



Groundwater Quality Analysis for Drinking purpose Using GIS of Chevella Sub basin, Rangareddy District, Telangana State, India

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Abstract

About 24 water samples representing 24 villages covering 180 sq km have been collected for assessing suitability for drinking and spatial distribution which leads to enhance the knowledge of the hydro chemical system in the Chevella sub basin. Three physical constituents such as pH, TH, and TDS; consecutively in pre monsoon minimum is 7.1, 216 and 509 milligrams per liter and maximum is 8.3, 459 and 1082 milligrams per liter respectively; and maximum physical properties constituted as 8.2, 353 and 877 milligrams per liter while minimum constituted such as 7.1, 222 and 407 milligrams per liter respectively in post monsoon. Concentration of sodium in pre monsoon falls in between 63 milligrams per liter as minimum and 134 milligrams per liter as maximum. In post monsoon it varies from 56 milligrams per liter to 121 milligrams per liter. Maximum Magnesium, Calcium, Iron, Chloride, Sulfates, Bi-carbonates Carbonates and Nitrates is per liter, 159.3 milligrams per liter, 0.1 milligrams per liter, 3.6 milligrams per liter respectively where as maximum constituted as 52 milligrams per liter, 121 milligrams per liter, 0.5 milligrams per liter, 1.3 milligrams per liter, 175.2 milligrams per liter, 93.5 milligrams per liter, 338.4 milligrams per liter, 1.1 milligrams per liter, 19.8 milligrams per liter respectively in post monsoon. In pre monsoon maximum Magnesium, Calcium, Iron, Chloride, Sulfates, Bi-carbonates Carbonates and Nitrates is constituted as 68 milligrams per liter, 99 milligrams per liter, 0.6 milligrams per liter, 1.4 milligrams per liter, 202 milligrams per liter, 70 milligrams per liter, 175 milligrams per liter, 2.4 milligrams per liter, 20.8 milligrams per liter respectively.

Keywords: Groundwater, Drinking water quality, Chevella sub basin, Spatial distribution.

Introduction

Quality of groundwater depends on geology of the area source location and course of movement¹. Groundwater is part of hydrological cycle refers to water in both soil and geological formations that are fully saturated. Groundwater quality can be affected by including pumping the water from the deep portion of the earth crust, land use changes and reaching pollutants to groundwater. Prior analysis of water quality before its utilization for drinking is very important in the groundwater dependent areas like present study area. High yields can get from the corps by practicing suitable water management practices based on the quality of groundwater.

Study area: The Chevella sub basin is covering 24 villages of Chevella and Sankarapalli mandals located in Rangareddy district of Telangana State². The sub basin is located central part of the district, which is about 42 km from Hyderabad, lying on Hyderabad to Tanduru road. Chevella watershed forms part of survey of India toposheet Nos. 56 K/3 of 1: 50,000 scale, lying between East longitude 77^o21' to 78^o51' and North latitudes 16^o54' to 17^o48'.

Climate: The Chevella basin has southern Telanagana agro-climatic zone characteristics. Average precipitation of the

Chevella sub basin is area is 826 mm. Average rainy days is 28 in south-west monsoon whereas in north-east monsoon is 11 days. Average maximum and minimum temperature in the Chevella sub basin is 38.8 °C and 14.3 °C respectively.

