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Suitability assessment of groundwater for irrigation in Rajahmundry division of east Godavari District, Andhra Pradesh (India)

T Giri Shashank Reddy and P Mohana Rao

Abstract
This paper is an attempt to analyze the water quality of Rajahmundry division of East Godavari district of Andhra Pradesh in South India for irrigation purpose. Therefore, 79 groundwater samples were collected from this area to assess their quality and suitability for irrigation purposes over a period of pre and post-monsoon seasons (*kharif* and *Rabi*, 2017-2018). The groundwater samples were analyzed for pH, electrical conductivity (EC), sodium adsorption ratio (SAR) and residual sodium carbonate (RSC). Study of all these characteristics indicates that groundwater in pre-monsoon (*kharif*) season is slightly suitable for irrigation purpose compared to post-monsoon season because of high values of EC and salinity.

Keywords: Water analysis, Groundwater quality, Irrigation, SAR, RSC, Rajahmundry division, South India

Introduction
About 97.2% of world's water is found in oceans and seas and the remaining 2.8% of water is found as ground water and surface water, of which ground water (0.59%) is 30 times greater than surface water (0.02%). Groundwater quality as one of the most important aspects in water resource studies is largely controlled by discharge and recharges pattern, nature of host and associated rocks, and contaminated activities. In recent years, an increasing threat to ground water quality as well as quantity due to human activities has become of great importance. With the advent of the tube well along with the rapid growth of demand for agricultural and municipal water, annual global groundwater extraction has increased in recent decades from 100 cubic km/year in 1950 to a current estimated use of about 800 cubic km/year. Currently about 43% of global irrigation, with 45 % in India as well as more than 50% of the world's drinking water supply and a large share of global industrial activity depend on groundwater. Quality of water is assuming great importance with the rising pressure on agriculture and rise in standard of living. (Wani *et al.*, 2014) [15].

Descriptions of Area
Rajahmundry division (14 mandals) lies in East Godavari district which is one of the nine coastal districts of Andhra Pradesh and is known for its historical importance. The district enjoys a unique place and is known as "*rice bowel*" of Andhra Pradesh. The district forms part of the Godavari delta region and is endowed by a vast potential of surface water resources. The district lies between north latitude 16°30' and 18°20' and east longitude 81°30' and 82°36' spreading over an area of 10,807 Sq.km. It is broadly classified in to three natural divisions namely the Delta, Upland and Agency or hill tracts. The annual rainfall of the district is 1497 mm with an average 1100 mm. The mean seasonal rainfall distribution is 704 mm in southwest monsoon, 277 mm in northeast monsoon. Net cultivated area is about 40.54 per cent of the total geographical area of the district out of which rice farming is 58 per cent of total area sown. Average rice yield is of 2748 kg ha^{-1} during *kharif* and 3620 kg ha^{-1} during *rabi* (Groundwater Brochure, East Godavari district, Andhra Pradesh, Central Groundwater Board, 2013) [2].

