WATER QUALITY OF SOME POLLUTED LAKES IN GHMC AREA, HYDERABAD - INDIA

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Abstract: The present research work has been carried out in surface water in Greater Hyderabad Metropolitan City (GHMC), Telanga State, India during 2012-2013 to assess its quality for drinking and irrigation. Out of many lakes in GHMC, Saroornagar Lake, Miralam Tank, Hasmathpet Lake, Nallacheruvu, Safilguda Lake, Kapra Lake, Fox Sagar, Mallapur Tank, Pedda Cheruvu in Phirjadiguda, Noor Md. Kunta and Premajipet Tank are presented in this study. Results of the water quality shows alkaline character (pH: 6.4 to 7.6) with TDS varying fresh (878 to 950 mg/L) to brackish (1,056 to 3,984 mg/L). The Lakes show RSC negative (-1.3, to -4.1 and Premajipet Tank counts -28 me/L) indicates reduced risk of sodium accumulation due to offsetting levels of calcium and magnesium. The lakes represent Medium Hazard Class under Guidelines of Irrigation Hazard Water Quality Rating (Ir.HWQR) in respect of %Na, and Excellent (non hazard) in respect of SAR. Average EC are in the range 1463 – 2275, represent Medium except Noor Md. Kunta and Premajipet Tank, which represent High and Very High Hazard Class under Ir.HWQR with large negative RSC (-28). Premajipet Tank is Heavy Pollution receptor and Noor Md. Kunta follows it. The Lakes lie on Class E due to Low DO and High BOD as per CPCB Primary water quality criteria for "designated best uses" except Premajipet Tank and Noor Md. Kunta.

Index Terms— water quality of Saroornagar Lake, Miralam tank, Hasmathpet Lake, Nallacheruvu, Safilguda Lake, Kapra Lake, Fox Sagar, Mallapur Tank, Pedda Cheruvu, Phirjadiguda, Noor Md. Kunta and Premajipet Tank, Primary Water Quality Criteria for Designated Best Uses by CPCB (PWQC), Residual sodium carbonate (RSC), Sodium Absorption Ratio (SAR), Electric Conductance (EC), Percent Sodium (%Na).

1 INTRODUCTION

Many of the Lakes serving irrigation and drinking water needs in GHMC are in extensive stress due to population explosion. It is considered that the population growth [1] between 1998-1999 and 2012-2013 is around 100%. Many of the Lakes catchments were collapsed and became storage tanks of sewage and pollutants. A study [2] on Assessment of Water Quality Index of River Godavari at Rajahmundry classify the water quality is excellent and good. In India, the Central Pollution Control Board (CPCB), an apex body in the field of water quality management, has developed a concept of designated best use [3] rather than Water Quality Index (WQI) systems [4, 5, 6, 7, 8]. For each of these five "designated best uses", the CPCB has identified water quality requirements in terms of few chemical characteristics tabulated at Table 1 [9], known as primary water quality criteria (PWQC).

Industrial effluents tolerance limits [10] notified by CPCB for some parameters are as follows. TSS for Inland and On-land surface waters are 100 and 200 mg/L. COD for Inland surface water is 250 mg/L. The standards of the parameters are available at IS 10500 (2012) for drinking water standards of acceptance criteria [11] exceeded at all the Lakes parameters.

Carbonate and Bicarbonate [12] concentrations in irrigation waters are important in RSC relation to Ca^{2+} and Mg^{2+}. RSC is calculated by subtracting the water's calcium and magnesium from its carbonate and bicarbonate [RSC = (CO_3^{2-} meq/L + HCO_3^- meq/L) - (Ca^{2+} meq/L + Mg^{2+} meq/L)]. The precipitation of either calcium or magnesium from water as carbonate increases the relative proportion of sodium which directly raises the sodium hazard rating. This leads to excess soil salinity and impermeability resulting unsuitability of soil for supporting plants. A negative value indicates little risk of sodium accumulation due to offsetting levels of calcium and magnesium.

