

# Evaluation of Ground Water Quality for the Pre and Post-Monsoon Variations in Physico-Chemical Characteristics of North East Coast of Srikakulam District, A.P., India

H. Ramamohan<sup>1</sup>

<sup>1</sup>Assistant Professor of Environmental Studies,  
AITAM Engineering College,  
Tekkali.

I. Sudhakar<sup>2</sup>

<sup>2</sup>Assistant Professor of Environmental Studies,  
AITAM Engineering College,  
Tekkali.

**Abstract** - Ground water quality for physico-chemical parameters of a coastal region of Srikakulam district, AP has examined, which is having intricate sources of contaminants were known. Water analysis data for nine ground water samples collected in two seasons, winter (post monsoon) and summer (pre monsoon) from the uniformly distributed wells were used. The results indicated that the ground waters show wide variations among different parameters between two seasons during 2013-14. The present study was made an attempt to identify the water quality of the ground water in some selected stations of the coastal areas of Srikakulam district, Andhra Pradesh. The physico-chemical parameters which are very essential for potable purpose like pH, EC, TDS, Total Alkalinity, TH, Calcium, Magnesium, DO, Chlorides, Phosphates, Sulphates, Nitrates, Sodium and Potassium were analyzed and noticed that the water in the present study area is of poor quality. The results indicated that the water using for potable purposes by the rural people of the study area is doesn't meeting the required standards and majority of cases in all the nine field stations exhibiting poor water quality and unfit for potable purpose either in one season or in both the seasons.

**Key words:** Water quality, Potable, Pollution, Coastal area, Ground water.

## I. INTRODUCTION

Safe drinking water is essential to humans and other life forms for safe metabolic activities and functioning of all organs of the body. Historically, surface water has accounted for most of the human consumption, because it is easily accessible with the exception of arid and semi-arid regions, where ground water may be the only reliable source of water. Modern development and population growth however has greatly increased water demands. With the growing inter and intra sectorial competition for water and dealing fresh water resources, the utilization of poor and marginal quality water for potable purposes in rural areas has been posed a new challenge for the management of limited water resources. In water scarce areas there are competing demands from different sectors on the limited available water resources. Access of safe drinking water has impounded over the last decades in almost every part of the world.

Water resources in coastal areas assume a special significance since any development activity will largely depend upon availability of freshwater to meet industrial, domestic, and agricultural requirements is increases the dependency upon ground water for meeting the freshwater demand. Over exploitation of groundwater results in declining the water level as well as quality of water among different seasons. The physico-chemical parameters of water are examined on different seasons and better water quality was found in Post-monsoon season than Pre-monsoon season, extent of pollution occurred due to over exploitation of ground water [1]. Examined the coastal ground waters of Visakhapatnam and the results suggest that the brackish nature in most of the ground water is not due to the seawater influence, but is caused by hydro geochemical process [2]. Studied and found the drinking water quality of ground waters in monsoon season was better than pre monsoon season [3]. Tested the physico-chemical characteristics of different ground water samples of Gwalior city, M.P. showed that maximum samples were not suitable for drinking purpose [4]. Examined the ground water quality of Rampur district of U.P. showed the overall quality of water is found to be not suitable for drinking purposes with any prior treatment except at eight locations out of sixty village's samples [5].

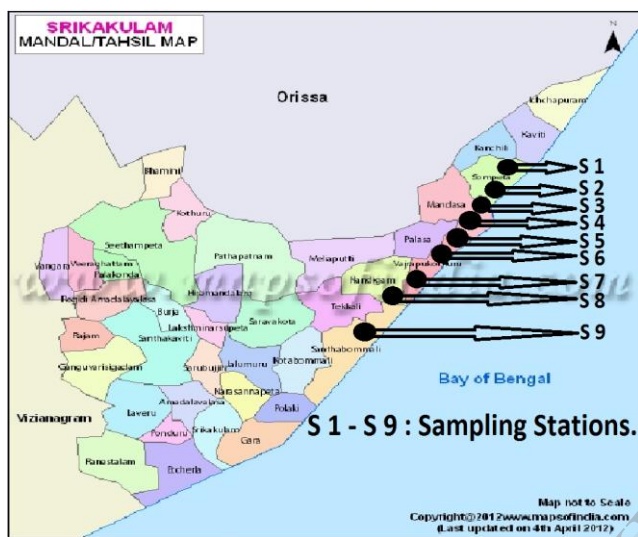
A ground water quality assessment has been carried to study the quality of water along coastal corridor of Srikakulam district, Andhra Pradesh. The ground water samples were collected from around nine field stations of Srikakulam district. The present study showed a special emphasis on the determination of levels of pollution or quality of ground waters in the costal corridor of Srikakulam district.

