RASĀYAN J. Chem.
Vol. 9 | No. 3 |465 - 470 | July - September | 2016
ISSN: 0974-1496 | e-ISSN: 0976-0083 | CODEN: RJCABP
http://www.rasayanjournal.com
http://www.rasayanjournal.co.in

# ASSESSMENT OF GROUNDWATER VULNERABILITY USING GIS BASED DRASTIC MODEL: A CASE STUDY OF SIPCOT-PERUNDURAI, ERODE

**S. Durgadevagi and R. Annadurai**
Department of Civil Engineering, SRM University, Kattankulathur-603203, Tamil Nadu, India
*E-mail: ddanirudh@gmail.com

**ABSTRACT**
Water is the basic element of social and economic infrastructure and is essential for healthy society. Due to urbanization and industrialization the demand of water is increasing day by day. Thus sustainable ground water development and preservation of ground water quality should be given importance. The people living near the SIPCOT industrial estate are suffering a lot by using of contaminated water, and hence it is an important need to assess the vulnerability of contamination and to take immediate effort to safeguard the groundwater. Accordingly this study aims to identify the ground vulnerability in and around the industrial area. The objective of this work is to identify the groundwater vulnerable zone using a GIS (Geographic Information System) based DRASTIC model. The result shows that more than 62% of the groundwater in and around SIPCOT area is under very high vulnerable zone. Thus the study suggests that this model can be an effective tool for identification of pollution vulnerable zone
**Keywords**: Groundwater quality, vulnerability, DRASTIC, GIS.


## INTRODUCTION

The drinking water quality in Indian cities has been deteriorating in recent years mainly due to the high growth of population, unplanned growth of cities, mixed land use patterns, no proper sewage system, and poor disposal of the wastewater both from household as well as industrial activities[1].A strategy for the protection of groundwater must be aimed at protecting aquifers from becoming contaminated, preventive efforts should be directed first at land use activities that pose a higher risk of causing pollution from both point and non-point sources. Care must be exercised to avoid ground water development that leads to the degradation of quality or the depletion of supplies[2].

The quality of groundwater depends on a large number of individual hydrological, physical, chemical and biological factors. Prevention of contamination is therefore critical for effective groundwater management[3].To properly manage and protect the resource, it is therefore important to determine areas with more aspects of vulnerable to contamination[4]. Groundwater vulnerability is considered an intrinsic property of groundwater that depends on its sensitivity to humans and natural impacts and can be defined as the possibility of percolation and diffusion of contaminants from surface of the earth into the groundwater system[5].Vulnerability zone maps have become an essential tool for groundwater protection and environmental management[6]. Several methods have been proposed for vulnerability assessment of aquifers. Hence, in this paper a standardized system called DRASTIC approach is used.

### Study Area

In Tamil Nadu, Erode is famous for its textile industries situated in the center part of Tamil Nadu. Perundurai is a developing town because of the advent of SIPCOT which is fully supported by Tamil Nadu Government. The exact location of the study area lies between 77˚30'55" E and 11˚15'22"N to between 77˚35'32"E and 11˚11'41" N.

The study area comes under the Toposheet 58E/8, 58E/9, 58E/11 and 58 E/12. The key plan of the study area is shown in Fig.-1. It is located in NH-47 between Salem and Coimbatore. Most of the villages around SPICOT depend on agriculture lands the sources of irrigation are streams, tanks and wells. Ground water plays a major role for irrigation and domestic use.

