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WATER QUALITY ANALYSIS OF DHUKESHWARI TEMPLE POND DEORI WITH REFERENCE TO CULTURAL EUTROPHICATION

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Abstract:
In the present investigation an attempt was made for assessment of Monthly and Seasonal Variation in some physicochemical properties in freshwater ecosystem of Dhukeshwari Temple Pond Deori in Gondia district of Maharashtra in the year 2014-2015. Expanding urbanization in the catchments area with consequent increase in anthropogenic activities, culminating in the introduction of untreated domestic sewage and immersion of idols, offerings, commercial waste and other socio-cultural practices also contributed to nutrient enrichment of this pond. Result shows, Water Temperature (22.2 ^{0}C to 32.2 ^{0}C), pH (7.1 to 7.8.), Transparency (22 cm -37cm.), TDS (340 mg/l to 620 mg/l.), DO (3.5 mg/l -6.7 mg/l.), Free CO2(3.5 mg/l -7.1 mg/l.), Total Alkalinity (122 mg/l -195 mg/l.), Total Hardness (135 mg/l - 430 mg/l.), Ca (90 mg/l - 370 mg/l.), Mg (35 mg/l - 85 mg/l.), Chloride (between 42 mg/l – 99.5 mg/l.), BOD (14 mg/l – 29.2 mg/l.), Sulphate (31.4 mg/l – 66 mg/l.), Phosphate (19 mg/l – 36.6 mg/l.), Nitrate (0.4 mg/l – 3.65 mg/l.). Having a glimpse of values of physicochemical properties such as BOD, Nitrate, Phosphate, Alkalinity, DO, Free CO2 etc. disclosed that the ecosystems under investigation are mildly polluted.

Key Words: *Freshwater Ecosystem, Temple Pond, Physicochemical properties, Eutrophication*

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INTRODUCTION:

The ponds and lakes are more productive ecosystems and their importance as life supporting systems in controlling water cycles and cleaning the environment has acknowledged by wetland experts worldwide. Generally lake possessed a vast array of diversity in its faunal composition which is dynamic and responsive to deviation from normal ecological homeostasis. Unfortunately they are degrading, become polluted due to inflow of domestic effluents, washing clothes, vehicles, cattle, immersion of idols etc. resulting in the accumulation of toxic chemicals and sludge leading to ecological imbalance. In an aquatic ecosystem the physicochemical environment exerts profound influence on its biotic components. It controls diversity, biomass and spatial distribution of biotic communities in time and space. The physical and chemical characteristics exert their influence both, individually and collectively and their interaction crates a biotic environment, which ultimately conditions the origin, development and finally succession of the biotic communities [1]. Thus the whole ecosystem is always in a state of dynamic flux and equilibrium. A well established and balanced ecosystem has all the physicochemical factors in optimum range and support maximum diversity of biota. However due to open nature of the system, continues exchange of matter and energy goes on. Any change in the physicochemical environment has got its effect on biotic community due to fact that different species of flora and fauna show variations in their responses to the altered water quality. Hence, highly sensitive species are eliminated altogether while other, more resistant and tolerant dominate the medium.

It is generally agreed that a single factor never acts independently as a limiting factor but only with the interactions with others. The knowledge of physicochemical parameters along with its biological characteristics can provide clear idea about the tropic status of the water body. The biological characteristic that is the animals living in water provide the best indicators of the overall health and ecological condition. Human activities that alter a watershed and interfere with the natural processes of water bodies have immediate as well as long lasting effects on the animals that live in the water. Till recent years, environmental assessment was confined to physicochemical analysis. However, when chemical and biological methods of environmental analysis are compared, the latter has specific advantages over the former as it is highly sensitive, the organisms are better indicators compared to any of chemical parameters. The lakes and ponds in the urban and rural area are now under the pressure of heavy siltation, domestic sewage discharge, industrial effluents and surface runoff from areas on which urban solid waste is dumped. Direct discharge of domestic sewage in a water body is the main problem of aquatic pollution. Sewage linked eutrophication of water is the major environmental issue today. Nutrient enrichment leads to eutrophication with its characteristics reflection like algal blooms, wild growth of aquatic weeds, foul smell, vector breeding, ground water pollution, fish kills and loss of biodiversity [2].

MATERIALS AND METHODS:

Collection of water:

During the study period, the pond water and zooplankton samples collected from October 2014 to September 2015. The studies were carried out for 12 months for every season. The seasons defined as winter (October to January), summer (February to May), monsoon (June to September),

Water Sampling:

The water samples were collected fortnightly in clean glass bottles of various sizes from the water surface of study sites. For the DO estimation, the sample was collected in the bottle of around 125-ml volume, as well as about 5 litre volumes of water was also collected in a container separately for other analysis. The sampling of surface water was done by simply dipping the container slowly in water without disturbing the surface and avoiding development of any air bubble in the near vicinity of collection spot as well as in the container. Some of water characteristics viz. Temperature and pH were determined at the sampling station with the help of portable equipments and others were mostly tested within 24 hours of collection. Preservation of water samples whenever necessary was done at 4°C.

Study Site:

The Dhukeshwari Temple pond was constructed before 50 years ago by impounding natural low lying areas nearby Goddesses “Dhukeshwari” Temple (N 21^0 4’ 29.4405”, E 80^0 21’ 44.6565”) along the National Highway No. 6, mainly for agricultural purposes.

Observation and Result: The main objective of the seasonal variation in physicochemical analysis of water is to determine its nutrient status. Since the water contains dissolved and suspended constituents in varying proportions, it has different chemical and physical properties along with biological variation. The quality of water may be affected in various ways by pollution. The results on water quality in terms of physicochemical properties are summarized in the Table 1 and 2.

