



## Impact of Physico-Chemical Characteristics of Shivaji University lakes on Phytoplankton Communities, Kolhapur, India

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### Abstract

The study deals with physico-chemical properties of Shivaji University lakes of Kolhapur city and its impact on phytoplankton population. Several limnological parameters were evaluated during the period from September, 2010 to February, 2011 from seven sampling stations sited along lakes of Shivaji university campus viz. Music Department Lake, Bhshabhavan Lake, Rajaram Lake. The physical parameters included were temperature, turbidity and chemical parameters included were pH, temperature, alkalinity, dissolved oxygen, total hardness and nitrate, phosphate and sulphate. A total 19 species were observed during the study period, maximum number of sp observed were in the Rajaram lake i.e. 13 sp. There were 9 species observed from the class Chlorophyceae, 4 species of the class Cynophyceae, 3 of the class Bacillariophyceae, 3 of the class Euglenophyceae. The *Microcystis* species was observed in Rajaram lake indicates the signs of eutrophication of lake, while species like *Desmidium*, observed from Music Department and Bhshabhavan lake were the indicator of better water quality. The physico-chemical parameters such as nitrates, phosphate, temperature and alkalinity are favorable for the growth of phytoplankton. Maximum species of the class chlorophyceae were observed during study period.

**Keywords:** Eutrophication, physico-chemical, biological properties, lakes, phytoplankton.

### Introduction

Water is one of the important sources to sustain life and has long been suspected of being the source of much human illness. Source of surface water and ground water have become increasingly contaminated due to increased industrial and agricultural activity. Water is known to contain large number of chemical elements<sup>1</sup>, the interaction of both physical and chemical properties of water play a significant role in composition, distribution and abundance of aquatic community. Characteristics of water bodies influence the quality of water individually and in combination with various pollutants, thereby, influencing the biota therein<sup>2</sup>.

The Physico-chemical study could help in understanding the structure and function of particular water body in relation to its habitants. The proper balance of physical, chemical and biological properties of water in ponds, lakes and reservoirs is essential for limnological study. Abundance of particular element might suggest the type of organism that may be found as well as indication of ecologically unstable or unfavorable ecosystem which can have negative or positive impact on the population i.e. high concentration of nitrate or phosphate is indicative of eutrophication. Physical properties such as temperature, light penetration, water movement play important role in plankton's distribution and lake stratification. The physical and chemical limnology of lake is characterized by hydrological impact, autogenic nutrient dynamics and biological aspects. These factors combine with each other to determine the water quality and consequently

community of the lake<sup>2,3</sup>. The physicochemical characteristic of lake can be significantly altered by human activities such as various agricultural practices and irrigation as well as natural dynamics which consequently affect the water quality and quantity, species distribution and diversity, production capacity and even disruption in the balance of ecological system operating in the lake.

Inland lakes exhibit a special prominence among our global freshwater resources. Containing more than 90% of all the liquid freshwater on the surface of our planet. They support a range of human activities, including agriculture, commerce, transportation, recreation, tourism, food and energy production. They also provide important habitat for a diverse array of organisms. It is because of their fundamental importance that we must enhance control of lake pollution and rehabilitate lakes overloaded with pollutants, so as to restore their ecosystem.

Kolhapur city is a prominent city of South Western Maharashtra, is rapidly emerging as a leading industrial and commercial centre. The development of city created directly or indirectly a number of water quality problems. The city once supposed to have 40 small and large lakes is presently left with only few<sup>3</sup>. Lakes in the Shivaji University campus are the sole source of water of gardening, laboratory use for various departments and hostels from the campus and these lakes has potential to sustain variety of biota. As the water from these lakes is used for drinking purpose there is need to study the physico-chemical and biological parameters. This

study also has significance because one of the lake from these i.e. Rajaram lake is used for irrigation, domestic purpose by neighboring population. Increasing settlement near Rajaram Lake, idol immersion, washing of clothes, animals, vehicles is creating threat of pollution to Rajaram Lake.

