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Limnological studies of Narsinh Mehta Lake of Junagadh District in Gujarat, India

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Abstract

The present study was carried out for ascertaining the quality of water for the purpose of the conservation of Narsinh Mehta Lake of Junagadh. Several physicochemical parameters such as pH, total alkalinity, total hardness, total dissolved solids, chloride content, dissolved oxygen (DO), biochemical oxyen demand (BOD) were meticulously observed in different seasons for the year 2012. The dissolved oxygen was found to be the highest (7.8 mgl^{-1}) and the lowest (6.4 mgl^{-1}) in winter and summer season, respectively. Likewise, Biochemical oxygen demand was recorded to be the lowest (15.20 mgl^{-1}) and the highest (25.67 mgl^{-1}) in monsoon season and summer season, respectively. DO showed negative correlation (r = - 0.71) with BOD. Water quality index was estimated and its value was found in the range of 169.93 to 256.97 in monsoon and summer season, respectively which indicated much pollution in the lake. The result indicated the lake was getting polluted due to continuous discharge of certain junk materials, debri of construction works and human interference affecting the quality of aquatic life.

Keywords: Dissolved oxygen, biochemical oxygen demand, water quality.

Introduction

Junagadh, a historical town of Gujarat (India), boasts of Girnar mountain and several water bodies including lakes. Narsinh Mehta Lake is situated in the heart of town witnessing enough anthropogenic pressure. The deterioration in water quality of this lake is increasingly high in recent past. Water is one of the most important natural resources in the world since without it life can't exist. Essentially, all life depends upon the water for being a major component of living organisms and an elixir of life. It is one of the most important commodities which man has exploited than any other resource for the sustenance of his life according to Kumar[1].

Water pollution has now reached a critical point especially in developing world. Almost every water body is polluted to an alarming level. Aquatic ecosystem is not only source of water and resources such as fish and crop for household and agro industrial uses, but also a vital part of natural environment for the survival which was observed by Singh [2]. Thus, estimation of quality of water is extremely important for proper assessment of the associated hazards. Due to increase in population and over exploitation of fresh water resources and waste water disposal, the direct or indirect modifications and alterations in creating the physical, chemical and biological characteristics of water have occurred profound and deleterious effects on human health and the environment as well.

Water is most indispensable requirement for all living organisms and any alterations in water may lead to the issue of survival for these organisms. Water maintained by several physicochemical factors and any decrease or increase cause the death of organisms as reported by Shastri [3]. Water quality and the risk to waterborne diseases are critical public health concerns in many developing countries today. Water gets polluted by the discharge of large amounts of organic substances directly or indirectly and willingly or unwillingly affecting human beings in particular and environment in general as narrated by Mudgal[4].

Water quality is critical public health concern in India. Thus the provision of safe and adequate water contributes to better health and increased individual productivity. All forms of life are based on the requirement of water. It is one of the most important commodities which man has exploited than any other resource for the sustain of his life. These physicochemical characteristics in many ways have significant influence and impact on aquatic life according to Garg[5]. The dissolved oxygen is of great importance to all the living organisms and is considered to be the sole parameter which to a large extent can reveal the nature of whole water body. Eutrophic water bodies have a wide range of dissolved oxygen and as such oligotrophic water bodies have narrow range of dissolved oxygen as described by Patil and Patil[6].

Material and Methods

Narsinh Mehta Lake is situated in the middle of Junagadh town which is adjacent to Arabian sea. (figure 1 and 2). The river Kalwa is the main source of water for the Lake. Water flowing

from Kalwa river is diverted to this lake in monsoon season when Wellington dam overflows. It maintains water and water level of surrounding areas throughout the year. Morphometric features of the lake were noted (table 1).

Water samples were taken in plastic bottles in triplicates and analysed onsite and offsite for selected physicochemical parameters such as pH, alkalinity, total hardness, total dissolved solids, chloride content, dissolved oxygen (DO) and biochemical oxygen demand (BOD). pH was conducted onsite while the total hardness, alkalinity, total dissolved solids, chloride, dissolved oxygen and BOD were analysed in the laboratory after the samples were properly transported using a pre-cleaned 1 L plastic containers in an ice box. All analyses were done as per NEERI [7] and APHA[8] (table-2). A correlation matrix of different physicochemical characteristics was incorporated (table-3). Water quality index is defined as a rating reflecting the composite influence of different water quality parameters on the overall quality of water. WQI was calculated by Weighted Arithmatical Index method.

$$WQI \sum_{n=1}^{n} q_n W_n / \sum_{n=1}^{n} W_n$$

Where, qn = 100 $[V_n - V_{io}]/ (S_n - V_{10})]$, q_n = Quality rating for the n^{th} water quality parameter, V_n = estimated value of the n^{th} parameter at a given sampling station, S_n = standard permissible value of n^{th} parameter, V_{io} = ideal value of nth parameter in pure water. (pH = 7, DO = 14 mg/l and for other parameter = 0), W_n = unit weight for n^{th} parameter, S_n = standard value for nth parameter, K = constant for Proportionality.

