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Evaluation of surface water quality characteristics of Hussain Sagar and Saroornagar lake water studies

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ABSTRACT

The study was conducted to analyze surface water quality fluctuations of Hussain sagar lake and Saroornagar lake water from the seasonal variation from the 2016 to 2020 year. Total fiver year wise water quality monitoring and were analyzed including temperature, color, odour, turbidity, pH, electrical conductivity (EC), total dissolved solids (TDS), dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), total hardness (TH as $CaCO_3$), calcium (Ca^{2+}), magnesium (Mg^{2+}), total alkalinity (TA), chloride (Cl^-), nitrate (NO_3-), sulphate (SO_4^{2-}) and Fluoride (F^-). The study used water quality index (WQI) and principal component analysis (PCA) methods to analyze surface water quality. The results showed that the surface water was contaminated with organics (low DO and high BOD, COD) and chemical parameters like TDS, TH, Ca^{2+}, TA, Cl^-, NO_3- and F^- concentrations are exceeded the allowable limits of BIS. WQI classified water quality from bad to very good (WQI = 50 to 100) due to the impact of hydrological conditions, navigation, urban and industrial zones. Seasonal variations in water quality parameters were recorded compared with standards, and pollution status was studied using the water quality index.

Keywords: *Chemical parameters, Water quality, Seasonal variations and Water quality index (WQI)*

1. INTRODUCTION

Water is the most important resource on the planet earth after air for the survival of all the living beings 71% of the earth consist of water, 97% of it is present in oceans and the other 3% of it is present is fresh water in the form of lakes rivers and ground water (Adarsh et al. 2019). Of the 3% of the fresh water 79% of it is present in ice caps and glaciers and 29% of it is ground water and accessible surface fresh water is only 1%. if we further divide this 1% of this fresh accessible surface water lakes constitute about 52%, soil moisture is 38% water vapors is 8% and rivers constitute about 1%. This percentage shows that that how precious a fresh water resource is for our survival and even more points to the importance of lakes which constitute a major portion of accessible surface fresh water (Rama Kumari et al. 2018). This puts a greater emphasis on the reality that protection of these lakes is a matter of grave importance for our sustenance.

The environmental status of lakes in our country has deteriorated over the decades at a greater rate (Yadav et al. 2011). Some lakes are even subjected to encroachment. The major factor of deterioration of these lakes is the decrease in water quality of these lakes. Lakes are a major source of water supply for the city of Hyderabad. Sadly, these water bodies have become subject of pollution degradation and various other factors which resulted in the considerable amount decrease of water quality (Brindha and Kavitha 2015). Increase in human activity and consumption of water, dumping of domestic and industrials wastes into water bodies, global warming and illegal encroachment of lakes are major of many reasons which cause this depletion of lakes (Crittenden et al. 2012; Brindha and Kavitha 2015; Brill et al. 2017; Sudarshan et al. 2019). To identify the current water quality of lakes in Hyderabad is the main objective of this project. For this water samples of five major and historical lakes of Hyderabad namely Hussain Sagar Lake and Saroornagar Lake. This paper helps to gauge the seriousness of the issue of degradation of our precious lakes and identify steps to be taken to improve their quality and also the hurdles caused for their implementation.

Hyderabad and its urban conglomerates comprise of many man-made wetlands that were built for various hydrological purposes to serve the needs and water demand of the city. Hyderabad wetlands have been experiencing anthropogenic stress especially due to the sustained inflow of sewage altering the chemical integrity of wetlands. The present study was carried out to evaluate seasonal variation in the physico-chemical parameters of water quality of Hussain sagar and Saroornagar lakes of Hyderabad.

2. THE STUDY REGION AND GENERAL GEOLOGY

The aerial extent of Hussain sagar lake latitude 17° 24' 42.58" north and longitude 78° 28' 18.19" east; Saroornagar lake water latitude 17° 21' 31.29" north and longitude 78° 31' 28.95" east (Fig. 1 and Table 1). The study area consists of rocky terrain and monolithic rocks on the outskirts of the region. The regular yearly average rainfall of the region is 1009.7 mm during from the year 2020. The climate of the study area is generally hot. The average temperature in summer is 44^0C and in winter it is 16^0C.

