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Spatial Analysis of Soil and Water Quality in Tsunami AffectedAreas of Nagapattinam District, Tamilnadu, India

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ABSTRACT
In India, the natural disasters, especially the Tsunami in 2004 having exposed our unpreparedness, variability, diverse scientific, engineering, financial and also social processes. Vedaranyamtalukof Nagapattinam coastal region of Tamilnadu, India,was severely affected by Tsunami-2004. Due to its unique geological nature and climate conditions, the quality of soil and water resources was subjected to natural and synthetic changes. The recent efforts of prawn culture and saltpan in these areas also affect the natural resources. This study has revealed the present scenario of soil and water resources by analyzing their chemical parameters in the Tsunami affected areas after ten years of Tsunami-2004. For this study, soil samples (less than 30cm depth from land surface) and groundwater samples (from existing hand/bore pumps) were collected in the study area. It was observed from the analysis that the pH of soil was improved well and EC was lowered significantly except few places. Regarding the available N, P, K of soil, N was low, P and Kwere low to medium range. Further thepH,DO, Turbidity, Hardness,Cl and Mgof groundwater were within the permissible limit;EC and TDS were slight to moderate range for irrigation and drinking.The SAR is within the maximum allowable limit which inferred that groundwater can be used for irrigation without any risk.Thisspatial-temporal variability of soil and water parameters were mapped in GIS environment (Surfer ver. 9) and compared with pretsunami-2004 as well as ground truth scenario. Keeping these results, the soil is suitable for agriculture production. The natural flash flood has helped to reduce contamination of soil and water due to Tsunami-2004. However,due to alkaline in nature the quality of groundwater is not fit for drinking in some places but suitable for irrigation. Among the affected villages, Vedaranyam village has worst quality. This study also recommends suitable management strategies for sustainable development.

Keywords: Tsunami, water and soil parameters, spatial analysis, Surfer ver. 9

I. INTRODUCTION

Natural resources are the sources that are useful and essential to human being and all other living things. Soil and water are very vital for the advancement of civilization for a sustainable development. Groundwater is not static and its quality varies daily and seasonally.Tsunami is a harbour wave or tidal waves which affectdistant shores, originate from undersea or coastal seismic activity, landslides, and volcanic eruptions. Whatever the cause, seawater is displaced with a violent motion and swells up, ultimately surging over land with great destructive power.

Due to an undersea earthquake (9.4 Richter scale) at the Indian ocean on December 26,2004 led to massive inflows of seawater (Tsunami-2004) which caused loss of life, injuries and devastatingdamage to natural sources, especially agricultural land's products, livelihoods and disrupt the governmental system of our country. Nagapattinamregion was one of the worst affected coastal belts ofTamilnadu state.

Indian Agricultural Research Institute, New Delhi (2005) made spot investigation in some of the Tsunami affected areas of Nagapattinam and reported that due to poor drainage and sea water stood for a few days, the quality of soil and water was severely affected. The EC of soil and shallow ground water increased by about ten times and fifteen times respectively, and the degree of variations differed from place to place. Higher concentration of Calcium, Magnesium, Sodium, Chlorides, Sulphatesand Bicarbonate indicated that the soil turned saline. The EC varied from 3.9 to 46 ds/m compared with 0.5 ds/m for non-contaminated water, the pH was more than 8.5. The essential prerequisite for quality of water is to be safe for use to people and crops but should not damage it. The spatial analysis of water resources is essential to identify the areas most vulnerable to contamination for better decision–making. (Poongothai et al. 2008).The qualities of both surface and shallow ground water sources were observed to be unfit for irrigation and domestic purposes (Chandrasekaran et al. 2008).The groundwater increases its major ion concentration in

the summer season in comparison to the post and premonsoon period, because of evaporation, precipitation and environment weathering (Ramkumaret al. 2010). Remediation of groundwater needs knowledge of the existing nature, magnitude, and sources of the various pollutions to assessing groundwater quality (Shankar et al. 2011). Rainfall is the most important cyclic phenomenon in tropical countries as it brings important changes in the hydrographic characteristics of the marine and estuarine environments (Ramalingam et al. 2012).

