Investigating Groundwater Quality for Irrigation: A Study in Periyapatna Taluk, Mysuru District, Karnataka, India

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Abstract

An Assessment of quality parameters of groundwater for domestic and irrigation purposes was carried out in Periyapatna Taluk, Karnataka, India. The study area spreads over about 815 km^2 and lies in the Northern parts of Hassan District and in the south parts of Hunsur Taluk. Groundwater is the major source of water supply, for both drinking and agricultural activities. Groundwater samples collected from 120 bore-wells, during pre-monsoon and post-monsoon periods in the year 2014, were analyzed for their physical and chemical characteristics. The suitability of groundwater for irrigation purposes was evaluated based on several parameters including Salinity hazard percentage, Sodium, Sodium Adsorption Ratio, and other qualities. Data interpretation has also been done using USSL diagram, Gibbs diagram, Kelly's ratio and Permeability Index. The Physical and Chemical parameters of groundwater, such as, Electrical Conductivity, pH, Na^+, K^+, Ca^{2+}, Mg^{2+}, Cl^-, HCO_3^-, CO_3^{2-}, SO_4^{2-}, NO_3^-were determined. The Interpretation of analytical data shows that some of the major ions are dominant. Ca, Mg, Cl, Ca, Cl, and Na-Cl are the dominant hydro chemical faces of the study area. The results of analysis were also compared with the Water Quality Standards of Indian Standard Institute (ISI), and World Health Organization (WHO). The overall groundwater quality is found suitable for drinking and irrigation purposes. The systematic planning of groundwater exploitation using modern technologies is essential for the proper utilization of this precious natural resource. The spatial evaluation made from this study could be used for effective identification of suitable locations for extraction of potable water by rural population.

Introduction

Water is a precious inevitable and essential natural resource. It occurs in almost all parts of the world, for human and animal consumption and for the whole biosphere to survive. It is also one of the most manageable natural resources as it is capable of diversion, transport, storage, and recycling [11]. About a decade ago, it was found that, in India, there were over 20 million private water supply wells, in addition to the government tube wells [4]. Overexploitation of groundwater is leading to reduction of flows in the rivers and declining the groundwater resources. Groundwater accounts for about 80% of domestic water requirement and more than 45% of the total irrigation in the country [11].Groundwater is still found to be the major source of water for domestic, agricultural and industrial purposes, in many countries. India accounts for 2.2% of the global land and 4% of the world water resources and has 16% of the world's population. It is estimated that approximately one third of the world's population use groundwater for drinking. Intensive agricultural activities have increased the demand on groundwater resources in India. Despite the limitations pertaining to quantity, the quality of water used for various activities need to be checked very often. Water quality is influenced by several natural and anthropogenic factors, including local climate, geology and irrigation practices. Water quality issues and management options need to be given greater attention, in all places. Once undesirable situation is encountered, it is difficult to control their effects. The chemical characteristics of groundwater play an important role in assessing the quality of water. There is a need for frequent monitoring of water quality. This study has been oriented to evaluate the groundwater quality of a drought- prone area, in Karnataka, India.

Study Area

Periyapatna Taluk covers an area of 815 sq.km. This area is situated between $12^0 34^{'}$N latitudes and $76^0.1^{'}$E longitudes. It covers 203 villages coming under survey of India toposheet Nos. 57D/2, 57D/3, 57D/4 48P/14, 48P/15 **(Fig.1).** This area falls into the western block of Proterozoic basins of Southern Karnataka. This area comes under the semi arid type of climate. Gneisses occupies the total area. This area has very limited recharge facilities. It is a drought prone area for several years. Rainfall is very meager. During the recent years, there is an unpredictable behavior of the onset of monsoon and hence search for subsurface resources of water has been given primary focus by both private and some of the government organizations. Proper groundwater

management and utilization practices were not followed, due to several reasons. These demands for groundwater both for drinking and agricultural purposes is increasing. Irrigated agriculture is a major consumer of water using 75% of available surface and groundwater resources. In the present study, various chemical parameters of groundwater were analyzed to find out its suitability for irrigation purpose. The chemistry depends upon many factors like ionic concentrations quality of water, soil type, salt tolerance, climate and drainage, and the characteristic of the soils [13]. A better understanding of the chemistry of groundwater is essential to evaluate the suitability of groundwater for irrigation purpose. The hydrochemistry of groundwater of periyapatna Taluk is highlighted in this work.

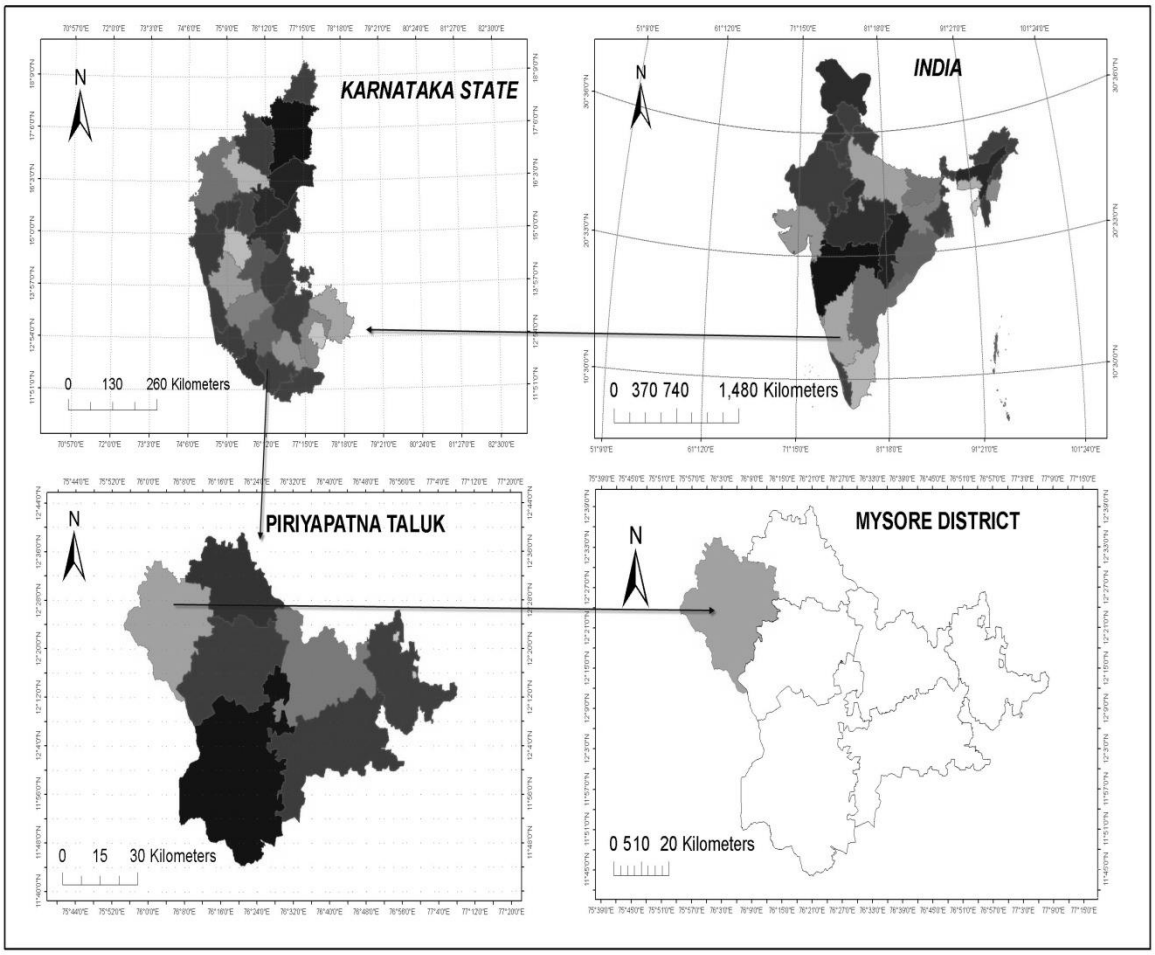

Figure 1: Location Map of the Study Area

Methodology

120 Groundwater samples have been collected, in dry and clean one liter plastic cans, during two seasons as pre-monsoon and post-monsoon, in 2014 .The samples were collected from the available bore wells that are being used for drinking and irrigation purposes. The physico- chemical analysis were done by following the standard analytical methods. The samples were analyzed for pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS).The major anions and cations were analyzed by adopting standard analytical procedures [17]; [16]; [9]; [10]; [8]; [1]. Electrical Conductivity (EC) and pH were measured using digital meters,]immediately after sampling. Ca^{2+},Mg^{2+},Cl^{-},HCO_3^{-},CO_3^{2-} and TDS were analyzed by volumetric titrations. Concentration of Ca^{2+} and Mg^{2+} were estimated titrimetrically using 0.05N EDTA solution and 0.01 N. H_2SO_4 was used to determine the concentration of HCO_3^{-} and CO_3^{2-}. $AgNO_3$ was used to estimate the concentration of Cl. Flame photometer was used to measure Na^{+} and K^{+} ions. The SO_4^{2-},NO_3^{-} in groundwater were determined by using spectrophotometric techniques.

