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OBSERVATIONS ON PHYSICO-CHEMICAL CHARACTERISTICS OF THE WATER OF NARIKULAM TANK IN KANYAKUMARI DISTRICT, INDIA

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ABSTRACT

In order to understand the utility, various physico-chemical characteristics of the water of Narikulam tank in Kanyakumari District of India were studied for a period of five months starting from January to June, 2009. Ecological parameters like temperature, pH, electrical conductivity, chlorinity, salinity, dissolved oxygen content, biochemical oxygen demand and total hardness were analysed and compared with standard permissible limits to assess the best-designated use of this water for various purposes. Coliform study was also made. The results indicate that this water can very well be used for agricultural purposes, washing, bathing, etc. and proper purification is needed, if used for drinking purposes.

Key words: Water quality analysis, Physico-chemical characteristics, Ecological parameters, Assessment of water quality, Tank water

INTRODUCTION

The quality of water is now the concern of experts in all countries of the world. The decision of WHO's 29th session (May 1976) emphasizes that water delivered to the consumer should meet the high requirements of modern hygiene and should at least be free from pathogenic organisms and toxic substances. Also, the quality of water depends on the location of the source and the state of environmental protection in a given area. Therefore, the quality and the nature of water are determined by physical and chemical analysis[1,2]. Water quality provides current information on concentration of various parameters at a given place and time. Water quality principles furnish the basis for judging the suitability of water for its designated uses and for improving existing conditions. For optimum development and management of water for the beneficial uses, current information is needed, which is

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provided by water quality programs[3]. Physico-chemical characteristics of water have been analyzed by several researchers considering water samples of different water resources of the world by Bagde and Varma[4]; Efe et al.[5]; Jadhav et al.[6]; Kelly-Quinn et al.[7]; Khadwal et al.[8]; Kulkarni et al.[9]; Mahamed Abdo[2]; Muhammad Ali et al.[3]; Prapuma and Shashikanth[10]; Qudri and Yousuf[11]; Sadhuram et al.[12]; Sakhre and Joshi[13] and Singhal et al.[14]

In the present study, we have examined the physico-chemical character of the water of Narikulam Tank (located in a place called Mahadhanapuram, which is close to Kanyakumari, the southernmost part of India). The continuous monitoring of this tank's water quality is very essential to determine the state of pollution in this. This information is important to communicate to general public (especially the people of Mahadhanapuram and Panchalingapuram, a closeby village to the former) and the Government in order to develop the policies for the conservation of this important water resource.

EXPERIMENTAL

Materials and methods

Narikulam tank is fed by water from two considerably big dams, namely, Pechiparai and Perunchani located in the district of Kanyakumari. It is also fed by the run off water from the nearby paddy fields situated beyond its western bank. People use this tank for human bathing and cattle washing. Water from the wells existing in the southern part of the tank is used for drinking purpose.

For the assessment of water quality, five different sites were selected in the tank. Figure 1 shows the site map of the Narikulam tank. Site I (Theppakulam) represents the southern side of the tank. There is a canal in between the tank and the Theppakulam. The tank enters the Theppakulam through this canal. People use this Theppakulam for human bathing. Site II (well) represents also the southern part of the tank. The water in the well is used for drinking purpose. Site III represents the western side of the tank. Water coming from Pechiparai dam through the Puthanar channel flows into the tank in this site. People use this site for cattle washing. Site IV represents the middle of the eastern side of the tank. People use this site for human bathing. Site V represents the northeastern corner of the tank. Near this part of the tank, there is a pepple tree. The surplus water of the tank overflows from here.

The present work involves the physico-chemical analysis of the water samples of the tank for 6 months starting from January to June 2009 (mostly summer season). The seriousness of pollution is understood to be only within this season.

