

## Assessment of seasonal variations in physico-chemical parameters in Panchet reservoir, Dhanbad district, Jharkhand

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### ABSTRACT

*The assessment of water quality based on monthly variations in different physico-chemical parameters of Panchet dam, Dhanbad (Jharkhand) was studied during January 2016 to December 2018. Several parameters such as water temperature, dissolved oxygen content, rainfall, free CO<sub>2</sub>, total alkalinity, pH, CO<sub>2</sub>, HCO<sub>3</sub> and hardness were determined. Water temperature ranged from 18.0 to 30.44 °C, dissolved oxygen from 5.3 to 10.3 mg/L, rainfall 1.9 to 463 mm, free CO<sub>2</sub> from 2.84 to 11.2 mg/L, total alkalinity from 6.30 to 182.83 mg/L and pH from 6.60 to 8.25. The ranges of CO<sub>3</sub>, HCO<sub>3</sub> and hardness in water were from 34+3.25 to 75+4.65 and 53.33+5.07 to 65.0+2.25, mg/l, respectively. Significant seasonal variations in different parameters were observed and the study has a great value in terms of ecosystem of Panchet dam as well as water quality in different seasons. Water temperature, dissolved oxygen and rainfall were higher in summer and monsoon respectively. In general free CO<sub>2</sub>, total alkalinity and pH were higher during summer and monsoon. The higher values of CO<sub>3</sub>, HCO<sub>3</sub> and hardness, in general were recorded during winter season.*

**Keywords:** Reservoir, water quality parameters, ecosystem, Panchet dam

### INTRODUCTION

Reservoirs play a major role in agriculture, fishery along with the use of water for drinking purposes. Several factors, which determine the water quality of a reservoir, include seasonal climatic changes (Banik *et. al.*, 2010). Water, by means of its physical, chemical and biological characteristics, reflects the significance as potent ecological factor and quality for sustenance. Seasonal precipitation, wind action and pattern of hydrological cycle prevalent in dams and reservoirs which does not favour colonization by macrophytic communities. Plankton by virtue of drifting habit and short turnover period constitutes the major link in the trophic structure and events in the reservoir ecosystem. Fish production in reservoir is directly or indirectly dependent on the abundance of planktons. It is an interdisciplinary science which deals with the detailed field as well as laboratory studies to understand the structural and functional aspects associated with the freshwater environment. A considerable works have been done on freshwater reservoirs and changing ecological behavior of reservoirs, ponds and dams (Malik and Sulehria, 2004; Jnuja *et. al.*, 2009; Sulehria *et. al.*, 2012; Mirza *et. al.*, 2013). The physico-chemical characteristics are also greatly changed due to

discharge of domestic, municipal, industrial and other factors like religious offerings, recreational activities in the catchment area. Thus, the study was carried out to evaluate the seasonal variations in water quality parameters based on physico-chemical characteristics of Panchet reservoir.

### MATERIALS AND METHODS

Different physico-chemical parameters were determined from five experimental sites of Panchet reservoir, Dhanbad district, Jharkhand, during second week of every month from January 2016 to December 2018. A Celsius thermometer (scale ranging from 0°C to 100°C) was used to measure surface water temperature, The pH of the water was measured directly using a digital electrode pH meter (Systronics, model no. Sys - 335). The water of the reservoir was collected in sterile BOD glass bottles between 7.00 am and 9.00 am from 50 cm depth from each collection site. The closed bottles were dipped in the reservoir and then bottles were opened inside and after collection of water were closed again to bring them out at the surface. Dissolved oxygen was measured on the spot by modified Winkler's method. Conductivity was measured by conductivity meter (EC 300 Ecosence). For the determination of total

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alkalinity and free carbon-di-oxide ( $\text{CO}_2$ ) water was taken in one liter sampling bottles and brought to the laboratory within eight hours following the standard methods as recommended by APHA (1989). Monthly data was collected. Total hardness, carbonate ( $\text{CO}_3$ ) and bicarbonate ( $\text{HCO}_3$ ) contents were examined by Systronics Water Analyser 371 .

