Identification of Groundwater Recharge Potential Zones in Thiruverumbur block, Trichy district using GIS and Remote Sensing

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Abstract

Groundwater is deliberated as the desired source of water for facing the requirements of domestic, industrial and agricultural purposes. Due to its elongated residence time in the ground, low level of contamination, wide circulation, and accessibility within the reach of the end user. It is a precious resource of restricted extent. Moreover the prevailing wells are getting dried-up due to exhaustion of ground water table as the natural recharge is not sufficient. Groundwater recharge is a basic precondition for resourceful groundwater resource development and management, which is mainly significant for India with broadly predominant semi-arid and arid climate. Such precious groundwater can be used in a proper way hence accurate evaluation method is required. Suppose the natural recharge is not enough for the users, the authorized department have to meet with artificial recharge wherever it is necessary. For the process of constructing artificial recharge extents, the appropriate locations with hydro-geometric data will be required and also a suitable map showing such groundwater recharge potential zones for appropriate restore will be organized. Incorporated remote sensing and GIS can afford such appropriate platform for convergent analysis of various data sets for decision making in groundwater management and development. This paper proposed to recognize the groundwater recharge potential zones, to be used for better and enhanced groundwater resources. The various thematic layers deliberated are soil, land use and coverage, geomorphology, slope, drainage and contour density, which are organized using satellite imagery and other predictable data. Consequently, all thematic layers were combined using ArcGIS software to recognize the groundwater recharge potential zones and produce a map showing these groundwater recharge potential zones namely poor, moderate, good and excellent mainly based on the factors of the weights. The use of proposed methodology is demonstrated for a nominated study area Thiruverumbur block of Trichy district, Tamilnadu. This groundwater prospective information will be beneficial for effective identification of suitable locations for the process of extraction of groundwater.

Keywords: *Groundwater, Remote Sensing, GIS, recharge, thematic layers.*

I. INTRODUCTION

Groundwater recharge demonstrates the collection of water from the retarded area below the water table surface, composed with the connected flow from the water table within the drenched region. Groundwater recharge happens when water flows previous the groundwater level and penetrates into the drenched region. Field examinations help to describe the process of groundwater recharge and estimate the spatial-temporal difference in the study area. Nevertheless, these field examinations often focus on a single affecting factor or an indirect site-specific detail for groundwater recharge, reducing the reliability of the investigations. In recent times remote sensing and geographic information system technique is proved to be a cost effective and time saving tool to produce valuable data on geomorphology, geology, land use land cover, slope, lineament density, drainage density, etc. which helps to decipher groundwater recharge potential zones.

Groundwater is one of the most cherished natural resources, which maintains human health, commercial growth and environmental diversity. For the reason that its numerous characteristic qualities it has become an massively significant and reliable source of water supplies in all climatic regions including both urban and rural areas of developed and developing countries. Groundwater is a form of water inhabiting all the holes within a geographical stratum. Water bearing developments of the earth's crust act as outlets for transmission and as reservoirs for storing water. The groundwater existence in a geological formation and the choice for its exploitation chiefly depends on the formation of penetrability. Extraordinary liberation and steep slopes inform higher overflow, while geographical despairs increase penetration. An area of high drainage concentration also increases surface overflow associated to a low drainage density area. Surface water bodies like rivers, ponds, etc., can act as refresh zones. Over the years the developing significance of groundwater based on agrowing need has led to instinctive utilization of groundwater generating a water stress condition. This frightening situation calls for a cost and time operative practise for proper assessment of groundwater resources and management planning. A groundwater emerging program necessitates a large volume of data from numerous sources. Hence, identification and quantization of these structures are significant for producing a groundwater potential model of a study area. Presently groundwater is achieving more attention due to famine problem, rural water supply, irrigation project and low cost of improvement it needs. Notwithstanding the general research and technical progression, the study of groundwater has persisted more dangerous, as there is no direct method to expedite observation of water below the surface. Its existence or lack can only be contingent indirectly by learning the geological and surface restrictions. The different hydrogeological subjects can be used to classify the groundwater potential zone of the present area. The remote sensing and Geographic information system (GIS) tool can exposenovel path in water resource studies. Inquiry of remote sensing data along the survey of India (SOI) topographical sheets and security information with essential ground truth confirmations help in producing the starting position in format ion for groundwater targeting. Identification of groundwater existence location using remote sensing data is based on indirect exploration of directly noticeable terrain structures like geological structures, geomorphology, and their hydrologic features. Also features play important role in groundwater assessment in all type of terrain. Application of GIS and RS can also be deliberated for multi criteria exploration in resource assessment and hydro geomorphologic mapping for water resource management. The use of remote sensing and GIS tools to excerpt comprehensive drainage, slope and geomorphic structures in parts of Trichy District proposes suitable methods for groundwater potential zone studies.