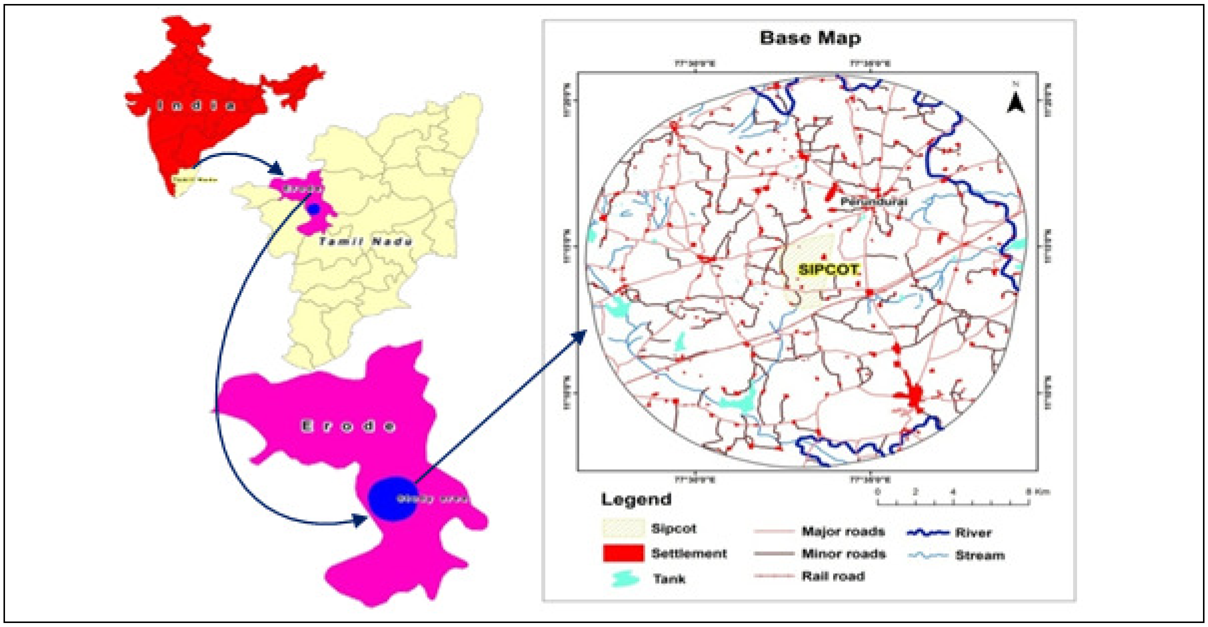


Fig.-1: Study Area

## EXPERIMENTAL

The methodology adopted in this study includes field data collection and assessment of groundwater vulnerability map using DRASTIC model. An overview of the methodology adopted for this study is presented as a flow chart (Fig.-2). The concept of groundwater vulnerability to contamination is based on the assumption that the physical environment may provide some degree of protection to groundwater against natural and human impacts with respect to contaminants in the groundwater[7].

Groundwater vulnerability to contamination is the tendency or likelihood for contaminants to reach a specified position in the groundwater system after introduction at some location above the uppermost aquifer[8] groundwater vulnerability is not an absolute or measurable property, but an indication of the relative possibility with which contamination of groundwater resources will occur. This understanding implies a very basic vulnerability concept that all groundwater is vulnerable[9].

## RESULTS AND DISCUSSION

The weight and ratings of different hydro geological parameters of Perundurai is calculated based on the pumping test data, rainfall and using various thematic maps. Depth to water therefore impacts on the degree of interaction between the percolating contaminant and sub-surface materials hence the weightage given to this parameter is high. The bore well data was collected from the Central groundwater board, Chennai. These point data were contoured by interpolating and divided into five categories i.e. 5.34-7.55 m, 7.55-9.08m, 9.08-10.28m, 10.28-11.85m, and 11.85-15.58m (Fig.-3). DRASTIC ranges rating are shown in Table-2. The areas with high water tables are vulnerable because pollutants have short distances to travel before contacting the Groundwater, deeper the Groundwater smaller the rating value.

Recharge water is a significant vehicle for percolating and transporting contaminants within the vadose zone to the saturated zone. It carries the solid and liquid contaminants to the water table and also increases the contamination level in water table[10]. The map incorporates available features like slope, soil permeability and rainfall, are used to calculate the recharge component (Fig.-4). A digital elevation model (DEM) of the study area was used to identify the slope % and soil permeability was calculated from soil

Vol. 9 | No. 3 |465 - 470 | July - September | 2016

type, average rainfall of the study area was used as a recharge index and the finalized recharge value was calculated.