Results and Discussion

The analytical results and computed values of chemical parameters of water samples of study area for both pre and post monsoon season, are given in Table 1. The groundwater quality data interpretation, for irrigation, was been carried out, as per the guidelines given by Ayers [2] and Christiansen [3]. The following are the major aspects considered for evaluating the groundwater quality.

1. Salinity 2.Sodium Adsorption Ratio 3. Kelly's Ratio, 4.Residual Sodium Carbonate 5.Permeability Index 6.Sodium Hazard by Wilcox method and 7. USSL Classification of Water.

Salinity

The salinity is normally interpreted based on Electrical Conductance (EC) which affects the suitability of water for growing various crops. The EC varies from 50 micromhos/cm to 8000 micromhos, for pre monsoon season and EC varies from 300 micromhos/cm to 2980 micromhos/cm for post monsoon, A careful analysis shows that this study area falls under "increasing problem" category (Table.3 & 4). The highest EC value (8000 micromhos/cm) for pre monsoon season is observed in one bore well water of Halaganahalli (Sample No .119) and the highest EC value for post monsoon season (2980 micromhos/cm) is observed in the bore well of Sulekote (Sample No.111). The EC values of other locations `are excellent to good and good to permissible limit [21].

Table 3. Salinity level of groundwater Samples of Periyapatna Taluk for Pre monsoon

Salinity Range EC,uScm^{-1} based on EC	Effects	Sample Numbers (Sample Locations)	Percentages (%)
0-750	No problem	1,3-5,14,15,17,19,20,22,24,30,38,44,50,61, 63-65,74,77,79,82-84,90,98,104,115	24.16%
750-2750	Increasing Problem	2,6-13,16,18,21,23,25-29,31-37,39-43,45-49,51-60,62,64,66-73,75,76,78,80,81,83,85-89,91-97,99-103,105-114,116-118,120	74.16%
Above 2750	Severe Problem	51,119	1.6%

Table 4. Salinity Level of Groundwater Samples of Periyapatna Taluk for Post monsoon

Salinity Range based on EC,uScm^{-1}	Effects	Sample Numbers (Sample Location)	Percentages (%)
0-750	No problem	1,3-5,14,17,19,24,30,39,44,48,50,61, 63,65,74,79,82,84,90,98,99,104,107,108,110	23.3%
750-2750	Increasing Problem	2,6-13,15,18,20-23,25-29,31-37,40-43,45-47,49,52-60,62,64,66-73,75-78,80,81,83,85-89,91-97,100-103,105,106,109,112-120.	74.16%
Above 2750	Severe Problem	38,51,111	2.5%

Sodium Adsorption Ratio (SAR)

The suitability of waters for irrigation purpose can be evaluated by using the USSL-Salinity Hazard diagram of U.S. Department of Agriculture [19]. The ability of water to expel calcium and magnesium by sodium can be estimated with the aid of Sodium Adsorption Ratio, SAR [5]. High SAR value indicates the risk of displacement of the alkaline earth. It will also adversely affect the soil structure. The adverse effect caused by high concentration of sodium in soil is known as sodium hazard. The index that is used for predicting the sodium

hazard in water is SAR. There is a significant relationship between SAR values of irrigation water and the extent to which sodium is absorbed by the soil. If groundwater used for irrigation is high in sodium and low in calcium, the cation-exchange capacity may become saturated with sodium. SAR for the groundwater from the study area was estimated by the formula and all ions should be in epm value.

$$\text{SAR} = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}}$$

Calculation of SAR value for a given groundwater provides a useful index of the sodium hazard of that water used for soil and crops. The waters having SAR values less than 10 are considered excellent, 10 to 18 as good, 18 to 26 as fair, and above 26 are unsuitable for irrigation use [18]. In the present study, the SAR values are less than 10 are observed in all the wells in the area under study (Table 1). The water from the study area can thus, be graded as excellent for irrigation use.

Kelley's Ratio (KR):

Kelley [12] have suggested that the sodium problem in irrigational water could very conveniently be worked out on the basis of the values of Kelley's ratio.

$$\text{Kelley's ratio} = \frac{Na}{\text{Ca+ Mg}} \quad \text{(All ions in epm)}$$

Ground water having Kelly's ratio more than one is generally considered as unfit for irrigation. The Kelley's ratio has been calculated for all the water samples of both seasons of the study area. It varies from 0.045 to 3.87epm for pre monsoon season (Table .1&2). Forty one water samples of the area have Kelley's ratio more than one. It varies from 0.07 to 4.18 epm for post monsoon season (Table 2). Thirty two samples of the area for post monsoon season have Kelley's ratio more than one. The formula used in the estimation of this ratio is explain as:

Residual Sodium Carbonate (RSC):

Residual Sodium Carbonate (RSC) is defined as ($CO3+HCO_3$) - (Ca+Mg), where all concentrations are expressed in epm. Water having excess of carbonate and bicarbonate concentration over the alkaline earth mainly of calcium and magnesium (beyond permissible limit) affects agriculture severely [7]; [15] Table.5 and Table.6 shows the classification of water on the basis of RSC value for post monsoon season, which shows that thirty eight percent of the samples are safe and suitable for agricultural purposes. Twenty seven percent of samples are marginally suitable and the rest of thirty five percent are unsuitable for irrigation use. For pre monsoon season about thirty four percent of samples are found to be safe and suitable for agriculture purposes and twenty percent samples are marginally suitable and forty six percent of remaining samples are unsuitable for irrigation uses.

Bicarbonate:

Bicarbonate concentration for most of the samples, for both the seasons, come under "increasing problem" category (Table.7). Bicarbonate ranges for pre monsoon season from 2.5epm to 11.6 epm, in the study area. Bicarbonate ranges for post monsoon season (Table.8) also same as that of the pre monsoon. Bicarbonate content more than 1epm in water is necessarily attributed to the biological activities of plant roots, from the oxidation of organic matter, included in the soil and rock [14].

Permeability Index (PI):

Permeability of the soil is influenced by the sodium content of the irrigation water. The Permeability index was proposed by Donnen. The Permeability Index (PI) is obtained by considering the ions (epm), which influence permeability [6]. Permeability index is defined as, the concentration of cations and anions are in epm.

$$PI = \frac{\text{Na}+\sqrt{\text{HCO3}}}{\text{Ca+Mg+Na}} * 100$$

The groundwater samples of the study area falls in class –I and class-II of Donnen's chart (Fig.2) and (Fig.3). Most of the samples fall in class-I and a few samples fall in class-II for pre monsoon season and for post monsoon season all the samples fall in class-I. It is inferred, on the basis of the permeability index that the ground water of the study area is of good quality for irrigation purposes. The increase percentage of groundwater samples for both season under class-I was due to dilution and subsequent lower values of permeability index.

Wilcox Diagram (WD):

Percentage of sodium content in natural water is an imperative parameter to assess its suitability for agricultural use. A maximum of 60% sodium in groundwater is allowed for agricultural purposes [20]; [19]. Sodium percentage can be defined in terms of epm of the common cations [20].

The concentration of cations is in epm as $\text{Na\%} = \frac{(Na+K)*100}{\text{Ca+ Mg+Na+K}}$

Table 5. Residual Sodium Carbonate in groundwater for pre monsoon season

RSC (epm)	Water category	No. of samples (Total 120)	
		No. of wells	% of samples
<1.25	Safe	41	34%
1.25-2.5	Marginally	24	20%
>2.5	Unsuitable	55	46%

Table 6. Residual Sodium Carbonate in groundwater for post monsoon season

RSC (epm)	Water category	No. of samples (Total 120)	
		No. of wells	% of samples
<1.25	Safe	46	38%
1.25-2.5	Marginally	32	27%
>2.5	Unsuitable	42	35%

Table 7. Bicarbonate Concentration of Groundwater Samples for Pre Monsoon Season

S.No	Bicarbonate (epm)	Effects	No. of samples
1.	0-1.5	No problem	Nil
2.	1.5-8.5	Increasing problem	104
3.	>8.5	Severe problem	16

Table 8. Bicarbonate Concentration of Groundwater Samples for Post Monsoon Season

S.No	Bicarbonate (epm)	Effects	No. of samples
1.	0-1.5	No problem	Nil
2.	1.5-8.5	Increasing problem	103
3.	>8.5	Severe problem	17

