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LIMNOLOGICAL STATUS OF KHANAPUR FRESHWATER RESERVOIR FROM AJARA TAHSIL, KOLHAPUR DISTRICT (MS), INDIA

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Abstract: The present study deals with the physico-chemical characteristics of Khanapur perennial reservoir of Ajara Tahsil, Kolhapur District (MS) from India. Various physico-chemical parameters were studied during the period of July 2011 to June 2012 and various parameters like Temperature, Transparency, pH, Electrical Conductivity, Free CO_2, Total Hardness, Calcium, Magnesium, Total Alkalinity, Chlorides and Dissolved Oxygen were analyzed monthly whereas sodium, potassium, nitrate, phosphate and sulfate were analyzed seasonally from surface water of reservoir. Results revealed that Temperature, Transparency, pH, Electrical Conductivity, Free CO_2, Total Hardness, Calcium, Magnesium, Total Alkalinity, Chlorides and Dissolved Oxygen were showed monthly variations while sodium, potassium, nitrate, phosphate and sulfate showed seasonal variation, since nitrate and phosphate were in very small concentration. All the parameters are in the acceptable limit hence, from the study it has also been concluded that water from reservoir is suitable for drinking and fishing purpose and recommended for commercial fishing.

Introduction

Aquatic ecosystem is revolving around the water. Along with aquatic animals, water also plays an important role in the life of other animals including human. It is most important natural resource and continuous supply of clean water is mandatory for the survival of all living organisms. According to different study, it has been estimated that out of total earth surface approximately 70% area is covered by water, out of which only 2.4% is considered to be freshwater. Now-a-days huge pressure is being exerted on the water resources because of uncontrolled population growth and ultimately the quality as well as quantity of water has declined. However the water quality of some water reservoirs are in good status and supports both flora and fauna directly or indirectly by balancing ecological parameters. Since the proper categorization of water resources should be made according to their physico-chemical characteristics. As physico-chemical parameters plays a major role in ascertaining the distributional pattern and quantitative abundance of organisms inhabiting a particular

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ecosystem (Singh *et al.,* 2009), It is the need of today to conserve these ecosystems. Several investigators have studied the physico-chemical dynamics of varied lentic water bodies with the intent to assess the water quality (Islam, 2011; Venkateshwarlu *et al.,* 2003, Sayaswara *et al.,* 2010). Hence periodic monitoring of water quality of wetlands like lakes, ponds, reservoirs, ditches and pools is necessary.

Study Area

Khanapur reservoir (N 16^0 08' 945" and E 74^0 17' 777") is manmade, reservoir having a submergence area of 20.71 ha during rainy season shown in figure 2, situated at Khanapur village which is 9-10 km away from Ajara on the southern part. Reservoir area is covered by thick forest on its three sides. Forest consists of monoculture of Australian Acacia. The population of this village is about 1800 and the annual rainfall of this area is about 2689 mm. Water from this reservoir is used for domestic purposes like cloth washing and bathing. Water is also used for animal washing, animal drinking and irrigation purpose. Locally, fishing is also observed during the study period. Although the limnological studies and water quality status was exclusively studied over the last few decade, this area of Kolhapur district from Maharashtra have been neglected so the present study is carried out to reveal the physico-chemical characteristics and accordingly the suggestions were given to enhance the sustainability of people around the reservoir.

Collection of Samples

The samples of surface water were collected monthly from Khanapur reservoir during July 2011 to June 2012 for EC, Total Hardness, Calcium, Magnesium, Total Alkalinity and Chlorides while seasonally collected for sodium, potassium, nitrate, phosphate and sulfate. The samples were collected in plastic container in the morning hours and brought to the laboratory for further analysis.

Analysis of physico-chemical properties

For the analysis, the standard methods were used. Some parameters like Temperature, pH, Transparency was done at the investigation sites. The sample for DO was fixed in the BOD bottle at the sites and then brought to the Laboratory for analysis. Winkler's method was followed for this analysis, while remaining analysis was made by the standard methods of APHA (2005) and Trivedy and Goel (1986).

Results and Discussion

The results of monthly variation in physico-chemical characteristics of surface water from Khanapur reservoir is given in table 1 and 2 while seasonal variation of some physico-chemical parameters of surface water is given in figure 1.

Temperature

Temperature is a vital parameter for growth of organisms. Atmospheric and water temperature plays an important role in physico-chemical and physiological behavior of aquatic system. It also exerts profound direct or indirect influence on metabolic and physiological behavior of aquatic ecosystems (Welch, 1952). The monthly variation in atmospheric and water values ranges from 20^0 C to 32^0 C and 19^0 C to 29^0 C respectively. Air temperature was reported highest in the month of April and lowest in the month of August while water temperature was highest during April and may whereas lowest during July.