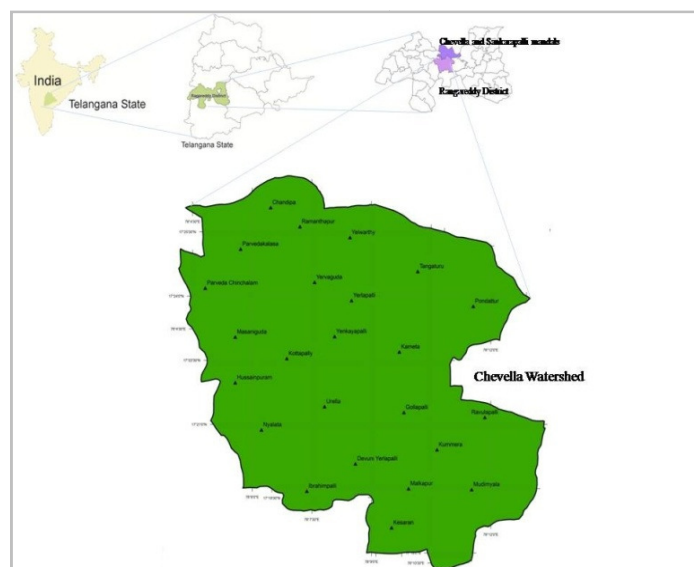


Figure-1
Location map of Chevella watershed

Geology and Hydrogeology: Hard compact nature of predominantly granite and alkali feldspar granite of peninsular gneissic complex of Archean age are the geological formations in the study area. These are overlain by parallel layered Deccan traps of Cretaceous to Paleocene. Deccan traps are underlain by moderate hard porous laterites of Pleistocene. Bedded and laminated Intra-trappeans of Cretaceous age are lying between Deccan traps and peninsular gneissic complex. Lineaments which are favorable for groundwater recharge are also found in the sub basin. Groundwater developed in weather and Fracture zone in the study area in both Deccan traps and peninsular gneissic complex.

Materials and Methods

Twenty four water samples have been analyzed for this study in 2013 during May and November months representing twenty four villages in the study area which represents pre and post monsoon. BIS standards are used for analysis for pre and post monsoon seasons as well as GIS are used for preparation of spatial distribution maps³. Groundwater from the source is collected in the one liter plastic bottles from source and sends them to laboratory within 24 hours. After lab analysis the results are analyzed for drinking water suitability. In order to assess the groundwater quality three physical parameters such as pH, Total Dissolved Solids (TDS), Total Hardness (TH) and eleven chemical parameters were analyzed like Sodium (Na), Potassium (K), Calcium (Ca), Magnesium (Mg), Sulfates (SO₄), Nitrates (NO₃), Chloride (Cl), Bi-Carbonates (HCO₃). Bureau of Indian Standards (BIS) IS: 10500, 1992 (Reaffirmed 1993) standards have been used for analysis of water quality for drinking purpose. Spatial distribution maps of these parameters have been prepared in GIS as shown in Figure-2 and Figure-3.

