



Seasonal Variation Of Physico-Chemical And Plankton Characteristics Of Two Urban Lakes Of Nagpur City

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Abstract

The recently reported results have shown that even a very tiny but consistent change in the climatic conditions can lead to widespread destruction, which is evident through flash floods, draught and similar other situations. Since, these changes have large impact on the livelihood of the people living in these areas, a comprehensive information of the various parameters that determine the ecological balance of an environmental compartment such as land locked water bodies i.e. lakes is very important. This knowledge has the potential to delineate strategies for management of these lakes. In the backdrop of above information, this study was carried out to determine the seasonal variation of selected physico-chemical and plankton characteristics of lakes present in the Nagpur City of Maharashtra, India. During the course of this study, all the data was generated using standard methods and it (data) was analysed using PASW 18.0 software. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in physico-chemical as well as plankton density of surface water of Ambazari and Futala lakes of Nagpur. This information has potential value for designing action tasks that can contain the parameters such as turbidity, dissolved oxygen, total phosphorous, plankton abundance in these lakes.

Keywords: Ecological balance, lake, seasonal variation, physico-chemical parameters, plankton

1.0 Introduction

The climatic changes have resulted in many environmental changes, of which some are recorded and monitored, while many are not even recorded (Biswas et al., 2009). This lack of information of change in the environmental factors is likely to present a big challenge to the mankind for sustainable development. Although all the environmental compartments (air, water and soil) are experiencing adverse impact, the changes in these compartments need to be studied in greater details and for a longer period of time so that this information can be used to ascertain the prevailing risks and the possible mitigation measures. Overall health

of the ecosystem (Nawab et al., 2018) often depends on the anthropometric activities within that area (Goldman and Horne, 1983; Chapman and Reiss, 1995). This is immensely true in case of the freshwater ecosystems like lakes and rivers (Bose, 2003). Hence, it is important to assess the ecosystem's health periodically so that any necessary mitigation actions can be performed promptly.

In view of the human intervention with the ecosystem, the idea of ecosystem health is becoming more and more important. This is because the aquatic ecosystems serve as the last destination for "wash" from practically all sources (Chandrasekhar and Kodarkar, 1996). Because biotic systems must traverse a variety of terrains, they naturally accumulate contaminants and become "laden" with extrinsic materials, which degrade their ability to function naturally (Bhatt et al., 1999). Additionally, the lake's confined structure means that when it becomes polluted (Kumar et al., 2018), it stays in that state for a significantly longer time, frequently leading to lake ageing and eventually dying (Reddy and Char, 2004; Karagul et al., 2005; Kedar and Patil, 2011). Since, the lake water has multiple benefits; society must keep water in the best condition possible. The utility of this precious resource by various stake holders is limited by the change in water quality. The quality of clean river water can therefore vary depending on whether it is used for drinking, bathing, enjoyment, agriculture, or power generation. In view of the importance of the aquatic ecosystem for growth and development of the region, this study was conducted to study the seasonal variation of physico-chemical and plankton characteristics of selected lakes present in the Nagpur City of Maharashtra, India.

2.0 Materials & Methods

The data collection in this study was carried out using standard methods. Various abiotic i.e. physico-chemical and biotic i.e. biological parameters were assessed in this study. The physico-chemical parameters included in this study are surface water temperature (determined using mercury filled glass thermometer having a quick response, and was recorded at Celsius scale to the nearest 0.1°C), turbidity (was determined using nephlo-turbidimeter and recorded as NTU), electrical conductivity (measured as per the instruction manual supplied with the instrument and the results expressed as μ Siemens/cm), total suspended solids (determined gravimetrically), pH of water (was measured with the help of a pH meter, using a glass combination electrode saturated with KCl), dissolved oxygen (was determined using Azide Winkler method), total phosphorus (was determined using Stannous Chloride Method), phytoplankton and zooplankton enumeration was done using calibrated cell counters (Sarojini, 1996). The data generated in this study was analyzed using PASW 18.0 software. The comparative assessment of the parametric values with respect to seasons was done by using one way ANOVA procedure. The significance level was selected as 0.05.

