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Analysis of Groundwater Suitability for Irrigation Purpose Using Overlay Technique

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ABSTRACT

This study is employed in Sweta Nadi 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 results show that the class of groundwater for irrigation purpose (Highly suitable , Suitable, Moderately Suitable, Unsuitable and Highly unsuitable) that predominated in the study area, during pre and post monsoon seasons and were analyzed for hydro parameters such as (PH) Hydrogen ion concentration, (TH) Total hardness, (TDS) Total Dissolved Solids, (PI) Permeability index, (SSP) Sodium soluble percent, (EC) Electrical conductivity, (SAR) Sodium adsorption ratio and (RSC) Residual sodium carbonate. The important ratios and indices (PH, TH, TDS, PI, SSP, EC, SAR and RSC) are considered to evaluate the groundwater for agriculture purpose.

1. Introduction

Groundwater is main resource for agricultural, domestic, and industrial activities depends on it. Groundwater has more minerals concentration in comparison with surface water. The demand for groundwater in a study area requires detail consideration of availability and quality. However, a number of trace elements are found in water which can limit its use for irrigation, especially anion and cation variations determined by the water quality. Groundwater often consists of seven major chemical elements Calcium, magnesium, Chloride, Potassium, Sulphate and Sodium (Kelley, W. P.1940) and (Wilcox. L. V.1948). The control of water quality must be effective. High clean up costs for effluent treatment and the low general public awareness are the main reasons why an improvement in the situation is difficult to achieve (Mull et al. 1992). Evaluated the groundwater quality in the upper Gunjanaeru River basin, Cuddapah District, Andhra Pradesh, South India (Raju, 2007). Kumaresan *et al.,* (2006) have considered major ion chemistry of environmental samples around sub-urban of Chennai city. Jagdap *et al.,* (2002) and Sunitha *et al.,* (2005) classify the water in order to assess the water quality for various purposes. Class of groundwater quality for agriculture use based on salinity hazard was done according to the recommendation of Balachandar et al. (2010). Exercising irrigation action has an essential role to elevate irrigation production rate and to meet continuously increasing food demands of the growing population (Alemu and Desta 2017). WQI is a mathematical model studied to convert a lot of water quality variables into a single indicator value which represents the water quality level at a certain location and time (Rabeiy 2017; Boah et al. 2015).

2. Study Area

The Sweta Nadi basin lies in the districts of Namakkal, Salem, Tiruchirappalli and Perambalur of Tamil Nadu State. The Sweta River originates from the northern parts of Kolli hills in Namakkal District. It is located between 11^0 15' N and 11^0 45' N latitudes and 78^0 15' E and 78^0 58' E longitudes (as read from the survey of Indian Topographic sheets C44A6 (58 I/6), C44A7 (58 I/7), C44A10(58 I/10), C44A11(58 I/11) and C44A15(58 I/15) (Fig.1). The river originates from the northern parts of Kolli hills, a part of Manmalai, adjoining Kolli hills and Palakkadu Malai in Pachamalai. The total geographical area of the basin is 1,034.43 Sq.km (1,03,443 ha) within 82 Revenue villages. The study area is based upon the three major relief orders such as the hills, uplands, and the plains. The river runs over 116 kms from the west to the east, and joins Vellar River, which runs into the Bay of Bengal given in Figure 1.

3. 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. 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 parameters of PH, TH, TDS, PI, SSP, EC, SAR and RSC from 1980 to 2010 for both pre monsoon (July) and post monsoon (December) seasons. Weighted overlay analyses using GIS Software (Arc GIS 10.1), overlay operation using raster calculator and finally all data values are ranked and compiled by author then using weighted overlay analysis through the Arc GIS Software after that displayed results are Tables 1 & 2 and maps are given in Figure.2, 3, 4 and 5.

