ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 05, Iss 02, 2016

IMPACT OF HUSSAIN SAGAR LAKE POLLUTION ON THE WATER QUALITY PARAMETERS: ENVIRONMENTAL HEALTH PERSPECTIVES

Dr. Babu Rao Gundi[1]

[1*]Head, Department of Zoology, N.B Science College and PG Centre, Hyderabad Telangana.

dr.g.baburao786@gmail.com

ABSTRACT:

Water resources like lakes are vital resources of fresh water as they are prominent effect on ground water table and water quality aspects which regulate urban climate and its ultimate effect on environment. Water bodies like rivers, streams, lakes and ponds are polluted to a lesser extent by natural sources but are highly polluted by anthropogenic sources such as urbanization, industrialization, various human developmental activities and improper management of water resources. This has led to severe water quality impairment. Hussain Sagar Lake (HSL) connects the twin cities of Hyderabad and Secunderabad and it was originally used as a source of drinking and irrigation water during 1894–1930. Hussain Sagar Lake is now grappling with a concerning decline in water quality with recent measurements from Telangana State Pollution Control Board (TSPCB), indicating steady degradation of vital parameters that show the quality of water.

The surface water qualities of Hussainsagar, an eutrophic urban lake in the midst of twin cities of Hyderabad and Secunderabad (India) receiving large quantities of external inputs both untreated municipal sewage containing industrial effluents, and treated sewage, a large number of annually immersed idols of God and Goddess, and intense boating activities were assessed in relation to the concentration of elements including heavy metals of the water along the necklace road of the lake. Elemental analyses of water using ICP-MS revealed 26 elements including heavy metals viz., As, Cd, Cr, Ni, Pb, Cu, Fe, Mn, Se, Ba, Zn, Mo, V, Co, Ag, Sr, Rb, Mg, K, Ca, Al, Si, Sb, Na, Li, and B, in the surface water of the lake. Of these, the first 15 elements were found in elevated concentrations in the water at the outfall point of the untreated municipal sewage which was the main dominating source of contamination of the lake water while Cu and Sb were recorded in higher concentrations at the outfall of treated effluent from Sewage Treatment Plant, and three elements (Ba, Si, and B) were in higher concentration at the sites of outfall of sewage flowing from an oxygenated pond, Ca, Zn, and Sr, at the site immersed with idols in most of locations of lake and Pb, Ag, and at the certain locations of the lake. Concentrations of most of these elements exceeded the maximum permissible limits of national (Indian Council Medical Research) standards and maximum desirable limits of BIS for drinking water.

Keywords: Hussain Sagar Lake, Quality of water, Lake Water, BOD, COD, Water Quality, Physicochemical Parameters, Chemical Parameters, Biological Parameters, Heavy metals, Arsenic, Chromium, Health effects

INTRODUCTION:

Hussain Sagar Lake water pollution poses one of the most serious environmental problems of modern times. Though this lake was originally built for irrigational purposes and provision of drinking water, at present it is only used for recreational purposes. The lake has now become dumping ground for various industrial and domestic waste waters. The lake is fed by four major nullahs viz., Kukatpally, Picket, Banjara and Balkapur Nullahs, the former two joining from the North West and North East respectively (Umamaheswara Reddy and Venugopal Rao,2013).

Fresh Water Lakes serve infiltration source for ground water, for recharge of water to the water table, in addition to these, lakes can receive domestic sewage and industrial effluents