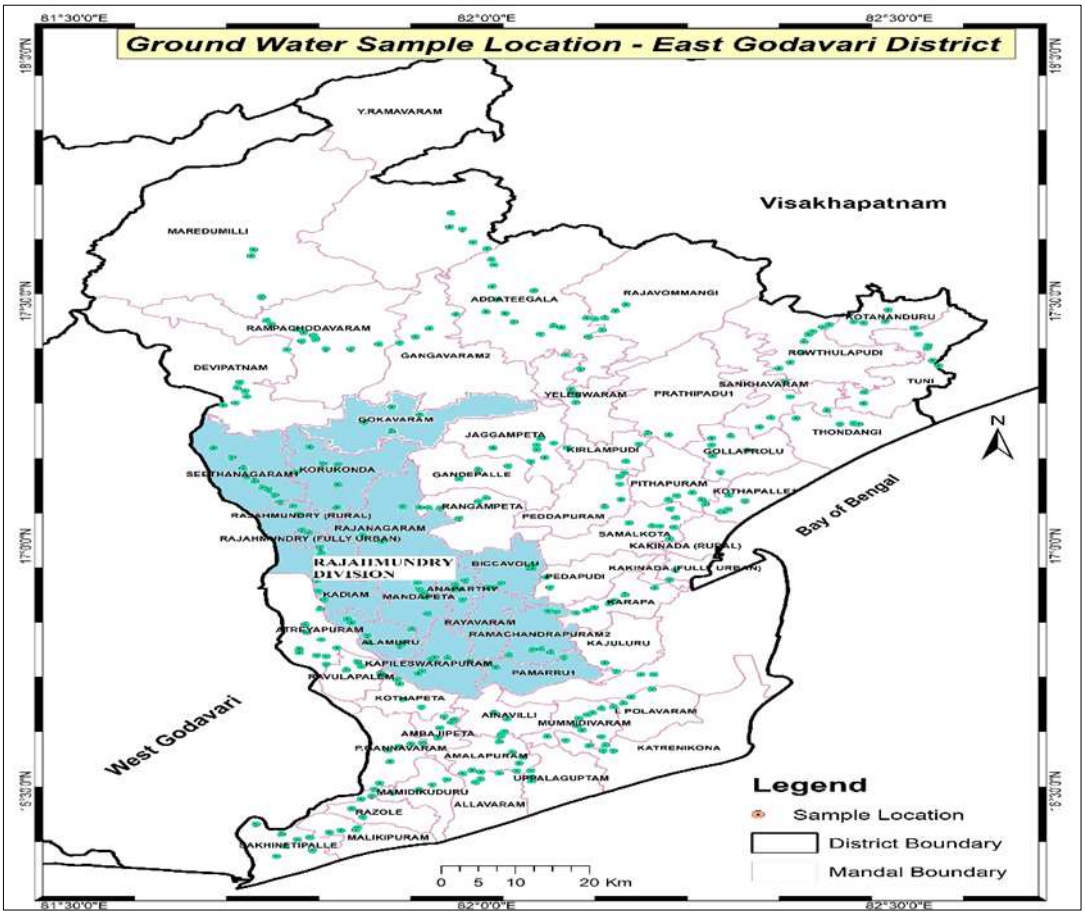

Fig: Location of survey area for groundwater samples collection in Rajahmundry division of East Godavari district, A.P.

In East Godavari The total net area irrigated is 2,83,592 ha. The net area irrigated through canals and tanks is 1,81,165 and 23,871 ha. respectively, and irrigation through lift and other sources is 644 ha. The net area irrigated through tube wells and filter point wells is 62540 ha. and thus constituting 12.70 percent through ground water irrigation in the district (Groundwater Brochure, East Godavari district, Andhra Pradesh, Central Groundwater Board, 2013) [2]. Mismanagement of land at all levels, particularly in agriculture, has led to the problem of rising water table, soil salinization and pollution of surface and groundwater resources (Manjunatha *et al.*, 2011) [7]. Several factors such as discharge of industrial, agriculture and domestic water, land use practices, geological formations, rainfall patterns and infiltration rates affect the groundwater quality (Patil and Patil, 2010) [8].

In India unfortunately, salinity hazards are extensive irrigation regions problem. In addition, different crops require different irrigation water qualities. Therefore, testing the irrigation water is prior to contribute to effective management and utilization of the groundwater resources by clarifying relations among many hydrogeological considerations. In the present study, the physicochemical quality of groundwater has assessed and dissimilar index methods which were used like EC, SAR and RSC with reference to their suitability for irrigation. (Srinivasareddy, 2013) [12].

Material and Methods

The 79 groundwater samples were collected from selected sites during pre-monsoon (July, 2017) and post-monsoon seasons (January, 2018) from Amalapuram division of East Godavari district (Wells and tube wells).

The dug well waters were lifted to the ground surface by rope and bucket while tube well waters were pumped to surface by using hand pump. The pumps were run for 5 to 6 minutes prior to collection of water samples. Samples were collected in polythene bottles and immediately after collection of water samples toluene was added.

The following water analysis techniques were used to assess the quality of water.

Water Reaction (pH)

pH in the water sample was measured potentiometrically using pH meter (Jackson, 1973) [4].

