VOL- VII ISSUE- X OCTOBER 2020 PEER REVIEW e-JOURNAL IMPACT FACTOR 6.293 ISSN 2349-638x

Correlation Studies of Bhakuchi Wadi Reservoir of Sangli District, Maharashtra

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Abstract

This Investigation describes the physico- chemical profile and correlation matrix of Bhakuchi wadi perennial reservoir of Sangli in Maharashtra where limnological studies were conducted from August 2016 to July 2017. The physico-chemical parameters varied seasonally. The Secchi disc values varied from 13.5 to 81.5 cm. The pH remained alkaline between 8.0 to 8.8. The dissolved oxygen varied from 4.32 to 9.53 mg/l during study period. The total alkalinity values ranged between 108 and 302 mg/l. The total hardness values varied from 115 to 412 mg/l for annual period. Calcium content was fluctuated from 43.62 to 66.26 mg/l. The magnesium values are ranged between 29.71 to 34.1 mg/l. The values of total dissolved solids were observed from 200 to 510. Chlorides and total dissolved solids were maximum during summer and minimum in winter season. The reservoir may be placed under the category of oligotrophic in winter season. In correlation matrix free carbon di-oxide is negatively correlated with all parameters.
Key words: Physico-chemical parameters, Correlation coefficient, Bhakuchi wadi reservoir

Introduction

India has vast fresh water resources in the form of both lentic and lotic ecosystems. The lentic ecosystems include ponds, lakes, tanks and reservoirs. The perennial reservoirs play an important role as a valuable water resource for domestic, agriculture and aquaculture. The lentic ecosystems have long attracted attention of ecologists, both for their importance as a source of drinking water and the development of fisheries.

Several limnological studies have been carried out in this region, notable among these are of Kamat (1965), Goel *et al* (1988) and Bhosale *et al* (1994). Most of the studies were carried out in water bodies of urban area. Few of studies from rural area are reported by Hujare (2008) and Jadhav *et al* (2009).

The study has been designed to understand the hydrobiological features of reservoir, to assess water quality which will state the potability, suitability for fish culture and irrigation purpose.

Material And Methods

Study Area:

The fresh water reservoir of Bhakuchi wadi is located in Sangli district (74^{O} 37' N latitude and 17^{O} 19' E longitude) of south-eastern Maharashtra. A year can be broadly divided into three seasons; summer season from March to May, rainy season from June to October and winter from November to February.

This is minor irrigation project constructed in 1988-91 in Khanapur tahsil of Sangli district. The total capacity of storage is 680.30 Mcft and dead storage is 59.96 Mcft. The catchment area of reservoir is 261.21 sq. miles.. Total length of dam including slipway is 1990 M with 150 M is only the length of slipway. It is of clear overflow type. Earthen type of dam having height of 19.70 M. Total water spread is 1207 hector having 108.80 hectare of submergence area. The bottom of reservoir is rocky. The reservoir water is formerly used for irrigation but also for washing, bathing and pisciculture activities. The reservoirs store rain water received from adjoining catchment area and is much influenced by anthropogenic activities.

The surface water samples were collected approximately 10 meters from border line monthly from site I, site II and site III. The air and water temperature were measured using mercury thermometer. The transparency of water was measured by using Secchi Disc. The pH was determined by using pH meter (Hann). The water samples were analyzed by Slandered methods as described by APHA, AWWA WPCF (1985) and Trivedy *et al* (1998) were followed for various physico chemical parameters.

Results And Discussion

Average values (ranges in parentheses) of physical and chemical parameters recorded at Bhakuchi wadi reservoir were depicted in Table 1. Temperature of water in fluctuated from 24.3 ^{o}C (December) to 28.1 ^{o}C (May) during the study year. Overall, there were fluctuations in the water temperature of water bodies as the atmospheric temperature of the locality.

The Secchi disc transparency of reservoir ranged from 13.5 to 81.5 cm during the investigation. The lowest transparency was observed during summer and highest values were recorded during winter season.

