Pre- Monsoon and Post-Monsoon Variation in Physico-Chemical Characteristics in Groundwater Quality of Sweta Nadhi Basin, Tamil Nadu, India

S. Priyadharshini[1] Dr. S. Aruchamy[2]
[1]Research Scholar [2]Professor
[1,2]Department of Geography
[1,2]Bharathidasan University, Tiruchirappalli, Tamil Nadu, India

Abstract— The present work is employed in Sweta Nadhi Basin, Water quality data for 34 control wells collected from Groundwater Division for the year 1980-2010 are taken into consideration for the analysis. These observation wells are regularly maintained by the Public Works Department of Government of Tamil Nadu. The aim of the study was to determine the suitability of water for irrigation during post monsoon and pre monsoon on the basis of the quality indices of water for irrigation. Water quality data used in the analysis include Hydrogen Ion Concentration (PH), Total Hardness as (TH), Total Dissolved Solids (TDS), Permeability Index (PI), Electrical Conductivity (EC), Sodium Adsorption Ratio (SAR), Sodium Soluble Percent (SSP), Residual Sodium Carbonate (RSC) for during pre monsoon (July) and post monsoon (December) seasons of the Sweta Nadhi Basin.

Key words: PH, TH, TDS, PI, EC, SSP, RSC, GIS, Sweta Nadhi Basin

I. INTRODUCTION

Ground water quality is a very important source for people around the world. This study is done to evaluate the status of groundwater quality and its suitability for irrigated agriculture. Ground Water quality plays an important role in groundwater protection and quality conservation. Hence, it is very important to assess the groundwater quality not only for its present use, but also from the viewpoint of a potential source of water for future consumption (Kori *et al.*, 2006). The present study, different maps and graphical representations are used to classify and interpret the geochemical data in terms of interpolation map of chemical parameters suitability for Irrigation purpose only. Water is the universal solvent and human survival depends on the use of unpolluted and cleaned water. The physical, chemical and bacterial characteristics of ground water determine its usefulness for domestic, industrial, municipal and agricultural applications.

II. STUDY AREA

The sweta nadhi basin lies in the districts of Namakkal, Salem, Trichy and Perambalur of Tamil Nadu state. This basin comes under the semi arid tract of climatic conditions. This river originates from the northern portion of Kollihills in Namakkal district. It is partly in the central part of Salem and some area covered by Thiruchirappalli district, then it is partly in the eastern part of Perambalur district. It is located between 11^0 15' N and 11^0 45' N latitudes and 78^0 15' E and 78^0 00' E longitudes (as read from the survey of India Topographic sheets 58 I/6, I/7, I/10, I/11, I/14 (Fig.1). This river basin situated in Namakkal district in East, Salem district in south, Trichirappalli district in the north and Perambalur district in the west. It is based on the study area, major three relief order like hill, upland, and plain. The river originated in the northern portion of Kolli hills, part of Manmalai, adjoining Kollihills and Palakkadu malai with Pachamalai. The area of study, area of Sweta Nadhi 1034 Sqkm within 82 Revenue villages, The 34 revenue villages in Salem district, 27 revenue villages in Namakkal district, 17 revenue villages in Perambalur district and remaining 4 revenue villages in Tiruchirappalli district. The major taluks of basin Gangavalli, Rasipuram and Veppanthattai. The Sweta Nadhi is one of the tributaries of the Vellar Basin The river flows in the west to East direction with length with of 116 km and basin breath is 35 km. The physiographic feature has controlled by structural hills, denudational and pediplain and fluvial process in the study area.

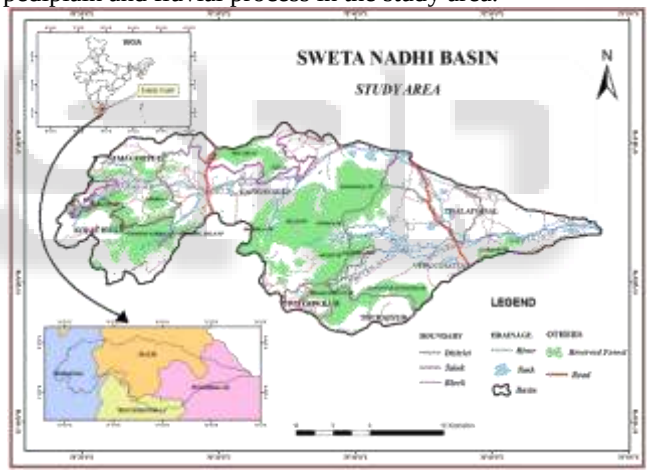

Fig. 1: Sweta Nadhi Basin- Study area

III. MATERIALS AND METHODS

The Study area selected control wells around the basin and inside the basin totally 34 control wells are selected for this analysis (Fig.2). The results are mapped in GIS Software package ArcGIS 9.3 by applying spline interpolation and interpolation techniques are employed to map pre monsoon and post monsoon variation water quality of the basin. Water quality data collected form Ground Water Division (GWD), Tamil Nadu, Chennai. Water quality data are utilized in the present study to analyze the groundwater chemistry from 1980 to 2010 for both pre monsoon (July) and post monsoon (December) seasons. Analysis is carried out using following formulae and standard procedures.

