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RESEARCH ARTICLE

SEASONAL VARIATIONS IN PHYSICO-CHEMICAL CHARACTERISTICS OF PAHUJ RESERVOIR, DISTRICT JHANSI, BUNDELKHAND REGION, CENTRAL INDIA

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ABSTRACT

Pahuj, a small reservoir has been built on Pahuj river and is located approximately 5 km in the west of Jhansi city. The water in the reservoir is used for irrigation, fish culture, drinking and for other domestic purposes. The present investigation deals with the study of seasonal variations in physico-chemical characteristics of Pahuj reservoir. The study was carried out on monthly basis for the period of one year from August 2008 to July 2009 at four different stations of the reservoir. The physico-chemical parameters such as water depth, water temperature, Transparency, pH, Electrical conductivity, Dissolved oxygen, free carbon dioxide, Alkalinity, Total hardness, Chloride, Silicates, Nitrate nitrogen and Total phosphorus were studied. The range of various parameters of reservoir water (water depth 3.00 - 5.70 m, water temperature 15.12- 35.75 ^{0}C, Transparency 3.00- 370 cm, pH 7.34- 8.82, Electrical conductivity 224.00- 660.30 µS/cm, dissolved oxygen 7.10- 10.52 mg/L, free Carbon dioxide 13.42- 19.35mg/L, Alkalinity 100.82- 170.42 mg/L, Total hardness 85.60- 176.50 mg/L, Chloride 23.60- 85.32 mg/L, Silicates 2.50- 8.52 mg/L, nitrates 24.4- 460 µg/L and phosphates 24.80- 375µg/L) exhibit monthly as well as seasonal variations. During the period of study, the higher values of nutrients like nitrates and phosphates were observed during post-monsoon and lower during summer season. This was due to allocthonous brought nutrients into the reservoir from the surrounding catchment area.

INTRODUCTION

Water is one of the most important natural resources. All living organisms on our earth are so intimately connected with water that life on this planet is believed to have evolved in and around water. Similarly water is equally vital for growth of plants, agriculture development and industrial uses. The freshwater body of India includes a large number of rivers, ponds, dams, impoundments and lakes. The reverine system with the constructed dams also presents a different area of aquatic environment. The measurement of the productivity and the energy of any water body needs full assessment of the physico-chemical characteristics of the water bodies besides the aquatic organisms for perpectuality of life. The physico-chemical characteristics are altered or molded due to the activities of the aquatic biota particularly the metabolism of the aquatic organisms. Any alteration in the environmental parameters may bring in an undesirable aquatic condition which may lead to the aquatic pollution. Jhansi is a well known district of Bundelkhand region of Uttar pradesh with a geographical area of 502.75 thousand hectare at 24^0 11'- 25^0 57' N latitude and 78^0 10' – 79^0 23' E longitudes. The district is situated in the south west corner of the region. Jhansi is located in the plateau of central Indian area dominated by rocky reliefs and minerals underneath the soil. The region relies heavily on monsoon rains for irrigation purposes. Being on a rocky plateau, Jhansi experiences extreme temperatures.

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Winter begins in October with the retreat of the Southwest Monsoon (Jhansi does not experience any rainfall from the Northeast monsoon). The mercury generally reads about 4^{0}C minimum and 21^{0}C maximum in winter. Spring arrives by the end of February and is a short-lived phase of transition. Summer begins by April and the summer temperatures can peak at 47^{0}C in May.

The rainy season starts by the third week of June (although this is variable year to year). Monsoon rains gradually weaken in September and the season ends by the last week of September. In the rainy season, average high temperature goes around 36^{0}C with high humidity. The average rainfall for the city is about 900mm per year, observed almost entirely within the three- and- a-half months of the South West monsoon. Jhansi which is situated in Central part of India of Bundelkhand region of Uttarpradesh having two rivers namely Betwa and Pahuj in East and West part of city respectively. The Pahuj River has been dammed near Jhansi town and the reservoir meets its drinking water requirements. Present study aims at investigating the physico-chemical parameters in Pahuj water reservoir of Jhansi district of Uttar Pradesh, Bundelkhand region, Central India. Many researchers have done studies on Physico-chemical characteristics of dam, reservoir and river water (Arya *et al*., 2011, Bade *et al*., 2008 and Garg *et al*., 2008). However little work has been carried out on water quality of Pahuj water reservoir, hence present study was carried out.

