Integrated geological, geoelectrical and geochemical studies for groundwater resource evaluation in coastal areas of Sagar Island region, West Bengal, India

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INTRODUCTION

The importance of water for sustenance of life cannot be overemphasized, and groundwater, being a part of the hydrological cycle, needs proper evaluation and management, not only to meet our needs for the present, but also for future generations. Sagar Island, the largest island in the Ganga Delta, is an almost flat, low-lying region built up of unconsolidated alluvial sediments of Quaternary age. In the whole island there are 46 villages spread over 235 km^2 with a total population of about 0.3 million. The reclamation of land for settlement and cultivation by deforestation has accelerated land erosion, especially in the east, west and southern sector of the island. For water supply, villagers are totally dependent on the sweet groundwater tapped from deep confined aquifers through tube wells of more than 240 m depth. The deeper sweet aquifers lie between 180 and 335 m below ground level (bgl). Surface water or dug well water is totally saline. The overlying shallow aquifer is also saline water-bearing. The present study comprises

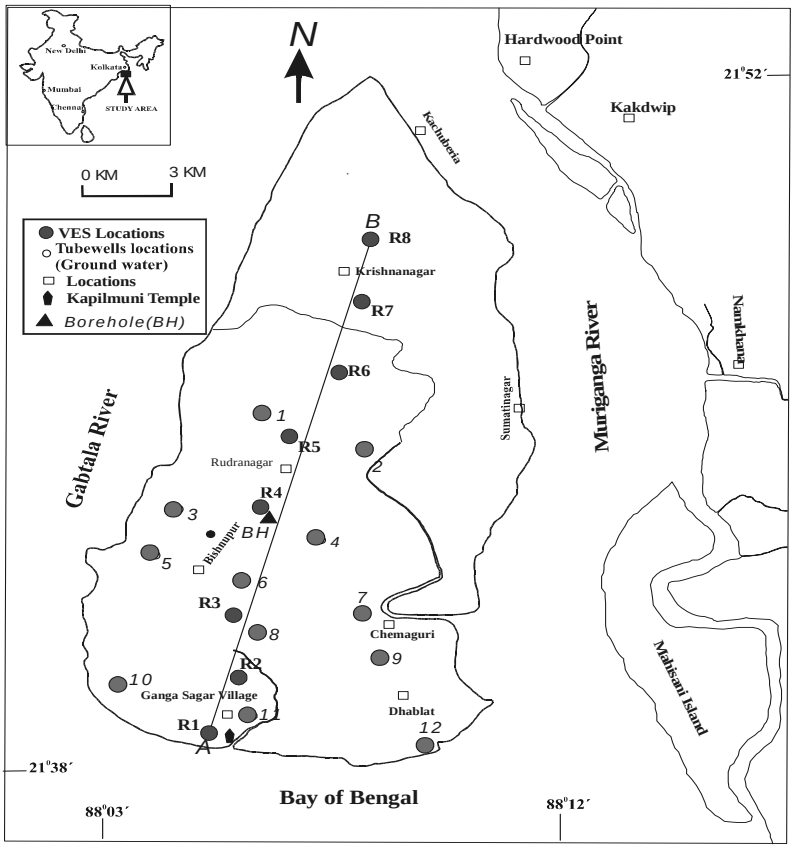
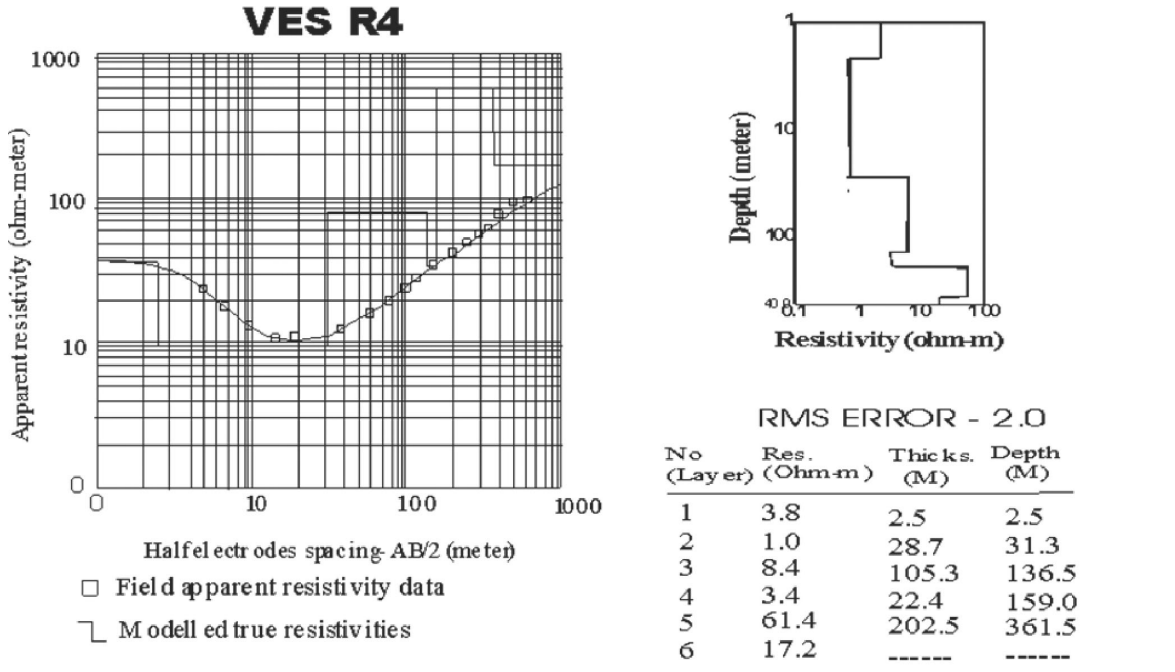


