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Full Length Research Paper

Assessment Of Water Quality In Saroornagar Lake, Hyderabad

Hina Alam[1], Dr. Masroor Fatima[2], Dr. Shakeel Ahmed[3]

[1] Research scholar, Maulana Azad National Urdu University, Gachibowli, Hyderabad, Telangana-500032
[2] Assistant Professor, Department of Zoology, Maulana Azad National Urdu University, Gachibowli, Hyderabad, Telangana-500032
[3] Professor, Maulana Azad National Urdu University, Gachibowli, Hyderabad, Telangana-500032
hinaqasim2005@gmail.com

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Abstract: *Hyderabad is popularly known as the Lake City of India owing to the presence of numerous lakes across the twin cities. In recent times, the city has experienced unplanned urbanization and increased industrial activity. Consequently, the water quality in most Hyderabad lakes has decreased because of irresponsible discharge of sewage and industrial effluents. The current research is centered on the evaluation of Saroornagar Lake's water quality in the eastern region of Hyderabad. The evaluation has been done through the review of data from 2016 to 2022, taking into consideration some key parameters like DO, pH, Conductivity, BOD, Nitrates, Total coliforms, Fecal coliforms, COD, Chlorides, Sulfates, TDS, Sodium, Calcium, Magnesium, Alkalinity, and Hardness. The lake's water quality has been found not suitable for drinking purposes based on Bureau of Indian Standards (BIS) standards for drinking water (IS -10500: 2012). Further research discloses that the lake's water is heavily polluted, dangerous to aquatic life. Results of this research can assist the government in preparing policies to avoid further degradation. They can also act as inputs to create water treatment processes for polluted water and to maintain a balanced aquatic ecosystem.*

Keywords: *Industrialization, Urbanization, Water Quality index parameters, aquatic life.*

Introduction

The capital city of Hyderabad is geographically situated in an arid zone surrounded by land and with no perennial river. There is only one seasonal river, “Musi River." Over time, and with the city's expansion, rulers constructed several lakes to fulfil the drinking water needs of the residents. The Saroornagar lake was built in the late 16th century during the Qutb Shahi era to provide water for irrigation. The lake served the intended purpose for a while until the rapid industrialization and urbanisation caused water bodies to become contaminated and unsafe to drink. The Saroornagar lake was built in the late 16th century during the Qutb Shahi era to provide water for irrigation. The lake remained relatively clean until 1956, when Hyderabad expanded. Saroornagar Lake has started facing difficulties because of inadequate farming practices, urban runoff, and sewage discharge.

High levels of contamination have disrupted or modified the ecosystem of Saroornagar Lake, leading to eutrophication and a decline in water quality (Suresh, 2015). Although Hyderabad Urban Development Authority restored the lake in 2003–01 at a cost of ₹200 million (US$2.4 million), an assessment of the Water Quality Index for Saroornagar has shown the poor quality of lake water, which necessitates the urgent installation of effective environmental monitoring systems (Khan and Seenayya, 1985). The primary contributors to the pollution of urban water bodies are careless home waste and sewage disposal. Disposal of dangerous industrial waste irresponsibly, agriculture runoff during flood situations. The contamination for along period led to a change in morphological features as well as the water quality of the lake (Manisha, 2018; Ramachandraiah et al., 2007; Mary Esther Cynthia Johnson and Olive Kezia Ruth, 2014).

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Figure 1: Saroornagar Lake *(source: Wikipedia)*

Saroornagar Lake Location And Morphological Features

Hyderabad serves as the capital of the southern Indian state of Telangana. It covers an area of 625 square kilometres (241 mi2) and is located along the banks of the Musi River. Between 17° 22' 31" N latitude and 78° 28' 27" E longitude, the Metropolis of Hyderabad is situated at an average elevation of 542 meters (1,778 feet) above mean sea level. One of Hyderabad's larger lakes, Saroornagar Lake, is located east of the city. The Saroornagar Lake is thought to have been constructed in 1626, under the reign of Quli Qutubshah, to supply water for irrigation of agricultural land and household use. This lake, which was formed 400 years ago, is one of Hyderabad's main water sources. This lake, which is 400 years old, was one of Hyderabad's main water sources.

Table 1: Morphometric and Hydrological characteristics of Saroornagar Lake

Location	d Dist
Latitude	°N
Longitude	°E
Construction	
Catchment area	40 ha)
Water temperature	egrees

Approximately 180 acres used to be covered by Saroornagar Lake. However, urbanisation, land encroachment, and the consequent discharge of trash and sewage into the lake resulted in the submergence area being reduced to 99 acres and 63 acres. However, there have been efforts in recent years to improve the lake's and its surroundings' appeal. The lake was restored by the Hyderabad Urban Development Authority (HUDA). Due to significant residential and sewage waste pollution caused by the sewage treatment plant's filtering unit malfunctioning in recent years, the lake's water quality has worsened (Khanum, 1980).

Figure 2: Saroornagar Lake (*Source: Google Maps)*

Morphological Features:

The following figures show the physical characteristics of Shamirpet Lake from 1970 to 2022. The data below show that the area was smaller than in previous years. 6.62 sq km of the area was occupied in 1970, and 5.86 sq km will be in 2022. There is a 0.76 sq km reduction in the area. The huge reduction happened due to urbanisation and pollution of water (TSPCB).