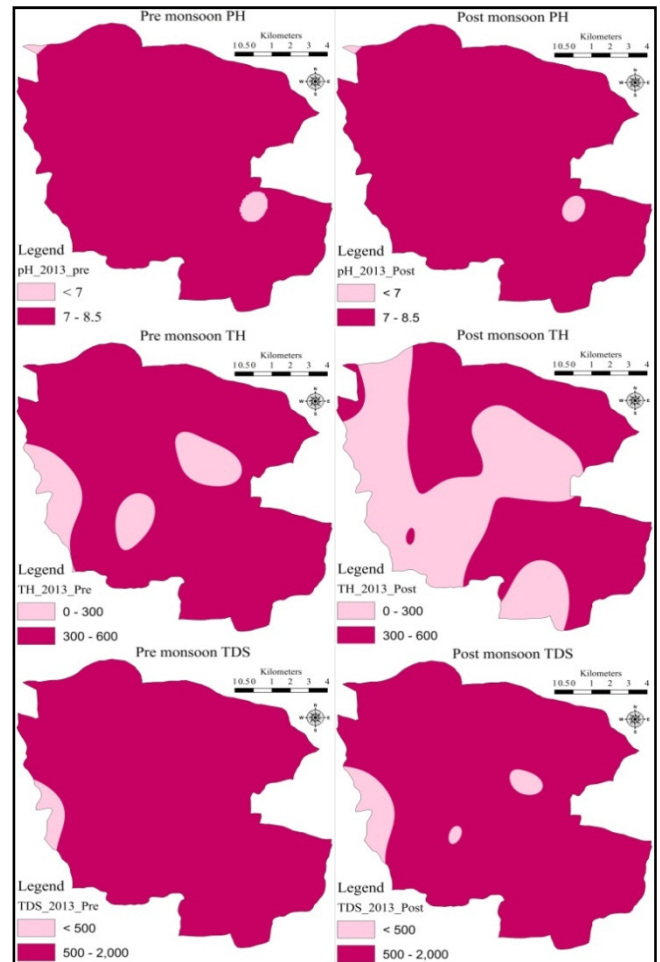


Figure-2
 Spatial distribution of the physical parameters



Figure-3
 Spatial distribution of the Chemical parameters

Results and Discussion

Statistical analyses of pre and post monsoon groundwater quality characteristics like physical and chemical parameters of the twenty four villages were presented in the Table-1 and Table-2. BIS standards portrayed in Table-3.

pH: Negative logarithm of hydrogen ion concentration is called pH, measures in moles per liter⁴. Minimum pH in pre and post monsoon is 7.1 while maximum varied from 8.3 in pre monsoon to 8.2 in post monsoon it indicates generally basic nature in both seasons. Standard deviation and mean in pre and post monsoon is 0.3 and 7.8 respectively. According to BIS standards groundwater in the watershed is suitable for drinking.

Total Dissolved Solids: Minimum and maximum TDS of Chevella sub basin is 509 milligrams per liter and 1082 milligrams per liter⁵. Mean TDS is 878 milligrams per liter while standard deviation is 150.3 milligrams per liter in pre monsoon. Similarly in post monsoon minimum is 407 milligrams per liter, maximum is 877 milligrams per liter, mean is 697 milligrams per liter and standard deviation is 122.6 milligrams per liter.

According to BIS standards TDS in all samples in Chevella sub basin is fall under maximum accepted limit (2000 milligrams per liter). In post monsoon maximum BIS limits accepted 95.8 percent samples remaining 4.2 percent samples come under permissible limit. In pre monsoon 83.3% of samples are classified as fresh (0-1000milligrams per liter of TDS) and 16.7% are brackish water (1000-10000 milligrams per liter); while in post monsoon all samples are classified as fresh water.

Total Hardness: Hardness of the water can be determined by the concentration of Calcium and Magnesium constituents in the sample. Regarding BIS, 12.5 percent of samples have possess permissible limits (300) remaining 87.5 percent samples has maximum accepted limit (600) in pre monsoon. Similarly in post monsoon all samples are maximum accepted limit (600). In pre monsoon all samples are very hard (> 300milligrams per liter as CaCO₃) while in post monsoon 45.8 percent of samples changed into hard (150-300milligrams per liter as CaCO₃) and 54.2 percent of samples are still very hard (> 300milligrams per liter as CaCO₃). Minimum TH in pre and post monsoon is 216 and 407 respectively.

Maximum TH varied from 222 to 353. Mean of TH reduced from 372.4 to 301.8 and standard deviation is 63.7 in pre monsoon and 38.1 in post monsoon.

Sodium: Concentration of Sodium measures in milligrams per liters. Maximum and minimum sodium constituted as 134 milligrams per liter and 63 milligrams per liter respectively similarly mean and standard deviations are constituted 108.5 milligrams per liter and 18.7 milligrams per liter in pre monsoon⁶. In post monsoon maximum and minimum amounted

to 121 milligrams per liter and 56 milligrams per liter respectively while mean and standard deviations accounted to 91.7 milligrams per liter and 18.6 milligrams per liter. All samples in pre and post monsoon are not conveyed BIS limit (50 milligrams per liter).

Potassium: Concentration of Potassium measures in milligrams per liters. Maximum and minimum potassium formed in groundwater as 6 milligrams per liter and 3 milligrams per liter respectively similarly mean and standard deviations are constituted 4.6 milligrams per liter and 0.9 milligrams per liter in pre monsoon⁷.

