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Hydrological study of Dhangarmola freshwater reservoir from Ajara tahsil of Kolhapur district, Maharashtra (India)

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Abstract: The present study deals with the hydrological parameters from Dhangarmola freshwater reservoir of Ajara tahsil, Kolhapur district, Maharashtra (India). The investigation was carried out during July 2011 to June 2012 so as to detect physical parameters like air temperature, water temperature, transparency, electric conductivity and pH and chemical parameters like free CO_2, alkalinity, total hardness, calcium, magnesium, chlorides, total dissolved solids, dissolved oxygen and biological oxygen demand. The present investigation revealed that all parameters were within the permissible limit for drinking, agricultural and domestic purposes. The study also concludes that reservoir water supports many biological entities as their feeding and breeding ground.

Keywords: Hydrological study, Dhangarmola, Freshwater reservoir, water quality, support, biological entities

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[1]. Ever since the pre-historic times man has been intimately associated with water[2].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. Such water becomes basic need of all land and aquatic organisms. This exists in rivers, streams, ponds, lakes, reservoirs, tanks, pools, marshes, bogs and even underground water forms. This freshwater is a base for all organisms. According to Patil *et al.*[3] 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.

MATERIALS AND METHODS

Study Area: Dhangarmola freshwater reservoir (**Figure 1 and 2**) is situated at south-west to the Ajara city with longitude and latitude of 16^0 03' 687" and 74^0 05' 647". The dam was constructed in the year 2000. The height and length of the dam is about 19.28 m and 510 m respectively. The total catchment area is about 8.6 km. The total submergence area of the reservoir with respect to government records is 41.09 ha and actual submergence area mapped by GPS is 55.17 ha. The submergence area mapped during summer season is 7.32 ha. The present investigation showed that the submergence area of this reservoir is increased as compared to government records which might be due to land sliding and weathering. The submergence area of reservoir was shrink during summer season might be due to release of water downstream[4].

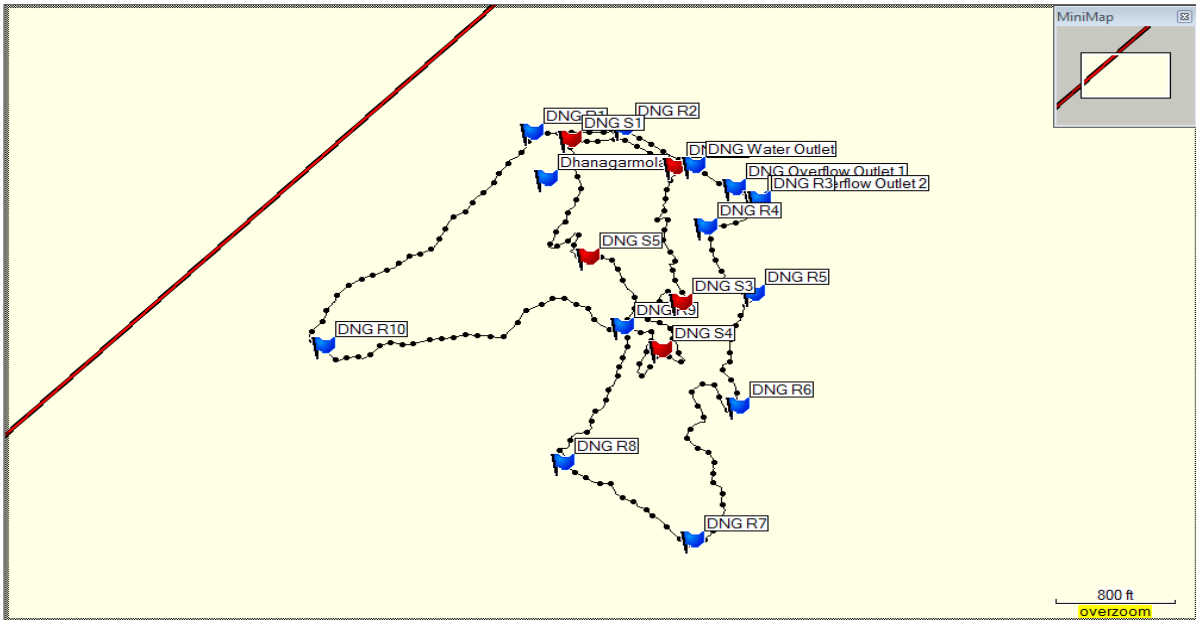

Figure 1: GPS map of Dhangarmola freshwater reservoir

Figure 2: Google map of Dhangarmola freshwater reservoir

Collection of samples: The samples of surface water were collected monthly from Dhangarmola 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. Two sampling sites were selected and samples were collected from surface water in plastic containers of two liter capacity early in the morning.