3.0 Results and Discussion

3.1 Physico-chemical characteristics

3.1.1 Seasonal variation in surface water Temperature ($^{\circ}\text{C}$)

Table No. 1: Seasonal variation of surface water temperature recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	27.6	28.1
	SD	± 1.3	± 1.9
	Min	26.6	26.3
	Max	28.1	30.2
Monsoon	Mean	24.1	24.3
	SD	± 1.2	± 1.3
	Min	22.9	22.9
	Max	25.4	25.6
Winter	Mean	22.2	23.4
	SD	± 1.4	± 1.2
	Min	20.8	22
	Max	23.5	24.9

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 1 presents results of surface water temperature values recorded at various lakes of Nagpur city. Average surface water temperature recorded at Ambazari Lake during summer, monsoon and winter seasons was $27.6 \pm 1.3^{\circ}\text{C}$, $24.1 \pm 1.2^{\circ}\text{C}$ and $22.2 \pm 1.4^{\circ}\text{C}$ respectively. However, the surface water temperature of Futala Lake was $28.1 \pm 1.9^{\circ}\text{C}$ in summer season, while it was $24.3 \pm 1.3^{\circ}\text{C}$ in monsoon and $23.4 \pm 1.2^{\circ}\text{C}$ during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in surface water temperature of Ambazari and Futala lakes.

3.1.2 Seasonal variation in surface water Turbidity (NTU)

Table No. 2: Seasonal variation of surface water turbidity recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	14.9	15.3
	SD	±1.3	±2.1
	Min	13.7	13.9
	Max	16.2	16.6
Monsoon	Mean	16.8	16.2
	SD	±2.3	±2.4
	Min	15.1	14.3
	Max	18.2	17.8
Winter	Mean	9.7	17.1
	SD	±1.2	±1.7
	Min	8.4	16.2
	Max	10.9	19.8

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 2 presents results of turbidity values recorded at various lakes of Nagpur city. Average turbidity recorded at Ambazari Lake during summer, monsoon and winter seasons was 14.9 ± 1.3 NTU, 16.8 ± 2.3 NTU and 9.7 ± 1.2 NTU respectively. However, the turbidity of Futala Lake was 15.3 ± 2.1 NTU in summer season, while it was 16.2 ± 2.4 NTU in monsoon and 17.1 ± 1.7 NTU during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in turbidity of Ambazari and Futala lakes.

3.1.3 Seasonal variation in surface water Electrical conductivity ($\mu\text{S}/\text{cm}$)

Table No. 3: Seasonal variation of surface water electrical conductivity recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	430.2	561.3
	SD	±22.3	±19.4
	Min	417.3	545.4
	Max	443.9	577.5
Monsoon	Mean	580.6	662.2
	SD	±24.6	±23.8
	Min	564.7	649.3
	Max	601	678.4
Winter	Mean	402.5	510.1
	SD	±23.1	±30.2
	Min	383.7	494.2
	Max	416.2	530.5

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 3 presents results of electrical conductivity values recorded at various lakes of Nagpur city. Average electrical conductivity recorded at Ambazari Lake during summer, monsoon and winter seasons was 430.2 ± 22.3 $\mu\text{S/cm}$, 580.6 ± 24.6 $\mu\text{S/cm}$ and 402.5 ± 23.1 $\mu\text{S/cm}$ respectively. However, the electrical conductivity of Futala Lake was 561.3 ± 19.4 $\mu\text{S/cm}$ in summer season, while it was 662.2 ± 23.8 $\mu\text{S/cm}$ in monsoon and 510.1 ± 30.2 $\mu\text{S/cm}$ during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in electrical conductivity of Ambazari and Futala lakes of Nagpur.

3.1.4 Seasonal variation in surface water Total Suspended Solids (mg/L)

Table No. 4: Seasonal variation of surface water total suspended solids recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	175.2	154.3
	SD	± 5.9	± 8.4
	Min	162.3	138.4
	Max	188.9	170.5
Monsoon	Mean	162.3	144.2
	SD	± 11.3	± 8.2
	Min	146.4	131.3
	Max	178.5	160.4
Winter	Mean	141.8	137.2
	SD	± 10.3	± 14.9
	Min	125.9	121.3
	Max	158	150.9

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 4 presents results of total suspended solids values recorded at various lakes of Nagpur city. Average total suspended solids recorded at Ambazari Lake during summer, monsoon and winter season was 175.2 ± 5.9 mg/L, 162.3 ± 11.3 mg/L and 141.8 ± 10.3 mg/L respectively. However, the total suspended solid of Futala Lake was 154.3 ± 8.4 mg/L in summer season, while it was 144.2 ± 8.2 mg/L in monsoon and 137.2 ± 14.9 mg/L during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in total suspended solids of Ambazari and Futala lakes.

