ABSTRACT

The Minjur-Panjetty aquifer system (MPAS) situated North of the city of Madras in Tamilnadu state, India is a multiaquifer system, formed from the alluvial deposits. The aquifer system consists of an upper water table aquifer having very low hydraulic conductivity, a potential lower artesian aquifer and an aquitard, separating these two aquifers. The recharge water to the upper aquifer builds up head in it, leaks through the aquitard and becomes the source of water to the lower aquifer. The abstraction of water takes place from the lower aquifer. A study of the hydrographs of the upper and lower aquifers and the relative position of these hydrographs with reference to the elevations of the three formations reveals that the aquifers respond together for the given hydrologic stresses, a portion of the lower aquifer changes between confined and unconfined condition and the annual fluctuation of hydrographs in the upper aquifer is of the same order of magnitude of that in the lower aquifer. These conditions indicate that the MPAS is subjected to the following nonlinear flow features:

(i) The variations in transmissivity resulting from variations in saturated thickness of the lower aquifer

(ii) The changes in storage coefficient value of the lower aquifer due to the aquifer changing between confined and unconfined conditions
(iii) The changes in leakage caused by changes in the condition of the lower aquifer and variations in the elevation of the water table in the upper aquifer.

A model for two-layer aquifer system, taking into account all the nonlinear flows mentioned above, is developed and tested with the MPAS data.

The governing flow equations of the two-layer aquifer system are written in finite difference equations, incorporating the nonlinear flow features in them. The model uses iterative technique for the solutions. The model is validated using the analytical solutions of the one- and two-dimensional flow problems.

The hydrogeologic parameters of the three formations of the MPAS are estimated from the available pumping test results and the soil classification. A study period of seven years from 1976 to 1982 is taken for the simulation and the various flows of the aquifer system are estimated for the period. An empirical model is proposed for the estimation of rainfall recharge. The model is run for the seven years data and calibrated by adjusting the hydrogeologic parameters and the flows.

The simulated groundwater head hydrographs of the upper and lower aquifers are compared with field hydrographs and the model is found to simulate the MPAS fairly accurately. The model predicts that 10-14 percent of the lower aquifer area changes between confined and unconfined conditions every year and simulates the net discharge to sea and the vertical leakage.
The results of the study on the effects of ignoring anyone or all of the nonlinear features in the proposed model are presented and discussed. The main conclusions arrived at are:

(1) The proposed model which takes all the nonlinear features into account simulates the MPAS satisfactorily.

(2) A model which ignores anyone or all the nonlinear features leads to the following:

(i) Ignoring the changing conditions of the lower aquifer between confined and unconfined and using the confined storage coefficient value has increased the fluctuation of groundwater head to an extent of 2.5 times.

(ii) Neglecting the changing condition of the lower aquifer during a time step has decreased the recovery of groundwater head by about 20 percent.

(iii) Either treating the MPAS as a linear system or assuming a constant water level elevation in the upper aquifer has led to:

a. decrease in the groundwater head fluctuation by 0-50 percent

b. increase in the vertical leakage by 4-17 percent and

c. increase in the discharge to sea by 2 to 23 times.

(3) Nonlinear features of an aquifer system are to be taken into consideration when modelling it. Such models lead to better understanding of the flow mechanism in the system.