Analysis of physico-chemical properties: 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[5], Methods for physical and chemical analysis of freshwaters [6], Standard methods for the examination of water and waste water[7] and Practical methods in ecology and environmental science[8]. The analysis of dissolved oxygen and free carbon dioxide were made on the study sites only.

RESULTS AND DISCUSSION

Hydrological characteristics of water from Dhangarmola freshwater reservoir is depicted in **Table 1&2.**

Temperature: The temperature plays an important role in primary productivity of water by influencing the abundance of primary producers, on which primary consumers are dependent. The temperature affects not only the metabolic activity of plankton but also their purification. Banarjee *et al.*[9] suggests that water temperature between 15^0C and 35^0C is favorable for healthy growth of fishes; however, for breeding purpose 20^0C to 31^0C is ideal. The values for ambient temperature during 2011-12 varied from 20 ^{0}C to 34 ^{0}C while water temperature varied from 16.5 ^{0}C to 30.5 ^{0}C. The ambient temperature was observed minimum in the month of December and January while maximum in the month of May. The water temperature was observed minimum in the month of December whereas higher in the month of May. The values of ambient temperature during 2012-13 is ranged from 21 ^{0}C to 32 ^{0}C while water temperature

ranged from 18 ^{0}C to 27.5 ^{0}C. Both ambient as well as water temperatures were recorded lower in the month of January and higher in the month of May.

During the tenure of study, water temperature was noted 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 may be due to decreased ambient temperature and decreased value of ambient temperature may be due to increased velocity of winds and high water level. The increased level of water temperature is attributed to increased level of ambient temperature which is due to high intensity of sunlight and low water level. Such observations have been noticed by Swarnalatha and Rao[10] and Shastri and Pendase[11].

Table 1: Hydrological parameters of water from Dhangarmola freshwater reservoir during the year 2011-12

	Site I			Site II			Annual
Parameter	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**	**Average**
Transparency	62	133	102.67	59	116	96.25	99.45
pH	6.08	8.34	7.22	6.78	8.3	7.34	7.28
EC	0.043	0.183	0.104	0.042	0.203	0.117	0.11
Free CO_2	3.66	11.73	8.6	4.4	13.2	8.61	8.31
Alkalinity	10	28	16.41	12	28	18.33	17.37
Total Hardness	14	42	29.5	18	52	32.16	30.83
Calcium	2.21	12.83	6.87	3.21	12.03	7.08	6.97
Magnesium	2.37	8.09	5.42	3.45	9.58	6.03	5.73
Chlorides	17.04	45.42	26.91	17.04	42.06	26.53	26.72
TDS	24	44	31.66	28	56	35.33	33.5
DO	6.89	15.81	9.69	7.3	14.6	10.09	9.89
BOD	1.48	5.12	3.51	1.48	5.12	3.51	3.51

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

Transparency: The transparency is one of the vital physical parameter that not only influence on photosynthesis of plankton but also the metabolic rate of other aquatic animals. The penetration of light in the water or the visibility in the water is called as transparency. The levels of transparency ranged between 59.50± 3.64 cm and 132.10± 4.57 cm with an annual mean 99.63± 4.82 cm. The depth of visibility was low in the month of August at SII while high at SII in the month of May. During the year 2012-13, the transparency level at this reservoir varied from 59.30± 4.61 cm to 132.30± 1.61 cm with an annual mean of 104.61± 5.85 cm. The light penetration in the month of July at SII was decreased while it was increased at SI in the month of December.

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. Such type of observations were also noted by various limnologists like Dutta *et al.*[12], Bade *et al.*[13], Kumar[14], Sawant *et al.*[15,16] and Abujam *et al.*[17]. The light penetration was higher in the months of winter season during 2012-13 while it was higher in the months of summer season during 2011-12. 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[18], Manjare *et al.*[19] and Sawant *et al.*[20] coincide with the present investigation. Khan and Chaudhari[21] have also noted higher transparency during summer months.