Water Temperature:

The Water Temperature of this site during the year Oct 2014 to Sept 2015, ranged between 22.2 ^{0}C to 32.2 ^{0}C The minimum temperature was recorded in the month of February and maximum in the month of June, As far as the seasonal variation, the

minimum temperature was observed 25.025 ± 1.3073 ^{0}C in the winter season and the maximum to the extent of 28.8 ±4.903 ^{0}C in the summer season of the year 2014-2015. The Annual average was recorded to be 27.20833 ±3.512**. pH:** The pH during the Oct 2014 to Sept 2015, ranged between 7.1 to 7.8. The minimum value was recorded in the month of January, June and August and maximum in the month of April. As far as the seasonal variation, the minimum value was observed as 7.15 ±0.057 in the monsoon of the year 2014-2015. The annual average of the year 2014-2015, was observed to be 7.341667 ±0.242. **Transparency (cm):** The Transparency during the year 2014-2015, ranged between 22 cm -37cm. the minimum transparency was recorded in the month of June and maximum in the month of Feb. as for as the seasonal variation, the minimum transparency was observed to the extent of 26.75 ±5.737 cm in the monsoon season in the year 2014-2015 while maximum 31.75 ±2.872 cm in the winter. The annual average of the year 2014-2015 was 29.83333 ±4.969 cm**. TDS (mg/l):** The TDS during the year 2014-2015, ranged between 340 mg/l to 620 mg/l. the minimum value was recorded in the month of October and maximum in the month of May. As far as the seasonal variation, the minimum value of 377.5 ±29.860 mg/l in the winter season of the year 2014-2015 and maximum of 512.5 ±79.230 mg/l in the summer season. The annual average of the 2014-2015 was observed to be 452.5 ±88.536 mg/l. **Dissolved oxygen (mg/l):** The Dissolved oxygen during the year 2014-2015 ranged between 3.5 mg/l -6.7 mg/l. the minimum value was recorded in the month of February and maximum in the month of December. As far as the seasonal variation, the minimum value observed was 4.275 ±6.665 mg/l in the summer season of the year 2014-2015 and maximum was 6.575 ±1.228 mg/l in monsoon season. The annual average of the 2014-2015 was observed to be 5.4 ±1.373 mg/l. **Free CO2 (mg/l):** The Free CO2 (mg/l) during the year 2014-2015 ranged between 3.5 mg/l -7.1 mg/l. the minimum value was recorded in the month of April and maximum in the month of September. As far as the seasonal variation, the minimum value observed was 4.125 ±0.590 mg/l in the summer season of the year 2014-2015 and maximum was 6.125 ±0.518 mg/l in winter season. The annual average of the 2014-2015 was observed to be 5.066667 ±1.234 mg/l. **Total alkalinity (mg/l):** The Total alkalinity (mg/l) during the year 2014-2015 ranged between 122 mg/l -195 mg/l. the minimum value was recorded in the month of July and maximum in the month of May. As far as the seasonal variation, the minimum value observed was 134.75 ±10.688 mg/l in the monsoon season of the year 2014-2015 and maximum was 170.5 ±21 mg/l in the summer season. The annual average of the 2014-2015 was observed to be 148.5 ±20.615 mg/l. **Total hardness (mg/l):** The Total hardness (mg/l) during the year 2014-2015 ranged between 135 mg/l - 430 mg/l. the minimum value was recorded in the month of September and maximum in the month of July. As far as the seasonal variation, the minimum value observed was 243.75 ±108.26 mg/l in the summer season of the year 2014-2015 and maximum was 357.5 ±87.702 mg/l in the winter season. The annual average of the 2014-2015 was observed to be 302.6667 ±109.22 mg/l. **Calcium (mg/l):** The Calcium (mg/l) during the year 2014-2015 ranged between 90 mg/l - 370 mg/l. the minimum value was recorded in the month of September and maximum in the month of July. As far as the seasonal variation, the minimum value observed was 194.75 ±94.164 mg/l in the summer season of the year 2014-2015 and maximum was 303.25 ±79.533 mg/l in the winter season. The annual average of the 2014-2015 was observed to be 245.5 ±99.983 mg/l. **Magnesium (mg/l):** The Magnesium (mg/l) during the year 2014-2015 ranged between 35 mg/l - 85 mg/l. the minimum value was recorded in the month of April and maximum in the month of August. As far as the seasonal variation, the minimum value observed was 49 ±15.513 mg/l in the summer season of the year 2014-2015 and maximum was 68.25 ±19.207 mg/l in the monsoon season. The annual average of the 2014-2015 was observed to be 57.16667 ±16.202 mg/l. **Chlorides (mg/l):** The Chlorides (mg/l) during the year 2014-2015 ranged between 42 mg/l – 99.5 mg/l. the minimum value was recorded in the month of September and maximum in the month of December. As far as the seasonal variation, the minimum value observed was 66.875 ±22.0694 mg/l in the winter season of the year 2014-2015 and maximum was 71 ±14.282 mg/l in the summer season. The annual average of the 2014-2015 was observed to be 68.375 ±20.017 mg/l. **BOD (mg/l):** The BOD (mg/l) during the year 2014-2015 ranged between 14 mg/l – 29.2 mg/l. the minimum value was recorded in the month of March and maximum in the month of January. As far as the seasonal variation, the minimum value observed was 15.3 ±1.013 mg/l in the summer season of the year 2014-2015 and maximum was 25.5 ±3.934 mg/l in the winter season. The annual average of the 2014-2015 was observed to be 21.18333 ±5.482 mg/l. **Sulphate (mg/l):** The Sulphate (mg/l) during the year 2014-2015 ranged between 31.4 mg/l – 66 mg/l. the minimum value was recorded in the month of September and maximum in the month of May. As far as the seasonal variation, the minimum value observed was 35.725 ±4.694 mg/l in the monsoon season of the year 2014-2015 and maximum was 60.975 ±5.657 mg/l in the summer season. The annual average of the 2014-2015 was observed to be 46.575 ±12.009 mg/l**. Phosphate (mg/l):** The Phosphate (mg/l) during the year 2014-2015 ranged

between 19 mg/l – 36.6 mg/l. the minimum value was recorded in the month of May and maximum in the month of January. As far as the seasonal variation, the minimum value observed was 21.975 ±3.337 mg/l in the summer season of the year 2014-2015 and maximum was 34.3125 ±2.642 mg/l in the winter season. The annual average of the 2014-2015 was observed to be 26.7875 ±6.345 mg/l.