### *Study area and description:*

The study area Srikakulam, is the extreme northeastern district of Andhra Pradesh, situated within the geographic co-ordinates of 18°-20' and 19°-10' N and 83°-50' and 84°-50' E. The study area is bounded by Vizianagaram District in the south and west, while Odisha

State is on the north and Bay of Bengal on the East. Srikakulam district occupies an area of 5,837 square kilometers; district can be divided into two main distinct natural divisions. A portion of Srikakulam district is plain terrain with intense agriculture and another portion of the district is rocky and hilly terrain covered with forests. Srikakulam district has the longest coast line about 193 km in the state of Andhra Pradesh. Currently selected nine sampling stations for the present study from Sompeta to Santhabommali Mandals of Srikakulam district, AP is shown in **Fig.1**.

Fig: 1. Showing the Study Area Along With Sampling Stations



Major Rivers flowing through the district are River Nagavali, River Vamsadhara, Mahendratnaya, Champavati, Bahuda, Kumbhikota Gedda, Suvarnamukhi, Vegavati, Gomukhi. The Nagavali and Vamsadhara are the major rivers in Srikakulam district. These two river basins together constitute about 5% of the area. The Mahendratnaya and Bahuda rivers are two minor river basins in the district. Others are Benjigedda, Peddagedda, Kandivalasa gedda. Google maps were used to locate the current study area and to identify the sampling stations of the study area.

## II. MATERIALS AND METHODS

### *Sampling methods:*

In the current study area water samples were collected from both dug wells and bore wells of nearby coastal areas at random both in winter (post monsoon) and summer (pre monsoon) seasons. Water samples have been collected in 2 liter capacity polythene bottles (soaked overnight in 2% nitric acid and washed well in distilled water) from each location. The collected samples were properly labeled which indicates the source of the sample time and date of collection. The samples were brought to the laboratory and analyzed for the parameters within the 48 hours of collection; which has been carried out using the Standard methods of water analysis is employed to analyze the physico- chemical parameters of the water following APHA [6].

### *Importance of sampling:*

In the analysis of pollutant, the importance of sampling should not be undermined since any error due to improper sampling can lead to incorrect result. Since the quality of ground water remains constant with only slight variation throughout the year, grab samples are sufficient for the analysis.

### *Precaution taken during sampling:*

The samples that are taken on tap are directly connected to the main hand pump. While during collection of the samples inside and outside of the tap is thoroughly cleaned. The samples of well are collected in such a way that, the well water is pumped sufficient so that the representative sample of ground water feeding the well will be collected to consideration. All water samples are analyzed as per standard procedures. Proper care taken in the storage of the sample, in such a way that their composition does not change between the period of collection and analysis. The samples are sealed and stores under cool and dry condition.

### *Testing and Analysis of Water Quality Parameters:*

The Physico-Chemical parameters of the samples analyzed in triplicate by adapting standard procedures from manual of American Public Health Association [6], the test results compared with standards of water quality parameters given by the IS: 10500 of BIS rules [7].

## III. RESULTS AND DISCUSSIONS

The physico-chemical parameters of the ground water which are essential for potable purpose like pH, EC, TDS, Total Alkalinity, TH, Calcium, Magnesium, DO, Chlorides, Phosphates, Sulphates, Nitrates, Sodium and Potassium were analyzed and presented in **Tables. 2, 3, 4 and 5**. The sampling stations, source of the water from where sampling has been done and utilization of water by the people etc., is given in **Table.1**.

Table: 1. Sampling Stations, Source of Water and Utilization in the Study Area

Table.1: Sampling stations, water source and utilization of water in the study area during 2013-14.			
Station Code	Name of the Sampling Station	Water Source	Utilization
S1	Isakapalem	Bore well	Drinking
S2	Baruva	Bore well	Drinking
S3	Ratti	Bore well	Drinking
S4	M.Ganguvada	Hand pump	Drinking
S5	Dokulapadu	Bore well	Drinking
S6	Nuvvalarevu	Bore well	Drinking
S7	Devunalthada	Hand pump	Drinking
S8	Hukumpeta	Bore well	Drinking
S9	H.N.Peta	Bore well	Drinking

Table: 2. Physico Chemical Characters of Ground Water During Winter and Summer

Table-2: Physico chemical characteristics of ground water collected from different sampling location in Winter and Summer seasons (2013-14)										
Station Code	pH		TA (mg/l)		EC ( $\mu$ s)		TDS (mg/l)		DO (mg/l)	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
S1	7.04	7.2	148	152	1860	2000	1016	1111	7.46	7.8
S2	7.28	7.3	100	122	940	1200	426.6	450	7.7	7.9
S3	7.1	7.4	127	173	1580	1600	826.6	830	5.73	5.6
S4	7.2	7.4	172	188	2400	2800	1430	1600	8.1	8.3
S5	7.4	7.9	140	157	1550	1800	1226	1300	6	6
S6	7.25	7.5	166	190	1970	2000	630	690	7.96	8
S7	7.21	7.4	290	310	4390	4500	1220	1330	7.23	7.5
S8	7.25	7.5	188	192	2580	2000	1423	1500	6.5	6.7
S9	7.68	8.2	192	217	3190	3000	1020	1222	7.86	8