## Material and Methods

**Study Area: Shivaji University campus, Kolhapur:** Shivaji University is situated between the latitude (16°40'31.81'') and longitude (74°15'12.10''). The University is tapping rain water that gets gathered on the terraces of buildings in the campus. The water tanks conserve water to the capacity of 1, 86,000 cubic feet. The University's program of rain water harvesting includes building of Nala construction, canal contours and resuscitating of water springs in the different wells. The daily water need of the University is 5.5 lakh liters and the University used to purchase water from the Municipal Corporation also. Now, due to rain water harvesting program the campus is completely self-sufficient in the supply of water. The university is also constructing a water purification plant of one MLD capacity on the campus in order to provide clean and pure drinking water. The University campus has three lakes as Music Department Lake, Bhashabhavan Department Lake and Rajaram Lake. The present study is associated with physicochemical and biological parameters of lake water evaluated from three lakes of Shivaji University Campus, Kolhapur as,

| Site                         | latitude      | longitude     |
|------------------------------|---------------|---------------|
| Music Department lake        | 16°40'59.44'' | 74°15'13.98'' |
| Bhashabhavan Department lake | 16°40'25.75'' | 74°15'13.70'' |
| Rajaram lake                 | 16°40'48.25'' | 74°15'49.90'' |

**Music Department Lake:** This lake is situated at latitude 16°40'59.44"N and longitude 74°15'13.98"E in depression of north side of campus. The lake has catchment area of about 0.244sq. Km. It has maximum flood flow up to 6.51m<sup>3</sup>/sec, total storage capacity of about 99.50 million cubic feet and total stored water 1.86 million cubic feet. The length of embracement of dam is 175 m and height 6.55 m. This water is mainly used for ladies hostel use and staff quarters for bathrooms and toilets.

**Bhashabhavan Department Lake:** The lake is flowing from south to north and situated on the West of Language Department building at latitude 16°40'25.75"N and longitude 74°15'13.70"E. The lake has catchment area of about 0.45 sq. km with average rainfall of about 984 mm., 11.76 m<sup>3</sup>/sec, total storage capacity of tank is about 104.50 m<sup>3</sup> and total water stored of about 8.52 million cubic feet. The length of embankments of dam is about 330m and height is about 11.16 m. This water is mainly used for drinking purpose after pumping into Sutar well from the University campus.

**Rajaram Lake:** This lake was constructed in the year 1928 in memories of Shri Rajaram Chhatrapati Maharaja of Kolhapur. This situated at latitude 16°40'48.25"N and longitude 74°15'49.90"E, and near the national highway no.4. The tank was design to store 38 million cubic feet of water. The length of Rajaram tank is 1250 m and covers about 5400 acre area somewhat fan shaped with rocky shore line and depth of about 30 m. The lake water is basically used for irrigation, activities like bathing, washing of animals and idol immersion even though it is prohibited.

Water samples were collected from these three lakes for Physico-chemical and biological analysis. Samples were taken once every month from September 2010 to February 2011. Water samples were collected in one liter plastic bottles and collection was usually completed during morning hours between 8:00 A.M. to 10:00 A.M. For each sampling event, pH, temperature, and dissolved oxygen were monitored at the sampling sites while total dissolved solids, total alkalinity, total hardness, chloride and BOD were analyzed by methods described in APHA<sup>4</sup> and Maiti<sup>5</sup>.

**Methodology:** For present study three lakes of Shivaji University Campus, Kolhapur was selected. Each sampling sites were visited seasonally for the period from September, 2010 to February, 2011. Water temperature and pH were measured insitu using a thermometer (accurate to nearest, pH- meter). Dissolved oxygen, total alkalinity, total hardness, sulphate, phosphate and nitrate were estimated following standard protocols of APHA<sup>4</sup>. For phytoplankton study and identification Limnology workbook by Adoni were followed.