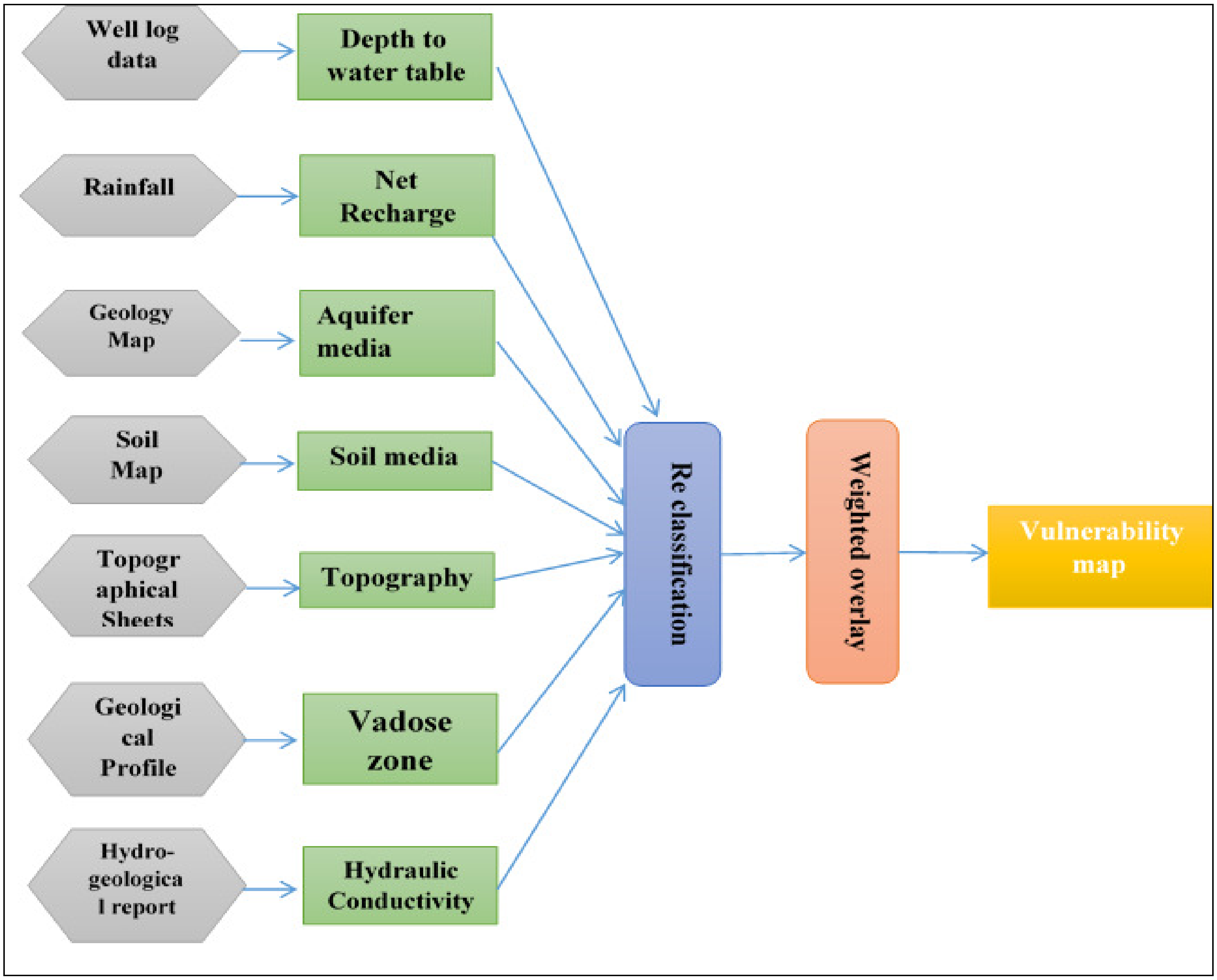


Fig.-2: Flow chart showing the methodology adopted in this study

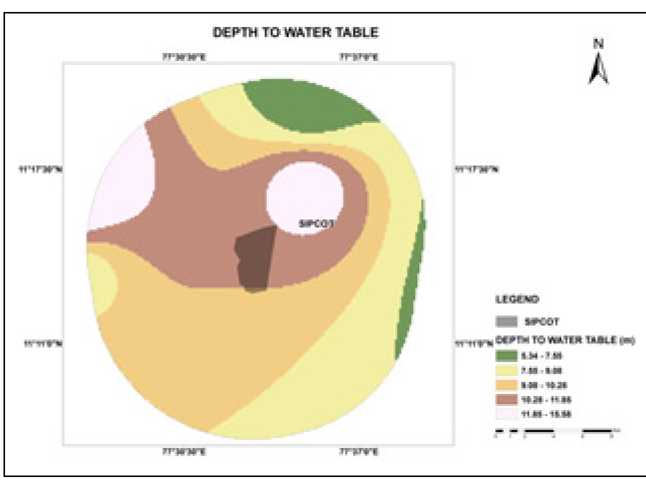


Fig.-3: Depth to water table

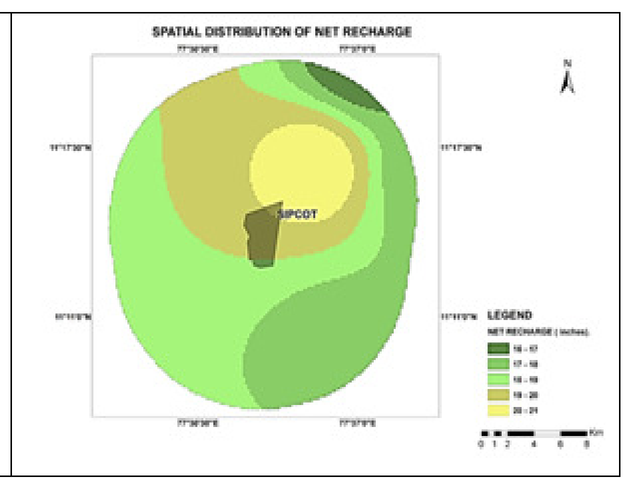


Fig.-4: Net Recharge

Table-1: Range and rating for DRASTIC model

<table>
<tr><td colspan="2">Depth to water table</td><td colspan="2">Net recharge</td><td colspan="2">Aquifer Media</td><td colspan="2">Topography</td></tr>
<tr><td>Ranges</td><td>Ratings</td><td>Ranges</td><td>Ratings</td><td rowspan="2">Range</td><td rowspan="2">Rating</td><td rowspan="2">Range</td><td rowspan="2">Rating</td></tr>
<tr><td>4.0 - 6.0</td><td>1</td><td>4.0 - 6.0</td><td>1</td></tr>
<tr><td>6.0 - 8.0</td><td>2</td><td>6.0 - 8.0</td><td>2</td><td rowspan="3">Gneiss</td><td rowspan="3">2</td><td>18+</td><td>1</td></tr>
<tr><td>8.0 - 10.0</td><td>3</td><td>8.0 - 10.0</td><td>3</td><td colspan="2">Vadose Zone</td></tr>
