

Assessment of Sea Water Intrusion in Muthupettai Block

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ABSTRACT

Salt water intrusion into coastal aquifers is potentially a major problem in the coastal region of Muthupettai block in Thiruthuraipoondi taluk (Thiruvarur District, Tamil Nadu), hence in order to assess the vulnerability area, ground water study should be done. By the water quality variations sea water mixing index is assessed. Seawater mixing index is used to describe the vulnerability area and the extension of intrusion over the study area. Thematic maps of factors influencing the sea water intrusion were prepared and overlaid using Geographical Information System (GIS). By the vulnerability mapping, the suitable area for the remediation technique of sea water intrusion that should be practiced in the study area will be decided. Rain water harvesting and artificial recharge techniques are more useful as a tool in remediation of salt water intrusion. Estimation of surplus run-off is also very important in planning artificial recharge schemes.

Keywords: *Sea water intrusion, Aquifer vulnerability mapping, GIS, artificial recharge*

INTRODUCTION

Saltwater intrusion into a fresh water bodies affecting water quality, vegetation and soil condition hence it is consider as a global issue. Contamination of this fresh water resource with sea water becomes threatening for water supply of coastal communities and their economic development. The most important causes for the degradation of fresh water in coastal aquifers are (i) its close proximity to sea water, and (ii) the significant water demand associated with coastal areas whereby ground water is often the main source of drinking water. This issue of saltwater intrusion is not new and has been addressed by many researches in the world. Various techniques can be adopted for resolving the problem. Field studies and numerical simulations are useful for planning the development activities in the coastal region over the coming years.

Groundwater recharge is the replenishment of an aquifer with water from the land surface. It is usually expressed as an average rate of mm of water per year, similar to precipitation. Artificial recharge is one of the remedial measures to minimize seawater intrusion in coastal aquifers. Modern tools such as Geographical information system (GIS) can be extensively used in groundwater investigations and analysis for mapping purposes, based on the compiled database. GIS is used to delineate areas favourable for recharge both in hard rock and sedimentary environs and to recommend simple recharge structures.

METHODOLOGY

Saltwater intrusion in the coastal region is a major issue related with the water management. The Studies on Remediation mechanisms of seawater intrusion through the implementation of artificial recharge system is carried out. Generally the groundwater samples from the different wells are collected and the physical and chemical parameters are analyzed. Sea water mixing index is calculated for the study area in order to find out the vulnerable area of sea water intrusion in the proposed area. Feasibility study of remediation technique is conducted by calculated the run off of the study area and suggest the suitable remediation technique with the help of hydrogeological, hydrometeorological and hydrological studies. Artificial recharge method is a simple and effective method in the coastal areas for the effective recharge of the aquifer.

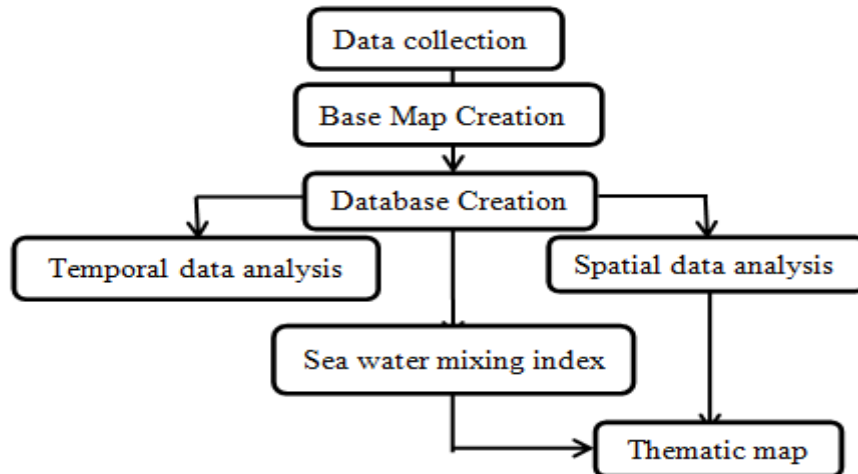


Figure 1 : Methodology flow chart

STUDY AREA

The study area is selected along the coastal zone of Thiruthuraipoondi taluk of Thiruvarur District which includes Koraiyar, Pamaniyar, Kandakurichan Channel, Kilaittangiar River, and Marakkakoraiyar River. The area forms part of Cauvery delta with gentle slope towards the Bay of Bengal. Muthupet mangrove forest is located at the southern end of the Cauvery delta, covering an area of approximately 13,500 ha of which only 4% is occupied by well-grown mangroves. At the tail end, they form a lagoon before meeting the sea. The zone is spread over an area of about 177 Km² and the Mullippallam creek covers an area of 11.4 Km². The study area lies between latitudes 10°16'00"N and 10°34'00"N and longitudes 79°30'00"E and 79°37'30"E. The area is bordered on the East by Koraiyar and Kandaparichanar, on the west by Marakkakoraiyar, on the south by Bay of Bengal coast.

