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"Study of various Physico-chemical Parameters of upper lake water in Bhopal region of Madhya Pradesh, India."

Satyam Kumar[1]	Dr. A.K. Saxena[2]	AbhishekSirothiya[3]
M.E. Environmental Engineering	Professor	M.E. Environmental Engineering
Department Of Civil Engineering	Department Of Civil Engineering,	Department Of Civil Engineering
SATI, Vidisha,	SATI, Vidisha,	SATI, Vidisha,
Madhya Pradesh, India	Madhya Pradesh India	Madhya Pradesh, India

***Abstract*—In India, various manmade and natural lakes, reservoirs and wetlands are located within the urban limits of major cities. These water resources objectively fulfil different demands of mankind but due to ever increasing anthropogenic influences and ambient urbanization, several water bodies are gradually being degraded badly. The cumulative Impacts of anthropogenic pressure and pollution load from point and non-point sources are affecting water quantity and quality of these urban water bodies. The Upper Lake is one of the important urban lakes of India, located in Bhopal which is a state capital of Madhya Pradesh. Constructed in the 11th Century, the 1000 years old water body is still one of the major potable water sources for the people of Bhopal city. This lake is being used as a prime source of drinking water supply for Bhopal city. The present study was carried out to evaluate the use of simple, easy-to-perform, physico-chemical analysis for assessing upper lake water quality. The aim of the study is to evaluate the use of simple physico-chemical parameters to assess lake water quality. And also find out the organic load increase to domestic drain, when, drain are without treatment discharge in lake. The upper lake which is used by local inhabitants and is moderate pollution. Primary survey around the upper lake to finding out some domestic drain and rainy season drain are without treatment discharge in the upper lake. First of all, required data are collected i.e. catchment area and physico-chemical parameter of upper lake. Selection of simple, physico-chemical parameters to assess the water quality of lake, and physico-chemical parameters to assess the water quality of domestic drain. Analysing those simple, physico-chemical parameters to assess organic load effect on the upper lake water quality. Those simple, physico-chemical parameter result indicate are organic load increase in upper lake.**

Keywords- Water quality of Upper Lake, Domestic Drain, physico-chemical parameter (Temperature, pH, Dissolved oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD).

1. INTRODUCTION

Water on Earth is one of the most important substances. All plants and animals must have water to survive. If there were no water there would have been no life on earth. Water is so important that the water which people drink and use for other purposes is fresh water. This means that the water must be free of disease and chemicals and be clear (not cloudy).Water that is secure for drinking is called potable water. Water is a unique substance, because it can naturally renewal and cleanses itself, by allowing pollutants to settle out (the process of sedimentation) or break down, or by diluting the pollutants to a spot where they are not in harmful concentrations. After all, its natural process takes time, and is difficult when intense quantities of harmful contaminants are added to the water leading to water pollution.

The four major sources of water are surface water source, Underground water source, Atmospheric water source and Oceanic water source. In our daily life we use only surfacewater and underground water. In this research work, we would be discussing only on the surface water source and its issues on pollution.

Urban Sector	Semi-Urban Sector	Rural Sector
Untreated Sewage Inflow. Municipal Solid wasteDumping. Human Intervention. Anthropogenic activitiesBathing, washing ofClothes and vehicles.	Partly urban and partlyrural waste joining to Lake.	Agriculture waste. Chemical Fertilizer Residue. Cattle Intervention/grazing. Inflow of silt/soil. Municipal Solid waste of Villages. Pesticides and Insecticides.

In this study Upper lake of Bhopal (M.P) is selected for the study purpose. It has high population around its surrounding areas. The urban catchment area comes under the Bhopal settlement.

The settled are has variety of land use consisting of housing, business, institutions, parks playgrounds, recreation sites, worshiping places and open places. To the south of the lake hilly tract is reserved for the zoo in natural surroundings. Due to protection of the area, the hilly tract has rich vegetation over the years. On hill top land is used for institutions, residential and commercial purposes. To the north of the lake land is mainly put to use for medical college, institutions, residences, encroachments and workshops, on the Idgah hill areas it is totally occupied with residences towards the hilly tracts of Cave temple is located with little plantations. The northern part of the lake was open till a decade back, but now it is the most thickly populated area called Koh-e-fiza. Further to the west Bairagarh Township has emerged.There are about eighteen wards that interact with the Upper. Gandhi Nagar, CTO, Nehru park, One tree hill, Gufamandir, Noor mahal, Malipura, Sharma Colony, parts of Jamalpura and Moti Masjid of these wards Gandhi Nagar, CTO, Jamalpura and Shastrinagar are of lesser importance as compared to remaining wards concerned.