II. RELATED WORK

MurugesanBagyaraj et al., (2012) have carried out groundwater study in the Dindigul district of kodaikanal hill, which is a mountainous terrain in the Western Ghats of Tamilnadu. Ground water potential zones have beendemarcated with the help of remote sensing and Geographical information (GIS) techniques. All thematic maps are generated using the resource sat (IRS P6 LISS IV MX) data and Inverse distance weight (IDW) model is used in GISdata to identify the groundwater potential of the study area. For the various geomorphic units, weight factors we reassigned based on their capability to store groundwater. Prabir Mukherjee et al., (2012) made an attempt to determine the groundwater potential zones within an arid region of Kachchh district, Gujarat. Thematic layers have been generated by using ancillary data and digital satellite image. The potential zones have been obtained by weighted overlay analysis, the ranking given for each individual parameter of each thematic map and weights were assigned according to their influence. Deepesh Machiwal et al., (2010) proposed a standard methodology to delineate groundwater potential zones using integrated RS, GIS and multi-criteria decision making (MCDM) techniques. The methodology is demonstrated by acase study in Udaipur district of Rajasthan, western India. Initially, ten thematic layers have been considered. Weights of the thematic layers and their features then normalized by using AHP (analytic hierarchy process) MCDM technique and eigenvector method. Finally, the selected thematic maps were integrated by weighted linear combination method I a GIS environment to generate a groundwater potential map. Cheng-Haw Lee et al., (2008) proposed that assessing the potential zone of groundwater recharge is extremely important for the protection of water quality and the management of groundwater systems. Further groundwater potential study was carried out in Taiwan with the help of remote sensing and the geographical information system. GIS, by integrating the five contributing factors: lithology, land cover/land use, lineaments, drainage, and slope. The weights of factors contributing to the groundwater recharge are derived using aerial photos, geology maps, a land use database, and field verification. Job in Thomas et al., (2011) determined groundwater potential zone in tropical river basin (Kerala, India) using remote sensing and GIS techniques. The information on geology, geomorphology, lineaments, slope and landuse/land cover was gathered from Landsat ETM + data and Survey of India (SOI) top sheets of scale 1:50,000 in addition, GIS platform was used for the integration of various themes. The composite map generated was further classified according to the spatial variation of the groundwater potential. The spatial variation of the potential indicates that groundwater occurrence is controlled by geology, structures, slope and landforms.

III. METHODOLOGY AND STUDY AREA

The study area forms a part of the Tamil Nadu which falls in between North Latitudes 10° 48'north and Longitude 78° 41' east. The study area (Topographic sheet No: 58 J) covering by Trichy district. The two major rivers of Trichy district are Cauvery River and its northern tributary coleroon river. The Cauvery Delta begins 16 kilometres (9.9 mi) west of the city. Thiruverumbur taluk is a taluk of Tiruchirappalli district of the Indian state of Tamil Nadu.

