation during this studies period and could be partly responsible for high nutrients concentrations in the surface water. In contrast, Bosga reservoir is received low precipitation. Furthermore, the reservoir has a roughly S-shaped cross-section, with such a bathymetry also responsible for its clear water. Because photosynthetic activity in a water body depends on the availability of sunlight energy penetrating into the water column, water clarity is an important environmental factor influencing the productivity of natural waters.

The water transparency of Bosga reservoir during the monsoon season, measured as Secchi depth, ranged between 0.1.5 and 2.0 m. During the northeast monsoon season, it ranged between 2.2 and 3.5 m. In comparison, the Secchi depth for Khaji Kotnoor reservoir only ranged between 0.9 and 3.1 m over all seasons. Despite having a larger Secchi depth, however, Bosga reservoir does not support much fish growth, mainly because of its poor primary productivity. In contrast, Khaji Kotnoor reservoir showed a higher fish production. Bosga reservoir has almost 72% of its gross capacity as live water storage. Thus, an almost complete renewal of water can take place on an annual basis, while, Khaji Kotnoor reservoir has only 39% of its gross capacity as live water storage, thereby facilitating the longer retention of nutrients, algae and hydrophytes. The renewal of water also is less frequent and might favor overall productivity in this reservoir

References

[1] APHA (1998) *Standard Methods for the Examination of Water and Wastewater. American Public Health Association, Washington, DC*.

[2] Anand V. K. (1982) *J. of Inland Fish. Soci. Ind.* 14: 1-5.

[3] Gaarder T. and Gran H. H. (1927) *Proc. Verb. Cons. Int. Explor. Mer*. 42, 1–48.

[4] Gupta B. P. (1982) *J. of Inland Fish. Soci. Ind* 34 : 49-54.

[5] Jhingran A. G. and Pathak V. (1988) *J. of Inland Fish. Soci. Ind* 20: 43- 53.

[6] Kar G.K., Mishra P.C., Dash M.C. and Das R.C. (1987) *Indian J. Envir. Hth* 29 : 322-329.

[7] Mishra S. R. and Saksena D. N. (1992) *J. of Inland Fish. Soci. Ind*, 24 (1): 61-68.

[8] Patra A. K. (1985) *Proc. of Nat. Acad. of Sci. India*. (B) IV : 290-295.

[9] Rajyalashmi T. and Premswarup T.V. (1975) *Ind. J. Fish* 22 : 205-214.

[10] Ramarao S. V., Singh V.P. and Mall L.P. (1979) *Water Research*, 13 : 1017-1021.

[11] Saha L. C., Chowdhury S.K. and Singh N.K. (1985) *Geobios*. 12 : 63-65.

[12] Schiemer F., Amarasinghe U.S., Frouzova J., Sricharoendham B. & Silva E. I. L. (2001) *Ecosystem structure and dynamics – A management basis for Asian reservoirs and lakes. In De Silva, S. S. (ed.), Reservoir and Culture-Based Fisheries: Biology and Management. Australian Centre for international Agricultural Research. Canberra: 215–226.*

[13] Shukla S. C., Kant R. and Tripath B. D. (1989) *Geobios*.16: 20-27.

[14] Smith V.H. (1983) 221, 669–71.

[15] Talling J. F. and Lemoalle J. (1998) *Ecological dynamics of tropical inland waters. Chapter 3.1. In Resource Utilization and Biological Production – Primary Utilization: Energy: 82–117. Cambridge University Press, Cambridge*, U.K.: 441.

[16] Verma P. K. and Datta Munshi J.(1989) *Proc. of Nat. Acad. of Sci. India* 59(3): 87-91.

Table1- Seasonal variations of nitrogen (N) and Phosphosrus (P) concentrations, N:P ratio and GPP in Khaji Kotnoor reservoir and Bosga reservoir.

Seasons	N(mgL^{-1})		P(mgL^{1})		N:P		GPP mg C L^{-1} day^{-1})	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Khaji Kotnoor reservoir								
2009								
Summer	0.1-0.2	0.1	0.01-0.3	0.01	2.1-3.4	2.7	0.35-0.43	0.40
SWM	0.9-3.8	2.1	0.5.8	0.8	1.5-4.0	3.5	0.22-0.31	0.26
NEM	0.4-0.9	0.6	0.2-0.6	0.3	0.8-2.5	1.9	0.24-0.29	0.21
2010								
Summer	0.1-0.2	0.1	0.01-0.2	0.01	2.3-2.9	2.1	0.38-0.45	0.32
SWM	1.1-2.9	1.9	0.8^{-1}.6	0.9	0.4-.4.2	3.5	0.12-0.18	0.14
NEM	0.2-0.4	0.2	0.2-0.4	0.2	0.3^{-1}.5	0.9	0.18-0.22	0.16
Bosga reservoir								
2009								
Summer	0.1-0.3	0.1	0.20-0.30	0.26	0.4-0.50	0.38	0.07-0.18	0.28
SWM	0.3-0.8	0.3	0.04-0.32	0.14	0.94-2.03	1.36	0.11-0.21	0.12
NEM	0.2-0.9	0.4	0.03-0.28	0.12	0.28^{-1}.21	0.95	0.14-0.27	0.21
2010								
Summer	0.1-.02	0.1	0.16-0.21	0.18	0.2-0.41	0.26	0.05-0.11	0.21
SWM	0.3-0.6	0.4	0.03-0.39	0.12	0.81^{-}1.25	1.06	0.09-0.19	0.11
NEM	0.1-0.4	0.2	0.02-0.28	0.11	0.18-0.64	0.52	0.17-0.21	0.18

NEM= Northeast monsoon season, SWM= Southeast monsoon season

Table 2- Physical characteristics of Khaji Kotnoor reservoir and Bosga reservoir

Charecterstic	Kaji Kotnoor reservoir	Bosga reservoir
Meteorology	High precipitation (<800)	Low precipitation (<300)
Surrounding land use	Agricultural and urban activates, industry	Traditional agricultural and less anthropogenic activity
Morphology bathymetry	Plains	Hill area
Shape	Linear	Slightly curved
Total catchment area	265.70 sq.Km	210.70 sq.Km
Storage capacity	5.1784 m^3	4.2812 m^3
Gross water	6.2180 m^3	5.8590 m^3
Depth	9 meters	10.25 meters