Groundwater quality studies of chipri village of shirol taluka, kolhapur district, maharashtra

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Abstract: Groundwater is a vital that is available beneath the earth crust within the aquifers. This is distributed as per the subsurface soil condition. Groundwater is most pure natural resource below the subsurface but due to increase in the contaminant into the pore of soil, water flows were polluted. Increase in the tremendous stress on subsurface water need to check the quality of water periodically. The different physical viz; Colour, Odour, Test, Turbidity and chemical parameters such as pH, Total Dissolved solids (TDS), Total Hardness (TH), Ca^{2+}, Mg^{2+}, Na^{2+}, K^{+}, HCO_3^{-}, Co_3^{-}, SO_4^{-} and Cl^{-} were determined by using standard method proposed by WHO (2004), APHA(1994) and Trivedy and Goal(1986). This study seeks to serve as a preliminary study to assess the groundwater quality and it's Suitability for drinking, industrial and agricultural purposes in Chipri Village.

Index Terms – Ground water quality, hydro-chemical facies

I. INTRODUCTION

Since water is one of the most important elements of life, it is important to conserve water properly and use it properly. As man has progressed, the resources around him have been strained; increasing industrialization and the use of chemical fertilizers in the fields have taken a toll on human health. But the flow of water due to pesticides, fertilizers goes into the beneath the soil and pollute the water aquifers. Therefore, it is very important to check the quality of ground water from time to time, so that it can be understood whether it's drinkable, good for agriculture and industry. As per previous literature of above subject the authors reveal that groundwater is very pure source of water. It is use newly developed places such as industry, agriculture and urban areas of cities. Pollution in ground water tends to be removed or reduced in concentration with time and with distance travelled. This quality survey carried out with similar format basis as previously done by researcher and implement in the Chipri village.

The water quality data is essential for the implementation of responsible water quality regulations for characterizing and remediating contamination and for the protection of the health of human beings and effect on the ecosystem. Regular monitoring of groundwater resources thus plays a key role in sustainable management of water resources.

1.1 Study area

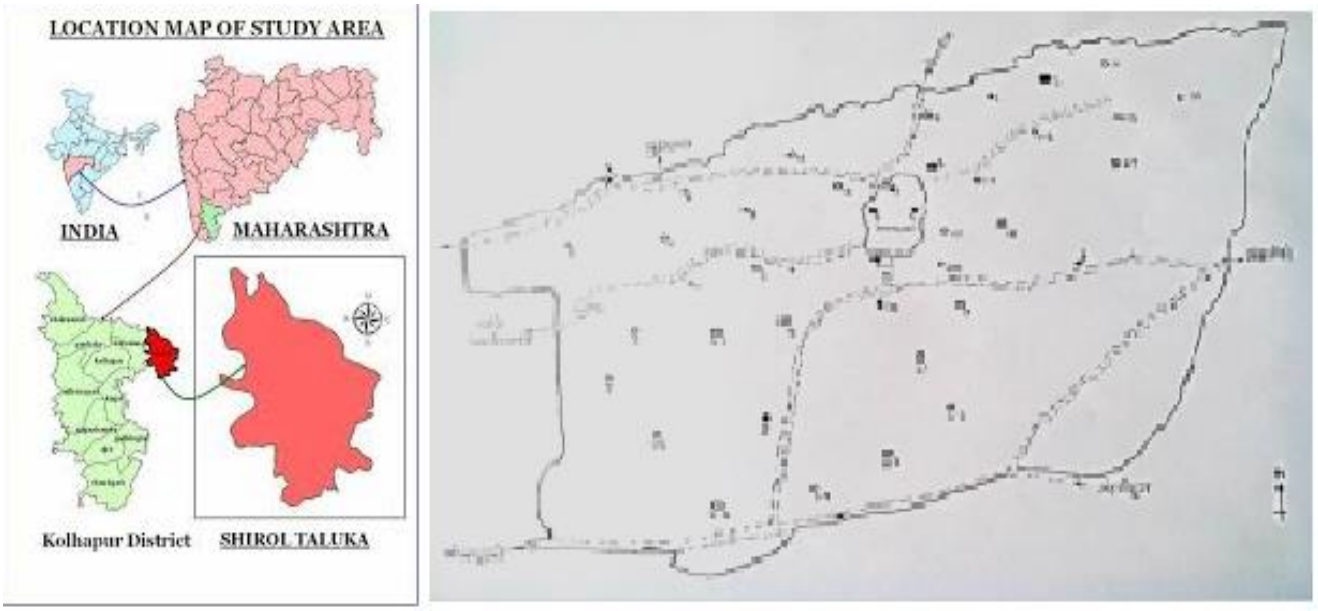
Command area situated near about 30 KM from Kolhapur city having name of Chipri in Shirol tehsil. This area circumferences between the latitude 16°45'00"N to 16°46'40" N and longitude 74°30'00" E to 74°32'30" E in Survey of India Topographic Sheet No. 47L/9 on scale 1:50000. The present study area is research about 7.5 Km^2 and having moderate rainfall as per the Indian meteorology department. This research area is agricultural and industrial sector which consume large amount of groundwater.

