Assessment of quality and sustainable usage of water resources in varthur lake of bengaluru, karnataka

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Abstract

Eco system is the major part on this earth and lakes play a very important role in it. Lakes once served the function of meeting the requirements of domestic and cultural purposes. Varthur lake is the second largest lake in Bangalore. Rapid urbanizations involves industrial development, commercial complex`s, residents, apartments which intern gradually encroached the area of the lake. Sudden drastic change in climate considering draught, flash floods and also the waste water released into the environment has led to the deterioration in ecological environment of the Varthur Lake. The major part is to study and analyze water quality management by standard test such as biological oxygen demand, chemical oxygen demand, pH, hardness, total solids and dissolved oxygen. High water contaminations are recorded at many places in surface and ground water samples of the study area. Based on the quality standard, decision making approach for majority of the samples are of decreased quality when compared with the WHO standards. The study area is also aimed at sustained and improved infrastructure development of lake in order to reduce the waste dumping of solid waste, disposal of liquid waste in the lake. Emerging trends such as membrane bioreactor (MBR) is a biological process with the integrated of permeable and semi-permeable membrane can be adopted to solve the sewage treatment in the study area. Improvisation of lake rejuvenation and recharge structures are to be considered for the maximum utilization from lakes without degradation as well as a sustainable and efficient working of lakes.

Keywords: Water contaminations, Water quality, Chemical tests, impervious surface, Membrane bioreactor (MBR).

Introduction:

Bangalore was once known as the "Land of Thousand Lakes" (V Balasubramanian IAS Retd former additional chief secretary, Govt of Karnataka). Demand of water for the Bangalore city was once met from the lakes and tanks, which were built in 16th century and these lakes were the source for

irrigation, drinking, fishing etc. The major exigency faced in the recent times is to count on the portable water resources.

Bangalore south is located with the second largest lake i.e., Varthur lake. The population was 5431 and Varthur was the largest town from the Census of India 1981. Villages with small farms growing rice, raggi, fruits & vegetables surrounding the lake (Government of Karnataka, 1990). The pollution of the Varthur lake began in the recent years. Natural contamination due to particular geological environments can be an important factor in limiting the available water resources (Lubna Kouser et al., 2013). An increase in the level of contamination can cause a threat to the people who are residing around the lake (Shwetmala et al., 2012).

The west bank of the lake has a large number of Apartments, industries, residents etc, where the effluents from these sources enter the lake without getting secondary or advanced treatment for the effluents. South end of the lake is interconnected with other canal and other lakes and tanks such as Bellandur Lake which is also one of the most polluted lakes in Bangalore south is also adding up the effluent from its bed.

The samples were collected at the source and also at the bore wells within the radius of 500mtrs from the lake during pre monsoon and post monsoon season. These samples were tested for different parameters such as pH, Hardness, BOD & COD. The concentration level of the effluents were recorded and compared with BIS (Bureau of Indian Standard). Overall twenty samples are analyzed from the same location.

Study Area:

Varthur lake located geographically between latitude from N 12^0 57' 24.98'' – 12^0 56' 31.24'' and longitude from E 77^0 44' 03.02'' – 77^0 44' 51.1'' (Fig1). It covers an area of 148sqkm in Southeast of Bangalore, built 1000 years ago by the Ganga King to store water for the drinking and irrigation purpose (Durga Madhab Mahapatra et al., 2011). The lake quality has drastically changed over the time.
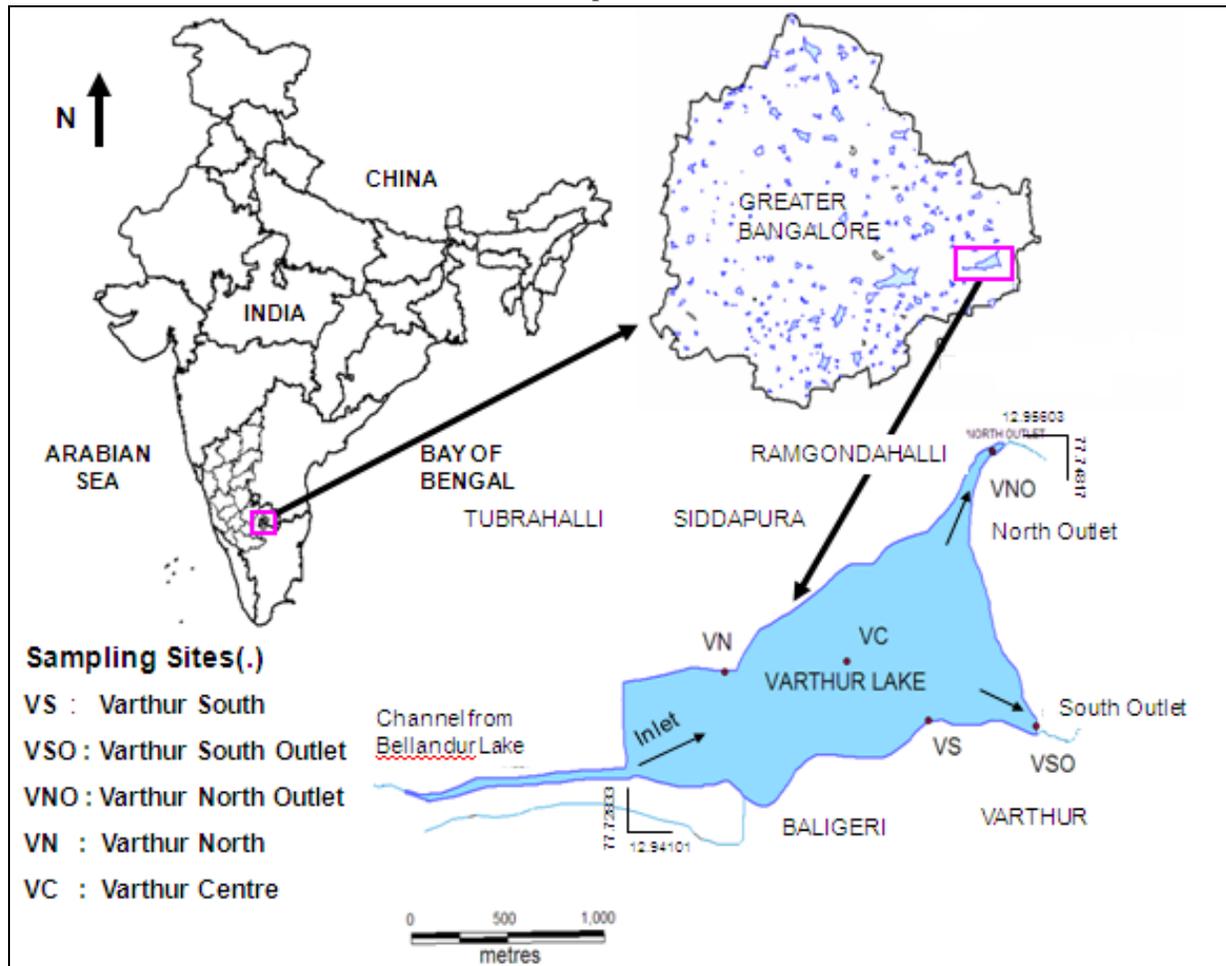
Figure1: The Location Map of the Varthur Lake

Data used and methodology:

Collection of Sample
Field investigation & samples collection are chosen to have good spread over the entire study area (Fig.2 & Fig.3). The latitude and the longitude of each sample location is been listed in the Table 1.

