Application of GIS model in pollution abatement

Shravya H C[1], Sinchana P[2], Shashi Prasad T[3], Punith N[4] Dr MC Sampath Kumar[5]

[1]*Student,Department of Civil Engineering,BMS College Of Engineering, Karnataka,India*
[2] *Student,Department of Civil Engineering,BMS College Of Engineering, Karnataka,India*
[3] *Student,Department of Civil Engineering,BMS College Of Engineering, Karnataka,India*
[4] *Student,Department of Civil Engineering,BMS College Of Engineering, Karnataka,India*
[5] *Professor,,Department of Civil Engineering,BMS College Of Engineering, Karnataka,India*

Abstract

Land use types, anthropogenic activities, industrial activity represent considerable threats to groundwater. One of the most important sources of drinking water is groundwater in India. To effectively monitor the groundwater quality due to pharmaceutical industry waste water disposal and measure its pollution levels before they become severe we have conducted this study. In this study, we used a GIS-based DRASTIC model (Depth to water, Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, Hydraulic conductivity) to analyze the area's hydrological attributes to assess the groundwater susceptibility to pollution. Considering the importance of anthropogenic activities,we have used an adjusted DRASTIC model called DRASTICA, which incorporates anthropogenic impact as a parameter in the model.

Keywords – *GIS, DRASTICA model,groundwater pollution,pollution assessment through advanced tools.*

---

1. 1. INTRODUCTION

The pharmaceutical industry that was selected for our studies is situated in South Bangalore Karnataka,India. Over its short history, since commencing operations in 2007, the company has become a powerhouse for drug and new products development and manufacture, with equal emphasis on biological and chemistry based products and services. For the study, wastewater samples from the industry were collected and conducted primary analysis which revealed the presence of traces of heavy metals and the sample was highly alkali. As the presence of heavy metals in drinking water is highly poisonous hence studies were conducted on groundwater using advanced GIS tools. The total area selected is 1159km^2 around our pharmaceutical industry and studies were conducted using the DRASTICA model.The ArcGIS 10.3 software was used to obtain the drastic models.

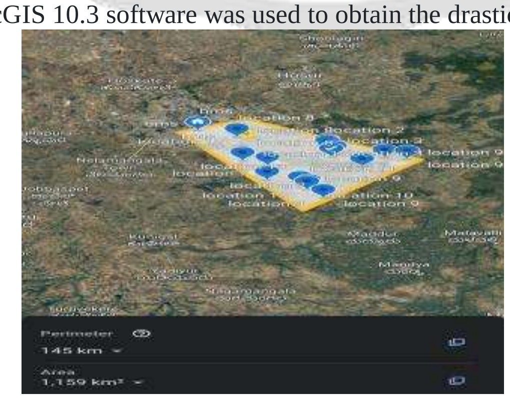

Figure 1 Google earth image of the study area

2. Laboratory Analysis

2.1 Primary Analysis of the pharmaceutical wastewater

Primary laboratory experiments were conducted on the waste water collected from the pharmaceutical industry. The following table gives us the result. The primary tests were conducted for the sample as received, 10%dilution with water and 20%dilution with water. The test results reveal that our sample is highly alkaline and has high TDS.

Table 1. Result chart of the conducted laboratory analysis.

Sr no	Parameters	Concentration	10% dilution	20% dilution	Standard
1	pH	8.5	7.5	7	7
2	Total Acidity(mg/L)	40	48	60	400
3	Total alkalinity(mg/L)	3080	2880	2440	200
4	Total dissolved solids(mg/L)	2380	2100	1847	500
5	Conductivity(mg/L)	3.68	3.23	2.84	0.05
6	Dissolved oxygen(mg/L)	0.42	1.1	1.64	8
7	Mercury(mg/L)	0.96	Not detected	Not detected	0.0005
8	Cadmium(mg/L)	0.005	Not detected	Not detected	0.005
9	Nickel(mg/L)	0.1373	0.1349	0.1338	0.1
10	Iron(mg/L)	0.2619	0.2919	0.2456	2

Inference drawn from the above table is that the wastewater can not be directly disposed without conducting treatment..To check the effect of disposal of this untreated wastewater in the surrounding lakes and river,studies were conducted using the DRASTIC model tests.

1. 2.2.DRASTICA model

The DRASTIC (Depth to water, Recharge, Aquifer media, Soil media, Topography, Impact of the vadose zone, Hydraulic conductivity) model is commonly used to assess the susceptibility of groundwater due to pollution. Hydrological and geological factors control the groundwater flow into and out of an aquifer. In the DRASTIC model, these factors are compositely represented as hydrogeological settings. The main hydrogeological features of an area that control the groundwater susceptibility are the dwelling time of rainwater, infiltration of water past the soil, the amount of water reaching the water table, and the water flowing into the aquifer. The movement of contaminants in an aquifer is controlled by seven hydrogeological parameters that are considered in the DRASTIC model. An abrupt upsurge in urban development has negatively impacted the quality and quantity of groundwater hence in our studies we have included anthropogenic impact as one of our parameters in the model.

2.2.a. Basemap

Basemaps serve as a reference map on which you overlay data from layers and visualize geographic information. An individual basemap can be made of multiple features, raster, or web layers. They are the foundation for maps and provide context for your work.