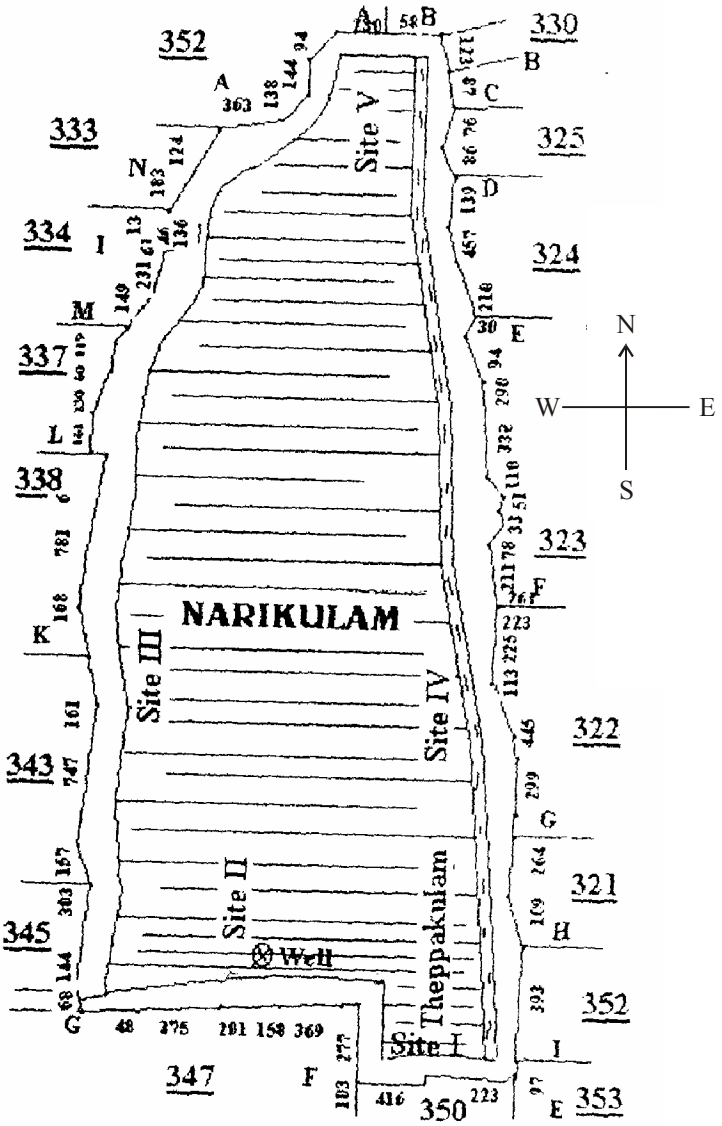

Fig. 1: Site map of the Narikulam tank (The underlined numbers denote the survey numbers of the adjacent land areas. The small size free numbers denote the measurement in 'links').

Water sample was collected in plastic bottles having well fitted stoppers. Bottles with holding capacity of about 1 litre of water were used for the analysis. Bottles were thoroughly cleaned and filled thrice with water and thrice emptied before collecting the sample. For collecting the water samples from the tank, the whole bottle with stopper was

dipped well under the surface of water and then the stopper was removed by means of a clean piece of string and the bottle was filled with water. Thus, the entry of floating materials was prevented entering into the bottle. After collecting the sample, the stopper was well fitted and the sample bottles were labeled stating the source, date and time of collection.

Fortnightly, water samplings were made over a period of six months from January to June 2009, every time at 8.00 a.m. Standard known methods (APHA[15]; Trivedy and Goel[16]; Vogel[17]) were followed for the physico-chemical analysis. All the measurements were done within 24 hrs of the sample collection. All the reagents used for the analysis are of analytical reagent (AR) grade. Various physico-chemical parameters like temperature, pH, electrical conductivity, chlorinity, salinity, dissolved oxygen (DO) content, biochemical oxygen demand (BOD) and total hardness were measured.

The temperature of the water was recorded using a graduated 110^{o}C mercury thermometer (accuracy is ± 0.1^{o}C) on the spot of sample collection. The pH was recorded using a digital pH meter (accuracy is ± 0.01) (Systronics make). Electrical conductivity was measured using a conductivity bridge (Elico make). Chlorinity was determined by the Mohr's method. As the chlorinity of water sample has a definite relationship with salinity, the salinity was determined from chlorinity using Knadsen's equation,

Salinity = 0.003 + (1.805 x chlorinity).

DO was determined by the Winkler's iodometric method. Two samples were considered for this analysis. DO was determined for the first sample immediately. The second sample was incubated for five days and then the DO was determined. The BOD was determined using the relation,

BOD = DO before incubation - DO after incubation.

The total hardness was determined by the EDTA titrimetry. This is expressed in terms of degree of hardness. A sample of water is said to have one degree of hardness, when its power of soap destroying is equivalent to the effect of 14.25 mg of $CaCO_3$ in a liter of water. It has been found that each degree hardness causes wastage of about 0.60 g of soap.

