Research Paper

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Assessment of Water Quality in Manas Lake (Pune-India) With Reference to the Human Impact

Environment

KEYWORDS : Water quality, Physical-chemical parameters, Manas Lake,

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ABSTRACT

The Manas lake is one of the most important lake near Pune city, Maharashtra state that there is large number of tourist come there for enjoying scenery and recreation reason. Also there are many restaurant, hotels and agricultural land that direct or indirect discharge their sewage into the lake. For identify measure of pollution on this lake sampling and measuring process was taken place on December 2008 and April 2009. The analysis of water has been done and the results for pH, Biological oxygen demand, Chemical oxygen demand, Total alkalinity, Hardness, Dissolved oxygen, Sulphate, Nitrate and other parameters in both samples were compared to understanding the level of pollution on this lake.

Introduction

Water quality is considered to be a key contributor to both health and the state of disease for humans. Surface water quality in a region is largely influenced by both natural processes and by anthropogenic inputs. Reported that human activities mainly impact surface water quality through atmospheric pollution, effluent discharges, the use of agricultural chemicals, in addition to the increased exploitation of water resources. This has generated great pressure on aquatic ecosystems, resulting in a decrease of water quality and biodiversity, loss of critical habitats, and an overall decrease in quality of life for local inhabitants. It is therefore essential to prevent and control water pollution and to implement regular monitoring programs.

Rapid industrialization and indiscriminate use of chemical fertilizers and pesticides in agriculture are causing heavy and varied pollution in aquatic environment leading to deterioration of water quality and depletion of aquatic biota. Due to use of contaminated water, human population suffers from water born diseases. It is therefore to check the water quality at regular interval of time.

This paper have studied the factors which caused the Manas lake pollution such as: Nitrogen, Phosphorous, Dissolved oxygen chemical, Oxygen demand, Biochemical oxygen demand and some other factors like as: pH, suspended solid, etc. analysis of these factors has helped to identify possible sources of pollution that influenced into the lake water and have offered valuable tools in the management of the lake water pollution.

Manas Lake (Bhugaon) which is situated in the vicinity of a fast growing city of Pune, in the Maharashtra, India. Pune located on Deccan plateau. It is located at 585.83m ASL and 18 32'N latitude and 78 5'E longitudes. The city is situated on the bank of 3 Rivers, namely Mula, Mutha and Pavana. It is surrounded by small hills of Sahyadri ranges and is situated nearly 160 km from Mumbai (India). Manas Lake (Bhugaon) is an artificial lake. This lake located on lake is located north Pune- Paud road, on east village bhugaon-1.5 km from lake, on south-NDA, on west-village Bhugaon-1.5 km from lake. Manas Lake (Bhugaon) was contracted on 1977 for irrigation of agriculture land near the lake and to provide drinking water for villages near that as Bhugaon village, Green villa, Sarovar, Matalwad, Agrewadi and Bavdhan area in Pune city. Total area that using the water from the lake 630 ha and irrigable land is 510.40 ha.

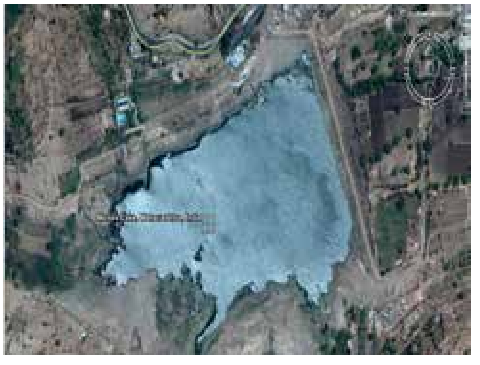
The area of the lake is 10.24km. This lake is mainly fed by rain water in monsoon season from June to October and average of the rainfall is 1407 cm.

Volume of the tank of the lake is 1.90 million meter2. Length of the dam is 550 m and height of that is 21.19 m .Submerged area is 42.21ha and the channel going ahead the lake is 7 km The only river that goes from the Manas(Bhugaon) lake is call Ram Nadi (River) and goes to the Pashan and Banner area.

In this study, various water quality parameters were analyzed, as well as influence of the pollution sources on the water quality parameters was ascertained.