## RESULTS AND DISCUSSION

### Water temperature

The water temperature of the Panchet Dam ranged between  $18.0\text{ }^\circ\text{C} \pm 1.51$  and  $30.44\text{ }^\circ\text{C} \pm 1.296$ . Monthly variation during the study period was recorded minimum  $18.0\text{ }^\circ\text{C} \pm 1.51$  in the month of February. However, in the month of April, May and June the water temperature increased to  $27.15\text{ }^\circ\text{C} \pm 1.348$ ,  $28.82\text{ }^\circ\text{C} \pm 0.87$  and  $30.44\text{ }^\circ\text{C} \pm 1.296$  respectively. During July to September, the water temperature declined to  $27.8\text{ }^\circ\text{C} \pm 0.24$ ,  $28.5\text{ }^\circ\text{C} \pm 0.85$  and  $22.8\text{ }^\circ\text{C} \pm 1.59$ , respectively. During October and November i.e. onset of winter the water temperature further declined to  $21.0\text{ }^\circ\text{C} \pm 0.45$  and  $19.5\text{ }^\circ\text{C} \pm 0.86$  (Table 1). The data derived indicates the seasonal fluctuations in water temperature, being higher during summer months and exhibit lower values in winter months. Higher

temperature recorded during the months of April, May and June is due to bright sunshine, long duration and high air temperature. Chary (2003) reported similar trend of water temperature in tropical countries. Thus ambient higher temperature may be one of the factors because of its requirement in different metabolic activities of the fish in the ecosystem. During the months of rainy season, lowering of temperature is observed which may be due to the cloudy weather and influx of rain water. Similarly, during winter months the water temperature remains minimum due to low temperature and short duration of sunshine. This observation is also in agreement with the findings of Srivastava and Srivastava (2011). Tamuli (2018) also reported maximum water temperature during the month of August and minimum during the month of January in Central Brahmaputra Valley Zone in Assam.

### Dissolved oxygen (DO)

Dissolved oxygen is one of the most important parameter for assessing the quality of water, directly affecting survival and distribution of fauna in an ecosystem. It is very interesting to note that the level of dissolved oxygen content greatly fluctuated during different months of the year (Table 1).

Table 1: Average water temperature, dissolved oxygen ( $\text{O}_2$ ) and rainfall at the fish collection area

| Months    | Water temperature ( $^\circ\text{C}$ ) | Dissolved oxygen (DO) mg/L | Rainfall (mm) |
|-----------|--|----------------------------|---------------|
| January   | $19.2 \pm 0.86$                        | $7.05 \pm 0.275$           | 14            |
| February  | $18.0 \pm 1.51$                        | $6.90 \pm 0.215$           | 29            |
| March     | $26.9 \pm 1.245$                       | $6.3 \pm 1.12$             | 15            |
| April     | $27.15 \pm 1.348$                      | $5.9 \pm 0.268$            | 38            |
| May       | $28.62 \pm 0.87$                       | $9.90 \pm 1.20$            | 120           |
| June      | $30.44 \pm 1.296$                      | $10.3 \pm 0.67$            | 183           |
| July      | $27.8 \pm 0.24$                        | $9.5 \pm 0.88$             | 263           |
| August    | $28.51 \pm 0.85$                       | $9.2 \pm 1.16$             | 463           |
| September | $22.8 \pm 1.59$                        | $8.4 \pm 0.37$             | 275           |
| October   | $21.0 \pm 0.45$                        | $7.9 \pm 0.76$             | 44            |
| November  | $19.5 \pm 0.86$                        | $7.5 \pm 0.31$             | 1.9           |
| December  | $18.5 \pm 1.56$                        | $7.9 \pm 1.15$             | 00            |

The dissolved oxygen was recorded minimum ( $2.5\text{ mg/L} \pm 0.268$ ) in April and maximum ( $10.3\text{ mg/L} \pm 0.67$ ) during June. During July and August, the dissolved oxygen was recorded to  $9.5\text{ mg/L} \pm 0.88$  and  $9.2\text{ mg/L} \pm 1.16$ . Again the value tended to be decrease

from the month of October ( $7.9\text{ mg/L} \pm 0.76$ ) and continued up to March ( $6.3\text{ mg/L} \pm 1.12$ ). The amount of dissolved oxygen (DO) content in water directly or indirectly dependent on atmospheric water temperature, aquatic vegetation and partial pressure of water. Higher

dissolved oxygen content of water during the months of May, June, July and August is largely attributed due to increase in aeration level with the increase flow of water in the reservoir (Tidame and Shinde, 2012, Singh 2014). Higher amount of DO during winter months i.e. October to January may be due to increasing solubility of oxygen along with the decrease in decomposition ratio. Similar finding has been recorded by Januja *et al.* (2009).