II. METHODOLOGY

2.1 Selection of sampling site -This site was selected on the basis of consumption of groundwater for agriculture and industrial purpose. So that it is priority to know the quality of groundwater to the safety of health and soil. Location of the sampling site can be considered by the taking the help of topographical map of Chipri village.

In selecting sampling points each locality should be considered individually. Selection of the site depends on the character of the water body. Sampling points should be selected such that the samples taken are representative of the different sources from which water is obtained by the public and utilized for different purposes. Sampling points should be uniformly distributed throughout an area.

2.2 Sampling frequency - The numbers of sample required depends on the topographical area of the Chipri village. 30 dug well samples and 10 bore well samples was collected from the study area in post monsoon (November 2014) and pre-monsoon (March 2015) seasons (Fig 1). The sample location on the map was carried out with the help of the GPS system. The locations of the water samples are generally divide the topographical condition of the village. Water was collected from the Chipri village command area of Shirol Tahsil to study the variation in its quality. Sample was collected by use of 1 litre polythene bottle and as per norms of W.H.O.



○- Dug well ●- Bore well

Fig. 1: Location map and sampling frequency of the study area

In the present investigation about 40 groundwater samples from the representative dug wells and the bore wells collected in post-monsoon (Nov 2014) and post-monsoon (March 2015) seasons which are fitted with hand pumps and jet pumps. Chemical parameters such as pH, Total Dissolved solids (TDS), Total Hardness (TH), Ca2+, Mg2+, Na2+, K+, HCO3-, Co3-, SO4- and Cl- were determined by using standard method proposed by WHO (2004), APHA(1994) and Trivedy and Goal(1986).

Table 1: Chemical concentration of different chemical parameters from bore well water samples of the study area (post-monsoon season).

SAMPLE NO.	pH	EC	TH	TDS	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl
BW1	6.71	0.31	284	248.4	46.49	40.93	87	1	112	16	23.5	88.75
BW2	6.73	0.31	302	248.4	43.28	46.78	76	0	120	12	28.5	74.55
BW3	7.09	0.26	156	216.4	28.05	20.95	62	6	70	16	14.5	31.95
BW4	6.84	0.24	138	203.6	30.46	15.1	59	1	58	16	17.5	31.95
BW5	6.51	0.24	240	203.6	53.7	25.82	41	0	116	12	14.5	37.275
BW6	6.6	0.22	152	190.8	33.66	16.56	31	0	42	36	11.5	35.5
BW7	6.57	0.23	160	197.2	41.68	13.64	43	4	96	8	14	24.85
BW8	6.77	0.24	180	203.6	43.28	17.54	54	1	62	12	20	37.275
BW9	6.56	0.24	248	203.6	59.31	24.36	46	0	102	12	25.5	42.6
BW10	6.6	0.23	230	197.2	51.3	24.85	30	0	176	16	15.5	30.175

pH: in log of H+ concentration
TDS = Total Dissolved Solids (in ppm)
DW= Dug well

TH = Total hardness (in ppm)
Ca, Mg, K, Na, HCO3, CO3, Cl in ppm
BW= Bore well

Table 2: Chemical concentration of different chemical parameters from dug well water samples of the study area (post-monsoon season).

