



RESEARCH ARTICLE

ASSESSMENT OF GROUNDWATER QUALITY IN AND AROUND KOLLERU LAKE, ANDHRA PRADESH, INDIA

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ARTICLE INFO

Article History:

Received 24<sup>th</sup> March, 2013  
Received in revised form  
19<sup>th</sup> April, 2013  
Accepted 04<sup>th</sup> May, 2013  
Published online 15<sup>th</sup> June, 2013

Key words:

Kolleru Lake, Groundwater quality,  
Physiochemical parameters,  
WHO and CPHEEO.

ABSTRACT

Various samples of groundwater were collected from different areas in and around Kolleru Lake and analyzed for their physicochemical characteristics. The results of this analysis were compared with the water quality standards of WHO and CPHEEO. In this analysis the various physicochemical parameters such as P<sup>H</sup>, total dissolved solids, Ca, Mg, Na, NO<sub>3</sub>, K, Cl, SO<sub>4</sub> and HCO<sub>3</sub> etc., determined using standard procedures. The quality of groundwater samples were discussed with respect to these parameters and thus an attempt were made to ascertain the quality of groundwater used for drinking and domestic purposes in the sampling areas.

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INTRODUCTION

Water is essential for existence of life on the planet. It mentioned in the Vedas that water is one of the five components of the human body. It has played an important role in the development of ancient civilizations. Human civilization developed near the rivers or source of water. It is also known that some of the ancient civilizations perished due to unexpected droughts representing climate variability (Brown, 2009). According to the Moshe (interviewee) the main reason for deterioration of water quality is industrial effluents entering the lake. A huge amount of untreated waste by products and toxic chemicals enters the lake from the industries, which are located on the banks of inflowing drains, like tanneries, pulp and paper mills, distilleries, dairy industries, chemical and sugar factories. Additionally, the Lake Kolleru receives domestic waste from nearby towns Vijayawada, Eluru, Gudivada as well as from island and shoreline villages of the lake. The agricultural and aquaculture practices in the catchment area are responsible for release of nutrients like potassium, phosphates and pollutants like pesticides and fungicide residues, which leads to eutrophication and in turn weed infestation in the lake. But farmers are unaware of the fact that the pesticides and fertilizers, which are used for their crop protection deteriorates the water quality of the lake and in long run their health is at risk. All these pollutants reach the lake through 15 inflowing drains deteriorating the quality of the lake waters (Rao and Sekhar, 2003; Rao and Rao 2000). In the most part of our country ground water is a major source of drinking water. Groundwater in several parts of India is affected by arsenic and Fluoride pollution due to the geo-genic contamination and anthropogenic pollutions (CGWB, 2010). A regional ground-water quality survey from 28 wells in the Coventry area of the United Kingdom identified widespread ground-water pollution, chlorinated hydrocarbon solvents (CHS<sub>s</sub>) were detected at concentrations exceeding 1 microgram per liter (µg/l) in all industrial and public supply wells within the urban area

(Nazari *et al.*, 1993). National Geophysical Research Institute (CSIR), Hyderabad has been doing studies related to assessment and management of water contamination (NGRI, 2005). The various physical, chemical and biological parameters determined for the water samples and the water quality of the various areas around Punam clearly indicates that the water samples are highly polluted (Raja and Venkatesan, 2010). An important source of pollution of the ground water with nitrates is the excessive use of nitrate infiltrate into the soil and concentrate in the groundwater, in the water, the nitrate undergoes chemical and biological processes and nitrite and ammonium are formed (Cornelia Muntean *et al.*, 2006). Naturally, groundwater contains mineral ions; these ions slowly dissolve from soil particles, sediments, and rocks as the water travels along mineral surfaces in the pores or fractures of the unstatured zone and the aquifer (Thomas Harter, 2003). Temporal changes in ground water quality in an industrial area of Andhra Pradesh have been studied by (Srinivasa Rao, *et al.*, 2007).