4. Results and discussion

Analysis of groundwater suitability for irrigation purpose using overlay technique

The groundwater suitability for irrigation has been analysed by applying the formula given below raster overlay techniques available in Arc GIS 9.3. the important ratios and indices (PH, TH, TDS, PI, SSP, EC, SAR and RSC) are considered to evaluate the groundwater for agriculture purpose. Further, these parameters are reclassified with ratings ranging from highly suitable to highly unsuitable.

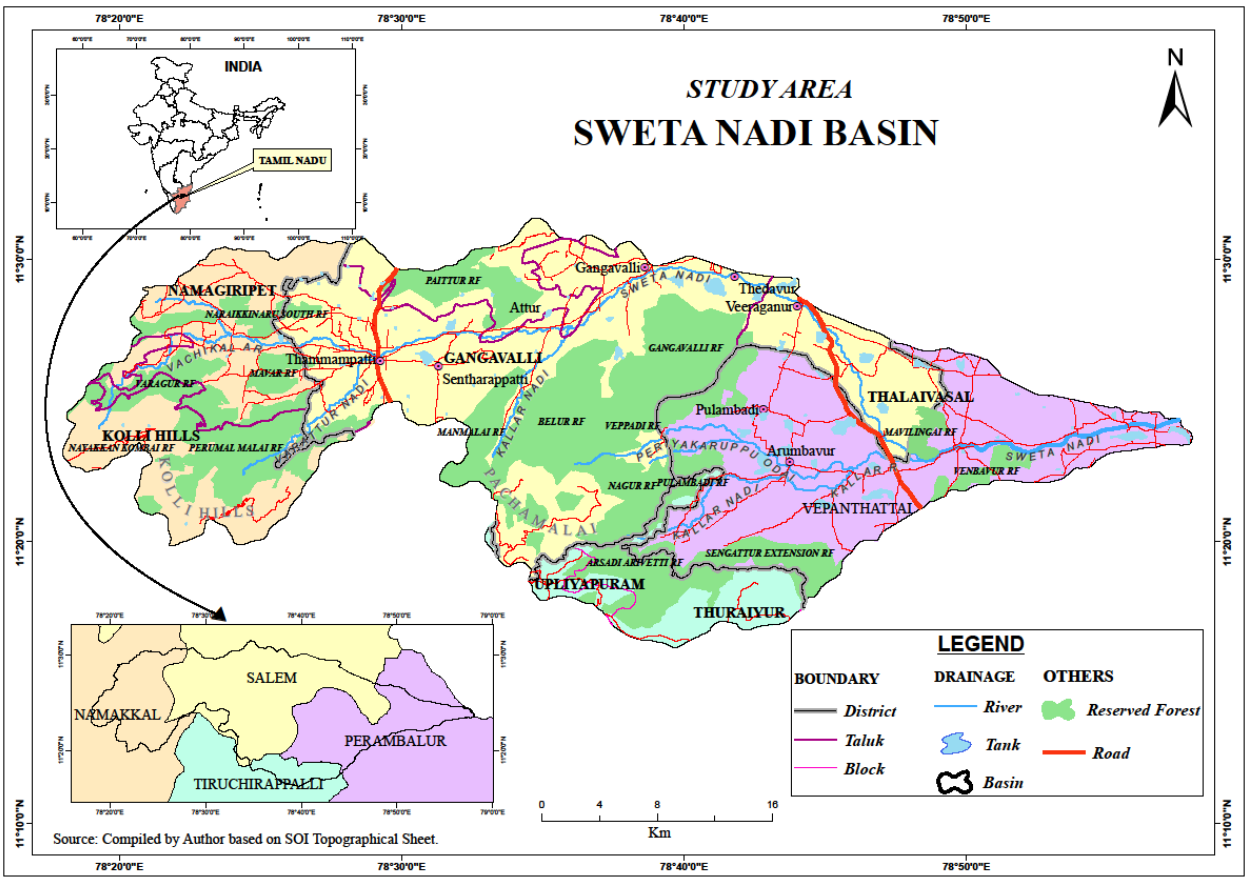

Figure 1 Study Area-Sweta Nadi Basin

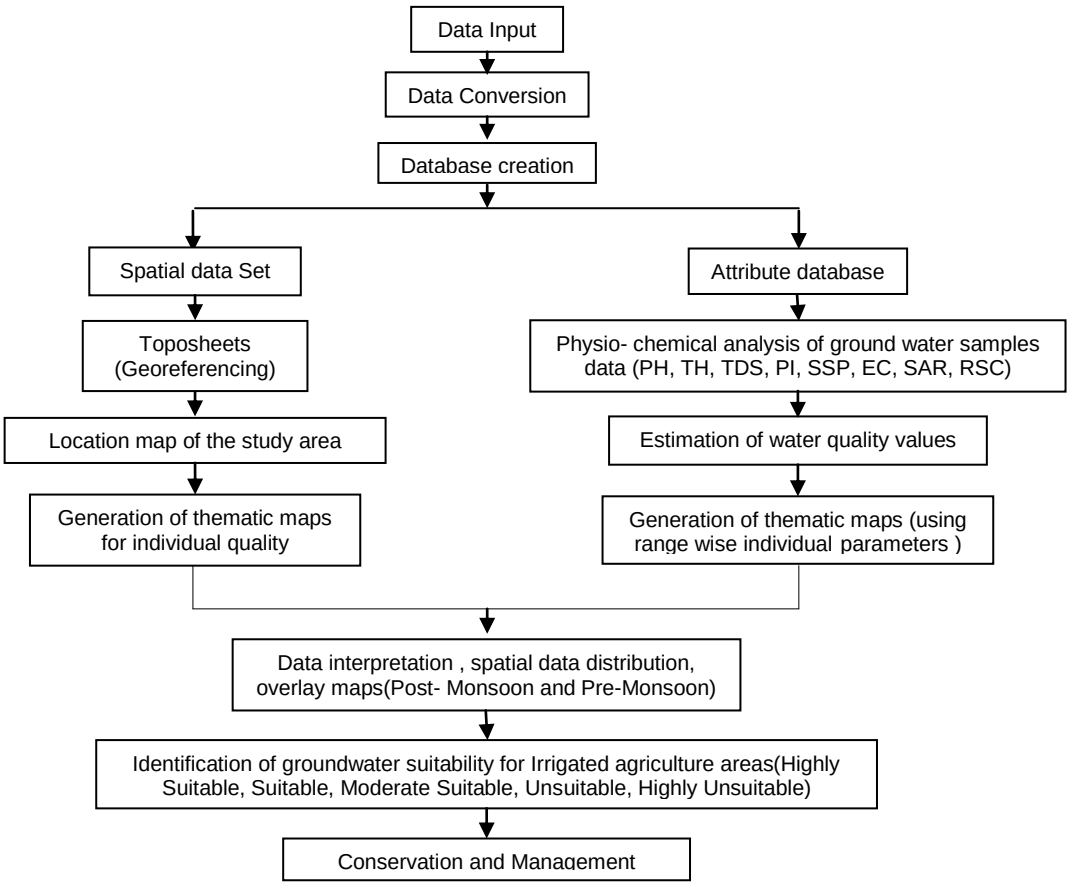

Figure 2 Flow Chart

The formulate given below is applied and the parameters are reclassified for overlay operation using a raster calculator (table 1)

$$IWQ_i = \sum_{i=1}^{8} (R_i)$$

Where, IWQ_i = Irrigation Water Quality Index for mapping unit

R_i = Rating factor for parameter

The overlay operation is carried out on different parameters and ratios to identify the suitability of groundwater quality for irrigation purpose. The area covered by highly suitable level of groundwater quality for irrigation purpose is observed in 39692 ha. of the study area (study area excluding hills and reserved forests) during pre and post monsoon seasons respectively. The highly suitable and suitable of ground water quality is identified in 53097 ha. (73 %) and 25394 ha. (34 %) of areas during pre and post monsoon respectively, and the moderately suitable level is found in 11051 ha.(15 %) and 32223 ha. (44 %) of areas during pre and post monsoon seasons respectively. During the pre-monsoon season, the unsuitable and highly unsuitable levels are found in 8996 ha. (12 %) of areas respectively. During the time of the post-monsoon season, the unsuitable and highly unsuitable levels are found in 15526 ha. (21 %) of areas respectively in the total area (study area excluding hills and reserved forests), (table 2).