1) Hydrogen Ion Concentration (PH)- Bucks and Gilbert 1979; Makayama and Bucks 1991
2) Total Hardness as (TH) -Freeze and Cherry, 1979

$$TH = (Ca + Mg) \times 50$$

Where, all the ions are expressed in Mg/L.

3) Total Dissolved Solids (TDS) - SWRDC, WRO, PWD, Chennai.
4) Permeability Index (PI) - Doneen, 1964

$$PI = \frac{Na + \sqrt{HCo3}}{Ca + Mg + Na} X100$$

Where, all the ions are expressed in meq/L.

5) Electrical Conductivity (EC)- Wilcox 1955
6) Sodium Adsorption Ratio (SAR)- Richards (1954)

SAR= [Na+] / {([Ca2+] + [Mg2+]) / 2}1/2

Where all the ions are expressed in meq/L.

7) Sodium Soluble Percent (SSP) - Wilcox (1948 and 1955)

$Na\% = [(Na^+ + K+) / (Ca^{2+} + Mg^{2+} + Na^+ + K^+)] 100$

8) Residual Sodium Carbonate (RSC) - Karanth (1987))

RSC = (HCO3 + CO3) - (Ca + Mg)

Where, RSC and the concentration of the constituents are expressed in epm/L.

9) U. S. Salinity Laboratory Water Classification-USSL, 1954.

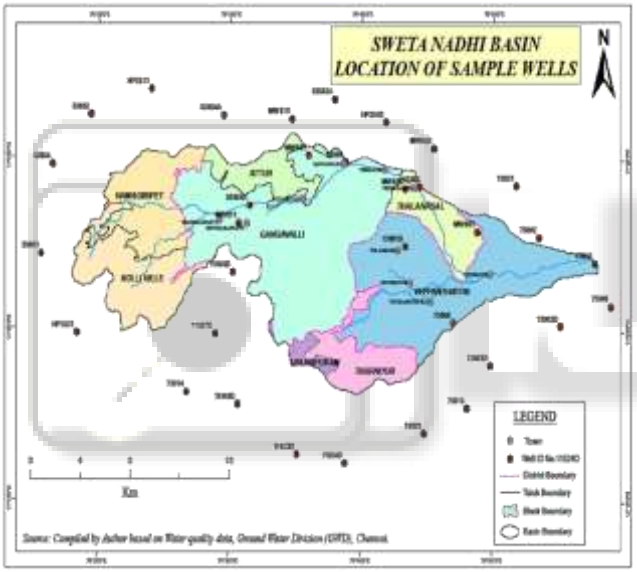

Fig. 3: Location of control wells

IV. Results and Discussion

The results of various physico-chemical parameters are presented following tables and their statistical measures such as minimum, maximum, range of water conditions, significance, concentrations and percentage of samples during post and pre monsoon seasons for irrigation purposes are given in tables.

A. Hydrogen Ion Concentration (pH):

pH refers to the effective concentration of hydrogen ions in the water expressed as the negative logarithm (base 10) of the hydrogen ion activity in moles per liter. The pH value of natural water is a measure of its net alkalinity or acidity. Further, exactly stated, the pH value is a measure of the hydrogen ion concentration of water. In most natural waters, the pH value is dependent on the carbon-di-oxide–carbonate-bicarbonate equilibrium. As the stability is noticeably affected by temperature and pressure.

Sl.No	Ranges	Water Condition	Range of Concentration
1	< 7.0	Minor	< 500 mg/l
2	7.0 - 8.0	Moderate	500 – 2000 mg/l
3	> 8.0	Severe	> 2000 mg/l

*Sources:Bucks and Gilbert 1979; Nakayama and Bucks 1991.

Table 1: Hydrogen Ion Concentration (pH) Classes

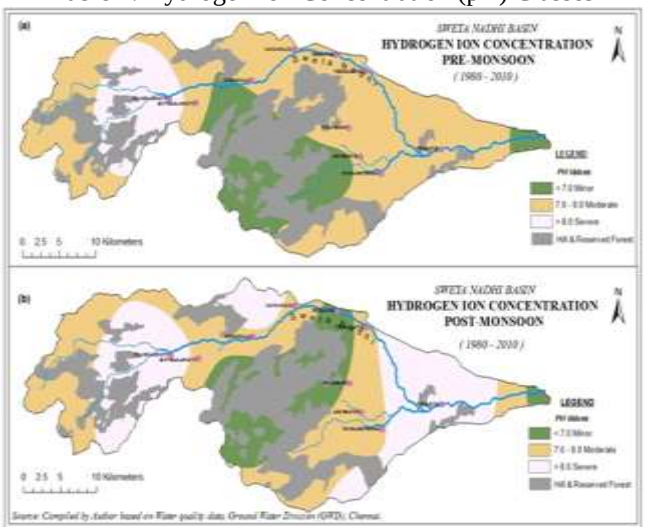

Fig. 3: Hydrogen Ion Concentration (a) Pre monsoon (b) Post monsoon)

In the study area pH was found to be alkaline in nature in most of samples range between 7.0 to 9.1 in Pre Monsoon and 7.2 to 8.7 in Post Monsoon. WHO has recommended maximum permissible limit of pH from 6.5- to 9.2 (De, 2002). pH value of different samples is within the desirable and suitable range. Here pH was found in the range Comparatively higher pH recorded during pre-monsoon than post monsoon is due to dilution of water as a result of precipitation (Fig.3a&b). Only one control well during pre-monsoon have a pH value of 9.1 in a Sendarapatti village in Salem district Paithur village control well have pH value of 8.7 during post monsoon season. It is obvious that the study area contains moderate to strong alkaline content in both the seasons, but more severe in the post monsoon season compared with the pre monsoon season in the basin.