Post monsoon maximum and minimum amounted to 7 milligrams per liter and 3 milligrams per liter respectively while mean and standard deviations accounted to 5.6 milligrams per liter and 1.0 milligrams per liter.

Magnesium: Concentration of Magnesium measures in milligrams per liters. Minimum is recorded as 32 milligrams per liter and 33 milligrams per liter in pre and post monsoon respectively while maximum is 68 milligrams per liter and 52 milligrams per liter respectively in same seasons⁸.

Mean in pre monsoon is 55 milligrams per liter and 44.3 milligrams per liter in post monsoon. Standard deviation is 9.4 milligrams per liter and 5.4 milligrams per liter in pre and post monsoon respectively. All samples satisfied BIS maximum accepted limit (100 milligrams per liter) in pre and post monsoon.

Calcium: Concentration of Calcium measures in milligrams per liters. Minimum is recorded as 47 milligrams per liter and 57 milligrams per liter in pre and post monsoon respectively while maximum is 99 milligrams per liter and 121 milligrams per liter respectively in the same seasons⁹.

Mean in pre monsoon is 80.5 milligrams per liter and 98.3 milligrams per liter in post monsoon. Standard deviation is 13.7 milligrams per liter and 16.9 milligrams per liter in pre and post monsoon respectively. 25 percent of samples satisfied BIS permissible limit (75 milligrams per liter) and 75 percent of samples constitute maximum accepted limit (200 milligrams per liter) in pre monsoon; and post monsoon while 12.5 percent of samples fulfilled BIS permissible limit and remaining 87.5 percent come under maximum accepted limit.

Iron: Concentration of Iron measures in milligrams per liters. Minimum is recorded as 0.02 milligrams per liter and 0.01 milligrams per liter in pre and post monsoon respectively while maximum is 0.6 milligrams per liter and 0.5 milligrams per liter respectively in same seasons. Mean and standard deviation in pre and post monsoon is 0.1 milligrams per liter. Percentage of samples in BIS permissible limit increased to 92 to 95.8 in pre monsoon and decreased to 8 to 4.2 percentages in post monsoon.

Table-1
Physio-Chemical parameters of pre monsoon season of 2013 in Chevella sub basin of Rangareddy district

