

**ASSESSMENT OF GROUNDWATER POLLUTION POTENTIAL THROUGH REMOTE SENSING AND GIS
TECHNIQUE
A CASE STUDY FOR ANEKAL TALUK, BANGALORE URBAN DISTRICT, INDIA.**

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Groundwater is regarded to be the most valuable resources. Groundwater quality is affected by virtually every activity of the society thereby making groundwater protection complicated. The protection of groundwater is always cheaper than restoring already polluted aquifer. DRASTIC index methodology helps in the assessment of groundwater pollution potential.

DRASTIC index uses a set of seven hydrogeological parameters viz., D-depth to Groundwater table; R-recharge due to rainfall; A-aquifer media; S-soil media; T-topography; I-impact of vadose zone; C-hydraulic conductivity. These parameters are weighed with respect to their relative importance.

All the DRASTIC parameter layers in spatial formats are put into GIS. The layers were assigned weights and ratings and they are combined interactively in the computer system.. The DRASTIC index map was generated on a minute grid and seven categories of groundwater pollution potential zones were identified.

The Drastic Index represents the relative measure of groundwater pollution potential, which helps planners and administrators in broadly screening areas for waste disposal sites. Pollution potential map also helps in evaluating alternatives for directing the financial resources and land use activities to the appropriate areas.

INTRODUCTION:

The importance of water for sustaining human, animal and plant life needs no emphasis. Human health and welfare, agricultural growth, industrial development and ecobalance are all at critical stage, unless water and land resources are managed more efficiently now than in past. Even today more than 90% Indian population is primarily dependent on groundwater. So, it is essential to conserve groundwater quantity as well as quality.

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. Regulatory and technological measures must cover all categories of point and industrial landfills, mining operations and agricultural practice over exploitation of aquifers leading to quality degradation must be prevented.

A unique study has been made for Anekal Taluk, one of the three taluks of Bangalore urban district, Karnataka, India. It is alarming to note that the quality of water has deteriorated and aquifers are recharged with low quality water. The pollution potential of the study area is assessed by "DRASTIC" methodology, where in hydrogeological setting is given more importance besides, each alphabet representing a parameter.

STUDY AREA:

Anekal Taluk is geographically located between 12° 39' 39" to 12° 56' 30" North latitude and 77° 32' to 77° 50' East Latitude. The Taluk measures 512 Sq. km. Anekal Taluk represents an uneven landscape with intermingling of hills and valleys. The ground is much dissected and is a region of rapid erosion. The eastern portion of the Taluk is a

plane country. The western portion of Taluk is jungly and marketed by continues hills. The atmosphere is neither very humid nor dry. The Annual precipitation of this region is 890mm.

Anekal Taluk has a typical hydrogeologic setting. The entire Taluk comprise of mainly Granitic gneiss belonging to pre-Cambrian age. The granitic gneiss is exposed as a continuous chain of mounds raising from 300 to 500 feet above ground level. The depth of weathering is gentle. The central and eastern portions of taluk show maximum thickness of weathered mantle.

The population mainly depends on agriculture for their subsistence. The farming is mainly dry farming, as Taluk has not got any big rivers. Irrigation is mainly carried out by means of tanks and wells. The principle dry crops are ragi and gram. The wet crops consist of paddy, sugarcane and jowar. In addition to other crops aracca, betlevine, coconut, grapes, banana sugarcane, ground nut, vegetables etc., are also raised to some extent mulberry cultivation is also seen here and these.

DRASTIC METHDOLOGY:

DRASTIC - DRASTIC is a ground water pollution vulnerability assessment spatial deterministic model.

