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SPATIAL DISTRIBUTION OF GROUNDWATER QUALITY PARAMETERS KANDIVALASA RIVER BASIN SRIKAKULAM AND VIZIANAGARAM DISTRICT ANDHRA PRADESH A GIS APPROACH

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Abstract
Groundwater is the most basic standard resource needed for toasting numerous people around the world, especially in common domains. The resource can't be undeniably used and overseen except if the idea of groundwater is overviewed. The assessment portrayed here uses geographic information system (GIS) advancement to depict quality for drinking and improvement, utilizing data delivered from compound examination of water tests accumulated from the region under assessment. In this work, we will consider distinctive topographical features of Kandivalasa River Basin catchment area by social occasion assorted kinds of data related to ground water. This data is used to translate a guide and digitize it with the help of ArcGIS 10.3 programming. Utilizing GIS forming systems, spatial spread guides of pH, TDS, TH, Cl, HCO3, SO4, NO3, Ca, Mg, Na, F and K, have been made. Edge this guide one can without a very remarkable stretch review the idea of water present at various spots of this area and moreover it helps in taking decision of what are the progressions that are to be made in the water use and its quality. The physical-mix works out as expected were stood apart from the standard manage sees as proposed by the World Wellbeing Association (WHO) for drinking and general flourishing to have a system of the present groundwater quality.

Keywords: Groundwater, ArcGIS, Chemical analysis and Quality maps

1.Introduction: GIS software for the development of thematic maps for Hydrogeochemistry [1] (The thematic maps have been generated by ArcGIS 10.3 software using a spatial analysis tool. Shows the spatial distribution of water quality parameter maps). Water is in continuous movement on, above and below the surface of the earth. As the water is recycled through the earth, it picks up many things along its path. Water quality varies from place to place, with the seasons, and with various kinds of rock and soil which it moves through [2]. For the most part, it is natural processes that affect water quality [3]. For instance, water moving through underground rocks and soils may pick up natural contaminants [4], even with no human activity or pollution in the area. In addition to Natures influence, water is also polluted by human activities, such as open defecation. (http://water.usgs.gov/edu/earthgwaquifer.html). The groundwater quality is normally characterized by different Physio-Chemical characteristics [5]. These parameters change widely due to the various types of pollution, seasonal fluctuation, groundwater extraction, etc.[6]. Hence a continuous monitoring of groundwater becomes mandatory in order to minimize the groundwater pollution and have control on the pollution[7]-

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caused agents. The objective of this part of the study is to assess the groundwater quality of water supply system and to predict the water level rise and change of water quality[8] in the Kandivalasa River Basin catchment area.Various chemical constituents of water occur as dissociated particles or ions. In the present area of study, the chemistry of groundwater with respect to the major elements and chemically related properties has been determined [9]. Sample data were collected from the different locations ofthe study area from location 119 samples were collected and analyzed for this chemistry [10]. Similarly the chemically related properties such as hydrogen ion activity (pH), Total Dissolved Solids (TDS) and Total Hardness (TH) EC Electrical conductivity And other parameters adapting standard Hydro Chemical Methods and determined major cations include calcium (Ca), magnesium (Mg), Sodium (Na), Potasium, (K), Bicarbonate (HCO3) chloride (Cl),Flouride (F) Nitrate (No3). And Sulphate (SO4) are analyzed for two seasons. An interjection procedure, standard Inverse Distance Weighted (IDW), was utilized to acquire the spatial dissemination of groundwater quality parameters[11].

2.MATERIAL AND METHODS: Water samples from 60 study areas (240 samples) collected from bore wells, dugwells and tube wells namely**,** Mentada, Akkayapalem, Kontalapalem, Ommi, Pedda Battivalasa, Karakam, Ramalingapuram, Yelakalopeta, Kodoru, Duvvam, Pedda Nagallavalasa,Shesapupeta,Chinnamallupeta,Kanlmella, Chinna Pativada, Gollapeta, Thottadam,Varisam,ChinnaNadipalli,Appapuram,Itkarlapalli,Sivaram,Cheerurupalli, Tirupatipalem,Nellvada,Artamoru,Konuru,Parla,Alugolu,Gollapalem,Ladagalapeta, Valluru, Ragolu, Chillapetarajam, Kamavaram and Galatula Chodavaram. Study area is the extreme North-eastern District of Andhra Pradesh lies between the $83^0$30’22’’ to $84^0$50’26’’ East Longitude and $18^0$20’12’’ N to $19^0$30’21’’ North Latitude. The study area has an industrial area which is situated at Pydibhimavaram. The study area is skirted to a distance by Kandivalasagedda at certain stretches of their courses white a line of heights of the great Eastern Ghats run by North East. Water sample collection from an open well in the study area are Ragolu, Chillapetarajam, Kamavaram and Galatula Chodavaram.The study is undertaken for sixty sampling stations throughout the Kandivalasa River Basin catchment area. Following the methodology described in the previous chapter the suitability of groundwater at different locations over the study area for drinking and irrigation purposes have been evaluated and the results are presented in different sections. Figure 1and table 1a and 1b Shows the location map of the study area with sampling stations.