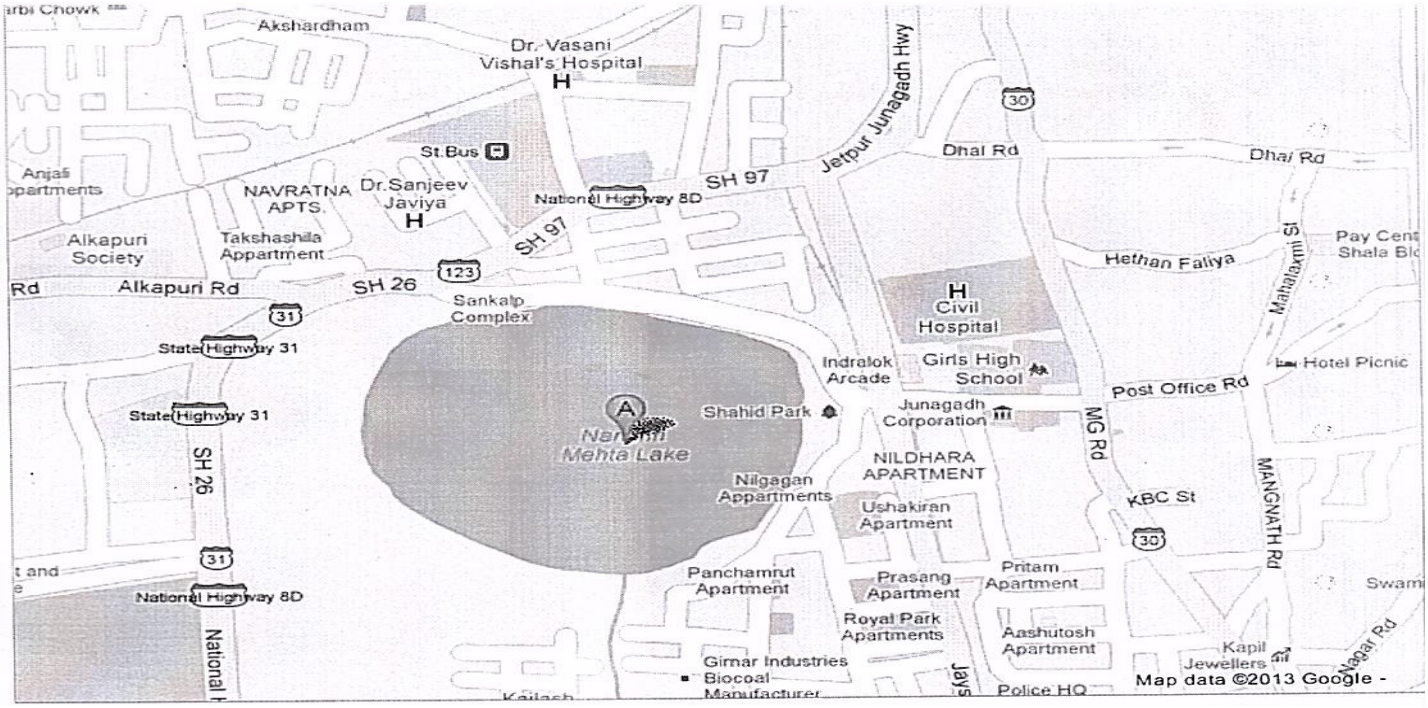

Figure-1
Map showing Narsinh Mehta lake of Junagadh

Table-1
Morphometric features of Narsinh Mehta Lake

1	Longitude	$70^{0}30$ “
2	Latitude	$21^{0}25$ “
3	Altitude	107 m
4	Average rainfall	75 cm
5	Surface area of Lake	85500 m^2
6	Maximum depth	10 m
7	Average depth	5 m
8	Maximum length	450 m
9	Maximum width	210 m
10	Mean width	190 m

