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Original Research Paper

Assessment of Water Quality in Kalpakkam Region, Tamil Nadu

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ABSTRACT

Assessment of water quality in a region is important as water is used for domestic and agricultural purposes. In most parts of south India groundwater is used extensively for domestic and agricultural purposes. The aim of this study was to assess the water quality of Kalpakkam region based on the major ions. Geologically, this study area has two distinct formations: crystalline charnockite rocks of Archean age and quaternary/recent sediments. The quaternary/recent sediments, weathered and fractured crystalline charnockite function as an unconfined aquifer system. The hydrogeochemical characteristics of water and its quality were studied from physico-chemical analysis of the water samples. Two characteristic facies were determined based on the results of hydrochemical analyses: (1) Na-Cl and (2) Ca-Mg-Cl facies are dominant in this region. Groundwater from the study unit is generally good for drinking purposes. However, samples from some wells exceeded drinking water standards established by the BIS for EC, TDS, sodium, chloride and sulphate ions.

INTRODUCTION

Excessive use of groundwater to meet the requirements in coastal regions may lead to degrading of groundwater quality. Numerous research studies have reported the problem of development of coastal aquifers which resulted in degradation of groundwater quality (Boukari et al. 1996, Lambrakis 1998, Foppen 2002, Faye et al. 2004). Likewise, agricultural activities also result in groundwater quality deterioration (Lowrance et al. 1997, Fakir et al. 2002, Cardona et al. 2004). Kalpakkam region, Tamil Nadu, India is one such region where groundwater is extensively used for domestic and agricultural purposes. The present study was carried out with the objective of assessing the water quality and to determine the possible reasons for degradation of water quality in Kalpakkam region.

Kalpakkam coast of Kancheepuram District, Tamil Nadu is located 60 km away from the Chennai city and covers an area of 2 km^2 (Fig. 1). The eastern side of this area is bounded by the Bay of Bengal, western side by Buckingham canal and southern side by back water. The maximum temperature in this area is about 44°C during the months of May and June. The minimum temperature is about 24°C during the months of December and January. The total annual rainfall is about 1260 mm in the study area. Rainfall received during the southwest monsoon (June to September), the northeast monsoon (October to December) and the transition period is 40%, 51% and 9% respectively.

Topographically this area is elevated in the centre and slopes towards the east and west direction. The sand dune is found in the northeastern side. The Highest elevation was measured in the north-eastern part of study area is about 7.5 m above msl. Geologically, this study area has two distinct formations: crystalline charnockite rocks of Archean age and quaternary/recent sediments. The quaternary/recent sediments, weathered and fractured crystalline charnockite function as unconfined aquifer system. Recharge to this aquifer system is mainly from direct rainfall, which occurs mostly during the north east monsoon from October to December. Natural discharge from this aquifer occurs towards coast on the eastern side, Buckingham canal on west, and to the back water on south.

The groundwater head follows the topography, i.e., it flows towards the east and west from the central part of the area. Groundwater of this region is used for domestic and agricultural purposes. This region has several hand pumps, some are fitted with small motor pumps which are used by the households, and a few dug cum-bore wells which use submersible pumps for irrigation. Depth of these wells is generally penetrated only up to quaternary/recent sediments.

METHODOLOGY

Water samples were collected from dug wells, bore wells, dug cum bore wells, hand pumps and surface waters (water bodies). Groundwater samples were collected from 20 wells and 2 samples from surface waters. The hydrogeochemical characteristics of waters and their potability were obtained from physicochemical analysis of the water samples. EC (µS/cm), hydrogen-ion activity (pH) and redox potential (E_h) in mV of water samples were measured in the field using portable meters. The total dissolved solids (TDS) were computed by multiplying the EC value by 0.64 (Brown et al. 1970). The major elements such as Ca^{++}, Mg^{++}, K^+, Na^+, Cl^-, SO_4^-, CO_3^- and HCO_3^- were analysed in the laboratory. The analytical procedures used are according to APHA (1998). During the analytical procedures, blanks and standards were run to check the reliability of the methods adopted. In general, ion balance error was within 10%. The analysis was carried out immediately after the collection of water samples at the Hydrochemistry lab in the Department of Geology, Anna University, Chennai, India.