The coliform study was also made to understand the pollution aspects. The polluted water normally contains a huge number of pathogens and each has a separate detection procedure. Indicator organisms have generally been used for the detection of pathogens, since the concentration of these pathogens is small to be measured. The indicator most commonly used is a group of microbes called coliforms, which are organisms normally

found in the digestive tracts of warm blooded animals. In the present study, the tank water has been found to be polluted (containing 4 colony forming units per 100 mL). However, in the well (site II) water, no coliform was observed.

RESULTS AND DISCUSSION

The physico-chemical parameters obtained in the present study are provided in Table 1.

Table 1: Seasonal variation of physico-chemical properties of water of Narikulam tank

Date	Parameters for				
	Site I	**Site II**	**Site III**	**Site IV**	**Site V**
	Temperature (^oC)				
02.01.2009	26.0	25.0	25.0	26.0	25.0
16.01.2009	26.5	25.5	26.1	26.8	26.3
30.01.2009	26.5	25.9	26.6	27.9	26.6
13.02.2009	27.8	26.6	27.9	28.4	27.0
27.02.2009	28.9	27.8	28.3	28.8	28.0
13.03.2009	30.5	28.2	29.9	30.0	30.0
27.03.2009	29.9	28.9	30.3	31.0	30.3
10.04.2009	31.0	29.0	29.9	31.0	30.0
24.04.2009	31.0	29.4	31.0	30.0	29.9
08.05.2009	28.4	28.0	28.2	28.7	28.1
18.05.2009	28.6	28.0	28.1	28.9	28.2
01.06.2009	28.0	27.9	28.1	28.5	27.8
10.06.2009	28.2	28.1	27.9	28.0	27.4
	pH				
02.01.2009	7.20	6.56	7.20	7.23	7.29
16.01.2009	7.29	6.57	7.18	7.29	7.26
30.01.2009	7.30	6.56	7.19	7.30	7.28

Cont…

Date	Parameters for				
	Site I	Site II	Site III	Site IV	Site V
13.02.2009	7.53	6.69	7.25	7.38	7.43
27.02.2009	7.53	6.70	7.26	7.37	7.43
13.03.2009	7.61	6.76	7.37	7.40	7.50
27.03.2009	7.64	6.83	7.43	7.42	7.52
10.04.2009	7.68	6.91	7.74	7.50	7.61
24.04.2009	7.69	6.93	7.79	7.62	7.60
08.05.2009	7.14	6.24	7.04	7.12	7.17
18.05.2009	7.14	6.20	7.01	7.08	7.10
01.06.2009	7.05	6.11	7.09	7.07	7.12
10.06.2009	7.04	6.10	7.05	7.06	7.10
Electrical conductivity ($x10^{-3}$ mho/cm)					
02.01.2009	2.70	4.25	2.61	2.55	2.51
16.01.2009	2.74	4.20	2.63	2.59	2.54
30.01.2009	2.69	4.25	2.60	2.54	2.60
13.02.2009	2.72	4.36	2.63	2.61	2.62
27.02.2009	2.75	4.38	2.61	2.60	2.63
13.03.2009	2.78	4.49	2.64	2.68	2.65
27.03.2009	2.76	4.52	2.66	2.70	2.68
10.04.2009	2.79	4.60	2.73	2.73	2.70
24.04.2009	2.79	4.69	2.75	2.80	2.73
08.05.2009	2.06	4.10	2.15	2.24	2.31
18.05.2009	2.05	4.11	2.14	2.23	2.30
01.06.2009	2.04	4.10	2.12	2.21	2.30
10.06.2009	2.03	4.09	2.10	2.28	2.55
Chlorinity (g/kg)					
02.01.2009	0.181	0.155	0.207	0.181	0.181
16.01.2009	0.181	0.155	0.207	0.181	0.181