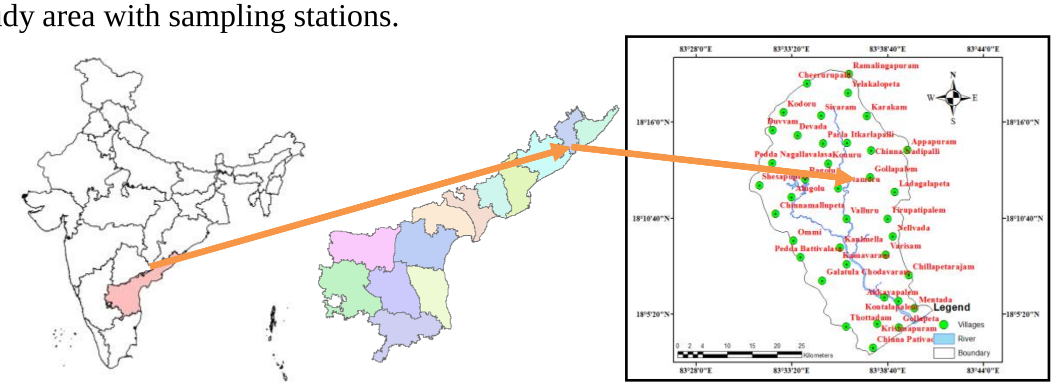

Figure 1 Shows the location map of the study area with sampling stations

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Table 1a Comparison of Pre monsoon and Post monsoon of 2019

Samples Sites	pH Pre	pH Post	EC pre	EC Post	TDS pre	TDS post	HCO3 Pre	HCO3 Post	Cl pre	Cl post	F Pre	F post
S1	8.52	7.98	1100	690	704	441.6	240	150	92.196	150	0.88	0.64
S2	8.06	7.82	700	4200	448	2688	100	90	56.736	710	0.17	0.23
S3	8.27	8.14	600	1350	384	864	200	140	56.736	260	0.41	0.16
S4	8.25	8.27	110	1860	70	1190.4	20	180	14.18	290	0.03	0.79
S5	8.52	8.2	350	1380	224	883.2	120	340	28.368	140	0.58	0.89
S6	8.52	7.82	1000	4200	640	2688	240	680	92.196	710	0.26	0.21
S7	8.03	8.18	3200	510	2048	326.4	120	70	496.44	60	0.38	0.06
S8	8.15	8.5	1500	1900	960	1216	180	390	212.76	470	0.28	0.14
S9	8.41	8.27	250	1280	160	819.2	120	170	35.46	290	0.4	0.26
S10	7.89	8.45	1400	210	896	134.4	80	40	177.3	30	0.02	0.02
S11	8.31	8.46	400	450	256	288	80	80	28.37	70	0.05	0.12
S12	8.26	8.47	800	420	512	268.8	40	130	42.552	30	0.31	0.16
S13	7.98	8.07	600	580	384	371.2	40	60	70.92	90	0.13	0.08
S14	8.01	7.94	1400	1900	896	1216	180	230	177.3	400	0.41	0.7
S15	7.98	8.69	600	850	384	544	60	180	99.29	100	0.02	0.51
S16	8.17	8.14	600	440	384	281.6	80	90	35.46	40	0.09	0.12
S17	8.45	8.19	730	580	467	371.2	120	120	90	60	0.21	0.08
S18	8.12	7.75	2700	2600	1728	1664	200	220	354.6	420	0.05	0.22
S19	7.64	7.92	2000	2000	1280	1280	60	190	425.52	400	0.16	0.2
S20	8.53	7.84	320	310	205	198.4	180	40	21.276	40	0.34	0.17
S21	8.17	7.58	800	1530	512	979.2	100	390	99.288	360	0.06	0.38
S22	7.92	8.12	800	890	512	569.6	140	140	56.736	150	0.14	0.15
S23	7.47	8.43	5600	1840	3584	1177.6	560	420	198.58	390	0.12	0.19
S24	8.93	8.35	1100	1050	704	672	300	130	106.38	180	0.43	0.56
S25	8.15	8.22	600	950	384	608	160	110	49.644	200	0.36	0.21
S26	8.34	8.62	700	5300	448	3392	100	870	92.196	1360	0.18	0.82

