Nature Environment and Pollution Technology © Technoscience Publications	Vol. 6	No. 4	pp. 583-588	2007

SPATIAL ANALYSIS OF GROUNDWATER QUALITY IN THE TSUNAMI AFFECTED COASTAL AREAS OF TAMILNADU, INDIA

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ABSTRACT

Groundwater is a precious resource lying beneath the earth's surface. More than 50% of Indian population depends on groundwater for drinking water supplies. Problems due to groundwater pollution have been amplified due to urbanization, industrialization, solid and hazardous waste disposal, fertilizers, chemicals, and natural calamities such as cyclones, earthquakes and tsunami etc. In India, recent tsunami has affected most of the coastal regions of Tamilnadu. Therefore, it is very important to study the effect of tsunami on coastal water quality and to implement necessary water management strategies for sustainable development.

The study area is the coastal region of Sirkazhi taluk, Nagapattinam district, Tamilnadu, India. The water quality in this coastal region has been affected significantly by December 26, 2004 tsunami, and this study has attempted to find out the source, degree, extent and nature of the groundwater pollution in the study area. Historical data on groundwater quality of observation wells of the study area were collected from the year 1970 to 2000. Groundwater samples after tsunami were collected from the study area and analysed for water quality parameters. Various maps were prepared using ILWIS-GIS package. It was observed that the major pollution is due to conductivity, sodium and chloride. Results show that there is significant degradation in the water quality due to tsunami in the study area. A micro level study is to be carried out to manage efficiently the groundwater quality of the study area for sustainable development.

INTRODUCTION

As nearly one fifth of all the water used in the world is obtained from groundwater resources and in many areas groundwater is the only freshwater source available, protection of groundwater quality has become a high priority management goal (Singh & Anand 1991). The increasing trend of domestic, industrial and agricultural needs prompts the exploitation of groundwater and hence its budgeting occupies a key position in any national plan (Gupta 1981). Groundwater forms a major source of drinking water supply for urban and rural people of India. It is now generally recognized that the quality of groundwater is just as important as its quantity. Since quality of public health depends to a greater extent on the quality of drinking water, it is imperative that in-depth information about the quality of drinking water should be systematically collected and monitored. The Objective of this paper is to find out the source, degree, extent and nature of the groundwater pollution in coastal region due to recent tsunami and to show the application of GIS and kriging technique to interpolate the groundwater quality in tsunami affected areas of Sirkazhi taluk, Nagapattinam district, Tamilnadu, India.

STUDY AREA

The study area is the Sirkazhi taluk coastal region, which is part of Nagapattinam district, situated in the south of Tamilnadu State, India. It lies between latitudes of N 11º6' and N 11º27' and longitudes between E 79º36' and E 79º54'. It is located in the east coastal region of Bay of Bengal. Figs. 1 and 2 show the study area with sample locations after tsunami and before tsunami respectively.

MATERIALS AND METHODS

The historical data (1970-2000) on water quality for four observation wells during premonsoon season (July) were collected from Groundwater Division, Tamilnadu. The sampling locations of the observation wells are namely Pudupattinam (43052), Sirkali (43031), Tirumullaivasal (43032), Cauveripoompattinam (43015) as shown in Fig. 2. Groundwater samples were also collected from 11 wells after the tsunami whose locations are Pazhyar 1, Pazhyar 2, Dharkaz, Madavaimedu, Puthupattinam 1, Puthupattinam 2, Kotiyamedu, Thandavankulam, Thirumullaivasal, Thoduvai and Koozhaiyar as shown in Fig. 1. Samples were analysed for pH, EC, Cl, Na, hardness, dissolved oxygen, % salinity, turbidity, TDS, nitrite, nitrate, Ca, Mg and Fe. Various maps using GIS software-ILWIS 3.2 Academic, ITC, RSG/GSD, JAN 2004 were prepared to spatially locate the polluted areas.

RESULTS AND DISCUSSION

The results of water quality parameters of the 11 samples are presented in Table 1. The results were compared with World Health Organization (WHO) and Bureau of Indian Standards (BIS) drinking water quality standards.