Table 1: Primary Water Quality Criteria by CPCB (PWQC)

Designated-Best-Use	Class of water	Parameters						
		pH	DO mg/L	BOD mg/L	Free NH3 as N	EC micro mhos/cm	SAR	Total Coliform MPN /100ml
Drinking water source without conventional treatment but after disinfection	A	6.5 – 8.5	≥ 6	≤ 2	-	-	-	≤ 50
Outdoor bathing (Organized)	B	6.5 – 8.5	≥ 5	≤ 3	-	-	-	≤ 500
Drinking water source after conventional treatment and Disinfection	C	6.0 – 9.0	≥ 4	≤ 3	-	-	-	≤ 5000
Propagation of Wild life and Fisheries	D	6.5 – 8.5	≥ 4	-	-	-	-	-
Irrigation, Industrial Cooling, Controlled Waste disposal	E	6.0 – 8.5	≥ 4	-	-	2250	26	-

Table 2 is the "Guidelines for Evaluation of Quality of Irriga-

tion Water" Hazardous Water Quality Rating (Ir.HWQR) based on EC, SAR, RSC and %Na Classifications in relation to hazardous effects as per IS 11624 (1986) [13]. The standards of each parameter referred as Std.1, Std.2 and Std.3 in incremental order of value in the upcoming trend figures.

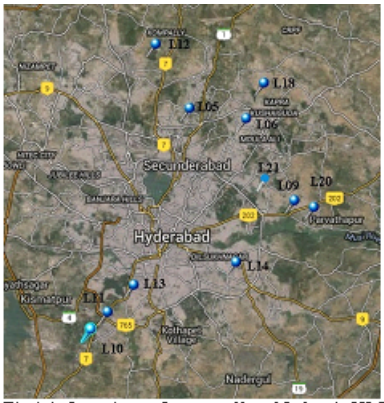
Table 2: Ir.HWQR based on Parameters in relation to hazardous effects

Ir.HWQR	Total Salt Concentration expressed as the EC	SAR	RSC	Percent Sodium
	Range (micromhos/cm)	Range (millimole/L)$^{1/2}$	Range (me/L)	%Na
Low	Below 1500	Below 10	Below 1.5	<20
Medium	1500-3000	10-18	1.5-3.0	20-40
High	3000-6000	18-26	3.0-6.0	40-60
Very high	Above 6000	Above 26	Above 6.0	60-80

2 Methodology:

Standard Methods and SOPs adopted for data generation and for checking correctness of the analysis [14, 15, 16] which include pH, EC, TDS and major anionic and cationic constituents lye with little deviations and in well below the stipulated ranges [17].

The Lakes shown at Fig.1.1 are taken to this study (around 300 records) on increasing order of average TDS and are Saroornagar Lake (L14), Miralam tank (L13), Hasmathpet Lake (L05), Nallacheruvu (L09), Safilguda Lake (L06), Kapra Lake (L18), Fox Sagar (L12), Mallapur Tank (L21), Pedda Cheruvu (L20), Noor Md. Kunta (L11) and Premajipet Tank (L10).



Lake	Latitude N	Longitude E
L05	17°28'22.5"	78°29'34.5"
L06	17°27'53.9"	78°32'18.6"
L09	17°24'6.8"	78°34'40.2"
L10	17°18'7.9"	78°24'44.0"
L11	17°18'55.5"	78°25'33.1"
L12	17°31'23.7"	78°27'54.0"
L13	17°20'10.4"	78°26'49.4"
L14	17°21'13.4"	78°31'47.9"
L18	17°29'34.7"	78°33'9.6"
L20	17°23'47.2"	78°35'36.1"
L21	17°25'45"	78°34'14"

Fig.1.1: Locations of some polluted Lakes in HMDA area with Lat-Long data.

3. Results and Discussions

The minimum, average and maximum trends of these Lakes for the parameters TDS, TSS, COD, Chloride, Sulphate, pH, DO, %Na and SAR during 2012 – 2013 are shown in Figs. 1.2 – 1.10. The Lakes are having Low DO, High BOD and show either Class D or E under PWQC (Table 1).

