



Phytoplankton, Primary Productivity and Certain Physico-Chemical Parameters of Goverdhan Sagar Lake of Udaipur, Rajasthan

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Abstract:

The current research work was conducted to find out the fish production potential of Goverdhan Sagar, a medium class water body of Udaipur in southern Rajasthan. Goverdhan Sagar is a shallow lake with a maximum depth of 7.62 meters and a shoreline of 3888.8 meters with relatively fringed margins and an area of 30.81 ha. Attempt has been made to assess the current water quality status of Goverdhan Sagar and to establish its relation with phytoplankton and primary productivity to suggest proper management practice for getting the optimum fish production. Physico-chemical parameters of Goverdhan Sagar were found to be congenial for productivity throughout the study period. The average water quality parameters of the lake during the study period were: air temperature-30.75 °C, water temperature-28.57°C, depth of visibility-96.23 cm., pH-7.18, EC-381.8 $\mu\text{S cm}^{-1}$, dissolved oxygen-5.56 mg l^{-1} , free CO_2 -6.56 mg l^{-1} , carbonates-35.41 mg l^{-1} , bicarbonates-137.44 mg l^{-1} , total alkalinity-185.73 mg l^{-1} , orthophosphates-0.13 mg l^{-1} , nitrate-nitrogen-0.46 mg l^{-1} , GPP-0.42 $\text{g C m}^3 \text{h}^{-1}$, NPP-0.26 $\text{g C m}^3 \text{h}^{-1}$, CR-0.17 $\text{g C m}^3 \text{h}^{-1}$. The Average phytoplankton count in Goverdhan Sagar was 36.71 Nos/ml distributed in 29 genera showed the order of dominance – Chlorophyceae > Bacillariophyceae > Cyanophyceae > Desmidiaceae. For effective channelization of the energy stocking of suitable fish species is also suggested.

Keywords: Fish production, Phytoplankton, Primary productivity and Water quality.

1.0 Introduction:

The growing number of man-made reservoirs and impoundments for various purposes warrant an early investigation of their water quality for aquaculture and domestic uses. The physico-chemical features greatly influence the primary productivity and in turn the growth of the fish in an aquatic environment. The primary productivity of different water bodies has been widely investigated to assess the fish production potentialities of a water body and to formulate fishery management policies. In general, the growth of a fish is influenced by the quality and quantity of food material available and consumed. Studies of plankton and productivity of Udaipur waters in comparison to the selected waters of Rajasthan have been carried out by Sharma (1980). Ayyappan and Gupta (1980) studied the primary productivity of Ramasamudra Tank situated in Karnataka. Sharma and Durve (1990) studied water clarity in relation to the

phytoplankton of 26 waters of Rajasthan state including Udaipur waters.

Studies on limnological aspects have been conducted on Daya reservoir (Gupta, 1991 and Rajkumar, 2007). Balai (2007) studied fish and planktonic biodiversity of Jaisamand reservoir of Udaipur (Rajasthan). Chouhan and Sharma (2007) reported pollution status of a perennial lake the Buddha Pushkar of Ajmer, Rajasthan in relation of its physico-chemical and biological status. Nandan and Magar, (2007) studied 16 physico-chemical parameters of the Girma dam of Nashik district from Maharashtra. Paulose and Maheshwari (2007) conducted a comparative study of Jalmahal and Ramgarh lake of Jaipur with special reference to plankton diversity and suggested a correlation of high nitrate content with phytoplankton and organic decomposition. Looking to the diverse limnological studies, there is an urgent need for location specific

study of aquatic ecology of selected waters and on the basis there is a need to develop a proposal of its scientific fisheries management. This study is aimed to assessment the diversity profile and dominance of main primary producers viz. phytoplankton in Goverdhan Sagar lake in relation to its water quality and primary productivity. Attempt has also been made to suggest appropriate stocking of the lake. Patil *et al.* (2012) studied the physico-chemical properties of Shivaji University lakes of Kolhapur city and its impact on phytoplankton population. Tiwari *et al.* (2012) studied the physico-chemical parameters in order to find their relation to seasonal fluctuation of phytoplanktonic populations in Devi tank 24°3'N latitude and 81°23'E longitude of Vyauhari, Shahdol district of Madhya Pradesh.

2.0 Materials and Methods:

The present study was carried out during January 2012 to June 2012. This zone experiences a subtropical climate with average rainfall ranging from 67 cm. and relative humidity of 75-95 per cent

during the monsoon period. The summers are hot (38-41°C) and winters are cool (1-5°C) in Udaipur, the southern province of Rajasthan state.