Nitrate-N (mg/l): The Nitrate-N (mg/l) during the year 2014-2015 ranged between 0.4 mg/l – 3.65 mg/l. the minimum value was recorded in the month of May and maximum in the month of September. As far as the seasonal variation, the minimum value observed was 0.7 ±0.270 mg/l in the summer season of the year 2014-2015 and maximum was 2.235 ±1.264 mg/l in the monsoon season. The annual average of the 2014-2015 was observed to be 1.5325 ±0.996 mg/l.

DISCUSSION:

The physicochemical environment in aquatic ecosystem has profound influence on its biotic components. It controls biodiversity, biomass and spatial distribution of biotic communities in time and space. The physicochemical properties exert their influences both individually and collectively, their interactions produce abiotic environment which ultimately conditions the origin, development and finally succession of biotic communities. Each ecosystem has its characteristic abiotic or biotic features and therefore thorough understanding is essential for its effective management and conservation. Fluctuations in physicochemical parameters often create an adverse effect on organisms, limiting their production and reduce their ability to compete with other population within the environment. Rawson (1960)[3] proposed a scale for oligotrophic and Eutrophic lakes on the basis of physicochemical parameters. These properties may be used to evaluate the trophic status of lakes [4]. The fluctuation or variation in the physicochemical properties may be due to some potent factors like climatic changes related to the total rainfall, evaporation of water which may lead to changes in water level and it affects the size of the actual water body, input of pollutants through anthropogenic and other activities on the water body margin and aquatic vegetation.

Water Temperature:

Temperature plays a crucial role in aquatic ecosystem affecting the various properties, increases metabolic rates and physiological reactions of organisms, etc. the rate of oxidation of organic matter is much greater during summer than in winter. From the tables it is clear that, temperature at the sampling site range between 22.2 ^{0}C to 32.2 ^{0}C and seasonally ranges between 25.025°C To 28.8°C in winter and summer respectively with yearly average of about 27.20°C. Similar observations was also reported by Jayabhaye et al., (2008)[5] in a minor reservoir of Sawana, Hingoli MS who recorded the temperature fluctuation between 22°C To 31°C with average of 26.42°C highest in summer and lowest in winter season. He reported that the highest water temperature in summer is due to the low water level and clear atmosphere. Similar observation is reported by Shastri et al., (2008)[6] in Chingrajpara Pond, Bilaspur CG; R. Srinivas Rao (2004)[7] in Banjara lake, Hyderabad; Kedar (2002)[8] in Rishi lake; Washim; Chandrasekhar (2002)[9] in Saroornagar lake, Hyderabad. During the present findings, the maximum values of water temperature were observed in summer months and minimum in winter months. Higher temperature in summer season might be due to low water level and greater solar radiation with clear atmosphere; higher rate of oxidation of organic matter and other anthropogenic activities. Winter minimum may be due to the higher water level, high humidity and lower solar radiation.

pH:

It is one of the most precious properties of water and is measured as an intensity of acidity or alkalinity on a scale ranging from 0-14. In natural water pH is governed by the equilibrium between CO2, bicarbonate and carbonate ions and ranges in 4.5 to 8.5 although mostly basic. It tends to increase during day, largely due to the photosynthetic activity (consumption of CO2) and decreases during night due to respiratory activity. Most of the polluted or waste water have lower or higher than 7 pH value, depends on the nature of pollutant. The organisms can survive in narrow range of pH from slightly alkaline condition. Drastic change in pH adversely affects the biota. The optimum range of pH for water organisms is 6.8 to 9, while 6.7 to 8.4 is a suitable and below 5 and above 9.3 are detrimental [10]. In the present investigations, the pH was recorded during the Oct 2014 to Sept 2015, ranged in 7.1 to 7.8. The minimum value was recorded in the month of January, June and August and maximum in the month of April. As far as the seasonal variation, the minimum value was observed as 7.15 in the monsoon. The annual average of the year 2014-2015, was observed to be 7.34. Pearsall (1930)[11] and Zafar (1966)[12] observed that the pH of the water appears to be dependent upon the relative quantities of Ca, carbonates and bicarbonates. In the present investigation the minimum value was observed in monsoon might be due to the cloudy weather [13] and heavy fresh water inflow into water body [5]. Chandrasekhar and Kodarkar (1994)[14] observed the range of pH from 8.0 to 9.0 in Saroornagar Lake, Hyderabad. Kulkarni et al., (1995)[15] recorded highest value in summer season (8.45) as

against monsoon (7.2). Pennak (1989)[16] stated that varying water chemistry and variation in magnitude of photosynthesis were responsible for the variation of pH. In alkaline water bodies, evaporation, amount of dissolved nutrients and gases, standing biomass of organisms, addition of organic matter from extraneous sources and influx of rainwater are some of the important factors which determine pH range. It is clear that maximum pH recorded during the summer season might be due to high temperature, clear sunlight and high photosynthesis. And minimum pH recorded in monsoon could be due to inflow of fresh rain water into the pond. Similar finding was also reported by Bagade and Verma (1985)[17]. From the above observations, it is clear that, the pond is slightly alkaline in nature.

