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RESEARCH ARTICLE

PHYSICO-CHEMICAL CHARACTERIZATION OF WATER FROM FOREST COVERED GAVASE WETLAND OF KOLHAPUR DISTRICT, MAHARASHTRA (INDIA)

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ABSTRACT

The present investigation deals with the characterization of physic-chemical parameters of water from Gavase freshwater reservoir of Ajara tahsil, Kolhapur district, Maharashtra (India). The investigation was carried out during July 2011 to June 2012 for the analysis of physical parameters like air temperature, water temperature, transparency, electric conductivity and pH while chemical parameters like free CO2, alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids, dissolved oxygen and biological oxygen demand. The study revealed that all parameters were within the permissible limit for drinking, agricultural and domestic purposes. On the basis of present investigation, the entire reservoir water supports many biological entities as their feeding and breeding ground.

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INTRODUCTION

Water is a basic and primary need of all vital processes and it is now well established that the life first arose in aquatic environment (Patil *et al.,* 2013a). Ever since the pre-historic times man has been intimately associated with water (Patil *et al.,* 2012).The freshwater comes on the land by hydrological cycling process. It is consumable, useful, healthy and clean water for the organisms living on the land. The entire life of the organisms on the land, their evolution and development depends on desirable quality of freshwater.

The certain useful contents existing on the natural land are mixing in the water. The water with some definite concentration of mixed contents from land becomes very suitable for drinking. Along with aquatic animals, water plays an important role in the life of other animals including human (Rahul *et al.,* 2015). According to Patil *et al.* (2013b), 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.

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MATERIALS AND METHODS

Study Area

Gavase freshwater reservoir (Figure 1 and 2) is situated south-west to the Ajara city at N 16^0 05' 761" and E 74^0 07' 596". The reservoir was man-made and construction of the dam was completed in the year 2003. The storage capacity of the reservoir is about 1.15 cuM. along with dam height and length of 23.87 m and 29.5 m respectively.

The catchment area is about 2.85 km. According to government records, the total submergence area of the reservoir is 15.2 ha while the actual submergence area estimated during the study is 37.04 ha during monsoon season and 3.79 ha during summer season. It indicates that the total submergence area has increased at present than in the past.

This might be due to natural processes like weathering, land sliding etc. On the other hand, submergence area was decreased during summer season and it might be due to evaporation and release of water from reservoir to downstream (Patil *et al.,* 2015).