B. Total Hardness as (TH)

When water passes through or over deposits such as limestone, the levels of Ca2+, Mg2+, and HCO3 – ions present in the water can greatly increase and cause the water to be classified as hard water. Total Hardness is defined as the sum of calcium and magnesium hardness in mg/L as CaCO3. In addition to total hardness, the test described here will allow you to determine the concentration of Mg2+, in mg/L.

Sl. No	Water Condition	Range of Hardness as CaCO3	Pre Monsoon	%	Post Monsoon	%
1	Soft	0 - 50 (Mg/l)	-	-	1	3
2	Moderate Soft	50- 100 (Mg/l)	-	-	-	-
3	Slightly	100 - 150	1	3	-	-

	Hard	(Mg/l)				
4	Moderately Hard	150 - 200 (Mg/l)	-	-	1	3
5	Hard	200 – 300 (Mg/l)	2	6	3	9
6	Very Hard	> 300 (Mg/l)	31	91	29	85

*Source: Freeze and Cherry, 1979

Table 2: Range of Hardness of Sweta Nadhi Basin

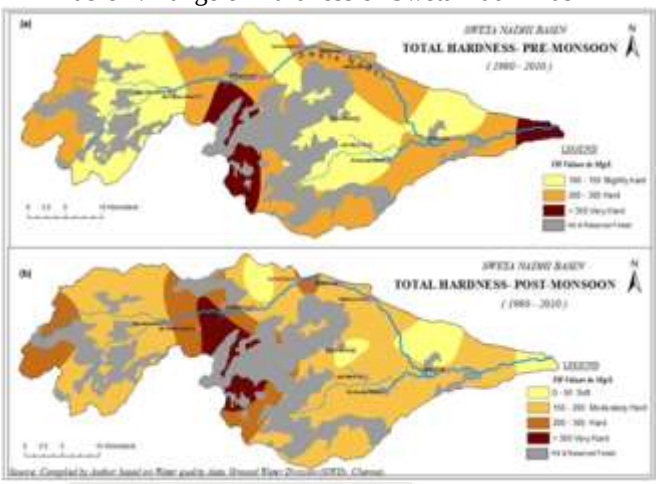

Fig. 4: Total Hardness-(a) Pre monsoon (b) Post monsoon)

Hardness is very important parameter in decreasing the toxic effect of poisonous element. The hardness was found to be in the range of 0-190 mg/lit to 1056.5 mg/lit in Post-monsoon and 140 mg/lit to 1200mg/lit in Pre monsoon. Water can be classified into Six classes based on its hardness (Table.2). The concentration of total hardness ion during pre-monsoon season is found to between (100 -150 mg/L) in only one control well. In the basin having 91 percent of control wells very hard water during pre monsoon season. The concentration of total hardness ion during post-monsoon season, 85 percent of control wells having very hard water. The pre monsoon season generally found following three hardness characteristics slightly hard, hard, very hard, but the post monsoon having 4 characteristics of hardness (soft, slightly hard, hard, very hard) only control well having the soft nature of hardness in the basin (Fig.4 a & b).

C. Total Dissolved Solids (TDS)

Sl.No	Water Condition	Water Condition	Range of Concentration
1	Minor	Good	< 500 mg/l
2	Moderate	Moderate	500 – 2000 mg/l
3	Severe	Poor	> 2000 mg/l

*Sources:Bucks and Gilbert 1979; Nakayama and Bucks 1991

Table 3: Water quality based on Total Dissolved Solids

The mineral constituents dissolved in water constitute dis-solved solids. Concentration of dissolved solids in water decides its applicability for drinking, irrigation and industrial purposes. The Total Dissolved Solids (TDS) was classified to three ranges based on SG and SWRDC, WRO, PWD, Chennai (Good < 500mg/l, Moderate 500 – 2000mg/l, Poor > 2000mg/l) and Groundwater can be also classified according to its TDS content Bucks and Gilbert 1979; Nakayama and Bucks 1991 (Minor < 500mg/l, Moderate Moderate500 – 2000mg/l, Severe> 2000mg/l). The spatial variation map for TDS was prepared based on these ranges and presented in Figure.5 a&b.