Study Area

The study area is located in between 16°17'00" and 16°59'00" N latitudes and 80°50'00" and 81°39'00" E longitudes, covering in and around Kolleru lake region (Fig. 1). Water source to this lake is from its tributaries – Budameru, Tammileru and Ramileru, originating from the Eastern Ghats.

METHODOLOGY

For the present study, about 50 water samples were collected from open wells from selected locations in and around Kolleru Lake (Fig.2). Various water samples were collected in clean and dry polyethylene bottles from open wells after running those 3 minutes. All the collection samples are immediately preserved in dark boxes and processed for the different analysis within 10 hours after location. In this present study, various physical and chemical parameters of

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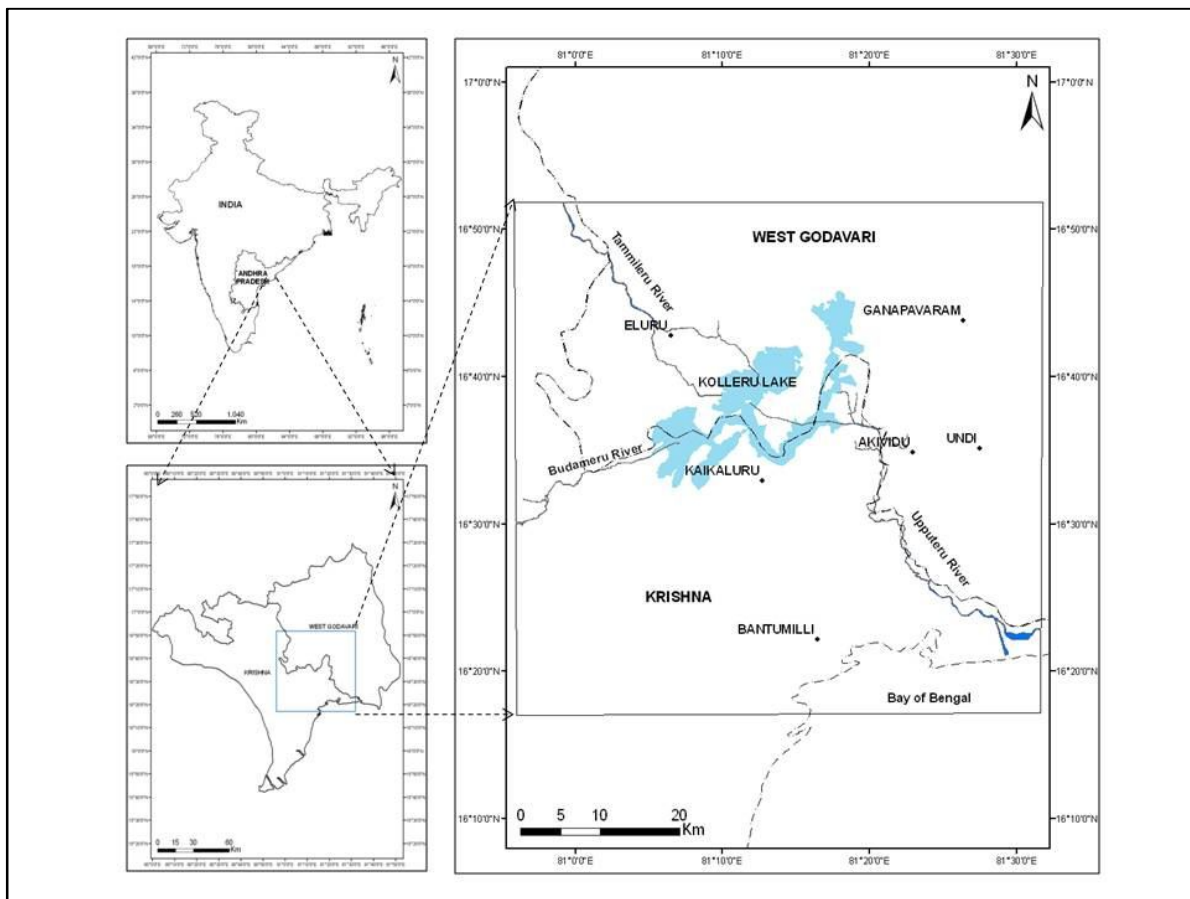