The topography of the region is homogenous comprising Precambrian granite which is mainly comprised of pink and grey granites. Intrusive dolerites, gneisses, amphibolites, epidote, pegmatite, aplite and quartz veins frequently traverse the region. The granite rock covers a significant part of a region with calcium, sodium and potassium-rich feldspars.

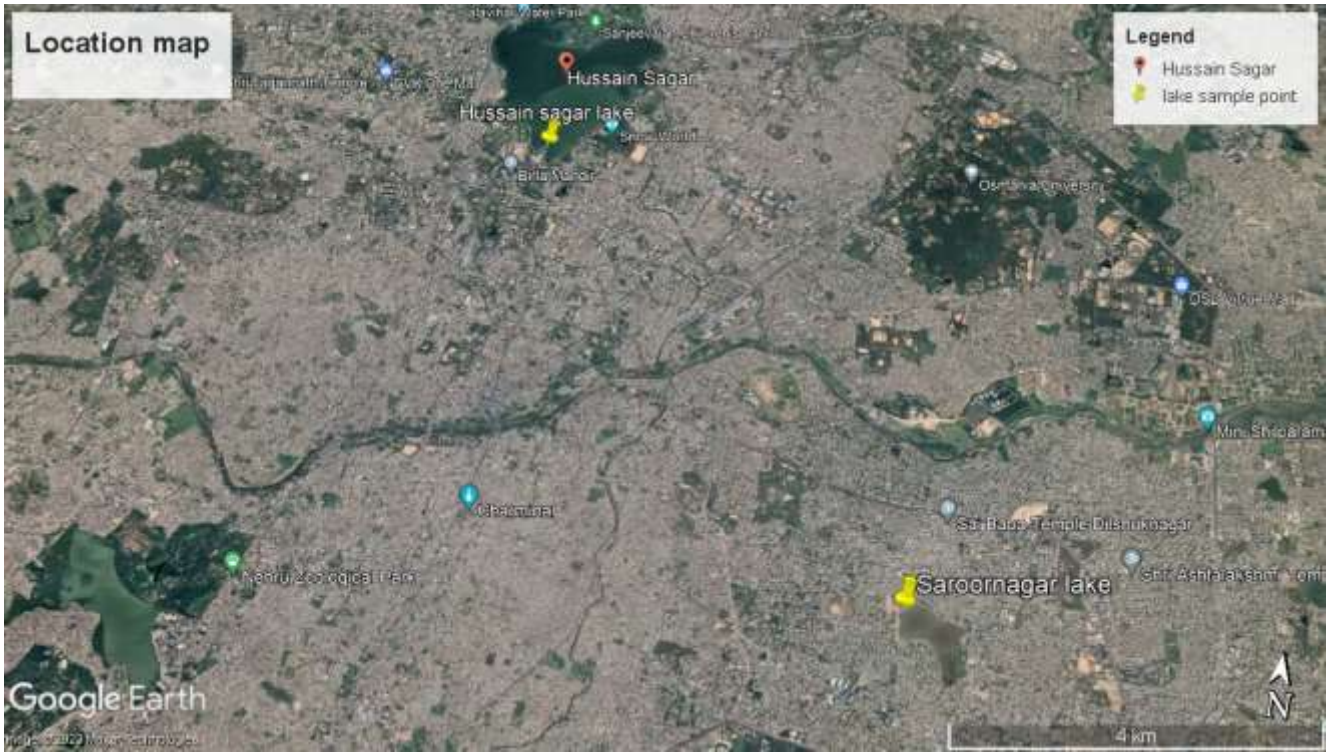

Fig. 1: Lakes view on Hussain Sagar Lake and Saroornagar Lake from the source of Google earth

Table 1 Hydrological data of Hussain sagar and Saroornagar Lakes

HUSSAIN SAGAR LAKE	Hussain Sagar is a heart-shaped lake in Hyderabad, Telangana, built by Ibrahim Quli Qutb Shah in 1563. It is spread across an area of 5.7 square kilometers and is fed by the River Musi. A large monolithic statue of the Gautama Buddha, erected in 1992, stands on Gibraltar Rock in the middle of the lake. It also separates the city centre of Hyderabad from its neighborhoodSecunderabad. The maximum depth of the lake is 32 feet.
SAROOR NAGAR LAKE	In 1626, the lake was created for agricultural and drinking purposes. Spread over 99 acres (40 ha), the lake has a maximum depth of 6.1 meters (20 ft). It is one of five major water bodies in Hyderabad.