The aim of this investigation is to analyse the present scenario of soil and water qualityandcreate spatial-temporal variability maps in the Tsunami-2004 affected Vedaranyamtaluk of Nagapattinam district, Tamilnadu through the development of GIS software (Surfer ver.9). Also, suggestion ofsuitable management strategy is effort for sustainable development.

II. STUDY AREA

The study was conducted in Vedaranyamtaluk of Nagapattinam district, which situated in the east coast line of Tamilnadu state, India. Its location is at $79^0$37'30"- $79^0$51'30" E and $10^0$16'00"- $10^0$39'00"N. The geographical area of Vedaranyamtalukis 533.03 sq. km and the average annual rainfall was 1100mm. Geomorphologically, the study area consists of flood plains, delta plain and natural levees. The formation isa sedimentary terrain (Alluvium, Sandyclay and Beachsand).The hydrological soil types are Group A (30%), Group C (65%) and Group D (5 %,) andthe slope is -1%. The important crops are paddy and groundnut. The main sources of irrigation are bore well (81%), cannel (21%) and rain-fed tanks (31%).

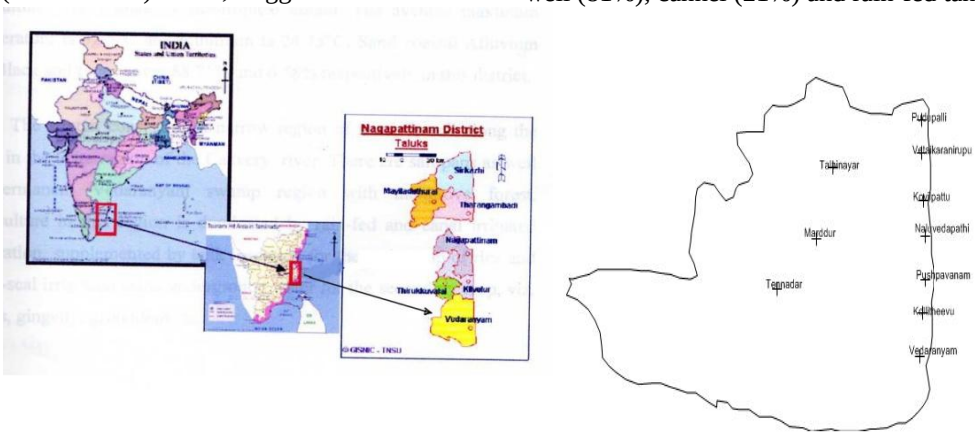


Fig. 1 Location map of study area with sample locations

III. MATERIALS AND METHODS

To analyse the spatial variability of soil and water sources, the primary data on 15 water samples (compressing surfacewater and bore water) and 10 surface soil samples (upto 20cm depth) were collected from affected and unaffected areas on December 2013 for measurement of specific chemical parameters of soil viz: pH, EC, N, P and K and of water viz: pH, EC, TDS, Turbidity, Salinity, DO, Hardness, Na, Cl, Ca, Mg and SAR were analysed at the Environmental laboratory, Annamalai University. The location of the sample acquisition points was recorded by using hand held Geo Positioning System (GPS).

The results of soil and water quality parameters were inferred in the Excel spreadsheet for comparison with pretsunami-2004scenario (secondary data on soil and water quality 2000 -2012 collected from Government organization, Nagapattinam) and with crop tolerable limits by FAO for irrigation and BIS for domestic purposes.Various maps using GIS package (Surfer ver.9)were prepared to spatially locate the polluted area. (Fig.4&5)

IV. RESULT AND DISCUSSION

The findings are summarized in Table 1&2. Sample wise parameter variations are presented in Fig.2&3.