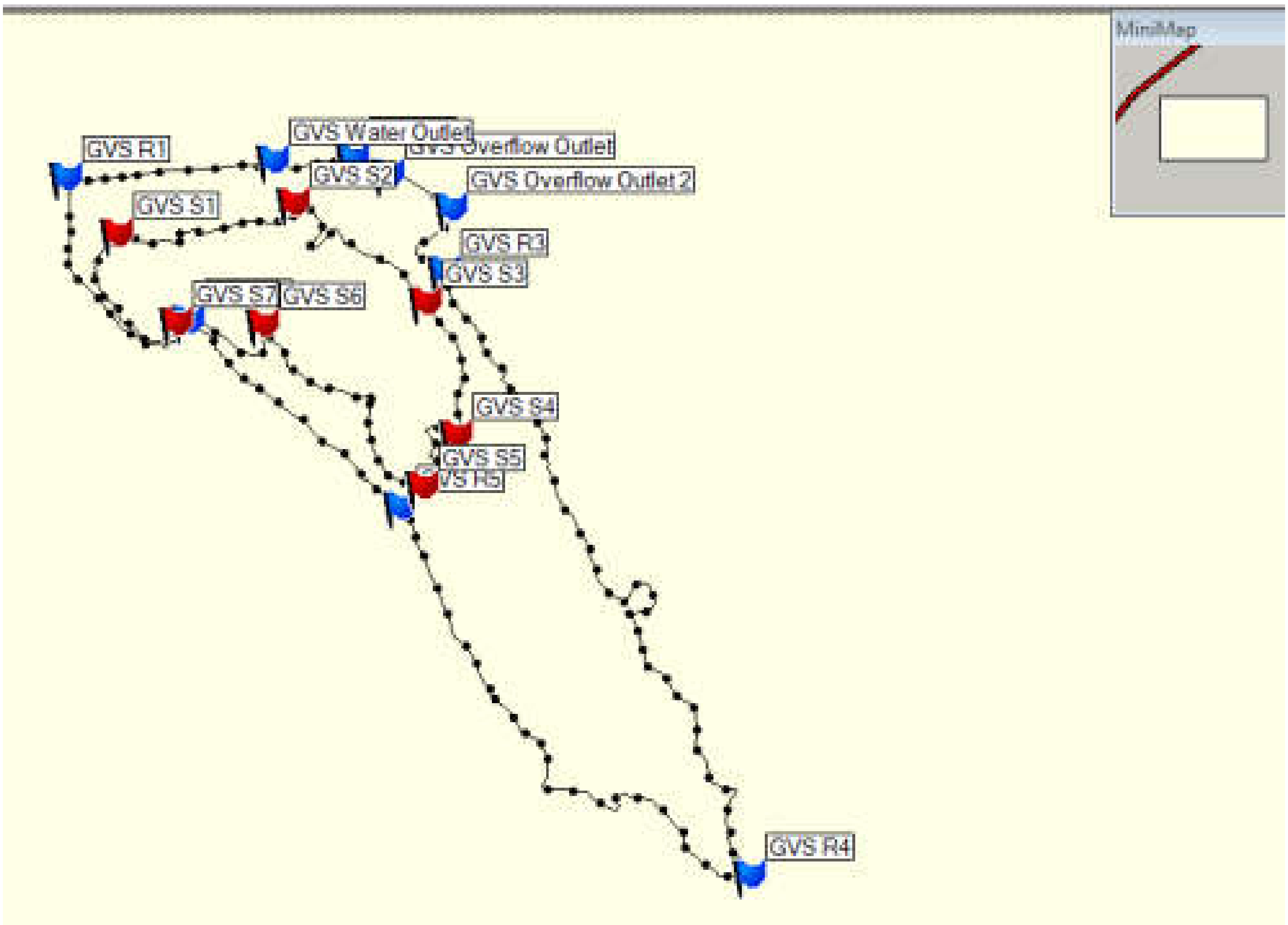

Figure 1. GPS map of Gavase freshwater reservoir

Figure 2. Google map of Gavase freshwater reservoir

Collection of samples

The samples of surface water were collected monthly from Khanapur reservoir during July 2011 to June 2013 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

Two sampling sites were selected and samples were collected from surface water in plastic containers of two liter capacity early in the morning. Samples were brought to laboratory and analysis was made within 24 hours from the time of collection by using standard literatures such as Handbook of common methods in limnology (Lind, 1974), Methods for physical and chemical analysis of freshwaters (Golterman *et al.*, 1978), Standard methods for the examination of water and waste water (APHA, 21th Edition) and Practical methods in ecology and environmental science (Trivedy and Goel, 1987). The analysis of dissolved oxygen and free carbon dioxide were made on the study sites only.

RESULTS AND DISCUSSION

The values of physic-chemical parameters for the year 2011-12 and 2012-13 are given in Table 1 and 2 respectively.

Temperature

The level of ambient temperature fluctuated from 18.5 ^{0}C to 32 ^{0}C while water temperature fluctuated from 15.5 ^{0}C to 28.5 ^{0}C during the year 2011-12. Both ambient and water temperatures were observed lower in the month of November whereas higher in the month of April. The level of ambient temperature during 2012-13 was fluctuated from 19 ^{0}C to 32 ^{0}C and water temperature fluctuated from 15.5^{0}C to 27.5 ^{0}C. The ambient as well as water temperature was recorded lower in the month of November and higher in the month of April. Verma et *al.* (2011) have given the range from 16 ^{0}C to 28 ^{0}C for Kankaria Lake. During the tenure of study, water temperature was lower in the months of winter and higher in the months of summer season. The decreased values of water temperature in the months of winter season might be due to decreased ambient temperature. The increased level of water temperature is attributed to increased level of ambient temperature which was due to high intensity of sunlight and low water level. Such observations have been noticed by Swarnalatha and Rao (1998) and Shastri and Pendase (2001). Similar trend of declined water temperature during winter season and inclined water temperature during summer season was recorded by Pant *et al.* (1981).

