

GIS BASED MODELING OF GEO-CHEMICAL QUALITY OF GROUNDWATER IN CHANDIGARH

Siby John, L.N.Sharma* and Rajesh Bansal

Dean, Punjab Technical University, Jalandhar, johnsiby@rediffmail.com

Deptt. Of Applied Sciences, Punjab Engineering College, Sector 12, Chandigarh, lnsharma@yahoo.com

SDE, W/S Sub Div 2, Fifth Floor, Additional Deluxe Building, Sector 9, Chandigarh., rkbansal1@rediffmail.com

* corresponding author

KEY WORDS: GIS, Geochemical parameters, Groundwater, heavy metals & geo-spatial data

ABSTRACT:

As surface water is inadequate to meet the increasing human demand, groundwater sources are largely being resorted to. Groundwater, many a times, is not adequate and safe for direct human consumption. Chandigarh is located at the foot of Himalayan ranges and meets its water requirement from both surface and groundwater. Exponential increase in the population led to lowering of the groundwater table. Since 25% water for human consumption in the city is supplied through tube wells, its purity is important factor. The purity of groundwater need to be evaluated time and again. About 105 water samples collected in 1997 & 2001 from tube wells were analyzed for geochemical parameters including heavy metals. The paper deals with the use of GIS as a tool for understanding spatial distribution of these parameters. Using Map-INFO map containing geo-referenced location of tube wells was digitized. Thematic maps were generated for each geo-chemical parameter of ground water. Geochemical parameters included pH, EC, TDS, HCO₃, Cl, SO₄, NO₃, F, PO₄ Ca, Mg, Na, K, SiO₂, Total hardness. The study reveals that parameters such as Fe, Mn, Pb, Cd, Ni and NO₃ are found to be beyond permissible limit as per EPA standards. Thus, it is concluded from the above study that continuous monitoring of ground water in Chandigarh is need of the hour. Further, GIS based models could be used as potential tool for not only understanding yearly distribution of data but also a geospatial data base will be created for the years to come. Time variation among these parameters can be understood in a more efficient manner using this methodology.

1. INTRODUCTION:

Water is the life line without which life on planet is impossible. Every living being including the animals and the plants require water to meet with their daily needs. However, complete requirement of the human beings are not met from the surface water only and as such they have to depend upon the underground water that may or may not be potable. It is imperative to study the geo-chemistry of ground water being used as potable water. Therefore, proper treatment of the contaminated ground water is required before use. The Geographical information system (GIS) has emerged as an effective tool for analyzing the vast volumes of different data types, obtained from different sources. GIS based models help in understanding yearly distribution and provides a data base for future use. It is being used to manage environmental, climatic and hydrological data to support decision making and meet regulatory requirements.

S.D Dhiman & A.K.Kesari (2002) carried out GIS based analysis of Geochemical species present in the groundwater of Mehsana District of Gujarat.

This paper deals with analysis of geo-chemical parameters of the ground water in Chandigarh with the help of GIS as a tool.

Chandigarh, the city beautiful, is fast emerging as one of the most advanced cities of India. Located in

Shivalik Foot Hills at 76°-42' to 76° 51' Longitude and 30°-40' to 30°-46' Latitude. It is surrounded with Patiala Ki Rao On North –West and Sukhna Choe on the North East direction and spread over an area of 114 sq km. The city had a population of 9 lac in 2001 and expected to grow in the year 2020 to 15 lac. The city receives about 50 MGD of water through canal supply from Bhakra Main Canal and 15 MGD of water from deep tube wells. The projected demand in the years from 2006 to 2020 could be from 125 MGD to 151 MGD.

The Central Ground Water Board had attempted to carry out a study to know the hydrology of the ground water in Chandigarh. CGWB in 1997 & 2001 collected samples from various tube wells located in Chandigarh. Collected samples were analyzed for pH, EC, TDS, CO₃, HCO₃, Cl, SO₄, NO₃, F, PO₄ Ca, Mg, Na, K, SiO₂, B, and T.H. and heavy metals such as Cd, Cr, Cu, Fe, Mn, Ni, Pb & Zn,

Taking this data of geochemical parameters of groundwater in Chandigarh into account it was felt that using GIS following efforts will further help in understanding spatial and temporal variation of these parameters

- (i) Digitalization of Chandigarh map with marking of tube well sites from where samples were taken.
- (ii) Spatial location of tube wells in terms of latitude and longitude.
- (iii) Analysis of geo-chemical parameters and its spatial as well as temporal variations in city.

2 METHODOLOGY:

The layout plan containing information about various sectors, roads, villages, water bodies, tube wells and municipal corporation boundary of Chandigarh was scanned and digitalized with help of software R2V (Figure 1). Using MAP-INFO, a GIS package, the locations of all the tube wells in Chandigarh were marked on it in relation to the longitude and latitudes.



Figure 1. Layout plan of Chandigarh

The tube wells in the city are managed by two different agencies namely Chandigarh Administration and Municipal Corporation, were digitized by assigning different symbols and stored as separate layers. The tube wells whose chemical analysis was available were marked separately. Also, tube wells having geochemical parameters were created in two separate layers with chemical data and heavy metal data (figure 2).

