Use of Geographic Information System (GIS) for Ground Water Quality Mapping

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Abstract – Groundwater quality is one of the major environmental aspects, depending on the analysis and local distribution of it. If the use of underground management of groundwater resources in Wagholi not only reduces the quality, groundwater quality will be reduced. The purpose of this study is to provide an overview to evaluate ground water quality in the Wagholi area as a case study for frequent delivery using Geographic Information System (GIS) and Geostatistics algorithms.GIS, a tool which is used for collecting, analysing and showing the result spatial data is also used for investigating ground water quality information. The groundwater quality analysis has been made through the temperature (24°C-32°C), pH (6.5-8.5), TDS (110-280 mg/l), total alkalinity (118-230 mg/l), total hardness (230-610 mg/l), and chloride (23-85 mg/l) from the existing municipal and agricultural wells in Wagholi. Maps of each parameter were created using geostatistical (Kriging) approach. Experimental semi-differential appraisals were tested so that the best fit could be identified for the quality of the ten water samples for drinking quality and the best models would be selected. The basis of mean square error (MSE), root mean square error (RMSE), average standard error (ASE), and root mean square standardized error (RMSSE). Maps of 5 groundwater quality parameters were used to calculate the groundwater quality index (GWQI) map using the index method.GIS will be useful for monitoring and managing groundwaterpollution in the field of study. In view of the quality of water, the mapping code for the drinking water was done in the absence of good alternative sources and non-nutrient areas in the study area.

Keyword:- Ground water quality, water quality mapping, ArcGIS, spatial data, physical and chemical parameters.

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1. INTRODUCTION

In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than surface water. Groundwater can become contaminated either naturally or because of numerous types of human activities, residential, municipal, commercial, industrial, and agricultural activities can all affect groundwater quality GIS is an effective tool for groundwater quality mapping and essential for monitoring the environmental change detection. GIS has been used in the map classification of groundwater quality, based on correlating total dissolved solids (TDS) values with some aquifer characteristics or land use and land cover. Other studies have used GIS as a database system in order to prepare maps of water quality according to concentration values of different chemical constituents. In such studies, GIS is utilized to locate groundwater quality zones suitable for different usages such as irrigation and domestic. A GIS-based groundwater quality index method which synthesizes different available water quality data by indexing them numerically relative to the WHO standards. The use of GIS technology has greatly simplified the assessment of natural resources and environmental concerns, including groundwater.

GIS data represents real objects (such as roads, land use, elevation, trees, waterways, etc.) Withdigital data determining the mix. Real objects can be divided into two abstractions: discrete objects (e.g., a house) and continuous fields (such as rainfall amount, or elevations). Traditionally, there are two broad methods used to store data in a GIS for both kinds of abstractions mapping references: raster images and vector. Points, lines, and polygons are the stuff of mapped location attribute references. GIS thematic maps then are becoming more and more realistically visually descriptive of what they set out to show or determine.

1.1 Study Area:-

Wagholi is the fast developing village in Pune district, is situated at 18°31’13”N 73°51’24”E. at the mean sea level of 560 m. It spreads to an area of 826 sq km, and has a population of 56628. Average annual rainfall is about 420 mm and the mean daily temperatures for the same period range from 22°C in winter to over 43°C in summer. The study area is identified as chronically drought prone district of the Pune state. The City is served by piped potable water supply derived from Bhīmariver. There is no record of the number of private bore wells in the city. Dependency on groundwater is currently very high and it is preferred for drinking purpose by large number of the population. Because of the inadequacy and concern over quality of tap water, ground water will continue to be a significant source of domestic water supply for this city.

1.2 Geo-Statical analysis:

Generating a continuous surface used to represent a particular attribute is a key capability required in most Geographic Information System (GIS) applications. Perhaps the most commonly used surface type is a digital elevation model of terrain. These datasets are readily available at small scales for various parts of the world. However, just about any measurement taken at locations across a landscape, subsurface, or atmosphere can be used to generate a continuous surface. A major challenge facing most GIS modelers is to generate the most accurate surface possible from existing sample data as well as characterize the error and variability of the predicted surface.Understanding the quality of this data can greatly improve the utility and purpose of GIS modeling. This is the role of the Geostatistical Analyst toolbox.