Fig.1. Location map of the study area

water samples were determined and the results were compared with the values of various water quality standards such as World Health Organization (WHO) and Central Public Health and Environmental Engineering Organisation (CPHEEO). The parameters analyzed were pH, total dissolved solids, calcium, magnesium, chlorides, sodium, nitrate, potassium, sulphate and hydro carbonate. Standard methods were used for the determination of the chemistry of the water samples. All the chemical constituents are expressed in mg/L (milligrams/liter) except pH.

## RESULTS AND DISCUSSION

The rapid expansion of groundwater irrigated areas has eventually contributed in increased crop production. However, our population is increasing day by day, which will require more water for agriculture and domestic usage. This will additionally stress the ground water resources because life may inhabit the regions where recharge of ground water is less due to less precipitation, and potential of ground water development is inadequate (Bates et al., IPCC 2008). The various physical and chemical parameters determined for the water samples were given in Table 1. The statistical evaluation was given in Table 2. From the analyzed results it was found that the quality of water considerably varies from location to location. The pH of groundwater in the study area is varying between 7 and 8. The limit of pH for drinking water is specified as 6.5 – 8.5 & 6.5-9.2 (WHO & CPHEEO). pH values of the samples are within the desirable limits. Groundwater pH is fundamental property that describes the acidity and alkalinity of groundwater. Though it has no direct effect on human health, all bio-chemical reactions are sensitive to variations of pH. Concentration of total dissolved solids is an important parameter to assess quality of water. From the analysis TDS values are varying from 1000 mg/L to 5560 mg/L with an average value of 1843.8 mg/L. The desirable limit of TDS in drinking water is 500 mg/L. Rambabu

and Somashekar rao, 1996 have expressed that the dissolution of soil particles containing minerals under slightly alkaline conditions favors in increasing the TDS concentration in groundwater. TDS values above 1500 mg/L cause gastrointestinal irritation according to Bhavani Sankar and Muthu Krishnan, 1994. In the present study, Very high concentration of 5560 mg/L, 5490 mg/L, 4800 mg/L and 4090 mg/L were observed at Kanukollu (W24), Matlam (49), Timmarao Gudem (W13), and Punukollu (W4) locations which are nearby industries, People who depend on these well waters are at high risk of getting sick from polluted water. Calcium concentrations of the groundwater are ranged between 16 mg/L and 348 mg/L with an average value of 58.66 mg/L (Table 2). The limit of calcium for drinking water is specified as 75 mg/L. It was observed that 95% of the groundwater in the study area not exceeded the permissible limit and high concentration of calcium of 348 mg/L was observed at Parasannapalem (W27) followed by Chintalapudi (W26) with 188 mg/L. Magnesium concentrations are varying from 6 mg/L to 523 mg/L with an average value of 119.76 mg/L in the study area. Very high concentration of 523 mg/L were observed at Parasannapalem (W27) followed by Pedalanka (W33) 483 mg/L, Adavikolanu (W19) 387 mg/L and Chintalapudi (W26) 381 mg/L. The limit of Magnesium concentration for drinking water is specified as 50 mg/L. Magnesium content in water does not have any health hazard. But it contributes to hardness in water. Chloride concentrations are varying from 70 mg/L to 3290 mg/L with an average value of 738.4 mg/L. The limit of chloride concentration for drinking water is 250 mg/L. High value of 3290 mg/L was noticed at Pedalanka (W33), followed by Chavalipudi (21) 3270 mg/L and Chintalapudi (W26) 3030 mg/L. The sulphate concentration was observed to be higher at Chintalapudi (W26) and Kondangi (W32) compared with the values of other locations. The concentrations are varying from 15 to 680 mg/L with an average value of 137.32 mg/L and the permissible limit for  $\text{SO}_4$  concentration is 200 mg/L. Very low concentrations were observed at