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S27	8.05	8.01	1500	970	960	620.08	320	220	141.84	150	0.78	0.28
S28	7.34	7.65	500	1900	320	1216	80	480	99.288	370	0.41	0.22
S29	8.13	8	2700	1750	1728	1120	160	350	35.46	220	0.2	0.27
S30	8.36	7.9	900	2700	576	1728	180	670	42.552	250	0.18	0.12
S31	8.36	8.25	600	620	384	396.8	100	120	106.38	70	0.34	0.15
S32	8.03	8	1000	930	640	595.2	100	230	106.38	240	0.06	0.05
S33	8.34	8.02	1300	1370	832	876.8	260	30	156.02	300	0.17	0.08
S34	8.07	7.82	1500	470	960	300.08	180	90	141.84	50	0.25	0.32
S35	8.01	8.04	1100	1300	704	832	100	290	106.38	160	0.18	0.12
S36	8.4	7.94	1000	1330	640	851.2	200	260	99.29	130	0.48	0.15
S37	8.21	8.46	500	600	320	384	100	60	56.74	40	0.1	0.52
S38	7.81	8.06	700	990	448	633.6	100	190	70.92	120	0.14	0.38
S39	8.03	8.18	3200	510	2048	326.4	120	70	496.44	60	0.38	0.06
S40	8.15	8.5	1500	1900	960	1216	180	390	212.76	470	0.28	0.14
S41	8.41	8.27	250	1280	160	819.2	120	170	35.46	290	0.4	0.26
S42	7.89	8.45	1400	210	896	134.4	80	40	177.3	30	0.02	0.02
S43	8.31	8.46	400	450	256	288	80	80	28.37	70	0.05	0.12
S44	8.26	8.47	800	420	512	268.8	40	130	42.552	30	0.31	0.16
S45	7.98	8.07	600	580	384	371.2	40	60	70.92	90	0.13	0.08
S46	8.01	7.94	1400	1900	896	1216	180	230	177.3	400	0.41	0.7
S47	7.98	8.69	600	850	384	544	60	180	99.29	100	0.02	0.51
S48	8.17	8.14	600	440	384	281.6	80	90	35.46	40	0.09	0.12
S49	8.45	8.19	730	580	467	371.2	120	120	90	60	0.21	0.08
S50	8.12	7.75	2700	2600	1728	1664	200	220	354.6	420	0.05	0.22
S51	7.64	7.92	2000	2000	1280	1280	60	190	425.52	400	0.16	0.2
S52	8.53	7.84	320	310	205	198.4	180	40	21.276	40	0.34	0.17
S53	8.17	7.58	800	1530	512	979.2	100	390	99.288	360	0.06	0.38
S54	7.92	8.12	800	890	512	569.6	140	140	56.736	150	0.14	0.15
S55	7.47	8.43	5600	1840	3584	1177.6	560	420	198.58	390	0.12	0.19
S56	8.93	8.35	1100	1050	704	672	300	130	106.38	180	0.43	0.56

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S57	8.15	8.22	600	950	384	608	160	110	49.644	200	0.36	0.21
S58	8.34	8.62	700	5300	448	3392	100	870	92.196	1360	0.18	0.82
S59	8.05	8.01	1500	970	960	620.08	320	220	141.84	150	0.78	0.28
S60	7.34	7.65	500	1900	320	1216	80	480	99.288	370	0.41	0.22

Table 1b Comparison of Pre monsoon and Post Monsoon of 2019

Samples Sites	No3 Pre	No3 post	So4 Pre	So4 post	Na pre	Na post	K pre	K post	Ca pre	Ca post	Mg Pre	Mg Post
S1	14.76	5.38	54	28	8.51	42.64	2.2	5.16	16	72	36	19.45
S2	45.64	23.21	20	122	20.4	57.6	0.76	12.2	24	168	3.6	131.3
S3	2.836	0.18	10	56	25.83	109.9	0.9	52.6	12	80	32.4	48.62
S4	3.06	6.84	10	56	5.05	108.1	4.12	260.9	8	88	7.2	43.76
S5	1.673	9.85	24	94	0.85	98.65	1.4	1.9	12	104	14.4	63.21
S6	0.655	12.84	34	122	6	657.6	17.5	12.2	32	168	14.4	131.3
S7	37.53	1.45	185	71	3.42	44.98	14.4	1.3	44	40	90	19.45
S8	25.24	12.22	109	47	8.51	218	11.9	20.8	16	112	43.2	68.07
S9	0.95	18.33	10	25	0.78	125.8	10.8	6.3	8	56	18	58.34
S10	25.13	14.18	65	9	4.62	24.6	30.9	0.53	32	16	18	4.862
S11	20.25	10.21	7	21	8.44	19.1	1.94	6.2	20	32	32.4	24.31
S12	13.71	11.53	7	57	12.93	27.24	1.84	0.68	20	48	21.6	9.724
S13	1.53	1.29	8	76	15.58	85.84	0.66	1.34	8	24	25.2	19.45
S14	8.873	11	59	63	9.72	189.3	3.5	172.4	12	88	32.4	43.76
S15	14.18	2.37	26	20	17.91	90.62	9.22	39.88	16	32	10.8	34.03
S16	30.22	13.35	16	58	10	29.86	0.86	0.86	36	40	-7.2	14.59
S17	13.1	41.38	63	46	63.06	54.4	1.14	23.98	64	32	24.31	19.45
S18	0.436	2.33	117	212	9.11	402.6	114	178.8	16	64	46.8	53.48
S19	18.65	27.56	124	97	98.8	208.6	1.25	40	68	38.9	43.2	260
S20	1.82	10.18	86	10	11.02	28.16	4	0.94	12	24	25.2	9.724
S21	9.964	1.45	13	48	22.8	132.8	10.8	22.8	16	104	36	58.34
S22	14.29	21.96	24	34	11.04	55.28	6.34	9.52	24	64	10.8	38.9