It is provides two groups of interpolation techniques: deterministic and geostatistical. All methods rely on the similarity of nearby sample points to create the surface. Deterministic techniques use mathematical functions for interpolation. Geostatistics rely on both statistical and mathematical methods, which can be used to create surfaces and assess the uncertainty of the predictions.

In addition to providing various interpolation techniques, Geostatistical Analyst also provides many supporting tools. For example, prior to mapping, Exploratory Spatial Data Analysis (ESDA) tools can be used to assess the statistical properties of the data. Having explored the data, the user can then create a variety of output map types (for example, prediction, error of prediction, probability, and quantile) using many variants of kriging and co-kriging algorithms (for example, ordinary, simple, universal, indicator, probability, and disjunctive) and associated tools (for example, data transformation, declustering, and detrending).

1.3 CHEMICAL:

1.3.1 Chloride (Cl):

Chloride is minor constituent of the earth’s crust. Rain water contains less than 1 ppm Chloride. Chloride in drinking water originates from natural sources, sewage and industrial effluents, urban runoff containing de-icing salt, and saline intrusion (WHO, 1993). Its concentration in natural water is commonly less than 100mg/L unless the water is brackish or saline. The level of chloride taste perception is variable from person to person, but is generally of the order of 250 mg/L. Animals usually can drink water with much more concentration than humans can tolerate (300 to 400 mg/L). This could be due to sewage mixing and increased temperature and evapo- transpiration of water. The maximum contaminant level (MCL) for chloride in drinking water is given as 250 mg/L by the WHO standards has been classified as show in table no.1

1.3.2: Nitrate ($No3^-$):

The main source of nitrate in water is from atmosphere, legumes, plant debris and animal excreta (WHO, 1993). During recent years, the problem of groundwater contamination by nitrates has been studied thoroughly all over the world. The concentration in natural water is less than 10 mg/L. Water containing more than 100 mg/L is bitter to taste and causes physiological distress. Water in shallow wells containing more than 45 mg/L causes methemoglobinemia the so called blue baby syndrome in humans. Nitrate compounds are highly soluble and nitrate is taken out of natural water only by the activity of organisms or through evaporation and eventually reaches the groundwater. NH4+ from organic sources is converted to NO3- by oxidation. Concentrations of NO3- commonly reported for groundwater are not limited by solubility constraints. Because of this and because of its anionic form NO3- is very mobile in groundwater has been classified as show in table no.1.

1.3.3 Total Dissolved Solids (TDS):

The mineral constituents dissolved in water constitute dissolved solids. The concentration of dissolved solids in natural water is usually less than 500 mg/L, while water with more than 500 mg/L is undesirable for drinking and many industrial uses. Water with TDS less than 300 mg/L is desirable for dyeing of cloths and the manufacture of plastics, pulp paper, etc. It was reported that TDS value of 500 mg/L is the desirable limit and 2000 mg/L is the maximum permissible limit and that water containing more than 500 mg/L of TDS causes gastrointestinal irritation. High value of TDS influences the taste, hardness, and corrosive property of the water has been classified as show in table no.1.

1.3.4 Total Hardness:

Total Hardness of water is the capacity to neutralize soap and is mainly caused by carbonates and bicarbonates of calcium, magnesium. In study area, Maximum concentration in ground water is >1000 mg/l and Minimum concentration in ground water is <500 mg/l and the study area has been classified as show in table no.1

1.4 Criteria for Acceptability and Rejection in Water Quality:

In this stage, the criteria for suitability and non-suitability of the water samples were elucidated for analysis. This was performed based on the water quality standards stipulated by the WHO, and ISI. Ranks were assigned for each parameter depending on the respective tested values, as given below in following table number 1.