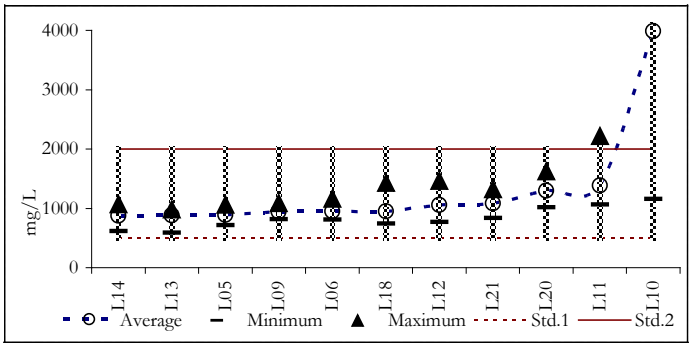


Fig.1.2: Trends of TDS in Lakes during 2012 – 2013

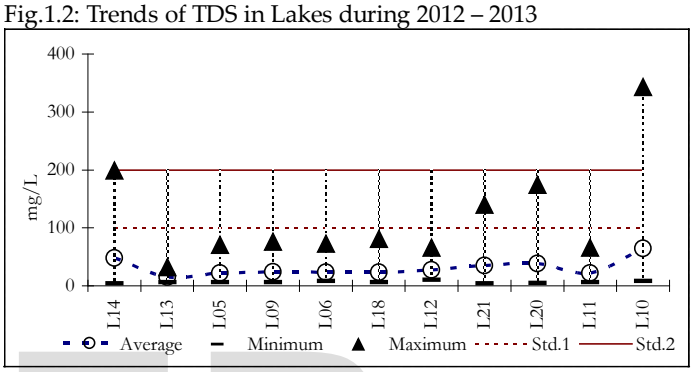


Fig.1.3: Trends of TSS in Lakes during 2012 – 2013

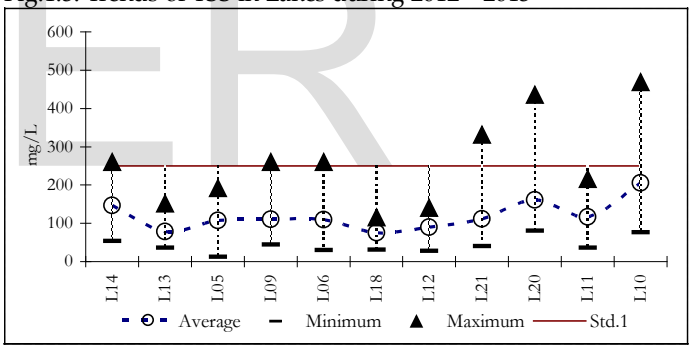


Fig.1.4: Trends of COD in Lakes during 2012 – 2013

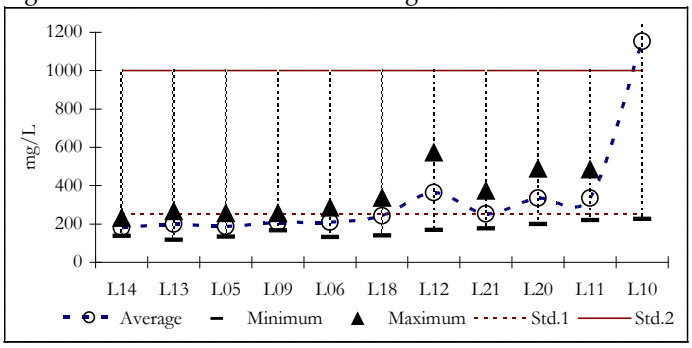


Fig.1.5: Trends of Chloride in Lakes during 2012 – 2013

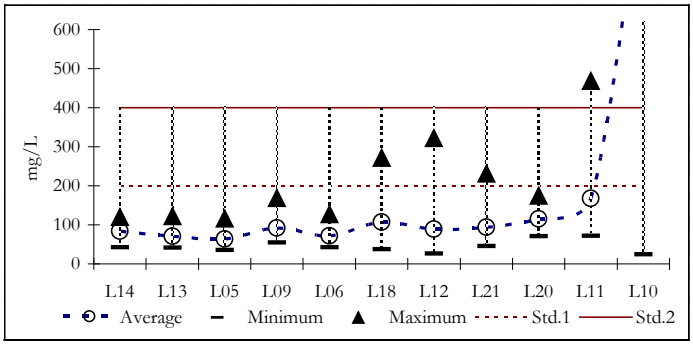


Fig.1.6: Trends of Sulphate in Lakes during 2012 – 2013

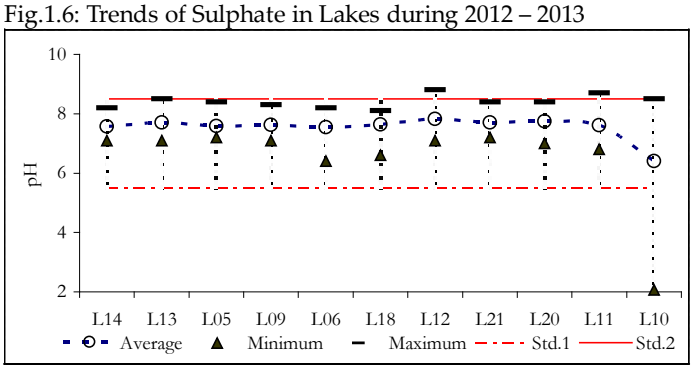


Fig.1.7: Trends of pH in Lakes during 2012 – 2013

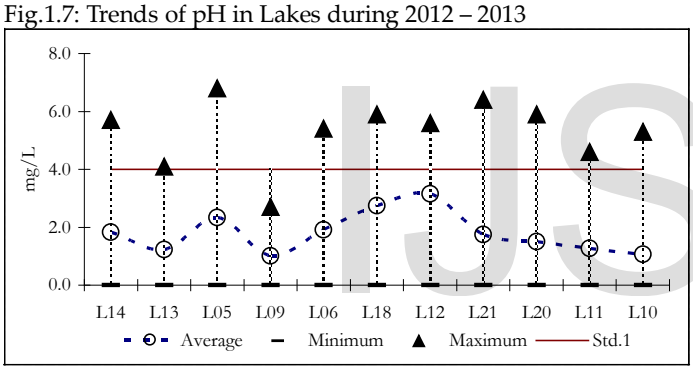


Fig.1.8: Trends of DO in Lakes during 2012 – 2013