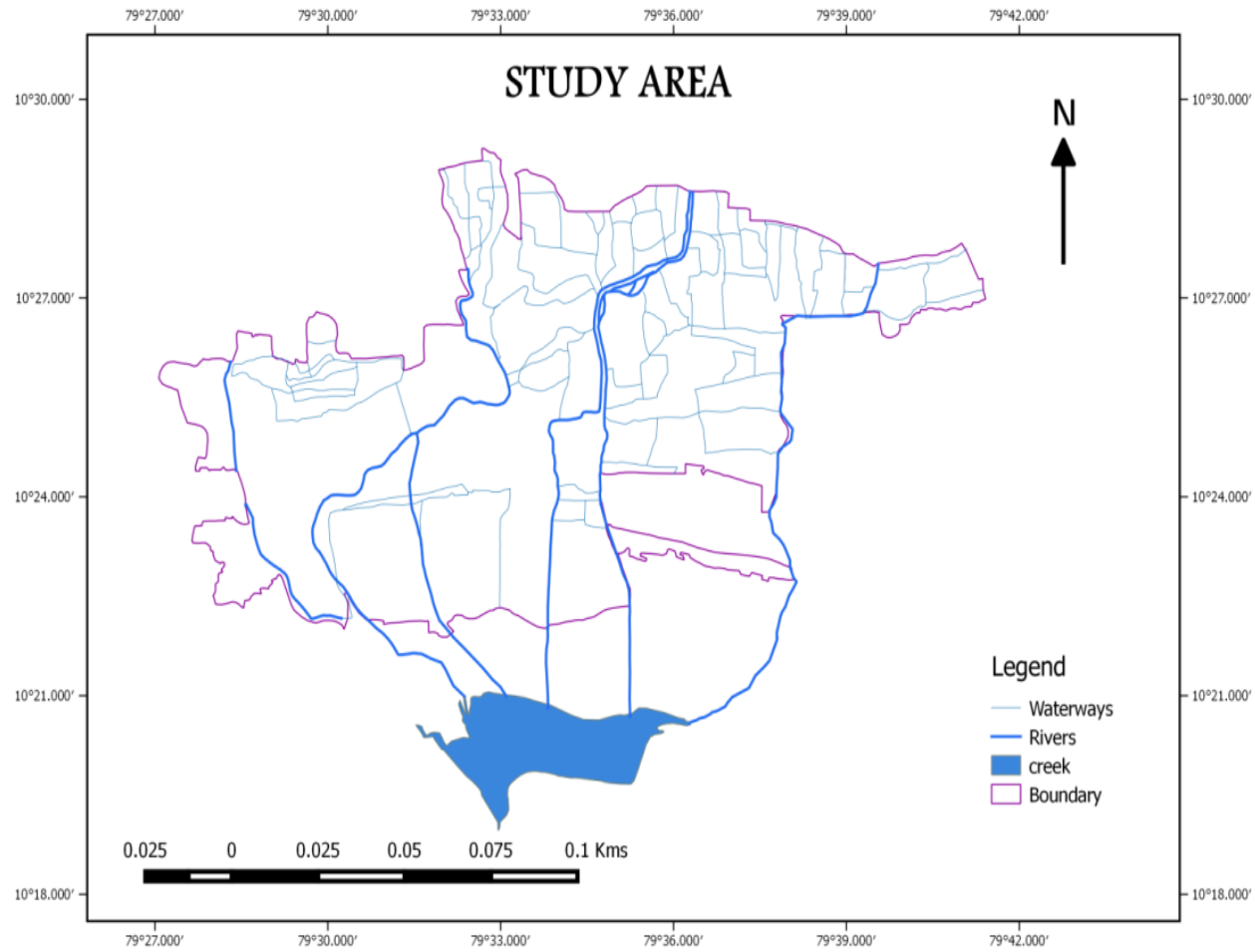


Figure 2 : Study area

DATA COLLECTION

The secondary data (Water level and water quality data) was collected from Central Ground Water Board, Ministry of Water Resources, and State Ground and Surface Water Data Resources Organization, Govt of Tamil Nadu. The secondary data includes the rainfall data from 1985 to 2015 and water quality data from 2004-2014. The water quality data I categorized in respective locations and database for the temporal variation is analysed.