Fig. 1 VES and groundwater sample locations in Sagar Island.

an integrated geological, geoelectric and geochemical investigation to assess the prevailing surface- and groundwater condition, viz. aquifer depth, chemical quality of groundwater and hydrological characteristics in some parts of Sagar Island and the adjoining mainland for groundwater resource studies, as shown in Fig. 1.

GEOELECTRIC STUDIES

Geoelectric methods have become one of the most important techniques for delineating upper subsurface layers (Majumdar *et al.*, 2000, 2002).Vertical electric soundings (VES) were carried out with maximum electrode spacing of 1200 m. The resistivity layer parameters obtained from VES studies throw light on the facies change in subsurface lithology, and reveal the existence of a saline water-bearing zone overlying a freshwater-bearing zone. The VES curves are interpreted by a 1-D inversion technique and the results show the presence of five to six prominent layers consisting of alluvial top soil, saline water, brackish water, impermeable clay layer, freshwater and bottommost clay with silt and sand lenses, under the prevailing hydrodynamic condition. Such a fresh confined aquifer is typically developed in the area with overlying clay-rich silty formation which prohibits the infiltration of saline and brackish water. The average thickness of the freshwater-bearing zone under confined condition is about 180 m at an average depth of about 182 m from the surface. The resistivity section and fence diagrams are constructed from VES interpretations for showing lithological and hydrological characteristics of the area. Some zones of the aquifer are marked for potential drinking water purposes**.**



VES No.	ρ1 (ohm-m)	h1 (m)	ρ2 (ohm-m)	h2 (m)	ρ3 (ohm-m)	h3 (m)	ρ4 (ohm-m)	h4 (m)	ρ5 (ohm-m)	h5 (m)	ρ6	h6	RMS error
R4	3.8	2.5	1.0	28.7	8.4	105.3	3.4	22.4	61.4	202.5	17.2	∞	**2.0**

ρ1, ρ2, ρ3, ρ4, ρ5 and ρ6 - true resistivity of five layers

h1, h2, h3, h4, h5 and h6 - thickness of six layers

Fig. 2 Typical resistivity field curves with model parameters.

GEOCHEMICAL STUDIES

Chemically fresh groundwater is Na-HCO_3 type with TDS ranging from 500 to 780 mg/L. Chemically the groundwater is safe for drinking and domestic purposes (WHO, 2004) with low to medium Sodium Adsorption Ratio (SAR) values. It is free from As and Pb. The Na content is relatively higher than the values of other elements present in the groundwater. The seawater contamination (SWC) values for these water samples are significantly low.

CONCLUSIONS

Vertical electrical soundings (VES) have delineated the topsoil, the saline/brackish groundwater zones, an impermeable clay layer, a thick freshwater aquifer and clay with fine sand lenses (low groundwater yield) in the subsurface geological formations. The freshwater zone is of appreciable average thickness of 180 m and at an average depth of 182 m. There is no evidence of seawater mixing with groundwater. Groundwater of this area is Na-HCO_3 type. The chemical quality of groundwater is safe for drinking and domestic purposes, and suitable for irrigation purposes.

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