2.1 Study Area:

Goverdhan Sagar lies on the Udaipur-Ahmedabad highway, at about 2.5 km distance from Udaipur city (24°32'N latitude and 73°41'E longitude). The morphometric features of Goverdhan Sagar are given in Table 1 and the location map with Google satellite imagery in Figure 1. The lake is totally rain-fed and retains water throughout the year. However, it dries during certain drought years, leaving thin layer of water at its bottom for one or two months. When the northerly located Pichhola lake is over-flooded during the above normal rainfall year by Kotra river, it feeds water to the Goverdhan Sagar. The outlet of Goverdhan Sagar lies towards the south of the tank and its water join Ahar river through a tributary. The deeper position of the lake lies towards north east bank which has steep slope, while towards south and western sides, the slope is gradual.

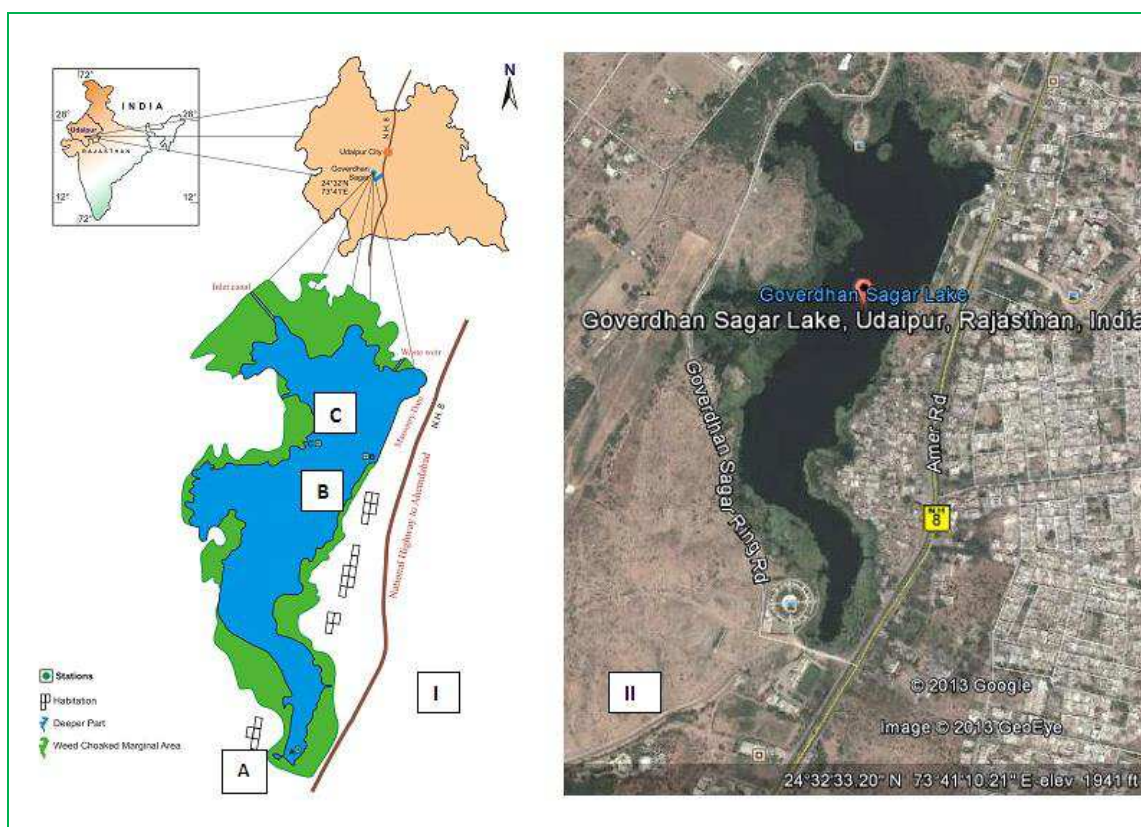


Figure 1. Location map (I) with stations - A,B,C and satellite imagery (II) of Goverdhan Sagar Lake, Udaipur (Rajasthan)

2.2 Sampling Stations:

For the proposed study, three sampling stations were fixed in Goverdhan Sagar for collection of surface water samples and phytoplankton (Figure 1). Station A was located on the south eastern shore and station B near the dam on eastern shore. Sampling station C was located at the western end of the lake.

2.3 Collection of Samples and Analysis:

During the study period, surface water samples from all the three selected sampling stations were collected every week using a plastic bucket. Water quality parameters such as temperature of water and air around lake, depth of visibility, pH, alkalinity (carbonates, bicarbonates and total alkalinity), dissolved oxygen, free carbon di-oxide, electrical conductivity (EC) were determined in the field itself. While for the analysis of nitrate-nitrogen and orthophosphates the samples were brought to the laboratory in plastic bottles of one liter capacity and analyzed as soon as possible. The water quality, primary productivity (Gross primary productivity-GPP, Net primary productivity-NPP and Community respiration-CR) and phytoplankton of Goverdhan Sagar were analyzed using standard methods (Trivedy *et al.*, 1987 and APHA, 1989). The phytoplankton samples were collected by filtering 50 liters of surface water through bolting silk No. 25 (mesh size 64 μm) and plankton thus obtained were preserved in 4% neutral formalin for further quantitative and qualitative analysis following the standard methods of Edmondson (1965) and Adoni (1985).

