

# STATISTICAL STUDY OF GROUNDWATER QUALITY IN PEDACHERLO PALLE MANDAL VILLAGES, PRAKASAM DISTRICT, ANDHRA PRADESH,

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**Abstract** : Ground water is a valuable natural source and its quality is a important issue due to increase the population and industrial development, in the study area the communities depends on groundwater as directly for drinking purpose, hence the quality of groundwater is very important, water samples were collected from ten villages in the study area and analysed in the laboratory using standard APHA, procedures for various parameters, such as pH, TDS, Total Hardness, Electrical Conductivity, F<sup>-</sup>, SO<sub>4</sub><sup>2-</sup>, Cl<sup>-</sup>, Ca<sup>2+</sup>, Mg<sup>2+</sup>, K<sup>+</sup>, Na<sup>+</sup>, F<sup>-</sup>, Fe<sup>-</sup>, and compared with the BIS, WHO and APHA standards to study the physico-chemical and statistical, the results reveals that maximum concentrations and exceeded the standard values and cause health impacts, so that it requires groundwater treatment before consumption for its use.

**Key Words:** Groundwater, Health impacts, Quality, standards, statistical

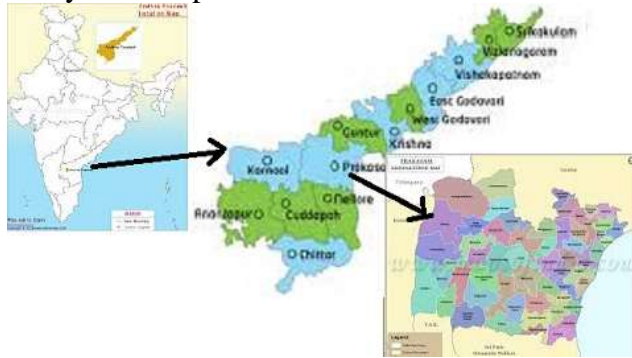
## I. INTRODUCTION

The fresh water on the earth is only 2.8% out of all the waters on the earth and out of that 0.03% of fresh water is readily available for drinking and other purposes in the form of surface water and ground water. (Venkata rao and Kalpana 2016), It is a nature's most wonderful abundant and useful compound, and not only essential for the lives of animals and plants, but also occupies a unique position in industries, most of the people directly depends on surface, ground and rain water to meet their needs especially for Drinking and domestic purpose (Sudhakar et al., 2014), In India, most of the population is depends on groundwater as the only source for drinking supply, and it is believed that comparatively much clean and free from pollution than surface water.( Mangukiya et al 2012), The Groundwater is the prime resource and most significant environmental problems in coastal Andhra Pradesh, that increase in salinity of the groundwater. The source of salinity and the mechanism of groundwater salinization in the coastal Andhra Pradesh are not known. (Sudhakar et al., 2014a), the drinking water quality depends on many physico-chemical parameters concentrations and indicators to measure the quality for of irrigation (Sudhakar et al., 2014b, Srinivas et al., 2018). The quality of groundwater for drinking and other purposes have been assessed by comparing with the guidelines recommended by World Health Organization (WHO, 2004). and several researchers has been done on groundwater for irrigation, domestic and other purposes (Singh et al. 2008; Xiang et al. 2009; Shrestha et al.,2010).

## 1.1 Study area

Prakasam district was originally constituted on 2 February 1970, carved out of Guntur, Nellore and Kurnool districts of Andhra Pradesh. It was carved out of three taluks of Guntur District i.e. Addanki, Chirala and Ongole, four taluks of Nellore district, i.e. Kandukuru, Kanigiri, Darsi and Podili and three taluks of Kurnool district i.e. Markapur, Yarragondalalem and Giddalur. It is one of the nine districts in the Coastal Andhra Pradesh. The PC Palle is one of the mandal in 56 mandals of Prakasam district, it consists of 68 Villages and 18 Panchayats (Srinivasa Rao et al., 2018).