Table-1
Parameters used in overlay analyses for irrigation water quality zones

Sl.No.	Parameters	Ranges	Pre Monsoon		Post Monsoon	
			Class	Ratings	Class	Ratings
1	TDS	1000mg/l	Good	9	Good	9
		1,000-3000	Moderate	7	Moderate	7
		3000	Poor	3	Poor	3
2	TH	0 – 50	Soft	10	Soft	10
		50- 100	Moderate Soft	8	Moderate Soft	8
		100 – 150	Slightly Hard	6	Slightly Hard	6
		150 – 200	Moderately Hard	4	Moderately Hard	4
		200 – 300	Hard	2	Hard	2
		> 300	Very Hard	1	Very Hard	1
3	SAR	0 - 1.5	Good	10	Good	10
		1.5 - 3.0	Fair	6	Fair	6
		3.0 - 5.0	Marginal	4	Marginal	4
		> 5.0	Unacceptable	2	Unacceptable	2
4	RSC	<1.25	Good	9	Good	9
		1.25-2.5	Medium	7	Medium	7
		> 2.5	Bad	3	Bad	3
5	PH	< 7.0	Minor	9	Minor	9
		7.0 - 8.0	Moderate	7	Moderate	7
		> 8.0	Severe	3	Severe	3
6	SSP	0-20	Excellent	10	Excellent	10
		20-40	Good	8	Good	8
		40-60	Permissible	6	Permissible	6
		60-80	Doubtful	4	Doubtful	4
		>80	Unsuitable	2	Unsuitable	2
7	EC	<250	Excellent	10	Excellent	10
		250-750	Good	8	Good	8
		750-2250	Permissible	6	Permissible	6

		2250-5000	Doubtful	4	Doubtful	4
		> 5000	Unsuitable	2	Unsuitable	2
8	PI	Class I	Very Good water	9	Very Good water	9
		Class II	Good water	7	Good water	7
		Class III	Bad water quality	3	Bad water quality	3