Table 2: Hydrological parameters of water from Dhangarmola freshwater reservoir during the year 2012-13

	Site I			Site II			Annual
Parameter	**Minimum**	**Maximum**	**Average**	**Minimum**	**Maximum**	**Average**	**Average**
Transparency	67	132	108.75	59	121	100.33	104.54
pH	6.45	8.21	7.48	6.96	8.42	7.72	6.7
EC	0.049	0.187	0.105	0.052	0.183	0.102	0.104
Free CO_2	2.93	11.73	7.94	4.4	12.46	8.43	8.18
Alkalinity	12	30	18.33	10	28	16.5	17.41
Total Hardness	28	40	32.83	30	56	36.16	49.95
Calcium	7.21	19.24	11.89	8.02	20.85	12.54	12.21
Magnesium	6.57	11.21	9.15	6.56	11.45	9.15	9.15
Chlorides	19.88	51.12	27.21	17.04	45.44	26.27	26.74
TDS	28	40	32.83	30	56	36.16	34.5
DO	8.92	14.1	10.93	8.92	13.78	10.94	10.94
BOD	1.48	5.26	3.53	1.35	5.12	3.5	3.51

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

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[22], 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. pH balance in an ecosystem is maintained when it is within the range[23] of 5.5 to 8.5.

The pH was found between 6.09± 0.022 and 8.34± 0.009 with an average of 7.28±0.88 (2011-12). The decreased pH was noted in the month of May at SI whereas increased pH was noted in the month of January at SI. The pH values were ranged between 6.45±0.015 and 8.43± 0.019 with an average of 7.61± 0.173 during year 2012-13. The lower pH value was observed in the month of June at SI and higher pH was observed in the month of January at SII. The authors like Fundi *et al.*[24]has reported similar values for various freshwater reservoirs

The lower pH values were observed in the months of rainy season during 2011-12 and 2012-13. 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 decreases in the pH values. Egborge[25] has also given the same justification for decrease in the value of pH. Similar trend of minimum pH values during monsoon season have also been observed by different authors like Sawant *et al.*[16], Manjare *et al.*[19] and Verma *et al.*[26].

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.*[27]. According to Wetzel[28], the pH values ranges from 8 to 9 units in Indian waters. Many authors like Sinha and Sinha[29], Ghose and Sharma[30] and Nair [31] have noted similar trend of pH, higher during winter months.

Electric conductivity: It is considered as an excellent indicator of TDS, which is a measure of solubility that affects the taste of potable water [32,] According to Murugsen *et al.*[33], it is a tool to access the purity of water. The values of EC varied from 0.042± 0.002 mhos/cm to 0.202± 0.0037 mhos/cm, with an annual mean of 0.111± 0.0091 mhos/cm. The minimum EC value was recorded in the month of June at SII and maximum EC value was recorded in the month of November at SII. The EC value for year 2012-13 was fluctuated from 0.05± 0.002 mhos/cm to 0.186± 0.0021 mhos/cm with an annual mean of 0.105± 0.002 mhos/cm. The fall in the EC was observed in the month of June at SI and a rise was observed in the month of September at SI. Ramesh and Sardhamani[34] have emphasized the values of EC from 0.020 mhos/cm to 0.120 mhos/cm for Pokara Dam. Krishnamoorthy *et al.*[35] have reported the value of EC between 0.076 mhos/cm to 0.160 mhos/cm for some lakes of Tamil Nadu.

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[36]. The EC values increased in the months of monsoon during 2012-13 and winter during 2011-12. The E. C. is used as an index to select the suitability of water for agricultural purpose. The electrical conductivity more than 0.5 mhos/cm is considered unsuitable for irrigation purpose. The electric conductivity of investigated water reservoir is below 0.5 mhos/cm and considered asan excellent for the agricultural productivity. According to Bharadwaj and Sharma[37], the values of EC vary from 0.20 mhos/cm to 0.27 mhos/cm and indicate eutrophic nature of the water body. On the basis of above criterion, reservoir is not falling under eutrophic although the maximum value is exceeding higher limit as it is negligible.