MATERIALS AND METHODS

Pahuj, a small manmade reservoir with 480 ha water spread area, has been built on the river Pahuj and is located approximately 5 km in the west of Jhansi city. The reservoir was officially commissioned in 1909, with a total storage capacity of 18.25 FRL 10^6x m^3. Geographically it lies between 23^0 8' and 26^0 30' N latitude and 78^0 11' and 81^0 30' E longitude and at an altitude of 272 m from mean sea level. The area of the reservoir is 543 hectares at full reservoir level (FRL) and 55 hectares at dead storage level (DSL) and has a catchment area of 310.80 km^2. Reservoir is used for different purposes like irrigation, drinking water supply, fisheries, and thus is a true multipurpose tank. Four sampling stations viz., station- S1, S2, S3, and S4 were established for analysis of physico-chemical Characteristics of water. The sampling locations were chosen carefully in order to get maximum representation of the diverse eco-hydrological environments within the reservoir as shown in (Fig. 1)

Water samples were collected from all the four sampling stations of Pahuj reservoir every month in the morning hours between 6.00 to 8.00 am for a period of twelve months during the year August 2008 to July 2009. The temperatures were recorded at the time of sampling on the spot using centigrade thermometer. The transparency of water to light was measured by Secchi disc. The pH was determined by using standard pH meter. The other parameters of water such as dissolved oxygen, free carbon dioxide, alkalinity, total hardness, chlorides, Silicates, nitrate nitrogen and total phosphorus were estimated by the procedures given by APHA (American Public Health Association), 1995.

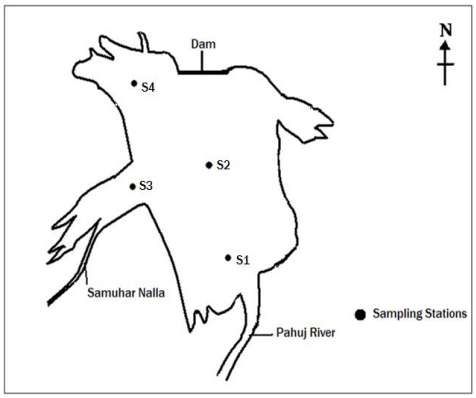

Figure 1: Map of study area showing location of different water sampling stations

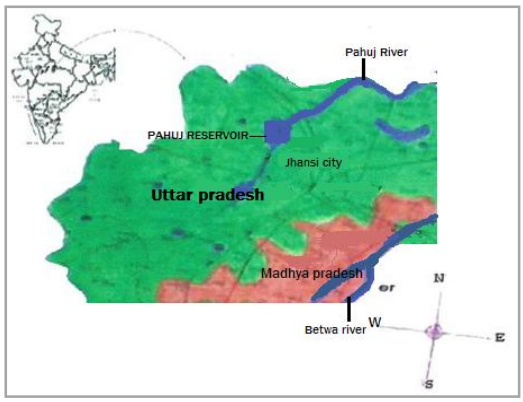

Figure 2: Map showing the location of study Area

RESULTS AND DISCUSSION

Range of variation and their mean along with standard deviation of various Physico-chemical characteristics of water of Pahuj reservoir, Jhansi have been given in (Table. 1). plays an important role in governing the water quality. Like, any other water body, in Pahuj reservoir, maximum water depth (5.70 m) was recorded in monsoon season while also minimum water depth (3.00 m) was recorded in summer season during the year of study with an average of 4.63± 1.01m. The slight decrease in water level during summer season may be due to evaporation and supply for the irrigation. Similar seasonal variations were also recorded by (Surve *et al*., 2005) and (Garg *et al*., 2008). In the present study water temperature was found ranging between 15.12^0C to 35.75^0C with a mean value of 26.07±7.27. The maximum value (35.75^0C) was noticed in summer season and the minimum value (15.12^0C) in winter season. Many workers observed similar trends while working on different water bodies (Dwivedi and Pandey, 2002) and (Singh and Mathur, 2005). Transparency in the present study ranged between 30 cm to 370 cm with an average of 135.0±125.6 cm.

During this study, higher values were reported in post-monsoon while the lower values in summer season. The higher values during post-monsoon may be attributed to settlement of sand, silt and clay in the reservoir (Garg et al., 2008), while as lower values of transparency during summer season may be due to low level of water and organic pollution. (Kadam *et al*., 2007) also reported similar observations from Masoli reservoir of Parbhani district of Maharashtra. pH is considered as one of the most important chemical parameter of water since most of the aquatic organisms are adopted to an average pH. The pH values in the present study ranged from 7.34 to 8.82 with an average of 7.84±0.43. Higher value 8.82 was reported in summer season while the lower value 7.34 in winter season. Higher value of pH in summer season may be due to low level of water and sewage discharged by Jhansi city. Gupta and Mathur (2001) noticed the higher values of pH in summer period in lakes around Udaipur city (Rajasthan). Electrical conductivity measures the capacity of a substance or solution to conduct electrical current. The electrical conductivity was found to fluctuate between 224.00µs/cm to 660.30µs/cm with an average of 327.4±181.30 µs/cm.