Table: 3. Physico Chemical Characters of Ground Water During Winter and Summer

Table-3: Physico chemical characteristics of ground water collected from different sampling location in Winter and Summer seasons (2013-14)						
Station Code	TH (mg/l)		Ca+ (mg/l)		Mg+ (mg/l)	
	Winter	Summer	Winter	Summer	Winter	Summer
S1	316.6	320	11	13	19.6	100
S2	653.3	670	23	24	523.3	525
S3	413.3	425	23	26	253.3	257
S4	416.6	431	11.54	13	256.6	262
S5	760	781	17.3	19	690	709
S6	773.3	794	23	26	583.3	596
S7	480	489	17.3	18.6	330	345
S8	476.6	495	11.54	12.9	366.6	378
S9	523.3	549	23	24.7	373.3	380

Table: 4. Physico Chemical Characters of Ground Water During Winter and Summer

Table-4: Physico chemical characteristics of ground water collected from different sampling location in Winter and Summer seasons (2013-14)								
Station Code	Chlorides (mg/l)		Phosphates (mg/l)		Sulphates (mg/l)		Nitrates (mg/l)	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
S1	140	135	9.13	10	7.5	8	10.4	11
S2	100	125	12.76	13	3.5	3	12.83	13
S3	130	149	12.03	13	11	12	11.76	12.3
S4	160	161	11.06	12	16	16.5	16.1	16.4
S5	138	155	12.73	13.1	33	33.6	11	11.7
S6	150	172	11.73	12.33	17.5	17.9	11.33	11.9
S7	752	699	14.06	14.3	3.5	5	12.03	12.2
S8	185	210	11.93	12.1	33.5	34	13.76	14
S9	200	210	12.4	12.9	23.5	24	12.9	13.4

Table: 5. Physico Chemical Characters of Ground Water During Winter and Summer

Table-5: Physico chemical characteristics of ground water collected from different sampling location in Winter and Summer seasons (2013-14)				
Station Code	Na+ (mg/l)		K+ (mg/l)	
	Winter	Summer	Winter	Summer
S1	4	5.2	53.3	54
S2	44.6	49	42.5	43
S3	45.96	50.2	47.73	48
S4	48.66	51.2	52.46	53.4
S5	45	46.4	96	97
S6	6.53	6.9	43.4	44.8
S7	42.1	42.9	66.6	69.1
S8	40.93	41.8	72.5	73.1
S9	47.4	49.2	55.9	56.9

**pH:** The pH values of study area is ranged from 7.04 to 7.68 during post monsoon and 7.2 to 8.2 during pre monsoon. The minimum and maximum values have recorded during post and pre monsoon seasons at the same field stations. The pH values of all the stations indicating alkaline condition and within permissible limits (6.5 to 8.5 pH) as per the Indian Standards, given in **Table. 2 and Fig.1**. The pH values of the study area show that higher values have recording during pre monsoon season than post monsoon.

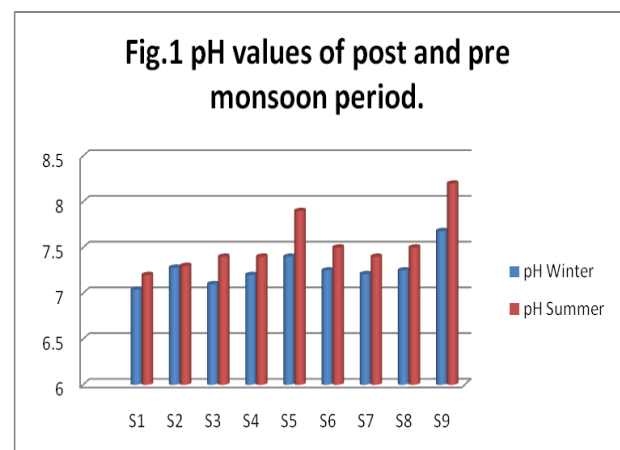


Fig: 1. pH for the Post and Pre Monsoon Seasons

**Total Alkalinity:** The Total Alkalinity for the ground water quality of the study region is ranged from 100 to 290 mg/l during post monsoon and 122 to 310 mg/l during pre monsoon season. The minimum and maximum values have recorded for both post and pre monsoon seasons in the same stations. The Total Alkalinity of all the stations is less than the desirable limit (200 mg/l) except Devunalthada, where the values are recorded at more than the desirable limits for both the seasons, H.N.Peta, where the TA is more than the desirable limit only for pre monsoon season, given in **Table.2 and Fig.2**. However all the values are with in the maximum permissible limits (600 mg/l). It is observed that the values of TA from all the sampling stations are recorded at higher in pre monsoon season than the post monsoon.