3. MATERIALS AND METHODOLOGY

3.1 Sampling and Laboratory analysis

To evaluate the surface water samples were collected at Hussain sagar and Saroornagar sagar lakes of Hyderabad city, Telangana State, India. One liter capacity bottle was collected for water samples, 1:1 dilute nitric acid cleaned with bottles and washed with distilled water. In the field before collecting the samples in once again washed with the same sample, following the standard procedure (APHA, 2005). After collecting water samples directly measured pH/EC meter. The TDS values are calculated with EC (0.64) subtract.

The major ions like cations (calcium, magnesium, sodium and potassium); anions (bicarbonate, chloride, sulphate and nitrate) and fluoride were analyzed as per the standard procedure (APHA, 2005). Calcium, Total hardness, Chloride and Bicarbonate were estimated by titration method. Sodium and Potassium were determined by flame photometry. Sulphate and Nitrate are explored utilizing a spectrophotometer. For the computation of analytical error, the total cations ($Ca^{2+}+Mg^{2+}+Na^{+}+K^{+}$) and the total anions ($HCO_3^{-}+Cl^{-}+SO_4^{2-}+NO_3^{-}+F^{-}$) were used, which was observed to be ±5% (Laxman et al., 2021) reflecting the reliability of the chemical data.

3.2 Physical parameters

3.2.1 Temperature of water: Temperature is also important because of its influence on water chemistry. The rate of chemical reactions generally increases at higher temperature. Water, particularly groundwater, with higher temperatures can dissolve more minerals from the surrounding rock and will therefore have a higher electrical conductivity. Warm water holds less dissolved oxygen than cool water, and may not contain enough dissolved oxygen for the survival of different species of aquatic life. Some compounds are also more toxic to aquatic life at higher temperatures. The temperature from of the Hussain sagar and Saroornagar lake water was <35˚C.

3.2.2 Odour and color of water: Odor and color of water are the primary indicators of water quality. These are a major giveaway for water quality. By the color of the water in the lake we can easily assume the type of contaminants present in water and by the odor of water we can identify different types of chemical mixing or pollution on the surface. The Hussain sagar lake was green in color, septic in odour and Saroornagar lake was light green color and pungent odour.

3.2.3 Turbidity of water: Turbidity affects the growth rate of algae (micro-aquatic plants) and other aquatic plants in streams and lakes because increased turbidity causes a decrease in the amount of light for photosynthesis. Turbidity can also increase water temperature because suspended particles absorb more heat. These factors lead to a decrease in dissolved oxygen. Turbidity can also affect how well aquatic life can see or function underwater. Excessive turbidity is known to clog the gills of fish, interfere with their ability to find food, and bury bottom dwelling creatures and eggs. An electronic hand-held meter is often used to measure turbidity. Measurements can also be conducted by use of a Secchi disc or similar instrument. Measurements may differ for the same sample depending on the instrument used and how precise that instrument is. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU). The nephelometric meter compares how light is scattered in a water sample against the amount of light scattered in a reference solution. The Hussain sagar lake water of turbidity comparison ranged from 270 to 75.7 during the period of 2016 to 2020 years. The Saroornagar lake water of turbidity ranged from 38 to 207 during the period of 2016 to 2020. The permissible value of turbidity is 5 NTU and maximum value 10 NTU. The graph above shows the uneven trend followed by the parameter. The rate of increment in the percentage of the parameter it was not a good sign.

3.3 Water Quality Index (WQI): The water quality index on groundwater suitability for drinking water specification on each variable was calculated. The major ions of groundwater of the study region such as major ions (cations and anions) pH, TDS, and F^- were given to the assigned high significance. The hydrochemical appraisal on groundwater quality is main purpose of impact on human health. The study region on the WQI was estimated for each sample with below formulae.

$$W_i = \frac{w_i}{\sum_{n=1}^{n} w_i}$$

As per formulae, the relative weight is W_i; the assigned weight is w_i and rating of water quality (q_i) on variables for drinking water is Sahu and Sikdar, 2008; Laxman et al. 2022.

