Groundwater Modeling Using Geospatial Technology

A Case Study on Coimbatore City

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Abstract:

Water, the Elixir of all living beings and a life supporting commodity is nowadays becoming scarce in the present world due to various anthropogenic activities. The various usage of water in different sectors like agricultural, domestic, and industries including recreational aspects increases rapidly and in turn groundwater gets depleted day by day and causes instability to the water table levels and affects the groundwater balance. In order to establish sustainable groundwater usage, groundwater modeling study has proved to be a potential tool in understanding aquifer response and thereby evolve appropriate management schemes. Before modeling groundwater, we need to find the total ups and downs in our study area, Coimbatore. Data Collection and SRTM data of Coimbatore gives contour lines of Coimbatore. From that contour lines, we can generate 3D Elevation, DEM file, Flow direction, Flow accumulation of Coimbatore using ArcGIS10.3. The ups and downs gives the data about groundwater zones. The study area is an industrial hub comprising of major industries paves the way for urbanization, that leads to increase in population, industrialization and commercialization, consequently has led to scarcity of water for drinking and other usage. As there is less perennial source, the people of Coimbatore ought to depend on groundwater for all water usage which necessitated for investigation of groundwater potential. This project highlights about groundwater modeling based on which necessary mitigatory measures can be taken for the conservation of groundwater.

Keywords—Data collection, SRTM data, Contour Lines,3D Elevation, DEM file, Flow direction, Flow accumulation, Groundwater Modeling

INTRODUCTION

1.1 Introduction

Ground water constitutes an important of water supply for various needs such as domestic, industrial and agriculture, while the surface water resources are inadequate to fulfill the water demand and productivity. Development of the nation is highly depending upon the groundwater resources.

Increasing population and social changes after adversely the ground water potential. In this context it is very much essential to study about natural resources by applying modern techniques. Keeping this in view the present study and attempt has made to select demarcate area ground water potential zones and improvement techniques using an integrated approach of Remote Sensing and GIS.

1.1.1 Groundwater

Ground water is one of the most important fresh water resources on earth. Apart from polar ice, almost 90% of available fresh water quantities on the earth are founded in hydrology systems. As the use of ground water becomes very important, we are using more water because the population constantly increasing. Ground water is more reliable source, which has been available in need quantities.

1.1.2 Groundwater Conditions

Ground water availability in the present area is mainly in hard shear and granitiod genesis rocks. The river is seasonally and the surface flow could be seen in peek monsoon only. The accuracy and movement of groundwater in granitiod genesis rocks is controlled by the secondary opening like joints, fractures and fissures present in them.

1.1.3 GIS and Hydrology

Geographic information system (GIS) has become a particularly useful and important tool in hydrology and to hydrologists in the scientific study and management of water resources. Climate change and greater demands on water resources require a more knowledge disposition of arguably one of our vital resources. As every hydrologist knows, water is constantly in motion. Because its occurrences various spatially and temporally throughout the hydrologic cycle, its study using GIS is especially practical. GIS system previously was mostly static in their geospatial representation of hydrologic features. Today GIS platforms have increasingly dynamic, narrowing the gap between historic data and current hydrologic reality.

1.2 Need for Remote Sensing And GIS

Geographical Information System (GIS) is computer based information system used to represent the region digitally and analyze the geographical features present on the earth surface and events that take place on it. GIS is the tool for storing, manipulating, retrieving and presenting both spatial and non-spatial data. GIS is an effective tool in the design and monitoring of groundwater development and its uses.

1.3 Aim And Objectives

The main aim of the present study is to demarcate the groundwater potential zones and improvement of groundwater in Coimbatore Union.

- To collect the ancillary data to analyse the remote sensing data for getting information that is related to groundwater Modeling.
- To prepare different thematic maps.
- To develop a GIS model to demarcating groundwater potential zones.
- To study various characteristics of potential.
- Integrate the zones and their trend.
- To support the decision make with people with efficient spatial database and information.
- To develop groundwater improvement techniques.

2.1 Geographical Location

The Coimbatore city located in between $10^{o}10'$ and $11^{o}30'$ North latitude and $76^{o}40'$ and $77^{o}30'$ East longitude. The town situated 411 meter above the mean sea level. The district covers an extent of 4723 Sq. km., of which, reserve forest comprising of 1052 Sq. km. And the forest cover of the district is about 22 percent of the district geographical area.

3.1 Data used

Satellite images are used for locating favorable groundwater potential areas. Landuse, geomorphologic and lineament maps are prepared with the help of satellite images.