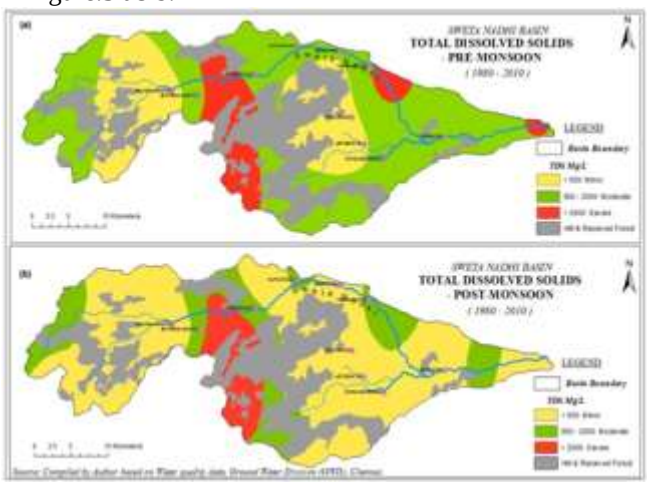

Fig. 5: Total Dissolved Solids-(a) Pre monsoon (b), Post monsoon

In the study area, pre-monsoon TDS values up to 2001.7 mg/L and drops down 357.7 mg/L and it goes up to 2208.5 mg/L and drops down to 0 mg/L during post monsoon season in the study area, the concentration of TDS ranges below (less than 500mg/L) fall in six per cent wells central part of the basin and western part of basin that area have good water condition and 500 to 2000 mg/l range of concentration fall in entire basin expect northeast some patches in rim of the basin have 94 percent of control wells the range of water condition is Moderately distributed and Attur and Gangavalli some central part of the basin has severe range of water conditions during pre-monsoon season (table.3).

During the post-monsoon period,. The concentration of TDS is found to be Minor level concentration fall in central and western part of the study area. 80 percent Moderately distributed eastern part and north and western rim of the basin severe range condition same in pre monsoon and post monsoon in Attur and Gangavalli central part of the basin. According to the average value of TDS(Davis and De Wiest, 1996), water condition of the study area ranges from freshwater to slightly saline i.e., less than 1000 mg/l to 1000 to 3000 mg/l.

D. Permeability Index (PI)

The soil permeability is affected by the long-term use of irrigated water and the influencing constituents are the total dissolved solids, sodium bicarbonate and the soil type. In the present study, pre monsoon season the PI values range between 37 to 94 and post monsoon season ranges PI index values range between 0 – 81. The above result, therefore, suggests that control wells fall within Class I and Class II and can be categorized as good irrigation water (Doneen, 1964). PI values plotted on Doneen diagram revealed that 85% of the groundwater quality fall in Class I remaining 15 % of control wells fall in Class II during pre monsoon season and the post monsoon season, 79 % of the control wells fall in Class I remaining 21 % of control wells fall in

Class II(Fig.6). The water sample fall under, Classes I in the Doneen diagram is generally good for irrigation purposes.

$$PI = \frac{Na + \sqrt{HCo3}}{Ca + Mg + Na} X100$$

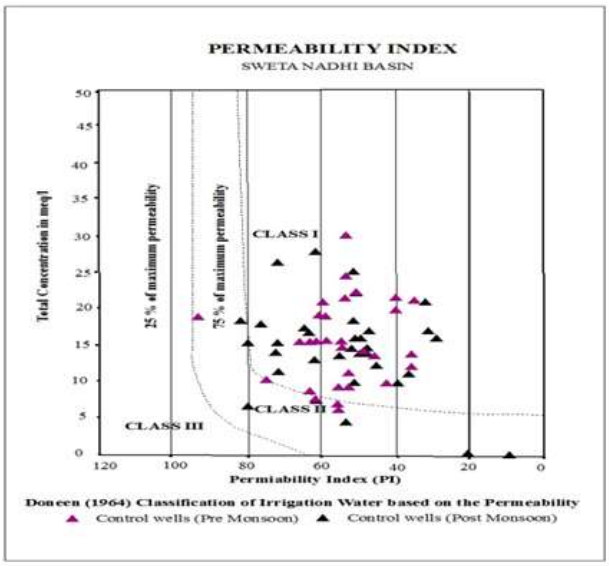

Fig. 6: Permeability Index

E. Electrical Conductivity (EC)

Electrical conductivity (EC) is a calculate of the total salt content of water based on the flow of electrical current through the sample. The higher the salt content, greater will be the flow of electrical current. Measured EC values range from 627.6 to 2580 microsiemens/cm. in pre monsoon season and EC values range from 640.7 to 3755.2 microsiemens/cm. in post monsoon season. The highest value of 3755.2 microsiemens/cm is found in the Sendarappatti village during the post monsoon season. It is obvious that the study area contains Good to Doubtful content in both the seasons same conditions except the northeastern rim of the basin (Fig.7 a&b). Permissible conditions in both season have 74 % and 76 % in the study area (table.4).

Sl. No.	Water Condition	Ranges	Salinity Significance
		EC (micro mhos/cm)	
1	Excellent	<250	Water of low salinity is generally composed of higher proportions of calcium, magnesium and bicarbonate ions.
2	Good	250-750	Moderately saline water, having varying ionic concentrations
3	Permissible	750-2250	High saline waters consist mostly of sodium and chloride ions
4	Doubtful	2250-5000	Water containing high concentration of sodium, bicarbonate and carbonate ions have high pH
5	Unsuitable	> 5000	-