Table 1 Chemical Analysis of Soil samples on December 2013

Sl.No.	Sampling places	pH	EC ds/m	Nitrogen (N)Kg/ha	Phosphorus (P)Kg/ha	Potassium (K)Kg/ha
1.	Pudupalli	7.19	0.493	178	22	272
2.	Vettaikkaraniruppu	6.82	0.327	112	11	119
3.	Kovilpattu	7.44	1.17	159	17	214
4.	Naluvedapathi	7.62	0.631	152	21	261
5.	Pushpavanam	7.21	0.520	143	19	210
6.	Kollitheevu	7.01	0.432	137	24	195
7.	Vedaranyam	8.60	1.250	180	28	172
8.	Talainayar *	7.25	0.550	380	24	240
9.	Marddur *	7.30	0.560	420	20	230
10.	Tennadar *	7.40	0.350	450	22	210
FAO Permissible limit		**6.5 - 7.5**	**< 2**	**250 - 500**	**20 - 50**	**125 - 300**

*Unaffected area

Table 2 Chemical Analysis of Water samples on December 2013

Sl. No.	Sampling Places	pH	EC ds/m	TDS mg/L	Turbidity NTU	DO mg/L	Hardness mg/L	Na mg/L	Cl mg/L	Salinity %	Ca mg/L	Mg mg/L	SAR
1.	Pudupalli	8.45	3.495	450	1	3.8	210	180	186	2	28	30	5.63
2.	Vettaikkaraniruppu	8.50	2.725	220	3	3.5	175	170	165	3	30	21	5.82
3.	Kovilpattu	8.60	3.600	1775	2	3.2	140	235	1150	3	24	17	8.92
4.	Naluvedapathi	8.25	2.244	760	2	3.6	240	160	142	2	36	29	4.81
5.	Pushpavanam	7.90	1.094	420	3	3.2	210	70	410	1	24	34	2.16
6.	Kollitheevu	8.20	2.854	190	2	3.5	230	110	380	1	36	29	3.31
7.	Vedaranyam	9.02	13.500	1387	5	2.4	260	870	1210	6	38	34	24.71
8.	Talainayar*	7.78	0.927	210	1	3.0	105	80	20	0	12	21	3.22
9.	Marddur *	7.60	0.510	165	1	3.4	90	65	18	0	20	16	2.63
10.	Tennadar *	7.98	0.719	180	1	2.8	95	70	20	0	20	17	2.78
BIS Permissible limit		**6.5 - 8.5**	**< 3**	**2000**	**10**	**6**	**600**	**200**	**1000**	**Nil**	**200**	**100**	**< 26**