Cont…

Date	Parameters for				
	Site I	**Site II**	**Site III**	**Site IV**	**Site V**
30.01.2009	0.207	0.155	0.232	0.207	0.207
13.02.2009	0.207	0.181	0.232	0.207	0.181
27.02.2009	0.207	0.181	0.232	0.207	0.207
13.03.2009	0.232	0.181	0.258	0.232	0.207
27.03.2009	0.232	0.207	0.258	0.232	0.232
10.04.2009	0.285	0.207	0.284	0.258	0.258
24.04.2009	0.204	0.232	0.284	0.284	0.284
08.05.2009	0.232	0.181	0.232	0.207	0.232
18.05.2009	0.208	0.181	0.234	0.207	0.258
01.06.2009	0.232	0.232	0.234	0.284	0.284
10.06.2009	0.232	0.207	0.232	0.284	0.232
Salinity (%)					
02.01.2009	0.329	0.283	0.329	0.329	0.283
16.01.2009	0.329	0.283	0.329	0.329	0.283
30.01.2009	0.329	0.283	0.329	0.329	0.329
13.02.2009	0.376	0.329	0.376	0.376	0.329
27.02.2009	0.376	0.329	0.376	0.376	0.376
13.03.2009	0.376	0.329	0.422	0.422	0.422
27.03.2009	0.422	0.376	0.622	0.422	0.422
10.04.2009	0.516	0.376	0.516	0.516	0.516
24.04.2009	0.422	0.329	0.944	0.516	0.516
08.05.2009	0.376	0.329	0.422	0.422	0.422
18.05.2009	0.376	0.329	0.422	0.422	0.422
01.06.2009	0.422	0.376	0.944	0.576	0.576
10.06.2009	0.422	0.376	0.943	0.578	0.574
Dissolved oxygen (mg/L) (before incubation)					
02.01.2009	5.0	8.0	4.4	5.2	5.2

Cont…

Date	Parameters for				
	Site I	Site II	Site III	Site IV	Site V
16.01.2009	4.4	7.6	4.6	4.6	4.2
30.01.2009	4.4	8.1	4.4	4.5	4.3
13.02.2009	4.2	6.9	4.2	4.4	4.2
27.02.2009	4.0	7.0	4.2	4.4	4.0
13.03.2009	3.9	6.8	4.1	4.3	4.1
27.03.2009	3.6	6.7	4.0	4.2	4.0
10.04.2009	3.2	6.5	3.9	4.1	3.8
24.04.2009	3.0	6.2	3.6	4.0	3.7
08.05.2009	5.2	8.4	5.5	5.6	4.9
18.05.2009	5.1	8.3	5.5	5.4	4.7
01.06.2009	3.2	6.4	3.5	3.9	3.8
10.06.2009	3.1	6.1	3.2	3.6	4.0
Biochemical oxygen demand (mg/L)					
02.01.2009	2.8	1.2	1.0	2.8	2.4
16.01.2009	3.0	1.4	1.2	3.0	2.6
30.01.2009	3.2	1.4	1.2	3.0	2.6
13.02.2009	3.2	1.6	1.4	3.2	2.8
27.02.2009	3.4	1.6	1.4	3.4	3.0
13.03.2009	3.6	1.8	1.6	3.4	3.2
27.03.2009	3.4	2.0	1.6	3.6	3.2
10.04.2009	3.6	2.2	1.8	3.6	3.4
24.04.2009	3.8	2.2	2.0	3.6	3.6
08.05.2009	4.0	2.4	2.0	3.8	3.6
18.05.2009	3.9	2.3	2.1	3.7	3.6
01.06.2009	3.7	2.1	2.0	3.7	3.8
10.06.2009	3.5	2.0	2.2	3.7	3.9

Cont…

Date	Parameters for				
	Site I	**Site II**	**Site III**	**Site IV**	**Site V**
	Total hardness (degree of hardness)				
02.01.2009	6.3	12.7	6.9	6.2	6.1
16.01.2009	6.4	13.4	7.1	6.3	6.0
30.01.2009	6.2	12.4	6.2	6.3	6.2
13.02.2009	6.7	14.5	8.8	6.9	6.3
27.02.2009	5.3	12.0	7.8	6.9	6.2
13.03.2009	6.4	12.4	6.7	6.6	6.4
27.03.2009	6.4	12.4	6.7	6.6	6.4
10.04.2009	6.6	13.4	6.8	6.5	6.3
24.04.2009	6.5	12.6	6.9	6.6	6.2
08.05.2009	6.6	12.7	6.8	6.7	6.3
18.05.2009	6.6	12.5	6.8	6.7	6.3
01.06.2009	6.5	12.5	6.8	6.4	6.3
10.06.2009	6.4	12.8	6.4	6.2	6.1

The temperature varies from 25-31^{o}C only (with maximum during the month of April). March, April and May are normally the hot months and the solar radiation is high at that time.

