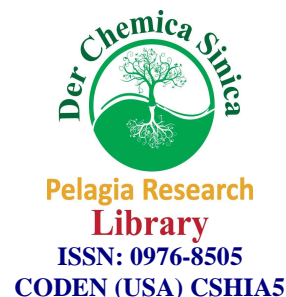




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Der Chemica Sinica, 2012, 3(1): 287-291



Assessment of ground water quality for application in Kakinada coast

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ABSTRACT

Studies on Characterization of twenty ground water samples Collected from various open wells around Kakinada city have been carried out The parameters considered for characterization include p^H , EC, TDS, Total Hardness, Cl, F, NO_3^- , Ca^{+2} , Mg^{+2} , Na, K, Percent Sodium and SAR. Higher concentrations of Na, K, Ca, and Mg are due to intensive Agriculture and industrial activities while higher concentration of Calcium may be contributed to the excessive utilization of Nitrogenous fertilizers. The parametric studies also indicate the influence of sea water intrusion on the quality of ground water in various locations The results of the study further revealed the unsuitability of the water for domestic uses

Key words: Sea water, Intrusion, Parameters.

INTRODUCTION

The area under study Kakinada is located at 16°56'N 82°13'E / . It has an average elevation of 2 metres (6 ft) and many areas of the city are below sea level. The city has roughly a north-south orientation and is confined to a long narrow strip parallel to the sea coast [NIH1-1996] revealed that the flow of groundwater is controlled by the drainage of the area and a subdued replica of surface topography. The influence of seawater was clearly observed on Total Dissolved Solids (TDS), Cl, Na and HCO_3^- contents in the observation wells. According to the hardness classification, the study area falls under hard to very hard zone. The change in major anions and cations in the observation wells indicate mixing of shallow groundwater in the study area. The hydro chemical ratios of Mg/ Cl, Cl/ HCO_3^- and Mg/Ca for each sample have been calculated. The report also revealed that SAR and per cent Na in each well indicated that the study area falls under medium hazard of sodium in the study area and the TDS, HCO_3^- and NO_3^- contents exceeded the maximum desirable limits of the ISI (1983) drinking water standards and finally recognized that the direction of groundwater flow is perpendicular to the sea coast. Saltwater intrusion occurs in virtually all coastal aquifers, where they are in hydraulic continuity with seawater ["CWPTionary Saltwater Intrusion".LaCoast.gov. 1996]. The result is that the aquifer becomes contaminated with salt water. This is happening to many coastal communities [Todd, David K-1960; Delleur, Jacques Willy- 2006] The flow of saltwater inland is limited to coastal areas. When freshwater levels drop, saltwater will be intrusion can proceed inland, reaching the pumped well. Then saltwater, unfit for drinking or irrigation, Hydrological and Hydro geochemical studies for sea water intrusion on the South Coast of Laizhou Bay, China have been carried out by [Yuqun Xue et al., 2000].The research results revealed that the brine originated from ancient sea water and that the bicarbonate/sodium water was formed by cation exchange Assessment of ground water salination by sea water intrusion in a typical Lebanese horticultural area has been carried out [M.EI Moujabber et al., 2002]. The research results revealed that the vulnerability of the krastic area to assess the sea water intrusion and most of the wells

showed the values of Electrical Conductivity higher than 2 dS m^{-1} for the whole period of observation with peak values of 5.5 dS m^{-1} . The studies [Jin-Yong Lee *et al.*, 2008] revealed that the ground water levels were mainly affected by pumping for agricultural, irrigation and tidal fluctuations.