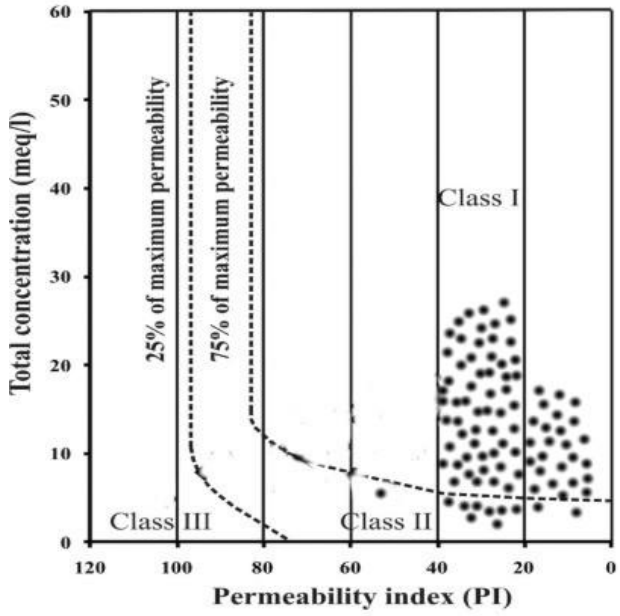

Figure2: Classification of irrigation water for pre monsoon season with respect to Permeability index (Doneen, 1962)

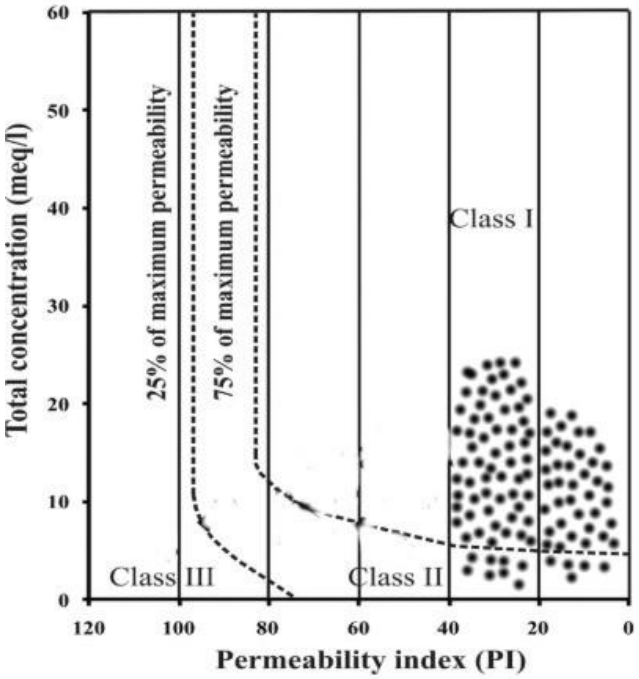

Figure 3: Classification of irrigation water for post monsoon season with respect to Permeability index (Doneen, 1962)

The Sodium percentage (Na%) in the study area for pre monsoon ranges from17.2 % to 84.8 %.The highest percentage of sodium was found in the bore well water of Lingapura (sample No. 40).The minimum value of Na% is located in the bore well water sample of Chapparadahalli (Sample No.57). For post monsoon season, (Na%) found the study area ranges from 7.14% to 80.7%. the highest percentage was found in bore well water of Sunkadahalli (Sample No. 100), also the minimum value of Na% is found in the bore well water sample of Avarthi (Sample No.99). By plotting the data of the Periyapatna Taluk on Wilcox diagram relating to electrical conductivity and sodium percentage (Fig.4) and (Fig.5) the quality aspects were evaluated. It helps to find out the water types for irrigation on the basis of Na% value. The results are presented in the Tables 9 and Table 10. Excellent to good and good to permissible water can be used for the purpose of irrigation.

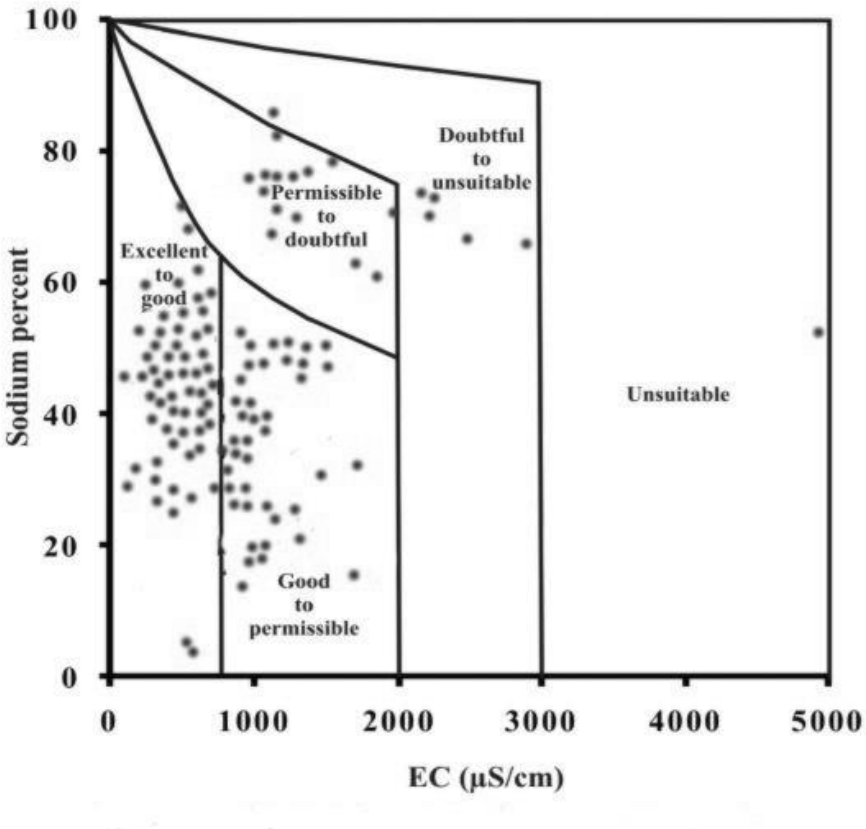

Figure 4: Wilcox diagram (1955) for classification of groundwater for Pre monsoon season based on EC and Na%

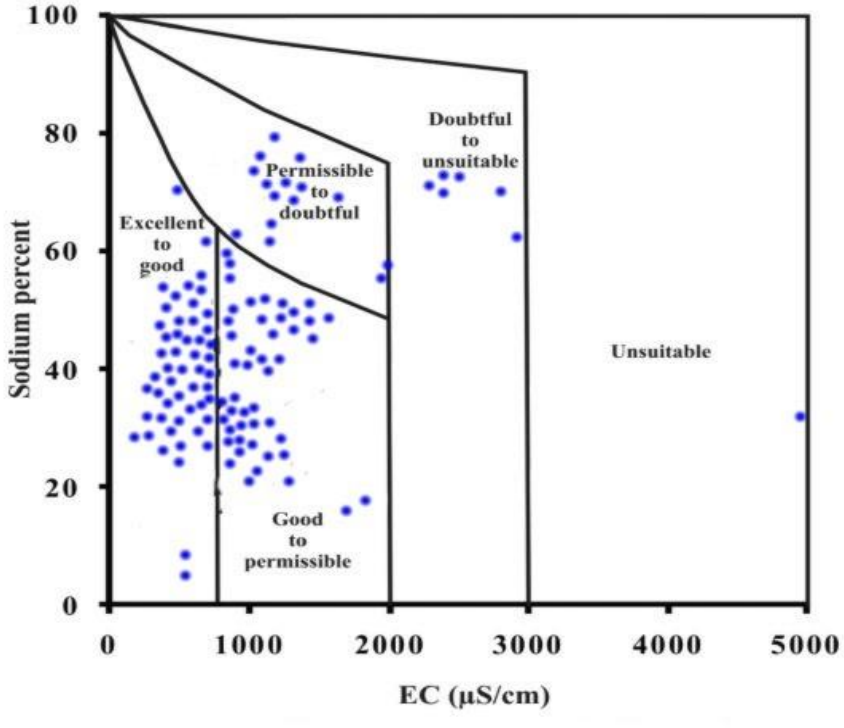

Figure 5: Wilcox diagram (1955) for classification of groundwater for Post monsoon season based on EC and Na%

Table 9. Water classes for irrigation on the basis of Na% for Pre monsoon Season

Water class for irrigation	%Na	No of samples
Excellent to Good	Up to 20	58
Good to Permissible Permissible to Doubtful	20-40 40-60	42 14
Doubtful to Unsuitable	60-80	5
Unsuitable	>80	1

Table 10. Water classes for irrigation on the basis of Na% for Post monsoon Season

Water class for irrigation	%Na	No of samples
Excellent to Good	Up to 20	53
Good to Permissible	20-40	45
Permissible to Doubtful	40-60	15
Doubtful to Unsuitable	60-80	6
Unsuitable	>80	1

USSL Diagram

By using the U.S. Salinity laboratory diagram (Fig.6) and (Fig.7) which uses Sodium Absorption Ratio (SAR) and a specific electrical conductance [19], the two most important parameters of sodium and salinity hazards can be determined. It also helps to determine the suitability of water for agriculture purpose. Out of 120 water samples for pre monsoon season, 3 samples fall within C_1S_1 , which indicate low salinity and lower alkali water. In total, 25 samples fall within C_2S_1 reveals which medium salinity and lower sodium water. 70 samples belong to C_3S_1 zone indicating moderate to high salinity and are suitable for irrigation purpose. Almost 14 samples within C_3S_2 zone indicating moderate to high salinity and moderate alkaline in nature. 3 samples, which fall in C_3S_3 are highly alkaline in nature and have moderate to high salinity (Table11).

