Groundwater Quality Monitoring Sysetm using GIS

A Case Study for Madurai District

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Abstract -- Water is the basic element of social and economic infrastructure and it is essential for healthy society and sustainable development. Due to rapid increase in density of population, fast urbanization, industrialization and agricultural activities, demand for water is increasing day by day. As a result surface water and ground water level is decreasing continuously .Groundwater is the favorite alternative for surface water and it is facing threats due to anthropogenic activities in our country, which leads to degradation in quality. Hence, monitoring of ground water quality has become indispensable. It is not possible to monitor the quality of ground water in every place by conducting the survey and it also take large amount of time to perform various analysis. But by using GIS, analysis can be done by integrating multiple data and maps can be generated for separate parameters in year wise. Thus the GIS based models help in understanding yearly distribution and provide a database for future use. In this paper, ground water quality analysis was carried out for Madurai district, using GIS and the required data were collected from Public Work Department, Madurai. Query based analysis is performed to display suitable wells. The strategically analyzed results are presented in a GIS based maps.

Keywords: Groundwater quality, GIS, Query analysis.

I. INTRODUCTION

A. 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. Ground water is the water present beneath Earth's surface in soil pore spaces and in the fractures of rock formations. A unit of rock or an unconsolidated deposit is called an aquifer when it can yield a

usable quantity of water. The depth at which soil pore spaces or fractures and voids in rock become completely saturated with water is called the water table. Groundwater is recharged from, and eventually flows to, the surface naturally, natural discharge often occurs at springs and seeps, and can form oases or wetlands. Groundwater is also often withdrawn for agricultural, municipal, and industrial use by constructing and operating extraction wells. The study of the distribution and movement of groundwater is hydrogeology, also called groundwater hydrology. Groundwater is often cheaper, more convenient and less vulnerable to pollution than surface water. Therefore, it is commonly used for public water supplies. In Madurai region the groundwater could be spoiled due to waste disposal and Improper Agricultural practices. The groundwater quality in and around Madurai is potable. All the people used the groundwater for domestic purposes. The Agricultural communities utilized the groundwater for farming in their lands. But today the scenario is completely different. In many part of Madurai region, groundwater usage is obsolete. The number of monitoring wells within the corporation limit is very less. The water level is affected in these regions because of increased structures and bore wells. This in-turn will affect the water quality. Therefore water quality monitoring is necessary in Madurai district.

II. STUDY AREA & DATA USED

A. Study area

In this paper, we have chosen the study area as Madurai district which located in south India.

Geographic location of Madurai city

Longitude	77 °48'	and	78°35'	East
Latitude	10 °25'	and	9°65'	North



Fig 1.Study area

Taluks taken for case study are Melur, Vadipatti, Thirumangalam, Usalampati, Peraiyur, Madurai North and Madurai South.

B. Satellite data

Satellite data usually covers large area, hence it is used for spatial analysis purpose.

1) Imagery used:

The satellite data used in this paper is a raster data of Madurai area taken from the LANDSAT 7 satellite which is 30 m resolution.

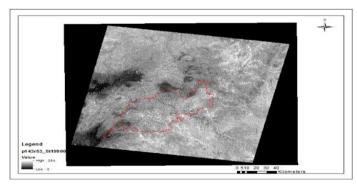


Fig. 2. LANDSAT 7

C. Water quality datasets

The Public Work Department (PWD) has water quality measure for 59 wells across the Madurai district. The water quality parameters are pH, Total Dissolved Solids (TDS), Turbidity, Nitrates (NO3), Fluoride (F), Total Hardness (TH), Alkalinity, Chlorides (Cl), Sodium (Na), Potassium (K), Sulphates (SO4), Chemical Oxygen Demand (COD).The work is carried out for monitoring the ground water quality which is suitable for drinking purpose. For the following parameters analysis was performed pH, Total Dissolved solids (TDS).Total Hardness (TD), Chloride (Cl).

D. Software used

ArcGIS is a suite consisting of a group of geographic information system (GIS) software products produced by ESRI. ArcMAP section provides an introduction and overview to ArcMap, which is the central application used in ArcGIS. ArcMap is where you display and explore the datasets for your study area, where you assign symbols, and where you create map layouts for printing or publication. ArcMap is aslo the application you use to create and edit datasets. ArcMap represents geographic information as a collection of layers and other elements in a map. Common map elements include the data frame containing map layers for a given extent plus a scale bar, north arrow, title, descriptive text and a symbol legend.

III. METHODOLOGY

A. Introduction

This study methodology comprises of different stages. The initial stage is the data collection stage where the water quality for the wells are obtained from PWD (Public Work Department) and the LANDSAT 7 satellite data of Madurai district is obtained. On other side, water quality parameter for Madurai district is collected from Public Work Department (PWD) of Madurai for the period of year 2002-2012. These data are integrated into GIS. Then the spatial variation for water quality parameters are identified using interpolation tool. By performing query analysis acceptable and not acceptable wells are identified. The flow chart for the methodology is shown below.

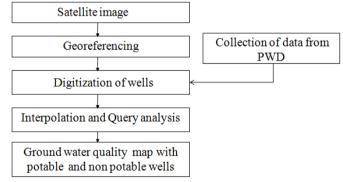


Fig.3. Methodology

B. Geo referencing

Geo-reference something means to define its existence in physical space i.e., establishing its location in terms of map projections. Different maps may use different projection systems. Geo referencing is done by collecting Ground Cross Point (GCP) and feeding it to satellite data

C. Digitization of wells

Digitization means marking the geographical element in the spatial data by creating shape files. The shape files can be point, line and polygon. The latitude and longitude value of the wells are imported as point features into the GIS. Each point in the satellite image represents the wells. This can be done by Add XY data option in the ArcGIS software. After importing it as point features, these points as saved as point shape file.