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. The level of free carbon dioxide at this reservoir fluctuated from 3.66± 1.27 mg/l to 13.20± 0.00 mg/l with an annual mean of 8.31± 0.432 mg/l (2011-12). The free carbon dioxide level during this year was declined in the month of May at SI and inclined in the month of July at SII. The values of free carbon dioxide were fluctuated from 2.93± 1.27 mg/l to 12.46± 1.27 mg/l with an annual mean of 8.18± 0.345 mg/l (2012-13). The free carbon dioxide value during 2012-13 was decreased in the month of May at SI and increased in the month of July at SII.

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.*[38], Patralekh *et al.*[39] and Narayan *et al.*[40]. 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.*[41], Ghosh and Nath[42] and Vijayverjiya[43]. The lower value of free CO_2 during winter 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 during these

months. 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.*[38] and Narayan *et al.*[40].

Alkalinity: It is important for aquatic life present in freshwater since it equilibrates the change in pH due to natural phenomenon like photosynthesis. Alkalinity of water has the capacity to neutralize a strong acid and is characterized by presence of all hydroxyl ions capable of combining with hydrogen ions[44]. Change in alkalinity might also be due to release of carbon dioxide. The monthly variation of alkalinity during 2011-12 ranged between 9.7±1.345 mg/l and 27.9±1.513 mg/l with an annual mean of 17.23±1.331 mg/l. The decreased value of total alkalinity was observed in the month of May at SI and increased in the month of January at SII. The monthly variations in total alkalinity during 2012-13 were 10.10±1.044 mg/l to 30.1±1.005 mg/l with an annual average of 17.346± 1.361 mg/l. The amount of alkalinity was lower in the month of May at SI and higher in the month of January at SI. Ramesh and Sardhamani[34] have given the similar range of alkalinity from Pukara Dam. The alkalinity ranges at Shivaganga Pond were also as similar as the present study and the values fluctuated[39] from 4 mg/l to 17.60 mg/l.

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[45]. Very few workers have noted the alkalinity values lower during summer season such as Ohal *et al.*[46] and Verma *et al.*[26]. However, total alkalinity values higher during winter season were noticed by many authors like Angadi *et al.*[47], Hujare[48], Ajagekar *et al.*[49], Ohal *et al.*[46] and Latha and Mohan[50].

Total hardness: The content of total hardness at Dhangarmola water body during 2011-2012 ranged between 13.80± 1.40 mg/l to 51.40± 3.11 mg/l with an average of 30.75±1.86 mg/l. It was decreased in the month of June at SI whereas increased in the month of January at SII. The hardness values ranged from 35.40± 2.20 mg/l to 66.30± 1.90 mg/l with an average of 49.86± 0.25 mg/l. It was declined in the month of July at SI while inclined in the month of May at SII during the year 2012-2013. Various authors have reported range of total hardness for different reservoirs. Dhanalaxmi *et al.*[51] have noted the hardness variation from 30.5 mg/l to 60.80 mg/l. Narayan *et al.*[40] have reported the total hardness values 20 mg/l to 44 mg/l at Basavanhole reservoir from Karnataka.

The present investigation revealed that the level of total hardness was decreased during the months of monsoon season during both the years. Total hardness values decreased in the months of monsoon due to dilution of water by rain. However, the elevation of hardness during the months of summer during the year 2012-13. Increase in total hardness during the months of summer season may be due to evaporation rate and decreased water level. The total hardness values increased in the months of winter have also observed during the year 2011-12. Leaching of calcium and magnesium from catchment area may also cause increased level of hardness.

Calcium: Calcium levels during 2011-12 were fluctuated from 2.57± 0.70 mg/l to 12.91± 0.84 mg/l with an annual mean of 7.15±0.08 mg/l. The calcium level during this year was decreased in the month of April at SI and increased in the month of December at SI. The level of calcium was fluctuated from 7.30±

0.76 mg/l to 20.69±1.06 mg/l with an annual mean of 12.17± 0.26 mg/l (2012-13). The calcium value during this year was decreased in the month of July at SI and increased in the month of May at SII. According to Dadhick and Saxena[52], the annual average of calcium was fluctuated from 9.25 mg/l and 10.93 mg/l for Ganger Pond and Shivhari temple tank respectively.