**Table-1**  
Mean ± SD (range) of physico-chemical Characteristics of three lakes from University campus, Kolhapur

| Characteristic | Rajaram lake   |                |               | Bhashabhavan lake |                | Music department lake |                |
|----------------|----------------|----------------|---------------|-------------------|----------------|-----------------------|----------------|
|                | Site I         | Site II        | Site II       | Site I            | Site II        | Site I                | Site II        |
| Temperature    | 20 ± 5.97      | 20 ± 5.163     | 19.33 ± 5.088 | 20.166 ± 4.980    | 20.666 ± 4.570 | 19 ± 5.972            | 19.66 ± 5.821  |
| pH             | 7.846 ± 0.840  | 7.798 ± 0.595  | 7.586 ± 0.498 | 6.79 ± 0.490      | 7.071 ± 0.308  | 7.708 ± 0.607         | 7.571 ± 0.301  |
| DO             | 3.941 ± 0.624  | 3.941 ± 0.651  | 4.016 ± 0.504 | 4.116 ± 0.445     | 4.233 ± 0.422  | 3.933 ± 0.478         | 4.05 ± 0.434   |
| Alkalinity     | 136.5 ± 39.37  | 147.16 ± 48.36 | 127.5 ± 34.67 | 109 ± 30.97       | 123.66 ± 34.72 | 167 ± 54.46           | 195.83 ± 68.95 |
| Hardness       | 150.16 ± 32.12 | 156.6 ± 29.74  | 170.5 ± 52.75 | 156.6 ± 62.31     | 170.83 ± 46.53 | 185.83 ± 70.18        | 199.6 ± 80.86  |
| Nitrate        | 0.815 ± 0.020  | 0.84 ± 0.036   | 0.78 ± 0.101  | 0.737 ± 0.051     | 0.822 ± 0.109  | 0.967 ± 0.164         | 0.9 ± 0.284    |
| Phosphate      | 199.6 ± 80.86  | 1.628 ± 0.159  | 1.521 ± 0.193 | 1.436 ± 0.100     | 1.52 ± 0.235   | 1.833 ± 0.300         | 1.64 ± 0.518   |

**Table-2**  
**Analysis of phytoplankton's from three lakes of University campus, Kolhapur**

| Sr. no                   | Sites                    | Phytoplankton            | Class                    |                     |                          |
|--------------------------|--------------------------|--------------------------|--------------------------|---------------------|--------------------------|
| 1.                       | Rajaram lake             | <i>Volvox sp</i>         | <i>Chlorophyceae</i>     |                     |                          |
|                          |                          | <i>Spirogyra sp</i>      |                          |                     |                          |
|                          |                          | <i>Zygnema sp</i>        |                          |                     |                          |
|                          |                          | <i>Eudorina sp</i>       |                          |                     |                          |
|                          |                          | <i>Ankistrodesmus sp</i> |                          |                     |                          |
|                          |                          | <i>Coelastrum sp</i>     |                          |                     |                          |
|                          |                          | <i>Chlorella sp</i>      |                          |                     |                          |
|                          |                          | <i>Sperocystis</i>       |                          |                     |                          |
|                          |                          | <i>Mycrocystis sp</i>    |                          | <i>Cynophyceae</i>  |                          |
|                          |                          | <i>Synechocystis sp</i>  |                          |                     |                          |
|                          |                          | <i>Oscillatoria sp</i>   |                          |                     |                          |
|                          |                          | <i>Anabaena sp</i>       |                          |                     |                          |
|                          |                          |                          |                          | <i>Synedra sp</i>   | <i>Bacillariophyceae</i> |
|                          |                          | 2.                       | Music Department lake    | <i>Desmidium sp</i> | <i>Chlorophyceae</i>     |
| <i>Spirogyra sp</i>      |                          |                          |                          |                     |                          |
| <i>Ankistrodesmus sp</i> |                          |                          |                          |                     |                          |
| <i>Volvox sp</i>         |                          |                          |                          |                     |                          |
| <i>Coelastrum sp</i>     |                          |                          |                          |                     |                          |
| <i>Synedra sp</i>        | <i>Bacillariophyceae</i> |                          |                          |                     |                          |
| <i>Navicula sp</i>       |                          |                          |                          |                     |                          |
| <i>Cymbella sp</i>       |                          |                          |                          |                     |                          |
| 3.                       | Bhashabhavan lake        | <i>Navicula sp</i>       | <i>Bacillariophyceae</i> |                     |                          |
|                          |                          | <i>Cymbella sp</i>       |                          |                     |                          |
|                          |                          | <i>Synedra sp</i>        |                          |                     |                          |
|                          |                          | <i>Zygnema sp</i>        | <i>Chlorophyceae</i>     |                     |                          |
|                          |                          | <i>Sphaerocystis sp</i>  |                          |                     |                          |
|                          |                          | <i>Volvox sp</i>         |                          |                     |                          |
|                          |                          | <i>Euglena sp</i>        | <i>Euglenophyceae</i>    |                     |                          |
|                          |                          | <i>E.viridis sp</i>      |                          |                     |                          |
|                          |                          | <i>E.gelatinosa sp</i>   |                          |                     |                          |