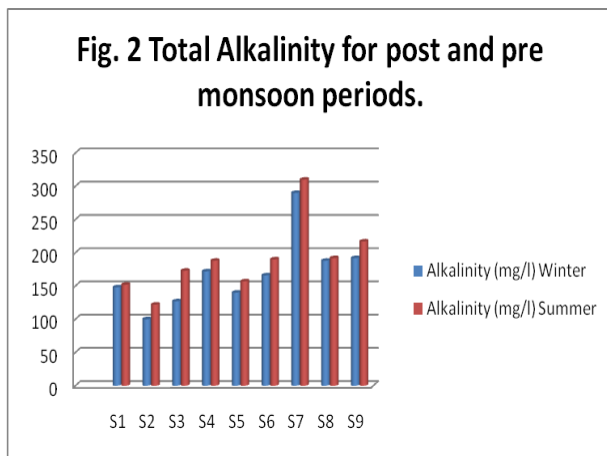


Fig. 2. Total Alkalinity for the Post and Pre Monsoon Seasons

**Electrical Conductivity:** The Electrical Conductivity of the sampling waters for winter and summer seasons are ranging from 940 to 4390 micro semens and 1200 to 4500 micro semens correspondingly. The values of minimum and maximum have recorded in the same field stations, given in **Table. 2 and Fig. 3**. The EC values from all the field stations recoded at higher in pre monsoon season than post monsoon except Hukumpeta and H.N.Peta, where the values are recorded at higher during post monsoon season than pre monsoon.

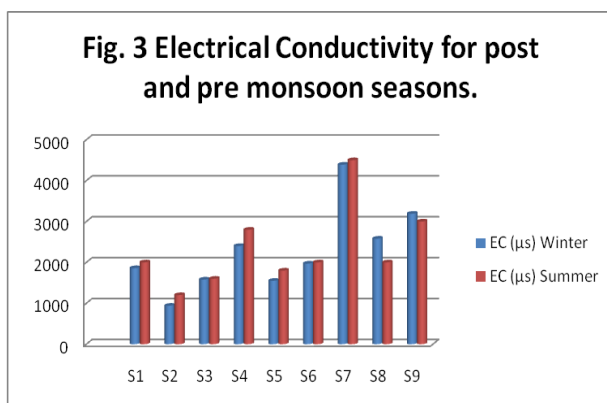


Fig. 3. Electrical Conductivity for the Post and Pre Monsoon Seasons

**Total Dissolved Salts:** The Total Dissolved Salts of the sampling area is ranging from 426.6 mg/l to 1430 mg/l in winter and 450 mg/l to 1600 mg/l in summer. The minimum and maximum values have recorded in the same field stations and data given in **Table. 2 and Fig. 4**. It is observed that the TDS from all the sampling stations is recorded at more than the desirable limit (500 mg/l) during both post and pre monsoon seasons except from Baruva, where the TDS is present less than the desired limit. However the values are with in the maximum permissible limits (2000 mg/l). It is observed that the TDS values are recorded at higher during pre monsoon than post monsoon season.

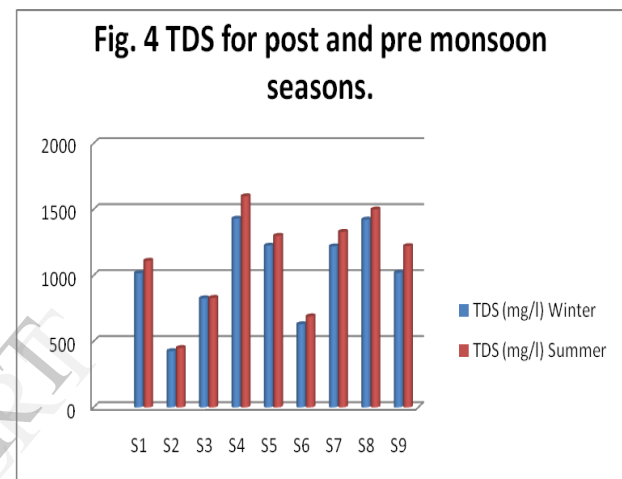


Fig. 4. TDS for the Post and Pre Monsoon Seasons

**Dissolved Oxygen:** The Dissolved Oxygen of the study area is ranging from 5.73 mg/l to 8.1 mg/l during winter and this was 5.6 mg/l to 8.3 mg/l during summer. The minimum and maximum values recorded in the same field stations, is shown in **Table.2 and Fig. 5**. The DO concentration from all the stations is recorded at more or equal during pre monsoon season than post monsoon except Ratti, where the value is more during post monsoon than pre monsoon season.