Material and methods

The Water samples collected 2time. First sample was collected December 2008 almost after monsoon season and second sample was collected on April 2009 in summer season from 13 sites in pre washed plastic container which were sterile having capacity of two liter. After sampling collected samples were immediately brought to analytical laboratory and kept in refrigerator at temperature below 4C and further analysis started without delay. An analysis was carried according to standard methods of physico-chemical parameters analyzed for water and sediments samples include: pH (digital pH meter), Colour, Total dissolve solid (TDS), biological Oxygen Demand (BOD), Chemical oxygen demands (COD),Dissolved Oxygen(DO), Total Suspended Solid (TSS), Total Alkalinity (TA) as Hco_3^-, Calcium (Ca^{2+}), Magnesium (Mg^{2+}), Total hardness (TH), Chloride (CL^-), Sulphates (So4), Nitrate ($No3^{2-}$), Iron (Fe), Aluminium (Al), Fluoride (F), Mercury.



Standard permissible limit of water

Contaminant	Canadian Limits* (mg/L)	US Limits ** (mg/L)	WHO Limits *** (mg/L)
Aluminum	0.1	0.05 - 0.2	no limit listed
Antimony	0.006	0.006	0.018
Arsenic	0.010	0.010	0.01
Asbestos	-	7 million fibers per liter	no limit listed
Barium	1.00	2	0.7
Beryllium	no limit listed	0.004	no limit listed
Boron	5.00	no limit listed	0.5
Bromate	0.01	0.010	0.010
Cadmium	0.005	0.005	0.003
Calcium	200	-	-
Chloramines	3.0	-	3
Chloride	less than 251	-	no limit listed
Chlorite	-	1.0	-
Chromium	0.050	0.01	0.05
Cobalt	no limit listed	-	-
Total Coliforms (including fecal coliform & E. coli)	0/100 mL	5.0%	-

Copper	1.0	1.3	2
Cryptosporidium	no limit listed	0	-
Colour	less than 16 TCU^	-	-
Cyanide	0.2	0.2	0.07
Cyanobacteria (total microcystins)	0.0015	-	0.001
Fluoride	1.5	4.0	1.5
Giardia lamblia	no limit listed	0	-
Gold	no limit listed	-	-
Hardness (as CaCO3)	75 - 150 mg/L	-	no limit listed
Heterotrophic plate count	no limit listed	500 bacterial colonies/ml	-
Iron	0.300	0.3	no limit listed
Lanthanum	no limit listed	-	-
Lead	0.010	0	0.001
Legionella	no limit listed	0	-
Magnesium	50.0	-	-
Manganese	0.050	0.05	0.4
Mercury	0.001	0.002	0.001
Molybdenum	0.25	-	0.07
Nickel	no limit listed	-	0.020
Nitrate	45	10	-
Nitrite	-	1	-
Odour	unoffensive	-	-
pH	6.5 - 8.5	6.5 - 8.5	no limit listed
Phosphorus	0.010	-	-
Potassium	no limit listed	-	-
Scandium	no limit listed	-	-
Selenium	0.01	0.05	0.01
Silicon	no limit listed	-	-
Silver	0.050	0.10	no limit listed
Sodium	200	no limit listed	no limit listed
Strontium	no limit listed	-	-
Sulphate	500	-	500
Sulphide	-	-	-
Thallium	-	0.002	-
Titanium	no limit listed	-	-
Total Dissolved Solids (TDS)	less than 500	-	no limit listed
Trichloroethylene (TCE)	0.005	-	-
Trihalomethanes (total)^^	0.1	0.1	1
Tungsten	no limit listed	-	-
Turbidity	0.5/1.0/3.1 NTU^^^	5 NTU	-
Uranium	0.02	-	0.009
Vanadium	no limit listed	no limit listed	-
Viruses (enteric)	no limit listed	0	-
Zinc	5.00	5	no limit listed

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1. PH:

The PH is the activity of Hydrogen ions in the water and expressed by negative logarithm to the base 10 of the H^+ ion activity in moles/L. pH is measure with help of portable pH meter. The pH meter is the first calibrated by using buffer solution having pH 4.7 and 9.2.

2. BOD(Biological Oxygen Demand):

Biological Oxygen Demand (BOD) is a measure of the oxygen used by microorganisms to decompose this waste. If there is a large quantity of organic waste in the water supply, there will also be a lot of bacteria present working to decompose this waste.