<tr><td>10.0 - 12.0</td><td>4</td><td>10.0 - 12.0</td><td>4</td><td>Range</td><td>Rating</td></tr>
<tr><td>12.0 - 14.0</td><td>5</td><td>12.0 - 14.0</td><td>5</td><td colspan="2">Soil media</td><td>Gneiss</td><td>2</td></tr>
<tr><td>14.0 - 16.0</td><td>6</td><td>14.0 - 16.0</td><td>6</td><td>Range</td><td>Rating</td><td colspan="2">Hydraulic Conductivity</td></tr>
<tr><td>16.0 - 18.0</td><td>7</td><td>16.0 - 18.0</td><td>7</td><td rowspan="2">BROWN SOIL</td><td rowspan="2">4</td><td rowspan="2">Range</td><td rowspan="2">Rating</td></tr>
<tr><td>18.0 - 20.0</td><td>8</td><td>18.0 - 20.0</td><td>8</td></tr>
<tr><td>20.0 - 22.0</td><td>9</td><td>20.0 - 22.0</td><td>9</td><td rowspan="2">RED SOIL</td><td rowspan="2">8</td><td rowspan="2">1 -100</td><td rowspan="2">1</td></tr>
<tr><td>22.0 - 24.0</td><td>10</td><td>22.0 - 24.0</td><td>10</td></tr>
</table>