3.1.5 Seasonal variation in surface water pH (pH units)

Table No. 5: Seasonal variation of surface water pH recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	6.8	6.7
	SD	±0.7	±0.5
	Min	6.4	6.2
	Max	7.1	7
Monsoon	Mean	7.3	7.4
	SD	±0.6	±0.5
	Min	7	7.1
	Max	7.4	7.7
Winter	Mean	6.9	6.7
	SD	±0.5	±0.6
	Min	6.5	6.4
	Max	7.2	7.2

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 5 presents results of pH values recorded at various lakes of Nagpur city. Average pH recorded at Ambazari Lake during summer, monsoon and winter seasons was 6.8 ± 0.7 pH units, 7.3 ± 0.6 pH units and 6.9 ± 0.5 pH unit respectively. However, the pH of Futala Lake was 6.7 ± 0.5 pH units in summer season, while it was 7.4 ± 0.5 pH units in monsoon and 6.7 ± 0.6 pH units during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in pH of Ambazari and Futala lakes.

3.1.6 Seasonal variation in surface water Dissolved Oxygen (mg/L)

Table No. 4.2.6: Seasonal variation of surface water Dissolved Oxygen recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	4.2	3.8
	SD	±0.8	±0.9
	Min	3.8	3.2
	Max	5.6	5.1
Monsoon	Mean	3.9	3.7
	SD	±0.4	±0.6
	Min	3.5	3.4
	Max	4.9	4.8
Winter	Mean	4.6	4.3
	SD	±0.6	±0.8
	Min	3.8	3.9
	Max	5.7	5.7

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 6 presents results of surface water dissolved oxygen values recorded at various lakes of Nagpur city. Average dissolved oxygen recorded at Ambazari Lake during summer, monsoon and winter seasons was 4.2 ± 0.8 mg/L, 3.9 ± 0.4 mg/L and 4.6 ± 0.6 mg/L respectively. However, the dissolved oxygen of Futala Lake was 3.8 ± 0.9 mg/L in summer season, while it was 3.7 ± 0.6 mg/L in monsoon and 4.3 ± 0.8 mg/L during winter seasons. The comparative assessment showed that there is significant ($p<0.05$) seasonal variation in dissolved oxygen of Ambazari and Futala lakes.

3.1.7 Seasonal variation in surface water Total Phosphorus (mg/L)

Table No. 7: Seasonal variation of surface water total phosphorus recorded from the lakes of Nagpur city

Seasons		Ambazari	Futala
Summer	Mean	0.09	0.12
	SD	± 0.01	± 0.03
	Min	0.07	0.08
	Max	0.13	0.12
Monsoon	Mean	0.13	0.18
	SD	± 0.04	± 0.05
	Min	0.09	0.16
	Max	0.15	0.2
Winter	Mean	0.12	0.16
	SD	± 0.05	± 0.03
	Min	0.1	0.14
	Max	0.15	0.19

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 7 presents results of total phosphorus values recorded at from various lakes of Nagpur city. Average total phosphorus recorded at Ambazari Lake during summer, monsoon and winter seasons was 0.09 ± 0.01 mg/L, 0.13 ± 0.04 mg/L and 0.12 ± 0.05 mg/L respectively. However, the total phosphorus of Futala Lake was 0.12 ± 0.03 mg/L in summer season, while it was 0.18 ± 0.05 mg/L in monsoon and 0.16 ± 0.03 mg/L during winter seasons. The comparative assessment showed that there is significant ($p<0.05$) seasonal variation in total phosphorus of Ambazari and Futala lakes.

