

A Study on Quality of Ground Water near Kakinada Coast in East Godavari District of Andhra Pradesh, India

¹Dr. K Sri Hari Varma, ²D.Gangabhavani, ³Kanaka Raju Bondada

¹Dept. of Chemistry, Ideal College of Arts and Sciences, Kakinada, India

²Dept. of Chemistry, Sir CRR College of Engineering, Eluru, AP, India

³Dept. of Chemistry, Sir CRR college of Engineering, Eluru, AP, India

Abstract

Water is the most abundant compound in the universe. It is required in pure state for various uses but due to various activities like vast agricultural activities, urbanization, industrialization and also intrusion of sea water in coastal areas the ground water is polluted. The present research is focused on the analysis of ground water. 12 water samples were collected and characterized for physiochemical parameters viz., pH, Electrical conductivity(EC), Total dissolved solids(TDS), Total hardness(TH), Total Alkalinity(TA), Ca²⁺, Mg²⁺, Na⁺, K⁺, Cl⁻, SO₄²⁻, PO₄³⁻, F⁻ and NO₃⁻ to assess the chemical contamination status. Higher levels of EC, TDS, TH, TA, Ca²⁺, Mg²⁺, Na⁺, K⁺, Cl⁻, SO₄²⁻ and NO₃⁻ reveal that the water is unsuitable for domestic and industrial purposes. The water is to be treated properly before using.

Keywords

Abundant, Ground Water, Characterization, Parameter, Drinking

1. Introduction

Water is essential to all forms of life but due to human activities like discharge of agricultural, domestic and industrial wastes, land use patterns and also the geological patterns, rainfall pattern in that area the ground water is polluted. As this water flows from recharge to discharge areas its chemical composition is altered. The suitability of water for various reasons depends on the type and concentration of dissolved minerals. The addition of pollutants from agency sewage, industrial effluents, agricultural runoff etc into the water make it polluted. The agricultural activities directly or indirectly effects the concentrations of large number of ground species in ground water viz., NO₃⁻, N₂, Cl⁻, SO₄²⁻, H⁺, K, Mg, Ca, Fe, Cu, B, Pb and Zn. Hence the present study focused on the evaluation of ground water quality in Kakinada coastal region to find that concentration status and to assess the end use utilities.

2. Experimental Methods

Twelve samples from various places near coastal area of Kakinada were collected and analysed various parameters by using the following methods. The analysis was done two times i.e., pre-monsoon season and post-monsoon season. The details of sample code, location, source type and coordinates are presented in Table.

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Table 1: Sample Code, Location, Source Type, Longitude and Latitude

Sampling code	Sampling location	Type of source	Co-ordinates	
			Longitude	Latitude
G-1	Pagadala Peta	BW	16°.55'N	82°.14'E
G-2	Chollangi	BW	16°.892'N	82°.239'E
G-3	Matlapalem	OW	16°.855'N	82°.233'E
G-4	Talarevu	BW	16°.781'N	82°.233'E

G-5	Korangi	OW	16°.8121N	82°.231'E
G-6	Peddaboddu-ayudupalem	OW	17°.3211N	82°.041'E
G-7	Georgepeta	BW	16°.7441N	82°.224'E
G-8	Neelapalli	BW	16°.7351N	82°.227'E
G-9	Yanam	OW	16°.7331N	82°.216'E
G-10	Dariyalatippa	OW	17°.3211N	82°.041'E
G-11	Bhirapalem	OW	16°.7381N	82°.311'E
G-12	Gadimoga	BW	16°.7481N	82°.292'E

S: Sample water, BW: Bore Well, OW: Open Well

The polythene sample bottles were used and preserved for analysis by following the standard procedures. The samples were analyzed for physicochemical parameters which include pH, Electrical Conductivity (EC), Total Dissolved solids (TDS), Total Alkalinity (TA), Total hardness (TH), Ca and Mg, Na, K, Chloride, Sulphate and Phosphate.