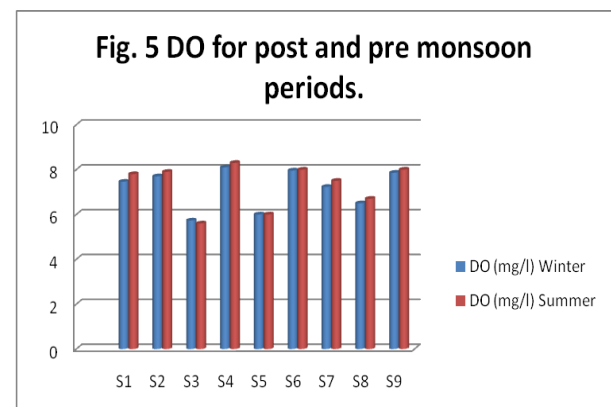


Fig. 5. DO for the Post and Pre Monsoon Seasons

**Total Hardness:** The Total Hardness from the study stations is ranging from 316.6 mg/l to 773.3 mg/l in winter and this was 320 mg/l to 794 mg/l in summer expressed as CaCO<sub>3</sub>. The minimum and maximum hardness has recorded from the same sampling stations, were given in **Table. 3 and Fig. 6**. It is noticed that the concentration of Total Hardness recorded in pre monsoon season is more than the post monsoon season. But the TH is recorded in all the study stations is more than the desirable limit (300 mg/l) and it is recorded more than the maximum permissible limit (600 mg/l) in the stations of Baruva, Dokulapadu and Nuvvalarevu for both pre and post monsoon seasons.

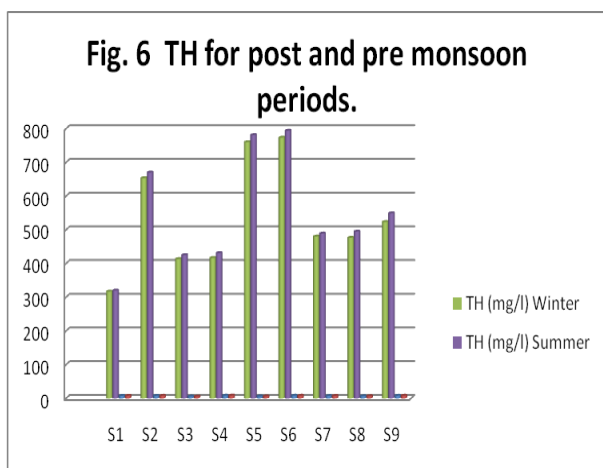


Fig: 6. Total Hardness for the Post and Pre Monsoon Seasons

**Calcium:** The Calcium values from the sampling stations were ranging from 11 mg/l to 23 mg/l in winter and this was 12.9 mg/l to 26 mg/l during summer expressed as Ca. The minimum value has recorded from field station of Isakapalem and maximum values recorded from different field stations like Bruva, Ratti, Nuvvalarevu and H. N. Peta during winter and the minimum values have recorded from Isakapalem and M.Ganguvada, maximum values recorded from Ratti and Nuvvalarevu during summer were discussed in **Table. 3 and Fig. 7**. It is noticed that the Ca concentration in all the study stations are less than the desirable limit (75 mg/l) for both pre and post monsoon seasons. The Ca values are recorded at higher concentration during pre monsoon than post monsoon season.

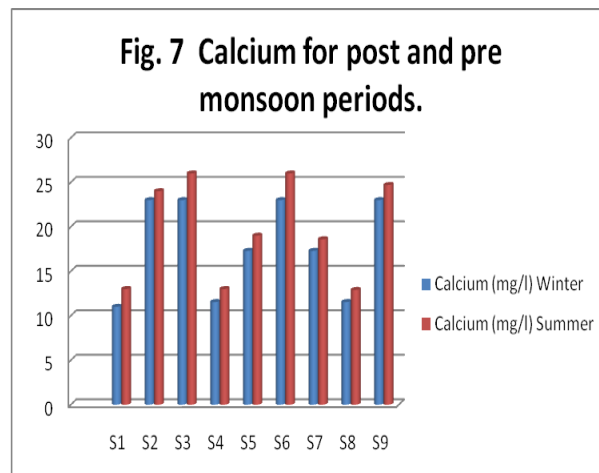


Fig: 7. Calcium for the Post and Pre Monsoon Seasons

**Magnesium:** The values of Magnesium have been recorded from the study area is ranging from 19.6 mg/l to 690 mg/l in winter and 100 mg/l to 709 mg/l during summer expressed as Mg. The minimum and maximum values recorded from the same field stations, were discussed in **Table. 3 and Fig. 8**. As per the observations the concentrations are recorded at higher during pre monsoon than post monsoon season. However except Isakapalem all the samples baring the Mg concentration more than the maximum permissible limit (100 mg/l) during pre and post monsoon seasons. Where as in Isakapalem this was less than the desirable limit (30 mg/l) during post monsoon season only, in pre monsoon season this was within the desirable limit.