The present study has revealed that the calcium values are lower in the months of monsoon during 2012-13, may be due to addition of water by rain and dilution of the water. However, lower calcium was also noted in the months of summer season during 2011-12. The lower value of calcium during summer season was noted by Mathivanan *et al.*[53] and Narayan *et al.*[40]. The calcium values were observed higher in the months of summer season during 2012-13. The calcium values higher in the months of summer season may be attributed to decreased amount of water. Billore[54] has also emphasized the amount of calcium increases during summer season due to rapid oxidation or decomposition of organic matter. The calcium value was also observed maximum in the months of winter 2011-12, might be due to leaching from calcium rich rocks and ultimately increased in the reservoir water. The trend of higher calcium during winter season was given by Kuhawar *et al.*[55], Ramesh and Sardhamani[34] and Shivanna and Nagendrappa[56] .

Magnesium: Magnesium is one of the important parameter, which is required for chlorophyll containing plants. It is an important constituent of chlorophyll. Calcium and magnesium are associated with each other and both together forms total hardness. However, concentration of magnesium remains generally lower than the calcium[57]. The magnesium values for Dhangarmola water body during 2011-12 is presented in Table. The value of magnesium fluctuated from 2.38± 0.36 mg/l to 9.58± 0.62 mg/l, with an annual mean of 5.73± 0.432 mg/l. The minimum magnesium was recorded in the month of July at SI and maximum was recorded in the month of January at SII. The magnesium value for year 2012-13 is emphasized in Table with a fluctuation of 6.56± 0.33 mg/l to 11.46± 0.68 mg/l with an annual mean of 9.16± 0.002 mg/l. There was fall of magnesium value in the month of August at SII and rise of the value was observed in the month of February at SII. Goel *et al.*[58] have recorded the values of magnesium from 2.7 mg/l to 14.10 mg/l for Kalamba Lake. Jemi *et al.*[59] have also reported the similar values of magnesium from 7.08 mg/l to 12.25 mg/l at temple pond at Kanyakumari district.

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.*[60] 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 while 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. Ramesh and Sardhamani[34], Verma *et al.*[26] and Verma *et al.*[61] 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.*[62], Shidhamallaya and Pratima[63], Nirmalkumar *et al.*[64], Devi *et al.*[65], Hulyal *et al.*[66] and Shivanna and Nagendrappa[56].

Chlorides: Chloride controls the salinity of water and osmotic stress on biotic communities (Banerjee, 1967) and also increases the degree of eutrophication[68].The excess chloride in drinking water may induce heart failure[69] and hypertension[70].The chloride values fluctuated from 16.76± 1.97 mg/l to 46.01± 1.17

mg/l with an average of 26.92± 0.07 mg/l. The chloride value was found minimum in the months of June, July at SI and August at SII while maximum in the month of January at SI. The chloride value was noted lower (17.04± 2.12 mg/l) in the month of May and June at SII and higher (51.44± 1.99 mg/l) in the month of December at SI with an average of 26.97± 0.76 mg/l. The values of various authors are on similar lines. Saify *et al.*[71] have emphasized the chloride from 16 mg/l to 46 mg/l for sewage fed Motia pond.

In present investigation, chloride concentration was lower in the months of rainy season during 2011-12. Decreased amount of chloride content in rainy months is due to dilution by rain water and consequently increased quantity of water. Jha and Barat[72] have reported low concentration of chloride ion in lake water particularly in the monsoon indicates there low amount of organic wastes of animal origin. Lower value of chlorides during monsoon season was also reported by Pendase *et al.*[73] and Padmavathi[74].Chloride values also noted minimum in the months during the year 2012-13.Content of chloride higher in the months of winter season was observed during both years. Higher concentration of chloride during winter months may be 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, Mathivanan *et al.*[53], Devi *et al.*[65], Nikam *et al.*[75], Sawant *et al.*[16] and Sarma and Dutta[45].

Raghvendran[76] and WHO[32] suggested the desirable limit of chloride concentration in drinking water is 250 mg/l According to this criteria the chloride values falls under acceptable limit.

