Role of Remote Sensing and GIS in Artificial Recharge of the Ground Water Aquifer in the Shanmuganadi sub watershed in the Cauvery River basin, Tiruchirappalli District, Tamil Nadu.

Muthukrishnan. A.[1] and Manjunatha. V.[2],

[1] Research Scholar
Department of Geography, School of Geosciences,
Bharathidasan University, Tiruchirappalli

Email: geomks16@yahoo.co.in

[2]M. Tech., in Geohydroinformatics,
Department of Geology, School of Geosciences,
Bharathidasan University, Tiruchirappalli

ABSTRACT

The importance of water is felt in all sectors as the demand and needs of the populace is growing. The present study area is basin of Shanmuganadi river lies between 10 ^{o}56' and 11^{o} 7'North latitude and between 78^{o}43' and 78 ^{o} 49'east longitude covered Trichirappalli district of Tamil Nadu. The basin area is demarcated from the survey of India Topographical maps were used, it covers an area about 93.25sq.km. The problem of the present study is a representative case of overexploitation of groundwater resources, leading to the continuous exhaustion of the grained as well as the ground water aquifers. The application of the increasingly and internationally accepted method of artificial recharge on the ground water aquifer was decided to be the most effective for the restoration of balance of the hydrogeological system. Deep knowledge of the details of the geological structure and the hydrogeological conditions of the area is necessary for the success of the method, whose planning has to be made based on the principles of environmental protection and sustainable development. Use of state-of-the-art technology and estimation of all the parameters involved, which are necessary, have been taken into account. Keeping this as an objective, to identify the suitable sites for artificial recharge zones an integrated approach of remote sensing and GIS techniques were adopted.

1. INTRODUCTION

Remote sensing and GIS are playing a rapidly increasing role in the field of hydrology and water resources development. Remote sensing provides multi-spectral, multi-temporal and multi-sensor data of the earth's surface (Choudhury, 1999). One of the greatest advantages of using remote sensing data for hydrological investigations and monitoring is its ability to generate information in spatial and temporal domain, which is very crucial for successful analysis, prediction and validation (Saraf, 1999). By the GIS technology provides suitable alternatives for efficient management of large and complex databases.

According to conserve to next generation people to consider going the present work is an attempt towards this direction. The study focuses on development of remote sensing and GIS based analysis and methodology in groundwater recharge studies in watershed. In order to demonstrate the Role of remote sensing and GIS based methodology, the basin of Shanmuganadi sub watershed in Cauvery river basin Tiruchirappalli district state of Tamil Nadu (India) has been taken for analysed.

2. AIM AND OBJECTIVES

The present study to conduct the remote sensing and GIS technology were to identify the suitable sites for artificial recharge zones an integrated approach of remote sensing and GIS approach techniques are followed by these objectives.

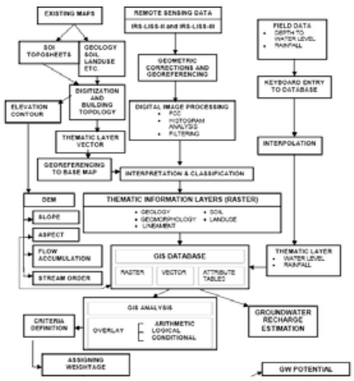
- To develop and test a role of remote sensing and GIS technique in groundwater recharge investigations in sub water shed.
- To delineate the groundwater potential zones in the sub water shed.
- To identify the interrelationships of recharge areas with geology, geomorphology, soils and structure of the sub water shed.
- To have qualitative and quantitative assessment of groundwater recharge.
- To suggest suitable sites and methods for artificial recharge to augment groundwater recharge with percolation pond in the sub water shed.

3. DATA USED

- Basin area is demarcated from the survey of India Topographical maps No's, 58J/9, 58J/13, 58I/16, and 58I/12 with scale of 1: 50 000.
- Groundwater data: Depth to water level of 4 wells (TWAD) and rainfall data.
- LANDSat TM data with spatial resolution 80m.