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S23	6.873	5.49	270	44	22.18	164.62	147.8	69.73	8	136	82.8	48.62
S24	1.964	18.87	120	14	3.9	164.6	0.6	21.5	16	24	54	34.03
S25	17.64	5.16	24	52	15.98	142.7	1.32	1.73	16	40	46.8	29.17
S26	12.25	12.91	35	38	22.43	804.2	0.92	23	20	224	7.2	155.6
S27	3.055	14.62	16	46	17.01	44.26	1.7	10.36	8	88	14.4	43.76
S28	14.22	5.71	4	64	41.26	113.8	1.27	52.81	24	160	-3.6	68.07
S29	18.22	9.86	144	121	7.36	188.1	69.8	81.9	40	104	39.6	43.76
S30	1.091	0.897	26	213	15.69	235.8	0.92	9.6	24	176	18	116.7
S31	1.273	0.964	8	6	17.03	57.66	0.46	1.24	12	40	25.2	24.31
S32	28.15	2.44	14	24	0.82	34.58	2	2.62	28	104	25.2	29.17
S33	1.273	71.45	23	65	5.65	156.82	33.3	38.67	32	96	18	29.17
S34	2	19.93	111	20	10.7	46.05	13.6	6.17	16	24	18	19.45
S35	2.218	0.15	135	72	1.4	112.6	0.8	1.6	44	112	18	43.76
S36	0.65	2.58	32	94	7.79	166.2	0.3	51	12	48	14.4	48.62
S37	10.33	5.1	6	48	16.8	125.4	3.26	0.6	16	24	21.6	4.86
S38	49.6	29.21	256	48	10.16	113.6	1.44	3.6	20	48	18	43.76
S39	37.53	1.45	185	71	3.42	44.98	14.4	1.3	44	40	90	19.45
S40	25.24	12.22	109	47	8.51	218	11.9	20.8	16	112	43.2	68.07
S41	0.95	18.33	10	25	0.78	125.8	10.8	6.3	8	56	18	58.34
S42	25.13	14.18	65	9	4.62	24.6	30.9	0.53	32	16	18	4.862
S43	20.25	10.21	7	21	8.44	19.1	1.94	6.2	20	32	32.4	24.31
S44	13.71	11.53	7	57	12.93	27.24	1.84	0.68	20	48	21.6	9.724
S45	1.53	1.29	8	76	15.58	85.84	0.66	1.34	8	24	25.2	19.45
S46	8.873	11	59	63	9.72	189.3	3.5	172.4	12	88	32.4	43.76
S47	14.18	2.37	26	20	17.91	90.62	9.22	39.88	16	32	10.8	34.03
S48	30.22	13.35	16	58	10	29.86	0.86	0.86	36	40	-7.2	14.59
S49	13.1	41.38	63	46	63.06	54.4	1.14	23.98	64	32	24.31	19.45
S50	0.436	2.33	117	212	9.11	402.6	114	178.8	16	64	46.8	53.48
S51	18.65	27.56	124	97	98.8	208.6	1.25	40	68	38.9	43.2	260
S52	1.82	10.18	86	10	11.02	28.16	4	0.94	12	24	25.2	9.724

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S53	9.964	1.45	13	48	22.8	132.8	10.8	22.8	16	104	36	58.34
S54	14.29	21.96	24	34	11.04	55.28	6.34	9.52	24	64	10.8	38.9
S55	6.873	5.49	270	44	22.18	164.62	147.8	69.73	8	136	82.8	48.62
S56	1.964	18.87	120	14	3.9	164.6	0.6	21.5	16	24	54	34.03
S57	17.64	5.16	24	52	15.98	142.7	1.32	1.73	16	40	46.8	29.17
S58	12.25	12.91	35	38	22.43	804.2	0.92	23	20	224	7.2	155.6
S59	3.055	14.62	16	46	17.01	44.26	1.7	1.36	8	88	14.4	43.76
S60	14.22	5.71	4	64	41.26	113.8	1.27	5.81	24	160	-3.6	68.07

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Seasonal Variation for the year 2019

pH: The range of pH is from 7.34 to 8.93 in pre monsoon and 7.58 to 8.69 in post monsoon. Most of the stations in the study show alkaline tendency. In pre monsoon, 58% of sample stations pH values are more than the highest desirable level (6.5-8.5). These are suitable for drinking (6.5 to 8.5) and not suitable for drinking (less than 6.5 and greater than 8.5) is observed in the Thottadam,Varisam and ChinnaNadipalli area. Figure 2a and 2b show the spatial distribution of water quality parameter pH.