The pH values were variable between 8 and 8.8 with an average of 8.33. The pH of reservoirs remained alkaline throughout the study period. The annual fluctuations were negligible, indicating good buffering capacity. The water having pH range of 6.5 and 9.0 are most suitable for pond aquaculture (Jhingran 1982). According to WHO (1993) the desirable pH of drinking water is between 7.0 and 8.5. In the present work the highest values of pH during summer may possibly due to removal of sufficient amount of CO_2 by photosynthetic process of the aquatic system. (Solanki *et al* 2005, Kaur *et al* (1997).

At Bhakuchi wadi reservoir, electrical conductivity values showed marked seasonal variations, being maximum (0.724 m mhos) during summer and minimum (0.258 m mhos)during winter months. Hujare (2005) has mentioned maximum electrical conductivity value during summer and minimum during winter in the reservoirs of Hatkanangale tahsil of Kolhapur district, which is in agreement with the observations in present study.

The amount of dissolved oxygen in reservoir ranged from 4.32 to 9.53 mg/l with average value 5.23 mg/l. Sobha and Harilal (2005) have observed dissolved oxygen as 0.41 mg/l in August 2000 and 3.25 mg/l in March 1999 in the aquatic system located at Ampalathara, south of Thiruvanthpuram city. It is interesting to note that, dissolved oxygen increased appreciably during summer and decreased in monsoon months. However, very little variation is observed during summer and monsoon.

The minimum dissolved oxygen limit for fish growth is 4.0 mg/l (Jhingran 1982). According to APHA (1985) the lowest dissolved oxygen for maintaining fish in healthy condition is 5.0 mg/l and the critical value is 3.0 mg/l. In present study the range of dissolved oxygen is found optimum for fish growth. The dissolved oxygen content of the reservoirs is favourable for fish production. The major cause of oxygen depletion during monsoon may be due to reduction in the photosynthetic activity. Relatively higher values of dissolved oxygen during summer probably as a result of photosynthetic activity (Solanki *et al* 2007). Similar type of observation was made by Khare *et al* (2007).

The free carbon dioxide values varied from 0.1 to 2.3 mg/l during the year of investigation. Free carbon dioxide values were decreased during summer and increased during rainy season. The values of free carbon dioxide were very negligible in winter and summer seasons. Free carbon dioxide in water forms carbonic acid which after dissociation gives H^{+} ions thus, decreasing pH values. The free carbon dioxide is essential for photosynthesis. Well aerated waters with very little pollution usually have no or very little free carbon dioxide (Goel & Chavan 1991, Hujare 2005). The intense sunlight during winters and summers seem to accelerate photosynthesis by phytoplankton thereby utilizing carbon dioxide and giving off oxygen. During rainy months dilution reduces the phytoplankton population remarkably; more over diffused sunlight during cloudy atmosphere may reduce the rate of photosynthesis. (Ahmed & Krishnamurthy 1990). The monsoon rains brought a fresh supply of free carbon dioxide causing reduction in pH. Similar observations have also been made by Gupta *et al*

(2008), Devi (1993), Kumar *et al* (1996) and Mishra *et al* (1999).

The values of total alkalinity in Bhakuchi wadi water body fluctuated from 108 to 302 mg/l during the study period. In reservoir, during rains total alkalinity declined while, increased up to summer season. Many workers have observed similar pattern of variations in total alkalinity which supports present findings (Shrivastava 2005, Hujare 2008, Sukhija 2007, Sharma & Jain 2000, Chatterjee & De 2008, Jadhav & Chavan 2009 ; Sawant & Telave 2009). Raveen *et al* (2008) have also reported the highest range during summer and the lowest during monsoon. Jackson (1961) has suggested that the alkalinity below 50 mg/l indicates low photosynthetic rate. Based on this both reservoirs have higher photosynthetic rate. Alka Patil 2013 has observed same fluctuations of total alkalinity in Bhambarde water body.