RESULTS AND DISCUSSION

Physical parameters of surface and groundwaters: The most common *in situ* water tests such as EC, pH and Eh provide useful preliminary information about a system together with water quality information. The electrical conductivity is a measure of the total salt content of water based on the flow of electrical current through the sample. The measurements conducted during this study indicate that the EC values ranged between 300 and 600 µS/cm in the surface water and 110 and 2350 µS/cm in the groundwater (Fig. 2). The pH and redox potential (Eh) generally vary from 6.4 to 7.4 (mean = 6.9) and 86 to 240 mV (mean = 160mV). Central part of the region has high pH values. Thus, the water samples vary from slightly acidic to slightly alkaline.

Total dissolved solids (TDS) are described as the solid residue remaining after evaporation of a water sample. TDS denotes the concentration of mineral constituents dissolved in water. The maximum TDS recommended for public water supplies is 1000 mg/L. The recommended limit for TDS

Table 1: General classification of water according to TDS (Carroll 1962).

Category of water	TDS (mg/L)
Freshwater	0 – 1000
Brackish	1000 – 10000
Saline	10000 – 100000
Brine	> 100000

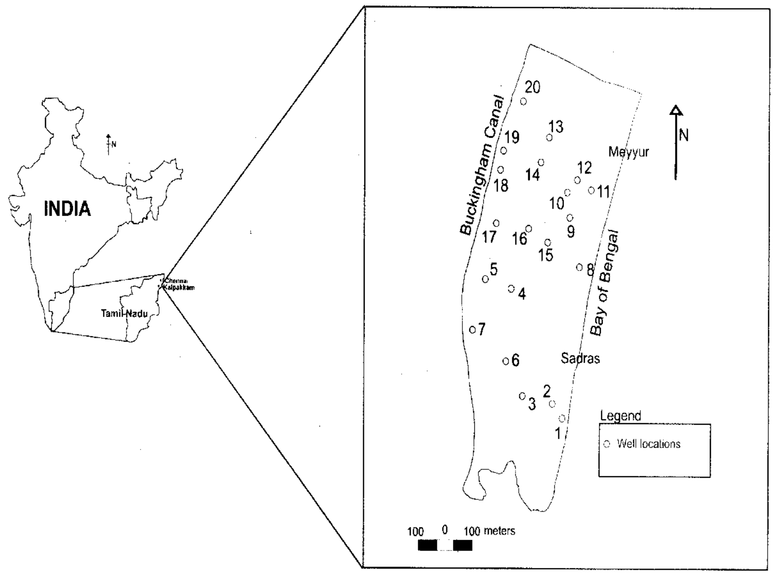

Fig. 1: Study area map with location of wells.

is based mainly on taste thresholds and not physiological effects. Water that greatly exceeds (several thousand mg/L TDS) the 1000 mg/L threshold is generally not palatable. A general classification of ground water according to the TDS is shown in Table 1. The surface water and groundwater of the study area has TDS range of 190-380 mg/L and 70-1500 mg/L respectively. Hence, it is clear that some of the groundwater samples are having TDS values more than the recommended limit.

Chemical parameters in surface and groundwaters: The chemical quality of groundwaters of the study area varies with respect to space. The groundwater can have unique chemical properties depending upon the geologic formation that are present. The quality can range from excellent to poor, and the presence of an undesirable constituent or excessive hardness can make the water unsuitable for some purposes.

Major cations are sodium, calcium, magnesium and potassium, and major anions are chloride, sulphate, carbonate and bicarbonate. Sodium concentration ranges from 10 to 390 mg/L in groundwaters and from 35-100 mg/L in surface waters. Calcium concentration ranges from 10 to

Table 2: Permissible limits and various physico-chemical parameters of the surface and groundwaters.