*Source:Wilcox 1955

Table 4: Classification of Irrigation Water Based on Electrical Conductivity

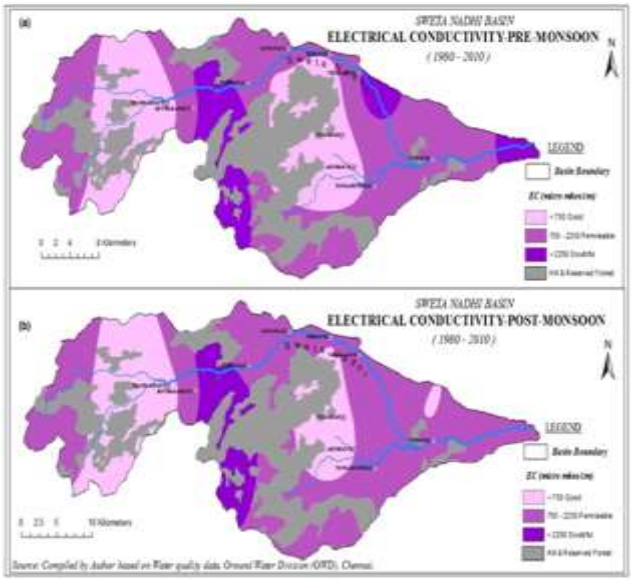

Fig. 7: Electrical Conductivity-(a) Pre monsoon (b), Post monsoon

F. Sodium Adsorption Ratio (SAR)

Sl. No	Water Condition	Sodium Adsorption Ratio (SAR)	Pre Monsoon	%	Post Monsoon	%
1	Good	0 - 1.5 (Meq)	4	12	6	18
2	Fair	1.5 - 3.0 (Meq)	18	53	15	44
3	Marginal	3.0 - 5.0 (Meq)	9	26	10	29
4	Unacceptable	> 5.0 (Meq)	3	9	3	9

*Source: Koegelenberg, 2004.

Table 5: Sodium Adsorption Ratio of Sweta Nadhi Basin

The most common measure to assess sodicity in water and soil is called the Sodium Adsorption Ratio (SAR). The SAR defines sodicity in terms of the relative concentration of sodium (Na) compared to the sum of calcium (Ca) and magnesium (Mg) ions in a sample. The SAR assesses the potential for infiltration problems due to a sodium imbalance in irrigation water. The SAR is mathematically written below, where Na, Ca and Mg are the concentrations of these ions in milliequivalents per liter (meq/L). Sodium concentration is important in classifying the water for irrigation purposes because sodium concentration can reduce the soil permeability and soil structure

Sodium hazards are very low, and the groundwater can be used on most crops for irrigation purposes. Generally high concentrations of bicarbonate and carbonate are predominant anion in the alkali soils, and chloride and sulfate are the predominant anion in the saline soils. Based on sodium percentage, the prominent groundwater samples are suitable for irrigation except a three control wells (Table.5).

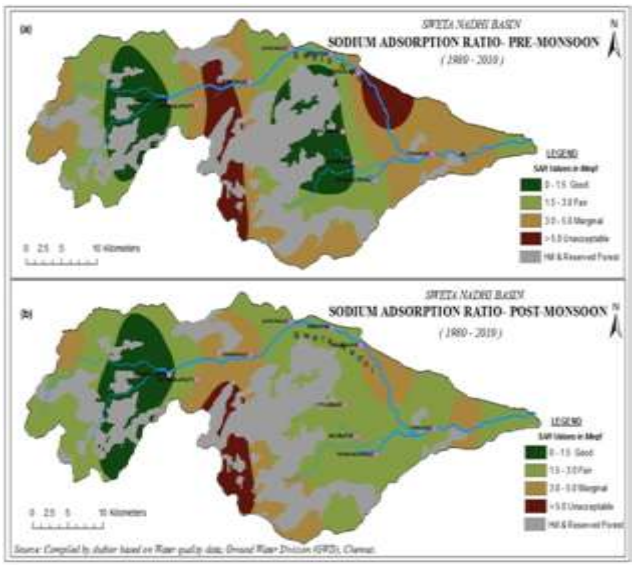

Fig. 8: Sodium Adsorption Ratio-(a) Pre monsoon (b), Post monsoon

Among the 34 control wells of the entire basin, the concentration of SAR ranges from 1.1 to 9.0 during pre-monsoon period. The 4 control wells fall in good water type (0 -1.5) during pre-monsoon period SAR ranges fair water condition in 18 control wells only reaming the control wells are marginal to unacceptable ranges in the study area. This condition nearly same during post monsoon season also. SAR good ranges found in Mid central and western central part of the study area, but post monsoon season, having good condition in the western central part of the study area (Fig.8 a&b).

G. Sodium Soluble Per Cent (SSP)

Irrigation with waters that have high concentrations of Na+ ion relative to divalent cations may cause an accumulation of exchangeable Na+ on soil colloids. Continued use of alkaline waters for irrigation in a closed system may have adverse effects on soil physical properties, deteriorate the soil and water resources of the region and affect the sustainability of crop production in the long run. Wilcox (1955) has proposed a classification scheme for rating irrigation water on the basis of sodium soluble percent. The scheme of classification proposed by Wilcox is given in Table.6.