$$q_i + \frac{C_i}{S_i} x100$$

Where, q_i is referred to as the water qualitative C_i is the attentiveness of each chemical variable in each sample mg/L, and S_i as per the recommended standard of the WHO, 2011 calculated the WQI, the SI is first determined for each chemical variable, which is then used to determine the WQI as per the following equation.

$$SI_i = q_i x W_i$$

Finally, WQI was calculated by the summation of the sub index values of all the chemical parameters using following equation.

$$WQI = \sum_{i=1}^{n} SI_i$$

In deciding the overall water quality of the region which is assigned due to weights, relative weights and respective drinking water specifications presented in **Table 2.**

Table 2 Assigned weights, relative weights and respective (WHO, 2011) standards

Parameter	pH	TDS	Na^+	K^+	Ca^{+2}	Mg^{+2}	TA	Cl^-	SO_4^{-2}	NO_3^-	F^-
S_i	8.5	500	200	12	75	50	500	250	200	45	1.5
w_i	4	5	2	2	2	1	3	3	4	5	5
W_i	0.111	0.139	0.056	0.056	0.056	0.028	0.083	0.083	0.111	0.139	0.139

Table 3a Hussain sagar lake water samples physico-chemical analysis

Year	pH	EC (µS/cm)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TH (mg/l)	Ca^{+2} (mg/l)	Mg^{+2} (mg/l)	TA (mg/l)	Cl^- (mg/l)	NO3 (mg/l)	SO4 (mg/l)	F- (mg/l)
2016	8	1430	1008	3.0	16	2	415	101	42	256	346	26	38	2
2017	7.7	1409	896	1.45	16.90	99	368	88	38	226	310	29	10.2	1.7

2018	7.6	1521	926	1.30	14.50	103	432	106	43.1	349.6	194	44	19.4	1.3
2019	7.6	1516	946	2.50	19.70	95	346	85	34.4	339	218	47	13.8	0.4
2020	8.02	1613	1038	1.28	19.50	72	457	108	48	346	251	149	46.1	2.05

Table 3b Saroornagar lake water samples physico-chemical analysis

Year	pH	EC (µS/cm)	TDS (mg/l)	DO (mg/l)	BOD (mg/l)	COD (mg/l)	TH (mg/l)	Ca^{+2} (mg/l)	Mg^{+2} (mg/l)	TA (mg/l)	Cl^- (mg/l)	NO3 (mg/l)	SO4 (mg/l)	F- (mg/l)
2016	8.00	1357	916	1	17	14	506	132	50	433	186	9	18	1
2017	7.70	1227	796	1	28	169	458	112	48	387	172	24	32.3	2.1
2018	7.50	1469	939	0.50	20.6	152	400	96	42	368	176	54	13.8	1.5
2019	7.40	1423	920	0.10	25.4	147	378	86	42	336	233	43	14.3	1
2020	7.32	1466	940	0.80	95	347	404	94	46	356	210	99	27.89	2.54

Table 4 Statistics of lake water chemistry

Parameter	Hussain sagar			Saroornagar			BIS, 2012*
	Minimum	Maximum	Mean	Minimum	Maximum	Mean	
pH	7.60	8.02	7.78	7.32	8.00	7.58	**6.5 - 8.5**
TDS (mg/l)	896	1038	936	796	940	902	**500**
EC (µS/cm)	1409	1613	1498	1227	1469	1388	-
DO (mg/l)	1.28	3.0	1.91	0.10	1.0	0.68	**6**
BOD (mg/l)	15	20	17	17	95	37.2	**2**
COD (mg/l)	2	103	74	14	347	166	**250#**
TH (mg/l)	346	457	404	378	506	429	**300**
Ca^{2+} (mg/l)	85	108	98	86	132	104	**75**
Mg^{2+} (mg/l)	34	48	41	42	50	46	**30**
Cl^- (mg/l)	194	346	264	172	233	196	**250**
TA (mg/l)	226	350	303	336	433	376	**200**
NO_3^- (mg/l)	26	149	59	9	99	46	**45**
SO_4^{2-} (mg/l)	10	46	26	14	32	21	**200**
F- (mg/l)	0.40	2.05	1.49	1	2.54	1.63	**1**

*Surface water quality standards (as per IS: 2296), Class A-Drinking water without conventional treatment but after disinfection
#COD (General Standards for Discharge of Effluents)