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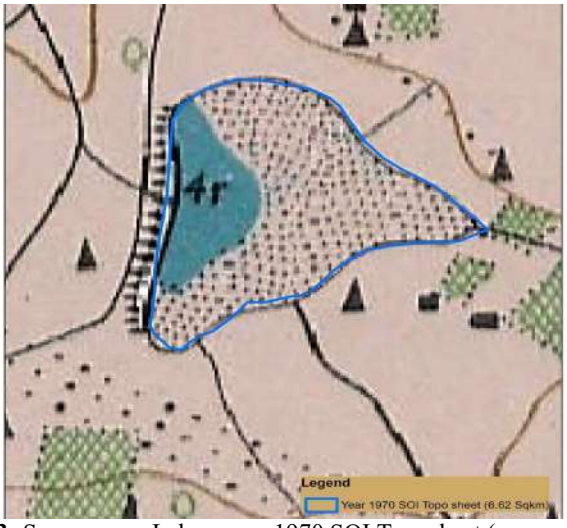

Figure 3: Saroornagar Lake as per 1970 SOI Toposheet (source :TRAC)

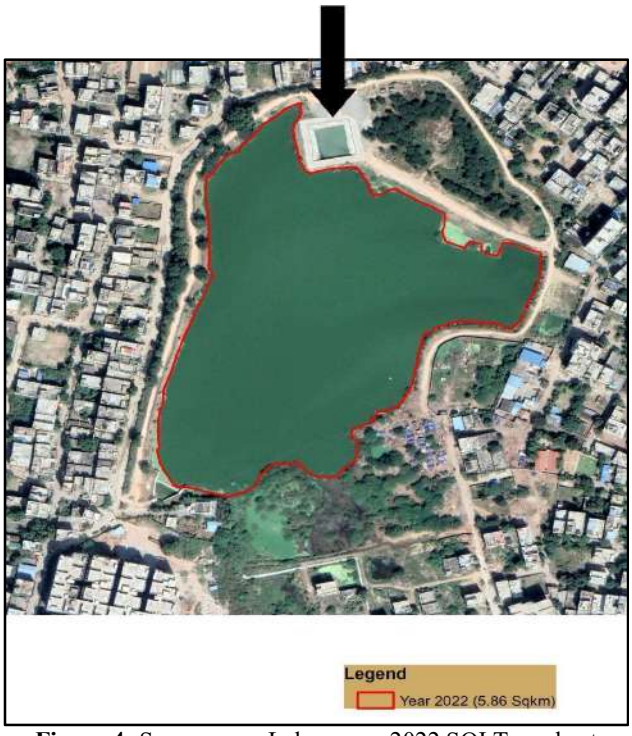

Figure 4: Saroornagar Lake as per 2022 SOI Toposheet

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Evolution of Lake in Terms of Water Quality

Figure 5: Saroornagar Lake *(source: Wikipedia)*

The 400-year-old Qutub Shahi lake in Saroornagar actually experiences seasonal colour shifts in its water. The change in the ancient lake is because of pollution levels, and lake colour shifts are from green to blue-green. Heavy metals and biological agents pollute Saroornagar Lake, while chemical, industrial, and sewage contamination primarily affects numerous Hyderabad water sources. Saroornagar Lake is so heavily populated with zooplankton and phytoplankton that the water no longer has a neutral appearance. The lake is dominated by one group of microorganisms in the summer and another in the winter (Prahalad , 1987; Premsudha, 2018.). The lake waters contain Eichhornia an invasive Eichhormia (water hyacinth), This represents an excess nutritional load brought on by humans. Winter lake water is green because Chlorophyceae, a kind of phytoplankton, is present. When summer approaches, the lake water will progressively become blue-green because Cyanophyceae, another phytoplankton, will predominate. Due to sewage, industrial pollution, chemical pollution, and biological contamination, the lake does not have enough oxygen.

Water demand and availability are complicated by climate change. In India, lakes and reservoirs are the primary water sources. As yearly variations in weather patterns can affect lake water quality, it is crucial to understand how lakes respond to climate change. The lakes' quality changes because of the effects of climate change. The biotic component of the water body is directly impacted by changes in the physicochemical environment. Hyderabad is home to Saroornagar Lake. Unprecedented population increase, industrialisation, and insecticide- and fertiliser-intensive agriculture all contributed towards lake pollution (Vani and Kamraju., 2016).

Untreated home sewage, solid waste, and industrial effluents inexorably found their way into the lake's catchment region. Hyderabad Urban Development renovated the lake. A few years after the lake was restored, migrating birds started to return to the lake in large numbers. After the repair, the lake was given the appropriate attention. However, in 2009, the sewage treatment plant's filter unit ceased to operate correctly. This caused the lake to become contaminated with residential trash. The Saroornagar Lake's very existence is vulnerable due to deforestation in the watershed area and the release of untreated sewage into the lake. The Saroornagar lake is found to contain a range of suspended, dissolved floating, microbiological, and bacteriological pollutants. Several factors are taken into consideration in the present study, and lake water was found to be unsuitable for drinking, agricultural, and aquaculture purposes. (Padma Priya et al., 2015, 2017).

The variety of phytoplankton indicates that the lake is contaminated with organic matter, has a high pollution load, and is polysaprobic. The lake's physical-chemical conditions show eutrophication and a significant drop in water quality, making it unsuitable for drinking, cooking, and recreational uses. The quality of lakes has declined over the past years as a result of the exponential growth in the human population and the disposal of waste products into water bodies. Numerous factors, such as geological changes in land use patterns, agricultural practices, industrialization, and biological productivity, all had an impact on the metal load in the river silt (Sri Lakshmi, K. 2016). There have been reports of residential and industrial pollution of several lakes in the past (Akan et al., 2012; Malik and Biswas, 2013; Hakeem et al., 2020).