3.0 Results and Discussion:

The results indicate that the Physico-chemical parameters of Goverdhan Sagar (Table 2) were found to be moderate throughout the study period. The water clarity of Goverdhan Sagar was within the range of 86.0 to 105.0 cm. during the study period. Sharma and Durve (1990) classified lakes on the basis of water clarity and found moderately eutrophic nature of lake Jaisamand with average water clarity values between 88.75 to 101.33 cm. In present investigation the observed values of water clarity might be mainly influenced by the suspended particulate matter, plankton and variations in water level. The recorded depth of visibility points out relatively moderate levels of nutrients in Goverdhan Sagar and thus can be acclaimed in the category "Moderately eutrophic". However, Jain (1978) observed water clarity of 35 to 107 cm. in

Goverdhan Sagar during the period from September to August and also reported that this lake has fairly moderate productivity. Plankton in inland water bodies holds a key position in the metabolism of water bodies, trophic levels, food chains and energy flow. As producers and consumers they play an important role in the transformation of energy from one trophic level to the higher trophic levels, ultimately leading to fish production. During the present investigation average phytoplankton count in Goverdhan Sagar (36.71 Nos/ml) was represented by 29 genera (Figure 2). The order of dominance was – Chlorophyceae > Bacillariophyceae > Cyanophyceae > Desmidiaceae.

Rao and Durve (1987) have reported 52 genera in Jaisamand lake out of which 25 belong to Chlorophyceae, 12 from Bacillariophyceae, 2 from Euglenophyceae, 01 from Xanthophyceae and 12 from Myxophyceae. Jain (1978) reported 35 genera of phytoplankton in Goverdhan Sagar thus, indicating slight decrease in diversity of phytoplankton during the present study. The correlation between water quality and other parameters indicated greater production of phytoplankton at higher temperature ($r = 0.526$), Nitrate N ($r = 0.086$), Orthophosphates ($r = 0.100$) coinciding with lower solubility of gases DO ($r = -0.968$), low EC ($r = -0.901$), low visibility ($r = -0.294$), pH ($r = -0.537$), bicarbonates ($r = -0.174$) and total alkalinity ($r = -0.115$). Paulose and Maheshwari (2007) concluded with a correlation of high nitrate content with phytoplankton and organic decomposition in a comparative study of Jalmahal and Ramgarh lake of Jaipur with special reference to their plankton diversity. The relationship between phytoplankton and productivity indicated a negative correlation with NPP ($r = -0.291$) and positive with GPP ($r = 0.189$) and CR ($r = 0.985$) in Goverdhan Sagar. Willen (1990) and, Yusuff and Patimah (1994) considered eutrophic lakes on the basis of blue-green algae. From this point of view, on the basis of observed planktonic densities, Goverdhan Sagar cannot be assigned a eutrophic status.

The higher primary productivity found in the present study may be assigned to high concentration of nutrients, higher temperature and higher photosynthesis during the pre-summer and summer months. Rajkumar (2005) also reported higher average GPP ($0.45 \text{ g C m}^{-3} \text{ h}^{-1}$) in Daya reservoir. However, Gupta (1991) found only $0.19 \text{ g C m}^{-3} \text{ h}^{-1}$ GPP in the Daya reservoir. The increase in GPP was

acclaimed for adequate influx of water. Sultan *et al.* (2003) investigated a small reservoir, Pahunj located at Jhansi in Uttar Pradesh for its physico-chemical features and productivity status and concluded that higher primary productivity indicated congenial environment for biological production. From the results of water quality parameters and observations on phytoplankton it is appropriate to place this water body somewhere between “mild eutrophic-to-eutrophic”. For effective channelization of the energy trapped in the form of primary producers (macrophytes and phytoplankton) stocking of suitable fish species is also suggested.

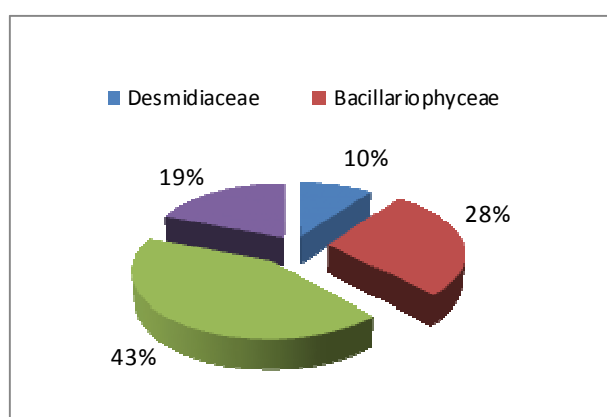


Figure. 2 Phytoplankton diversity of Goverdhan Sagar, Udaipur (Rajasthan)

Table 1: Morphometric features of Goverdhan Sagar, Udaipur (Raj.)