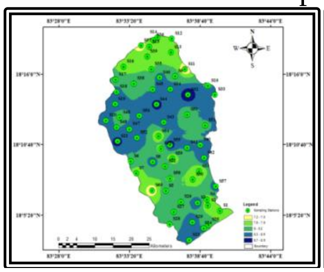
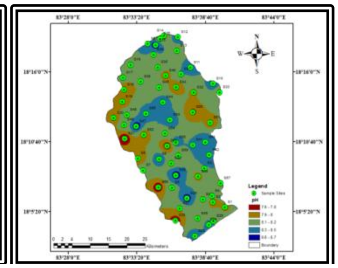

Fig. 2a pH Pre monsoon Fig. 2b pH Post monsoon

Electrical Conductivity: Electrical Conductivity was observed from 110 to 5600 µs/min pre-monsoon and 210 to 5300 µs/min post monsoon. There are observed in the Appapuram,Itkarlapalli,Sivaram and Cheerurupalli area. Figure 3a and 3b show the spatial distribution of water quality parameter total hardness in both pre monsoon and post monsoon.

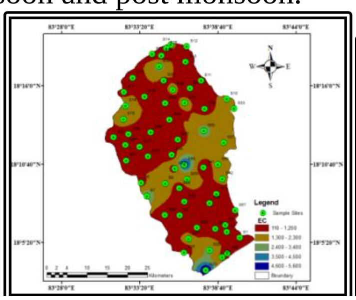
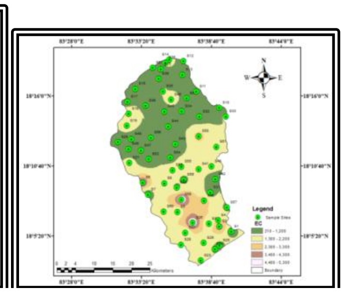

Fig. 3a EC Pre monsoon Fig. 3b EC Post monsoon

T**otal Dissolved Solids:** The range of total dissolved solids from 70.4 to 3584 mg/l during pre monsoon and 134.4 to 3392 mg/l in the post monsoon. These are most suitable for less than desirable value for drinking (<500 mg/l) and permissible for drinking (in between 500-1500 mg/l). And unsuitable for drinking is greater than 1500 mg/l is observed in the Alugolu, Gollapalem, Ladagalapeta and Valluru area. Figure 4a and 4b show the spatial distribution of water quality parameter TDS in both pre monsoon and post monsoon.

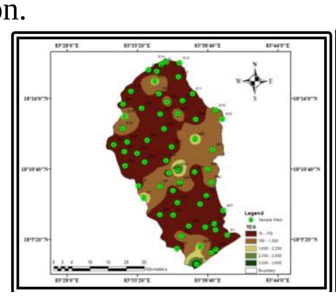
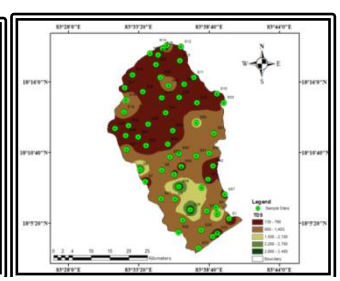

Fig. 4a TDS Pre monsoon Fig. 4b TDS Post monsoon

Total Hardness: The determined total hardness in all stations is from 0 to 720 mg/l during pre monsoon and the post monsoon season shows that 60 to 1200 mg/l. The hardness of the many stations in pre and post monsoon seasons is well above the standard level set by BIS as 300 mg/l. Hardness has got no adverse effect on human health. Water with hardness above 300 mg/l may cause scale deposition in the water distribution system and more soap consumption. These are most suitable for less than

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desirable value for drinking (<600 mg/l) and permissible for drinking (in between 600-1000 mg/l) and unsuitable for drinking is greater than 1000 mg/l is observed in the Ragolu, Chillapetarajam and Kamavaram area. Figure 5a and 5b show the spatial distribution of water quality parameter total hardness in both pre monsoon and post monsoon.