Fig: 1 Study area Map



## 2. MATERIALS AND METHODS

### 2.1 Sample collection

The samples were collected from ten villages in the study area based on the consumption of groundwater for drinking and domestic. The sampling points of selected villages are noted as sample- S1-Battupalle, S2-Chinavari Madugu, S3-Chinthagum Palle, S4-Chowta Gogula Palle, S5- Guntu Palle, S6-Lakshmakka Palle, S7-Marella, S8-Muddapadu, S9-Murugammi, S10-Neredu Palle. A field investigation was done to overview the quality of groundwater in various villages of the Pedacherlopalle mandal. The capacity of each sample bottle is 1L. 10 samples were collected from different villages in the study area and analyzed using standard procedures in the laboratory (APHA, 1985, WHO, BIS). The list of samples collected from the study area given in Table 1. The parameters include various physical and chemical constituents are analyzed in the laboratory according to lab procedures and several studies refers to ground water quality analysis has been explored by many authors like Rajan & Paneerselvam (2005), and Shikha Bisht et al. (2007), Arun Kumar et al, (2015).

Correlation analysis was measures with the closeness of relationship between independent and dependent variables of chosen parameters. If the correlation coefficient is near to +1 or -1, it shows the probability of linear relationship between the variables x and y. (Sudhakar et al., 2014 a), The correlation between the parameters is strong, when it is in the range of +0.8 to 1.0 and -0.8 to -1.0, moderate when it is having value in the range of +0.5 to 0.8 and -0.5 to -0.8, weak when it is in the range of +0.0 to 0.5 and -0.0 to -0.5, the following equation is used to find the correlation of parameters. (equ-1)

$$R = \frac{\sum (X - \bar{X})(Y - \bar{Y})}{\sqrt{\sum (X - \bar{X})^2 \sum (Y - \bar{Y})^2}} \text{-----(equ-1)}$$

Where, x (x =values of x- water quality parameters. If the values of correlation coefficient 'R' between two variables x and y are fairly large, it implies that these two variables are highly correlated. Variable, X =average values of x) and y (y =values of y-variable, Y =average values of y) represents two different

## 3. RESULTS AND DISCURSION

The groundwater quality of selected sampling sites in Pedacherlopalle mandal were observed by analyze groundwater sample parameters are physico-chemical, and study the statistical analysis. pH indicates the intensity of acidity and alkalinity in water. It is one of the important parameter of water body. In present study, the pH values are found to be in the range from 6.9 to 8.9. All the ground water samples are within the permissible limit (6.5 – 8.5 according to WHO & BIS). Except Sample 6- and Samples 10 (table1&3), the average is 8.02, in statistical analysis the Standard deviation and standard errors are 0.639 and 0.202. In the study area the pH is slightly basic nature in few sampling station, the high values of pH result by waste discharge, microbial decompositions in the water body (Patil et al., 2012). Total dissolved solids concentration in all sampling stations were exceeded the permissible limit 500 Mg/l, the average, minimum, maximum, standard deviation and standard error are observed 1960.3 mg/l, 1125 mg/l, 2741 mg/l, 482.84 and 152.67, the correlation with the other parameters Fe, Mg, and Ca positive correlation which leads the increase the dissolved particles in groundwater, due to over extraction of groundwater through bore wells and salt water intrusions affect the dissolved substances in the ground aquifers, High concentration of Total Dissolved Solids are aesthetically unsatisfactory for use (Kumar and Kumar, 2013).

Hardness of water is defined as the inhibition of soap action in water in presence of magnesium and calcium salts such as carbonates, sulfates, and chlorides (Sudhakar et al., 2014 b), The hardness values in the study area to be high in all samples except S4