Figure-2
Exact location of Narsinh Mehta lake of Junagadh

Table-2
Physicochemical parameters and their methodology

S.No.	Parameters	Unit	Methodology
1	pH	-----	Digital electrode pH Meter
2	Alkalinity	mgl^{-1}	Titrimetry with H_2SO_4
3	Total hardness	mgl^{-1}	Titrimetry with EDTA
4	Total Dissolved Solids	mgl^{-1}	TDS Method
5	Chloride	mgl^{-1}	Argentometric method
6	Dissolved Oxygen	mgl^{-1}	Winkler's method
7	BOD	mgl^{-1}	BOD_5 method

Results and Discussion

The pH of the water is directly proportional to temperature of water. The range of pH was found to be between 8.90 and 8.24 in summer and winter season, respectively. The greater pH may be caused due to increase in dissolved oxygen produced as a result of photosynthesis as proposed by Wetzel. The pH is directly dependent on the amount of CO2 present and inversely proportional to the activity of photosynthesis as opined by Sharma and Sarang[9] (figure 3) The amount pH was negatively correlated with DO (r = - 1.00).

The amount of alkalinity is dependent on the nature of materials discharged in lake as per Mishra . It was found to be the highest (350.5 mgl^{-1}) and the lowest (309.78 mgl^{-1}) during monsoon and winter season, respectively (figure 4). High value of total Hardness indicated the greater productivity and surge in eutrophication of water body. Hard and alkaline water may be attributed to high planktonic growth to some extent as observed by Sujitha[10]. Maximum value (653.98 mg l^{-1}) of hardness was recorded during summer season but Its lowest value (456.87 mgl^{-1}) was found to be during monsoon season (figure 5). Total hardness was positively correlated with pH (r = + 0.65).

The total dissolved solids (TDS) is the sum of the cations and anions concentration. A high content of solids elevates the density of water, reduces solubility of gases like oxygen and mitigates the utility of water for drinking, irrigation and other purposes. TDS was found to be highest 292.83 mgl^{-1}) during monsoon season and the lowest (228.33mgl^{-1}) was reported in winter season (figure 6). TDS values was positively correlated with total alkalinity (r = + 0.91).

Organic waste of animal origin was found to have high chloride content. Sindhu and Sharma[11] opined the chloride content which indicated domestic as well as industrial pollution. The increase in chloride concentration is an indication of growing anthropogenic pressure chloride in water is generally due to salts of sodium, potassium and calcium. Low level of chloride at various sites indicated least human interference. Chloride

content was found to be the highest (180.98 mgl^{-1}) in summer season but rapidly decreased as the winter started approaching (figure 7). Chloride contents was negatively correlated with DO (r = - 1.00).

Dissolved oxygen is the term commonly used in liquid analytical work for the measurement of the amount of oxygen dissolved in a unit volume of water. It is an important indicator of the degree of usefulness of a sample of water for a specific application as described by Abowei[12]. Dissolved oxygen fluctuated in the range of 6.4 mgl^{-1} to7.8 mgl^{-1} (figure 8). DO was negatively correlated with BOD (r = - 0.71).

Biochemical Oxygen Demand (BOD) is defined as the amount of oxygen required by bacteria while stabilizing decomposable organic matter under aerobic condition. The range of BOD was found to be from 15.2 mg l^{-1} to 25.67 mg l^{-1} in summer and monsoon season, respectively. The comparison of BOD and DO in the present study indicated that there was an inverse relationship between both parameters as mentioned by Iqbal[13] (figure 9).

In the present study the value of Water Quality Index (WQI) was found to be highest (256.57) in summer season. Its value further decreased in winter (190.05) and monsoon (169. 93) seasons, respectively. Prashar[14] described the WQI limit for water, if it is 0 – 25 then water quality is excellent, its values ranged between 26 – 50 showed good water quality, 51 – 75 indicated poor water quality, 76–100 indicated very poor quality of water and 100 and above indicated water is unsuitable for drinking purposes. Present study indicated very poor water quality (WQI 69.10 to 124.03) in different seasons and so unsuitable for drinking purposes (figure 10).

Various physicochemical parameters were found to be within permissible limit as per BIS[3]. Suthar[15] studied WQI in the river and reported WQI values ranged between 189.48 - 329.00, 192.47 – 356.36 and 175.03 – 292.84 during summer, monsoon and winter season, respectively indicating unsuitability of water for drinking purpose. He asserted the best water quality in winter followed by summer and monsoon season. The present investigation agreed with them and reported similar findings. Toman[16] also reported WQI values 58.60, 67.92 and 69.63 from a reservoir. He concluded that the water was safe for drinking, irrigation and industrial purposes.