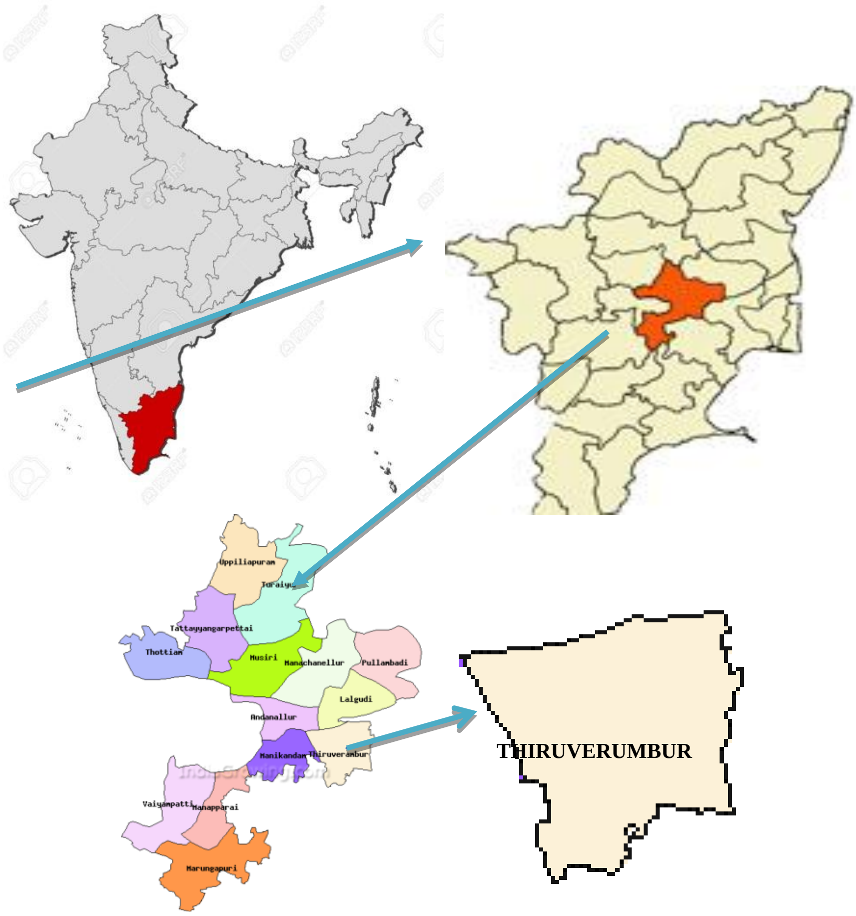

Fig.1: Location Map of Study Area

At First SOI top sheets are geocoded with the support of recognized ground control points (GCPs) on it. These geocoded top sheets are then mosaicked to generate the boundary map of study area with significant details, in the form of shape file using ArcGIS software. Snipping operation is carried out for attaining essential details for study area from the mosaicked toposheets. Using map to image registration technique provided by the Geomatica software, the IRS P6 LISSIII satellite image is geometrically resolved and recorded with SOI toposheets on 1:50000 scale. To develop the satellite imagery linear, equalization and root development techniques have been used for enhanced analysis of the geomorphologic, soil, structural and other information for planning of thematic maps from it. For digitization, editing, and topology creation of numerous structures of ArcGIS software has been used. The most significant work of consignment of rank and weight age to different structures/ themes and classes within theme was determined and then combination of multi-thematic figures is done to recognize groundwater potential zones and to produce map for the same. The groundwater recharge possible regions map, thus produced through remote sensing and GIS technique, with the zones viz. poor, moderate, good, better has been confirmed with field data to determine the validity of the study accompanied. All the thematic layers will overlap by using GIS to discover the final combined output of groundwater potential zones in the current study, geomorphology, slope, drainage density, Land use and land cover, geology and lineament density are deliberated for the identification of groundwater potential.

IV. ASPECTS PROMPTING GROUNDWATER

A. Slope

Slope is a significant feature for the identification of groundwater potential sectors. Continuous runoff is identified by the high degree of slope results and increased erosion rate with delicate recharge potential. Survey of India (toposheet 58 j/12) on 1:50,000 scales are used for raising the information on slopes. Hence the slope map is resultant from the digital elevation model. The zones having fewer slopes measured as good for groundwater storage, since less run off and high penetration .The areas having high slope cause reasonably high runoff and low penetration hence it is poor class for groundwater storage.

Table.1: Slope Gradient and Category

Class	Degree	Slope type
1	0-1	Poor
2	1-3	Moderate
3	3-6	Good
4	6-12	Excellent

B. Geomorphology

The process of identification and categorization of different landforms and structural structures in the study area was very significant from geomorphologic study point of view. Various features are constructive for existence and recharge of groundwater and are categorized in terms of groundwater recharge. Geomorphologic units are defined based on the image features such as tone, texture, shape, colour and suggestions. By intersecting the base map over the geocoded FCC image, the geomorphologic units and landforms, the essential information and physical development lines are integrated. Structural hills are perceived on southern east part of the study area, which are the linear or acute hills displaying definite trend lines and typically act as runoff zones due to its sloping topography. This demonstrates poor potentiality for groundwater existence and recharge. Foothill is a small portion of land which has reasonable high elevation likened to local surrounding land and having extensive slope due to which this also acts as runoff zone. This confirms poor potential for ground water existence and recharge.