Figure 2: Samples locations of the study area in Post monsoon (Dec 2017)

Figure 3: Samples locations of the study area in Pre monsoon (April 2018)

Table 1: Location of the sample collected				
Sample No	Latitude of Location	Longitude of Location	Distance from the lake banks	Sample collection
A	12.9533	77.7434	0	The sample was collected during Post Monsoon (Dec 2017) & Pre monsoon (Apr 2018)
B	12.9457	77.7276	0	
C	12.9567	77.7408	310-320	
D	12.9519	77.7317	500-510	
E	12.9568	77.7486	470-480	
F	12.9463	77.7508	450-465	
G	12.9415	77.7492	480-500	
H	12.9405	77.7414	495-510	
I	12.9390	77.7326	450-475	
J	12.9478	77.7228	480-500	

Some visual evidences were noted and recorded. Color of the water from the lake was found to be sandy, foul smell & foam (Fig. 4)

Fig.4 photos of lake and water samples

The chemical measurements made for ground water as well as surface water samples and their values were compared with standard permissible limits and also to check the level of rejuvenation of the lake and the treatments to be adopted.

Methodology

Physicochemical parameters such as BOD, COD, Hardness & pH are tested in the laboratory for the samples collected. The location of the sample is randomly chosen and proximity to the Varthur lake. Standard procedures were used for the collection of the samples (1:4) one from the lake and four from the ground source (Bore well). As it is the largest lake and ideal of collecting samples are one at the

inlet and other at the outlet of the lake with ground water samples. The samples were collected in the month of Post monsoon Dec 2017 and Pre monsoon April 2018. The chemical tests were conducted on different parameters and the contaminations were compared with the standard values.

Results and Discussion:

A complete set of results for the physiochemical parameter have been analyzed for different monsoon and the results have been tabulated in the table 2 and table 3. This table also includes standard values for unpolluted water bodies as well as guidelines.
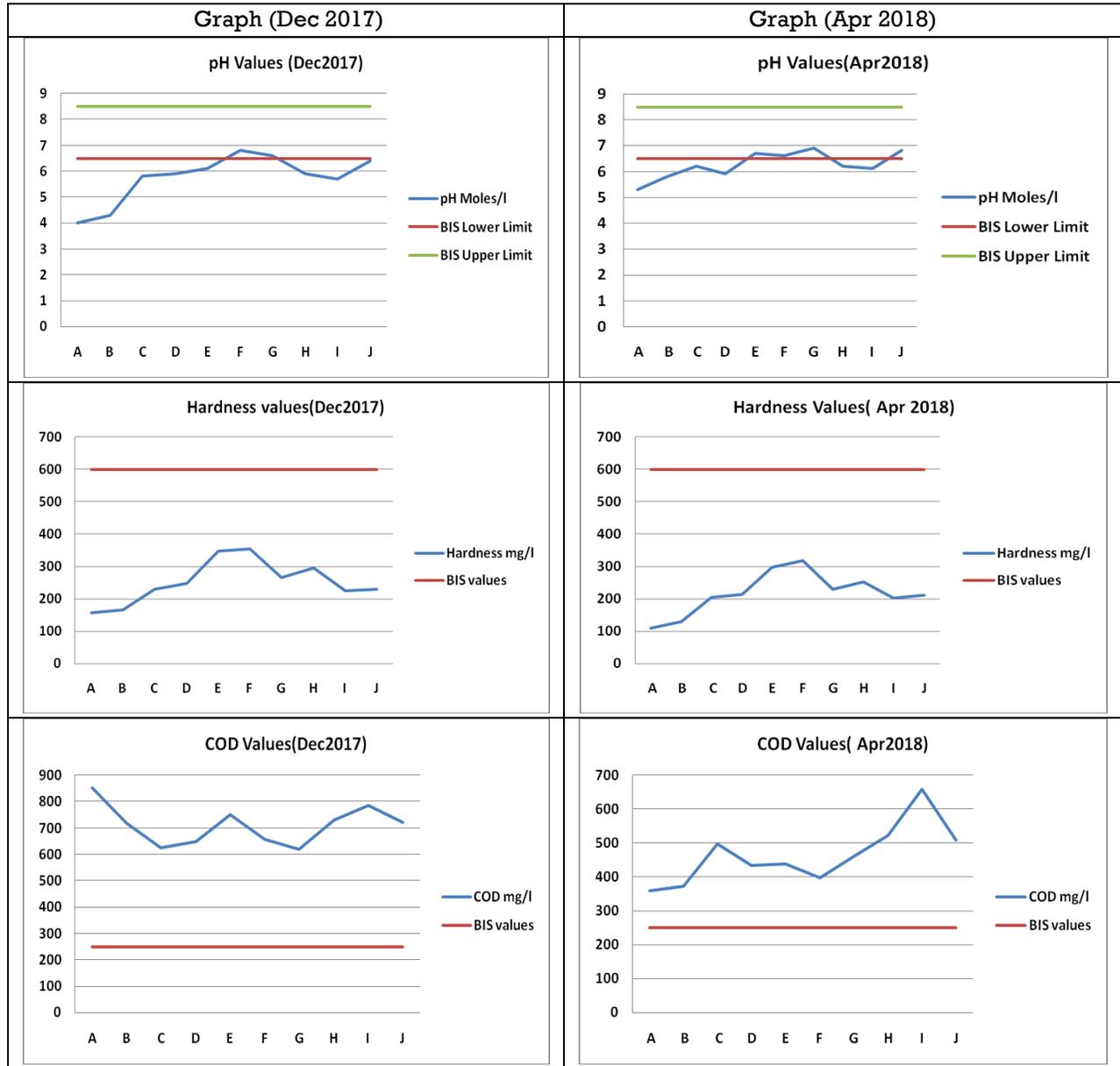
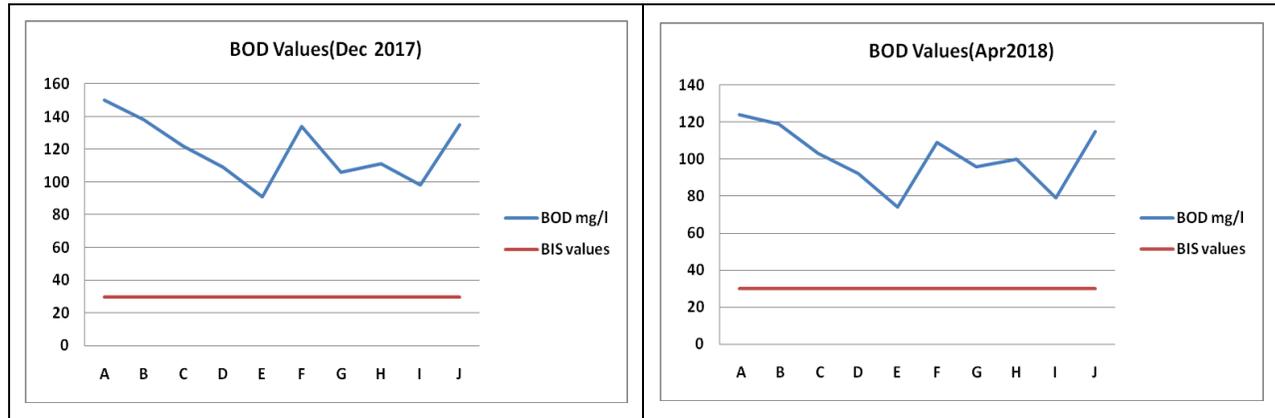| Table 2: Results for the samples collected in the month of Dec 2017												
Parameter	**Unit**	**Location points of samples**										**BIS Limit for Drinking Water**
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	
pH	Moles/l	4.0	4.3	5.8	5.9	6.1	6.8	6.6	5.9	5.7	6.4	6.5-8.5
Hardness	mg/l	158	167	230	248	349	355	267	297	225	230	600
COD	mg/l	853	719	628	649	752	658	621	732	785	723	250
BOD	mg/l	150	138	122	109	91	134	106	111	98	135	30

Table 3: Results for the samples collected in the month of Apr 2018												
Parameter	**Unit**	**Location points of samples**										**BIS Limit for Drinking Water**
		A	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**	**J**	
pH	Moles/l	5.3	5.8	6.2	5.9	6.7	6.6	6.9	6.2	6.1	6.8	6.5-8.5
Hardness	mg/l	109	129	206	214	299	319	231	252	202	211	600
COD	mg/l	359	372	497	435	439	397	462	523	660	510	250
BOD	mg/l	124	119	103	92	74	109	96	100	79	115	30

Temperature of water is basically important because it effects biochemical reactions in aquatic organisms. A rise in temperature of water leads to the speeding up of chemical reactions in water, reduces the solubility of gases and amplifies the tastes and odor (Ramesh N & Krishnaiah S, 2014). The chemical parameter shows there is high level of contaminants in the lake as well the ground water is also polluted when compared with the drinking standard parameters (Fig 5).