Transparency

The transparency is one of the vital physical parameter that not only has an influence on photosynthesis of plankton but also on the metabolic rate of other aquatic animals.

Table 1. Annual range and average values of physico-chemical parameters during the year 2011-12

2011-12							
		Site I			Site II		Annual
Parameter	Minimum	Maximum	Average	Minimum	Maximum	Average	Average
Transparency	80.2	153.1	122.108	88.1	140.2	118.175	120.142
pH	6.563	8.44	7.45808	6.525	8.491	7.38325	7.42067
EC	0.0474	0.2245	0.12345	0.0456	0.2338	0.13484	0.12915
Free CO_2	4.4	11.733	8.55556	4.4	13.2	8.61667	8.58611
Alkalinity	12	25.8	18.8167	13.8	26.2	18.2833	18.55
Total Hardness	25.6	47.4	34.65	21.9	50.2	36.275	35.4625
Calcium	6.1754	13.4745	9.41889	7.2982	15.4786	11.1399	10.2794
Magnesium	3.5297	8.96519	6.13521	3.54824	9.23152	6.10884	6.12202
Chlorides	17.04	45.44	27.0747	16.756	42.6	26.5347	26.8047
TDS	34.8	55.2	43.3833	39.6	65.1	48.6833	46.0333
DO	6.931	15.758	10.3676	7.333	14.947	10.3167	10.3421
BOD	2.71667	4.7233	3.779	2.71667	4.72333	3.79	3.784

Note: All parameters are in mg/l except Temperature (0 C), Transparency (cm) and EC (mhos/cm).

Table 2. Annual range and average values of physico-chemical parameters during the year 2012-13

2012-13							
		Site I			Site II		Annual
Parameter	Minimum	Maximum	Average	Minimum	Maximum	Average	Average
Transparency	113.3	153.1	133.9	102.8	142.9	120.5	127.2
pH	6.529	8.495	7.38533	7.017	8.348	7.58067	7.483
EC	0.0529	0.2188	0.12846	0.0556	0.211	0.12443	0.12645
Free CO_2	4.4	11.7333	8.55556	4.4	13.2	8.61667	8.58611
Alkalinity	15.6	29	21.3833	15.8	27.8	20.4167	20.9
Total Hardness	25.1	59.8	42.25	26.6	61.1	43.3167	42.7833
Calcium	8.6676	13.5547	10.6872	7.7794	15.4816	11.2493	10.9683
Magnesium	3.58527	11.6666	7.66975	3.71591	11.65117	7.79237	7.73106
Chlorides	19.596	51.12	27.1557	16.756	45.156	26.0703	26.613
TDS	39.8	54.3	43.825	40.1	61.9	47	45.4125
DO	7.657	14.987	11.0723	7.25111	14.583	10.7997	10.936
BOD	2.60333	4.99667	3.792	2.71667	4.723333	3.771	3.782

Note: All parameters are in mg/l except Temperature (0 C), Transparency (cm) and EC (mhos/cm).

The monthly variation of light penetration was fluctuated from 80.20± 2.89 cm to 153.10± 1.30 cm with an annual mean of 120.14± 2.78 cm. There was fall in transparency level in the month of August at SI while rise in the month of April at SI. The level of transparency at same reservoir during 2012-13 was fluctuated from 102.80± 2.82 cm to 153.10± 164 cm with an annual mean of 127.20± 9.47 cm. The level was decreased in the month of August at SII and increased in the month of January at SI. In present study, the seechi disk transparency was estimated lower in the months of monsoon season. It was mainly due to heavy rain that brings the silt and particulate matter from the surrounding area.