*Unaffected area

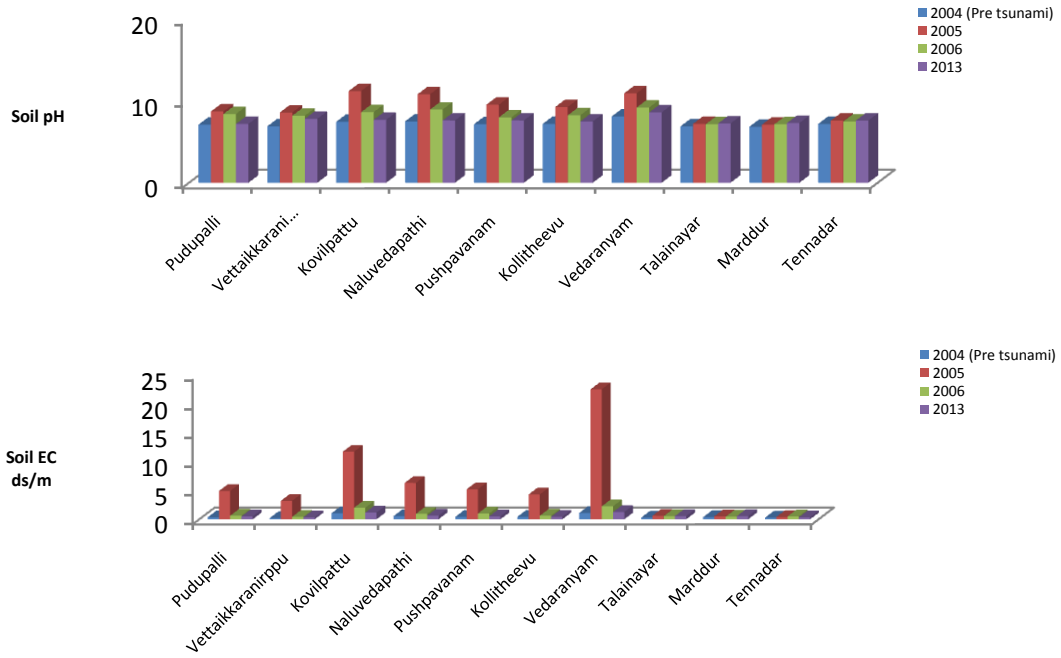


Fig.2 Variability of pH and EC in soil samples