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Methodology

Various physico-chemical parameters were analyzed in Saroornagar Lake, Hyderabad district, from the year 2016 to the year 2022. For analysis, monthly data of Saroornagar Lake for seven years, from 2016 onwards, was collected from the Telangana State Pollution Control Board (TSPCB). The yearly mean of the parameters was taken to understand the average values of the selected parameters and prepare graphs showing variations over a period of seven years.

The quality of water was analyzed by studying pH, temperature, dissolved oxygen, total suspended solids, total dissolved solids, electrical conductivity, total alkalinity, total hardness, and chlorides. These parameters were compared with the limits provided by BIS, Indian Standard DRINKING WATER — SPECIFICATION (Second Revision) IS 10500:2012.

Another important indicator of the lake's health is algal bloom. Saroornagar Lake has been facing the problem of algal blooms for several years. An algal bloom is a thick layer of algae formed on the water surface due to excessive nutrients, particularly fertilizers, entering the lake through agricultural runoff and untreated sewage. Algal blooms are a major cause of declining oxygen levels in water, making it difficult for fish and other aquatic organisms to survive.

Water Quality Index of Saroornagar Lake:

The Saroornagar Lake's water quality is shown in the following tables. The WQI for Saroornagar Lake during the seven years is shown in the table below. It demonstrates that the water quality is extremely poor and unstable for drinking and other uses, etc. The WQI is maximum in the year 2018 at 1771.2.

Table 2: WQI for Saroornagar Lake (2016-2022)

Year	WQI	Rating of Water Quality for Saroornagar Lake
2016	**482.33**	**Unsuitable for Drinking**
2017	**771.65**	**Unsuitable for Drinking**
2018	**1812.17**	**Unsuitable for Drinking**
2019	**607.19**	**Unsuitable for Drinking**
2020	**670.06**	**Unsuitable for Drinking**
2021	**528.61**	**Unsuitable for Drinking**
2022	**566.04**	**Unsuitable for Drinking**

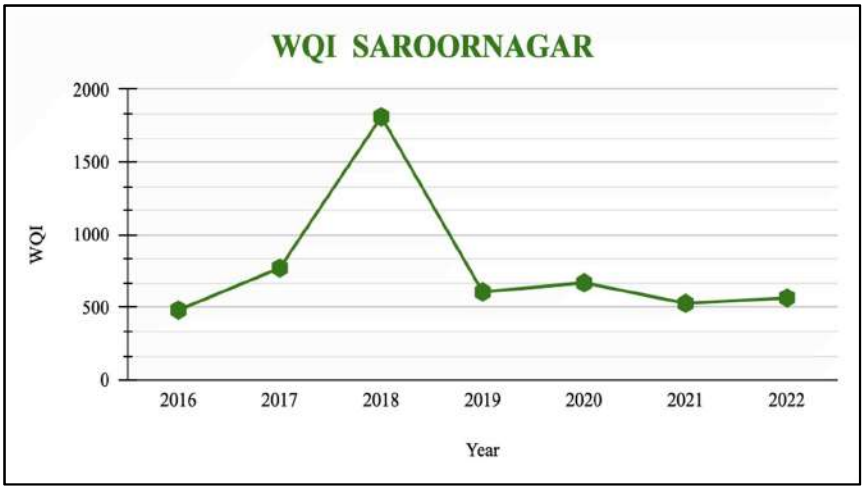

Figure.6: WQI - Saroornagar Lake

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Results:

The data obtained for Saroornagar Lake's Water Quality Index (WQI) parameters is displayed in the table below.

TABLE-3: Saroornagar Lake Water Quality

SAROORNAGAR LAKE WATER QUALITY											
Sl.No	**Parameters**	**Unit**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**Permissible Limit**	**Remarks**
1	**Temperature**	℃	-	26.67	28.85	27.12	28.27	31.92	28.83	10 - 20 °C	Exceeds the limit
2	**DO**	mg/l	1.13	1	0.06	0.09	0.93	0.38	0.65	18	Lesser than the limit
3	**pH**	mg/l	7.7	7.72	7.51	7.35	7.25	7.54	7.31	6.5 - 8.5	Exceeds the limit
4	**Conductivity**	µs/cm	1430.2	1409	1522.5	1512.9	1318.6	1349.9	1315.1	400	Exceeds the limit
5	**BOD**	mg/l	16.58	28.01	20.5	32.75	21.25	10.53	10.51	2.16	Less than the limit
6	**Nitrates**	mg/l	2.26	5.42	12.05	8.97	4.27	6.85	6.18	10	Less than the limit
7	**Total Coliforms**	mpn/ml	341.27	595.2	1803.6	430.83	554.75	415.83	455	0	Exceeds the limit
8	**Faecal Coliforms**	mpn/ml	62.55	72.1	144.64	42.5	26.75	31.42	27.21	0	Exceeds the limit
9	**COD**	mg/l	143.08	169.17	148.17	169.58	114.17	101.5	132.27	500	Less than the limit
10	**Chlorides**	mg/l	187.42	172.33	178.08	176.17	175.25	175	146.55	250	Less than the limit
11	**Sulphates**	mg/l	78.5	80.17	97.25	93.75	84.63	96.67	86.36	400	Less than the limit
12	**TDS**	mg/l	915.83	869.42	958.5	974.33	813.67	817.5	802.36	500	Less than the limit
13	**Sodium**	mg/l	132.75	131.5	43.3	143	160.96	151.67	118	200	Less than the limit
14	**Calcium**	mg/l	131.8	146.27	94.57	102.03	68.23	77.13	79.27	75	Less than the limit
15	**Alkalinity**	mg/l	337.58	687.42	368.25	405.5	301.58	289.58	316.45	200	Less than the limit
16	**Magnesium**	mg/l	49.47	63.01	42.24	44.87	33.59	31.02	32.23	30	Less than the limit
17	**Hardness**	mg/l	468.08	439.92	410.25	439.75	308.75	320.5	330.82	200	Less than the limit