Source: Compiled by Author

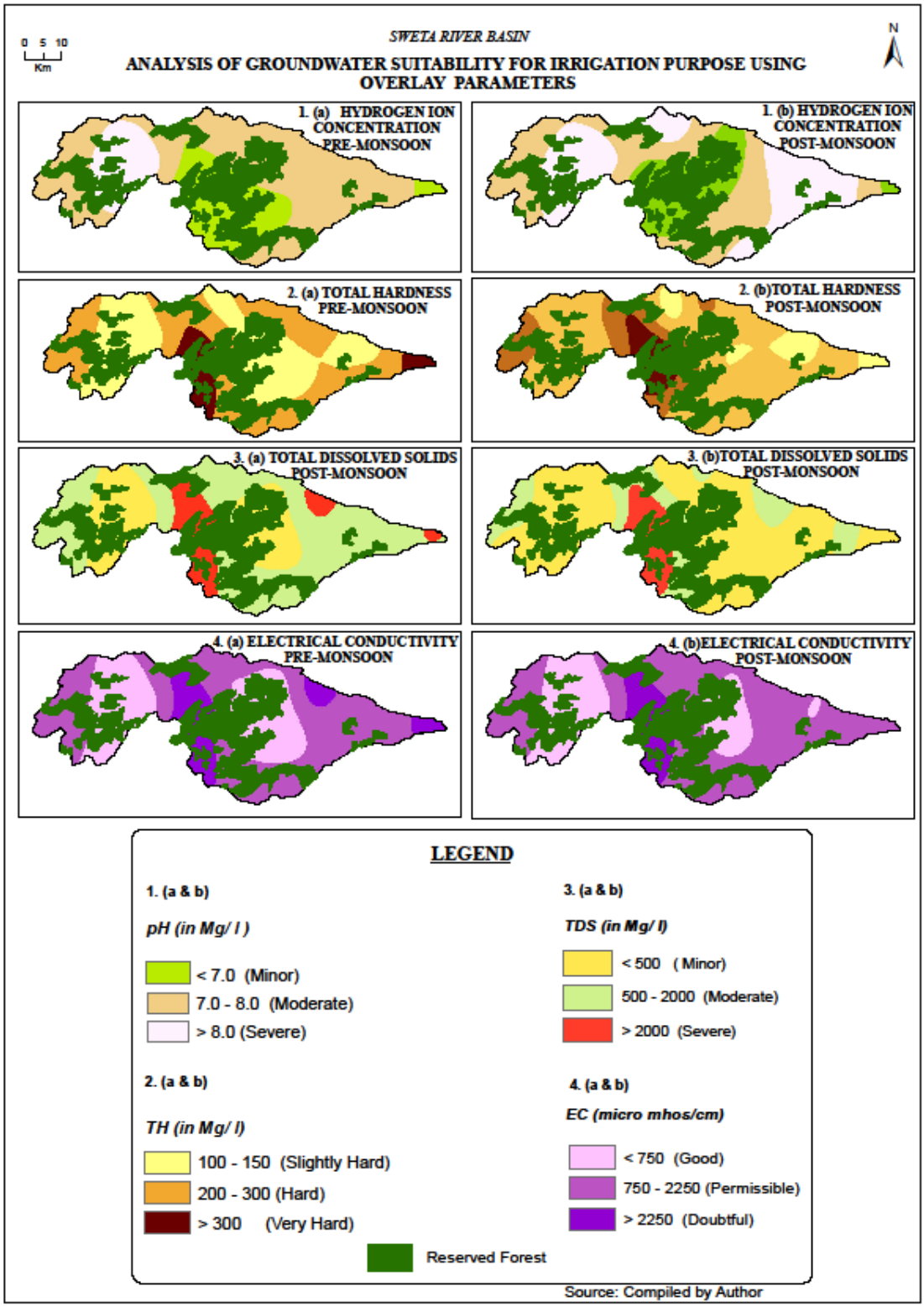

Figure 3 Analysis of Groundwater suitability for irrigation purpose using overlay parameters (pH, TDS, TH and EC).