SAMPLE NO.	pH	EC	TH	TDS	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl
DW1	6.62	0.26	304	216.4	80.16	22.9	46	2	86	20	27	58.57
DW2	6.7	0.26	296	216.4	74.54	26.8	47	3	88	16	27.5	56.8
DW3	6.71	0.23	180	197.2	36.07	21.92	34	3	52	32	14.5	24.85
DW4	6.72	0.21	184	184.4	44.08	18.03	32	1	74	24	7.5	24.85
DW5	6.9	0.22	216	190.8	48.09	23.39	43	2	44	36	7.5	33.72
DW6	6.82	0.25	340	210	81.76	33.13	63	2	132	8	19.5	63.9
DW7	6.66	0.27	380	222.8	104.20	29.23	65	1	102	28	5	53.25
DW8	6.78	0.27	312	222.8	54.5	42.88	63	0	130	4	4	65.37
DW9	6.65	0.28	344	229.2	49.59	53.603	75	3	122	20	28	74.55
DW10	6.7	0.34	428	267.6	66.53	63.83	100	1	102	28	26	134.9
DW11	7.2	0.31	304	248.4	36.87	51.65	71	1	124	16	24	74.55
DW12	6.76	0.31	382	248.4	54.5	59.93	73	1	98	20	21.5	94.075
DW13	6.92	0.3	270	242	57.71	30.69	64	14	98	12	29	81.65
DW14	6.8	0.3	280	242	64.128	29.23	67	3	70	24	27.5	56.8
DW15	6.66	0.32	336	254.8	67.33	40.93	87	1	92	16	24	97.625
DW16	6.72	0.34	390	267.6	63.32	56.52	82	0	94	24	34	94.075
DW17	6.46	0.33	396	261.2	76.95	49.72	55	2	96	28	21	76.325
DW18	6.9	0.31	306	248.4	67.33	33.62	40	0	56	20	27	46.15
DW19	6.67	0.31	370	248.4	86.57	37.62	42	0	64	28	33	40.825
DW20	6.76	0.35	412	274	89.77	45.8	54	0	82	20	22.5	85.2
DW21	6.8	0.3	248	242	52.104	28.75	26	0	36	28	28	12.425
DW22	6.82	0.28	184	229.2	36.07	22.9	32	1	76	16	16.5	21.3
DW23	6.9	0.26	250	216.4	28.05	43.85	41	0	90	8	10.5	17.75
DW24	6.95	0.24	158	203.6	36.07	16.56	34	2	52	16	15.5	24.85
DW25	6.75	0.26	222	216.4	54.5	20.95	47	1	68	24	14.5	39.05
DW26	6.91	0.25	232	210	55.31	22.9	43	0	60	28	18	37.275
DW27	6.56	0.27	272	222.8	68.136	24.85	50	0	66	20	7.5	47.925
DW28	6.64	0.26	230	216.4	57.715	20.95	41	0	90	8	13	33.725
DW29	6.88	0.28	292	229.2	68.93	29.23	35	0	80	16	15.5	49.7
DW30	6.54	0.3	388	242	92.98	38	70	1	76	36	25	56.8

Table 3: Chemical concentration of different chemical parameters from dug well water samples of the study area (pre-monsoon season).