The acidity or alkalinity of water is measured in terms of its pH or hydrogen ion concentration. A neutral water has the pH value of 7.0. If the pH value is less than 7.0, the water is acidic. Similarly, the water is alkaline, if the pH value is more than 7.0.

In the present work, no significant changes have been observed in the pH values throughout the study period. The pH value ranges from 6.24 to 7.79. Water from site II is found to be slightly acidic with the pH varying from 6.24 to 6.93. Water from the other 4 sites (I, III, IV and V) is found to be slightly alkaline. In hot summer, the pH values were maximum due to photosynthetic activity. In the month of May, there was a small decease in the pH values due to the small rainfall (11.5 mm on 07.05.2007). This is due to the fact that rain water has a lower pH value than that of tank water.

The electrical conductivity value ranges from 2.06 x 10^{-3} to 4.69 x 10^{-3} mho/cm.

Conductivity value in site II was high, as compared to that in other sites. In the hot summer, the conductivity values increased. However, in May, these were slightly decreased due to the rainfall. Conductivity of water increases by the evaporation of water and decreases by the addition of rain water. Solubility and conductivity are interrelated. Strong electrolytes are highly soluble and show high conductivity while weak electrolytes are less soluble and show low conductivity. A measure of the total electrolyte in natural water can therefore be obtained by measuring the electrical conductivity of a sample of that water. One of the principal causes apparently is the change in electrolyte content due to the assimilation process of green plants. Many lakes show annual variation of conductivity. It can be more or less parallel to the pH of water in pattern and periodicity. This is in agreement with the findings of Bagde and Varma[4].

Water quality can be assessed by its chloride content. Low chloride content indicates pure water. High chloride content indicates polluted water. The increased trends in chloride content in the tank water may be taken as an indicator of tropic evolution. In the present study in Narikulam tank, only small amounts of salinity and chlorinity were recorded (Table 1).

DO represents the amount of oxygen in dissolved state in sewage. The concentration of DO depends on many factors such as temperature, decompositional activities, photosynthesis and the level of aeration. In the present study, the DO concentration decreased during the hot summer and increased during the rainy season. Site I is Theppakulam and the water coming from the tank to Theppakulam through canal is stagnant. For this reason, the DO level in this site was very low when compared to that in the other sites during the hot summer months. The low DO content of site I can be attributed to the enhanced microbial activity[18]. The low DO contents observed in sites III, IV and V may be due to the inflow of paddy field water into the tank and enhanced microbial activity. The decomposition of organic matter is an important factor in the consumption of DO, which is more vigorous in warm weather.

The DO level in site II was very high, when compared to that in other sites. Maximum DO content was observed in May due to rainfall (Table 1). During rainy season, the DO content increased due to circulation by cooling and drawdown of DO in water.

Amount of oxygen required to carry out the biological decomposition of dissolved solids in sewage under aerobic conditions at standard temperature is known as the biochemical oxygen demand (BOD). In actual practice, the BOD test is made for a period of 5 or 10 days, the former is very common. It has been proved by various experiments that 5

days BOD is about 68% and 10 days BOD is about 90% of the ultimate BOD. Thus, the purpose of determining the BOD is to measure oxygen consumed by bacteria during the process of oxidizing organic matter under aerobic conditions. The oxidation proceeds slowly and it is not usually complete in the standard 5 days period of incubation.

Excessive nutrients such as nitrates and phosphates commonly originate in domestic sewage, run off from domestic fertilizers, waste material from animal feed lots, packing plants, etc. These nutrients are responsible for water pollution primarily because they stimulate the growth of micro-organisms which often increase the BOD entophication (well nourished or enriched). This is a natural process in many lakes and ponds as nutrients accumulate through natural succession. Entophication, however, becomes excessive because of abnormally high amounts of nutrients from sewage, fertilizers, animal wastes, etc entering into steams, lakes or ponds. This causes excessive growth or bloom of micro-organisms and aquatic vegetation.

In the present investigation, we have observed a minimum BOD of 1.0 mg/L in site II and a maximum BOD of 4.0 mg/L in site I. When compared to site II, the other sites have somewhat greater BOD values.

