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A Critical Study of Physico-Chemical Characteristics of Lake Water Present in the Vicinity of Industrial Area

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Abstract
The fast paced industrial development of the central India region in general and that of Butibori Industrial Area in particular has made the environmental compartments vulnerable to pollution. In view of this, the present study was carried out to determine the physico-chemical nature of the water body situated near the Butibori Industrial Area. The data was generated by using the standard methodology. The results of the study indicated that there is significant difference in the parametric values vis-à-vis different seasons. Besides, the nutrient availability (P and N) in the lake water was also found to be of moderate nature. More specifically, the parameters appeared negatively affected during the monsoon season in view of the sustainability of the aquatic ecosystem. Apart from the physic-chemical nature of the lake water, the qualitative and quantitative assessment of the fish species in the lake showed that the average fish catch was between 1.7 and 2.2 tonne per day and the predominant fish species are *Labeo rohita* (Rohu) and *Catla Catla* (Catla). Overall, it appears that the lake water is moderately affected during the different seasons.

Keywords: Industrial development, pollution, water, nutrient availability, fish, *Labeo rohita* (Rohu) and *Catla Catla* (Catla).

Introduction

The unprecedented development in the field of various industrial activities has led to rapid economic growth. However, with it the problem of waste generation has also seen an ascendency. Though the waste can be categorized in many forms like, solid waste, liquid waste and the gaseous waste, all the three types of wastes pose a serious threat to the environment. Besides, the entry of these wastes, especially, the solid and liquid wastes in the lotic or lentic systems results in manifold increase in the problem of pollution. Amongst all the aquatic ecosystems, freshwater ecosystems have been very important for sustaining life on the earth. This is because, we rely on freshwater systems for multiple uses, which include but are not limited to drinking water, agriculture, transportation, energy production, industrial processes, waste disposal, fisheries, etc. In view of the above, the role of systematic investigations in the mitigation of pollution related problems has gained high importance.

Amongst different sources, the point and non-point sources of pollution, especially the industries in the industrial zones, are arguably the most significant sources for environmental studies that are related to pollution. In view of the threat of water pollution to the sustainable use of the water for longer period of time, this study has been carried out to know the water quality status of lake present in the vicinity of the industrial area. For this purpose, the lake system situated near the Butibori industrial area near Nagpur, Maharashtra has been selected. Furthermore, the advent of economic development is likely to put a significant pressure on the environmental compartments in this region as it (this region) is poised to grow exponentially in the near future, due to favourable Government policies. Moreover, this study can act as a reference for future studies to assess the deviation in water quality as a function of industrial activities. The study was carried out with following objectives

Research Objectives:

1. To study the physic-chemical characteristics of the lake situated near Butibori Industrial Area
2. To study the presence of toxins in the lake situated near Butibori Industrial Area
3. To study the fish productivity of the lake situated near Butibori Industrial Area
4. To study histopathology changes in the fish affected due to toxins

Methodology

In the present study, all the standard methods were used for the purpose of conducting experiments and data generation. The parameters were selected in line with the objectives set in this study and the description pertaining the different parameters is presented below

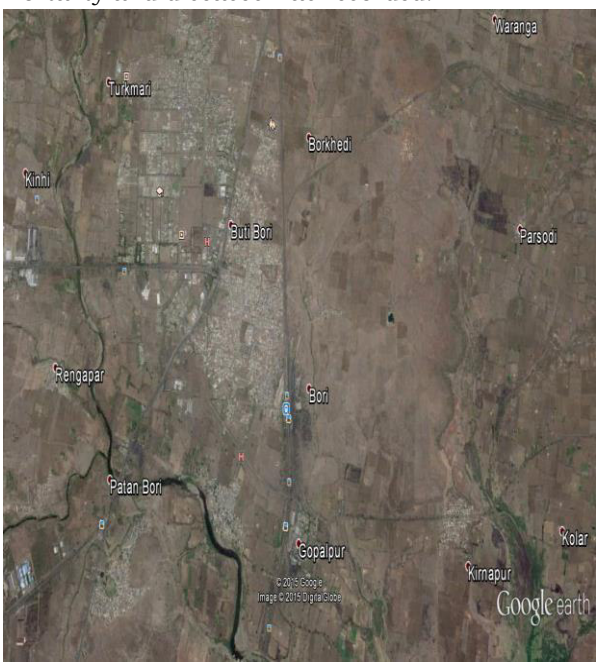
Material and Methods

Sampling

- The water samples were collected asceptically and were processed by following standard methods of water and wastewater analysis (APHA-AWWA).
- The fish productivity data was collected at the site.

Site Description

For this research work, survey of lake near Butibori region was done. Butibori region has largest number of industries in the central India. During survey water samples were collected and also the data pertaining to fish mortality and diseases was recorded.



Study area – Butibori

Physico-chemical Analysis of Water at Sample Site

A number of logical methods were used for the purpose of data collection.