SAMPLE NO.	pH	EC	TH	TDS	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl
DW1	7.43	0.38	328	293.2	92.184	23.87	95	1	72	12	18	47.92
DW2	7.34	0.32	204	254.8	72.144	5.84	98	1	90	16	22	46.15
DW3	7.46	0.28	159	229.2	36.07	15.1	74	1	100	16	7	21.3
DW4	7.36	0.26	158	216.4	43.28	12.18	66	2	62	20	8	17.75
DW5	7.46	0.3	218	242	68.136	11.69	93	2	76	16	17.5	33.72
DW6	7.3	0.33	304	261.2	69.73	31.67	120	0	120	20	27.5	45.2
DW7	7.27	0.34	278	267.6	68.136	26.31	125	1	90	24	28	62.125
DW8	7.36	0.33	284	261.2	61.72	31.67	120	1	122	12	18.5	56.8
DW9	7.5	0.34	312	267.6	44.88	48.73	138	1	84	24	20	63.9
DW10	7.53	0.37	416	286.8	69.73	58.96	171	1	110	20	23	127.8
DW11	7.91	0.34	306	267.6	36.07	52.62	140	1	126	16	18.5	67.45
DW12	7.69	0.33	278	261.2	52.104	36.06	120	1	120	16	15.5	71
DW13	7.6	0.35	344	274	89.77	29.23	120	1	88	12	21.5	140.225
DW14	7.61	0.33	288	261.2	81.76	20.46	137	1	110	20	23	69.225
DW15	7.24	0.34	314	267.6	73.74	56.03	155	1	106	16	25.5	88
DW16	7.56	0.32	394	254.8	51.3	64.81	149	1	90	24	27	94.075
DW17	7.26	0.29	308	235.6	62.52	37.03	104	0	100	28	18	49.7
DW18	7.69	0.22	104	190.8	16.83	15.1	88	0	50	16	10.5	17.75
DW19	7.33	0.29	140	235.6	72.94	38.49	86	2	106	12	33	40.82
DW20	7.35	0.29	378	235.6	75.35	46.29	101	1	100	20	17.5	58.57
DW21	7.22	0.25	344	210	58.51	48.24	60	0	52	16	29.5	14.2
DW22	7.38	0.24	234	203.6	31.26	38	74	1	84	24	15	24.85
DW23	7.78	0.23	174	197.2	20.84	29.72	89	1	66	20	12.5	17.75
DW24	7.62	0.23	210	197.2	32	31.67	75	1	48	24	11.5	23
DW25	7.52	0.26	344	216.4	53.6	51.16	90	1	72	12	14.5	31.95
DW26	7.3	0.29	208	216.4	27.25	34.11	82	0	62	16	12	23
DW27	7.32	0.29	244	235.6	71.8	16.56	89	1	92	20	18.5	44.37
DW28	7.42	0.19	114	171.6	16.83	17.54	55	1	38	16	6.5	19.52
DW29	7.34	0.26	240	216.4	56.91	23.87	80	0	76	12	11.5	49.7
DW30	7.23	0.39	448	299.6	115.43	38.98	136	1	92	16	24	110

Table 4: Chemical concentration of different chemical parameters from bore well water samples of the study area (pre-monsoon season).

SAMPLE NO.	pH	EC	TH	TDS	Ca	Mg	Na	K	HCO_3	CO_3	SO_4	Cl
BW1	6.72	0.32	275	250	47	41	88	1	114	15	22	89
BW2	6.75	0.32	290	249	44	46	77	0	121	12	21.5	75
BW3	7.29	0.25	196	210	41.68	22.41	122	19	114	24	10	42.6
BW4	7.66	0.24	220	203.6	28.85	36.06	112	0	62	16	7.5	26.62
BW5	7.17	0.25	196	210	55.31	14.13	86	1	122	20	7.5	40.82
BW6	7.2	0.21	150	18.4	28	19.49	70	1	94	20	4	21.3
BW7	7.24	0.22	174	190.8	41.68	17.05	85	4	86	20	7	30.17
BW8	7.63	0.23	208	197.2	57.71	15.1	64	1	62	20	14	31.95
BW9	7.62	0.24	230	203.6	53.7	23.39	90	1	90	24	11.5	39.05
BW10	7.13	0.28	178	229.2	33.45	23.39	74	1	100	20	6.5	24.85

III. RESULT AND ANALYSIS

3.1 Result of experiment: After the chemical analysis of groundwater samples in post monsoon and pre monsoon season, the results are compere with IS 10500:2012, WHO (2004) (table 1, 2, 3, 4). After comparing with W.H.O. standard it is seen that average chemical parameter in pre monsoon season are exceed than post monsoon season but does not exceed the permissible limit of Indian standard and W.H.O. International standard. (Table 5, Table 6)

Table 5: Data showing the range, average and standard deviation values for post monsoon period

Parameters	Indian Standards Institution(2012)		W.H.O. International Standards(2004)		Post monsoon period					
	Highest desirable	Maximum Permissible	Highest desirable	Maximum Permissible	Range		Average		Standard deviation	
					Dug well	Bore well	Dug well	Bore well	Dug well	Bore well
pH	6.5 - 8.5	6.4 - 9.2	7.0 - 8.5	6.4-9.2	6.46-7.2	6.51-7.09	6.762	6.698	0.149	0.173
TH	300	600	100	500	158-428	138-302	296.86	209	76.167	59.196
TDS	500	1500	500	1500	184.4-274	190.8-248.4	230.69	211.28	23.147	20.639
Ca	75	200	75	200	28.05-104.20	28.05-65.52	61.29	43.121	18.757	10.172
Mg	30	100	30	150	16-63.83	13.64-46.78	34.67	24.653	13.341	11.047
Cl	250	1000	200	600	12.42-134.9	24.85-88.75	55.96	43.487	28.269	20.939
Na	-	-	-	-	26-100	30-87	54.0	52.9	18.476	18.585
K	-	-	-	-	0-14	0-6	1.5	1.3	2.583	2.057
HCO_3	-	-	-	-	36-132	42-176	83.3	95.4	24.732	39.237
CO_3	-	-	-	-	4 -36	8 - 36	20.8	15.6	8.163	7.647
SO_4	200	400	-	-	4 - 34	11.5-32	19.8	18.5	8.428	5.651