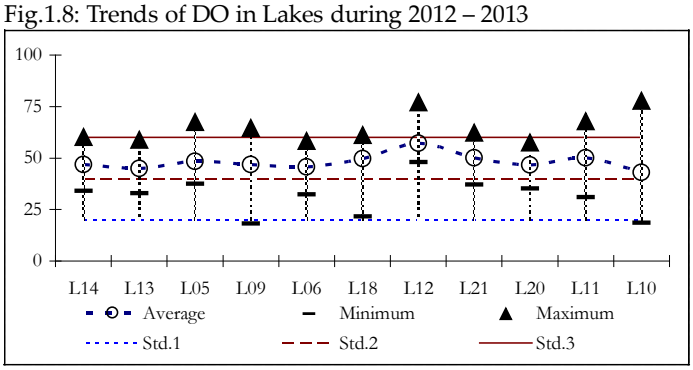


Fig.1.9: Trends of %Na in Lakes during 2012 – 2013

Average values at Lakes are 7.8± 0.2 pH (Fig.1.7) indicating slightly basic except L10. DO values shown in Fig.1.8 vary widely ranging from 0 – 6.8 mg/L and COD reflects the same ranging 78.5 - 205.6 mg/L (Fig.1.4) indicating difficulty in aquatic life and ecosystem of fresh water. The sampling was conducted on day time and hence algal activity supported the rise in DO. The lakes are arranged increasing order of their TDS and same trends are observed with Chloride, Sulphate, %Na and SAR as shown in Figs.1.2, 1.5, 1.6, 1.9 and 1.10.