3.2 Software Used

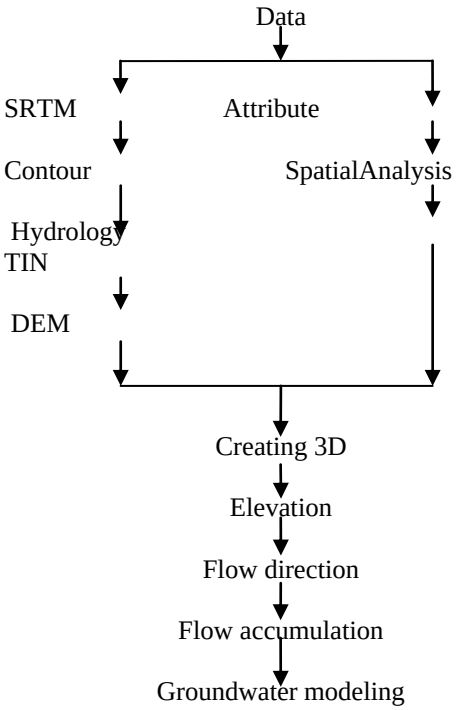
The packages have been used to perform the data processing and analyses are ArcGIS10.3 and MS office for data processing.

3.3 GIS Techniques

Geographic information system (GIS) is a technology, which enables the analysis of data related to entities, which have geographical spatial distribution. GIS helps in understanding spatial analysis and is therefore applicable to a wide variety of disciplines. For the present study GIS technique used to demarcate the analyzing groundwater potential zones of the study area.

3.4 Methodology

The methodology for the groundwater modeling is followed as per the flow chart.



3.4.1 Satellite data Analysis

The main task in this stage is to do an analysis and interpretation of satellite data, in order to produce basic maps such as structural and land use / land cover map in digital form. Basically, satellite data registration, correction and other image processing (such as classification and other GIS process).

3.5 Spatial Data Analysis

This stage will process all the input layers from stage 2 and 3 in order to extract a spatial features which are relevant to the groundwater zones. This phase includes various analysis such a table analysis and classification, polygon classification and weight calculation. Polygons in easch of the thematic layers were categorized depending on the recharge characteristics and suitable weightage were assigned.

3.6 Important Feature in Spatial Analysis
Boundary:

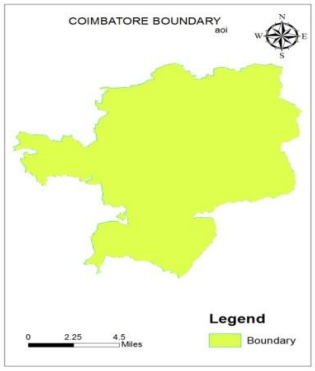


Fig 3.1 Boundary

Clip file**:**
In GIS, to clip is to overlay a polygon on one or more target features (layers) an extract from the target feature (or features) only the target feature data that lies within the area outlined by the clip polygon.

DEM file:

A digital elevation model (DEM) is a digital model or 3D representation of a terrain's surface commonly for a planet (including Earth), moon, or asteroid created from terrain elevation data.

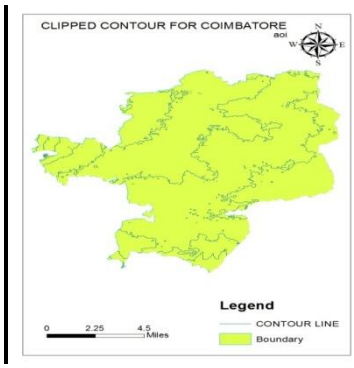


Fig 3.2 Contour Line

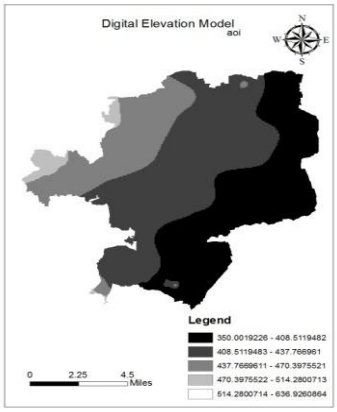


Fig 3.3 Digital Elevation Model

SRTM:

The Shuttle Radar Topography Mission(SRTM) is an international research effort that obtained digital elevation models on a near-global scale from 56° S to 60° N, to generate the most complete high-resolution digital topographic database of Earth prior to the release of the ASTER GDEM in2009