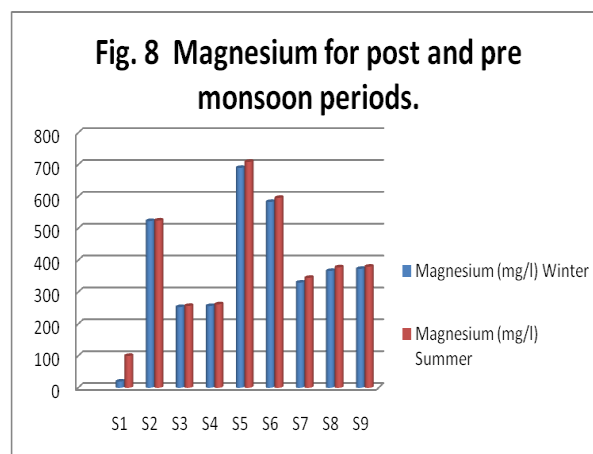


Fig: 8. Magnesium for the Post and Pre Monsoon Seasons

**Chlorides:** The values of Chlorides have been recorded from the study area is ranging from 100 mg/l to 752 mg/l in winter and 125 mg/l to 699 mg/l during summer expressed as Cl. The minimum and maximum values recorded from the same field stations, were discussed in **Table. 4 and Fig. 9**. Observations revealed that the chloride concentration of the entire sample waters from study stations possess less than the desirable limit (250 mg/l) for both pre and post monsoon seasons except Devunalthada. Where as in

Devunalthada the waters possess the concentrations more than the desirable limit but within the maximum permissible limit (1000 mg/l) recorded for both the seasons. The values recorded at higher in pre monsoon than post monsoon season except in Isakapalem and Devunalthada, where this was reversed.

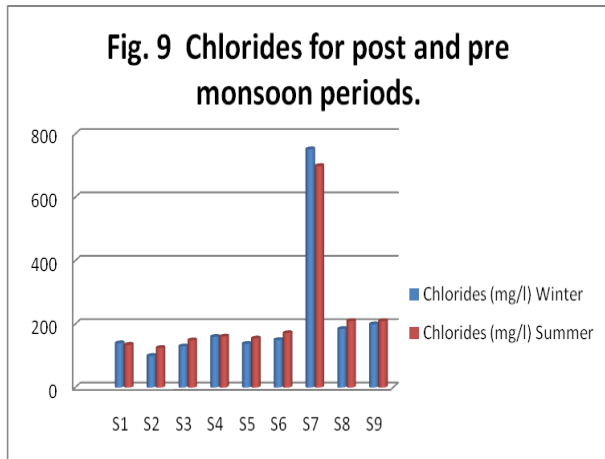


Fig. 9. Chlorides for the Post and Pre Monsoon Seasons

**Phosphates:** The values of Phosphates have been recorded from the study area is ranging from 9.13 mg/l to 14.06 mg/l in winter and 10 mg/l to 14.3 mg/l during summer. The minimum and maximum values recorded from the same field stations, were discussed in **Table. 4 and Fig. 10**. The phosphate concentration of sample waters in all the stations recorded at higher during pre monsoon than post monsoon season.

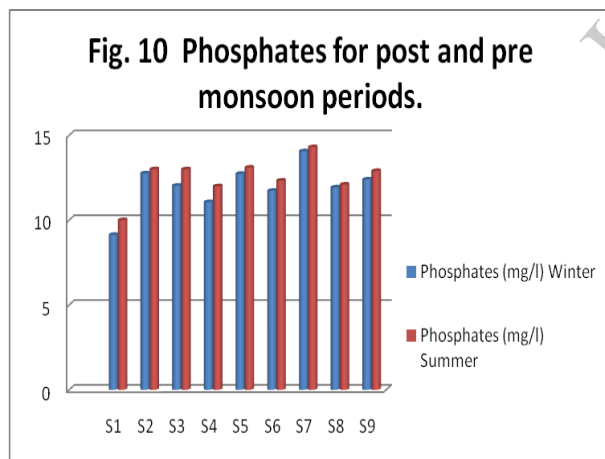


Fig. 10. Phosphates for the Post and Pre Monsoon Seasons

**Sulphates:** The values of Sulphates have been recorded from the study area is ranging from 3.5 mg/l to 33.5 mg/l in winter and 3 mg/l to 34 mg/l during summer expressed as  $SO_4$ . The minimum and maximum values recorded from two field stations (Baruva and Devunalthada) and maximum value recorded from the Hukumpeta in winter, while the minimum and maximum values have been recorded from the field stations, i.e., Baruva and Hukumpeta in summer were discussed in **Table. 4 and Fig. 11**. It is observed that all the sample waters from all the study stations possess less concentration and it is less than desirable limit (200 mg/l) for both pre and post monsoon seasons. The sulphate

concentration is recorded at higher during pre monsoon than post monsoon season except Bruva, where this was reversed.