However, the low intensity of sunlight also influences the light penetration and subsequently affects the visibility in freshwater. During monsoon season, the turbulence also affects the transparency level. Such type of observations were also noted by various limnologists like Dutta *et al.* (1987) and Bade *et al.* (2009). The light penetration was higher in the months of winter season during 2012-13. The higher light penetration during winter season may be due to clear atmosphere, better light intensity and gradual settlement of silt and suspended particle. The findings of Pandey and Pandey (1983) and Manjare *et al.* (2010) coincide with the present investigation.

However, the depth of visibility was also recorded maximum in the months of summer season during 2011-12. Khan and Chaudhari (1994) and Shinde *et al.* (2011), have also given the resembling trend.

pH

pH of natural water might be change with the influence of temperature, biological processes etc. Hence, shows diurnal and seasonal variation. The variation might be due to change in processes like respiration and photosynthesis. According to Kaul and Handoo (1980), the increased pH in water bodies is due to increased metabolic activities of autotrophs, because in general they utilize the CO_2 and liberate O_2 thus reducing H^+ ion concentration. The values of pH ranged from 6.53± 0.029 to 8.49± 0.047 with an average of 7.42± 0.053 (2011-12). A fall in pH was observed in the month of June at SII whereas a rise in pH was observed in the month of January at SII. The variations are in between 6.52± 0.031 to 8.49± 0.051 with an average of 7.48±0.138 (2012-13). The minimum value was observed in the month of June at SI while maximum pH was in the month of January at SI. Some of the workers have noticed similar range of pH at various water bodies. Jain and Dhamija (2000) have recorded the values of pH from 6.8 to 8.5 at lentic water body of Jabalpur.

The values of pH fluctuated from 6.9 to 8.3 for Pichhola Lake (Sharma *et al.,* 2011). The lower pH values were observed in the months of rainy season during both the years. The fall in pH during monsoon season may be due to heavy rain and dilution of water. Sometimes, poor sunlight ultimately reduces the rate of photosynthesis hence accumulation of free CO_2 increases and decrease the pH values. Egborge (1994) has also given the same justification for decrease in the value of pH. According to him, accumulation of free CO_2 due to little photosynthetic activities of phytoplankton will lower the pH values of the water. Similar trend of minimum pH values during monsoon season have also been observed by different authors like Sawant *et al.* (2011) and Manjare *et al.* (2010).There was rise in the level of pH during the months of winter season for both the years. The higher pH during winter season may be due to increased photosynthetic activity with appropriate sunlight, good transparency and optimum temperature that ultimately reduces the free carbon dioxide. This statement is in agreement with Mounditiya *et al.* (2004). Many authors like Sinha and Sinha (1993) and Ghose and Sharma (1988) have noted similar trend of pH, higher during winter months. The suggested pH for freshwater aquatic life by Environment protection Agency of United States is 6.5 to 6.9. The safe pH value recommended by ICMR (1975) and WHO (1985) is 7 to 8.5 while ISI (1991) suggested range is 6.5 to 8.5. This concludes that the results obtained from the present study are within the safe limit as per above standards. pH below 4.0 and above 9.6 is hazardous to most of life forms (WHO, 1993).

