Nature Environment and Pollution Technology
An International Quarterly Scientific Journal

Vol. 8	No. 2	pp. 257-260	2009

Original Research Paper

Irrigation Water Quality Status Studies Through GIS in Upper Manimuktha Sub-basin, Villupuram District, Vellar Basin, Tamil Nadu, India

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Key Words:
Groundwater
Salinity
SAR
Alkali hazard
Irrigation water quality
GIS

ABSTRACT

An attempt has been made to demarcate sites for groundwater irrigation quality at upper Manimuktha sub basin, Velar basin, Tamil Nadu through GIS technique using ARC/GIS Software. The irrigation quality standard output was taken to GIS platform. The work was executed with the weighted rating analysis in GIS environment. Spatial and non-spatial data were assessed in a quick and efficient way in GIS. The term 'geographic' in GIS refers to the locational attributes which define the spatial positioning of the piece of information on the face of the earth. The advent of digital computers, with high data processing speed and the development of analytical tools in GIS to handle geographically referenced data with ease and flexibility, computer aided GIS has become a reality of late. Using of GIS in hydrogeology is only at its beginning, but there have been successful applications that started to develop. The favourabilty of the irrigational quality was demarcated in GIS. The favourable area occupying in premonsoon was 269 km^2 and in the postmonsoon 239 km^2.

INTRODUCTION

Depletion of water tables, saltwater encroachment, drying of aquifers, groundwater pollution, water logging and salinity, etc. are major consequences of overexploitation and intensive irrigation. It has been reported that in many parts of the country the water table is declining at the rate of 1-2 m/year freshwater availability for irrigation, domestic and industrial uses. If this trend continues unchecked, India is going to face a major water crisis in the near future. This paper highlights the irrigation quality of the groundwater in upper Manimuktha subbasin. The investigation area lies between the east longitude 78°43' to 79°00'and north latitude 11°47' to 11°57'. The total study area covers 513 km^2 in which the plain area occupies 310 km^2, and hill area 203 km^2.

MATERIALS AND METHODS

In order to assess the groundwater chemistry, a total of 26 groundwater samples were collected from bore wells for investigation during pre and post monsoon 2006 (Fig. 1). The groundwater samples were collected in well cleaned 1000 mL polythene bottles. The samples were analysed for physico-chemical parameters (pH, EC), major cations (Ca, Mg, Na, K) and major anions (CO_3, HCO_3, SO_4, Cl) as per standard procedures. A diagram widely used for evaluating waters for irrigation by the U.S. Salinity Laboratory (1954) was made. The specific conductance, as an index of dissolved solid

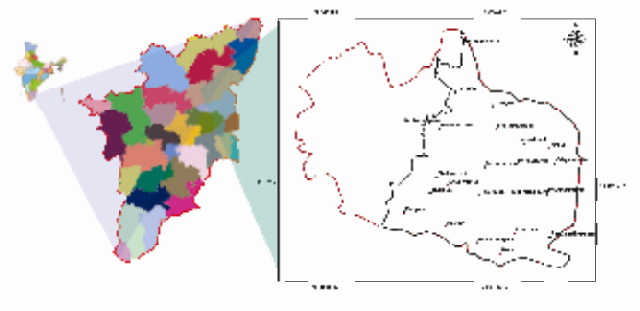

Fig.1: The study area.

Table 1: Quality classification of irrigation water.

Water class	Salinity hazard		Alkali hazard
	EC in µmhos/cm at 25°C	Salt concentration in me/L	
Excellent	< 250	< 0.25	Up to 10
Good	250-750	0.25-7.50	10-18
Medium	250-2250	7.50-22.50	18-26
Bad	2250-4000	22.50-40.00	> 26
Very bad	> 4000	> 40	

Table 2: USSL Classification fields and sample locations.