Hardness is originally defined as the soap consuming capacity of a water sample. The excess hardness of water is undesirable due to various reasons. It causes more consumption of soap, affects the working of dyeing system, provides scales on boiler, causes corrosion and incrustation of pipes and makes food tasteless.

The water having hardness of about 5 degrees is reasonably soft and a very soft water is tasteless. The total hardness of pond or tank water increases as the volume of water decreases due to surface evaporation. In the present study, we have observed the total hardness varying from 6.0 to 8.0 degrees in sites I, III, IV and V. The water of site II was observed to be harder than that all other sites. The total hardness observed in site II varies from 12.0 to 14.5 degrees.

With the results obtained in the present study, we can make certain definite correlations. The water temperature and DO contents are inversely related. The solubility of oxygen in water is high at low temperatures and low at high temperatures. Chlorinity and rainfall are inversely related. Chlorinity decreases due to addition of rain water. Also, salinity and rainfall are inversely related. Salinity decreases due to heavy rainfall. DO content and the amount of rainfall are directly related. DO content and the amount of rainfall are directly related. DO content increases during the rainy season.

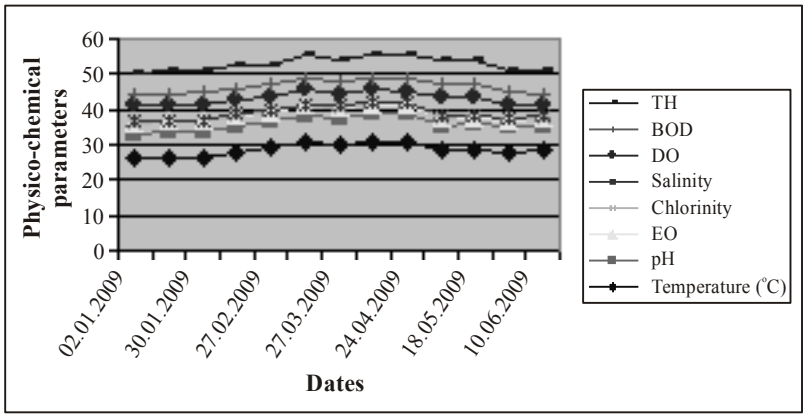

Fig. 1: Physico-chemical parameters Site -I

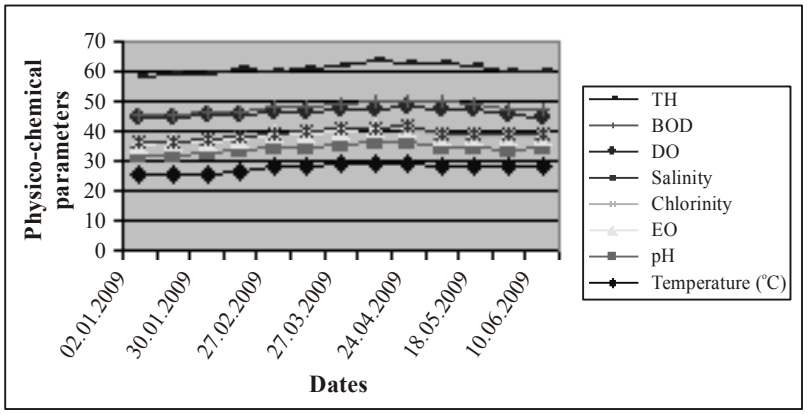

Fig. 2: Physico-chemical parameters Site –II

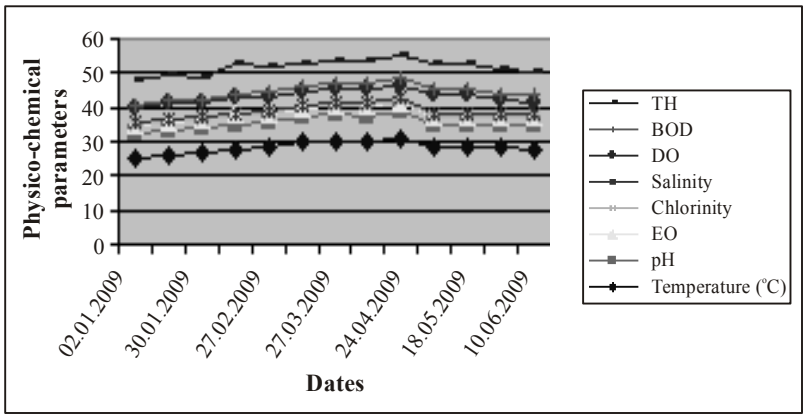

Fig. 3: Physico-chemical parameters Site –III

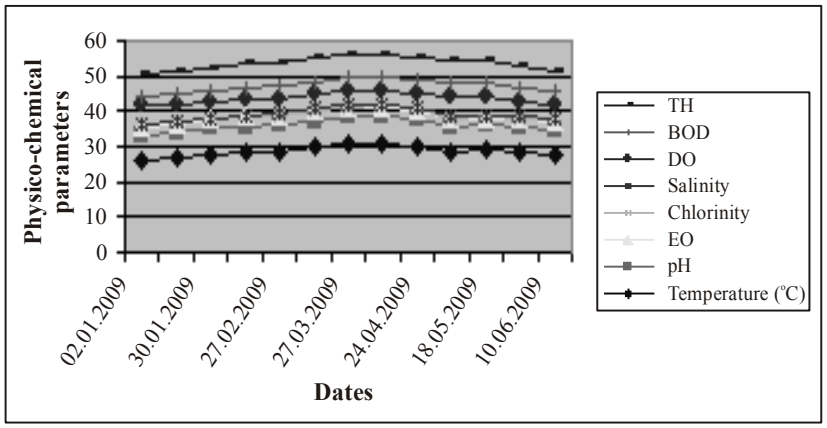

Fig. 4: Physico-chemical parameters Site –IV

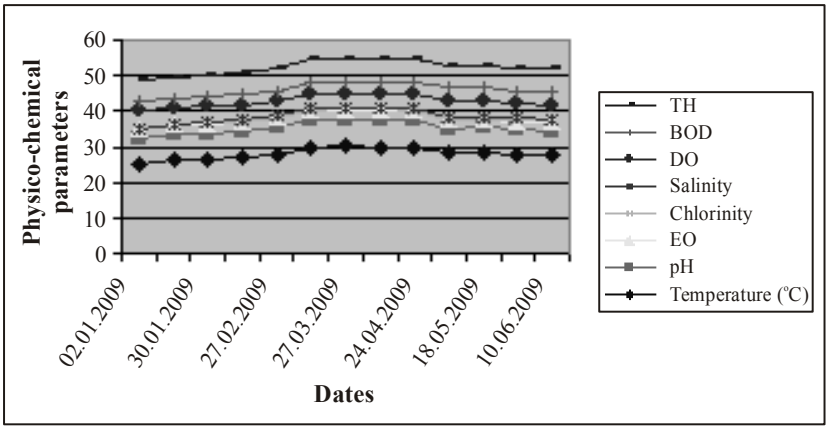

Fig. 4: Physico-chemical parameters Site –V