Transparency:

It is one of the properties of water that varies with the combined effect of colour and turbidity. It measures the light penetrating through the water body and is determined by using Secchi disc. Transparency is the actual light penetrating capacity of water and is inversely proportional to the turbidity created by inorganic and organic matter [18]. Sechhi depth has been used for many years as a limnological tool for measuring water clarity, growth and decay of planktons and suspended detritus. It is a reliable indicator of the trophic state of a water body. In the present investigation, the minimum transparency was observed to the extent of 26.75 cm in the monsoon season might be due to the fine silt, held in suspension as a result of large inflow of runoff from the catchment area decreasing the light penetration, while maximum 31.75 cm in the winter. Higher the transparency value in winter might be due to settlement of very rich dead and decaying biomass [7]. Oomachand (1981)[19] reported minimum transparency in monsoon and maximum in January from lower Lake of Bhopal.

TDS:

Dissolved solids consist of carbonates, bicarbonates, sulphates, chlorides, phosphates and nitrate of calcium, magnesium, sodium, potassium, iron and manganese etc. The high concentration of total dissolve solids increases water turbidity, which in turn decreases the light penetration affecting the photosynthesis. The level of TDS plays an important role in community structure due to the limiting impact on primary production and tropic dynamics. In the present investigation, the minimum value of 377.5 mg/l in the winter season and maximum of 512.5 mg/l in the summer season. Similar observation was reported by Jayabhaye et al., (2008)[5] recorded higher TDS in summer season followed by monsoon and winter. Maximum TDS in summer season might be due to discharge of domestic sewage from locality and low water level, whereas lower values in winter season might be due to profuse growth of submerged and marginal macrophytes, which might have utilized more dissolved nutrients. The TDS also increases with increase in pollution of water [20]. In the present investigation maximum value of TDS of 620 mg/l was recorded in the month of May and minimum value of 340 mg/l during October. According to WHO, BIS and ICMR the desirable limit of TDS is 500 mg/l. in the present investigation the pond water is polluted with regard to TDS. The pollution has a direct relationship with the TDS [21][22], this is agreement with the present investigation.

Dissolved Oxygen:

Dissolved oxygen is important parameters in water quality assessment. Its presence is essential to maintain variety of biological life in the water and the effects of waste discharge in a water body are largely determined by the oxygen balance of the system. Dissolved oxygen is a regulator of metabolic activities of organisms and thus governs the metabolism of the biological communities as a whole and also acts as an indicator of trophic status of water body [23]. Eutrophication causes an increase in plankton production, which ultimately increases detritus, leads to oxygen depletion and increase in bacterial oxygen demand particularly at higher temperature [24]. In the present investigation, The Dissolved oxygen ranged between 3.5 mg/l to 6.7 mg/l. The minimum value was recorded in the month of February and maximum in the month of December. The seasonal variation, the minimum value observed was 4.275 mg/l in the summer season of the year 2014-2015 and maximum was 6.575 mg/l in monsoon season. The minimum DO in summer might be due to the higher temperature and the high rate of oxygen consumption by oxidizable matter coming in along with the domestic sewage. The decomposition of organic matter was an important factor in consumption of DO which is vigorous in warm weather [25], minimum DO in summer might be due to the higher temperature and greater consumption of oxygen [6]. At higher temperature, the water has a lesser oxygen holding capacity and surplus oxygen will be lost to the atmosphere [26][27]. Maximum DO during monsoon might be due to increased flow of water dilution of decomposable matter, higher aeration rate and increased water level due to rainfall, thus the water becomes oxygenated in monsoon due to circulation and mixing by inflow of rain water. The low value in summer might be due to DO depletion with high temperature and was in conformity with Agarwal et al., (1976)[28]. Yeole and Patil (2005)[29] recorded higher value of 7.5 mg/l during monsoon and lower during summer season in Yedshi Lake Washim. According to them the higher value in monsoon

was possibly due to comparatively high photosynthetic activity. Narayan et al., (2007)[30] recorded highest DO during rainy and lowest during summer in Texi Temple Pond, Etawah. Arumugam and Fernando (1979)[31] stated that the higher level of DO is indicators of eutrophication while Salaskar and Yeragi (1997)[1] stated that persistent low DO value in the lake indicate a very high degree of organic pollution.

Free CO_2:

Carbon dioxide is a normal component of all natural waters. It is an end product of bacterial decomposition and respiratory processes of plants and animals. When the level of carbon dioxide increases in water it leads to pollution. Carbon dioxide is an end product of both aerobic and anaerobic bacteria oxidation; therefore, its concentration is not limited by the amount of dissolved oxygen. The free CO_2 content of water depends upon the temperature of water, depth of water, rate of respiration, decomposition of organic matter and chemical nature of the bottom. The free CO_2 is about 200 times more soluble in water than the oxygen. In the present Investigation, The Free CO_2 (mg/l) ranged between 3.5 mg/l to 7.1 mg/l. the minimum value was recorded in the month of April and maximum in the month of September. Seasonally, the minimum value observed was 4.125 mg/l in the summer season and maximum was 6.125 mg/l in winter. Maximum free CO_2 in winter may be due to the excessive concentration of biodegradable wastes in the water, mainly through sewage and surface runoff, algal blooms, microbial decomposition of organic matter and also absorption from atmosphere. Salaskar and Yeragi (2000)[32] stated slightly increased CO2 during winter season when the temperature was lower in Powai Lake, Mumbai. Main reason of maximum CO2 in winter is either due to absorption from atmosphere or due to microbial decomposition of organic matter. Minimum value of free CO_2 in summer may be due to very low water level and very high temperature and profuse growth of macrophytes. The minimum value in summer could be mainly due to complete utilization in photosynthetic activity [33]. Kadam et al., (2007)[34] reported very low value of free CO2 during April, May and June in Masoli reservoir, Parbhani. Low level of free CO2 might be either due to its consumption in carbon assimilation or its complete conversions into carbonic acid and ultimately into stable carbonates and bicarbonates [35].