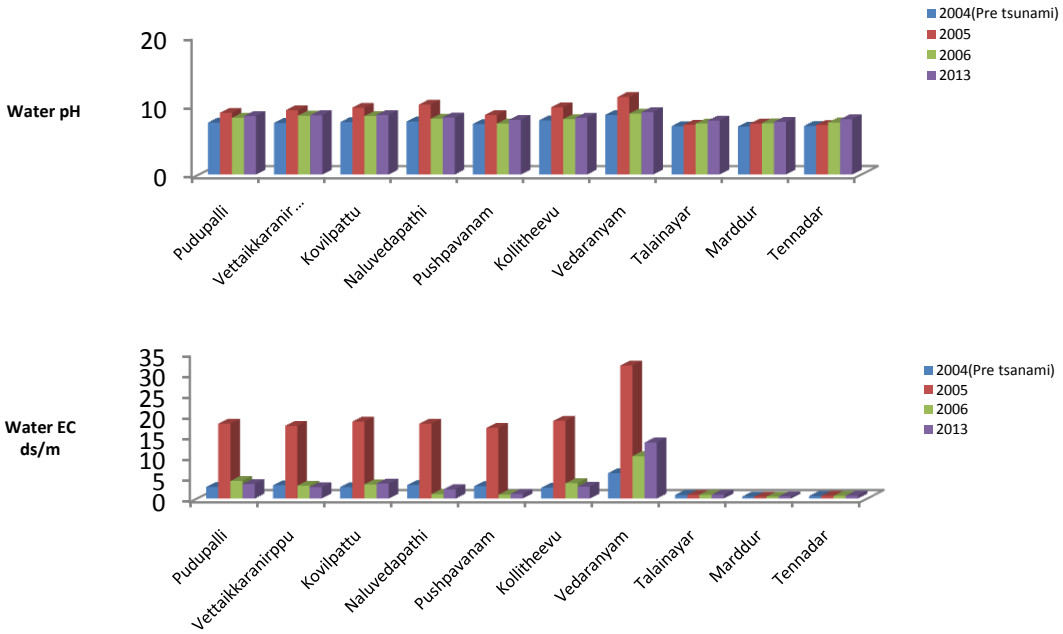
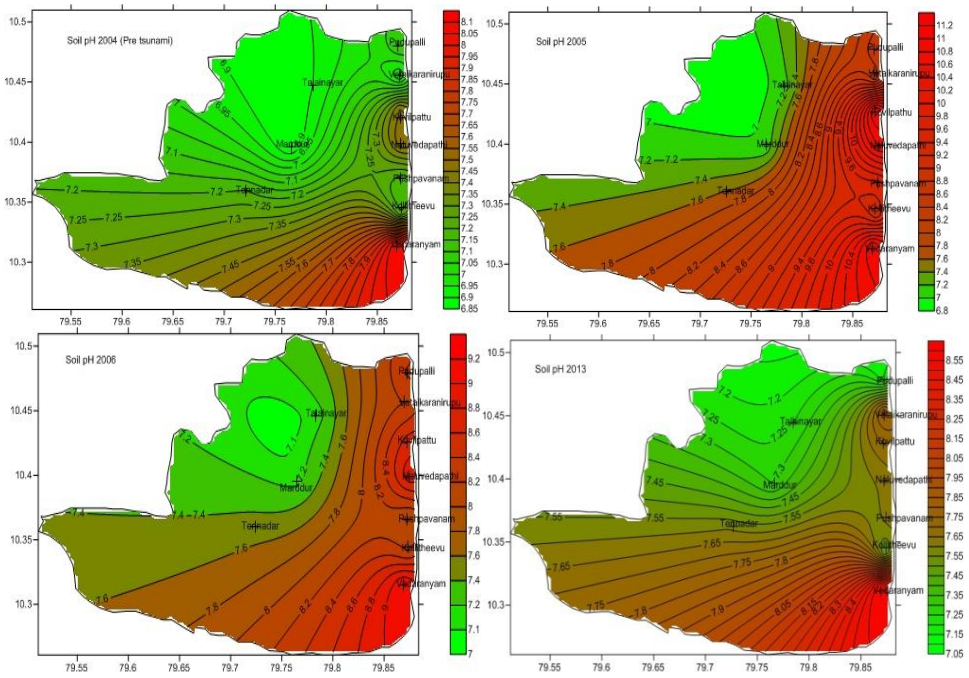