The Bureau of Indian Standards (BIS 1991)[19] has laid down the permissible limits of pH of drinking water to be 6.0-7.0 and the DO content to be 3 ppm. The pH values of the Narikulam tank range from 6.24 to 7.79 during the period considered in the present study. This is nearly a good range. The DO content values vary between 3.00 and 8.4 mg/L. Since high DO content is a favourable parameter for drinking, the water of Narikulam tank can be used for drinking purpose. But, sediments due to soil erosion, cattle dung, detergents, oil, etc brought into water due to washing activities cause pollution. So, this water needs proper purification, if it is to be used for drinking purpose. This water can always be used for agricultural purposes, washing, bathing, etc. The well water (site II), which is not polluted, can be used for drinking purpose due to high DO content.

CONCLUSION

Various physico-chemical parameters of Narikulam tank water were determined taking water samples from five different sites (I, II, III, IV and V) of the tank.

The study was carried out for a period of five months starting from January to June 2009.

The temperature varies from 25 to 31^{o}C. Site II remains slightly acidic whereas sites I, III, IV and V remain slightly alkaline throughout the study period.

The measured values of electrical conductivity, chlorinity, salinity, dissolved oxygen content, biochemical demand for oxygen, etc. and coliform study indicate that the water samples of sites I, III, IV and V are polluted whereas that of site II is not polluted.

Although the water of site II (well) is more hard, this can be used for drinking purpose. Water from other sites should be purified, if it is to be used for drinking purpose.

The Narikulam tank water can always be used for agricultural purposes, cattle washing, human bathing, etc.

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