Total Alkalinity:

Alkalinity of water is its quantitative capacity to neutralize a strong acid to a designated pH and is characterized by the presence of the (OH^-) ions capable of combining with hydrogen (H^+) ions. A number of bases such carbonates. Bicarbonates Hydroxide, phosphate, nitrates, silicates, borates, etc. contribute to the alkalinity. In the present investigation, the Total alkalinity (mg/l) ranged between 122 mg/l to 195 mg/l. the minimum value was recorded in the month of July and maximum in the month of May. As far as the seasonal variation, the minimum value observed was 134.75 mg/l in the monsoon and maximum was 170.5 mg/l in the summer season. Maximum Total alkalinity in summer might be due to rise in temperature, evaporation, concentration of nutrients and bicarbonates in the particular. Hazelwood and Parker (1961)[36] showed that a decreased water level due to evaporation can cause steady increase in alkalinity during summer. Minimum total alkalinity during monsoon and might be due to the dilution of pond water by ran water which ultimately decreases the value of bicarbonates. Dilution plays an important role in lowering alkalinity of water [37]. Saroj Panda and Dash (2002)[38] stated that greater amount of alkalinity in small community ponds was due to large scale use of its banks as open air toilet and flushing of human and animal excreta into the ponds. The higher total alkalinity range in Dhukeshwari Temple pond shows high pollution load in it.

Total Hardness:

Hardness of water is imparted predominantly by alkaline earth metal cations, like calcium, magnesium, with minor contribution of strontium, Barium, Zinc, Aluminum, and Iron. Hardness may be temporary (caused by soluble calcium and magnesium) or permanent (may be due to predominance of bicarbonates and sulphates of Calcium and magnesium). Ecologically, temporary hardness plays a key role in buffering capacity and has a great effect on biotic diversity and biomass. The hardness is used in the assessment of water quality and is governed by the content of calcium and magnesium salts that largely combine with carbonates and bicarbonates and with sulphates, chloride, etc. In the present investigation, The Total hardness (mg/l) ranged between 135 mg/l to 430 mg/l. the minimum value was recorded in the month of September and maximum in the month of July. As far as the seasonal variation, the minimum value observed was 243.75 mg/l in the summer season and maximum was 357.5 mg/l in the winter season. Minimum hardness during summer might be due to complete utilization of carbonate and bicarbonate by phytoplankton during active photosynthesis and maximum hardness during winter might be due to the anthropogenic activity at the bank of pond. Usha et al., (2006)[39] observed total hardness ranged between 168 to 589 mg/l in Perumal Lake, Cuddalore, TN. Pejavar and Somani (2000)[40] recorded that total hardness ranges between 360 ppm to 400 ppm in Railadevi Lake,

Thane. Sawant and Telawe (2009)[41] recorded highest hardness in Gijwane pond Kolhapur which shows its Eutrophic nature. Devendra Mohan et al., (2007)[42] explained that the high value of total hardness might be due to receiving of human fecal matter through household drainage of from the bank of the ponds. High total hardness recorded might be due to the discharge of domestic sewage which is rich in organic matter [43]. Chatopadhyay et al., (1984)[44] attributed higher values of hardness due to surface water runoff and sewage discharge. In the present investigation also Dhukeshwari pond showed higher values of total hardness throughout the year which might be due to the continued discharge of domestic sewage which increases the nutrient load in water.

Calcium and Magnesium:

Calcium is an important micronutrient in an aquatic ecosystem and found in abundance in all natural waters and its source lies in the rocks from which it leaches out due to weathering. Thus the concentration of calcium depends on the nature of basin. Like calcium, magnesium is also found in all natural sediments and water and weathering of rocks in the catchments is the main source of this anion. Its level is generally lower than calcium. As a micronutrient, magnesium is essential for chlorophyll biosynthesis and enzymatic transformation, particularly the photophosphorylation in algae, fungi and bacteria [45]. In the present investigation, The Calcium (mg/l) ranged between 90 mg/l to 370 mg/l. the minimum value was recorded in the month of September and maximum in the month of July. As far as the seasonal variation, the minimum value observed was 194.75 mg/l in the summer season and maximum was 303.25 mg/l in the winter season. The Magnesium (mg/l) ranged between 35 mg/l to 85 mg/l. the minimum value was recorded in the month of April and maximum in the month of August. As far as the seasonal variation, the minimum value observed was 49 mg/l in the summer season and maximum was 68.25 mg/l in the monsoon season. Sulabha et al., (2006)[46] recorded Ca values ranged from 18.64 mg/l during rainy season to 20.38 mg/l during non rainy season while Mg values ranged from 13.74 mg/l during non rainy season to 14.75 mg/l during rainy season in Thirumullavaram temple pond Kerala. Less Mg during summer might be due to its utilization by algae, fungi and bacteria for enzymatic transformation, particularly in photophosphorylation. In the Dhukeshwari Temple Pond under study, the maximum Ca and Mg might be due to receiving large amount of domestic sewage, and anthropogenic activities in the vicinity of the pond.