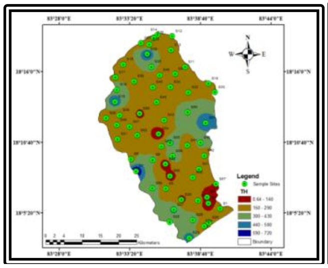
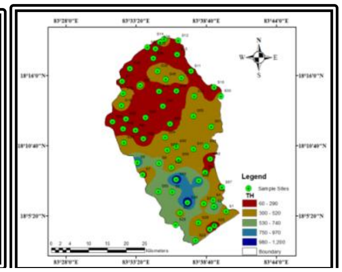

Fig. 5.a Total Hardness Pre monsoon   Fig.5.b Total Hardness Post monsoon

Calcium: Calcium in the sampling stations range from 8 to 68 mg/l during pre monsoon and 16 to 224 mg/l during post monsoon. In some of the stations, it falls above the standards of 75 mg/l. The higher value is mainly attributed due to the abundant availability of limestone in the area. Consequently, more solubility of calcium ions is present. These are suitable for drinking (<75) and not suitable for drinking (75-200 and >200) is observed in the Valluru, Ragolu and Chillapetarajam area. Figure 6a and 6b show the spatial distribution of water quality parameter calcium in both pre monsoon and post monsoon.

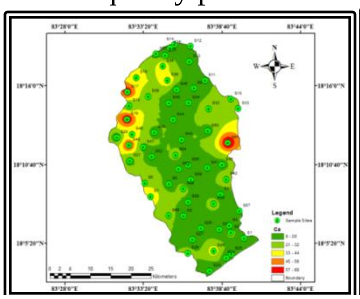
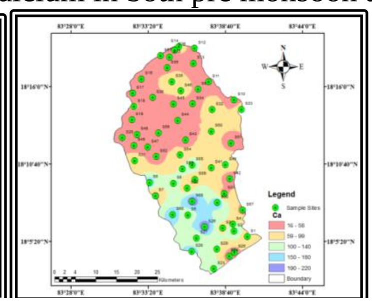

Fig. 6a Calcium Pre monsoon   Fig. 6b Calcium Post monsoon

Magnesium: Magnesium in the sampling stations ranges from -7.2 to 90 mg/l in the pre monsoon and 4.86 to 260 mg/l in the post monsoon season. In some of the sampling stations, magnesium falls above the standard desirable limit in both the seasons. The concentration of magnesium may be very high due to the dissolution of magnesium, calcite, gypsum, and dolomite. These are most suitable for less than desirable value for drinking (<30 mg/l) and permissible for drinking (in between 30-100 mg/l) and unsuitable for drinking is greater than 100 mg/l is observed in the Saravakota, Pathapatnamand Ganguvarisigadamarea. Figure 7a and 7b show the spatial distribution of water quality parameter magnesium in both pre and post monsoon.

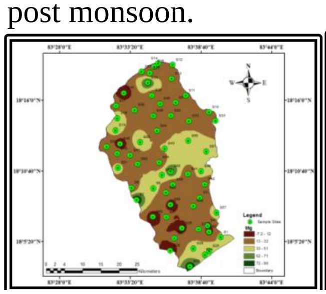
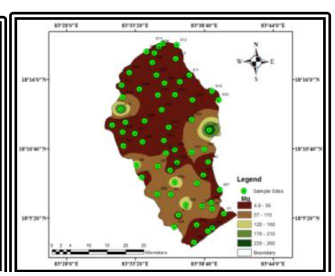

Fig. 7a Magnesium Pre monsoon   Fig. 7b Magnesium Post monsoon

Sodium: Sodium concentration in sampling sites ranging from 0.78 to 98.8 mg/l in pre monsoon and 19.1 to 804.2 mg/l in the post monsoon respectively. Fig.5.21a graph plotted for the sodium comparison between the pre and post monsoon. These are suitable for drinking (<20 mg/l) and not suitable for

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drinking (>200 mg/l) is observed in the Chillapetarajam, Kamavaram and Galatula Chodavaram area. Figure 8a and 8b show the spatial distribution of water quality parameter calcium in both pre and post monsoon.

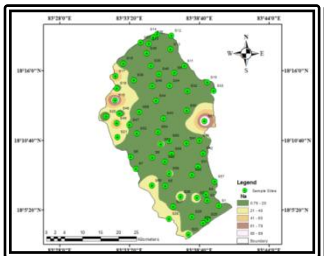
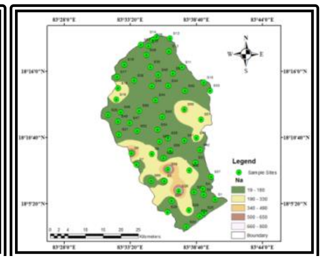

Fig. 8a Sodium Pre monsoon Fig.8b Sodium Post monsoon

Potassium: Potassium concentration in sampling sites ranging from 0.3 to 147.8 mg/l in pre monsoon and 0.53 to 260.9 mg/l in the post monsoon respectivelyThese are suitable for drinking (<100 mg/l) and not suitable for drinking (>200 mg/l) and not acceptable (>500 mg/l) is observed in the Konuru, Parla, Alugolu and Gollapalem area. Figure 9a and 9b show the spatial distribution of water quality parameter potassium in both pre monsoon and post monsoon.