Table 1: Groundwater quality parameters of the study area (after tsunami).

Sl No	Date of Sampling	Name of the sampling place	Distance from seashore	pH	EC mmhos	Cl (mg/L)	Na (mg/L)	Hard ness (mg/L)	Sali nity (%)	Turbi dity (NTU)	DO (mg/L)
1	09.01.2005	Pazhyar 1	150 m	6.71	10.10	3058	1300	1900	8	Nil	6.7
2	09.01.2005	Pazhyar 2	800 m	6.72	11.86	2321	1310	2000	10	Nil	6.2
3	09.01.2005	Dharkaz	1000 m	6.77	2.65	1547	610	652	3	Nil	7.5
4	09.01.2005	Madavamedu	300 m	6.58	4.24	1400	840	888	3	43	7.3
5	09.01.2005	Pudupatinam 1	3000 m	7.07	0.541	160	70	264	0	Nil	7.3
6	09.01.2005	Pudupatinam 2	3000 m	6.69	0.781	140	180	292	0	15	7.5
7	09.01.2005	Kotiyamedu	100 m	7.03	5.45	1760	780	980	4	Nil	7.7
8	09.01.2005	Thandavankulam	1000 m	6.77	0.622	160	70	272	0	Nil	7.7
9	09.01.2005	Tirumullaivasal	100 m	6.50	1.236	230	240	328	2	Nil	7.0
10	09.01.2005	Thoduvai	800 m	6.64	4.72	1360	590	1040	4	Nil	7.4
11	09.01.2005	Koozhaiyar	500 m	6.70	4.01	1300	560	648	3	9	7.8

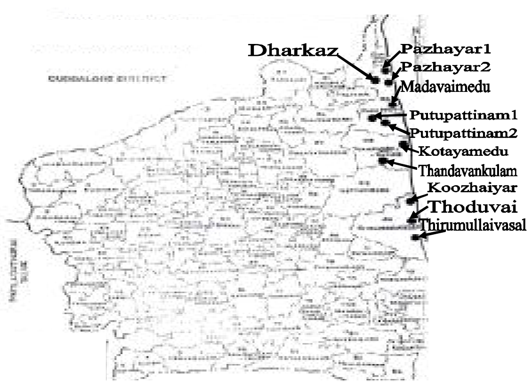

Fig. 1: Study area with sample locations (after tsunami).

Fig. 2: Study area with sample locations (before tsunami).