3.2 Biotic parameters

3.2.1 Seasonal variation in surface water phytoplankton

Table No. 8: Seasonal variation in surface water phytoplankton

Seasons		Ambazari	Futala
Summer	Mean	152	168
	SD	±10.2	±13.9
	Min	134	154
	Max	169	180
Monsoon	Mean	149	158
	SD	±9.8	±10.5
	Min	138	146
	Max	155	168
Winter	Mean	130	141
	SD	±10.1	±14.9
	Min	120	134
	Max	142	152

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 8 presents results of phytoplankton density recorded at from various lakes of Nagpur city. Average phytoplankton density recorded at Ambazari Lake during summer, monsoon and winter seasons was 152 ± 10.2 ind./cm³, 149 ± 9.8 ind./cm³ and 130 ± 10.1 ind./cm³ respectively. However, the phytoplankton of Futala Lake was 168 ± 13.9 ind./cm³ in summer season, while it was 158 ± 10.5 ind./cm³ in monsoon and 141 ± 14.9 ind./cm³ during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in phytoplankton of Ambazari and Futala lakes.

3.2.2 Seasonal variation in surface water zooplankton

Table No. 9: Seasonal variation in surface water zooplankton

Seasons		Ambazari	Futala
Summer	Mean	88	92
	SD	±8.8	±8.2
	Min	82	82
	Max	94	96
Monsoon	Mean	93	101
	SD	±7.5	±6.9
	Min	88	95
	Max	98	108
Winter	Mean	90	94
	SD	±6.7	±8.1
	Min	85	86
	Max	94	98

SD: Standard deviation; **Min:** Minimum; **Max:** Maximum

Table 9 presents results of zooplankton density recorded from various lakes of Nagpur city. Average zooplankton density recorded at Ambazari Lake during summer, monsoon and winter seasons was 88 ± 8.8 ind./L⁻¹, 93 ± 7.5 ind./L⁻¹ and 90 ± 6.7 ind./L⁻¹ respectively. However, the zooplankton of Futala Lake was 92 ± 8.2 ind./L⁻¹ in summer season, while it was 101 ± 6.9 ind./L⁻¹ in monsoon and 94 ± 8.1 ind./L⁻¹ during winter seasons. The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in zooplankton density of Ambazari and Futala lakes.

4.0 Conclusions

4.1 Physico-chemical parameters

4.1.1 Seasonal variation in surface water Temperature (°C)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in surface water temperature of Ambazari and Futala lakes of Nagpur. The surface water temperature was high at all the lakes during the summer season.

4.1.2 Seasonal variation in surface water Turbidity (NTU)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in turbidity of Ambazari and Futala lakes of Nagpur. The surface water turbidity was high at Ambazari Lake during monsoon season while it was high at Futala lake during winter season.

4.1.3 Seasonal variation in surface water Electrical conductivity (µS/cm)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in electrical conductivity of Ambazari and Futala lakes of Nagpur. The surface water electrical conductivity was high at all the lakes during the monsoon season.

4.1.4 Seasonal variation in surface water Total Suspended Solids (mg/L)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in total suspended solids of Ambazari and Futala lakes of Nagpur. The surface water electrical conductivity was high at Ambazari and Futala lakes during summer season.

4.1.5 Seasonal variation in surface water pH (pH units)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in pH of Ambazari and Futala lakes of Nagpur. The surface water pH was high at all the lakes during the monsoon season.

4.1.6 Seasonal variation in surface water Dissolved Oxygen (mg/L)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in dissolved oxygen of Ambazari and Futala lakes of Nagpur. The surface water dissolved oxygen was high at all the lakes during the winter season.

4.1.7 Seasonal variation in surface water Total Phosphorus (mg/L)

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in total phosphorus of Ambazari and Futala lakes of Nagpur. The surface water total phosphorus was high at all the lakes during the monsoon season.

4.2 Biotic components

4.2.1 Seasonal variation in surface water phytoplankton

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in phytoplankton of Ambazari and Futala lakes of Nagpur. The surface water phytoplankton was high at all the lakes during the summer season.

4.2.2 Seasonal variation in surface water zooplankton

- The comparative assessment showed that there is significant ($p < 0.05$) seasonal variation in zooplankton of Ambazari and Futala lakes of Nagpur. The surface water zooplankton was high at all the lakes during the monsoon season.

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