DRASTIC uses a set if seven hydrogeologic key parameters to classify the vulnerability or pollution potential of an aquifer. The parameters are weighed with respect to their relative importance to the pollution potential of the aquifer. The DRASTIC parameters are

- The Depth to ground water
- The Recharge due to rainfall
- The Aquifer media
- The Soil media
- The Topography
- The Impact of vadose zone
- The hydraulic conductivity

$$\text{DRASTIC INDEX (DI)} = D_R D_W + R_R R_W + A_R A_W + S_R S_W + T_R T_W + I_R I_W + C_R C_w$$

R refers to rating of the parameter ranges and W refers to the weighting of the parameter. Rating varying from 1 to 10, are intended to reflect the relative significance of classes with in each factor. The weightages and rating for various DRASTIC parameters is given in Table (1 to 7)

Depth to water is an important primary data, which determines the depth of material through which a contaminant must travel before reaching the Aquifer. The published reports of department of mines and geology are used for finding depth to water in the study area. Recharge is defined as the total quantity of water, which is applied on the ground surface. Recharged water is the principle vehicle for leaching and transporting solid and liquid contaminants to water table. The rainfall data of fixed rain gauge stations with sixteen years of observations has used. The recharge value polygons are obtained using revised norms of ground water estimation committee report. Aquifer media refers to the consolidated or unconsolidated rock, which serves as storage of water. In preparation of polygonal unit of aquifer media satellite remote sensing derived hydrogeomorphological maps and geological maps are used. The soil map from NBLUSS centre Bangalore was enlarged to 1:50,000 scale the soil units represented on maps are suitably combined into various textural unit polygons representing varied ability of a contaminant to move vertically into vadose zone. Topography refers to Slope and slope variability of the land surface. The slope map is derived using SOI top sheets. The impact vadose zone in complex phenomena combining aquifer media and topography characteristics. Hydraulic conductivity refers to the ability of the aquifer material to transmit water. The hydraulic conductivity values are calculated after calculating transmistivity from pumping test data. The weightages are assigned using, US EPA (works of Aller) for all the DRASTIC parameters.

Suitable modification are done in assigning ranges depending on the parameter values in hydrogeologic setting for Anekal Taluk.

Ranges, rating and weightages of DRASTIC PARAMETERS:

TABLE: 1
Depth to ground water table

Ranges (Mts.)	Ratings
0-4	10
4-8	9
8-12	7
12-16	5

Weight :5

Table:2
Recharge due to rainfall

Ranges (inches)	Ratings
<2.5	1
2.5-3.0	3
3.0-3.5	6
>3.5	8

weight:4

TABLE:3
Aquifer Media

Ranges	Ratings
Granetic Gneiss	1
Weathered Granetic Gneiss	6
Fractured Granetic	5
Weathered Fractured Granetic Gneiss	8
Valley Fills, Recent Sand Deposits	9

Weight:3

TABLE:4
Soil Media

Ranges	Ratings
Shrinking/Aggregated Clay	7
Sandy Loam	6
Loam	5
Clay loam	4

Weight:2

TABLE:5
Topography

Ranges (%Slope)	Ratings
0-2	10
2-6	9
6-12	5
13-18	3
>18	1

weight:1

TABLE:6
Impact of Vadose Zone

Ranges	Ratings
Granetic Gneiss	5
Weathered Granetic Gneiss	6
Fractured Granetic Gneiss	7
Weathered Fractured Granetic Gneiss	8
Valley Fills, Recent Sand Deposits	9

WEIGHT:5

TABLE :7
Hydraulic Conductivity of Aquifer

Ranges	Ratings
1000G.P.D. /Feet Square	
<20	2
20-40	4
40-60	6
60-80	8
80-100	10

Weight: 3

USE OF G.I.S. IN ARRIVING AT DRASTIC INDEX:

DRASTIC parameter layers were put as polygon coverages. THE G.I.S. approach provides the decision-makers powerful tools for collecting, storing, retrieving, analyzing and displaying the parameter layers of data. The assigning weightages for DRASTIC parameter values in the accompanying text files is done. Finally the range of each DRASTIC parameter is multiplied with weights and a layer by addition resulted in a final number called DRASTIC index. DRASTIC INDEX ranges were ranged from less than 110 as first category up to seventh category which is having DRASTIC INDEX greater than 160. Thus pollution potential map with minute grid obtained.