Numerical modeling of salt water intrusion due to human activities and sea level change in the Godavari delta, India has been studied by [A.Ghosh Bobba 2008]. The study results indicate that a considerable advance in sea water intrusion can be expected in the coastal aquifer. A ground water quality survey [N.S Rao *et al.*, 1992] has been carried out by Rao, and brackish ground waters were observed in the wells along the Visakhapatnam coast and the rest of the well waters exhibit fresh water environment. As a part of these research studies the factors responsible for the brackish ground water quality with respect to the influence of sea water are assessed using the standard ratios like $\text{Ca}^{+2} : \text{Mg}^{+2}$, TA: TH, $\text{Cl}^- : \text{HCO}_3^-$. The research results suggested that the brackish nature in most of the ground waters is due to the sea water influence. Various Physicochemical parameters like pH, TDS, EC, Hardness, Sulphate, Nitrate, Phosphate along with trace metals such as Pb, Cd, Fe, Cu, Zn, Mg, and Na were investigated [Abdulrafiu, O *et al.*, 2011] for the quality assessment of ground water in the vicinity of dump sites in Ifo and Lagos, Southwestern Nigeria and the results revealed that Ifo ground water is soft while Isolo water is moderately hard, acidic in nature. The studies also indicate the necessity of further treatment for the water to be employed as Potable. Physicochemical analysis of Ground Water in Gandhi Nagar area, District Bhopal, Madhya Pradesh has been carried out [Archana Singh *et al.*, 2011] to assess the ground water quality. The analytical data concerned to parameters pH, EC, Chloride, Total alkalinity, TDS and Total Hardness was carried with WHO, ICMR and IS: 105900 standards to find the quality of ground water for its suitability for drinking purposes.

A study [Mohammed Saidu, 2011] was conducted to evaluate the effect of solid waste dumps on ground water quality. Water samples collected dry and wet seasons from hand dug wells were characterized for the parameters pH, TDS, EC, Hardness, chloride, Ca, P, DO and BOD. The study results reveal that the hand dug water around the refused dump sited are not safe for human consumption. A study [Sayyed Juned A. *et al.*, 2011] was carried out in the Nanded city area, Marathwada, India to identify the quality of ground water where ground water used for domestic and agricultural purposes. Water samples collected during pre and post monsoon periods from different borewells were analysed for parameters Cl, Na and K. The study revealed that the quality of ground water was controlled the agricultural activities, geological formations and local environmental conditions. The study further revealed that ground water in few sampling sites were unsuitable for domestic and irrigation purposes. The studies [Moscow, S. *et al.*, 2011] on the impact of agricultural activities on ground water of Cauvery belt in Papanasanam taluk, Tamilnadu, India revealed that the quality of ground water has been altered due to modern agriculture practice. Water quality assessment has been carried out for parameters pH, TDS, EC, Cl, Na, k, Ca, Mg, Fe, and Cu. The study results suggested that the over all quality of ground water of this area is safe for drinking, domestic purposes and also suitable for irrigation purposes.

Keeping in view the fact that clean water is absolutely essential for healthy living, it is proposed to take up the present research work to evaluate the quality of ground water and to assess the impact of sea water intrusion on the quality of ground water in the Kakinada coastal aquifer and to suggest accordingly the seriousness of the problem of contamination of ground waters.

MATERIALS AND METHODS

Water samples from 20 locations were collected in two frequencies viz., pre monsoon and post monsoon periods from a depth of 3 - 10m below ground level from open wells in the down stream and the samples were analyzed as per the standard methods APHA [APHA- 2005.] for the parameters such as pH (ELICO-LI 613, Digital pH meter), Electrical Conductivity (EC) (Elico Conductivity meter Model No. Eq.- 548), Total dissolved solids (TDS), Total hardness (TH), Calcium (Ca) and chloride (Cl), by Titrimetry. Fluoride (F), sulphate (SO_4^{-2}), phosphate (PO_4^{-3}) (By Spectrophotometer Systronics - 106 Model), Sodium, Potassium (Elico Digital Flame Photo Meter), Magnesium (Mg),