Name of the parameter	Methods for determination
pH	Digital Ph meter(Global- DPH505,India-Model)
Electrical Conductivity	Digital conductivity meter(Global-DCM-900-Model)
Total dissolved solids	Digital conductivity meter(Global-DCM-900-Model)
Total hardness, total alkalinity, chlorides	Titrimetry (Complexometry method using EDTA solution)
Calcium and magnesium	Titrimetry (Complexometry method using EDTA solution)
Sulphates, Phosphates	Spectrophotometer(Model-167, Systronics)
Sodium, Potassium	Flame photometer(Model- 125, Systronics)
Fluorides, Nitrates	Ion-selective method

The satellite picture of the study area selected is presented in fig. 1

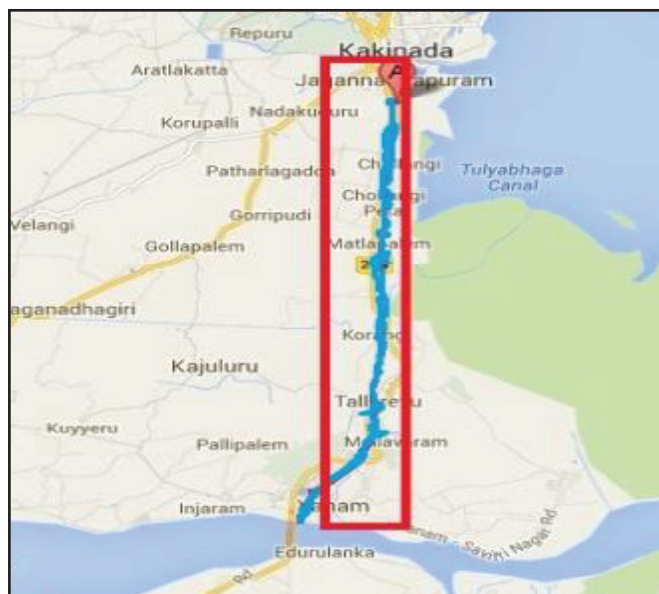
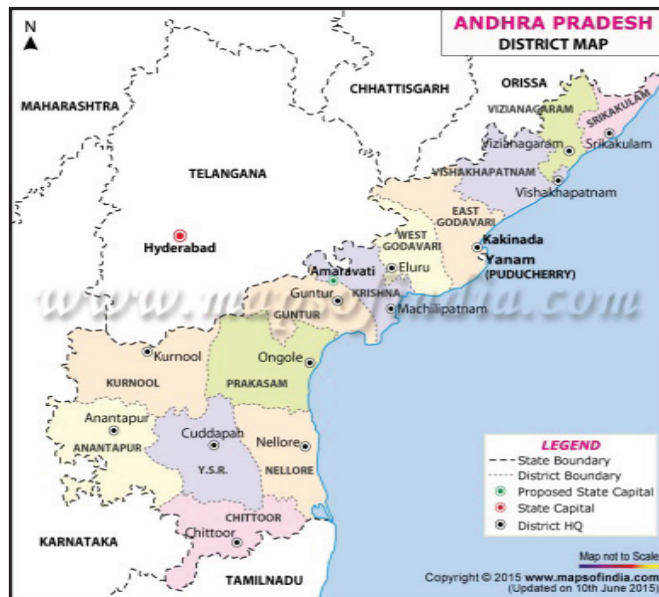


Fig. 1: Study Area – A Nonpoint Source and Sampling Location
 The analytical data is presented in tables 2 & 3 respectively. The values are also represented
 Table 2: Physicochemical Characteristics of Ground Waters

Sample code	pH		EC (µmhos/cm)		TDS (mg/l)		TH (mg/l)		TA (mg/l)		Ca ²⁺ (mg/l)		Mg ²⁺ (mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
G-1	7.80	7.27	3220	3650	2060.8	2336	400	650	405	352	70	150	25.4	24.4
G-2	7.30	6.56	4350	4672	2784	2990	700	800	1038	976	190	350	121.0	120
G-3	8.10	7.23	1680	2050	1075	1312	500	600	702	245	95	170	42.4	23.4
G-4	7.80	6.85	1560	1891	998.4	1210.5	900	1050	1225	986	83	89	46.8	90.6
G-5	7.85	6.45	3090	3570	1977.5	2284.8	900	1300	1250	1362	190	283	96.6	70.2
G-6	6.90	6.42	3240	4720	2073.6	3020.8	1800	1600	498	290	290	230	325.2	155.6
G-7	7.52	7.04	5640	6520	3609.6	4172.8	1150	1145	1098	1093	190	409	120.8	69.4
G-8	7.10	6.19	4560	4370	2918	2796	1100	1250	762	392	200	180	190.8	96.2
G-9	7.20	7.01	2870	980	1836.5	627.2	1600	1300	468	241	90	130	124.8	83.2
G-10	6.98	6.24	3250	710	2080	454.2	1000	1400	428	294	310	190	218.4	98.8
G-11	7.12	6.58	5250	7330	3360	4691.2	3300	3500	1042	396	360	370	336.4	685.6
G-12	7.50	7.96	2858	890	1829	569.6	1600	1800	1064	274	165	185	266.0	68.8