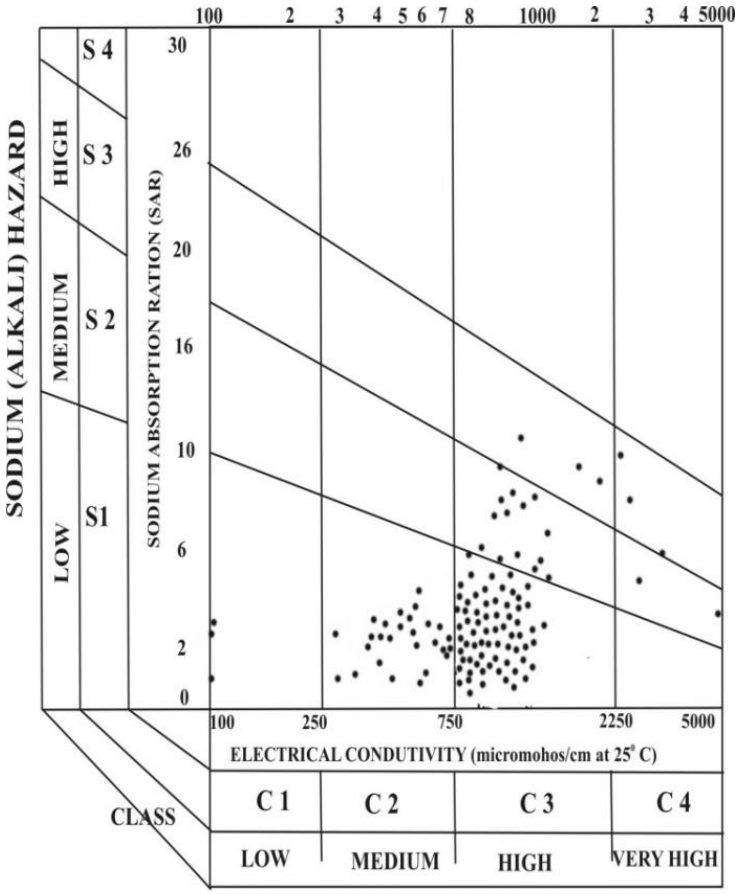

Figure 6: U.S. Salinity Laboratory diagram for classification of water samples of pre monsoon

Table 11. Groundwater classification based on USSL, diagram for Pre monsoon season

Category	No. of samples	Water quality
C_1S_1	3	Low salinity and lower alkali water
C_2S_1	25	Medium salinity and lower sodium water, Good for medium permeable soil
C_3S_1	70	Moderate to high salinity and less alkaline water
C_3S_2	14	Moderate to high salinity and moderate alkaline
C_3S_1	3	Highly alkaline and have moderate to high saline
C_4S_2	2	Highly alkaline and saline water
C_4S_3	3	Very high alkaline and saline

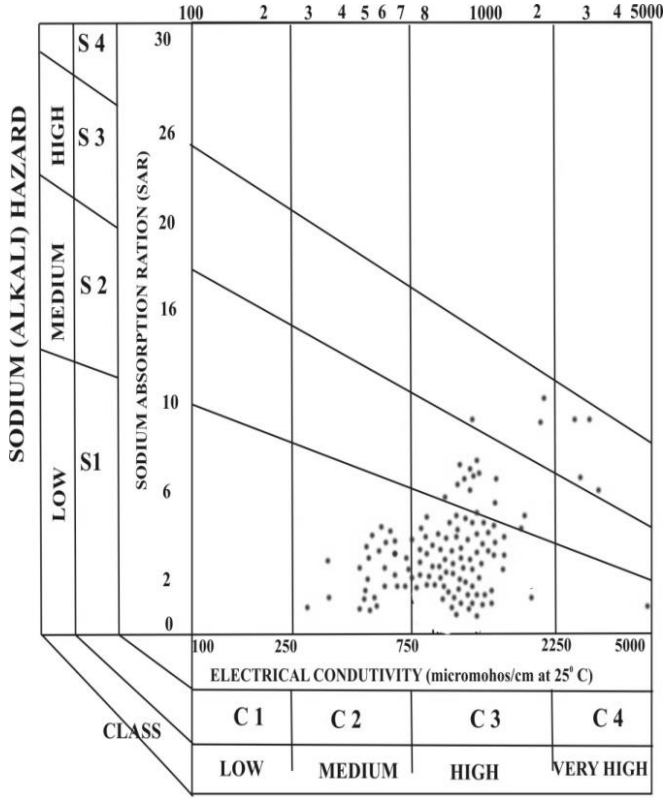

Figure.7: U.S. Salinity Laboratory diagram for classification of water samples of post monsoon

Table 12. Groundwater classification based on USSL, diagram for Post monsoon season

Category	No. of samples	Water quality
C_1S_1	0	Low salinity and lower alkali water
C_2S_1	27	Medium salinity and lower sodium water
C_3S_1	71	Moderate to high salinity and less alkaline water
C_2S_2	Nil	Moderately alkaline and medium salinity
C_3S_2	14	Moderate to high salinity and moderate alkaline
C_3S_3	3	Highly alkaline and have moderate to high saline
C_4S_1	1	high alkaline and saline
C_4S_3	4	Very high alkaline and saline

Conclusion

The study is based on the quality assessment of the groundwater occurring in a drought prone district of Karnataka. Analytical works have been carried out to identify the suitability of water for irrigation purpose. Various water quality parameters including Sodium Absorption Ratio (SAR), Sodium percent (Na %) and Residual Sodium Carbonate, for both season pre and post monsoon are estimated. The groundwater falls under class-I for most of the zones as per classification of Doneen's Permeability Index and could be treated as good for irrigation. The Wilcox Classification shows that most of the samples come under good to permissible category. The Residual Sodium Carbonate values, show that about 34 to 38% of the water samples are under 'safe' situation.. According to U.S. Salinity Diagram, the majority of groundwater samples belong to C_3S_1. As a whole, the groundwater of the study area is safe for irrigation purpose.

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Table 1. Anions and cations concentration of groundwater samples of Pre monsoon (epm values).

sample No	Location	Ca	Mg	Na+K	HCO_3	CO_3	Cl	SO_4	pH	EC	TDS	K. Ratio	RSC	SAR	Na %	Mg Hazards
1	Periyapatna	2.2	2.4	4.7	5.1	1.1	1.5	0.9	7.89	600	720	1.02	1.61	3.05	50.53	52.17
2	Harvemallarajapatna	1.3	2.8	5.7	6.5	1.8	1	0.4	7.3	870	545	1.39	4.07	3.93	58.16	68.3
3	Rajapura	1.7	1.6	3.3	4.2	1.1	0.5	0.3	7.92	460	370	1	2.01	2.52	50	48.48
4	Abbur	3.1	2.1	3.9	6.1	1.4	0.4	0.2	7.62	620	500	0.75	2.29	2.39	42.85	40.38
5	Tatanahalli	2.9	2.1	5.3	7.4	1.6	0.9	0.5	7.67	630	615	1.06	4.03	3.37	51.45	42
6	Harlapura	4.7	4.	3.3	4.3	0	4.	3.	7.3	106	780	0.3	4.6	1.5	27.0	47.19