Table.2: Grade of Geomorphological Unit

Sl.no	Geomorphological unit	Grade
1	Valley	Excellent
2	Submerged Pedi plain	Good
3	Pedi plain	Moderate
4	Foothill	Poor
5	Structured hill	Very poor

C. Land Use and Land Cover

Land use land cover aspects govern the existence of groundwater and also reasons for penetration for rejuvenate, with range of classes among itself. Remote sensing data and GIS practice afford trustworthy, precise baseline information for land use land cover planning, which plays dynamic role in defining land use pattern and changes therein on different times. The result of land use land cover is demonstrated either by decreasing runoff and expediting, or by deceiving water on their leaf.

Table.3: Land Use & Land Cover and its Ranking

Sl. no	Land use and land cover	Ranking
1	Agricultural land	Better
2	Urban built up land	Moderate
3	Rural built up land	Good
4	Waste land	poor

D. Types of Soil

Soil is one of the natural resources, which is a significant consideration to describe potential groundwater zones and it plays a vibrant role in groundwater recharge and encounters the basic requirements of all agricultural production. The study area is prominently consisting in the deltaic region of Tamilnadu and falls partly in red, black and alluvium soil. The soil is fine grained and is shaped of deposits brought down by rivers. It comprises humus and fine clay; hence, it is very fertile. These soils are deliberated as good for groundwater existence, holding and recharge prospective. Black soils are black in colour and are also known as black cotton soils. They are familiar for their capability to preserve moisture. These soils have adequate effect as a regulatory factor for groundwater existence and recharge potential for this study area. The areas partaking less slope considered well for groundwater storage, because less run off and high penetration.

Table.4: Soil types and ranking

Sl.no	Soil types	Ranking
1	Alluvial soil	Better
2	Black soil	Good
3	Red soil	Poor

V. RESULTS AND ANALYSIS

This study evaluated the hydrologic and geographic aspects of the watershed in study area and recognized the most important causes prompting ground water recharge potential, (i.e.) slope, geomorphology, soil, land use land cover and types of soil. Each aspect was observed and allotted an appropriate weight. Each recharge potential aspect may guide the groundwater recharge process to a different degree.

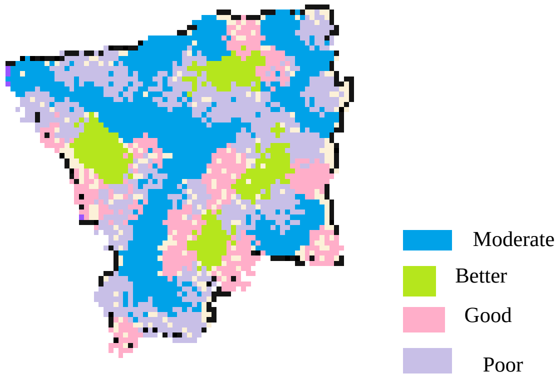

Fig.2: Groundwater Recharge Potential Zones Map

The various thematic maps were dispensed with different weightages of numerical value to derive groundwater recharge potential zones. On the basis of assigning values to these assumptions and fetching them into the function of spatial analyst for incorporation of these thematic maps, a map indicating groundwater recharge potential zones is obtained, which is shown as per fig. 2 above. This map has been categorized into four zones; they are better, good, moderate and poor from groundwater recharge potential point of view.

VI. CONCLUSION

The study formed a groundwater recharge potential map for study area. The outcomes specify that the most effective groundwater recharge potential zone is located on east-north part of the study area. Geographical information system and remote sensing has demonstrated to be dominant and cost effective method for defining groundwater potential in parts of Trichy district. Remote sensing and GIS is the significant tool for managing water resources. The numerous thematic layers such as geology, geomorphology, drainage, slope and types of soils are combined and dispensed proper values to prepare groundwater recharge zonation map. The groundwater recharge map demonstrates the mixture of moderate and highly favourable zone due to deep buried pediments and pediments. The recharge potential zones of the incorporated groundwater system map for the study area has been characterized into four types. They are better, good, moderate and poor zones on the basis of the ranks allocated to different structures of the thematic maps. From this study it is witnessed that remote sensing and GIS technique can be used efficiently to explain groundwater recharge potential zones map, which can be used for development in the groundwater recharge and allotment for the study and well-organized groundwater management for the progress of the society.

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