Transparency

Light rays are the major source for aquatic systems, influences the activity of photosynthesis. Transparency is a characteristic of water that varies with the combined effect of turbidity and color. Turbidity is majorly caused because of silt, clay, planktons and colloidal organic matter which results into low transparency. The values of transparency range between 25 cm and 171.5 cm. Transparency value was inclined in the month of November whereas declined in the month of July. Low values of transparency during rainy season may be due to silt brought into the reservoir from adjoining catchment area through rain water while high value of transparency due to gradual settlement of suspended particles. Similar trend of inclined values for transparency during winter and declined during rainy was noted by Thirupathaih *et al.* (2012).

pH

pH balance in an ecosystem is maintained when it is within the range of 5.5 to 8.5 (Chandrasekhar *et al.,* 2003). The monthly variation in the pH values ranges between 6.4 and 8.64. pH values were increased in the month of January and decreased in the month of May. Similar trend of increased pH during winter and decreased during summer was given by Mathivanan *et. al.* (2005). Kaul and Handoo (1980) emphasized that increased surface water pH in water bodies is due to increased metabolic activities of autotrophs, because in general they utilize the CO_2 and liberates O_2 thus reducing H^+ ions. In water bodies liberation of acids from decomposing organic matter under low concentration result in low pH and usually decomposition of organic matter takes place during summer months.

Electric conductivity

The conductivity of lake water is a measure of the capacity of substances or a solution to conduct electric flow. It depends upon dissolved solids (APHA, 2005). The monthly variation in the values of EC ranges from 0.057 mhos/cm to 0.23 mhos/cm. EC values were seen decreased in the month of June and increased in the month of April. Higher values during summer months may be due to the accumulation of ions owing to evaporation, biological turn over and interaction of sediments. Dilution of water during rainy season causes decreased EC due to addition of rain water. Similar trend of decreased EC during rainy season while increased during summer season was given by Pushpendra and Madhyasatha (1994).

Free CO_2

Although CO2 is a minor component of air it is abundant in water because of its solubility which is 30 times more than that of oxygen, and the amount of CO_2 in water usually shows an inverse relationship with oxygen (Radhika *et al.,* 2004). Free CO_2 is essential for photosynthesis and its concentration affects the phytoplankton, and its productivity. Excess of it gets dissociated into carbonic acid. The limit of free CO_2 as per acceptable Standards is 10 mgL-1 of surface water. Increase in CO_2 indicates increase in pollution load (Koshy and Nayar, 1999). Free CO_2 values ranges from 4.4 mg/l to 13.2 mg/l. Particular trend of CO_2 value was not observed during the study period, it was fluctuating throughout the year.

Total Hardness

Hardness is the property of water which prevents lather formation with soap and increases the boiling point of water. Principal cations imparting hardness are calcium and magnesium. However, other cations such as strontium, iron and manganese also contribute to hardness. The anions responsible for hardness are mainly bicarbonate, carbonate, sulfate, chloride, nitrate and silicates, etc. The monthly variation in total hardness ranges from 30 mg/l to 64 mg/l. It was minimum in the month of June whereas maximum in the month of December. It was minimum during rainy season because of dilution due to rain water and maximum during winter season because of leaching salts salt from the catchment area. Similar trend of higher in winter and lower in rainy season was given by Sarma and Dutta (2012) and Sayeswara *et al.* (2012).

Calcium

Calcium, in the form of the Ca2+ ion, is one of the major inorganic cations, or positive ions, in saltwater and freshwater. It can originate from the dissociation of salts, such as calcium chloride or calcium sulfate, in water.

$$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2\ Cl^{-}(aq)$$

$$CaSO_4(s) \rightarrow Ca2^{+}(aq) + SO_4^{2-}(aq)$$

Most calcium in surface water comes from streams flowing over limestone, $CaCO_3$, gypsum, CaSO4•2H2O, and other calcium-containing rocks and minerals. Calcium ion concentration was show monthly variation from 5.61 mg/l to17.64 mg/l. It was lower in the month of August whereas higher in the month of December. Minimum values of calcium ion concentration during rainy season might be due to greater dilution b addition of rain water whereas maximum during winter season might be due to leaching of underground aquifers leach even higher concentrations of calcium ions from rocks and soil. Calcium carbonate is relatively insoluble in water, but dissolves more readily in water containing significant levels of dissolved carbon dioxide.

$$CaCO_3(s) + CO_2(aq) + H_2O(l) \longleftrightarrow Ca_2^{+}(aq) + 2HCO_3^{-}(aq).$$

Magnesium

Magnesium is often associated with calcium in all kinds of waters but its concentration remains generally lower than the calcium (Venkatsubramani and Meenmbal, 2007). The monthly variation in magnesium ion concentration values ranges from 4.75 mg/l to 11.26 mg/l. It was minimum in the month of June and maximum in the month of December. Similar trend of higher during winter and lower during rainy was also noted by Verma *et al.* (2011).

