

The use of DRASTIC modelling indices for the assessment of groundwater pollution potential

M. CHANDRA SEKHAR & K. KARUNA KUMAR

Water & Environment Division, Regional Engineering College, Warangal 506004, India
e-mail: mcs@recw.ernet.in

Abstract The vulnerability of groundwater to pollution depends on various factors such as depth to water table, net recharge, aquifer media, soil media, topography, impact of vadose zone, hydraulic conductivity of the aquifer, cropping pattern etc. The Kakatiya canal area studied in this investigation was found to have polluted groundwater aquifers calling for immediate counter-measures and integrated management of pollution. However, some of the factors investigated, termed "DRASTIC" factors, constitute varying risks for pollution of the aquifer groundwaters. The vulnerability to groundwater pollution is estimated by giving suitable weights and rating to these DRASTIC factors which are determined from the seasonal data which has been collected.

INTRODUCTION AND METHODOLOGY

In groundwater resource evaluation, the quality of groundwater is as important as the quantity (Sharaf & Hussein, 1996). The present study aims to assess groundwater pollution potential through the use of DRASTIC modelling indices within the Sri Ram Sagar Project area. In 1985, the US Environmental Protection Agency placed groundwater pollution by agricultural chemicals at the top of their priority list and has developed methodologies that evaluate the probability of agricultural chemicals contained in groundwater. One of the methodologies termed DRASTIC, focuses on classic hydrogeologic parameters while concentrating on the movement of pesticides through soil pores (Sathish Kumar Reddy *et al.*, 1985). "DRASTIC" factors are those factors which influence the groundwater pollution potential of an area to a maximum extent. After considering various factors affecting groundwater pollution potential, the following factors: depth to groundwater table (D), net recharge (R), aquifer media (A), soil media (S), topography (T), impact of vadose zone (I) and hydraulic conductivity of the aquifer (C) have been identified as the most important factors in the area under study. The factors have been assigned weights depending upon their relative importance in determining the groundwater pollution potential. The factors are later suitably rated taking the pollution transport phenomenon into account.

The DRASTIC index or pollution potential of each grid was calculated using the expression:

$$\text{Pollution Potential} = D_r D_w + R_r R_w + A_r A_w + S_r S_w + T_r T_w + I_r I_w + C_r C_w$$

where r and w indicate rates and weights assigned to each of the DRASTIC factors. A higher DRASTIC Index points to high vulnerability of groundwater to pollution and a lower value indicates that the groundwater in the area is relatively safe.

RESULTS AND DISCUSSION

The DRASTIC Index is calculated for various grids and the results for both pre-monsoon and post-monsoon periods have been obtained assuming net recharge for pre-monsoon as 83 mm and for post-monsoon as 703 mm (85% of total rainfall).

Variation in index The DRASTIC index gives an indication of the areas which are more vulnerable to groundwater pollution. The results reveal that the DRASTIC index values varies from 135 to 195 for pre-monsoon periods. The entire region may be classified into three zones with respect to DRASTIC indices. As the DRASTIC index provides only relative assessment of groundwater pollution potential, areas with an index value ranging between 135 and 155 are less prone to pollution. However, the areas with indices 155–175 have moderate vulnerability possibly due to variation in aquifer characteristics and hydrogeological features within the study area. For the post-monsoon period, the results reveal that the DRASTIC index values vary from 165 to 205. The depth to groundwater table plays an important role for such observed increases in the DRASTIC index during the post-monsoon season.

Seasonal variation The values of the DRASTIC index are found to be higher during the post-monsoon season which points to the fact that the groundwater is more susceptible to pollution during this season due to increased levels of water table as a result of higher rainfall recharge. However, the groundwater is more prone to pollution during the post-monsoon period as the quantity of water entering the groundwater is higher. Another explanatory reason is that depth to the groundwater table is less during this period, which means the filtering media available to absorb pollution is less. In other words, time taken for the water to reach groundwater has a short time lag and hence more pollution reaches the underlying water. Whenever field specific conductance values are low, the DRASTIC indices are also found to be low.

Correlation studies Correlation studies have been carried out for results from randomly selected grids within the study area and from field data. There exists a significant correlation between the DRASTIC indices determined during the study and specific conductance (representing the amount of total dissolved solids) values obtained from the field data. The coefficient of correlation was found to be 0.68, which implies a good correlation between the results of the present study and field data. Hence, it can be concluded that as the pollution potential increases the vulnerability of the area to groundwater pollution increases.

CONCLUSIONS

The higher the DRASTIC index, the greater is the susceptibility to groundwater pollution. The results of the study are substantiated by a comparison of the pollution DRASTIC indices with background values obtained in the form of specific conductance. Additionally, DRASTIC indices demonstrate significant spatial variation but no point specification or localization, indicating that the pollution is non-point

sourced, since there are no point sources of pollution in the study area. With the patterns shown in the region, it is logical to assume that DRASTIC factors exert significant influence on the pollution patterns. Consequently, it is also evident from the comparison with background values for the area, that the weights assigned to the DRASTIC factors and factor ratings are quite meaningful and result-oriented. The probable avenue of pollution is mainly from the agricultural sector as the entire area consists of irrigated cropland. Certain other distinctions with respect to hydrochemistry are also possible. While variations in Total Dissolved Solids (TDS) have been considered for comparison during the study, other parameters, especially nitrates, phosphorous, potassium and pesticide residues, have not been considered due to lack of sufficient data. The results nevertheless, are useful in identifying critical regions vulnerable to groundwater pollution in terms of planning integrated studies of the groundwater in the region. It must however, be borne in mind that DRASTIC indices provide only a relative screening-type evaluation and do not provide absolute answers.

REFERENCES

- Sathish Kumar Reddy, K., Ranga, K. & Ranganna, G. (1995) Hydrogeological studies on groundwater pollution susceptibility through "DRASTIC" indices method (Karwar Taluk, Karnataka State). *Proc. National Seminar on Environmental Aspects of Water Resources Development and Management, Trivandrum*, III 50–55.
- Sharaf, M. A. & Hussein, M. T. (1996) Groundwater quality in the Saq aquifer, Saudi Arabia. *Hydrol. Sci. J.* **41**(5), 683–695.