An aquifer media map was prepared from the well log data and topographical maps. Based on the geological description of the study area, the aquifer media was classified as Granite Gneiss (Fig.-5). The contaminant attenuation of the aquifer depends on the amount and sorting of fine grains. The larger the grain-size and the more fractures or openings within the aquifers, the higher the permeability and lower the attenuation capacity, consequently the greater the pollution potential[11].

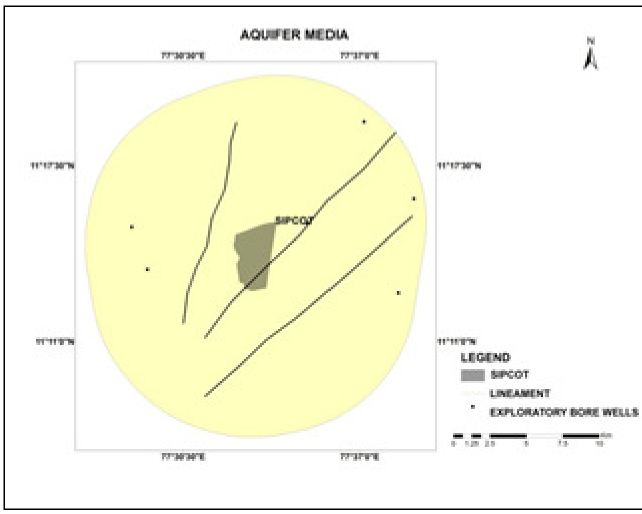


Fig.-5: Aquifer media

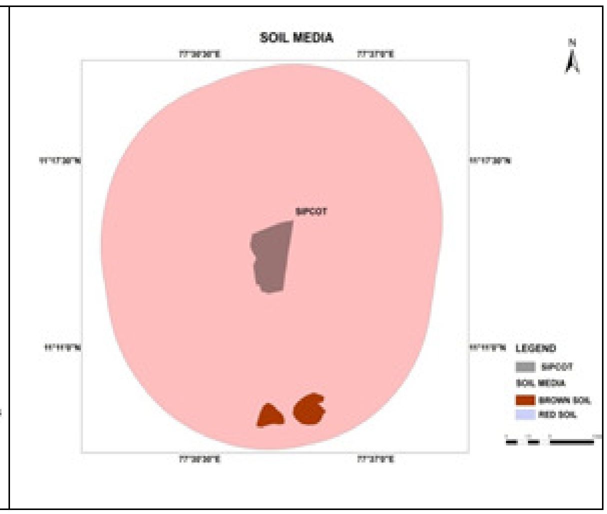


Fig.-6: Soil media

A soil map was prepared from the district soil map and weightages and ratings were assigned (Table-1). Soil found in the study area is either red soil or brown soil (Fig.-6).the weightage given for the soil map is 2. The topographic map was prepared from Toposheet. Contours of 20m were digitized and then digital elevation model (DEM) was prepared in ArcView. The slope was extracted from the DEM and it was divided into five classes (Table-1). Topography will give an indication on whether a pollutant will run off or remain on the surface long enough to infiltrate into the groundwater[12]. Slope variation in the study area is very small, i.e. 89.90-90.00m (Fig.-7). Flat areas were assigned high rates because in flat areas the runoff rate is less, so more percolation of contaminants will be more to the groundwater.