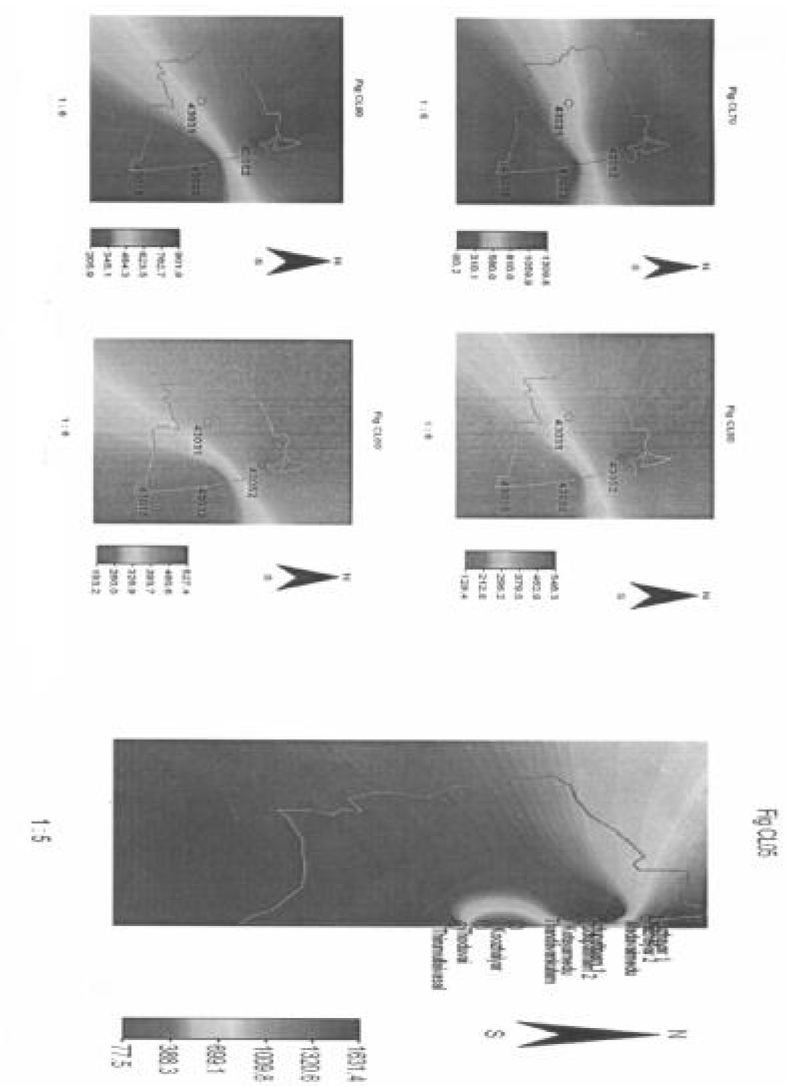

Fig.. 3: Water quality parameter – Chlorine (mg/liter), 1970 -2005.

Pictorial representation of water quality parameters using ILWIS-GIS package are presented in Figs. 3 to 6. The results show that the pH ranges from 8.3 to 8.5 (1970), 7.7 to 8.3 (1980), 8.3 to 8.9 (1990) and 8.5 to 8.9 (2000). But in the year 2005 (after tsunami) it ranges from 6.5 to 6.9. Therefore, it is concluded that after tsunami the water quality has become more acidic. Natural water contains low chloride. Higher concentration of chloride in water is often found in conjunction with sodium concentration. WHO and BIS have prescribed 250 mg/L as the maximum permissible value. If the chlorine value exceeds 300 mg/L and the presence of major cation is sodium the water becomes salty. With reference to the Fig. 3, it is observed that the chloride content before tsunami was highest at 1300mg/L (1970). But in the year 1980, 1990 and 2000, it is 546mg/L, 900mg/L and 527 mg/L respectively. But after tsunami its highest value was 1600mg/L.