from the catchment area they existed and turn into disposal sites for waste water. In contrast to the perennial flowing water bodies like streams and rivers, mostly the natural lakes are formed at mountain areas, where as the artificial lakes are also constructed in and around the cities to meet the water demand of that particular area, and also to serve wastewater basins for the catchment area they existed. Lakes can retain the waste materials without disturbing ecosystem up to certain extent, but when the discharging wastewater loads increasing, they will lose the ability of self purification
process. Due to rapid industrialization and population growth, the requirement of water being increased at alarming rate in order to meet the water requirements of future generation, there is great need of protecting water bodies to promote sustainable development .Natural water bodies like rivers and fresh water lakes across the world are being polluted by domestic and industrial sewage due to a wide range of pollutants. Some of the pollutants are persistent and stable environmental contaminants (Karadede-Akin, and Unlu,2007). Water bodies in flowing state normally have the capacities to purify itself from the contamination of external sources discharge into the river (Maamar Mokadem,et.al.,2014; Omole,et.al.,2012). Self-purification of water is a tedious process involving physical, chemical and biological processes that occur simultaneously, allows lakes to restore its natural state over a certain period (Kaushik Rajat (2015); Menezes Paulo oao Cunha de, et.al., (2015). The process of purification is mainly depends on absorption and dissolution of atmospheric oxygen from the water body surface. This absorbed and dissolved oxygen (DO) is necessary for the growth of bacteria to break down the organic and inorganic pollutants thereby reducing its strength for a period of time Schiewer Ulrich and Schernewski Gerald,2004). Self-purification capacity of water bodies is mainly depends on natural factors. These include the water velocity, depth, discharge and temperature (Tian Shimin, et.al.,2011). The turbulent of water bodies helps the river to very clean because of the natural capacity to absorb and digest pollutants at a very high rate. Stagnant water bodies like Hussain Sagar Lake tend to become septic because of the low rate of oxygen absorption. Furthermore, the depth of the water body also affects the rate of diffusion and mixing of the absorbed oxygen (Madras school of Economics (MSE),(2005). The temperature of water is high; low DO concentration because biological and chemical activity increases (Mehrdadi, et.al.,2006). At a certain temperature the saturated dissolved oxygen is the maximum DO level that a river can attain. Maximum DO ranges from 14.6 mg/L of DO at 0^0c to 7.2 mg/L at 35^0c (Prati, and Richardson,1971).
Domestic sewage poses health related issues while industrial effluents carry a wide variety of toxic elements like Cd, Cr, Pb, Hg and Zn which can cause significant toxicity even in trace amounts. The pollutants enter various parts of environment by anthropogenic activities as well as natural processes and degrade the surface and ground water quality and make them unsuitable for drinking, industrial, irrigation, recreation or other purposes (Howarth,et.al.,1996; Carpenter,et.al.,1998).

Hussain sagar lake is being polluted year by year due to Ganesh chaturthi festival and immersion of Ganesh idols at Hussain Sagar Lake. Annual immersion oLord Ganesh idols after the 10 day Ganesh Chaturthi celebrations on Ananta Chaturdashi. Locally this event is called Ganesh Nimajjanam(immersion). That is immersion of Ganesh idols during the festival of Ganesh Chaturthi in to the Hussainsagar tank. While the Municipal authorities and police estimated that 13,000 idols are immersed in Hussainsagar, the Bhagyanagar Ganesh Utsav Samithi put the figure at 50,000. It is obvious that the surface waters of the Hussainsagar are polluted, but according to a study, the pollution extends to the depths of the historic lake, poisoning aquatic life and birds, also deep earth crust to the large extent over all the years. The immersion of Ganesh idols only makes a bad situation worse (Bob Pears and Chandra Sekhar,2016).The Hussain Sagar Lake water body over decades, has been polluted adversely

from discharging of organic and inorganic pollutants through open drains as well as point and non point sources and also presents various measures had taken to rejuvenate Hussain Sagar Lake to its past glory. The concentrations of most of the elemental contaminants showed exceeding maximum allowable limits of BIS (Vikram Reddy, et.al.,(2012).

Important limnological studies on Hussain Sagar lake have been conducted during 1998 (Reddy *et al.,* 1998), 2004 (Gurunadha Rao *et al.,* 2008), 2005 (Suneela *et al.,* 2008), 2007 (Chandrasekhar *et al.,* 2007), 2011 (Sulekh Chandra etal, 2012) and these studies have shown progressive deterioration in the quality of lake water. In 1992 EPTRI has estimated an inflow of settleable solids with the concentration of 280 mg/l in dry weather inflow of 25.73 M.Cum / year, the maximum siltation would be 3602 tons per year assuming only 50% of the solids are settled and the study further added that there is an inflow of 18 tons and 70 tons of phosphorus and nitrogen along with settleable solids. The studies conducted on the lake reveled that there has been considerable increase of contamination level since past four decades and accumulation of pollutants in the lake bed in the form of sediments pose a potential threat of contributing pollution load to the surrounding ground water.