Sl. No	Water Condition	Sodium Soluble Percent (SSP) in epm	Pre Monsoon	%	Post Monsoon	%
1	Excellent	0-20	1	3	2	6
2	Good	20-40	19	56	20	59
3	Permissible	40-60	13	38	11	32
4	Doubtful	60-80	1	3	1	3
5	Unsuitable	>80	-	-	-	-

*Source:Wilcox 1955

Table 6: Sodium Soluble Percent (SSP) condition of Sweta Nadhi Basin duringPre and Post monsoon seasons

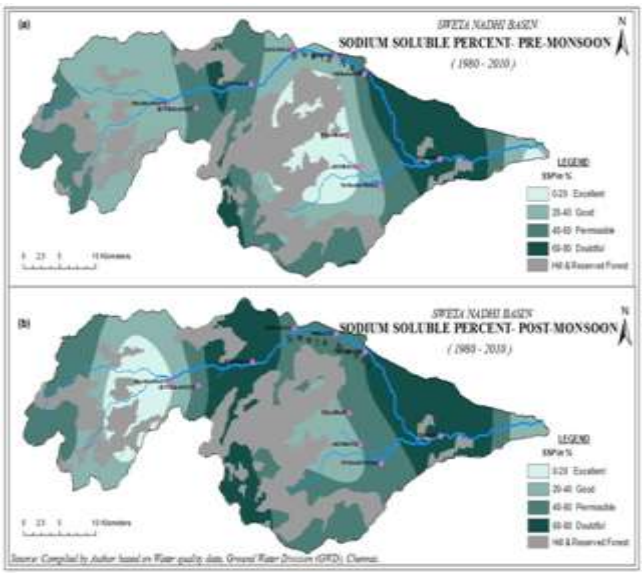

Fig. 9: SSP-(a) Premonsoon (b), Postmonsoon

Sodium Soluble Percent (*SSP*) is ranging from 20.4 to 78.4 epm in during pre-monsoon season and from 0 to 63.3epm in during post-monsoon season. Almost same condition in SSP ranges of control wells in both seasons (table.6). Excellent water quality found in the central part of the study area during the pre monsoon season and western central part of the study area found in excellent water quality during the post monsoon season (Fig.9 a&b). Majorly occupy SSP ranges of good and doubtful water quality in both seasons more less equally distributed the entire basin.

H. Residual Sodium Carbonate (RSC)

The water with high RSC has a high pH and land irrigated by such waters becomes infertile owing to deposition of sodium carbonate as known from the black color of the soil.

Sl. No	Water Condition	Residual Sodium Carbonate (RSC) in epm	Pre Monsoon	%	Post Monsoon	%
1	Good	<1.25	27	79	29	85
2	Doubtful	1.25-2.5	6	18	2	6
3	Unsuitable	> 2.5	1	3	3	9

*Source: Karanth 1987.

Table 7: Residual Sodium Carbonate (RSC) condition of Sweta Nadhi Basin

1) During Pre and Post Monsoon Seasons

According to the USSL, RSC value less than 1.25 meq/L is safe for irrigation, a value between 1.25 and 2.5 meq/L is of permissible quality and a value more than 2.5 meq/L is unsuitable for irrigation. RSC less than zero and are best suitable for irrigation purposes. Karanth (1987) has suggested that waters having carbonate and bicarbonate ions in excess of calcium and magnesium will lead to much greater alkaline formation than is indicated by its SAR and thereby decreasing the soil permeability(table.7).

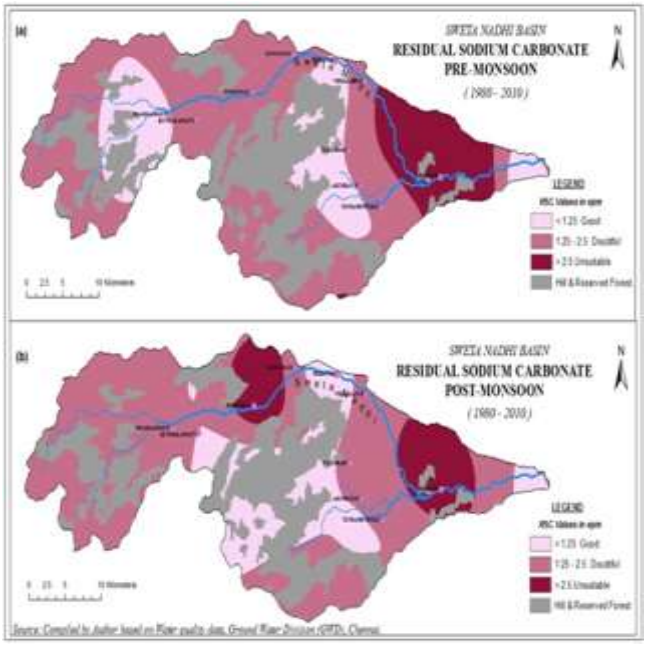

Fig. 10: RSC-(a)Premonsoon (b), Postmonsoon

I. U. S. Salinity Laboratory Water Classification

USSL Diagram for irrigation water quality Evaluation United State Regional Salinity Laboratory published in 1954a classification USSL diagram for classification of irrigation waters, with reference to SAR as an index of sodium (alkaline) hazard and EC as an index of salinity hazard. Electrical Conductivity in mmhos per centimeter at 25° C is plotted on the X axis against SAR on Y-axis and are shown in Fig. 11&12 for pre monsoon and post-monsoon seasons respectively. The significance and interpretation of the quality ratings on the diagram are summarized as for purposes of the two most significant parameters of sodium and salinity hazards indicate usability for agricultural purposes. USSL classification of groundwater in the study area determination SAR and EC, irrigation water can be classified into four categories only. The estimated values are tabulated. The plotting of the chemical data in the said diagram gives an idea about the groundwater suitability for irrigation and it would be possible to group the areas with good, moderate and bad waters.