			2				6	1	2	0		7	1	4	4	
7	Bekya	2.9	3.8	3.5	6.8	1.4	1.1	0.2	7.85	928	540	0.52	1.45	1.91	34.31	56.71
8	Sathyagala	0.5	5.3	20.3	10.5	1.4	9.3	4.6	7.21	2300	830	3.5	6.15	11.88	77.7	91.37
9	Sathyagala Kaval	2.3	2.4	10.1	7.8	0.5	4.1	1.5	8.81	1100	860	2.14	3.56	6.59	68.24	51.06
10	Halasoor	2	5.2	12	6.4	1.4	8.3	2.1	8.32	1970	1125	1.66	0.67	6.31	62.5	72.22
11	Hunsekuppe	2.4	5.6	7	7.9	1.3	3.9	2.1	7.75	1520	840	0.87	1.17	3.52	46.66	70
12	Ichanahalli	2.2	3.5	11.3	9.4	2.4	2.1	2.5	8.3	830	600	1.98	6	6.64	66.47	61.4
13	Ankanahalli	2.6	4.6	8	11.6	0	2.4	1	7.74	1000	1140	1.11	4.38	4.2	52.63	63.88
14	Habatoor	2.1	2.1	3.9	5.1	1.6	0.8	0	8.5	590	447	0.92	2.54	2.69	48.14	50
15	Mummadikaval	2.9	2.1	5.3	5.5	1.1	1.8	1	8.5	85	610	1.06	1.67	3.38	51.45	42
16	Abbalathi	0.9	2.2	12	9.4	1.5	3.5	0.1	9.3	1530	1078	3.87	7.78	9.57	79.47	70.96
17	Malangi	1.7	1.2	1.7	2.5	1.4	0.5	0	8.7	380	250	0.58	0.99	1.43	36.95	41.37
18	Chowkur	2.3	2.4	6.1	7.1	1.9	1.3	0.6	7.7	780	620	1.29	4.31	4	56.48	51.06
19	Panchavalli	2.8	2.7	3.9	7.2	0.8	1.2	0.2	8.6	650	495	0.7	2.44	2.35	41.48	49.09
20	Ittigahalli	3	2.9	4.8	6.7	1.8	0.8	0.6	8.5	76	600	0.81	2.51	2.77	44.85	49.15
21	Uthenahalli	0.4	2.7	11.2	10	1.1	2.2	0.5	8.3	1200	850	3.61	7.98	8.95	78.32	87.09
22	Alalur	2.5	4.4	4	6.6	1.9	1	0.4	7.56	740	525	0.57	1.58	2.14	36.69	63.76
23	Muddanahalli	1.6	3.6	4.4	6.5	1.6	0.7	0.2	8.55	800	540	0.84	2.88	2.74	45.83	69.23
24	Kachuvanahalli	1.3	4.9	2.4	5.4	1.8	0.8	1.2	8.38	600	430	0.38	0.85	1.37	27.9	79.03
25	Anechowkur Forest	4.1	3.5	5.2	6.8	1.9	3.6	0.3	8	1000	820	0.68	1.13	2.66	40.62	46.05
26	Laxmipura	2.6	1.5	2.5	3.8	1	0.8	0.5	7.8	960	350	0.6	0.64	1.75	37.87	36.58
27	Kogilvadi	3.5	3	4.4	7.8	1.3	1.4	0.2	7.61	800	670	0.67	2.51	2.42	40.36	46.15
28	Chowthi	2.9	3.8	3.5	7.8	0.1	1.1	1	7.95	900	540	0.52	1.21	1.91	34.31	56.71
29	Thimakapura	4.2	3	3.4	4.8	1.4	2.7	0.8	7.81	970	610	0.47	-1.03	1.77	32.07	41.66
30	Halepeteka Tapura	1.8	1.6	2.9	4.3	0.2	0.7	1	8.43	660	380	0.85	1.05	2.19	46.03	47.05
31	Magali	1.8	6.2	2.8	3.8	1.8	4.1	1	7.67	1200	695	0.35	-2.46	1.41	25.9	77.5
32	Begur	2.9	3.8	4.5	5.1	1.6	2.7	0.9	8.84	1000	640	0.67	-1.55	2.47	40.17	56.71
33	Sulagodu	2.3	6.3	2.1	7.1	1.4	1.6	0.5	8	1020	615	0.24	3.58	1	19.62	73.25
34	Kalethimma	1.1	4.	4.8	7	1.	1	0.	8.5	100	590	0.8	2.7	2.8	46.6	80

	nahalli		4			3		5		0		7		7		
35	Muthur	6.3	3	2.2	6.9	1	2.2	1	7.66	1000	560	0.23	-1.46	1	19.13	32.25
36	Naralapura	1.4	4	3	5.4	1.1	1.3	0.6	9.5	990	525	0.55	1.1	1.82	35.71	74.07
37	Kirangoor	6.9	1.2	5.2	7.1	1.6	3.1	1	7.91	1035	805	0.64	0.65	2.59	39.09	14.81
38	Lingapura	2.8	1.2	1.8	3.5	0.8	0.6	0.4	7.58	560	322	0.45	0.32	1.29	31.03	30
39	Ayarabeedu	2.2	6.6	0.4	5.2	2.8	0.9	0.3	8	760	450	0.045	0.8	0.18	4.34	75
40	Lingapura Forest	0.9	1.5	13.4	9.5	2.1	3	1	8	1250	935	5.58	9.15	12.27	84.81	62.5
41	Naviloor	2.3	3.9	4.3	5.8	1.4	1.1	1.7	8.7	860	560	0.69	1	2.46	40.95	62.9
42	Bemmathi	3	3.9	6.3	3.2	0.8	6.1	2.1	7.97	1200	775	0.91	-2.98	3.37	47.72	56.52
43	Illapura	4	2.9	7.6	8.4	1	3.3	1.7	8.95	1150	825	1.1	2.45	4.08	52.41	42.02
44	Kamanahalli	0.7	2.4	4.6	4.2	1.4	1	0.4	8.24	600	396	1.48	2.51	3.67	59.74	77.41
45	Boothanahalli	2.4	3.5	7	6.7	1.3	2.3	2.5	8.72	1200	760	1.18	2.11	4.11	54.26	59.32
46	Korla Hosalli	2.1	2.6	8	8.1	1.3	1.7	1.2	8.89	790	660	1.7	4.69	5.19	62.9	55.31
47	Alanahalli	1.2	2	4.3	5.2	1	0.7	0.4	7.5	764	455	1.34	2.96	3.42	57.33	62.5
48	Manchadevanahalli	3	2.8	2	4.6	2.1	0.8	0	8.2	760	350	0.34	0.81	1.14	25.64	48.27
49	Kundanahalli	1.6	2.7	10.7	9.6	2.6	1.5	1.2	8.71	1225	910	2.48	7.89	7.31	71.33	62.79
50	Hunasawadi	2.8	2.9	3.6	6.4	1.4	0.4	0.3	8.1	700	520	0.63	2.18	2.11	38.7	50.87
51	Mallinathapura	1.9	4.6	13	3.3	0	12.3	3.7	7.28	2900	1500	2	-3.21	7.2	66.66	70.76
52	Belathur	2.2	5.6	23.7	14.8	3	5.7	7.1	7.79	2125	1925	3.03	9.97	11.96	75.23	71.79
53	Chennenahalli	1.6	3.6	4.5	6.5	1.6	0.7	0.4	8.5	800	540	0.86	2.88	2.77	46.39	69.23
54	Chittenahalli	1.9	3.5	3.5	6.5	1.1	0.8	0.4	7.9	800	575	0.64	2.23	2.14	39.32	64.81
55	Chowdenahalli	3.4	2.3	3.4	5.4	1.6	1.7	0.4	8.43	840	520	0.59	1.22	2	37.36	40.35
56	Haranahalli	3.4	3	4.3	7.8	1.3	1.4	0.4	7.6	870	670	0.67	2.61	2.37	40.18	46.87
57	Chapparadahalli	9.6	5.3	3.1	8.3	0	7.6	2.1	7.32	1700	1125	0.2	-6.7	1.14	17.22	35.57
58	Voddarabylakuppe	2.8	3.5	2.9	4.6	2.8	1.4	0.3	7.71	980	525	0.46	1.02	1.63	31.52	55.55
59	Ganganakuppe	3.3	3.1	5.4	7.9	1.6	1.3	0.4	8.25	980	670	0.84	3.12	3.03	45.76	48.43
60	Garigudda Kaval	0.6	2.4	9.8	8.1	1.6	1.4	1.5	8.17	1230	760	3.26	6.67	7.94	76.5	80
61	Kanagal	2.2	2.4	4.7	5.1	1.1	1.5	0.9	7.79	600	720	1.02	1.61	3.05	50.53	52.17
62	Basavanaha	1.3	2.	5.7	6.5	1.	1	0.	7.5	680	545	1.3	4.0	3.9	58.1	68.29