Temperature: Saroornagar Lake, being an urban lake with a relatively smaller size compared to others, experiences rapid temperature changes due to its shallowness and high levels of human activity. The lake's temperature rises quickly during peak summer, which can stress fish populations. The frequent temperature fluctuations can impact fish health and behaviour, potentially leading to reduced growth rates and altered spawning patterns.

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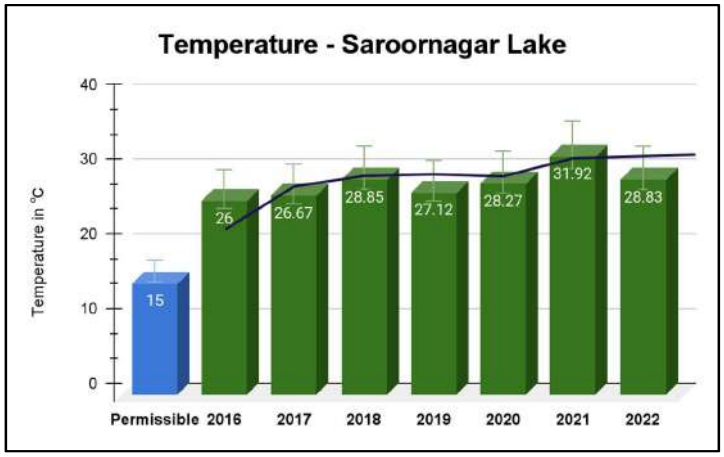

Figure 7: Temperature in Saroornagar Lake

Dissolved Oxygen (DO): In the previous seven years, dissolved oxygen levels ranged from 0.06 mg/l to 1.13 mg/l, falling short of the ideal requirement of 18 mg/l. It demonstrates that the oxygen supply needed by the water in Saroornagar Lake to sustain microbial activity and maintain an aerobic environment was inadequate, which caused the water to become eutrophic. The highest DO value was recorded in 2016.

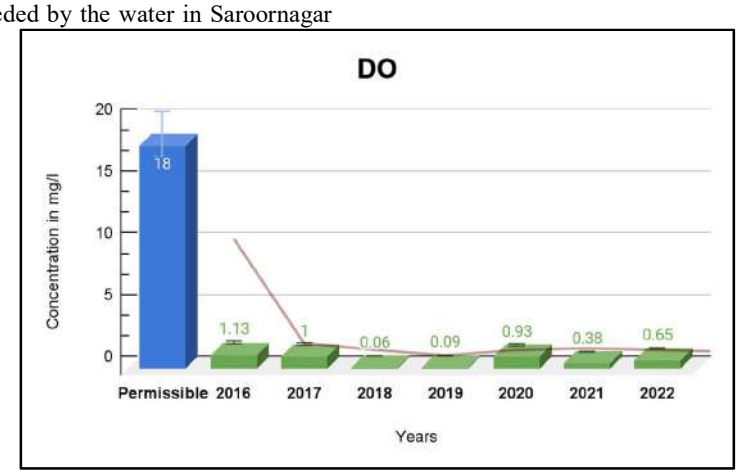

Figure 8: DO in Saroornagar Lake

pH: According to the study, pH values are greater than the permitted limit, which is shown in Table and Fig. Lake water turns alkaline when there is a larger quantity of bicarbonates present. The pH value has exceeded the allowable limit in the previous seven years.

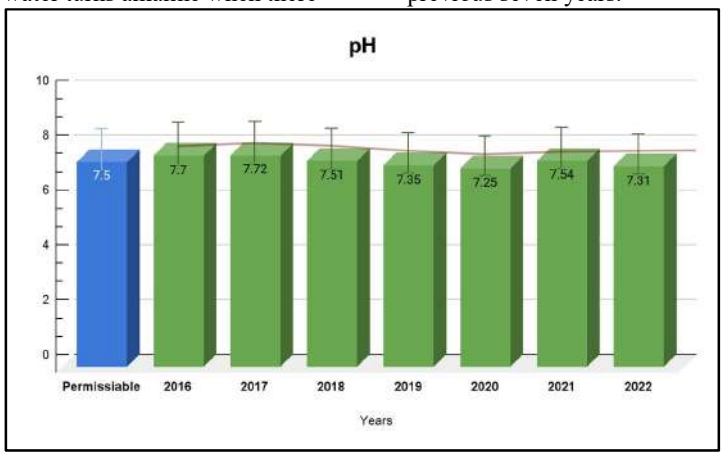

Figure 9: pH in Saroornagar Lake

Conductivity: A water body's conductivity may be used as a general indicator of water quality and as a means to understand the presence of pollutants in a water body. Each body of water

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typically has a range of conductivity that is rather stable, which is utilised as a reference point with frequent conductivity measurements. Substantial variations in water conductivity are a sign that pollution has entered the aquatic resource from a discharge or another source. The conductivity levels in Saroornagar Lake during seven years are unmistakably indicative of pollutants. The values go beyond the allowable limit.