The range of hardness is recorded 115 and 412 mg/l during winter and summer season of investigation, respectively. The highest hardness values in summer season are mainly attributed to rising temperature, thereby increasing the solubility of calcium and magnesium salts (Garg 2003). The permissible limits prescribed by both WHO (1993) and Bureau of Indian Standards (1991) is 300 mg/l. The hardness of reservoir lies beyond the limit during summer months and hence the water is not suitable for drinking as it is hard. The higher hardness values in summer season are mainly attributed to rising temperature thereby increasing the solubility of calcium and magnesium salts (Garg 2003). Singh and Gupta (2004) observed minimum values of hardness during November and maximum during April. Maximum values during summer months may be due to scarcity of rainfall. (Khabade and Mule 2005). Mathivannan *et al* (2005) also reported similar pattern of variations at Mettur Dam.

In Bhakuchi wadi reservoir calcium content was found minimum during winter 43.62. mg/l and maximum in summer 66.26 mg/l during the study period. The maximum desirable limit of calcium in drinking water is 75 mg/l (WHO, 1993 & BIS, 1991). The calcium content in both reservoirs is below the desirable limit. Subhashini and Saradhamani (2005) have recorded similar pattern of change in calcium content in Aliyar reservoir of Coimbatore district.

Magnesium values remained higher in summer 34.1 mg/l, followed by rainy season and decreased during winter 29.71 mg/l. The concentration of magnesium was minimum compared to concentration of calcium possibly due to lesser occurrence of magnesium minerals in the bottom of reservoir.

According to WHO (1993) and BIS (1991), the permissible limit of magnesium for drinking water is 50 mg/l. The present results of these reservoirs are within the permissible limit. Shrivastava & Mansood (2007) have recorded the highest values of magnesium in pre monsoon season. Deshmukh & Pingale (2007) have reported higher values in April and lowest during December at Wiscon dam water.

The average value of chloride was 33.15 mg/l during the investigation. The chloride values in the reservoir were increased during summer and decreased in winter of sampling year. According to WHO (1993) and BIS (1991) permissible limit of chloride is 200 mg/l for drinking water. The water from the selected reservoirs is below limit and therefore, it is noted that the water is fit for drinking. Similar condition was observed by Anand & Sharma (2000), Sharma & Jain (2000), VijayKumar *et al* (2005), Khare *et al* (2007), Raveen *et al* (2008), Hujare & Mule (2008) and Sawant & Telave (2009). Rise in the level of chlorides may be due to increased temperature and evapo-transpiration (Chatterjee & De 2008). In general, concentration of chlorides is affected by several factors, such as increased human and cattle activities. This also indicates the organic load of animal origin.

The lowest values of total dissolved solids were observed during winter 200 mg/l, while in summer, it reached upto 510 mg/l. The total dissolved solid indicates the general nature of water quality. The water containing 500 mg/l total dissolved solids is the desirable limit for potable water (WHO 1993, BIS 1991). It is evident that the total dissolved solid values were beyond the desirable limit with onset of summer. In rainy and winter seasons, reservoir water was within the limit. This investigation highest total dissolved solids

values were obtained during summer, which can be attributed to high rate of evaporation and consequently decreased water level leading to accumulation of dissolved solids.

On the basis of concentration of total dissolved solids water is classified by ICMR (1975) and accordingly Bhakuchi wadi reservoir water is only desirable in rainy and winter and permissible during summer.

The amount of total nitrogen is 2.98 mg/l in December. It increased in May up to 15.03 mg/l. According to Omana and Mohan (2008) the range of total nitrogen is between 0.1 to 4.0 mg/l, highest values were observed during summer. However, Kosygin & Haobijam (2005) and Jain *et al* (2005) described the highest range of total nitrogen in March with decreasing range in monsoon to winter. Sonawane (2011) studied physico- chemical profile of Sukhana River in Aurangabad.

Phosphorus is an essential nutrient for plant growth, but too much phosphorus cause excessive growth of algae and weeds. Hence it is used as an indicator of the pollution for algal growth in fresh water ecosystem. The values for total phosphorus were 0.003 and 0.56 mg/l in December and May, respectively during the study period. The minima is observed during winter and then in monsoon. Similar observations have reported by Anand & Sharma (2000), Sobha & Harilal (2005) and Kosygin & Haobijam (2005). The presence of high concentration of phosphorus in water may lead to pollution. Lee *et al* (1981) have classified the water bodies on the basis of phosphorus content.

