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Evaluate the Irrigation Water Quality in Salem District, Tamil Nadu, India

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Abstract: *Water is one in all the foremost indispensable renewable assets and is that the elixir of life. In this present world population is increasing tremendously. Rate of technological development in industry and agriculture is also high. The mentioned top of the reason has enlarged the demand for water which is going to be a major crisis in next to the upcoming future. Quality of groundwater was assessed by collecting sixty-six sampling spots in January 2017(Post monsoon) and May 2017(pre monsoon) Irrigation water quality interpretation was done by using Sodium Adsorption Ratio (SAR), USSL classification, Doneen's classification and Wilcox's classification. The influence of anions and cations was done by Piper's trilinear diagram. Groundwater quality for irrigation purpose during premonsoon season is in doubtful category in almost all parts of the study area.*

Keywords :Salem District, USSL Classification, Doneen's Classification and Wilcox's Classification

I. INTRODUCTION

Groundwater is an important natural source that has to be explored and sustained for the future. Salem district is accepted for its mineral deposi t(magnesite, bauxite, limestone, quartzite, iron ore and granite), Stanley reservoir(Mettur dam) and for Mango fruit. Water from the stream Cauvery is accumulating in Stanley reservoir and it is the main source of water for irrigation. The study area has a dry and temperate climate and it lies within the western part of Tamil Nadu, placed between 11°15' to 12°00' north latitudes and 77°35' to 78°50' east longitudes (Maheswaran and Elangovan2014)and the total geographical area is about 5207 sq.kms out of that Stanley reservoir wrap an vicinity of regarding 164.5 sq.kms

II. METHODOLOGY

Quality of groundwater was assessed by collecting and testing groundwater samples, by the procedures prescribed in IS 3025 – 1983, from sixty-six sampling spots January 2017 (Post monsoon) and May 2017(pre monsoon). Irrigation water quality interpretation was based on SAR, USSL classification, Doneen's classification and Wilcox's classification. The influence of anions and cations was done by Piper's trilinear diagram and statistical analysis

III. RESULT AND DISCUSSION

Groundwater suitability to irrigation can also be classified based on Sodium Adsorption Ratio (Richards 1954). A higher Sodium Adsorption Ratio indicates that the soil was capable of absorbing more of sodium when compared to calcium and magnesium. The soil becomes impervious if the calcium and magnesium were replaced by sodium (Sreedevi 2004). If the amount of sodium exceeds it produces deleterious effects by reducing the permeability of soil (Kelley 1951, Karanth 1987). If the irrigation water has excess of sodium then this will be absorbed by soil and it would become sodic. The physical characteristics of sodic soil are that the permeability is lowered and soil becomes impervious. This may ultimately lead to water logging problems and cause dwindling of plant growth. Thus a desirable quality of irrigation water should be of low SAR. Based on IS 2296-1963 the SAR was categorized as excellent, good, fair and bad for irrigation which is shown in Table 1 (Ragunath 2007)and it can be calculated by using equation 1

S.No	S.A.R	Category	Percentage of samples	
			Premonsoon	Postmonsoon
1.	0-10	Excellent	98.5	98.5
2.	10-18	Good	1.5	1.5
3.	18-26	Fair	Nil	Nil
4.	> 26	Poor	Nil	Nil

$$SAR = \frac{Na}{\left(\frac{(Ca+Mg)}{2}\right)^{1/2}}$$

Table: 1 Categorization based on SAR

Table 5.8 reveals that 65 locations fall under excellent category (98.5%) and one location fall under good category in both the seasons.

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A. *USSL Classification*

The appropriateness of groundwater samples meant for irrigation was resolute using USSL classification. The classification was supported on salinity (conductivity) and sodium hazard (alkali) (Richards, 1954).

The notations C1, C2, C3, C4 and S1, S2, S3, S4 represents the low, medium, high and very high for salinity and sodium hazard respectively. The diagram was divided into 16 divisions. Based on the classification, the groundwater was categorized as good, moderate and badly suitable for irrigation and classification for both premonsoon and postmonsoon which were shown in Figures1 and 2 respectively. The results based on USSL classification is shown in Table 2.