RESULTS AND DISCUSSION

The pH values both in pre and post monsoon periods are in the permissible limits of 6.5 – 8.4 [R.S Ayer 1976]. Electrical Conductivity values at three locations exceeded the permissible limits ($4000 \mu\text{mhos/cm}$) [U.S.Salinity Laboratory Staff-1953] and at seven locations EC levels exceeded of $2250 \mu\text{mhos/cm}$ which indicate that these

waters are hazardous to sensitive crops [P.C .Tyagi et al.,1991] and in one location the value of EC is with in the permissible limit of 750 $\mu\text{mhos/cm}$. Total Hardness, Chloride, Fluoride and sulphate levels are with in the permissible limits of IS:10500-1992 of drinking water standards[IS: 10500–1992]. The percent sodium levels at only two locations exceeded the permissible limits (60 me/l) [IS: 2296 – 1963] and in all other locations they are with in the permissible limits. SAR values in all the locations are with in the permissible limits of (26me/l) [IS: 11624 – 1986]. In many locations the concentrations of Sodium, Potassium, Calcium and Magnesium are at higher side. The ratio of chloride to Bi carbonate in respect of water samples except with Sl. Nos 2,9,19 and 20 are on the higher side of the permissible limit indicating the intrusion of sea water in to the ground water

S. No	Location from which the sample is collected	pH		EC ($\mu\text{mhos/cm}$)		TDS (mg/l)		TH (mg/l)		Cl ⁻ (mg/l)		F ⁻ (mg/l)		No ₃ ⁻ (mg/l)		SO ₄ ⁻² (mg/l)	
		Pre	Post	Monsoon Pre	Monsoon Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
1	Vakalapudi	7.81	8.10	2110	2280	1414	1459	315	371	247	256	0.25	0.30	35	37	55	70
2	Valasapakala	7.70	7.90	1383	1394	885	892	235	347	235	247	0.27	0.20	36	40	55	70
3	Light House	6.90	7.90	2570	2990	1644	1913	344	367	251	264	0.20	0.26	40	41	120	125
4	Surya Rao Peta	6.90	7.40	4860	5140	2470	2662	94	97	94	97	0.30	0.25	40	42	227	238
5	Indrapalem	8.00	8.40	2264	2311	1448	1479	482	515	420	446	0.20	0.27	36	38	201	205
6	Cheediga	6.99	7.44	1060	1086	678	691	156	171	155	161	0.25	0.27	45	47	40	42
7	Indira colony	7.40	8.10	2210	2360	1424	1510	454	464	249	254	0.30	0.35	46	50	115	118
8	Temple street	7.20	7.90	2416	2500	1546	1600	286	304	254	288	0.26	0.20	45	41	152	148
9	Achempeta	7.60	8.20	950	990	585	614	91	101	92	96	0.25	0.31	41	44	39	40
10	Madhura Nagar	6.88	7.14	1224	1346	783	861	204	211	201	210	0.30	0.33	34	39	30	34
11	R.T.C. Colony	7.00	7.50	2140	2270	1369	1452	274	291	271	286	0.28	0.25	29	27	62	60
12	Ramanayyapeta	6.54	7.60	2150	2330	1376	1491	488	467	295	307	0.20	0.28	34	36	60	67
13	Sarpavaram	7.33	7.50	860	890	550	569	257	272	243	269	0.20	0.25	21	25	135	143
14	Gaigolapadu	6.88	7.14	268	274	171	175	124	132	125	134	0.27	0.28	41	43	80	87
15	Jagannaikpur	7.81	8.20	1220	1260	780	806	198	217	201	210	0.30	0.25	32	36	96	92
16	Ramarao Peta	9.01	9.74	2650	2610	1568	1670	384	311	311	325	0.45	0.30	32	37	72	85
17	Madaline	7.10	7.70	4670	4717	1428	1458	65	68	64	71	0.35	0.36	42	43	22	20
18	MSN Charties	7.40	7.90	5940	5996	601	672	94	102	93	104	0.55	0.65	33	38	44	48
19	A.P.S.P colony	6.99	7.40	1140	1212	729	775	86	99	82	91	0.25	0.29	36	43	26	22
20	Raidupalem	7.00	7.70	1800	1820	1152	1164	168	197	104	115	0.25	0.20	30	33	83	88