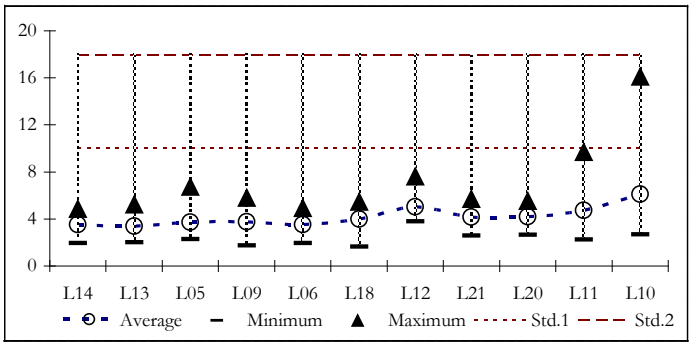


Fig.1.10: Trends of SAR in Lakes during 2012 – 2013

3.1. Saroornagar Lake (L14)

Averages of TDS, TSS, COD, Chloride and Sulphate at L14 are 878, 48, 147, 181, 84, respectively, ranging 617-1068, 4-199, 54-260, 137-232 and 42-120 mg/L. The pH ranging and average are 7.1-8.2 and 7.6. The DO reached zero frequently, fluctuating up to 4 during 2012 – 2013 and around 4 mg/L during 1998 – 1999. RSC is negative. %Na and SAR fluctuate 47±5 and 3.5±1.4, respectively, represent Medium and Excellent classes under Ir.HWQR. Sewage and treated Sewage from surrounded habitation joined Saroornagar [18] Lake (Fig.1.11) and is monitored during 1998 – 1999 and 2012 – 2013.

Fig.1.11: A photographic view of Saroornagar Lake (L14)

3.2. Hasmathpet Lake (L05)

This lake is monitored at three points namely Midstream (L05), Periphery (L05-1), Inlet drain from RTC Colony (L05-2) during 1998 – 1999 and L05 during 2012 – 2013. Fig.1.12 represents graphical view of TDS at L05, L05-1 and L05-2, and similar trends are observed for Chloride and Sulphate.

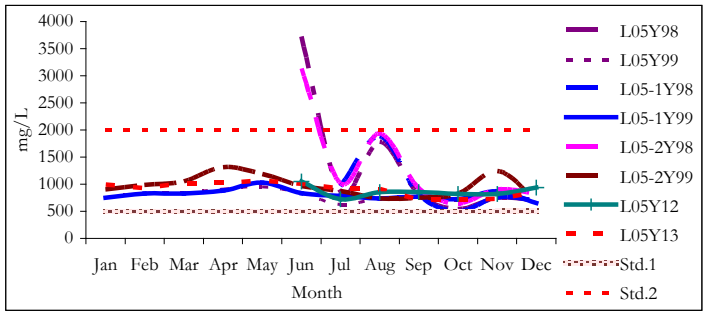


Fig.1.12: TDS of L05, L05-1 and L05-2 during 1998-1999 and 2012-2013.

Averages of TDS, TSS, COD, Chloride and Sulphate at L05 are 892, 22, 108, 187, 64, respectively, ranging 716-1063, 6-71, 12-192, 133-256 and 35-116 mg/L during 2012-2013. High TDS at Lake and drain from RTC Colony are 3720 and 3130, respectively, in June 1998 and 2000 in August 1998 (Fig.1.12). The same trend is observed for Chloride and Sulphate. The pH ranging and average are 7.2-8.4 and 7.6. The DO is zero at inlet drain and periphery from September to January in 1998 and 1999. Lake DO fluctuate 2.5-6.8, reaches zero in November and December in 2012, 2013. Averages of %Na and SAR are 48 and 3.7, respectively, ranging 37-68 and 2.3-6.7, represent Medium and Excellent classes under Ir.HWQR. The average COD at L05 (108 mg/L) represents the pollution load and RSC is negative. L05 (Fig.1.13) experienced pollution through sewage discharges from the surrounded habitation.

Fig.1.13: A photographic view of Hasmathpet Lake (L05)

3.3. Mir Alam Tank (L13)

Averages of TDS, TSS, COD, Chloride and Sulphate at L13 (Fig.1.14) are 886, 15, 78, 200, 71, respectively, ranging 586-980, 6-32, 36-153, 118-268 and 41-122. Averages of pH are 7.7±0.7. The DO reached zero frequently and raised 2.4 in March, April, and August - October. Averages of %Na and SAR are 45 and 3.4, respectively, ranging 33-59 and 2.0-5.2, respectively, represent Medium and Excellent classes under Ir.HWQR. Water quality is stable during 2012-2013 with moderate deviations and RSC is negative. Sewage and industrial waste joins the Lake.