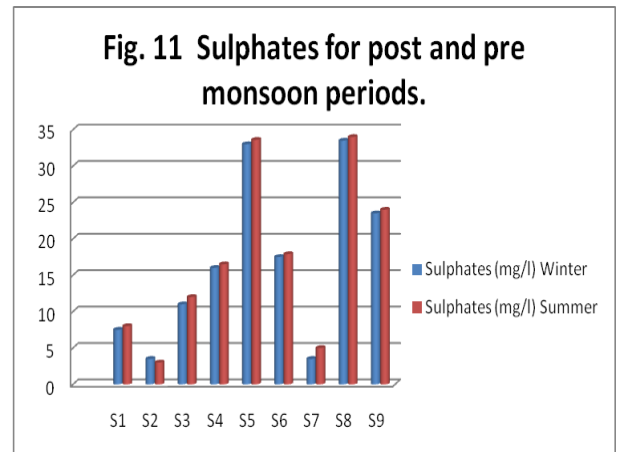


Fig. 11. Sulphates for the Post and Pre Monsoon Seasons

**Nitrates:** The values of Nitrates have been recorded from the study area is ranging from 10.4 mg/l to 16.1 mg/l in winter and 11 mg/l to 16.4 mg/l during summer expressed as  $NO_3$ . The minimum and maximum values recorded from the same field stations, i.e., Isakapalem and M.Ganguvada respectively were discussed in **Table. 4 and Fig. 12**. The nitrate concentration from all the study stations is recorded at higher during pre monsoon than post monsoon season. Observations revealed no sample possess desirable concentration of nitrates, all the sample waters of entire study area baring less than desirable limit (45 mg/l) for both pre and post monsoon seasons.

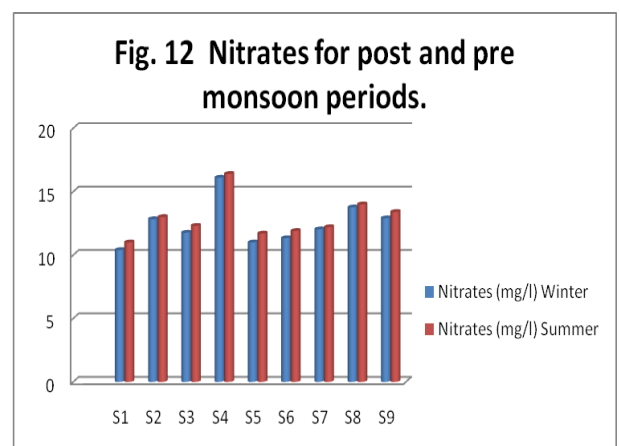


Fig. 12. Nitrates for the Post and Pre Monsoon Seasons

**Sodium:** The values of Sodium have been recorded from the study area is ranging from 4 mg/l to 48.66 mg/l in winter and 5.2 mg/l to 51.2 mg/l during summer. The minimum and maximum values recorded from the same field stations, i.e., Isakapalem and M.Ganguvada respectively were discussed in **Table. 5 and Fig. 13**. It is noticed that the sodium values recorded at higher during pre monsoon than post monsoon season.

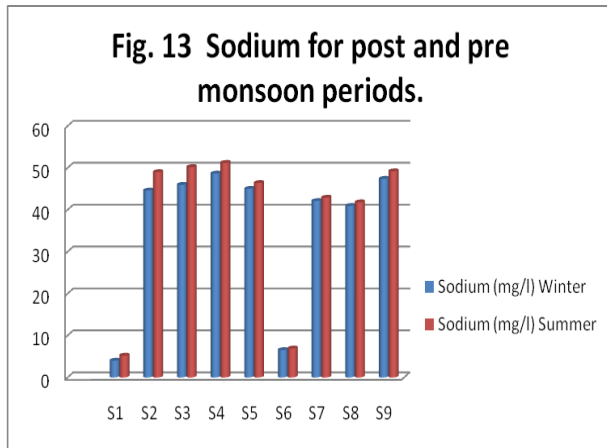


Fig. 13. Sodium for the Post and Pre Monsoon Seasons

**Potassium:** The values of Potassium have been recorded from the study area is ranging from 42.5 mg/l to 96 mg/l in winter and 43 mg/l to 97 mg/l during summer. The minimum and maximum values recorded from the same field stations, i.e., Baruva and Dokulapadu respectively were discussed in **Table. 5 and Fig. 14**. It is noticed that the potassium values recorded slightly higher during pre monsoon than post monsoon season.