& S5 in the study area, the standard permissible limit is 300mg/l according to WHO & BIS, the correlation of Total Hardness with  $SO_4$ -0.843, Na-0.628, Mg-0.572, Cl-0.564 are positive correlation (table 4 & figure 5), the minimum and maximum values are 234-652 Mg/l and the standard deviation is 144.1 mg/l and standard error is observed in the groundwater samples are 45.51 (table 3 & figure 3), it indicates the groundwater having the more hardness by the presence of Ca and Mg salts (Kataria et al., 2011), and causes Urolithiasis. The chloride concentration in the groundwater samples lied between 220-425 mg/L. It is normally the dominant anion. The permissible limit for chloride in drinking water is 250-mg/L (WHO and BIS) high concentration of chloride is due to the invasion of domestic wastes and disposals by human activities (Jha and Verma., 2000, Jothi et al., 2010). In the present study; the value of chlorides except S4 & S5 samples are in permissible limit remaining all samples found to be high concentration table: 2, 3 & 4, figure 2, which can cause corrosion on iron plates or pipes. The correlation of the chlorides with other parameters like  $SO_4$ -0.687, TH-0.564, Mg-0.463, Na-0.253 and K-0.23 are positive correlation which indicates the TDS and Hardness of water will increase and effect to the organism's health without proper treatment, the chloride concentration serves as an indicator of pollution by sewage. People accustomed to higher chloride in water are subjected to Laxative (Fried & combarnous, 1971).

The Iron concentration in study are groundwater samples are observed that the minimum level is 1.5 mg/l, maximum levels is 5.2 mg/l, Standard deviation and standard errors were observed in statistical study that are 1.67 & 0.369, (table 2 & figure 4 and 6) shows in graphical representation, except S10 remaining all sampling stations were exceeded the permissible limit of Iron (table 3) according to the standards BIS and WHO, The high concentration of iron causes a bitter astringent taste to water and a brownish color to laundered clothing and plumbing fixtures. (Manjesh and Ramesh, 2012). Electrical conductivity of water is a direct function of its total dissolved salts (Harilal et al, 2004). According to WHO and USPH total dissolved solid values for drinking water permissible minimum is 500 mg/L, the maximum permissible limit is 1500 mg/L. The analyzed data shows that three samples had more than the maximum permissible limit. Electrical conductivity is the indicator the total ionized constituent of water. It is directly related to sum of the cations and anions (Maruthi and Rao S R K, 2004), Electrical Conductivity in present study all the samples are exceeded in groundwater samples according to WHO and BIS standards 300  $\mu$ mhos/cm, the values are range from 1024 to 3214, the standard deviation and Standard errors are 634.14 and 200.83, the high conductivity values obtained for the groundwater is an indication of its effect on the water quality.

The Sodium, Mg, Ca, Potassium and Fluoride values are exceeded in all sampling stations according to WHO and BIS Standards indicated in table 2 & 3, and the graphical representation shows that ranges of all sampling stations figure: 4 & 7, the correlation study is use to find out the relationship of different independent and dependent variables either positive or negative, indicated in table 4. It is the measurement of the strength and statistical significance of the relation between two are more water quality (Mehta, 2010). The Sulphates concentration in the study area range from 48 to 274 mg/l, some of the sampling sites S1, S2 and S8 were exceeded the standard level, the standard deviation and standard errors are 76.06, 24.053, the correlation with TH-0.843, Cl-0.68, Mg-0.65 Na-0.35 and K-0.221 are observed the positive relation, it indicates the formation of acidity and leads to acidic nature of water, the similar studies were observed by the Sudhakar et al., (2014c).

Table 1: Sampling stations in the study area

S.No	Sample Name	Sample No
1	Battupalle	S1
2	Chinavari Madugu	S2
3	Chinthagum Palle	S3
4	Chowta Gogula Palle	S4
5	Guntu Palle	S5
6	Lakshmakka Palle	S6
7	Marella	S7
8	Muddapadu	S8
9	Murugammi	S9
10	Neredu Palle	S10

	pH	TDS	Cl	Na	Ca	Mg	F	K	SO4	EC	Fe	TH
Min	6.9	1125	220	145	101	49	1.9	54	48	1024	1.5	234
Max	8.9	2741	425	325	184	95	4.6	162	274	3214	5.2	652
Average	8.02	1960.3	298.8	257.2	142.5	74.3	2.612	108.1	140.5	2301.2	2.887	450