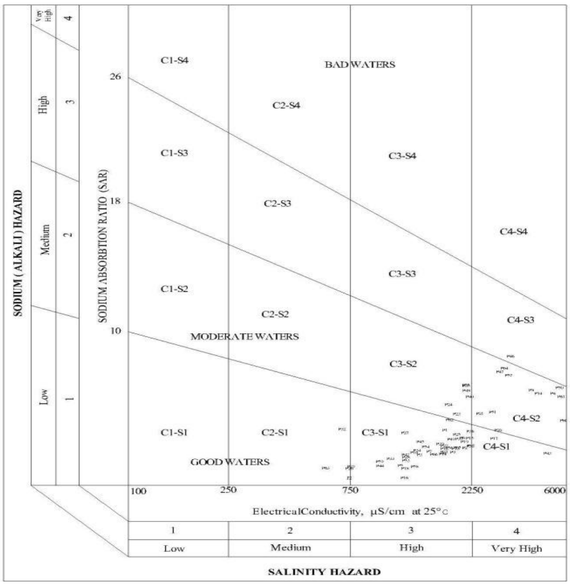

Figure 1 Suitability of Water based on USSL Classification (Premonsoon)

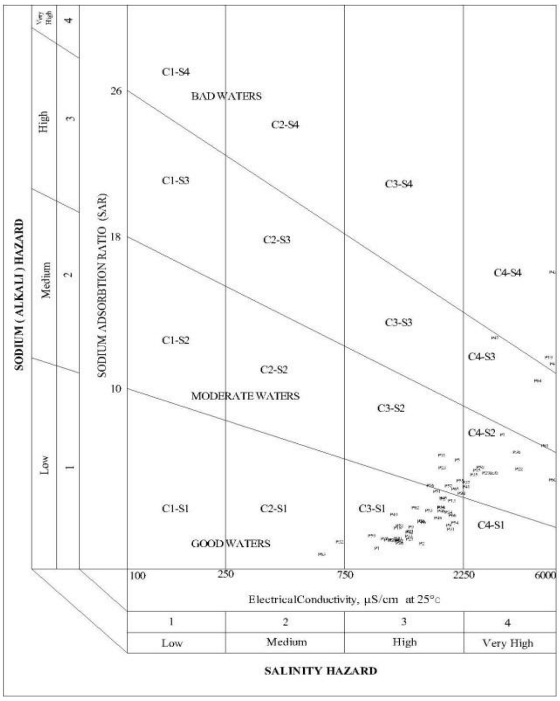

Figure 2 Suitability of Water based on USSL Classification (Postmonsoon)

Table 3 Categorization of based on USSL Classification

Classification	Suitability for irrigation	Percentage of samples			
		Premonsoon		Postmonsoon	
C2-S1	Good	6.06	69.70	1.51	59.09
C3-S1	Good	60.61		57.58	
C4-S1	Good	6.06		Nil	
C3-S2	Moderate	9.09	25.76	12.12	30.30
C4-S2	Moderate	16.67		18.18	
C4-S3	Bad	Nil	1.51	6.06	10.61
C4-S4	Bad	1.51		4.55	

The combinations C2-S1, C3-S1 and C4-S1 was considered as good, C3-S2 and C4-S2 as moderate, C4-S3, and C4-S4 fall under bad group which was unfit for irrigation.

B. Doneen's Classification

. The permeability index was mainly influenced by sodium, magnesium, potassium and bicarbonates and it was classified based on Doneen's permeability index (Doneen 1964). The formula for calculating the permeability is shown below:

$$PI = \frac{Na + \sqrt{HCO_3}}{Ca + Mg + Na} \times 100$$

Based on the categorization the groundwater sample were classified into three classes in which class I and class II will have 75 % maximum permeability and class III will have 25 % of maximum permeability. If the groundwater falls under class I and II it is considered as fine for irrigation and class III not fit for irrigation. The groundwater samples were plotted according to Doneen's classification for both the seasons which was shown in Figures 3 and 4.