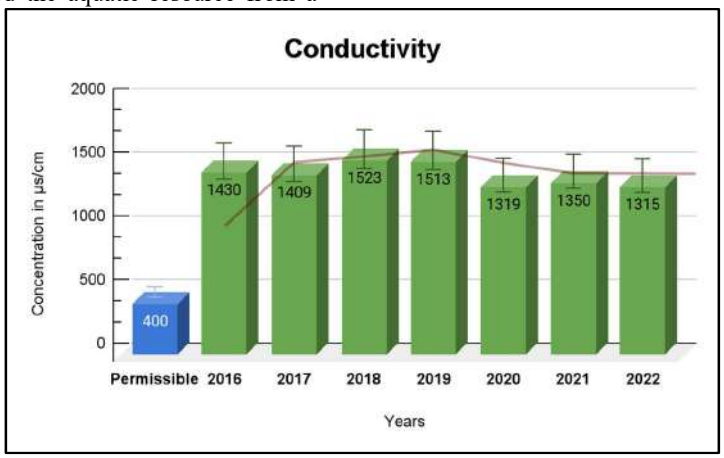

Figure 10: Conductivity in Saroornagar Lake

BOD: Dissolved oxygen and BOD are directly related; a higher BOD value is a proxy for lower DO and more biodegradable organic matter. The current study shows that the water is eutrophic. Compared to the DO, the BOD value is greater.

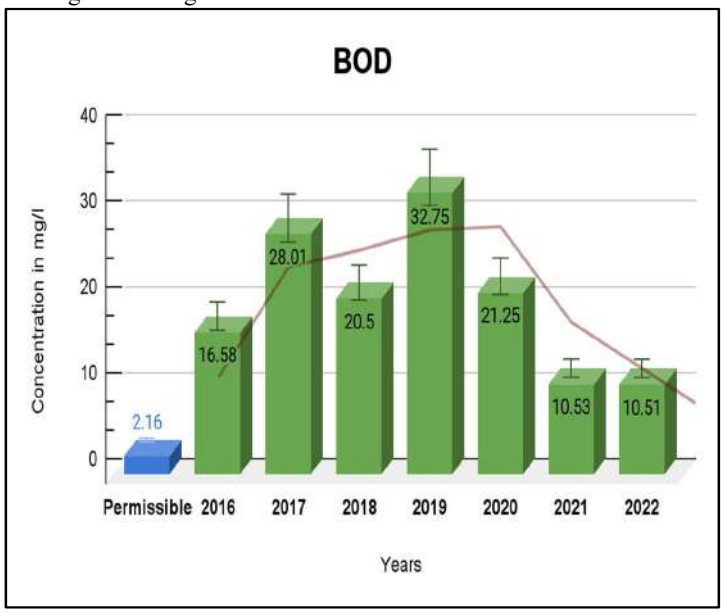

Figure 11: BOD in Saroornagar Lake

Nitrates: Nitrates are the most important nutrients for aquatic ecosystems and are necessary for the growth of aquatic plants and animals. Nitrate, the highly oxidised form of nitrogen molecules commonly found in natural water, is produced by the aerobic decomposition of organic nitrogenous compounds. It has been demonstrated that Saroornagar Lake has greater nitrate concentrations.

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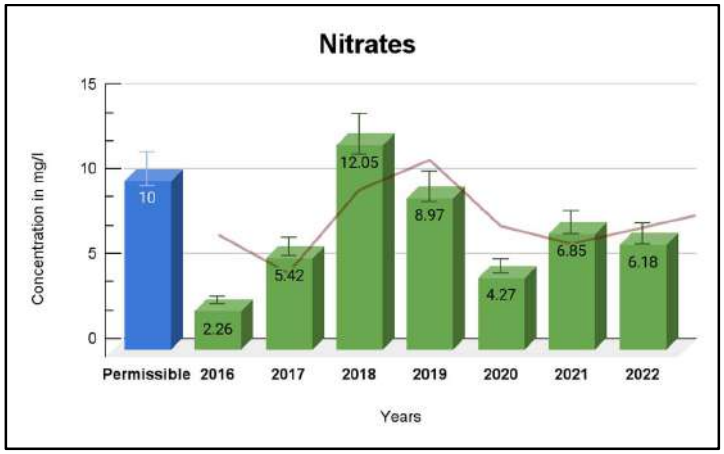

Figure 12: Nitrates in Saroornagar Lake

Total Coliforms: Total coliform bacteria is a sign of water system pollution. The sources include surface runoff from surrounding areas that contain animal faeces. Septic tanks that have collapsed are another significant factor. E. coli pollution of freshwater bodies is a severe issue. In 2018, there were the most coliform bacteria ever recorded.