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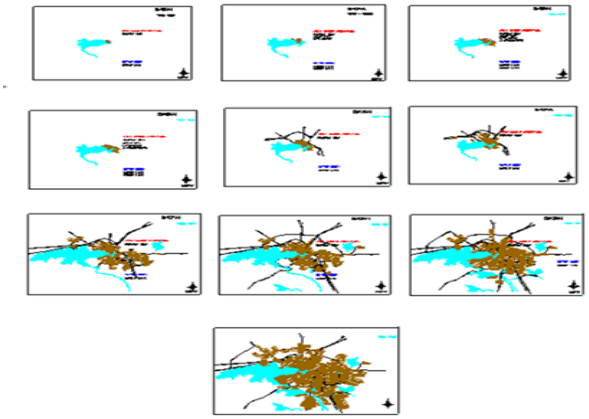

Human Settlements around the Upper Lake in Past 1000 Years

Objective of Work:

The purpose of the present study to determine the organic load flow in unknown drain around upper lake, it is organic load completely discharge in lake through some unknown drains, and find out the impact of organic load on upper lake. And which is impact on water quality. The some drains are rainy season drain and some are domestic drains.

Water quality analysis conducted by laboratory of Bhoj Wetland Project and Lake Conservation Authority which reveals that water quality of Upper Lake is progressively improving after intervention of BhojWetland Project.

2. MATERIALS AND METHODS

2.1 Study area

In the present Study Upper lake of Bhopal city was chosen for the research execution.Bhopal city lies in the middle of latitude 23°07' to 23°34' N and longitude 77°10' to 77°30' E. Bhopal is situated on the Malwa Plateau, at an altitude of 625m spreading over 285sqkm. The minimum and maximum temperature reported is 10°C and 45°C respectively. Average rainfall of the city is 1270 mm. Population of Bhopal is 1886120 as per 2011 census. Bhopal's Upper and Lower lakes together constitute which is known as the Bhoj wetland. Of these two, the Upper Lake is one of the major sources of water for the city, providing drinking water to 40 per cent of the population. The inflow of raw sewage into the upper lakes has deteriorated its water quality.

Panoramic view of Upper Lake

2.2 Selection of sample sites

Table below shows the sampling stations for the selection of water samples.

Sampling Station	Distance from Upper lake	Sampling station number
Garamgaddhasajida Nagar	Origin	1
Ahmadabad pump house Karbala	608 m	2
Halalpurpiliya Christian kabristanBairagad	5.108 km	3

2.3 SAMPLING STATIONS

Some unknown drains are finding out around the Upper Lake, the drains are without treatment disposed in the

Lake. Sample was collected from the identified sampling points after survey during May (2016). Water samples were collected directly from discharge point of drain. Samples was further mixed together in a plastic container and brought into laboratory.

Location of all Domestic Drains.

2.5 Selection of determinants:

In the Initial Phase of the study various determinants were identified to carry out the testing process:

Parameters for Testing Purpose:

- pH
- D.O
- BOD
- COD
- Temperature.

3. Methodology:

3.1 pH method:

The pH for samples was measured using digital pH meter (Eutech instruments pH510 Ph/mV/oC meter) which was calibrated by using standard buffer solution of 4.02 and 9.2.

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A photograph of the pH meter is shown.

3.2 Dissolved Oxygen:

The sample ware collected in a BOD bottles. 2ml of Alkali azide and 2ml of Magnus sulphate (MnSO4) were added to the sample bottles. A tip of the pipette should be below the liquid level while adding this reagent. Stoppard the bottle immediately after adding above two reagents. The sample bottles were mixed it properly by inverting the bottle 2-3 times and allowing the precipitation to settle down while leaving 150 ml levels supernatant. At this, 2m ml of conc. H2SO4 were added to the bottle for making the precipitation goes into solution. 100 ml of sample were taken in a conical flask and titrating against sodium thiosulphate (Na2S2O3) by using starch as an indicator.