MATERIALS AND METHODS:

The surface water samples from Hussain Sagar Lake were collected during March to April, 2016 from six different identified locations of Hussain Sagar Lake by lab sampling techniques, preservations and analysis was carried out as per standard methods (APHA 1998 and US EPA SW-846) (Suneela 2008). Two liters capacity of polyethylene bottle where used to collect samples, after collection of samples it was transported to Iota Laboratories, Hyderabad, India for physicoc-chemical, chemical and biological analysis. Physico-chemical parameters such as Temperature, pH, EC, TSS, Total dissolved solids, BOD, COD, TN and TP were analyzed. Heavy metals viz., Al, As, Pb, Zn, Cu, Fe, Mn, Mo, Cd, Co, Cr, Ni and Hg were analyzed as per the guidelines of AOAC (1985) and APHA (2005) standard methodology and the results were compared with earlier researchers (Bajpai, et.al.,2003 and Vikram Reddy et.al.,(2012).

Sample collection, preservation; Physico-chemical analysis was carried out as per standard methods (APHA, 1998 and US EPA SW-846) at Iota Laboratories, Hyderabad, India. Analysis of water samples were carried out for various water quality parameters such as pH , DO, BOD, COD, CO2, TDS, Nitrate , Chlorides , Sulphates , alkalinity , acidity , total hardness etc. using standard methods. All the reagents used for the analysis were prepared in AR grade and double distilled water. These experimental results were compared with the results carried out in the frequent intervals from 1977 by several organizations and researchers.

RESULTS AND DISCUSSION:

The mean concentrations values of water quality parameters of the Hussain Sagar lake was analyzed for all the water samples collected from various identified six locations of the lake was analyzed. The physic-chemical, Chemical and Biological Parameters were analyzed and are presented in Table 1,2 and 3 respectively.

Despite the pH levels of the lake water remaining relatively stable, fluctuating within the range of 7.3 to 8.2, other indicators paint a grim picture. The electrical conductivity (EC) values have consistently shown high levels, ranging from 1.36 – 4.75 dS/m suggesting an abundance of dissolved salts and minerals. Total Dissolved Solids (TDS) were found to be 835.60 mg/Lit and Total Suspended Solids (TSS) were 392.50 mg/Lit. Bicarbonates (HCO3) of Sodium and Calcium was 17.5 mg/lit. Sulphates (SO4) were ranged between 625.0 and 975.50 mg/Lit. Nitrate Nitrogen (NO3-N) was 121.5 in mg/Lit and Total Nitrogen was 95.2 mg/Lit. Phosphates (PO4) were ranged between 15.2 and 20.85 mg/Lit. It was noticed that

Calcium content was exceeding permissible limits and it was 268.17 mg/Lit and Magnesium (Mg) was with the limits of 35.18 mg/Lit.

Elemental analyses of water using ICP-MS revealed 26 elements including heavy metals viz., As, Cd, Cr, Ni, Pb, Cu, Fe, Mn, Se, Ba, Zn, Mo, V, Co, Ag, Sr, Rb, Mg, K, Ca, Al, Si, Sb, Na, Li, and B, in the surface water of the lake. Of these, the first 15 elements were found in elevated concentrations in the water at the outfall point of the untreated municipal sewage which was the main dominating source of contamination of the lake water while Cu and Sb were recorded in higher concentrations at the outfall of treated effluent from Sewage Treatment Plant, and three elements (Ba, Si, and B) were in higher concentration at the sites of outfall of sewage flowing from an oxygenated pond, Ca, Zn, and Sr, at the site immersed with idols in most of locations of lake and Pb, Ag, and at the certain locations of the lake. Concentrations of most of these elements exceeded the maximum permissible limits of national (Indian Council Medical Research) standards and maximum desirable limits of BIS for drinking water.