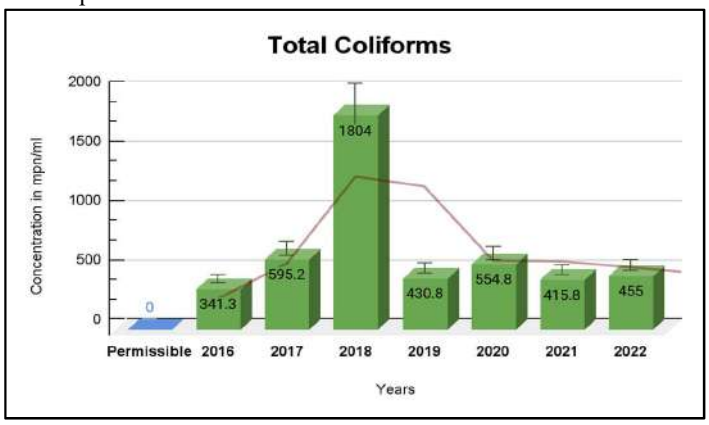

Figure 13: Total Coliforms in Saroornagar Lake

Faecal Coliforms: The bacteria known as faecal coliforms indicate that human or animal waste has contaminated water bodies in aquatic environments. This type of contamination may contain viruses and bacteria that cause illness. The fact that water has faecal contamination makes it evident that there are hazards associated with exposing it to the environment. Saroornagar Lake had the highest concentration of coliform bacteria in 2016 and 2018.

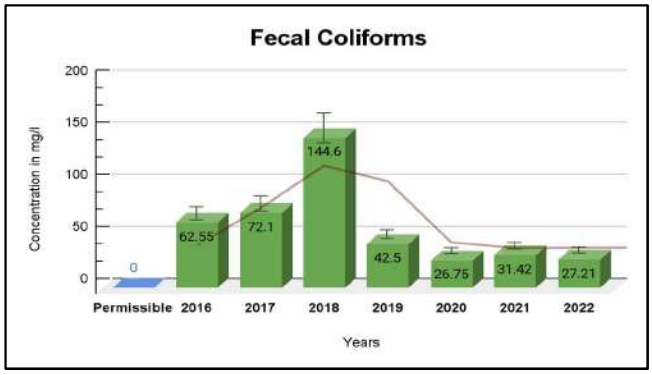

Figure 14: Faecal Coliforms in Saroornagar Lake

COD: As indicated by Table 6 and Fig. 14, the COD values, which varied from 101.5 mg/l to 169.6 mg/l, did not exceed the allowed limit of 500 mg/l. Both BOD and COD readings indicated that there had not been a considerable amount of non-biodegradable organic material contamination of the lake water. Water in a lake can therefore be easily treated by utilising a conventional biological treatment system.

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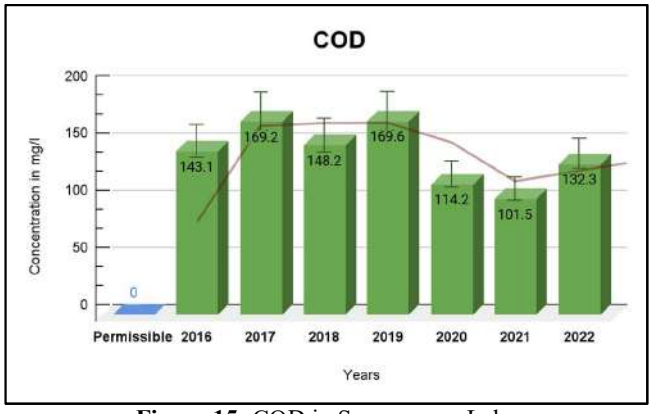

Figure 15: COD in Saroornagar Lake

Chlorides: In semi-arid conditions, fertiliser applications and/or leaching from top soil layers are to blame for the existence of chloride content in water. Chlorides, though minor in quantity, play a vital role in essential cellular processes in both plant and animal life. All of the examined samples were found to have chloride contents that ranged from 146.6 mg/l to 187.4 mg/l, above the allowed limit of 250 mg/l.

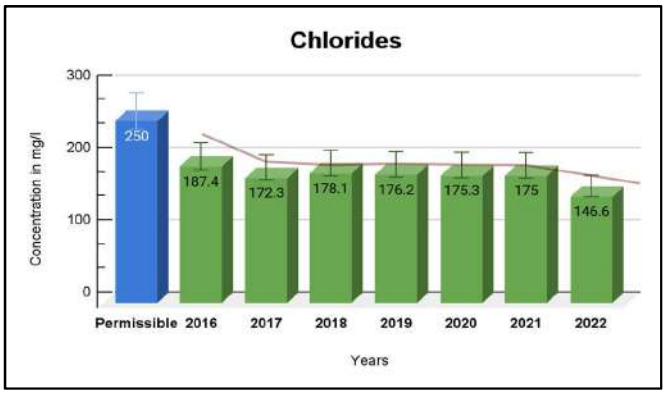

Figure 16: Chlorides in Saroornagar Lake

Sulphate: Bicarbonate predominates in hard water reservoirs, with sulphate coming in second. Sulphates are a result of industrial pollution or sewage that might be natural or manufactured. They often come about as a consequence of air deposition, water flowing over rock or soil that contains gypsum and other common minerals, or naturally occurring leaf breakdown that enters a stream. 2018 marks the peak sulphate level in Saroornagar Lake. Nonetheless, it is below the sulphate-allowed limit.