3. COD (Chemical Oxygen Demand):

Chemical oxygen demand is related to biochemical oxygen demand (BOD), another standard test for assaying the oxygen-demanding strength of waste waters. However, biochemical oxygen demand only measures the amount of oxygen consumed by microbial oxidation and is most relevant to waters rich in organic matter.

$$\text{COD, (mg/l)} = \frac{\text{(b-a)} \times \text{of Ferrous ammonium sulfate} \times 1000 \times 8}{\text{ml of Sample}}$$

Where, a = ml of tartan with sample. b= ml of titrant with blank

4. TA (Total Alkalinity):

Total alkalinity is the total concentration of bases in water expressed as parts per million (ppm) or milligrams per liter (mg/L) of calcium carbonate ($CaCO_3$). These bases are usually Bicarbonates (HCO3) and carbonates (CO3), and they act as a buffer system that prevents drastic changes in pH. Alkalinity is usually given in the unit mEq/L (mill equivalent per liter). Commercially, as in the pool industry, alkalinity might also be given in the unit ppm or parts per million.

$$\text{P.A.mg/l} = \frac{\text{ml of HCL used with phenolphthalein} \times \text{Normality of HCL} \times 1000 \times 50}{\text{ml of sample}}$$

$$\text{T.A.mg/l} = \frac{\text{ml of HCL used with phenolphthalein and Methyl orange} \times \text{normality of HCL} \times 1000 \times 50}{\text{ml of sample}}$$

5. Temporary hardness:

Temporary hardness is caused by a combination of calcium ions and bicarbonate ions in the water. It can be removed by boiling the water or by the addition of lime (calcium hydroxide). Boiling promotes the formation of carbonate from the bicarbonate and precipitates calcium carbonate out of solution, leaving water that is softer upon cooling.

The following is the equilibrium reaction when calcium carbonate (CaCO3) is dissolved in

water:

$$CaCO_3(s) + H_2CO_3(aq) \leftrightharpoons Ca^{2+}(aq) + 2HCO_3^-(aq)$$

6. Parameter Hardness:

Permanent hardness is hardness (mineral content) that cannot be removed by boiling. It is usually caused by the presence of calcium and magnesium sulfates and/or chlorides in the water, which become more soluble as the temperature rises. Despite the name, permanent hardness can be removed using a water softener or ion exchange column, where the calcium and magnesium ions are exchanged with the sodium ions in the column.

Table: Hardness based classification of water

Hardness (mg/l)	Classification of water
0-60	Soft
61-120	Moderately hard
121-180	Hard
> 180	Very hard

$$\text{Hardness (mg/l) As } caco_3 = \frac{\text{ml of EDTA used for titration} \times 1000}{\text{ml of sample}}$$

Results and analysis:

Information is presented on water quality variations of color, pH, BOD, COD, TDS, TSS, nitrate, sulfate, fluoride, chloride, phosphorus, alkalinity, hardness, Fe, Hg, Al and algae. Sampling and analyzing was done after monsoon and in February i.e. winter season in the Manas Lake.

December 2008(table1)

Sr No.	Parameters	Unit	Results
01	pH	----	7.52
02	Color	----	Pale green
03	Total Suspended solids	mg/l	28
04	Total Dissolved solids	mg/l	246
05	Total Hardness	mg/l	136.0
06	Total Alkalinity	mg/l	152.0
07	Sulphate	mg/l	13.42
08	Chlorates	mg/l	10.0
09	Nitrates	mg/l	3.26
10	Iron	mg/l	0.012
11	Fluoride	mg/l	0.002
12	Mercury	mg/l	BDL
13	Total phosphorus	mg/l	0.014
14	Aluminium	mg/l	Nil
15	Algae	----	Present
16	Chemical Oxygen Demand	mg/l	3.52
17	Biological Oxygen Demand	mg/l	1.62
18	Dissolved Oxygen	mg/l	4.90

April 2009(table2)

Sr No.	Parameters	Unit	Results
01	pH	----	7.14
02	Color	----	faint yellow
03	Total Suspended solids	mg/l	----

04	Total Dissolved solids	mg/l	210
05	Total Hardness	mg/l	134
06	Total Alkalinity	mg/l	144
07	Sulphate	mg/l	24.30
08	Chlorates	mg/l	4.0
09	Nitrates	mg/l	1.54
10	Iron	mg/l	0.07
11	Fluoride	mg/l	0.03
12	Mercury	mg/l	BDL
13	Total phosphorus	mg/l	0.09
14	Aluminium	mg/l	Nil
15	Algae	----	Present
16	Chemical Oxygen Demand	mg/l	4.82
17	Biological Oxygen Demand	mg/l	1.8
18	Dissolved Oxygen	mg/l	5.2