Sl. No	Water Class	Category	Pre Monsoon		Post Monsoon		Descriptions
			No. of Wells	%	No. of Wells	%	
1	Good	C1S1	0	0	0	0	Low Salinity, water with low sodium water
		C2S1	2	5.9	1	2.9	Medium Salinity, water with low sodium water
		C3S1	24	70.6	27	79.4	High Salinity, water with low sodium water
		C4S1	4	11.8	1	2.9	Very High Salinity, water with low sodium water
2	Moderate	C3S2	1	2.9	0	0	High Salinity, water with Medium sodium water
		C4S2	3	8.8	5	14.7	Very High Salinity, water with Medium sodium water
3	Poor	Nil	Nil	Nil	Nil	Nil	Nil
4	Very poor	Nil	Nil	Nil	Nil	Nil	Nil
Total			34	100	34	100	

*Source: Classified by Author based on the USSL Classification (USSL, 1954).

Table 8: Water Quality Based on U.S.S.L Pre and Post-monsoon Seasons

J. Pre Monsoon Season

From the USSL pre monsoon diagram interpretation is given in the Figure.11 about 70.6 % of control wells falls under good quality zone but the C3S1defined as High Salinity water with low sodium water C3-cannot be used on soil with restricted drainage, special management for salinity control may be required and S1- can be used for irrigation on almost all soils with little danger of the development of harmful levels of exchangeable sodium. Sodium sensitive crops such as stone –fruit trees may accumulate injurious concentrations of sodium.

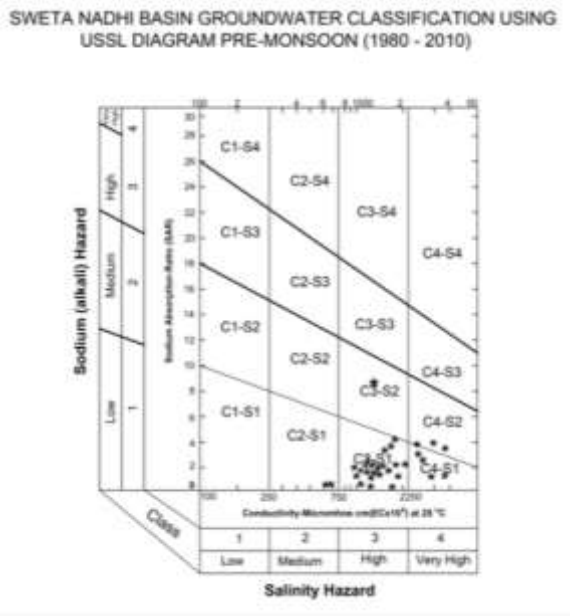

Fig. 11: USSL Diagram-Pre Monsoon

Next observed that about 11.1 % of control wells falling under C4S1 category its reveal that Very High Salinity water with low sodium water C4-is not suitable for irrigation under ordinary conditions but may be occasionally under special circumstances. The soil must be permeable, drainage must be adequate, very salt tolerant crops should be selected.

About 5.9 % of control wells falling under C2S1 category its are observed that Medium Salinity water with low sodium water, C2 –can be used if a moderate amount leaching occurs. Plants with moderate salt tolerance can be grown in most instances without special practices for salinity control that no need for any special management. Finally 30 control wells fall in under good water quality zone remaining 4 control wells fall in under moderate quality zone C3S2 and C4S2 during pre monsoon season.

K. Post Monsoon Season

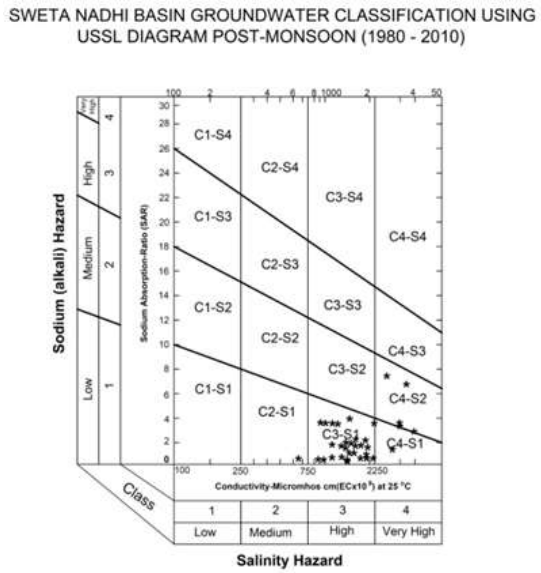

Fig. 12: USSL Diagram-Post Monsoon

The USSL post-monsoon shows appreciable changes in groundwater quality about 79.4 % of control wells fall in under good quality zone category C3S1. Remaining the C2S1and C4S1 equally shared by 2.9 % of only one well fall in under this category.

About 14.7 % of control wells fall in moderate zone belongs to C4S2 category, it's compared with pre monsoon increased this quality, condition Based on USSL methods of classification, the irrigation water is based on control wells of the basin area classified in table. 8.