Fig.1.14: A photographic view of Mir Alam Tank (L13).

3.4. Nalla Cheruvu (L09)

Averages of TDS, TSS, COD, Chloride and Sulphate at L09 (Fig.1.15) are 945, 24, 111, 208, 92, respectively, ranging 814-1088, 6-76, 44-260, 167-256 and 55-169 mg/L. The pH ranging and average are 7.1-8.3 and 7.6. The DO reached zero and fluctuate to 2.7. Averages of %Na and SAR are 47 and 3.7, respectively, ranging 18-65 and 1.8-5.8 represent Medium and Excellent classes under Ir.HWQR. Water quality is stable during 2012-2013 with moderate deviations and RSC is negative. Untreated sewage and effluents joins the Lake.

Fig.1.15: A photographic view of Nalla Cheruvu (L09).

3.5. Safilguda Lake (L06)

Averages of TDS, TSS, COD, Chloride and Sulphate at Fig.1.16 of Safilguda Lake (L06) are 947, 24, 109, 209, 72, respectively, ranging 807-1166, 8-73, 30-260, 131-285 and 42-127 mg/L. Average and ranging of pH are 7.6 and 6.4-8.2. The DO fluctuate 1-3 and reached zero in October and November 2013. Chloride

exceeds (around 320) in June and July 2012 and 2013, respectively. Sulphate touches the standard in June 2013 and exceeds (272) in December 2013. %Na and SAR fluctuate 46±14 and 2.9±1.0, respectively, represent Medium and Excellent classes under Ir.HWQR. It experienced sewage and cottage industrial waste and RSC is negative. Treated swage joins the Lake.

Fig.1.16: A photographic view of Safilguda Lake (L06).

3.6. Kapra Cheruvu (L18)

Averages of TDS, TSS, COD, Chloride and Sulphate at Fig.1.17 of L18 are 950, 24, 75, 242, 107, respectively, ranging 744-1430, 6-81, 31-116, 140-338 and 37-272 mg/L. Average and ranging of pH are 7.6 and 6.6-8.1. The DO fluctuate 1-6 and reached zero in April and December 2013. %Na and SAR fluctuate 41±19 and 3.4±1.8, respectively, represent Medium and Excellent classes under Ir.HWQR. It is experience sewage and cottage industrial waste.

Fig.1.17: A photographic view of Kapra Cheruvu (L18).

3.7. Fox Sagar (L12)

Averages of TDS, TSS, COD, Chloride and Sulphate at L21 are 1085, 35, 112, 252, 94, respectively, ranging 834-1322, 4-140, 40-331, 176-364 and 45-231 mg/L. Average and ranging of pH are 7.7 and 7.2-8.4. Average DO is 1.7 and reach zero in 2012 and December 2013. Sulphate exceeds 322 and 240, respectively, in March and October 2013. %Na and SAR fluctuate in 37-57 and 2.6-5.4, respectively, represent Medium and Excellent classes under Ir.HWQR. It experienced sewage and industrial waste. Fig.1.18 is a photographic view of Fox Sagar [19,20].

Fig.1.18: A photographic view of Fox Sagar, Jeedimetla (L12).

3.8. Mallapur Tank (L21)

Averages of TDS, TSS, COD, Chloride and Sulphate at L12 are 1056, 27, 89, 363, 89, respectively, ranging 770-1462, 10-66, 28-140, 168-573 and 26-322 mg/L. Average and ranging of pH are 7.8 and 7.1-8.8. The DO fluctuate 1.4-5.3 and reaches zero in June, October 2012 and April 2013. Sulphate exceeds 322 and 240, respectively, in March, October 2013. %Na and SAR fluctuate in 71-77 and 4-6.4, respectively, represent Medium and Excellent classes under Ir.HWQR. It experienced sewage and cottage industrial waste.