Chlorides:

Chloride is universally present in soil mostly as a soluble ion. The high chloride concentration is considered to be an indicator of pollution due to organic wastes of animal origin. The animal excreta have high quantity of chloride along with nitrogenous wastes. Klein, (1973)[10] found direct correlation between chloride concentration and pollution level. The presence of higher values of chloride in the river shares high pollution load. Munawar, (1970)[47] suggested that a higher values of chloride in water is an index of pollution of animal origin. In the present investigation, The Chlorides (mg/l) ranged between 42 mg/l to 99.5 mg/l. the minimum value was recorded in the month of September and maximum in the month of December. As far as the seasonal variation, the minimum value observed was 66.875 mg/l in the winter season and maximum was 71 mg/l in the summer season. Maximum chloride value in summer might be due to lowering of water level and increase of anthropogenic activities. Minimum value in winter season might be due to dilution effect of post monsoon period and high sedimentation rate. The maximum chloride during summer and minimum in winter, similar observations by Sulabha et al., (2006)[48] who recorded maximum chloride during non rainy season and minimum during rainy season in Thirumullavaram pond, Kerala. Higher value in summer might be due to the evaporative loss of water. Salve and Hiware (2007)[49] also recorded high chloride range (21.26 mg/l) during summer. Rajshekhar et al., (2007)[50] noticed summer maxima and winter minima in minor reservoir, Sumeetra Meena et al.,(2007)[51] observed that high level of chlorides in the lake Pichhola (56-150 mg/l) clearly points out to excessive human interference into water body. Chloride content significantly increases with the degree of eutrophication [52]. Summer chloride maxima are linked with the loss of water by transpiration due to high temperature [53]. Low value in winter encountered due to high sedimentation rate, Similarly the Dhukeshwari Temple Pond under study receive high amount of domestic sewage, religious offerings and human and animal wastes causes accumulation of polluting substance showing peak of chloride during study period.

BOD (Biochemical Oxygen Demand):

Biochemical oxygen demand is defined as the amount of oxygen required by the microorganisms, while stabilizing, biologically decomposable organic matter in waste water under aerobic conditions. It is the rate of consumption of oxygen in aerobic degradation of the dissolved organic matter in water. The main sources of organic

pollution are untreated domestic sewage, agricultural runoff and certain industrial effluents. The organic matter can be served as food for the bacteria and the energy is released from its oxidation on the basis of demand for oxygen and is proportional to the amount of organic wastes to be degraded aerobically. BOD is an important parameter that indicates the magnitude of water pollution by oxidizable or biodegradable organic matter. In unpolluted water, BOD is lower, while it is high in the case of polluted water [54]. BOD also affects the benthic diversity [55]. In the present investigation, the BOD (mg/l) ranged between 14 mg/l to 29.2 mg/l. The minimum value was recorded in the month of March and maximum in the month of January. As far as the seasonal variation, the minimum value observed was 15.3 mg/l in the summer season and maximum was 25.5 mg/l in the winter season. Similar results were reported by Narayan et al., (2007)[56] in Texi Temple Pond, Etawah. Minimum BOD during summer season might be due to the increased temperature and sedimentation load while maximum BOD during winter season attributed to the release of domestic sewage, human faecal matter in the pond which increases organic load ultimately increasing BOD. High BOD during winter is attributed to immersion of idols of Ganesh, Durga, Gauri, Krishna festivals and religious offerings, which are particularly celebrated during post monsoon and early to mid winter season. Similar results are also reported by Vyas et al., (2006)[58]. Nutrient level into water body is increased as a consequence of immersion of idol [59]. Sarang et al., (2007)[60] reported high BOD during winter and low during summer season in Rajasthan. BOD indicates the intensity of the decomposition processes of organic matter and the high load of biodegradable organic matter [61]. In the present investigation, the Dhukeshwari Temple pond showing the high BOD values might be due to high load of organic matter.

Sulphate:

In all natural waters the Sulphate is contributed from weathering of rocks, domestic sewage and industrial effluents. Therefore the level of Sulphate is an indication of pollution from organic matter. Biological oxidation of sulphur containing organic matter and precipitation in zones of high sulphur emission adds to sulphates into the water. Many Sulphate compound are readily soluble in water. Most of them originate from oxidation of Sulphate ores, presence of shells and the solution of the Gypsum and anhydride. In the absence of dissolved oxygen, nitrate and Sulphate serve as a source of oxygen for biochemical oxidation by anaerobic bacteria. Under anaerobic conditions Sulphate ion is reduced to sulphide ion and with hydrogen ion from hydrogen sulphide. The presence of hydrogen sulphide leads to corrosion of pipes [62]. In humid region, Sulphate is readily leached from zone of weathering by infiltrating water and surface runoff [63]. Decomposition of organic matter containing pertinacious sulphur and anaerobic reduction of Sulphate in water contributes to alter the conditions that markedly affect the cycling of nutrient productivity and bottom sediments [64]. In the present investigation, the Sulphate (mg/l) ranged between 31.4 mg/l to 66 mg/l. the minimum value was recorded in the month of September and maximum in the month of May. As far as the seasonal variation, the minimum value observed was 35.725 mg/l in the monsoon season and maximum was 60.975 mg/l in the summer season. Maximum in summer might be due to evaporative loss of water with influx of domestic sewage, containing sulphur compounds and biological oxidation of sulphur containing organic matter and minimum in monsoon might be due to the dilution effect. Similar observation is reported by Shiddamallayya et al., (2008)[65], who reported higher concentration of sulphate during summer season and lower during monsoon season in Bhalki tank, Bidar and confirmed with Agarkar et al., (2000). Higher values of sulphate in summer attributed to evaporative loss of water with influx of domestic sewage containing sulphur compounds and biological oxidation of sulphur containing organic matter from urban area while lower values during monsoon might be due to dilution effect. Raj Narayan et al., (2007)[67] reported that Sulphate makes the salty taste of water, making it unfit for human consumption and record sulphate value of 10 mg/l during summer and monsoon and of 5 mg/l during winter season in Texi Temple Pond, Etawah. From the above values it is evident that the Dhukeshwari temple pond with high values of sulphate shows high pollution load. Sawant and Telawe (2008)[68] recorded the Sulphate values of 40 mg/l and 80 mg/l in Mumewadi and Gijwane pond respectively in Gadhinglaj Tank, Kolhapur. Chatterjee (1992)[69] reported maximum Sulphate value of 29.5 mg/l and minimum of 5.7 mg/l in Nandankanan Lake, Orissa. In the present investigation, the higher values of Sulphate in Dhukeshwari Pond might be due to the anthropogenic activities and weathering of rocks. High concentration of Sulphate is due to the decomposition of the organic substances in latrine soil. The present observation is in conformity with Sakhare et al., (2002)[70].