	lli		8			8		4				9	7	3	6	
63	Gobbali Kaval	1.7	1.6	3.3	4.2	1.1	0.5	0.3	7.93	580	370	1	2.01	2.52	50	48.48
64	Manuganahalli	3.1	2.1	3.9	6.1	1.4	0.4	0.2	7.64	528	500	0.75	2.29	2.39	42.85	40.38
65	Ichanahalli	2.9	2.1	5.3	7.4	1.6	0.9	0.5	7.97	550	615	1.06	4.03	3.37	51.45	42
66	Gudibadrana Hosahalli	4.7	4.2	3.3	4.3	0	4.6	3.1	7.42	1060	780	0.37	4.61	1.54	27.04	47.2
67	Rajanabilaguli	2.9	3.8	3.5	6.8	1.4	1.1	0.2	7.95	930	540	0.52	1.45	1.91	34.31	56.71
68	Rasimarti Kaval	0.5	5.3	20.3	10.5	1.4	9.3	4.6	9.21	2300	830	3.5	6.15	11.88	77.77	91.37
69	Hunsethoppalu	2.3	2.4	10.1	7.8	0.5	4.1	1.5	8.91	1300	860	2.14	3.56	6.59	68.24	51.06
70	Hasuvina Kaval	2	5.2	12	6.4	1.4	8.3	2.1	8.32	1850	1125	1.66	0.67	6.31	62.5	72.22
71	Byadarabilaguli	2.4	5.6	7	7.9	1.3	3.9	2.1	7.65	1400	840	0.87	1.17	3.52	46.6	70
72	Haleyur	2.2	3.5	11.3	9.4	2.4	2.1	2.5	8.2	860	600	1.98	6	6.64	66.47	61.4
73	Chikkanerale	2.6	4.6	8	11.6	0	2.4	1	7.64	1000	1140	1.11	4.38	4.2	52.63	63.88
74	Tarikallu	2.1	2.1	3.9	5.1	1.6	0.8	0	8.7	580	447	0.92	2.54	2.69	48.14	50
75	Doddanerale	2.9	2.1	5.3	5.5	1.1	1.8	1	8.59	850	610	1.06	1.67	3.38	51.45	42
76	Gulledahalli Jungle	0.9	2.2	12	9.4	1.5	3.5	0.1	9.2	1560	1078	3.87	7.78	9.57	79.47	70.96
77	Hosahalli	1.7	1.2	1.7	2.5	1.4	0.5	0	8.99	380	250	0.58	0.99	1.43	36.95	41.37
78	Basavanahalli	2.3	2.4	6.1	7.1	1.9	1.3	0.6	7.7	780	620	1.29	4.31	4	56.48	51.06
79	Poonadahalli	2.8	2.7	3.9	7.2	0.8	1.2	0.2	8.5	540	495	0.7	2.44	2.35	41.48	49.09
80	Charapura	3	2.9	4.8	6.7	1.8	0.8	0.6	8.4	780	600	0.81	2.51	2.77	44.85	49.15
81	Handigudda Kaval	0.4	2.7	11.2	10	1.1	2.2	0.5	8.5	1200	850	3.61	7.98	8.95	78.32	87.09
82	Tirumalapura	2.5	4.4	4	6.6	1.9	1	0.4	7.53	740	525	0.57	1.58	2.14	36.6	63.76
83	Doddahonnur Kaval	1.6	3.6	4.4	6.5	1.6	0.7	0.2	8.5	720	540	0.84	2.88	2.74	45.83	69.23
84	Muthagur	1.4	5.4	2.7	5.4	1.8	0.8	1.2	8.37	50	430	0.39	0.26	1.43	28.42	79.41
85	Dodda Honnur	4.2	3.5	5.3	6.8	1.9	3.6	0.3	7.97	1000	820	0.68	0.95	2.69	40.76	45.45
86	Bylakuppe	2.6	1.5	2.5	3.8	1	0.8	0.5	7.62	850	350	0.6	0.64	1.75	37.87	36.58
87	Guddenahalli	3.5	3	4.4	7.8	1.3	1.4	0.2	7.61	870	670	0.67	2.51	2.42	40.36	46.15
88	Laxmipura	2.9	3.8	3.5	7.8	0.1	1.1	1	7.95	930	540	0.52	1.21	1.91	34.31	56.71
89	Gollara Hosalli	4.2	3	3.4	4.8	1.4	2.7	0.8	7.61	900	610	0.47	1.03	1.77	32.07	41.66
90	Basavanaye	2	1.8	3.2	4.3	0.2	0.7	1	8.43	640	380	0.84	0.6	2.28	45.71	47.36
91	Kailasapura	1.8	6.2	2.8	3.8	1.8	4.1	1	7.67	1300	695	0.35	2.46	1.41	25.92	77.5

92	Aralikumari	2.9	3.8	4.5	5.1	1.6	2.7	0.9	7.84	990	640	0.67	1.55	2.47	40.17	56.71
93	Doddaharve	2.3	6.3	2.1	7.1	1.4	1.6	0.5	8	1000	615	0.24	3.75	1	19.62	73.25
94	Doddaharve Forest	1.1	4.4	4.8	7	1.3	1	0.5	8.5	1000	590	0.87	2.7	2.87	46.6	80
95	Lingapura	6.3	3	2.2	6.9	1	2.2	1	7.56	1075	560	0.23	1.46	1	19.13	32.25
96	Dodda Hosur	1.4	3.9	3	5.4	1.1	1.3	0.6	9.5	990	525	0.56	1.14	1.83	36.14	73.58
97	Giragoor	6.9	1.2	5.2	7.1	1.6	3.1	1	7.91	1035	805	0.64	0.65	2.59	39.09	14.81
98	Koppa	2.8	1.2	1.8	3.5	0.8	0.6	0.4	7.58	540	322	0.45	0.32	1.29	31.03	30
99	Avarthi	2.2	6.6	0.4	5.2	2.8	0.9	0.3	8	800	450	0.04	0.8	0.18	4.34	75
100	Sunkadahalli	0.9	1.5	13.4	9.5	2.1	3	1	8	1230	935	5.58	9.15	12.27	84.81	62.5
101	Maradiyur	2.3	3.9	4.3	5.8	1.4	1.1	1.7	8.7	830	560	0.69	1	2.46	40.95	62.9
102	Benagal	3	3.9	6.3	3.2	0.8	6.1	2.1	7.97	1200	775	0.91	-2.98	3.37	47.72	56.52
103	Bilagunda	4	2.9	7.6	8.4	1	3.3	1.7	8.95	1250	825	1.11	2.45	4.08	52.41	42.02
104	Kesarakere	0.7	2.4	4.6	4.2	1.4	1	0.4	8.24	600	396	1.48	2.51	3.67	59.74	77.41
105	Ambalare	2.4	3.5	7	6.7	1.3	2.3	2.5	8.72	1200	760	1.18	2.11	4.11	54.26	59.32
106	Channakal Kaval	2.1	2.6	0.8	8.1	1.3	1.7	1.2	8.89	990	660	0.17	4.69	5.19	14.54	55.31
107	Dindagadu	1.2	2	4.3	5.2	0.9	0.7	0.4	7.5	764	455	1.34	2.93	3.42	57.33	62.5
108	Chikkamaravalli	3	2.8	2	4.6	2.1	0.8	0	8.2	660	350	0.34	0.81	1.14	25.64	48.27
109	Doddakamaravalli	1.6	2.7	10.7	9.6	2.6	1.5	1.2	8.71	1225	910	2.48	7.89	7.31	71.33	62.79
110	Shanubogan ahalli	2.8	2.9	3.6	6.4	1.4	0.4	0.3	8.1	780	520	0.63	2.18	2.11	38.7	50.87
111	Sulekote	1.9	4.6	13	3.3	0	12.3	3.7	7.28	2600	1500	2	3.21	7.2	66.66	70.76
112	Chamarayanakote	2.2	5.6	23.7	14.8	3	5.7	7.1	7.79	2000	1925	3.03	9.97	11.96	75.23	71.79
113	Hegathur	1.6	3.6	4.5	6.5	1.6	0.7	0.4	8.5	760	540	0.86	2.88	2.77	46.39	69.23
114	Kambipura	2.1	3.9	3.9	6.5	1.1	0.8	0.4	7.9	870	575	0.65	1.62	2.23	39.39	65
115	Adagoor	3.4	2.3	3.4	5.4	1.6	1.7	0.4	8.43	640	520	0.59	1.22	2	37.36	40.35
116	Bettadapur	3.4	3	4.3	7.8	1.3	1.4	0.4	7.6	770	670	0.67	2.61	2.37	40.18	46.87
117	Gorahalli	2.5	10.3	6.1	8.3	0	7.6	2.1	7.32	1700	1125	0.47	4.5	2.4	32.27	80.46
118	Suragahalli	3	3.9	3.2	4.6	2.8	1.4	0.3	7.71	900	525	0.46	0.44	1.7	31.68	56.52
119	Halaganahalli	3.3	3.1	5.4	7.9	1.6	1.3	0.4	8.25	8000	670	0.84	3.12	3.03	45.76	48.43
120	Haradur	0.6	2.	9.8	8.1	1.	1.	1.	8.1	100	760	3.2	6.6	7.9	76.5	80

			4			6	4	5	7	0		6	7	4	6	

Table 2. . Anions and cations concentration of groundwater samples of Post monsoon (epm values)

