Geophysical Research Abstracts,
Vol. 10, EGU2008-A-04923, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-04923
EGU General Assembly 2008

Freshwater mapping and quantification in coastal aquifers using Magnetic Resonance Soundings and Time Domain Electro-Magnetism

J. Hoareau (1,2), J.M. Vouillamoz (1,2), M. Grammare (1), M. Descloitres (2), C. Kumar (1), L. Nandagiri (3)

(1) Indo French Cell for Water Sciences, Institut de Recherche pour le Développement, Indian Institute of Sciences, Bangalore 560012, India (johan.hoareau@gmail.com), (2) Laboratoire d'étude des Transferts en Hydrologie et Environnement - HGP, Bât Cermo, Domaine Universitaire, 460 rue de la piscine, 38400 Saint Martin d'Hères, France, (3) National Institute of Technology of Karnataka, Dept.of Applied Mechanics, Surathkal, Srinivasnagar P.O.,Mangalore 575025, India

This paper presents an innovative approach for spatial mapping and quantification of freshwater resources in coastal aquifers. The proposed methodology, involving the combined use of field-scale hydrological information and geophysical measurements, is demonstrated for a groundwater aquifer in Surathkal, on the West coast of India.

The study area comprises of a narrow strip of land bounded by the Arabian Sea on one side and the Pavanje River on the other. Groundwater resources in this area mainly consist of unconfined sandy aquifers exploited through shallow wells. Freshwater occurs as a shallow and narrow groundwater lens, highly vulnerable to saline water intrusion.

In order to define a sustainable development policy for this aquifer, one needs to characterize it, *i.e.* to assess its geometry, hydrodynamic parameters and water quality. However, since the rarity of freshwater and the risk of saline water intrusion prevent the use of pumping tests, this characterization must be done with alternative tools, such as non-intrusive geophysical methods. An additional advantage of geophysical methods is their ability to provide spatial information.

Accordingly, Time Domain Electro-Magnetism (TDEM) soundings were carried out to delineate the extension and the thickness e_{fw} of the freshwater lens, using the vertical changes in electrical resistivity $\rho(z)$. Also, Magnetic Resonance Soundings (MRS) were performed to estimate both specific yield $S_{y_{MRS}}$ and transmissivity T_{MRS} of the aquifer. Electrical conductivity of groundwater (EC) was measured in wells and bore wells close to the sounding locations.

The combined use of these geophysical and hydrological characteristics enabled the calibration of the parameters of Archie's law (*a* and *m*) for this clay-free area. This was done by fixing the values of aquifer electrical resistivity, aquifer porosity and groundwater electrical conductivity in Archie's equation with $\rho(z)$ from TDEM, $S_{y_{MRS}}$ from MRS and EC from bore wells information respectively. Application of this calibrated Archie's law enabled direct calculation of aquifer porosity from $\rho(z)$ and groundwater EC measurements.

The results obtained in this study were used to develop the following maps for the aquifer:

- extension and thickness of the freshwater lens, with TDEM soundings only;
- distribution of the hydraulic conductivity *K*, obtained from T_{MRS} and e_{fw};
- distribution of the freshwater volume, derived from the calibrated Archie's law, TDEM information and water EC measurements.