Fixed DO **Relief DO**

3.3 Chemical Oxygen Demand (COD)

Chemical oxygen demand (COD) is defined as the amount of a specified oxidant that reacts with the sample under controlled conditions. The quantity of oxidant consumed is expressed in terms of its oxygen equivalence. Because of its unique chemical properties, the dichromate ion (Cr2O7-) is the specified oxidant and is reduced to chromic ion (Cr +3). Most types of organic matter are oxidized by a boiling mixture of chromic and sulphuric acids. A sample is refluxed in strongly acid solution with a known excess of potassium dichromate (K2Cr2O7). After digestion, the remaining unreduced K2Cr2O7 is titrated with ferrous ammonium sulphate to determine the amount of K2Cr2O7 consumed and the oxidizable matter is calculated in terms of oxygen equivalent. Both organic and inorganic components of a sample are subject to oxidation, but in most cases the organic component predominates and is of the greater interest. The COD test was performed as closed reflux for better precision. Feed stock COD was used to determine the reactor organic loading rate.

20 ml sample were taken in a COD condenser flask with pinch of 2 gm mercuric sulphate (HgSO4) and silver sulphate (Ag2SO4), mixing it with 10 ml of potassium dichromate (K2Cr2O7) (0.25N). 30 ml of conc. Sulphuric acid (H2SO4) were added to it.

Then the flasks containing the digestion reagents and samples were refluxed at 150 0C for 3 hours (KJeloplus-KJL/2LWC Pelican EquipmentsInc. After digestion the samples were cooled at room temperature, and then titrated with 0.1 N solutions of Ferrous

Ammonium Sulphate (FAS) using ferroin indicator. Sharp colour changed from orange to green to wine red colour. The appearance of wine red colour marked the end point of titration.

Photograph of COD Titration.

3.4 Biological Oxygen Demand (BOD)

Biochemical oxygen demand represents the amount of dissolve oxygen consumed by bacteria and other microorganisms while they are decompose organic matter under aerobic situations at a specified temperature. The BOD test is performed to determine what impact dirty water, containing bacteria and organic matter, will have on animal and plant life. when released into a pond or lake. when there is an abundance of bacteria and organic matter, the bacteria will take in oxygen in order to breakdown these molecules. If bacteria are taking in large amounts of oxygen, this will have a detrimental impact on the surrounding ecosystem. On the city, when there are low scales of organic waste in the water, there are few bacteria present, the BOD will be lower and the dissolved oxygen levels higher.

The biochemical oxygen demand (BOD) is used to determine the relative oxygen requirements of waste water, effluents and polluted water that are useful in evaluating the BOD removal efficiency of such treatment systems. It measures the molecular oxygen utilized during specified incubation duration for the biochemical degradation of inorganic and organic substance.

The biochemical oxygen demand (BOD) was measured following APHA 5210B (2005). The BOD was calculated in units of mg/l after 3 days of incubation period at 27 0C.

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Pictureof BOD Incubator equipment.

4. RESULT:

Initial DO			Final DO	
Days	Morning (6-8)	Evening (6-7)	Morning	Evening
1	7.50	7.60	2.20	1.90
2	8.20	7.90	1.90	2.40
3	9.10	8.20	2.30	2.10
4	8.90	8.10	2.20	2.30
5	9.30	7.80	2.10	2.10
Sum.	43.00	39.60	9.30	10.80
Avg. DO	8.60	7.92	1.86	2.16
Total Avg. DO	8.20		2.01	

Showing DO variation at Drain Halalpurpiliya Christian KabristanBairagarhand at Drain Gram gaddhasajida Nagar
Showing DO variation at Drain Ahmadabad pump house Karbala.

Showing BOD variation of three stations.
Showing Avg. pH, COD and Temperature variation of three stations.

Drains	Initial DO	Final DO	Difference	Dilution Time	BOD 3Day (mg/l)
HalalpurpiliyaCristainKabristaanBairagah. 23 16.423'N (Latitude) 77 21.228'E (Longitude)	6.40	1.92	3.78	2	7.56
Garamgaddhasajida Nagar. 23 15.593'N (Latitude) 77 23.172'E (Longitude)	7.05	2.54	4.51	2	9.02
Ahmadabad pump house Karbala. 23 15.660'N (Latitude) 77 22.801'E (Longitude)	8.26	2.01	6.25	2	12.50

Recent Water quality's tendency in Upper Lake Bhopal

4.1 Temperature:

For a polluted lake, seasonal and diurnal variation in temperature determines extent of release of nutrients and productivity. The temperature of the upper lake ranged between 25 ^{0}C to 34 ^{0}C with a mean temperature of 29.5 ^{0}C .The maximum temperature of 33.4 ^{0}C was observed at sampling location 1 while the minimum temperature of 32.8 ^{0}C was observed at sampling locations 3 the average temperature of drains ranged between 33.4^{0}C,33.1^{0}C and 32.8 ^{0}C.The presence of high temperature in a lake body could be because of higher metabolic activity taking place due to high organic pollution at that particular location. Similarly, lower liquid temperature might be due to low metabolic activity at that particular sampling location.