Electrical Conductivity (EC)

Conductivity Bridge was used to determine the electrical conductivity of the water sample (Willard *et al.*, 1974) [16].

Sodium adsorption ratio (SAR)

SAR was computed to indicate the sodicity or alkalinity hazard of irrigation waters by using the following formula (Richards, 1954) [10].

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Residual sodium carbonate (RSC)

RSC was computed using the following formula (Karanth, 1987) [6].

$$RSC\ (me\ L^{-1}) = (CO_3^{2-} + HCO_3^{-}) - (Ca^{2+} + Mg^{2+})$$

Classification of groundwater samples based on different criteria

Table 1: Rating chart for ground water quality

Water quality rating	EC (dS m^{-1})	SAR	RSC (me L^{-1})
Good	<2	<10	<2.5
Marginally saline	2-4	<10	<2.5
Saline	>4	<10	<2.0
High SAR saline	>4	>10	<2.5
Marginal alkali	<4	<10	2.5-4.0
Alkali	<4	<10	>4.0
High alkali	Variable	>10	>4.0

(Gupta *et al.*, 1994) [3]

Table 2: Classification of irrigation water

i) Salinity (EC dS m^{-1})		
Class	EC range	USSL,1954 [13]
C-1 – low salinity	0.0-0.25	
C-2 – medium salinity	0.25-0.75	
C-3 – high salinity	0.75-2.25	
C-4 – very high salinity	>2.25	
ii) SAR (Sodium Adsorption Ratio)		
Class	SAR	
S-1 – low sodium water	< 10	
S-2 – medium sodium water	10-18	
S-3 – high sodium water	18-26	
S-4 – very high sodium water	> 26	
iii) RSC (Residual Sodium Carbonate)		
Class	RSC (me L^{-1})	
A-1 – Water can be used safely	<1.25	
A-2 – Water cab be used with certain management	1.25-2.5	
A-3 –Not suitable for irrigation	>2.5	
iv) Water Reaction (pH)		Anonymous, 1984 [1]
Acidic	< 6.5	
Neutral	6.5-7.5	
Alkaline	>7.5	

Table 3: Rating chart for ground water quality

SAR	EC dS m^{-1}			
	C_1(0-0.25)	C_2 (0.25-0.75)	C_3(0.75-2.25)	C_4(>2.25)
S_1 <10	C_1-S_1	C_2-S_1	C_3-S_1	C_4-S_1
S_2 10-18	C_1-S_2	C_2-S_2	C_3-S_2	C_4-S_2
S_3 18-26	C_1-S_3	C_2-S_3	C_3-S_3	C_4-S_3
S_4 >26	C_1-S_4	C_2-S_4	C_3-S_4	C_4-S_4

Results and Discussion

The results of various physico-chemical parameters are presented following tables and their statistical measures such as minimum, maximum, range of water conditions, significance, concentrations and percentage of samples during post and pre monsoon seasons for irrigation purposes are given in tables.

Hydrogen Ion Concentration pH

pH refers to the effective concentration of hydrogen ions in the water expressed as the negative logarithm (base 10) of the hydrogen ion activity in moles per liter. The pH value of natural water is a measure of its net alkalinity or acidity. Further, exactly stated, the pH value is a measure of the hydrogen ion concentration of water. In most natural waters, the pH value is dependent on the carbon-di-oxide–carbonate-bicarbonate equilibrium. As the stability is noticeably affected by temperature and pressure.

In the study area (Rajahmundry division) pH was found to be slightly acidic to alkaline in nature in most of samples ranged from 6.5 (P and T Colony) to 7.9 (Pamarru) and the highest (7.6) mean pH value recorded in Pamarru mandal and lowest (7.2) mean value was recorded in Rajahmundry mandal in pre-monsoon season and the pH value ranged from 6.6 (Srikrishnapatnam) to 7.7 (Yandagandi) whereas, highest (7.5) mean pH value recorded in Pamarru mandal and lowest (7.2) value recorded in Rajanagaram mandal in post-monsoon season.

In Rajahmundry division about 85 per cent samples recorded under neutral and 15 per cent samples were under alkali range in pre-monsoon season and the 80 per cent samples recorded under neutral and 20 per cent samples were under alkali range (table. 1).