< 0.0079 mg/l : Oligotrophic
0.008 to 0.011 mg/l : Oligomesotrophic
0.012 to 0.027 mg/l : Mesotrophic
0.028 to 0.039 mg/l : Meso-eutrophic
> 0.040 mg/l : Eutrophic

According to above criteria, the reservoir may be placed under the category of oligotrophic in winter season. Shukla and Shukla {2013) recorded phytoplankton productivity of Marhani Lake, Basti, U.P.

The correlation coefficients (r) were calculated and correlation matrix was obtained. The values of correlation matrix of Bhakuchi wadi reservoir is given in Table 2.

Very high positive correlation was found between chlorides and electrical conductivity (0.919), total dissolved solids (0.914), and total nitrogen (0.926). Total alkalinity and dissolved oxygen (0.933), total dissolved solids (0.946).

Very poor positive correlation was recorded in calcium and pH (0.328), free carbon dioxide (-0.299). pH and chlorides (0.352).

It is interesting to note that free carbon dioxide was negatively correlated with all parameters. Surface Water Qualitry Assessment of Abandoned studied by Sandipan Pal *et. al.* (2013).

Table 1 Average values (ranges in parentheses) of physical and chemical parameters recorded at Bhakuchi wadi reservoir from August 2016 to July 2017.

Parameters	**Minimum and Maximum values**		
WT (ºC)	26.24	(24.3-	28.1)
Transp.(cm)	39.87	(13.5-	81.5)
pH	8.33	(8-	8.8)
EC (m mhos)	0.47	(0.258-	0.724)
DO (mg/l)	5.23	(4.32-	9.53)
CO2 (mg/l)	0.73	(0.1-	2.3)
TA (mg/l)	163.17	(108-	302)
TH (mg/l)	210.33	(115-	412)
Ca (mg/l)	47.39	(43.62-	66.26)
Mg (mg/l)	32.40	(29.71-	34.1)
Cl (mg/l)	33.15	(21.34-	35.51)
TDS (mg/l)	306.67	(200-	510)
TN (mg/l)	8.94	(2.98-	15.03)
TP (mg/l)	0.11	(0.003-	0.56)

Table 2 Correlation matrix of physic-chemical of Bhakuchiwadi reservoir from August 2016 to July 2017.

	WT	pH	EC	DO	CO2	TA	TH	Ca	Mg	Cl	TDS	TN
WT	1											
pH	0.611 **	1										
EC	0.638 **	0.532	1									
DO	0.640 **	0.865 *	0.755 *	1								
CO2	-0.652	-0.765	-0.222	-0.629	1							
TA	0.681 **	0.849 *	0.826 *	0.933 *	-0.620	1						
TH	0.671 **	0.336	0.884 *	0.617 **	-0.158	0.682 **	1					
Ca	0.544	0.328	0.830 *	0.619 **	-0.299	0.725 *	0.794 *	1				
Mg	0.463	0.426	0.569	0.422	-0.156	0.624 **	0.500	0.525	1			
Cl	0.667 **	0.352	0.919 *	0.550	-0.227	0.697 **	0.886 *	0.820 *	0.537	1		
TDS	0.681 **	0.711 *	0.914 *	0.878 *	-0.438	0.946 *	0.778 *	0.823 *	0.717 *	0.785 *	1	
TN	0.694 **	0.521	0.926 *	0.659 **	-0.285	0.730 *	0.880 *	0.706 **	0.391	0.915 *	0.769 *	1
TP	0.653 **	0.597 **	0.807 *	0.853 *	-0.351	0.735 *	0.765 *	0.683 **	0.317	0.613 **	0.791 *	0.736 *

*Significant at 1% level (>0.708)
**Significant at 5% level (>0.576)

Acknowledgement:

Author is thankful to Dr. M. S. Hujare, Principal, P.D.V.P. Mahavidyalaya, Tasgaon, Dist: Sangli (MS) for encouragement and providing necessary facilities to carry out the work.

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