4. RESULTS AND DISCUSSION

4.1 pH

pH is really a measure of the relative amount of free hydrogen and hydroxyl ions in the water. Water that has more free hydrogen ions is acidic, whereas water that has more free hydroxyl ions is basic. Since pH can be affected by chemicals in the water, pH is an important indicator of water that is changing chemically. The seasonal variations of the pH mean values were 7.78 of Hussain sagar lake and 7.58 of Saroornagar lake during period of 2016 to 2020 year (Table 3a and Table 3b), the acceptable limit of pH is 6.5 to 8.5 (BIS, 2012), based on the results its alkaline condition of the study area (**Table 3a and 3b**).

4.2 Electrical conductivity (EC)

Conductivity is a measurement of the ability of an aqueous solution to carry an electrical current. An ion is an atom of an element that has gained or lost an electron which will create a negative or positive state. Conductivity is a measurement used to determine a number of applications related to water quality. Summarizes the variations in electrical conductivity over the study area. The seasonal variations of EC mean value 1498 µS/cm at Hussain Sagar Lake and 1388 µS/cm at Saroornagar lake (**Table 3a and 3b**).

4.3 Total dissolved solids (TDS)

TDS in drinking-water originate from natural sources, sewage, urban run-off, industrial wastewater, and chemicals used in the water treatment process, and the nature of the piping or hardware used to convey the water, i.e., the plumbing. In the United States, elevated TDS has been due to natural environmental features such as mineral springs, carbonate deposits, salt deposits, and sea water intrusion, but other sources may include: salts used for road deicing, anti-skid materials, drinking water treatment chemicals, storm water, and agricultural runoff, and point/non-point wastewater discharges. The mean values of TDS ranged from 963 mg/l at Hussain sagar and 902 mg/l at Saroornagar lake during 2016 to 2020 year (**Table 3a and 3b**).

4.4 Dissolved oxygen (DO)

Dissolved oxygen analysis measures the amount of gaseous oxygen (O2) dissolved in an aqueous solution. Dissolved oxygen is one of the most important parameters in aquatic systems. This gas is an absolute requirement for the metabolism of aerobic organisms and also influences inorganic chemical reactions. Therefore, knowledge of the solubility and dynamics of oxygen distribution is essential to interpreting both biological and chemical processes within water bodies. Oxygen gets into water by diffusion from the surrounding air, by aeration (rapid movement) and as a waste product of photosynthesis. The amount of dissolved oxygen gas is highly dependent on temperature. Atmospheric pressure also has an effect on dissolved oxygen. In the present study of Hussain sagar lake and Saroornagar lake the DO values range between 1.28 to 3 mg/l with a mean of 1.91 mg/l and 0.10 to 1.0 mg/l with a mean of 0.68 mg/l during 2016 to 2020 year (**Table 3a and 3b**).

4.5 Biochemical oxygen demand (BOD)

Biochemical oxygen demand, or BOD, measures the amount of oxygen consumed by microorganisms in decomposing organic matter in stream water. BOD also measures the chemical oxidation of inorganic matter (i.e., the extraction of oxygen from water via chemical reaction). A test is used to measure the amount of oxygen consumed by these organisms during a specified period of time (usually 5 days at 20 C). The rate of oxygen consumption in a stream is affected by a number of variables: temperature, pH, the presence of certain kinds of microorganisms, and the type of organic and inorganic material in the water. BOD directly affects the amount of dissolved oxygen in rivers and streams. The greater the BOD, the more rapidly oxygen is depleted in the stream. This means less oxygen is available to higher forms of aquatic life. The consequences of high BOD are the same as those for low dissolved oxygen: aquatic organisms become stressed, suffocate, and die.

The seasonal variation of Hussain sagar lake ranged from 15 to 20 mg/l with a mean of 17 mg/l and Saroornagar lake ranged from 17 to 95 mg/l with a mean of 37.2 mg/l during 2016 to 2020 year (**Table 3a and 3b**).