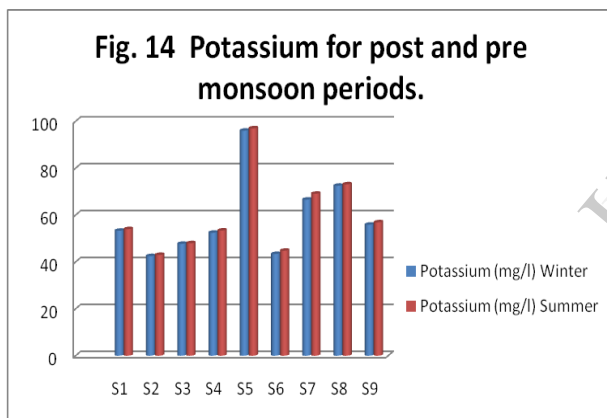


Fig. 14. Potassium for the Post and Pre Monsoon Seasons

#### IV. CONCLUSION

The physico-chemical parameters of the ground water have been assessed in order to know the quality of water along a stretch of north-east coast of Srikakulam district, the current study area of nine stations. Based on the study some deviations were observed and the results showed that the water quality is poor and majority of the waters doesn't meeting the standards as per Indian Standards for drinking water (BIS: 10500, 2003). Even some field stations not possessed minimum desirable limits required for drinking waters. This may be reason due to the nearness to the sea coast or drop of water table due to over use of ground waters. It is observed that the water quality parameters recorded at higher concentration during pre monsoon season than post monsoon season may be due to the influence of monsoon rains. The pH of all the study stations is at alkaline condition but within the range of 6.5 to 8.5. The Total Alkalinity of all the stations is less than the desirable limit except Devunalthada, where the values

are recorded at more than the desirable limits for both the seasons, H.N.Peta, where the TA is more than the desirable limit only for pre monsoon season. It is observed that the TDS from all the sampling stations is recorded at more than the desirable limit during both post and pre monsoon seasons except from Baruva, where the TDS is present less than the desired limit. However the values are within the maximum permissible limits.

The TH is recorded in all the study stations is more than the desirable limit and it is recorded more than the maximum permissible limit in the stations of Baruva, Dokulapadu and Nuvvalarevu for both pre and post monsoon seasons. It is noticed that the Ca concentration in all the study stations are less than the desirable limit for both pre and post monsoon seasons. However except Isakapalem all the samples baring the Mg concentration more than the maximum permissible limit during pre and post monsoon seasons. Where as in Isakapalem this was less than the desirable limit in post monsoon season only. Observations revealed that the chloride concentration of the entire sample waters from study stations possess less than the desirable limit for both pre and post monsoon seasons except Devunalthada. Where as in Devunalthada the waters possess the concentrations more than the desirable limit but within the maximum permissible limit recorded for both the seasons. It is observed that all the sample waters from all the study stations possess less concentration of sulphates and it is less than desirable limit for both pre and post monsoon seasons. Observations revealed no sample possess desirable concentration of nitrates, all the sample waters of entire study area baring less than desirable limit for both pre and post monsoon seasons. The results indicated that the water using for potable purposes by the rural people of the study area is doesn't meeting the required standards and majority of cases in all the nine field stations exhibiting poor water quality and unfit for potable purpose either in one season or in both the seasons.

#### V. REFERENCES

- 1) Akhilesh Jinwa and Savita Dixit (2008) Pre- and Post-Monsoon Variation in Physico-Chemical Characteristics in Groundwater Quality of Bhopal "The City of Lakes" India *Asian J. Exp. Sci.*, Vol. 22, No. 3; 311-316.
- 2) Subba Rao, N; Saroja Nirmala, I and Suryanarayana, K (2005) Groundwater quality in a coastal area: A case study from Andhra Pradesh, India. *Environmental Geology*, 48: 543-550.
- 3) Sivakumar, K. K; C. Balamurugan; Ramakrishnan, D and Leena Hebsibai, L (2011) Studies on Physicochemical Analysis of Ground Water in Amaravathi River Basin at Karur (Tamil Nadu), India, *Water Research & Development*, Vol. 1 |No.1 | 36-39 |
- 4) Parihar S.S., Kumar Ajit, Kumar Ajay, Gupta R.N., Pathak Manoj, Shrivastav Archana and Pandey A.C.(2012) Physico-Chemical and Microbiological Analysis of Underground Water in and Around Gwalior City, MP, India. *Research Journal of Recent Sciences*, Vol. 1(6), 62-65.
- 5) Yadav, S. S and Rajesh Kumar (2010) ASSESSMENT OF PHYSICO-CHEMICAL STATUS OF GROUND WATER TAKEN FROM FOUR BLOCKS (SUAR, MILAK, BILASPUR, SHAHABAD) OF RAMPUR DISTRICT, UTTAR PRADESH, INDIA. *RASAYAN. j. Chem.* Vol.3, No.3 (2010), 589-596.
- 6) Standard methods for examination of water and waste waters, APHA, AWWA and WPCF Inc., New York, 1205 (2005).
- 7) BUREAU OF INDIAN STANDARDS, Indian Standard Drinking Water - Specification, IS: 10500 (2003).