S.No	Physico-chemical parameters	Standrads~ (Prmissible limits)	Groundwater samples		Surface water samples	
			Min	Max	Min	Max
1.	pH~	6.5 to 8.5	6.4	7.4	7.3	7.8
2.	Electrical conductivity (EC)	1500	110	2350	300	600
3.	Total dissolved solids (mg/L)	1000	70	1500	190	380
4.	Calcium~(mg/L)	75	10	170	10	30
5.	Sulphate~(mg/L)	200	10	330	40	100
6.	Sodium (mg/L)	200	10	390	35	100
7.	Chloride~(mg/L)	250	15	300	20	150

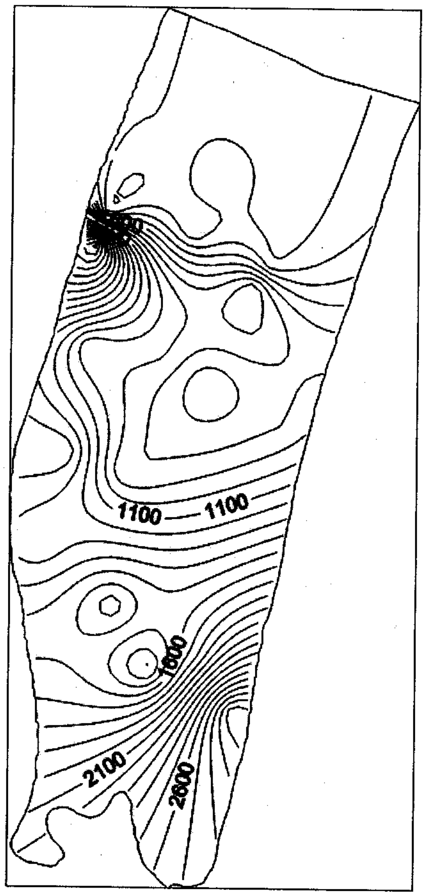

Fig. 2: Regional variation in Electrical Conductivity of groundwater in the month of December 2006.

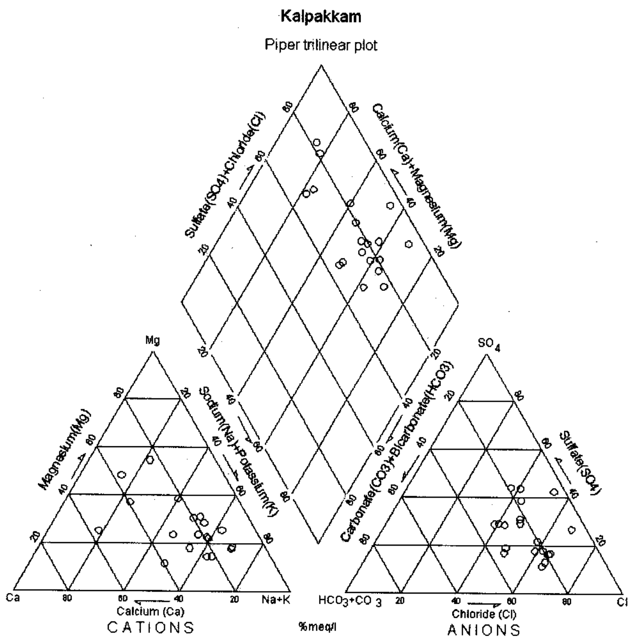

Fig. 3: Piper trilinear classification.

170 mg/L in groundwater and from 10-30 mg/L in surface waters. Magnesium concentration ranges from 10 to 130 mg/L in groundwater and from 10 to 40 mg/L in surface waters. Chloride concentrations ranges from 15 to 300 mg/L in groundwater and from 20 to 150 mg/L in surface waters. Sulphate concentration ranges from 10 to 330 mg/L in groundwater and from 40 to 100 mg/L in surface water. Bicarbonate concentration ranges from 10 to 200 mg/L in groundwater and from 80 to 160 mg/L in surface waters. Thus, the major ion concentrations of sodium, chloride and sulphate exceed the Bureau of Indian Standards (BIS) recommended limit. Permissible limits and various Physicochemical parameters of surface and groundwaters are shown in Table 2. Groundwaters from three wells from the eastern side and three wells from the western side of the study have the concentration of these major ions over and above the allowable standard limit.