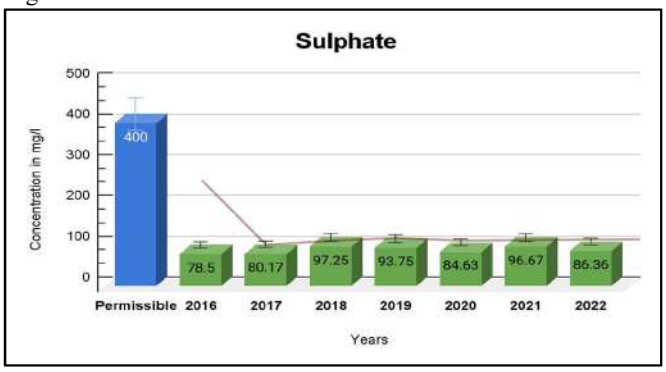

Figure 17: Sulphate in Saroornagar Lake

TDS: The phrase "total dissolved solids" (TDS) refers to the quantity of all inorganic substances that are dissolved in water. TDS is a broad measure of water quality or salinity. TDS levels were over the permitted limit throughout the investigation, ranging from 802.4 mg/l to 915.8 mg/l. Leaching of various contaminants into the surface water is the main cause of this. Elevated total dissolved solids (TDS) can decrease potability, cause gastrointestinal distress, and cause laxative effects in individuals.

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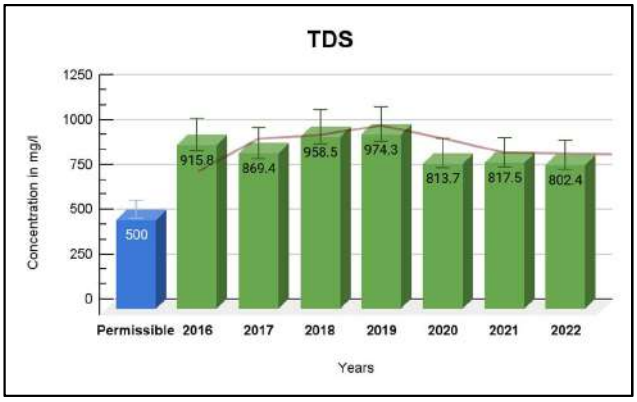

Figure 18: TDS in Saroornagar Lake

Sodium: Water naturally contains sodium-containing compounds. As was already said, soils and rocks both contain salt. In addition to containing considerable levels of salt, rivers and lakes may also do so. Nonetheless, depending on the geological context and wastewater pollution, concentrations are much lower. In addition to their numerous other industrial applications, salt compounds may wind up in industrial water sources. It falls short of the permitted upper limit

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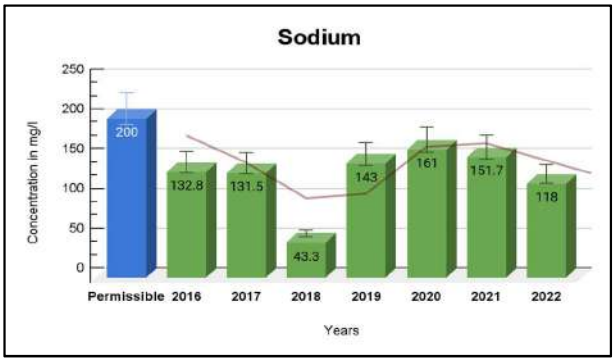

Figure 19: Sodium in Saroornagar Lake

Calcium: Since calcium is widely present in most rocks and is closely connected to hardness, it is frequently found in groundwater. According to Table 6 and Fig. 7 and 8, the calcium content has fluctuated, ranging from 68.23 mg/l to 146.3 mg/l over the past seven years, exceeding the permissible threshold of 75 mg/l.

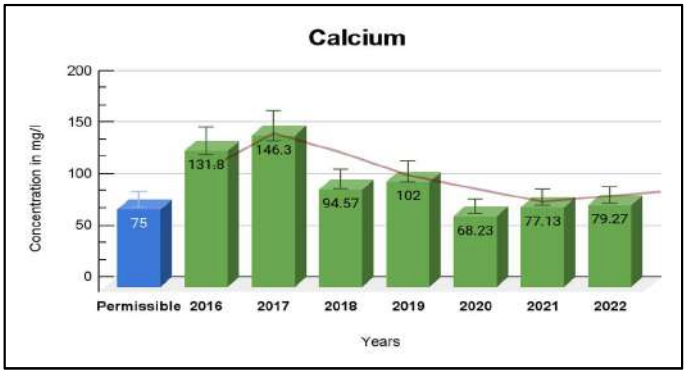

Figure 20: Calcium content in Saroornagar Lake

Alkalinity: Alkalinity is the amount of acid that may be added to a liquid without noticeably affecting its pH, according to the Water Quality Association. It is often referred to as the water's quantitative acid-neutralising capacity. In spite of the fact that alkaline water is defined as having a pH of 7 or higher, alkalinity and pH are occasionally used interchangeably. Alkalinity and pH are not the same things, even though water can have a high alkalinity level without being overly basic (pH > 7). Alkalinity and pH are related because higher alkalinity levels aid in preserving pH levels. The alkalinity concentration has fluctuated between 289.6 mg/l and 687.4 mg/l over the last seven years, exceeding the permitted limit.

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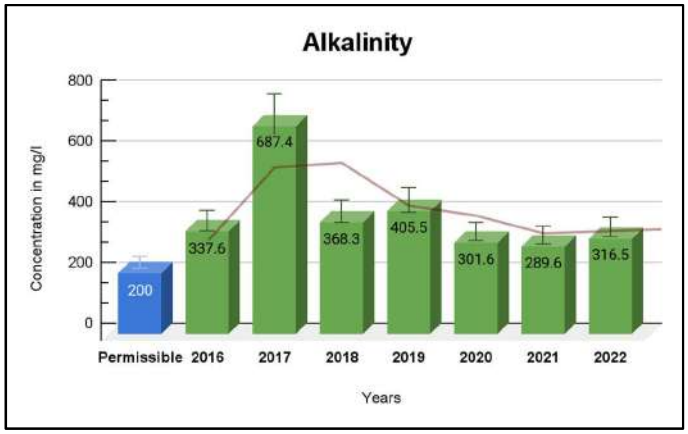

Figure 21: Alkalinity in Saroornagar Lake

Magnesium: Over the preceding seven years, magnesium contents were over the BIS-recommended limit of 30 mg/l, ranging from 31.02 mg/l to 63.01 mg/l. Because magnesium-rich minerals dissolve slowly, magnesium is frequently found in lower amounts than calcium.