Here pH was found in the range comparatively higher pH recorded during pre-monsoon than post-monsoon is due to dilution of water as a result of precipitation (Priyadharshini and Aruchamy, 2015) [9].

Electrical Conductivity (EC)

Electrical conductivity (EC) is a calculate of the total salt content of water based on the flow of electrical current through the sample. The higher the salt content, greater will

be the flow of electrical current.

In study area (Rajahmundry division) EC was ranged from 0.3 (P and T colony) to 14.6 dS m^{-1} (Oduru) and the highest (5.3 dS m^{-1}) mean value recorded in Ramachandrapuram, lowest (0.7 dS m^{-1}) mean value recorded in Kadiam mandal in pre-monsoon season and the EC values ranged from 0.2 (P and T colony) to 10.9 dS m^{-1} (Oduru) and the highest (4.1 dS m^{-1}) mean value recorded in Ramachandrapuram mandal, lowest (0.5 dS m^{-1}) salinity recorded in Kadiam mandal in post-monsoon season.

In Rajahmundry division 11 per cent samples were found to be under C_2 class, 63 per cent samples were come under C_3 class and 25 per cent samples found to be C_4 class in pre-monsoon season and the about 4 per cent were fall in C_1, 15 per cent samples came under C_2 class and 67 per cent samples were came under C_3 class and 14 per cent samples came under C_4 class in post-monsoon season (table. 2 and 3).

During post-monsoon season water samples had lower EC values compared to pre-monsoon season water samples. This might be due to precipitation during monsoon season which resulted in flushing of salts and rain diluted the salt content (Satyanarayana *et al.*, 2016) [11].

Sodium adsorption ratio (SAR)

The most common measure to assess sodicity in water and soil is called the Sodium adsorption ratio (SAR). The SAR defines sodicity in terms of the relative concentration of sodium (Na) compared to the sum of calcium (Ca) and magnesium (Mg) ions in a sample. The SAR assesses the potential for infiltration problems due to a sodium imbalance in irrigation water. Sodium concentration is important in classifying the water for irrigation purposes because sodium concentration can reduce the soil permeability and soil structure.

In study area (Rajahmundry division), SAR values of water samples ranged from 0.3 (Burrilanka) to 27.8 (Oduru) and the highest (13.3) mean value was found in Ramachandrapuram mandal and lowest (1.3) value found in Kadiam mandal in pre-monsoon season and the SAR values ranged from 0.2 (Burrilanka) to 21.3 (Narsaraopeta) and the highest (9.7) mean value was found in Ramachandrapuram mandal and lowest (0.8) value was found in Kadiam mandal in post-monsoon season.

In Rajahmundry division, about 95 per cent samples were found to be S_1 class, 3 per cent samples came under S_2 class, 1 per cent samples came under S_3 class and 1 per cent samples came under S_4 class in pre-monsoon season and the 94 per cent samples came under S_1 class, 4 per cent samples were S_2 class and 2 per cent samples comes under S_3 class (table 4 and 5).

High SAR values in pre-monsoon season indicated that the relative adsorption of Ca^{+2} + Mg^{+2} was low in summer and reverse was true in post-monsoon season (Venkateswarlu, 2001) [14].

Residual sodium carbonate (RSC)

The concentration of bicarbonate and carbonate also influences the suitability of water for irrigation purpose. One of the empirical approaches is based on the assumption that all Ca^{2+} and Mg^{2+} precipitate as carbonate. Considering this hypothesis, Eaton (1950) proposed the concept of residual sodium carbonate (RSC) for the assessment of high carbonate waters. The water with high RSC has high pH and land irrigated with such water becomes infertile owing to deposition of sodium carbonate; as known from black colour of the soil.

In study area (Rajahmundry division), RSC values of water samples ranged from -14.8 (Vedullapalli) to 9.1 me L^{-1} (Draksharamam), the highest (3.3 me L^{-1}) mean value was found in Kapileswarapuram mandal and lowest (-5.7) value in Korukonda mandal in pre-monsoon season and the RSC values ranged from -9.4 (Oduru) to 9.0 me L^{-1} (Draksharamam), the highest (3.7 me L^{-1}) mean value found in Kapileswarapuram mandal and lowest (-3.3 me L^{-1}) value found in Korukonda mandal in post-monsoon season.