Total dissolved solids (TDS): The level of dissolved solids in freshwater ecosystem is mainly influenced by activity of plankton and organic material[77], location, geographical basin of the water body, drainage, rainfall, inflowing water and human and animal activities [78].Kirubavathy*et al.*[79] have emphasized that TDS values in excess amount at the freshwater ecosystem negatively influence the ecological balance and damage the aquatic fauna. The level of TDS was fluctuated from 24.10± 1.30 mg/l to 55.50± 0.92 mg/l with an annual mean of 33.44± 2.52 mg/l. There was decrease of TDS value in the month of August at SI and increase in the month of March at SII. During the year 2012-13, the TDS values ranged from 27.90± 0.94 mg/l to 56.80± 1.47 mg/l with an annual mean of 34.45± 2.48 mg/l. There was decrease of TDS in the month of August and September at SI and increase in the month of March at SII. Krishnan[80] has emphasized the range of TDS from 19 mg/l to 47.2 mg/l for Periyar Lake. Abujam*et al.*[16] have reported TDS values from 30 mg/l to 50 mg/l for Manjan Beel.

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. Krishna *et al.*[81], Jemi *et al.*[59], Sinha and Biswas[82] are in agreement with the present findings of lower TDS in the months of monsoon season. TDS values were increased in the months of summer season at 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 Chinnaih *et al.*[83], Sumitra *et al.*[84], Verma *et al.*[61], Tiwari and Ranga[85], Atanafu *et al.*[86].

Dissolved oxygen: Dissolved oxygen plays an important role in the metabolic activity in majority of organism at aquatic ecosystems. In the aquatic ecosystems, phytoplankton plays a major role in addition of oxygen while different microorganisms and animals utilize the dissolved oxygen. The values of DO during 2011-12 fluctuated from 6.89± 0.45 mg/l to 15.79± 0.33 mg/l with an annual mean of 9.89± 0.28 mg/l. The value of DO declined in the month of May at SI and inclined in the month of December at SI.

The estimates of DO values during 2012-13 at same reservoir fluctuated from 8.91± 0.54 mg/l to 14.21± 0.34 mg/l and an annual mean of 10.94± 0.01 mg/l. The DO values were declined in the month of May at SI and June at both sites while inclined in the month of December at SI. Similar DO values were observed by some of the workers like Zutshi *et al.*[87], who recorded the range of DO from 8.96 mg/l to 14.00 mg/l. Sairy[88] reported the DO values between 6 mg/l and 13 mg/l for Kundalika Dam.

Dissolved oxygen was decreased during the months of summer and the higher values of Dissolved oxygen were observed during winter season. 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.*[89] justified that the depletion of DO in aquatic ecosystem is due to high temperature and increased microbial activity. The increase in dissolved oxygen during winter season might be due to increased transparency, high activity of photosynthesis, low temperature and decreased microbial decomposition. Enhancement in DO value during winter months was also observed by Tiwari and Ranga[85] , Karne *et al.*[90], Baruah *et al.*[91], Ramesh and Sardhamani[34], Latha and Mohan[50], Tirupathaiah *et al.*[92], Nikam *et al.*[75], Sharma *et al.* [93], Ranjan *et al.*[94] and Khuhawar *et al.*[55].

Biochemical oxygen demand: 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. BOD indicates the organic load in water body. The amount of BOD at Dhangarmola water body for year 2011-12 varied from 1.48±0.19 mg/l to 5.12±0.51 mg/l with an annual mean of 3.51±0.57 mg/l. The fall of BOD at this reservoir was observed in the month of July at SI and September at SII while rise in BOD was observed in the month of February at SI and April at SII. The amount of BOD during year 2012-13 fluctuated from 1.35±0.19 mg/l to 5.26±0.32 mg/l with an annual mean of 3.51±0.58 mg/l. The fall of BOD at this reservoir was observed in the month of September at SII while rise in BOD was observed in the month of February at SI. The BOD values are on similar line of Sinha and Biswas[82] as 1.80 mg/l to 4.20 mg/l at Kalyani Lake.

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.*[95], Jemi *et al.*[59], Latha and Mohan[50] and Verma *et al.*[26].

Conclusion:

The present study can be concluded that all parameters were within the permissible limit for drinking, agricultural and domestic purposes. Moreover, the reservoir water also supports many biotic lives with special reference to their feeding and breeding ground.

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