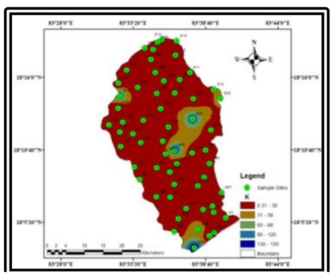
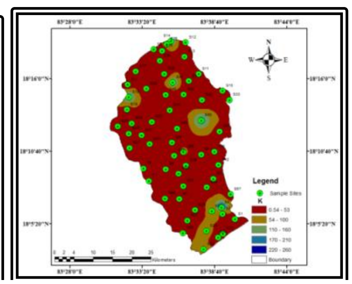

Fig. 9a Potassium Pre monsoon Fig.9b Potassium Post monsoon

Bicarbonates: Bicarbonate concentration in sampling sites ranging from 20 to 750 mg/l in pre monsoon and 30 to 870 mg/l in the post monsoon respectively. Figure 10a and 10b show the spatial distribution of water quality parameter bicarbonates in both pre monsoon and post monsoon. Most of the stations are well within the desirable limit of 45 mg/l. These are most suitable for less than desirable value for drinking (<45 mg/l) and unsuitable for drinking is greater than 45 mg/l is observed in the Parla,Alugolu and Gollapalem area.

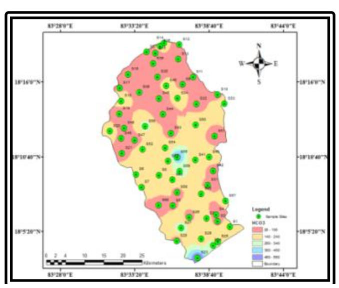
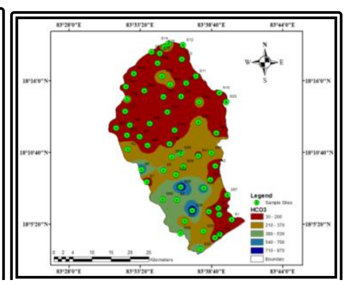

Fig. 10a Bicarbonate Pre monsoon Fig. 10b Bicarbonate Post monsoon

Nitrates: Nitrates concentration in the study stations has ranged from -1.82 to 49.6 mg/l in the pre monsoon and -1.45 to 71.45 mg/l in the post monsoon season. Most of the stations are well within the desirable limit of 45 mg/l. Nitrate concentration of more than 45 mg/l causes a dangerous disease Mathemoglobianemia for infants. These are most suitable for less than desirable value for drinking (<45 mg/l) and unsuitable for drinking is greater than 45 mg/l is observed in the Konuru,Parla,Alugolu,Gollapalem and Ladagalapeta area. Figure 11a and 11b show the spatial distribution of water quality parameter nitrates in both premonsson and post monsoon.

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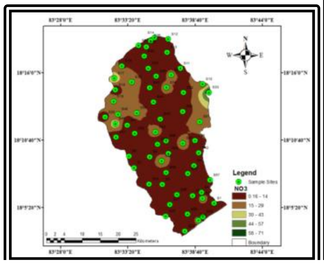
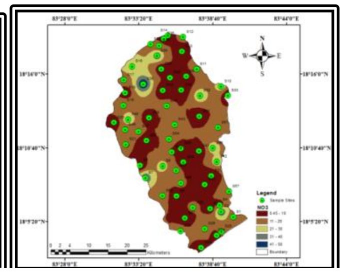

Fig. 11a Nitrates Pre monsoon Fig. 11b Nitrates Post monsoon

Chlorides: The chlorides value ranges from 14.184 to 496.44 mg/l in pre monsoon and 30 to 1360mg/l in post monsoon was observed. Chloride concentration in most of the samples found higher than highest desirable level (250 mg/l) stipulated by BIS, yet these values are well below the maximum permissible limit (1000 mg/l). Excess of chloride is due to anthropogenic activity like septic tanks effluents, usage of bleaching agents by people nearby bore well. These are most suitable for drinking (<250 mg/l) and not suitable for drinking (in between 250-600 mg/l and greater than 600 mg/l) is observed in the Valluru, Ragolu and Chillapetarajam area. Figure 12a and 12b show the spatial distribution of water quality parameter chlorides in both pre soon and post monsoon.