4.6 Chemical Oxygen demand (COD)

Chemical Oxygen Demand is an important water quality parameter because, similar to BOD, it provides an index to assess the effect discharged wastewater will have on the receiving environment. Higher COD levels mean a greater amount of oxidizable organic material in the sample, which will reduce dissolved oxygen (DO) levels. A reduction in DO can lead to anaerobic conditions, which is deleterious to higher aquatic life forms. The COD test is often used as an alternate to BOD due to shorter length of testing time.COD is a good indicator of oxidable chemical waste in the water and thus most water pollution controls focus on COD as it also reports the reduced substances like sulfides, sulfites, ferrous iron along with organic carbon.

In the years 2016-2020, the COD content of lake water has been found to be between 2 to 103 mg/l with a mean of 74 mg/l at Hussain sagar and Saroornagar lake was 14 to 347 mg/l with a mean of 166 mg/l (**Table 3a and 3b**).The findings of the present study indicate that, higher value of COD (66 mg/l and 174 mg/) in the year 2018 and 2020 as compared to previous years, this is may be due to the presence of higher concentration of organic and non-biodegradable components in the lake water which require higher amount of oxygen for their decomposition (Dubber and Gray 2010; Gwaski et al. 2013) in the study area are under permissible limits only.

4.7 Total Hardness, Calcium and Magnesium in water

Hardness is due to the presence of multivalent metal ions which come from minerals dissolved in the water. Hardness is based on the ability of these ions to react with soap to form a precipitate or soap scum. In fresh water the primary ions are calcium and magnesium. The most important impact of hardness on fish and other aquatic life appears to be the affect the presence of these ions has on the other more toxic metals such as lead, cadmium, chromium and zinc. Generally, the harder the water is the lower the toxicity of other metals to aquatic life. In hard water some of the metal ions form insoluble precipitates and drop out of solution and are not available to be taken in by the organism. Large amounts of hardness are undesirable mostly for economic or aesthetic reasons. The total hardness of Hussain sagar lake ranges from 346 to 457 mg/l with a mean of 404 mg/l. Saroornagar lake water ranges from 378 to 506 mg/l with a mean of 429, all of the samples are unacceptable limit of total hardness is 200 mg/l as per BIS, 2012 drinking water specifications (**Table 4**).

4.7a Calcium: Calcium salts and calcium ions are among the most commonly occurring in nature. They may result from the leaching of soil and other natural sources or may come from man-made sources such as sewage and some industrial wastes. Calcium is usually one of the most important contributors to hardness. Even though the human body requires approximately 0.7 to 2.0 grams of calcium per day as a food element, excessive amounts can lead to the formation of kidney or gallbladder stones. High concentrations of calcium can also be detrimental to some industrial processes. Thus, both domestic and industrial water users have to consider calcium concentrations. The calcium of Hussain sagar lake mean value ranges from 98 mg/l and Saroornagar lake water mean value ranges from 104 mg/l, all of the sample are unacceptable limit of calcium is 75 mg/l as per BIS, 2012 drinking water specifications.

4.7b Magnesium: Magnesium is widely distributed in ores and minerals. It is also very chemically active; therefore, it is not found in the elemental state in nature. With the exception of magnesium hydroxide, which has a high pH value, its salts are very soluble. Magnesium ions are of particular importance in water pollution. They may contribute to water hardness. The magnesium of Hussain sagar lake mean value ranges from 41 mg/l and Saroornagar lake water mean value ranges from 46 mg/l, all of the sample are unacceptable limit of magnesium is 30 mg/l as per BIS, 2012 drinking water specifications.

4.8 Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids (see pH description). Alkaline compounds in the water such as bicarbonates (baking soda is one type), carbonates, and hydroxides remove H+ ions and lower the acidity of the water (which means increased pH). They usually do this by combining with the H+ ions to make new compounds. Without this acid-neutralizing capacity, any acid added to a stream would cause an immediate change in the pH. Measuring alkalinity is important in determining alkalinity essentially becomes a measure of the buffering capacity of the carbonate/bicarbonate ions and to some extent the hydroxide ions of water. The alkalinity of Hussain sagar lake mean value ranges from 303 mg/l and Saroornagar lake water mean value ranges from 376 mg/l, all of the sample are unacceptable limit of alkalinity is 200 mg/l as per BIS, 2012 drinking water specifications (**Table 4**).

4.9 Chloride (Cl^-)

Chlorides are salts resulting from the combination of the gas chlorine with a metal. Some common chlorides include sodium chloride (NaCl) and magnesium chloride ($MgCl_2$). Chlorine alone as Cl is highly toxic and it is often used as a disinfectant. In combination with a metal such as sodium it becomes essential for life. Small amounts of chlorides are required for normal cell functions in plant and animal life.