The sampling and measuring process was taken place two times 2008 and 2009. The results of the measuring data show that the concentration of the bacteriological and physicochemical parameters as well as heavy metal analyses have been found to be below the permissible levels of surface water quality standards. Conclusively leaching of the agricultural wastes due to agricultural activities in the area as well as commercial and domestic wastewater is generally at acceptable levels. The aesthetic character of the lake is also at an acceptable level. The increasing industrial and agricultural production that is occurring throughout the world not only represents greater liquid discharges to receiving water bodies, but also the addition of new pollutants. Including the consequences of pollution growth, the ecosystem experiences many changes, some of which have adverse effects. Sometimes these effects and changes are not well understood, but they should be evaluated and controlled periodically.

Discussion:

Table 1 and 2 show the observable values of the physical-chemical water quality features and their relationship to the related standards, as compared to permissible limits according to exiting legislation. The data show that measurements are, in general, at acceptable levels of any of the measured parameters. These small changes in artificial lake water chemistry have been attributed to the alterations of season and the amount of water in the lake as well as some activity such as agriculture and wastewater of restaurant that is discharged to this lake.

The higher BOD5 values that observed after monsoon can be attributed in increased quantities of organic matter that flow in the Manas Lake (Bhugaon).Although rain can increase the amount of lake water DO due to dilution and turbulence but simultaneously the runoff due to rain from the city and agricultural area around the lake are coming into this lake and consequently increase the amount of organic matter and other pollutant that cause an increment in the BOD and COD factor.

The COD concentration is 2.7 time higher than the BOD5, non-biodegradable compounds might cause this imbalance with BOD5, which might have a high potential of adverse health effects on human. These non-biodegradable compounds might accumulate and biomagnified in living organism tissue.

DO does not present certain particular local fluctuation, merely due to the renewal of body water of lake. Generally, the conditions of oxygenation in the lake water are satisfactory and the degree of saturation of water in oxygen is larger than 70%, value that constitutes the minimal allowed level. However, as it can be seen from the result the amount of DO increased in the rainy season and this change can be due to turbulence of water because of rain.

The TDS of both sampling were almost stable in the period of research with an increasing in the second sampling, which shows no problem for agricultural irrigation water. Although no absolute TDS also is at acceptable level and consequently low in EC (Electro-conductivity). TSS is at acceptable level and more after monsoon.

The concentrations of hardness in both sampling are at acceptable level and almost same that indicate the amount of calcium and magnesium remain almost stable in lake water.

The concentration of sulfate shows significant change and almost it became half in February, from 24.3 mg/l reduced to 13.42 in February. In other word, the concentration of Sulphate in monsoon was almost two times of the concentration in February. This high change of sulfate concentration is related to the effluent of wastewater and runoff and discharge of agricultural wastewater. Although the permissible standards for this anion is 250 mg/l (desirable < 50 mg/l) (Hammer, 2003), and therefore at acceptable level but the high change of concentration of this anion should take into consideration to find out the source of pollution and avoiding the adverse effect of this anion. Here the main reason can be agricultural drainage and runoff that contains pollutant during rainy season.

Nitrates represent the final product of the biochemical oxidation of ammonia. Its presence is probably due to the presence of nitrogenous organic matter of animal and, to some extent, vegetable origin, for only small quantities are naturally present in water.

At the second sampling an increase is observed for nitrate i.e. 3.26 mg/l. Concentrations greater than 3 mg/l indicate significant man –made contribution (Salvato, 2003). Although organic matter containing nitrogen is discharged into the lake, in nitrification process it finally changes to nitrate ion, which is consumed by algae or the mychrophytes. High growth of algae and green color of lake water is well indicating an increase in concentration of nitrate .Maximum concentration of NO3 in drinking water is 45 mg/l for human and 100 mg/l for livestock. It seems no limitation exist from this aspect for drinking water consumption. Although nitrate at this level could cause algal blooms if other nutrients such as phosphorous and CO2 present.

High phosphorus concentration, as phosphates, together with nitrate and carbon dioxide are often associated with heavy aquatic plant growth, although other substances in water also have an effect. Uncontaminated waters contain 0.01 to 0.03 mg/l total phosphorus. Most waterways naturally contain sufficient nitrogen and phosphorus to support massive algal blooms. The concentration of phosphorus of the lake water is very small (0.014mg/l). However the effluents of two restaurants, containing detergents, which contain phosphorus, are discharging to this lake.

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