Table 6: Data showing the range, average and standard deviation values for pre monsoon period

Parameter	Indian Standards Institution(2012)		W.H.O. International Standards(2004)		Post monsoon period					
	Highest desirable	Maximum Permissible	Highest desirable	Maximum Permissible	Range		Average		Standard deviation	
					Dug well	Bore well	Dug well	Bore well	Dug well	Bore well
pH	6.5 - 8.5	6.4 - 9.2	7.0 - 8.5	6.4-9.2	7.82-7.91	6.72-7.66	7.44	7.37	0.17	0.33
TH	300	600	100	500	104-448	150-290	269.16	193.71	88.72	43.98
TDS	500	1500	500	1500	171.6-299.6	18.4-250	240.93	178.97	32.37	65.74
Ca	75	200	75	200	16.83-115.43	28-57.71	57.42	42.67	23.68	10.64
Mg	30	100	30	150	5.84-64.81	14.13-46	43.06	21.23	15.40	71.22
Cl	250	1000	200	600	14.2-140.225	21.3-89	52.59	30.68	32.98	22.38
Na	-	-	-	-	55-171	64-122	104.3	83.00	29.99	18.10
K	-	-	-	-	0-2	0-19	0.90	1.85	0.57	5.76
HCO_3	-	-	-	-	38-126	62-122	86.80	88	23.63	22.14
CO_3	-	-	-	-	12-28	12-24	17.86	22	4.42	3.78
SO_4	200	400	-	-	6.5-33	4-22	18.50	8.28	6.99	6.26

Also this groundwater analysis classified with the help of following methods

3.2 Piper trilinear diagram

It is seen from fig. 2 (a) that out of 40 sample of post monsoon no sample should represent the strong acid. 100% samples are representing in Ca+Mg is exceeding Na+k of the hydrochemical facies. Similarly out of 40 groundwater samples of post monsoon 3 sample (92.5%) are represent HCO3+CO3 exceed SO4+Cl2 i.e. week acid exceed than strong acid. And 7.5% SO4 > Cl2 i.e. strong acid exceed than week acid of the hydrochemical facies. From fig. 2 (b) it is seen that out of 40 samples in pre monsoon season 33 samples (82.5%) Ca+Mg > Na+K (alkaline earth exceed alkalies) and 17.5% sample belongs to Na+K > Ca+Mg of hydrochemical facies. Similarly, out of 40 samples 31 samples (77.5%) are belongs to HCO3+CO3 > SO4+Cl2 (week acid exceed than strong acid) and 9 samples are (i.e.22.5%) SO4+Cl2 > HCO3+CO3 (strong acid exceed than week acid).