Sample No.	Location	Premonsoon			Postmonsoon		
		EC	SAR	USSL Field	EC	SAR	USSL Field
1	Ranganathapuram	2390	5.1	C_4S_2	1220	1.8	C_3S_1
2	Paramanatham	1100	4.1	C_3S_1	1430	3.7	C_3S_1
3	Valayampattu	1540	5.6	C_3S_2	940	1.5	C_3S_1
4	Virilur	750	1.4	C_2S_1	1850	2.0	C_3S_1
5	Vadasiruvalur	770	3.1	C_3S_1	840	1.4	C_3S_1
6	Mogur	2910	0.9	C_4S_1	2360	3.0	C_4S_1
7	Phuthathur	1690	3.2	C_3S_1	1140	3.0	C_3S_1
8	Ammapalayam	2100	5.1	C_3S_2	2690	6.5	C_4S_2
9	Tavadipatu	1600	0.6	C_3S_1	1160	1.2	C_3S_1
10	Nedumanur	1200	2.4	C_3S_1	3550	4.2	C_4S_2
11	Sangarapuram	1660	4.6	C_3S_1	1530	2.8	C_3S_1
12	Urangani	620	2.1	C_2S_1	1670	2.6	C_3S_1
13	Pavalam	4000	5.2	C_4S_2	2100	5.2	C_3S_3
14	Rengapananur	960	1.9	C_3S_1	1900	3.1	C_3S_1
15	Arasampattu	600	2.5	C_2S_1	730	0.6	C_2S_1
16	Pudhupalapattu	2000	5.2	C_3S_2	1090	1.2	C_3S_1
17	Pachari	620	2.1	C_2S_1	810	0.5	C_2S_1
18	Gudalur	1000	1.1	C_3S_1	950	1.9	C_3S_1
19	Parigam	960	2.4	C_3S_1	790	1.2	C_3S_1
20	Manmalai	1200	2.3	C_3S_1	1820	2.8	C_3S_1
21	Mattaparai	630	1.1	C_2S_1	580	1.5	C_2S_1
22	Chellampattu	1180	1.6	C_3S_1	1990	3.6	C_3S_1
23	Kardichithur	1000	1.2	C_3S_1	830	1.7	C_3S_1
24	Mathur	780	1.9	C_3S_1	1480	3.7	C_3S_1
25	Moorarpalayam	1370	3.1	C_3S_1	1430	3.6	C_3S_1
26	Semapalayam	2800	8.0	C_4S_2	2600	8.6	C_4S_3

concentration was plotted on one axis, and the sodium-adsorption ratio on the other. The diagram is divided into 16 areas that are used to rate the degree to which particular water may give rise to salinity problems and undesirable ion-exchange effects in soil.

Based on salinity, the study area can be classified into four zones viz. C_1, C_2, C_3 and C_4. Based on the sodium hazard the area can be classified into four viz. S_1, S_2 S_3 and S_4 giving sodium hazard zones. Table 1 gives quality classification of irrigation water.

Geochemistry-GIS Study

To find out the spatial distribution of groundwater quality for irrigation of the study area, GIS was employed. The geochemical locations were digitized and the corresponding values of their attributes were given as an input. Using these data, the interpolation raster maps were generated. Subsequently, these maps were classified with respect to our interest and converted into vector maps. These maps were clipped with the boundary to arrive within the boundary of the study area.

Thematic maps as described above have been converted into raster form considering 30m as cell size to achieve considerable accuracy. These were then reclassified and assigned suitable weightage. GIS has been considered for multicriteria analysis in resource evaluation. Shahid et al. (2000), Boutt et al. (2001), Elkadi et al. (1994) and Gurugnanam et al. (2008) have carried out groundwater modelling through the use of GIS.

RESULTS AND DISCUSSION

The results were plotted in the USSL diagram to assess the irrigational quality of water. After plotting the values in the diagram (Fig. 2 and Fig. 3), the results of various classes have been given in the Table 2. Most of the samples fall in C_3S_1 field in both the seasons. C_3 and C_4 were high salinity zones, and S_3 and S_4 were high alkali hazard zones. C_3 and C_4 can be used for irrigation (Karanth 1987) but

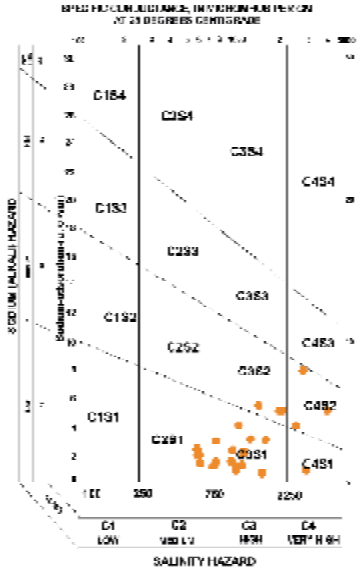

Fig. 2: USSL-Classification of groundwater of upper Manimuktha subbasin premonsoon.