SD	0.6391	482.811	55.7072	65.168	23.057	16.806	0.807	37.655	76.062	634.14	1.167	144.1
SE	0.2021	152.678	17.6162	20.608	7.2912	5.3147	0.2552	11.907	24.053	200.53	0.369	45.57

Table 2: Min, Max, Average, Standard deviation and Standard Error of Groundwater quality parameters

Table: 3 Standard Values of parameters and exceeded samples in the study area

S.No	Parameter	Range	Standards	Exceeded samples
1	pH	6.5-8.5	WHO/BIS	S6, S10
2	EC	300	WHO/BIS	All samples
3	TDS	500	WHO/BIS	All samples
4	TH	300	WHO/BIS	Except S4 & S5
5	Ca	75	WHO	All samples
6	Mg	30	WHO/BIS	All samples
7	Cl	250	WHO/BIS	Except S4 & S5
8	SO4	200	WHO/BIS	S1, S2 & S8
9	Na	60	WHO	All Samples
10	K	20	WHO	All Samples
11	F	1.5	WHO/BIS	All Samples
12	Fe	0.1	WHO/BIS	Except S10

Table 4:

Correlation coefficient in Ground water

	pH	TDS	Cl	Na	Ca	Mg	F	K	SO4	EC	Fe	TH
pH	1											
TDS	-0.423	1										
Cl	0.1633	0.002	1									
Na	0.5524	-0.406	0.253	1								
Ca	0.1878	0.132	0.033	-0.203	1							
Mg	0.258	0.346	0.463	0.17	-0.232	1						
F	0.1865	-0.141	-0.136	0.158	0.317	-0.001	1					
K	-0.347	-0.309	0.232	-0.24	-0.104	0.0396	-0.057	1				
SO4	0.1922	0.048	0.687	0.355	-0.498	0.6544	-0.386	0.221	1			
EC	0.0445	-0.362	-0.486	-0.382	0.14	-0.546	0.4015	0.164	-0.485	1		
Fe	-0.54	0.691	-0.334	-0.611	-0.244	-0.035	-0.247	-0.24	-0.147	0.145	1	
TH	0.2226	-0.191	0.564	0.628	-0.582	0.5725	-0.371	0.152	0.843	-0.686	-0.3979	1