A step must be taken to stop ingress of organic pollutants so that the organic load is minimized and resources can be recovered in a sustainable way. It is recommended that anthropogenic activity must be reduced in Lake. Materials like wheat, rice, milk, oil, and flowers etc. should be prohibited from mixing in lake water.

Table-3
Correlation matrix of physicochemical parameters at Narsinh Mehta Lake

Parameters	pH	TDS	DO	BOD	Total alkalinity	Total hardness	Chloride
pH	0.00	-	-	-	-	-	-
TDS	0.41	0.00	-		-	-	-
D.O.	-1.00	-0.44	0.00		-	-	--
B.O.D.	0.74	-0.32	-0.71	0.00	-	-	-
Total alkalinity	0.00	0.91	-0.04	-0.67	0.00	-	-
Total hardness	0.65	-0.43	-0.62	0.99	-0.76	0.00	-
Chloride	1.00	0.48	-1.00	0.68	0.08	0.59	0.00

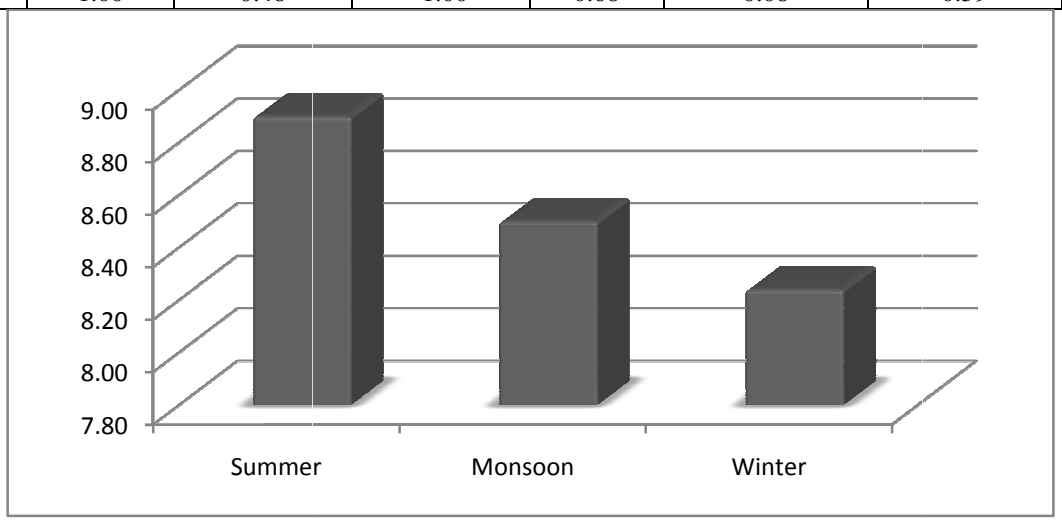

Figure-3
Variation in the values of pH in different seasons

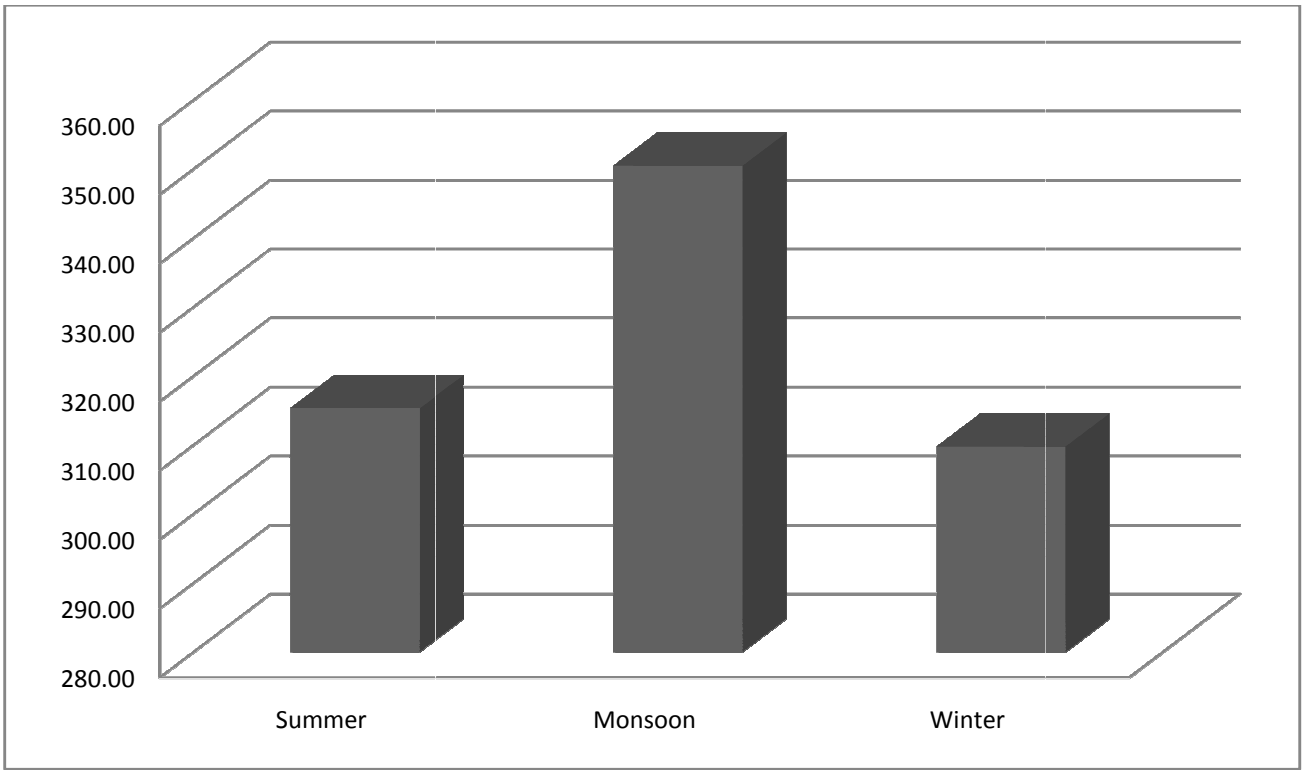

Figure-4
Variation in the values of Total alkalinity in different seasons

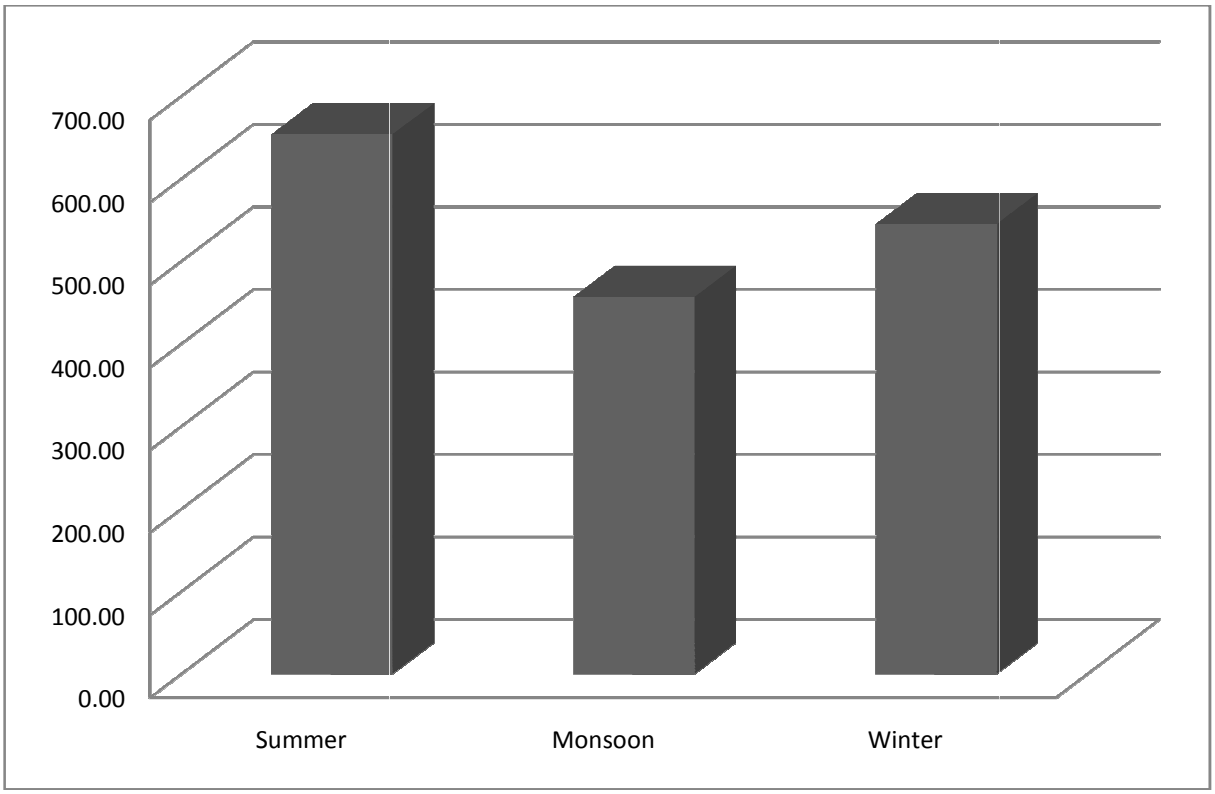

Figure-5