3.9. Pedda Cheruvu (L20)

Averages of TDS, TSS, COD, Chloride and Sulphate at L20 are 1295, 39, 161, 334, 116, respectively, ranging 1020-1628, 5-174, 81-436, 200-489 and 71-175 mg/L. Average and ranging of pH are 7.7 and 7.0-8.4. The DO reaches to zero and some time fluctuate to 5.9. COD exceeds standard in July (436) and October (400) 2013. All values of Chloride exceeds acceptable limit of CPCB. Sulphate value did not exceed the standards. %Na and SAR fluctuate in 35-58 and 2.7-5.5, respectively, represent Medium and Excellent classes under Ir.HWQR. It experienced sewage and industrial waste. Fig.1.19 is a photographic view of L20.

Fig.1.19: A photographic view of Pedda Cheruvu (L20).

3.10. Noor Mohammad Kunta (L11)

Averages of TDS, TSS, COD, Chloride and Sulphate at L11 are 1385, 22, 117, 335, 167, respectively, ranging 1064-2224, 6-66, 36-216, 220-484 and 72-468 mg/L. Average and ranging of pH are 7.6 and 6.8-8.7. The DO reach zero many times and fluctuate to 4.6. Sulphate exceeds (400 permissible and 200 desirable limits) 469, 282 and 254, respectively, in February, July 2013 and June 2012. %Na and SAR fluctuate to 31-68 and 2.2-9.7, respectively, represent Medium and Excellent classes under Ir.HWQR. It experienced industrial effluent dumps and surrounding industrial wastes. Fig.1.19 is a photographic view of L11.

Fig.1.20: A photographic view of Noor Mohammad Kunta (L11).

3.11. Premajipet Tank (L10)

Fig.1.21 is a photographic view of L10 covered with cottage electroplating and oil refining unit and hillock on other side. Figs.1.22 – 1.25 are representing graphical view of the parameters TDS, Chloride, Sulphate, pH, and SAR, respectively, during 2012 – 2013.

Fig.1.21: A photographic view of the Premajipet Tank (L10).

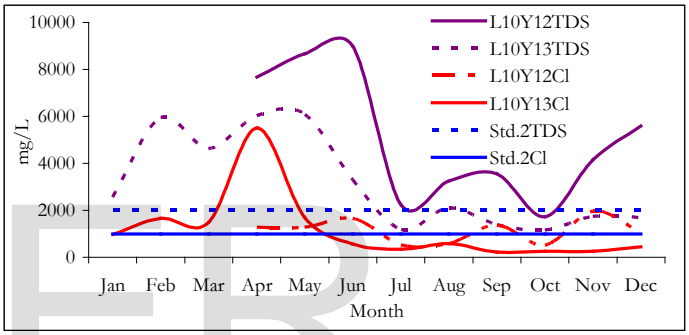


Fig.1.22: TDS and Chloride of L10 during 2012 – 2013

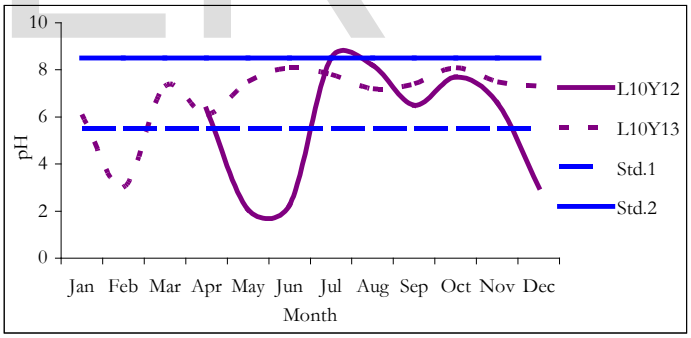


Fig.1.23: pH of L10 during 2012 – 2013

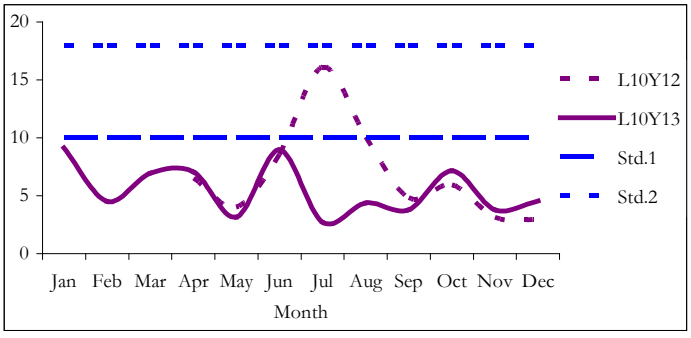


Fig.1.24: SAR of L10 during 2012 – 2013.