Phosphate: In the natural water phosphorus occurs in both organic and inorganic forms. Inorganic phosphorus as an orthophosphate plays a very crucial role by acting as the limiting nutrient. On precipitation, orthophosphate gets trapped in the sediment and in the reducing condition it is obtained in the eutrophic ecosystems. The major

sources of phosphate are domestic sewage, industrial effluents, agricultural runoff, detergents and soaps, etc. Phosphates are also normal constituents of human excreta [71]. Phosphate in a large quantity in the fresh water indicates pollution through growth of nuisance causing microorganisms. Phosphorus present in low concentration is the most important nutrient, limiting growth of autotrophs and biological productivity of aquatic ecosystem. High phosphorus content causes increased algal growth. The high uptake by phytoplankton is one of the reasons for the depletion of phosphorus from water. Through phosphate poses problems in surface water, its presence is necessary for biological degradation of wastewater [72]. In the present study, the estimation of phosphorus in inorganic form (PO4) is considered. The Phosphate (mg/l) ranged between 19 mg/l to 36.6 mg/l. the minimum value was recorded in the month of May and maximum in the month of January. As far as the seasonal variation, the minimum value observed was 21.975 mg/l in the summer season and maximum was 34.3125 mg/l in the winter season. Minimum Phosphate in summer might be due to the uptake of phosphate by abundance of phytoplankton and maximum values during winter season might be due to the anthropogenic influences contains influx of detergents. Similar observation was also reported by Gnana Sudha and Mary (1996)[73] who recorded high phosphate during winter and low during summer in Banjara Lake, Hyderabad which shows its Eutrophic nature. High value of phosphate during winter season may be due to anthropogenic influences especially influx of domestic sewage and use of detergents. With increase in the concentration of detergents, there is continuous increase in phosphates [74]. Slower utilization of phytoplankton due to low temperature results in winter maxima of phosphate [75]. Lowest concentration of phosphate during summer due to the uptake of phosphates by algal blooms [65] at high temperature phosphate is rapidly assimilated by plankton and microorganisms [76] and also by higher consumption by macrophytes [77] and heterotrophic uptake of microorganisms and sediment adsorption [78]. Urban water bodies subjected to pollution from domestic sewage exhibit high level of phosphate which shows the signs of eutrophication [79]. Magdy Khalil (1990)[80] noticed maximum phytoplankton with minimum phosphate level in Manzala Lake, Egypt. In the present study, the highest phosphate was recorded in Dhukeshwari Temple Pond is attributed to the old age of the ponds. Pennak (1958) [81] attributes the amount of phosphorus in Lakes to the age of the basin. Similar observation is also reported by Sarkar and Rai (1964)[82]. Moreover, constant death and decay of phytoplanktonic organisms and invertebrate fauna maintain the phosphate content of the water. Second reason of the higher phosphate values is due to the receiving of high amount of domestic sewage.

Nitrate-N:

Though nitrogen is a major constituent of atmosphere, it is found in small amount in aquatic ecosystem due to low solubility but it is also found in small amount in the form of ammonia, nitrates, nitrites, organic nitrogen and so on. When nitrogenous matter is oxidized it remains mainly in the form of nitrates and its presence can be considered as an indication of sewage pollution. Significant sources of nitrates in water come from chemical fertilizer, domestic effluents and industrial discharge and due to change in land use patterns. Some atmospheric pollutants also contribute to the increased nitrates levels in rain water during monsoon, ultimately affecting surface water, aerobic and anaerobic decomposition of organic matter form ammonia which is then oxidized to nitrites and finally to nitrates. Unpolluted natural waters contain minute amount of nitrate. High concentration of nitrates in potable water cause serious conditions in young ones; it reduces nitrites in their intestinal tract which may lead to Met-haemoglobinaemia. In the present investigation, only the nitrates were quantitatively estimated from the ponds under study. The stimulation of plant growth by nitrates may results in eutrophication especially due to algae. The subsequent death and decay of plants produce secondary pollution. In the present investigation, the Nitrate-N (mg/l) ranged between 0.4 mg/l to 3.65 mg/l. the minimum value was recorded in the month of May and maximum in the month of September. As far as the seasonal variation, the minimum value observed was 0.7 mg/l in the summer season and maximum was 2.235 mg/l in the monsoon season. Low value of nitrate during summer may be attributed to the growth of macrophytes. Nitrate is one of the factors which control the initial growth of macrophytes. Nitrate is one of the factors which control the initial growth of macrophytes. When the macrophytes were established, there is a sharp decrease in the nitrate [83]. Higher values of nitrate during monsoon may be due to the influx of nitrogen rich water runoff from the catchment area bringing domestic sewage, fecal matter from pond bank and also runoff from nearby agricultural fields. Gnana Sudha and Mary (1996)[73] reported higher value of nitrate (2.414 mg/l) during monsoon and lower values (1.75 mg/l) during summer in Banjara Lake, Hyderabad. Jakher and Rawat (2003)[84] reported higher nitrate nitrogen value of 17.49 mg/l during monsoon and of 6.41 mg/l during winter in a tropical Lake, Jodhpur Rajasthan. Narayan et al., (2007)[30] stated that the presence of nitrate in the sample is suggestive of some bacterial action and bacterial growth who recorded nitrate from Texi

Temple Pond, Etawah UP. In the present study the nitrate range of Dhukeshwari Temple pond showed their productive nature which attributed to the release of raw sewage and catchment inflow. Rao and Shrivastava (2004)[85] reported more nitrate value in monsoon which gradually reduced during winter and summer due to biotic consumption in Gandhisagar reservoir, Mandisaur MP. In the present investigation, the Dhukeshwari Temple Pond shows productivity with higher nitrate value due to consistent anthropogenic activities and receives high input of domestic sewage during study.