Study area has been delineated from the Topo sheets (No 44th H7, H11) which is obtained from Survey of India. The base map is created in ArcGIS.

WATER QUALITY VARIATIONS

The water quality data collected from the CGWB is taken for the analysis comparing with the rainfall data. Graphs are drawn with parameters like TDS, EC concentration which are more responsible parameters for indicating the Seawater intrusion. The variation in the EC and TDS graph shows that the EC and TDS value is higher for Muthupet and Uppur when compared with the EC and TDS values of Sangandi from the fig 3 and 4 respectively.

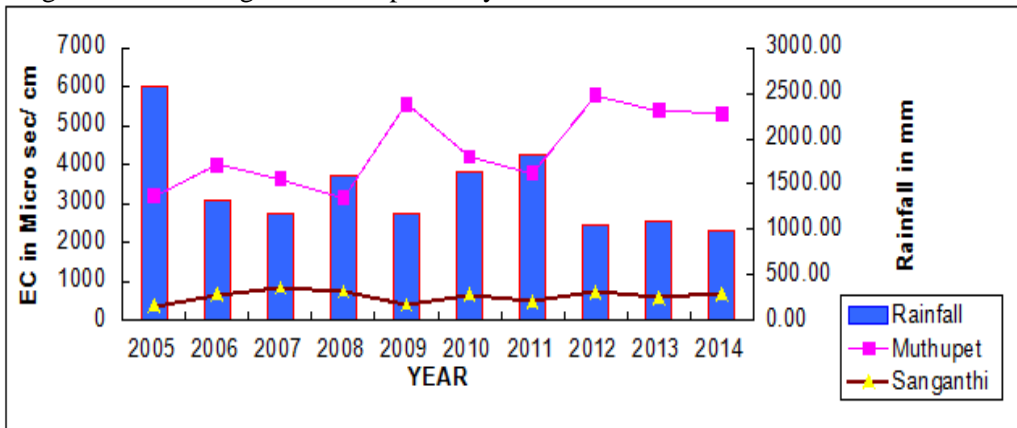


Figure 3 Variation of electrical conductivity from 2005 – 2014

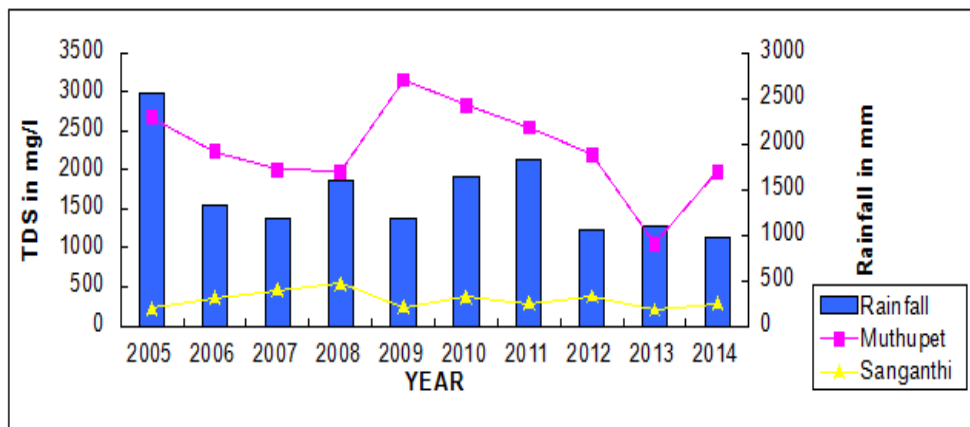


Figure 4 Variation of Total Dissolved solids from 2005-2014

SAMPLE COLLECTION

The water samples are collected at various areas in the study field, with an equal interval of 2degree 30 minutes. The details of the sample location are given in the figure 3.5. Totally 16 samples were collected. These samples are collected in Polyethylene containers and brought to the laboratory within 24 hours for further testing procedures of samples and analysis of water quality parameters.