4. METHODOLOGY

The methodology adopted in the present study is presented schematically in flow chart 1 and described in the following steps:
a). in the initial stage of GIS spatial database development various analogue maps, were converted into raster to vector by using GIS MapInfo software.
b). the satellite data Landsat (2000) were classified using supervised classification technique.
c). the integrated analysis of multi-disciplinary data sets to construct composite information set to explain various queries in the spatial context.



Flow chart1. Work flow

5. STUDY AREA

The present study area is sub watershed of Shanmuganadi river lies between 10 °56' and 11° 7'North latitude and between 78°43' and 78 ° 49'east longitude covered Trichirappalli district of Tamil Nadu (fig.1). The sub watershed is bounded in the North part is covered a Taluk of Perambalur district, On the East by the taluk of Lalgudi, on the South by taluk of Manachanallur, and on the West by the Manachanallur taluk of Tiruchirappalli District. The revenue villages are 12 in Manachanallur and remaining 2 from Lalgudi taluk has been covered Shanmuganadhi sub watershed. The sub watershed most of the area is covered within the Manachanallur Taluk and remaining on the eastern part of the Lalgudi Taluk. The physiographic of the watershed can be divided into two major topographic regions viz. (a) the elevated areas in the north, which is an extension of Tiruchirappalli plain (b) the connecting tract in the middle and (c) the alluvial plains in the south.

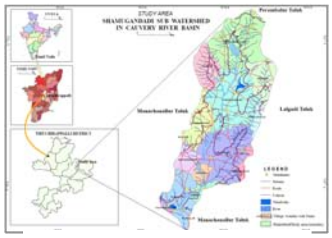


Fig1. Study area.

6. GEOMORPHOLOGY

The whole of the watershed forms an intermediate tract between Tiruchirappalli in the west and the alluvial plains in the east, presenting erosional of landform (fig.2). Moderate to gentle sloping land interspersed with isolated plains and pediments characterize the western part of the watershed. The southern part mainly consists of flood plains and alluvial fills. Pediment area is found in the south central part of the watershed. The northeastern part gullies are distributed along the streams.

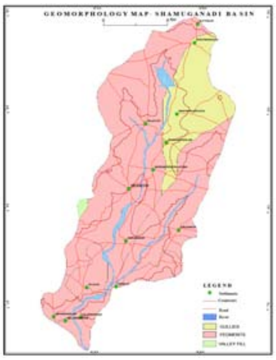


Fig 2. Geomorphology

7. SOILS

The soils of the watershed can be grouped under following types: (1) fine soil, (2) coarse soils, (3) fine loamy soils and, others (fig.3). Amongst the alluvial soils, the older alluvium is unaffected by floods and siltation and show profile development whereas the younger and newer alluvium are enriched by silt deposition during floods.

Fig 3. Soil

8. LANDUSE/LAND COVER

The land use / land cover of the study area is characterized by a mixture of forest cover, agricultural activities and wasteland besides water body and river sediment. These are readily interpretable from the satellite images. The western part of the watershed has very little forest cover as compared to the northern part. In the eastern part, large areas are covered by land with scrub or degraded forest. Agricultural lands are restricted along the Shamugandi River. The remaining areas are either fallow or wastelands. The western part has most of wastelands and fallow lands, and irregular patches of arable land occur in random fashion in the study area.