- Temperature: The temperature of water measured with the help of standard centigrade thermometer in °C. Temperature of water recorded at the site.
- Electrical Conductivity: Conductivity was measured by using conductivity meter
- Turbidity: The turbidity of water was measured by using turbidimeter.
- Total Solids (mg/L): Total solids were determined gravimetrically
- pH of water: The pH of water is measured with the help of a pH meter, using a glass combination electrode saturated with KCI.
- Total Alkalinity (As $CaCO_3$): Total alkalinity was determined titrimetrically
- Chloride (mg/L): Chloride was determined titrimetrically
- Dissolved Oxygen: The dissolved oxygen was determined by Winkler Iodide Azide method
- Phosphate: The total phosphate was determined by using $SnCl_2$ method.
- Nitrate: The surface water nitrate concentration was determined by using UV spectrophotometric method.

Statistical Procedure and Significance Level

The data characteristics (descriptive statistics) such as Mean, Standard Deviation, Minimum, Maximum, Skewnes, Kurtosis, etc. were determined. The data was analysed using SPSS 18.0 Software. The significance level was chosen to be 0.05 (or equivalently, 5%).

Results and Discussion

The data was collected in each season for a period of two years. Subsequent to data generation its analysis was carried out by following appropriate statistical tests (Analysis of Variance and Correlation Coefficient). Specifically, the results of temporal variation for physico-chemical and biological parameters are presented by using suitable Tables and Charts.

Surface Water Temperature

Table 1: Seasonal variation of surface water temperature at different sampling locations in Wakeshwar Lake near MIDC

Season	Mean	S.D.	Min.	Max.	F	P
Summer	25.2	±2.3	21.0	26.4	9.279	<0.05
Monsoon	23.4	±1.1	22.0	25.1		
Winter	20.7	±1.2	18.3	23.9		

SD: Standard Deviation; **Min.**: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 1** presents results pertaining seasonal variation in surface water temperature of Wakeshwar Lake near MIDC at different sampling locations. The surface water temperature at the Water body near MIDC during summer, monsoon and winter season was 25.2±2.3°C, 23.4±1.1°C and 20.7±1.2°C respectively. The data showed significant ($P<0.05$) difference in surface water temperature during different seasons at all the sampling stations, with summer indicating higher temperature.

Conductivity (µS/cm)

Table 2: Seasonal variation in conductivity of Wakeshwar Lake near MIDC

Season	Mean	S.D.	Min.	Max.	F	P
Summer	228.4	±16.8	210.0	268.0	21.254	<0.05
Monso	281	±15	240	320		

on	.4	.7	.0	.0		
Winter	164.3	±21.4	148.8	248.0		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 2** presents results of seasonal variation in surface water conductivity at different sampling locations of Wakeshwar Lake near MIDC. The conductivity at Water body near MIDC during summer, monsoon and winter season was 228.4±16.8, 281.4±15.7 and 164.3±21.4 µS/cm respectively. The comparative assessment of the conductivity data showed significant (P<0.05) difference at all the sampling locations during the different seasons at all the sampling stations, with summer indicating higher conductivity.

Turbidity (NTU)

Table 3: Seasonal variation in turbidity of Wakeshwar Lake near MIDC

Season	Mean	S.D.	S.E.	Min.	Max.	F	P
Summer	3.4	±1.0	0.4	2.3	3.8	6.324	<0.05
Monsoon	6.8	±1.9	0.9	4.2	7.8		
Winter	2.8	±0.7	0.3	1.8	3.9		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Table 3 presents results of the seasonal variation in turbidity of Wakeshwar Lake near MIDC water. The turbidity at Water body near MIDC during summer, monsoon and winter season was 3.4±1.0, 6.8±1.9 and 2.8±0.7 NTU respectively. The results clearly showed strong (P<0.05) influence of season on turbidity in Water body near MIDC water at all the sampling stations, with monsoon indicating higher turbidity.

Total Dissolved Solids (mg/L)

Table 4: Seasonal variation in total dissolved solids of Wakeshwar Lake near MIDC

Season	Mean	S.D.	S.E.	Min.	Max.	F	P
Summer	107.5	±6.8	2.4	88.4	124.0	17.655	<0.05
Monsoon	129.4	±7.4	2.7	98.7	141.3		
Winter	103.4	±8.4	4.3	92.0	122.0		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 4** presents results pertaining the TDS concentration on the water of Wakeshwar Lake near MIDC. The TDS at Water body near MIDC during summer, monsoon and winter season was 107.5±6.8, 129.4±7.4 and 103.4±8.4 mg/L respectively. The comparative assessment showed that there was a significant (P<0.05) difference in TDS during different seasons, with monsoon revealing noticeably higher TDS.