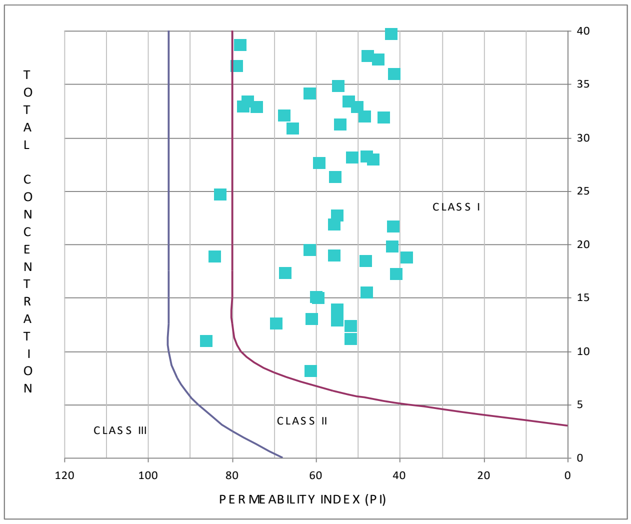

Figure 3 Suitability of Water based on Doneen's Classification (Premonsoon)

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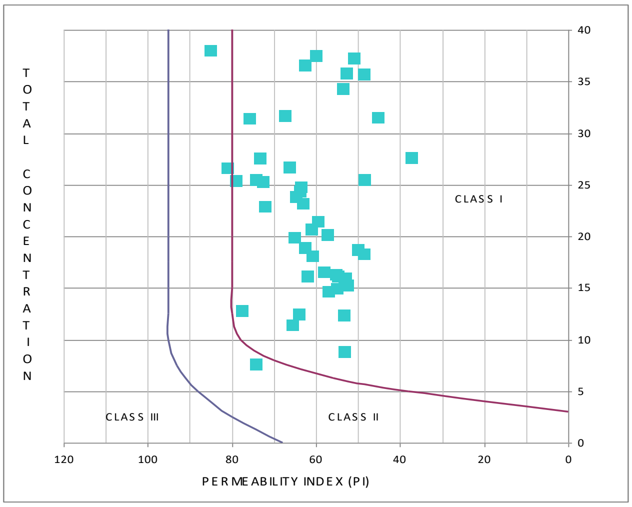

Figure 4 Suitability of based on Doneen's Classification (Postmonsoon)

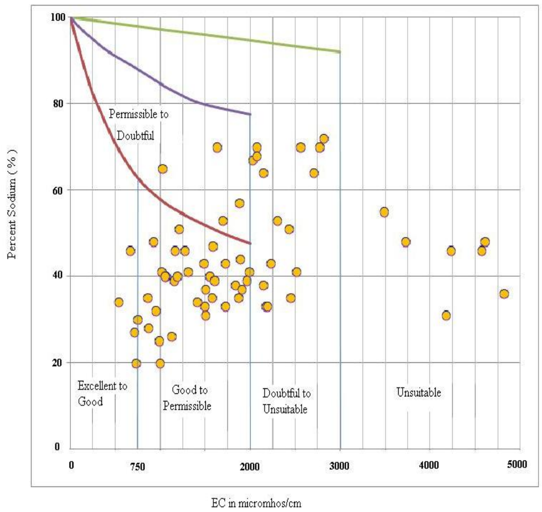

Figure 5 Suitability of Water based on Wilcox Classification (Premonsoon)

The co on between the premonsoon and postmonsoon based on Doneen's permeability index reveals that 95.45 % and 4.55 % of the samples fall under class I and class II respectively throughout the year which is shown in table 2s.