Variation in the values of Total hardness in different seasons

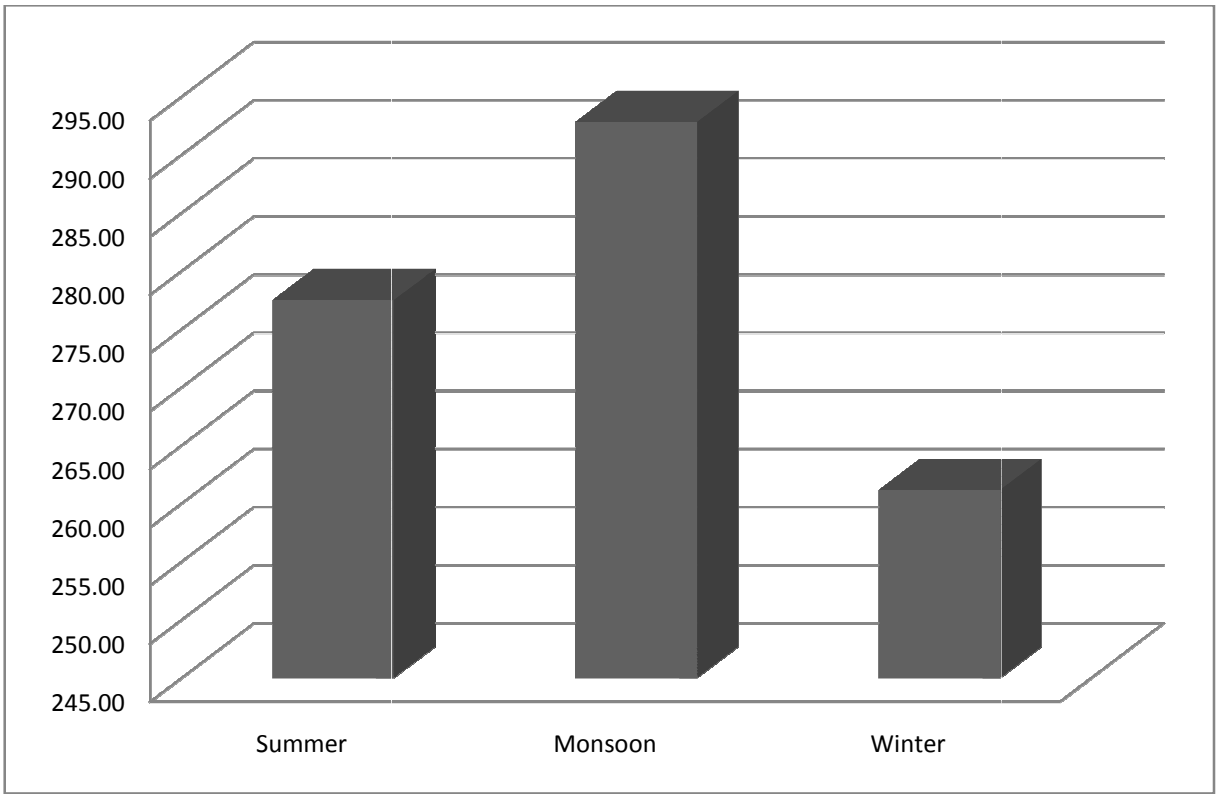

Figure-6
Variation in the values of TDS in different seasons

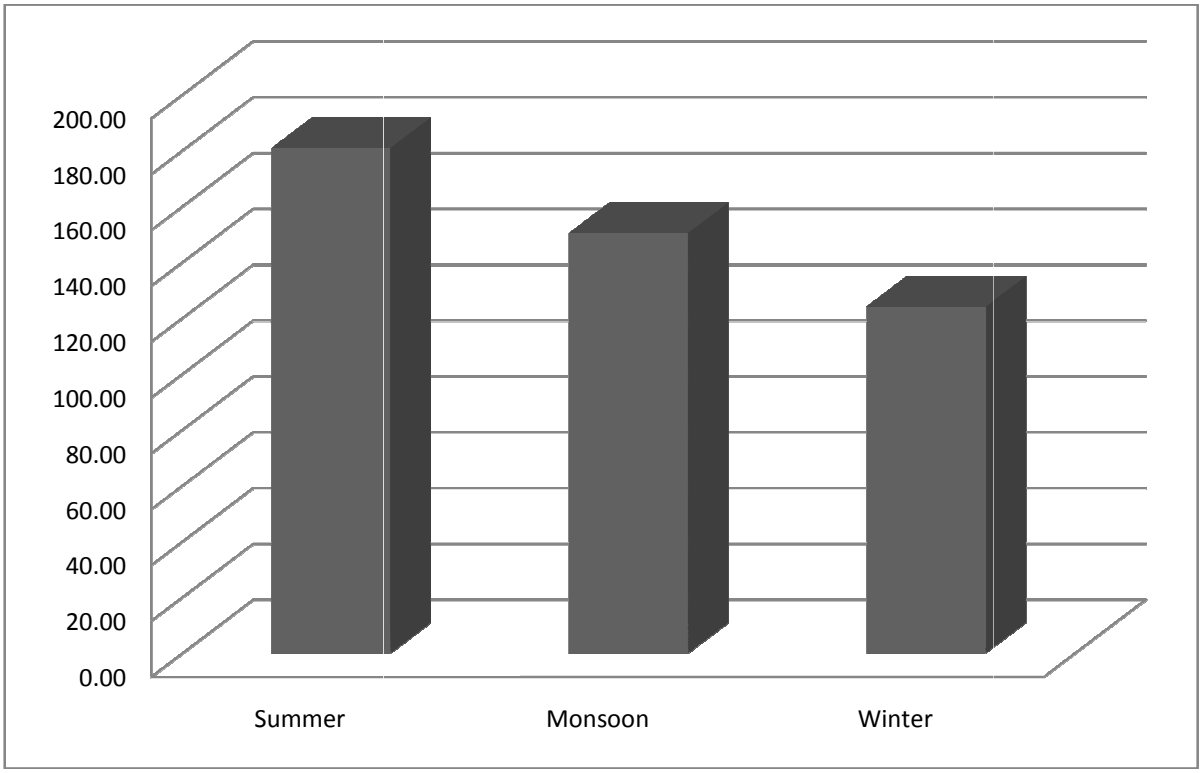

Figure-7
Variation in the values of chloride in different seasons

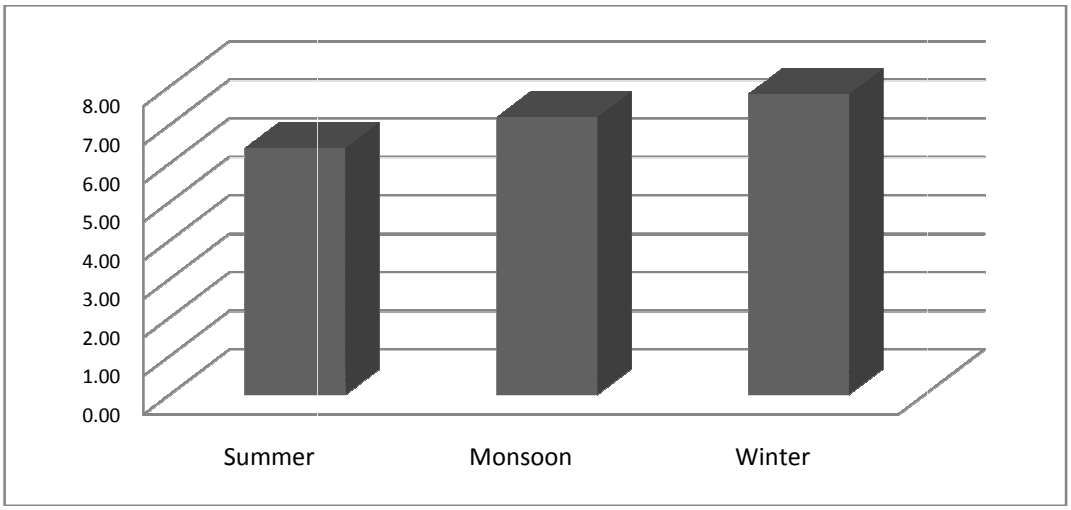

Figure-8
Variation in the values of DO in different seasons

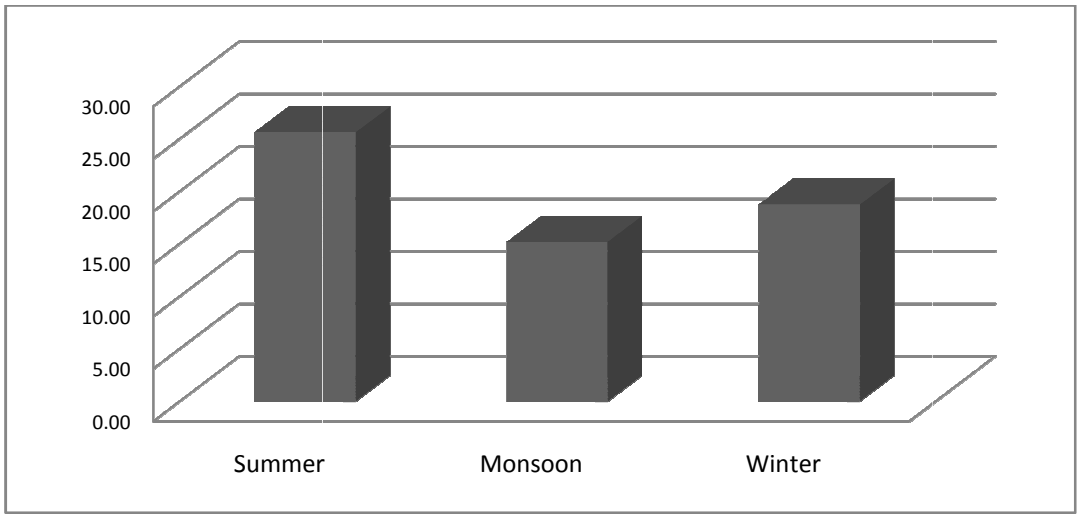

Figure-9
Variation in the values of BOD in different seasons

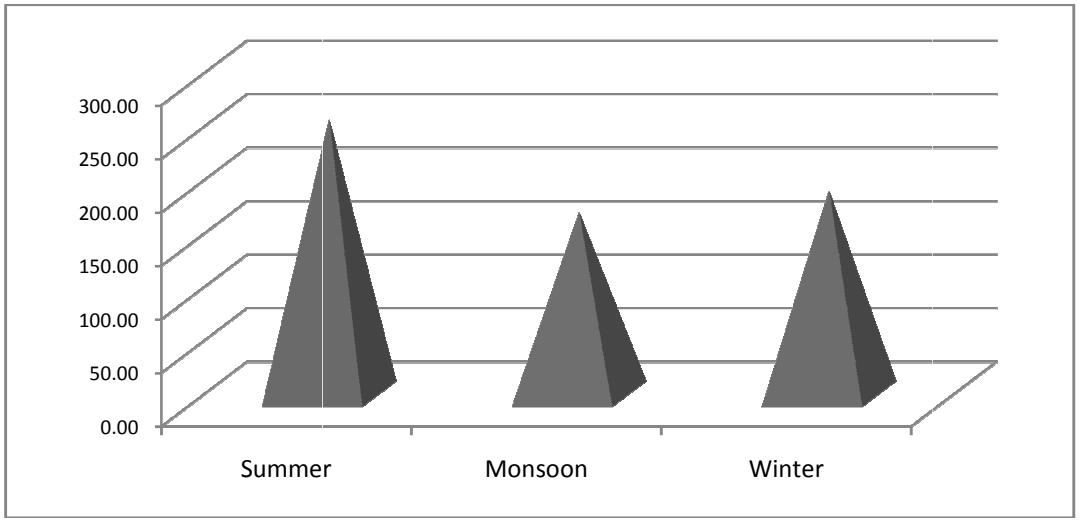

Figure-10
Variation in the values WQI in different seasons at Narsinh Mehta Lake

Conclusion

It was concluded that anthropogenic pressure was found to be maximum at this lake resulting into loss of water quality to a greater extent. The contents of chloride, total dissolved solids and biochemical oxygen demand were exceptionally large which clearly showed greater level of eutrophication at this water body. The seasonal variations of all physicochemical parameters were not in harmony of good water quality of this lake. Maximum dissolved oxygen was noticed in winter season which was reciprocal to the value of biochemical oxygen demand. Water quality index was found to be maximum in summer season which declined progressively in winter and monsoon thereafter, indicating that water of the lake was unsuitable for aquatic organism. It is recommended to prohibit all antropogenic activities from polluting the aesthetic beauty of Narsinh Mahta lake.

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