Table 1. Criteria For Acceptability And Rejection In Water Quality:

Sr. No.	Parameter	Rank	Criteria	Remark
1	Chloride (Cl)	1	<250	Desirable
		2	250-1000	Acceptable
		3	>1000	Not Acceptable
2	Nitrate (NO_3^-)	1	<45	Desirable
		2	45-100	Acceptable
		3	>100	Not Acceptable
3	TDS	1	<500	Desirable
		2	500-1000	Acceptable
		3	>1000	Not Acceptable
4	Total Hardness	1	<500	Desirable
		2	500-1000	Acceptable
		3	>1000	Not Acceptable

2. REVIEW OF LITERATURE

[1] Sandeep A., Vinit Kumar, Minakshi and Anshu Dhaka.

Water that is not specifically made for drinking but is not harmful for humans when used for food preparation is called safe water Seasonal variation on physiochemical parameters of groundwater in Jhansi city of Bundelkhand region, Uttar Pradesh was determined. Groundwater samples were taken from ten locations of city Ground water is water located beneath the ground surface in soil pore space and in the fractures of lithologic formation .The quality of ground water is the resultant of all the processes and reactions that act on the water from the moment it condensed in the atmosphere to the time it is discharged by a well or spring and varies from place to place and with the depth of the water table . Water fit for human consumption is called drinking water or “Portable water”.

[2] P. Balakrishnan, Abdul Saleem and N. D. Mallikarjun.

Spatial variations in ground water quality in the corporation area of Gulbarga City located in the northern part of Karnataka State, India, have been studied using geographic information system (GIS) technique. GIS, a tool which is used for storing, analyzing and displaying spatial data is also used for investigating ground water quality information. The ground water quality information maps of the entire study area have been prepared using GIS spatial interpolation technique for all the above parameters. The results obtained in this study and the spatial database established in GIS will be helpful for monitoring and managing ground water pollution in the study area. Mapping was coded for potable zones, in the absence of better alternate source and non-potable zones in the study area, in terms of water quality.

[3] Jagadish Kumar M, Sunitha V, Ramakrishna Reddy, Jayarami Reddy.

The spatial variations in ground water quality in central part of Proddatur town which is located in Andhra Pradesh state, India, have been studied using geographic information systems. The study area lies in the South western part of Y.S.R Kadapa District, Andhra Pradesh. For this study, water samples were collected from 43 of the open wells and bore wells which represent the entire municipality area. The samples were systematically analyzed for physio-chemical parameters such as pH, TH, Ca, Mg, Cl, F and alkalinity. It is observed that ground water quality of the study area is deteriorating beyond the limits and hence can affect human health adverselyif not properly mitigated. The maps were prepared using Spatial Analyst and Geostatistical Analyst extensions of ARC-GIS 9.3.

[4] Abdalkarim S. Gharbia, Salem S. Gharbia, Thaer Abushbak1, Hisham Wafi, Adnan Aish, Martina Zelenakova, Francesco Pilla.

Groundwater quality is a major environmental aspect which needs to be analyzed and managed depending on its spatial distribution. Utilization of insufficient management of groundwater resources in Gaza Strip, Palestine, produces not only a reduction in quantity but also deterioration in quality of groundwater. The aim of this study is to provide an overview for evaluation of groundwater quality in the Gaza Strip area as a case study for applying spatially distributed by using Geographic Information System (GIS) and geostatistical algorithms.

3. METHODOLOGY:-

In the present study, water samples are collected from three bores in the Wagholi region for the interpretation of data. The map of Wagholi is is collected from the GPS. From three different locations, samples are collected as per prescribed in water standards recommended by BIS.

The GPS coordinates will export on to the GIS platform for further analysis. Thewater samples were collected during December 2017. The analysis of ground water samples were performed according to the procedure of BIS, and necessary steps were followed to prevent contamination. The key parameters determined were: pH, Total hardness (TH), Total Dissolved solids (TDS), Chloride (Cl), Fluoride (F) and alkalinity. The well locations will be establish in the GIS environment and the results of the every parameter under study will added to the concerned well.