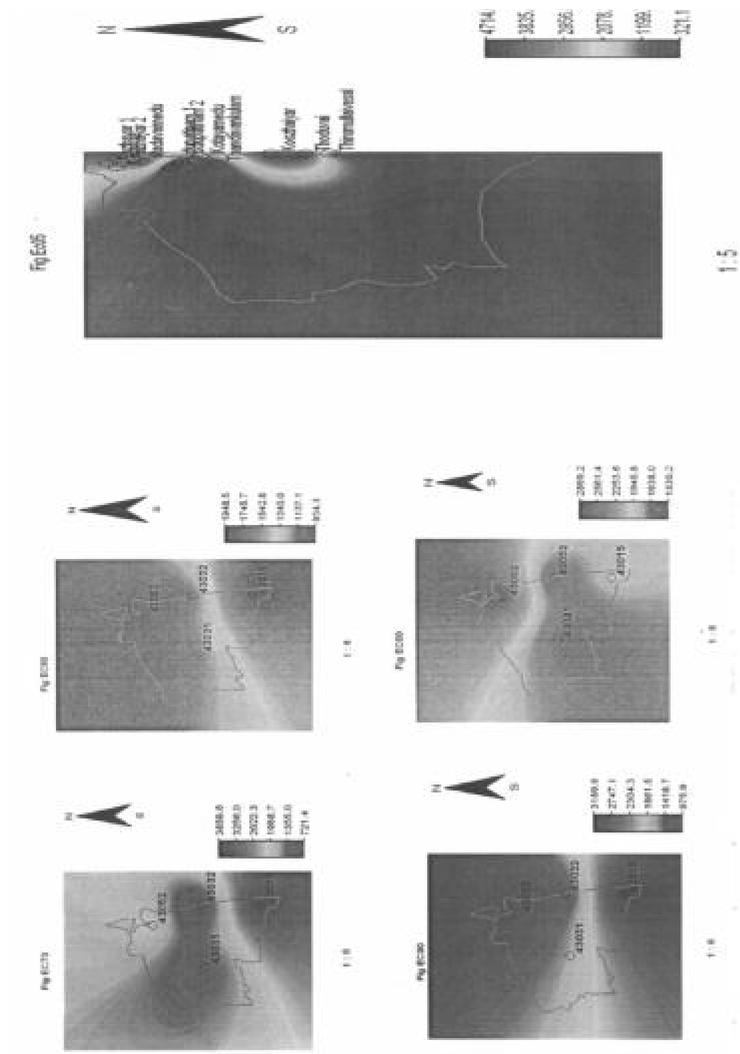

Fig. 4: Water quality parameter – EC (mhos), 1970 -2005.

Hardness is defined as the sum of the polyvalent cations present in the water, notably calcium and magnesium. In the present study, the hardness varied between 264 and 2000 mg/L. WHO has fixed 150 mg/L as the standard value, while BIS has fixed 300 mg/L as the limit for hardness. Puthupattinam 1, Puthupattinam 2 and Thandavankulam are the places where hardness values are below 300 mg/L while other places have higher hardness values.

The Electrical conductivity is the parameter, which influence crops. The present study shows that the EC ranges from 0.571mmhos to 11.16 mmhos. Puthupattinam 1, Puthupattinam 2 and Thandavankulam have shown less concentration of salts as compared to others. Sodium concentration is an important factor in classifying irrigation water. High level of sodium inhibits soil permeability.

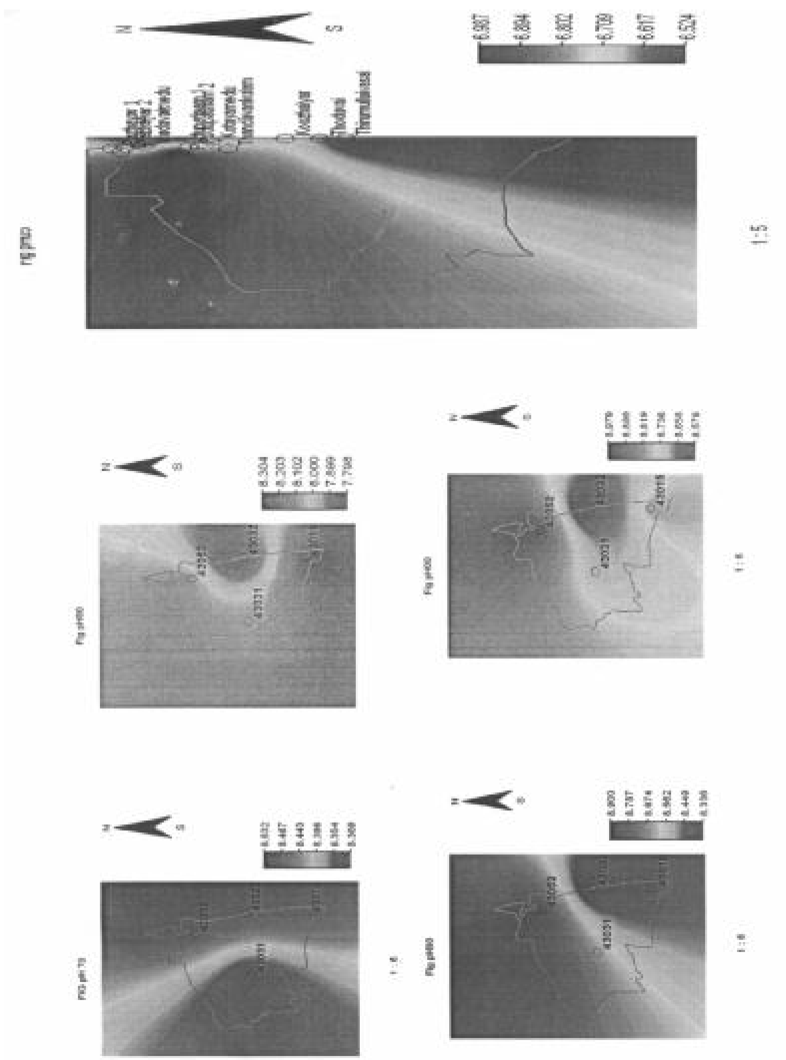

Fig. 5: Water quality parameter – pH, 1970 -2005.