Table:1. Mean Concentration Values of Physico-chemical and Chemical parameters of water quality of Hussain Sagar Lake in March- April, 2016

WATER PARAMETERS	Parameter Status of Hussain Sagar Lake during March-April, 2016	Maximum Allowable or Desirable by BIS (Bureau of Indian Standards
pH (Range)	7.30 – 8.20	6.5 – 8.5
E.C. (dS/m) OR mg/Lit	1.36 – 4.75	2.35 dS/m OR 1,500 mg/Lit
Turbidity (NTU units)	35 – 72	0.50
Total Dissolved Solids (TDS) in mg/Lit	835.60	500 mg/Lit
Total Suspended Solids (TSS) in mg/Lit	392.50	100 mg/Lit
Bicarbonates (HCO3) in mg/Lit	17.50	200 mg/Lit
Chlorides (Cl) in mg/Lit	1,450.0	1,000 mg/lit
Sulphates (SO4) in mg/Lit	625.0 – 975.50	400 mg/Lit
Nitrate Nitrogen (NO3-N) in mg/Lit	121.5	100 mg/Lit
Total Nitrogen (N) in mg/Lit	95.2	200 mg/Lit
Phosphates (PO4) in mg/Lit	15.2 – 20.85	5-10 mg/Lit
Calcium (Ca) in mg/Lit	268.17	200 mg/Lit
Magnesium (Mg) in mg/Lit	35.18	100 mg/Lit
Fluoride (Fl) in mg/Lit	1.50 – 2.10	1.5 mg/Lit
Total Hardness as CaCO3 in mg/Lit	875.5	600 mg/Lit
Total Alkalinity as NaCO3 in mg/Lit	216 – 587	600 mg/Lit

Kalavathi and Giridhar (2016) reported that due to increased industrialization and unplanned urbanization Hussain Sagar lake has been polluted with potentially toxic elements, other trace elements and heavy metals like As, Cd, Cr, Ni, Pb, Hg, Cu, Fe, Mn, Se, Ba, Zn, Mo, V, Co, Ag, Sr, Rb, Mg, K, Ca, Al, Si, Sb, Na, Li and B due to discharge of untreated sewage containing municipal and industrial effluents, idol immersions, urban runoff and boating activities. Out of the above mentioned pollutants Arsenic and Chromium have severe impact on human health. Several studies have been carried out to assess the level of Cr and As and have reported results exceeding the desirable limits. With regard to human health Arsenic by virtue of its nature is found to be very effective in deteriorating water quality. For improved

human health, a systematic strategy for water quality assessment and monitoring needs to be formulated (Kalavathi and Giridhar (2016).

Dissolved oxygen (DO) levels, crucial for supporting aquatic life, have remained insufficient throughout the monitoring period 1.024 mg/Lit, falling below recommended thresholds. Though DO levels fluctuated, they generally remained within a range considered not adequate for supporting aquatic life, ranging from 1.0 to 1.2 mg/L.

Table:2. Mean Concentration Values of Heavy Metals of water quality of Hussain Sagar Lake in March- April, 2016

WATER PARAMETERS	Parameter Status of Hussain Sagar Lake during March-April, 2016	Maximum Allowable or Desirable by BIS (Bureau of Indian Standards
Lead (Pb) in mg/Lit	824.6	0.05 in mg/Lit
Aluminum (Al) in mg/Lit	560.2	0.20 in mg/Lit
Zinc (Zn) in mg/Lit	325.7	1.50 in mg/Lit
Copper (Cu) in mg/Lit	450.3	1.50 in mg/Lit
Iron (Fe) in mg/Lit	22,547.0	1.0 in mg/Lit
Manganese (Mn) in mg/Lit	0.65	0.30 in mg/Lit
Molybdenum (Mo) in mg/Lit	3.83	0.50 in mg/Lit
Born (B) in mg/Lit	2.56	1.50 in mg/Lit
Cadmium (Cd) in mg/Lit	0.036	0.01 in mg/Lit
Chromium (Cr) in mg/Lit	9.25	0.05 in mg/Lit
Cobalt (CO) in mg/Lit	14.35	2.50 in mg/Lit
Mercury (Hg) in mg/Lit	0.067	0.001 in mg/Lit
Nickel (Ni) in mg/Lit	65.20	30.50 in mg/Lit
Arsenic (As) in mg/Lit	0.325	0.05 in mg/Lit

However, BOD and COD levels fluctuated, ranging from 40.5 – 60.5 and 261.0 – 353.2 indicating varying degrees of organic and inorganic pollution. Despite some improvements, total coliform and faecal coliform bacteria levels still exceeded safe limits at times as 2.7×10^3 E. Coli) MPN/100 ML. Alarming rise in total coliform bacteria, including faecal coli form, surpassing safe limits, indicating potential faecal contamination and the presence of harmful pathogens is of particular concern for the safe use of lake water. The total Fungal Count was found to be as 3.65×10^3 CFU/100ML sample and Blue Green Algae in terms of Total Microsystins (µg/Lit) was noticed as 4.92×10^3 µg/Lit.