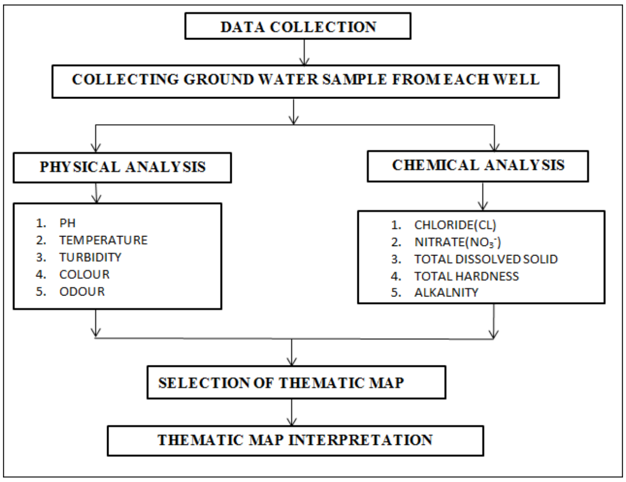

Figure No.02 Flow Chart Of The Method Adopted.

4. RESULTS AND CONCLUSIONS:

GIS utilities are shown with the analysis of analytical data collected for assessing and mapping the quality of groundwater. On the map of total dissolved solids, total alkalinity, total hardness, local distributors of chloride and nitrate, these conclusions are that these parameters are not uniformly limited in the entire study area.

Table2- Results of test of water sample with well location

Well No	Well Location	Easting	Northing	Cl- (mg/L)	NO3- (mg/L)	TH (mg/L)	TDS (mg/L)	ALKALINITY (mg/L)
1	Sayali hostel	735951.8	183531.6	310	105	1078.8	960	188
2	Jyoti Mess	735951.8	183533.3	185	45	864.9	750	208
3	kesnand phata	735941.9	183452.4	143	59	892.8	630	396
4	Wagheshwar Temple	735839.6	183453.6	182	31	362.7	750	180
5	Bhairavnath Hotel	735910.8	183453.6	247	67	1553.1	840	120
6	Nikhil Dairy	735858.1	183434.6	188	47	799.8	750	228
7	Bharat petrol pump	735914.7	183457.7	227	42	381.3	690	284
8	Bhagwant Complex	740005.6	183528.5	224	71	939.3	810	280
9	Neo City	740015.7	183524.1	204	34	1097.4	660	208
10	Hotel Dhanashree	740008.8	183523.4	184	44	985.8	900	160

5. DISCUSSION AND FUTURE SCOPE:

1. It provides the overview of ground water quality hence it will helps to determine whether the water quality is high or low.

2. To create a geo-spatial data base of pipe water supply same by mapping or drinking water sources including all components the same.

3. To determine the quality of water in its natural form in the state of Maharashtra.

4. To assess the impact of various activities performed by human beings upon the quality of water.

5. To deeply observe the water sources and to check for presence of specified hazardous or harmful substances in water.

6. To identify the contaminated sources, i.e. ground water based sources and other water bodies.

7. To obtain the reliable and useful data of water quality as a whole and to adopt corrective measure ensure safe supply of drinking water in rural areas.

8. To train the villagers for future drinking water quality monitoring.

REFERENCES:-

Abdalkarim S. Gharbia, Salem S. Gharbia, Thaer Abushbak, Hisham Wafi, Adnan Aish, Martina Zelenakova, Francesco Pilla. "Groundwater Quality Evaluation Using GIS Based Geostatistical Algorithms". Department of Civil, Structural and

Environmental Engineering, Trinity College, Dublin, Ireland.

Jagadish Kumar M, Sunitha V, Ramakrishna Reddy, Jayarami Reddy. "GIS based groundwater quality mapping in central part of Proddatur town, Y.S.R Kadapa district, Andhra Pradesh, India". Department of Civil Engineering YSR Engineering College of Yogi Vemana University, Proddatur-516 360.

P., Balakrishnan, Abdul Saleem and N.D., Mallikarjun (2011). Groundwater Quality Mapping using Geographic Information System (GIS): A Case Study of Gulbarga City, Karnataka, India. African Journal of Environmental Science and Technology.

Sandeep Arya, Vinit Kumar, Minakshi and Anshu Dhaka: "Assessment of underground water quality: A case study of Jhansi city, Uttar Pradesh, India". Institute of Environment& Development Studies, Bundelkhand University, Jhansi (U.P.) India.

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