### Rainfall

There was a common trend showing peaks of rainfall during May to August depicting pre monsoon and monsoon during this time. During the study period maximum rainfall was recorded in August (463 mm). A gradual increase of rainfall from the months of May to August has been found to be correlated with the maturation of sex cells in gonads of fishes. Minimum rainfall in the winter months reflected to the almost cessation or quiescent phase of gonads.

### Free carbon-di-oxide (CO<sub>2</sub>)

The average value of free CO<sub>2</sub> varied between 2.84 and 11.2 mg/L. However, higher level of free CO<sub>2</sub> was observed during July to September (11.2 mg/L ± 1.02, 11.0 mg/L ± 0.85 and 10.9 mg/L ± 0.96). This may be due to the wastes being added to the dam during monsoon months. The value of free CO<sub>2</sub> showed a trend to decrease from 6.4 mg/L ± 0.27 to 2.84 mg/L ± 1.12 during the month of October, November, December, January and February. From March onwards the value of free CO<sub>2</sub> showed an increasing trend and recorded to 3.8 mg/L ± 1.22, 6.5 mg/L ± 0.45, 8.9 mg/L ± 0.56 and 8.8 mg/L ± 0.45 during the months of March, April, May and June respectively (Table 2). Higher level of free CO<sub>2</sub> was observed during July, August and September which could be due to the wastes from different sources being added to the reservoir during rainy season and also influx of water during this season. However, free CO<sub>2</sub> in water was mainly originated from the respiration of aquatic biota and decomposition of organic matters. Similar results have also been observed by Singh (2014).

Table 2: Average monthly range of pH, free carbon-di-oxide (CO<sub>2</sub>) and total alkalinity concentration of Panchet Dam

| Months    | Free CO <sub>2</sub> mg/L | Total alkalinity(mg/L) | pH           |
|-----------|---------------------------|------------------------|--------------|
| January   | 3.68 ± 1.48               | 6.30 ± 0.38            | 7.67 ± 0.62  |
| February  | 2.84 ± 1.12               | 10.8 ± 4.25            | 7.75 ± 0.41  |
| March     | 3.8 ± 1.22                | 15.6 ± 5.14            | 7.24 ± 0.58  |
| April     | 6.5 ± 0.45                | 50.8 ± 2.60            | 7.20 ± 0.114 |
| May       | 8.9 ± 0.56                | 146.6 ± 3.56           | 7.72 ± 0.058 |
| June      | 8.8 ± 0.45                | 143.4 ± 4.25           | 8.25 ± 0.116 |
| July      | 11.2 ± 1.02               | 179.0 ± 0.57           | 7.9 ± 0.29   |
| August    | 11.0 ± 0.85               | 182.83 ± 7.50          | 7.5 ± 0.37   |
| September | 10.9 ± 0.96               | 167.7 ± 3.65           | 6.9 ± 0.16   |
| October   | 6.4 ± 0.27                | 162.5 ± 2.59           | 6.60 ± 0.56  |
| November  | 6.2 ± 0.39                | 165.5 ± 3.65           | 6.8 ± 0.45   |
| December  | 4.58 ± 0.03               | 6.4 ± 0.27             | 7.2 ± 1.15   |

### Alkalinity in water

Alkalinity of water is the capacity to neutralize strong acids. The alkalinity values varied from 6.30 mg/L ± 0.38 to 182.83 mg/L ± 7.50 during different months of the year, The higher value was observed in July (179 mg/L ± 0.57) and by highest in August (182.83 mg/L ± 7.50). The alkalinity value was minimum during

December (6.4 mg/L ± 0.27) and January (6.3 mg/L ± 0.38). From the month of February alkalinity values tended to increase (10.8 mg/L ± 4.25) followed by March (15.6 mg/L ± 5.14), April (50.8 mg/L ± 2.60), May (146.6 mg/L ± 3.56) and June (143.4 mg/L ± 4.25) respectively (Table 2). Alkalinity values varied from 6.30 mg/L to 182.83 mg/L during January to August, of which maximum value (182.83 mg/L) was

observed in August and minimum in December and January. This fluctuation had also been supported by Khanna *et al.* (2011) and Kumar *et al.* (2014).