Surface waster pH

Table 5: Seasonal variation in pH of Wakeshwar Lake near MIDC

	Mean	S.D.	S.E.	Min.	Max.	F	P
Summer	7.4	±0.4	0.12	6.9	8.0	4.867	<0.05
Monsoon	6.5	±0.5	0.21	6.2	7.1		
Winter	7.9	±0.6	0.23	7.2	8.2		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 5** presents results pertaining seasonal variation in surface water pH at different sampling locations of Wakeshwar Lake near MIDC. The surface water pH at Water body near MIDC during summer, monsoon and winter season was 7.4±0.4, 6.5±0.5 and 7.9±0.6 respectively. The data showed significant (P<0.05) difference in surface water pH stratification during different seasons at all the sampling stations.

Chlorine (mg/L)

Table 6: Seasonal variation in chlorine of Wakeshwar Lake near MIDC

	Mean	S.D.	S.E.	Min.	Max.	F	P
Summer	32.3	±0.9	0.3	22.0	42.5	12.385	<0.05
Monsoon	38.4	±3.6	1.5	24.1	46.9		
Winter	26.9	±0.7	0.4	25.9	38.3		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 4.6** presents results pertaining seasonal variation in surface water chlorine concentration at different sampling locations of Wakeshwar Lake near MIDC. The chlorine concentration at Water body near MIDC during summer, monsoon and winter season was 32.3±0.9, 38.4±3.6 and 26.9±0.7 respectively. The data showed significant (P<0.05) difference in chlorine concentration

during different seasons at all the sampling stations.

Dissolved Oxygen (mg/L)

Table 7: Seasonal variation in Dissolved oxygen of Wakeshwar Lake near MIDC

	Mean	**S.D.**	**S.E.**	**Min.**	**Max.**	**F**	**P**
Summer	6.8	±1.3	0.3	5.6	7.5	3.214	<0.05
Monsoon	5.0	±0.8	0.5	4.6	6.1		
Winter	8.7	±0.7	0.5	6.2	9.4		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 7** presents results pertaining seasonal variation in DO at different sampling locations of Wakeshwar Lake near MIDC. The DO of water at Water body near MIDC during summer, monsoon and winter season was 6.8±1.3, 5.0±0.8 and 8.7±0.7 mg/L respectively. The data showed significant (P<0.05) difference in DO of water during different seasons.

Phosphates (mg/L)

Table 8: Seasonal variation in phosphate of Wakeshwar Lake near MIDC

	Mean	**S.D.**	**Min.**	**Max.**	**F**	**P**
Summer	1.24	±0.21	0.89	1.90	4.285	<0.05
Monsoon	3.41	±0.90	1.20	4.70		
Winter	1.68	±0.31	0.81	2.10		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 8** presents results pertaining seasonal variation in phosphate concentration at different sampling locations of Wakeshwar Lake near MIDC. The phosphate concentration at Water body near MIDC during summer, monsoon and winter season was 1.24±0.21, 3.41±0.90 and 1.68±0.31 mg/L respectively. The phosphate concentration data showed significant (P<0.05) during different seasons at all the sampling stations.

Nitrates (mg/L)

Table 9: Seasonal variation in nitrates of Wakeshwar Lake near MIDC water at different sampling location

	Mean	**S.D.**	**Min.**	**Max.**	**F**	**P**
Summer	0.95	±0.3	0.48	1.21	3.285	<0.05
Monsoon	1.26	±0.4	0.7	1.9		
Winter	0.61	±0.4	0.41	1.32		

SD: Standard Deviation; **Min**.: Minimum; **Max.**: Maximum; **'F'**: 'F' ratio; **P**: 'P' Value

Above **Table 9** presents results pertaining seasonal variation in nitrate concentration at different sampling locations of Wakeshwar Lake near MIDC. The nitrate concentration at Water body near MIDC during summer, monsoon and winter season was 0.95±0.3, 1.26±0.4 and 0.61±0.4 mg/L respectively. The data showed significant (P<0.05) difference in nitrate concentration during different seasons at all the sampling stations.

Fish productivity in the selected water body

From the data collected from the lake, the fish catch was found to be between 1.7 and 2.2 tonne per day. Also, the qualitative assessment of the collected data indicated that *Labeo rohita* (Rohu) and *Catla Catla* (Catla) are the predominant fish.

Conclusions

The sustainability of an aquatic ecosystem depends on the smooth interaction between abiotic and biotic components. However, in case of significant variation, the aquatic ecosystem becomes vulnerable to the dominance of certain species, for example, the availability of nutrients like P and N often result in the uncontrolled growth of the algal species. Besides, the excessive growth of these species leads to accumulation of organic matter in the aquatic ecosystem thereby affecting the physiology of lake. The natural degradation of this organic matter in the anaerobic conditions leads to generation of toxic compounds like ammonia and methane. Hence, the study results, which showed higher phosphate values in the monsoon season indicated higher risk of nutrient pollution in this season. Besides, dissolved oxygen also showed noticeable variation thereby indicating the threat to the fish community, especially during the monsoon season. Thus, in view of the importance of the physic-chemical nature of the water body, it is warranted that the data be generated continuously so that the lake conservation measures can be taken more pragmatically with high degree of success.

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