Averages of TDS, TSS, COD, Chloride and Sulphate at L10 are 3984, 65, 206, 1152, 979, respectively, ranging 1154-8992, 8-343,

76-469, 226-5503 and 24-3085 mg/L. Average and ranging of pH are 6.4 and 2.1-8.5. The DO is zero most time and in July to November 2013, it raised 1.9 and more. COD exceeds standard in November 2012 and February 2013. Chloride (Fig.1.22) exceeds acceptable limit in January to May 2013 and in permissible limit in July - September 2012. Sulphate exceeded the standards except Rainy seasons (July – November). TDS exceeds the standard in 2012 and 2013 except rainy seasons in 2013 (July – December). Averages of %Na and SAR are 43, 6.1, respectively, ranging 19-78 and 2.7-16, represent Medium and Excellent classes under Ir.HWQR except Medium of SAR in July 2012 (Fig.1.24). The trends reflected wide deviations in parameters, indicate heavy pollution of lake and the frequent dumping of highly acidic, basic and organic effluents. The extremely negative (-28) RSC and low pH (2.3pH) wide ranging to 8.5pH (Fig.1.23) indicate extreme acetic and basic effluent dumps.

4. Conclusions and suggestions

The analysis data of the 1st set in the periods 1998 – 1999 is deep study for taking immediate control measures in implementation of controlling pollution. While the 2nd set during later periods 2012 – 2013 covers many areas of the city with gaining national importance and a vigil on water bodies against pollution. On observation of results in periods 1998 – 1999 and 2012 – 2013, the influence of insignificant ions' such as heavy metals, fluoride, phosphate and some other ions contribution is within the acceptable limits of data variations [21] and are omitted for discussion.

The RSC of all the water bodies are negative and shown in Fig.1.25 indicates little risk of sodium accumulation due to offsetting levels of calcium and magnesium. There is no hazardous toxicity [22] in respect of RSC [23] in interpreting irrigation water in this location. However, some lakes such as L10 and L20 show extreme deviations -28 and -4.1, respectively, these are identified as effluent dumping receivers. These lakes indicate efficiency in reducing RSC toxicity to some extent.

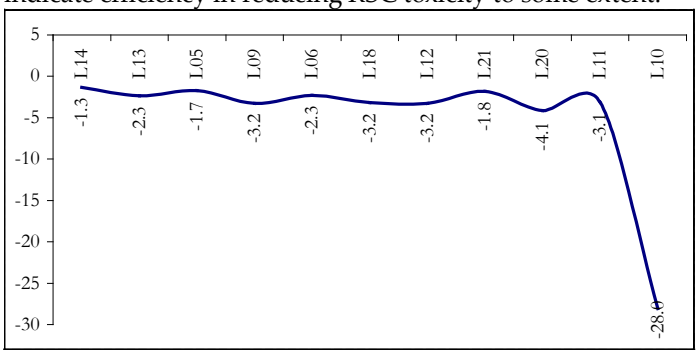


Fig.1.25: Trends of RSC in Lakes during 2012 – 2013

Most of the lake catchments are urbanized with human colonies and the sewage generated is joining the lake. The only alternative to charge the lakes is establishment treatment facility. Hence, every lake inlet should be through STPs in addition to preliminary treatment of rain water for removal of silt, Suspended Solids and plastic waste. The boundaries of each lake are encroachments and some are disappearing. Lake Boundaries should be reestablished to possible extent with clearing encroachments for retaining the capacity of lake and should be preserved for recreation / park for the public to feel the nature [24] and charging the ground water table with good quality water. In the lake bed, it is desirable to design elements such as fountains to enhance aeration of water for aquatic life which facilitates removal of organic matter. Regular removal of algae and floating plants such as water hyacinth is to be adopted. The Lakes are facilitating growth of flowering fresh water plants such as Kaluva (lotus family plant) for esthetic view.

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