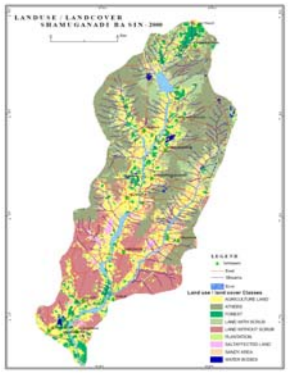


Fig 4. Land use/Land cover

9. GROUNDWATER RESOURCE EVALUATION

Quantitative assessment of groundwater recharge is an important issue in groundwater development. Estimation of groundwater recharge requires proper understanding of the recharge and discharge process and their interrelationship with geological, geomorphological, soil, land use / land cover and climatic factors. The Shamuganadi watershed groundwater level fluctuation and specific yield method is used for the quantitative estimate of groundwater recharge. Groundwater movement is controlled by natural boundaries. For analysis purpose the watershed boundary for groundwater recharge estimation. In technique of remote sensing and GIS to adapt the spatial distribution pattern are preparing an information layer for the whole of a watershed. Further, with help of remote sensing data to reduce the fieldwork. And the seasonal information is also required for estimation of recharge.

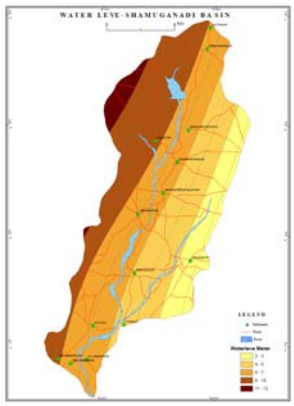


Fig 5. Water Level

Table 1. Water Level Pre Monsoon Water Level

Sl. No	Sample Well	Pre monsoon water level bgl
1	17	6.91
2	15	2.76
3	11	2.77
4	10	6.65
Total		19.09

Table 1a. Water Level Pre Monsoon Grid Deviation

Sl. No	Sample Well	Pre monsoon water level bgl	Grid deviation
1	17	6.91	2.114
2	15	2.76	-2.01
3	11	2.77	-2
4	10	6.65	1.88
Total		19.09	
Total in %		4.77	

Table 2. Water Level Post Monsoon Water Level

Sl. No	Sample Well	Pre monsoon water level bgl
1	17	7.4
2	15	5.35
3	11	3.7
4	10	9.22
Total		25.67
Total in %		6.41

Table 2a. Water Level Post Monsoon Grid Deviation

Sl. No	Sample Well	Pre monsoon water level bgl	Grid deviation
1	17	7.4	1
2	15	5.35	-1.05
3	11	3.7	-2.7
4	10	9.22	2.82
Total		25.67	
Total in %		6.41	

9. 1 Weighted Index Overlay Method for Groundwater Prospects

Weighted Index Overlay Analysis (WIOA) is a simple and straightforward method for a combined analysis of multi-class layers can be incorporated in the analysis to consideration of relative importance leads to a better representation of the actual ground situation. Considering to the hydro-geomorphic conditions of the study area weighted indexing has been adopted (table 5) to delineate groundwater prospective zones (fig.5) from the integration of geomorphology, geology, soils, land use / land cover and water level.

9.2 Artificial Recharge Zones

Artificial recharge is the process of augmenting the natural movement of surface water into underground formations by some artificial methods. Hence, groundwater cannot suffice the requirement for agriculture or drinking water. Thus, additional recharge by artificial methods becomes necessary to meet the water deficit. The present study successfully demonstrated an integrated remote sensing and GIS technique to suggest the suitable zone for future artificial recharge structures in the Shamuganadi watershed.

Table 5: To assign weightage factor on various parameters of Groundwater prospects & Artificial Recharge zones.

Sl. No	Parameter		For Artificial recharge	GWP zone
1		*Pediment*	2	2
	Geomorphology	*Valley fill*	2	2
		Gullies	4	4
2	**Geology**	*Charnockite*	2	2
		Biotite & Hornblende	1	1
		Cretaceous	2	2
3	**Soil**	*Fine*	2	2
		Fine Loamy	1	2
		Coarse Loamy	2	1
		Others	4	4
4	**Land use / Land cover**	*Forest*	3	4
		Water bodies	3	3
		Land with scrub	3	2
		Land without scrub	4	3
		Sandy area	4	3
		Salt affected land	3	3
5	**Water Level (P.M)**		<8	5
			7 – 8	4
			6 – 7	3
			5 -6	2
			Below 5	1