The highest values were observed in post-monsoon season and lower values in winter season. Similar observations were also reported by (Srivastava and Shina., 1996). Dissolved oxygen is one of the most important chemical parameter of the water quality, directly affecting survival and distribution of flora and fauna in an ecosystem. In the present study dissolved oxygen values ranged from 7.10mg/L to 10.52 mg/L with an average of 9.25±1.25 mg/L. Dissolved oxygen was found to be higher in early summer (March) followed by post-monsoon season and the lower value in summer season. High dissolved oxygen concentration during early summer and the post-monsoon season could be due to vigorous photosynthetic activity by autotrophs as myxophyceae bloom was observed during these seasons in the reservoir. A marked decrease in dissolved oxygen content towards the summer season could be the result of increase in water temperature and increased rate of decomposition. Free Co_2 in the present study varied from 13.42 to 19.35mg/L with a mean value of 16.35±2.24 mg/L.

Free carbon dioxide exhibited a prominent inverse relationship with the amount of DO and increase in one of these parameters lead to the decrease of others and vice versa. The free carbon dioxide was high during summer season and low during post-monsoon season. The high concentration of free Co_2 during summer may be attributed to decomposition of organic matter due to increased temperature (Joshi *et al*., 1995) while as low concentration of free Co_2 during Post-monsoon season could be due to high photosynthetic activity by Autotrophs. The total alkalinity ranged from 100.82 to 170.42 mg/L with an average of 136.60±26.93 mg/L, of which maximum value 170.42 mg/L was observed in summer season and minimum value (100.82 mg/L) in monsoon season. The higher values of alkalinity in summer season may be due to decomposition of organic matter. Similar observations were made by (Bade *et al*., 2009), (Nair and Rajendra, 2000) and (Mane *et al.*, 2002).

Total hardness values ranged from 85.60 to 176.50 mg/L with an average of 117.6 ± 37.30 mg/L, of which higher value 176.50 mg/L was found in summer season while the lower value (85.60 mg/L) in winter season. The similar results were reported by Hujare (2008). The increase in hardness can be attributed to the decrease in water volume, high loading of organic substance and addition of calcium and magnesium salts from detergent and soaps used for washing clothes in the Jhansi city. Similar findings were observed by (Ratushnyak *et al*., 2006), (Ajmal and Razi-ud-din, 1988), (Mathivanan *et al*., 2007) and (Park and Shin. 2007). During the present study, the chloride values were found ranging between 23.60 mg/L to 85.32 mg/L with an average of 45.01± 24.69 mg/L (Table 1). Higher values were recorded in summer season and lower in monsoon season. The relatively lower values during rainy season can be attributed to the increase in dilution of rain water (Sangpal *et al*., 2011). In case of Pahuj reservoir the higher value of chlorides in summer season is probably due to organic pollution (Venkatasubramani and Meenambal, 2007). The concentration of silicates ranged from 2.50 mg/L to 8.52 mg/ L with an average of 5.10± 2.26 mg/ L.

Lower values of silicates were recorded in winter months while as higher values in the summer season. The higher values during summer season may be attributed to higher evaporation rate (Ahangar *et al*., 2012). During the investigation period the values of nitrate nitrogen recorded were in the range 24.4µg/L to 460µg/L with an average of 126.2±161.4 mg/L. Higher values were recorded during post-monsoon while the lower values were recorded in winter. The high NO_3-N concentration during post-monsoon could be due to leaching and surface run-off of fertilizers from vast catchment area into the reservoir water. Phosphate is an important nutrient for the maintenance of the fertility of water body. During the present investigation the phosphate concentration was reported higher 375 µg/L in post monsoon and lower 24.80µg/L in summer season. Higher concentration of phosphate during post-monsoon season may be related to the weathering of rocks liberating soluble alkali phosphate, and the anthropogenic inputs of super phosphate applied to the agriculture field in the catchment area of reservoir can be the other source of phosphate. This is in agreement with the findings of (Adeyemo *et al*., 2008).The lower concentration during summer may be attributed to the utilization of nutrients by autotrophs (Kaul *et al*., 1978).

Table 1: Range of variation, mean and standard deviation of water quality parameters of Pahuj reservoir Jhansi during August 2008 to July 2009

S.no	Parameters	Range of variation		Mean + SD
		Min	Max	
1	Depth (m)	3.00	5.70	4.63±1.01
2.	Temperature (ºC)	15.12	35.75	26.07±7.27
3.	Transparency (cm)	30.00	370.00	135.0±125.6
4.	pH	7.34	8.82	7.84±0.43
5.	Conductivity (µS/cm)	224.00	660.30	327.4±181.30
6.	Dissolved oxygen (mg/l)	7.10	10.52	9.25±1.25
7.	Free Carbon dioxide (mg/l)	13.42	19.35	16.35±2.24
8.	Total alkalinity (mg/l)	100.82	170.42	136.60±26.93
9.	Total hardness (mg/l)	85.60	176.50	117.6±37.30
10.	Silicates (mg/l)	2.50	8.52	5.10±2.26
11.	Chlorides (mg/l)	23.60	85.32	45.01±24.69
12.	Nitrate (µg/l)	24.4	460	126.2±161.4
13	Phosphate(µg/l)	24.80	375	128±123.7

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