Fig. 3 Variability of pH and EC in water samples



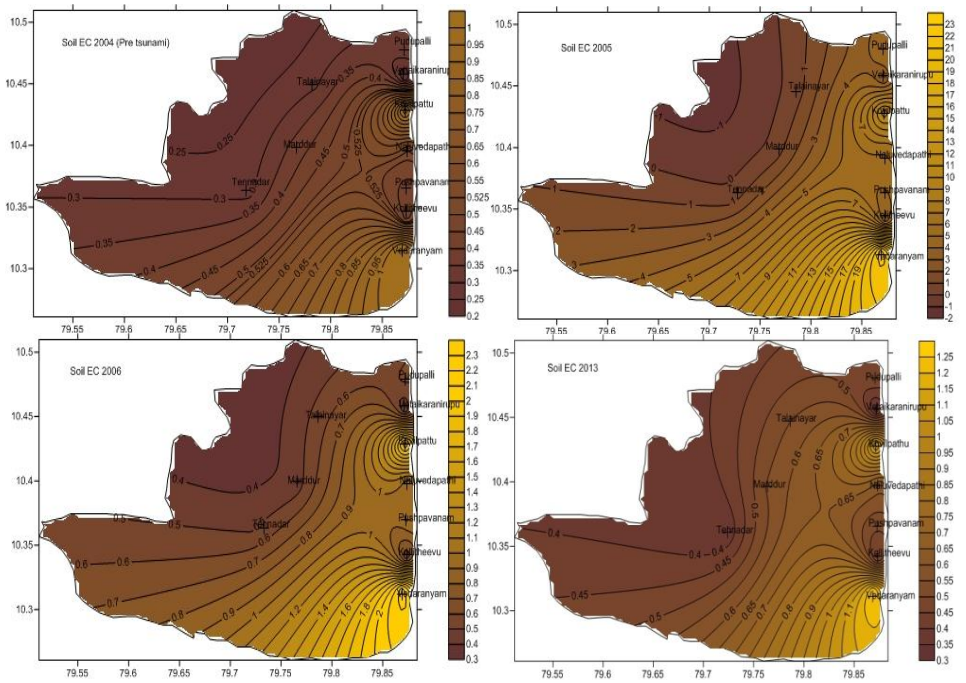
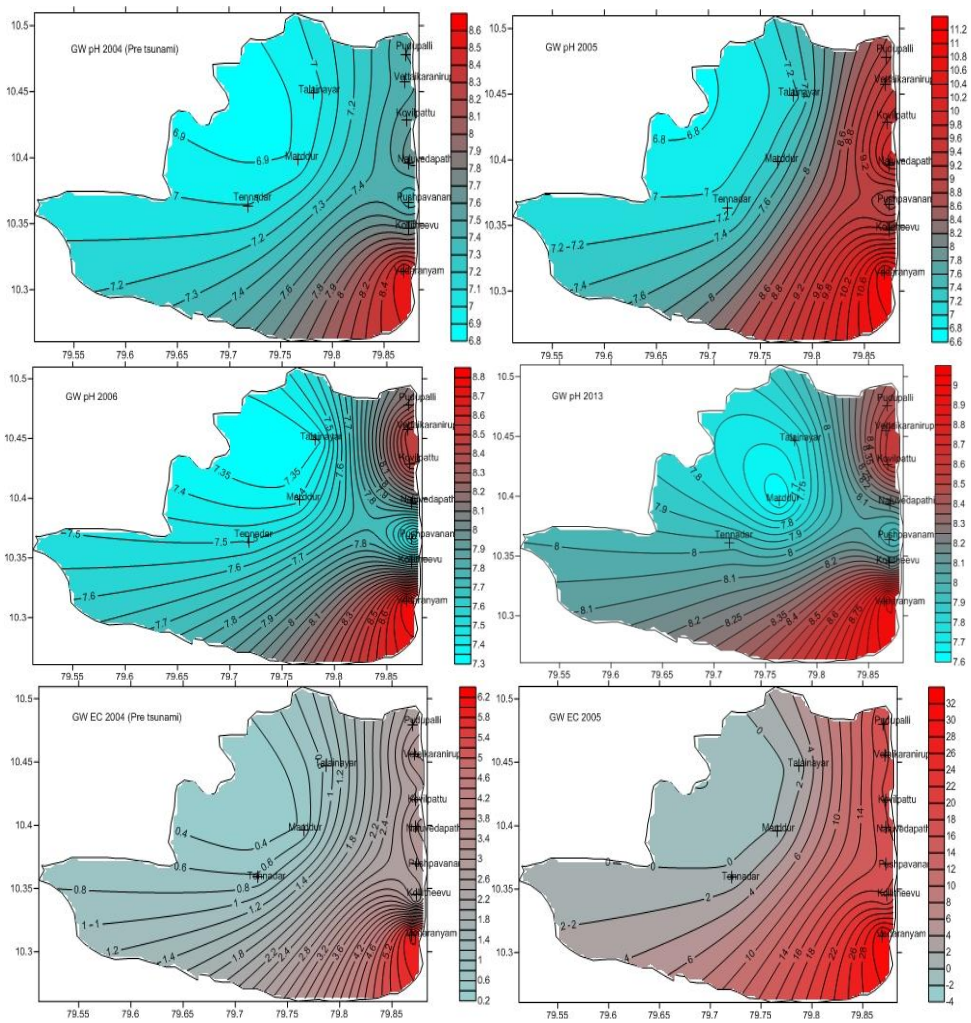