sample No	Location	Ca	Mg	Na+K	HCO_3	CO_3	Cl	SO_4	pH	EC	TDS	K. Ratio	RSC	SAR	Na%	Mg Hazards
1	Periyapatna	2	2.8	4.4	5.1	1.2	1.5	1.1	7.89	700	730	0.91	1.46	2.84	47.82	58.33
2	Harvemallarajapatna	1.4	3	6.1	6.5	1.9	1	0.6	7.56	900	555	1.38	4.06	4.15	58.09	68.18
3	Rajapura	1.9	1.9	3.4	4.2	1.3	0.5	0.4	7.98	500	350	0.89	1.7	2.49	47.22	50
4	Abbur	2.9	2.6	3.4	6.1	1.6	0.4	0.3	7.74	700	550	0.61	2.23	2.04	38.2	47.27
5	Tatanahalli	2.9	2.9	5.7	7.4	1.6	0.9	0.7	8	700	655	0.98	3.2	3.36	49.56	50
6	Harlapura	4.6	4.7	3.4	4.3	0.3	4.6	3.3	7.62	1100	790	0.36	-4.67	1.59	26.77	50.53
7	Bekya	3	4	3.5	6.8	1.8	1.1	0.4	7.97	1000	560	0.5	1.44	1.84	33.33	57.14
8	Sathyagala	0.9	6.1	20.7	10.5	1.8	9.3	4.8	9.23	2500	850	2.95	5.26	11.03	74.72	87.14
9	Sathyagala Kaval	2.1	2.9	9.9	7.8	0.8	4.1	1.7	8.96	1300	870	1.98	3.6	6.28	66.44	58
10	Halasoor	2.3	6	12.4	6.4	2.1	8.3	2.3	8.38	2000	1135	1.49	0.17	6.06	59.9	72.28
11	Hunsekuppe	2.4	6.4	7.5	7.9	2	3.9	2.3	7.68	1600	850	0.85	0.96	3.55	46.01	72.72
12	Ichanahalli	2.4	4.4	11.7	9.4	2.7	2.1	2.7	8.28	900	670	1.72	5.31	6.36	63.24	64.7
13	Ankanahalli	2.7	5.1	7.9	11.6	0.3	2.4	1.2	7.68	1050	1180	1.01	4.19	3.99	50.31	65.38
14	Habatoor	2	2.4	3.7	5.1	1.9	0.8	0.2	8.78	670	467	0.84	2.64	2.48	45.67	54.54
15	Mummadikaval	3.4	2.9	5.8	5.5	1.8	1.8	1.2	8.58	940	630	0.92	1.01	3.25	47.93	46.03
16	Abbalathi	1.2	2.7	11.3	9.4	1.8	3.5	0.3	9.28	1640	1088	2.89	7.27	7.99	74.34	69.23
17	Malangi	2.2	1.4	1.5	2.5	1.8	0.5	0.2	8.98	300	257	0.41	0.66	1.1	29.41	38.88
18	Chowkur	5.1	4.9	9.7	7.1	2.3	1.3	9	7.78	800	680	0.97	-0.61	4.34	49.23	49
19	Panchavalli	3	2.9	4	7.2	1.1	1.2	0.3	8.57	680	595	0.67	2.36	2.32	40.4	49.15
20	Ittigahalli	2.9	2.8	4.7	6.7	2.1	0.8	0.8	8.47	800	700	0.82	3.027	2.77	45.19	49.12
21	Uthenahalli	0.5	3.1	11.6	10	1.4	2.2	0.7	8.57	1400	890	3.2	7.78	8.62	76.31	86.11
22	Alalur	2.6	4.6	3.8	6.6	2.3	1	0.6	7.58	760	625	0.52	1.65	2.01	34.54	63.88
23	Muddanahalli	2.6	3.7	4	6.5	1.9	0.7	0.6	8.59	760	640	0.63	2.14	2.25	38.83	58.73
24	Kachuvanahalli Jungle	2.3	5.8	2.9	5.4	2.1	0.8	1.7	8.36	650	630	0.35	-0.63	1.42	26.36	71.6
25	Anechowkur Forest	4.2	4	5.4	6.8	2.3	3.6	0.5	7.98	1100	920	0.65	0.74	2.65	39.7	48.78

26	Laxmipura	2.5	2.5	2.7	3.8	1.6	0.8	0.6	7.64	1000	550	0.54	0.47	1.71	35.06	50
27	Kogilvadi	3.4	3.3	4.6	7.8	1.6	1.4	0.4	7.64	890	870	0.68	2.64	2.48	40.7	49.25
28	Chowthi	3.1	4.2	3.6	7.8	0.2	1.1	1.2	7.96	970	640	0.49	0.63	1.88	33.02	57.53
29	Thimakapura	4.4	3.5	3.5	4.8	2.1	2.7	1	7.66	960	710	0.44	-1.01	1.76	30.7	44.3
30	Halepeteka Tapura	2	2.7	2.8	4.3	0.2	0.7	1.2	8.46	660	480	0.59	-0.21	1.84	37.33	57.44
31	Magali	3	8.9	4.1	3.8	2.1	4.1	1.2	7.68	1360	795	0.34	-5.99	1.69	25.62	74.78
32	Begur	2.4	3.3	5.8	5.1	1.9	2.7	1.2	7.88	1000	740	1.01	1.26	3.44	50.43	57.89
33	Sulagodu	2.5	6.3	2.7	7.1	1.8	1.6	0.9	8.08	1100	715	0.38	8.89	1.26	23.47	71.59
34	Kalethimmanahalli	2	4.1	5.5	7	1.9	1	0.9	8.58	1120	690	0.9	2.75	3.12	47.41	67.21
35	Muthur	6.5	3.9	2.6	6.9	1.6	2.2	1.2	7.58	1175	660	0.25	-1.82	1.14	20	37.5
36	Naralapura	2.1	4.2	3	5.4	1.5	1.3	1	9.58	1000	625	0.47	0.53	1.69	32.25	66.66
37	Kirangoor	7	1.5	6.1	7.1	1.9	3.1	1.2	7.98	1100	905	0.71	0.61	2.95	41.78	17.64
38	Lingapura	3.1	1.2	1.9	3.5	1.5	0.6	0.6	7.59	6000	422	0.44	0.56	1.26	30.64	27.9
39	Ayarabeedu	4.5	8.7	0.6	5.2	3.1	0.9	4.4	8.8	740	450	0.04	-4.9	2.19	4.34	65.9
40	Lingapura Forest	3.4	1.7	11.1	9.5	2.4	3	1.2	8	1300	955	2.17	6.75	6.92	68.51	33.33
41	Naviloor	2.3	3.9	4.3	5.8	1.8	1.1	1.5	8.9	870	660	0.69	1.33	2.46	40.95	62.9
42	Bemmathi	8	10.8	15.3	3.2	1.1	6.1	22.9	7.98	1320	785	0.81	-14.46	4.98	44.86	57.44
43	Illapura	4.5	3.7	8	8.4	1.3	3.3	1.9	8.98	1200	885	0.97	1.46	3.95	49.38	45.12
44	Kamanahalli	0.9	2.6	4.5	4.2	1.8	1	0.6	8.28	600	496	1.28	2.34	3.34	56.25	74.28
45	Boothanahalli	2.6	3.9	6.9	6.7	1.6	2.3	2.7	8.78	1400	860	1.06	1.7	3.8	51.49	60
46	Korla Hosalli	2.4	3	7.7	8.1	1.6	1.7	1.5	8.98	900	760	1.42	4.28	4.63	58.77	55.55
47	Alanahalli	1.5	2.4	4.6	5.2	1.6	0.7	0.8	7.6	764	555	1.17	2.97	3.27	54.11	61.53
48	Manchadevanahalli	3.5	3.6	2.4	4.6	2.4	0.8	0.2	8.62	660	450	0.33	-0.17	1.26	25.26	50.7
49	Kundanahalli	1.3	2.2	12.4	9.6	2.9	1.5	1.4	8.78	1200	920	3.54	9.01	9.34	77.98	62.85
50	Hunasawadi	2.9	3.2	3.5	6.4	1.8	0.4	0.5	8.6	720	620	0.57	2.08	2.01	36.45	52.45
51	Mallinathapura	1.9	4.4	13.8	3.3	0.3	12.3	4	7.68	2920	1600	2.19	-2.68	7.76	68.65	69.8