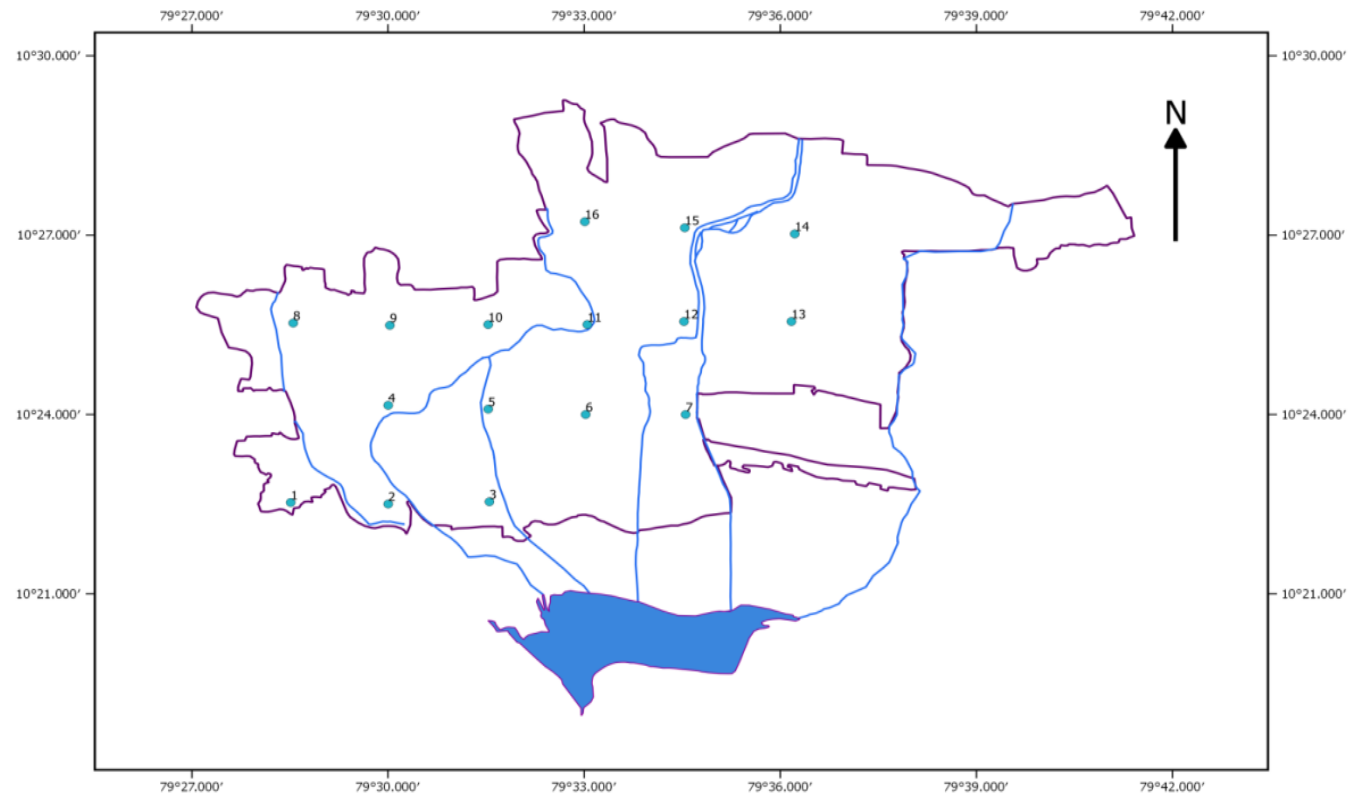


Figure 5 : Location of sample wells

Sample no	Village	Sample no	Village
1	M.K.Nagar	9	Uppur
2	Pettai	10	Kovilur
3	Jambuvanodai colony	11	Gopalamudram
4	Muthupettai	12	Palliyamodu
5	Viranvayal	13	Idumbavanam
6	Kaluvangadu	14	Kikkadau
7	Mel vadiyakadu	15	Sangandi
8	Pettavilamkottagam	16	Nachikulam

RESULTS AND DISCUSSION

a. Sea water mixing index The concentration of Na^+ , Mg^+ , Cl^- , SO_4^{2-} are used to calculate the sea water mixing index. It had been calculated using the following equation.

$$SMI = a \times \frac{C_{Na}}{T_{Na}} + b \times \frac{C_{Mg}}{T_{Mg}} + c \times \frac{C_{Cl}}{T_{Cl}} + d \times \frac{C_{SO_4}}{T_{SO_4}}$$

Where, Constants a, b, c and d denotes a relative proportion of Na^+ , Mg^+ , Cl^- , SO_4^{2-} respectively, there values are (a = 0.31, b = 0.04, c = 0.57, d = 0.08), T is the regional threshold values and C is the calculated Concentration of groundwater samples.