Impact of vadose zone was prepared using DEM and Well log data. The vadose zone has a high impact on water movement if it is composed of a permeable material. The weights and ratings for the vadose zone are shown in Table-1. Vadose zones have been mapped as shown in Fig.-8. Hydraulic conductivity has been calculated from the pumping test data and spatial hydraulic conductivity map obtained from geological survey of India (Fig.-9). An aquifer with high conductivity is vulnerable to substantial contamination as a plume of contamination can move easily through the aquifer (Table-1). This is different from an aquifer media as an aquifer with an impermeable media can still conduct water in the presence of fractures[13].

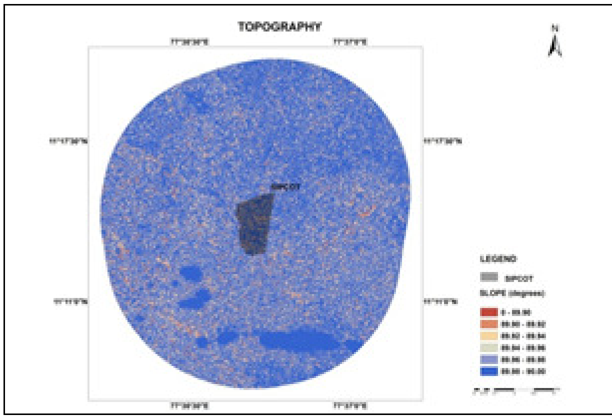

Fig.-7: Topography

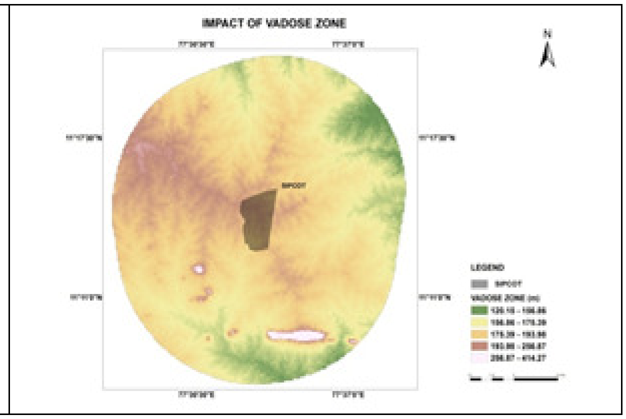

Fig.-8: Vadose zone

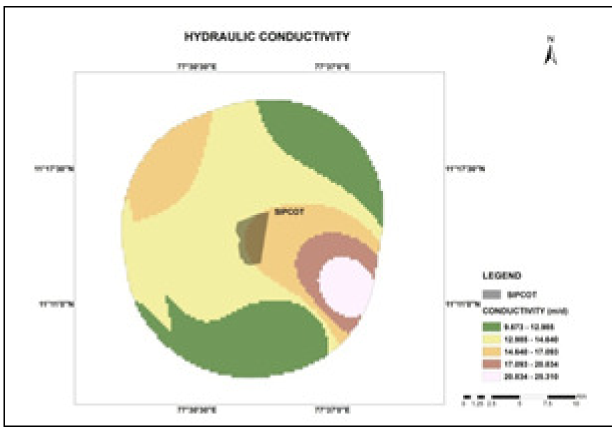

Fig.-9: Hydraulic Conductivity

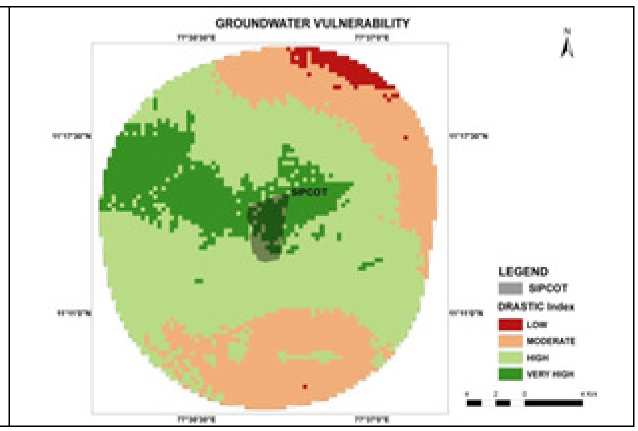

Fig.-10: Groundwater vulnerability in the study area

The final vulnerability map was obtained by running the model GIS environment by using the seven hydro-geological data layers. The DRASTIC scores obtained from the model were reclassified into four classes i.e., low vulnerable zones, moderate vulnerable zones and high vulnerable zones and very high vulnerable zone (Fig.-10). The results of this study shows that 10 % of total area is in the low vulnerable zone, 28 % are in the moderately vulnerable zone, 48% are in high vulnerable zone and about 14% are in very high vulnerable zone . This means that more than half of the Perundurai groundwater is at high risk in terms of pollution potential.

## CONCLUSION

This study employed a GIS based DRASTIC model to determine the vulnerability of groundwater to contamination in and around SIPCOT industrial estate Perundurai, Erode which is under cluster of pollution. Highly vulnerable zones are very difficult to monitor, as it requires the drilling of many monitoring wells, which is very expensive. This study is a valuable tool for local authorities for managing groundwater resources, monitoring this problem closely and to act accordingly.