The water quality parameters like P_H , TDS, EC, HCO_3 , Cl , SO_4 , Ca, Mg,Na, and SAR value for twenty two locations in Anekal taluk is assessed in laboratory. The water quality assessment is made for monsoon and non-monsoon. These are compared with the standard values and DRASTIC Indices. The DRASTIC Indices ranges are future classified as very high, moderate, low, and low ground water pollution vulnerability.

“DRASTIC INDEX MAP” or “POLLUTION POTENTIAL MAP” prepared using G.I.S. is compared with the manually prepared pollution potential map. The result show that variation between Drastic Index Map prepared using G.I.S. and Drastic Index Map prepared manually is quite small.

Assuming non-linearity between DRASTIC indices and water quality parameters, spearman rank correlation coefficient in calculated (Ref. Table9). The spearman rank correlation co-efficient lying between 0.85-0.90 show that water quality parameters and DRASTIC indices are positively correlated.

The pollution potential map or D.I map so prepared helps in classifying areas into different vulnerability classes. This classification helps in identifying the areas and villages, which are more vulnerable to ground water pollution.

TABLE:8
Table of Relative Valnerability to Ground Water Pollution:

Drastic Index	Valnerability
<110	Very less
>110<or=120	Less
>120<or=130	Moderate
>130<or=140	Moderately high
>140<or=150	High
>150<or=160	Very high

TABLE:9
Calculation of Spearman's Correlation Co-efficient to measure the degree of relation between Drastic Indices and Water Quality Parameters:

Water quality parameters	Spearman's Correlation Co-efficient
1. Total dissolved solids	0.8838
2. Chlorine	0.8520
3. Magnesium	0.8823
4. Calcium	0.8367
5. Electrical conductivity	0.880
6. Bicarbonate hardness	0.9014

CONCLUSSIONS:

The following conclusions can be drawn

- The DRASTIC methodology adopted for preparing pollution potential map can be used as a screening tool ascertain whether the area is more or less vulnerable to ground water pollution.
- DRASTIC methodology may be used for preventive purposes through the prioritization of areas where ground water quality protection is critical. The system may also be used to identify areas where special attention or protection efforts are warranted. The moderately, highly and very highly vulnerable areas identified in Anekal taluk for ground water pollution helps the planners and administrators to undertake some precautionary measures, and to conduct detailed study against ground water pollution.
- The pollution potential map prepared using DRASTIC methodology helps in prioritization of areas for monitoring purposes. In current study area, denser monitoring system might be installed in moderately, highly and very highly vulnerable areas.
- Th efficient allocation of resources for clean up and restoration has occurred is another more possible use of 'DRASTIC index map' or 'pollution potential map'.
- DRASTIC index map or pollution map prepared manually and computer assisted (G.I.S.) DRSASTIC index map yield comparable results.
- The pollution potential map thus prepared for Anekal Taluk helps the planners in broadly screening areas for waste disposal sites, industrial sites etc.

- The Drastic methodology also helps users to recommend the most hydrogeologically acceptable setting for municipal and waste disposal sites, and also helps users to direct resources for further evaluation.
- When the state or local administrator have limited resources available to devote to ground water protection, they are forced to focus these resources in certain areas. The pollution potential map helps identify areas, which are more or less vulnerable than others to contamination. This delineation allows administrators to direct their resources to those vulnerable areas most critical to ground water contamination, thereby making use of most of the limited resources available.

REFERENCE:

Linda, A., Bennet, T., Lehr, J.H. and G.Hackett (1987): DRASTIC – A standardized system for evaluation groundwater pollution potential using hydrogeologic settings. USEPA, Ada, Oklahoma, USA.