Graph (Dec 2017)	Graph (Apr 2018)

pH Values (Dec2017)

pH Values(Apr2018)

Hardness values(Dec2017)

Hardness Values(Apr 2018)

COD Values(Dec2017)

COD Values(Apr2018)

Fig 5: Comparative Graph for the chemical parameters tested during the post and pre monsoon season.

As the above results show the existing water in the lake was not fit for drinking because the criteria which is given by BIS was not satisfied.

The BOD level in the lake is found to be higher than the recommended values shows the presence of nitrates and phosphates which automatically increases the BOD levels. These also lead to quick growth of algae and weeds in the lake. As the weeds grow at faster rate, it decreases the D.O levels in the lake because the oxygen which is available in the water is consumed by the bacteria. Since less D.O is present in the lake water, it affects the aquatic life (Pattusamy V et al., 2013). The other reason is due to the presence of organic waste.

The COD difference in the results of the samples are very high after rains which indicates that the values from industrial waste has the presence of H_2O_2 which can play a role in alteration of COD and parameters keeps on fluctuating.

Hardness considerations vary from 60-180 where 60 refer to soft; 60-120 refers to moderately hard & 120-180 refers to hard. The readings from lake study is very hard referring >180 indicates the large extent of calcium and magnesium intake which effects the human health such as Cardiovascular disease, cancer, diabetes, effects the nervous system etc and also aquatic life.

Quality analysis of the lake water and the bore well water were taken to check if there is any correlation between the two. Transparency indicates the extent of turbidity and also measures the light penetration through the water. It ranged from 24 (summer) to 28 cm (monsoon). Reduced transparency during summer is due to increase of suspended particles on account of organic debris's decomposition with higher water temperature and reduced flow (Durga Madhab Mahapatra et al., 2010).

As the graph represents the effluent level in the samples for Post monsoon and Pre monsoon is relatively high when compared with the standard values of BIS. Untreated sewage, solid waste, municipal, and industrial effluents are the factors which are contributing in the lake deterioration. Contaminants in the lake have also led to the decrease in quality of the ground water when it is recharged in and around the lake area.

Conclusions:

The results of the tests conducted clearly shows that the Bio Chemical Oxygen Demand (BOD) and the Chemical Oxygen Demand (COD) are way beyond the limits suggested by the BIS. This clearly indicates that the water is polluted. The degradation of the lake has led to the loss of both direct and indirect benefits from the lake, which affects residents in several ways such as foul smell, health hazards, polluted ground water, and aquatic life. Remedial measures are proposed for the betterment of the lake and the groundwater quality which can help in mitigating the pollution and also provide good and portable groundwater to the local residents.

Membrane Bio-Reactor can be implemented to upgrade the lake water treatment plant to treat the water to the preferred standard. The MBR is a series of membrane were the water with the bacteria, sludge and suspended particles are allowed in to the aeration unit and then its let to flow in to the membrane filter unit. The filtered water flows out and the sludge is removed with separate outlet. This treated water is clean from all the contaminants and the effluents; it can be used for domestic purpose.

Portable Activated carbon filters can be adopted for the ground water treatment were the water drawn can be passed through the filter system and filtered water can be used for domestic needs. This filter can keep a check on the COD and BOD level on bore well water.

Lake can be developed as the park, island at centre so that the aeration process becomes easy as it increases the D.O levels of the water which helps the aquatic life for easy survival and reduce the foul smell around the lake where these aspects helps in aesthetic appearance and also improves the atmosphere of the surroundings.

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