S.NO	VILLAGE	SMI	NATURE OF WATER	S.NO	VILLAGE	SMI	NATURE OF WATER
1	M.K.Nagar	3.189	SALINE	9	Uppur	6.739	SALINE
2	Pettai	2.604	SALINE	10	Kovilur	1.304	SALINE
3	Jambuvanodai colony	3.667	SALINE	11	Gopalamudram	1.507	SALINE
4	Muthupettai	7.144	SALINE	12	Palliyamodu	0.818	FRESH
5	Viranvayal	2.714	SALINE	13	Idumbavanam	0.805	FRESH
6	Kaluvangadu	0.978	FRESH	14	Kikkadau	0.802	FRESH
7	Mel vadiyakadu	0.762	FRESH	15	Sangandi	0.400	FRESH
8	Pettavilamkottagam	1.190	SALINE	16	Nachikulam	0.583	FRESH

b. Spatial Variation maps

The variations of the water quality for the study area from the 16 wells are studied using ArcGIS. The spatial variation of TDS, Cl and EC for the pre-monsoon and post monsoon seasons are shown. Because, statistical analysis proves that EC, Cl and TDS are the best indicators of sea water intrusion.

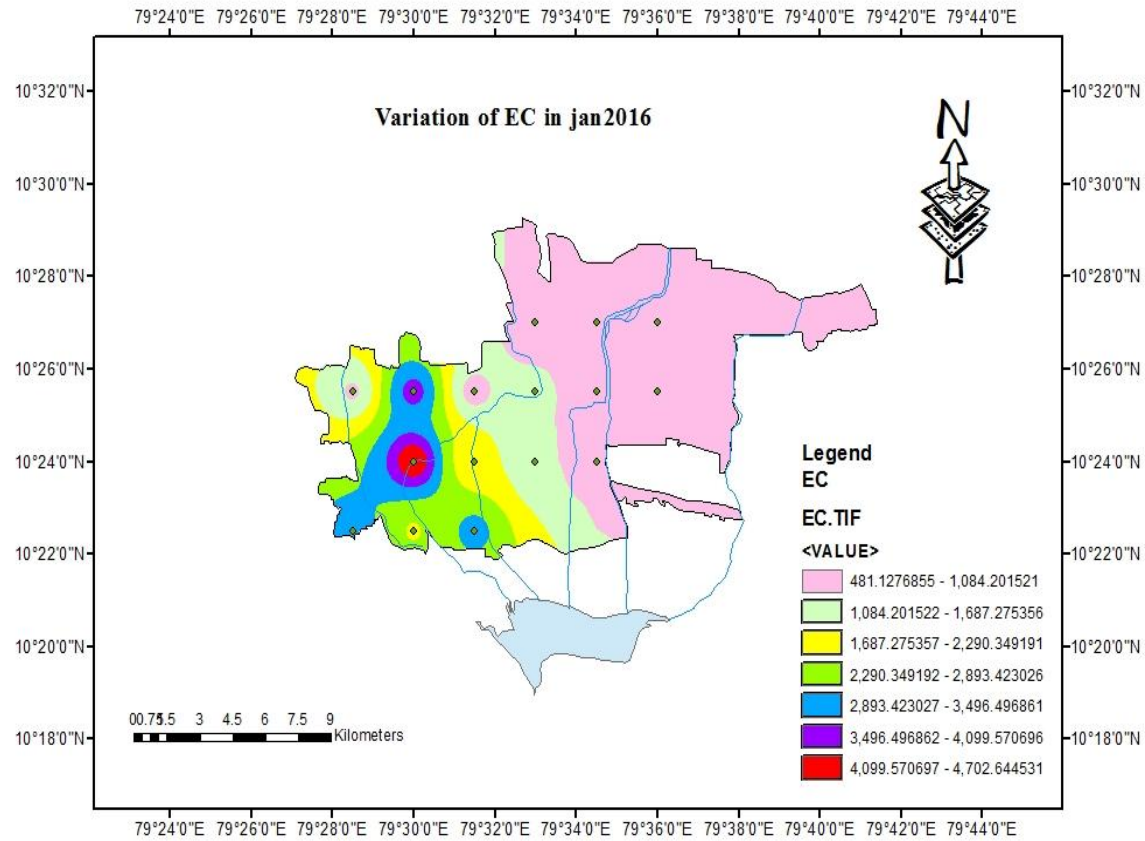


Figure 6 : spatial variation map of EC