Alkalinity

In pure natural water alkalinity is mostly due to dissolved CO_2 or carbonate ions and it represents the main carbon source for assimilation during photosynthesis. The monthly variation in the alkalinity values ranges from 10 mg/l to 30 mg/l. The alkalinity values inclined in the month of November whereas declined in the month of April. Similar trend of inclined alkalinity during winter was given by Latha and Mohan (2010) while declined alkalinity during summer was reported by Rahul (2012). According to Kaul *et al.* (1980) increase in atmospheric temperature and the consequent increase in photosynthetic process in hot season, alkalinity values usually decrease in summer.

Chlorides

Chloride is an important parameter in assessing the water quality. It controls the salinity of water and osmotic stress on biotic communities (Banerjee, 1967). It also increases the degree of eutrophication (Goel *et al.* 1980). The monthly variation in the chloride values ranges between 14.2 mg/l and 36.82 mg/l. It was observed minimum in the month of July and maximum in the month of March. Chloride values were higher during summer might due to high anthropogenic and animal activities whereas lower during rainy season might be due to dilution of rain water and decreased anthropogenic and animal activities. Similar trend of chloride ion concentration was given by Garg *et al.* (2011).

Dissolved Oxygen

The oxygen content of water body is one of the important parameter in quality assessment. It presence is essential in aquatic ecosystems to keep the organisms in balance. It also affects the solubility and availability of many nutrients hence affecting the productivity of aquatic ecosystems (Wetzel, 1983). The monthly variations in dissolved oxygen values range from 6.4 mg/l to 15.2 mg/l. It was minimum in the month of April while maximum in the month of December. Lower oxygen content were observed during summer season due to DO decreases with increased temperature and oxygen level increased during winter season because of DO increases with decreased temperature. The trend of dissolved oxygen maximum in winter season and minimum in summer season was also given by Tiwari and Ranga (2012) and Sinha and Biswas (2011).

Sodium

Sodium is one of the important cation occurring naturally. The concentration of sodium in freshwater is generally lower than calcium and magnesium (Trivedi and Goel, 1986). In present study, a seasonal variation in sodium values ranges between 7 mg/l to 12 mg/l. Maximum values were observed during summer while minimum during winter season. Similar trend of sodium values increased during summer and minimum during winter was emphasized by Garg *et al.* (2011).

Potassium

Potassium is a naturally occurring element in water; however its concentration mostly remains lower than that of sodium, calcium and magnesium. The potassium values showed seasonally variation from 00 mg/l to 1 mg/l. Potassium values were increased during summer whereas decreased during winter season. Similar trend of potassium values increased during summer and minimum during winter was also emphasized by Garg *et al.* (2011).

Nitrate

Nitrate is the most highly oxidized form of nitrogen compounds commonly found in waters, as it is the product of anaerobic decomposition of organic nitrogenous waste. Usually unpolluted, natural water contain minute amount (Shinde *et al.,* 2011). Nitrate values ranges from 0.006 mg/l to 0.064 mg/l; higher nitrates were observed during summer and lower during winter season. Similar trend of higher nitrates during summer and lower during winter season was also noted by Bade *et al.* (2009)

Phosphate

Phosphorus is prime nutrient for the growth of plant next to the nitrogen and plays an important role in metabolism of both plants as well as animals. In natural waters phosphorus ranges from 0.005 mg/l to 0.020 mg/l (Shinde *et al.* 2011). Higher amount of phosphorus can cause eutrophication in water reservoirs leading to algal bloom. Seasonal variations in phosphate values range between 0.005 mg/l to 0.092 mg/l; increased concentration of phosphates were noted during summer season and lower phosphates during rainy season.

Sulfate

The main source of sulfate is runoff of water from catchment area rich in mineral and organic sulfur. Seasonal variation in sulfate value ranges from 0.6 mg/l to 8 mg/l. It was observed highest during rainy season while lowest during summer season. The trend of sulfate is agreement with Latha and Mohan (2010).

Conclusions

In above study major as well as important physico-chemical parameters have been estimated and it has been concluded that the water from this reservoir is of potable quality. It has also been concluded that the water is suitable for the commercial fish culture and recommended to the commercial fishing in the water reservoir as the reservoir is of perennial type and during summer season the water level reduces to maximum level (about 85%); it is easy to fish catching.

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Table 1: Monthly Variation in Air Temperature (AT), Water Temperature (WT), Transparency, pH, EC and CO_2.