Village	TH	pH	TDS	Na	K	Mg	Ca	Fe	F	Cl	SO ₄	HCO ₃	CO ₃	NO ₃
Chandippa	388	7.8	916	113	5	57	84	0.1	1.3	171	60	148	0.8	17.6
Devunierravally	419	7.8	988	122	5	62	91	0.1	1.1	184	64	160	1	19
Earlapally	435	7.9	780	96	4	49	72	0.1	1	146	51	126	1	15
Elverthy	216	7.9	1082	134	6	68	99	0.1	1	202	70	175	1.5	20.8
Gollapally	332	7.8	1025	127	5	64	94	0.6	0.7	191	67	166	1.1	19.7
Hussainpur	251	7.6	509	63	3	32	47	0.3	0.9	95	33	82	0.3	9.8
Ibrahimpalli	370	8.3	783	97	4	49	72	0.1	1	146	51	127	2.4	15.1
Kammeta	402	8.1	592	73	3	37	54	0.03	1	110	39	96	1.2	11.4
Kesaram	385	8	872	108	5	55	80	0.2	1.2	163	57	141	1.3	16.8
Kothapalli	364	7.8	949	117	5	59	87	0.04	0.6	177	62	154	0.9	18.3
Kummera	307	7.1	909	112	5	57	83	0.2	1.2	170	59	147	0.2	17.5
Malkapur	408	8.2	859	106	5	54	79	0.02	0.6	160	56	139	2.2	16.5
Masaniguda	360	8	724	89	4	45	66	0.1	0.9	135	47	117	1.1	13.9
Mudimyal	360	8	962	119	5	60	88	0.02	0.8	180	63	156	1.6	18.5
Nyalata	360	7.9	849	105	4	53	78	0.1	0.8	159	55	138	1.1	16.3
Parveda Chinchalam	459	7.7	849	105	4	53	78	0.1	0.8	159	55	138	0.6	16.3
Parvedakalasa	401	7.7	849	105	4	53	78	0.1	0.8	159	55	138	0.6	16.3
Proddutur	405	8.1	1081	134	6	68	99	0.04	1	202	70	175	2.3	20.8
Ramanthapur	448	8.2	946	117	5	59	87	0.5	1.4	177	62	153	2.4	18.2
Ravulapally	263	7.2	956	118	5	60	88	0.3	1.4	178	62	155	0.3	18.4
Tangatooor	459	7.8	1056	130	6	66	97	0.1	1.1	197	69	171	1	20.3
Urella	391	7.8	619	76	3	39	57	0.1	1.1	116	40	100	0.6	11.9
Yenkapally	331	7.6	921	114	5	58	84	0.1	1.1	172	60	149	0.6	17.7
Yervaguda	423	7.7	997	123	5	62	91	0.1	0.9	186	65	162	0.8	19.2
Minimum	216	7.1	509	63.0	3.0	32	47	0.02	0.6	95.0	33.0	82.0	0.2	9.8
Maximum	459	8.3	1082	134.0	6.0	68	99	0.6	1.4	202.0	70.0	175.0	2.4	20.8
Mean	372.4	7.8	878	108.5	4.6	55	80.5	0.1	1.0	164.0	57.2	142.2	1.1	16.9
Standard Deviation	63.7	0.3	150.3	18.7	0.9	9.4	13.7	0.1	0.2	28.0	9.8	24.4	0.7	2.9

Table-2
Physio-Chemical parameters of post monsoon season in 2013 Chevella watershed of Rangareddy district

Village	TH	pH	TDS	Na	K	Mg	Ca	Fe	F	Cl	SO ₄	HCO ₃	CO ₃	NO ₃
Chandippa	305	7.8	742	107	6	45	103	0.1	1.1	136	52	286	0.4	8
Devunierravally	324	7.8	789	109	6	48	111	0.1	1.0	133	52	309	0.5	15
Earlapally	332	7.9	632	72	5	40	87	0.0	0.9	136	24	244	0.5	9
Elverthy	222	7.9	876	120	7	51	121	0.1	1.0	146	94	338	0.7	10
Gollapally	277	7.8	787	95	7	48	115	0.5	0.6	151	57	321	0.6	10
Hussainpur	230	7.5	407	56	3	33	57	0.2	0.8	38	20	159	0.1	7
Ibrahimpalli	283	8.2	601	81	5	41	88	0.1	0.9	116	22	245	1.1	9
Kammeta	321	8.1	479	61	4	34	66	0.0	0.9	61	26	185	0.6	12
Kesaram	319	8.0	670	81	6	42	98	0.2	1.1	109	44	273	0.7	20
Kothapalli	290	7.8	768	102	6	47	106	0.0	0.6	123	55	297	0.5	15
Kummera	252	7.1	736	99	6	47	102	0.2	1.1	116	48	284	0.1	14
Malkapur	331	8.2	686	86	6	43	96	0.0	0.6	128	45	269	1.0	13
Masaniguda	299	8.0	556	71	5	37	81	0.1	0.8	76	46	227	0.6	11
Mudimyal	291	8.0	780	98	6	48	108	0.0	0.8	146	53	301	0.7	11
Nyalata	291	7.9	678	89	5	44	95	0.1	0.7	112	51	266	0.6	9
Parveda Chinchalam	353	7.7	652	91	5	43	95	0.1	0.8	97	38	266	0.3	12
Parvedakalasa	341	7.7	652	91	5	43	95	0.1	0.8	97	38	266	0.3	12
Proddutur	332	8.1	877	121	7	52	121	0.0	0.9	155	68	338	1.0	13
Ramanthapur	345	8.1	726	82	6	50	106	0.4	1.3	107	44	296	1.1	4
Ravulapally	238	7.2	775	102	6	49	107	0.3	1.3	175	17	299	0.1	7
Tangatooor	349	7.8	843	120	7	50	118	0.1	1.0	155	58	330	0.5	9
Urella	319	7.8	501	62	4	35	69	0.1	1.0	76	23	194	0.3	9
Yenkappally	272	7.5	707	93	6	46	103	0.1	1.0	127	34	288	0.2	8
Yervaguda	327	7.7	808	111	6	48	112	0.1	0.8	126	78	312	0.4	14
Minimum	222.0	7.1	407.0	56.0	3.0	33.0	57.0	0.0 1	0.6	38.0	17.4	159.3	0.1	3.6
Maximum	353.0	8.2	877.0	121.0	7.0	52.0	121.0	0.5	1.3	175.2	93.5	338.4	1.1	19.8
Mean	301.8	7.8	697.0	91.7	5.6	44.3	98.3	0.1	0.9	118.4	45.2	274.6	0.5	10.9
Standard Deviation	38.1	0.3	122.6	18.6	1.0	5.4	16.9	0.1	0.2	32.4	18.6	47.0	0.3	3.4