The chloride of Hussain sagar lake mean value ranges from 264 mg/l and Saroornagar lake water mean value ranges from 196 mg/l. Seasonal variation of Hussain sagar lake water samples are high chloride concentration from the year wise 2016, 2017 and 2020 excess the limits of chloride is 250 mg/l as per BIS, 2012 drinking water specifications. Chlorides may get into surface water from several sources including: rocks containing chlorides, agricultural runoff, wastewater from industries, oil well wastes, Effluent wastewater from wastewater treatment plants and road salting (**Table 4**).

4.10 Nitrate (NO_3^-)

Nitrate is one form of dissolved nitrogen that occurs naturally in soil and water. It is the primary source of nutrients for plants and may be used as fertilizer. Most natural concentrations are not a health concern to humans, but when excess nitrates get into water this can pose a problem for human health. Some human activities that introduce nitrates into water are fertilizing, runoff from animal feedlots, leaky septic tanks, industrial wastes and wastewater treatment lagoons. The nitrate concentration of Hussain sagar lake water ranges from 26 to 149 mg/l with a mean of 59 mg/l and Saroornagar lake water nitrate value ranged from 9 to 99 mg/l with a mean of 46 mg/l, acceptable limit of nitrate is 45 mg/l as per BIS, 2012 drinking water specifications. Seasonal variation of Hussain sagar lake water high concentration of nitrate during the year wise 2019 and 2020 excess limits and Saroornagar lake water during the period of 2018 and 2020 year had exceeded the limit of drinking water specifications (**Table 4**).

4.11 Sulphate (SO_4^{2-})

Sulfate is second to bicarbonate as the major anion in hard water reservoirs. Sulfates (SO_4^{2-}) can be naturally occurring or the result of municipal or industrial discharges. When naturally occurring, they are often the result of the breakdown of leaves that fall into a stream, of water passing through rock or soil containing gypsum and other common minerals, or of atmospheric deposition. Point sources include sewage treatment plants and industrial discharges such as tanneries, pulp mills, and textile mills. Runoff from fertilized agricultural lands also contributes sulfates to water bodies. The sulphate of Hussain sagar lake mean value ranges from 26 mg/l and Saroornagar lake water mean value ranges from 21 mg/l, all of the sample are acceptable limit of sulphate is 200 mg/l as per BIS, 2012 drinking water specifications.

4.12 Fluoride (F^-)

Fluorine is a natural trace element and exists in almost all soils. Fluoride is classified as any binary compound of fluorine with another element. Perhaps the most widely known use of fluoride is its addition to public drinking water supplies at about one milligram per liter (mg/l) of a fluoride salt, measured as fluoride, for the purpose of reducing tooth decay. Children under nine years of age exposed to levels of fluoride greater than about 2 mg/l may develop a condition known as mottling or discoloration of the permanent teeth. Exposure to drinking water levels above 4 mg/L for many years may result in cases of crippling skeletal fluorosis, which is a serious bone disorder resembling osteoporosis and characterized by extreme density and hardness and abnormal fragility of the bones. **Table 3a and 3b** shown the fluoride of Hussain sagar lake water value ranges from 0.40 to 2.05 mg/l with a mean of 1.49 mg/l and Saroornagar lake water value ranges from 1 to 2.54 mg/l with a mean of 1.63 mg/l. Seasonal variation of Hussain sagar 2016, 2017, 2018 and 2020 year and Saroornagar lake water during period of 2016, 2017, 2018, 2019, 2020 year wise had exceeded permissible limits of fluoride is 1 mg/l as per BIS, 2012 drinking water specifications (**Table 4**).

4.13 Water quality index (WQI)

The first step is on calculation of WQI using weighted arithmetic index given unit weight for each parameter. The unit weight of each parameter and standard values for each parameter as per WHO is given in Table 2. The summary of WQI values of the water samples from Himayat sagar and Osman sagar lakes for all seasons are given in **Table 5**. The results showed that water samples from excellent to good permissible limits (28 to 81) at Himayat sagar lake and Osman sagar is 26 to 60 WQI its shown the excellent to good water quality index.