For analysis purpose the present study select the parameters such as geology, geomorphology, soils, and slope were ranked. The assigned rank values is lower indicates higher reliability of GWP/ artificial recharge zones. In weighted index overlay, the individual thematic layers and also their classes are assigned weightage (table 5) on the basis of their relative contribution towards the output. In the present study, weighted indexing method has been used to demarcate the suitability zones for artificial recharge sites (fig 6). The classes with higher values indicate the most favorable zones for artificial recharge structures. From the Figure 6: Potential zones for future artificial recharge sites to provide better groundwater recharge conditions.

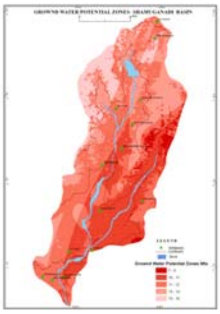


Fig 6. Potential Groundwater

12. CONCLUSION

The Groundwater recharge of the watershed is the result of an interaction between geomorphology and water level in the process of permanent adjustment between constraining properties. The total area of the basin is 95.60sqkm or 9560ha.

The high favorable condition to be occurring from the central to northern area covers of Siruganur to Kuttanur village and 28.9sqkm or 289ha is about 28.1 per cent of the total study area (fig.7). Followed by the moderately suitable area for recharge zone covers an area about 25.1sqkm or 251ha and 26.3 per cent of the total study area. Remaining the two zones is free from the limitation of the problem because of these areas naturally fall under the river tract. It covers an area in low 19.9sqkm/199ha or 20.9 per cent; 23.63sqkm/236ha it covers 24.7 per cent of the total study area. This alarming situation calls for a cost and time-effective technique for proper evaluation of groundwater resources and management planning.

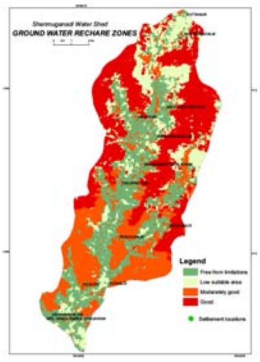


Fig 7. Artificial Recharge Zones

Generally, the recharge sites situated on a gentle slope and lower order streams are likely to provide artificial recharge to a larger area.

13. REFERENCES

Choudhury, P. R. 1999, integrated remote sensing and GIS techniques for groundwater studies in part of Betwa basin, Ph.D. Thesis (unpublished), Department of Earth Sciences, University of Roorkee, India.

CSME, 1993, Groundwater Resources Assessment and Management of the Bankura District, West Bengal, A report by Center for Study of Man and Environment, Calcutta, 26p.

Karanth, K. R., 1987, Ground water assessment, development and management, Tata McGraw Hill Publishing Company Ltd., New Delhi, 720p.

NBSS & LUP, 1992, The Soils of Bankura District (West Bengal) for Landuse Planning, Soils Bulletin NBSS Publication No.33, National Bureau of Soil Survey & Landuse Planning, Nagpur.

Saraf, A.K. and Jain, S.K., 1996, Integrated use of remote sensing and GIS methods for groundwater exploration in parts of Lalitpur District, U.P., International conference on Hydrology and Water Resources, New Delhi, Dec 20-22, 1993, 251-259.

Saraf, A. K. and Choudhury, P. R., 1998, Integrated Remote Sensing and GIS for Groundwater Exploration and Identification of artificial recharge sites, International Journal of Remote Sensing. 19(10), 1825-1841.

Srivastava, A., 1998, Landuse modeling in GIS for Dwarkeshwar Watershed, Bankura District, West Bengal, M. Tech. Dissertation report, University of Roorkee.

Thornthwaite, C. W. and Mather J. R., 1957, The water balance, Publ.Climatology, Lab. Climatology, Centeron, New Jersey, 8(1).

-----------x----------