3.3 Wilcox diagram

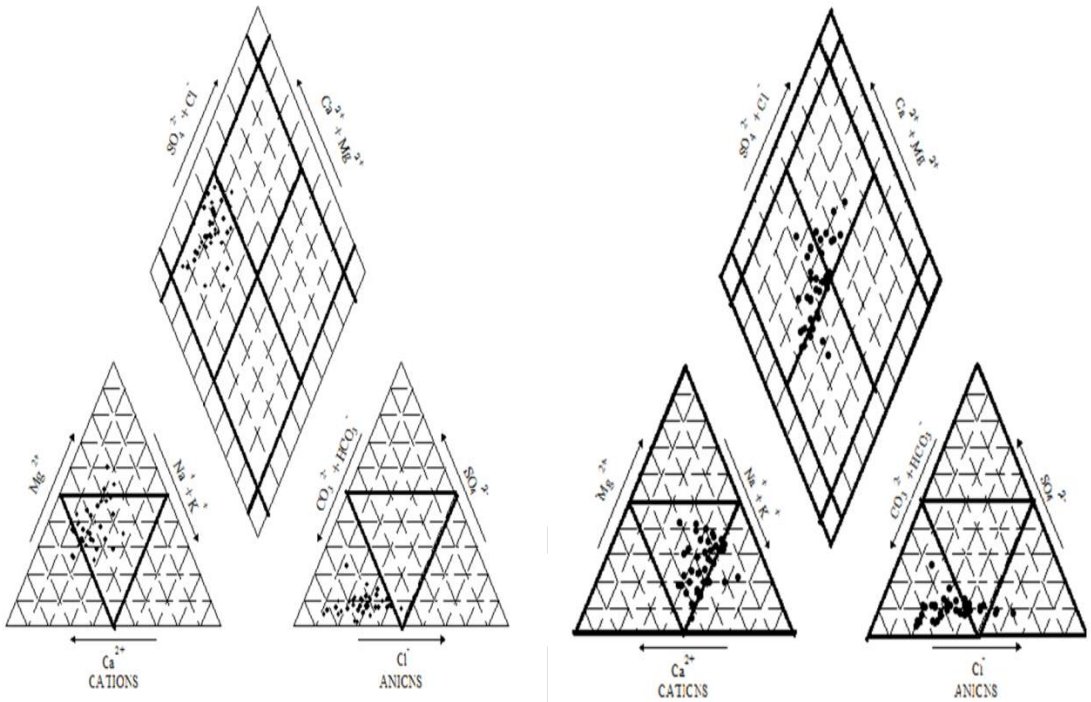
Wilcox parentage is sodium and electrical conductance in evaluating the suitability of groundwater for irrigation. Wilcox diagram show that water is excellent in use of post monsoon and pre monsoon seasons. It is good for use of irrigation purpose. (Fig..3(a),3(b)).

3.4 US salinity diagram

Generally the total dissolved solids, sodium content and sodium absorption ratio (SAR) values indicate the suitability of water for drinking and irrigation purpose. It is seen from fig. 4 (a) that the majority of the samples of post monsoon season fall in the C1 to S2, C2 to S2. It suggests that the salinity hazards and sodium hazards are varying in low to medium. Similarly, Fig 4 (b) pre monsoon season fall in C1 to S3, C2 to S3. This field suggest that the groundwater is medium to high salinity hazards and sodium hazards.it is good for irrigation purpose.