Electrical conductivity

Electrical conductivity is the ability of aqueous solution to pass electric current through it and is expressed in numerical expression. The electric conductivity in freshwater is mainly due to different ions which are attributed from organic nutrients and inorganic substances. The amount of EC for 2011-12 at Gavase water body was fluctuated from 0.046± 0.0017 mhos/cm to 0.234± 0.0018 mhos/cm with an annual mean of 0.129± 0.0081 mhos/cm. There was a decline of the EC value in the month of June at SI and inclined in the month of October at SII. The amount of EC for 2012-13 for same reservoir was fluctuated from 0.053± 0.002 mhos/cm to 0.219± 0.0021 mhos/cm with an annual mean of 0.126± 0.0028 mhos/cm. The declined value of EC was noticed in the month of June at SI and inclined in the month of October at SI. During the study period, the EC values were noticed lower in the months of monsoon season. The lower values of electric conductivity might be due to increase in the level of water by the rain. Dilution of water by precipitation is bringing down the EC values (Trivedi and Goel, 1986). Many workers viz. Munawar (1970) and Sreenivasan *et al.* (1997), reported the same trend of lower EC during monsoon season and their observation corresponds to the present investigation. The EC values are noticed higher in the months of winter season during the both years. Similar finding was given by Mathivanan *et al.* (2005).

Free carbon dioxide

Free CO_2 is one of the important chemical parameter without which autotrophs cannot prepare their own food. On the other hand, through the phenomenon of photosynthesis, these autotrophs liberate O_2 that ultimately supports other forms of life in all sorts of ecosystem, without any exception. Temperature, depth, rates of respiration and decomposition of organic matter influences the concentration of free carbon dioxide in freshwater. Concentration of free CO_2 sometimes depends upon alkalinity and hardness of the water body. The monthly values of free carbon dioxide for both the years varied from 4.4± 0.00 mg/l to 13.20± 0.00 mg/l with an annual mean of 8.59± 0.043 mg/l. There was decrease in free carbon dioxide level in the month of May at both sites while increase in the month of July at SII. Kumar (1995) has noted the values of free carbon dioxide from 00 mg/l to 5 mg/l at freshwater body in Bihar. Hujare (2005) has noted free CO_2 values from 00 mg/l to 10 mg/l at Tamadalge tank. The present investigation for the chemical parameter, free CO_2 revealed that the lower values were recorded in the months of summer. Similar trend of lower values during summer season was given by Phukon *et al.* (2011), Patralekh (2012) and Narayan *et al.* (2005). On the contrary, higher values of free CO_2 were noted in the months of monsoon during both the years. Higher value of free CO_2 during monsoon season was also observed by Sayeshwara *et al.* (2010) and Ghosh and Nath (2012). The lower value of free CO_2 during summer season might be due to intense sunlight and increased transparency which ultimately enhances the rate of photosynthesis. Hence, the free carbon dioxide is utilized by autotrophs. On the other hand, higher amount of free CO_2 during monsoon season might be due to cloudy environment and lower level of transparency which ultimately diminish the rate of photosynthesis. Hence level of free carbon dioxide is increased. Similar trend of lower values during summer season and higher during monsoon season were recorded by Phukon *et al* (2011) and Narayan *et al.* (2005).

Alkalinity

Total alkalinity is an important parameter that indicates the buffering capacity of water. Total alkalinity is attributed to bicarbonates, carbonates, OH ions, borates, silicates and phosphates (Kataria *et al.,* 1995). The values of total alkalinity during the year 2011-12 were ranged from 12±2.00 mg/l to 26.2± 2.088 mg/l with an annual average of 18.55± 0.377 mg/l. The lower value of alkalinity was observed in the month of April at SI and higher value was observed in the month of January at SII. The alkalinity values for the year 2012-13 were fluctuated from 15.60± 2.154 mg/l to 29±2.41 mg/l with an annual average of 20.90± 0.683 mg/l. The value was lower in the month of March at SI while higher value was observed in the month of November at SI. Krishnan (2008) has noted the alkalinity range from 13.1 mg/l to 22.5 mg/l from Periyar Lake that is coinciding with present investigation. The present study exhibited the definite pattern of total alkalinity during both the years. The total alkalinity was declined in the months of summer season while it was observed inclined in the months of winter season. Decrease in total alkalinity during summer months may be due to fluctuations in the bicarbonates while higher values of alkalinity during winter season may be due to nutrients added from catchment area. The later statement is in agreement with Sarma and Dutta (2012). Very few workers have noted the alkalinity values lower during summer season such as Ohal *et al.* (2011) and Verma *et al.* (2011). However, total alkalinity values higher during winter season were noticed by many authors like Angadi *et al.* (2005) and Hujare (2005).