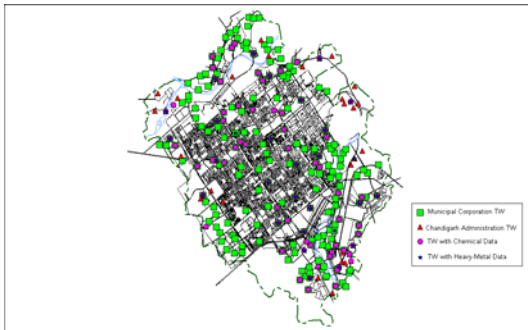


Figure 2. Map showing spatial distribution of tube wells

2.1 RESULTS AND DISCUSSION :

Then using GIS, the spread area of various geo-chemical parameters has been evolved separately for each parameter and shown on a separate plan. The groundwater of Chandigarh is alkaline in general, having pH value up to 8.3. The alkalinity of groundwater is more in NW and western parts of the city (Figure.3).

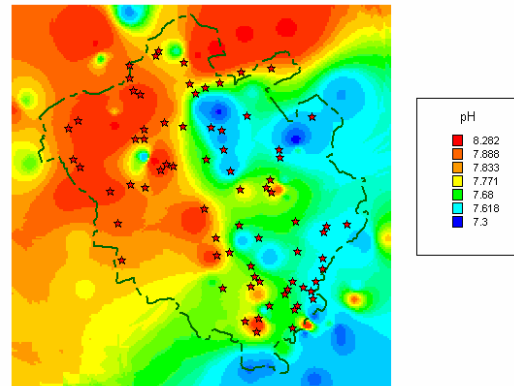


Figure 3. Map showing spatial distribution of pH concentration

Spatial distribution of Alkali/ Alkaline earth metals such as Na, K & Mg, Ca was brought out. It is observed that the value of Ca is beyond desirable limit on the Eastern and Northern parts of the city (Figure 4).

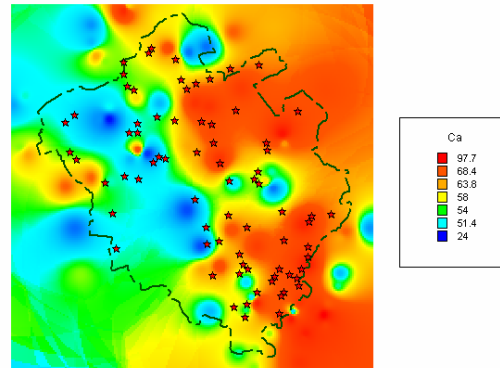


Figure 4. Map showing spatial distribution of Calcium concentration

From the study of spatial distribution of Nitrate, it is revealed that the values of nitrate are more in NE region (Figure5).

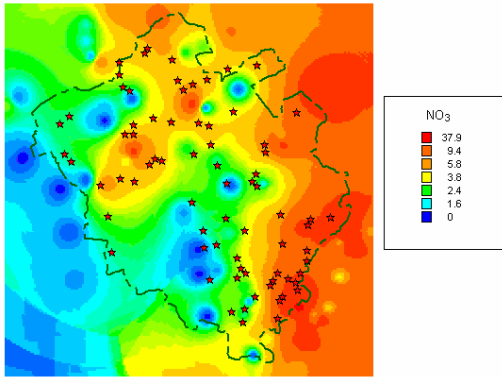


Figure 5. Map showing spatial distribution of Nitrate concentration

The transitional metals such as iron content in the groundwater is much beyond the permissible limit specifically in the southern areas. In addition Mn is also reported to be beyond permissible limit here. This is attributed to industries and agriculture practices in the area. (Figure 6).

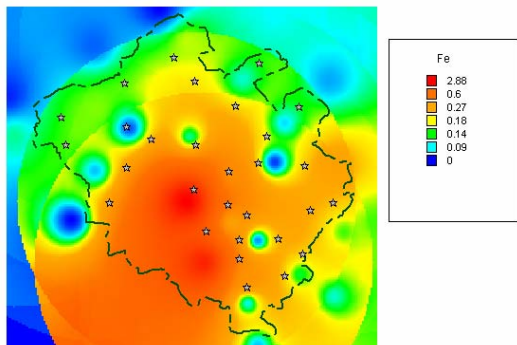


Figure 6. Map showing spatial distribution of Iron concentration

Among the heavy metals it is observed that concentration of Pb is beyond permissible limit in the western and central parts of the city. (Figure7).

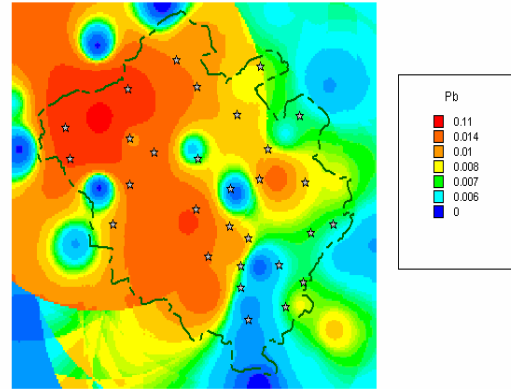


Figure 7. Map showing spatial distribution of Lead concentration

The spatial distribution of heavy metal “Cd” shows that the concentration is more than desirable limits in the western and southern parts of the city (Figure 8).