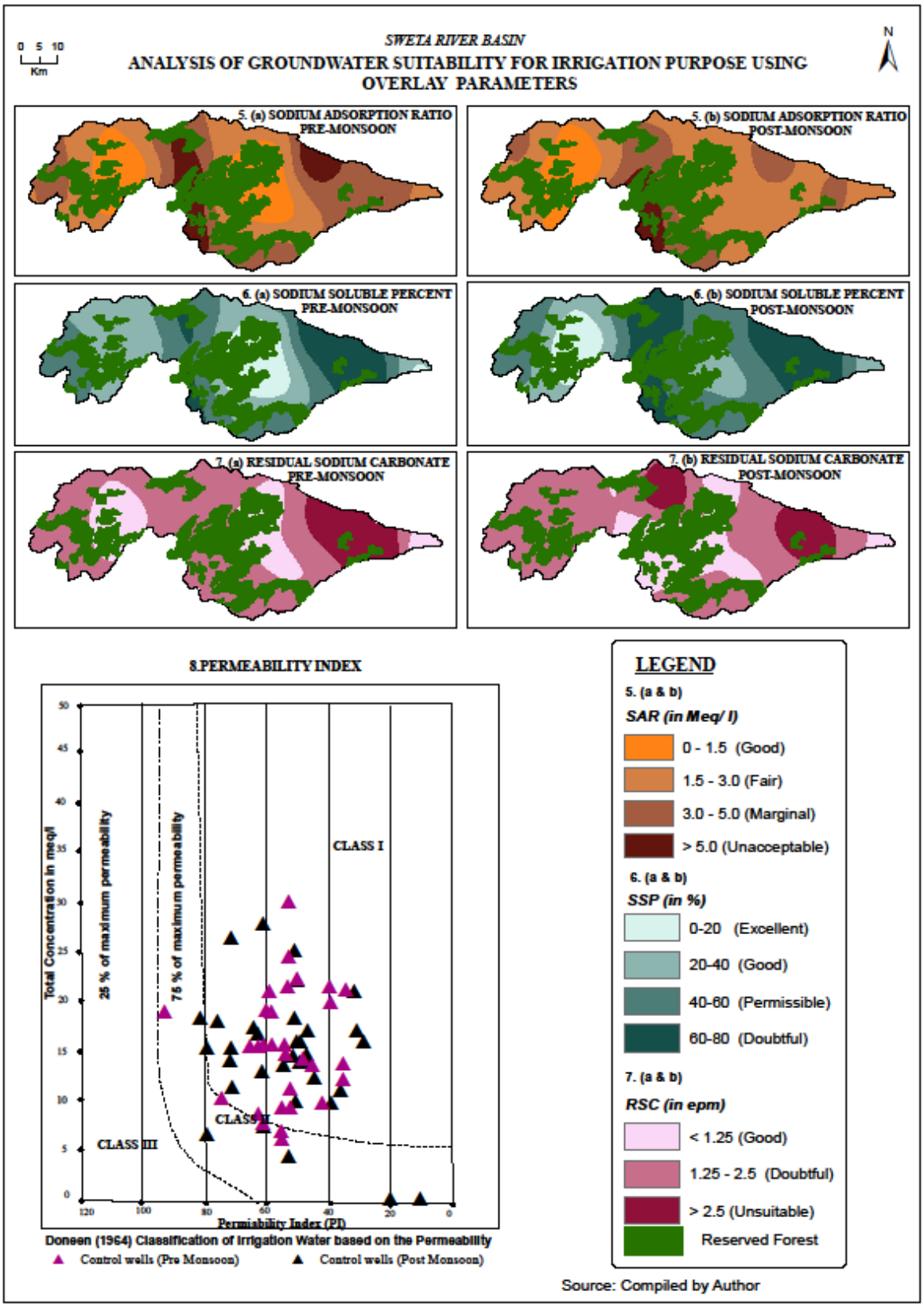

Figure 4 Analysis of Groundwater suitability for irrigation purpose using overlay parameters (SAR, SSP, RSC and PI).

Table-2
Groundwater Suitability for Irrigation Purpose during monsoon and post monsoon seasons of Sweta Nadi basin

Classification of groundwater for irrigation purpose	Spatial Extent of Dominance			
	Pre monsoon		Post monsoon	
	Area in ha.	% of Area	Area in ha.	% of Area
Highly suitable	21863	30	13484	18
Suitable	31234	43	11910	16
Moderately Suitable	11051	15	32223	44
Unsuitable	6014	8	10425	14
Highly unsuitable	2982	4	5101	7