Total hardness

Total hardness is mainly classified as temporary hardness and permanent hardness. Temporary hardness is due to carbonates and bicarbonates of calcium and magnesium while permanent hardness is the effect of chlorides and sulphates. Total hardness is a key indicator for the suitability such as drinking, cooking, washing etc. The monthly variation in total hardness at Gavase water body ranged from 21.90± 1.79 mg/l to 50.20± 2.39 mg/l with an average of 35.46±1.14 mg/l during the year 2011-2012. It was found minimum in the month of June at SII and maximum in the month of December at SII. The total hardness during the year 2012-2013 fluctuated from 25.10± 1.38 mg/l to 61.10± 1.76 mg/l with an average of 42.78±0.75 mg/l. The minimum value was recorded during July at SII while maximum during May at SII. Several authors pointed out the similar values of total hardness in their investigation. Narayan *et al.* (2005) have observed the total hardness values from 20 mg/l to 44 mg/l from Basavanhole tank. Kemdirin (2005) has given similar range of hardness from 19 mg/l to 35 mg/l from Kangimi reservoir, Nigeria. The range of total hardness fluctuated from 29 mg/l to 59 mg/l for Aiba,Iwa,Osan, Nigeria (Atobatale *et al.,* 2008). The total hardness ranges are similar to above findings that were emphasized by Sarma and Dutta (2012) for two riverine wetlands from Assam.

The present investigation revealed that the level of total hardness was decreased during the months of monsoon season. Total hardness values decreased in the months of monsoon due to dilution of water by rain. However, the elevation of hardness in the months of summer have been observed during 2012-13 and in the months of winter during 2011-12. Increase in total hardness during the months of summer season may be due to evaporation rate and decreased water level. High anthropogenic activity especially cloth washing have been observed during these months may also be the cause for increase in hardness level. Leaching of calcium and magnesium from catchment area may also cause increased level of hardness. Sawyer (1960) classified water into categories on the basis of hardness as soft (00 mg/l to 75 mg/l), moderately hard (76 mg/l to 150 mg/l) and hard (151 mg/l and above). From the above findings, Gavase freshwater body falls under the soft category. Since this water body is very untouched by human activities.

Calcium

Calcium is considered as an important micronutrient essential for growth and development of all aquatic organisms (Meshram, 2005). A main cation or factor causes hardness in natural water. It originates from natural process like dissolvent of minerals containing calcium and other sources such as agricultural wastes and considered as non-toxic (Krishna Ram, 2007). The content of calcium at Gavase water body for the year 2011-12 varied from 6.18± 0.72 mg/l to 15.48± 0.72 mg/l with an annual mean of 10.28± 1.22 mg/l. There was decline of calcium level in the month of June at SI while inclined in the month of July at SII. The content of calcium at same reservoir for the year 2012-13 fluctuated from 7.78± 0.63 mg/l to 15. 48± 0.63 mg/l with an annual mean of 10.97± 0.40 mg/l. There was a decline in level of calcium in the month of December at SII and an incline in the month of August at SII. Chatterjee (1992) has reported similar calcium values ranged from 3.6 mg/l to 6.8 mg/l at Nandankanan Lake.

The present study has revealed that the calcium values are lower in the months of monsoon at Gavase water body during 2011-12, the calcium level was decreased during these months may be due to dilution of the water. Similar trend was also noted by Subhasani and Sardhamani (2005). This water body has also showed lower value in the months of winter during 2012-13. Similar observation of lower value of calcium during winter season was given by Verma *et al.* (2011) and Verma *et al.* (2012). The higher value of calcium was observed in the months of monsoon at Gavase for both the years. It might be due to inflow of calcium from catchment area along with rainwater. According to Verma *et al.* (2012), relatively high amount of calcium in surrounding rocks and soil may also contribute to the rich calcium amount in the lake water. Similar trend was given by Dhanalashmi *et al.* (2009) and Usha (2012).