Drains	Temperature	pH	COD
HalalpurpiliyaCristainKabristaanBairagah. 23 16.423'N (Latitude) 77 21.228'E (Longitude)	33.4	7.142	24.8
Garamgaddhasajida Nagar. 23 15.593'N (Latitude) 77 23.172'E (Longitude)	33.2	7.353	27.2
Ahmadabad pump house Karbala. 23 15.660'N (Latitude) 77 22.801'E (Longitude)	32.8	8.401	31.1

S.No	Sampling point	Sampling location	pH	DO	COD	BOD
1	YatchClube	Near intake water supply	7.4	4.2	12	2.6
2	KarblaGhat	Near pumping Station	7.8	3.7	10	2.4
3	Bairaghar	KhanuGaon	8.3	5.6	13	3.8
4	Kamla park	Sheetal Das kiBagiya	7.9	5.2	14	3.3

Initial DO			Final DO	
Days	Morning (6-8)	Evening (6-7)	Morning	Evening
1	6.30	4.90	2.30	1.90
2	5.90	5.20	1.90	1.20
3	6.90	4.70	2.90	1.70
4	6.40	4.90	2.40	1.10
5	6.50	5.30	2.50	1.30
Sum.	32.00	25.00	12.00	7.20
Avg. DO	6.40	5.00	2.40	1.44
Total Avg. DO	5.70		1.92	

Initial DO			Final DO	
Days	Morning (6-8)	Evening (6-7)	Morning	Evening
1	7.30	5.60	2.30	1.60
2	6.90	6.20	2.90	2.30
3	7.90	7.10	3.10	2.90
4	7.40	6.80	2.40	2.10
5	8.10	7.20	3.50	3.20
Sum.	37.60	32.90	14.20	12.10
Avg. DO	7.52	6.58	2.84	2.24
Total Avg. DO	7.05		2.54	

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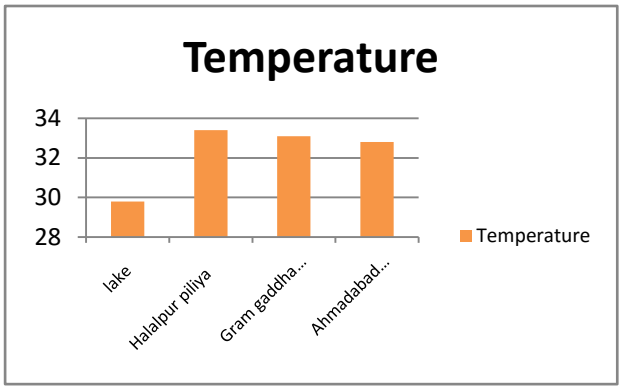
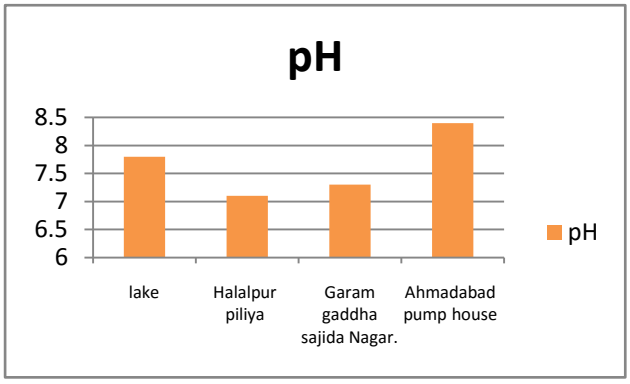
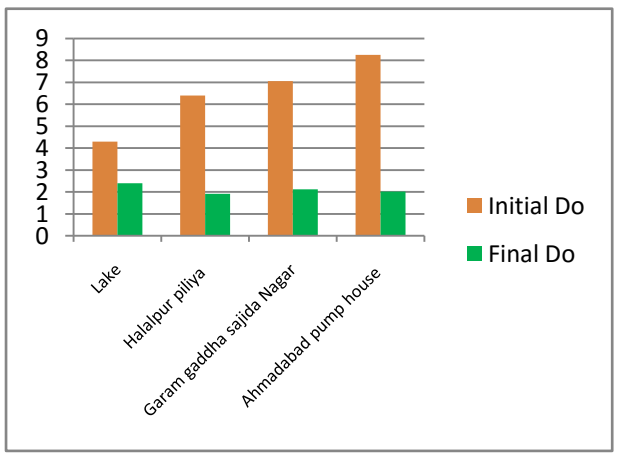