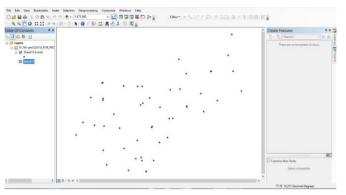


Fig. 4. Digitized wells

D. Interpolation

Interpolation is a procedure used to predict the value at the cell where there is a lack sampled point. It based on the principle of spatial autocorrelation or spatial dependency which measure degree of relationship/dependency between near distance object. Spatial auto correlation determines if values are interrelated .If values are interrelated, it determines the spatial pattern.

E. Query analysis

Query analysis is used to select the particular feature which satisfies the given condition. By developing the query related to the various conditions, the geographical area that satisfy those condition are projected. These queries are written in query builder.

IV. RESULTS AND DISCUSSION

A. Result

GIS is used to evaluate the quality of ground water in Madurai region. Spatial variation map of major water quality parameters like pH, TDS, Chloride, Total Hardness were prepared for Madurai district for pre monsoon and post monsoon. Based on these spatial variation maps of major water quality parameters and integrated ground water quality map of Madurai district was prepared using GIS. This integrated ground water quality map help us to know the existing ground water condition of the study area. This spatial variations are found by using interpolation tool.

By developing queries the highly suitable wells, acceptable wells, non acceptable wells are also found for the years between 2002-2012. With the help of this, graph for suitable wells are plotted in arcGIS in taluk wise. As the result no wells from Maduari north and Madurai south is suitable for drinking water. Although analyzed spatial variation for these wells in previous year, no acceptable wells from these taluks

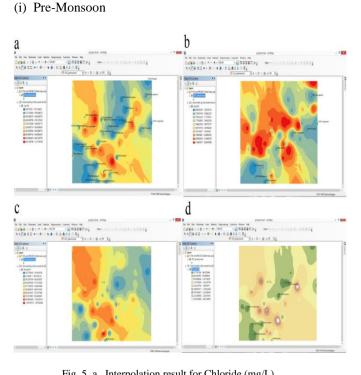


Fig. 5. a. Interpolation result for Chloride (mg/L) b. Interpolation result for pH c .Interpolation result for hardness (mg/L) d .Interpolation result for TDS (mg/L)

(ii) Post-Monsoon

В.

Interpolation Results

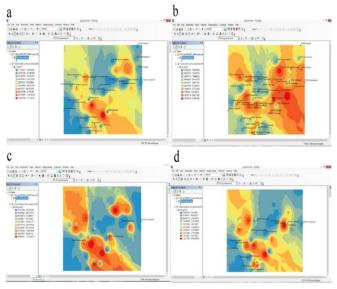


Fig 6 .a . Interpolation result for Chloride (mg/L) b. Interpolation result for pH c . Interpolation result for hardness (mg/L) d .Interpolation result for TDS (mg/L)

The above result shows the spatial distribution of Chloride, pH, Total hardness, TDS parameters for pre monsoon and post monsoon. The spatial pattern of water quality is varies in both pre monsoon and post monsoon. It displays the name of the wells which satisfies the drinking water quality condition. For pH, it should be between 6.5 and 8.5.For Chloride (Cl), it should be less than 120 mg/L .For Total Hardness (TH), it should be between 120 and 180 mg/L .For TDS, it should be less than 500 mg/L. Along with spatial distribution , the wells which satisfies these condition are displayed.

C. Query output

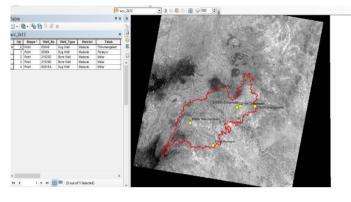


Fig.7. Acceptable wells

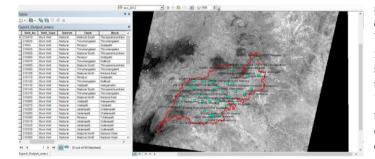


Fig.8. Not Acceptable wells

The above query result shows the acceptable wells and non- acceptable wells. The wells which satisfies all four conditions are acceptable wells and which doesn't satisfies are not acceptable wells.

D. Conclusion

Water is the prime requirement for the existence of life. Ground water is a precious resource of finite extent. Over the years increasing population urbanization and expansion in agriculture has head in the scientific exploitation of ground water creating a water stress condition. Madurai district is under threat due to the critical issues of environmental pollution and water scarcity problems. The ground water quality in Madurai district has been reduced due to pollution. Hence monitoring the ground water quality is indispensable. GIS technologies can provide appropriate platform for convergent analysis of large volume of multidisciplinary data and decision making for ground water studies can be effectively done. The GIS bare zoning of ground water quality map may be used as a guideline for predicting the ground water quality to new areas.

The study also finds that GIS is a good tool in monitoring ground water concentration in graphical

approaches. Furthermore the graphical display of GIS approaches makes the presentation of ground water and easier to understand as well as interesting to the uses compared with hard copy format. The final outcome can be used as new database or update previous ground water data at the area, ground water quality map also important for the purpose of urban planning for planner.

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