Figure 2: TDS and EC levels in groundwater samples in the study area

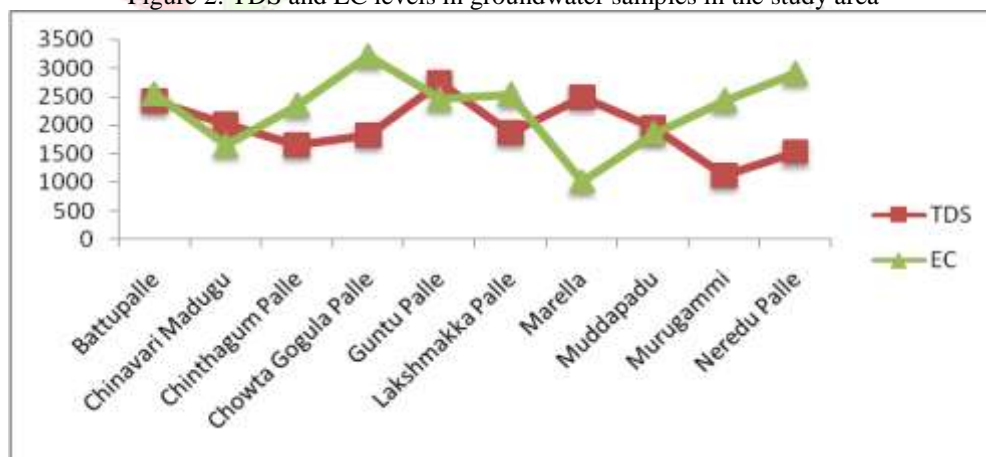


Figure 3: Cl, SO4, TH levels in the groundwater samples of the study area

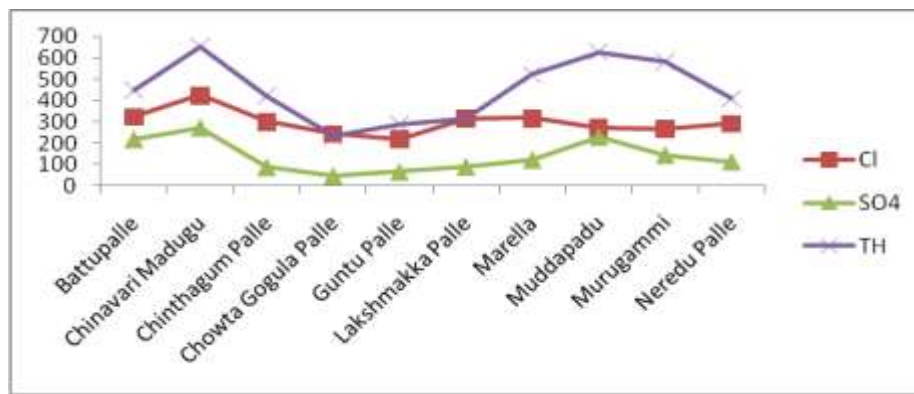


Figure 4: Fluoride and Iron levels in the groundwater samples

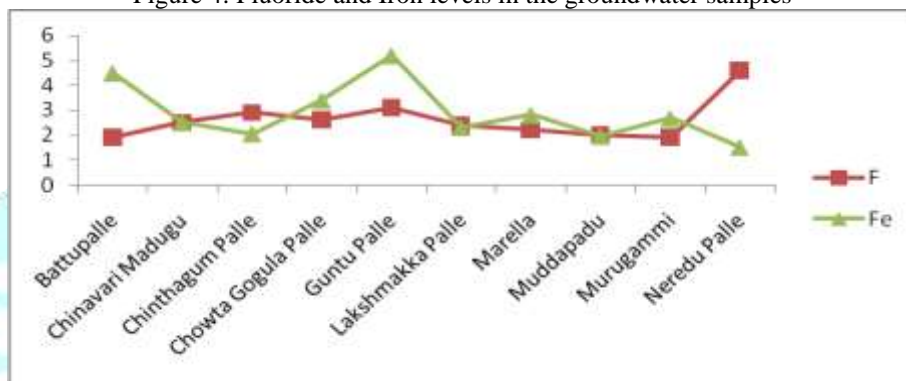


Figure 5: Standard deviation and Standard error of the TDS, EC and TH

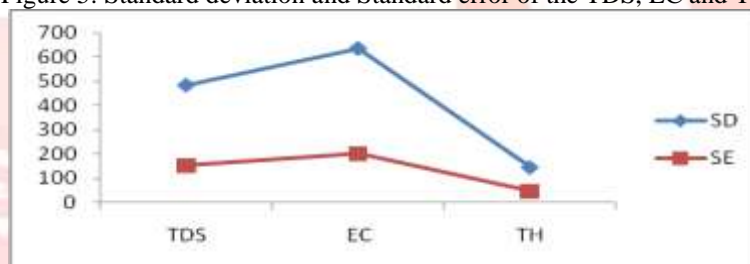


Figure 6: Standard deviation and Standard error of the pH, F & Fe

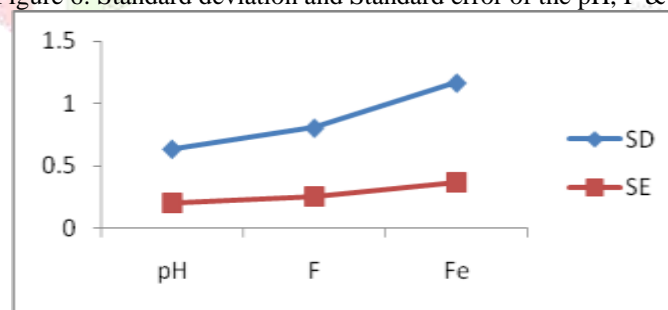
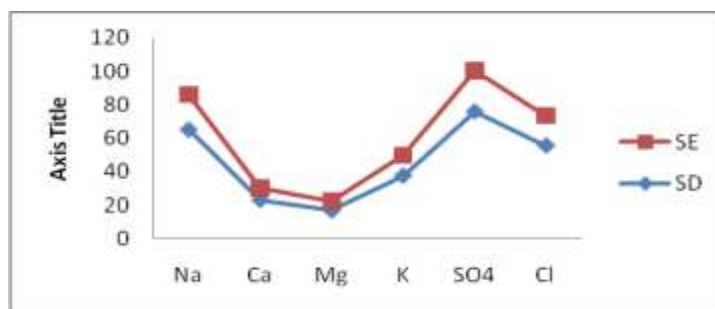


Figure 7: Standard deviation and Standard error of the groundwater parameters



#### 4. CONCLUSIONS

The groundwater quality in the study area is not good condition, according to the laboratory analysis of the selected water samples in Pedacherlopalle mandal region, 90 percent of the samples are exceeded the standard values of WHO and BIS, the direct use of the groundwater for drinking purpose cause the health problems due to high concentrations of the parameters like TDS, TH, EC, Cl, Ca, Mg, Na, K, F, effect on the skin, bones and kidneys, as well as gastrointestinal problems, over hair falling, scaling formation on utensils, so this paper concluded that the primary and secondary treatment are required before use by the communities

#### REFERENCES

- [1] APHA, (1985), Standard methods for the examination of water and wastewater, American Public Health Association, New York, U.S.A.
- [2] B.Shikha, Patra, B. A., Gupta N. C., Arora Saurabh, and R. Singh. 2007 Assessment of Drinking Water Quality of Delhi, India .In:12th ISMAS-WS-2007, March 25-30, Cidade de Goa, Dona Paula, Goa. Nitrate pollution of groundwater in northern China
- [3] BIS 10500-(2012)- Bureau of Indian standards for drinking water
- [4] D.Srinivasa Rao, M. Jyothi, Dr. G. Sudhakar, Dr. P. Brahmajirao, (2018), Assessment of Fluoride Content in Groundwater of PC Palle Mandal, Prakasam District, Andhra Pradesh, International Journal for Research in Applied Science & Engineering Technology (IJRASET), Vol 6 (II),pp- 1622-1627, ISSN: 2321-9653
- [5] Fried, J. J. and Combarous, M. A. (1971): Dispersion in porous media. Advances Hydro science, 7: 169 – 282
- [6] G. Arun Kumar, P. Sankara Pitchaiah, G. Sudhakar, Swarnalatha. G (2015), Physico-Chemical Analysis of Selected Groundwater Samples of Inkollu Mandal, Prakasam District, Andhra Pradesh, India Int. Journal of Engineering Research and Applications Vol. 5, Issue 4, ( Part -4), pp.65-70. ISSN: 2248-9622.