Table 3: Physicochemical Characteristics of Ground Water

Sample code	Na+		K+		Cl-		SO ₄ ²⁻		PO ₄ ³⁻		F-		NO ₃ ⁻	
	(mg/l)		(mg/l)		(mg/l)		(mg/l)		(mg/l)		(mg/l)		(mg/l)	
	Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon		Monsoon	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
G-1	59	65	6	6	683	881	65	102	1.3	BDL	0.83	0.87	21	23
G-2	69	67	25	3	841	769	208	69	2.6	BDL	0.86	0.92	35	39
G-3	106	19	12	10	162	356	BDL	43	3.2	2.4	0.48	0.59	17	26
G-4	191	38	9	2	136	296	1	39	3.3	2.0	0.52	0.63	15	20
G-5	257	120	53	16	531	1208	79	208	3.6	BDL	0.85	0.89	26	39
G-6	310	85	202	13	680	899	223	189	1.0	BDL	0.83	0.88	22	26
G-7	873	75	121	19	896	2482	98	161	3.9	BDL	0.83	0.91	49	52
G-8	432	29	165	14	98	467	53	82	1.8	BDL	0.32	0.36	33	36
G-9	291	11	125	0.9	490	111	264	81	11.4	1.9	0.66	0.68	41	43
G-10	457	13	235	0.8	39	613	203	67	1.9	0.9	0.42	0.52	46	49
G-11	939	636	233	62	684	1520	149	137	2.1	BDL	0.66	0.66	44	47
G-12	209	18	165	0.9	161	88	120	45	2.6	1.0	0.90	0.95	33	39

III. Results and Discussion

A. pH

p^H of pre and post monsoon water samples range from 6.9 to 8.1 and 6.19 to 7.16 respectively and all these are well within the permissible range (6.5-8.5) of drinking water standards. But very few samples viz., G-5, G-6, G-8 & G-10 are slightly acidic as their pH values are in the lower side of permissible range. So, these samples are not safe for human consumption.

B. Electrical Conductivity (EC)

EC of ground water samples of pre and post monsoon seasons ranges from 1560-5640 μ mhos/cm and 710-7330 μ mho/cm respectively. All these samples are exceeded the permissible limits of WHO standards 410-1530 μ mho/cm. This excessive conductivity is due to large excess of dissolved ions in water samples.

C. Total Dissolved Solids (TDS)

The TDS of water samples of pre and post monsoon seasons ranging from 998.4- 3609 mg/lit and 454.2-4691.2 mg/lit respectively. Almost all water samples exceed the permissible limit (500 mg/lit) in both the seasons except G-10 sample in post monsoon season. This indicates the presence of large excess of soluble solid matter making the water unsuitable for drinking.

D. Total Hardness (TH)

TH of water samples of pre and post monsoon seasons ranging from 400-3300mg/lit and 600 -3500 mg/lit respectively. All water samples exceeded the permissible limit of 300mg/lit. Hence these waters are not suitable for domestic application as they cause corrosion on water supply systems.

E. Calcium (Ca²⁺)

Ca²⁺ in ground water samples of pre and post monsoon season ranges from 70-360mg/lit and 89-409 mg/lit respectively. In pre monsoon season except G-1, and in post monsoon season all the water samples are exceeded the permissible limit (75 mg/lit). In post monsoon samples Ca²⁺ levels range from. In all water samples Ca²⁺ exceeded the permissible limit. Hence the waters are not suitable for human consumption. Excessive Ca²⁺ can

cause extrusion on water supply system. So, all these samples are not fit for usage.

F. Magnesium (Mg²⁺)

Mg²⁺ ion concentration in ground water samples of pre and post monsoon seasons ranging from 25.4 to 336.4 mg/lit and 23.4 – 685.6 mg/lit respectively. In pre-monsoon season only one sample G-1 is in the permissible range of 30 mg/lit whereas in post monsoon season two samples G-1 & G-3 are in the permissible range, and remaining water samples are exceeded the permissible limit. Excessive Mg²⁺ can cause gastrointestinal irritation if used by human.