Magnesium

The value of magnesium during 2011-12 varied between 3.53± 0.66 mg/l to 9.23± 0.70 mg/l with an annual mean of 6.12± 0.018 mg/l. There was decrease of the magnesium value in the month of July at SI and increase in the month of January at SII. The level of magnesium for 2012-13 fluctuated from 3.58± 0.40 mg/l to 11.67± 0.58 mg/l with an annual mean of 7.73± 0.086 mg/l. The declined value of magnesium was observed in the month of July at SI and inclined in the month of May at SI. Manimangalai *et al.* (2008) have observed the magnesium from 4.45 mg/l to 11.20 mg/l in Ooty Lake.

The present investigation revealed that the lower values of magnesium were observed in the months of monsoon during both the years. In these months intake of magnesium by biota might be the reason for decline in quantity. Rath *et al.* (2000) also made such type of observation. However, the dilution of water due to heavy rainfall might also being the reason for decrease in magnesium content. On contrary, higher values of magnesium were observed in the months of winter season during 2011-12 and summer season during 2012-13. Inclined values of magnesium in the months of winter might be due to leeching of magnesium from catchment area while increase during summer season might be due to increased temperature and ultimate evaporation of water that brings magnesium values increased. Verma *et al.* (2011) and Verma *et al.* (2012) have observed similar trend of increased magnesium during winter season. However lower magnesium during monsoon and higher during summer season was reported by Khabade *et al.* (2005).

Chlorides

The chloride values ranged from 16.76± 2.35 mg/l to 45.44± 2.54 mg/l with an average of 26.81±0.38 mg/l (2011-12). The lower value was observed in the month of August at SII while higher in the month of January at SI. The chloride values were noted between 16.76± 2.35 mg/l and 51.12± 2.54 mg/l with an average of 26.61± 0.97 (2012-13). It was declined in the month of July at SI and inclined in the month of December at SII. Many workers noticed similar observations. Goel and Chavan (1991) have observed the chloride values from 12.8 mg/l to 33.7 mg/l for Residency tank, Kolhapur. Solomon *et al.* (2011) have noted the range of chloride between 18 mg/l and 33 mg/l from Omi Dam, Nigeria.

In present investigation, decreased chloride concentration in the months of rainy season was observed at Gavase and Khanapur during both years and Dhangarmola during 2011-12. Decreased amount of chloride content in rainy months is due to dilution by rain water and consequently increased quantity of water. Swarnalatha and Rao (1998) have also justified that minimum chlorides during monsoon season may be due to high water level. Jha and Barat (2005) have reported low concentration of chloride ion in lake water particularly in the monsoon indicates there low amount of organic wastes of animal origin. Content of chloride was noted higher in the months of winter season which is attributed with leaching of high salts from catchment area as well as increased human and animal activities. The similar trend of higher chloride content during winter was noticed by Masood and Krishnamurthy (1990), Mathivanan *et al* (2005).

Total dissolved solids (TDS)

The natural freshwater bodies contain total dissolved solids as the water is considered as universal solvent. According to Esmaeili and Joshi (2005), the dissolved solids are mainly due to different parameters like carbonates, bicarbonates, calcium, magnesium, nitrates, sulphates, phosphates, sodium, potassium, iron etc. The amount of TDS at Gavase water body during the year 2011-12 ranged of 34.80± 1.08 mg/l to 65.10± 2.88 mg/l being an annual mean of 46.03± 3.75 mg/l. The TDS value during this year was decreased in the month of July at SI while increased in the month of June at SII. The values of TDS at this reservoir ranged between 39.80± 2.23 mg/l to 61.90± 1.92 mg/l with an annual mean of 45.41± 2.25 mg/l (2012-13). The TDS values during this year is decreased in the month of July at SI and increased in the month of March at SII. Sayeswara *et al.* (2011) have noted the range of TDS from 32 mg/l to 59 mg/l from Barehalla tank. The present investigation revealed that the TDS value decreased in the months of monsoon season during 2011-12. Total dissolved solids decreased in the months of monsoon season mainly due to dilution by rainwater and increased water level. Limnologists such as Gomzalves and Joshi (1946) have justified that the TDS values decreased might be due to dilution by rain water.