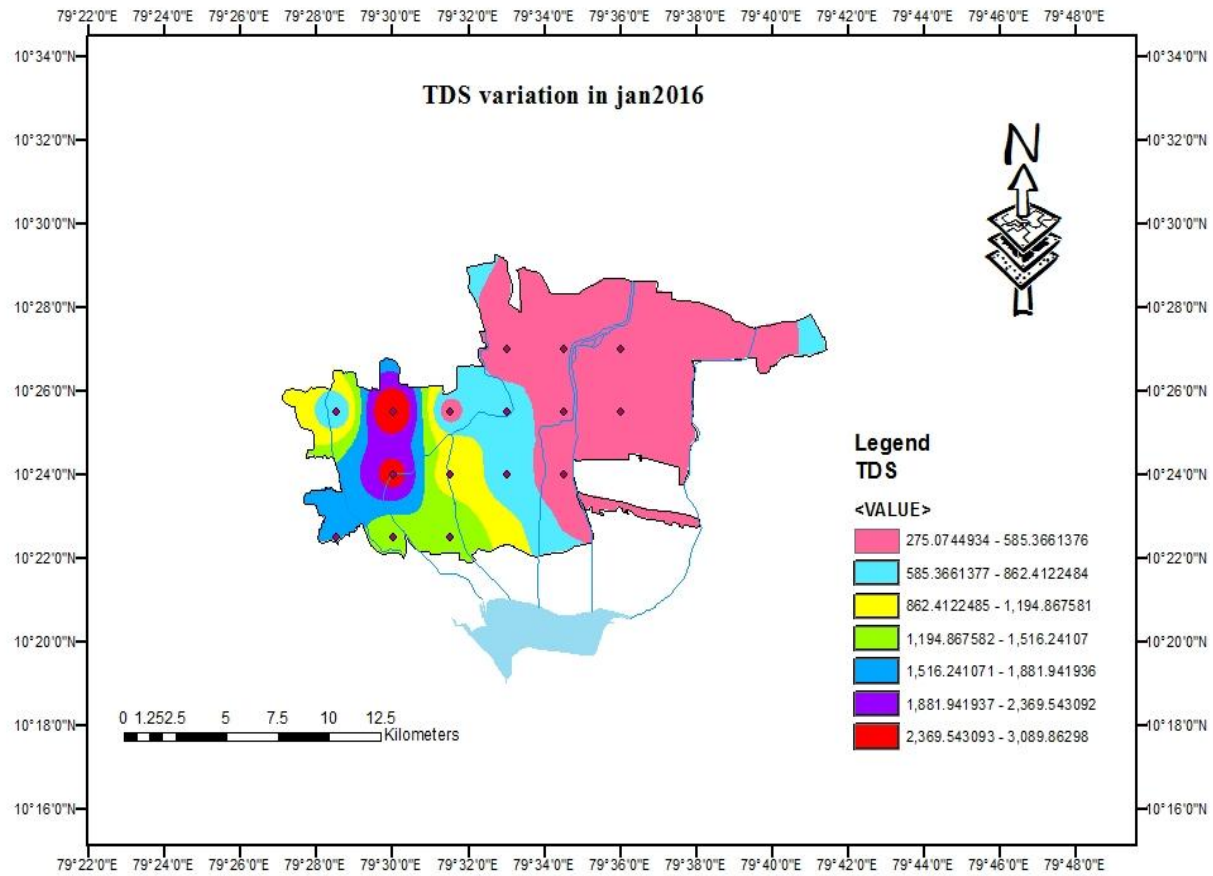


Figure 7 : Spatial variation map of TDS in the study area

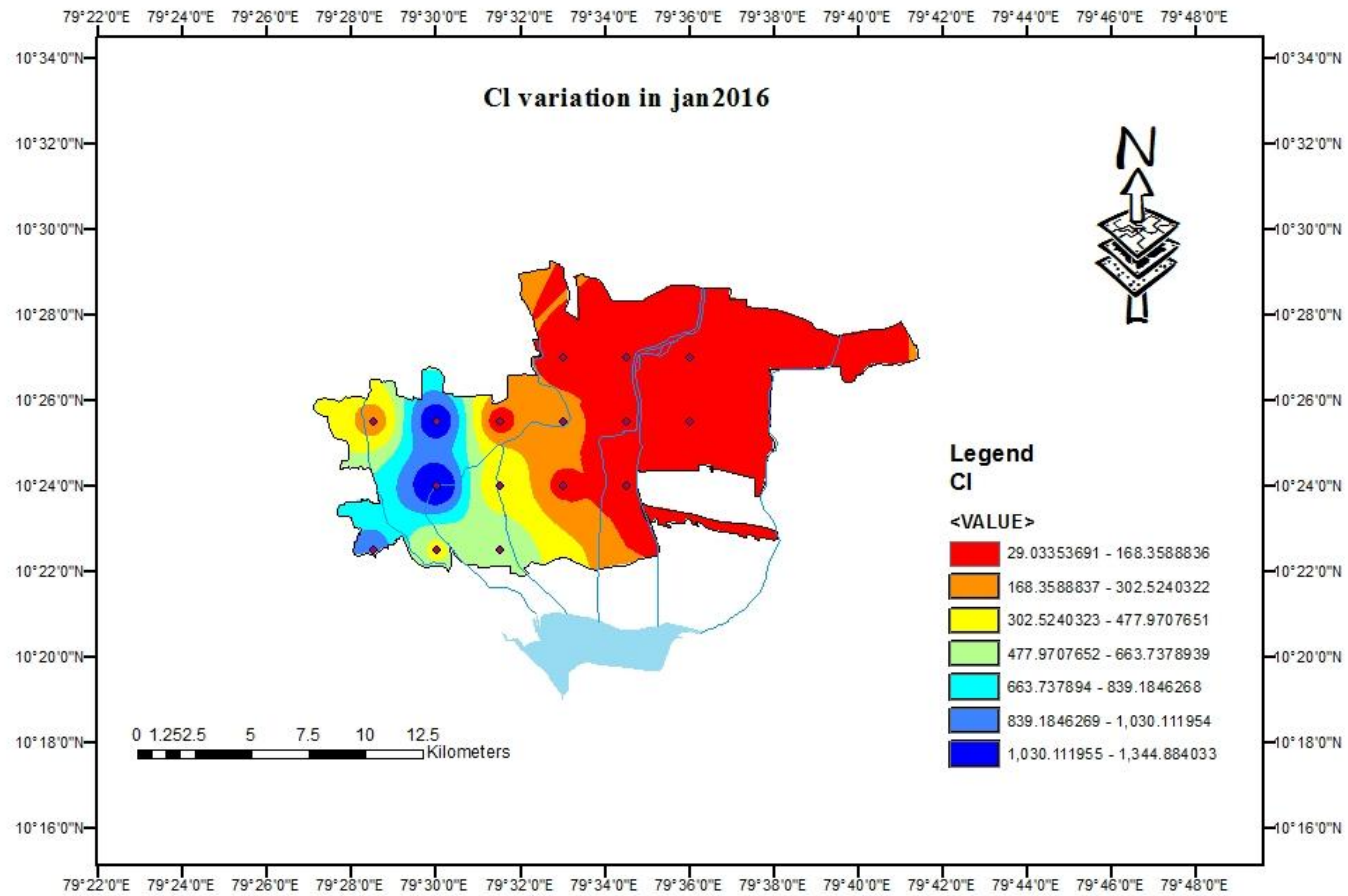


Figure 8 ; Spatial variation map of CI in the study area

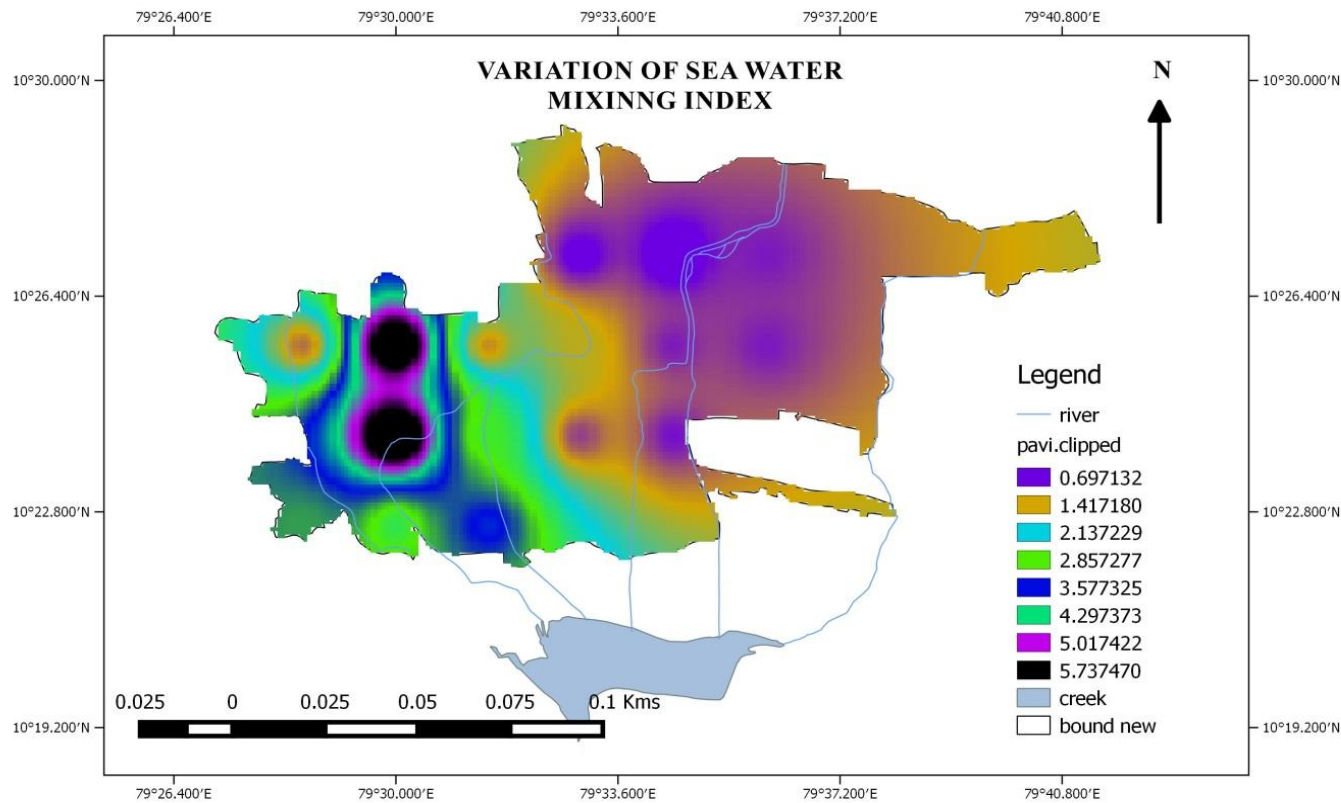


Figure 9 : variation of SMI in the study area

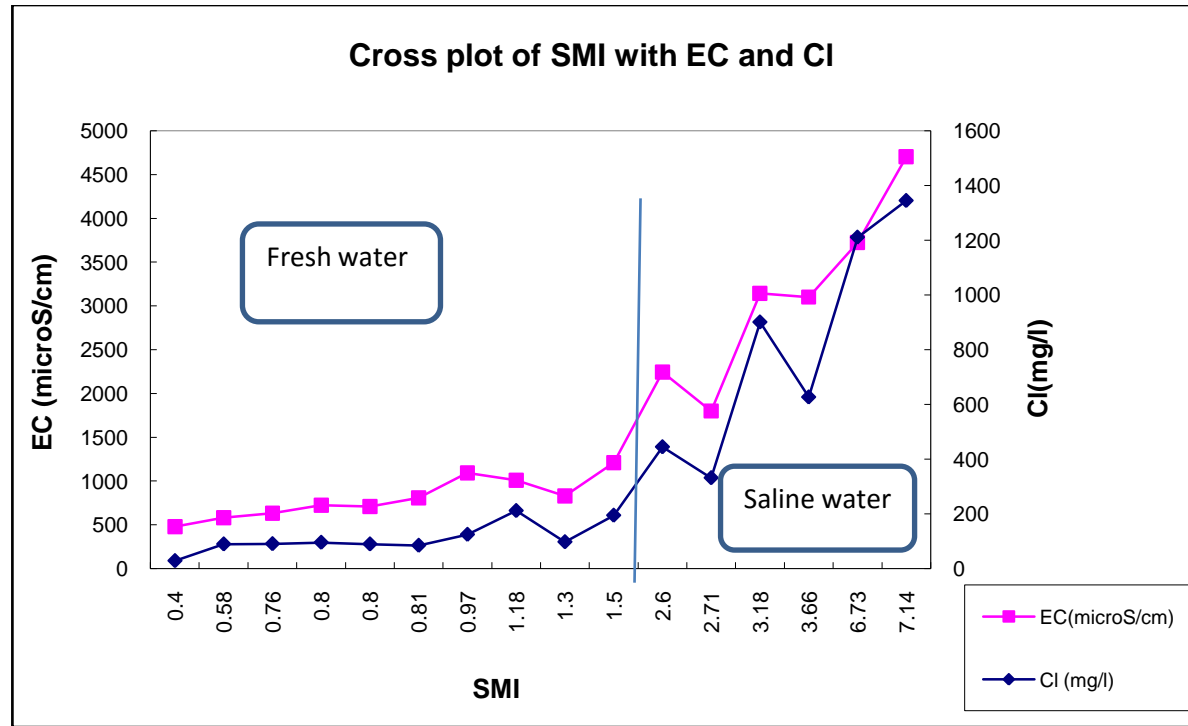


Figure 10 : Cross plot of SMI with EC and cl

CONCLUSION

The sea water mixing index shows that most of the areas in the Muthupettai block are intruded with sea water. From the temporal and spatial analysis it is concluded that uppur village and Muthupettai town prone to higher vulnerability to sea water intrusion. Even both the areas have been similar in site characteristics; uppur village is selected for the construction of artificial recharge structure, because it has enough field area for the construction procedure when compared to Muthupettai.

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