In Rajahmundry division, 80 per cent samples came under A_1 class (safe), 6 per cent samples came under A_2 class (marginal) and 14 per cent samples came under A_3 class (harmful) in pre-monsoon season and the 77 per cent samples comes under A_1 class (safe), 9 per cent samples comes under A_2 class (marginal) and 14 per cent samples came under A_3 class (harmful) in post-monsoon season (table 5 and 6).

Pre-monsoon season water samples had high RSC values compared to post-monsoon season is due to water samples containing bicarbonates in excess over calcium and magnesium ions influences unsuitability for irrigation (Jeyaseelan *et al.*, 2013) [5].

Table 1: Classification of groundwater samples based on pH basis during pre and post-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	Pre-monsoon				Post-monsoon			
			Neutral (6.5-7.5)		Alkaline (>7.5)		Neutral (6.5-7.5)		Alkaline (>7.5)	
			No.	%	No.	%	No.	%	No.	%
1	Rajahmundry	6	6	100.0	0	0.0	4	66.7	2	33.3
2	Sithanagaram	9	9	100.0	0	0.0	7	77.8	2	22.2
3	Korukonda	5	3	60.0	2	40.0	3	60.0	2	40.0
4	Gokavaram	5	2	40.0	3	60.0	4	80.0	1	20.0
5	Kadiam	5	4	80.0	1	20.0	4	80.0	1	20.0
6	Alamuru	7	6	85.7	1	14.3	6	85.7	1	14.3
7	Rajanagaram	5	4	80.0	1	20.0	4	80.0	1	20.0
8	Mandapeta	7	7	100.0	0	0.0	7	100.0	0	0.0
9	Kapileswarapuram	5	4	80.0	1	20.0	4	80.0	1	20.0
10	Pamarru	5	3	60.0	2	40.0	3	60.0	2	40.0
11	Ramachandrapuram	6	6	100.0	0	0.0	6	100.0	0	0.0
12	Anaparthi	5	4	80.0	1	20.0	4	80.0	1	20.0
13	Rayavaram	4	4	100.0	0	0.0	3	75.0	1	25.0
14	Bikkavolu	5	5	100.0	0	0.0	4	80.0	1	20.0
	Total (division)	79	67	84.8	12	15.2	63	79.7	16	20.3

Table 2: Classification of groundwater samples based on EC basis during pre-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	EC (dS m^{-1})							
			C_1 (0.1-0.25)		C_2 (0.25-0.75)		C_3 (0.75-2.25)		C_4 (2.25-5.00)	
			No.	%	No.	%	No.	%	No.	%
1	Rajahmundry	6	0	0	1	17	4	67	1	17
2	Sithanagaram	9	0	0	1	11	6	67	2	22
3	Korukonda	5	0	0	1	20	1	20	3	60
4	Gokavaram	5	0	0	0	0	3	60	2	40
5	Kadiam	5	0	0	3	60	2	40	0	0
6	Alamuru	7	0	0	0	0	7	100	0	0
7	Rajanagaram	5	0	0	1	20	3	60	1	20
8	Mandapeta	7	0	0	0	0	7	100	0	0
9	Kapileswarapuram	5	0	0	0	0	5	100	0	0
10	Pamarru	5	0	0	0	0	2	40	3	60
11	Ramachandrapuram	6	0	0	0	0	2	33	4	67
12	Anaparthi	5	0	0	1	20	3	60	1	20
13	Rayavaram	4	0	0	0	0	3	75	1	25
14	Bikkavolu	5	0	0	1	20	2	40	2	40
	Total (division)	79	0	0.0	9	11.4	50	63.3	20	25.3