In the present study, TDS values were increased in the months of summer season during both years. This may be due to the evaporation of water, which leads to the decrease in water level and ultimately results into increased concentration of TDS. Many of the investigators are in agreement with present study such as Sumitra *et al.* (2007), Verma *et al.* (2012), Tiwari and Ranga (2012), Atanafu *et al.* (2011). The agencies like WHO (1993) has given the desirable limit for drinking purpose is 500 mg/l meanwhile Wilcox (1955) and ICMR (1975) emphasized the drinking water criteria, according to which, the reservoir under investigation water is desirable for drinking purpose.

Dissolved oxygen

Dissolved oxygen at Gavase water body during 2011-12 fluctuationed from 6.93± 0.22 mg/l to 15.76± 0.84 mg/l with annual mean of 10.34± 0.04 mg/l, being lower in the month of May at SI while higher in the month of December at SI. The values of DO ranged between 7.25± 0.56 mg/l and 14.99± 0.40 mg/l with an annual mean of 10.94± 0.19 mg/l (2012-13). The DO value was observed minimum in the month of June at SII while maximum DO was observed in the month of January at SI. Many of the authors worked on DO and given different ranges for the same. Manjare *et al.* (2010) have estimated the DO values from 6.40 mg/l to 15.15 mg/l for Tamadalge tank. Dissolved oxygen was decreased during the months of summer as well as monsoon season and increased during winter. The lower values of DO during summer season may be due to higher ambient temperature ultimately increases the water temperature and consequently the level of dissolved oxygen deplete. Kataria *et al.* (2006) justified that the depletion of DO in aquatic ecosystem is due to high temperature and increased microbial activity. Increase in dissolved oxygen in the months of winter season due to increased transparency, high activity of photosynthesis, low temperature and decreased microbial decomposition.

Biochemical oxygen demand

Biochemical oxygen demand is relative oxygen required for the biochemical degradation of organic material and the oxygen used to oxidize inorganic material (APHA, 2005). Variation in BOD indicates dynamism in aquatic life present in the pond. The assemblage of it is a good index of the organic pollution and therefore helps in determining the suitability of water for consumption. The maximum tolerance limit of BOD is 6.5 mg/l for public use (WHO, 1993). The values of BOD ranged between 2.72±0.16 mg/l and 4.72±0.19 mg/l with an annual mean of 3.78± 0.17 mg/l (2011-12). It was recorded lower in the month of June at SII and July at SI while higher in the month of March and April at SI. The values of BOD ranged between2.60±0.16 mg/l to 4.99±0.19 mg/l with an annual mean of 3.78± 0.17 mg/l (2012-13). It was recorded lower in the month of July at SI while higher in the month of April at SI. Similar types of ranges have given by worker like Shiddamallaya and Pratima (2008) have recorded the BOD from 2.78 mg/l to 4.31 mg/l.

The present investigation emphasized that the lower values of BOD was noted during monsoon season during both the years while higher values recorded during summer season. The lower values of BOD observed during monsoon months might be due to decreased microbial activity and increased BOD values during summer months might be due to increased temperature and ultimate increase in the microbial activity. Similar pattern of BOD values were also noted by Rahul *et al.* (2012) and Jemi *et al.* (2012).

Conclusion

The study can be concluded that all parameters were within the permissible limit for drinking, agricultural and domestic purposes. However, the reservoir water supports many biological entities as their feeding and breeding ground.

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