Rajaram Lake



Music Department Lake



**Bhashabhavan Department Lake**

## Result and Discussion

The average water temperature of the lakes was ranging between 19°C to 20°C during study period. There was no significant change in average values of three lakes. The pH of lakes was found to be alkaline during the study period, ranging from 6 to 7 pH of all lakes was within the acceptance range of BIS i.e. 6.5-8.5.

D.O. is an important indicator of ability of a water body to support aquatic life. Low D. O. Concentration i.e. <3 mg/lit in fresh water aquatic system indicates higher pollution causing negative effects on aquatic ecosystem<sup>6</sup>. Maximum average of D. O. recorded from Music department lake during January 2011(4.8mg/l) indicates the better quality of water than Rajaram lake. It may be due to change in season and presence of more domestic sewage<sup>7</sup>. Average of D. O. of all sites are slightly beyond the limits of BIS (4 mg/lit) except month of September and November.

Alkalinity of lakes is ranging from 50 to 195 mg/lit which was within the limits of BIS (200 mg/lit). Maximum average alkalinity was higher at Music Department during rainy season (228 mg/l) than Rajaram lake and Bhashabhavan lake. The maximum fluctuation ( $\pm 54.46$  to  $\pm 68.95$ ) in the alkalinity was reported from Music Department Lake during December 2010 which was above the limit and it may be due to decrease in water level of the Lake. A lake water alkalinity may results due to waste discharge, microbial decomposition of organic matter in the water body<sup>7</sup>.

The hardness values observed were in the range of 60 to 276 mg/l. All the values are within the limit of BIS (300mg/lit). Hardness shows seasonal variation, being minimum in winter and maximum during summer season.

The concentration of Nitrates is indication of level of micronutrients in water bodies and has ability to support plant growth. High concentration of Nitrate favored growth of phytoplankton. The nitrate values observed during month of October to February was between the ranges of 0.7 to 0.9

mg/lit. There was no significant change in nitrate values of all the three lakes during study period. These values are favorable for growth of phytoplankton.

Phosphate content in a lake is may be due to release of phosphate from bottom sediment and organic load of the water, this helps in growth of the phytoplankton and weeds in the lake<sup>8</sup>. Phosphate values are near and more than 1mg / l during the month of September to February. Maximum values observed was 2.78 mg/l during study period from Music department hostel site on the month of January and Minimum 1.29 at Rajaram west during the month of September, which was slightly above the permissible limits of BIS (1.0 mg/l). Household detergents, domestic sewage leaching of phosphate fertilizer may be reason for phosphate levels increase.

Phytoplanktons were collected from the study sites during the period of study. A total of 19 species were recorded of which 9 species belong to the class Chlorophyceae, 4 species of the class *Cynophyceae*, 3 of the class Bacillariophyceae, and 3 of the class *Euglenophyceae*. Maximum species of the class *chlorophyceae* were observed during study period. Nineteen phytoplankton species were observed during study. Maximum no. of species was observed in Rajaram Lake (13 species). The *Microcystis* species was observed in Rajaram Lake indicates the signs of eutrophication of lake due to agricultural runoff, anthropogenic activities. Whereas species like *Desmidium* observed from Music Department and Bhashabhavan Lake were the indicators of better water quality. The Physico-chemical parameters such as nitrates, phosphate, temperature and alkalinity are favorable for the growth of phytoplankton.

## Conclusion

All the physico-chemical parameters favors growth of phytoplankton but in Rajaram Lake due to anthropogenic activities and agricultural runoff water quality gets deteriorated. Some species found during study like *Microcystis* indicates the signs of eutrophication. Other two lakes namely Music Department Lake and Bhashabhavan Lake were in good condition.

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