Table 3: Classification of groundwater samples based on EC basis during post-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	EC (dS m^{-1})							
			C_1 (0.1-0.25)		C_2 (0.25-0.75)		C_3 (0.75-2.25)		C_4 (2.25-5.00)	
			No.	%	No.	%	No.	%	No.	%
1	Rajahmundry	6	1	16.7	0	0.0	5	83.3	0	0.0
2	Sithanagaram	9	0	0.0	1	11.1	6	66.7	2	22.2
3	Korukonda	5	0	0.0	1	20.0	2	40.0	2	40.0
4	Gokavaram	5	0	0.0	0	0.0	3	60.0	2	40.0
5	Kadiam	5	2	40.0	1	20.0	2	40.0	0	0.0
6	Alamuru	7	0	0.0	0	0.0	7	100.0	0	0.0
7	Rajanagaram	5	0	0.0	2	40.0	3	60.0	0	0.0
8	Mandapeta	7	0	0.0	2	28.6	5	71.4	0	0.0
9	Kapileswarapuram	5	0	0.0	1	20.0	4	80.0	0	0.0
10	Pamarru	5	0	0.0	1	20.0	2	40.0	2	40.0
11	Ramachandrapuram	6	0	0.0	0	0.0	4	66.7	2	33.3
12	Anaparthi	5	0	0.0	1	20.0	4	80.0	0	0.0
13	Rayavaram	4	0	0.0	1	25.0	2	50.0	1	25.0
14	Bikkavolu	5	0	0.0	1	20.0	4	80.0	0	0.0
	Total (division)	79	3	3.8	12	15.2	53	67.1	11	13.9

Table 4: Classification of groundwater samples based on SAR basis during pre-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	SAR							
			S_1 (0-10)		S_2 (10-18)		S_3 (18-26)		S_4 (>26)	
			No.	%	No.	%	No.	%	No.	%
1	Rajahmundry	6	6	100.0	0	0.0	0	0.0	0	0.0
2	Sithanagaram	9	9	100.0	0	0.0	0	0.0	0	0.0
3	Korukonda	5	5	100.0	0	0.0	0	0.0	0	0.0
4	Gokavaram	5	5	100.0	0	0.0	0	0.0	0	0.0
5	Kadiam	5	5	100.0	0	0.0	0	0.0	0	0.0
6	Alamuru	7	7	100.0	0	0.0	0	0.0	0	0.0
7	Rajanagaram	5	5	100.0	0	0.0	0	0.0	0	0.0
8	Mandapeta	7	7	100.0	0	0.0	0	0.0	0	0.0
9	Kapileswarapuram	5	5	100.0	0	0.0	0	0.0	0	0.0
10	Pamarru	5	4	80.0	1	20.0	0	0.0	0	0.0
11	Ramachandrapuram	6	3	50.0	1	16.7	1	16.7	1	16.7
12	Anaparthi	5	5	100.0	0	0.0	0	0.0	0	0.0
13	Rayavaram	4	4	100.0	0	0.0	0	0.0	0	0.0
14	Bikkavolu	5	5	100.0	0	0.0	0	0.0	0	0.0
	Total (division)	79	75	94.9	2	2.5	1	1.3	1	1.3

Table 5: Classification of groundwater samples based on SAR basis during post-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	SAR							
			S_1 (0-10)		S_2 (10-18)		S_3 (18-26)		S_4 (>26)	
			No.	%	No.	%	No.	%	No.	%
1	Rajahmundry	6	6	100.0	0	0.0	0	0.0	0	0.0
2	Sithanagaram	9	9	100.0	0	0.0	0	0.0	0	0.0
3	Korukonda	5	5	100.0	0	0.0	0	0.0	0	0.0
4	Gokavaram	5	5	100.0	0	0.0	0	0.0	0	0.0
5	Kadiam	5	5	100.0	0	0.0	0	0.0	0	0.0
6	Alamuru	7	7	100.0	0	0.0	0	0.0	0	0.0
7	Rajanagaram	5	5	100.0	0	0.0	0	0.0	0	0.0
8	Mandapeta	7	7	100.0	0	0.0	0	0.0	0	0.0
9	Kapileswarapuram	5	3	60.0	2	40.0	0	0.0	0	0.0
10	Pamarru	5	4	80.0	1	20.0	0	0.0	0	0.0
11	Ramachandrapuram	6	4	66.7	0	0.0	2	33.3	0	0.0
12	Anaparthi	5	5	100.0	0	0.0	0	0.0	0	0.0
13	Rayavaram	4	4	100.0	0	0.0	0	0.0	0	0.0
14	Bikkavolu	5	5	100.0	0	0.0	0	0.0	0	0.0
	Total (division)	79	74	93.7	3	3.8	2	2.5	0	0.0