The areas, which are under the high vulnerable pollution are mainly in the central parts that is 5 to 6 km around the SIPCOT industrial area where the physical factors like gentle slope and high water table are very well supporting the chances of getting shallow aquifer water polluted. Wastewater discharge from industries remains there for months together and even years in low lying areas and hence the groundwater recharged by this wastewater leads to the high vulnerable The DRASTIC map produced can be applied to any pollutant which interacts with water at the surface but it does not give a clear picture of the pollution potential of individual chemical constituents as to how much they contribute to the pollution of Groundwater. This is one of the important limitations of this study.

## REFERENCES

1. Vowinkel, Clawges, Buxton, Stedfast, and Louis, US Geological Survey Fact Sheet FS-165-96, **3**. (1996)
2. Sniffer, Project report code WFD **28**, September 2004,
3. Dixon, Scott, Dixon, and Steele, *Physical Geography*, **23**, 130(2002).
4. Aller, Bennet, Lehr, and Petty, USEPA document no. EPA/600/2-85-018. (1987).
5. S. Shahid, *Journal of Environmental Hydrology*, **8**, 124 (2000).
6. Barber, Bates, Barron, and Allison, *Journal of Australian Geology and Geophysics*, **14(2/3)**, 1147 (1993).
7. L. Rosen, 37th conference of the International Association for read Lakes Research and Estuarine Research Federation. Buffalo, NY: IAGLR. 166. (1994).
8. National Research Council Survey- Research- Doctorate Programs in the United States UC Comparison Programs, 16. (1993).
9. Vrba and Zaporotec, *International Contribution for Hydrogeology*, **16**, 94(1994).
10. Kim and Hamm, *Hydrogeology Journal*, **7(2)**, 227 (1999).
11. M. Anwar, Prem, and Rao, Proceedings of the international conference **18**,399(2003).
12. Michael, Thomas, Michael, and Dennis, http://pubs.water.usgs.gov/cir1224 , USGS Publishing Network. (2005).
13. Babiker, Mohammed, Hiyama, and K. Kato, *Science of the Total Environment*, **345**, 127 (2005).
14. N. Raman and D. Sathiyanarayanan, *Rasayan J. Chem.*, **4(2)**, 481(2011).
15. N. Raman and D. Sathiyanarayanan, *Rasayan J. Chem.* **1(4)**, 828(2008).
16. K. Prasanna and R. Annadurai, *Rasayan J. Chem.*, **9(2)**, 287(2016).

[RJC-1426/2016]