- [7] Harilal C.C., Hashim A., Arun P.R. and Baji S., (2004), *J Ecology Environ Conservation*, 10(2), 187-192
- [8] Jha A.N. and Verma P.K., (2000), Physico-chemical properties of drinking water in town area of Godda district under Santal Pargana (Bihar), India, *Poll. Res.*, 19(2), 75–85.
- [9] Jothi venkatachalam, K., Nithya A and Mohan S C, (2010). Correlation analysis of drinking water quality in and around Perur block of Coimbatore District, Tamil Nadu, India, *Rasayan Journal 13. Chemistry*, 3(4): 649-654.
- [10] Kataria H.C, Gupta M, Kumar M, Kushwaha S, Kashyap S, Trivedi S, Bhadoriya R and Bandewar N K, (2011), Study of Physicochemical Parameters of Drinking Water of Bhopal city with Reference to Health Impacts Current World Environment, 6(1): 95-99.
- [11] Kumar M and Kumar R, (2013), Assessment of Physico-Chemical Properties of Groundwater in Granite Mining Areas in Goramachia, Jhansi, UP,India., *Int. Res. J. Environment Sci.* Vol. 2(1), 19-24.
- [12] Mangukiya Rupal, Bhattacharya Tanushree and Chakraborty Sukalyan, (2012), Quality Characterization of Groundwater using Water Quality Index in Surat city, Gujarat, India, International Research Journal of Environment Sciences, 1(4), pp 14-23. ISSN 2319–1414.
- [13] Manjesh Kumar & Ramesh Kumar (2012), Assessment of Physico-chemical Properties of Ground Water in Granite Mining Areas in Jhansi, U.P., *Inte Journal of Eng Rese & Techy*, 1(7): 1-9.
- [14] Maruthi A and Rao S R K; 2004, Asian Journal of Chemistry; 16,1, 122
- [15] Mehta, K.V., 2010. Physicochemical characteristics and statistical study of groundwater of some places of Vadgam taluka in Banaskantha district of Gujarat state (India), *Journal of Chemical Pharmaceutical Research*, 2(4): 663-670
- [16] Patil, S. G., Chonde, S. G., Jadhav, A. S. and Raut, P. D. (2012): Impact of physico – chemical characteristics of Shivaji University lakes on phytoplankton communities, Kolhapur, India. *Research J. of Recent Sciences*, 1: 56 -60.
- [17] Rajan M. R. and I. Paneerselvam. 2005. *Indian J. Environ and Ecoplan.* Vol. 10, No.3: 771-776.
- [18] Shrestha RA, Kafle BK, Sillanpaa. M, (2010), Water quality of Dhulikhel area. *Nepal Res J Chem Environ* 14(2):36–38.
- [19] Singh A.K, Mondal G.C, Kumar S, Singh TB, Tewary BK, Sinha. A, (2008), Major ion chemistry, weathering processes and water quality assessment in upper catchments of Damodar River basin, India. *Environ Geol* 54:745–758.