G. Total Alkalinity (TA)

TA in pre and post monsoon seasons varies from 405-1250 mg/lit and 241-1362 mg/lit. In pre monsoon season all water samples and in post monsoon samples G-1, G-2, G-4, G-5, G-7, G-8 & G-11 exceeded the permissible limit (300 mg/lit). This excess total alkalinity is mainly due to intrusion of industrial sewage. Hence these waters are not suitable for drinking purpose as they can cause unpleasant taste to the waters.

H. Sodium and Potassium (Na⁺ & K⁺)

Sodium ion concentration in pre and post monsoon seasons ranging from 59-939 mg/l and 11-636 mg/lit and K⁺ ranging from 6-235 mg/lit and 0.8-62 mg/lit respectively. The concentration of sodium in pre monsoon season of samples G-5, G-7, G-8, G-9, G-10 & G-11 and in post monsoon season except G-11 all samples are exceeded the permissible limit of 250 mg/lit. The concentration of potassium in pre monsoon season of samples except G-1 & G-3 and in post monsoon season except G-11 all samples are exceeded the permissible limit of 12 mg/lit.

Sodium and Potassium are the most important minerals occurring naturally. The higher values of Na are related to the precipitation or absorption of the cations by soil or coating on the minerals and also due to the percolation of effluents. Sodium is also present in association with high concentration of chloride resulting in salinity. The concentration of Sodium is important in classifying irrigation waters as it reacts with soil permeability. Na⁺ & K⁺ concentrations

are also influenced by the cation exchange mechanism. High values of sodium at certain locations are attributed to the possible contamination by industrial effluents and residues such as filter cake. Higher levels of sodium and potassium during pre monsoon season may be due to excess ground water exploitation in the study area locations and further

the higher levels of sodium and potassium may also indicate the leaching and dissolution of secondary salts in the pore spaces.

I. Chloride (Cl-)

Chloride ion concentration in both seasons ranging from 39 to 896 mg/lit and 88-2482 mg/lit respectively. In pre monsoon season samples G-1, G-2, G-5, G-6, G-7, G-9 & G-11 and in post monsoon except G-9 & G-12 all other samples exceeded the permissible limit of 250 mg/lit. This may be due to the intrusion of sea water. Excessive chlorides give irritating smell and taste to the water.

J. Sulphate (SO₄²⁻)

Sulphate in ground water samples of pre and post monsoon seasons ranging from 1 to 264 mg/lit and 39-208 mg/lit respectively. In pre monsoon samples –G-2, G-6, G-9, G-10 and in post monsoon sample G-5 exceed the permissible limit of 200 mg/lit. The higher values of sulphate in water reveals that the discharge in the form of sulphate fertilizers by man made activities in the location.

K. Phosphate (PO₄³⁻)

Phosphate levels in pre and post monsoon seasons ranging from 1.0-11.4 mg/lit and 0.9 –2.4 mg/lit. In pre and post monsoon all samples except G-9 are in the permissible limit of 5 mg/lit. Excessive phosphate in G-9 indicates the discharge from phosphate fertilizer into the ground water.

L. Fluoride (F-)

Fluoride in pre and post monsoon seasons are ranging from 0.32 –0.90 mg/lit and 0.36 to 0.95 mg/lit respectively. In both seasons all samples are within the permissible limit of 3 mg/lit.

N. Nitrate (NO₃⁻)

Nitrate levels in pre and post monsoon seasons ranging from 15-49 mg/lit and 20-49 mg/lit respectively. In pre monsoon samples G-7 & G-10 and in post monsoon samples G-7, G-10 & G-11 exceeded the permissible limit of 45 mg/lit. In all most 70% of samples the levels reached threshold limit of drinking water standards. The high nitrogen content is an indicator of organic pollution. It results from the added nitrogenous fertilizer, decay of dead plants and animals and their residues. Low nitrate levels may be due to the less usage of nitrogenous fertilizers and fewer disposals of other wastes around the locations or it may be due to de-nitrification.

IV. Conclusions

It is concluded that the samples collected from coastal area near Kakinada, East Godavari (dist) of A.P state, chemical contamination of ground water in addition to salt water inundation in the study areas is revealed in the research. The main contributors for these results are higher values of EC, TDS, TH, Ca²⁺, Mg²⁺, TA, Na⁺, K⁺, Cl⁻ and NO₃⁻. Hence the water is not suitable either for drinking or for domestic purposes in the research areas.

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