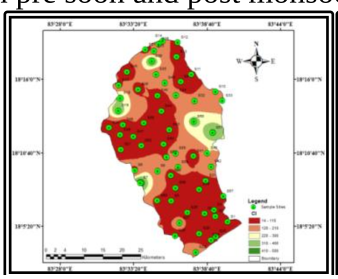
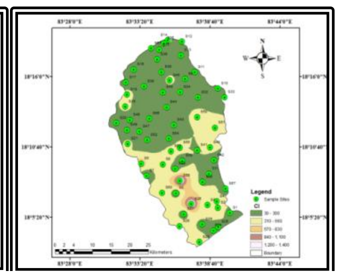

Fig. 12a Chloride Pre monsoon Fig. 12b Chloride Post monsoon

Fluorides: Fluoride, the most commonly occurring form of fluorine, is the natural contaminant of water. Groundwater usually contains fluoride dissolved by geological formation. Fluoride concentration in the sampling stations ranges from 0.02 to 0.88 mg/l in pre-monsoon and 0.02 to 0.89 mg/l in post monsoon seasons. Higher concentrations of fluorides may lead to diseases like dental fluorosis and skeletal fluorosis. These are most suitable for less than desirable value for drinking (<1 mg/l) and not suitable for drinking (in between 1-1.5 mg/l and greater than 1.5 mg/l) is observed in the Alugolu,Gollapalem,Ladagalapeta and Valluru area. Figure 13a and 13b show the spatial distribution of water quality parameter fluorides in both pre monsoon and post monsoon.

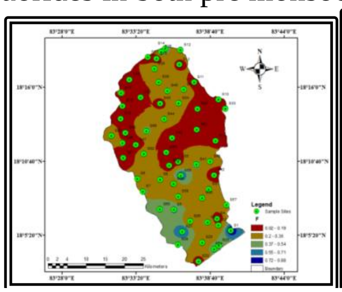
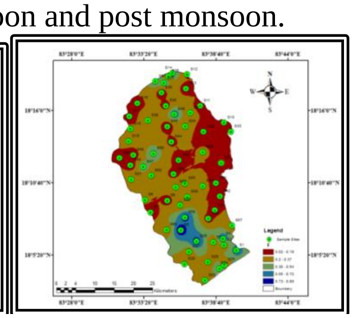

Fig. 13a Fluoride Pre monsoon Fig. 13b Fluoride Post monsoon

Sulphates: Sulphates concentration in the sampling sites ranging from 4 to 270 mg/l in pre monsoon and 6 to 213 mg/l in post monsoon respectively. These are suitable for drinking (<250 mg/l) is observed in the Tirupatipalem,Nellvada,Artamoru and Konuru area. Figure 14a and 14b show the spatial distribution of water quality parameter calcium in both pre monsoon and post monsoon.

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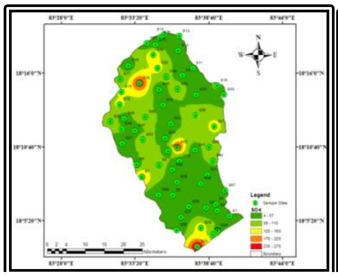
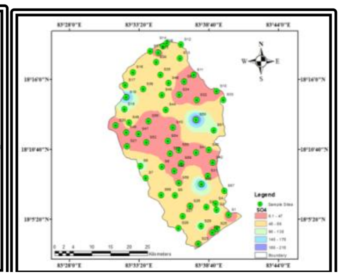

Fig. 14a Sulphates Pre monsoon Fig. 14b Sulphates Post monsoon

3. Results and conclusions

In the present study, from analysis of pre and post monsoon data, and the average values obtained it has been inferred that certain parameters like Calcium, Magnesium, Total hardness, TDS have increased and remaining parameters like pH, Chlorides, Fluorides, Nitrates show a decrease in concentration. The reason can be attributed to increase in concentration as a result of greater leaching and decrease in concentration as a result of dilution [12]. The usage of groundwater has gradually increased due to the increase of water demand and the shortage of surface water during the growth of population and rapid industrialization [13]. The final output has been given in the spatial representation of groundwater quality in the study area. The analysis indicates that the groundwater of the study area needs some degree of treatment before consumption[14]. The study helps to understand the quality of water as well as to develop suitable management practices to protect the groundwater sources [15]. In general water quality of observation well which are located near to Pydibhamvaram and Nathuvalsa villages effected due to industial waste dumping in the open land and agriculture activity. No fluoride contaminated water has been observed in the present study. Out of thirty-eight groundwater stations in the study area, ten stations show nitrate concentration more than 45 mg/l and may cause blue baby disease for infants. Hence an alternative source of water supply may be chosen. pH is from 6.5 to 8.8 in pre-monsoon and 7.2 to 8.9 in post monsoon. EC was observed from 246 to 3301µs/min pre-monsoon and 330 to 2025 µs/min post monsoon of Electrical conductivity is observed in the Kodoru, Duvvam, Pedda Nagallavalasa.

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