Fig. 4Spatial variability of pH and EC in soil samples



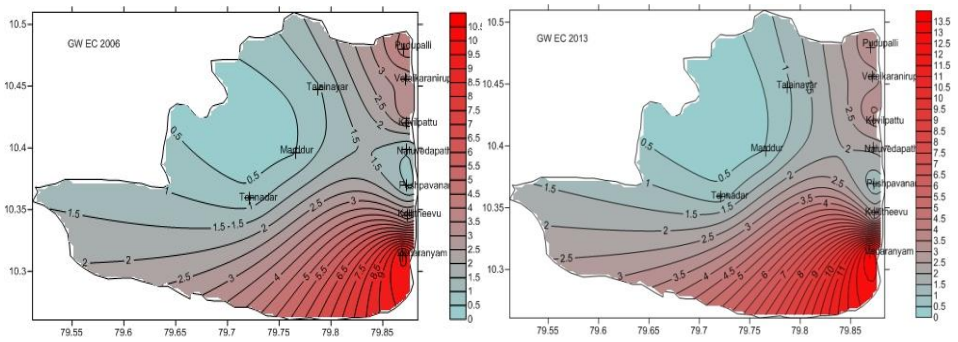


Fig. 5Spatial variability of pH and EC in water samples

4.1 Soil Quality

With reference to pH values, there is a good improvement and within normal range of 6.5 to 7.5 except Naluvedapathi and Vedaranyam villages. The soil of these villages is clayey intexture whereas other affected villages are of sandy soil. There was a significant decrease of soil EC in comparison to values immediately after Tsunami-2004.This is due to the rainfall flushing of the surface salts that resulted in lowering of the EC of the surface soil. The soil samples where low in available N could be due to low amount of organic carbon in the soils, and most of the samples were low to medium in available P and K, which needs regular monitoring of fertility status.Depending on soil type, the gypsum of appropriate quantities can be applied before taking up agricultural activities.

4.2 Water Quality

The pH is well within the norms in all the samples except Kovilpattu and Vedaranyam villages indicating study area water falls in alkaline nature. The EC influences crop and drinking purposes.The EC values for drinking purposes show poor category of >3 ds/m in Pudupalli, Kovilpattu and Vedaranyamvillages. In this study, the TDSvalues varied between 410 to7490 mg/L and are within the maximum permissible limit for drinking as per the BIS in all samples except Pudupalli, Kovilpattu and Vadaranyam villages.The highest concentration of TDS is likely due to mixing of groundwater with seawater. Turbidity is the cloudiness or haziness of water. No samples in the study area contain turbidity. DO, a vital parameter to know the status of the aquatic ecosystem, is within the norms (<6 mg/L) in all sample locations. Water hardness is determined by the concentration of multivalent cations in the water. Vedaranyamvillage has a higher concentration of hardness (840mg/L) which may cause health hazards.The high level of sodium inhibits soil permeability and gives a salty taste.Maximum concentration of Nahas been observed inthe Kovilpattu village (235mg/L) and Vedaranyam village (870 mg/L) due to seawater influence and study area near to saltpan deposits.Kovilpattu and Vedaranyamvillagesamplesrepresent maximum Cl concentration of 1150 and 1210 mg/L, which is more than BISfor drinking water, andbecome unsuitable for drinking purpose.Salinity is the saltiness content of water or soil. The salinity levels in the study area are varying between 0 to 6%.SAR is a measure of alkali/sodium hazard to crops. The SAR values ranged from 2.16 to 24.71are within the maximum allowable limit shows that groundwater can be used for irrigation without any risk. From the secondary sources and comparative study of pre and post Tsunami data, it was reported that the groundwater was fit for irrigation and drinking purposes before Tsunami-2004, but after Tsunami-2004 the quality of groundwater got deteriorated and needs conservation practices.

V. CONCLUSION

The study reveals that the surface soil samples qualities of Tsunami-2004 affected agricultural areas in Vedaranyamtaluk indicated faster improvement and are moderately suitable for agriculture production. But the qualities of groundwater were observed to beinhibited for irrigation and drinking purposes.Also, due to non-availability of good quality water in the study area, people are compelled to use water from bore/hand pumps. Groundwater in the study area is generally alkaline in nature, especiallyVedaranyamvillage which was worst affected.From questionnaire survey results show 43% respondents report a decreasing trend in the yield due to salinity land and low fertility. Moreover, to reclaim, both short-term and long-term strategyefforts should be made, such as adoption of improved crop varieties, water management practices, construction of drainage, drip and sprinkler irrigation system, renovation of defaulttanks and ponds and desilting of drainage channels and cannels. Micro level field data and mapping are required for sustainable development of natural resources of the study area.

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