Table 1. Physico-Chemical characteristics of groundwater samples in and around Kolleru Lake

WELL No	Name of Locations	p <sup>H</sup>	TDS	Ca	Mg	Na	No <sub>3</sub>	K	Cl	S04	HCO <sub>3</sub>
W1	Pinakadimi	8	385	40	34	80	1	1	100	45	320
W2	Koppaka	7	970	16	51	120	2	2	150	65	338
W3	Bogapuram	7	980	16	64	240	2	1	280	65	492
W4	Punukallu	8	409	42	32	31	1	0	70	50	212
W5	Pedapadu	8	960	32	48	171	11	2	200	85	348
W6	Kottamupparru	7	1450	56	119	184	1	1	240	150	744
W7	Satyavolu	7	2430	67	24	621	2	2	720	150	388
W8	Polukonda	7	3970	40	199	700	2	2	1270	110	768
W9	Tamirisa	7	1430	64	78	240	4	0	280	25	810
W10	Vasanta Vada	7	1640	32	83	390	2	2	460	110	588
W11	Sriparru	7	2870	24	97	670	2	3	830	220	708
W12	Gudivani Lanka	7	2320	37	92	421	3	2	580	55	732
W13	Timmarao Gudem	8	480	24	39	58	2	2	90	37	184
W14	Malka Puram	7	910	39	102	135	3	0	300	82	384
W15	Paturu	8	700	40	35	130	0	0	90	64	452
W16	M.M.Puram	7	810	68	54	142	12	0	130	85	552
W17	Peda Nindra Kolanu	7	910	32	68	140	10	1	160	95	418
W18	Rayachuru	8	2	42	54	471	13	0	420	150	666
W19	Adavi Kolanu	7	8	82	387	1701	2	4	2860	155	1756
W20	Kaikaram	8	1	76	49	240	4	2	260	64	538
W21	Chavalipadu	7	7	98	267	1704	1	4	3270	135	852
W22	Penumaka lanka	7	1	44	61	212	12	2	260	124	324
W23	Unikili	8	1	19	22	189	1	1	160	84	234
W24	Kanukollu	7	556	18	36	141	1	0	170	27	288
W25	Chiguru kota	8	3	57	138	720	8	3	1180	220	566
W26	Chintalapudi	7	8	188	381	1790	4	3	3030	680	1768
W27	Parasannapalem	7	7	348	523	1054	12	5	2800	225	1287
W28	Kochcharla	8	2	85	64	470	5	1	530	260	732
W29	Narayana Puram	7	3	84	173	700	8	2	1060	210	876
W30	Ramavarapu Modi	7	1	42	86	238	2	1	260	65	686
W31	Pandragi	8	5	84	270	1080	5	2	1480	420	1052
W32	Kondangi	7	4	128	283	743	5	3	1200	650	1064
W33	Pedalanka	8	8	45	483	1725	14	3	3290	265	516
W34	Munipetu	8	3	67	186	724	12	3	1140	250	524
W35	Seetanapalli	8	1	24	58	208	3	1	340	20	320
W36	Pallevada	7	1	48	123	247	3	0	280	20	840
W37	kolleti Kota	8	5	24	156	1264	9	7	1890	250	1092
W38	Nandamillipadu	7	1	48	127	221	5	1	250	104	744
W39	Gummuluru	8	3	46	146	671	2	3	900	140	1200
W40	Pamulaparru	8	411	36	6	99	2	0	110	40	142
W41	Kalamarru	7	1	80	69	198	3	1	290	85	421
W42	Laxmi narasimha puram	8	1	72	29	268	2	2	320	110	336
W43	Mandapadu	7	1	32	100	158	4	1	245	55	480
W44	Peda Amiram	8	5	120	255	1242	17	6	1880	280	920
W45	Seesali	8	377	39	20	74	2	1	110	15	180
W46	Doddanapudi	8	1	40	44	299	12	2	320	105	358
W47	Gutlapadu	8	1	22	64	123	7	1	185	63	272
W48	Pada Tadika	8	372	34	30	54	2	1	70	15	276
W49	Matlam	7	549	53	44	74	2	0	90	26	360
W50	Urlagunda tuppa	8	1	39	35	294	3	0	320	61	485