Table-3
Comparison with BIS drinking water standards in Pre and post monsoon

Parameters	Standard limits		% of samples in Pre monsoon		% of samples in Post monsoon	
	Permissible	Maximum Accepted	Permissible	Maximum Accepted	Permissible	Maximum Accepted
TH	300	600	12.5	87.5	0	100
pH	6.5-8.5	6.5-9.2	100	0	100	0
TDS	500	2000	0	100	4.2	95.8
Na	50	-	0	0	0	0
K	-	-	-	-	-	-
Mg	30	100	0	100	0	100
Ca	75	200	25.0	75.0	12.5	87.5
Fe	0.3	1	92.0	8.0	95.8	4.2
F	1	1.5	54.2	45.8	79.2	20.8
Cl	250	1000	100	0	100	0
SO ₄	200	400	100	0	100	0
HCO ₃	30	-	0	0	0	0
CO	75	200	100	0	100	0
NO ₃	45	-	100	0	100	0

Bi-Carbonates: Concentration of Bi-Carbonates measures in milligrams per liters. Minimum is recorded as 82 milligrams per liter and 159.3 milligrams per liter in pre and post monsoon respectively while maximum is 175 milligrams per liter and 338 milligrams per liter respectively in same seasons¹¹. Mean in pre monsoon is 142.2 milligrams per liter and 274.6 milligrams per liter in post monsoon. Standard deviation is 9.8 milligrams per liter and 47 milligrams per liter in pre and post monsoon respectively. BIS limits are not satisfied neither pre nor post monsoon.

Carbonates: Concentration of Carbonates measures in milligrams per liters. Minimum is recorded as 0.2 milligrams per liter and 0.1 milligrams per liter in pre and post monsoon respectively while maximum is 2.4 milligrams per liter and 1.1 milligrams per liter respectively in same seasons¹². Mean in pre monsoon is 1.1 milligrams per liter and 0.5 milligrams per liter in post monsoon. Standard deviation is 0.7 milligrams per liter and 0.3 milligrams per liter in pre and post monsoon respectively.

Nitrates: Concentration of Nitrates measures in milligrams per liters. Minimum is recorded as 9.8 milligrams per liter and 3.6

milligrams per liter in pre and post monsoon respectively while maximum is 20.8 milligrams per liter and 19.8 milligrams per liter respectively in same seasons¹³. Mean in pre monsoon is 16.9 milligrams per liter and 10.9 milligrams per liter in post monsoon. Standard deviation is 2.9 milligrams per liter and 3.4 milligrams per liter in pre and post monsoon respectively.