CONCLUSION

At three locations the Electrical Conductivity values exceeded the permissible of limits 4000 $\mu\text{mhos/cm}$ and hence these waters are with saline nature and are not suitable for irrigation purposes and waters at seven locations are with EC levels higher than 2250 $\mu\text{mhos/cm}$ and are hazardous to sensitive crops while the waters having EC value below 750 $\mu\text{mhos/cm}$ are suitable for irrigation and drinking purposes. The Percent sodium levels at two locations exceeded the permissible limits of 60me/l and hence these waters are not fit for irrigation. The levels of SAR at only two locations exceeded the permissible limits of 26me/l and hence these waters are not fit for irrigation. The higher concentrations of Sodium, Potassium, Calcium and Magnesium are attributed to the intensive industrial and agricultural activities. Except in water samples with sl.nos 2,9,19 and 20 the other water samples are with higher levels of chloride to bi carbonate ratio indicate the sea water intrusion in to these ground waters and hence these waters are not fit for either drinking purposes. Finally the results of the study revealed that the quality of ground water varies widely from place to place and significantly with in the same locality these waters are mainly not suitable for drinking purposes.

Acknowledgements

The authors express their thanks to the authorities of National Institute of Hydrology (NIH), Kakinada for their cooperation in extending laboratory facilities for the completion of the research work.

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S. No	Sample location	Na (mg/l)		K (mg/l)		Ca (mg/l)		Mg (mg/l)		% Na (me/l)		SAR (me/l)	
		Monsoon Pre	Monsoon Post	Monsoon Pre	Monsoon Post	Monsoon Pre	Monsoon Post	Monsoon Pre	Monsoon Post	Monsoon Pre	Monsoon Post	Monsoon Pre	Monsoon Post
1	Vakalapudi	176	184	61	74	160	180	50	58	36.7	36	3.11	3.05
2	Valasapakala	124	156	66	71	94	106	26	30	51.33	54.30	2.07	2.43
3	Light House	391	470	68	79	117	126	101	110	61.7	60.78	4.52	5.2
4	Surya Rao Peta	164	178	94	101	94	80	64	78	49.0	49.6	2.26	2.40
5	Indrapalem	126	134	33	47	70	78	51	67	53.5	49.4	2.85	2.68
6	Cheediga	78	81	25	46	63	71	31	38	48.5	43.7	2.01	2.0
7	Indira colony	64	121	54	64	117	130	28	33	33.8	45.6	1.38	2.45
8	Temple street	196	198	121	134	104	116	32	38	36.4	52.1	4.41	4.08
9	Achempeta	74	88	20	27	78	96	39	42	44.15	43.9	1.7	1.87
10	Madhura Nagar	121	138	64	71	75	78	44	57	53.6	53.8	2.74	2.89
11	R.T.C. Colony	94	98	90	98	96	98	40	47	45.9	37.6	2.03	2.08
12	Ramanayyapeta	44	47	96	78	72	84	41	44	24.2	26.1	1.02	1.03
13	Sarpavaram	76	89	54	68	141	153	31	38	34.7	35.09	1.51	1.67
14	Gaigolapadu	64	77	41	56	176	198	40	46	28.1	28.7	1.13	1.28
15	Jagannaikpur	64	78	76	84	91	104	51	62	30.5	31.6	1.34	1.49
16	Ramarao Peta	194	247	99	107	64	68	39	51	59.44	62.05	4.71	5.51
17	Madaline	84	86	113	121	74	91	31	44	37.7	34.76	2.06	2.03
18	MSN Charties	261	284	29	41	73	84	30	31	74.9	73.5	6.49	6.71
19	A.P.S.P colony	88	94	19	21	79	104	27	30	51.6	48.2	2.18	2.09
20	Raidupalem	92	96	21	32	86	117	23	31	52.4	45.3	2.27	2.03