Table 2 Categorization based on Doneen's Permeability Index

S.No	Classification	Premonsoon		Postmonsoon	
		Sample locations	Percentage of locations	Sample locations	Percentage of locations
1	Class I	P1, P2, P4 to P10, P12 to P35 and P37 to P66	95.45	P1to P19, P21to P37, P39 to P 58 and P60 to P66	95.45
2	Class II	P3, P11and P36,	4.55	P20, P38 and P59	4.55
3	Class III	Nil	Nil	Nil	Nil

C.Wilcox Classification

Percent sodium in water is a parameter computed to evaluate the suitability for irrigation (Wilcox 1948). In Wilcox chart, values were plotted for electrical conductivity and percent sodium in x and y axis respectively. Excess sodium combining with carbonate will lead to the formation of alkaline soils while with chloride the saline soils are formed. Both the soils will not support the growth of soils (Sreedevi 2004).

The sodium percent is calculated by the formula mentioned below:

Sodium percent (Na %) =

$$\frac{Na+K}{Ca+Mg+Na+K}\times 100$$

The analysed results based on Wilcox diagram for premonsoon and postmonsoon is shown in Figures 5and 6 respectively. The comparison between premonsoon and postmonsoon based on Wilcox classification was shown in Table 3.

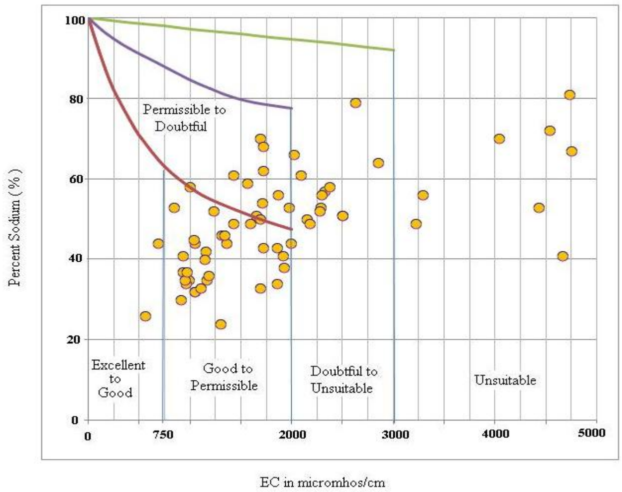

Figure 6 Suitability of Water based on Wilcox Classification (Postmonsoon)

Table 3 Categorization of Groundwater Samples for Irrigation based on Wilcox Diagram

S.No	Classification	Premonsoon		Postmonsoon	
		Sample locations	Percentage of locations	Sample locations	Percentage of locations
1	Excellent to good	P1, P4 P6, P10 and P15	7.58	P4	1.52
2	Good to permissible	P2, P7, P9, P12, P13, P16, P17, P19, P24, P25, P26, P27, P28, P31, P33, P34, P35, P39, P40, P45, P48, P49, P50, P51, P53, P54, P55, P57, P58, P59, P63, P64 and P65	50	P2, P3, P6, P7, P9, P10, P11, P12, P13, P15, P16, P25, P26, P27, P29, P30, P31, P32, P34, P35, P36, P39, P40, P48, P49, P54, P55, P56, P60, P62, P63, P64, P65 and P66	51.52

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3	Permissible to doubtful	P3, P11, P22 and P60	6.06	P22, P24, P26, P33, P45, P47 P51, P58 and P59	13.63
4	Doubtful to unsuitable	P5, P8, P14, P18, P26, P30, P32, P36, P37, P38, P43, P44, P47, P56, P61 and P66	24.24	P1, P5, P14, P17, P19, P23, P37, P38, P43, P44, P53, P57 and P61	19.70
5	Unsuitable	P20, P21, P23 P29, P41, P42, P52 and P62	12.12	P8, P18, P20, P21, P28, P41, P42, P50 and P52	13.63

Figures 5 and 6 reveals that out of sixty six groundwater samples, 12.12 % in premonsoon and 13.63 % in postmonsoon were unsuitable for irrigation.