Note: p<sup>H</sup>, TDS- Total Dissolved solids, Ca- Calcium, Mg- Magnesium, Na- Sodium, No<sub>3</sub>- Nitrate, K- Potassium, Cl- Chloride, S04-Sulphate and HCO<sub>3</sub>-bicarbonate

Table 2. The minimum, maximum, average concentration and standard deviation of chemical parameters with water quality standard

Chemical Parameters	Observed Concentration				Water Quality Standard	
	Min.	Max.	Mean	Std. Dev.	WHO	CPHEEO
p <sup>H</sup>	7	8	7.48	0.50	6.5-8.5	6.5-9.2
TDS	1000	5560	1843.8	1297.78	500	500
Calcium	16	348	58.66	52.67	75	200
Magnesium	6	523	119.76	119.80	50	150
Sodium	31	1790	477.38	487.14	100	100
Potassium	0	7	1.74	1.5	10	10
Chloride	70	3290	738.4	904.87	250	1000
Sulphate	15	680	137.32	138.79	200	400
Nitrate	0	17	4.94	4.32	45	45
HCO <sub>3</sub>	142	1768	611.86	367.05	--	--

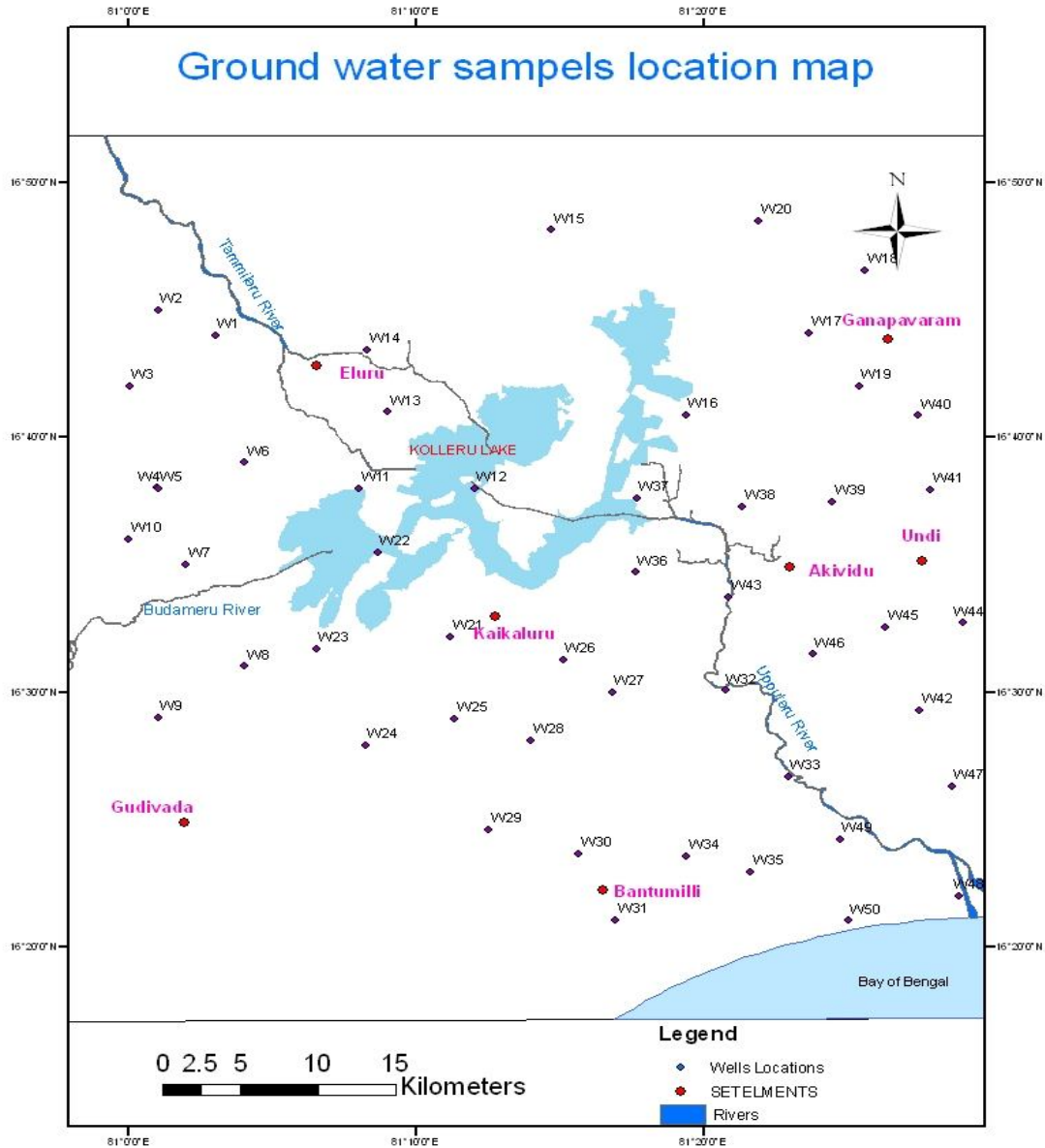


Fig.2. Ground-water locations of the study area

Seesali (W45) 15 mg/L and Pada Tadika (W48) 15 mg/L. Sodium concentration are varying from 31mg/L to 1790 mg/L with an average value of 477.38 mg/L. The limit of sodium concentration for drinking water is 100 mg/L. High value of 1790 mg/L was observed at Chintalapudi (W26) followed by Chavalipadu (21) 1704 mg/L and Adavikolanu 1701 mg/L. Very low concentration were observed at Punukallu (W4) 31 mg/L and Timmarao gudem (W13) 58 mg/L. Potassium concentration are varying from 0 to 7 mg/L with an average value of 1.78 mg/L. The limit of potassium concentration for drinking water is 10 mg/L. It was observed that 100% of the samples below the permissible limit and high concentration of potassium of 7 mg/L was observed at Kolletikota(W37). Nitrate concentration is varying from 0 to 17 mg/L with an average value of 4.94 mg/L. It was observed that all the collected samples nitrate concentration below the permissible limit according to WHO and CPHEEO 45mg/L. High nitrate concentration is found at Pedaamiram (W44) 17mg/L and Pedalanka (W33) 14mg/L, also low nitrate concentration 0mg/L were observed at Paturu (W15)