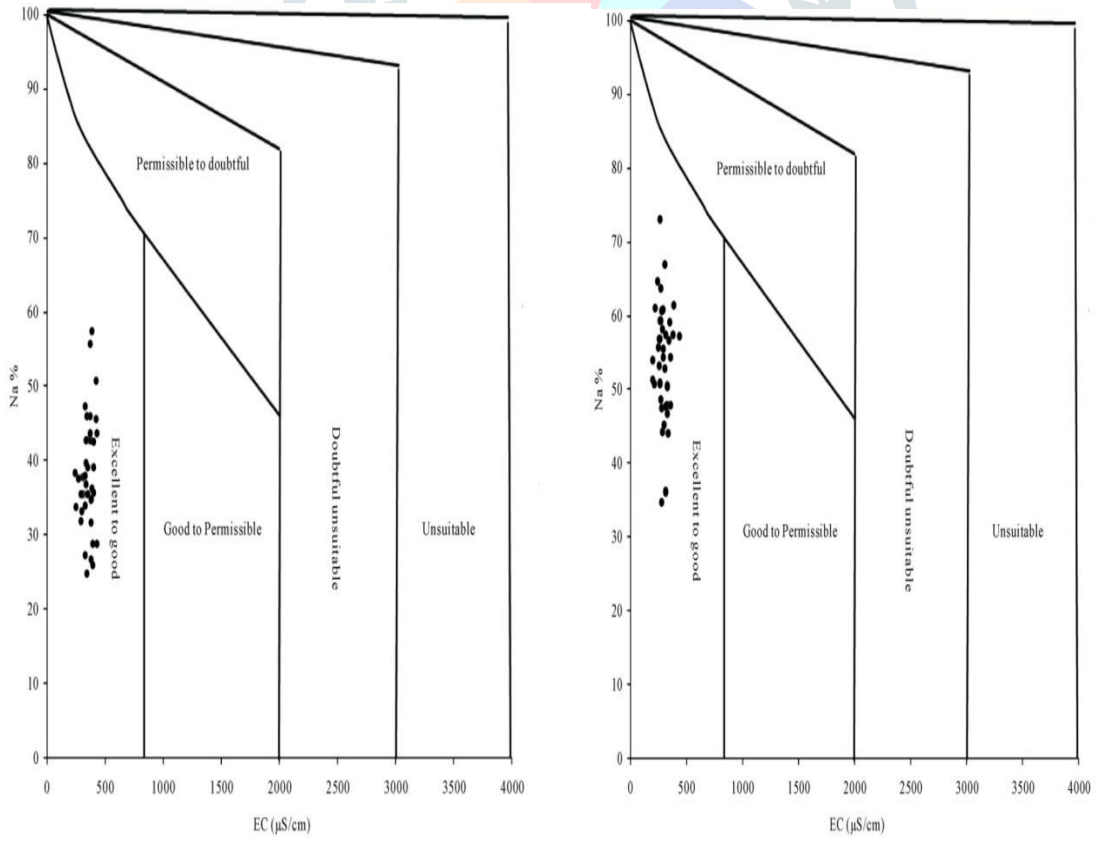
3.5 Gibbs diagram

In Gibbs diagram fig. 5 (a), 5(b) chemistry of water is controlled by lithological unit of area in post monsoon season and pre monsoon season. It indicates that the increase the hardness due to the increase the evaporation of the groundwater.



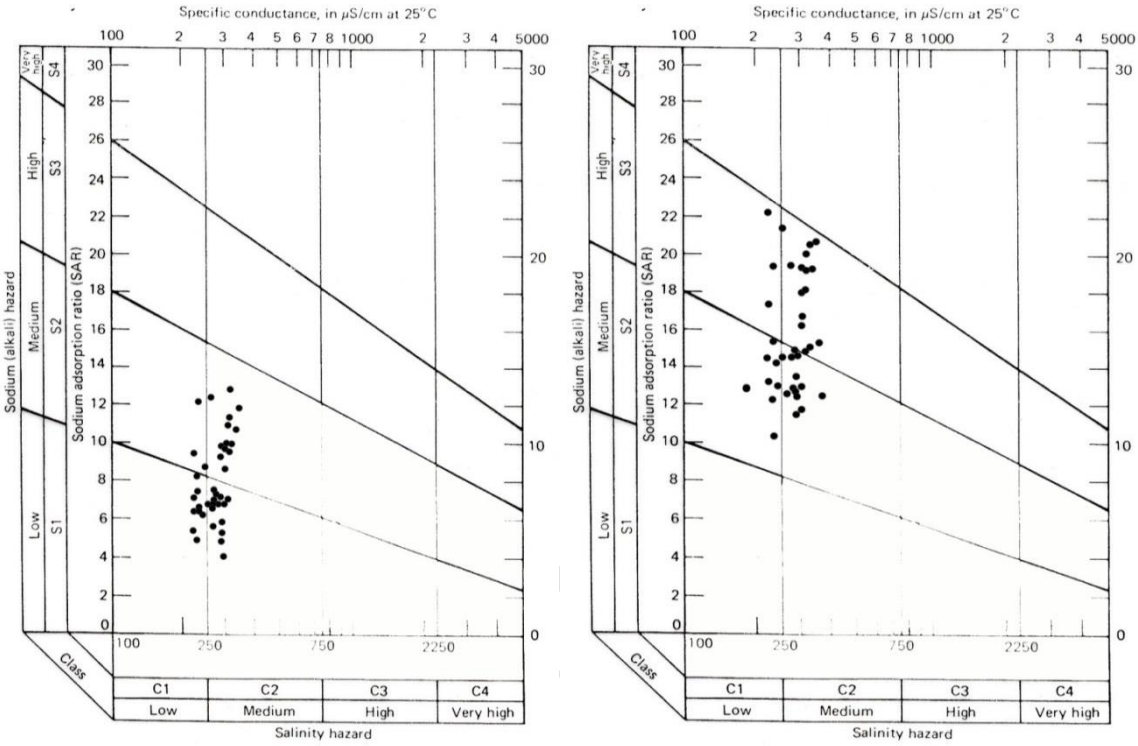
(a) Post monsoon season (b) Pre monsoon season

Fig.2: Piper tri-linear diagram showing analysis of groundwater quality in post monsoon and in pre monsoon period.