## pH

pH ranged between 6.60 and 8.25 showing slightly acidic to alkaline condition of the Panchet dam water. Higher values of pH during March, April and May were recorded as 7.24, 7.20 and 7.72 respectively. During onset of monsoon season i.e. June, July and August the

pH was recorded as 8.25, 7.90 and 7.50 respectively. During October to February the pH was recorded as 6.60, 6.80, 7.20, 7.67 and 7.75 respectively (Table 2).

## Hardness

Total hardness of water exhibit higher during summer month and comparatively lower in monsoon and again slightly increased during late winter. The total hardness of the study area was recorded between  $55.33 \pm 5.07$  to  $65 \pm 2.25$  (Table 3).

Table 3: Average monthly range of carbonate ( $\text{CO}_3$ ), bicarbonate ( $\text{HCO}_3$ ) and total hardness of Panchet Dam

| Month     | Carbonate(mg/L) | Bicarbonate( $\text{HCO}_3$ ) | Hardness (mg/L)  |
|-----------|-----------------|-------------------------------|------------------|
| January   | $34 \pm 3.25$   | $170 \pm 4.36$                | $60.0 \pm 0.57$  |
| February  | $39 \pm 2.92$   | $181 \pm 4.12$                | $61.0 \pm 0.56$  |
| March     | $36 \pm 1.59$   | $189 \pm 4.32$                | $64.0 \pm 0.58$  |
| April     | $42 \pm 2.66$   | $165 \pm 3.25$                | $60.0 \pm 0.05$  |
| May       | $44 \pm 1.25$   | $151 \pm 3.56$                | $61.0 \pm 0.06$  |
| June      | $59 \pm 1.22$   | $275 \pm 3.48$                | $57.2 \pm 3.12$  |
| July      | $65 \pm 2.49$   | $288 \pm 2.65$                | $53.33 \pm 5.07$ |
| August    | $62 \pm 2.98$   | $279 \pm 4.10$                | $58.67 \pm 1.70$ |
| September | $48 \pm 3.55$   | $163 \pm 3.11$                | $59.2 \pm 3.52$  |
| October   | $75 \pm 3.12$   | $305 \pm 3.09$                | $56.6 \pm 1.70$  |
| November  | $71 \pm 2.87$   | $328 \pm 4.65$                | $65.0 \pm 2.25$  |
| December  | $55 \pm 1.32$   | $159 \pm 3.68$                | $61.33 \pm 3.71$ |

## Carbonates ( $\text{CO}_3$ ) and Bicarbonates ( $\text{HCO}_3$ )

The carbonates and bicarbonates exhibit moderately higher in monsoon, little bit lower in late winter to summer. In the study area the carbonate ranges between  $34 \pm 3.25$  to  $75 \pm 3.12$ , and the bicarbonate ranges between  $170 \pm 4.36$  to  $328 \pm 4.65$ . (Table 3).

The pH of water remain weakly acidic to alkaline throughout the period of investigation ranging from 6.9 to 8.36. The pH was higher in the months of May, June and July which may be due to the abundance of buffering substances brought with rainwater and also due to the presence of sufficient quantities of carbonates in

the water. This result has been corroborated with the findings of Chaurasia and Pandey (2007). The lower pH in the months of September, October and November may be due to low water level in the reservoir and probably accumulation of free  $\text{CO}_2$ . (Shiddamallaya and Pratima 2008, Sivlingam *et al.* 2013) noticed that pH is positively correlated with alkanity, dissolved oxygen, hardness and showed negative correlation with free carbon-di-oxide. Kumar *et al.* (2014) found maximum pH during monsoon and minimum during summer season. Total hardness showed insignificant positive correlation with total alkalinity (Tamuli *et al.* 2018).

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