Source: Compiled by Author

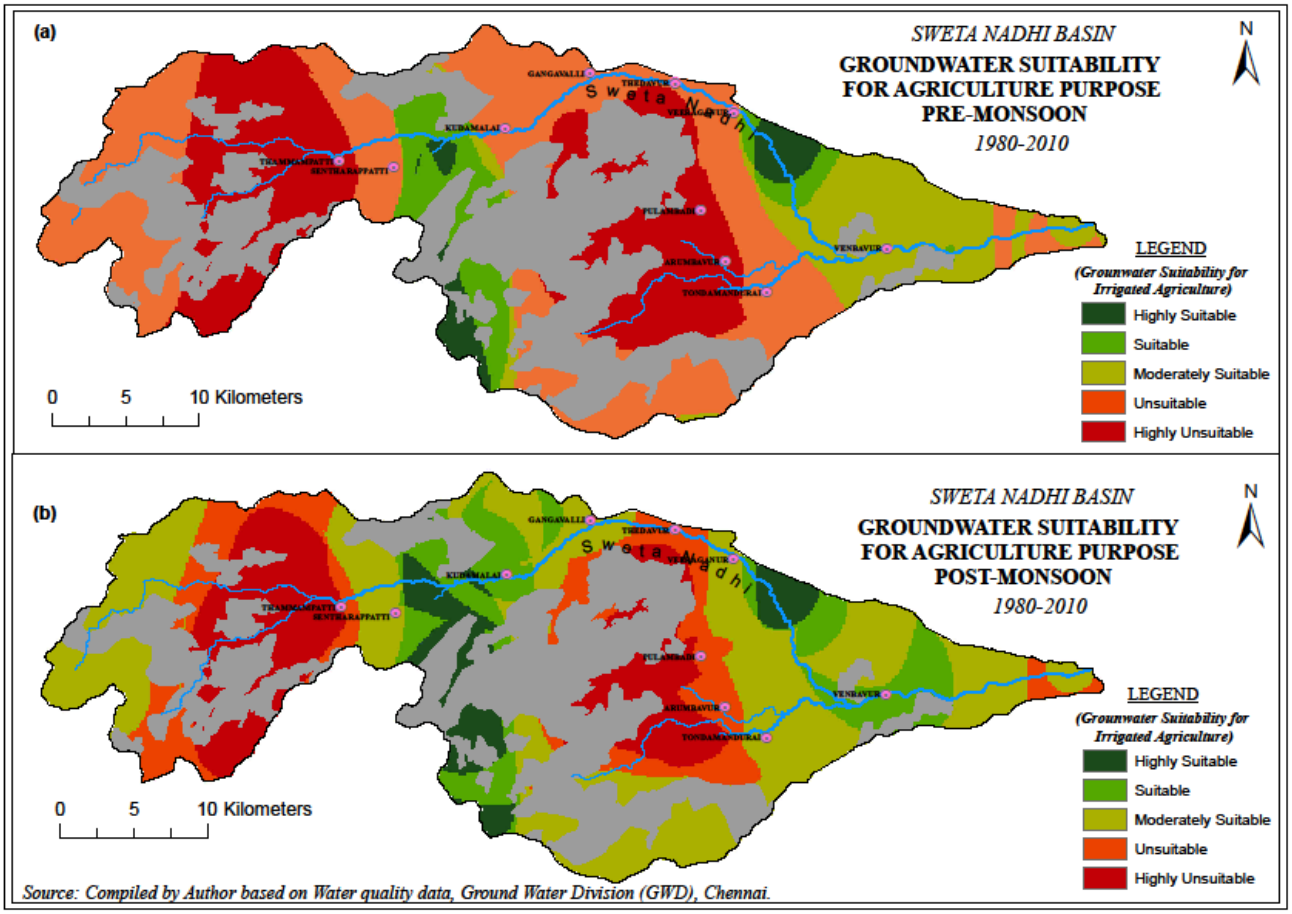

Figure 5 The Result Map of the Groundwater suitability for Agriculture purpose (Pre & Post Monsoon Seasons)-Sweta Nadi Basin.

5. Conclusion

Analysis of Groundwater suitability for irrigation purpose using overlay parameters determining (SAR, SSP, RSC and PI) suitability of groundwater quality for irrigation based on GIS tools and water quality index (WQI) is one of the main key issues for sustainable agricultural development. The present study area sweta river basin has been evaluated for their water quality parameters and suitability for agricultural uses. The overall view of the study area confirm that most of the water quality have for irrigation uses of highly suitable and suitable area in 30% and 43% in pre monsoon season, 18% and 16% in post monsoon season moderately suitable to highly unsuitable comes under 27 % in pre monsoon season and 65% in post monsoon season, which areas have unsuitable for irrigation poor water classes revealed by the WQI Studies. The finally the results were generated by weighted overlay analysis plotted in map format, its helps much easier for decision makers, water quality improvement management system makers and agricultural extensions in the river basin. The final result output map has been given in the representation of ground water quality in both seasons. The effort helps us to understand the quality of the water as well as to develop suitable for irrigation purpose practices to defend the ground water resources.

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