Month/ Parameter	AT	WT	Transparency	pH	EC	Free CO_2
July	21	19	25	7.82	0.163	8.8
August	20	22	87.5	7.5	0.128	8.8
September	24	22	142	7.48	0.115	4.4
October	21	20	129.5	7.57	0.17	4.4
November	28	23	171.5	7.86	0.18	8.8
December	25	22	132	7.85	0.18	13.2
January	29	21	103	8.64	0.17	8.8
February	30	22	119.5	7.35	0.1	8.8
March	28	26	125.5	7.58	0.125	4.4
April	32	29	131	7.64	0.23	8.8
May	31	29	142	6.4	0.078	8.8
June	21	23	89.5	6.9	0.057	13.2
Average	25.833	23.166	116.5	7.549	0.141	8.433
SD	4.179	3.077	35.542	0.52	0.047	2.816

Table 2: Monthly Variation in Total Hardness (TH), Calcium, Magnesium, Total Alkalinity (AT), Chloride and Dissolved Oxygen (DO).

Month/ Parameter	T. H.	Calcium	Magnesium	TA	Chloride	DO
July	30	10.42	13.01	22	14.2	8
August	32	5.61	6.41	16	17.04	9.6
September	48	11.22	8.93	24	19.88	8
October	44	12.03	7.76	14	19.08	9.2
November	44	13.63	7.37	30	25.06	6.4
December	64	17.64	11.26	16	31.24	15.2
January	54	16.04	9.22	16	25.56	12.8
February	46	13.63	7.83	26	19.88	7.6
March	50	12.83	9.03	20	36.92	7.2
April	32	10.42	5.24	10	31.24	6.4
May	32	12.03	6.41	16	28.4	8
June	30	10.42	4.75	16	19.88	7.6
Average	42.166	12.16	8.101	18.833	24.031	8.833
SD	10.565	2.9262	2.286	5.444	6.546	2.526

Note: All values are in mg/l except temperature (^{0}C), transparency (cm), pH and E.C (mhos/cm).

Fig 1: Seasonal variations in Sodium, Potassium, Nitrate, Phosphate and Sulphate

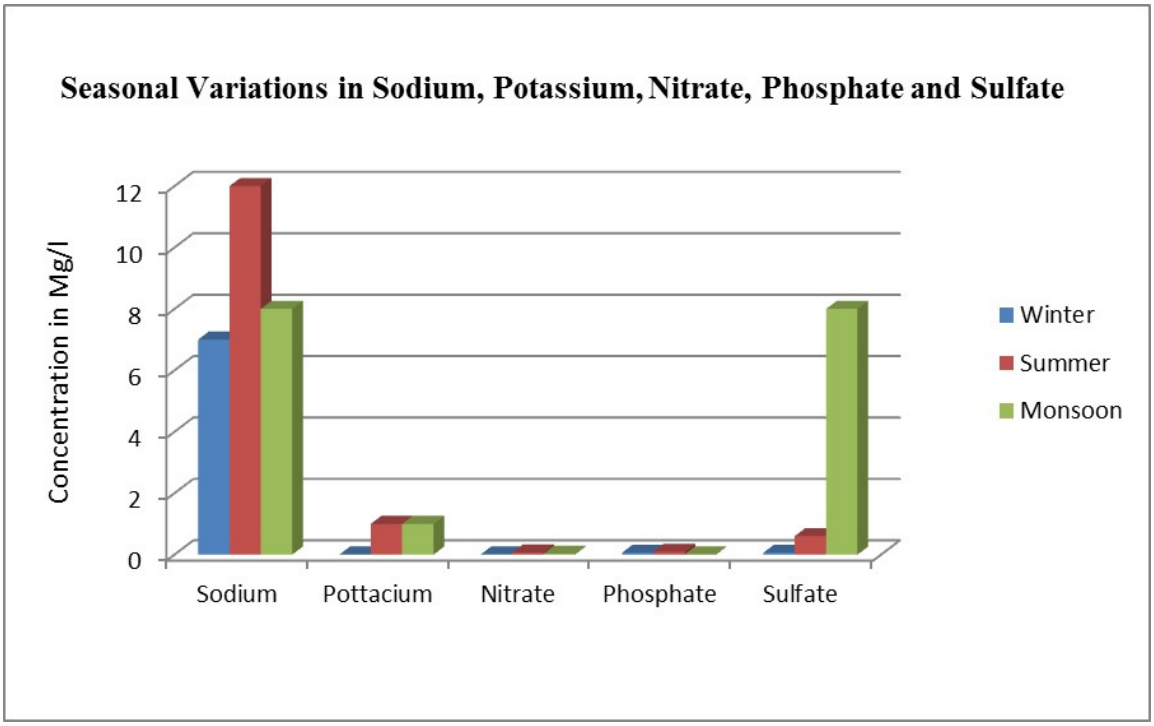

Fig 2: GPS Map of Khanapur Reservoir