D. Influence Of Ionic Concentration In Groundwater

The Piper's trilinear diagram (Walton (1970),Piper 1953) was used to find the influence of cations (calcium, sodium, potassium and magnesium) and anions (chlorides, sulphate, carbonates and bicarbonates) in the groundwater. The Piper's trilinear diagram which is shown in Figure 7 consists of a left triangle, a right triangle and an upper diamond. All sides of the triangles and diamond are equally divided from 0 to 100% and the cations and anions were plotted in the lower left and right triangle in meq/l respectively. The lower left triangle indicates the influence of calcium, magnesium, sodium and potassium and right triangle indicates the influence of sulphate, chloride and bicarbonate.

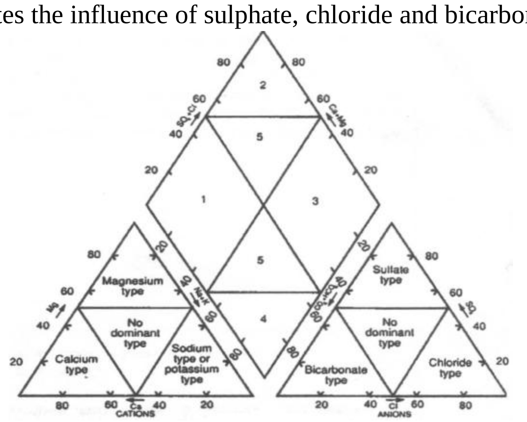

Figure 7 Categorization of Piper's Trilinear Diagram

The plotted values were projected to the central diamond. The upper diamond is made into three triangle types and two diamond types in which diamond 1 corresponds to magnesium - bicarbonate type, triangle 2 corresponds to calcium - chloride type, diamond 3 corresponds to sodium – chloride type, triangle 4 corresponds to sodium – bicarbonate type and triangle 5 correspcCATIONSixed type. The influence of the ions in the groundwater was known by the locations of the sample values in the triangles and in the diamond. The trilinear diagram indicates the dominant type of cation and anion in the water samples. The influences of the ions were studied for both premonsoon and postmonsoon based on Piper's trilinear diagram is shown in Figures 8 and 9 respectively. A comparison was done between both the season and it is shown in Table 4.

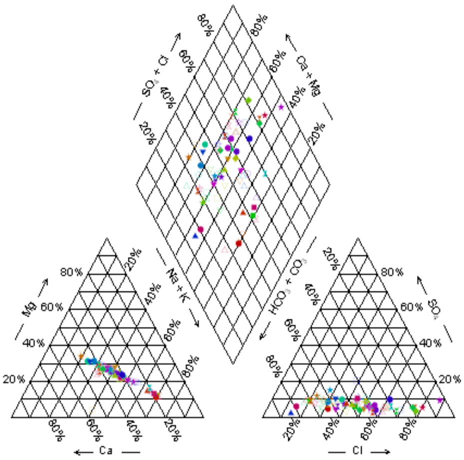

Figure 8 Piper's Trilinear Diagram for Premonsoon

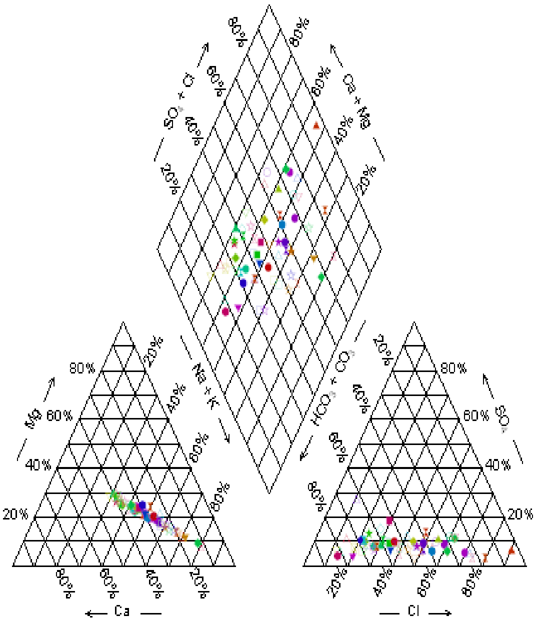

Figure 9 Piper's Trilinear Diagram for Postmonsoon

Figure 8 reveals that during premonsoon the anion dominance shows that 45 % of the samples were dominated by bicarbonate, 38 % by chlorides and 17 % of no dominant type. The cation dominance shows that 72.75 % of the samples were of no dominant type, 25.75 % were dominated by sodium and potassium and 1.5 % by calcium type. The diamond shows that 36 % of the water samples have a combined concentration of calcium, magnesium and bicarbonate, which indicates that it was hard water. 17 % of the water samples had a combined concentration of alkali metals, sulphate and chloride, which indicated that the samples were saline in nature. 47 % of the samples were of no dominant type.