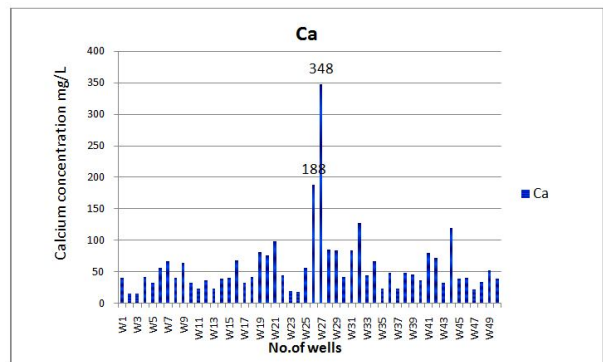


Fig.3. The Concentrations of calcium ions in water samples

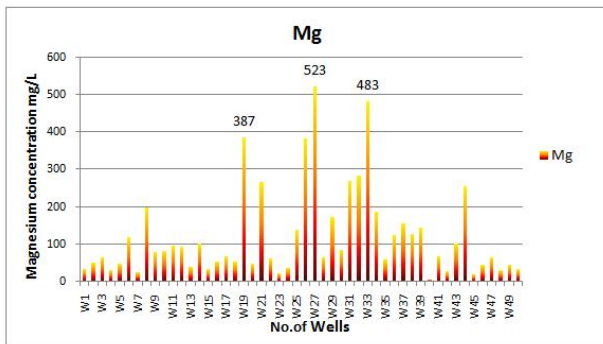


Fig.4. The Concentrations of magnesium ions in water samples

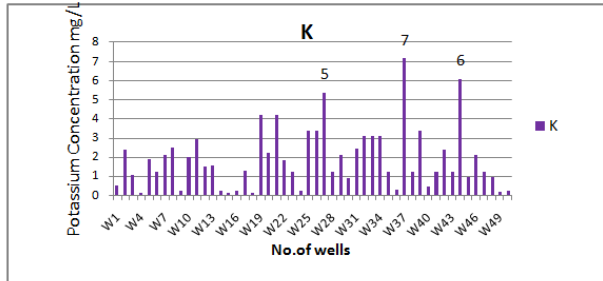


Fig.5. The Concentrations of Potassium ions in water samples

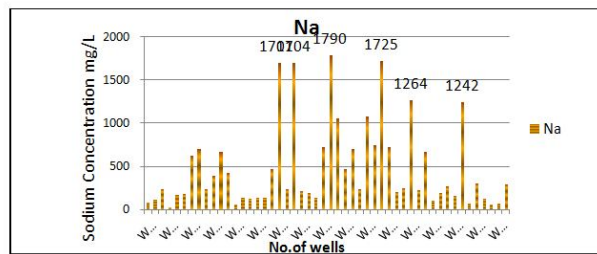


Fig.6. The Concentrations of Sodium ions in water samples

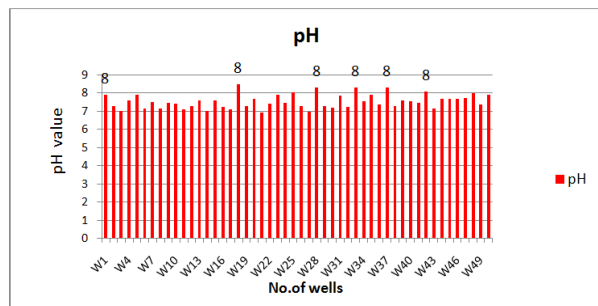


Fig.7. The values of pH of water samples

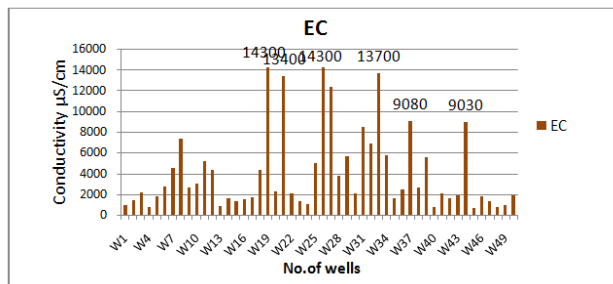


Fig.8. The values of Conductivity of water samples

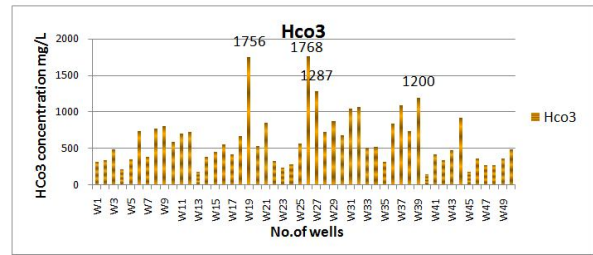


Fig.9. The Concentrations bicarbonate ions in water samples

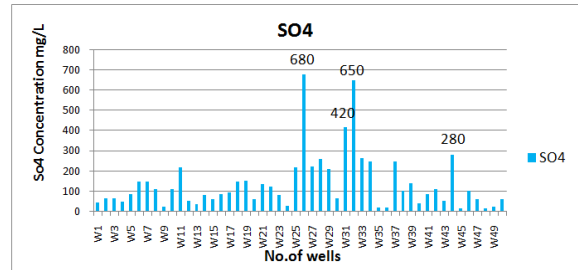


Fig.10. The Concentrations Sulphates in water samples

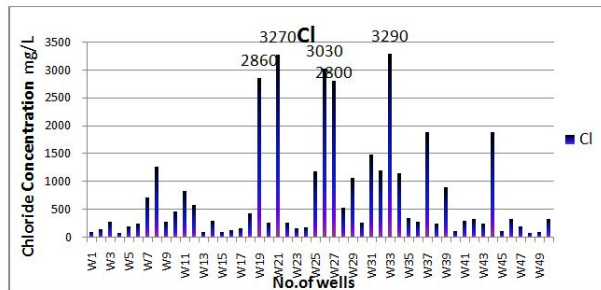


Fig.11. The Concentrations of Chlorides in water samples

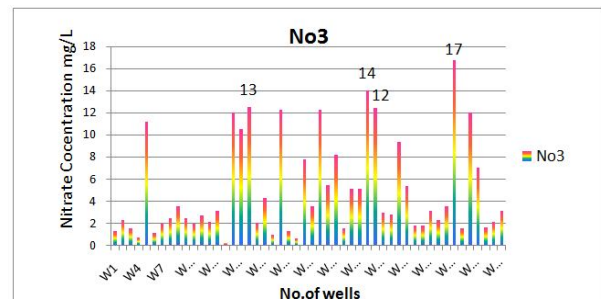


Fig.12. The Concentrations of Nitrates in water samples

and Pinakadimi (W1) 1mg/l and Punukallu (W4) 1mg/L. Bicarbonate concentration are varying from 142mg/L to 1768 mg/L with an average value of 611.86 mg/L. It was observed that high bicarbonate concentration at Chintalapudi (W26) 1768 mg/L followed by Adavikolanu (W19) 1756 mg/L and Parasnnapalem (W27) 1287mg/L. Low bicarbonate concentration is found at Pamulaparru (W40) 142 mg/L.

**Conclusion**

Quality of water is as important as availability of water because it is directly related with health and environment. The water quality parameter of the various areas around Kolleru Lake clearly indicates that the water samples are highly polluted. It observed that the water

taken from Parasannapalem, Chintalapudi, Kanukollu, Timmarao gudem, Punukollu and Adavikolanu are alarmingly get polluted followed by Chavalipadu. These areas situated nearer to the paper mills, distilleries, dairy industries, chemical and sugar factories. So, the proper environment plan may be adopted to control the release of effluents. The major part of the polluted area covered by the southern part of the in and around Kolleru lake. High concentrations of Total dissolved solids,  $P^{H}$ , calcium, magnesium, Sodium, Chloride, Nitrate, Potassium and Sulphate are observed at Chintalapudi (W26), Pedalanka (W33), Parasannapalem (W27) and Adavikolanu (W19). The present study emphasizes the need for regular monitoring of groundwater quality and brings awareness among the people about the impacts of water pollution on human health.

#### Acknowledgements

The authors acknowledge DST, Ministry of Science and Technology, New Delhi, for sanctioning the research project "Hydrogeological and Groundwater resource evaluation studies in and around Kolleru Lake".

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