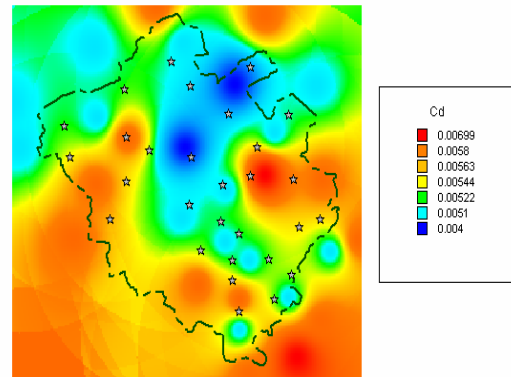


Figure 8. Map showing spatial distribution of Cadmium concentration

In addition to the spatial distribution of various geochemical parameters, the bivariate relationship between the pH and Total Dissolved Solids (TDS) was analyzed (Figure 9). The correlation coefficient between the two variables is found to be 0.628 and equation derived is shown in the figure.

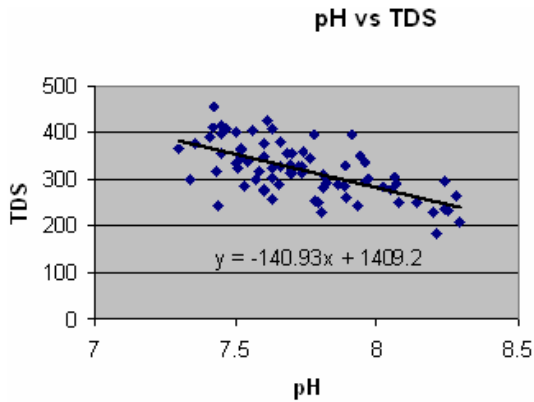


Figure 9. Graph showing bivariate analysis between pH and TDS

From the bivariate analysis of TDS vs Cl the correlation coefficient was found out to be 0.547 as shown in Figure 10. Regression analysis clearly brought out that the variation between TDS and Cl can be best approximated by a three degree polynomial equation shown in the graph.

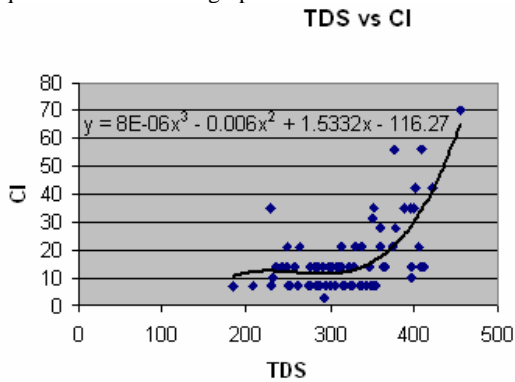


Figure 10. Map showing bivariate analysis between TDS and Cl.

Also the bivariate analysis between the pH and Fe was found out which is described by a linear equation as shown in the Figure 11.

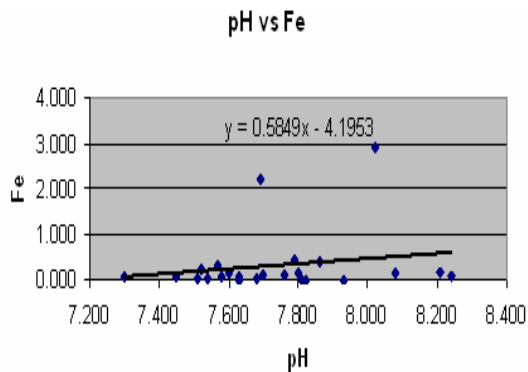


Figure 11. Map showing bivariate analysis between Ph and Fe

4. CONCLUSIONS:

Thus, from the study it is concluded that GIS has proved to be an effective tool to understand spatial distribution of various geochemical parameters of groundwater in Chandigarh. The bivariate analysis attempted between several parameters has clearly brought out the interdependence among them as displayed by the strong correlation coefficients. Keeping in view the contamination of groundwater, it is imperative to treat it to make it potable. The monitoring of geochemical parameters of groundwater is thus becomes essential for the better management and control of this precious resource from futuristic point of view.

5. ACKNOWLEDGEMENT

The authors express their gratitude to Central Ground Water Board, Chandigarh for providing geochemical data. We wish to thank the Director, Punjab Engineering College, Chandigarh and the coordinator, computational engineering lab for motivating and extending GIS facility, respectively. Thanks are also due to Manish Gupta, student Thapar Institute of Engineering And Technology, Patiala for extending help during the analysis of data.

6. REFERENCES:

1. A.L.Ramanathan et al , Recent trends in Hydrogeochemistry, Capital publishing company, New Delhi, 2002
2. Hydrogeology of Chandigarh, CGWB, NW region, Chandigarh, 2002