CONCLUSION:

Dhukeshwari Temple pond receives untreated sewage from the localities in its catchment from the several years. The pond receives organic source in the form of religious offerings and idol immersion, every day cloth washing, bathing, other anthropogenic activities increases the organic load. This lentic ecosystem is undergoing several changes due to anthropogenic activities and therefore it is an obligatory need of control its degradation from anthropogenic activities and assures its conservation. Having a glimpse of observation on physicochemical properties, such as Free CO_2, DO, pH, BOD, Nitrate, Phosphate, Sulphate, etc. it is clear that the Dhukeshwari Temple Pond in Deori is quite polluted and may be classified mesotrophic to eutrophic nature.

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A. View of Dhukeshwari Temple Pond Deori Dist. Gondia

B. Satellite View of Dhukeshwari Temple Pond Deori Dist. Gondia

Table 1: Monthly variation of physicochemical factors in the year 2014-2015

S.N.	PARAMETERS	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
1	Water Temp. (^{0}C)	26.3	25.2	25.4	23.2	22.2	28.3	31.1	33.6	32.2	27.4	25.4	26.2
2	pH	7.3	7.6	7.2	7.1	7.7	7.4	7.8	7.4	7.1	7.2	7.1	7.2
3	Transparency (cm)	35	32	28	32	37	34	25	28	22	24	26	35
4	TDS (mg/l)	340	370	390	410	430	490	510	620	570	510	440	350
5	DO (mg/l)	4.2	4.5	6.7	6	3.5	4.4	4.1	5.1	5.8	6.6	8.3	5.6
6	Free CO2 (mg/l)	6.9	5.9	5.8	5.9	4.9	3.9	3.5	4.2	3.9	3.9	4.9	7.1
7	Total alkalinity (mg/l)	142	144	135	140	145	165	177	195	145	122	130	142
8	Total hardness (mg/l)	420	230	410	370	395	234	140	206	307	430	355	135
9	Calcium (mg/l)	365	188	345	315	325	194	105	155	224	370	270	90
10	Magnesium (mg/l)	55	42	65	55	70	40	35	51	83	60	85	45
11	Chlorides (mg/l)	55	52	99.5	61	56	62	86	80	87	95	45	42
12	BOD (mg/l)	20.2	25	27.6	29.2	16	14	15	16.2	23	26.5	25	16.5
13	Sulphate (mg/l)	37	41.5	45	48.6	53.4	60	64.5	66	42	36.5	33	31.4
14	Phosphate (mg/l)	35.15	35	30.5	36.6	22.4	20	26.5	19	20.5	22.4	24.4	29
15	Nitrate-N (mg/l)	2.45	1.30	1.10	1.8	0.87	0.98	0.55	0.4	0.8	1.64	2.85	3.65

Table 2: Seasonal variation of physicochemical factors in the year 2014-2015

S.N.	PARAMETERS	WINTER	SUMMER	MONSOON	ANNUAL AVERAGE
1	Water Temperature(^{0}C)	25.025 ± 1.3073	28.8 ±4.903	27.8 ±3.046	27.20833 ±3.512
2	pH	7.3 ±0.2160	7.575 ±0.206	7.15 ±0.057	7.341667 ±0.242
3	Transparency (cm)	31.75 ±2.872	31 ±5.477	26.75 ±5.737	29.83333 ±4.969
4	TDS (mg/l)	377.5 ±29.860	512.5 ±79.230	467.5 ±94.648	452.5 ±88.536
5	Dissolved oxygen (mg/l)	5.35 ±1.195	4.275 ±6.665	6.575 ±1.228	5.4 ±1.373
6	Free CO2 (mg/l)	6.125 ±0.518	4.125 ±0.590	4.95 ±1.508	5.066667 ±1.234
7	Total alkalinity (mg/l)	140.25 ±3.862	170.5 ±21	134.75 ±10.688	148.5 ±20.615
8	Total hardness (mg/l)	357.5 ±87.702	243.75 ±108.26	306.75 ±125.18	302.6667 ±109.22
9	Calcium (mg/l)	303.25 ±79.533	194.75 ±94.164	238.5 ±16.25	245.5 ±99.983
10	Magnesium (mg/l)	54.25 ±9.429	49 ±15.513	68.25 ±19.207	57.16667 ±16.202
11	Chlorides (mg/l)	66.875 ±22.0694	71 ±14.282	67.25 ±27.6.45	68.375 ±20.017
12	BOD (mg/l)	25.5 ±3.934	15.3 ±1.013	22.75 ±4.406	21.18333 ±5.482
13	Sulphate (mg/l)	43.025 ±4.953	60.975 ±5.657	35.725 ±4.694	46.575 ±12.009
14	Phosphate (mg/l)	34.3125 ±2.642	21.975 ±3.337	24.075 ±3.649	26.7875 ±6.345
15	Nitrate-N (mg/l)	1.6625 ±0.601	0.7 ±0.270	2.235 ±1.264	1.5325 ±0.996

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