Chlorine: Concentration of Chlorine measures in milligrams per liters. Minimum is recorded as 95 milligrams per liter and 38 milligrams per liter in pre and post monsoon respectively while maximum is 202 milligrams per liter and 175.2 milligrams per liter respectively in same seasons¹⁴. Mean in pre monsoon is 164 milligrams per liter and 118.4 milligrams per liter in post monsoon. Standard deviation is 28 milligrams per liter and 32.4 milligrams per liter in pre and post monsoon respectively.

Fluoride: Concentration of Fluoride measures in milligrams per liters. Maximum fluoride constituted as 1.4 milligrams per liter in pre monsoon and 1.3 milligrams per liter in post monsoon. Minimum amounted to 0.6 milligrams per liter in pre monsoon and post monsoon seasons¹⁵. Mean and standard deviation is 1

milligram per liter and 0.2 milligrams per liter in pre monsoon while in post monsoon mean and standard deviation is 0.9 milligrams per liter and 0.2 milligrams per liter respectively¹⁶.

Spatial variation: Spatial variation described as per the BIS standard limits termed as permissible limit and maximum accepted limit which has been considered where water is not available in the permissible limit. Figure 2 shows that there is no major change in geographical distribution of pH in comparing pre and post monsoon season; except little area where pH range 8.0 to 8.5 at all directions reduced to 7.0 to 8.0¹⁷. TDS in pre monsoon, permissible limits lies at extreme west tip whereas in post monsoon area of permissible limit is added at and central south west also; remaining area had maximum accepted limit¹⁸. Regarding TH Small portions of the extreme west, central south west, and central east had satisfied with BIS permissible limit. Remaining part of the basin had constituted maximum accepted limit¹⁹. In post monsoon eastern, central south, central north, north east parts constituted maximum accepted limit and remaining area spread permissible limit²⁰. Figure-2 revealed that, in respect to Sodium only extreme western tip of the basin in pre and post monsoon constituted permissible limit; remaining portion falls in the maximum acceptable limit²¹. Regarding magnesium permissible limits is constituted at extreme western tip of the basin in all seasons while remaining is has maximum accepted limit. Regarding Calcium permissible limits is constituted at central south west, central east, and west of the basin in pre monsoon while remaining parts had maximum accepted area²¹. In post monsoon permissible limits reduced at same segments and increased maximum acceptable limit area. On the subject of Iron, It is found that permissible limits representing small circles at north, west, central south east, and extreme south east in the year 2013²². Carbonates, Sulfates and Nitrates are in permissible limit in both seasons while bi-carbonates are spread in maximum acceptable limit in the sub basin²³. Regarding Chloride Chevella sub basin contented with permissible limit except very extreme north east in pre monsoon and extreme south east which follow maximum accepted limit. Permissible limit of fluoride is at west, south east and north east tip and remaining area has maximum accepted limit in pre monsoon²⁴. In post monsoon fluoride content in terms of permissible limit increased comparing to pre monsoon. Maximum accepted limit only concentrated like a strip extended at south west, east and north tip of the Chevella sub basin.

Conclusion

Groundwater in the Chevella sub basin is posses' basic type of characteristics. It is suitable for drinking as per the BIS standards. 16.7% of the samples only containing brackish water in pre monsoon and remaining are fresh water in both seasons. In pre monsoon percentage of very hard type of water reduced from 100 to 54.2; 48.2 % of villages changed into hard water from very hard water. Carbonates, Sulfates and nitrates in pre and post monsoon have permissible limits. Bi-carbonates have

maximum accepted limits in pre and post monsoon. Sodium and Magnesium permissible limits spread at edge of the west and remaining area has maximum accepted limit. No change in spatial distribution of pH and Iron in Chaevella sub basin. Reducing of groundwater total hardness (TH) and Calcium content in the sub basin in post monsoon has been moving towards permissible limits to east from west and to north east from south west comparing to pre monsoon. Total dissolved solids are increasing in post monsoon. Fluoride content in the sub basin is changing towards maximum acceptable limit.

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