Table:3. Mean Concentration Values of Biological parameters of water quality of Hussain Sagar Lake in March- April, 2016

WATER PARAMETERS	Parameter Status of Hussain Sagar Lake during March-April, 2016	Maximum Allowable or Desirable by BIS (Bureau of Indian Standards
Dissolved Oxygen (DO) in mg/Lit	1.024	4.0

ISSN PRINT 2319 1775 Online 2320 7876
 UGC CARE Listed (Group -I) Journal Volume 05, Iss 02, 2016

Biological Oxygen Demand (BOD) in mg/Lit	40.5 – 60.5	5.0
Chemical Oxygen Demand (COD) in mg/Lit	261.0 – 353.2	10.0
Bacteria (E. Coli) MPN/100 ML)	2.7×10^3	*0.0 (E. Coli) MPN/100 ML)*
Total Fungal Count (CFU/100ML sample)	3.65×10^3	0.0 (MPN/100 ML)
Blue Green Algae (mg/Lit) OR Total Microsystins (µg/Lit)	4.92×10^3	0.0015 mg/Lit OR 1.5 µg/Lit
Chlorophyll (mg/Lit)	50.2 – 90.5	0.0 mg/Lit
Oxidizable Organic Matter (mg/Lit)	3.75	1.00 mg/Lit

Reasons for deteriorating water quality

• Steady decline of water quality at Hussain Sagar
• Biological oxygen demand (BOD), chemical oxygen demand (COD) and total suspended solids levels beyond permissible limits
• Coliform bacteria and faecal matter levels exceeded safety limits
• Dissolved oxygen levels crucial to support aquatic life remained insufficient
• Accumulation of Heavy metals viz., As, Cd, Cr, Ni, Pb, Cu, Fe, Mn, Se, Ba, Zn, Mo, V, Co, Ag, Sr, Rb, Mg, K, Ca, Al, Si, Sb, Na, Li, and B, in the surface water of the lake
• Inflow of freshwater through rains is crucial for water quality at Hussain Sagar

CONCLUSIONS:

The present study focuses on the assessment of water quality of Hussainsagar, Hyderabad was observed that the Water Quality Index (WQI) for Hussainsagar is above 100 and it is unfit for consumption and usage for house hold purpose. . As per NPI, the parameters such as conductivity, TDS, BOD, COD, chloride, sodium, calcium, magnesium, alkalinity and hardness were responsible for pollution in Hussainsagar. Domestic sewage entering the lake contains levels of Nitrates and Phosphates beyond permissible limits, which promote the growth of algae/water hyacinth in the lake. As the algae/water hyacinth decompose, it uses lot of available oxygen in the water thereby making it deficient for other aquatic fauna like fish etc. Hussain Sagar lake in the city is now grappling with a concerning decline in water quality with recent measurements from Telangana State Pollution Control Board (TSPCB), indicating steady degradation of vital parameters that show the quality of water. The water bodies like Hussain Sagar Lake were polluted especially with heavy metals. It is worrisome because due to deterioration of potable water, these water resources are harmful for domestic and drinking purpose. The cumulative effect of this usage can be disastrous because many of these metals are poisonous. The possible ways of dealing with this grave problem is by creating awareness among the masses. The lack of awareness among our people is the main reason behind such an environmental pollution. Environmental awareness campaigns and meetings should be organized to make public aware of environmental damage caused due to dumping waste, immersion of idols in to water bodies. Different communication media may serve as a useful tool for such a campaign. A Co-ordinated Committee comprising Police, Non-Government Organization, Local Authorities, State Pollution Control Boards, representatives of puja committees and stakeholders should be set up for guiding the public in carrying out the immersion with minimal impact on water bodies. Organizations and companies with different communication media may serve as a useful tool for such a campaign. A Co-ordinated Committee comprising Police, Non-Government Organization, Local Authorities, State Pollution Control Boards, representatives of puja committees and

stakeholders should be set up for guiding the public in carrying out the immersion with minimal impact on water bodies. Actually no one can change the problem. Only awareness among the masses can reduce the pollution gradually.

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