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Figure 9 that during postmonsoon the anion dominance shows that 21.21% of the samples were of no dominant type, 28.79% of the samples were of chloride dominance and 50% of the samples were of bicarbonate dominance. In the cation dominance 62.12% of the samples were of no dominant type, 37.88% of the samples were of sodium or potassium type. The central diamond indicates that 40.91% of the samples were of primary hardness, 28.79% of the samples were of primary salinity type and 30.30% samples were neither hard nor saline.

Piper's trilinear diagram for both premonsoon and postmonsoon (Figure 8 and Figure9) shows linear pattern in both the triangles (anion and cation). In right triangle (anion dominance), it was observed that in both premonsoon and postmonsoon all the plotted samples were close to the bicarbonates and chloride line. This pattern reveals a mixing of groundwater with bicarbonates and chlorides. In left triangle (cation dominance), it was observed that in both premonsoon and postmonsoon the plotted groundwater samples form a linear trend which reveals that it was due to the mixing of calcium, sodium and potassium ions in groundwater.

Table 4 Categorization of Groundwater during Premonsoon and Postmonsoon based on Piper's Trilinear Diagram

S.No.	Description	Premonsoon	Postmonsoon
1	Anion dominance	45 % by bicarbonates	50 % by bicarbonates
		38 % by chloride	28.79 % by chloride
		17 % by no dominant type	21.21 % by no dominant type
2.	Cation dominance	25.75 % by sodium and potassium	37.88 % by sodium and potassium
		1.5 % by calcium	Nil
		72.75 % no dominant type	62.12 % no dominant type
3	Combined concentrations	36 % by calcium, magnesium and bicarbonate	40.91 % by calcium, magnesium and bicarbonate
		17 % by alkali metals, sulphate and chloride	28.79 % by alkali metals, sulphate and chloride
		47 % of no dominant type	30.30 % of no dominant type

Table 4 reveals that in the anion dominance the influence by bicarbonates was high in both the seasons. In the cation dominance influenced by sodium and potassium was more in both the seasons. Both cation and anion combined concentration reveal that the influence by calcium, magnesium and bicarbonate is high in both the seasons.

IV. CONCLUSION

Suitability of groundwater for irrigation reveals that all the groundwater samples were appropriate for irrigation in both the seasons based on SAR. As per USSL categorizations throughout premonsoon 98.49 % and in postmonsoon 89.39 % of the water samples were unfit for irrigation. Based on Doneen's classification all the groundwater samples were suitable for irrigation in both premonsoon and postmonsoon. According to Wilcox diagram 87.91 % and 86.37 % of the samples were suitable for irrigation during premonsoon and postmonsoon respectively. From the Piper's trilinear diagram in the anion dominance, influence of bicarbonates and chloride was more and in cation dominance sodium and potassium were more.

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AUTHORS PROFILE

Geetha Selvarani. A has completed her Ph.D at the age of 31 years from Anna University, Chennai. She has published more than 35 papers in reputed journals and conferences and has been serving as an editorial board member and reviewer for various reputed journals. She has published five books are having with ISBN No and filed two patterns. She was participated as Invited speaker and chair person for the 5th International Conference on Civil Engineering and Urban Planning (CEUP2016) held in Xian, China from 23rd to 26th,August.She is a member in Technical Program Committee for " International Conference on Geomatics and Civil Engineering [GCE2017]", September 8th - 10th, 2017, Shanghai, China.

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