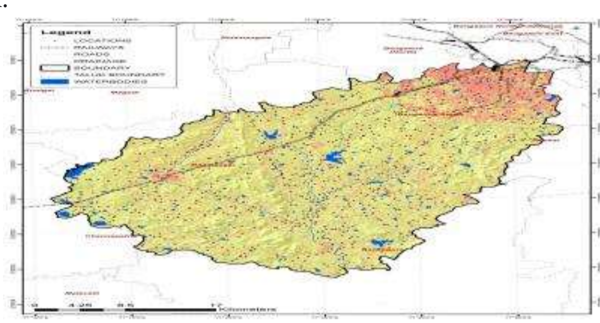

Figure 2 Base map of our study area

2.2.b. Depth to Water

The gap between the water table and the land surface is the depth to the groundwater table, which plays an active role in the evaluation of a certain area's susceptibility to pollution. The depth to water is of primary importance because the distance and the sum of time can be determined. In general, if the groundwater level is deeper and therefore less susceptible to contamination and vice-versa.

2.2.c .Digital elevation models (DEMs)

A DEM is a raster representation of a continuous surface usually referencing the surface of the earth.
The layer is symbolized by a color ramp.DEMs are used for a variety of spatial analysis.The most common datasets derived from DEMs are slope, aspect, hydrology and watersheds.

2.2.d Watershed area analysis

A watershed is defined by topographic divides between two or more adjacent catchment basins, such as a ridge or a crest. Delineation of watersheds can take place at different spatial scales. Delineation of watersheds can be divided into types and these are area based (series of watersheds, one for each stream section) and point based (watershed for each selected point. The selected point may be an outlet, a gauge station or a dam)

2. 3. Experiment and Discussion

Maps were prepared by exercising the DRASTIC model in ArcGIS 10.3 software.

3.1 Depth to Water

As the Ground water level is at 5-10m depth from the pharmaceutical industry, less susceptible to pollution compared to other locations.

Figure 3 Depth to water map of our study area

3.2 Digital elevation models (DEMs)

Selected location of the pharmaceutical industry is at the highest elevation compared to other water sample locations. Because of being located in high elevation, the wastewater disposed of from our industry enters the other sample water bodies in the surrounding area.

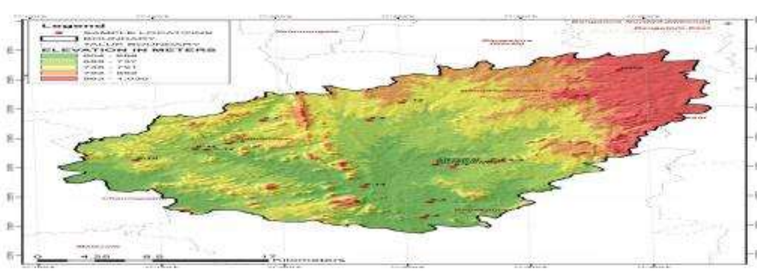

Figure 4 DEM map of our study area

3.3 Watershed area analysis

Pharmaceutical industry comes under the Arkavathy river basin.Arkavathi is a tributary of Cauvery River and flows for a length of 193 kms and the basin area is around 4253 square kilometers.Continuous disposal of these harmful chemicals into our water body will ultimately lead to deterioration of human and aquatic life directly or indirectly.

Figure 5 Watershed map of our study area

3. 4.CONCLUSION

In a typical DRASTICA model we distinguished the study area into three susceptibility classes namely, high, moderate, and low susceptibility to groundwater pollution. With the studies conducted we can conclude that our Arkavathi basic is highly susceptible to pollution . Due to the scarcity of water in urban areas of Bangalore,people depend greatly on groundwater sources. Our studies show that the harmful untreated wastewater from the industries are entering the groundwater source. Hence treatment of pharmaceutical waste before disposal is highly recommended. Further studies on other DRASTICA models will give us a detailed explanation of the groundwater pollution.The groundwater susceptibility map is an utmost cost-effective tool to detect zones of potential groundwater contamination, particularly in light of the chaotic and unrestrained expansion of land and objectionable events putting groundwater conditions at stake.. Policymakers and local authorities can use this as an operative tool in managing groundwater. Proper wastewater management policies need to be implemented, and wastewater plants must be installed to protect groundwater resources.

5.REFERENCES

[1] GIS based DRASTICA model for Assessment of groundwater vulnerability in Bangalore region,India, Swetha.A, Dr.Sampath Kumar, Dr Rajalaxmi M

[2] James W Merchant, “GIS -Based Groundwater Pollution Hazard Assessment”, *2004*.

[3] A Rahaman, "A GIS based drastic model for assessing groundwater in shallow aquifer," Elsevier, 2008

[4] K Voudouris, "Assessment of Intrinsic Vulnerability using the drastic model and GIS " European waters 2010.

[5] R Lathamani , " Evaluation of aquifer vulnerability using drastic model and GIS", Elsevier, 2015

[6] Aquifer Vulnerability Studies using DRASTICA Model 1,Amadi, A. N. , 2,Olasehinde, P. I., 3,Nwankwoala, H. O., 4,Dan-Hassan, M. A. and 5,Okoye, N. O. 1Department of Geology, Federal University of Technology, Minna, Nigeria 2Department of Geology, University of Port-Harcourt, Nigeria Rural Water Supply and Sanitation Department, FCT Water Board, Garki, Abuja, Nigeria

[7] .A modified-DRASTIC model (DRASTICA) for assessment of groundwater vulnerability to pollution in an urbanized environment in Lucknow, Indian Anjali Singh, S. K. Srivastav, Sudhir Kumar & Govind J. Chakrapani Environmental Earth Science

[8] A GIS-based DRASTIC Model and an Adjusted DRASTIC Model (DRASTICA) for Groundwater Susceptibility Assessment along the China–Pakistan Economic Corridor (CPEC) Route Ahsen Maqsoom 1 , Bilal Aslam 2 , Umer Khalil 1 , Omid Ghorbanzadeh 3,* , Hassan Ashraf 1 , Rana Faisal Tufail 1 , Danish Farooq 4 and Thomas Blaschke