Location:	
Latitude	24°32'N
Longitude	73°41'E
Altitude	582 m (MSL)
Average rainfall	670 mm
Water spread area	Over 17.97 ha.
Weed choked marginal area	Over 12.83 ha.
Total area	30.81 ha.
Catchment area	2.56 sq.km.
Maximum depth (Zm)	25 ft.
Maximum length (L)	1.97 km
Maximum width (bx)	0.72 km
Length of shoreline (L)	3888.8 m
Capacity of F.T.L.	9 million cubic meter
Type of dam	Masonry
District	Udaipur
Accesses	2.5 km away from Udaipur.

Table 2: Water quality and primary productivity of Goverdhan Sagar, Udaipur (Raj.)

Parameters	Min. – Max.	Avg.	S.D.
Air temperature °C	28.86 - 32.80	30.75	1.25
Water temperature °C	27.50 - 30.70	28.57	1.26
Transparency (cm)	90.00 - 100.33	96.23	3.21
pH	7.00 - 7.30	7.18	0.09
EC(μS cm ⁻¹)	366.67 - 396.67	381.87	11.80
Dissolved oxygen (mg l ⁻¹)	4.90 - 6.10	5.56	0.49
Free CO ₂ (mg l ⁻¹)	0.0 - 24.00	19.68	11.13
Carbonate (mg l ⁻¹)	26.66 - 45.50	35.41	6.37
Bicarbonates (mg l ⁻¹)	92.00 - 153.00	137.44	19.45
Total alkalinity (mg l ⁻¹)	177.00 - 202.00	185.73	9.18
Orthophosphates (mg l ⁻¹)	0.05 - 0.27	0.13	0.07
Nitrate-nitrogen (mg l ⁻¹)	0.41 - 0.58	0.46	0.06
Primary productivity (g C m⁻³ h⁻¹)			
Gross primary productivity	0.38 - 0.45	0.42	0.03
Net primary productivity	0.22 - 0.30	0.26	0.03
Community respiration	0.15 - 0.20	0.17	0.02

The potential fish production on the basis of GPP (0.42 g C m³ h⁻¹) is 289.29 kg/ha/yr or 8913 kg/yr following conversion factor of (Odum, 1971). However, the Odum's conversion does not take into account the macrophyte production which is a dominant factor in Goverdhan Sagar. Ayyappan *et al.* (2006) suggested productivity of such medium class waters to the tune of 3-35 kg/ha/yr without management and it can be raised to 70-275 kg/ha/yr with scientific management. The present fish production of the lake as reported by the contractor was only 6500 kg/yr *i.e.* 211 kg/ha/yr. Thus, stocking of phytophagous fish namely grass carp (*Ctenopharyngodon idella*) @ 125 fingerlings/ha and bottom feeder such as mrigal (*Cirrhinus mrigala*) can be a good choice to take care of available food resources in the lake. This fish can be stocked @ 500 fingerlings/ha. Surface feeder catla (*Catla catla*) can be stocked only in a few numbers *i.e.* 50 fingerlings/ha., and the total number required would be 1540 advanced fingerlings. Browser fishes, such as rohu (*Labeo rohita*) can be stocked @ 300 fingerlings/ha. Considering all above the total

number of fish suggested to be stocked are 30339 @ 985 advanced fingerlings/ha. However, the performance of stocked fish as per schedule stated above should be assessed periodically for further improvement in the stocking ratio and density. As such, with assumed weight of 1 kg and 20 percent losses after one year, almost a fourfold increased fish production of 24032 kg/yr., can be achieved through scientific management of the lake.

4.0 Conclusions:

Physico-chemical parameters of Goverdhan Sagar were found to be congenial for productivity throughout the study period.

- The gross and net primary productivity was 0.42 and 0.26 g C m³ h⁻¹ respectively.
- The Average phytoplankton count in Goverdhan Sagar was 36.71 No's/ml distributed in 29 genera and
- It showed an order of dominance – Chlorophyceae > Bacillariophyceae > Cyanophyceae > Desmidiaceae. On the basis of water quality and productivity the water body was placed somewhere between “mild eutrophic-to-eutrophic”.
- By effective channelization of the energy and stocking of suitable fish species almost a fourfold increased fish production of 24032 kg/yr., can be achieved.

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