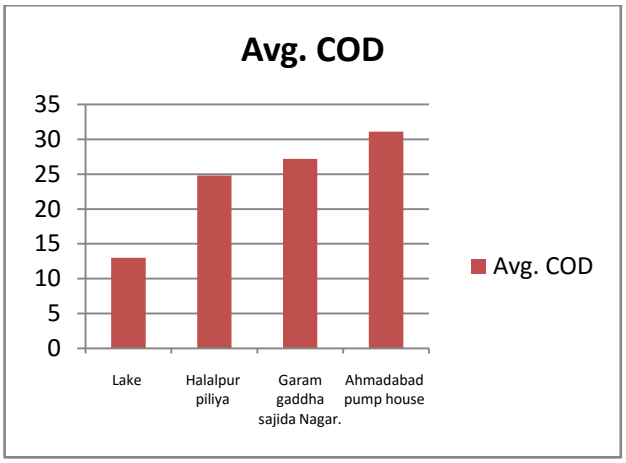
4.2 pH: The highest value of pH 8.4 was observed for sample location 3. A gradual increase in pH was observed from 7.1 to 8.4 between sampling locations 1 to 3 and thereafter the pH gradually increased to 7.8.Overall,the average pH of drains range between 7.1,7.3and 8.4. The pH of upper lake water is neither highly alkaline nor acidic and so suitable for the growth of flora and fauna.



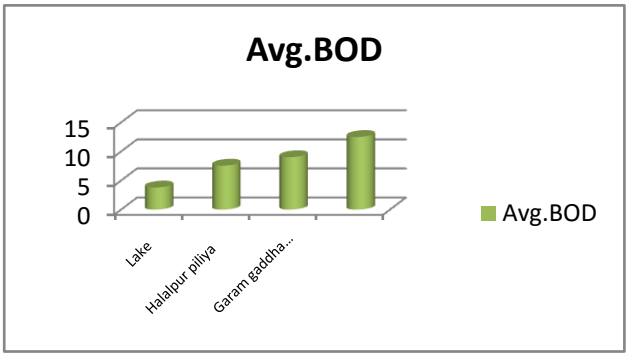
4.3 Dissolved Oxygen:
DO levels in the upper Lake were found to be in the range of 3.5-11.9 mg/L.The highest value of DO is found for the sampling site 3.The average initial DO value of drains range between 6.40, 7.05 and 8.26 mg/L,and final DO value of drains range between 1.92, 2.12 and 2.01(table 4.4).High value of DO concentration in the lake water indicates the lake is highly eutrophic in nature was taken. The cell was then dipped into the beaker containing the sample, and electrical conductivity was measured in accordance with the instructions and reported as micro Siemens.



4.4 Chemical Oxygen Demand (COD):
In the present study of domestic drains, the average COD concentrations ranged between 24.8, 27.4 and 31.2 (mg/L). There is a total COD disposal in the lake, While a clean lake has an average COD of 27 (mg/L). The average COD value for the upper lake water was estimated to be 13- 75 mg/L.



4.5 Biochemical Oxygen Demand (BOD):
BOD levels in the upper Lake were found to be in the range of 2.6-3.8 mg/l. The highest value of BOD is found for the sampling site 12.5.The average initial DO value of drains range between 6.40, 7.05 and 8.26 mg/L (table4.4),and final DO value of drains range between 1.92, 2.12 and 2.01(table 4.4).the average BOD of drains range between 7.56,9.02 and12.50. The total amounts of BOD are discharge in the upper lake. High value of BOD concentration in the lake water indicates the increase organic load.



5. CONCLUSION:
Main aim of this study was to understand the level of organic pollution concentration in the lake and results revealed that concentration of all the important parameters which mainly govern the lake chemistry are measurable the permissible limits. The present study was carried out to evaluate the use of simple, easy-to-perform, physico-chemical analysis for assessing a lake water quality. The aim of the study is to evaluate the use of simple physico-chemical parameters to assess lake water quality. And also find out the organic load increase to domestic drain, when, drain are without treatment discharge in lake.

- The analytical results indicate that upper Lake of Bhopal is moderately polluted due to discharge of domestic waste water.

- The accumulations of nutrients over years of uncontrolled mixing of domestic waste water into the lake are make the lake unfit of drinking purpose.

- BOD Mixing concentration are main factors which affects the organic load increase in Upper Lake.

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