CONCLUSIONS

The quality of water samples collected from different groundwater sources as affected by tsunami is clearly revealed by the study. Contamination of drinking water sources by tsunami can occur from saline water incursion. The findings of the study indicate that a detailed hydro-geological study of the area with reference to predictive modelling for assessment of water quality is warranted in order to establish the exact cause of groundwater contamination. The hydro-geological studies would comprise of quantitative/qualitative assessment of water reserves, its pathways and the identification of potential sources of contamination. The predictive modelling would also provide the future scenario on the basis of the present data, which will help the concerned authorities in planning their future strategies.

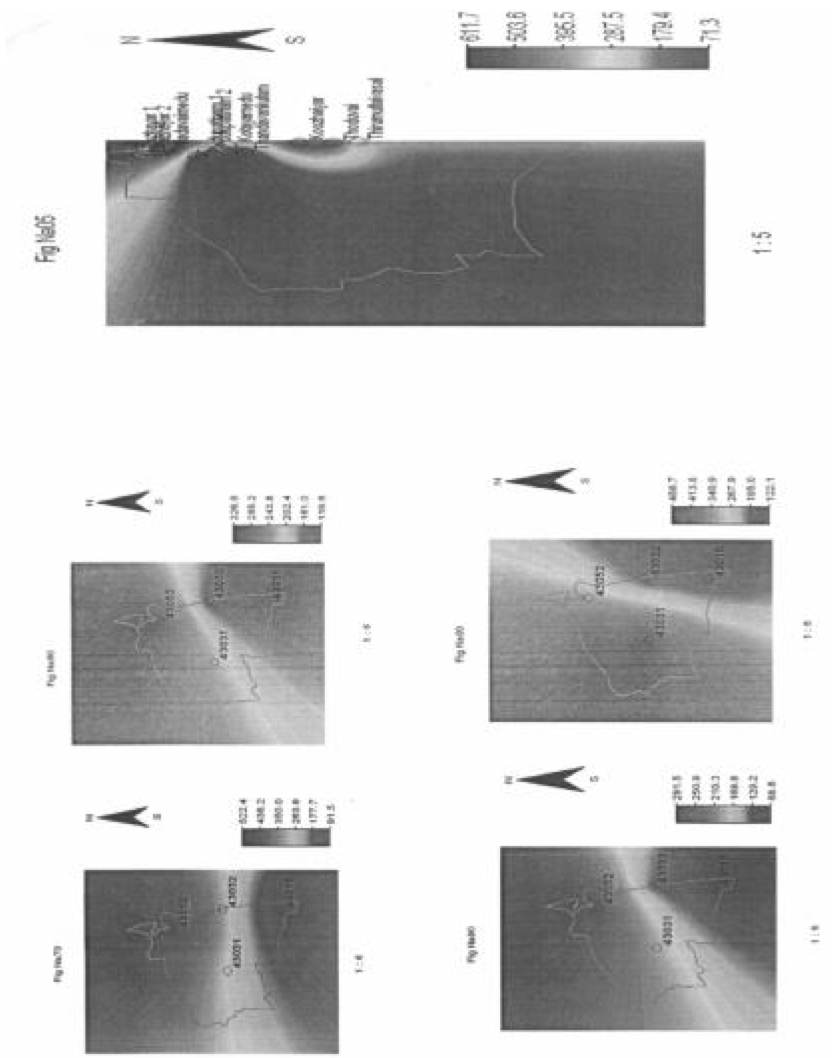

Fig. 6: Water quality parameter – Na (mg/Liter), 1970 -2005.

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