Table 5 Estimated WQI and respective classification of drinking water

Year	Hussain sagar WQI	Class	Saroornagar WQI	Class
2016	95	Good water	75	Good water
2017	83	Good water	82	Good water
2018	84	Good water	87	Good water
2019	75	Good water	79	Good water
2020	132	Poor water	111	Poor water

5. CONCLUSION

Hussain Sagar Lake and Saroornagar Sagar Lake seasonal change in a variety of physico-chemical parameters was investigated, and a water quality index was developed. It is evident that the lakes' pH tends slightly toward an alkaline state. Based on the region's water's total dissolved solids, COD, BOD, hardness, alkalinity, chloride and nitrate concentrations are excess limits for drinking purposes. Based on seasonal water quality throughout the years 2016 to 2020, the seasonal fluctuations in the WQI values were evaluated. As per BIS, there were permitted limitations for pH and DO. The overall water quality index ranged from good to poor water quality.

6. ACKNOWLEDGEMENT

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7. REFERENCES

[1] Adarsh.S, Manasa. MP, Shesha Prakash. MV (2019). Water quality assessment of lakes in Mysuru India-A case study. International Journal of Engineering Research & Technology (IJERT), ISSN: 2278-0181, Vol. 8, Issue 06.

[2] APHA (2005) Standard methods for the examination of water and wastewater American Public Health Association, Washington DC, USA.

[3] BIS, (Bureau of Indian Standards) 2012. Indian standard drinking water specification, Second Revision ISO: 10500:2012, Bureau of Indian Standards, Drinking Water Sectional Committee, FAD 25. New Delhi, India.

[4] Brill, G., Anderson, P. and O'Farrell, P. 2017. Methodological and empirical considerations when assessing freshwater ecosystem service provision in a developing city context: Making the best of what we have. Ecological Indicators, 76: 256-274.

[5] Brindha. K, Kavitha. R (2015). Hydrochemical assessment of surface water and groundwater quality along Uyyakondan channel, South India. Environ Earth Sci (2015) 73:5383-5393

[6] Crittenden, J. C., Trussell, R. R., Hand, D. W., Howe, K. J., and Tchobanoglous, G. (2012). MWH's water treatment: principles and design. John Wiley and Sons, 92-93 pp.

[7] Dubber, D., & Gray, N. F. (2010). Replacement of chemical oxygen demand (COD) with total organic carbon (TOC) for monitoring wastewater treatment perfor mance to minimize disposal of toxic analytical waste. Journal of Environmental Science and Health, Part A, 45(12), 1595–1600.

[8] Gwaski, P. A., Hati, S. S., Ndahi, N. P., & Ogugbuaja, V. O. (2013). Modelling parameters of oxygen demand in the aquatic environment of lake had for depletion estimation. Journal of Science and Technology, 3(1), 116–123.

[9] Laxman Kumar D., Kiran Kumar P., Ratnakar Dhakate., Himabindu V., (2022). Health risk assessment of nitrate and fluoride toxicity in groundwater contamination in the semi-arid area of Medchal, South India. Appl Water Sci 12, 11 (2022). doi.org/10.1007/s13201-021-01557-4

[10] Rama Kumari and Ramesh C. Sharma "Seasonal Variation in the Physico-Chemical Variables of Western Himalayan Sacred Lake Prashar, Himachal Pradesh, India". International Research Journal of Environmental Sciences (2018) Vol. 7(7), pp.29-36 ISSN 2319–1414.

[11] Sahu, P., Sikdar, PK., 2008. Hydrochemical Framework of the Aquifer in and around East Kolkata Wetlands, West Bengal, India. Environmental Geology 55:823-835. doi.org/10.1007/s00254-007-1034-x

[12] Sudarshan. P, Mahesh. MK, Ramachandra. TV (2019). Assessment of Seasonal variation in water quality and water quality Index (WQI) of Hebbal lake, Bangalore, India. Environment and Ecology 37 (1B): 309-317

[13] Yadav, K., Nikhil, S. V. andPandav, C. S. 2011. Urbanization and health challenges: need to fast track launch of the national urban health mission. Indian Journal of Community Medicine, 36(1): 3.

[14] WHO, 2011. Guidelines for Drinking water quality, fourth ed. World Health Organization.