Hydrochemical facies: The Piper trilinear plot, prepared from the major ion analyses of groundwater samples during December 2006, clearly indicate the hydrochemical facies (Fig. 3). Two major hydrochemical facies, identified based on the major ion chemistry of groundwater of this area, are:

i. NaCl facies

ii. Ca-Mg-Cl facies

The Na-Cl and Ca-Mg-Cl facies are dominant in this region. Na-Cl facies is found in some wells in the eastern and western regions. The Ca-Mg-Cl facies of groundwater is generally present in the coastal region. The average total dissolved solids are above 900 ppm and chloride concentration is 65% of the total anions of the study area.

CONCLUSION

Groundwater from the study area is generally good for drinking purpose. However, samples from some wells exceeded drinking water standards established by the BIS for EC, TDS, sodium, chloride and sulphate ions. Poor groundwater quality in few of the wells, located in the western part of the area, is due to intensive agricultural activities. In the case of wells located in the eastern part of the region, the poor groundwater quality is attributed to mixing of seawater. The results of hydrochemical facies reveal that Ca-Mg-Cl and Na-Cl facies are dominant in this region. Continuous monitoring of water quality of this region is essential as groundwater is used extensively, which may result in ingress of seawater into the aquifer system.

REFERENCES

APHA, 1998. Standard Methods for Examination of Water and Wastewater (20th edition), American Public Health Association, Washington DC.

BIS 1983. Indian Standard Specification for Drinking Water IS: 10500, Bureau of Indian Standards.

Boukari, M., Gaye, C.B., Faye, A. and Faye, S 1996. The impact of urban development on coastal aquifers near Cotonou, Benin. J African Earth Sci., 22(4): 403-408.

Brown, Eugene, Skougstad, M.W. and Fishman, M.J. 1970. Methods for collection and analysis of water samples for dissolved minerals and gases: Techniques of Water Resources, Investigation of the U.S. Geological Survey, Book 5, Chap. Al, 160 p.

Cardona, A., Rivera, J.J.C., Alvarez, R.H. and Castro, E.G. 2004. Salinization in coastal aquifers of arid zones: An example from Santo Domingo, Baja California Sur, Mexico. Environ. Geol., 45: 350-366.

Caroll, D. 1962. Rain water as a chemical agent of geologic processes - A review. US Geological Survey, Water Supply Paper, 1535-G, 18 p.

Fakir, Y., Mernissi, M.E., Kreuser, T. and Berjami, B. 2002. Natural tracer approach to characterize groundwater in the coastal Sahel of Oualidia (Morocco). Environ. Geol., 43: 197-202.

Faye, S.C., Faye, S., Wohnlich, S. and Gaye, C.B. 2004. An assessment of the risk associated with urban development in the Thiaroye area (Senegal). Environ. Geol., 45: 312-322.

Foppen, J.W.A. 2002. Impact of high-strength wastewater infiltration on groundwater quality and drinking water supply: The case of Sana'a, Yemen. J. Hydrol., 263: 198-216.

Lambrakis, N.J. 1998. The impact of human activities in the Malia coastal area (Crete) on groundwater quality. Environ. Geol., 36: 87-98.

Lowrance, R., Altier, L.S., Newbold, J.D., Schnabel, R.R., Groffman, P.M., Denver, J.M., Correll, D.L., Gilliam, J.W., Robinson, J.L., Brinsfield, R.B., Staver, K.W., Lucas, W. and Todd, A.H. 1997. Water quality functions of riparian forest buffers in Chesapeake Bay watersheds. Environ. Management, 21: 687-712.

Piper, A.M. 1944. A Graphical interpretation of water-analysis, Trans American Geophysical Union, 25: 914-928.