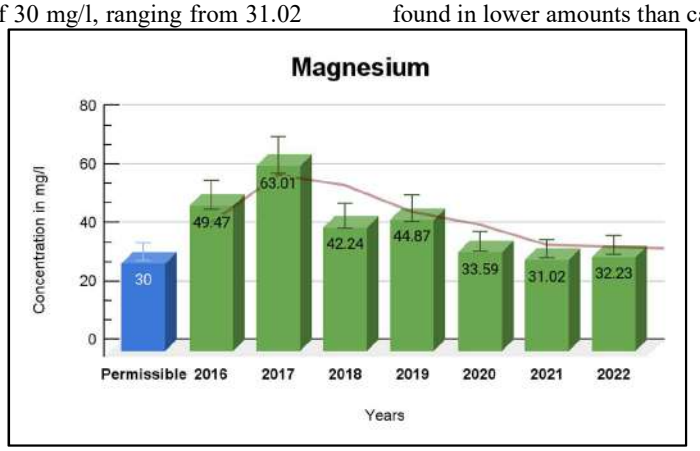

Figure 22: Magnesium in Saroornagar Lake

Hardness: When using water for domestic purposes, hardness is an important consideration. The two most important elements in determining the total hardness of groundwater are magnesium and calcium. Table and Fig. 17 demonstrate that the allowed limit of 200 mg/l was significantly higher than the overall hardness values, which ranged from 308.8 mg/l to 468.1 mg/l. Excessive hardness is detrimental for aquatic life to survive.

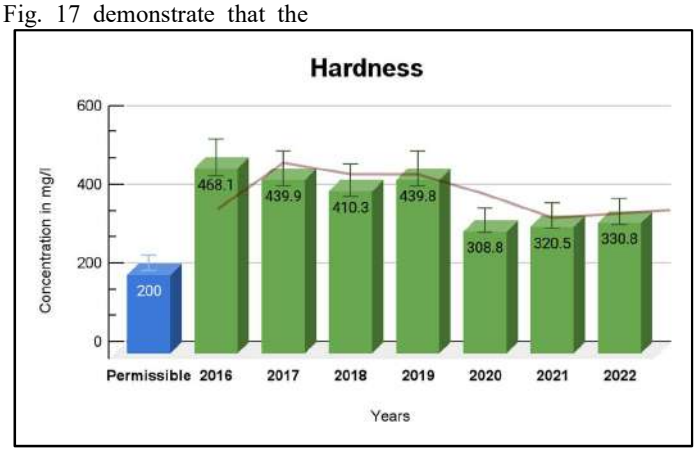

Figure 23: Hardness in Saroornagar Lake

Summary

Saroornagar Lake's detailed pollution status revealed the greater level of contamination. This resulted from washing clothing, cleaning cars, and discharging untreated home and industrial sewage. Many significant variables, including pH, conductivity, total dissolved solids, total hardness, calcium, magnesium, total coliforms, faecal coliforms, alkalinity, and nitrates, exceeded the allowable limit. Nonetheless, the concentrations of

DO, BOD, chlorides, sulphates, sodium, and COD are far below the allowable limit. The elevated levels of both BOD and COD suggest significant contamination of the lake water with organic biomaterials. The data above clearly demonstrate the eutrophic state of the lake water in Saroornagar, since it was unable to sustain an aerobic condition due to a lack of oxygen delivery. As detailed above, the WQI of Saroornagar Lake indicates that it is not appropriate for drinking.

Combined efforts of the public and government can be helpful to improve the water quality of Saroornagar Lake.Since One of the primary causes of poor water quality in Saroornagar Lake is water pollution, it is important to identify the sources of pollution and take steps to reduce or eliminate them. This includes implementing stricter regulations on industries and businesses that are located in surrounding areas of Saroornagar Lake and discharge pollutants into the lake, educating the public on of proper waste disposal is also very important .Several other management practices, such as reducing fertilizer use and properly disposing of hazardous waste, can help to reduce the amount of pollutants entering the lake and improve water quality.

Increasing the vegetation cover can also prove helpful as vegetation plays an important role in maintaining water quality by absorbing excess nutrients and pollutants. Increasing vegetation cover around the lake can help to reduce the amount of pollutants entering the lake and improve water quality. Along with these implementations of aeration systems can help to improve water quality by increasing the amount of dissolved oxygen in the water. This can help to reduce the growth of harmful algae thus reducing the chances of algal bloom and improving the overall health of the lake ecosystem.

Apart from that, regular monitoring of water quality is essential to identify any changes or trends in water quality over time. This can help to identify potential problems early on and corrective measures can be taken timely.

Overall, improving the water quality of Saroornagar Lake will require a multi-faceted approach that involves reducing pollution, increasing vegetation cover, implementing aeration systems, monitoring water quality, and implementing best management practices.

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