Table 5: Classification of groundwater samples based on RSC basis during pre-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	RSC					
			<1.25 (safe)		1.25-2.5 (marginal)		>2.5 (harmful)	
			No.	%	No.	%	No.	%
1	Rajahmundry	6	6	100.0	0	0.0	0	0.0
2	Sithanagaram	9	6	66.7	0	0.0	0	0.0
3	Korukonda	5	5	100.0	0	0.0	0	0.0
4	Gokavaram	5	4	80.0	1	20.0	0	0.0
5	Kadiam	5	4	80.0	1	20.0	0	0.0
6	Alamuru	7	5	71.4	1	14.3	1	14.3
7	Rajanagaram	5	5	100.0	0	0.0	0	0.0
8	Mandapeta	7	6	85.7	0	0.0	1	14.3
9	Kapileswarapuram	5	1	20.0	0	0.0	4	80.0
10	Pamarru	5	3	60.0	0	0.0	2	40.0
11	Ramachandrapuram	6	3	50.0	1	16.7	2	33.3
12	Anaparthi	5	5	100.0	0	0.0	0	0.0
13	Rayavaram	4	2	50.0	1	25.0	1	25.0
14	Bikkavolu	5	5	100.0	0	0.0	0	0.0
	Total (division)	79	63	79.7	5	6.3	11	13.9

Table 5: Classification of groundwater samples based on RSC basis during post-monsoon periods in Rajahmundry division of East Godavari district at mandal level

S. No.	Mandal	No. of samples	RSC					
			<1.25 (safe)		1.25-2.5 (marginal)		>2.5 (harmful)	
			No.	%	No.	%	No.	%
1	Rajahmundry	6	6	100.0	0	0.0	0	0.0
2	Sithanagaram	9	9	100.0	0	0.0	0	0.0
3	Korukonda	5	4	80.0	0	0.0	1	20.0
4	Gokavaram	5	5	100.0	0	0.0	0	0.0
5	Kadiam	5	5	100.0	0	0.0	0	0.0
6	Alamuru	7	4	57.1	2	28.6	1	14.3
7	Rajanagaram	5	5	100.0	0	0.0	0	0.0
8	Mandapeta	7	5	71.4	2	28.6	0	0.0
9	Kapileswarapuram	5	1	20.0	1	20.0	3	60.0
10	Pamarru	5	2	40.0	2	40.0	1	20.0
11	Ramachandrapuram	6	3	50.0	0	0.0	3	50.0
12	Anaparthi	5	5	100.0	0	0.0	0	0.0
13	Rayavaram	4	2	50.0	0	0.0	2	50.0
14	Bikkavolu	5	5	100.0	0	0.0	0	0.0
	Total (division)	79	61	77.2	7	8.9	11	13.9

Conclusion

Based on pH and EC values majority of water samples were under slightly acidic to neutral in nature and in C_3 class (EC 0.75-2.25 dS m^{-1}) in both both pre and post-monsoon seasons of Rajahmundry division and based on SAR classification, about 94.9 and 93.7 per cent water samples were under S_1

class i.e., low salinity (S_1 <10) in pre and post-monsoon seasons, respectively. Whereas, based on RSC classification, about 79.7 and 77.2 per cent of water samples were under A_1 class (RSC<1.25 me L^{-1}). i.e., water can be used safely for irrigation in both pre and post-monsoon seasons respectively. As per the USSL (1954) [13] classification majority of the samples were recorded under C_3-S_1 category *i.e.* high salinity-low sodium hazard class in both pre- and post-monsoon seasons, respectively *i. e.*, indicated that major of groundwater samples in Rajahmundry division were slightly suitable for irrigation purpose in crop production.

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