52	Belathur	2	4.8	21	14.8	3.2	5.7	3.1	7.89	2200	1965	3.08	11.19	11.3	75.53	70.58
53	Chennenahalli	1.3	2.2	6.7	6.5	1.9	0.7	0.6	8.8	800	560	1.91	4.92	5.08	65.68	62.85
54	Chittenahalli	3.6	6.4	5.9	6.5	1.5	0.8	6.7	7.98	860	585	0.59	-2.03	2.64	37.1	64
55	Chowdenahalli	5.9	4.7	5.8	5.4	1.9	1.7	6.7	8.83	780	560	0.54	-3.31	2.5	35.36	44.33
56	Haranahalli	3.9	3.9	4.3	7.8	1.6	1.4	0.4	7.8	880	680	0.55	1.62	2.2	35.53	50
57	Chapparadahalli	47.5	29.8	17.3	82.9	0.3	7.6	2.7	7.82	1820	1135	0.22	5.96	2.78	18.28	38.55
58	Voddarabylakuppe	3.1	4.1	3.2	4.6	3.1	1.4	0.5	7.81	930	565	0.44	0.48	1.67	30.76	56.94
59	Ganganakuppe	3.4	3.5	5.3	7.9	1.9	1.3	0.6	8.85	890	680	0.76	2.94	2.82	43.44	50.72
60	Garigudda Kaval	0.8	3.2	10.2	8.1	1.9	1.4	1.7	8.87	1320	780	2.55	5.98	7.17	71.83	80
61	Kanagal	2.3	2.7	4.7	5.1	1.5	1.5	1.1	7.89	600	780	0.94	1.56	2.93	48.45	54
62	Basavanahalli	2.3	3	5	6.5	2.1	1	0.6	7.8	890	575	0.94	3.28	3.09	48.54	56.6
63	Gobbali Kaval	1.8	2.1	3.1	4.2	1.5	0.5	0.4	7.98	580	370	0.78	1.79	2.2	44.28	53.84
64	Manuganahalli	3.1	2.6	3.4	6.1	1.8	0.4	0.4	7.84	678	570	0.59	2.16	2	37.36	45.61
65	Ichanahalli	3.4	2.9	5.7	7.4	1.9	0.9	0.7	7.98	680	675	0.9	3.05	3.24	47.5	46.03
66	Gudibadrana Hosahalli	5.5	5.5	4	4.3	0.3	4.6	3.5	7.82	1090	790	0.36	-6.34	1.72	26.66	50
67	Rajanabilaguli	3	4	3.5	6.8	1.8	1.1	0.4	7.98	960	570	0.5	1.44	1.87	33.33	57.14
68	Rasimarti Kaval	1	6.1	20.7	10.5	1.8	9.3	5	9.28	2400	890	2.91	5.16	10.95	74.46	85.91
69	Hunsethoppalu	2.5	2.9	9.3	7.8	0.5	4.1	1.7	8.98	1300	890	1.72	2.94	5.64	63.26	53.7
70	Hasuvina Kaval	2.3	5.6	11.7	6.4	1.8	8.3	2.5	8.38	1970	1195	1.48	0.24	5.86	59.69	70.88
71	Byadarabilaguli	2.9	6.4	7.5	7.9	1.6	3.9	2.5	7.68	1560	890	0.8	0.18	3.46	44.64	68.81
72	Haleyur	2.7	4.4	11.7	9.4	2.7	2.1	2.7	8.82	880	690	1.64	5.01	6.22	62.23	61.97
73	Chikkanerale	3.1	4.6	8.4	11.6	0.3	2.4	1.2	7.84	1030	1190	1.09	4.21	4.28	52.17	59.74
74	Tarikallu	2.2	2.4	3.6	5.1	1.9	0.8	0.2	8.87	670	497	0.78	2.49	2.38	43.9	52.17
75	Doddanerale	3.1	2.6	5.2	5.5	1.5	1.8	1.2	8.89	870	690	0.91	1.36	3.1	47.7	45.61
76	Gulledahalli Jungle	1.2	2.7	11.3	9.4	1.8	3.5	0.3	9.82	1560	1098	2.89	7.27	8	74.34	69.23
77	Hosahalli	1.7	1.6	1.7	2.5	1.8	0.5	0.2	8.89	380	290	0.51	0.99	1.32	34	48.48
78	Basavanahalli	3.1	2.2	6.1	7.1	2.3	1.3	0.8	7.88	780	690	1.15	3.96	3.7	53.5	41.5
79	Poonadahali	2.9	3.5	3.9	7.1	1.5	1.2	0.5	8.59	740	595	0.6	2.12	2.17	37.86	54.6

80	Charapura	3.1	3.2	4.6	6.7	2.1	0.8	0.8	8.49	780	620	0.73	2.46	2.59	42.2	50.79
81	Handigudda Kaval	0.4	3.2	10.7	10	1.4	2.2	0.7	8.59	1310	870	2.97	7.75	7.94	74.82	88.9
82	Tirumalapura	2.5	4.5	3.7	6.6	2.3	1	0.4	7.59	740	575	0.52	1.78	1.98	34.57	64.28
83	Doddahonnur Kaval	1.7	4.4	4	6.5	1.9	0.7	0.4	8.58	780	5740	0.65	2.38	2.32	39.6	72.13
84	Muthagur	1.9	5.1	3	5.4	1.8	0.8	1.7	8.37	630	4730	0.42	0.14	1.6	30	72.85
85	Dodda Honnur	4.2	4	5.7	6.8	2.3	3.6	0.5	7.97	1010	890	0.69	0.79	2.8	41	48.78
86	Bylakuppe	2.8	2.1	2.7	3.8	1.3	0.8	0.7	7.62	960	370	0.55	0.25	1.7	35.52	42.85
87	Guddenahalli	4.7	4.5	6.2	7.8	1.6	1.4	4.4	7.61	880	690	0.67	0.11	2.86	40.25	48.91
88	Laxmipura	3.4	4.6	4	7.8	2.1	1.1	1.2	7.95	930	640	0.5	1.84	1.97	33.33	57.5
89	Gollara Hosalli	4.4	3.5	3.5	4.8	2.1	2.7	1	7.61	920	680	0.44	-1.01	1.76	30.7	44.3
90	Basavanaye	2	2.7	2.9	4.3	0.3	0.7	1.2	8.48	650	580	0.61	-0.11	1.86	38.15	57.44
91	Kailasapura	2.2	6.3	3.1	3.8	2.1	4.1	1.2	7.68	1320	895	0.36	-2.61	1.51	26.72	74.11
92	Aralikumari	3.1	4.2	4.9	5.1	2.3	2.7	1.3	7.84	1000	740	0.67	4	2.57	40.16	57.53
93	Doddaharve	3.1	6	2.8	7.1	2.1	1.6	0.9	8.08	1100	715	0.3	0.15	1.3	23.5	65.93
94	Doddaharve Forest	1.6	5.3	5.2	7	2.3	1	0.9	8.58	1100	790	0.75	2.38	2.81	42.97	76.81
95	Lingapura	6.5	3.9	2.6	6.9	1.6	2.2	1.2	7.88	1100	760	0.25	-1.82	1.14	20	37.5
96	Dodda Hosur	1.7	4.3	3.1	5.4	1.5	1.3	0.8	9.85	1000	725	0.51	0.85	1.78	34.06	71.66
97	Giragoor	7	2	6.1	7.1	2.3	3.1	1.2	7.98	1050	805	0.67	0.45	2.87	40.39	22.22
98	Koppa	3.3	2	2.3	3.5	1.8	0.6	0.6	7.88	600	622	0.43	5.89	1.39	30.26	37.73
99	Avarthi	2.4	6.7	0.7	5.2	3.1	0.9	0.5	8.8	750	750	0.07	-0.8	3.46	7.14	73.62
100	Sunkadahalli	1	2.3	13.8	9.5	2.4	3	1.2	8.8	1350	955	4.18	8.57	10.76	80.7	69.69
101	Maradiyur	2.5	4.3	4.3	5.8	1.8	1.1	1.9	8.87	870	860	0.63	0.81	2.33	38.73	63.23
102	Benagal	3.3	4.4	6.3	3.2	1.5	6.1	2.5	7.98	1320	875	0.81	-2.97	3.2	45	57.14
103	Bilagunda	4.5	3.7	8	8.4	1.3	3.3	1.9	8.98	1200	875	0.97	1.46	3.95	49.38	45.12
104	Kesarakere	0.7	2.9	4.5	4.2	1.8	1	0.6	8.28	600	496	1.25	2.35	3.38	55.55	80.55
105	Ambalare	2.6	3.9	6.8	6.7	1.6	2.3	2.7	8.78	1400	860	1.04	1.79	3.78	51.12	60
106	Channakal Kaval	2.4	3	7.7	8.1	1.6	1.7	1.5	8.99	900	760	1.42	4.23	4.61	58.77	55.5

107	Dindagadu	1.3	2.4	4.1	5.2	1.3	0.7	0.4	7.58	700	555	1.1	2.83	3.04	52.56	64.8
108	Chikkamaravalli	3.5	3.6	2.8	4.6	2.4	0.8	0.4	8.82	600	550	0.39	-0.17	1.49	28.28	50.7
109	Doddakamaravalli	1.9	3.2	10.8	9.6	2.9	1.5	1.4	8.81	1200	920	2.11	7.38	6.71	67.92	62.74
110	Shanuboganahalli	2.9	3.2	3.5	6.4	1.8	0.4	0.5	8.81	750	620	0.57	2.08	2.01	36.45	52.45
111	Sulekote	2.6	4.9	12.7	3.3	0.3	12.3	4	7.88	2980	1600	1.7	-3.9	6.56	62.87	65.3
112	Chamarayanakote	2.6	6.1	23.3	14.8	3.3	5.7	7.3	7.89	2200	1935	2.67	9.36	11.18	72.81	70.11
113	Hegathur	2.2	3.8	4.3	6.5	1.9	0.7	0.6	8.85	800	640	0.71	2.4	2.45	41.74	63.3
114	Kambipura	2.4	4.2	3.9	6.5	1.5	0.8	0.6	7.89	820	675	0.59	1.38	2.13	37.14	63.63
115	Adagoor	5.9	4.6	5.7	5.4	1.9	1.7	6.7	8.84	760	620	0.54	-3.18	2.48	35.18	43.8
116	Bettadapur	3.9	3.9	4.3	7.8	1.6	1.4	0.6	7.86	970	680	0.55	1.62	2.2	35.53	50
117	Gorahalli	10.5	6.6	3.8	8.3	0.3	7.6	2.5	7.82	1900	1145	0.22	-8.45	1.3	18.18	38.59
118	Suragahalli	3.1	4.2	3.2	4.6	3.1	1.4	0.5	7.81	980	545	0.43	0.34	1.67	30.47	57.53
119	Halaganahalli	3.3	3.4	5.5	7.9	1.9	1.3	0.6	8.85	890	680	0.82	3.21	3	45.08	50.74
120	Haradur	0.6	2.6	8.9	8.1	1.9	1.4	0.4	8.87	1320	780	2.7	6.89	7.06	73.55	81.25