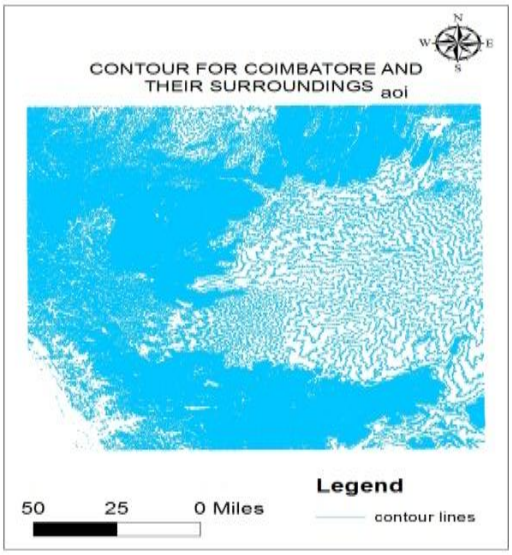


Fig 3.4 SRTM data

TIN file:

A triangulated irregular network (TIN) is a digital data structure used in a geographic information system (GIS) for the representation of a surface.

TIN is a vector-based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three-dimensional coordinates (*x*, *y*, and *z*) that are arranged in a network of nonoverlapping triangles.

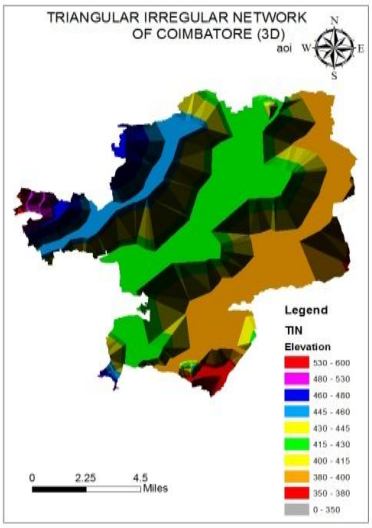


Fig 3.5 TIN File

Flow direction:

This tool takes a surface as input and outputs a raster showing the direction of flow out of each cell.

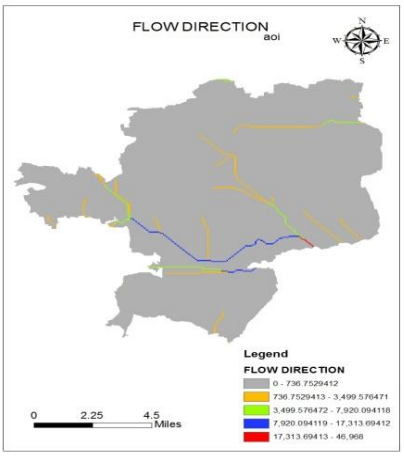


Fig 3.6 Flow direction

Flow Accumulation:

The Flow Accumulation tool calculatesaccumulated flow as the accumulated weight of all cells flowing into each down slope cell in the output raster. If no weight raster is provided, a weight of 1 is applied to each cell, and the value of cells in the output raster is the number of cells that flow into each cell.

- After analysis, the layers were classified by symbology in ArcGIS10.3
- Data frame information is covered into layout view for publication of map.
- Finally all cartographic elements has been inserted in all the layer.

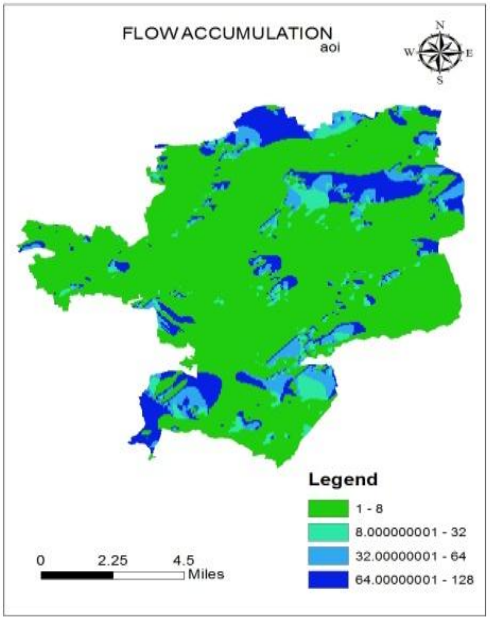


Fig 3.7 Flow Accumulation

CONCLUSION

The topographical features of the study area were analyzed using GIS.Due to less perennial&non-perennial rivers in the Coimbatore city,water scarce are planned to reduce using groundwater source. Streams are disconnected due to artificial slope regions caused by dumping waste materials. So the flow directions are getting changed in the Coimbatore city. We find the groundwater zones for Coimbatore city from the flow accumulation map generated from ArcGIS10.3. The flow accumulations also get varied in field area, when compared with map. So we can use thedata of groundwater zones in map for further surface leveling,flow direction and flow accumulation. Finally, we can provide groundwater management & improvement techniques in effective manner for present and future from this groundwater modeling.

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