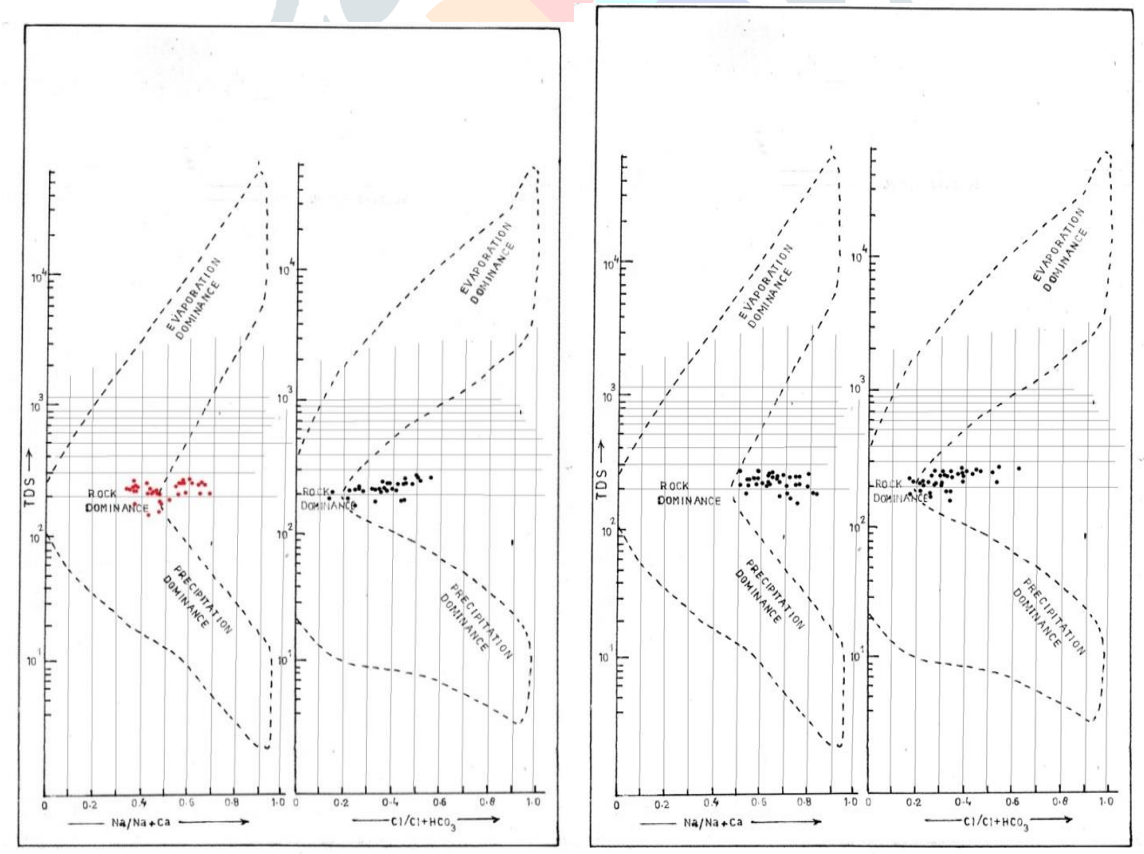
(a) Post monsoon season (b) Pre monsoon season

Fig.3: Wilcox diagram in post monsoon season and pre monsoon season



(a) Post monsoon season (b) Pre monsoon season

Fig.4: US Salinity diagram for Chipri village post monsoon season and pre monsoon season



(a) Post monsoon season (b) Pre monsoon season

Fig.5: Gibbs variation diagram of groundwater quality for post monsoon season and pre monsoon season

IV. CONCLUSION

After the careful study of analysis, interpretation and discussion of the numerical data following conclusion have been drawn for the Chipari village study area. Water is slightly hard in almost all the sampling point. There is decrease in the water level

in pre monsoon period. There is increase the pH in pre monsoon period due to evaporation of water. The dominant hydro chemical facies observed in the study area are Ca+Mg > Na+K and HCO3+CO3> SO4+Cl2. Slight changes on temporal scale in the groundwater type from Ca+Mg in pre monsoon season to Na+K in post monsoon indicates cation exchange process. And also changes in the anion facies of pre monsoon season. US Salinity shows that sodium hazard as well as salinity present in low to medium in post monsoon seasons and medium to high field in pre monsoon seasons. Water quality is suitable for the irrigation purpose. Wilcox shows that water sample is excellent for irrigation purpose. Gibbs diagram shows that Chemistry of water is controlled by lithological unit of area.

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