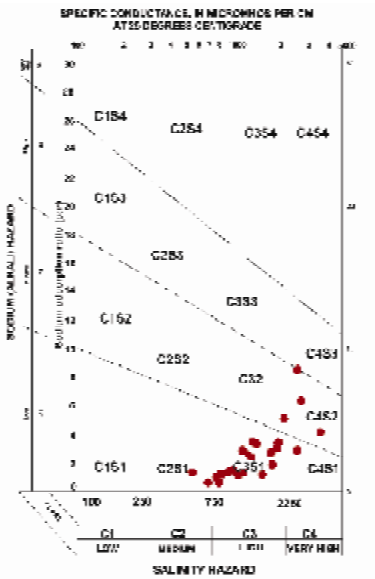

Fig. 3: USSL-Classification of groundwater of upper Manimuktha subbasin postmonsoon.

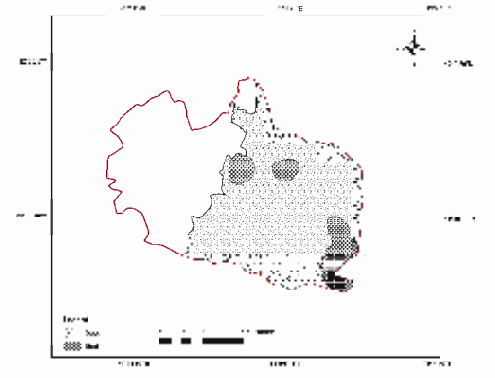

Fig. 4: GIS results-Spatial distribution of irrigation quality during premonsoon.

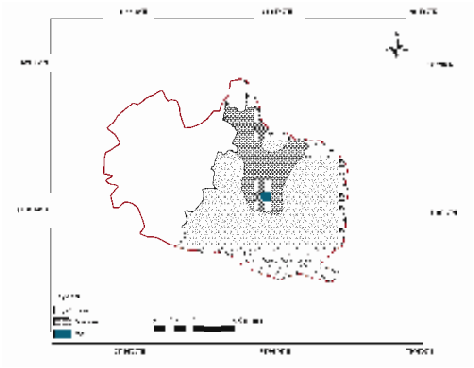

Fig. 5. GIS results-Spatial distribution of irrigation quality during postmonsoon.

proper irrigation methods to be adopted. Only one sample in postmonsoon period at Semapalayam (C_4S_3) location was observed in high salinity and alkali hazard zone. This location is not suitable for irrigation.

Table 3: GIS results-Irrigation water quality of Manimuktha subbasin.

GIS Class	Postmonsson	Premonsoon
	Area in km^2	Area in km^2
Good	239.62	269.86
Medium	68.69	39.86
Poor	1.4	-

Irrigation Quality in GIS

In the USSL, 16 fields are represented, according to the field the weightage given in GIS. More weightage is given to good quality zone and low weightage number was given to poor quality field. These data were further classified into good, medium, poor and bad with reference to USSL field. These data were taken into GIS environment for thematic map preparation. The favourable and unfavourable areas were demarcated in GIS as shown in Fig. 4 and Fig. 5. The spatial distribution result is given in Table 3.

CONCLUSION

Generally, groundwater in the study area is good for irrigation purposes. Among 26 groundwater samples, only one sample falls in bad field with respect to the USSL. In GIS, the weightage factor is assigned as numbers and it was classified as bad, poor, medium and good. The good area is demarcated for irrigation purposes, which covers 269 km^2 in the premonsoon and 239 km^2 in the postmonsoon. The poor area occupies 1.4 km^2, where care must taken to improve water quality.

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