In the USSL diagram of both pre and post-monsoon seasons, the level of electrical conductivity is generally good up to 2250 mmhos/cm and it is tolerable up to 4000 mmhos/cm and more than 4000 mmhos/cm and SAR less than 18 is generally good, 18 to 26 tolerable and more than 26 is beyond tolerable level for irrigated agriculture (Fig.12). In the USSL diagram the categories, namely C1-S1, C2-S1, C3- S1, C4-S1, C2-S2,C3-S2, C4-S2, C2-S3, C3-S3, C4-S3, C1-S4, C3-S4, C4-S4 and C5S4 are falling under three different classes shown in Table.8. Considering the category of good water, it includes C1-S1, C2-S1, C3-S1 and C4-S1 classes. The C2-S1 class in generally harmless for all crops, whereas all other types need remedial measures such as application of gypsum and good drainage. In the study area, C2-S1 type is observed in 2 control wells in during pre-monsoon season and only one wells in during the post monsoon season.

The EC value is more than 750 mmhos/cm in several locations. The alkalinity hazard is noticed in medium range and in one location, it is high i.e. the SAR value exceeds more than 18. The prevailing criteria to evaluate water quality and their associated potential hazards to crop growth are salinity and sodium hazards. The quality of groundwater of the study area can be evaluated on the basis of these criteria.

V. CONCLUSIONS

The present study reveals that the assessment of ground water quality retrogression is due to various reasons . In the present study, data were analyzed to understand the concentration of pH, electrical conductivity, Total Hardness and TDS and permeability index in the study area. The suitability of groundwater for irrigation purposes was assessed using USSL method. The pH ranges most of samples range between 7.0 to 9.1 in Pre Monsoon and 7.2 to 8.7 in Post Monsoon moderate to strong alkaline content in both the seasons. The hardness was found to be in the range of 0-190 mg/lit to 1056.5 mg/lit in Post-monsoon and 140 mg/lit to 1200mg/lit in Pre monsoon. In the basin having 91 % and 85 % of control wells very hard water during pre monsoon season and pre monsoon.

Sodium Soluble Percent (SSP) is ranging from 20.4 to 78.4 epm in during pre-monsoon season and from 0 to 63.3epm in during post-monsoon season. The groundwater samples fall in the USSL class C3 S1 class indicating low sodium hazards about 70.6 % of control wells falls under good quality zone during pre monsoon season and post-monsoon shows appreciable changes in groundwater quality about 79.4 % of control wells fall in under good quality zone. Finally, following villages are Keeripatti, Mettupalayam, Veeraganur, Pasumbalur, Vengalam, Tiruvilandurai, Gangavalli, Kallatukombai, Paithur, Thalugai, Pudupatti and Sendarappatti etc.. quality of ground water conditions indicated severe limitations and sodicity hazards from irrigation using ground water.

However, ground water of the study area was moderately hard and based on the seasonal variations were found to have significant influence in Sendarappatti control well only, another part of basin area no significance on the suitability of groundwater for irrigation uses in the study area.

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REFERENCES

[1] L. A. Richards, "Diagnosis and Improvement of Saline and Alkali Soils", Agriculture Handbook 60, US Department of Agriculture, Washington, DC, pp.160,1945.
[2] L.V. Wilcox, Classification and Use of Irrigation Waters", U.S. Department of Agriculture Circle, American Journal of Science, Vol, 8, No.3, pp. 123128, 1955.
[3] L.D. Doneen, "Notes on Water Quality in Agriculture", Water Science and Engineering, 1964.
[4] R. A. Freeze, and J. A. Cherry, " Groundwater: Englewood Cliffs", NJ, Prentice-Hall, pp.604, 1979.
[5] K.R.Karanth,"Groundwater Assessment Development and Management", Tata McGraw Hill publishing company Ltd., New Delhi, pp.725, 1987.
[6] I.M., Raghunath, "Groundwater", 2nd Edn., Wiley Eastern Ltd., New Delhi, India,1987.
[7] K.R. Karanth, "Groundwater Assessment, Development and Management", New Delhi: Tata McGraw-Hill. 154,1989.
[8] USSL, 1954. Diagnosis and Improvement of Saline and Alkali Soils. USDA Agr. Handbook N 60. Washington, D.C.
[9] BIS, "Indian standard specification for drinking water" B. S. 10500, 1991.
[10] F.S. Nakayama, and D.A. Bucks, "Water quality in drip/trickle irrigation" a review. Journal of Irrigation Science, 12, pp.187–192. 1991.
[11] S. N. Davis, and De Wiest, "Hydrogeology", John Wiley & Sons, New York, P. 463. 1996
[12] F. H. Koegelenberg, "Irrigation User's Manual", Chapter 5: Water. Agricultural Research Council, Silverton, South Africa, 2004.
[13] WHO, "International Standards for drinking water", World Health Organization, Geneva,2005.
[14] R. Kori, A. Saxena, and N. Upadhayay, " Groundwater quality Assessment of Mandideep Industrial area", National Seminar on Environmental & Development, Bhopal, 2006, pp-155.
[15] A.K. De, "Environmental Chemistry", New Age International Publishers, 4th Edition, New Dehli,pp. 245-252, 2002