- [20] Sudhakar Gummadi, Swarnalatha G, P.Brahmaji Rao, V. Venkataratnamma (2014c), Water Quality Analysis in Acharya Nagarjuna University Region, Guntur, Andhra Pradesh, India, IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT), Vol- 8 (9) Ver. II, PP 37-40
- [21] Sudhakar Gummadi, Swarnalatha. G, V. Venkataratnamma, Z. Vishnuvardhan (2014 b) Determination of Water Quality Index for Groundwater of Bapatla Mandal, Guntur District, Andhra Pradesh, India, International Journal of Engineering Research & Technology (IJERT), Vol-3(3),pp-77-80, ISSN: 2278-0181
- [22] Sudhakar Gummadi, Swarnalatha. G, Z. Vishnuvardhan, Harika.D, (2014 a), Statistical Analysis of the Groundwater Samples from Bapatla Mandal, Guntur District, Andhra Pradesh, India, IOSR Journal Of Environmental Science, Toxicology And Food Technology (IOSR-JESTFT),Vol- 8(1) Ver. II, PP 27-32, ISSN:2319-2399.
- [23] Sudhakar Gummadi, Swarnalatha.G, V. Venkataratnamma, Z.Vishnuvardhan. (2014), Water quality index for groundwater of Bapatla Mandal, coastal Andhra Pradesh, India, International Journal of Environmental Sciences, Vol, 5 (1), pp- 23-33 ISSN 0976 -4402
- [24] Venkata Rao Gummadi and Kalpana Polipalli, (2016), Assessment of Ground Water Quality in and around Pydibhimavaram Industrial Area, AP, India, International Journal of Environmental Science and Development, Vol. 7, No. 9.
- [25] WHO. (2004). Guidelines for drinking water Quality. Geneva.
- [26] World Health Organization (2011) Guidelines for Drinking-water Quality -4<sup>th</sup> edition 2011.
- [27] Xiang H, Mika S, Gjessing ET, Vogt RD, (2009), Water quality in the Tibetan plateau: major ions and trace elements in the hard waters of four major Asian rivers. Environ Poll 407(24):270–277.

